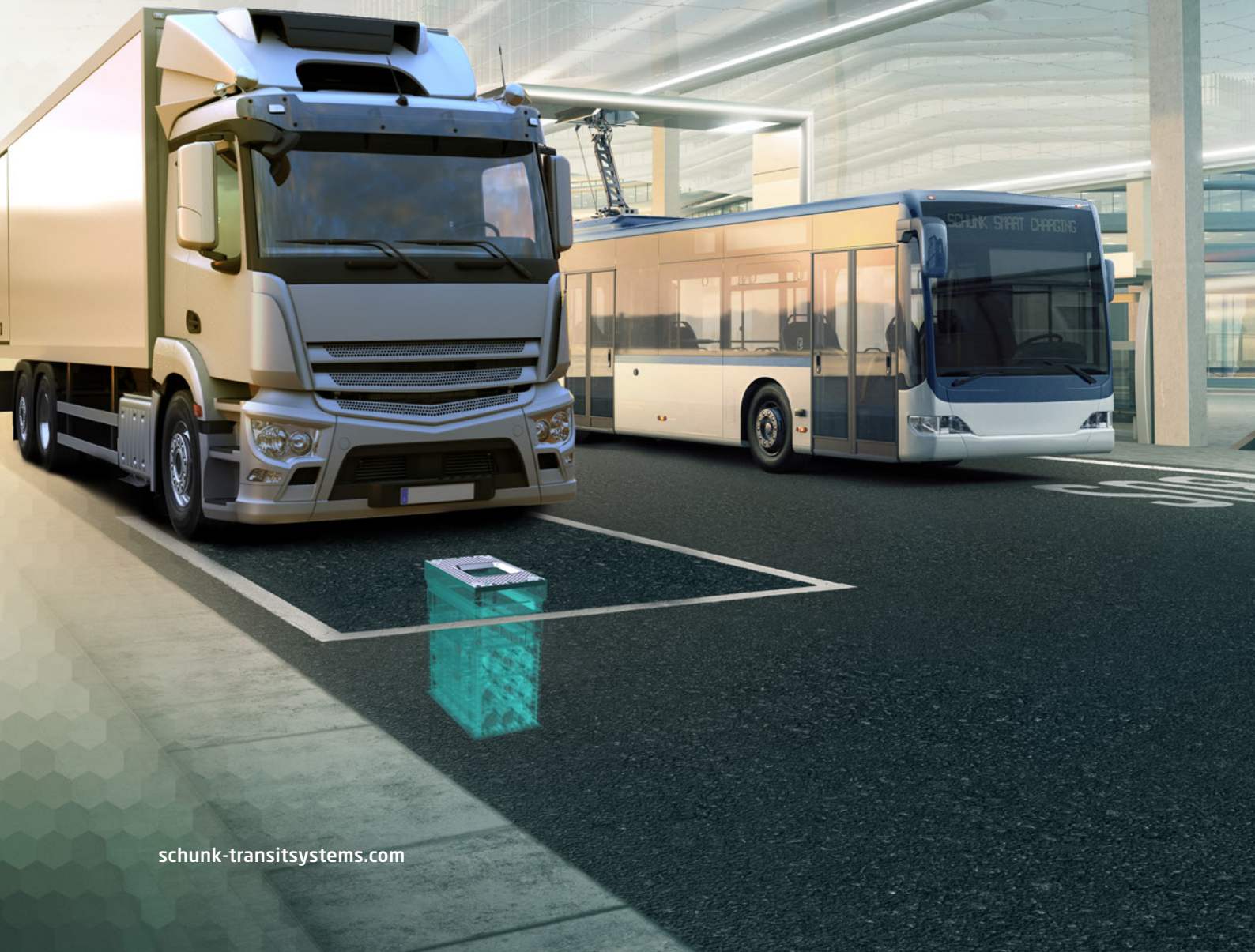




Transit Systems

SCHUNK SMART CHARGING

Pioneering charging solutions for the mobile future



THE POWER OF CONNECTION

MOBILITY IS COMING. GET IN!

Around the world, mobility is becoming more environmentally friendly, more connected, more efficient and lighter. Schunk has been there from the very beginning. As a development partner for our customers, we are paving the way to a new mobile future with innovative developments for e-mobility.

The way we get around is in a constant state of flux that has lasted for centuries. In the course of this development, there have always been decisive developments that have taken mobility to a new level: Think of the inventions of the steam engine and the internal combustion engine. Today, we are once again at such a stage: mobility is becoming electric!

Battery-powered vehicles are an important part of this new mobility and are increasingly taking over transportation tasks in the private, industrial and municipal sectors. In addition to batteries and vehicles, it is especially the charging systems and infrastructures that must be further developed to electrify our mobility.

Schunk supports you in taking the decisive step toward e-mobility. Because with Schunk Smart Charging, we offer you technologically leading, mature and field-tested charging systems for buses and trucks that bring the advantages of hybrid and fully electric vehicles to the road: Greater sustainability, less environmental and noise impact, and greater efficiency and economy.

In collaboration with our customers, we are driving forward the development of e-mobility and opening up new, emission-free drive alternatives that adapt flexibly to the respective operating parameters. For example, our charging system for e-buses and industrially used e-vehicles enables automated, reliable charging of the batteries in seconds via a roof-mounted or an inverted pantograph.

With the Underbody Charger, Schunk is presenting a prototype of the e-charging station of the future, which will allow autonomous charging of various vehicle types efficiently, safely and conveniently in just a few seconds. This is made possible by a charging station that can be retracted into the roadway and the docking module installed in the vehicle floor.

Schunk is a leading global specialist and your competent development partner for all aspects of e-mobility. Take advantage of our extensive materials know-how, our innovative and our flexibility to meet your specific requirements. Get on board the mobility of the future and let's pick up speed together.

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SCHUNK SMART CHARGING MAKES E-BUSES SUITABLE FOR EVERYDAY USE

With the innovative Schunk Smart Charging system, everything runs according to schedule when it comes to e-buses. Because our system enables reliable charging of the batteries on the route or in the depot within seconds.



More and more cities and companies are banning diesel-powered buses in favour of zero-emission, battery driven vehicles. The largest problem here are the batteries. To ensure that electric buses have sufficient range for daily use, batteries must either be large enough or be charged more frequently.

We have developed a fitting solution in the form of Schunk Smart Charging. With short charging times and the associated large operating ranges of the buses, this innovative charging system opens up entirely new possibilities in matters of efficiency, performance and flexibility. The electric buses are charged automatically, reliably and in just seconds at the depot or during operation at end stops.

This allows batteries to be sufficiently charged even while passengers are getting on and off at a stop. Even a full charge of empty batteries can be accomplished in less than

20 minutes. This allows the battery size to be significantly reduced to achieve a highly-effective relationship between battery size, passenger capacity and range.

The extremely flexible system can be custom-designed and optimally integrated into a completely new charging infrastructure installation or in connection with pre-existing solutions. The system can be implemented with a roof-mounted pantograph or an inverted pantograph - You can read about both variants and their respective advantages on the following pages.

NEXT STOP: CHARGING.

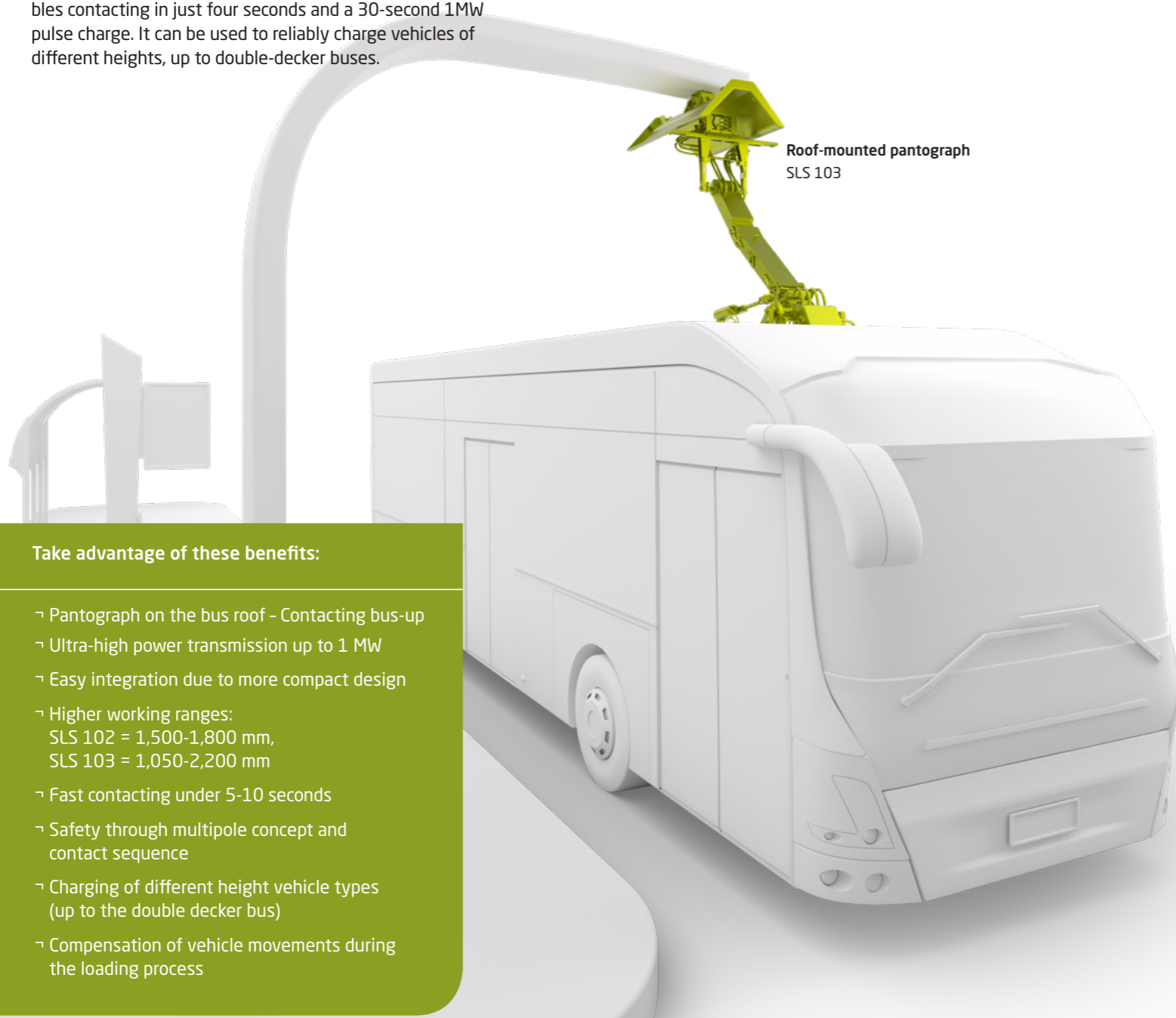
Our SLS 102 and SLS 103 roof-mounted pantographs are technological milestones which, thanks to years of unprecedented standards in the market segment for conductive, fully automatic recharging of e-buses.

The compact SLS 102 and SLS 103 roof-mounted pantographs are mounted on the roof of the e-bus and operate according to the „bus-up“ principle: the bus stops under the charging station, where the roof-mounted pantograph extends, connects to the charging station and charges the batteries.

Charging can take place both in the depot and during on going operation at a charging station within the route network - without delaying regular driving operations. This is guaranteed by the extremely fast contacting and the very high current transmission. The SLS 102, for example, enables contacting in just four seconds and a 30-second 1MW pulse charge. It can be used to reliably charge vehicles of different heights, up to double-decker buses.

The system's drive mechanisms compensate for vehicle movements during recharging as well as parking tolerances. Our SLS 102 roof-mounted pantograph is already being used reliably on a large number of buses worldwide. With Schunk at your side, the economical use of e-buses is not just a gray theory, but becomes green practice.

In addition, our roof-mounted pantographs can be individually tailored to customer requirements or existing infrastructures in terms of design and contact interfaces.



Roof-mounted pantograph SLS 103

Take advantage of these benefits:

- Pantograph on the bus roof - Contacting bus-up
- Ultra-high power transmission up to 1 MW
- Easy integration due to more compact design
- Higher working ranges:
SLS 102 = 1,500-1,800 mm,
SLS 103 = 1,050-2,200 mm
- Fast contacting under 5-10 seconds
- Safety through multipole concept and contact sequence
- Charging of different height vehicle types (up to the double decker bus)
- Compensation of vehicle movements during the loading process

WE DO WHAT YOU WANT.

When designing and implementing the charging system, your requirements and circumstances provide the framework for us. We can precisely tailor our rooftop charging pantographs to your specific power transmission and availability needs.



Contact dome

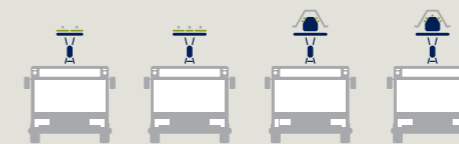


Roof-mounted pantograph SLS 103



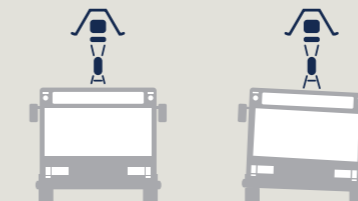
Roof-mounted pantograph SLS 102

CONTACT UNITS



Depending on the general conditions, different contact units can be used. For example, an existing infrastructure can be used - even different power grids do not pose a problem for the system.

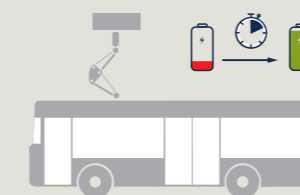
TOLERANCE COMPENSATION



With our drive mechanisms, we offer fast and efficient reloading - in any road conditions. This compensates for vehicle movements during reloading as well as parking tolerances.

- ± 500 mm in the direction of travel
- +/-250mm transverse to the direction of travel
- 4° kneeling

POWER TRANSMISSION



Whether flash, opportunity or depot charging - our system allows you to charge the batteries in a flexible, situation-optimized manner.

- 1 MW up to 30 s
- 750 kW up to 60 s
- 500 kW up to 15 min
- 150 kW duration

CHARGING TURNED ON ITS HEAD.

Whether in Seattle, Zaragoza or Los Angeles: our inverted pantographs are in use all over the world. They form the internationally proven standard for flexible, fast and safe charging of e-buses and battery-powered industrial vehicles.

Our patented contact systems can also be adapted to other vehicles and specific customer requirements.

The SLS 201 inverted pantograph is integrated in a central location on the infrastructure side, where its contacting works according to the „top-down“-principle: The vehicle parks under the inverted pantograph, which lowers, connects to the compact counterpart on the vehicle roof and charges the batteries.

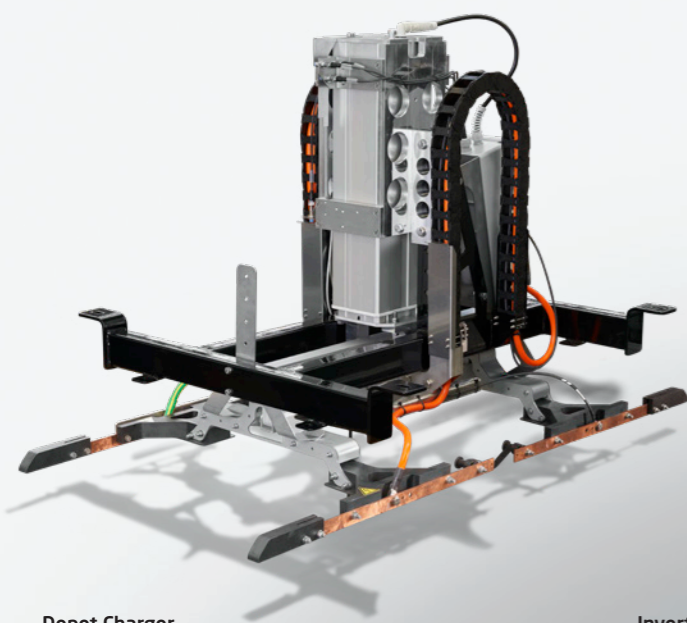
With the Depot Charger SLS301, we also offer a charging device for automated charging at the depot. The advantage: although the Depot Charger can charge at high power, similar to the inverted standard pantograph, its simple, compact and lightweight design makes it an economical solution for charging in the depot. Both pantograph systems can contact existing vehicle interfaces (High Power Charging Rails) and are therefore compatible. The systems are UL certified and Buy America compliant.

Take advantage of these benefits:

- Ultra-high power transmission up to 1 MW
- Easy integration due to more compact design
- Very large working range and an extension length of up to 2.3m
- Fast contacting under 5 seconds
- Mechanical contact sequence
- Charging of different height vehicle types (up to the double-decker bus)
- Space-saving and simple design for economical charging



High Power Charging Rails



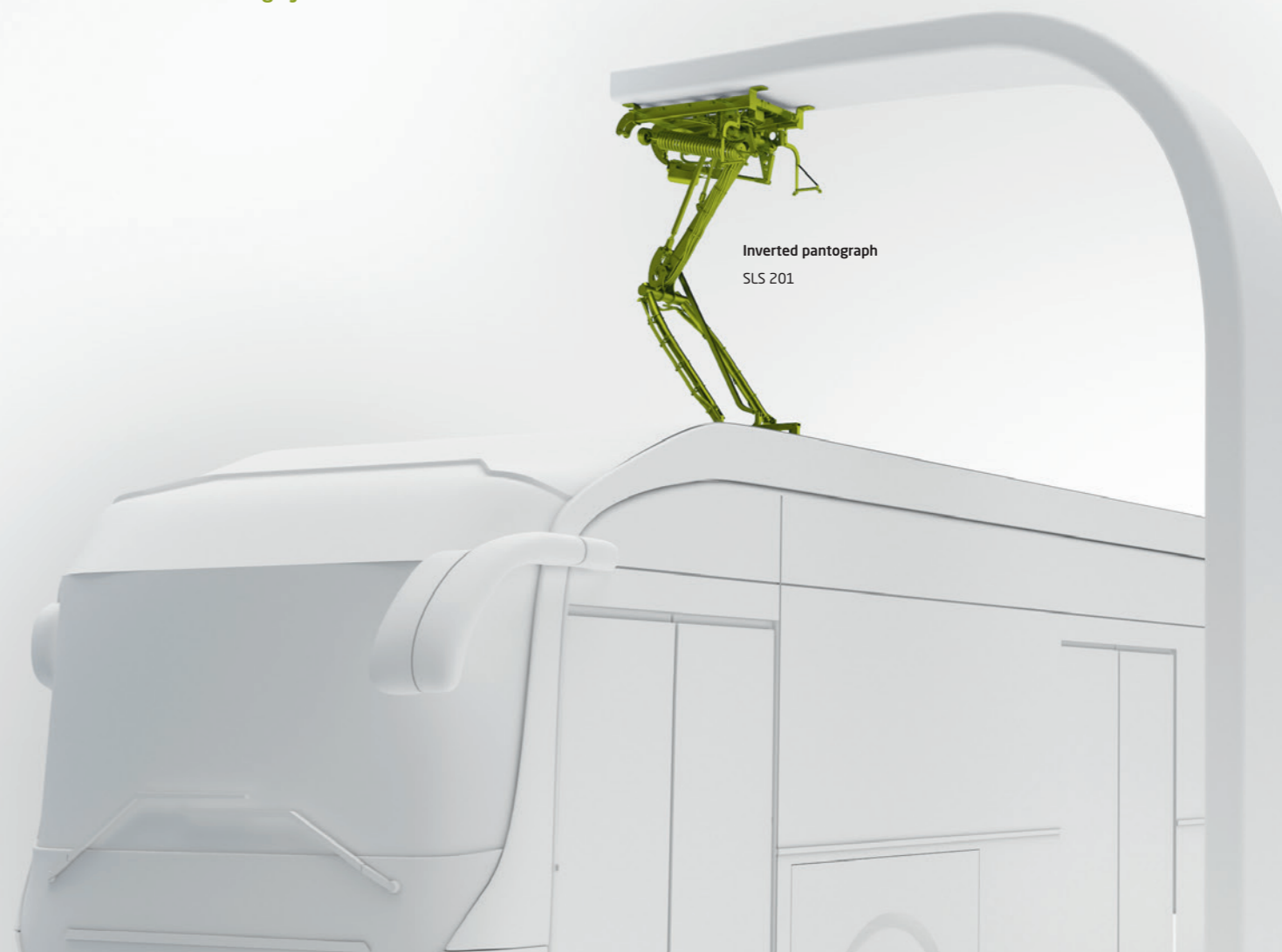
Depot Charger
SLS 301



Inverted Pantograph
SLS 201

FLEXIBLE FROM ZERO TO FULL

When developing the SLS 201 inverted pantograph, the focus was on precisely tailoring it to the requirements of our customers. It can be used to create completely new charging infrastructures as well as to embed them in existing systems.



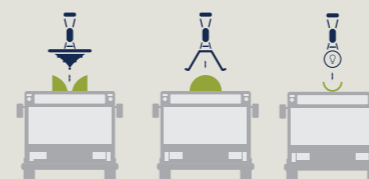
Inverted pantograph
SLS 201

WORKING AREA



The flexible half-scissors design of the inverted pantograph allows charging of different vehicles (conventional buses as well as double-decker buses) at one station or charging point.

CONTACT UNITS



The 4-pole system ensures a constant contact pressure distribution on all four busbars and reliably compensates for vehicle movements during reloading.

SUCCESSFULLY IN USE WORLDWIDE

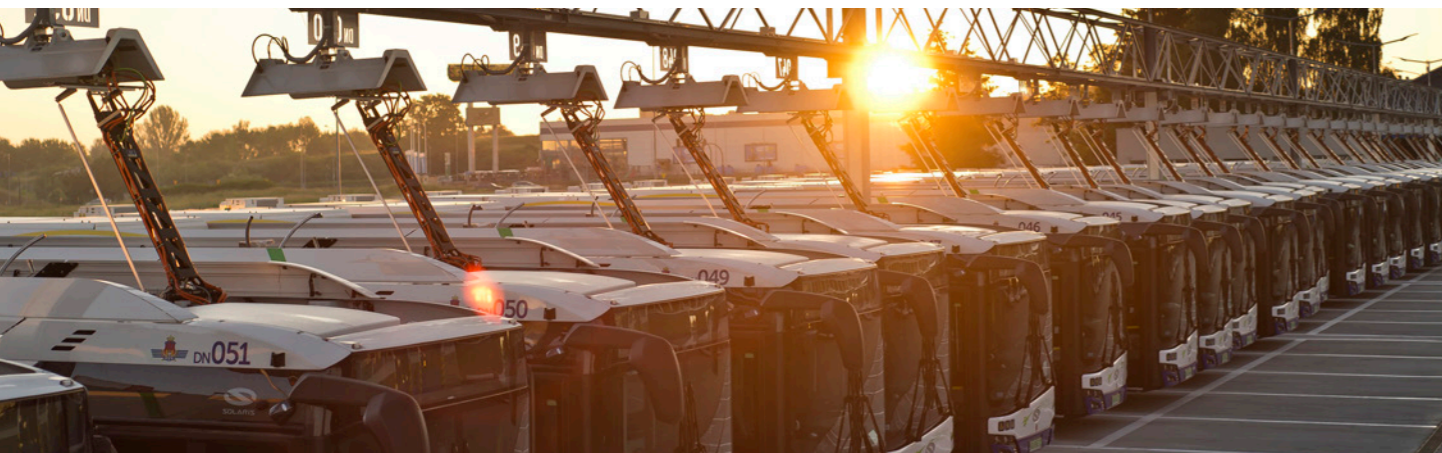
E-mobility is picking up speed everywhere. Now it is important not to miss the boat! With Schunk, you can make the transition from pure concept on paper to successful application in practice. You can rely on our years of experience, which we have already gathered as a world market leader in over 180 international projects.*

The efficient and flexible options within Schunk Smart Charging make our charging system one of the most attractive solutions worldwide. Numerous vehicle and charging station manufacturers work closely with us to develop the best application for each customer and country.

The projects are becoming more and more extensive: Whereas in the beginning only individual buses were equipped, today we supply the key technology for fleets of up to 200 vehicles. With Schunk, you have a partner at your side who can handle these dimensions - the following projects are good examples of this. We would be happy to provide you with further information - just contact us!

*Stand 2023

Krakau, Poland | Roof-mounted pantograph



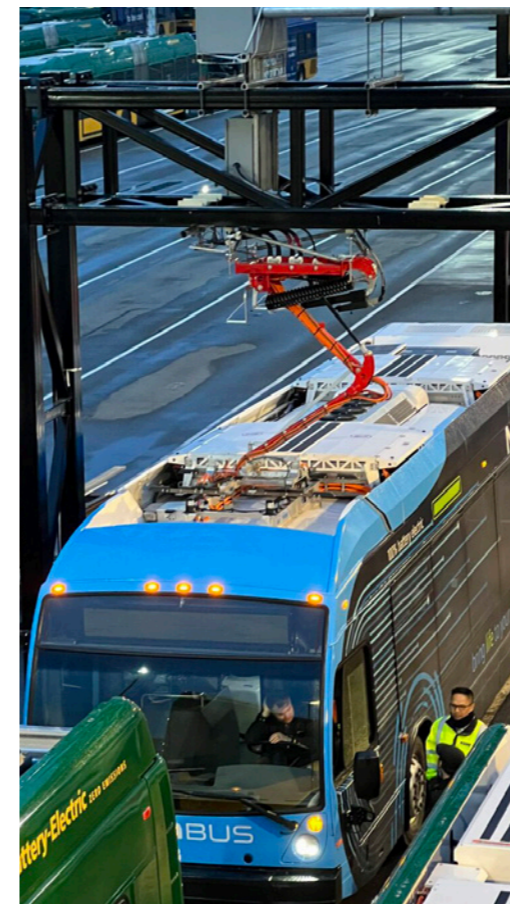
PROJECT START	2016
CURRENT VOLUME	>100 buses
SYSTEM	SLS102 roof-mounted pantograph according to the bus-up principle
CHALLENGE	Cost-efficient combination of Opportunity Charging and Overnight Charging
SOLUTION	The Polish city of Krakow has an ambitious goal: by 2025, 32 % of the fleet, or 132 buses, are to be fully electric. For this purpose, investments were made in new buses as well as in the charging infrastructure. At strategic stops, the buses can now be charged quickly on the route using pantographs with high charging power (opportunity charging). In less than 15 minutes, a battery capacity for a journey of around 100 km is reached - the bus can thus remain on the route for the entire day. The buses are also charged at night in the depot via the roof-mounted pantograph (overnight charging) - after automatic contacting with low charging power. No manual operation is required, space-saving parking is possible and battery cells with different charge levels can be gently brought to the same charge level. Another plus point: in the morning, the energy for the vehicle heating can be drawn directly from the charging station via the pantograph without using energy from the battery.

Saragossa, Spain | Depot Charger



PROJECT START	2022
CURRENT VOLUME	68 buses
SYSTEM	Depot Charger SLS 301 according to „top-down“- principle
CHALLENGE	One of the first product installations worldwide - together with Los Angeles and San Diego, USA
SOLUTION	Spain's fifth-largest city wants to become climate-neutral and is relying on the Depot Charger system from Schunk, which is being used in Zaragoza for the first time worldwide. The Depot Charger can charge at high power, similar to the inverted standard current collector, but its simple, compact and lightweight design makes it an economical solution for overnight charging at the depot. It works according to the „top-down“ principle: the pantograph contacts the rails on the vehicle roof from above. This type of vehicle-side counterpoint offers two advantages compared to a pantograph: The rails take up less space and are much lighter. While a pantograph weighs around 115 kg, the rails only mean around 15 kg additional weight for the bus. This way, the buses are both efficient on the road and very space-saving to park in the Deopt. A system installation on the track can thus be omitted, but would also be possible as a combination solution due to the identical interface.

Seattle, USA | Inverted pantograph

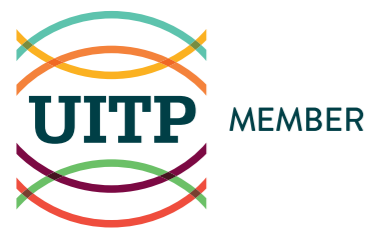


PROJECT START	2021
CURRENT VOLUME	3 pantographs SLS 201
SYSTEM	Inverted current collector according to the „top-down“ principle
CHALLENGE	First ETL/UL-certified and Buy America-compliant pantograph installed in North America
SOLUTION	The special thing about this project in Seattle: Schunk is the only company worldwide that can offer pantographs that are manufactured in the USA. This means that we meet the requirements for legally prescribed local content and are thus Buy America compliant. In addition, the pantographs are certified according to ETL/UL and therefore do not require any additional and costly on-site acceptance during commissioning. The SLS 201 inverted pantograph is integrated at a central location on the infrastructure side, where its contacting works according to the top-down „top-down“ principle: The vehicle parks under the inverted pantograph, which descends, connects to the compact counterpart on the vehicle roof and charges the batteries. Since the pantograph can compensate for different vehicle heights, different vehicle types are charged with the same pantograph in this project - this demonstrates the high degree of compatibility of the Schunk pantograph system.



CHARGING BECOMES AS EASY AS REFUELLING

In the Logistics industry, e-mobility is slowed down primarily by the insufficient charging infrastructure. Either it is simply not available, or the current charging stations require too much time and complex, manual operation. Schunk is developing the technologically leading alternative for this: the e-charging station of the future.



The uncomplicated charging of batteries will decisively advance the everyday suitability of e-mobility. This is precisely the challenge that Schunk is addressing with the development of the Underbody Charger. In the future, this underbody charging system will allow efficient, safe and convenient charging in just a few seconds.

This is made possible by a charging station that can be retracted into the road surface, the interface built into the vehicle floor and the extremely high power transmission of up to 1 MW. The charging system is recessed into the road surface and is driven over by the vehicles to be recharged. In this way, approx. 10 charging processes can be carried out on one contact system per hour.

The outstanding innovation of this charging solution, apart from the enormous reduction in charging time, is the complete automation of the charging process. No more charging cable and plug – the truck is positioned exactly above the charging station and charged autonomously.

Since the project began at the end of 2017, Schunk has already achieved remarkable results with the Underbody Charger. Following prototype production, the first pilot projects have already been successfully realised. If you also want to put e-mobility on the fast track, we will be happy to put our development know-how to work for you!

FULLY AUTOMATIC UNDERFLOOR CHARGING SYSTEM FOR E-LOGISTICS TRUCKS

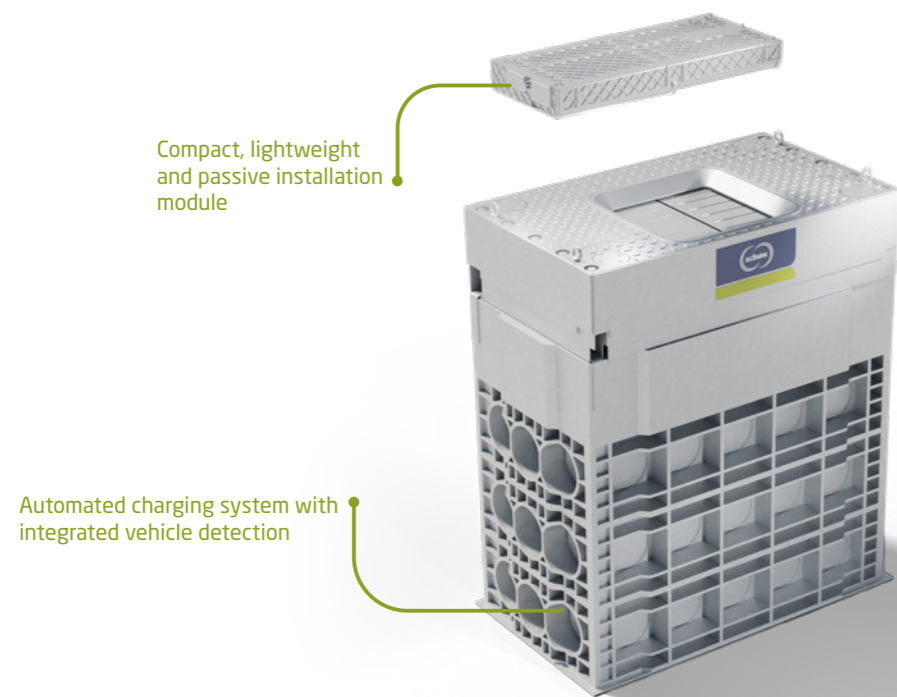
Rising energy costs and increasingly restrictive environmental regulations are forcing many logistics and transportation companies to act more sustainably. Electromobility offers itself as a lever here, but at the same time brings with it new challenges.

In order for the use of electric logistics trucks to contribute to greater energy efficiency and cost reduction in the company, transport companies must carefully examine which parameters can be changed. Fast, safe and space-saving charging of e-trucks is a crucial point here - and Schunk offers an innovative solution for precisely this with its fully automatic underfloor solution.

The charging station of the future is in the ground

With the Underbody Charger, Schunk has developed a fully automatic charging system that sets new standards.

Bulky charging columns and error-prone charging cables are nowhere to be found here. The underbody solution consists of a charging system sunk into the road surface and an interface built into the vehicle floor as a counterpart. If the logistics truck drives over the charging system, charging starts fully automatically with an extremely high power transmission of up to 1 megawatt. The Underbody Charger thus enables fast, safe and efficient recharging without touching a cable.



Compared to a plug-in solution, there are many advantages:

- Up to 1 megawatt charging power - resulting in shorter downtimes and around ten charging processes on one contact system per hour
- Space-saving - no charging stations required in the loading depot
- Error-proof - no manual operation, no charging cables
- A hands-free alternative to the MCS (Megawatt Charging System)
- Secure connectivity - integrated vehicle detection system and integrated parking tolerance compensation +/- 60 mm
- Easy to retrofit - as a passive module, the interface can be easily and cost-effectively integrated into the logistics truck

SAFE & RELIABLE

STRENGTHS OF THE UNDERBODY SOLUTION COMPARED TO THE PLUG-IN

The fully automatic underbody loading system is space-saving, simple and safe. It complies with DIN EN 61851-23-1 and ISO15118 and meets all relevant design standards and basic safety regulations.

To ensure a high system voltage, the contact systems are designed to be particularly safe and reliable. This includes protection against accidental contact, the prevention of electric arcs and unwanted heating as well as fused charging sequence control.



SCHUNK GROUP

ENGINEERING COMPETENCE IN MATERIALS TECHNOLOGY AND MECHANICAL ENGINEERING

The Schunk Group is a global technology company. The company is a leading supplier of products made of high-tech materials - such as carbon, technical ceramics and sintered metal - as well as machines and systems - from environmental simulation to air conditioning technology and ultrasonic welding to optics machines. The Schunk Group has around 9,600 employees in 26 countries and generated a turnover of 1.6 billion euros in 2023. The company is divided into ten different Business Units.

The Business Unit Transit Systems is driving ahead technologically - whether in the propulsion of high-speed trains or in efficient charging processes for electrically powered buses. Schunk's current collectors, third-rail systems and collector strips are technological pioneers worldwide in power transmission for rail transport. And with Smart Charging, Schunk ensures emission-free travel for electrically powered buses in public transport.

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