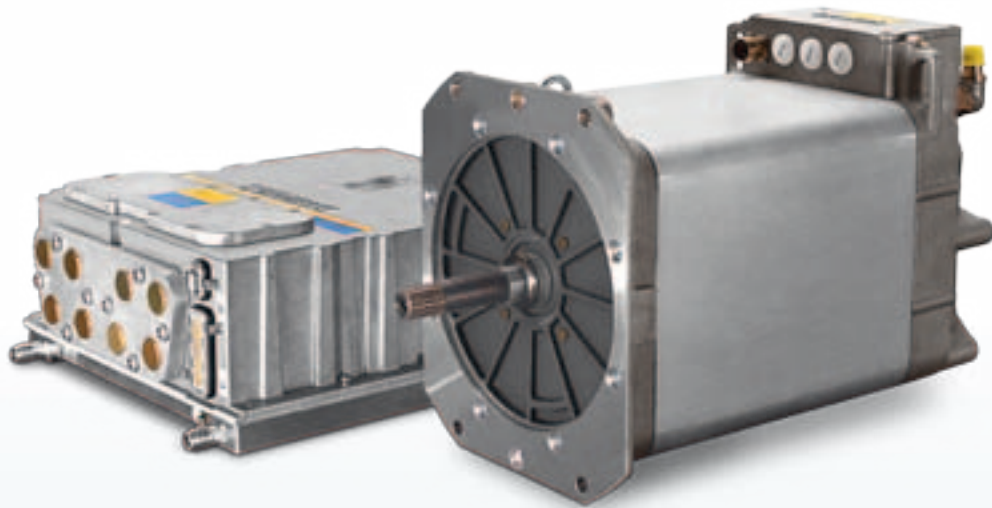


How do we make city buses cleaner and more comfortable?



With the intelligent and leading edge
ELFA hybrid drive system

Answers for industry.

SIEMENS

Economical, ecological and efficient: The intelligent response to ever increasing demands

As a result of ever rising fuel prices, the operation of individual motor vehicles will become increasingly less economical – especially in cities. At the same time, in booming major cities around the world with populations in the millions, the desire to be mobile is increasing and the amount of traffic is continually on the rise. As a consequence of all this, city buses are becoming more and more significant as a form of public transport.

In conjunction with these trends, the requirements placed on modern city buses are also increasing: Their operating costs should be as low as possible, the buses should be absolutely reliable in day-to-day service, quiet, reduce the impact on the environment through lower exhaust emission and offer maximum passenger comfort. Siemens shows the way forward in this extremely complex area of conflict – using innovative hybrid traction drives utilizing the ELFA® concept.

ELFA: advantages at a glance

- Up to 40 percent less energy consumption and exhaust emission
- Emission-free operation possible in inner city areas and at bus stops
- Noticeably more quiet
- Higher degree of comfort for passengers as the bus accelerates a lot more smoothly
- Extremely reliable and low-maintenance traction systems
- All components from a single source – motor, generator, traction converter and control
- Series hybrid system concept for maximum degree of flexibility and cost effectiveness
- Can be adapted to all city bus types as a result of the modular design
- Proven thousands of times over




Well-conceived concept: Minimum energy requirement but with the maximum degree of comfort

City buses equipped with ELFA traction systems are significantly more efficient and comfortable than conventional buses. The reason for this is the well-conceived concept with the ELFA electric traction system as core. ELFA combines mobile energy generators – such as diesel generator sets and fuel cells – with high-performance energy storage devices. These allow the energy that is released when braking to be harnessed and stored. Just the diesel-electric hybrid concept alone provides enormous advantages. With this concept, the diesel engine drives a generator. This supplies an electric traction motor with energy using state-of-the-art power electronics (drive converter). With ELFA, these advantages are well pronounced due to the fact that innovative converter technology is used – this is especially true when it comes to the overall efficiency, noise emission and driving characteristics. For instance, passengers benefit from the especially soft and smooth starting. Put in other words – these buses offer a noticeable increase in the level of passenger comfort.

Focused competence from the global market leader: ELFA from Siemens

ELFA is a Siemens product – the global leader in large drives. Based on more than 100 years of experience in drive technology and the power of innovation of our company, we craft solutions for all types of applications. In our competence center for large drives, our experts work side by side to develop and produce drive systems for industrial plants, ships and rail vehicles – for subways in major cities around the world and also for high-speed trains such as the ICE and Velaro. The resulting synergies flow directly into ELFA. The result is convincing: Components that are perfectly harmonized with one another and having the highest degree of reliability are combined to form an optimum system – a system that also distinguishes itself as a result of the highest degree of efficiency. This is convincingly proven by already more than 1,000 buses in the widest variety of configurations that are in daily service around the globe.





The decisive key to achieving significantly less energy consumption in bus traffic: The high amount of braking energy that occurs for typical stop and go operation. Here, savings of over 30 percent are definitely feasible – and has already been able to be proven in various applications. This braking energy is intelligently used with ELFA: Contrary to conventional buses where the energy is simply wasted, with ELFA, it is converted back into electrical energy by the regenerative operation of the traction motor and is fed into an energy storage device – i. e. in high-performance capacitors or batteries. The energy yield is enormous, especially for city buses that are continually braking and accelerating. Depending on the bus type and the application conditions, operating companies can profit from significant cost savings. This makes it quite clear why an investment in an ELFA traction drive has an extremely short payback time.

Sensible: Braking energy is regenerated and stored

Always on the green route: Diesel engine operation

With ELFA, the stored braking energy is always reused when starting: The diesel engine only has to be started at higher bus speeds or higher acceleration power. Depending on the storage capacity of the system, the bus can also be driven purely electrically, i. e. without any exhaust emission. This is especially important in environmentally sensitive inner city zones and at bus stops. A diesel engine can always be operated at a speed independent of the bus speed. This means that the engine can always be operated in a range that has the most favorable fuel consumption.

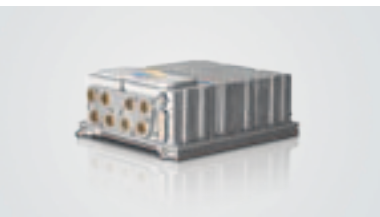
Increased degree of cost effectiveness and flexibility: The series hybrid

ELFA systems utilize the series hybrid principle – a superior concept with a whole raft of significant advantages for city buses: On one hand, the series hybrid can be standardized. This means that the same electrical traction system can be operated in a diesel hybrid, a fuel cell hybrid or a battery-powered vehicle.

As a consequence, a series hybrid can be easily adapted to new developments in the area of internal combustion engines and energy storage devices – the same also applies to leading-edge fuel cell technology. On the other hand, with the series hybrid, the traction drive is completely decoupled from the internal combustion engine. This means that the diesel engine can be mounted in the vehicle so that it does not generate a torque reaction and the drive torque doesn't have to be supported by the vehicle chassis. This significantly reduces the amount of noise and vibration therefore ensuring a significantly higher degree of passenger comfort. Additional advantages: A higher degree of latitude when designing the traction system and a higher degree of overall flexibility. This is because only the generator depends on the selected diesel engine. Thanks to its flexibility, the series hybrid can be perfectly adapted to upcoming innovation in the area of energy storage devices – associated with the future transition to Li-ion technology: More precisely – it is possible to use a smaller diesel engine than was previously used (downsizing).



For buses around the world: Tailored and system-based solutions



With their unbeatable degree of flexibility, ELFA traction drives can be adapted to every bus type around the world, independent of individual special configurations and regions, climatic or topographical situations. The reason for this is its modular design: The complete system is assembled in a modular fashion from an extensive range of components – and is perfectly tailored to the specific requirement profile. We also offer many alternative possibilities for the mechanical integration – and certainly always the optimum solution for the specific project.

The standard: Systems with rugged induction motors

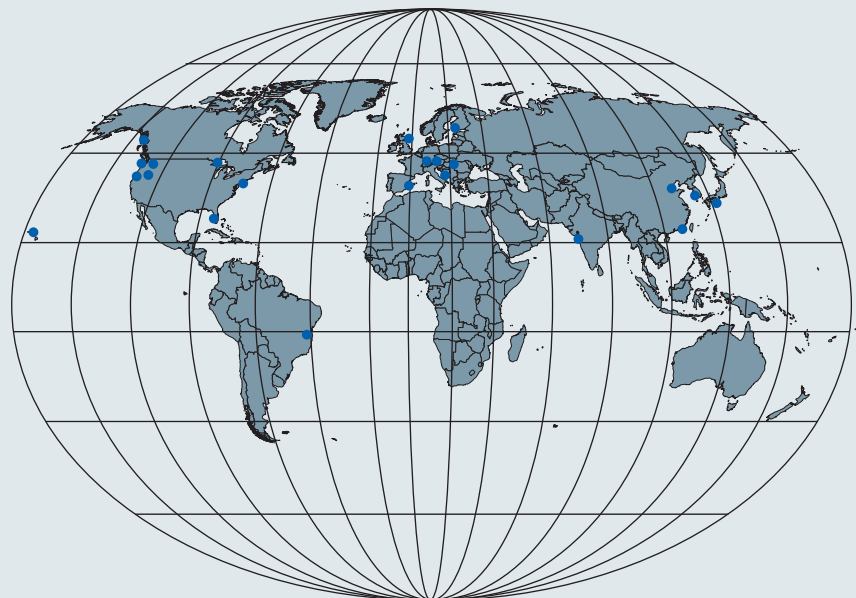
Rugged liquid-cooled induction motors with power ratings from 50 kW to 180 kW with reduction gearboxes are used as standard for ELFA traction systems. Also possible: Operation with electrical axle drive solutions. The motors are convincing thanks to their extremely high degree of reliability, high efficiency and space-saving design thanks to their small envelope dimensions and low weight for the particular power rating.

The alternative: Systems with permanent-magnet synchronous motors

Our latest development in the modular ELFA system: A permanent-magnet synchronous traction motor as direct drive. This distinguishes itself due to the efficiency that has been increased yet again in the lower speed range. Further, for this motor, a step-down gear unit is not required. This guarantees a further improvement in the efficiency, eliminates the need to use gearbox oil – and when all is said and done – also reduces the fuel consumption, operating costs and exhaust emission.

The generators: Common mechanical unit together with the traction motor

Permanent-magnet generators are used for all of the latest ELFA traction drive generation – there are no exceptions. Their radial dimensions are exactly the same as those of the traction motor. This means that they can be mounted as a single unit. As a consequence, vehicle manufacturers can essentially keep their chassis design when changing over to



hybrid traction technology – and install the unit in the space previously occupied by the automatic gearbox.

The traction converters: Compact and can be used in a modular fashion

The traction converters play a key role in our ELFA traction systems. They control the traction motors, generators and auxiliary systems. Their compact, water-cooled aluminum frame corresponds to the environmental demands in the automobile sector and ensures the highest power density. This in turn significantly simplifies installation in the vehicle itself. The latest generation of traction converters completely fulfill the requirements placed on modularity and current market demands such as a 6K9K degree of protection. Alternative operation with 12-V and 24-V onboard supplies is also possible without requiring any modification.

The open-loop control software – tailored customer solutions

The complete ELFA traction system is controlled using just one standard traction converter software. A wide range of different applications can be param-

eterized at the system level using this software. In addition to the basic functions, various routines are integrated in the software – also customer-specific higher-level software modules that in conjunction with the standard software modules represent the system control. Using the setpoints from the driver, the traction control determines the torque and speed setpoints for the motors, generators and auxiliary systems – taking into account internal and external system limits. The required system performance is also determined in the traction control. This is the input for the hybrid control that in turn determines the distribution of power between the internal combustion engine and the energy storage device for the various applications.

A real milestone for urban bus traffic

ELFA sets standards for hybrid-powered city buses – for bus manufactures, passengers and local municipalities. With our innovative series hybrid traction drive, you are benefiting from more than one hundred years of Siemens experience – the global market leader for large drives. In other words: You can profit from maximum reliability, highest efficiencies and a global service network whose experts are always there to provide you with competent support.

ELFA traction drives have already proven themselves thousands of times over. The first ones went into operation back in 1998 and in the meantime have many millions of operating hours and kilometers under their belt – reliably and economically. Together with bus manufacturers around the world, we are developing traction drive systems for city buses. This is based on our experience and competence in drive technology, our power of innovation and global presence and represents cutting edge technology when it comes to ecological and economic issues.



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