eMobility

Innovation electrified.

Powering Business Worldwide

In the midst of a revolution, experience matters. At Eaton, we've been innovating electric transportation breakthroughs for decades. We understand the electric revolution because we make it work.

Power to Improve

Today, the world has awakened to the limitations of fossil fuels. The global oil supply is not infinite. Emissions are not without consequences. Sustainability is not optional. How we move must change — and now, more than ever, that change is electric.

Eaton is leading the way

Our vast engineering and manufacturing resources span the globe with expertise that's deep and wide. We do more than design custom electric vehicle (EV) products, systems and services efficiently — **we power your success**!

What's inside

Powering your success

Designing EVs is a challenging endeavor. So which partners you choose to work with is an important decision. At Eaton, we offer a great depth of experience in complex power electronics and software — experience your company can put to work, making the best EV systems possible.

This digital brochure is interactive! Simply click on any button like the one below for more information and insights on the eMobility product portfolio.

eMobility Overview

Safer. Faster. Farther.

Eaton is committed to helping you develop the safest, most efficient electric vehicles that travel faster and farther, with superior system protection.

Efficient, Effective, eMobility

Bring us your toughest challenges — we're ready. Our extensive integration experience helps us deliver the cost, packaging and timing efficiencies you need most. Our expertise in software development ensures more effective communication between different vehicle functions and the charging station. And we regularly transfer knowledge and apply technology advancements from our Electrical, Mobility and Aerospace groups. Our experience in AC and DC and in multi- and single-phase systems, is a key competitive advantage.

Delivering on a Global Scale

Eaton expertly manages ever-changing global standards and regulations. We have manufacturing facilities worldwide, with notable certifications such as ISO, IATF, IRIS and many others. Another unique advantage, especially when it comes to speed to market, is Eaton's world-class simulation and testing capabilities.

Engineering Excellence Defined

The Eaton engineering team is as global and comprehensive as the original equipment manufacturers (OEMs) we serve. This includes the full resources of the Eaton Engineering Centers of Excellence, as well as proven external partnerships. As a result, Eaton provides uncommon agility and innovation in all stages of development and manufacturing.

Next-Level Safety

At Eaton, vehicle and system safety are at the forefront of everything we do. It always will be as EV manufacturers are tasked with building consumer confidence while navigating the many challenges of new, complex systems.

We proudly offer proven power protection expertise with market leadership in EV high-voltage fuses. And we're taking EV safety to the next level with new innovations, like Breaktor® circuit protection technology that reliably protects people and components from overloads and short-circuit events — all while being resettable.

EATON KEY ADVANTAGES

Here is a look at some of the ways Eaton stands out:

- Expertly converges electrical and mechanical power competencies
- Deep experience with vehicle dynamics and system integration
- Proven safety and regulatory powerhouse
- Excellent OEM relationships
- Diverse industrial expertise, including vehicle, and aerospace.
- Power utility, commercial, industrial, residential and vehicle markets
- Unique high-voltage experience (greater than 36kV)
- Leader in power protection (greater than 30k amps)
- Global engineering and manufacturing facilities
- World-class simulation and testing capabilities
- Comprehensive electric vehicle product portfolio

A powerful portfolio of solutions for every EV application.

Serviceability, performance, efficiency, safety, range — we understand the challenges and are working alongside you to deliver powerful, brilliant solutions. Eaton offers a world-class portfolio of electric vehicle products and software. Along with our global expertise, we're connecting the full EV ecosystem to drive advancements in technology to meet tomorrow's challenges.

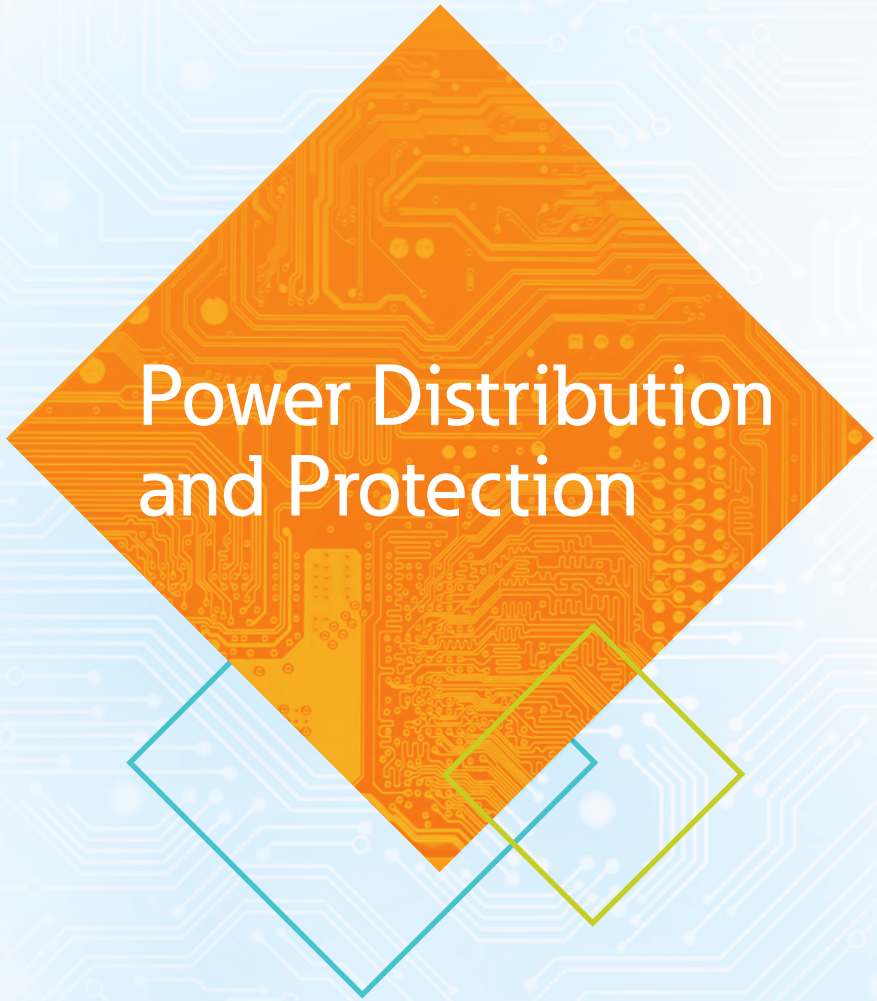
Learn more

"Our eMobility products go through multiple simulation rounds including drive cycles, temperature cycles and vibration cycles. Everything a product would experience in the field; we can simulate in a computer before we ever have to build a product. Then we have a full lab on site where we can do development tests on performance levels and environmental exposures to the product."

— ***Brandon Fisher***
Head of Engineering, Power Distribution and Protection

Powering Business Worldwide

	Passenger Vehicles		Commercial Vehicles	
	Electric/Hybrid electric	Mild-Hybrid/ICE	Electric/Hybrid electric	Mild-Hybrid/ICE
Power Distribution and Protection				
EV Fuses	√		√	
Breaktor® circuit protection	√		√	
Battery disconnect units (BDU)	√			
Power distribution units (PDU)	√			
FLEX power distribution units			√	
EV battery vent valves	√		√	
Power Connections				
Stamped battery terminals	√	√	√	√
Eyelet terminals	√	√	√	√
High-power lock box terminals	√	√	√	√
Connectors	√	√	√	√
Busbars	√	√	√	√
Support Service	√	√	√	√
Inverters				
High-voltage inverters	√			
ePowertrain				
EV transmissions			√	
Traction-enhancing differentials	√	√		
EV drive module gearing	√			
Low voltage and Power Conversion				
Low-voltage power conversion			√	√
48V commercial vehicle solutions				√
High-voltage power conversion			√	√
Low-voltage power management			√	√
Low-voltage power distribution			√	√
Low-voltage circuit protection	√		√	√
Vehicle controls			√	√
Wireless mobile machine controls			√	√
Electric Vehicle Charging Infrastructure (EVCI)	√		√	



The advantages of being a global power management company and an experienced automotive industry supplier are brilliantly demonstrated with our Power Distribution and Protection solutions. We have multiple systems and breakthrough products (see Breaktor® on page 19) to intelligently measure and distribute power to multiple sources, as well as provide exceptional, compact circuit protection.

We have uncommon range, and we are innovative. Choose a complete system or specific components to deliver power to all critical loads within the EV system while protecting components and vehicle occupants.

Our Power Distribution and Protection solutions:

- Fuses
- Battery disconnect units (BDU)
- Power distribution units (PDU)
- FLEX power distribution units (FLEX PDU)
- Breaktor® circuit protection technology
- EV battery vent valves

Learn more

We have specialized knowledge at Eaton. It's unique that we know exactly how to deal with this type of energy, making it safe and reliable within multiple automotive applications.

— ***Mike Lau***
Product Strategy Engineer

Eaton Bussmann® fuses are on 7 of the top 10 electric vehicle platforms globally.

— ***Kevin Calzada***
Director, Global Marketing & Strategy

Fuses

Eaton's Bussmann® series electric vehicle fuses are tailored protection solutions that feature market-leading compact and high-speed designs, with lifetime durability simulation capabilities.

Available for 500–1,000V DC vehicle systems, 50 to 400 amps, Bussmann® EV fuses provide high-performing DC protection of drive, auxiliary and battery systems. The fuses are also available as custom solutions for higher-voltage and current ratings. Primary uses include battery protection, battery inverter and fast charging. Auxiliary uses include DC/DC converter, HVAC and OBC.

These fuses open up to 10 times faster under high fault-current conditions, which helps ensure reliable protection of the circuit and components.

- **Customizable** — unique ratings or performance characteristics for custom applications
- **Require up to 48% less space with reduced weight**
- **Simulation testing to help enable the life of the fuse in your application** — unique driving profiles and conditions can be simulated to verify proper fuse size and performance under a wide range of driving behaviors
- **Operation as low as 200% overload** — provides backup protection to the battery management system
- **Data-logging system** — each fuse has a serial number and date code for traceability of critical-to-quality characteristics
- **Greater ampacity** — can be applied in parallel to realize greater ampacity within sizing guidelines
- **Battery fuses available in various case diameters and sizes**

Learn more

High-Power Fuses

Higher current rating in EVs come along with higher power requirements, especially for battery electric vehicles with the demands of faster charging, increased vehicle range and premium systems. For these applications, the Eaton Bussmann® series of electric vehicle fuses includes high-power fuse solutions up to 1,000V DC.

- **1,000V DC charging-protection fuses** — enable fast-charging the vehicle via the DC/DC fast-charging unit
- **High interrupting rating** — protects high-capacity battery packs with increased power levels
- **Industry-leading** — simulation of fuse lifetime in both charging and high-demand driving cycles to reduce replacement needs for fuse protection
- **Produced in IATF environment** — with traceability and technical cleanliness options
- **Products are available in three square body diameters:**
  - o 43mm (500V, up to 630A; 1,000V, up to 350A)
  - o 51mm (500V, up to 800A; 1,000V, up to 630A)
  - o 59mm (500V, up to 900A; 1,000V, up to 800A)

Battery Disconnect Units (BDU)

Featuring Breaktor® circuit protection technology, the BDU is designed to efficiently distribute power throughout the EV system. The BDU provides improved quality and simplified architecture by combining current switching and resettable bi-directional short-circuit protection with fast actuation (up to 900V).

Breaktor's integrated coil driver, economizer and sensing/triggering circuit reduce overall cost and complexity. Additionally, its self-triggering design, diagnostic electronics and mirror contact help to ensure the utmost safety and reliability.

- **Compact** — enables reduction of up to 15 components from PDU assembly
- **Intelligently safe** — self-triggering device can sense current spikes
- **Reliable** — switching and protection function in one unit

> ***Our customers are looking for a unified solution that can be used across their entire product line. They want a single motor system, a single battery system and a scalable vehicle architecture that can go from producing a compact car all the way up to a full-size SUV. Eaton's battery disconnect units can be used across that entire range.***
>
> — ***Mark VanWingerden***
> Product Strategy Manager,
> eMobility

Key Features — Battery Disconnect Units

Breaktor® used for primary circuit protection, including integrated electronics module, and replaces two contactors, one fuse and one pyro

Integrated pre-charge circuit includes pre-charge contactors and power resistor

Up to 350kW DC fast-charge circuit includes positive and negative contactors and DCFC fuse

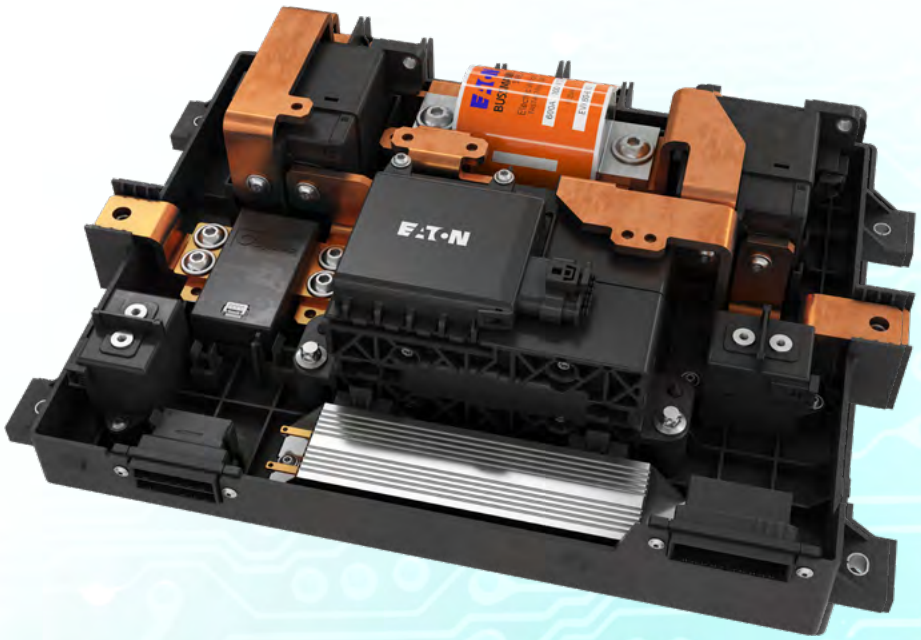
Low-voltage connectors for external control and communication of active components

Isolation detection available

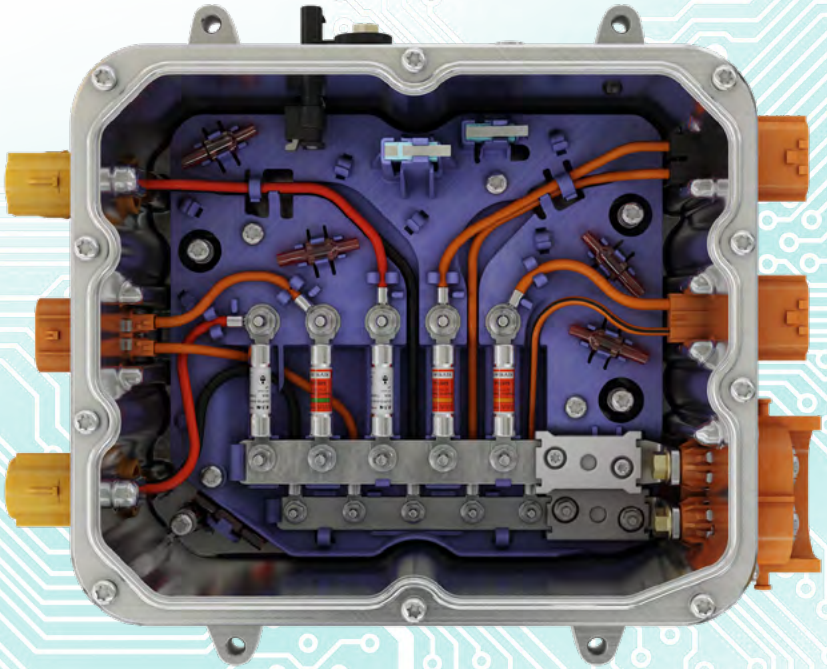
Current and voltage sensing available

Current sensor monitored by BMS

Integrated components including busbars, eyelets and fuses



Learn more



Power Distribution Units (PDU)

The high-voltage PDU delivers power to all critical loads within the electric vehicle system, while protecting electrical and electronic components and vehicle occupants with reliable circuit protection solutions. Eaton's power management and circuit protection heritage provide proven safety and circuit protection during a fault or crash event.

- **Power dense** — featuring integrated components including connectors, terminals and busbars for improved power density
- **Safe and reliable** — Breaktor® and Bussmann® EV fuses offer best-in-class circuit protection for improved system-level safety for any application requirements including high power auxiliary circuits
- **Customizable** — flexible configurations with proven and optimized components that meet unique specifications for current and voltage ratings, circuit protection and output loads

Learn more

Key Features — Power Distribution Units

Input connector rated up to 900V

Vent for pressure regulation

High-voltage insulator with integrated cable routing

High-pressure, die-cast housing for under-hood applications

Sealed high-voltage connectors

HV interlock in PDU cover

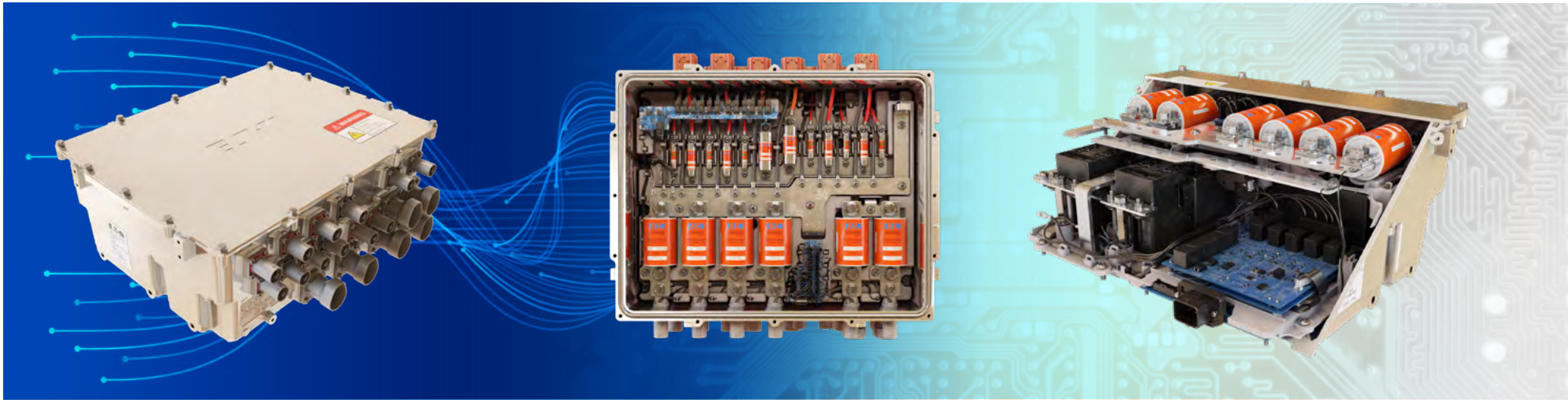
Integrated components including busbars, eyelets and fuses

FLEX Power Distribution Units (FLEX PDU)

The high-voltage, intelligent FLEX PDU is the next-generation option for monitoring and managing all power distributed to power electronics and provides central protection for the electrical system in commercial vehicles.

The FLEX PDU is made up of a series of power distribution elements, which are configurable to meet specific needs.

- **Safe and efficient** — seamless overcurrent protection
- **Fully customizable** — based on a vehicle's power level, number of electric auxiliaries and battery packs
- **Intelligent software** — complete programmable control of system components, communicating operational status and diagnostics



Key Features — FLEX Power Distribution Units

A completely customizable solution with short lead time

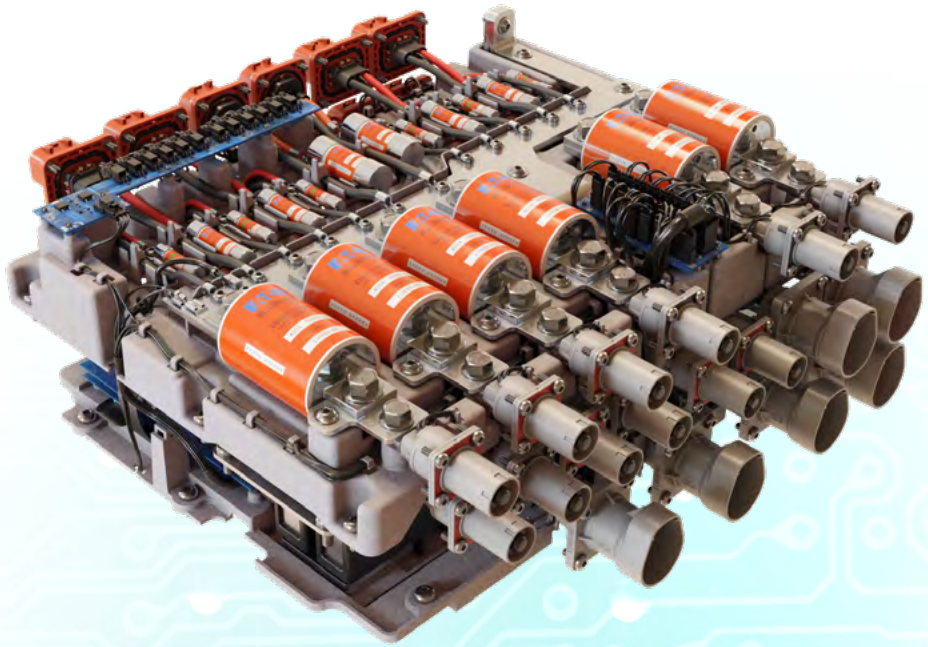
Software integration for complete programmable control of system components

Contactor and fuse operational status monitoring communicates vehicle operational status and diagnostics via Controller Area Network (CAN)

Overcurrent protection between fuse(s) and contactor(s) or Breaktor®

Optional ground fault detection for load circuits

Integrated components including connection systems, terminals and busbars



"Our intelligent FLEX PDU leverages our industry experience and electrical expertise to ensure complete power protection with enhanced vehicle performance and efficiency."

— ***Scott Adams***
Senior Vice President, Mobility Group

Learn more

Automotive News PACE pilot
2022 INNOVATION TO WATCH

Breaktor® Circuit Protection Technology

EV systems must safely and reliably protect people and components during all load situations, including short circuits, overloads and collision events, as well as quick-charging and normal driving scenarios. Eaton's Breaktor® is integrated in battery disconnect units (BDU), power distribution units (PDU) and FLEX power distribution units (FLEX PDU) for a complete power distribution and protection solution.

- **Intelligently safe** — self- and external triggering device can sense current spikes to interrupt the circuit; less than 4-milisecond actuation for short-circuit faults up to 900 volts and 25,000 amps
- **Reliable** — switching and protection function in one unit, with consistent reaction time and no fatigue
- **Easy to service** — resettable like a circuit breaker, enabling reactivation of the device rather than time-consuming vehicle service appointments and device replacements

Watch now

> ***What's very unique about Breaktor is that, upon sensing an overcurrent, it can shut off power completely in less than 5 milliseconds — that's protection in the blink of an eye.***
>
> — ***Kevin Calzada***
> Director, Global Marketing & Strategy

Key Features — Breaktor®

Permanent magnet system
Helps control location of arcing

Splitter plates
Split the arcing into smaller, lower-voltage arcs to help with extinguishing

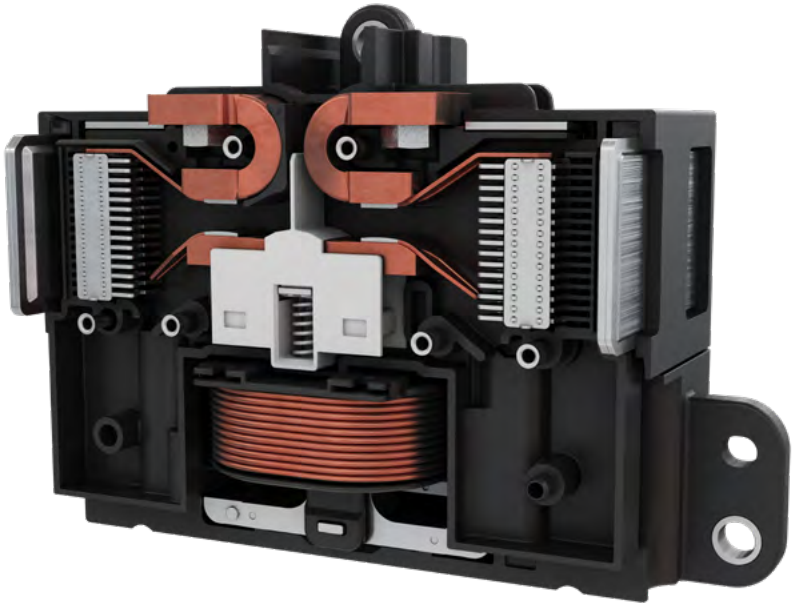
Current sensor
Senses unsafe overcurrent conditions and communicates to on-board PCBA

Driver electronics
Powers Breaktor® actuation and deenergizes coil during overcurrent event

Driver coil
Actuates Breaktor with low-voltage current

350kW DC fast charging
When used to protect and switch the DC fast-charge circuit

Multiple configurations available
Including voltage levels and multi-pole designs



Learn more

EV 3-in-1 Battery Vent Valve

A battery pack thermal runaway situation can occur when individual cells inside the unit fail through physical impact or short circuit. Eaton battery vent valves are designed to enable rapid overpressure release in an electric vehicle battery pack. Battery packs are becoming progressively more powerful and create more heat with stricter ingress protection to increase battery life.

OEMs are designing in new safety systems to ease the impact of thermal events and protect their battery systems from external impacts.

Unique leak check feature

- **Eliminates the need to remove the valve before checking** the battery pack assembly for a leak
- Enables **leak check of all sealing surfaces** of the battery system
- Could **reduce cycle time and cost** of battery system end of line leak check testing

Learn more

Power Connections

High-Precision Connector Technologies

Acquired by Eaton in 2022, our Power Connections business, formerly Royal Power Solutions, is recognized for its numerous industry-leading electrical connectivity components, including battery and eyelet terminals for both electrified vehicle and internal combustion engine vehicles. Demand for these innovative components is rapidly increasing among our global customers.

Our Power Connections technologies provide our customers with components possessing superior reliability, while its in-house design expertise specializes in manufacturing efficiency and system architectures.

Check out more details on our Power Connections portfolio.

Learn more Watch now

Battery Terminals: Eaton's progressive die stamped and formed battery terminals provide leading performance, cost, and weight savings. The stamped battery terminals, which are the electrical contacts used to connect a load or charger to a single- or multiple-cell battery, are designed to meet all industry standards, in addition, Eaton's innovative stamped battery terminals can be customized to customer specifications.

Eyelet Terminals: Eaton's eyelet terminals are produced in our state-of-the-art stamping facilities and feature numerous benefits, including our ability to produce billions of parts annually that are customized to customer specifications, and an extensive product offering with internal manufacturing capability for single sourcing of large programs. Eaton also has an extensive background in die making and stamping, which enables us to meet customer timelines.

High Power Lock Box Terminals: Ideal for current and future electrified vehicle solutions, the High Power Lock Box (HPLB) terminals offer a space-saving profile, superior performance, cost savings and reduced manufacturing complexity, providing efficiency and reliability as well as protection against the elements.

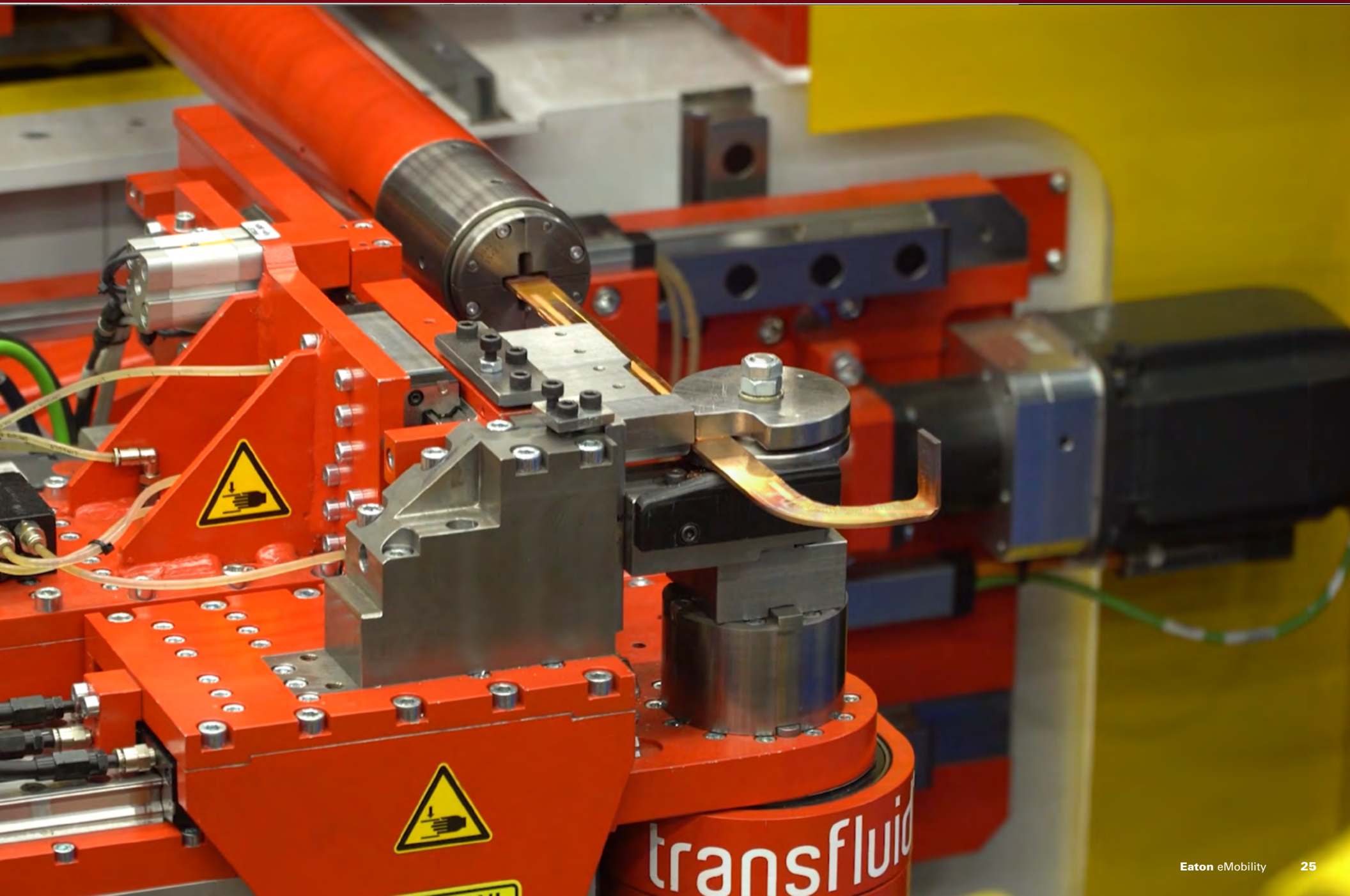
Connectors: Eaton's electrical connectors, which are designed to create an electrical connection between parts of an electrical circuit, or between different electrical circuits anywhere within vehicles. This is especially important in electric vehicles (EVs), where we provide increased affordability, efficiency and safety in power distribution. Connectors use an improved "male/female" connection, which provides a stronger pairing between the "male" protrusion section and the "female" cavity, improving overall reliability and power flow.

Power Connections

Busbars: Eaton offers numerous busbar manufacturing technologies, ensuring the right busbar for every application. Our primary manufacturing processes include progressive stamping, Computer Numerical Control (CNC) bending and our RigiFlex™ technology that delivers flexible solutions. We specialize in both low- and high-volume product mix and can provide prototypes to support development activities.

Support Service: We are a leader in complete system solutions for electrification challenges. We offer one-stop-shop capabilities to design, test and manufacture new products in-house for passenger cars, on- and off-road commercial vehicles and varied industrial uses. Our quality control, certifications and testing deliver exceptional results to meet customer specifications.

The support service power solutions portfolio includes clips, battery terminal covers, power strip assemblies, injection molding, brackets and Insert molding.

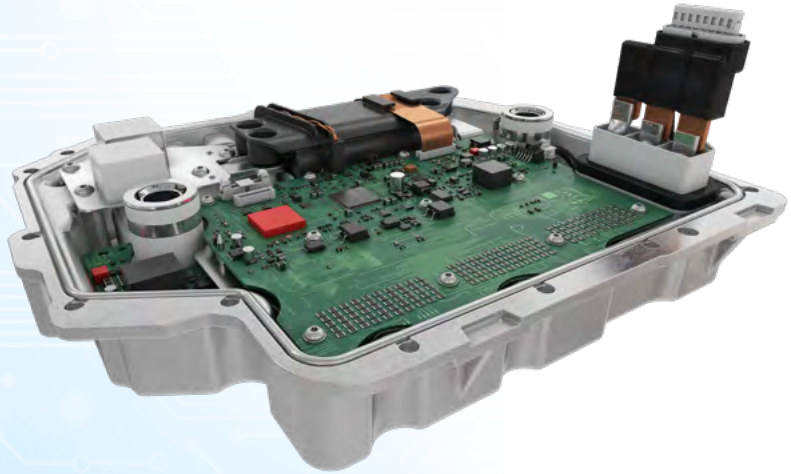

transfluid

Inverters

A better-performing electrified vehicle is the result of our full line of power-dense inverters, from low- to high-voltage. Our high-voltage inverter converts direct current (DC) from the batteries or generator to alternating current (AC) to power the traction drive motors. Eaton's power-dense inverters can be custom configured and integrated to support your unique system requirements. We are also an established and trusted powertrain partner.

Our inverter solutions:

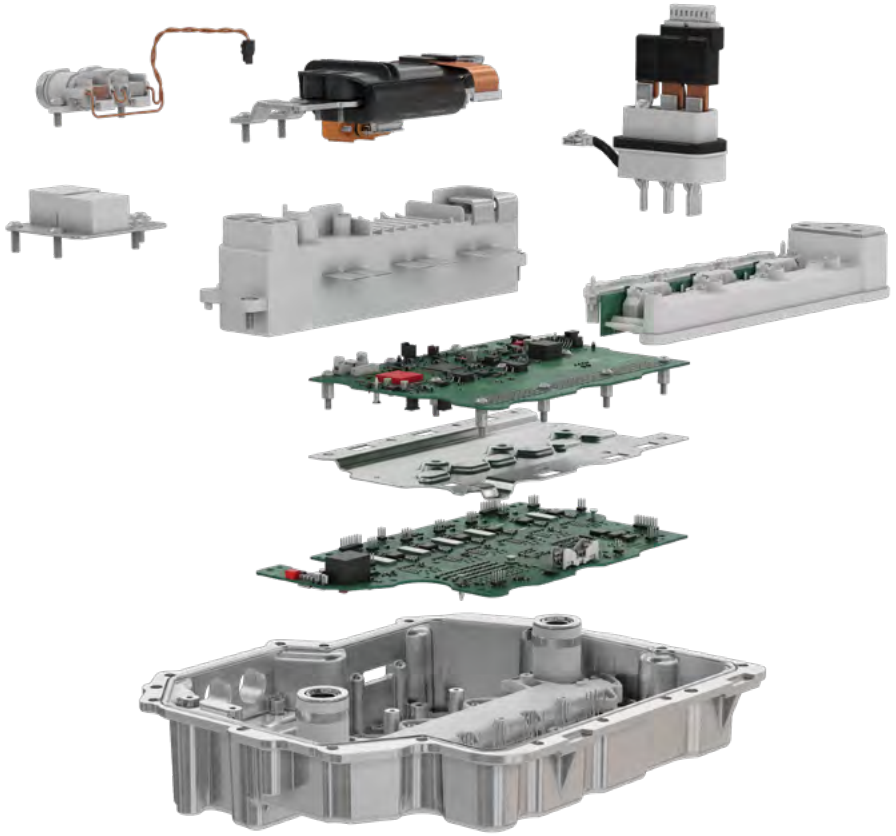
- **Best-in-class power density** — with 56kW per liter, takes up less space in vehicle
- **Efficiency** — optimized use of battery
- **Compact and lightweight** — easier to implement package design
- **Customized mechanical package** — includes motor integration
- **Maximized range** — efficient use of battery
- **Adaptable and scalable** — flexible design allows multiple power levels

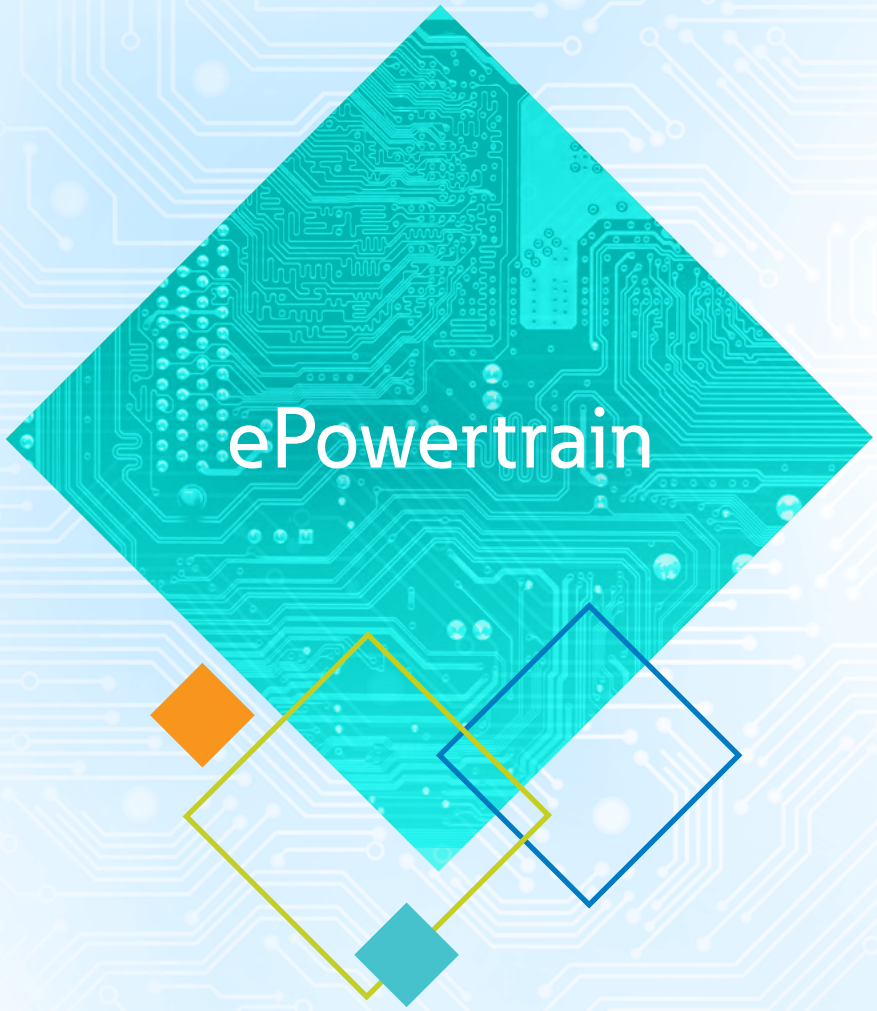


Key Features – High-voltage Inverters

- ISO 26262- and AUTOSAR-compliant
- 35kW-per-liter output
- 70 ˚C with 10L-per-minute flow rate
- 400V system, 85–200kW
- 96% efficiency
- Operating temperatures of -40 ˚C to 125 ˚C
- Custom and integrated aluminum enclosures
- IGBT from 300 to 800A

Learn more





Vehicle manufacturers face many challenges when developing an EV powertrain, such as optimizing efficiency, weight, noise, vibration and harshness (NVH) and dealing with packaging constraints. We help manufacturers meet these challenges by utilizing our many years of experience and in-house capabilities in the design, validation and manufacturing of high-precision, high-quality gearing, transmissions and torque-control solutions.

Eaton's ePowertrain solutions are meeting global needs for more efficient electric vehicle transmissions and accessories.

Our ePowertrain solutions:

- EV Transmissions (diversified commercial applications)
- EV drive module gearing
- EV differentials

Learn more

EV Transmissions

Eaton offers a variety of EV transmissions for commercial vehicles and buses. With over 15 years and 2 billion miles of safe, reliable service, our EV transmissions deliver the efficiency and performance required for the most challenging applications.

Eaton's proven EV transmissions improve performance on grades, allow motors to operate more efficiently and improve top speed in a smaller and lighter package.

- **Efficient motor** — extended range and/or reduced battery size
- **Performance** — improved starting ability with a smaller motor and better acceleration
- **Tailored to the application** — bus, truck, a variety of motor pairings, custom shift calibrations

> ***"The performance and acceleration in electric commercial vehicles is phenomenal. And when you have this peak torque at zero speed, you no longer have to worry about clutches closing."***
>
> — ***Julie Marshaus***
> Engineering Manager

Key Features — EV Transmissions

Integrated electric actuation system

SAE nodal mounts

Transmission-mounted ECU

Direct-drive top gear

Helical gearing

All-aluminum enclosure

Portfolio of EV Transmissions

Eaton offers flexibility to meet application needs.

FEATURE	MD EV 4	MD EV 6	HD EV 4**
Number of forward speeds	4	6	4
EV	√	√	√
PHEV	√	√	
Housing	Aluminum	Cast iron	Aluminum
Max. torque (Nm)	1,200 Nm (Drive) & 850 Nm (Regen)	1,150 Nm	2,600 Nm
Max. input speed (rpm)*	5,000 (EV) 2,800 (PHEV)	4,000 (EV) 2,800 (HEV/PHEV)	5,000
Helical gearing	√	√	√
Smart gear selection	√	√	√
Typical EV applications	City delivery, beverage, tourist bus, shuttle bus,school bus, city bus, logistics	City delivery, beverage, tourist bus, shuttle bus, school bus, yard tractor, municipal, city bus, logistics	Beverage, tourist bus, yard tractor, drayage, city dump truck, municipal, logistics

Note: *Max input speed vocation dependent. **Start of production Q3 2024; final specifications may differ.

EV Transmissions
Medium-Duty 4-Speed Key Specifications & Capacities

Max. input speed	5,000 rpm
Max. torque capacity	1200 Nm (Drive) & 850 Nm (Regen)
Dry weight	101.38 kg
Total length	450 mm (including output flange)
Oil capacity	7.5 liters
Maintenance intervals	3 years or 300,000 km oil change

Ratio	1st	2nd	3rd	4th	Overall
	4.83	2.82	1.65	1.00	4.83

Learn more

EV Transmissions
Medium-Duty 6-Speed Key Specifications & Capacities

Max. input speed	4,000 rpm (EV) 2,800 rpm (HEV/PHEV)
Max. torque capacity	1,150 Nm
Dry weight	170 kg
Total length	590 mm (including output flange)
Oil capacity	9.2 liters
PTO	Side PTO
Maintenance intervals:	3 years or 300,000 km oil change (bus/vocational)

Ratio	1st	2nd	3rd	4th	5th	6th	Reverse	Overall
	7.05	4.13	2.52	1.59	1	0.78	6.75	9.03

Learn more

EV Transmissions
All-New Heavy-Duty 4-Speed Key Specifications & Capacities

Max. input speed	5000 rpm
Max. torque capacity	2600 Nm
Dry weight	192 kg
Total length	650 mm (including output flange)
Oil capacity	7L
PTO	Rear PTO
Maintenance intervals	TBD

Ratio	1st	2nd	3rd	4th	Overall
	5.88	3.30	1.82	1.00	5.88

Note: *Start of production Q3 2024; final specifications may differ.

- **Pupose-built design for electrified commercial vehicles**
- **Improves vehicle performance**
- **Flexible shift schedules**
- **Engineered with industry leading expertise**
- **Uncompromised gradeability**
- **Efficient motor use, extended range and/or reduced battery size**

Learn more

Precision in Packaging

Eaton delivers packaging efficiencies to meet the unique needs of each application. Our advantage comes from our deep experience managing electrical energy around the world and our automotive prowess, proven on roads for decades.

Lighter, smaller, smarter, tighter — we understand the requirements. More importantly, we can help you meet them. Less weight, more fuel efficiency, less cost, more intelligence — these are the solutions we're bringing to our automotive partners every day.

"Electric buses and trucks need to be able to go up hills and run at highway speeds when they are fully loaded. Our solution is to expand the range of the motor by adding an EV transmission. With this addition, the vehicle can perform well on hills and efficiently at highway speeds with a smaller, less costly motor."

— ***Scott Adams***
Senior Vice President,
Mobility Group Global Products

EV Differentials

As the market transitions to EVs, drivers' performance expectations will remain the same. We have a full range of limited-slip and locking differentials that offer improved traction in adverse conditions, better stability while towing and maximum off-road performance regardless of the drivetrain. With decades of experience working with global automotive manufacturers integrating differentials into new vehicle platforms, we have the necessary capabilities to design and optimize our differentials for the unique torque requirements and efficient packaging requirements of electric vehicles.

- **15 years** of experience developing hybrid systems
- **Partnering** with major OEMs and suppliers to develop and provide torque management solutions
- **More than 500,000** differentials supplied for EVs since 2015

IntelliTrac

Smart, electronically controlled, limited-slip differential is fully integrated to the vehicle to provide instant response and optimized vehicle performance at any speed or under any traction condition.

Truetrac

Helical-gear, limited-slip differential maximizes wheel traction and enhances driving and handling characteristics. Easily integrated into compact packaging spaces, with high-power density capacity.

ELocker

Electronic locking differential that allows for maximum driveline flexibility. Users can switch from a fully open to a fully locked axle at tthe touch of a button or it can be integrated into the vehicle (auto-locking). High torque capacity and range, with compact designs for EV applications.

Open

Compact open differential that allows a cost-effective solution for managing torque between left and right wheels.

InfiniTrac

InfiniTrac is an electronically controlled, hydraulically-actuated limited slip differential that provides variable torque up to full axle lock. Integrated with vehicle sensors, it automatically identifies the optimal traction solution at any speed.

Learn more

EV Gearing

We help electric vehicle manufacturers improve performance and driving range with our world-class capabilities in modeling, simulation, design, and manufacturing, which deliver EV drive gearing solutions that optimize system efficiency, NVH, and cost. As a proven leader in reduction gear design and manufacturing, we can improve EV drive units with innovative solutions.

Learn more

Innovative solutions

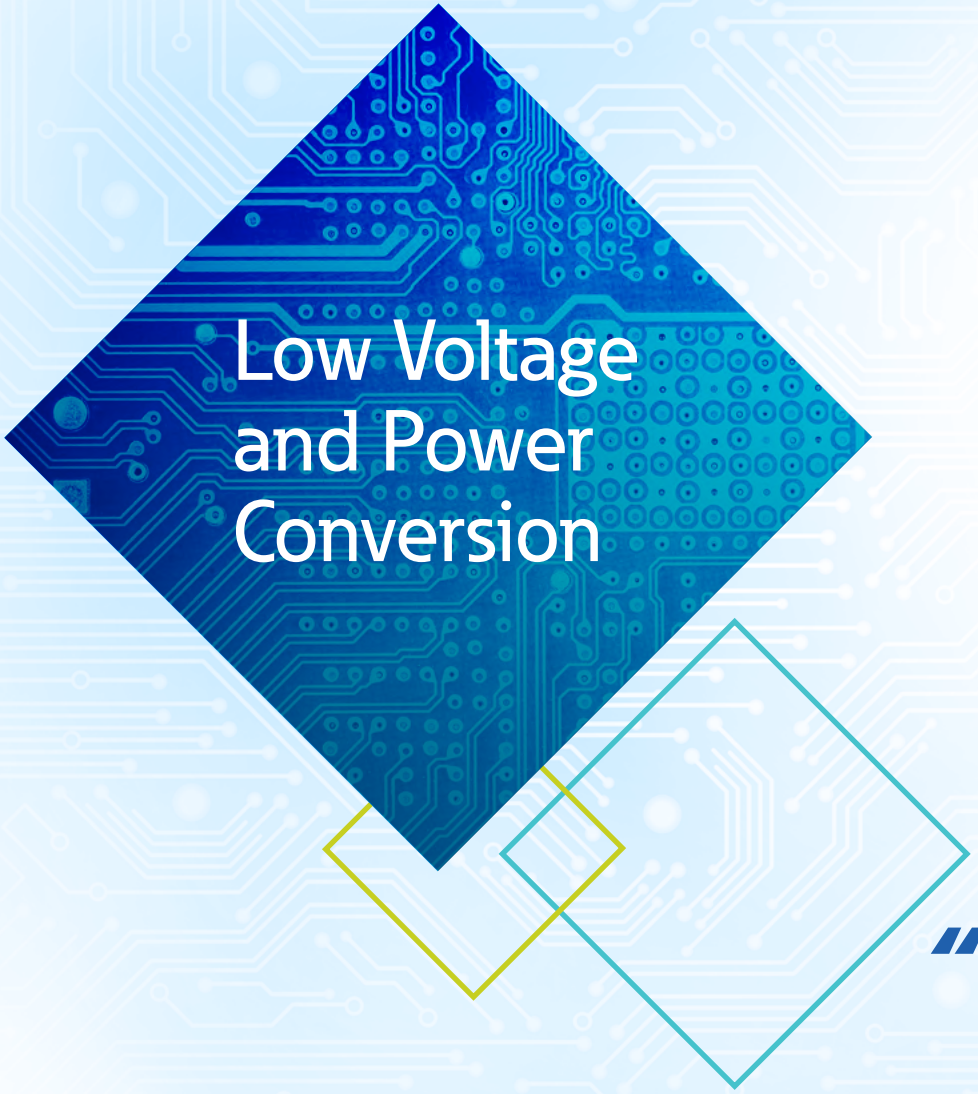
- Lightweight, low-NVH EV drivetrain gear designs
- Compact, power-dense reduction gear solutions
- Optimized gearing designed for efficiency, NVH, weight and cost
- Eaton proprietary steels to reduce cost
- Gear and shaft joint design optimized for cost and ease of manufacture

Proven performance

- Supporting both commercial vehicle and light vehicle EV drive markets
- Over 100 years experience supplying the global vehicle transmission and gearing market
- Manufacturer of high-quality and precision gears and shafts
- Tailored system design, manufacturing and assembly to accurately control gear characteristics
  - o Inspection and monitoring of in-process parameters
  - o Manufacturing process selection for precision hard finishing

Global gearing capabilities

- Global manufacturing and engineering footprint
- State-of-the-art proprietary design tools and in-house know-how to optimize:
  - o Root geometry for maximum strength and reduced weight
  - o Microgeometry for noise and efficiency
  - o Power losses trade-off studies
- In-house forge, heat-treat and machining capabilities



Our team at Eaton brings together vast electrical and industrial experience to give you a robust portfolio of Low Voltage and Power Conversion products. These commercial vehicle solutions range from off-the-shelf catalog products to fully customized, next-generation systems that enable differentiation.

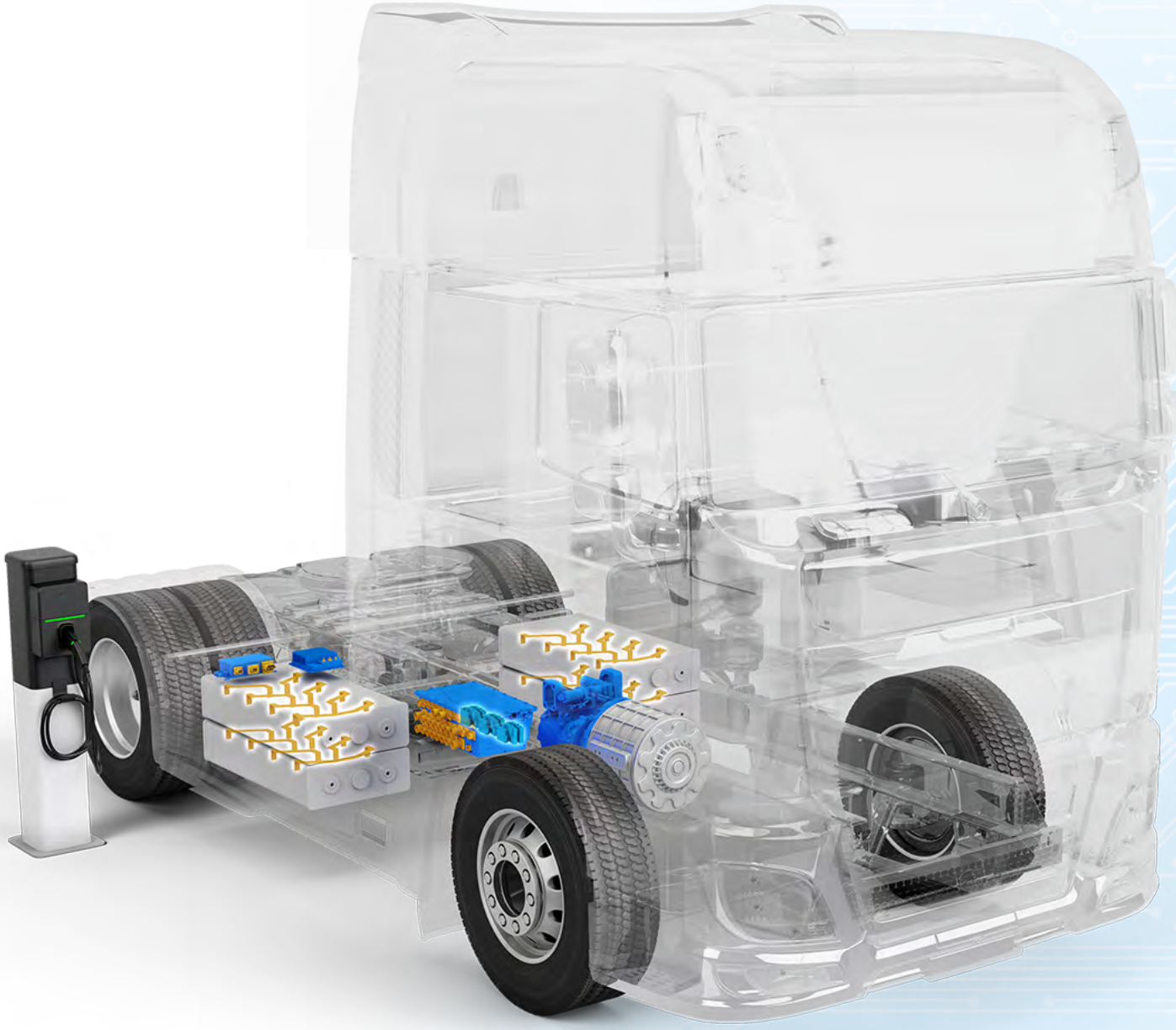
The engineering strength and proven track record of the Eaton, Bussmann®, Sure Power and OMNEX product portfolio provide you with the capability to accelerate "smart system" and custom component development, resulting in innovative, industry-leading solutions.

We are experts on the effects of harsh environments relating to temperature extremes, vibration, high moisture, chemicals and transient power fluctuations. We know vehicle power and control systems from the smallest to largest platforms and will partner with you to develop reliable products and system solutions. Check out more details on our Low Voltage and Power Conversion portfolio.

Learn more

"Our low-voltage product portfolio is highly diverse, competitive and customizable to meet the power management needs of our on-road and off-road key OEM customers, as well as channel partners. Our continued investment in this portfolio ensures that we maintain our technical superiority in key product lines."

— ***Pratik Trivedi***
VP General Manager



Low-Voltage Power Conversion

Eaton's power conversion solutions provide standard and custom products for a wide range of DC/DC conversion, battery equalizer and DC/AC inverter requirements. Exceeding the most stringent performance requirements of military, commercial vehicle, agriculture and construction applications, Eaton provides rugged products that maximize vehicle productivity and useful life.

Our low-voltage power conversion solutions:

- **Optimally ruggedized** for transportation applications including state-of-the-art vibration, emissions and abnormal use features, such as reverse polarity protection
- **Designed to meet specific customer requirements** including, SAE, ISO, E mark, CE and military standards, as well as application specific environmental requirements

Learn more

> ***Eaton eMobility has supplied traditional low-voltage 24/12V DC/DC converters and battery equalizers for 30 years. These power conversion products are designed, tested and validated to meet commercial vehicle and construction/agriculture and military vehicle standards and have demonstrated millions of combined hours and miles of reliability in these rugged applications.***
>
> — ***Carl Smith***
> Sales Manager

DC/DC Converters provide regulated power directly to accessory or main loads. The DC/DC converters produce 24V power from a 12V source and 12V power from a 24V, 48V and 72V sources.

DC/DC Charger Series allows operators to charge a remote battery bank at a temperature compensated voltage. This technology eliminates voltage loss due to long wire lengths and automatically adjusts for temperature extremes.

DC/DC Battery Equalizers maintain battery balance in vehicle applications with multiple voltages and high peak load demand. Eaton battery equalizers produce 10A to 100A outputs to equalize 12V and 24V systems.

True Sine Wave Commercial Vehicle and Military Inverters can power all electrical loads up to 1,800W, including sleep apnea machines, tools, motors and other demanding electrical devices.

48V E-Heater Power Electronics Controller

The Eaton aftertreatment e-heater controller is an air-cooled, power-electronic converter designed to regulate 48-volts to a catalyst heater element for commercial vehicle emission control applications.

Designed for high efficiency and accurate power output up to 10kW, the e-heater controller contains all the necessary power electronics to ensure the electrical system remains stable during operation.

Our 48V E-Heater Power Electronics Controller:

Optimally ruggedized for transportation applications including state-of-the-art vibration, emissions and thermal performance, with exceptionally long life.

Learn more

Key Features – 48V E-Heater Power Electronics Controller

Controls a total of 200 amps of load current to a resistive heater element

Regulates and supplies power to a heating coil in the vehicle's aftertreatment system

Helps reach efficient operating temperatures as quickly as possible and maintains these temperatures during low load operation

Significant NOx reduction of up to 75 percent

Eaton integrated components include power connectors (HPLB RD8) and signal connectors (TE HDSCS 12-pin)

Key Differentiators

- Manages power to aftertreatment heater
- >99% peak efficiency
- Soft-start and soft-stop control
- Precise power regulation
- Optional power protection/limitation software feature
- Air cooled power electronic converter for easy integration

48V DC/DC Converter

Eaton's family of 48V DC/DC converters offers high-efficiency, bi-directional operation and air-cooled design specifically designed for the demands of commercial vehicle electrical systems.

- **Rugged design** — robust design to operate in harsh applications
- **Clean output power** — enables powering of sensitive loads, including radios and controllers
- **System flexibility** — multiple power and voltage levels available, supporting unique system requirements

Learn more

"Eaton has legacy of developing low-voltage power conversion and power electronics solutions. We have been selling these technologies for decades for global agricultural and military applications, among others. We are now introducing this innovative 48V technology to the commercial vehicle sector."

— Ben Karrer
Head of Engineering, Low Voltage and Power Conversion

Key Features – 48V DC/DC Converter

Input voltage range: 28V–72V

12V–28V output available with CAN control

500W–6kW versions available

IP69K sealed enclosure

CAN diagnostics

Bi-directional-capable

Efficiency of up to 97%

Air-cooled, reducing integration costs

Key Differentiators

- Operation at ambient temperatures up to 85 °C
- Up to 97% efficient design, optimized to provide low power loss over a wide operating range
- IP69K-sealed, including power and control connectors
- Digital control architecture; flexible control modes through firmware adaptation
- Compatible with ASIL B functional safety requirements
- Family of converters allows OEMs to choose a DC/DC converter similar to alternator specification

High-Voltage DC/DC Converters

Exceptionally reliable, safe and easily customizable, our DC/DC converter changes the higher voltage of the battery to the lower voltage needed to power a vehicle's entertainment system, windows and/or safety features.

Eaton DC/DC converters are proven to provide clean and reliable power for the high-voltage system. Because of their excellent performance and reliability, they are selected for a variety of applications, including construction, agriculture, commercial and passenger vehicles.

- **Proven design** — 50+ years of DC/DC converter expertise, including 7+ years of BEV production
- **Custom solutions** — leveraging standard production processes
- **Quiet, clean output power** — enables powering of sensitive loads, including radios and controllers
- **Compact, lightweight design**
- **Excellent system flexibility** — accepts wide range of input voltage and multiple output voltages

Learn more

Key Features – DC/DC Converter

Input voltage range input: 225V —850V

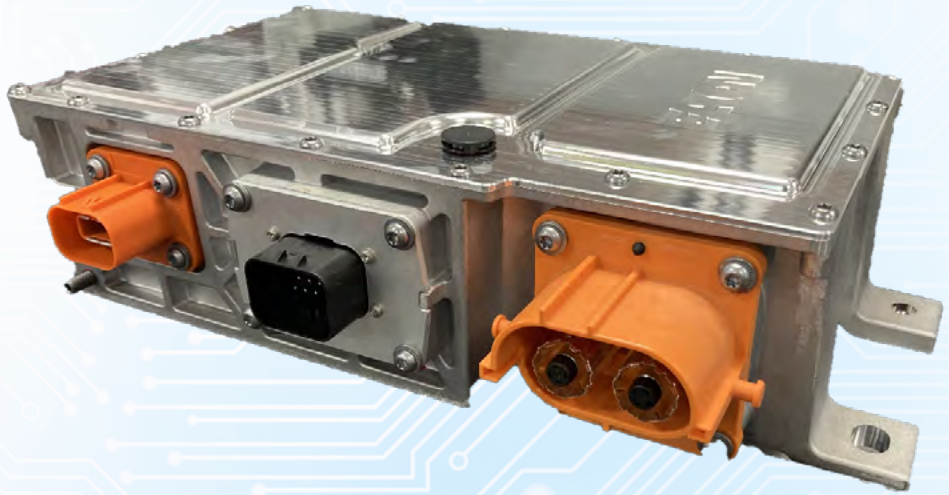
Output voltages of 12, 24 or 48V

3kW output power

95% efficiency

Custom aluminum enclosures

Custom cooled



Key Differentiators

- Operation at ambient temperatures up to 85 °C
- 95% efficient design, optimized to provide low power loss over a wide operating range
- IP6k9k-sealed, including power and control connectors
- Compatible with ASIL B functional safety requirements
- Compatible for Cybersecurity UN R155 regulation
- Flash Over the Air functionality
- Power density 1 kW / l
- Reversible with Pre charge function

Low-Voltage Power Management

Eaton's commercial vehicle power management product portfolio offers a wide variety of battery management and protection solutions, including:

- Intelligent battery separators and interconnect controllers
- Manual and automatic low-voltage disconnects
- Battery isolators

We also have expertise in providing specialty control solutions:

- DC current sensors
- Solid-state flashers
- Daytime running lights

Battery Separators

Battery Interconnect Controller

DC Current Sensor

> ***Manufacturers are striving to electrify all aspects of vehicles and are in various stages of the technology curve. Eaton's low-voltage products are rugged and able to withstand harsh environments, making them ideal for off-highway applications.***
>
> — ***Craig Pytel***
> Product Manager, Vehicle Controls and Wireless

Learn more

Low-Voltage Power Distribution

Eaton's off-the-shelf and custom-designed power distribution products provide and protect vehicle power distribution, including vehicle electric centers, power distribution modules, fuse panels, fuse holders and junction blocks.

Our product range offers multiplexing capabilities, high power ratings, ignition protection options, and flexible configurations, with rugged and serviceable, agency-compliant designs with a range of sealing options up to IP6K9K.

- Fuse holders and panels
- Rear-fed fuse and relay modules
- Vehicle electrical centers and connectors
- Power fuse and power relay modules
- Stud type junction blocks

Learn more

Series 31M – multiplexed vehicle electrical center offers economical Controller Area Network (CAN) oversight for high-power circuits in vehicle power distribution. The mVEC may be configured to provide various OEM circuit protection and switching functions, using industry standard fuses, relays and breakers.

PDM-AMI Series (multiple fuse holder family) has been designed to allow up to four bolt-in style AMI (midi) fuses to be connected while providing protection from difficult environmental conditions. This holder is a sealed solution for higher current (30A-200A) requirements.

Series 154M – multiplexed rear-fed fuse and relay has a Controller Area Network (CAN) interface and rear fed sealed connectors. The mRFRM communicates with other devices on the vehicle's CAN bus using the SAE J1939 protocol and can be part of a multiplexing system that eliminates the need for individual connections between switches and loads.

Low-Voltage Circuit Protection

Eaton's leadership in circuit protection extends into commercial vehicles with blade and bolt-on circuit protection devices, including a variety of thermal circuit breaker and fuse solutions.

Solutions range from low-current branch circuit fuses and circuit breakers up through 200-amp switchable circuit breakers that protect and control heavy-vehicle electrical systems. Eaton also offers a range of manual and automatic battery disconnects in our line of commercial vehicle power management products.

Learn more

Vehicle Controls

Our vehicle controls portfolio offers a broad range of solutions not only for on- and off-road vehicles, but also for commercial machine applications that require rugged, dependable switches. These products are at the heart of many systems, including heavy-duty trucks, construction and agriculture.

Eaton is proud to offer solid-performance vehicle and commercial controls for global applications, including everything from electromechanical push-button rocker and toggle designs to electronic rocker, indicator and display devices — all of which are customizable.

- Electronic switches and keypads
- Rockers
- Special devices
- Toggle switches
- Dimmers and wipers
- Pushbuttons

Learn more

Electronic switch modules

Designed to support harsh environmental applications, the E33 electronic multiplex switch module offers sealing to IP68 and additional features including guarded and locking rockers. The E33 also provides flexibility of up to eight switch modules (24 switches total) per CAN node and exceptional visual feedback via Eaton's extensive library of icons and multi-color indicator bar.

Keypad multiplexed switch modules

The E31 Keypad modules are sealed to IP68 from the front and rear. This allows them to meet requirements in severe environment applications with exceptional tactile and visual operator feedback with up to four independent indicator LEDs.

Wireless Controls

For more than 25 years, Eaton's OMNEX Trusted Wireless™ remote control products have been used to wirelessly control high value machinery in harsh environments with utmost reliability, precision and durability. Our team of engineering experts develop customized solutions for applications that require high degrees of operator flexibility and safety when operating and manipulating vehicle-mounted equipment and mobile machinery.

Learn more

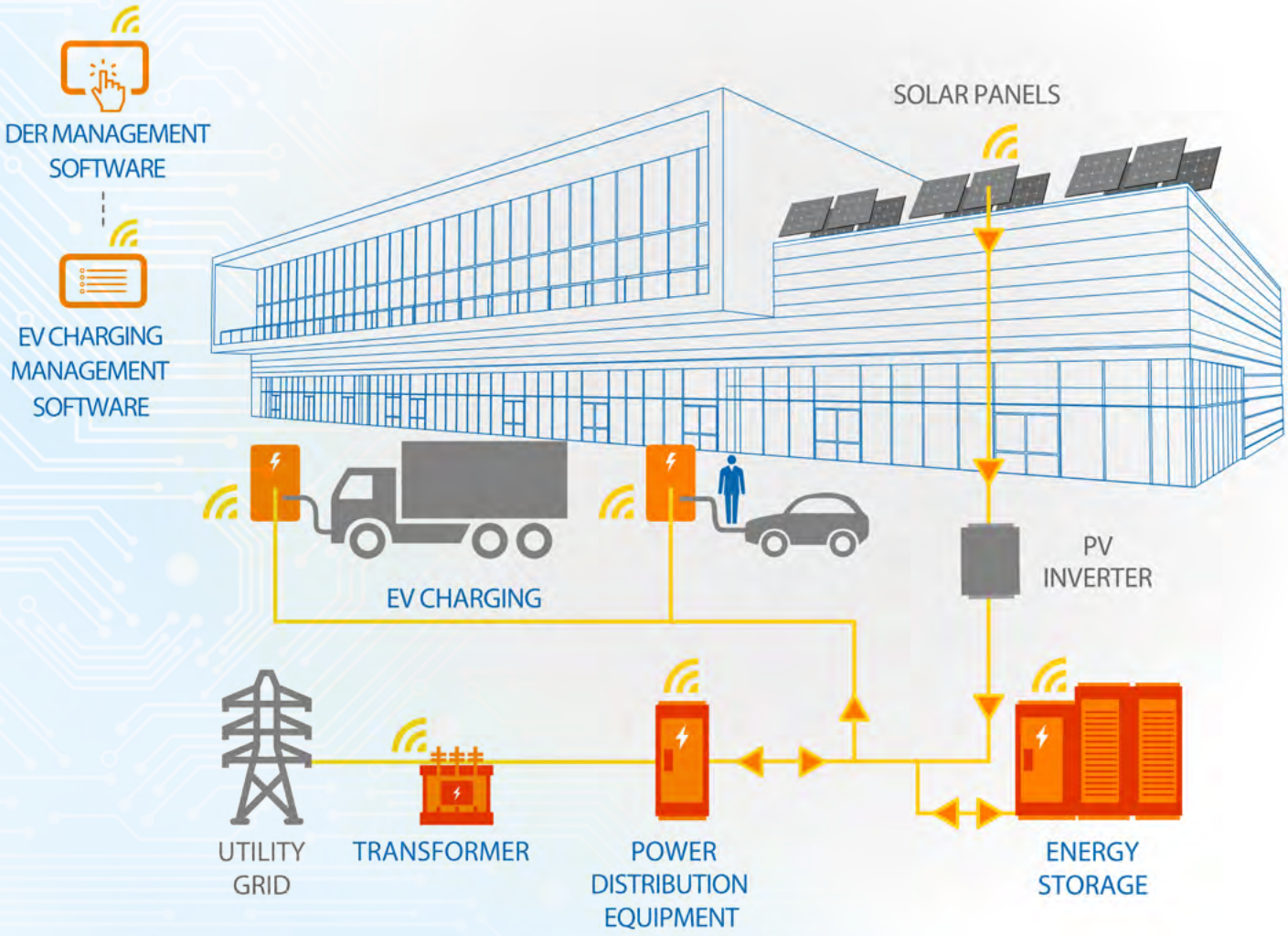
Receivers

Eaton's factory-configurable receivers are designed to work with our transmitters to provide complete mobile control solutions that stand up under the most demanding industrial conditions. Receivers directly connect to machine hydraulic valves and/or CAN bus for complete control. Our industrially hardened Trusted Wireless FHSS radio technology and impact resistant packaging are your assurance of dependable operation and precise control.

Two-way transmitters

Eaton's OMNEX Trusted Wireless™ robust, easy-to-use one-way and two-way remote-control transmitters are designed to perform on a large variety of mobile industrial machines. OMNEX industrially hardened Trusted Wireless FHSS radio technology and impact-resistant packaging are your assurance of dependable operation and precise control.

Comprehensive EVCI Solutions



The future of electric vehicles is here, and the demand will only increase. As there are more EVs on the road, drivers will want the option to conveniently charge on the go, and buildings will need the infrastructure to support this demand. Eaton is here to help.

Our comprehensive electric vehicle charging infrastructure (EVCI) solutions and services to unite the power needs of buildings and electric vehicles with on-site renewable energy generation. We can help you plan, deploy and manage sustainable systems that support electric vehicle charging safely and reliably.

EV charging

AC Level 2 and DC Level 3 fast chargers for residential, commercial and fleet operations

Energy storage

Eaton xStorage battery energy storage system (BESS) includes batteries, inverters and management software to shave peak demand cost for EV charging applications

EV charging network management software

Eaton EV Charging Network Manager software enables users to operate a network of charging stations, from charging point management and power management to financial rules

Microgrids and Distributed Energy Resource (DER) integration

Incorporates local solar photovoltaics and other renewables into EV charging infrastructure to help meet sustainability goals

Power distribution equipment and grid connection upgrades

Installation and upgrades of electrical equipment, including transformers, switchgears, switchboards, circuit breakers and battery storage

Electrical engineering services

Include feasibility analysis of planned EV deployment sites, power systems analysis of electrical infrastructure, electrical system conceptual design and configurations, system

Learn more

EV Charging and Energy Management Solutions

Eaton's full EV charging infrastructure portfolio works together to simplify electrification and enables lower total cost of ownership (TCO)

	AC Charger Range			DC Charger Range	Power Distribution Equipment	Energy Storage	Digital Solutions	
	Eaton Green Motion EV Smart Breaker Charger	Eaton Green Motion Building series	Eaton Green Motion Fleet series	Eaton Green Motion DC Fast Charger	Eaton Broad Portfolio of Power Distribution Equipment	Eaton xStorage battery energy storage system	Eaton Green Motion EV Charger Manager App	Eaton Charging Network Manager
								
Max. Output Power Rating	**7.7kW @ 240Vac**	**7.7kw -11.5kw @ 240Vac**	**19.2kW @ 240Vac**	**50kW - 150kW @ 480Vac**	**120Vac - 38kVac**	**250kW - 1MW 1+ hour runtimes**		
Residential Private	√				√		√	
Multi-Tenant Residential	√	√	√		√	√		√
Workplace and Community		√	√	√	√	√		√
Fleet and Highways			√	√	√	√		√

Designing the Products of Tomorrow.

What does the future of electric transportation look like? Ask Eaton eMobility's Advanced Technology Team. They're designing it every day.

More power density, adding more intelligence to components, new ways of combining electrical and mechanical engines, more electric performance cars, improved battery performance and brand-new modes of transportation are on the short list.

While the innovations of 10, 15 or 20 years from now are in development at Eaton, our work today is better, thanks to this kind of forward-thinking exploration.

Learn more

"Our commitment to innovation puts us at the forefront of a transformative era, where clean and intelligent transportation will reshape the way we move, connecting us to a brighter, greener future."

— ***Mark Schneider***
President, eMobility

Powering Business Worldwide

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