Power Electronics for Public Transport Vehicles

TRAMS, METRO, eBUSES, TROLLEYBUSES

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MEDCOM is a manufacturer of modern propulsion inverters for asynchronous drives and auxiliary converters installed in vehicles powered by 600 VDC/750 VDC catenary system.

Propulsion inverters are based on the IGBT or SiC technology. Owing to the application of modern control systems, they ensure antislip control of the drive torque of the respective vehicle axles, effective electrodynamic braking within the whole speed range of the vehicle and a possibility of emergency braking in case of blackout in the traction network.

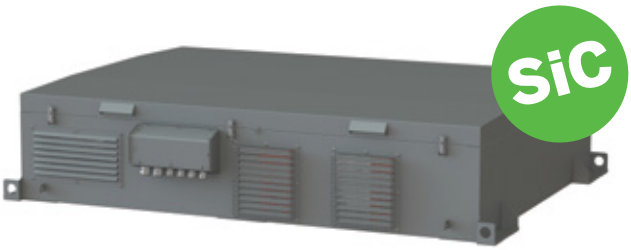
Currently produced inverters with output power range from 80 kW to 450 kW ensure very good driving parameters of the vehicle. Their main advantages are a low level of noise emission and a high driving comfort.

Auxiliary converters with output power ranging from 5 kW to 500 kW ensure power supply for sub-assemblies of the propulsion system and all other loads (control, lighting, compressors, fans of the devices) of the vehicle. Apart from that, the auxiliary converters may also supply heating, ventilation and air conditioning systems.

All inverters and converters are equipped with a diagnostic-control system based on a MVB, CAN 2.0 B or RS232 interface.

FT-50-600-Q-Combo/PSM-50 SiC

Propulsion inverter
for Asynchronous Drives



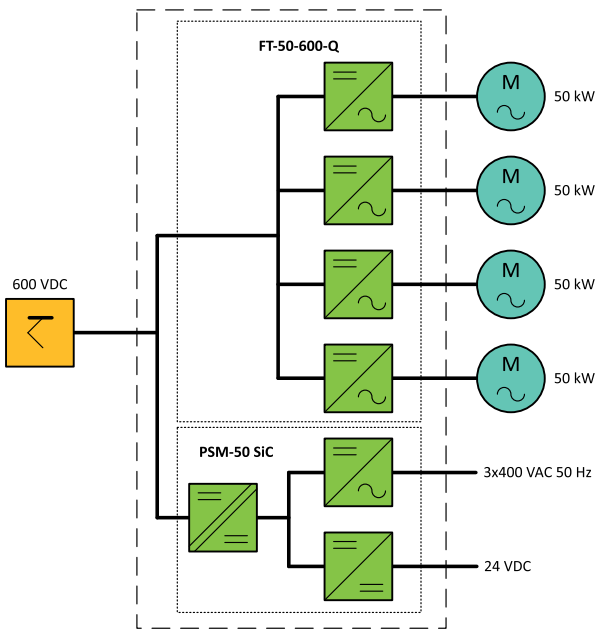
The power box and propulsion of the FT-50-600-Q-Combo tram consists of four FT-50-600 inverters and one PSM-50 SiC auxiliary converter. The FT-50-600 propulsion inverter is a device that transforms the input voltage from the pantograph into a three-phase alternating voltage of variable amplitude and frequency while maintaining a constant U/f ratio.
Key benefits of the inverter include: a low distortion level of the AC output voltage, and very high efficiency and overload capability. The inverter is equipped with its own system of forced cooling, which ensures correct operation in a wide range of outdoor temperatures. The speed control of the fan is realized as a function of the inverter temperature.

The capacitors used in the DC circuits are made using a "self--healing", segment technology that provides high reliability and durability. One box contains four inverters; each inverter controls one motor (a one-to-one solution). Their control system is based on the DSP (Digital Signal Processor) and provides control and supervision over the operation of the inverters. The applied FOC SV PWM algorithm (Field Oriented Control Space Vector Pulse Width Modulation) ensures correct traction parameters of the drive.
The PWM (Pulse Width Modulation) technology with integrated LC filter and applied algorithms maintains a total harmonic distortion of less than 5% in the supply voltage of the asynchronous motors and other devices for alternating current. This increases the reliability of the device and limits voltage surges.

Advanced control and diagnostic features provide trouble-free and efficient operation of the vehicle. The control system of the inverter ensures that the drive has a precisely controlled torque (on the shaft) and provides regenerative braking. The device is equipped with internal cooling by forced air fans (with increased durability) and is designed for installation on the tram roof. Communication with the tram control system is provided by the CAN 2.0B HMI. The control algorithms of inverters are equipped with a software anti--slip system that ensures the immediate return of adhesion between wheel and rail (by reducing the torque on the shaft – if there is a slip). DSP provides optimum control of the drive and protects the drive against damage of the whole chain of equipment: inverter-motor--brake resistor.
The modular design of the inverter allows easy access to every component, simplifying maintenance.
Each inverter control system is programmed to detect any lock and wheel slip.
The converter is made with SiC technology (silicon carbide) that provides improved performance parameters such as: switching speed, working temperature, current density, dielectric strength and lower activation resistance. This technology reduces the size and weight of the inverter, while increasing its efficiency.
The control system ensures high frequency stability, very good symmetry of the output phase voltages and a very low level of interferences generated by the system.

Semiconductor components of the device are selected with some excess to ensure the correct level of system overload.
The device is completely maintenance-free – the control system controls the status of the output terminals and protects the inverter during prolonged overload or a short circuit.
The PSM-50 SiC auxiliary converter is designed for transforming the overhead contact line voltage of 600 V to 24 VDC and 3×400 VAC (50 Hz) voltages and supplying the auxiliary circuits of the vehicle.

BLOCK DIAGRAM

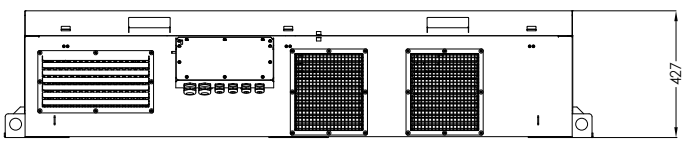


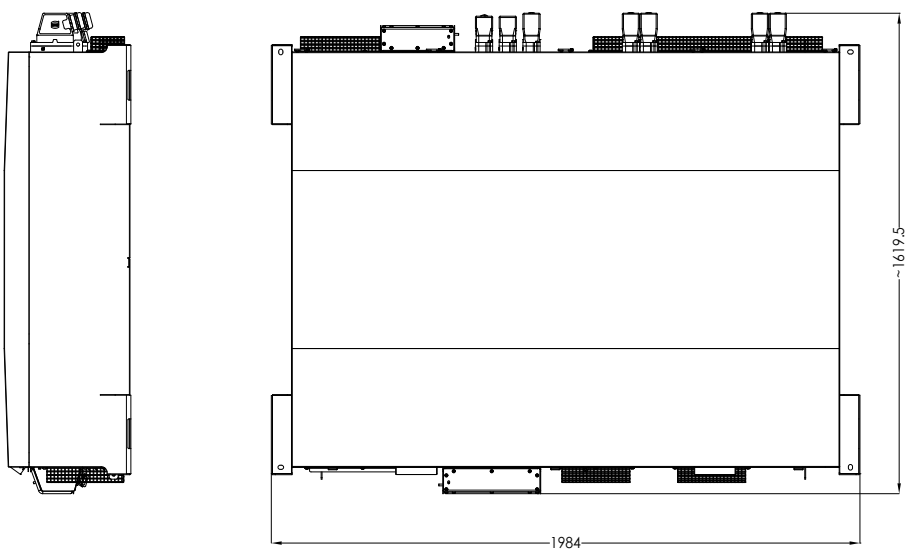
FT-50-600-Q-Combo/PSM-50 SiC

Propulsion inverter
for Asynchronous Drives

FT-50-600		
Input voltage	**600 VDC +25% ÷ –30%**	
Rated power	**50 kW**	
Rated current	**4 × 150 A**	
Auxiliary voltage	**24 VDC +25% ÷ –30%**	
PSM-50SiC		
Input voltage	**600 VDC +25% ÷ –30%**	
Output power	**50 kVA**	
DC Output	**24 V / 6 kW**	
AC Output	**3×400 V / 50 kVA, cosφ=0,9**	
Auxiliary voltage	**24 VDC +25% ÷ –30%**	
Housing		
Cooling	**forced-air**	
Weight	**555 kg**	
Dimensions	**1984 × 1620 × 427 mm**	
Protection degree	**Clean section**	**IP54**
	Dirty section	**IP20**

HOUSING



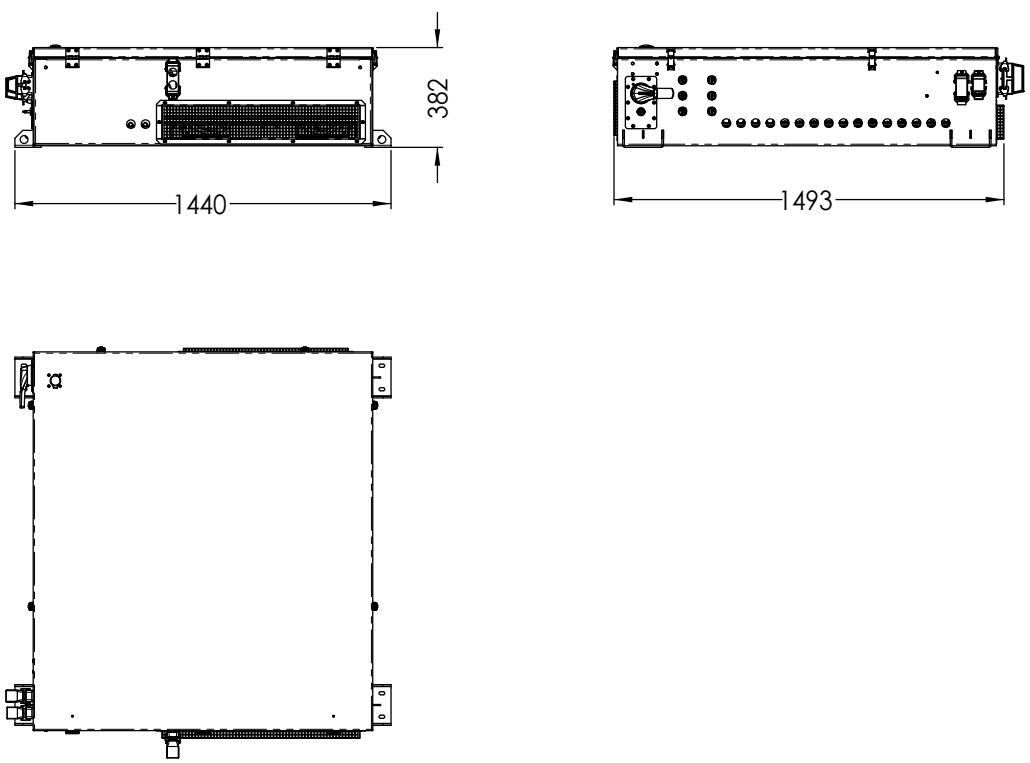


FT-80-600D/PSM-42

Propulsion inverter integrated with Auxiliary Converter

Propulsion inverter is intended to supply traction motor which drive the bus wheels. The inverter container with the RWN switchgear and PSM auxiliary converter is intended for installation on the vehicle roof.
The propulsion inverter is intended for power supply from a traction battery.
The power train of the system enables accelerating, driving with a set torque, coasting and regenerative braking. It also enables accelerating, driving and braking when travelling in a reverse direction.
The propulsion inverter enables conversion of the input voltage to regulated output variable voltage within a range of 0 to the rated traction motor voltage, while maintaining a constant relationship between the output voltage and voltage frequency (U/f).
The traction drive used in the electric bus is composed of the propulsion inverter, traction motor and braking resistor. The high voltage circuit is additionally composed of the PSM auxiliary converter.
Propulsion inverter and auxiliary converter are cooled by forced air circulation. The braking resistor is cooled by natural air circulation. The use of air cooling enables reliable operation in a wide range of external temperatures. The supply of the fan in the drive box is provided by a 3x400 V, 50 Hz inverter in the auxiliary converter.
The power supply when driving is provided by a set of batteries grouped in battery packs. The Battery Management System (BMS) manages the operation of the packs, controlling the charge level of the cells and sending information to the drive control system on the current which may be drawn from the battery at a given moment.
The inverter is manufactured in the HV IGBT technology. The inverter control is provided by DSP (Digital Signal Processing), using FOC SVPWM (Field Oriented Control Space Vector Pulse Width Modulation). The control system ensures constant torque acceleration and low power losses.
The inverter meets the UN and EN standards on safety and electromagnetic compatibility. The system has very low levels of low frequency interferences generated in the traction wire network.
Inverter diagnostics and control is provided using the CAN-Bus interface. The system is adopted to operate with a recorder of traction parameters and inverter parameters, which enables the reconstruction of power supply conditions in case of interferences in the operation or in case of failure of the propulsion system.

HOUSING



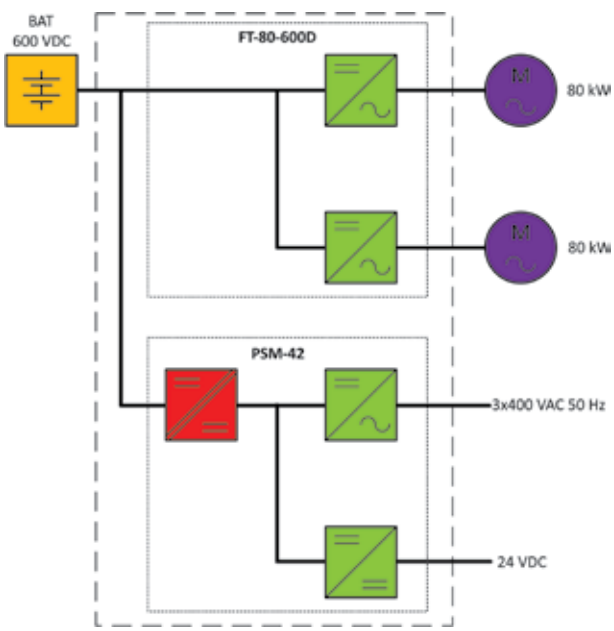
FT-120-600D/PSM-42

Propulsion inverter integrated
with Auxiliary Converter

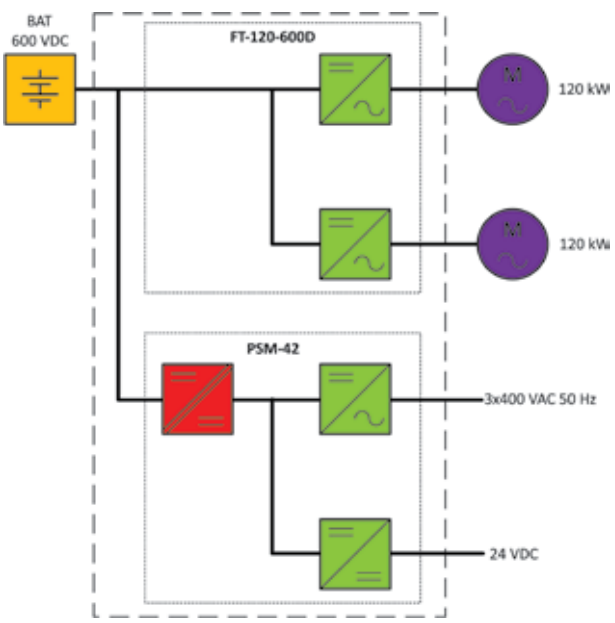
FT-80-600D		
Input voltage	**600 VDC**	
Rated power	**2 × 80 kW**	
Rated current	**185 Arms**	
Auxiliary voltage	**24 VDC +25% –30%**	
PSM-42		
Input voltage	**600 VDC**	
Output power	**42 kW**	
DC Output	**24 VDC / 12 kW**	
AC Output	**3×400 V 50 Hz / 30 kVA**	
Auxiliary voltage	**24 VDC +25% –30%**	
Housing		
Cooling	**Forced-air**	
Weight	**310 kg**	
Dimensions	**1440 × 1450 × 382 mm**	
Protection degree	**Clean section**	**IP55**
	Dirty section	**IP20**

FT-120-600D		
Input voltage	**600 VDC**	
Rated power	**2 × 120 kW**	
Rated current	**185 Arms**	
Auxiliary voltage	**24 VDC +25% –30%**	
PSM-42		
Input voltage	**600 VDC**	
Output power	**42 kW**	
DC Output	**24 VDC / 12 kW**	
AC Output	**3×400 V 50 Hz / 30 kVA**	
Auxiliary voltage	**24 VDC +25% –30%**	
Housing		
Cooling	**Forced-air**	
Weight	**310 kg**	
Dimensions	**1440 x 1450 x 382 mm**	
Protection degree	**Clean section**	**IP55**
	Dirty section	**IP20**

BLOCK DIAGRAM FOR THE SYSTEM WITH THE FT-80-600D INVERTER



BLOCK DIAGRAM FOR THE SYSTEM WITH THE FT-120-600D INVERTER



FT-105-600D

Propulsion inverter for Asynchronous Drives

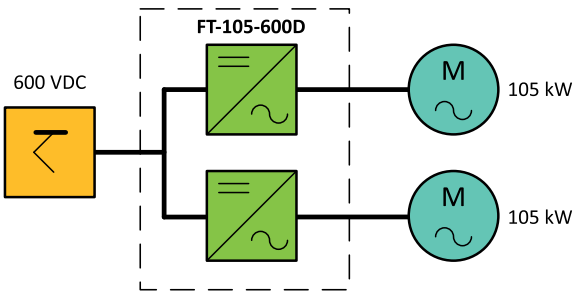
The application of independent inverters for powering of single motors guarantees high traction parameters, perfect performance at the slip point and no influence of non-uniform wear of wheels on the drive's performance. The FT-105-600D drive inverter is a modern module inverter incorporating the IGBT technology.

The converter control operates in the DSP technology (Digital Signal Processor) with application of the Field Oriented Control Space Vector Pulse Width Modulation. The inverter system enables the drive to work with regulated torque, regenerative braking or rheostatic braking. The inverter has been equipped with a forced air-cooling system and can be built up on the vehicle's roof (two inverter modules in one container). It is controlled by a MVB, CAN 2.0 B connection. The inverter's controller has been equipped with a built-in anti-slip system. Additionally, the system is equipped with an emergency power supply system (from the vehicle's battery), which enables the vehicle to move out the intersectional isolator or crossing (in case of main power failure).

Specification of the FT-105-600D inverter	
Input rated voltage	**600 VDC (750 VDC), +30 ÷ –30%**
Auxiliary voltage	**24 VDC +30 ÷ –40%**
Rated current	**2 × 200 A**
Peak current	**2 × 400 A**
Rated power	**2 × 105 kW**
Cooling	**forced-air**
Weight	**400 kg**
Dimensions	**450 × 1200 × 1320 mm**

Parameters of the tram car with the FT-105-600D inverters	
Supply voltage	**600 VDC (750 VDC), +25 ÷ –30%**
Rated power	**4 × 105 kW**
Number of motors per vehicle	**4**

BLOCK DIAGRAM OF THE FT-105-600D INVERTER



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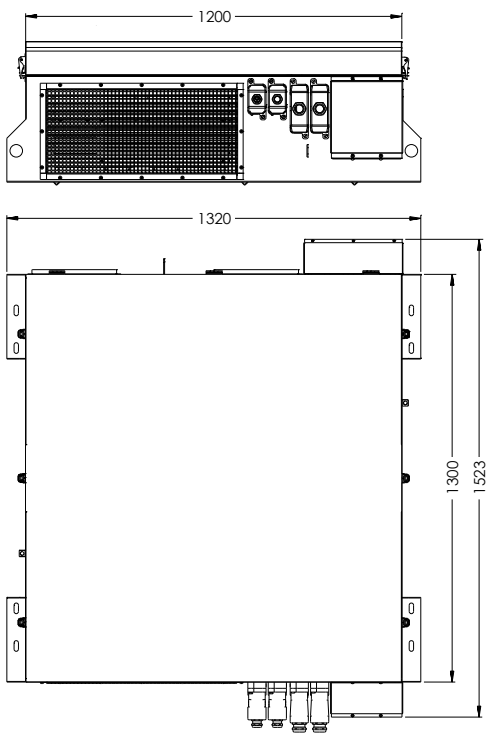


FT-120-750D/PSM-60I

Propulsion inverter integrated with Auxiliary Converter – Traction set for Trams

The application required inverters for powering motors on one bogie with the virtual axle algorithm for axleless vehicle. System guarantees high traction parameters and perfect dynamic performance. The FT-120-750D drive inverter is a modern module inverter incorporating the IGBT technology. The converter control operates in DSP technology with application of the Field Oriented Control Space Vector Width Modulation. The inverter system enables the drive to work with regulated torque, regenerative braking or rheostatic braking. The inverter has been equipped with a forced air-cooling system and can be built up on the vehicle's roof (two inverter modules in one container) It is controlled by a CAN 2.0B connection. The inverter's controller has been equipped with a built-in anti-slip system. Additionally, the system is equipped with a an emergency power supply system (from the vehicle's battery), which enables the vehicle to move out the intersectional isolator or crossing (in case of main power failure). Integrated with propulsion inverters FT-120-750D auxiliary converter PSM-60I has been designed to convert DC voltage of the 750 VDC traction into 26 VDC voltage as well as into 3×400 VAC voltage, needed to supply the auxiliary circuitry in the tram system, driver's air conditioning and car ventilation. The very lightweight, extremely efficient converter based on IGBT technology.

Specification of the FT-120-750D inverter	
Input voltage	**750 VDC, +25 ÷ –30%**
Auxiliary voltage	**24 VDC, +25 ÷ –30%**
Rated current	**2 × 300 A**
Maximum current	**2 × 600 A**
Rated power	**2 × 120 kW**
Cooling	**forced-air**
Dimensions	**470 × 1700 × 1700 mm** (integrated set)

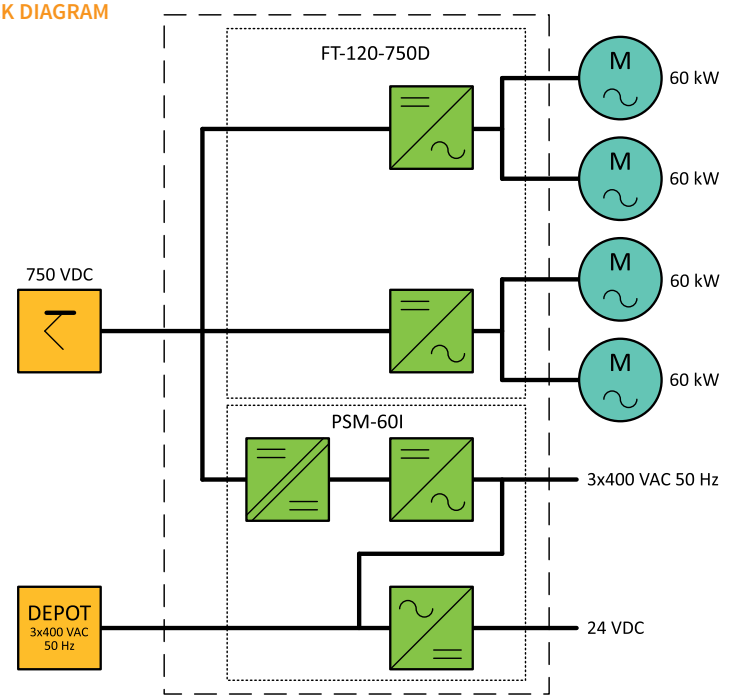
Integrated PSM-60I auxiliary converter	
Output voltage DC	**26 VDC**
P = 10 kW; In = 390 A; Un = 28.1 V (20°C); Thermal voltage compensation: up to 5°C: 28.4 V; Temperature range up to +40°C; Reduction of battery charging current; Voltage stability ≤ 1%; Voltage ripples ≤ 0.5%; Electronic (overload, short circuit) protection	
Output voltage AC	**3×400 VAC (50 Hz)**
S = 50 kVA; Voltage stability ≤ ±5%; Frequency stability ≤ ±0.1%; THD(u) ≤ 5%; Electronic (overload, short circuit) protection	
Maximum power	**60 kW**
Total efficiency	**≥ 92%**
Protection: • against the change of power supply polarity • against overvoltages in the power supply network • against short-lasting (up to 10 s) blackouts • inverter interlock at the one-phase decay	
Monitoring	**CANopen**
Weight of the set	**550 kg**

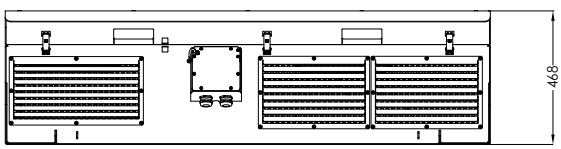
Parameters of the tram car with the FT-120-750D inverter	
Supply voltage	**750 VDC, +25 ÷ –30%**
Rated power	**2 × 4 × 60 kW**
Number of motors per vehicle	**8**

FT-120-750D/PSM-60I

Propulsion inverter integrated with Auxiliary Converter – Traction set for Trams

BLOCK DIAGRAM





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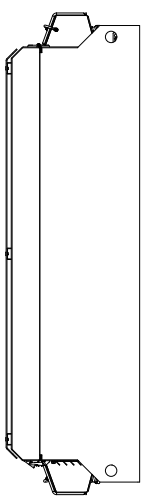
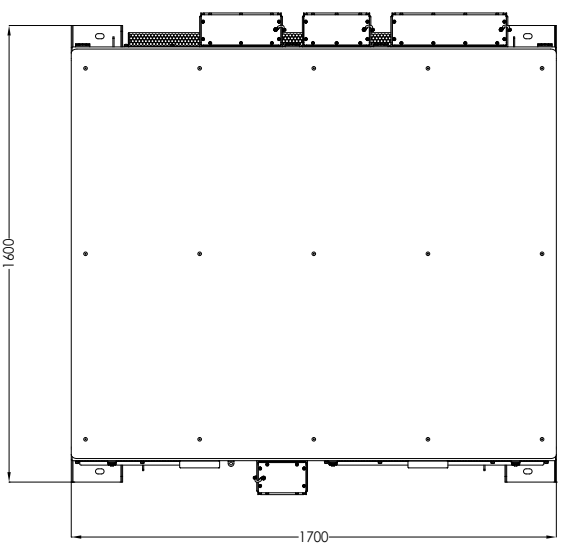




FT-130-600D-EO

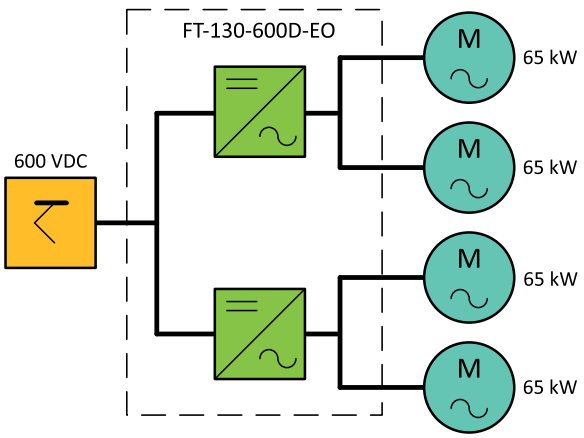
Propulsion inverter
for Asynchronous Drives

The application required inverters for powering motors on one boogie with the virtual axle algorithm for axleless vehicle. System guarantees high traction parameters and perfect dynamic performance. The FT-130-600D-EO drive inverter is a modern module inverter incorporating the IGBT technology. The converter control operates in the DSP technology (Digital Signal Processor) with application of the Field Oriented Control Space Vector Pulse Width Modulation. The inverter system enables the drive to work with regulated torque, regenerative braking or rheostatic braking.

The inverter has been equipped with a forced air-cooling system and can be built up on the vehicle's roof (two inverter modules in one container). It is controlled by a CAN 2.0 B connection. The inverter's controller has been equipped with a built-in anti-slip system. Additionally, the system is equipped with an emergency power supply system (from the vehicle's battery), which enables the vehicle to move out the intersectional isolator or crossing (in case of main power failure).

Specification of the FT-130-600D-EO inverter	
Input rated voltage	**600 VDC, +30 ÷ –33%**
Auxiliary voltage	**24 VDC, +25 ÷ –30%**
Rated current	**300 A**
Peak current	**600 A**
Rated power	**2 × 130 kW**
Cooling	**forced-air**
Weight (with/without DCDC)	**352 kg/332 kg**
Dimensions	**450 × 1280 × 1300 mm**

BLOCK DIAGRAM OF THE FT-130-600D-EO INVERTER

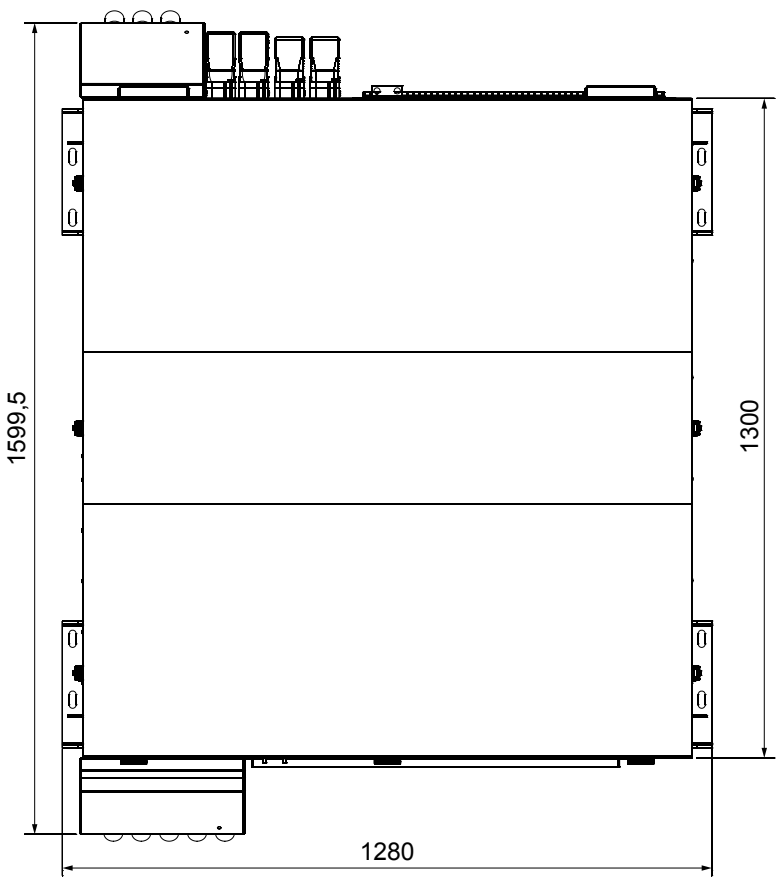


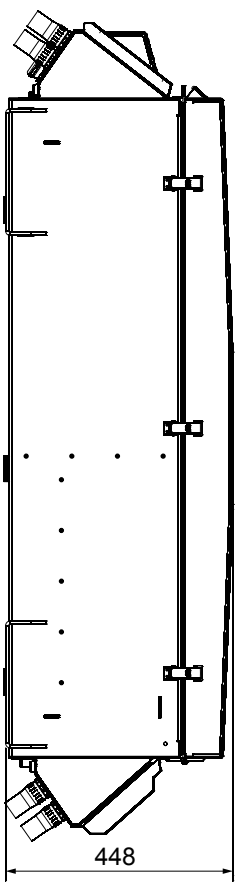
Parameters of the tram car with the FT-130-600D-EO inverter	
Supply voltage	**600 VDC (750 VDC), +25 ÷ –30%**
Rated power	**2 × 4 × 65 kW**
Number of motors per vehicle	**8**

FT-130-600D-EO

Propulsion inverter
for Asynchronous Drives

HOUSING





FT-130-600D-EO SiC/PSM-55 SiC /UOE-05-DCDC

Propulsion inverter integrated with Auxiliary Converter and Energy Recovery System

CONVERTERS BOX

SUPERCAPACITOR BOX

The propulsion inverter integrated with auxiliary power supply and energy recovery system is placed in one container that can be mounted on the vehicle roof. The inverter as well as the converter are equipped with a forced ventilation with integrated fans, which ensures the proper operation in the wide range of ambient temperature. The diagnostics and control of the system components is provided via CANBus interface. Additionally, diagnostic data of the PSM-55SiC auxiliary power supply are available via Ethernet.

Nominal Power of propulsion inverter FT-130-600D-EO SiC is 130 kW. In the Combo Box are two propulsion inverters. Each inverter supplies two traction motors. The propulsion inverter is built using SiC transistors. It ensures smooth regulation rotation speed of the traction motors during each phase of vehicle movement: starting, driving and electrodynamic braking (motors are powered by regulated voltage) and provides dynamic characteristics according to customer requirements. Starting and braking is performed without jerks or sudden acceleration changes. The propulsion system is controlled by a master microprocessor controller, which allows the setting of start-up torque, driving and braking. The control of tractions inverter is based on DSP (Digital Signal Processor) and provides the control and operation supervision for both inverters. Implemented algorithm FOC SV PWM (Field Oriented Control Space Vector Pulse Width Modulation) guarantees the proper traction parameters of propulsion system. In high speed range the control system operates with BCPWM (Bus Clamping Pulse Width Modulation), which causes the decrease the energy losses and noise level. The control system ensures the startup with constant torque and low loss power. Advanced control and diagnostics lead to reliable and cost-efficient operation of the vehicle.

Auxiliary power supply PSM–55 SiC is fully automated device designed to convert DC voltage of the 600 VDC traction into 3x400 VAC as well as into 24 VDC (according to EN 50155) used to supply loads and batteries charging. The auxiliary power supply is based on a multiple energy conversion technique and is equipped with forced ventilation system with integrated fan. The control system ensures high frequency stability, very good symmetry of output phase voltages and very low level of interferencess generated by the system. The inverter produces a sinusoidal AC voltage with a low harmonic ratio at the output by using single chip microprocessors and SiC transistors. The system is equipped with the DBS (Dead Battery System) allows starting the converter in case of lack of on-board battery voltage with availability of catenary voltage.

The Combo Box is equipped with a part of the Energy Recovery System: UOE-05-DCDC. This unit consist of two elements: DC/DC converter and contactors with a precharge system. DC/DC converter ensures correct charging of the supercapacitors and transfer of energy from the supercapacitors to the propulsion system. To charge the supercapacitor unit, the energy recovered during electro-dynamic tram braking is used. The energy stored in the supercapacitor box (UOE-05 SC) is used to supply the propulsion system during start-up, exit from section insulator, emergency exit from a crossroads and emergency drive to nearest stop in the event of traction voltage interruption.

The UOE-05-DCDC and UOE-05 SC supercapacitor energy recovery system is a system enabling the storage of energy recovered during braking in a supercapacitors. The energy stored in the supercapacitors is used to supply the propulsion inverter during:

- start up,
- leaving the section insulator,
- emergency leaving the crossroads,
- emergency drive to the nearest stop in the event of traction voltage interruption

The supercapacitor energy recovery system enables the selection of one of the two modes of energy recovery: the mode of energy regeneration to the overhead contact line and the priority mode of charging the energy storage bank. If energy return to the catenary is impossible and if the supercapacitor energy storage is fully charged, the braking energy is lost at the braking resistor.

NEW

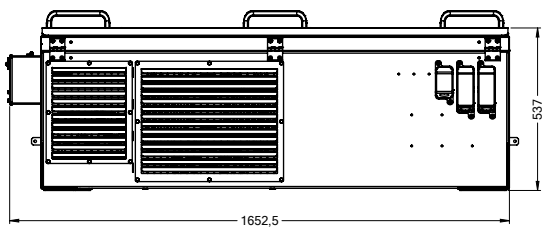
FT-130-600D-EO SiC/PSM-55 SiC /UOE-05-DCDC

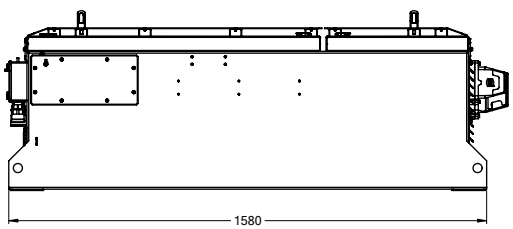
Propulsion inverter integrated with Auxiliary Converter and Energy Recovery System

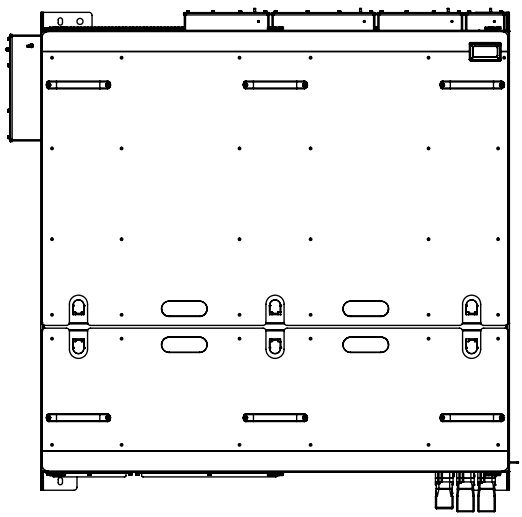
FT-130-600D-EO SiC		
Input voltage		**600 VDC**
Nominal power		**2 x 130 kW**
Nominal current		**2 x 200 A**
Auxiliary voltage		**24 VDC +25% -30%**
PSM-55 SiC		
Input voltage		**600 VDC**
DC Output		**24 VDC / 10 kW**
AC Output		**3x400 VAC, 50 Hz / 45 kVA**
Auxiliary voltage		**24 VDC +25% ÷ -30%**
Housing		
Cooling		**Forced air**
Weight		**547 kg**
Dimensions		**1653 x 1580 x 537 mm**
Protection degree	Clean section	**IP20**
	Dirty section	**IP55**

UOE-05 SC		
Nominal catenary voltage		**600 VDC**
Maximum voltage of supercapacitors		**710 VDC**
Quantity of strings		**2**
Stored energy (per string)		**670 Wh**
Rated capacity of supercapacitors (per string)		**12.6 F**
Nominal power (per string)		**2 x 65 kW**
Auxiliary voltage		**24 VDC +25% ÷ -30%**
Housing		
Cooling		**Forced air**
Weight		**660 kg**
Dimensions		**2100 x 1580 x 416 mm**
Protection degree	Clean section	**IP20**
	Dirty section	**IP55**

HOUSING OF THE CONVERTERS BOX



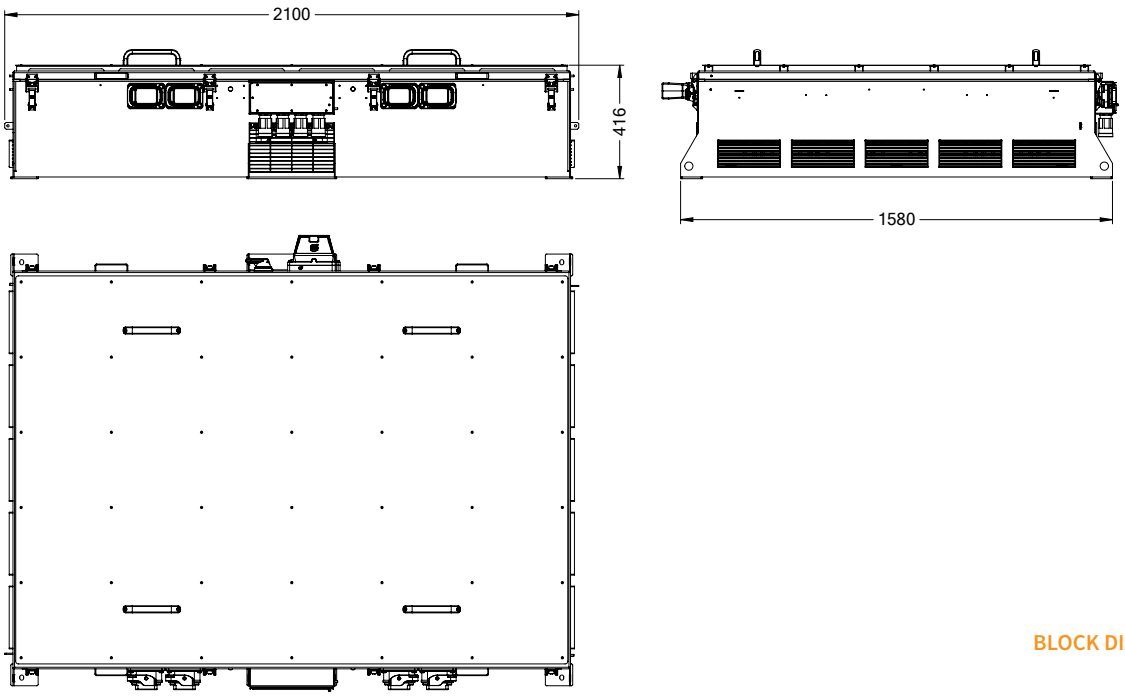




FT-130-600D-EO SiC/PSM-55 SiC /UOE-05-DCDC

Propulsion inverter integrated with Auxiliary Converter and Energy Recovery System

HOUSING OF THE SUPERCAPACITOR BOX



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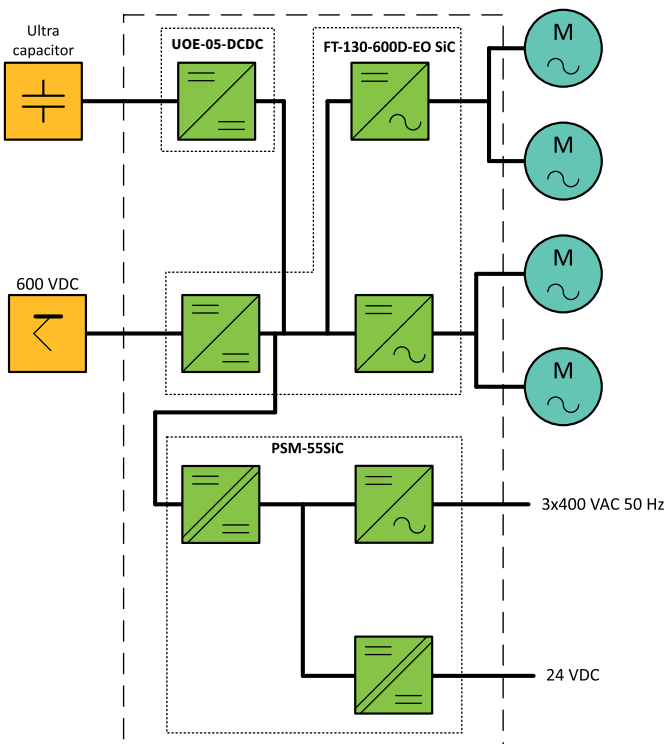

FT-160-600 SiC/PSM-42 SiC

Propulsion inverter integrated
with Auxiliary Converter

The FT-160-600 SiC propulsion inverter has been designed to drive eBus. The inverter is based on the IGBT full-SiC technology. It is controlled by means of the DSP (Digital Signal Processor) technology, applying the FOC SVPWM (Field Oriented Control Space Vector Pulse Width Modulation) algorithm. The controller guarantees optimum control of the asynchronous motor's performance, achieving very good traction parameters and a high level of driving comfort. The inverter has been equipped with a natural air-cooling system. The system meets all European standards and Regulation no. 100 with regard to safety and radio interferencess. The system is installed on the roof. The system has been equipped with an integrated high voltage switchgear to connect traction battery, battery chargers and precharge system. The latest generation components and an extensive diagnostic system guarantee a high level of reliability and low operating costs. A static 30 kVA/3×400 VAC and 12 kW/24 VDCconverter are placed in the same case.

Electric vehicles are an important part of life all over the world. By incorporating the newest silicon carbide (SiC) technology in our traction converters, power losses can be reduced up to 30% of conventional devices along with significant noise reduction. Utilizing SiC enables reduction of size and weight even by 40%. The use of this technology is a true technical evolution in designing of innovative power electronics devices for public transport.

Specification of the FT-160-600 SiC inverter	
Input voltage	**520–750 VDC**
Auxiliary voltage	**24 VDC, +30 ÷ –40%**
Rated current	**300 Arms**
Maximum current	**500 Arms**
Rated power	**160 kW**
Cooling	**natural air**
Dimensions	**1430 × 990 × 330 mm**

Specification of the PSM-42 SiC converter	
Input voltage	**520–750 VDC**
Auxiliary voltage	**24 VDC, +30 ÷ –40%**
AC output nominal power	**30 kVA**
AC output voltage	**3x400 VAC ±10% (sinus)**
AC output frequency	**50 Hz**
AC output current	**43 A**
Overcurrent	**1.5 In/30 s**
Electronic protection	**overcurrent/overvoltage/overheating**
DC output nominal power	**12 kW**
DC output voltage	**24 VDC**
DC output current	**500 A**
Insulation strength	**2.5 kV**
Cooling	**natural air**
Weight of the set	**165 kg**

FT-160-600 SiC/PSM-42 SiC

Propulsion inverter integrated
with Auxiliary Converter

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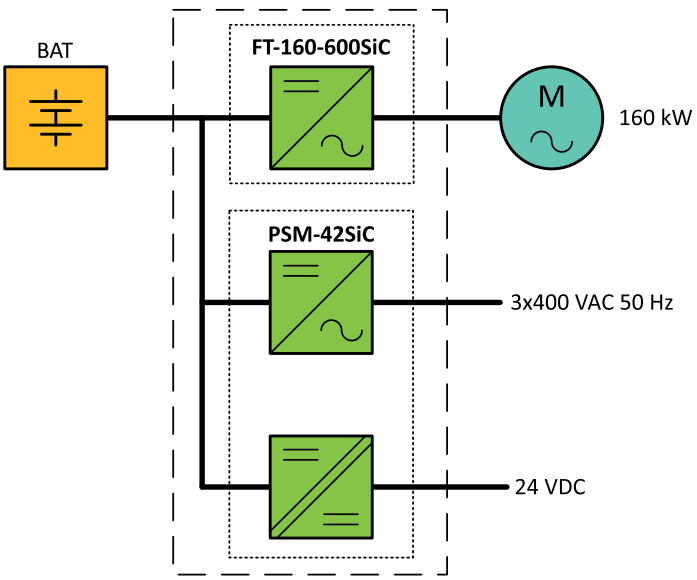

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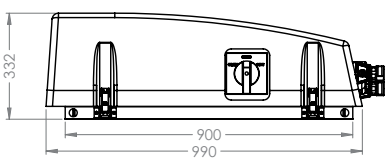
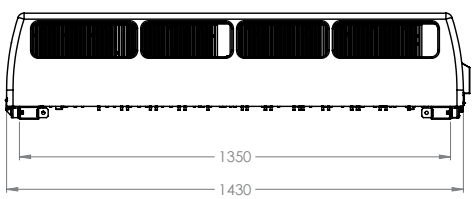
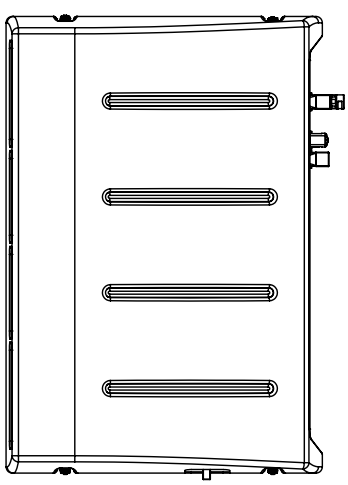






FT-160-600 SiC/PSM-42

Propulsion inverter integrated with Auxiliary Converter

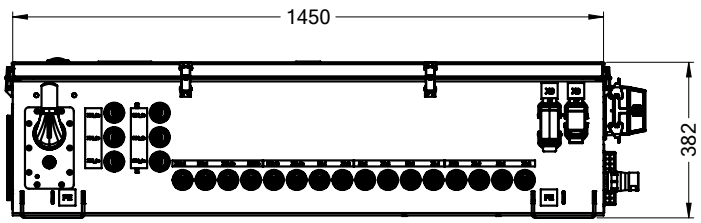
Propulsion inverter is designed to supply the motor or motors driving the wheels in an electric bus. Container of the inverter with HV switchgear and PSM auxiliary converter is designed for installation on the roof of the vehicle. Propulsion inverter is designed to be powered from the traction battery.

The drive unit in the vehicle enables starting, driving at a given torque, running out and braking the vehicle with regeneration. It also enables starting, driving and braking in backward direction.The propulsion inverter makes it possible to convert the input voltage into a regulated alternating output voltage in the range from 0 to the nominal traction motor voltage, while maintaining a constant relation between the output voltage and voltage frequency (U/f). The propulsion inverter and auxiliary converter are cooled by forced air circulation. The use of air cooling enables reliable operation over a wide range of outdoor temperatures. The power supply of fans in the drive box is provided by 24 VDC.

Power supply while driving is provided by a set of batteries grouped in packages (Battery Pack). The battery banks are managed by the Battery Management System (BMS), which monitors the charge status of the cells and sends information to the drive control and control system about the current that can be drawn from the battery at a given moment.

The inverter is made in silicon carbide (SiC) technology. The control of the converter is performed in DSP (Digital Signal Processing) technology with the use of FOC SVPWM (Field Oriented Control Space Vector Pulse Width Modulation) control. The control system provides constant torque starting and low loss power. The inverter complies with UN regulations and EN standards for safety and electromagnetic compatibility. The system has very low levels of low-frequency interferencess.

Diagnostics and control of the inverters is carried out via the CAN interface. The system is adapted to cooperate with a recorder of traction parameters and inverter parameters, which allows to replay power supply conditions in the event of malfunctions in operation or in the event of failure of the propulsion system.



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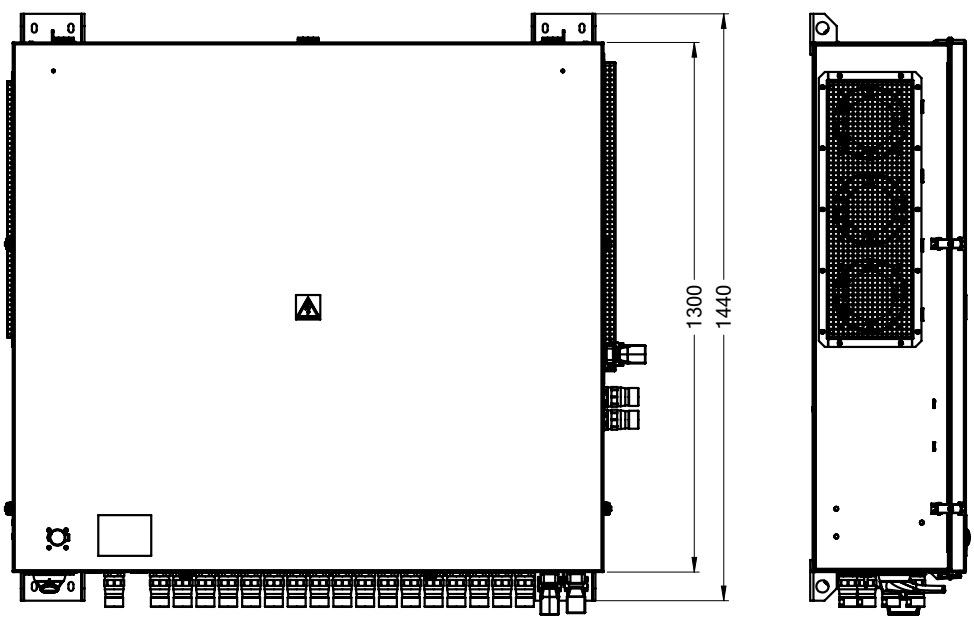

FT-240-600 SiC/PSM-42

Propulsion inverter integrated
with Auxiliary Converter

FT-160-600 SiC		
Input voltage		**510-750 VDC**
Auxiliary voltage		**24 VDC, +25% ÷ -30%**
Rated current		**185 Arms**
Rated power		**160 kW**
Output voltage		**3x430 V**
PSM-42		
Input voltage		**510-750 VDC**
Auxiliary voltage		**24 VDC, +25% ÷ -30%**
AC output nominal power		**30 kVA**
AC output voltage		**3x400 VAC ±10% (sinus)**
AC output frequency		**50 Hz**
AC output current		**44 A**
Overcurrent		**1.5 In / 5 s**
Short-circuit protection		**132 A**
DC output nominal power		**12 kW**
DC output voltage		**28.8 VDC**
DC output current		**416 A**
Housing		
Weight		**310 kg**
Dimensions		**1450 x 1440 x 382 mm**
Cooling		**Forced air**
Protection degree	Dirty section	**IP20**
	Clean section	**IP54**

FT-240-600 SiC		
Input voltage		**510-750 VDC**
Auxiliary voltage		**24 VDC, +25% ÷ -30%**
Rated current		**278 Arms**
Rated power		**240 kW**
Output voltage		**3x430 V**
PSM-42		
Input voltage		**510-750 VDC**
Auxiliary voltage		**24 VDC, +25% ÷ -30%**
AC output nominal power		**30 kVA**
AC output voltage		**3x400 VAC ±10% (sinus)**
AC output frequency		**50 Hz**
AC output current		**44 A**
Overcurrent		**1.5 In / 5 s**
Short-circuit protection		**132 A**
DC output nominal power		**12 kW**
DC output voltage		**28.8 VDC**
DC output current		**416 A**
Housing		
Weight		**310 kg**
Dimensions		**1450 x 1440 x 382 mm**
Cooling		**Forced air**
Protection degree	Dirty section	**IP20**
	Clean section	**IP54**

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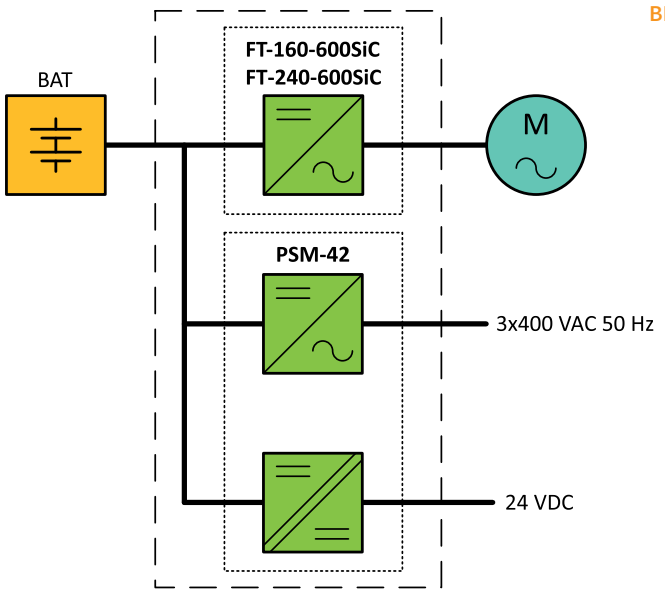
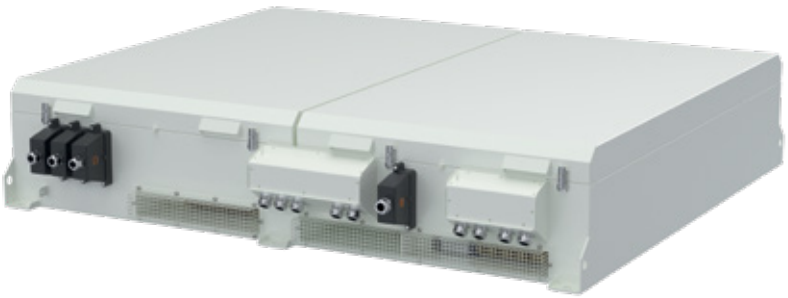


NEW

FT-160-600(750)/PSM-42T/ZBBT-13

Propulsion inverter integrated
with Auxiliary Converter
and Traction Battery Charger



The traction drive used in an trolleybus consists of a propulsion inverter, a traction motor, high voltage switchgear and a braking resistor. The high voltage circuit also consists of a auxiliary converter PSM. The propulsion inverter and auxiliary converter are cooled by forced air circulation. The braking resistor is cooled by natural air circulation. The use of air cooling enables reliable operation over a wide range of outdoor temperatures. The operation of the fans in the unit is controlled by an inverter. The inverter is made with HV IGBT 1.7 kV technology. The control of the converter is performed in DSP (Digital Signal Processing) technology with the use of FOC SVPWM (Field Oriented Control Space Vector Pulse Width Modulation) control. The control system provides constant torque starting, low loss power. The used busbar system in conjunction with the IGBT driver guarantees failure-free operation at short-circuits, additionally eliminating the possibility of secondary damage in the event of a transistor failure. The capacitors used ensure high durability and protect the circuit due to voltage changes in the catenary system. The inverter complies with UN regulations and EN standard for safety and electromagnetic compatibility. The system has very low levels of low-frequency interferencess. Diagnostics and control of the inverters is carried out via the CAN-Bus interface. The system is adapted to cooperate with an event recorder of traction parameters and inverter parameters, which allows to replay power supply conditions in the event of malfunctions in operation or in the event of failure of the propulsion system.
The ZBBT-13 placed inside the box enables charging of the traction batteries from the catenary line while vehicle is in motion.

FT-175-600(750)		
Input voltage		**600 VDC / 750 VDC**
Nominal power		**160 kW**
Nominal current		**240 A**
Auxiliary voltage		**24 VDC +25% ÷ -30%**
PSM-42T		
Input voltage		**600 VDC / 750 VDC**
DC output		**28.8 VDC / 10.8 kW**
AC output		**3x400 VAC, 50 Hz / 30 kVA**
Auxiliary voltage		**24 VDC +25% ÷ - 30%**
ZBBT-13		
Input voltage		**600 VDC / 750 VDC**
Rated battery voltage		**662 VDC**
Charging power		**53 kW**
Housing		
Cooling		**Air forced**
Weight		**630 kg**
Dimensions		**2000 x 1750 x 405 mm**
Protection degree	Clean section	**IP55**
	Dirty section	**IP20**

FT-160-600(750)/PSM-42T/ZBBT-13

Propulsion inverter integrated
with Auxiliary Converter
and Traction Battery Charger

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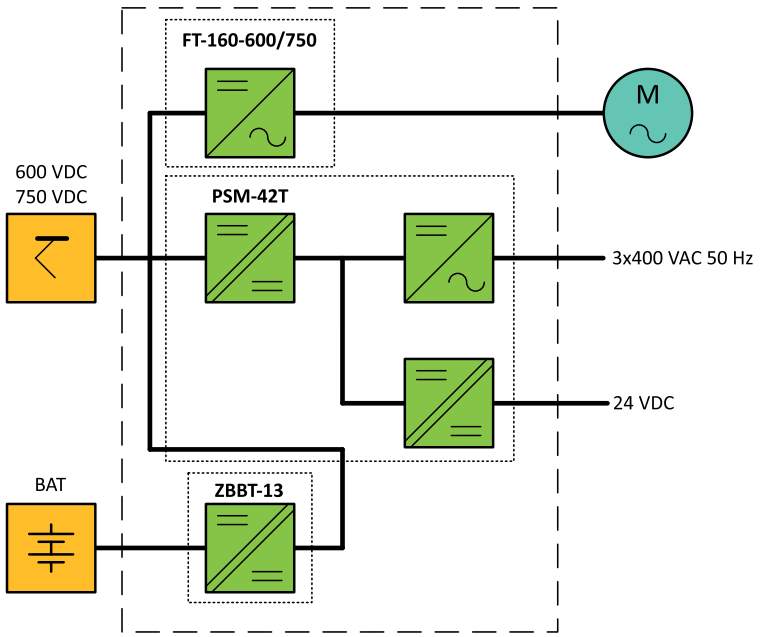

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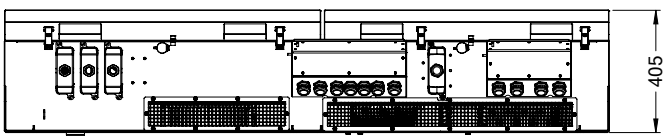

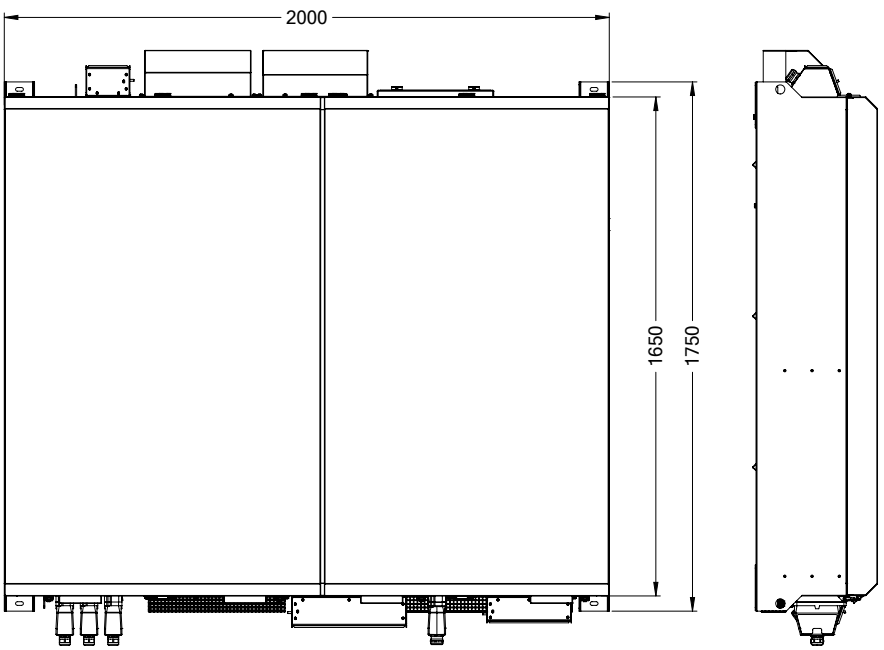

FT-175-600/PSM-30TE

Propulsion inverter
for Asynchronous Drives

The traction drive used in a trolleybus consists of a propulsion inverter, a traction motor, high voltage switchgear and a braking resistor. The high voltage circuit also consists of a static converter PSM. The traction inverter and static converter are cooled by forced air circulation. The braking resistor is cooled by natural air circulation. The use of air cooling enables reliable operation over a wide range of outdoor temperatures. The operation of the fans in the unit is controlled by an inverter.
The inverter is made with HV IGBT technology. The control of the converter is performed in DSP (Digital Signal Processing) technology with the use of FOC SVPWM (Field Oriented Control Space Vector Pulse Width Modulation) control. The control system provides constant torque starting, low loss power. The used busbar system in conjunction with the IGBT driver guarantees failure-free operation at short-circuits, additionally eliminating the possibility of secondary damage in the event of a transistor failure. The capacitors used ensure high durability and protect the circuit due to voltage changes in the catenary system.
The inverter complies with UN and EN standards for safety and electromagnetic compatibility. The system has very low levels of low-frequency interference.
Diagnostics and control of the inverters is carried out via the CAN-Bus interface. The system is adapted to cooperate with an event recorder of traction parameters and inverter parameters, which allows to replay power supply conditions in the event of malfunctions in operation or in the event of failure of the drive system.

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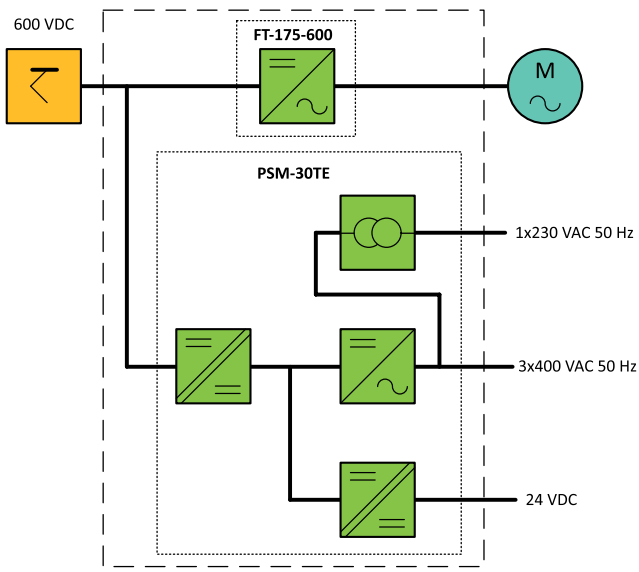

FT-175-600	
Input nominal voltage	**600 VDC**
Minimal input voltage	**420 VDC**
Maximal input voltage	**900 VDC**
Output voltage	**3x430 VAC 2÷130 Hz**
Control voltage	**24 VDC +25% ÷ -30%**
Nominal output current	**312 Arms**
Maximal output current	**406 Arms**
Nominal power	**175 kW**
PSM-30TE	
Input voltage	**420 ÷ 900 V DC**
DC output	**28.8 V DC / 375 A (10.8 kW)**
AC output	**3x400 V / 50 Hz (18 kVA)**
AC output	**1x230 V / 50 Hz (2.5 kVA)**
Current overload capacity of the AC output	**2 x In / 5 s**
Housing	
Weight	**630 kg**
Dimension	**2000 x 1750 x 405 mm**
Cooling	**Air forced**
Operating temperature	**-30°C ÷ +40°C**

FT-175-600/PSM-30TE

Propulsion inverter
for Asynchronous Drives

Traction parameters of the Trollino12M trolleybus with the FT-175-600	
Input voltage	**600 VDC, +30 ÷ –30%**
Rated power	**175 kW**
Maximum torque referred to the motor shaft	**450 Nm**
Acceleration at starting up to the speed 35 km/h	**1.5 m/s²**
Vehicle deceleration at braking (electrical)	**1.7 m/s²**
Vehicle deceleration at emergency braking	**3 m/s²**
Vehicle maximum speed at constant power	**65 km/h (18 m/s)**

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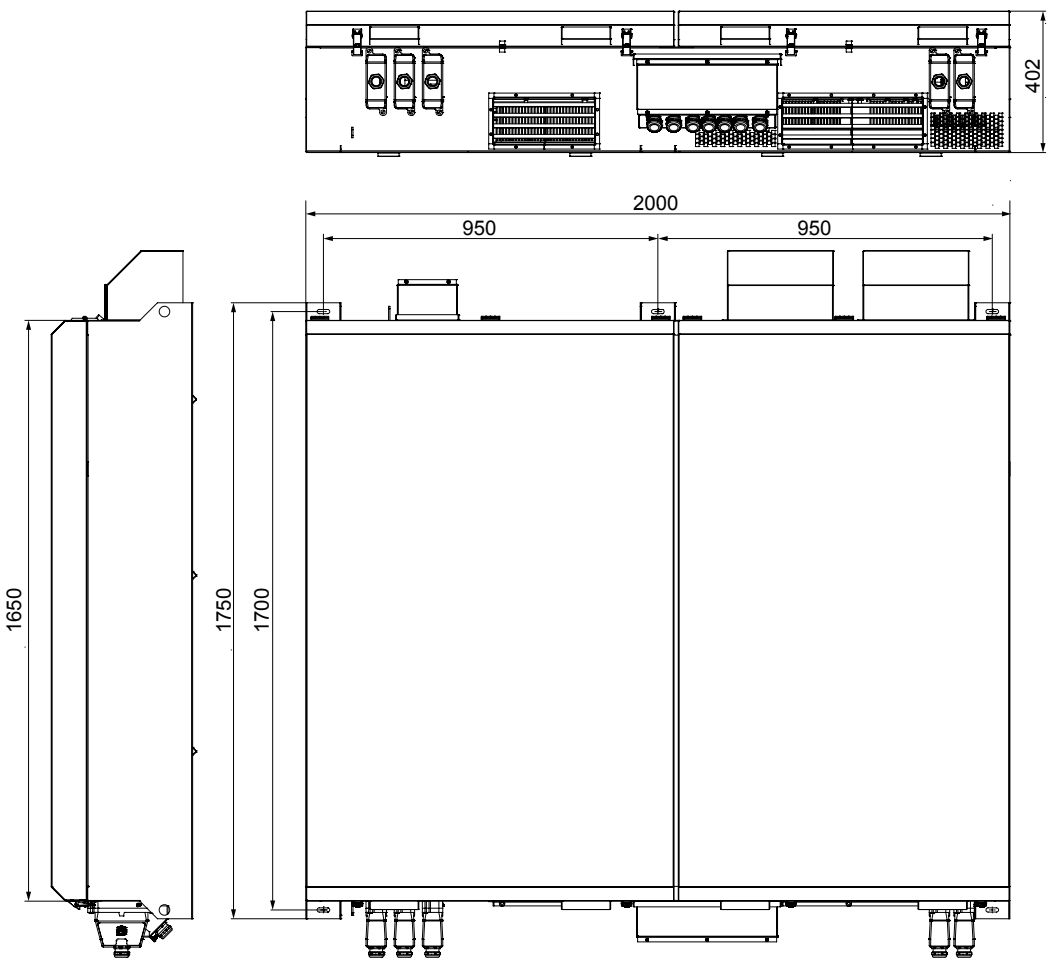

FT-250-600T/PSM-44T

Propulsion inverter integrated with Auxiliary Converter

The FT-250-600T propulsion inverter is designed to power the traction motor, which drives the wheel axle of the trolleybus. The container that houses the FT-250-600T propulsion inverter with a RWN 300-600 switchboard and PSM-44T auxiliary converter is to be mounted on the roof of the vehicle. The propulsion inverter is designed for the traction power supply of 600 VDC.
The drive assembly ensures the vehicle start-up, driving at a set torque, coasting and braking of the vehicle. It also enables start-up, driving and braking after setting driving in the reverse direction.
The propulsion inverter transforms the input voltage of 600 VDC into an adjustable output voltage in the range from 0 to the rated voltage of the traction motor, maintaining a constant ratio between the output voltage and voltage frequency (U/f).

The FT-250-600T inverter is made with HV IGBT technology. Control of the converter is provided by the DSP (Digital Signal Processor), which uses FOC SVPWM (Field Orientation Control Space Vector Pulse Width Modulation). In the range of high speeds, the system operates with synchronized Bus Clamping Pulse Width Modulation (BCPWM), which reduces the losses and noise emissions. The control system provides the start-up with a constant torque and low power loss. The system of bus bars combined with the IGBT driver guarantee a failure-free operation during short-circuits and eliminates the risk of secondary damage during transistor failure. The polypropylene capacitors ensure high durability and resistance of the system to voltage changes in the overhead line. The inverter meets UN regulations and EN standards for safety and electromagnetic compatibility. The system has very low levels of low-frequency interferences generated in the overhead line. The diagnostics and inverter control is provided via the CANBus interface. The system is adapted to cooperate with a device that records traction and inverter parameters, which allows the user to review the conditions of power supply in case of malfunctions or failures in the propulsion system.

FT-250-600T		
Input voltage	**600 VDC +25% –30%**	
Rated power	**250 kW**	
Rated current	**430 Arms**	
Auxiliary voltage	**24 VDC +25% –30%**	
PSM-44T		
Input voltage	**600 VDC +25% –30%**	
Output power	**44 kW**	
DC Output	**28.8 VDC / 420 A (12 kW)**	
AC Output	**3×400 V / 50 Hz (32 kVA)**	
Auxiliary voltage	**24 VDC +25% –30%**	
Housing		
Cooling	**forced-air**	
Weight	**700 kg**	
Dimensions	**2000 × 1750 × 405 mm**	
Protection degree	**Clean section**	**IP55**
	Dirty section	**IP20**

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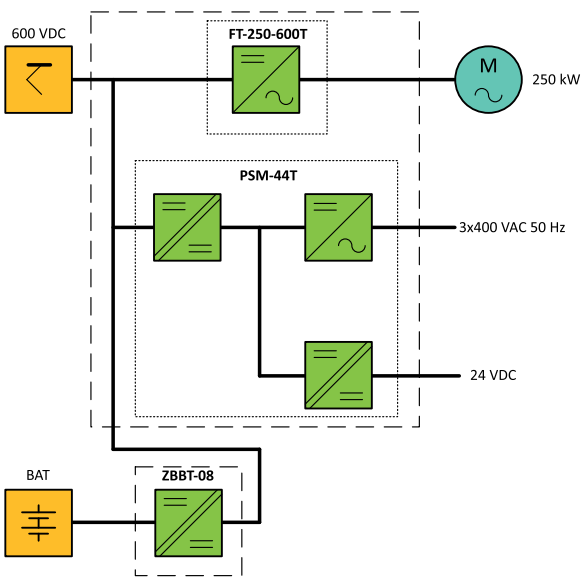

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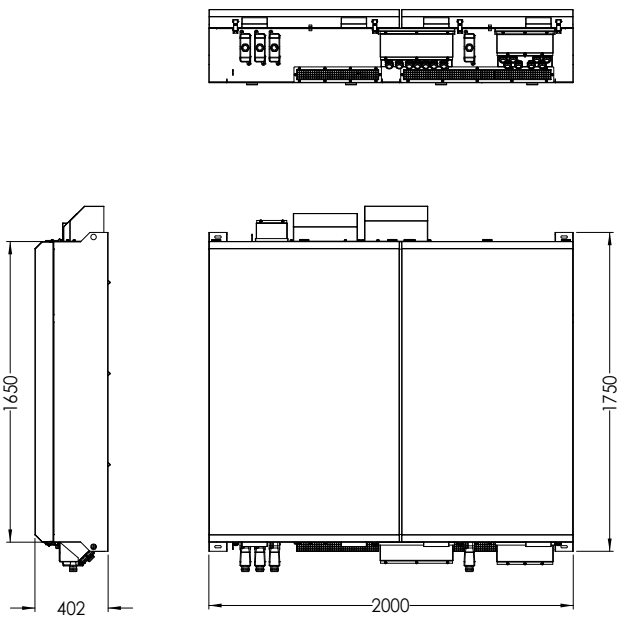

FT-250-600(750)/PSM-52T/FCEC-85

Propulsion inverter integrated with Auxiliary Converter and Fuel Cell Converters

The FT-250-600/750 propulsion inverter is designed to power the traction motor, which drives the wheel axle of the trolleybus. The container that houses the FT-250-600/750 propulsion inverter together with the RWN-360-600/750 switchboard, PSM-52T auxiliary converter and FCEC-85 fuel cell converter, is to be mounted on the roof of the vehicle. The propulsion inverter is used for the traction power supply of 600/750 VDC.

The drive assembly ensures the vehicle start-up, driving at a set torque, coasting and braking of the vehicle. It also enables start-up, driving and braking after setting driving in the reverse direction. The propulsion inverter transforms the input voltage of 600/750 VDC into an adjustable output voltage in the range from 0 to the rated voltage of the traction motor, maintaining a constant ratio between the output voltage and voltage frequency (U/f).

The traction drive used in the trolleybus consists of the FT-250-600/750 propulsion inverter, MT drive motor, RH braking resistor, RWN-360-600/750 high voltage switchboard, PSM-52T auxiliary converter and FCEC-85 fuel cell converter. The high voltage circuit comprises also a current collector, surge limiter and fast circuit breaker. The transistor converters, line choke and inverters are cooled by forced air circulation. The brake resistor is cooled naturally. The use of air cooling ensures reliable operation over a wide range of outdoor temperatures. The fans installed in the housing of the drive assemble are controlled by FT-250-600/750 inverters. The inverter controls the operation of the inverter fan and the fan for the PSM-52T auxiliary converter.

The FT-250-600/750 inverter is made with HV IGBT technology. Control of the converter is provided by the DSP (Digital Signal Processor), which uses FOC SVPWM control (Field Orientation Control Space Vector Pulse Width Modulation). In the range of high speeds, the system operates with synchronized Bus Clamping Pulse Width Modulation (BCPWM), which reduces the losses and noise emissions. The control system provides the start-up with a constant torque and low power loss. The system of bus bars combined with the IGBT driver guarantee a failure-free operation during short-circuits and eliminates the risk of secondary damage during transistor failure. The polypropylene capacitors ensure high durability and resistance of the system to voltage changes in the overhead line. The inverter meets UN regulations and EN standards for safety and electromagnetic compatibility. The system has very low levels of low-frequency interferences generated in the overhead line.

Diagnostics and inverter control is provided via the CANBus interface. The system is adapted to cooperate with a device that records the traction and inverter parameters, which allows the user to review the conditions of power supply in case of malfunctions or failures in the propulsion system.

The PSM-52T auxiliary converter is designed for transforming an overhead contact line voltage of 600/750 V, to 24 VDC and 3x400 VAC (50 Hz) voltages of the traction battery or fuel cell and for feeding the auxiliary circuits of the vehicle.

The fuel cell inverter is designed for transforming the fuel cell voltage to the voltage required to power the propulsion inverter over the sections without access to the overhead line.

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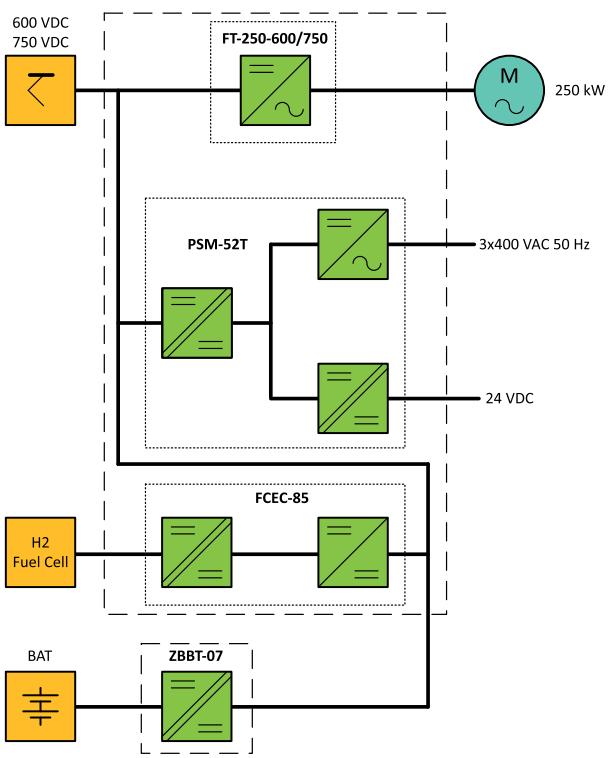
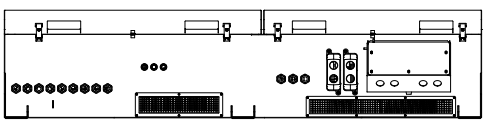


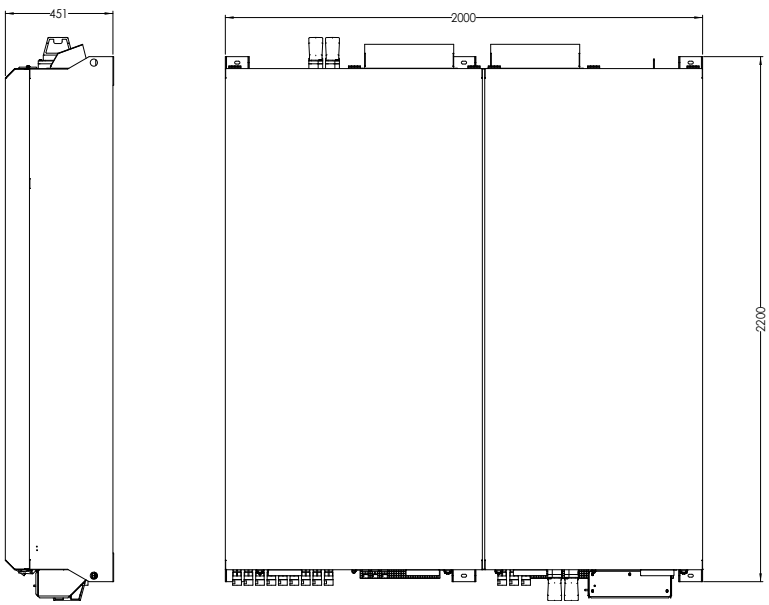
FT-250-600(750)/PSM-52T /FCEC-85

Propulsion inverter integrated with Auxiliary Converter and Fuel Cell Converters

FT-250-600/750		
Input voltage	**600/750 VDC**	
Rated power	**250 kW**	
Rated current	**430 Arms**	
Auxiliary voltage	**24 VDC +25% ÷ –30%**	
PSM-52T		
Input voltage	**600/750 VDC**	
Output power	**52 kW**	
DC Output	**24 VDC / (19 kW)**	
AC Output	**3×400 V / 50 Hz (30 kVA)**	
Auxiliary voltage	**24 VDC +25% ÷ –30%**	
FCEC-85		
Input voltage	**280-420 VDC**	
Input power	**85 kW**	
Rated current	**288 ADC**	
Housing		
Cooling	**forced-air**	
Weight	**945 kg**	
Dimensions	**2200×2000×450 mm**	
Protection degree	**Clean section**	**IP55**
	Dirty section	**IP20**

HOUSING





FT-250-600D SiC + FCEC-125 + ZB24DC800 + RWN-630-600

Modular Power Converters Set for Hydrogen Buses

The Modular Power Converters Set is designed for vehicles with traction battery packs and hydrogen fuel cells. The units are made using the latest SiC technology, which results in high electrical performance values and low power losses. The use of SiC technology transistors in the converters and the liquid cooling system have helped to reduce the weight and dimensions of the devices. Each component is mounted in a separate housing, allowing any arrangement of equipment on the vehicle and enables improved maintenance indicators in terms of time and cost effectiveness.

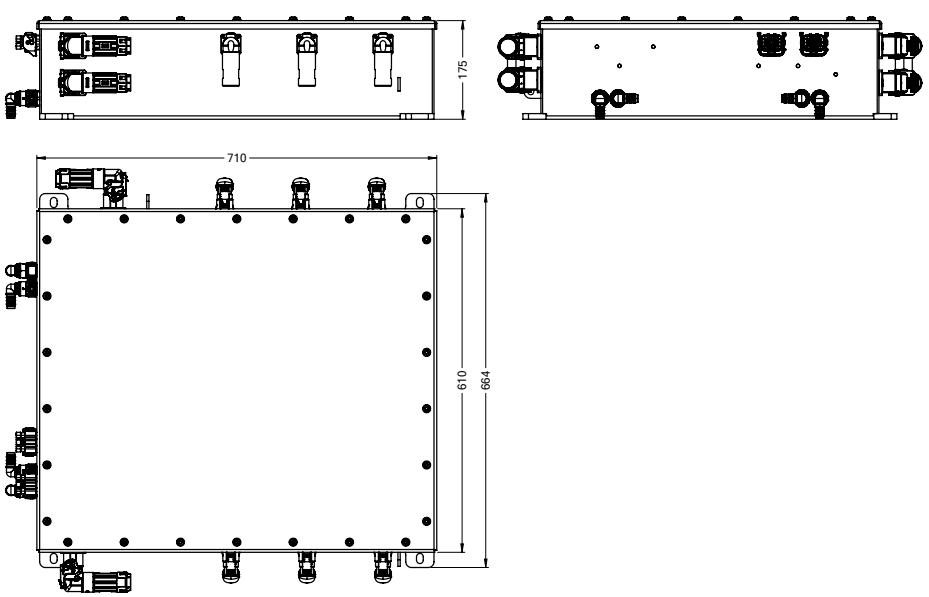
FT-250-600D SiC

The FT-250-600D SiC propulsion inverters are designed to supply motors driving the wheels in an electric bus. Propulsion inverters are designed to be powered from the traction battery. The drive unit in the vehicle enables starting, driving at a given torque, running out and braking the vehicle with energy regeneration to the traction battery and braking using the braking resistor. The propulsion inverters make it possible to convert the input voltage into a regulated alternating output voltage with a variable value in the range from 0 to the nominal traction motor voltage, while maintaining a constant value between the output voltage and the frequency of this voltage (U/f). The traction drive used in an electric bus consists of a FT-250-600D SiC propulsion inverters, traction motors and a braking resistor. The FT-250-600D SiC propulsion inverters box is equipped with a cooling system that uses a coolant to reduce the temperature of the components of the unit. The inverters are made in silicon carbide (SiC) technology. The control system provides constant torque starting and low loss power. The system has very low levels of low-frequency interferencess. Diagnostics and control of the inverters is carried out via the CAN-Bus interface. The system is adapted to cooperate with a recorder of battery parameters and traction parameters, which allows to replay power supply conditions in the event of malfunctions in operation or in the event of failure of the propulsion system.

FT-250-600D SiC

Specification of FT250-600D SiC	
Input voltage	**510 ÷ 750 VDC**
Rated power	**2 x 250 kW**
Rated current	**2 x 135 Arms**
Auxiliary voltage	**24 VDC, +25% ÷ -30%**
Output voltage	**3 x 430 VAC**
Housing	
Dimensions	**710 x 664 x 175 mm**
Cooling	**Liquid**
Weight	**60 kg**
Protection degree	**IP67**

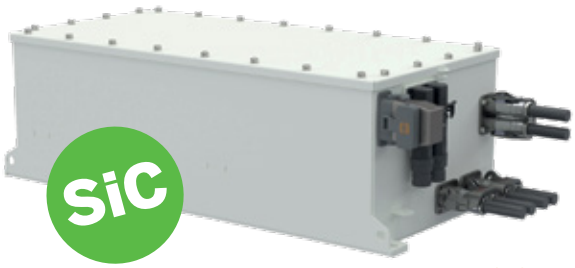
HOUSING OF FT-250-600D SiC



NEW

FT-250-600D SiC + FCEC-125 + ZB24DC800 + RWN-630-600

Modular Power Converters Set for Hydrogen Buses



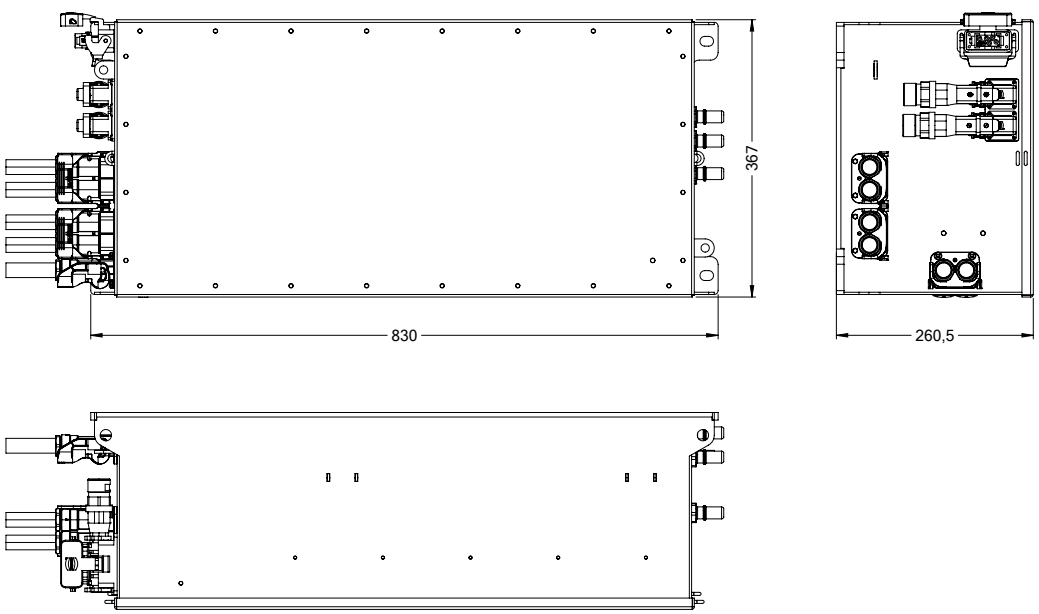
FCEC-125

FCEC-125
The FCEC-125 fuel cell energy converter is intended for electric bus with hydrogen fuel cell applications. Box is designed for installation on the roof of the vehicle. The converter is equipped with cooling system, which uses coolant medium to reduce the converter elements temperature. The converter enables:

- charging of traction battery from the fuel cell with charging power regulation according to the battery discharge rate,
- CAN communication with fuel cell and control unit,
- measurement of current and voltage of fuel cell and battery circuits.

Specification of FCEC-125	
Input voltage	**224 ÷ 560 VDC**
Input power	**125 kW**
Rated current	**360 ADC**
Auxiliary voltage	**24 VDC, +25% ÷ -30%**
Output voltage	**468 ÷ 750 VDC**
Output current	**208 ÷ 165 A**
Output protection	**Overcurrent / overvoltage / short-circuit**
Housing	
Dimensions	**830 x 367 x 261 mm**
Cooling	**Liquid**
Weight	**90 kg**
Protection degree	**IP67**

HOUSING OF FCEC-125



FT-250-600D SiC + FCEC-125 + ZB24DC800 + RWN-630-600

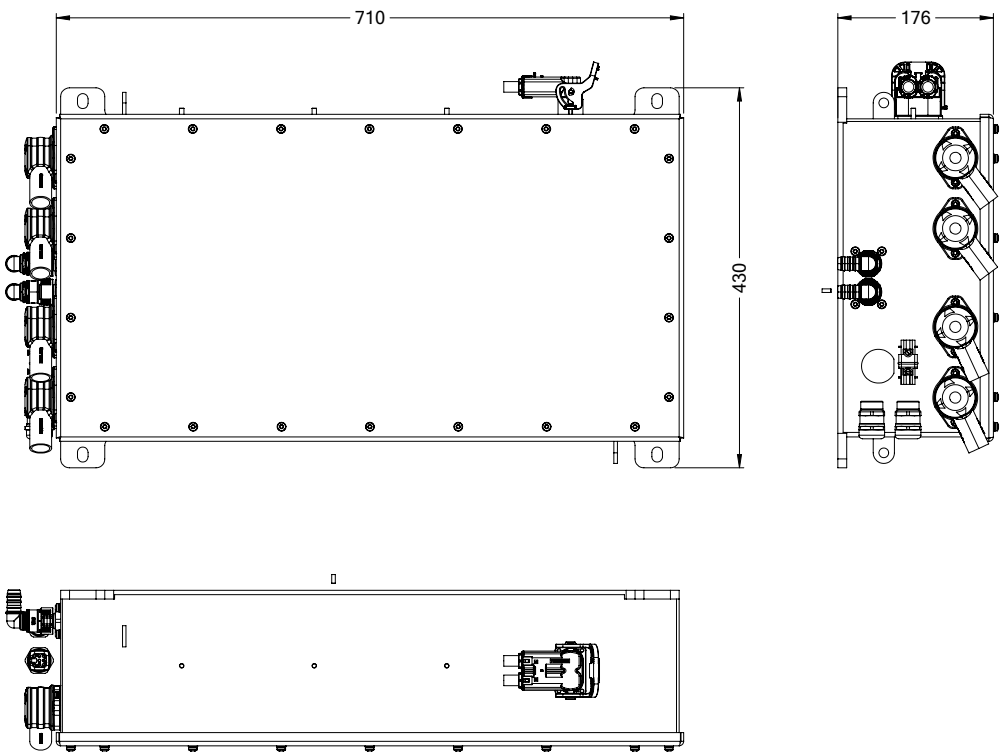
Modular Power Converters Set for Hydrogen Buses

ZB24DC800

ZB24DC800
Battery charger ZB24DC800 is designed to convert the voltage from the traction battery to 24 VDC, intended for supplying low-voltage installations. Container is designed for installation inside the vehicle. The battery charger is equipped with cooling system, which uses coolant medium to reduce the temperature of the units components. The battery charger is made in silicone carbide (SiC) technology.

Specification of ZB24DC800	
Input voltage	**510 ÷ 750 VDC**
Output voltage	**24 VDC**
Output voltage stability	**≤ 2%**
Output voltage ripple	**≤ 1%**
Output current	**800 A**
Output power	**23 kW**
Operating temperature	**-40°C ÷ +40°C**
Housing	
Dimensions	**700 x 430 x 182 mm**
Cooling	**Liquid**
Weight	**45 kg**
Protection degree	**IP67**

HOUSING OF ZB24DC800



NEW

FT-250-600D SiC + FCEC-125 + ZB24DC800 + RWN-630-600

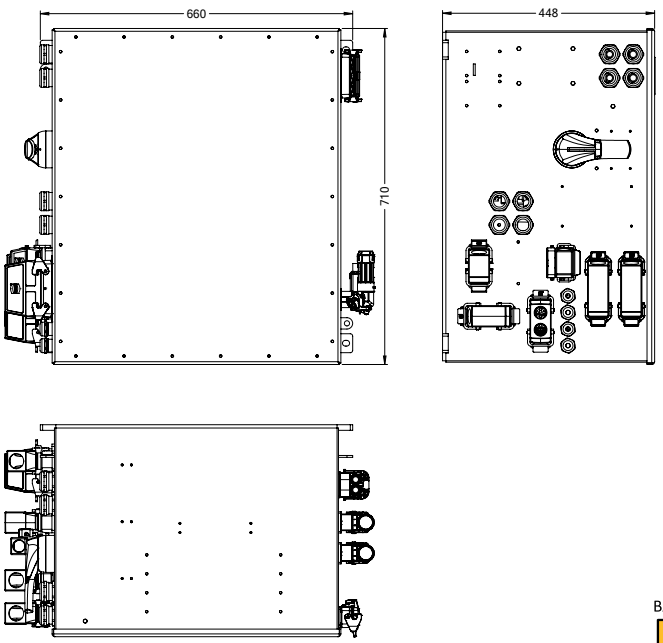
Modular Power Converters Set for Hydrogen Buses

RWN-630-600

RWN-630-600
The RWN-630-600 switchgear is powered from 662 VDC traction batteries. It is fully automated device and it contains switching and control apparatus. The switchgear supplies voltage from the traction batteries to the FT-250-600D SiC propulsion inverters circuits, ZB24DC800 battery charger and the vehicle heating. The RWN 630-600 must be immune to disturbances caused by the higher harmonic content of the voltage. The control circuit is supplied with nominal voltage of 24 VDC.

Specification of RWN630-600	
Input voltage	**510-750 VDC**
Auxiliary voltage	**24 VDC, +25% ÷ -30%**
Output voltage	**510-750 VDC**
Rated current	**800 A**
Isolation strength	**2.3 kV**
Housing	
Dimensions	**784 x 710 x 448 mm**
Cooling	**Natural**
Weight	**90 kg**
Protection degree	**IP65**

HOUSING OF RWN-630-600



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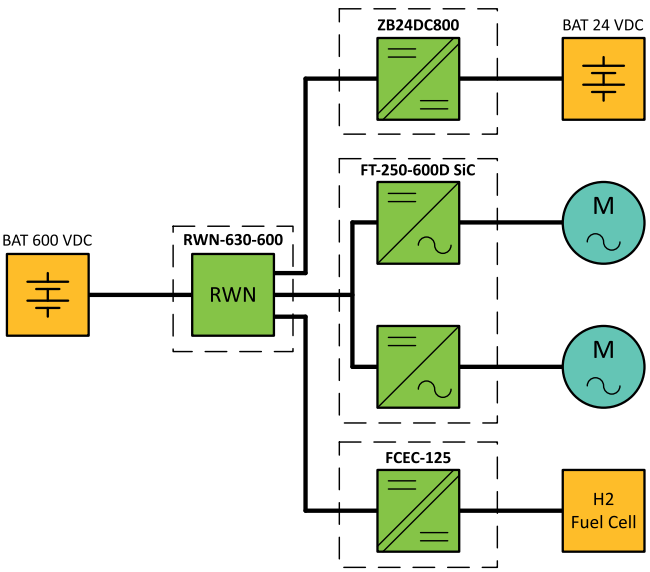
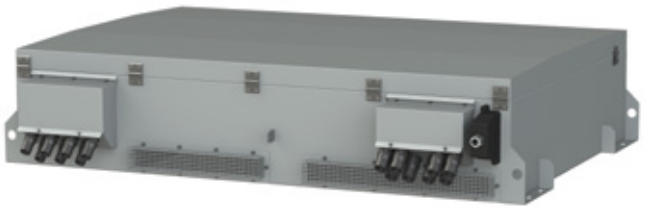


FT-350-600 /PSM-38i

Propulsion inverter integrated
with Auxiliary Converter



The application of independent inverters for powering of two motors guarantees high traction parameters, perfect performance at the slip point and no influence of non-uniform wear of wheel's tires on the drive's performance. The FT-350-600 drive inverter is a modern module inverter incorporating the IGBT technology. The converter control operates in the DSP technology (Digital Signal Processor) with application of the Field Oriented Control Space Vector Pulse Width Modulation. The inverter system enables the drive to work with regulated torque, regenerative braking or rheostatic braking. The inverter has been equipped with a forced air-cooling system and can be built up on the vehicle's roof (two inverter modules in one container). It is controlled by a CAN 2.0 B connection. The inverter's controller has been equipped with a built-in anti-slip system. Additionally, the system is equipped with an emergency power supply system (from the vehicle's battery), which enables the vehicle to move out the intersectional isolator or crossing (in case of main power failure).

FT-350-600		
Input voltage	**600 VDC**	
Rated power	**210 kW**	
Rated current	**380 Arms**	
Auxiliary voltage	**24 VDC +25% ÷ –30%**	
PSM-38i		
Input voltage	**600 VDC**	
Output power	**38 kW**	
DC Output	**26 V / 10 kW**	
AC Output	**3×400 V 50 Hz / 35 kVA**	
Auxiliary voltage	**24 VDC +25% ÷ –30%**	
Housing		
Cooling	**forced-air**	
Weight	**580 kg**	
Dimensions	**1950 x 1300 x 424 mm**	
Protection degree	**Clean section**	**IP65**
	Dirty section	**IP20**

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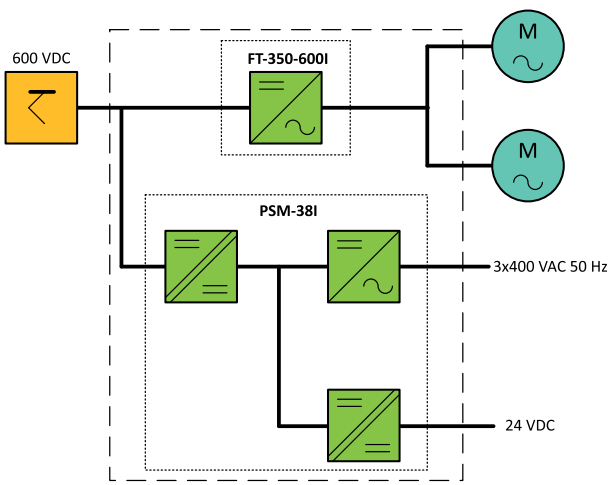
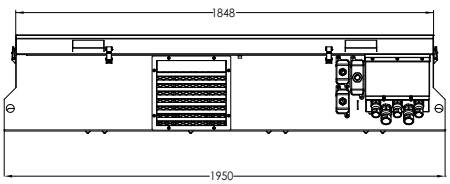
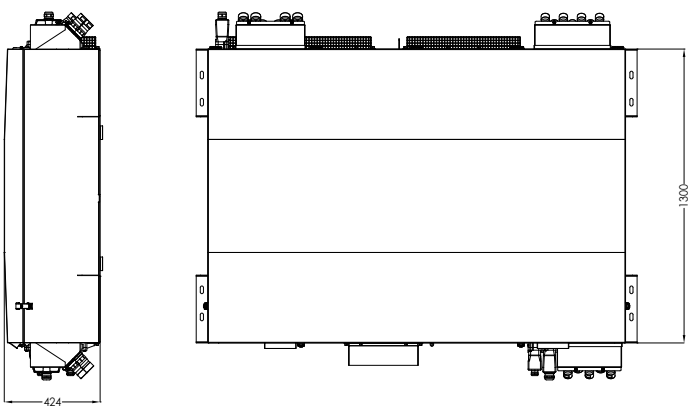


HOUSING



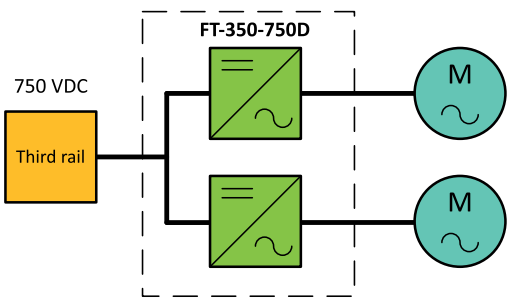


FT-350-750D

Propulsion inverter for
Asynchronous Drives

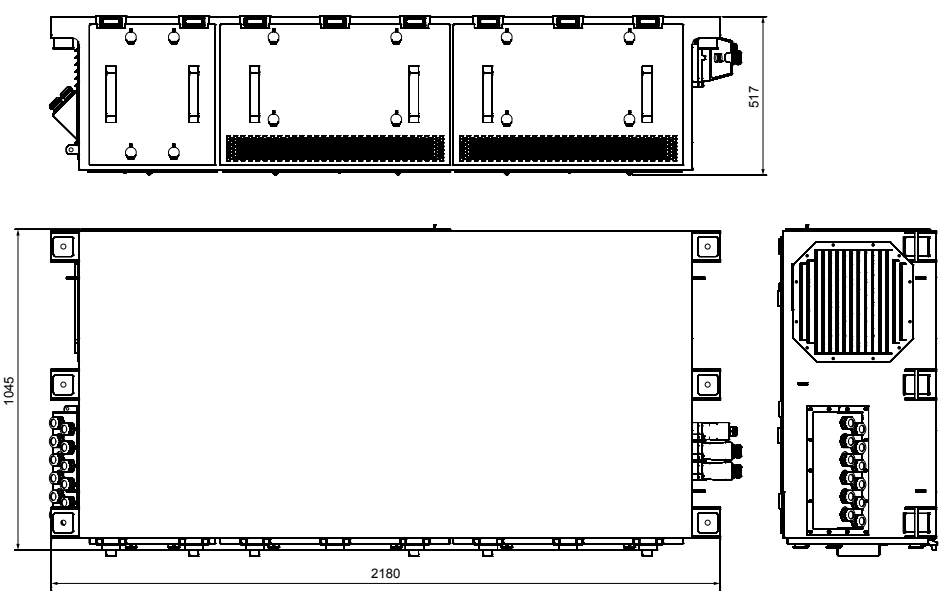
The FT-350-750D propulsion inverter has been designed to drive motors of metro vehicles and is powered from the 750 VDC traction. This inverter has been designed as two inverters, each of them to power one traction motor. Both inverters have been designed and built in the IGBT technology. Digital Signal Processor (DSP) system provides the control and monitoring of the operation. FOC SVM (Field Oriented Control Space Vector Modulation) algorithm ensures perfect traction parameters of the propulsion. Advanced control and diagnostics system ensures a failure-free and cost effective operation of the vehicle. The inverter system enables the performance of the drive with a regulated torque, regenerative or rheostatic braking. The inverter is equipped with an internal cooling system with durable fans; it is designed to be mounted under the frame of the car. The inverter is controlled by CAN 2.0 B or MVB connections and its controller is equipped with a very effective anti-slip system. The inverter has two independent outputs for motors with fully independent motor control capability. This allows for achieving much higher traction performance parameters of vehicles in acceleration and braking modes and provides special advantage in difficult rail conditions like soiled, wet or uneven rails as well as superior performance on curves and rail junctions. Due to its excellent anti-sllPand full motor control the inverter provides perfect protection of motor and gearbox against overload and generates savings on wheels maintenance costs owing to a larger tolerance for wheels diameter difference.

BLOCK DIAGRAM OF THE FT-350-750D INVERTER



Specification of the FT-350-750D inverter	
Input voltage	**750 VDC (550–925 VDC)**
Auxiliary voltage	**48 VDC, 24 VDC**
Rated current	**2 × 300 Arms**
Maximum current	**2 × 400 Arms**
Rated power	**360 kW**
Cooling	**forced-air**
Weight	**600 kg**
Dimensions	**2180 × 1045 × 517 mm**

HOUSING



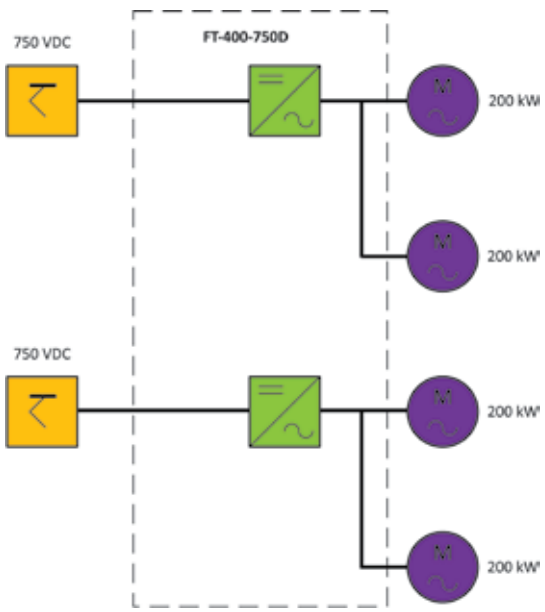
FT-400-750D

Propulsion inverter for Asynchronous Drives

The FT-400-750D propulsion inverter has been designed to drive motors of metro vehicles and is powered from the 750 VDC traction. This inverter has been designed as two inverters, each of them to power one traction motor. Both inverters have been designed and built in the IGBT technology. Digital Signal Processor (DSP) system provides the control and monitoring of the operation. FOC SVM (Field Oriented Control Space Vector Modulation) algorithm ensures perfect traction parameters of the propulsion. Advanced control and diagnostics system ensures a failure-free and cost effective operation of the vehicle. The inverter system enables the performance of the drive with a regulated torque, regenerative or rheostatic braking. The inverter is equipped with an internal cooling system with durable fans; it is designed to be mounted under the frame of the car. The inverter is controlled by CAN 2.0 B or MVB connections and its controller is equipped with a very effective anti-slip system. The inverter has two independent outputs for motors with fully independent motor control capability. This allows for achieving much higher traction performance parameters of vehicles in acceleration and braking modes and provides special advantage in difficult rail conditions like soiled, wet or uneven rails as well as superior performance on curves and rail junctions. Due to its excellent anti-slip and full motor control the inverter provides perfect protection of motor and gearbox against overload and generates savings on wheels maintenance costs owing to a larger tolerance for wheels diameter difference.

FT-400-750D		
Input voltage	**750 VDC**	
Rated power	**2 × 400 kW**	
Rated current	**3 × 560 A**	
Auxiliary voltage	**24 VDC +25% ÷ –30%**	
Housing		
Cooling	**forced-air**	
Weight	**870 kg**	
Dimensions	**2900 × 1060 × 900 mm**	
Protection degree	**Clean section**	**IP56**
	Dirty section	**IP20**

BLOCK DIAGRAM



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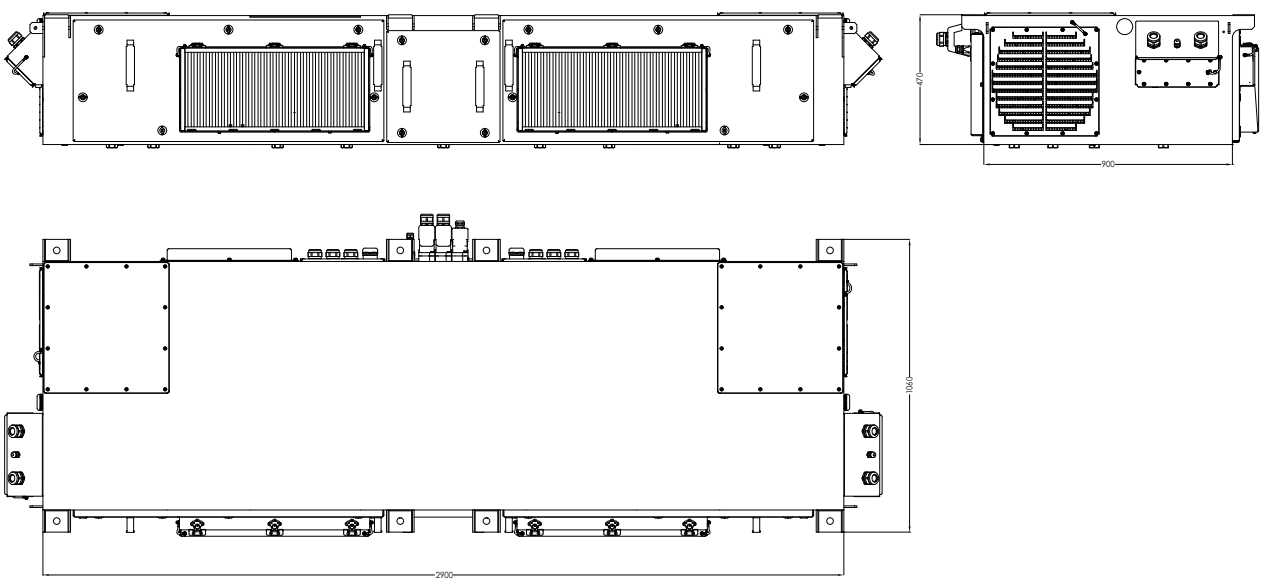


NEW

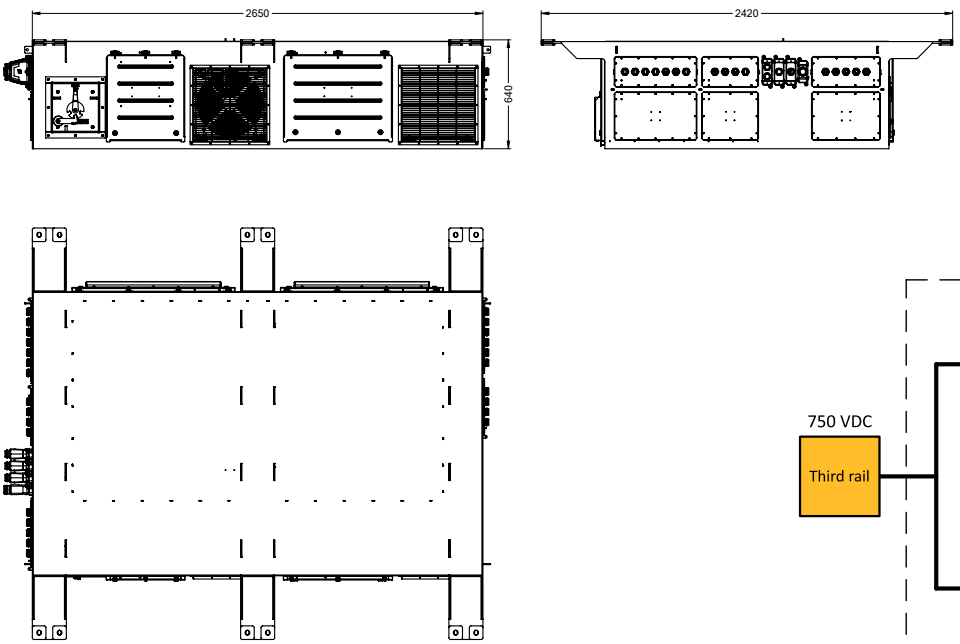
FT-400-750DS

Propulsion inverter for
Asynchronous Drives

The traction container box is designed to power the traction motors driving the wheel axles in a metro vehicle. The device is designed for installation under the vehicle floor. Propulsion inverters are designed to be supplied by 750 VDC traction voltage. The drive units in the vehicle enable starting, driving with a given torque, coasting and braking the vehicle. They also enable starting, driving and braking with the set reverse travel direction.
Traction container consists of two inverters, each inverter powers two traction motors (one-per-two solution). Their control system is based on Digital Signal Processor (DSP) system and provides the control and monitoring of the operation of both inverters. Applied FOC SV PWM (Field Oriented Space Vector Pulse Width Modulation) algorithms provides perfect traction parameters of the propulsion.
The advanced control and diagnostic system ensures a failure-free and cost effective operation of the vehicle. Inverter control system enables the performance of the propulsion with the precise control and regulation of the torque (on the shaft) and regenerative (or rheostatic) braking. The device is equipped with internal forced-air cooling system using durable fans, and is designed to be mounted under the frame of the car. Communication with TCMS is provided via CAN 2. Control algorithms of the inverters are equipped with the excellent anti-slip system which provides immediate recovery of adhesion between wheels and rails (via torque reduction, if slide happens). Construction of the inverters is modular with easy access to any of its part and segment which results easy service activity.

Specification		
Input voltage		**750 VDC**
Nominal power		**2 x 300 kW**
Nominal current		**2 x 420 A**
Auxiliary voltage		**110 VDC**
Housing		
Cooling		**Air forced**
Weight		**970 kg**
Dimensions		**2650 x 2420 x 630 mm**
Protection degree	Clean section	**IP55**
	Dirty section	**IP20**

HOUSING



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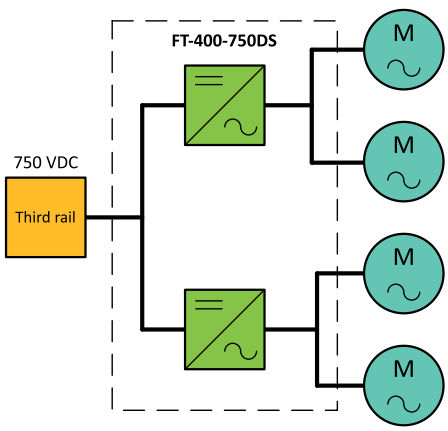


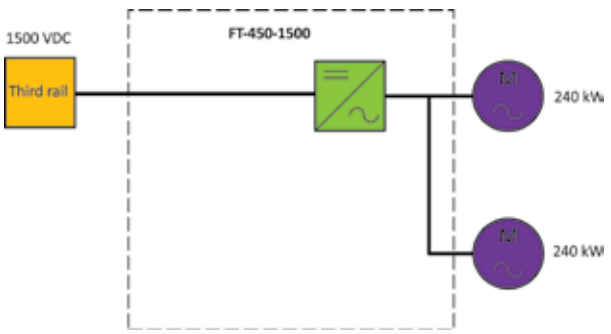
FT-450-1500

Propulsion inverter for
Asynchronous Drives

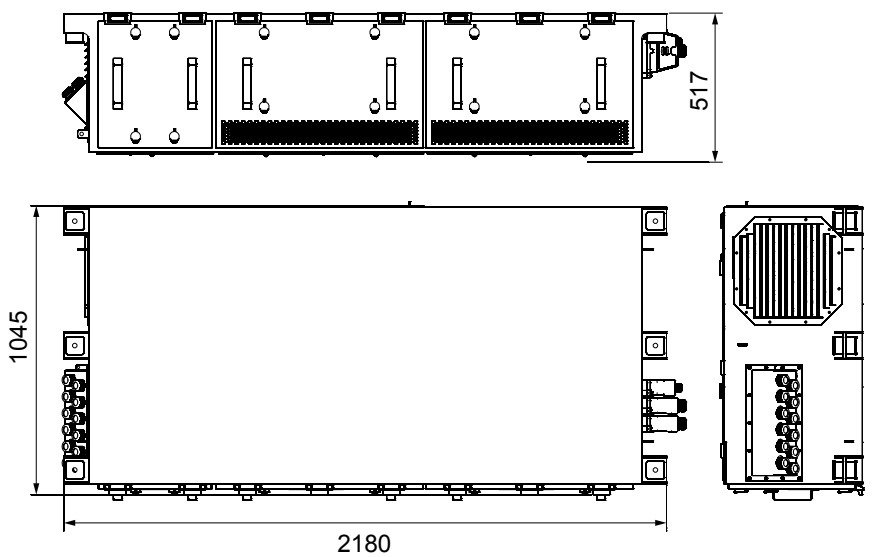
The FT-450-1500 propulsion inverter has been designed to drive motors of metro vehicles and is powered from the 1500 VDC traction. This inverter supplies two traction motors. The inverter has been designed and built in the IGBT technology. Digital Signal Processor (DSP) system provides the control and monitoring of the operation. FOC SVM (Field Oriented Control Space Vector Modulation) algorithm ensures perfect traction parameters of the propulsion. Advanced control and diagnostics system ensures a failure-free and cost effective operation of the vehicle. The inverter system enables the performance of the drive with a regulated torque, regenerative or rheostatic braking. The inverter is equipped with an internal cooling system with durable fans; it is designed to be mounted under the frame of the car. The inverter is controlled by CAN Open or MVB connections and its controller is equipped with a very effective anti-slip system. Additionally the inverter system is also protected with a thyristor crowbar. The inverter meets UN and EN standards requirements in regard to safety and electromagnetic compatibility. The system has very low levels of low frequency interferencess generated to the traction network.

Specification of the FT-350-750D inverter	
Input voltage	**1500 VDC (1000–1800 VDC)**
Auxiliary voltage	**110 VDC**
Rated current	**320 A**
Maximum current	**420 A**
Rated power	**480 kW**
Cooling	**forced-air**
Weight	**500 kg**
Dimensions	**2180 × 1045 × 517 mm**

BLOCK DIAGRAM OF THE FT-450-1500 INVERTER



HOUSING

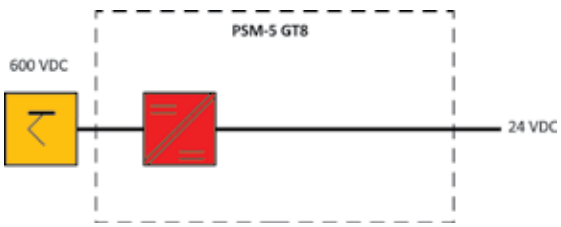


PSM-5 GT8

Auxiliary converter

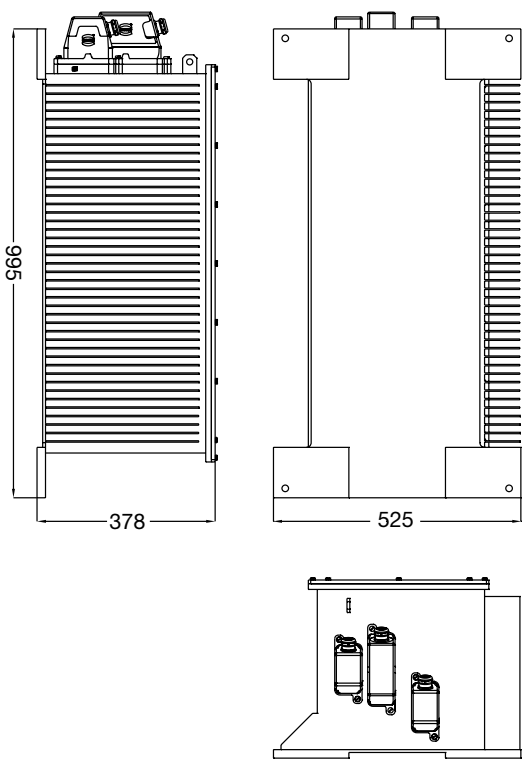
The PSM-5 GT8 auxiliary converter is a device designed to convert the traction supply voltage of 600 V into 24 VDC for tram low voltage grid.

BLOCK DIAGRAM



Specification	
Input voltage	**400–900 VDC**
Output power	**5 kW**
Output DC	**24 VDC / 210 A**
DC Voltage stability	**< 1%**
DC Voltage ripples	**< 1 Vpp (at nominal load)**
General efficiency	**≥ 90%**
Ambient temperature	**–30 ÷ +40°C**
Protection degree	**IP64**
Weight	**100 kg**
Dimensions	**378 × 995 × 525 mm**

HOUSING



PSM-8E

Auxiliary converter

Static auxiliary converter PSM-8E is a device designated for the conversion of the input of the catenary's voltage of 600 VDC into auxiliary voltages of 100 VDC and 2×200 V 60 Hz.

The PSM-8E converter is a completely automatic device which provides power supply to low voltage circuits using the energy from the catenary line. For starting, operation supply of an auxiliary voltage 100VDC from a battery is not required because the converter is equipped with a dead battery start unit (DBS).

Owing to the application of the latest generation single chip microprocessors and IGBT transistors, the converter delivers a sinusoidal voltage on its output with low harmonics contents. In the case of supplying the electric motors, this feature is advantageous (as compared to power supplies with square or trapezoidal output waveforms) because it significantly reduces power losses in the motors.

The control system ensures very good frequency stability, very good phase symmetry of the output voltage and a very low level of interferences generated by the system.

The semiconductors used in the device are selected with a margin allowing obtaining appropriate overloads of the system.

The device is a completely automatic device – the controller controls the states of the output terminals and prevents the inverter operating in case of prolonged overload or a short circuit.

The PSM-8E converter is designed as a single unit placed inside aluminium housing and mounted on the underframe of the tram.

PSM-8E		
Input voltage	**600 VDC**	
Output power	**8 kVA**	
DC Output	**100 VDC ±1%**	
AC Output	**2 × 200 V 60 Hz**	
Housing		
Cooling	**Natural air cooling**	
Weight	**150 kg**	
Dimensions	**1128 × 600 × 386 mm**	
Protection degree	**Clean section**	**IP54**

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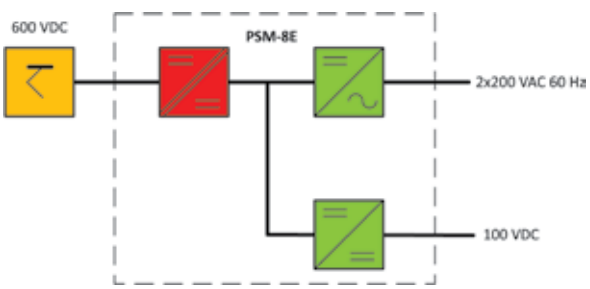
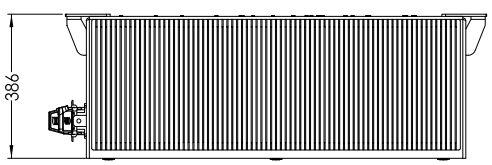
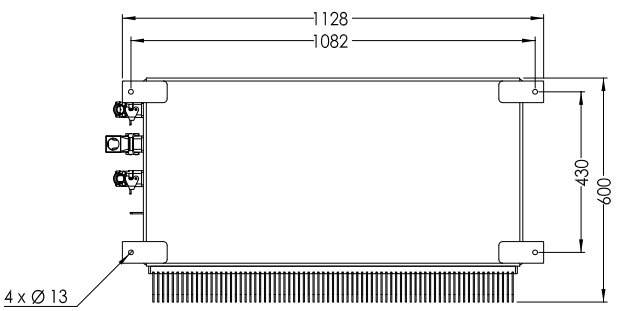


HOUSING





PSM-18T

Auxiliary converter

The PSM-18T auxiliary converter has been designed to convert DC voltage of the 600 VDC traction into 24 VDC voltage as well as 3×400 VAC nd 230 VAC voltage, needed to supply the auxiliary circuitry in the tram system, driver's air conditioning and car ventilation.

Specification	
Input voltage	**420–750 VDC**
Output voltage DC	**24 VDC**
P = 2.4 kW; In = 100 A; Un = 28.1 V (20 °C); Thermal voltage compensation: up to 5°C: 28.4 V, above 5°C: drop of 57 mV/°C; Temperature range up to +40°C; Reduction of battery charging current; Voltage stability ≤ 1%; Voltage ripples ≤ 0.5%; Electronic (overload, short circuit) protection	
Output voltage AC	**3×400 VAC (50 Hz)**
S = 4.5 kVA; Voltage stability ≤ ±5%; Frequency stability ≤ ±0.2%; THD(u) ≤ 5 %; Acceptable unbalancing of phase load – 30%; Electronic (overload, short circuit) protection	
Maximum power	**9 kW/5 s**
Total efficiency	**≥ 85%**
Protection: • against the change of power supply polarity • against overvoltages in the power supply network • against short-lasting (up to 10 s) blackouts • inverter interlock at the one-phase decay	
Monitoring	**CANopen**
Ambient temperature	**–30 ÷ +40°C**
Protection degree	**IP64**
Weight	**170 kg**
Dimensions	**1300 x 620 x 450 mm**

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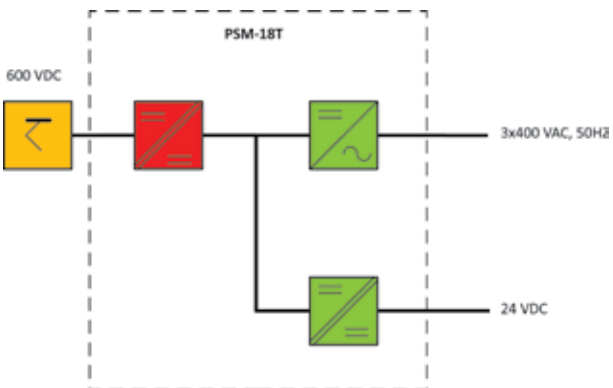
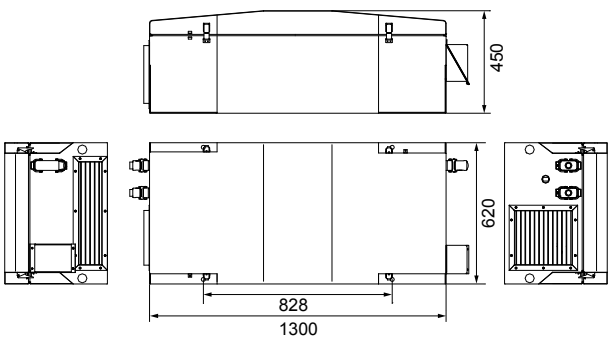
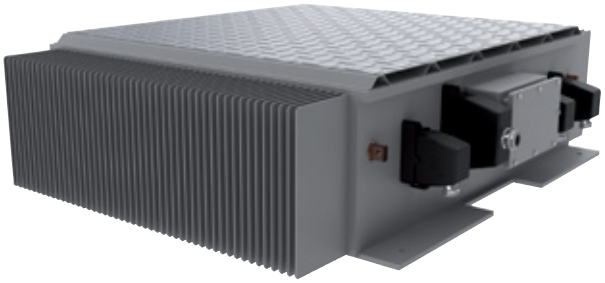


HOUSING



PSM-30T

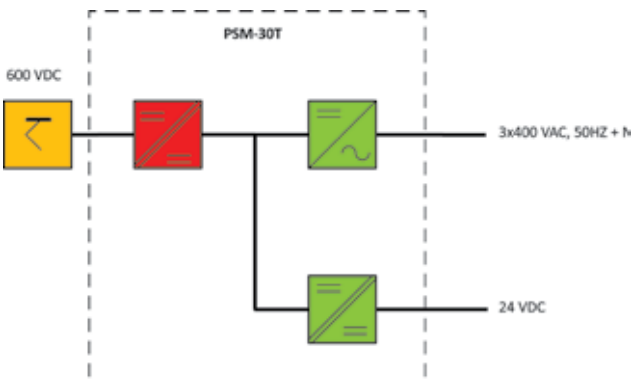
Auxiliary converter



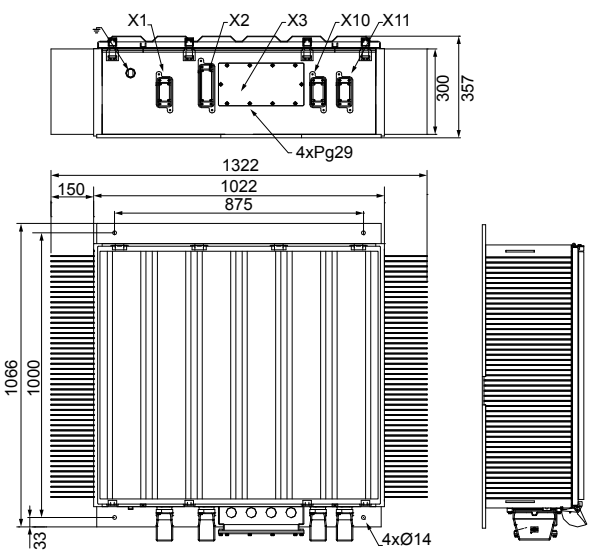
The PSM-30T auxiliary converter has been designed to convert DC voltage of the 600 VDC traction into 24 VDC voltage as well as into 3×400 V and 230 VAC voltage, needed to supply the auxiliary circuitry in the tram system, driver's air conditioning and car ventilation.

Specification	
Input voltage	**400–900 VDC**
Output voltage DC	**26 VDC**
P = 10 kW; In = 390 A; Un = 28.1 V (20°C); Thermal voltage compensation: up to 5°C: 28.4 V, above 5°C: drop of 57 mV/°C; Temperature range up to +40°C; Reduction of battery charging current; Voltage stability ≤ 1%; Voltage ripples ≤ 0.5%; Electronic (overload, short circuit) protection	
Output voltage AC	**3×400 VAC (50 Hz)**
S = 20 kVA; Voltage stability ≤ ±5%; Frequency stability ≤ ±0.1%; THD(u) ≤ 5%; Electronic (overload, short circuit) protection	
Maximum power	**35 kW**
Total efficiency	**≥ 92%**
Protection: • against the change of power supply polarity • against overvoltages in the power supply network • against short-lasting (up to 10 s) blackouts • inverter interlock at the one-phase decay	
Monitoring	**CANopen**
Ambient temperature	**–30 ÷ +40°C**
Protection degree	**IP55**
Weight	**240 kg**
Dimensions	**1322 x 1066 x 357 mm**

BLOCK DIAGRAM



HOUSING



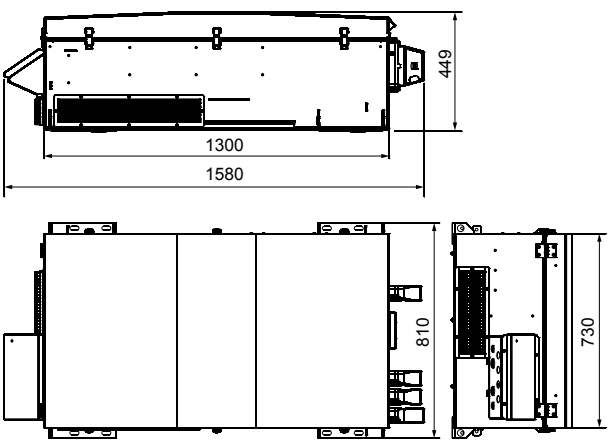
PSM-30TI

Auxiliary converter

The PSM-30TI auxiliary converter has been designed to convert DC voltage of the 600 VDC traction into 26 VDC voltage as well as into 3×400 VAC voltage, needed to supply the auxiliary circuitry in the tram system, driver's air conditioning and car ventilation.

Specification	
Input voltage	**400–900 VDC**
Output voltage DC	**26 VDC**
P = 10 kW; In = 390 A; Un = 28.1 V (20°C); Thermal voltage compensation: up to 5°C: 28.4 V, above 5°C: drop of 57 mV/°C; Temperature range up to +40°C; Reduction of battery charging current; Voltage stability ≤ 1%; Voltage ripples ≤ 0.5%; Electronic (overload, short circuit) protection	
Output voltage AC	**3×400 VAC (50 Hz)**
S = 25 kVA; Voltage stability ≤ ±5%; Frequency stability ≤ ±0.1%; THD(u) ≤ 5%; Electronic (overload, short circuit) protection	
Maximum power	**35 kW**
Total efficiency	**≥ 92%**
Monitoring	**CANopen**
Ambient temperature	**–30 ÷ +40°C**
Protection degree	**IP56/IP23**
Weight	**220 kg**
Dimensions	**1300 × 810 ×450 mm**

HOUSING



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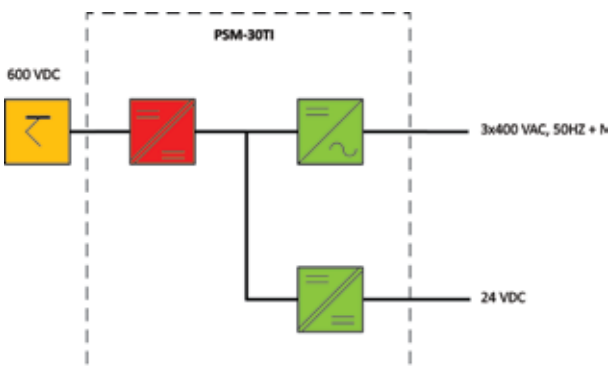
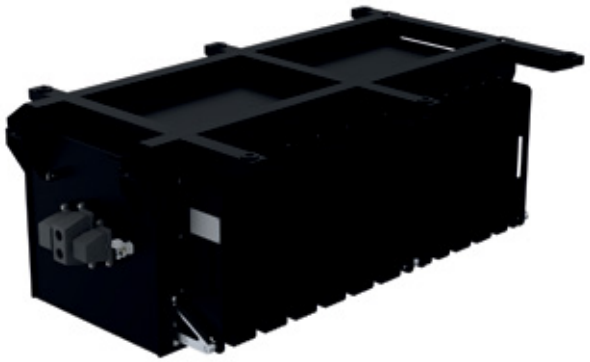


PSM-32M

Auxiliary converter



The PSM-32M converter is a high power device based on IGBT technology. It is a fully automated device designed for converting traction voltage 750 VDC to 220 VAC 60 Hz and 72 VDC voltage of auxiliary circuits and battery charging.
The device uses technique of multiple conversion of energy. The 72 VDC output voltage is adjusted to floating charging, so output voltage is not constant. The converter is convectively cooled and operates within the wide range of external temperatures. The PSM-32M converter is mounted under the frame of metro car. The diagnostics and control of the converters are provided via defined interface.

Specification	
Input voltages	**750 VDC**
DC Output	**72 VDC / 15 kW**
AC Output	**220 VAC, 60 Hz / 17.5 kVA**
Auxiliary voltage	**24 VDC +25% ÷ 30%**
Housing	
Cooling	**natural**
Weight	**380 kg**
Dimensions	**1695 x 775 x 570 mm**
Protection degree	**IP65**

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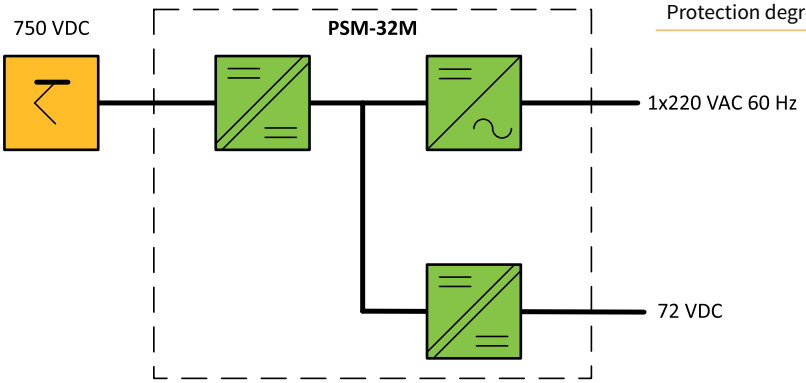

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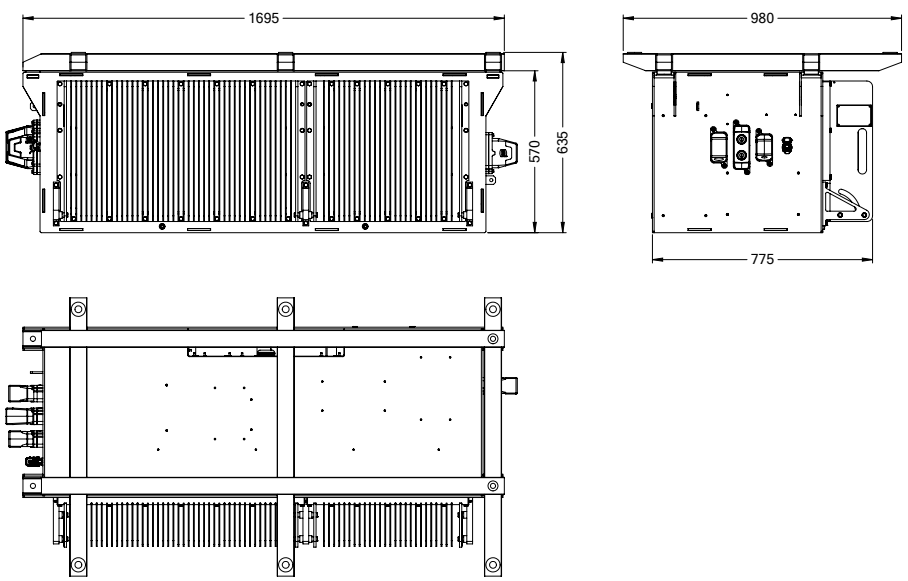


NEW

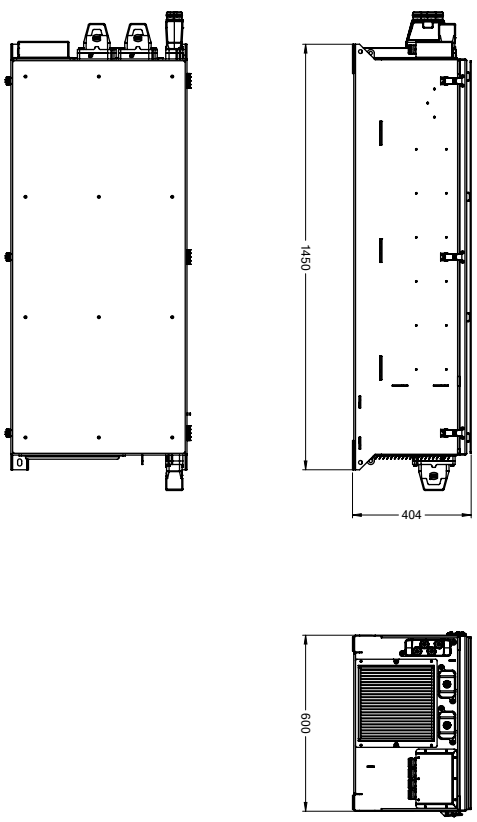
PSM-38Ti

Auxiliary converter

The PSM-38Ti auxiliary converter is a fully automated device designed to convert 600 VDC traction voltage into 3x400 V / 50 Hz AC and 24 VDC voltage and for charging the battery. The device uses multiple energy conversion technology. The traction voltage is converted to high AC voltage and then converted to low DC voltage 24 VDC and AC voltage 3x400 VAC. As a result of incorporating single-chip microprocessors and IGBT transistors, the converter generates a sinusoidal AC voltage with low harmonic content at the output. The APU ensures proper charging of the batteries and is also equipped with a battery charging current limitation system. The charger included in the unit implements a temperature compensation function regarding the final charging voltage using the measurement information received from the thermal probe installed on the battery container. The battery charging current is regulated using measurement data provided by the converter current transducer. The control system adopted ensures high frequency stability, very good phase symmetry of the output voltage and a very low level of interferencess generated by the system. The semiconductor elements used in the device are selected with sufficient margin to achieve the assumed system overloads. The converter is equipped with a module enabling communication with the vehicle main controller via a CAN interface. In this way, information on the operation or failure of the unit is transmitted. The unit is entirely self-maintaining - the control system monitors the states at the output terminals and protects the converter in the event of a long-term overload or short circuit. The unit is mounted on the roof of the tram. The unit has its own cooling system (air only), with a separate dirty zone where a mechanical filter is installed to prevent dirt from entering the container.

Specification		
Input voltage		**400-900 VDC**
Total power		**40 kVA**
DC output		**26 V / 10 kW In= 390 A;**
DC voltage stability		**< 1%**
AC output		**3 x 400 V / 30 kVA, cosφ=0.9**
AC voltage stability		**≤ ±5%**
Frequency stability		**≤ ±0.1%**
Harmonic content (THD)		**≤ 5%**
Max. neutral conductor current		**43 A**
Overall efficiency		**> 92%**
Housing		
Dimensions		**1450 x 600 x 404 mm**
Weight		**180 kg**
Protection degree	Clean section	**IP65**
	Dirty section	**IP23**
Ambient temperature		**−30°C ÷ +40°C**
Cooling		**Forced air**

HOUSING



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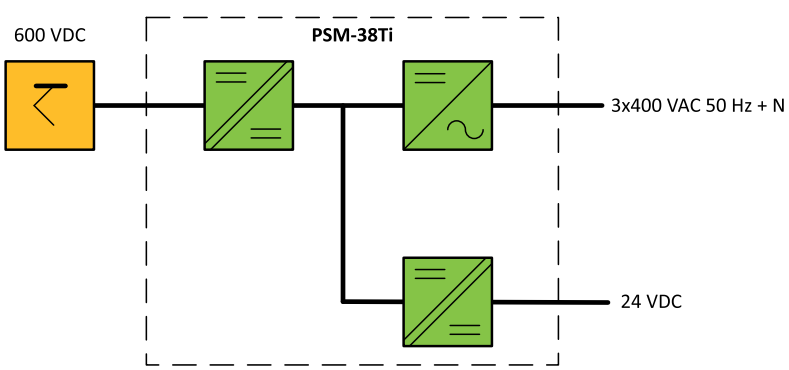

PSM-55

Auxiliary converter

The converters are equipped with a natural air-cooling system which operates within a wide range of external temperatures. The diagnostics and control of the converters are provided via a defined interface.

The converter is a high power device based on IGBT technology.

The auxiliary converter PSM-55 is a fully automated device designed for converting the traction power supply voltage 750 VDC to the 72 VDC voltage of auxiliary circuits, 3x220 V/60 Hz and batteries charging. The 72 V output voltage is adjusted to the charge status of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In the case of overload of the converter, an internal current limit circuit operates.

The PSM-55 converter is mounted under the frame of the metro vehicle.

PSM-55		
Input voltage	**750 VDC**	
DC Output	**72 VDC +/-2% / 15 kW**	
AC Output	**3×220 VAC +/-5% / 60 Hz / 40 kVA**	
Housing		
Cooling	**Natural air cooling**	
Weight	**560 kg**	
Dimensions	**2050 × 860 × 635 mm**	
Protection degree	**Clean section**	**IP56**

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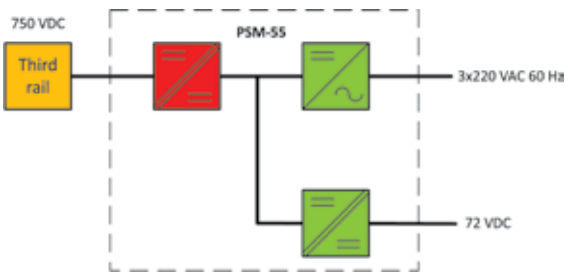

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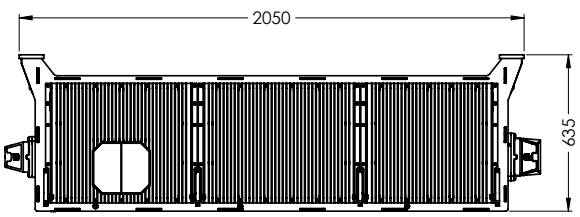
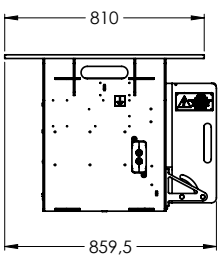
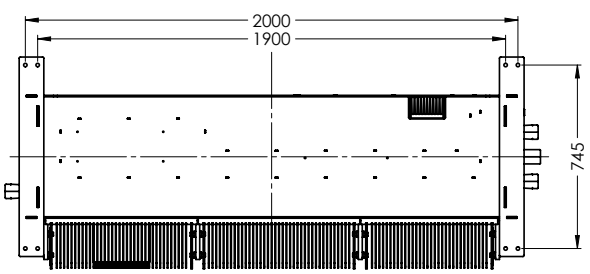
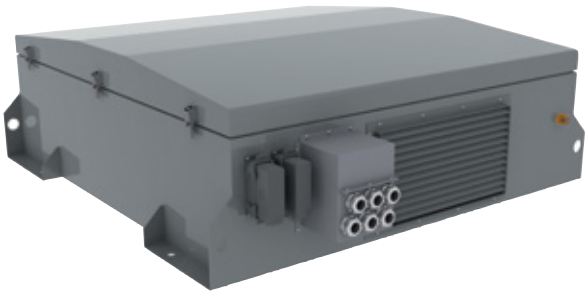






PSM-60T

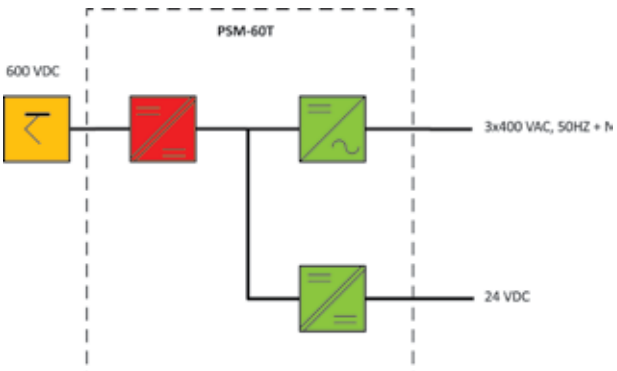
Auxiliary converter



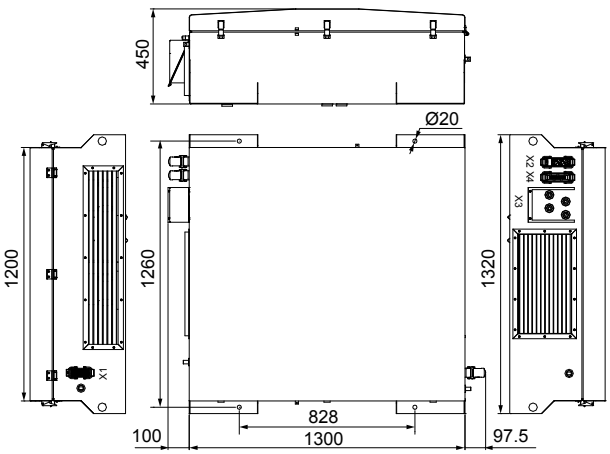
The PSM-60T auxiliary converter has been designed to convert DC voltage of the 600 VDC traction into 24 VDC voltage, as well as 3×400 VAC and 230 VAC voltage, needed to supply the auxiliary circuitry of the tram system, driver's air conditioning and car ventilation.

Specification	
Input voltage	**400–900 VDC**
Output voltage DC	**26 VDC**
P = 10 kW; In = 390 A; Un = 28.1 V (20°C); Thermal voltage compensation: up to 5°C: 28.4 V, above 5°C: drop of 57 mV/°C; Temperature range up to +40°C; Reduction of battery charging current; Voltage stability ≤ 1%; Voltage ripples ≤ 0.5%; Electronic (overload, short circuit) protection	
Output voltage AC	**3×400 VAC (50 Hz)**
S = 50 kVA; Voltage stability ≤ ±5%; Frequency stability ≤ ±0.1%; THD(u) ≤ 5%; Electronic (overload, short circuit) protection	
Maximum power	**60 kW**
Total efficiency	**≥ 92%**
Protection: • against the change of power supply polarity • against overvoltages in the power supply network • against short-lasting (up to 10 s) blackouts • inverter interlock at the one-phase decay	
Monitoring	**CANopen**
Ambient temperature	**–30 ÷ +40°C**
Protection degree	**IP30**
Weight	**420 kg**
Dimensions	**1300 × 1200 × 450 mm**

BLOCK DIAGRAM



HOUSING



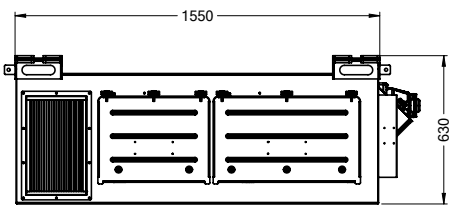
PSM-61

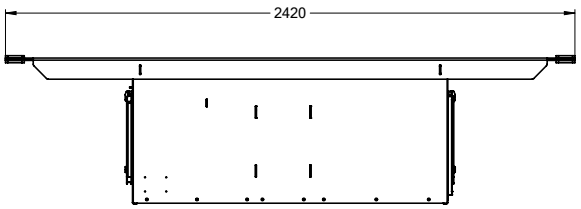
Auxiliary converter

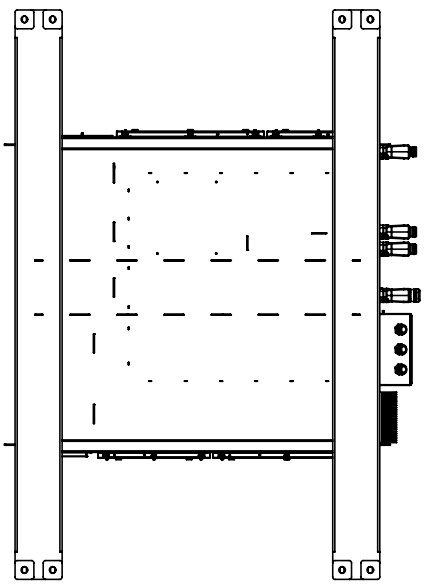
Auxiliary converter is a fully automated device designed for converting traction power supply voltage 750 VDC to 110 VDC and 3x400 VAC / 50 Hz of auxiliary circuits and batteries charging. The device uses technique of multiple conversion of energy.
Auxiliary Power Unit (APU) is mounted under the frame of the metro car. Auxiliary converter is equipped in precharge system. Each startup of APU is realized via precharge circuit. This system limits the inrush current of mains filter capacitors. APU is equipped in input filter. It smooths the input voltage. APU provides 110 VDC output. LVPS block contains transformer ensuring galvanic insulation. The converter is equipped with dead battery system (DBS) that enables converter start when input high voltage is present but onboard battery is discharged.
Thanks to applied parallel structure of the power converter DC output and AC output are powered independently and failure in one of them does not block the operation of the other.

PSM-61		
Input voltage		**750 VDC**
DC output		**110 VDC / 33 kW**
AC output		**3x400 V, 50 Hz / 28 kVA**
Auxiliary voltage		**24 VDC +25% - 30%**
Housing		
Cooling		**Air forced**
Weight		**363 kg**
Dimensions		**1550 x 2420 x 630 mm**
Protection degree	Clean section	**IP55**
	Dirty section	**IP20**

HOUSING







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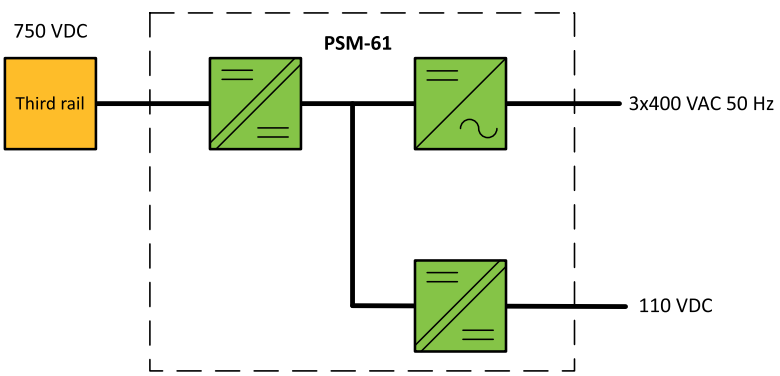

PSM-68

Auxiliary converter

The auxiliary converter PSM-68 is a fully automated device designed for converting traction power supply 750 VDC voltage to 110 VDC voltage of auxiliary circuits, 3×400 V/50 Hz and batteries charging. The device uses the technique of multiple conversion of energy. 110 V output voltage is adjusted to the charge state of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In case of converter overload an internal current limit circuit operates. The PSM-68 converter is mounted under the frame of a metro car. Access to its components is provided from the side of the vehicle, after removal of the side flaps.

Specification	
Input voltage	**750 VDC**
Output voltage AC	**3×400 VAC, 1×230 VAC**
Voltage stability AC: ±5%; Frequency Tolerance: ±1%; Harmonics content (THD); ±5%	
Output voltage DC	**110 VDC**
Battery charging limit: 50 A; Current battery charge: ±5%; Battery charging methods IU and IU0U	
Operating temperature	**–25 ÷ +45°C**
Output power	**3AC – 28 kVA, DC – 40 kW**
General efficiency	**≥ 92%**
Monitoring	**MVB**
Protection degree	**IP55**
Weight	**380 kg**
Dimensions	**2000 × 620 × 720 mm**

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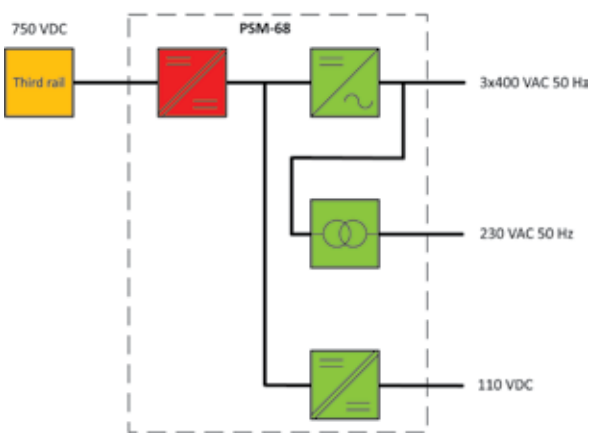
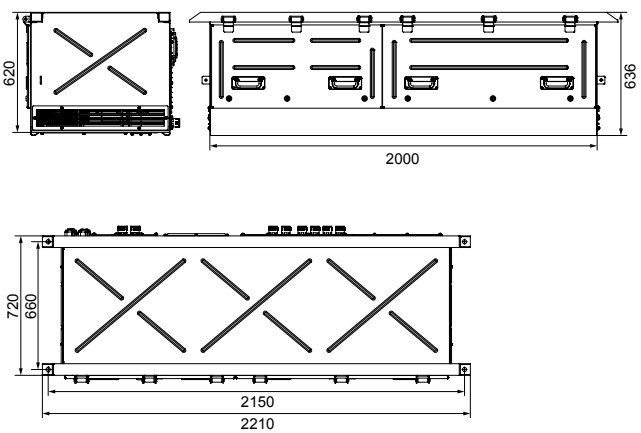


HOUSING



PSM-69ST2

Auxiliary converter

The auxuliary power unit (APU) for the application in the LRV project is designed with the application of state-of-the-art modern solutions provided by the world's technology: IGBT modules, Digital Signal Processors, modern magnetic materials, resin stabilization and others. The applied technological and circuitry solutions provides excellent output parameters.

The APU for the LRV project is supplied from the 1500 VDC overhead power supply. The APU provides three-phase 208 VAC (60 Hz), one--phase 120 VAC (60 Hz) and 29.6 VDC.

The converter (PSM-69) will consist of a pre-charge circuit that limits the inrush current during the converter switching on. The APU has Depot input that enables power supply to the battery charger or the battery charger and 3AC / 1AC output (current limited to 25 A).

Control of the converter is made with the application of microprocessor circuits that provide perfect control over the output parameters of the converter as well as protection against overload and short-circuit conditions.

PSM-69ST2		
Input voltage 1	**1500 VDC**	
Input voltage 2	**3×208 VAC, 60 Hz**	
Output power	**69 kW**	
DC Output	**29.6 VDC 14 kW**	
AC Output 1	**3×208 VAC, 60 Hz / 45 kVA**	
AC Output 2	**120 VAC, 60 Hz / 10 kVA**	
Housing		
Cooling	**forced-air**	
Weight	**475 kg**	
Dimensions	**1850 × 1260 × 491 mm**	
Protection degree	**Clean section**	**IP54**

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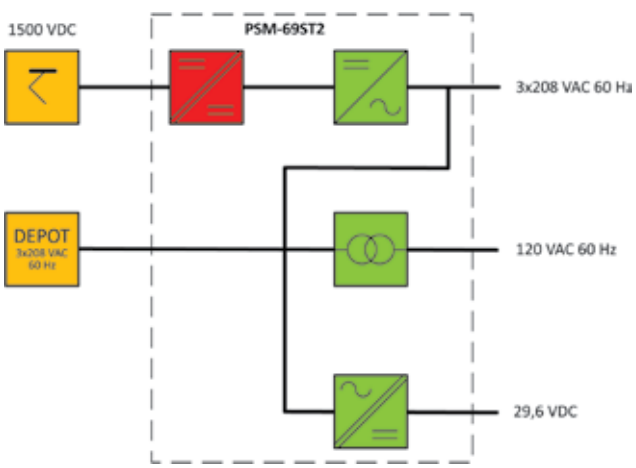
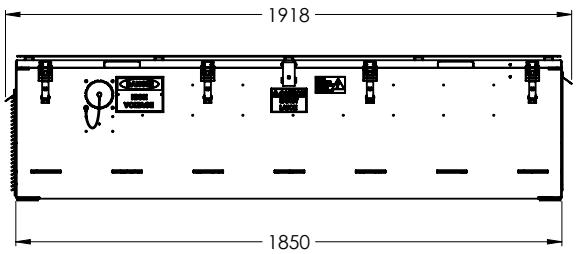
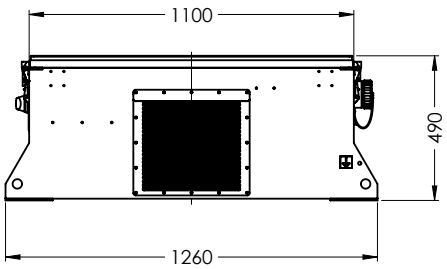


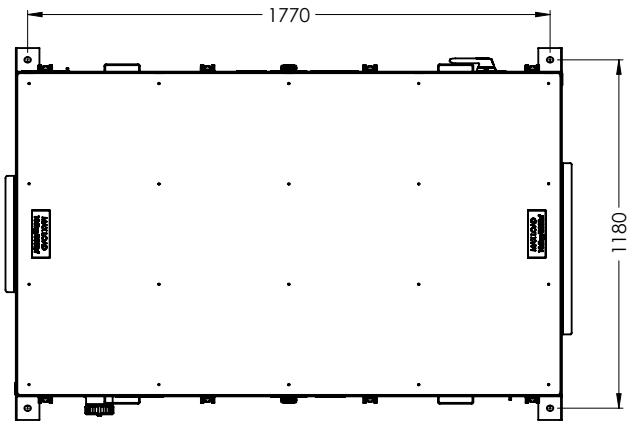
PSM-69ST2

Auxiliary converter

HOUSING







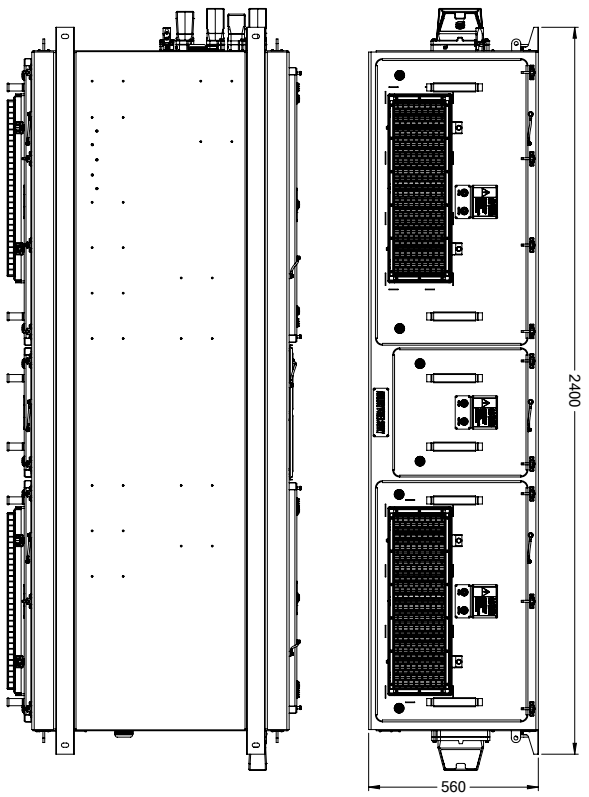
PSM-96M SiC

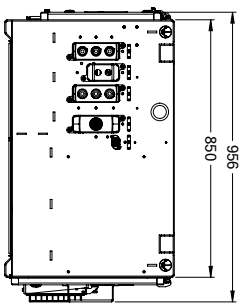
Auxiliary converter

The converter is equipped with forced air cooling system operating within the wide range of external temperatures. The diagnostics and control of the converter are provided via defined interface. The converter is high power device based on SiC technology.
Auxiliary converter PSM-96M is a fully automated device designed for converting traction power supply voltage 750 VDC to 110 VDC voltage of auxiliary circuits, 3x440 V/60 Hz / 220 VAC, and batteries charging. The device uses technique of multiple conversion of energy. output voltage is adjusted to the charge status of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In the case of overload of the converter an internal current limit circuit operates. PSM-96M converter is mounted under frame of metro coach.

Specification		
Input voltage		**750 VDC**
DC Output		**110 VDC / 12 kW**
AC Output 1		**3x440 VAC, 60 Hz / 78 kVA**
AC Output 2		**220 VAC, 60 Hz / 5.5 kVA**
Auxiliary voltage		**110 VDC +25% ÷ -30%**
Housing		
Cooling		**Forced air**
Weight		**508 kg**
Ambient temperature		**+15°C÷ +40°C**
Dimensions		**2400 x 956 x 560 mm**
Protection degree	Clean section	**IP20**
	Dirty section	**IP65**

HOUSING





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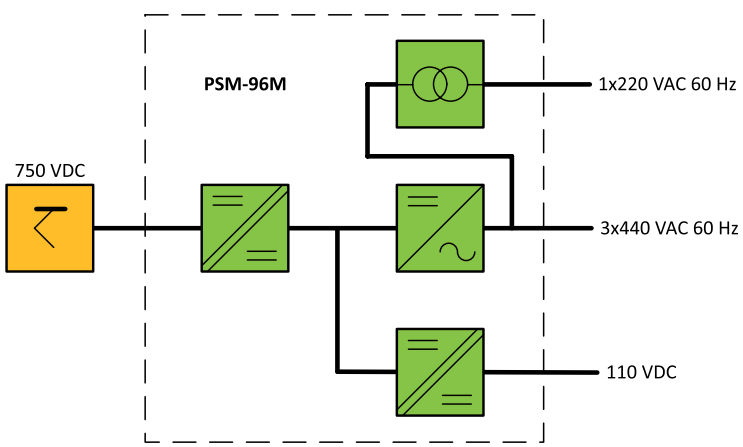


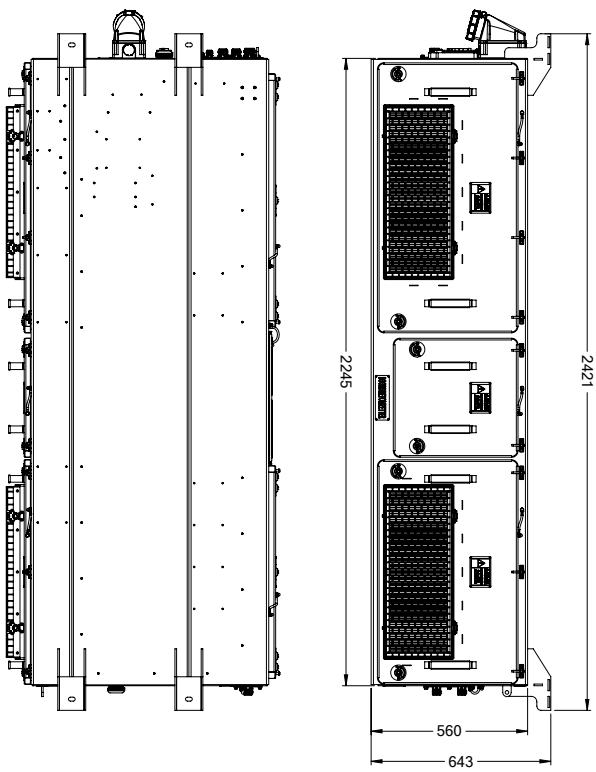
PSM-110AMS SiC

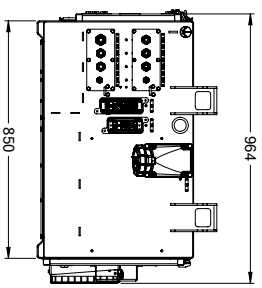
Auxiliary converter

The converter is equipped with forced air cooling system operating within the wide range of external temperatures. The diagnostics and control of the converter are provided via defined interface. The converter is high power device based on SiC technology.
Auxiliary converter PSM-110AMS SiC is a fully automated device designed for converting traction power supply voltage 750 VDC to 110 VDC voltage of auxiliary circuits, 3x400 V/50 Hz, and batteries charging. The device uses technique of multiple conversion of energy. 110 V output voltage is adjusted to the charge status of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In the case of overload of the converter an internal current limit circuit operates.

Specification		
Input voltage		**750 VDC**
DC Output		**110 VDC / 20 kW**
AC Output		**3x400 VAC, 50 Hz / 90 kVA**
Auxiliary voltage		**110 VDC +25% ÷ -30%**
Housing		
Cooling		**Forced air**
Weight		**515 kg**
Operating temperature		**-25°C ÷ +40°C**
Dimensions		**2421 x 964 x 643 mm**
Protection degree	Clean section	**IP20**
	Dirty section	**IP66**

HOUSING





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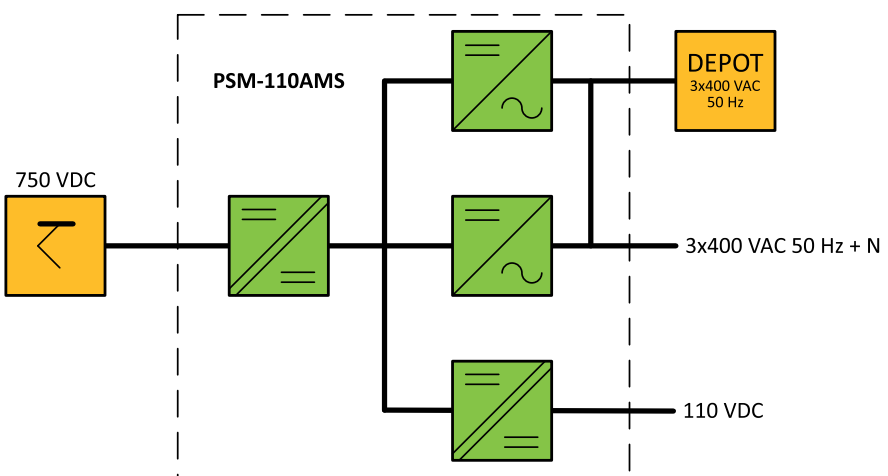


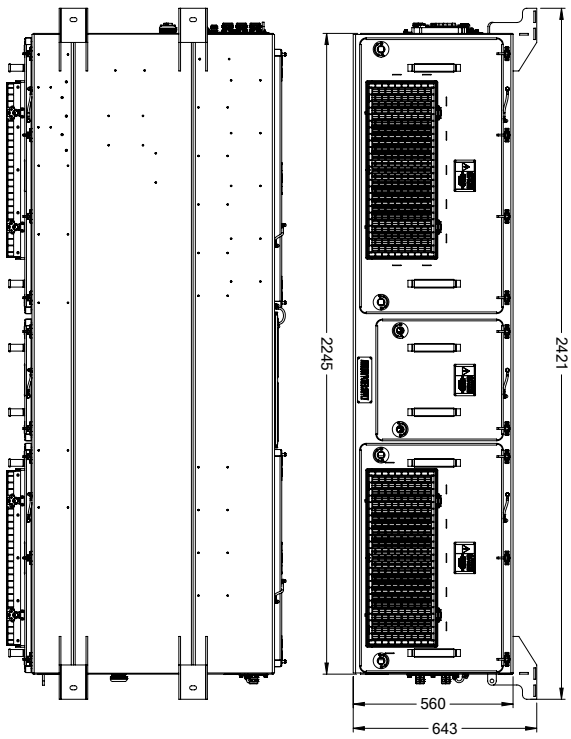
PSM-110DLR SiC

Auxiliary converter

The converter is equipped with forced air cooling system operating within the wide range of external temperatures. The diagnostics and control of the converter are provided via defined interface. The converter is high power device based on SiC technology.
Auxiliary converter PSM-110DLR SiC is a fully automated device designed for converting traction power supply voltage 750 VDC to 110 VDC voltage of auxiliary circuits, 3x400 V/50 Hz, and batteries charging. The device uses technique of multiple conversion of energy. 110 V output voltage is adjusted to the charge status of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In the case of overload of the converter an internal current limit circuit operates. PSM-110DLR converter is mounted under frame of metro coach.

Specification		
Input voltage		**750 VDC**
DC Output		**110 VDC / 20 kW**
AC Output		**3x400 VAC, 50 Hz / 90 kVA**
Auxiliary voltage		**110 VDC +25% ÷ -30%**
Housing		
Cooling		**Forced air**
Weight		**511 kg**
Operating temperature		**-25°C ÷ +40°C**
Dimensions		**2421 x 964 x 643 mm**
Protection degree	Clean section	**IP66**
	Dirty section	**IP20**

HOUSING



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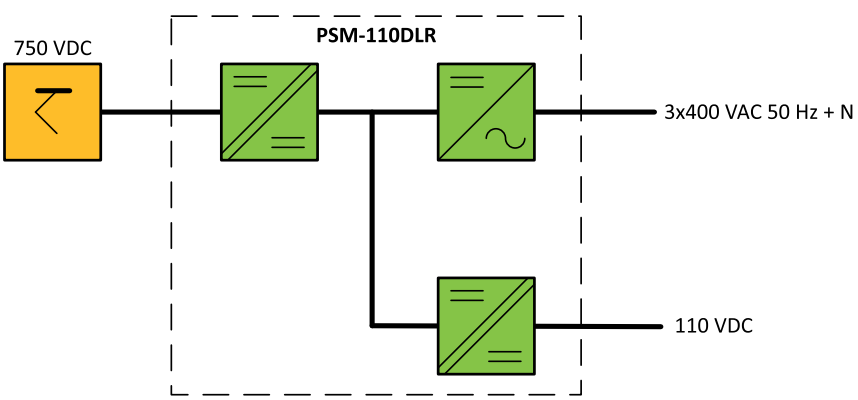
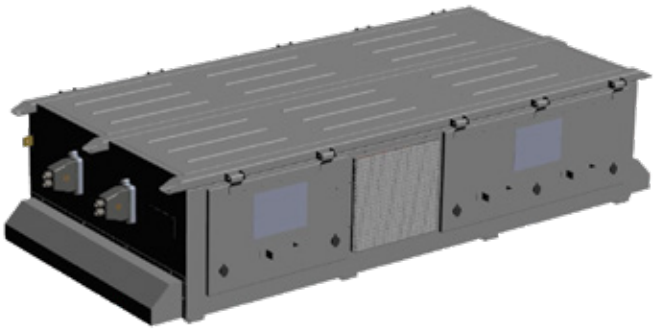


PSM-114

Auxiliary converter



Auxiliary converter PSM-114 is a fully automated device designed for converting traction power supply voltage 750 VDC to 28 VDC voltage of auxiliary circuits, 3×208 V/60 Hz and batteries charging. The device uses technique of multiple conversion of energy. 28 V output voltage is adjusted to the charge status of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In the case of overload of the converter an internal current limit circuit operates.
PSM-114 converter is mounted under frame of LRV S200 car. Access to its components is provided on the side of the vehicle, after removing the side flaps and bottom covers (applies to main fans).

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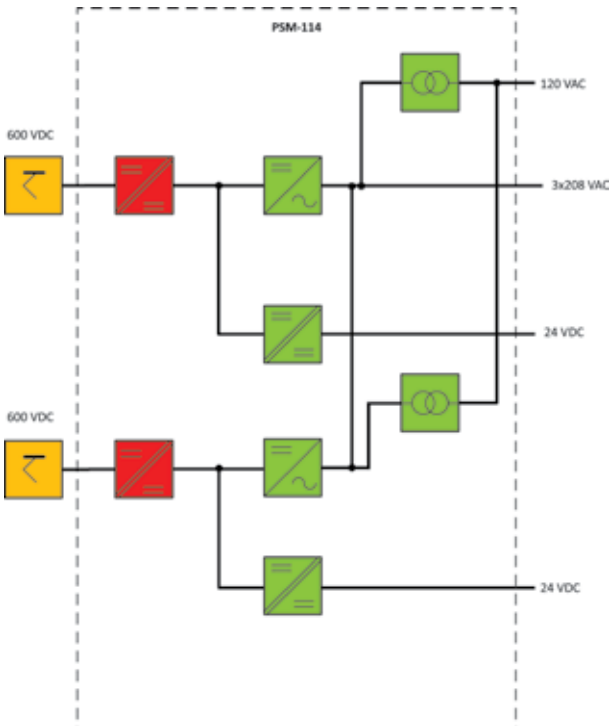
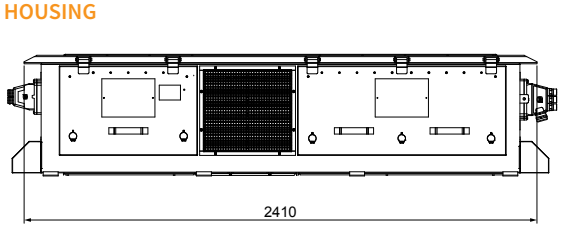
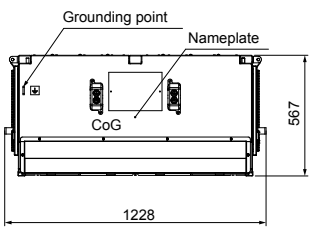
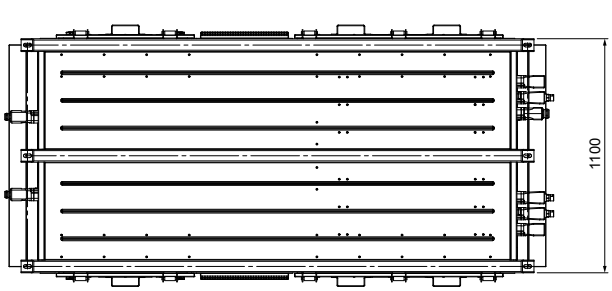


Specification		
Input voltage	**600/750 VDC**	
Operating range	**420÷1100 VDC**	
Total power	**114 kVA**	
Output DC1	**28.6 V/7 kW**	
Output DC2	**28.6 V/7 kW**	
Additional parameters of DC outputs	**In = 250 A; thermal voltage compensation; Electronic protection (overload shortcircuit)**	
DC output stability	**< 1%**	
DC voltage ripples	**< 1 Vpp (at rated load)**	
Output AC1	**3×208 V/90 kVA**	
Output AC2	**120 V/10 kVA**	
AC output stability	**≤ ±5%**	
Overall efficiency	**> 88%**	
Ambient temperature	**-40 ÷ +47°C**	
Protection degree	**Dirty zone** **Clean zone**	**IP20** **IP64**
Weight	**765 kg**	
Dimensions (H×W×D)	**567 × 1100 × 2410 mm**	

HOUSING







PSM-114SD9

Auxiliary converter

The auxiliary converter PSM-114SD9 is a fully automated device designed for converting the traction power supply voltage 750/600 VDC to the 29.6 VDC voltage of auxiliary circuits, 3×460 VAC / 60 Hz and batteries charging. The device uses the technique of the multiple conversion of energy. The 29.6 V output voltage is adjusted to the charge status of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In the case of overload of the converter an internal current limit circuit operates.
The PSM-114SD9 converter is mounted on the roof of the LRV car. The main function of the APU for this project is to convert from the 600/750 VDC catenary power supply to the three-phase 460 VAC, single phase 120 VAC 60Hz and 29.6 VDC and to provide the three--phase voltage to AC loads and to provide the 29.6 VDC to the DC load and to charge the battery.
In addition to this main function, the APU has various functions for protection, support of diagnosis, and support maintenance.

The functions of the APU are shown as follows:

- AC output voltage control
- DC output voltage control
- Battery discharging current
- Start and stop logic
- Protections
- Fault data
- Portable Test Unit (PTU) functions
- Train Network Communication

PSM-114SD9		
Input voltage	**600/750 VDC**	
Output power	**114 kW**	
DC Output	**29.6 VDC 14 kW**	
AC Output 1	**3×460 VAC 60 Hz 90 kVA**	
AC Output 2	**120 VAC 60 Hz 10 kVA**	
Housing		
Cooling	**forced-air**	
Weight	**488 kg**	
Dimensions	**1918 × 1260 × 490 mm**	
Protection degree	**Clean section**	**IP55**
	Dirty section	**IP20**

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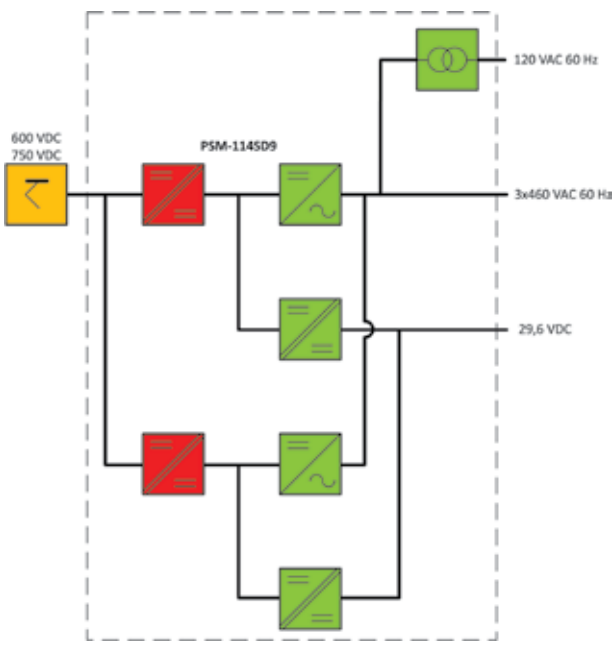
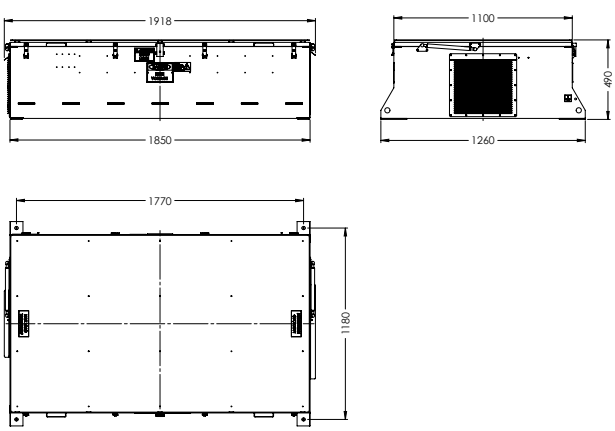


HOUSING



PSM-130MS

Auxiliary converter

The on-board auxiliary power supply system is energized by two auxiliary inverters (AUX) in the Metro cars. The primary circuit of the auxiliary inverters is connected directly to the 1500 VDC main circuit. The auxiliary inverter in the Metro car is supplied by the neighbouring motor car.
Each auxiliary inverter includes a three-phase inverter and DC/DC converter (battery charger).
The auxiliary inverter has the following outputs (with galvanic insulation to the input):

- 3×400 VAC for auxiliary components (air compressor, traction container fans, cab and passenger HVAC)
- 230 VAC only for sockets
- 110 VDC for the battery charger, control supply, lighting, ventilation of passenger compartments and ventilation of HVAC cab.

The auxiliary inverter is mounted on the underframe of the metro car. Access to the components of the inverter is provided on the side of the vehicle, after removing the maintenance flaps.
The auxiliary inverter is designed to convert the incoming DC voltage to the DC voltage (110 V) and AC (3×400 V, 230 V) necessary in low-voltage train installations.
The inverter is designed to work with the MVB bus control. It is also fitted with the Ethernet bus, used for equipment diagnostics. The inverter is equipped with an auto-start system (in the presence of HV voltage) and a pre-charge circuit, limiting the inrush current.
The inverter is started by the MVB bus control signals.

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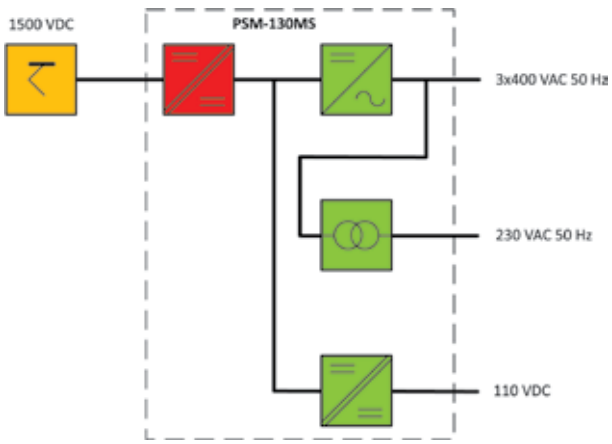
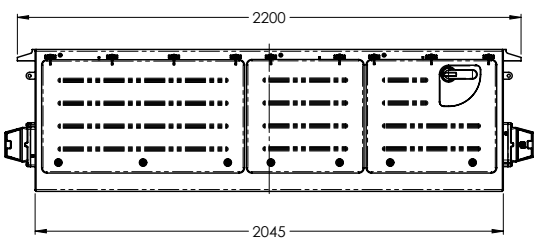
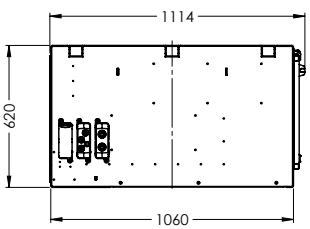
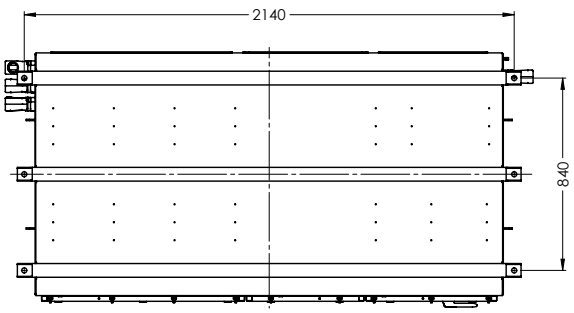


PSM-130MS		
Input voltage	**1500 VDC**	
Output power	**130 kW**	
DC Output	**110 VDC / 30 kW**	
AC Output 1	**3×400 V / 50 Hz / 97 kVA**	
AC Output 2	**230 V / 50 Hz / 3 kVA**	
Housing		
Cooling	**forced-air**	
Weight	**655 kg**	
Dimensions	**2200 × 1114 × 620 mm**	
Protection degree	**Clean section**	**IP55**

HOUSING







PSM-132

Auxiliary converter

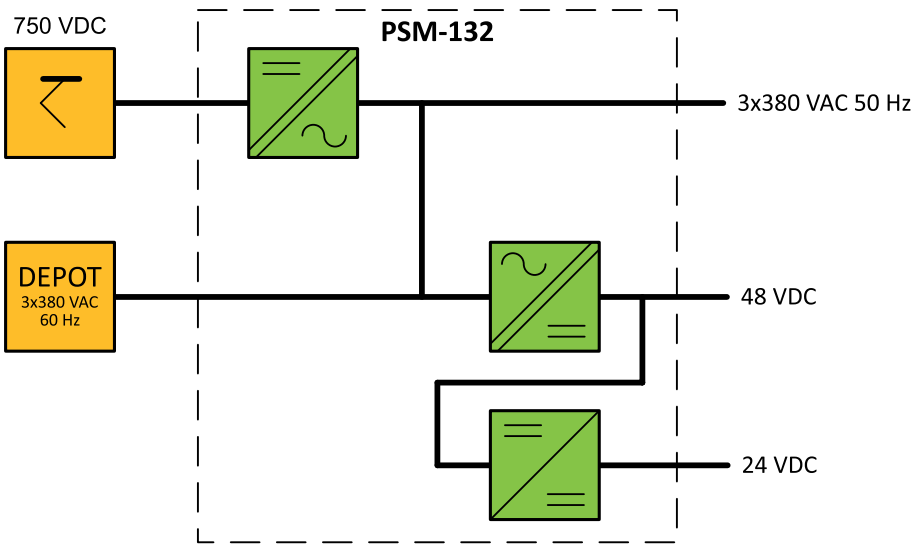
The PSM-132 auxiliary converter has been designed to convert DC voltage of the 750 VDC metro traction into 3×380 VAC 60 Hz AC voltage, applied in the low voltage systems of metro, used to supply the auxiliary circuitry in the metro system, air conditioning and DC loads.

Specification	
Input voltage	**750 VDC**
Operating input voltage	**500–1000 VDC**
Depot input voltage	**3×380 VAC/60 Hz***
Overvoltage protection	**YES**
Output voltage DC1	**48 V (45–52 V)***
P = 15 kW, In = 270 A; Voltage stability ±1%; Battery current regulator 0.1–1 In; Voltage ripples < 2%; Voltage thermal compensation	
Output voltage DC2	**24 VDC**
P = 1 kW; In = 42 A; Voltage stability ±3%; Voltage ripples < 2% ; Electronic short circuit protection	
Output voltage AC	**3×380 V/60 Hz**
S = 117 kVA; Overload capacity 2×In/3 s (200%/3 s); Voltage stability ±5%; Frequency stability ±1%; Output wave shape sinusoidal; THD(u) < 5%; Electronic short circuit protection	
Total output power	**132 kW**
Total efficiency	**≥ 92%**
* other voltages on request	
Protection • overload protection • overcurrent protection • overtemperature protection • protection against short circuit	
Monitoring	**CANopen, MVB**
Mounting	**under the frame**
Cooling	**forced-air**
Ambient temperature	**–25 ÷ +45°C**
Protection degree	**IP55/IP20**
Weight	**1050 kg**
Dimensions	**2180 × 1000 × 600 mm**

PSM-132

Auxiliary converter

BLOCK DIAGRAM



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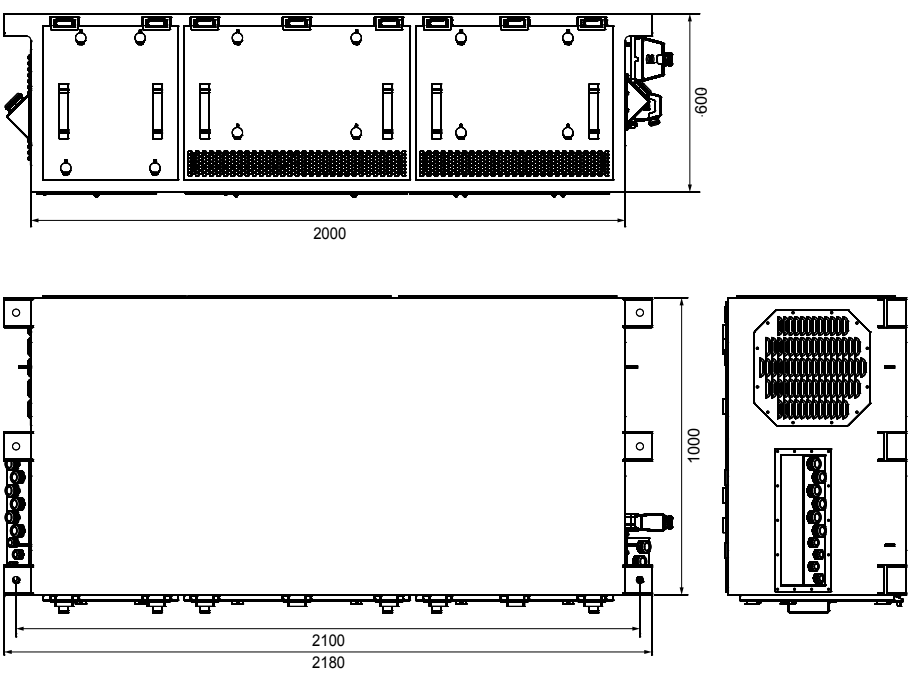

PSM-145 SiC

Auxiliary converter

The MEDCOM Auxiliary Power Unit PSM-145 SiC is designed with the application of state-of-the-art modern solutions provided by the world's technology: IGBT and SiC modules, Digital Signal Processors, modern magnetic materials, resin stabilization and others. The modern technological and circuitry solution provides excellent output parameters.
The converter's maintenance is optimized, and automatic control systems monitor the states of the outputs and protect them against overloads or short circuits. Every fault state is detected and followed by an appropriate alarm signal.
The controls of the converter are performed in DSP (Digital Signal Processor) technology.
The system is characterized by a low level of harmonics distortion in the output voltage, very high efficiency and high overload capability.
The applied bus-bar system in combination with a perfect IGBT and SiC driver guarantees a failure free performance on short-circuits and eliminates the possibility of secondary damages in case of transistor failure.
The converters meet the international and EN standards in safety and electromagnetic compatibility.
The system provides a very low level of interferencess emitted to the traction network and loads.
The converters are equipped with a natural air-cooling system to cool down power elements (IGBT and SiC).
The system operates within a wide range of external temperatures.
The diagnostics and control of the converters are provided via the defined interface.

HV circuit
The input is equipped with a pre-charge system, which limits the inrush converter current resulting from charging of the internal capacitors. DC/DC chopper converter is connected to the DC/DC resonant converter. The output voltage DC/DC is stabilized, which allows normal operation within a wide range of input line voltages. The output voltage is designed in an optimal range which allows using SiC transistors with very low commutation losses.

3AC circuit (based on SiC technology)
From the voltage supplied by the resonant converter the output inverter creates 3×380 V 50 Hz voltage.
The AC output of the converter is:
- protected from short circuits and overloads by an electronic control system of the inverter
- connected to the train's AC network through a three-phase contactor
- protected against over-voltage and under-voltage

DC output (based on SiC technology)
The DC link voltage converter provides 110 VDC output. The charger block contains transformers ensuring galvanic insulation. The filtered output voltage is in the 77-137.5 V range.
The DC output of the converter is:
- protected from short circuits and overloads by an electronic control system
- protected against over-voltage and under-voltage

The control system monitors the output current by adjusting the output voltage. Increase in the output current above the nominal value in the event of an overload or short circuit reduces the output voltage and causes stabilization of the maximum current.
The output voltage is limited by the converter to prevent the overload risk to the battery circuit.
The charger control system has electronic protection against short circuits and overloads. In the case of short circuit or overload, the power supply current regulator lowers the DC output voltage and the output current is stabilized so as not to exceed the maximum current power supply.

NOTE
Thanks to the applied parallel structure of the power converter, the DC output and AC outputs are powered independently and failure in one of them does not block the operation of the other.

Control system
The microprocessor control block ensures proper operation of the converter in a wide range of supply voltage used in the traction grid. It also controls the alarm signals of the DC and 3AC outputs.
The control of the converter is performed in DSP (Digital Signal Processor) technology. The system is characterized by a low level of harmonics distortion in the output voltage, very high efficiency and high overload capability. The applied bus-bar system in combination with IGBT and SiC technology guarantees a failure-free performance upon short-circuits and eliminates the possibility of secondary damages in case of transistor failure. The converter meets the international and EN standards in safety and electromagnetic compatibility. The system provides a very low level of interferencess emitted to the traction network and loads.

Inverter control is implemented through hardwire signals. In addition, the converter is equipped with an Ethernet interface (CAN-ETH module).
Owing to the application of the latest generation single-chip microprocessors, IGBTs and SiC technology, the converter delivers a sinusoidal voltage on its output with low harmonics contents. In case of supplying the electric motors, this feature is advantageous (as compared to power supplies with square or trapezoidal output waveforms) because it significantly reduces power losses in the motors.
The control system ensures high frequency stability, very good phase symmetry of the output voltage and very low level of interferences generated by the system.
The semiconductor components are selected with a high margin that enables high overload of the system.
The device requires simple maintenance – the control system tests the states of the output terminals and protects the converter in case of prolonged overload or short-circuit.
The converter is equipped with a dead battery system that enables a converter start when input high voltage is present but the vehicle battery is discharged.

PSM-145 SiC

Auxiliary converter

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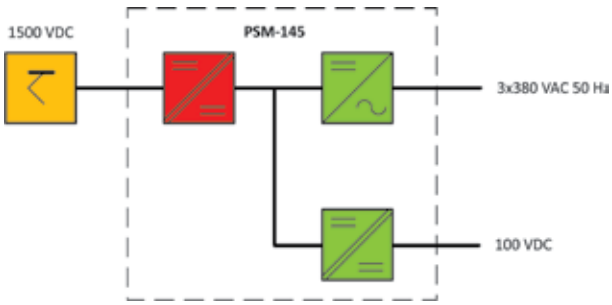
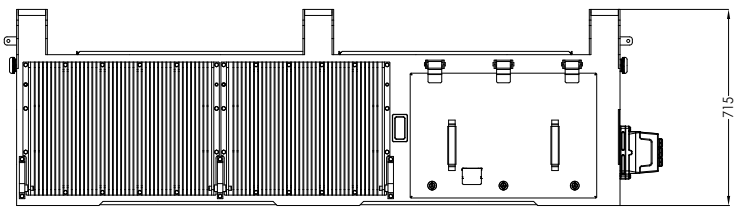
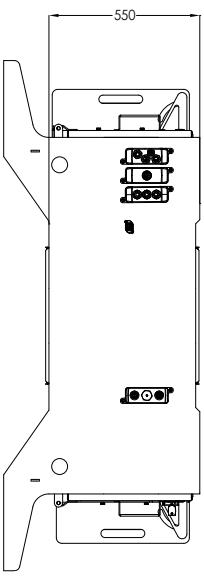
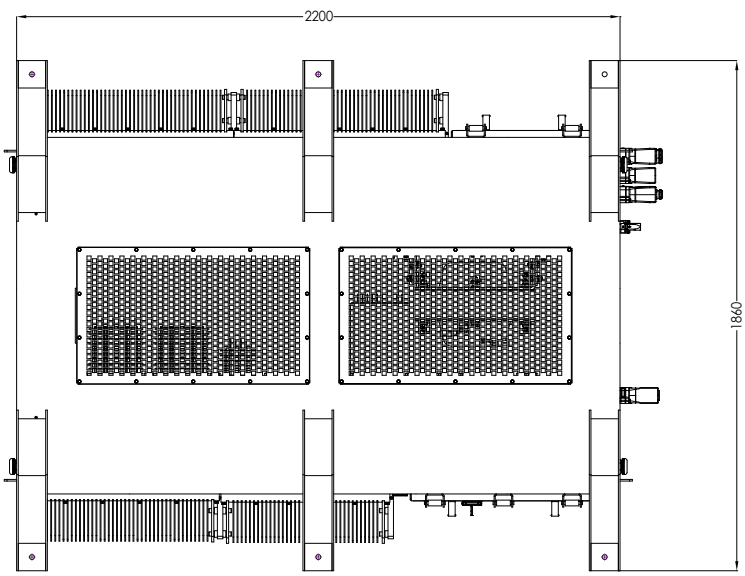


PSM-145		
Input voltage	**1500 VDC**	
DC Output	**110 VDC / 25 kW**	
AC Output	**3x380 V / 50 Hz / 120 kVA**	
Housing		
Cooling	**Natural air cooling**	
Weight	**820 kg**	
Dimensions	**2200 × 1800 × 715 mm**	
Protection degree	**Clean section**	**IP54**

HOUSING







PSM-245

Auxiliary converter

Auxiliary converter is a fully automated device designed for converting traction power supply voltage 750 VDC to 110 VDC, 3x415 VAC / 50 Hz and 230 VAC / 50 Hz of auxiliary circuits and batteries charging. The device uses technique of multiple conversion of energy. Constant voltage from the catenary line (750 VDC) is converted into alternating voltage and then rectified and transformed to obtain low DC voltage. The 110 V output voltage is adjusted to the charge status of the battery cooperating with the converter so that the charging current of the connected battery is not exceeded. In case of overload of the converter an internal current limit circuit operates. Auxiliary converter is mounted under the frame of the vehicle. Access to its components is provided on the sides of the container.

Specification		
Input voltage		**750 VDC**
DC Output		**110 VDC / 34 kW**
AC 1 Output		**3x415 VAC, 50 Hz / 189 kVA**
AC 2 Output		**230 VAC, 50 Hz / 16 kVA**
Auxiliary voltage		**110 VDC +25% ÷ -30%**
Housing		
Cooling		**Forced air**
Weight		**1479 kg**
Dimensions		**2400 x 1840 x 704 mm**
Protection degree	Clean section	**IP20**
	Dirty section	**IP65**

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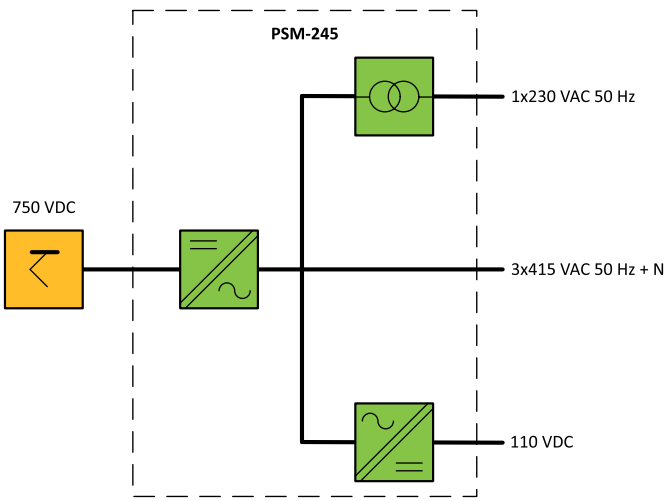

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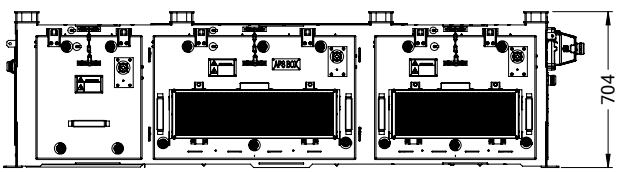

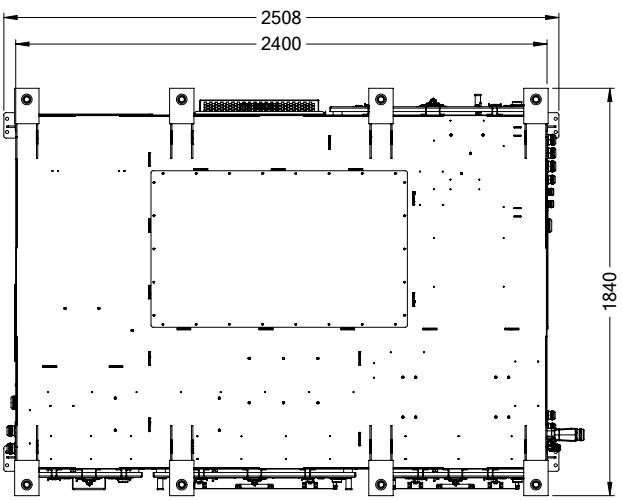

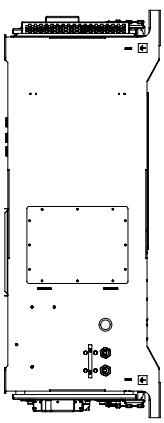

UOE-60S

Battery Power Supply for Propulsion Drives

Energy Storage Battery Charger UOE-60S is a fully automated device designed for converting traction power supply voltage 600/750 VDC to the battery voltage for charging and back, to convert battery voltage to the traction voltage level. Battery is charged by constant value of current up to the full charge statement. Back conversion, from battery to traction voltage is done while battery voltage is higher than bottom limit, as determined by the battery manufacturer. In the case of overload of the converter an internal current limit circuit activates. UOE-60S is prepared to be mounted on the roof of the vehicle. Access to its components is provided by upper cover or via dismounting of the side covers.

In 2014, Medcom, together with Siemens Rail Systems USA and Corvus, broke the Guinness World Record for the longest distance travelled by a battery-powered tram. On 15 July 2014, on the San Diego Green Line, a controlled and supervised test was performed to drive the vehicle as far as possible on a single electrical charge.

The result was stunning – 24.596 km (15.283 miles) with a maximum speed of 40 km/h – and was certified as a Guinness World Record, for the "longest distance travelled in 24 hours by a battery powered tram on a single charge".

This result improved on the previous record by one-third.

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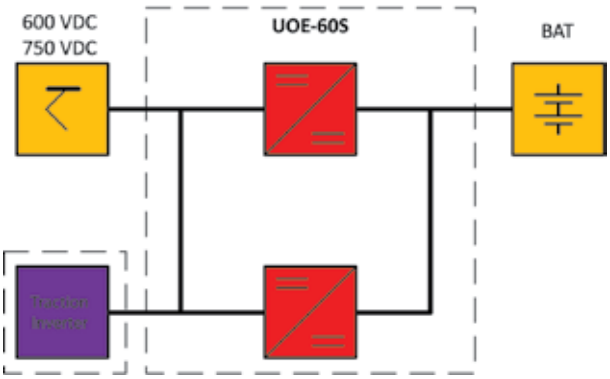
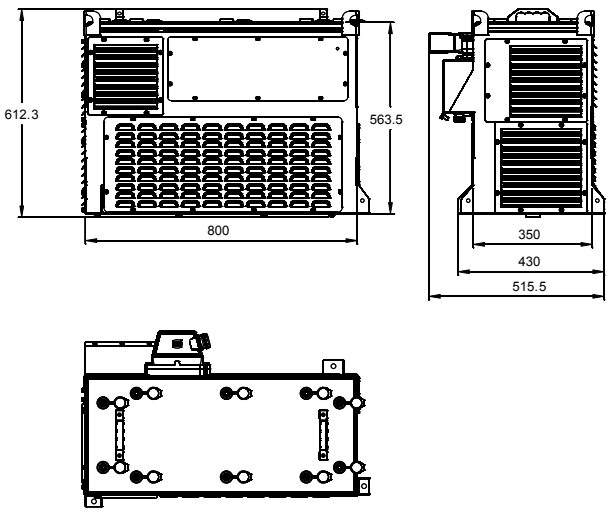


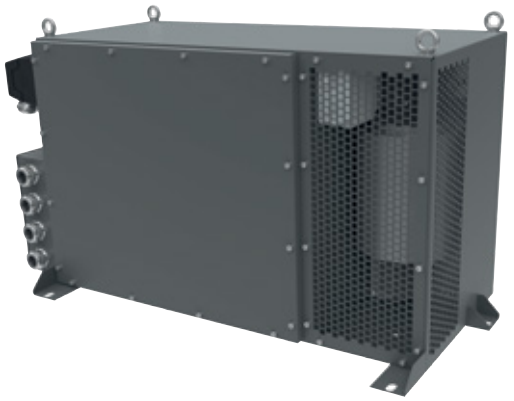
Specification	
Input parameters	
Input voltage	**600/750 VDC**
Overvoltage protection	**OV3 class**
Operating temperature	**–40 ÷ +45°C**
Output power	**60 kW continuous** **160 kW/20 s**
General efficiency	**≥ 92%**
Protection class	**IP55**
Weight	**ca. 146 kg**
Dimensions	**800 × 612 × 430 mm**
Output parameters	
Rated voltage	**355 VDC**
Output current	**150 A**
Output power	**60 kW**
Current overload	**400 A 20 s**
Short circuit protection	**yes**
Battery charging methods	**CC-CV**

HOUSING



UOE-01

Supercapacitor Energy Recovery Unit



Supercapacitor Energy Recovery Unit UOE-01 is a sophisticated device that enables you to use your energy in the most efficient way. The idea behind the device assumes rapid energy storage through braking energy recovery of a light rail or metro train that is in motion. UOE-01 can be installed on a vehicle or in a substation and its main benefit is the reduction of grid power consumption. This is followed by energy reuse for acceleration and bridging of non-powered sections. Application of the UOE-01 allows for exploitation of larger or heavier trains with the possibility of more trains simultaneously running in the same network.

The UEO-01 is based on supercapacitors as the main energy storage unit. Heavy transportation vehicles have special demand for energy storage devices. These are first of all robustness and reliability, long lifetime and low maintenance requirements. Such energy recovery devices must be able to efficiently deliver high peak currents in difficult conditions. The operational duty cycle is high and the level of frequent discharges is deep. Additionally, the device should be easy to integrate with the construction of the vehicle.

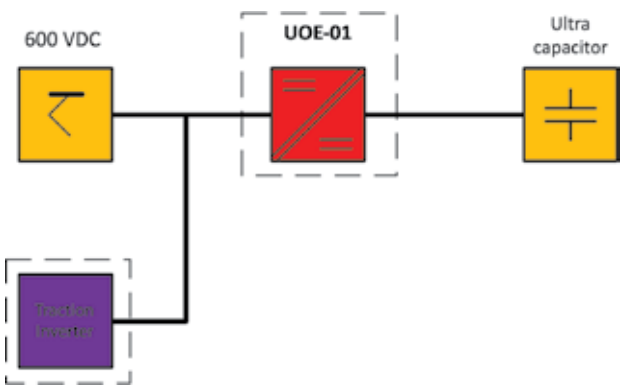
Its main advantage in the case of trams and trains is that their primary energy demand can be reduced largely, which is reflected in longer or higher performance of the vehicles on an existing track. Moreover, energy recovery unit can be also used to cope with peak power demands.

The technical solution is based on a DC-DC converter and a bank of supercapacitors. To make the design as simple as possible, which is reflected in higher reliability, the DC-DC constant current regulator is the most straightforward form of active charging. Such a DC-DC converter may come in two forms, either as a boost or buck regulator, depending on application. Because the load on track varies quickly supercapacitors, which can be charged and discharged fast and most importantly at the same rates as opposed to classic battery, are a perfect choice. This is very useful in energy recovery systems applied in electrodynamic braking.

Main advantages of supercapacitors as energy storage devices are:
- high efficiency,
- high current capability,
- wide temperature range – unlike traditional batteries whose capacity varies with temperature,
- wide voltage range – possible operation in series,
- condition monitoring – state of charge and health,
- ease of maintenance – practically maintenance free.

Specification	
Control method	**PWM controlled chopper converter**
Nominal traction supply voltage	**600 VDC**
Traction supply voltage tolerance	**+25 ÷ –25%**
UCM supercapacitors nominal voltage	**3×125 = 375 VDC**
Supercapacitors supply voltage tolerance	**+4 ÷ –50%**
Auxiliary supply voltage 1	**24 VDC**
Auxiliary supply voltage 1 tolerance	**+25 ÷ –30%**
Auxiliary supply voltage 2	**230 VAC 50 Hz**
Auxiliary supply voltage 2 tolerance	**+10 ÷ –10%**
Driving with the supercapacitors battery	
Discharging the supercapacitors battery	
Regeneration to the supercapacitors battery	
Nominal power	**100 kW**
Cooling	**forced-air**
Protection degree	**IP65**
Weight	**130 kg**
Dimensions	**800 × 350 × 480 mm**

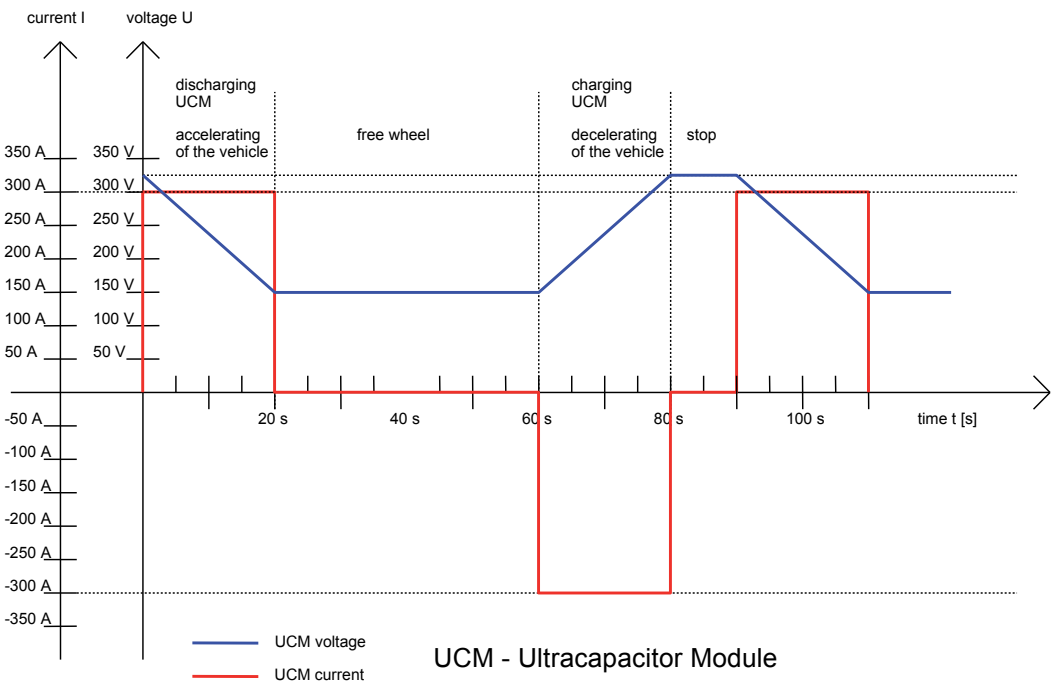
BLOCK DIAGRAM



UOE-01

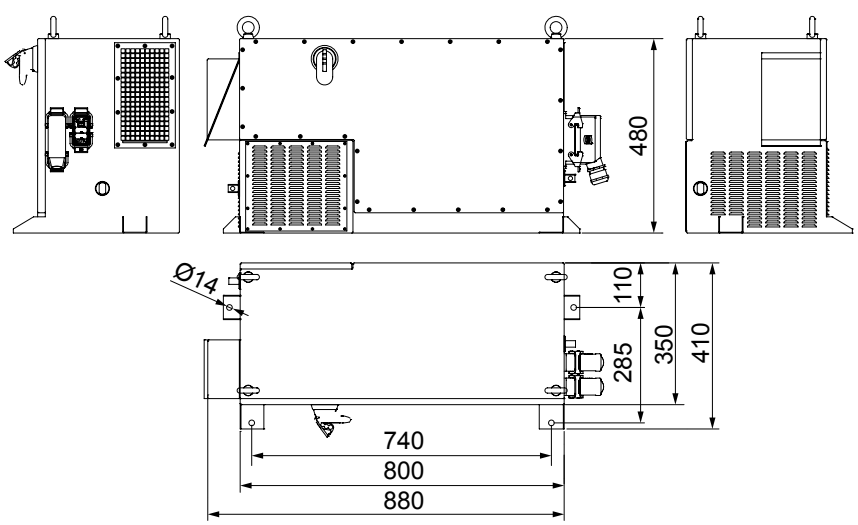
Supercapacitor Energy Recovery Unit

CURRENT AND VOLTAGE COURSES AT THE SUPERCAPACITOR SYSTEM



UCM - Ultracapacitor Module

HOUSING



UOE-02

Supercapacitor Energy Recovery Unit

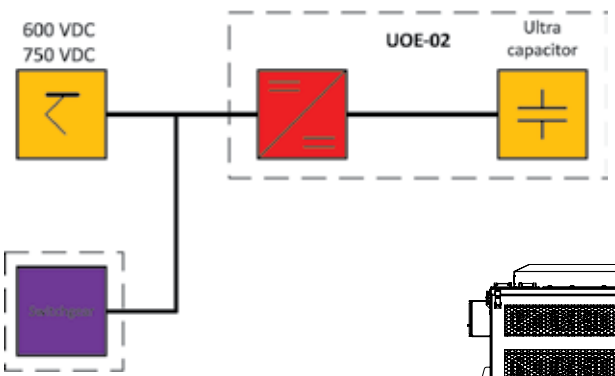
Energy recovery system UOE-02 with banks of supercapacitors are used to recovery LRV braking energy and storage them in supercapacitors. Storage energy is used to supply auxiliary circuit on LRV during stand or it is consumed by propulsion inverter during start-up of LRV. When emergency driving is required, energy stored in supercapacitors can be also consumed by propulsion system (eg. in case of no catenary voltage appearance).

UOE-02 is equipped with a CAN communication interface. Energy regeneration system communicates with the propulsion inverter and, on the base of the data received about torque and vehicle speed, starts charging or discharging supercapacitors. Information about the operating mode, alarms and measured parameters in energy recovery system are transmitted to the driver's control panel.

System is mounted on the roof of vehicle. System and super capacitors are forcing air-cooled. Energy recovery system is designed to operate in ambient temperatures of –40°C to +50°C.

Specification	
Type	**UOE-02**
Nominal catenary voltage	**600 VDC (750 VDC)**
Maximum catenary voltage	**850 VDC (1000 VDC)**
Catenary voltage tolerance	**+25 ÷ –25%**
Average power	**100 kW**
Maximum power	**360 kW**
Auxiliary voltage 1	**24 VDC**
Tolerance of auxiliary voltage 1	**+25 ÷ –30%**
Auxiliary voltage 2	**3×400 VAC, 50 Hz**
Stored energy	**1 kWh**
Nominal capacity of super capacitor bank	**20–60 F**
Weight	**640 kg**
Dimensions	**2054 × 1503 × 564 mm**

BLOCK DIAGRAM



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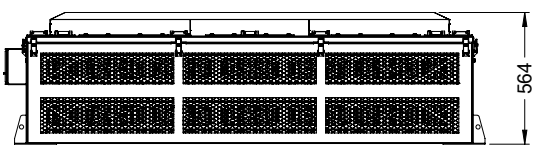
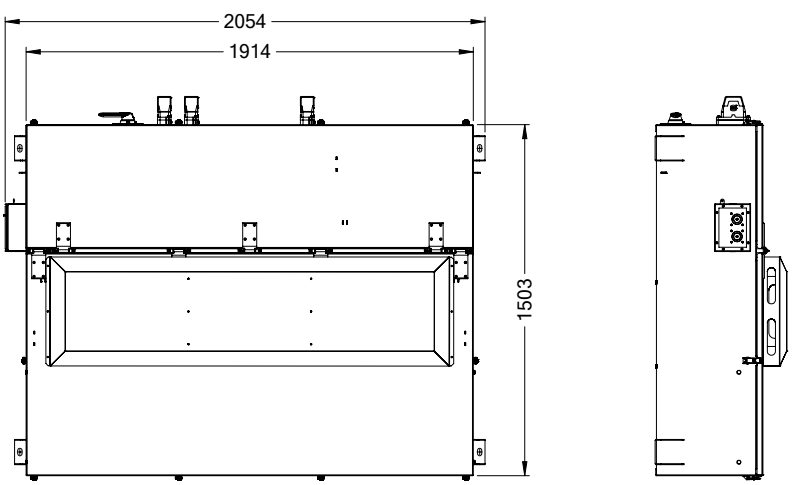




OESS-100S

Onboard Battery Energy Storage System

MEDCOM OESS-100S for the application in LRVs has been designed with the application of state-of-the-art modern solutions provided by the world's technology: IGBT modules, Digital Signal Processors, modern magnetic materials, resin stabilization and others. Its modern technological and circuitry solution provides excellent output parameters.

The MEDCOM OESS-100S is powered from the DC line (750 VDC). Using power conversion technology and modern PWM algorithms, the LTO battery is charging and discharging depending on the state of the operation.

MEDCOM OESS-100S for the application in LRVs has been designed with the application of state-of-the-art modern solutions provided by the world's technology: IGBT modules, Digital Signal Processors, modern magnetic materials, resin stabilization and others. The modern technological and circuitry solution provides excellent output parameters.

Basic features of the MEDCOM OESS-100S:
The controls of the converter are performed in DSP (Digital Signal Processor) technology.
The applied bus-bar system in combination with a perfect IGBT driver guarantees a failure free performance upon short-circuits and eliminates the possibility of secondary damages in case of transistor failure.
The converters meet the international and EN standards in safety and electromagnetic compatibility.
The system provides a very low level of interferencess emitted to the traction network and loads.
The converters are equipped with a liquid cooling system which operates within a wide range of external temperatures.
The diagnostics and control of the converters are provided via a defined interface.

The system input is equipped with a manual CD1 disconnector that disconnects the OESS-100S system from the power supply (insulation break). Behind the switch, the common input signal is divided into two redundant DC/DC systems. Each system is protected by fuses and is equipped with a pre-charging system to prevent any inrush current. The pre-charge system is monitored and controlled by the DSP (control unit). Behind the pre-charge system LC filters are provided, independent for each system.

The bidirectional DC/DC converter was built on IGBT technology. Two branches of choppers are charged and discharged according to the operating mode. Each battery works with one DC/DC converter. The DSP communicates with the BMS, which protects the battery from damage in case of for example a high battery temperature.

Both converters communicate with each other and implement a digital algorithm for balancing the battery currents. This ensures even battery charging.

Two cooling units assigned to each converter are responsible for cooling of the system.

A microprocessor control block ensures proper operation of the converter in a wide range of supply voltage used in the traction grid. The control of the converter is performed in DSP (Digital Signal Processor) technology.

The converter meets the international and EN standards in safety and electromagnetic compatibility. The system provides a very low level of interferencess emitted to the traction network and loads.
MEDCOM OESS-100S is supplied from the DC line (750 VDC). Using power conversion technology and modern PWM algorithms, the LTO battery is charging and discharging depending on the state of the operation.

The OESS system is designed to charge a battery and to use the energy stored in a battery for autonomous driving (with a lowered pantograph).

Depending on the permissible load of the catenary, the system adjusts the charging parameters of the battery so that it does not exceed the permissible power input of the vehicle.

The converter works with BMS and adjusts the charging / discharging parameters for information sent from the BMS. This is to protect the battery from damage.

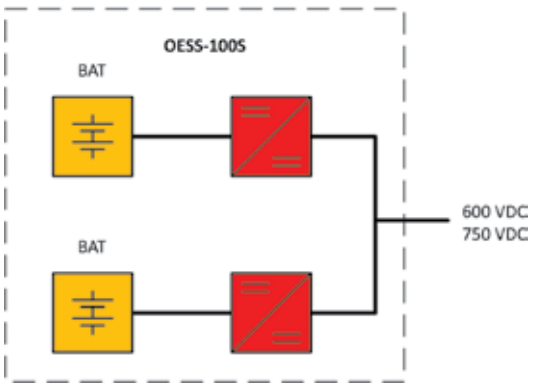
The converter is protected from the input side by a fuse and has electronic overload protection. The batteries too are protected by fuses.
For maintenance work, the energy storage system can be disconnected using a service disconnect switch. This ensures the isolation of both battery poles from the remaining electrical circuits of the vehicle.
The battery charger maintenance is optimized, and automatic control systems monitor the states of the outputs and protect them against overloads or short circuits. Every fault state is detected and followed by an appropriate alarm signal sent through the gateway to the MVB network.

Redundancy concept
The OESS include two completely independent subsystems, each capable of supplying power / charging at half of the rate of the entire OESS. A single point failure never leads to a 100% failure but only to a 50% power / capacity reduction. This also includes single point failures of the control electronics, sensors, and cooling / chiller components. A single point failure in the cooling system does not lead to a failure of both the independent OESS subsystems.

OESS-100S

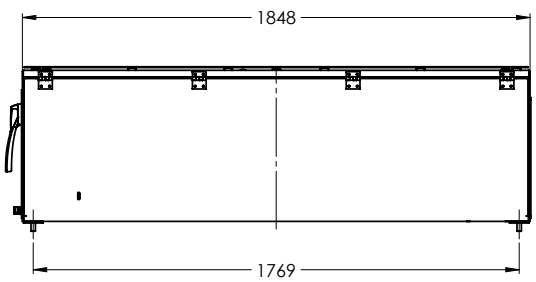
Onboard Battery Energy Storage System

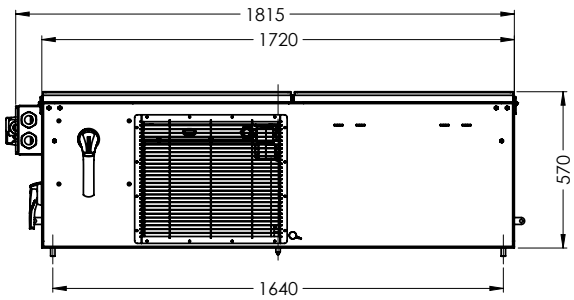
BLOCK DIAGRAM

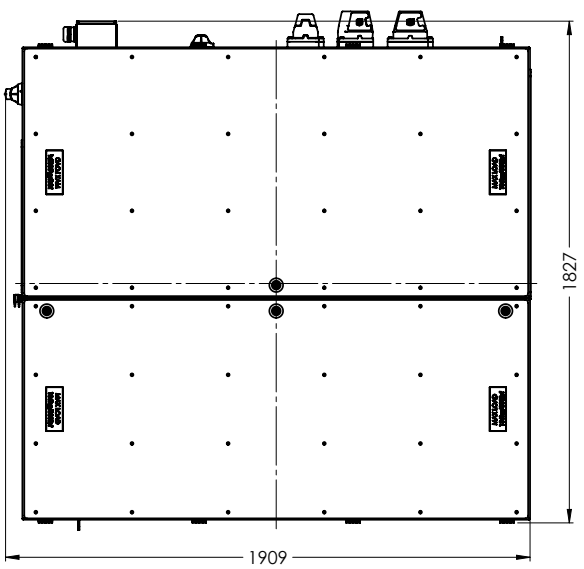


OESS-100S		
Input / Output voltage	**600/750 VDC**	
Rated power	**2 × 100 kW**	
Battery type	**LTO**	
Housing		
Cooling	**Forced-liquid**	
Weight	**1560 kg**	
Dimensions	**1848 × 1720 × 570 mm**	
Protection degree	**Clean section**	**IP55**
	Dirty section	**IP21**

HOUSING

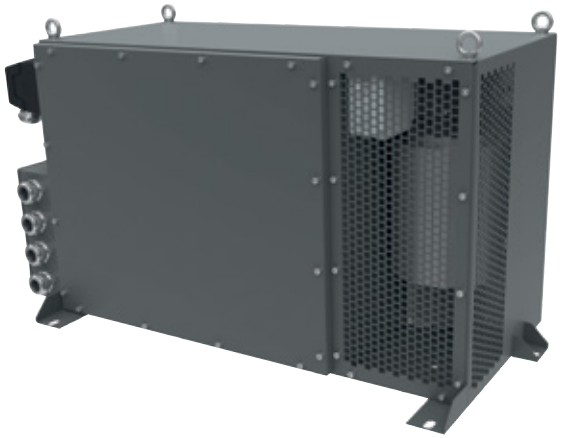






ZBBT200-DC40-AU250

Battery Power Supply for Propulsion Drives



The battery power supply for propulsion drives ZBBT200-DC40--AU250 is used for:

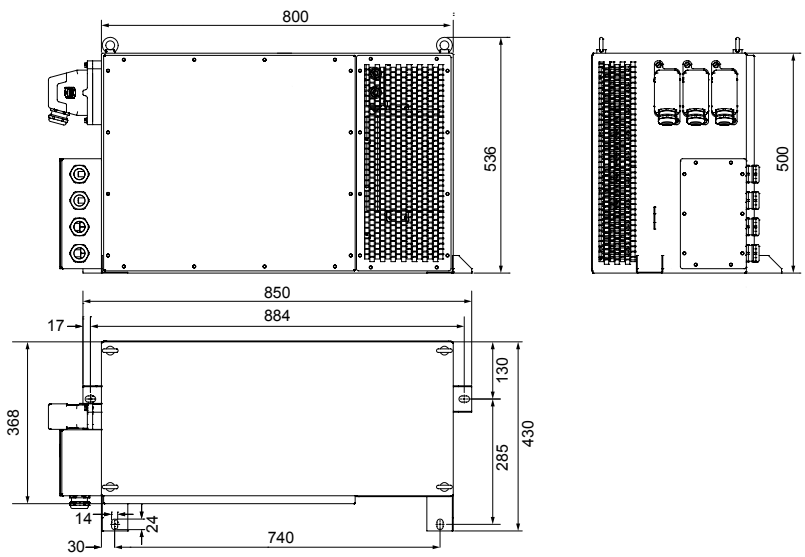
- powering traction and auxiliary converters from the battery; if no grid power is available on current collectors,
- charging the traction battery from the catenary including the re-generated energy,
- charging the traction battery from the 3×400 V 50 Hz platform grid isolated from power supply by a separating transformer.

The advantage of the solution is that the trolleybus can drive even if no supply voltage is available or if it has to pass a section of the route with no grid, e.g. a historical district of a town.
During its normal operation the ZBBT200-DC40-AU250 power supply charges the trolleybus traction battery by converting the supply power in a suitable manner. The ZBBT200-DC40-AU250 power converter is controlled via a microprocessor controller, which monitors the supply voltage and the battery's charging current, protecting it against damage. During the stop time at the depot the traction battery may be charged with 3×400 VAC supply voltage from external grid. The pantograph must be lowered when the battery is being charged from a 3×400 VAC source. If there is no supply voltage in the traction grid, the propulsion inverter is powered by the ZBBT200-DC40-AU250 power supply with traction battery voltage. This allows the vehicle to return to the depot in emergency mode (with the battery discharged in various profiles).

Battery charging regeneration boost method	
Battery current	**40 A**
Maximum instantaneous current	**300 A**
Nominal power	**50 kW**
Cooling	**forced-air**
Weight	**130 kg**
Dimensions	**800 × 430 × 500 mm**

Specification	
Control	**Resonant two quadrant converter**
Nominal traction supply voltage	**600 VDC (+30 ÷ –30%)**
Nominal battery supply voltage	**200 VDC (+40 ÷ –30%)**
Auxiliary supply voltage 1	**24 VDC (+25 ÷ –30%)**
Auxiliary supply voltage 2	**230 VAC 50 Hz (+10 ÷ –10%)**
Basic/forming battery charging	IUI charging with direct current, switching off after certain voltage is reached and time controlled switching off
Basic battery float charging	
Battery current Current from the traction	**16 A** **7 A**
Basic battery boost charging	
Battery current Current from the traction	**40 A** **18 A**
Nominal voltage of switching threshold of battery charging current	**255 VDC for T = 20°C**
Driving on battery	

HOUSING



EBC-60M

Battery Chargers for eBuses

Mobile devices with power up to 60 kW. Easy operation and compact size. Mobile equipment, fitted with wheels. Charging performed via CCS Type 2 or CHAdeMO interfaces. The device has a communication interface for remote dispatcher monitoring.
The devices are equipped with:

- LED signals informing about the charger status
- OLED operator panel
- transportation wheels
- Emergency button
- Visual error information
- State of charge information
- Key switch for operation authorization
- Possibility of limiting the output power.

Specification of the mobile EBC chargers	
Charging type	**DC**
Rated power	**30-60 kW**
Maximum charging current	**60-120 A**
Charging rated voltage	**200-800 VDC**
Efficiency	**≥96%**
THDi	**≤5%**
Active power factor cos (Φ)	**≥0.99**
Operating temperature	**-30°C ÷ +45°C**
Interface type	**CCS type 2, CHAdeMO**
Protection degree	**IP54**

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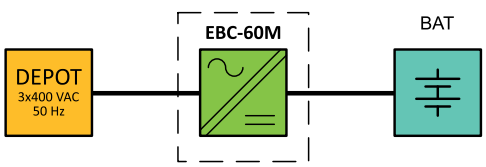
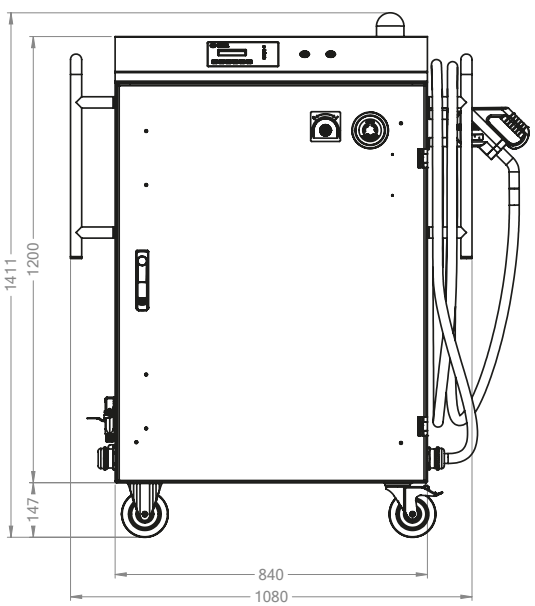


HOUSING



NEW

EBC-120S-2 SiC

Battery Chargers for eBuses

Stationary double output charger used to charge one or two electric vehicles at the same time. Wireless communication via Wi-Fi, LTE possible. The possibility of monitoring via mobile applications with the option of saving data in the cloud, reporting, data archiving, using the OCPP or MODBUS TCP protocol. Available in a version with transportation wheels (mobile execution).
The devices are equipped with:

- LED signals informing about the charger status
- OLED operator panel
- Emergency button
- Operation authorization key switch
- Visual error signaling
- Battery charge status signaling
- Operation authorization key switch
- Possibility of limiting the output power

OCPP communication interface available as an option.

Specification of the stationary EBC chargers	
Input voltage	**3x400 VAC ±10% / 50 Hz**
Active power factor cosΦ	**≥ 0.99**
THDI	**≤ 5%**
Charging rated voltage	**200-800 VDC**
Maximum output power	**60-120 kW**
Maximum charging current	**120-240 A**
Efficiency	**≥ 96%**
Connector	**CCS type 2, CHAdeMO**
Ambient temperature	**-30°C ÷ +45°C**
Housing	
Dimensions	**1500 x 780 x 1325 mm**
Weight	**477 kg**
Coolings	**Internal air forced**
Protection degree	**IP54**

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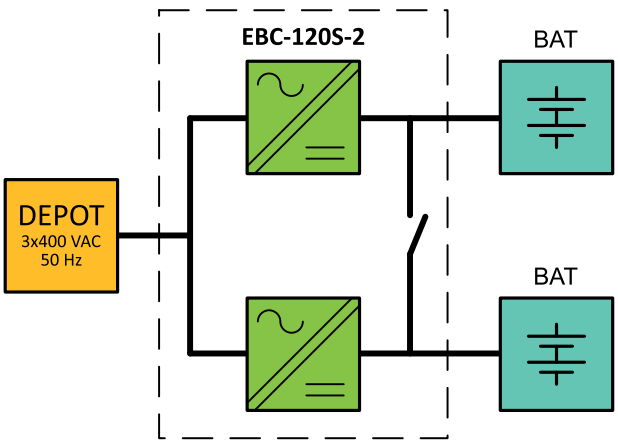

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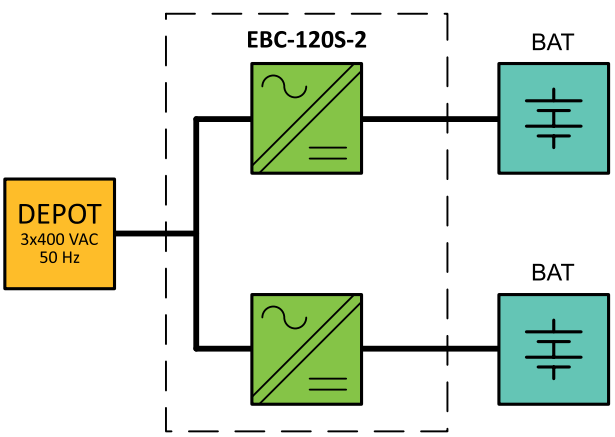
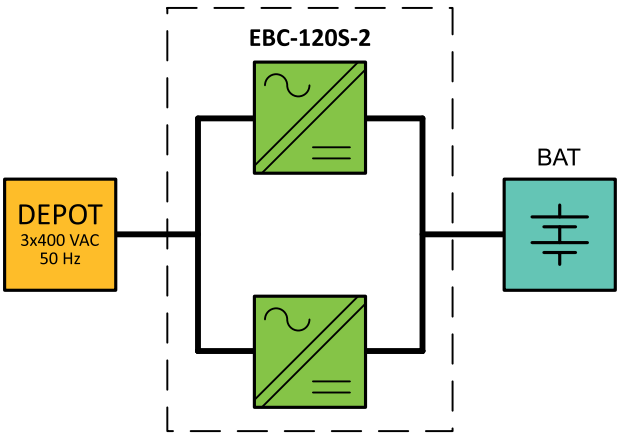


EBC-120S-2 SiC

Battery Chargers for eBuses

BLOCK DIAGRAM CONFIGURATION 3



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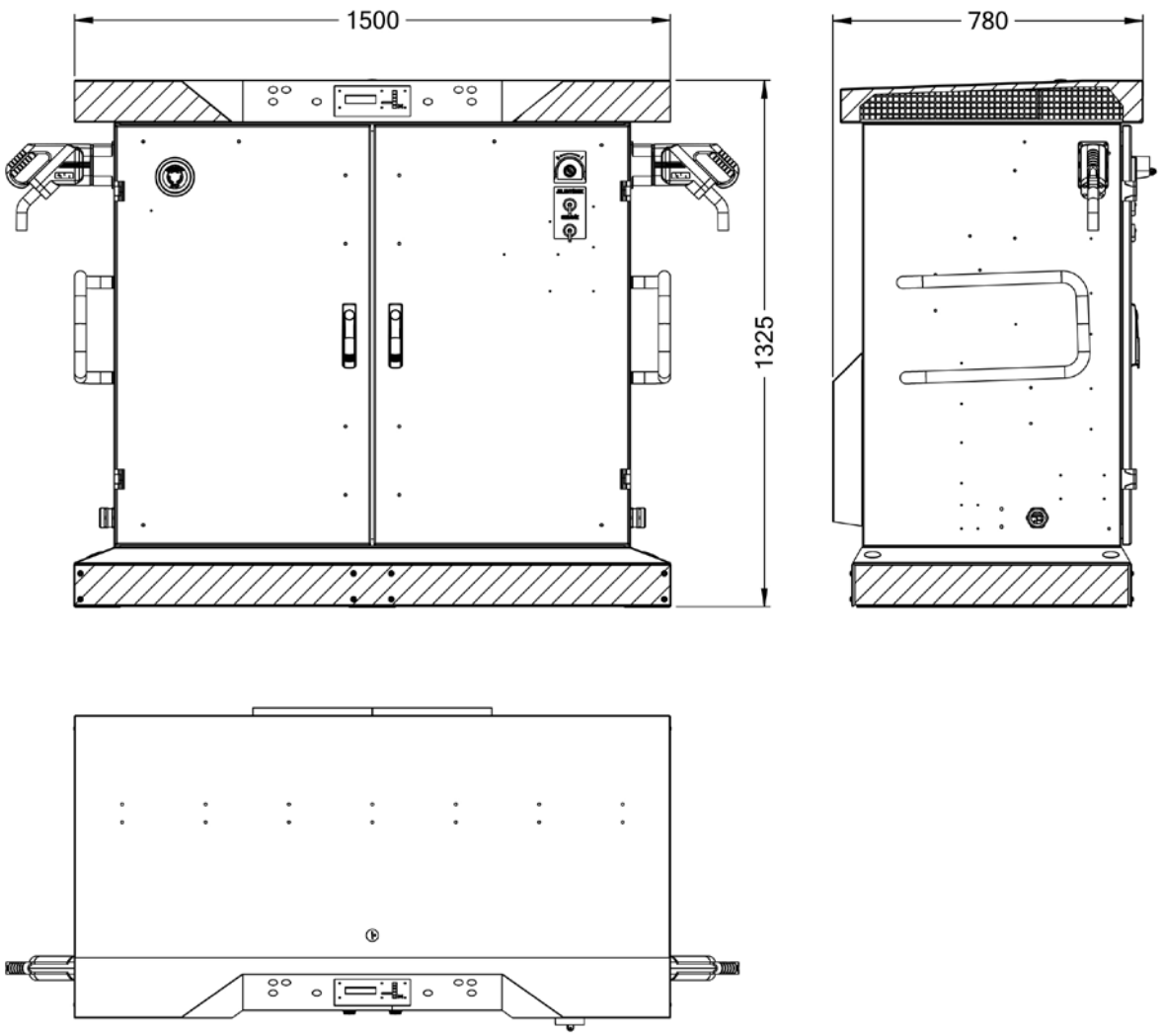


NEW

EBC-B-150S SiC V2G

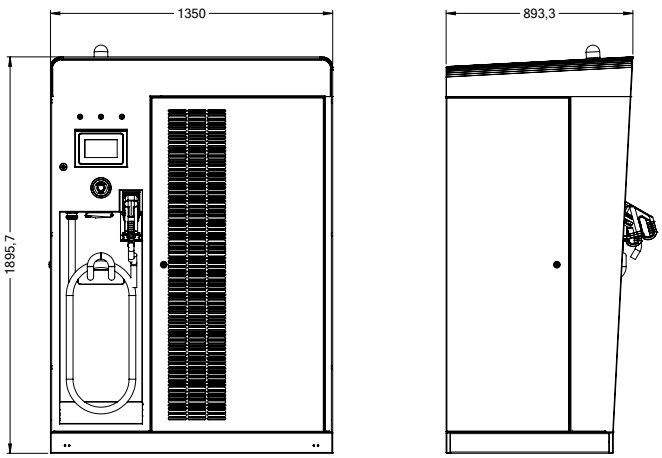
Battery Chargers for eBuses

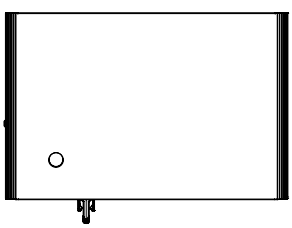
The EBC-B-150S charger is a bidirectional device. In charging operation mode, the device converts the AC supply voltage into DC voltage for charging the traction batteries located on the electric vehicle. The charger cabinet is supplied with 3 x 400 VAC and converts AC voltage to DC voltage in the range of 200 ÷ 800 VDC. The unit also allows the return of power to the grid when the energy storage (traction batteries) is discharged. Charging or discharging is performed via CCS Type 2 interface. The user has the option of setting limit values for charging and discharging modes. The device has a communication interface for remote supervision by the dispatcher.
The device is equipped with:

- LED indicators informing about the charger status
- Main operator panel
- Emergency button
- Key switch enabling the operation
- Visual error signaling
- Battery charge status signaling.

Specification	
Input voltage	**3x400 VAC ±10% / 50 Hz**
Active power factor cosΦ	**≥ 0.99**
THDi	**≤ 5%**
Output voltage	**200-800 VDC**
Maximum output power	**150 kW**
Maximum charging current	**250 A**
Efficiency	**≥ 96%**
Connector	**CCS type 2, CHAdeMO**
Ambient temperature	**-30°C ÷ +40°C**
Housing	
Dimensions	**1350 x 1895 x 894 mm**
Weight	**735 kg**
Cooling	**Internal air forced**
Protection degree	**IP54**

HOUSING





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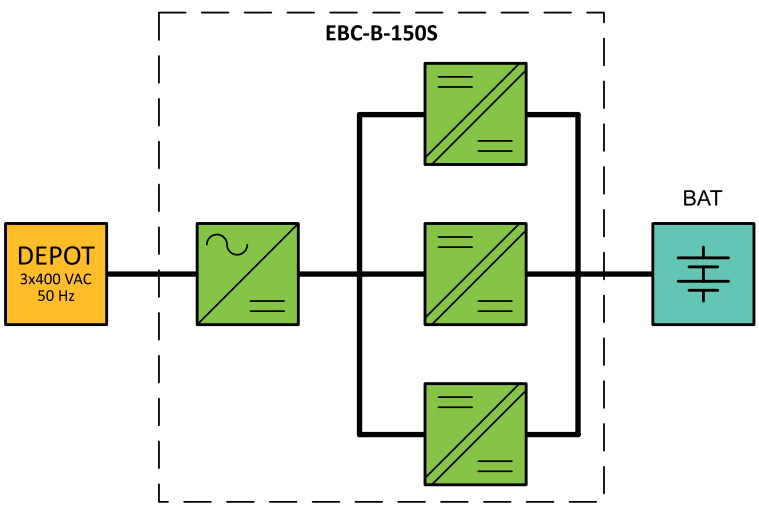
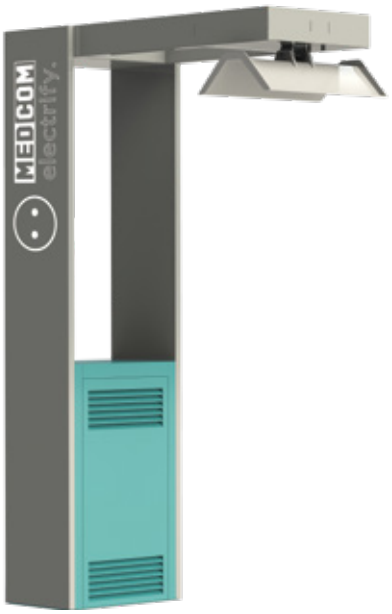


EBC-180P

Battery Chargers for eBuses



PANTOGRAPH CHARGERS

Fast, modular chargers with a pantograph connector (inverted pantograph or pantograph contact unit). Completely customised design, the dimensions have not been standardized. Offer includes integrated version of the charger and separately charger with distribution pole. The station is designed to charge electric vehicles via the panto-graph connector with output power from 150 to 950 kW. It may be also equipped with an emergency plug-in connector, up to 250 A. The wireless communication is available via Wi-Fi and LTE. Chargers of this type offer the monitoring function performed via mobile appli-cations with data saving in the cloud, reporting features and data archiving using OCPP and MODBUS TCP.

The devices are equipped with:

- Light signalling of the power supply
- Signalling the battery charge status
- Communication interface for remote supervision by the dispatcher
- Signalling the battery charge status is installed on the vehicle.

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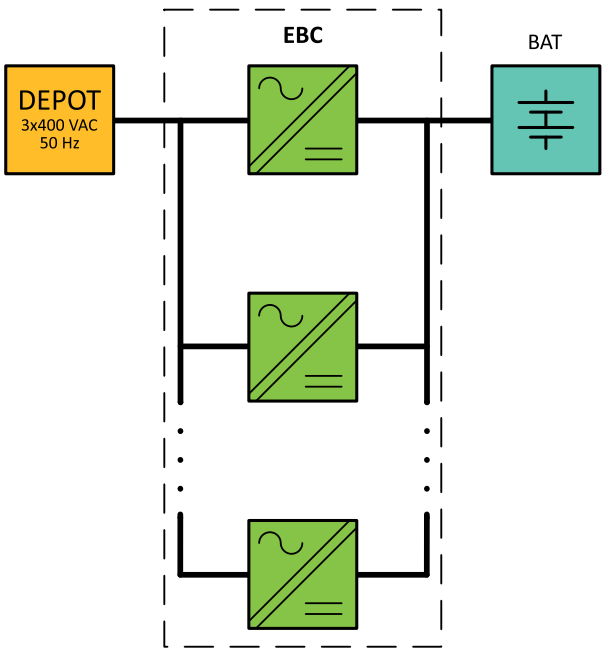
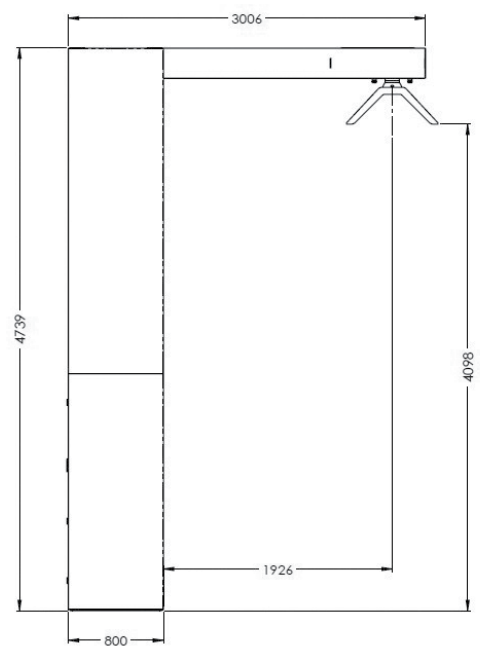


Fast charging station with a pantograph interface	
Catalog designation	**EBC**
Charging type	**DC**
Station rated power	**150-420 kW**
Maximum charging current	**300-840 A**
Charging rated voltage	**200-800 VDC**
Efficiency	**≥95%**
THDi	**≤5%**
Active power factor cos (Φ)	**≥0.99**
Operating temperature	**-30°C to +45°C**
Interface type	**pantograph interface, emergency plug-in interface as an option**
Protection degree	**IP 54**

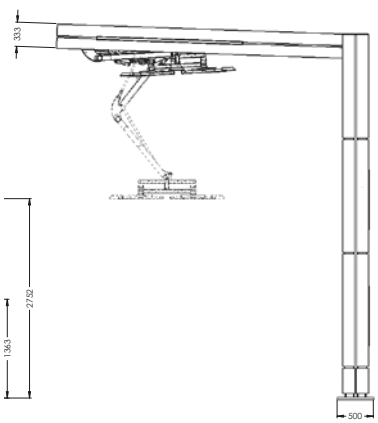
HOUSING

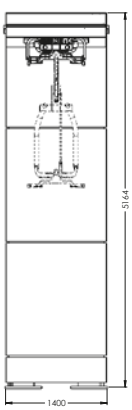


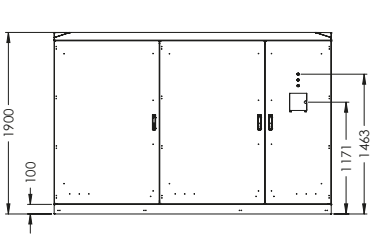
EBC-250SP

Battery Chargers for eBuses

HOUSING







Fast charging station with a pantograph interface	
Catalog designation	**EBC**
Charging type	**DC**
Station rated power	**150-900 kW**
Maximum charging current	**300-1200 A**
Charging rated voltage	**200-800 VDC**
Efficiency	**≥95%**
THDi	**≤5%**
Active power factor cos (Φ)	**≥0.99**
Operating temperature	**-30°C to +45°C**
Interface type	**pantograph interface, emergency plug-in interface as an option**
Protection degree	**IP 54**

SERIES OF CHARGERS (eBus)

Type		Maximum battery charging current	Maximum charging power
MOBILE CHARGERS	EBC-30M	**60 A**	**30 kW**
	EBC-40M	**80 A**	**40 kW**
	EBC-50M	**100 A**	**50 kW**
	EBC-60M	**120 A**	**60 kW**
	EBC-80M	**160 A**	**80 kW**
	EBC-100M	**200 A**	**100 kW**
	EBC-120M	**240 A**	**120 kW**
STATIONARY CHARGERS	EBC-30S	**60 A**	**30 kW**
	EBC-40S	**80 A**	**40 kW**
	EBC-50S	**100 A**	**50 kW**
	EBC-60S	**120 A**	**60 kW**
	EBC-80S	**160 A**	**80 kW**
	EBC-100S	**200 A**	**100 kW**
	EBC-120S	**240 A**	**120 kW**
PANTOGRAPH CHARGERS	EBC-150	**300 A**	**150 kW**
	EBC-180	**360 A**	**180 kW**
	EBC-200	**400 A**	**200 kW**
	EBC-240	**480 A**	**240 kW**
	EBC-300	**600 A**	**300 kW**
	EBC-350	**700 A**	**350 kW**
	EBC-360	**720 A**	**360 kW**
	EBC-420	**840 A**	**420 kW**
	EBC-450	**900 A**	**450 kW**
	EBC-480	**960 A**	**480 kW**
	EBC-500	**1000 A**	**500 kW**
	EBC-540	**1080 A**	**540 kW**
	EBC-600	**1200 A**	**600 kW**
	EBC-650	**1200 A**	**650 kW**

NEW

EBC-450SP-10

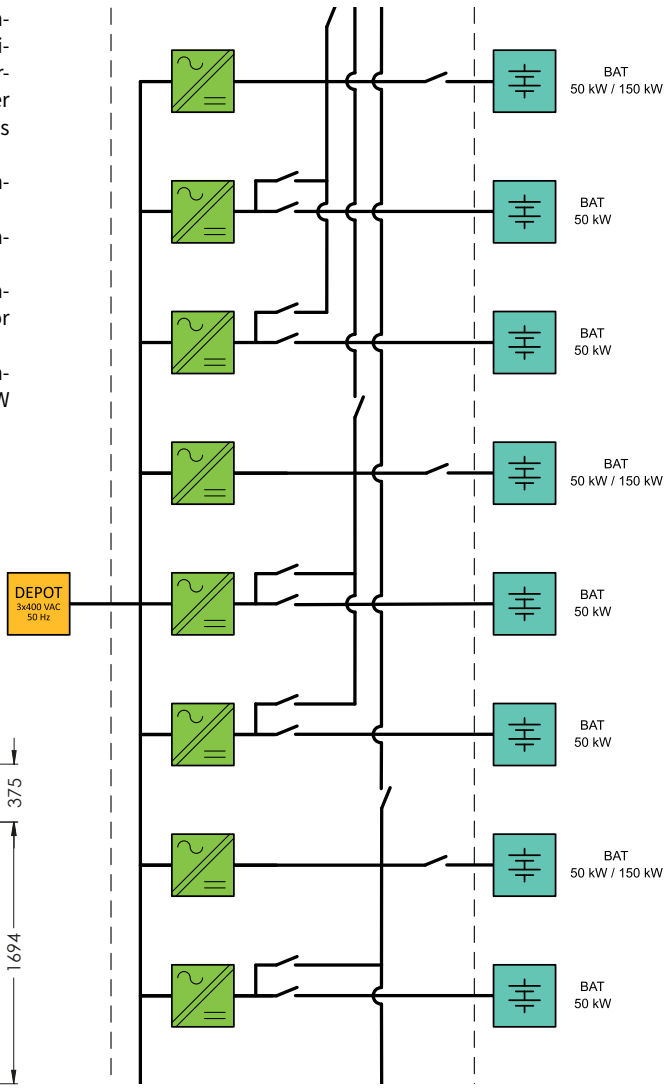
EBC-450SP-10										
Output number	**CH1**	**CH2**	**CH3**	**CH4**	**CH5**	**CH6**	**CH7**	**CH8**	**CH9**	**CH10**
Output voltage range	**200-800 VDC**									
Maximum charging current	**450 kW**	**150 kW / 50 kW**	**50 kW**	**50 kW**	**150 kW / 50 kW**	**50 kW**	**50 kW**	**150 kW / 50 kW**	**50 kW**	**50 kW**
Maximum charging current	**900 A**	**300 A / 100 A**	**100 A**	**100 A**	**300 A / 100 A**	**100 A**	**100 A**	**300 / 100 A**	**100 A**	**100 A**
Efficiency	**≥ 95%**									
THDi	**≤ 5%**									
Active power factor cos (Φ)	**≥ 0,99**									
Operating temperature	**from -30°C to +40°C**									
Connector type	**inverted pantograph / docking station**	**docking station / CCS Type 2**								
Degree of protection of the enclosure (IP code)	**IP 54**									

EBC-450SP-10

Examplary high power charger from special implementation at Oslo depot - 139 charging points, including chargers with reversed pantographs, docking stations and CCS Type 2 connectors. Power configuration according to design requirements, different for each charging zone. Local and remote (via OCPP system) switching of power configuration. Ability to charge buses traveling in both directions from a single charging point.
Sixteen units of 300-450 kW chargers have been produced, examples :

- EBC-450SP-9, a 450 kW charger with nine outputs - docking stations, power configuration of 1 x 450 kW or 9 x 50 kW
- EBC-450SP-10, 450 kW charger with ten outputs -docking sta-tions, plug-in, power configuration 1 x 450 or 3 x 150 kW or 9 x 50 kW
- EBC-300SP-7, 300 kW charger with seven outputs - reverse pantograph, plug-in, power configuration 1 x 300 kW or 2 x 150 kW or 6 x 50 kW.

BLOCK DIAGRAM



HOUSING