Indian Railways

Driver's Manual

WAG-9/9H Locomotives

CHITTARANJAN LOCOMOTIVE WORKS
CHITTARANJAN (W.B)

Driver's Manual

(Maintenance Manual, Vol-1)

For WAG-9/9H Locomotives

➢ **GENERAL NOTE:**

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CHITTARANJAN LOCOMOTIVE WORKS
CHITTARANJAN (W.B)

Contents

1. INTRODUCTION:

1.1 Use of the Driver's Manual:

This Driver's Manual describes the locomotive characteristics, the technical options available and the operation of locomotives of the WAG-9, WAG-9H & WAP-7 Series.
No reference will be made to official railway regulations and restrictions.

A layout has been selected which makes it possible to answer specific questions by referring to the relevant section. The Driver's Manual is intended to enable the user to obtain a more detailed understanding of the various systems and the way they interact with one another. Above all, trained personnel are recommended to use the Driver's Manual in conjunction with circuit diagrams and control electronics software documents.

The Chapters differ in terms of content, layout and intended target audience in accordance with the following list:

Chapter	Contents
1	Introduction
2.	Brief description of the loco
3.	System description
4.	Vehicle operation
5.	Faults
6.	Latest Up gradation
7.	Index
8.	Illustrations

Item numbers of equipment:

Equipment item numbers are listed down of the left margin.

1.2 Inspection Sheet for Amendments:

This final version of the Driver's Manual for the WAG-9 / 9H locomotive was compiled by Electric Loco Design Office, Chittaranjan Locomotive Works Chittaranjan.

Version	Dept.	Issue Date	Checked by	Approved by	Comments
Edition 0/VER-1	ELDO/ CRJ	20.02.2011.			Ref to Edition 0/en BTI drivers manual, ISSUED ON 30.12.2001

1.3 Abbreviations:

ALG	Drive Control Unit	Drive Inverter and Line Converter Control
ASC	Drive Converter Control	
ASR	Drive Converter	
BL	Key Switch	
BLCP	Spring-loaded Switch	Main compressors AUTO mode
BLDJ	Spring-loaded Switch	Main circuit breaker
BLHO	Spring-loaded Switch	Hotel load (not active on WAG-9)
BLPR	Switch	Headlights
BPCS	Illuminated Push-button, Green	Constant speed control
BPFA	Illuminated Push-button, Yellow	Acknowledgement all fault messages
BPFL	Illuminated Push-button, Yellow	Emergency flash light
BPPB	Illuminated Push-button, red	Parking brake(not active on WAP-7)
BPVG	Push-button, Green	Vigilance
BPVR	Push-button, Yellow	Acknowledge vigilance
BUR	Auxiliary Converter	
BZ-V-O-F	Buzzer	
CEL	Central Electronics	
CSC	Constant Speed Control	
DDA	Display Data Control	
DDS	Diagnostic Data Set	
DIA	Diagnostic Control	
FBV	Vehicle Bus Administrator	
FLG	Vehicle Control Unit	
GTO	Gate Turn Off Switch	
HB	Cubicle Auxiliary Circuits	
HBB	Processor	
HRA	Switch	Cab blower/heating
LSAF	Indication Lamp, Red	Train parting
LSCE	Indication Lamp, Amber	Over temperature CEL
LSDJ	Indication Lamp, Red	Main circuit breaker
LSFI	Indication Lamp, Red	Fault message, priority 1
LSHO	Indication Lamp, Yellow	Hotel load (not active on WAG-9)
LSP	Indication Lamp, Yellow	Wheel slipping
LSVW	Indication Lamp, Yellow	Vigilance Warning
MCB	Main Circuit Breaker	
MCE	MICAS-S2 Control Electronics	

MSC	Master Sequential Control	
SPM	Speedometer	
MR	Machine Room	
MUB	Over voltage Protection Unit	
MVB	Multifunction vehicle Bus	
NSC	Line Converter Control	
NSR	Line Converter	
Pan	Pantograph	
PCLH	Socket	Hand lamp
PP	Pneumatic Panel	
SB	Cubicle Control Circuits	
SLG	Converter Control Unit	
SR	Traction Converter	
STB	Low Voltage Cubicle Control	
TE/BE	Tractive/Braking Effort	
UBA	Voltmeter	Battery Voltage
UIC	Union International des chemins de fer	
VCB	Vacuum Circuit Breaker	Main Circuit Breaker
ZBAN	Spring loaded Switch	Banking Operation
ZBV	Train Bus Administrator	
ZLC	Switch	Driver’s cab lighting
ZLDA	Switch	Assistant Driver’s Desk Illumination
ZLDD	Switch	Driver’s Desk Illumination
ZLFR	Switch	Marker Lights, Red
ZLFW	Switch	Marker Lights, White
ZLH	Switch	Socket Hand Lamp
ZLI	Switch	Instrument Lighting
ZPRD	Switch	Head Light, intensity
ZPT	Spring-loaded Switch	Pantograph
ZTEL	Switch	Max. traction limitation
ZK	DC link	

2. BRIEF DESCRIPTION OF THE LOCO:

The WAG-9 &9H is a high-speed main line locomotive for hauling FREIGHT trains and WAP-7 is a high-speed main line locomotive for hauling PASSENGER trains.

This locomotive is a double-ended design, which means that there are a driver's cab and coupling elements at both ends of the loco.

2.1 Mechanical Features:

The three axles, three motor Co-Co bogie assemblies, is one of the major parts of the locomotive. Two bogie assemblies support the entire weight of the locomotive and provide a means for transmission of the tractive effort to the rails.

The bogies are designed to withstand the stresses and vibrations resulting from normal rolling stock applications. An important function of the bogie is to absorb and isolate shock caused by variations in the trackbed. The suspension systems minimize the transmission of these shocks to the locomotive under frame.

The traction motors are suspended in the bogie frame and on the individual axis. The motors transmit their energy to the driving axles through a gearbox mounted on the driving axle. The force from the driving axles is transmitted to the contact point between the wheel tread and the rail. Traction force is, in turn, transmitted through the axle journal boxes and guide rods to the bogie frame. The push-pull link rod, connected between the bogie transom and car under frame, transmits the tractive forces to the car body.

The WAG-9/9H is equipped with the following pneumatic braking systems: automatic train brake, direct loco brake, parking brake, and anti-spin brake. As with the tractive effort, braking effort is transmitted to the bogie frame by the axle journal boxes and guide rods and from the bogie frame to the locomotive by the traction rods.

Isolation and absorption of shock loads and vibration is performed by the primary and secondary suspension. Movement between the car body and bogie is smoothly controlled by the primary and secondary suspension. Although the springs permit free movement in any direction, lateral buffers and dampers limit the amount and rate of lateral movement. Rebound limit chains and vertical dampers limit the amount and rate of the vertical rebound of the locomotive car body. Yaw (longitudinal) dampers control the car body pitch rate. Guide rods control the fore and aft movement between the axles and the bogie frame, while the link rod controls the fore and aft movement between the bogies and the locomotive car body.

The primary suspension, located between the axles and the bogie frame, is provided by twin coil springs on the axle journal box fore and aft of the axle line. Vertical hydraulic dampers are used to dampen the rebound rate of the springs. This “Flexi coil” arrangement permits lateral movement of the axle. Longitudinal control of the axle, and the transmission of tractive and braking effort to the bogie frame, is provided by guide rods connected between the axle journal boxes and bogie frame. Spheribloc rubber bushes in the guide rods allow the axle lateral movement without undue restriction.

Secondary suspension is also provided by coil springs and vertical hydraulic dampers, located between the bogie frame and the locomotive under frame on each side of the bogie. The weight of the locomotive car body is carried by the secondary suspension springs. The “Flexi-Float” arrangement of the secondary suspension allows the locomotive car body to move both laterally and vertically within certain limits relative to the bogies.

2.2 Electrical Features:

- **Vehicle propulsion concept:**

3-phase converter drive.

- **Main transformer**

The main transformer is housed in an aluminium tank. It is mounted underframe between the two bogies.

- **Traction Converter**

The machine room contains one traction converter per bogie with 2-point switching. This comprises a line converter (NSR) and a 3-phase drive converter (ASR).

The traction motors are supplied with power directly by two relevant bogie selective drive converters with appropriate control electronics.

- **Axle drive**

Three externally ventilated three-phase asynchronous squirrel cage motors of Type 6 FRA 6068 are installed on both bogies. The three traction motors on each bogie are supplied with power by one traction converter.

- **Harmonic Filter**

The harmonic filter consisting of resistor and capacitor reduces the high frequency harmonics.

- **Auxiliary Circuits**

Three modular auxiliary converters (BUR) are used to supply power to the 3-phase auxiliary circuit motors. The auxiliary circuits are designed in a bogie-selective manner.

- **Control electronics (MICAS-S2)**

All functions of the locomotive are controlled by the control electronics. It takes the form of bus stations with processors.

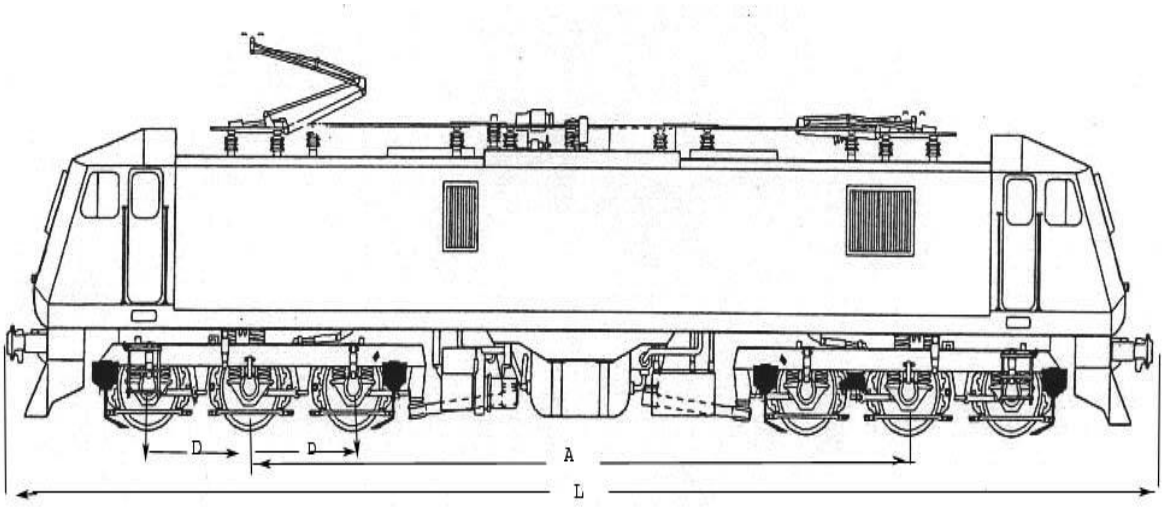
The bus stations communicate with each other via fibre optic cables which are resistant to the effects of Electro Magnetic Interference (EMI). The diagnostic equipment comprises a diagnosis computer with monitor and keyboard in the driver’s cab. This provides an effective support for the duties of the locomotive driver and maintenance personnel.

- **Multiple Unit Control**

The locomotive is equipped for multiple unit control with locomotives of the same kind. However, no more than two locomotives can be connected together. Commands are transmitted by the UIC cable.

Comfort Equipment

Every driver’s cab is equipped with two fans and a unit for recirculating and heating the air.
Recently cab air-condition has been introduced in WAG-9 type locomotive.



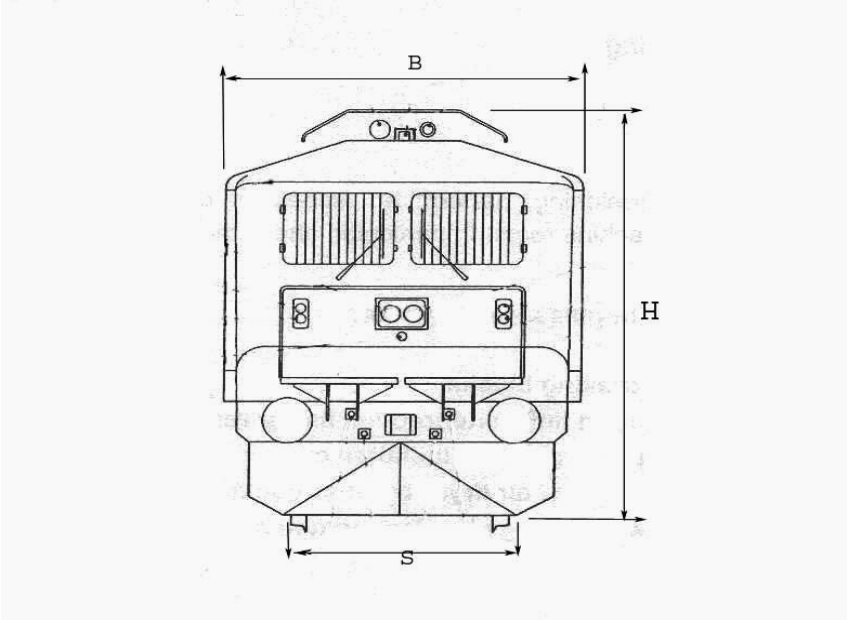


Fig.2.1 Dimension of the locomotive;

A	Distance between bogies (center – center)	12000 mm
L	Length over buffers	20562 mm
D	Distance between axles of bogie	1850 mm
B	Overall width	3152 mm
H	Max. height with pantograph locked down(Overall)	4255 mm
S	Gauge	1676 mm

2.3 Technical Data:

Customer		Indian Railways
Designation		WAG-9 / 9H & WAP-7
Manufacturer		Chittaranjan Locomotive Works, Chittaranjan (W.B)
Axle arrangement		Co-Co
Gear Ratio	WAG-9 & 9H WAP-7	107:21 72:20
Gauge		1676 mm
Length over buffers		20562 mm
Overall width		3152 mm
Max. height with pantograph locked down		4255 mm
Distance between the bogie centers		12000 mm
Distance between axles of bogie		1850 mm
Wheel diameter	New Half worn Worn	1092 mm 1054 mm 1016 mm
Maximum permitted difference of wheel diameter on the same axle.		0.5 mm
Maximum permitted difference of wheel diameters within one bogie		4 mm
Maximum permitted difference of wheel diameter between bogies		20 mm
Sharpest negotiable curve radius		174 m
Total weight	(without ballast) (with ballast for WAG-9H)	123 t 132t

Catenary voltage	Normal	25 kV
	Minimum	19 kV
	Maximum	27.5 kV
	Brief minimum	17.5 kV
	Occasionally maximum	30 kV
Frequency		50 Hz +/- 3%
Static power supply to auxiliary circuits		
Voltage		415 V +/- 10%
Frequency		0 ….. 50 Hz
Battery voltage		110 VDC
Regenerative brake		
	Maximum braking force	260 kN
Mechanical brake systems:		
Automatic train brake-	Maximum braking force	242 kN
	Coefficient of adhesion	35%
Parking Brake		
	Maximum braking force	37 kN
Power & FAD of each of the two main compressor		15 KW & 1745 l/min
Continuous rating on wheel rim between 80 and 120 km/h		4500 kW
Traction force on wheel rim between 0 and 50 km/h.		
	Maximum	460 kN
	Continuous	325 kN
Maximum Speed (G-9 & 9H)	With half worn wheels	100 km/h
	At constant speed	100 km/h
Maximum ambient temp.	In the sun	70ºC
	In the shade	50ºC
Minimum ambient temp.		0ºC
Reference to site conditions-	Temperature	47ºC
	Humidity	60%
	Height above sea level	160 m

2.4 Layout of locomotive:

2.4.1 Overview:

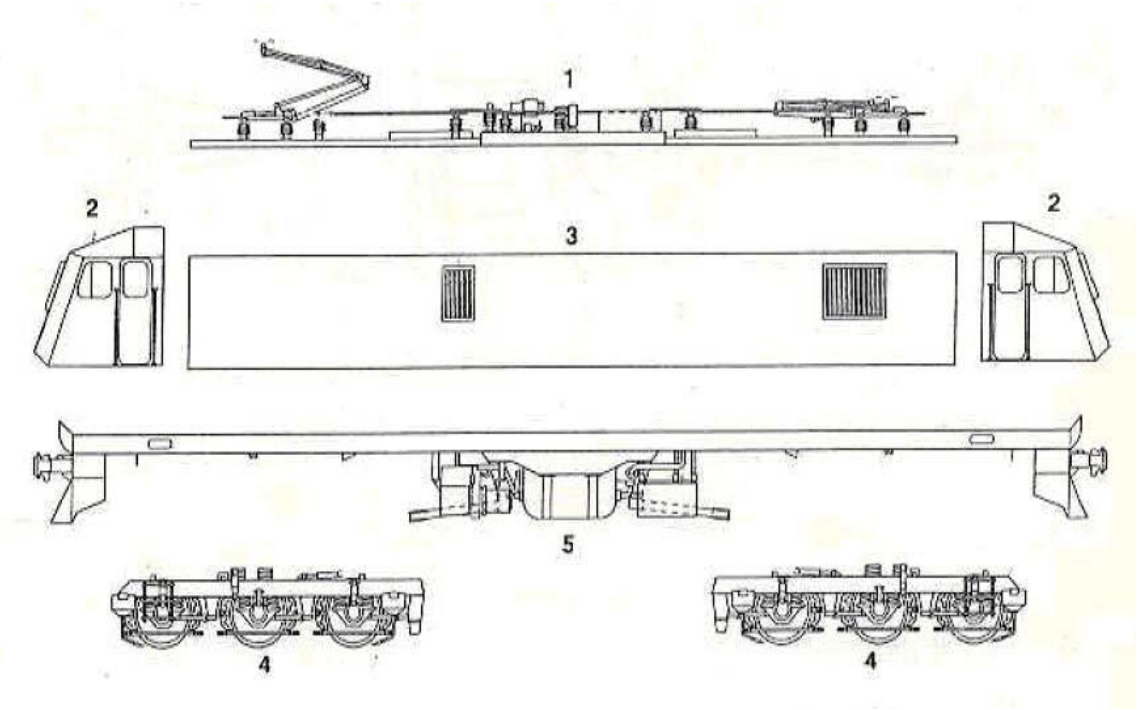


Fig. 2.2 Layout of the locomotive

1 Roof
2 Driver’s cab
3 Machine Room
4 Bogie
5 Frames

2.4.1.1 Roof layout:

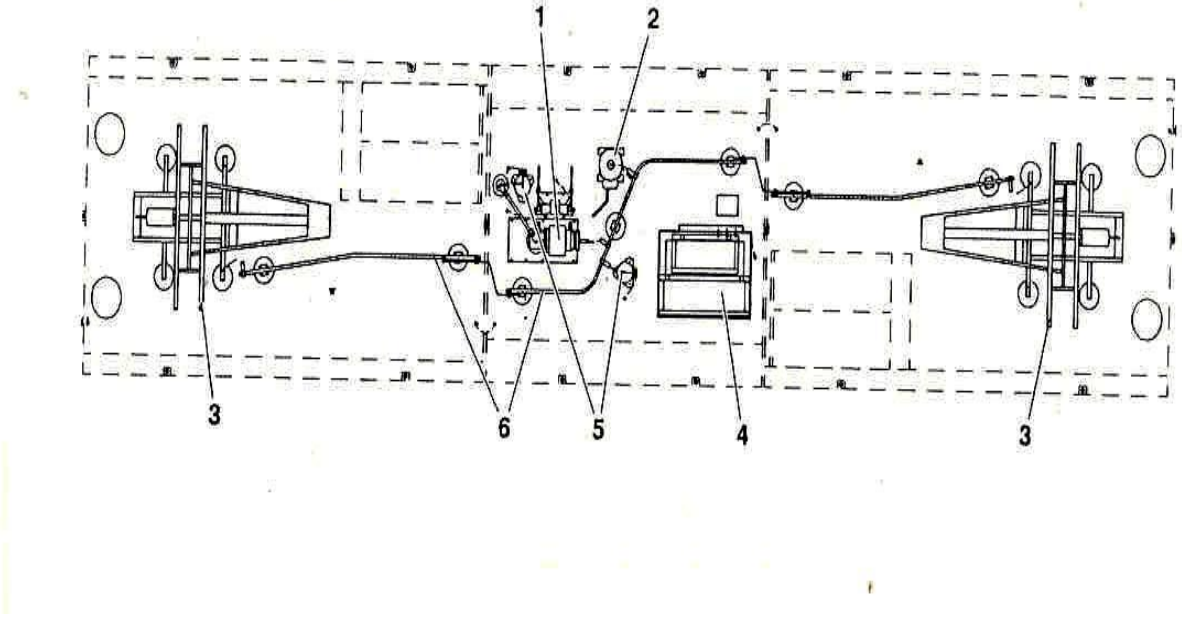


Fig.2.3 Roof layout

1 Main circuit breaker
2 Transducers
3 Pantograph
4 Resistor harmonic filter
5 Surge arrestor
6 Roof line

2.4.1.2 Underframe layout:

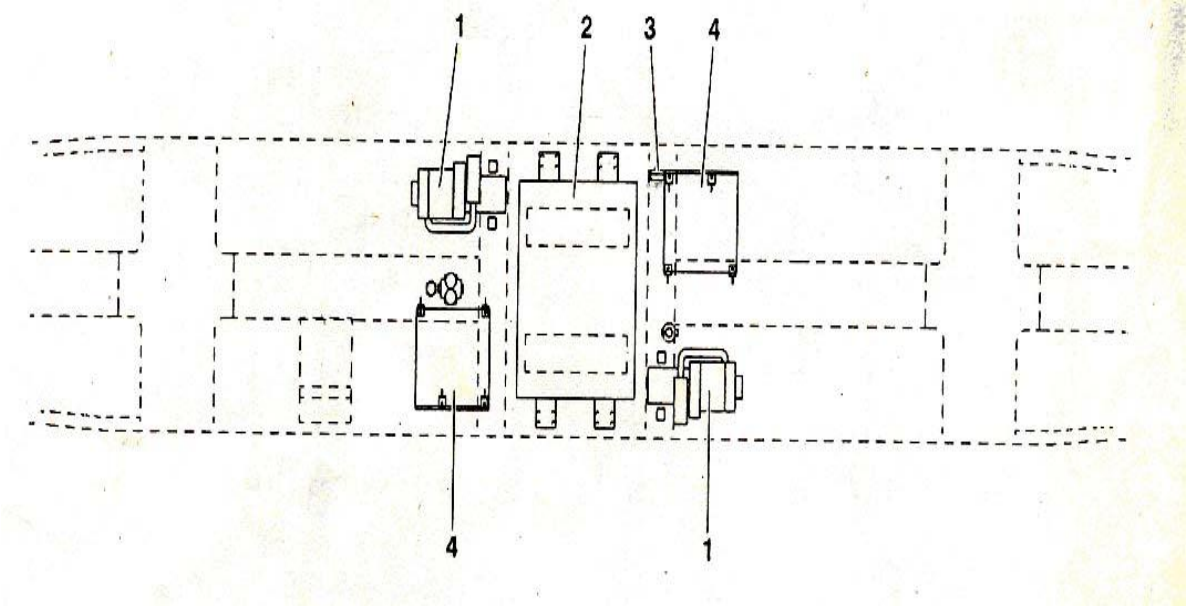


Fig. 2.4 Underframe layout:

1. Main Compressor (600 kg)
2. Transformer (9450 kg)
3. Circuit breaker battery
4. Batteries box (Empty Box-234 kg + Battery-374 kg. per box)

2.4.1.3 Bogie layout:

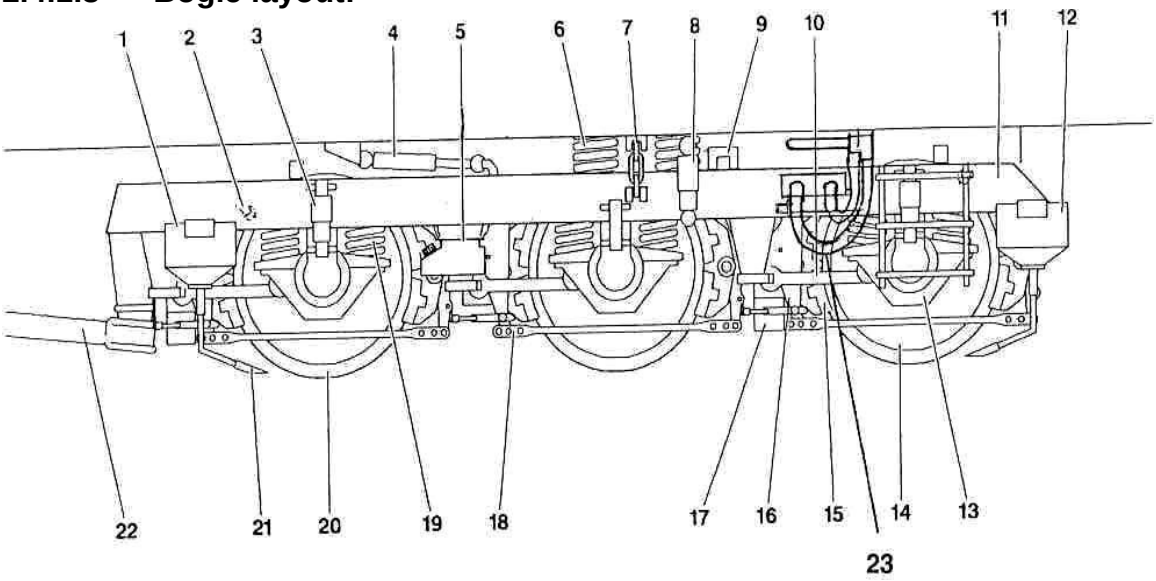


Fig.2.5 Bogie layout

1 Sanding box
2 Wheel flange lubrication nozzle (deleted)
3 Primary suspension damper
4 Secondary suspension yaw damper
5 Wheel flange lubrication reservoir
6 Secondary suspension spring
7 Safety chain
8 Secondary suspension vertical damper
9 Horizontal damper
10 Wheel set guide
11 Bogie frame
12 Sanding box
13 Wheel set
14 Wheel
15 Brake block
16 Brake lever
17 Brake cylinder
18 Brake rod
19 Primary suspension spring
20 Wheel flange
21 Sanding pipe
22 Traction link
23 Anti compounding valve

2.4.2 Machine Room:

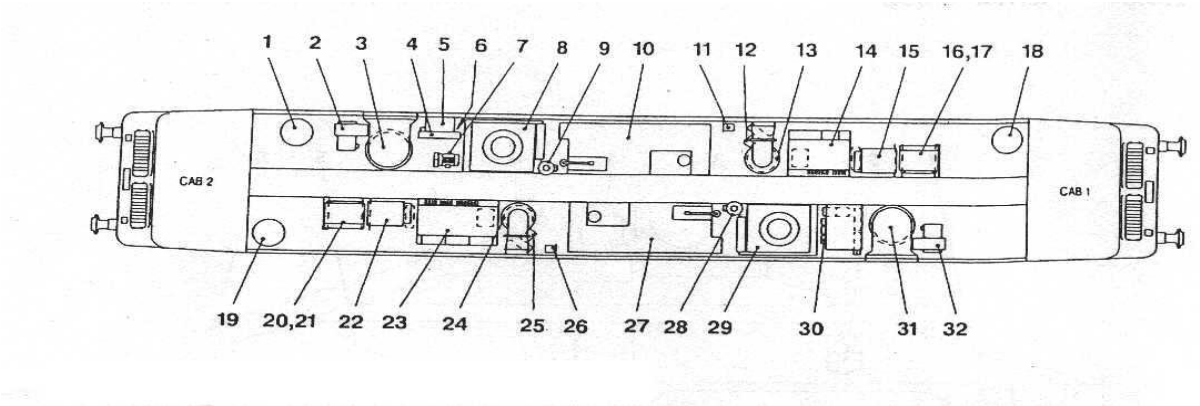


Fig.2.6 Detailed layout of machine room

	1	Auxiliary reservoir (135 kg)
55/2	2	Scavenge blower to traction motor blower unit- 1 (42 kg)
53/2	3	Traction motor blower bogie 2 (416 kg)
237	4	Vigilance control equipment } (430 kg)
260	5	Control electronics pneumatic manifold } (430 kg)
PT	6	Pneumatic panel } (430 kg)
48	7	Auxiliary compressor (50 kg)
59/1	8	Oil cooling unit, transformer/ converter 1 (930 kg)
63/1	9	Oil pump converter 1 (95 kg)
SR1	10	Traction converter 1 (3500 kg)
56.5/1	11	Scavenge blower capacitor to machine room blower 1(780 g)
56/1	12	Scavenge blower to machine room blower 1(37 kg)
54/1	13	Machine room blower 1 (140 kg)
1050.1	14	Auxiliary converter box 1 (608 kg)
HB1	15	Cubicle auxiliary circuits 1 (220 kg)
SB1	16	Cubicle control circuits 1 (160 kg)
411	17	Central electronics 1 (CEL 1)- (32.34 kg)
	18	Main reservoir (330 kg)
	19	Main reservoir (330 kg)
412	20	Central electronics 1 (CEL 2) – (31.34 kg)
SB2	21	Cubicle control circuits 2 (170 kg)
HB2	22	Cubicle auxiliary circuits 2 (105 kg)
1050.2	23	Auxiliary converter box 2 (1130 kg)
54/2	24	Machine room blower 2 (140 kg)
56/2	25	Scavenge blower to machine room blower 2 (37 kg)
56.5/2	26	Scavenge blower capacitor to machine room blower 2 (780 g)
SR2	27	Traction converter 2 (3500 kg)
63/2	28	Oil pump converter 2 (95 kg)

59/2	29	Oil cooling unit, transformer / converter 2 (930 kg)
FB	30	Filter cubicle (400 kg)
53/1	31	Traction motor blower bogie 1 (416 kg)
55/1	32	Scavenge blower to traction motor blower unit 2 (42 kg)

2.4.3 Driver's cab:

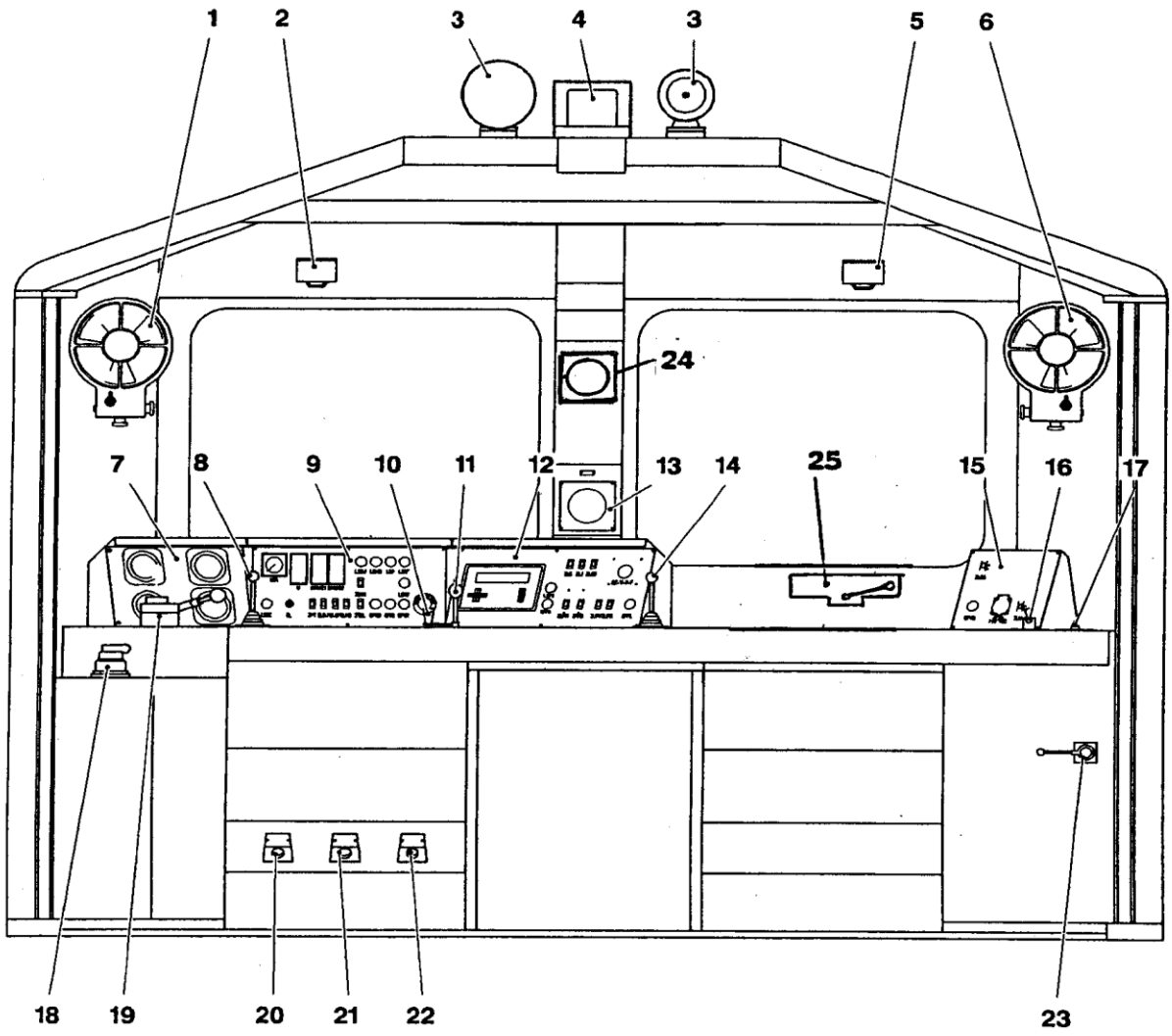


Fig.2.7 Overview driver's cab

69.7	1	Crew fan
325.21	2	Lamp driver’s desk illumination
	3	Pneumatic horn
318.3	4	Emergency flasher light
325.22	5	Lamp assistant driver’s desk illumination
69.7	6	Crew fan
	7	Panel B
	8	Control lever for horn
	9	Panel A
140	10	Reverser
150	11	TE/BE Throttle
	12	Panel C
94.2	13	SPEEDOMETER
	14	Control lever for horn
	15	Panel D
	16	Operation of window wipers/washers
65.6	17	Rotary switch cab heater / fan device
293	18	Brake handle direct loco brake
	19	Brake handle automatic train brake
192.1	20	Foot switch “SANDING”
262	21	Foot switch “PVEF” for release of loco brake
235	22	Foot switch “VIGILANCE”
	23	Emergency brake cock
	24	Parking brake (PB) Gauge
	25	Wiper Motor

2.5 Tractive/Braking Effort (WAG-9):

2.5.1 Tractive effort/speed-diagram (at wheel rim):

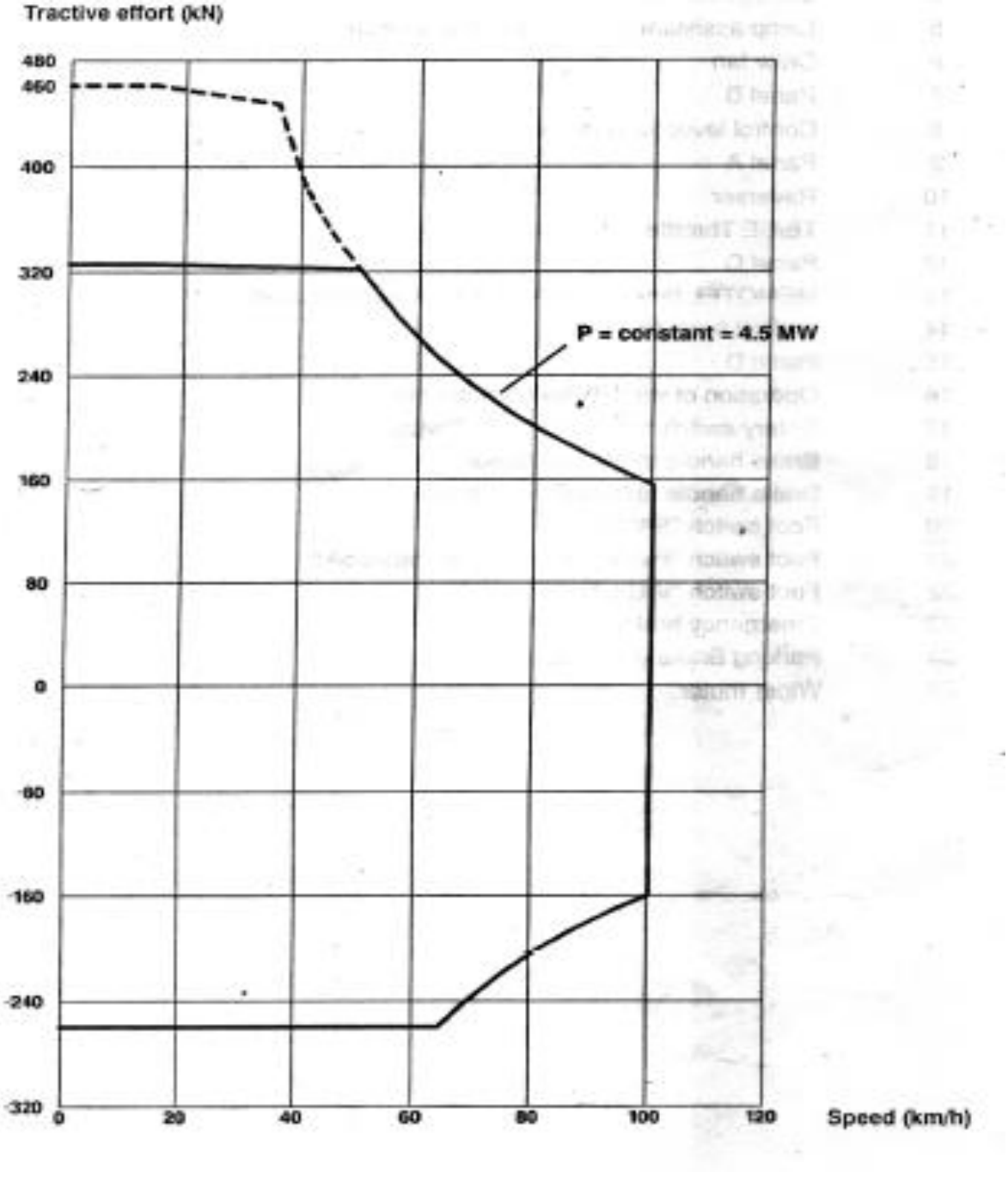


Fig. 2.8 Tractive effort/speed-diagram

2.5.2 Push/Pull Diagram (WAG-9):

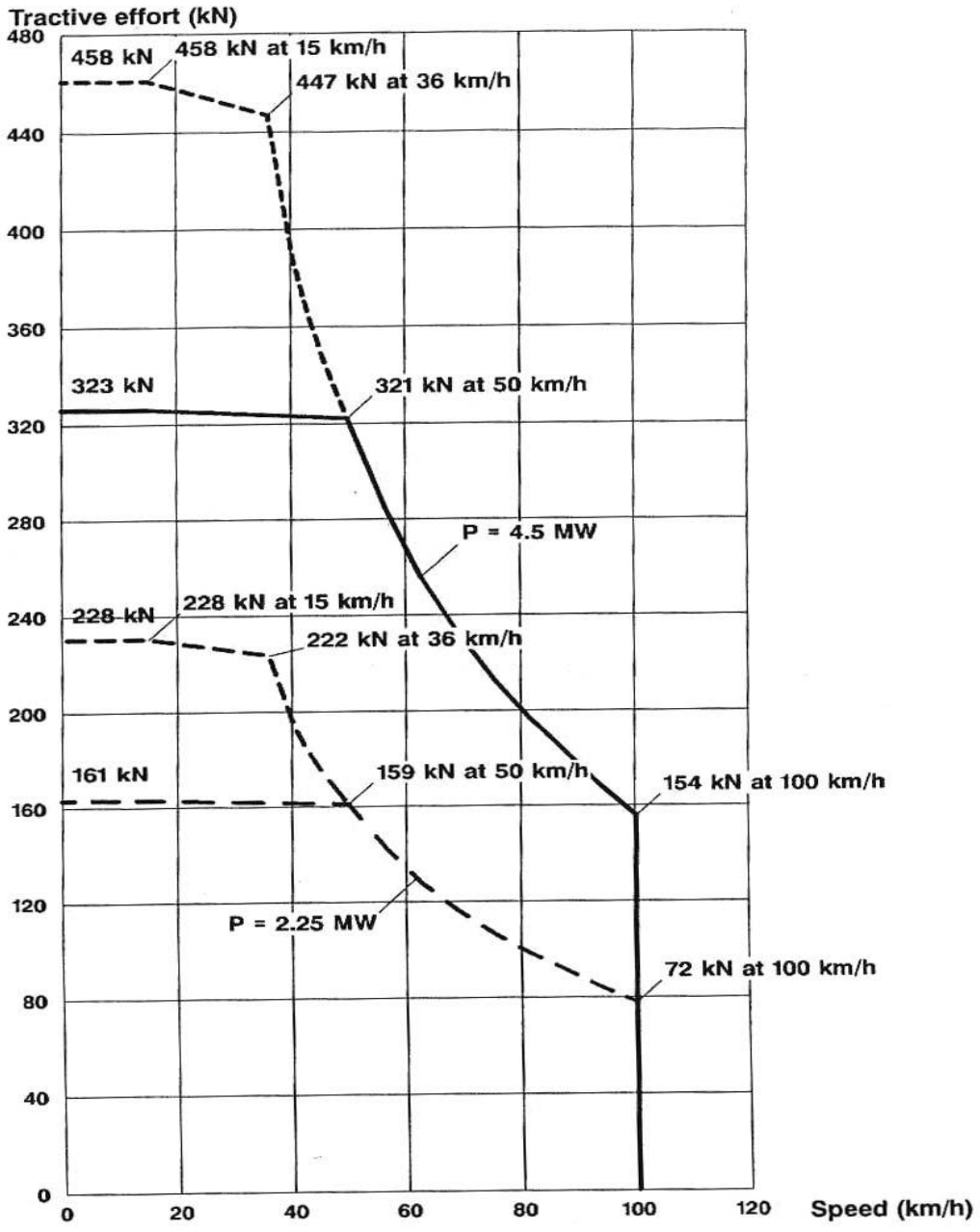


Fig. 2.9 Push/Pull-Diagram

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3. SYSTEM DESCRIPTION

3.1 Braking Concept, Overview

The following brake systems are present on this locomotive.

- Regenerative brake (controlled by angle transmitter)
- Pneumatic automatic train brake (controlled by pneumatic automatic brake handle)
- Direct loco brake (controlled by direct loco brake handle)
- Parking brake (controlled by parking brake push button, not for WAP-7)
- Anti-spin brake (controlled by SLG, FG90)
- Emergency brake (controlled by emergency brake valve)

It’s released by following brake requests:

- Emergency brake vigilance
- Emergency stop push button cab1, cab 2
- Emergency brake cock cab 1, cab 2
- Emergency brake in case of over speed from SPEEDOMETER.
- Emergency brake if brake electronic fails
- Emergency brake sensed by pressure switch

Note:

If regenerative brake fails, pneumatic brake effort on loco can be controlled by angle transmitter, except processor HBB2 or FLG2 fails.

3.1.1 Regenerative Brake

The regenerative brake is an electrical brake system.

Braking effort is generated by using the drive motors as generators, with energy being supplied into the overhead Catenary system.

The electric brake is actuated by the TE/BE throttle.

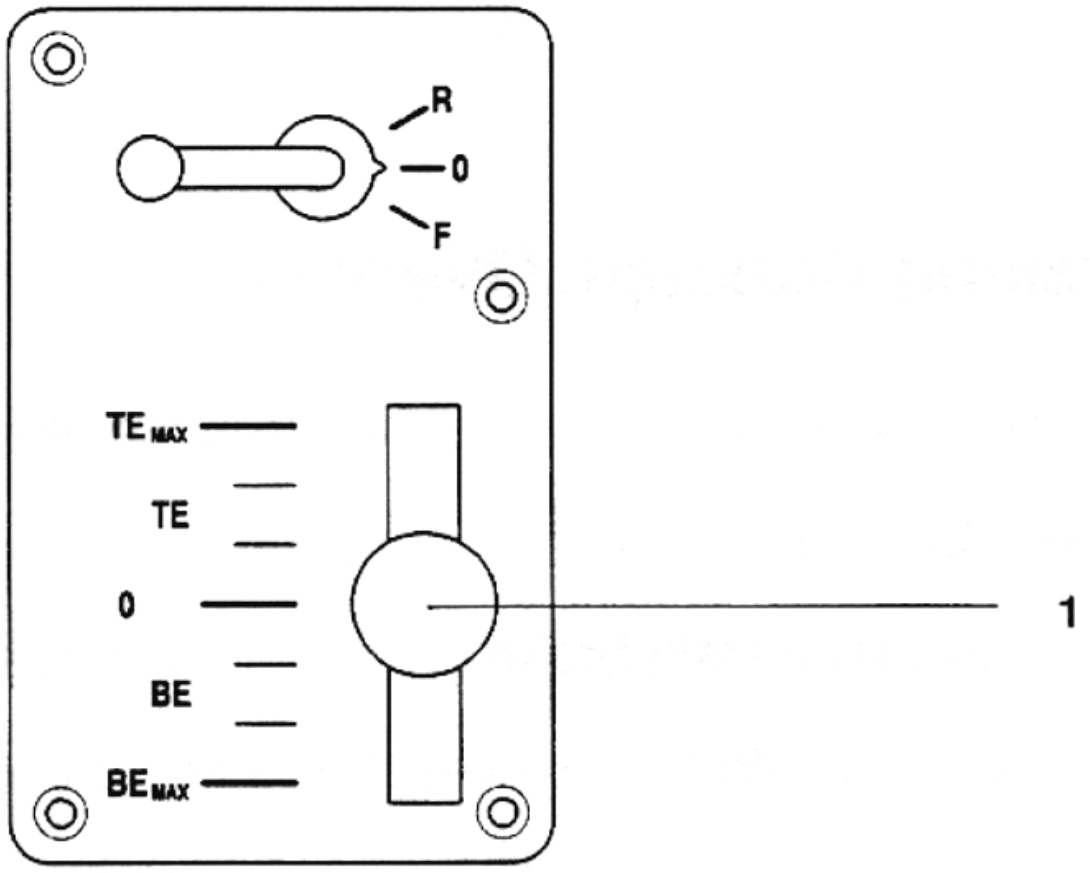


Fig. 3.1 Master Controller:

1 TE/BE Throttle

If regenerative braking effort exceeds 10 kN, the automatic locomotive brake is inhibited. If the regenerative brake is not available or if it fails during a braking operation, the pneumatic locomotive brake automatically takes over its function, except in the case, when VCB is opened by the spring – loaded switch “BLDJ”. The full electric braking effort is reduced from 10 km/h to 0 kN at 0 km/h.

Note:
Even if the electrical and pneumatic brakes are activated together due to a fault in the system, excessive braking of the locomotive is avoided because the anti-spin/slide control system reduces the electrical braking effort.

3.1.2 Main diagram pneumatic brake systems

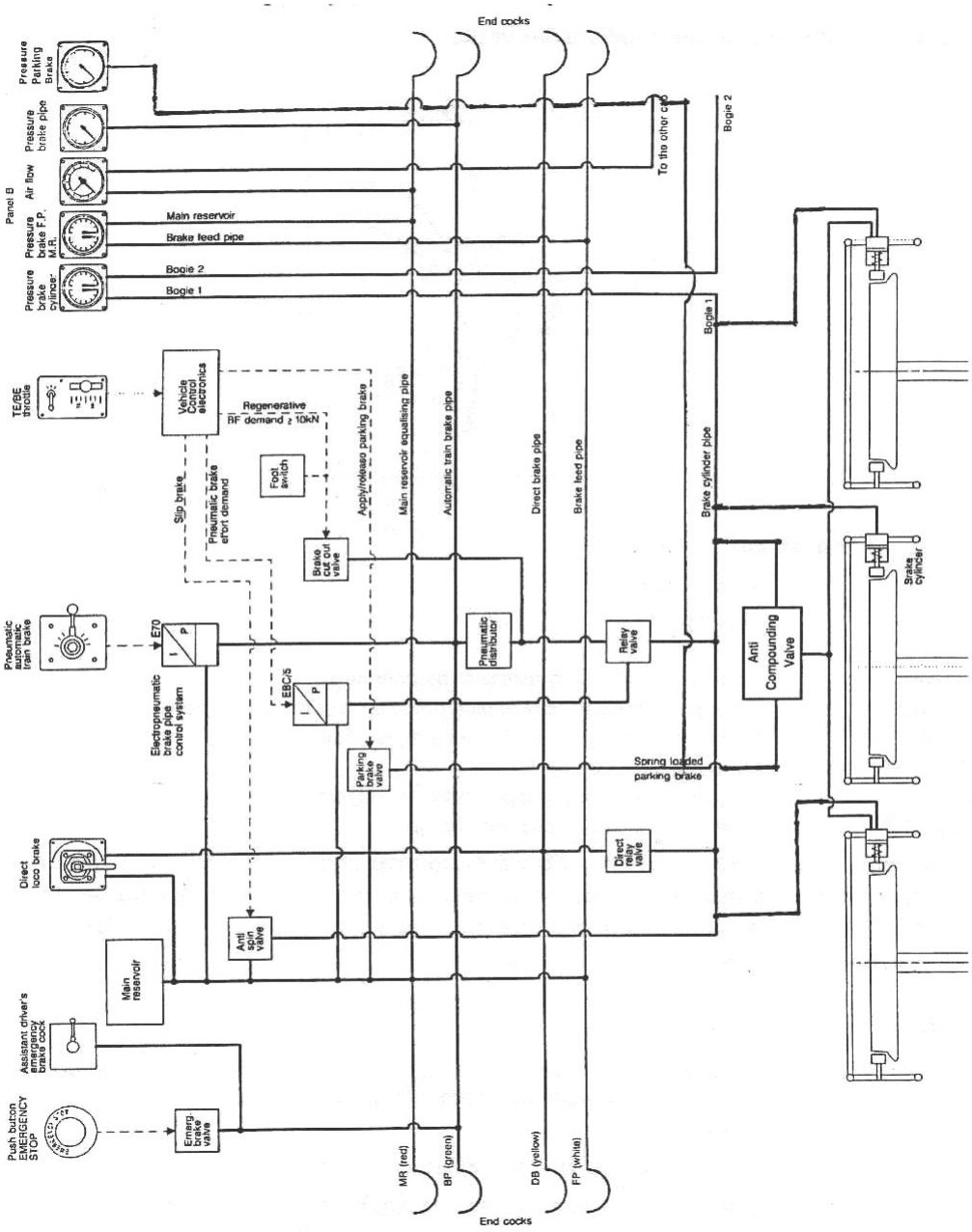


Fig.-3.2 Main diagram pneumatic brake systems

3.1.2.1 Pneumatic automatic train brake

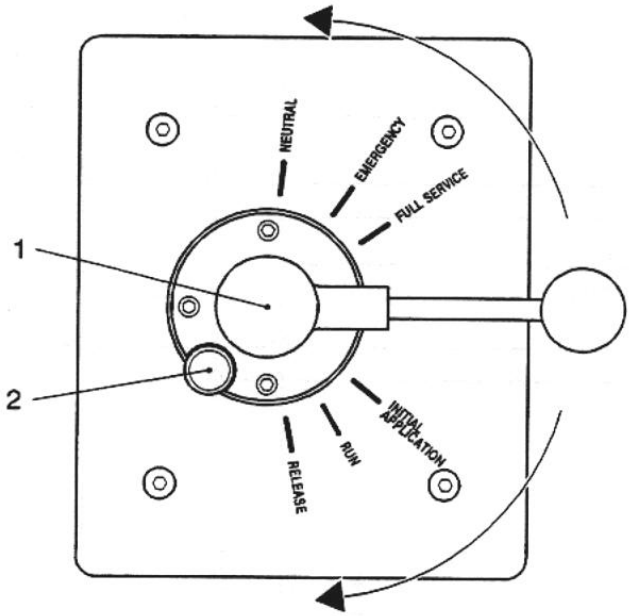


Fig. 3.3 Automatic train brake:

1	Brake handle
2	Locking device

NEUTRAL	Cab inactive (Locking device to be operated)
EMERGENCY	Emergency braking (Brake pipe pr. <0.3 kg/cm^2)
FULL SERVICE	Max braking effort (Brake pipe pressure 3.35 kg/ cm^2)
INITIAL APPLICATION	minimum braking effort
RUN	Driving position (Brake pipe pressure 5 kg/ cm^2)
RELEASE	Initiation of low-pressure overcharge

The automatic train brake is capable of braking the train and the locomotive. It acts on the brake discs of the locomotive and the brake blocks on the coaches. It is actuated by the brake handle (1). The handle can only be plugged in or removed in the “NEUTRAL” position, in conjunction with the locking device.

Note:
If the electronic brake control system fails, a priority 1 fault message appears on the display and an emergency brake is triggered. A Start/Running Interlock is initiated whenever:

- *Brake pipe pressure falls bellow 4.75 kg/cm^2 and*
- *the speed of the locomotive exceeds 10 km/h and*
- *there is brake cylinder pressure on the loco as indicated on the instruments on panel B.*

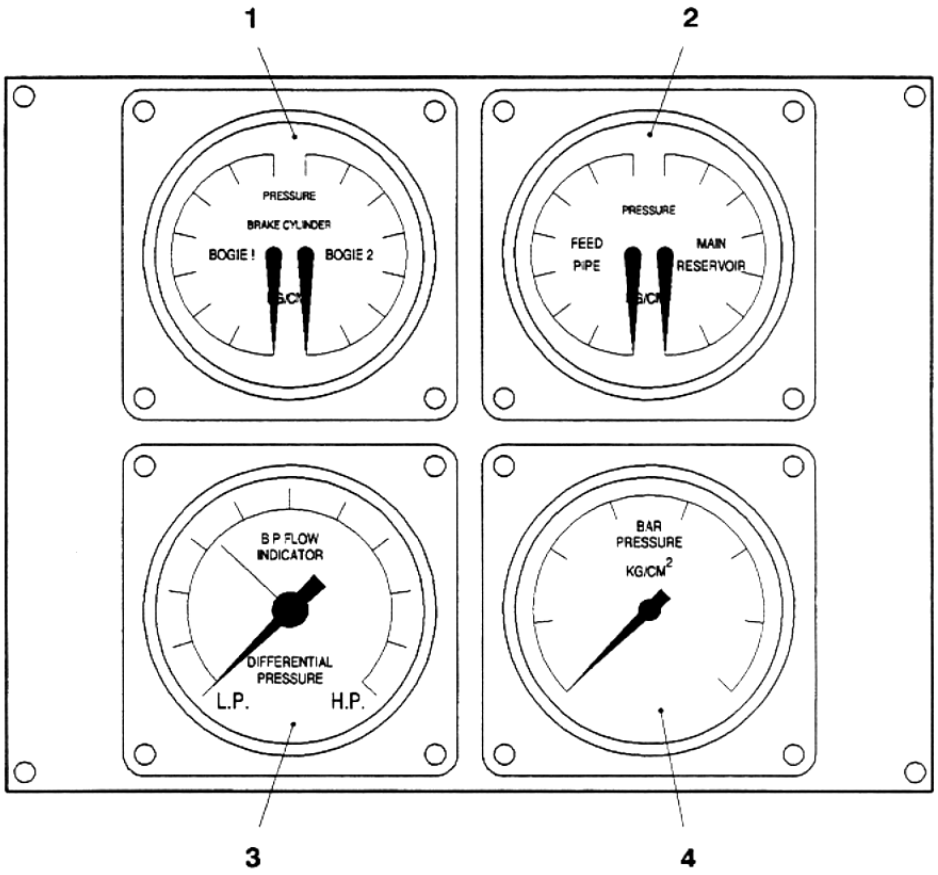


Fig. 3.4 Panel B:

81.2	1	Pressure Brake Cylinder Bogie 1 + 2
81.1	2	Pressure Brake Feed Pipe/Main Reservoir
81.4	3	Air Flow Meter
81.3	4	Pressure Brake Pipe

3.1.2.2 Direct Brake (Pneumatic)

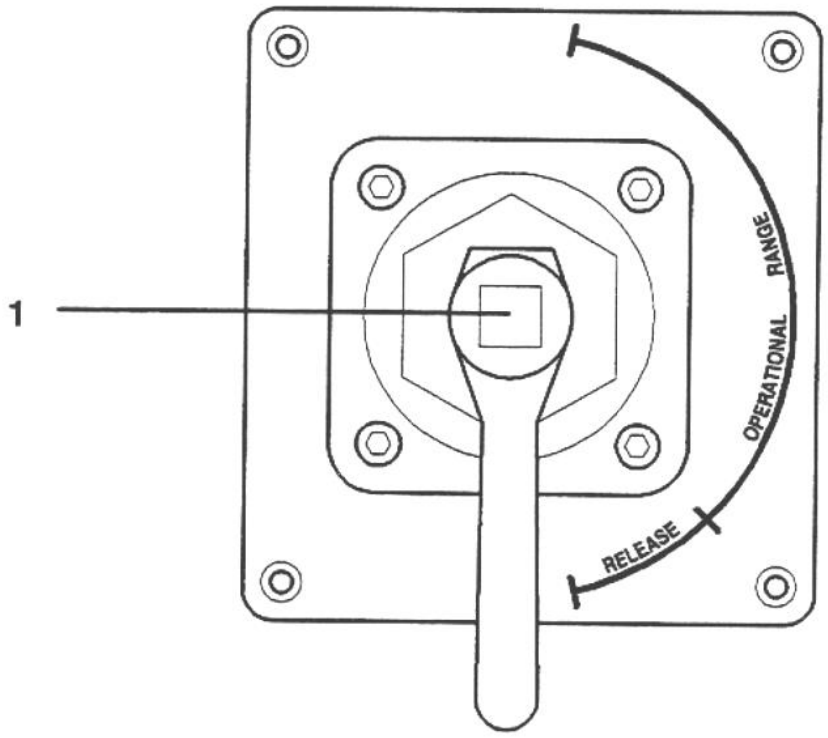


Fig. 3.5 Direct Brake:

The direct brake acts on the brake discs of the locomotive and is only able to brake the loco. In multiple operations, the direct brake also acts on the slave locomotive. Due to its direct action it is used whenever careful graduated braking is required (e.g. shunting).
The brake handle (1) is only active when the driver's cab is activated.
A Start/Running Interlock is initiated whenever speed of the loco is above 10 km/h and there is brake cylinder pressure on the loco indicated on the instrument on panel B.

Note:
For train operation, the handle has to be set to the release stop, in the fully clockwise direction
In special situations, e.g. hill start (Starting on gradients), the direct brake can be applied.

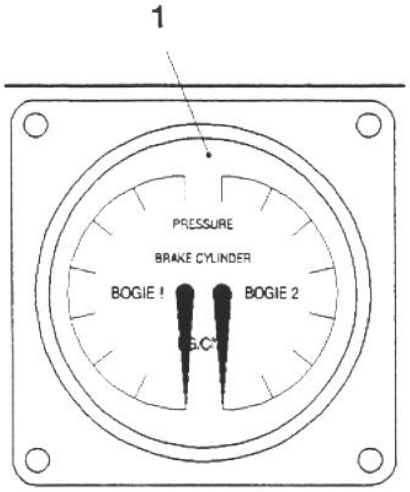


Fig. 3.6 Pressure gauge:

1 Pressure Brake Cylinder Bogie 1 + 2

3.1.2.3 Parking Brake (inactive in WAP-7)

When loco is stationary, parking brake secures it from rolling.

It acts on one brake discs on the axles 1 and 3, activated and released by the illuminated

268 parking brake push button “BPPB” on Panel A (inactive in WAP-7)
Parking brake applied = push-button “BPPB” lit
Parking brake released = push-button “BPPB” not lit

Once the parking brake has been activated, the locomotive is unable to move (Start/Running Interlock).

The parking brake cannot be activated if the speed of the locomotive exceeds 5 km/h.
The parking brake can be applied and released at the pneumatic panel in the machine room independently from the vehicle electronics
Refer to Chapter 4, page22, Item 14
The parking brake pressure can be seen in the parking brake (PB) gauge, provided in the cab.

Note:

If there is no air in the pneumatic system, the parking brake applies automatically by springs. Release of the parking brake is than possible by operating the individual handles on the bogie frame (not applicable in WAP-7).

Warning

The use of the parking brake release handle outside the loco is strictly forbidden in normal operation!

For authorized personnel only!

Before shunting or towing the dead locomotive, it must be ensured that the parking brakes must be released.

Note
*If the BL key switch in the main driver's cab is turned **OFF**, the MCE automatically applies the parking brake (not for WAP-7).*

Warning:

Before switching OFF the BL key, it must be ensured that the locomotive is stand still.

3.1.2.4 Emergency Braking

An emergency braking operation can be initiated by:

1. Response from the Vigilance control module
2. Permitted maximum speed being exceeded (Speedometer)
3. Moving of the driver's brake handle to position EMERGENCY (automatic train brake)
4. Actuation of the emergency brake cock on the assistant driver's side

244

5. Actuation of the emergency stop push button on the panel 'A'.
6. Failure of the electronic brake control system
7. Train parting

Note:

The emergency stop button is only active in the activated driver's cab. However, its function is not dependent on the speed of the locomotive. When the emergency stop button is pressed, the main circuit breaker opens and the pantograph is lowered.

Emergency braking is actuated directly in all cases and is not controlled by the MCE. However, the MCE responds to emergency braking by reducing traction effort to '0'.

If an emergency braking operation is triggered in multiple operations, it is transferred to the slave locomotive also.

3.2 Driving

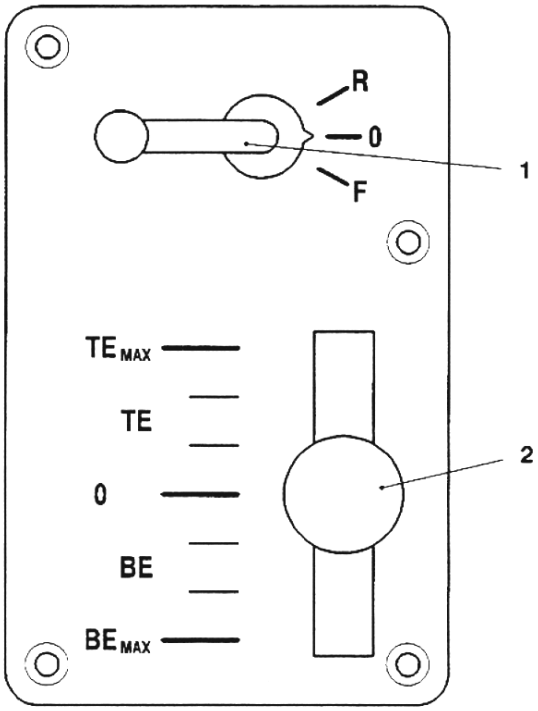


Fig. 3.7 Master Controller:
1 Reverser (140)
2 TE/BE Throttle (150)

3.2.1 Reverser

140 The reverser has the following three positions:

Pos. ”F”	Forward
Pos. “O”	Neutral
Pos. “R”	Reverse

Note:
A mechanical interlock ensures that the reverser can only be actuated if the TE/BE Throttle is in Pos. “O”.
In addition, the speed of the locomotive must be 0 km/h.

3.2.2 TE/BE Throttle

The TE/BE throttle controls traction and the electric braking effort of the locomotive with an angle transmitter and auxiliary contacts.

The TE/BE throttle has the following three end positions:

Position TE max	= Maximum traction	(100%)
Position “O”	= No tractive / no braking effort	(0%)
Position BE max	= Maximum action of the regenerative brake	(100%)

The tractive/braking effort is indicated on the two-tractive/braking meters on panel A.

3.2.3 TE/BE meters

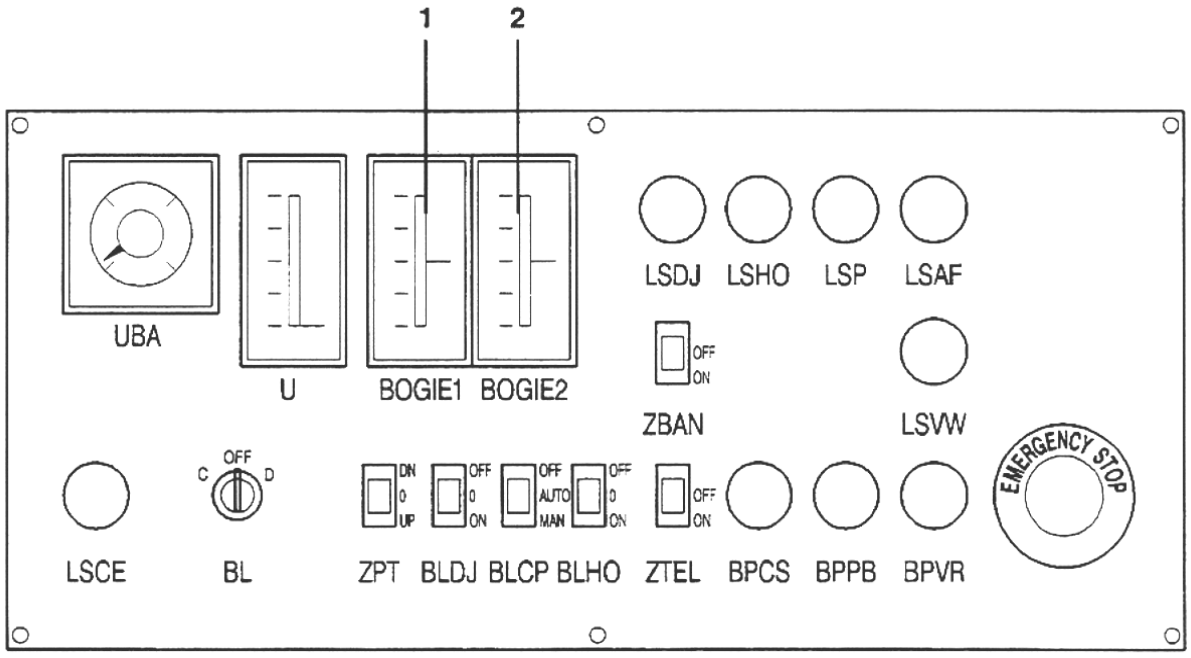


Fig. 3.8 TE/BE meters:

79.1	1	TE/BE meter bogie 1
79.2	2	TE/BE meter bogie 2

Note:

The increase/reduction in tractive/braking effort is restricted to 50 kN/s.

In case the angle transmitter fails, the auxiliary contacts act in the following positions:

Driving:	*TE max*	*= 100%*
	2/3 TE	*= 67%*
	1/3 TE	*= 33%*
Neutral:	*TE/BE*	*= 0%*
Braking:	*1/3 BE*	*= 33%*
	2/3 BE	*= 67%*
	BE max	*= 100%*

3.2.4 Constant Speed Control (CSC)

This system enables the train to maintain a constant speed automatically and can be activated at any speed above 5 km/h by pressing the illuminated push-button “BPCS” (constant speed control).

151.4 TE/BE demand from throttle must be greater than zero.
The CSC has access to 100% traction and braking force, i.e. the position of the TE/BE throttle (angle transmitter drive controller) has no impact on the effective speed.

Note:

To minimize oscillation, the CSC should be set during a slow acceleration phase.

The action of the CSC is cancelled by:

150 Moving the TE/BE throttle.

151.4 Pressing the illuminated push-button “BPCS” while the CSC system is active.
260 Drop in brake pipe pressure below 4.75 kg/cm^2.
269.6 Brake cylinder pressure above 0.6 kg/cm^2.

3.2.5 SPEEDOMETER

The WAG-9 locomotive is designed for operational speeds between 0 and 100 km/h.

The speed of the locomotive is monitored and recorded by the SPEEDOMETER. If the maximum permitted speed of 100 km/h is exceeded, the system initiates the following actions:

1. Speed 105%

   Buzzer: continuous tone 745 Hz

2. Speed 110%

   Emergency braking is initiated
   Fault message priority 2: maximum speed exceeded

Note:

If the speed indicator fails, a fault message with priority 2 appears on the terminal

At the same time, a signal sounds; continuous tone 745 Hz.

3.2.6 Limitation of acceleration / deceleration

The max. acceleration is limited to 0.25 m/s^2.
The max. Deceleration is limited to 1 m/s^2.

Note:

For multiple operations, the master locomotive determines the acceleration of the train.
The train driver can brake the train using the regenerative brake as well as the pneumatic brake.

3.2.7 Anti-spin Protection/Anti-slide Protection

The automatic anti-spin protection/anti-slide protection is initiated as soon as the ratio between effective tractive/braking effort and requested tractive/braking effort is less than 0.5.

As required, one or more of the following actions is/are initiated:

1. Reduction of tractive effort to the adhesion limit from the electronics of the traction converter (independently on each bogie).
2. If required, the wheel-spin brake is activated.
3. The sanding valves are activated depending on direction of travel.

Note:

92 A wheel spin/slide is indicated by the yellow illuminated indication lamp "LSP" (panel A).

3.2.8 Sanding

192.1 Sanding can be initiated by the driver by pressing the "SANDING" foot switch, or automatically by the anti-spin protection unit.

Depending on the direction of travel, only the sanding valves of the wheels of the leading axles of each bogie are activated.

3.2.9 Train Parting

81.5 A high air flow in the brake pipe (e.g. train parting) is detected by a pressure switch and indicated by the red indication lamp train parting "LSAF" in the driver's cab.

The airflow of the brake pipe is indicated on the air flow meter (panel B).

3.2.10 Wheel Flange Lubrication (Deleted)

At regular intervals an oil/grease mixture is applied to the wheel flanges of the leading axle of each bogie. The wheel flange lubrication is controlled by SPEEDOMETER.

3.3 Traction Equipment

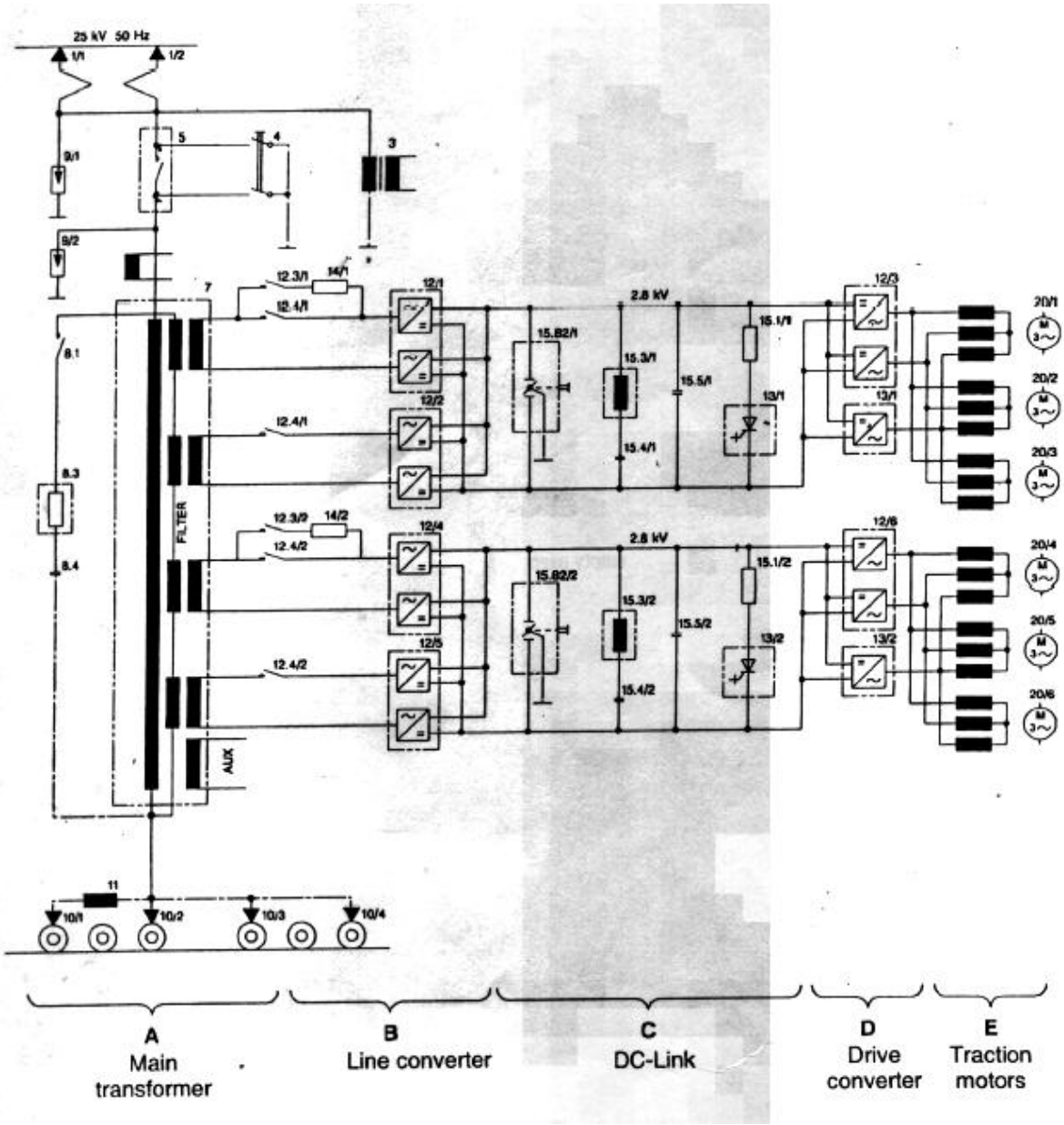


Fig. 3.9 Main diagram traction equipment

1 Pantograph
3 Primary voltage transformer
4 Earthing switch to VCB
5 Main circuit breaker (VCB)
7 Main transformer
8.1 Filter contactor

8.3 Resistor harmonic filter
8.4 Capacitor bank harmonic filter
9 Surge arrestor
10 Earth return brush
11 Earthing choke
12 Valve set 2*ZV
12.3 Pre-charging contactor of converters
12.4 Contactor converter
13 Valve set ZV + MV
14 Pre-charging resistors of converters
15.1 Resistor of over voltage protection unit
15.3 Series resonant circuit choke
15.4 Capacitor bank of series resonant circuit
15.5 Capacitor bank of DC-link
15.82 Earthing switch of DC-Link
20 Traction motors

3.3.1 General Description

Due to technical and economical reasons electric traction vehicles are nowadays provided with three-phase asynchronous traction motors. The three-phase voltage required for operating the traction motors is generated on the vehicle by means of the traction converter connected between the vehicle's main transformer (single phase) and the traction motors.
The traction converter allows the train not only to drive but also to brake electrically. To control the tractive or braking effort, and hence the speed of the vehicle, both the frequency and the amplitude of the three-phase converter output voltage are continuously changed according to the demand from the driver's cab. This allows continuous adjustment of the driving or braking torque of the traction motors, which means that the driving speed changes smoothly.
When braking electrically the traction motors act as generators. In the converter the resulting three-phase electrical energy is converted into single-phase energy which is fed back into the line (recuperation brake).

Output voltage of the Traction converter	2180 V
Output current	831 A
Output power	2365 kW

89.4 An earth fault detection is integrated at the output of the Line converter.

3.3.2 Main Transformer

The locomotive is equipped with a main transformer.

The main transformer converts the overhead line voltage (25 kV) to the lower operating voltages. There are four secondary traction windings (two on each converter unit, 1269 V), one for feeding the auxiliary circuits (1000 V) and one for the harmonic filter. The main transformer is installed in an enclosed, oil-tight aluminum tank together with series resonant choke for traction converter & 3 DC link chokes for auxiliary converters. This aluminum tank is divided into two chambers. The larger chamber contains the main transformer; the smaller chamber accommodates the series resonant chokes at the bottom and the auxiliary converter chokes above them. The transformer tank is made entirely of aluminum. This construction saves weight and, above all, exerts a damping effect on high frequency magnetic fields.

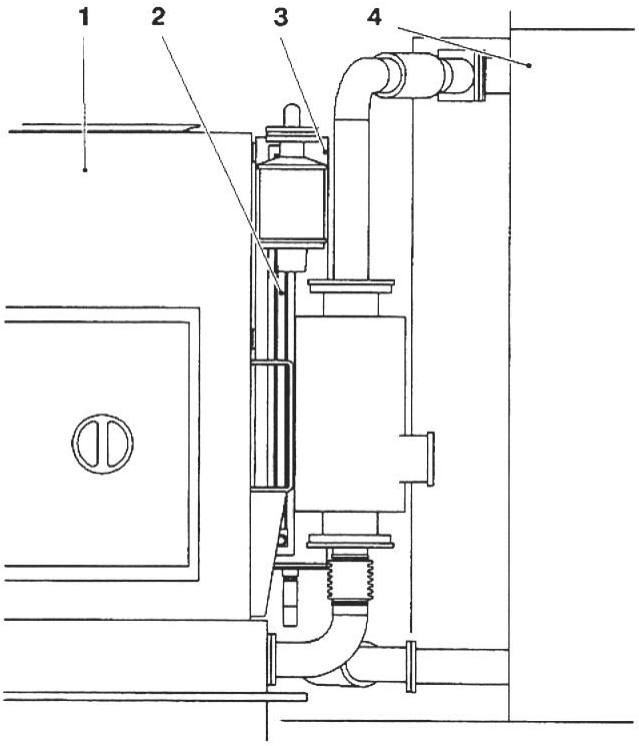


Fig. 3.10 Oil Sight Glass:

1 Oil cooling unit
2 Oil sight glass
3 Expansion tank
4 Traction converter

The tank is filled with transformer oil. An oil level sight glass is located in the machine room (See figure 3.10).

Mineral transformer oil (type Shell Diala DX / Apar oil) is used for cooling the tank.

Two cooling circuits are provided to cool the transformer tank. The two oil pumps of the transformer oil circuit are mounted on the tank. A sensor measures the oil temperature. The maximum allowable oil temperature is 150ºC.

3.3.3 Converter Unit

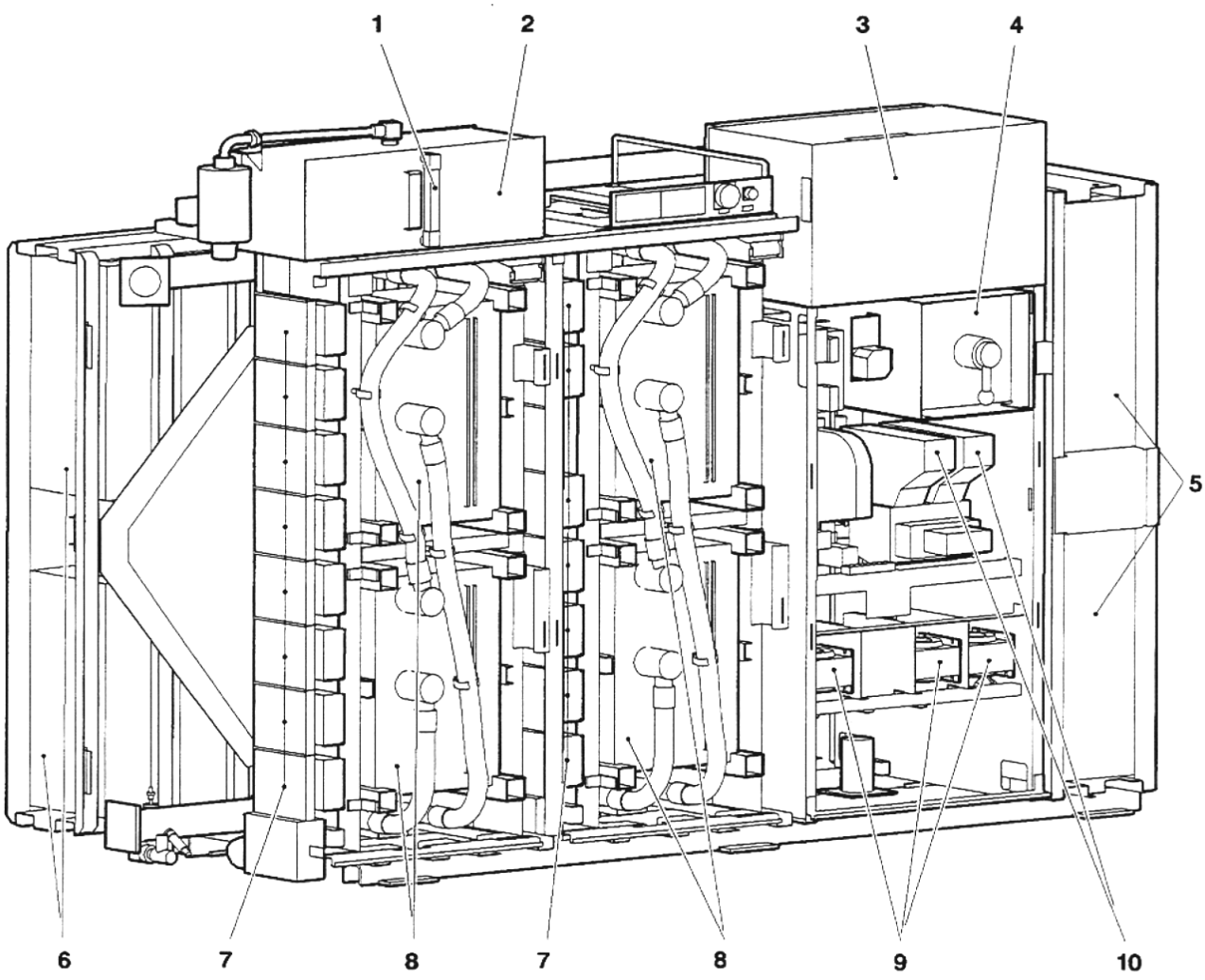


Fig. 3.11 Overview converter unit

1 Oil sight glass
2 Expansion tank
3 Bus station on converter unit
4 Earthing switch
5 Capacitor bank series resonant circuit
6 Capacitors DC-Link
7 Gate Units
8 Valve set
9 Current sensors
10. Converter contactors

The converter unit has the task of converting power between the transformer and the asynchronous traction motors in such a way that optimum tractive or braking effort can be generated at any speed.

Due to GTO technology, the line is ideally loaded with a power factor of almost 1.

A 2-point circuit converter unit is installed on each bogie. The line converter (NSR) converts the constant frequency AC voltage supplied by the transformer into DC voltage (intermediate link).

The drive converter (ASR) generates a 3-phase system with variable voltage and frequency. The energy flow is reversed during regenerative braking.

The power elements of the converter unit (line converter, drive converter) are oil-cooled.

The power semiconductors and all snubber circuits are installed in the valve set tank.

The 2-point circuit valve set in simple terms, performs the function of two static changeover switches in each case.

3.3.3.1 Line Converter (NSR)

The line converter of a bogie comprises two identical valve sets. These connect the secondary traction windings of the transformer to the DC-Link.

3.3.3.2 DC-Link

The power passing through the line converter and the traction converter is not equal at every time interval. Compensation of these energy differences is performed in the intermediate voltage link.

The capacitor bank in the DC-Link maintains DC-Link voltage at a constant level.

To retain control of over voltages in the DC-Link, the DC-Link is equipped with an over voltage protection unit (MUB). This consists of a resistor and a GTO. In case of a protective shut-down the GTOs of ASR & NSR are blocked and the energy stored in the DC-Link is converted into heat in the MUB.

3.3.3.3 Drive Converter

The drive converter (ASR) of a bogie comprises two valve sets. These connect the 2-point intermediate voltage link to the three phases of the traction motors.

On the traction side, it must be possible to set the terminal voltage and the frequency in an infinitely variable manner. To achieve desired values, the cycle pattern is generated with three different control principles:

- ISR (Indirect Self Control) in the lower frequency range.
- DSR (Direct Self Control) in the middle frequency range up to motor rated frequency.
- Full block process for the range above that of the motor rated frequency (weak field area).

3.3.3.4 Main diagram traction converter

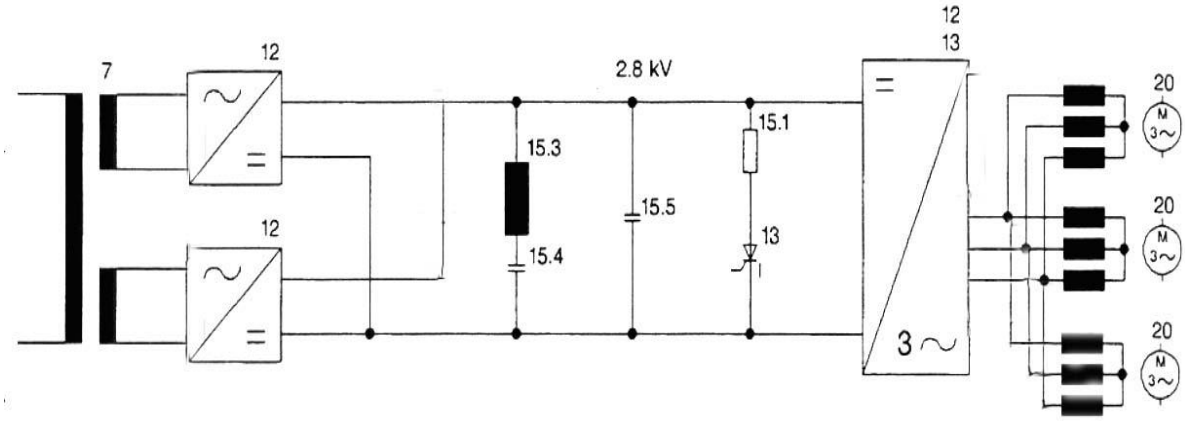


Fig. 3.12 Main diagram traction converter

7 Main transformer
12 Valve set 2*ZV
13 Valve Set ZV + MV
15.1 Resistor over voltage protection unit
15.3 Series resonant circuit choke
15.4 Capacitor bank series resonant circuit
15.5 Capacitor bank DC-Link
20 Traction motors

3.3.4 Traction Motors

The traction motors are asynchronous squirrel cage motors adapted in electrical terms to the traction converter providing the power source.

All three traction motors of one bogie are ventilated by one traction motor blower. The traction motors are connected to the gear box.

Each traction motor is equipped with two temperature sensors and two motor speed sensors.

3.4 Auxiliary Circuit Equipment

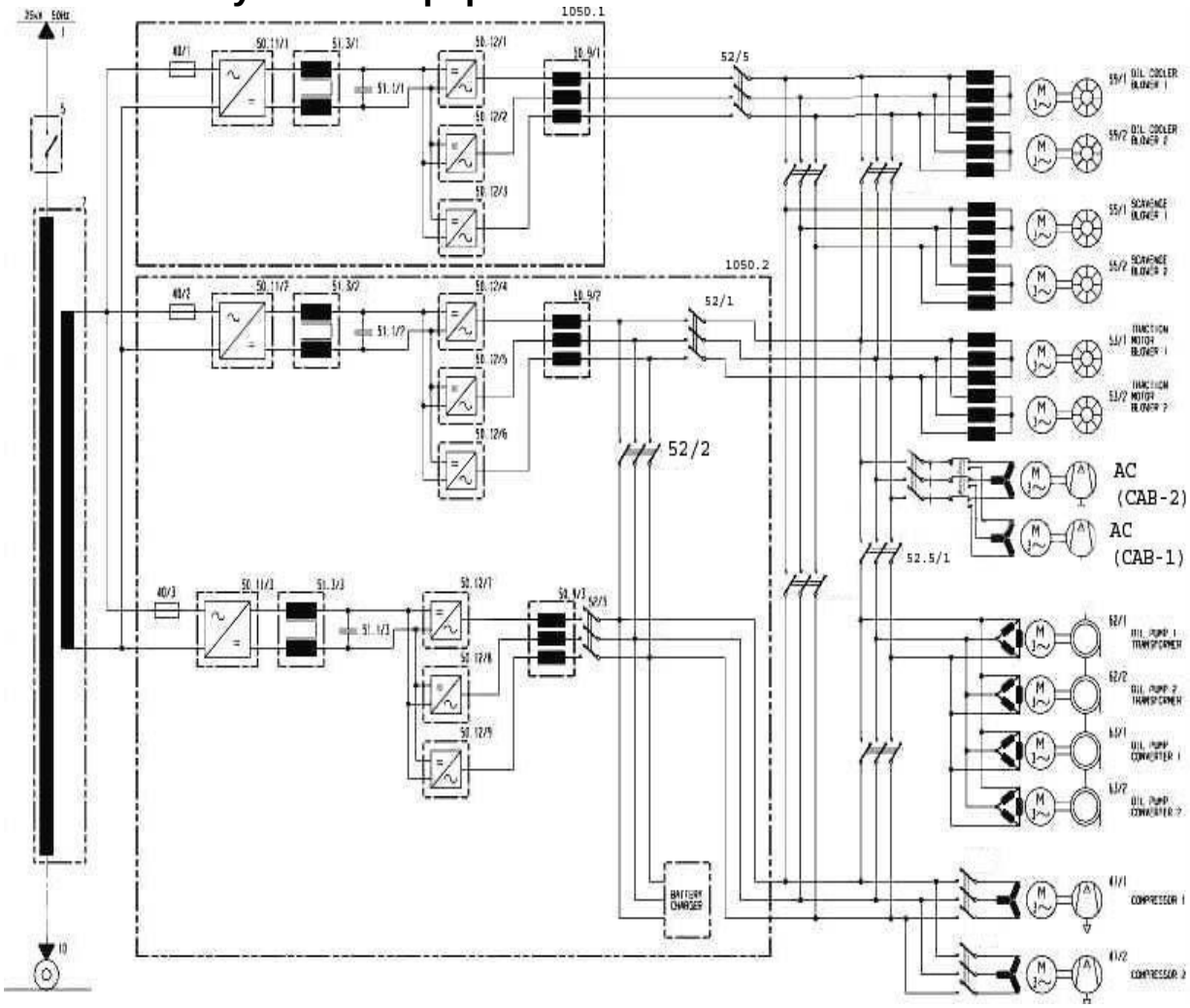


Fig. 3.13 Main diagram auxiliary circuit equipment

1.	Panto graph.
5.	Main circuit breaker (VCB)
7	Main transformer
10.	Earth return brush
40.	Fuse auxiliary converter input
47	Main compressors
47.2	Contactors main compressors
50.11	Rectifier module auxiliary converters
50.12	Inverter module auxiliary converters
50.9	3-phase output choke
51.1	Capacitor bank DC-Link, auxiliary converters
51.3	DC-Link choke, auxiliary converters
52	Contactors for auxiliary circuits
52.4	Contactor scavenge blowers
52.5	C contactor oil pumps
53	Traction motor blowers
55	Scavenge blowers to traction motor blowers
59	Oil cooling unit (Transformer, converter)
62	Oil pump transformer
63	Oil pump converter
1050.1	Auxiliary converter, Box 1 (BUR1)
1050.2	Auxiliary converter, Box 2 (BUR2 + BUR3)

3.4.1 Auxiliary Circuits

The motors used for the auxiliary circuits are 3-phase squirrel cage motors. The cost of maintenance is therefore low. The 3-phase power required is supplied by the auxiliary converter controls (BUR), which in turn receive their power from a secondary winding on the main transformer.
The following loads are connected to the auxiliary converters:

- Blower for the traction motors
- Blower for oil cooler on converter and transformer
- Scavenge blowers to traction motor blowers and oil cooling blowers
- Oil pumps for converter and transformer
- Compressors
- Battery charger

The auxiliary circuits are controlled as required. The oil cooler blowers run only when required (BUR1). The control electronics adjust the selected stage of measured operating temperatures, nominal traction values and speed.

The machine room blowers and the corresponding scavenge blowers are directly supplied by the auxiliary transformer. Therefore, these blowers are running as soon as the VCB is closed (independent of MCE).

The oil pumps for the transformer and for each converter and the traction motor blower of both bogies work continuously during operation of the auxiliary converter (BUR2). The scavenge blowers to traction motor blowers and compressor works during operation of the auxiliary converter (BUR3).

3.4.1.1 Starting Cycle for One Main Compressor.

273.3 To avoid the compressor to start against air pressure, there is one unloading valve provided for both compressors. If both compressors do not operate, the unloading valve shall remain de-energized. During compressor start, the unloading valve shall be energized. Both compressors will be used alternately i.e. after a pump up of compressor 1, the next pump up will be done by compressor 2 and so on.

172.2 1. Monitoring of low air pressure switch

2. Ramp down the frequency of the auxiliary inverter (BUR 3) from 50 Hz to 0 Hz with rate of 2Hz/sec.

273.3 At the same time release the air by opening the unloading valve. (If not already open).

47.2/2 3. Close compressor contactor.

Or

47.2/1 4 Ramp up the BUR frequency from 0 Hz to 50 Hz with rate of 5Hz/ sec.

5 3 sec. after the BUR is running on 50 Hz, the unloading valve shall be de-energized

3.4.1.2 Starting cycle for two main compressors

172.3 1. Monitoring of low air pressure by pressure switch

2. Ramp down the frequency of the auxiliary inverter (BUR 3) from 50 Hz to 0 Hz with rate of 2Hz/sec..

273.3 At the same time release the air by opening the unloading valve. (If not already open).

47.2/2

Or 3. Close both the compressor contactor.

47.2/1

4. Ramp up the BUR frequency from 0 Hz to 50 Hz with rate of 5Hz/sec.

5. '3' sec after the BUR is running on 50 Hz, the unloading valve shall be de-energized

272.3 Or 269.4 If one compressor is running and the pressure switch requires the second compressor to start up, the following sequence will happen:

Ramp down the auxiliary inverter (BUR3) frequency from 50 Hz to 0 Hz with rate of 2Hz/sec. At the same time release the air with opening of unloading valve.

3.4.2 Single Phase 415/110 V Auxiliary Circuit

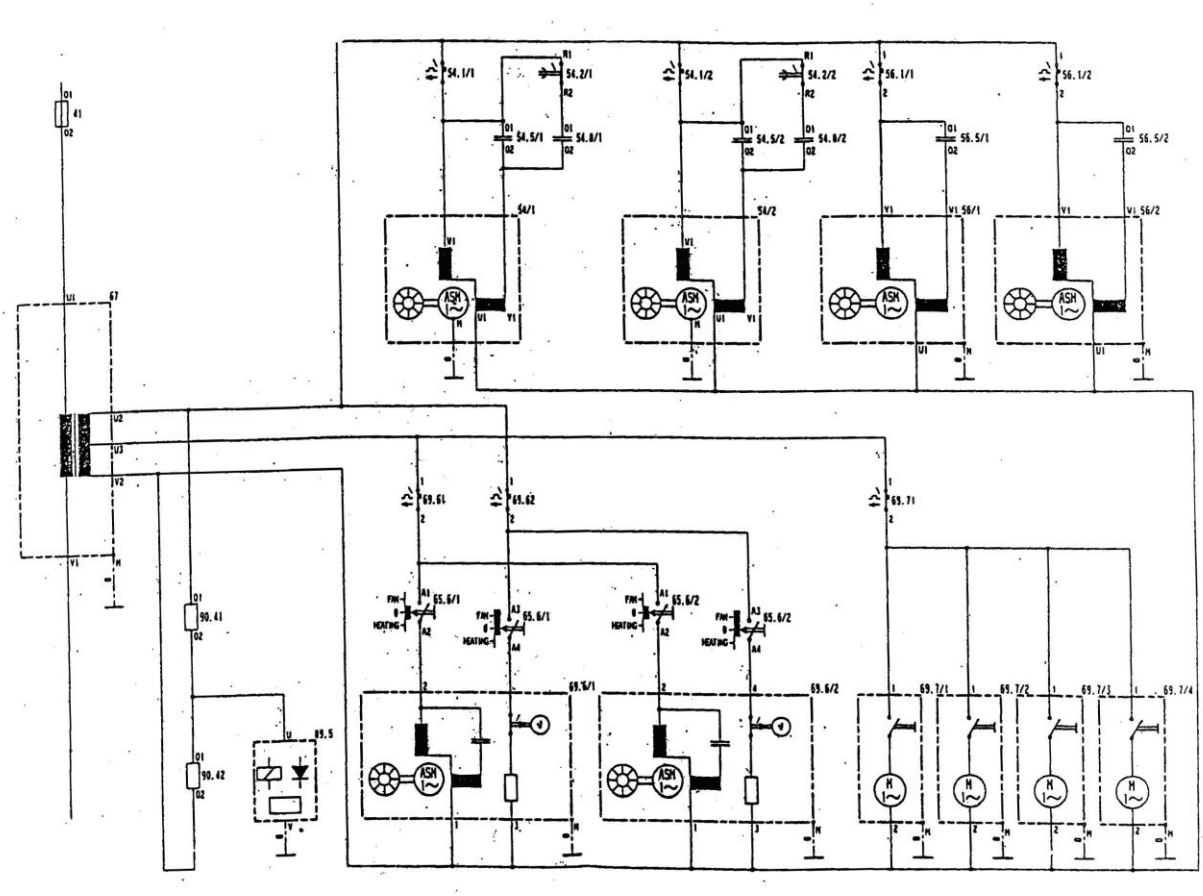


Fig.3.14 Main diagram single phase 415/110 V auxiliary circuit

41 Fuse auxiliaries 415 V/ 110 V
54 Machine Room Blower
54.1 Circuit breaker to MR blower
54.2 Time relay MR blower
54.5 Capacitor to MR blower motor
54.8 Capacitor to MR blower motor (start-up)
54.A Connector MR blower
56 Scavenge blower to MR blower (item 54)
56.1 Circuit breaker to scavenge blower MR (item 56)
65.6 Rotary switch cab heater / fan device
67 Auxiliary transformer 415 V / 110 V
69.6 Cab heater / ventilation
69.61 Circuit breaker cab ventilation
69.62 Circuit breaker cab heater
69.7 Crew fan
69.71 Circuit breaker crew fan
89.5 Earth fault relay 415 V / 110 V
90.41 Earthing resistor earth fault detection 415 V / 110 V
90.42 Earthing resistor earth fault detection 415 V / 110 V

3.4.2.1 Single Phase 415/110 V Auxiliary Circuit

The auxiliary transformer is located in the cubicle – 1 (HB1) and supplied the following systems with single phase power:

- 415 V AC for the two machine room blowers
- 415 V AC for the two scavenge blowers to MR blowers
- 415 V AC for cab heating elements (cab 1 and 2)
- 110V AC for cab heater fans and crew fans (cab 1&2)

89.5 At the output of the transformer an earth fault relay is connected to detect earth fault in this circuit.

The following circuit breakers are provided for protection of auxiliary motors:

54.1 Circuit breaker to MR blower
56.1 Circuit breaker to scavenge blower MR
69.61 Circuit breaker cab ventilation
69.62 Circuit breaker cab heater
69.71 Circuit breaker crew fan

3.4.3 Ventilation system

3.4.3.1 General

The locomotive is equipped with the following ventilation systems:

56 Two scavenge blowers for the machine room blower
54 Two machine room blowers
55 Two scavenge blowers for the traction motor blowers and the oil cooling units
53 Two traction motor blowers
59 Two oil cooling units (transformer/converter)

The ventilation of the traction motor and oil circuits is based on a three-stage design, with ventilation being controlled by the equipment temperatures.

Note:

If one of the on-board converters (BUR) fails the whole load is distributed between the two remaining BURs. They can continue to supply the auxiliary circuits, practically without losses and full traction is also available.

The machine room blower and the corresponding scavenge blowers are fed directly from the auxiliary transformer and therefore operate independently of the MCE, as soon as the VCB is closed. Therefore the loco can be cooled even if MCE is not in operation.
The blowers on the traction motor and the oil cooling units are individually supplied for each bogie by the auxiliary converter (BUR).

However, if two BUR fail, there is no traction available and the power supply to the auxiliary circuit fails.

Reaction:

LOCO DEAD

3.4.3.2 Scavenge Blowers

Each of the three ventilation systems is using a centrifugal filter panel where contaminated air is removed via a scavenge flow system. The efficiency of the filter panel is dependent on the removal of contaminants by the scavenge system, and therefore it is important that the scavenge system meets the minimum flow rate requirements.

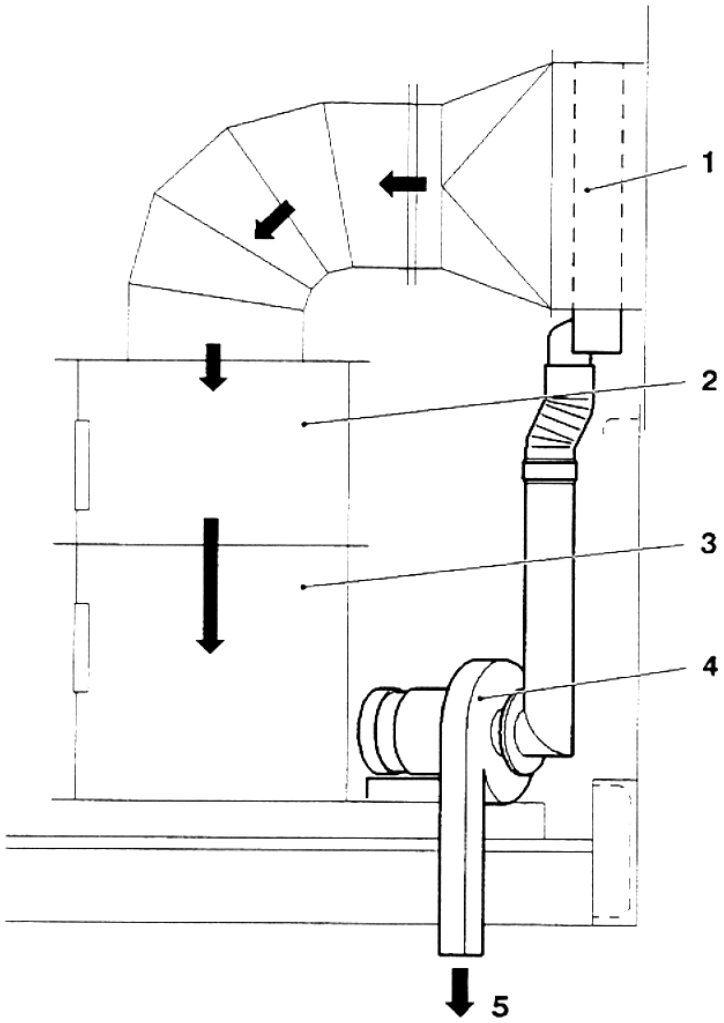


Fig. 3.15 Scavenge Blower:

1 Filter panel
2 Machine room blower
3 Air duct
4 Scavenge blower to MR blower
5 Outlet of contaminated air

3.4.4 Cooling Concept

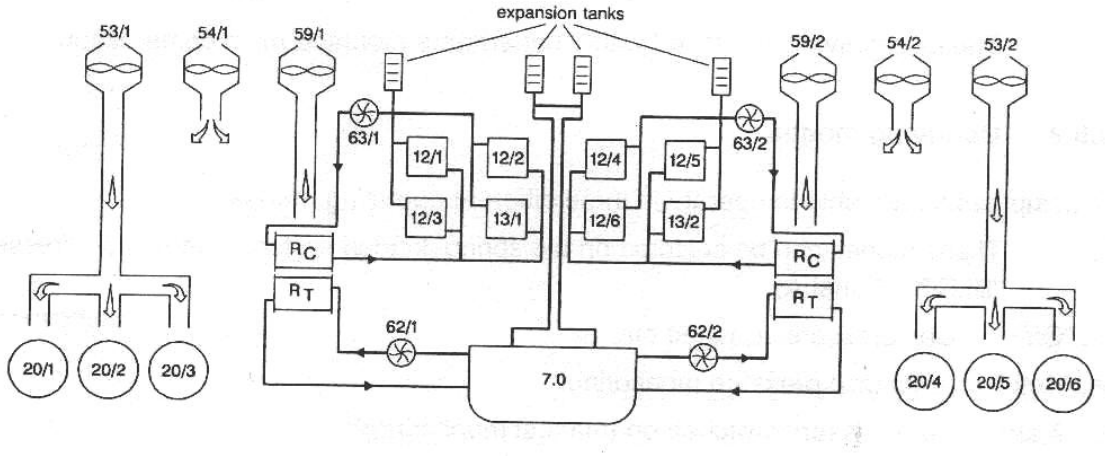


Fig.3.16 Overview oil circuits

7.0 Main transformer
12 Valve set 2* ZV
13 Valve set ZV + MV
20 Traction motor
53 Traction motor blower
59 Oil cooling unit blower
54 Machine room blower
62 Oil pumps for transformer
63 Oil pumps for converter
R_C Radiator converter
R_T Radiator transformer

3.4.4.1 Oil Pumps

The system comprises:

62 Two oil pumps for the transformer
63 One oil pump on each of the two converters

Note:
The oil pumps run continuously as soon as the auxiliary converters are switched on.

3.4.5 Generation of Compressed Air

3.4.5.1 Main Compressors

47 The locomotive is equipped with 2 underframe mounted main compressors.

3.4.5.2 Operating Modes

The compressors are able to operate in three different operating modes.

172 These modes can be selected on the spring-loaded switch on main compressor “BLCP”, (Panel A).

Pos. “Off” Compressors switched off.
Pos. “Auto” Automatic pressure monitoring.
Pos. “Man” Compressors switched on (manual monitoring).

3.4.5.2.1 Operating mode “OFF”

172 Move spring-loaded switch “BLCP” into position “OFF”
Both main compressors are switched off.

3.4.5.2.2 Operating mode “AUTO”

The compressors are monitored by the specified pneumatic switches.

172.2 If the pressure drops below 8 kg/cm^2, the “Main compressor” switch 8 kg/cm^2 cuts out. Both units start to run at the same time until a pressure of 10 kg/cm^2 is reached

172.3 If the pressure drops below 8 kg/cm^2, the “Main compressor” switch 8 kg/cm^2 cuts out. Both units start to run at the same time until a pressure of 10 kg/cm^2 is reached.

269.4 If the pressure drops below 5.6 kg/cm^2, when the “Low main reservoir” pressure switch closes, this initiates a Start/Running Interlock and the message “Low pressure, main reservoir appears on the monitor.

Both compressors start to run until a pressure of 10 kg/cm^2 is reached.

3.4.5.2.3 Operating mode “MAN”

172 In this operating mode, the driver moves the “BCLB” switch into the position “MAN”. Both compressors run as long as the VCB is closed and the switch is set in the position “MAN”.

Note:

The compressors are not cut out even if the main reservoir pressure exceeds 10 kg/cm^2. The compressors are, however, protected against over pressure by their safety valves.

3.4.5.3 Auxiliary Compressor

172.4 The auxiliary compressor is used if the prevailing pressure is too low to raise the pantograph. While the control circuit is switched on, the auxiliary compressor is controlled by a pneumatic switch independently of the MCE. If the pressure is low, the auxiliary pressure will start automatically on switching on the control circuit till the pressure reaches 6.0 kg/cm^2.

3.4.5.4 Air dryers

284.5 The air dryer is actuated when at least one of the main compressors is switched on.

3.5 Control circuit

3.5.1 Battery

111 The battery is a NI-Cd accumulator, which consists of 78 cells, which are connected in series. The nominal capacity is 199 Ah/C5A (C5A means that the capacity is 199 Ah assuming the battery has discharged in 5 h).

The battery is in two halves, which are located on each side of the locomotive.

All electrical components in the control current circuit are designed for a nominal voltage of 110 V DC + 25% / - 30%.

Note:
If due to a fault the battery ceases to be charged, a fully charged battery is able to supply the control circuits with power for approx. 5 hours.

3.5.2 Control Current Distribution

The battery provides a direct power supply

1 To the control circuit of the locomotive.
2 To the lighting of the machine room.

The following main circuit breakers are provided to be operated manually:

110 Circuit breaker battery charger output (SB2)
112.1 Circuit breaker control circuit loco (SB2)
310.4 Circuit breaker lighting machine room (SB2)
112 Circuit breaker battery (location: outside battery – half 111/1)

The following circuit breaker is operated automatically by BUR 3:

100 Circuit breaker battery charger input

3.6 Control Electronics

3.6.1 General

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

The master sequential control (MSC) defines the current state of the locomotive with the aid of a node number. The node number is the central reference for all the system processors and is therefore decisive for maintaining the proper locomotive operating procedures. The MSC also performs various protection functions, e.g. the main circuit-breaker can only be closed after the MSC has reached the corresponding node or state.

A sub-sequential control defines the current state of a processor with the aid of a node number. It is generally controlled by the MSC.

The most important functions are duplicated to enable the locomotive to remain in operation in spite of the failure of a sub-system

3.6.2 Bus Concept

The remote arrangement of computers for the control electronics means that not much wiring is required for the control signals.

Information is recorded as closely as possible to their sources and the actuating members are piloted by the nearest computer.

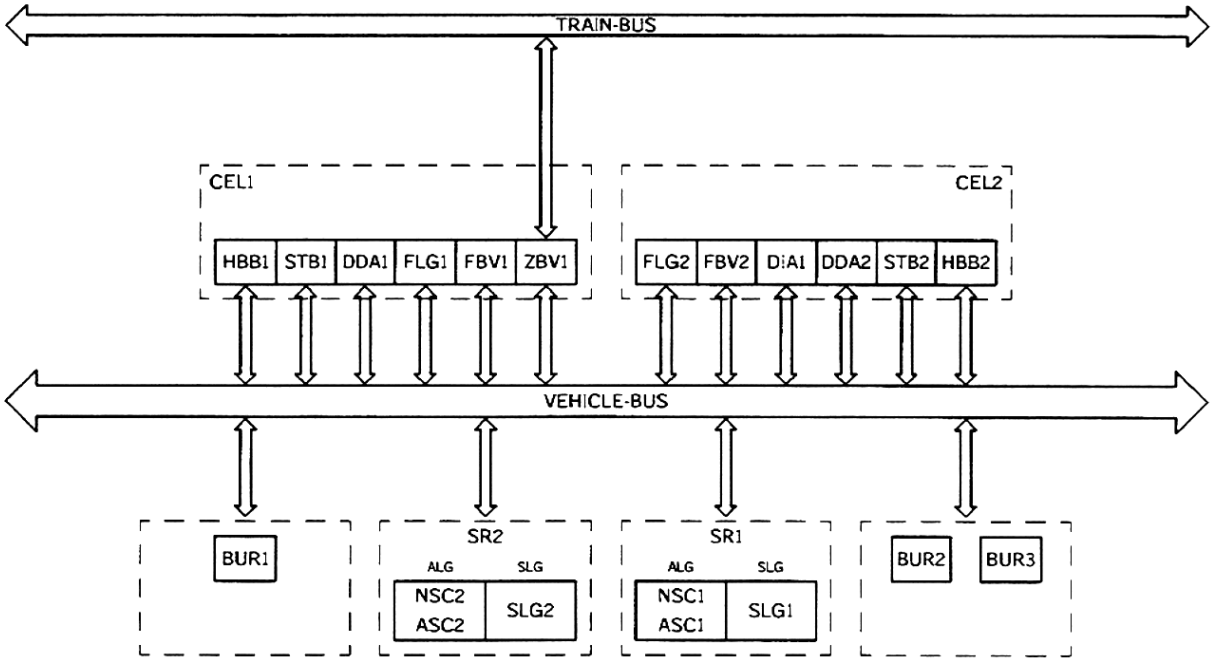


Fig. 3.17 Main diagram control electronics

SR Converter
ALG Drive Control Unit
SLG Converter Control Unit
ASC Drive Converter Control
NSC Line Converter Control
BUR Auxiliary Converter Control

HBB Auxiliary Cubicle Control
STB Low Voltage Cubicle Control
FLG Vehicle Control Unit
FBV Vehicle Bus Administrator
ZBV Train Bus Administrator
DIA Diagnostic Control
DDA Display Data Control

The vehicle bus directs the information flow to the different computers by fiber-optic cable. The networking of signals takes place solely in the computers which means that the control electronics system always has a complete picture of the status of the locomotive at all times. This is a major benefit, especially when dealing with faults in the system.

3.6.3 Bus Stations

A control electronics level with at least one computer and a connection to the vehicle bus is defined as a bus station.

3.6.4 Third Party Control Electronics

The following third party systems are operated by their own control electronics and independent from the above mentioned bus concept:

Brake control (Pneumatic brake systems)

Automatic Vigilance

Fire detection

Speedometer

3.7 Safety Systems

3.7.1 Vigilance Control Module (Automatic Vigilance Control):

The WAG-9/9H & WAP-7 locomotive is equipped with a safety system which initiates rapid braking if there is doubt about the train driver's presence in the cab, or about his level of vigilance.

3.7.1.1 Dead Man Mode

Release of the foot pedal at any time causes an automatic switch to the "Dead man" safety mode. In this mode the audible warning is sounded after 60 seconds and the brake application and power cut off initiated after 8 seconds. Resetting from the driver's controls is not possible, pressing of the vigilance pedal or the push-button "BPVG" is the only means of resetting the system.

Reaction:
The alarm will be triggered and the emergency brake is applied after 8 secs.

Note:

The acknowledgement of the alarm can be done only by pressing the foot switch "VIGILANCE", or the push-button "BPVG on assistant driver desk (panel D)

3.7 1.2 Resetting after penalty brakes

Bring the TE/BE throttle to "0".

237.5 Pres the yellow vigilances acknowledge push-button BPVR, on panel-A.
Press & release the VIGILLANCE, foot switch

Note

A reset cannot be made for at least 120 seconds after penalty brakes are applied.

3.7.1.3 Vigilance Mode

235 Within a period of 60 seconds the train crew must press the spring-loaded "VIGILANCE" foot switch

or

192.1 initiate sanding by pressing the "SANDING" foot switch

or

the train driver alters the position of the TE/BE throttle in such a way that a difference of at least 3% appears between the first and the second value.

236 the train crew must press the green push-button "BPVG" on panel "D".

If one of these conditions is met, the monitoring cycle is reset and the 60 seconds cycle starts again.

3.7.1.4 Alarm Operation

If none of these conditions is met within 60 seconds, an alarm is triggered.

Reaction:

An intermittent signal sounds in the driver's cab (546 Hz) from BZ-V-O-F.

242.1 The yellow vigilance warning indication lamp "LSVW" is lit continuously.

Acknowledgement of the alarm:

235 Press and release the "VIGILANCE" foot switch or the push-button "BPVG".

Note:

If the acoustic alarm is not acknowledged within 8 seconds, rapid braking is initiated.

3.7.2 Fire Detection System

212 The locomotive is equipped with a fire detection system in the machine room.

Through a ring line with apertures at regular distances air in the machine room is extracted with a fan and checked for traces of smoke by a detector.

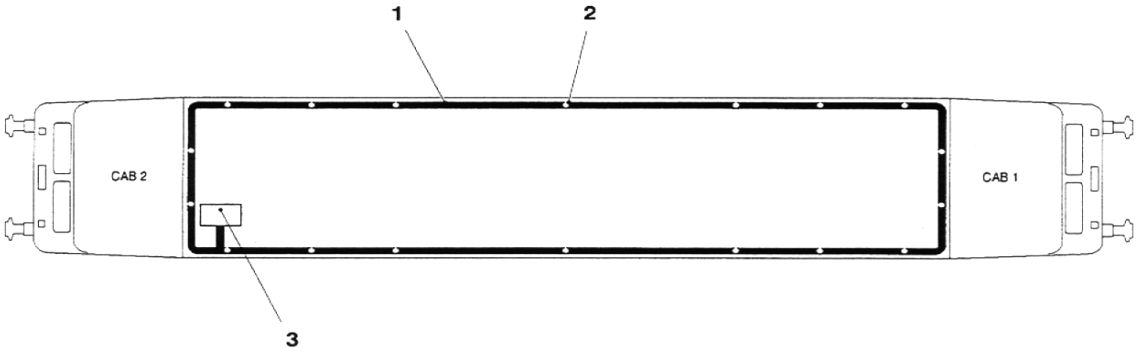


Fig. 3.18 Fire alarm system

1 Air intake line
2 Air Suction aperture
3 Fire Detection Equipment in SB2

The fire detection unit is equipped with two smoke sensors.

- **1. The first detector which detects smoke triggers an alarm:**

An intermitted signal (1170 Hz) sounds in the driver's cab, from the buzzer BZ-V-O-F.A fault message priority 2 appears on the monitor.

Note:

The machine room has to be inspected.

- ***2. If both detectors detect smoke in the machine room the following actions will be initiated**:*

-

A fault message priority 1 on the monitor (the red "LSFI" fault status indication lamp flashes)
A Start/Running Interlock (TE/BE becomes 0)

Note:
The driver takes the specified course of action.

3.7.2.1 Reset of the Fire Alarm

Press “Reset” button on the Fire Detection Equipment in the machine room.

163.1 Press “BPFA” acknowledge button in the driver’s cab. The yellow lamp extinguishes.
A fire alarm is recorded by the monitoring system.

The detection of a failed fire detection unit will create a priority 2 fault message. Afterwards, there is no limitation to drive the loco.

3.7.3 Fire Extinguishers

The WAG-9 /9H & WAP-7 is equipped with a total of 4 fire extinguishers:

There is one in each driver’s cab. There are two in the machine room. The fire extinguishers are to be operated manually to extinguish fire.

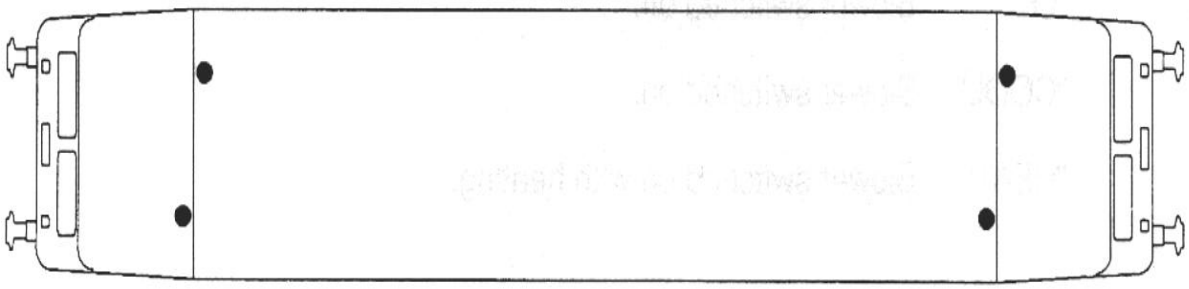


Fig. 3.19 Location of the fire extinguishers

3.8 Comfort Equipment

3.8.1 Ventilation/Heating

3.8.1.1 Fan

69.7 In the driver's cab, there are two fans in the top corners, each vertically and horizontally adjustable. The one in the top left corner is for the train driver and the one in the top right corner is for the assistant driver. The switches for operating these fans are located on the front of each fan.

3.8.1.2 Cab Ventilation / Heating (recirculating air blower)

69.6 The cab is equipped with a recirculating air blower connected to a heater.

65.6 The rotary switch cab heater is located on the right side beside panel D on the assistant driver's side and has 3 settings:

"O"	Blower switched off.
"COOL"	Blower switched on.
"HEAT"	Blower switched on with heating.

3.8.1.3 Forced Ventilation

There are two apertures on the roof of the cab on left and right sides, fitted with revolvable blades, which ventilate the cab while the train is in motion.

3.9 Windshield Wiper/Washer Unit

To clean the windshield, each of the two windshields is fitted with a pneumatically driven wiper blade, the speed of which is continuously adjustable. If the pneumatic fails, the wiper can be operated manually. The operating switch for the wipers is located on the driver's desk towards the assistant driver's side.
In addition, a spray device is fitted. The water tank for this is located on the right side of the driver's cab below the window.

3.10 Protection Concept

3.10.1 General

The protection concept is based on the following two main principles:

1. Prevention of dangerous situations
2. Prevention of damage

There are passive and active forms of protection:

Passive protection is defined as preventive measures such as

- Contact protection
- Earthing
- Adequate dimensions
- Over voltage surge arrestor.

Initiation of protective measures in dangerous situations means active protection

Active protection

Most measures are controlled by the MCE. For this purpose, the MCE monitors a range of values such as voltages, currents, temperatures, pressures and other signals.

In addition

- earthing switches
- circuit breakers
- fuses

are used for active protection.

3.10.2 Interlocking Concept (for Maintenance / Repair)

To prevent high voltage reaching the locomotive while high voltage components are accessible, the locomotive is equipped with a lock and key based interlocking system. This operates with different coloured keys and starts in the following manner:
Key A (light blue) and B (yellow)

By locking the pantograph valve at Pneumatic Panel (PP), key A becomes free.

Key A unlocks the earthing switch on the main circuit breaker. If this is moved into earthing position, the locomotive is earthed and both B keys become free.

Key B is used to unlock the key multiplier No. 1 for key C. Key multiplier No. 1 is located in the machine room behind the cab.

Note:

The second B key (yellow) can be kept in the custody of a responsible supervisor for additional safety.

The seven C keys (green) are used for:

- Opening the auxiliary circuit block 1
- Opening the auxiliary circuit block 2
- Opening the auxiliary converter 1
- Opening the auxiliary converter 2
- Opening the filter block
- Unlocking the earthing switch on traction converter 1
- Unlocking the earthing switch on traction converter 2

By actuating the earthing switch on the traction converter, one D key (black) becomes free in each case. With both D keys together, the key multiplied No. 2 for key E (white) is unlocked. Key multiplier No. 2 is located in the machine room behind the cab.

With the 6 E keys, the following doors can be opened:

1004.6	Traction converter 1, door lock 1 - 3
1004.6	Traction converter 2, door lock 1 – 3

Note:

The following actions have to be taken before the above-mentioned procedure is executed:

125	*1*	*set the key switch to the position “O”*
112.1	*2*	*set circuit breaker “Control Circuits Locomotive” on SB2 to position “OFF”*

To cancel the Earthlings of the locomotive, proceed in reverse sequence.

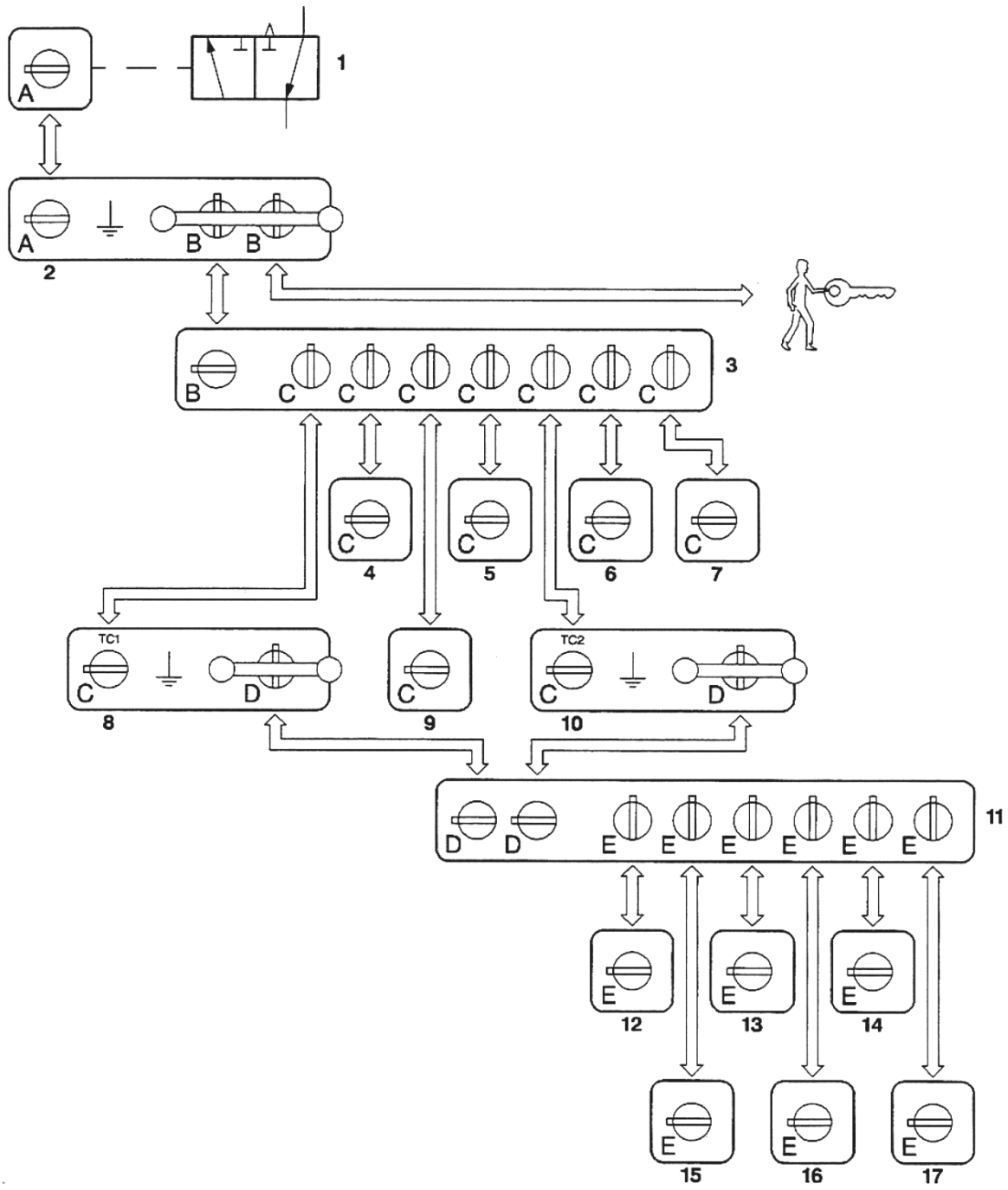


Fig. 3.20 Interlocking concept

1004.1	1	Pantograph air supply isolating cock	Blue
4	2	Earthing switch of main circuit breaker	1 blue, 2 yellow
1004.2	3	Key multiplier 1	1yellow, 7 green
1004.4	4	Door lock auxiliary circuits, Block 1	Green
1004.4	5	Door lock, auxiliary circuits, Block 2	Green
1004.4	6	Door lock, auxiliary converter 1	Green
1004.4	7	Door lock, auxiliary converter 2	Green
15.82/1	8	Earthing switch on traction converter 1	1 green, 1 black
1004.4	9	Door lock on filter block	Green
15.82/2	10	Earthing switch on traction converter 2	1 green, 1 black
1004.5	11	Key multiplier 2	2 black, 6 white
1004.6	12	Door lock, traction converter 1	White
1004.6	13	Door lock, traction converter 1	White
1004.6	14	Door lock, traction converter 1	White
1004.6	15	Door lock, traction converter 1	White
1004.6	16	Door lock, traction converter 1	White
1004.6	17	Door lock, traction converter 1	White

3.10.3 Protective Measures

3.10.3.1 Protective shut down

The MCE initiates the following actions:

1. Stop pulsing traction converter
5 2. The vacuum circuit breaker (VCB) is switched off (the pantograph remains in raised position).
15.1 3. The MUB (Over voltage Protection Unit) cuts power to the DC-Link and the contactors on the converter open.

4. Master Flow Chart in disturbance node.

Reasons for a protective shut down:

- Vehicle bus fault between SLG and ASC or NSC.
- Fault in power supply to Gate Unit.
- Fault in contactor on power converter.
- Negative plausibility checks on processors SLG, ASC, NSC.
- Traction motor over-current, DC-Link over-voltage and over-current, MUB over-temperature.

3.10.3.2 Disturbance with VCB “OFF”

The following actions are initiated:

1. Stop pulsing traction converter
2. VCB opens (pantograph remains raised, converter contactors stay closed)
3. Master Flow Chart in disturbance node.

Reasons for a disturbance with VCB “OFF”:

- Disturbance in loco bus or train bus
- Disturbance node with VCB “OFF” from Master Flow Chart
- Disturbance node with VCB “OFF” from Sub Flow Charts
- Limit monitoring of SLG 1 or SLG 2
- Emergency stop button pressed

3.10.3.3 Traction Interlock

Following actions are initiated:

1. Ramp down the tractive/braking effort by approx. 100 kN/s
2. Stop pulsing of the traction converter (no tractive/braking effort available)
3. Master flow chart in disturbance node without VCB “OFF”.

Reasons for a traction interlock:

- Initiation of emergency braking by the vigilance control module
- Fault in angle transmitter

269.1 - Pressure switch emergency brake open

- Battery voltage too low
- SPEEDOMETER 10% over maximum speed (=110% speed)
- Brake electronics failure

Note:

The traction interlock is released as soon as the reason is eliminated and the train crew moves the TE/BE throttle through position “O”. Releasing this interlock never occurs automatically but always requires manual intervention.

3.10.3.4 Start/Running Interlock

The Start/Running Interlock means that traction is set to “O” with a ramp of approx. 100 kN/s. However, the regenerative brake is still available.

Reason Start/Running Interlock are

- Parking brake applied (not applicable for WAP-7).
- Direct loco brake applied.
- Automatic brake applied.
- The pressure in the main reservoir has fallen below 5.6 kg/cm^2.

293.2
- The isolating cock brake pipe control system is closed.
- Fire alarm.
- Emergency exhaust isolating cock open.

Note:

The interlock is released as soon as the reason is eliminated and the train crew moves the TE/BE throttle through the “O” position. The Start/Running Interlock is never released automatically but always requires manual intervention.

3.10.4 Catenary Voltage

If catenary voltage moves outside the permitted range of 17 kV to 30 kV, the VCB switches off automatically.

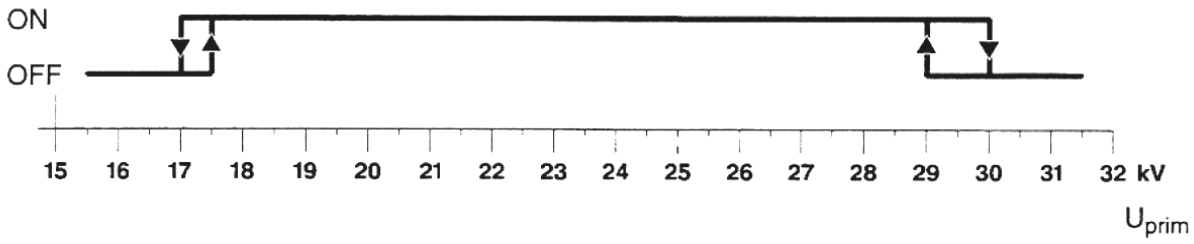


Fig. 3.21 Switching hysteresis, main circuit breaker

3.10.5 Transformer

The primary and the secondary traction windings are equipped with over current sensors. The pressure of the transformer oil is monitored by a range of different measurements. Furthermore, the oil pump circuit breakers and the temperature of the transformer oil circuit are monitored. If one circuit breaker (MCB) is triggered, a fault message with priority 2 is issued.

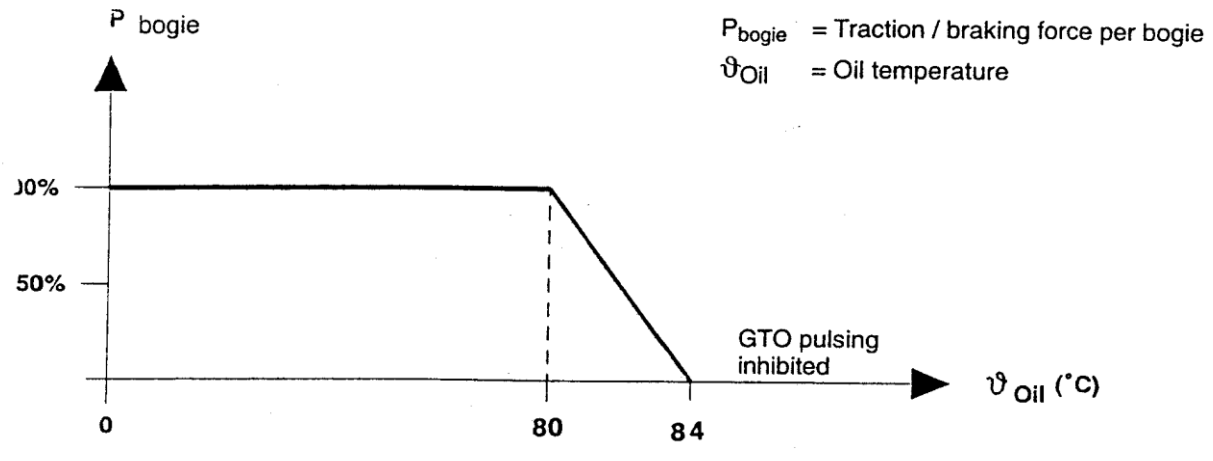


Fig.3.22 Diagram P_{bogie} /V_{Oil} Transformer

	Oil Temperature	Action
1.	T<47°C	Ventilation OFF
2.	T=50°C (ON) T=47°C (OFF)	Ventilation Level 1
3.	T=55°C (ON) T=52°C (OFF)	Ventilation Level 2
4.	T=60°C (ON) T=57°C (OFF)	Ventilation Level 3
5.	T<80°C) 80°C<T<84°C	TE/BE 100% Linear reduction of the TE/BE from 100% to 0%
6	T> = 84°C	GTO pulsing inhibited
7.	T> = 84°C longer than 10 sec	VCB OFF

3.10.6 Line Converter

The protection of the converter is based on four measures:

1. An over voltage chopper in the DC-Link with over voltage protection (MUB).The MUB is controlled by the ALG and protects the DC-Link from over voltage, When a protective shutdown occurs, the DC-Link is rapidly discharged by the MUB. The ALG monitors the temperature of the MUB. Excess temperature in the MUB leads to a protective shut down. The maximum permitted temperature has been selected to allow a protective shut down to occur without endangering the MUB.

2. Power reduction with converter at exceeded temperature.

3. Start/Running Interlock at

- extremely high oil temperatures
- excessively low oil pressures

4. Protective shut down at
- over voltage DC-Link
- over current in the line or traction converter
- contactor on converter stucks in open or closed position
- Gate unit or Gate Unit power supply faulty
- Over voltage protection unit (MUB) faulty
- Fault in ALG/SLG.

5. Battery voltage < 86 V inhibits GTO pulsing of the traction converter.

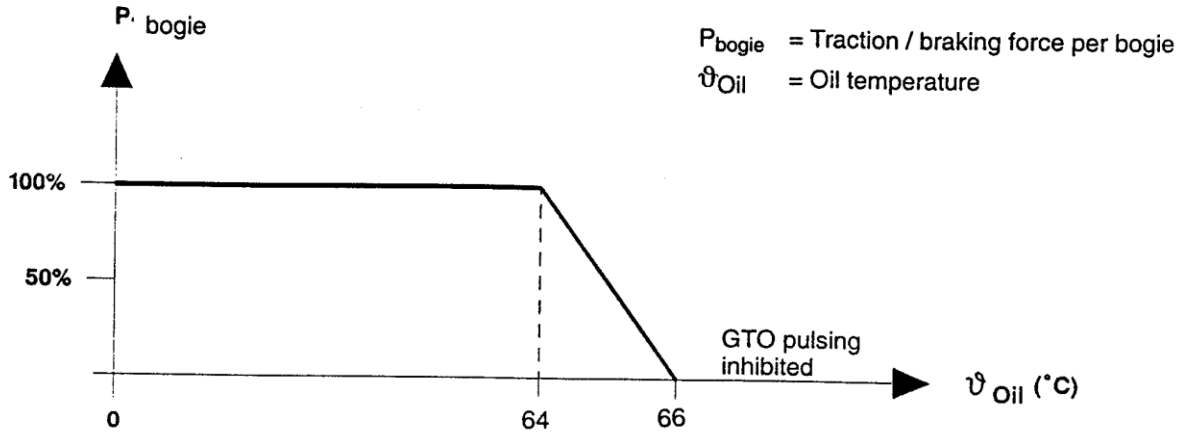


Fig.3.23 Diagram P_{bogie}/V_{Oil} Converter

	Oil Temperature	**Action**
1.	T<42°C	Ventilation OFF
2.	T=45°C (ON) T=42°C (OFF)	Ventilation Level 1
3.	T=50°C (ON) T=47°C (OFF)	Ventilation Level 2
4.	T=55°C (ON) T=52°C (OFF)	Ventilation Level 3
5.	T<62°C 64°C<T<66°C	TE/BE 100% Linear reduction of the TE/BE from 100% to 0%
6	T> = 66°C	GTO pulsing inhibited
7.	T> = 80°C longer than 10 sec	VCB OFF

3.10.7 Traction Motors

The traction motors are protected against excess current by the converter. Appropriate protective measures are implemented in the ALG processor.
The motors are also protected against excessive speed and excessive temperature.

3.10.8 Auxiliary Converters (BUR)

The BURs are protected against the following faults:

- BUR DC-Link – voltage too high
- BUR DC-Link – current too high
- No DC-Link voltage present although rectifier is switched on , e.g.
- Fuse 40 defective
- Inverter faulty.
- Inverter output current too high
- Power supply frequency outside permitted range (50 Hz ± 3%).

In addition:

- Current in the secondary winding of the auxiliary circuits is monitored.
- An earth fault in one of the secondary winding of the auxiliary circuits is detected.
- An earth fault 415 V (single phase) is detected.

3.10.9 Oil Pump and Fan

62; 63 The transformer and converter oil pimps are monitored by:

62.1; 63.1
- the status of the MCBs
- the oil pressure in the converter and transformer.

53; 53.1 The traction motor blowers are monitored by the status of the MCBs.

59; 59.1 The oil cooling blowers are monitored by the status of the MCBs.

53.1; 591 If one of the MCBs has tripped, a fault message with priority 2 is issued.

3.10.10 Battery

1. The control circuits are switched off when the driver’s cab is activated and none of the pantographs is raised for more than 10 minutes (this does not apply during simulation mode).

2. If the output current of the battery charger drops below 10 A, a fault message with priority 2 appears on the display in the driver’s cab.

3. If battery voltage drops below 92 V for more than 30 seconds, a fault message/ warning with priority 2 appears on the display in the driver’s cab.

4. If battery voltage drops below 86 V, an interlock ensures correct switch-off procedure. A priority 1 fault message appears on the display in the driver’s cab.

5. If battery voltage drops below 82 V, then loco will be shut down and all control circuits shall be switched off under all operating conditions.

3.10.11 Control Electronics

3.10.11.1 Reciprocal Monitoring of the Processors

All processors linked to the vehicle bus transmit a monitoring signal to the master vehicle control unit (FLG 1 or 2, i.e. to the Master processor).

A failure of a processor or of the link via the vehicle bus is detected by the FLG because it is unable to receive the corresponding monitoring signal. When this occurs, the VCB is switched off. In a similar manner, the FLG transmits a monitoring signal to all other bus stations. Failure of the FLG processor or of the link via the vehicle bus is detected by the bus stations because they were unable to receive the corresponding monitoring signal.

If the monitoring signal fails only briefly, the protective function trips the VCB.

If it fails for longer than 30 seconds, the affected processor is isolated.

The function of the diagnosis terminal is not monitored by the MCE.

3.10.11.2 Train bus

The train bus during multiple operation is controlled in a similar manner by monitoring the corresponding signals between slave and master locomotive and between master and slave.

If a train bus fault is detected on the master locomotive, the master locomotive generates a fault message with priority 1, without tripping the VCB.

3.10.11.3 VCB

The correct position of the VCB is monitored by the MCE. The following switch modes on the auxiliary contacts are recognized.

1. One N/O contact remains in the “OFF” position for 1 second after the command to switch on: Stuck-Off is detected and the command to switch on is resetted and a priority 1 fault message is generated.

2. One N/O contact remains in the “ON” position for 1 second after the switch-off command has been given: Stuck-“ON” is detected and the command to switch off is resetted, a priority 1 fault message is generated: LOCO DEAD

Protective Actions:

VCB in OFF Position: VCB control changed to redundant processor

VCB in ON Position: Converter contactor opens
Pantograph lowers

3.10.11.4 Converter

15.5 CD Link Capacitors are monitored. If over pressure is detected, value of capacitance should be checked, and capacitors inspected at next maintenance interval.

219 The power supply of the Gate Units is monitored by the converter electronics. If the power supply fails, a protective shut-down operation is initiated.

3.10.11.5 Software

When the wrong software is loaded (e.g. software for WAP-5 installed on WAG-9), a fault message with priority 1 is issued and the pantograph can not be raised into position. (This is for the knowledge of maintenance/commissioning staff).

3.10.11.6 CEL Temperature

211.1 The CEL temperature is monitored by two thermostats. Excess temperature
- generates a DDS (Diagnostic Data Set). A diagnostic data set (DDS) is generated whenever a protective action takes place.
- Actuates the indication lamp “LSCE” and
- Indicates the corresponding fault message on the display.

125 Above 70°C control electronics does not switch on. The driver has to move the cab-activating key to position “C” (cooling mode). Raise pantograph and close VCB. This starts the machine room blowers.

166 When the temperature becomes normal the amber indication lamp “LSCE” extinguishes. Now the cab-activating key switch can be moved to position “D” (driving mode).

Note:

If above message appears during run, do not switch off the CEL.

3.10.11.7 Speed Sensors on Traction Motor

The sensors are monitored by the converter electronics. A defective sensor does not however disconnect the corresponding bogie.

3.10.11.8 Harmonic Filter Circuit

An earth fault in the harmonic filter circuit is detected. The harmonic filter circuit is also protected against over current.

3.11 Redundancy

Certain important systems are double or installed with redundancy to ensure the locomotive remains as functional as possible whenever faults occur.

3.11.1 Auxiliary Circuits

The auxiliary converters (BURs) supply the voltage for the aux. ckts (3 x 415 V).

If one BUR fails, the other two can continue to supply the auxiliary circuits, practically without losses and full traction is also available.

However, if two BURs fail, there is no traction available and the power supply to the auxiliary circuits fails.

Reaction

LOCO DEAD

3.11.2 Traction Motor

Every bogie is equipped with a separate converter. At every major fault, each bogie can be isolated from the electrical power supply. The locomotive can then still be driven at half traction power.

3.11.3 Central Electronics (CEL)

The CEL which contains the processors FLG, HBB and STB can be found in control circuits 1 and 2 (SB1 and SB2).

Failure of the processors has the following consequences:

3.11.3.1 Failure of HBB1

38.1 If HBB1 fails, cab 1 is isolated and, since the earth fault relay on the hotel load is no longer being monitored, the hotel load (WAP-7) must also be disconnected.

Reaction

A change of driver’s cab is necessary, if the driver has been driving from cab 1.

In addition, the following functions will also fail:

1. Monitoring of the miniature circuit breakers (MCB)
2. Monitoring of the earth fault relays 415/110 V.
3. Monitoring of the fuse auxiliaries 415/110 V.

3.11.3.2 Failure of HBB2

A failure of the HBB2 has the following consequences:

- Isolation of cab 2.

Reaction:

A change of driver's cab is required; if the driver has been driving from cab 2.
In addition, the following functions fail or are only available to a limited extent:

1. The parking brake can only be released manually on the PP.
2. The regenerative brake is no longer available.
3. The Vigilance control module has to be isolated manually (message for the train driver).
4. Pantograph 1 not operative.
5. The following pressure switches are no longer monitored:

- Direct brake
- Pantograph 1 and 2
- Train parting
- Low pressure main reservoir
- Brake feed pipe
- Brake cylinder, bogies 1 and 2

3.11.3.3 Failure of STB1

A failure of the STB1 has the following consequences:

- Isolation of driver's cab 1 and of hotel load (for WAP-7).

Reaction:

A change of driver's cab is necessary, if the driver has been driving from cab 1.

In addition, the following functions fail:

1. Air dryer
2. Anti-spin protection valve, bogie 1
3. Switch Failure mode operation
4. Switch Simulation mode
5. Switch bogie cutout.

3.11.3.4 Failure of STB2

A failure of the STB2 has the following consequences:

- Isolation of driver’s cab 2.

Reaction:

A change of driver’s cab is necessary, if the driver has been driving from cab 2.

In addition, the following functions fail:

1. Monitoring circuit breaker for oil pumps, oil cooling unit and traction motor blowers (Including Scavenge Blowers).
2. Input 105% and 110% over speed.
3. Alarm speedometer failure (Pos. 94.2)
4. Monitoring of BUR earth fault relay.
5. Fire alarm on the master locomotive when fire breaks out on the slave locomotive.
6. Input signals from vigilance module for the buzzer.

Note:

Once STB2 has been isolated on the slave locomotive and a fire alarm has been triggered, this cannot be detected on the master locomotive

3.11.3.5 Failure of FLG1

If the FLG1 fails,

- the angle transmitter on the Master Controller in cab 1 also fails
- Failure of TE/BE meter communication in Cab 1.
- Failure of multiple operation via UIC train bus

Note:

See failure mode operation in Chapter or drive from Cab-2.

3.11.3.6 Failure of FLG2

Failure of the FLG2 has the following consequences:

1. Failure of the angle transmitter on the Master Controller in cab 2
2. Failure of the blending unit.
   For safety reasons, the regenerative brake is not available.
3. Failure of TE/BE meter communication in cab 2.

Note:

See failure mode operation Chapter 4, or drive from Cab-1.

3.11.3.7 Failure of DDA1

Following function is not available:

Driver’s cab display in cab 1.

3.11.3.8 Failure of DDA2

Following function is not available.

Driver’s cab display in cab 2.

3.11.3.9 Failure of DIA 1

The following display not available
-Energy consumption
-Loco number
-Diagnostic data sheet (DDS)

3.12 Simulation Mode

3.12.1 General

The simulation mode serves as a check on the MCE software when commissioning the locomotive and during maintenance work without risk to the locomotive. In this mode, the pantograph control module and the concerning fault messages are not active.

The functions of the locomotive are similar to normal conditions but the catenary voltage is absent.

The simulation mode can also be activated if the locomotive and the DC-Link of the converter are earthed.

3.12.2 Setting up and Simulation of Driving

125 1. Move cab activating key switch in the driver's cab into Position "O".
2. Wait until control electronics is switched off.
179 3. Move key switch on cubicle SB1 into position "SIM".

Note:

If the simulation mode is switched on while the MCE is in Normal Mode, this command will be ignored.

4. Move key switch in the driver's cab into position "D", MCE is activated.
125

5. Move the spring-loaded switch "ZPT" briefly into "UP" position:
However, the pantograph does not rise, since it is inoperative in simulation
129 mode. The raising of the pantograph and the Catenary voltage are simulated by the software.

134 6. Move the spring-loaded switch "BLDJ" briefly into the "ON" position:
The VCB closes.

7. Select the direction of travel with the reverser. The converter is set-up and the DC-Link voltage is simulated. The Gate Units are supplied with power.

140

8. Set demanded traction effort with the TE/BE throttle. The effective tractive/braking effort is displayed on both TE/BE meters. The MCE also simulates the appropriate levels of acceleration and speed.

79.1
79.2

Note:

SPEEDOMETER is not activated in simulation mode. The simulated speed is displayed on the screen.

In simulation mode, the battery is not charged and none of the main compressors is operating. Parking brake (not applicable for WAP-7) is applied by the MCE and can not be released by the push button in the driver's cab.

268

3.12.3 Simulation of other Functions

Faults and their remedies
- Emergency braking
- Vigilance control module

Note:

The sander and the wheel flange lubrication are inactive.

4. VEHICLE OPERATION

4.1 Overview Driver's Cab

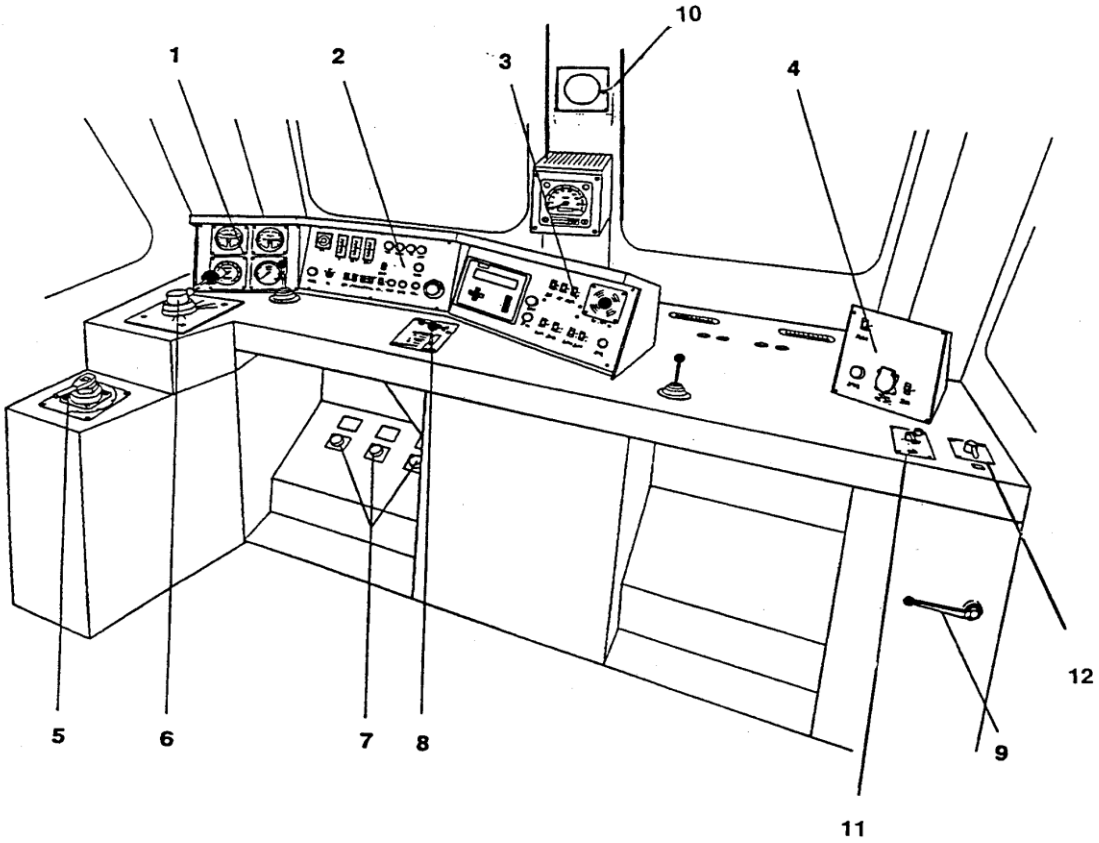


Fig. 4.1 Overview Driver's Cab

1 Panel B
2 Panel A
3 Panel C
4 Panel D
5 Handle Direct Loco Brake
6 Handle Automatic train brake
7 Foot switches
8 Master controller
9 Emergency brake cock
10 Parking brake gauge
11 Wiper knob
12 HRA switch

4.2 Operating Concept

Left hand	**Right hand**
Train-loco brake	**Driving and braking**
Pneumatical	**Electrical**

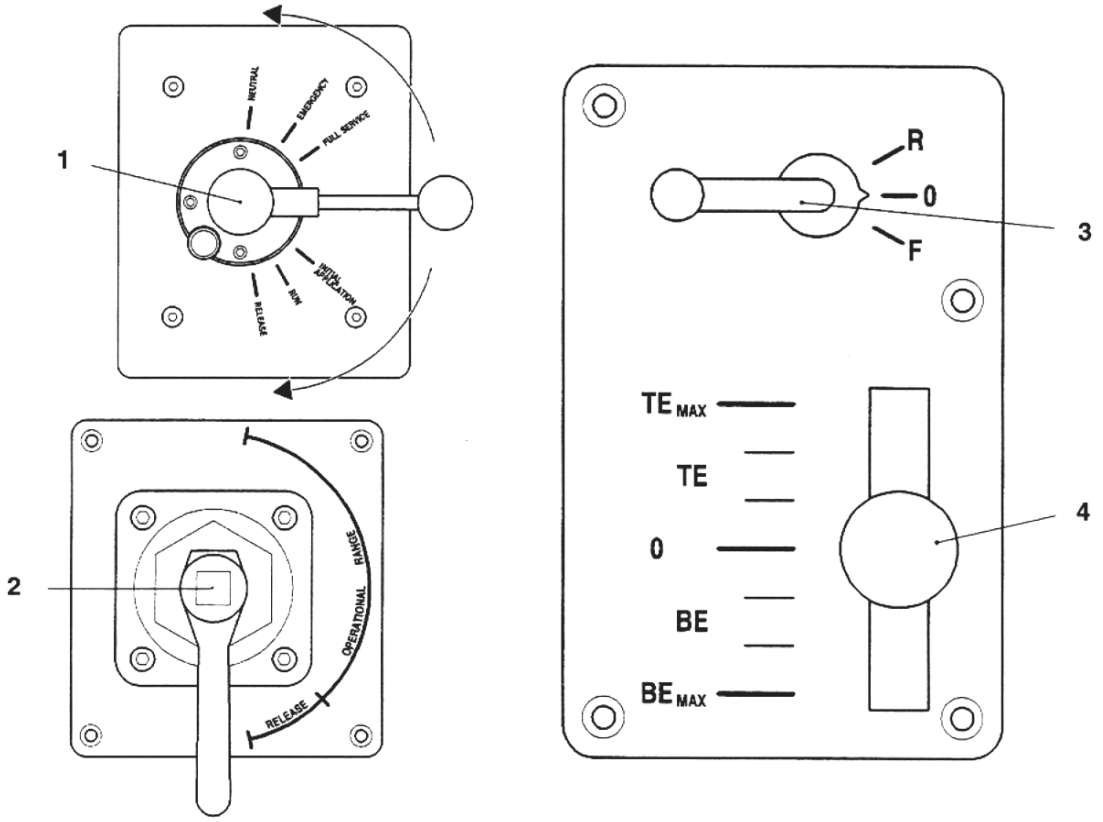


Fig. 4.2 Operating concept:

1 Automatic train brake handle
2 Direct loco brake handle
3 Reverser
4 TE/BE throttle

4.3 Controls

4.3.1 Panel A

Panel A is located in the centre of the field of view of the train driver
It contains the following controls and displays:

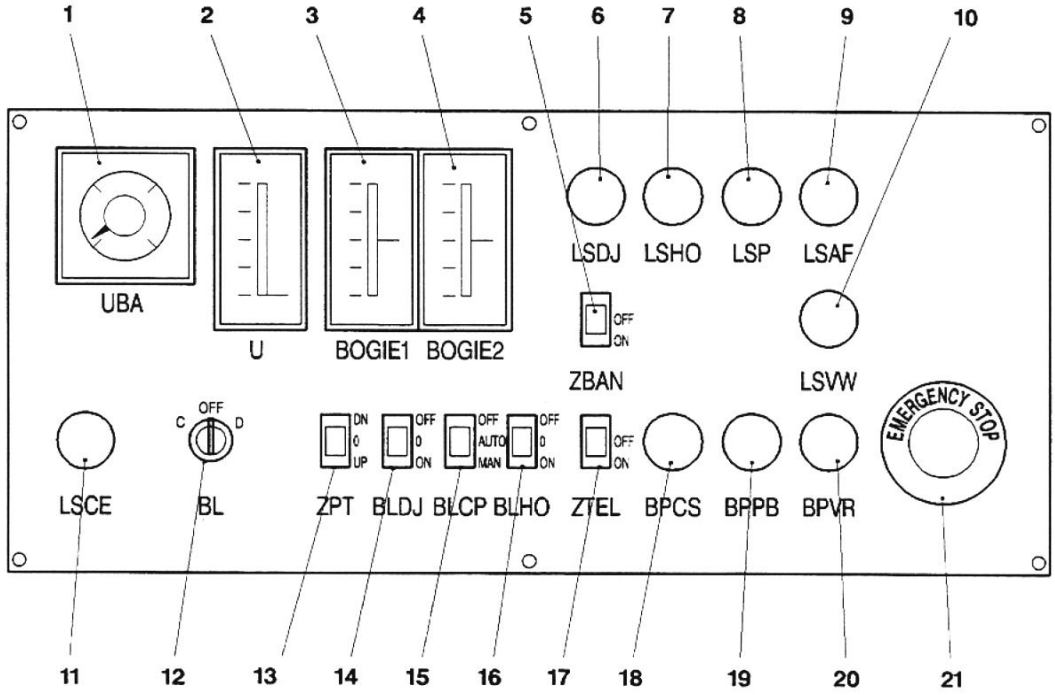


Fig. 4.3 Panel A

116	1	UBA	Voltmeter	Battery voltage
74	2	U	Voltmeter	Catenary voltage
79.1	3	BOGIE 1	TE/BE meter	Traction/braking effort, bogie 1
79.2	4	BOGIE 2	TE/BE meter	Traction/braking effort, bogie 2
153	5	ZBAN	Spring-loaded switch	Banking operation “ON”/”OFF”
137.3	6	LSDJ	Indication lamp, red	Main circuit breaker “OFF”
169.3	7	LSHO	Indication lamp, yellow	Hotel load “ON”(inactive on WAG-9)
92	8	LSP	Indication lamp, yellow	Wheel slipping
81.5	9	LSAF	Indication lamp, red	Train parting
242.1	10	LSVW	Indication lamp, yellow	Vigilance warning
166	11	LSCE	Lamp, amber	Over temperature CEL
125	12	BL	Key switch	Activation of Driver’s cab
129	13	ZPT	Spring-loaded switch	Raise/ Lower Pantograph

134	14	BLDJ	Spring-loaded switch	Main circuit breaker "ON"/"OFF"
172	15	BLCP	Spring-loaded switch	Main compressors
169.1	16	BLHO	Spring-loaded switch	AUTO mode "ON"/"OFF" (inactive on WAG-9)
151.1	17	ZTEL	Switch	Max. traction limitation
151.4	18	BPCS	Illuminated push-button, green	Constant Speed Control
268	19	BPPB	Illuminated push-button, red	Parking brake(inactive on WAP-7)
237.5	20	BPVR	Push-button, yellow	Acknowledge vigilance
244	21	Emergency Stop	Emergency Stop button, red	Emergency stop

4.3.2 Panel B

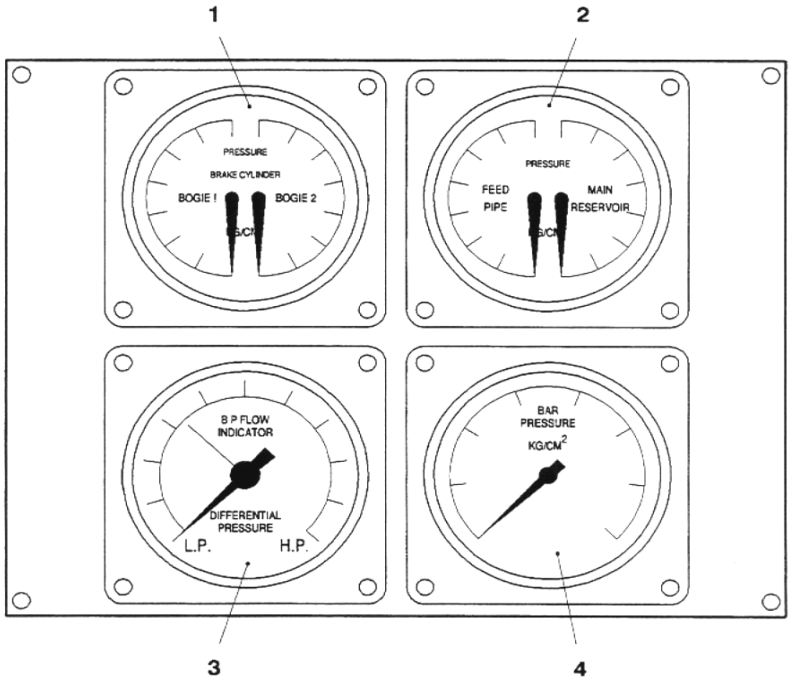


Fig. 4.4 Panel B

1 Pressure Brake Cylinder Bogie 1+2
2 Pressure Brake Feed Pipe/Main Reservoir
3 Air Flow Meter
4 Pressure Brake Pipe

4.3.3 Panel C

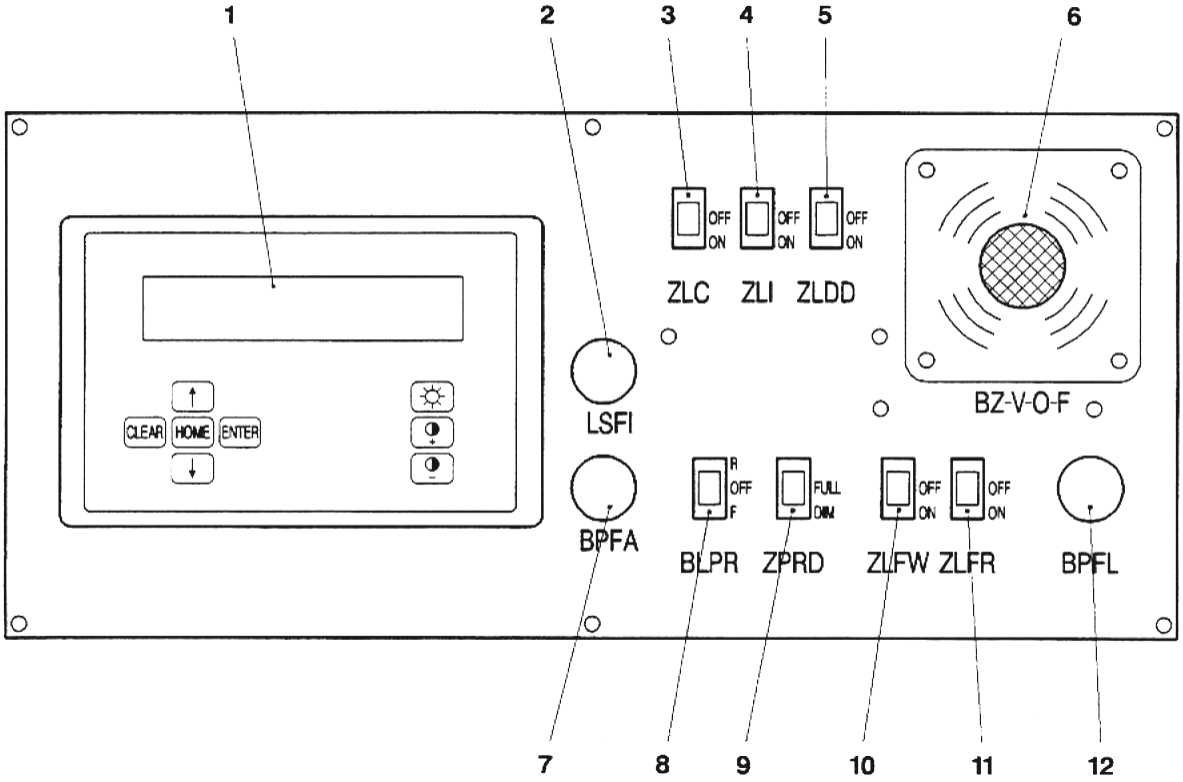


Fig. 4.5 Panel C

435	1		Screen	Display of messages / diagnosis
163	2	LSFI	Indication lamp, red	Fault message, priority 1
324	3	ZLC	Switch	Driver’s cab lighting
324.1	4	ZLI	Switch	Instrument lighting
324.21	5	ZLDD	Switch	Driver’s desk illumination
238	6	BZ-V-O-F	Buzzer	Warning signal, 3 frequencies
163.1	7	BPFA	Illuminated push-button, yellow	Acknowledgement all fault messages
316	8	BLPR	Switch	Headlights
317	9	ZPRD	Switch	Headlights, Intensity
316.11	10	ZLFW	Switch	Marker lights, white
316.12	11	ZLFR	Switch	Marker lights, red
316.2	12	BPFL	Illuminated push-button, yellow	Emergency flash light

4.3.4 Panel D

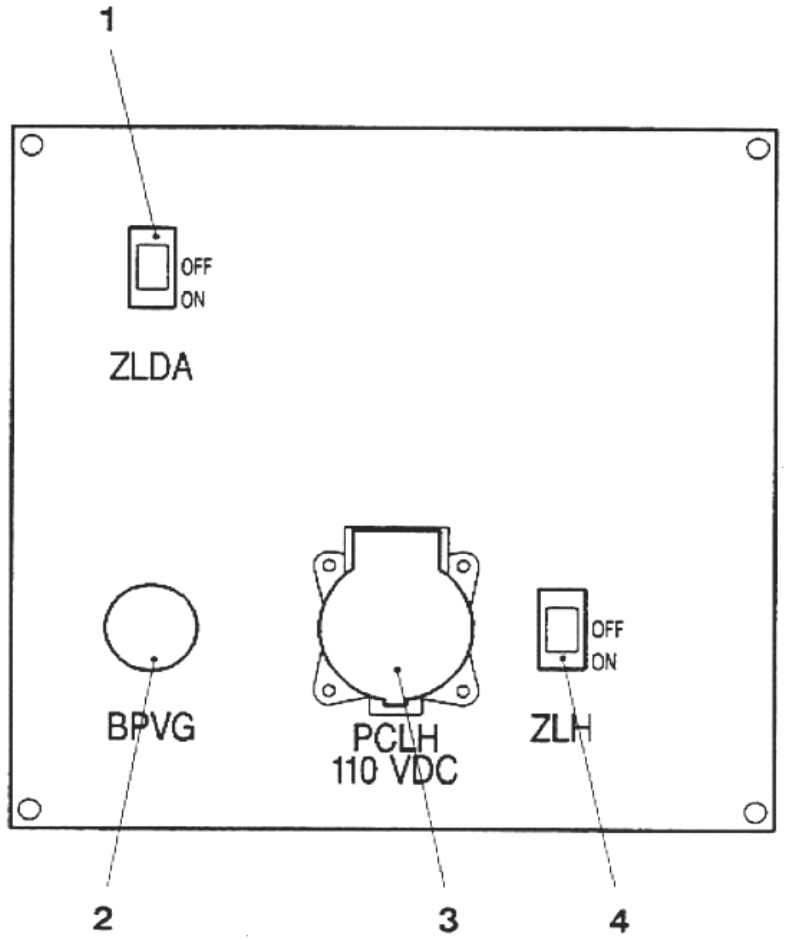


Fig. 4.6 Panel D

324.22	1	ZLDA	Switch	Assistant driver's desk Illumination
236	2	BPVG	Push-button, green	Vigilance
334.1	3	PCLH	Socket	Hand lamp
337	4	ZLH	Switch	Socket hand lamp

4.3.5 Windshield Wiper/Washer Unit

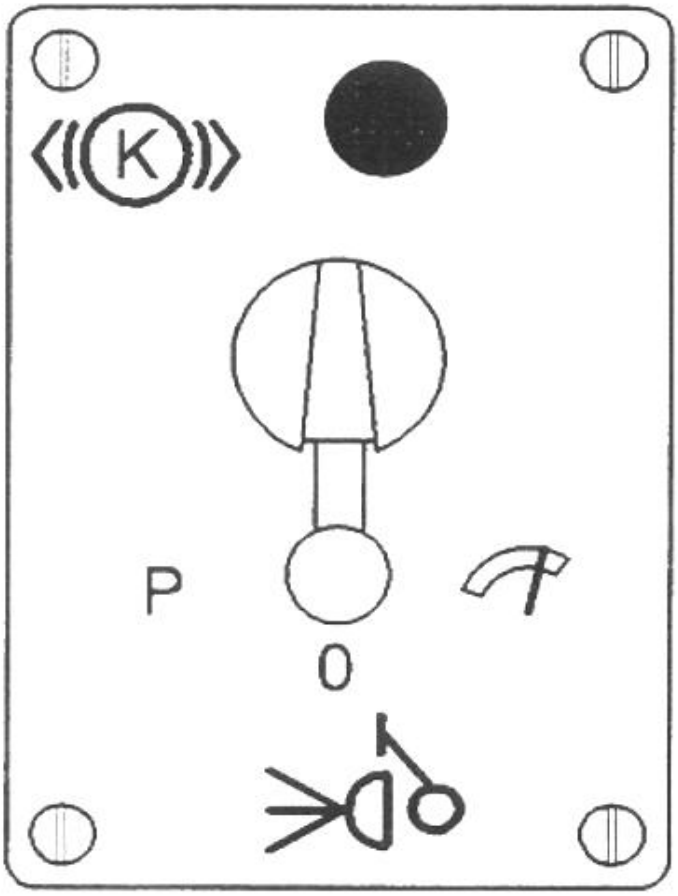


Fig. 4.7 Windshield wiper/washer unit

● Knob for wipers speed control
P Parking position
O Neutral position
Operating position
Press handle to operate washer

4.3.6 Comfort Equipment

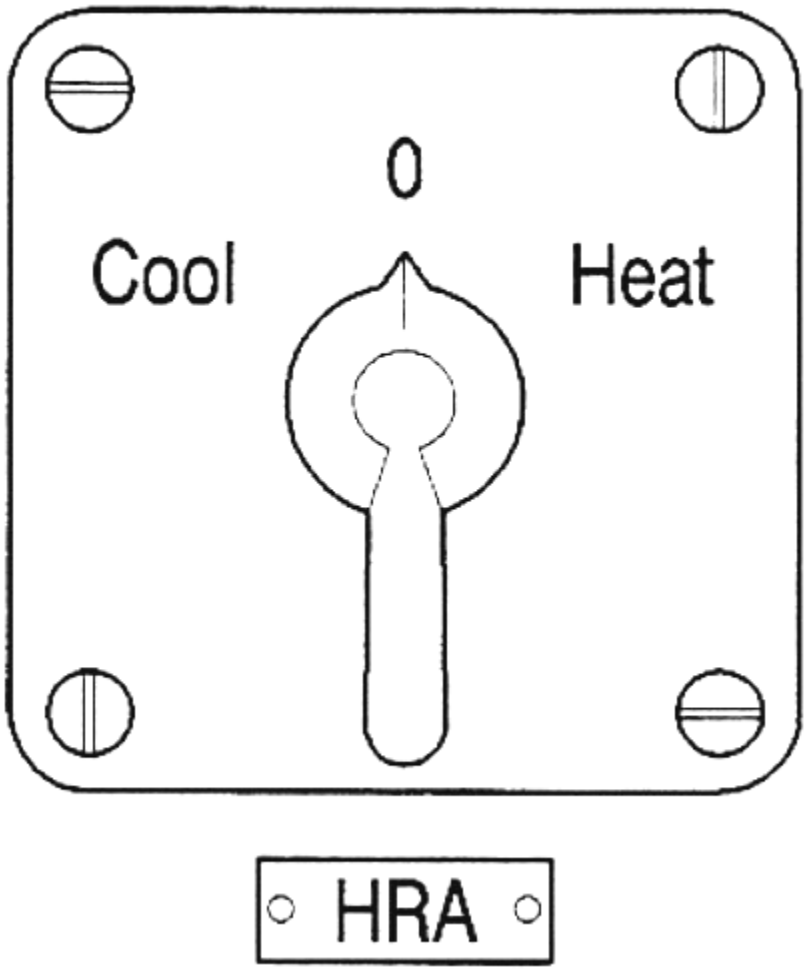


Fig. 4.8 Blower/Heating

O	“OFF”
Cool	Blower “ON”
Heat	Blower/Heating “ON”

4.3.7 Detailed layout of light switches and sockets (driver's cab)

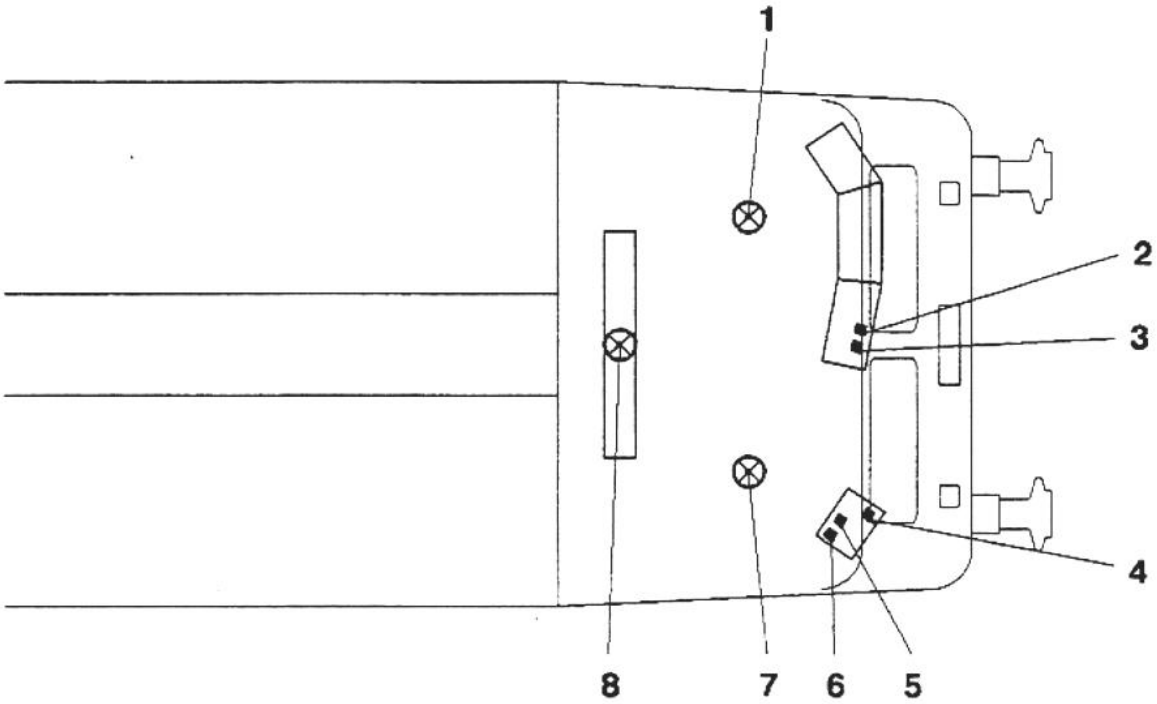


Fig. 4.9 details layout of light switches and sockets (driver's cab)

325.21	1	Lamp driver's desk illumination
324	2	Switch driver's cab lighting
324.21	3	Switch driver's desk illumination
324.22	4	Assistant driver's switch desk illumination
334.1	5	Socket hand lamp
337	6	Switch hand lamp
325.22	7	Lamp Assistant driver's desk illumination
325	8	FL-Lamp driver's cab lighting

4.3.8 Detailed layout of light switches and sockets (Machine room)

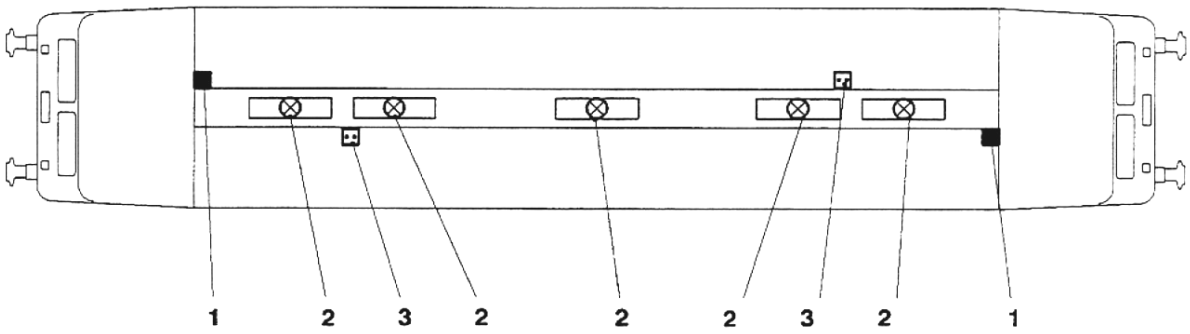


Fig. 4.10 Detailed layout of light switches

327	1	Latching push-button corridor lighting
330	2	FL Lamp corridor lighting
334.2	3	Terminal bar 110 V DC

4.3.9 Auxiliary Circuits, Cubicle – 1 (HB1)

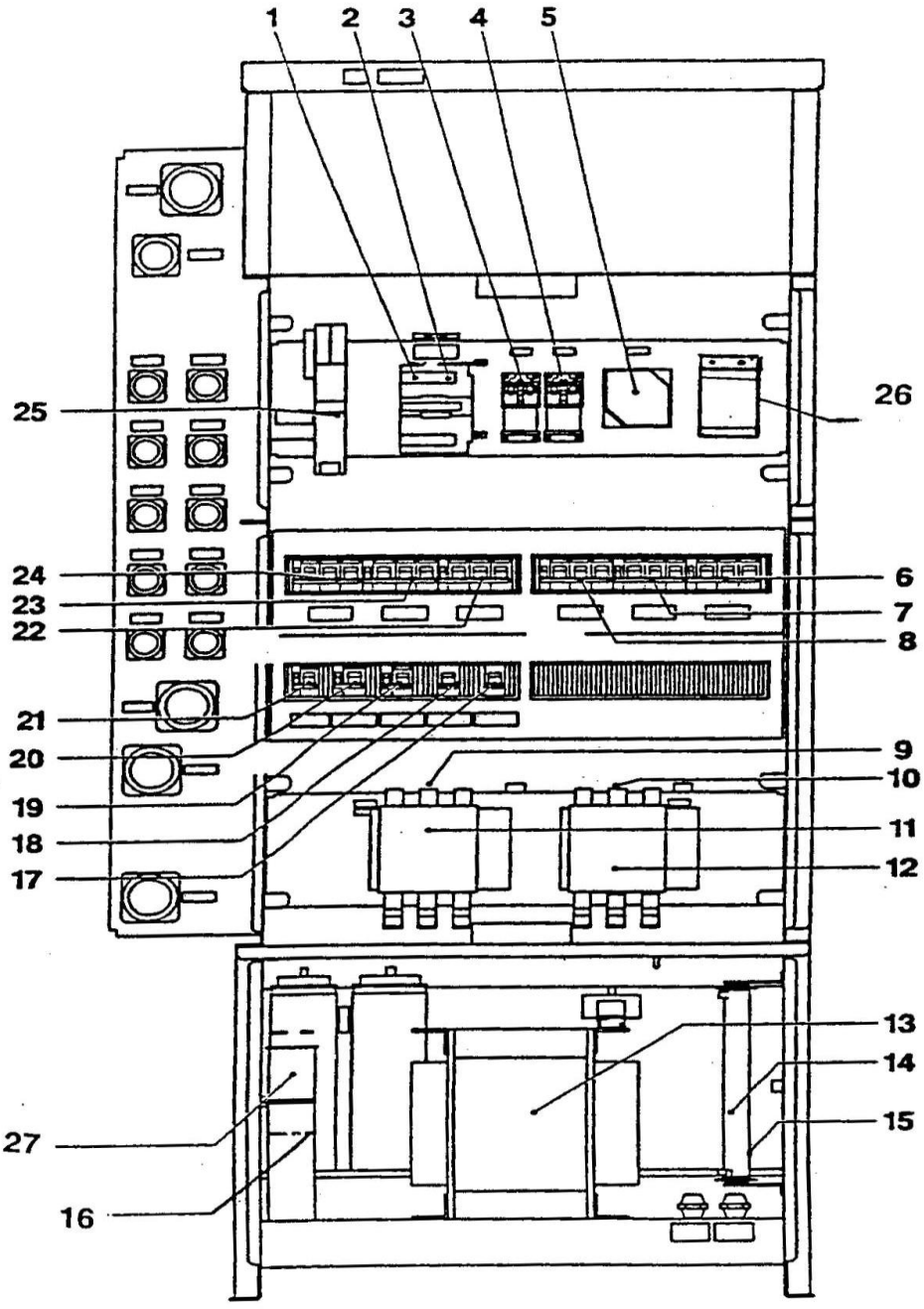


Fig. 4.11 Auxiliary circuits, cubicle-1

1.	47.2	Contactor, main compressor
2.	47.2A/1	Snubber circuit to item 47.2
3.	52.3/4	Auxiliary contactor to item 52
4.	52.3/5	Auxiliary contactor to item 52
5.	89.5	Earth fault relay 415/110 V
6.	59.1/1	Circuit breaker, oil cooling unit, transformer/converter
7.	55.1/1	Circuit breaker, scavenge blower to traction motor blower and oil cooling unit
8.	53.1/1	Circuit breaker, traction motor blower
9.	52.A/4	Snubber circuit to item 52
10.	52.A/5	Snubber circuit to item 52
11.	52/4	Contactor auxiliaries
12.	52/5	Contactor auxiliaries
13.	67	Transformer, auxiliary circuits 415/110 V
14.	90.41	Earthing resistor earth fault detection 415/110 V
15.	90.42	Earthing resistor earth fault detection 415/110 V
16.	54.4/1	Capacitor to MR blower motor
17.	69.71	Circuit breaker, crew fan
18.	69.62	Circuit breaker, cab heater
19.	69.61	Circuit breaker, cab ventilation
20.	56.1/1	Circuit breaker, scavenge blower to machine room blower
21.	54.1/1	Circuit breaker, machine room blower
22.	47.1/1	Circuit breaker, main compressor
23.	63.1/1	Circuit breaker oil pump converter
24.	62.1/1	Circuit breaker oil pump transformer
25.	41	Fuse auxiliary 415/110 V.
26	54.2/1	Time, relay for MR blower
27.	54.8/1	Capacitor to MR blower

4.3.10 Auxiliary Circuits, Cubicle-2 (HB2)

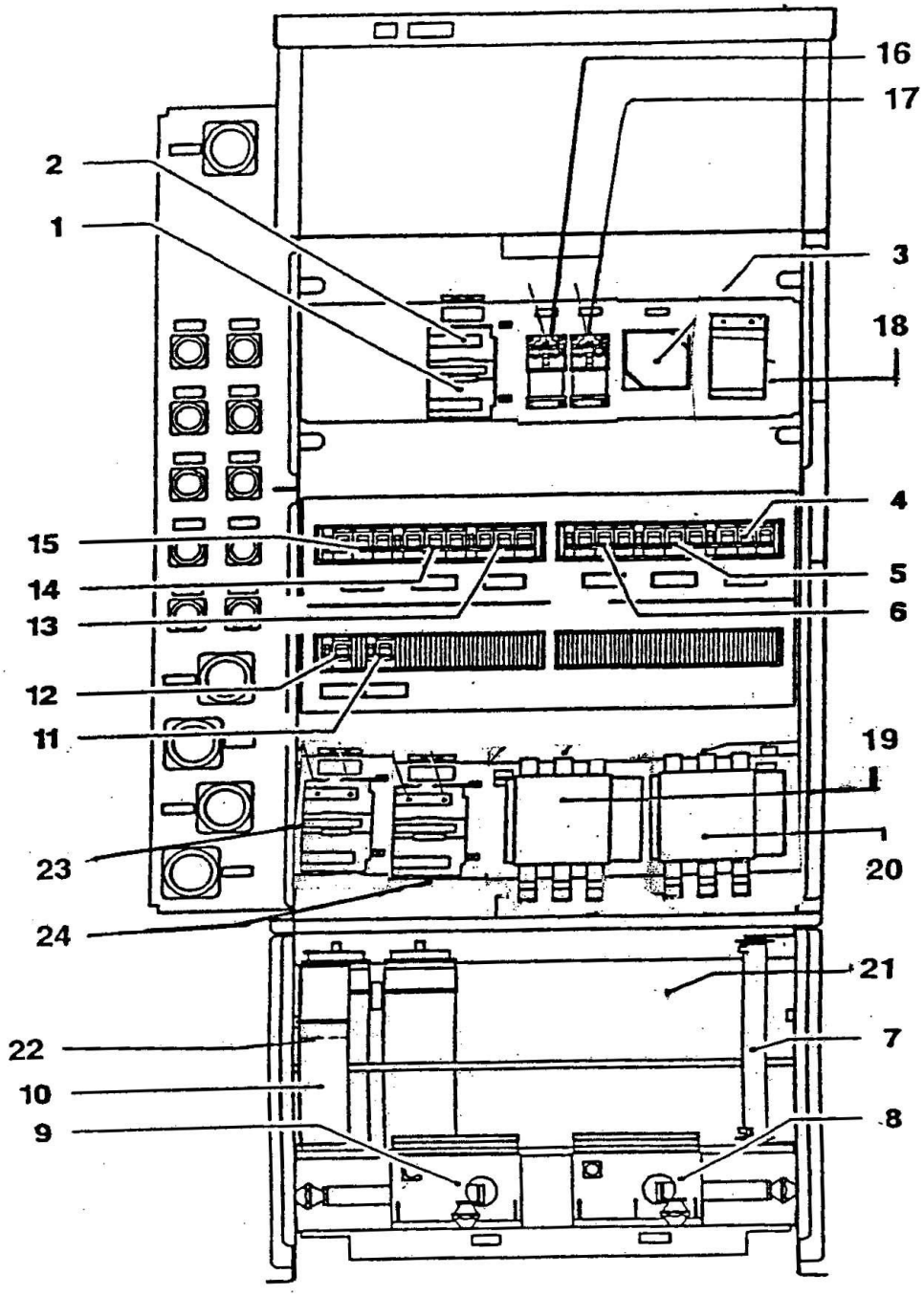


Fig. 4.12 Auxiliary circuits, cubicle-2

1.	47.2A/2	Snubber circuit to item 47.2
2.	47.2/2	Contactor, main compressor
3.	89.2	Earth fault relay, auxiliary converter
4.	59.1/2	Circuit breaker, oil cooling unit, transformer/converter
5.	55.1/2	Circuit breaker, scavenge blower to traction motor blower and oil cooling unit
6.	53.1/2	Circuit breaker traction motor blower
7.	90.3/1-2	Earthing resistor earth fault detection auxiliary converter
8.	42.3/2	Current sensor, auxiliary circuits
9.	42.3/1	Current sensor, auxiliary circuits
10.	54.5/2	Capacitor to MR blower motor
11.	56.1/2	Circuit breaker, scavenge blower to machine room blower
12.	54.1/2	Circuit breaker, machine room blower
13.	47.1/2	Circuit breaker, main compressor
14.	63.1/2	Circuit breaker, converter oil pump
15.	62.1/2	Circuit breaker, transformer oil pump
16.	52.6/1	Auxiliary contactor to item 52.4
17.	52.6/2	Auxiliary contactor to item 52.5
18.	54.2/2	Time relay for MR blower
19.	52.5/1	Contactor oil pumps
20.	52.5/2	Contactor oil pumps
21.	49	Input filter Auxiliary converter
22.	54.8/2	Capacitor to MR Blower (Start up)
23.	52.4/1	Contactor Scavenge Blower
24.	52.4/2	Contactor, Scavenge Blower

4.3.11 Control Cubicle- (SB1)

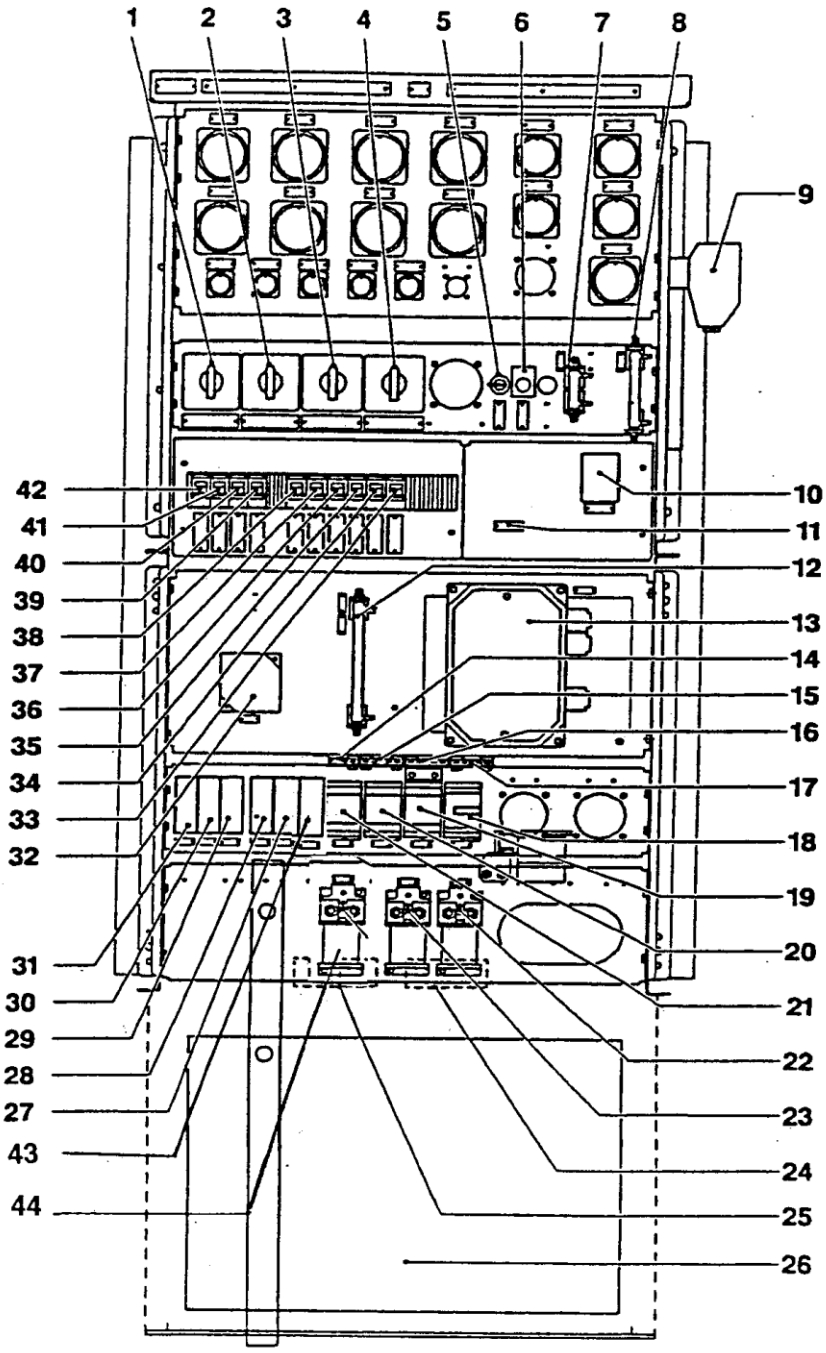


Fig. 4.13 Control cubicle-1

1	152	Rotary switch	Failure mode operation
2	154	Rotary switch	Bogie cut-out
3	160	Rotary switch	Configuration
4	237.1	Rotary switch	Vigilance device cut-off
5	179	Key switch	Simulation
6	161	Illuminate push-button	Configuration
7	381.71	Wire resistor	Earthing screen Train bus
8	78.1	Resistor	Maximum current relay
9	211.1/1	Thermostat	Control electronics
10	78	Relay	Maximum current
11	86	Relay	Minimum voltage
12	90.7	Resistor	Earth fault detection, Cont Ckt.
13	381.7	Connecting box	Train bus
14	126.5A	Relay	Control electronics "OFF"
15	136.4A	Snubber circuit to item 136.4	
16	126.7A	Snubber circuit to item 126.7	
17	136.3A	Snubber circuit to item 136.3	
18	136.3	Relay	Time delay VCB
19	136.4	Contactor	Auxiliary contactor VCB
20	126.7/1	Contactor	Power supply cab
21	126.5	Relay Control Electronics OFF	
22	218	Contactor	Control electronics
23	126	Contactor	Control circuits "ON"
24	118.5/1	DC/DC converter	
25	118.4/1	DC/DC converter	
26	411	Rack	Central electronics (CEL1)
27	123.1/1	Blocking diode	Illumination test
28	123/7	Blocking diode	
29	123/5	Blocking diode	
30	123/3	Blocking diode	
31	123/1	Blocking diode	
32	89.7	Relay earth fault	Control circuit
33	127.9/2	Circuit breaker	Central electronics
34	127.9/1	Circuit breaker	Central electronics
35	127.22/1	Circuit breaker	Electronics, auxiliary converter
36	127.2/1	Circuit breaker	Monitoring
37	127.11/1	Circuit breaker	Power supply Gate Units
38	127.1/1	Circuit breaker	Electronics traction converter
39	310.1/1	Circuit breaker	Lighting front
40	127.91/1	Circuit breaker	Power supply 24V/48V
41	127.12	Circuit breaker	Pantograph/VCB Control
42	127.3/1	Circuit breaker	Drivers cab
43	123/9	Blocking diode	Head light
44	338/1	Contactor	Head light

4.3.12 Control Cubicle - 2 (SB2)

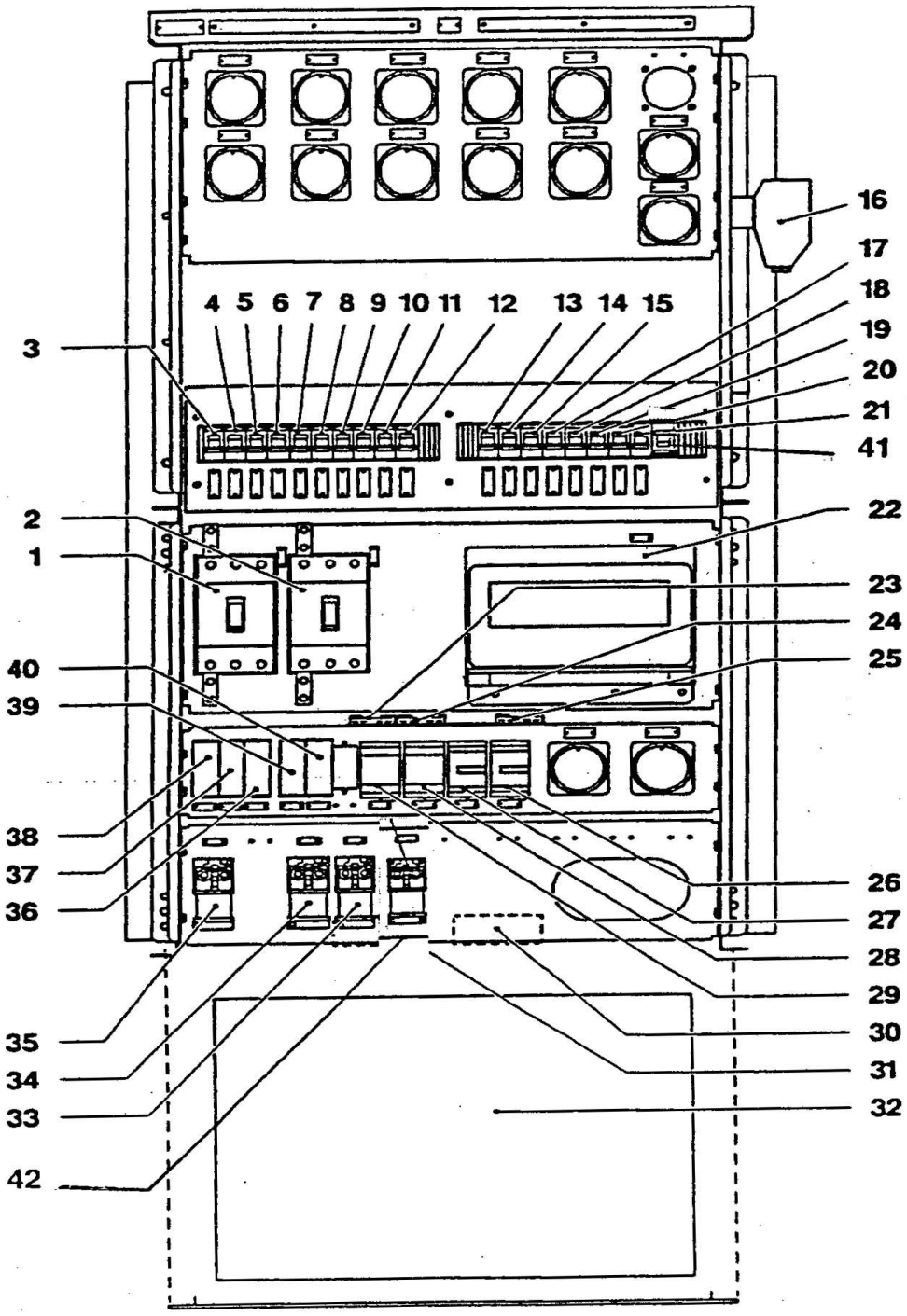


Fig.4.14 Control Cubicle-2

1	110	Circuit Breaker	Output battery charger
2	112.1	Circuit Breaker	Control circuit locomotive
3	127.81	Circuit Breaker	Commissioning 1
4	127.15	Circuit Breaker	Vigilance control
5	127.7	Circuit Breaker	Pneumatic panel
6	127.82	Circuit Breaker	Commissioning 2
7	48.1	Circuit Breaker	Auxiliary compressor
8	127.3/2	Circuit Breaker	Driver's cab
9	127.91/2	Circuit Breaker	Power supply 24V/48 V
10	310.7/1	Circuit Breaker	Marker lights
11	310.1/2	Circuit Breaker	Lighting front
12	310.4	Circuit Breaker	Lighting machine room
13	127.1/2	Circuit Breaker	Electronics traction converter
14	127.11/2	Circuit Breaker	Power supply Gate Units
15	127.2/2	Circuit Breaker	Monitoring
16	211.1/2	Thermostat	Control electronics
17	127.22/2	Circuit Breaker	Electronics auxiliary converter
18	127.22/3	Circuit Breaker	Electronics auxiliary converter
19	127.9/3	Circuit Breaker	Central electronics
20	127.9/4	Circuit Breaker	Central electronics
21	127.92	Circuit Breaker	Speedometer
22	212	Fire detection equipment	
23	130.1A	Snubber circuit to item 130.1	
24	211.A	Snubber circuit to item 211	
25	126.7A/2	Snubber circuit to item 126.7	
26	126.7/2	Contactor	Power supply driver's cab
27	126.6	Safety relay	Control electronics "ON"
28	211	Relay	Temperature control, Electronics
29	130.1	Auxiliary contactor	Pantograph
30	118.5/2	DC/DC Converter	
31	118.4/2	DC/DC Converter	
32	412	Rack	Central electronics (CEL2)
33	300.3/2	Auxiliary contactor	Wheel flange lubrication
34	300.3/1	Auxiliary contactor	Wheel flange lubrication
35	48.2	Contactor	Auxiliary compressor
36	123/6	Blocking diodes	
37	123/4	Blocking diodes	
38	123/2	Blocking diodes	
39	123/8	Blocking diodes	
40	123.1/2	Blocking diodes	Illumination test
41	127.24	Circuit breaker	Electronics auxiliary converter
42	338/2	Auxiliary contactor	Head light

4.3.13 Filter Cubicle

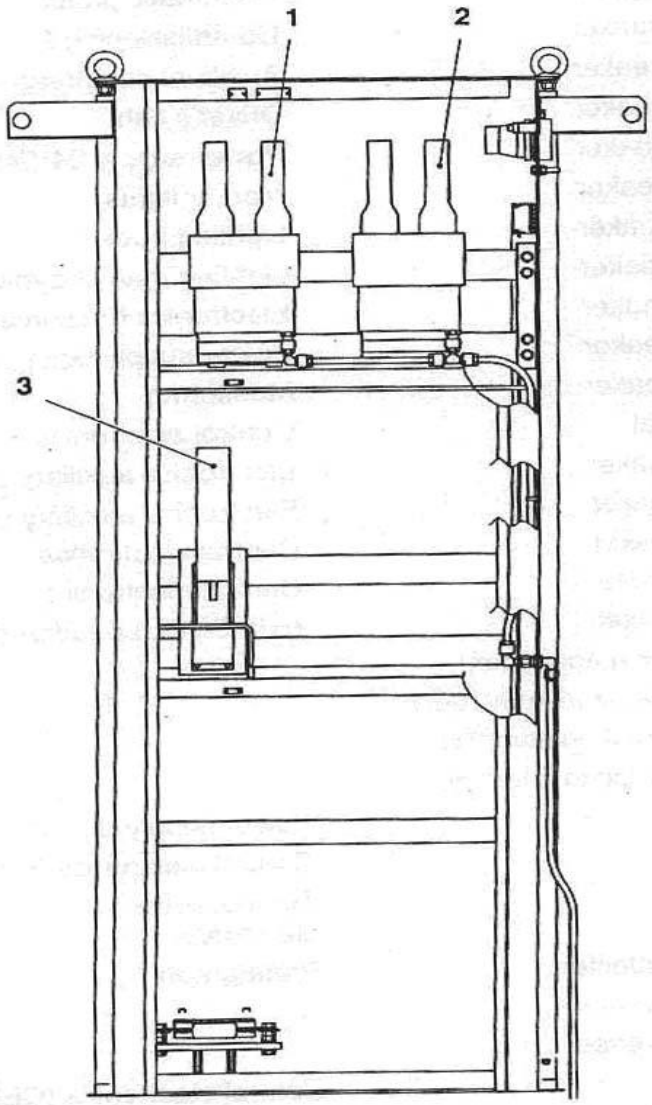


Fig.4.15 Filter Cubicle

8.1	1	Contactor filter adaption
8.2	2	Contactor filter "ON"/ "OFF"
8.41	3	Contactor for discharging resistor

4.3.14 Converter Unit

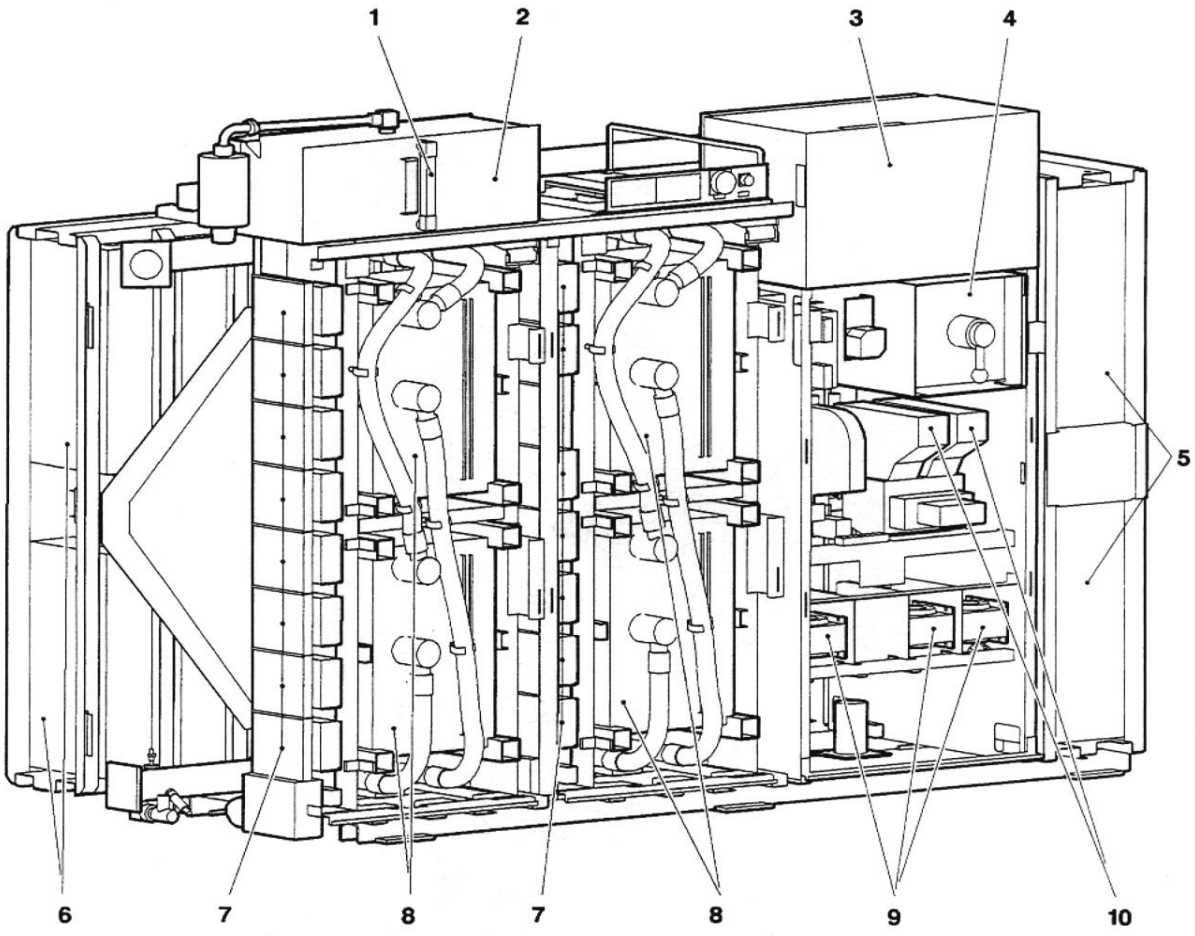


Fig.4.16 Converter unit

1 Oil sight glass
2 Expansion tank
3 Bus station on converter unit
4 Earthing switch DC link
5 Capacitor bank series resonant circuit
6 Capacitors DC-Link
7 Gate Units
8 Valve set
9 Current sensors
10 Converter contactors

4.3.15 Front of Pneumatic Panel

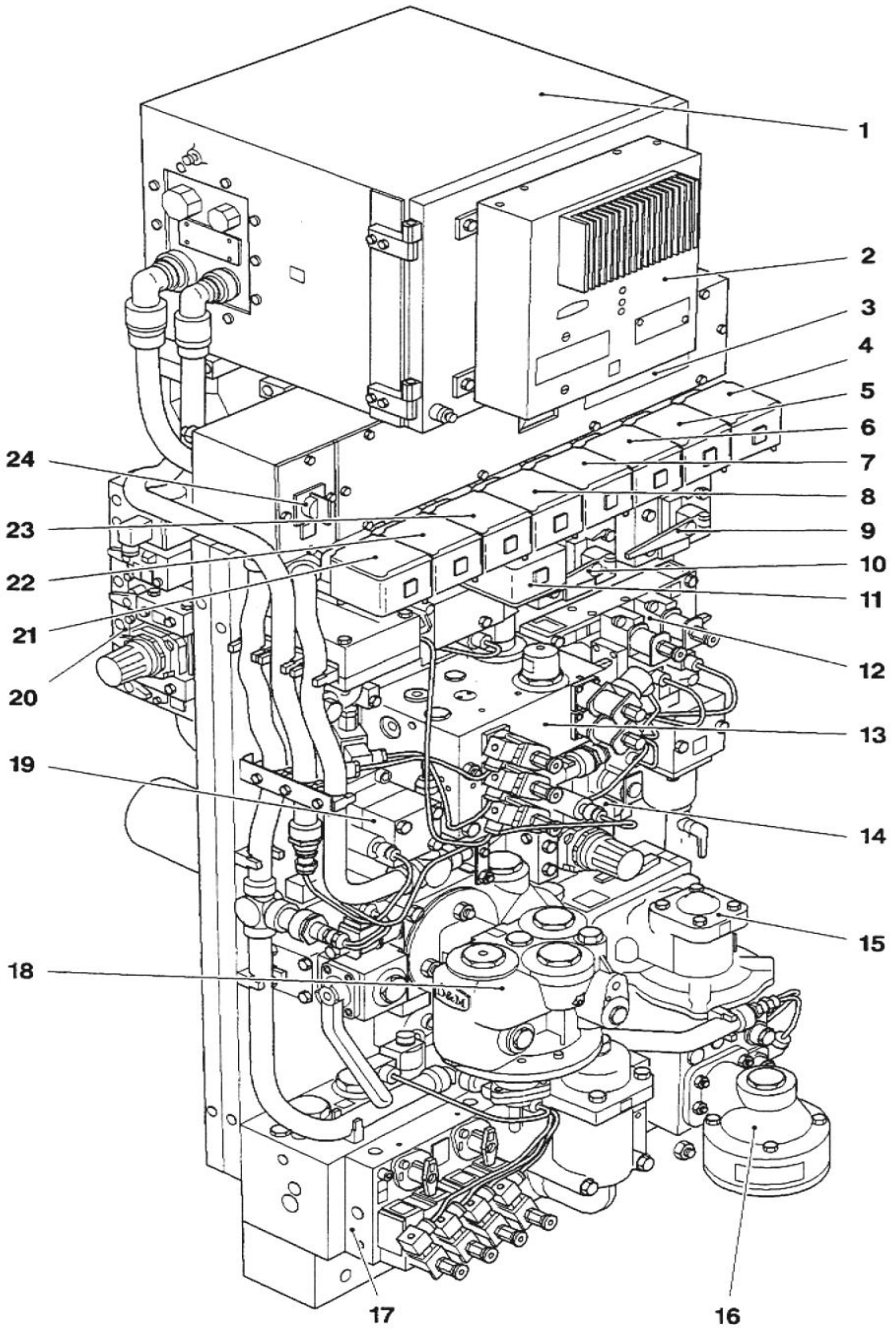


Fig.4.17 Front of pneumatic panel

260	1	Control electronics pneumatic manifold
237	2	Vigilance control equipment
	3	Instructions regarding isolating cock position (see Fig.4.18)
130.4/1	4	Pressure switch pantograph 1
130.4/2	5	Pressure switch pantograph 2
269.1	6	Pressure switch emergency brake
172.4	7	Pressure switch auxiliary compressor
269.3	8	Pressure switch parking brake (inactive on WAP-7)
293.2	9	Isolating cock brake pipe control system (E70)
237.3	10	Isolating cock on emergency brake/vigilance control
269.2	11	Pressure switch direct brake
	12	Pneumatic equipment, pantograph and VCB
	13	Brake pipe control unit (E70)
	14	Pneumatic equipment, parking brake
	15	Relay valve, automatic brake
	16	Relay valve, direct brake
	17	Pneumatic equipment, sanding
	18	Distributor, automatic brake
	19	Blending unit EBC5
	20	Pneumatic equipment, wheel flange lubrication, traction converter, filter cubicle
269.41	21	Pressure switch, flow indication
269.5	22	Pressure switch, vigilance control
269.42	23	Pressure switch, brake feed pipe
129.1	24	Rotary switch, pantograph selection

MODE		ISOLATING COCK POSITION			
		47 DEAD ENGINE	74 (EMERGENCY / VIG.)	136 (BRAKE FEED PIPE)	70 (E70 BRAKE PIPE)
MULTIPLE UNIT	LEAD (LIVE)	CLOSED	OPEN	OPEN	OPEN
	TRAIL (LIVE)	CLOSED	OPEN	CLOSED	OPEN
	TRAIL (DEAD)	CLOSED	CLOSED	CLOSED	CLOSED
BANKING LOCO (ONLY)		CLOSED	OPEN	CLOSED	CLOSED
TOWED " DEAD "		OPEN	CLOSED	CLOSED	CLOSED

Fig.4.18 Isolating Cock Position:

Note:

Towed "DEAD" means that the towed loco is completely "DEAD".
Trail "DEAD" means that on the master loco no tractive effort is available, but the driver's cab of the master loco still controls the slave locomotive.

4.3.15.1 Back Face of Pneumatic Panel

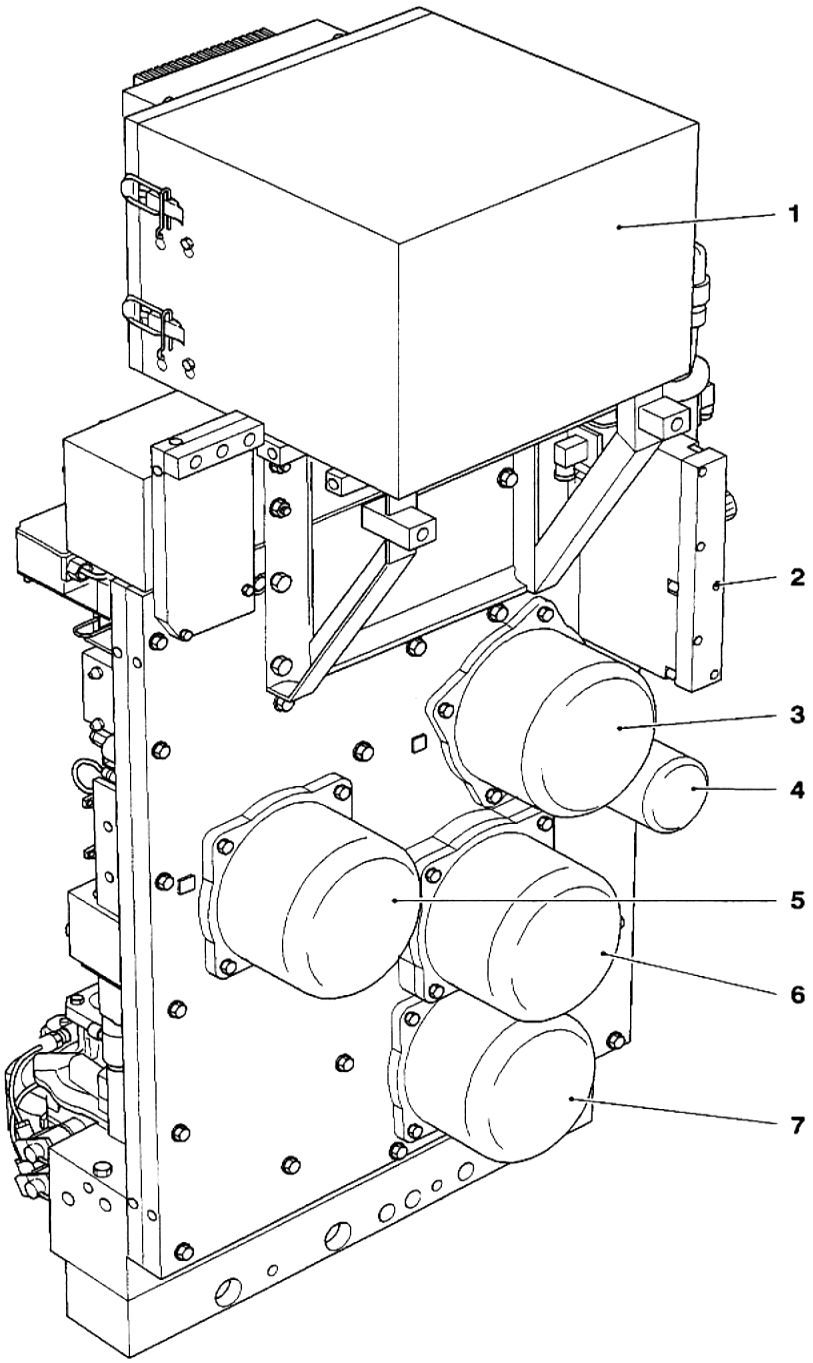


Fig. 4.19 Back face of pneumatic panel

260
1 Control electronics pneumatic manifold
2 Pneumatic equipment, wheel flange lubrication, traction converter, filter cubicle
3 Capacity reservoir, distributor
4 Control reservoir, brake pipe control unit (E70)
5 Air reservoir, pantograph and VCB
6 Control reservoir, distributor automatic brake
7 Capacity reservoir, sanding valves

4.3.16 Outside Controls (Symmetrical on both sides of the loco)

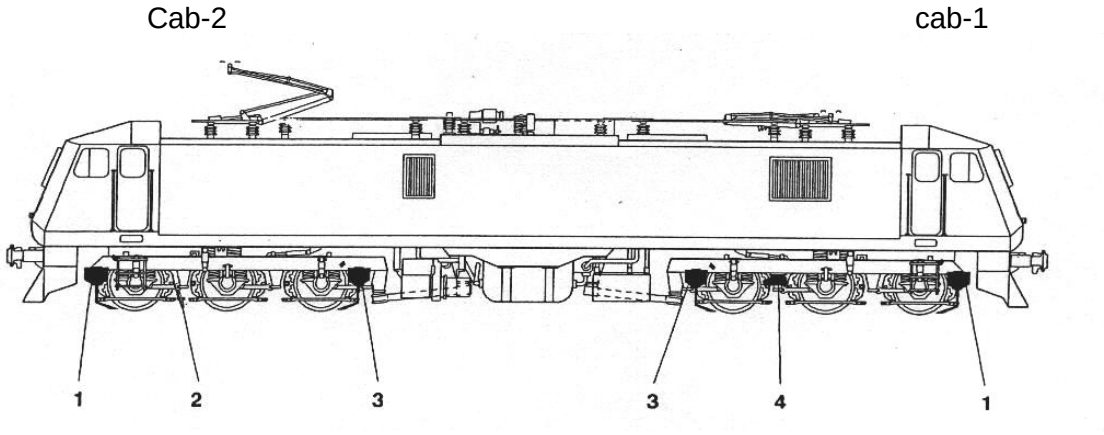


Fig. 4.20 Outside controls

1 Sanding box (axle 1 and 6)
2 Handle release parking brake
3 Sanding box (axle 3 and 4)
4 Tank Wheel flange lubrication

4.3.17 Lighting and Outside Connections

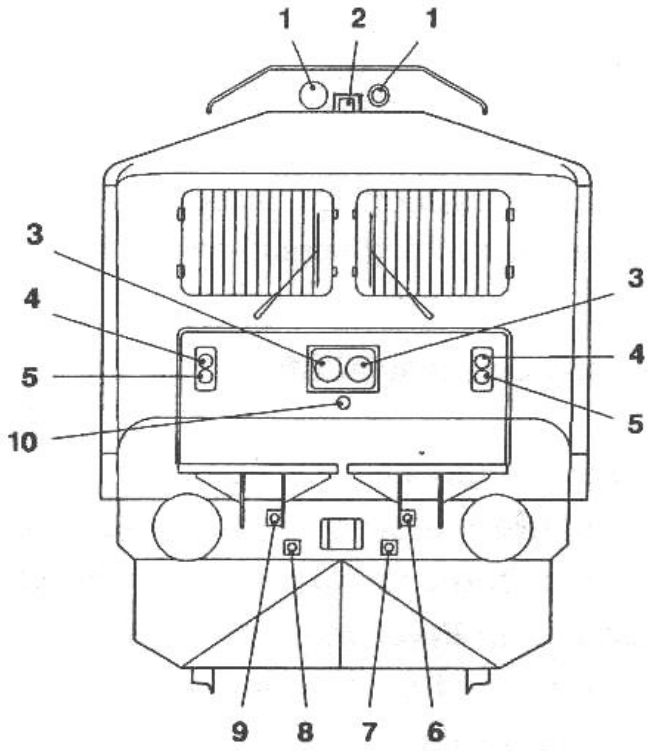


Fig. 4.21 Lighting and outside connections

1 Signal horn
2 Emergency flash light
3 Headlights
4 Marker light, white
5 Marker light, red
6 End cock direct brake (DB, yellow)
7 End cock main reservoir (MR, red)
8 End cock brake pipe (BP, green)
9 End cock feed pipe (FP, white)
10 Coupling, UIC cable

4.4 Driving/Braking

4.4.1 Commissioning

4.4.1.1 Preparations

Before commissioning, perform an inspection check of the locomotive and through the machine room. In particular, check the following items:

1. Underframe:

- Check sight glasses oil level of: Both main compressors
  All gear boxes
- Check all braking blocks
- Check traction links and traction motor reaction rods
- Check position of bogie isolation cocks (PP pos. 63)
- Check position of air dryer by-pass cocks
- Filling of wheel flange lubrication tanks (deleted)
- Filling of sanding boxes

2. Driver's Cab:

- Filling of windshield washing unit

3. Machine Room:

- Check sight glass oil level of: Traction converters
  Main transformer
- Check position of pneumatic panel isolating cock (PP pos.90)
- Check the correct position of all earthing switches
- Check the correct position of all circuit breaker and rotary switches in cubicles HB1, HB2, SB1, SB2
- Check the position of all isolating cocks: Pantograph 1 and 2 (PP pos. 8)
  VCB (PP pos. 5)

- Pantograph key switch (PP pos. 85)
- Set the isolating cocks on the pneumatic panel according to the following table:

MODE		ISOLATING COCK POSITION			
		47 DEAD ENGINE	74 (EMERGENCY/ VIG.)	136 (BRAKE FEED PIPE)	70 (E70 BRAKE PIPE
MULTIPLE UNIT	LEAD (LIVE)	CLOSED	OPEN	OPEN	OPEN
	TRAIL (LIVE)	CLOSED	OPEN	CLOSED	OPEN
	TRAIL (DEAD)	CLOSED	CLOSED	CLOSED	CLOSED
BANKING LOCO (ONLY)		CLOSED	OPEN	CLOSED	CLOSED
TOWED " DEAD "		OPEN	CLOSED	CLOSED	CLOSED

Fig. 4.22 Isolating Cock Position

Preconditions:

The temperature in the central electronics (CEL) must be < 70°C. The catenary voltage (U_{prim}) must be in the range of 17.5 kV and 30 kV (17.5< U_{prim} < 30 kV).

4.4.1.2 Activating Driver's Cab

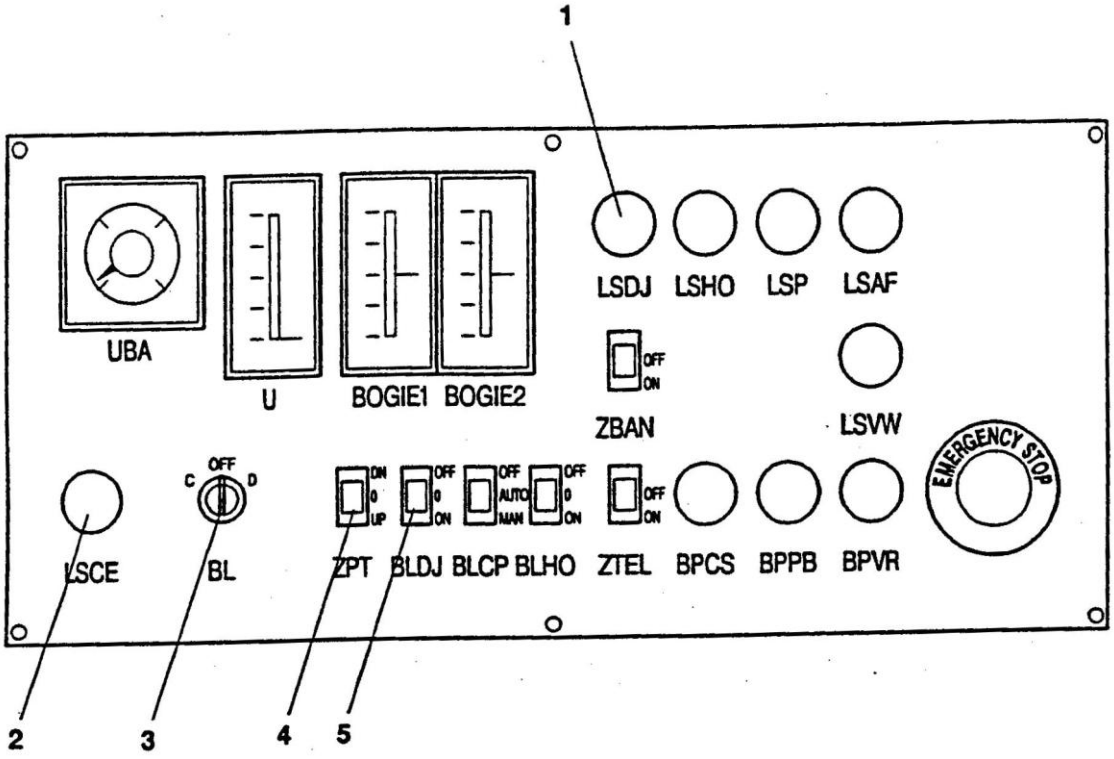


Fig. 4.23 Panel A

1. Plug in the automatic brake handle
125 2. Turn key switch "BL" (3) into Pos. "D"

Reaction:

The MCE control electronics (= MICAS-S2) are switched on
Start self-tests (duration approx. 2 mins.)
An Information message "Train bus configuration running, please wait" appears on the diagnostic display screen.
Self-test of all indication lamps starts (duration 10 seconds)

At the end of the self-test of all indication lamps they have the following status:

Panel A:	LSDJ (1)	lit	(Main circuit breaker in "OFF" Position)
	LSHO	off	
	LSP	off	
	LSAF	off	
	LSVW	off	
	LSCE	off	
Panel B:	LSFI	off	

The relevant driver's cab is now activated.

Note:

166 *If the temperature inside the CEL is higher than 70°C, the amber "LSCE" lamp (2) lights up on panel A.*

If this happens, the following action must be taken:

Action 1: *shut down the locomotive.*
-Turn key switch (3) into position "C"
-Raise pantograph (refer to 4.4.1.3)
-Close main circuit breaker (refer to 4.4.1.4)

Reaction:

The machine room blowers and the corresponding scavenge blowers inside the CEL block start to run. Once the temperature in the CEL block has dropped below 70°C, the amber indication lamp "LSCE" extinguishes (2).

Action 2: Open main circuit breaker (move switch "BLDJ" (5) briefly into "OFF Pos.).
Lower pantograph (move switch "ZPT" (4) briefly into "DN" Pos.).
Turn key switch (3) into position "O".

Action 3: Turn key switch (3) into position "D".

Subsequent procedure (refer to 4.4.1.2).

4.4.1.3 Raising the Pantograph

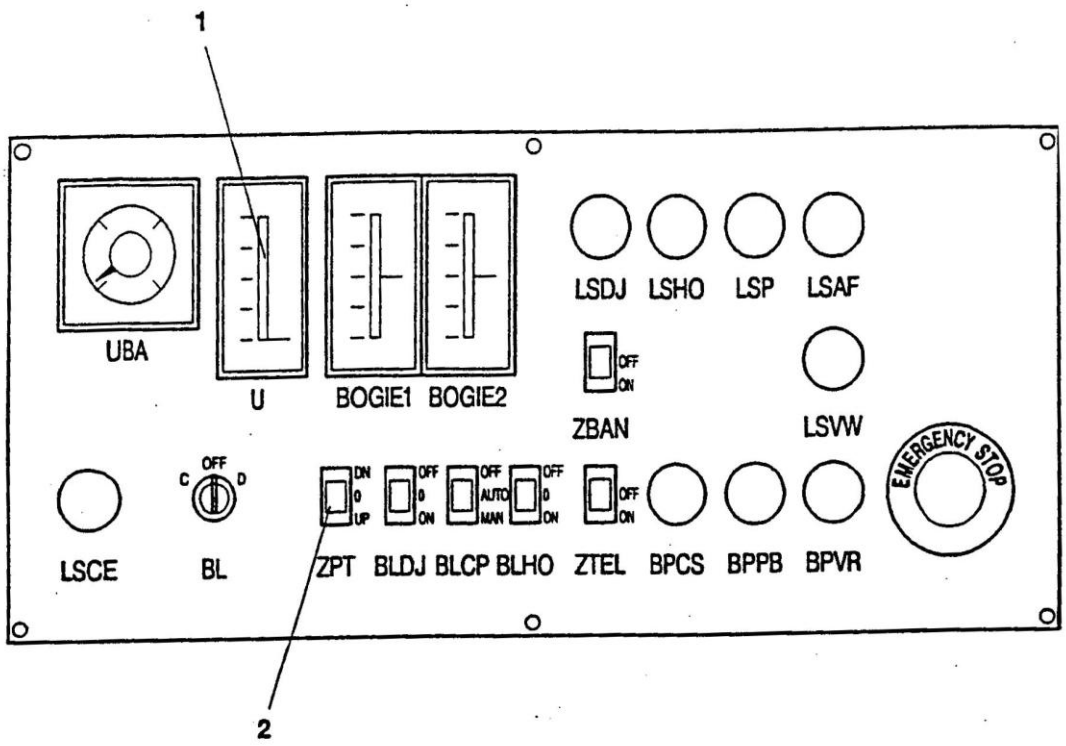


Fig. 4.24 Panel A:

129.1 One of the following options can be pre selected on the "Pantograph selection" rotary switch (on the PP in the machine room):

Pos.I	The pantograph towards cab 1 end is selected, irrespective of whichever Cab is active
Pos.AUTO	The pantograph towards the inactive driver's cab is selected.
Pos II	The pantograph towards cab 2 end is selected, irrespective of whichever Cab is active.

Note:

Normally, the rotary switch will be in position "AUTO". The switch will be required to be thrown to Pos. I or Pos. II when there is a need to isolate one of the pantographs.

129 **Move "ZPT" switch (2) briefly into "UP" position**.

Reaction:

The pantograph is raised. Information message on the diagnostic display.

74 The catenary voltage is displayed on the voltmeter "U" (1), once the pantograph makes contact with the overhead wire.

Note:

48 If there is insufficient pressure to raise the pantograph, the auxiliary compressor is switched on automatically by pressure switch 172.4 on the pneumatic panel (PP).

The auxiliary compressor will stop automatically after it has built up a pressure of 5.2 kg/cm^2.

Wait until auxiliary compressor has stopped running.

4.4.1.4 Closing Main Circuit Breaker

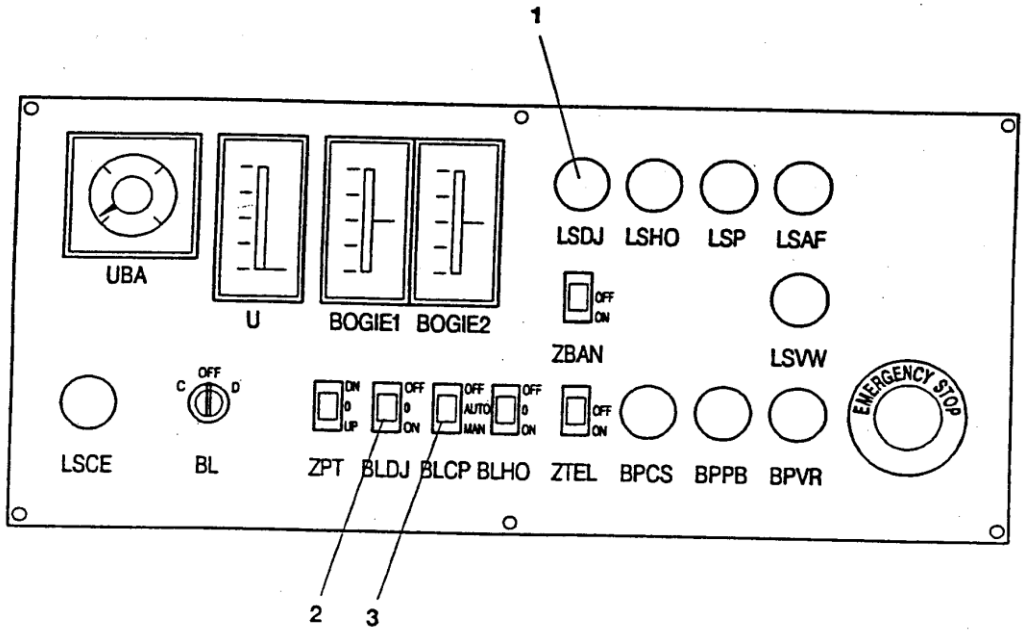


Fig. 4.25 Panel A:

134 Move switch "BLDJ" (2) briefly into "ON" position.

Reaction:

The main circuit breaker (VCB) closes.

137.3 The indication lamp "LSDJ" (1) extinguishes.

4.4.1.5 Switching on the Main Compressors

The compressors are able to operate in three different operating modes.

172 These modes can be selected on the spring-loaded switch "BLCP" (3).

Pos."Off" Compressor switched off.
Pos. "Auto" Automatic pressure control
Pos. "Man" Compressor switched on (manual monitoring).

4.4.1.5.1 Operating mode "OFF"

172 If the spring-loaded switch "BLCP" is kept in the position "OFF", both main compressors are switched off.

4.4.1.5.2 Operating Mode "AUTO"

If the spring-loaded switch BLCP is in position "AUTO", working of the compressors is monitored by the specified pneumatic switches.

172.2 & 172.3 If the pressure drops below 8 kg/cm^2, the "Main compressor switch 8 kg/cm^2" cuts out (Pr. Sw. 35 & 36). Both compressors start to run at the same time until a pressure of 10 kg/cm^2 is reached.

269.4 If the pressure drops below 5.6 kg/cm^2, the "Low main reservoir switch" closes. This initiates a Start/Running Interlock and the message "Low pressure, main reservoir" appears on the fault display unit.
Both compressors start to run until a pressure of 10 kg/cm^2 is reached.

4.4.1.5.3 Operating mode "MAN"

172 In this operating mode, the driver moves the spring-loaded switch "BCLP" into the position "MAN". Both compressors run as long as the VCB is closed and the switch is kept pressed in the position "MAN".

Note:

In the "MAN" mode, the compressors are not cut out even if the main reservoir pressure exceeds 10 kg/cm^2.

4.4.2 Driving/Braking

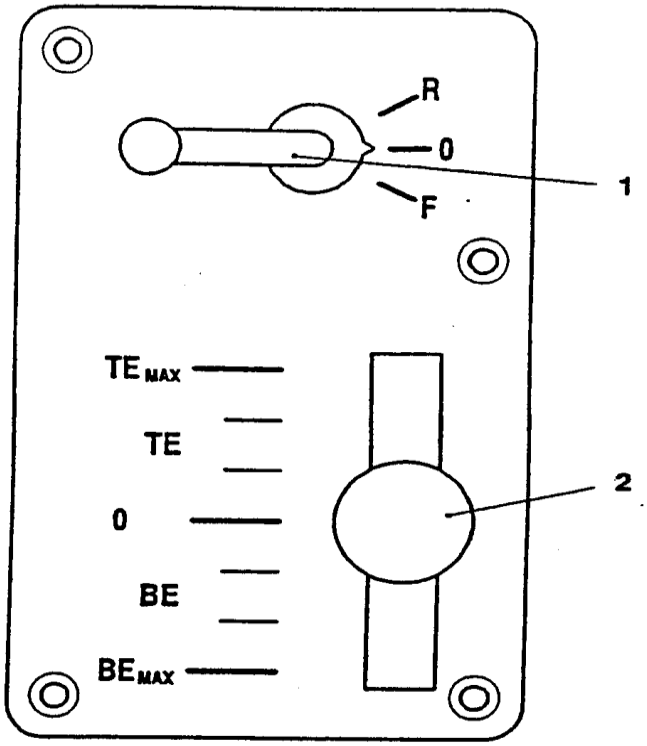


Fig. 4.26 Master Controller

1 Reverser
2 TE/BE throttle

140 The reverser has the following three positions:

Pos. "F"	=	Forward
Pos. "O"	=	Neutral
Pos. "R"	=	Reverse

Note:

A mechanical interlock between reverser (1) and the TE/BE throttle (2) means that the reverser can only be actuated if the TE/BE throttle on 'O' and the speed of the locomotive is 0 km/h.

4.4.2.1 Driving

1. Move the reverser into the desired position

268 2. If the parking brake is applied (indicated by the illuminated push-button "BPPB") release the parking brake by pressing the push-button "BPPB" (inactive from Loco No-30279 / WAP-7 & onwards, as conventional type brake arrangement introduced)

3. Bring the direct brake handle to the "Release stop" in the fully clockwise direction.

4. Bring the automatic train handle to the position "Run" and wait until the brake pipe pressure has reached 5 kg/cm^2.

5. Check the flow indicator and ensure that there is not a high air flow when the brakes have been released.
   The illuminated push-button "BPPB" must not be lit up (not applicable in WAP-7) and there must not be an isolation message that the brake pipe is isolated from the E70.

6. Set the TE/BE throttle to the desired position in the range 0 to TE_{MAX} (tractive effort)

Note:

192.1 *In order to improve adhesion and to avoid wheel spinning the sanding valves can be activated by pressing the foot switch "SANDING".*

262 *The automatic air train brake is cut out only on the loco as long as the foot switch "PVEF" is pressed down and as long the pressure in the automatic air train brake pipe is not lowered.*

4.4.2.2 Braking

1. Set the TE/BE throttle to the desired position in the range 0 to BE_{MAX} (braking effort)

2. move the handle of the automatic train brake from the position "Run" to "Initial Application". If more brake force is required move the handle to the desired position between "Initial Application" and "Full Service". For gradual release of the automatic train brake move the handle in the clockwise direction between "Full Service" and "Initial Application". For full release move the handle to position 1.

3. When the train stops, set the direct loco brake handle to the desired position within the "Operational range".

4. Apply the parking brake (not applicable in WAP-7).

Note:

The regenerative brake is only effective if brake cylinder pressure is "0" (See panel B, Brake Cylinder Pressure Gauge)

To initialize the brakes of the train after coupling move handle of the automatic train brake to position "Release". This position has also to be chosen for a fast release of the train brakes.

4.4.2.3 Emergency Braking

The emergency brake is independent of the control electronics. It can be activated in the following ways:

1. pressing the push-button emergency stop
2. setting the automatic train brake handle to the position "Emergency".
3. Operating the emergency brake cock in the driver's cab (assistant driver's side).

4.4.3 Shutting Down

4.4.3.1 Switch off Main Circuit Breaker

134 Move "BLDJ" switch briefly into "OFF" position.

Reaction:

The main circuit breaker opens.

137.3 The "LSDJ" indication lamp lights up.

4.4.3.2 Lower Pantograph

129 Move "ZPT" switch briefly into "DN" position.

Reaction:

The pantograph lowers.

4.4.3.3. Deactivating Driver's Cab

125 Move key switch into "0" position.

Reaction:

The MCE remains in self-hold mode for 10 minutes while the cab is being deactivated. An appropriate priority 2 message appears on the screen. During this 10 minutes period, the driver's cab can be changed or the train can be prepared for multiple operations.
10 minutes after the pantograph has been lowered, the self-hold setting is interrupted and the MCE shuts down

Note:

125 *If the key switch is moved from Pos. "D" to Pos. "0" without the train driver opening the VCB, and the pantograph lowering, this initiates an automatic shut-down.*

The MCE can be shut down immediately by moving the BL key from pos "O" to position "C". Ensure that the electronics is switched OFF and than remove the key from pos. "O"

Warning:

Before switching "OFF" the BL key, it must be ensured that the locomotive is stand still.

4.4.3.4 Active Functions with Deactivated Driver's Cab

While the cab is deactivated (key switch in position "0"), the following functions remain operative:

1. SPEEDOMETER functions
2. Catenary voltage display
3. Emergency brake cock on assistant driver's side
4. Driver's cab lighting
5. Windshield wipers
6. Fault display screen
7. Marker lights switches
8. Battery voltmeter
9. Cab venting and heating
10. Hand lamp
11. Crew fan

4.4.3.5 Knorr's Computer Controlled Brake (CCB) in WAG-9 Loco:

Cab Set Up:

In the in-operative cab, mode-switch on brake controller should be in TRL (trial) and Auto/A9 handle locked in FS (Full Service).
In the operative cab, mode-switch should be in LEAD and Auto/A9 handle be unlocked.
In case of multiple locomotive operations, trailing locomotive both mode switch in TRL.
In case of banking operation, on banker locomotive, in addition to switching the 'ZBAN' switch on, the mode switch should be kept in HLPR (helper).

AUTO/A9 Operation:

To charge the BP on first up (i.e. energizing the locomotive) Auto A9 handle should be moved to FS. After 10 seconds BP will charge to 3 Kg/CM^2. Now check Parking Brake (PB) pressure gauge. If pressure is zero then BPPB on driver's desk should be toggled to release the PB. Now check, PB gauge should show pressure more that 5 Kg/Cm^2. Now on moving the Auto handle to RUN (Running) position, BP would charge to more that 5 kg/cm^2 and BC would reduce to zero.
For quick release of brake on farthest wagon, automatic BP overecharge of 0.2 kg/cm^2 is provided after every brake application (service/emergency). This will bleed automatically if handle is left in RUN position.
To intimate manual overcharge which overcharge BP by 0.5 kg/cm^2, Auto/A9 handle to be held in REL (Release) position for 3-5 seconds.
To release Loco auto brake, PVEF function can also be performed by lifting bail-ring on Direct Brake/SA9 handle.
To check train BP leakage rate, move mode switch to TEST. For safety this would apply BC pressure on locomotive only till mode switch is in TEST position. After test is over move mode switch back to LEAD.

Parking Brake (PB) Operation (not applicable in WAP-7):
For the safety reasons whenever PB is applied, penalty auto brake would also be applied and BP would be dropped to 3 kg/cm^2 and to recover this, first release of PB by pressing BPPB on driver's desk, move Auto/A9 handle to FS and then back to RUN. BP would charge to more than 5 kg/cm^2.
PB-PDS (parking Brake Pneumatic Disable Switch) cock on brake panel, normally is kept "Horizontal" (open). It is turned to vertical position to cut-off air to PB cylinders for maintenance purpose or in case PB is defective.
PB-BUS (Parking Brake Back Up Switch) cock on brake panel, normally is kept. It is used for manual operation on PB. It is turned to vertical position to only in case of 'DEAD MODE' or 'PTDC' mode to keep PB released to manually apply PB PB-BUS cock should be turned to Horizontal position.
Recover of Vigilance/Penalty Brake:

Vigilance penalty would results into dropping BP to 3 kg/cm^2 and application of full BC pressure. To recover vigilance penalty, bring throttle handle (TE/BE) to 0, wait for 120 seconds after the penalty then, move Auto/A9 handle to FS and press BPVR on driver's desk. Then move Auto/A9 handle to RUN. BP would charge to more than 5 kg/cm^2. Acknowledge the fault by pressing BPFA. Resume normal operation.

Recover of Penalty Service Brake:

Penalty service brake would be applied by dropping BP to 3 kg/cm^2 if
Both BC1 and BC2 cut out cock on brake panel are closed (isolated) at any time in LEAD mode.
PB-PDS cock for some reason is in vertical position and BPPB from driver's desk is operated at any time in LEAD mode.
PB-BUS cock for some reason is in vertical position and BPPB is operated at any time in LEAD mode.
PB-R-COS cock for some reason is in vertical position and BPPB is operated at any time in LEAD mode.
To recover this penalty brake, position of respective switch/cock should be set right and after that move Auto/A9 handle to FS and then back to RUN. BP then would charge to more than 5 kg/cm^2.

Recovery of Penalty Emergency Brake:

Emergency penalty brake can also get applied by over speed relay or emergency stop button, to recover this penalty Auto/A9 handle should be moved to EMER and back to FS and then to RUN BP would charge to more than 5 kg/cm^2.

PTDC (Pneumatic Time Dependent Controller) Set Up:

PTDC mode would only work until speed is below 10 kmph to make PTDV active:

- Open Pneumatic Panel MCB in SB2 panel.
- Turn PB-BUS cock on brake panel to vertical position.
- Turn PER-COS (Pneumatic equalizing Reservoir Cut Out Switch) cock on brake panel to vertical position.
- Unlock the Auto/A9 handle in operative cab and lock the same in other cab.
- Ensure vigilance panel MCB in SB2 is on.
- Move and hold the PTDC handle, in active driver's cab in the Release position. BP would charge to normal level of 5 kg/cm^2 and BC should reduce to zero. If BC is not reducing to zero then give brief pulls to quick release lever at bottom of distributor valve. Ensure BC reduces to zero.
- Apply and release auto brake through PTDC as per requirement by keeping the handle in Apply and Release position (spring loaded0 for sufficient enough time by observing the BP pressure gauge.

Bogie Isolation Cocks:

Bogie isolation cocks BC1-COS and BC2-COS for bogie 1 and bogie 2 respectively are located on brake panel itself and not on underframe as in other locos.

Dead Locomotive Set Up:

- Switch off control electronics.
- Open dead engine cock (47) provided just below the auxiliary manifold (OLP).
- Close Vigilance SIFA cock (74) on brake panel (Move handle upward to close).
- Close FP cock (136) on the auxiliary manifold (Turn to Horizontal position to close).
- Check that PNAI-COCK and PAN2-COCK on the auxiliary manifold are in closed position (Knob to be in vertical position to close).
- Auto/A9 handle in both the cans should be kept locked.
- Direct/SA9 Brake Handle in both cabs should be in 'REL' position.
- Verify that after charging BP pressure to normal level, brakes are fully released and BC pressure is zero in the gauge. If BC is not reducing to zero then give brief pulls to quick release lever at bottom of distributor valve. Ensure BC reduces to zero.
- Turn PB-BUS cock for vertical position to keep the parking brake released (not applicable in WAP-7).
  Check that pressure in PB gauge is 5 kg/cm^2.

Note:
In this locomotive anti compounding double check valve is mounted on brake panel.

- After releasing the PB of Dead Loco by operating the PB-BUS cock, there is no need to Pull the pull arrangement provided on the PB cylinder Parking Brake is to be released only by using PB-BUS cock (not applicable in WAP-7).

Note:
*Before moving the Dead Locomotive, please check pressure in PB gauge, it should be 5 kg/cm**2**.*

4.5 Changing the Driver's Cab

4.5.1 Single Unit Running

125 1. Move key switch "BL" into position "0" and remove the key.

2. Set automatic brake controller to position "Neutral" and remove handle.

3. Release direct brake.

4. Change driver's cab and insert key.

5. Move key switch "BL" into position "D".

6. Insert automatic brake controller handle and set to "Run" position.

Note:

After moving the key switch "BL" to position "0", the MCE remains active for 10 minutes. The change of driver's cab should take place during this time.
If the MCE has to be restarted, it takes longer to set up the locomotive because peripheral tests have to be carried out.

4.5.2 Multiple Unit

125 1. Move key switch "BL" on master locomotive into position "0" and remove the key.
2. Set automatic brake controller to position "Neutral".
3. Release direct brake.
4. Set the brake feed pipe cock 136 to the “close position”
5 Change the loco & set the brake feed pipe cock 136. to the ”open “ position on this previous slave loco.
6. Insert key in driver's cab of previous slave locomotive.
7. Move key switch "BL" into position "D".

Note:
The change of driver's cab has to take place within this 10 minute period otherwise the MCE has to be restarted.

4.6 Automatic Vigilance

4.6.1 Vigilance Mode

235 Within a period of 60 seconds the train crew must press the "VIGILANCE" foot switch
Or

192.1 Initiate sanding by pressing the "SANDING" foot switch
Or

While train is in motion after the position of the TE/BE throttle in such a way that a difference of at least 3% appears between the first and second value.
Or

236 The train crew must press the green push-button 'BPVG', on panel "D".

If one of these four conditions is achieved, the monitoring cycle is reset and the 60-second cycle starts again.

Note:

The automatic vigilance control system is activated only if speed is greater than 1.5 km/h and brakes are released (brake cylinder pressure is below 1 kg/cm^2).

4.6.2 Triggering Alarm

If neither of these four conditions is fulfilled within a 60 second period, an alarm is triggered:

Reaction:

An intermittent signal sounds in the driver's cab (546 Hz), from the buzzer BZ-V-O-F.

242.1 The yellow lamp "LSVW" lights up.
Acknowledgement of the alarm:

235 The "VIGILANCE" foot switch or the push-button "BPVR" must be pressed and released.

Note:
If the acoustic alarm is not acknowledged within 8 seconds, an emergency brake and power cut off is initiated.

4.6.3 Dead Man Mode

Release of the foot pedal at any time causes an automatic switch to the "Dead man" safety mode. In this mode the audible warning is sounded after 60 seconds and the brake application and power cut off initiated after further 8 seconds. Resetting from the driver's controls is not possible, pressing of the vigilance pedal or the push-button "BPVG" is the only means of resetting the system.

Reaction:

An acoustic alarm is triggered and emergency brake is applied after 8 seconds.

The Acknowledgement of the alarm of the “VIGILANCE" unit can be done by pressing either the push button “BPVG” on assistant driver’s desk (panel "D".) or pressing the foot switch.

4.6.4 Resetting after Penalty Brakes

- Bring the TE/BE throttle to "0".
237.5 - Press the yellow vigilance acknowledge push-button "BPVR" on Panel A.
- Press and release the "VIGILANCE" foot switch.

Note:
A reset cannot be made for at least 180 seconds after penalty brakes are applied.

4.6.5 Fire Alarm

The fire detection unit is equipped with two smoke sensors and detects any fire in the machine room by checking the machine room air at for smoke.

-1. The first detector which detects smoke triggers an alarm:

An intermittent signal (1170 Hz) sounds in the driver's cab, from the buzzer BZ-V-O-F

A fault message priority 2 appears on the monitor.

Note:
The machine room has to be inspected.

- 2. If both detectors detect smoke in the machine room the following actions will be initiated:

A fault message priority 1 on the monitor (the red "LSFI" fault status indication lamp flashes)
A Start/Running Interlock, (TE/BE becomes 0).

Note:
The driver takes the specified course of action.

4.7 SPEEDOMETER

4.7.1 Controls and Displays

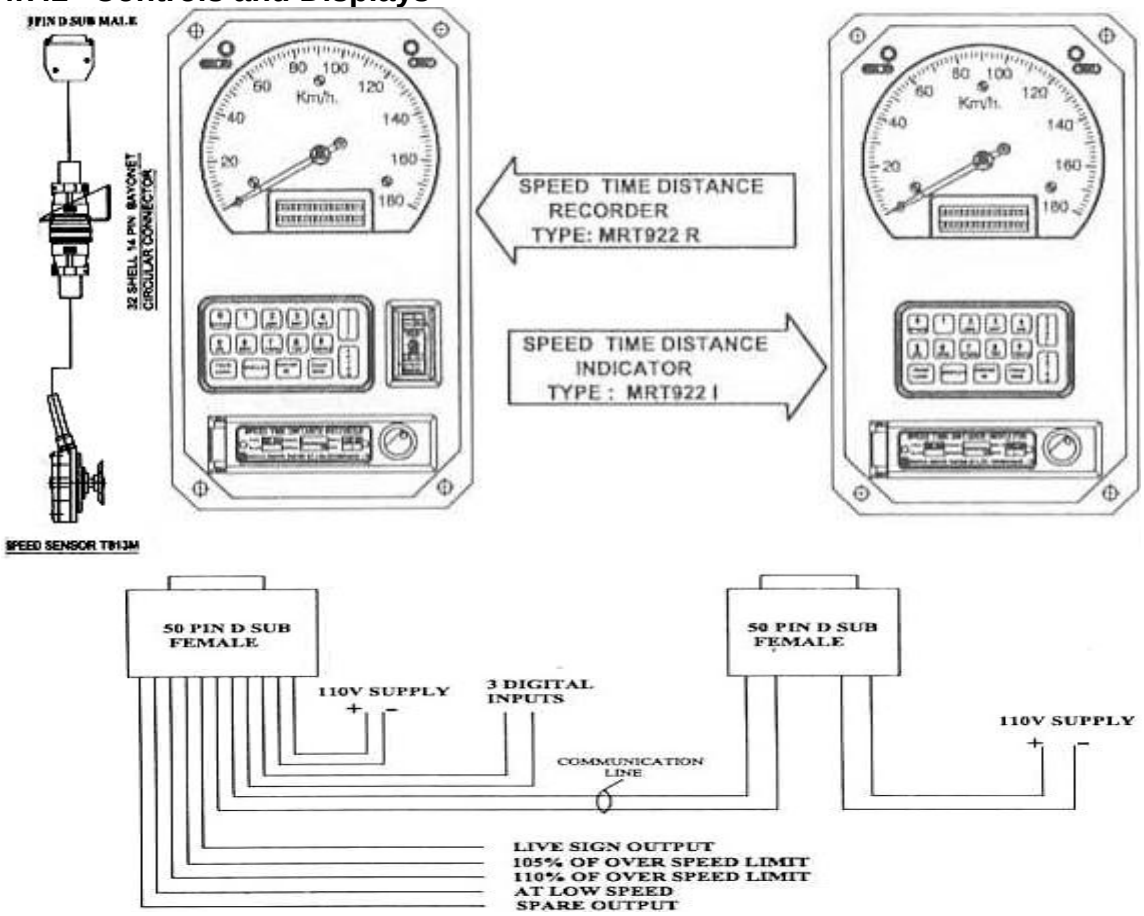


Fig. 4.27 SPEEDOMETER

PIN Assignment of 50 Pin D Type Male connectors on Recorder		
SL	Signal Name	Pin No
1	B+ Ve	35
2	B_Ve	34
3	Digital Input 1 +Ve	6
4	Digital Input 1 -Ve	5
5	Digital Input 2 +Ve	21
6	Digital Input 2 -Ve	37
7	Digital Input 3 (Spare) +Ve	8
8	Digital Input 3 (Spare) -Ve	7
9	Analog Input 1 in	36
10	Analog Input 1 return	20
11	Analog Input 2 return	4
12	Analog Input 2 return	3
13	Live Sign (NO)	25
14	Live Sign (NC)	41
15	Live Sign (P)	9
16	105% of Max speed (NO)	46
17	105% of Max speed (NC)	30
18	105% of Max speed (P)	45
19	110% of Max speed (NO)	14
20	110% of Max speed (NC)	29
21	110% of Max speed (P)	13
22	At Low Speed (P)	27
23	At Low Speed (NO)	43
24	Spare (P)	42
25	Spare (NO)	11
26	Communication line 1 (RS485A)	50
27	Communication line 2 (RS485B)	17
28	RS485GND	33
29	Shield	1

PIN Assignment of 9- Pin D Type Female connectors on Recorder		
SL	Signal Name	Pin No
1	Sensor Supply	4
2	Sensor GND	7,8
3	Detector 1 Input	3
4	Detector 2 Input	5
5	Shield	

PIN Assignment of 50 Pin D Type Male connectors on Indicator		
SL	Signal Name	Pin No
1	B+ Ve	35
2	B_Ve	34
3	Communication line 1 (RS485A)	50
4	Communication line 2 (RS485B)	17
5	RS485GND	33
6	Shield	1

Note:

Memory Card and interface for Service Computer are available in Cab 1.

4.7.2 Functions and settings

4.7.2.1 Self Test

The unit has a self-diagnostic for checking the health of its own components as well as the peripherals.

Note:

In case of any fault an error massage would be flashed on the display and fault LED indication would be ON.

4.7.2.2 Adjustment of Brightness (Dial Illumination)

- Set Dial Illumination using the key board.
- Select Dial Illumination level with the Numeric keys 0-9.
- Dial Illumination level will be displayed after pressing the key.
- Display will return to the default display mode after displaying the message “Dial Illumination Level”. For 1 second.
- Illumination level adjusted as a percentage value of 10 – 90%.

4.7.2.3 Indication Lamps

4.7.2.3.1 Indication Lamp for System / Memory fault (Green LED)

- Whenever the analogue indication fails, LED will glow & “Indicator faulty” message will come along with existing default display speed (after pressing Display key, time & speed will be displayed).
- Also whenever there is some system failure (like configuration memory fail) the LED will be ON continuously. The LED will glow whenever the memory card is faulty or it is not inserted.

4.7.2.3.2 Indication Lamp for over Speed (Red LED)

Whenever locomotive speed exceeds the set speed limit, this red LED glows along with flashing message on LCD and sounding of buzzer.

4.7.2.4 Data Entry Keyboard

A 16 key alphanumeric keyboard is provided on the Recorder cum Indicator unit, for entry of different data by the loco crew and the shed staff.

- Key 0 acts as numeric key on 1_{st} & as “SPACE” key on 2_{nd} pressing.
- Key 2-9 acts as numeric as well as alphabet keys. The first pressing of these keys shows the numeric value and subsequent pressing shows the alphabet with rolling back to numeric value after all the alphabet printed on the particular key. After selecting a digit or alphabet, if no key is pressed for 3- seconds, the entry is taken in and curser shifts to next position. Driver can enter the Load, train number, driver ID. One more switch(with lock provision) along with keyboard is used for entering various parameters like loco number, wheel dia, speed limit, odometer setting, time & date, locomotive type, shed name e.t.c. These parameter setting is possible only at loco standing position

4.7.2.5 Digital Display

This display comprises 32 character Alpha-numeric back lit LCD display for-

Speed	km/h
Time	HH:MM:SS
Date	DD:MM:YY
Distance covered	km
Fault message & Diagnostic message	DEF XY

4.7.2.6 Memory Freeze

In the event of an accident, to stop the recording of the data in short term memory the glass on the front facia can be broken and the switch can be operated. The LED above the switch glows indicating the freezing of memory and also a “Memory freeze ON” message is displayed on the LCD. There will not be any more recording in the short Memory as long as the Memory Freeze switch is on. There is no effect on the recording in the long memory.

4.7.2.7 Reading / Downloading of the recorded Data.

The journey data is recorded in both the internal system memory and also the memory card as per the format of recording selected in system configuration. Both the short term & long term memory data can be downloaded onto a PC / Laptop by using the RS-232 connector provided inside the Door. The serial communication cable shall be used for this purpose.
For downloading memory to be released and connect the memory card to the PC using the data retrieval unit. Download the data onto the PC. After the complete data transfer, remove the memory card from the Data Retrival Unit. Insert the Memory card into the holder mechanism inside the Recorder. The mechanism will snap and hold the card in its designated lace. Close and lock the door.

4.8 Constant Speed Control (CSC)

151.4 When the locomotive is moving at a certain speed, pressing the illuminated push- button "BPCS" will maintain the speed automatically.

The push-button "BPCS" remains illuminated when constant speed control is active.

CSC has access to 100% traction and braking force, i.e. the position of the TE/BE throttle (angle transmitter) has no impact on the effective speed.

Note:

To minimize oscillation, the CSC should be set during a slow acceleration phase.

The action of the CSC is cancelled by:

150 Moving the TE/BE throttle
151.4 Pressing the illuminated pushbutton "BPCS" while the CSC system is active.
260 Drop in brake pipe pressure below 4.75-kg/ cm^2.
269.6 Brake cylinder pressure above 0.6 kg/cm^2.

4.9 Neutral Section

4.9.1 When driving on a neutral section, all necessary actions to comply with Indian Railways regulations must be taken manually by the train driver.

4.10 Multiple Operation

4.10.1 Multiple operation with two locomotives

In multiple operation a maximum of two locomotives can be operated. Both must be directly coupled to one another. They must not be separated by a carriage.

While in motion, the front driver's cab is usually activated.

When linking up or in unusual situations, it is also possible to control the locomotives from another driver's cab.

The train bus configuration for multiple operation is only possible from the driver's cab at the uncoupled end. A configuration from a rear driver's cab is referred to as single-unit traction.

The train bus automatically checks the configuration:
The leading manned locomotive is called the master locomotive and the other one is called the slave locomotive.

The two locomotives are correctly linked together once the mechanical and pneumatic systems and the UIC cable have been connected.

Commands are transmitted down the UIC cable.

4.10.1.1 Pantograph

In multiple operation, both the most distant pantographs are raised if "pantograph selection switches" in both the locomotives are in position "AUTO". The train bus connections define the free end of each locomotive.
The command from the master locomotive to raise/lower the pantographs also controls the pantographs on the slave locomotive.

Note:

179 Whenever the simulation key switches on the master and slave locomotives are not in the same position, the pantographs are not active (fault message).

4.10.1.2 Main Circuit Breaker

The command from the master locomotive to switch the main circuit breaker "ON"/"OFF" also controls the main circuit breaker on the slave locomotive.
The VCB on the slave locomotive is switched on after a delay of 0.5 seconds following the switch on of the VCB on the master locomotive. When switching off, there is no delay.

Note:

If the VCB on the slave locomotive cannot be closed due to a fault, an appropriate fault message appears on the screen.

4.10.1.3 Regenerative Brake

During multiple operation, there is a limitation on the regenerative brake on the slave locomotive. This limitation reduces forces on the loco buffers (prevention of derailing).

4.10.1.4 Constant Speed Control (CSC)

During multiple operation, the constant speed control of the slave locomotive is inactive. The train bus transmits the selected tractive/braking effort from the master locomotive to the slave locomotive. The master loco performs speed-controlling function, demanding TE/BE on master and slave loco.

4.10.1.5 Anti-spin Protection

The anti-spin protection of the slave locomotive is independent of the master locomotive.

4.10.1.6 Compressor Control

The compressors are able to operate in three different operating modes.

172	These modes can be selected with the spring-loaded switch "BLCP", (Panel A).
Pos. "Off"	Compressor switched off.
Pos. "Auto"	Automatic pressure monitoring.
Pos. "Man"	Compressor switched on (manual monitoring).

172 The selected position of the compressor switch is transmitted to the slave locomotive.
In the "Man" and "Off" positions, all main compressors in both locomotives are controlled directly.

In the position "Auto", there are the following options:

172.2 1. A main reservoir pressure below 8 kg/cm^2 on the master or slave locomotive activates a particular compressor on both locomotives. Each locomotive switches alternately and independently between its two compressors.

172.3 2. A main reservoir pressure below 7.5 kg/cm^2 on the master or slave locomotive activates all compressors on both locomotives at the same time.

269.4 3. At a main reservoir pressure below 6.4 kg/cm^2, each locomotive independently controls its compressors.

4.10.1.7 Parking Brake (deleted in WAP-7)

The multiple unit cannot drive if one of the parking brakes is applied.

Note:

268 An activated parking brake on the master or slave locomotive is indicated in the activated driver's cab of the master locomotive by the red illuminated push button "BPPB".

4.10.1.8 Emergency Brake

An emergency brake on the slave loco can only be initiated in the following manner:

1. By actuating the brake handle of the automatic train brake to "Emergency" position.
2. By actuating the emergency brake cock on the assistant driver's side.

269.1 If the pressure switches 269.1 on the master or slave locomotive registers actuation of the emergency brake, the ensuing command for emergency braking applies to both locomotives.
The master for all other emergency braking commands is the master locomotive in the double (multiple) unit.

4.10.1.9 Other Brake Functions

269.6 If the pressure switch (269.6) registers a pressure in the brake cylinder of any bogie, and if speed exceeds 10 km/h, tractive effort is set to ‘0’.

Note:

If the electrical brake on one of the two locomotives fails, the electrical brake on the other locomotive remains functional.

4.10.2 Coupling

1. Both locomotive must be deactivated.
- The key switch must be in position "O".

2. Couple both locomotives mechanically, pneumatically and connect the UIC cable.

Pn 136 3. Close the isolating cock on the brake supply line of the slave locomotive (see Fig. 4.22).

4. Move the key switch on the slave locomotive into position "D" and, as soon as the light test starts, turn back to position "0". The MCE on the slave locomotive is now in self-hold mode.

5. During the self-hold mode of the slave locomotive, move key switch into Pos. "D" on the master locomotive. The control electronics starts to configure the train bus.

6. After the configuration procedure, screen 12 on the display shows the serial numbers of the master and slave locomotives.

Example:

Train configuration	
Loco 31001	Loco 31002

Fig. 4.28 Screen train configuration

Note:

If configuration proves impossible (or if no slave locomotive is available) locomotive number 00000 appears.

If more than one driver's cab is activated in both locomotives, one is shut down and a corresponding message appears on the displays in both locomotives.

Action: Initiate procedure 4.10.2 from Point 1.

4.10.3 Uncoupling

Starting Position:
Master and slave locomotives are available and both are ready.

1. Shut down both locomotives in accordance with regulations (VCB switched off, pantograph lowered).

2. Remove the UIC cable and disconnect the locomotives pneumatically and mechanically.

3. Both the locomotives are now ready for setting up as a single locomotive.

Note:

If for any reason the train bus link is interrupted, or if both locomotives are set up or in motion, the system protection initiates a monitored shut down of the slave locomotive.

Reaction:

The pantograph of the slave locomotive is lowered and a corresponding fault message appears on the screen of the master locomotive.

4.10.4 Sanding

192 Sanding on both locos can be initiated by the driver by pressing the sanding foot switch on the master loco.

4.10.5 Fire Alarm

A fire detection on the slave locomotive initiates an audio signal on the master locomotive (1170 Hz).

238 In addition, the VCB on the slave locomotive is switched off and a priority 1-fault message appears on the displays of both locomotives.

4.11 Trailing Mode

Trailing mode means that on the master locomotive in a multiple unit no tractive effort is available, if both bogies are electrically isolated. The driver's cab of the master locomotive still controls the slave locomotive.

The status of the master locomotive is as follows:

1. VCB switched off.
2. Pantograph is lowered.
3. Train bus is working correctly.
4. Pneumatic brake system is working correctly.
5. Brakes are controlled from the master locomotive.

79.1/2 6. The TE/BE meters show the values for the slave locomotive.

Note:

All equipments on the master locomotive are supplied by the battery and are functional for a maximum of 5 hours, if battery is fully charged.

4.12 Banking Mode

153 1. Set switch "ZBAN" "Banking operation" to position "ON" (Panel A).

2. Set up the loco in the normal manner.

3. Cock Position 136 and 70 should be “Close” on pneumatic panel.

Note:

The brake pipe on the locomotives is not filled by the slave locomotive but, in emergencies, on the slave locomotive the train brake can be actuated.
During the Set Up, the train driver receives a priority 2 message that banking mode is active.

4.13 Towing Mode

To prepare the loco for towing mode, the following actions have to be taken:

4.13.1 Making a live locomotive dead and the towing it:

Switch off the BLDJ, (Main Circuit Breaker). Lower the Pantograph.

Switch off the Control Electronics.

Couple the new live Locomotive to the dead locomotive

Open isolating cock 47 (dead engine cock).

Close ;isolating cock 74 (Emergency/Vigilance isolating cock).

Close isolating cock 70 (E70 Brake Pipe Isolating Cock).

Close isolating cock 136 (Brake Feed pipe isolating cock).

Note:

Check that the pantograph isolating cocks 8 are closed.

The “AUTO A9” Brake Controller should be in the “NEUTRAL” position in both cabs of the dead locomotive.

The “DIRECT SA9” Brake Controller should be in the “RELEASED” position in both cabs on the dead locomotive.

Pull the distributor releaser on the dead locomotive to exhaust any residual pressure in the brake cylinders.

Connect the Brake Pipes and the Feed Pipes of the leading and dead locomotive and open the BP and FP end cocks.

Release the Parking Brake (deleted in WAP-7) by operating the release push button on the latched solenoid valve (30) on the brake frame, and lock in position.

Check the condition of the Parking Brake Gauge (not applicable in WAP-7) in the drivers cab; this should indicate 5.0 Kg/Cm^2.

The brake rigging should be loose and the brake pads away from the discs.

Check:

Double check if the Parking Brake has released on the respective wheels by moving the shoe hangers and checking for clearance between the shoe and the wheel.

The locomotive is now ready to be towed.

Note:
In normal locomotive running conditions the cab Parking Brake Gauge should indicate 6.0 Kg/Cm^2(not applicable in WAP-7)*.*

4.13.2 Making a dead locomotive ready for towing (When brakes are already applied):

1. Couple the live locomotive to the dead locomotive.
2. The “AUTO A9” Brake Controllers should be in the “NEUTRAL” position in both cabs of the dead locomotive.
3. The “DIRECT SA9” Brake Controller should be in the “RELEASED” position in both cabs on the dead locomotive.
4. Pull the distributor releaser on the dead locomotive to exhaust any residual pressure in the brake cylinders.
5. Close isolating cock 70 (E70 Brake Pipe Isolating Cock)
6. Close isolating cock 74 (Emergency/Vigilance isolating cock).
7. Close isolating cock 136 (Brake Feed pipe isolating cock).
8. Open isolating cock 47 (Dead Engine cock).

Note:

Check that the pantograph isolating cocks 8 are closed.

Connect the Brake Pipes and the Feed Pipes of the leading and dead locomotive and open the BP and FP end cocks.

Release the Parking Brake (not applicable in WAP-7) *by operating the release push button on the latched solenoid valve (30) on the brake frame, and lock in position.*

Check the condition of the Parking Brake Gauge (not applicable in WAP-7) *in the drivers cab; this should indicate 6.0 Kg/Cm^2.*

Note:

The brake rigging should be loose and the brake shoe away from the wheel.

Check:

Double check if the Parking Brake has fully released on the respective wheels by moving the shoe and checking for clearance between the shoe and wheel.
The locomotive is now ready to be towed.

Note:
In normal locomotive running conditions the cab Parking Brake (not applicable in WAP-7) *gauge should indicate 6.0 Kg/Cm^2 Nominal.*

4.13.3 Towing a dead locomotive (When no brake is applied on the dead locomotive):

1. Bring the live locomotive adjacent to the dead locomotive.
2. Close isolating cock 70 (E70 Brake Pipe Isolating Cock).
3. Close isolating cock 74 (Emergency/Vigilance isolating cock).
4. Close isolating cock 136 (Brake Feed pipe isolating cock).
5 Open isolating cock 47 (Dead Engine Cock).
6. Connect the Brake Pipes of both the locomotives and open their respective end cocks, allowing sufficient time for the pneumatic system to charge on the dead locomotive prior to moving to the next step.

Warning:

Do not connect the UIC cable between the loco and the towing vehicle.

4.14 Failure Mode Operation

Rotary switch failure mode operation (152), location cubicle SB1.

If the master controller does not work properly an according isolating message will appear on the screen (Screen-No. F170103). The TE/BE-throttle has to be brought to zero and the rotary switch Failure mode operation has to be turned to position “I”.

In this mode, driving and electrical braking are controlled by the auxiliary contacts on the TE/BE throttle.

Important: *If the rotary switch Failure mode operation is in position “I”, the TE/BE values will be set only corresponding to the auxiliary contacts on the angle transmitter, i.e. 33%, 67% and 100% of TE/BE max. Please refer to chapter 3.2.*

4.14.1 Definition

150.1 This mode allows the locomotive to operate even if the angle transmitter of the TE/BE throttle has failed.

In this mode, driving and electrical braking are controlled by the auxiliary contacts on the TE/BE throttle.

4.14.2 . Driving in Failure Mode

Driving in failure mode becomes necessary if the difference between auxiliary contacts and the absolute value of the angle transmitter is greater than 25% of the full range because of a defective master controller.

The following steps are initiated with a time delay of 2 sec:

1. Traction is set to 0 by the MCE.
2. A priority 2 fault message is displayed.

152 3. The driver must now move the rotary switch "Failure Mode Operation" in the machine room (SB1) into position 1.

4. The driver must move the TE/BE throttle into position "0".

5. The driver must acknowledge the fault message.

6. The driver can now select a new TE/BE throttle value.

Note:
Rate of increase in tractive/braking effort between the individual auxiliary contact positions is usually 20 kN/s.

4.15 Information on Display Screen

4.15.1 General

A lot information can be called up on screen describing the status of the locomotive and its sub-systems.

If a fault occurs, the following messages appear automatically on the screen:

Fault messages.

Messages on isolated sub-systems.

Information messages

4.15.2 Operation of Display Screen

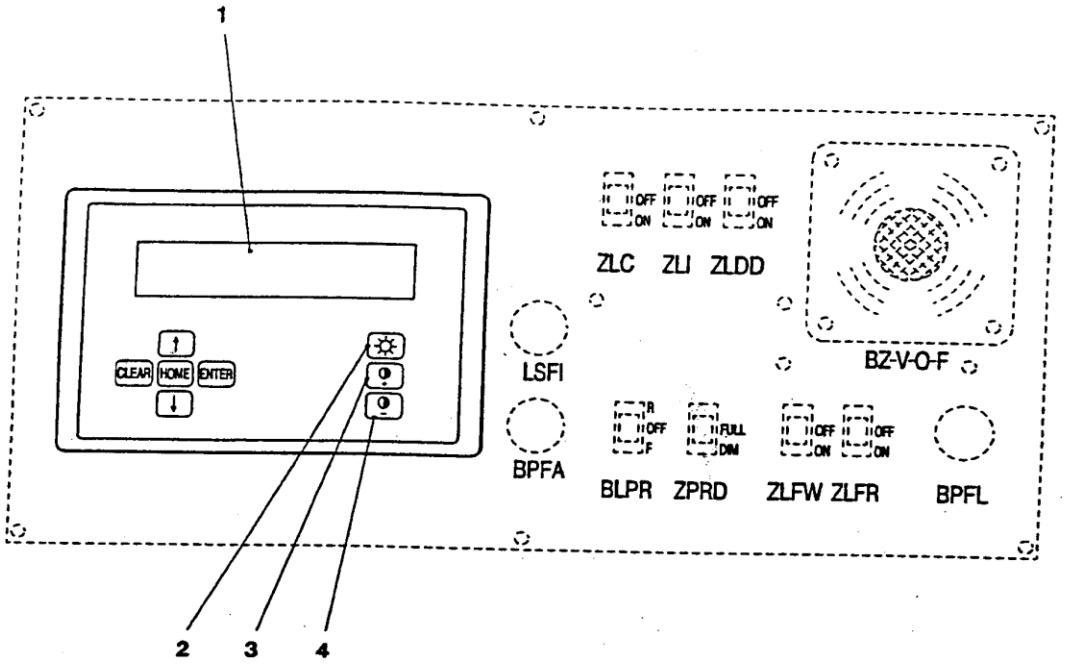


Fig. 4.29 Display Screen:

1 Display
2 Display illumination "ON"/"OFF"
3 Contract: brighter
4 Contrast: darker

CLEAR	→	Stand-by screen
HOME	→	Main Menu
ENTER	→	Sub menu
↑	">"	Up
↓	">"	Down

4.15.3 Screen Structure

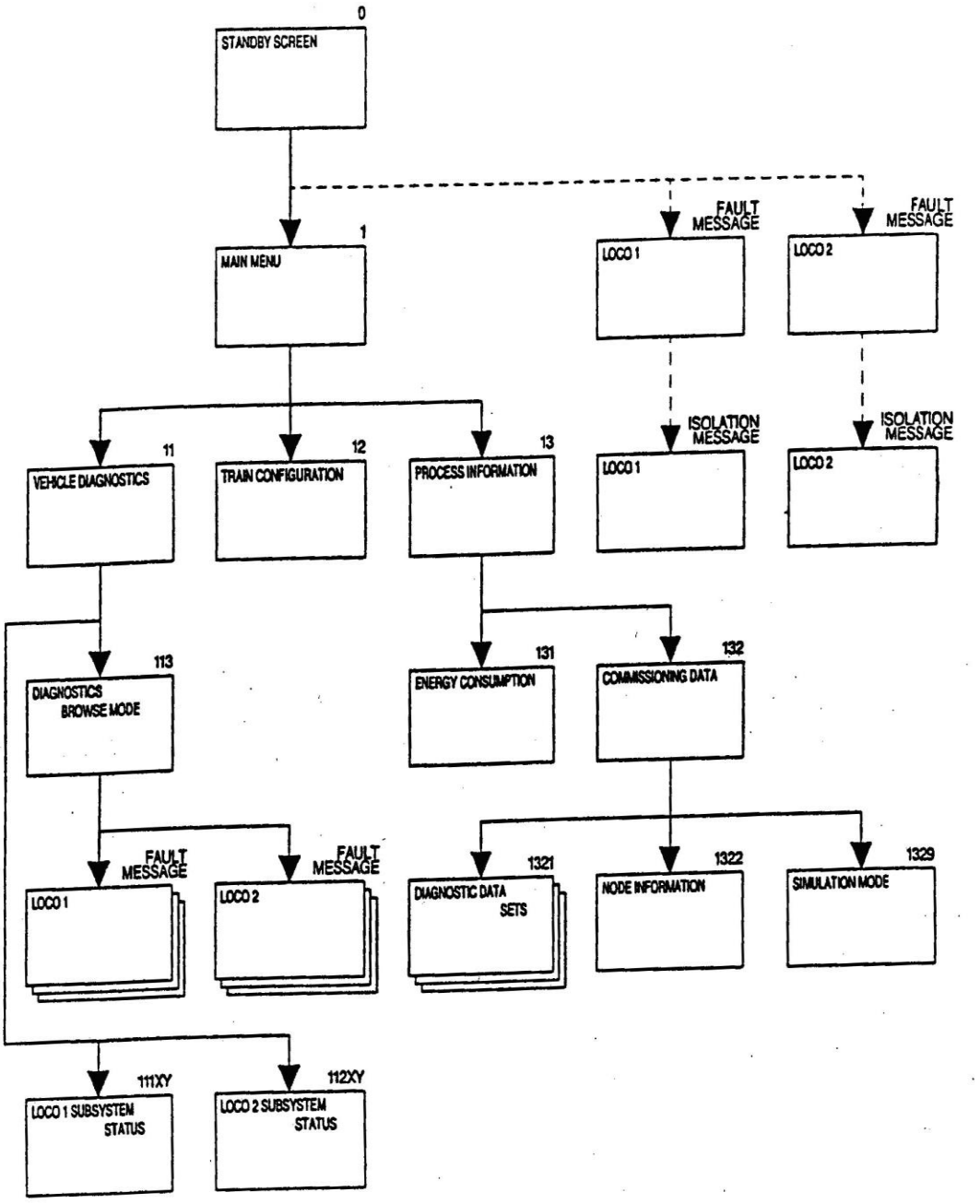


Fig. 4.30 Screen Structure

4.15.4 Stand-by Screen:

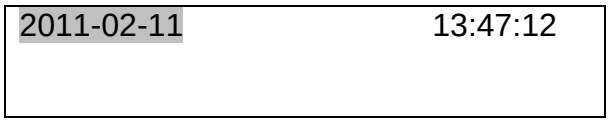


Fig. 4.31 Stand-by screen

This information appears on screen if the locomotive is fault-free or if it has been selected on display with the CLEAR button.

This screen simply shows the time and date on the top line. The display screen is otherwise empty which means that any display of fault messages will immediately attract the train driver's attention.

Note:

A few sub-programs are equipped with a time limit. If the keyboard on the display screen is not used for more than 60 seconds, the system changes over automatically to the stand-by screen.

5. FAULTS

5.1 General

Most faults are detected by the relevant monitoring equipment and are reported to the train driver by indication lamps or displays on the screen

5.1.1 Fault message Priorities

A distinction is made between 2 priorities of fault messages:

Faults with Priority 1

- The action to be taken is entirely clear
- The action to be taken must be initiated immediately
- A protective action is initiated (VCB off).

Faults with Priority 2

- The action to be taken is not entirely clear.
- The action to be taken does not have to be initiated immediately.
- The faults can be remedied manually by the train driver.

Note:

163.1 163 If a fault message appears on screen, the yellow illuminated push button "BPFA" lights up. If this is a fault message of priority 1, the red indication lamp "LSFI" starts flashing at the same time.

If a fault message with priority 1 is displayed, a fault message with priority 2 is suppressed on the screen.

A fault message with priority 2 remains on the screen until it is overwritten by a fault message with priority 1 or by a subsequent fault with priority 2.

5.1.2 Isolating of Sub-systems

A constant priority 1 fault or a priority 2 fault which occurs twice within one 30 minute period causes the appropriate sub-system to be isolated.

If a sub-system has been isolated, it does not issue any more fault messages and signals. The screen displays an isolation message and the
163 red fault indication lamps "LSFI" remains lit continuously.

5.1.2.1 Overview of Sub-systems

SS01 Main power supply
SS02 Traction bogie 1
SS03 Traction bogie 2
SS04 Harmonic Filter
SS05 Hotel load (inactive on WAG-9)
SS06 Converter, auxiliary circuits 1
SS07 Converter, auxiliary circuits 2
SS08 Converter, auxiliary circuits 3
SS09 Battery system
SS10 Brake system
SS11 Auxiliary circuits HB 1
SS12 Auxiliary circuits HB 2
SS13 Driver's cab 1
SS14 Driver's cab 2
SS15 Fire alarm
SS16 Speed indicator
SS17 FLG 1
SS18 FLG 2
SS19 Train bus

Warning:

When sub-systems are isolated it is not recommended to reset the fault-status by switching the locomotive off and on, since this resets the fault counter to zero.

At the end of the journey the driver must inform the maintenance staff to check and, if necessary, repair the locomotive.

5.1.2.2 Restrictions due to isolating of various sub-systems

1. Isolation of one traction bogie: Only half traction and braking power available.
2. Isolation of both traction bogies: No traction and braking power available.
3. Isolation of harmonic filter: Speak to TLC before proceeding further.
4. Isolation of HBB1: Cab-1 isolated, driving possible from cab-2 only.
5. Isolation of HBB2: Cab-2 isolated, driving possible from cab-1 only.
6. Isolation of STB1: Cab-1 isolated, driving possible from Cab-2 only.
7. Isolation of STB2: Cab-2 isolated, driving possible from cab-1 only.
8. Isolation of FLG1: No multiple operations.
9. Isolation of FLG2: No regenerative brake.

5.1.3 Acknowledgement of Fault Messages

5.1.3.1 Fault Messages with Priority 1

If a priority 1 fault occurs, the fault message must be acknowledged before the loco can travel further. If the train driver fails to acknowledge, the protection measures introduced remain in force. The fault is not remedied.

163.1 A fault is acknowledged by pressing the yellow illuminated push button "BPFA". If a priority 1 fault appears, a sub-system isolation message appears on the screen. If the train driver now presses the fault acknowledge push button "BPFA" on the screen, the displayed sub-system is isolated.

Note:

All priority 1 faults are acknowledged simultaneously when the acknowledgement button is pressed. However, if the train driver first wishes to see which faults have been reported, he must press the "ENTER" key before acknowledging the faults. When he does this, all faults are displayed in the following sequence:

Faults in the individual sub-systems of the master locomotive

Faults in the individual sub-systems of the slave locomotive

By pressing the "CLEAR" button, the highest priority fault is displayed once again.

Also, after the last fault message has appeared, the fault with the highest priority is displayed once again (ring buffer principle).

5.1.3.2 Fault Messages with Priority 2

They are also acknowledged by pressing the illuminated push-button "BPFA".

Even if this acknowledgement is not forthcoming, the locomotive is still able to operate. The fault message still remains visible on the screen until it is overwritten by a fault message with priority 1 or by a subsequent fault with priority 2.

Note:

If a fault message with priority 1 is displayed, any priority 2 fault message present at the same time is not displayed on the screen.

5.1.3.3 Resetting the status of the Locomotive

Dependent on the degree & frequency of a certain failure of the control electronics tries to restore or isolate the concerned sub-system.

In case of blocking the train traffic due to isolation of too many sub-systems it may be helpful to set up the locomotive in original conditions.

To reset the locomotive, the following procedure has to be carried out.

1. VCB off
2. Lower the pantograph
3. BL Key switch to zero position, i.e MCE complete off
4. Wait one minute
5. Set up locomotive again as usual

5.1.4 Status display of the sub-systems

5.1.4.1 Select Main Menu Screen

Main menu	Loco 31001
> 1. Vehicle diagnostics	
2. Information train bus	
3. Process information	

Fig. 5.1 Main Menu Screen

5.1.4.2 Select Vehicle Diagnostics (move ">" with arrow keys)

Vehicle diagnostic	Loco Status
> 1. Loco 31001	01
2. Loco 31002	92
3. Browse mode	

Fig. 5.2 Vehicle Diagnostics Screen

The status of the locomotives is now displayed.
Subsequent procedure: Select the desired locomotive (move ">" with arrow keys)

Press "ENTER" key
The status of the first sub-system is now displayed.

Press "ENTER" key once again.
The status of the next sub-system is now displayed.

Press the "HOME" key to return the system to the Main Menu.

5.1.5 Key to Codes

Vehicle diagnostic	Loco Status
> 1. Loco 31001	01
2. Loco 31002	92
3. Browse mode	

Fig. 5.3 Vehicle Diagnostics Screen

Encoding of locomotive status:

First digit

"0" = no sub-system is isolated
"9" = at least one sub-system is isolated.

Second digit

"0" = no fault in system.
"1" = there is at least one fault with priority 1 in the system.
"2" = there is at least one fault with priority 2 in the system.

Example: Fig. 5.3

Status of locomotive 31001:	No sub-system isolated At least one fault with priority 1.
Status of locomotive 31002:	At least one sub-system isolated At least one fault with priority 2

5.1.6 Browse

With the help of the Browse Menu, all current sub-system isolations and fault messages can be displayed.

Vehicle diagnostic	Loco Status
1. Loco 31001	01
2. Loco 31002	92
> 3. Browse mode	

Fig. 5.4 Vehicle Diagnostics Screen (browse mode)

Press the "ENTER" key to call up the next display on screen.

Diagnostics: Browse mode
> 1. Loco 31001: Fault / isolation messages
2. Loco 31002: Fault / isolation messages

<ENTER>

Loco 31001: SSO3: Traction bogie 2
Disturbance in converter 2
F0301P1

<ENTER>

Loco 31001: SS12: Auxiliaries HB2
MCB(S) tripped in aux. Cubicle 2
F1201P1

<ENTER>

Loco 31001: SSO3: Traction bogie 2
Bogie 2 isolated

Fig.5.5 Browse Mode Screens

The displays appear in the following order:

1. Fault with priority 1
2. Fault with priority 2
3. Isolations of sub-systems starting with the lowest number.

5.1.7 Train Configuration

In the Main Menu, place ">" on "Information trainbus".

Press "ENTER" key.

This display shows the numbers of the locomotives, which have been activated in the train configuration.

Train configuration
Loco 31001 Loco 31002

Fig 5.6 Train Configuration Screen

5.1.8 Energy Consumption

Energy consumption is recorded and displayed on screen in kWh (kilowatt hours). The value is stored in the database of processor DIA1, i.e. the cumulative consumption is displayed on screen.

Display energy consumption:

In Main Menu, place ">" on "process information".

```
Main Menu                    Loco 31001
  1. Vehicle diagnostics
  2. Information trainbus
> 3. Process information
```

Fig 5.7 Main Menu Screen

Press "ENTER" key

```
> 1. Energy consumption
  2. Commissioning data
```

```
Energy consumption
Loco 31001                   XXXXXXXX kWh
```

Fig. 5.8 Energy Consumption Screen

Note:
After 50'000'000 kWh the counter starts again at 0.

5.2 Earthing

To earth the locomotive takes the following steps:

125 1. Set the key switch to the position "0".

112.1 2. Set circuit breaker "Control Circuits Locomotive" on SB2 to position "OFF"

3. Follow the procedure "Interlocking concept" (refer to 3.10.2).

5.3 Fault / Isolation Messages

5.3.1 Fault Message Display

A fault message is displayed on the screen in the cab and gives the following information:

5.3.1.1 Example:

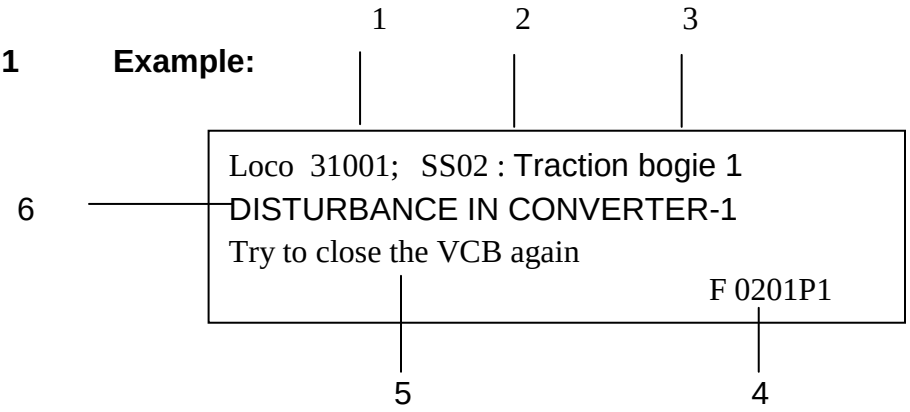


Fig. 5.9 Fault messages No. F02001P1

1 Loco No.
2 Sub-system No.
3 Sub-system affected
4 Fault message No.
5 "What has to be done?"
6 Fault

5.3.1.1.1 Explanations

Situation: The Converter Contactor of the Traction Converter 1 is not closed.

Action: The driver tries once more to close the VCB by bringing the switch "BLDJ" into position “ON"

Possible consequences

1. The VCB closes. Converter Contactor closes. Loco OK.
Or
2. The Converter Contactor does not close.

Further action

The driver presses the acknowledgement push-button "BPFA" and bogie 1 will be isolated. An isolation message in Fig. 5.10 will appear on the display.

Consequences
Only half traction and braking power available.

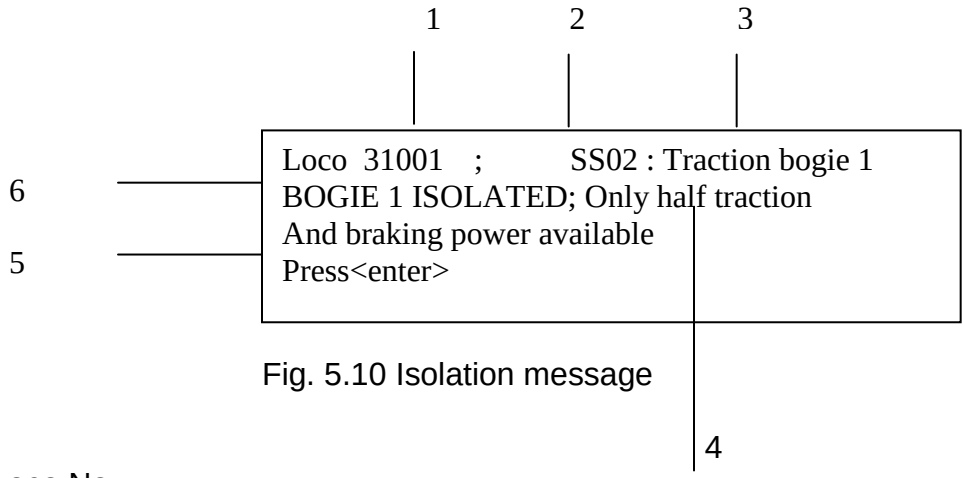


Fig. 5.10 Isolation message

1 Loco No.
2 Sub-system No.
3 Sub-system affected
4 Consequence.
5 "What has to be done?"
6 Sub-system isoleted.

5.4 List of fault messages

SS01: Main Power	F0101P1	VCB STUCK IN ON POSI-TION Loco will be shutdown		Converter contactor opens Hotel load contactor opens Panto lowers		Bring throttle to "0" position	MAIN POWER ISOLATED VCB inhibited Loco is dead	Ask for relief loco
	F0102P1	VCB STUCK IN OFF POSITION Try to close VCB again		VCB control changed to redundant processor	1ST	Press BLDJ to close VCB		
					2ND		MAIN POWER ISOLATED VCB inhibited Loco is dead	VCB can not be closed Shut down loco Ask for relief loco
	F0103P1	LOW PRESSURE PANTO/ FAULTY PANTO Check iso. cock, aux. reservoir pressure	LSDJ	Pantograph will not be raised		Wait for aux. Reservoir pressure reaches 5.2 kg/cm^2.		Check isolating cock; Check auxiliary reservoir pressure; Check auxiliary compressor.
	F0104P1	CATENARY VOLTAGE OUT OF LIMIT Watch catenary voltmeter Close VCB when voltage is OK	LSDJ	VCB off		Bring throttle to "0" position. Wait for catenary voltage to reach within limits		
	F0105P1	TRANSFORMER OIL TEMP. OR PRESSURE NOT OK TE/BE reduction or VCB trip's Try to close the VCB if open		TE/BE reduction GTO pulsing inhibited Hotel load off VCB off		Wait for transformer oil temp./pressure normalises		Check manually whether oil pumps or oil cooling unit work or not; Check oil level transformer expansion tanks; Check whether the valves in the oil circuit are open or not
	F0106P1	FILTER ON/OFF CONTAC-TOR STUCK ON VCB will not close again		Filter discharging contactor must be open				If VCB opens, it will not close again

	F0107P1	PRECHARGE OR MAIN CONTACTOR STUCK ON Main converters blocked		VCB tripped		Bring throttle to "0" position	MAIN POWER ISOLATED VCB inhibited Loco is dead	VCB can not be closed. Ask for relief loco
	F0108P1	PRIMARY OVERCURRENT Check over current relay flag Try to close the VCB again	LSDJ	Max. Current relay interrupts power supply to VCB closing/ holding oil	1ST	Press BLDJ to close VCB		Check overcorrect relay flag
					2nd		MAIN POER ISOLATED VCB inhibited Loco is dead	VCB can not be closed Ask for relief loco
	F0109P1	AUXILIARY WINDING OVERCURRENT Try to close the VCB again	LSDJ	VCB trips	1st	Press BLDJ to close VCB		
					2nd		MAIN POER ISOLATED VCB inhibited Loco is dead	VCB can not be closed Ask for relief loco
	F0110P1	FATAL ERROR IN MAIN CKT./ TOO MANY SUB-SYSTEMS ARE ISOLATED Turn off the loco	LSDJ	VCB trips Panto lowers		Bring throttle to "0" position	MAIN POER ISOLATED VCB inhibited Loco is dead	Loco shutdown Ask for relief loco
	F0101P2	OVER TEMPERATURE CONTROL ELECTRONIC To be checked during maintenance	LSCE	Control electronics contactor will not close		Put BL key to "C" position. Wait for LSCE to extinguish		
	F0102P2	TRANSFORMER OIL PRESSURE NOT OK Any oil pump circuit not working TE/BE will be reduced		TE/BE reduced Increase ventilation Hotel load off VCB trips				Check manually whether transformer oil pumps work or not
	F0103P2	EARTH FAULT AUX. WINDING Circuit To be checked during maintenance						Inform maintenance staff

	F0104P2	LOW FREQUENCY CATERNARY VOLTAGE Wait one minute & set TE/BE again				Wait one minute & set TE/BE again		
	F0105P2	HIGH FREQUENCY CATERNARY VOLTAGE Wait one minute & set TE/BE again				Wait one minute & set TE/BE again		
	F0106P2	AUX CAPACITOR MR-BLOWER.MOT.NOT. OFF Normal operation can continue				To be checked during maintenance.		
SS02: Traction bogie 1	F0201P1	DISTURBANCE IN CONVERTER 1 Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0202P1	CONVERTER CONTACTOR STUCK OFF Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0203P1	GATE UNIT SUPPLY STUCK OFF Try to close VCB again			1st	Press BLDJ to close VCB		
					2nd		BOGIE 1 ISO-LATED; only	Inform maintenance staff.

							half traction and electrical braking power available	
	F0205P1	CONVERTER 1 OIL TEMPERATURE TOO HIGH Try to close the VCB again			1st	Press BLDJ to close VCB		Check oil level converter expansion tank. Check manually whether oil cooling unit works or not
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0206P1	CONVERTER 1 OIL PRESSURE NOT OK Check oil level Try to close the VCB again			1st	Press BLDJ to close VCB		Check oil level converter 1 expansion tank. Check manually whether converter oil pump 1 works or not.
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0207P1	TRACTION MOTOR TEMPERATURE TOO HIGH Converter 1 blocked Bogie 1 may get isolated			1st			Check manually whether traction motor blower 1 works or not
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0201P2	EARTH FAULT IN CONVERTER 1						Inform maintenance staff.

		Normal operation can continue To be checked during maintenance						
	F0202P2	TRACTION MOTOR OVERSPEED TE is being reduced Reduce loco speed				Reduce speed		
	F0203P2	MUB RESISTANCE TOO HOT IN CONVERTER 1 Wait for 30 seconds				Wait for 30 seconds. Then press BLDJ to close VCB		
	F0204P2	FAULTY MOTOR TEMPERATURE Sensors Normal operation can continue To be checked during maintenance						Inform maintenance staff.
	F0205P2	EQUIPMENT TEMPERATURE HIGH TE/BE is being reduced						
	F0206P2	DC LINK CAPACITORS PRESSURE NOT OK Normal operation can continue To be checked during maintenance						Inform maintenance staff; capacitors have to be checked during maintenance
	F0207P2	WHEEL SKIDDING AT BOGIE-1 Normal operation continue Reduce braking effort			1st	Reduce braking effort		
SS03 Traction Bogie-2	F0301P1	DISTURBANCE IN CONVERTER 2 Try to close the VCB again if tripped			1st	Press BLDJ to close VCB		

					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0302P1	CONVERTER CONTACTOR STUCK OFF Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0303P1	GATE UNIT SUPPLY STUCK OFF Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0305P1	CONVERTER 2 OIL TEMPERATURE TOO HIGH Try to close the VCB again			1st	Press BLDJ to close VCB		Check manually whether oil cooling unit works or not
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.

	F0306P1	CONVERTER 2 OIL PRESSURE NOT OK Check oil level Try to close the VCB again			1st	Check oil level; Press BLDJ to close VCB		Check oil level converter 2 expansion tank. Check manually whether converter oil pump works or not
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0307P1	TRACTION MOTOR TEMPERATURE TOO HIGH Converter 2 blocked Bogie 2 may get isolated			1st			Check; manually whether traction motor blower works or not
					2nd		BOGIE 1 ISO-LATED; only half traction and electrical braking power available	Inform maintenance staff.
	F0301P2	EARTH FAULT IN CONVERTER 2 Normal operation can continue To be checked during maintenance						Inform maintenance staff.
	F0302P2	TRACTION MOTOR OVERSPEED TE is being reduced Reduce loco speed				Reduce speed		
	F0303P2	MUB RESISTANCE TOO HOT IN CONVERTER 2 Wait for 30 seconds				Wait for 30 seconds . Then press BLDJ to close ;VCB		
	F0304P2	FAULTY MOTOR TEMPERATUE SENSORS						Inform maintenance staff

		Normal operation can continue To be checked during maintenance						
	F0305P2	EQUIPMENT TEMPERATURE TOO HIGH TE/BE is being reduced						
	F0306P2	DC LINK CAPACITORS PRESSURE NOT OK Normal operation can continue To be checked during maintenance						Inform maintenance staff; capacitors have to be checked during maintenance
	F0307P2	WHEEL SKIDDING AT BOGIE-1 Normal operation continue Reduce braking effort			1st	Reduce braking effort		
SS04: Harmonic filter	F0401P1	HARMONIC FILTER CURRENT TOO HIGH Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd	Reduce speed to max. 40 km/h	HARMONIC FILTER ISOLATED	Speak to TLC Max. permitted speed is 40 km/h
	F0402P1	HARMONIC FILTER CONTACTOR(S) STUCH OFF/ON Harmonic filter will be isolated. Speak to TLC				Reduce speed to max. 40km/h	HARMONIC FILTER ISOLATED	Speak to TLC Max. permitted speed is 40 km/h
	F0404P1	FILTE;R DISCHARGE RESISTOR TOO HOT No. of filter discharges exceeded VCB will remain inhibited 15 min.				Wait 15 minutes and try to close VCB again by pressing BLDJ		

	F0401P2	FILTER CONTACTOR 8.1 STUCK ON If VCB opens it will not close again						If VCB opens, it will not close again; Then ask for a relief loco.
	F0402P2	EARTH FAULT HARMONIC FILTER CKT Normal operation can continue To be checked during maintenance						Inform maintenance staff.
SS05: Hotel load	F0503P1	EARTH FAULT IN HOTEL LOAD CIRCUIT Hotel load will be isolated				Lift switch BLHO to OFF position to open Hotel load contactor	Hotel Load isolated	Inform maintenance staff.
	F0504P1	OVERCURRENT IN HOTEL LOAD CIRCUIT Try to close ;the VCB again			1st	Press BLDJ to close VCB		
					2nd		Hotel Load isolated	Inform maintenance staff
	F0501P2	HOTEL LOAD CONTACTOR STUCK OFF Hotel Load not available						Inform maintenance staff
	F0502P2	HOTEL LOAD CONTACTOR STUCH ON For un/coupling hotel load trip VCB				For un/coupling hotel load trip VCB		Inform maintenance staff. Work on hotel load is allowed only when VCB is open!
SS06: Aux. Converter 1	F0601P1	DISTURBANCE IN PROCESSOR BUR 1 Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		Aux. Converter 1 isolated. Max. ventilation level will be reduced	Inform maintenance staff

	F0602P1	FAULT AUXILIARY CONVERTER 1 Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		Aux. Converter 1 isolated. Max. ventilation level will be reduced	Inform maintenance staff
	F0603P1	CONTACTOR FAULT IN HB1 Contactor 52/4 or 25/5 stuck off					Aux. Converter 1 may get isolated	Check contactor. Inform maintenance staff.
	F0604P1	BOGIE-1 VENTILATIONS BUR-1 DISTURBED Press Acknowledge to reconfigure to BUR-2				Press acknowledge to reconfigure to BUR-2		
SS07: Aux. Converter 2	F0701P1	DISTURBANCE IN PROCESSOR BUR 2 Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		Aux. Converter 2 isolated. Max. ventilation level will be reduced	Inform maintenance staff
	F0702P1	FAULT AUXILIARY CONVERTER 2 Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		Aux. Converter 2 isolated. Max. ventilation level will be reduced	Inform maintenance staff
	F0703P1	CONTACTOR FAULT IN AUX.CONV. BOX2/HB1					Aux. Converter 2 may get isolated	Check contactor. Inform maintenance staff.

		Contactor 52/1/2/4 stuck off or on						
	F0704P1	BOGIE-2 VENTILATIONS BUR-2 DISTURBED Press Acknowledge to reconfigure to BUR-1				Press Acknowledge to reconfigure to BUR-1		
SS08: Aux. Converter 3	F0801P1	DISTURBANCE IN PROCESSOR BUR 3 Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		Aux. Converter 3 isolated. Max. ventilation level will be reduced	Inform maintenance staff
	F0802P1	FAULT IN AUXILIARY CONVERTER 3 Try to close the VCB again			1st	Press BLDJ to close VCB		
					2nd		Aux. Converter 3 isolated. Max. ventilation level will be reduced	Inform maintenance staff
	F0803P1	CONTACTOR FAULT IN AUX. CONVERTER BOX 2 Contactor 52/3 stuck off					Aux. Converter 3 may get isolated	Check contactor. Inform maintenance staff.
SS09: Battery System	F0901P1	BATTERY VOLTAGE; TOO LOW Electronics will switch off					Main power isolated, VCB cannot be closed. VCB inhibited. Loco is dead	Ask for relief loco.
	F0902P1	LOW BATTERY VOLTAGE Converters being switched off Open VCB, lower Panto				Press BLDJ to open VCB Press ZPT to lower panto		Ask for relief loco.
	F0903P1	PAN LOWERED LONGER						

		THAN 10 MINUTES Control electronics will switch off						
	F0901P2	WARNING: LOW BATTERY VOLTAGE Driving available for less than 30 min. Check battery charger MCB						Check battery charger MCB.
	F0902P2	BATTERY CHARGER MCB OFF Try to close the MCB						Try to close battery charger MCB
	F0903P2	LOW BATTERY CHARGER CURRENT Battery charger; MCB may have tripped. Battery not being charged						Check batter and connection of battery cables. Try to close battery charger MCB
	F0904P2	DIAGNOSIS MEMORY BATTERY EMPTY Inform TLC during next stop						Inform TLC during next stop
	F0905P2	EARTH FAULT BATTERY CIRCUIT Normal operation can continue To be checked during maintenance						Inform maintenance staff.
SS10: Brake System	F1001P1	FAULT IN BRAKE ELECTRONICS Emergency brake applied No traction allowed				Bring TE/BE throttle to "0" position		Ask relief loco.
	F1002P1	LOW PRESSURE MAIN RESERVOIR No traction allowed till pressure reaches 6.4 kg/cm^2.				Bring TE/BE throttle to "0" position. Wait until a pressure of 6.4 kg/cm^2 is reached.		Check whether compressor work or not. Check train for heavy leakage in pneumatic system.

	F1003P1	VIGILANCE EMERGENCY BRAKE APPLICATION Bring TE/BE throttle to zero Press vigilance reset push button.				Bring TE/BE throttle to "0" position. Press vigilance-reset push button.		
	F1004P1	BRAKE CONTROL ISOLATED Open isolating cock brake control Bring TE/BE throttle to zero				Open isolating cock brake control. Bring TE/BE throttle to "0" position		
	F1005P1	TRACTION WITH AUTO BRAKES NOT ALLOWED Release auto air brake Bring TE/BE throttle to zero				Release auto air brake. Bring TE/BE throttle to "0" position		
	F1006P1	TRACTION WITH PARKING BRAKES NOT ALLOWED Release parking brakes Bring TE/BE throttle to zero				Bring TE/BE throttle to "0" position Release parking brakes.		
	F1007P1	REGENERATIVE BRAKE FAILURE Pneumatic loco brake applied					Not electrical brake power available	Inform maintenance staff.
	F1008P1	EMERGENCY STOP; SHUT DOWN ON THE LOCO To release, reset Emergency Stop push button Bring TE/BE throttle to zero				Bring TE/BE throttle to "0" position. Reset Emergency Stop push button		
	F1009P1	TRACTION NOT ALLOWED WITH APPLIED BRAKES Release loco brakes Bring TE/BE throttle to zero				Bring TE/BE throttle to "0" position. Release loco brakes.		
	F1010P1	EMG EXHAUST COCK				Bring TE/BE throttle to "0"		

		CLOSED, NO TRACTION For traction open the cock Bring TE/BE throttle to zero				position. Open the emergency exhaust cock.		
	F1001P2	LOCO IS IN BANKING MODE Loco brake controller isolated Emergency brakes can be applied					Loco brake controller isolated.	
	F1002P2	ALARM CHAIN PULLINGP CHECK THE CCOACHES				Check the coaches		
SS11: Auxiliaries HB1	F1101P2	MCB(S) TRIPPED IN AUX. CUBICLE 1 Traction power may get reduced, if temperature exceed						Check MCBs in Auxiliary cubicle 1
	F1102P2	EARTH FAULT 415/110V CIRCUIT Normal operation can continue To be checked during maintenance						Inform maintenance staff.
	F1103P2	MCB OF MAIN COMPRESSOR -1OPEN Compressor 1 not available					Compressor 1 not available	
	F1104P2	OVERLOAD ON OIL COOLER BLOWER-1 Inform the service staff to clean the radiators						Inform the service staff to clean the radiators
SS12: Auxiliaries HB2	F1201P2	MCB (S) TRIPPED IN AUX. CUBICLE 2 Traction power may get reduced, if temperature exceed						Check MCBs in Auxiliary cubicle 2
	F1202P2	MCB OF MAIN COMPRESSOR -2OPEN					Compressor 2 not available	

		Compressor 2 not available						
	F1203P2	OVERLOAD ON OIL COOLER BLOWER-2 Inform the service staff to clean the radiators						Inform the service staff to clean the radiators
SS13: Cab 1	F1301P1	DISTURBANCE IN PROCESSOR HBB1 Cab 1 may get isolated; Drive from Cab 2 REFER TO DRIVER'S MANUAL				Change to Cab 2 (see chapter 4.5)		Inform maintenance staff.
	F1302P1	DISTURBANCE IN PROCESSOR STB1 Cab 1 may get isolated; Driver from Cab 2 REFER TO DRIVER'S MANUAL				Change to Cab 2 (see chapter 4.5)		Inform maintenance staff.
	F1303P1	REVERSER DEFECTIVE Drive from Cab 2				Change to Cab 2 (see chapter 4.5)		Inform maintenance staff.
SS14: Cab 2	F1401P1	DISTURBANCE IN PROCESSOR HBB2 Cab 2 may get isolated; Drive from Cab 1 (Refer To Driver's Manual)				Change to Cab 1 (see chapter 4.5)		Inform maintenance staff.
	F1402P1	DISTURBANCE IN PROCESSOR STB2 Cab 2 may get isolated; Driver from Cab 1 (Refer To Driver's Manual)				Change to Cab 1 (see chapter 4.5)		Inform maintenance staff.
	F1403P1	REVERSER DEFECTIVE Drive from Cab 1				Change to Cab 1 (see chapter 4.5)		Inform maintenance staff.

SS15: Fire detection	F1501P1	FIRE IN MACHINE ROOM Extinguish the fire Reset the fire detection unit	LSFI Buzzer					Extinguish the fire by using the fire extinguishers. Reset the fire detection unit. Inform maintenance staff.
	F1501P2	FAULT IN FIRE DETECTION UNIT No fire detection possible Normal operation can continue						Inform maintenance staff.
	F1502P2	WARNING: SMOKE IN MACHINE ROOM Inspect machine room						Inspect machine room. Inform maintenance staff.
SS16: Speedo-meter	F1601P1	SPEED LIMIT EXCEEDED Emergency brakes applied Bring TE/BE throttle to zero	LSVW			Bring TE/BE throttle to "0" position		
	F1601P2	FAULT IN SPEEDOMETER No display of speed in the cab Drive ca JAN-04refully, use diagnostic screen				Drive carefully. Watch speed on display (commissioning data / simulation mode, screen 9)		Inform maintenance staff.
SS17: Processor FLG1	F1701P1	DISTURBANCE IN PROCESSOR FLG1 FLG1 will be isolated.					FLG 1 isolated.	
	F1702P1	SOFTWARE MISMATCH WAP-5/WAG-9 Panto will not raise						Inform maintenance staff Check software Ask for relief loco.
	F1703P1	FAULT IN ANGLE TRANSMITTER OF THROTTLE Bring TE/BE throttle to zero Operate switch failure mode				Bring TE/BE throttle to "0" position. Drive loco in failure mode operation (see chapter 4.14)		Operate switch failure mode. Inform maintenance staff.

	F1704P1	SIMULATION SWITCH POSITION NOT MATCHING Check simulation key on master/slave				Bring TE/BE throttle to "0" position		Check simulation key position on master/ slave loco.
	F1701P2	DISTURBANCE IN PROCESSOR DIA 1 DIA 1 will be isolated No fault data will be stored						Inform maintenance staff.
SS18: Processor FLG2	F1801P1	DISTURBANCE IN PROCESSOR FLG2 FLG2 will be isolated.					FLG 1 isolated.	Inform maintenance staff.
	F1802P1	SOFTWARE MISMATCH WAP-5/WAG-9 Panto will not raise						Inform maintenance staff Check software Ask for relief loco.
	F1803P1	FAULT IN ANGLE TRANSMITTER OF THROTTLE Bring TE/BE throttle to zero Operate switch failure mode				Bring TE/BE throttle to "0" position. Drive loco in failure mode operation (see chapter 4.14)		Operate switch failure mode. Inform maintenance staff.
	F1804P1	SIMULATION SWITCH POSITION NOT MATCHING Check simulation key on master/slave				Bring TE/BE throttle to "0" position		Check simulation key position on master/ slave loco.
	F1801P2	DISTURBANCE IN PROCESSOR DIA 1 DIA 1 will be isolated No fault data will be stored.						Inform maintenance staff.
SS19: Train bus	F1901P1	COMMUNICATION DISTURBANCE Try to close the VCB again Multiple operation not possible				Press BLDJ to close VCB		Check cable for multiple operation. Inform maintenance staff.

5.5 List of Isolation Messages:								
SS01: Main power		MAIN POWER ISOLATED; VCB inhibited Loco is dead Press <enter>				Press <enter>	MAIN POWER ISOLATED.	Ask for relief loco.
SS02: Traction bogie 1		BOGIE 1 ISOLATED; Only half traction and braking power available Press <enter>				Press <enter>	BOGIE 1 ISOLATED Only half traction and electrical braking power available.	Inform maintenance staff.
SS03: Traction bogie 2		BOGIE 2 ISOLATED; Only half traction and braking power available Press <enter>				Press <enter>	BOGIE 2 ISOLATED Only half traction and electrical braking power available.	Inform maintenance staff.
SS04: Harmonic filter		HARMONIC FILTER ISOLATED Speak to TLC Press <enter>				Press <enter> Reduce speed below 40 km/h	HARMONIC FILTER ISOLATED	Inform maintenance staff. Speak to TLC.
SS05: Hotel load		HOTEL LOAD ISOLATED Driving still possible Press <enter>				Press <enter>	HOTEL LOAD ISOLATED	Inform maintenance staff.
SS06: Aux. Converter 1		AUXILIARY CONVERTER 1 ISOLATED Driving still possible Press <enter>				Press <enter>	AUXILIARY CONVERTER 1 ISOLATED Max. ventilation level will be reduced	Inform maintenance staff.
SS07: Aux. Converter 2		AUXILIARY CONVERTER 2 ISOLATED Driving still possible Press <enter>				Press <enter>	AUXILIARY CONVERTER 2 ISOLATED Max. ventilation level will be reduced	Inform maintenance staff.

SS08: Aux. Converter 3		AUXILIARY CONVERTER 3 ISOLATED Driving still possible Press <enter>				Press <enter>	AUXILIARY CONVERTER 3 ISOLATED Max. ventilation level will be reduced	Inform maintenance staff.
SS13: Cab 1		CAB 1 ISOLATED Drive from Cab 2 Press <enter>				Press <enter> Change to Cab 2 (see chapter 4..5)	CAB 1 ISOLATED	Inform maintenance staff.
SS14: Cab 2		CAB 2 ISOLATED Drive from Cab 1 Press <enter>				Press <enter> Change to Cab 1 (see chapter 4..5)	CAB 2 ISOLATED	Inform maintenance staff.
SS17: FLG 1		FLG 1 ISOLATED Refer to Driver's Manual Press <enter>				Press <enter>	FLG 1 ISOLATED No multiple operation possible	Inform maintenance staff.
SS18: FLG 2		FLG 2 ISOLATED Refer to Driver's Manual Press <enter>				Press <enter>	FLG 2 ISOLATED No electrical brake power available.	Inform maintenance staff.
SS19: Train bus		TRAINBUS ISOLATED Multiple operation not possible Press <enter>				Press <enter>	TRAINBUS ISOLATED No multiple operation possible	Inform maintenance staff.

5.6 List of Information Messages:								
Information 001		SELF HOLD MODE ACTIVE After 10 min. MCE will switch off				Change cab or prepare train for multiple operation within 10 minutes		
Information 002		MORE THAN ONE CAB ACTIVE De-active non driving cab Otherwise after 10 min. MCE switches off				De-active non driving cab within 10 minutes		
Information 003		TRACTION MAY NOT BE AVAILABLE ON THIS LOCO OR ON THE SLAVE LOCO Bring throttle to "0' pos. then set again				Bring TE/BE throttle to "0" and set it again.		
Information 004		TRAINBUS CONFIGURATION RUNNING Please wait.				Wait.		
Information 005		FULL TE/BE RESTORED						
Information 006		PANTO RAISING PLEASE WAIT				Wait		

6. LATEST UPGRADATION:

6.1 HOTEL LOAD:

- **The Concept**
  - Power is taken from the OHE through pantograph to the Transformer of locomotive which is provided with a hotel load winding of 945 kVA, at nominal voltage of 750 V single-phase.
  - 750 Volts single-phase supply from Hotel Load winding will be fed to IGBT based Hotel Load Converter, which will give 750 Volts 3-phase 50 Hz supply as output, for feeding the hotel load of the train.
  - Converter output will be used to at suitable voltage levels using step down transformers to operate the lights, fans, air conditioning, water raising apparatus of the coaches and the pantry car equipment.
  - Rajdhani /Shatabdi rake shall be used for HOG power supply scheme.
- **Merits**
  - No air or noise pollution which is generated by power cars.
  - Highest reliability as compared to Self Generation (SG) and End on Generation (EOG) system due to reduced number of equipments and devices.
  - Low maintenance requirement.
  - Reduced dead weight as compared to SG & EOG system
  - Possibility of Elimination of under-slung equipments like alternator & battery in conventional coaches thus enhanced safety.
  - One set of Diesel Alternator (DA) will not be required. Other set would be required only as standby mode for supply. One DA set will be removed from the power car which will pave space for commercial use.

The hotel load is supplied by a separate secondary winding of the main transformer:

Voltage:	750 V AC
Frequency:	50 Hz
Power:	850 kVA

169.1 The spring-loaded hotel load supply switch “BLHO” in the driver’s cab switches contactor 32 via the MCE. When it is closed, the yellow hotel load supply
169.3 indication lamp “LSHO” lights up in the cab. The hotel load is connected to the
35 train via the four-pin hotel load sockets. There are two hotel load sockets outside at both ends of the loco (See Fig. 6.1)

Warning:

- Never connect the hotel load cable to another loco.
- Never connect the hotel load cable to a coach when the pantograph is raised.

6.1.1 Hotel Load Supply in Multiple Operation

32 In multiple operation the hotel load supply contactor on the master loco shall be in “OFF” position. Only the slave loco which is coupled to the train is able to feed the hotel load supply.

169.1 The command of the hotel load switch on the master loco will be transmitted to the slave loco by train bus. If the VCB is closed the hotel load supply contactor will close only on the slave loco.

169.3 The yellow indication lamp “LSHO” will be illuminated on the master loco, if the hotel load supply contactor on the slave loco is closed.

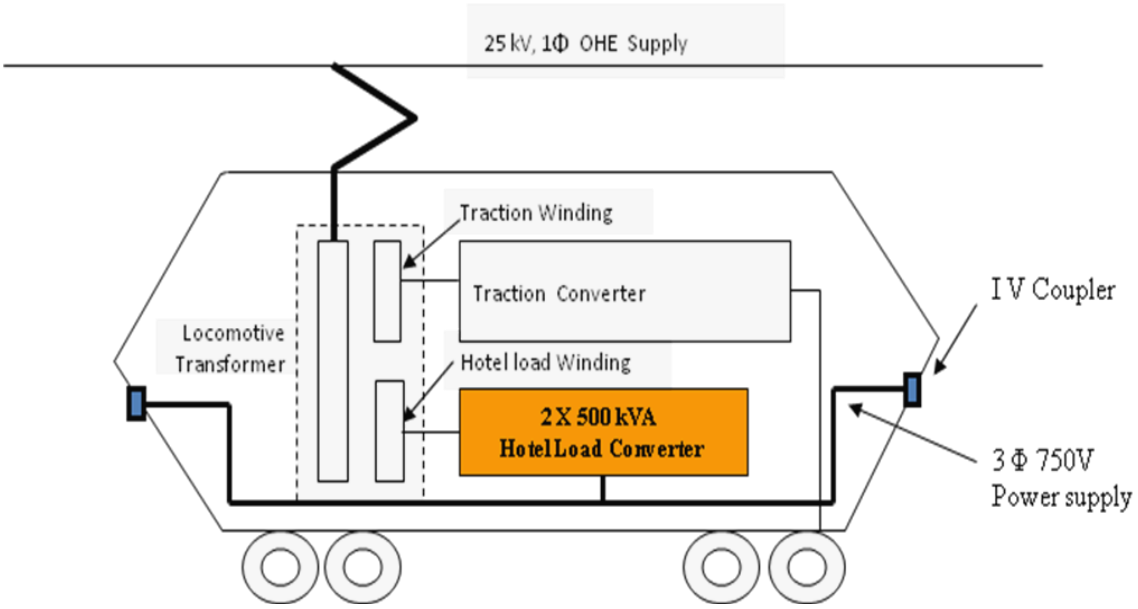


Fig-6.1a

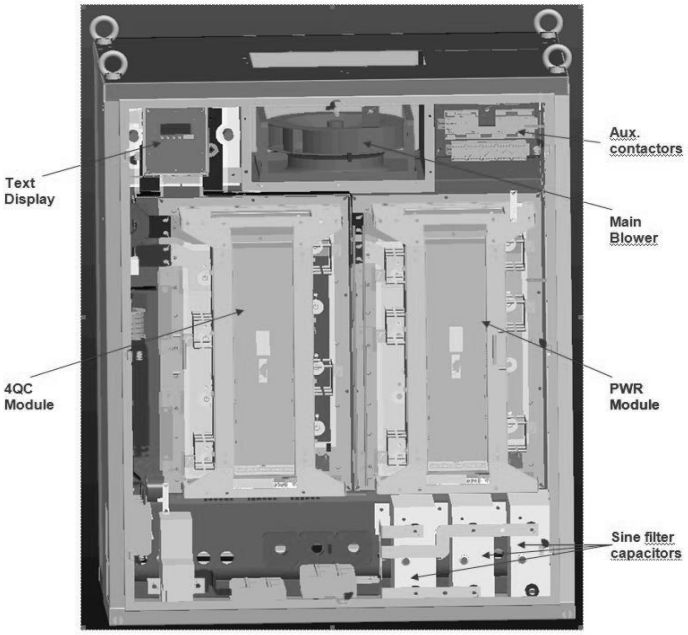


Fig-6.1b

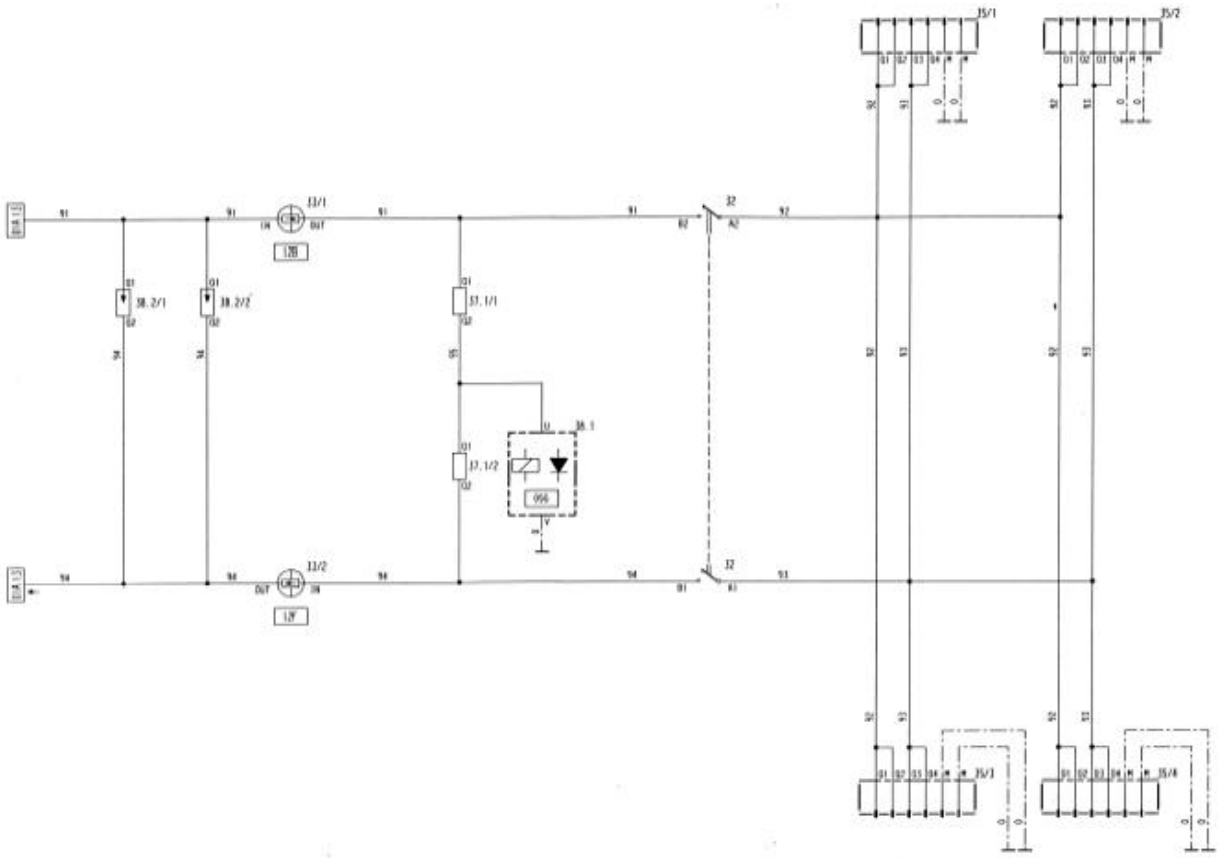


Fig 6.1c

Pos.	FUNCTIONAL DESCRIIPTION	PIN LAYOUT
32	CONTACTOR HOTEL LOAD SUPPLY	
33	CURENT SENSOR HOTEL LOAD SUPPLY	24B
35	SOCKET HOTEL LOAD SUPPLY	
37.1	RESISTOR EARTH FAULT DETECT. HOTEL LOAD	
38.1	EARTH FAULT RELAY HOTEL LOAD	26A
38.2	SURGE ARRESTOR HOTEL LOAD	

6.2 IGBT Traction Converter based Locomotive

Introduction

In the recent past, all over the world the trend has been to switch over from conventional DC drives to 3-Phase AC drives based on Insulated Gate Bipolar Transistor (IGBT) technology. At present, the flagship locomotive of Indian Railways is the 3-phase locomotive. Presently, different variants, viz, WAG9, WAG9H, WAP7 and WAP5 are running over Indian Railways. The heart of the locomotive is traction converter which is responsible for conversion of single phase AC drawn from OHE to 3-phase AC which drives the traction motor. At present, switching device used in the traction converter is GTO. Considering the obsolescence of the GTOs, Indian Railways have embarked on their ambitious plan to migrate from current Gate Turn Off (GTO) based system to IGBT based traction propulsion system retaining same transformer and traction motors, owing to the advantages offered by IGBT as a power device. GTO being a thyristor device need snubber circuits, resulting in high losses. GTO's are sensitive to failures because of complicated gate drivers. IGBT does not require snubber circuit (because of di/dt and dv/dt control) and belongs to a power transistor family, has lesser losses, better control ability, higher performance and reliability. Along with this, control also is changing to open standard controls Train Control Network (TCN) confirming to IEC61375.
As the IGBT Traction converter is smaller in size and the liberated space can be utilized for the installation of future new equipments like Hotel load converter, etc. The first locomotive equipped with IGBT based traction converter flagged of from CLW.
The IGBT based traction converter has been installed and commissioned by M/S BTIL, also BHEL in association with M/s Strukton (Netherland), has developed the prototype of IGBT based propulsion system for CLW.

Salient Features

- The existing GTO based traction converter is a group drive, i.e., all the traction motors in a bogie are connected in parallel. While, the IGBT based converter has got single axle drive capability, therefore, in case of any problem with a particular TM, only that particular TM can be isolated unlike in the GTO based converter where the whole bogie has to be isolated.

- Due to single axle drive it has got better adhesion performance.

- Because of smaller size of the converter it may be possible to install additional equipments like hotel load converter in the locomotive.

- In order to improve the control of the drive, the active type speed sensors have been provided which have better resolution by incorporating sensors which can provide strong signals at 200 pulse per revolution.

- This converter has taken full advantage of the advancement in the processor speed which has paved the way for less number of PCB cards with better performance at the higher temperatures.

- Power loss reduction by approx. 50% in comparison with GTO loco equipment.

- Annual energy saving (considering @ Rs 4.62 / unit) will be approx. Rs. 34 lakhs assuming loco utilization of 85% service per day.

- 40% reduction in weight and compact in size compared to GTO equipment.

- 60% reduction in usage of electric cards (only 3 major cards compared to 17), hence increasing the loco reliability.

- Sensor less speed control.

- Water cooled system thus safer vis-à-vis oil cooled system.

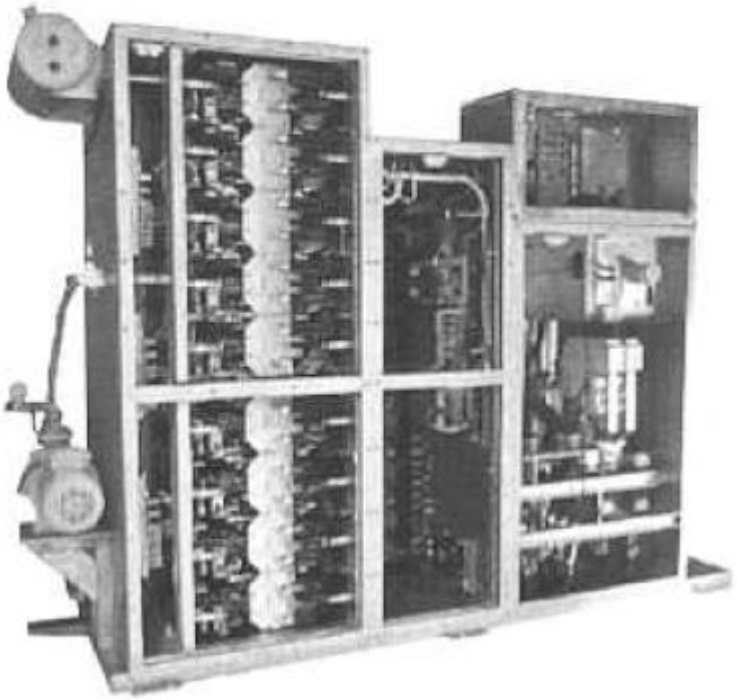
- Better slip / slide controls, because of axle control and modern high speed digital signal processing algorithm.

- Less harmonics because of high switching frequency.

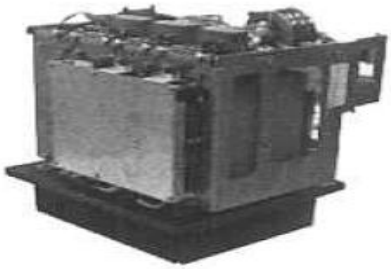
- Designed without using any proprietary ASIC.

- Configured to open standard controls TCN based network.

- Modern design of software using Matlab / Simulink.



Traction Converter

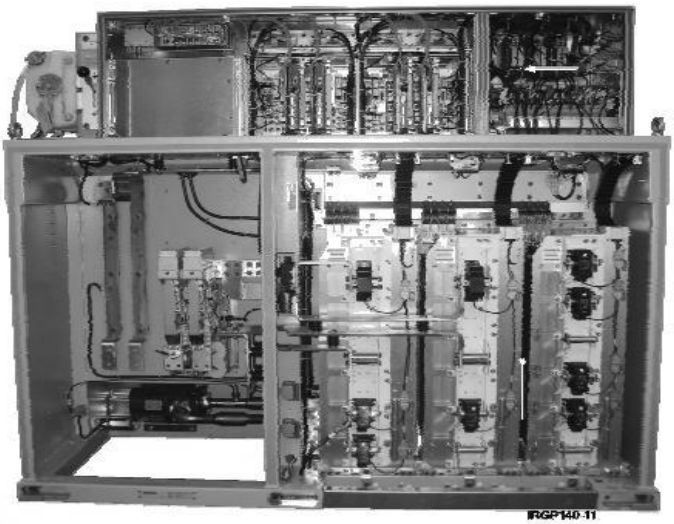


IGBT based modular
stand-alone inverter

Water Cooled IGBT
Power module

Fig 6.2a

Traction Converter
MITRAC TC 3300 AC V03



Traction chain WAG 9 CoCo

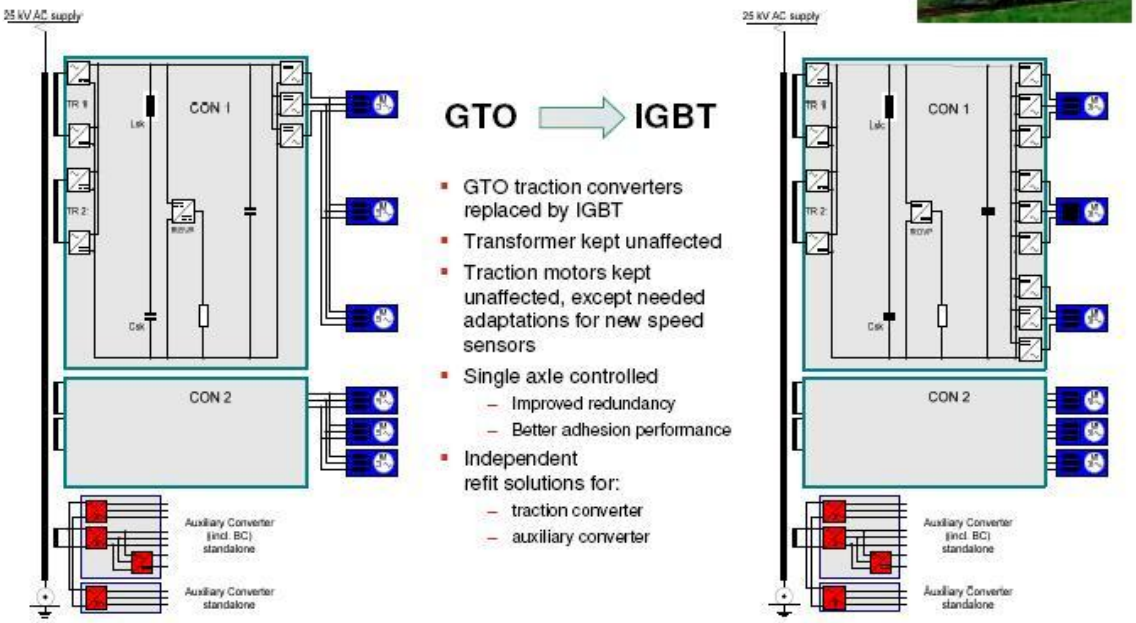


Fig 6.2b

6.3 AIR CONDITIONED CAB

FEATURES:

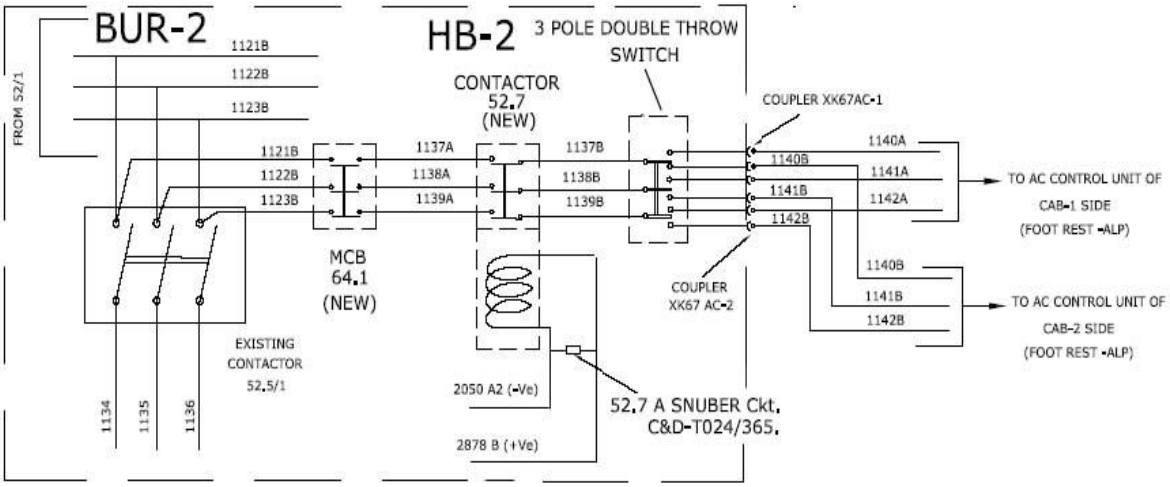
1. COOLING CAPACITY: 1.5 T AT 50° C AMBIENTS.
2. HEATING CAPACITY: 2.2 KW
3. TEMPARATURE: SUMMER: 23° C TO 25° C
   WINTER : 19° C TO 21° C
4. NO. PER LOCO: 2 NOS (1 NO. EACH CAB)
5. DIMENSION: 1120 X 1000 X 430
6. SUPPLY: 415 V 3 PHASE

ELECTRICAL CONNECTION

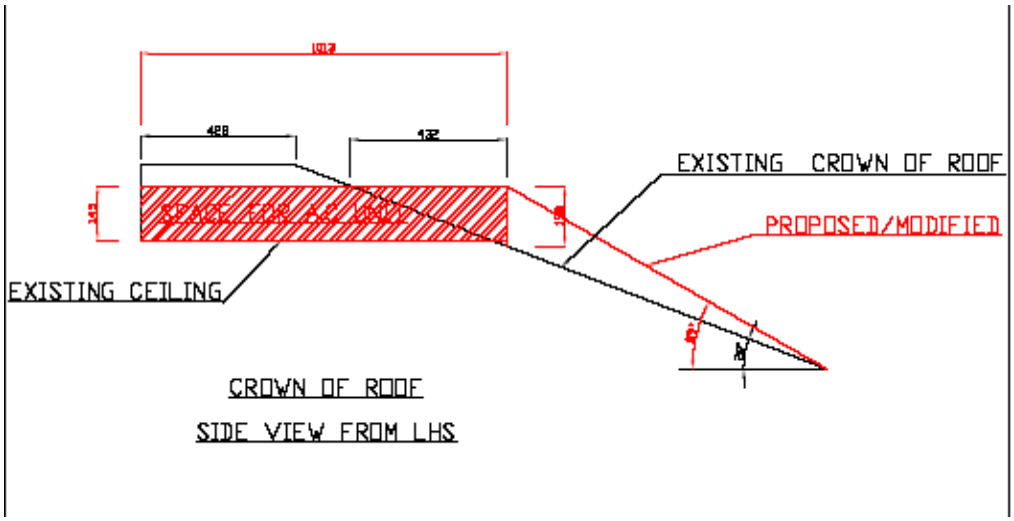
The supply taken from BUR-2 interlocking to-

I) Only one Cab AC will run at a time.

II) In case of isolation of any of Aux converter the AC unit will not run.



1	64.1=> MCB rating 16 Amps--- 01 No (Type-17)		
2	52.7=. Contactor 3-Phase 80 Amps---01 No (type-LPID 80)		
3	Socket 4P/24 PIN 'N'- 3HW470071P0001 (ABB part no) Coupler XK32 ---- 2 Nos.		
4	PLUG—4P BU 'N' IRCA/Connector—3HW47004R0001 (ABB part no) Coupler XK67 ---- 2 Nos.		
5	PIN---8GH—2.5---8 Nos.	13	SCREW---M6X16---03 Nos.
6	SOCKET---8GH—2.5---8 Nos.	14	NUT—M6---03Nos.
7	FASTOON LUG—6.3X 0.8—4 Nos.	15	SPRING WASHER—M6—03 Nos.
8	SOCKET—2.5/8 mm (m 8)---4 Nos.	16	PLANE WASHER—M6---03 Nos.
9	N-SLEEVE—2.5 – 12 mm---12 Nos.	17	END STOPPER---02 Nos.
10	PRINTABLE SLEEVES –3/16—60 Nos.	18	52.7A=> Snuber Ckt., C&D –T024/365
11	JOINTING SLEEVES—6.3 X 0.8—1 No.	19	CABLE 2.5 Sq. mm –26 mts---03 Nos.
12	BLACK SLEEVES—6.4 X 0.288K—1meter	20	CABLE 2.5 Sq. mm –11 mts---03 Nos.



AIR CONDITIONING UNIT

WAG-9 LOCO WITH AIR CONDITIONED CAB

Fig 6.3

6.4 LOCO TROL

Basic Technical Requirements for Distributed Power Equipment on Electric Locomotives for WAG-9 and WAG-9H Class

6.4.1 Preamble:

Operation of trains in graded & curved sections calls for increased tractive effort. Increasing the amount of head-end tractive effort in conventional train operations eventually exceed the capacity of the wagon coupler. By distributing the locomotive throughout the train the coupler forces are reduced and in-train forces are reduced. This document is an Equipment Specification for the procurement of a Distributed Power system to be fitted to the 3-φ propulsion drive based electric locomotives.

6.4.2 Nomenclature:

Explanation of the terms used in this Technical Requirement is indicated below.

6.4.2.1 Distributed Power:

A system where one or more Locomotives, or multiple unit consists, are distributed throughout a train and remotely controlled by the driver of the locomotive at the head of the train. Communication between the lead and remote locomotive/s is achieved via radio wireless communication link. The term Distributed Power is hereinafter abbreviated as DP.

6.4.2.2 DP Equipped Locomotive:

A locomotive that has been fitted with DP equipment and made be set up as either a Lead or Remote Locomotive. Lead locomotive is also referred to as master and the remote locomotive as slave locomotive. The lead/master locomotive has its cab manned.

6.4.2.3 Lead Locomotive:

The DP Equipped Locomotive attached at the head of the train and set up as Lead from where the operator drives the train.

6.4.2.4 Remote locomotive:

A DP equipped locomotive placed any where in the train other than at the head and set up as a remote.

6.4.2.5 Remote Consist:

A group of multiple unit locomotives containing at least one remote locomotive that are separated from the lead locomotive by some number of wagons. There is no restriction where the remote locomotive is located within the remote consist. Only one DP equipped locomotive in the remote consist may be set up and active as a remote locomotive.

6.4.2.6 Synchronous Control:

An operating mode of DP operation where commands made by the driver in the lead locomotive are transmitted via a wireless communication link to, and followed by, all remote locomotives in the train.

6.4.2.7 Independent Control:

An operating mode of DP operation where the operator may setup and independently operate the remote locomotives in a front group and a back group. The front group always includes the lead locomotive, and all remote locomotives in the front group follow the commands made by the driver using the lead locomotive controls. Which remote locomotives are in the front or back groups are selectable by the driver in real time. The remote locomotives in the back group are controlled by commands entered by the driver on the DP equipment on the lead locomotive.

6.4.3.0 General

This specification covers the locomotive distributed power system for application on the WAG-9 & WAG-9H class locomotives. The system shall include:

6.4.3.1 DP equipment fitted on the locomotive. At a minimum, the DP equipment shall include processor based hardware that can monitor and control the locomotive functions, safety features, and logging described later in this specification, redundant radio communication hardware, and a Human Machine Interface for set up, control, and monitoring. The equipment shall allow easy set up as either a lead or remote locomotive and have fail-safe means to ensure the desired train configuration has been implemented. The tenderer shall supply and install the additional hardware required to meet the specified functionality. Any existing locomotive hardware to be replaced/abandoned and the method of interfacing to existing locomotive systems is with in the scope of supply.

6.4.3.2 Test Equipment and facilities to be set up in loco sheds for maintenance and upkeep of this equipment.

6.4.3.3 Any auxiliary radio communication equipment as may be recommended as determined from communication surveys of a given area of operation.

6.4.3.4 Any auxiliary equipment required for neutral section operation.

6.4.4 Technology Maturity:

There has been substantial advancement in the wireless technology in recent past and also, lot of standardization has been achieved. The tenderer, hence is expected to offer solutions which reflect state-of-the-art equipment and to the extent possible should be designed around standard sub-assemblies.

6.4.5 Service conditions:

The equipment shall be capable of working satisfactorily under the service conditions indicated below.

6.4.6.0 Operating Requirements:

6.4.6.1 Control

The DP system shall provide either synchronous or independent control and status of up to four remote locomotives in a train by signals transmitted via a wireless radio link to and from the remote locomotives and the lead locomotive.

6.4.6.2 System Isolation

A Fool-proof means of ensuring that one DP train cannot affect another DP train or other individual DP equipped locomotive not in a train; and that an individual DP equipped locomotive not in a train cannot affect any DP train or other individual DP locomotive regardless of proximity.

6.4.6.3 Wireless Communications

The transmission frequency of lead unit shall be selectable. The frequency band will be finalized after discussion with the tenderer and the availability of

frequency spectrum. The tenderer shall specify type of antenna used, transmission frequency employed, power and sensitivity of receivers used.

Preference shall be given to a system where the radio protocol used by the DP System is provided as a license free.

The scheme used for error detection of transmitted data shall be Cyclic Redundancy Checking (CRC16) or better. If a scheme other than Cyclic Redundancy Checking is used, the Tenderer shall provided details comparing CRC16 with the proposed scheme and its advantages.

The wireless communication system should implement the following communication control features:

- System linking using locomotive numbers
- Lead & remote set-up to ensure proper linking
- Controlled address codes & duplication detection
- Radio channel contention with priorities based on message type
- Dual radios with automatic switching
- Communication-loss idle-down & brake cut-out fail-safe logic
- Periodic radio communication check
- Remote-initiated communication check when required
- Automatic test of back-up radio when linking
- On-board command message repeat function
- Maintenance logger clock synchronization at remote locomotives
- Operation of multiple trains on each radio channel

The radio communication system shall be closed loop such that lack of an acknowledgement of a command sent by the lead locomotive to any remote locomotive is displayed as a communication loss. The radio communication link shall have sufficient margin to close the link between locomotives that are up to 1500 metres apart. The system shall be capable of operating in tunnels, jungle areas, and deep cuttings without any loss of safe operation via the wireless link. Wireless commands shall be persistent and sent upon operator commanding or in the case of no operator input, once every 20 seconds.

6.4.6.4 Self Test

The DP system shall run a self-test at power ON, and on a periodic basis to verify satisfactory functioning of all component system including I/O. During operation, the system shall be capable of identifying internal faults as may occur from time to time and their indication to the driver. Fault recovery capabilities and limited fault tolerance are desirable details, which shall be indicated in the offer for evaluation of the system.

6.4.6.5 Operating Modes

It shall be possible to place remote locomotive consists in the following operating modes:

ISOLATE – in this mode electrical and air brake functions of the lead locomotive except emergency are not performed. The remote locomotive brake valve is cut-out.

IDLE – in this mode electrical functions of the lead locomotive are not performed on the remote but air brake functions are performed.

BRAKE – in this mode only dynamic brake and air brake functions of the lead locomotive are performed. The remote locomotive's dynamic brake status is displayed on the lead locomotive DP display.

MULTIPLE UNIT – in this mode all electrical and air brake functions of the lead locomotive are performed. The remote locomotive's traction system and dynamic brake status is displayed on the DP Display.

INDEPENDENT CONTROL – in this mode the electrical power and dynamic braking functions of the remote locomotives can be independently controlled via the DP display screen. The rules of anti-stretch logic shall apply. Air brake functions of the lead locomotive are performed.

6.4.6.6 Control of Functions:

The following functions are to be carried out on remote locomotives when actuated from the lead unit and the actual status of each operation on the remote locomotive shall be displayed on a graphical display unit on the lead locomotive:

- Throttle control
- Dynamic brake control

- Automatic brake control controlled
- Independent brake control
- Manual sanding
- Automatic emergency braking
- Vacuum Circuit breaker on/off
- Pantograph raise/lower
- Manual compressor control

6.4.6.7 Status

The following status shall be continuously displayed on the distribute power graphical display for the lead locomotive and all of the remote locomotives:

- Actual Throttle/Dynamic Brake Command
- Tractive Effort level
- Brake pipe pressure
- Automatic Brake system flow rate
- Remote locomotive operating mode
- Equalizing reservoir pressure
- Brake cylinder pressure
- Main reservoir pressure

6.4.6.8 Alarms

The alarms shall be sensed and generated at the remote locomotives and transmitted to the lead locomotive for display on the distributed power graphical display.

7. INDEX:

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8. ILLUSTRATIONS: