



| Siemens Commercial Vehicles

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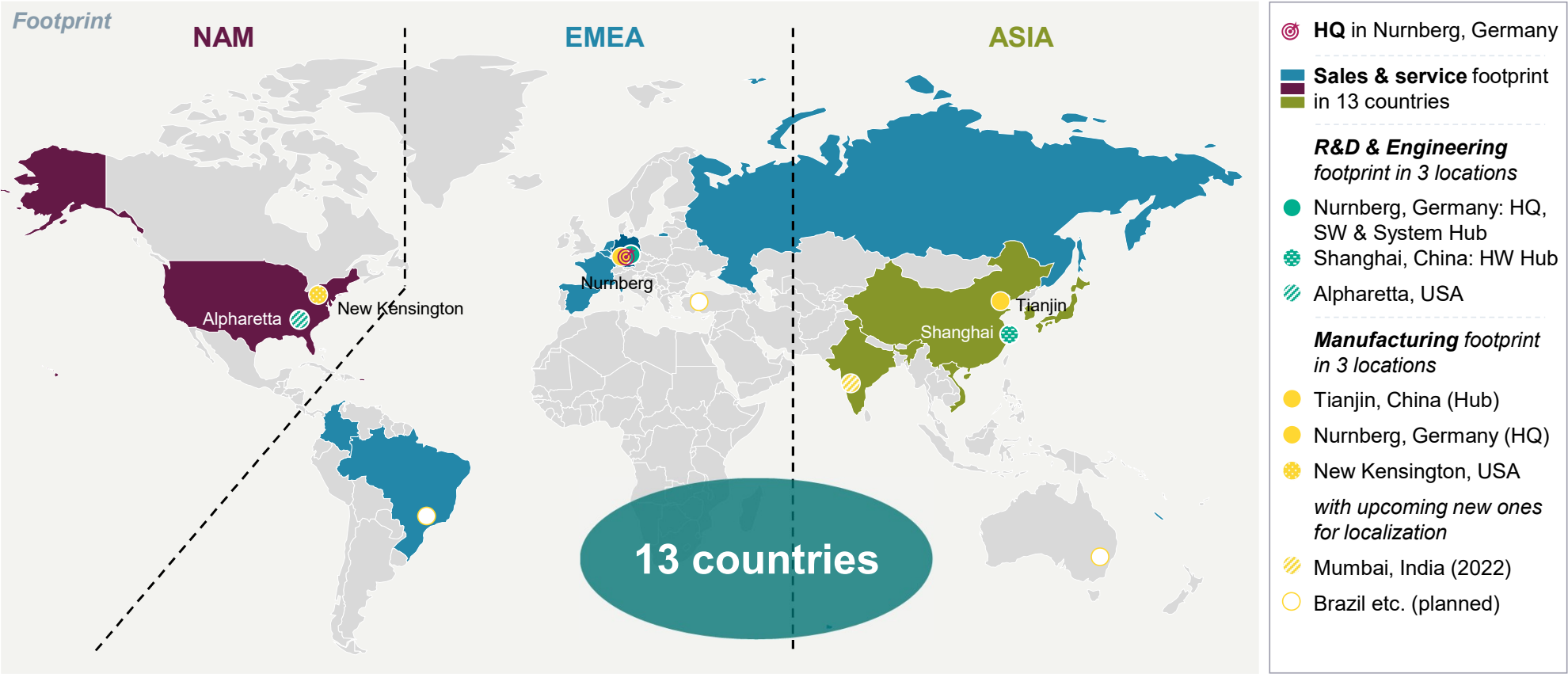
Electric drive systems for buses, trucks and off-road vehicles >7.5t GVW, applicable across hybrid, battery, fuel cell electric powertrains

	Bus	Truck	Off-road
Applications	 City bus	 Coach	 Medium duty
	 Heavy truck	 Underground mining	 Marine
Applications	 Articulated bus/ BRT	 Airport bus	 Garbage pickup
	 Sewer vacuum	 Taxi-bot	 AGV
Portfolio	 Motor  Generator²⁾  Inverter  DC-DC converter²⁾, Brake chopper²⁾  Auxiliary inverter		
	 Service  Health checks  Field service  Repair³⁾  Spares  Training & consulting  Service contracts		
			 ✓ Component control ✓ Drive system control ✓ Energy management ✓ Special applications

BRT: Bus Rapid Transit **AGV:** Automated Guided Vehicle 1) Other hardware supplied are HV distribution boxes, data loggers, auxiliary motors, cables & connectors
 Page 3 Restricted | © Siemens Industry, Inc. 2022 | K. Ferguson | CV S NAM 2) New platforms under development 3) Including overhaul

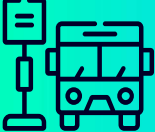
SIEMENS

Lean and scalable global footprint in 13 countries with best sourced sales, service, product development and manufacturing competencies



Global market leader of electric drive systems for buses

Bus



NAM

✓ #1 electric drive system supplier by market share for buses in 2020¹⁾



EMEA

✓ #1 electric drive system supplier by market share for buses in 2020²⁾

✓ ~20 customers in the region today



ASIA

✓ #2 electric drive system supplier – of non-Chinese origin – by market share for buses in 2020²⁾

✓ Business through system integrators



1) Only zero emission market considered since hybrid electric is not addressable due to no new platforms 2) Across hybrid, battery, fuel cell electric powertrains

Propelling electric buses across the globe with >25 years trust, >17,000 systems delivered, 45 countries deployed, >2 bn km covered, 1.8 mn MT CO2 reduced



Paris



London



Moscow



Barcelona



Hamburg



De Lijn



Eindhoven



Lisbon



Vienna



Budapest



Martinique



Las Vegas



New York



Aberdeen



Tel Aviv



Mumbai



Shanghai



Jeju Island Korea



Taipei



Hong Kong

>25 years
customer trust

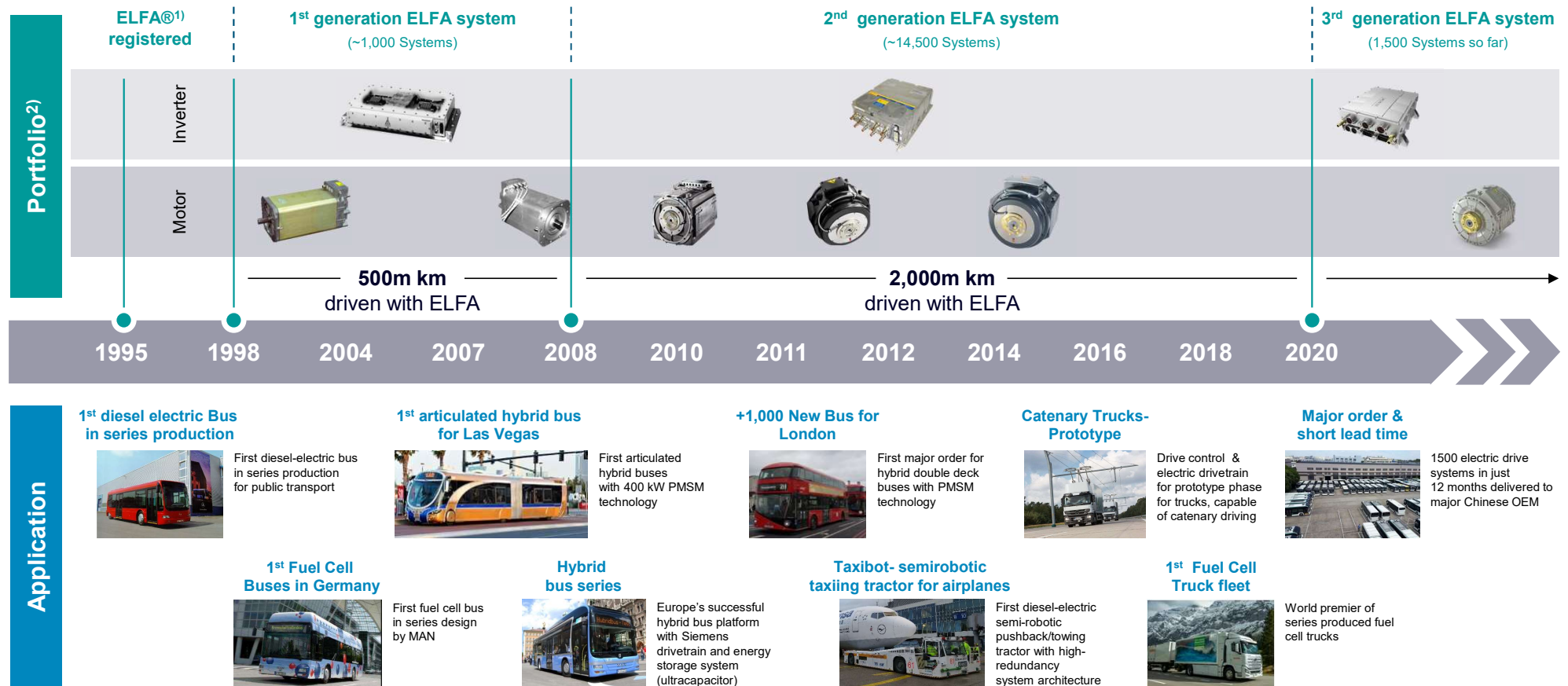
>17,000
system
delivered

45
countries

>2 bn km
total distance
driven

1.8 million MT
CO2 reduced

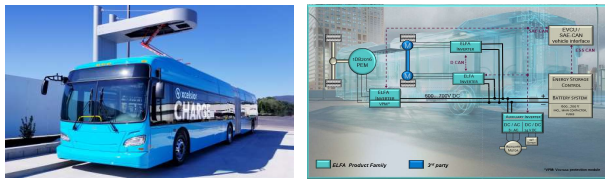
Pioneering >25 years of electromobility in buses and other commercial vehicles



1) ELFA is the Siemens registered trademark for electric motor + inverter propulsion system
2) Simplified overview

Selected project examples

Complex e-drive system for articulated 18m battery electric bus



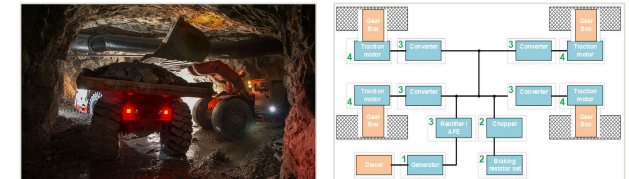
- ✓ **Complexity** due to double traction system from 2 suppliers for an articulated bus (18m)
- ✓ **Solution** is a combination of
 - 1 ELFA central drive system with 1 motor & 1 inverter
 - 1 third party e-axle with induction motors and 2 ELFA inverters
 - Complex SW-functionality across entire double traction system including deployment on snow/ ice during winter

First fuel cell truck fleet globally



- ✓ **Complexity** due to first ever fuel cell e-drive system for heavy duty trucks globally
- ✓ **Solution** is a(n)
 - Custom designed ELFA electric drive system for high torque applications on Alpine roads for 38T truck
 - Adaption of PEM parameters for 4-speed AMT for high performance
 - Managing complex international network of OEM, financiers and fleet operators

Complex diesel-electric system for 116T underground mining truck



- ✓ **Complexity** due to size of vehicle, all-wheel drive and number of e-drive components including auxiliaries and integration
- ✓ **Solution** is a(n)
 - Electric drive system consisting of 2 generators, 4 motors, 8 inverters, 1 auxiliary inverter for all-wheel-drive drivetrain
 - Complex SW-functionality including special applications e.g. steep-slope start etc.

PEM: Permanent Magnet Motor, same as Permanent Magnet Synchronous Motor (**PMSM**) **AMT:** Automated Manual Transmission

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Our new modular motor platform is tailored for a wide range of applications with higher performance and lower costs (1/2)

Single or Double winding stator version available - for **high power** applications or **lower DC voltage (400V)**

Increased power output combined with **smaller¹⁾** installation space required

13% in motor weight¹⁾ savings with lightweight and robust **aluminum housing**

Optional for **direct drive** or with **transmission**, mounting with SAE Flange and splined shaft end

Unmatched performance due to its extra wide operational range with consistently **efficiency of > 97%**

1) Compared to ELFA 2 PEM Motors;

Save up to **75%** in cable termination time when choosing **HV plugs** over PG-connectors

Minimize stress with our additional **supports for strain relief clamps** for HV cables

Zero-error principle: Increase productivity with coded AC connectors (color and form coding) – no probability of failures during installation

Maintenance free bearings
12-15 years, 1Mio km, 60000h, lifetime greased

Ready for harsh conditions with dust, water and steam and shocks thanks to its **IP6K9K** protection class

Robust position sensor (VR Resolver)

Next Generation Motor Platform



1CS2016-1FA50-0AA0

- 12-18t CityBus
- 3.000/1.650 Nm
- 230/175 kW
- ≈ 270 kg



1CS2010-1FA50-0AA0

- CM, 7.5t-12t CityBus
- 2.000/1.100 Nm
- 250/160 kW
- ≈ 210 kg



1CS2010-1FB50-1AA0

- TA, 12t-18t CV
- 2.000/1.100 Nm
- 250/160 kW
- ≈ 210 kg



1CS2016-1FA40-0AA0

- CM, 12t-19t CV
- 3.000/1.650 Nm
- 350/230 kW
- ≈ 270 kg



1CS2016-2FB24-1AA0

- TA, 19t-32t CV
- 2.900/1.650 Nm
- 400/250 kW
- ≈ 270 kg



1CS2022-2FA24-0AA0

- CM, 19t-29t CV
- 5.000/2.200 Nm
- 550/330 kW
- ≈ 350 kg



1CS2022-2FB24-1AA0

- TA, 32t-44t CV
- 5.000/2.200 Nm
- 550/330 kW
- ≈ 350 kg

SW – single winding

DW – double winding

DS – drive shaft

TA – transmission application

CM – Central Motor, drives cardan shaft

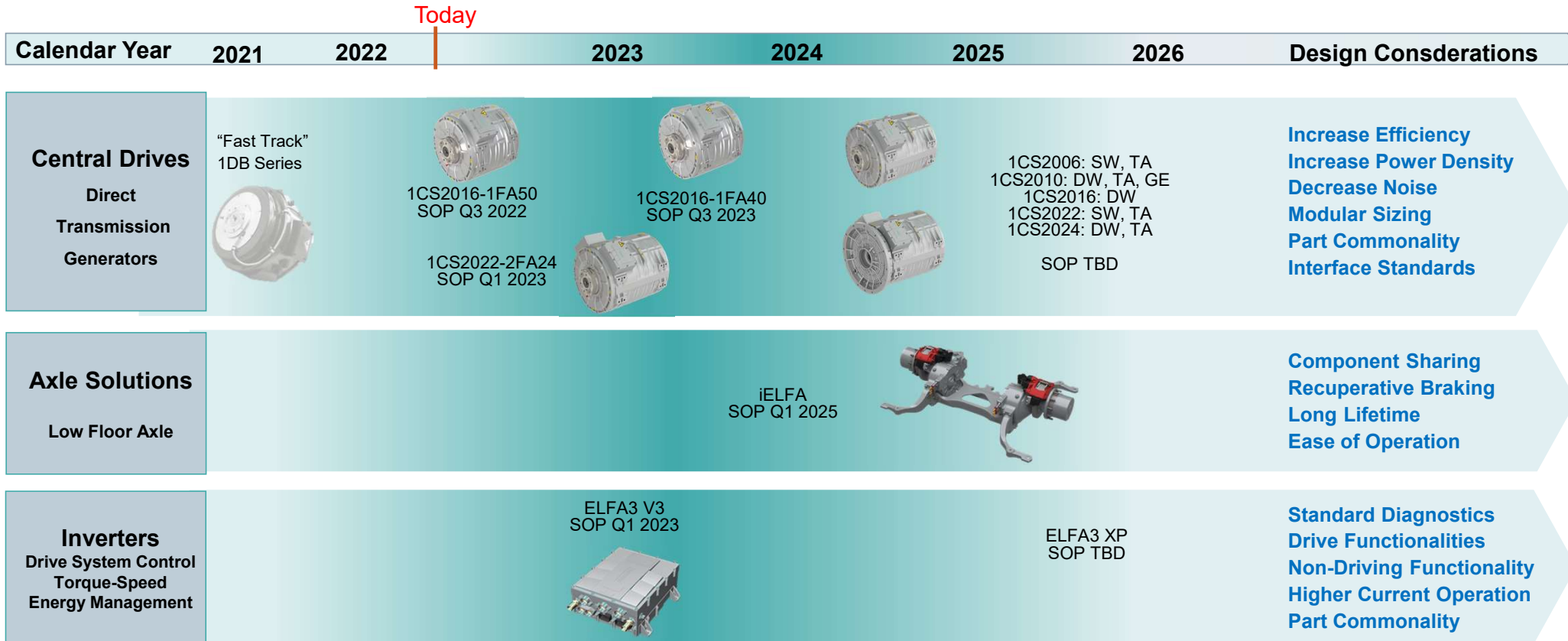
TA – transmission application

CV – Commercial vehicle, Bus, Coach or Truck

Strategic Roadmap*

*Dates Estimated

**Subject to Customer Demand, R&D Prioritization, & Managerial Initiatives

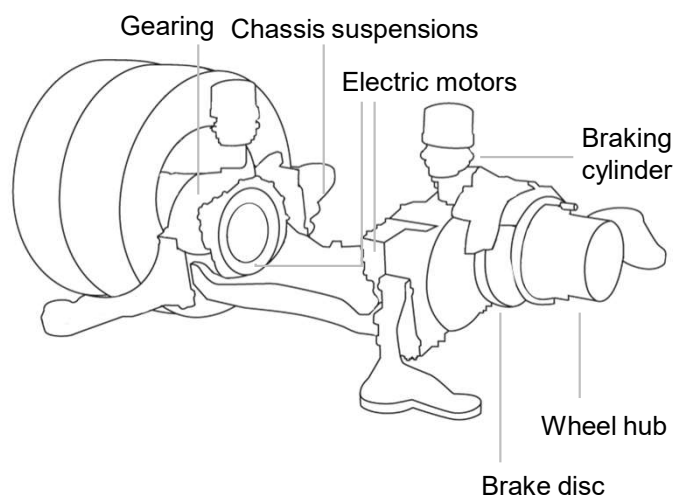


ELFA 3: 3rd Gen Traction Inverter – Perfect combination of fine tuned hardware and software features



E-Axle for new generation low floor city vehicles

Schematic overview of E-Axle



Joint development with experienced mechanical partner



Planned production start in 2023/24 for EU and US markets

Comments

Applications:

- **City bus** with easier accessibility for (disabled) passengers
- **City delivery truck** with low floor designs
- Low floor axle design enables **low center of gravity**

Advantages:

- **Additional passenger space / capacity**
- Motor / Axle technology with **benchmark power** and **torque**
- **Optimized electric-mechanical integration**
- **High battery-to-wheel overall efficiency**
- **Acoustically optimized**
- **Robust system** composed of well-known technology

Comprehensive software portfolio from Component to Application level – demonstrated in thousands of installed systems

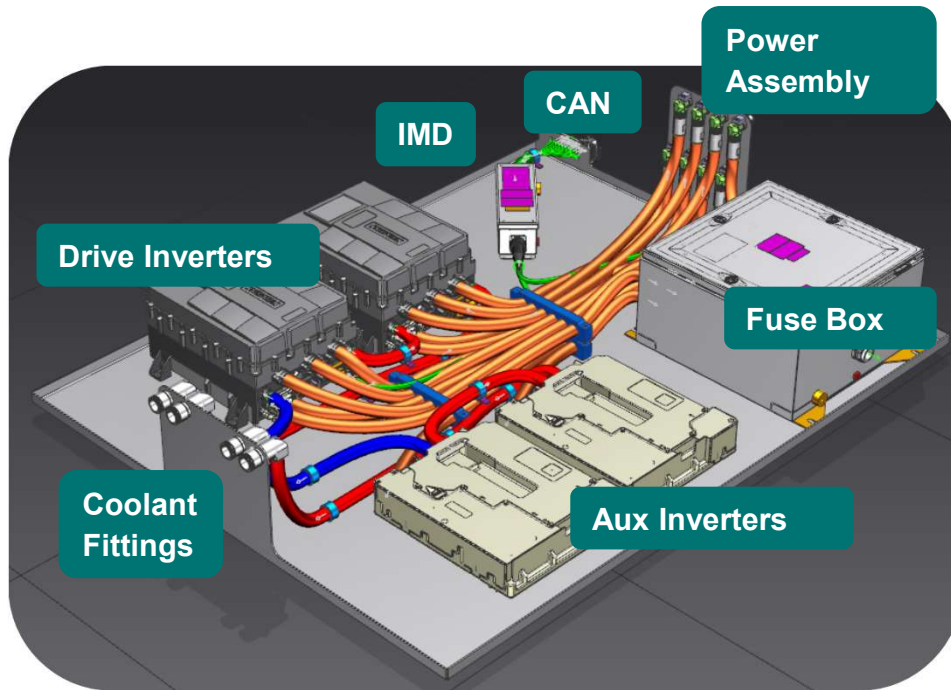
Software layer	Description	Key functions				
Services	Software services	SW upgrades and patches			...	
Applications	Special functions unique to the vehicle application	CAN Signal Manager			...	
		Limp mode	Anti-slide	Anti-roll back	Hill start assist	...
		Automatic speed limit		ABS support	Autonomy interface	...
		Cruise control		Creepage control	2-Axle	...
Energy management	Functions to manage & optimize on-board energy sources	Energy storage holder		Voltage ripple reduction		...
		Interface & optimization (BMS, Engine, Generator, Brake Chopper)				...
Drive-system control	Functions to manage overall e-drive system	Drive control logic (incl. driving functions)				...
		Differential torque control		Stability & Control	Emergency management	...
Component control	Functions to manage individual e-drive components	TSI	EBS Support	Brake Chopper	Protection & Safety	...
		Motor controller		Other ²⁾ controllers	Diagnostics ¹⁾	

- **Optimization** and **synchronization** of **HW** with adjacent systems and auxiliaries
- **Best-Safety, -EMC, -acoustics** and **serviceability** both on product and vehicle level
- SW systems to **exact customer needs**: full drive control vs. basic torque-speed interface
- Functions to improve **battery life** and longevity
- **Reliability** through extensive parametrization, proven algorithms and testing
- **Interoperable** platform
- **Cybersecurity** functions included

HIL: Hardware in the loop, **TSI:** Torque Speed Interface

1) Including Freeze Frame 2) Generator, Brake Chopper, DC-DC, Auxiliary

Plug & Play, Pre-Assembled Propulsion Racks & Fuse Boxes



**Rack Visualization is not vehicle specific and is not available for production.*

Propulsion Rack Assembly

- **Placed, Fastened, & Secured**
 - Onboard Equipment
 - Digital Twin Identification
- **Crimped, Connected & Assembly**
 - Control (CAN) Cables
 - Connectivity Verification
 - Coolant Hoses
 - Pressure Confirmation
- **Uploaded, Tested & Verified**
 - Application Soft & Firmware

Comprehensive set of services offered through CV, Siemens and partner network for best lifecycle performance

Services		CV local service network	CV global repair centre / HQ support	Siemens local service network	Partnered 3 rd party repair centre
Health check	✓ Investigation	✓		✓	
	✓ Recommend or adjust maintenance plan				
Field service	✓ System know how for detailed analysis	✓		✓	
	✓ Onsite support				
Training & consulting	✓ Onsite & classroom training on our products & systems	✓	✓		
	✓ Individual training				
Repair & overhaul	✓ Repair of products at qualified repair centers	✓	✓		✓ Plan
	✓ Complete overhaul				
Spares	✓ Make to order parts	✓	✓		
	✓ Parts on stock				
	✓ Recommendations				
Service contracts	✓ Tailored service solution	✓		✓	
	✓ Combine all aspects of the portfolio				

- ✓ New products are **designed for zero maintenance** for life with minimal service requirement
- ✓ Standard warranty of 2 years; additional paid **warranty packages** up to 8 years are offered
- ✓ Plan for right regional/ local **stocking/ inventory** to minimize downtime of vehicles during product repair or replacement
- ✓ **Long shelf life/** availability of products
- ✓ **Software patches** and upgrades offered as and when necessary

ELFA advantage

1	Proven solutions across complex electric drive systems for vehicles of various sizes and powertrain types	✓
2	Reliability: >25 years, >17,000 vehicles deployed across 5 continents in various environmental conditions	✓
3	Benchmarked performance: pickup, efficiency, gradeability, density, acoustics, maintenance free, highest protection class	✓
4	Battery impact: improved life and range of battery from hardware design and software functions	✓
5	Comprehensive set of software functionalities for electric drive systems	✓
6	Automotive grade: smaller products, competitive pricing, rigorous continuous improvement, filled innovation pipeline	✓
7	Localization: open to further localization to meet customer's or nation's requirements	✓
8	Service: global siemens network leveraged for localized and rapid response services	✓
9	Financing: offer for low cost financing on project or product basis	✓
10	Collaborative and flexible approach to customer requirements and needs	✓

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