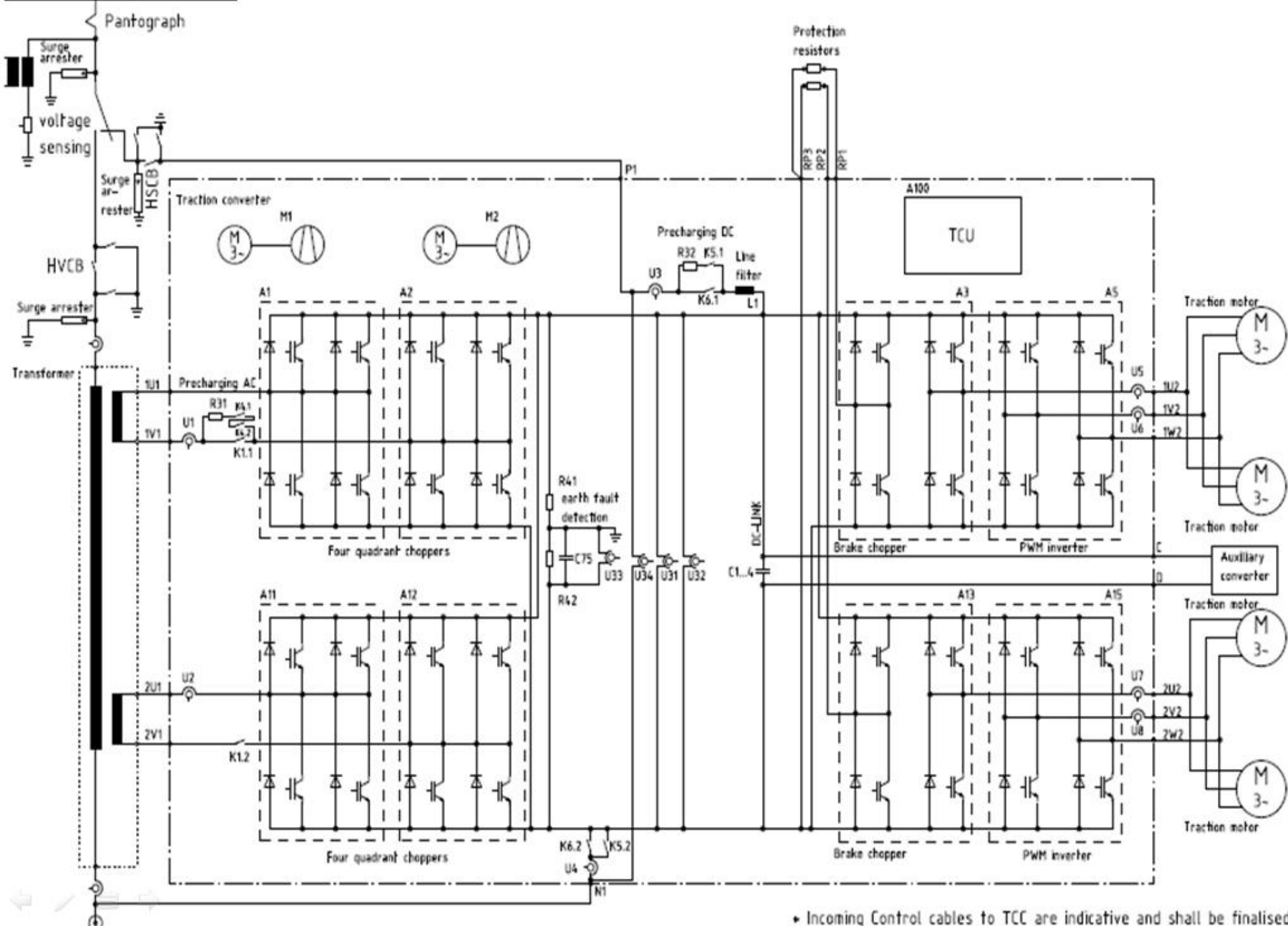


# SIEMENS 3 PHASE EMU COMPONENTS

**N.D.TURKAR/PL/IRIEEN**

AC 25KV 50 Hz; DC 1500 V



• Incoming Control cables to TCC are indicative and shall be finalised

# PANTOGRAPH

## – PANTOGRAPH – 25kVAC/1500V DC

	(For proto type)	(For series)
• Type	AM18-B2	WBL 23.03
• Make	Stone India Ltd.	Schunk
• Rated Current	400A in AC	60A in AC
•	1100A in DC application	1100A in DC
• Overall length	2240mm	
• Locked Height 360mm)	575mm (with foot insulator	
• Max. Extended Height	2490mm.	

# PANTOGRAPH

- The pantograph is mounted on the motor coach.
- The pantograph feeds the power from the overhead line either 25kV AC or 1500 V DC operation.
- An Electro pneumatic control valve operates the pantograph. Max. Pressure required for complete extension /lower are 5kg/sq cm and 3.3 to 4kg /sq cm

# 25kV AC SURGE ARRESTORS

- The 25 kV AC surge arrester protects the traction system against Overhead line voltage surges.
- 25kV AC operation, two surge arrester are provided. One surge arrester 34N (Rated voltage 34KV AC) directly connected to the pantograph protects the supply voltage-sensing unit.

# 25kV AC SURGE ARRESTORS

- The Second one 32N (Rated voltage 32KV AC) protects the main transformer and Four Quadrant Controller in case of opening of the VCB. Both surge arrestor are mounted on the vehicle roof.

# DC SURGE ARRESTOR

- A surge arrester for 1500V DC is mounted on the pantograph side of the system selector switch is rated for 2 KV DC.
- In this way the train is always protected against over voltage coming from 1500V supply.
- All parts of system that are designed for 1500V DC only are always protected against over voltage relative to a 1500V system.

# PRIMARY CURRENT TRANSFORMER

- The primary current transformer rated for 75/1A, 3VA is part of the roof bushing.
- In case if over current is detected, this protects the system and opens the VCB.



# LINE VOLTAGE SENSING TRANSFORMER

- This unit senses the over head line supply and communicates the type of supply to relay logic as well as to the traction converter control, to ensure activation of the proper mode of operation.
- The relay signals are used to generate interlock signals for the various line and changeover switches.

# AC/DC SUPPLY CHANGE OVER SWITCH

1. The AC/DC SUPPLY CHANGE OVER SWITCH (AC/DC COS) rated 25KVAC/1500 V DC, 1000A is mounted on the roof of the motor coach.
2. It is pneumatically (compressed air) operated switch consisting of moving arm, witch can take two different positions.

# AC/DC SUPPLY CHANGE OVER SWITCH

- One of these positions corresponds to 25 kV Ac operation and connects the pantograph to the main transformer, the other position corresponds to 1500V DC operation will connect pantograph to the DC Circuit Breaker (HSCB).

# AC/DC SUPPLY CHANGE OVER SWITCH

- In case no over head line voltage is detected, the change over contactor will always move to the AC position. Required air pressure is 4 to 5 Kg/sq. cm.

# VACUUM CIRCUIT BREAKER

- The VCB is rated for 25KVAC, 50 HZ, 1000A.
- In the AC mode operation, the VCB supplies 25 kV AC to the primary of the main traction transformer.
- The VCB is operated by pneumatic pressure through an electric solenoid valve.
- The VCB is mounted on the roof.

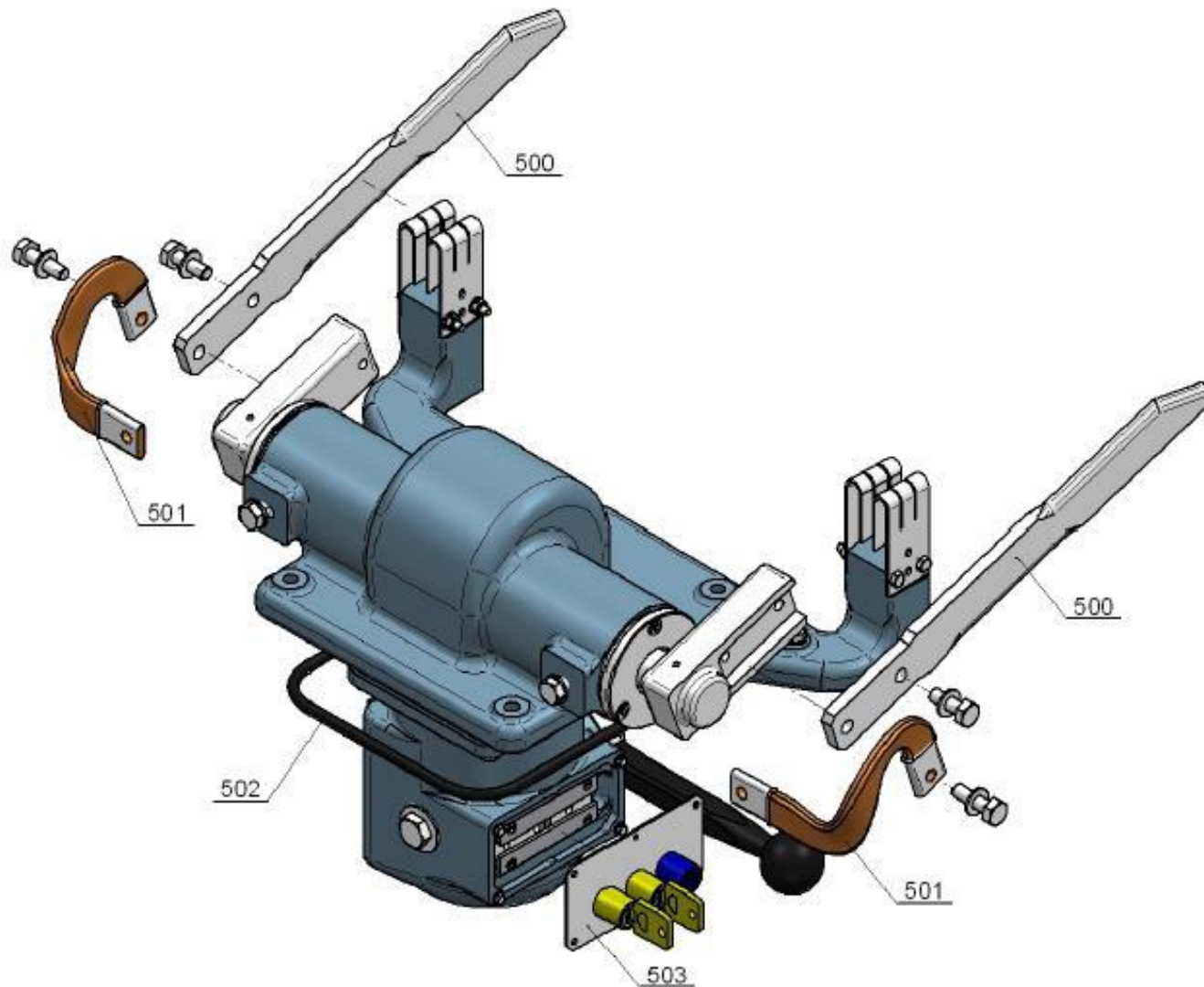
# AC EARTHING SWITCH

- The AC earthing switch is a double pole double throw type switch, connected across the VCB.
- It is mounted on the roof and mechanically interlocked with HT room door as safety precaution i.e. as soon as HT room door is opened the earthing switch connects the whole traction system to earth.

# **AC EARTHING SWITCH**

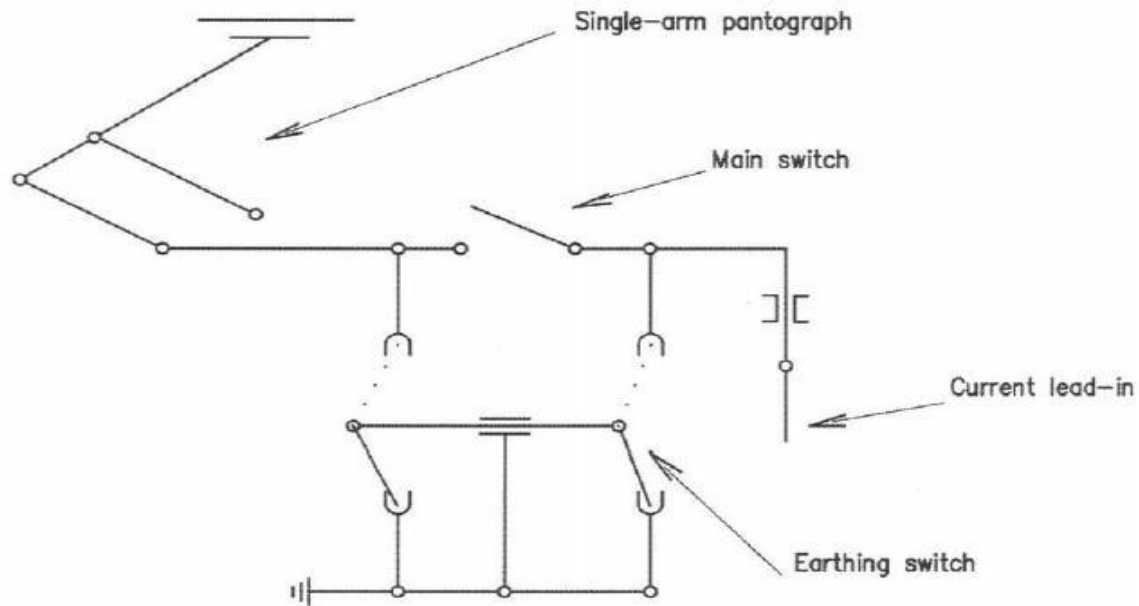
- This earthing switch ensures proper earthing of roof mounted power equipment as well as HT room and under framed mounted power equipment.

# AC EARTHING SWITCH





# AC EARTHING SWITCH



# DC EARTHING SWITCH

- The DC earthing is also a double pole double throw switch, connected across the DC Circuit Breaker
- It is mounted in the Switch Gear Rack and is mechanically interlocked with HT room door as a safety precaution i.e. as soon as HT room door is opened the DC earthing switch connects the traction system to earth.
- This is done for discharging the DC link capacitors.

# TRACTION TRANSFORMER

- **Type - LOT1250**
- Primary-1250 KVA continuous corresponding to 22.5 KV and Primary current 56 Amps. Secondary 2 x 855VAC at rated continuous current 731Amps.
- Total weight 3100kgs oil quantity – 530 liters (510 Kg in weight)

# TRACTION TRANSFORMER

- The transformer is of modular construction complete with oil pump, oil pump motors, radiator with blower, conservator and protection equipment all assembled as a single module.
- The transformer is provided with two secondary traction windings suiting to requirements of IGBT based converters.

# TRACTION TRANSFORMER

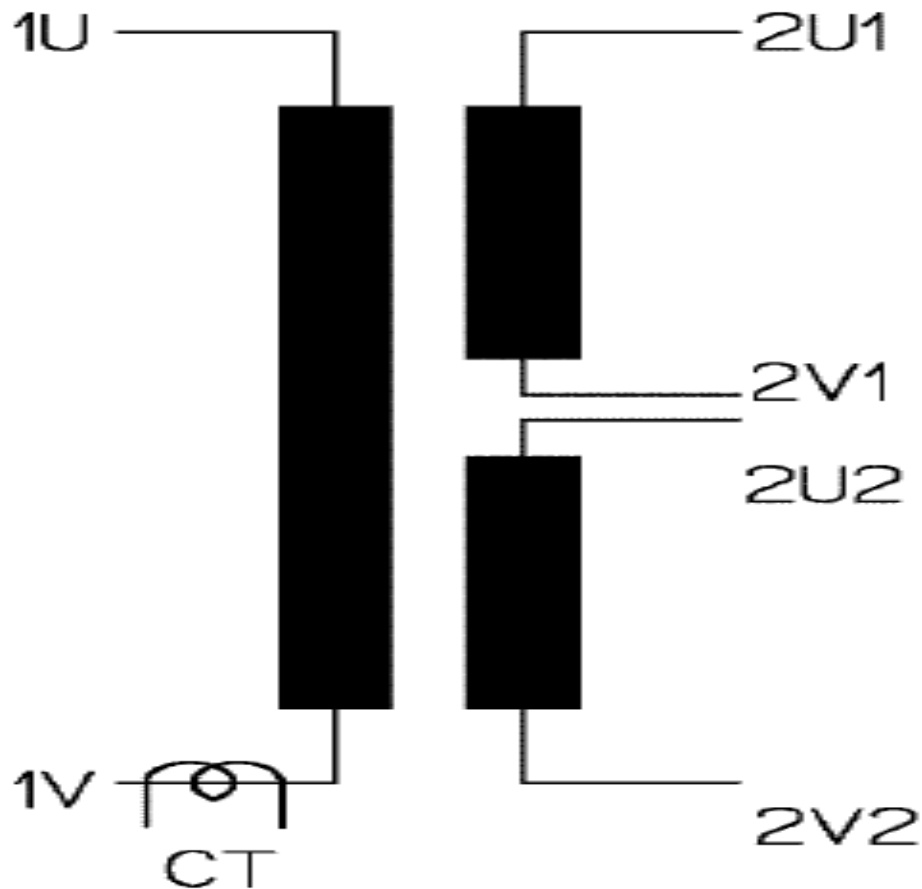
- The transformer is under slung mounted and provided with flexible cable head of suitable length for connection from circuit breaker over the roof to a transformer primary.
- Pump and the cooling fans are supplied from the 415v three-phase system of the auxiliary supply.

# TRACTION TRANSFORMER

TYPE LOT 1250(ABB)

PRIMARY 1250KVA, 22500V, 55A, 50Hz

SECONDARY 2X625KVA, 2X855V, 2X731A



- Main Traction Transformer is mounted under the Motor coach.

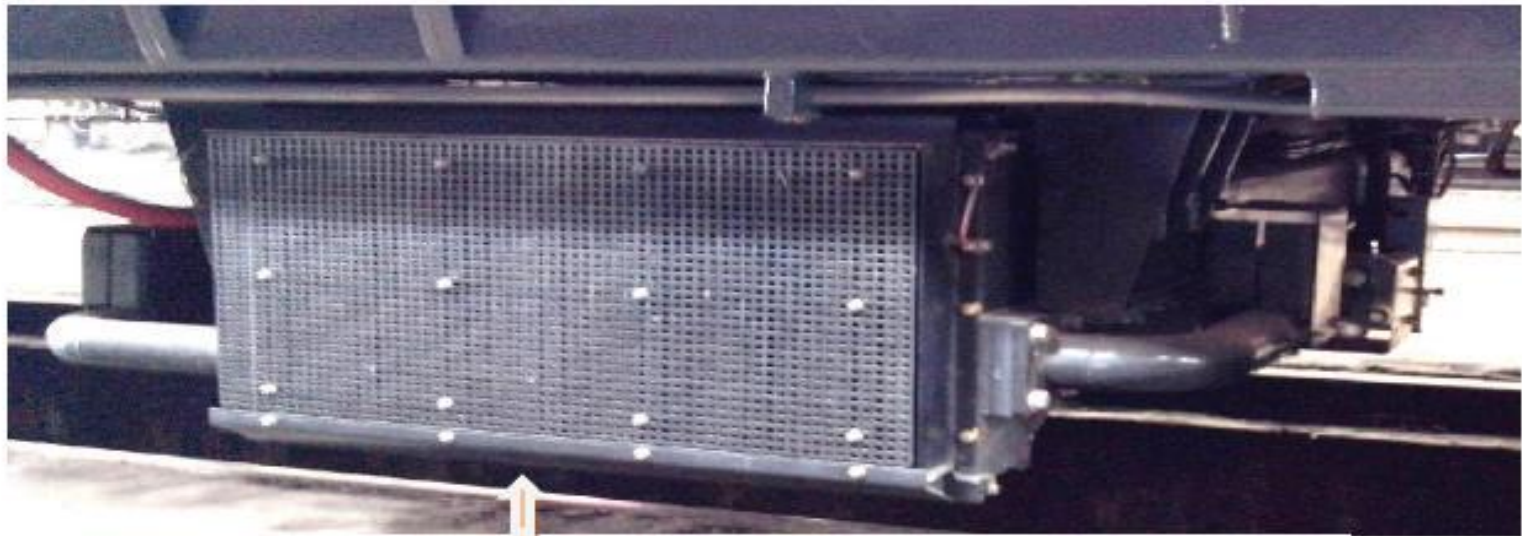
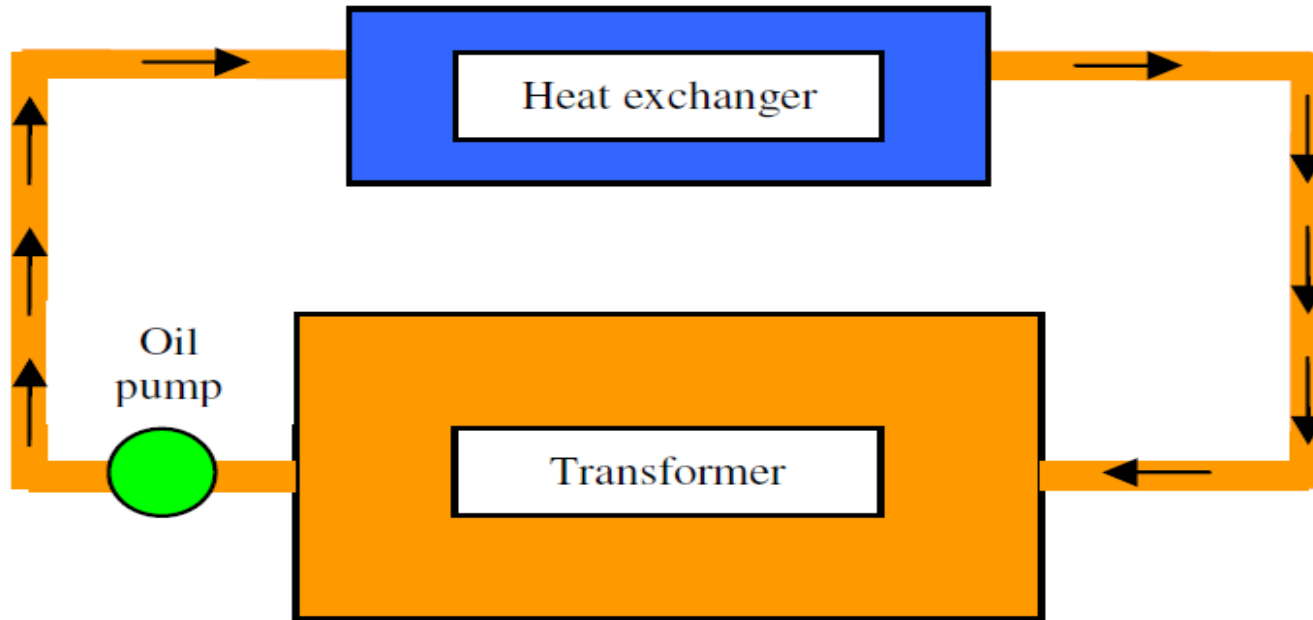


Figure 39: Cooling circuit diagram

# TRANSFER COOLING SYSTEM





# HSCB-DC CIRCUIT BREAKER

- When operating in 1500 V DC, the traction converter is protected with a DC line breaker.
- The breaker has built in over current detection facility; hence it will provide protection against the short circuit.
- The Dc circuit breaker (HSCS) is mounted in HT compartment.

# LINE FILTERS- L1

**(1500 V DC Operation only) 6mH at 1 KHZ**

- The line filter choke L1 along with the DC link capacitors (C1-C4) forms L-C filter.
- This provides an over voltage protection and also limits the harmonic currents of the system and the DC link.

# LINE FILTERS- L1

- It protects the traction system against surge voltages on the overhead supply system.
- The indicator is forced air cooled and provided in TCC.

# VOLTAGE SENSING SYSTEM-VSS

- The VSS is used to operate the AC/DC COS to sense the system voltage whether 25 KVAC or 1500VDC automatically through LVT primary winding in series with 25 Kilo Ohms.
- Accordingly changes the switch arm position either 25KVAC or 1500VDC.
- This VSS is mounted in the HT compartment.

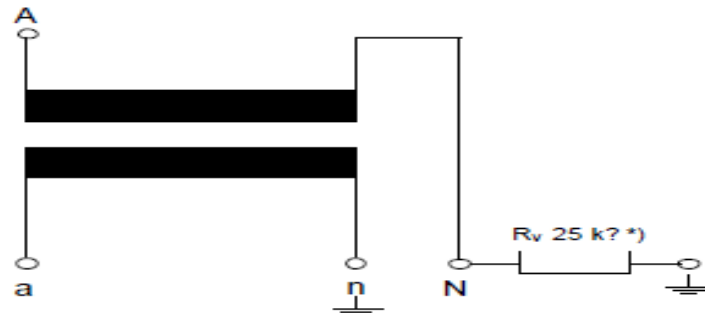
# VOLTAGE SENSING DEVICE

## 4 TECHNICAL DATA

Rating frequency	50 Hz	DC
Primary rating voltage	25000 V	2000/1500
Secondary rating voltage	150 V	ext. over 25k $\Omega$
Accuracy class	0.5	
Rated accuracy	5 VA	
High voltage $U_m$		36 kV
Power-frequency with stand tests voltage		70 kV
Basic insulation level (BIL)		170 kV

## 5 CONNECTION DIAGRAM

One winding:



\*) The resistance  $R_v$  will be delivered and installed by the customer

# VOLTAGE SENSING DEVICE



# VOLTAGE SENSING DEVICE



# VOLTAGE SENSING DEVICE





# **AC INPUT LINE CONTACTOR (K1.1, K1.2), AC CHARGING CONTACTOR (K4) & RESISTOR (R31).**

- The traction converter system contains filter chokes & capacitors.
- For initial charging of all these reactive components, the system will have a high inrush current.
- To limit the inrush current, an AC Charging Contactor K4 (ACCC) is provided in series with a limiting resistor R31 and this combination is provided in parallel to the AC line Contactors K1.1 & K1.2 (ACLC).

## **AC INPUT LINE CONTACTOR (K1.1, K1.2), AC CHARGING CONTACTOR (K4) & RESISTOR (R31).**

- The line contactor is closed after the DC link voltage has reached 90% of the theoretical final value charge ( $=\sqrt{2} * U_{trans. Sec} \text{ voltage}$ ).
- After charging the capacitors the charging contactor will open and the ACLC will close.
- This ACLC protects traction converter when operating in 25kV AC.
- The ACLC, ACCC and resistor are mounted in Switch Gear rack in the HT compartment.

# **DC LINE CONTACTOR (K6.1, K6.2), DC CHARGING CONTACTOR (K5.1, K5.2) & RESISTOR (R32).**

- To limit the system initial inrush current when operating in 1500V DC, the DC Charging Contactor K5.1 in series with a current limiting resistor R32 is provided in parallel to DC line contactor K6.1.
- After charging the capacitors, the DCCC will open and the DC line contactor will close. This DC line contactor in series with HSCB protects the traction converter. These contactors and resistor are mounted in Traction converter cubicle (TCC).

# 100 HZ FILTER CIRCUIT.

- In 25 kV AC operation the train will exchange power with a single-phase power supply.
- It can be shown mathematically that this means that the instantaneous power consists of a constant (DC) terms plus a term which varies sinusoidally with twice the overhead line supply frequency.
- In order to provide the traction inverter with a constant flow of electrical power, the latter term is compensated by a 100 HZ resonant circuit, connected across the DC link.

# 100 HZ FILTER CIRCUIT.

- This 100 HZ frequency will be countered via the control system of PWMI by software control.
- Therefore Hardware 100HZ resonant filter is not necessary.

# TRACTION CONVERTER

- The traction converter works on dual voltage system i.e. line input of 1500V DC or 950V AC, 1ph, 50HZ AC at 25KV AC line).
- The converter consists of two four quadrant chopper, one DC link, two PWM Inverters each delivering two traction motors.
- The converters also include DC link contactors, transducers, blowers etc.

# TRACTION CONVERTER

- The function of the traction converter is controlled and monitored by Traction Control Unit (TCU) SIBAS 32S.
- Forced air cooling by 2nos blower rated for 415V AC each 3.1 KW.

## **4QC MODULES (A1, A2 Upper modules. A11, A12 lower modules)**

- Number of 4QCC per TCC – 2
- Semiconductor - IGBT
- Type of phase module - SIBAC BB S P  
1500 FL
- Pulse frequency - 750 HZ
- All modules are mounted in TCC.
- A module contains 4 numbers of IGBT.



## **4QC MODULES (A1, A2 Upper modules. A11, A12 lower modules)**

- In AC mode operation the AC/DC Changeover Switch, is in AC position selected by LVT & VSS automatically,
- The modules are used as a 4-Quadrant controller, to control the exchange of electrical power between the traction inverter and the 50 Hz AC overhead supply.
- The 4 QC is therefore only active when the train is running on 25 kV AC.

## **4QC MODULES (A1, A2 Upper modules. A11, A12 lower modules)**

- The two modules A1 & A2 together generate a sinusoidal PWM voltage across the one of the upper secondary windings of the main transformer and other two modules A11 & A12 together generate a sinusoidal PWM voltage across the other lower secondary windings of the main transformer, in such a way that the resulting primary supply current has a correct amplitude and the correct phase relation with overhead line voltage.

## **4QC MODULES (A1, A2 Upper modules. A11, A12 lower modules)**

- The control principle of 4 QC makes regenerative breaking just as easy as driving.
- In DC mode operation, the line 1500 DC volts is fed to the Traction inverter directly.

# DC LINK CIRCUIT

- The DC link capacitors are required as an energy storage unit.
- It provides the reactive power and serves to smooth the DC link voltage.
- In DC mode, the DC link capacitor is part of the LC line filter.
- Capacitor C1-C4 each of 3mF is put in parallel. Hence the total capacitance is 12mF.

# TRACTION INVERTERS(A3, A5, A13, A15)

- Pulse width modulated inverters
- Number of PWMI per TCC - 2
- Number of traction motors per PWMI – 2
- Semiconductors - IGBT
- Type of phase module - SIBAC BB S D 1500 FL
- Pulse frequency - Variable up to 800 HZ
- In this section upper contains three inverter modules plus Brake chopper module,

# TRACTION INVERTERS(A3, A5, A13, A15)

- Each phase module A3, A5, A13, A15 consists of two inverter branches are needed for one inverter, the remaining four branches is used as a brake chopper.
- The traction inverter controls the exchange of electrical power between the DC link and the asynchronous traction motors.

# TRACTION INVERTERS(A3, A5, A13, A15)

- The inverter consists of three identical power modules that generate a 3-phase Variable Voltage Variable Frequency (VVVF) voltage of the appropriate frequency across the 3 phase motors connections.
- As a consequence of the operating principle of the voltage source inverter, dynamic braking is just as easy as motoring, so the inverter enables four quadrant operations as well.

# TRACTION INVERTERS(A3, A5, A13, A15)

- The traction inverter phase modules are mounted in the TCC.
- Data of the Power Modules
- Rated Voltage 1500VDC
- Max. Voltage 2200VDC
- Rated current 1500 A
- Max. Turn off Current 3600 A
- Pulse frequency 1000 HZ
- Type of cooling Forced air cooling
- Ambient of IGBT MITSUBISHI



# BRAKE CHOPPER MODULE. (A3) –

- Type a Phase module - SIBAC BB S D 1500 FL
- Pulse frequency - 250 HZ
- Consisting of Braking chopper and one phase of inverter module.
- Generally during dynamic braking, the kinetic energy is converted to regenerate into the overhead supply, if the line is not receptive, the regenerated energy must be dissipated in the braking resistor.
- The brake resistor is mounted on the roof of the motor coach.

# **BRAKE CHOPPER MODULE. (A3) –**

- The braking resistor is not rated for full dynamic braking.
- Instead it has the thermal capacity to accept the full dynamic braking power only temporarily, for a period of two seconds.
- Its purpose is to enable the traction drive to transfer smoothly from dynamic braking into friction braking when the overhead supply becomes non-receptive.

# Brake Chopper:

- Protection resistors are externally connected to the brake chopper for protection.
- When any serious fault is detected by SIBAS, it turns off all IGBT modules and fires brake chopper.
- During this, entire DC link gets discharged through protection resistors.

# **BRAKE RESISTOR**

1. During brake blending, it is possible that the line becomes suddenly non- receptive.
2. The braking efforts being regenerated are suddenly lost.
3. Although the TCU/BECU shall make up for this loss by applying additional friction brakes, there will be a time lag of few seconds due to application time of friction brakes.

# **BRAKE RESISTOR**

5. To overcome such time lags, a short term rated braking resistor comes to circuit, the movement the line becomes non-receptive and remains in the circuit till the additional brakes are applied.
6. This ensures practically zero time lags in switching over thus providing additional safety feature.

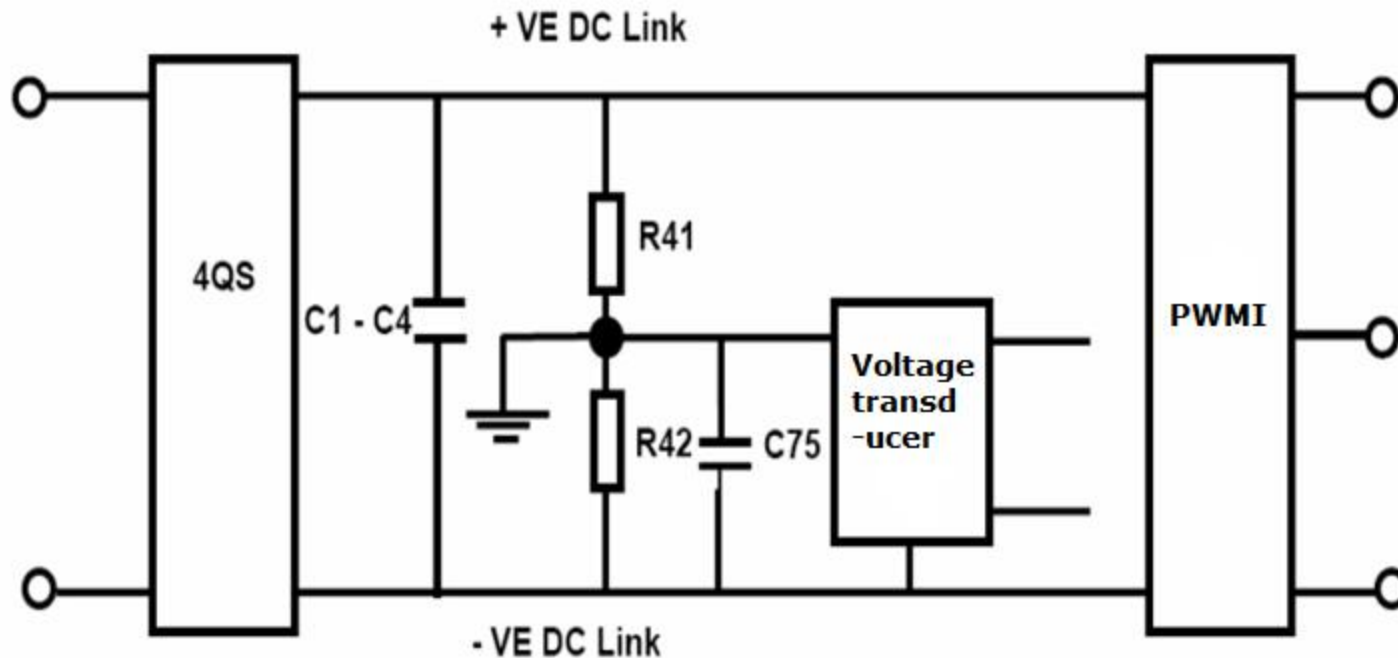
# EARTH FAILURE DETECTOR

- This system detects any earth fault when operating in 1500V DC and 25Kv AC mode.
- In AC mode the resistance (R41, R42, C75 & U33 Voltage sensor) are used in earth fault detection circuit.
- In DC mode the earth fault detected using the values of current transducers U3- U8. These components are mounted in TCC.

# EARTH FAILURE DETECTOR

- When an earth fault occurs during in AC & DC mode, if the earth current is above the specified maximum the VCB & HSCB will opened.

## Capacitive Earth fault Detection in the AC Mode



►  $R41 = 99K$ ,  $R42 = 33K$

► During normal operation the transducer depicts  $\frac{1}{4}$  of the total DC link voltage.

► A tolerance of  $\pm 30\%$  (referring to  $\frac{1}{4}$  of the DC link circuit voltage) is to be taken into consideration.



# CURRENT TRANSDUCERS

- Current Transducers are used to detect the current  
Flowing in the particular circuit for  
protection and control
- Current transducers U1 and U2 are used for  
sensing the input currents of the 4 quadrant  
choppers  
A1, A2 & A11, A12 respectively in the AC  
Mode.

# CURRNT TRANDUCERS

- Current transducer U3 and U4 are used for sensing the DC line current in P1 and N1 line respectively in the DC Mode.
- Current transducers U5 and U6 are used for sensing the currents in 2 phases for one set of motors fed from PWM Inverter A3 & A5.

# CURRENT TRANSDUCERS

- Current transducers U7 and U8 are used for sensing the currents in 2 phases for one set of motors fed from PWM Inverter A13 & A15.
- All the current transducers output is given to SIBAS control for control, monitoring and protection

# U1, U2, U3, U4, U5, U6, U7 and U8 (Current transducers)



# Voltage Transducers

1. Voltage transducers U31 and U32 are used for sensing the DC Link voltage in both the AC Mode and DC Mode.
2. Two sensors are used in parallel to provide redundancy. In case of failure of one the other still works.
3. Voltage transducer U33 is used to sense the earth voltage in AC Mode.

# Voltage Transducers

4. Voltage transducer U34 is used to sense the DC Line voltage in DC Mode
5. All the voltage transducers output is given to SIBAS control for control, monitoring and protection.

# **TRACTION MOTORS –Type 1TB2022 – OTA03**

**Squirrel cage Induction motors, 6-Pole, 3Phase,  
cont...Rating – 240 KW (cont), 161 Amps, 1029  
RPM, 0.81 PF.93.3% 64HZ.**

- Each Traction motors are VVVF controlled asynchronous induction motors. The traction motors are self-ventilated.
- The intake of the cooling air is the same as for the existing DC motors.

# **TRACTION MOTORS –Type 1TB2022 – OTA03**

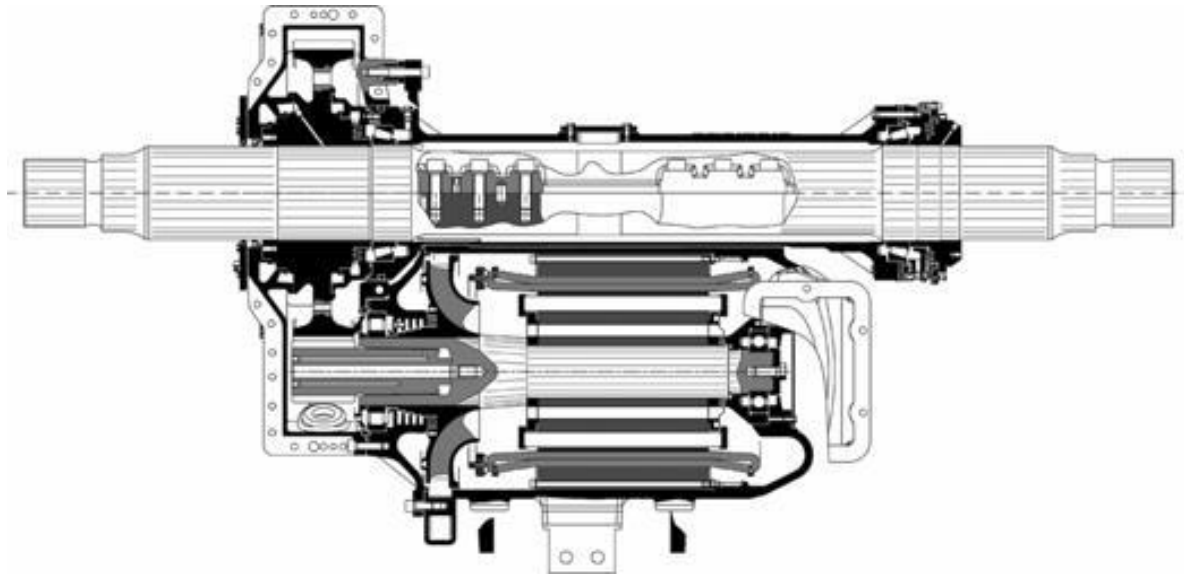
- The air inlet duct has the same dimensions so that the existing air inlet bellows can be mounted on the new traction which out interfacing problems.
- Each traction motor is provided with speed sensor only prototype rakes, which is connected to the traction converter control electronics by means of 4-wire, shielded cables.



# **TRACTIONMOTORS –Type 1TB2022 – OTA03**

- The traction motors is a axle-hung nose suspended type, complete with pinion, Roller suspension Bearing, Gear wheel, Gear case, Nose suspension, Earth return brush and rectangular air Bellow.
- After proto type speed sensor less drive through stator current of the motor calculated by the software of inverter controlling purpose.

# TRACTION MOTORS



## SPECIFICATION

IEC60349-2

RATED VOLTAGE

932V

RATED CURRENT

200A

RATED POWER

240KW

RATED SPEED

2000rpm

RATED FREQUENCY

101.5Hz

THERMAL CLASS

200

# **FIRE DETECTION SYSTEM. (Make – M/s Wagner)**

1. To detect FIRE in the major equipments in the HT compartments of Fire Detection system is provided.
2. The major equipments are TCC, ACU & ECAB. The active Detector ASD-mono 2 plus consists of following items.
  - (1) Smoke detection system
  - (2) Air sampling unit.

# **FIRE DETECTION SYSTEM. (Make – M/s Wagner)**

3. Air samples are extracted from the area of the monitored via an air sampling system with defined openings and led to the smoke detectors.
4. If the smoke detectors identifies the smoke aerosols in the air sample an alarm signal is displayed at the ASD-MONO 2 Plus.

## **FIRE DETECTION SYSTEM. (Make – M/s Wagner)**

5. If the fire is noticed in any of the motor coach this will give indication of DTC, also fire alarm / indication is available in that particular motor coach.
6. Then driver has to come to that motor coach and then press the starting of the FIRE EXTINGUISHING PB provided in shunting desk. The fire extinguishing system is not automatic only through driver.

# **PASSENGER INFORMATION SYSTEM**

## **PIS (Make – M/s Televic)**

1. The AC/DC EMUs are provided with PASSENGER INFORMATION SYSTEM PIS for driver guard inter communication cum public address system from M/s TELEVIC supplied by M/s SIEMENS.
2. It provides voice communication between guard and driver as well as both the provision for both the driver and the guard for to make public announcements.

# **PESSENGER INFORMATION SYSTEM**

## **PIS (Make – M/s Televic)**

3. Nine speakers are provided in each coach, with a console, microphone and amplifier being provided in the leading and trailing driving trailer coach cabs.
4. The system works on 110 V DC.
5. Apart from speaker in each coach 4nos passenger information display is provided.

# AIR HANDLING UNIT (make – M/s Sidwal)

1. To improve the passenger comfort besides carriage fans additional blowers are provided for improving fresh air.
2. Two blowers assembled in a unit called AIR HANDLING UNIT.
3. Under SDCL condition the CO<sub>2</sub> level inside coach varies from 1000ppm to 1250ppm.
4. The out side fresh air is pumped in the coach to reduce the CO<sub>2</sub> level up to 800ppm. Each blower capacity is 1.1KW, 415V AC, 50HZ.



## **AIR HANDLING UNIT (make – M/s Sidwal)**

5. There are 2Nos of AHU in a coach is 4.4 KW.
6. Control for this AHU is provided in E/W  
SKS/415V AC control panel.

Thanking You All

