Hind Rectifiers Limited

As per RDSO Spec. No. RDSO/2008/EL/SPEC/0071, Rev 5. Issued in June 2016

Indian Railways

IGBT-based 3-phase drive propulsion equipment for electric locomotives

Operation and Maintenance Manual

Revision 00
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N.B.: RDSO Spec. No. RDSO/2008/EL/SPEC/0071, Rev 5 is a technical specification for IGBT-based 3-phase drive propulsion equipment, specifically for WAG9/WAG9H/WAP7/WAP5 electric locomotives, issued by the Research Designs & Standards Organization (RDSO).

LIST OF ABBREVIATIONS

Sr No.	Abbreviations	Definition
1	IR	Indian Railways
2	CLW	Chittaranjan Locomotive Works
3	RDSO	Research Designs and Standards Organization
4	HIRECT	Hind Rectifiers Limited
5	IGBT	Insulated Gate Bipolar Transistor
6	SCR	Silicon Controlled Rectifier
7	PWM	Pulse width modulation
8	THD	Total harmonic distortion
9	DSP	Digital Signal Processor
10	CAN	Controller Area Network
11	CT	Current Transducer
12	IEC	International Electro technical Commission
13	UIC	International Union of Railways
14	IC	Integrated Circuits
15	VSI	Voltage Source Inverter
16	PCB	Printed Circuit Board
17	DIO	Digital Input Output
18	AC	Alternating Current
19	DC	Direct Current
20	MOV	Metal Oxide Varistors
21	BOM	Bill of Materials
22	SIV	Static converter
23	IVPS	Intermediate circuit Voltage Power Supply
24	EHVAC	Extra High Voltage AC
25	LVPS	Low Voltage Power Supply
26	HF	High Frequency
27	EMI	Electro Magnetic Interference
28	LED	Light Emitting Diode
29	NO	Normally Open
30	NC	Normally Closed

Contents

1. Chapter 1 -Safety Instructions

1.1. Introduction

This chapter outlines essential safety guidelines for the installation, operation, and maintenance of the traction converter. Before powering on the unit, please read the instructions carefully and keep this manual in a secure location.
The unit's design and safety features ensure safe installation and operation when used as intended and in accordance with this manual. However, certain risks may still exist if the safety instructions are not followed.

1.1.1 Qualified Personnel and Safety Responsibility

Only qualified and trained personnel are authorized to install, operate, maintain, troubleshoot, or repair the traction converter and its components. Non-compliance with this requirement will *void warranty claims* and limit Hind Rectifiers Ltd.'s liability.

Qualified personnel must have the technical training and experience to identify and manage potential hazards, and be familiar with relevant standards, safety regulations, and converter operating conditions. They should be authorized by safety officers to carry out required tasks (see IEC 60364 for detailed definitions).

All personnel must be trained in first-aid and emergency procedures. Unqualified personnel are strictly prohibited from working with high-voltage installations, as per DIN VDE 0105 and IEC 60364.

This manual is intended for the installation, commissioning, operations, and maintenance teams, all of whom should be experienced mechanics or electricians with specialized expertise.

1.2. Safety Symbols & Notes

Safety notes are given at the start of sections or within instructions where there may be a risk of injury to people or damage to the equipment. These safety notes are divided into five categories, each with its own symbol:

	**DANGER!** This symbol indicates an immediate and imminent hazard which will lead to serious bodily and life-threatening injuries.
	**WARNING!** This symbol indicates that failure to observe the necessary precaution can result in considerable material damage.

	**NOTE!** This symbol indicates a situation which could lead to damage, one in which either the product or objects in its immediate vicinity could be damaged and as attention to refer other information.
	**Attention!** Always ensure that the system is properly isolated from power sources before working on it. Follow all safety procedures to avoid electrical shock. **Warning: Residual Voltage in Capacitors** The converter remains charged even after input voltage is disconnected. Always wait at least 10 minutes for capacitor discharge before starting any work.
	**CAUTION!** This symbol indicates a potentially hazardous situation, which can lead to minor or moderate injury.
	**NOTE!** Observe precautions for handling of electrostatic devices and semiconductors inside of the unit. An ESD bracelet shall be used during handling of these items. Replaced items shall be placed inside of an antistatic bag.

1.3. Safety Labels

The traction converter is equipped with several safety labels designed to prevent improper handling that could result in injury to maintenance personnel or damage to the equipment. **[Labels to be displayed]**

1.4. Hazardous Areas

This chapter provides general safety instructions for working on the traction converter. Additional warnings and guidelines are included throughout the manual as needed. The list below highlights potential hazards inside the unit's cabinet. Always follow these safety points during maintenance, along with the general and specific instructions.

	**CAUTION!** Sharp edges inside the converter can cause injury. Always wear protective gloves when assembling or disassembling components and sub-assemblies to ensure your safety.
	**CAUTION!** The coolant is a 52% Antifogging N mixture. Follow safety instructions carefully, especially when replacing or disposing of the coolant. Always wear safety goggles. If the coolant comes in contact with your eyes, rinse immediately with water and seek medical attention.
	**CAUTION!** The converter contains components (coolant pipes, heat sink, bus bars, power cables, capacitors, water pump, charging and VLU resistors) that can exceed 40°C during operation. Always check their temperature before handling or performing maintenance. Wear protective gloves when assembling or disassembling components and sub-assemblies.

1.5. Safety Rules

The traction converter is a high-voltage unit as per industry standards. Before beginning any work on high-voltage systems, ensure the work area is prepared according to these five essential safety regulations:

1. **Isolate the system**
2. **Prevent reconnection**
3. **Ensure absence of voltage**
4. **Ground and short circuit**
5. **Protect against live parts**

If the unit covers need to be removed for maintenance or repair, following precautions must be observed:

Personnel must check the voltage LED indicator located above the earthing switch. During normal operation, this LED will either flash or remain on depending on the voltage. If the voltage is below 50V, the LED will turn off.

1.6. Safety Interlocks and Loco Grounding Technique

The traction converter features an interlocking system designed to ensure safety. The doors can only be opened once the power capacitors are fully discharged and the DC-link is grounded. The keys to access the converter doors are released following the procedure outlined in the section below.

1. Pantograph air supply isolating cock
2. Earthing switch of main circuit breaker
3. Key multiplier 1
4. Door lock auxiliary circuits, Block 1
5. Door lock auxiliary circuits, Block 2
6. Door lock auxiliary converter 1
7. Door lock auxiliary converter 2
8. Earthing switch on traction converter 1
9. Door lock on filter block

10. Earthing switch on traction converter 2
11. Key multiplier 2
12. Door lock, traction converter 1
13. Door lock, traction converter 1
14. Door lock, traction converter 1
15. Door lock, traction converter 2
16. Door lock, traction converter 2
17. Door lock, traction converter 2

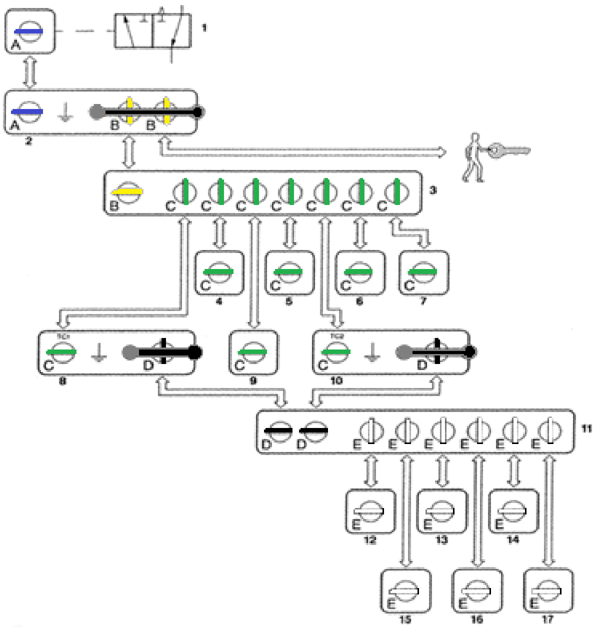


Fig 1.1: Key Inter Locking System

When repairing or testing electrical equipment (unless otherwise authorized), the locomotive's high-voltage system must be isolated using the Key Interlocking System. This system isolates and grounds various parts of the electrical system and includes five distinct key types: A, B, C, D and E, each with a unique color.

Key	Color	Qty.	Location
A	Blue	1	Pantograph air supply isolating cock
B	Yellow	2	Main circuit breaker earthing switch
C	Green	7	Key Multiplier No. 1
D	Black	2	1 on each traction converter earthing switch
E	White	6	Key multiplier No. 2

Follow these steps to safely earth and isolate the locomotive using the Key Interlocking System:

1) Shut down the locomotive first.
2) Turn off the air supply to the pantographs by activating Key A on the air supply isolating cock located on the brake frame (pneumatic panel). This exhausts the air, locking the pantograph in the lowered position.
3) Release Keys B by inserting and turning Key A in the main circuit breaker earthing switch. A bolt will release, unlocking the breaker arm. Move the arm to the EARTH position, then remove Key B.

4) One Key B should be held by the maintenance supervisor. The other is used in the key multiplier No. 1 to release Keys C. Use the seven Keys C for the following:
   - Unlocking the earthing switch on traction converter 1 & 2
   - Opening auxiliary circuit blocks 1 & 2
   - Opening auxiliary converters 1 & 2
   - Opening the filter block
5) Move the battery isolating switch to the "Off" position, if required.
6) Before operating the traction converter earthing switches, ensure the master switch on the driver's desk is in the "0" position and the "Control Circuits Locomotive" (112.1) circuit breaker is turned off (located in SB2). Check that the "Fault DC-Link Discharge" message is not displayed and the voltage indicator LED is off for at least 15 seconds. It takes about 5 to 10 in minutes to discharge the DC-Link capacitors completely. The LED should be flashing slower than once every 15 seconds before proceeding.
7) Release Keys D by inserting Key C into the traction converter earthing switch. This will release the bolt and unlock the switch arm. Move it to the EARTH position, then remove Key D.
8) Repeat the process for the second traction converter.
9) After removing both Keys D, use them to release Keys E from key multiplier No. 2, located in the machine room behind the cab. The six Keys E will unlock the door locks for both traction converters.

2. Chapter 2 -Propulsion System

2.1. Introduction

The **propulsion system** of an electric locomotive is crucial to its ability to convert electrical energy into mechanical power, enabling the locomotive to move and haul trains effectively.
In Indian Railways **(IR)**, conventional electric locomotives used DC traction motors directly connected to rectifiers. However, over the past two decades, there has been a shift towards AC traction motors, which offer better controllability, enhanced reliability, and are less prone to breakdowns and maintenance issues. As part of this evolution, **CLW** has been manufacturing three-phase electric locomotives, utilizing technology acquired from ADTRANZ/ABB. These locomotives were initially equipped with traction converters based on GTO (Gate Turn-Off) technology, but modern advancements in power electronics have favoured IGBT (Insulated Gate Bipolar Transistor) technology for traction applications due to its higher reliability and simpler gate drive circuit, which eliminates the need for complex snubber circuits. This shift is not only improving the operational efficiency of Indian Railways but also contributing to the sustainability and long-term performance of the nation's railway infrastructure.

Hind Rectifiers Ltd. has developed an indigenous IGBT-based 3-phase drive propulsion system for WAG9, WAG9H, and WAP7 electric locomotives.

The propulsion system of modern electric locomotives consists of several key modules, such as:

- **Vehicle Control Units (VCU1 & VCU2)** – Manage the operation and control of the locomotive.
- **IGBT-based Traction Converters (SR1 and SR2)** – These units convert AC from the overhead supply to drive the AC traction motors. (Type-**HR-TC2400AC)**
- **Auxiliary Converter Boxes (BUR1, BUR2, BUR3)** – Power auxiliary systems, including battery chargers. (Type-**V-3)**
- **Driver Display Units (DDU1 & DDU2)** – Provide real-time operational data to the driver.

The power schematic of the electric locomotive, with a focus on the Traction Converters, is illustrated in Fig 2.1. The primary winding of the transformer is connected to the 25 kV Overhead Electrification (OHE) voltage through a Vacuum Circuit Breaker (VCB). In instances when the transformer's primary windings are not connected to the OHE lines, an Earthing Switch (not shown in Fig 1.1, but connected in parallel to the VCB) is employed to safely ground both the transformer primary winding and the pantograph, ensuring optimal safety and operational efficiency.

No.	Description
1)	Pantograph
2)	Vacuum Circuit Breaker (VCB)
3)	Transformer
4)	Filter Winding with Contactor, Harmonic Filter (RC)
5)	Converter Contactor
6)	Pre-charging Contactor
7)	Pre-charging Resistor
8)	Line Converters
9)	100 Hz Resonant Filter Choke
10)	100 Hz Resonant Filter Capacitor
11)	DC Link Capacitor Bank
12)	Over voltage limiting Resistor
13)	Over voltage limiting IGBT with Freewheeling Diode
14)	Voltage Indicator Lamp
15)	Earthing Switch
16)	Earth fault Detection Resistors
17)	Earth fault Detection Voltage Sensor
18)	Motor Drive Converter (3 per Traction Converter)
19)	Traction Motors

Table 2.1: Components

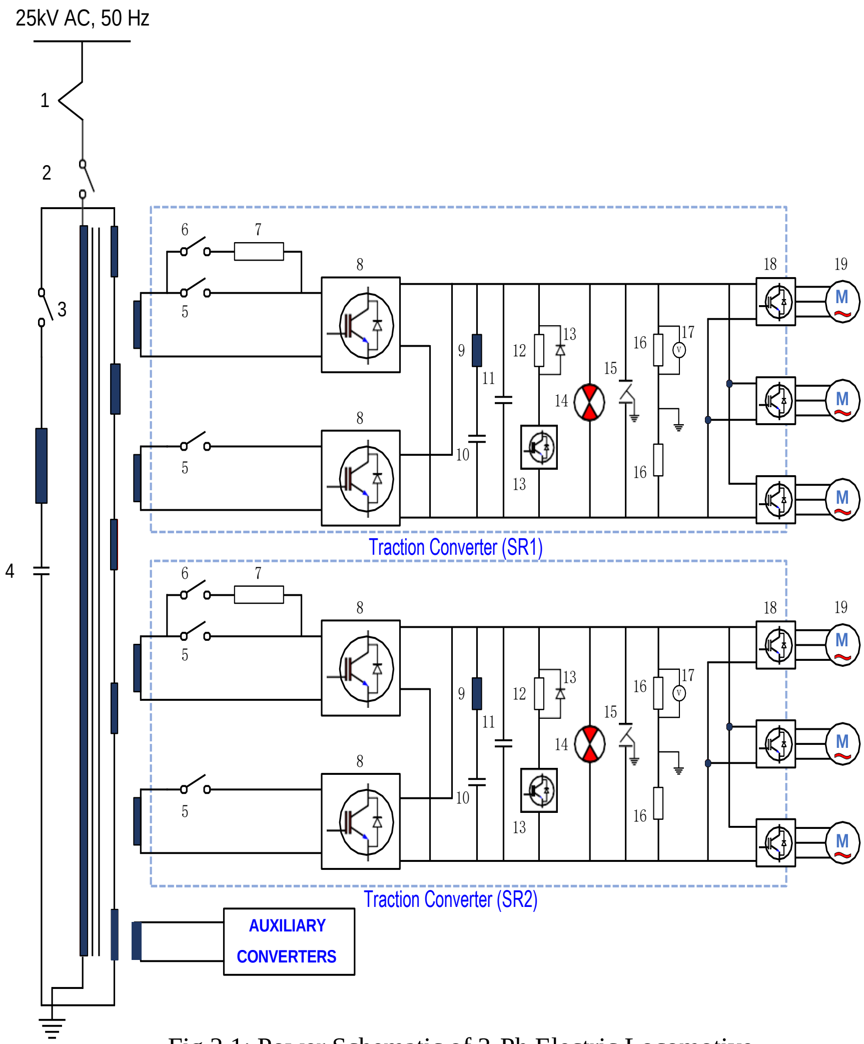


Fig 2.1: Power Schematic of 3-Ph Electric Locomotive

The electric locomotive (WAG9, WAG9H, WAP7) is powered by a sophisticated and well-coordinated set of components designed for optimal performance and efficiency. The transformer's secondary winding consists of four traction windings, each rated at 1449 kVA, one auxiliary converter winding rated at 334 kVA, one winding for filter rated at 400 kVA, and optionally, a hotel load winding (only in WAP7 locomotives) rated at 945 kVA. Additionally, the transformer houses two numbers series resonant filter choke **(SOD)** for SR converters and six number filter chokes (**GOD)** for auxiliary converters. This entire setup is oil-cooled through a dual oil pump system, supported by two blowers that circulate oil through the radiator for efficient cooling.

Each locomotive is equipped with two traction converters. Each converter is made up of two-line converters, a DC link, and three motor drive converters, all working together seamlessly to ensure smooth and efficient operation of the locomotive.

The **line converters** are connected in parallel, with the traction windings of the transformer's secondary side acting as the input interface for those converters. The outputs of those converters are then linked to form the DC link. Each line converter features a single-phase full-bridge rectifier, equipped with fully-controlled IGBTs. The DC link includes a 100 Hz resonant filter, an earthing switch, an earth leakage detection circuit, a DC link capacitor bank, and a Voltage Limiting Unit **(VLU)** for over-voltage protection of the DC link. The **motor drive converters** are equipped with 3-phase full-bridge inverters, also using IGBTs as active switching devices.

The traction converters (SR1 & SR2) are powered by their own dedicated microcontroller-based computer system**,** which not only control and protect the converters but also communicate with each other & Auxiliary converters and the VCU through MVB cables in serial communication.

For cooling of the traction converters, the traditional radiator section is retained and repurposed for water-based cooling of the traction converters, replacing the previous oil-based cooling system. In this setup, the oil pump for the traction converter is replaced with a water-based coolant pump to maintain the system's efficiency.

The **3x130 kVA Auxiliary Converters** are configured into three sub-systems, each rated at 130 kVA, named BUR1, BUR2, and BUR3. These are organized into two cubicles: BOX1 (for BUR1) and BOX2 (for BUR2, BUR3, and the Battery Charger). All the BURs are interconnected, and the load is distributed through 5 main contactors (52/1, 52/2, 52/3, 52/4, and 52/5) and 4 auxiliary contactors (52.4/1, 52.4/2, 52.5/1, and 52.5/2). The changeover logic, used in the event of BUR isolation, is maintained with the same contactors to ensure seamless transitions. The air-cooling mechanism for these units, provided by machine room blowers, remains unchanged. Each auxiliary converter is equipped with its own control computer and electronics, which handle protection, control, and communication with the vehicle control electronics via MBV serial communication to the SR and VCU.

Finally, the **Vehicle Control Units (VCUs)**, located in two cabinets (SB1 and SB2), communicate with each other and other subsystems (including both Traction Converters, Auxiliary Converters, WTB for multiple-unit communication, and DDUs) via MVB serial communication. The Driver Display Unit (DDU) provides vital information and fault status updates for the various equipment within the locomotive, ensuring smooth and efficient operation.
This comprehensive system architecture ensures that the electric locomotive operates with maximum efficiency, reliability, and ease of maintenance.

2.2. Subsystems Interconnection & Communication

The MVB-wired, serial communication system integrated into the Hind Rectifiers Ltd. made propulsion system of the WAG9, WAG9H, and WAP7 locomotives ensures efficient and reliable data exchange in between subsystems onboard, using the Train Communication Network (TCN) as the communication architecture. The MVB protocol, which stands for Multifunction Vehicle Bus, facilitates high-speed serial data transfer between critical components such as Traction Converters, Auxiliary Converters, Vehicle Control Units (VCUs), Driver Display Units (DDUs). It supports multiple-unit communication (WTB), allowing synchronized operation when multiple locomotives are in a train. The system also interfaces with the Driver Display Unit (DDU), providing the operator with real-time information on system health, fault statuses, and operational parameters, ensuring safe and efficient locomotive operation. Additionally, the MVB system facilitates continuous fault monitoring, diagnostics, and data transfer, enabling quick troubleshooting and enhancing overall locomotive performance. Full connections are shown in Fig. 2.2 below.

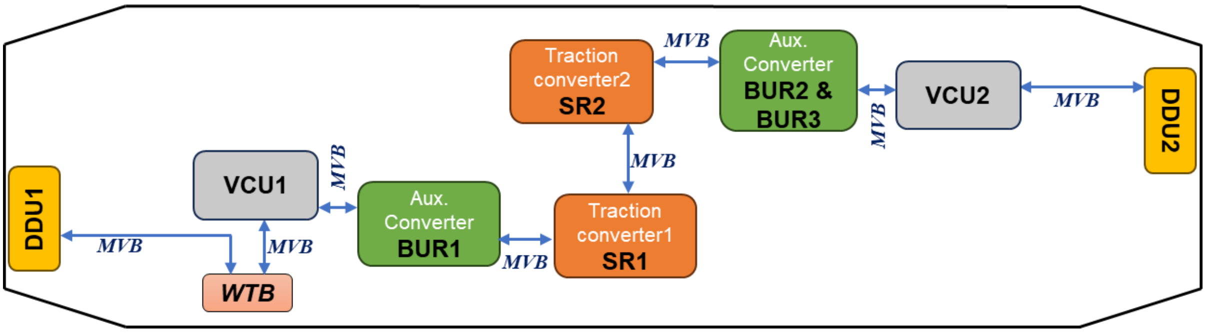


Fig 2.2: Architecture of interconnection & communication in-between subsystems

3. Chapter 3 -Vehicle Control Unit I & II

3.1. Introduction

Indian Railways' 3-phase electric locomotives (WAG9, WAG9H, WAP7, and WAP5) use a distributed architecture for control and communication. The control system of the vehicle consists of several bus stations responsible for managing its functions:

- Vehicle Control Unit (HRLP6000 VCU)
- Drive Inverter & Line Converter Control Unit (SR/DCU)
- Auxiliary Converter (AUX-V3)
- Driver Display Unit (DDU)

The propulsion system has been indigenously developed by Hind Rectifiers Limited, utilizing state-of-the-art hardware and software. The Vehicle Control Unit complies with the IEC-61375 standard for functional equivalence.

The HRLP6000 VCU is provided with two Vehicle Control Units (VCU1 and VCU2), located in the SB1 and SB2 cubicles, respectively. Each VCU consists of the following PCBs:

- Main Processor Card (HRT104)
- Digital Input and Output Card (HRT102)
- Analog Input and Output Card (HRT103)
- Power Supply Card (HRT105)
- Temperature Card (HRT107)
- Motherboard/Backplane Card (HRT106)

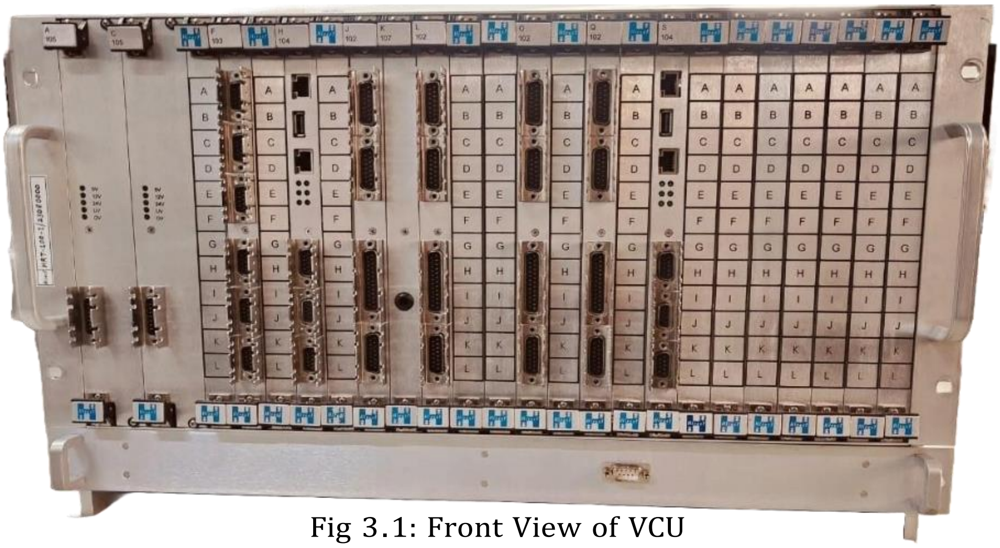


Fig 3.1: Front View of VCU

By default, VCU1 operates in the master mode, while VCU2 operates in the slave mode. The CPU inside the master-VCU controls the overall system operation, based on various digital and analog inputs, commands received from the loco pilot, and the monitoring conditions of various equipment. The master-VCU is responsible for the overall control of the locomotive and interfaces intelligently via the MVB network (EMD) with various systems and nodes on the locomotive, such as AUX1, AUX2, AUX3, DCU1, DCU2, DDU1, and DDU2. It is also responsible for Multiple Unit (MU) operation via the Wire Train Bus (WTB). All PCBs are housed in independent enclosures (6Ux104T), and the complete VCU unit is enclosed in a rugged MS (Mild Steel) enclosure with a heat exchanger. The design is based on a motherboard, with proper polarization of backplane connectors to prevent accidental insertion of cards in the wrong position. Furthermore, external connectors are properly coded to avoid connector swaps.

3.2. Architecture of Communication system

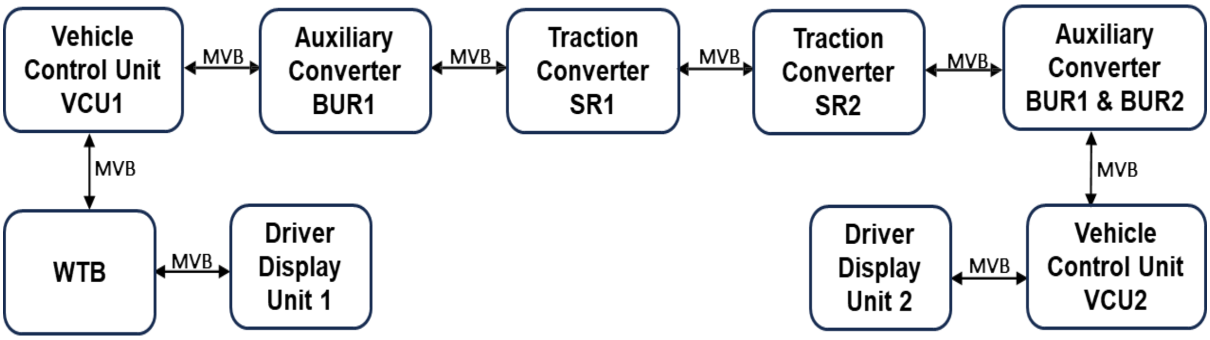


Fig 3.2: Architecture of control & communication

3.3. Vehicle Control functions

The Vehicle Control Unit (VCU) is designed to handle both input and output signals, and it processes them accordingly to manage the locomotive's functions.

The VCU consists of two processor cards along with their associated peripheral devices. Communication between the processors within a single VCU occurs via a **CAN bus**, while communication between the processors of different nodes is facilitated through the **Multifunctional Vehicle Bus (MVB EMD)**.

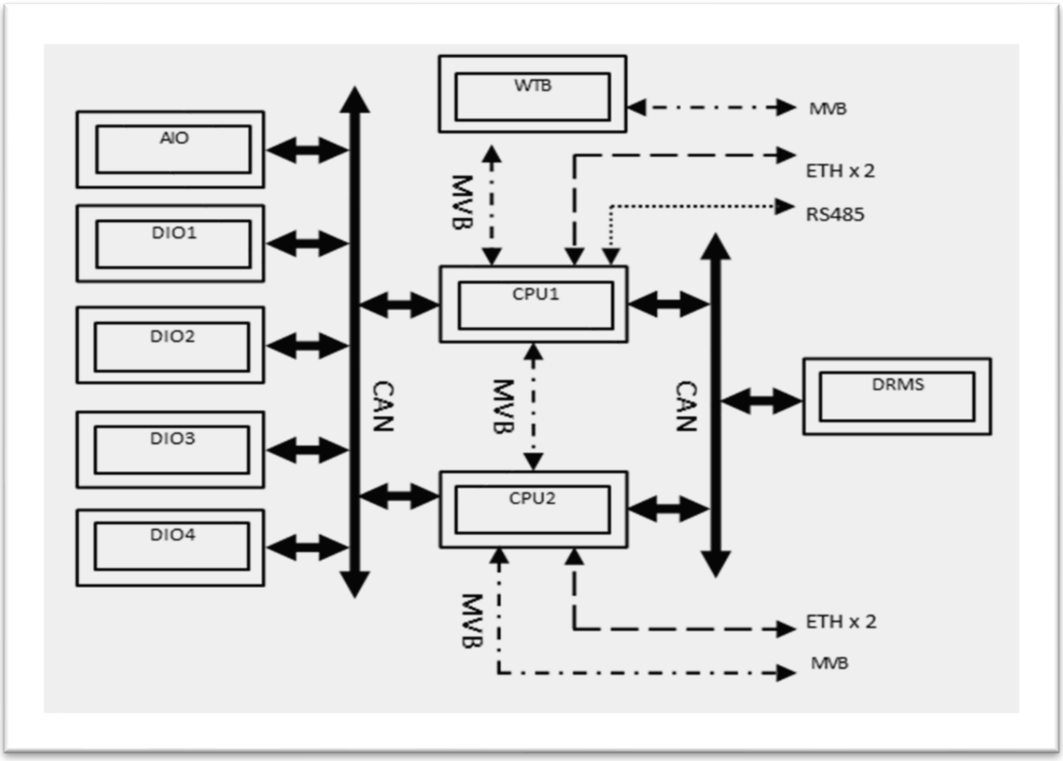


Fig 3.3: VCU1 Architecture

Each Vehicle Control Unit (VCU) is equipped with spare slots, allowing for future upgrades in processing power or peripheral expansion to meet evolving requirements.

The primary functions of the VCU are configured across two Application Processors: **Application Processor 1** and **Application Processor 2**. Initially, **Application Processor 2** operates as a redundant unit to **Application Processor 1** and handles the processing of all analog and digital I/O signals.

Application Processor (CPU) 1:

- **System-wide control** with integrated data logging module.
- **Driver's Cab control**.
- **Low Voltage Block control**.
- **Auxiliary Block control**.
- **Pneumatic Block control**.
-

Application Processor (CPU) 2:

- **Driver's Cab control**.
- **Low Voltage Block control**.
- **Auxiliary Block control**.
- **Pneumatic Block control**.

3.4. Redundancy Concept in Vehicle Control Unit (VCU)

To eliminate the risk of single points of failure in the Bus station of the Vehicle Control Unit (VCU) that could lead to vehicle malfunction, each VCU is equipped with a redundant application processor. This processor is capable of processing both analog and digital signals, as well as redundant signals, and ensures that all signals are made available on the MVB bus in the event of a failure of the main application processor. This configuration guarantees full cab redundancy, even if one application processor fails in the VCU of an adjacent cab.

The following measures are implemented to ensure vehicle availability:

- ➢ Read important signals in separate ports.
- ➢ Output important signals from separate ports.
- ➢ Read redundant signals on separate Application processor
- ➢ Output redundant signals on separate Application processor
- ➢ Redundant application processor to process signals of I/O ports.
- ➢ Redundant power supply for each VCU
- ➢ Redundant coupling of the Bus stations VCU 1 & VCU 2 by means of MVB.

VCU1		VCU2		DRIVING POSSIBILITY
Processor-1	**Processor-2**	**Processor-1**	**Processor-2**	
Healthy	Healthy	Healthy	Healthy	**Yes**
Healthy	Faulty	Healthy	Faulty	**Yes**
Faulty	Healthy	Faulty	Healthy	**Yes**
Healthy	Healthy	Faulty	Healthy	**Yes**
Healthy	Healthy	Healthy	Faulty	**Yes**
Faulty	Healthy	Healthy	Healthy	**Yes**
Healthy	Faulty	Healthy	Healthy	**Yes**
Faulty	Faulty	Healthy	Healthy	**No**
Healthy	Healthy	Faulty	Faulty	**No**

These measures ensure that the VCU remains operational and reliable, minimizing the risk of vehicle failure due to component malfunctions.

3.5. Rack Allocation

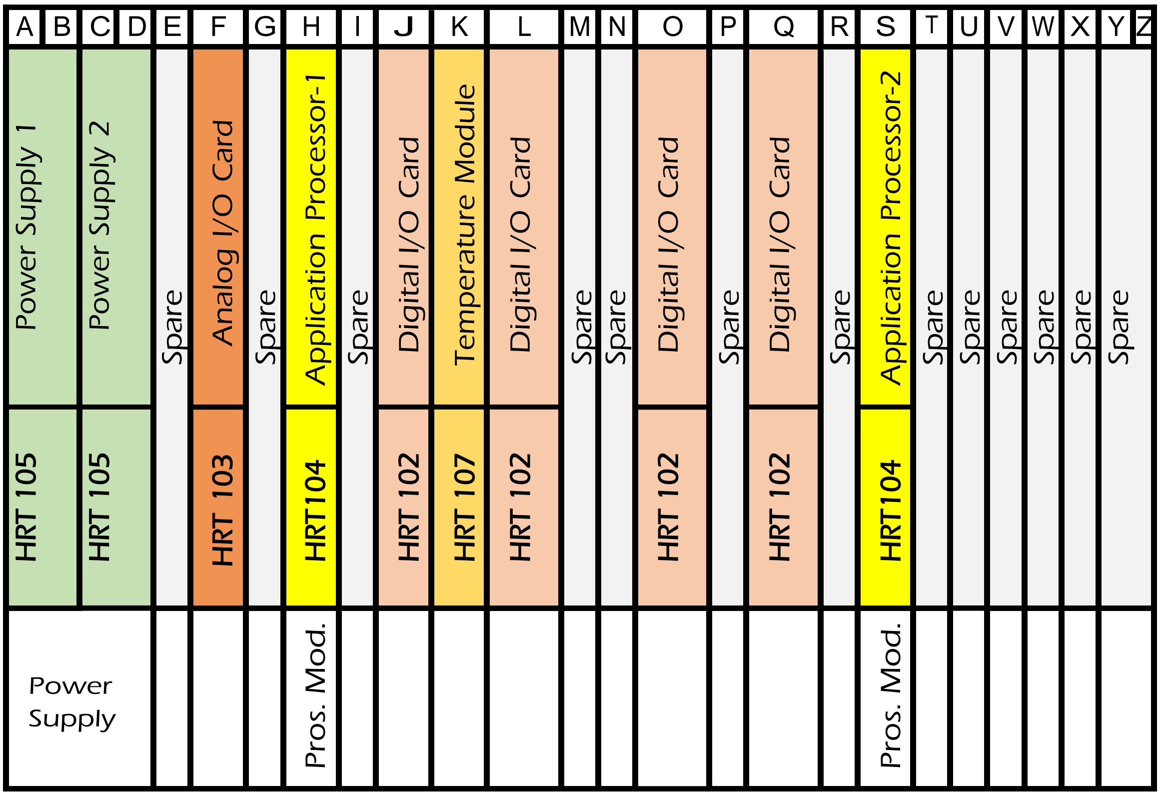


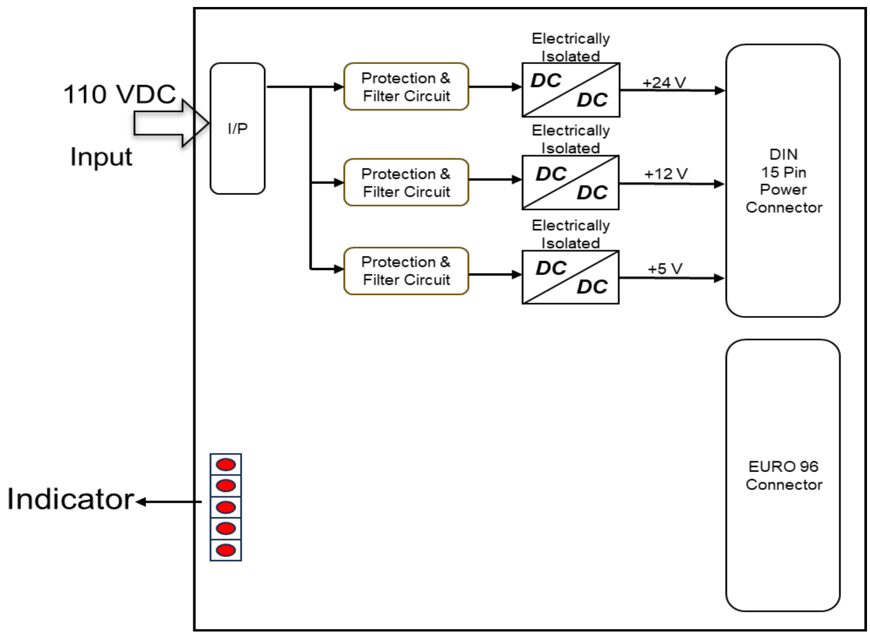
Fig 3.4: Rack allocation Bus station Vehicle Control Unit

The Rack allocation for the bus stations VCU 1 & VCU 2 are consists of following modules where more than one module of same type is used.

Module	***Description***	***Quantity***
HRT 105	Power Supply (110V DC input) Card	2 No.
HRT 103	Analog Input and Output Card	1 No.
HRT 102	Digital Input and Output Card	4 No.
HRT 104	Application Processor Card	2 No.
HRT 107	Temperature Card	1 No.
HRT 106	Backplane Card	1 No.
Fan Assembly	(A set of Fan-3 no’s)	1 Set

3.5.1 HRT105- Power Supply Module

The Bus Stations VCU 1 & VCU 2 are directly supplied from vehicle battery(110V). For the separate supply of application processors or the redundant supply of the individual modules, two power supplies for each rack are used. All the output voltages and input voltage are monitored for over and under voltage The Input voltage is 110V having a tolerance of +25% -30%. DC outputs of 5V, +12V and 24V.



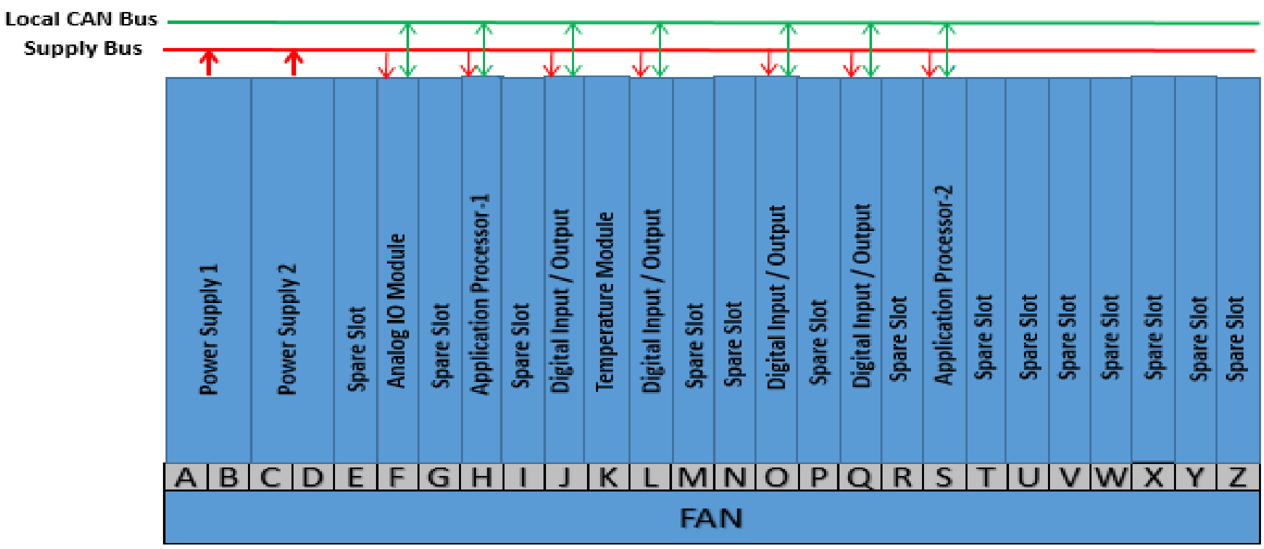


Fig 3.6: Concept of Power Supply Redundancy

Technical data

No. of Devices per Bus Station	2
Device Slot	A (Power Supply 1), C (Power Supply 2)
Front Connector Slot	1
Back Plane Connector type	For Output Supply: DIN Power (15 Pin) For Signal: EURO 96 Pin
Nominal Input Voltage	110 VDC +25% -30%
Nominal Output Voltage	+5V ± 5% +12V ± 5% +24V ± 5%
Power Consumption	< 61W
Under Voltage	Below 77 V
Reaction	Should the input Voltage Below 77 V, the power fail Signal is activated.
Monitoring of Output Voltage	All output Voltages are monitored to assure their adherence to defined tolerance range.
Reaction	Should one of output voltages leave the defined tolerance range, the respective output voltage Signal error is activated.
Hardware Self-test Capacity	No

Major Components of HRT 105

Description	**Part No.**	**Make**
DC DC converter 110V/5V 50W	URF1D05QB-50WR3	MORNSUN
DC DC converter 110V/12V 50W	URF1D12QB-50WR3	MORNSUN
DC DC converter 110V/24V 6W	URB1D24YMD-6WR3	MORNSUN
Power connector	09061152911222/ 51590291523660LF	HARTING/ Amphenol FCI
Euro Connector	86093967113745ELF/ 09031966921222	Amphenol FCI/ Harting
D-sub 15 Pin male Connector	D15P33E4GX00LF	Amphenol FCI

Fig 3.7: Power Supply Card Image (HRT 105)

*Image for representative purpose only

3.5.2 HRT103- Analog Input Output Module

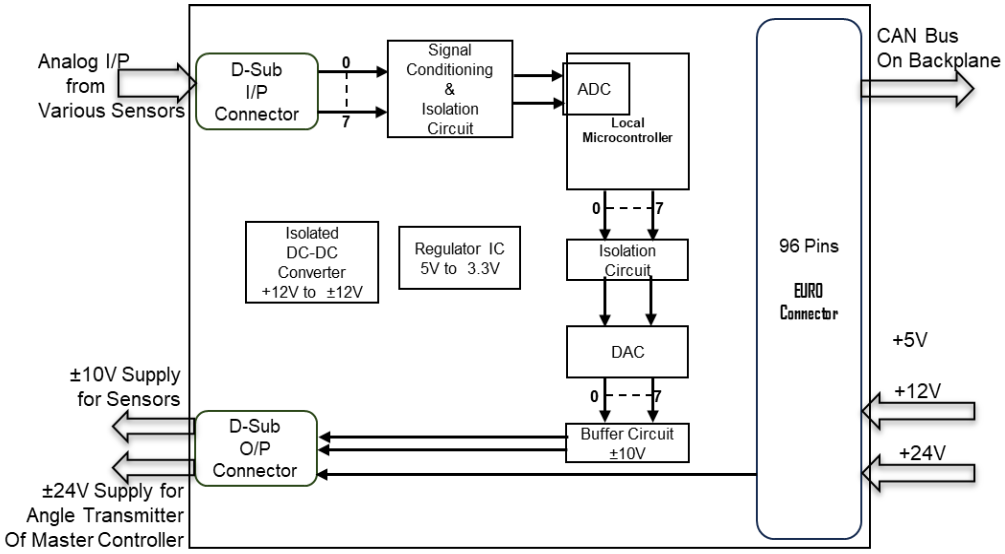


Fig 3.8: Analog Input Output Card Block Diagram

The Analog Input/Output card is a data acquisition module featuring 8 no analog input channels and 8 no analog output channels. Both the input and output are optically isolated from the external interface. It is installed in the slot F of the VCU and is designed to receive analog inputs such as 4-20mA current signals and voltages up to 10V from various sensors. It provides analog output voltages ranging from ±10V.The card uses a 12-bit Analog-to-Digital Converter (ADC) to sample data from the 8 input channels. The microcontroller processes the sampled data and transmits it to the CPU board through the CAN interface. This data is continuously available on the CAN bus for further processing by the main CPU board. For analog output, the card employs a 16-bit Digital-to-Analog Converter (DAC) with 8 output channels. The DAC output is passed through an amplifier for offset correction and gain adjustment before being routed to the output connector and subsequently to the load. The DAC receives control instructions and data from the local microcontroller via an isolated SPI interface.

Technical Data:

Number of Devices per Bus Station	1					
Device Slot	F					
Front Connector Slot	A	C	E	G	I	K
Power Supply for external sensor	+24V	+24V	+24V	+24V	+24V	+24V
Max Input Voltage/ Current range	DC (4- 20mA) Or (- 10V to +10V)	DC (4- 20mA) Or (- 10V to +10V)	DC (4- 20mA) Or (- 10V to +10V)	-	-	-

Max output Voltage/ Current range	-	-	-	DC -10V to +10 V	DC -10V to +10 V	DC -10V to +10 V
Front Connector Slot Type	A, C, E, G, I, K: Sub-D 9 Pin					
Back Plane Connector Type	For Supply and Signal – Each EURO 96					
Hardware Self-test Capacity	Yes, all analog input function and amplification tested in booting self-test cycle.					
Card Presence	Yes, On Backplane Hardware code which will be verified at the time of booting self-test cycle.					

3.5.2.1. Function Analog Signals/Interface details: VCU 1 & VCU 2:

System	Connector	Pin	Signal Description	Signal type	Status Signal
VCU1	A	3	XAngTrans	IN	+24V
		5			±20mA
		9			
	G	1	XMeterT/B1	OUT	±10VDC
		6			
	I	1	XMeterT/B2	OUT	±10VDC
		6			
VCU2	A	3	XAngTrans	IN	+24V
		5			±20mA
		9			
	C	1	XPrAutoBkLn	IN	0-10VDC
		6			
	G	1	XMeterT/B1	OUT	±10VDC
		6			
	I	1	XMeterT/B2	OUT	±10VDC
		6			
	K	7	WPnBEdem	OUT	±10VDC
		8			

Major Components of HRT 103

Description	Part No.	Make
D-sub 9 Pin male Connector	**D09P33E4GX00LF**	**Amphenol FCI**
Micro-controller	**STM32F**	**STMICROELECTRONICS**
DC/DC converter	**VRA1212YMD-6WR3**	**MORNSUN**
Euro Connector	86093967113745ELF/ 09 03 196 6921 222	**Amphenol FCI/ Harting**

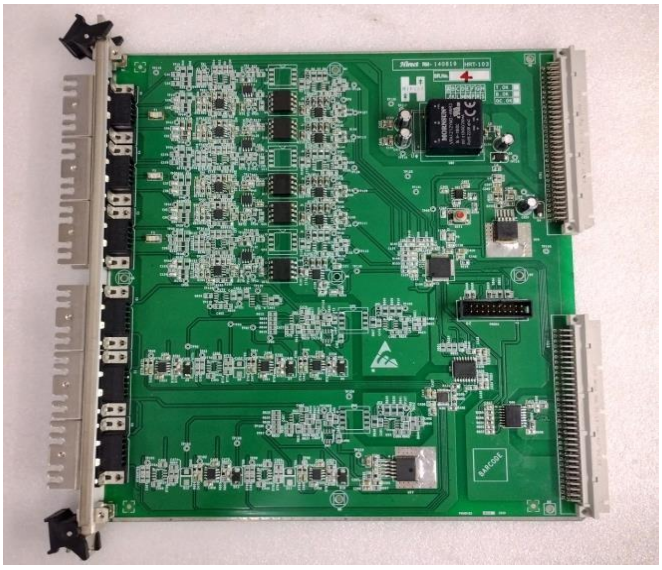


Fig 3.9: Analog Input Output Card

*Image for representative purpose only

3.5.3 HRT102-Digital Input Output Module

Digital Input Output card is used as an interface between system and VCU for fetching digital data and passing the same after processing information. It is placed in VCU slot J,L,O and Q and Each DIO card has 16 digital Inputs and 16 Digital Potential free relay Outputs. The inputs are connected to the A & D connectors (both 15 pin male) and the outputs are connected to J (15 pin male) and G (25pin male) connectors. All Input channels are isolated for better reliability of the system. Digital Inputs are of ratings 72 to 120 V DC, Digital Outputs are Potential Free NO/NC. The microcontroller processes the data and sends it to the CPU boards through CAN Interface and again from CPU boards processed data is sent to the DIO board through the CAN Interface. This data is continuously available on the CAN bus. Shown below is the basic architecture of the board.

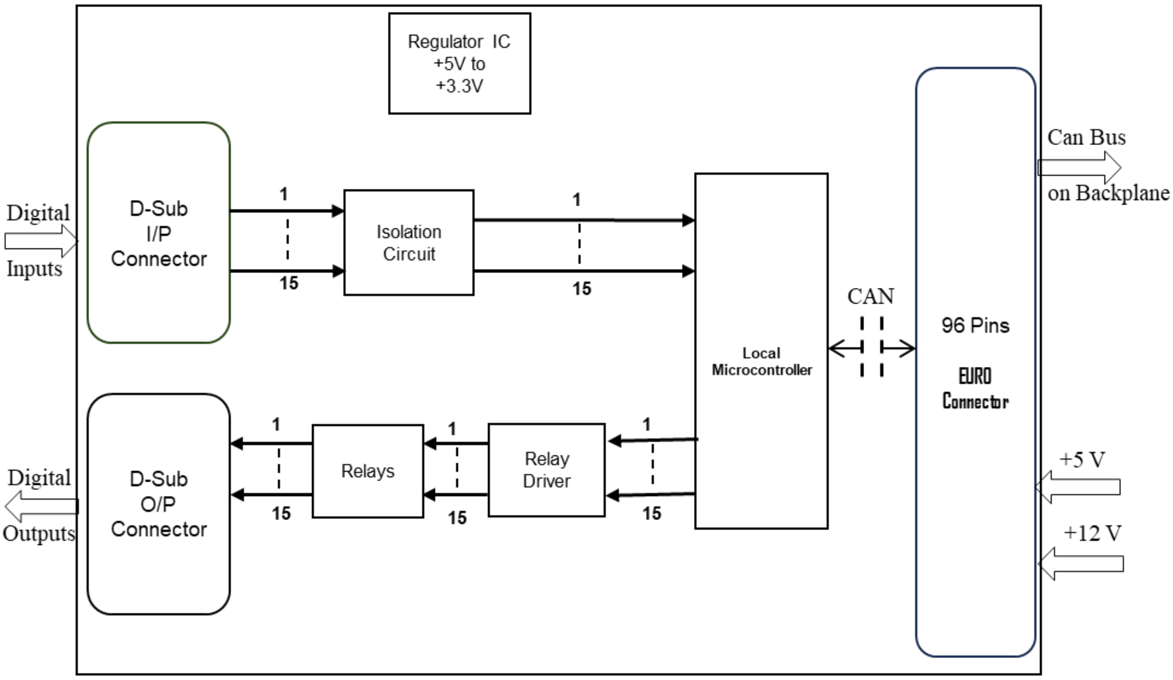


Fig 3.10: Digital Input Output Card Block

Technical data

Number of Devices per Bus Station	4			
Device Slot	J / L / O / Q			
Front Connector Slot	A	D	G	J
Channel type	IN		OUT (Potential free contact)	
Nominal Voltage	72 V to 120 V			
Reference potential	Battery Minus			
Input Channels	16			
Output Channels	16			
Front Connector Slot Type	G- Sub D 25 Pin A,D & J - Sub D 15			
Back Plane Connector Type	For Supply and Signal – Each EURO 96			
Overvoltage Protection	Used Transorb		MOV	
Type of Output	Potential Free Contacts.			
Hardware Self-test Capacity	Yes, All active Components of binary inputs, test on logic “0” and “1”. NO Self-test of Binary Output Available			
Card Presence	Yes, On Backplane Hardware code which will be verified at the time of booting self-test cycle.			

Major Components

Description	**Part No.**	**Make**
Micro-controller	STM32F	STMICROELECTRONICS
D-sub 25 Pin male Connector	D25P33E4GX00LF	Amphenol FCI
D-sub 15 Pin male Connector	D15P33E4GX00LF	Amphenol FCI
Euro Connector	86093967113745ELF/ 09031966921222	Amphenol FCI/ Harting

3.5.3.1. Function Signals/Interface details: VCU 1

Signal type: Digital IN

Connector	Pin	J Slot	L Slot	O Slot	Q Slot
A	1	MMCBCompr1	MReTempCEL	-	MFuseAux
	2	LTEDemand	LSBogOut2	LEmgStop	MMCBBloMR1
	3	LActKSwD	LSwFailMode	LMaxTELimit	MMCBPumpC1
	4	LConstSpeed	LSBogOut1	LSwComprOff	MMCBBloTM1
	5	110V_GND	110V_GND	110V_GND	110V_GND
	6	-	-	-	-
	7	110V_GND	110V_GND	110V_GND	110V_GND
	8	110V_GND	110V_GND	110V_GND	110V_GND
	9	LParkBrake	LSwBogOut1	MRelMCEOn	MMCBBloCT1
	10	LHotelOn	LSwConfig	MMRBlowerOK	MMCBMScBlo1
	11	LActKSwC	MRelMCEOn	LSwBankOp	MMCBPumpT1
	12	LHotelOff	-	LSwComprDir	MMCBTScBlo1
	13	-	-	-	-
	14	-	-	-	-
	15	-	-	-	-
D	1	LFootSwSand	LP/BConFig	LFootSwLock	MEFR415/110
	2	LTrvDirRev	LSwKSim	LTrvDirRev	MAuxConVCB
	3	LBEDemand	MAuxConVCB	LBEDemand	MEFRFilter
	4	LT/8Dem>2by3	MIPrimHigh	LT/Edem>2/3	BDetCOCO
	5	110V_GND	110V_GND	110V_GND	110V_GND
	6	-	-	-	-
	7	110V_GND	110V_GND	110V_GND	110V_GND
	8	110V_GND	110V_GND	110V_GND	110V_GND
	9	LTrvDirFor	LVCBOn	LTrvDirFor	MEFRHotel
	10	Lvigoff	MContHotel	LTEDemand	LVCBOn
	11	LT/BDem>1by3	BDetCOCO	LT/Edem>1/3	MEFRContrl
	12	-	LSwComprOff	LPBFaultAck	LSwFailMode
	13	-	-	-	-
	14	-	-	-	-
	15	-	-	-	-

Signal Type: Digital OUT

Connector	Pin		J Slot	L Slot	O Slot	Q Slot
G	2	O		BContSelfH	BBuzzRed	
	3	O	-	MLampConfig	BBuzzBlack	-
	4	I		BLampTest		
	6	I	MLampParkBk	BSelfMCE		
	7	O	MLampWSlip	BRelMCEOff	MLampFInd	-
	9	I	MLampTPart	BVCBDisable		-
	10	O	MLampHotel	BVCBOn		
	12	O		BVCBOnPulse		
	14	I	-	BcontSelfH	BBuzzRed	-
	15	I		MLampConfig	BBuzzBlack	
	17	O	-	BLampTest	-	-
	18	O	MLampParkBk	BSelfMCE	-	-
	19	I	MLampWSlip	BRelMCEOff	MLampFind	-
	20	O	MlampCSpeed	-	MLampFault	-
	21	O		BVCBDisable	-	
	22	O	MLampTPart		-	
	23	I	MLampHotel	BVCBOn	-	-
	24	I	-	BVCBOnPulse	-	-
J	1	I				BVCBDisable
	2	I	BContHotel	BContcompr1	BContCP1	-
	3	O	BAirDryer	-	BSelfMCE	BContSelfH
	4	I	BEPAntSpin1			BVCBOn
	6	I		-	-	BVCBOnPulse
	9	O	BConHotel	BContCompr1	BContCP1	BVCBDisable
	10	I	BAirDryer	-	BSelfMCE	BContSelfH
	12	O	BEPAntSpin1	-	-	BVCBOn
	13	O				BVCBOnPulse

3.5.3.2. Function Signals/Interface details: VCU 2

Signal type: Digital IN

Connector	Pin	J Slot	L Slot	O Slot	Q Slot
A	1	LTEDemand	MMCBBloCT2	MMCBCompr2	MPrSwPan1
	2	LBEDemand	MMCBMScBlo2	LEmgStop	MPrSwParkBk
	3	LActKSwD	MMCBPumpT2	LMaxTELimit	LCockBkCon
	4	LConstSpeed	MMCBTScBlo2	LSwComprOff	MPrSwLocoBk
	5	110V_GND	110V_GND	110V_GND	110V_GND
	6	-	-	-	-
	7	110V_GND	110V_GND	110V_GND	110V_GND
	8	110V_GND	110V_GND	110V_GND	110V_GND
	9	LParkBrake	MMCBBloMR2	LActKSwD	MPrSwPan2
	10	LHotelOn	MMCBPumpC2	MMRBlowerOK	MBrakElecOK
	11	LActKSwC	MMCBBloTM2	LSwComprDir	LEmgBkOut
	12	LHotelOff	MEFRBUR	LSwBankOp	MPrSwEmgBk
	13	-	-	-	-
	14	-	-	-	-
	15	-	-	-	-
D	1	LFootSwSand	LPanUp	LFootSwLock	MPrSwAFlow
	2	LTrvDirRev	MSmogWarn	LTrvDirRev	MPrSw75bar
	3	MSpeed105%	MPrSwEmgBk	LBEDemand	MPrSwBkCyl2
	4	LT/8Dem>2by3	MVigWarn	LT/Edem>2/3	MPrSw8bar
	5	110V_GND	110V_GND	110V_GND	110V_GND
	6	-	-	-	-
	7	110V_GND	110V_GND	110V_GND	110V_GND
	8	110V_GND	110V_GND	110V_GND	110V_GND
	9	LTrvDirFor	MPrSwBkCyl1	LTrvDirFor	LPanUp
	10	LT/BDem>1by3	MFailFireEq	LTEDemand	MFireAlarm
	11	MSpeed110%	MPrSwParkBk	LT/Edem>1/3	MPrSwLowMR
	12	MSpeedAlarm	MEmgBkVig	LPBFaultAck	MPrSwBkFP
	13	-	-	-	-
	14	-	-	-	-
	15	-	-	-	-

Signal Type: Digital OUT

Connector	Pin		J Slot	L Slot	O Slot	Q Slot
	2	I			BBuzzRed	BEPLBkOut
	3	O	-	-	BBuzzBlack	BEPCPUnload
	4	I				BEPSand13
	6	I	MLampParkBk			BEPRelPBk
	7	I	MLampWSlip		MLampFInd	
	9	O	MLampTPart	-	-	BEPApplyPBk
	10	I	MLampHotel			BEPPan1
	12	O		-	-	BEPSand24
G	14	O	-	-	BBuzzRed	BEPLBkOut
	15	I			BBuzzBlack	
	17	O	-	-	-	BEPSand13
	18	O	MLampParkBk	-	-	BEPRelPBk
	19	O	MLampWSlip	-	MLampFind	-
	20	O	MlampCSpeed	-	MLampFault	-
	22	I	MLampTPart	-	-	BEPApplyPBk
	23	O	MLampHotel	-	-	BEPPan1
	24	I				BEPSand24
	1	I	BPanDisable			BPanDisable
	2	I		BEPPan2	BVigControl	
	3	O		BEPLBkOut	BEPAntSpin2	BContCompr2
	4	I	BContCompr2	BEPCPUnload	BVigReset	
	6	I	BLampTest		BReaVigPeBk	
J	7	O	-	-	BEPutBkOut	-
	9	O	BPanDisable	BEPPan2	BVigControl	BPanDisable
	10	I	-	BEPLBkOut	BEPAntSpin2	BContCompr2
	12	O	BContCompr2	BEPCPUnload	BVigReset	-
	13	O	BLampTest	-	BReaVigPeBk	-
	14	I			BEPAutBkOut	

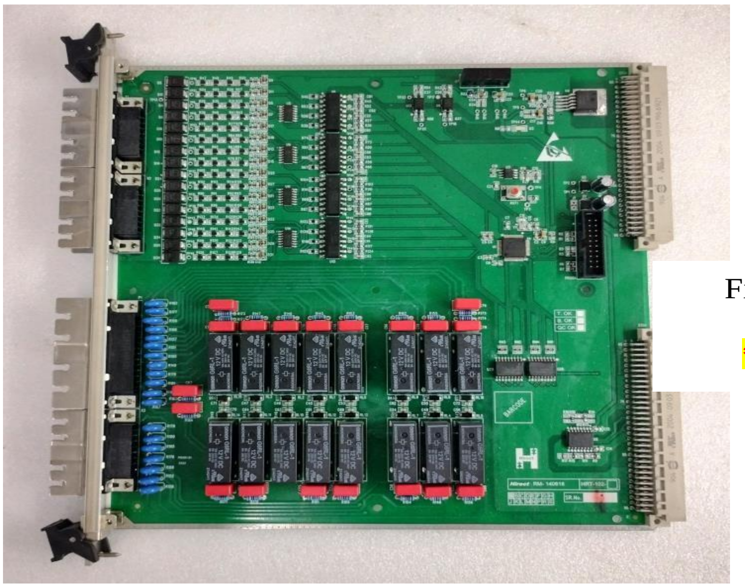


Fig 3.11: Digital Input Output Card Image

*Image for representative purpose only

3.5.4 HRT104-Application Processor with MVB Module

The VCU Application Processor (CPU) Board serves as the core controller for the Vehicle Control Unit, responsible for processing and managing various functions. The board is housed in the VCU rack, where two boards operate in parallel. Each board hosts a separate application processor, ensuring redundancy and reliability.
The CPU board communicates with other cards in the system via the backplane CAN interface, obtaining various types of data from these cards. It processes this information and provides output to the respective boards through the CAN interface, according to its designated functions.
This board includes MVB (Multifunction Vehicle Bus) Interface logic hardware, which can function as the bus administrator, managing communication between devices on the network.
Additionally, a supervisory controller is integrated into the system, equipped with a watchdog timer and reset functionality. This ensures that in the event of an unexpected failure of the main CPU, the controller will reset itself to maintain system integrity.

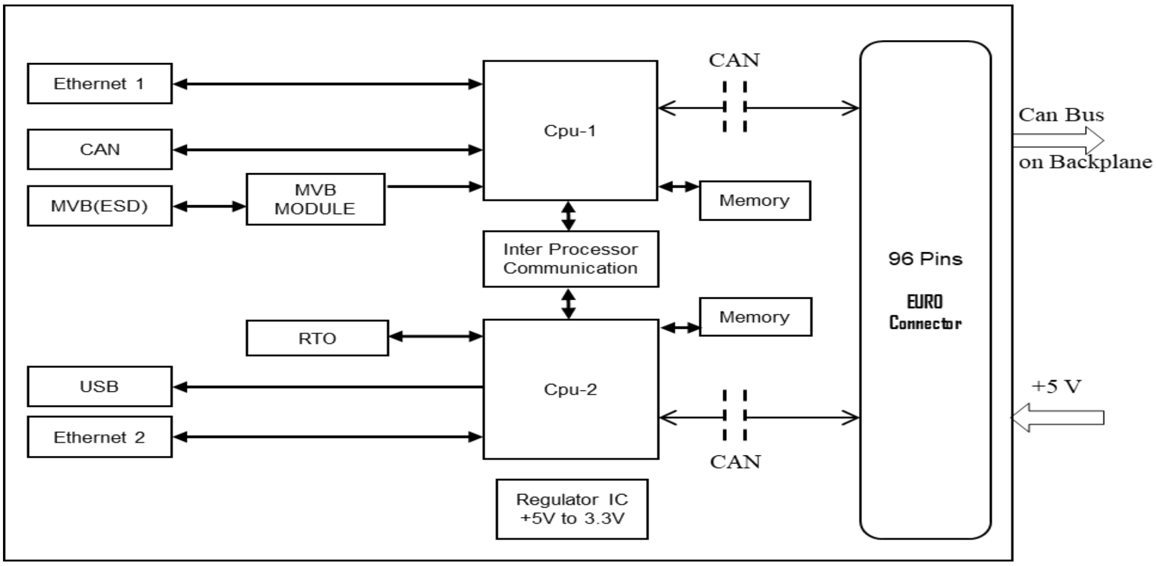


Fig 3.12: Application Processor Card Block Diagram

Technical data

Number of Devices per Bus Station	2
Device Slot	H / S
Front Connector Slot Type	A & C -Ethernet B - USB G - Sub D 9 Pin Right Angle for CAN /ESD MVB I - Sub D 9 Pin Right Angle for RS485/ESD MVB
Back Plane Connector Type	For Supply and Signal – Each EURO 96
Real Time Clock	Yes
Bus Administrator	Yes
Lithium Battery	Yes
LED on Facia	Processor, Configuration and Communication Status
Hardware Self-test Capacity	Yes, in Booting Cycle.
Card Presence	Yes, On Backplane Hardware code which will be verified at the time of booting self-test cycle.

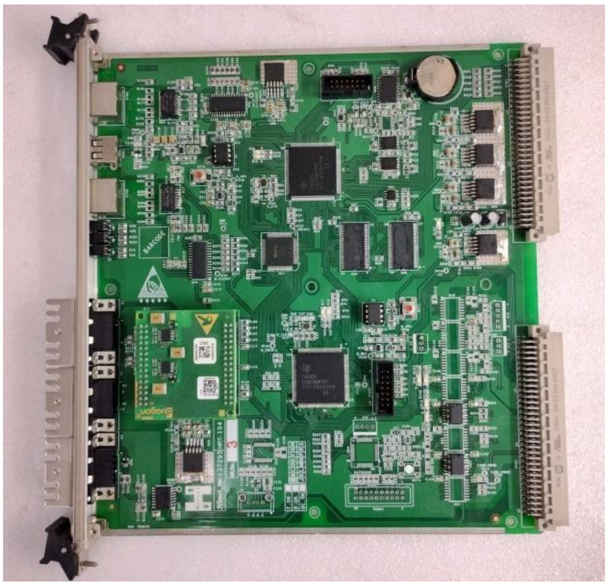


Fig 3.13: Application Processor Card Image

*Image for representative purpose only

Major components

Item	Part No.	Make
Micro-controller	C2000 Series TMS320F28	TEXAS INSTRUMENTS
MVB Module	D013	DUAGON
D-sub 9 Pin male Connector	D09P33E4GX00LF	Amphenol FCI
Euro Connector	86093967113745ELF / 09 03 196 6921 222	Amphenol FCI/ Harting

3.5.5 HRT107-Temperature Sensing Card

The temperature measurement assembly (PCB) is designed to hold the thermostat probe at the "K" slot, enabling the monitoring of the temperature inside the rack. The thermostat contains a fluid and features a capillary tube connected to a thermostat switch. The purpose of this setup is to activate the thermostat switch when the temperature reaches 70°C.

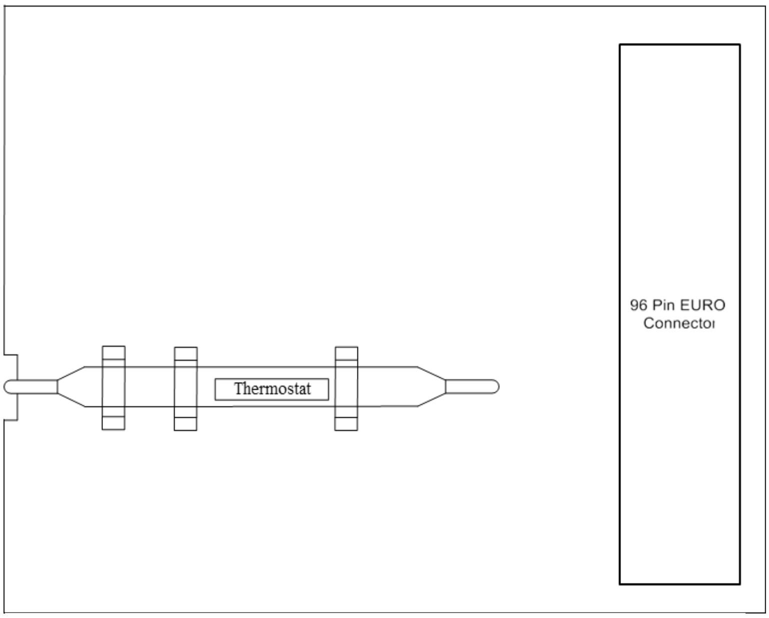


Fig 3.14: Temperature Sensing Card Block Diagram

The capillary tube is routed through the front plate of the K-slot PCB and is used to operate the switch, which is enclosed in a robust, epoxy-coated, aluminium die-cast housing. This thermostat switch housing is mounted externally on the side wall of the SB panel, outside the VCU rack.

Fig 3.15: HRT107-Temperature Sensing

Fig 3.16: Thermostat Switch placed at SB2

Major components

Description	Part No.	Make
Thermostat	414.2620	TRAFAG
Euro Connector	86093967113745ELF/ 09031966921222	Amphenol FCI/ Harting

3.5.6 Backplane Module

The backplane card is used as an interface for CAN and MVB communication, as well as for power distribution throughout the rack assembly.

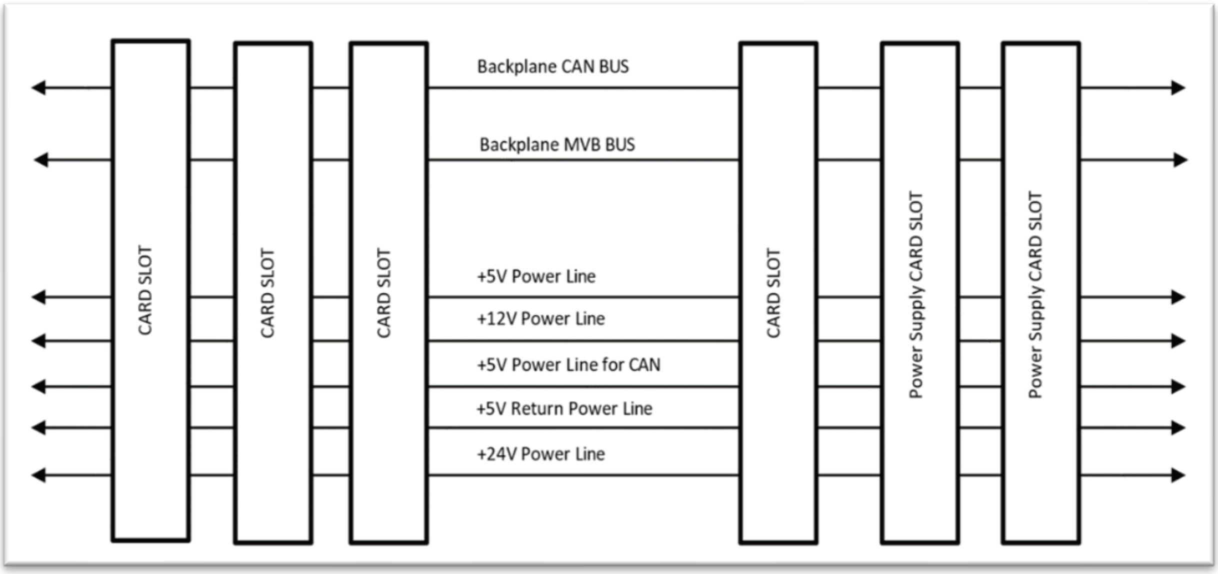


Fig 3.17: Backplane Card Block Diagram

Major components

Description	Part No.	Make
Power connector	09 06 215 2821 222	HARTING
Euro Connector	86093968114745V1LF/ 09 03 296 6824 222	Amphenol FCI/ HARTING

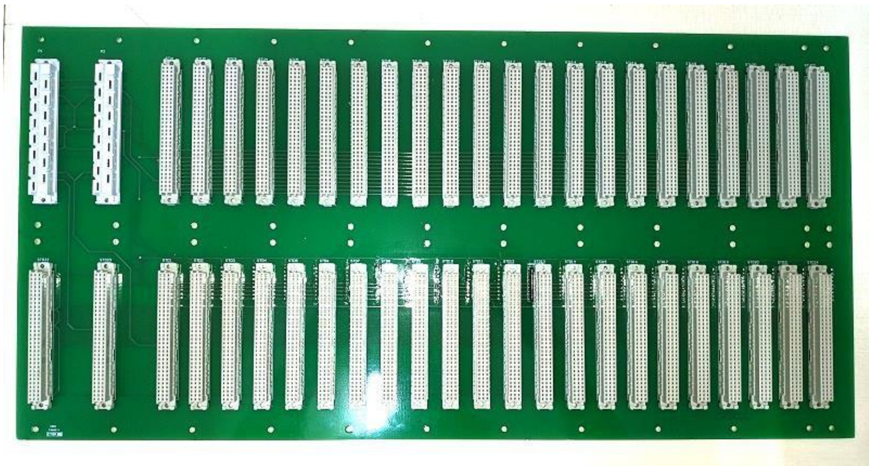


Fig 3.18: Backplane Card Image

*Image for representative purpose only

3.6. Train Bus Coupling

The Train Bus Coupling system relies on two essential hardware components: the Train Bus Computer and the Train Bus Interface.
The Train Bus Computer serves as a gateway, converting data between the Vehicle Bus and the Train Bus. It facilitates seamless communication by converting and routing data from the Vehicle Bus to the Train Bus and vice versa, ensuring efficient data exchange across the train system.
One of the standout features of the WTB (Train Bus) module is its ability to function as a bus repeater. Typically, the WTB module is responsible for transferring data from a device in one locomotive to another via inter-vehicular cables. When acting as a bus repeater, it regenerates the data stream, which helps resolve potential issues caused by incompatible cabling between different locomotives. This feature is particularly valuable in maintaining consistent performance under extreme operating conditions.
The WTB module is a powerhouse for both control application processing and gateway functions. Powered by a PowerPC processor with a 400 MHz core speed, it has more than enough processing power to handle demanding applications. The system is equipped with 64 megabytes of 64-bit wide, 100 MHz SDRAM, providing the necessary memory capacity for smooth operation and efficient data handling.
To ensure smooth communication, the WTB module exchanges essential data from the VCU1 via the CAN network. It incorporates a dedicated CAN sub-module that efficiently handles data transfer to and from the VCU, ensuring optimal information flow throughout the system.

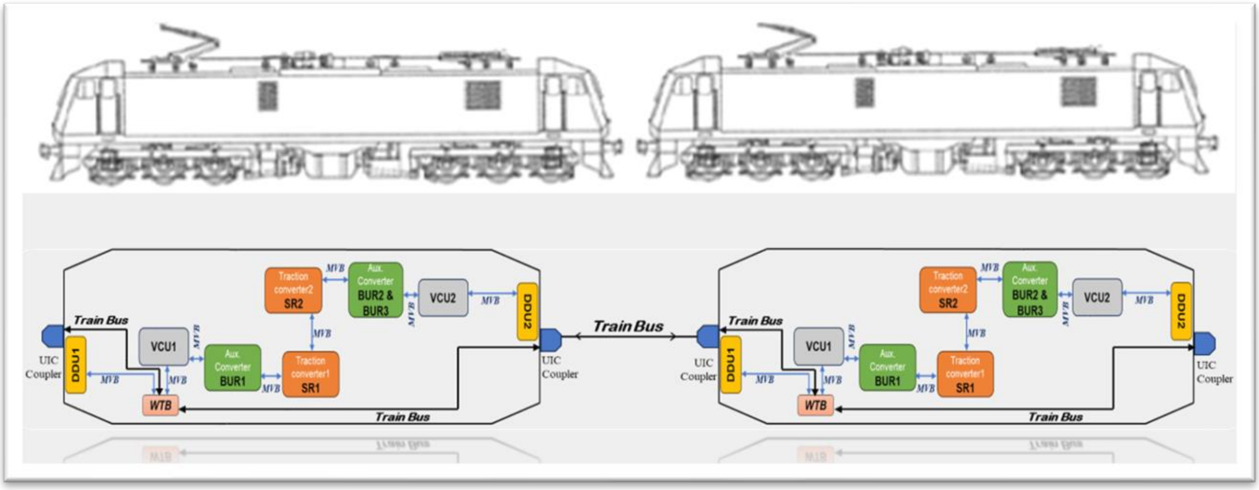


Fig 3.19: WTB Network Architecture

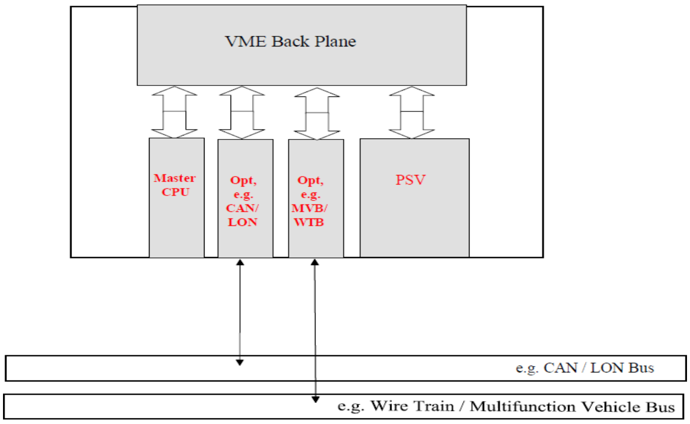


Fig 3.20: General functional diagram of WTB module

The WTB module will be mounted on the SB1 panel in the locomotive. The WTB module consists of three sub-modules, with each sub-module having its own dedicated slot. These slots are equipped with pre-defined interfaces for the 110V power supply, WTB connection, and CAN connection. In addition to the connectors, each sub-module features status indication LEDs on its front panel.

Fig 3.21: WTB Module

Fig 3.22: WTB Module Mounting into

Power supply details of WTB:

Nominal Input Voltage	110VDC
Input Voltage range	77 VDC – 138 VDC
Maximum Input current	2A

3.6.1. Signal Details Over Train Bus

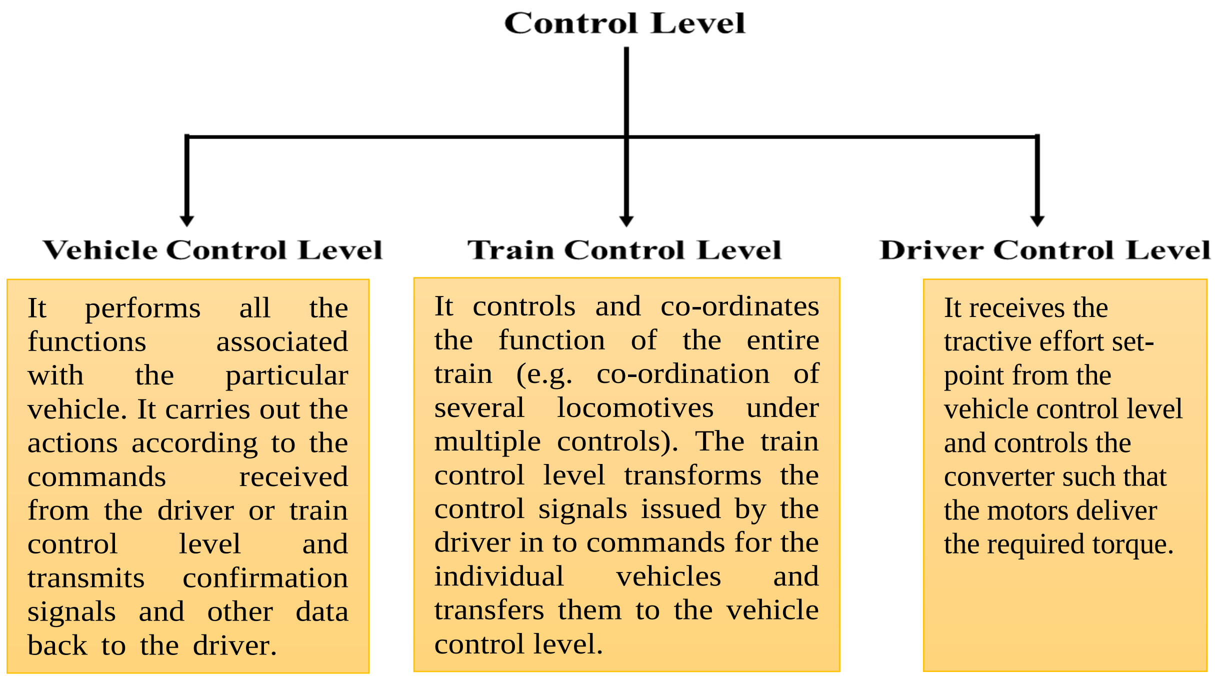
To meet the requirement of standard communication protocol within IR, the WTB has been configured according to the latest received signal details from CLW.

3.7. Vehicle's Control System

This part of the document is intended to provide over view of the essential contents of the Vehicle control equipment/ vehicle control software. This Specification describes control system functions of consequence for the operation of the WAP-5 and WAG-9 locomotives for the Indian Railways Project.

3.7.1. Control Levels

The Vehicle control system is divided in to three control levels to operate the vehicle more preciously.



3.7.2. Vehicle System Functions

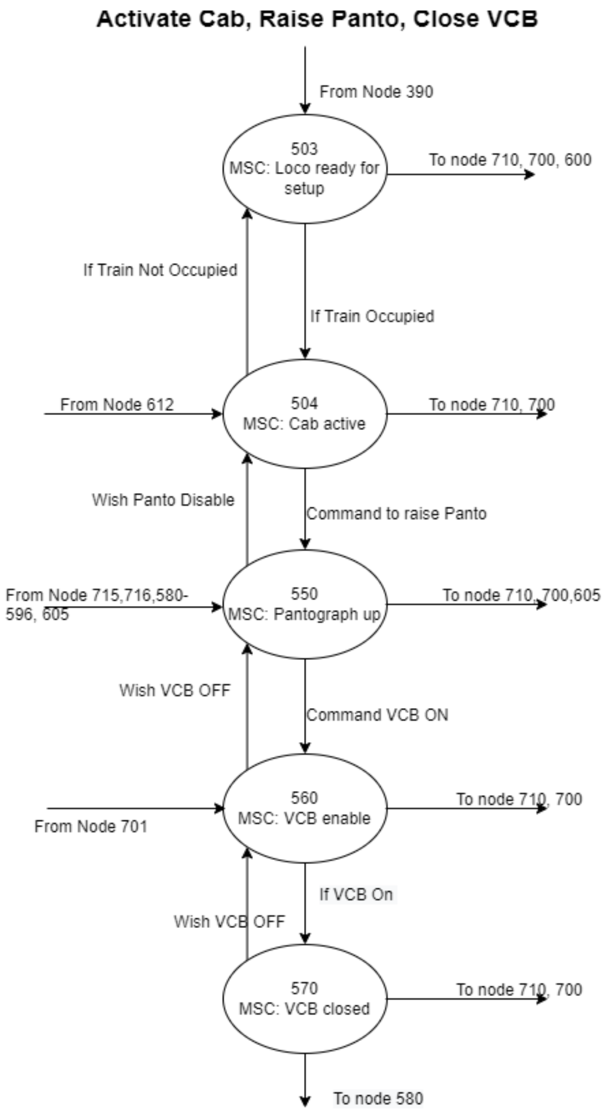
A sequential control system monitors the operating status and determines the order in which operations are carried out. It consists of nodes (states) that are connected by transitions. The state of a system or sub-system can thus be controlled in a simple and logical manner. The sequential control can only be in one defined state at any given time.

3.7.2.1. The Master Sequence Control

The Master State Control (MSC) coordinates all processors and manages key vehicle operations such as self-test, setup, shutdown, driving, and disturbance handling. It defines the vehicle's current state using a node number. The MSC is structured as a sequential state machine, where each state has specific attributes and a unique state number. This state number serves as the central reference for all system processors, ensuring proper vehicle operation. Transitions between states occur when specific conditions are met. The MSC also handles various protection functions. Typically, the CPU completes initial actions, such as self-testing and configuring the locomotive for charging (node 504), within 50 seconds.

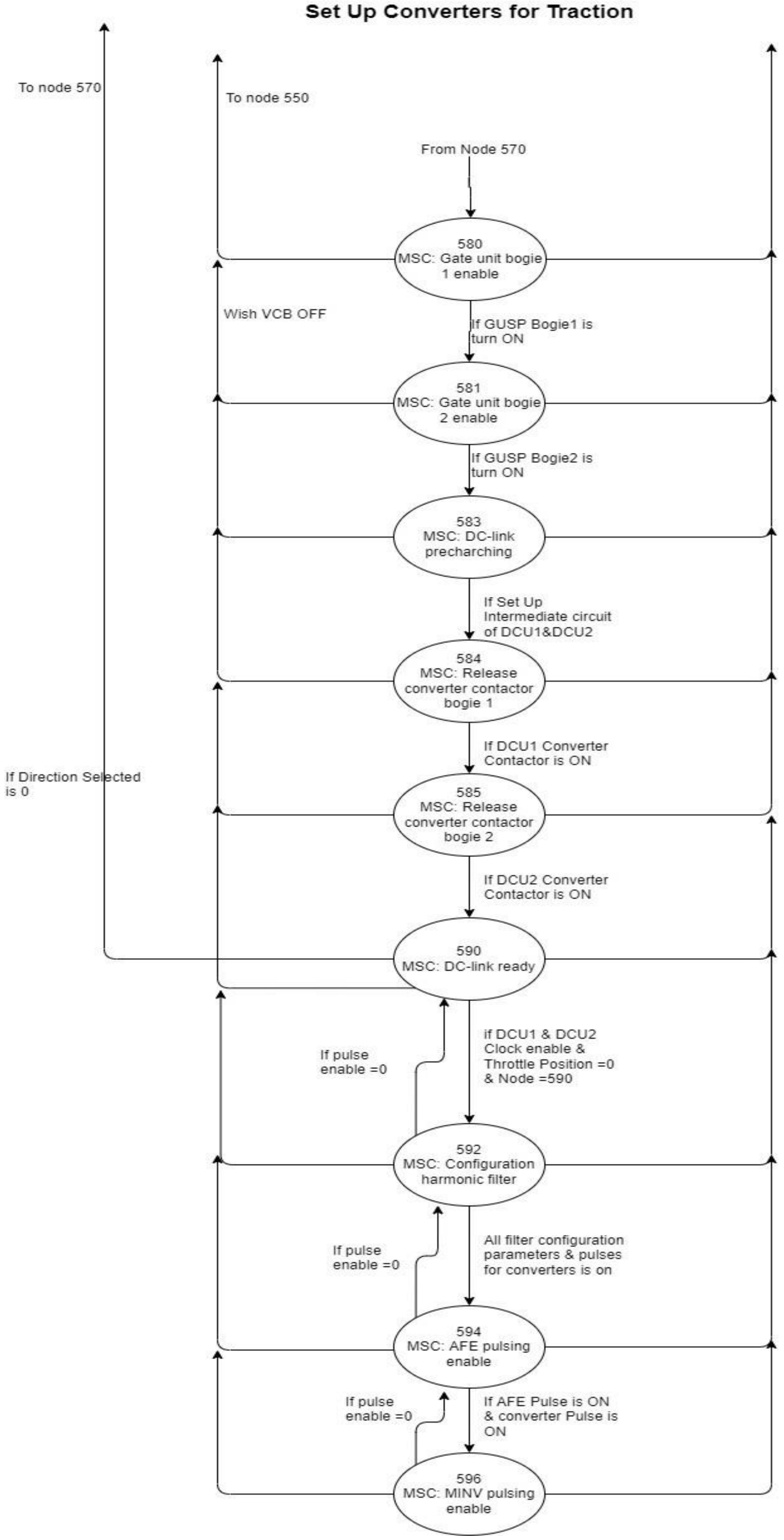
The MSC is fully redundant, operating primarily on CPU1, but in the event of a CPU1 failure, control automatically switches to CPU2.Each processor has a sub-sequential control that defines its current state with a node number. This is generally managed by the MSC.

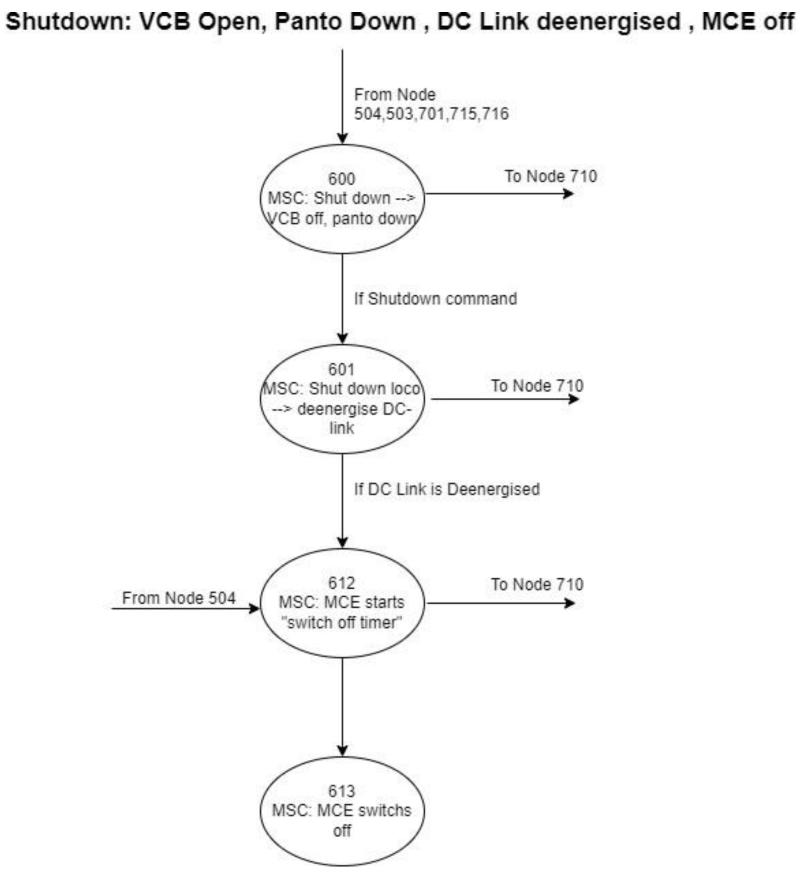
3.7.2.2. Algorithm and Flowchart of the Master Sequential Control



Initialisation Test , Life Sign Test Periphery test of DCU

Set Up Converters for Traction




Shutdown: VCB Open, Panto Down , DC Link deenergised , MCE off
From Node 504,503,701,715,716
600
MSC: Shut down --> VCB off, panto down
To Node 710
If Shutdown command
601
MSC: Shut down loco --> deenergise DC-link
To Node 710
If DC Link is Deenergised
From Node 504
612
MSC: MCE starts "switch off timer"
To Node 710
613
MSC: MCE switchs off

3.8. Installation & Maintenance Procedure for VCU 1 & 2

3.8.1. Mechanical Specifications of VCU

The bus station is housed in a mild steel cabinet with a yellow zinc-plated passivation finish, offering protection against environmental factors. All PCBs are mechanically polarized for specific VCU rack slots, featuring stiffeners to resist vibration and ensure a safe earth connection. Sub-D connectors on the PCBs are polarized to prevent incorrect connections. The front cover of the rack is easily removable with a screwdriver.

Maximum mechanical dimension (envelope) of VCU housing Case:

- Length - 760 mm
- Width - 502 mm
- Height - 560 mm.

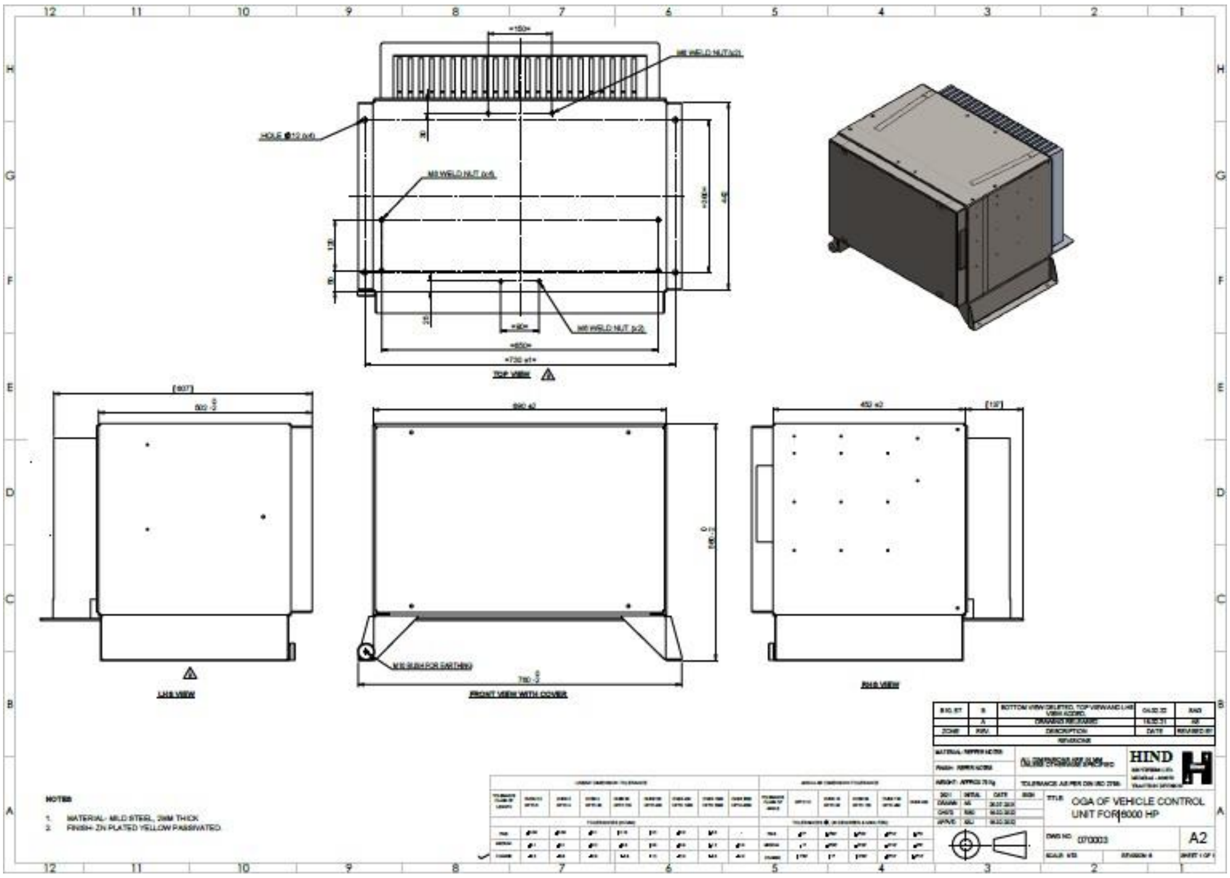
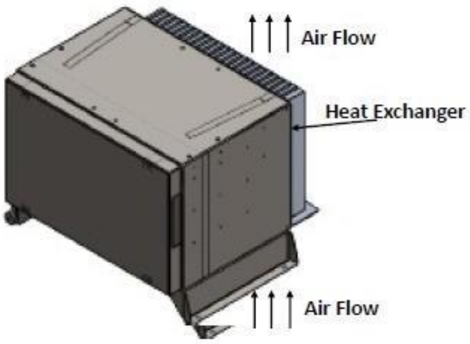


Fig 3.23: OGA of Vehicle Control Unit

3.8.2. Cooling Mechanism of VCU

The electronic racks are mounted within a sealed casing located in the low-voltage cubicles (SB1 & SB2). To ensure the control electronics remain operational under the specified environmental conditions, a proven heat exchanger is provided at the backside of each VCU enclosure. Air from the machine room blower continuously cools the heat exchanger.



To avoid any localized heat within the enclosure, a fan assembly consisting of three number 48V DC cooling fans *(Make: REXNORD & Equivalent)* is provided at the bottom of the VCU enclosure. The fan assembly ensures internal airflow for uniform thermal distribution within the VCU, facilitating effective heat transfer to the heat exchanger.

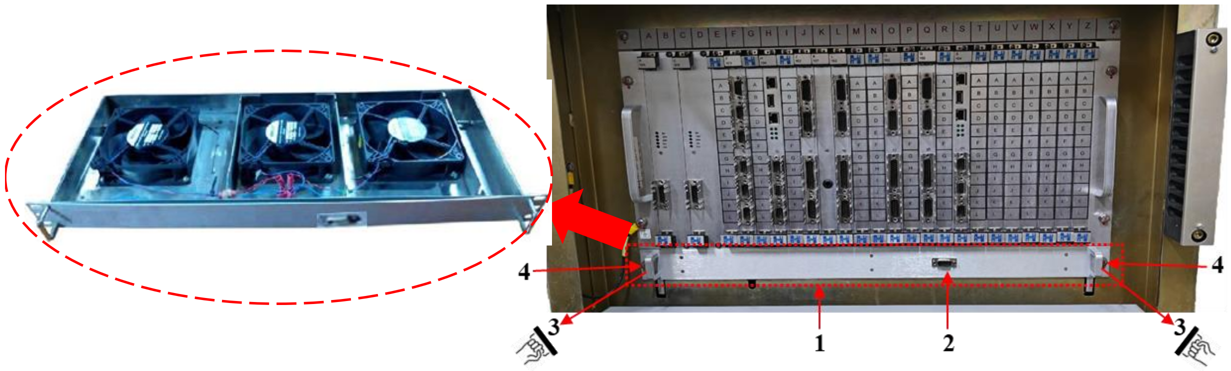


Fig 3.24: Cooling Fan Tray of VCU

1	Cooling Fan Tray
2	Input Power Connector (Sub-D9) of Cooling FAN (48V)
3	Handles for Dismantle & Placement of Fan Tray during service
4	Fixation Bolt of Fan Tray of VCU

3.8.3. Installation Procedure of SB panel on VCU

Mount the SB panel onto the VCU using the tapped holes provided on the top surface of the VCU frame, as shown in Figure 3.25. Use suitable lifting equipment to lift the SB panel and attach it to the eye bolts on the panel. Then, install the bolts along with the spring washers and plain washers to secure the SB panel to the VCU frame.

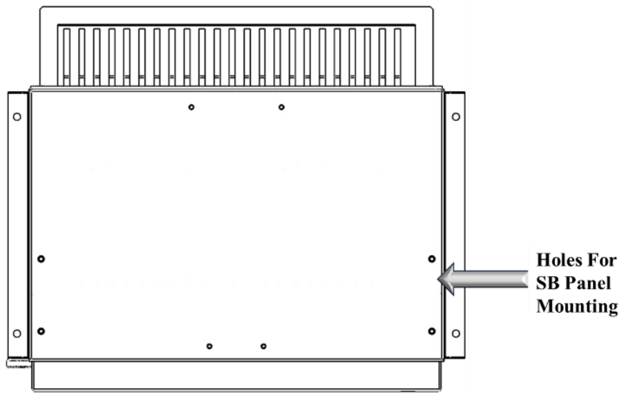


Fig 3.25: VCU top view with mounting provision for SB panel

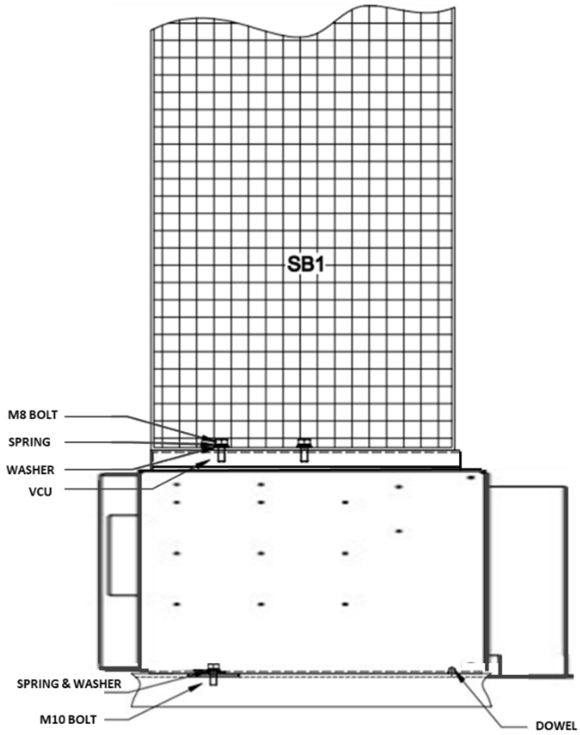


Fig 3.26: Side view of SB & VCU Mounting

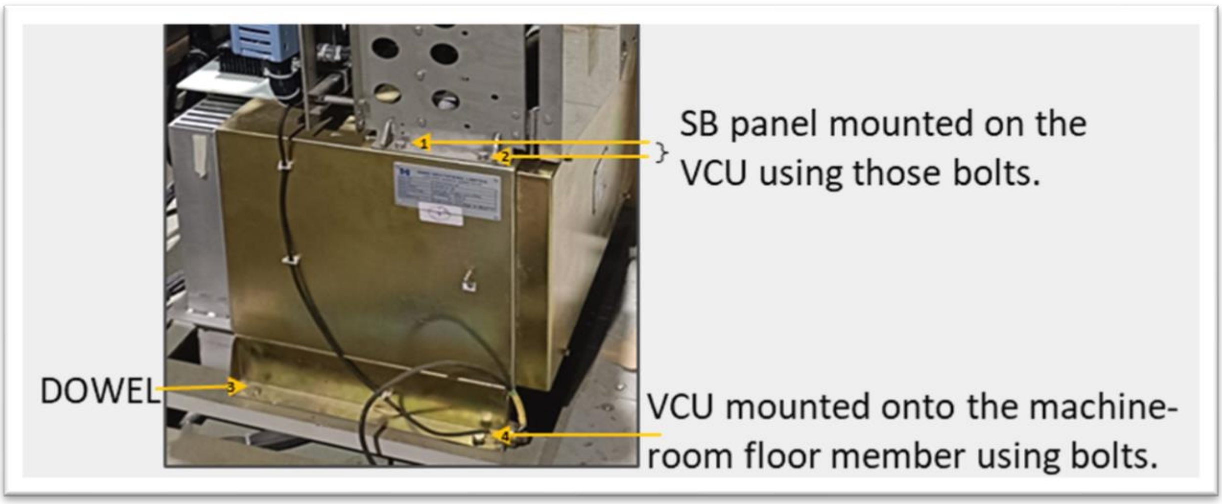


Fig 3.27: Left Side view of SB & VCU Mounting

3.8.4. Installation Procedure on Machine Room Floor

Attach suitable lifting equipment to the eye bolts on the SB panel and lower the SB panel with the VCU over the dowels on the machine room floor member as shown in Fig 3.28.

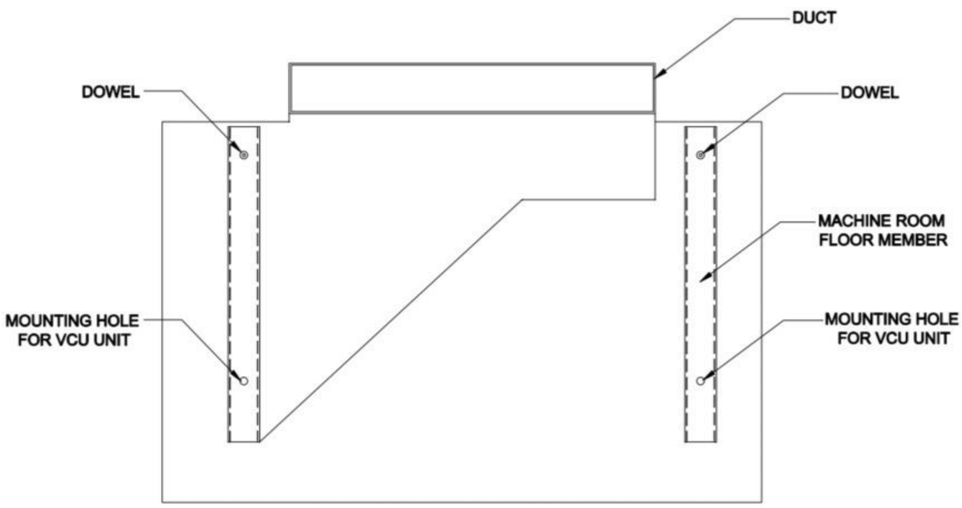


Fig 3.28: Mounting Surface for VCU on Machine Room Floor

3.8.5. Routine Maintenance of Vehicle Control Unit (VCU)

The Vehicle Control Unit (VCU) is overall maintenance-free, but the following checks should be carried out once a year during the Annual Overhaul (AOH):

1. Blow out dust from the entire unit.
2. Check the input and output cable connections. If any unacceptable tear-outs or damage are found, replace the cables.
3. Open the unit to ensure all internal connections are secure.
4. Inspect for wear and tear of bolts. Vibrations may cause damage to threads; if any bolts are damaged, replace them and ensure they are tightened securely.

3.8.6. Dismantling of Vehicle Control Unit

Follow these steps to safely remove the Vehicle Control Unit (VCU):

1. Disconnect the earth cable connections (refer to fig 3.29).
2. Unlock and open the VCU front door and remove the all MVB cables from the PCB Modules.
3. Remove the VCU cubicle's bottom fixing by unscrewing the M10 hardware
4. Re-secure the mounting hardware (both bottom and top) that was removed during disassembly, ensuring it is kept for reuse during reassembly.

5. Ensure there is nothing entangled between the locomotive and the VCU with the SB panel before lifting.

Lift the VCU Cubicle with the SB panel vertically using suitable lifting equipment. Attach the lifting equipment to the eye bolts on the SB panel.

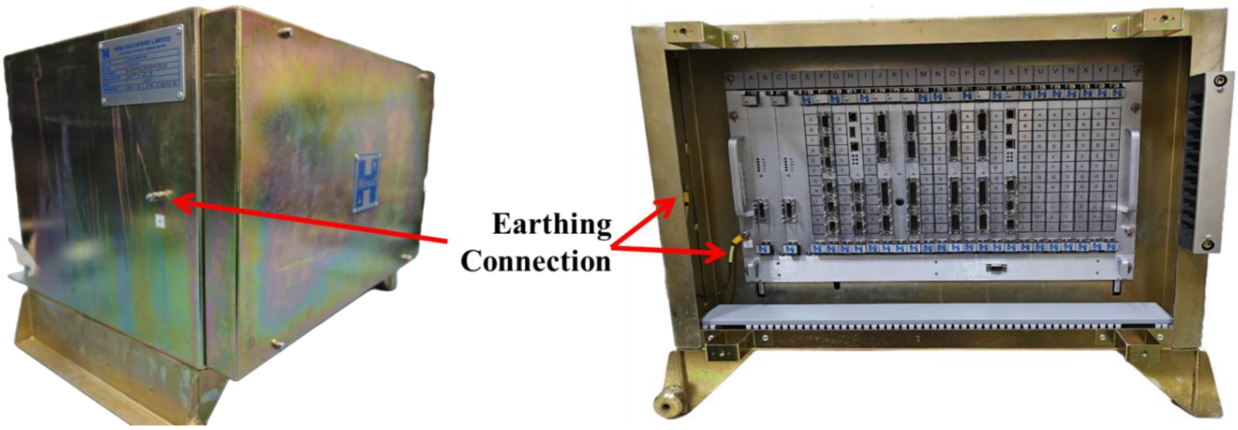
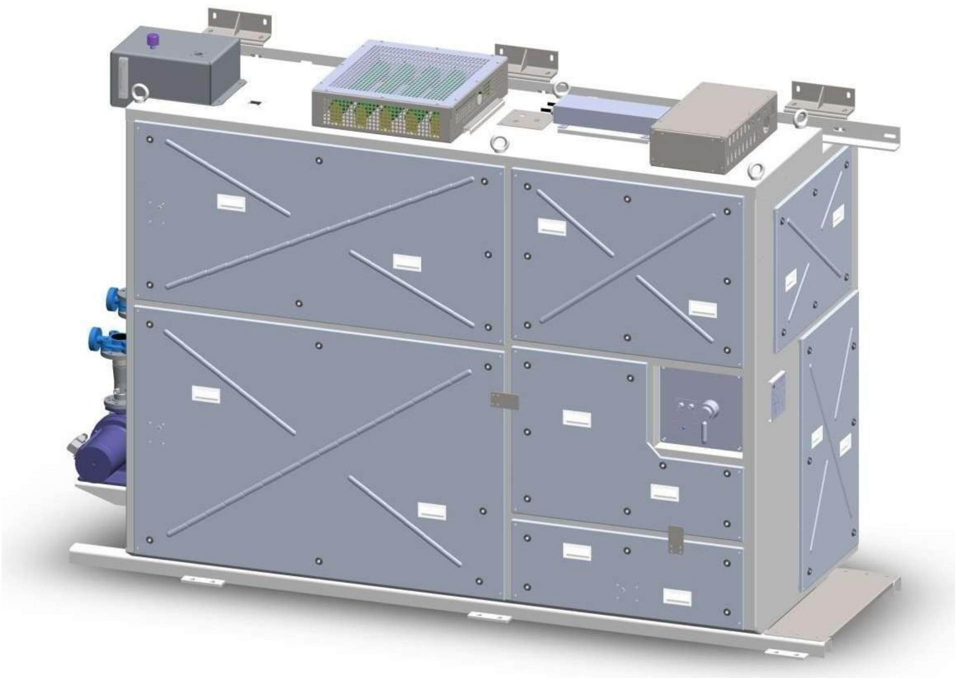


Fig 3.29: Earthing Cable Connection of VCU

4. Chapter 4 -Traction Converter (SR-I & SR-II)



4.1. Functional Description

The IGBT-SR HR-TC2400AC Traction Converters are rugged, compact units designed with advanced IGBT technology for rail vehicle applications. These converters efficiently transform single-phase line voltage into drive power for three-phase asynchronous traction motors, based on the tractive effort demand from the driver's cabinet. Each locomotive is equipped with two HR-TC2400AC converters—one for Bo-Bo locomotives, supplying two motors, and one for Co-Co locomotives, supplying three motors.

The system features two traction secondary windings from the transformer feeding a single converter's input stages (four-quadrant converters - 4QC). Each converter has two parallel input stages that supply power to the DC link and regulate its voltage. These stages ensure sinusoidal input current and maintain a unity power factor. To minimize grid disturbances, the control units for both converters are synchronized and interleaved, optimizing pulse patterns.

In case of severe OHE power fluctuations or faults, an over-voltage protection chopper (or VLU) safely removes excess energy from the DC link, keeping the voltage within set limits. This protection does not absorb braking energy. Voltage spikes can occur during power imbalances between the converter's input and output (e.g., wheel slip, faults on the line or motor side, pantograph bounce, etc.).

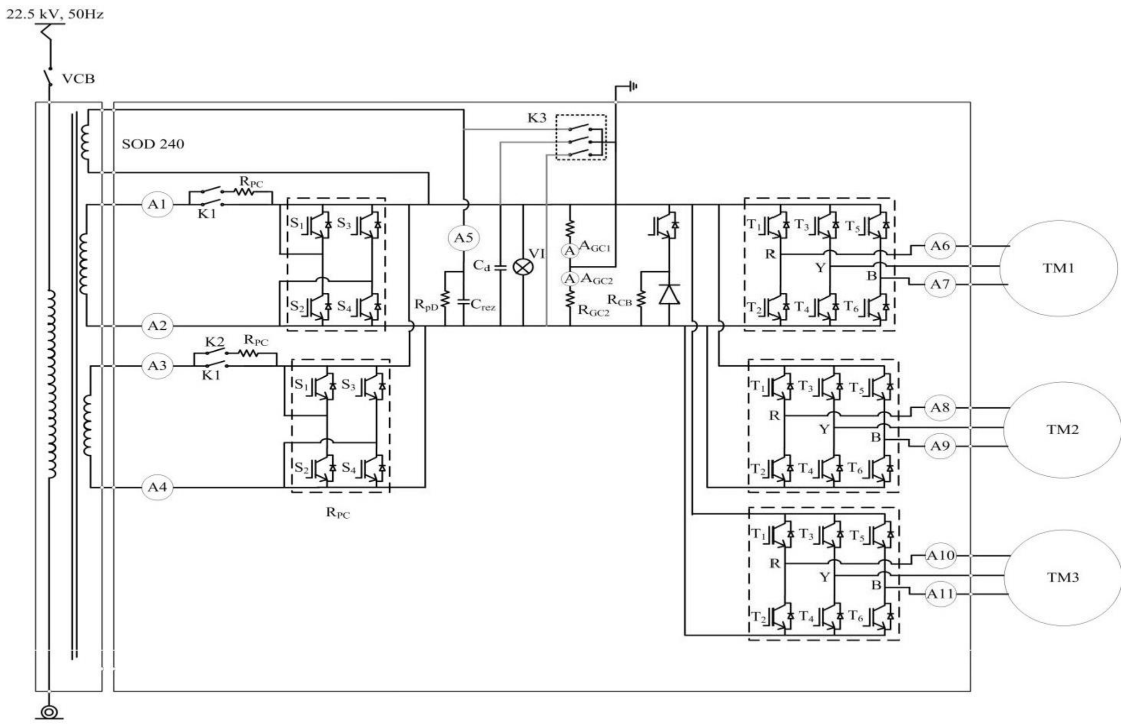


Fig4.1: IGBTSR HR-TC2400AC schematic overview for CO-CO Type

Due to the rectification of input voltage, power fluctuations at twice the grid frequency occur in the DC link. To minimize these fluctuations, a resonant filter is employed, using the existing reactor integrated into the traction transformer.

Symmetry resistors are used to passively discharge the DC link and provide a neutral point connection to the ground. Leakage current through the resistors is monitored by two current transducers, which detect potential earth faults. For safety during maintenance, an Earthing switch and voltage indicator are installed. The Earthing switch short-circuits the positive and negative terminals of the DC link and the second harmonic filter capacitors' positive terminal. It is fully compatible with the locomotive's interlocking system. The voltage indicator is self-powered and signals when critical voltages are present in the DC link.

The motor inverters (Voltage-Source Inverter, VSI) are powered by the traction DC link, with each motor connected to its dedicated inverter. Each inverter is controlled by its own hardware unit, ensuring high reliability and redundancy. The braking process is regenerative, with recuperated power being returned to the catenary. In the event of failure, downgraded operation with fewer inverters can be implemented.

The converter's input and output power stages are compact units containing four IGBTs each, mounted on liquid-cooled plates. The Line Converter Power Units (LCPU) and Motor Inverter Power Units (MIPU) share the same components and mechanical design.

For Co-Co locomotives, there are 9 power units (4×LCPU and 5×MIPU), while Bo-Bo locomotives have 8 units (4×LCPU and 4×MIPU). The cooling system uses Ethylene Glycol-based coolant and is connected to the locomotive's heat exchanger. The pump is integrated into the converter cabinet and powered by the locomotive's 415VAC three-phase power.

The converter is designed for installation in the locomotive machine room, using the same mounting positions as the old GTO converter. It features an IP54-rated stainless steel cabinet with removable aluminum front covers for reduced weight. The control interface connectors are matched to those of the old GTO converter, ensuring compatibility. New power connections (bushings) allow existing cables to be connected without modification.

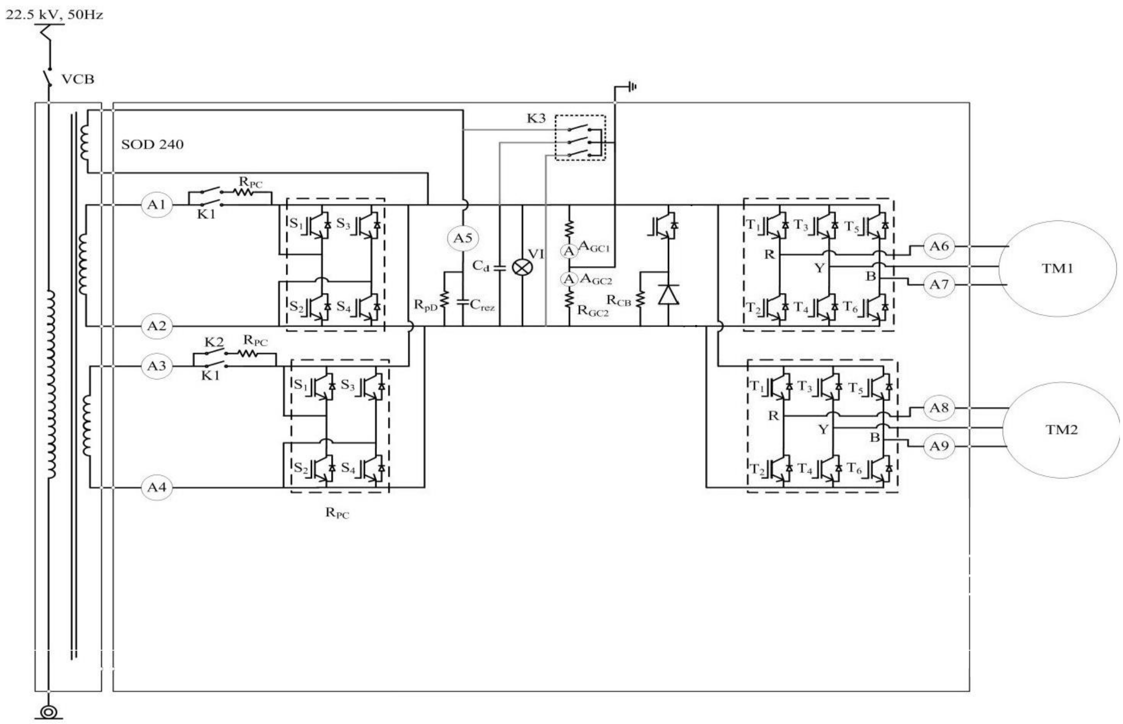


Fig 4.2: IGBTSR HR-TC2400AC schematic overview for BO-BO Type

Symbol	Description
VCB	Vehicle circuit breaker
SOD240	2^{nd} harmonic reactor (integrated in the traction transformer)
A1, A2, A3, A4	Line side current measurements
K1	Main contactor
K2	Pre-charge contactor
R_{PC}	Charging resistor
K3	Earthing switch
R_{pD}	Passive discharge resistors for resonant capacitor bank
C_{rez}	Resonant capacitor bank
A5	2^{nd} harmonic filter current measurement
V1	DC-link voltage measurements
C_d	DC-link capacitor bank
R_{GC1}, R_{GC2}	Balancing and mid-point earthing resistors, passive DC-
A_{GC1}, A_{GC2}	Leakage current measurements
VI	Voltage indicator
R_{CB}	Protective resistor
A6, A7, A8, A9, A10, A 11	Motor inverter current measurements

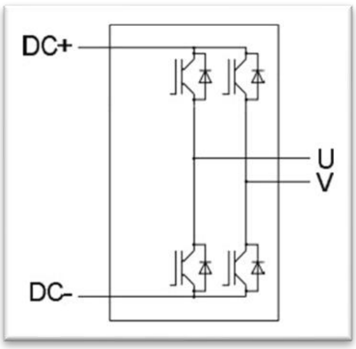
Table 4.1- Symbol description

4.1.1. Description of Line Converter Power Unit

Each Line Converter Power Unit (LCPU) is implemented with parallel IGBTs, consisting of a total of four IGBTs. The LCPU represents one phase leg of the line converter 4QC (reference error in source 9). The respective IGBTs are connected using low-inductive laminated busbars. The parallel IGBTs are driven using a synchronized master-slave driver configuration to ensure that the current is evenly distributed between the individual IGBTs.

Components of Line converter power unit:

1) IGBT - 4 Nos.
2) Gate Driver “Master - 2 Nos.
3) Gate Driver “Slave” - 2 Nos.
4) Gate Driver Power - 2 Nos.
5) Laminated DC Busbar - 2 Nos.
6) Laminated AC Busbar - 2 Nos.
7) Cooling Plate - 1 Nos.
8) Temperature Sensor - 2 Nos.
9) Weight - 42 Kg



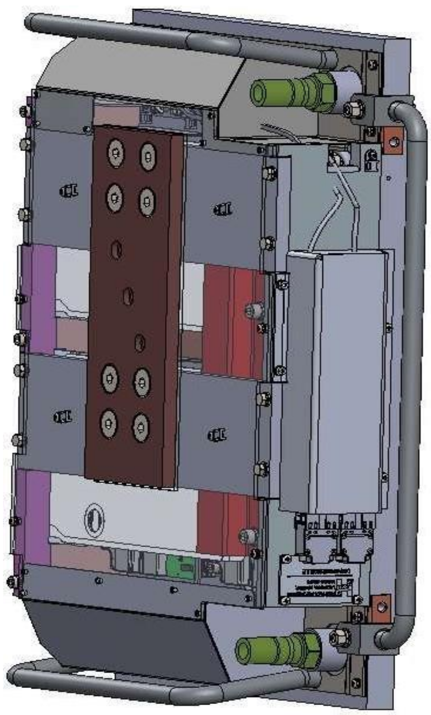


Fig 4.3: Line converter power unit (AFE)

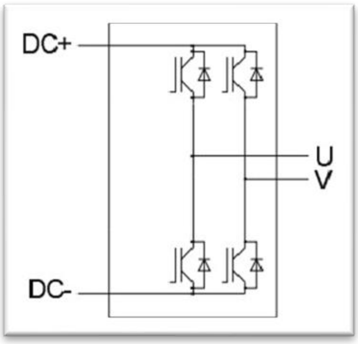
- Continuous DC Voltage : 2800 VDC
- Rated IGBT Voltage : 4500 V
- Rated IGBT Current : 1200 A
- Switching Frequency : 250 Hz
- Comply Standards : IEC 61287, IEC61373

4.1.2. Description of Motor Inverter Power Unit

The Motor Inverter Power Unit (MIPU) is used to realize the three legs of the output inverters. The main difference is that the AC outputs of the respective phases in a single power unit are not connected in parallel. Additionally, each IGBT driver has its own dedicated power supply and is controlled independently, following a 'Master' configuration for all IGBTs.

Components of Motor Inverter power unit:

1) IGBT - 4 Nos.
2) Gate Driver “Master - 4 Nos.
3) Gate Driver Power - 4 Nos.
4) Laminated DC Busbar - 2 Nos.
5) Laminated AC Busbar - 2 Nos.
6) Cooling Plate - 1 Nos.
7) Temperature Sensor - 2 Nos.
8) Weight - 42 Kg



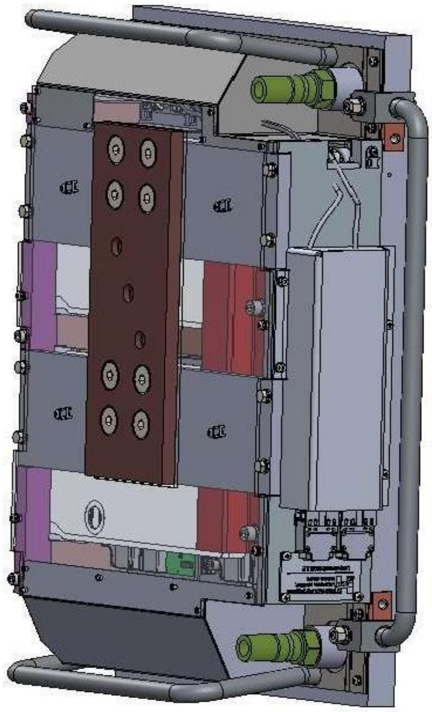


Fig 4.4: Motor Inverter power unit

- Continuous DC Voltage : 2800 VDC
- Rated IGBT Voltage : 4500 V
- Rated IGBT Current : 1200 A
- Switching Frequency : 500 Hz
- Comply Standards : IEC 61287, IEC61373

4.1.3. Over voltage protection Unit

The overvoltage protection unit is designed to limit the voltage rise in the DC link during dynamic power disturbances (such as wheel-slip, pantograph bouncing, etc.). If the DC-link voltage exceeds a predefined threshold, energy is dissipated using a crowbar resistor, which is connected via one phase leg of the inverter power unit.

The resistor is mounted on top of the converter cabinet and is protected by an open grid to ensure natural cooling inside the locomotive machine room. The resistor can handle several consecutive maximum load cycles (approximately 1 MJ each) with a minimum cooling period of 5 seconds between cycles. After 2 to 3 repetitions, a longer cool-down period of at least 10 minutes is required.

The crowbar resistor also serves to actively discharge the DC link when the converter shut-down procedure is initiated. To monitor the current through the crowbar resistor, the same type of current sensor used for the line converter is employed. The energy supplied to the resistor is continuously monitored to prevent overload.

Voltage sensors of the same type as those used for measuring the DC-link voltage are installed for accurate measurements. All data is continuously compared, providing multiple redundancies in the overvoltage protection system. Each DCU control card is connected to at least two independent DC-link voltage measurements to ensure redundancy in case of sensor failure. A safety chain communication between control cards ensures safe shutdown or corrective actions in the event of issues with the DC-link measurement (such as overvoltage or significant discrepancies between multiple voltage sensors).

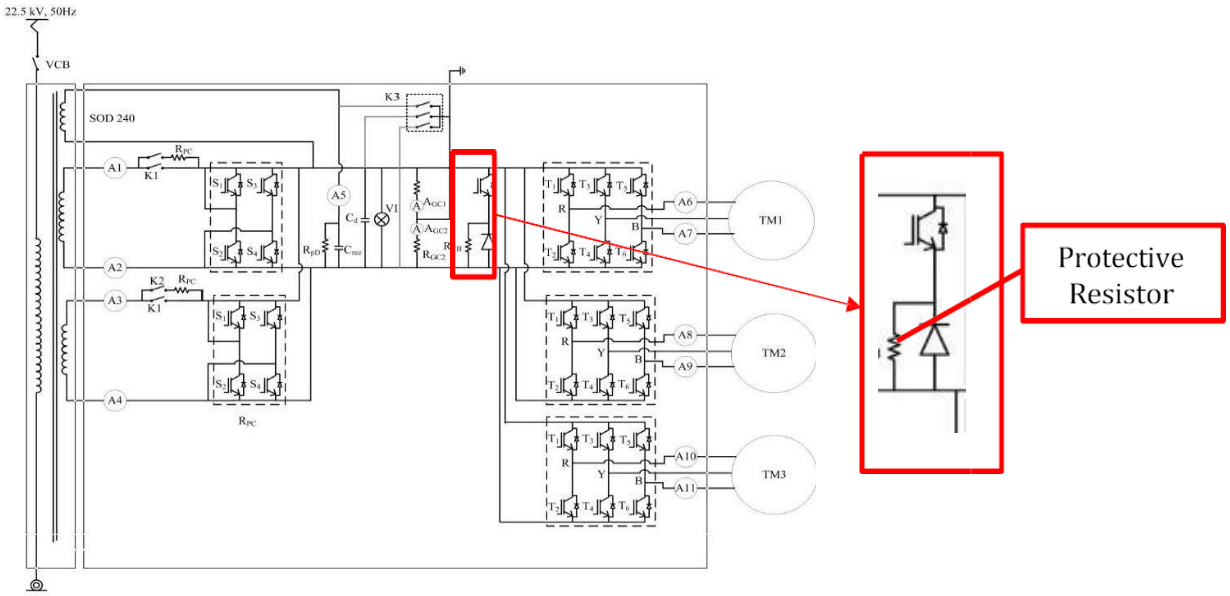


Fig 4.5: Voltage Limiting unit

4.1.4. Traction Control Unit

The TCU is responsible for regulation, protection, communication, supervision, and diagnostic tasks of the converter. It is housed in the compartment labelled as 4 in Fig 4.6. The TCU features a multiprocessor controller architecture based on HIRECT's proprietary software and hardware solutions. Thanks to its modular design, various configuration options are available. The electronic modules are designed to operate within an extended temperature range (from -40°C to +85°C) in accordance with the IEC 60571 standard.
The traction converter's control electronics architecture is shown in Figure 11. The control rack is a single unit that houses all the necessary interfaces and processing components required for the control of the traction converter.

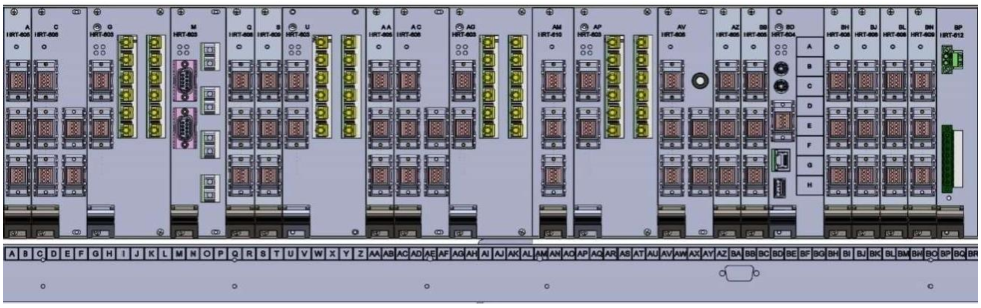


Fig 4.6: Control electronics Unit

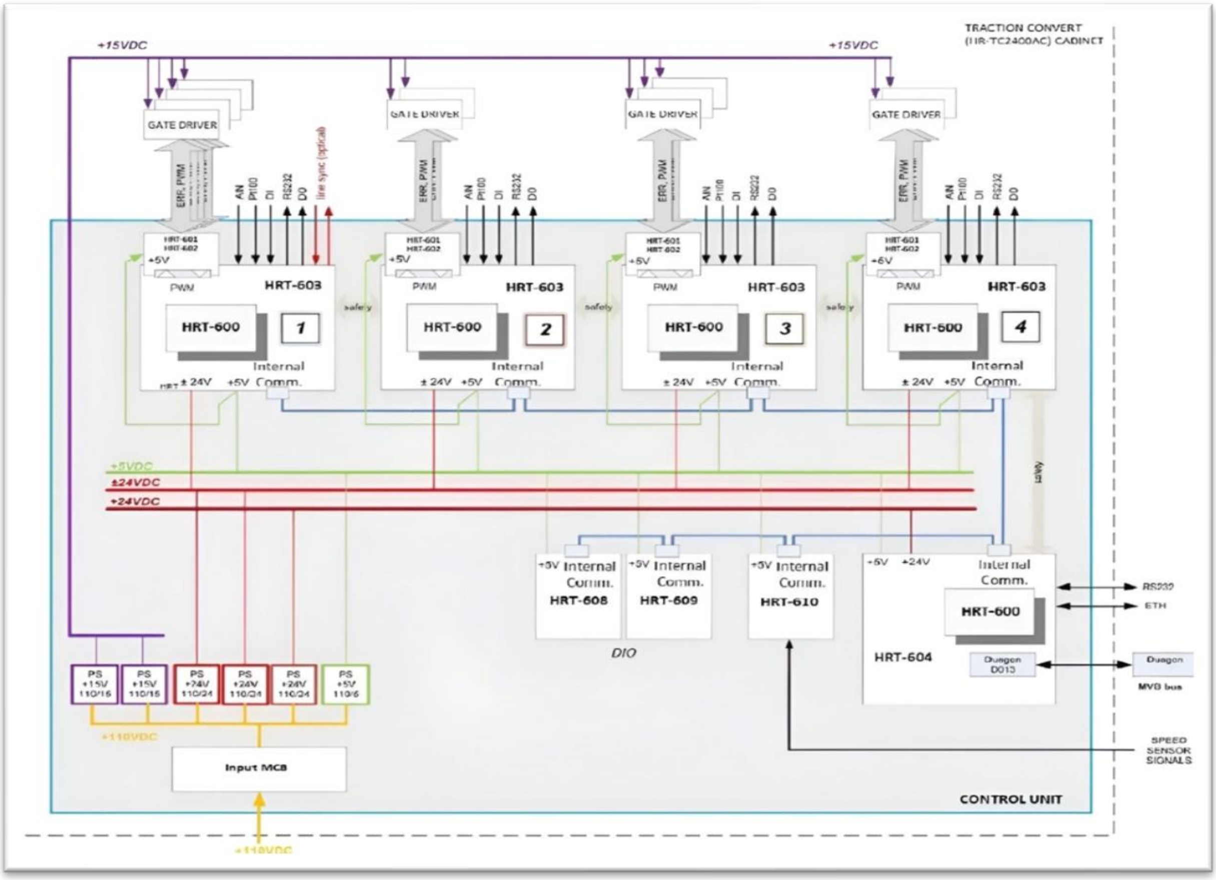


Fig 4.7: Control architecture

Traction converter control electronics consist of various control cards, which are assembled in a control rack. The list of control cards for each control electronics set is as follows:

SN	Number	Name	Functional Description
1	**HRT-600**	DSP Daughter Card	Consist of two CPUs
2	**HRT-601**	PWM RX Card	Fiber optical links
3	**HRT-602**	PWM TX Card	Fiber optical links
4	**HRT-603**	AFE / INV Base Card	Peripherals for DSP and communication interface
5	**HRT-604**	SLG Base Card	Multifunction Vehicle Bus, Ethernet and RS232
6	**HRT-605**	Analog Interface Card	Isolation and processing of analog signals
7	**HRT-606**	RTD Card	Interface for PT100 temperature sensors
8	**HRT-607**	RTD Daughter Board	Interface for PT100 temperature sensors
9	**HRT-608**	DI Card	Digital Inputs
10	**HRT-609**	DO Card	Digital Output
11	**HRT-610**	Speed Sensor card	Decoding data from speed sensors.
12	**HRT-613**	Motherboard	Interconnecting multiple PCB with each other’s
13	**HRT-615**	Interface Card	Interfacing between Gate drive and power supply card.

Table 4.2- Card Details of Traction Control Unit (TCU)

4.1.5. Cooling System of Traction Control Unit

The converter cabinet is cleverly divided into four key compartments, as depicted in Fig 4. 8.. On the left-hand side, marked as "1," you'll find the heart of the system, while the right-hand side is organized into compartments marked "2," "3," and "4." In the larger compartment (marked "1"), two internal water-to-air heat exchangers, paired with their dedicated fans, work tirelessly to circulate air and remove the heat generated by the line and motor converter power units (LCPU and MIPU), the DC-link bus bars, capacitors, power cables, and even part of the harmonic filter capacitor bank.

This advanced cooling system operates on an open-loop design, utilizing a water and ethylene glycol mixture as its cooling medium. It's a carefully engineered solution designed to keep everything running smoothly under intense conditions. The cooling system is made up of several essential components:

- Piping that ensures efficient flow
- A water pump to keep everything circulating
- An expansion vessel with indicators to monitor system pressure
- Valves to regulate flow and ensure optimal performance
- Internal water-to-air heat exchangers that are the backbone of heat management.

Together, these elements form a highly effective, integrated cooling system that helps the converter cabinet maintain peak performance even under demanding conditions.

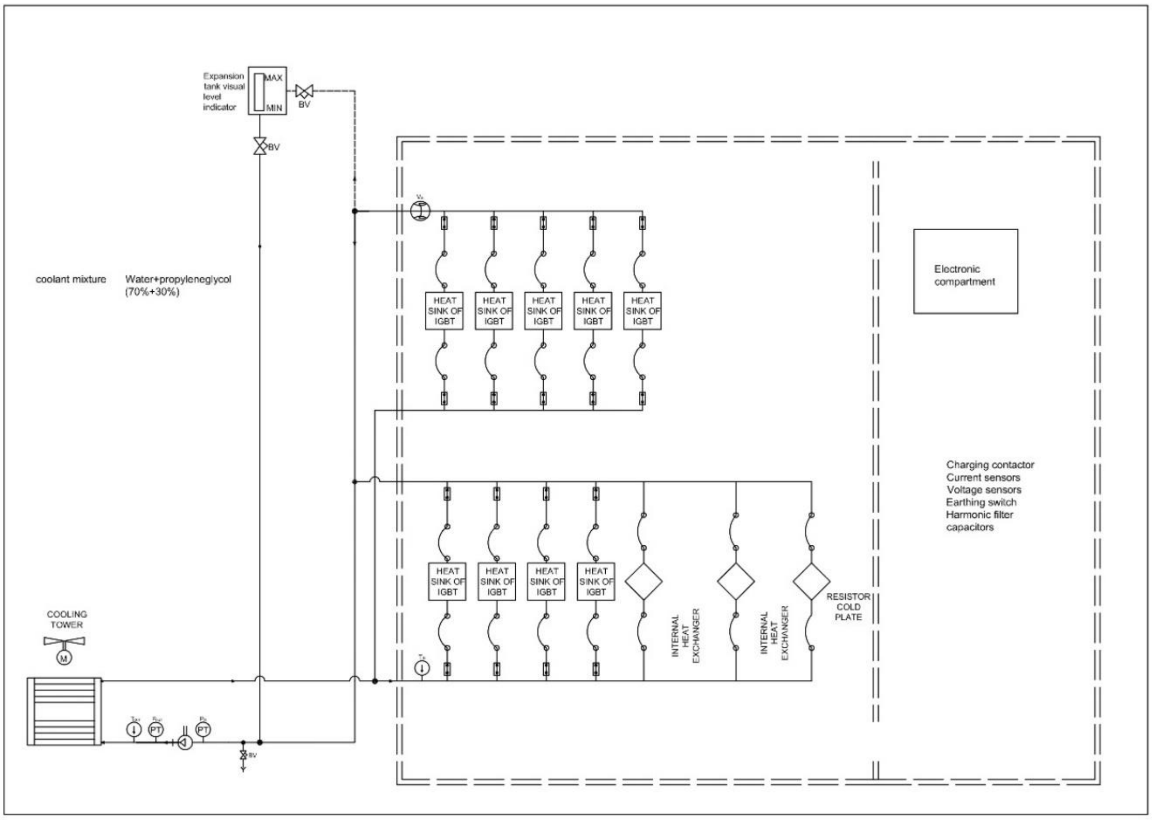


Fig 4.8: Cooling System Layout

4.2. Technical Specification

4.2.1. Line Side Converter

Number of inputs	2 single phase inputs connected to transformer secondary windings
Rated input voltage	1269 VRMS
Maximum input voltage	1523 VRMS
Minimum input voltage	838 VRMS
Supply frequency	50±4 Hz
Secondary transformer input voltage range for full power WAP-5 /WAP-7 locomotive	1142 - 1396 VRMS
Switching device	IGBT
Converter input voltage waveform During operation	Pulse-width modulated
IGBT switching frequency	250 Hz
Maximum voltage rise (du/dt)	4 kV/µs

Rated input phase current	1142 ARMS
Protective measures in case of short circuit or other harmful events in the converter	All IGBT pulses are blocked and VCB is activated
Protective measures in case of over current or short circuit	Blocking of IGBT pulses

4.2.2. Motor Side Inverter

Number of inverters per traction converter	2 for Bo-Bo / 3 for Co-Co
Rated output continuous current	370 ARMS
Maximum output current (short time overload)	540 ARMS
Switching device	IGBT
Output voltage waveform	Pulse-width modulated
Switching frequency	100 - 400 Hz
Rated output voltage range (fundamental Component)	0 - 2180 VRMS
Frequency range of fundamental component of output voltage	0 - 175 Hz
Maximum output voltage rise	4kV/µs

4.2.3. Auxiliary Supply

DC power supply	
Rated DC-supply voltage	110VDC
Minimum DC-supply voltage	77VDC
Maximum DC-supply voltage	130VDC
Power consumption control electronics	≈ 1kW

AC power supply	
Power supply for pump and internal fans	3×415 VRMS ± 10%,50Hz
Power consumption cooling pump	≈ 6kW
Power consumption internal fans	≈ 1kW

4.2.4. Safety Requirements

Active DC-link discharge time (DC-link voltage below60VDC)	<2 s
Passive DC-link discharge time (DC-link voltage below60VDC)	<10min
Converter earthing	Middle point of DC-link connected to earth using high-ohmic voltage divider.

4.2.5. Signal interface to vehicle

Measurement sensors	
Motor speed sensor	Dual channel active Hall-effect speed sensor (3 dual channel sensors)
Catenary supply voltage sensor	0 - 250 VRMS analog input
Current sensors	Analog input (±24Vtransducer power supply) (upto6 inputs)
Transformer oil pressure sensor	4 - 20 mA analog input, 24V power supply
Digital inputs and outputs	
Digital outputs (Relay contacts)	Up to 16 (110VDC,500mA)
Digital inputs (Relay contacts)	Up to 16 (110VDC,5mA)
Communication interfaces	
Internal communication bus	CAN
External communication buses	MVB
Service interfaces	Ethernet

4.2.6. Converter cooling system

Cooling of power parts	Forced liquid cooling with cooling pump inside converter cabinet. The heat exchanger is mounted in the machine room, and is not in scope of supply
Cooling liquid	Ethylene Glycol based

Maximum power losses transferred to Liquid cooling system	≤ 49 KW
Maximum cooling liquid temperature at inlet Continuous water flow	≈60 °C
Continuous water flow	≈ 240 L/min
Pressure drops in the system	≤ 2.2 bar

4.3. Mechanical Specification

The preliminary front view of the converter outline is shown in Fig. 4.9. The main components of the converter are labelled with numbers from 1 to 4. The largest component is the **power module compartment**, which houses all the **Active Front End (AFE) modules**, **inverter modules**, and their corresponding **DC-link capacitors**. Internal fans provide forced ventilation inside this compartment, circulating air according to the natural ventilation flow.

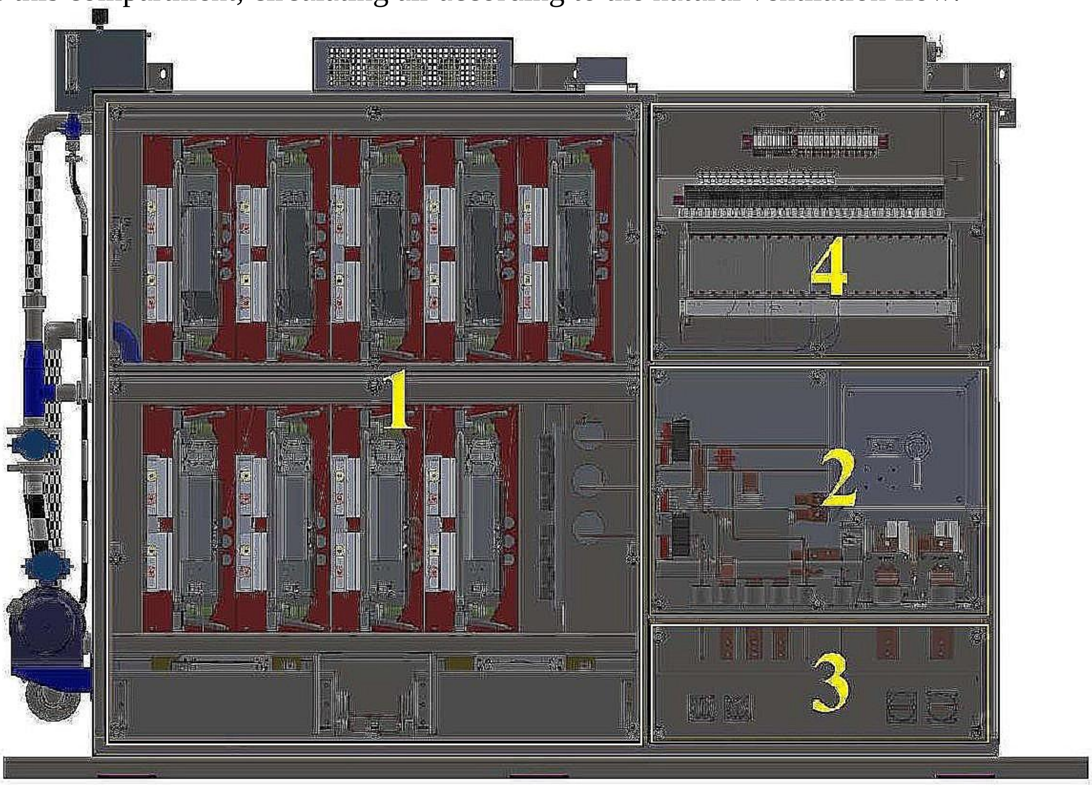


Fig 4.9: Front View of SR Converter Cubicle and preliminary Component Configuration

The **connection cubicle**, marked as number 3 and located in the lower middle part of the converter, contains all the main terminals for power cabling.

In the compartment labelled number 2, the **main**, **pre-charge**, and **output contactors** are located, along with some of the **voltage** and **current sensors**. The **resonant capacitor bank**, along with the **matching unit capacitors**, is mounted at the bottom of this compartment.

The **control electronics**, including the necessary **power supplies**, are located in the part marked with number 4. This section also houses all the **connection interfaces** for control and communication with the rest of the locomotive.

The **expansion vessel** and the **cooling system pump** are located on the **left wall** of the converter cubicle, as shown in Fig. 4.10.

4.3.1. Components Placement with Functional Briefing of the SR Cubicle

The traction converter cubicle houses various key electrical and electronic components that are essential for the efficient operation, safety, and cooling of the system. These components are strategically placed to ensure optimal functioning and ease of maintenance. Below is an overview of the main components, their placement within the cubicle, and their technical specifications and ratings.

Front View

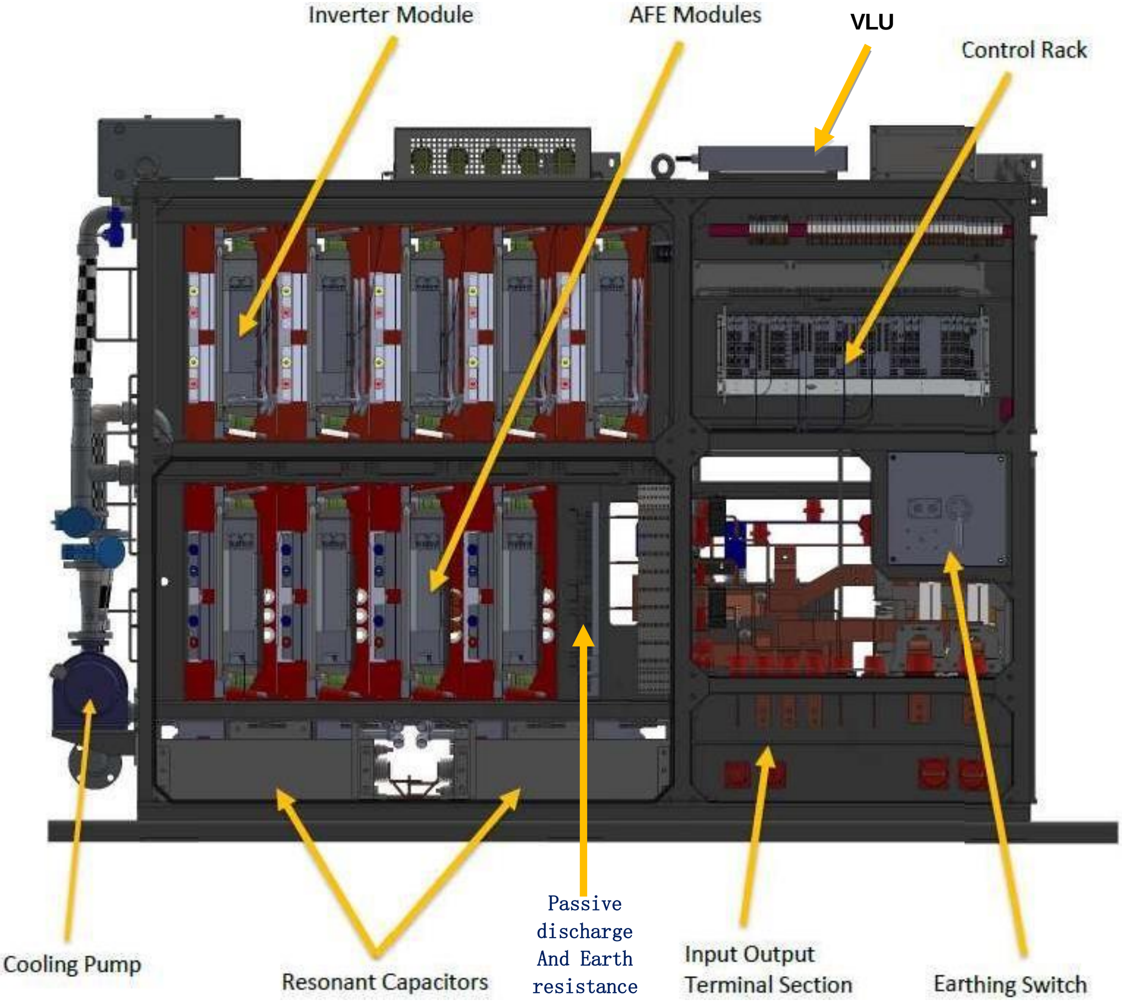


Fig 4.10: Layout of Components from Front View of SR Converter

Rear-view

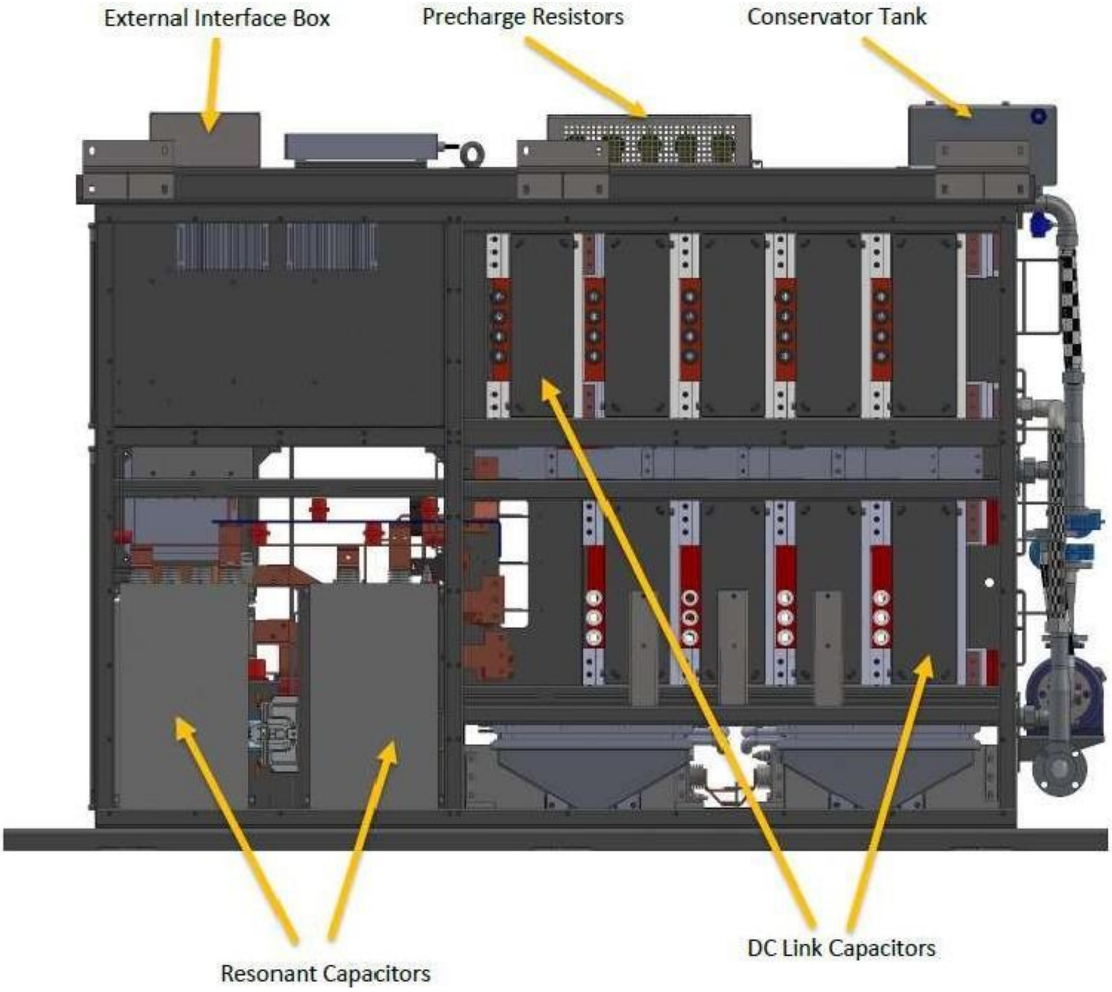


Fig 4.11: Layout of Components from Rear-view View of SR Converter

4.3.1.1. Power Modules (LCPU & MIPU)

Placement:

- MIPU (Motor Inverter Power Unit): Positioned centrally within the cubicle, ensuring optimal thermal management.
- LCPU (Line Converter Power Unit): Located towards the lower section of the cubicle to facilitate efficient cooling.

Functionality:

The traction converter utilizes two key power modules LCPU and MIPU to manage power conversion and motor control with high efficiency.

LCPU (Line Converter Power Unit):

- Each LCPU is equipped with parallel IGBTs and an AFE (Active Front End) module.
- A total of 4 IGBTs are installed in each unit, representing one phase leg of the line converter 4QC.
- The IGBTs are connected using low-inductive laminated busbars, minimizing electrical losses.

- These IGBTs operate in a master-slave configuration, ensuring equal current distribution for balanced operation.

MIPU (Motor Inverter Power Unit):

- The AFE-based MIPU controls the three output legs of the inverter, with no parallel connection between AC outputs of respective phases.
- Each IGBT driver has its own power supply and is independently controlled in a “Master” configuration for all IGBTs.
- The AFE ensures smooth power delivery to the motor, while also improving efficiency by regenerating power back to the grid.

Key Features of AFE in LCPU & MIPU:

- Bidirectional Power Flow: Regenerates power back to the grid in both LCPU and MIPU, reducing energy costs.
- PWM Modulation: Smoothens current peaks, forming a near-perfect sine wave, ensuring optimal power quality.
- Power Factor Correction: The power factor is nearly 1, maintaining a balanced load-to-power ratio for maximum efficiency.
- Harmonic Reduction: THD <5%, eliminating high-order harmonics and reducing the need for additional power quality equipment.
- Stable Power Quality: Both modules ensure stable power, unaffected by fluctuations in the mains supply, and support flexible parallel or serial configurations.

Technical Specifications & Ratings:

		LCPU	MIPU
Continuous DC Voltage	:	2800 VDC	2800 VDC
Rated IGBT Voltage	:	4500 V	4500 V
Rated IGBT Current	:	1200 A	1200 A
Switching Frequency	:	250 Hz	500 Hz

- **Cooling Type: Liquid-cooled**

4.3.1.2. Main Contactor (K1)

Placement:

- Positioned near the DC link input terminal, connected to the power source and high-voltage components.

Functionality:

- The main contactor connects and disconnects the DC link to the traction converter system. It isolates the system during fault conditions or maintenance to prevent electrical damage.

Technical Specifications & Ratings:

- Rated Operating Voltage (Ue) : 1800 V
- Conventional Thermal Current (Ith) : 1600 A
- Temperature Range : -40°C to +85°C
- Maximum Switching Frequency : 1000 cycles per hour

4.3.1.3. Pre-Charge Contactor (KP)

Placement:

- Located near the DC link capacitors, ensuring proper current flow control during startup.

Functionality:

- The pre-charge contactor limits the inrush current when charging the DC link capacitors, protecting the system from current spikes that could damage components.

Technical Specifications & Ratings:

- Nominal Control Voltage : 110 VDC
- Maximum Input Voltage : 1573 VRMS
- Peak Input Voltage : 2224 Vpeak
- Maximum Temperature : 75°C
- Inrush Current Rating : 5000 A

4.3.1.4. DC Link Capacitors

Placement:

- Positioned at the top or sides of the cubicle, often located in banks for ease of maintenance and optimal energy storage.

Functionality:

- DC link capacitors store energy and stabilize voltage, acting as energy buffers to ensure smooth power delivery. They filter out fluctuations and provide consistent voltage to the traction motor.

Technical Specifications & Ratings:

- Capacitance : 2.2 µF per capacitor
- Voltage Rating : 2200 V DC
- Energy Storage Capacity : 4.8 kJ per capacitor
- Operating Temperature Range: -40°C to +85°C

4.3.1.5. Cooling Pump and Motor Unit

Placement:

- Typically located in the lower section of the cubicle, integrated with the liquid cooling system for efficient heat dissipation.

Functionality:

- The cooling pump circulates a coolant (water and ethylene glycol mixture) through the system, keeping critical components like IGBTs, capacitors, and resistors within safe operating temperatures.

Technical Specifications & Ratings:

- Flow Rate : 50 L/min
- Operating Pressure : 4 bar
- Coolant Type : Water and ethylene glycol mixture (50:50)
- Motor Power : 1.5 kW
- Temperature Range : -10°C to +45°C

4.3.1.6. Pre-Charge Resistors (R1 – R5)

Placement:

- Mounted near the DC link capacitors, often placed on the cooling plate or heat sinks to manage heat dissipation during charging.

Functionality:

- These resistors limit the inrush current when charging the capacitors, ensuring a controlled startup process and preventing damage due to sudden current spikes.

Technical Specifications & Ratings:

- Nominal Resistance (Each Resistor) : 15 Ω
- Total Resistance (5 Resistors in Series) : 75 Ω
- Power Rating (Each Resistor) : 10 W
- Tolerance : ±10%

4.3.1.7. Passive Discharge Resistors (R6 – R11)

Placement:

- Positioned near the IGBT modules or power electronics components, often mounted on a separate cooling plate for thermal management.

Functionality:

- These resistors ensure that the DC link voltage is safely discharged after the converter is turned off, reducing the voltage to below 60V for safe maintenance and preventing dangerous residual charge.

Technical Specifications & Ratings:

- Nominal Resistance (Each Resistor) : 10 Ω
- Total Resistance (6 Resistors in Parallel) : 1.67 Ω
- Power Rating (Each Resistor) : 20 W
- Maximum Discharge Time : Less than 10 minutes to reach <60V

4.3.1.8. Earthing Resistors (R12 – R17)

Placement:

- Typically mounted on the cooling plate, close to the DC link capacitor and other critical power components.

Functionality:

- Earthing resistors are part of the fault detection system. They ensure that the DC link is grounded and monitor leakage currents, detecting any earth faults that could compromise system safety.

Technical Specifications & Ratings:

- Nominal Resistance (Each Resistor) : 15 Ω
- Total Resistance (Two Groups in Parallel) : 7.5 Ω
- Power Rating (Each Resistor) : 10 W
- Maximum Fault Detection Time : 10 ms

4.3.1.9. Crowbar Resistor (R18)

Placement:

- Located near the DC link, positioned to dissipate energy in the event of overvoltage conditions caused by dynamic power disturbances.

Functionality:

- The crowbar resistor provides overvoltage protection by absorbing excess energy when the DC link voltage rises beyond a set threshold, protecting the converter from transient overvoltage events.

Technical Specifications & Ratings:

- Nominal Resistance : 2.5 Ω ±10%

- Energy Dissipation per Load Cycle : 1000 kJ
- Maximum Voltage Rating : 2200 V DC

4.3.1.10. Earth Switch (K2)

Placement:

- Positioned near the DC link and associated power electronics, to connect the system to ground once the DC link is de-energized.

Functionality:

- The earth switch is a critical safety component that ensures the system is grounded and safe for maintenance work by discharging any residual voltage.

Technical Specifications & Ratings:

- Rated Voltage : 2200 V DC
- Current Rating : 1000 A
- Switching Mechanism : Manual or automatic with key interlock
- Operating Temperature Range : -40°C to +85°C

4.3.2. Functional Overview of the Entire Traction Converter Cubicle

The traction converter cubicle serves as the central unit for converting, controlling, and conditioning electrical power for traction motors used in transportation systems like trains or trams. Key functions include:

1. **Power Conversion:**
   IGBTs and associated modules convert DC power to AC, ensuring controlled power delivery to the motor.
2. **Voltage Stabilization:**
   DC link capacitors smooth out voltage fluctuations, while resistors manage inrush current during startup and voltage discharge during shutdown.
3. **Overvoltage Protection:**
   Crowbar resistors protect against transient overvoltage, and earthing resistors monitor leakage currents to detect faults.
4. **Thermal Management:**
   The cooling pump circulates coolant to maintain optimal operating temperatures for critical components.
5. **Safety Features:**
   The earth switch and contactors provide safety mechanisms for system isolation during faults or maintenance.

By efficiently placing these components, the cubicle ensures reliable power conversion, thermal management, and safety, all of which are essential for the smooth and safe operation of the traction system.

4.4. Transport, Shipping, and Storage Guidance

- **Transport**

The converter must be transported carefully to avoid any damage. Hard impacts should be avoided for all devices with electronic components. The environmental conditions during transportation should be clean and free of contaminants. Openings in the enclosure must be sealed with suitable materials to prevent dirt and moisture from entering.

- **Shipping**

The pallet used should be appropriately sized for the converter.

Traction Converter Cubicle External Dimensions (with 3000 mm lifting hook width):

- Depth: 1100 mm
- Height: 2080 mm

To secure the converter during transport, use safety straps. To protect the unit from pollution and humidity, wrap it with appropriate plastic films.

For shipping, a container with a cover, such as one made of wood, is recommended. The weight of the traction cubicle is 2700 kg, and the converter must be securely fastened to prevent any movement during transport.

➢ **Storage**

- Do not stack the converters on top of each other.
- The storage location must be clean and dry.
- The storage temperature range should be between 0°C and +55°C.
- Ensure all openings in the enclosure are sealed with suitable materials to prevent ingress of dirt or moisture.

4.5. Handling of Traction Converter

4.5.1. Unboxing the traction converters

The traction converter is packed in a wooden box with nut bolts (M16-17) and wrapped in plastic to prevent moisture and water damage. To unbox the traction converter, carefully inspect the packaging for any mechanical damage before cutting any securing straps or plastic wrap on the plywood box. Use appropriate lifting equipment, such as a crane, to remove the converter from the box, ensuring it is lifted by the designated points to avoid damage. Once unboxed, visually inspect the converter for any signs of damage, particularly to the coolant pump section on the left side of the cubicle. Check for loose parts and ensure all openings are sealed. Clean any debris from the surface with a dry cloth and move the converter to its installation location, ensuring the environment is clean and dry.

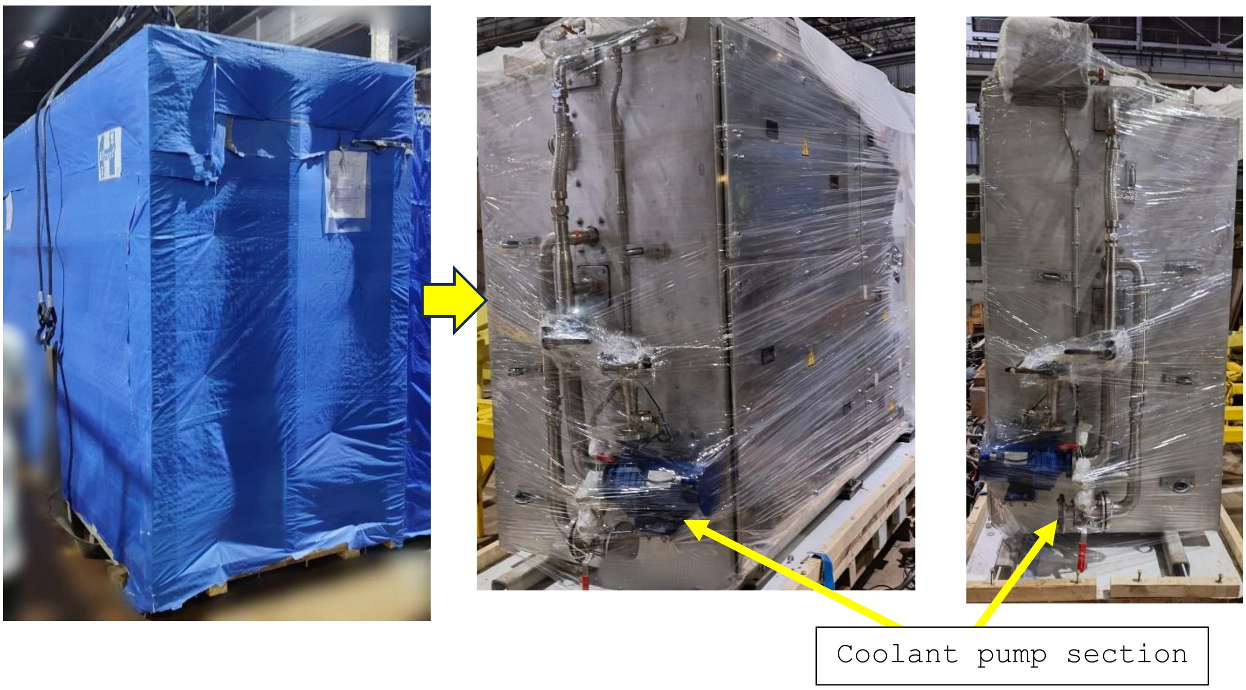


Fig 4.12: Before & after unboxing of Traction converter

4.5.2. Lifting of Traction Converter

Attach the traction converter lifting tackle (D-shackle) to the converter as shown in Fig 4.13, then lift the converter from its position. For refitting or reinstallation, follow the reverse procedure. Verify that the converter is lifted properly along with the lifting tackle, ensuring the tackle is securely attached. During lifting, inspect the converter for any damage to ensure safe handling.

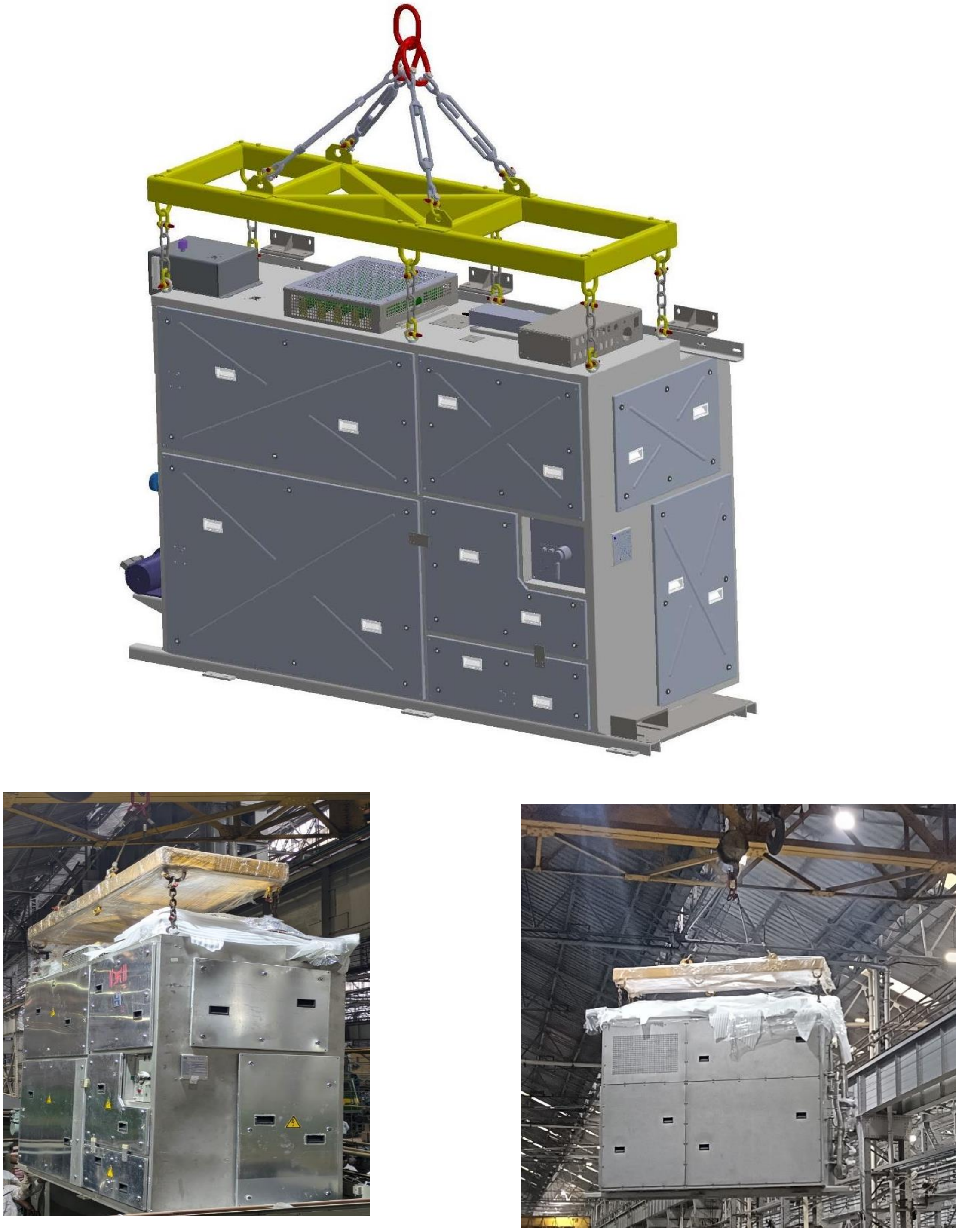


Fig 4.13: Lifting tackle of Traction Converter Cubicle

4.6. Installation of Traction Converter

Always use a crane to smoothly lift the converter with a lifting jig, ensuring the angle between the chains of the lifting gear doesn’t exceed 60°. With careful precision, lift the converter into the vehicle and place it securely in its designated position, making sure it's perfectly aligned for optimal performance.

4.6.1. Mechanical Specification Of Traction Converter

The overall space requirement for the traction converter panel can be determined from its overall dimensions.

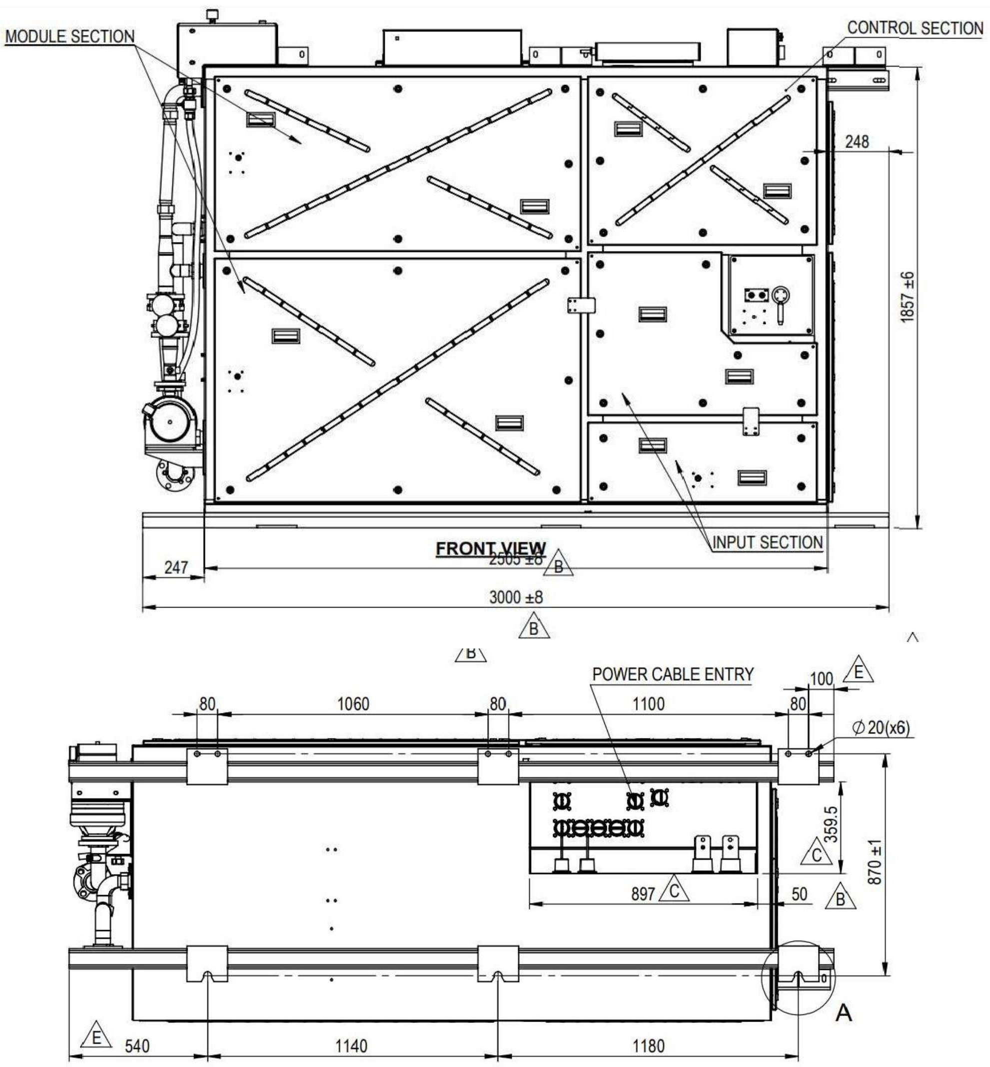


Fig 4.14: OGA of the Traction Converter

4.6.2. Traction Converter Cubicles mounting instructions

The Traction Converter panel is secured to the locomotive frame using the upper and lower fixing rails (Refer Fig 4.14).

4.6.2.1 Bottom Fixing Rail

The front bottom side of the traction converter is secured to the locomotive frame using six M16x40 hexagonal bolts, along with M16 plain washers and M16 spring washers. These bolts are arranged in three pairs: one pair on the left, one in the middle, and one on the right, using washers for proper placement. (Refer to Fig 4.14)

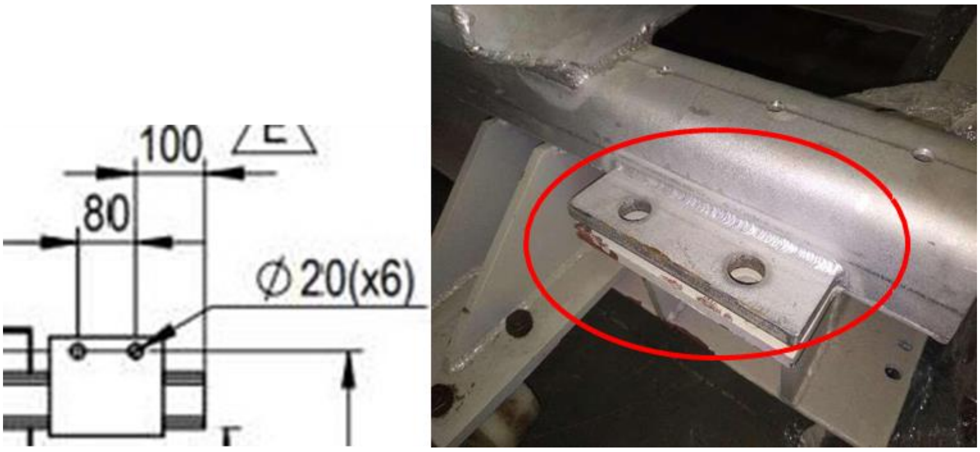


Fig 4.15: Bottom Mounting (Front Side)

Fig 4.15.1: Base Mounting of Traction Converters

The rear bottom side of the traction converter is secured by three guiding pins located on the bottom part of the frame. These pins are arranged at equal intervals: one on the left, one in the middle, and one on the right.

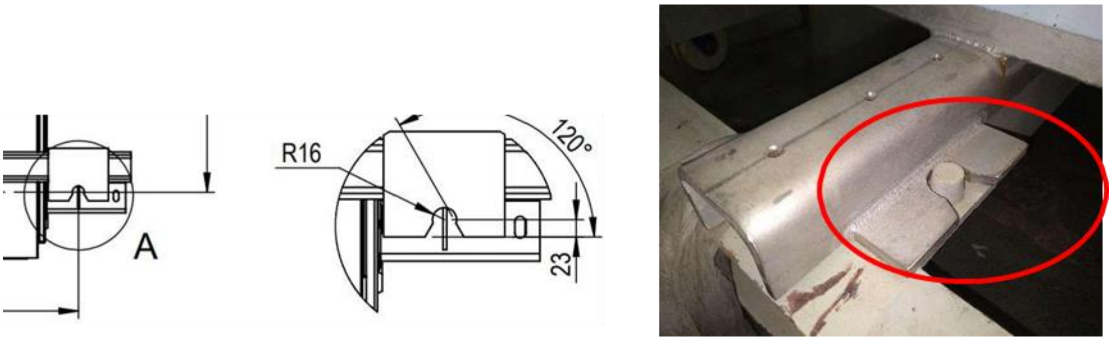


Fig 4.16: Lower Mounting (Back Side)

4.6.2.2 Top Fixing Rail

On top rear side of the traction converter is fixed with the help of angle brackets 6nos.(3 X 2nos.) to the loco side wall at 3 different locations as shown in Figure 4 with the help of M12X35 hexagonal bolt(18nos.), M12 plain washer(30nos.), M12 spring washer(18nos.) and M12 nut(12nos).

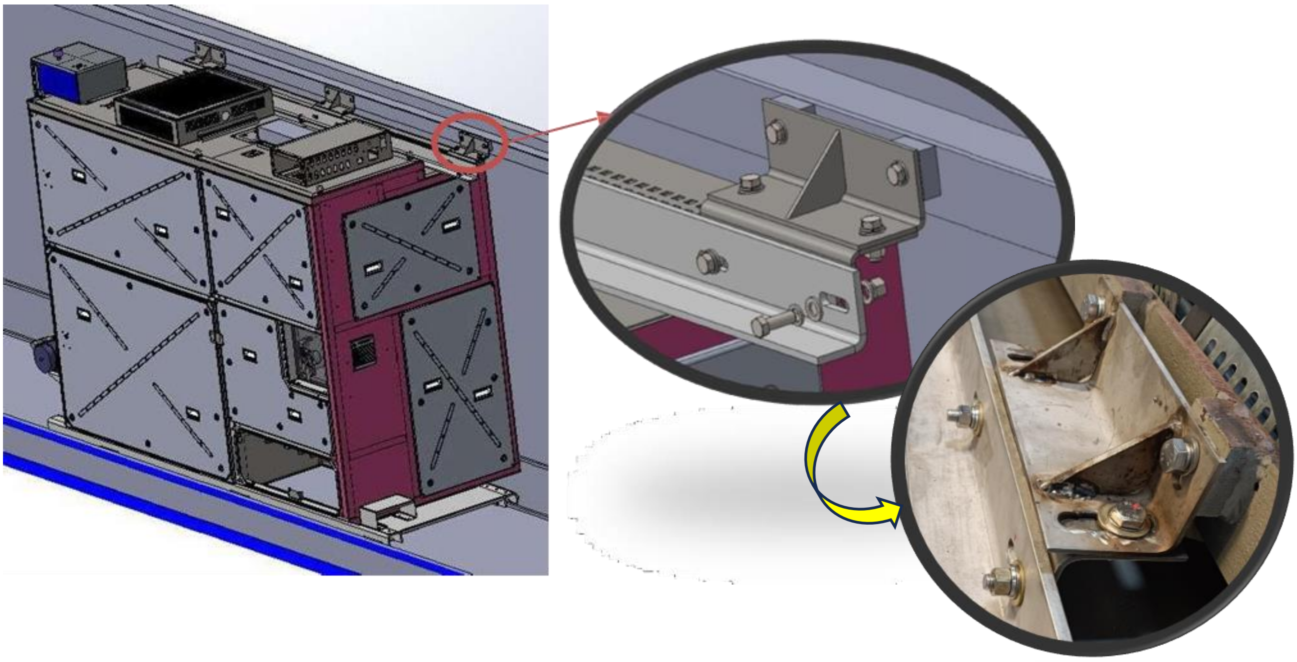


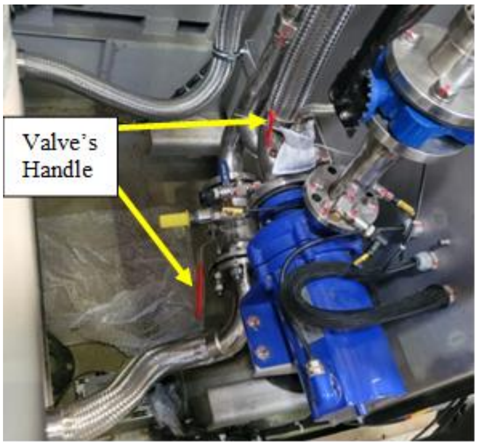
Fig 4.17: Top Mounting angle brackets

- If the device is not properly installed, the converter may malfunction or be damaged.
- The converter should only be installed by qualified personnel.
- Follow the instructions under "Transporting the Converter" on how to safely transport the converter with a crane.
- If the converter is damaged during installation in the vehicle, cease the installation and return it to the manufacturer for repair.
- Before starting work, refer to the relevant instructions and notes in the vehicle manufacturer's technical documentation.

4.6.3. Coolant Filling Procedure for Converter System

1. Check the connection of inlet outlet flexible pipes in between converter and heat exchanger.

2. Open all the valves of the converter.



3. Connect the external pump to the drain valve male coupling of the traction converter using a flexible hose pipe of ½ inch diameter.

4. Fill the coolant by external pump connected through flexible pipe until it reaches the 50% level of the float level indicator mounted on the expansion tank, then close the ½ inch drain ball valve.

5. Remove the external pump and flexible hose pipe after closing the ½ inch drain valve.

4.6.4. Electrical Connections of Traction Converter

To connect the converter electrically, follow these steps:

- **Disconnect the locomotive battery** before working on the control plugs to ensure safety.
- **Establish a grounding connection** between the traction converter and the locomotive frame. This is necessary as the traction converter is not welded to the underframe. Protective earth connections must be properly terminated.
- **Protect all cable lugs** with heat shrink tubing to ensure proper insulation and prevent damage.
- **Connect all power cables** according to the detailed instructions provided in the documentation.

4.6.4.1 Power terminals details & Connection

The power terminals are located on the lower right-hand side of the converter (refer to Fig 4.10). All terminal connections can be made using M12-sized hardware (bolt, nut, and washers).

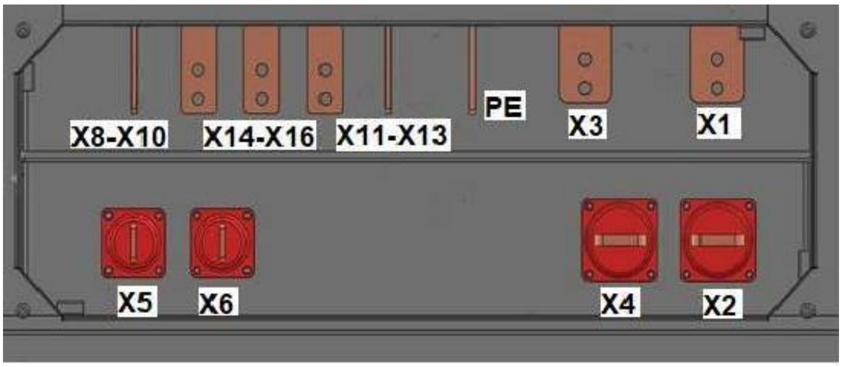


Fig 4.18: Power Terminal Layout

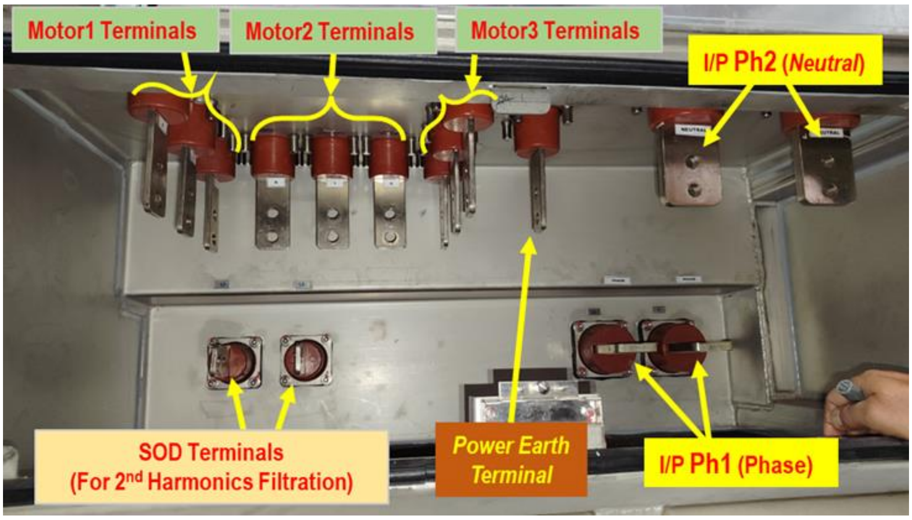


Fig 4.19: Input-Output Power Terminals

Description	**Converter Input Terminals**	**Destination Connection**		**Cable No. SR1(loco)**	**Cable No. SR2(loco)**	**Cable Size (locomotive)**
		SR1	***SR2***			
NSR 1 (Ph2-*Neautral*)	**X1**	**2V4**	**2V2**	801A	801B	320 sq mm
NSR 1 (Ph1-*phase*)	**X2**	**2U4**	**2U2**	804A	804B	
NSR 2 (Ph2-*Neautral*)	**X3**	**2V1**	**2V3**	811A	811B	320 sq mm
NSR 2 (Ph1-*phase*)	**X4**	**2U1**	**2U3**	814A	814B	
2nd Harmonic (SOD)	**X5**	**X11**	**X21**	851A	851B	320 sq mm
2nd Harmonic (SOD)	**X6**	**X12**	**X22**	852A	852B	
ASR 1 phase 1	**X8**	**Motor 1**		101A	101B	2X120 sq mm
ASR 1 phase 2	**X9**			102A	102B	
ASR 1 phase 3	**X10**			103A	103B	
ASR 2 phase 1	**X11**	**Motor 2**		101A	101B	2X120 sq mm
ASR 2 phase 2	**X12**			102A	102B	
ASR 2 phase 3	**X13**			103A	103B	
ASR 3 phase 1	**X14**	**Motor 3**		101A	101B	2X120 sq mm
ASR 3 phase 2	**X15**			102A	102B	
ASR 3 phase 3	**X16**			103A	103B	
Power Earth				PE		95 sq mm

Table 4.3: Power Cable terminal

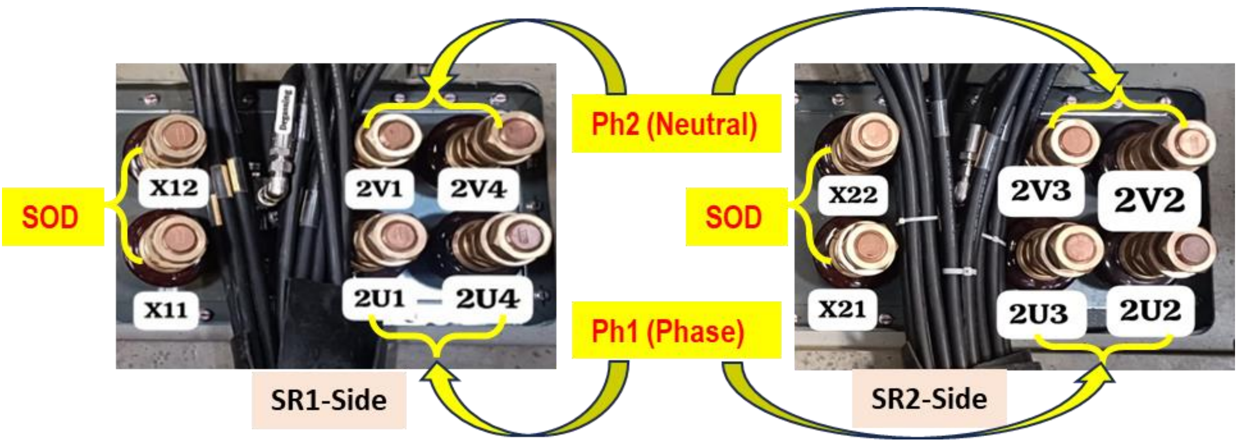


Fig 4.20: Transformer side terminals for Traction Converters Power Connections

➢ **Flexible Bus Bars Installations of Input Terminals:**

Confirmed correct alignment and secure attachment. Inspected for proper insulation and checked for full tighten of hardware.

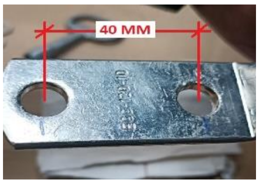
➢ **Rigid & Flexible Bus Bar Installations of SOD Terminals:**

Ensure correct alignment and secure attachment. Inspect for proper insulation and verify that hardware is fully tightened. Only M10 x 40 mm long hex bolts should be used for the installation of the input section busbars.

➢ **Motor connections of Output Terminals:**

Confirm correct alignment and secure attachment, inspect for proper insulation, and ensure hardware is fully tightened using M10 x 40 mm long hex nut and bolt, along with spring and flat washers.

✓ Lug Model: ECC-120-10



4.6.4.2 Control Cable connections of Traction converter

The connectors for the control and signal circuits are conveniently located on the right-hand top side of the traction converter cabinet, allowing for easy access from the outside without the need to open any doors (Refer to Fig 4.10).

Fig 4.21: Control Interface Terminals

Description	HR-TC2400AC ports	Plug Converter 1	Plug Converter 2	Connector Type
Auxiliary supply (3x415V/50Hz)	**XA18**	XK42C	XK57C	Harting 6-pins
Converter control port	**XA20**	XK42A	XK57A	Gimota 35-pins
Primary voltage measurement	**XA16**	XK42B	XK57B	Gimota 5-pins
Primary return current measurement	**XA1**	415.AA/1	415.AA/2	D-Sub 9-pins
Auxiliary current measurement	**XA2**	415.AC/1	415.AC/2	D-Sub 9-pins
Harmonic filter current measurement	**XA3**	415.AE/1	415.AE/2	D-Sub 9-pins
Hotel load winding measurement	**XA4**	415.AG/1	415.AG/2	D-Sub 9-pins
Transformer oil pressure measurement	**XA15**	415.AI/1	415.AI/2	D-Sub 9-pins
Motor 1 temperature measurement	**XA5**	415.DA/1	415.DA/2	D-Sub 9-pins
Motor 2 temperature measurement	**XA6**	415.DC/1	415.DC/2	D-Sub 9-pins
Motor 3 temperature measurement	**XA7**	415.DE/1	415.DE/2	D-Sub 9-pins
Transformer oil temperature measurement	**XA14**	415.DI/1	415.DI/2	D-Sub 9-pins
Motor 1 speed sensor supply	**XA9**	415.HA/1	415.HA/3	D-Sub 9-pins
Motor 1 speed measurement	**XA8**	415.HA/2	415.HA/4	D-Sub 9-pins
Motor 2 speed sensor supply	**XA11**	415.HC/1	415.HC/3	D-Sub 9-pins

Motor 2 speed measurement	**XA10**	415.HC/2	415.HC/4	D-Sub 9-pins
Motor 3 speed sensor supply	**XA13**	415.HE/1	415.HE/3	D-Sub 9-pins
Motor 3 speed measurement	**XA12**	415.HE/2	415.HE/4	D-Sub 9-pins
MVB	**XA19.1 / XA19.2**	415.MR/1 / 415.MR/2	415.MR/3 / 415.MR/4	D-Sub 9-pins
Ethernet	**XA17**			M12 D-coded

Table 4.4: Control & Signal connection details

4.6.4.2.1. Auxiliary voltage supply connector overview (XA18)

		Comment/Suggestion
Designation port HR- TC2400AC	-XA18	
Designation plug SR1	XK42C	Locomotive level
Designation plug SR2	XK57C	Locomotive level
Supplier	Harting	
Type	6-pin	
Conductor size	2.5 mm^2	
	Item	Part number
Port description	Housing	09 30 006 0301
	Insert	09 33 006 2602
	Male pin	09 33 000 6102
Plug description	Housing	19 30 006 1540
	Insert	09 33 006 2702
	Female pin	09 33 000 6202
Pin assignment	Input/Output	Description
1	I	Phase U 230 VAC
2	I	Phase V 230 VAC
3	I	Phase W 230 VAC
4, 5,6	n.c.	

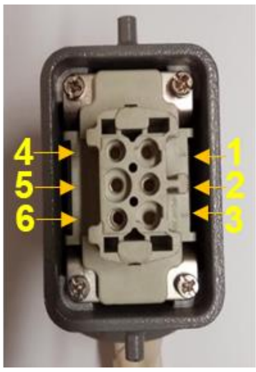
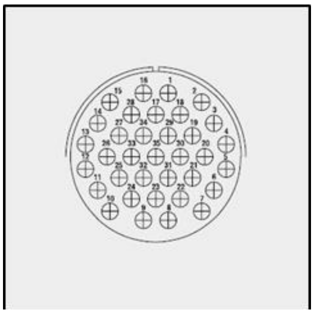


Fig 4.22: Male/Female Hearting Connector (6-pins)

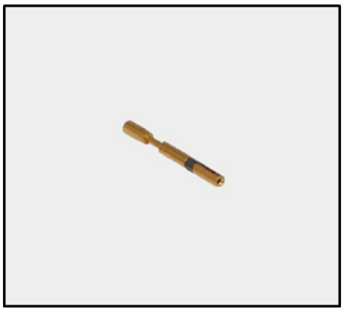
4.6.4.2.2. Converter Control Connector Overview

		Comment/suggestion
Designation port HR-TC2400AC	-XA20	
Designation plug SR1	XK42A	
Designation plug SR2	XK57A	
Supplier	Gimota	
Type of connector	35-pins circular	
Conductor size	2.5 mm^2	
	Item	**Part number**
Port description	Port set	GB210-40-35PN-EAC
	Contact Pin	10-40561-22AU
Plug description	Plug set	GB60-40-35SN-EAC
	Contact Socket	10-40560-22AU

Port housing Gimota 35-pins

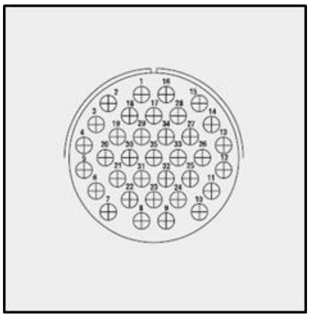


Port pin layout Gimota 35-pins

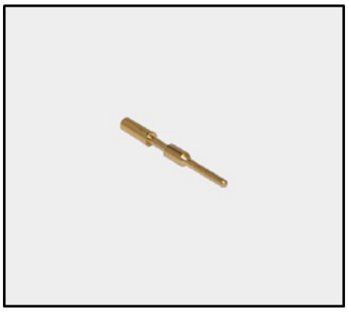


Pin contact size 12, 2.5 mm2 Gimota

Plug housing Gimota 35-pins



Port housing Gimota 35-pins



Socket contact size 12, 2.5 mm2 Gimota

4.6.4.2.3. List of converter control connector signals:

Pin assignment	Conductor SR1	Conductor SR2	Input/ Output	Description
1	2324A/2340	2324B/2325	O	Fast release command FET output
2			I	48 V(DC) supply
3	2322A/2320	2322B/2340	I	Power Supply Fast release FET output
4	2323A/2340	2323B/2320	I	Power Supply Fast release Relay output
5	2321A/2325	2321B/2340	O	Fast release command Relay output
6	2601A	2601B	I	Power supply 1 (110V)
7	2601A	2601B	I	Power supply 2 (110V)
8	2050	2050	I	Battery GND (110V)
9	2050	2050	I	Battery GND (110V)
10	5101A	5101B	I	Digital Outputs power supply
11	2050	2050	I	Battery GND
12	5209	5209	O	Confirmation Protective Shutdown to other SR
13	n.c.	n.c.		
14	5109A/5108A	5109B/5108B	I	Protective Shutdown from other SR
15	5155A/5101B	5155B/5101A	I	Power supply Protective Shutdown
16	5156A/5108B	5156B/5108A	O	Command Protective Shutdown
17	2864	2864	O	Command Harmonic Filter Contactor
18	2866	2866	O	Command Harmonic Filter Adaption Contactor
19	2867	2867	O	Command Harmonic Filter Discharging Contactor
20	2861A	2861B	I	Harmonic Filter Contactor Status
21	2862A	2862B	I	Harmonic Filter Adaption Contactor Status
22	2863A	2863B	I	Harmonic Filter Discharging Contactor Status
23	n.c.	n.c.		
24	n.c.	n.c.		
25	n.c.	n.c.		
26	n.c.	n.c.		
27	n.c.	n.c.		
28	n.c.	n.c.		
29	n.c.	n.c.		
30	n.c.	n.c.		
31	n.c.	n.c.		
32	n.c.	n.c.		
33	n.c.	n.c.		
34	n.c.	n.c.		
35	n.c.	n.c.		

All external sensors are connected to SRCB via D-sub-9-pins connectors, except primary voltage measuring unit.

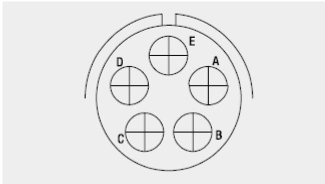
D-sub 9 pins connector items are shown on

Fig 4.24: D-Sub 9 connector and its housing holdings and male & female pin contact (20-24 AWG Gimota)

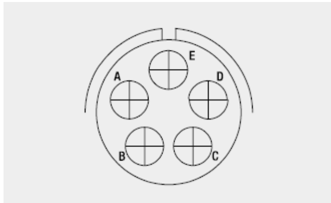
4.6.4.2.4. Primary Voltage Connector overview

Secondary winding output of the external voltage transformer is used by internal voltage transducer to measure primary voltage.

		Comment/Suggestion
Designation port HR-TC2400AC	-XA16	
Designation plug SR1	XK42B	
Designation plug SR2	XK57B	
Sensor scheme position	224.1	
Supplier	Gimota	
Type of connector	5-pins circular	
Conductor size	2,5 mm^2	
	Item	**Part number**
Port description	Port set	GB210-18-11PN-EAC
	Contact Pin	10-40561-22AU
Plug description	Plug set	GB60-18-11SN-EAC
	Contact socket	10-40560-22AU
Pin assignment	**Input/Output**	**Description**
A	I	Phase Voltage 250 VAC
B	I	Neutral 0 VAC
C	I	Earth
D, E	n.c.	



Port pin layout Gimota



Socket pin layout Gimota

4.6.4.2.5. Primary return current Connector overview

		Comment/suggestion
Designation port HR-TC2400AC	-XA1	
Designation plug SR1	415.AA/1	
Designation plug SR2	415.AA/2	
Sensor scheme position	6.2	
Supplier	Gimota	
Connector type	D-Sub 9-pins Male type	
Conductor size	0,5 mm^2	
Coding	See **Error! Reference source not found.**	
	Item	**Part number**
Port description	Port set	TRACHDOP09C09S
	Contact Pin	SUPCP20-24AU2
Plug description	Plug set	TRACHSTS09C09S1
	Contact socket	SUPCS20-24AU2
Pin assignment	**Input/output**	**Description**
2	Supply	-24 V
3	Supply	+24 V
6	I	Measurement
1,4,5,7,8,9	-	n.c.

4.6.4.2.6. Auxiliary winding current Connector overview

		Comment/suggestion
Designation port HR-TC2400AC	-XA2	
Designation plug SR1	415.AC/1	
Designation plug SR2	415.AC/2	
Sensor scheme position	42.3	
Supplier	Gimota	
Connector type	D-Sub 9-pins male type	
Conductor size	0,5 mm^2	
Coding	See **Error! Reference source not found.**	
	Item	**Part number**
Port description	Port set	TRACHDOP09C09S
	Contact Pin	SUPCP20-24AU2
Plug description	Plug set	TRACHSTS09C09S1
	Contact socket	SUPCS20-24AU2
Pin assignment	**Input/Output**	**Description**
2	Supply	-24 V
3	Supply	+24 V
6	I	Measurement
1,4,5,7,8,9	-	n.c.

4.6.4.2.7. Harmonic filter current Connector overview

		Comment/suggestion
Designation port HR-TC2400AC	-XA3	
Designation plug SR1	415.AE/1	
Designation plug SR2	415.AE/2	
Sensor scheme position	8.5	
Supplier	Gimota	
Connector type	D-Sub 9-pins male type	
Conductor size	0,5 mm^2	
Coding	See **Error! Reference source not found.**	
	Item	**Part number**
Port description	Port set	TRACHDOP09C09S
	Contact Pin	SUPCP20-24AU2
Plug description	Plug set	TRACHSTS09C09S1
	Contact socket	SUPCS20-24AU2
Pin assignment	**Input/output**	**Description**
2	Supply	-24 V
3	Supply	+24 V
6	I	Measurement
1,4,5,7,8,9	-	n.c.

4.6.4.2.8. Hotel load winding current connector overview

		Comment/suggestion
Designation port HR-TC2400AC	-XA4	
Designation plug SR1	415.AG/1	
Designation plug SR2	415.AG/2	
Sensor scheme position	33	
Supplier	Gimota	
Connector type	D-Sub 9-pins male type	
Conductor size	0,5 mm2	
Coding	See **Error! Reference source not found.**	
	Item	**Part number**
Port description	Port set	TRACHDOP09C09S
	Contact Pin	SUPCP20-24AU2
Plug description	Plug set	TRACHSTS09C09S1
	Contact socket	SUPCS20-24AU2
Pin assignment	**Input/Output**	**Description**
2	Supply	-24 V
3	Supply	+24 V
6	I	Measurement
1,4,5,7,8,9	-	n.c.

4.6.4.2.9. Transformer oil pressure connector overview

		Comment/suggestion
Designation port HR-TC2400AC	-XA15	
Designation plug SR1	415.AI/1	
Designation plug SR2	415.AI/2	
Sensor scheme position	213.5	
Supplier	Gimota	
Connector type	D-Sub 9-pins male type	
Conductor size	0,5 mm2	
Coding	See **Error! Reference source not found.**	
	Item	**Part number**
Port description	Port set	TRACHDOP09C09S
	Contact Pin	SUPCP20-24AU2
Plug description	Plug set	TRACHSTS09C09S1
	Contact socket	SUPCS20-24AU2
Pin assignment	**Input/output**	**Description**
3	Supply	+24 V
6	I	Measurement (4-20 mA signal)
9	O	0 V
1,2,4,5,7,8	-	n.c.

4.6.4.2.10. Motor Temperature Measurement Connector Overview

				Comment/suggestion	
Designation port HR-TC2400AC	-XA5	-XA6	-XA7		
Designation plug SR1	415.DA/1	415.DC/1	415.DE/1		
Designation plug SR2	415.DA/2	415.DC/2	415.DE/2		
Sensor scheme position	98 (2x measurements)				
Supplier	Gimota				
Connector type	D-Sub 9-pins male type				
Type of input	Voltage input			RTD (PT100) sensor input	
Conductor size	0,5 mm^2				
Coding	See **Error! Reference source not found.**				
	Item			**Part number**	
Port description	Port set			TRACHDOP09C09S	
	Contact Pin			SUPCP20-24AU2	
Plug description	Plug set			TRACHSTS09C09S1	
	Contact socket			SUPCS20-24AU2	
Pin assignment	**Input/output**			**Description**	**Description**
1,6	I			Measurement	Sensor 1 Supply
4	O			0 V	Sensor 1 Measuring
7	O			Constant current generator	Sensor 1 Measuring
5,9	I			Measurement	Sensor 2 Supply
2	O			0 V	Sensor 2 Measuring
8	O			Constant current generator	Sensor 2 Measuring
3	-			n.c.	

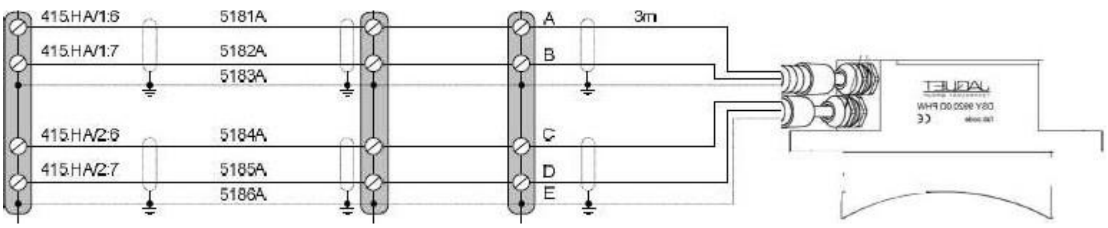
4.6.4.2.11. Transformer Oil Temperature Measurement Connector Overview

		Comment/suggestion	
Designation port HR-TC2400AC	-XA14		
Designation plug SR1	415.DI/1		
Designation plug SR2	415.DI/2		
Sensor scheme position	210.5		
Supplier	Gimota		
Connector type	D-Sub 9-pins male type		
Conductor size	0,5 mm2		
Coding	See **Error! Reference source not found.**		
	Item	**Part number**	
Port description	Port set	TRACHDOP09C09S	
	Contact Pin	SUPCP20-24AU2	
Plug description	Plug set	TRACHSTS09C09S1	
	Contact socket	SUPCS20-24AU2	

Pin assignment	Input/output	Description	Description
6	I	Measurement	PT100 sensor 2
1	I(O)	Measurement (Constant current generator)	PT100 sensor 2
5	I	Measurement	PT100 sensor 1
9	I(O)	Measurement (Constant current generator)	PT100 sensor 1

4.6.4.2.12. Motor Speed Measurement Connector Overview

				Comment/suggestion
Designation port HR-TC2400AC	-XA8	-XA10	-XA12	
	-XA9	-XA11	-XA13	
Designation plug SR1	415.HA/1	415.HC/1	415.HE/1	
	415.HA/2	415.HC/2	415.HE/2	
Designation plug SR2	415.HA/3	415.HC/3	415.HE/3	
	415.HA/4	415.HC/4	415.HE/4	
Supplier	Gimota			
Port type	D-Sub 9-pins male type			
Conductor size	0,5 mm^2			
Coding	See **Error! Reference source not found.**			
	Item			**Part number**
Port description	Port set			TRACHDOP09C09S
	Contact Pin			SUPCP20-24AU2
Plug description	Plug set			TRACHSTS09C09S1
	Contact socket			SUPCS20-24AU2
Pin assignment	**Input/output**			**Description**
6,7 (XH1, XH3, XH5)	I			Measurement
6,7 (XH2, XH4, XH6)	O			Supply (+15V)
1,2,3,4,5,8,9	-			n.c.



4.6.4. Removal of Traction Converter

Danger to life in the event of contact with DC link capacitors and electrical connections

High voltages c use death or serious injury if safety instructions and notices are not observed or if the equipment is handled incorrectly.

Before removing the converter, confirm the following:

- Follow the 5 safety rules
- All capacitors must be discharged.
- All electrical connections must be disconnected fr m the power supply.
- The conv rearmost be secured against inadvertent re-switching on, e.g. by means of locking.

4.6.4.1. Preparation for removal

Remove cover plates and open following electrical connections

- Power Terminals
- Connections to control and auxiliary circuits

  Drain of coolant mixture according to filling & draining instructions and open following other connections
- Connection to the cooling system
- Close any shut-off valves located outside the converter
- Fit blanking plates on water pipes
- Short the resonance capacitors
- Keep the earth switch in earthed position to avoid electric shocks.

4.6.4.2. Removing the converter

- Remove converter fixing bolts
- Disconnect all interfaces between the converter and locomotive
- Place the traction converter on horizontal & clean surface only

4.7. Maintenance of Traction Converter

All parts of the converter unit undergo thorough testing before shipment. It is not required for the operator of the locomotive to perform the same level of testing. The operator is responsible for specific tests under normal conditions during repairs or servicing of the converter. The scope of these tests is outlined below. For additional testing requirements, please contact the HiRect support department.

4.7.1. Periodical Maintenance of Traction Converter

4.7.1.1. Visual Inspection of Liquid Connections

- **Cleanliness:** Ensure the system and surroundings are free from dirt, grease, rust, and other contaminants. Remove any cleaning agent residue before filling.
- **Hoses:** Inspect hoses for any damage such as abrasions, blisters, cracks, or colour changes. Ensure hoses are not rubbing against metal parts or twisted. Maintain adequate slack and bend radius.

- **Leakage:** Inspect for leaks in all external and internal connections, including radiator flanges, pump connections, pressure sensor connections, and manifolds. Low fluid levels in the expansion tank may indicate leakage.
- **Coolant:** Annually check the concentration of Antifogging N and during each top-up. Look for signs of coolant fouling, such as low pH, high conductivity, colour changes, oily layers, or a burnt smell.
- **Valves & Fittings:** Ensure valves are not seized and seals are intact without cracks, swelling, or distortion. Clean expansion tank breathers if clogged. Ensure connectors are properly connected and check for unusual pump noise that may indicate cavitation.

4.7.1.2. Visual Inspection & Coolant Refilling

- **Coolant Monitoring:** Every 3 months, monitor the coolant's colour and pH value. Replace the coolant if the pH is outside the desired range. Under normal conditions, coolant should be changed every 2 years. Follow the refilling procedure outlined in Section 4.6.4.
-

4.7.1.3. Proof Connectors Maintenance

- **Connector Inspection:** Check for damage, corrosion, or debris in connector threads. Clean and inspect connectors every 3 months to prevent clogging and thermal seizing, with these tasks performed by HiRect's service engineers.
- **Maintenance:** Ensure connectors are not damaged during plugging/unplugging. Replace any damaged, dirty, or corroded connectors. Avoid over-tightening to prevent damage. Ensure connectors are from the same make and maintain a stock of spare connectors for replacement needs.

4.7.2. Maintenance during Service

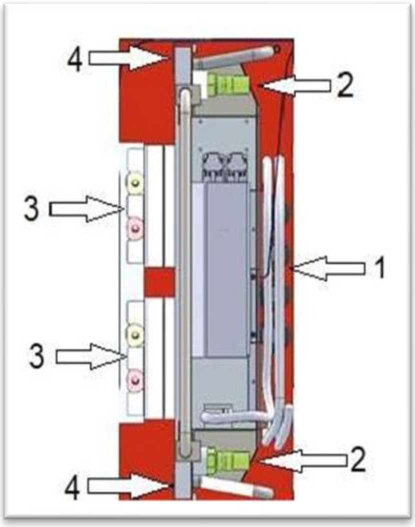
The following checks should be performed after replacing any components in the traction converter:

- **Fixings for Mechanical and Electrical Connections:** Ensure all connections are properly secured.
- **Electrical Connections:** Verify that all electrical connections are correctly made.
- **Cable Routing:** Ensure cables do not come in contact with sharp edges.
- **Cable Insulation:** Check for any damage to the cable insulation.
- **Visual Inspection:** Perform a thorough visual inspection of all components.
- **Spill Check:** Remove any water spills inside the panel.
- **Tools or Hardware:** Ensure no hardware or tools are left inside the panel.

4.7.2.1. Fitting and Removal of Front Cover

The converter's front side is protected by 5 removable metal doors. These doors are interlocked and can only be opened sequentially with the appropriate key. For safe and secure removal, refer to "1.4 Discharging and Grounding the Converter."

4.7.2.2. Fixing and Removal of IGBT Module (LCPU & MIPU)



1. Disconnect all control connections.
2. Remove 4 M12 Allen bolts from power cables.
3. Pull the quick-release coupling to disconnect from the coolant network.
4. Disconnect 4 M8 Allen bolts from the DC Link Capacitor.
5. Remove 4 M10 hex bolts to disconnect the module from the main converter.
6. Pull out the IGBT module from the main converter.

To assemble, reverse the above procedure.

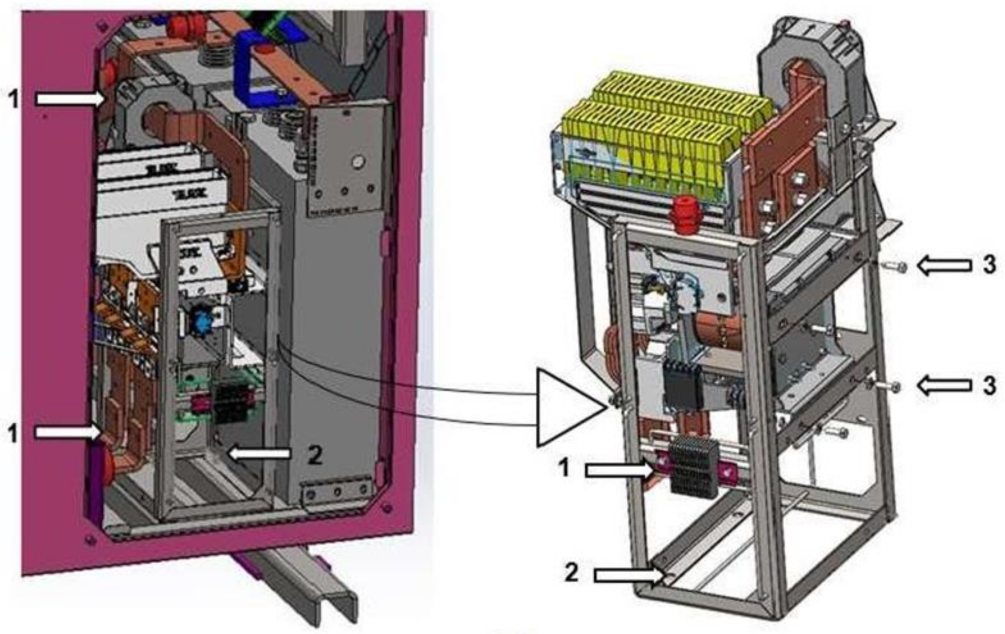
4.7.2.3. Fixing and Removal of Main Contactor (K1)

The contactors assembly is Located at right side of the converter and can be accessed easily through removable doors.

1. Disconnect input power bus bars from the contactor terminals by removing 4 M8 hex bolts and disconnect control connections to the coils.
2. Remove mounting hardware (M8 hex bolts) and pull out the main contactor assembly from the converter.
3. To mount the contactor, reverse the disassembly procedure.

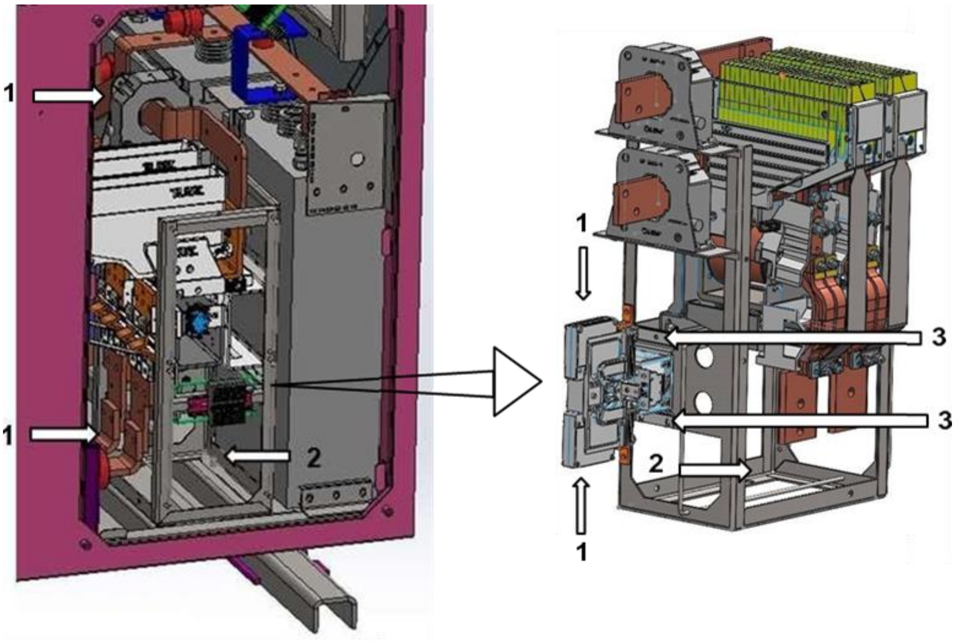
Details:

- Number of poles: 2
- Rated operating voltage (Ue): 1800 V
- Conventional thermal current (Ith): 1600 A
- Temperature range: -40°C to +85°C



4.7.2.4. Fixing and Removal of Pre-Charge Contactor (KP)

The Pre-contactors assembly is Located at right side of the converter and can be accessed easily through removable doors.



1. Disconnect input power bus bars from the contactor terminals by removing 4 M8 hex bolts and disconnect control connections.
2. Remove mounting hardware (M8 hex bolts) and pull out the pre-charge contactor assembly.
3. To mount the contactor, reverse the disassembly procedure.

Details:

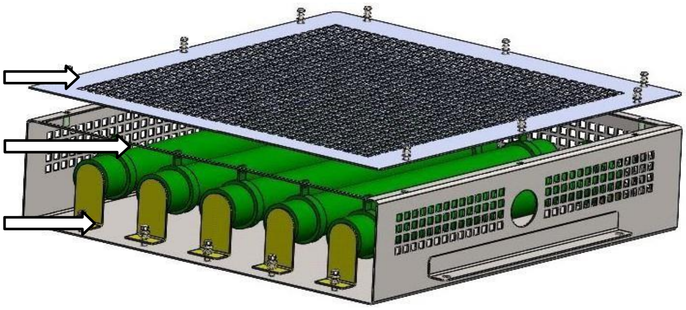
- Nominal input voltage: 1269 VRMS
- Maximum input voltage: 1573 VRMS
- Peak input voltage: 2224 V_{Peak}
- Maximum temperature: 75°C

4.7.2.5. Fixing and Removal of Pre-Charge Resistors (R1 – R5)

The resistors are mounted on top of the converter cabinet protected with an open grid. Each resistor can be accessed after removing the top grating.

1. Remove M6 hex bolts to remove top grating.
2. Disconnect all power cables from the defective resistor.
3. Remove mounting hardware (2 M6 nuts) to unmount the desired resistor.

To assemble, reverse the procedure.

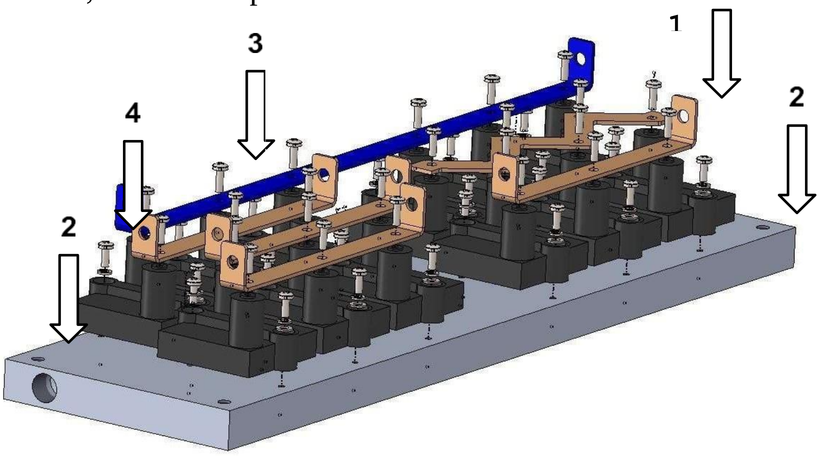


Details:

- Nominal Resistance (Individual Resistor): 15 Ω
- Total Resistance: 75 Ω
- Tolerance: ±10%

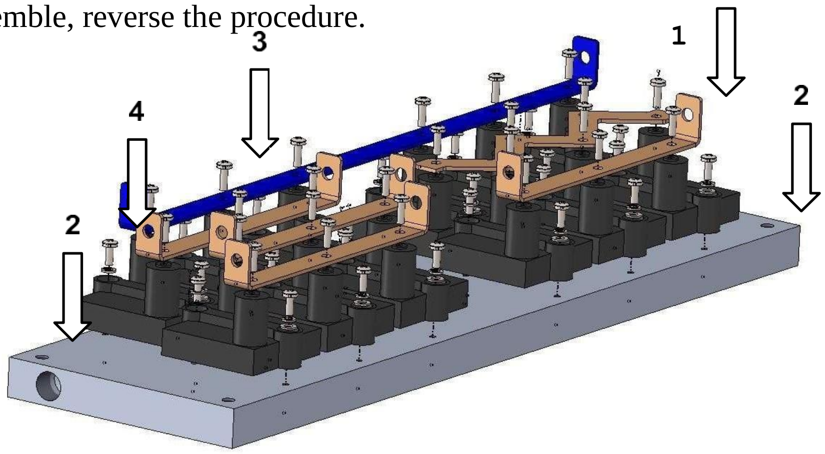
4.7.2.6. Fixing and Removal of Passive Discharge Resistors (R6 – R11)

1. Remove M6 hex bolts and disconnect power cables from the passive discharge resistor assembly.
2. Remove mounting hardware (M6 hex bolts) to unmount the cooling plate.
3. Unmount the respective bus bar by removing M5 pen-headed screws.
4. Remove the M5 pen-headed screws to unmount the desired resistor from the cooling plate. To assemble, reverse the procedure.



4.7.2.7. Fixing and Removal of Earthing Resistors (R12 – R17)

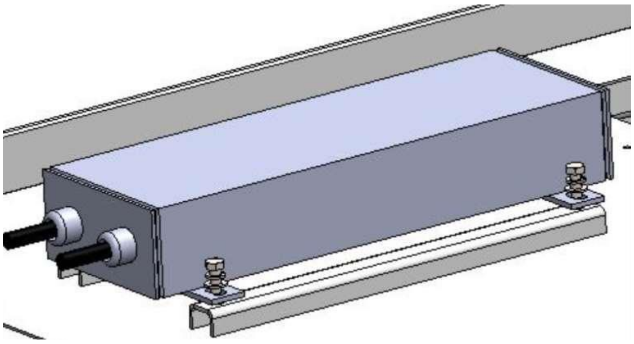
1. Remove M6 hex bolts to disconnect power cables from the earthing resistor assembly.
2. Remove mounting hardware (M6 hex bolts) to unmount the cooling plate.
3. Unmount the respective bus bar by removing M5 pen-headed screws.
4. Remove M5 pen-headed screws to unmount the desired resistor from the cooling plate. To assemble, reverse the procedure.



4.7.2.8. Fixing and Removal of Crowbar Resistor (R18)

1. Disconnect power cables from the 5th inverter assembly by removing M8 hex bolts.
2. Loosen the cable glands and extract the cables from inside the converter.
3. Remove the mounting hardware (M8 hex bolts) to remove the crowbar resistor assembly from the converter.

To assemble, reverse the procedure.

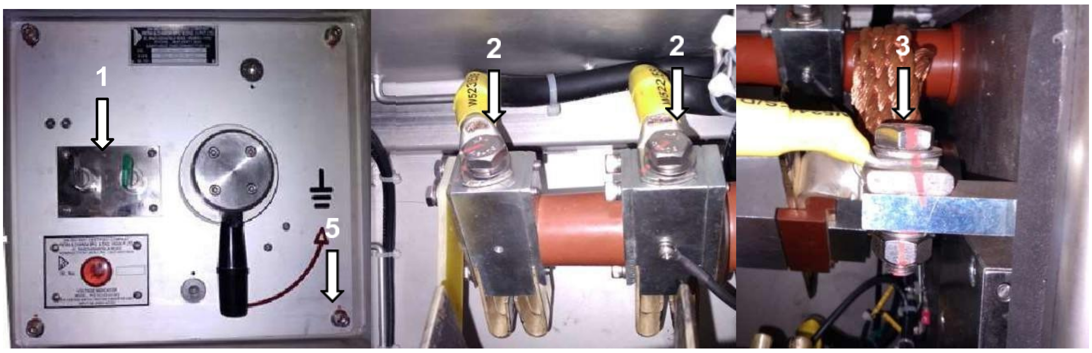


Details:

- Resistance: 2.5 ±10% Ω
- Energy per load cycle: ≈1000 kJ

4.7.2.9. Fixing and Removal of Earth Switch (K2)

1. Remove the green and black interlocking keys.
2. Disconnect power cables from the switch.

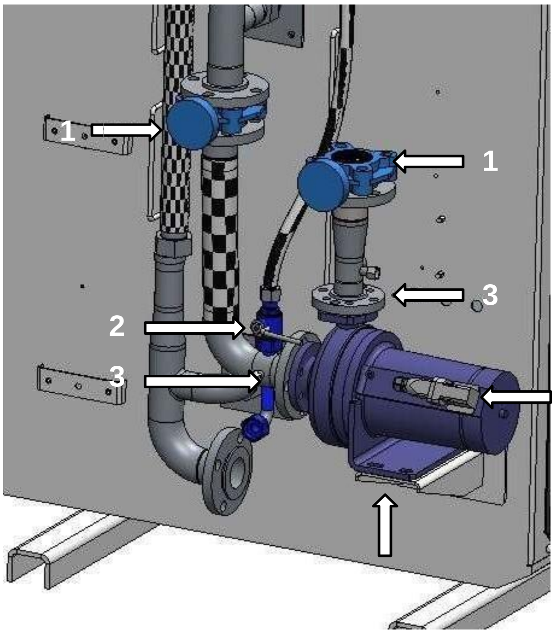


3. Disconnect the earthing cable from the switch.
4. Disconnect cables from the voltage indicator.
5. Remove mounting hardware and unmount the earthing switch.

To assemble, reverse the procedure.

4.7.2.10. Fixing and Removal of Cooling Pump & Motor Unit

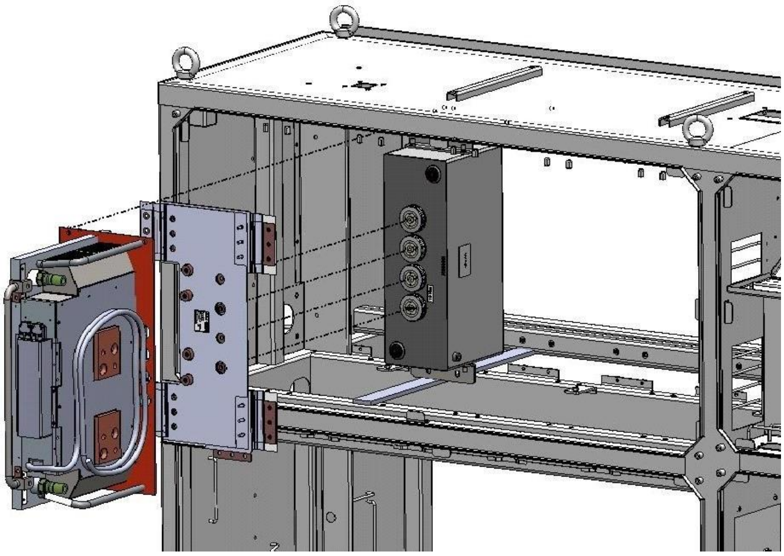
1. Close the pump inlet and outlet butterfly valves.
2. Drain the coolant via the drain valve.
3. Remove 4 M12 hex bolts from the pump's inlet and outlet connections.
4. Remove the mounting hardware (M12) to disconnect the pump.
5. Disconnect power cables from the pump's terminal box.
6. Unmount the motor from the converter.



4.7.2.11. Fixing and Removal of DC Link Capacitor

1. Place the sliding jig inside the cabinet.
2. Position the capacitor on the sliding jig and slide it towards the mounting position.
3. Secure the capacitor with the mounting clamp.
4. Align the capacitor according to the centre-to-centre distance.
5. Mount the bus bar to the capacitor using a grub screw.
6. Assemble all hardware to connect the capacitor bus bar to the adjacent bus bar.
7. Mount the FRP plate and the top and bottom mounting plates of the module.
8. Mount the module in the cabinet and connect all hardware as shown in the assembly procedure.

To remove, reverse the procedure.



4.7.3. Tightening Instructions for Critical Components

It is crucial to adhere to the tightening instructions and properly tighten critical components as outlined in the following table. Ensuring that these components are tightened to the specified torque values helps maintain the safety, efficiency, and reliability of the system.

Component	Tightening torque Nm
DC link capacitor terminal	12
Filter Capacitor Terminal	8
IGBT mounting Terminal	5
IGBT busbar Terminal	10
Thermal Switch on heatsink	0.8
IGBT gate driver	2

In normal circumstances, all screwed joints should be tightened using hand tools, unless otherwise specified. However, special connections—such as high-current carrying joints, hardware joints made of non-ferrous materials, and similar critical connections—require specific torque values to ensure proper functionality and safety.
For these specialized joints, it is important to use a torque wrench or a screwdriver with a torque indicator to ensure the correct amount of torque is applied.
Torque Specifications for S.S. Hardware Joints:

- Torque Tolerance: ±10%

Thread	**Tightening torque Nm**
M3	0.7
M4	1.6
M5	3.0
M6	5.3
M8	12.5
M10	25.0
M12	43.0
M16	104.0
M20	202.0

For brass screws following values has been specified (tolerance ± 10%).

Thread	**Tightening torque Nm**
M3	0.4
M4	1.0
M5	2.0
M6	3.4
M8	8.2
M10	16.0
M12	30.0

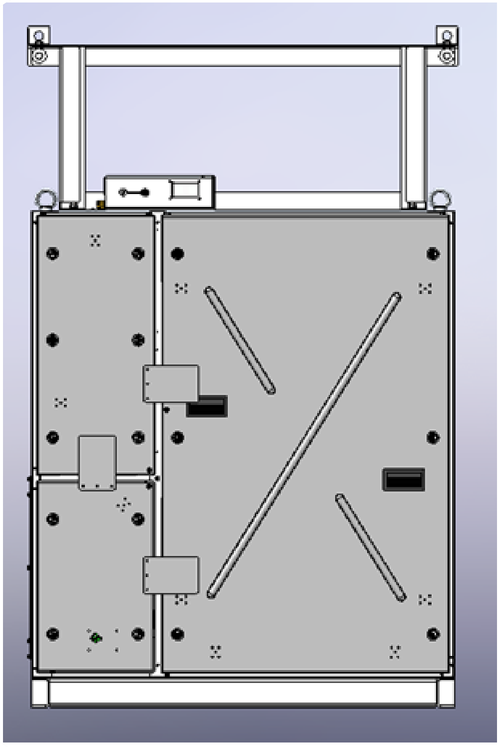
4.8. Maintenance Schedule of Traction Converter

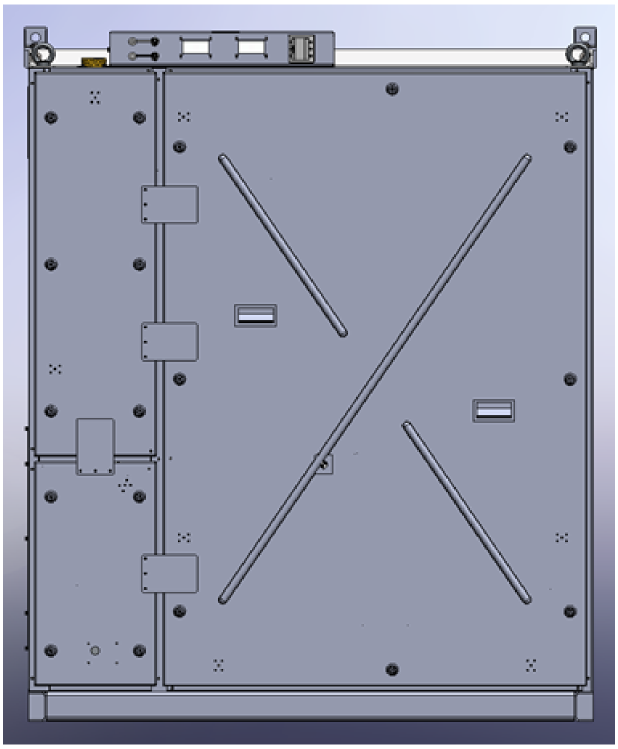
As per maintenance schedule of AC locomotives

Nature of Inspection/overhaul
i) Trip Inspection, IT
ii) Monthly Inspection, IA + 5 days
iii) Two-monthly Inspection, IB + 5days.
iv) Four monthly Inspection, IC + 10 days
v) Annual overhaul, AOH + 15 days.
vi) Intermediate overhaul, IOH 300,000 km after POH or first commissioning or 3 years whichever is earlier ± 1 month.
vii) Periodical overhaul (POH) 600,000 km after commissioning or last POH or 6 years whichever is earlier ± 3 month.

Maintenance Activity	IA	IB	IC	TOH	IOH	POH
Downloading of Event data	√	√	√	√	√	√
Checking Tightening of mounting bolts	√	√	√	√	√	√
Checking Tightening of Earthing to Converter panel	√	√	√	√	√	√
Checking Tightening of Earthing to Contactor panel	√	√	√	√	√	√
Cleaning of dust accumulated on major components like Choke, IGBT, Busbar, contactor, Filter capacitor.			√	√	√	√
Cleaning of Dust accumulated on Heat pipe fins.		√	√	√	√	√
Cleaning of control supply section			√	√	√	√
Cleaning of both Blower Fans			√	√	√	√
Checking Tightness of all control connectors.			√	√	√	√
Check tightness of all incoming & Outgoing cables with converter and contactor			√	√	√	√
Cleaning of internal churning fans of control rack.		√	√	√	√	√
Measure capacitance value of DC link capacitor.				√	√	√

5. Chapter 5 -Auxiliary Converter (V-3)





5.1. Introduction

The WAG9, WAG9H, and WAP7 electric locomotives are equipped with three auxiliary converters, each rated at 130 kVA, along with a battery charger. The auxiliary converters are arranged as follows: two converters (Bur2 and Bur3) and the battery charger are housed together in a single cabinet (Box2), while the third auxiliary converter is located in a separate cabinet (Box1). As a result, the locomotive is equipped with two physical cabinets for the auxiliary converters.

Each 130 kVA Auxiliary Converter consists of the following components:

- Line Rectifier
- DC Link
- Inverter

These auxiliary converters are responsible for powering all auxiliary loads on the locomotive. The system is designed with redundancy features to ensure continuous operation. In case of failure of one auxiliary converter, the load is automatically transferred to the remaining two converters through a contactor logic changeover, allowing all auxiliary loads to remain powered. The auxiliary converters provide a three-phase output of 415 V AC derived from a 1000 V single-phase AC input, while the battery charger delivers 111 V DC.

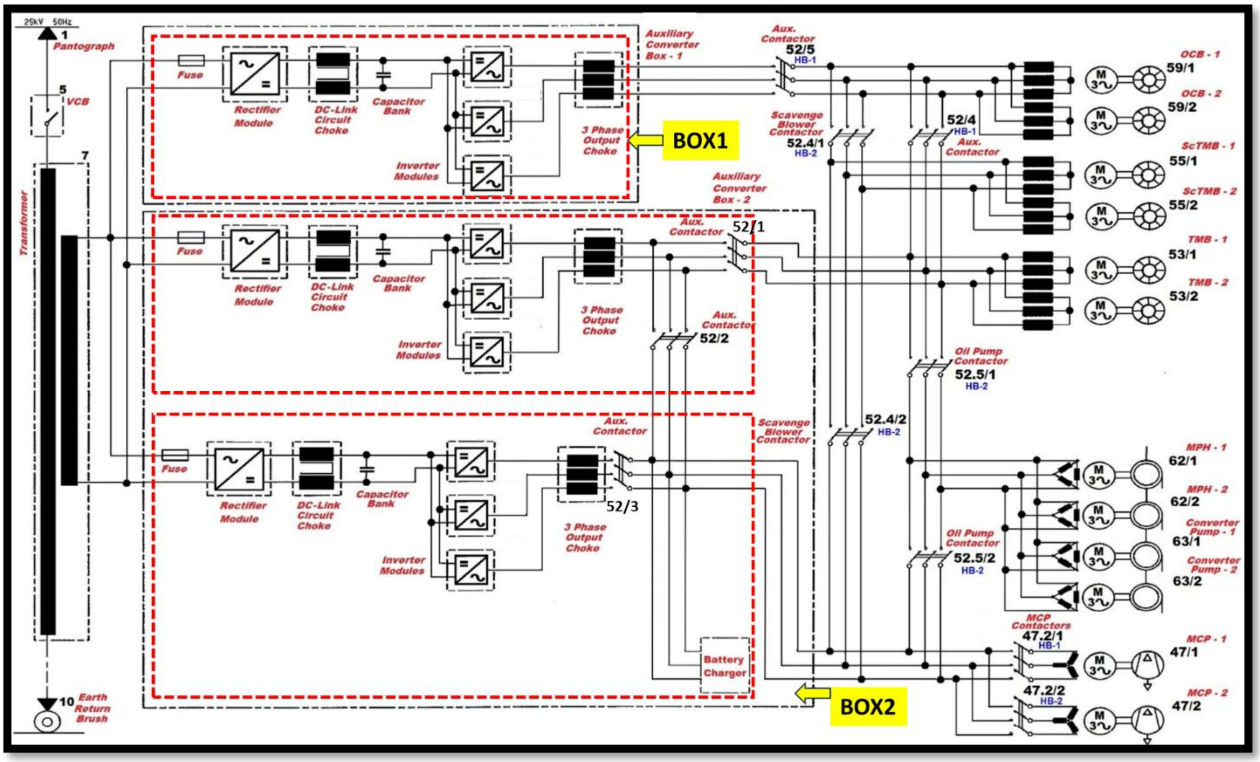


Fig 5.1: Block Diagram of Auxiliary Converter System with Auxiliary Loads

5.2. Transport, shipping and storage

5.2.1. Transport:

The converter must be transported with care to avoid any damage.

- Hard impacts should be avoided, especially for devices containing electronic components.
- Environmental conditions must be clean and controlled during transportation.
- All openings in the enclosure should be sealed with suitable material to prevent contamination.

5.2.2. Shipping

- A suitable-sized pallet is required for shipping.
- **Box 1**: External dimensions (with lifting hook): 1160 mm (width) x 1020 mm (depth) x 1860 mm (height).
- **Box 2**: External dimensions (with lifting hook): 1520 mm (width) x 1000 mm (depth) x 1860 mm (height).
- Use safety straps to securely fasten the converter.
- To protect the converter from pollution and humidity, use plastic film wrapping.
- A covered container (e.g., wooden) should be used to protect the converter.
- The converter must be firmly secured to prevent any movement during transit.

5.2.3. Storage

- Do not stack the converters on top of each other.
- The storage area must be clean and dry.
- Recommended storage temperature: 0°C to +55°C.
- All openings in the enclosure should be sealed with suitable material to maintain the integrity of the unit.

5.3. Commissioning & Installation of Auxiliary Converters

5.3.1. Lifting

When lifting or moving the converter, ensure the cover remains closed at all times.

- Attach the auxiliary converter lifting tackle (D-shackle) to the converter as shown in **Fig 5.2** & **Fig 5.3**.
- Lift the converter using the appropriate lifting device and ensure the

tackle is securely attached.

- Verify that the converter is properly lifted along with the lifting tackle, ensuring a secure connection before proceeding.
- Do not use metal chain ropes, as they may cause damage to the converter.
- Avoid lifting the converter from the bottom, as this could lead to potential damage.
- During lifting, inspect the converter for any signs of damage to ensure safe handling.

For refitting or reinstallation, follow the reverse procedure carefully to avoid any damage or mishandling.

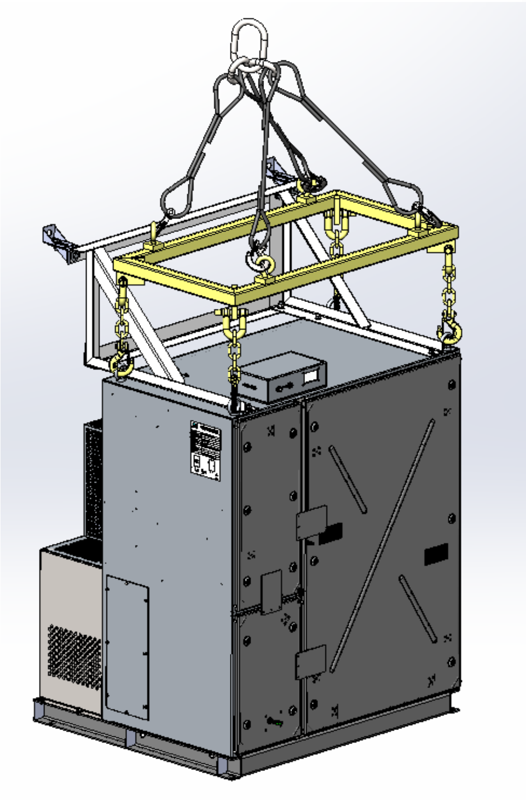


Fig 5.2: BOX1 Lifting arrangement

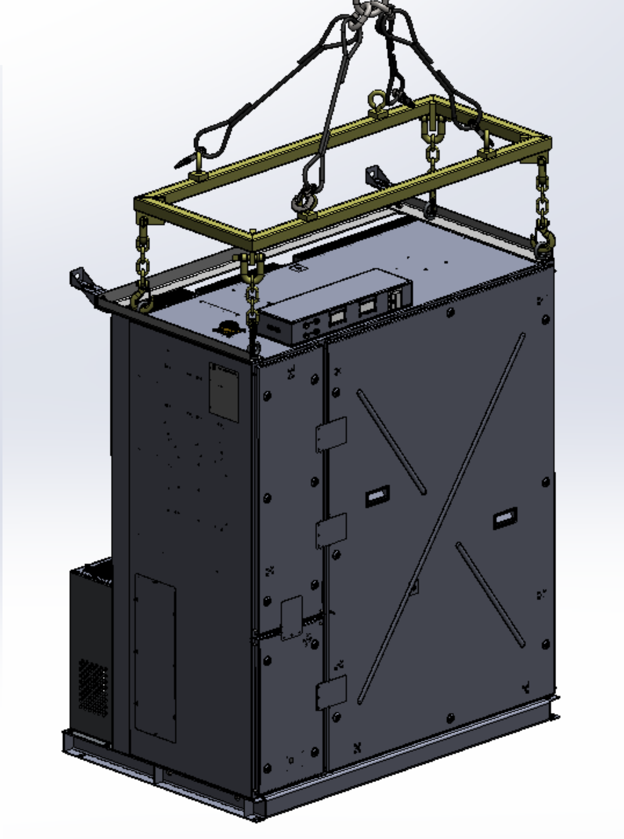


Fig 5.3: BOX2 Lifting arrangement

5.3.2. Installation of Box 1 and Box 2

Both converter boxes should be mounted upright inside the locomotive, ensuring proper positioning and stability.

- Ensure the correct position of the duct and inspect the base frame for any damage.
- Verify that there are no obstructions in the duct to avoid interference with the air-cooling system of the auxiliary converter.

Fig 5.4: BOX1 Side Duct on the Base

Fig 5.5: BOX2 Side Duct on the Base

- **Fig 5.6** illustrates the fastening points for Box 1, and **Fig 5.7** shows the fastening points for Box 2.
- Each box is equipped with eight fastening points:
  - Four mounting holes located at the base frame.
  - Four slotted mounting holes located at the back of the top frame.
- For lifting purposes, the converters are equipped with four eye bolts on the top frame.
- Ensure proper alignment and an airtight connection for both air inlets at the bottom of the converters.

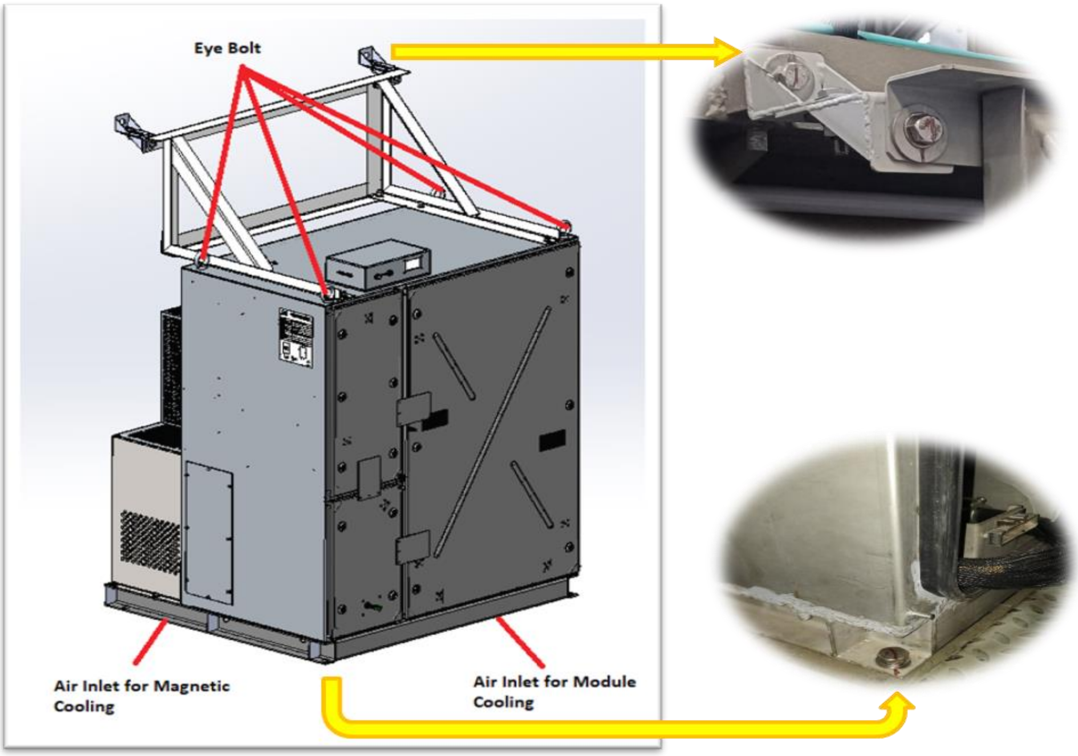


Fig 5.6: Base Bolt Mounting & Top Angle Brackets Mounting of Box1

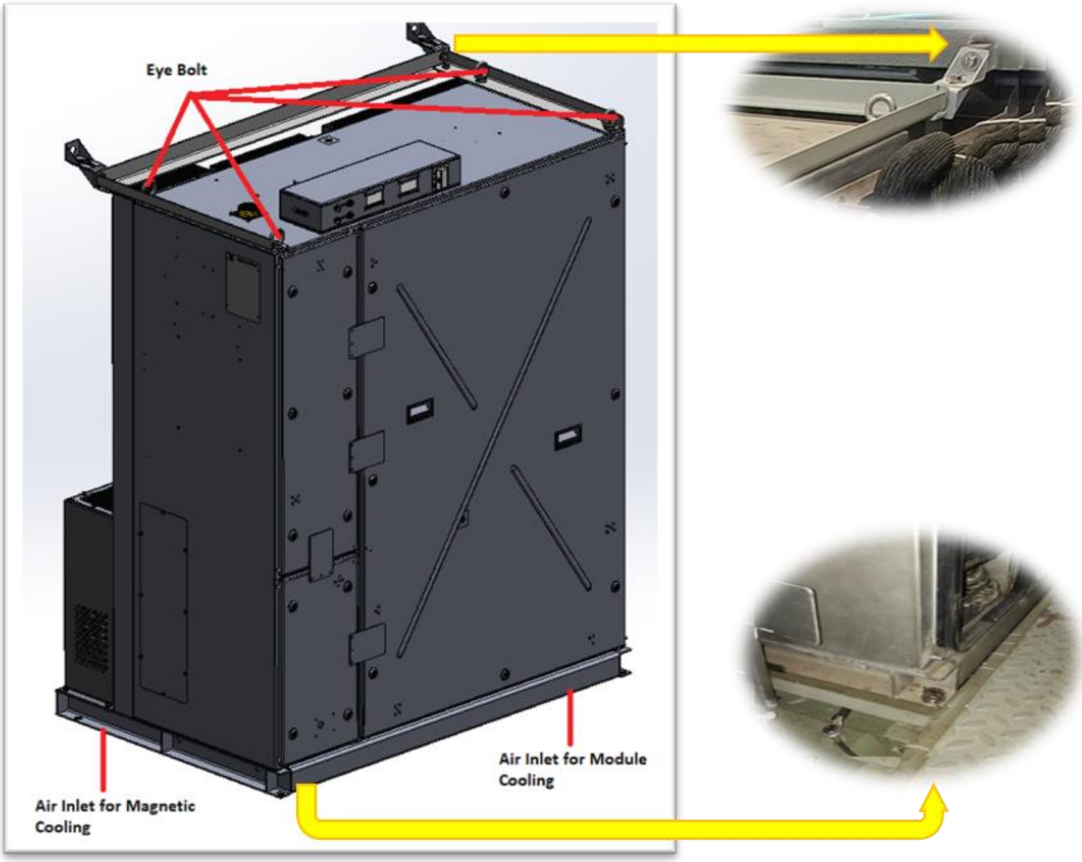


Fig 5.7: Base Bolt Mounting & Top Angle Brackets Mounting of Box2

5.3.3. Electrical Interface of Box 1 and Box 2

5.3.3.1. Connections of Box 1:

Location	Connection	BUR/BOX	Terminals / Connector	Bolt terminal/ Cable lug size	Recomm. wire size (vehicle)	Max. Torque to fix cable lug terminals
Lower left side of front service door	Earth	Box1	Earth point	M10	16 mm²	30 Nm
	GOD (External Chock)	Bur1	STP 501 STP 502 STP 503 STP 504	M10	95 mm² or 2 x 50 mm²	30 Nm
	AC Input	Bur1	L11 (1) L12 (2)	M10	95 mm² or 2 x 50 mm²	30 Nm
	AC Output	Bur1	X301 (50.X4)	–	70 mm²	–
On Top Floor of Box 1	MVB	Box1	X703 (50.X1/1) -> board A751	–	–	–
	Control / feedback signals	Box1	X702 (50.X2)	–	–	–

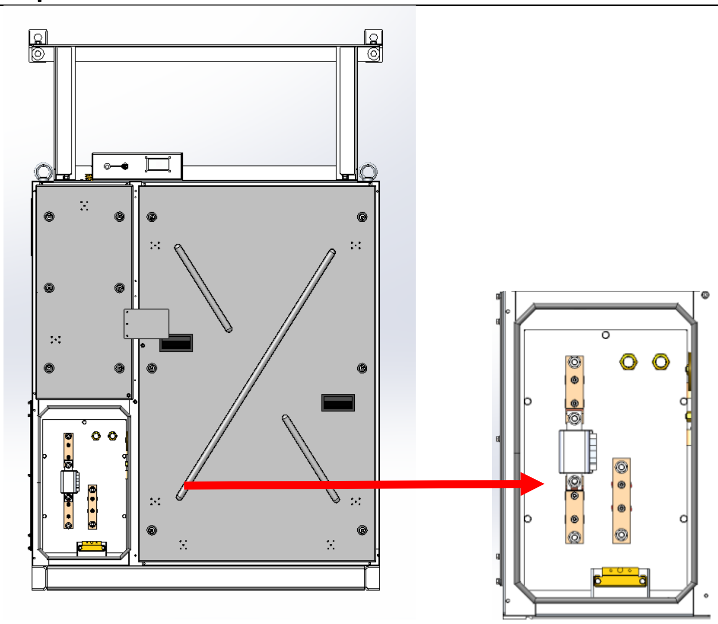
Table 5.1: Cables and terminals - designations and values

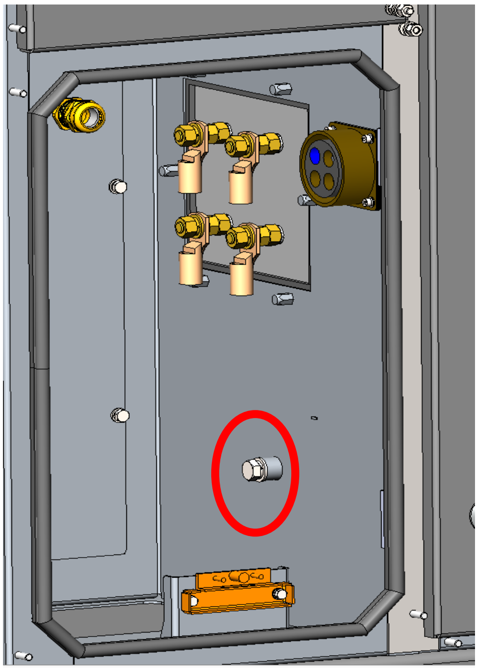
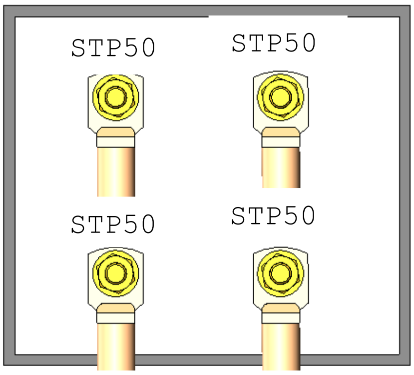
A. power connections box 1

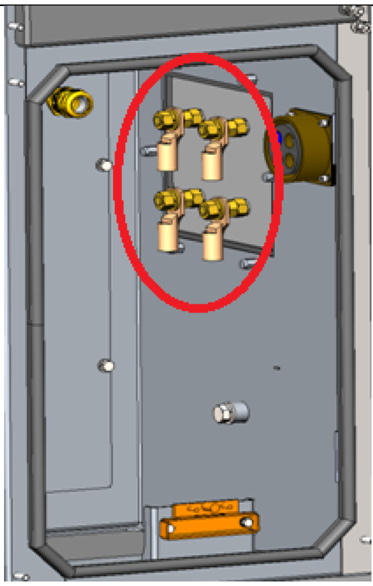
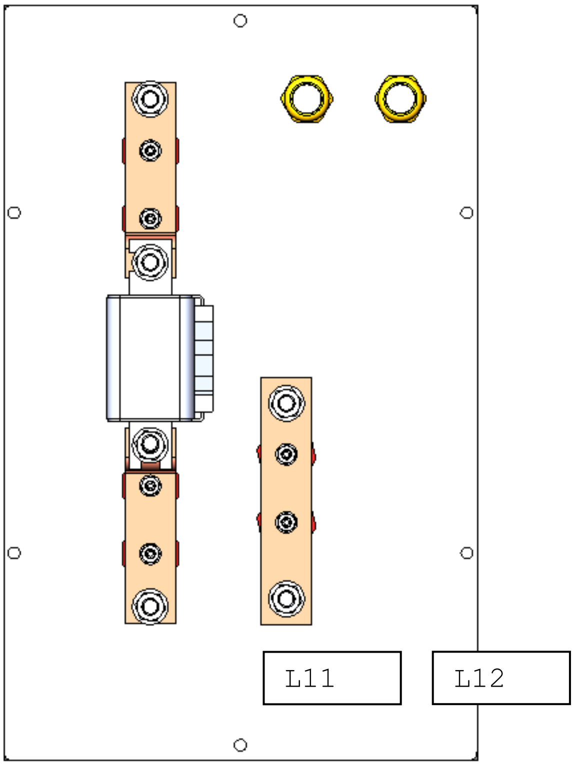
The electrical power connections are located in the terminal box behind the lower-left service cover The terminal box is open at the bottom, so all power cables should be routed through the lower opening.

Steps:

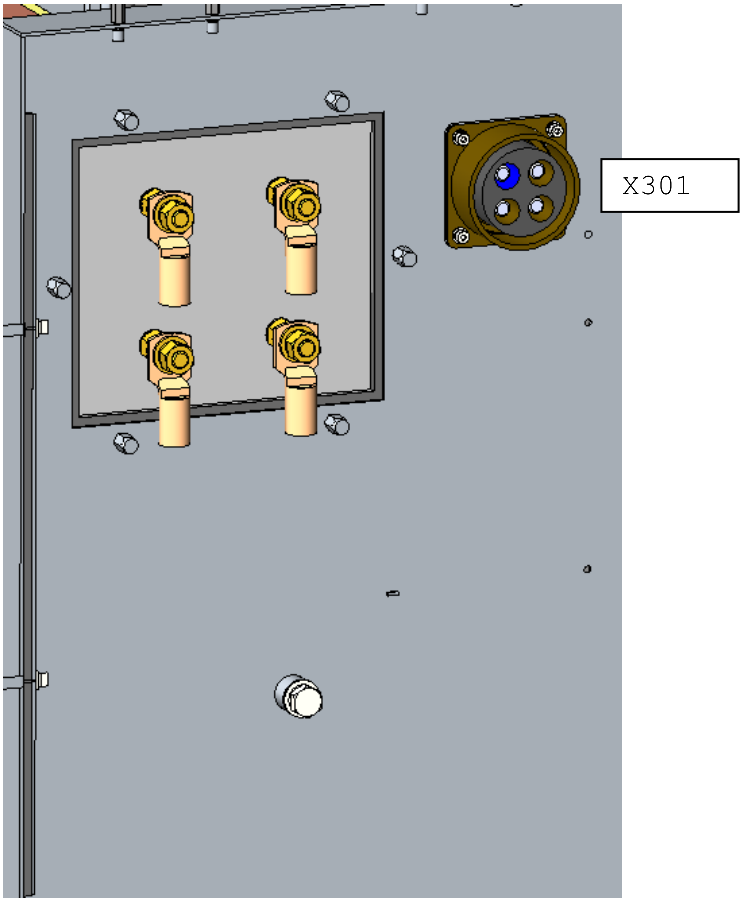
1. Unlock the large service cover
2. Unlatch 6 quarter-turn fasteners, loosen the earth cable, and remove the cover.
3. Unlatch 4 quarter-turn fasteners, loosen the earth cable, and remove

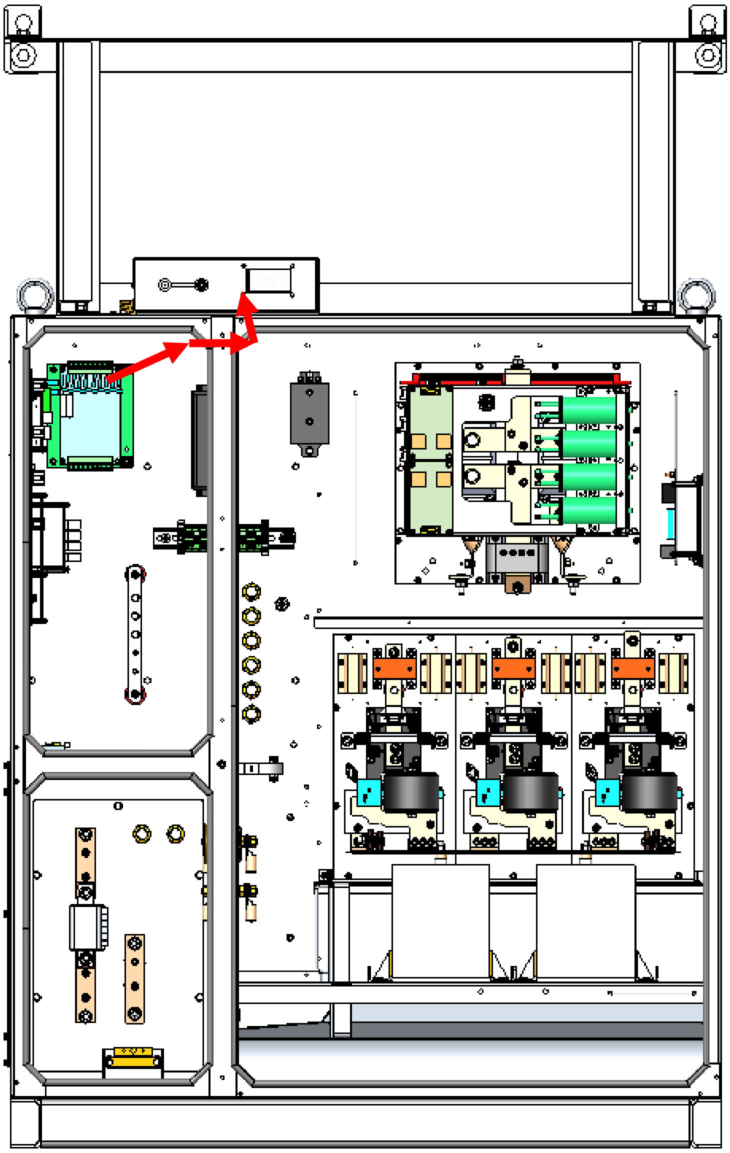
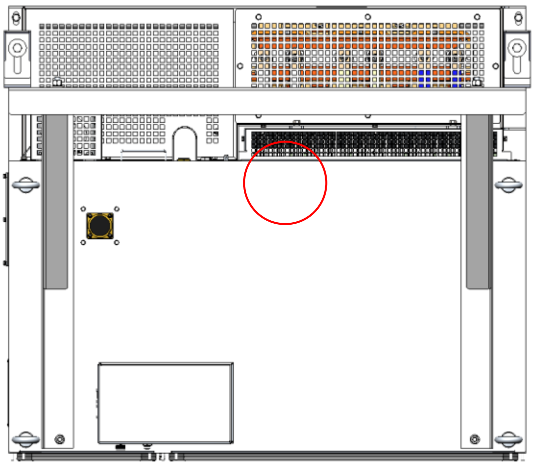


the lower-left cover.	
	B. Earth connections
Attach the earth cable lug using an M10 screw.	
Connect the 4 x M10 bolt terminals for external choke (GOD): 1) STP501 XB11 1107A 2) STP502 XB12 1108A 3) STP503 XB13 1106A 4) STP504 XB14 1109A	

	
C. AC input connections	
1. Connect the AC input **BUR1** terminal to **L11(Ph1/W1103)** and **L12(Ph2/W1117)**.	
D. Output connections	

1. Connect the AC output **BUR1** plug to connector **X301 (50.X4)**.
2. Connect the additional AC output **BUR1** to terminals **X303.1**, **X303.2**, and **X303.3**.



E. MVB Signal Connection	
1. Lead the MVB shielded MVB cable (50.X1/1) through the X703 box on top of the enclosure, then route the cable through the interior of Box 1. 2. Connect the Line A and Line B connectors of the MVB shielded cable strand to the **HRT-1302-1** card.	
F. DC signal connection	
Connect the main signal plug to connector **X702 (50.X2)** at the top of the enclosure.	

➢ **Pin description of signal connector X702**

The table below shows the pin description of signal connector X702. Signal potential is battery voltage (110VDC).

Pin		Pin	
1	+Batt (external)	8	Contactor 52/5 feedback
2	–Batt (external)	9	Contactor 52/4 feedback
3	Spare	10	Contactor 52/4 coil
4	Spare	11	+Batt to 52/4 and 52/5
5	Spare	12	+Batt to 52.3/5
6	Spare	13	Spare
7	Contactor 52/5 coil		

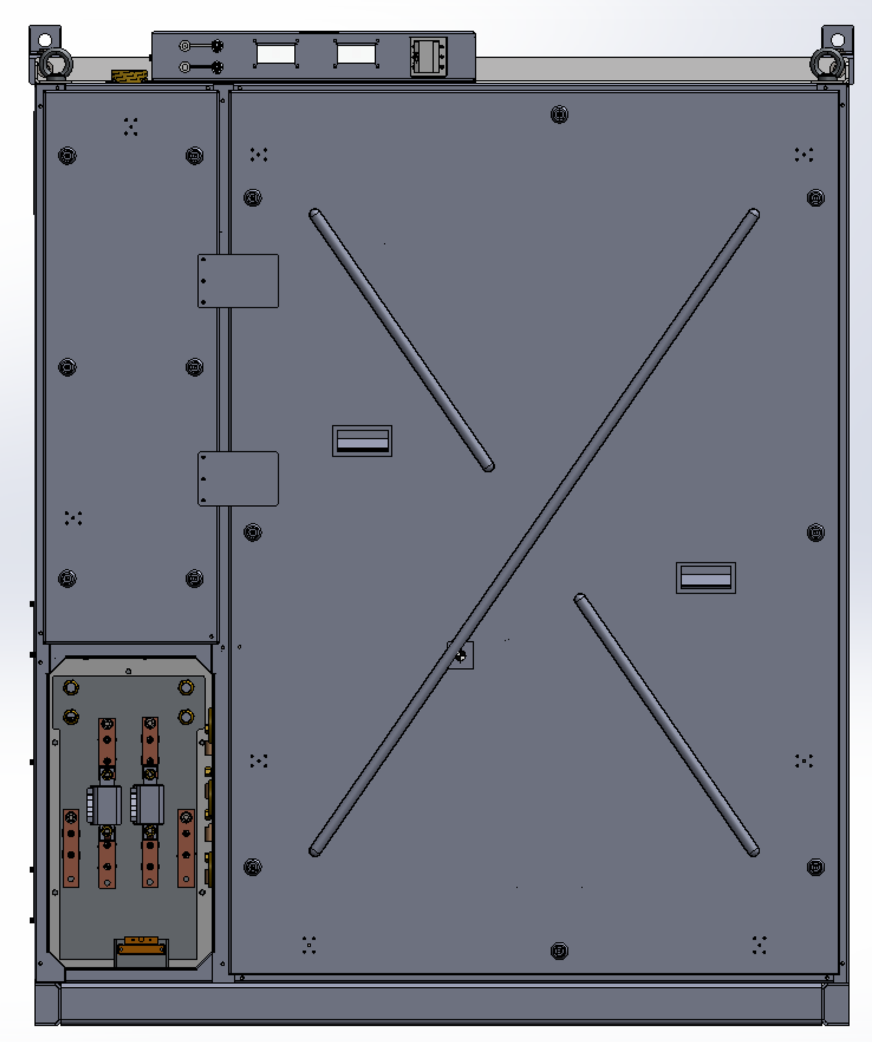
Table 5.2: Pin description of signal connector X702

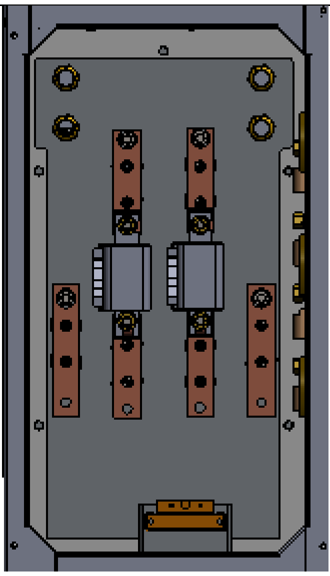
5.3.3.2. Electrical connection of Box 2

The table below shows all required designations and values around cable fixing.

Location	**Connection**	**Box / Bur**	**Terminals / Connector**	**Bolt terminal/ Cable lug size**	**Recomm. wire size(vehicle)**	**Max. Torque to fix cable lugsat terminals**
Front, lower left service cover	Earth	Box2	Earth point	M10	16 mm²	40 Nm
	External choke 2	Bur2	STP 501 STP 502 STP 503 STP 504	M10	95 mm² or 2 x 50 mm²	30 Nm
	External choke 3	Bur3	STP 508 STP 509 STP 510 STP 511			
	AC Input	Bur2	L11 (1) L12 (2)	M10	95 mm² or 2 x 50 mm²	40 Nm
	AC Input	Bur3	L21 (11) L22 (12)	M10	95 mm² or 2 x 50 mm²	40 Nm
	AC Output	Bur2	X301 (50.X5)	–	70 mm²	–
	AC Output	Bur3	X302 (50.X6)	–	70 mm²	–
	DC Output	CHBA	X401 (50.X7)	–	35 mm²	–
Top of Box 2	MVB 1	Bur2	X712 (50.X1/2) -> board A751.1	–	–	–
	MVB 2	Bur3	X713 (50.X1/3) -> board A751.2	–	–	–
	Control / feedback signals		X701 (50.X3)	–	–	–

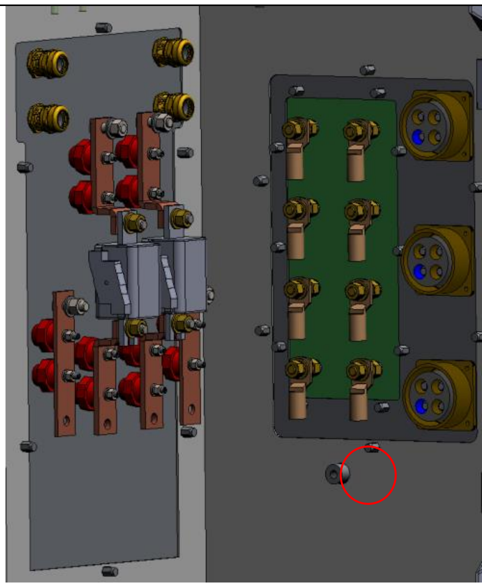
Table 1 Cables and terminals - designations and values

A. Power connections, Box 2
The electrical power connections are located in the terminal box behind the lower left service cover at the front side, see Figure 55. The terminal box is open at the bottom, all power cables have to be led through thelower opening. Access to the power connections 1. Unlock big service cover, see Figure 55. 2. Unlatch 8 quarter-turn fasteners. Loosen earth cable and remove big service cover. 3. Unlatch 4 quarter-turn fasteners. Loosen earth cable and remove lower left service cover.




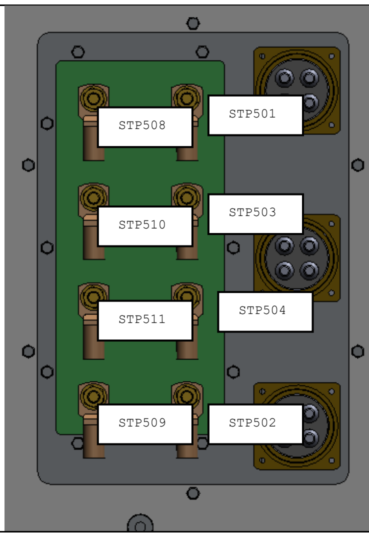
B. Earth Connection

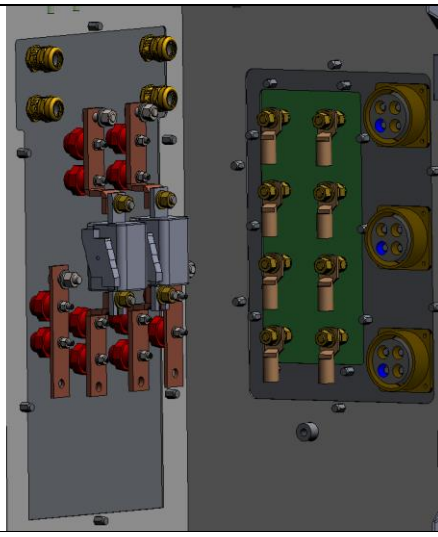
1) Use a M10 screw to attach earth cable lug.

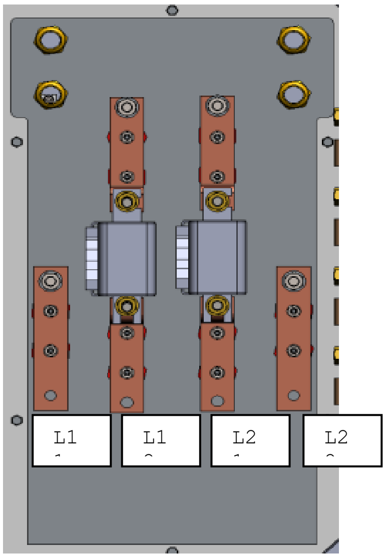
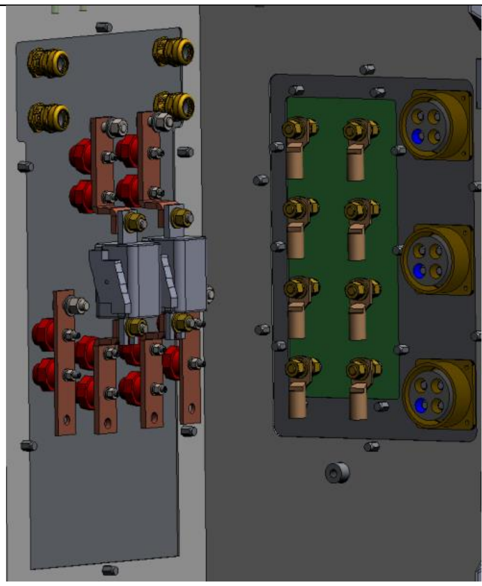
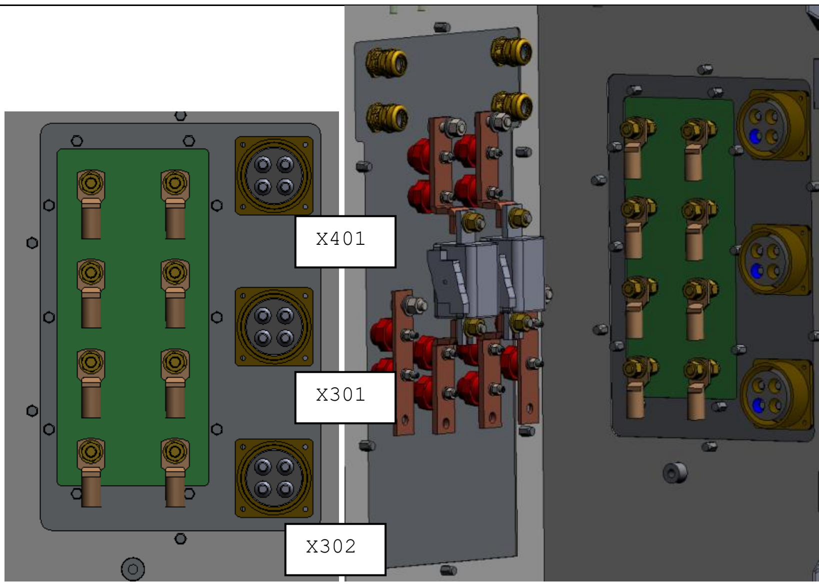


C.. Connection of external choke

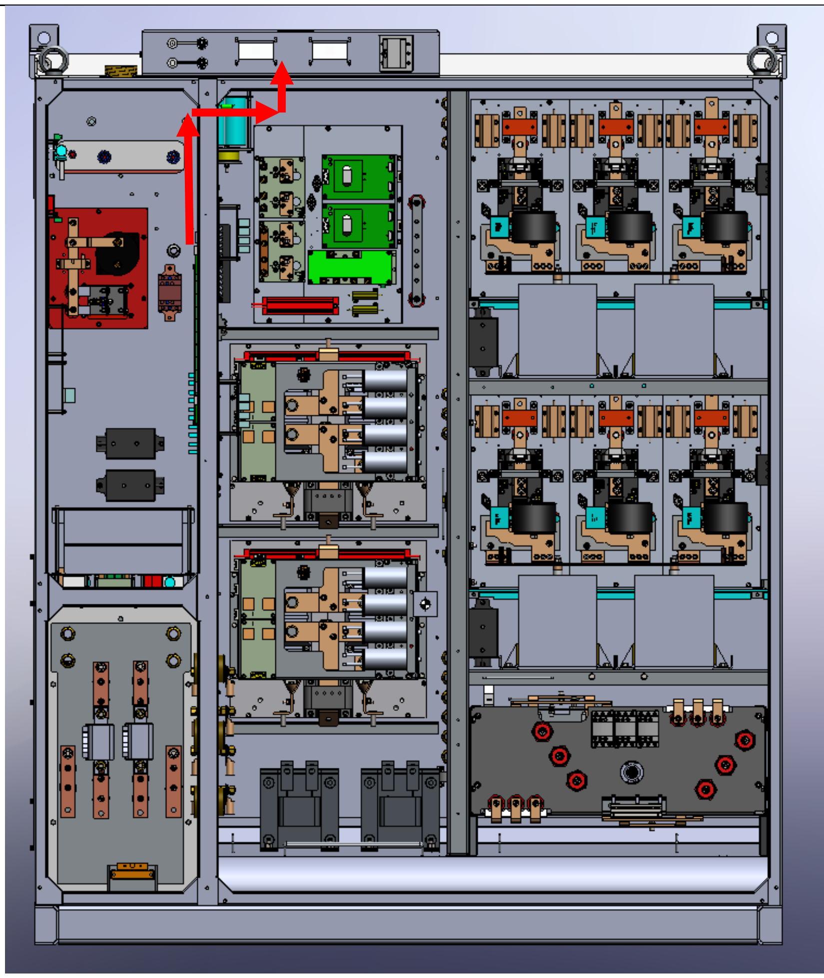
1) Connect 4 X M10 Nut terminal for external choke 2 :
STP 501 XB21 1107B
STP 502 XB22 1108B
STP 503 XB23 1106B
STP 504 XB24 1109B
2) Connect 4 X M10 Nut terminal for external choke 3 :
STP 508 XB31 1107C
STP 509 XB32 1108C
STP 510 XB33 1106C
STP 511 XB34 1109C



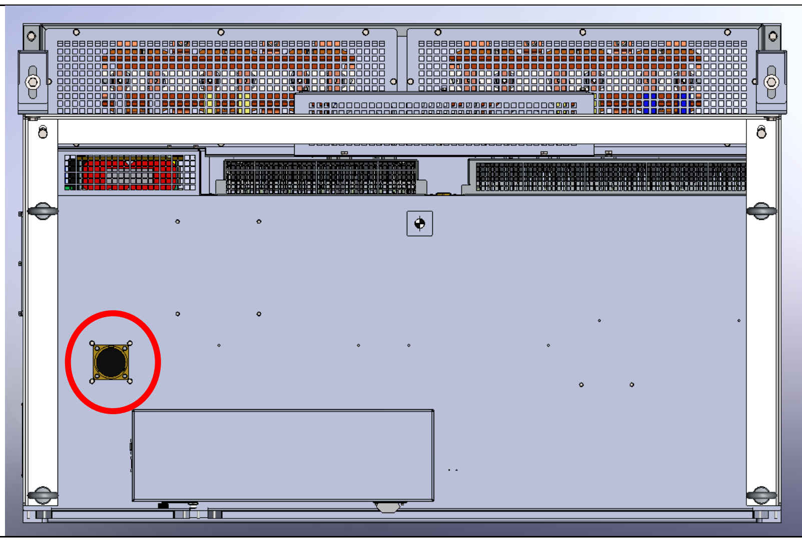


D. AC input connections	
1.Connect AC Input BUR 2 to terminals L11 (1) and L12 (2). 2.Connect AC Input BUR 3 to terminals L21 (11) and L22 (12).	 
E. Output connections	
1.Connect AC Output BUR 2 plug to connector X301 (50.X5). 2.Connect AC Output BUR 3 plug to connector X302 (50.X6). 3.Connect DC Output plug to connector X401 (50.X7).	

F. MVB Connections box 2

1.Lead MVB 1 shielded MVB cable strand (50.X1/2) through X712 box on top of the enclosure. Lead strand through interior of Box 2. 2.Connect Line A and Line B connectors of MVB 1 shielded MVB cable to MVB interface board A751.1. 3.Lead MVB 2 shielded MVB cable (50.X1/3) through X713 box on top of the enclosure. Lead strand through interior of Box 2. 4.Connect Line A and Line B connectors of MVB 2 shielded MVB cable to MVB interface board A751.2	

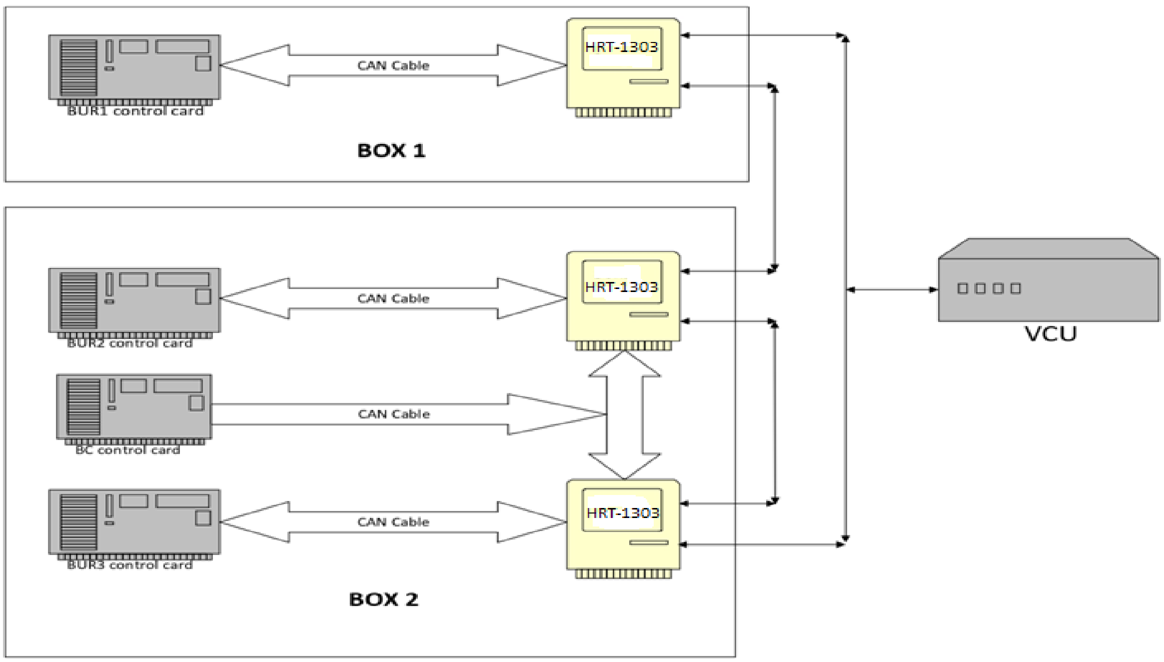
G. DC connections box 2

1) Connect main signal plug to connector X701 (50.X3) at the top of the enclosure.	

G. Pin description of signal connector X701

Pin		Pin	
1	TBat+	19	Spare
2	TBat–	20	–VBatt sense Batt Box 2
3	Spare	21	Contactor 52.4 feedback
4	Spare	22	(+) (Batt+)
5	–Batt2	23	+Batt BUR 2 (ext.)
6	+Batt BUR 3 (ext.)	24	–Batt BUR 2 (ext.)
7	–Batt BUR 3 (ext.)	25	Contactor 52/4
8	+48 VDC BUR 2, internally not used	26	Contactor 52/1
9	–Batt 3	27	Screen
10	+48 VDC BUR 3, internally not used	28	Screen
11	+Batt 3	29	+Batt 2
12	Contactor 52/5	30	Contactor 52.4/2 and 52.5/1 feedback
13	–VBatt sense Batt Box 2	31	Contactor 52.4
14	Contactor 52.1 and 52.3 feedback	32	–Batt 2
15	Contactor 52.4/1 and 52.5/2 feedback	33	+Batt 1
16	+VBatt sense Batt Box 1	34	Screen
17	+VBatt sense Batt Box 1	35	Spare
18	Screen		

5.3.3.3. MVB inter-connections between BOX1 & BOX2:



5.3.4. Functional Test

<table>
<tr><th colspan="2">Functional test of Box 1</th></tr>
<tr><td></td><td>The functional test has to be performed
After the installation of Box 1 on the locomotive
After each repair task
After all maintenance tasks affecting the interior of Box 1.</td></tr>
<tr><td></td><td>The following procedure requires working on the running converter while covers are removed. Do not touch parts inside the converter!</td></tr>
<tr><td colspan="2">1) Ensure that all converter components and all electrical connections are properly installed.
2) Switch on control electronics including converter electronics.
3) Connect test computer(PTU) with converter diagnostics software to diagnostic connector(X701/X702/X703)
4) Start SmartPro software on PTU.
5) Check messages in Online mode. No error message should appear.
6) Clear event log.
7) Connect input voltage to converter and start the converter (startup requested by vehicle control).
8) Connect some type of loads to output and observe Smartpro window for some minutes.
9) If no error shown in SmartPro, the converter is working properly.
10) Disconnect PTU
11) Exit Smartpro.</td></tr>
</table>

Functional test of Box 2

The functional test has to be performed

- After the installation of Box 1 on the locomotive
- After each repair task
- After all maintenance tasks affecting the interior of Box 1.

The following procedure requires working on the running converter while covers are removed. Do not touch parts inside the converter!

1) Ensure that all converter components and all electrical connections are properly installed.
2) Switch on control electronics including converter electronics.
3) Connect test computer (PTU) with converter diagnostics software to diagnostic connector (X701/X702/X703)
4) Start SmartPro software on PTU.
5) Check messages in Online mode. No error message should appear.
6) Clear event log.
7) Connect input voltage to converter and start the converter(startup requested by vehicle control).
8) Connect some type of loads to output and observe Smartpro window for some minutes.
9) If no error shown in SmartPro, the BUR2 is working properly.
10) Disconnect PTU from connector () and connect to connector ().
11) Repeat step 4 to 8. If no errors shown in SmarPro, BUR3 is working properly.

12) Exit Smartpro.

5.4. Maintenance

Before performing any maintenance jobs:

Always wait at least five minutes for capacitor discharging before beginning of work operations at the converter.

In case of damaged discharge resistors the discharge time can extend indefinitely longer.

Observe safety notes

5.4.1. Tools and Test Equipment

In addition to standard shop equipment (e.g., metric tools), only a few special tools are required for the maintenance of the converter boxes:

- Key for unlocking the large front service cover
- Square spanner for removing service covers
- Notebook computer (PTU) with SmartPro diagnostic software

5.4.2. Maintenance Schedule

The maintenance schedule outlines the tasks to be performed along with the corresponding time intervals.

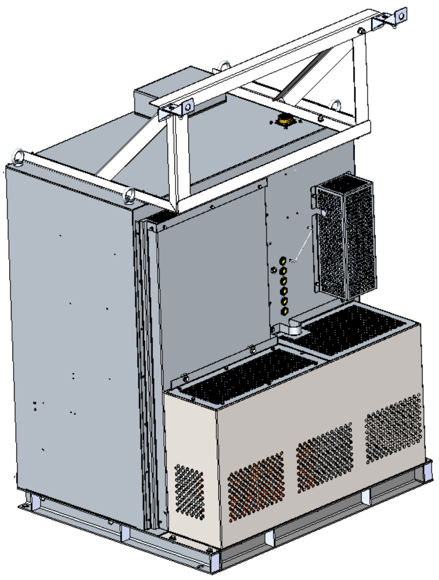
- Longer maintenance intervals encompass the tasks of the shorter intervals.
- For example, after 4 years, all tasks from the maintenance plan must be completed.

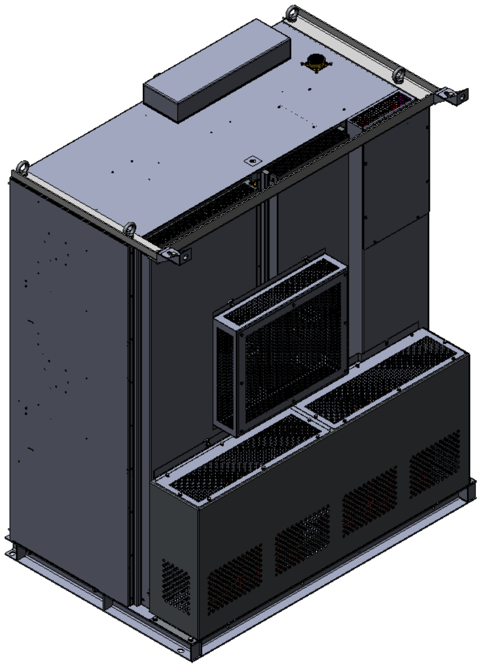
5.4.2.1. Maintenance schedule for Auxiliary Converter, WAP5/WAP7/WAG9 locomotive

No.	Maintenance tasks, auxiliary converters Box 1 / Box 2,WAP5/WAP7 locomotive	Interval		
		180 days	18 months	4 ½ years
1	Clean **converter compartments** flown through by cooling air: Air duct, power modules' heat sinks	X		
2	Check **earth connection** of Box 1 and Box 2.		X	
3	Connect PTU with TTProDiag. Check condition of **data bufferbatteries** on control boards. Replace low batteries.		X	
4	Replace **data buffer batteries** on control boards.Box 1: • A701_702 control board Box 2: • A701_702.1/.2 control boards • A701_704, LVPS control board.			X
5	Service covers: • Check **gaskets**. Replace damaged or worn gaskets. • Check **fasteners** and **closing mechanism**. Lock fasteners. Replace damaged parts. • Check **earth cables** of service cover for fit and damage.	Always when opening a service cover		

5.4.2.2. Cleaning Air Duct and Heat Sinks

1. Box 1: Remove back covers 1 and 2
   Box 2: Remove back covers 1, 2a, and 2b
   - Remove the cover fixing screws, loosen the earth cables, and remove the covers.
2. Visual Inspection:
   Inspect the air duct, all components in the air duct, and the heat sinks of the power modules for any pollution.
   - Cleaning is required only if the cooling effect is compromised due to dust or contamination.
   - Small dust deposits do not need to be removed, and a thin layer of dirt on the power module cooling fins or other components does not necessitate cleaning.
3. Cleaning Process:
   - Use a vacuum cleaner to clean the air duct, components in the air duct, and the heat sinks of the power modules.
   - If needed, use a brush, but be careful not to damage surfaces or twist the cooling fins.
4. Reinstall Covers:
   - Reinstall the covers and ensure the earth cables are properly attached.



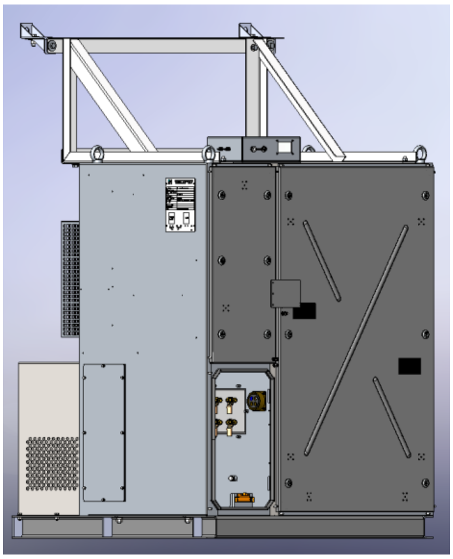


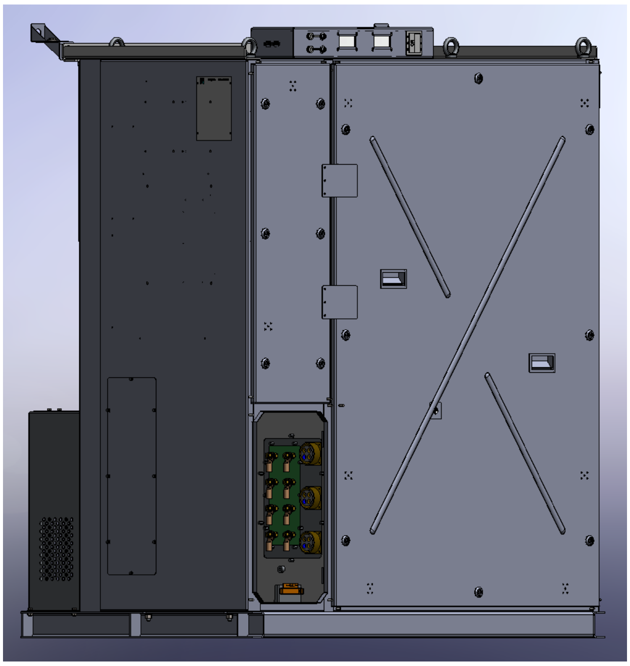
5.4.2.3. Checking earth connections

1. Unlock big service cover (1), see Figure 119 and Figure 120.
2. Unlatch quarter-turn fasteners. Loosen earth cable and remove big service cover.
3. Unlatch 4 quarter-turn fasteners. Loosen earth cable and remove lower left service cover.
4. Check earth connection of Box 1 and Box 2 for firm fit. Use torque wrench. Torque ground connection to 30 Nm.

If connection is damaged in any way or if attaching elements are missing, repair earth connection.

5. Install covers again. Do not forget attaching earth cables.

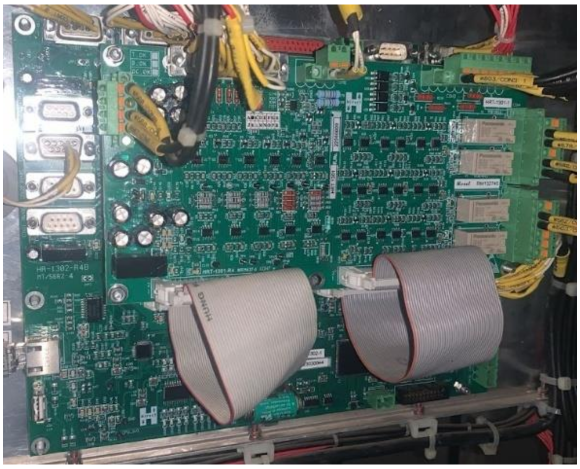




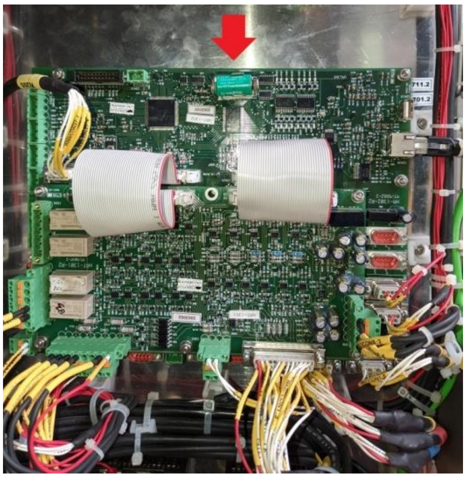
5.4.2.4. Replacing batteries on control boards

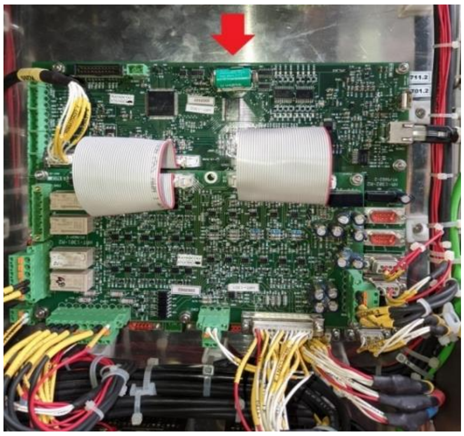
- **Replacing batteries, Box 1**

1. Remove big front service cover.
   Unlock cover, unlatch quarter-turn fasteners, loosen earth cable and remove cover.
2. Locate control boards: Two boards A701.
3. Replace batteries of control boards. Refer to section replacing battery on board.
4. Install cover again. Do not forget attaching earth cable.



- **Replacing batteries, Box 2**
  1. Remove big front service cover.
     Unlock cover, unlatch quarter-turn fasteners, loosen earth cable and remove cover.
  2. Remove upper left service cover.
     Unlatch quarter-turn fasteners, loosen earth cable and remove cover.
  3. Locate control boards:
     Four boards A701.1, A701.2 at the right-side wall. Right One board A704 at the left side wall,
  4. Replace batteries of all 3 control boards. Refer to section replacing battery on board.
  5. Install covers again. Do not forget attaching earth cables.





5.4.2.5. Replacing battery on PCB

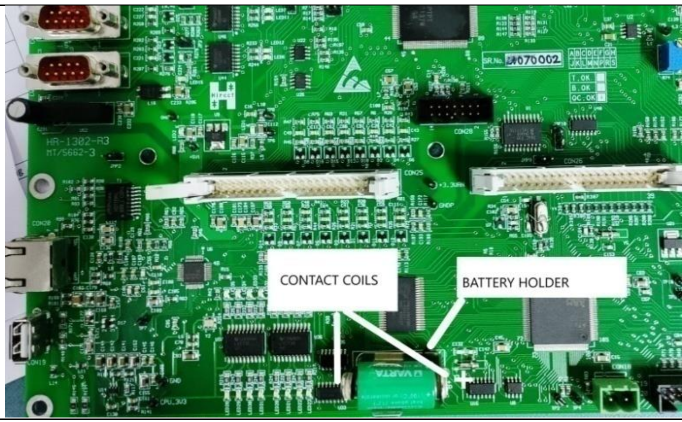
1 **Battery replacement with data loss**

Following data will get lost when changing battery and converter is free of voltage:

- Data of the event memory as well as the state of the hour meter
- Lists of recent service actions and list of recent command entries
- These data have to be stored before the battery is replaced (reading out in file or print out).
- The time has to be re-entered after the converter has been switched on again,unless it is synchronized automatically by the vehicle control.

2 **Battery replacement without data loss**

- Only possible in the workshop when board removed
- To be carried out only by qualified personnel
- In order to avoid data loss, supply the control board with +15 V auxiliary voltagebefore removing the battery.
- Power supply connector: X1, +15 V: pin 1, ground: pin 3 (see figure below)

Work Instruction	
1) Use cable tie or similar suitable tool to release the battery from clip. Remove the battery. 2) Insert new battery into the clip(plus pole as indicated in image). 3) Take care that battery contacts fit tightly to contact spring of battery clip.	
Note: Do not use any sharp-edged tool. Do not lever out battery	

5.4.3. Repair of converters

5.4.3.1. Handling of sensitive components

Observe ESD instructions

	Attention, electrostatic sensitive devices! Danger of electrostatic discharge (ESD). Touching board or component permitted only within electrostatically protectedenvironment. Strictly do not touch any PCB without previous body discharging.

Several electronic components, as e.g. CMOS components, may be damaged by electrostatic discharge(ESD). These components are mainly used on printed circuit boards.
For electrostatic sensitive components, special handling instructions are valid. See also IEC 61340.

- **Handling of electrostatic sensitive components:**
  1. Touch grounded parts (e.g. device housing) to avoid possible static load prior to handling ofcomponents. Use ESD wristlet and conductive pad.
  2. Only touch PCB's at the edges.
     Do not touch surface or pins to avoid damage to the circuits or components.
  3. Procedure for removal of PCB's and electrostatic sensitive components:
     1. Cut off supply voltage and all other voltages
     2. Remove all plugs and electrical connections. Then remove component.
  4. Use antistatic packaging material for transport and storage.
  5. Take care of the right mounting position of the electronic units

5.4.3.2. Power semiconductors

	IGBT's, IGBT modules When IGBT's are not connected, the gate and emitter connections must be shorted. This is done by joining the connections of each control line pair with conductive materials. If this is notdone, the IGBT may be damaged irreparably. This also applies, for instance, when the IGBT driver is removed/disconnected while the IGBT'sare mounted. New IGBT's are also supplied with the gate and emitter connections shorted
	Modules on heat sinks Lossy components on heat sinks must be mounted with conduction paste (e.g. IGBT modules).Evenly spread conduction paste on the contact surface.

5.4.3.3. Removal of converter boxes

In general, removal of the converter boxes is done in reverse order of the installation.

- First, disconnect all electrical connections.
- Loosen mechanical connections.
- Use eye bolts to lift converter box out of vehicle. Pay attention to avoid damage of air inlet connections at the bottom of the converters.

5.4.3.4. Removal of modules

Components/modules are always removed in the same manner. Additional steps for removal of heavy subassemblies:

Removal of components	
No.	**Steps**
	**Basic rules** • Avoid pulling any cable. • Never use force to release plug-and-socket connections. • Always use a second open-ended wrench to hold the second nut when releasing locked nuts. • Make sure you do not damage the cables when cutting through cable ties. • **Risk of shorting!** Do not allow any loose parts to fall into the converter. Collect reusable fixing components in suitable containers. • For removal of some modules, the help of a second person is recommended. • For removal of IGBT's or IGBT drivers, special procedures have to be observed.
1	Open / remove the service cover for the module concerned.
2	Check labels on cables, connectors and plugs of the module for legibility. If any labels are illegible, label cables/connectors/plugs so that they can be assigned clearly when assembling.
3	Disconnect all electrical connections from the module: • Disconnect all cable connectors to the module (plugs, screw terminals etc.). If necessary, cut through and remove cable ties. • If present, loosen screw connections of contact bars.
4	Release screw connections which secure the module.
5	Carefully remove the module from the converter.

5.4.3.5. Tightening torques

Tightening torques for usual screwed connections

The following tightening torque values are valid for all screwed connections in the converter secured with special washers "Dacromet" with these exceptions:

- Screwed power semiconductors

Screwed connections Stainless steel screws, securing element: Special washer "Dacromet"						
Thread	M5	M6	M8	M10	M12	M14
Tightening torque [Nm]	4.0 Nm 35 lbf-in	7.2 Nm 62 lbf-in	17.5 Nm 150 lbf-in	36 Nm 318 lbf-in	61 Nm 540 lbf-in	95 Nm

5.4.3.6. Tightening torques for screwed power semiconductors

Screwed connections of power semiconductors require different/lower tightening torque values than usualscrewed connections.

Observe tightening torques!

To avoid damage of power semiconductors, maximum tightening torques have to be observedunder all circumstances for

- connection of power semiconductor to heat sink.
- connection of electrical cables to power semiconductor terminals.

Tightening torques for power semiconductors						
Module	**Component**	**Qty. ***	**Type**	**Designation**	**Tightening torque [Nm]** Connection to terminals	Connection to heat sink
AC to 3AC sections, Box 1 and Box 2						
A201.x	V01	1	Hirect - HTT500N36	Thyristor module 500 A, 3600 V	18	12
	V02	1	Hirect - HDD800N44	Dual diode module 800 A, 4400 V	18	12
A301.x	V01, V02	6	Infineon FF900R12IE4/ Fuji 2MBI900VXA-120E	Dual IGBT module 900 A, 1200 V	M4 screw: 1.7 – 2.1 M8 screw: 8.0 – 10.0	4.25 – 5.75
A401	VD1, VD2 (A03)	2	APT APT2x101DQ100J	Diode module 2 x 100 A, 1000 V	1.0	–
	VD1, VD2 (A03)	2	IXYS DSEI2x61-06C	Diode module 2 x 60 A, 600 V	1.5	1.5
	V11	1	Semikron SKM150GB12T4G	Dual IGBT module 150 A, 1200 V	2.5 – 5	3 – 5
	V12	1	Semikron SKM200GB125D	Dual IGBT module 200 A, 1200 V	2.5 – 5	3 – 5

5.4.3.7. Special procedures for removing/installing modules

Help of a second person

Risk of damage and injury!

For removal and installing heavy converter modules, consulting a second person is requested.

Modules on heat sinks:

Box 1 and Box 2:	A201.x, A301.x Only Box 2: A401
Chokes (GOD):	L101.x, L301.x
Transformer in Box 2:	T402

Assembly paste:
All heat sinks are fixed with stainless steel screws and -nuts. The fixing elements have to be provided with fitting lubricant.

5.4.3.8. Power Semiconductors

Tightening torques	Screwed connections of power semiconductors require different/lower tightening torque values than usual screwed connections.
IGBT modules	If IGBT's are not connected, the gate and emitter terminals must be shorted. This is achieved by bridging the terminals of each control line pair with conductive materials. Otherwise, the IGBT may be damaged irreparably.
⚠	This also applies, for instance, if the IGBT driver is removed/disconnected while the IGBT's are mounted. New IGBT's are delivered with the gate and emitter terminals shorted.
Components mounted on heat sinks	Lossy components have to be mounted on the heat sink using heat-conductive paste(e.g. IGBT modules). Evenly apply heat-conductive paste to the contact surface.

5.4.4. Disassembly and servicing of main contactor

- Purpose
  The purpose of this SOP is to outline the step-by-step procedure for disassembling the auxiliary ABB main contactor assembly for servicing, repair, or replacement of components. This ensures efficient servicing while minimizing the risk of damage.
- **Scope**
  This SOP applies to all personnel involved in the disassembly, servicing, and reinstallation of the main contactor assembly.

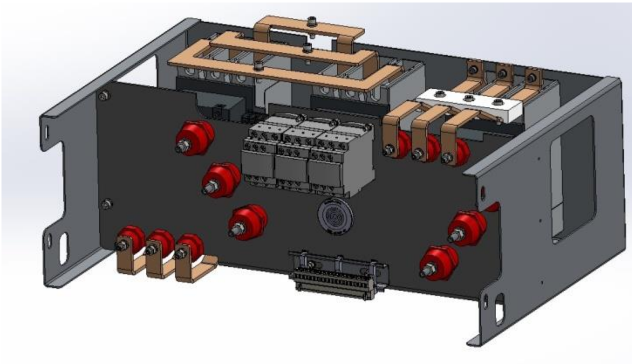
Disassembly Procedure:

Step 1: Removal of Connection

1. Gather all necessary tools and safety equipment.
2. Contactor assembly is located at right side bottom corner shown in Fig. (a) of Box 2.
3. Remove all cables connection from the different terminals/locations w.r.t. contactor.

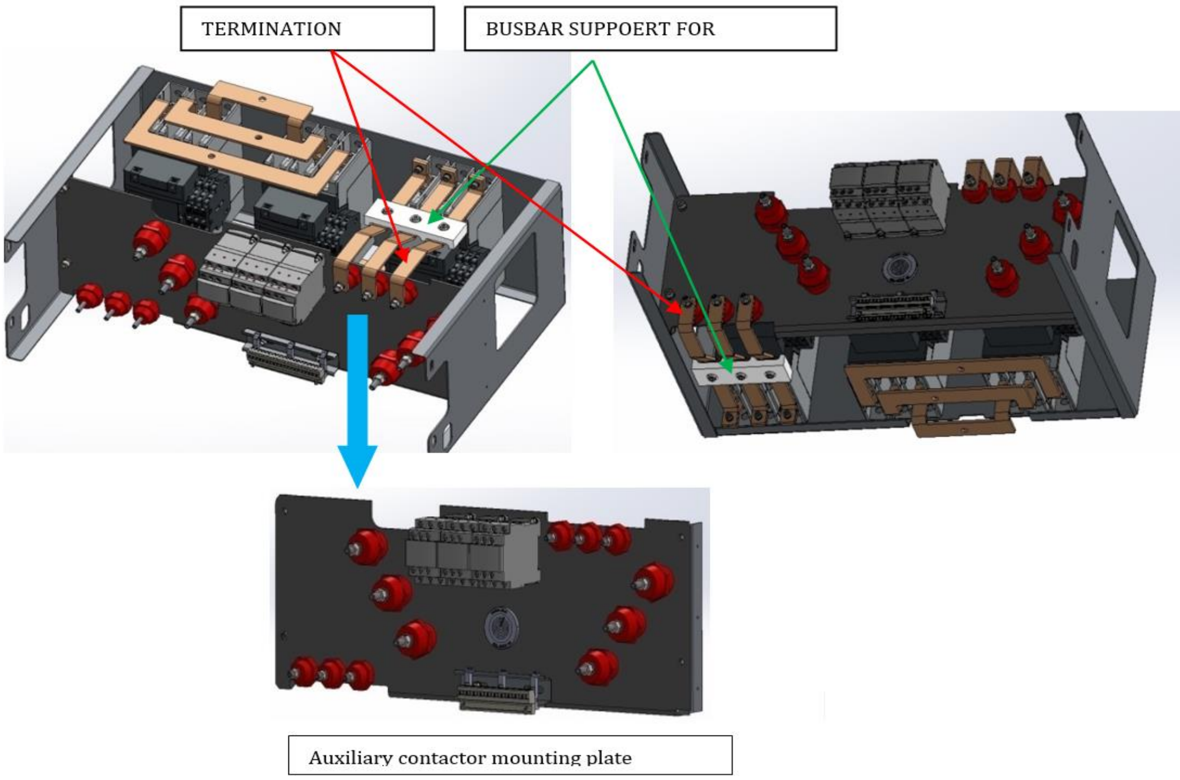
Step 2: Removal of Main Contactor Modular Assembly from the Panel

1. Unscrewing the hardware of M6 bolt along with plain & spring washer as shown in red marks in Fig. 1
2. Remove the main contactor complete assembly from inside the panel by sliding towards door side.



Step 3: Removal of External Components

1. Remove the termination busbar for the contactor by loosening the M6 bolts, plain & spring washers.
2. Unscrew and detach the busbar support from the termination busbar.
3. Repeat this process for the bottom-side termination busbar.



Step 4: Detaching Auxiliary Contactor Mounting Plate (Refer Fig. (b)**)**

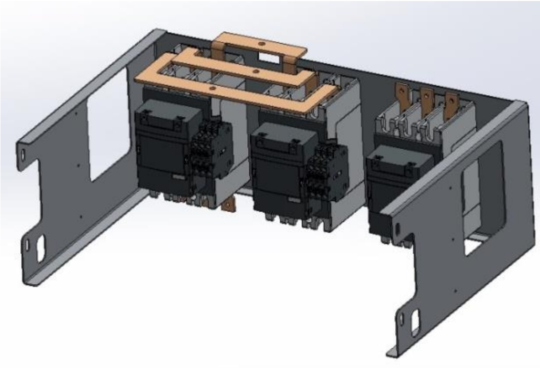
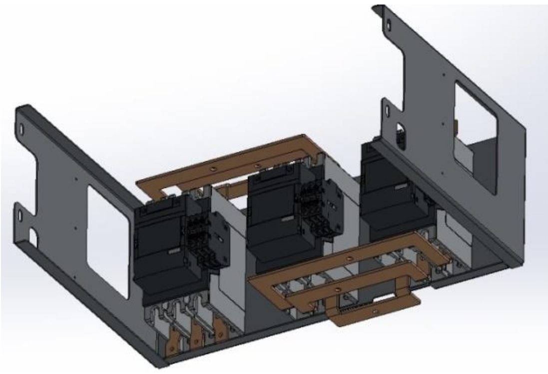
1. Locate and unscrew the M6 bolts securing the auxiliary contactor mounting plate.
2. Carefully remove the mounting plate from the SS frame.
3. Detach the cable entry plate.

Step 5: Removal of Contactor Components

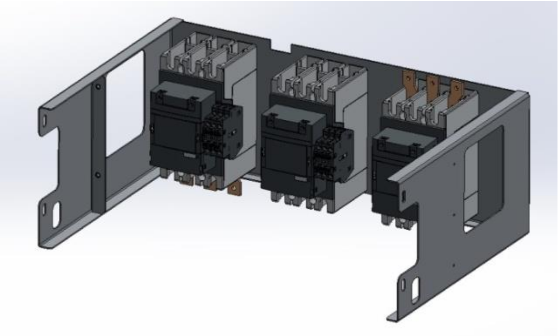
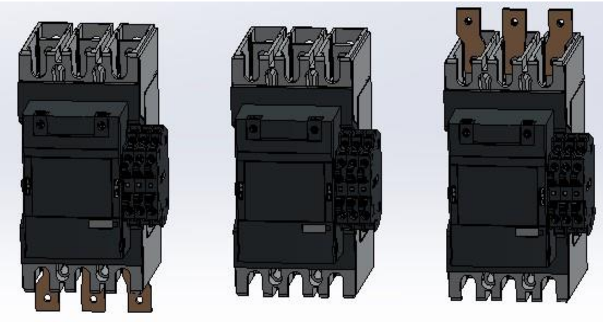
1. Remove the WAGO adaptor and connector male by sliding them off the DIN rail.
2. Unscrew and remove the DIN rail from the mounting frame.
3. Detach epoxy insulators (M6 and M8) by removing the securing grub screws.

Step 6: Disassembly of Busbars and Insulation Components

1. Remove CU busbars (Inner, Center, and Outer) by loosening the M8 bolts along with spring and plain washers.

Step 7: Dismounting the Main Contactor
1. Unscrew the M5 bolts securing the main contactor to the SS frame.
2. Gently remove the contactor from the frame.
3. Store the removed components safely for servicing or replacement.

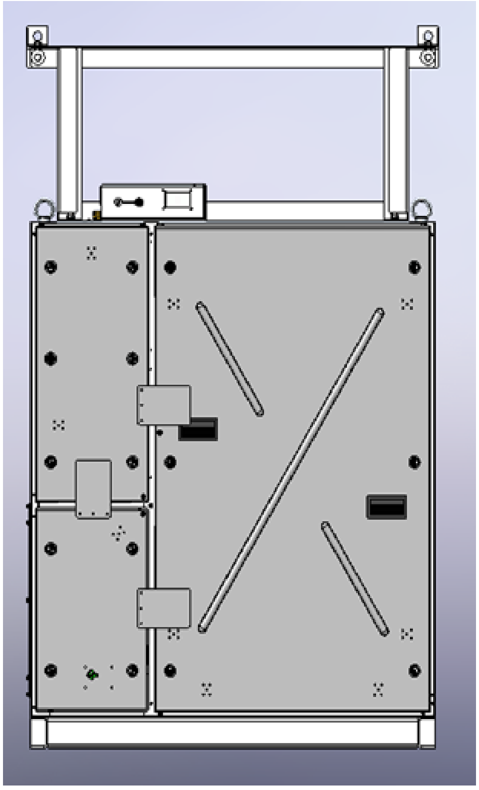
Step 8: Final Disassembly Steps
Perform a final check to ensure all components have been removed and accounted for.

N.B.: For Re-Assemble follow the step in reverse.

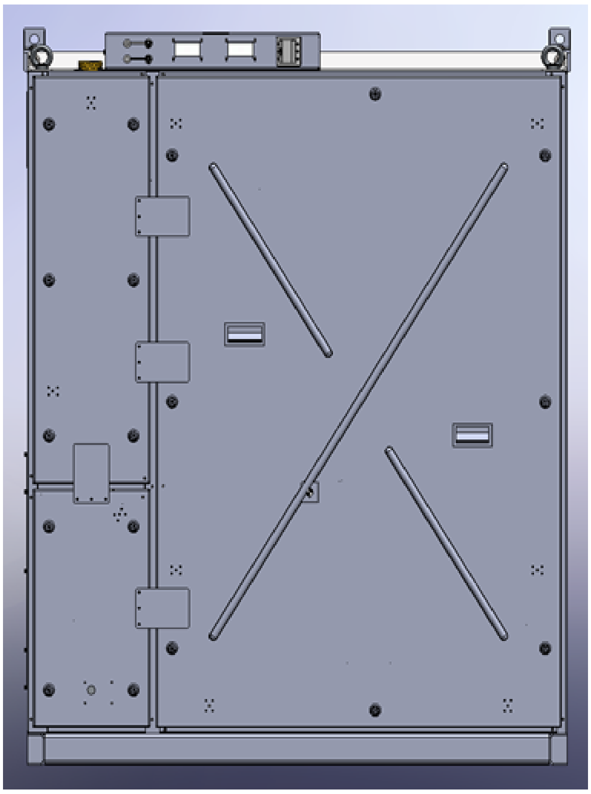
5.5. Components List and Section Details of Auxiliary Converter

Following spares for HIRECT make 3x130 kVA Auxiliary Converter to be kept by Electric Loco sheds for 3 years Maintenance.

Sr. No.	Description of item	Type/Designation	Make/ Sources	Spares Quantity
1	Fuse	170M4244	FERRAZ	2
2	Inverter module Assembly	-	HIRECT	2
3	Semi controlled SCR bridge Module Assembly	-	HIRECT	2
4	Combined Battery Charger module Assembly	-	HIRECT	1
5	Control Electronics for BUR	HRT-1301	HIRECT	3
6		HRT-1301	HIRECT	3
7	Control Electronics for Battery Charger	HRT-1302	HIRECT	1
8		HRT-1302	HIRECT	1
9	Dual IGBT driver for inverter	HRT-1324	HIRECT	6
10	Single thyristor driver	1703	HIRECT	4
11	Dual IGBT module	2MBI900VXA-120E-54/ FF900R12IE4	FUJI/ INFINEON	6
12	Dual Thyristor module	HTT500N36	Hirect	2
13	Dual diode module	HDD800N44	Hirect	2
14	Diode module	DSS2x101-02A	IXYS	2
15	Circuit breaker	D2AKXA0647	CBI	2
16	DC/DC converter	IC265_3	INTREXIS	2
17	Contactor, AC, 3-pole	AF190-30-11-13	ABB	2
18	Auxiliary contactor, AC, 3-pol	LC1D09FD	SCHNEIDER	2

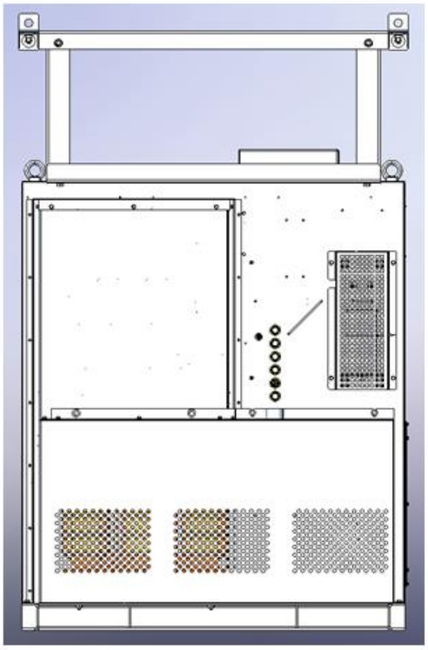


BOX 1 Contain BUR1

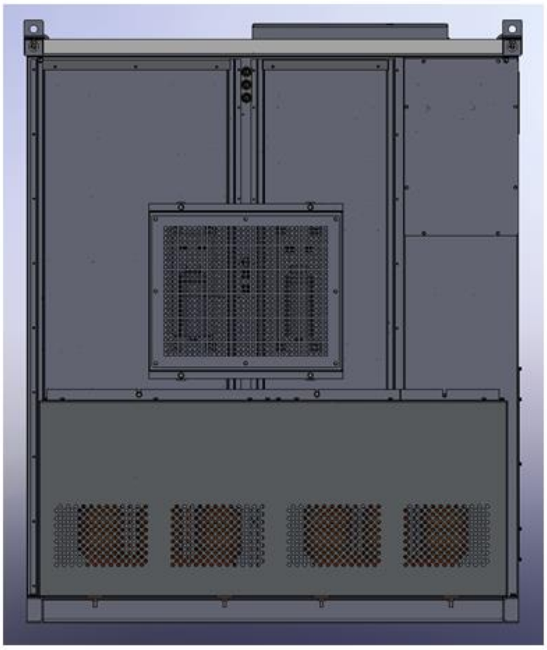


BOX 1 Contain BUR2, BUR3 & Battery Charger

Front View with Door Closed



BOX 1 Back Side



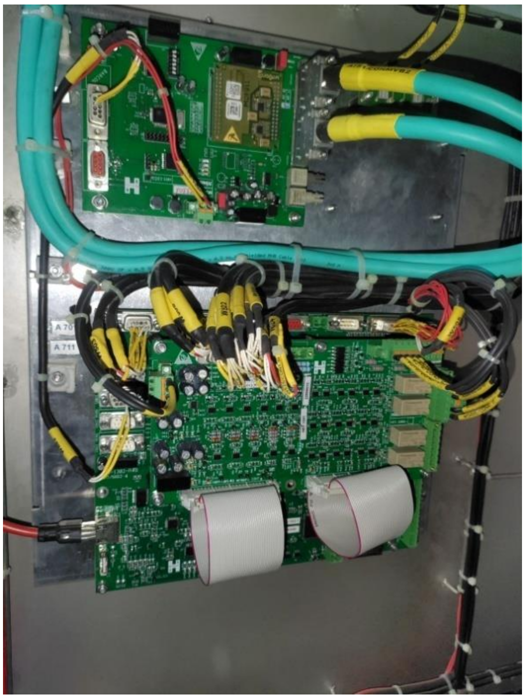
BOX 2 Back Side

Rear View with Door Closed

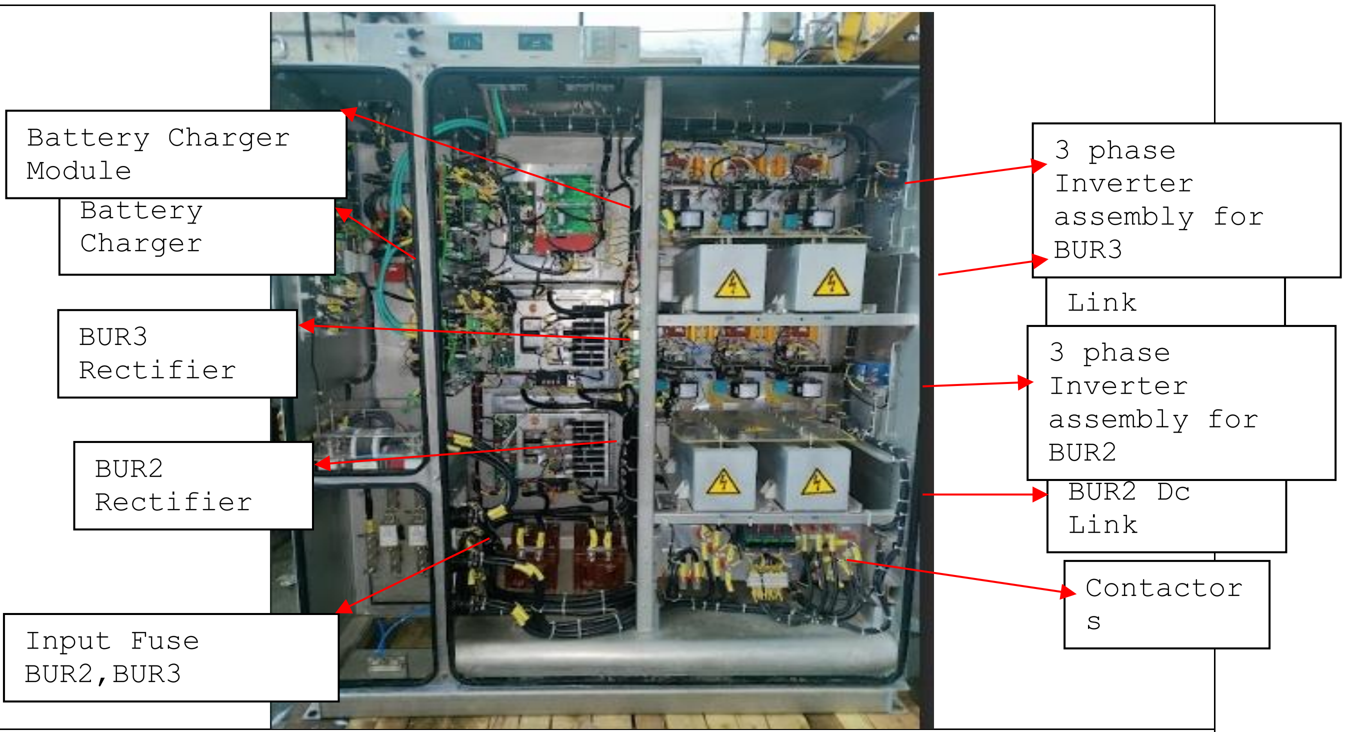
Box-1

Box-2

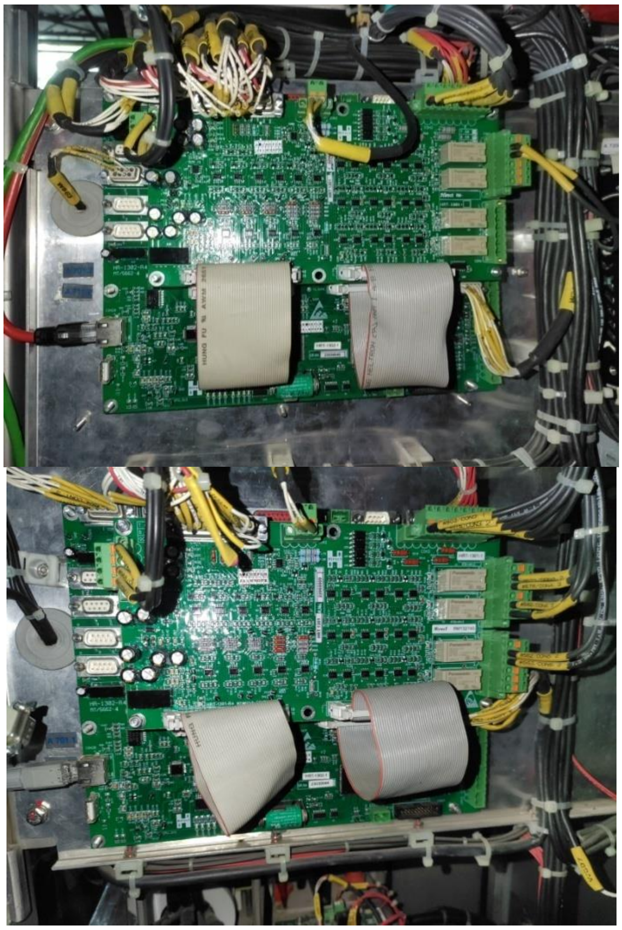
Front View with Door Opened



BOX1 - BUR1 Control Electronics



BOX2 – Assembly / Components Layout



BOX2 control Electronics

Rectifier Assembly

Inverter Assembly


Battery Charger

Auxiliary Contactor


Power Supply

6. Chapter 6-DDU (DRIVER DISPLAY UNIT)

6.1. Safety Precautions

Before using this product, please read this chapter carefully.
This chapter describes the safety precautions recommended when using the Driver Display Unit.
Before installing and using the equipment, this chapter must be thoroughly read and understood.

Explanation of symbols used	
Signal words such as DANGER, WARNING, and CAUTION will be followed by important safety information that must be Carefully reviewed and followed.	
WARNING	Indicates a potentially hazardous situation which if not avoided could result in minor or Moderate injury, if you do not follow the instructions.
CAUTION	Indicates a potentially hazardous situation which if not avoided, may result in property Damage

CAUTIONS
• **Operating Environment** The equipment must only used within the range of ambient temperature, humidity and dust detailed in the specification and in an environment free of abnormal vibration.
• **Ratings** Before applying the DC power supply to the equipment, check that they confirm to the equipment ratings.
• **Printed Circuit Boards** Do not remove or attach printed circuit boards when the DC power to the equipment is on, as this may cause the equipment to malfunction.
• **External Connections** When connecting the output contacts of the equipment to an external circuit, carefully **check the supply voltages** and ratings of the circuit used in order to prevent the equipment from malfunctioning or damage.
• **DC Power** When connecting the DC power to the terminals of equipment, confirm the polarity of the supply. Connecting reverse polarity may damage the equipment.
• **Connecting Cables** When connecting the external cables avoid applying excessive force, which may damage the connectors.
• **Modifications** Do not modify this equipment, as this may cause the equipment to malfunction.
• **Disposal** When disposing of this equipment, do so in a safe manner according to the local regulations.

6.2. Introduction

To run a system safely and properly functioning, it is always necessary to have clear and detailed status information of the all the parts of the system. Obviously, the pilot of a locomotive must have all the detailed status of the locomotive during its operation to run the locomotive safely. To facilitate the loco-pilot, a Driver Display Unit (DDU) is being provided for three phase type locomotives. The basic function of the display unit is to communicate with the locomotive control system through MVB and display the required parameters. In short, it is the man-machine interface between the loco-pilot and the locomotive control system.
The DDU consists of a backlit 10.4” LCD screen and membrane keypad for interaction with the loco driver. The LED backlit on the LCD screen provides better visibility even during daylight conditions.

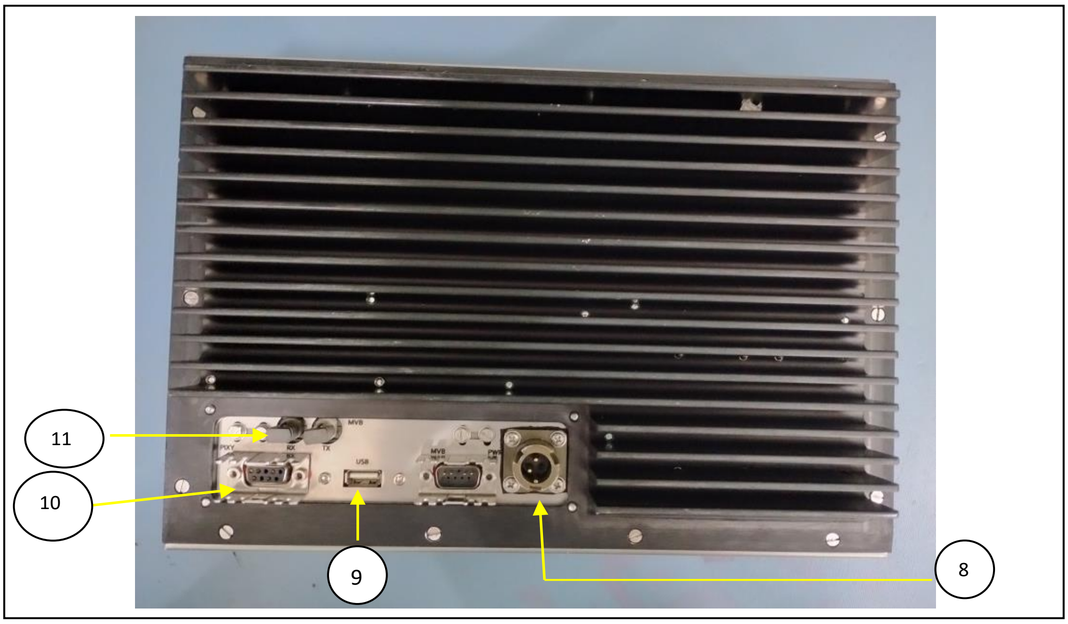
6.3. Technical Specification & Design

The Driver Display Unit (DDU) consists of the following materials:

- LCD
- KEYPAD
- USB socket (front)
- 3-pin circular connector
- Optical connector
- D-Sub connector

6.3.1. Front view of the Driver Display Unit

6.3.2. Back view of the Driver Display Unit

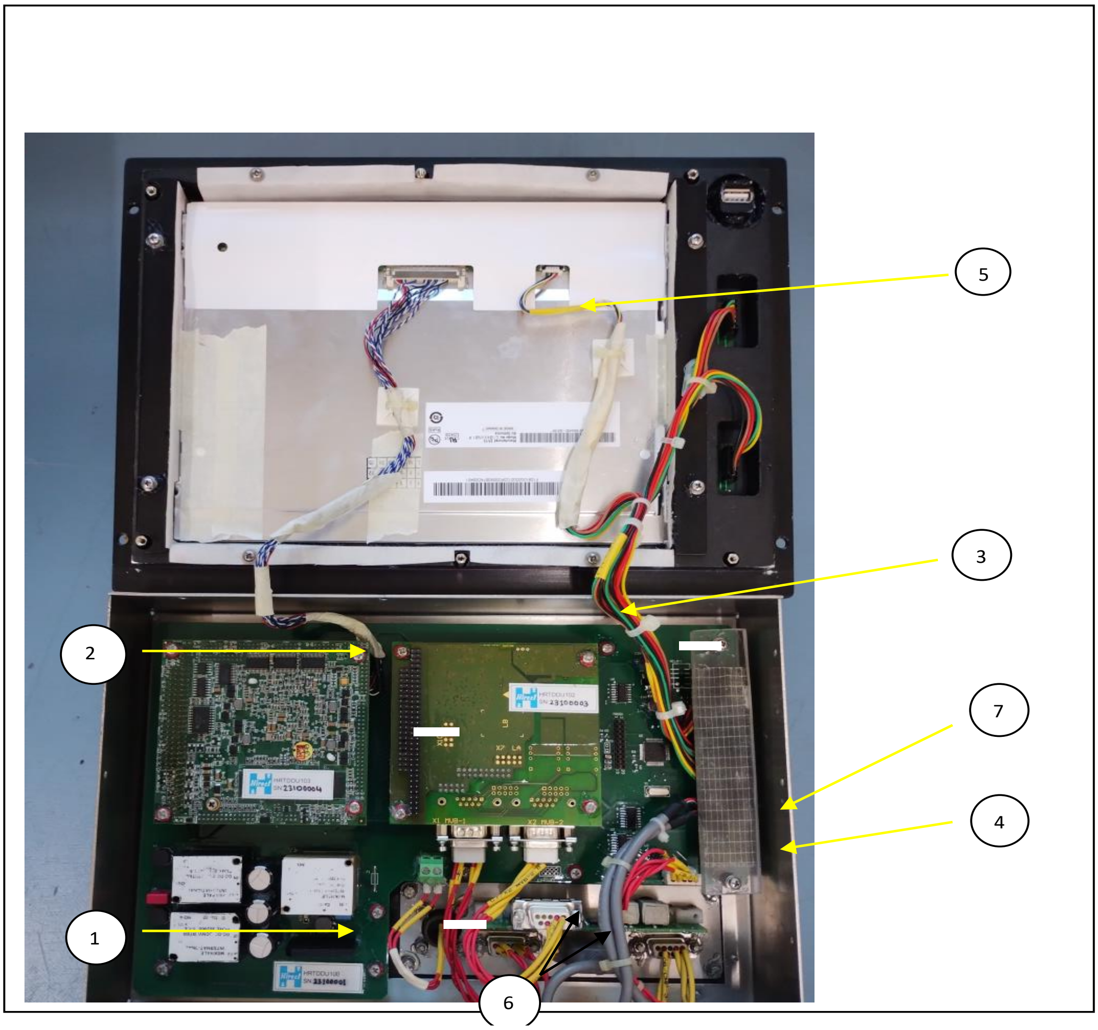


6.3.3. Indications

SIDE	SR NO	FUNCTION	EXPLANATIONS
Front	1	LCD	To Display parameters
	2	Power Key	To ON and OFF the display backlight
	3	Brightness Control Key	To control the LCD display brightness i.e. Min to Max
	4	Contrast key	To set the LCD display in Night Mode (i.e. Min. brightness)
	5	Function Key	For invoking special functions and screens
	6	Navigation Key	For Navigating screens 1. Left & Right key is used to navigate through screens 2. Up, Down, Menu & Enter key is used to navigate through pixy screen 3. Home Key is used to come to the main screen from any other screens
	7	USB socket	To connect External USB device
BACK	8	3 Pin Circular connectors	Power Supply 110V DC
	9	USB socket	To connect External USB device
	10	D-SUB 9 Pin	Pixy
	11	Optical connector	MVB

6.3.4. Interior view of the Driver Display Unit

SL No.	Function	Explanation
1	Main Control Card	Power supply and control
2	Motherboard	Control All Function
3	MVB communication card	MVB communication
4	ESD to OGF card	Converter card
5	LCD	To Display parameters
6	Cable 6	MVB Data transfer
7	Cable 7	Pixy data transfer



6.4. Function/ Operation

Driver Display Unit consists of a LCD display for displaying various screens according to the user input through a keypad. The Display screens have been designed with the purpose of simplifying the user experience while utilizing maximum screen area for more effective use. The screen area is organized in a manner that allows the user to monitor critical system parameters at all times while navigating through options and other screens for specific information.

6.4.1. Keypad

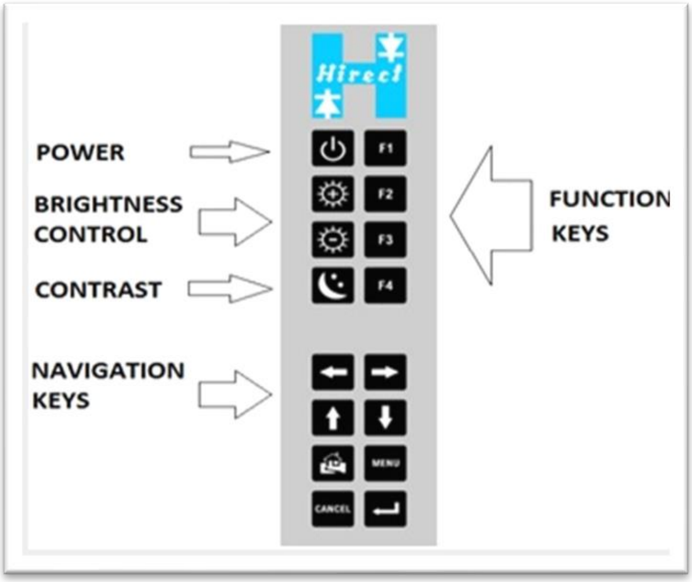
The Driver Display Unit has a keypad for user interaction. The keys have been organized in two different clusters.

"PIXY" display control:

It consists of eight membrane keys of rugged type. The keys are protected from direct ingress of dust and moisture using a silicon rubber mould. The keys are suitable for operation by fingers. The function assigned to each key is given below.

"Function" keys:

The function keys are six in number and are used for invoking special functions and screens as detailed below.



6.4.2. Display

High resolution of 1024 X 768 pixels, graphical LCD is used for displaying the various screens to the pilot. Simultaneous display of multiple screens also has been provided for better interface. In addition, LED backlit, brightness control features enable the driver improved visibility even during daylight condition.

Display Screens:

The Driver display has pre-defined dedicated screens in order to monitor real time process variables pertaining to a particular section or sub-system of the locomotive. These screens are meant for online monitoring by technical staff whenever required.

The design philosophy followed is such that all the critical process variables and PIXY screen which are needed to be monitored always by the driver has been provided in a permanent location and is available always irrespective of any pre-defined screen is selected. For other screens, only the portion of speed display dial gets changed to show other required parameters.

Default Screen:

The driver normally uses the default screen while driving, even though he can navigate to any other investigative screens, if required. This screen is divided into various sections. The parameter values are fetched from MVB.

HOME SCREENS

Fig. 6.1 Default Screen

The default screen shows the driver the following information:

- Locomotive Speed
- Catenary Voltage
- Battery Voltage
- TE Reference & TE Actual
- MR Pressure and BP Pressure
- Circuit Breaker Status
- Panto UP/DOWN Status
- Brake Application on Locomotive
- Brake Application on Train
- Parking Brake Applied
- Wheel Slip Status
- Real Time Clock

In addition, any fault messages pop up in case of any error to alert the driver. Pop messages may appear on default screen as well as on other screens. Pop up screens disappear when the driver acknowledges the same error.

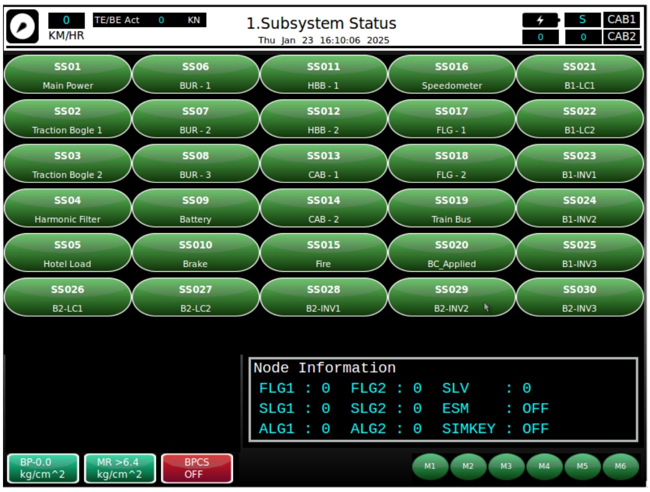
Navigation to Other Screens

While in default screen when Left or Right key is pressed in the lower group keypad, a new screen will appear in the place of speedometer dial. The speedometer portion has been sacrificed here to give a menu of pre- defined screens that can be viewed. Please note that the Driver will normally drive using default screen only. Other sub-screens are needed for investigative purpose.

6.4.3. List of Other Screens

1: Sub-System Status

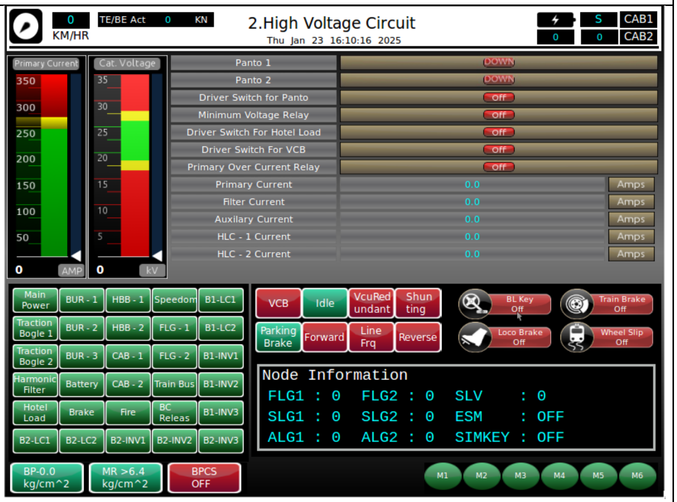
This screen shows ON/OFF status of all sub-systems.



2: High Voltage Circuit

The below mentioned parameters are displayed on this screen.

Sub-System status, Catenary voltage, VCB ON/OFF Status, Panto Up/Down Status, Primary Over Current Relay Status, Minimum Voltage Relay Status, Driver's Switch Status for Panto, VCB and Hotel Load.



3:Traction converter 1 & 2

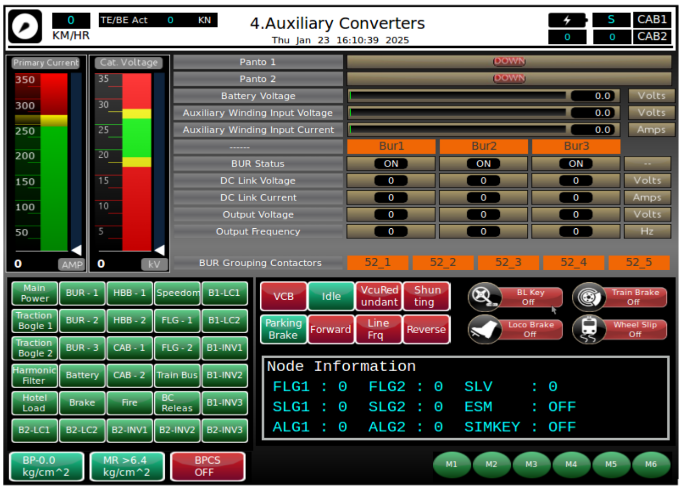
The below mentioned parameters are displayed on this screen.

Subsystems status, Input Contactor ON/OFF Status, Pre-Charge Contactor ON/OFF status, Input current, DC link voltage, Output phase current, Oil pressures, Oil temperature, Catenary Voltage, Panto Up/Down Status, VCB ON/OFF.

4: Auxiliary Converter 1, 2 & 3.

The below mentioned parameters are displayed on this screen.

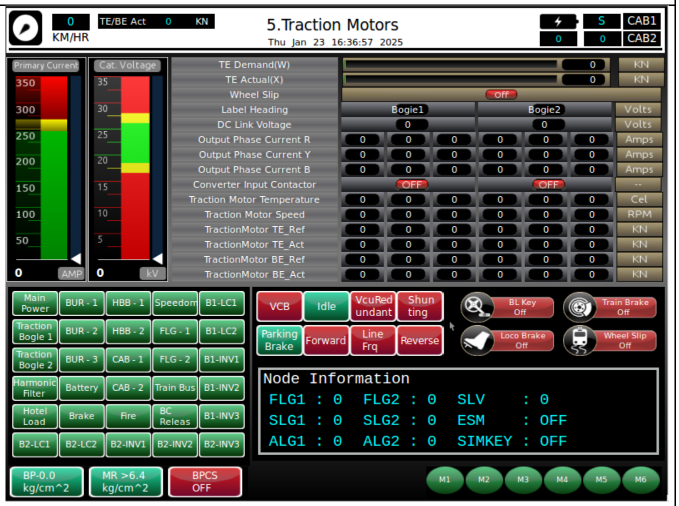
Sub-system Status, Catenary voltage, Panto Up/Down Status, VCB ON/OFF Status, Auxiliary Winding Voltage, Auxiliary Winding Input Current, DC Link Voltages, DC Link Currents, Output Voltages, Output Frequencies, BUR grouping contactors status, Battery Voltage.



5: Traction Motor

The below mentioned parameters are displayed on this screen.

Sub-system status, Converter input contactor ON/OFF status, Converter DC Link Voltage, Converter Output Currents, Motor Speeds, Motor Temperatures, TE reference & TE actual, Wheel Slip Status.



6: Auxiliary System

The below mentioned parameters are displayed on this screen.

VCB ON/OFF Status, Panto Up/Down Status, Cooling mode status, Auxiliary Winding Input Voltage, BUR sub-system status, contactor status of auxiliary machines like machine room blowers, Oil cooling blowers, Oil pumps transformer, Oil pump converter, Compressors.

7: Braking System

The below mentioned parameters are displayed on this screen.

VCB ON/OFF Status, Panto Up/Down Status, BL Key status, Master Controller status, BE reference, MR pressure, BP pressure, Compressors ON/OFF status, Braking effort electrical, Equivalent Pneumatic Brake demand, Parking Brake ON/OFF Status, Emergency Brake Applied Status, Vigilance Activated/Penalty Brake Status, Brake Cylinder Pressure, Train Brake Applied Status, Loco Brake Applied Status, Anti-Slip Brake Applied Status.

8: Energy Monitoring

The below mentioned parameters are displayed on this screen.

Cumulative Traction Energy, Cumulative Regenerative Energy, Cumulative Traction Energy and Braking Energy from the start of the trip, Cumulative Specific Energy consumption, Cumulative Specific energy consumption for the trip.

9: Temperatures

The below mentioned parameters are displayed on this screen.

VCB Status, BL Key Status,,

Temperature Transformer Oil,

Temperature Converter Oil, High

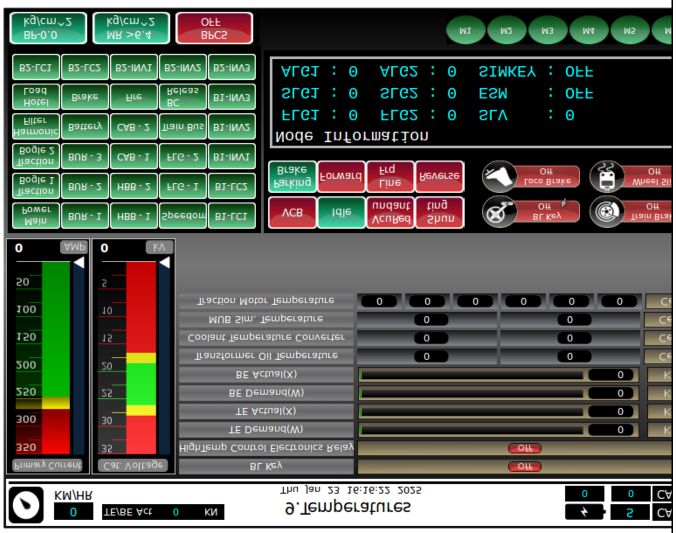
Temperature Control Electronics

ON/OFF relay Status, Temperature

Traction Motors, MUB simulated

temperature, TE reference, TE actual,

BE reference and BE actual.



10: Pressures

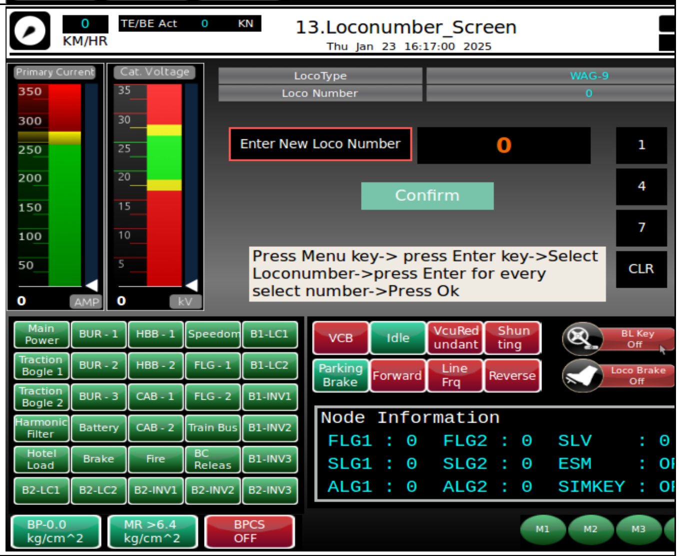
The below mentioned parameters are displayed on this screen.
VCB Status, BL Key Status, Oil Pressure Transformer, Oil Pressure Converter, MR pressure, BP pressure, Brake cylinder pressure.

11: Inching mode Screen

In this screen set speed for inching press up and down button then press Enter then appear password screen enter password (select number from display keyboard and press enter after put 4-digit password then press ok form display keyboard) then again press
Enter for send the speed to mvb port. The below mentioned parameters are displayed on this screen VCB Status, BL Key Status, Oil Pressure Transformer, Oil Pressure Converter, MR pressure, BP pressure, inching set speed & actual speed.

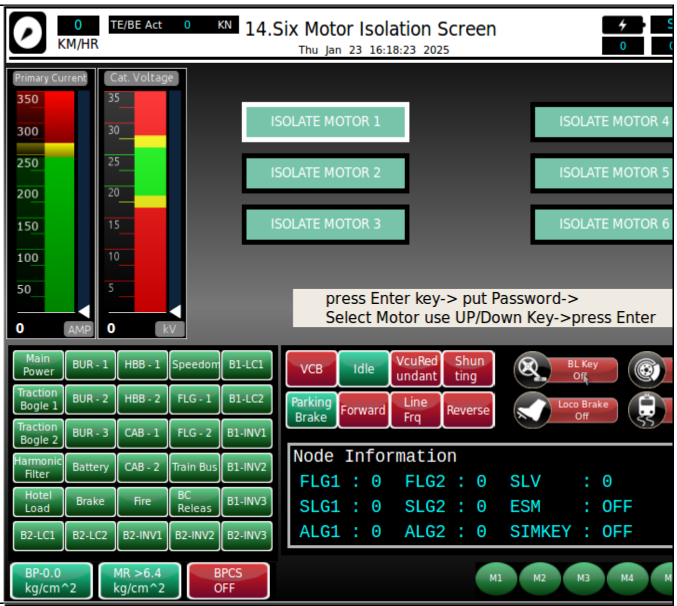
12: Loco Number Screen

In this screen put loco number using display keyboard. The below mentioned parameters are displayed on this screen , BL Key Status, Oil Pressure Transformer, Oil Pressure Converter, MR pressure, after put loco Number then see in actual loco number



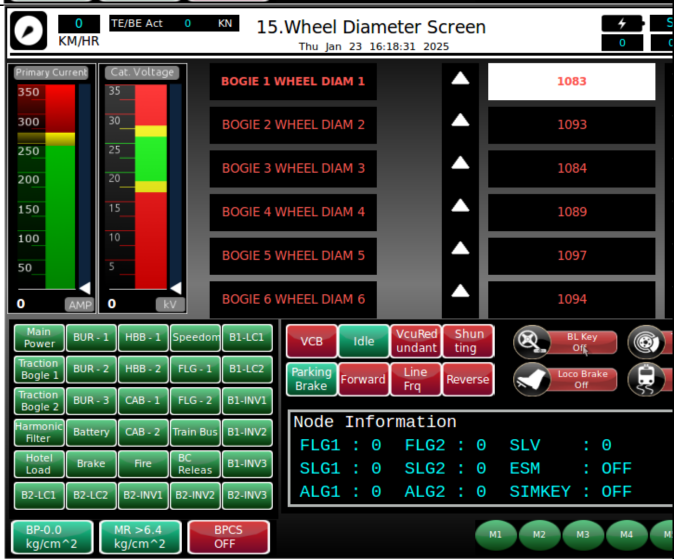
14: Six Motor Isolation Screen

In this screen there is six motor Isolation selects any motor press enter for isolate. The below mentioned parameters are displayed on this screen, BL Key Status, Oil Pressure Transformer, Oil Pressure Converter, MR pressure, after put loco Number then see in actual loco number.

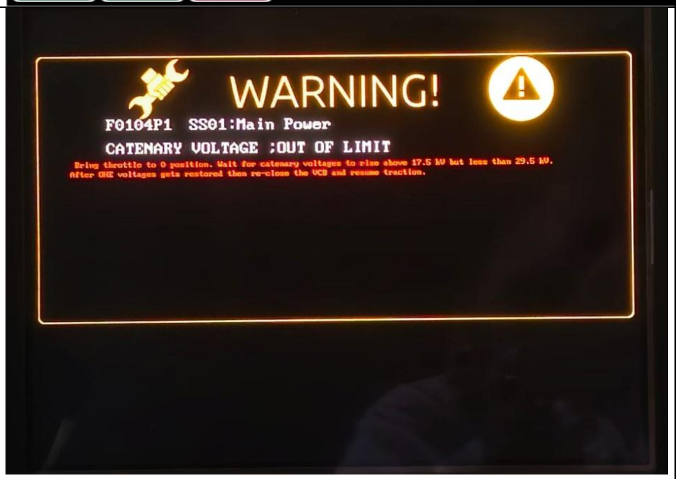


15: Wheel Diameter Screen

In this screen there is six Wheel diameter present select wheel and press enter after that using up and down key adjust wheel diameter then again press enter to send diameter to mvb port. The below mentioned parameters are displayed on this screen, BL Key Status, Oil Pressure Transformer, Oil Pressure Converter, MR pressure.



Error Screen



6.4. Commissioning & Installation

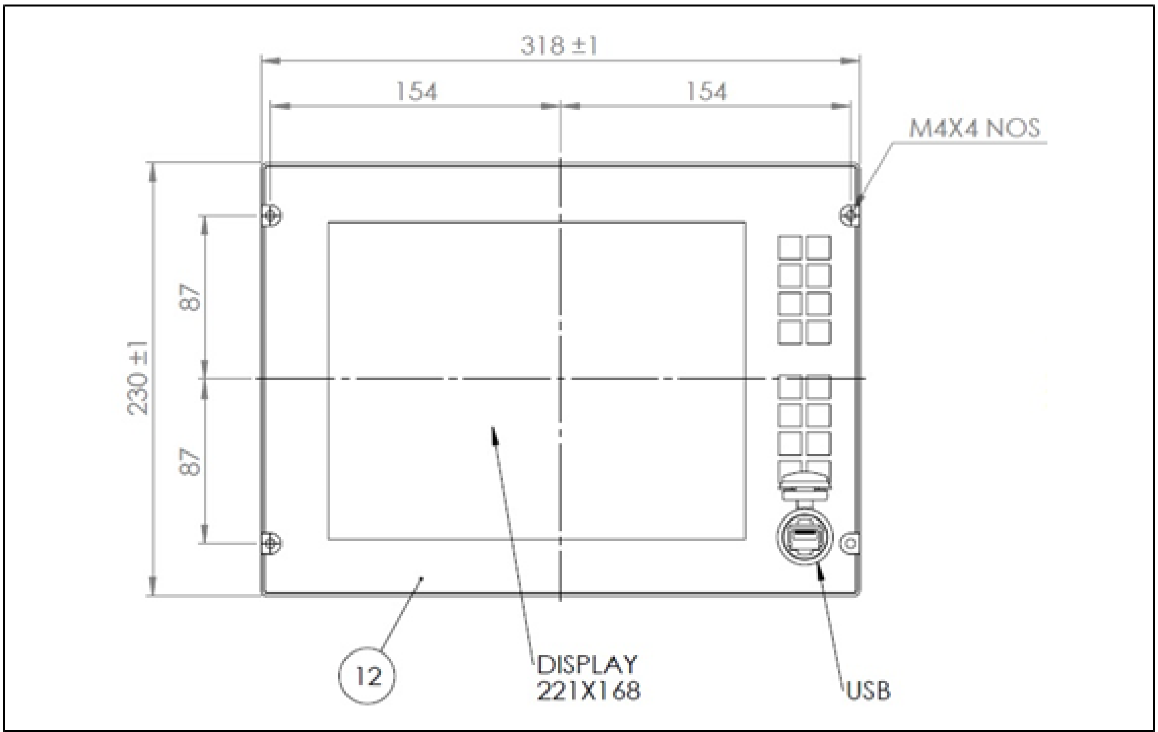
6.4.1. Mounting the DDU unit

- ✓ The Driver Display Unit (DDU) is installed in the C-Panel on the Driver Desk
- ✓ The DDU is fastened to the C-panel with ALLEN CAP SCREW M4 X 20MM

Parameter	Description	Remarks
Fittings	Driver Display Unit (DDU)	ALLEN CAP SCREW M4 X 20MM

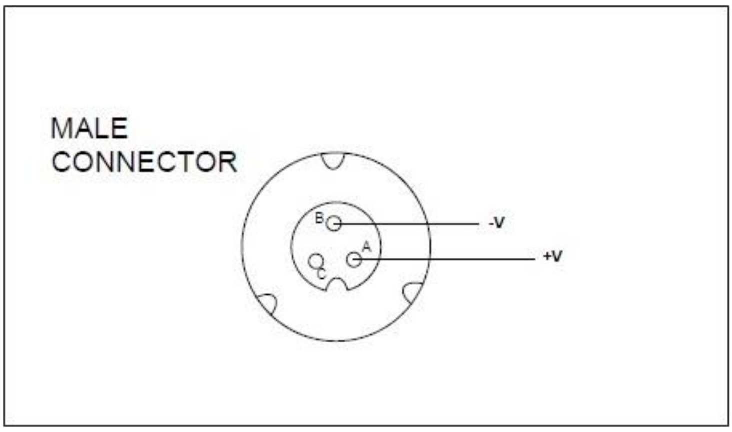
Hole spacing:

The following diagrams show the spacing of the holes (All dimensions are given in mm).



6.4.2. Electrical Connections

1. The unit is connected electrically via a 3-pin circular connector (Female). The following diagram shows pin assignments for the 3-pin circular connector in the DDU unit.
Note: Fix the 3-pin circular connector (Female) tightly in place to ensure supply to the unit



6.5. Maintenances

Remove the DDU from the C-panel by removing ALLEN CAP SCREW M4 X 20MM present on it.

6.5.1. Visual Inspection

Make sure that…

- DDU is correctly mounted.
- Cover screws are tightened properly
- Power supply plug is plugged in and secured.
- The D-Sub cable 9 pin is plugged in and secured.
- The optical cable is plugged in and secured

6.5.2. Inspection Frequency

Maintenance and upkeep required regular inspection and maintenance. The DDU are first inspected when they are put in service and thereafter every three months. At fourth inspection i.e. once in a year, further checks should be performed.

- Quarterly inspection = **Inspection**
- Annual inspection = **Maintenance**

6.4.3. List of Spare Items:

Sr No.	SAP Code	Item Name	Qty/ set	UOM
1	RM113523	Cable 6	2	Nos.
2	RM125115	Cable 7	2	Nos.
3	RM114585	Keypad	1	Nos.
4	RM122464	ASSEMBLED PCB FOR DDU MAIN CARD (as per latest revision)	1	Nos.
5	RM123731	ASSEMBLED PCB FOR ESD TO OGF CONVERTER (as per latest revision)	1	Nos.
6	RM100508	ALLEN CAP SCREW M4 X 20MM MAKE TVS	10	Nos.
7	RM114904	SS M3 NUT FOR D-SUB AS PER DWG NO 5245403150 REV.00	6	Nos.
8	RM111185	SS HEX FULL NUT M3	10	Nos.

Fault findings Manual
for
IGBT based 3- Phase Drive Propulsion Equipment on WAG9/WAG9H/WAP7/WAP5 Electric Locomotive (Traction Converter Part)

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Email: marketing@hirect.com

Table of Contents

Table of Figures

1. DOCUMENT HYSTORY

Revision	Revision Description	ages	Prepared By	Approved By Date	Date
0.0	First Release	172	RKG, MR	KK, JS	20/11/2024

2. Introduction

The Fault-Finding Manual is an essential resource for effectively diagnosing and localizing faults.

2.1. Use of Fault Finding Manual

Before working on the locomotive, make sure to study and follow the safety regulations in Section 2. Most faults are identified by the electronic fault detection and recording system, which is embed in the Vehicle Control Unit. The VCU generates fault IDS and corresponding fault messages. Chapters 6 to 10 provide a complete list of DDS with their priority, messages and course of action sorted by subsystems. If a diagnostic PC is connected with dedicated application GUI, we can access the DDS and logged faults directly. The DDS Message Forms include possible causes, which need to be confirmed by inspecting the relevant components

2.2. Abbreviations

AIB	Additional Info Bit
DCU	Drive Control Unit (Drive Inverter and Line Converter Control combined)
BUR	Auxiliary Converter
MCE	Main Control Electronics
CEL	Central Electronics
DDS	Diagnostics Data Set
EC	Error Class
GDU	Gate Drive Unit
HB	Cubicle Auxiliary Circuit
IPH	Input Phase
MGR	Motor Group
MR	Machine Room
VLU	Overvoltage Limiting Unit
AFE	Active Front End (Line Converter Unit)
MINV	Motor Inverter
Pan	Pantograph
PP	Pneumatic Panel
PSU	Power supply Unit
SB	Cubicle Control Circuits
SS	Speed Sensor
STB	Low Voltage Cubicle Control
TE/BE	Tractive / Braking effort
VCB	Vacuum Circuit Breaker (Main Circuit Breaker)
VCU	Vehicle Control Unit
AIO	Analog Input/output unit
DIO	Digital Input/output unit
WTB	Wire Train Bus
TBA	Train Bus Administrator
MVB	Multifunction Vehicle Bus
EMD	Electrical Medium Distance

3. Safety Instructions-Precautions and Practices

3.1. General Safety Precautions

1. **Injury Prevention**: Employees must avoid injury to themselves and others. Always check that the overhead line is isolated before starting maintenance.
2. **Isolation and Earthing**: Approach overhead line equipment only after it has been properly isolated and earthed.
3. **Safety Precautions:** Complete all safety checks before beginning any examination.
4. **Circuit Isolation:** Do not use buzzers, bells, megger, or flash test equipment until all circuits with semiconductor devices are isolated.
5. **Power Off:** Never make repairs or adjustments in control cubicles or the driver's desk while the power is on. Disconnect the battery supply.
6. **Solvent Safety:** Follow cleaning solvent manufacturers' instructions, as some may be toxic or flammable. Adhere to local workshop regulations when handling lubricants and similar substances.
7. **Lubrication:** Clean lubricating points before applying lubricant and remove any excess after application.
8. **Welding Precautions:** Secure the welding return lead close to the welding point. Short circuit all electronic devices. Follow an Approved Welding Procedure, as the locomotive structure is critically stressed.
9. **Defect Rectification:** Address any defects found during inspections and those reported by the driver.
10. **Control Operations:** Do not operate any controls on a locomotive under maintenance/testing without ensuring that no one is working on or under it.
11. **System Interaction:** When starting equipment like a compressor, ensure that any systems that could pose a safety risk are vented/isolated before beginning work.
12. **Jack Safety:** Always use safety supports when lifting a locomotive with jacks.
13. **Caution signs:** (stating personnel working on locomotive) to be fitted at both ends of locomotive.

3.2. Locomotive Isolation

When carrying out repairs or testing of electrical equipment (unless specifically authorized otherwise), the locomotive high voltage equipment must be isolated by using the Key Interlocking System:

a) Observe the pantograph is in the lowered position.

b) Turn off the air supply to the pantographs by switching key A on the air supply isolating cock. The air in the system will be exhausted and by this the pantograph will be locked down.

c) To release the B keys insert and turn the A key in the Earthing Switch of main circuit breaker. A bolt will be released, unlocking the electrical arm of the main circuit breaker Earthing Switch. Move the electrical arm to the EARTH position then turn and remove the B keys.

d) Move the battery isolating switch to off position

Warning:

The Key Interlocking System prevents 25kV a.c. power supply through the pantograph, but NOT power supply through Battery Supply 110V DC Before working on these power supplies ensure that:

a) Isolate the Locomotive

b) Isolate the battery.
c) Discharge the capacitors on the battery charger output.

Extreme care must be taken when approaching equipment which has been live and could remain live for a short period of time because of the delayed discharge time of capacitors.

3.3. Battery isolation

1. **Switch Off Loads**: Ensure all loads are switched off and isolate the battery before starting work.
2. **Avoid Flames:** Keep flames, lighted cigarettes, and welding operations away from batteries, as the gases are highly flammable. If a battery is overheated, allow gases to disperse before taking action.
3. **Use Insulated Tools:** Only use approved insulated spanners on battery connections. Do not place tools on the batteries.
4. **Check Isolation**: Confirm that the battery is electrically isolated before removing cells or the entire battery. Tie back cables in the battery box to prevent short circuits, and insulate them after disconnection.
5. **Protect Against Electrolyte:** Keep electrolyte away from your eyes, skin, and clothing. Wear protective clothing, rubber boots, and approved chemical goggles. If electrolyte contacts skin or eyes, rinse immediately and seek medical help. For clothing contamination, use a boracic solution (1 teaspoon of boracic powder per pint of water) to neutralize.
6. **Cable Safety**: Ensure all floating cables for battery charging are protected and positioned safely to prevent hazards to personnel and avoid damage to cables and equipment.
7. **Electrolyte Disposal**: Dispose of electrolyte according to local regulations and agreements with authorities and the depot.

3.4. Break And Compressed Air

1. **Air Venting**: Before operating any cocks, check the air venting direction to avoid injury or damage from compressed air blasts.
2. **Hazardous Equipment**: Follow workshop regulations and manufacturer instructions when using compressed air, electrical supplies, or degreasing equipment.
3. **Brake Maintenance**: Ensure the locomotive is safely parked with the brakes released and chock the wheels to prevent movement before performing maintenance on brake equipment.
4. **Air Isolation**: Before dismantling anything connected to a compressed air system, isolate it from the air supply and exhaust all air from the system.
5. **Compressor Work**: Do not dismantle compressor valves, cylinder heads, or associated parts without closing the main reservoir isolating cock, venting air from the reservoirs, and disconnecting the compressor motor from the electrical supply.
6. **Blowing Out Pipes**: When using compressed air to clean pipes, wear goggles and avoid areas where air may blow out harmful particles.
7. **Brake Testing**: During brake tests, ensure no personnel are in danger from moving brake components. Place warning signs at both ends of the locomotive, and if the brake system is isolated, add indicators at both ends and on both driver's desks.

3.5. Operating Keys

The locomotive uses two key systems for security and safety:

1. **Locomotive Operation Keys**: These keys allow access through the outside cab doors and are needed to initiate the operation setup.
2. **Safety Interlock Keys**: These keys enable the commencement of the operation setup after being inserted into the key switch

3.6. Safety Interlock Keys

Access to roof-mounted electrical and high-voltage equipment (such as filter cubicles, auxiliary converters, and traction converters) is strictly forbidden unless the equipment is de-energized and grounded using the appropriate earth switches. Maintenance and operating staff must use a key interlock system that ensures access to power equipment is only allowed when it is safe.

3.6.1.Key Interlock System Features:

1. **Five Key Types**: There are five different types of keys, each marked with a letter and color-coded for identification.
   Locations of the different keys:

Type	Color	No. Of	Location
A	Light Blue	1	Panto air supply isolating cock
B	Yellow	2	Earthing Switch of VCB
C	Green	7	Key multiplier No. 1
D	Black	2	Earthing Switch of Traction Converter
E	White	6	Key multiplier No. 2

2. **Interchangeability**: Keys of the same type are interchangeable, but keys from different types are not.
3. **Access Sequence**: When used in the correct sequence, the keys allow access to roof equipment via the roof hatch and high-voltage cubicles through their doors.

3.6.2.Operation Of The Key Interlock System:

To safely remove a key from a piece of equipment, isolation and earthing are necessary. This ensures that certain parts of the locomotive are safe to access.

3.6.2.1. Key Access Steps:

1. **Air Supply Isolation**: Turn off the air supply to the pantographs by using **Key A** on the air supply isolating cock. This will exhaust the system and lock the pantograph down.
2. **Unlocking B Keys**: Insert and turn **Key A** in the Earthing Switch of the main circuit breaker. This will release a bolt, allowing you to move the electrical arm of the earthing switch to the EARTH position and remove **Keys B**.
3. **Releasing C Keys**: Insert and turn one **Key B** in Key Multiplier 1 to release up to seven **Keys C**. Keep a second **Key B** with a responsible person for safety. Two **Keys C** will operate the earthing switches of the traction converters, while the others unlock the covers of auxiliary cubicles and the filter cubicle.
4. **Releasing D Key**: Use one of the **Keys C** in the earth switch of each traction converter. Move the earth switch handle to the EARTH position, then turn and remove the **D Key**.
5. **Releasing E Keys**: Insert and turn both **Keys D** in Key Multiplier 2 to release up to six **Keys E**, which can be used to open the access covers on the traction converters.

To return to normal mode we have to reverse the above mentioned 5 steps

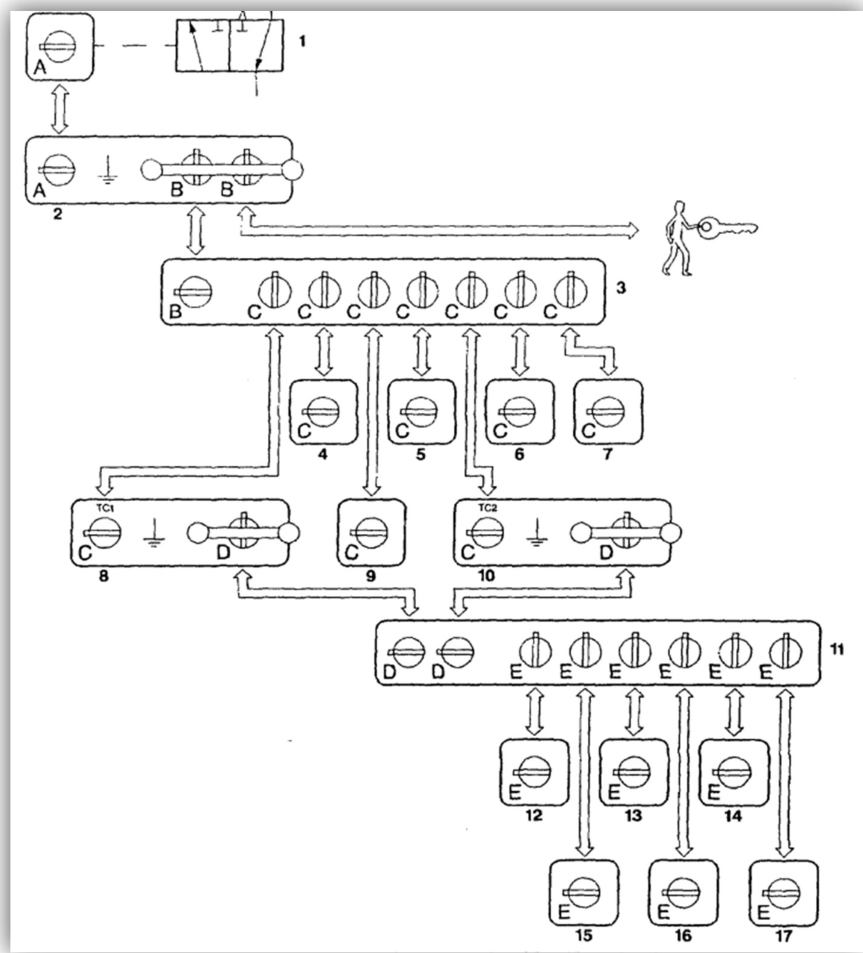


Figure 1- Key Interlocking Diagram

1. Pantograph air supply isolating cock
2. Earthing switch of main circuit breaker
3. Key multiplier 1
4. Door lock auxiliary circuits, Black 1
5. Door lock auxiliary circuits, Block 5
6. Door lock auxiliary converter 1
7. Door lock auxiliary converter 2
8. Earthing switch on traction converter 1
9. Door lock on filter block
10. Earthing switch on traction converter 2
11. Key multiplier 2
12. Door lock, traction converter 1
13. Door lock, traction converter 1
14. Door lock, traction converter 1
15. Door lock, traction converter 2
16. Door lock, traction converter 2
17. Door lock, traction converter 2

4. Fault Finding Steps

When a disturbance occurs in the vehicle, a fault message with an error code appears on the driver's display and in the vehicle diagnostic system. This document provides supplementary instructions for each error code related to the converter control electronics.

The Diagnostic System or the data logging system is a sub-system of the TCMS on board the vehicle and implemented in the VCU. The VCU collects and stores information about events, faults, and vehicle status from connected sub systems.

The event information in the diagnostic database is displayed on a color display unit at the driver's desk and can also be uploaded to an off-board maintenance system (server) or laptop for long-term storage and offline analysis.

4.1. Steps to locate fault:

1. **Check Displays**: Read the fault message and fault code on the driver's display. If that display is not functioning, check the second driver's display on the other CAB for the fault messages.
2. **Locate Fault Code**: Find the fault code in the Fault-Finding Instruction and follow the recommendations for each fault, which usually identifies the faulty component.
3. **Perform Tests**: Conduct any recommended routine tests as outlined in the Routine Function Test Instruction.
4. **Replace Component**: If a component is faulty, replace it following the maintenance instructions.

4.2. Important Safety Guidelines

- **Authorized Personnel Only**: Fault finding should be conducted by authorized personnel familiar with train systems. Drivers are not permitted to perform fault finding that involves high-voltage components.
- **Do Not Open Hatches**: Unauthorized personnel must not open hatches related to propulsion products.

4.3. Tool and Material Management

- **Check for Leftovers**: Ensure that tools, spare parts, nuts, bolts, washers, etc., are not left behind after the job. Missing items can increase the risk of flashover and short circuits, potentially causing serious equipment damage.
- **Count Tools**: A good practice is to count all tools and materials before and after the task.

4.4. Caution for Working on Converter Locomotives

1. **Dangerous Voltage**: Converter locomotives have capacitors (traction and auxiliary converters) that can store dangerous voltages.
2. **Discharge Procedure**: If the locomotive is shut down, the main DC-Link capacitors are typically discharged, but it's essential to verify this.
3. **High Voltage Check**: Always check for high voltage on the capacitors before attempting to touch any components.
4. **Earthing Requirement**: When working on electronic parts of the locomotive, ensure the locomotive is properly earthed to mitigate risks.

Safety first! Always follow established safety protocols when handling electrical components.

Figure 3- DC link voltage indicator BOX1 AUX 1

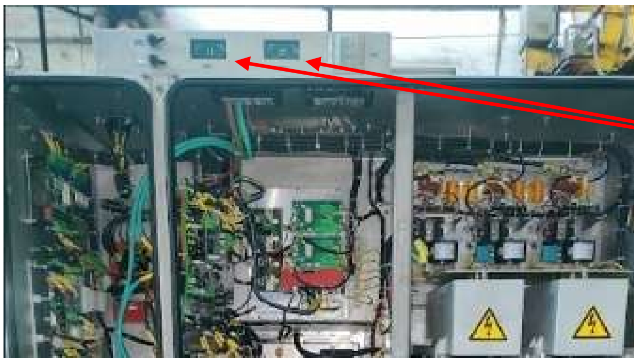


Figure 2- DC link voltage indicator BOX2 AUX1 & 2

DC link capacitor voltage indicator

Figure 4- DC link voltage indicator Traction Converter

5. Special Tools and Softwares

For Fault finding and working on sensitive components special tools and guidelines has to be followed.

5.1. List of Special Tools

1. **Use ESD Tools:** When handling circuit boards, always use tools designed for ESD-sensitive components to prevent damage.
2. **Electrical Measurements:** When using measuring devices like multimeters or oscilloscopes, adhere to standard signal handling practices to ensure accurate readings with minimal interference.
3. Use ferrite cores to reduce potential interference.
4. Place one core between the oscilloscope and probes, winding both probe cables several times through the core.
5. Place another core between the oscilloscope and power source, winding the power cable several times through the core.

Following these guidelines helps ensure the integrity of measurements and the safety of sensitive components.

Tools	Suggestion
Standard Personal toolkit	Force
Digital multimeter	Fluke 179
Oscilloscope	Tektronix TPS 2024B
Laptop windows 2010 or above	---
Ethernet cable RJ 45 to M12	More than 2m
Ethernet cable RJ45 to RJ 45	More than 2m
RS 232 cable	More than 2m
ESD band	standard
DSP programmer	XDS100v3
STM programmer	ST link v2 , J link

5.1.1.Documents May be referred

Document Name	Document No.
O&M manual Traction converter	
O&M manual Auxiliary converter	
O&M manual VCU	
O&M manual DDU	

6. Overview of Diagnostic Function

The diagnostic function in locomotive systems is crucial for monitoring and maintaining operational efficiency. It encompasses several key components:

1. **Fault Detection**: The system continuously monitors various parameters to identify faults or anomalies in the locomotive's performance. When a disturbance occurs, a fault message along with an error code is generated.
2. **Data Presentation**: Fault messages and error codes are displayed on the driver's Human Machine Interface (HMI) DDU. This allows operators to quickly assess issues and take appropriate action.

3. **Event Logging**: The system records events and fault data in a database, which can be accessed for analysis. This information is essential for troubleshooting and long-term maintenance planning.
4. **Testing and Validation**: The diagnostic function includes routine tests and validation checks that can be performed to ensure all systems are functioning correctly. These tests help to confirm that repairs or maintenance have been successful.
5. **Guidance for Maintenance**: The system provides recommendations for each error code, guiding maintenance personnel on the necessary steps to identify and rectify faults.
6. **Safety Protocols**: Diagnostic functions are integrated with safety measures, ensuring that maintenance personnel are informed about high-voltage areas and that appropriate precautions are taken.
7. **Communication with External Systems**: The diagnostic system can upload data to off-board maintenance systems for further analysis, facilitating long-term monitoring and maintenance strategy development.

6.1. Benefits of Diagnostic Function

1. **Increased Reliability**: Early detection of faults helps prevent serious failures, enhancing the reliability of the locomotive.
2. **Improved Maintenance Efficiency**: Provides clear guidance on fault resolution, allowing maintenance teams to work more effectively.
3. **Enhanced Safety**: Ensures that safety protocols are adhered to, protecting personnel and equipment.
4. **Data-Driven Decisions**: The collected data aids in making informed decisions about maintenance schedules and system upgrades.

In summary, the diagnostic function plays a vital role in ensuring the safe and efficient operation of locomotives, providing essential tools for fault detection, maintenance, and system reliability.

6.2. Indication and Acknowledgement of Faults

Fault indications can be observed in the two DDU HMI provided in each CAB driver desk panel known as Panel C. The Faults are logged with background data in the VCU data logging system. The on board data logging system is equipped with a redundant processor based implementation; where redundant CPU will take over all the activities of main processor in case of any disturbance in main processor.

6.2.1.Indication Lamp and Buzzer

There are two indication lamps present in C panel

1. LSDJ Red led : For VCB off/on status
2. LSHO yellow led : For Hotel load converter contactor status
3. LSP yellow led : For wheel sleep indication lamp
4. LSAF red led : For Train parting indication lamp
5. LSVW Yellow led : Vigilance warning lamp
6. LSCE Yellow led : Control electronics over temperature indication
7. BPFA Yellow led puss button : Fault indication/acknowledgement puss button

8. LSFI red led : Fault status indication lamp will start to blink for priority 1 faults additional with BPFA. It will turn off after acknowledgement the fault, in case of any subsystem isolation the LSFI will continue to glow.

Figure 5- CAB View

6.3. DDU Pop ups and entries

1. **Fault Notification**:
   - When a fault occurs, a diagnosis message is immediately displayed in DDU with additional instruction for the loco pilot.
   - The fault acknowledgment push-button will illuminate.
2. **Acknowledgment Process**:
   - The driver must acknowledge all diagnostic messages by pressing the fault acknowledgment button BPFA.
   - Upon acknowledgment, the acknowledgment lamp (BPFA) will turn off and the message will be cleared from the display.
3. **Priority Faults**:
   - **Priority 1 Fault**:
     - The fault status lamp LSFI will blink.
     - If not acknowledged, the locomotive will shut down after 10min.

- If there is a persistent isolation of a subsystem, the lamp LSFI will stay lit, and the affected subsystem will be indicated on the screen in red at the bottom left portion of the DDU.
- **Priority 2 Fault**:
  - If not acknowledged, the fault message remains on the display until a priority 1 fault message appears.

4. **Fault/Isolation Message Details**:
   - Each message includes:
     - **Locomotive Number**: Indicates the specific locomotive affected.
     - **Subsystem Name**: Identifies the subsystem involved (SS01 to SS19).
     - **Type of Fault/Subsystem Isolation**: Describes the fault or isolation and its consequences.
     - **Instructions**: Provides guidance for the driver on how to proceed.

6.3.1.Browsing Diagnostic messages on Request

Loco pilot and service/ maintenance personal can access previous diagnostic messages that occurred after electronics ON from the DDU by pressing F3 button.

The browsing capability for status messages enhances communication between operating and relieving personnel, ensuring a seamless transition and continued awareness of the locomotive's condition.

6.4. DDS and Tool for Maintenance personnel

DDS is systematic approach to fault detection and data storage that provides service personnel with critical information for diagnosing and addressing issues effectively, ultimately enhancing the reliability and safety of locomotive operations.

6.4.1.Data logging and DDS record

1. **Fault Recognition**:
   - When a processing computer detects a locomotive fault, it transmits a Diagnosis Data Set (DDS) to the diagnosis processor to record the data set.
2. **Contents of DDS**:
   - **Time of Fault Occurrence**: The exact timestamp when the fault was identified.
   - **Fault Identification**: Specific identification of the fault or fault code.
   - **Environmental Field Data**: This includes a series of figures derived from various process signals, providing context about the conditions at the time of the fault.
3. **Environmental Data Collection**:
   - Each processing computer has its own unique set of environmental field data.
   - Some systems capture environmental data from 2 cycles before and 1 cycle after the fault occurs, aiding in detailed analysis. The cycle time varies based on the processor.
4. **Data Storage**:
   - The DDS is stored in the diagnosis computer's non-volatile memory, ensuring data retention even after power loss.

- The system also records when a fault clears, although this record does not include environmental data.

5. **Ring Buffer Principle**:
    - DDS entries are managed according to the ring buffer principle, meaning older data will be overwritten as new data is added once the buffer reaches its capacity. This ensures that the most recent data is always available for analysis.

Importance:

This systematic approach to fault detection and data storage provides service personnel with critical information for diagnosing and addressing issues effectively, ultimately enhancing the reliability and safety of locomotive operations.

6.4.2.Components of DDS and Data Retrieval

To simplify and visualize the process of analyzing Diagnostic Data Sets (DDS) for service personnel, the DATA logging tool allows the data to be viewed and sorted on a PC screen using various filters and criteria. Below are the components of DDS packets-

1. Fault Time Stamps: View when the fault became active and inactive.
2. Event ID: A unique identifier for the fault.
3. Signal Information: Details like the signal name and description text.
4. Subsystem Classification: The subsystem to which the fault is related.
5. Fault Priority: Categorization based on the fault's priority level.
6. Environmental data for 640 ms before and 640 ms after the occurrence of the fault including the data during the fault occurrence.
7. Information for LOCO pilot and maintenance personnel.

6.5. Diagnostic Screen Structure and Operations

The **Driver Display Unit (DDU)** positioned in front of the driver in both CABs is designed to show important information such as fault messages, subsystem statuses, individual motor status and diagnostic details in a clear, concise format. This display serves as a crucial interface for the driver to stay informed and take necessary actions in real-time. Here's a breakdown of the icons on the DDU and how they are used by the driver:

6.5.1.Home Screen

The **Home Screen** of the Driver Display Unit (DDU) serves as a centralized interface, displaying key operational parameters and statuses of the train systems, allowing the driver to quickly assess the train’s performance and health. Here's a breakdown of the key information displayed on the **Home Screen**:

Figure 6- Home screen

1. **Pantograph Status**:
   - Indicates whether the pantograph (device that connects the train to the overhead electrical lines) is raised or lowered.
   - A raised pantograph means the train is connected to the power source, while a lowered pantograph indicates disconnection.
2. **VCB (Vacuum Circuit Breaker) Status**:
   - Shows whether the Vacuum Circuit Breaker is open or closed (RED-open; Green-closed).
   - This breaker disconnects the train from the power supply in case of electrical faults or manual intervention.
3. **Battery Voltage**:
   - Displays the current battery voltage, allowing the driver to monitor if the train's auxiliary systems are sufficiently powered.
4. **Input Power Frequency**:
   - Provides the frequency of the power supplied to the train, important for ensuring compatibility with the train's electrical systems. (Green-45-55Hz, Red- beyond range)

5. **Primary Current**:
    - Indicates the amount of electrical power being drawn from the overhead catenary system.
    - Helps the driver ensure that the power input is within operational limits.
6. **Tractive Effort**:
    - Displays the tractive effort (the force applied by the train's motors to move the train) for both bogies (sets of wheels/Axles).
    - Helps in monitoring how much force is being exerted by each bogie.
7. **Braking Effort**:
    - Shows the braking effort for each bogie, indicating the level of braking force applied.
    - This is crucial for safe stopping distances and ensuring balanced braking across the train.
8. **Catenary Voltage**:
    - Displays the voltage of the overhead catenary system that powers the train.
    - Helps the driver ensure that the voltage is within safe operating limits.
9. **Speed**:
    - Indicates the train's current speed, providing real-time information to ensure the driver adheres to speed limits and safe operating conditions.
11. **Pressure of Brake Cylinder**:
    - Displays the pressure in the brake cylinders, which controls the braking force applied to the wheels.(Red-break release; Green- Applied)
    - Monitoring this is essential for ensuring the brakes are functioning properly and the train can stop safely.
12. **BP pressure:**
    - Indicates the pneumatic brake applied and break pipe pressure (0kg/cm2 full application of brake, 5kg/cm2)

13. **Subsystem Status:**
    - Indicates all subsystems' (19nos) status (Red-isolated, Green- Healthy)

Major Functionalities Covered by the Home Screen:

- The home screen provides real-time monitoring of **key systems**, ensuring the driver has an overview of the **power, traction, braking, and safety systems**.
- With the **pantograph and VCB statuses**, the driver can see the train’s connection to the overhead power supply.
- The display of **tractive and braking efforts** for each bogie allows for close monitoring of the train's propulsion and deceleration forces.
- **Speed and catenary voltage** ensure the train operates within safe limits, while the **battery voltage** and **brake cylinder pressure** offer insight into auxiliary power and braking system health.

This comprehensive home screen is designed to give the driver all the essential data required for safe and efficient operation at a glance, covering all critical systems and functionality.

6.5.2. Fault messages

The fault messages often come with accompanying codes, fault information and instruction for LOCO pilot or maintenance personnel that provide further details about the issue, helping the driver assess the situation.

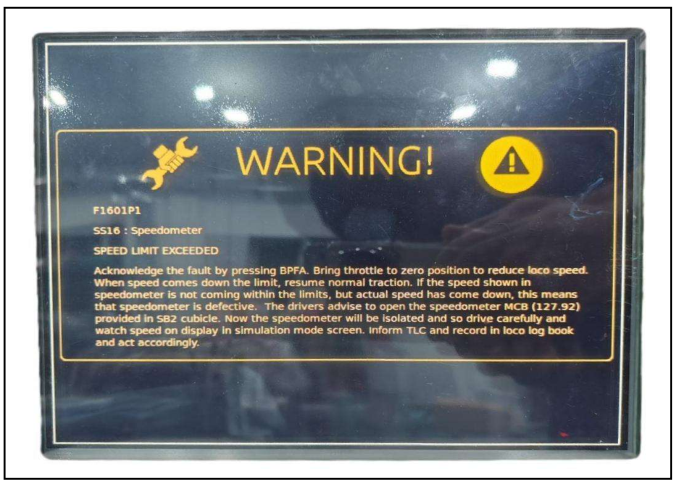
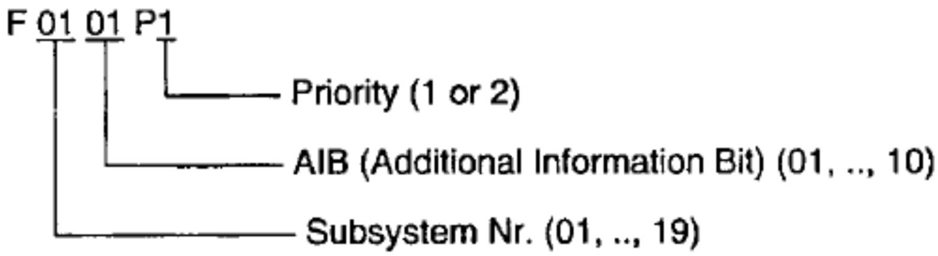


Figure 7-Warning Page P1

First line of each fault popup contains fault ID or F code identifier and contains following information:



When faults occur within the system, they are assigned one of two priority levels based on the severity and the urgency of the corrective action required. Priority 1 faults require immediate attention and may trigger protective actions. Here's a detailed explanation of how faults are managed-

Priority 1 faults:

When a **Priority 1 fault** occurs, the system requires immediate action. Here's a simplified breakdown:

1. **Immediate Action**:
    - The system automatically takes protective measures like reducing power, disabling traction, shutting off the VCB, or shutting down parts of the system to prevent damage.
2. **Fault Message**:
    - A **Priority 1 fault message** appears on the screen, replacing any less critical Priority 2 messages.
    - Example: *"Speed Limit Exceeded (F1601P1)"*.
3. **Acknowledgement**:
    - The driver must acknowledge the fault by pressing the **flashing fault button BPFA**.
4. **Isolation Counter**:
    - The system counts how many times the fault occurs within a set period.
5. **Subsystem Isolation**:
    - If the fault happens too many times, the affected subsystem is isolated to prevent further issues.
    - An **isolation message** appears (e.g., *"SS02"*), and the driver must press the **ACK** key to confirm. Then the particular subsystem will turn red in DDU to signify as isolated.

Priority 2 Faults:

Figure 8- Warning Page P2

A Priority 2 fault occurs when:

- Immediate action isn't necessary.
- The driver needs to take manual action.
- The required action isn't clear.

When a **Priority 2 fault** happens, a message appears on the display. The driver can acknowledge it by pressing the **flashing fault button (BPFA)**. The message stays visible until it is either acknowledged or replaced by a more critical **Priority 1 fault**.

Example: *"Earth fault in converter 1 (F0201P2)"*.

This ensures the driver is aware of the fault, but it does not demand urgent attention.

Additional Information Bit:
Each Subsystem and each priority level has 10 additional information bits for 10 separate messages.

19 Subsystems are as Bellow:

SS No.	Name	SS No.	Name
SS01	Main Power	SS11	Auxiliary Control HB1
SS02	Traction Bogie 1	SS12	Auxiliary Control HB2
SS03	Traction Bogie 2	SS13	CAB 1
SS04	Harmonic Filter	SS14	CAB 2
SS05	Hotel Load (NA for WAG9)	SS15	Fire Detection Unit
SS06	Aux Converter 1	SS16	Speedometer
SS07	Aux Converter 2	SS17	CPU1 /FLG1
SS08	Aux Converter 3	SS18	CPU2/FLG2
SS09	Battery Charger	SS19	Train Bus
SS10	Brake System	Spare	----

6.6. List Of Fault Messages:

All faults from each subsystem and their recovery is as below-

6.6.1. Subsystem SS01: Main Power

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0101P1	Loco XXXXXX SS01: Main Power VCB STUCK IN ON POSITION Loco will be shutdown	LSDJ will not glow	Converter contactor opens Panto lowers	1st	1. Bring Throttle to '0' position. 2. Coast to clear the block section. 3. Bringing the loco to dead stop. 4. Switch OFF and ON the Electronics and check if LSDJ is glowing. (Procedure for switching ON/OFF electronics is given chapter 5.6.1) 5. If so, raise panto and close VCB and resume Traction. 6. Try from rear cab.		Inform maintenance staff
	Loco XXXXXX SS01 : Main Power MAIN POWER ISOLATED VCB Inhibited Loco is dead	LSDJ will not glow	VCB will not close	2nd	1. Switch OFF the Electronics and Switch it ON once again. Try to resume traction, if not successful.	MAIN POWER ISOLATED VCB inhibited	Ask for relief loco
F0102P1	Loco XXXXX SS01 : Main Power VCB STUCK IN OFF POSITION Try to close VCB again F0102P1	LSDJ will glow	VCB control changed to redundant processor	1st	1. Press BLDJ to close VCB. 2. If VCB gets closed then resume traction. 3. Otherwise coast to clear the block section, if possible, then bring the loco to dead stop. 4. Switch OFF the Electronics and Switch it ON once again. 5. Raise panto and close VCB and resume Traction.		
	Loco XXXXXX SS01 : Main Power MAIN POWER ISOLATED VCB Inhibited Loco is dead	LSDJ will glow	VCB will not close	2nd	1. Switch OFF the Electronics and Switch it ON once again. Try to resume traction, if not successful,	MAIN POWER ISOLATED VCB inhibited	Ask for relief loco
F0103P1	Loco XXXXX SS01 : Main Power LOW PRESSURE PANTO/FAULTY PANTO Check iso. Cock Check Aux reservoir pressure	LSDJ will glow	Panto will not raise		1. Ensure that IG-38 (Blue key Is inserted and keep horizontal on Pn. Panel. 2. Check that auxiliary compressor is working or not. Check MCB 48.1 (SB-2) of MCPA. 3. If not working, tap gently on Pressure switch No. 26 on pneumatic panel. 4. Check that pressure is available in Aux. Reservoir and more than 5.2 Kg/cm2 on the gauge provided on pneumatic panel. Ensure that drain cock is closed(parallel to pipe). 5. Check Panto isolating and VCB cocks on pneumatic panel. 6. Try to raise pantograph. If not successful, try to raise		Check isolating cock Check auxiliary reservoir pressure; Check auxiliary compressor

					other pantograph by changing the position of panto selector switch (85) on pneumatic panel. 7. Pressure in Pan circuit is monitored by a pressure switch (130.4/1 & 130.4/2). After giving panto raising command, if pressure switch not picked up within 35 sec, then VCB will be disabled. In case VCB is closed then it will open with delay of 2 seconds, if above pressure switch not picked up. 8. Try by changing the cab/changing panto selector switch no. 84 on pneumatic panel. 9. If not, then Switch OFF the Electronics and Switch it ON once again.		
F0104P1	Loco XXXXX SS01 : Main Power CATENARY VOLTAGE OUT OF LIMITS Watch catenary voltmeter Close VCB when voltage is OK	LSDJ will Glow	VCB remain trip between Catenary voltage 17.5 kV to 30.0 kV	1st	1. Bring throttle to '0' position. 2. If U-meter showing '0' then either no tension or fuse blown off 2.1 Check 2 Amps. Fuse at SB-1, if it is blown off change it with the spare fuse. Check for OHE voltage getting restore, then close the VCB and resume traction. 2.2 If 2 Amps fuse is not blown, wait for Catenary voltage to rise above 17.5 KV but less than 29.5 KV. After OHE voltage get restored, then re-close the VCB and resume traction. 3 If OHE voltmeter is showing voltage between 17.5kv to 29.5kv, then try by isolating Traction converter 1 or Traction converter-2 one by one.If not getting isolated try following: (i) If DDS shows background message having FLG1/SLG1-LP has to isolate Traction Converter-1 by MCB 127.1/1(SB-1). (ii) If DDS shows background message having FLG2/SLG2-LP has to isolate Traction Converter-2 by MCB 127.1/2(SB-2). 4. If not succeed try following: 4.1 Switch OFF the Electronics and Switch it ON once again. Try to resume traction, if not succeed, then- 4.2 Try by changing panto. 4.3 Try by changing cab.		
F0105P1	Loco XXXXX SS01 : Main Power TRANSFORMER OIL TEMP. OR PRESSURE NOT OK TE/BE reduction or VCB trip's Try to close the VCB if open		Possibility of Reduced TE/BE. pulsing will stop.		1. Bring throttle to '0' position. 2. Try to clear the block section by coasting. 3. Check manually if Transformer oil pumps are working by touching the pumps outlets and inlet pipes in the under frame. Check if MCB 62.1/1 and HB1& 62.1/2 in HB2 Cubicle. If found tripped open VCB and reset MCB once. If oil pump not working then a) Switch OFF and ON Electronics. b) Keep loco in idle mode for 10 minutes.		Check manually whether oil pumps or oil cooling unit work or not; check oil level transformer expansion tanks; Check whether the valves in the oils circuit are open or

					4. Check the oil level in both the expansion tanks of transformer in Machine room located near Oil Cooling Unit. It should be in between the Max & Min Mark. 5. Driver should check the working of Oil cooler blower unit located in machine room; If it is not working then ensure that MCB 59.1/1 (in HB-1 Cubicle) & 59.1/2 (in HB-2 Cubicle) should not be in tripped condition. If found tripped, then open VCB & reset MCB only once. If OCBs are not working, then a) Switch OFF and ON Electronics. b) Keep loco in idle mode for 10 minutes. 6. If driver noticed that OCB impeller and its casing got physically damaged, then driver should immediately isolate a) Concerned OCB by opening MCB 59.1/1 OR 59.1/2 b) Concerned traction converter pump by opening oil pumps MCB 63.1/1 OR 63.1/2 c) Concerned transformer oil pumps by opening MCB 62.1/1 OR 62.1/2. Driver should operate above MCB after opening VCB and switching OFF control electronics. Then driver should isolate concerned Bogie-by-Bogie isolating switch (154) located in SB-1 cubicle. Switch ON control electronics raise panto & close VCB. Work the train with one bogie in service after making conversation with TLC. 7. Try to resume traction. 8. If the same message repeats, bring throttle to 0. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume traction. 9. If not successful within 20 minutes, ask for relief loco.		not
F0106P1	Loco XXXXX SS01 : Main Power FILTER ON / OFF CONTACTOR STUCK ON VCB will not close again	LSDJ will Glow	Filter dischargin g contactor will open		1. If VCB opens, it will not close again. 2. Bring Throttle to 0. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume Traction if loco get normal. 3. Harmonic filter get isolated automatically. Driver can work at 40 KMPH.		If VCB opens, it will not close again
F0107P1	Loco XXXXX SS01 : Main Power PRECHARGE OR MAIN CONTACTOR STUCK ON Main converters blocked	LSDJ will Glow	VCB will trip	1st	1. Bring throttle to '0' position and try to clear block section in coasting. 2. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume traction. 3. If no success received, then clear block section with one bogie in service by isolating the converter, if not successful in isolating the bogie then try following: (i) If DDS shows background message having FLG1/SLG1-LP has to isolate Traction Converter-1 by		. Inform maintenance staff

					MCB 127.1/1 (SB-1). (ii) If DDS shows background message having FLG2/SLG2-LP has to isolate Traction Converter-2 by MCB 127.1/2(SB-2) and then talk to TLC and act accordingly. 4. If not successful within 20 minutes ask for relief loco.		
	Loco XXXXX SS01 : Main Power MAIN POWER ISOLATED VCB inhibited Loco is dead	LSDJ will Glow	VCB will trip	2nd	1. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume traction 2. If VCB cannot be closed, shut down loco.	MAIN POWER ISOLATED VCB inhibited	VCB cannot be closed Ask for relief loco
F0108P1	Loco XXXXX SS01 : Main Power PRIMARY OVERCURRENT Check overcurrent relay flag Close VCB after unlocking relay	LSDJ will glow	Power supply of VCB closing / Holding coil will interrupt through Maximum current relay.	1st	1. Don't close DJ until you check the loco specially OCR (Relay 78) and all oil points in machine rooms. 2. Coast to clear block section. Bringing the loco to dead stop. 3. Check over current relay-78 flag in SB1 panel 4. Inspect the Machine Room for any oil spillage. 5. Check the oil level in both the expansion tanks of transformer in Machine room located near Oil Cooling Unit and the expansion tanks of both converters. It should be in between the Max. & Min. Mark. If there is any abnormality like splashing of oil inside the machine room or from Transformer/converter, sign of overheating/sparking of connection; shut down the loco. Ask for relief loco within 20 minutes. 6. If flag found dropped in Primary Over Current relay provided in SB-1 and there is no abnormality of oil splashing and oil level is in between max & min in all the four gauges, then unlock the relay by moving the screw clock wise provided on the front side of the relay. The relay flag shall disappear. 7. Press BLDJ to close VCB after unlocking the relay. Inform TLC and record in the logbook. 8. If not successful after making one attempt as given above then VCB will be inhibited, ask for relief loco without loosing time.		Check overcurrent relay flag
	Loco XXXXX SS01 : Main Power MAIN POWER ISOLATED VCB inhibited Loco is dead	LSDJ will glow	VCB will not close	2nd	1. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume Traction. 2. If not successful then, VCB cannot be closed. 3. Ask for relief loco within 20 minutes.	MAIN POWER ISOLATED VCB inhibited	VCB cannot be closed. Ask for relief loco
F0109P1	Loco XXXXX SS01 : Main Power AUXILIARY WINDING OVERCURRENT Try to close the VCB again	LSDJ will glow	VCB will trip	1st	1. Press BLDJ to close VCB.		

	Loco XXXXX SS01 : Main Power MAIN POWER ISOLATED VCB inhibited Loco is dead	LSDJ will glow	VCB will not close	2nd	1. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume Traction. 2. If VCB cannot be closed, shut down the loco.	MAIN POWER ISOLATED VCB inhibited	VCB cannot be closed. Ask for relief loco
F0110P1	Loco XXXXX SS01 : Main Power FATAL ERROR IN MAIN CIRCUIT Restart the Loco	LSDJ will glow	VCB will Open & panto will Lower	1st	1. Bring throttle to '0' position. 2. Check MCB's in HB / SB, if found tripped, reset once. 3. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume Traction. 4. More than one sub system isolated.		Inform maintenance staff
	Loco XXXXX SS01 : Main Power MAIN POWER ISOLATED VCB inhibited Loco is dead	LSDJ will glow	VCB will not close	2nd	1. Trouble shoot as per Additional instructions given at end of SS-01 for OCB, TMB, MPCB and MCP. If not successful then, 2. Switch OFF the Electronics and Switch it ON once again. Raise panto and close VCB and resume Traction 3. If VCB cannot be closed, shut down loco.	MAIN POWER ISOLATED VCB inhibited	Loco shut down Ask for relief loco
F0101P2	Loco XXXXX SS01 : Main Power OVERTEMPERATURE CONTROL ELECTRONIC Turn off the locomotive Setup Cooling Mode	LSCE will glow	Control electronics contactor will not close		1. Check MCB's in HB / SB, if found tripped, reset once. 2. Try to clear section. 3. Advice station, regarding inability for 10-15 minutes. A-9 to be kept on Emergency (to save MR pressure) before putting loco on cooling mode. 4. Switch OFF the control Electronics. Put BL Key in position 'C' raise pantograph with ZPT, close VCB both Machine Room Blowers will start working. The loco is now, in cooling mode and Electronics is being cooled wait till LSCE extinguished. 5. If VCB trips during cooling mode before closing VCB, check OCR (relay 78) and all oil points in machine room and act accordingly. 6. After LSCE extinguished, open DJ, lower panto. Put BL Key to 'D' position. Raise panto, close VCB and resume traction.		
F0102P2	Loco XXXXX SS01 : Main Power TRANSFORMER OIL PRESSURE NOT OK Any oil pump circuit not working TE/BE will be reduced		Possibility of reduced TE/BE, Ventilation will increase, VCB will trip		1. Coast to clear block section. 2. Check manually that oil pumps are working or not by touching the pumps outlets and inlet pipes in the under frame. Check MCB 62.1/1 in HB1 & 62.1/2 in HB2 panels. If found tripped, open VCB and reset MCB once.		Check manually whether transformer oil pumps work or not
F0103P2	Loco XXXXX SS01 : Main Power EARTH FAULT AUX. WINDING CIRCUIT Normal Operation can continue To be checked during maintenance				1. Inform TLC and record in the logbook. 2. Check visually machine room for burning / burning smell of Auxiliaries. If found, trip MCB of that Aux. 3. If fault repeats, trouble shoot as per additional instruction given at the end of SS01.		Inform maintenance staff

F0104P2	Loco XXXXX SS01 : Main Power LOW FREQUENCY CATENARY VOLTAGE Wait for 1 minute and set TE/BE again		Traction will start above 45 Hz.		1. Coast to clear block section. 2. Inform TLC at scheduled stop and record in the logbook. 3. Keep trying for traction and resume normal operation.		
F0105P2	Loco XXXXX SS01 : Main Power HIGH FREQUENCY CATENARY VOLTAGE Wait for 1 minute and set TE/BE again		Traction will start till the frequency is below 55 Hz.		1. Coast to clear block section. 2. Inform TLC at scheduled stop and record in the logbook. 3. Keep trying for traction and resume normal operation.		
F0106P2	Loco XXXXX SS01 : Main Power AUX.CAPACITOR MACH.RM.BLOW.MOT.NOT OFF Normal operation can continue To be checked during maintenance				1. If MRB 1 and 2 working, continue normal operation. 2. Inform TLC at scheduled stop and record in the logbook.		
Additional instructions for Subsystem 1(OCB)							
SS01	If there is earth fault in OCB-1 or OCB-2, then driver will encounter following sequence of messages. a) F0103P2: Earth fault Auxiliary winding circuit in the front display. b) STB2:004: Earth fault Auxiliary circuit in the background DDS. c) Auxiliary converter -1 isolated due to inverter over current. d) Auxiliary converter-2 isolated due to inverter over current. e) Main power off. VCB inhibited				A) If there is no tripping of MCB No. 59.1/1 or 59.1/2, following instructions should be followed by driver. 1. Isolate OCB-1 by tripping MCB no. 59.1/1 located in HB-1. 2. Close VCB. 3. Check for following message. a) F0601P1- Disturbance in processor BUR-1 b) F0602P1- Fault in Auxiliary converter -1 c) F0103P2- Earth fault Auxiliary winding circuit If there is no message, then faulty OCB has been isolated. d) Switch off control electronics. e) Isolate BG-1 by operating Bogie cut out switch No. 154. Half traction will be available. Continue traction with one bogie to clear the section and ask for relief after clearing the section. If messages are repeated, then i) Close 59.1/1 in HB-1 panel. Put BG-1 in service. ii) Isolate OCB-2 by tripping MCB 59.1/2 located in HB-2. iii) Switch off control electronics. iv) Then isolate BG-2 by Bogie cut out switch 154.Half traction will be available. Continue traction with one bogie to clear the section and ask for relief after clearing the section. B) If MCB No. 59.1/1 or 59.1/2 trips due to faulty motor of OCB, a) Do not reset MCB. b) Switch off control electronics. c) Isolate the concerned Bogie by Bogie cut out switch No. 154		

					d) Half traction will be available. Continue traction with one bogie to clear the section and ask for relief after clearing the section.		
Additional instructions for Subsystem 1(TMB)							
	If there is earth fault in TMB-1 or TMB-2, then driver will encounter following sequence of messages. a) F0103P2: Earth fault Auxiliary winding circuit in the front display. b) STB2:004: Earth fault Auxiliary circuit in the background DDS. c) Auxiliary converter -1 isolated due to inverter over current. d) Auxiliary converter-2 isolated due to inverter over current. e) Main power off. VCB inhibited				A) If there is no tripping of MCB No. 53.1/1 or 53.1/2, following instructions should be followed by driver. 1. Isolate one by one TMB-1 by tripping MCB no. 53.1/1and TMB-2 by tripping MCB 53.1/2 located in HB-1 and HB-2 respectively. 2. Close VCB. If succeed with isolation of TMB-1 or TMB-2, concerned BG to be kept isolated by Switch off control electronics. Half traction will be available. Continue traction with one bogie to clear the section. B) If MCB No. 53.1/1 or 53.1/2 trips due to faulty motor of TMB, a) Do not reset MCB. b) Switch off control electronics. c) Isolate the concerned Bogie by Bogie cut out switch No. 154 d) Half traction will be available. Continue traction with one bogie to clear the section.		
Additional instructions for Subsystem 1(MPCB)							
SS01	If there is earth fault in MPCB1 or MPCB2, then driver will encounter following sequence of messages. a) F0103P2: Earth fault Auxiliary winding circuit in the front display. b) STB2:004: Earth fault Auxiliary circuit in the background DDS. c) Auxiliary converter -1 isolated due to inverter over current. d) Auxiliary converter-2 isolated due to inverter over current.				A) If there is no tripping of MCB No. 63.1/1 or 63.1/2, following instructions should be followed by driver. 1. Isolate one by one MPHC1 by tripping MCB no. 63.1/1and MPH-C2 by tripping MCB 63.1/2 located in HB-1 and HB-2 respectively. 2. Close VCB. If succeed with isolation of MPH-C1 or MPH-C2, concerned BG to be kept isolated by Switch off control electronics. Half traction will be available. Continue traction with one bogie to clear the section. B) If MCB No. 63.1/1 or 63.1/2 trips due to faulty motor of MPHC, a) Do not reset MCB. b) Concerned BG will get isolated automatically. c) Half traction will be available. Continue traction with one bogie to clear the section.		
Additional instructions for Subsystem 1(MCP)							
SS01	If there is earth fault in MCP-1 or MCP-2, then driver will encounter following sequence of messages.				A) If there is no tripping of MCB No. 47.1/1 or 47.1/2, following instructions should be followed by driver. 1. Isolate one by one MCP-1 by tripping MCB no.		

	a) F0103P2: Earth fault Auxiliary winding circuit in the front display. b) STB2:004: Earth fault Auxiliary circuit in the background DDS. c) Auxiliary converter -1 isolated due to inverter over current. d) Auxiliary converter-2 isolated due to inverter over current. e) Main power off. VCB inhibited				47.1/1and MCP-2 by tripping MCB 47.1/2 located in HB-1 and HB-2 respectively. 2. Close VCB. If succeed with isolation of MCP1 or MCP-2, try to work with one MCP in service. B) If MCB No. 47.1/1 or 47.1/2 trips due to faulty motor of MCP, a) Do not reset MCB. b) Work the train with one MCP in service.		
	If MCB No. 47.1/1 or 47.1/2 trips without earth fault message				Try to reset MCB once. Close VCB.		

6.6.2. Subsystem SS02: Traction bogie 1

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0201P1	Loco XXXXX SS02 : Traction Bogie 1 DISTURBANCE IN CONVERTER 1 Try to close the VCB again if tripped	LSDJ		1st	1. Press BLDJ to close VCB. 2. If the message repeats, switch OFF the electronics and switch it ON once again after 5 minutes. Raise panto, close VCB and resume traction if loco gets normal. 3. If the message repeats and bogie-1 is not getting isolated automatically then isolate bogie 1 by Switch No. 154 Provided in SB-1 cubicle. 4. Inform TLC and record DDS message which comes before isolation of bogie in the logbook.		
	Loco XXXXX SS02 : Traction Bogie 1 BOGIE 1 ISOLATED : Only half traction and electrical braking power available Press <Enter>	LSFI will glow	Bogie 1 will isolate. Only half TE/BE power will available.	2nd	1. If bogie-1 is isolated by Driver through (154) switch then only acknowledge the isolation message by pressing <ENTER> on display key board otherwise- 2. Switch OFF the Electronics and Switch it ON once again. Raise the panto and close VCB and resume traction. 3. If the same message repeats resume normal operation with half traction/braking power. 4. Inform TLC and record in the logbook.	BOGIE 1 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff Try to restart the Loco
F0202P1	Loco XXXXX SS02 : Traction Bogie 1 CONVERTER CONTACTOR			1st	1. Check MCBs in SB-1 specially MCB 127.1/1. If found tripped, reset it once after switching MCE OFF. 2. Press BLDJ to close VCB.		

	STUCK OFF Try to close the VCB again				3. Check for air leakage from SR-1. If air is leaking, then isolate air supply to concerned SR by cock 125 on left inside (fourth from top) of pneumatic panel then isolate Bogie-1 by switch 154 (SB-1). 4. If VCB not closed and same message repeated, then this will lead to isolation of Bogie-1.		
	Loco XXXXX SS02 : Traction Bogie 1 BOGIE 1 ISOLATED: Only half traction and electrical braking power available Press <Enter>	LSFI will glow		2nd	1. If bogie-1 is isolated by Driver through (154) switch then only acknowledge the isolation message by pressing <ENTER> on display key board otherwise- 2. Switch OFF the Electronics and Switch it ON once again. Raise the panto and close VCB and resume traction. 3. If the same message repeats resume normal operation with half traction/braking power. 4. Inform TLC and record in the logbook.	BOGIE 1 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff
F0205P1	Loco XXXXX SS02 : Traction Bogie 1 CONVERTER 1 COOLANT TEMPERATURE TOO HIGH Check coolant level and pump Try to close the VCB again	LSDJ		1st	1. Check oil level in converter expansion tank, located above the converter cubicle. 2. Check manually that oil-cooling blower unit-1 is working by checking the air coming out of the radiator in the underframe. Check MCB 59.1/1 in HB1 panel. If found tripped, open VCB and reset MCB once. Ensure working of traction converter pump-1. If not working then check MCB (62.1/1) located in HB1. If found tripped, reset it once after opening VCB. 3. Driver should also inspect the oil cooler blower motor-1 impeller and casing for any sign of damage. If found damaged, then driver should open VCB, lower panto and switch off control electronics. Open MCB 59.1/1, open MCB 62.1/1 & MCB 63.1/1 (all located in HB1 cubicle). Then isolate bogie-1 by bogie isolating switch 154 (located in SB-1) cubicle. 4. Energies the loco and work the train with one bogie in service. Under such condition, LSFI will glow permanently. Inform to TLC		Check coolant level converter expansion tank Check manually whether cooling blower unit 1 works or not . Inform maintenance staff
	Loco XXXXX SS02: Traction Bogie 1 BOGIE 1 ISOLATED: Only half traction and electrical braking power available. Press <Enter>	LSFI will glow	Bogie 1 will isolate. Only half TE/BE power will available.	2nd	1. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume Traction. 2. If the same message repeats resume normal operation with half traction/braking power. 3. Inform TLC and record in the logbook.	BOGIE 1 ISOLATED; Only half traction and electrical braking power available	
F0206P1	Loco XXXXX SS02 : Traction Bogie 1 CONVERTER 1 COOLANT PRESSURE NOT OK Check coolant level	LSDJ		1st	1. BUR-II to be kept isolated by MCB 127.22/2 (SB-2) after opening VCB and try to close VCB. 2. If problem disappear, work with BUR-II isolated. 3. If problem persist, BG-I will get automatically isolated. 4. Check oil level in converter expansion tank.		Check coolant level converter 1 expansion tank Check manually whether cooling blower unit 1 works or not

	Try to close the VCB again				5. Check manually that converter-1 oil pumps are working or not by touching the pumps outlet and inlet pipes in the machine room. Check MCB 63.1/1 in HB1 panel. If found tripped, open VCB and reset MCB only once. 6. If MCB 63.1/1 getting trip again after resetting it once then do not try to reset the MCB again. BG-I will get automatically isolated. Work with half traction. 7. Driver should also inspect the traction converter No.1 oil pipeline for any sign of damage causing oil leakage and inspect the oil cooler blower-1 casing for any sign of damage due to failure of its impeller. In this case it may lead to damage of converter radiator causing oil leakage and lead to fault message "Converter No.1 oil pressure low". Then driver should open VCB, lower panto & switch off control electronics. Open MCB 59.1/1, 63.1/1 (all located in HB-1 cubicle). Isolate bogie-1 by putting rotating switch 154 at position-1. Energize the loco and work the train with one bogie in service. Under such condition LSFI will glow permanently if driver isolated the bogie-1 as described in step 6 & 7 above. Inform TLC and record in loco logbook.		Inform maintenance staff
	Loco SS02: Traction Bogie 1 BOGIE 1 ISOLATED : Only half traction and electrical braking power available. Press <Enter>	LSFI will glow	Bogie 1 will isolate. Only half TE/BE power will available.	2nd	1. Switch OFF the Electronics and Switch if ON once again. Raise panto, close VCB and resume traction. 2. If the same message repeats, resume normal operation with half traction / braking power. 3. Inform TLC and record in the logbook.	BOGIE 1 ISOLATED; Only half traction and electrical braking power available	
F0207P1	Loco XXXXX SS02 : Traction Bogie 1 TRACTION MOTOR TEMPERATURE TOO HIGH Converter 1 blocked Bogie 1 may get isolated			1st	1. Clear block section. Bring throttle to '0' position. 2. Check manually whether traction motor blower-1 is working or not, by checking air suction at TM Louver. Check MCB 53.1/1 in HB1 panel. If found tripped, open VCB and reset MCB once.		Check manually whether traction motor blower 1 works or not
	Loco XXXXX SS02: Traction Bogie 1 BOGIE 1 ISOLATED: Only half traction and electrical braking power available Press<Enter>	LSFI will glow	Bogie 1 will isolate. Only half TE/BE power will available.	2nd	1. BUR-II to be kept isolated and try to close VCB. 2. Switch OFF the electronics and switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 3. If problem disappear, work with BUR-II isolated. 4. If problem persist, BG-I will get automatically isolated 5. If the same message repeats, resume normal operation with half traction / braking power. 6. Inform TLC and record in the logbook.	BOGIE 1 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff

F0201P2	Loco XXXXX SS02 : Traction Bogie 1 EARTH FAULT IN CONVERTER 1 Normal operation can continue To be checked during maintenance				1. Resume normal operation. 2. Inform TLC and record in the logbook.		Inform maintenance staff
F0202P2	Loco XXXXX SS02 : Traction Bogie 1 TRACTION MOTOR OVERSPEED TE is being reduced Reduce loco speed				1. Reduce speed. 2. Resume normal operation.		
F0203P2	Loco XXXXX SS02 : Traction Bogie 1 MUB RESISTOR TOO HOT IN CONVERTER 1 Wait for 30 seconds	LSDJ			1. Wait for 30 seconds before re closing VCB in order to cool MUB resistance (15.1 located in converter cubicle) 2. Press BLDJ to close VCB.		
F0204P2	Loco XXXXX SS02 : Traction Bogie 1 FAULTY MOTOR TEMPERATURE SENSORS Normal operation can continue To be checked during maintenance				1. Resume normal operation. 2. Inform TLC and record in the logbook.		Inform maintenance staff
F0205P2	Loco XXXXX SS02 : Traction Bogie 1 EQUIPMENT TEMPERATURE HIGH TE/BE is being reduced			TE/ BE will continuously reduce.	1. Clear block section. Bring throttle to '0' position. 2. Wait for 10 minutes or some time till transformer / converter oil temperature normalizes. 3. Check MCBs in HB/SB, if tripped, reset it once. 4. Ensure working of all auxiliaries and MRB. 5. Resume normal traction. 6. If message persists, switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction if loco get normal otherwise isolate bogie-1 by switch (154) & work the train on one bogie after making conversation with TLC. 7. If no success within 20 minutes, ask for relief loco.		

F0207P2	Loco XXXXX SS02 : Traction Bogie 1 LINE CONVERTER ISOLATED BOGIE 1 Reduced Traction/Braking effort				Acknowledge the fault by pressing BPFA & resume normal operation. Inform TLC and record in the logbook.	BOGIE 1 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff
F0208P2	Loco XXXXX SS02 : Traction Bogie 1 MOTOR 1 ISOLATED BOGIE 1 Reduced Traction/Braking effort				Acknowledge the fault by pressing BPFA & resume normal operation. Inform TLC and record in the logbook.		
F0209P2	Loco XXXXX SS02 : Traction Bogie 1 MOTOR 2 ISOLATED BOGIE 1 Reduced Traction/Braking effort				Acknowledge the fault by pressing BPFA & resume normal operation. Inform TLC and record in the logbook.		
F0210P2	Loco XXXXX SS02 : Traction Bogie 1 MOTOR 3 ISOLATED BOGIE 1 Reduced Traction/Braking effort				Acknowledge the fault by pressing BPFA & resume normal operation. Inform TLC and record in the logbook.		

6.6.3. Subsystem SS03: Traction bogie 2

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0301P1	Loco XXXXX SS03: Traction Bogie 2 DISTURBANCE IN CONVERTER 2 Try to close the VCB again if tripped	LSDJ , LSFI		1st	1. Press BLDJ to close VCB. 2. If the message repeats, switch OFF the electronics and switch it ON once again after 5 minutes. Raise panto, close VCB and resume traction if loco gets normal. 3. If the message repeats and bogie-2 is not getting isolated automatically then isolate bogie 2 by Switch No. 154 Provided in SB-1 cubicle. 4. Inform TLC and record DDS message which comes before isolation of bogie in the logbook.		
	Loco XXXXX SS03: Traction Bogie 2 BOGIE 2 ISOLATED : Only half traction and electrical braking power available Press <Enter>		Bogie 2 will isolate. Only half TE/BE power will available	2nd	1. If bogie-2 is isolated by Driver through (154) switch then only acknowledge the isolation message by pressing <ENTER> on display key board otherwise- 2. Switch OFF the Electronics and Switch it ON once again. Raise the panto, close VCB and resume traction. 3. If the same message repeats resume normal operation with half traction/braking power.	BOGIE 2 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff Try to restart the Loco

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
					4. Inform TLC and record in the logbook.		
F0302P1	Loco XXXXX SS03: Traction Bogie 2 CONVERTER CONTACTOR STUCK OFF Try to close the VCB again			1st	1. Check MCBs in SB-2 specially MCB 127.1/2. If found tripped, reset it once after switching MCE OFF. 2. Press BLDJ to close VCB. 3. Check for air leakage from SR-2. If air is leaking, then isolate air supply to concerned SR by cock 88 on left inside (second from top) of pneumatic panel then isolate Bogie-2 by switch 154 (SB-1). 4. If VCB not closed and same message repeated, then this will lead to isolation of Bogie-2.		
	Loco XXXXX SS03: Traction Bogie 2 BOGIE 2 ISOLATED: Only half traction and electrical braking power available Press <Enter>	LSFI will glow	Bogie 2 will isolate. Only half TE/BE power will available.	2nd	1. If bogie-2 is isolated by Driver through (154) switch then only acknowledge the isolation message by pressing <ENTER> on display key board otherwise- 2. Switch OFF the Electronics and Switch it ON once again. Raise the panto, close VCB and resume traction. 3. If the same message repeats resume normal operation with half traction/braking power. 4. Inform TLC and record in the logbook.	BOGIE 2 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff
F0305P1	CONVERTER 2 COOLANT TEMPERATURE TOO HIGH Check coolant level and pump Try to close the VCB again	LSDJ , LSFI		1st	1. Check oil level in converter expansion tank, located above the converter cubicle. 2. Check manually that oil-cooling blower unit-2 is working by checking the air coming out of the radiator in the under frame. Check MCB 59.1/2 in HB2 panel. If found tripped, open VCB and reset MCB once. Ensure working of traction converter pump-2. If not working, then check MCB (62.1/2) located in HB-2. If found tripped, reset it once after opening VCB. 3. Driver should also inspect the oil cooler blower motor-2 impeller and casing for any sign of damage. If found damaged, then driver should open VCB, lower panto and switch off control electronics. Open MCB 59.1/2, open MCB 62.1/2 & MCB 63.1/2 (all located in HB-2 cubicle). Then isolate bogie-2 by bogie isolating switch 154 (located in SB-1) cubicle. 4. Energize the loco and work the train with one bogie in service. Under such condition, LSFI will glow permanently. Inform TLC and record in Loco logbook.		Check coolant level converter expansion tank Check manually whether cooling blower unit 2 works or not
	Loco XXXXX SS03: Traction Bogie 2 BOGIE 2 ISOLATED: Only half traction and electrical braking power available.	LSFI will glow	Bogie 2 will isolate. Only half TE/BE power will	2nd	1. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume Traction. 2. If the same message repeats resume normal operation with half traction/braking power. 3. Inform TLC and record in the logbook.	BOGIE 2 ISOLATED; Only half traction and electrical	Inform maintenance staff

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	Press <Enter>		available.			braking power available	
F0306P1	Loco XXXXX SS03: Traction Bogie 2 CONVERTER 2 COOLANT PRESSURE NOT OK Check coolant level Try to close the VCB again	LSDJ		1st	1. BUR-II to be kept isolated by MCB 127.22/2 (SB-2) after opening VCB and try to close VCB. 2. If problem disappear, work with BUR-II isolated. 3. If problem persist, BG-2 will get automatically isolated 4. Check oil level in converter expansion tank. 5. Check manually that converter-2 oil pumps are working or not by touching the pumps outlet and inlet pipes in the machine room. Check MCB 63.1/2 in HB-2 panel. If found tripped, open VCB and reset MCB only once. 6. If MCB 63.1/2 getting tripped again after resetting it once then do not try to reset the MCB again. BG-2 will get automatically isolated. Work with half traction. 7. Driver should also inspect the traction converter 2 oil pipeline for any sign of damage causing oil leakage and inspect the oil cooler blower casing-2 for any sign of damage due to failure of its impeller. In this case it may lead to damage of converter radiator causing oil leakage and lead to fault message "Converter No.2 oil pressure low". Then driver should open VCB, lower panto & switch off control electronics. Open MCB 59.1/2, 63.1/2 (all located in HB-2 cubicle). Isolate bogie-2 by putting rotating switch 154. Energize the loco and work the train with one bogie in service. Under such condition LSFI will permanently glow if driver isolated the bogie-2 as described in step 6 & 7 above. Inform TLC and record in loco logbook.		Check coolant level converter expansion tank Check manually whether cooling blower unit 2 works or not
	Loco XXXXX SS03: Traction Bogie 2 BOGIE 2 ISOLATED: Only half traction and electrical braking power available. Press <Enter>	LSFI will glow	Bogie 2 will isolate. Only half TE/BE power will available.	2nd	1. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume traction. 2. If the same message repeats, resume normal operation with half traction / braking power. 3. Inform TLC and record in the logbook.	BOGIE 2 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff
F0307P1	Loco XXXXX SS03: Traction Bogie 2 TRACTION MOTOR TEMPERATURE TOO HIGH Converter 2 blocked Bogie 2 may get isolated	LSFI		1st	1. Clear block section. Bring throttle to '0' position. 2. Check manually whether traction motor blower-2 is working or not, by checking air suction at TM Louver. Check MCB 53.1/2 in HB-2 panel. If found tripped, open VCB and reset MCB once.		Check manually whether traction motor blower works or not
F0301P2	Loco XXXXX SS03: Traction				1. Resume normal operation.		Inform maintenance

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	Bogie 2 EARTH FAULT IN CONVERTER 2 Normal operation can continue To be checked during maintenance				2. Inform TLC and record in the loco logbook.		staff
F0302P2	Loco XXXXX SS03: Traction Bogie 2 TRACTION MOTOR OVERSPEED TE is being reduced Reduce loco speed				1. Reduce speed. 2. Resume normal operation.		
F0303P2	MUB RESISTANCE TOO HOT IN CONVERTER 2 Wait for 30 seconds				1. Wait for 30 seconds before re closing VCB in order to cool MUB resistance (15.1 located in converter cubicle) 2. Press BLDJ to close VCB.		
F0305P2	EQUIPMENT TEMPERATURE HIGH TE/BE is being reduced			TE/ BE will cont inuo usly redu ced	1. Clear block section. Bring throttle to '0' position. 2. Wait for 10 minutes or some time till transformer / converter oil temperature normalizes. 3. Check MCBs in HB/SB, if tripped, reset it once. 4. Ensure working of all auxiliaries and MRB. 5. Resume normal traction. 6. If message persists, switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction if loco get normal otherwise isolate bogie-2 by switch (154) & work the train on one bogie after making conversation with TLC. 7. If no success within 20 minutes, ask for relief loco.		
F0307P2	LINE CONVERTER ISOLATED BOGIE 2 Reduced Traction/Braking effort					BOGIE 2 ISOLATED; Only half traction and electrical braking power available	Inform maintenance staff
F0308P2	MOTOR 1 ISOLATED BOGIE 2 Reduced Traction/Braking effort				Acknowledge the fault by pressing BPFA & resume normal operation. Inform TLC and record in the logbook.		
F0309P2	MOTOR 2 ISOLATED BOGIE 2				Acknowledge the fault by pressing BPFA & resume normal operation. Inform TLC and record in the logbook.		

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	Reduced Traction/Braking effort						
F0310P2	MOTOR 3 ISOLATED BOGIE 2 Reduced Traction/Braking effort				Acknowledge the fault by pressing BPFA & resume normal operation. Inform TLC and record in the logbook.		

6.6.4. Subsystem SS04: Harmonic filter

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0401P1	Loco XXX SS01: Harmonic filter HARMONIC FILTER CURRENT TOO HIGH Try to close the VCB again	LSDJ , LSFI will glow		1st	1. Press BLDJ to close VCB 2. If the message persists. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume Traction.		
	Loco XXX SS01: Harmonic filter HARMONIC FILTER ISOLATED Speak to TLC Max. permitted speed is 40 Kmph Press <Enter>	LSFI will glow	Harmoni c Filter will isolate. Max speed 40 Kmph	2nd	1. Speed will be reduced to 40 KMPH. 2. Inform TLC and Resume normal Traction. 3. After passing 1-2 section, switch OFF the CE and switch it ON again. 4. If Harmonic filter comes in service, resume normal traction with normal speed. 5. If not successful, work the train with 40 KMPH and both SR in service or isolate SR- 1 by switch 154, switch OFF the electronics & switch it ON and work with half TE / BE at normal speed.	HARMONIC FILTER ISOLATED	Speak to TLC Max. permitted speed is 40km/h
F0402P1	Loco XXX SS01: Harmonic filter HARM. FILTER CONTACTOR(S) STUCK OFF/ON Harmonic filter will be isolated Speak to TLC	LSDJ , LSFI will glow		1st	1. Press BLDJ to close VCB. 2. If the message persists, switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume Traction.	HARMONIC FILTER ISOLATED	Speak to TLC Max. permitted speed is 40km/h
	Loco XXX SS04: Harmonic filter HARMONIC FILTER ISOLATED Speak to TLC Max. permitted speed is 40 Km/h Press <Enter>	LSFI will glow	Harmoni c Filter will isolate. Max speed 40 Kmph	2nd	1. Speed will be reduced to 40 KMPH. 2. Inform TLC and Resume normal Traction. 3. After passing 1-2 section, switch OFF the CE and switch it ON again. 4. If Harmonic filter comes in service, resume normal traction with normal speed. 5. If not successful, work the train with 40 KMPH and both SR in service or isolate SR- 1 by switch 154, and work with half TE / BE at normal speed.		
F0404P1	Loco XXX SS04: Harmonic filter FILTER DISCHARGE RESISTOR TOO HOT No. of filter discharges exceeded VCB will remain inhibited 15 min	LSDJ , LSFI will glow	Harmoni c Filter will isolate. Max speed 40 Kmph		1. Wait for 15 minutes and try to close VCB again by pressing BLDJ. 2. If the message persists, switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction.		
F0401P 2	Loco XXX SS04: Harmonic filter FILTER CONTACTOR 8.1 STUCK ON If VCB opens it will not close again				1. If VCB opened it will not be possible to close VCB again by pressing BLDJ. 2. Switch OFF the electronics and switch it ON once again. Raise panto, close VCB and resume Traction. 3. If VCB not closing ask for relief loco.		If VCB opens, it will not close again; Then ask for a relief loco
F0402P 2	Loco XXX SS04: Harmonic filter EARTH FAULT				1. Acknowledge the fault by pressing BPFA & resume normal operation.		Inform maintenance staff

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	HARMONIC FILTER CIRCUIT Normal operation can continue To be checked during maintenance				2. Inform TLC and record in the logbook.		

6.6.5. Subsystem SS05: Hotel Load Converter

Not applicable for WAG9/WAG9H

6.6.6. Subsystem SS06: Auxiliary converter 1

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0601P1	Loco XXX SS06: Aux-converter1 DISTURBANCE IN PROCESSOR BUR1 Try to close the VCB again	LSDJ		1st	1. Press BLDJ to close VCB.		
	Loco XXX SS06: Aux-converter1 AUX CONVERTER1 ISOLATED Driving still Possible Max. ventilation level will be reduced	LSFI will glow	Aux. Converter 1 will isolate. Driving possible but Max ventilation level will reduced.	2nd	1. Check MCB No. 127.22/1 in SB-1. If found tripped, reset it once after switching MCE OFF. 2. Switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 3. If the same message repeated, resume normal operation with BUR 1 isolated and don't try to bring BUR-1 in service by switching ON/OFF control electronics and work the train with BUR-1 isolated. 4. Inform TLC and record in the logbook.	Aux. Converter 1 isolated Max. ventilation level will be reduced	Inform maintenance staff
F0602P1	Loco XXX SS06: Aux-converter1 FAULT IN AUXILIARY CONVERTER 1 Try to close the VCB again	LSDJ		1st	1. Press BLDJ to close VCB.		
	8. Loco XXX SS06: Aux-converter1 AUX CONVERTER1 ISOLATED Driving still possible Max. ventilation level	LSFI will glow	Aux. Converter 1 will isolate. Driving possible but Max ventilation level will reduced	2nd	1. Check MCB No. 127.22/1 in SB-1. If found tripped, reset it once after switching MCE OFF. 2. Switch OFF the electronics and switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 3. If the same message repeated resume normal operation with BUR-1 isolated. If BUR-1 is not getting isolated, then isolate the BUR-1 by opening	Aux. Converter 1 isolated Max. ventilation level will be reduced	Inform maintenance staff

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	will be reduced				MCB (127.22/1) located in SB-1 cubicle after opening VCB and switching OFF control electronics. 4. Energize the loco and work the train with BUR-1 isolated. Under such condition LSFI will glow permanently. 5. Inform TLC and record in the logbook.		
F0603P1	Loco XXX SS06: Aux-converter1 CONTACTOR FAULT IN HB1 Contactor 52/4 or 52/5 stuck off	LSDJ			1. Press BLDJ to close VCB. 2. If fault still persist, then BUR-1 will get isolated. Driver should continue normal operation till next schedule stop.		
F0604P1	Loco XXX SS06: Aux-converter1 BOGIE 1 VENTILATION BUR1 DISTURBED Press acknowledge to reconfigure to BUR2	LSFI will glow	Aux. Converter 1 will isolate. Driving possible but Max ventilation level will reduced.		1. Switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 2. If the same message repeated, resume normal operation with BUR-1 isolated. 3. Inform TLC and record in the logbook.		

6.6.7. Subsystem SS07: Auxiliary converter 2

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0701P1	Loco XXX SS07: Aux-converter2 DISTURBANCE IN PROCESSOR BUR2 Try to close the VCB again	LSDJ		1st	1. Press BLDJ to close VCB.		
	Loco XXX SS07: Aux-converter2 AUX CONVERTER2 ISOLATED Driving still Possible Max. ventilation level will be reduced Press<Enter>	LSFI will glow	Aux. Converter 2 will isolate. Driving possible but Max ventilation level will reduced.	2nd	1. Check all MCB No. 127.22/2 in SB-2. If found tripped, reset it once after switching MCE OFF. 2. Switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 3. If the same message repeated, resume normal operation with BUR 2 isolated. 4. Inform TLC and record in the logbook.	Aux. Converter 2 isolated Max. ventilation level will be reduced	Inform maintenance staff
F0702P1	Loco XXX SS07: Aux-converter2			1st	1. Press BLDJ to close VCB.		

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	FAULT IN AUXILIARY CONVERTER 2 Try to close the VCB again						
	Loco XXX SS07: Aux-converter2 AUX CONVERTER2 ISOLATED Driving still possible max. ventilation level will be reduced Press<Enter>	LSFI will glow	Aux. Converter 2 will isolate. Driving possible but Max ventilation level will reduced.	2nd	1. Check MCB No. 127.22/2 in SB-2. If found tripped, reset it once after switching MCE OFF. 2. Switch OFF the electronics and switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 3. If the same message repeated, resume normal operation with BUR-2 isolated. If BUR-2 is not getting isolated, then isolate BUR-2 by opening MCB (127.22/2) located in SB-2 cubicle after opening VCB and switching OFF control electronics. 4. Energize the loco and work the train with BUR-2 isolated. Under such condition LSFI will glow permanently. 5. Inform TLC and record in the logbook.	Aux. Converter 2 isolated Max. ventilation level will be reduced	Inform maintenance staff
F0703P1	Loco XXX SS07: Aux-converter2 CONTACTOR FAULT IN AUX. CONV. BOX2 / HB2 Contactor 52/1/2/4 stuck off or on				1. Press BLDJ to close VCB. 2. If fault still persist, then BUR-2 will get isolated. Driver should continue normal operation till next schedule stop.	Aux. Converter 2 may get isolated	Check contactors; inform maintenance staff
F0704P1	Loco XXX SS07: Aux-converter2 VENTILATION BUR2 DISTURBED Press acknowledge to reconfigure to BUR1	LSFI will glow	Aux. Converter2 will isolate. Driving possible but Max ventilation level will reduced.		1. Switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 2. If the same message repeated, resume normal operation with BUR-2 isolated. 3. Inform TLC and record in the logbook.		

6.6.8. Subsystem SS08: Auxiliary converter 3

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0801P1	Loco XXX SS08: Aux-converter3 DISTURBANCE IN PROCESSOR BUR3 Try to close the VCB again	LSDJ		1st	1. Press BLDJ to close VCB.		
	Loco XXX SS08: Aux-converter3 AUX CONVERTER3 ISOLATED Driving still Possible Max. ventilation level will be reduced Press<Enter>	LSFI will glow	Aux. Converter 3 will isolate. Driving possible but Max ventilation level will reduced.	2nd	1. Check MCB No. 127.22/3 in SB-2. If found tripped, reset it once after swiching MCE OFF. 2. Switch OFF the electronics and Switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 3. If the same message repeated, resume normal operation with BUR 3 isolated and don't try to bring BUR-3 in service by switching ON/OFF control electronics and work the train with BUR-3 isolated. 4. Inform TLC and record in the logbook.	Aux. Converter 3 isolated Max. ventilation level will be reduced	Inform maintenance staff
F0802P1	Loco XXX SS08: Aux-converter3 FAULT IN AUXILIARY CONVERTER 3 Try to close the VCB again	LSDJ		1st	1. Press BLDJ to close VCB.		
	Loco XXX SS08: Aux-converter3 AUX CONVERTER3 ISOLATED Driving still possible Max. ventilation level will be reduced Press<Enter>	LSFI will glow	Aux. Converter 3 will isolate. Driving possible but Max ventilation level will reduced.	2nd	1. Check MCB No. 127.22/3 in SB-2. If found tripped, reset it once after swiching MCE OFF. 2. Switch OFF the electronics and switch it ON once again. Raise panto, close VCB and resume traction if loco gets normal. 3. If the same message repeated, resume normal operation with BUR-3 isolated. 4. Inform TLC and record in the logbook.	Aux. Converter 3 isolated Max. ventilation level will be reduced	Inform maintenance staff
F0803P1	Loco XXX SS08: Aux-converter3 CONTACTOR FAULT IN AUX. CONVERTER BOX 2 Contactor 52/3 stuck off	LSDJ			1. Press BLDJ to close VCB. 2. If fault still persist, then BUR-3 will get isolated. Driver should continue normal operation till next schedule stop.	Aux. Converter 3 may get isolated	Check contactors; inform maintenance staff

6.6.9. General Instruction for Auxiliary converter 1, 2 & 3 trouble shooting

S.S. No.	Observation	Action to be taken by Driver
SS06, SS07, SS08	1) If driver experiences repeated tripping of MCB 59.1/1 or/and59.1/2 of OCB-1 or/andOCB-2.	1. Reset MCB. 2. Switch OFF electronics. 3. BUR- I to be isolated by tripping MCB 127.22/1 located in SB-1. 4. Try to work with BUR-I isolated and OCB 1/2 will work on BUR-II. Note: This problem may arise due to unbalance output voltage of BUR-I.
	2) If driver experiences repeated tripping of MCB 63.1/1 or/and63.1/2 (of Converter Oil Pump 1 or/and2) OR/AND MCB 62.1/1 or/and 62.1/2 (of transformer Oil Pump 1 or/and 2).	1. Reset MCB. 2. Switch OFF electronics. 3. BUR- II to be isolated by tripping MCB 127.22/2 located in SB-2. 4. Try to work with BUR-II isolated and MPH-C 1/2 will work on BUR-III. Note: This problem may arise due to unbalance output voltage of BUR-II.
	3) If driver experiences repeated tripping of MCB 53.1/1 or/and53.1/2 of TMB-1 or/andTMB-2.	1. Reset MCB. 2. Switch OFF electronics. 3. BUR- II to be isolated by tripping MCB 127.22/2 located in SB-2. 4. Try to work with BUR-II isolated and TMB 1/2 will work on BUR-I. Note: This problem may arise due to unbalance output voltage of BUR-II.
	4) If driver experiences repeated tripping of MCB 47.1/1 or/and47.1/2 (of MCP-1 or/andMCP-2) OR/AND MCB 55.1/1 or/and 55.1/2 (of SCTM-1 or/and SCTM-2).	1. Reset MCB. 2. Switch OFF electronics. 3. BUR- II to be isolated by tripping MCB 127.22/2 located in SB-2. 4. Try to work with BUR-II isolated and MPH-C 1/2 will work on BUR-II. Note: This problem may arise due to unbalance output voltage of BUR-III.

6.6.10. Subsystem SS09: Battery System

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F0901P1	Loco XXX SS09: Battery system BATTERY VOLTAGE TOO LOW Electronics will switch off	LSFI will glow		1st	1. Check MCB (112.1 & 110) in SB-2. MCB 112, located besides battery Box No. 2, should not be in tripped condition. If so, then reset the MCB. 2. If message is generated by BUR-II and actual voltage in UBA is above 82 volts, then try by isolating BUR-II. 3. If message is generated by BUR-III and actual voltage in UBA is above 82 volts, then try by isolating BUR-III. Note. Some of the Ajni based locos has been down loaded with modified software in which, if battery voltage is available to any of BUR II OR BUR-III, this message will not appear. 4. If UBA showing voltage less than 82 volts then immediately ask for relief loco. Note: For status of battery MCB 112, check immediately machine room light/cab light, if glowing, Battery MCB 112 is OK. Alternatively LP should check MCB 112 in cooling mode.	Main Power isolated VCB cannot be closed; VCB inhibited Loco is dead	Ask for relief loco

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	Loco XXX SS09: Battery system MAIN POWER ISOLATED VCB can not be closed: VCB inhibited Loco is dead	LSDJ, LSFI will glow	VCB will not close	2nd	1. If the battery can't be switched ON ask for relief loco.		
F0902P1	Loco XXX SS09: Battery system BATTERY LOW VOLTAGE Converters being switched off Open VCB, lower PANTO			1st	1. Check MCB (112.1 & 110) in SB-2. MCB 112, located besides battery Box No. 2, should not be in tripped condition. If so, then reset the MCB. 2. Try to switch OFF / ON Electronics once. 3. Check battery voltage on UBA, if above 82 volts and MCB-100 trips, Reset MCB. Loco to be kept energized for battery charging.		
	Loco XXX SS09: Battery system MAIN POWER ISOLATED VCB cannot be closed: VCB inhibited Loco is dead	LSDJ will glow	VCB will not close	2nd	1. If the battery can't be switched ON, ask for relief loco.		Ask for relief loco
F0903P1	Loco XXX SS09: Battery system PAN LOWERED LONGER THAN 10 MINUTES Control electronics will switch off	LSDJ will glow	Control electronics will OFF		1. If BL key is at D and panto is lowered longer than 10 minutes, then this message is expected. 2. Switch ON electronics once again by BL Key if required. Driver could avoid occurrence of such fault message by raising one pantograph within 10 minutes after activating the particular cab by putting BL Key in driving position. 3. If panto pan is not raising and message arise then trouble shoot as per F 0103P1.		
F0901P2	Loco XXX SS09: Battery system WARNING: LOW BATTERY VOLTAGE Driving available for less than 30 min. Check battery charger MCB		Loco may be energized for 30 minutes. Guiding available.		1. Check battery charger output MCB 110 in SB-2. If found tripped, reset battery charger output MCB.		Check battery charger MCB
F0902P2	Loco XXX SS09: Battery system BATTERY CHARGER MCB OFF Try to reclose the MCB				1. Check MCB 110 in SB2 and 100 in BUR Box 2 or in HB2. If tripped, reset it once. 2. Clear the block section. 3. Reset MCB 100 in HB2 panel and work further. 4. If MCB-100 is tripping repeatedly, then isolate BUR-III and try to work with CHBA on BUR-II. 5. If still message persist, then inform TLC and ask for relief loco. Loco can work till battery voltage drops to 86 V. 6. Record in Logbook that driver could not Trouble shoot because it is not possible for the driver to reset the battery charger input MCB (100) which is located inside Auxiliary Converter box-2. (In		Try to close battery charger MCB

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
					case of unmodified locos)		
F0903P2	Loco XXX SS09: Battery system LOW BATTERY CHARGER CURRENT Battery charger MCB may have tripped Battery not being charged				1. Check battery charger output MCB 110 in SB2 and MCB 112, located besides BA box No. 2. If found tripped, reset the tripped MCB. 2. Check battery and connection of battery cables.		Check battery and connection of battery cables Try to close battery charger MCB
F0904P2	Loco XXX SS09: Battery system DIAGNOSIS MEMORY BATTERY EMPTY Inform TLC during next stop		No more faults will store in DDS.		1. Resume normal operation. 2. Inform TLC and record in the logbook.		Inform TLC during next stop
F0905P2	Loco XXX SS09: Battery system EARTH FAULT BATTERY CIRCUIT Normal operation can continue To be checked during maintenance				1. Resume normal operation. 2. Inform TLC and record in the logbook.		Inform maintenance staff

6.6.11. Subsystem SS10: Brake System

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1001P1	Loco XXX SS10: Brake System FAULT IN BRAKE ELECTRONICS Emergency brake applied No Traction allowed	LSFI	Emergency brake will apply		1. Check MCB No. 127.7. If found tripped, reset 127.7 once after switching MCE OFF . 2. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume Traction, if loco get normal. 3. If the message repeated bring TE/BE throttle to '0' position. 4. With CCB equipped locomotive, use the instructions* to		Ask for relief loco

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
					make PTDC mode of CCB active to clear the line. 5. If not successful within 20 minutes, ask for relief loco.		
F1002P1	Loco XXX SS10: Brake System LOW PRESSURE MAIN RESERVOIR No traction allowed till pressure reaches 6.4 kg/cm2	LSFI	TE/BE will not possible till MR pressure reaches to 6.4 Kg/cm2		1. Bring TE/BE throttle to '0' position. 2. Wait until a MR pressure of 6.4 Kg/cm2 reached. 3. Check whether compressor works or not. Check the MCB of compressors 47.1/1 in HB1 & 47.1/2 in HB2 panels. If found tripped, open VCB and reset the MCB once. 4. Check leakage from Air dryer. If leakage persists, then isolate Air dryer by isolating D in cock & by putting D out to normal position provided in under frame. 5. Check leakage from Auto drain valve provided under the main reservoir 1 & 2 or air leakage from CP delivery pipe. 6. Check train for heavy leakage in pneumatic system. 7. If there is no leakage and MCBs of both the Compressors are in closed condition, even then compressor are not working and MR is not being maintained, Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume Traction if loco get normal. 8. If not successful within 20 minutes, ask for relief loco.		Check whether compressor work or not Check train for heavy leakage in pneumatic system Ask for relief loco
F1003P1	Loco XXX SS10: Brake System VIGILANCE EMERGENCY BRAKE APPLICATION Bring TE/BE throttle to zero Press vigilance reset pushbutton	LSVW, LSFI will glow	Emergency brake BP pressure will drop to 3 kg to 2.5 kg/cm2. Buzzer will sound		A. If this message is due to not acknowledging VCD by crew,then 1. Bring TE/BE Throttle to '0' position. 2. Apply A-9 to emergency to avoid depletion of MR through BP. 3. Wait for 120 seconds as Penalty Brake applied due to Vigilance can be reset only after 120 seconds. So, don't press BPVR during these 120 seconds. 4. Press yellow Vigilance Reset Pushbutton BPVR on Panel A of Driving Desk after 120 seconds. Ensure LSVW goes OFF and Buzzer stop blowing. Note: If CCB of Knorr Bremse, Press BPVR after32 seconds (vigilance reset time is 32 seconds) 5. Press and Release 'Vigilance' Paddle Switch. 6. Press BPFA 7. Move A9 Handle to run. After resetting Penalty Brake, BP will be charged to 5 Kg/cm2. 8. If the penalty brakes remains applied even after the above, Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume normal traction. B. If vigilance penalty brakes are applied even when driver is alert during running, there is a chance that vigilance control Device may be defective or vigilance acknowledge switch of driver side not working. In this condition check with Asst. Driver's side pushbutton. If still the same condition, Vigilance		

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
					control device may be defective. So switch OFF control Electronics and put vigilance isolating switch (Vigilance Cut-out Switch 237.1) provided on SB1 panel to '0' position. This will make vigilance control device isolated. 1. Switch ON Electronics, close VCB and resume Normal traction with VCD in isolated condition. 2. Inform TLC and be vigilant. Note: In this case low MR pressure message is expected. So ignore it.		
F1004P1	Loco XXX SS10: Brake System Working WRONG CONFIGURATION BRAKE SYSTEM Check isolating cock brake control Wrong cock pos. to reset open VCB	LSFI			1. Bring TE/BE throttle to '0' position. 2. Check isolating Cock No. 70 (E70 Brake Pipe isolating cock) provided on pneumatic panel. If found close then open cock No. 70. Close VCB. 3. Also check ZBAN switch. It should be OFF, if not, put it at OFF position. 4. Resume Normal Traction.		
F1005P1	Loco XXX SS10: Brake System TRACTION WITH AUTO BRAKES NOT ALLOWED Release auto air brake Bring TE/BE throttle to zero	LSFI	Auto brake applied TE/BE not possible.		1. Release Auto Air Brake. Check BP, it should be 5 Kg/cm2. 2. Bring TE/BE Throttle to '0' position. 3. Resume normal traction. 4. If not successful, try from other cab.		
F1006P1	Loco XXX SS10: Brake System TRACTION WITH PARKING BRAKES NOT ALLOWED Release parking brakes Bring TE/BE throttle to zero	LSFI	Auto brake applied TE/BE not possible.		1. Bring TE/BE Throttle to '0' position. 2. Release parking brake with illuminated Red Push Button BPPB. In case parking brakes get released, then parking brake gauge will show pressure of 6 Kg/cm2 and BPPB will extinguish. 3. If parking brake is not getting released, then inspect the Latch Solenoid valve (30) on pneumatic panel. If it is found permanently latched in applied condition, then release it. 4. Press releasing knob and lock in that condition if necessary. 5. If still parking brakes not released, check for any sign of air leakage from parking brake cylinder hosepipe. If there is leakage, then arrest the leakage. 6. After releasing parking brakes, resume normal traction.		
F1007P1	Loco XXX SS10: Brake System REGENERATIVE BRAKE FAILURE Pneumatic loco brake applied	LSFI	Brake will apply to loco.		1. Bring TE/BE Throttle to '0' position, loco brakes will be released. 2. Control the train through A-9. Press PVEF, till BC-1/BC-2 gauge pressure reaches '0' Kg/cm2 3. No electrical Brake power available; braking can be done with A9/SA9 only.	No electrical brake power available	Inform maintenance staff

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
					4. Resume Normal Traction 5. Inform TLC and record in the Logbook.		
F1008P1	Loco XXX SS10: Brake System EMERGENCY STOP; SHUTDOWN ON THE LOCO To release, reset Emg. stop pushbutton Bring TE/BE throttle to zero	LSDJ	VCB open, panto lower, TE/BE '0', Emergency brake will apply		1. Bring TE/BE throttle to '0' position. 2. Reset Emergency Stop push Button by rotating it in the direction of Arrow marked on it. It will come out a little bit. 3. Press BPFA. 4. Raise Pantograph. 5. Close VCB. 6. Resume Normal Traction after charging BP and MR. 7. If not successful, try from other cab.		
F1009P1	Loco XXX SS10: Brake System TRACTION NOT ALLOWED WITH APPLIED BRAKES Release loco brakes Bring TE/BE throttle to zero		Loco brake is applied		This fault messages is generated, when BC pressure is over 0.65 Kg/cm2, throttle is not at zero position and speed is over 10 KMPH. 1. Bring TE/BE throttle to '0' position. 2. Release Loco Brakes with SA9. 3. If loco brake not released then Tap gently Pressure Switch 269.6/1 & 269.6/2 (provided between AR & Pneumatic panel)		
F1010P1	Loco XXX SS10: Brake System EMG EXHAUST COCK CLOSED, NO TRACTION For traction open the cock Bring TE/BE throttle to zero		BP is reduced to '0'		1. Bring TE/BE throttle to '0' position. 2. Open the Emergency Exhaust Cock No. 74 on the pneumatic panel 3. If cock 74 is already open and even though message appears, then problem may be with limiting switch provided on cock, operate it manually 2-3 times. 4. If loco becomes normal, then proceed otherwise, switch off MCE and switch it ON again.		
F1001P2	Loco XXX SS10: Brake System LOCO IS IN BANKING MODE Loco brake controller isolated Emergency brakes can be applied				1. This message is expected, when loco is in banking mode (ZBAN is ON and Cock 70 is isolated). If not in Banking mode follow the procedure given below: 2. Bring TE/BE throttle to '0'. 3. Check position of ZBAN switch. If ON, then switch it OFF. 4. It could be due to maloperation of ZBAN microswitch. Operate ZBAN switch 2-3 times vigorously, it will normalize if stuck up. 5. Close VCB and resume normal traction. 6. If not successful, try to work from rear cab after switching ON/ OFF MCE.	Loco brake controller isolated	
F1002P2	Loco XXX SS10: Brake System ALARM CHAIN PULLING / TRAIN PARTING Check the load				1. Bring the train to a halt at convenient place immediately. Work as per operating Manual and GR. 4.45/1. Check the affected coach, find out the reason of ACP, reset the ACP and work the train accordingly.		

6.6.12. Subsystem SS11: Auxiliaries HB 1

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	Loco XXX SS11: Auxiliaires HB1 MCB(S) OPEN IN AUX. CUBICLE 1 Traction power may get reduced, if temperatures exceed				1. Acknowledge the fault by pressing BPFA and continue normal operation till block section is cleared. 2. Check MCB's in Auxiliary cubicle HB1. If any MCB found tripped then reset it once after opening VCB. 3. If any MCB is not tripped but still message is coming and all auxiliaries are working, ignore it. This may be due to defective control contact of concerned MCB. 4. If MCB (59.1/1 or 62.1/1 or 63.1/1 or 53.1/1) getting tripped after resetting it once as given in step 2 above, then driver should not try to reset these MCBs. Trouble shoot as per general instruction of SS06, SS07, SS08 (page no. 66) 5. Inform TLC and record in loco logbook. Resume traction with bogie 1 in isolated condition if automatically isolated. 6. In case of any other MCB excluding MCB given in step 4 above is getting tripped after resetting once, then continue normal operation as long as possible and inform TLC.		
F1102P 2	Loco XXX SS11: Auxiliaries HB1 EARTH FAULT 415/110V CIRCUIT Normal operation can continue To be checked during maintenance				1. Resume normal traction. 2. Inform TLC and record in loco logbook.		Inform maintenance staff
F1103P 2	Loco XXX SS11: Auxiliaries HB1 MCB OF MAIN COMPRESSSOR 1 OPEN Compressor 1 not available				1. Check MCB No. 47.1/1 provided in Auxiliary cubicle 1 (HB1). If found in tripped condition, then open VCB and reset MCB once. 2. Resume normal traction. If the message repeats then work the train with one compressor. 3. Inform TLC and record in loco logbook.	Compre ssor 1 not available	
F1104P 2	Loco XXX SS11: Auxiliaries HB1 OVERLOAD ON OCB-1 Isolate OCB				Isolate MCB 59.1/1 (Oil Cooling Blower) in HB-1. Bogie-1 also to be isolated in this condition. Normal operation can be continued with one bogie.		Inform service staff to clean radiators
F1105P 2	Loco XXX SS11:Vigilance Cut Off Rotary Switch Vig Off Check On/Off Position 237.1 Normal Operation can continue				1. Resume normal traction. 2. Inform TLC and record in loco logbook.		Inform maintenance staff
F1106P 2	Loco XXX SS11: Auxiliaries HB1 Loco in shunting mode Speed can not be more than 15 kmph				Check switch no. 160 (SB-2), if it is on '0', bring throttle to '0', bring speed '0' and Reverser on '0' then put switch 160 on 'I' to achieve normal speed.		

6.6.13. Subsystem SS12: Auxiliaries HB 2

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1201P2	Loco XXX SS12: Auxiliaries HB2 MCB(S) OPEN IN AUX. CUBICLE 2 Traction power may get reduced, if temperatures exceed				1. Acknowledge the fault by pressing BPFA and continue normal operation till block section is cleared. 2. Check MCB's in Auxiliary cubicle HB2. If any MCB found tripped then reset it once after opening VCB. 3. If any MCB is not tripped but still message is coming and all auxiliaries are working, ignore it. This may be due to defective control contact of concerned MCB. 4. If MCB (59.1/2 or 62.1/2 or 63.1/2 or 53.1/2) getting tripped after resetting it once as given in step 2 above, then driver should not try to reset these MCBs. Trouble shoot as per general instruction of SS06, SS07, SS08 (page no. 66) . 5. Inform TLC and record in loco logbook. Resume traction with bogie 2 in isolated condition if automatically isolated. 6. In case of any other MCB excluding MCB given in step 4 above is getting tripped after resetting once, then continue normal operation as long as possible and inform TLC.		Check MCBs in Auxiliary cubicle 2
F1202P2	Loco XXX SS12: Auxiliaries HB2 MCB OF MAIN COMPRESSOR 2 OPEN Compressor 2 not available				1. Check MCB No. 47.1/2 provided in Auxiliary cubicle 2 (HB2). If found in tripped condition, then open VCB and reset MCB once. 2. Resume normal traction Even if the message repeats, then work the train with one compressor. 3. Inform TLC and record in loco logbook	Compressor 2 not available	
F1203P2	Loco XXX SS12: Auxiliaries HB2 OVERLOAD ON OCB-2 Isolate OCB				Isolate MCB 59.1/2 (Oil Cooling Blower) in HB-2. Bogie-2 also to be isolated in this condition. Normal operation can be continued with one bogie.		Inform service staff to clean radiators

6.6.14. Subsystem SS13: Cab 1

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1301P1	Loco XXX SS13: Cab 1 DISTURBANCE IN PROCESSOR HBB1 Cab 1 may get isolated; Drive from Cab 2 REFER TO DRIVER'S MANUAL	LSFI	Cab 1 may get isolated,	1st	1. Switch OFF the Electronics and Switch it ON once again. Raise panto , close VCB and resume Traction. 2. Check MCB 127.3/1 (SB-1) if tripped, reset once after switching MCE OFF.		Inform maintenance staff
	Loco XXX SS13: Cab 1 CAB 1		Cab 1 isolated	2nd	1. If the same message repeats, change to Cab 2.		

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	ISOLATED Drive from cab 2 Press<Enter>				2. Inform TLC and record in loco logbook.		
F1302P1	Loco XXX SS13: Cab 1 DISTURBANCE IN PROCESSOR STB1 Cab 1 may get isolated; Drive from Cab 2 REFER TO DRIVER'S MANUAL	LSFI	Cab 1 may get isolated,	1st	1. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume traction.		Inform maintenance staff
	Loco XXX SS13: Cab 1 CAB 1 ISOLATED Drive from cab 2 Press<Enter>		Cab 1 isolated	2nd	1. If the same message repeats, change to Cab-2 2. Inform TLC and record in Loco logbook.		
F1303P1	Loco XXX SS13: Cab 1 REVERSER DEFECTIVE Drive from Cab 2				1. Operate Reverser 2-3 times .Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume traction. 2. If the same message repeats, change to Cab-2. Inform TLC and record in Loco logbook.		Inform maintenance staff

6.6.15. Subsystem SS14: Cab 2

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1401P1	Loco XXX SS14: Cab 2 DISTURBANCE IN PROCESSOR HBB2 Cab 2 may get isolated; Drive from Cab 1 REFER TO DRIVER'S MANUAL	LSFI	Cab 2 may get isolated,	1st	1. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume Traction. 2. Check MCB 127.3/2 (SB-2) if tripped, reset once after switching MCE OFF.		Inform maintenance staff
	Loco XXX SS14: Cab 2 CAB 2 ISOLATED Drive from cab 1 Press<Enter>		Cab 2 isolated	2nd	1. If the same message repeats, change to Cab 1. 2. Inform TLC and record in loco logbook.		
F1402P1	Loco XXX SS14: Cab 2 DISTURBANCE IN PROCESSOR STB2 Cab 2 may get isolated; Drive from Cab 1 REFER TO DRIVER'S MANUAL	LSFI	Cab 2 may get isolated,		1. Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume traction.		Inform maintenance staff
	Loco XXX SS14: Cab 2 CAB 2 ISOLATED Drive from cab 1 Press<Enter>		Cab 2 isolated		1. If the same message repeats, change to Cab-1 2. Inform TLC and record in Loco logbook.		
F1403P1	Loco XXX SS14: Cab 2 REVERSER DEFECTIVE Drive from Cab 1	LSFI			1. Operate Reverser 2-3 times .Switch OFF the Electronics and Switch it ON once again. Raise panto, close VCB and resume traction. 2. If the same message repeats, change to Cab-1. Inform TLC & record in logbook.		Inform maintenance staff

6.6.16. Subsystem SS15: Fire detection

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1501P1	Loco XXX SS15: Fire	LSFI			1. Open VCB, Lower Pantograph and switch off the		Extinguish the fire by using the fire

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	detection FIRE IN MACHINE ROOM Extinguish the fire Reset the fire detection unit	will glow, Buzzer will sound			Electronics. 2. Inspect the Machine Room. If there is any sign of smoke emission, use portable fire extinguisher. 3. In case of larger fire, especially in Traction converter, then open the cock of CO2 Cylinder provided in the locker on Asst. Driver side in each cab. Keep the machine room door locked. 4. Subsequently, reset the fire detection unit by pressing reset push button provided on fire detection unit (located in SB-2 cubicle) then acknowledge the fault by pressing BPFA. 5. Inform TLC and record in loco logbook.		extinguishers. Reset the fire detection unit. Inform maintenance staff
F1501P2	Loco XXX SS15: Fire detection FAULT IN FIRE DETECTION UNIT No fire detection possible Normal operation can continue				1. Resume Normal Traction. 2. Keep on checking the Machine Room as frequently as possible for the sign of any smoke/fire. 3. Inform TLC and record in the logbook.		Inform maintenance staff
F1502P2	Loco XXX SS15: Fire detection WARNING: SMOKE IN MACHINE ROOM Inspect machine room				1. Open VCB, lower pantograph and switch off the Electronics. 2. Inspect the Machine Room carefully. In case of any fire/smoke, extinguish the fire by using portable fire extinguishers. 3. In case of larger fire, especially in Traction converter, then open the cock of CO2 and operate regulator Cylinder provided in the locker on Asst. Driver side in each cab. Keep the machine room door locked 4. If everything is found normal, resume normal Traction. 5. Inform TLC and record in the logbook.		Inspect machine room Inform maintenance staff

6.6.17. Subsystem SS16: Speedometer

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1601P1	Loco XXX SS16: Speedometer SPEED LIMIT EXCEEDED Emergency brakes applied Bring TE/BE throttle to zero	LSFI	Emergency brakes will applied		1. Acknowledge the fault by pressing BPFA. 2. Bring throttle to zero position to reduce loco speed. 3. When speed comes down the limit, resume normal traction. 4. If the speed shown in speedometer is not coming within the limits, but actual speed has come down this means that speedometer is defective. The drivers advise to open the speedometer MCB (127.92) provided in SB2 cubicle. 5. Now the speedometer will be isolated. So drive carefully and watch speed on display in simulation mode screen. 6. Inform TLC and record in loco logbook and act accordingly.		
F1601P2	Loco XXX SS16: Speedometer FAULT IN SPEEDOMETER No display of speed in the cab Drive carefully, use diagn. Screen				1. Inspect the speedometer MCB (127.92) in SB2 cubicle. If found in tripped condition then reset the MCB once and resume normal operation if loco gets normal. 2. If fault still persist, then isolate the speedometer by opening MCB (127.92) provided in SB2 cubicle. 3. Now the speedometer will be isolated. So drive carefully and watch speed on display in simulation mode screen. 4. Inform TLC and record in the logbook. 5. As per instruction of TLC. Normal traction can be resumed.		Inform maintenance staff

6.6.18. Subsystem SS17: Processor FLG1 (CCUO1)

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1701P1	Loco XXX SS17: Processor FLG1 DISTURBANCE IN PROCESSOR FLG1 FLG1 will be isolated	LSFI	FLG1 will be isolated	1st	1. Resume Normal Traction. 2. Inform TLC and record in the logbook.	FLG1 isolated	
	Loco XXX SS17: Processor FLG1 FLG1 ISOLATED Refer to driver's manual Press<Enter>	LSFI	FLG1 is isolated	2nd	1. Multiple Operations is not possible. 2. Resume normal traction. 3. Inform TLC and record in the logbook.		
F1702P1	Loco XXX SS17: Processor FLG1 SOFTWARE MISMATCH WAP-5 / WAG-9 Panto will not raise	LSFI	Panto will not raise		1. Inform TLC and record in the logbook. 2. Ask for relief loco immediately.		Inform maintenance staff; Check software Ask for relief loco
F1703P1	Loco XXX SS17: Processor FLG1 FAULT IN ANGLE TRANSMITTER OF THROTTLE Bring TE/BE throttle to zero Operate	LSFI			1. Bring TE/BE Throttle to '0'. 2. Acknowledge the Fault with illuminated button BPFA. 3. Drive loco in Failure Mode Operation (by		Operate switch failure mode Inform maintenance staff

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	switch failure mode				operating Rotating Switch 152 from '0' to '1' position) located in SB1 panel. 4. Resume normal traction with 152 switch in failure mode position.If not success, operate switch 152 (SB-1) 2-3 times. 5. Switch OFF the control electronics. 6. Try from rear cab. If not success, inform TLC and record in the logbook.		
F1704P1	Loco XXX SS17: Processor FLG1 SIMULATION SWITCH POSITION NOT MATCHING Check simulation key on master/slave	LSFI	Panto will not rise.		1. Bring TE/BE Throttle to '0'. 2. Switch OFF the control electronics. 3. Check if Simulation key 179 in SB1 panel is on '0' position. If not, operate it from '1' to '0' position. 4. Resume Normal Traction. 5. Inform TLC and record in the logbook.		Check simulation key position on master/slave loco
F1701P2	Loco XXX SS17: Processor FLG1 DISTURBANCE IN PROCESSOR DIA1 DIA1 will be isolated No Fault data will be stored		DDS will not store.		1. Since no fault will be stored in DDS, record all faults in the loco logbook. 2. Resume Normal Traction. 3. Inform TLC and record in the logbook.		Inform maintenance staff

6.6.19. Subsystem SS18: Processor FLG2 (CCUO2)

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1801P1	Loco XXX SS18: Processor FLG2 DISTURBANCE IN PROCESSOR FLG2 FLG2 will be isolated	LSFI	FLG2 will be isolated	1st	1. Switch OFF the Electronics and Switch it ON once again.	FLG 2 isolated	Inform maintenance staff
	Loco XXX SS18: Processor FLG2 FLG2 ISOLATED Refer to driver's manual Press<Enter>		FLG2 is isolated	2nd	1. If the same message repeats resume normal traction. 2. No regenerative braking power is available. So control the train/loco with help of pneumatic brake (A9 or SA9).When apply A9 insure TE/BE Thottle to '0' position. 3. Inform TLC and record in the logbook.		
F1802P1	Loco XXX SS18: Processor FLG2 SOFTWARE MISMATCH WAP-5 / WAG- 9 Panto will not raise	LSFI	Panto will not raise		1. Inform TLC and record in the logbook. 2. Ask for relief loco immediately.		Inform maintenance staff; Check software Ask for relief loco
F1803P1	Loco XXX SS18: Processor FLG2 FAULT IN ANGLE TRANSMITTER OF THROTTLE	LSFI			1. Bring TE/BE Throttle to '0'. 2. Acknowledge the Fault with illuminated button BPFA.		Operate switch failure mode Inform maintenance staff

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
	Bring TE/BE throttle to zero Operate switch failure mode				3. Drive loco in Failure Mode Operation (by operating Rotating Switch 152 from ‘0’ to ‘1’ position) located in SB1 panel. 4. Resume normal traction with 152 switch in failure mode position. If not success , operate switch 152 (SB-1) 2-3 times. 5. Switch OFF the control electronics. 6. Try from rear cab. If not success, inform TLC and record in the logbook.		
F1804P1	Loco XXX SS18: Processor FLG2 SIMULATION SWITCH POSITION NOT MATCHING Check simulation key on master/slave	LSFI	Panto will not raise		1. Bring TE/BE Throttle to ‘0’. 2. Switch OFF the control electronics. 3. Check if Simulation key 179 in SB1 panel is on ‘0’ position. If not, operate it from ‘1’ to ‘0’ position. 4. Resume Normal Traction. 5. Inform TLC and record in the logbook.		Check simulation key position on master/slave loco

6.6.20. Subsystem SS19: Train bus

Screen number	Screen messages	Lamp	System Reaction	Occurrence	Expected Drivers Action	Result	Further Remedy Action
F1901P1	LocoXXX SS19: Train Bus COMMUNICATION DISTURBANCE Try to close the VCB again Multiple operation not possible			1st	1. Press BLDJ to close VCB. 2. Check cable for multiple operations. 3. Inform TLC and record in the logbook.		Check cable for multiple operation Inform maintenance staff
	LocoXXX SS19: Train Bus TRAIN BUS ISOLATED Multiple operation not possible			2nd	1. No multiple operations possible. 2. Inform TLC and record in the logbook. 3. Continue normal operation. LSFI will glow continuously.		

6.7. Additional information for Loco Pilot

6.7.1. Procedure of MCE Reset

If a loco pilot needs to switch OFF and, ON the electronics, to clear a transient fault, follow these steps:

1. Stop the Train: Bring the throttle to '0', stop the train, open the VCB, and lower the pantograph.
2. Turn Off BL Key: Move the BL key from 'D' to 'OFF' and wait few seconds for the FLG node to reach 612.
3. Shut down: Move the BL key from 'OFF' to 'C' and back to 'OFF'.
4. Wait: Allow 5-10 seconds for the electronics to shut down completely.
5. Check Display: Ensure the driver display is blank, confirming the electronics are OFF.
6. Restart: Move the BL key from 'OFF' to 'D' to switch the electronics back ON.

6.7.2. Instructions to loco pilot for CAB and corridor light during troubleshooting

RDSO issued Modification Sheet No. RDSO/2011/EL/MS/0403 (Rev.0) on 30.11.11, modifying the corridor and cab light circuit. Previously, these lights remained ON after the MCE was switched OFF or the locomotive was shut down, as they were directly connected to the battery through MCB 310.4.

The modification introduces an automatic 10-minute delay to switch off the machine room and cab lights if pantograph is lowered more than 10-minutes. However, this could cause difficulties in resetting the MCB or troubleshooting in the machine room since the lights would also turn OFF.

To address this, drivers must follow a specific key sequence to ensure machine room lights remain ON while troubleshooting:

Driving → Off → Cooling → Off → Cooling

This sequence ensures that contactor 126 closes while contactor 218 remains open, allowing necessary lighting during troubleshooting.

6.7.3. Procedure for Bogie Isolation

6.7.3.1. *(A) Old Procedure (Before Software Modification):*

1. Stop the train/loco.
2. Open the **VCB** and lower the **pantograph**.
3. Move **BL key** from **D → OFF → C → OFF**. The **speedometer light** and **DDS screen light** should turn off, indicating that **MCE is switched off**.
4. Use **switch 154** (in SB1):
   - Position **I** for **bogie 1 isolation**
   - Position **II** for **bogie 2 isolation**
5. Turn **BL key to D** position.
6. **Self-test and processor booting** begin.
7. After the self-test, **raise the pantograph** and **close VCB**.
8. If pressure is below **6.4 kg/cm²**, build up the pressure before resuming normal traction.

6.7.3.2. *(B) Modified Procedure (With Software Update - No Need to Switch Off Electronics):*

1. If the loco is running:

- Set **throttle to '0'**.
- Rotate the reverser to neutral.
- Open **VCB** (loco enters **Node 550**).
- Select the **desired bogie** using **Bogie Cut-out switch 154**.
- The bogie will be **isolated after 10 seconds**.

2. If the loco is stationary:

- Set **throttle to '0'** (loco enters **Node 590**).
- Select the **desired bogie** using **Bogie Cut-out switch 154**.
- The bogie will be **isolated after 10 seconds**.

We can make the individual SR by cutting the 127.1/1 and 127.1/2 MCBs located at SB1 and SB2 cubicle respectively.

6.7.4. PTDC (Pneumatic Time Dependent Controller) Setup

PTDC mode allows the locomotive to move at a **restrictive speed of 10 km/h** in case of **CCB brake system failure**. It remains active **only below 10 km/h**.

Procedur to Activate PTDC:

1. **Open** Pneumatic Panel **MCB (127.2) in SB2** and keep **Vigilance Circuit Breaker ON**.
2. **Turn PB-BUS cock** on brake panel to the **vertical position**.
3. **Turn PER-COS cock** on brake panel to the **vertical position**.
4. **Unlock** the Auto/A9 handle in the **operative cab** and **lock** it in the other cab.
5. **Move and hold** the PTDC handle in **Release position** (active driver's cab) until:
   - **BP charges** to **5 kg/cm²**.
   - **BC reduces to zero** (if not, give brief pulls to the quick release lever at the bottom of the distributor valve).
6. **Apply and release** auto brakes using PTDC by holding the handle in **Apply/Release position** for a sufficient time while monitoring **BP pressure gauge**.

7. List of Diagnostic Messages

7.1. Introduction

All disturbances stored as "Diagnosis Data Sets" (DDS) in the non-volatile memory of the VCU. Each DDS is documented in a "Diagnosis Message Form," providing complete disturbance details below.

Disturbances are sorted by processor name and ascending disturbance number.

Equivalent processors generate identical DDS and are listed only once:

FLG1 = FLG2

SLG1 = SLG2

Key Definitions:

Subsystems:

SS01…SS19 → Subsystems on the vehicle.

Diagnosis Message Display Criteria:

DDS message consists of subsystem no., priority and additional information no. Subsystem = SS01..SS19, Priority = 1 or 2, and AI-Bit = 1..10, a diagnosis message appears on the driver's display.

Example:

Sub=SS05, Pri=1, AIB=2 → Displays diagnosis message F0502P1 if disturbance occurs.

7.2. Diagnosis message Forms

7.2.1. SS01

7.2.1.1. Main Power VCB STUCK IN ON POSITION

Processor : STB1	Dist. Number: 1
Last Edit:19/02/2024	
1. Disturbance Signal Name:	32--_32-MVCBStuckOn
2. Disturbance Text:	SS01: Main Power VCB STUCK IN ON POSITION
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 1
4. Fault Code :	F0101P1
5. Protection Activities :	VCB will not open, LSDJ will not glow
6. Isolation Activities :	SS01
7. Page of Schematic :	05C
8. Detected Symptom :	VCB de-energised (VCB off command high) still VCB closed (detected through its auxiliary contacts)
9. Cause(s) :	1. VCB defective. 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered from signal PA32-P3203-MVCBStucOn

7.2.1.2. Main Power VCB STUCK IN OFF POSTION

Processor : HBB1	Dist. Number: 2
Last Edit:19/02/2024	
1. Disturbance Signal Name:	32--_32-MVCBStuckOf
2. Disturbance Text:	SS01: Main Power VCB STUCK IN OFF POSTION
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 2
4. Fault Code :	F0102P1
5. Protection Activities :	VCB will not close, LSDJ will glow continuously
6. Isolation Activities :	SS01
7. Page of Schematic :	05C
8. Detected Symptom :	VCB energised (VCB ON command high) still VCB open (detected through its auxiliary contacts)
9. Cause(s) :	1. VCB defective. (component No. 5) 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA31-P3103-MVCBStucof
11. Remarks :	VCB is controlled by STB1 of VCU1 main processor if VCB stuck off/on occur then the same STB1 of the VCU1 main processor will try to close again. VCB control switching will happen only when VCU1 main processor is isolated or faulty/hang. VCB control will be taken care by VCU1 redundant processor.

7.2.1.3. Main Power LOW PRESSURE PANTO/FAULTY PANTO

Processor : HBB2	Dist. Number: 3
Last Edit:19/02/2024	
1. Disturbance Signal Name:	31--_3110-MPan1NoPres
2. Disturbance Text:	SS01: Main Power LOW PRESSURE PANTO/FAULTY PANTO
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 3
4. Fault Code :	F0103P1
5. Protection Activities :	Panto will not rise, VCB will not close
6. Isolation Activities :	SS01
7. Page of Schematic :	05C
8. Detected Symptom :	Pressure switch pan1 opens indicating air pressure less than 2.5 Kg/cm sq in pan1 circuit.
9. Cause(s) :	1. Auxiliary reservoir pressure less than 2.5 Kg/cm sq. 2. Leakage in pan 1 pneumatic circuit. 3. pressure switch defective (Pos. 130.4).
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA31-P3110-MPan1NoPres.
11. Remarks :	This disturbance message is generated only when pressure in pan circuit is less than 2.5 Kg/cm sq and there is command for raising pan.

7.2.1.4. Main Power LOW PRESSURE PANTO/FAULTY PANTO

Processor : STB2	Dist. Number: 4
Last Edit:19/02/2024	
1. Disturbance Signal Name:	31--_3110-MPan2NoPres
2. Disturbance Text:	SS01: Main Power LOW PRESSURE PANTO/FAULTY PANTO
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 3
4. Fault Code :	F0103P1
5. Protection Activities :	Panto will not rise, VCB will not close
6. Isolation Activities :	SS01
7. Page of Schematic :	05A
8. Detected Symptom :	Pressure switch pan 2 opens indicating air pressure less than 2.5 Kg/cm sq in pan2 circuit.
9. Cause(s) :	1. Auxiliary reservoir pressure less than 2.5 Kg/cm sq. 2. Leakage in pan 2 pneumatic circuit. 3. pressure switch defective (Pos. 130.4).
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA31-P3110-MPan2NoPres.
11. Remarks :	This disturbance message is generated only when pressure in pan circuit is less than 2.5 Kg/cm sq and there is command for raising pan.

7.2.1.5. Main Power-CATENARY VOLTAGE OUT OF LIMIT

Processor : FLG1	Dist. Number: 5
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0901-MUprim<Min/MUprim>Max
2. Disturbance Text:	SS01: Main Power-CATENARY VOLTAGE OUT OF LIMIT
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 4
4. Fault Code :	F0104P1
5. Protection Activities :	VCB will open
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Catenary voltages is less than 17.5 kV or more than 29.5 kV
9. Cause(s) :	1. Line power fails. 2. Primary voltage transformer defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09_P0901-MUprim>Max/09--_0901-MUprim<Min

7.2.1.6. TRANSFORMR OIL TEMP. OR PRESSURE NOT OK

Processor : FLG1	Dist. Number: 6
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-BPTrTE/BE=0
2. Disturbance Text:	SS01: Main Power-TRANSFORMR OIL TEMP. OR PRESSURE NOT OK
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 5
4. Fault Code :	F0105P1
5. Protection Activities :	VCB will open.
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Transformer oil pressure out of tolerance range.
9. Cause(s) :	1. Transformer oil flow too low 2. Both oil pumps defective 3. Pressure sensors defective
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0902-MTrafRedc0

7.2.1.7. FILTER ON/OFF CONTACTOR STUCK ON

Processor : SLG1	Dist. Number: 9
Last Edit: 19/02/2024	
1. Disturbance Signal Name:	85--_8504-MFiltDAVCof
2. Disturbance Text:	SS01: Main Power-FILTER ON/OFF CONTACTOR STUCK ON
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 6
4. Fault Code :	F0106P1
5. Protection Activities :	VCB will open or will not close again.
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Harmonic filter contactor 8.1 for filter ON/OFF does not open while the VCB is open.
9. Cause(s) :	1. Contactor filter ON/OFF (8.1) fault
10. Trigger Disturbance for Test:	Force parameter PA85_P8504-MFiltDA

7.2.1.8. PRECHARGE OR MAIN CONTACTOR STUCK ON

Processor : SLG1	Dist. Number: 11
Last Edit:19/02/2024	
1. Disturbance Signal Name:	87--_8702-MSRS1-3DA
2. Disturbance Text:	SS01: Main Power-PRECHARGE OR MAIN CONTACTOR STUCK ON
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 7
4. Fault Code :	F0107P1
5. Protection Activities :	VCB will open.
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Converter contactor unable to open
9. Cause(s) :	1. Converter contactor fault. 2. Remote indication invalid.
10. Trigger Disturbance for Test:	Force parameter PA87_P8702-MSRS1-3DA

7.2.1.9. PRIMARY OVERCURRENT

Processor : SLG1	Dist. Number: 12
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0901-MIPrimHigh
2. Disturbance Text:	SS01: Main Power-PRIMARY OVERCURRENT
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 8
4. Fault Code :	F0108P1
5. Protection Activities :	VCB will open.
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Primary maximum current relay (Pos. 78) tripped.
9. Cause(s) :	1. Earth fault on 25 KV equipment. 2. Short circuit transformer. 3. Disturbance converter. 4. Disturbance in the overcurrent detection circuit.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0901-MIPrimHigh
11. Remarks	To take into account transformer inrush current the relay setting is 990A within 1 sec after switch on of VCB and after that is reduced to 360A.

7.2.1.10. AUXILIARY WINDING OVERCURRENT

Processor : SLG1	Dist. Number: 13
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0916-MIBUR>Max
2. Disturbance Text:	SS01: Main Power-AUXILIARY WINDING OVERCURRENT
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 9
4. Fault Code :	F0109P1
5. Protection Activities :	VCB will open.
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Auxiliary converter current greater than a specified maximum (370 A).
9. Cause(s) :	1. Auxiliary converter fault. 2. Error in measuring auxiliary converter current.
10. Trigger Disturbance for Test:	Force parameter PA09_P0916-MIBUR>Max
11. Remarks	---

7.2.1.11. TOO MANY SUB-SYSTEMS ARE ISOLATED (OR) TRACTION CONVERTER EARTHING SWITCH IN EARTH POSSITION

Processor : FLG1	Dist. Number: 14
Last Edit:19/02/2024	
1. Disturbance Signal Name:	More than one redundant subsystem isolated.
2. Disturbance Text:	SS01: Main Power-TOO MANY SUB-SYSTEMS ARE ISOLATED (OR) TRACTION CONVERTER EARTHING SWITCH IN EARTH POSSITION
3. Relations Subsystem: Priority : AI-Bit :	 SS01 1 10
4. Fault Code :	F0110P1
5. Protection Activities :	VCB will open.
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Isolation demand set from multiple redundant subsystems
9. Cause(s) :	1. Disturbance in multiple subsystems.
10. Trigger Disturbance for Test:	Can be forced by shutting down 2 or more essential subsystems
11. Remarks	**Can also be generated by rotating the earthing switch of either traction converter to earth position.**

7.2.1.12. OVERTEMPERATURE CONTROL ELECTRONIC

Processor : STB1	Dist. Number: 15
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0901-MReTempCEL
2. Disturbance Text:	SS01: Main Power-OVERTEMPERATURE CONTROL ELECTRONIC
3. Relations Subsystem: Priority : AI-Bit :	 SS01 2 1
4. Fault Code :	F0101P2
5. Protection Activities :	No action only popup on DDU.
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Relay temperature control electronics (Pos. 211) picks up.
9. Cause(s) :	1. High temperature inside control electronics cubicle. 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0901-MReTempCEL.
11. Remarks	In case of this fault cooling mode should be selected and when temperature comes down, indicated through lamp in the cab, driving mode should be selected.

7.2.1.13. TRANSFORMER OIL PRESSURE NOT OK

Processor : FLG1	Dist. Number: 16
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-BPTrTE/BE70
2. Disturbance Text:	SS01: Main Power-TRANSFORMER OIL PRESSURE NOT OK
3. Relations Subsystem: Priority : AI-Bit :	 SS01 2 2
4. Fault Code :	F0102P2
5. Protection Activities :	No action only popup on DDU.
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Transformer oil pressure out of range in any one cooling circuit.
9. Cause(s) :	1. Transformer oil flow in one cooling circuit low. 2. Any oil pump defective. 3. Pressure sensors defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0902-MTrafoRedc.
11. Remarks	

7.2.1.14. EARTH FAULT AUX. WINDING CIRCUIT

Processor : STB2	Dist. Number: 17
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MEFRBUR
2. Disturbance Text:	SS01: Main Power-EARTH FAULT AUX. WINDING CIRCUIT
3. Relations Subsystem: Priority : AI-Bit :	 SS01 2 3
4. Fault Code :	F0103P2
5. Protection Activities :	No action only popup on DDU.
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Earth fault relay(89.2) picks up.
9. Cause(s) :	1. Earth fault auxiliary circuit. 2. Earth fault relay defective (Pos. 89.2).
10. Trigger Disturbance for Test:	Disturbance can be triggered from signal PA09-P0902-MEFRBUR
11. Remarks	Normal operation can continue in case of single earth fault. In case of double earth fault over current sensors in the circuit will detect the fault.

7.2.1.15. CATENARY FREQUENCY OUT OF LIMIT

Processor : SLG1	Dist. Number: 18
Last Edit:19/02/2024	
1. Disturbance Signal Name:	#NSC1_NSC1-MStoefN<min
2. Disturbance Text:	SS01: Main Power-CATENARY FREQUENCY OUT OF LIMIT
3. Relations Subsystem: Priority : AI-Bit :	 SS01 2 4
4. Fault Code :	F0104P2
5. Protection Activities :	No action only popup on DDU.
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Catenary frequency not in range.
9. Cause(s) :	1. Due to fluctuation in OHE
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.1.16. CATENARY FREQUENCY HIGH

Processor : SLG1	Dist. Number: 19
Last Edit:19/02/2024	
1. Disturbance Signal Name:	#NSC1_NSC1-MStoefN>max
2. Disturbance Text:	SS01: Main Power-CATENARY FREQUENCY HIGH
3. Relations Subsystem: Priority : AI-Bit :	 SS01 2 5
4. Fault Code :	F0105P2
5. Protection Activities :	No action only popup on DDU.
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Catenary frequency not in range.
9. Cause(s) :	1. Due to fluctuation in OHE frequency
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.1.17. BB1_1210.AFL_Activated_FB

Processor : FLG1	Dist. Number: 20
Last Edit:19/02/2024	
1. Disturbance Signal Name:	HBB1_1210.AFL_Activated_FB
2. Disturbance Text:	SS01: Main Power-AFL activated
3. Relations Subsystem: Priority : AI-Bit :	 SS01 2 6
4. Fault Code :	F0106P2
5. Protection Activities :	No action only popup on DDU.
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Whenever automatic flasher light is activated through emergency or manual switch (BPFL).
9. Cause(s) :	1. Emergency brake application. 2. Manual switch BPFL 3. Train parting
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.2. SS02/SS03

Since **SS02** and **SS03** are functionally equivalent, they produce identical **DDS** and DDU messages, differing only in the fault code. Specifically, if **SS02** generates fault code **F0201P1**, **SS03** will generate **F0301P1**. Therefore, only **SS02** is listed below, with **SS03** requiring only a subsystem number substitution.

7.2.2.1. DISTURBANCE IN CONVERTER 1

Processor : SLG1	Dist. Number: 21
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS02: Traction Bogie 1-DISTURBANCE IN CONVERTER 1
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 1
4. Fault Code :	F0201P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	
9. Cause(s) :	
10. Trigger Disturbance for Test:	
11. Remarks	

7.2.2.2. BOGIE 1 ISOLATED

Processor : SLG1	Dist. Number: 22
Last Edit:19/02/2024	
1. Disturbance Signal Name:	SLG1_06-BSS02IsoDem
2. Disturbance Text:	SS02: Traction Bogie 1-BOGIE 1 ISOLATED
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 1
4. Fault Code :	F0201P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	Isolation demand is generated from SLG1
9. Cause(s) :	1. Life sign missing from SLG1 to VCU 2. Life sign missing from VCU to SLG1 3. 2 Line converters are isolated 4. 3 motor inverters are isolated 5. Can be isolated by rotating bogie cut out switch (154) 6. HRT-600, HRT-604 cards are faulty
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.2.3. CONVERTER CONTACTOR STUCK OFF

Processor : SLG1	Dist. Number: 23
Last Edit:19/02/2024	
1. Disturbance Signal Name:	87--_8701-MLdSDE
2. Disturbance Text:	SS02: Traction Bogie 1-CONVERTER CONTACTOR STUCK OFF
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 2
4. Fault Code :	F0202P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	Pre-charging contactor unable to close
9. Cause(s) :	1. Pre-charging contactor faulty. 2. Feedback faulty.
10. Trigger Disturbance for Test:	Force parameter PA87_P8701-MLdSDE
11. Remarks	

7.2.2.4. CONVERTER 1 OIL TEMPERATURE TOO HIGH

Processor : SLG1	Dist. Number: 25
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0912-MTmpSR>GW2
2. Disturbance Text:	SS02: Traction Bogie 1-CONVERTER 1 OIL TEMPERATURE TOO HIGH
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 5
4. Fault Code :	F0205P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	Converter coolant temperature exceeds a specified maximum (80 degC)
9. Cause(s) :	1. Converter fault. 2. Insufficient cooling. 3. Insufficient coolant flow. 4. Temperature measurement error. 5. Converter coolant leakage
10. Trigger Disturbance for Test:	Force parameter PA09_0912-MTmpSR>GW2
11. Remarks	

7.2.2.5. CONVERTER 1 OIL PRESSURE NOT OK

Processor : SLG1	Dist. Number: 26
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0912-MDruSR<GW1
2. Disturbance Text:	SS02: Traction Bogie 1-CONVERTER 1 OIL PRESSURE NOT OK
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 6
4. Fault Code :	F0206P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	Converter coolant pressure less than a specified minimum limit (0.6bar).
9. Cause(s) :	1. Insufficient coolant flow. 2. Problem in coolant pump. 3. BUR disturbance. 4. Converter coolant leakage. 5. Coolant flow measurement disturbance.
10. Trigger Disturbance for Test:	Force parameter PA09_P0912-MDruSR<GW1
11. Remarks	

7.2.2.6. TRACTION MOTOR TEMPERATURE TOO HIGH

Processor : SLG1	Dist. Number: 27
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0915-MTmpMot>Max
2. Disturbance Text:	SS02: Traction Bogie 1-TRACTION MOTOR TEMPERATURE TOO HIGH
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 7
4. Fault Code :	F0207P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	Motor temperature exceeds a specified maximum (230 degC)
9. Cause(s) :	1. Motor fault. 2. Ventilation level is not proper. 3. BUR out of order (isolation of BUR). 4. Very large rise in temperature in a short time. 5. Temperature sensor defective.
10. Trigger Disturbance for Test:	Force parameter PA09_P0915-MTmpMot>Max
11. Remarks	

7.2.2.7. TRACTION MOTOR FAULT IN SPEED SENSOR

Processor : SLG1	Dist. Number: 28
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS02: Traction Bogie 1-TRACTION MOTOR FAULT IN SPEED SENSOR
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 8
4. Fault Code :	F0208P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	
9. Cause(s) :	1. Motor fault. 2. Fauty speed sensor. .....
10. Trigger Disturbance for Test:	
11. Remarks	

7.2.2.8. EARTH FAULT IN TRACTION CONVERTER 1

Processor : SLG1	Dist. Number: 29
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS02: Traction Bogie 1-EARTH FAULT IN TRACTION CONVERTER 1
3. Relations Subsystem: Priority : AI-Bit :	 SS02 1 9
4. Fault Code :	F0209P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS02
7. Page of Schematic :	---
8. Detected Symptom :	
9. Cause(s) :	
10. Trigger Disturbance for Test:	
11. Remarks	

7.2.2.9. EARTH FAULT IN CONVERTER 1

Processor : SLG1	Dist. Number: 30
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0917-MErdschlZK+/09--_0917-MErdschlZK-
2. Disturbance Text:	SS02: Traction Bogie 1-EARTH FAULT IN CONVERTER 1
3. Relations Subsystem: Priority : AI-Bit :	 SS02 2 1
4. Fault Code :	F0201P2
5. Protection Activities :	DDU popup
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Earth fault negative/positive detected in the DC link main converter 1.
9. Cause(s) :	1. Earth fault in the DC link. 2. Earth fault relay (Pos:89.4) defective.
10. Trigger Disturbance for Test:	Force parameter PA09_P0917-MErdschlZK-/ PA09_P0917-MErdschlZK+
11. Remarks	

7.2.2.10. MUB RESISTANCE TOO HOT IN CONVERTER 1

Processor : SLG1	Dist. Number: 31
Last Edit:19/02/2024	
1. Disturbance Signal Name:	87--_8710-MMUBzuheiss
2. Disturbance Text:	SS02: Traction Bogie 1-MUB RESISTANCE TOO HOT IN CONVERTER 1
3. Relations Subsystem: Priority : AI-Bit :	 SS02 2 3
4. Fault Code :	F0203P2
5. Protection Activities :	DDU popup
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	MUB temperature is high
9. Cause(s) :	1. MUB fired before its temperature came below a limit. 2. Temperature detection error. 3. Temperature is out of limit.
10. Trigger Disturbance for Test:	Force parameter PA87_P8710-MMUBzuheis
11. Remarks	

7.2.2.11. FAULTY MOTOR TEMPERATURE SENSORS

Processor : SLG1	Dist. Number: 32
Last Edit:19/02/2024	
1. Disturbance Signal Name:	88--_8810-MTM2Stoe
2. Disturbance Text:	SS02: Traction Bogie 1-FAULTY MOTOR TEMPERATURE SENSORS
3. Relations Subsystem: Priority : AI-Bit :	 SS02 2 4
4. Fault Code :	F0204P2
5. Protection Activities :	DDU popup
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in temperature detection motor.
9. Cause(s) :	1. Temperature sensor 1 or 2 of any motor is interrupted. 2. Temperature sensor 1 or 2 of any motor is short circuited. 3. Temperature difference between sensor 1 and 2 of any motor is too large
10. Trigger Disturbance for Test:	Force parameter PA88_P8810-MTM2Stoe.
11. Remarks	

7.2.2.12. EQUIPMENT TEMPERATURE HIGH

Processor : SLG1	Dist. Number: 33
Last Edit:19/02/2024	
1. Disturbance Signal Name:	91--_9117-M-ZBK-Reduk
2. Disturbance Text:	SS02: Traction Bogie 1-EQUIPMENT TEMPERATURE HIGH
3. Relations Subsystem: Priority : AI-Bit :	 SS02 2 5
4. Fault Code :	F0205P2
5. Protection Activities :	DDU popup
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	TE / BE reduction due to high motor temperature.
9. Cause(s) :	1. Motor temperature exceeds a specified limit (190 degC)
10. Trigger Disturbance for Test:	Force parameter PA91_P9117-ZBKRed-A.
11. Remarks	

7.2.2.13. DC LINK CAPACITORS PRESSURE NOT OK

Processor : SLG1	Dist. Number: 34
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0925-MDruCZK
2. Disturbance Text:	SS02: Traction Bogie 1-DC LINK CAPACITORS PRESSURE NOT OK
3. Relations Subsystem: Priority : AI-Bit :	 SS02 2 6
4. Fault Code :	F0206P2
5. Protection Activities :	DDU popup
6. Isolation Activities :	No isolation
7. Page of Schematic :	---
8. Detected Symptom :	Pressure switch DC link capacitor open.
9. Cause(s) :	1. DC link capacitor defective
10. Trigger Disturbance for Test:	Force parameter PA09_P0925-MDruCZK.
11. Remarks	

7.2.2.14. WHEEL SKIDDING IN BOGIE 1

Processor : SLG1	Dist. Number: 35
Last Edit:19/02/2024	
1. Disturbance Signal Name:	90--_9012-MDG1-WSkdng
2. Disturbance Text:	SS02: Traction Bogie 1-WHEEL SKIDDING IN BOGIE 1
3. Relations Subsystem: Priority : AI-Bit :	 SS02 2 7
4. Fault Code :	F0207P2
5. Protection Activities :	DDU popup
6. Isolation Activities :	No isolation, press BPFA
7. Page of Schematic :	---
8. Detected Symptom :	LSP will glow during slip detection.
9. Cause(s) :	1. Low adhesion between wheel and track 2. Lock rotor condition.
10. Trigger Disturbance for Test:	
11. Remarks	

7.2.2.15. TRACTION MOTOR OVERSPEED

Processor : SLG1	Dist. Number: 35
Last Edit:19/02/2024	
1. Disturbance Signal Name:	90--_9012-MDG1-WSkdng
2. Disturbance Text:	SS02: Traction Bogie 1-TRACTION MOTOR OVERSPEED
3. Relations Subsystem: Priority : AI-Bit :	 SS02 2 8
4. Fault Code :	F0208P2
5. Protection Activities :	DDU popup
6. Isolation Activities :	No isolation, press BPFA
7. Page of Schematic :	---
8. Detected Symptom :	---
9. Cause(s) :	---
10. Trigger Disturbance for Test:	
11. Remarks	

7.2.3. SS04 (Harmonic Filter)

7.2.3.1. HARMONIC FILTER CURRENT TOO HIGH

Processor : SLG1	Dist. Number: 36
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0916-MIFilt>Max
2. Disturbance Text:	SS04: Harmonic Filter-HARMONIC FILTER CURRENT TOO HIGH
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 1
4. Fault Code :	F0401P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS04
7. Page of Schematic :	---
8. Detected Symptom :	Harmonic filter overcurrent (greater than 380 A during normal operation or greater than 600 A during switch on)
9. Cause(s) :	1. Harmonic filter fault. 2. Disturbance measuring harmonic filter current
10. Trigger Disturbance for Test:	Force parameter PA09_P0916-MIFilt>Max
11. Remarks	

7.2.3.2. HARMONIC FILTER CONTACTOR (S) STUCK OFF/ON

Processor : SLG1	Dist. Number: 37
Last Edit:19/02/2024	
1. Disturbance Signal Name:	85--_8503-MFiltWDE2Bg
2. Disturbance Text:	SS04: Harmonic Filter-HARMONIC FILTER CONTACTOR (S) STUCK OFF/ON
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 2
4. Fault Code :	F0401P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS04
7. Page of Schematic :	---
8. Detected Symptom :	Harmonic filter contactor 8.2/8.1/8.41 for filter adaption does not close for 2 bogie operation
9. Cause(s) :	1. Contactor filter adaption (8.1,8.2,8.41) fault
10. Trigger Disturbance for Test:	Force parameter PA85_P8503-MFiltAdpDE
11. Remarks	

7.2.3.3. FILTER DISCHARGE RESISTOR TOO HOT

Processor : SLG1	Dist. Number: 38
Last Edit:19/02/2024	
1. Disturbance Signal Name:	85--_8506-BFiltIntloc
2. Disturbance Text:	SS04: Harmonic Filter-FILTER DISCHARGE RESISTOR TOO HOT
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 4
4. Fault Code :	F0404P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS04
7. Page of Schematic :	---
8. Detected Symptom :	Temperature harmonic filter discharging resistor exceeds maximum allowable limit
9. Cause(s) :	1. Filter discharging took place within 10 sec. of the previous discharging. 2. Filter discharging took place more than 15 times within 147.5 sec.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.3.4. FILTER CONTACTOR 8.1 STUCK ON

Processor : SLG1	Dist. Number: 39
Last Edit:19/02/2024	
1. Disturbance Signal Name:	85--_8504-MFiltDAVCon
2. Disturbance Text:	SS04: Harmonic Filter-FILTER CONTACTOR 8.1 STUCK ON
3. Relations Subsystem: Priority : AI-Bit :	 SS04 2 1
4. Fault Code :	F0401P2
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Harmonic filter contactor (8.1) for filter ON/OFF does not open while the VCB is closed.
9. Cause(s) :	1. Contactor filter ON/OFF (8.1) fault
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.3.5. EARTH FAULT HARMONIC FILTER CIRCUIT

Processor : HBB1	Dist. Number: 40
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MEFRFilter
2. Disturbance Text:	SS04: Harmonic Filter-EARTH FAULT HARMONIC FILTER CIRCUIT
3. Relations Subsystem: Priority : AI-Bit :	 SS04 2 2
4. Fault Code :	F0402P2
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Earth fault relay filter(89.6) circuit picks up.
9. Cause(s) :	1. Earth fault in filter circuit. 2. Earth fault relay defective (Pos. 89.6).
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0902-MEFRFilter
11. Remarks	Normal operation can continue in case of single earth fault. In case of double earth fault current sensors in filter circuit will sense overcurrent.

7.2.4. SS06 (Auxiliary Converter 1)

7.2.4.1. DISTURBANCE IN PROCESSOR BUR 1

Processor : BUR1	Dist. Number: 41
Last Edit:19/02/2024	
1. Disturbance Signal Name:	05--_0503-MMVBDisturb
2. Disturbance Text:	SS06: Converter 1- DISTURBANCE IN PROCESSOR BUR 1
3. Relations Subsystem: Priority : AI-Bit :	 SS06 1 1
4. Fault Code :	F0601P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS06
7. Page of Schematic :	---
8. Detected Symptom :	The life-sign from FLG-master is missing.
9. Cause(s) :	1. The signal path FLG -> BUR1 via EMD cable is faulty. 2. The FLG-master processor is faulty. 3. Both bus administrators are faulty. 4. The HRT1303 card in the BUR1 is faulty.
10. Trigger Disturbance for Test:	Force parameter PA05_P0503-MMVBDistur.
11. Remarks	

7.2.4.2. FAULT IN AUX. CONVERTER 1

Processor : BUR1	Dist. Number: 42
Last Edit:19/02/2024	
1. Disturbance Signal Name:	Latch faults of AUX 1
2. Disturbance Text:	SS06: Converter 1- FAULT IN AUX. CONVERTER 1
3. Relations Subsystem: Priority : AI-Bit :	 SS06 1 2
4. Fault Code :	F0602P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS06
7. Page of Schematic :	---
8. Detected Symptom :	No output from the BUR1 will generate.
9. Cause(s) :	1. IGBT failure in inverter. 2. Short-circuit in inverter. 3. Wiring problems. 4. Line voltage failure. 5. Overload in BUR. 6. Over temperature in IGBT heat sink.
10. Trigger Disturbance for Test:	---
11. Remarks	Multiple signals can generate the fault.

7.2.4.3. CONTACTOR FAULT IN AUX.CONV1/HB1

Processor : BUR1	Dist. Number: 43
Last Edit:19/02/2024	
1. Disturbance Signal Name:	73--_7304-M52-4StukOf
2. Disturbance Text:	SS06: Converter 1- CONTACTOR FAULT IN AUX.CONV1/HB1
3. Relations Subsystem: Priority : AI-Bit :	 SS06 1 3
4. Fault Code :	F0603P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS06
7. Page of Schematic :	---
8. Detected Symptom :	Auxiliary converter contactor 52/4 is open but should be closed.
9. Cause(s) :	1. Faulty contacts in contactor 52/4. 2. Wiring problems affecting contactor 52/4. 3. Faulty BUR processor in BUR1 rack.
10. Trigger Disturbance for Test:	Force parameter PA06_P0603-M52-4StkOf.
11. Remarks	

7.2.5. SS07 (Auxiliary Converter 2)

7.2.5.1. DISTURBANCE IN PROCESSOR BUR 2

Processor : BUR2	Dist. Number: 44
Last Edit:19/02/2024	
1. Disturbance Signal Name:	10--_1013-MMVBDisBUR2
2. Disturbance Text:	SS07: Converter 2- DISTURBANCE IN PROCESSOR BUR 2
3. Relations Subsystem: Priority : AI-Bit :	 SS07 1 1
4. Fault Code :	F0701P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS07
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 does not receive the life-sign from BUR2 or vice versa.
9. Cause(s) :	1. The signal path BUR2 -> FLG1 through the EMD cable is faulty. 3. The HRT1303 card in BUR2 may be faulty. 4. The vehicle bus administrator may be disturbed.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA10-P1013-MMVBDiBUR2
11. Remarks	Traction will be possible after isolation of AUX2.

7.2.5.2. FAULT IN AUX. CONVERTER 2

Processor : BUR2	Dist. Number: 45
Last Edit:19/02/2024	
1. Disturbance Signal Name:	Latch faults from Aux 2
2. Disturbance Text:	SS07: Converter 2- FAULT IN AUX. CONVERTER 2
3. Relations Subsystem: Priority : AI-Bit :	 SS07 1 2
4. Fault Code :	F0702P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS07
7. Page of Schematic :	---
8. Detected Symptom :	No output from the BUR1 will generate.
9. Cause(s) :	1. IGBT failure in inverter. 2. Short-circuit in inverter. 3. Wiring problems. 4. Line voltage failure. 5. Overload in BUR. 6. Over temperature in IGBT heat sink.
10. Trigger Disturbance for Test:	---
11. Remarks	Multiple signals can generate the faut.

7.2.5.3. CONTACTOR FAULT IN AUX.CONV2/HB2

Processor : BUR2	Dist. Number: 46
Last Edit:19/02/2024	
1. Disturbance Signal Name:	73--_7304-M52-1StukOf/73--_7304-M52-2StukOf/73--_7304-M52-4StukOf
2. Disturbance Text:	SS07: Converter 2- CONTACTOR FAULT IN AUX.CONV2/HB2
3. Relations Subsystem: Priority : AI-Bit :	 SS06 1 3
4. Fault Code :	F0703P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS07
7. Page of Schematic :	---
8. Detected Symptom :	Auxiliary converter contactor 52/1,52/2,52/4 is open but should be closed.
9. Cause(s) :	1. Faulty contacts in contactor 52/1,52/2,52/4. 2. Wiring problems affecting contactor 52/1,52/2,52/4. 3. Faulty BUR processor in BUR2.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.6. SS08 (Auxiliary Converter 3)

7.2.6.1. DISTURBANCE IN PROCESSOR BUR 3

Processor : BUR3	Dist. Number: 48
Last Edit:19/02/2024	
1. Disturbance Signal Name:	10--_1013-MMVBDisBUR3
2. Disturbance Text:	SS08: Converter 3- DISTURBANCE IN PROCESSOR BUR 3
3. Relations Subsystem: Priority : AI-Bit :	 SS08 1 1
4. Fault Code :	F0801P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS08
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 does not receive the life-sign from BUR3 or vice versa.
9. Cause(s) :	1. The signal path BUR3 -> FLG1 through the EMD cable is faulty. 3. The HRT1303 card in BUR3 may be faulty. 4. The vehicle bus administrator may be disturbed.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA10-P1013-MMVBDiBUR3
11. Remarks	Traction will be possible after isolation of AUX3.

7.2.6.2. FAULT IN AUX. CONVERTER 3

Processor : BUR3	Dist. Number: 49
Last Edit:19/02/2024	
1. Disturbance Signal Name:	Latch faults from AUX 3
2. Disturbance Text:	SS08: Converter 3- FAULT IN AUX. CONVERTER 3
3. Relations Subsystem: Priority : AI-Bit :	 SS08 1 2
4. Fault Code :	F0802P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS08
7. Page of Schematic :	---
8. Detected Symptom :	No output from the BUR1 will generate.
9. Cause(s) :	1. IGBT failure in inverter. 2. Short-circuit in inverter. 3. Wiring problems. 4. Line voltage failure. 5. Overload in BUR. 6. Over temperature in IGBT heat sink.
10. Trigger Disturbance for Test:	---
11. Remarks	Multiple signals can generate the faut.

7.2.6.3. CONTACTOR FAULT IN AUX.CONV3/HB2

Processor : BUR3	Dist. Number: 50
Last Edit:19/02/2024	
1. Disturbance Signal Name:	73--_7304-M52-3StukOf
2. Disturbance Text:	SS08: Converter 3- CONTACTOR FAULT IN AUX.CONV3/HB2
3. Relations Subsystem: Priority : AI-Bit :	 SS08 1 3
4. Fault Code :	F0803P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS08
7. Page of Schematic :	---
8. Detected Symptom :	Auxiliary converter contactor 52/3 is open but should be closed.
9. Cause(s) :	1. Faulty contacts in contactor 52/3. 2. Wiring problems affecting contactor 52/3. 3. Faulty BUR processor in BUR3.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.7. SS09 (Battery Charger)

7.2.7.1. BATTERY VOLTAGE TOO LOW

Processor : AUX2/AUX3	Dist. Number: 51
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS09: Battery System- BATTERY VOLTAGE TOO LOW
3. Relations Subsystem: Priority : AI-Bit :	 SS09 1 1
4. Fault Code :	F0901P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS01
7. Page of Schematic :	---
8. Detected Symptom :	Battery bank voltage is below 82V.
9. Cause(s) :	1. MCB 112 tripped. 2. Battery voltage sensing in AUX2 faulty. 3. If AUX2 is isolated then the battery voltage sensing in AUX3 is faulty. 4. Battery charger is faulty.
10. Trigger Disturbance for Test:	
11. Remarks	Measure the actual voltage of the battery bank and check the scaling factor in AUX2 and AUX3.

7.2.7.2. BATTRY VOLTAGE

Processor : AUX2/AUX3	Dist. Number: 52
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS09: Battery System- BATTRY VOLTAGE
3. Relations Subsystem: Priority : AI-Bit :	 SS09 1 2
4. Fault Code :	F0902P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Battery voltage is less than 82V
9. Cause(s) :	1. MCB 112 tripped. 2. Battery voltage sensing in AUX2 faulty. 3. If AUX2 is isolated then the battery voltage sensing in AUX3 is faulty. 4. MCB100 is tripped.
10. Trigger Disturbance for Test:	---
11. Remarks	Measure the actual voltage of the battery bank and check the scaling factor in AUX2 and AUX3.

7.2.7.3. PAN LOWERED LONGER THAN 10 MINUTES

Processor : AUX2/AUX3	Dist. Number: 53
Last Edit:19/02/2024	
1. Disturbance Signal Name:	07--_07850-BPanShDown
2. Disturbance Text:	SS09: Battery System- PAN LOWERED LONGER THAN 10 MINUTES
3. Relations Subsystem: Priority : AI-Bit :	 SS09 1 3
4. Fault Code :	F0903P1
5. Protection Activities :	Shelf hold will be activated.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Cab active but pan not raised for 10 min.
9. Cause(s) :	1. MCB 112 tripped. 2. Battery voltage sensing in AUX2 faulty. 3. If AUX2 is isolated then the battery voltage sensing in AUX3 is faulty. 4. MCB100 is tripped.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.7.4. WARNING: LOW BATTEY VOLTAGE

Processor : AUX2/AUX3	Dist. Number: 54
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS09: Battery System- WARNING: LOW BATTEY VOLTAGE
3. Relations Subsystem: Priority : AI-Bit :	 SS09 2 1
4. Fault Code :	F0901P2
5. Protection Activities :	Only warning popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Battery voltage is below 96V.
9. Cause(s) :	1. Battery voltage sensing in AUX2 faulty. 3. If AUX2 is isolated then the battery voltage sensing in AUX3 is faulty. 4. MCB100 is tripped.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.7.5. BATTERY CHARGER MCB OFF

Processor : AUX2/AUX3	Dist. Number: 55
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS09: Battery System- BATTERY CHARGER MCB OFF
3. Relations Subsystem: Priority : AI-Bit :	 SS09 2 2
4. Fault Code :	F0902P2
5. Protection Activities :	Only warning popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Battery charger MCB 100 tripped.
9. Cause(s) :	1. MCB100 is tripped. 2. Feedback of the MCB100 faulty.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.7.6. LOW BATTERY CHARGER CURRENT

Processor : AUX2/AUX3	Dist. Number: 56
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS09: Battery System- LOW BATTERY CHARGER CURRENT
3. Relations Subsystem: Priority : AI-Bit :	 SS09 2 3
4. Fault Code :	F0903P2
5. Protection Activities :	Only warning popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Battery charger current is below 10A.
9. Cause(s) :	1. MCB 110 or 112 is tripped. 2. Feedback of current sensing faulty. 3. Battery charger output connection is wrong.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.7.7. EARTH FAULT BATTERY CIRCUIT

Processor : AUX2/AUX3	Dist. Number: 58
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MEFRContrl
2. Disturbance Text:	SS09: Battery System- EARTH FAULT BATTERY CIRCUIT
3. Relations Subsystem: Priority : AI-Bit :	 SS09 2 5
4. Fault Code :	F0905P2
5. Protection Activities :	Only warning popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Earth fault relay control circuit (89.7) picks up.
9. Cause(s) :	1. Earth fault in control circuit. 2. Earth fault relay defective (Pos. 89.7).
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0902-MEFRContrl
11. Remarks	Normal operation can continue in case of single earth fault. In case of double earth fault MCB in the control circuit will trip.

7.2.8. SS010 (Brake System)

7.2.8.1. FAULT IN BRAKE ELECTRONICS

Processor : FLG1	Dist. Number: 59
Last Edit:19/02/2024	
1. Disturbance Signal Name:	43--_4301-MBkElecFail
2. Disturbance Text:	SS010: Brake System- FAULT IN BRAKE ELECTRONICS
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 1
4. Fault Code :	F1001P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	SS10
7. Page of Schematic :	---
8. Detected Symptom :	Signal from the brake electronics (Pos. 260) to the control electronics.
9. Cause(s) :	1. Brake electronics defective. 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA43-P4301-MBkElecFail
11. Remarks	

7.2.8.2. LOW PRESSURE MAIN RESERVOIR

Processor : FLG1	Dist. Number: 60
Last Edit:19/02/2024	
1. Disturbance Signal Name:	51--_5101-MS/RLowMR
2. Disturbance Text:	SS010: Brake System- LOW PRESSURE MAIN RESERVOIR
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 2
4. Fault Code :	F1002P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	This disturbance is generated when pressure in the main reservoir falls below 5.6 Kg/cm sq.
9. Cause(s) :	1. Leakage in air pipes. 2. Pressure switch low main reservoir (Pos. 269.4) defective. 3. Main compressors not working.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA51_P5101-MS/RLowMR
11. Remarks	

7.2.8.3. VIGILANCE EMERGENCY BRAKE APPLICATION

Processor : FLG1	Dist. Number: 61
Last Edit:19/02/2024	
1. Disturbance Signal Name:	43--_4301-MEmgBkVig
2. Disturbance Text:	SS010: Brake System- VIGILANCE EMERGENCY BRAKE APPLICATION
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 3
4. Fault Code :	F1003P1
5. Protection Activities :	Traction interlock and buzzer indication.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Signal Emergency brake application by vigilance control (Pos.237).
9. Cause(s) :	1. Emergency brake application by vigilance control
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA43-P4301-MEmgBkVig.
11. Remarks	

7.2.8.4. WRONG CONFIGURATION BRAKE SYSTEM

Processor : FLG1	Dist. Number: 62
Last Edit:19/02/2024	
1. Disturbance Signal Name:	51--_5101-MS/RBkCock
2. Disturbance Text:	SS010: Brake System- WRONG CONFIGURATION BRAKE SYSTEM
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 4
4. Fault Code :	F1004P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	This disturbance is generated if loco brake cock is isolated on the loco which is not slave.
9. Cause(s) :	1. Brake pipe control system isolated with cock position 293.2 on single or master loco.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA51_P5101-MS/RBkCock
11. Remarks	

7.2.8.5. TRACTION WITH AUTO BRAKES NOT ALLOWED

Processor : FLG1	Dist. Number: 63
Last Edit:19/02/2024	
1. Disturbance Signal Name:	51--_5101-MS/RAutBk
2. Disturbance Text:	SS010: Brake System- TRACTION WITH AUTO BRAKES NOT ALLOWED
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 5
4. Fault Code :	F1005P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	This disturbance is generated if auto brakes are applied at speed more than 10 KPH and throttle is not at zero.
9. Cause(s) :	1. Auto brakes not released. 2. Pressure switch defective. 3. AIO card (slot F) of FLG2 fails.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA51_P5101-MS/RAutBk.
11. Remarks	

7.2.8.6. TRACTION WITH PARKING BRAKES NOT ALLOWED

Processor : FLG1	Dist. Number: 64
Last Edit:19/02/2024	
1. Disturbance Signal Name:	51--_5101-MS/RParkBk
2. Disturbance Text:	SS010: Brake System- TRACTION WITH PARKING BRAKES NOT ALLOWED
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 6
4. Fault Code :	F1006P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	This disturbance is generated when throttle is not at zero and parking brakes are applied.
9. Cause(s) :	---
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA51_P5101-MS/RparkBk.
11. Remarks	

7.2.8.7. REGENERATIVE BRAKE FAILURE

Processor : FLG1	Dist. Number: 64
Last Edit:19/02/2024	
1. Disturbance Signal Name:	45--_4504-MRegBkFail
2. Disturbance Text:	SS010: Brake System- REGENERATIVE BRAKE FAILURE
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 7
4. Fault Code :	F1007P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Braking demand from throttle (POS. 150) > 10kN and no regenerative brake available.
9. Cause(s) :	During regenerative braking either: 1. Traction interlock bogie 1 & 2. 2. Disturbance with VCB off.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA45-P4504-MRegBkFail.
11. Remarks	

7.2.8.8. EMERGENCY STOP: SHUTDOWN ON THE LOCO

Processor : FLG1	Dist. Number: 65
Last Edit:19/02/2024	
1. Disturbance Signal Name:	43--_43-MEmgStopShDn
2. Disturbance Text:	SS010: Brake System- EMERGENCY STOP: SHUTDOWN ON THE LOCO
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 8
4. Fault Code :	F1008P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Signal from emergency stop P/B.
9. Cause(s) :	1. Emergency stop P/B pressed. 2. Broken or stuck contact in emergency stop P/B.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA43-P43-MEmgStopShDn.
11. Remarks	

7.2.8.9. TRACTION NOT ALLOWED WITH APPLIED BRAKES

Processor : FLG1	Dist. Number: 66
Last Edit:19/02/2024	
1. Disturbance Signal Name:	51--_5101-MS/RLocoBk
2. Disturbance Text:	SS010: Brake System- TRACTION NOT ALLOWED WITH APPLIED BRAKES
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 9
4. Fault Code :	F1009P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Loco brakes applied at speed more than 10 KPH.
9. Cause(s) :	1. Loco brakes applied at a speed more than 10 KPH. 2. Pressure switch brake cylinder 1/2 defective (Pos 269.6 defective).
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA51_P5101-MS/RLocoBk.
11. Remarks	

7.2.8.10. EMERGENCY EXHAUST COCK CLOSED, NO TRACTION

Processor : FLG1	Dist. Number: 67
Last Edit:19/02/2024	
1. Disturbance Signal Name:	51--_5101-MS/REmgOut
2. Disturbance Text:	SS010: Brake System- EMERGENCY EXHAUST COCK CLOSED, NO TRACTION
3. Relations Subsystem: Priority : AI-Bit :	 SS010 1 10
4. Fault Code :	F1010P1
5. Protection Activities :	Traction interlock.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	This disturbance is generated when emergency brakes are isolated on the loco through emergency exhaust cock (Pos. 237.3). (SIFA COCK pos. 74)
9. Cause(s) :	---
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA51_P5101-MS/REmgOut.
11. Remarks	

7.2.8.11. ALARM CHAIN PULLING

Processor : FLG1	Dist. Number: 68
Last Edit:19/02/2024	
1. Disturbance Signal Name:	43--_43-BBuzerTPart
2. Disturbance Text:	SS010: Brake System- ALARM CHAIN PULLING
3. Relations Subsystem: Priority : AI-Bit :	 SS010 2 2
4. Fault Code :	F1002P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Message from the air flow detection meter (06A,269.41).
9. Cause(s) :	1.Alarm chain is pulled on a coach. 2.Train is parted. 3.Too much air flows out of the brake pipe on the train.
10. Trigger Disturbance for Test:	Force signal HBB2_01-MPrSwAFlow.
11. Remarks	

7.2.8.12. VIGILANCE CONTROL UNIT MANUALLY SWITCH OFF

Processor : FLG1	Dist. Number: 69
Last Edit:19/02/2024	
1. Disturbance Signal Name:	STB1_1100.VIGCutOutDetection
2. Disturbance Text:	SS010: Brake System- VIGILANCE CONTROL UNIT MANUALLY SWITCH OFF
3. Relations Subsystem: Priority : AI-Bit :	 SS010 2 3
4. Fault Code :	F1003P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	237.1 rotary switch is manually set to 0 position.
9. Cause(s) :	---
10. Trigger Disturbance for Test:	
11. Remarks	

7.2.9. SS011 (Auxiliary System HB1)

7.2.9.1. MCB(s) TRIPPED IN AUX. CUBICLE1

Processor : HBB1	Dist. Number: 70
Last Edit:19/02/2024	
1. Disturbance Signal Name:	MMCBBloCT1, MMCBBloMR1, MMCBBloTM1, MMCBMScBlo1, MMCBPumpC1, MMCBPumpT1, MMCBTScBlo1.
2. Disturbance Text:	SS11: Auxiliaries HB1-MCB(s) TRIPPED IN AUX. CUBICLE1
3. Relations Subsystem: Priority : AI-Bit :	 SS11 2 1
4. Fault Code :	F1101P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	If any one or more than one of MCBs (59.1/1 or 62.1/1 or 63.1/1 or 53.1/1) are off in HB1 cubicle.
9. Cause(s) :	1. Over current in blowers or pumps. 2. Defective MCBs.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0901-MMCBBloCT1...
11. Remarks	

7.2.9.2. EARTH FAULT 415/110v CIRCUIT

Processor : HBB1	Dist. Number: 71
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MEFR415/110
2. Disturbance Text:	SS11: Auxiliaries HB1-EARTH FAULT 415/110v CIRCUIT
3. Relations Subsystem: Priority : AI-Bit :	 SS11 2 2
4. Fault Code :	F1102P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Earth fault relay (89.5) picks up.
9. Cause(s) :	1. Earth fault in 415/110 V circuit. 2. Earth fault relay defective (Pos. 89.5).
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0902-MEFR415.
11. Remarks	No effect on normal operation in case of single earth fault. In case of double earth fault, fuse (41) will blow isolating the 415/110 V circuit.

7.2.9.3. MCB OF MAIN COMPRESSOR OPEN

Processor : STB1	Dist. Number: 72
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0901-MMCBCompr1
2. Disturbance Text:	SS11: Auxiliaries HB1-MCB OF MAIN COMPRESSOR OPEN
3. Relations Subsystem: Priority : AI-Bit :	 SS11 2 3
4. Fault Code :	F1103P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	05F,47.1/1
8. Detected Symptom :	MCB 47.1 tripped.
9. Cause(s) :	1. Overcurrent in compressor 1. 2. MCB 47.1 faulty.
10. Trigger Disturbance for Test:	Trip the 47.1 MCB manually.
11. Remarks	

7.2.9.4. OVERLOAD ON OCB 1

Processor : FLG1	Dist. Number: 73
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0903-SOCBCurr1
2. Disturbance Text:	SS11: Auxiliaries HB1-OVERLOAD ON OCB 1
3. Relations Subsystem: Priority : AI-Bit :	 SS11 2 4
4. Fault Code :	F1104P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Current of oil cooler blower 1 is too high.
9. Cause(s) :	1. Blower radiator may be dirty. 2. problem in Bearing of OCU.
10. Trigger Disturbance for Test:	Change parameter in FLG.
11. Remarks	For future use.

7.2.9.5. Loco In Shunting Mode

Processor : FLG1	Dist. Number: 75
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0903-SOCBCurr1
2. Disturbance Text:	SS11: Auxiliaries HB1-Loco In Shunting Mode
3. Relations Subsystem: Priority : AI-Bit :	 SS11 2 6
4. Fault Code :	F1106P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Switch 160 in 0 position, speed will not increase more than 15KMPH.
9. Cause(s) :	1. Switch 160 in 0 position.
10. Trigger Disturbance for Test:	---
11. Remarks	---

7.2.10. SS012 (Auxiliary System HB2)

7.2.10.1. MCB(s) TRIPPED IN AUX. CUBICLE2

Processor : STB2	Dist. Number: 76
Last Edit:19/02/2024	
1. Disturbance Signal Name:	MMCBBloCT2, MMCBBloMR2, MMCBBloTM2, MMCBMScBlo2, MMCBPumpC2, MMCBPumpT2, MMCBTScBlo2.
2. Disturbance Text:	SS12: Auxiliaries HB2-MCB(s) TRIPPED IN AUX. CUBICLE2
3. Relations Subsystem: Priority : AI-Bit :	 SS12 2 1
4. Fault Code :	F1201P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	If any one or more than one of MCBs (59.1/2 or 62.1/2 or 63.1/2 or 53.1/2) are off in HB2 cubicle.
9. Cause(s) :	1. Over current in blowers or pumps. 2. Defective MCBs.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0901-MMCBBloCT2...
11. Remarks	

7.2.10.2. MCB OF MAIN COMPRESSOR OPEN

Processor : HBB2	Dist. Number: 77
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0901-MMCBCompr2
2. Disturbance Text:	SS12: Auxiliaries HB2-MCB OF MAIN COMPRESSOR OPEN
3. Relations Subsystem: Priority : AI-Bit :	 SS12 2 2
4. Fault Code :	F1202P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	05F,47.1/2
8. Detected Symptom :	MCB 47.1 tripped.
9. Cause(s) :	1. Overcurrent in compressor 1. 2. MCB 47.1 faulty.
10. Trigger Disturbance for Test:	Trip the 47.1 MCB manually.
11. Remarks	

7.2.10.3. OVERLOAD ON OCB 2

Processor : FLG1	Dist. Number: 78
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0903-SOCBCurr2
2. Disturbance Text:	SS12: Auxiliaries HB2-OVERLOAD ON OCB 2
3. Relations Subsystem: Priority : AI-Bit :	 SS12 2 3
4. Fault Code :	F1203P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Current of oil cooler blower 2 is too high.
9. Cause(s) :	1. Blower radiator may be dirty. 2. problem in Bearing of OCU.
10. Trigger Disturbance for Test:	Change parameter in FLG.
11. Remarks	For future use.

7.2.11. SS013 (CAB 1)

7.2.11.1. DISTURBANCE IN PROCESSOR HBB 1

Processor : FLG1	Dist. Number: 79
Last Edit:19/02/2024	
1. Disturbance Signal Name:	10--_1008-MMVBDisHBB1
2. Disturbance Text:	SS13: CAB 1- DISTURBANCE IN PROCESSOR HBB 1
3. Relations Subsystem: Priority : AI-Bit :	 SS13 1 1
4. Fault Code :	F1301P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS13
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 does not receive the life-sign from HBB1 or vice versa.
9. Cause(s) :	1. HBB1 processor may be disturbed. 2. The rack 411 may be disturbed. 3. The vehicle bus administrator FBV may be disturbed.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA10-P1008-MMVBDiHBB1
11. Remarks	During redundancy mode if VCU 1 redundant processor is dead. This will cause main power isolation.

7.2.11.2. DISTURBANCE IN PROCESSOR STB 1

Processor : FLG1	Dist. Number: 80
Last Edit:19/02/2024	
1. Disturbance Signal Name:	10--_1006-MMVBDisSTB1
2. Disturbance Text:	SS13: CAB 1- DISTURBANCE IN PROCESSOR STB 1
3. Relations Subsystem: Priority : AI-Bit :	 SS13 1 2
4. Fault Code :	F1302P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS13
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 does not receive the life-sign from STB1 or vice versa.
9. Cause(s) :	1. HBB1 processor may be disturbed. 2. The rack 411 may be disturbed. 3. The vehicle bus administrator BA may be disturbed.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA10-P1006-MMVBDiSTB1
11. Remarks	During redundancy mode if VCU 1 redundant processor is dead. This will cause main power isolation.

7.2.11.3. REVERSER DEFECTIVE

Processor : FLG1	Dist. Number: 81
Last Edit:19/02/2024	
1. Disturbance Signal Name:	47--_4702-MDirFaultC1
2. Disturbance Text:	SS13: CAB 1- REVERSER DEFECTIVE
3. Relations Subsystem: Priority : AI-Bit :	 SS13 1 3
4. Fault Code :	F1303P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS13
7. Page of Schematic :	08C
8. Detected Symptom :	Both Forward and Reverse direction signals high on CAB 1.
9. Cause(s) :	1. Reverser defective (Pos. 140). 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA47_P4702-MDirFaltC1 if cab1 is active and by signal PA47_P4702-MDirFaltC2 if cab2 is active.
11. Remarks	

7.2.12. SS14 (CAB 2)

7.2.12.1. DISTURBANCE IN PROCESSOR HBB 2

Processor : FLG1	Dist. Number: 82
Last Edit:19/02/2024	
1. Disturbance Signal Name:	10--_1009-MMVBDisHBB2
2. Disturbance Text:	SS14: CAB 2- DISTURBANCE IN PROCESSOR HBB 2
3. Relations Subsystem: Priority : AI-Bit :	 SS14 1 1
4. Fault Code :	F1401P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS14
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 does not receive the life-sign from HBB2 or vice versa.
9. Cause(s) :	1. Processor may be disturbed. 2. The rack 412 may be disturbed. 3. The vehicle bus administrator FBV may be disturbed.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA10-P1009-MMVBDiHBB2
11. Remarks	During redundancy mode if VCU 2 redundant processor is dead. This will cause main power isolation.

7.2.12.2. DISTURBANCE IN PROCESSOR STB 2

Processor : FLG1	Dist. Number: 83
Last Edit:19/02/2024	
1. Disturbance Signal Name:	10--_1007-MMVBDisSTB2
2. Disturbance Text:	SS14: CAB 2- DISTURBANCE IN PROCESSOR STB 2
3. Relations Subsystem: Priority : AI-Bit :	 SS14 1 2
4. Fault Code :	F1402P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS13
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 does not receive the life-sign from STB2 or vice versa.
9. Cause(s) :	1. Processor may be disturbed. 2. The rack 412 may be disturbed. 3. The vehicle bus administrator BA may be disturbed.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA10-P1007-MMVBDiSTB2
11. Remarks	During redundancy mode if VCU 2 redundant processor is dead. This will cause main power isolation.

7.2.12.3. REVERSER DEFECTIVE

Processor : FLG1	Dist. Number: 84
Last Edit:19/02/2024	
1. Disturbance Signal Name:	47--_4702-MDirFaultC2
2. Disturbance Text:	SS14: CAB 2- REVERSER DEFECTIVE
3. Relations Subsystem: Priority : AI-Bit :	 SS14 1 3
4. Fault Code :	F1403P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS14
7. Page of Schematic :	08D
8. Detected Symptom :	Both Forward and Reverse direction signals high on CAB 2.
9. Cause(s) :	1. Reverser defective (Pos. 140). 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA47_P4702-MDirFaltC1 if cab1 is active and by signal PA47_P4702-MDirFaltC2 if cab2 is active.
11. Remarks	

7.2.13. SS015 (FDU)

7.2.13.1. FIRE IN MACHINE ROOM

Processor : FLG1	Dist. Number: 84
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MFireAlarm
2. Disturbance Text:	SS15: Fire detection- FIRE IN MACHINE ROOM
3. Relations Subsystem: Priority : AI-Bit :	 SS15 1 1
4. Fault Code :	F1501P1
5. Protection Activities :	LSFI will glow and traction interlock will occur.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Fire alarm from fire detection equipment.
9. Cause(s) :	Fire in the machine room detected.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA09-P0902-MS/RFireAlarm.
11. Remarks	

7.2.13.2. FAULT IN FIRE DETECTION UNIT

Processor : STB2	Dist. Number: 85
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MFailFireEq
2. Disturbance Text:	SS15: Fire detection- FAULT IN FIRE DETECTION UNIT
3. Relations Subsystem: Priority : AI-Bit :	 SS15 2 1
4. Fault Code :	F1501P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	11B
8. Detected Symptom :	Message from the fire detection equipment.
9. Cause(s) :	1. Fire detection equipment defective (Pos. 212). 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered from signal PA09-P0902-FailFireE.
11. Remarks	No fire detection possible; Normal operation can continue.

7.2.13.3. FAULT IN FIRE DETECTION UNIT

Processor : STB2	Dist. Number: 86
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MFailFireEq
2. Disturbance Text:	SS15: Fire detection- FAULT IN FIRE DETECTION UNIT
3. Relations Subsystem: Priority : AI-Bit :	 SS15 2 1
4. Fault Code :	F1501P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	11B
8. Detected Symptom :	Message from the fire detection equipment.
9. Cause(s) :	1. Fire detection equipment defective (Pos. 212). 2. Feedback defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered from signal PA09-P0902-FailFireE.
11. Remarks	No fire detection possible; Normal operation can continue.

7.2.13.4. WARNING; SMOKE IN MACHINE ROOM

Processor : FLG1	Dist. Number: 87
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MSmogWarn
2. Disturbance Text:	SS15: Fire detection- WARNING; SMOKE IN MACHINE ROOM
3. Relations Subsystem: Priority : AI-Bit :	 SS15 2 2
4. Fault Code :	F1502P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	11B
8. Detected Symptom :	Message from the fire detection equipment.
9. Cause(s) :	Smoke in the machine room detected by fire equipment.
10. Trigger Disturbance for Test:	Disturbance can be triggered from signal PA09_P0902-MSmogWarn
11. Remarks	

7.2.14. SS016 (SPEEDOMETER)

7.2.14.1. SPEED LIMIT EXCEEDED

Processor : FLG1	Dist. Number: 88
Last Edit:19/02/2024	
1. Disturbance Signal Name:	43--_4301-MSpeed110%
2. Disturbance Text:	SS16: Speedometer- SPEED LIMIT EXCEEDED
3. Relations Subsystem: Priority : AI-Bit :	 SS16 1 1
4. Fault Code :	F1601P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	10A
8. Detected Symptom :	Signal from the speedometer (Pos. 94.2) to the control electronics.
9. Cause(s) :	1. Speed of the loco more than 110% of the maximum permitted speed. 2. Speedometer defective.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA43-P4301-MSpeed110%.
11. Remarks	

7.2.14.2. SPEED LIMIT EXCEEDED

Processor : STB2	Dist. Number: 89
Last Edit:19/02/2024	
1. Disturbance Signal Name:	09--_0902-MSpeedAlarm
2. Disturbance Text:	SS16: Speedometer- SPEED LIMIT EXCEEDED
3. Relations Subsystem: Priority : AI-Bit :	 SS16 2 1
4. Fault Code :	F1601P2
5. Protection Activities :	Popup on DDU.
6. Isolation Activities :	---
7. Page of Schematic :	10A
8. Detected Symptom :	Message from the speedometer.
9. Cause(s) :	Speedometer defective (Pos. 94.2).
10. Trigger Disturbance for Test:	Disturbance can be triggered from signal PA09-P0902-MSpeedAl.
11. Remarks	No speed indication on the cab; Normal operation can continue.

7.2.15. SS17 (Processor FLG1)

7.2.15.1. DISTURBANCE IN PROCESSOR FLG 1

Processor : FLG2	Dist. Number: 90
Last Edit:19/02/2024	
1. Disturbance Signal Name:	----
2. Disturbance Text:	SS17: Processor FLG1-DISTURBANCE IN PROCESSOR FLG 1
3. Relations Subsystem: Priority : AI-Bit :	 SS17 1 1
4. Fault Code :	F1701P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS17
7. Page of Schematic :	---
8. Detected Symptom :	Life-sign missing from FLG1.
9. Cause(s) :	1. EMD cable is disturbed. 2. Disturbance in Rack 411. 3. Problem in BA. 4. Problem in control card 411 slot G.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.15.2. SOFTWARE MISMATCH WAP-5/WAG-9

Processor : FLG1	Dist. Number: 91
Last Edit:19/02/2024	
1. Disturbance Signal Name:	00--_0010-MSWMisMSLG1
2. Disturbance Text:	SS17: Processor FLG1-SOFTWARE MISMATCH WAP-5/WAG-9
3. Relations Subsystem: Priority : AI-Bit :	 SS17 1 2
4. Fault Code :	F1702P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Software not compatible with the type of loco. Either WAP-5 software downloaded into WAG-9 or vice versa.
9. Cause(s) :	1. Wrong SLG1 software downloaded.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.15.3. FAULT IN ANGLE TRANSMITTER OF THROTTLE

Processor : FLG1	Dist. Number: 92
Last Edit:19/02/2024	
1. Disturbance Signal Name:	26--_2610-MAnglTrFail
2. Disturbance Text:	SS17: Processor FLG1-FAULT IN ANGLE TRANSMITTER OF THROTTLE
3. Relations Subsystem: Priority : AI-Bit :	 SS17 1 3
4. Fault Code :	F1703P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	80C/80D
8. Detected Symptom :	Information of the angle transmitter does not match with the information of auxiliary contacts of the throttle. The difference of aux. contact position and the absolute angle transmitter value is greater than 70% of full scale.
9. Cause(s) :	1.TE/BE throttle (Pos. 150) defective. 2. Cable interrupted. 3. Defective AIO card in 411/412 slot F
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA26-P2610-MAngTrFai
11. Remarks	Loco can be driven in failure mode operation (152 switch in SB1 in "1" position), in case of this disturbance. In this mode the master controller operates with the aux. contacts of the throttle.

7.2.15.4. SIMULATION SWITCH POSITION NOT MATCHING

Processor : FLG1	Dist. Number: 93
Last Edit:19/02/2024	
1. Disturbance Signal Name:	18--_1801-BDisSimShDn
2. Disturbance Text:	SS17: Processor FLG1-SIMULATION SWITCH POSITION NOT MATCHING
3. Relations Subsystem: Priority : AI-Bit :	 SS17 1 4
4. Fault Code :	F1704P1
5. Protection Activities :	VCB will not close.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Simulation switch position not matching on master and slave.
9. Cause(s) :	1. Simulation switch ON in Master and OFF in slave. 2. Simulation switch OFF in Master and ON in Slave. 3. Simulation switch defective on Master. 4. Simulation switch defective on slave.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA18-P1801-MDiSimShDn
11. Remarks	

7.2.16. SS18 (Processor FLG2)

7.2.16.1. DISTURBANCE IN PROCESSOR FLG 2

Processor : FLG1	Dist. Number: 95
Last Edit:19/02/2024	
1. Disturbance Signal Name:	10--_1003-MMVBDisFLG2
2. Disturbance Text:	SS18: Processor FLG2-DISTURBANCE IN PROCESSOR FLG 2
3. Relations Subsystem: Priority : AI-Bit :	 SS17 1 1
4. Fault Code :	F1701P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS18
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 does not receive the life sign from FLG2
9. Cause(s) :	1. The signal path FLG2 -> FLG1 through the EMD cable is interrupted. 2. FLG2 processor may be disturbed in rack 412 slot G. 3. The vehicle bus administrator may be disturbed.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA10-P1003-MMVBDiFLG2.
11. Remarks	

7.2.16.2. SOFTWARE MISMATCH WAP-5/WAG-9

Processor : FLG1	Dist. Number: 96
Last Edit:19/02/2024	
1. Disturbance Signal Name:	00--_0010-MSWMisMSLG1
2. Disturbance Text:	SS18: Processor FLG1-SOFTWARE MISMATCH WAP-5/WAG-9
3. Relations Subsystem: Priority : AI-Bit :	 SS18 1 2
4. Fault Code :	F1802P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Software not compatible with the type of loco. Either WAP-5 software downloaded into WAG-9 or vice versa.
9. Cause(s) :	1. Wrong SLG software downloaded.
10. Trigger Disturbance for Test:	---
11. Remarks	

7.2.16.3. FAULT IN ANGLE TRANSMITTER OF THROTTLE

Processor : FLG2	Dist. Number: 97
Last Edit:19/02/2024	
1. Disturbance Signal Name:	26--_2610-MAnglTrFail
2. Disturbance Text:	SS18: Processor FLG2-FAULT IN ANGLE TRANSMITTER OF THROTTLE
3. Relations Subsystem: Priority : AI-Bit :	 SS18 1 3
4. Fault Code :	F1803P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	80C/80D
8. Detected Symptom :	Information of the angle transmitter does not match with the information of auxiliary contacts of the throttle. The difference of aux. contact position and the absolute angle transmitter value is greater than 70% of full scale.
9. Cause(s) :	1.TE/BE throttle (Pos. 150) defective. 2. Cable interrupted. 3. Defective AIO card in 411/412 slot F
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA26-P2610-MAngTrFai
11. Remarks	Loco can be driven in failure mode operation (152 switch in SB1 in “1” position), in case of this disturbance. In this mode the master controller operates with the aux. contacts of the throttle.

7.2.16.4. SIMULATION SWITCH POSITION NOT MATCHING

Processor : FLG1	Dist. Number: 98
Last Edit:19/02/2024	
1. Disturbance Signal Name:	18--_1801-BDisSimShDn
2. Disturbance Text:	SS18: Processor FLG2-SIMULATION SWITCH POSITION NOT MATCHING
3. Relations Subsystem: Priority : AI-Bit :	 SS18 1 4
4. Fault Code :	F1804P1
5. Protection Activities :	VCB will not close.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Simulation switch position not matching on master and slave.
9. Cause(s) :	1. Simulation switch ON in Master and OFF in slave. 2. Simulation switch OFF in Master and ON in Slave. 3. Simulation switch defective on Master. 4. Simulation switch defective on slave.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA18-P1801-MDiSimShDn
11. Remarks	

7.2.17. SS19 (Train Bus)

7.2.17.1. COMMUNICATION DISTURBANCE

Processor : FLG1	Dist. Number: 100
Last Edit:19/02/2024	
1. Disturbance Signal Name:	11--_1103-MTbDistMast
2. Disturbance Text:	SS19: Train Bus- COMMUNICATION DISTURBANCE
3. Relations Subsystem: Priority : AI-Bit :	 SS19 1 1
4. Fault Code :	F1804P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	SS19
7. Page of Schematic :	---
8. Detected Symptom :	The FLG1 on the slave loco does not receive the life-sign of the master loco.
9. Cause(s) :	1. Train Bus disturbed. 2. Train Bus administrator ZBV disturbed in master or slave loco. 3. UIC cable between two locos interrupted. 4. WTB module of master or slave loco is faulty.
10. Trigger Disturbance for Test:	Disturbance can be triggered by signal PA11-P1103-MTbDistMast.
11. Remarks	MU operation is not possible.

7.2.18. SS04 (Traction Bogie 1)

7.2.18.1. Motor1-Bogie1 Isolated

Processor : SLG1	Dist. Number: 101
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS04: Traction bogie 1- Motor1-Bogie1 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 5
4. Fault Code :	F0405P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in inverter 1 of bogie 1.
9. Cause(s) :	1. Communication error between SLG and inverters. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. Problem in speed sensors. 5. Over current in motor.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with reduced power

7.2.18.2. Motor2-Bogie1 Isolated

Processor : SLG1	Dist. Number: 102
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS04: Traction bogie 1- Motor2-Bogie1 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 6
4. Fault Code :	F0406P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in inverter 2 of bogie 1.
9. Cause(s) :	1. Communication error between SLG and inverters. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. Problem in speed sensors. 5. Over current in motor.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with reduced power

7.2.18.3. Motor3-Bogie1 Isolated

Processor : SLG1	Dist. Number: 103
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS04: Traction bogie 1- Motor3-Bogie1 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 7
4. Fault Code :	F0407P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in inverter 3 of bogie 1.
9. Cause(s) :	1. Communication error between SLG and inverters. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. Problem in speed sensors. 5. Over current in motor.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with reduced power

7.2.18.4. Line Converter1-Bogie1 Isolated

Processor : SLG1	Dist. Number: 104
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS04: Traction bogie 1- Line Converter1-Bogie1 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 8
4. Fault Code :	F0408P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in AFE unit 1 of bogie 1.
9. Cause(s) :	1. Communication error between SLG and AFE unit. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. DC earth fault. 5. Input over current.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with 25% reduced power

7.2.18.5. Line Converter2-Bogie1 Isolated

Processor : SLG1	Dist. Number: 105
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS04: Traction bogie 1- Line Converter2-Bogie1 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS04 1 9
4. Fault Code :	F0409P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in AFE unit 2 of bogie 1.
9. Cause(s) :	1. Communication error between SLG and AFE unit. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. DC earth fault. 5. In put over current.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with 25% reduced power

7.2.19. SS05 (Traction Bogie 2)

7.2.19.1. Motor1-Bogie2 Isolated

Processor : SLG2	Dist. Number: 106
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS05: Traction bogie 2- Motor1-Bogie2 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS05 1 5
4. Fault Code :	F0505P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in inverter 1 of bogie 2.
9. Cause(s) :	1. Communication error between SLG and inverters. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. Problem in speed sensors. 5. Over current in motor.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with reduced power

7.2.19.2. Motor2-Bogie2 Isolated

Processor : SLG2	Dist. Number: 107
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS05: Traction bogie 2- Motor2-Bogie2 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS05 1 6
4. Fault Code :	F0506P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in inverter 2 of bogie 2.
9. Cause(s) :	1. Communication error between SLG and inverters. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. Problem in speed sensors. 5. Over current in motor.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with reduced power

7.2.19.3. Motor3-Bogie2 Isolated

Processor : SLG2	Dist. Number: 108
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS05: Traction bogie 2- Motor3-Bogie2 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS05 1 7
4. Fault Code :	F0507P1
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in inverter 3 of bogie 2.
9. Cause(s) :	1. Communication error between SLG and inverters. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. Problem in speed sensors. 5. Over current in motor.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with reduced power

7.2.19.4. Line Converter1-Bogie2 Isolated

Processor : SLG2	Dist. Number: 109
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS05: Traction bogie 2- Line Converter1-Bogie2 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS05 1 8
4. Fault Code :	F0508P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in AFE unit 1 of bogie 2.
9. Cause(s) :	1. Communication error between SLG and AFE unit. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. DC earth fault. 5. In put over current.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with 25% reduced power

7.2.19.5. Line Converter2-Bogie2 Isolated

Processor : SLG2	Dist. Number: 110
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS05: Traction bogie 2- Line Converter2-Bogie2 Isolated
3. Relations Subsystem: Priority : AI-Bit :	 SS05 1 9
4. Fault Code :	F0509P1
5. Protection Activities :	VCB open.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	Disturbance in AFE unit 2 of bogie 2.
9. Cause(s) :	1. Communication error between SLG and AFE unit. 2. Issue in gate driver card. 3. Disturbance in OFC cable of driver card. 4. DC earth fault. 5. In put over current.
10. Trigger Disturbance for Test:	
11. Remarks	Traction is possible with 25% reduced power

7.2.20. SS45 (Main power)

7.2.20.1. MCE ON

Processor : FLG1	Dist. Number: 111
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS01: BOOT UP- MCE ON
3. Relations Subsystem: Priority : AI-Bit :	 SS45 3 60
4. Fault Code :	F4560P3
5. Protection Activities :	---
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	BL key in D position.
9. Cause(s) :	1. Loco is booting after a shutdown.
10. Trigger Disturbance for Test:	
11. Remarks	Ony event will log in DDS as information.

7.2.20.2. Traction not Possible Bring Te/Be to 0

Processor : FLG1	Dist. Number: 112
Last Edit:19/02/2024	
1. Disturbance Signal Name:	
2. Disturbance Text:	SS01: BOOT UP- Traction not Possible Bring Te/Be to 0
3. Relations Subsystem: Priority : AI-Bit :	 SS45 3 61
4. Fault Code :	F4561P3
5. Protection Activities :	Popup in DDU.
6. Isolation Activities :	---
7. Page of Schematic :	---
8. Detected Symptom :	During booting throttle is not in ZERO position.
9. Cause(s) :	1. Throttle position is not ZERO during MCE boot up.
10. Trigger Disturbance for Test:	
11. Remarks	