BOMBARDIER ZEFIRO

High-speed Trains for 200 to 350 km/h

Product Description Summary

The *Bombardier ZEFIRO* new family of high-speed trains was designed using proven components and technologies from around the world and are suited for operation on electrified high-speed lines worldwide. Compared with today's existing or under development trains for similar applications, the main advantages of *ZEFIRO* are:

- High seating capacity, and
- Unmatched flexibility of applications:
    - Speed range from 200 to 350 km/h
    - Train length from 100 to 400 m
    - From 1 to 4 power supply systems (1,5 & 3 kV DC, 15 & 25 kV AC)
    - Carbody in UIC or wide-body profile
    - Customised front-end design and interior layouts.

ZEFIRO is interoperable across national borders, with different power supply systems and different signalling and train control equipment.

ZEFIRO was designed keeping systematically in mind the economics of high-speed rail and, as such, it can maximise revenue generation for the train operator, because of

- its high capacity,
- its low operational cost, and
- the versatility of its utilisation in different countries and at different speeds.

Layout and Dimensions (applicable to all configurations)

Length (over coupler face)	from 100 m (4 car EMU) to 400 m (16-cars EMU)
Length end cars (over coupler face)	26 390 mm
Length intermediate cars (over coupler face)	24 775 mm
Bogie center distance	17 375 mm
Floor height (passenger area)	1 250 mm t.o.r
Entrance floor	1 250 mm t.o.r
Roof height from top of rail, new wheels	3 890 mm
Carbody width	2 900 mm or 3 400 mm
Pantograph working height	5 300-6 500 mm t.o.r.
External doors:Opening width	900 mm, 2 per car and side
Opening height	2 000 mm
Windows & interiors pitch	1 900 mm
Height of automatic coupler	880 mm t o r
Wheel diameter new/worn	915/835 mm

General Performance Data

Example: VHS EMU for 250 or >300 km/h, for 25 kV AC and wide carbody profile

	ZEFIRO **250**	*ZEFIRO* **300+**
Maximum operating speed	250 km/h	300 km/h
Maximum test speed	300 km/h	350 km/h
Design life	25 years	
Maximum stopping distance from 250 km/h at maximum load & on levelled grade track	<3 000 m	
Maximum stopping distance from 160 km/h at maximum load & on levelled grade track	<1 400 m	
Acceleration at start with full load	0.57 m/s^2 (up to 50 km/h)	
Residual acceleration at max operating speed	≥ 0.07 m/s^2	≥ 0.06 m/s^2
Service brake	0.6 m/s^2 250 km/h – 200 km/h	0.6 m/s^2 300 km/h – 200 km/h
	0.8 m/s^2 200 km/h – 0 km/h	
Parking brake	ensure stopping of a maximum normal weighted train on 30 ‰ gradient.	
Maximum power:	6 150 kW	8 200 kW
Voltage/frequency nom.	25 kV-50 Hz	
	min. 17.5 Kv	
	Max 30 kV, continuous	
	max. 31 kV, transient <1s	
Short circuit current	25 kA, 100 ms	
Capacity of the main circuit breaker	20 kA, 100 ms	
Multiple operation	Up to 16 cars (2×8-cars)	
Traction System	AC 1 phase / DC / AC 3 phases	
Auxiliary power supply		
Internal	3x 400V 50 Hz	
External	3x 380V 50 Hz	
Battery system	110 V DC, nominal	
Computer system	Distributed system	
Brake system	EP-direct (disc brakes) and electrodynamics	
Couplers	automatic coupling within 3 min	

Operating Conditions and Environment

Example: VHS EMU for 250 or >300 km/h, for 25 kV AC and wide carbody profile

Track System	
Track gauge	1 435 mm
Rail inclination	1/40
Minimum curve radius:	
Vertical curve	900 m concave, 600 m convex
Horizontal curve, train	150 m
Horizontal curve, single car shunting	120 m
Reverse curves	R1=190 m / 0 m straight / R2=190 m
	R1=150 m / 6 m straight / R2=150 m
Distance between lines	4.2 m
Maximum gradient:	30 ‰
Platforms	
Distance from track centreline to platform	1 750 mm
Platform height	1 250 mm
Catenary and current collection	
Height of contact wire	5 300-6 500 mm t o r
Contact wire tension	15-25 kN
Profile	
Static profile	National standards of the People's Republic of China rolling stock gauge for standard gauge railways, GB 146.1-83 and KCRC
Dynamic profile	The Interim Provisions on Clearance of Locomotive and Rolling Stocks Run on Dedicated Passenger Line
Power supply	
From catenary: (Voltage / Frequency)	
Nominal	25 kV-50 Hz
Minimum	17.5 kV
Maximum	31 kV
From stationary point	3x 380 V, 50 Hz
Signalling & communication	
ATP	Chinese standard
Train radio	Chinese standard
Climate and Environment	
Ambient temperature: min / max	-40°C/ +40°C
Humidity	95% at 25°C
Side wind velocity	15 m/s ordinary / 30 m/s occasionally
Maximum altitude	1 500 m from the sea level.

General Train Description

The train is built up using three types of cars:

Motorized end cars (**Mc**)

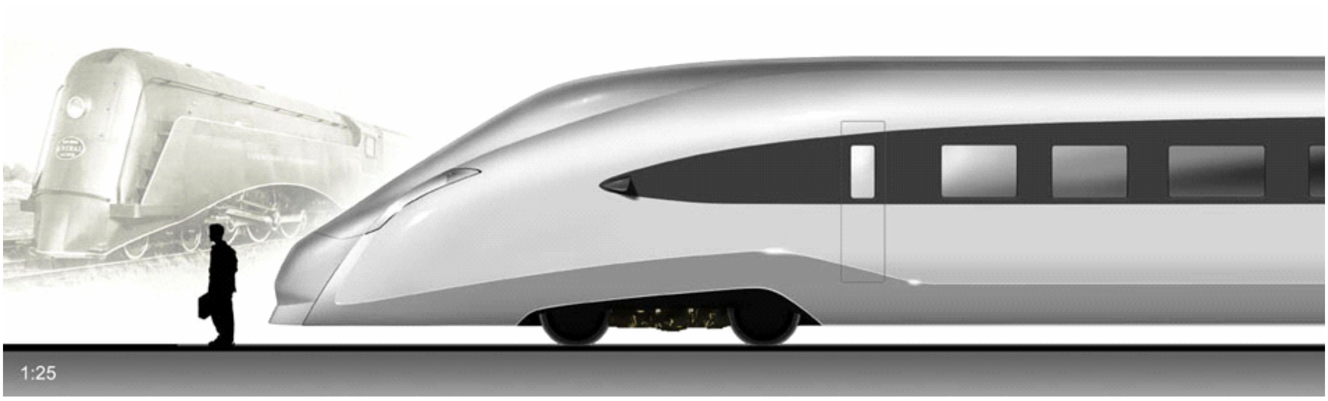
Intermediate trailer cars with pantograph (**Tp**) & without pantograph (**T**)

Intermediate motorized cars (**M**)

These cars are combined to create two train base units, as follows:

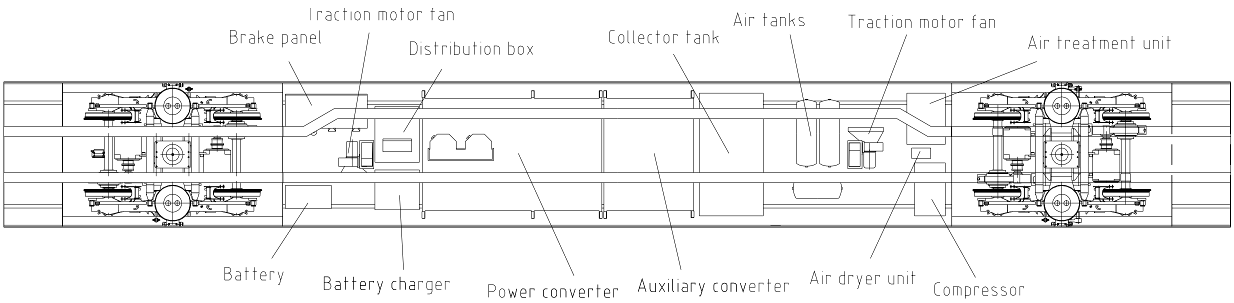
	Version for 250 km/h :	Version for 300 km/h
Train unit 1:	Mc1- Tp1-T1-M1	
Train unit 2:	Mc2-Tp2-T2-T3	Mc2-Tp2-T2-M2

Two base units form a fixed 8-cars train set.

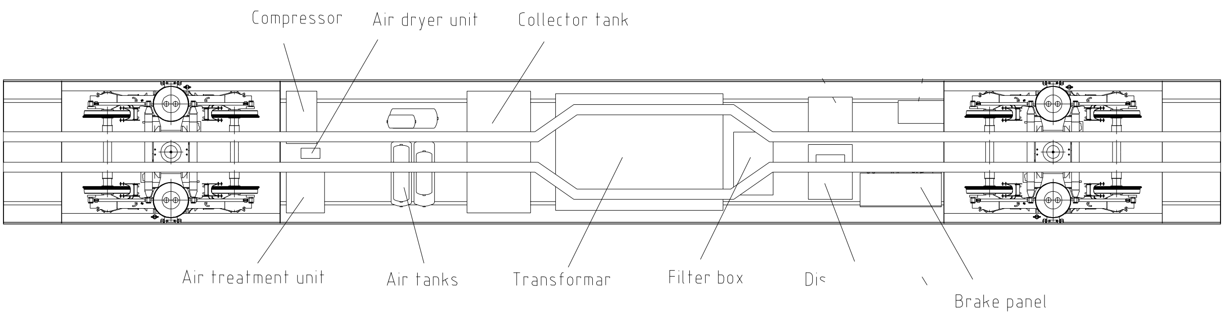


Each train base unit has its own complete system for propulsion, 400 V AC auxiliary supply and 110V battery supply.

The high voltage supply is connected between the train base units; one pantograph at a time feeds all the main transformers in an *ZEFIRO* EMU.



The Mc and the M cars have the same electrical system structure and equipment except for the additional equipment in the end car for the driver’s cab and ATP antennas. All four axles are driven in the motorized cars.



The Tp cars contain the high voltage equipment.

Carbody

Fully welded tube body structure with underframe, sidewalls, roof, cab structure, rear walls and welded brackets for inner and outer equipment.

There are three types of carbodies:

- **Mc**-carbody: Carbody with front structure in one end and preparation for power bogies.
- **T**- & **Tp**-carbody: Intermediate trailer carbodies.
- **M**-carbody: Intermediate carbody prepared for power-bogies.

The carbodies are be designed in accordance with the principles for lightweight design of body shells as far as is covered by the scope of supply and permitted by the customer requirements.

The sidewall are smooth with no protruding elements.

The carbodies are designed to offer an open tube throughout the whole carbody length, which can be utilised for different interior solutions

Driver's cab

There is one Driver's cab at each end of the *ZEFIRO* EMU. The front cab is in control while the inactive cab can be used as a crew cabin. The driver's environment is developed with focus on a good working environment and safety.

To reach the Driver's cab from the passenger compartment, a key shall be required to open the door. From the inside of the cab the door can be opened by a handle to give a quick evacuation in an emergency situation.

The cab is equipped with a rear view video camera system on each side. The video camera of each side shall be connected to one screen placed at the corresponding side of the driver desk.

The front window is heated by an electrical wire. The maximum heat output is 7 W/dm^2. The front window is designed for resisting impact from objects. The resistance of the front window complies with the standard TB 20.100 ed.2 (French standard).

The front has a sculptured shape that forms a balanced termination off the remaining uniform train profile. All parts of the front are well integrated and easy exchangeable for maintenance and repair. The side windows form continuity along the side of the train and thereby accentuate direction and dynamics. All windows and doors are mounted in level with the connecting carbody and the doors are given strong visual lines.

- **Side wind stability:**

  The train withstands cross winds up to 25 m/s above track at 250 km/h curving with the lateral track plane acceleration of 0.72 m/s^2 (110 mm cant deficiency) loaded according to service weight

- **Pressure pulses:**

  The body shell sustains, from a structural fatigue point of view, the aerodynamic load collective of a lifetime in revenue services, caused by pressure pulses during operation. A high degree of air tightness suitable for the high train speed ensures the comfort of the passengers in case of air pressure variation due to the running of the train in tunnels. For a single train passing through an 80 m^2 tunnel at 250 km/h the maximum pressure variation for any 4 seconds time interval will be less than 800 Pa. The air tightness will be ensured by the use of continuous welded aluminium profile car body structure, as well as careful selection of solutions and requirements for the systems making up the pressure tight shell, e.g. ventilation intakes and exhausts, doors, windows, toilets and gangways.

- **Static pressure distribution (air inlets and outlets)**

  Air inlets for HVAC compartment ventilation are placed above window level. Else, appropriate actions to prevent suction of snow, water and dust particles are required to prevent the airflow of inlets from being obstructed.

Gangways

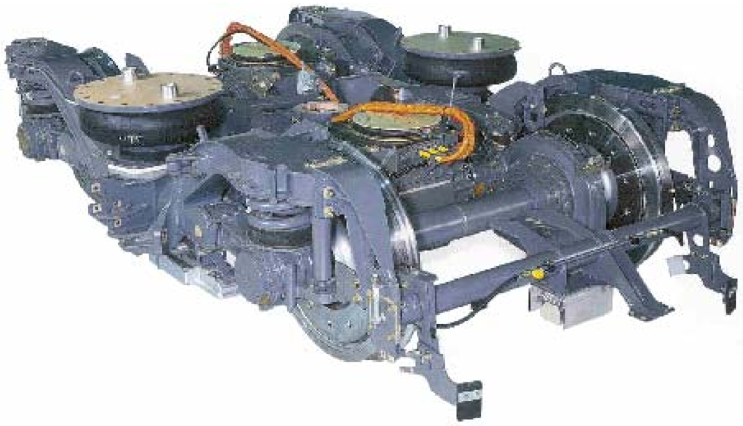
The gangways are designed as an end-to-end, over coupler gangway, with possibility to get support in the middle from the semi-permanent coupler.

The gangway is sealed from snow and water. The gangway is designed to reduce the external noise in the passage between the cars.

External length of gangway	800 mm
Height of gangway passage	2 000 mm
Width of gangway passage	1 100 mm

Bogies and Running Gear

The bogies are designed using standard components and equipment interfaces wherever possible and utilise existing body-bogie interfaces.



There are two main bogie types:

Power bogie – two traction motor driven axles, four wheel mounted cheek brake discs with inlaying brake units .

Trailer bogie – six axle mounted brake discs (three per axle) with inlaying brake units.

Technical Data:

Wheel base	2 500 mm
Wheel diameter	915 mm
Axle	UIC A4T
Brakes:	
Power bogie	Wheel disc
Trailer bogie	Axle mounted discs

Bogie construction

The H-shaped bogie frames are weight optimised and made from steel S355J2G3 in accordance with EN 10025.

The bogie frames are designed in accordance with UIC 515-4 for the trailer bogies and UIC 615-4 for the motorized bogies. The structural integrity and fatigue life is verified with FEM-calculations and a fatigue test.

The wheelsets are equipped with solid Monobloc wheels. The wheels have holes for hydraulic disassembly. They are made in accordance with UIC 812. The wheel profile ORE S1002 for a rail inclination of 1:40 is preferred. Different wheel profiles are possible in negotiation with Bombardier Transportation.

The axles are hollow axles. They are designed in accordance with EN 13103 for the trailer axles and EN 13104 for the motorized axles. Manufacturing tests in accordance with UIC 811 will be undertaken. The material for the axles is A4T.

The primary suspension cosists of a steel coil spring between bogie frame and axle box. An additional rubber metal spring between bogie frame and steel coil spring provides the acoustic isolation of the primary suspension. A swing arm with an elastic rubber bush is used for the axle guidance.

The carbody is suspended with two air springs at the bogie frame. In case of failure of the air springs, integrated emergency springs with rubber metal elements ensure continued safe running. To provide a high level of riding comfort auxiliary air tanks with a minimum volume of approximately 90 l per air spring are necessary. This volume is located inside the bolster above the air springs. Levelling valves between carbody and bogie ensure a level adjustment for different loading conditions.

The lateral movements of the bogie, after a free play, are restricted by a rubber bump stop with a progressive characteristic. To ensure the maximum allowed roll coefficient the bogies are equipped with two anti roll bar systems. These systems comprise a frame mounted torsion bar connected with two vertical rods to the carbody.

Traction and brake forces are transmitted between the car body and bogie bolster by a central pivot. Ride stabilization (yaw damping) is realized by friction pad bearings which are located between the bogie bolster and the car body.

Four linking rods transmit the traction and braking forces between the bogie bolster and the bogie frame. In order to avoid the transmission of longitudinal oscillations form the bogie frame to the car body the two linking rods are connected to a torsion bar which is elastically suspended to the bogie bolster.

The motorized bogies are equipped with 4 wheel disc brake units and the trailer bogies are equipped with 6 axle disc brake units. Two brake units at the trailer bogies are designed as park brake units. The brake pads are made from asbestos free material. They can be changed in an easy way beyond the vehicle.

Power Supply

Line Voltage System

The roof mounted high voltage system's prime function is to power the main transformer. It also protects the propulsion system from and filters out unwanted irregularities in the supply voltage.

Line Circuit Breaker and Earth Switch: The electrically operated line circuit breaker is of vacuum type and feature a high breaking capability and internal over current protection. The internal closing mechanism is operated using compressed air.

Surge Arrestor: The roof-mounted equipment shall be protected from transient over voltages by the surge arrestor. It features very high-energy input capacity, high-energy absorption capability and large protection distance. The surge arrestor shall be maintenance-free. The active part of surge arrestor is made of the zinc-oxide type with no internal air gap, and the housing is made of silicon rubber.

Main Transformer

The task of the main transformer is to transform the catenary voltage to a voltage level suitable for supplying the propulsion and auxiliary power supply systems. The high voltage primary winding and the secondary windings are galvanically separated.

The main transformer is designed to minimize the effect of inrush current. It is cooled by its own cooling system. Power losses are absorbed by ester or mineral oil coolant, circulating inside the main transformer also acting as electrical insulation. The coolant is circulated through an oil/air heat exchanger to release the heat before returning to the transformer housing.

Line Harmonic Filter

A line harmonic filter is used to counteract the resonance caused by background noise, generating interfering currents at the catenary-transformer resonance frequency. The filter shall also ensure electrical compatibility with other vehicles on the line. The line harmonic filter is connected to a secondary winding of the main transformer. The line harmonics filter components, except for the resistor, are placed in the box together with the control equipment for the main transformer. The line harmonic filter resistor is mounted separately on the roof.

Battery System

The task of the battery system is to generate and distribute a 110 V DC uninterrupted power supply voltage to all battery loads in the train base unit and to charge the batteries. The system is supplied from the three-phase auxiliary system.

The electrical battery systems comprises the following functions and protection of these.

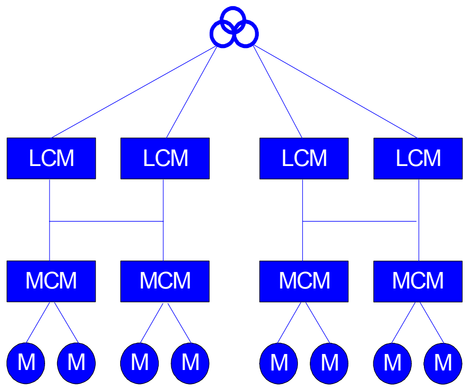
Battery systems, including distribution groups extending to connection points for distributed loads in the trains (for control system, lightning, emergency ventilation).

There are two battery chargers and two batteries in each train base unit. They are connected to a battery bus.

Propulsion

The main task of the propulsion system is to convert the main transformer output power into traction power at the wheels of *ZEFIRO* train. This conversion is done in several steps.

- The line converter module (LCM) converts the main transformer secondary side AC voltage to a stable DC-link voltage.
- The DC-link supplies the motor converter module (MCM)
- The MCM converts the DC-link voltage to a variable voltage, variable frequency (VVVF) supply for the traction motors.



The propulsion system is protected against permanent damage in case of over voltage, over current, earth fault and high temperature. The converters are short circuit proof; i.e. a direct short circuit on the output terminals shall not cause any damage to the converter.

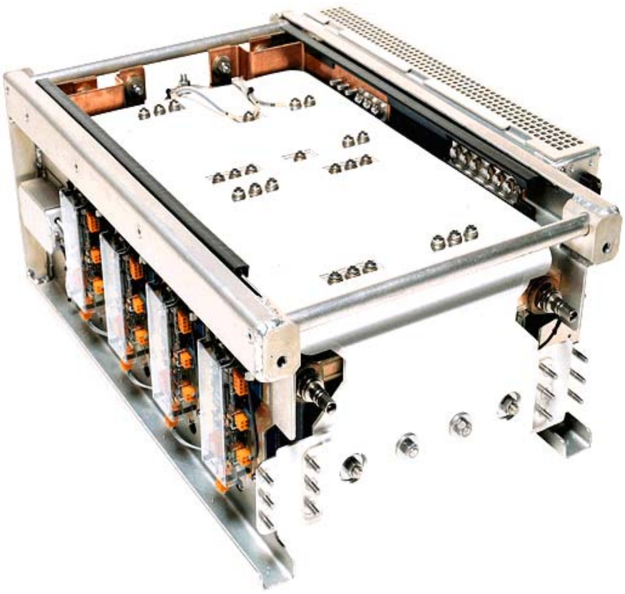
Charging Circuit

The task of the charging circuit is to connect the main transformer to the line converter module (LCM) in a controlled way and to be able to isolate a defective propulsion system.

When activating a propulsion system, the charging contactor shall first connect the line converter to the main transformer through the charging resistor, which limits the initial current charging the DC-link.

Line Converter Module

The task of the line converter module (LCM) is to convert the main transformer secondary side AC voltage to a stable DC-link voltage, thus feeding the energy from the catenary to the DC-link. It shall also be possible to feed the energy in the opposite direction, from the DC-link back into the catenary. This is used during electro-dynamic braking.



The power conversion utilizes IGBT's with microprocessor based control logic. Two line circuits form the four-quadrant line converter module. The AC side of each line circuit is connected to a main transformer secondary winding. On the DC side, the two line circuits are connected in parallel to the DC-link. The main transformer secondary voltage and phase angle is controlled in relation to the line voltage, i.e., both active and reactive power between the catenary and the train are controlled and the power factor at the pantograph is kept very close to 1.0.

A line converter module consists of four identical phases, where two phases form a line circuit. Each phase has an upper and a lower IGBT, each of high voltage/high current type. Paralleling of IGBT's shall be avoided.

The IGBT’s work as switches and are switched on and off by their respective Gate Drive Units (GDU). In this way, the IGBT’s connect the polarity of main transformer secondary side AC voltage to the DC+ and DC- terminals of the DC-link alternately.

DC-Link

The task of the DC-link is to stabilize the line converter output voltage, providing a power source for the converter modules connected to the DC-link. The DC-link is made up of parallel-connected capacitors, one part in each line- and motor converter module and one part in the 2nd harmonic link.

Second Harmonic Link

The task of the second harmonic link is to reduce the DC-link voltage ripple caused by pulsating power at 100 Hz from the line and from the LCM. The voltage ripple may otherwise induce torque ripple in the traction motors.

The second harmonic link is a serial resonance link with the same 100 Hz frequency as the second harmonic of the line voltage frequency.

Mid Point Earthing and Earth Fault Indication

The task of the mid point earthing is to connect the DC-link symmetrically to earth, which means that DC+ and DC- in the DC-link have defined voltage potentials of half the DC-link voltage respectively to earth. Mid point earthing provides the converters, main transformer and traction motors with the lowest possible voltage to earth.

Motor Converter Module

The task of the motor converter module (MCM) is to convert the DC-link voltage to a three-phase Variable Voltage and Variable Frequency (VVVF) to the traction motors. The power conversion utilizes IGBT's with microprocessor based control logic. As with the LCM, the MCM contains four IGBT phases. In the MCM, three of these are used for the converter, while the last IGBT phase is used as an over voltage chopper.

The MCM feeds the traction motors with variable voltage and variable frequency, VVVF. During electro-dynamic braking the power is taken from the motors (operating as generators) and fed back to the line via the LCM. In case of line voltage loss, such as when passing a neutral section, the MCM shall maintain the DC-link voltage by applying a low level of electro-dynamic braking. In this way the traction motors will maintain their magnetization, improving the reaction time of the propulsion system and also the ACM will be able to operate and maintain the auxiliary supply voltages.

The three converter phases are controlled using space vector modulation. In order to increase the output power above base speed of the traction motor, square wave modulation is used. The switching frequency of the converter is adjusted to avoid safety critical frequencies for the signal system.

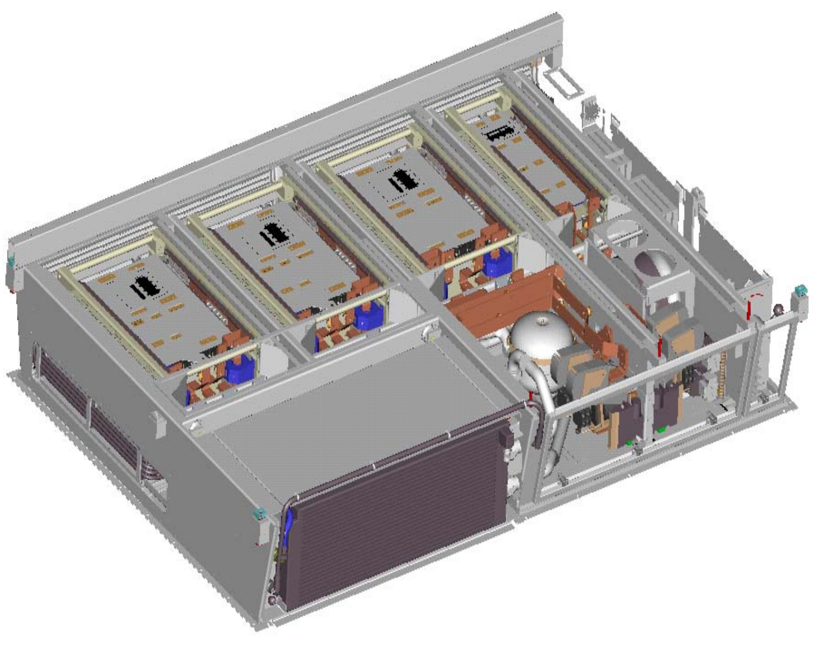
The converter uses switching frequencies in range 500 Hz -1 kHz, to enable the output three-phase power of the converter to be a low ripple sinusoidal current, minimizing energy losses and torque ripple in the traction motors. The DC-link capacitors and the IGBT-modules are connected by multi-layer bus bars, providing a low inductive conductor, eliminating the need for snubber components.

The over voltage chopper acts as an over voltage protection function (OVP) to suppress high DC-link voltages. It isalso used to discharge the DC-link when the converter is shut down.

The control of the MCM is done in the microprocessor based drive control unit.

Converter Box

The converter modules (LCM, MCM and ACM) are placed in the converter box, made of aluminium. The box shall offer a sealing class IP55 and protect sensitive parts of the converter from ingress of water, snow, dust etc.



The converter modules are liquid cooled where the coolant is a mixture of water and an anti-freeze agent. The coolant is cooled in a liquid to air heat exchanger placed in the converter box. In order to avoid internal hot spots the converter box is also equipped with an internal fan.

All converter modules are accessible from one side of the box, (train), whereas contactors and cooling equipment are accessible from the other side.

Mechanical drive system

The single axle transverse drive system is partly suspended and consists of traction motor, gear box with reaction arrangement and a gear coupling. The traction motor is of the three-phase, squirrel cage asynchronous type, designed for IGBT power supply. It is solidly mounted to the motor carrier frame which is flexibly mounted to the bogie frame.

The motor is a three-phase, squirrel cage asynchronous motor. It is ventilated by means of a forced air stream. One fan serves the two motors in one bogie.

Auxiliaries

Air Supply System

The train is fitted with one main compressor unit in each T-car. There is one auxiliary compressor for each pantograph unit. The auxiliary compressor is located in the trailer (Tp) car.

The main compressor is fitted with a safety valve to ensure that system pressure will not be higher than the maximum allowed. The main compressor unit is also fitted with an emergency pressure switch that indicates low system pressure and initiates an emergency brake at a system pressure level that can ensure safe stopping of the train.

The auxiliary compressor is supplied with battery voltage, 110 V. This to ensure that the pantograph can be raised during start up when there is no 3-phases supply available.

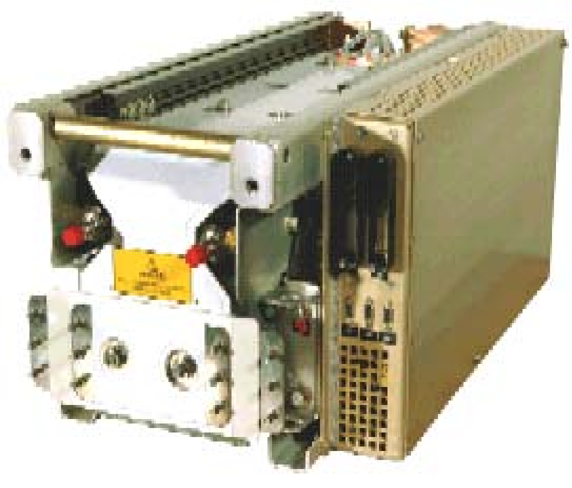
Auxiliary Electric System

The task of the system is to generate and distribute the three-phase 3×400 V, 50 Hz to all AC loads in the EMU.

The main funtions and consumers in the auxiliary system will be the following:

- Train heating
- HVAC
- Cooling of the converters and the transformers
- Battery chargers

The three-phase auxiliary system electric power is generated either by the auxiliary converters or taken from the external three-phase inlet connection. The supply voltage to the auxiliary converter is taken from the DC-link in the traction converter. The auxiliary converter converts the DC voltage to a three-phase voltage. A filter reduces the electric harmonics from the converter output. A transformer isolates the high voltage converter output from the 3 x 400 V, 50 Hz network.



There is one auxiliary converter in each Mc- and M-car. These converters are connected to a three-phase bus. If one converter fails, the output will be reduced. This is controlled via the TCMS.

External connection:

Supply voltage	3 x 380 V, 50 Hz
Locations	One on each side of the Tp cars.

Main distributions to the under frame mounted equipment and panels are located in a distribution box in the underframe. Distribution panels for interior equipment are located above floor (in both ends of a car). Distribution panels for cab equipment are located in the cab.

Fire Detection System

The train is equipped with a Fire Detection System, which detects smoke in driver's cab and passenger areas.

The Fire Detection System is installed in all cars in the train and consists of a number of fire detectors and control units for fire alarm. In case of an alarm it is possible to reset the system from the drivers cab.

The fire detectors react on both visible and invisible smoke particles. If smoke is detected inside the train, the Fire Detection System gives an acoustic and an optical signal in the drivers cab.

Each control unit is connected to a fire detector, via a two-wire detection loop. The control units are connected in series via a hard wire loop, which makes the system redundant. The hard wire loop gives an optical signal in the drivers cab and a fault signal to the TCMS.

Braking

The *ZEFIRO* EMU is equipped with a directly acting electro pneumatic braking system. The brake system can meet the maximum brake distance at maximum service speed using friction brake only (brake discs and pads).

The brake modes, described below, are achieved using wheel-mounted disc brakes on powered axles, axle mounted disc brakes on trailing axles and regenerative electro-dynamic brake.

The brakes are controlled from the TCMS communicating with one BCU (Brake Control Unit) per car.

All axles are equipped with a microprocessor based Wheel Slide Protection, WSP. The WSP is made according to UIC 541-05 and is active in all brake modes except Parking Brake. The WSP is optimised using simulation tools and finally validated during tests on track.

The brake system is able to interface a brake pipe controlled brake system for towing purpose. This is done by measuring the brake pipe pressure of the towing locomotive or train and by controlling the brakes via the EP system. This is possible as long as there is battery power supply.

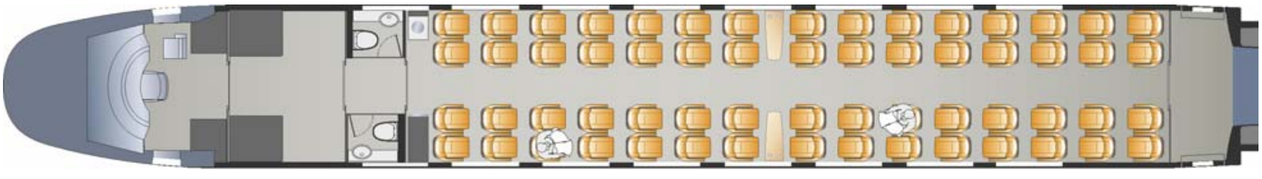
Service brake

The service brake is used during normal operation of the train and it achieves 0.6 m/s^2 from max. speed down to 200 km/h and 0.8 m/s^2 from 200 km/h down to 0 km/h as effective average deceleration. The service brake uses electro dynamic brake and mechanical brake. The brake blending is optimised with respect to LCC (brake pad and disc wear), comfort and adhesion. The brake blending makes maximum use of Electro Dynamic Brake before any mechanical brake is used. The service brake (mechanical brake only) is controllable when the train is being towed.

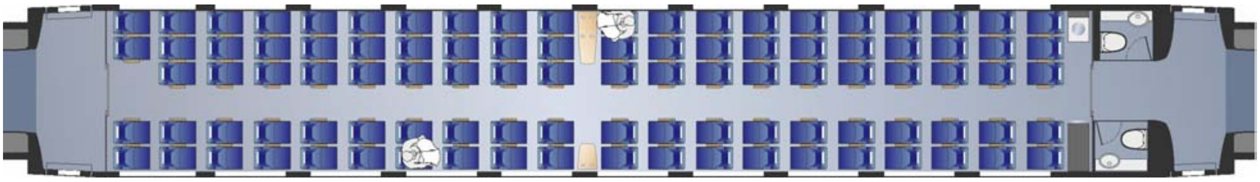
Interior Architecture

The interior offers a safe and comfortable environment for all users of the *ZEFIRO* EMU, i.e. passengers, train- and service personnel. The *ZEFIRO* EMU is designed in a modular way, which creates the possibility to apply flexible interior solutions.

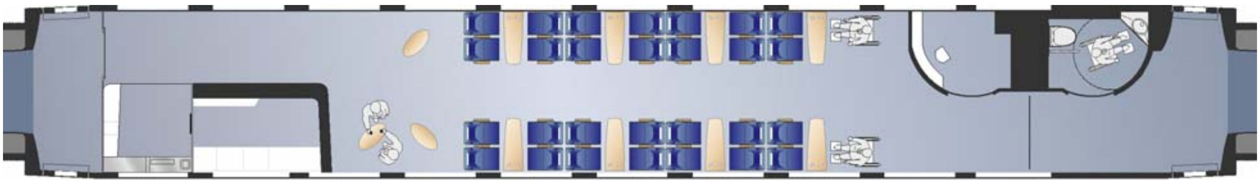
It is possible to apply and combine different interior solutions depending on the different traffic needs – and it is also possible to vary the seat pitch between different parts of the train/car.



The interior is designed taking both noise and thermal insulation into consideration. It is adapted for easy maintenance and cleaning and is resistant against vandalism.



The train has two comfort classes: 1st class and 2nd class. The both end cars are 1st class and the rest of the cars is 2nd class



The seats are fixed in c-rails against the wall and floor, which creates a flexibility to adapt the layout according to the different sevices needs. The number of bay seats and the seat pitch can be adapted according to customer wishes and operational requirements.

Walls

The wall panels are designed as individual, self-supporting, easily replaceable modular units. The sidewall unit are equipped with a zone for securing of a sidewall table and seats. In connection with the window frame / luggage shelves – roller blind and securing of this is integrated.

Floors

The floor is of a floating design. The design minimises the vibrations. It give also a good acoustic and heating insulation. The floor contains c-rail that support the interior equipment (e.g. seats, table).

In the passenger sections wall-to-wall floor covering ia laid on. The floor covering partly continues up the sidewall (e.g. to heating duct).

Floor coverings are anti-slip proofed and durable and able to withstand frequent and vigorous cleaning.

Ceilings

The ceiling panels are designed as individual, self-supporting, easily replaceable modular units matching the design of the wall units. Heating ducts, lighting, etc. are integrated in the internal walls and ceilings.

Vestibule

The entrances to the cars are arranged for comfortable boarding from different heights of platforms.

Entrance steps are designed to give good protection against slipping and shall be heated to prevent snow and ice from building up. There is a glass partition wall towards the short saloon. In each vestibule there are two large wastebaskets

The door pillars in each vestibule contain the following equipment:

- Loudspeaker (2 pcs/vestibule)
- Emergency door opening unit (2 pcs/vestibule)
- Emergency speech unit, incl. break handle (1 pcs/vestibule).
- Operating panel for door/lightning (2 pcs /vestibule)
- Handles

Luggage stacks, luggage racks and functions panels

Above each window there is a luggage rack, with the same length as the wall panels. In addition to the luggage racks, luggage stacks can be added. The number of luggage stacks can vary depending on customer wishes.

Audio video system

The train is equipped with an Audio Video System. The system offers the possibility to listen to music and watch movies, on fixed public screens. There are six 20” screens in each first class car and two 30” screens in the dining area of the T car. The screens are flat LCD or plasma screen.

The Audio video system allows broadcasting of multiple-channels from a central unit installed in the crew cabin.

HVAC

The HVAC-system in the passenger area operates with a return air function and is mixed with the fresh air before entering the evaporators via filters. There are exhaust air fans mounted for exhaust air from the toilets, catering area etc. The HVAC units for each passenger car is mounted in an opening on the roof and fixed to the roof via bolts on a flange of the unit. The supply-air flow into the passenger saloon is distributed via silencer and a rectangular duct placed between the roof and the ceiling, and via supply air terminal devices blown into the car. The heating of the car is done via heaters mounted in the car wall side, controlled via the HVAC-controller. The electrical and control equipment for the HVAC is mounted in an electrical locker in the car.

The driver’s cab has a separate compact HVAC- unit.

On Board Train Control

The Train Control and Management System, (TCMS) is distributed in order to minimize the cabling. The data communication between the different parts of the system follows the TCN standard, IEC 61375.

The TCMS uses dynamic configuration in order to support coupling and uncoupling when multiple train sets are operated as one train.

The VCU in the first EMU (car) handles the overall control and supervision of the entire train. The local control and supervision is handled by the distributed VCU's throughout the train.

The TCMS controls and/or supervises the following systems in the train:

- Air Supply System
- APC System
- ATP System
- Automatic Couplers
- Auxiliary Electric System
- Battery System
- Brake System
- Driver’s Safety Device
- Exterior Doors
- Fire Detection System
- Heating and Ventilation Air Conditioning System
- High Voltage System
- Interior Doors
- Interior Lighting
- Passenger Information System
- Propulsion System
- Toilets

The TCMS also handles the interface to the driver, crew, and service personnel. The buttons, switches, indicators and other gear on the driver’s desk are connected to the TCMS. The TCMS translates the operator’s actions into control signals to the various systems and report back to the operator via the indicators.

There is also an IDU with a colour touch screen on each driver’s desk. The IDU includes a number of menus presenting the status of the train and the systems in the train. It is also possible to control some of the systems functions from the IDU and to activate and de-activate systems and functions.

It is possible to log on to the IDU with different levels of access to the TCMS and to the IDU menus. Drivers need a certain level of access, while crew and service personnel need other levels of access. The different access levels and relating functionalities are defined during the design phase.

It is possible for the crew and service personnel to operate the IDU's in the non-activated driver's cabins while the train is in service. The TCMS is also equipped with additional IDU's in the crew cabin.

The TCMS contains redundancy for safety related and performance critical functions. A single point TCMS hardware failure does not affect any safety related or performance critical function.

The interface between the TCMS and the various systems listed above is MVB Class 1, serial RS-485 or discrete I/O.

Fault/Diagnostic System

The TCMS includes a Train Diagnostic System, TDS, which stores predefined faults and events that occur in the train. The defined faults and events cover all systems listed in the previous chapter as well as the TCMS itself.

The faults and events are classified based on severity and character. The faults and events that are relevant for the driver are presented on the IDU in the activated driver's cabin. It is possible for the driver, crew, and service personnel to see all active faults and events on the any of the IDU's in the train.

The TDS also stores other diagnostic data about the various systems such as operation time and number of operations. It is possible to perform remote upload of the stored diagnostic data to an off-board system. The up loading system shall be defined during the design phase.

Passenger Information System & External Displays

The main tasks for the Information System are to:

- Show travel related information to the passengers
- Take care of speech communication between onboard personnel and passengers

The Information System has the following functions:

- Public announcements, which shall make it possible for onboard personnel to make announcements to all passengers from the crew cabin or from the driver's cab.
- Cab-to-Cab communication/internal communication, which shall make it possible for onboard personnel to speak with each other between the crew cabin and other service areas.
- Emergency speech unit located in each vestibule, which shall make it possible for the passengers to speak with the driver in case of an emergency.
- Broadcast music to be selected in the crew cabin (CD player).

The system has electronic information displays in combination with digital voice announcements. There are two types of electronic information displays:

- Exterior Information Displays – placed outside the train, over the exterior doors. (4 pcs/ intermediate car, 2 pcs/ end car)
- Interior Information Displays – placed inside the trains. (2 pcs/car)

There is one handset in each driver's cab, each crew cabin– and there are provisions for extra handsets, “service handsets” throughout the train. It is possible to make a public announcement in the train (in case of multiple coupled trains: in all EMUs) from all handsets. Via the handsets it is possible to place an intercom call to any other handset present in a EMU, or multiple coupled EMUs.

In each crew cabin there is one gooseneck microphone, which makes it possible to make announcements in the train (in case of multiple coupled trains: in all EMUs).