ELECTRIC SYSTEMS AND COMPONENTS

ŠKODA

Škoda Group is one of the leading European companies in the field of transport engineering, with a history spanning more than 165 years. Škoda focuses on the development and production of vehicles for railway and urban public transport. Its products include primarily electric suburban train units, battery-powered trains, low-floor trams, metro trainsets, trolleybuses, electric buses, hydrogen buses, electric motors, components, passenger coaches, digital solutions, and complete drive systems for environmentally friendly public transport.

Thanks to its ecosystem of production plants, service centers, and engineering offices, the outstanding work of thousand of project engineers, and designers, and billions invested annually in its own research and development, Škoda Group boasts a portfolio of modern vehicles that meet the latest European standards. Škoda places great emphasis on the use of cutting-edge technologies for modern urban and rail transport vehicles. Škoda is also developing railway vehicles and buses with alternative propulsion systems.

Škoda Group's transport solutions are used in the Czech Republic, Slovakia, Germany, Finland, Poland, Lithuania, Latvia, Estonia, Italy, the Balkans, Australia, the USA, and many other countries around the world.

Škoda Group currently employs 10,000 people. In addition to its production sites and technology centers in the Czech Republic, Finland, and Turkey, Škoda Group also has branches in Germany, Italy, Austria, Belgium, Hungary, Poland, and Ukraine.

Škoda Group provides comprehensive transport solutions for urban, intercity, and mainline rail transport, and it continues to work to ensure that travel is comfortable, fast, sustainable, and safe. Thanks to a wide range of boarding height options, low-floor and barrier-free access is ensured in all areas where its vehicles operate.

Škoda Group is part of PPF Group, which invests in a wide range of sectors – from financial services and telecommunications to biotechnology, real estate, and engineering. PPF Group operates in Europe, Asia, Africa, and North America.

Škoda traction equipment is a complete propulsion and control product portfolio for all rolling stock and urban transit applications.

Škoda´s equipment is designed with a pure ambition to fulfill all requirements and needs. Traction Equipment originate solutions which are boosting customer competitiveness and are driven by reliability and committed to sustainable mobility.

TRACTION EQUIPMENT

- TRACTION CONVERTERS
- AUXILIARY CONVERTERS
- TRACTION MOTORS
- POWER ELECTRONICS
- HVAC UNIT POWER INVERTERS
- POWER INVERTERS FOR TRAIN ONBOARD POWER SUPPLY SYSTEMS AND BATTERY CHARGING
- AIR-CONDITIONING UNITS FOR TRAMS AND TRAINS
- TRAIN ON-BOARD POWER CONSUMPTION MEASURING SOLUTION
- CONTROL SYSTEMS FOR TRACTION MOTORS AND HYDRAULIC BRAKE SYSTEMS

KEY FEATURES OF ŠKODA TRACTION EQUIPMENT

PERFORMANCE
Regardless if the challenge is keeping tight timetables in the city center or hauling heavier loads in cargo transportation, Škoda equipment produces power effort whenever it is needed.

HIGH RELIABILITY
Varied configuration options make it possible to meet various requirements such as availability and energy efficiency.

OPTIMIZED DESIGN
Škoda Traction equipment provides an optimized design respecting the fundamental requirements of available space, axle load and efficiency resulting in a highly reliable solution with low maintenance needs during the lifetime of the product.

FUTURE PROOF
Škoda applies new long-lasting trends and introduces the latest technologies by taking into account safety, functionality and after sale service, which can be secured for the entire life cycle of the vehicle. Škoda Traction Equipment meets customer requirements as well as increasingly demanding industry standards and regulations, today and in the future. Our ambition is to provide true revenue-generating solutions in order to exceed the expectations of our customers in terms of reliability, innovation, zero emissions and energy efficiency. Receiving the IRIS (International Railway Industry Standard) award reflects the excellent quality of both products and management over the entire supply chain.

TRAM

TRACTION EQUIPMENT FOR TRAMS / LRV

A complete portfolio of the most advanced drives and traction motors for use on trams. Variable Voltage Variable Frequency (VVVF) traction inverters use the latest IGBT technology with a wide power range to ensure high dynamic power.

Containers can be roof-mounted or installed under the frame depending on the body shell construction, equipped with forced air or liquid cooling. The integrated traction controller is connected to all standardised higher-level communication networks for control, monitoring and diagnostics.

Asynchronous motors with squirrel-cage rotors (AM) and drives with permanent magnet synchronous motors (PMSM) have already been proven in real operation.

On-board traction batteries are also available as an option for tram operation on sections without catenary in a wide capacity range.

REFERENCES

Helsinki, Tampere, Jokeri Line, Rhein-Neckar-Verkehr (rnv), Ostrava, Pilsen, Bonn, Konya, Eskisehir, Chemnitz, Riga, Bratislava, Frankfurt-Cotbus-Brandenburg, Portland, Cagliari, Wroclaw, Prague, Brno, Miskolc, Schöneiche

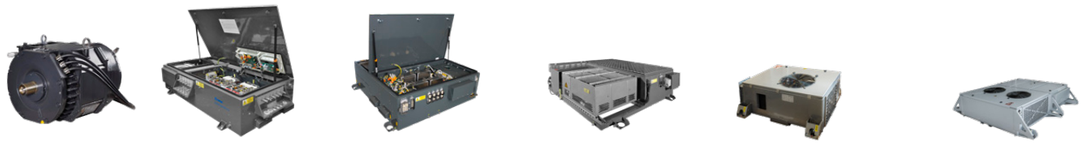
TRACTION MOTOR + GEARBOX
is a ready-made solution adapted to the actual underframe. The traction motor is forced or self-cooled with a durable, low-maintenance design.

TRACTION UNITS
are based as standard on compact IGBT technology and have a modular design. Depending on the type of motor used, multiple converters can be installed in one container. A new solution considers SiC technology. In most cases, each underframe has its own container. Cooling of the full-capacity brake rheostats and the traction container is integrated.

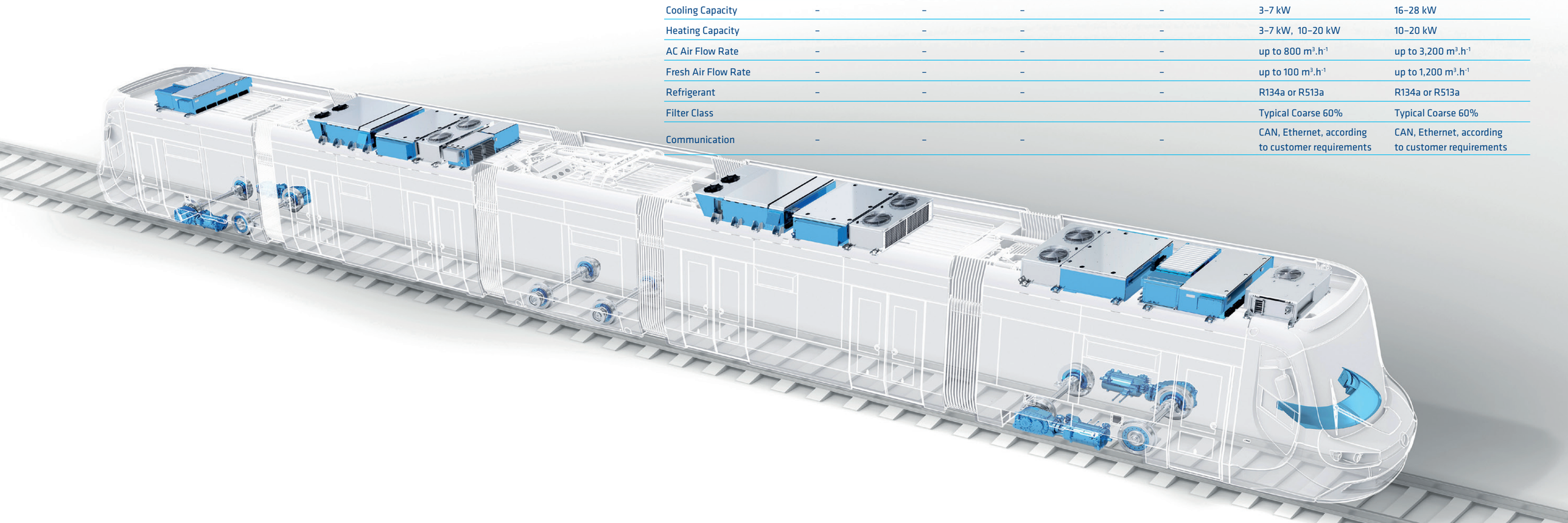
STATIC CONVERTER
is based on IGBT technology with high switching frequency and includes a three-phase converter for the AC tram equipment and a charger for the auxiliary battery.

BATTERY UNIT
contains modern and high-performance battery packs with a long service life. It has its own independent battery charger and integrated control and monitoring system to ensure the right battery conditions in all tram operating modes.

TCMS (TRAIN CONTROL MANAGEMENT SYSTEM)
is a microprocessor-based system that performs control algorithms on the vehicle level as well as the control and monitoring of subsystems with effective local and remote diagnostics.



	TRACTION MOTOR	TRACTION CONVERTER	AUXILIARY CONVERTER / BATTERY CHARGER	TRACTION BATTERY	HVAC CABIN	HVAC SALOON
Rated Power Output	60–120 kW	200–700 kVA	6–55 kVA / 3–25 kW	100 kW	–	–
Input voltage	400–570 V AC	600–750 V DC	600–750 V DC	600–750 V DC	Integrated converters 600/750 V DC, according to EN 50163 24V DC for control circuits other EN50155 on demand	Integrated converters 600/750 V DC, according to EN 50163 24V DC for control circuits other EN50155 on demand
Cooling	Air/Self, Liquid	Air, Liquid	Air, Liquid Air, Liquid	Air, Liquid Air Conditioned	with integrated converters	with integrated converters
Technology	Asynchronous, PMSM	IGBT, SiC	IGBT, SiC	LTO / NMC / LFP	–	–
Weight	300–400 kg	–	–	250–2,500 Kg	up to 150 kg ± 5%	up to 410 kg ± 5%
Instalation	In / Out of bogie frame, wheel hub	Roof	Roof	Roof	Roof	Roof
Torque	600–2,000 NM	–	–	–	–	–
RPM	700–5,000 RPM	–	–	–	–	–
Cooling Capacity	–	–	–	–	3–7 kW	16–28 kW
Heating Capacity	–	–	–	–	3–7 kW, 10–20 kW	10–20 kW
AC Air Flow Rate	–	–	–	–	up to 800 $m^3.h^{-1}$	up to 3,200 $m^3.h^{-1}$
Fresh Air Flow Rate	–	–	–	–	up to 100 $m^3.h^{-1}$	up to 1,200 $m^3.h^{-1}$
Refrigerant	–	–	–	–	R134a or R513a	R134a or R513a
Filter Class					Typical Coarse 60%	Typical Coarse 60%
Communication	–	–	–	–	CAN, Ethernet, according to customer requirements	CAN, Ethernet, according to customer requirements



TRACTION EQUIPMENT FOR METRO TRAINS

A standard solution for third-rail powered drives and auxiliary systems.

In case of modernisation project, DC chopper technology also available when using existing DC motors. The traction system has a high braking energy recovery efficiency.

Advanced and compact PMSM direct drive ready for use. Tested higher energy efficiency in comparison with conventional system, as well significant reduction of noise. Due to the elimination of mechanical gears, a significant reduction of maintenance costs is expected.

REFERENCES

Warsaw, Suzhou, Budapest, Prague, Kiev, Kazan, Incheon, St. Petersburg.

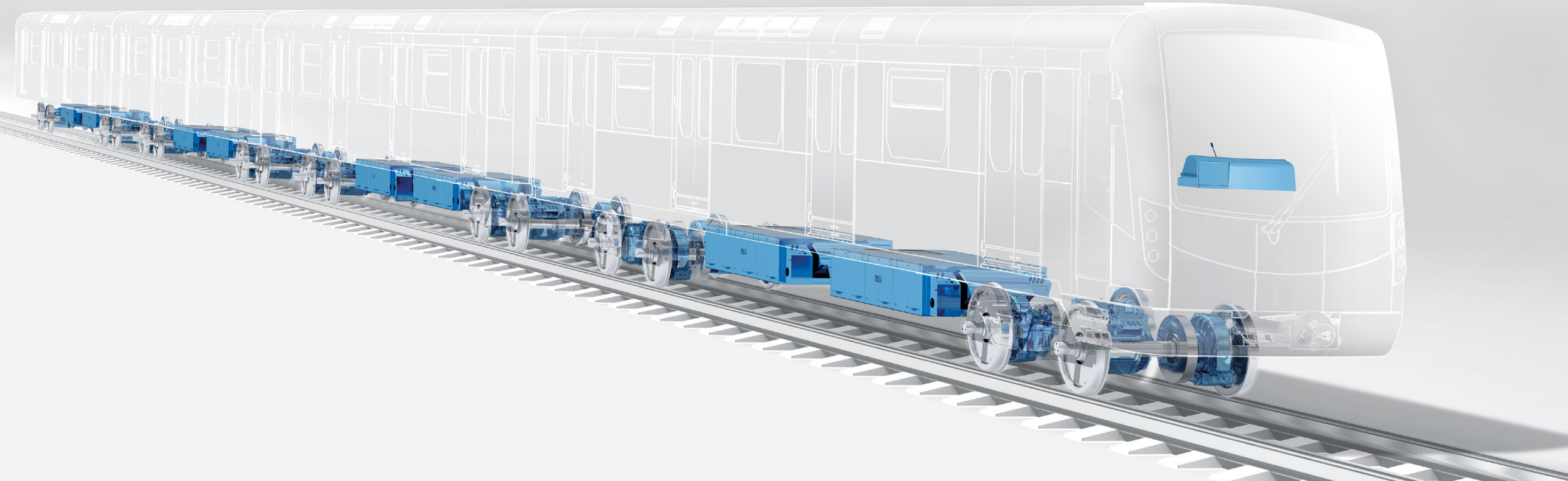
TRACTION MOTOR + GEARBOX
is a ready-made solution adapted to the actual underframe. The traction motor is forced- or self-cooled with a durable, low-maintenance design. The Direct drive PMSM solution should be used as an alternative.

TRACTION CONVERTER
has a modular design with forced-air cooling and an integrated traction control system. The durable construction allows safe and easy maintenance.

AUXILIARY POWER UNIT
(APU) is based on high switching frequency IGBT technology and includes a three-phase converter for the AC train equipment and a charger for the low-voltage battery. The trains have at least two APUs to provide redundancy and backup for important load equipment. The AC outputs of the APUs can be connected directly in parallel because of their synchronisation capability with the AC train line.

TCMS (TRAIN CONTROL MANAGEMENT SYSTEM)
is a redundant microprocessor-based system that performs train-level control algorithms, provides interfaces and control for subsystems, and includes efficient local and remote diagnostics.

	TRACTION MOTOR	TRACTION CONVERTER	AUXILIARY CONVERTER / BATTERY CHARGER
Rated Power Output	150–250 kW	500–1,000 kVA	up to 240 kVA / 35 kW
Input Voltage	400–570 V AC, 1,150 V, 1 350 V AC	600–750 V DC, 1,500 V DC, 25 kV AC	600–750 V DC, 1,500 V DC, 25 kV AC
Cooling	Air / Self	Air, Liquid	Air, Liquid
Technology	Asynchronous, PMSM	IGBT, SiC	IGBT, SiC
Weight	450–900 kg	–	–
Installation	Bogie frame, Direct drive	Underframe, Roof	Underframe, Roof
Torque	typically 2,500 Nm (direct drive 10,000 Nm)	–	–
RPM	typically 5,000 RPM (direct drive 750 RPM)	–	–



IPMSM DIRECT DRIVE FOR METRO

The most common metro mechanical drive composition consists of a traction motor and a gearbox with single or multiple couplings. SKODA took a new approach to drive design and developed the IPMSM direct drive motor, which makes the whole drive train a lot simpler. Not only simple by eliminating the coupling and gearbox, but also with increased efficiency, lower requirements for maintenance and less life cycle costs.

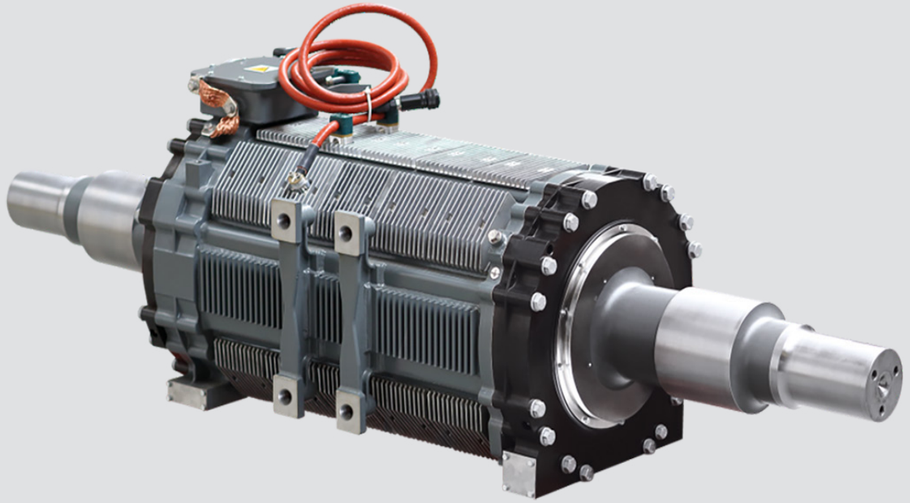
The SKODA IPMSM direct drive motor delivers up to 250 kW in drive and up to 425 kW in brake. Our compact solution creates a maximum 7750 Nm of traction torque, while the weight of the whole motor is only 860 kg. The stator of the SKODA IPMSM direct drive has natural cooling which, after careful and extensive testing, provides noiseless cooling in the whole speed range. Combined with non-existing noise gearbox SKODA IPMSM direct drive offers silent tunnel operation even at high speed.The rotor of the IPMSM traction motor is directly attached to the metro driving axle. There is a direct transfer of torque from the motor to the wheels without any need for a gearbox. With the elimination of a gearbox and couplings from the drive train, together with new SiC inverter, the motor operates with up to 97 percent efficiency. The design of the whole drive train was done with the goal of lower power consumption, a minimal need for maintenance and a long service life.

MAJOR ADVANTAGES OF THE SYSTEM

- Reduced weight
- Elimination of the gear unit
- Elimination of the full mechanical brake

LOWER LCC

- Improved efficiency of the power train
- Longer operating life due to less wear
- Lower maintenance costs for bogie and tracks due to oil-free direct drive concept
- Lower number of bearings
- Low overall height and less installation space
- Improved safety and better operational characteristics due to flexible bogie frame
- Lower noise emission of the drive system



TRACTION EQUIPMENT FOR EMU

Comprehensive drive equipment for electric multiple units that can be used for different voltages in AC and DC overhead lines as well for single deck or double deck unit. AC traction converters are based on high voltage IGBT technology single-deck or double-deck units.

This can be easily adapted to the specific requirements of the operators. EMUs can be two, three or multi-car trainsets with single or dual propulsion systems on motor vehicles.

Trains have a high braking energy recovery efficiency in both DC and AC networks. The 4Q input converter provides high power quality in the case of the AC overhead line under all operating conditions, and the integrated brake rheostat is capable of absorbing all brake energy if there is no other load on the line in the case of DC mains operation.

The drive unit can be installed on the roof, in the machine room or under the floor according to customer requirements and the precise EMU solution.

REFERENCES

National railways of the Czech Republic, Slovakia, Ukraine, Latvia, Italy, Estonia, Germany, Finland and Lithuania.

TRACTION MOTOR + GEARBOX
is a ready-made solution adapted to the actual underframe. The traction motor is forced- or self-cooled with a durable, low-maintenance design.

TRACTION CONVERTER
has a modular design with forced-air cooling and an integrated traction control system. The durable construction allows safe and easy maintenance.

AUXILIARY POWER UNIT
(APU) is based on high switching frequency IGBT technology and includes a three-phase converter for the AC train equipment and a charger for the low-voltage battery. Trains have at least two APUs to provide redundancy and backup for critical load equipment.

MAIN TRANSFORMER
is a highly efficient oil-cooled unit installed under the frame and with its own heat exchanger. Multiple independent secondary coils power the traction and auxiliary converters.

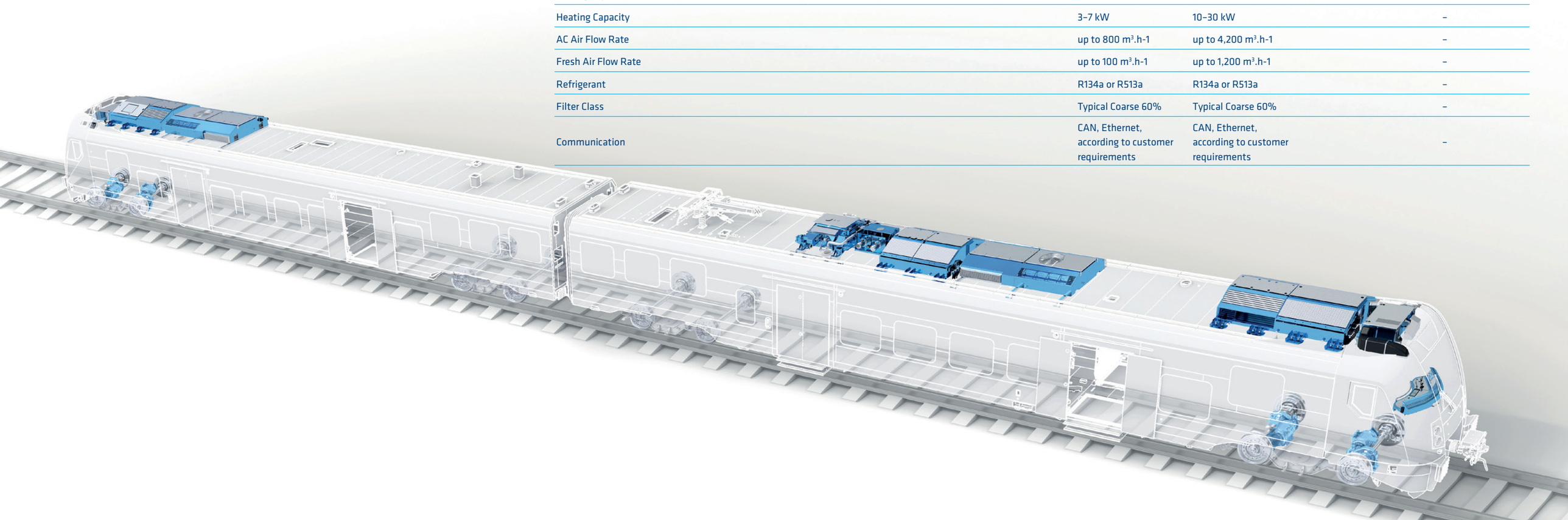
TCMS (TRAIN CONTROL MANAGEMENT SYSTEM)
is a redundant microprocessor-based system that performs train-level control algorithms, provides interfaces and control for subsystems, and includes efficient local and remote diagnostics.







	EMU						PASSENGER COACHES	BEMU
	TRACTION MOTOR	TRACTION CONVERTER	AUXILIARY CONVERTER / BATTERY CHARGER	TRACTION BATTERY	HVAC CABIN	HVAC SALOON	AUXILIARY CONVERTER / BATTERY CHARGER	BEMU BATTERY SYSTEM
Rated Power Output	250–500 kW	1,200 kVA	30–80 kVA / 6–12 kW	500 kW			30–80 kVA / 6–12 kW	150–300 kWh
Input Voltage	1,350 V, 2,260 AC	3 kV DC, 25 kV/50 Hz, 15 kV/16,7 Hz	3 kV DC, 25 kV/50 Hz, 15 kV/16,7 Hz	800 V DC	3×400 V AC, 50Hz 24 V DC for control circuits other EN50155 on demand	3×400 V AC, 50Hz 24 V DC for control circuits other EN50155 on demand	UIC 550 + 3,000 V AC	600–650 V DC
Cooling	Air / Self, Forced	Liquid	Liquid/Air Forced	Liquid Air Conditioned			Air	Liquid
Technology	Asynchronous	IGBT	IGBT, SiC	LTO		without integrated converters	IGBT, SiC	LTO
Weight	600–900 kg	–	–	9,000 kg	up to 135 kg ± 5%	up to 650 kg ± 5%	–	5,500–6,500 kg
Installation	Bogie frame	Roof	Roof, Underframe	Roof	Roof	Roof	Underframe, Roof	Roof
Torque	3,000–5,000 Nm	–	–	–	–	–	–	–
RPM	up to 4,900 RPM	–	–	–	–	–	–	–
Cooling Capacity					3–7 kW	20–45 kW		–
Heating Capacity					3–7 kW	10–30 kW		–
AC Air Flow Rate					up to 800 $m^3.h^{-1}$	up to 4,200 $m^3.h^{-1}$		–
Fresh Air Flow Rate					up to 100 $m^3.h^{-1}$	up to 1,200 $m^3.h^{-1}$		–
Refrigerant					R134a or R513a	R134a or R513a		–
Filter Class					Typical Coarse 60%	Typical Coarse 60%		–
Communication					CAN, Ethernet, according to customer requirements	CAN, Ethernet, according to customer requirements		–



AUXILLIARY POWER SUPPLY FOR PASSENGER COACHES

The auxiliary power supply (APS) is a compact, robust, multi-system converter unit powered directly from the train line. The APS is designed to operate with power systems according UIC 550: 1 kV AC (16.7 Hz, 22 Hz, 50 Hz, 60 Hz), 1.5 kV AC 50 Hz, 1.5 kV DC and 3 kV DC.

The APS provides power supply to the on-board network 3 × 400 V 50 Hz AC as well as charging of the 24 V vehicle battery. The outputs are galvanically isolated from input and from each other. The APS is based on IGBT and MOSFET technology.

The output of the 3 phase inverter is equipped with a sine filter to achieve a sinusoidal voltage waveform.

The converter is designed with a high overload capability, soft-start function for onboard electric motors and fans, and function of cooperation of multiple inverters into a common network without communication between them.

The equipment is designed to meet harsh operating conditions regarding shock andvibration resistance and extended temperature range operation. It is housed in a dustproof and waterproof container and is adapted for under-floor mounting.

TRACTION EQUIPMENT FOR LOCOMOTIVES

A proven solution of propulsion and auxiliary systems for overhead-line powered AC and DC locomotives. They have been installed on a wide range of train sets, such as passenger express trains and fast trains and freight trains.

Traction and auxiliary converters developed for locomotives are based on the latest high-voltage technology, IGBT.

They are capable of operating from a variety of power systems including 1 500 and 3 000 V DC, as well as 15 kV 16 2/3 Hz and 25 kV 50 Hz AC.

Compliant with latest standards and regulations, including compliance with the current TSI.

REFERENCES

Czech Railways, TCDD (Turkish railways) ZSSK (Slovakian railways), Deutsche Bahn, Railway of United Republic of Tanzania.

MAIN TRANSFORMER
is a highly efficient oil-cooled unit installed under the frame. It has multiple independent secondary coils to power traction and auxiliary converters.

TRACTION CONVERTER
has a modular design with water cooling and an integrated traction control system. Multiple independent converters power 4 traction motors with 4Q input converters in the case of an AC power supply. Highly effective braking energy recovery provides excellent performance quality and low harmonic content of the input current.

BATTERY CHARGER
is a device based on IGBT technology operated at high frequency to charge the locomotive auxiliary battery according to the required charging characteristics.

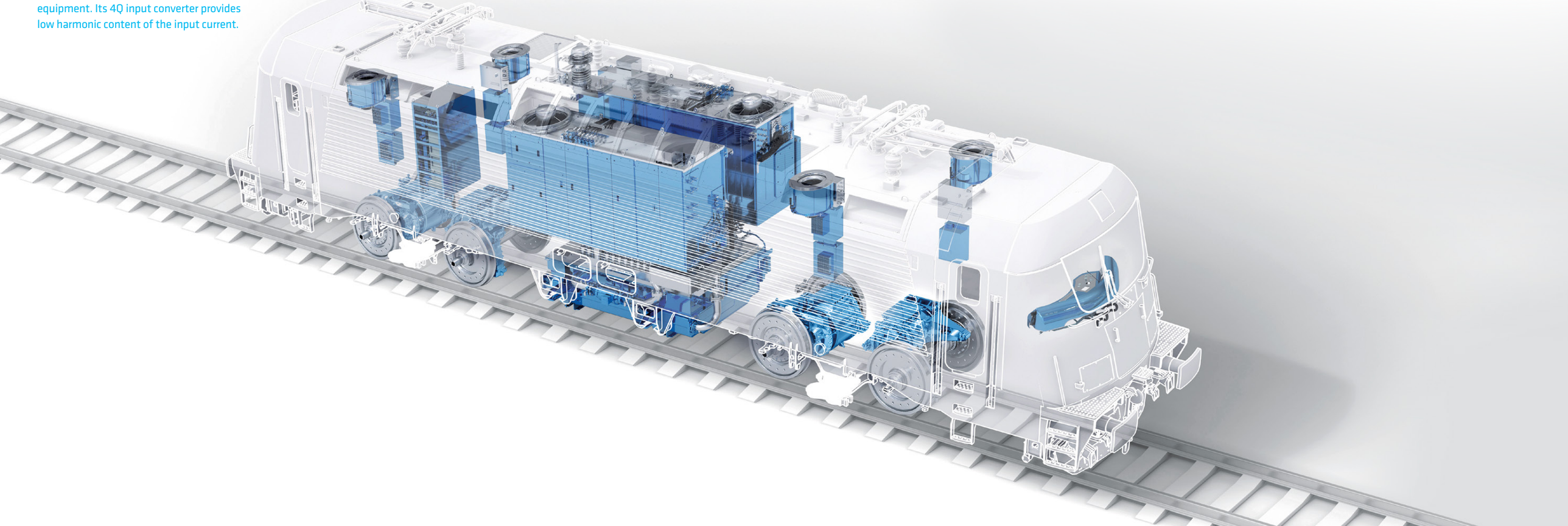
AUXILIARY POWER SUPPLY
is based on IGBT technology with integrated control to generate a three-phase AC network for the locomotive and train's load equipment. Its 4Q input converter provides low harmonic content of the input current.

WHEELSETS
including traction motor, gearbox and axle, it is a complete solution adapted to the actual bogie. Traction motors have forced or separate cooling with a durable design and low maintenance.

COOLING TOWER
with fan, contains liquid-to-air heat exchangers of water-cooled traction and auxiliary converters to provide efficient liquid re-cooling.

TCMS (TRAIN CONTROL MANAGEMENT SYSTEM)
is a redundant microprocessor-based system that performs train-level control algorithms, provides interfaces and control for subsystems, and includes efficient local and remote diagnostics.

	TRACTION MOTOR	TRACTION CONVERTER	AUXILIARY CONVERTER / BATTERY CHARGER
Rated Power Output	400–1,660 kW	up to 2,000 kVA per traction motor	120 kVA, 20kW
Input Voltage	1,350 V, 2,260 AC	3 kV DC, 25 kV/50 Hz, 15 kV/16,7 Hz	3 kV DC, 25 kV/50 Hz, 15 kV/16,7 Hz
Cooling	Air / Forced	Liquid, Air	Liquid, Air
Technology	Asynchronous	IGBT	IGBT, SiC
Weight	800–2,500 kg	–	–
Installation	Bogie frame	Machine Room	Machine Room
Torque	up to 10,000 Nm	–	–
RPM	up to 4,000 RPM	–	–



INTRO

TROLLEYBUS

Innovative and operation-tested solution of the complete electrical system for trolleybuses for all available lengths of vehicles such as 12 m, 15 m, 18 m and 24 m.

SMART SOLUTIONS

Efficient traction system using the energy recuperation and modern advance system for trolleybuses with batteries. It is able to operate indepedently of the trolley line and recharge the batteries in motion. Lower infrastructure costs, flexibility of operation, up to 50% of the line on batteries, universal interface for battery charging, extension of battery lifetime.

The comfort of the trolleybus ride is improved by the fully electric heating system, air conditioning of the driver's cab and the entire passenger compartment, automatic collectors, and user-friendly diagnostic and monitoring system.

REFERENCES

Bologna, Boston, Guadalajara, St. Etienne, San Francisco, Castellon, Coimbra, Limoges Bergen, Landskrona, Cagliairi, Lublin, Budapest, Szeged, Belgrade, Sofia, Varna, Burgas, Pleven, Stara Zagora, Riga, Pilsen, Bratislava, Ploiesti, Targu Jiu, Baia Mare, Vilnius, Rome, Timisoara, Jihlava, Mariánské Lázně, Prešov, Zlín, Brno, Opava, Ostrava, Pardubice, Žilina, Chomutov, České Budějovice, Ústí nad Labem, Hradec Králové, Teplice and others.

TRACTION MOTOR
The motor is asynchronous, 160–250 kW. The power is transmitted to the drive axle via a cardan shaft. Possibility of two motorised axles

TRACTION CONVERTER
The electrical equipment is connected to a processor-controlled asynchronous traction drive. The basis of the equipment is a rooftop unit with traction and auxiliary transistor-based converter. Contactors, power fuses and other devices, such as battery chargers, are also integrated in one unit.

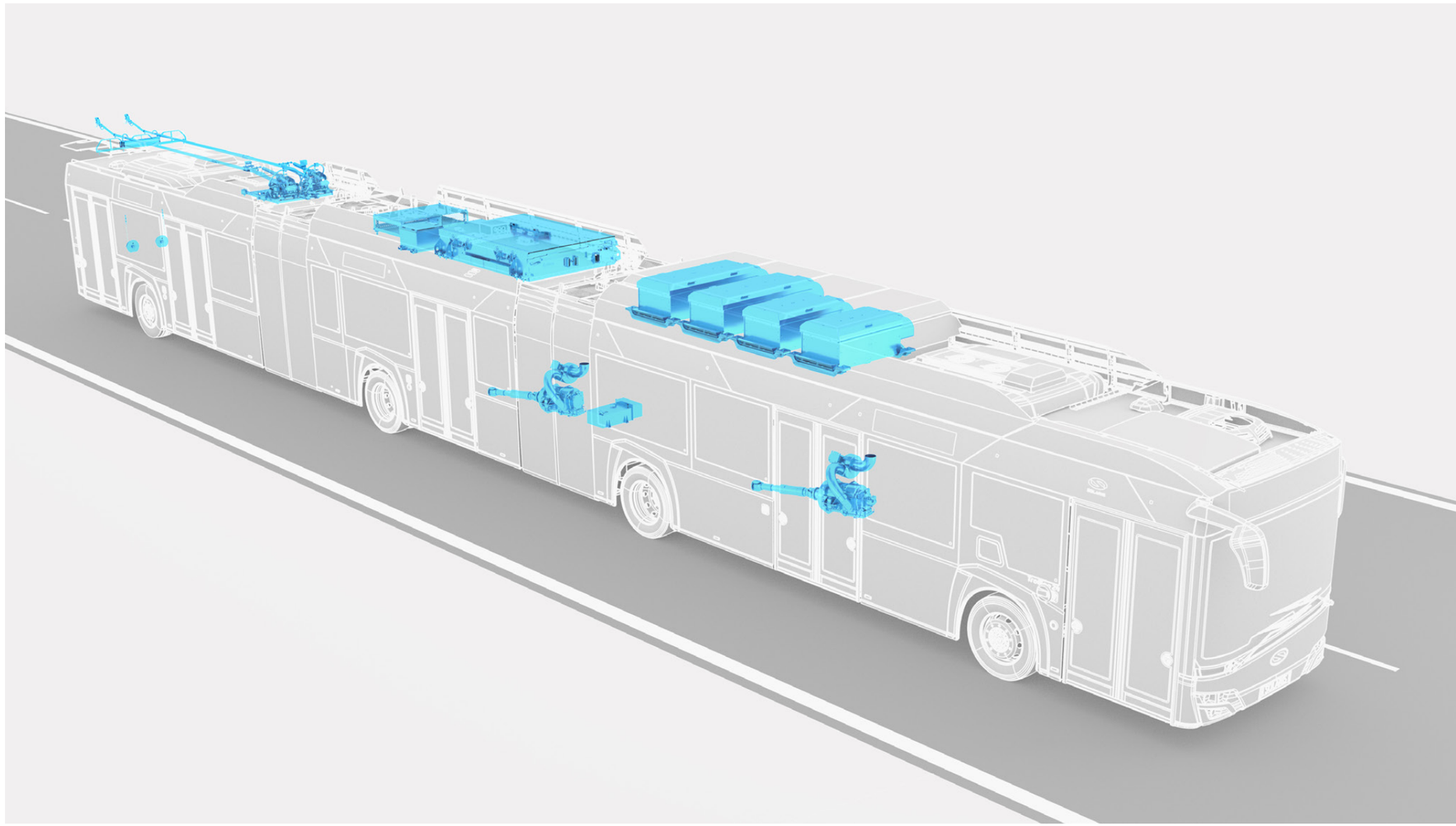
TRACTION BATTERIES
The trolleybus can be equipped with traction batteries, which serve as an independent source of energy for the trolleybus in the absence of power from the overhead line.

CURRENT COLLECTORS
The trolleybus collector system consists of a double circuit of laminated bar collectors with compression springs, cable reels and a lightning arrester.

BRAKE RESISTOR
It is used to convert unusable recovered energy into thermal energy.

AIR CONDITIONING
The trolleybus is equipped with heating and air conditioning systems for the passenger or driver compartment. The air-conditioning unit, which includes the air-conditioning compressor, is located on the roof of the vehicle. The operation of both systems is fully electric.

	TRACTION MOTOR	TRACTION CONVERTER	AUXILIARY CONVERTER / BATTERY CHARGER	TRACTION BATTERY
Rated Power Output	160–300 kW	up to 300 kVA	up to 50 kVA	40–70 kwh
Input Voltage	600–750 V DC	600–750 V DC	600–750 V DC	600–750 V DC
Cooling	Forced air	Air	Air	Air, Liquid Air Conditioned
Technology	Asynchronous	IGBT	IGBT, SiC	LTO, NMC
Installation	Underframe / cardan shaft	Roof	Roof	Roof, Machine room
Torque	up to 3,750 Nm	–	–	–
RPM	2,600 /4,500	–	–	–



ŠKODA GROUP
ELECTRIC SYSTEMS & COMPONENTS

ZERO EMISION BUSES

ZERO

ELECTRIC BUS SYSTEM

A variable portfolio of the electric system solutions for all lengths of urban electric buses, such as 9 m, 12 m, 15 m, 18 m or 24 m. The easy integration of the components on the bus body, silent operation and efficiency are some of the main advantages.

Advances technology using a modern synchronous motor system with motor with pemanent magnets and a traction inverter with SiC modules, enabling a silent, light and energy-saving solution.

Covering all types of charging systems: Plug-In overnight charging through strandard CC2 socket in power up to 150 kW. Oportunity conductive charging via bus or polemounted pantograph charing power up to 350 kW, including OPPCharge Flash rapid charging solution via bus mounted pantograph up charging power to 600 kW.

A unique solution of bi-pole oportunity charging, which is carried out from a bi-pole pantograph with power around 150 kW from the trolleybus or tram line. This solution is suitable for cities with an existing power infrastructure that can be shared with trams, trolleybuses or metro trainsets.

REFERENCES

Prague, České Budějovice, Zlín, Třinec, Trutnov, Žilina, Nové Zámky.

TRACTION MOTOR
A 160kW-250kW PMSM motor with considerable torque for starting a fully-occupied vehicle on elevations or accelerating in city traffic. The innovative control algorithm and accurate motor model are the main reasons for the great efficiency of the motor in a wide range of operation points. It is possible to reduce the current consumption and significantly reduce the power losses of the motor.

TRACTION CONVERTER
The electrical equipment is connected to a processor-controlled SiC technology.

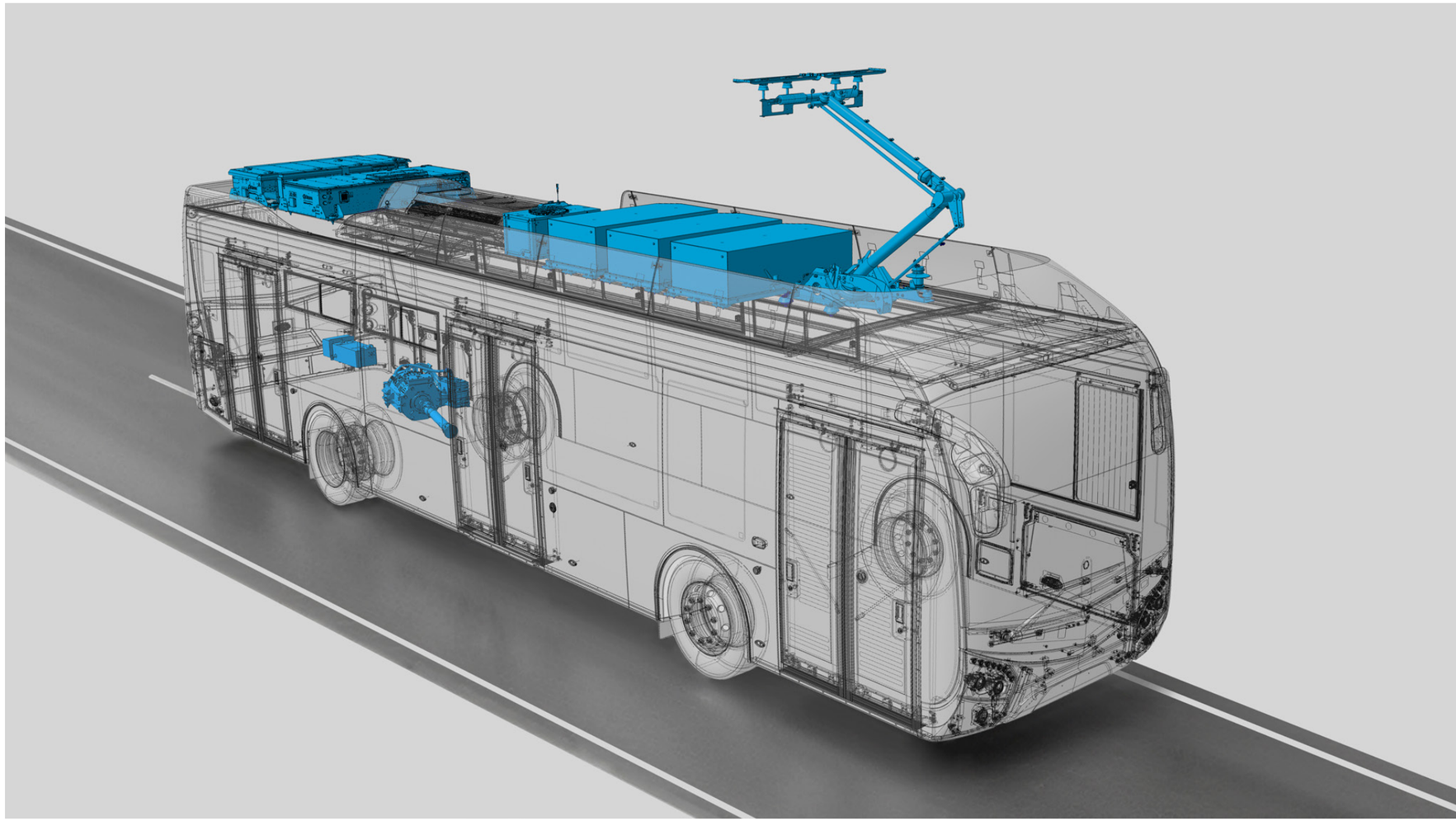
TRACTION BATTERIES
The modular range of traction batteries allows you to optimise the amount of energy for different range requirements. Li-Ion traction batteries are liquid cooled and are a maintenance-free technology.

ROOF CONTACTS FOR FAST CHARGING
They comply with the OPP-Charge standard and ensure the transfer of high charging power (DC) to the vehicle. The fast-charging operation is fully automatic. The advantage is the low weight of the vehicle's electrical equipment, as the power electronics and the inverted pantograph are part of the charging infrastructure and only the roof contacts are on the vehicle.

SOCKET FOR CABLE CHARGING
The standard CCS socket on the vehicle allows DC charging at the depot via cable if required.

AIR CONDITIONING
It is located in both the passenger compartment and the driver's compartment and the temperatures can be set separately.

	TRACTION MOTOR	TRACTION CONVERTER	AUXILIARY CONVERTER / BATTERY CHARGER	TRACTION BATTERY	STATIC CONVERTER MKA/B/C
Rated Power Output	160–300 kW	up to 300 kVA	up to 35 kVA, 6 kW	150–300 kWh	up to 15 or 25 kW
Input Voltage	400–520 V	600–750 V DC	600–750 V DC	600–750 V DC	150–850 V
Cooling	Air/Forced, Liquid	Air, Liquid	Air, Liquid	Air, Liquid Air Conditioned	Liquid
Technology	Asynchronous, PMSM	IGBT, SiC	IGBT, SiC	LTO, NMC	IGBT
Weight	300–600 kg	–	–	650–2,500 kg	7 kg
Installation	Underframe / cardan shaft	Roof	Roof	Roof, Machine room	In vehicle
Torque	up to 3,750 Nm	–	–	–	–
RPM	2,600 / 4,500	–	–	–	–



FUEL CELL BUS

A complete range of traction systems for fuel cell buses of various lengths and platforms. It is possible to provide a full OEM package covering the traction system, batteries, fuel cells and tanks. The easy integration of the components on the bus body, silent operation and efficiency are some of the main advantages of Skoda.

User-friendly diagnostics, telemetry and static system to improve the maintenance and smooth the vehicle operation.

Advanced technology using a modern synchronous motor system with pemanent magnets and a traction inverter with SiC modules, enabling a silent, light and energy-saving solution of the passenger compartment, increasing the range of operation of the bus.

REFERENCES

Prague, České Budějovice, Zlín, Třinec, Trutnov, Žilina, Nové Zámky.

TRACTION MOTOR
A 160kW-250kW PMSM motor with considerable torque for starting a fully occupied vehicle on elevations or accelerating in city traffic. The innovative control algorithm and accurate motor modelare the main reasons for the great efficiency of the motor in a wide range of operation points. It is possible to reduce the current consumption and significantly reduce the power losses of the motor.

TRACTION CONVERTER
The electrical equipment is connected to a processor-controlled SiC technology.

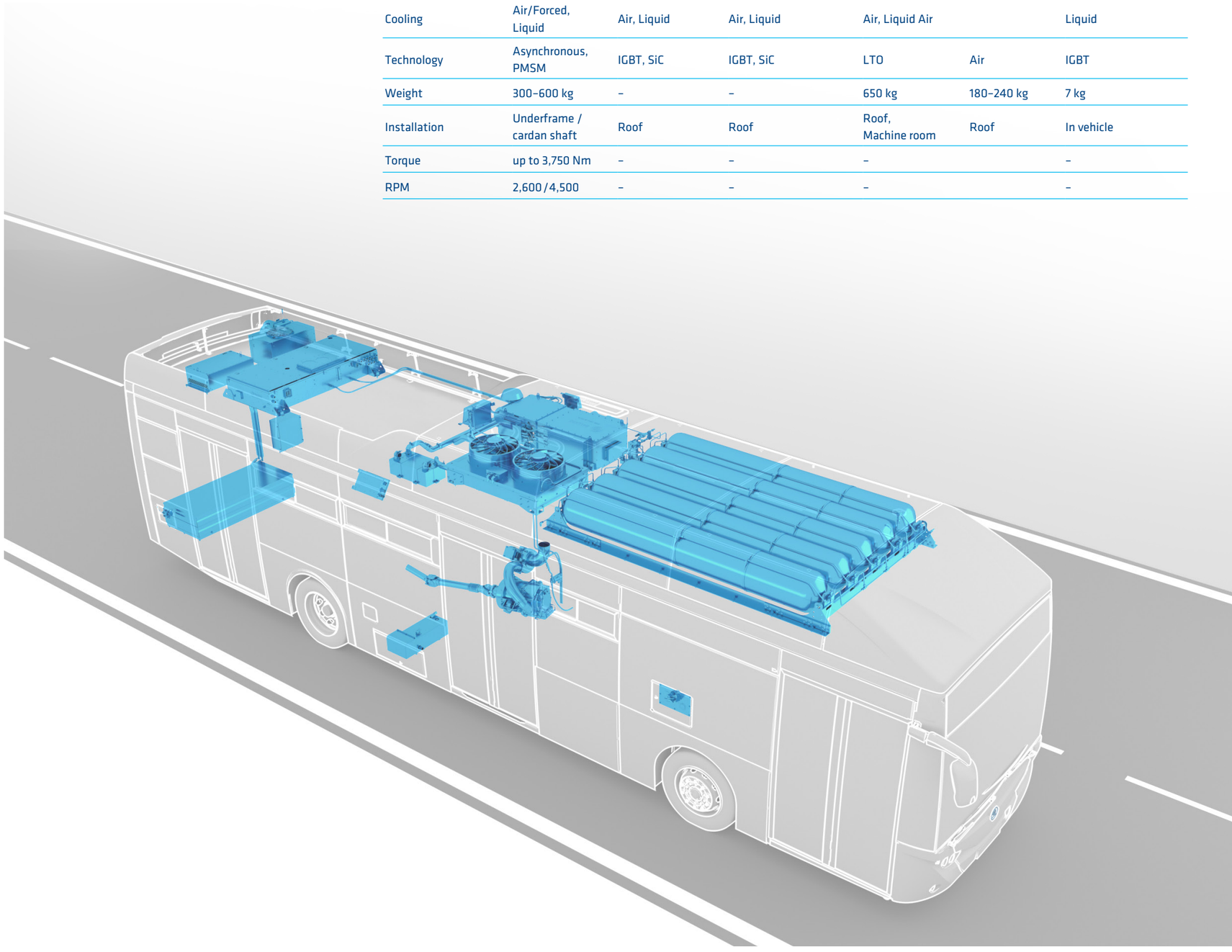
TRACTION BATTERIES
The modular range of traction batteries allows you to optimise the amount of energy for different range requirements. Li-Ion traction batteries are liquid cooled and are a maintenance-free technology.

SOCKET FOR CABLE CHARGING
The standard CCS socket on the vehicle allows DC charging at the depot via cable if required.

AIR CONDITIONING
It is located in both the passenger compartment and the driver's compartment and the temperatures can be set separately.

FUEL CELL
Fuel cell power regulation according to the state of charge of the traction battery.

	TRACTION MOTOR	TRACTION CONVERTER	AUXILIARY CONVERTER / BATTERY CHARGER	TRACTION BATTERY	FUEL CELL	STATIC CONVERTER MKA/B/C
Rated Power Output	160–300 kW	up to 300 kVA	up to 35 kVA, 6 kW	up to 150 kWH	50–80 kW	up to 15 or 25 kW
Input Voltage	400–520 V	600–750 V DC	600–750 V DC	600–750 V DC	600–750 V DC	150–850 V
Cooling	Air/Forced, Liquid	Air, Liquid	Air, Liquid	Air, Liquid Air		Liquid
Technology	Asynchronous, PMSM	IGBT, SiC	IGBT, SiC	LTO	Air	IGBT
Weight	300–600 kg	–	–	650 kg	180–240 kg	7 kg
Installation	Underframe / cardan shaft	Roof	Roof	Roof, Machine room	Roof	In vehicle
Torque	up to 3,750 Nm	–	–	–		–
RPM	2,600 / 4,500	–	–	–		–



IPMSM & SiC

The permanent magnet motor is an advanced alternative to induction asynchronous motors. Today, the permanent magnet motor is the most common and increasing choice for zero emission buses. Permanent magnet motors offer a wide range of technical solutions for multiple variants. Permanent magnet motors are changing the market trends in terms of the powertrain. Permanent magnet motors are bringing different kinds of traction drives in terms of different possibilities where to place and use an electric motor in an electric bus. These requirements are mainly regarding weight, efficiency and noise emissions, which are and will be ever more demanding in the future. A permanent magnet motor powered by an SIC inverter is now bringing new, more advanced and interesting options. PMSM and SIC simultaneously increase the performance and efficiency at a better size and weight configuration. Buses are operated in a different driving cycle characterised by frequent accelerating and braking, 24 hours a day, 7 days a week, which places demands on the high reliability of the entire traction chain. Škoda permanent magnets motors and SiC inverters are definitely prepared for that.

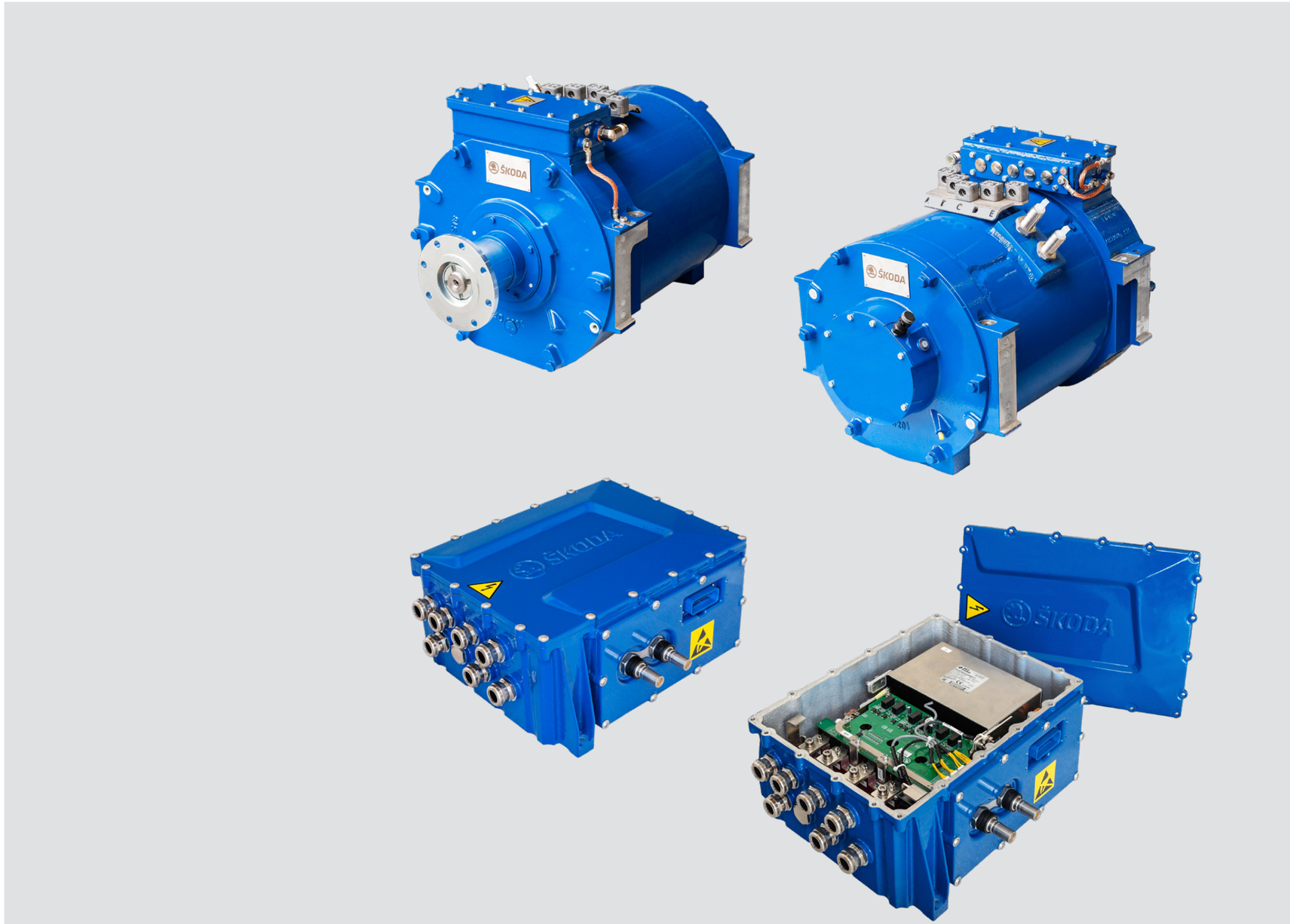
SIC TRACTION INVERTER FOR E-BUS

The SiC traction inverter is designed as a water-cooled inverter with high power density. Primarily, the traction SiC converter is designed for 12m and 18m electric buses, where a resolver position sensor with defined signals is used. The inverter can also be used as two 3-phase auxiliary drive inverters. All measurements required to control the 5f PMSM are integrated in the inverter.

The inverter can be placed in a roof box (without external covers – IP00) or near the traction motor with IP55. The traction motor and SiC inverter use one common water cooling system.

BASIC TECHNICAL PARAMETERS

Maximum power	500 kW
Nominal power	350 kW
Max phase current	370 A eff
Voltage Ud nominal	700 V
Voltage Ud max	800 V
Switching frequency – min.	10 kHz
Switching frequency – max.	20 kHz
Dimensions (L × W × H)	315 × 285 × 167 mm
Weight	14,5 kg ± 3%
Cooling	water cooling (distilled water with glycol)
Min. required coolant flow rate	10 l/min
IP level according to ČSN EN 60529	IP55



ŠKODA GROUP
ELECTRIC SYSTEMS & COMPONENTS

DIGITAL SOLUTIONS

DIGI

ASTRID & DISMON

Digital services from Škoda Group are your keys to an excellent fleet overview. We provide solutions essential for service and powerful tools for warranty issues. With our diagnostic and information systems, you can predict battery life and detect anomalies.

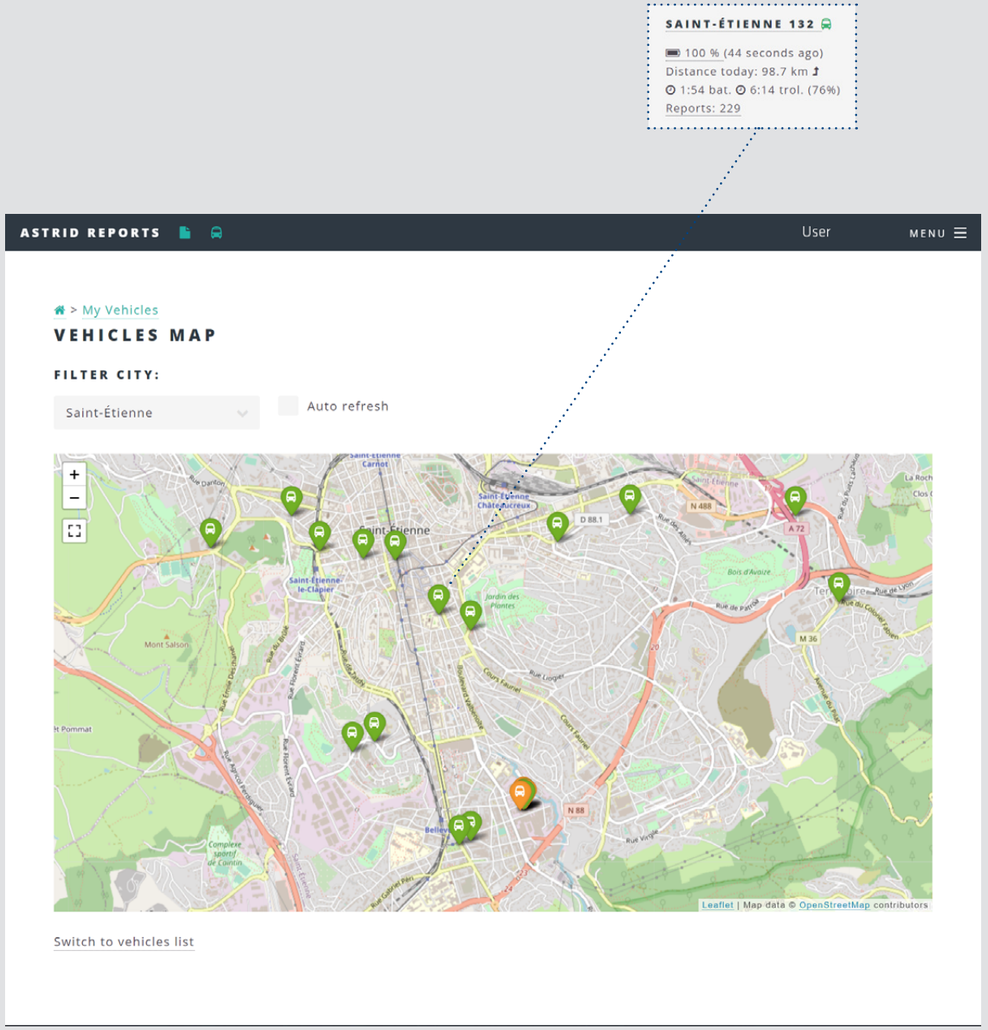
Our tools ASTRID & DisMon have been fuly developed in Škoda Group, in order to easily locate faults and conveniently display the functional conditions of E-buses and trolleybuses. They are standard for all new Škoda vehicles.

ASTRID

- Developed & maintained in-house by Škoda Group.
- Used for vehicles in several European countries.
- Collects telemetry data from vehicles.
- Provides vehicle status information.
- Generates statistical reports, predictions, anomaly alerts
- Localised for several languages, new languages can be added easily.
- User-friendly interface.

DISMON

- Tool for low-level diagnostics, both local & remote.
- DisMon is a “Swiss army knife”software tool for developers and service technicians.
- Low-level diagnostics/troubleshooting of the vehicle’s control units (onboard computers)



TCMS

TCMS implements control, monitoring and diagnostics functions at the vehicle. It integrates the vehicle computer, I/O modules, display units and communication infrastructure. Škoda TCMS is suitable for following applications as: Trolleybuses, Trams, LRVs, Metros, EMUs, and Locomotives.

Škoda TCMS is a comprehensive train control and monitoring system based on a long-term production history with respect and according to all relevant IEC, EN and IEEE standards.

The modular and flexible design provides wide possibilities to easily adapt the system to various requirements. Key components are available in redundant configurations that increase the reliability and availability of the system.

Škoda TCMS consists of:
Vehicle Control Unit (VCU), Driver Display Units (DDU,)which comprise the Intelligent Driver Display System (optional, not in the scope of the delivery). Remote I/O modules (RIOM) make it possible to access devices that are not connected to the TCMS communication system, which connects VCUs, intelligent systems and remote I/O modules and which and also connects onboard devices to a ground system.

There are two active communication devices included in the communication system:
the train gateway (GTW), connecting vehicle bus(es) and the train bus, and the Mobile Communication Gateway (MCG), connecting the onboard network with the ground communication infrastructure. (optional, not in the scope of the delivery).

TRAIN ON-BOARD ENERGY MEASUREMENT SYSTEM (EMS) EGM-3000, CEGM-3000

EGM-3000 and CEGM-3000 train on-board measurement systems (EMS) have been designed and developed as smart and reliable solutions for electricity consumption measurement of moving vehicles such as trains, trams, metros, tram-trains and stationary applications.

EMSenables the real-time monitoring of active and reactive energy, and consumed and recuperated energy in all traction power systems in accordance with the latest EU legislative requirements incl. metrology standards.

	LRV	EMU	METRO	ELECTRIC LOCOMOTIVE
Broadband power supply	16.8 V to 137.5 V DC	16.8 V to 137.5 V DC	16.8 V to 137.5 V DC	16.8 V to 137.5 V DC
Power supply failure class	S2	S2	S2	S2
Temperature class	OT4 (-40°C to +70°C)	OT4 (-40°C to +70°C)	OT4 (-40°C to +70°C)	OT4 (-40°C to +70°C)
Degree of protection	IP54	IP54	IP54	IP54
Isolated measuring inputs	2,000 V AC / 50Hz / 1 minute	2,000 V AC / 50Hz / 1 minute	2,000 V AC / 50Hz / 1 minute	2,000 V AC / 50Hz / 1 minute
Accuracy class	0.5 R according to EN 50463 / C according to EN 50470 / 0.5 S according to IEC 62053-22 and IEC 62053-24	0.5 R according to EN 50463 / C according to EN 50470 / 0.5 S according to IEC 62053-22 and IEC 62053-24	0.5 R according to EN 50463 / C according to EN 50470 / 0.5 S according to IEC 62053-22 and IEC 62053-24	0.5 R according to EN 50463 / C according to EN 50470 / 0.5 S according to IEC 62053-22 and IEC 62053-24
Nominal voltage range on the AC voltage input	40 V to 250 V	40 V to 250 V	40 V to 250 V	40 V to 250 V
Nominal current range on the AC current input	40 mA to 5 A	40 mA to 5 A	40 mA to 5 A	40 mA to 5 A
Nominal current range on the DC voltage input	20 mA to 100 mA	20 mA to 100 mA	20 mA to 100 mA	20 mA to 100 mA
Nominal current range on the DC current input	20 mA to 2 A	20 mA to 2 A	20 mA to 2 A	20 mA to 2 A
Record period	1 minute to 60 minutes	1 minute to 60 minutes	1 minute to 60 minutes	1 minute to 60 minutes
Record memory	at least 72 days	at least 72 days	at least 72 days	at least 72 days
Technology	Real time monitoring	Real time monitoring	Real time monitoring	Real time monitoring
Weight	1.5 kg	1.5 kg	1.5 kg	1.5 kg
Installation	In vehicle	In vehicle	In vehicle	In vehicle

SERVICE

SERVICE

Škoda also offers additional services throughout the whole product lifetime. Škoda provides its customers with a full range of after-sales service options. Warranty Service, After Warranty Service, Spare Parts Full Service and Upgrades.

FULL SERVICE

General maintenance of the vehicle fleet, including regular maintenance and unscheduled repairs.The customer is completely relieved of daily operational worries. No more dealing with human resources, missing spare parts or unreliable suppliers.

And above all - maintenance is performed directly by the manufacturer, i.e. by the most technologically qualified entity on the market, which has many years of experience with this model, in several countries and with different models and product types.

SPARE PARTS

The manufacturer is always a reliable guarantee of supply of original spare parts. Škoda Group also provides sophisticated options for the delivery of spare parts, where, for example, the customer can benefit from the convenience of storing parts directly on their premises. They are then literally “on hand”. This mainly concerns consignment warehouses or “stock replenishment”.

REPAIR AND MAINTENANCE

The customer can perform routine maintenance itself, but still has the option of contacting the manufacturer in the event of more complex operations or unexpected events. They can then be sure that the first major repair work, for example, will be performed in a competent and thorough manner, but also taking into account the economic aspect of the issue.

SUPPORT SERVICES

Škoda Group uses the latest technologies and innovations during development and production. This gives Škoda a great technological background, which it is happy to share with customers via technical support. Customised training, material analysis and measurement, provision of electronic diagnostics and on-line monitoring rank among the main services which customers use.

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