First Class Bogies

The complete programme for high-quality railway transportation

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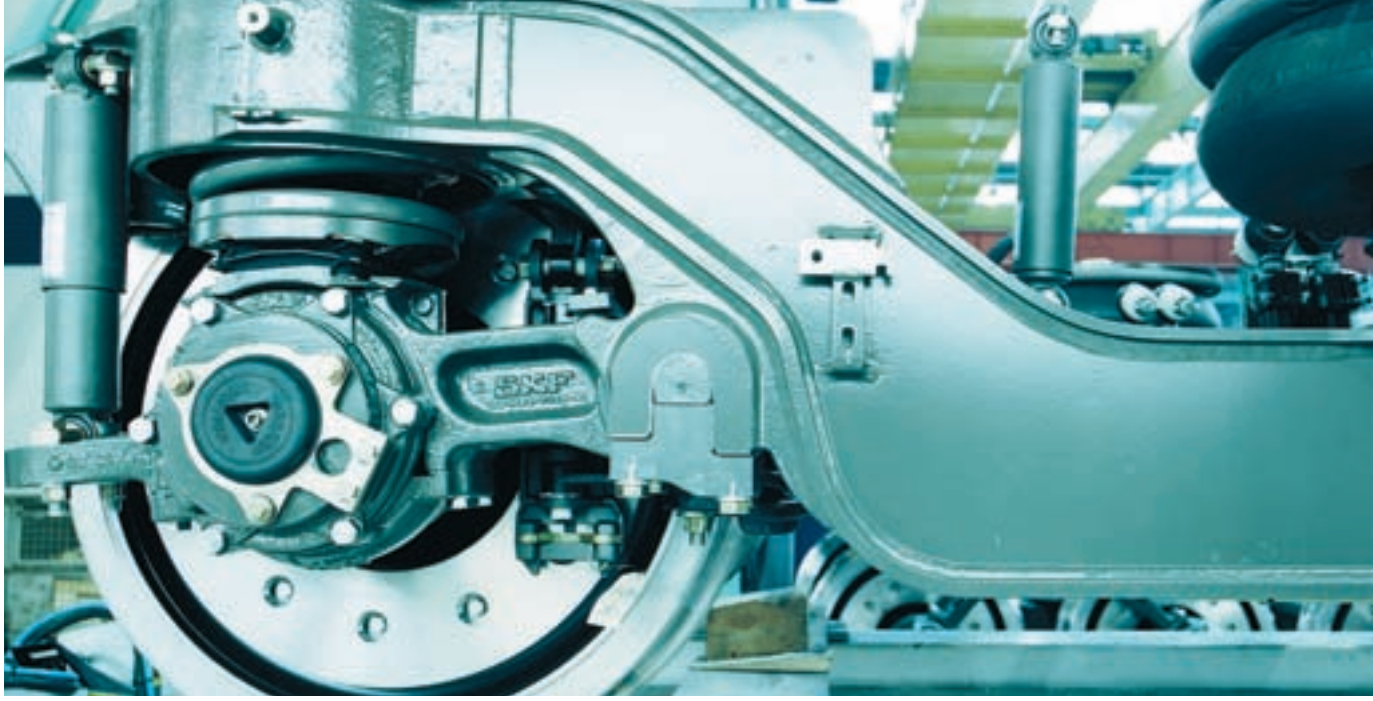


First Class Bogies

The complete programme for high-quality railway transportation

Siemens Transportation Systems Graz offers high-tech bogies to meet the widely varied requirements of modern passenger transportation

Bogies for mass transit:
- metro cars
- trams
- urban railways

Bogies for main-line traffic:
- locomotives
- passenger coaches
- trains

Modular design,
resulting in higher efficiency
A modular concept is used for the design of bogies of Siemens Transportation Systems Graz from the very start. This makes it so easy to adapt to specific requirements. And increases the efficiency of every individual solution.

Innovations, setting new standards
The development and design team of Siemens Transportation Systems Graz is among the most productive in the world. About 150 highly qualified engineers work on solutions, setting new standards in bogie technology:

- Bogies for the high performance locomotive "Taurus" of the Austrian Federal Railways, 10 000 HP and maximum speed of 230 km/h

- Bogies for the high speed railcar trains ICE 3 of the German Railways or VELARO E in Spain, for maximum speeds up to 350 km /h

- Bogie for AVANTO, low-platform urban rail vehicles with a low-floor portion of more than 70 % and a floor level height of 381 mm and 655 mm respectively.

Advantages, convincing worldwide
The bogies of Siemens Transportation Systems Graz convince in all aspects relevant for modern transportation technology. Apart from the specific advantages of the various types, they also offer the following advantages:
- high operating safety
- particularly smooth running
- extremely reliable
- low LifeCycleCosts
- efficient maintenance

Service guaranteeing lasting quality
Siemens Transportation Systems Graz offers after-sales service and comprehensive service packages to meet the individual requirements of our clients. If requested, support is provided throughout the complete life cycle – also extending to the modernization and retrofitting of old bogies.

Our Company – A First-Class Partner

The worldwide Centre of Competence for Siemens bogies

Siemens is one of the major manufacturers of railway rolling stock worldwide. The development and manufacture of bogies is the exclusive responsibility of Siemens Transportation Systems Graz.

An independent partner for every manufacturer of railway rolling stock
Siemens Transportation Systems Graz as developer and manufacturer of high-tech bogies is an independent partner of the worldwide railway rolling stock industry. A reliable and competent supplier, we are prepared for all types of cooperation.

The most productive manufacturer of bogies worldwide
37 000 bogies are manufactured worldwide per year, 2500 of which by the 850 employees of Siemens Transportation Systems Graz.

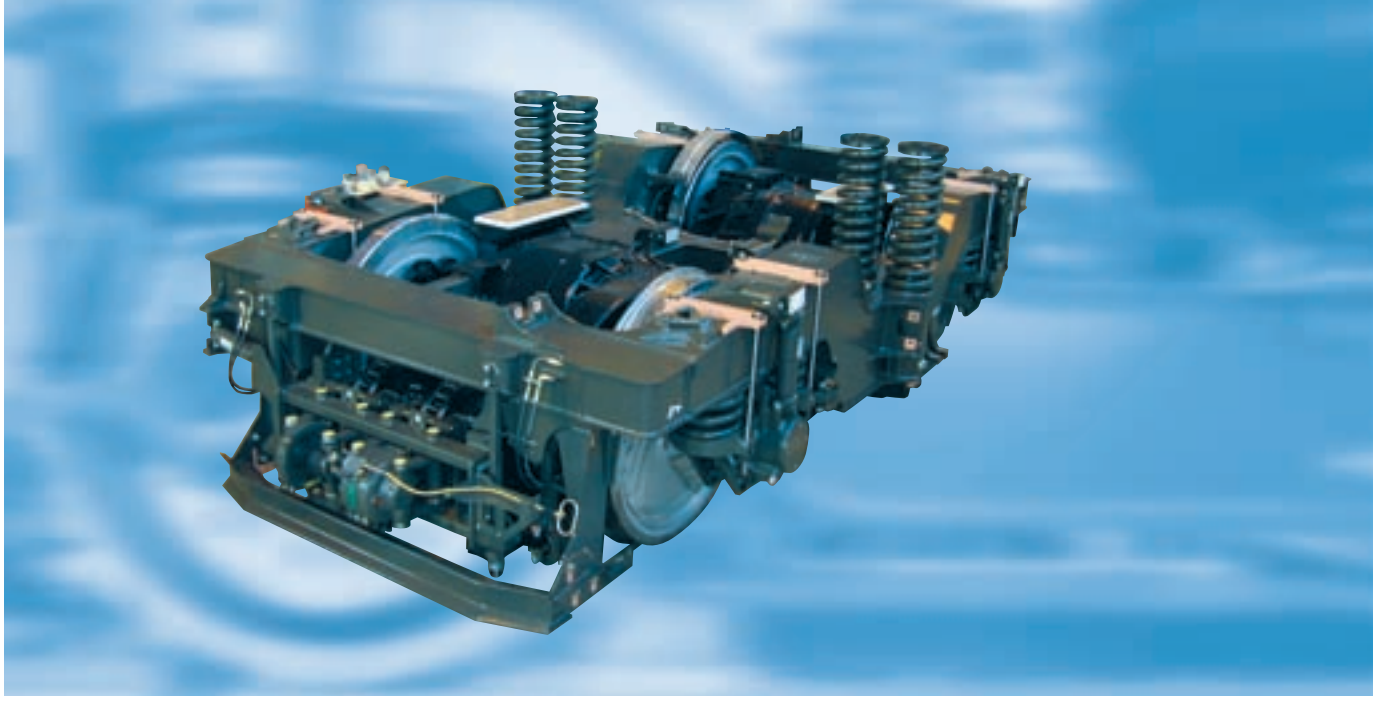
The plant with the highest degree of automation worldwide.
The degree of automation of bogie production at Siemens Transportation System Graz is the highest worldwide. Thanks to the so-called "flow manufacture" using state-of the-art robot technology, 1500 kilometres of welding seams are performed every year.

Productive proximity of development and manufacture
At Siemens Transportation Systems Graz, design engineers and manufacturing experts work under the same roof. This immediate neighbourhood of ideas and their realisation is one of the decisive factors for the flexibility and quality we offer.

The biggest competence is in the area of development and engineering
The core competences in the field of system engineering, developing of components vehicle dynamics, strength calculation and testing enable the emergence of innovations and bogie designs on the highest technical stage for all application areas.

A future-oriented partnership with the University of Technology Graz
The University of Technology Graz is a trend-setter enjoying worldwide reputation in the field of railway rolling stock. Our permanent cooperation with such specialists gives decisive impetus for the further development of bogie technology.

150 years of experience in the field of Railway Rolling Stock Manufacture
In 1854, Johann Weitzer, a forger, opened a small blacksmith's shop in Graz, which rapidly grew to become a production plant for railway rolling stock. The quality of our present high-tech bogies also has its roots in the experience gained over these past 150 years.



SF 1

Motor Bogie for electrical Locomotives

The SF 1 bogie was designed for electric high performance locomotives for up to 230 km/h.

Potential application for this universal bogie includes high quality passenger and freight traffic.

One application is in the high performance locomotive "Taurus" of the ÖBB (Austrian Federal Railways) with a continuous output of 6.4 MW. To correspond to the area of application of the Taurus, the bogie was designed for European high speed rail lines as well as multi-curve alpine lines with a low track quality.

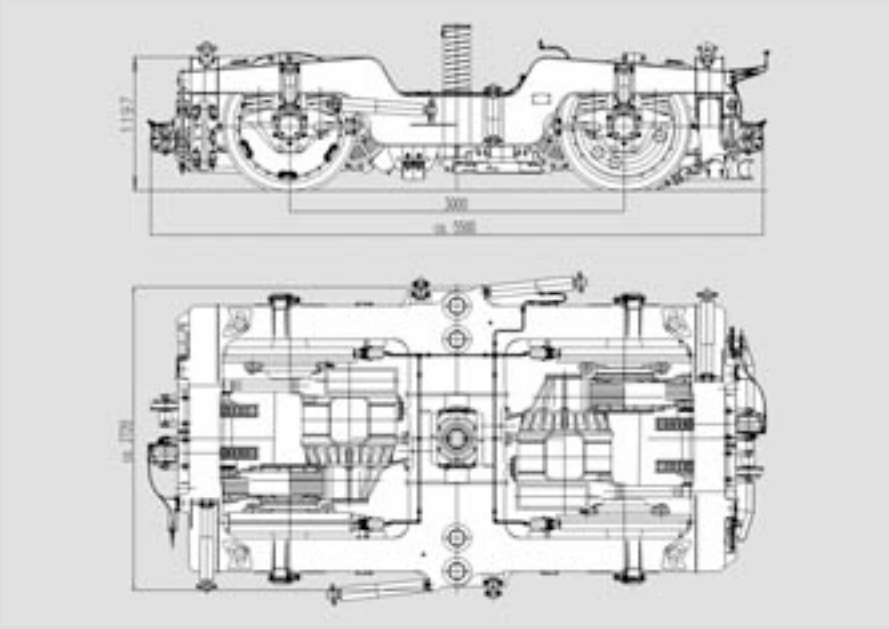
The bogie frame is of fully welded box construction, consisting of two offset side frames, one transom section and two head beams. During the construction of the frame special care was taken with regard to positioning and welding by robots.

The wheelset is guided in the bogie frame by means of a three-point wheelset guide with elastic bushes for each wheelset bearing housing. This allows passive radial adjustment of the wheelset, which has a positive effect on both running behaviour and wear on multi-curve lines.

The breaking system for each wheelset consists of two axle-mounted brake disks arranged on a separate brake shaft, two compact brake callipers with brake cylinder, spring-type cylinder and brake pad retainer. The brake shaft together with the brake disks can be removed without dismantling other components. The parking brake is designed as spring-loaded brake.

The drive is a HAB drive (high-performance drive with brake shaft), which was specially designed for drive units and locomotives. Each wheelset is driven by a three-phase asynchronous motor with 1.6 MW continuous output.

Drive and braking torque of the traction motor is transferred by the motor pinion to the gear wheel and via a coupling gear and hollow drive shaft to the wheelset. The traction motor, gearbox and brake shaft unit is suspended and fully cushioned in the bogie frame.



The secondary springs were arranged at right angles to relieve the bogie frame from torsional strain in the side frame and from bending load in the transom section. This allows further reduction of frame mass.

The tractive force is transferred wear-free from the bogie to the locomotive box via a sunken bogie pin bearing with lemniscate control rod. The power transmission point lies only 420 mm above the upper surface of the rail.

The bogie is fitted with a wheel flange lubrication system and a sand distribution system. The bogie can be equipped with a track guard or sweeper as well as a derailment guard.

All wheels can optionally be fitted with sound absorbers. The SF 1 bogie is also installed in the locomotive, that set the new world record for high speed locomotives in September 2006 between Nürnberg and Ingolstadt.

Reference:
ÖBB / Austria
DB AG / Germany
MAV / Hungary
GYSEV / Hungary
Dispolok / Europe
RTS / Austria
SZ / Slovenia
SNCB / Belgium

Technical Data	
Bogie	SF 1
Running speed	230 km/h
Axle load	21,5 t
Continuous power per wheelset	1600 kW
Max. starting tractive effort per wheelset	75 kN
Wheelbase	3000 mm
Track gauge	1435 mm
Wheel diameter new / worn	1150 / 1070 mm
Smallest radius of curvature	120 m
Weight	app. 18 t
Secondary transmission of longitudinal forces	pivot
Traction unit	HAB (high-performance drive with brake shaft)
Mechanical brake	Disk brakes on separate brake shaft

SF 2

Bogie-family for electrical Locomotives

The SF 2 bogie was developed for the quadruple-system locomotive BR 189 of DB Cargo AG for up to 6.4 MW installed output and speeds of up to 140 km/h. For Portugal Railways CP a broad gauge version of the SF 2 was designed.

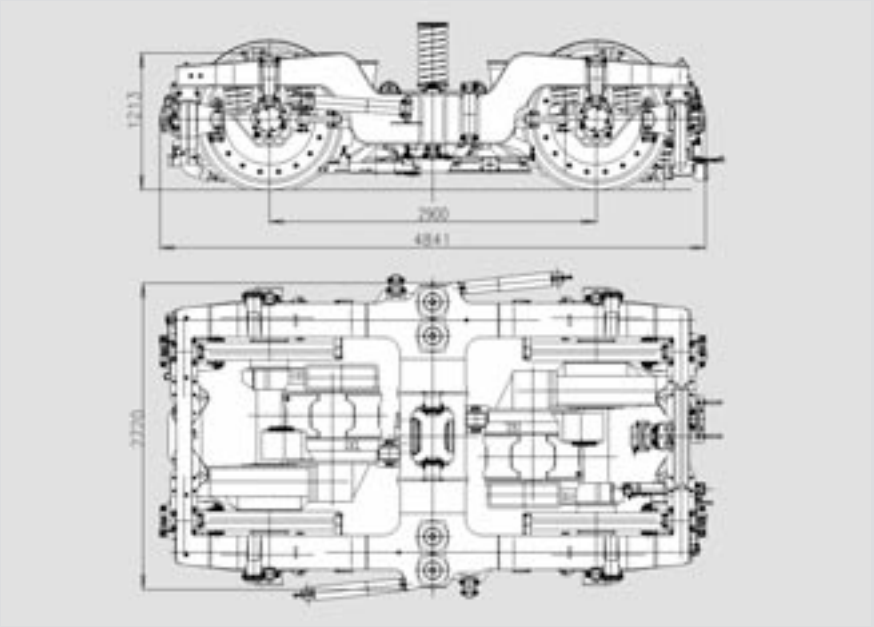
The compact and functional construction is based on proven components that were used on several bogies of Siemens Locomotives.

The enclosed bogie frame with box-type head beams, one transom section and offset side frames is robustly designed for a long working life and additionally has high reserves against excessive loads.

The shortened wheelbase of 2900 mm in comparison with the BR 152 makes the bogies track-friendly and specially suited for tight curves. The SF 2 bogie distinguishes itself through minimal wheel/track forces and therefore minimal maintenance costs for wheelsets and superstructure.

The required linking rigidity in the wheelset guide is attained with two flexible coil springs for each axle bearing and one three-point wheelset guide. This low maintenance design has proven itself in the SF 1 and SF 3 bogie.

The design with axle suspension drive is an ideal, cost-effective and proven solution for operating speeds of up to 140 km/h. The secondary spring stage for each side frame consists of two helical steel springs with low swivelling resistance fitted across the longitudinal axis of the vehicle. This arrangement prevents the introduction of torsional forces on the bogie frame. The SF 2 offers excellent riding comfort due to its large spring travel.



Transmission of force to the carbody is achieved via bogie pin.

Wheel disk brakes which contribute to the protection of the wheel profile are employed for the mechanical brake system. The parking brake is carried out as a spring loaded system.

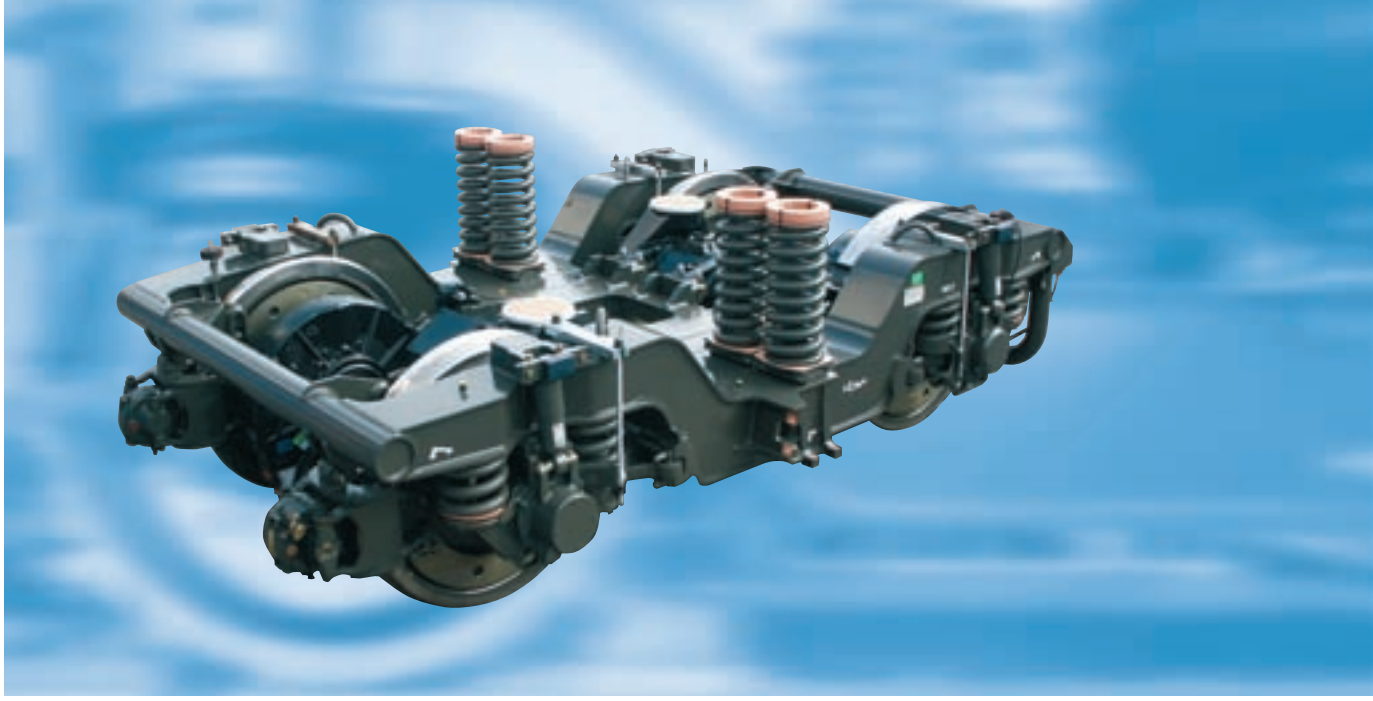
The SF 2 standard gauge bogie bogie can be fitted with antenna systems for three different country-packages (Northern, Southern and Eastern Europe).

A change over form broad gauge to standard gauge is possible within the same bogie frame.

Depending on customer requirements, all wheels can be fitted with sanding devices and wheel flange lubrication systems. The SF 2 bogies can be optionally equipped with an active jaw damper and diagnostic and monitoring systems.

References:
DB AG / Germany
Dispolok / Europe
SBB / Switzerland
Mitsui / Europe
CP / Portugal

Technical Data	
Bogie	SF 2
Running speed	140 km/h
Axle load	22 t
Continuous power per wheelset	max. 1600 kW
Max. starting tractive effort per wheelset	75 kN
Wheelbase	2900 mm
Track gauge	1435 mm
Wheel diameter new / worn	1250 / 1170 mm
Smallest radius of curvature	80 m
Weight	app. 17 t
Secondary transmission of longitudinal forces	pivot / sliding plates
Traction unit	axls suspension drive
Mechanical brake	wheel disk brake



SF 3

Bogie-platform for diesel-electric Locomotives

The SF 3 bogie-platform was developed for the Austrian Federal Railways for application with diesel-electric locomotive 2016.

The bogie was designed and continuous developed as a platform and can be used for low-powered as well as high-powered locomotives up to a wheelset load of 22 t and a maximum operating speed of 160 km/h.

The use of proven components, as many identical parts as possible and a high degree of standardization, makes the SF 3 bogie-platform an economical and technically safe solution.

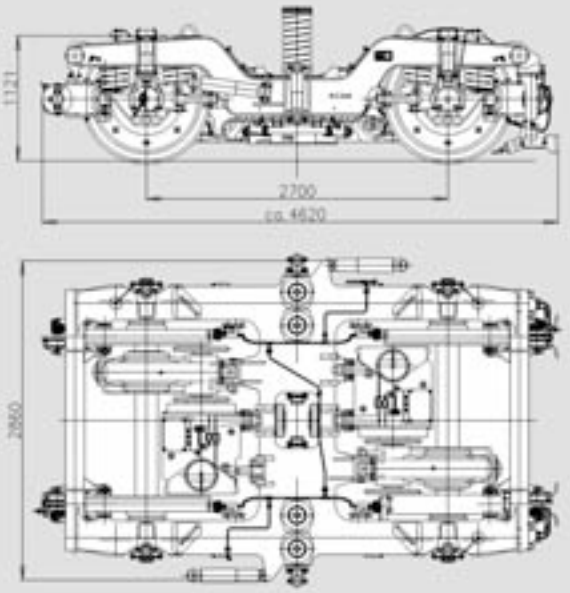
The bogie frame is a fully welded box construction consisting of two offset side frames, one transom section and two tubular head beams. The bogie-frame and the interfaces to all components is identical for all platform applications.

The wheelset shaft is a forged hollow shaft onto which the wheel disks are pressed. The wheelset is guided in the bogie frame by means of a three-point wheelset guide with elastic bushes for each wheelset bearing housing. This solution has proven itself in the SF 1 bogie of the high-performance locomotive Rh1216 of the Austrian Federal Railways, as well as in the SF 2 bogie of the BR 189 locomotive of German Railways.

The wheelset shaft is driven by a cross-mounted three-phase asynchronous motor, which is supported by the bogie frame, via an axle-mounted gearbox.

Primary suspension is achieved via two coil springs and a hydraulic damper connected in parallel.

The bogie air brake consists of four internally ventilated wheel brake disks with one braking unit for each axle. The locking brake is designed as spring-loaded brake.



The tractive force from bogie to locomotive box is transmitted via a bogie pin and slip surface of elastomer buffers coated with hard manganese.

The locomotive box is supported on both sides of the bogie with two cross-mounted coil springs. Movement between bogie frame and locomotive box is cushioned vertically and horizontally by dampers.

Two or four roll dampers can be used, depending on the demands made on maximum speed and maximum load on the bogie.

The SF 3 bogie family is equipped with a device for wheel-flange lubrication, a sanding device an rail guards. Optionally, the bogies can be fitted with a great number of antennas for train protection according their area of operation.

References:
ÖBB / Austria
KCRC Hong Kong / China
Dispolok / Europe
Several european operators

Technical Data	
Bogie	SF 3
Running speed	max. 160 km/h
Axle load	max. 22 t
Cont. power per wheelset	max. 750 kW
Max. starting tractive effort per wheelset	62,5 kN
Wheelbase	2700 mm
Track gauge	1435 mm
Wheel diameter new / worn	1100 / 1020 mm
Smallest radius of curvature	120 / 100 m
Weight	app. 14 t
Secondary transmission of longitudinal forces	pivot / sliding plates
Traction unit	partly suspended traction unit
Mechanical brake	wheel disk brake

SF 6

Bogie family for electrical Locomotives

The SF 6 bogie family covers 6 axle bogies for locomotives for standard gauge, broad gauge and narrow gauge .

The SF 6N standard gauge bogie was developed for heavy freight trains of the Danish Federal Railways. Since 2000, Danish railways have been operating 13 high performance locomotives from the EG 3100 series, all of which incorporate the SF 6 bogie.

The narrow-gauge bogie was designed for 1000 mm and 1067 mm as well. The bogie is equipped with a nose suspended drive. The brake is realised as a shoe-brake. The SF6S bogie is in service in the Asiarunner of the Vietnamese Railways.

The SF6B bogie was developed for the Lithuanian Railways for 1520 mm gauge.

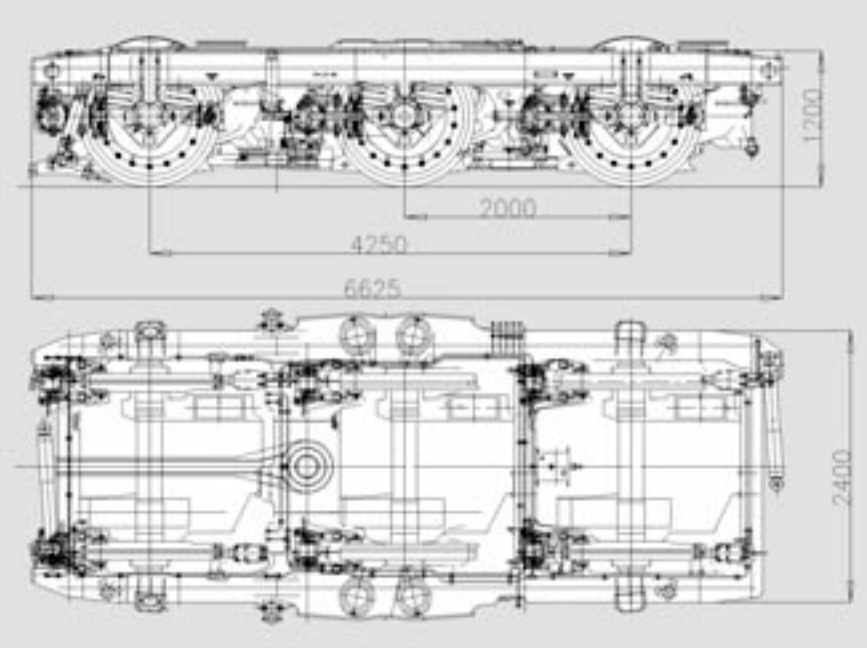
The bogie is equipped with a partly suspended drive, the operational brake is a wheel-disc brake. This broad gauge bogie can be adapted to a standard gauge bogie with a partly suspended drive.

The bogie frames of the SF 6 bogie family consists of longitudinal girders, two headbeams and two bogie centre beams, which form a closed frame. Pre cut parts are welded together to form a box section.

Each bogie wheelset is powered by a three-phase asynchronous motor.

The bogie frame is supported on the axle bearing by helical springs. The primary springs of the first and last wheelset of every bogie are damped hydraulically.

The secondary suspension for each side frame consists of helical steel springs with low swivelling resistance fitted across the longitudinal axis of the vehicle. This arrangement prevents the introduction of torsional forces on the bogie frame.



The tractive effort transfer of all SF 6 bogies occurs via wear free traction rods which connect the main bogie centre bar to the carbody.

The low point of impact on the bogie guarantees a fully equal wheelset load for heavy starts and thus also ensures an optimum tractive effort transfer with small wheel and track wear conditions.

In comparison with both outer wheelsets, the middle wheelset has a greater free lateral clearance in order to reduce the guidance forces in curves, especially those of the respective guiding wheelsets.

The wheelset consists of two rolled solid wheels and a forged axle. The horizontally arranged axle guide conducts the tractive efforts from the wheelsets to the bogie frame and takes over the longitudinal guidance of the wheelset on the track.

All SF 6 bogies can be equipped with wheel flange lubrication, a sanding facility and rail guards. The bogies are prepared to carry the most important antennas for train protection according their operation area.

Reference:
DSB / Denmark
LG / Lithuania
VR / Vietnam

Technical Data			
Bogie	SF 6N	SF 6B	SF 6S
Wheel arrangement	Co'Co'	Co'Co'	Co'Co'
Running speed	140 km/h	120 km/h	130 km/h
Axle load	21,5 t	23 t	13,5 to 16,25 t
Cont. power per wheelset	app. 1080 kW	app. 330 kW	250 / 330 kW
Max. starting tractive effort per wheelset	app. 70 kN	app. 75 kN	app. 53 kN
Wheelbase	2000 / 2250 mm	1795 / 2045 mm	1650 / 1650 mm
Track gauge	1435 mm	1520 /1435 mm	1000 /1067 mm
Wheel diameter new / worn	1250 / 1170 mm	1100 / 1020 mm	1016 / 936 mm
Smallest radius of curvatore	80 m	125 m	70 m
Weight	25,5 t	25 t	16 t
Secondary transmission of longitudinal forces	traction rod	traction rod	traction rod
Traction unit	axle-hung design	partly suspended drive	axle-hung design
Mechanical brake	wheel disk brake	wheel disk brake	shoe brake

SF 200

Trailer bogie for Passenger Coaches

The trailer bogie SF 200 was developed on the basis of the Eurofima trailer bogie Y 0362.

All system-dimensions as well as the interface to the carbody are identical to the Eurofima design. The maximum axle load was increased to 17 t and the maximum speed was raised to 200 km/h. Furthermore, the SF 200 bogie is equipped with 3 disc brakes and can optionally be provided with a magnetic track brake.

For this reason, the SF 200 qualifies as a replacement model for the timeworn Eurofima bogies. It fulfills the high requirements of a modern passenger coach bogie. The open H-frame is made of weather resistant steel and designed for a high degree of robot welding.

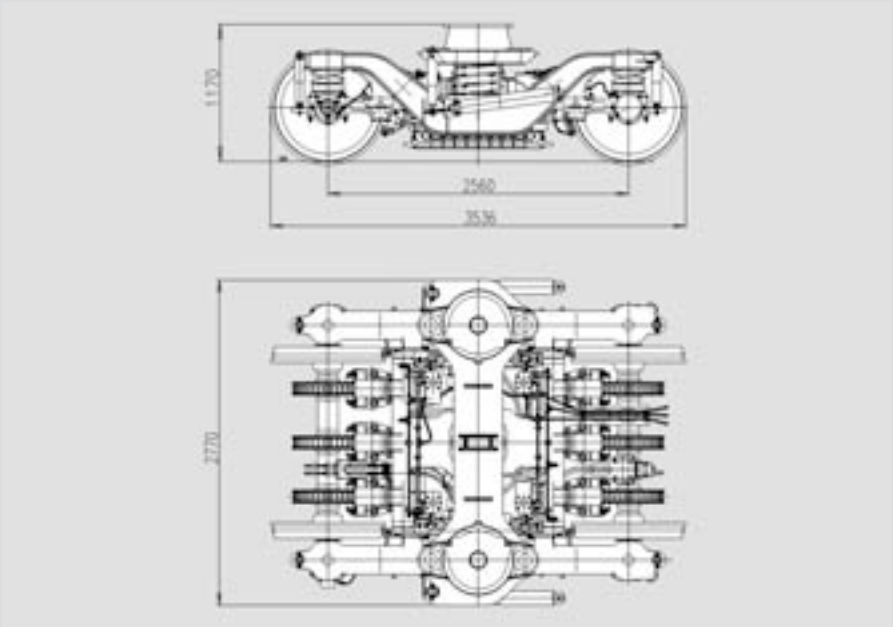
The wheelsets are designed for a maximum axle load of 17 t and are in accordance with all relevant UIC and EN standards. The wheelset bearings are provided as sealed, compact type bearing units.

The axle guidance of the SF 200 is carried out through one elastic bush per axlebox, which joins the radial arm with the frame.

The primary springs are located above the wheelset bearings and consist of steel coil springs and rubber elements for acoustical and electrical isolation.

Four hydraulic dampers are arranged in parallel to the primary suspension system. This ensures an optimal vibration and sound decoupling.

The secondary suspension consists of a steel coil system as well as rubber elements for acoustical isolation between the bogieframe and the carbody.



The secondary steel coils also take up the forces of transversal and horizontal rotation of the bogie and all movements between bogie and carbody. For vehicle speeds higher than 140 km/h, two yaw dampers are used.

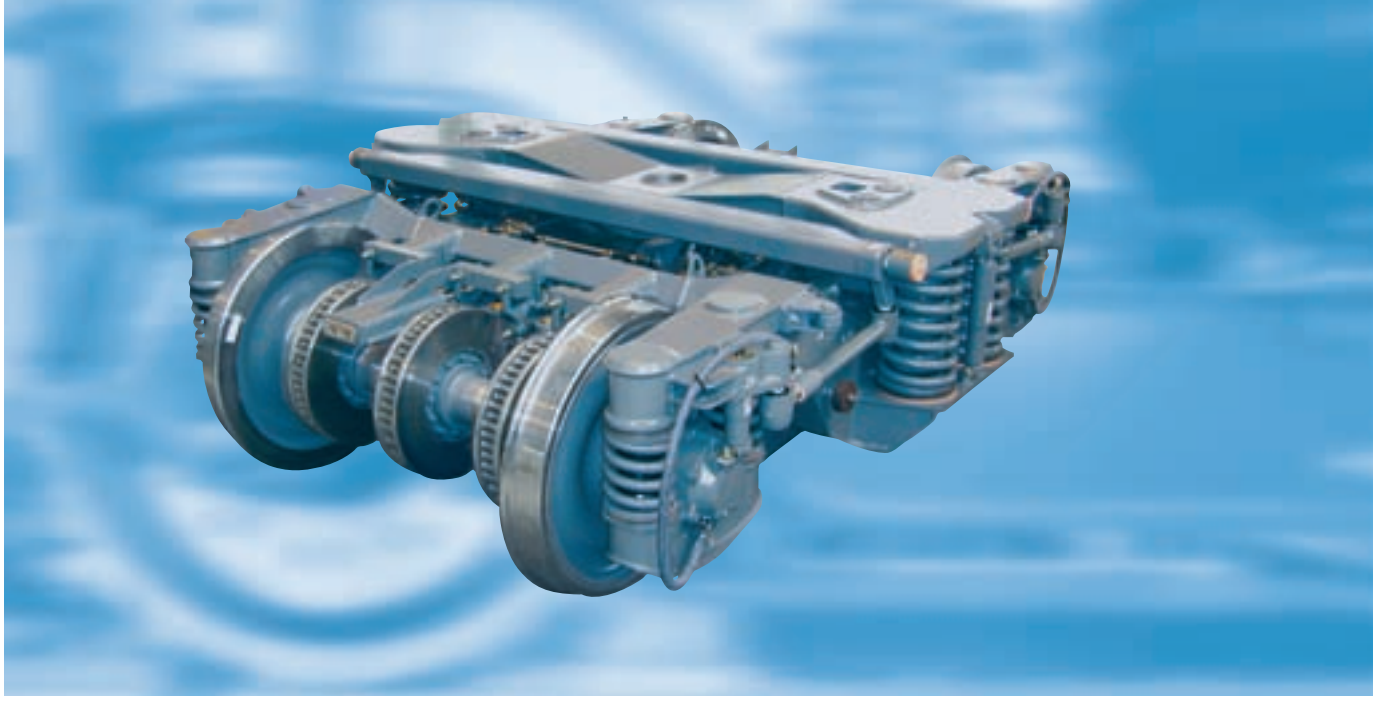
The transmission of braking and acceleration forces between bogie and carbody is performed by a king pin, a yoke and two guiding rods. To ensure the necessary flexibility, rubber bushes are integrated in the yoke and in the guiding rods.

The SF 200 bogie is used as replacement model in 20 sleeping coaches of the Swiss Federal Railways (SBB). The SF 200 bogie substitutes the Eurofima bogie Y 0362.

This enables the SBB to use existing carbodies and to meet the requirement of today's modern passenger coaches with high speed and high axle load. SBB also ensures that this occurs without safety risk.

References:
Swiss Federal Railways (SBB)

Technical Data	
Bogie	SF 200
Running speed	200 km/h
Axle load	max. 17 t
Wheelbase	2560 mm
Track gauge	1435 mm
Wheel diameter new / worn	920 / 860 mm
Smallest radius of curvature in service / workshop	150 / 80 m
Bogie height	949 mm
Weight incl. magnetic track brake	app. 7,7 t
Mechanical brake	Disc brake / optional electromagnetic track brake



SF 300

Trailer Bogie for Passenger Coaches

The trailer bogie SF 300 has been developed, for passenger coaches for speeds for up to 200 km/h and 16 t axle load.

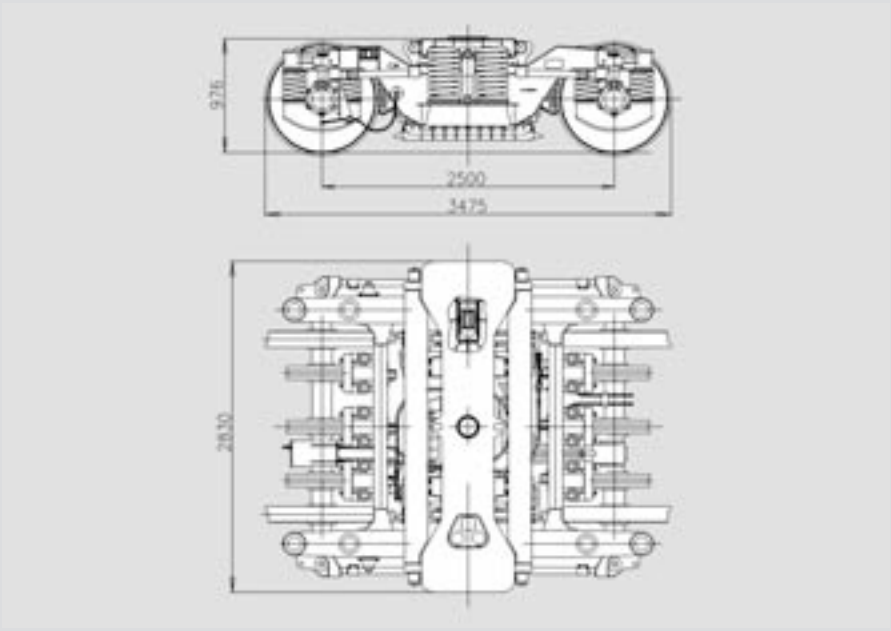
For this purpose, the SF 300 is used as standard-bogie by the Austrian Federal Railways since 1989. Various other railway authorities have also placed orders for the supply of this bogie type.

The bogie is extremely track-friendly even at high vehicle speed. Within the scope of the ERRI (ORE) trials B 176 conducted in the early nineties, the SF 300 bogie won an award for being one of the three most innovative and track-friendly trailer bogies in Europe.

Precise axle guidance is ensured by two guide pins, pressed into the bogie frame and by axle guide bushes. This arrangement permits both high running stability at high speeds and the radial adjustment of the wheelsets when negotiating curves.

Due to this innovative axle guidance, the wheel - track forces are reduced and the bogie becomes more track-friendly. The open H-frame of this bolster bogie is of flexible design.

The carbody is supported by slidingplates, mounted in a bolster which is connected with the bogieframe by the secondary suspension system. The secondary suspension system consists of four steel flexicoil springs for each bogie.



The springs do, however, only transmit longitudinal, transversal and vertical movements, while rotational movements are restrained due to a torsion resistant bolster / bogieframe connection.

Rotational movements of the bogie around the pivot are damped with respect to the carbody by the friction plates mounted in the bolster.

The free lateral spring travel of ± 60 mm is restricted by a curve-dependent limitation of lateral play, thus ensuring high ride quality and adherence to vehicle gauge in accordance to UIC.

Depending on customer requirements and running speed, two or three disc brakes per wheelset and a magnetic track brake are provided.

Technical Data	
Bogie	SF 300
Running speed	200 km/h (tested up to 330 km/h)
Axle load	16 t
Wheelbase	2500 mm
Track gauge	1435 mm
Wheel diameter new / worn	920 / 860 mm
Smallest radius of curvature in service / workshop	150 / 80 m
Bogie height	994 mm
Weight incl. track brake	app. 7,1 t
Mechanical brake	Disc brake / optional electromagnetic track brake

References:
ÖBB / Austria
CD / Czech Republic
PKP / Poland
OSE / Greece
ISR / Israel
ZSR / Slovakia

SF 400

Trailer Bogie for Passenger Coaches

The bogie family SF 400, was designed for push-pull service in locomotive-hauled passenger coaches. The maximum operational speed is 280 km/h.

The bogies for both, end- and centre coaches are equipped with airspring-systems and can be used for single and double-deck coaches.

During the development of this bogie family, a lot of theoretical and practical investigations were performed together with Deutsche Bahn AG, in order to design a modern, high performance and comfortable bogie family with high reliability and low life cycle cost.

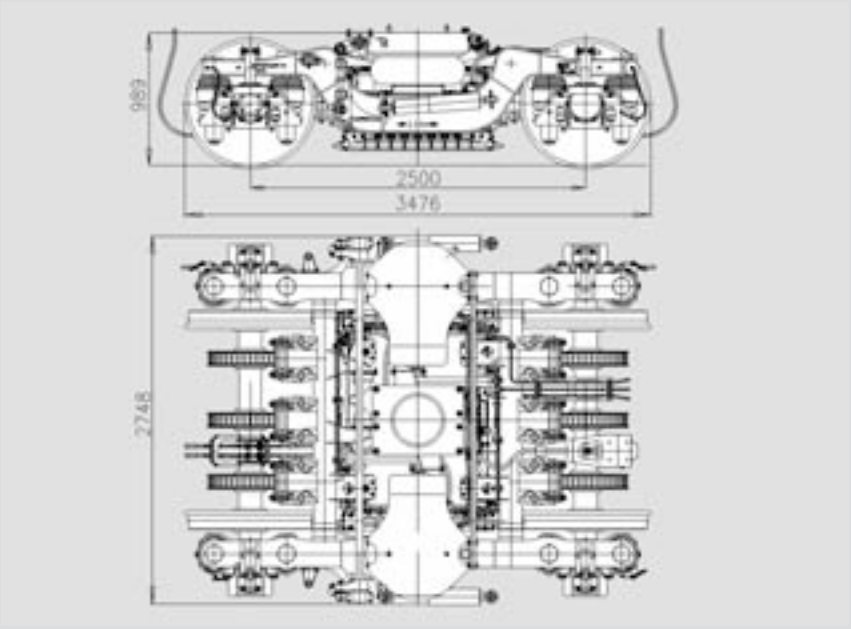
The concept of the SF 400 enables the production of high performance bogies for a lot of applications, due to its modular design.

The principle of the wheelset guidance was derived from the service-proven bogie SF 300 and consists of two pins that are pressed in the bogieframe and two guiding bushes in the axle box. This kind of wheelset guidance does not need any maintenance during the relevant maintenance intervals and is more or less free of wear.

The open H-shaped bogieframe is a high-sophisticated light weight design with a low torsion resistance. Between the two longitudinal beams, there are two transversal beams with brackets for the disc-brake units.

Depending on the requirement, the bogies can be equipped with three or four brakeunits. Spring applied brake units and magnetic track-brakes are optionally available.

The secondary suspension system is designed as a controlled airspring-system. Both airsprings are mounted in serial with a rubber emergency spring. This ensures operation with maximum speed, even when the airspring is deflated.



For damping of lateral and vertical movements, hydraulic dampers are installed.

The transmission of braking and acceleration forces between bogie and carbody is performed by a king pin, a yoke and two guiding rods.

References:
The bogie SF 400 – ICE® is in service in 264 center- and 44 end-coaches of ICE®2 with an operational speed of 280 km/h. A bogie of this family is in service in 324 doubledeck coaches of the Austrian Federal Railways. Further applications for this type of bogie are in couchette- and sleeping coaches for DB AG and ÖBB.
In 2004, a contract was concluded to equip 332 doubledeck coaches for Trenitalia with SF 400 bogies. 36 bogies are in service in cars of F.E.R / Italia and 10 "hotel – coaches" of Austrian Federal Railways are equipped with SF 400 bogies.
The new high-comfort and high-speed train of Austrian Federal Railways "railjet" is equipped with SF 400 bogies as well and will go in service in Dec. 2008.
In 2008, a contract for 100 bogies was concluded to equipe doubledeck coaches in cooperation with Changchun Railway Vehicles Co., Ltd (CRC).

Technical Data	
Bogie	SF 400
Running speed	up to 280 km/h
Axle load	17 t
Wheelbase	2500 mm
Track gauge	1435 mm
Wheel diameter new / worn	920 / 860 mm
Smallest radius of curvature in service / workshop	150 / 80 m
Bogie height	989 mm
Weight incl. track brake	app. 7,1 t
Mechanical brake	Disc brake / optional electromagnetic track brake

SF 30 C LFW

Trailer Bogie for Low Floor Tram Car

The bogie SF 30 C LFW is in service for the low floor tram Combino and has been in production since 1998.

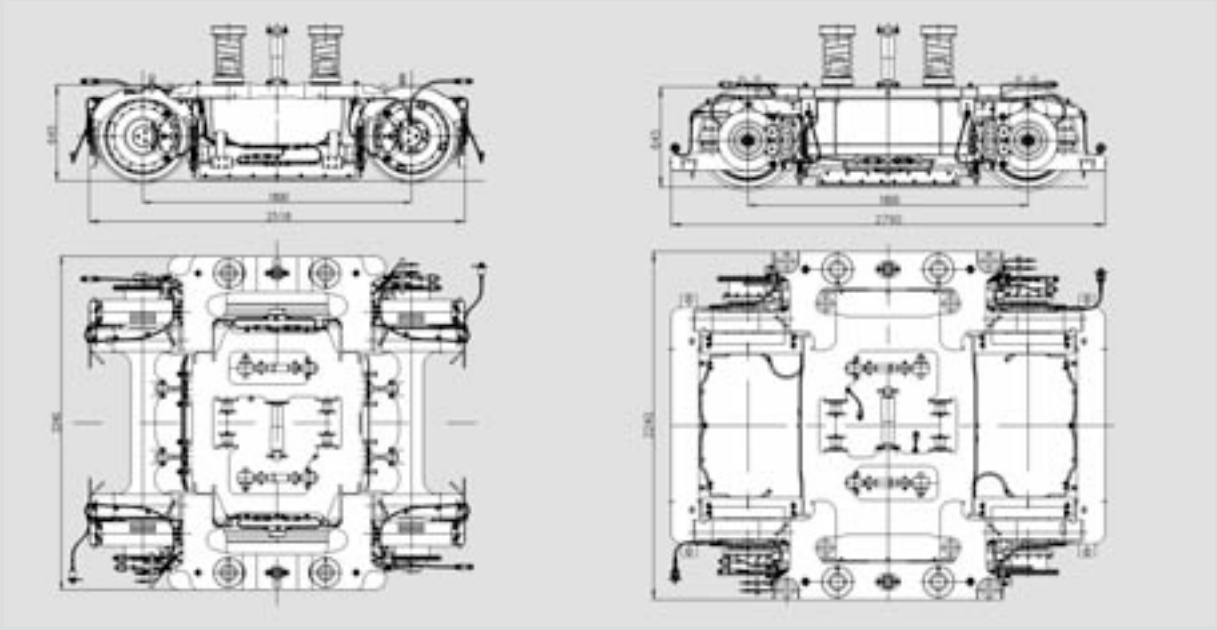
It allows for a floor height of 350 mm above TOR throughout the whole length of the car. The bogie family SF 30 C was developed in 1996 and allows for a high degree of modularity as well as the car design itself. The running gears are available for standard and meter gauge.

With regards to its vertical axis, the bogie has a torsion-resistant connection to the carbody by means of two longitudinal rods. This ensures optimum aisle width between the wheel guards.

The primary suspension is a conical rubber-metal-spring with good self-damping characteristics that guarantees elastic wheelset guidance in longitudinal and lateral direction.

The lateral secondary suspension is a coil spring combined with an additional rubber spring that effects a progressive spring characteristic.

The damping of vertical and lateral oscillations is realized by the use of hydraulic dampers.



The axle beam for the stub axle is a cast or forged design. Rubber suspended wheels are mounted on this axle beam in combination with tapered roller bearings. The wheel diameter is 600 mm new and 520 mm worn.

The stub axle has one ground brush for the basic variant. Optionally two ground brushes per axle can be mounted.

Each running gear is equipped with 4 brake discs and 4 active brake calipers as service brake. Optionally a magnetic track brake can be mounted. The bogie frame is a H-shaped combination of plates, cast and forged parts.

References:

Standard gauge
Potsdam
Hiroshima
Düsseldorf
Amsterdam
Melbourne
Posen

Meter gauge
Freiburg
Augsburg
Erfurt
Basel
Bern
Ulm

Technical Data	
Bogie	SF 30 C LFW
Running speed	70 km/h
Axle load	2 x 10 t
Wheelbase	1800 mm
Track gauge	1435 mm / 1000 mm
Wheel diameter new / worn	600 / 520 mm
Smallest radius of curvature	15 m
Weight	3 / 3,2 t
Additional equipment	wheel noise absorbers

SF 30 C TFW

Motor Bogie for Low Floor Tram Cars

The bogie SF 30 C TFW is in service for the low floor tram Combino and has been in production since 1998.

It allows for a floor height of 350 mm above TOR throughout the whole length of the car.

The bogie family SF 30 C was developed in 1996 and allows for a high degree of modularity as well as the car design itself. The bogies are available for standard and meter gauge.

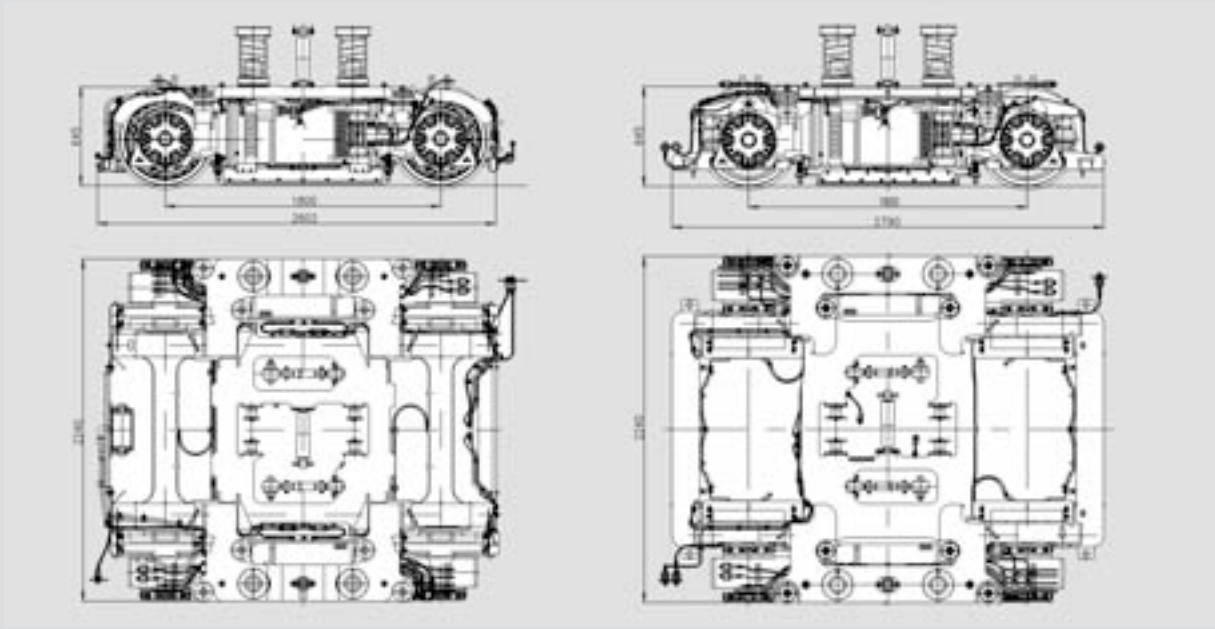
With regards to its vertical axis, the bogie has a torsion-resistant connection to the carbody by means of two longitudinal guides. This ensures optimum aisle width between the wheel guards.

The bogie is equipped with completely suspended traction drive units with self ventilated three-phase asynchronous motors. The wheels of these motors are arranged in line and speed-coupled by means of the motor gearing unit. This design gives the bogie excellent axle guidance characteristics such as self-centering and low tendency to lateral oscillation.

The traction drive units, equipped with spring-loaded brakes, are arranged at the side so that all major traction and brake components can easily be reached. As a result nearly all maintenance work can usually be performed without the need for a pit. The complete traction drive units can even be removed and installed without having to lift the vehicle or remove the bogies.

The torque transmission from the traction motor to the front and rear wheel is effected by a low-noise bevel gear and two cardanic spider couplings, which are arranged at different levels. Primary suspension features rotationally symmetrical rubber-metal springs with good selfdamping characteristics ensuring longitudinally and laterally flexible wheelset guidance.

Secondary suspension features steel helicoil springs, combined with additional rubber springs giving progressive spring characteristic for good ride quality in all load conditions. Vertical and lateral movement is damped hydraulically.



The stub axle of cast or forged design is equipped with an earthing contact, which is accessible from the vehicle side. If required each wheel can be equipped with a grounding device.

The wheel diameter for both standard and meter gauge bogies is 600 mm (new) and 520 mm (worn). To reduce wheel squeal, noise absorber can be mounted.

The bogie frame is a H-shaped combination of plates, cast and forged parts.

References:

Standard gauge
Potsdam
Hiroshima
Düsseldorf
Amsterdam
Melbourne
Posen

Meter gauge
Freiburg
Augsburg
Erfurt
Nordhausen
Basel
Bern
Ulm

Technical Data	
Bogie	SF 30 C TFW
Running speed	70 km/h
Axle load	2 x 10 t
Wheelbase	1800 mm
Track gauge	1435 mm / 1000 mm
Wheel diameter new / worn	600 / 520 mm
Smallest radius of curvature	15 m
Weight	4,3 / 4,5 t
Additional equipment	Sanding, wheel flange lubrication system, wheel noise absorbers

SF 30 Combino plus TFW / LFW

Motor Bogie for Low-Floor Tramcars

The bogie SF 30 Combino GT is in service for the low floor tram Combino plus and is a further development of the bogies which are in service since 1998.

In opposition to the original Combino-concept, the new bogies are located in the centre of the carbody modules which requires a swivelling angle of app. 4,5°. The floor height of 350 mm above TOR throughout the whole length of the car, however, remains the same for the new concept.

It allows for a floor height of 350 mm above TOR throughout the whole length of the car.

For the further development the conceptual differences for motor bogie and trailer bogie are limited to traction and brake units.

The transmission of longitudinal forces is realized via a longitudinal rod containing two rubber bushes.

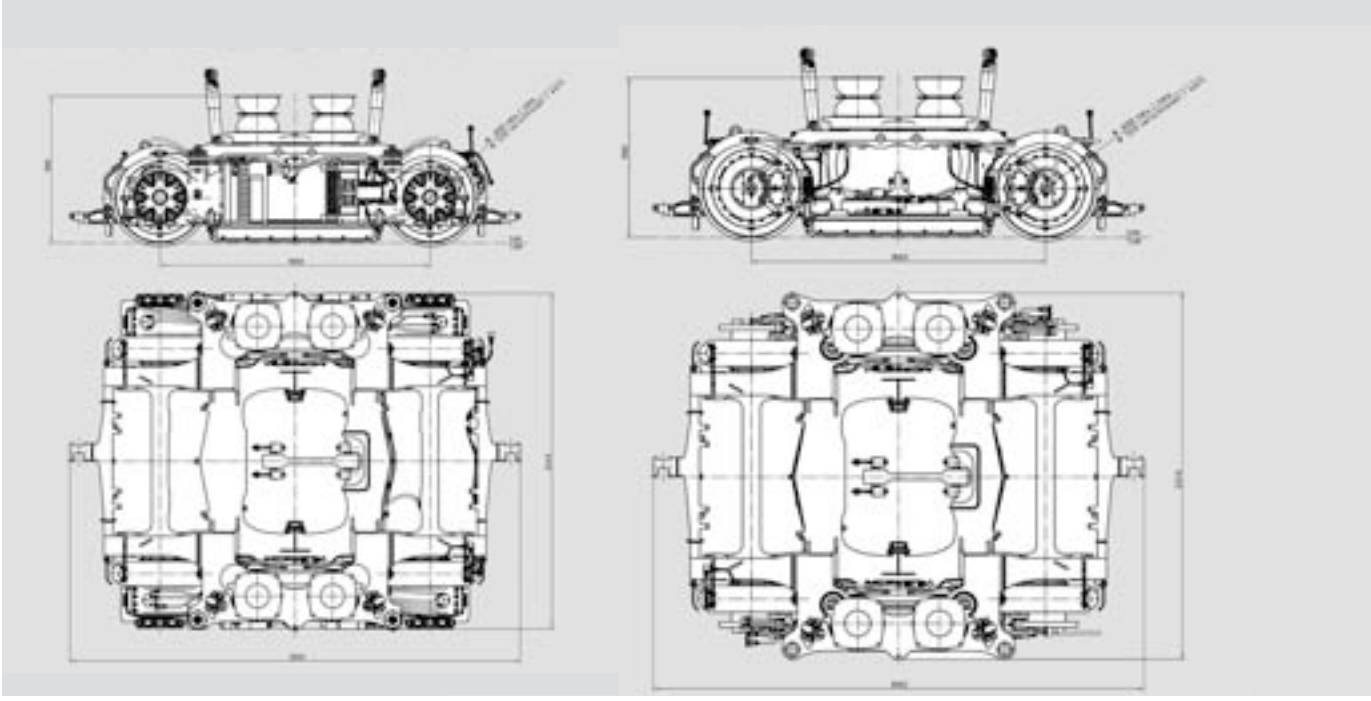
The secondary suspension is performed by 4 rubber springs (hourglass springs), which allow a higher lateral movement than steel coil springs.

For primary suspension the same conical rubber springs as for the original bogie design are applied.

The motor bogies with the outboard longitudinal traction units have small unsprung mass and a low centre of gravity compared with other 100% low floor bogies.

The motor bogie is equipped with completely suspended traction drive units with self ventilated three-phase asynchronous motors. The wheels of these motors are arranged in line and speed-coupled by means of the motor gearing unit. This design gives the bogie excellent axle guidance characteristics such as self-centering and low tendency to lateral oscillation.

The traction drive units are equipped with spring-loaded brakes, with the brake disc directly arranged on the motor shaft. This allows an easy access to all major traction and brake components. As a result nearly all maintenance work can usually be



performed without the need for a pit. The complete traction drive units can even be removed and installed without having to lift the vehicle or remove the bogies.

The torque transmission from the traction motor to the front and rear wheel is effected by a low-noise bevel gear and two cardanic spider couplings, which are arranged at different levels.

For the trailer bogie the brake disc is directly flanged to the wheel. Braking is carried out by active brake callipers.

The stub axle is of cast or forged design and carries tapered roller bearings. The wheel diameter for both motor and trailer bogie is 600 mm (new) and 520 mm (worn). To reduce wheel squeal, noise absorber can be mounted.

The bogie frame is a combination of plates, cast, forged parts and a head beam integrated on both of its ends.

References:
Metro Sul do Tejo
Budapest

Technical Data	
Bogie	SF 30 C TFW
Running Speed	70 km/h
Axle load	2 x 10 t
Continuous power	2 x 100 KW
Wheelbase	1800 mm
Track gauge	1435 mm
Wheel diameter new / worn	600 / 520 mm
Smallest radius of curvature	15 m
Weight	4,9 t
Addidional equipment	Sanding, wheel flange lubrication system wheel noise absorbers

SF 40

Trailer Bogie for 70 % Low Floor LRV Avanto / S 70

The SF 40 bogie is designed for the Avanto / S70 LRV with a floor height of 381 mm above the bogie.

The SF 40 has new requirements concerning speed and ride quality and it also allows for a higher axle load than previous low floor applications.

The new Avanto / S70 combines the advantages of high speed with all the convenience of a 70 % low floor car. Only one step is required for the transition between low and medium floor height areas.

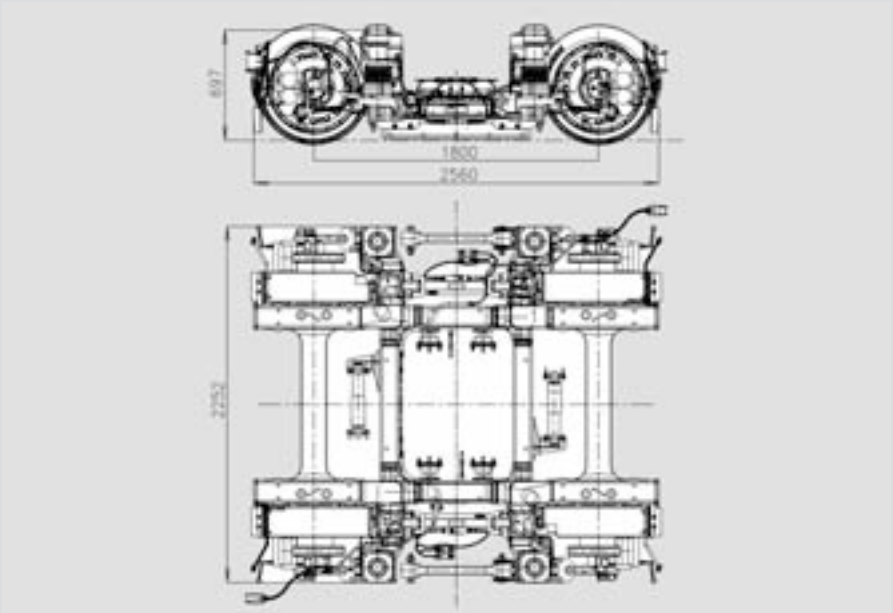
The SF 40 is in use under the short car-sections of the 3-section vehicle S 70 and the 5 section vehicle Avanto. With regards to its vertical axis, the bogie has a torsion-resistant connection to the carbody by means of two longitudinal rods. This ensures optimum aisle width between the wheel guards.

The secondary suspension is realised with 4 coil spring in combination with a rubber spring. As an option 4 hydropneumatic springs can be integrated to increase riding comfort and to allow load levelling.

For lateral suspension rubber buffers are mounted between the carbody and the bogie frame.

The bogie frame is H-shaped and a combination of rectangular tubes and cast parts.

The primary suspension features conical springs of metal rubber design with good self-damping characteristics, ensuring a flexible axle guidance in lateral direction.



The axle beam for the stub axle is a cast design. Rubber suspended wheels are mounted on this axle beam in combination with tapered roller bearings. The wheel diameter is 660 mm new and 580 mm worn.

For the basic variant the stub axle has one ground brush. As an option it is possible to mount two ground brushes per axle.

Each running gear is equipped with 4 brake discs and 4 active brake calipers as service brakes. Spring loaded brake units can be mounted optionally.

Another characteristic is the ground clearance of 100 mm between the wheels. This allows unrestricted operation on railroad lines (even in France acc. to UIC 505-1) regarding wheel wear.

References:
Houston / USA
San Diego / USA
Paris / France
Charlotte / USA
Portland / USA
Salt Lake City / USA
Norfolk / USA
Mulhouse / France

Technical Data	
Bogie	SF 40
Running speed	106 km/h
Axle load	2 x 11,5 t
Wheelbase	1800 mm
Track gauge	1435 mm
Wheel diameter new / worn	660 / 580 mm
Smallest radius of curvature	25 m
Weight	3,6 t
Additional equipment	HP-suspension, spring applied brake calipers, wheel noise absorbers

SF 70

Motor Bogie for 70 % Low Floor LRV Avanto / S 70

The SF 70 bogie family is designed for the Avanto / S 70 LRV with a floor height of 655 mm above the bogie.

It is a new generation of bogies for 70 % LRV´s. The SF 70 has new requirements concerning speed and ride quality.

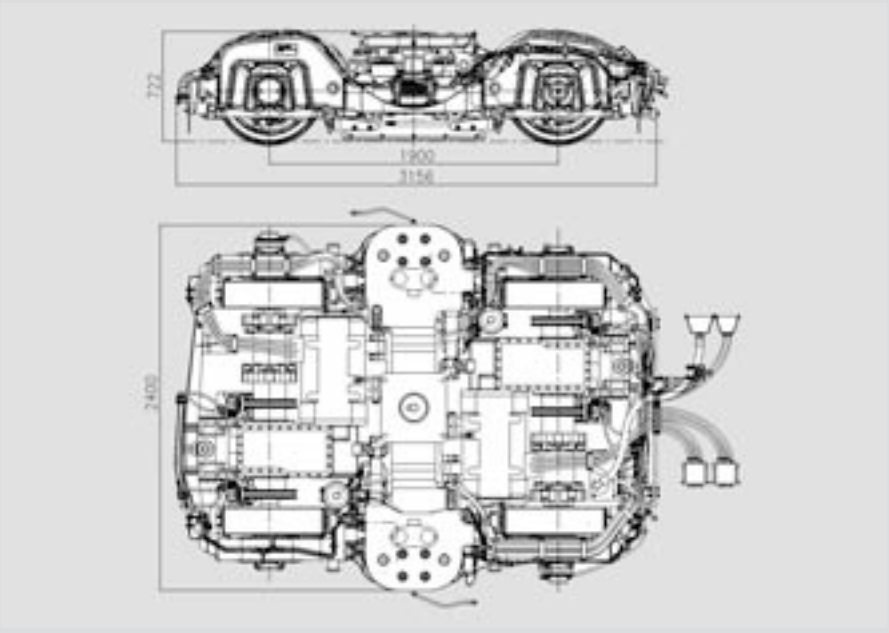
The new Avanto / S 70 combines the advantages of high speed with all the convenience of a 70 % low floor car. Only one step is required for the transition between low and medium floor height areas.

The SF 70 is a conventional bogie, which is able to swivel below the carbody by an angle of 12°. Therefore the bogie has a bolster, which is connected to the bogie frame with 2 traction rods. Longitudinal forces between the bolster and carbody are transmitted by a centre pivot. Friction plates are arranged between the bolster and the carbody in order to increase the swivel resistance and consequently the stability at higher speed.

The bolster itself is supported by four steel coil springs. As an option 2 hydropneumatic springs can be integrated to increase riding comfort and to allow load levelling.

For lateral suspension rubber buffers are mounted between the bolster and the bogie frame.

The bogie frame is H-shaped and a combination of plates and cast parts. The headbeam, which is connected to the bogie frame with rubber elements, is an additional support of the traction unit.



The primary suspension features laminated springs of metal rubber design (chevron spring) with good self-damping characteristics, ensuring laterally flexible axle guidance.

The traction unit comprises a laterally arranged self-ventilate three-phase asynchronous motor and a spur gear. The connection between axle and gearbox is realised with a hollow shaft and a spider coupling, which allows horizontal and vertical displacements. The traction units are completely suspended in the bogie frame to minimise unsprung mass.

The hydraulic spring loaded disc brake is mounted on the gear box. Depending on the required braking performance one or two brake callipers can be mounted for each axle. The brake discs mounted on the hollow shaft have a diameter of 360 mm.

References:
Houston / USA
San Diego / USA
Paris / France
Charlotte / USA
Portland / USA
Salt Lake City / USA

Technical Data	
Bogie	SF 70
Running speed	106 km/h
Continuous power per wheelset	140 KW
Axle load	2 x 10,5 t
Wheelbase	1900 mm
Track gauge	1435 mm
Wheel diameter new / worn	660 / 580 (610) mm
Smallest radius of curvature	25 m
Weight	5,7 t
Additional equipment	HP-suspension, wheel flange lubrication, noise absorbers

SF 90 TDG and LDG

Bogies for High Floor LRV

The bogie SF 90 was designed for the SD 160 LRV with a floor height of 1000 mm. Variations of this bogie family are in use in Calgary, Denver, Salt Lake City etc.

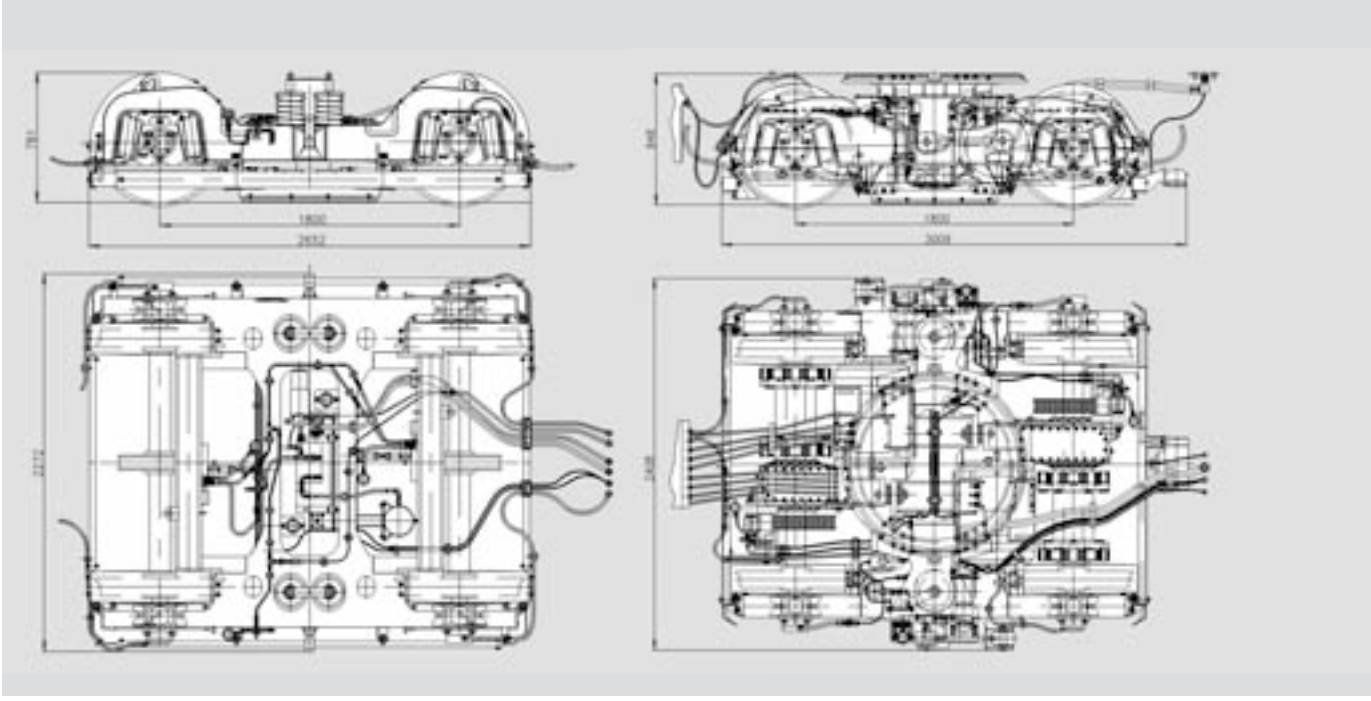
Two basic model variations can be supplied in accordance with the arrangement under the carbody.

Motor bogie - SF 90 TDG
Trailer bogie - SF 90 LDG

The motor bogies SF 90 have a bolster beam and can be pivoted with the carbody around the high axis via the ball bearing slewing ring.

The bogie bolster beam is joined to the bogie frame by means of two longitudinal rods. The primary suspension has rubber-metal chevron springs with good self-damping guaranteeing longitudinal and lateral elastic axle guidance. The secondary suspension has a steel coil spring. Vertical and longitudinal vibrations are hydraulically damped.

The motor bogies SF 90 are equipped with completely suspended drives. The gear unit and the wheelset axle are connected via a hollow shaft and a spider coupling.



The drive unit consists of a laterally arranged, self-ventilated three phase asynchronous motor and a low-noise spur gear unit.

The vehicles have an electro-hydraulic brake system. For the motor wheelset the brakedisc is fixed to the hollow shaft. The spring loaded brake unit is mounted directly to the gearbox.

For the trailer bogie the brake disc is mounted on the axle. The brake calliper is hung on an additional transversal beam for that application.

References:
Salt Lake City
Calgary
Denver
Edmonton

Technical Data	
Bogie	SF 90 TDG / LDG
Running speed	100 km/h
Continuous power per wheelset	140 KW
Axle load TDG / LDG	2 x 11,0 / 2 x 9,0 t
Wheelbase	1800 mm
Track gauge	1435 mm
Wheel diameter new / worn	720 / 660 mm
Smallest radius of curvature	25 m
Weight	5,5 / 3,5 t
Additional equipment	wheel flange lubrication, noise absorbers, sanding

SF 1000

Motor and Trailer Bogies for Light Rail Metro Vehicles

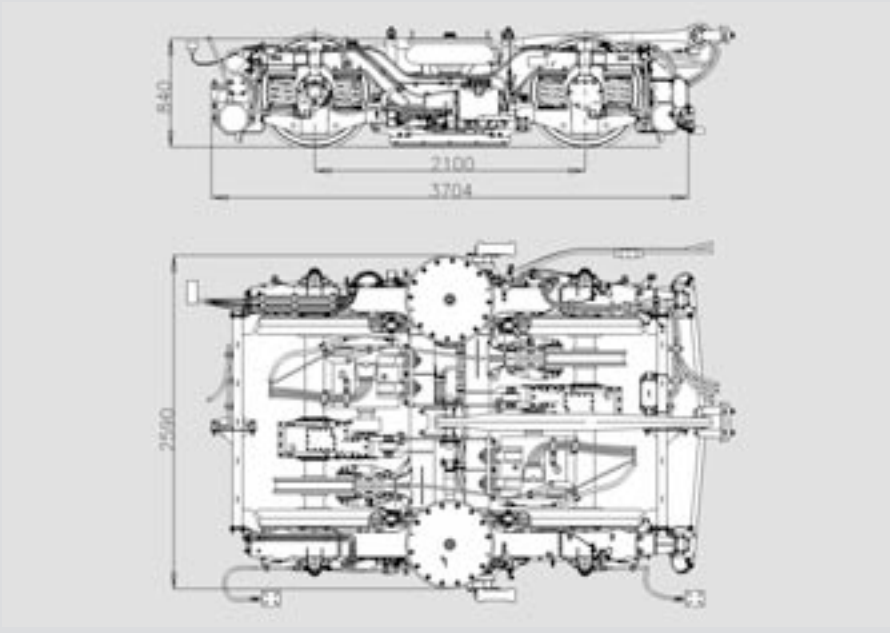
The SF 1000 motor and trailer bogies are designed for use on light weight metro vehicles with a maximum speed of 80 km/h. The maximum axle load is 13 t.

The modular bogie family SF 1000 is designed for high performance with low life cycle cost.

This bogie family is of modular design causing to a reduction in the number of different components required and thus resulting in rationalisation of manufacture.

The wheelbase of 2100 mm enables the bogies to be track friendly and particularly suitable for negotiating small radii of curvature.

The primary suspension system is equipped with pairs of steel coil springs. Rubber guidance elements inside of the springs provide axle guidance free from play.



The secondary suspension system features air springs and offers optimum ride quality as well as the possibility of level adjustment.

The secondary longitudinal guidance is achieved by low connected guides (traction rod). This arrangement ensures low wheel load reduction.

One disc brake per wheelset is provided as mechanical brake. The installation of magnetic rail brakes is also provided (option).

References:
Metro Nürnberg
Metro Oslo

Technical Data	
Bogie	SF 1000
Types	Motor and trailer bogies
Running speed	80 km/h
Axle load	13 t
Continuous power per wheelset	140/190 kW
Wheelbase	2100 mm
Track gauge	1435 mm
Wheel diameter new / worn	850 / 770 mm
Smallest radius of curvature in service / workshop	90 / 70 m
Weight	6,7 / 5,0 t
Bogie height	840 mm
Secondary transmission of longitudinal forces	Traction rod
Primary suspension	Steel coil spring with rubber guidance
Traction unit	Fully suspended drive and partially suspended gear
Mechanical brake	1 disc brake per wheelset

SF 1000 HS

Motor and Trailer Bogies for Light Rail Metro Vehicles

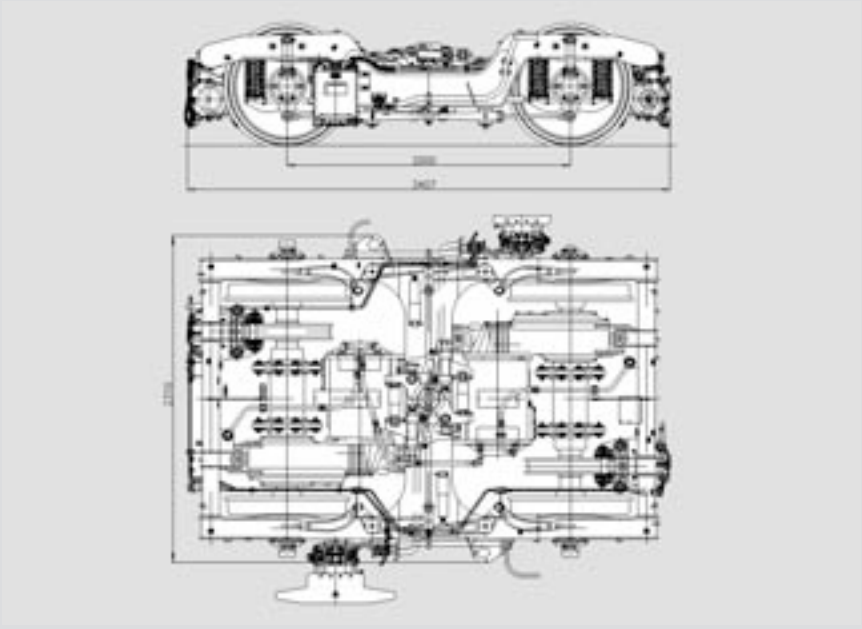
The SF 1000 HS motor and trailer bogies are designed for use on light weight metro vehicles (Metro Vienna) with max speeds of 80 km/h.

The maximum axle load is 11,5 t. The bogies are carried out with two axles, air-springs and steering wheelsets.

The wheelbase of 2000 mm allows the bogies to be track friendly and particularly suitable for negotiating small radii of curvature.

The primary suspension consists of four coil springs per wheelset, mounted between the bogie frame and the axle box. The coil springs have the function of an axle guidance and primary suspension.

The steering wheelsets are ensured from a lever mechanism. The lever mechanism provides the radial adjustment of the wheelsets.



The secondary suspension system features air springs and offers optimum ride quality as well as the possibility of level adjustment in the secondary suspension.

The secondary longitudinal guidance is achieved by low connected guides (center pivot). This arrangement ensures low wheel load reduction.

One disc brake per wheelset is provided as mechanical brake for the motor bogies. Two disc brakes per wheelset are provided as mechanical brake for the trailer bogies.

References:
Metro Vienna

Technical Data	
Bogie	SF 1000 HS
Types	Motor and trailer bogies
Running speed	80 km/h
Axle load	11,5 t
Continuous power per wheelset	160 kW
Wheelbase	2000 mm
Track gauge	1435 mm
Wheel diameter new / worn	840 / 760 mm
Smallest radius of curvature in service / workshop	100 / 50 m
Weight	6,4 / 4,4 t
Bogie height	787 mm
Secondary transmission of longitudinal forces	center pivot
Traction unit	Fully suspended
Mechanical brake (motor bogie)	1 disc brake per wheelset
Mechanical brake (trailer bogie)	2 disc brake per wheelset

SF 2000

Motor and Trailer Bogies for Heavy Metro Vehicles

The SF 2000 motor and trailer bogies are designed for mass rapid transit vehicles such as urban rail vehicles and metro cars, with maximum car weight of 65 t, installed output up to 1000 kW and running speeds usual for this type of rail vehicles.

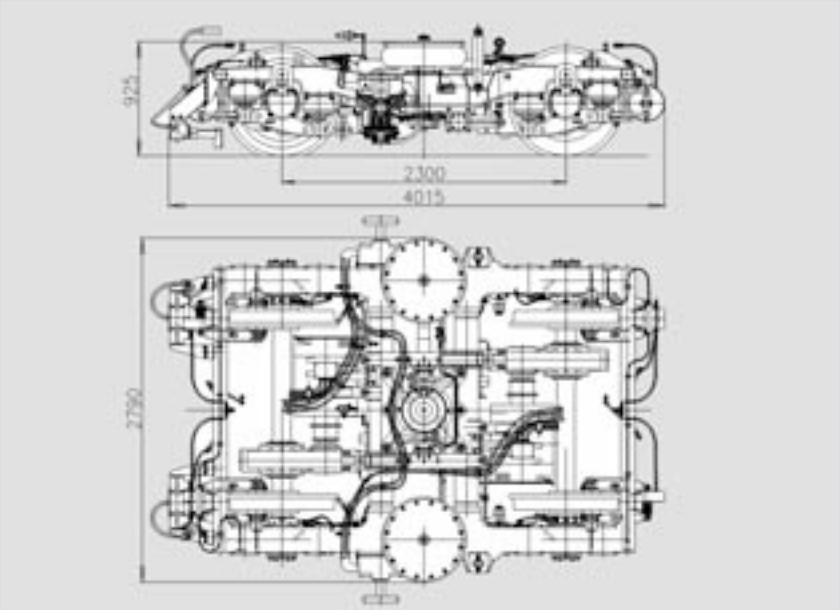
The SF 2000 bogie is a further development of the bogie for railcar series 4020, in revenue service on the Austrian Federal Railways since the seventies.

This bogie ensures low wheel wear, even under poor track conditions. Careful design calculation on running characteristics lead to optimum suspension stages for high ride quality under all operating conditions.

The motor and trailer bogies are basically of identical design, except for the fact that the traction unit is additionally fitted in the motor bogie. This reduces the number of components required and simplifies spare part stockkeeping.

Primary suspension comprises laminated conical sleeve springs of metal rubber design, which are fitted between the axle box and the bogie frame. The conical springs take over the function of axle guidance and primary suspension. Due to there special design, separate primary dampers are not required.

The low primary suspension stage gives an extremely flat, sturdy bogie frame with headbeam.



The wheelbase of 2300 mm gives optimum curving performance resulting in reduced wheel/rail wear and low space requirements beneath the vehicle.

The levelling valve ensures that the same floor height can be maintained under varying load conditions.

The three phase motors are fixed on the bogie frame and are arranged laterally in the bogie. Torque transmission from the lateral traction motors caused by a partially suspended low noise spur gear per axle together with a spiral toothed coupling. By separating the spiral toothed coupling, the axle and gear unit can be replaced without dismantling the traction motor.

The bogie is equipped with four wheel disc brakes, offering the advantage of low rolling noise. Brake units are arranged on the outside and allow easier access for maintenance work.

References:
TRTC Taipei
BTS Bangkok
MRTA Bangkok

Technical Data	
Bogie	SF 2000
Types	Motor and trailer bogies
Running speed	80 km/h
Axle load	16,2 t
Continuous power per wheelset	230 kW
Wheelbase	2300 mm
Track gauge	1435 mm
Wheel diameter new / worn	850 / 775 mm
Smallest radius of curvature in service / workshop	95 / 80 m
Weight	7,7 / 5,5 t
Bogie height	925 mm
Secondary transmission of longitudinal forces	Centre pivot
Traction unit	Motor fixed to frame, axle suspended gear
Mechanical brake	Wheel disc brake

SF 2100 IB

Motor and Trailer Bogies for Heavy Metro Vehicles

The SF 2100 IB motor and trailer bogies are designed for use on heavy weight metro vehicles with maximum speed of 100 km/h and a maximum axle load of 14 t.

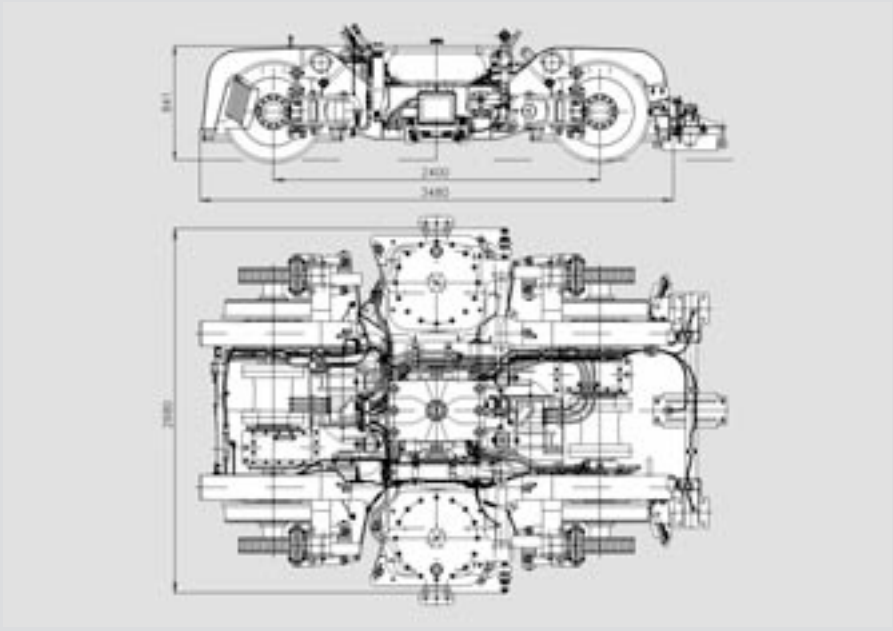
The bogies are designed with two axles, inner bearing, megi springs as a primary suspension and air spring as a secondary suspension.

The wheelbase of 2400 mm enables the bogies to be track friendly and particularly suitable for negotiating small radii of curvature.

The primary suspension system is equipped with chevron springs, ensuring good self damping characteristics and longitudinal and lateral flexible axle guidance.

The primary suspension is mounted between the bogie frame and the axle box. The chevron springs serves as an axle guidance and as a primary suspension.

The secondary suspension system features air springs and offers optimum ride quality as well as the possibility of level adjustment in the secondary suspension.



The secondary longitudinal guidance is achieved by a centre pivot pin. This arrangement ensures low wheel load reduction.

Axle mounted disc brakes are provided as mechanical brakes. We have developed an efficient bogie type of the highest reliability with perfect maintainability, high flexibility and excellent running behaviour.

References:
Metro Puerto Rico

Technical Data	
Bogie	SF 2100 IB
Types	Motor and trailer bogie
Running speed	100 km/h
Axle load	14 t
Continuous power per wheelset	150 kW
Wheelbase	2400 mm
Track gauge	1435 mm
Wheel diameter new / worn	710 / 635 mm
Smallest radius of curvature in service / workshop	150 / 80 m
Weight	6,8 / 4,8 t
Bogie height	841 mm
Secondary transmission of longitudinal forces	Center pivot pin
Traction unit	Motor and gear fixed to frame
Mechanical brake	Disc brake

SF 2500

Motor and Trailer Bogies for Metro Vehicles

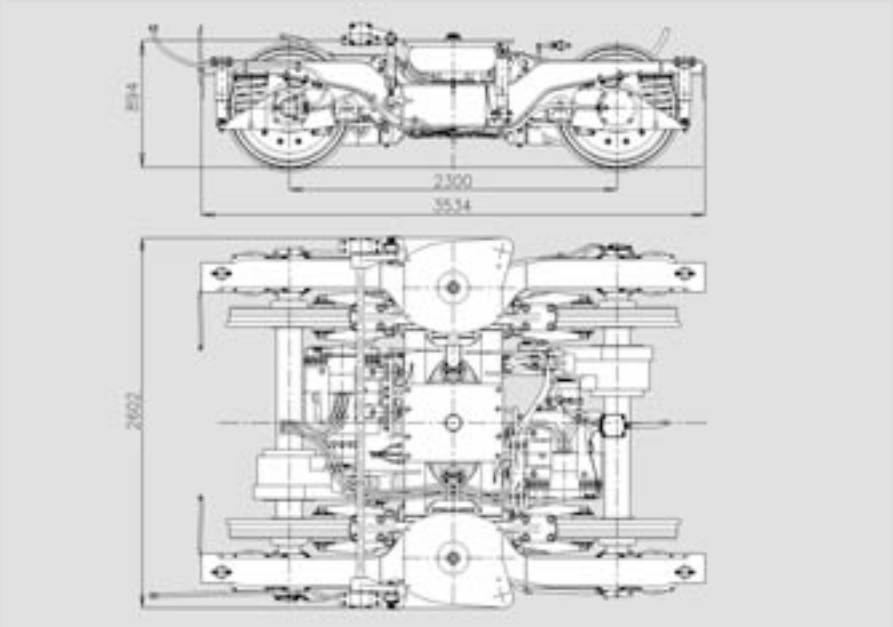
SF 2500 motor and trailer bogies are designed for mass rapid transit vehicles such as urban rail vehicles and metro cars, with maximum axle load of 14,5 t and running speed of 120 km/h.

SF 2500 bogie is a development which combines low installation space and short wheelbase with excellent running stability at high speed for metro appliances.

This bogie ensures low wheel wear, even under poor track conditions. Careful design calculation on vehicle dynamics leads to optimum suspension stages for high ride quality under all operating conditions.

Motor and trailer bogies are basically of identical design, except for the fact that the traction unit is additionally fitted in the motor bogie. This reduces the number of components required and simplifies spare part stock keeping.

The primary suspension system features an axle guidance rod. Primary springs are located next to the axle bearing box and consist in two concentric steel coil springs and one rubber element for electrical and acoustical insulation. This special design gives an extremely flat, sturdy bogie frame.



The secondary transmission of longitudinal forces is achieved by a traction rod. The secondary suspension system features air springs and offers optimum ride quality. The leveling valve ensures that a constant floor height can be maintained under varying load conditions.

The three phase motors are fixed on the bogie frame and are arranged laterally in the bogie. Torque transmission from the lateral traction motors caused by a partially suspended low noise spur gear per axle together with a curved toothed coupling.

By separating the curved toothed coupling, the axle and gear unit can be replaced without dismantling the traction motor.

The bogie is equipped with four pneumatic wheel disc brakes, offering the advantage of low rolling noise.

Technical Data	
Bogie	SF 2500
Types	Motor and trailer bogies
Running speed	120 km/h
Axle load	14,5 t
Continuous power per wheelset	230 kW
Wheelbase	2300 mm
Track gauge	1435 mm
Wheel diameter new / worn	840 / 770 mm
Smallest radius of curvature in service / workshop	250 / 150 m
Weight motor / trailer bogie	7,9 / 5,9 t
Bogie height	894 mm
Secondary transmission of longitudinal forces	Traction rod
Primary suspension	Axle guidance rod with helical springs
Traction unit	Motor fixed to frame, partially suspended gear
Mechanical brake	Wheel disc brake

References:
Guangzhou Line 3

SF 3000

Motor and Trailer Bogies for Heavy Rail Metro Vehicles

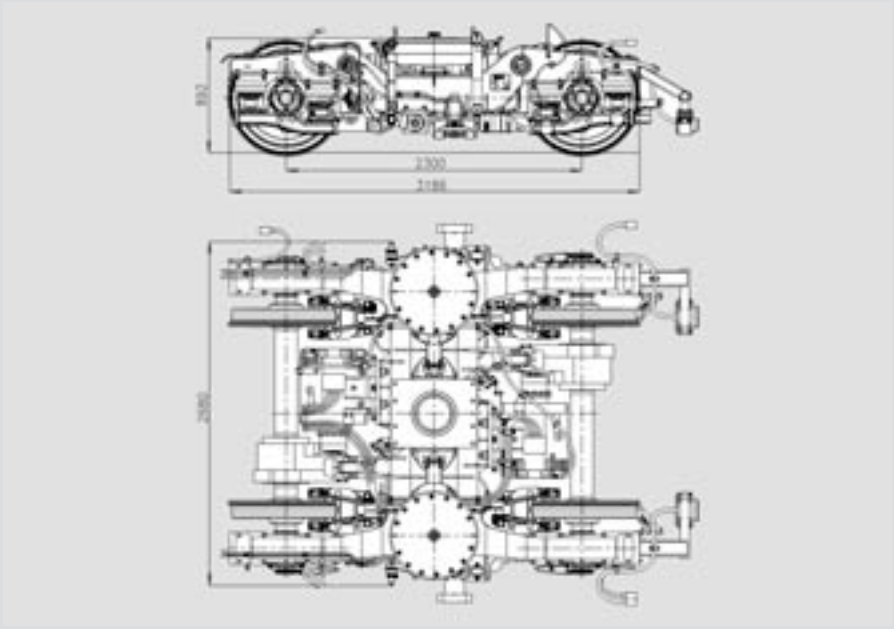
The SF 3000 motor and trailer bogies are designed for use on heavy weight metro vehicles with maximum speeds of 80 km/h and a maximum axle load of 17 t.

This bogie family is of modular design causing to a reduction in the number of different components required and thus resulting in rationalisation of manufacture.

The wheelbase of 2300 mm enables the bogies to be track friendly and particularly suitable for negotiating small radii of curvature.

The primary suspension system is equipped with pairs of conical rubber springs, ensuring good self damping characteristics and longitudinal and lateral flexible axle guidance.

The secondary suspension system features air springs and offers optimum ride quality as well as the possibility of level adjustment in the secondary suspension.



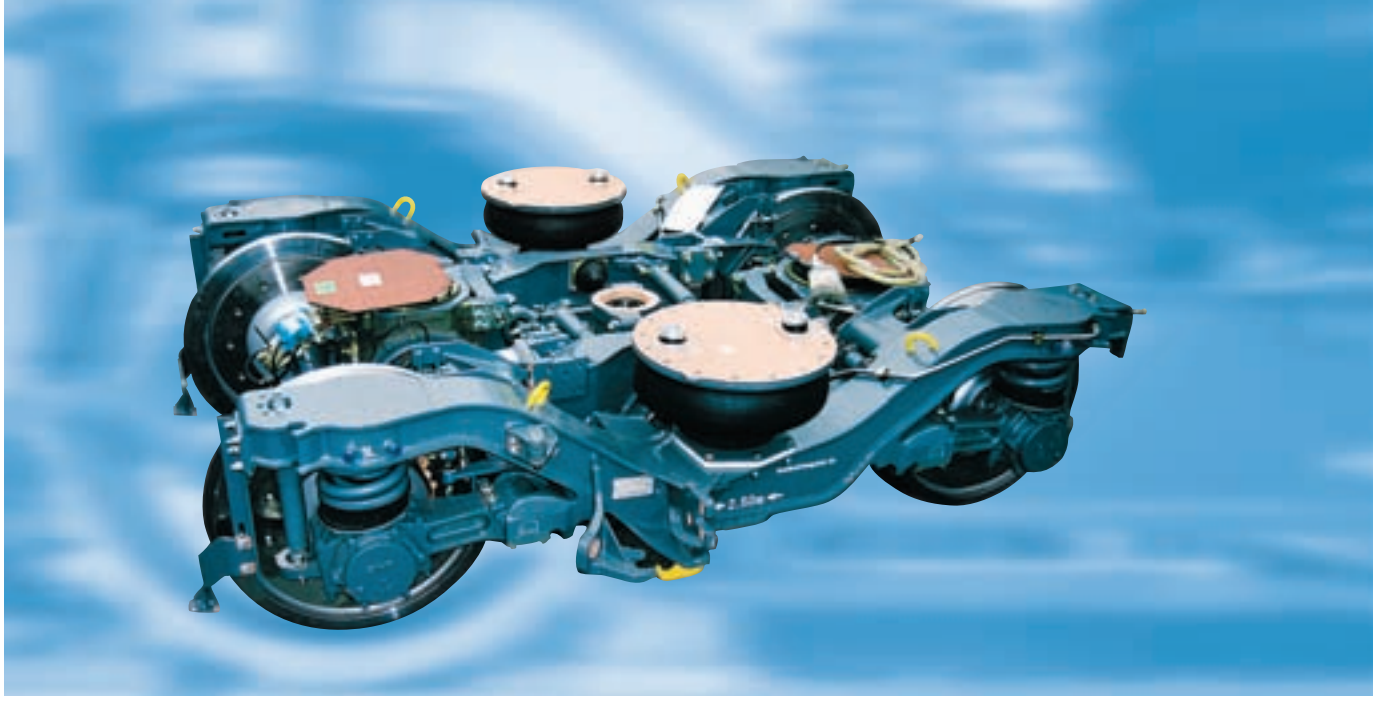
The secondary longitudinal guidance is achieved by traction rod.

Wheel disc brakes are provided as mechanical brake. The installation of magnetic rail brakes is also provided (option).

By use of proven design components (further development of the bogie SF2000) we have developed an efficient bogie family of the highest reliability with perfect maintainability, high flexibility and excellent running behaviour.

References:
KMRT Kaohsiung

Technical Data	
Bogie	SF 3000
Types	Motor and trailer bogies
Running speed	80 km/h
Axle load	17 t
Continuous power per wheelset	190 / 230 kW
Wheelbase	2300 mm
Track gauge	1435 mm
Wheel diameter new / worn	850 / 770 mm
Bogie height	892 mm
Smallest radius of curvature in service / workshop	100 / 80 m
Weight	8,1 / 6,1 t
Secondary transmission of longitudinal forces	Traction rod
Primary suspension	Conical rubber spring
Traction unit	Fully suspended drive, axle suspended gear
Mechanical brake	Wheel disc brake



SF 500 TDG and SF 500 LDG

Motor and Trailer Bogies for High Speed Trains

The SF 500 bogies were first used for the ICE® 3 (German Rail). Since then, there have been orders from the Netherlands State Railways (ICE® 3), the Spanish operator RENFE (Velaro E), the Chinese Ministry of Railways MoR (Velaro CN) and the Russian Railways RZD (Velaro RUS).

The bogies are designed for electric railcar trains and modern high-speed trains and provide optimum ride quality.

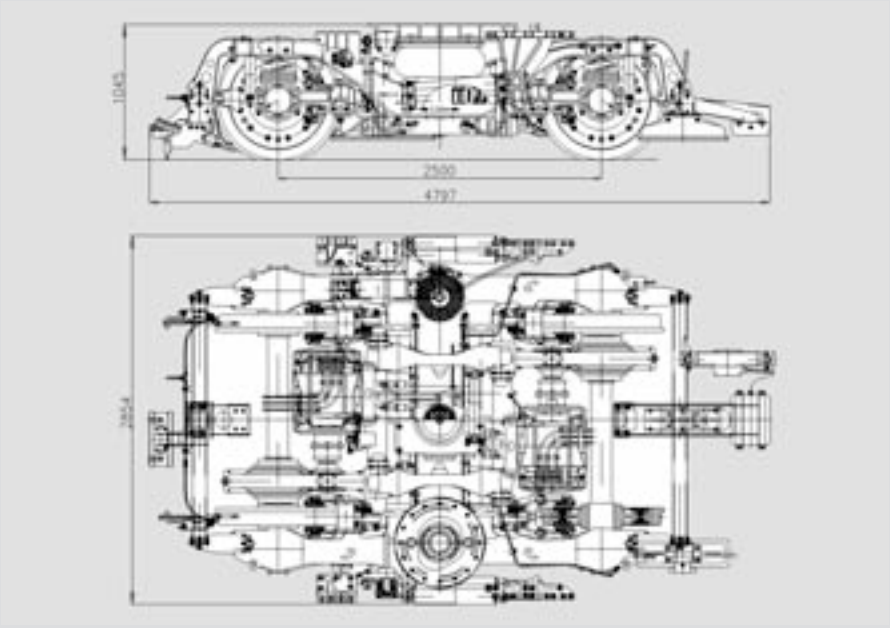
The modular design means that the SF 500 bogie can be designed both as motor bogies and as trailer bogies and can be fitted beneath carbodies with or without bolster.

Extensive calculations on running characteristics led to this design distinguished by its optimum stability and ride quality values as well as excellent axle guidance behaviour.

A service proven link system is used for axle guidance. Laminated guides can also be used as an alternative. The bogie frame is designed as a flexible, open H-Frame.

Excellent ride quality is achieved in the secondary suspension system by the high-tech air suspension system and the provision of large air volume. The pivot, the yoke and the two traction rods transmit the longitudinal forces.

Torque transmission from the lateral traction motor is achieved by a partially suspended, low-noise gear per axle together with spiral-toothed coupling.



Bogie traction motors are flexibly suspended in the bogie by a motor support structure and an innovative laminated spring damper system.

Suspension is designed taking running stability and acoustic requirements into consideration.

Redundant-type hydraulic yaw dampers are used to stabilise running behaviour at high speeds.

The trailer bogies are equipped with a mechanical brake system comprising disc brake (2,3 and 4 discs per axle) and a non-wear eddy-current brake. On the motor bogie, wheel disc brakes are used.

Technical Data	
Bogie	SF 500 TDG and SF 500 LDG
Types	Motor and trailer bogies
Running speed	up to 350 km/h
Axle load	17 t
Continuous power per wheelset	up to 500 kW
Max. starting tractive effort per wheelset	19 kN
Wheelbase	2500 mm
Track gauge	1435 mm
Wheel diameter new / worn	920 / 830 mm
Smallest radius of curvature in service / workshop	150 / 120 m
Bogie height	1045 mm
Weight with centre pivot and bolster	9,2 / 7,5 t

References:
ICE ® 3 - DB & NS
AVE® S103 – RENFE
Velaro RUS – Russia RZD
Velaro CN – MOR China

SF 500 DSW

Motor Bogies for Double Deck-Trains

The SF 500 DSW bogies are a further development of the SF 500 bogies, which are in use on the ICE® 3 of the Deutsche Bahn AG

They were designed for electric railcar trains and modern high-speed trains. They provide optimum ride quality.

The SF 500 DSW was designed to meet all requirements of modern double-deck EMUs with low floor entrance.

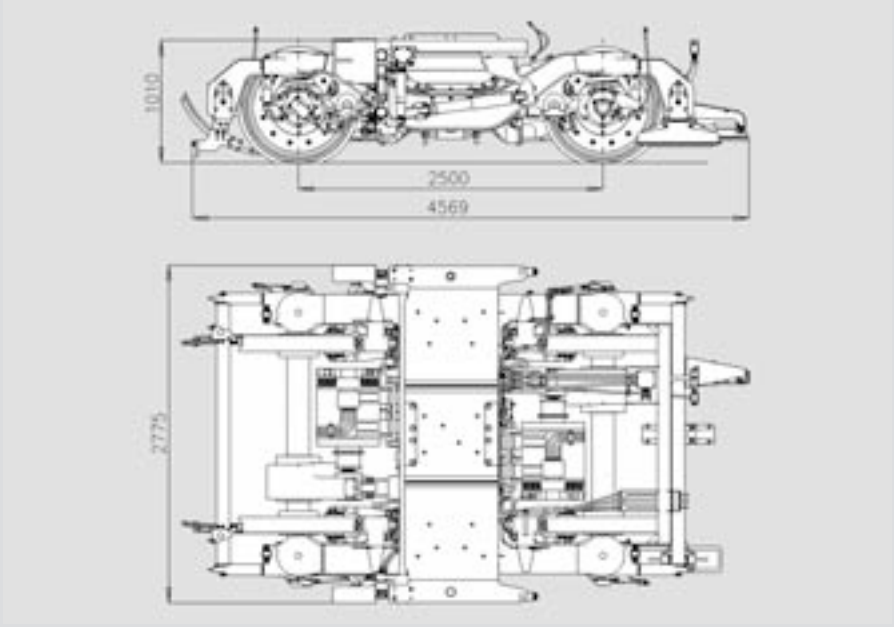
Extensive calculations on running characteristics led to this design distinguished by its optimum stability and ride quality values as well as excellent axle guidance behaviour.

The bogie frame is designed as a H-Frame.

A service proven link system is used for axle guidance. Primary suspension is provided by steel coil springs.

Excellent ride quality is achieved in the secondary suspension system by the high-tech air suspension system and the provision of large air volume.

The pivot, the yoke and the two traction rods transmit the longitudinal forces.



Torque transmission from the lateral traction motor is achieved by a partially suspended, low-noise gear per axle together with spiral-toothed coupling.

Both bogie traction motors are flexibly suspended in the bogie.

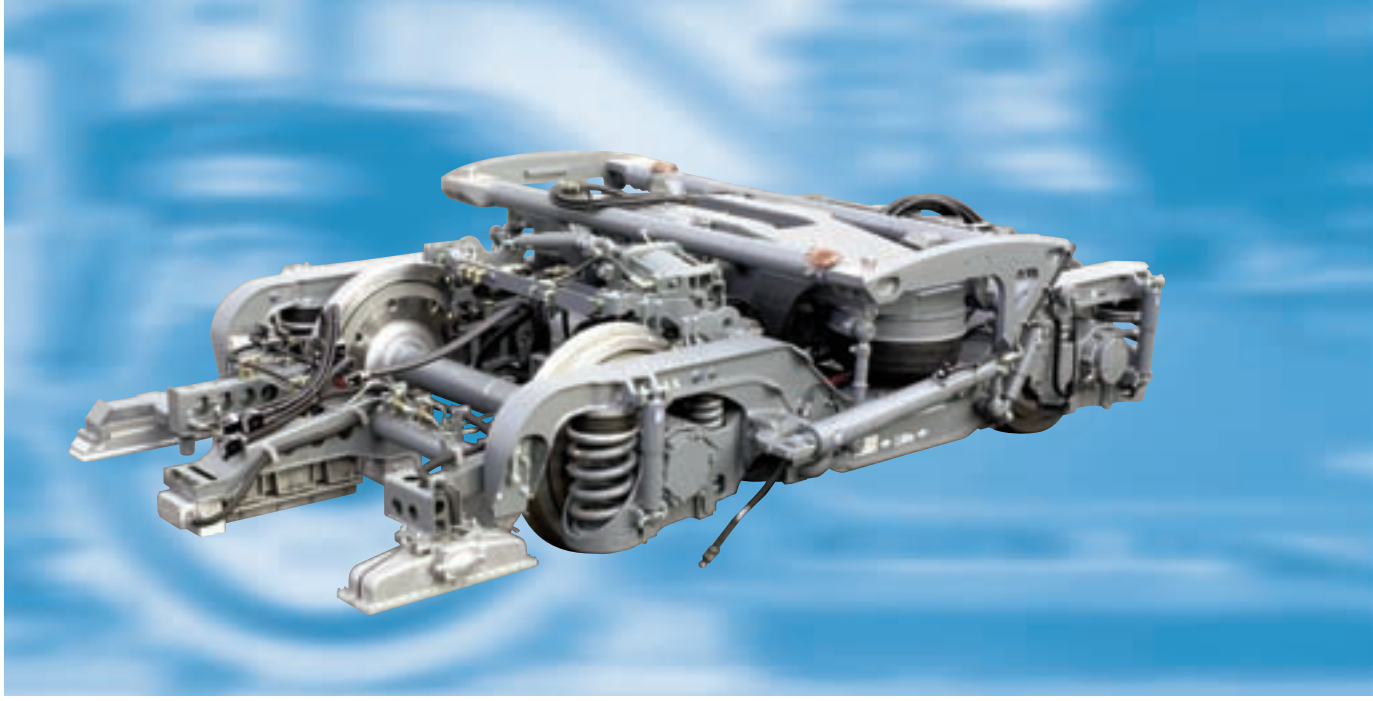
Suspension is designed taking running stability and acoustic requirements into consideration.

The bogies are equipped with a mechanical brake system comprising wheel disc brakes.

Technical Data	
Bogie	SF 500 DSW
Type	Motor bogie
Running speed	up to 140 km/h
Axle load	20 t
Continuous power per wheelset	app. 400 kW
Wheelbase	2500 mm
Track gauge	1435 mm
Wheel diameter new / worn	920 / 860 mm
Smallest radius of curvature in service / workshop	150 / 100 m
Bogie height	1010 mm
Weight with centre pivot and bolster	10,8 t

References:
S-Bahn Zurich

ICE® is a registered trade mark of Deutsche Bahn AG



SF 600 TDG and SF 600 LDG

Motor and Trailer Bogies for Vehicles Featuring Tilting-Train Technology

The SF 600 bogies are designed as high-comfort bogies for trains featuring active tilting technology for speeds up to 250 km/h and free lateral acceleration of up to 2 m/s².

The bogies combine high speed both on the straight track and on curves with highest ride-comfort. The drive, the active tilting facility and the innovative active horizontal suspension system are very compact.

The bogies are based on service-proven components from the SF 400 and SF 500 bogies (ICE® 2 and ICE® 3).

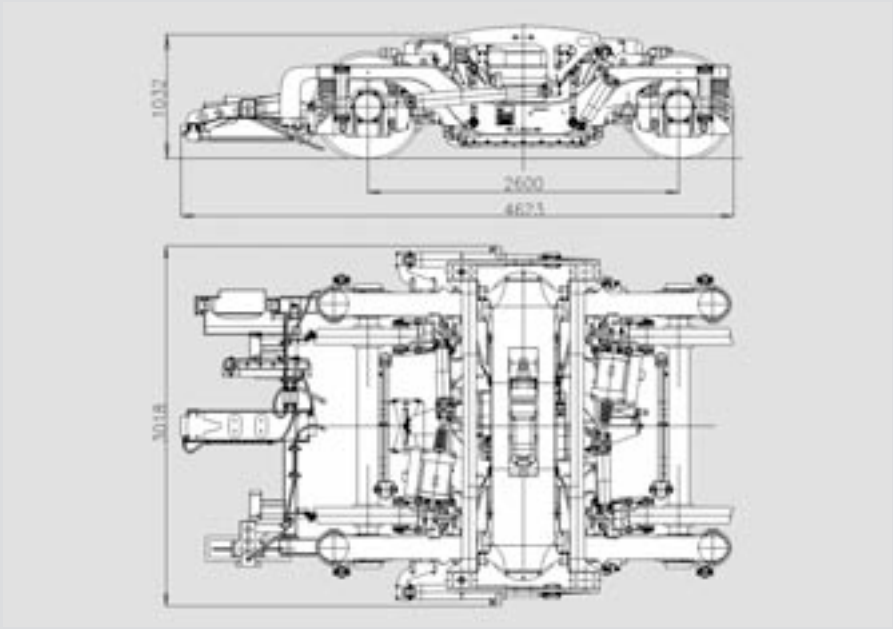
160 bogies of this type were delivered for the tilting train VT 605 for Deutsche Bahn AG.

Track friendliness is one of the basic characteristics of this bogie. This means minimum wheel/rail wear and a reduction in wheel/rail forces when negotiating curves. Optimisation of maintenance requirements is also reflected in the minimum Life Cycle Cost.

Active carbody control means that the vehicle can negotiate curves at significantly higher speeds without causing any riding discomfort to passengers. The tilting facility is integrated completely into the bogie. A clear, simple interface connects bogie and carbody.

Axle guidance is effected by a link supported by a rubber articulation to achieve optimum, defined axle guidance both in lateral and longitudinal direction. The bogie frame is an open H-frame of extremely light-weight construction.

The secondary suspension system features air springs with directly coupled additional air volume, offering high ride quality. In the lateral direction, the innovative active horizontal suspension system, which compensates the high centrifugal forces exerted when the vehicle negotiates curves, acts additionally, without basic spring rigidity having to be increased laterally. The secondary suspension system also features semi-active dampers, which permit adjustment to the damping characteristics, also giving higher ride quality.



The yaw damper system is fitted with hydraulic dampers, which can be automatically activated depending on the vehicle speed. Longitudinal forces are not transmitted by the tilting system, but directly between bogie frame and carbody by means of low-connected rods and a pivot.

A service proven traction drive system featuring an axle-suspended gearing is used. Despite the tilting system of the SF 600, the traction motors are arranged in the bogie, giving a simple interface to the carbody.

The SF 600 is equipped with four wheel disc brakes and optional electric or permanent magnetic track brakes.

The active electromagnetic tilting system features secondary suspension, is fitted beneath the floor in the bogie and can be fitted both in motor and trailer bogies.

References
VT 605 for Deutsche Bahn AG

ICE® is a registered trade mark of Deutsche Bahn AG

Technical Data	
Bogie	SF 600 TDG and SF 600 LDG
Types	Motor and Trailer Bogies
	with tilting technology
Running speed	250 km/h
Maximum axle load	17 t
Continuous power per wheelset	app. 310 kW
Max. starting tractive effort per wheelset	app. 13 kN
Wheelbase	2600 mm
Track gauge	1435 mm
Wheel diameter new / worn	860 / 790 mm
Smallest radius of curvature in service	150 m
Height of bogie (with bolster)	1032 mm
Weight motor bogie / trailer bogie	app. 9,0 / 7,0 t

SF 4000 TDG

Motor Bogie for Diesel Mulitple Units (DMUs)

The SF 4000 TDG is a motor bogie which was developed according to the requirements of modern Multiple Units and is in operation at a service speed of up to 120 km/h and a maximum axle load of 15 t.

The bogie consists of two axles with a two stage suspension system and an air spring as secondary suspension.
The motor bogies are driven by a cardan shaft on both axles and are combined with Jakobs type trailer bogies.

Therefore multiple units for express rail like the Siemens Desiro-family can be equipped completely with these bogies. Improved and optimised components of service proven bogies have enabled a high performance bogie family to be created.

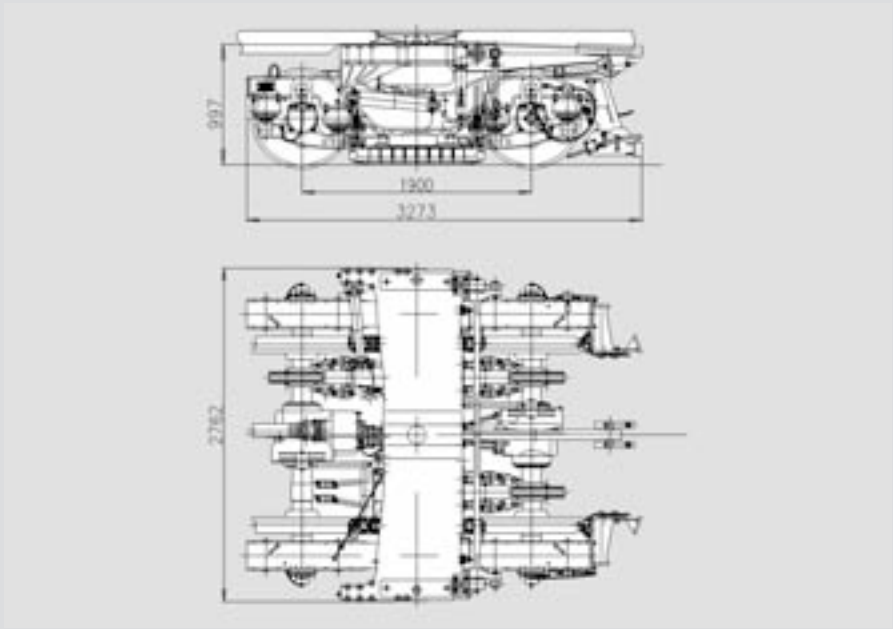
This bogie family ensures high reliability, easy maintenance, low service costs, high flexibility and excellent riding comfort. A typical application of the SF 4000 is for the train LVT 642 of the Deutsche Bahn AG.

The SF 4000 TDG with a wheelbase of 1900 mm is used as a motor bogie in express- and commuter-trains of up to 120 km/h in combination with the Jakobs-type trailer bogie SF 4000 JLDG.

Primary suspension comprises laminated conical sleeve springs of metal-rubber design with good self-damping characteristic, ensuring longitudinally and laterally flexible axle guidance.

Secondary transmission of longitudinal forces is achieved by a traction rod.The air springs in the secondary suspension system ensure high passenger ride quality. The levelling control valve ensures that the same floor height can be maintained under varying load conditions.

Transmission of traction-motor torque is achieved by cardan shaft on both axles of the bogie.



The modern braking system comprises disc brakes and optional magnetic track brakes, ensuring very short braking distance.

The carbody is supported on the secondary suspension by a bolster, which also serves as an additional air reservoir. This bolster is completely integrated into the bogie so that the bogie can be easily dismounted. This ensures the operator that the bogie contributes to the minimisation of the maintenance cost.

References
VT 642 (German Rail)
Vogtlandbahn Germany
Kahlgrundbahn Germany
DSB Danish State Railway
HHGB Hornbaekbahnen Danmark
Hessische Landesbahnen HLB
Nordjyske Jernbaner Danmark
Nordwestbahn Germany
OSE Greece
MAV Hungarian State Railway
SNTFC Romanian State Railway
BDZ Bulgarian State Railway
ÖBB Austrian Federal Railways
NCTD California / USA

Technical Data	
Bogie	SF 4000 TDG
Type	Motor Bogie
Running speed	120 km/h
Axle load	max.15 t
Continuous power per wheelset	137-170 kW
Max. starting tractive effort per wheelset	35-44 kN
Wheelbase	1900 mm
Track gauge	1435 mm
Wheel diameter new / worn	770 / 710 mm
Smallest radius of curvature in service / workshop	125 / 90 m
Bogie height (incl. Bolster)	997 mm
Weight	6,8 t

SF 4000 JLDG

Jakobs-Type Trailer Bogie for Diesel Multiple Units (DMUs)

The SF 4000 JLDG is a trailer bogie which was developed according to the requirements of modern Multiple Units. It has a service speed of up to 120 km/h and a maximum axle load of 16 t.

The SF 4000 bogie family comprises motor and Jakobs-trailer bogies.
The bogie consists of two axles with a two stage suspension system and an air spring as secondary suspension.
The motor bogies are driven by a cardan shaft on both axles and are combined with Jakobs type trailer bogies.

Therefore multiple units for express rail like the Siemens Desiro-family can be equipped completely with these bogies. Improved and optimised components of service proven bogies have allowed a high performance bogie family to be created.

This bogie family ensures high reliability, easy maintenance, low service costs, high flexibility and excellent riding comfort.

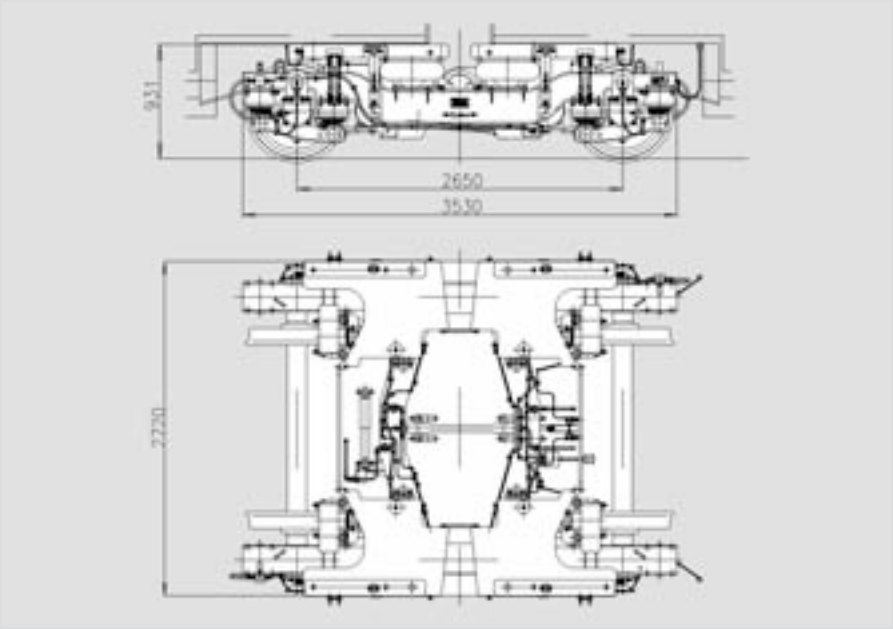
A typical application of the SF 4000 is for the train LVT 642 of the Deutsche Bahn AG.

The SF 4000 JLDG with a wheelbase of 2650 mm is used as a trailer bogie in express- and commuter-trains up to 120 km/h in combination with the motor bogie SF 4000 TDG.

Primary suspension comprises laminated conical sleeve springs of metal-rubber design with good self-damping characteristic, ensuring longitudinally and laterally flexible axle guidance.

Secondary transmission of longitudinal forces is achieved by a traction rod.The air springs in the secondary suspension system ensure high passenger ride quality. The levelling control valve ensures that the same floor height can be maintained under varying load conditions.

The two halves of the carbodies are supported on the longitudinal beam of the bogie by means of two air springs per carbody.



The modern braking system comprises wheel disc brakes, which are easy to maintain.

The bogie is equipped with auxiliary air reservoirs. The carbody is supported on the secondary suspension on these additional air reservoirs.

These auxiliary air reservoirs are completely integrated into the bogie so that the bogie can be easily dismounted. This ensures the operator that the bogie contributes to the minimisation of the maintenance cost.

References:
VT 642 (German Rail)
Vogtlandbahn Germany
Kahlgrundbahn Germany
DSB Danish State Railway
HHGB Hornbaekbahnen Danmark
Hessische Landesbahnen HLB
Nordjyske Jernbaner Danmark
Nordwestbahn Germany
OSE Greece
MAV Hungarian State Railway
SNTFC Romanian State Railway
BDZ Bulgarian State Railway
ÖBB Austrian Federal Railways
NCTD California / USA

Technical Data	
Bogie	SF 4000 JLDG
Type	Trailer Bogie
Running speed	120 km/h
Axle load	max.16 t
Wheelbase	2650 mm
Track gauge	1435 mm
Wheel diameter new / worn	770 / 710 mm
Bogie height (incl. auxiliary air reservoirs)	931 mm
Smallest radius of curvature in service / workshop	125 / 90 m
Weight	6,2 t

SF 5000 E TDG and SF 5000 LDG

Motor Bogie and Trailer Bogie for EMU and DEMU

The bogie family SF 5000 was developed according to the requirements of modern Multiple Units for a service speed of up to 200 km/h.

The bogie family consists of two axle bogies with a two-stage suspension system and an air spring as secondary suspension.

Due to the modular design of the bogie family the following configurations are possible:

Drive	End-bogie	Jakobs-bogie
Electric drive	X	X
Diesel Single drive	X	
Diesel Double drive	X	
Trailer bogie	X	X

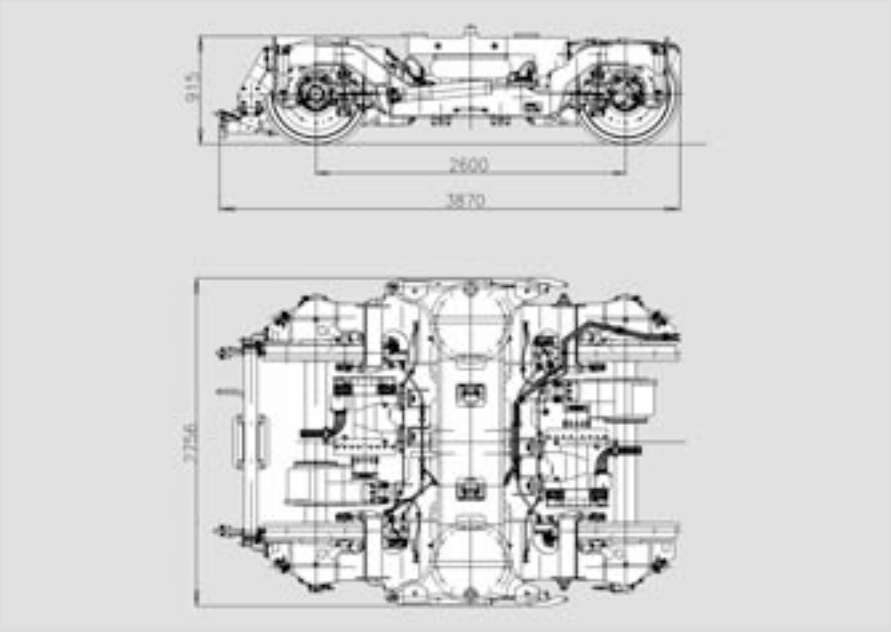
The use of improved and optimised components of tried and tested bogies has led to the creation of a high performance bogie family which ensures high reliability, easy maintenance, low service costs, high flexibility and excellent riding comfort.

The bogies SF 5000 E TDG and SF 5000 LDG with an axle distance of 2600 mm can be used as final bogies in Jakobs type multiple units and for single cars in the area express and commuter.

The axle guidance is carried out through one elastic bush per axlebox, which joins the radial arm with the frame. The primary springs are located above the wheelset bearings and consist of steel coil springs and rubber elements for acoustical and electrical isolation.

All longitudinal forces between bogie and carbody are transmitted via a traction rod. The secondary suspension system consists of air spring bags in combination with a pneumatic 2 point levelling valve system to compensate different loading conditions. Two anti roll bars reduce the dynamic tilting of the carbody in curves and through switches.

In the case of motor bogies the traction torque is transmitted from the motor to the wheels by a partially suspended helical toothed spur gear box and a flexible toothed coupling.



The traction motor is directly mounted on the bogie frame by the use of rubber elements for acoustical isolation. Separation of the coupling enables exchange of the wheelset unit with the gear unit without having to dismount the motor. Low-maintenance wheel disk brakes are used for mechanical braking.

The carbody can be supported on the secondary suspension by a bolster, which also serves as an additional air reservoir. Two anti yaw dampers per bogie can be provided to improve the stability of the vehicles.

References bogie family SF 5000

EMU:
Desiro EMG Slovenia
Desiro OSE Greece
EMU CPTM Sao Paolo
Metro Melbourne
BDZ Bulgarian State Railway

Desiro UK First Great Eastern
Desiro UK South West Train
Desiro UK West Coast Mainline
Desiro UK Heathrow Airport Link
Desiro UK WMF
ARL Bangkok

DMU:
Westrail Australia
IIRR Iranian Railways
Desiro UK TPE

Technical Data	
Bogie	SF 5000 E TDG and SF 5000 LDG
Types	Motor Bogie, Trailer Bogie
Running speed	up to 200 km/h
Maximum axle load	18,5 t
Continuous power per wheelset (TDG)	250 kW
Max. starting tractive effort per wheelset	30 kN
Wheelbase	2600 mm
Track gauge	1435 / 1600 mm
Wheel diameter new / worn	850 / 770 mm
Smallest radius of curvature in service / workshop	150 / 100 m
Height of bogie (with bolster)	app. 915 mm
Weight (without options) TDG / LDG	app. 8,2 / 5,8 t
Weight of bolster (option)	app. 980 kg

SF 5000 E JTDG and SF 5000 JLDG

Jakobs-Type Motor and Trailer Bogie for EMU and DMU

The bogie family SF 5000 was developed according to the requirements of modern Multiple Units for a service speed of up to 200 km/h.

The bogie family consists of two axle bogies with a two stage suspension system and an air spring as secondary suspension.

Due to the modular design of the bogie family the following configurations are possible:

Drive	End-bogie	Jakobs-bogie
Electric drive	X	X
Diesel Single drive	X	
Diesel Double drive	X	
Trailer bogie	X	X

The use of improved and optimised components of tried and tested bogies has led to the creation of a high performance bogie family which ensures high reliability, easy maintenance, low service costs, high flexibility and excellent riding comfort.

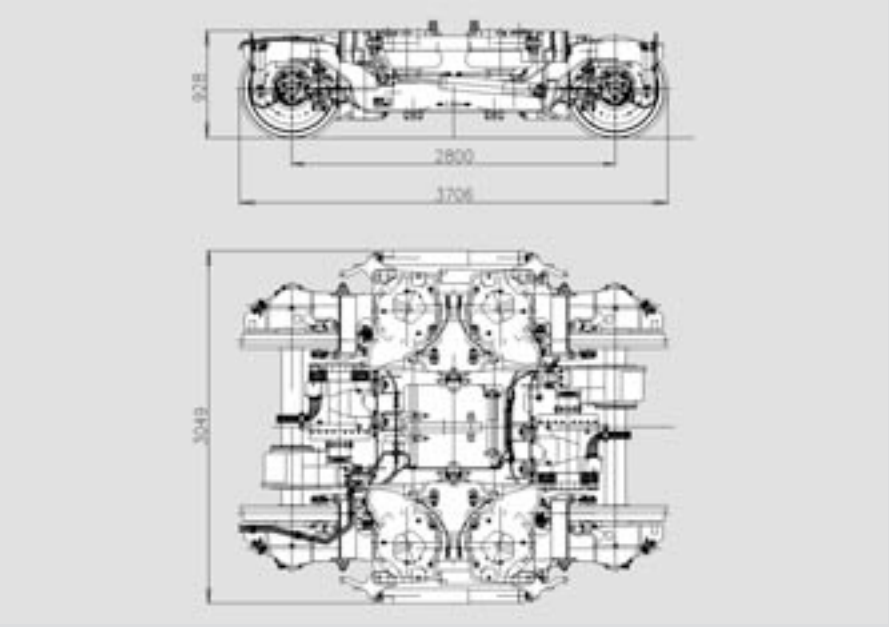
The bogies SF 5000 E JTDG and JLDG with an axle distance of 2800 mm are used in combination with the bogies SF 5000 ETDG and LDG for Express and Commuter trains.

A service proven link system is used as axle guidance. The primary springs are located above the wheelset bearings and consist of steel coil springs and rubber elements for acoustical and electrical isolation.

All longitudinal forces between bogie and carbody are transmitted via traction rod.

The secondary suspension system consists of air spring bags in combination with a pneumatic 2-point levelling valve system to compensate different loading conditions.

In the case of motor bogies, the traction torque is transmitted from the motor to the wheels by a partially suspended helical toothed spur gear box and a flexible toothed coupling.



The traction motor is directly mounted on the bogie frame by the use of rubber elements for acoustical isolation. Separation of the coupling enables the exchange of the wheelset with the gear unit without having to dismount the motor.Low-maintenance wheel mounted disk brakes are used for mechanical braking.

Optionally the bogie can be equipped with an auxiliary air reservoir.
This device is located between the airspring and the carbody.

References bogie family SF 5000

EMU:
Desiro EMG Slovenia
Desiro OSE Greece
EMU CPTM Sao Paolo
Metro Melbourne
BDZ Bulgarian State Railway

Desiro UK First Great Eastern
Desiro UK South West Train
Desiro UK West Coast Mainline
Desiro UK Heathrow Airport Link
Desiro UK WMF
ARL Bangkok

DMU:
Westrail Australia
IIRR Iranian Railways
Desiro UK TPE

Technical Data	
Bogie	SF 5000 E JTDG and SF 5000 JLDG
Types	Jakobs-Type Motor Bogie, Trailer Bogie
Running speed	up to 200 km/h
Maximum axle load	18,5 t
Continuous power per wheelset (JTDG)	250 kW
Max. starting tractive effort per wheelset	30 kN
Wheelbase	2800 mm
Track gauge	1435 mm
Wheel diameter new / worn	850 / 770 mm
Smallest radius of curvature in service / workshop	150 / 100 m
Height of connection to carbody (with auxiliary air reservoir)	app. 928 mm
Bogie height JTDG / JLDG (without auxiliary air reservoir)	app. 9,1 / 6,8 t

SF 5000 DMU SD and SF 5000 DMU DD

Motor Bogie for DMU

The bogie family SF 5000 was developed according to the requirements of modern Multiple Units for a service speed of up to 200 km/h.

The bogie family consists of two axle bogies with a two-stage suspension system and an air spring as secondary suspension.

Due to the modular design of the bogie family the following configurations are possible:

Drive	End-bogie	Jakobs-bogie
Electric drive	X	X
Diesel Single drive	X	
Diesel Double drive	X	
Trailer bogie	X	X

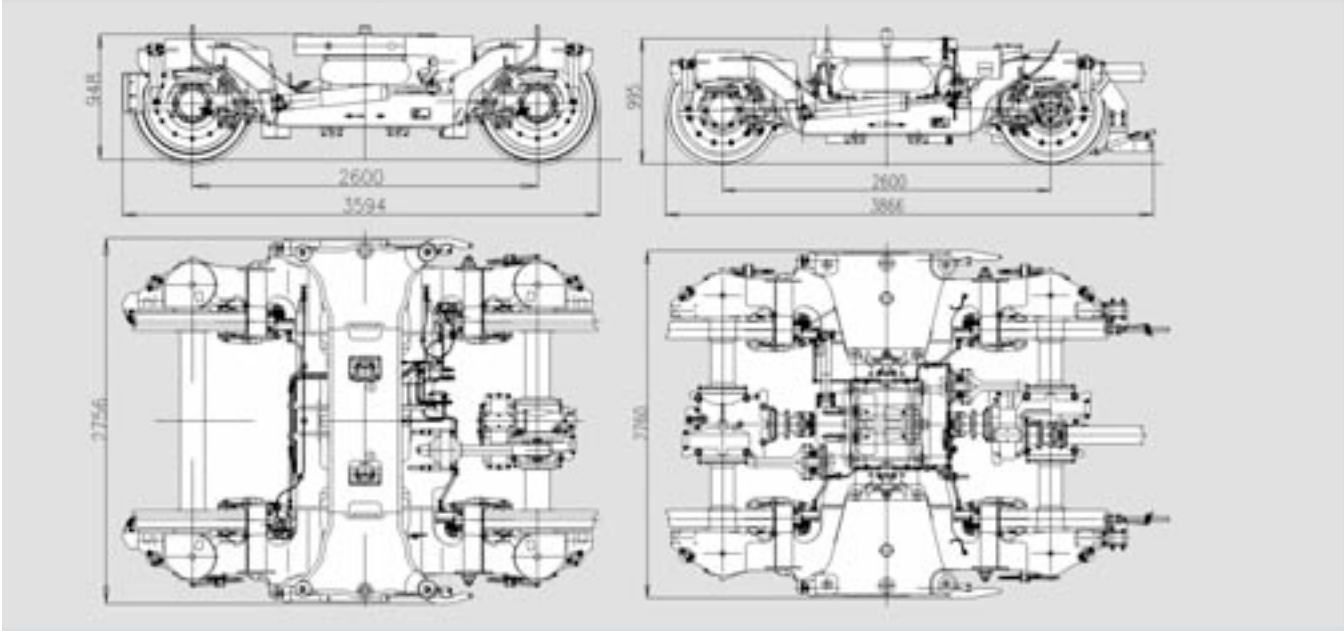
The use of improved and optimised components of tried and tested bogies has led to the creation of a high performance bogie family which ensures high reliability, easy maintenance, low service costs, high flexibility and excellent riding comfort.

Bogies SF 5000 DMU SD and SF 5000 DMU DD with axle distance of 2600 mm can be used as bogies for single cars in the express and commuter sector.

In the primary suspension stage, axle guidance with radial arm occurs. Primary springs are directly arranged over the wheelsets and consist of a steel coil spring and a rubber element used for acoustic and electric isolation.

The secondary longitudinal forces are transferred via traction rod. The secondary suspension stage is equipped with pneumatic springs to ensure comfortable riding. The air spring control valve facilitates equal floor height for different loading conditions.

The motor bogie is connected to the gear unit of the carbody with a cardan shaft.



The traction torque is transmitted to the wheelsets via the axle mounted gear units, which are joined to the frame with a torque reaction link.

The motor bogie SF 5000 DMU SD has one powered wheelset.

The motor bogie SF5000 DMU DD has a cardan shaft which links both wheelset gear units. Maintenance free wheel-mounted brake disk units are used for mechanical braking.

References bogie family SF 5000

EMU:
Desiro EMG Slovenia
Desiro OSE Greece
EMU CPTM Sao Paolo
Metro Melbourne
BDZ Bulgarian State Railway

Desiro UK First Great Eastern
Desiro UK South West Train
Desiro UK West Coast Mainline
Desiro UK Heathrow Airport Link
Desiro UK WMF
ARL Bangkok

DMU:
Westrail Australia
IIRR Iranian Railways
Desiro UK TPE

Technical Data	
Bogie	SF 5000 DMU SD and SF 5000 DMU DD
Types	Motor Bogie, Trailer Bogie
Drive mode "Single drive" (SD)	one axle driven
Drive mode "Double drive" (DD)	both axles driven
Running speed	up to 200 km/h
Maximum axle load	18,5 t
Wheelbase	2600 mm
Track gauge	1435 mm
Wheel diameter new / worn	850 / 770 mm
Smallest radius of curvature in service	150 m
Height of bogie (with bolster) SD / DD	app. 948 / 995 mm
Weight (with bolster) SD / DD	app. 7,8 / 9,0 t

SF 5000 UK TDG and SF 5000 UK LDG

Motor Bogie and Trailer Bogie for EMU and DEMU

The bogie SF 5000 UK is part of the bogie family SF 5000 and was developed especially for service on the UK infrastructure.

The bogie family SF 5000 was developed according to the requirements of modern Multiple Units for a service speed of up to 200 km/h. The bogie family consists of two axle bogies with a two-stage suspension system and an air spring as secondary suspension.

Due to the modular design of the bogie family the following configurations are possible:

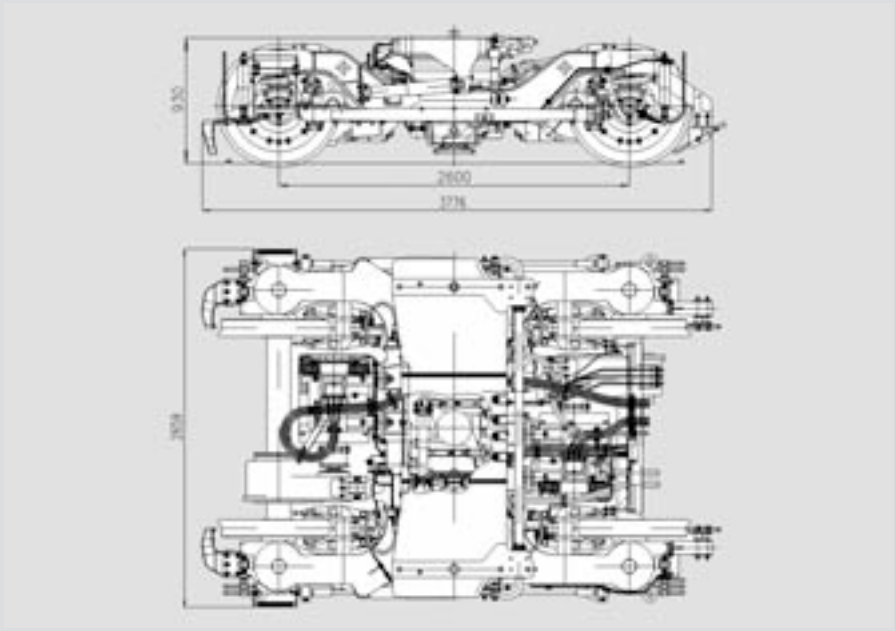
Drive	End-bogie	Jakobs-bogie
Electric drive	X	X
Diesel Single drive	X	
Diesel Double drive	X	
Trailer bogie	X	X

The use of improved and optimised components of tried and tested bogies has led to the creation of a high performance bogie family which ensures high reliability, easy maintenance, low service costs, high flexibility and excellent riding comfort. The bogies SF 5000 UK - TDG and LDG with an axle distance of 2600 mm are used especially on the UK market for Express and Commuter.

The axle guidance is carried out through one elastic bush per axlebox, which joins the radial arm with the frame. The primary springs are located above the wheelset bearings and consist of steel coil springs and rubber elements for acoustical and electrical isolation.

All longitudinal forces between bogie and carbody are transmitted via a traction centre and traction rods in combination with a centre pivot. The secondary suspension system consists of air spring bags and a pneumatic 2-point levelling valve system.

An anti roll bar reduces the dynamic tilting of the carbody in curves and through switches. The carbody is supported on the secondary suspension by a bolster, also serving as additional air reservoir. Two anti yaw dampers per bogie can be provided to improve the stability of the vehicles.



In the case of motor bogies the traction torque is transmitted from the motor to the wheels by a partially suspended helical toothed spur gear box and a flexible toothed coupling. The traction motor is directly mounted on the bogie frame by the use of rubber elements for acoustical isolation. By separation of the coupling the wheelset with the gear unit can be exchanged without dismounting the motor.

For mechanical braking low-maintenance wheel mounted disk brakes are used.

References bogie family SF 5000

EMU:
Desiro EMG Slovenia
Desiro OSE Greece
EMU CPTM Sao Paolo
Metro Melbourne
BDZ Bulgarian State Railway

Desiro UK First Great Eastern
Desiro UK South West Train
Desiro UK West Coast Mainline
Desiro UK Heathrow Airport Link
Desiro UK WMF
ARL Bangkok

DMU:
Westrail Australia
IIRR Iranian Railways
Desiro UK TPE

Technical Data	
Bogie	SF 5000 UK TDG and SF 5000 UK LDG
Types	Motor and trailer bogies
Running speed	up to 160 km/h
Axle load	max. 16,5 t
Continuous power per wheelset (TDG)	250 kW
Max. starting tractive effort per wheelset (TDG)	30 kN
Wheelbase	2600 mm
Track gauge	1435 mm
Wheel diameter new / worn	850 / 786 mm
Smallest radius of curvature in service / workshop	120 / 90 m
Height of connection to carbody (with bolster)	app. 935 mm
Weight with centre pivot and bolster TDG / LDG	app. 9,3 / 6,8 t

SF 6500 – TDG and LDG

Motor Bogie and Jakobs Bogie for EMU and DEMU

The bogie platform SF 6500 fulfils the requirements of modern low-floor Multiple Units for a service speed up to 160 km/h.

The bogie platform consists of two axle bogies with a two-stage suspension system using an air spring as secondary suspension.

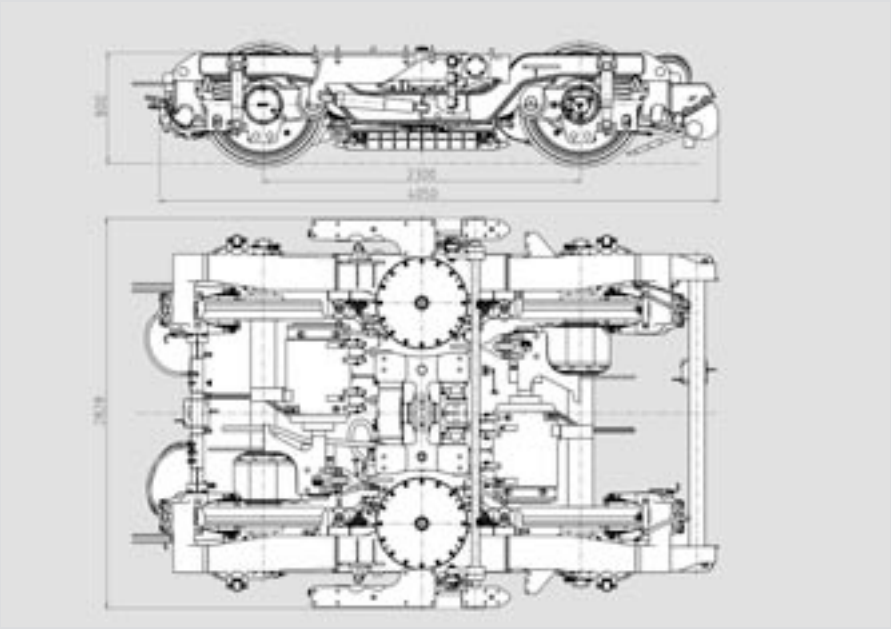
The bogie platform is characterized by its compact design. It is specially designed for high positions of carbody centre of gravity. The use of magnetic track brakes is possible in each bogie.

Because of the modular design of the bogie platform a large range of applications is possible. This high performance bogie platform ensures high reliability, easy maintenance, low service costs, high flexibility and excellent riding comfort.

The bogies SF 6500 TDG and LDG are used especially for Express and Commuter trains.

The axle guidance is carried out through one elastic bush per axle box, which joins the radial arm with the frame.
The primary springs are located in front of the wheelset bearings and consist of steel coil springs and rubber elements for acoustical and electrical isolation.

All longitudinal forces between bogie and carbody are transmitted via a centre pivot.



The secondary suspension system consists of air spring bags in combination with a pneumatic 2-point levelling valve system.

The traction torque is transmitted from the motor to the wheels by a partially suspended helical toothed spur gear box and a flexible toothed coupling.

The traction motor is directly mounted on the bogie frame by the use of rubber elements for acoustical isolation. Separation of the coupling enables exchange of the wheel set with the gear unit without having to dismount the motor.

Low-maintenance wheel cheek disk brakes are used. Optionally a magnetic track brake can be used for mechanical braking.

References:
Mittelrheinbahn (Germany)
RER Brüssel (Belgium)

Technical Data	
Bogie	SF 6500
Types	Motor Bogie, Trailer Bogie
Running speed	160 km/h
Maximum axle load (acc. to EN 13103/4)	18,0 t
Continuous power per wheelset	max. 235 kW
Wheelbase	2300 mm
Track gauge	1435 mm
Wheel diameter new / worn	850 / 780 mm
Smallest radius of curvature in service / workshop*	110 / 80 m
Height of bogie (top of airspring)	app. 800 mm
Weight Motor / Trailer Bogie (without options)	app. 9,0 / 6,7 t
Propulsion	partly suspended
Mechanical brake	wheel disc brakes / optional magnetic track brake

* With a center pin distance of 16 m

Referencelist Bogies

Segment	Type	Quantity	Client / Operator	State	for Vehicle
LOCOMOTIVES	SF 1	92	Dispolok	Europe	ES 64 U2
		902	ÖBB	Austria	Rh 1016, Rh 1116, Rh 1216 (Taurus)
		10	GySEV	Hungary	Rh 1047
		50	DB AG	Germany	BR 182
		20	MAV	Hungary	Rh 1047
		4	Rail Transport Service GmbH	Austria	Rh 1216
		40	SZ	Slovenia	Rh 1216
		120	SNCB	Belgium	HLE 18
		20	several operators	Europe	ES 64 U4
	SF 2	230	DB AG	Germany	BR 189
		98	Dispolok	Europe	ES 64 F 4
		38	SBB	Switzerland	Re 474
		54	CP	Portugal	LE 5600
		142	Mitsui	Europe	-
		40	several operators	Europe	ES 64 F4
	SF 3	208	ÖBB	Austria	Rh 2016 (Herkules)
		30	Dispolok	Europe	ER 20
		11	KCRC (Hongkong)	China	Serie 8000
		60	several operators	Germany	ER 20
	SF 6	28	DSB	Denmark	EG 3100
		32	VNR	Vietnam	AR 15
		72	LG	Lithuania	ER 20 CF
PASSENGER COACHES	SF 200	40	SBB	Switzerland	Couchette coach
	SF 300	232	CD	Czech Republic	Passenger coach
		308	ÖBB	Austria	Passenger coach
		20	PKP	Poland	Passenger coach
		370	OSE	Greece	Passenger coach
		50	ZOS Vrutky / ZSSK	Slovakia	Passenger coach
		180	ISR	Israel	Passenger coach
	SF 400	620	DB AG	Germany	ICE® 2
		84	DB AG	Germany	Comfort sleeping coach
		40	ÖBB	Austria	Couchette coach
		648	ÖBB	Austria	Double-deck coach

Segment	Type	Quantity	Client / Operator	State	for Vehicle
	SF 400	664	Trenitalia	Italy	Vivalto
		36	FER	Italy	Vivalto
		140	SBB	Switzerland	S-Bahn Zürich
		20	ÖBB	Austria	Hotel coach
		24	CD	Czech Republic	Sleeping coach
		938	ÖBB	Austria	railjet
		100	CRC	China	Double-deck coach
LIGHT RAIL	SF 30 C				
	LFW and TFW	112	Basler Verkehrsbetriebe	Swiitzerland	Combino Basel
		164	Stadtwerke Augsburg	Germany	Combino Augsburg
		45	Städtische Verkehrsbetriebe Bern	Swiitzerland	Combino Bern
		72	Freiburger Verkehrs AG	Germany	Combino Freiburg
		24	SWU Verkehr GmbH	Germany	Combino Ulm
		75	Erfurter Verkehrsbetriebe AG	Germany	Combino Erfurt
		14	Stadtwerke Nordhausen	Germany	Combino Nordhausen
		36	Hiroshima Electric Railway	Japan	Combino Hiroshima
		139	National Express Group	Australia	Combino Melbourne
		465	GVB Amsterdam	Netherlands	Combino Amsterdam
		144	Verkehrsbetriebe Potsdam	Germany	Combino Potsdam
		42	MPK Posen	Poland	Combino Posen
		153	Rheinische Bahngesellschaft	Germany	Combino Düsseldorf
		96	Metro Transportes do Sul	Portugal	Combino MST
		240	BKV Budapest	Hungary	Combino Budapest
	SF 40	18	Metropolitan Transit Authority of Harris Country, Texas	USA	S 70 Houston
		12	MTDB	USA	S 70 San Diego
		30	SNCF	France	Avanto Paris
		15	CATS	USA	S 70 Charlotte
	SF 70	36	Metropolitan Transit Authority of Harris Country, Texas	USA	S 70 Houston
		24	MTDB	USA	S 70 San Diego
		30	SNCF	France	Avanto Paris
		30	CATS	USA	S 70 Charlotte
		78	ETS	USA	SD 160 Edmonton
	SF 90				
	TDG and LDG	54	UTA	USA	SD 160 Salt Lake City
		183	Calgary LRT	Canada	SD 160 Calgary
		108	RTD	USA	SD 160 Denver

Segment	Type	Quantity	Client / Operator	State	for Vehicle
HEAVY RAIL	SF 1000	136	VAG Nürnberg	Germany	Metro Nürnberg „Rubin“
		392	Oslo Sporveier	Norway	Metro Oslo
	SF 1000 HS	96	Wiener Linien	Austria	Metro Wien
	SF 2000	219	BTS Bangkok	Thailand	Metro Bangkok “Skytrain”
		117	MRTA Bangkok	Thailand	Metro Bangkok
		512	TRTC Taipei	Taiwan	Metro Taipei
	SF 2100	651	SMC Shanghai	China	Metro Shanghai
		240	GMC Guangzhou	China	Metro Guangzhou
		726	KCRC Hongkong	China	Metro Hongkong
		1035	MRT Singapore	Singapore	Metro Singapore
		1536	MTRC Hongkong	China	Metro Hongkong
	SF 2100 IB	128	Tren Urbano San Juan	Puerto Rico	Metro Puerto Rico
	SF 2500	240	GMC	China	Metro Guangzhou Line 3
	SF 3000	258	KMRT Kaohsiung	China	Metro Kaohsiung
	SF VAL 208	184	SATTI Turin	Italy	VAL Turin
		16	STAR Rennes	France	VAL Rennes
		40	ADP Roissy	France	VAL Roissy
		224	SEMVAT Toulouse	France	VAL Toulouse
TRAINS	SF 500				
	TDG and LDG	1008	DB	Germany	ICE® 3
		416	RENFE	Spain	AVE® S 103
		64	Niederländische Staatsbahn NS	Netherlands	ICE® 3
		160	Russische Eisenbahnen RZD	Russia	Velaro RUS
		960	MOR China	China	Velaro CN
	SF 500 DSW	240	SBB	Switzerland	S-Bahn Zürich
	SF 600				
	TDG and LDG	160	DB AG	Germany	VT 605
	SF 4000				
	TDG and JLDG	702	VT 642 - DB AG	Germany	Desiro Classic DMU
		72	Vogtlandbahn	Germany	Desiro Classic DMU
		36	Connex über Angel Train	Germany	Desiro Classic DMU
		18	Nordwestbahn über Angel Train	Germany	Desiro Classic DMU
		36	DSB – Dänische Staatsbahn	Denmark	Desiro Classic DMU
		3	HHGB – Dänische Privatbahn	Denmark	Desiro Classic DMU
		18	Hessische Landesbahn HLB	Germany	Desiro Classic DMU
		21	Nordjyske Jernbaner	Denmark	Desiro Classic DMU
		24	OSE Griechenland	Greece	Desiro Classic DMU
		69	MAV Ungarn	Hungary	Desiro Classic DMU
		360	SNTFC Rumänien	Romania	Desiro Classic DMU

Segment	Type	Quantity	Client / Operator	State	for Vehicle
		75	Bulgarische Staatsbahn BDZ	Bulgaria	Desiro Classic DMU
		180	ÖBB	Austria	Desiro Classic DMU
		36	NCTD Kalifornien	USA	Desiro Classic DMU
	SF 5000 E TDG, LDG, JTDG, JLDG	110	Slowenische Staatsbahn	Slovenia	Desiro EMG 312
		80	CPTM Sao Paolo	Brazil	EMU CPTM Sao Paolo
		120	OSE Griechenland	Greece	Desiro OSE
		372	National Express Group Australia Pty Ltd	Australia	Metro Melbourne
		110	Bulgarische Staatsbahnen	Bulgaria	Desiro
	SF 5000 DMU SD and DD	120	IIRR Iran	Iran	DH 4
		22	Westrail	Australia	Goninan
	SF 5000 UK TDG and LDG	168	FGE First Great Eastern	Great Britain	Desiro UK Class 360
		240	WCML West Coast Mainline	Great Britain	Desiro UK Class 350/1
		450	SWT South West Train	Great Britain	Desiro UK Class 444
		880	SWT South West Train	Great Britain	Desiro UK Class 450
		32	HAL Heathrow Airport Link	Great Britain	Desiro UK Class 360/2
		62	ARL Bangkok	Thailand	Desiro UK
		296	West Midland Franchise	Great Britain	Desiro UK Class 350/1
	SF 5000 DMU UK TDG and LDG	306	TransPennine Express	Great Britain	Desiro UK Class 185
	SF 6000 TDG, JTDG and JLDG	209	Niederländische Staatsbahn NS	Netherlands	Sprinter LighTTrain
	SF 6500 TDG and LDG	102	Mittelrheinbahn	Germany	Desiro Mainline
		1830	RER Brüssel	Belgium	Desiro Mainline

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The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.

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