



**GOVERNMENT OF INDIA**  
**Ministry of Railways**



# INTRODUCTORY HANDBOOK ON TRAIN-18

IRCAMTECH.GWL.M/TRAIN-18/NOV-2018

**आअमा सं RDS**  
रेल अग्रदूत Transforming Railways



**Indian Railways**  
**Centre for Advanced Maintenance Technology**

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- *Stainless Steel Car Body*
- *LHB design as base design*
- *16 Coach Chair Car Type Configuration*
- *160 kmph speed*
- *Test speed- 176 kmph*
- *Maximum Axle Load – 17 T*
- *Starting Acceleration – 0.7 m/sec<sup>2</sup>*
- *Deceleration – 0.8 m/sec<sup>2</sup>*
- *Automatic Doors & Footsteps*
- *GPS based PIS/PAS*

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## PREFACE

While India has one of the world's largest rail networks, it is mostly creaky and outdated in terms of speed, technology, safety, and passenger comfort. The trains are mostly filthy and overcrowded. Accidents, caused by both human and technical factors, are frequent. Past attempts to overhaul and modernise the system have been piecemeal and mostly non-starters.

ICF has been striving hard since last few decades to clean the image of Indian railway by manufacturing advanced train-sets. Train 18 is one of best ever project initiated by ICF to overcome the criticism of Indian railway in terms of speed, safety and passenger comfort. Since its inception in 1955, the ICF has been running on technology from Switzerland's Swiss Cars and Elevators Manufacturing and Germany's Linke-Hofmann-Busch (LHB). Now, with some handholding by experts, the ICF is setting out to make indigenously-designed coaches using components procured in India.

The first of this kind, Train-2018 or Train-18, is rolled out this year. According to ICF designers, it is a marriage between the stability and sturdiness of LHB coach with the distributed traction power technology. This year, the railways have rolled out a 'first of its kind' semi-high speed, self-propelled train-set which will cut down the travel time by at least 20% in comparison to any train drawn by a loco due to faster acceleration and deceleration. Train 18 has 'world-class' passenger amenities such as on-board Wi-Fi and infotainment, GPS-based passenger information system and plush interiors with diffused LED lighting. The first train-set (train-18) is of 16 chair-car type coaches (executive and non-executive). There are two executive chair cars and 14 non-executive chair cars. The maximum seating capacity of executive chair is 56 passengers, while that of non executive chair car is 78.

Introductory Handbook on Train 18 (Train-Set) has been prepared by CAMTECH with the objective that it will deliver basic idea of self propelled, engineless and swanky Train-Set (Train 18). Technological up gradation and learning is a continuous process. Hence feel free to write us for any addition/modifications or in case you have any suggestion to improve the Introductory Handbook, your contribution in this direction shall be highly appreciated.

30<sup>th</sup>, Nov 2018  
CAMTECH, Gwalior

Manoj Kumar  
Jt. Director/Mech

## CHAPTER 1

### GENERAL DESCRIPTION

#### 1.0 INTRODUCTION

When one talks of trains in India, the image that strikes the mind is that of a locomotive hauling the coaches. Concept of Multi-Unit Distributed traction i.e. train-set is not heard in Indian Railways for Main line train operations. Even though Train-sets – Electric (EMUs) were running for almost a century and Diesel (DEMUs) were there since 1990s, for sub-urban services, the concept of train-sets for Main line intercity operations has not started. Advent of Metros in India has heralded a new era of Fully Air Conditioned Train-sets with Distributed Power System and introduced to the public the picture of Comfortable journey with aesthetics.

Train set is a set of rail coaches coupled mechanically and electrically with driving cabs at both ends and distributed traction power across the coaches. Depending on the requirement, the amount of power i.e. number of powered coaches can generally vary from 50% to 100%. In Train 18, **50% coaches are powered** coaches i.e. motor coaches.

The distributed power train-sets have lighter axle loads, allowing operation on lighter tracks, where locomotives may be prohibitive of higher axle loads. Another side effect of this is reduced track wear, as traction forces can be provided through many axles, rather than just the four or six of a locomotive.

Train sets generally have rigid couplers instead of the flexible ones often used on locomotive-hauled trains. That means **brakes/acceleration can be more quickly applied** without an excessive amount of jerk experienced in passenger coaches.

The most important advantage of high-speed train set is the weight reduction effect. In this, the traction system equipment is distributed over a train-set, and attractive axles throughout the train-set can obtain the required attractive effort without executing a heavy axle load. As a result, the maximum axle load is reduced.

Train sets are the best vehicle solution for suburban and regional passenger operation and for high-speed trains as well. It has been decided to Manufacture World Class Train-sets in India. Integral Coach Factory (ICF), Chennai has been chosen as the hub to “Make in India” World Class Train-sets at Half the Manufacturing cost compared to the same if imported. As ICF could make one such Train-set in 2018 therefore project is code named as Train-2018.

The Train-18 is semi-high Speed (160 Kamp) Multiple Unit Train-set with quicker acceleration and contemporary passenger amenities. It offers both comfort and pace to the passengers and suitable to fit the bill of replacing intercity express trains which have travel time in six hour range. All coaches are chair car type for day travel. The most prominent feature is that all coaches are inter-connected by fully sealed gangways so that passengers can move from one coach to other comfortably.

## 1.1 SALIENT FEATURES

- ❖ The train set manufactured by ICF, Chennai is a semi-high speed (160 Kmph) Multiple Unit Train-set.
- ❖ It has quicker acceleration ability and contemporary passenger amenities.
- ❖ It offers both comfort and pace to the passengers.
- ❖ It replaces intercity express trains which have travel time in six hours range.
- ❖ All coaches are of chair car type for day travel and **180 degree revolving seats at Executive Class.**
- ❖ **Stainless steel** car body with **continuous window glasses** for contemporary modern look.
- ❖ All coaches are inter-connected by fully sealed gangways so that passengers can move from one coach to other with ease.
- ❖ All **propulsion equipments** are shifted from **onboard to under-slung**. All power components such as **line & traction converters, auxiliary converter, air compressor, battery box, battery charger, brake chopper resistor** are mounted **under the frame.**
- ❖ It is provided with automatic plug type doors with retractable foot step which opens and closes automatically at the stations.
- ❖ To make the travel more joyful, all coaches of the train are provided with on-board Wi-Fi, infotainment and GPS based Passenger Information System (PIS) which keeps the passengers informed about the travel status.
- ❖ All coaches have one **on-board mini pantry.**
- ❖ Special provisions in DTC (Driving Trailer Coach) for **persons with disability** and place for wheel chair and special lavatory.
- ❖ The train has plush interiors and diffused LED lighting.
- ❖ The toilets of these coaches are fitted with **zero discharge vacuum based bio-toilets** and touch free fittings.
- ❖ All coaches are air-conditioned including driving cab.
- ❖ Equipped with improved mechanical couplers and modern **bolster-less** design bogies with **fully suspended traction motors**, pneumatic secondary suspension and anti-roll bar.
- ❖ The brake system is of Electro Pneumatic (EP brakes) type with **brake discs mounted directly on wheel**, which reduces the braking distance, so that full speed potential of the train can be harnessed.
- ❖ Motor Coach is equipped with Four Fully Suspended Traction Motors.
- ❖ The Train-18 has 50% Powering i.e. every alternate coach is powered
- ❖ All Propulsion equipments are under slung, leaving the on-board space for passengers.
- ❖ All coaches are of chair-car type (Executive Class as well as Second Class)



## 1.2 COMPARISON BETWEEN LOCO HAULED TRAINS AND TRAIN-SET

<i>S. No.</i>	<i>Loco hauled Train</i>	<i>Train set</i>
a)	Conventional train is hauled by a locomotive attached at the end of train formation.	Distributed power i.e.traction units or propulsion systems are distributed over the train formation.
b)	Reversal requirements at terminals.	No reversal requirement at terminals.
c)	Sluggish acceleration and deceleration.	Quick acceleration & deceleration. Reduction in travel time.
d)	Inferior utilisation of platform lengths as locomotive takes up some length.	Better utilisation of platform space as locomotive is not required.
e)	Concentrated weight in locomotive. Higher coupler forces.	Uniform weight distribution. Lower coupler forces.
f)	Requires higher capacity mechanical coupler resulting in jerks.	Because of distributed power semi-permanent coupler can be used which is jerk free.
g)	No redundancy	Redundancy

## 1.3 IMPORTANT TECHNICAL DETAILS

<i>Particulars</i>	<i>Details</i>
Number of Coaches in Basic Unit	4 car per basic unit DTC-TC-MC-TC (End BU) NDTC-MC-TC-MC (Middle BU)
Train formation	16 coaches- 4 BU per train
% Motoring	50%
Maximum test speed	176 kmph
Maximum service speed	160 kmph
Average acceleration from 0-40 kmph	0.8 m/sec <sup>2</sup>
Deceleration	0.8 m/sec <sup>2</sup>

### 1.4 CONFIGURATION OF TRAIN-18

- ❖ The Train18 consists of four basic units of four coaches each.
- ❖ The configuration of **end basic unit** is DTC+ MC+ TC + MC

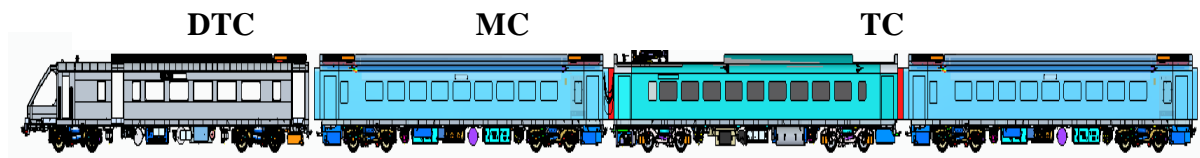


Fig1.4a: End Basic Unit

- ❖ The configuration of **middle basic unit** is - NDTC+MC+TC+MC

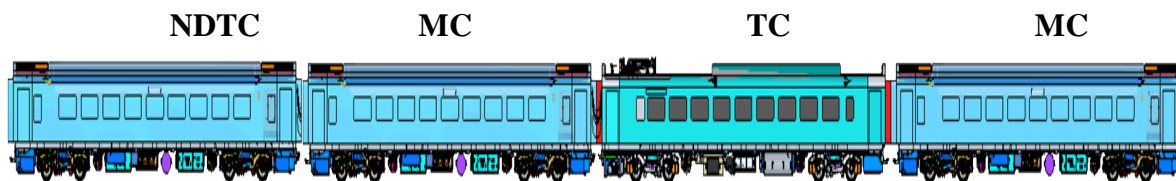


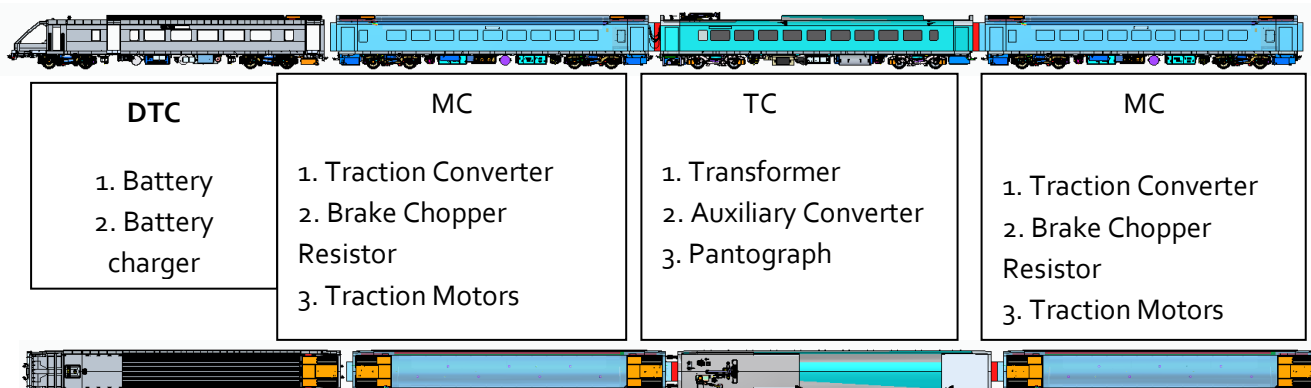
Fig1.4b: Middle Basic Unit

Where,

- |            |                         |             |                             |
|------------|-------------------------|-------------|-----------------------------|
| <b>DTC</b> | : Driving Trailer Coach | <b>MC</b>   | : Motor Coach               |
| <b>TC</b>  | : Trailer Coach         | <b>NDTC</b> | : Non-Driving Trailer Coach |

#### Propulsion Systems:

Train-18 is being provided with IGBT based Energy Efficient 3 Phase Propulsion system and Regenerative braking. In each Basic Unit of Four Cars, there will be Two Motor Coaches (MCs) and Two Trailer Coaches (2 TCs or TC and DTC). Distribution of Equipment is as follows:



**Formation of Rake (16 coaches) : 4 X 4 Basic Units - Each Basic Unit with Four Cars**

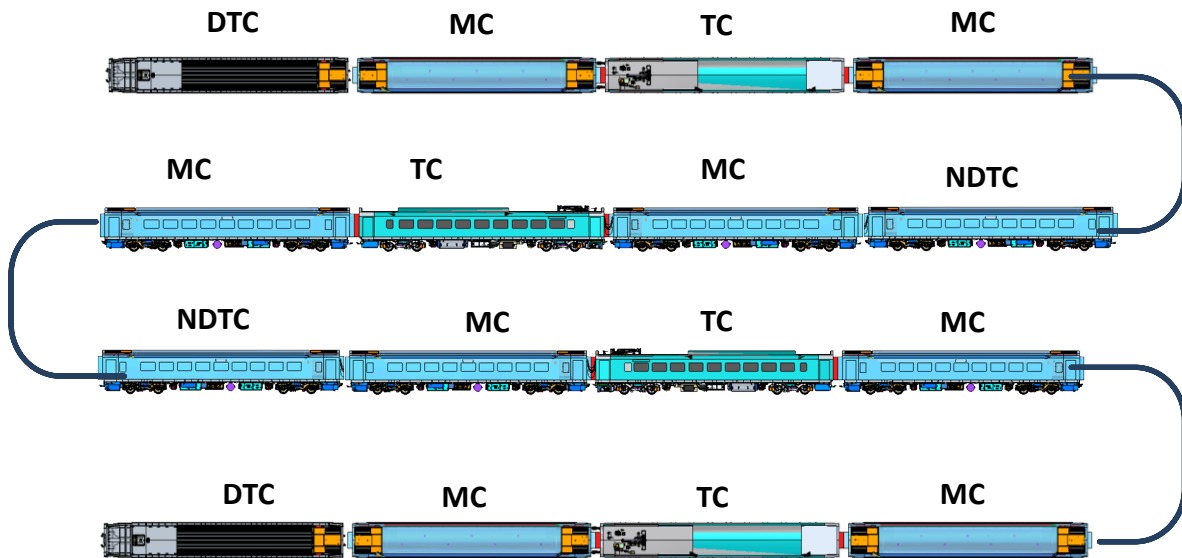


Fig1.4c: Car Formation

MC is equipped with Four 3 Phase synchronous Traction Motors, traction Converters. TC has the Pantograph mounted on the roof for Current Collection and Transformer and Auxiliary Converter mounted on the under frame. Auxiliary Converter feeds the Hotel Load of Four Coaches.

DTC has all the driver controls. TCMS controls the Automatic Doors, Sliding Footsteps and Brake Functioning. Ethernet backbone with redundancy is provided for the Train Communication network. All coaches are provided with LED displays for Passenger Information / Announcement system.

Train-18 is being provided with **IGBT** based energy efficient 3 phase propulsion system and regenerative braking. In each basic unit of four cars, there are two motor coaches (MCs) and two trailer coaches (2 TCs or TC and DTC). Complete propulsion system is being supplied by **M/s Medha** for the first prototype 16 car train set. The fully suspended traction motor is being developed by M/s Medha along with M/s. TRAKTIONS SYSTEME AUSTRIA (TSA) and M/s ECE Engineering , Poland. ESRA evolution brake system of M/s Knorr Bremse is being provided on Train-18. The brake system has in-built redundancy in brake electronics and brake control equipment.

## 1.5 DRIVING TRAILER COACH (DTC)

It is a non-powered vehicle with a driver cab at one end. The driver cab is furnished with a pre-fabricated driver desk. All driving operations are possible from driver desk. Feedback from all system in all the coaches / basic units is available for viewing on the driver desk. For this 10.4” touch based TFT display is provided on driver desk for showing combined status.

Various gauges are also provided on driver desk for knowing MR, BP, BC and parking brake pressure. The driver will also be able to control the Passenger Information System (PIS) from the driver desk.

It also consists of battery box, battery charger and compressor mounted under-slung. Rest of the DTC apart from the driver cab is passenger saloon area which consists of pantry, RMPU control unit, mono block pump controller, CRW, GCRW panel and various end wall panels. It is an air-conditioned coach. All passenger comfort related load can be controlled by driver from driver cab.

Train Control & Management System (TCMS) controls the automatic doors, sliding footsteps and brake functioning. Ethernet backbone with redundancy is provided for the train communication network.



Fig1.5a. DTC external view



Fig1.5b: DTC internal view

## 1.6 MOTOR COACH (MC)

Motor coach is a powered vehicle with four axles each equipped with a 3 phase asynchronous Traction Motor (TM). Traction motors are fully suspended i.e. traction motor weight is not loaded on to the wheel directly. This reduces the un-sprung mass, resulting in better ride comfort.

The motor coach consists of two Lines and Traction Converter unit (LTC), one for each bogie mounted under-slung. Brake chopper resistor is also mounted under-slung. Transformer secondary cable for both LTCs unit (from power transformer) comes from trailer coach via under-slung mounted IV coupler.

It also consists of passenger saloon area, pantry, RMPU, mono block pump controller, electrical cabinet and various end wall panels. It is an air-conditioned coach.



Fig1.6a: MC internal view



Fig1.6b: MC external view

## 1.7 TRAILER COACH (TC)

Trailing coach has the pantograph for current collection, vacuum circuit breaker and HV isolator mounted on the roof. For operation of the 16 car, two pantographs will be used.

It also consists of auxiliary converter unit and power transformer mounted under-slung. Power to LTC units of both motor coaches is distributed from same power transformer. Auxiliary converter feeds the total load of four coaches.

It also consists of passenger saloon area, pantry, RMPU, mono block pump controller, electrical cabinet and various end wall panels. It is an air-conditioned coach.

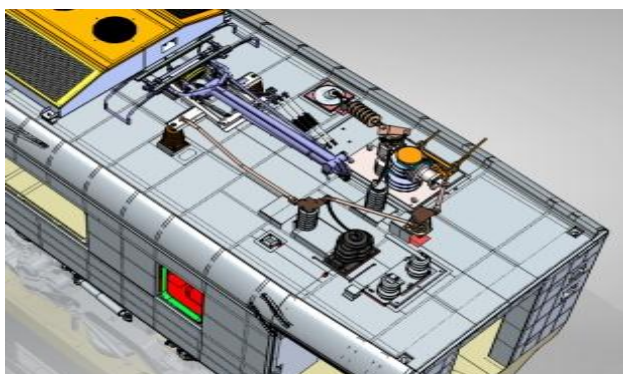


Fig1.7a: Pantograph on Trailer Coach

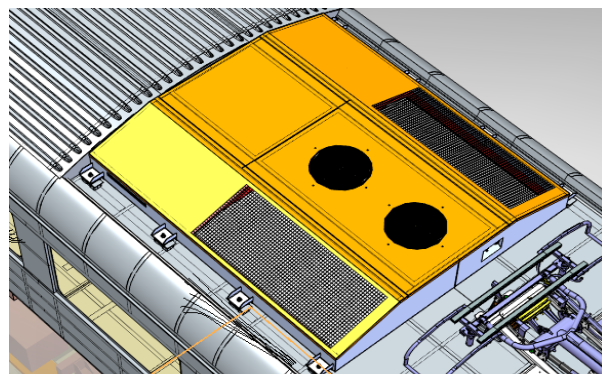


Fig1.7b: RMPU on Trailer Coach

## 1.8 NON DRIVING TRAILER COACH (NDTC)

It is similar to DTC except driver related interface. It also consists of battery box, battery charger and compressor mounted under-slung. It also consists of passenger saloon area which consists of pantry, RMPU control unit, mono-block pump controller, CRW, GCRW panel and various end wall panels. It is also an air-conditioned coach.



Fig1.8a: Non driving trailer coach (NDTC) external view



Fig1.8b: Non driving trailer coach (NDTC) end view

All coaches are provided with LED displays for passenger information/ announcement system. Each passenger has a power socket for **mobile charging**. The interior lighting is of **LED with direct light** as well as diffused lighting. Reading LED lights are provided in the luggage rack.

## 1.9 UNDER SLUNG EQUIPMENT

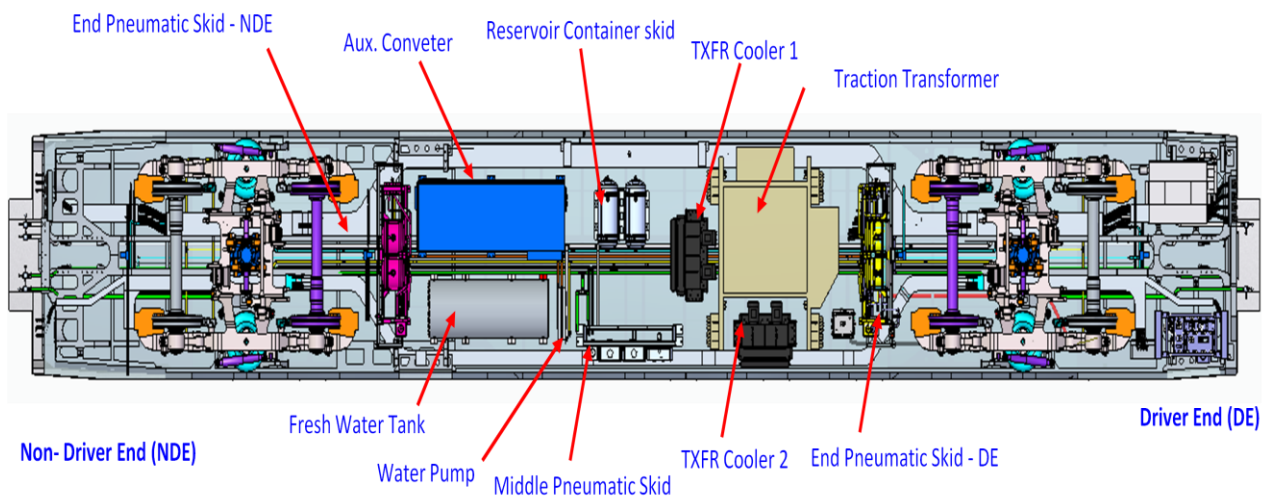


Fig1.9a: Under-Frame and mounted under-slung equipment

The under-frame is designed for bolster less design bogies, where-in the under frame directly rests on the Air Springs. For the Train-18 project Dellner Semi-permanent Couplers are being used. These couplers have a CBC type draft gear with Semi-permanent head. This eliminates the jerks, which are typical in locomotive hauled CBC coupler coaches.

The Front Driving Coaches (DTCs) has CBC couplers and the in between coaches will be permanently coupled with Semi-permanent couplers. To provide a through passage from one driving end to the other – all the sixteen coaches have been inter-connected by fully sealed gangways. To achieve this Semi-permanent inter-coach couplers have been lowered.

The LHB Coach design has been taken as the base design for the Train-18. Modifications have been done in the car body design to adapt it for Train-set. Design inputs from Consultant M/s EC Engineering Poland, Propulsion System supplier M/s Medha have formed the basis for the overall Carbody Design.

## CHAPTER 2 INTERIOR DESIGN

### 2.0 INTERIOR FEATURES OF TRAIN 18



Fig2.0a: Interior view of 2<sup>nd</sup> class of Train 18



Fig2.0b: Interior view of executive class of train 18

Train 18 is fitted with European-style comfortable seats. The Executive chair car seats of Train 18 are covered with a **golden coloured fabric and pink/purple headrest**. Fabric of the seats is **fire resistant** - a useful feature!

A very interesting feature in Train 18's executive chair car coaches is that **the seats can be rotated to face each other!** This is particularly convenient for passengers travelling in a group. But, what this also means is that **the Executive chair car will not have a centre table area.**



Another noteworthy feature of the seats in Train 18 is its new reclining facility. Unlike aircraft, where passengers have to push back their rest to recline the seat, in case of Train 18, the base seat has to be pushed ahead! This is similar to how people can adjust their seats in a car.

- The Executive Class has rotating seats which can be aligned in the direction of travel.
- Modular Toilets with Bio-Vacuum system.
- Modular Luggage rack with glass bottom
- Plush Interiors
- Fully sealed Gangway with inner flexible walls for seamless movement of passengers.
- On-board Infotainment system with Wi-Fi Streaming
- Toilet for PWD and space for wheel chair in the Driving Coach.
- Each passenger have a power socket for mobile charging.
- The interior lighting is of LED with direct light as well as diffused lighting.
- Reading LED lights are provided in the luggage rack.



Fig2.0c: Internal view of entrance area

The interiors including FRP panelling, Luggage rack, seats are being sourced from established players like M/s BFG, M/s Saira Asia and M/s FAINSA, COMPIN. In a 16 Car Train- set, there are two Executive Class coaches and, 12 Second Class AC Chair Car and 2 Second Class AC Chair with Driving Cab.

Executive Class has total 52 seats with rotating feature. The remains aligned in the direction of train movement. In Second Class, seats are reclining type with fixed backrest. These are different from the regular seats in Indian Railways - where reclining is achieved by the movement of the backrest. This avoids the intrusion of the seats into the leg space

In a Chair Car, seats play a very major role in providing comfortable travel. So for the first prototype train-set, ICF has managed to import seats which are being provided in the European high speed train-sets. These seats not only provide comfort for long distance travel but also are tested for (crashworthiness GMRT 2100 issue 5) full passive safety for the passenger.

## CHAPTER 3 EXTERIOR DESIGN

### 3.0 FEATURES OF CAR BODY



Fig3.0a: External view of train-18 having continuous flush window glass

- The Car body is equipped with Continuous Window Glasses for contemporary modern look.
- The Driving coach has aero-dynamic nose cone for reduced air-drag and for improved aesthetics.
- All coaches are equipped with automatic plug type sliding doors with sliding Foot-Step.
- All coaches are interconnected by fully sealed gangways with flexible sidewalls.
- Exterior fairings for the inter coach gangway giving a flushed look for the Train-set

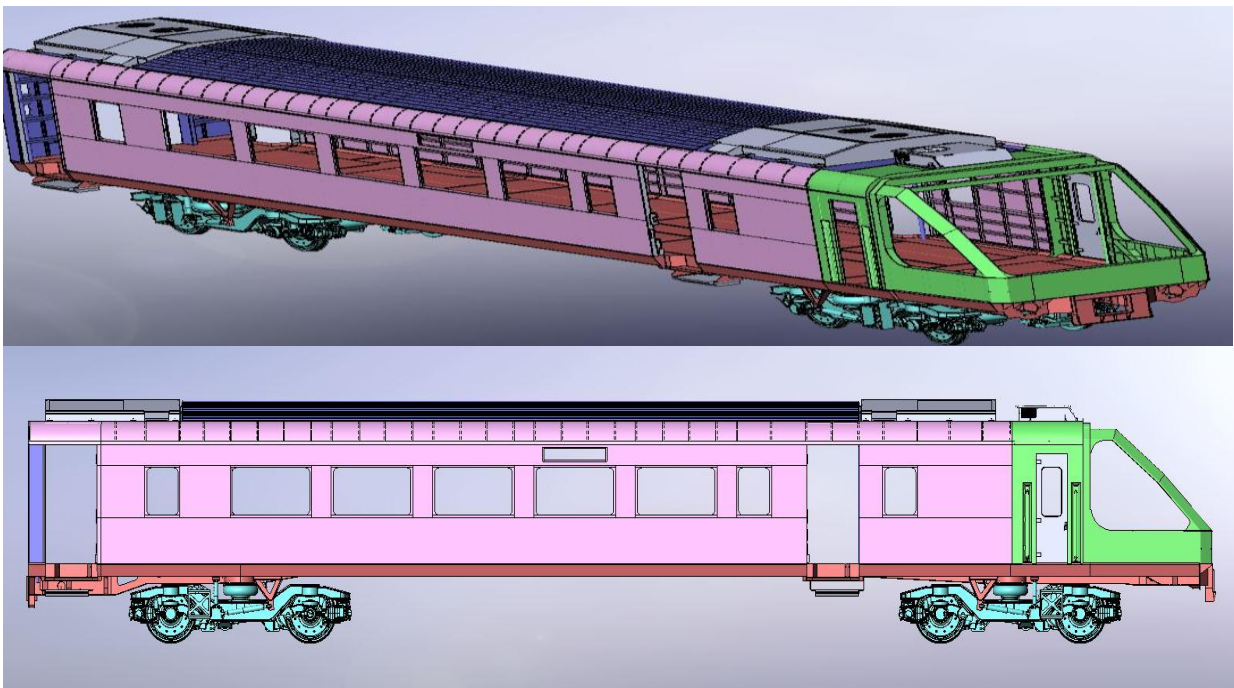


Fig3.0b: Car Body of Driving Trailer Coach

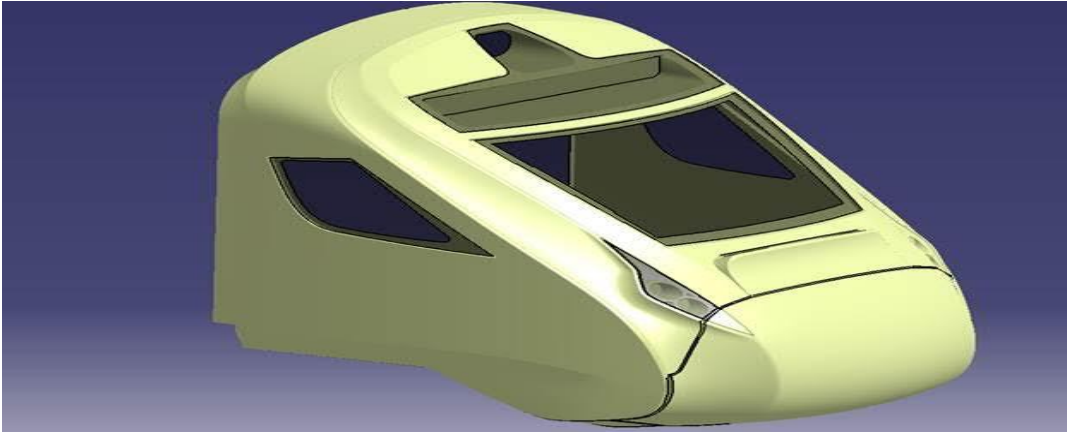


Fig3.0c: Front end FRP Nose Cone

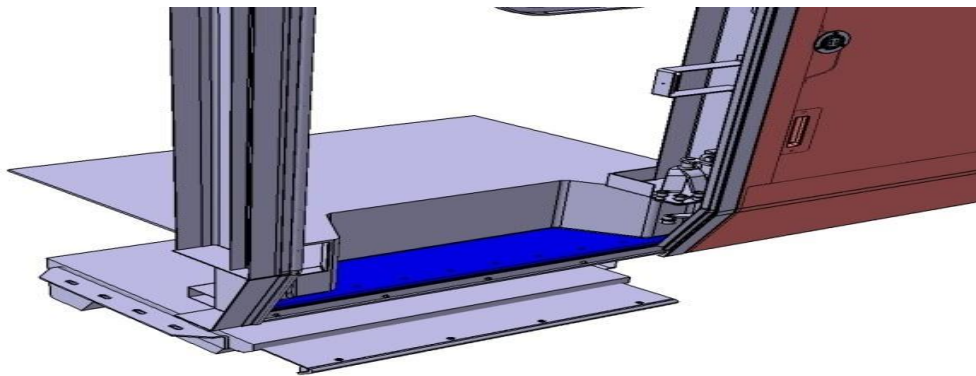


Fig3.0d: Automatic doors with sliding foot-step

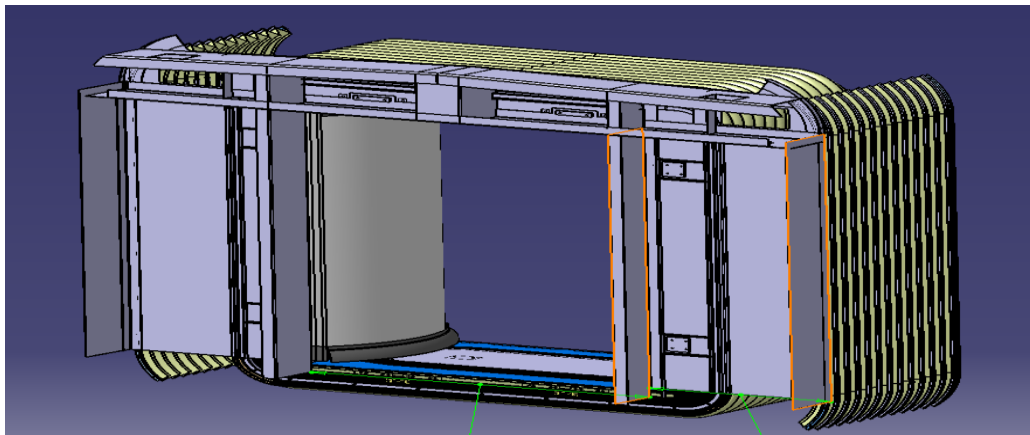


Fig3.0e: Sealed Gangway

Experience gained by ICF in manufacturing various self propelled coaches like DEMUs, EMUs and Metros particularly with 3 Phase Propulsion systems has given the confidence of taking up this endeavour of developing an entirely new Rolling Stock. Developments in the last decade enabled ICF to build its team of design and manufacturing competency. Also coming up of large scale Metro Coach manufacturing in India which resulted in development of sub-system suppliers has also helped in thinking big. During design phase, data is being exchanged with RDSO for design validation.. Train 18 is an ambitious project taken up by ICF that is designed and manufactured by harnessing in house resources. It is expected that the success of Train 18 will spur a huge demand for more of these best in Class train-sets made In India at a much economical cost.

## CHAPTER 4 DESIGN OF BOGIE

### 4.0 FEATURES OF TRAIN-18 BOGIE

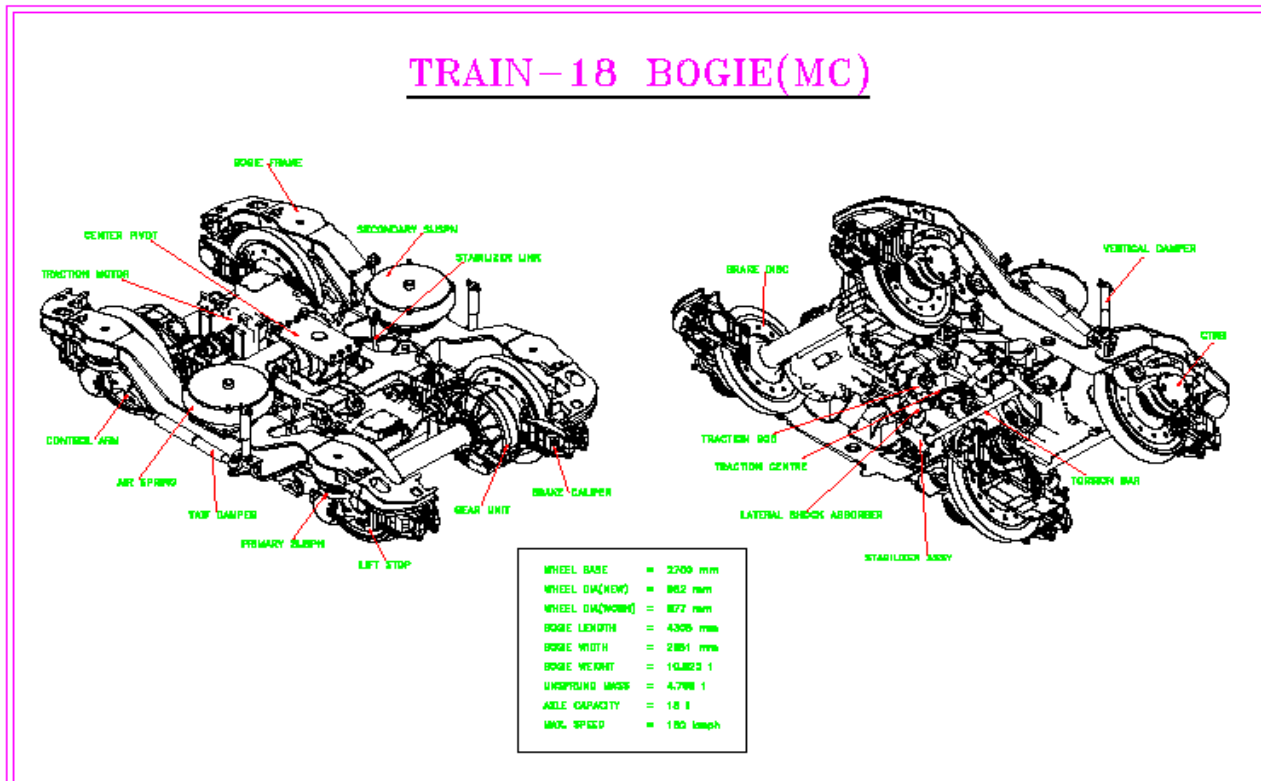


Fig4.0a: Enlarge view of Train-18 bogie

The important feature in this Train-set is New Bogie Design with Fully Suspended Traction Motors. The Bogie is being designed with following Contemporary Features:

- Fit for 160 kmph Operation
- Fully Suspended Traction Motors - wherein the Traction Motor weight is not loaded on to the wheel directly. This reduces the un-sprung mass, resulting in better ride comfort.
- The bogie is bolster less design with Fabricated Y-type bogie frame.
- Air Springs in Secondary suspension and Coil Spring with Control Arm in Primary suspension for better stability.
- Vertical, lateral and YAW dampers for jerk free ride.
- Wheel mounted disc brake system for better reliability, space utilization and less maintenance.
- Stabilizer (Anti -Roll Bar) mechanism for better passenger comfort.

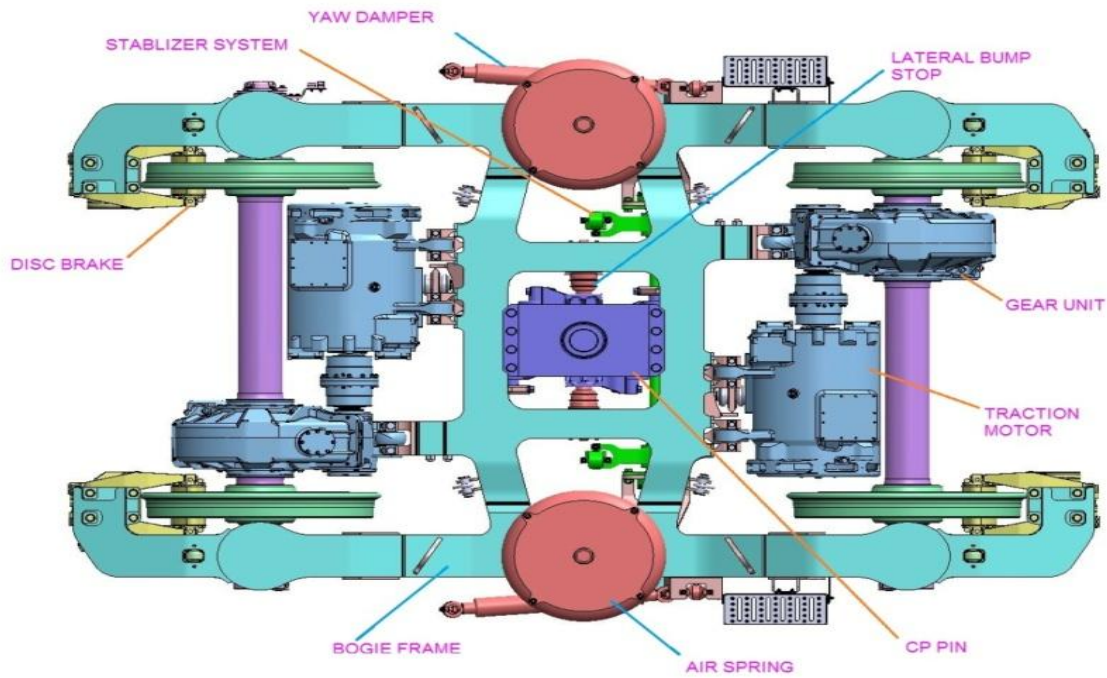


Fig4.0b: Top view of Train 18 Bogie

The development of bogie has been carried out with the help of M/s EC Engineering, Poland. and other items are developed with the help of M/s Bonatrans (wheels and axles), Knorr Bremse (Brake Disc and Brake Callipers), GMT (Metal bonded Rubber items and Air springs), Koni and Zf (dampers). The Bogie Design is the backbone for all new EMUs, DEMUs and Train-sets to be manufactured by Indian Railways.

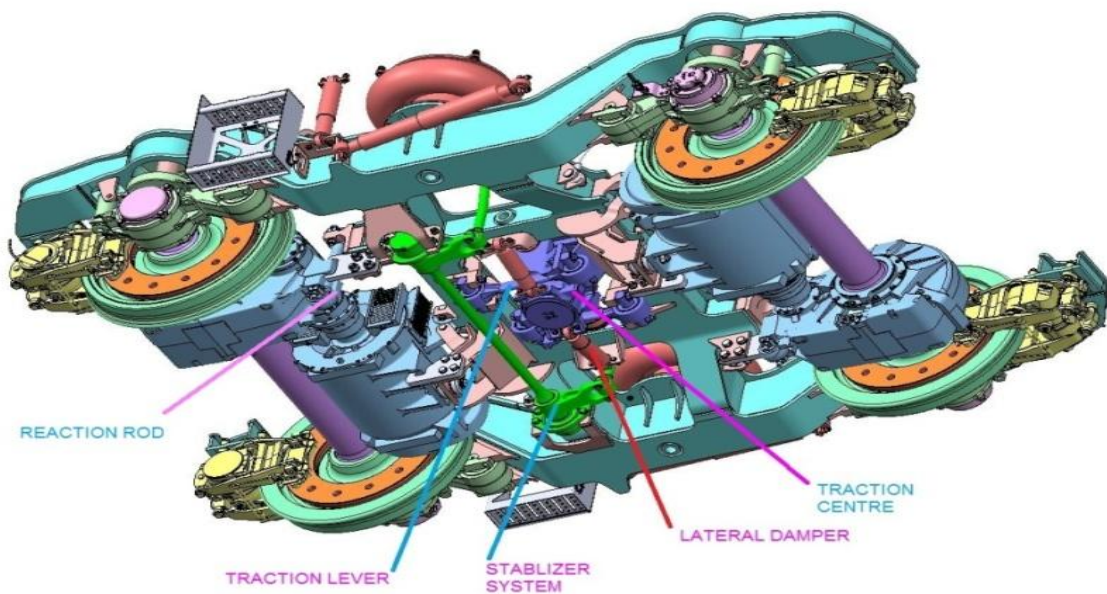


Fig4.0c: Bottom view of Train 18 Bogie

## CHAPTER 5 BRAKE CONTROL EQUIPMENT

### 5.1 INTRODUCTION:

The brake control module (BCU/EP-BGE) is a complete, compact brake control unit of modular design. Being bogie-oriented, it is especially suitable for use in mass transit systems and long-distance train set vehicles. Being a bogie controlled brake system there are 02 nos. of BCUs each controlling single bogie. In terms of functionality, safety and availability the brake control module satisfies all the requirements on a modern brake system.

The main functions offered by the BCU/EP-BGE are:

- Service brake
- Emergency brake
- Brake pressure limitation based on train load
- Pre-defined pilot pressure (Cv) for relays valve in case of failure of load pressure input.

### 5.2 DIRECT BRAKE:

The microprocessor based electronic brake control electronics (B26 - BCE) performs the local brake control functions. It is used for receiving and interpreting the brake demand signals as well as other train-lined signals to control the electro-pneumatic brake system. The BCE provides a linear brake control, according to the brake demand.

Input arriving from the master controller, in conjunction with the control of magnet valves within the DCL-controller (B03.A) at the BCU (B03). The microprocessor control logic includes fault diagnosis as well as a fault indication to facilitate maintenance and operation. Compressed air for the operation of the friction brake system is tapped from the main reservoir equalizing pipe (MR – A07). The pressure in the MRP is monitored by a pressure switch (B07). This pressure switch is connected to the propulsion interlock circuit and prevents the car from being moved if the pressure level in the main reservoir equalizing pipe is not sufficient.

**CAUTION** - The car builder must ensure that the train cannot start traction, in case the MR-pressure is low. This pressure switch B07.B07 is connected to the propulsion interlock circuit and prevents the car from being moved if the pressure level in the main reservoir equalizing pipe is not sufficient.

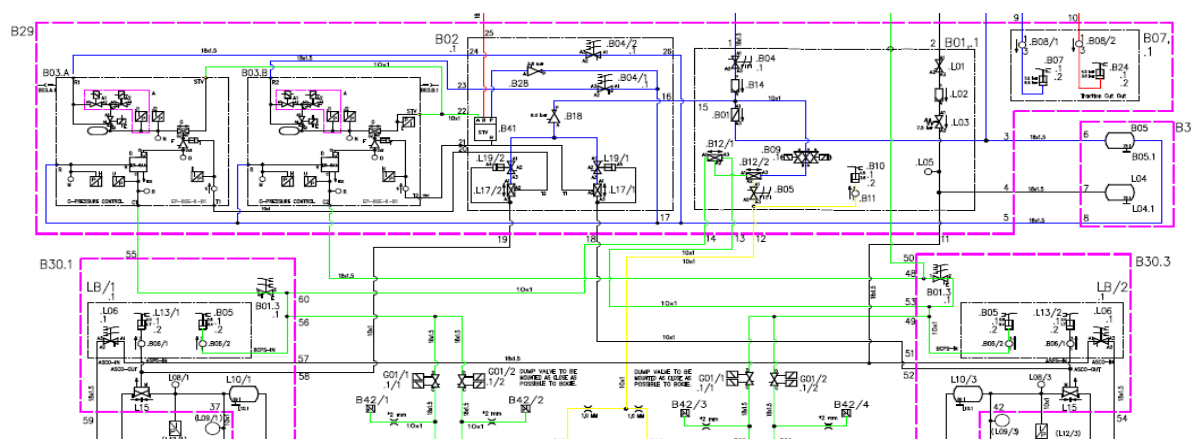


Fig5.0a: Overview Brake Control

The cock B04 isolates the complete BCU (B03) and thus one complete bogie. The cock B04/1 and B04/2 isolates the direct EP-Brake. Under this condition, only the indirect BP brake can be applied at that isolated unit. The cock B01.3 releases the brake cylinder pressure of one complete bogie.

**CAUTION:** The air supply to the unit can be isolated by means of vented cut-out cocks (B04, B04/1, and B04/2). The car builder must ensure that the cocks are correctly positioned before the train starts service and apply necessary performance restrictions, in case the cocks are closed and the train must be moved / set in service.

The EP converter (B03.A) modulates the electric friction brake demand signal from the electronic brake control electronics (B26) into a proportional pre-control pressure. The signals to the EP converter are application/release signals representative of the jerk limited and fully blended friction brake signal corresponding to the portion of the friction braking required meeting the total braking demand. The EP converter is equipped with a charging magnet valve and a venting magnet valve. The signal of the pressure transducer (B03.J) indicates the actual pressure level in the control unit. If the signal from the pressure transducer does not match the commanded pressure, the charging or venting valves are controlled by the electronic control unit (B26) to obtain the correct pressure level in the control volume. This technique provides a high accuracy, linearity and repeatability.

### 5.3 BRAKE PIPE CONTROLLED BRAKE (AUTOMATIC INDIRECT BRAKE):

The brake pipe (BP) pressure can be controlled by means of the driver's brake valve type FB11 (D01), (time dependent) in case of failure of the electro-pneumatic direct brake or in the rescue mode by a recovery train. The brake pipe can also be controlled from a rescue locomotive. Limitations to speeds and decelerations must be observed in rescue cases (towing operations) and failure modes (for continuous operation of service brake without retarder brake).

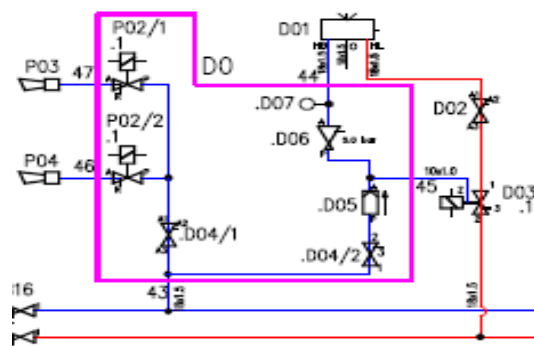


Fig5.0b: Driver's Brake Pipe Control Equipment

The brake pipe (BP) pressure is charged from MRP through a pressure reducing valve (D06) and kept at a constant level of 5 bars, via a pressure reducing valve (D06). With a decrease of the BP-pressure below 4.6 bar the first brake step will automatically be applied by the distributor valve (B02.b41) which transforms the BP-pressure reduction into an increase of the relay valve's pre-control pressure. By this logic the brake is applied redundant to the normal emergency brake application. However the pressure-built-up times for this redundant brake application are related to the pressure decrease in the brake pipe. Consequently - at long trains - the pressure built-up time will increase at the last car. Due to this physical effect, the operation speed in case of shunting of long trains is limited. With the time dependent brake valve type FB11 (D01) the brake pipe (BP) pressure can be reduced or increased depending on the time the brake lever is maintained at "braking" or "driving". The end-positions "braking" and "driving" are notched, thus the brake lever will remain in the selected position.

At normal service brake conditions (As long as the electro-pneumatic is operative) the brake pipe pressure is kept at a constant release pressure (5 bar) as long as the handle of the drivers brake valve FB11 is maintained in “driving” position in the active drivers cab. The pre-control pressure is then fed via the duplex check valve (B03.G) and the load dependent pressure limiting valve (B03.F), which limits the pressure level according to the actual pneumatic load signal from the secondary suspension, to the relay valve (B03.D) generating the brake cylinder pressure. The spring loaded distributor valve type STV (pos. B02.B41) will generate a brake cylinder pre-control pressure on an indirect logic e.g. (5.0 bar = 0 bar brake cylinder, 3.8 bar = max. brake cylinder pressure, limited by the pressure reducing valve (B02.B28) corresponding to the brake pipe pressure.

The control pressure from the distributor valve (B02.B41) can flow via the duplex check valve (B03.G) to the load dependent pressure limiting valve and relay valve to initiate a load weighed emergency brake application (indirect brake circuit). Via the pressure governor B24, the pressure level in BP can be monitored. The pressure governor (B24) gives the information, indirect brakes released/ indirect brakes applied to the TMS. The car builder must ensure that the train cannot start traction, in case the brakes are applied. Cock D0.D04 is used to isolate the air supply to the drivers brake valve system. It is equipped with electrical switches and is connected directly to TMS.

The car builder must ensure the necessary safety precautions, in order to avoid service with isolated driver’s brake equipment for indirect brakes. Magnet Valve WMV20 (D03) is used to disable the BP-control in the inactive drivers cab. For control purpose it is necessary, that the BP-control system is only activated in the active drivers cab.

To activate the BP control system the magnet valve needs to be de-energized, respectively it will be de-activated when the magnet is energized. In case of failure of the magnet valve or loss of power supply to the magnet valve the drivers brake valve can manually be isolated from the brake pipe by means of isolating cock D02. The air supply to the brake pipe BP can be isolated by means of the cut-out cocks D02. The car builder must ensure that the cocks are correctly positioned before the train starts service and apply necessary safety precautions, in case the cocks are closed and the train must be moved /set in service.

#### 5.4 PARKING BRAKE CONTROL:

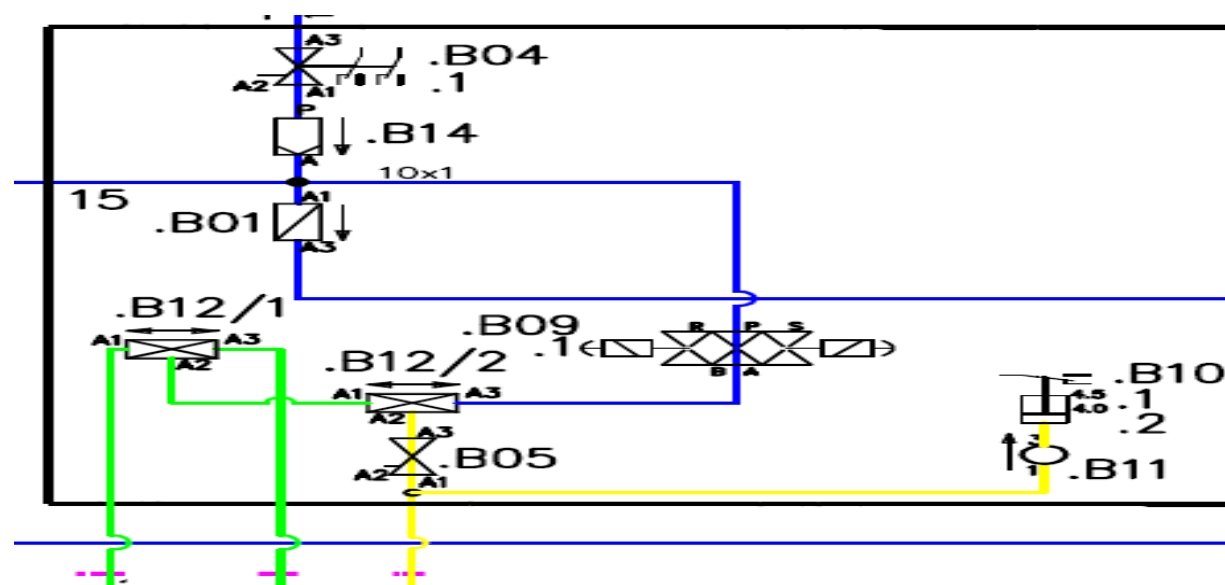


Fig5.0c: Parking Brake Control Equipment



Air pressure from the main reservoir equalizing pipe is fed to the impulse magnet valve (B01.B09) which is equipped with two magnets. The application or release of the parking brake actuators of spring-applied type is controlled by the impulse magnet valve (B01.B09), which only needs a short train lined impulse from the driver to apply and release the parking brake. It can be also manually operated by push buttons at the valve in the case the control voltage missing. For manual operation of the valve it is recommended to install it in an easily accessible location, such as inside of driver's cab.

The anti compounding is realized via the double check valves B12/1, B12/2. It allows either the brake cylinder pressure (BC) or main reservoir pressure (MR) to fill the parking brake pressure pipe (PB), thus releasing the parking brakes. Via the isolating cock B01.B05, the parking brake pressure PB can be released manually from the parking brake units, thus applying the parking brake force. The isolation of PB is indicated by the pressure switch (B01.B10). A signal from the pressure switch (B01.B10) is used to prevent the car from being moved under power until the spring-applied actuators are released. The car builder must ensure that the train cannot start traction, in case the brakes are applied (indicated by B01.B10).

Once the train is shut-off, emergency brakes are applied (due to de-energizing of the emergency brake loop). Over an extended period of time, the pressure in the service brake cylinders starts to fall and simultaneously the parking brake starts to apply. This ensures that the vehicle is safely immobilized.

## 5,5 WHEEL-SLIDE PROTECTION EQUIPMENT:

The printed circuit boards for the wheel slide control are also included in the microprocessor based brake control electronics (BCE) (B26). The BCE detects the speed of each axle and controls the brake pressure by regulating the anti-skid valves according to the achievable deceleration dependent on the available adhesion between wheel and rail. The microprocessor control logic includes fault diagnosis as well as fault indication to facilitate maintenance and operation.

The wheel-slide protection system is performed on a bogie basis. The equipment also includes anti-skid valves (G01), single channel speed sensor (G03) and pole wheels (G04) (not KB supply). The signal of the speed sensors (G03) is differentiated and compared to preset threshold levels of deceleration. In addition, the axle speed is compared to the electronically simulated fictive vehicle speed. When wheel-slide is detected, the electronic control unit will release/maintain/apply the brakes through energizing/de-energizing the magnets of the anti-skid valves. The wheel-slide protection equipment is also operative during an emergency brake application.

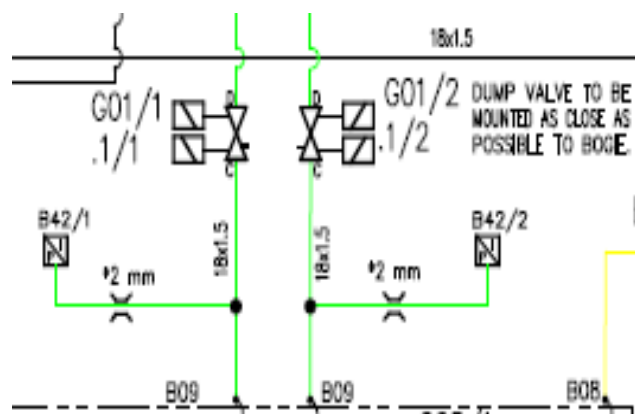


Fig5.0d: WSP Equipment

## 5.6 MECHANICAL BRAKE ACTUATING EQUIPMENT (BOGIE-MOUNTED) :

Each axle is equipped with 2 wheel mounted brake discs per axle (C06) in all cars and brake calliper units of compact design (C02, C03). The brake caliper units (C03) have spring-parking brake actuators incorporated.

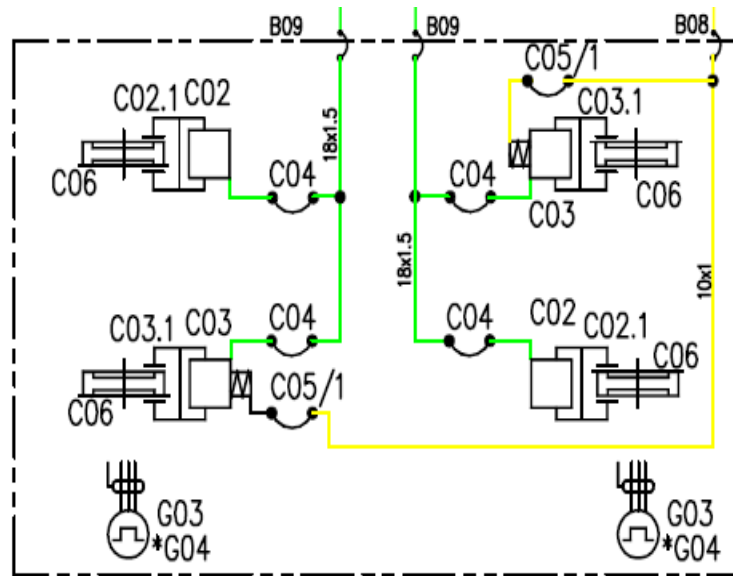


Fig5.0e: Motor Bogie Brake Equipment

The units with parking brake actuators are equipped with a mechanical release device. The manually released parking brake actuators are automatically reset by applying release pressure. The type of brake caliper units used is of modern design which has the following technical advantages:

- New suspension arrangement with a single central pin and no hangers
- allowing maximum lateral movement and tilt of the axle without constraints;
- Uniform brake pad pressure;
- Simple standard interface to the bogie, easy bogie-side mounting bracket;
- reduced number of bushes and joints;
- Less wear and noise, reduced life cycle costs.



Fig5.0f: Compact Brake Calliper

**CHAPTER 6**  
**ELECTRICAL EQUIPMENT IN TRAIN-18**

### 6.0 MAJOR ELECTRICAL EQUIPMENT

Following are major electrical equipments provided in various coaches of train-set along with their manufacturers/suppliers:

<i>Sr. No.</i>	<i>Equipment</i>	<i>Manufacturer/ Supplier</i>
1.	Traction transformer	JST
2.	Lightning arrester	Siemens
3.	VCB with earthing switch	Autometer, Patra & Chandra
4.	Pantograph with insulator	Schunk
5.	IGBT based line and traction converter	Medha
6.	Self-ventilated fully suspended AC traction motors	Medha, TSA JV
7.	Auxiliary converter with (415V, 3ph and 110V, DC) including battery charger	Medha
8.	Train control & management system	Medha
9.	Air supply (compressor, filter, dryer)	Knorr Bremse
10.	Complete driver desk with 10.4 inch LCD TFT driver display	Medha
11.	Passenger information system	Medha
12.	Control panels with contactors, relays, breakers etc.	Medha
13.	Inter-vehicular couplers	Huber-Suhner
14.	Coach air conditioning system (RMPU with panels)	<i>Sidwal</i>
15.	Cab air conditioning system	Subros
16.	Twin beam head light	--
17.	Speed recorder	
18.	Isolation (pantry) transformer	
19.	DC DC converter	
20.	Baby compressor	
21.	Earth return CT Box U/slung	
22.	Shunting remote	

## 6.1 POWER SCHEMATIC OF TRAIN-18

Block diagram of the power schematic of the train-set is shown below:-

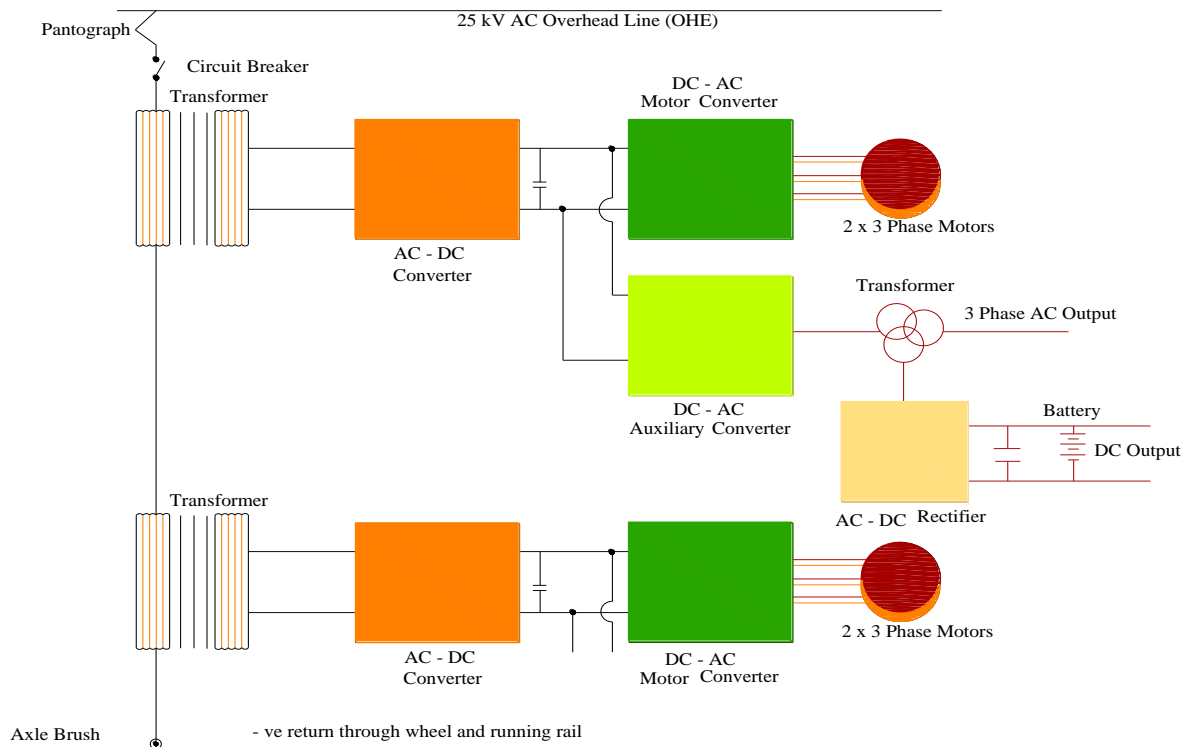


Fig6.0a: Block Diagram of Electronic Power and Auxiliary Services on TRAIN 18

The 25kV OHE voltage is connected to the transformer primary winding through the pantograph and Vacuum Circuit Breaker (VCB). During maintenance, when transformer primary winding is not connected to the OHE line, an earthing switch (connected in parallel to VCB) is used to ground the transformer primary winding and pantograph for safety.

## 6.2 TRACTION TRANSFORMER

- Traction transformer is mounted under slung of trailer coach (TC).
- There are 1 primary winding, 4 traction windings and 2 auxiliary windings in traction transformer.
- Continuous voltage: 19 – 27.5 kV
- 3 Frequency range: 47 – 53 Hz
- Total transformer continuous rating is 2880 kVA under 22.5 kV OHE voltage.
- Each traction winding continuous rating is 603 kVA
- Each auxiliary winding continuous rating is 234 kVA
- Peak power rating is 3616 kVA, each traction secondary peak rating is 787 kVA and auxiliary is 234 kVA.
- Total approximate weight of transformer is 4900+/-3% kgs.
- **One transformer feeds to two motor coaches.**
- Traction transformer is oil cooled with help of oil pump and blowers which cool the radiator through which oil is circulated using the oil pump.

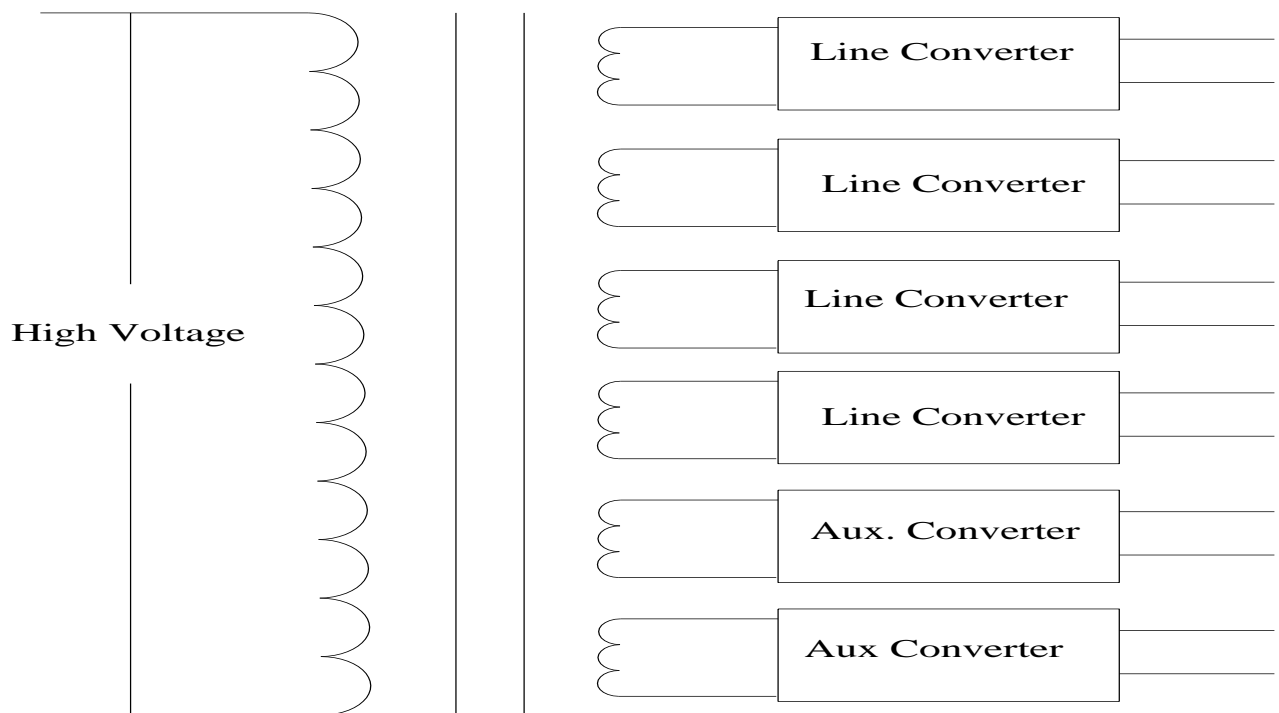


Fig6.0b: Block diagram of Traction Transformer

### Continuous Voltage Rating

	<i>Primary</i>			<i>Traction x4</i>			<i>Auxiliary x2</i>		
	<i>U line (kV)</i>	<i>Power (kVA)</i>	<i>Current (A)</i>	<i>Power (kVA)</i>	<i>Voltage (V)</i>	<i>Current (A)</i>	<i>Power (kVA)</i>	<i>Voltage (V)</i>	<i>Current (A)</i>
Exceptional	16	2109	132	429	608	705	197	240	820
Continuous	19	2505	132	509	722	705	234	285	820
	22.5	2880	128	603	855	705	234	338	692
	25	2880	115	603	950	635	234	376	623
	27.5	2880	105	603	1045	577	234	413	566
Exceptional	30	2880	96	603	1140	529	234	451	519

### 6.3 LINE AND TRACTION CONVERTER

- Each basic unit has 2 motor coaches and each motor coach has 4 traction motors.
- Each motor coach has 2 nos. of line and traction converter (LTC) mounted under slung and each control two traction motors of a bogie.
- Input power to line converter comes from transformer kept in adjacent trailer coach.
- Line and traction converters are forced air cooled.

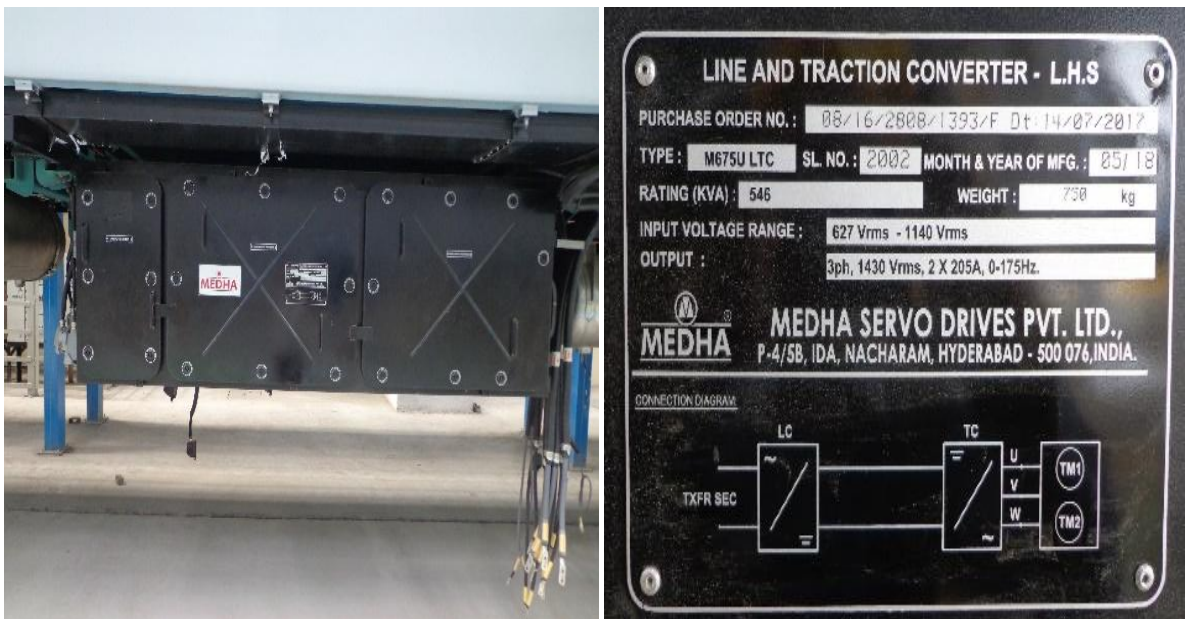


Fig6.0c: Line and Traction Converter

#### 6.3.1 Important Parameters of LTC

<i>Description</i>	<i>Rating</i>
Input voltage	950 V AC at 25 kV AC
Input current	639 A
Weight	<800+/-50 Kg
Dimension	2250*1220*700 mm
Line and traction converter rating	554 KVA

### 6.3.2 Line Converter

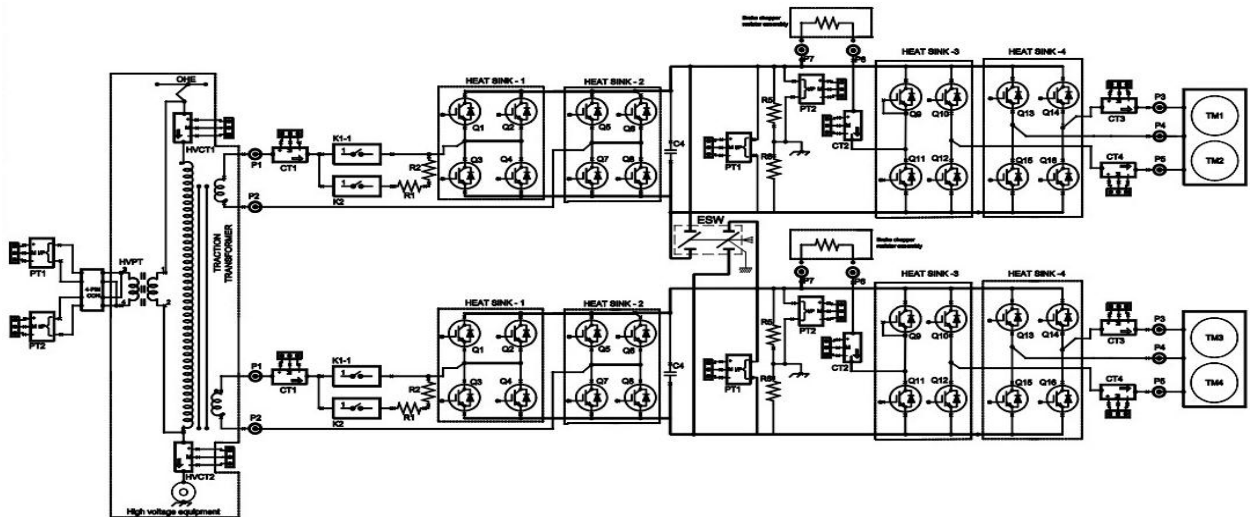


Fig6.0d: Block Diagram of Line and Traction Converter

- Each traction converter cubicle consists of one line converter, DC link, one traction inverter and line & traction control unit.
- The line converter interfaces with transformer secondary traction winding AC voltage on one side and DC link on the other side.
- Main function of line converter is to maintain stable DC link voltage at 1800 V irrespective of line and load variations at unity power factor.

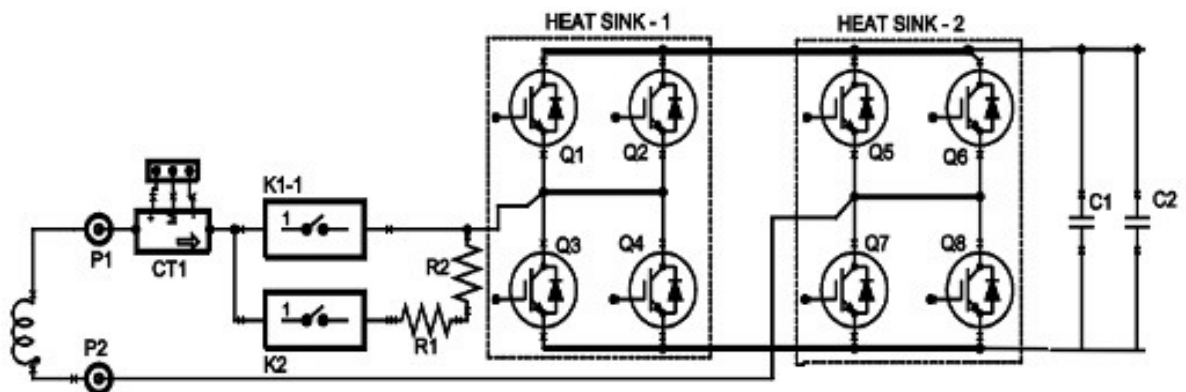


Fig6.0e: Block Diagram of Line

- The line converter consists of single phase full bridge rectifier with IGBTs as active switching devices.
- Line converter consists of input pre-charging circuit and line contactor. It consists of output DC link capacitor.
- The DC link consists of earth leakage detection circuit, DC link capacitor bank and brake chopper circuit (for over voltage protection).

### 6.3.3 Brake Chopper Circuit

- Each MC coach has two independent Brake Chopper Resistors. But both these resistors are placed in a single cubicle.
- Each Resistor is connected across DC link of Line and Traction Converter unit. The Brake chopper resistor unit is under-slung mounted.
- Brake chopper circuit comprises of BCH IGBT module and BCH resistor.
- The Brake chopper circuit is used to limit the over-voltages in DC link capacitors during abnormal conditions or during transients.
- Over voltages in the DC link capacitors may occur due to:
  - Non receptive OHE during regeneration
  - Transient Load Conditions.
- Resistance value calculations are described below:

Sr.No.	Description	Value
1.	Resistance (nominal)	3.6 $\Omega$
2.	Resistance (minimum)	3.42 $\Omega$
3.	Resistance (Maximum)	3.85 $\Omega$
4.	Power Rating	719 kW for 2.5 sec
5.	Energy Rating	1.8 MW-sec

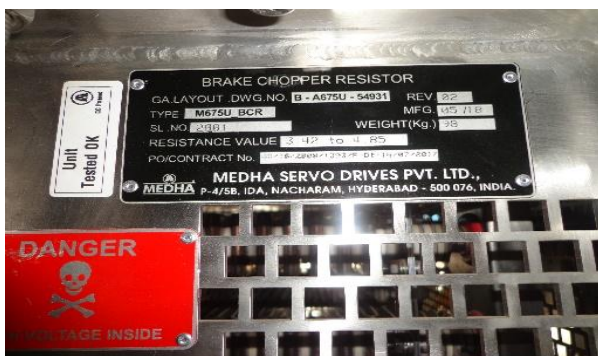


Fig6.0f: Brake chopper

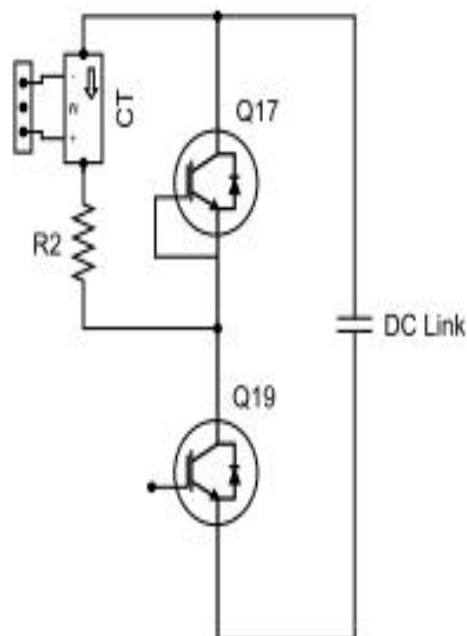


Fig6.0g: Block Diagram of Brake chopper



### 6.3.4 Earth Fault Detection Scheme

- Earth fault is detected by measuring the voltage ( $U_e$ ) across the resistor branch between the DC link terminals as shown in figure given below:

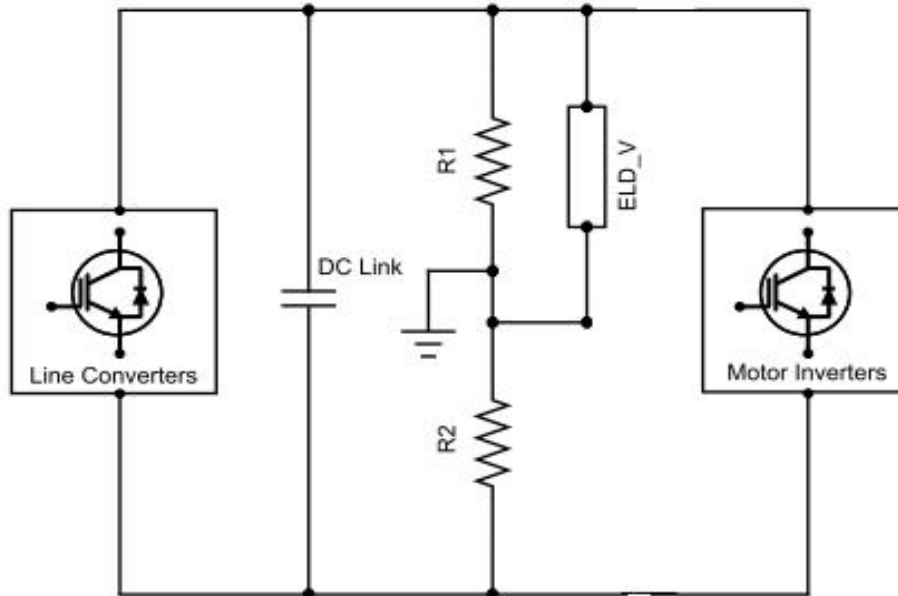


Fig6.0h: Earth fault detection Scheme

- There are two sets of resistor branches connected in series (their equivalent resistances are R1 and R2) between DC link terminals. R1 and R2 are different resistances each of values 66 k $\Omega$  and 20.4 k $\Omega$  respectively.

### 6.3.5 Line Converter Protections:

- Transformer primary over voltage and under voltage protection.
- Traction transformer secondary over current protection.
- IGBT heat sink over temperature protection.
- Failure of pre-charging contactor / resistor protection.
- Failure of main contactor protection.

### 6.3.6 DC Link Protections:

- DC link over voltage protection.
- DC link short circuit protection.
- Earth leakage protection.

### 6.3.7 DC Link Earthing Switch

- Each motor coach has two LTC units and has one common DC link earthing switch to protect the operating personnel from high voltage during maintenance activity.



Fig6.0i: DC link earthing switch

- One Earthing switch has four poles. Two LTC units DC link +ve and -ve are connected to a common earthing switch.
- The operation is through a key interlocking system similar to the EMU. When the earthing switch is in open condition, all four poles are completely independent.
- First operate the panto isolating cock and release **blue key** from it. Use it and operate the 25kV VCB earthing switch and two **Yellow keys** will be released.
- With this the panto will not raise as there will be no pressure and even if OHE comes the 25kV earthing switch will make it earth.
- To operate the DC link earthing switch the master **Yellow** key from 25kV VCB earthing switch is needed.
- After inserting the **Yellow** key in the DC link earthing switch it can be moved to earthing position and **Green** key will be released from DC link earthing switch.
- With **Green** key LTC unit door can be opened. Follow the same sequence in reverse order to restore the normal supply.

### 6.3.8 Traction Inverter

The traction inverter consists of a 3-phase full bridge inverter with IGBTs as active switching devices. Main function of TIC:

- Converts the DC input voltage to 3-phase **Variable Voltage Variable Frequency (VVVF)** output.
- Controls the traction motor torque in both motoring mode and braking mode.
- Each inverter controls two traction motors in parallel.
- Controls wheel slip/slide.
- Performs various fault diagnostics.

**Traction Inverter protections:**

- Output over current protection.
- Output short circuit protection.
- IGBT heat sink over temperature protection.
- Traction motor over temperature protection.
- Traction motor over speed protection.
- Phase imbalance protection.

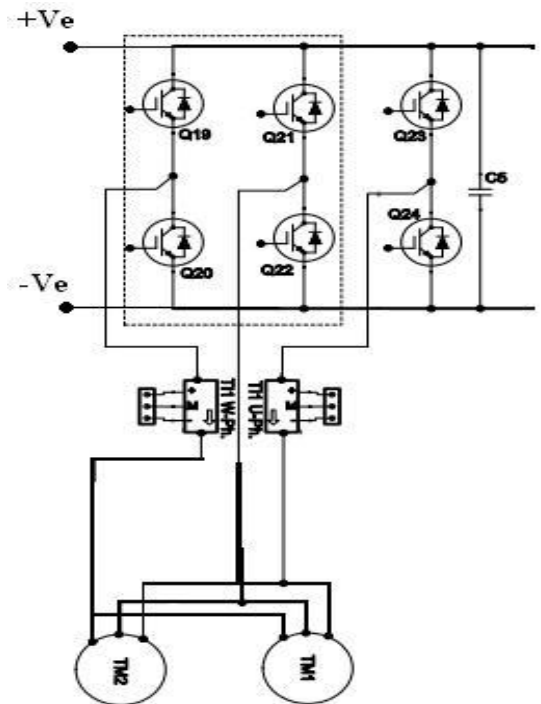


Fig6.0j: Traction Inverter Schematic diagram

**6.3.9 Line & Traction Control Unit (LTCU)**

Line & Traction Control Unit (LTCU) controls both the line converter and traction inverter and communicates with the Main Control Unit (MCU) through CAN interface. All the LTC's are similar in construction.



Fig6.0k: Line &amp; Traction Control Unit (LTCU)

### 6.3.10 Dc Link Capacitor

DC link capacitor has following functions:

- DC link capacitor is used to buffer the energy differences between line-side and motor-side of the converter.
- DC link capacitor absorbs the harmonic currents produced by line side and motor-side of the converter, thus reducing the ripple voltage.
- DC link capacitor is used to limit the switching over voltages of IGBTs. These over voltages occur due to loop inductance.
- Two DC link capacitors of 2mF are connected in parallel and form the DC Link which is directly connected to the IGBT Phase modules.

## 6.4 AUXILIARY POWER SUPPLY

### 6.4.1 Auxiliary Power Supply

- All auxiliaries and controls of coaches are required to work on two kinds of voltage **415VAC, 3phase, 50Hz and 110VDC**.
- Auxiliary converter unit is required to generate these types of voltages to serve these loads.
- It gets power directly from 2 nos. of secondary windings of transformer.
- Transformer and auxiliary converter are mounted in trailer coach.
- It is mounted under-slung and forced cooled system.
- Auxiliary converter is a PWM based IGBT converter, which converts 285VAC – 450V AC into two outputs:
  - i. Output-1: 415 V ac (line to line), 3 phase, 50Hz
  - ii. Output-2: DC output is isolated from input by using DC -DC isolation transformer. DC output is connected to BN Bus.

### 6.4.2 415VAC, 3phase, 50Hz loads:

- RMPU
- CAB AC
- Main compressor
- Traction converter cooling blowers
- Transformer radiator fan
- Transformer oil pump
- Water pump for toilet tank
- Aux converter cooling blower.

### 6.4.3 110VDC Loads

- Battery charging
- Coach, vestibules and driver cabin normal lights
- Coach and driver cabin emergency lights
- Twin beam/ auxiliary head light, marker light, tail light, flasher light, cluster light, spot lights, passenger alarm
- Indication light, electronic signal bell
- Control electronics loads: PIS, CCTV, Relays, Contactors,
- Driver desk, brake systems and all other control units
- Auxiliary compressor for pantograph
- Emergency ventilation blowers
- 110V DC toilet loads, seat lights & doors.

**Auxiliary power supply consists of two cubicles:**

- (i) **Auxiliary Converter Unit (ACU)** - ACU consists of below modules:
- AC1 module
  - AC2 module
  - DC converter module
- (ii) **Battery Charging System (BCS)**

### 6.4.4 Important Parameters of Auxiliary Converter

Requirement	Parameters
AC input voltage	285 V to 450 V, 1 phase, AC input from auxiliary secondary winding of main transformer
Control supply	77V to 137.5 V DC from battery (110Vdc nominal)
AC-1 output capacity	275 kVA, 415V $\pm$ 5% (L-L), 50 Hz $\pm$ 3%, 3 Phase, Sine wave (at >19kVac OHE) At <19kVac OHE, output voltage shall drop by maintaining V/F ratio constant.
AC-2 output capacity	235kVA, 415V $\pm$ 5% (L-L), 50Hz $\pm$ 3%, 3 Phase, Sine wave (at >19kVac OHE) At <19kVac OHE, output voltage shall drop by maintaining V/F ratio constant.
DC converter output capacity	115 V to 130 V DC (It is varying as per DC load sharing current requirement) DC Power: 30kW at 110V DC (BN, BD & battery charger loading on this).
Efficiency	92%

6.4.5 Schematic description of ACU

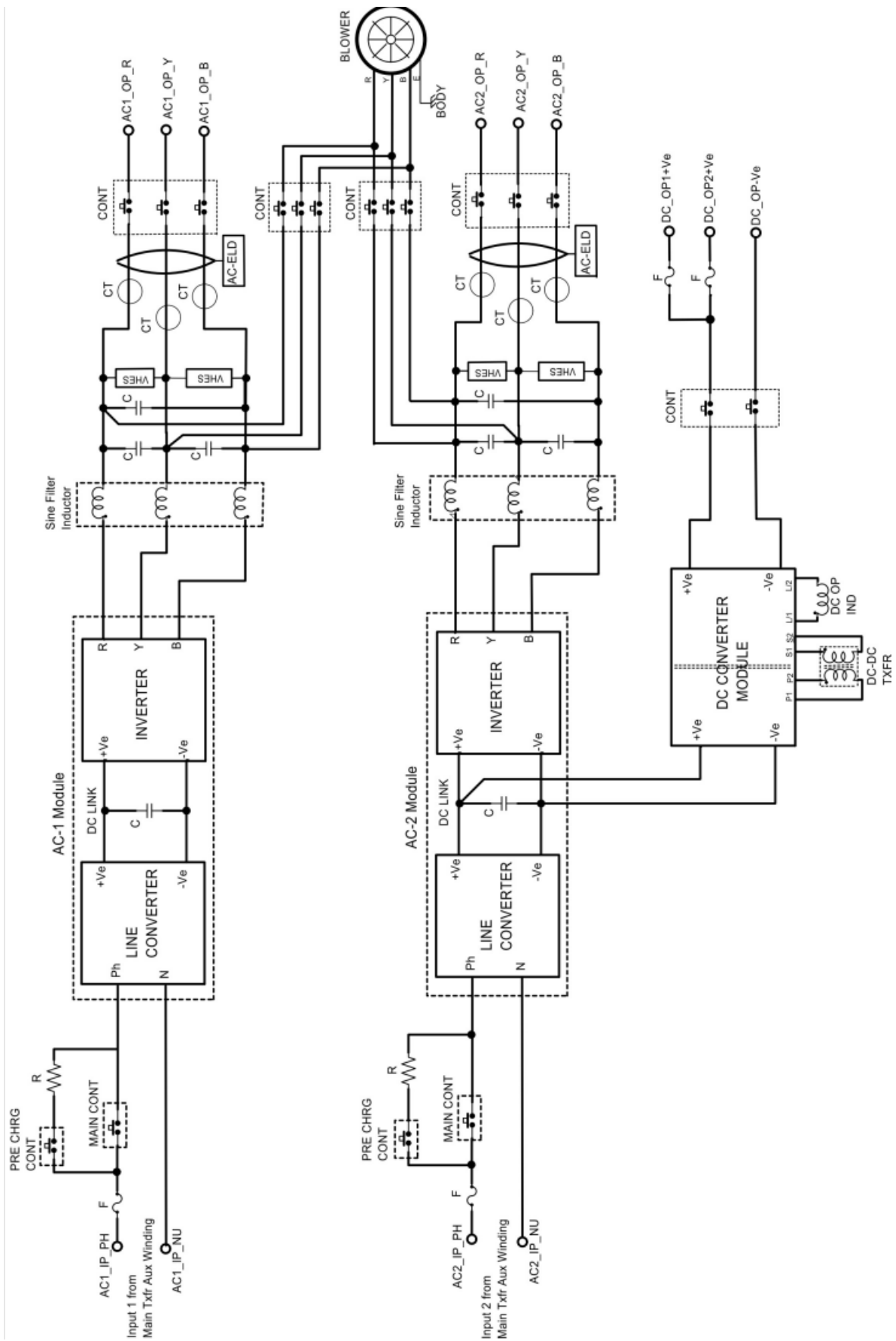


Fig-6.01: Auxiliary converter schematic diagram

ACU consists of modules/ sections mentioned below:

- Input section
  - AC-1 module (line converter & inverter section including master control)
  - AC-2 module (line converter & inverter section including master control)
  - 415Vac output section
  - DC converter module
  - DC output section
  - DC link voltage indicators
  - Control & communication connectors
  - Blower section
  - Isolation switch.
- 
- The input of the auxiliary converter is taken from the independent secondary windings of main transformer.
  - Input section consists of input fuse, input main & pre- charging contactors & input ac current sensor.
  - The purpose of input fuse is to protect DC link from over current.
  - The purpose of input ac current sensor is to control the line converter for regulating DC link voltage & to maintain unity power factor at input.
  - The purpose of pre- charging contactor & resistor is to limit the DC link capacitor charging current at source sudden ON. It will be switched off when DC link voltage reaches to defined value.
  - The purpose of input main contractor is to isolate the unit from source if any abnormalities in ACU.

#### **6.4.6 AC-1 & AC-2 Modules**

AC-1 & AC-2 modules consist of below sections:

- i. Line converter section
- ii. Inverter section
- iii. Master & module control section (both control & communication)

##### **6.4.6.1 Line Converter Section**

- The line converter section takes the input (variable single phase AC input) from secondary winding of main transformer and converts to fixed DC-link by controlling pulses of the IGBT's by using DSP controller.
- Line converter maintains unity power factor at AC input. Full bridge architecture is used for the line converter.
- Transformer primary, secondary, DC link voltages and input AC current sensors are used for feedback control, display the parameters and protect the line converter.
- Line converter output is connected to common DC link.

#### **6.4.6.2 Inverter Section**

- The inverter takes the input from common DC link. The IGBT based inverter section is provided after DC link capacitor. A three phase full bridge architecture is used for the inverter.
- An IGBT based inverter is controlled by using DSP. Input voltage and output current sensors are used for feedback control, display the parameters and protect the inverter.
- Temperature sensors are provided for sensing the heat sink temperatures of the IGBT modules and for protecting it.
- DSP controller is used for PWM control of line converter & inverter.

#### **6.4.6.3 Master Control Section**

- There is a controller which controls the line converter & inverter. It is also responsible for monitoring and protecting the complete auxiliary converter unit and records the faults in the memory.
- It also interfaces to TCMS to get commands and to send status to display at driver cabin through ethernet communication.
- It is also responsible for driving the contactors & to monitor it's healthiness by taking their feedbacks.
- It is also responsible for handling & processing the hardwired signals which are coming from LCC.

#### **6.4.6.4 ACU 415VAC Output Section**

- It consists of sine filter inductor, capacitor, current transformers, ELD sensor & output contactor.
- 3Ph 415V AC, which is passing through Sine filter capacitors for filtering PWM Sine waveform to pure Sine waveform. After filtering, the output is connecting to output terminal through output contactor.
- ELD sensor is used to measure the earth leak current if any AC output live terminal touches to the body & to isolate the faulty section by tripping the contactor.
- Current transformer is used to feedback control, displays the output AC current and protects the inverter.
- The purpose of output contactor is to isolate the AC module from load when AC module fails.



#### **6.4.6.5 ACU DC Converter Module**

- DC converter takes supply form common DC-link of AC2 and converts DC link voltage to isolated and regulated 110Vdc output by controlling pulses of IGBTs by using DSP controller.
- DC converter consists of H-bridge converter, isolation transformer, rectifier and filter.
- DC converter shall also regulate output voltage to maintain current share at output.
- An IGBT based DC-DC Converter is controlled by using DSP. Output voltage and output current sensors are used for feedback control, display the parameters and protect the DC Converter.
- Temperature sensors are provided for sensing the heat sink temperatures of the IGBT modules and for protecting it.
- It communicates with AC-2 module through CAN Communication.

#### **6.4.6.6 ACU DC Converter Output Section**

- DC converter output section consists of DC output contactor, DC output reverse polarity sense & BN-bus voltage indication (for both forward & reverse direction).
- The output of DC converter is fed to BN (Battery Normal) loads, BD (Battery Direct) loads as well as battery charger.
- DC converter output is connected to BN bus terminals through DC output contactor. It is used to isolate the DC converter module from load when DC module fails and if any reverse connection at BN bus.
- Contactor driving, monitoring, DC output reverse polarity check is done by AC-2 master controller.
- Voltage indication card is used for visual indication of BN bus voltage availability & if any reverse connections on BN bus.

#### **6.4.6.7 ACU DC Link Voltage Indicators**

- Voltage indicators are used to indicate voltage availability at DC link of AC-1, AC-2 & input of DC converter module by visual to avoid touching the power modules while servicing.

#### **6.4.6.8 ACU Cooling System**

- Self-contained blower is used for air cooling of the auxiliary converter.
- This blower takes 3phase 415V ac supply from AC-2 inverter output.
- Blower will take supply from AC-1 inverter output if AC-2 inverter fails.
- This action will be done by using change over contactors based on feedback of other AC.

### 6.4.7 Battery Charging System

Battery Charging System (BCS) is a PWM based IGBT converter, which is getting supply from BN bus and charge the battery with constant voltage & constant current limit topology.

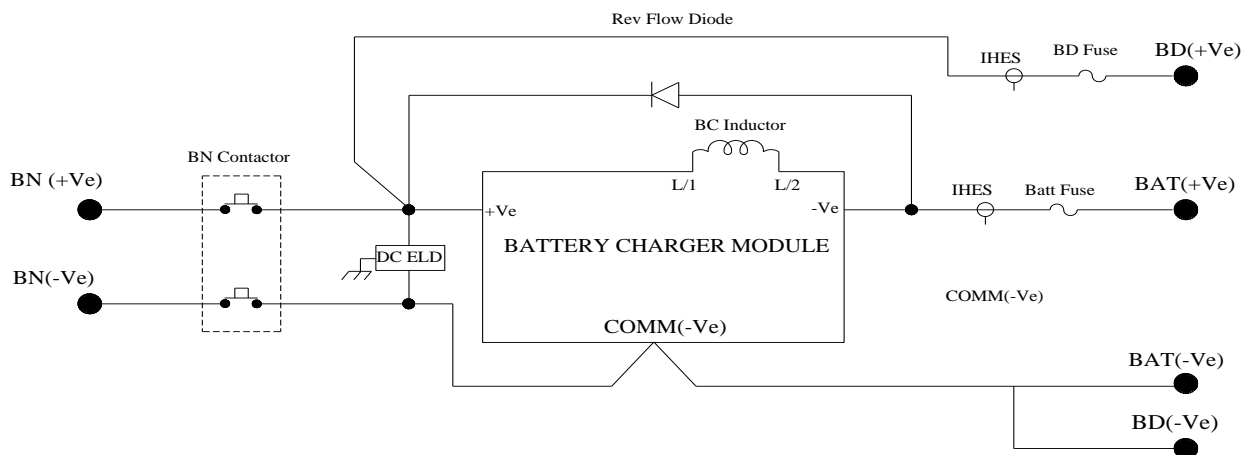


Fig6.0m: Block diagram of Battery Charging System



Fig6.0n: Battery Charger

**BCS consists of below sections:****BN Contactor:**

- ❖ BCS is having one contactor called BN contactor. It is used to isolate the BN bus from battery. BN contactor can be turned ON/OFF from driver cabin.

**Battery Charger:**

- ❖ Used to provide the 110Vdc supply for battery charging by taking supply from BN bus (115Vdc-130Vdc).

**Reverse Flow Diode:**

- ❖ It is used to provide the conductive path at the time of battery backup.

**Controller Section:**

- ❖ There is a controller used which is responsible for monitoring and protecting the complete battery charger and records the faults in the memory and also it interfaces to TCMS to get commands and to send status to display at driver cabin.

**Fuses Section:**

- ❖ Consists of battery fuse, BD fuse, battery charger input & output fuse. These are used to isolate the BCS from loads or source if any short circuit happens.

Battery charger unit is made natural cooled design.

**6.5 Auxiliary Loads**

Auxiliary systems in all coaches work on two different voltages- 415VAC 3-phase, 50Hz and 110VDC. Major equipment working with these power sources are as below-

**415V AC, 3 phase, 50Hz loads:**

<i>S.no</i>	<i>Load Name</i>	<i>Description</i>
1.	RMPU	Air conditioning unit for coaches. Cooling rating - 8TR
2.	CAB AC	Air Conditioning unit for driver cabin. Cooling rating - 2TR
3.	Main compressor	Main compressor for brake system. FAD – 920 lpm
4.	Traction converter cooling blower	Blower for cooling of traction converter unit
5.	Transformer radiator fan	Radiator fan for cooling of main transformer
6.	Transformer oil pump	Oil pump for cooling of main transformer
7.	Water pump for toilet tank	For water pumping for toilet tank

<i>S.no</i>	<i>Load Name</i>	<i>Description</i>
8.	230V supply for coach Wi-fi and TV	TV screen (4nos.) Wi-Fi control unit (1no.) Wi-Fi router (2nos.)
9.	Pantry appliances load at 230V	Microwave Oven (1no.) Hot case (1no.) Soup Warmer (1no.) Mini Refrigerator (1no.) Water Boiler (1no.)
10.	Toilet Loads at 230Vac	Per Toilet loads are as below- Hand drier (1no.) Shaver socket (1no.) Exhaust fan (1no.)
11.	110Vac sockets for Mobile & Laptop charging	110Vac single phase sockets in coaches for Mobile and Laptop charging.

**110 VDC Loads:**

<i>S.no</i>	<i>Load Name</i>	<i>Description</i>
1	Battery Charger	Battery charger is provided in Converter unit to charge the battery with C/10 rate.
2	Coach, Vestibules and Driver Cabin normal lights	Coach, Vestibules and Driver Cabin lights
3	Coach and Driver Cabin Emergency lights	Coach and Driver Cabin Emergency lights
4	Twin Beam/Auxiliary Head light, Marker Light, Tail Light, Flasher light, Cluster Light, Spot Lights, Passenger Alarm Indication Light, Electronic signal bell	Twin Beam/Auxiliary Head light, Marker Light, Tail Light, Flasher light, Cluster Light, Spot Lights, Passenger Alarm Indication Light, Electronic signal bell
5	Control Electronics Loads	PIS, CCTV, Relays, Contactors, Driver desk, Brake systems and all other control units.
6	Doors	Doors
7	Auxiliary compressor	Auxiliary compressor for Pantograph.
8	Emergency Ventilation Blowers	Emergency Ventilation Blower for coaches when RMPU is not working.
9	Toilet Loads at 110Vdc	Vacuum toilet Loads
10	Seat Lights	Seat Lights for reading

## **CHAPTER 7**

### **PASSENGER INFORMATION SYSTEM (PIS)**

#### **7.0 PASSENGER INFORMATION SYSTEM (PIS)**

- The passenger information system for train set (Train-18) provides required information to the passengers in a train throughout the journey in both visual and audio information.
- System has provision for public announcement where driver/guard can address all the passengers in the train, Inter Communication (IC) between driver and guard communication.
- The main aim of this system is to provide convenience to the passengers by providing the station information and other required information.
- The MMI (Man Machine Interface) and CCs (Coach Controller) in entire train are interfaced with CAN network.
- The MMI in the trailing coach will behave as Master based on direction of the journey and other MMI becomes Slave.
- The CC acts as local Master for each coach and interface with all the display boards.
- The leading and trailing coaches consist of Man Machine Interface (MMI) with GPS.
- Antenna, One Head Code, One Car Control (CC), Two SSD's, Two SDBDS, Two PECUs, Two ANM's, One cab loud speaker, Eight Saloon Speakers and One microphone.
- All other coaches other than leading and trailing coaches, will have one car control (CC) with built in audio amplifier unit, two single side displays, two ANM, two SDBDS, two PECUs and eleven loud speakers.
- Speaker of 6 watts R.M.S. rating of reputed make Ahuja is provided with 50% of sharing between coaches in case of single power amplifier failure; at least half of the speakers are still operative in the coach.
- Public address system is provided to enable communication between guard and passengers.
- Intercom is provided to enable communication between driver and guard.

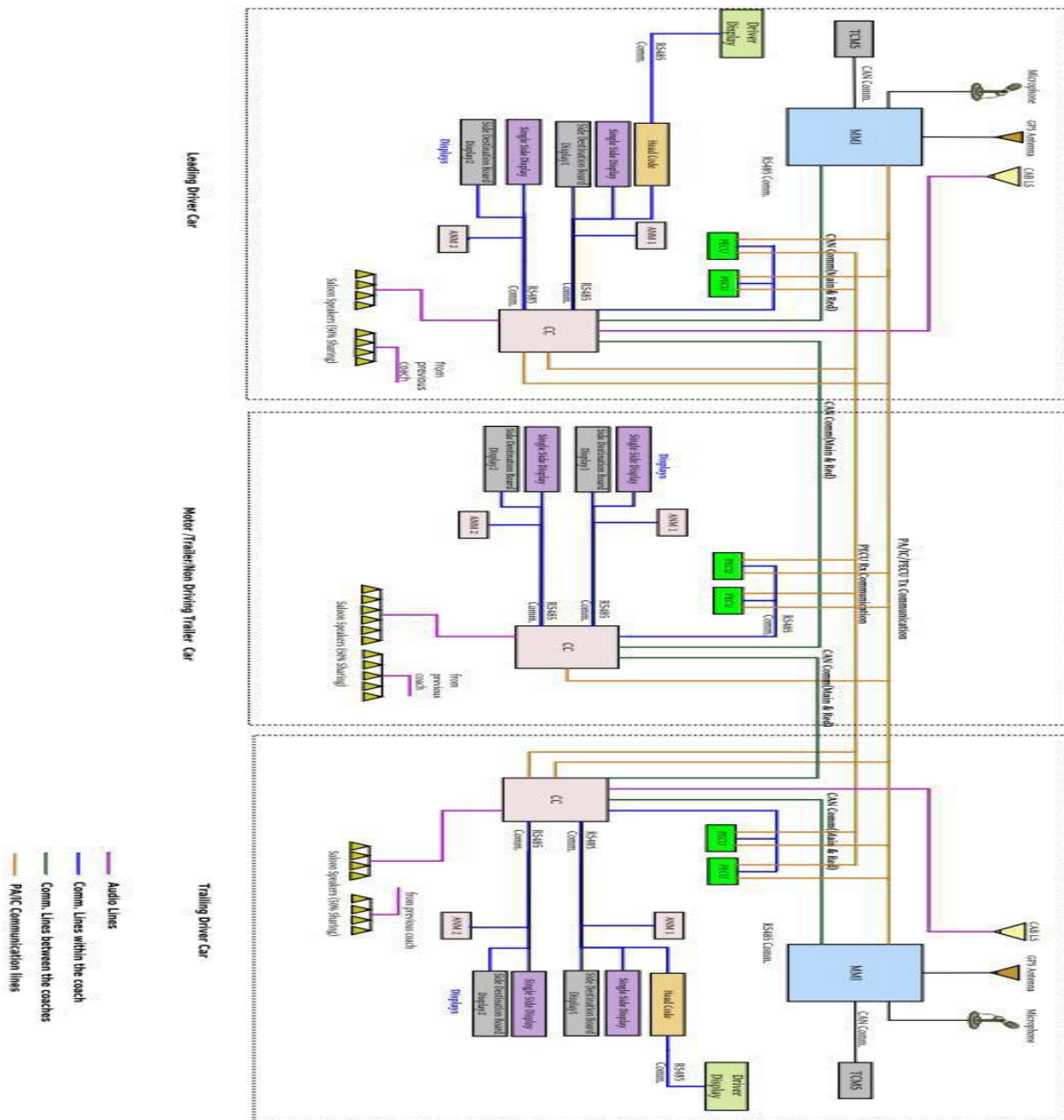


Fig7.0a: Block diagram of PIS

## 7.1 MAN MACHINE INTERFACE (MMI)

- Man machine interface is a user friendly module which has 20x4 Matrix LCD and 21 Keys keypad for displaying the menu screens and accepting the user inputs through keyboard.
- This module is mainly used for configuration and displaying the menu options, system status and route information to user (Driver/Guard).
- This module is mounted on the driver desk. User can also know the status of each sub system from MMI.
- User can enable the PA, IC, TR communication by using the keys provided on the keyboard of MMI module. It has three indications LED's (PA, IC, and TR) which will display the audio communication enable/ disable status.
- Complete PIS system can be configured using MMI Only.
- MMI has GPS interface to have real time GPS co-ordinates.
- MMI takes care of all operations such as train route simulation using GPS, fault diagnostic of the complete PIS system.
- Train route database of the PIS system is stored in MMI.



Fig7.0b: Man Machine Interface

## 7.2 CAR CONTROL UNIT (CC)

- Car controller is the main system to control and command all sub systems in that particular coach, it acts as local master for that coach.
- Upon receipt of train route selection from MMI, CC transfers the Fig: MMII Display required information to all displays, and then on receipt of station triggers from the MMI, CC will transfer the required display data to display and audio data to the speakers.
- All sub systems in a coach like head code display, single side display, side destination display board and ANM are connected through RS485 to car controller unit.
- It also monitors the health of all the sub systems which are under its control and exchanges the data with MMI for central data storage.
- Speakers are routed from CC in each coach by 50% audio sharing from next coach.
- Displays are routed using two RS485 channels in each coach. In case of failure in one channel also 50% displays will work in each coach.

- On the facia of CC unit LEDs are provided to indicate the health of the CC unit and CAN communication.



Fig7.0c: Car Control Unit (CC)

### 7.3 HEAD CODE DISPLAY (HCD)

The head code display comprises of LED boards. Head codes are provided at the front end of the driving coach (leading and trailing) above the lookout glass (LED Matrix size: 16x128.). It displays following:

1. Train no.
2. Name of destination station in English, Hind and Regional language
3. Type of service (Slow/Fast)
4. Handicap symbol along with coach location
5. Ladies special symbol along with coach no.

In case of communication failure between car control and head code, driver/guard can manually select the train route through driver display unit located in driver / guard cabin.



Fig7.0d: Head Code Display



## 7.4 IN-COACH DISPLAY UNIT (SINGLE SIDE DISPLAY)

- The in-coach display unit comprises of 16x144matrix multi-colour LED boards.
- ICD will display the route related information like present station and next station to the passengers throughout the journey.
- In addition to the route related data, the ICD will also display the safety messages upon receiving triggers from CC.



Fig7.0e: In-Coach Display unit

## 7.5 SIDE DESTINATION BOARD DISPLAY UNIT

- Side destination board display system is provided at each side of the coach.
- It displays information in two windows, in one window coach number and train number, in second window train name and source to destination, in English, Hindi and Regional language.
- LED Matrix size: 16x128.
- It will displays following:
  1. Train no
  2. Coach Number
  3. Train name
  4. Source to Destination.



Fig7.0f: Side Destination Board Display Unit

## 7.6 PASSENGER EMERGENCY COMMUNICATION UNIT (PECU)

- The purpose of passenger emergency communication unit is to provide the emergency communication between driver / guard to passengers.
- When a passenger emergency communication unit is operated by passenger, an indication will be given to the driver/guard of the location of the operated device.
- The driver/guard will acknowledge the PECU request which is showing on display screen of MMI thereby enabling bi-directional inter-communication between the driver and the passenger.



Fig7.0g: Passenger Emergency Communication Unit (PECU)

## 7.7 AMBIENT NOISE MEASUREMENT MODULE (ANM)

- ANM is basically a noise measurement module to adjust the announcements volume level in passenger area based on the surrounding noise with comprised microphone.
- It detects the background noise, measures the noise level and sends the same to CC.
- The CC will adjust the volume level based on the background noise received from ANM.
- It operates at 110V DC supply.



Fig7.0h: Ambient Noise Measurement Module

## 7.8 SALOON AND CAB LOUDSPEAKERS

- Speaker of 6 watts r.m.s. rating of reputed make Ahuja are provided.
- 50% of sharing is provided for the speakers between coaches in case of single power amplifier failure; at least half of the speakers will still operative in the coach.

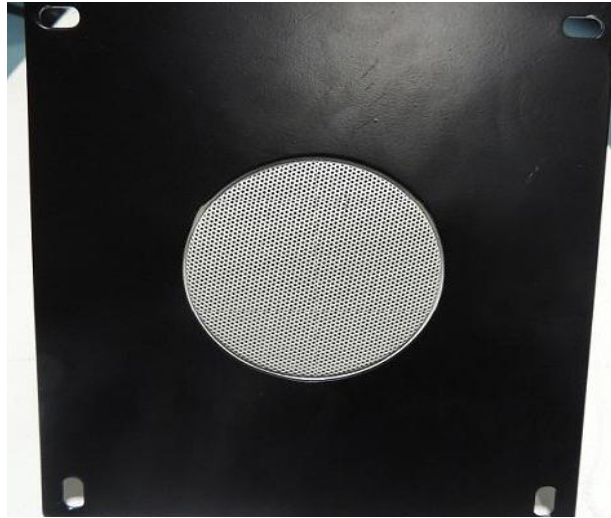


Fig7.0i: Saloon and Cab Loudspeakers

## 7.9 GPS ANTENNA

- A rugged GPS antenna with anti-theft protection of required cable length is provided for use on rail vehicles.
- This is located in the both driver desks to detect the GPS location and gives the information to MMI.

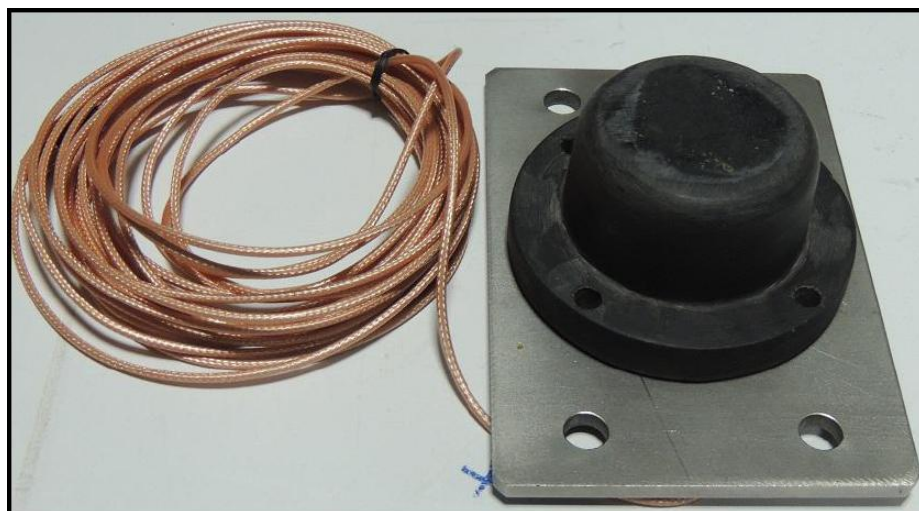


Fig7.0j: GPS Antenna

## CHAPTER 8 ELECTRICAL PANELS

### 8.1 CAB REAR WALL (CRW) PANEL

- One electrical cubicle is provided at rear side of driver cab in DTC.
- It houses all electrical & electronics components required for rake level control.
- The major equipments housed inside are mentioned below :
  1. CRW Panel
  2. CCU'S
  3. ERMS
  4. TPWS
  5. ECN Switches
  6. MCB's
  7. Relays &
  8. Contactors for various application.



Fig8.0a: Cab Rear Wall (CRW) Panel



### 8,3 MOTOR COACH (MC) EEC PANEL

- One electrical cubical is provided at driving end of MC cab.
- The major equipments housed inside MC ECC panel are mentioned below:
  1. MCU
  2. EBCU
  3. PIS Car Control Unit
  4. CCTV Ethernet Switches
  5. NVR
  6. MCB's, Relays & contactor for various applications.



Fig8.0c: Motor Coach (MC) EEC Panel

#### 8.4 TRAILER COACH (TC) ECC PANEL

One electrical cubical is provided at driving end of trailer coach. The major equipments housed inside TC ECC Panel are mentioned below:

1. EPCUS
2. EBCUS
3. PIS
4. CCTV Ethernet Switches
5. NVR
6. MCB's, Relays & contactor for various applications.

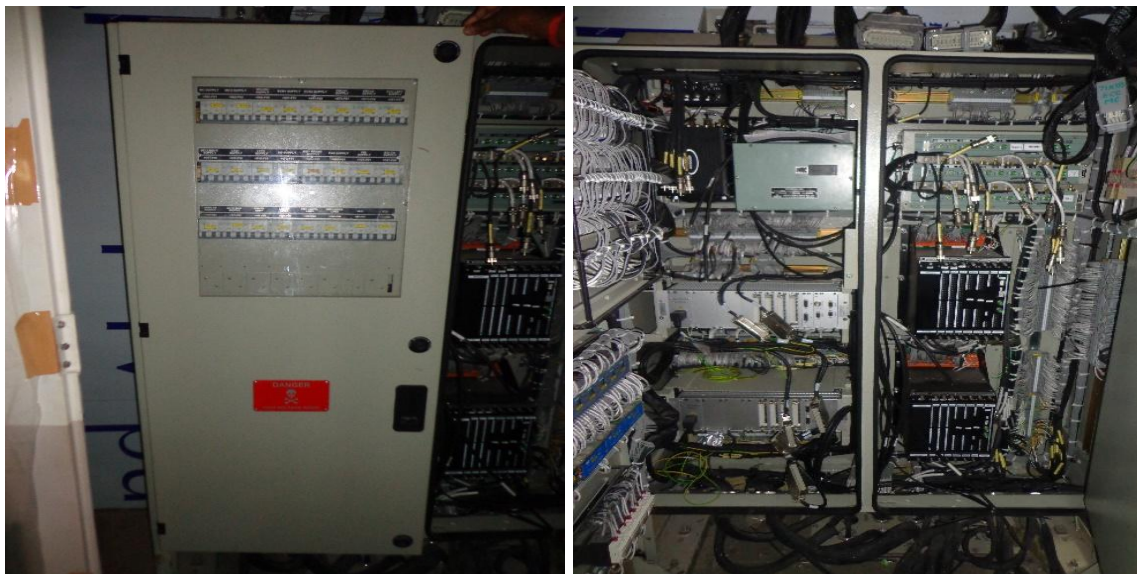


Fig8.0d: Trailer Coach (MC) EEC Panel

#### 8.5 NDTC ECC PANEL

One electrical cubical is provided at driving end of NDTC cab. The major equipments housed inside NDTC ECC Panel are mentioned below:

1. PCUs
2. EBCUs
3. PIS
4. CCTV Ethernet Switches
5. NVR
6. MCB's, Relays & contactor for various applications.

## 8.6 END WALL PANEL (EWP)

End wall panels are located at non driving end of NDTC, TC, MC, DTC & driving end of NDTC, TC, and MC. There are four types of EWP in each coach. They are EWP1, EWP2, EWP3 & EWP4.

The major equipment housed in EWP Panels are mentioned below:

- Terminal blocks & IV coupler plates
- Change over contactors
- Wi-Fi system, mono-block pump controller
- MCB's for passenger comforts like charging socket
- MCB, toilet MCB's, pantry MCB's etc.
- 

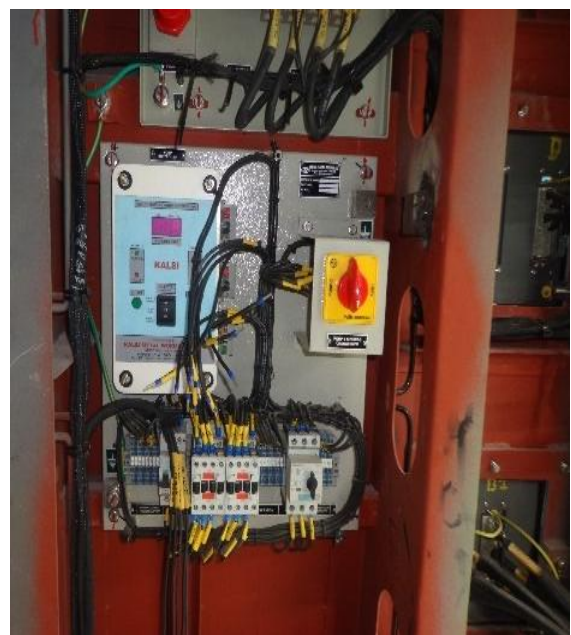


Fig8.0e: End Wall Panel



## **8.7 MAJOR FUNCTION OF TRAIN CONTROL & MANAGEMENT SYSTEM (TCMS)**

1. Interface to Drive Command
2. Pantograph Control - Panto 1 & 4 or Panto 2 & 3 work at a time
3. VCB Control
4. Traction Control
5. Regenerative Brake Control and total brake calculation
6. Brake Blending
7. Interface to RMPU control
8. Interface to Door control
9. Interface to Brake control
10. Compressor control - 4 compressor per rake,
11. Parking Brake control - from both driver and Guard cab
12. Light Control
13. Roll back Detection
14. Vigilance control (VCD)
15. Cruise Control (Speed Control)
16. Neutral Section Control
17. Test modes - to test input and output interface
18. Settings through DDU - Various indication on Driver Display
19. Event Recording
20. All train level protection - Important loops (EOL, EBL)
21. Load calculation
22. Air Bellow failure detection

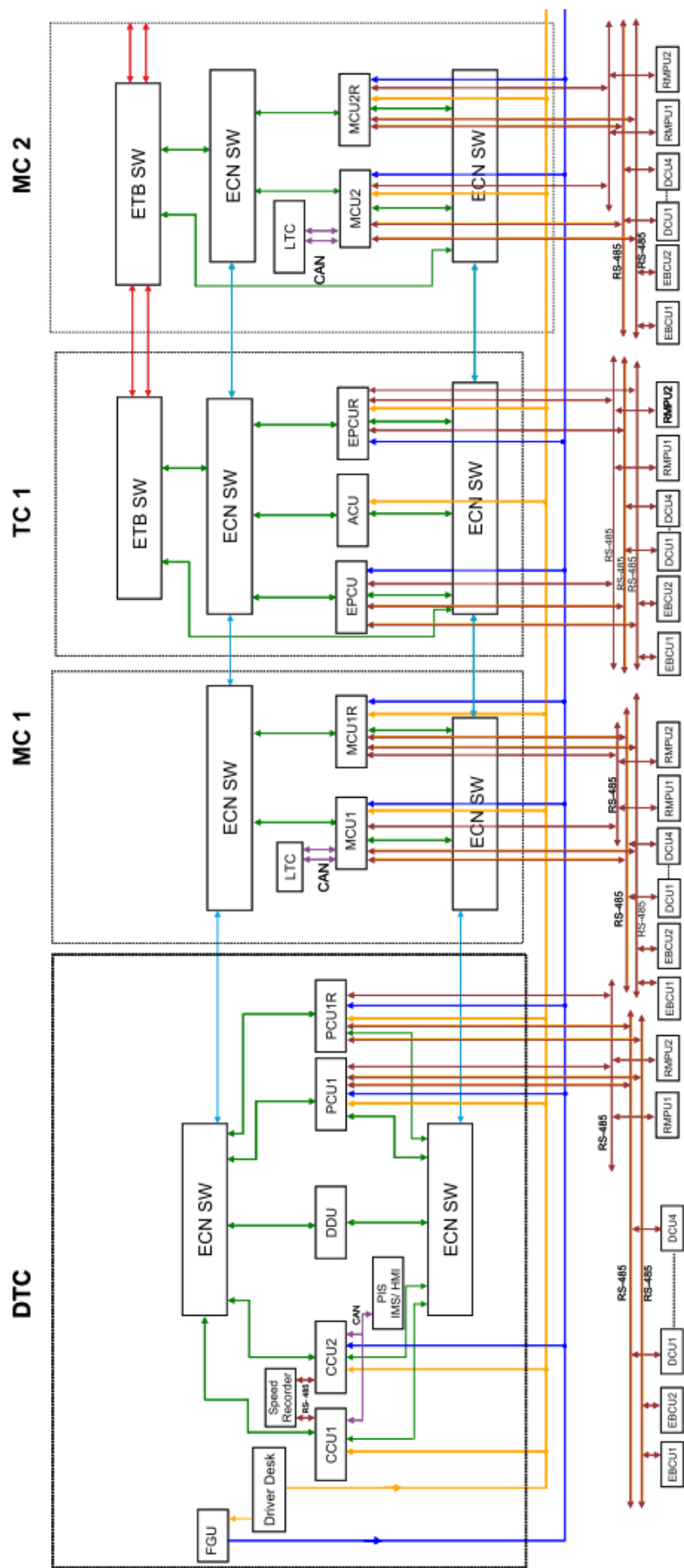


Fig-8.0f: End Basic Unit Architecture for TCMS

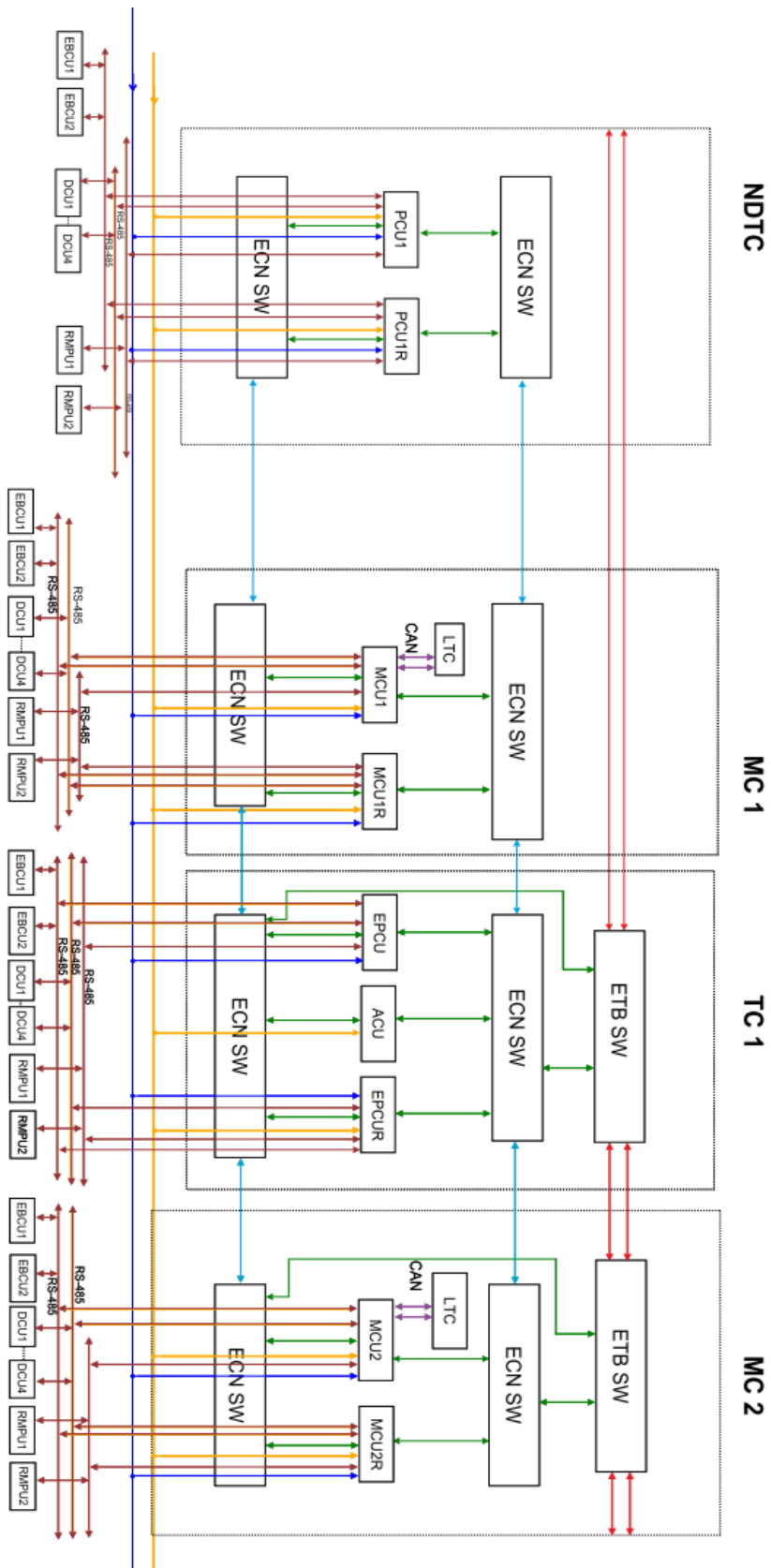


Fig8.0g Middle Basic Unit Architecture for TCMS

**ABBREVIATIONS**

<i>Abbreviation</i>	<i>Details</i>
AC	Alternating Current
ACU	Auxiliary Converter Unit
ADC	Analog to Digital Converter
AIP	Analog Input
ALC	Auxiliary Line converter Control
ANM	Ambient Noise Measurement
AOP	Analog Output
ATC	Auxiliary Traction Control
BCH	Brake Chopper
BCS	Battery Charging System
BD	Battery Direct
BE	Braking effort
BN	Battery Normal
BU	Basic Unit
CAN	Controlled Area Network
CCU	Coach/Car/ Control Unit
CRW	Cab Rear Wall
DC	Direct Current
DCLV	DC Link Voltage
DCS Key	Driver control Switch Key
DE	Driving End
DEMU	Diesel Electric Multiple Units
DIP	Digital Input
DMC	Data Management Computer
DOP	Digital Output
DPRAM	Dual Port Random Access Memory
DSP	Digital Signal Processor

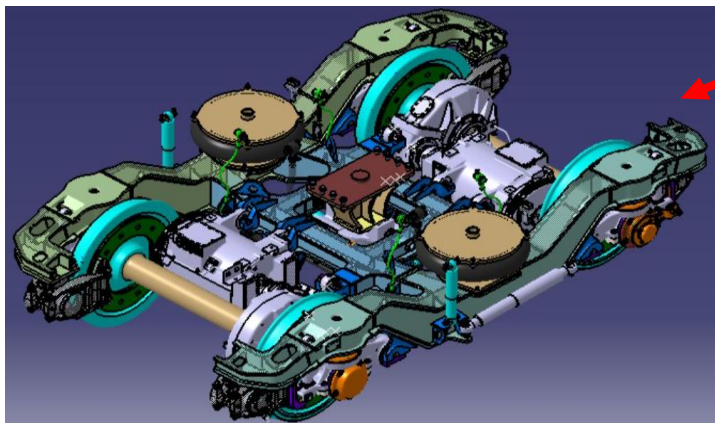
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<i>Abbreviation</i>	<i>Details</i>
DTC	Driving Trailer Coach
EBL	Emergency Brake Loop
EBU	End Basic Unit
ECN	Ethernet Consist Network
ED	Electro Dynamic
EEPROM	Electrically Erasable and Programmable Read Only Memory
ELD	Earth Leakage Detector
EMU	Electric Multiple Units
EOL	Emergency Off Loop
EP	Electro Pneumatic
ETB	Ethernet Train Backbone
EWP	End Wall Panel
FDP	Fault Data Pack
FQC	Four Quadrant Converter
GCRW	Guard Cab Rear Wall
GDPS	Gate Drive Power Supply
GPS	Global Positioning System
HCD	Head Code Display
HMM	Head code manual mode route selection Unit
HWTL	Hard Wired Train Line
IC	Inter Communication
ICD	In-Coach Display
ICF	Integral Coach Factory
IEC	International Electro technical Commission
IGBT	Integrated Gate Bipolar Transistor
IR	Indian Railways
IV	Inter Vehicular
LC	Line Converter
LCC	Line Converter Computer
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LIC	Line Inverter Computer

<i>Abbreviation</i>	<i>Details</i>
LTC	Line and Traction Converter
LTCU	Line & Traction Control Unit
LWS	Load weighing System
MAE	Medha AC-EMU
MBU	Middle Basic Unit
MC	Motor Coach
MCB	Miniature Circuit Breaker
MCH	Master Control Handle
MCU	Main Control Unit
MMI	Man Machine Interface
MSDPL	Medha Servo Drives Pvt. Ltd.
MU	Multiple Unit
MVB	Multifunction Vehicle Bus
NDE	Non Driving End
NDTC	Non Driving Trailer Coach
NVRAM	Non Volatile Random Access Memory
PA	Public announcement
PC	Personal Computer
PCC	Passenger comfort computer
<b>PCU</b>	<b>Passenger Control Unit</b>
PECU	Passenger Emergency Communication Unit
PIS	Passenger Information System
PLL	Phase Locked Loop
PS	Power Supply
PWM	Pulse Width Modulation
RAM	Random Access Memory
RDM	Rescue Drive Mode
RDSO	Research Design and Standards Organization
RMPU	Roof Mounted Packaged Unit

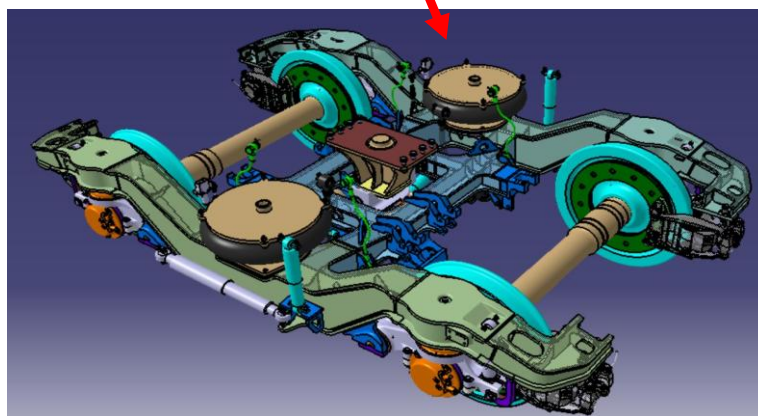
<i>Abbreviation</i>	<i>Details</i>
RMS	Remote Monitoring System
RPM	Revolution per Minute
SRAM	Static Random Access Memory
SSD	Single Side Display
TC	Trailer Coach
TCMS	Train Control & Management System
TCN	Train communication network
TE	Tractive Effort
TFT	Thin Film Transistor
THD	Total Harmonic Distortion
TI	Traction Inverter
TIC	Traction Inverter
TIC	Traction Inverter Computer
TM	Traction Motor
TSA	TRAKTIONS System Austria
UIC	International Union of Railways
UPF	Unity Power Factor
USB	Universal Serial Bus
VCB	Vacuum Circuit Breaker
VVVF	Variable Voltage Variable Frequency
WTB	Wire train bus

## Train-18 bogie



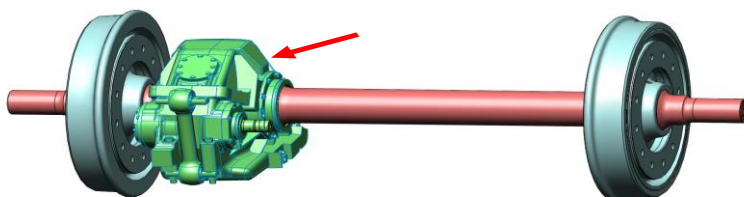
Motor bogie

Trailer bogie



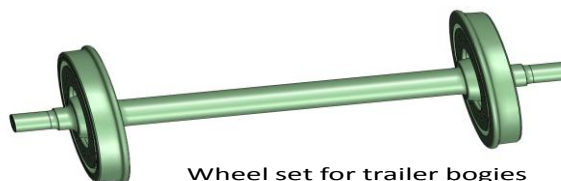
- Common bogie frame & suspension elements.
- Wheel sets are different.

## Wheel & axle



Gear box mounted for Motor bogie

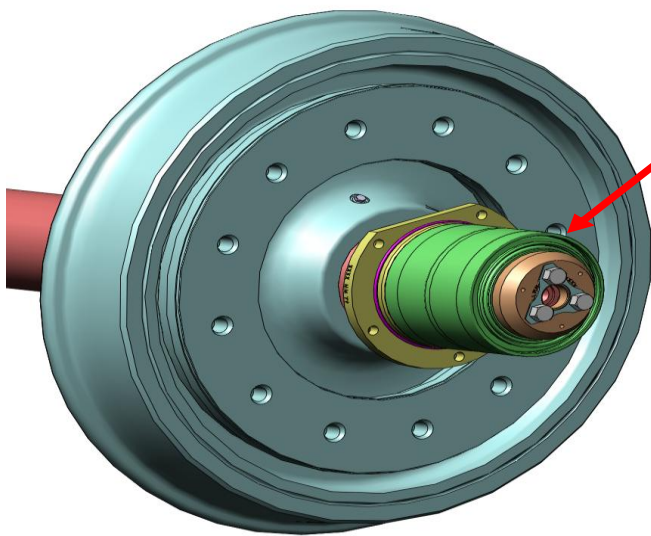
- Wheels with straight webs to fix brake disc.
- New wheel dia 952, wornout dia 877 – common for all bogies.
- Supplier – M/s Bonatrans.



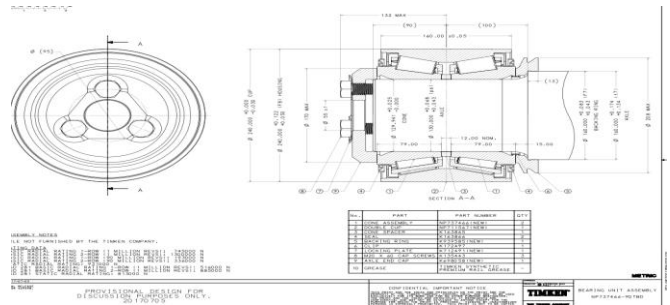
Wheel set for trailer bogies



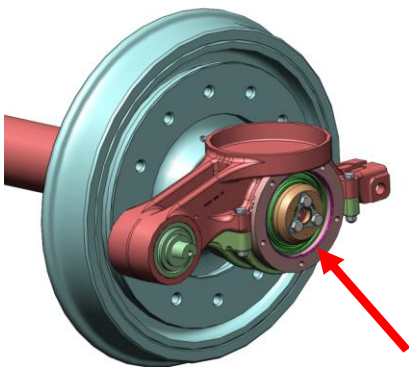
# CTRB



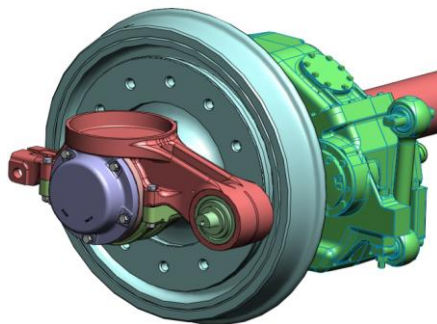
- 130mm dia CTRB.
- Supplier – M/s Timken.



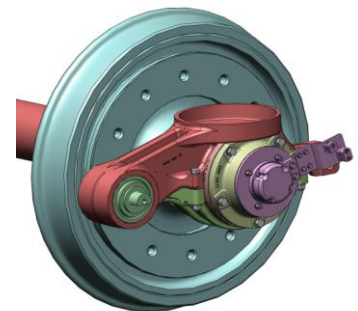
## Axle end equipments



Plain cover

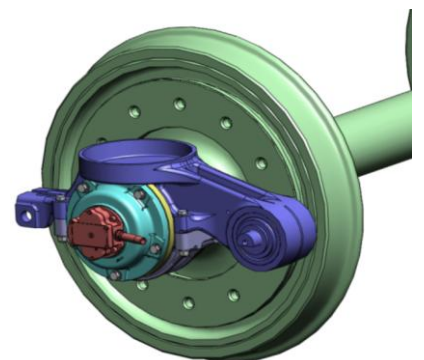


Phonic wheel sensor



Axle earthing - ERCU

➤ Different types of front covers

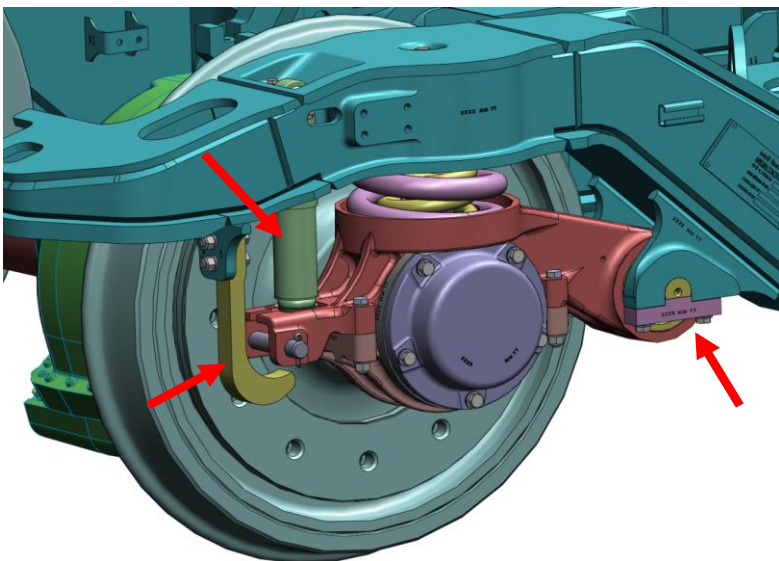


Tacho generator

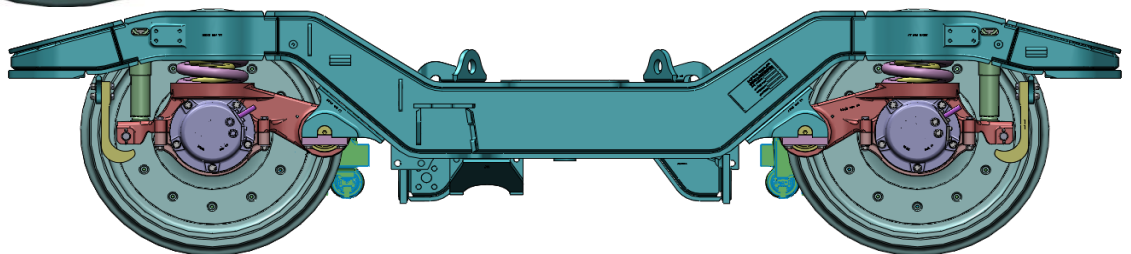
## Primary suspension



- Inner & outer springs.
- Rubber metal bonded items – Bump stop, primary spring pad – supplier M/s GMT.
- Bogie frame lowered on wheel sets with springs.

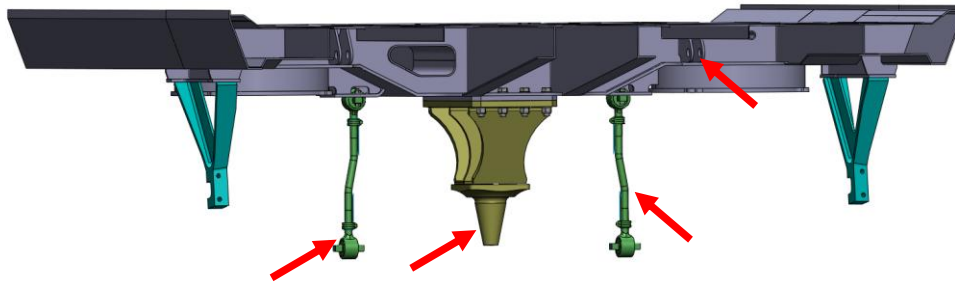


- Primary vertical damper – M/s ZF.
- Control arm locked with frame.
- Lift stop & pins.

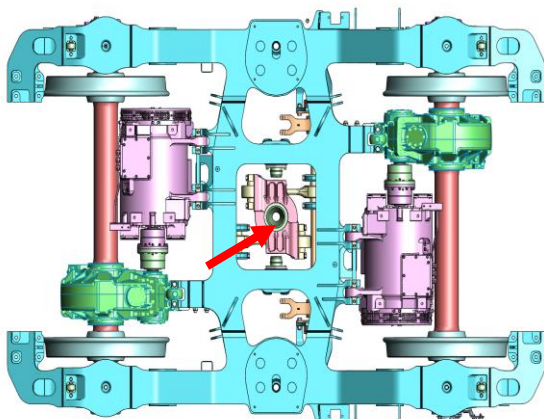




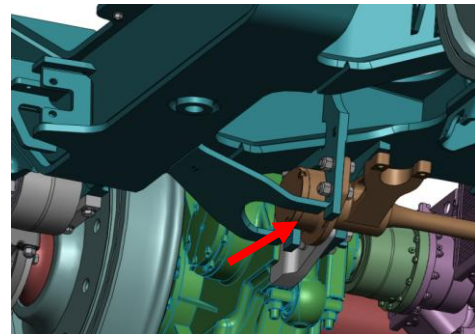
# Components fixed to car body



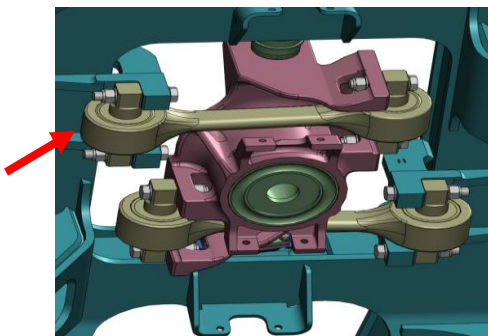
- CP pin.
- Stabiliser link.
- Wire rope.



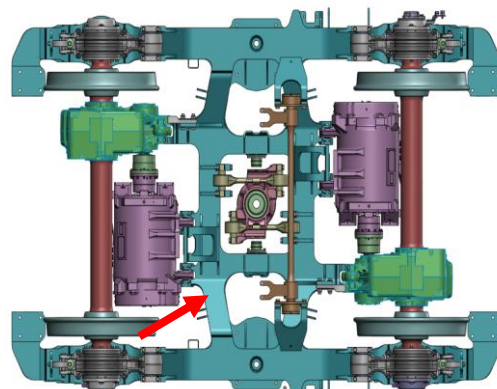
Top view



Stabiliser assembly

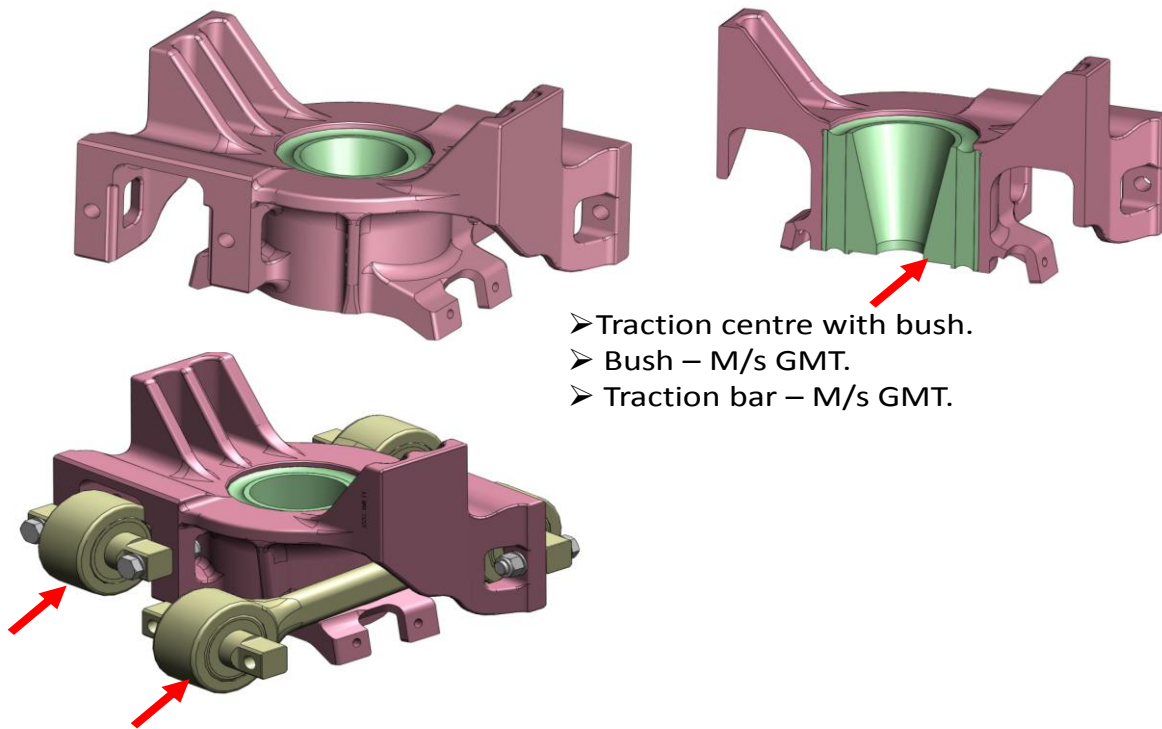


Traction centre, traction bar assembly



Bottom view

# Secondary suspension components





 **NOTE** 