



The DNA of tech.™

# Market Development

Diodes for the Automotive Industry:  
Application Overviews and Block Diagrams

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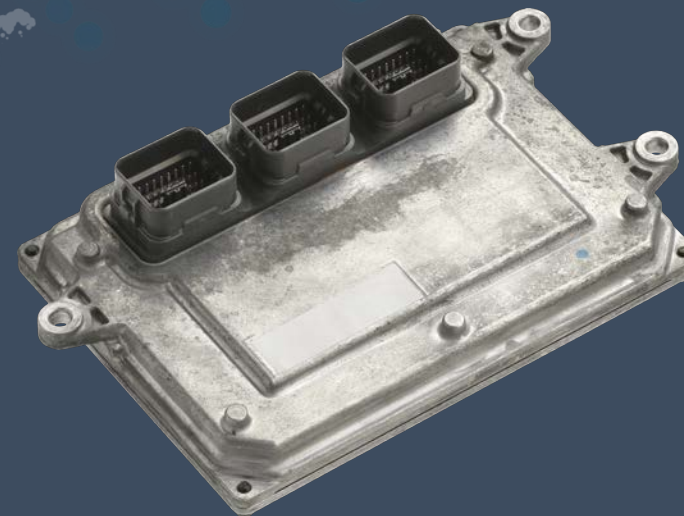
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# Engine Vehicle Control Unit - 12 V to 24 V

Engine Cooling System  
Exhaust Control System







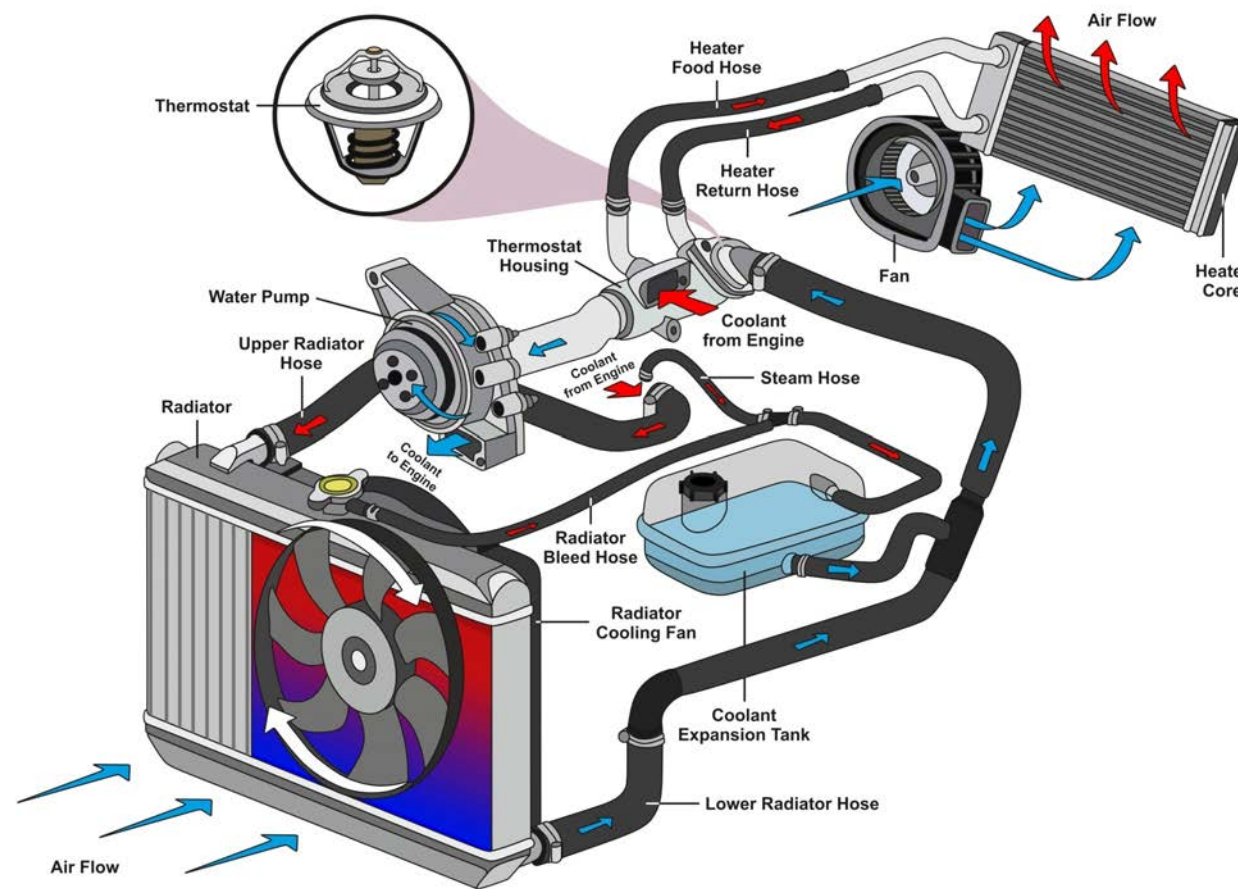
# Engine Cooling System



# Engine Cooling System

## Main Features

- A thermal management system optimizes the hot and cold balance in the vehicle. Heat is produced by the combustion engine in conventional vehicles or by electric vehicle components (battery, motor, and power electronics). This heat is absorbed at the heat source by the coolant circulating in the cooling circuit and dissipated at a heatsink
- Coolant pumps and valves are regulated by a superordinate control unit to provide demand-based circulation of the cold or warm coolant in any operating condition
- Key features:
  - Shorter warm-up phase
  - Fast passenger compartment heating
  - Low fuel consumption
  - Longer service life of the components

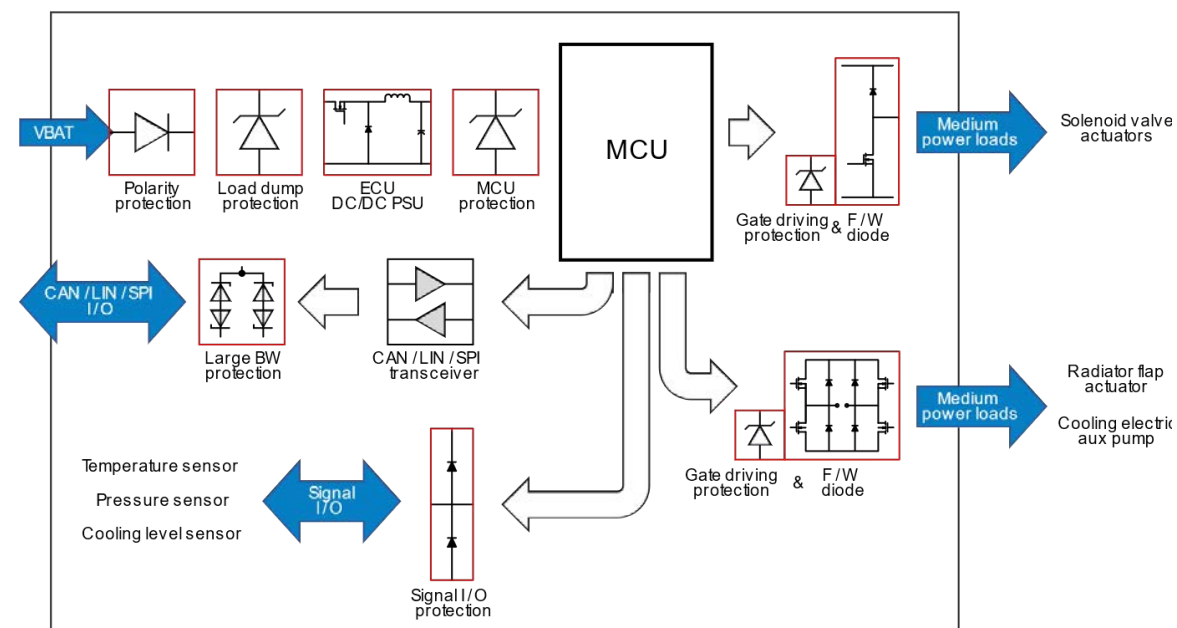


# Engine Cooling System

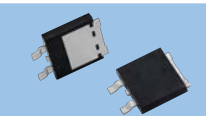



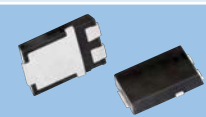

## System Benefits

- Vishay's 60 V to 120 V first-generation trench MOS barrier Schottky (TMBS®) devices deliver efficiency for high frequency rectification
- 200 V ultrafast FRED Pt® technology is optimized for soft behavior at any temperature. Offering high stability and robustness up to 175 °C, the devices are suitable for under the hood applications such as freewheeling diodes, load switching, HV boost, and polarity protection
- Surface-mount PAR® TVS provide stability in high temperature, high reliability conditions
- Vishay's enhanced surface-mount power (eSMP®) package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

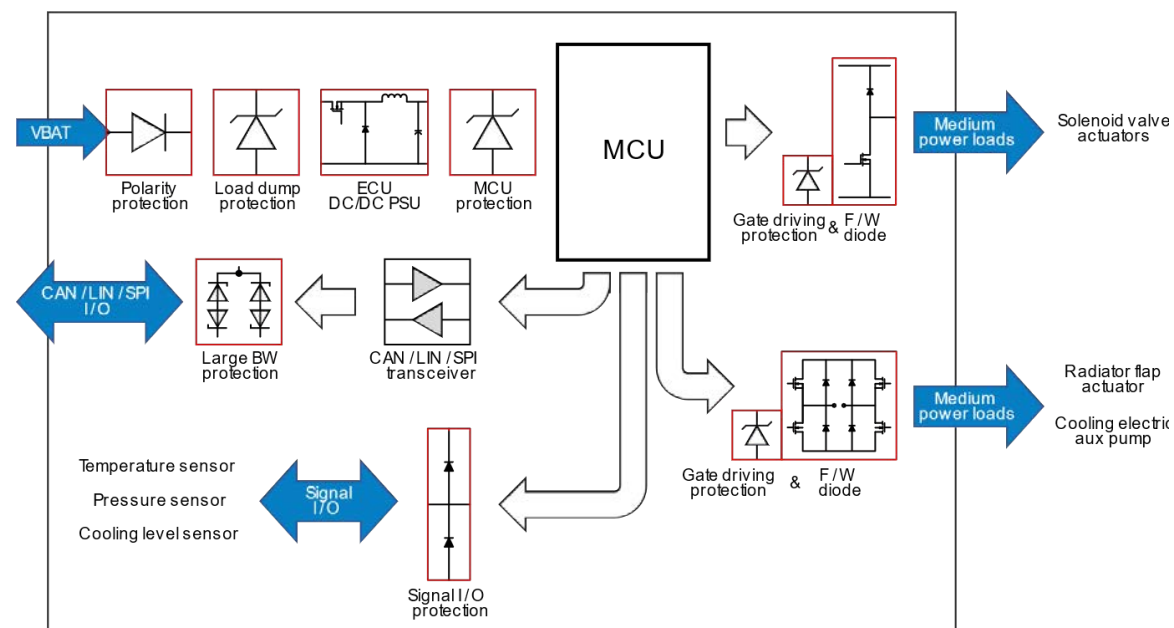
## Block Diagram

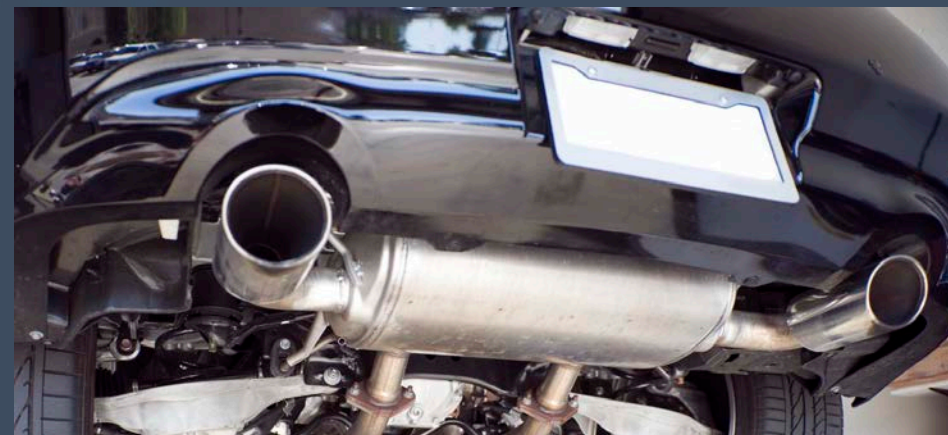


# Engine Cooling System

Function	Description	Image
Freewheeling Diode	20 A, 120 V dual high voltage TMBS® rectifier	 (SMPD)
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	 (DO-218AB)
HF Rectification	FRED Pt® hyperfast rectifier	 (SMF)
Load Switching	FRED Pt® hyperfast rectifier	 (SlimSMA)
HV Boost	FRED Pt® hyperfast rectifier	 (SMPC)
Voltage Stabilization	Standard recovery diode	 (SMF)

## Block Diagram





# Exhaust Emission Control System

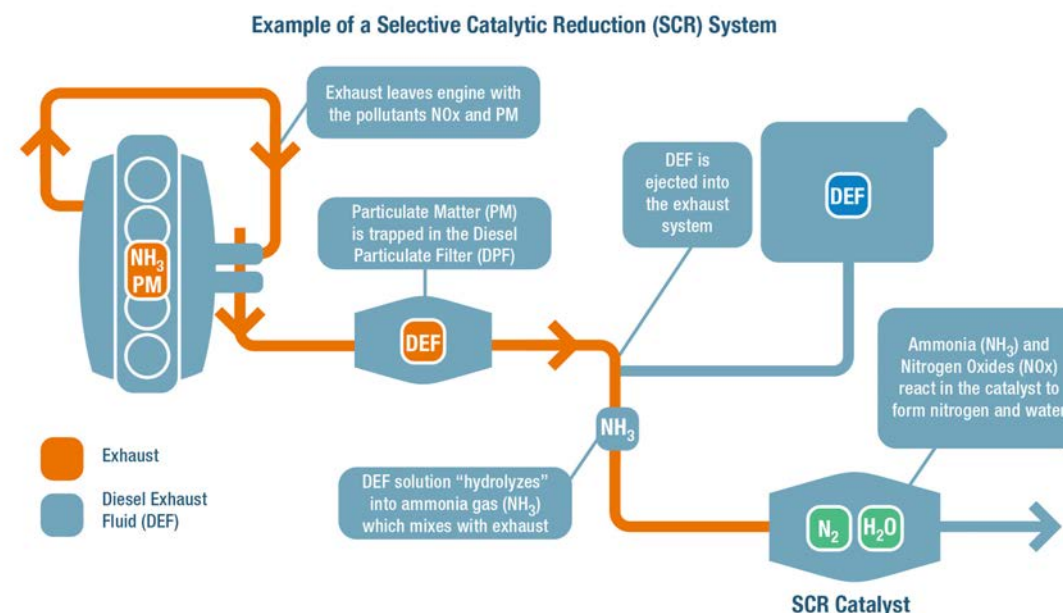




# Exhaust Control System

## Main Features

- Emission control system in automobiles, employed to limit the discharge of noxious gases from the internal combustion engine and other components. There are three main sources of these gases:
  - Engine exhaust
  - Crankcase
  - Fuel tank
- The exhaust pipe discharges burned and unburned hydrocarbons, carbon monoxide, nitrous oxide, and sulfur; as well as traces of various acids, alcohols, and phenols. These are very critical elements of pollution
- Being diesel largest ICE adopted WW, the latest exhaust control system is SCR. Selective catalytic reduction (SCR) is a chemical process that converts the NOx into diatomic nitrogen and water, as well as a small amount of CO<sub>2</sub>. This process is facilitated by the addition of automotive-grade urea (known as diesel exhaust fluid (DEF)) to convert hazardous NOx emissions from diesel into harmless N<sub>2</sub> and H<sub>2</sub>O

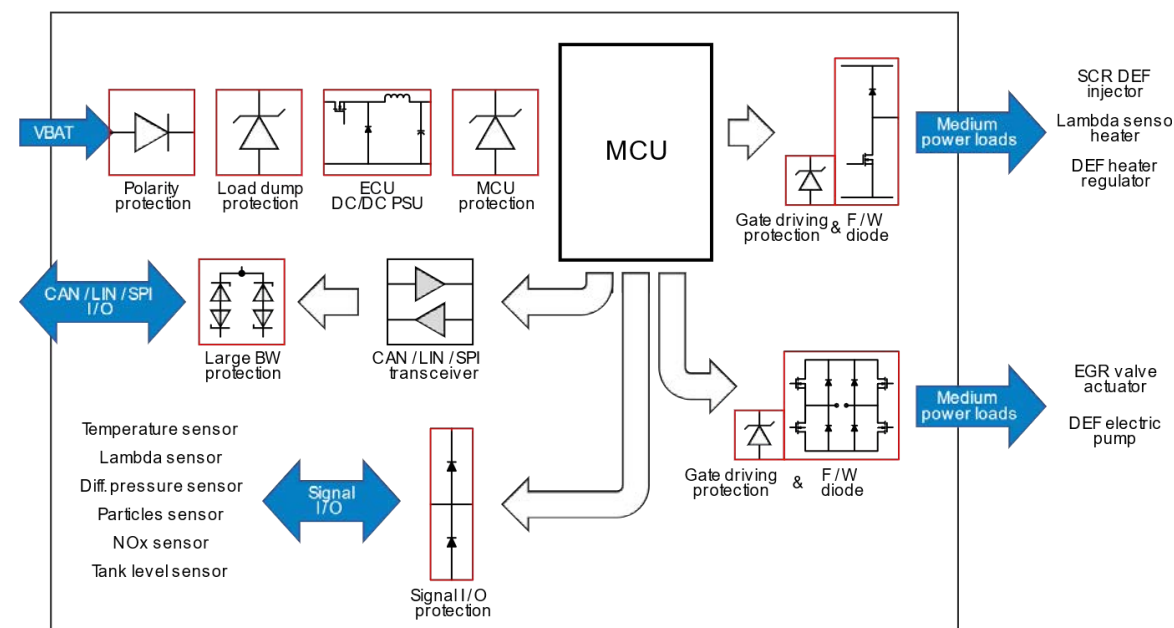


# Exhaust Control System

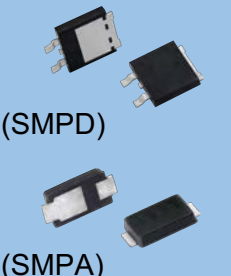



## System Benefits

- Vishay's 120 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- Surface-mount PAR® TVS provide stability in high temperature, high reliability conditions
- Standard recovery diodes with ESD capability in miniature packages for rail to rail line and power line protection
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

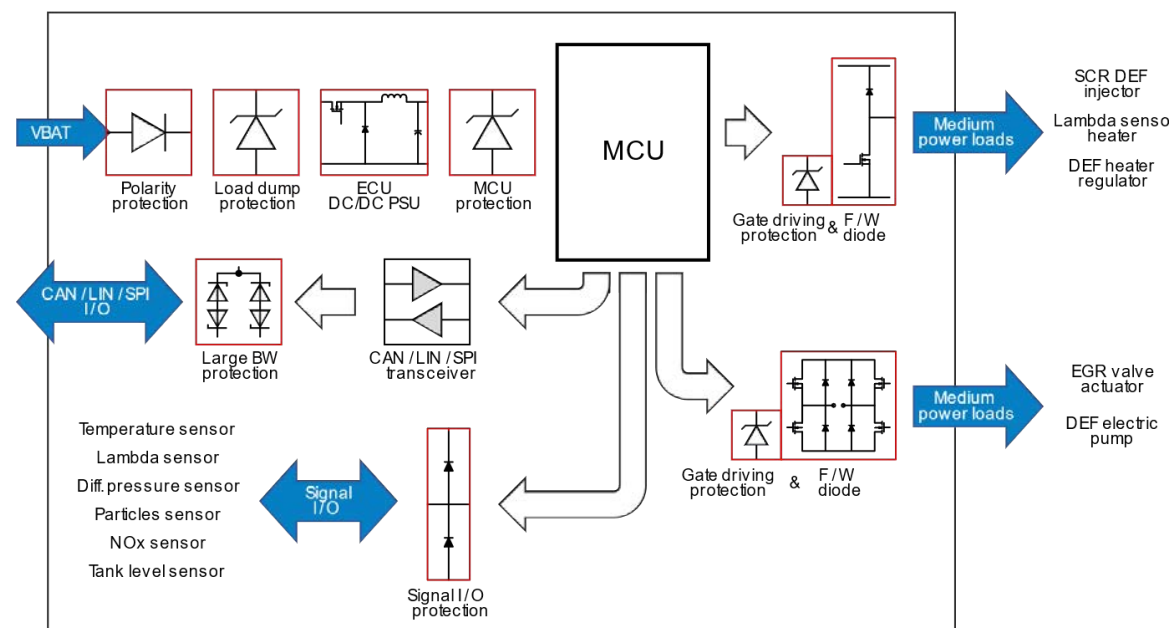
## Block Diagram



# Exhaust Control System

Function	Description	Image
Freewheeling Diode	8 A to 20 A, 120 V dual high voltage TMBS® rectifier	 (SMPD) (SMPA)
Surge Protection	Surface-mount PAR® TVS for stability in main load dump applications in high temperature, high reliability conditions	 (MicroSMP) (SMF)
Signal Protection	Zener diode in low profile package with surge capability and 2 % tolerance	 (DO-218AB)
Voltage Stabilization and Rail to Rail Signal Line Protection	Standard recovery diode: 1 A, 1.5 A, 600 V	 (SMF)

## Block Diagram





# Powertrain - Injection Control and Fuel Pump

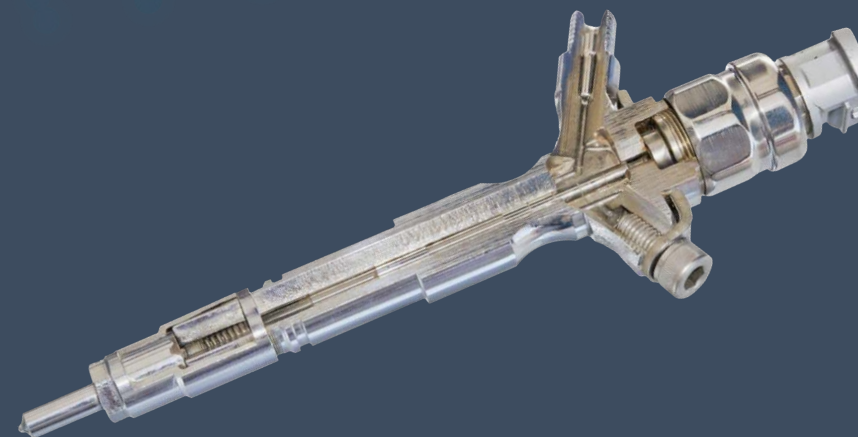
Direct Injection Control

Piezo Injection Control

Fuel Pump Control







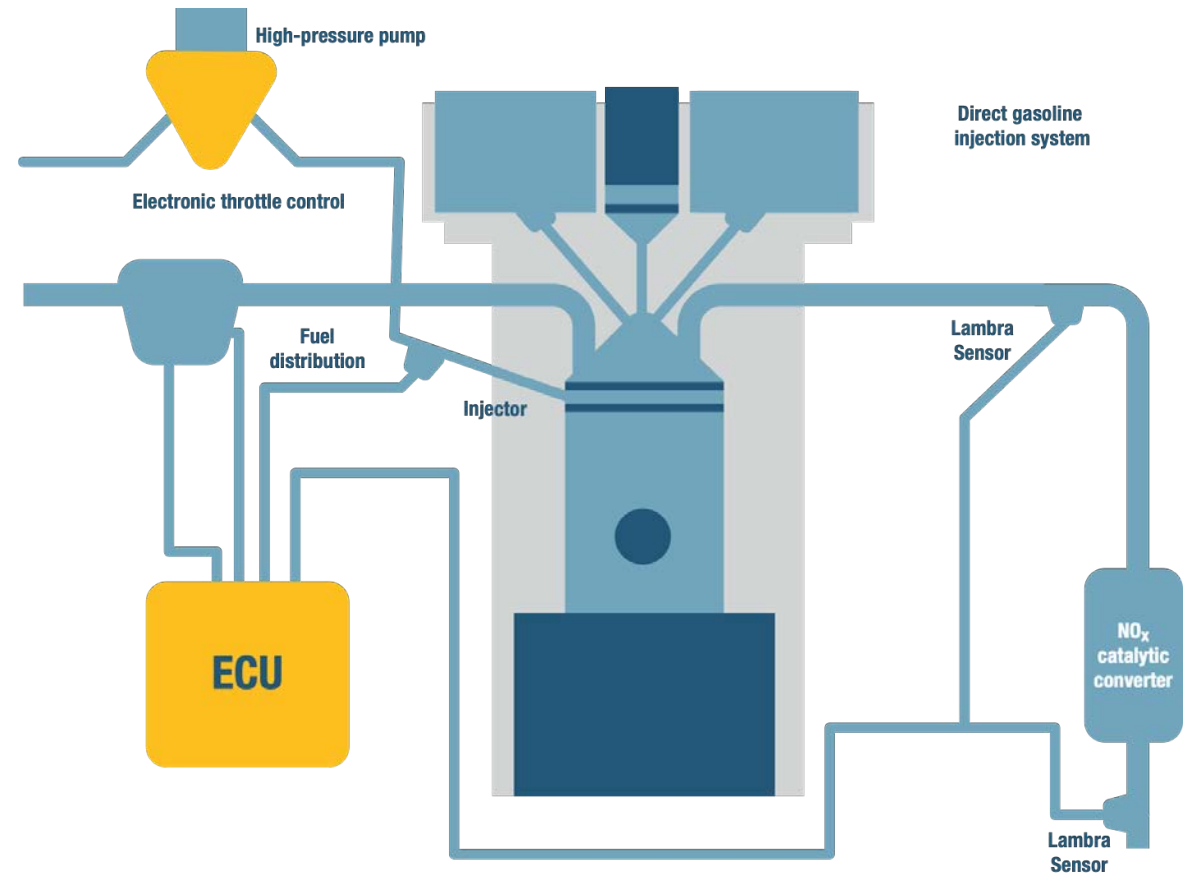
# Direct Injection Control



# Direct Injection Control

## Main Features

- Gasoline direct injection (GDI), also known as petrol direct injection (PDI), is a mixture formation system for internal combustion engines that run on gasoline (petrol), where fuel is injected into the combustion chamber. This is distinct from manifold fuel injection systems, which inject fuel into the intake manifold
- The use of GDI has several advantages:
  - Efficiency:** reduced fuel consumption and CO<sub>2</sub> emissions at the same power output due to downsizing and turbocharging
  - Flexibility** for use with various system pressures up to 350 bar
  - Dynamic** improved responsiveness and more dynamic handling due to increased torque at low engine speeds (high low end torque)
  - Up to a 50 %** downsizing ratio with cylinder reduction

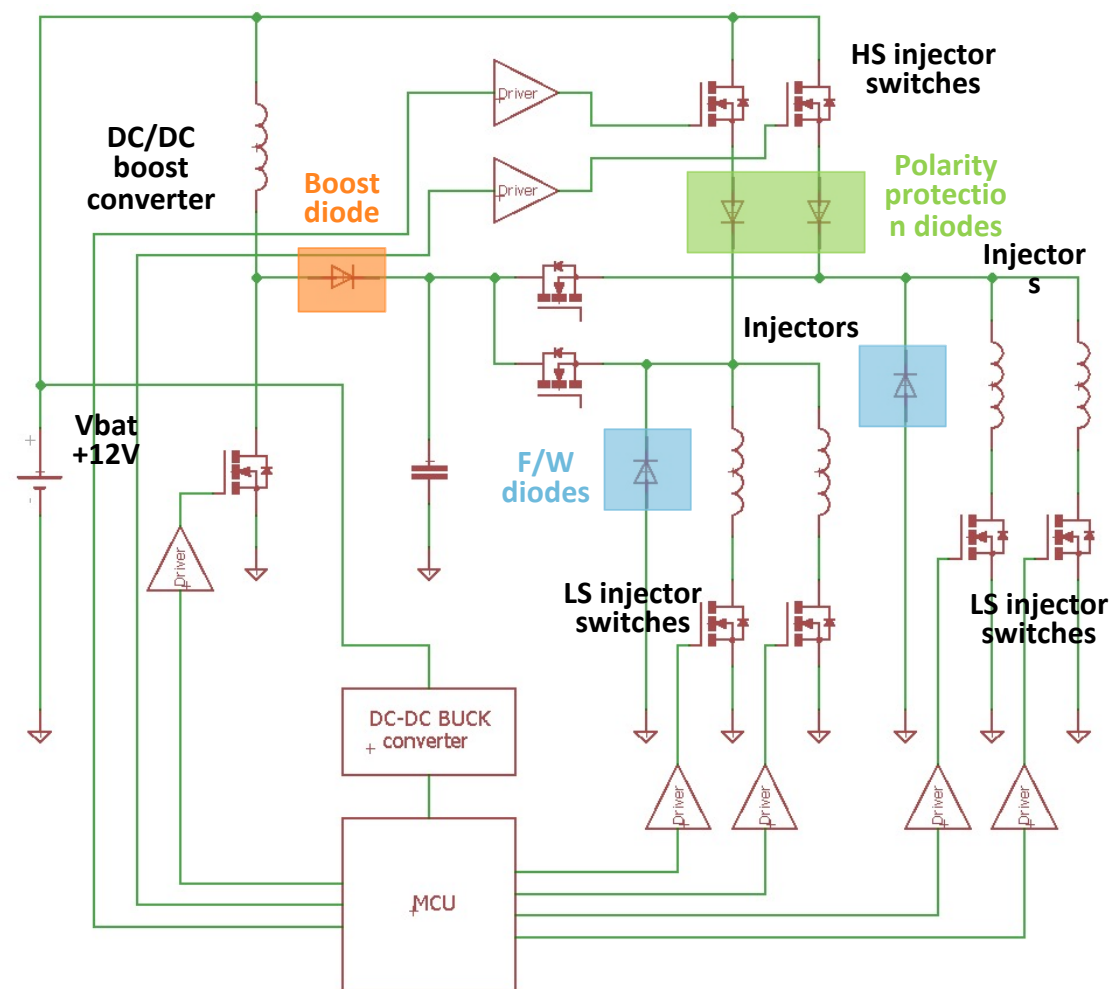


# Direct Injection Control









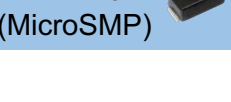
## System Benefits

- 200 V ultrafast FRED Pt® technology is optimized for load switching, particularly for freewheeling and snubber diodes where ESD and surge capability are needed. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Surface-mount PAR® TVS provide stability in high temperature, high reliability conditions
- Vishay's 200 V second-generation TMBS® devices deliver efficiency for high frequency rectification
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

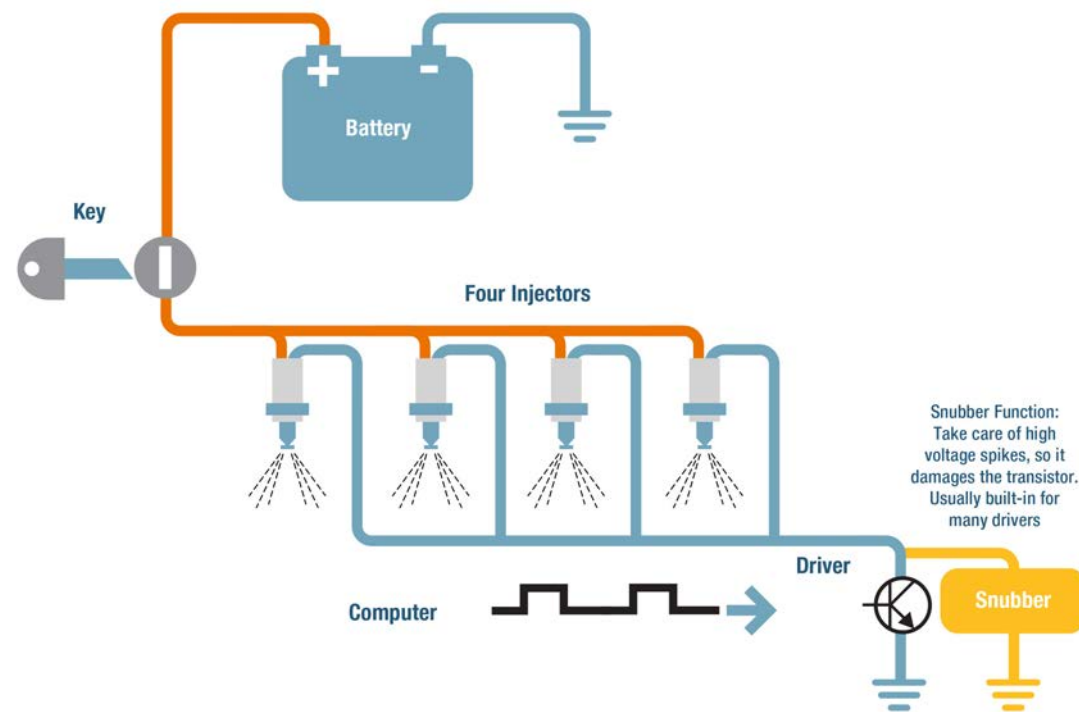
## Block Diagram



# Direct Injection Control

Function	Description	Image
HF Rectification	5 A, 200 V dual high voltage TMBS® rectifier	 (SMPA)
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	 (SlimSMA)
Snubber Diode	1 A to 8 A, 200 V FRED Pt® hyperfast rectifier	 (SMF)
		 (SlimSMA)
		 (SMPC)
		 (SlimDPAK)
Freewheeling Diode	FRED Pt® hyperfast rectifier	 (SMF)  (SMPC)
Voltage Stabilization and Rail to Rail Signal Line Protection	Standard recovery diode: 1 A, 600 V	 (MicroSMP)

## Block Diagram





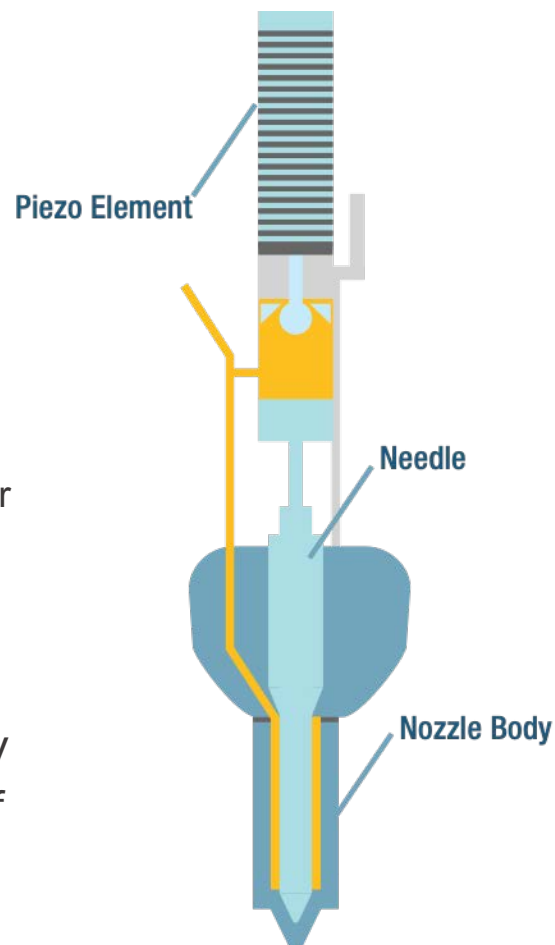
# Piezo Injection Control



# Piezo Injection Control

## Main Features

- The piezo injector is an evolution of the solenoid injector. This technology has several significant advantages:
  - Piezo is much faster, resulting in reduced dead times and allowing more accurate control over the injected fuel amount
  - The fast reaction also allows more injections per cycle (> 15), reducing rapid pressure changes in the cylinder and nearly eliminating typical diesel noise
- On the component level, the major difference between solenoid and piezo direct injection systems is the significantly higher operating voltage. While solenoid systems run at up to 120 V boost voltage, piezo systems need a boost level of 250 V to 300 V

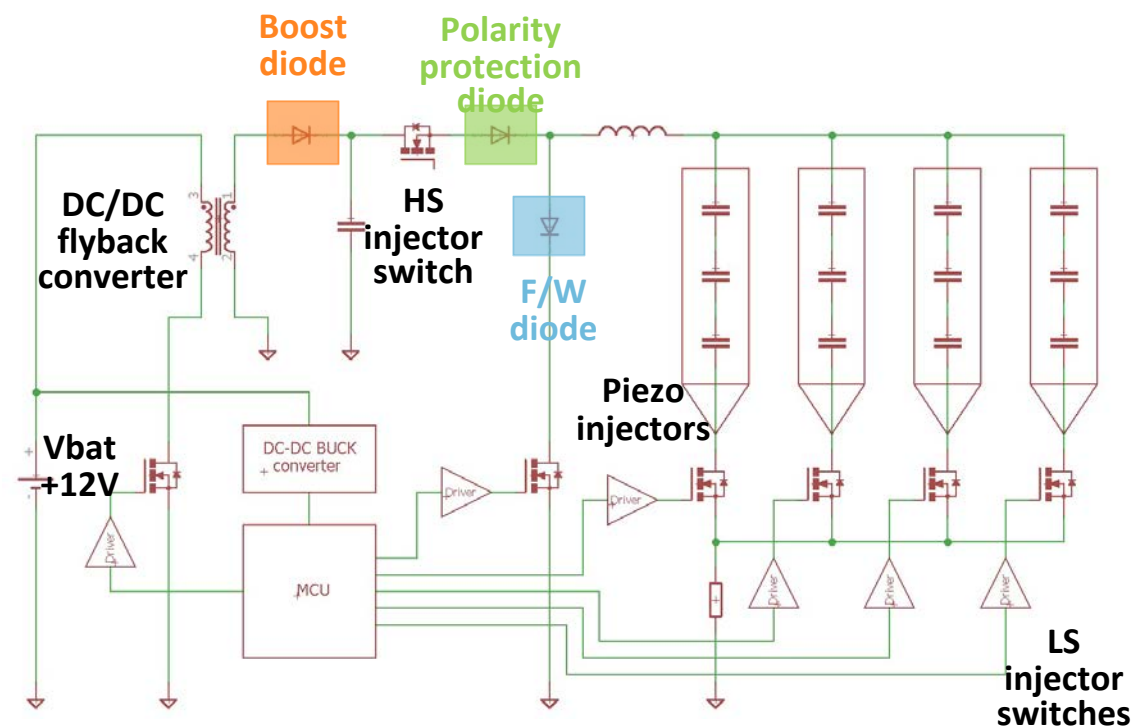


# Piezo Injection Control

## System Benefits

- 200 V ultrafast FRED Pt® technology is optimized for load switching, particularly for freewheeling and snubber diodes where ESD and surge capability are needed. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Surface-mount PAR® TVS provide stability in high temperature, high reliability conditions
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

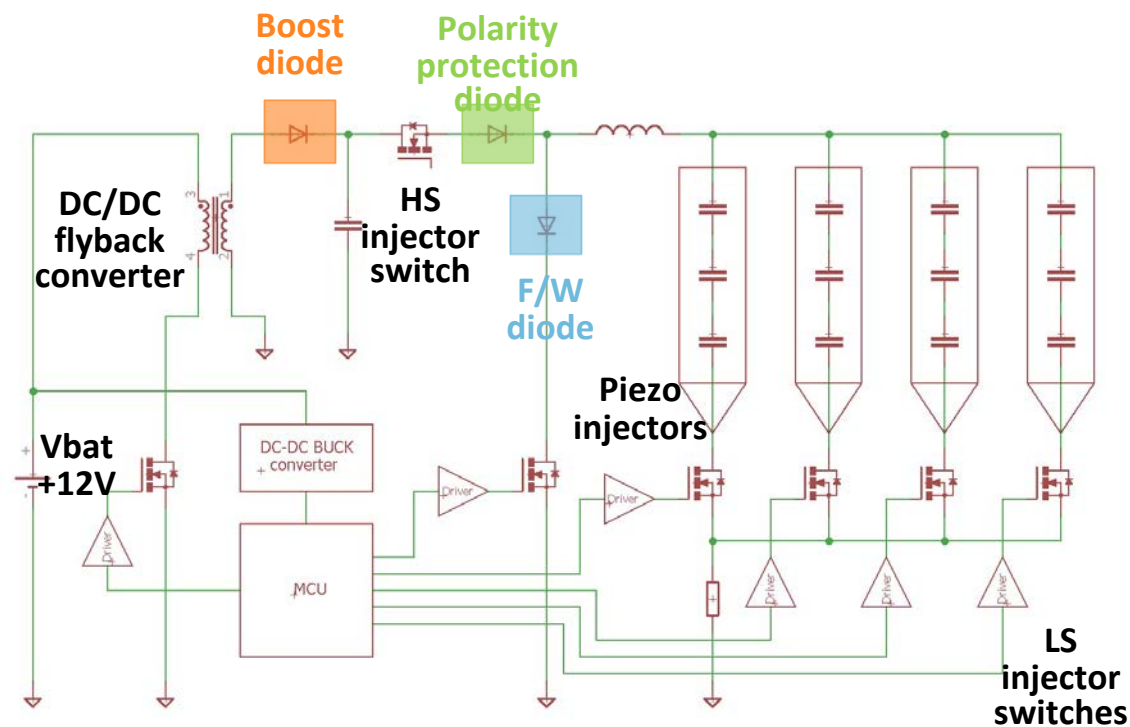
## Block Diagram



# Piezo Injection Control

Function	Description	Image
HF Rectification	3 A, 200 V dual high voltage TMBS® rectifier	(SMPA)
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	(SlimSMA)
Snubber Diode	1 A to 16 A, 200 V FRED Pt® hyperfast rectifiers	(SMF)
		(SlimSMA)
		(SMPD)
		(SlimDPAK)
Freewheeling Diode	1 A to 16 A FRED Pt® hyperfast rectifiers	(SMF)
		(SlimSMA)
		(SMPD)
		(SlimDPAK)
Voltage Stabilization and Rail to Rail Signal Line Protection	Standard recovery diode: 1 A, 600 V	(microSMP)

## Block Diagram





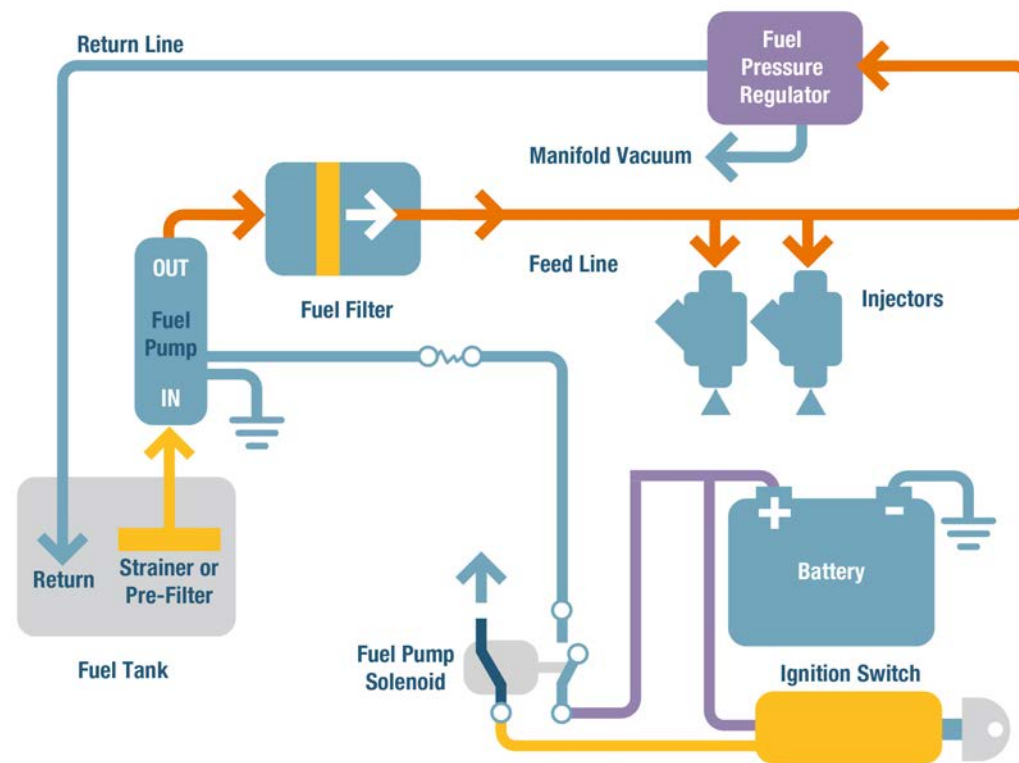
# Fuel Pump Control



# Fuel Pump Control

## Main Features

- Fuel pumps pump gasoline from the vehicle's fuel tank to the engine, and distribute fuel under low pressure to the carburetor or to the fuel injection system under high pressure
- Carburetor engines utilize low pressure pumps, which are located outside of the fuel tank. Fuel-injected engines typically utilize electric fuel pumps mounted in the fuel tank

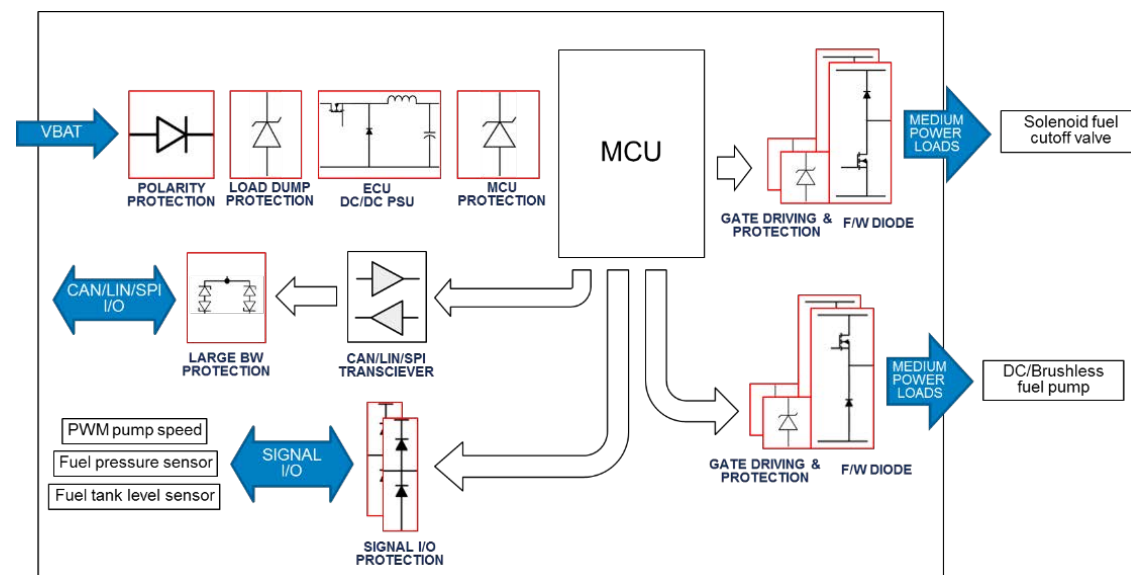


# Fuel Pump Control

## System Benefits

- 100 V and 200 V ultrafast FRED Pt® technology is optimized for load switching, particularly for freewheeling and snubber diodes where ESD and surge capabilities are needed. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Vishay's 120 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

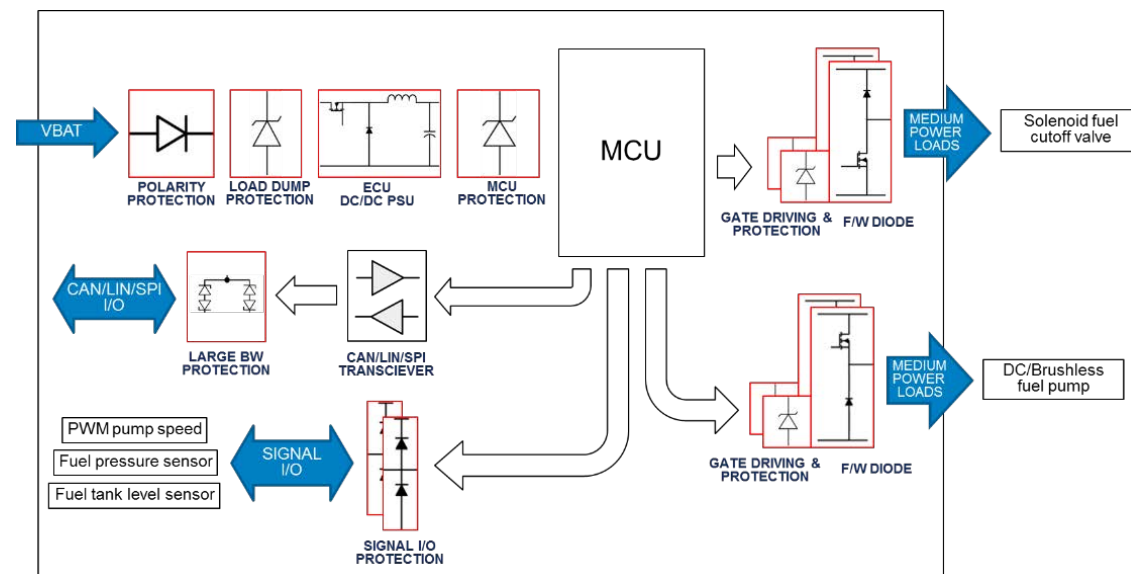
## Block Diagram



# Fuel Pump Control

Function	Description	Image
HF Rectification	35 A, 120 V dual high voltage TMBS® rectifier	(SMPD)
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	(SMC) (DO-218)
Snubber Diode	1 A to 16 A, 200 V FRED Pt® hyperfast rectifiers	(SMF) (SlimSMA) (SMPD) (SlimDPAK)
Freewheeling Diode	1 A to 16 A FRED Pt® hyperfast rectifiers	(SMF) (SlimSMA) (SMPD) (SlimDPAK)
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	(SMF) (microSMF)

## Block Diagram



# Chassis Control

Electric Power Steering (EPS)

Transmission ECU (TCU) And Double Clutch (DCT)







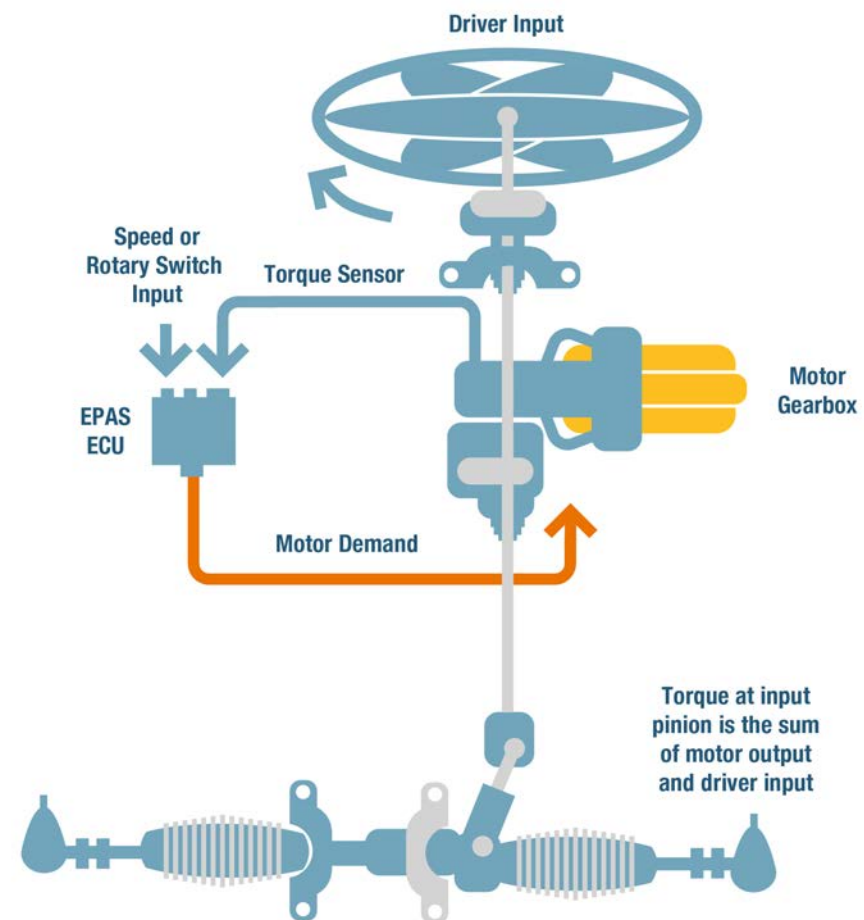
# Electric Power Steering (EPS)



# Electric Power Steering

## Main Features

- EPS uses an electric motor to assist the driver, unlike traditional systems that act on hydraulic pressure provided via a pump driven by the vehicle's engine. This pump is constantly running, whether the steering wheel is being turned or not. That continually places a load on the engine, affecting the vehicle's fuel consumption
- By moving to an electric motor, the load on the engine is reduced to only those occasions when the steering wheel is being turned one way or the other, therefore producing better fuel economy
- EPS also enables variable-assist power steering, where the level of assistance is greater at lower speed when it's needed most and reduced at higher speeds

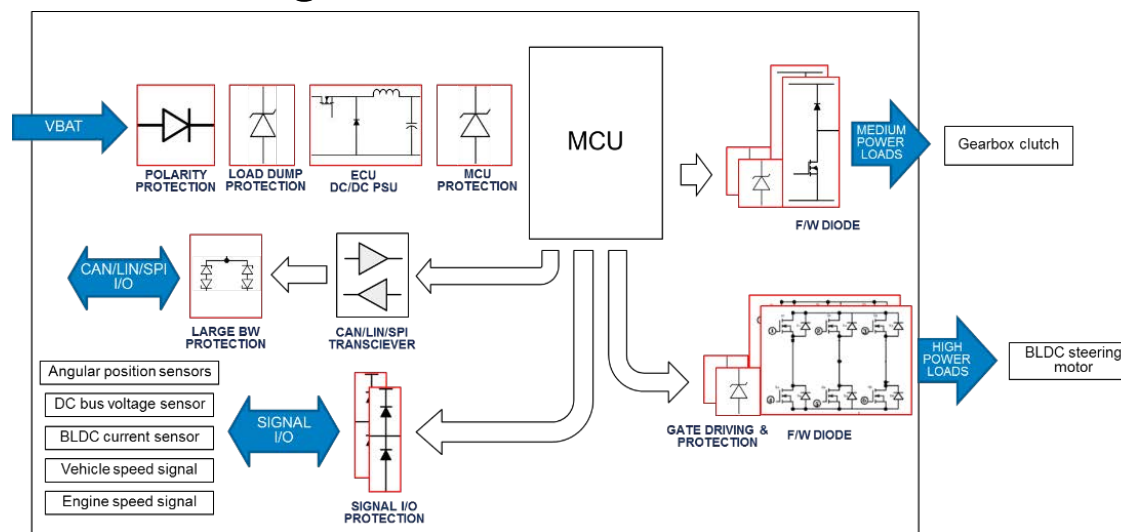


# Electric Power Steering

## System Benefits

- 200 V ultrafast FRED Pt® technology is optimized for load switching, particularly for freewheeling and snubber diodes where ESD and surge capability are needed. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Vishay's 120 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

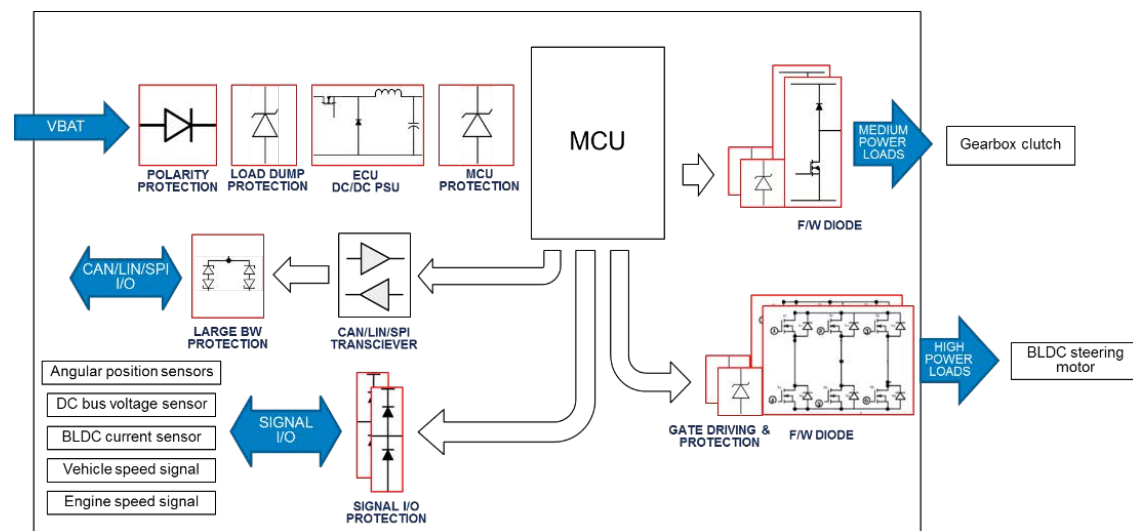
## Block Diagram



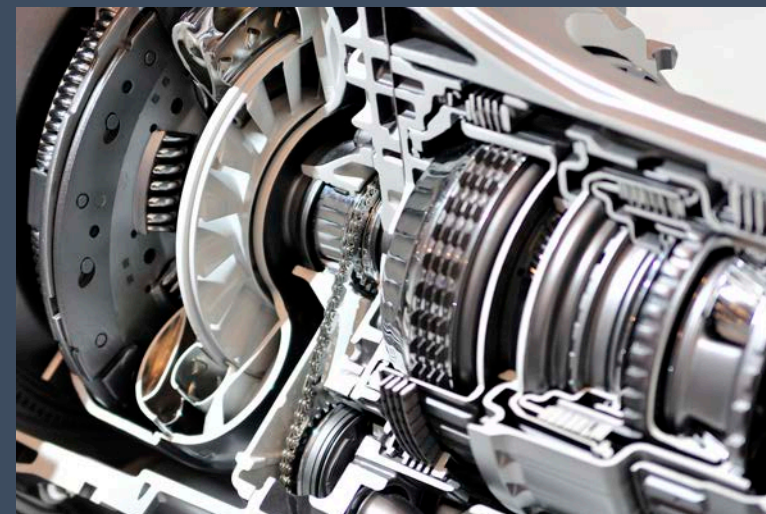
# Electric Power Steering

Function	Description	Image
HF Rectification	35 A, 120 V dual high voltage TMBS® rectifier	(SMPD)
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	(SMC) (DO-218)
Snubber Diode	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	(SMF) (SlimSMA) (SMPD) (SlimDPAK)
Freewheeling Diode	1 A to 16 A FRED Pt® hyperfast rectifier	(SMF) (SlimSMA) (SMPD) (SlimDPAK)
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	(SMF) (microSMF)

## Block Diagram



# Transmission ECU (TCU) and Double Clutch (DCT)

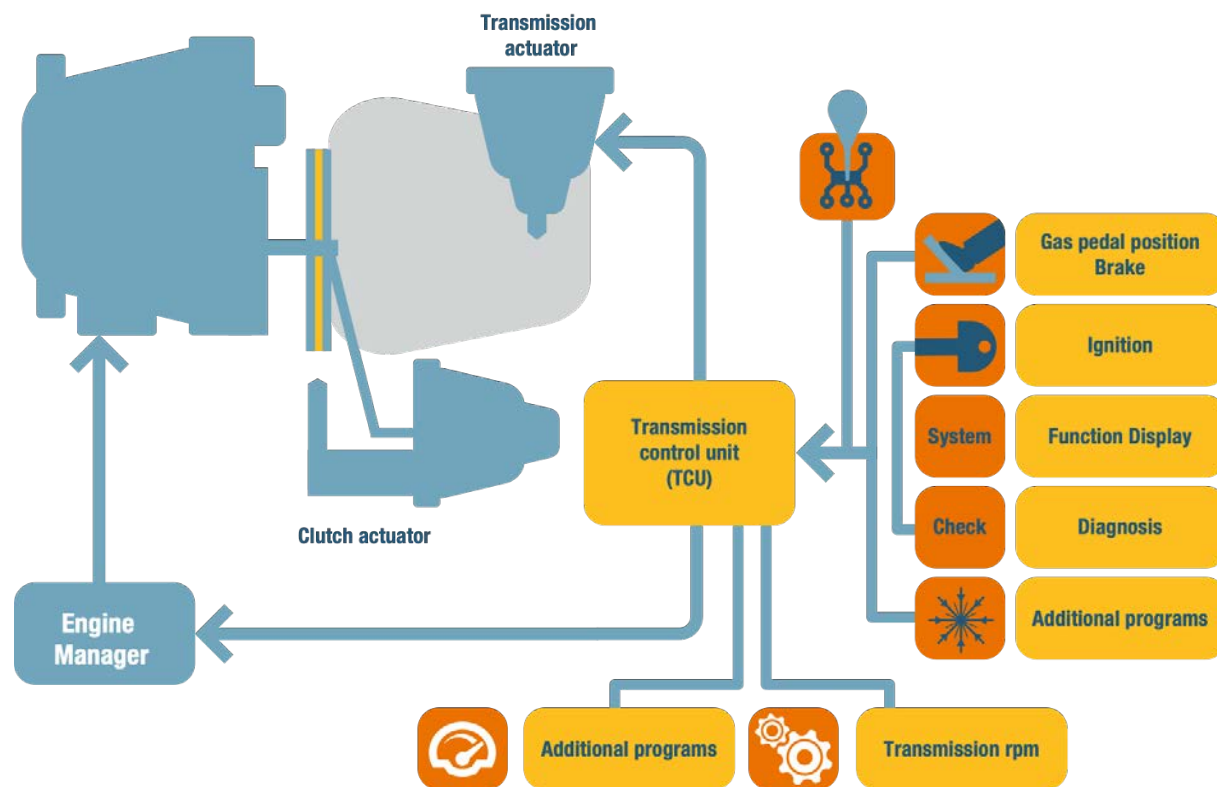




# TCU and DCT

## Main Features

- A TCU is a device that controls modern electronic automatic transmissions. A TCU generally uses sensors from the vehicle, as well as data provided by the engine control unit (ECU), to calculate how and when to change gears in the vehicle for optimum performance, fuel economy, and shift quality
- A DCT offers faster gear shift times and greater fuel economy, improving efficiency compared to the other transmission types
- The DCT operates via sophisticated controls. These controls eliminate the need for the driver to manually change gears and the entire process is automated. In this respect, a DCT can be looked upon as being like an automatic transmission. The main difference is that the DCT operates the odd and even gear numbers separately, which prevents the engine from being disengaged from interrupted power flow when the gears are changed. The core difference between a DCT transmission and a traditional automatic transmission is that the DCT transmission does not use a torque converter

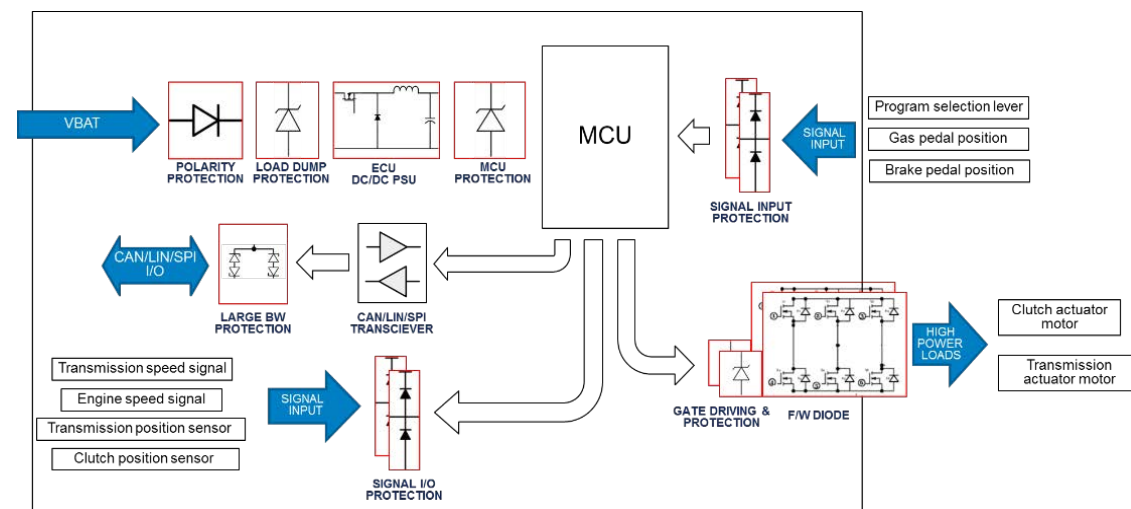


# TCU and DCT

## System Benefits

- 200 V ultrafast FRED Pt® technology is optimized for load switching, particularly for freewheeling and snubber diodes where ESD and surge capability are needed. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Vishay's 120 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

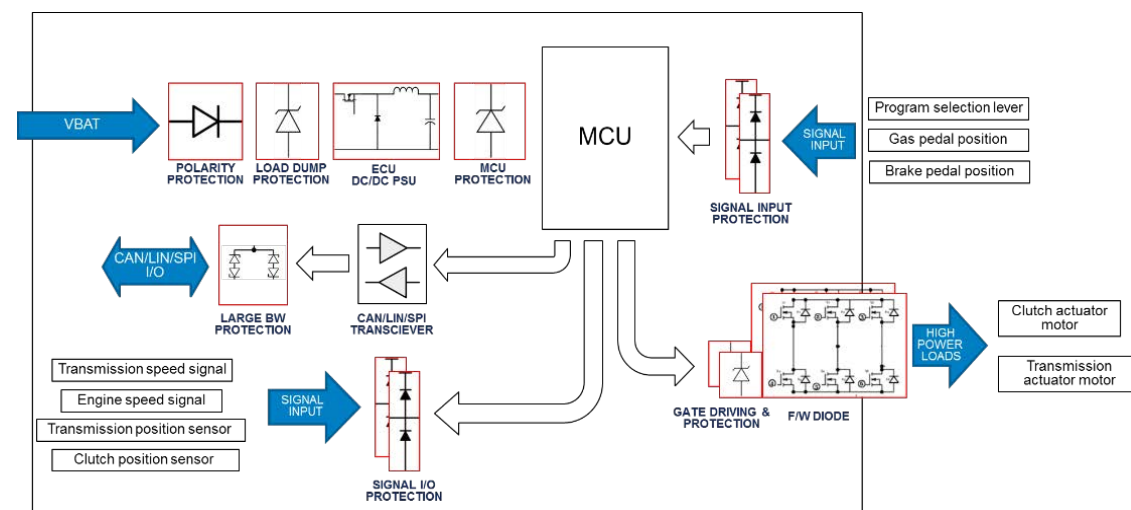
## Block Diagram



# TCU and DCT

Function	Description	Image
HF Rectification	35 A, 120 V dual high voltage TMBS® rectifier	(SMPD)
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	(SMC) (DO-218)
Snubber Diode	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	(SMF)
		(SlimSMA)
		(SMPD)
		(SlimDPAK)
Freewheeling Diode	1 A to 16 A FRED Pt® hyperfast rectifier	(SMF)
		(SlimSMA)
		(SMPD)
		(SlimDPAK)
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	(SMF) (microSMF)
Standard Recovery Diode	Up to 3 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	(microSMP)
		(SMA)

## Block Diagram





## Body Electronics

Comfort, Door, and Window Controls

Infotainment, Navigation, and Audio

Interior LED Lighting



# Comfort, Door, and Window Controls

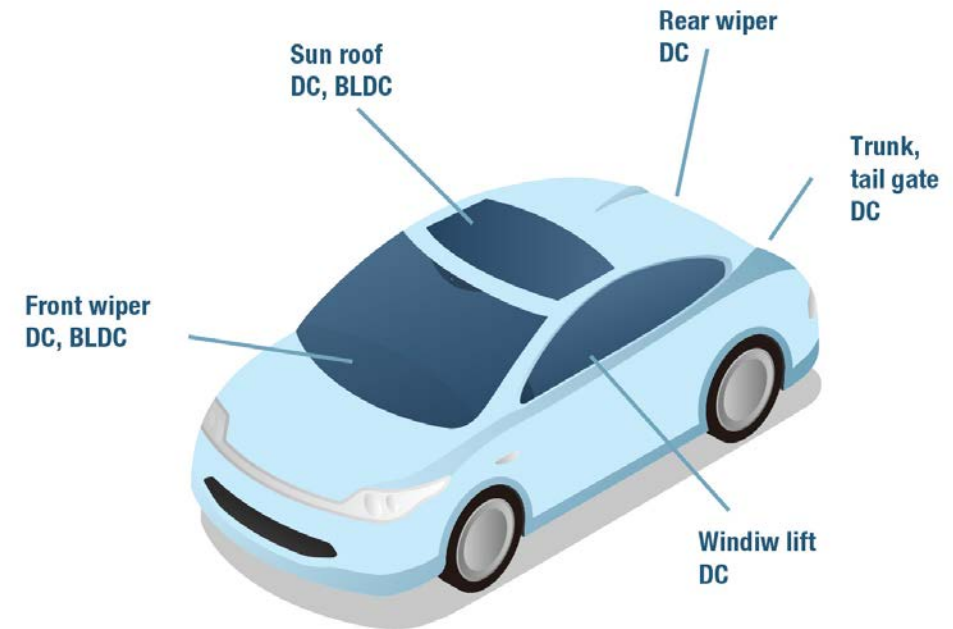




# Comfort, Door, and Window Controls

## Main Features

- Door modules, in their simplest form, need to be able to reliably control standard loads such as those presented by door locking motors. In more complex door zone systems, the chipset needs to not only control multiple standard loads such as door lock motors, mirror folders, and levelers, but also those for defrosters and several lighting functions from LEDs to incandescent bulbs. Solutions need to be both flexible and scalable to satisfy the need for different door electronic variants, from basic to premium

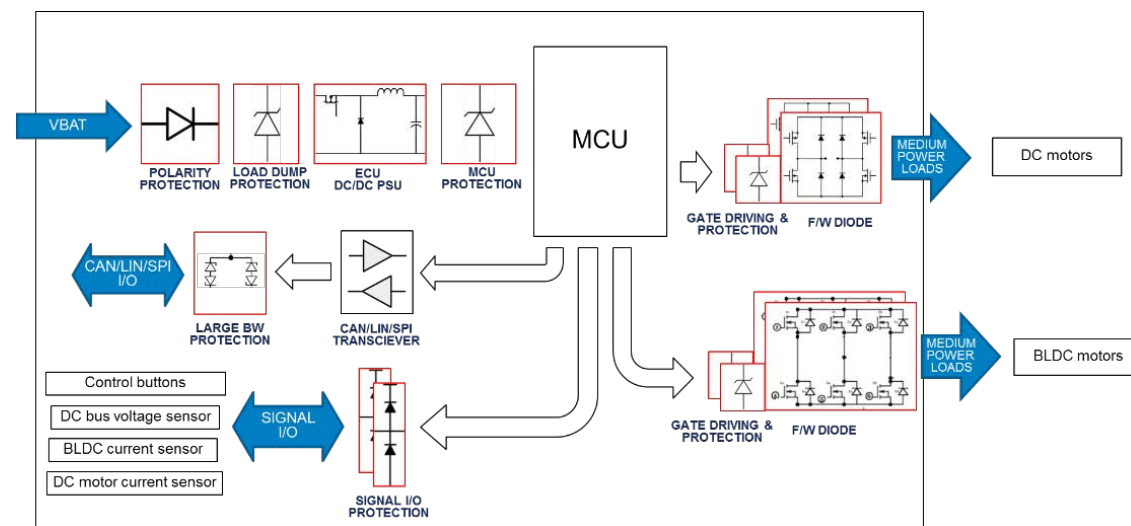


# Comfort, Door, and Window Controls

## System Benefits

- 100 V ultrafast FRED Pt® technology is optimized for load switching, particularly for freewheeling and snubber diodes where ESD and surge capability are needed. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Vishay's 45 V to 120 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- Surface-mount PAR® TVS in miniaturized packages
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

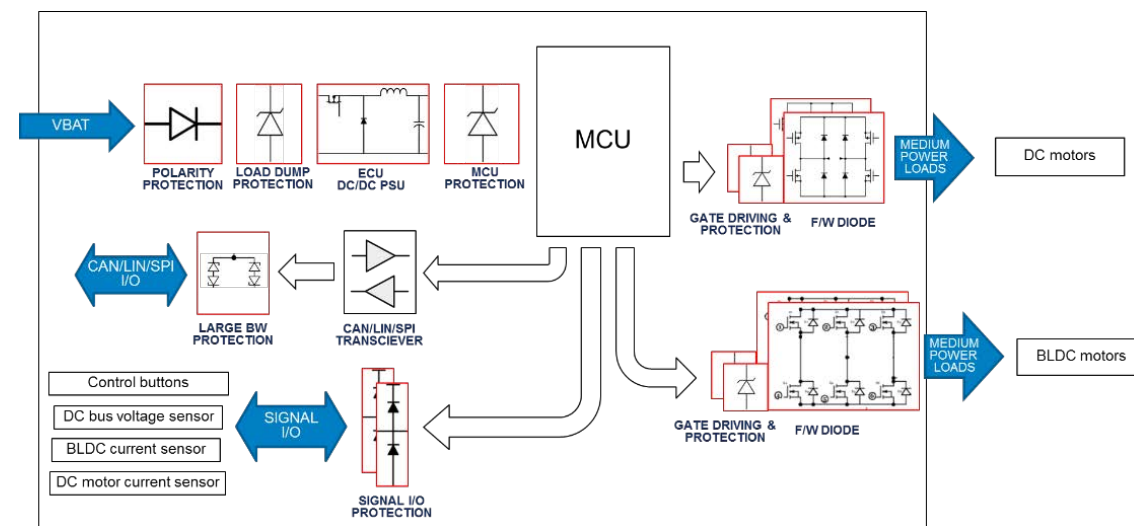
## Block Diagram



# Comfort, Door, and Window Controls

Function	Description	Image
HF Rectification	Up to 35 A, 100 V to 120 V, dual high voltage TMBS® rectifier	(SMPD) (SlimDPAK) 
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	(SlimSMA) 
Snubber Diode	1 A to 16 A, 100 V FRED Pt® hyperfast rectifier	(SMF) 
		(SlimSMA) 
		(SMPD) 
		(SlimDPAK) 
Freewheeling Diode	1 A to 16 A, 100 V FRED Pt® hyperfast rectifier	(SMF) 
		(SlimSMA) 
		(SMPD) 
		(SlimDPAK) 
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	(SMF) (MicroSMF) 
Standard Recovery Diode	Up to 3 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	(MicroSMP) 
		(SMA) 

## Block Diagram



# Infotainment, Navigation, and Audio



# Infotainment, Navigation, and Audio

## Main Features

- The entire automotive industry is moving towards developing innovative technologies to enable better connectivity, improve vehicle safety, and enhance the in-vehicle user experience. One of the key technologies, which works as a focal point for modern automotive systems – integrating their functions for control and monitoring from one central unit – is the in-vehicle infotainment system
- Applications for an in-vehicle infotainment system include navigation, communication and connectivity, remote services, and telematics services. In developed markets people even use infotainment systems for accessing social media and mails, checking the availability of parking spots across the city, and streaming high definition video and audio



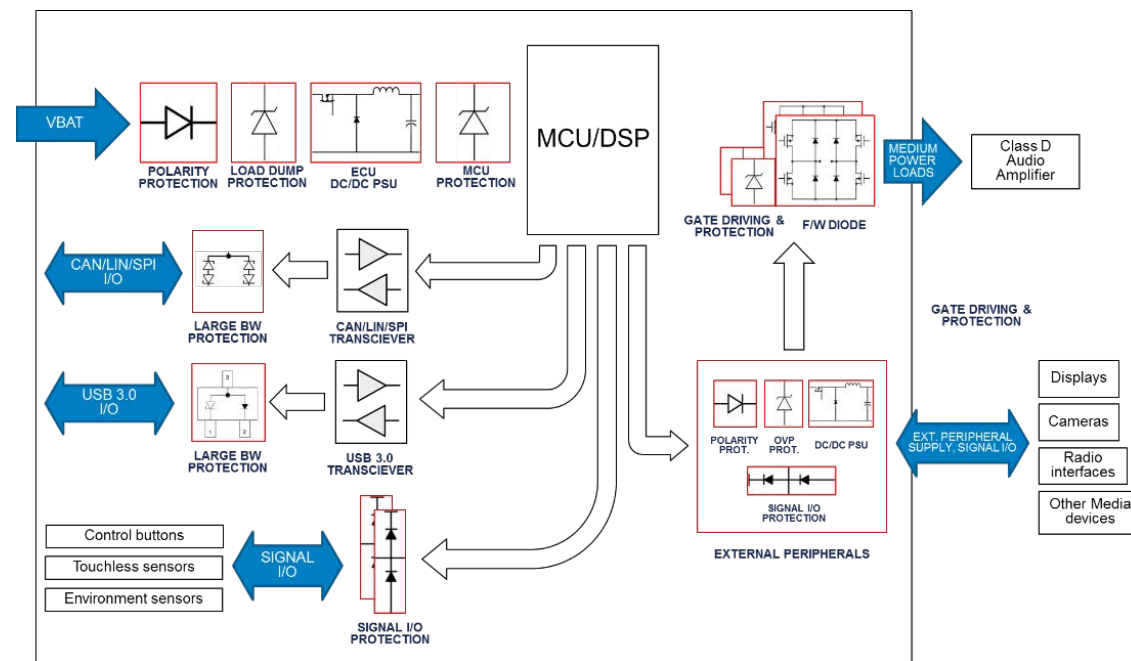


# Infotainment, Navigation, and Audio

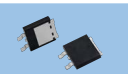


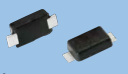
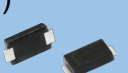




## System Benefits

- Vishay's 60 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- Surface-mount PAR® unidirectional TVS in miniaturized packages
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

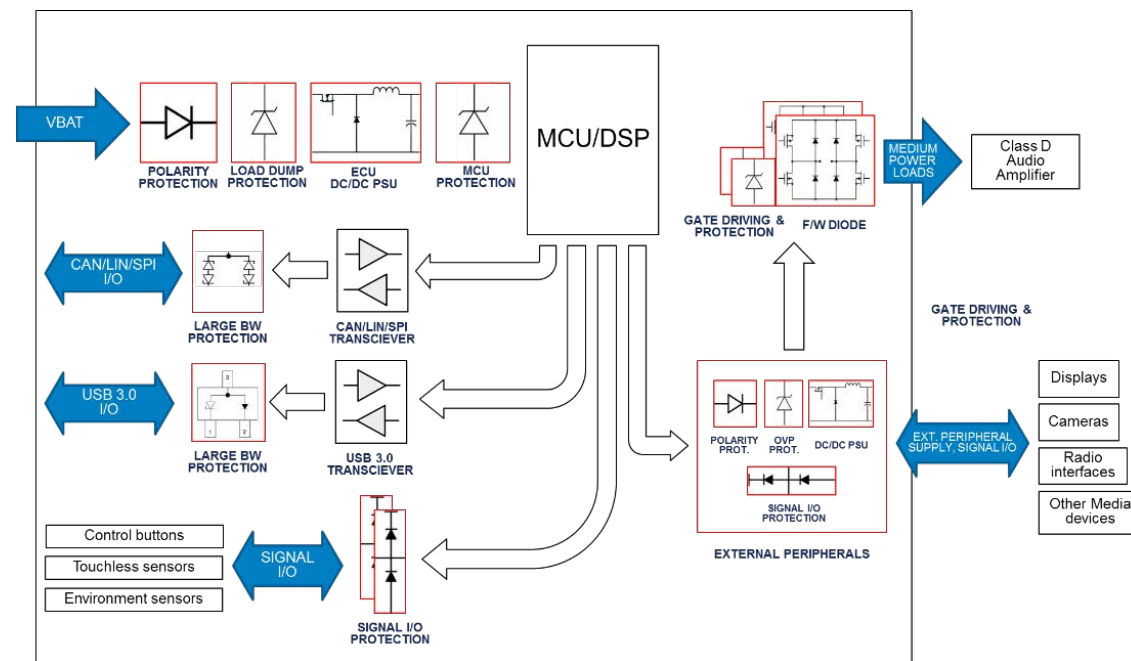
## Block Diagram

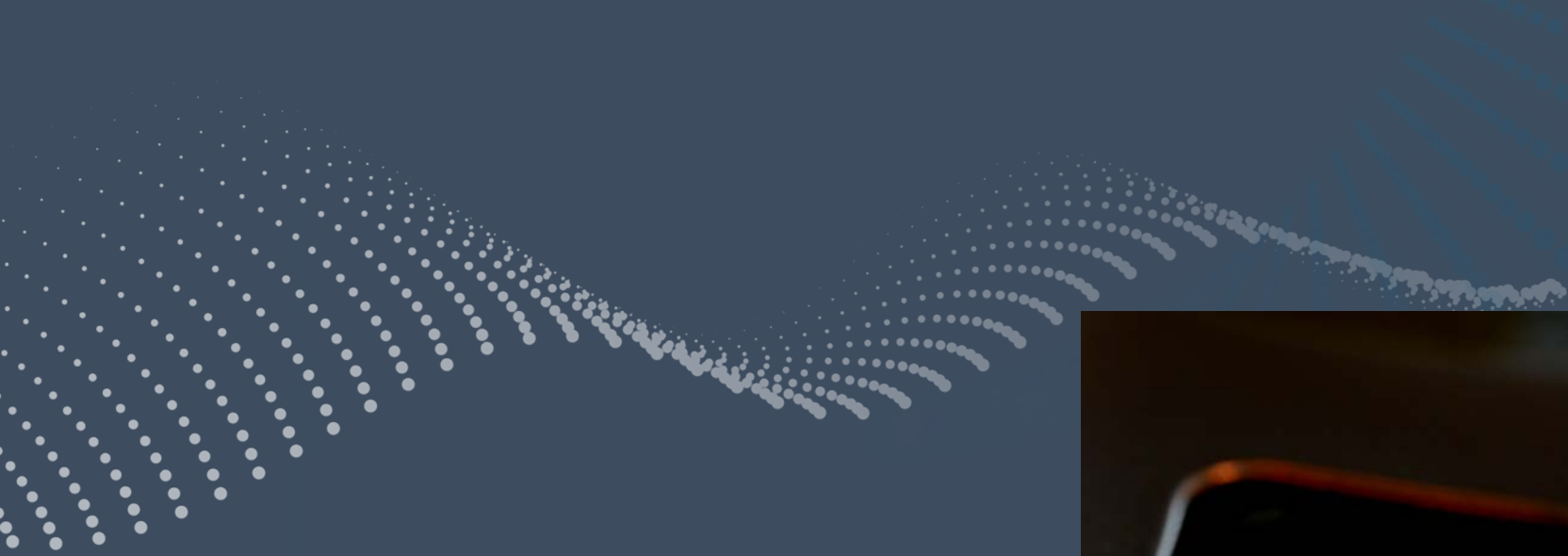


# Infotainment, Navigation, and Audio

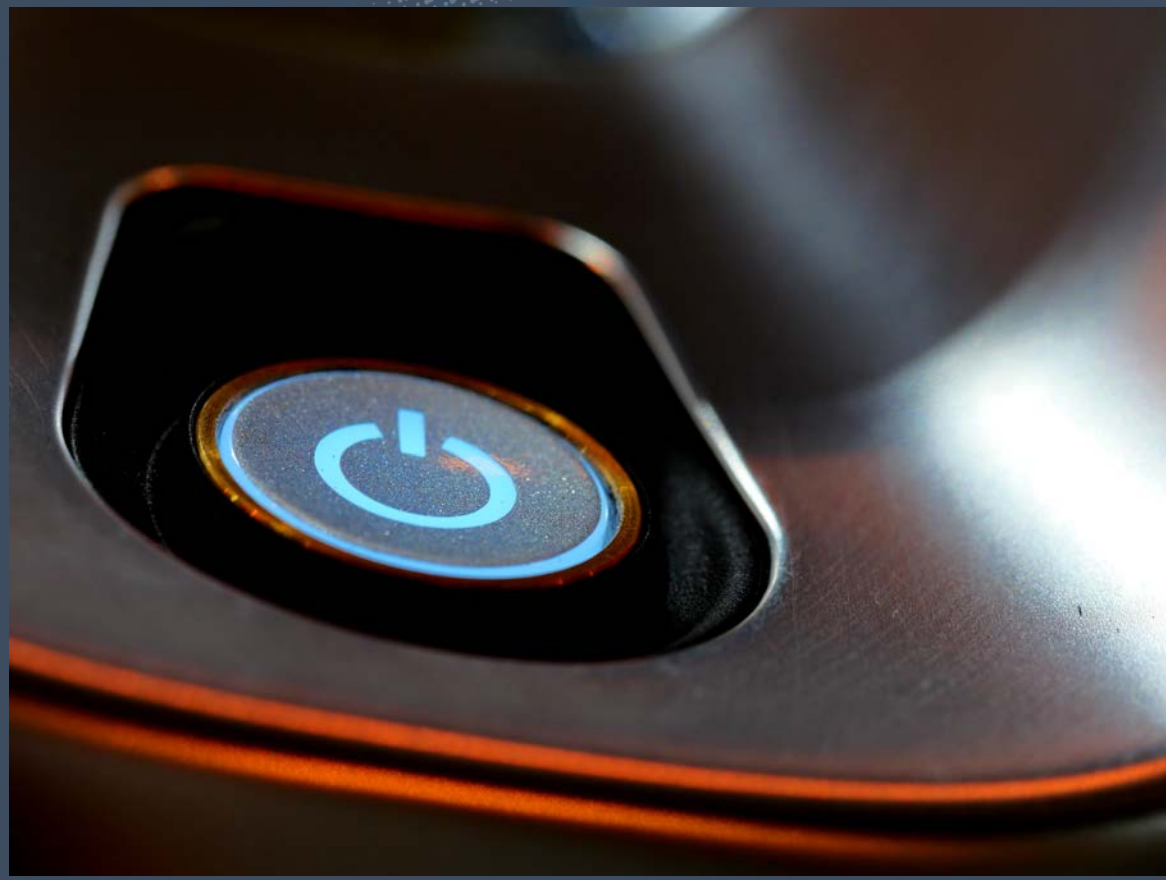
Function	Description	Image
HF Rectification	Up to 20 A, 100 V dual high voltage TMBS® rectifier	 (SMPD)
Surge Protection	Surface-mount TRANSZORB® TVS	 (SMC)  (DO-218)
Snubber Diode	1 A to 2 A, 100 V FRED Pt® hyperfast rectifier	 (SMF)  (SlimSMA)
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	 (SMF)  (MicroSMF)
Standard Recovery Diode	Up to 3 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	 (MicroSMP)  (SMA)

## Block Diagram





# Interior LED Lighting



# Interior LED Lighting

## Main Features

- Dome modules, generally placed at the top of the car roof, control dome and map lights as well as convenience lighting designed to illuminate driver and passenger compartments, including the trunk and storage areas. They can also be used to control windows and sunroofs, as well as emergency call buttons
- In designing a dome module, key challenges are high efficiency and reliability, together with extensive diagnostics for the variety of loads controlled – LED, bulbs, and motors – as well as reduced real estate and weight

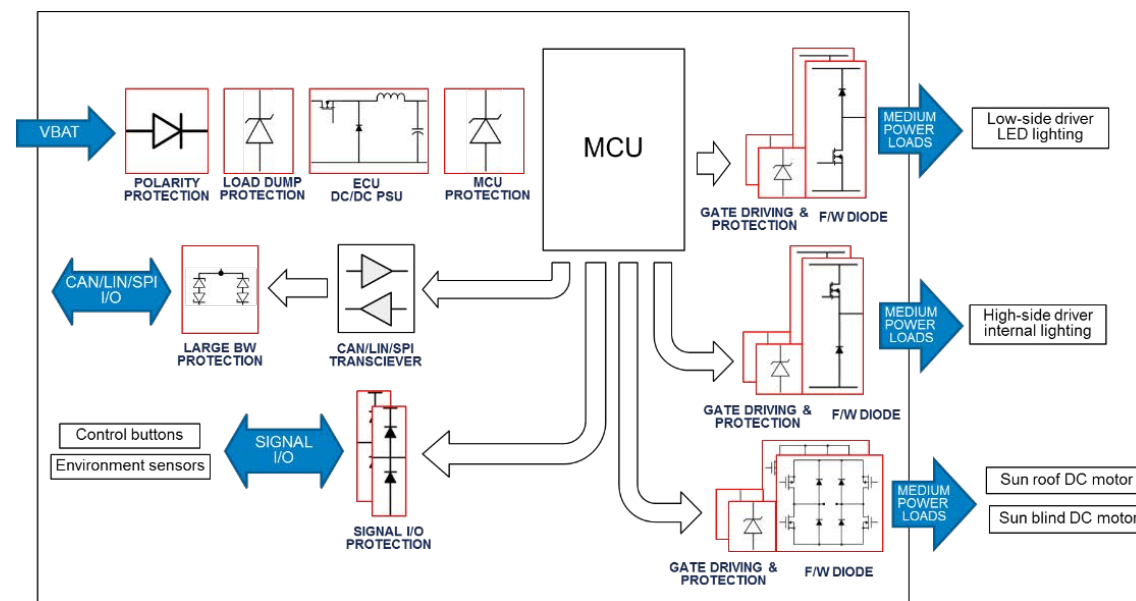


# Interior LED Lighting

## System Benefits

- Vishay's 60 V to 100 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- Surface-mount PAR® unidirectional TVS in miniaturized packages
- Standard recovery diodes with ESD capability for rail to rail signal line protection
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

## Block Diagram

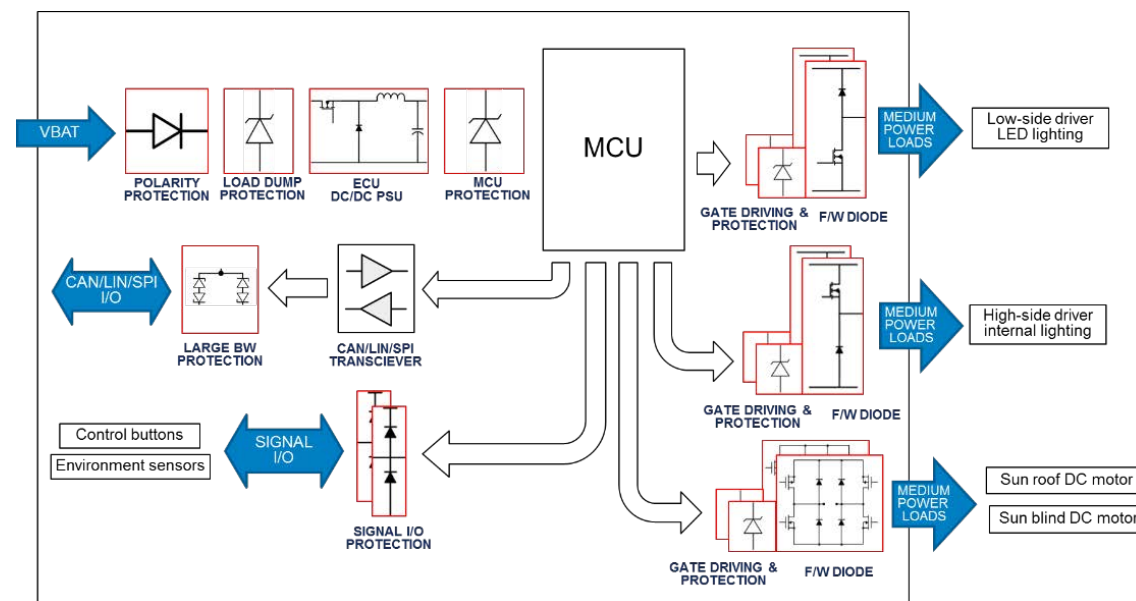




# Interior LED Lighting

Function	Description	Image
HF Rectification	60 V and 100 V dual high voltage TMBS® rectifier	(SMF) (microSMP) (SlimSMA)
Surge Protection	Surface-mount PAR® TVS with wide operating temperature range	(SlimSMA) (SMB)
Snubber Diode	1 A to 2 A, 100 V FRED Pt® hyperfast rectifier	(SMF) (SlimSMA)
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	(SMF) (MicroSMF)
Standard Recovery Diode	Up to 3 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	(MicroSMP) (SlimSMA)

## Block Diagram





## Active Safety

Enhanced Electrical Braking (EEB)

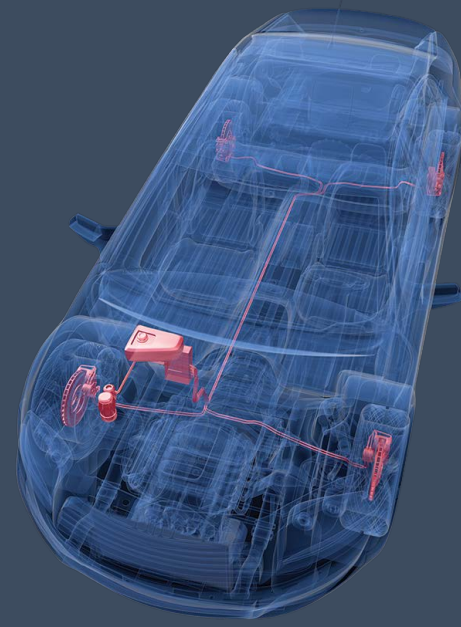
Electronic Stability Program (ESP) And Vehicle Stability Control (VSC)

Electrical Parking Brake (EPB), Integrated Parking Brake (IPB)

Advanced Driver Assistance Systems (ADAS)



# Enhanced Electrical Braking (EEB)



# Enhanced Electrical Braking System

## Main Features

- Designed to reduce the amount of pedal pressure needed for braking, electric brake boosters, which use a sensor in the brake pedal to read a driver's actions, are progressively replacing mechanical vacuum brake booster systems
- Increasingly used by car makers to enhance driver comfort and passenger safety, these electric brake boosters use a dedicated electronic system to process the signals from the brake pedal and operate the master cylinder by means of a brushless DC (BLDC) motor

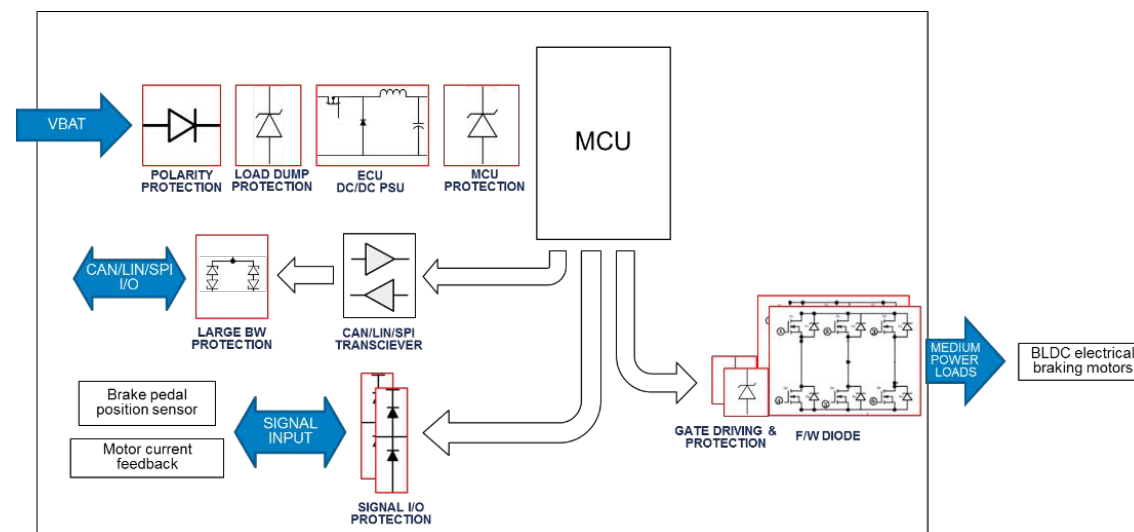


# Enhanced Electrical Braking System

## System Benefits

- Surface-mount PAR<sup>®</sup> unidirectional TVS in miniaturized packages
- 100 V ultrafast FRED Pt<sup>®</sup> technology is optimized for load switching and polarity protection. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Vishay's eSMP<sup>®</sup> package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

## Block Diagram

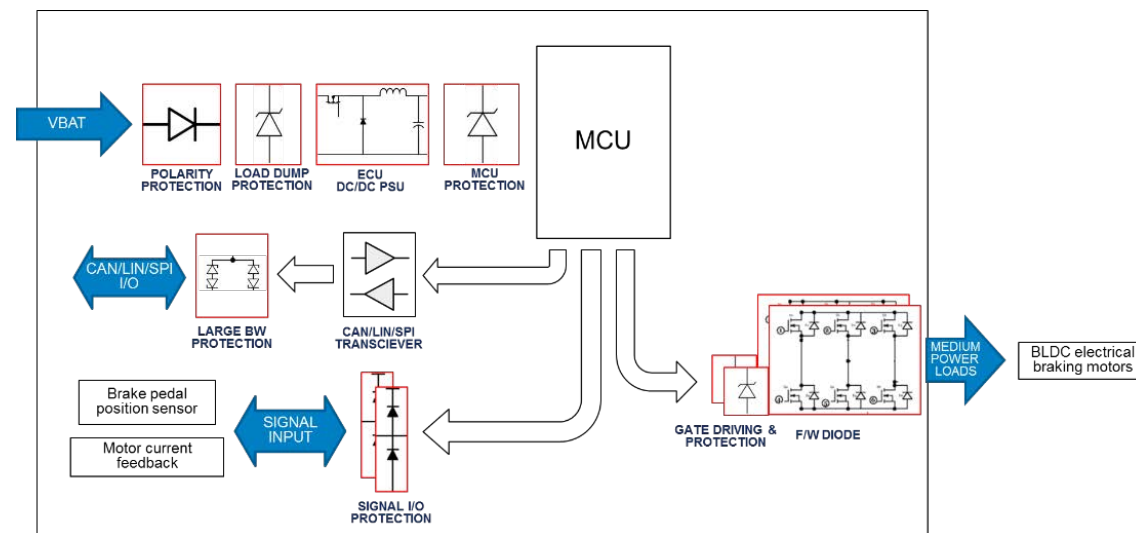




# Enhanced Electrical Braking System

Function	Description	Image
HF Rectification	120 V dual high voltage TMBS® rectifier	(SMPD)
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	(SMC)
		(DO-218)
Load Switch, Polarity Protection	1 A up to 16 A, 100 V FRED Pt® hyperfast rectifier	(SMF)
		(SlimDPAK)
		(SMPD)
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	(SMF)
		(MicroSMF)
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail-to-rail signal line and power line protection	(MicroSMP)

## Block Diagram





# Electronic Stability Program (ESP) and Vehicle Stability Control (VSC)



# ESP AND VSC

## Main Features

- 80 % of vehicle manufacturers in Europe use the acronym ESP® for the Electronic Stability Program. Some carmakers market the ESP® under different names, such as DSC (dynamic stability control), VSA (vehicle stability assist) or VSC (vehicle stability control). The functionality and operation of the ESP®, as well as the gain it provides in driving safety, is the same
- ESP helps drivers avoid crashes by reducing the danger of skidding or losing control as a result of over-steering. ESP becomes active when a driver loses control of their car. It uses computer-controlled technology to apply individual brakes and help bring the car safely back on track, without the danger of fish-tailing
- These systems are mandatory in order to achieve the highest possible scores in the various “New Car Assessment Programs (NCAP)” throughout the world, and are even required by law in some countries

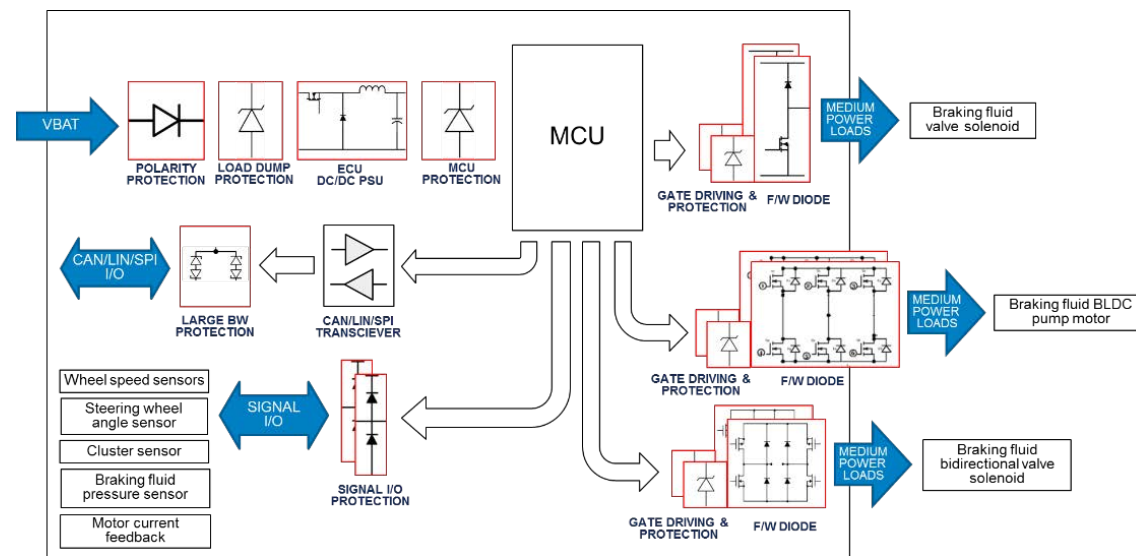


# ESP AND VSC

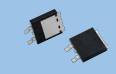



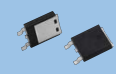
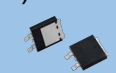



## System Benefits

- Zener diodes with surge current specification and ESD (> 8 kV HBM) in miniaturized packages. Voltages range from 3.6 V to 200 V with 2 % tolerance
- 200 V ultrafast FRED Pt® technology is optimized for load switching and polarity protection. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

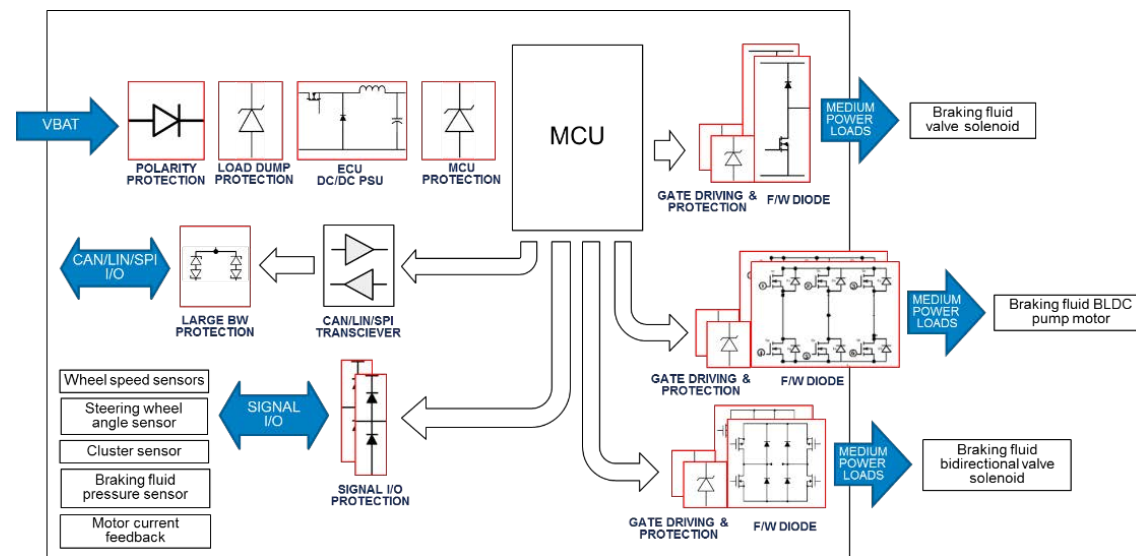
## Block Diagram



# ESP AND VSC

Function	Description	Image
HF Rectification	100 V dual high voltage TMBS® rectifier	 (SMPD)
Surge Protection	Surface-mount PAR® unidirectional TVS for power line load dump	 (SMC)   (DO-218)
Load Switch, Snubber, Polarity Protection	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	 (SMF)   (SlimDPAK)   (SMPD)
Zener Diode	3.6 V to 200 V with 2.5 % tolerance	 (SMF)   (MicroSMF)
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail-to-rail signal line and power line protection	 (MicroSMP)

## Block Diagram





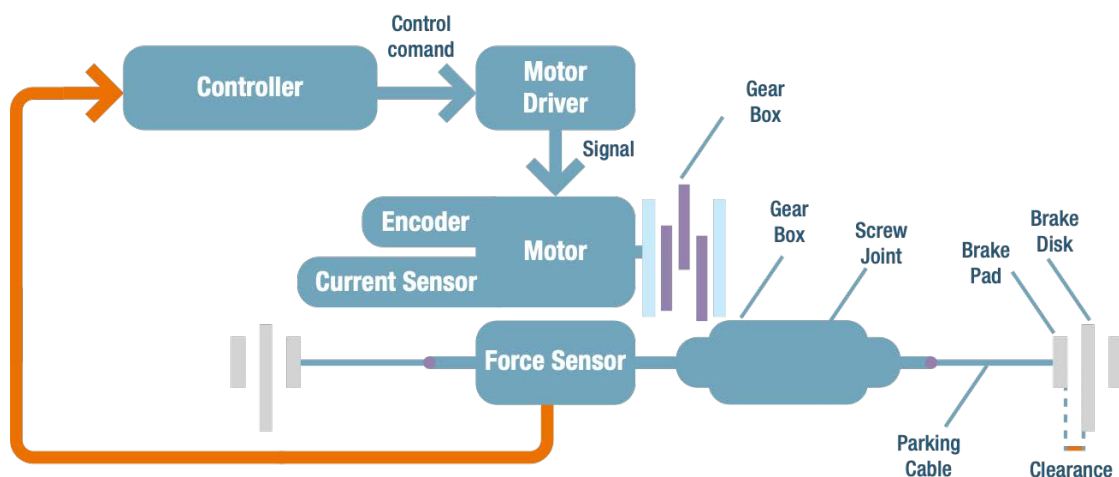
# Electrical Parking Brake (EPB) and Integrated Parking Brake (IPB)



# EPB AND IPB

## Main Features

- The electric park brake (EPB) functions as a conventional hydraulic brake for standard service brake applications, and as an electric brake for parking and emergency braking
- The EPB is a caliper with an additional motor (motor on caliper) that operates the parking brake. The EPB system is electronically controlled and consists of the EPB switch, the EPB caliper, and the electronic control unit (ECU)
- Main advantages:
  - Significant weight savings compared to mechanical parking brake systems to support enhanced fuel economy and reduced emissions
  - Vehicle coverage from small car to light truck segments
  - Electronic control allows for integration with other safety technologies

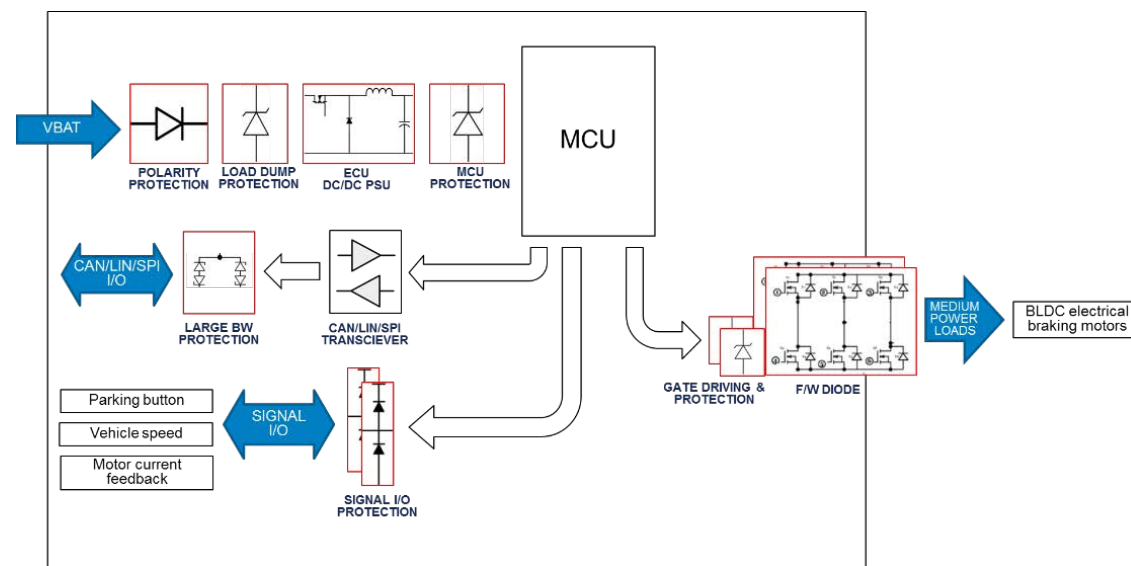


# EPB and IPB

## System Benefits

- Vishay's 100 V first-generation TMBS® devices deliver efficiency for high frequency rectification
- 200 V ultrafast FRED Pt® technology is optimized for load switching and polarity protection. The devices offer high stability and robustness up to 175 °C, with a good trade-off between soft recovery and  $V_F$
- Surface-mount PAR® unidirectional TVS in miniaturized packages
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

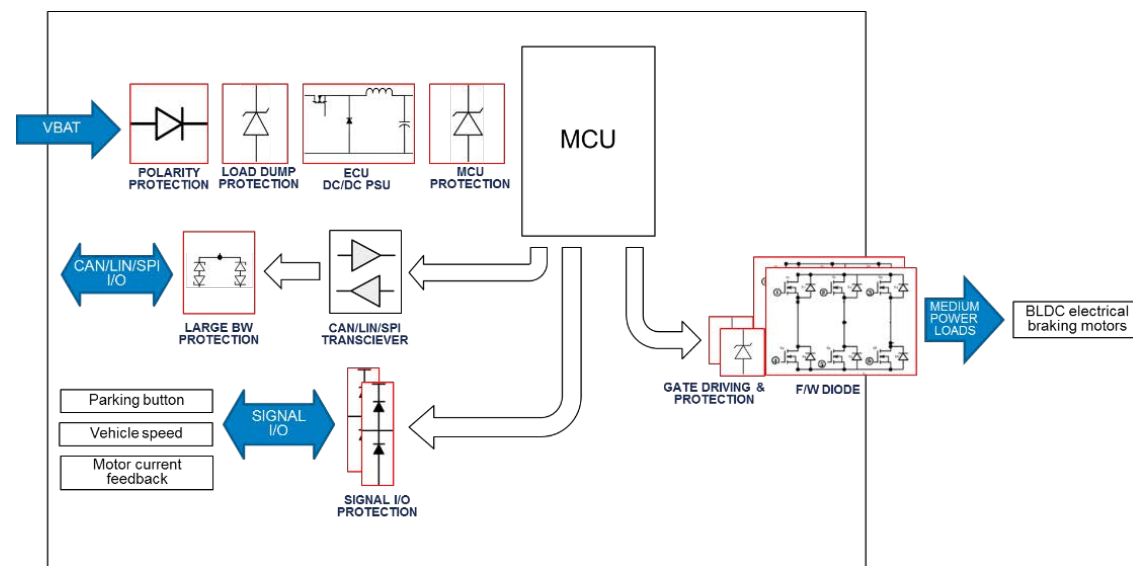
## Block Diagram



# EPB AND IPB

Function	Description	Image
HF Rectification	100 V dual high voltage TMBS® rectifier	(SMPD)
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	(DO-218)
Load Switch, Snubber, Polarity Protection	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	(SMF)
		(SlimDPAK)
		(SMPD)
Zener Diode	3.6 V to 200 V with 2 % tolerance	(SMF)
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	(MicroSMF)
		(MicroSMP)

## Block Diagram



# Advanced Driver Assistance Systems (ADAS)

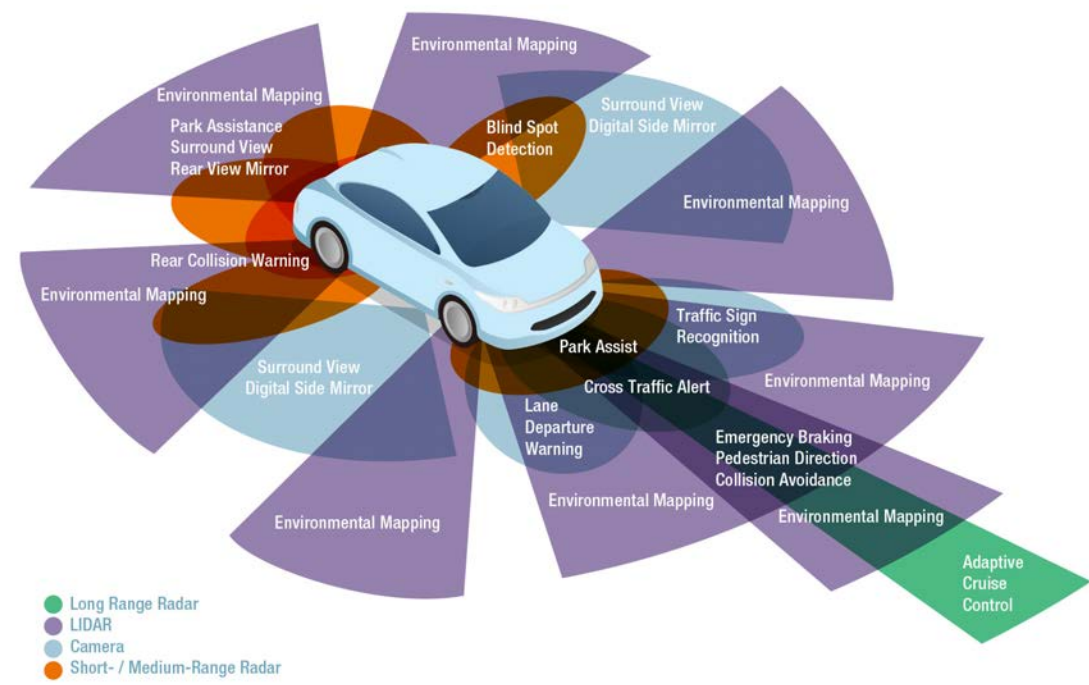




# ADAS

## Main Features

- ADAS constantly monitor the vehicle's surroundings, alert the driver of hazardous road conditions, and take corrective actions, such as slowing or stopping the vehicle. These systems use inputs from multiple sensors, such as cameras and radar. The fusion of these inputs is processed, and the information is delivered to the driver and other parts of the system. The same sensor technologies can be used both in the current ADAS and in the upcoming fully autonomous driving systems (level 4 and 5)
- Camera-based technologies provide high reliability and adaptability for a wide range of driver assistance applications, such as lane keeping, pedestrian detection, traffic sign recognition, rearview camera, driver monitoring, and electronic mirrors
- Radar-based ADAS use two different carrier frequencies, 24 GHz for narrow band and 77 GHz for wide band applications, to support features such as blind spot detection, automatic emergency braking, and adaptive cruise control

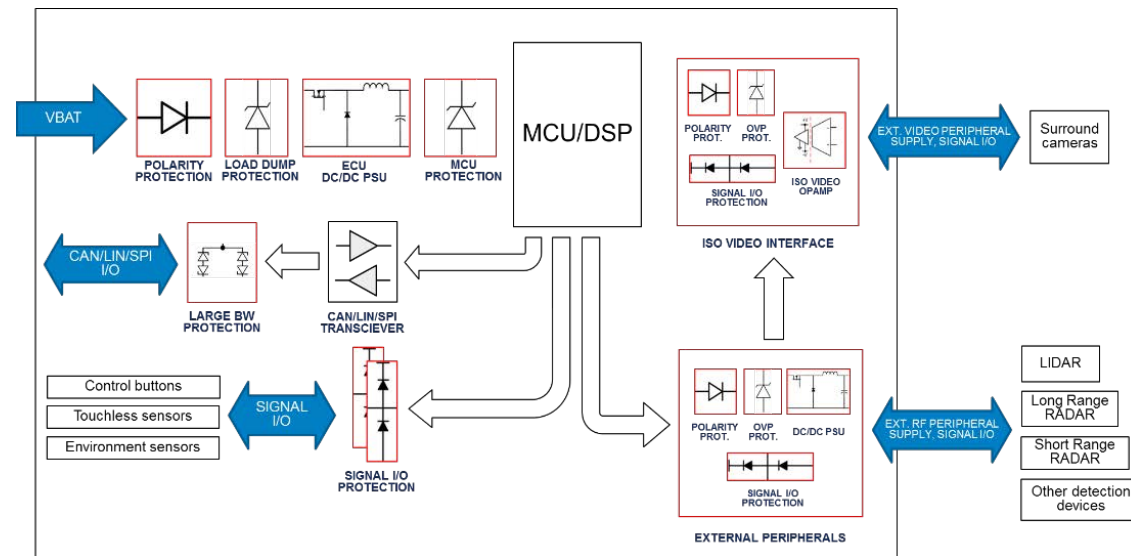


# ADAS

## System Benefits

- Vishay's 40 V to 100 V first-generation TMBS® devices deliver efficiency for high frequency rectification and DC/DC conversion
- Surface-mount PAR® unidirectional TVS in miniaturized packages
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

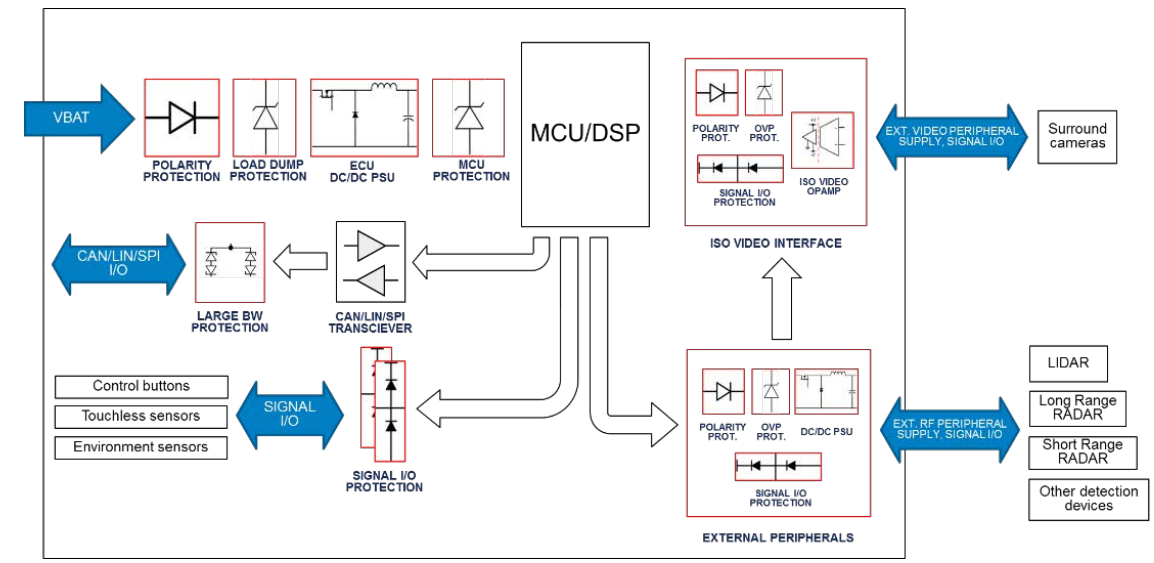
## Block Diagram



# ADAS

Function	Description	Image
HF Rectification	Up to 100 V dual high voltage TMBS® rectifier	(SlimDPAK) (SMA) 
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	(SMC) (DO-218) 
Load Switch, Polarity Protection	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	(SMF) (SlimDPAK) (SMPD) 
Zener Diode	3.6 V to 200 V with 2 % tolerance	(SMF) (MicroSMF) 
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail-to-rail signal line and power line protection	(MicroSMP) 

## Block Diagram

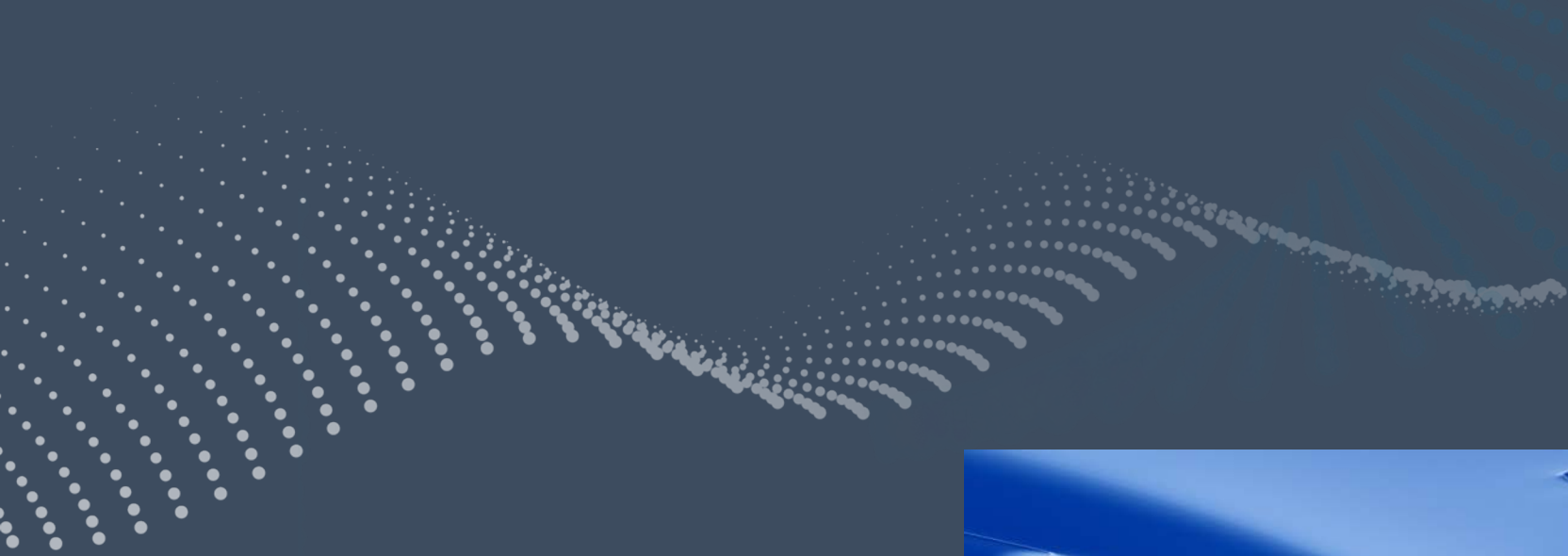


# Passive Safety

Airbag Control System

Pedestrian Protection System





# Airbag Control System

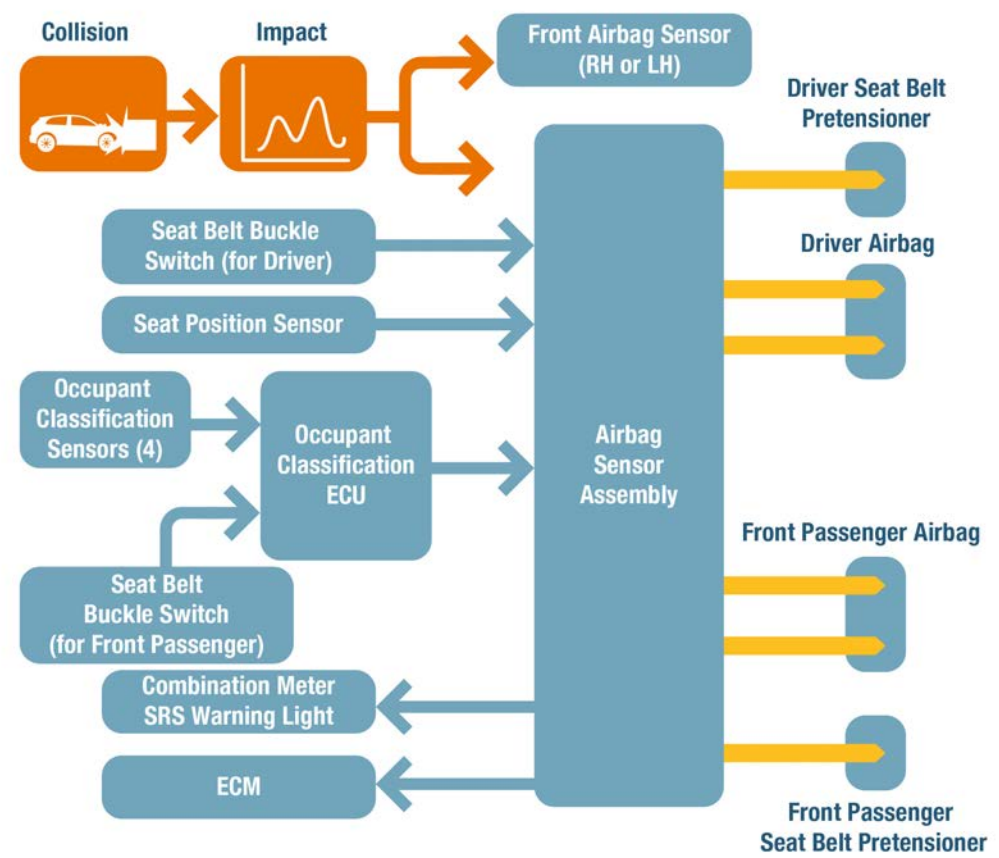




# Airbag Control System

## Main Features

- Airbags are a type of car safety restraint like seatbelts. They are gas-inflated cushions built into the steering wheel, dashboard, door, roof, or seat of the car that use a crash sensor to trigger a rapid expansion to protect occupants from the impact of an accident
- Car airbags are designed to save lives during collisions by cushioning the occupant as he / she decelerates after impact
- An airbag is more formally known as a supplementary restraint system (SRS), air cushion restraint system (ACRS), or supplemental inflatable restraint (SIR)



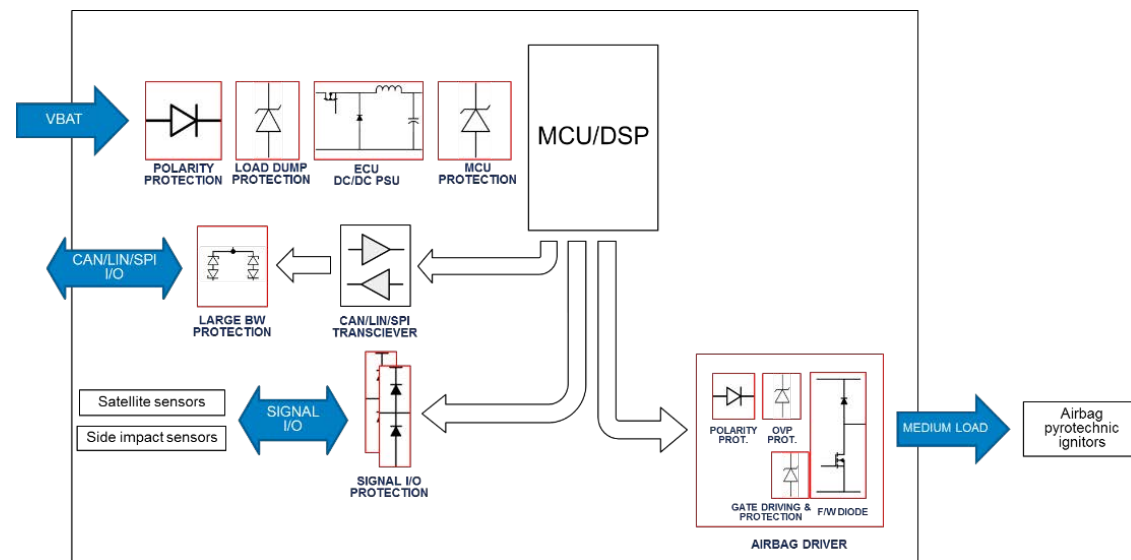


# Airbag Control System

## System Benefits

- Vishay's 200 V second-generation TMBS® devices deliver efficiency for high frequency rectification
- 200 V ultrafast FRED Pt® technology is optimized for load switching and polarity protection. The devices offer high stability and robustness for surge currents up to 175 °C
- Surface-mount PAR® unidirectional TVS in miniaturized packages
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

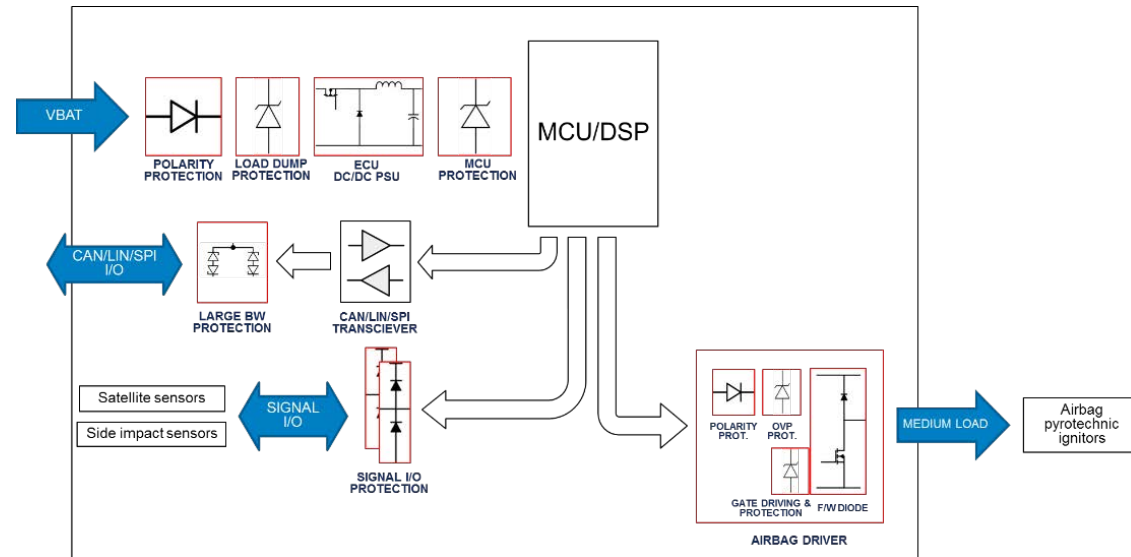
## Block Diagram



# Airbag Control System

Function	Description	Image
HF Rectification	200 V dual high voltage TMBS® rectifier	(SMPD)
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	(SMC) (DO-218)
Load Switch, Polarity Protection	1 A to 8 A, 200 V FRED Pt® hyperfast rectifier	(SMF) (SlimDPAK) (SMPC)
Zener Diode	3.6 V to 200 V with 2 % tolerance	(SMF) (MicroSMF)
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	(MicroSMP)

## Block Diagram





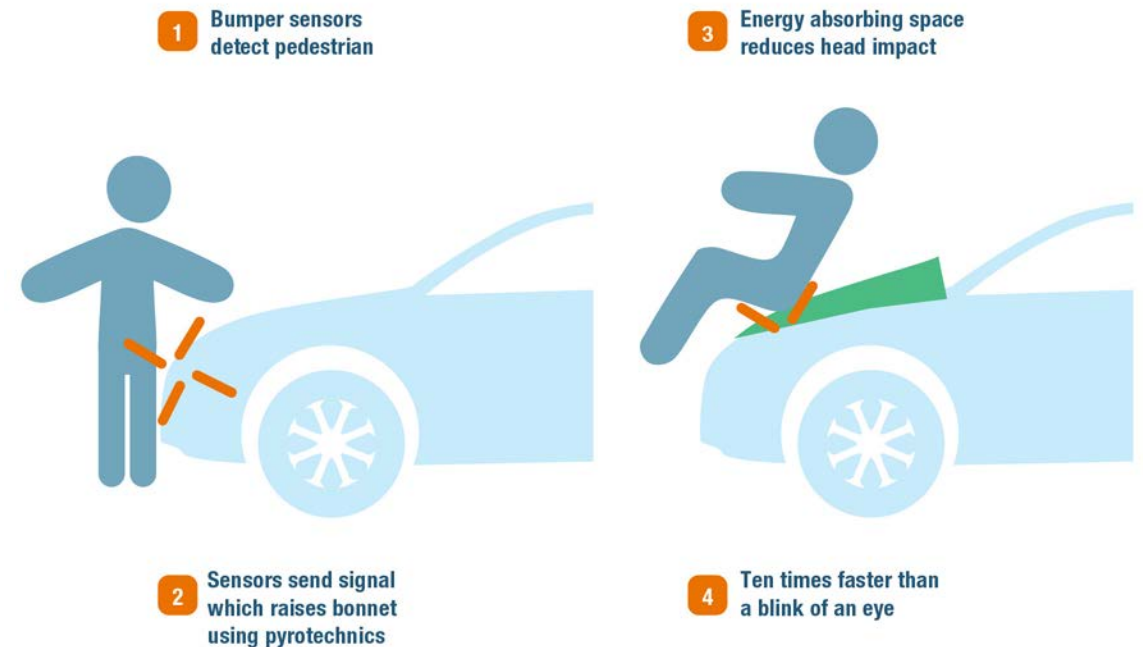
# Pedestrian Protection System



# Pedestrian Protection System

## Main Features

- Pedestrians are particularly at risk in traffic. In most accidents, the pedestrian collides with the front of the vehicle. Legal requirements and consumer protection tests for pedestrian protection have become significantly stricter in recent years. This presents challenges for sensor equipment, which must reliably detect an impact between the vehicle and a pedestrian

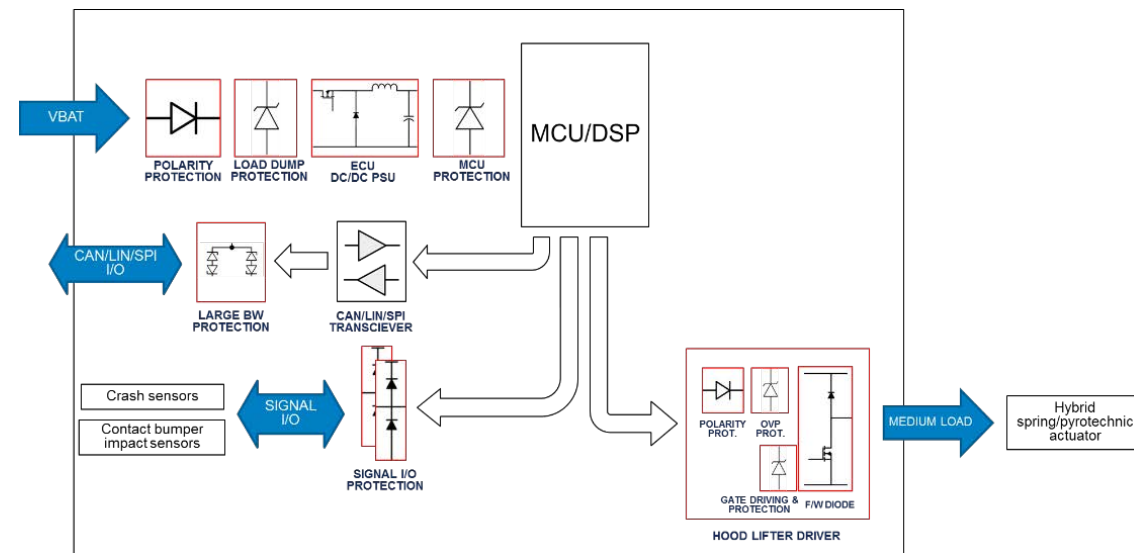


# Pedestrian Protection System



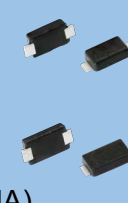


## System Benefits

- Vishay's 200 V second-generation TMBS® devices deliver efficiency for high frequency rectification
- 200 V ultrafast FRED Pt® technology is optimized for load switching and polarity protection. The devices offer high stability and robustness for surge currents up to 175 °C
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

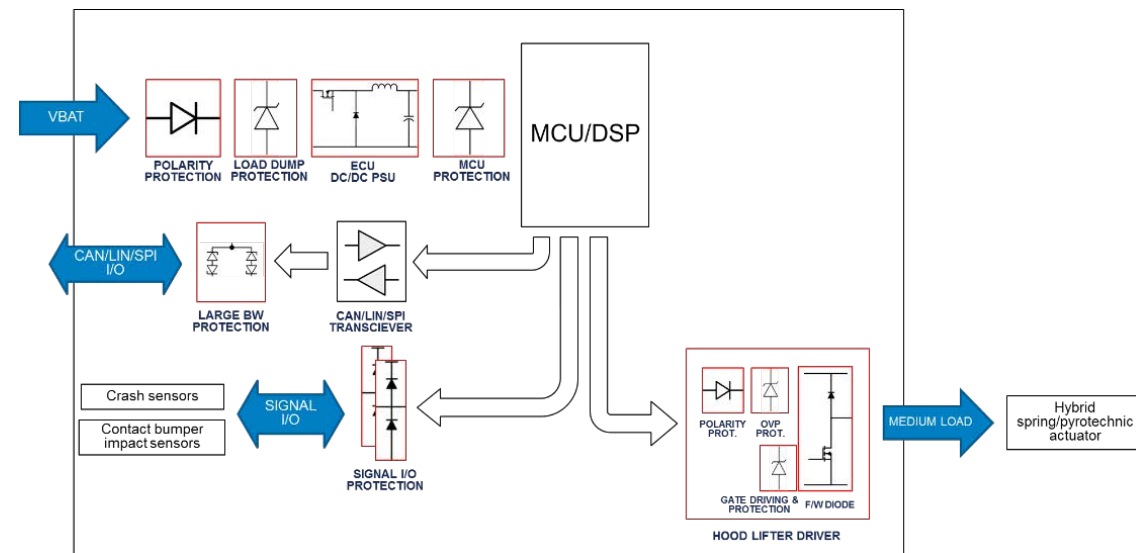
## Block Diagram



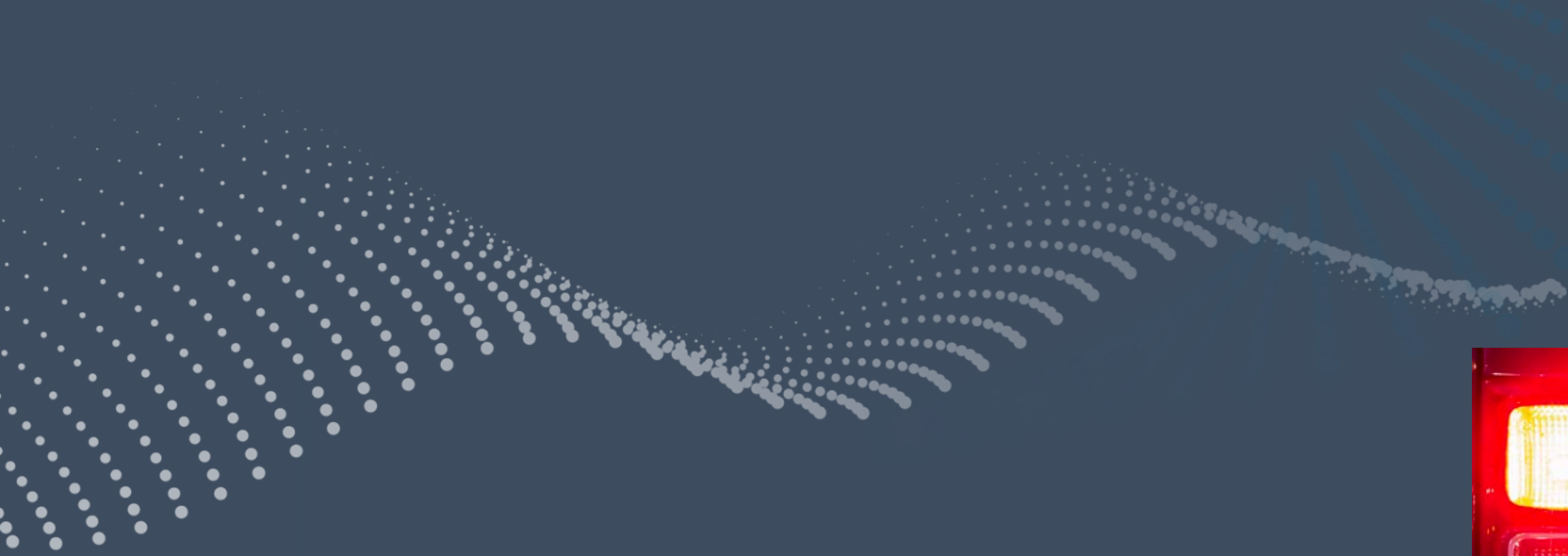
# Pedestrian Protection System

Function	Description	Image
HF Rectification	60 V to 100 V dual high voltage TMBS® rectifier	 (SlimDPAK) (SlimSMA)
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	 (SMC) (DO-218)
Load Switch, Polarity Protection	Up to 2 A, 200 V FRED Pt® hyperfast rectifier	 (SMF) (SlimSMA)
Zener Diode	3.6 V to 200 V with 2 % tolerance	 (SMF) (MicroSMF)
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	 (MicroSMP)

## Block Diagram

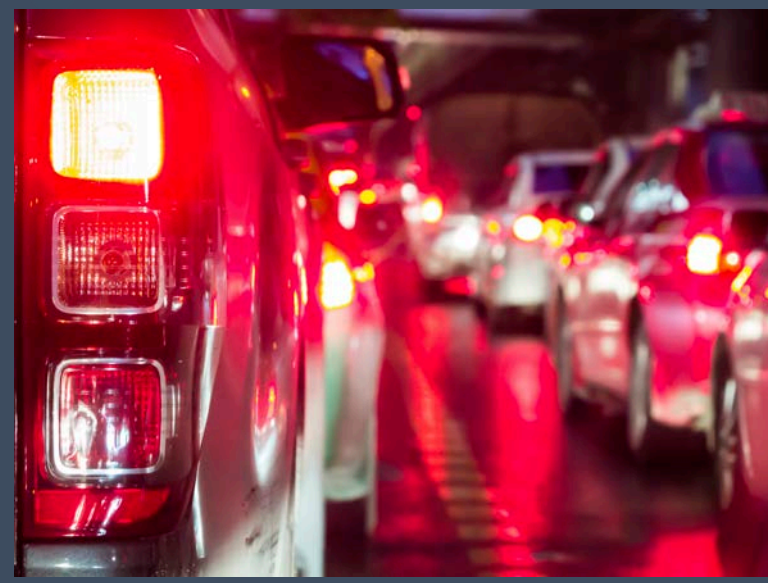


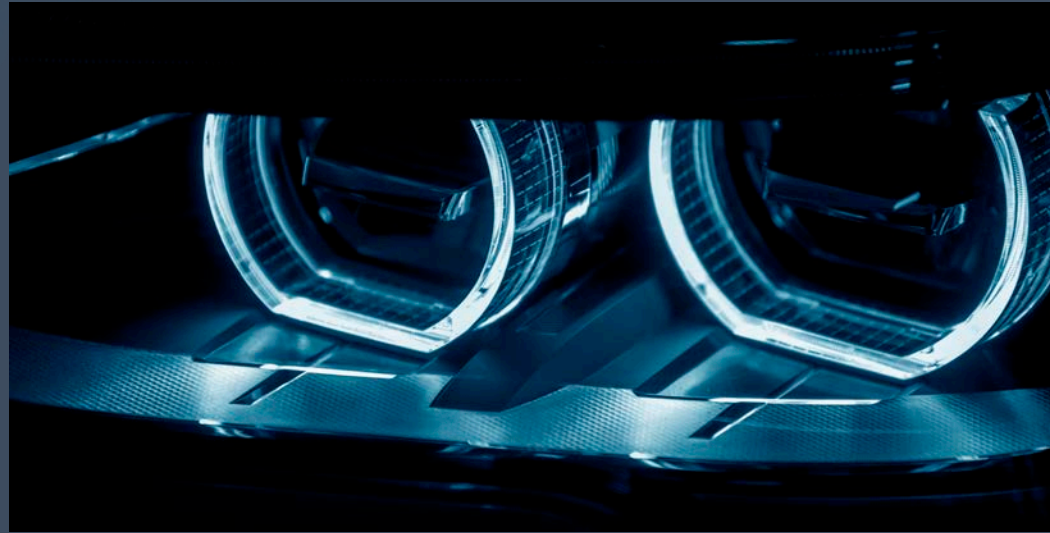
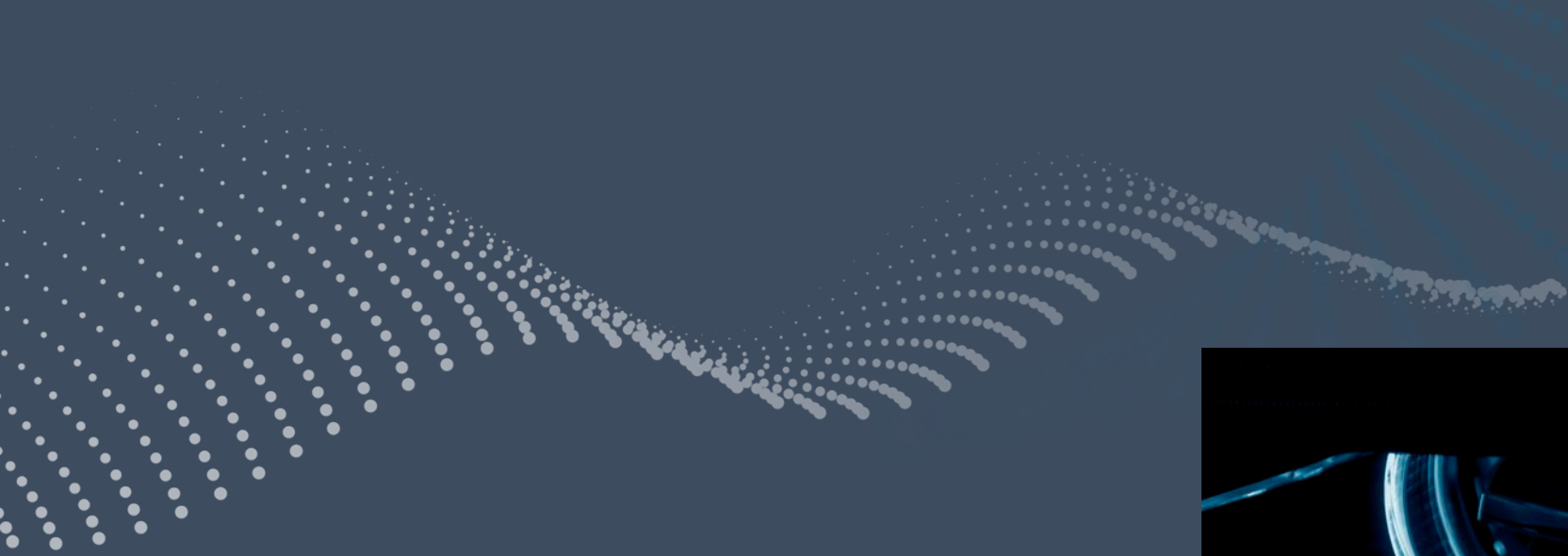




# Exterior Lighting

LED Headlight Unit





# LED Headlight Unit



# LED Headlight Unit

## Main Features

- Automotive exterior lighting systems, including turn signals, headlights, and taillights, are standard features in any vehicle
- Exterior lighting, especially LED front lighting, is one of the key differentiating factors for car makers in terms of brand recognition. It also plays an important role in safety (road illumination by automatically adjusting the headlamp cone of light depending on speed, steering angle, and vehicle tilt angle), reliability (extended lifetime), energy efficiency (low power consumption), and the so-called “user experience: UX” (emotional identification)
- As more and more dynamic and animated functions have come to the front lighting system, the complexity for supply, communication, sense, control, and actuation has been continuously increasing. To keep this complexity manageable in terms of space on the PCB, but also in terms of power dissipated, the integration of functions has become a key factor in design

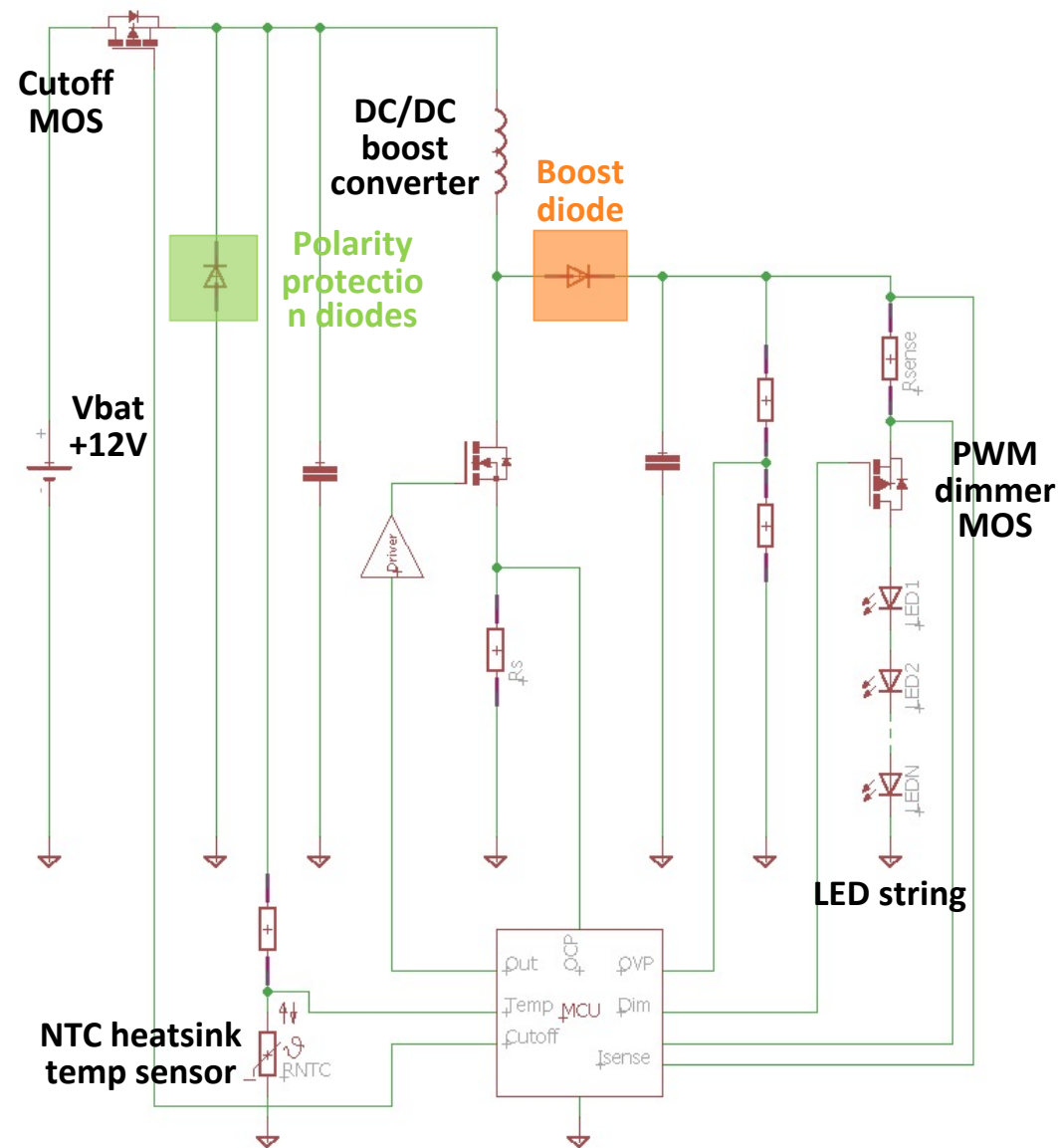


# LED Headlight Unit

## System Benefits

- Vishay’s 60 V to 120 V first-generation TMBS® devices deliver efficiency for DC/DC conversion
- Up to 200 V ultrafast FRED Pt® technology is optimized for polarity protection. The devices offer high stability and robustness for surge currents up to 175 °C
- Zener diodes with surge current specifications and 43 breakdown voltage from 3.6 V to 200 V, with tolerance of  $\pm 2\%$
- Vishay’s eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

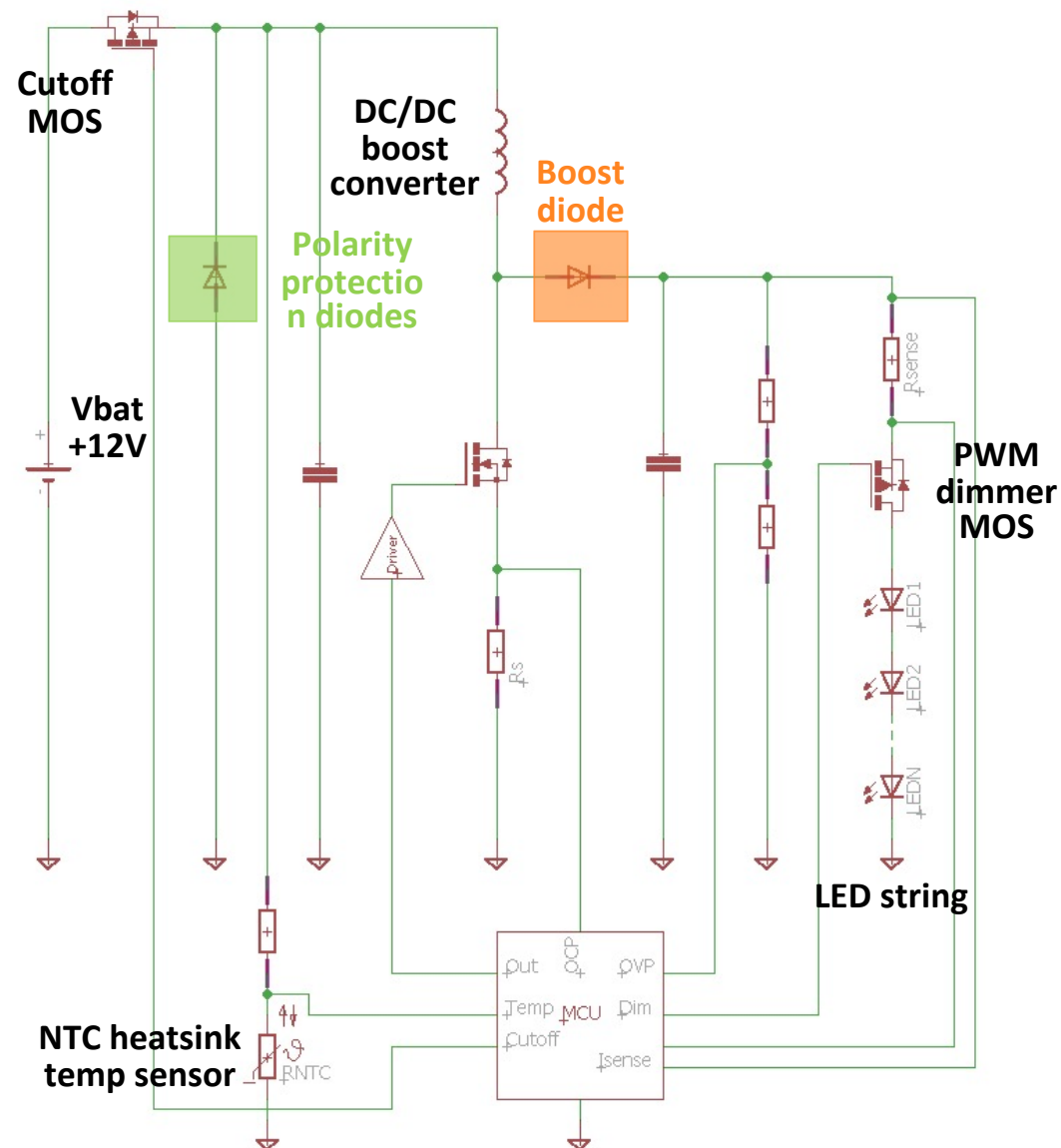
## Block Diagram



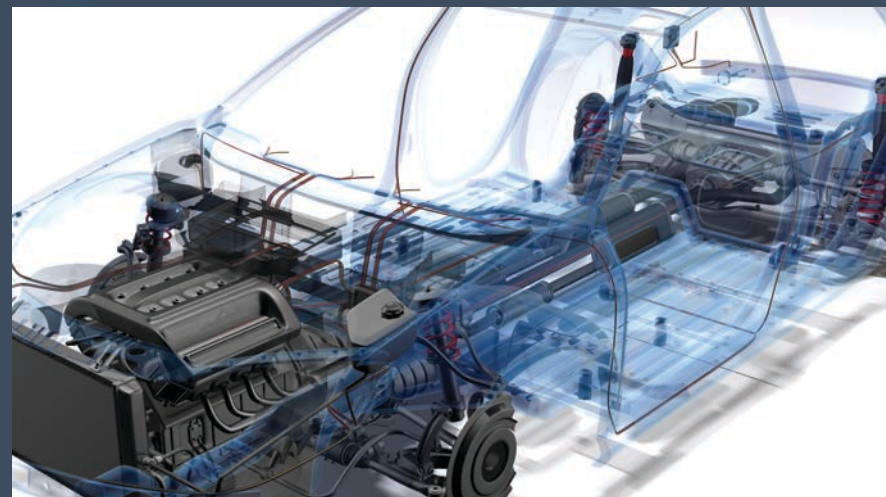
# LED Headlight Unit

Function	Description	Image
HF Rectification	60 V to 120 V dual high voltage TMBS® rectifier	(SMPC) (SMPA) 
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	(SlimSMA) 
Polarity Protection	Up to 2 A, 200 V FRED Pt® hyperfast rectifier	(SMF) (SlimSMA) 
Zener Diode	Zener diodes with surge current specification and 43 breakdown voltages from 3.6 V to 200 V, with ± 2 % tolerance	(SMF) (MicroSMF) 
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	(MicroSMP) 

## Block Diagram







## 48 V<sub>DC</sub> Boardnet

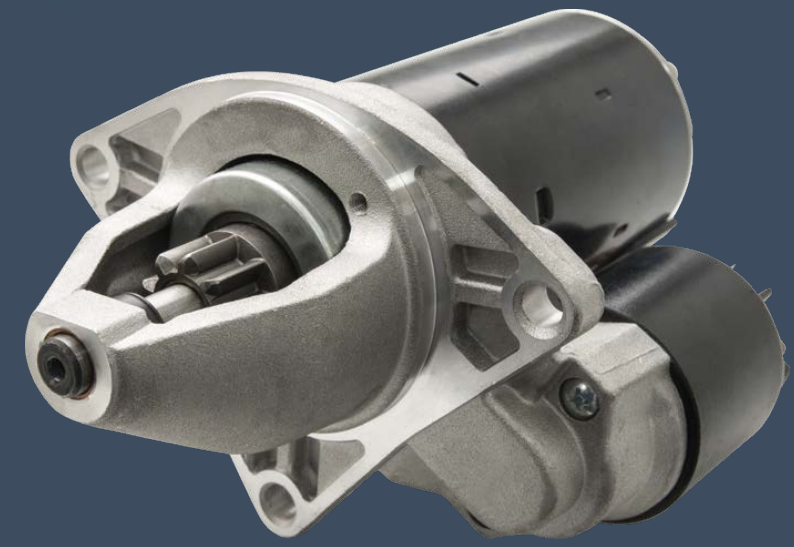
Integrated Starter Generator (ISG)

DC/DC Converter, Bidirectional

HVAC (E-Compressor)







# Integrated Starter Generator

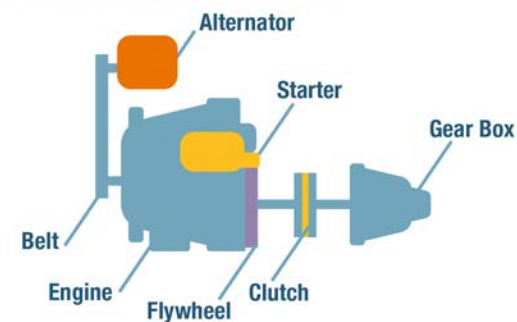


# Integrated Starter Generator

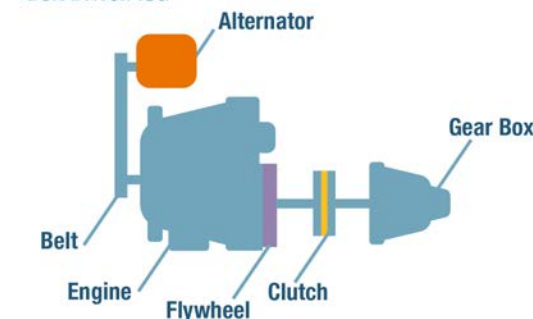
## Main Features

- The ISG replaces the conventional starter motor and the alternator (generator). In addition to its two basic functions (starter and alternator), it provides an auxiliary one as a convenient automatic vehicle start-stop system for further improved fuel efficiency. The electronic control system switches off the ICE at zero load (such as when standing at a traffic light) and automatically restarts it using the ISG very rapidly when the gas pedal is pressed. The ICE is accelerated to the required cranking speed (idle speed) and only then the combustion process for instant ignition is initiated
- During braking, the ISG can convert the vehicle's kinetic energy into electrical energy, and then feed this power back into the electrical system. As it fully supports the stop and start operation, electric drive-off and acceleration, and recycling of braking energy, the ISG helps to reduce both fuel consumption and emissions

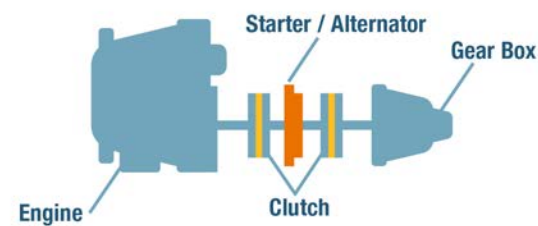
Independent Starter and Generator



Belt Driven ISG



Crankshaft ISG

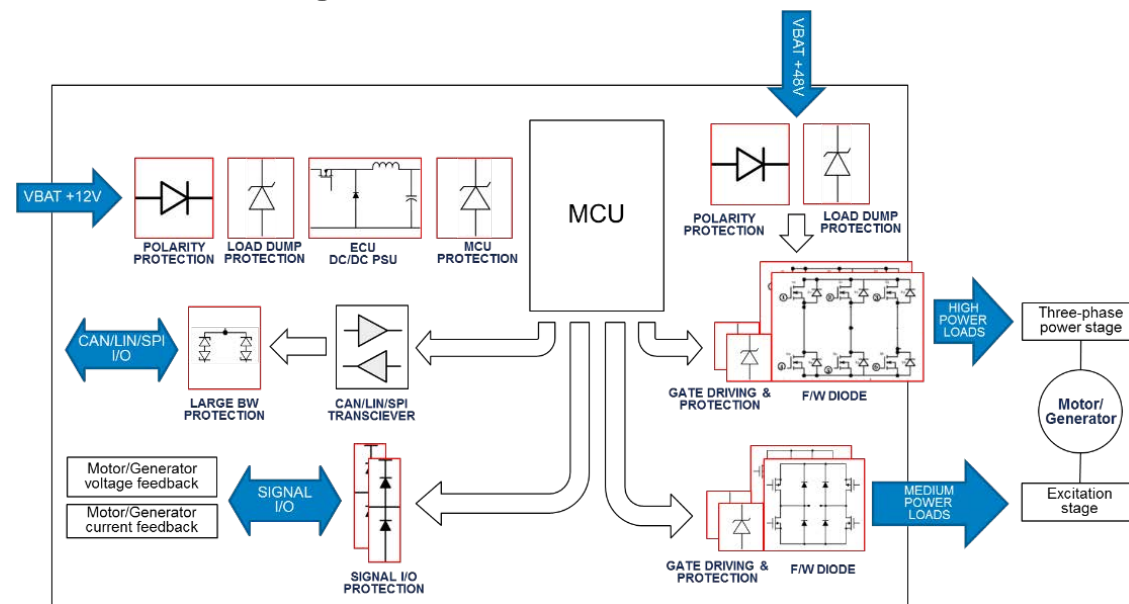


# Integrated Starter Generator

## System Benefits

- 200 V ultrafast FRED Pt® technology is optimized for load switching and polarity protection. The devices offer high stability and robustness for surge currents up to 175 °C
- Zener diodes with surge current specifications and breakdown voltage from 3.6 V to 200 V, with tolerance of  $\pm 2\%$
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

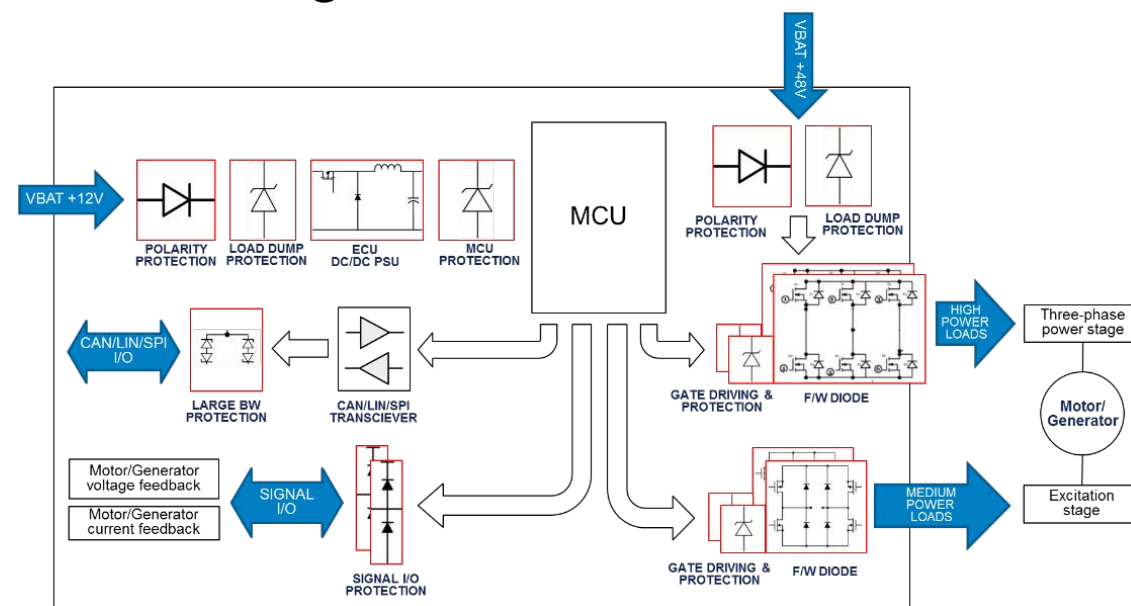
## Block Diagram



# Integrated Starter Generator

Function	Description	Image
Load Switch, Polarity Protection	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	(SMF)
		(SlimDPAK)
		(SMPC)
		(SMPD)
Surge Protection	Surface-mount PAR® TVS with a wide operation temperature range	(SlimSMA)
Zener Diode	3.6 V to 200 V with 2 % tolerance	(SMF)
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	(MicroSMP)

## Block Diagram





# DC/DC Converter, Bidirectional





# DC/DC Converter

## Main Features

- Automakers around the world have begun releasing vehicles that include a new 48 V power subsystem, also known as a board net
- While the introduction of 48 V subsystems does come with an incremental increase in vehicle cost, their widespread acceptance shows that automakers acknowledge them as a means to achieve lower CO<sub>2</sub> emissions, while improving fuel economy and providing vehicle drivability enhancements
- The 48 V system typically consists of several core elements. There is a 48 V battery, a 48 V starter / generator, and a 12 V / 48 V DC/DC Converter
- The 12 V / 48 V bidirectional DC/DC Converter is used to link the existing 12 V board net to the new 48 V board net. The converter typically supplies power up to 3.5 kW from the 48 V system to the 12 V net to power the existing vehicle electronics. In some situations, the 12 V board net must supply the 48 V electronics through the 12 V / 48 V DC/DC Converter as well, therefore requiring bidirectional power transfer



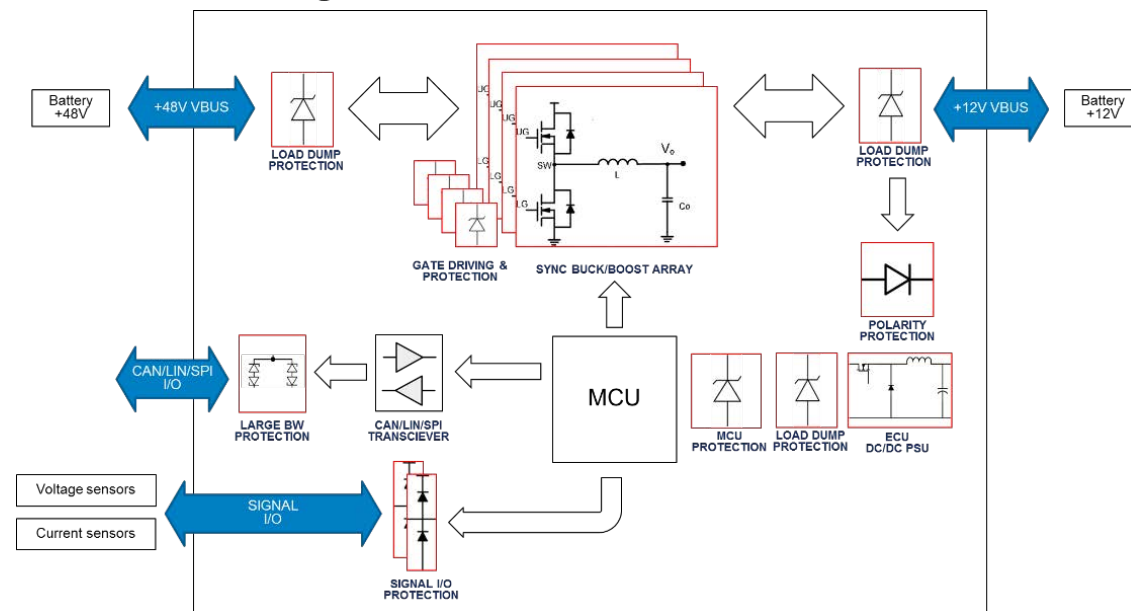


# DC/DC Converter



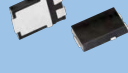


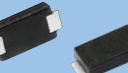


## System Benefits

- 200 V ultrafast FRED Pt® technology is optimized for load switching and polarity protection. The devices offer high stability and robustness for surge currents up to 175 °C
- Vishay's 120 V to 200 V first- and second-generation TMBS® devices deliver efficiency for DC/DC conversion
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

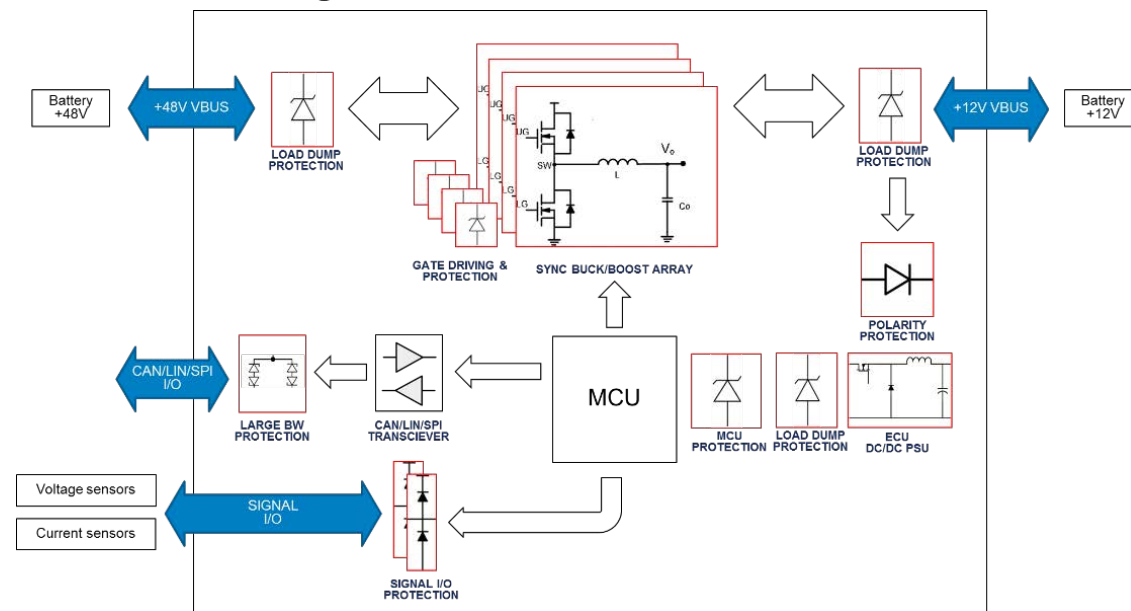
## Block Diagram



# DC/DC Converter

Function	Description	Image
Load Switch, Polarity Protection	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	 (SMF)  (SlimDPAK)  (SMPC)  (SMPD)
DC/DC Conversion	TMBS® technology up to 30 A, 200 V in SMD device	 (SMPD)
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	 (SlimSMA)
Zener Diode	3.6 V to 200 V with 2 % tolerance	 (SMF)
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	 (MicroSMP)

## Block Diagram





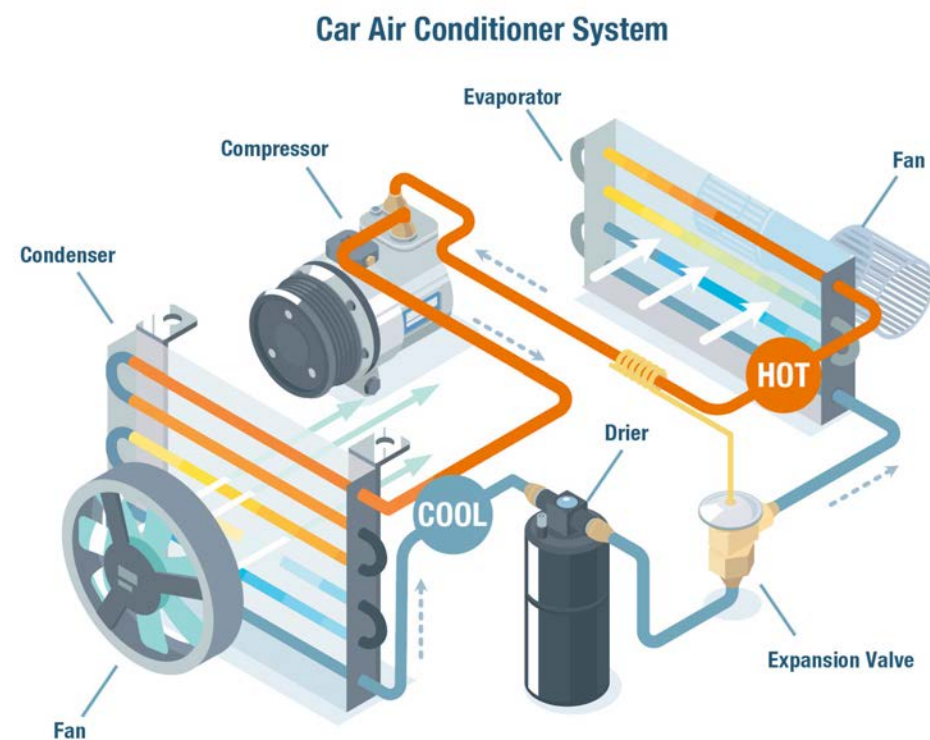
# HVAC (E-Compressor)



# HVAC (E-Compressor)

## Main Features

- A/C in vehicles works in the same way as your fridge at home. The heat from inside the car is pumped to the front, where there is a radiator that sits in front of your car's engine radiator. Once it passes through the radiator at the front (called the condenser), the gas turns into a liquid due to the high pressure and cooling. It then passes through what is known as a dryer, which is a device that absorbs water, if there is any. It is then sprayed into another radiator called the evaporator (via the expansion valve), where it absorbs the heat and turns back into gas
- The A/C pump is driven by the engine via a belt. There is a clutch on the pump pulley to reduce engine load when not in use, and to ensure that the evaporator maintains a steady temperature. The compressor clutch assembly has been the primary control of A/C for the past 30+ years, but in more recent vehicles it has been dispensed with, in favor of either a bypass valve in the pump or an ECU interactive expansion valve. Finally, in hybrid vehicles, the pump is driven electrically, so the A/C can continue operating even when the engine is not actually turning

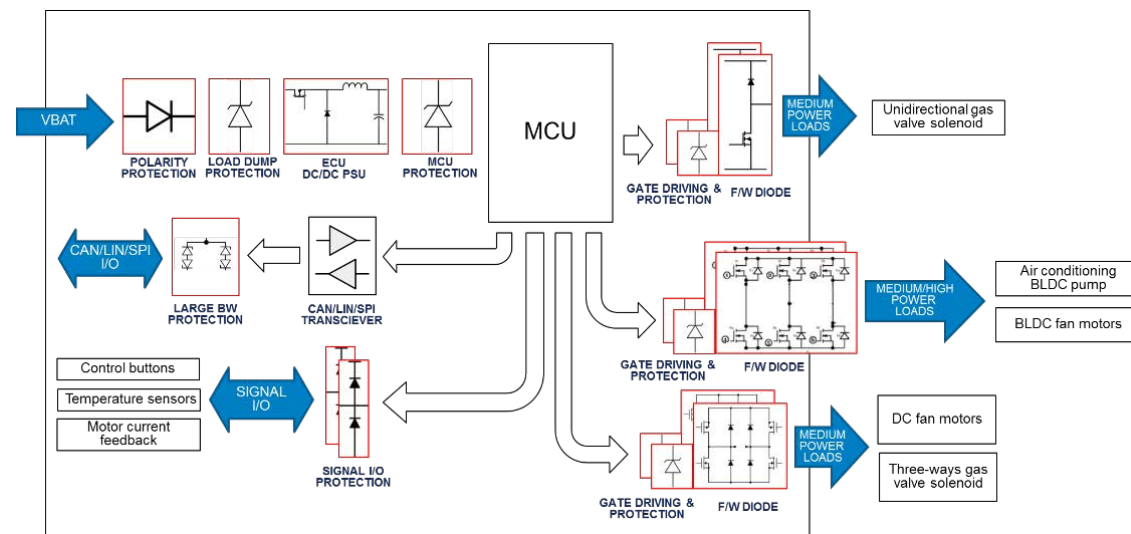


# HVAC (E-Compressor)

## System Benefits

- 200 V ultrafast FRED Pt® technology is optimized for load switching and polarity protection. The devices offer high stability and robustness for surge currents up to 175 °C
- Standard recovery diode up to 600 V with high ESD capability in miniaturized packages for rail to rail protection
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

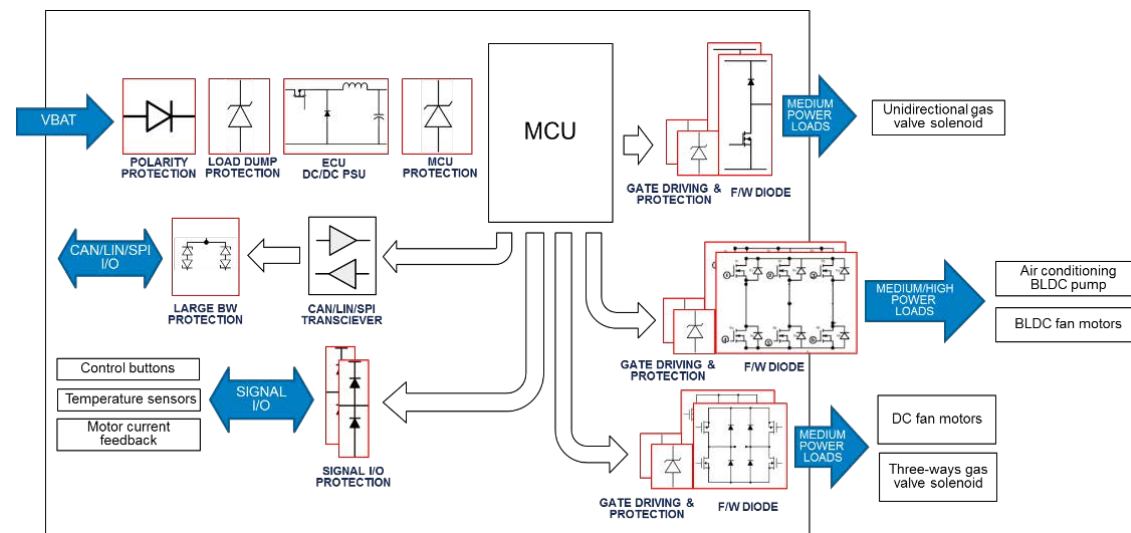
## Block Diagram



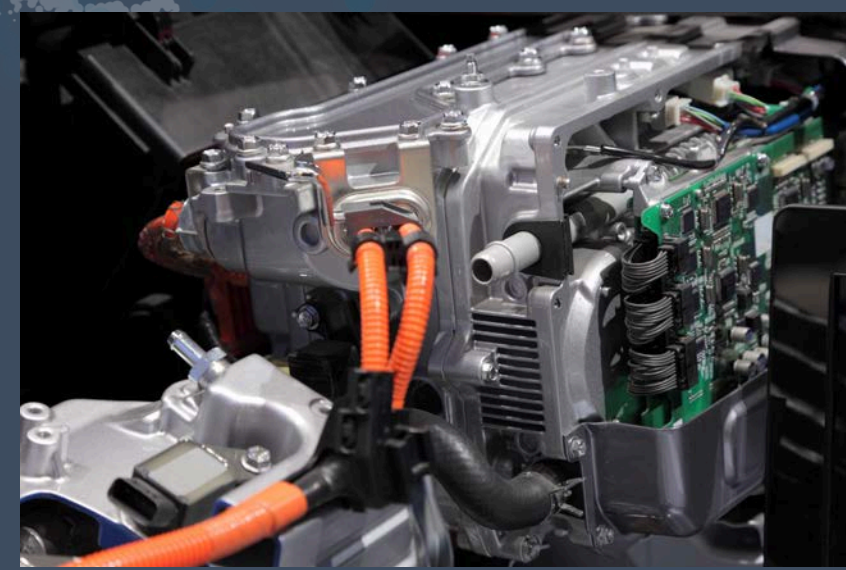
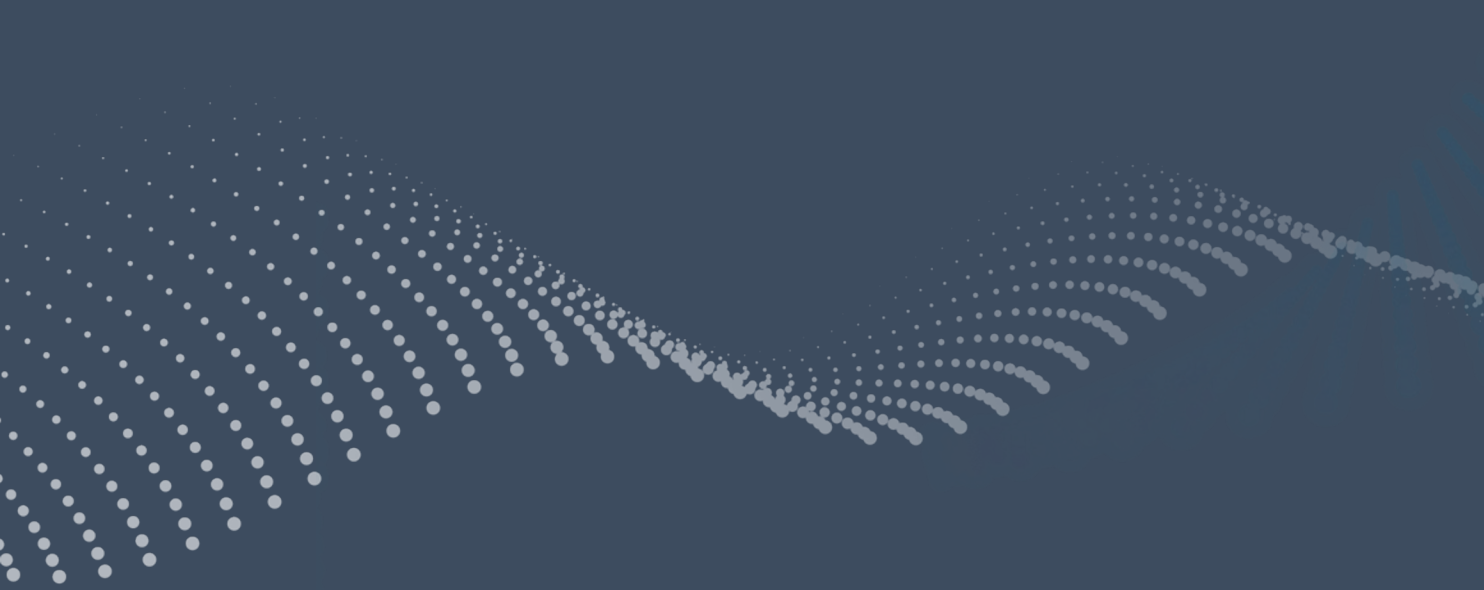
# HVAC (E-Compressor)

Function	Description	Image
Load Switch, Polarity Protection	1 A to 16 A, 200 V FRED Pt® hyperfast rectifier	<p>(SMF) (SlimDPAK) (SMPC) (SMPD)</p>
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	<p>(DO-218)</p>
Zener Diode	3.6 V to 200 V with 2 % tolerance	<p>(SMF)</p>
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	<p>(MicroSMP)</p>

## Block Diagram



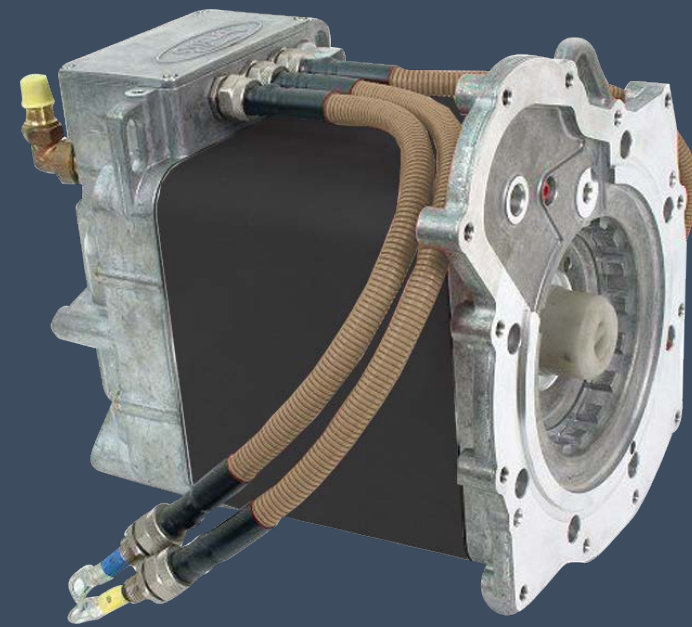




# Hybrid Electric Vehicle (HEV)

Electrical Motor Drives





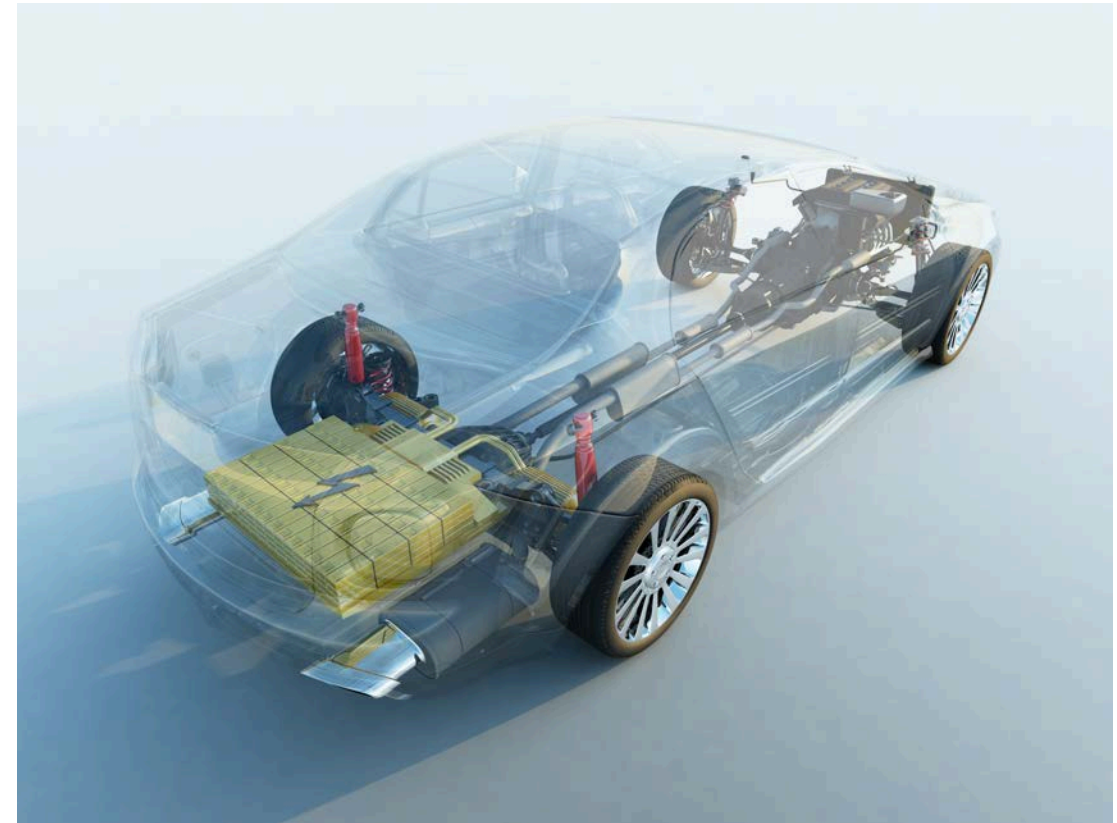
# Electrical Motor Drives



# Electrical Motor Drives

## Main Features

- A hybrid electric vehicle is distinguished from a standard ICE by four different parts: a) a device to store a large amount of electrical energy; b) an electrical machine to convert electrical power into mechanical torque on the wheels; c) a modified ICE adapted to hybrid electric use; d) a transmission system between the two different propulsion techniques
- Electric motors used on hybrid vehicles include: DC motors, induction motors (IM), permanent magnet synchronous motors (PMSM), and switching reluctance motors (SRM). The HEV can use the electrical machine to behave as a generator and thereby produce electrical energy, which can be stored and used later. The ICE may be the same type as those on conventional vehicles, but it must be designed and optimized for hybrid vehicles. The transmission system between the ICE and the electrical machine is typically of a series or parallel architecture. For power electronics, MOSFETs or IGBT transistors are used

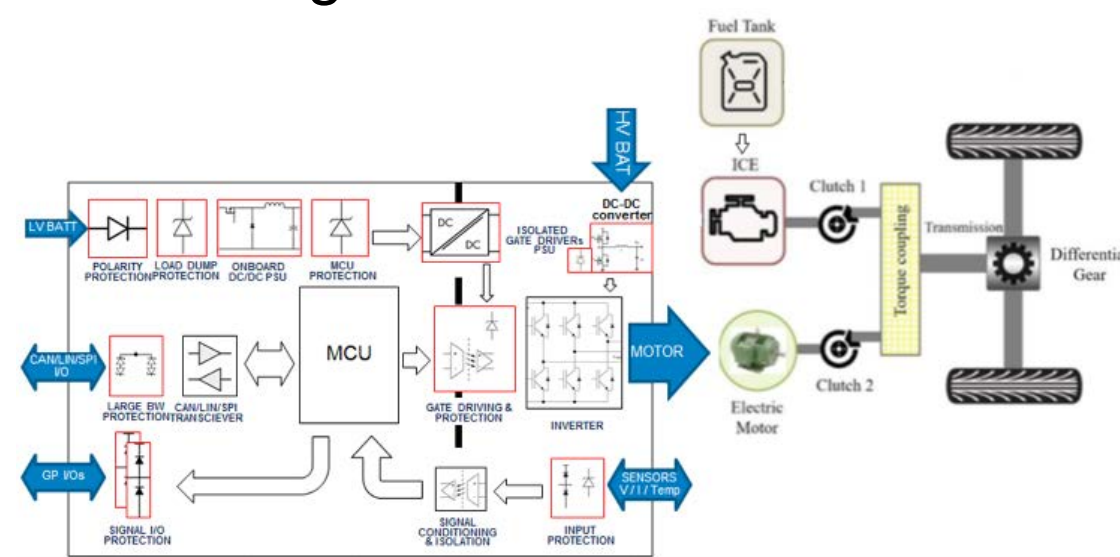


# Electrical Motor Drives

## System Benefits

- 600 V and 650 V ultrafast FRED Pt® technology is optimized for load switching and freewheeling. The devices offer high stability and robustness for surge currents up to 175 °C
- Zener diodes with surge current specifications and breakdown voltage from 3.6 V to 200 V, with tolerance of  $\pm 2\%$
- Surface-mount PAR® TVS offer stability in high temperature ( $T_J$  max. = 185 °C), high reliability conditions
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

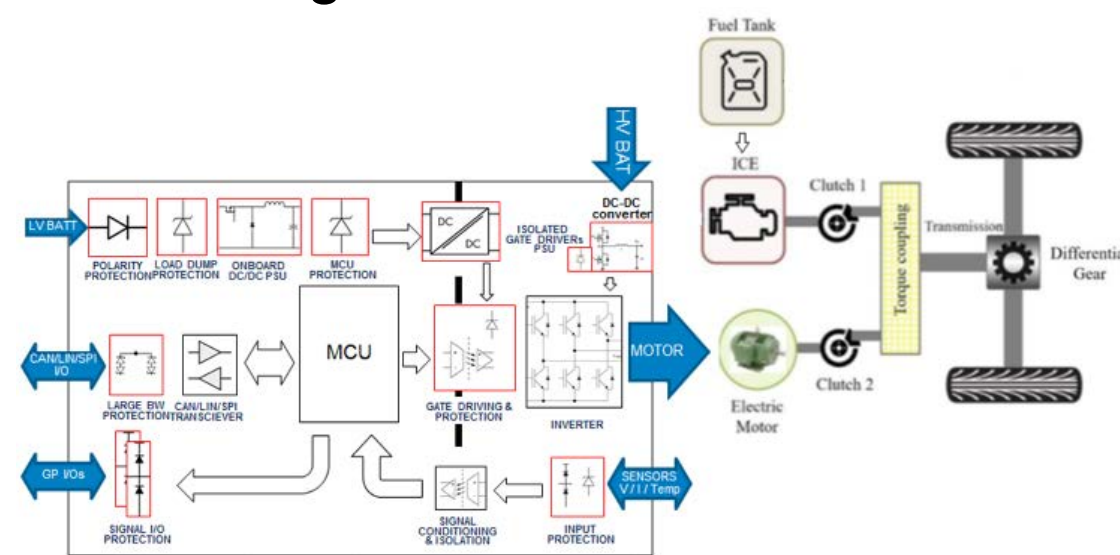
## Block Diagram



# Electrical Motor Drives

Function	Description	Image
Load Switching, Freewheeling Diode	1 A to 30 A, 600 V to 650 V FRED Pt® hyperfast rectifier	<p>(SMF) (SlimDPAK) (SMPC) (SMPD)</p>
Surge Protection	Surface-mount PAR® TVS with a wide operating temperature range	<p>(SlimSMA)</p>
Zener Diode for Rail to Rail Protection	3.6 V to 200 V with 2 % tolerance	<p>(SMF),</p>
Surge Protection	Surface-mount TRANSZORB® TVS	<p>(SMB)</p>
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	<p>(MicroSMP)</p>

## Block Diagram







## Full Electrical Vehicles (FEV)

Electrical Motor Drives

Battery Management and DC/DC Converter

On-Board Charger (OBC)





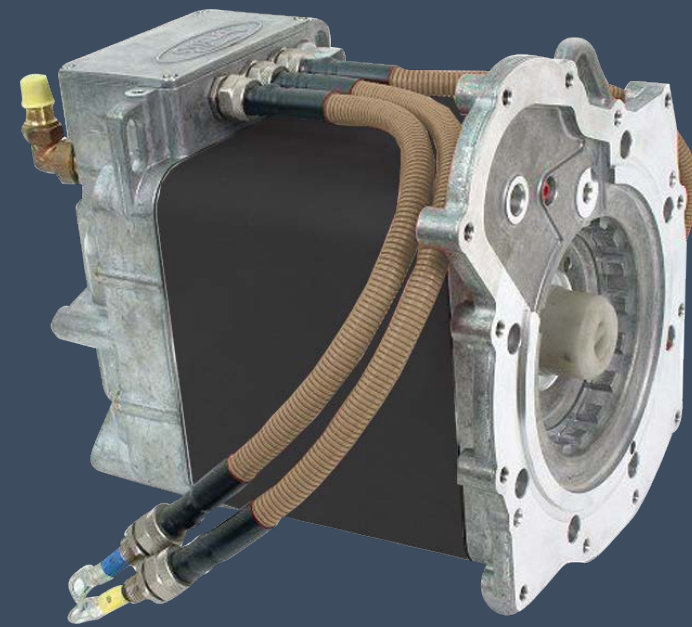
# Electrical Vehicle Applications Overview



**INVERTER  
(MAIN  
AND AUX)**

**On-Board  
Charger**

**ON-BOARD  
DC/DC  
HV to LV**



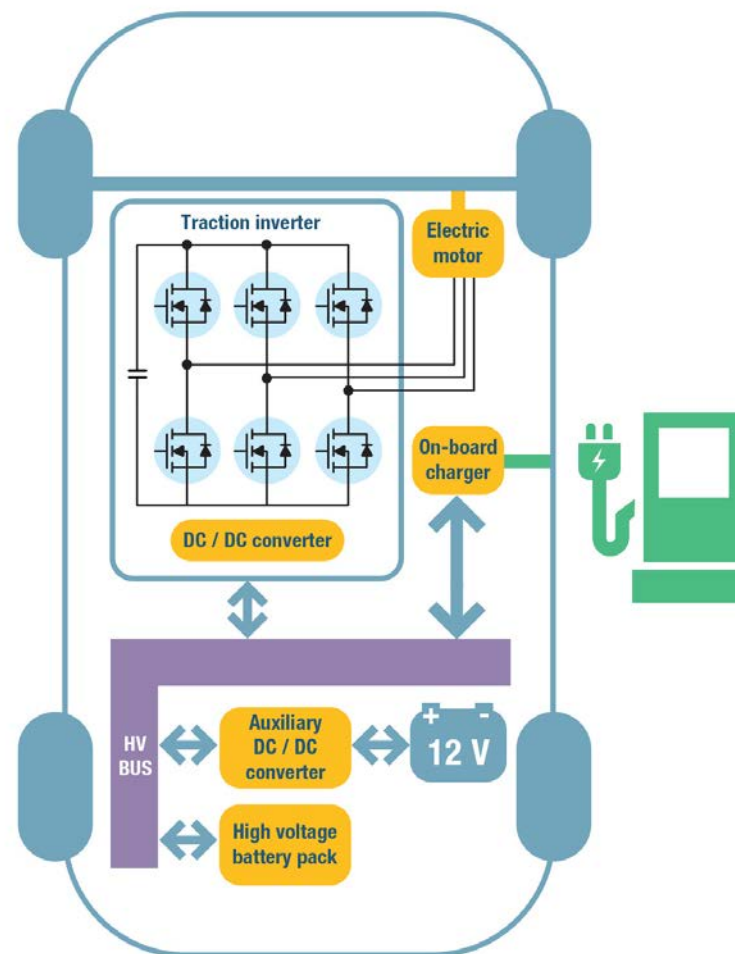
# Electrical Motor Drives



# Electrical Motor Drives

## Main Features

- The main inverter controls the electric motor. This is a key component in an electric car and determines its driving behavior. Regardless of whether the motor is synchronous, asynchronous, or brushless DC, the inverter always functions in a similar way and is controlled by an integrated PCB, which should be designed to minimize switching losses and maximize thermal efficiency. Not only does the inverter drive the electric motor, but it also captures the energy released via regenerative braking and feeds it back to the battery. As a result, the range of the vehicle is directly related to the efficiency of the main inverter
- In typical EV, auxiliary systems (PTC heaters, auxiliary drives, etc.) are supplied via the high voltage battery. Notably, the devices that were formerly belt-driven (such as the e-compressor for HVAC systems, oil pumps, and cooling pumps) have now been electrified and integrated into the power system. These auxiliary inverters now deliver power on demand, thereby increasing the vehicle's energy efficiency

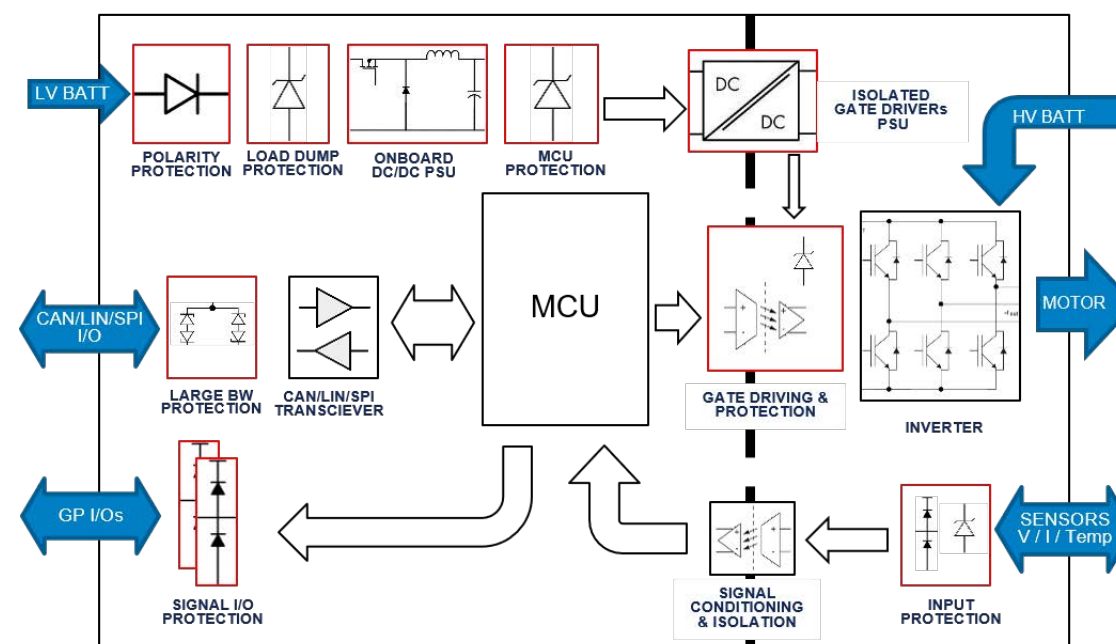


# Electrical Motor Drives

## System Benefits

- 600 V and 650 V ultrafast FRED Pt® technology is optimized for load switching and freewheeling for IGBTs. The devices offer high stability and softness and any temperature and minimize total conduction losses. They are available as bare die and in discrete packages
- Zener diodes with surge current specifications and breakdown voltage from 3.6 V to 200 V, with tolerance of  $\pm 2\%$
- Surface-mount PAR® TVS offer stability in high temperature ( $T_J$  max. = 185 °C), high reliability conditions
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

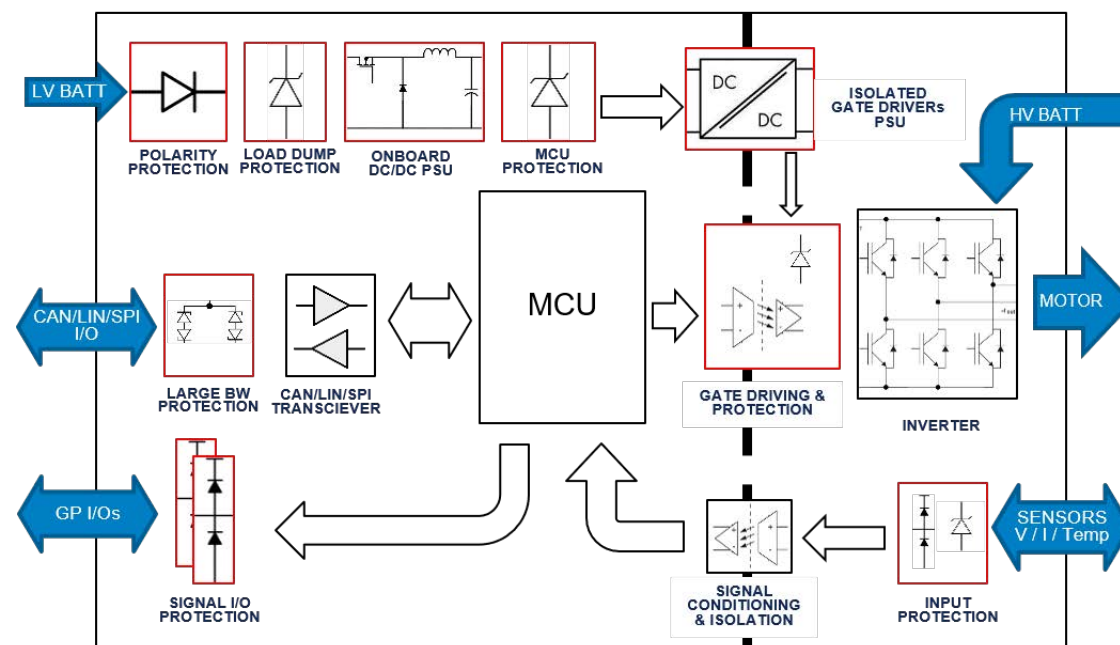
## Block Diagram



# Electrical Motor Drives

Function	Description	Image
Load Switch, Freewheeling Diode	1 A to 30 A, 600 V to 650 V FRED Pt® hyperfast rectifier	<p>(SMF) (SlimDPAK) (SMPC) (SMPD)</p>
Zener Diode for Rail to Rail Protection	3.6 V to 200 V with 2 % tolerance	<p>(SMF)</p>
Surge Protection	Surface-mount TRANSZORB® TVS	<p>(SMB)</p>
Standard Recovery Diode	1 A, 600 V standard recovery diode with ESD capability for rail to rail signal line and power line protection	<p>(MicroSMP)</p>

## Block Diagram





# Battery Management and DC/DC Converter

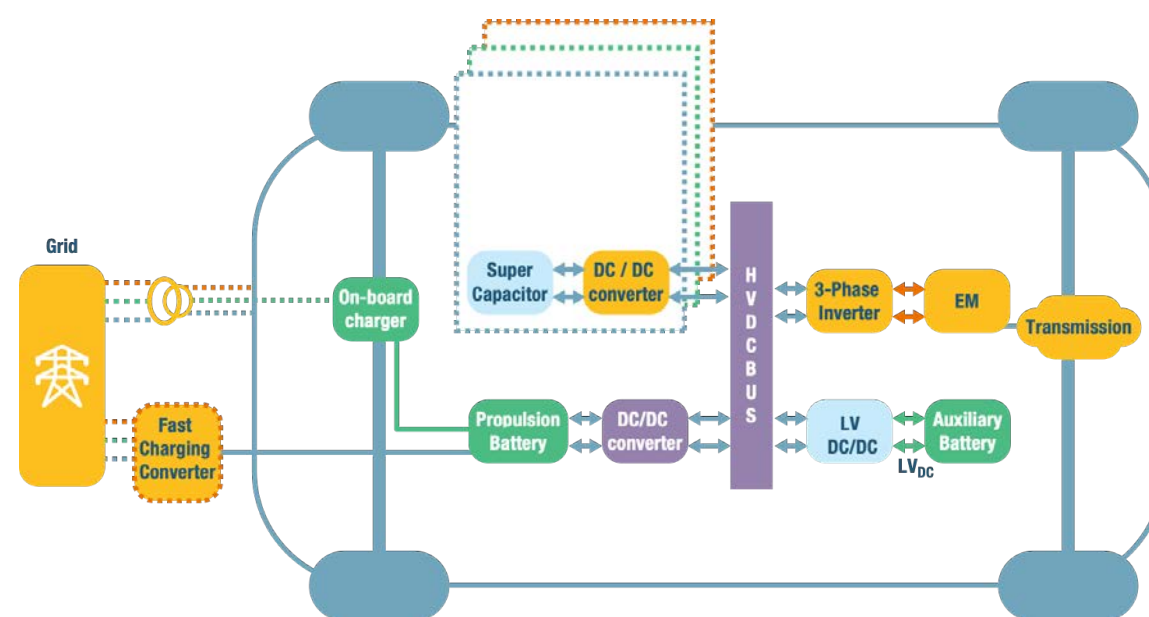




# DC/DC Converter

## Main Features

- DC/DC Converters convert high voltages to 48 V and 12 V, and 48 V to 12 V in the various configurations of EVs. The key design requirements for DC/DC Converters are low losses, high efficiency, low volume, and light weight. There are many architectures, each requiring different kinds of semiconductor devices
- EVs use two different power systems: a high voltage battery (200 V<sub>DC</sub> to 450 V<sub>DC</sub>) for traction and a low voltage (12 V) one for supplying all the electric appliances in the vehicle. Traditionally, the low voltage battery was charged by the alternator, but in today's vehicles it gets its power from the high voltage battery pack. However, in specific electric car architectures, this low voltage battery should be ready to help recharge the high voltage battery pack in order to provide energy for cranking the car
- This means that the on-board DC/DC Converter must be bidirectional and very efficient, as well as highly reliable in order to run the complex control algorithms needed to ensure an energy-efficient solution

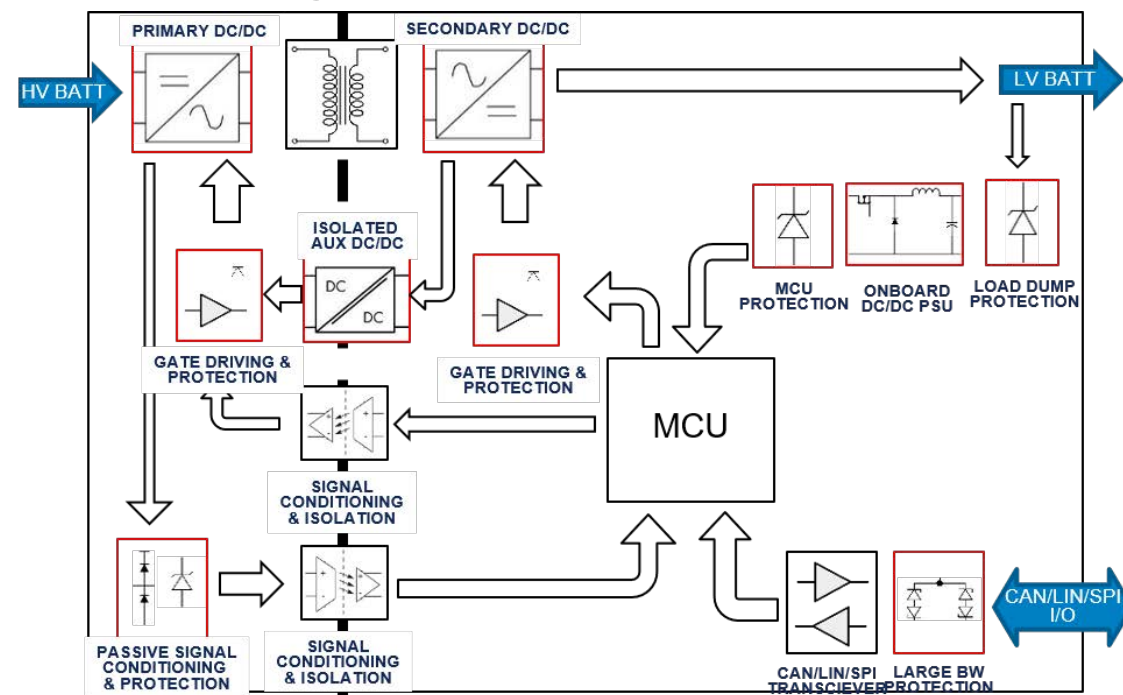


# DC/DC Converter

## System Benefits

- 600 V and 650 V ultrafast FRED Pt® technology is optimized for load switching. The devices offer high stability and robustness for surge current up to 175 °C
- 500 mW Zener diodes in the low profile MicroSMF (DO-219AC) package provide voltage stabilization
- Surface-mount PAR® TVS offer stability in high temperature ( $T_J$  max. = 185 °C), high reliability conditions
- Vishay's 100 V second-generation TMBS® devices deliver efficiency for DC/DC conversion
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

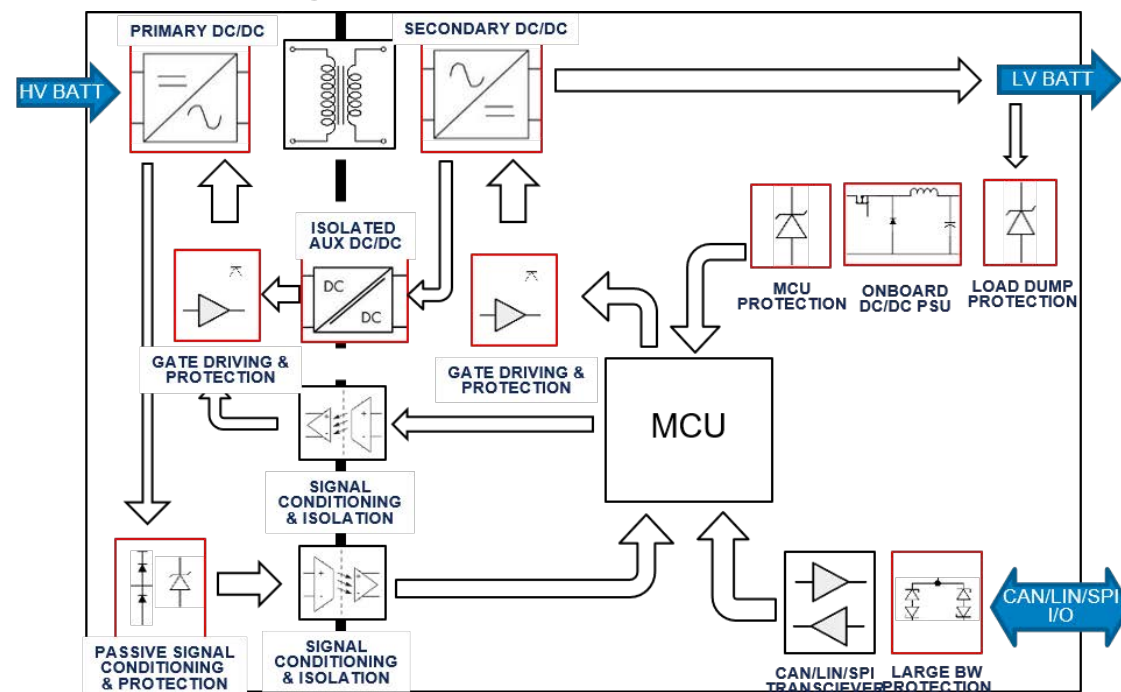
## Block Diagram



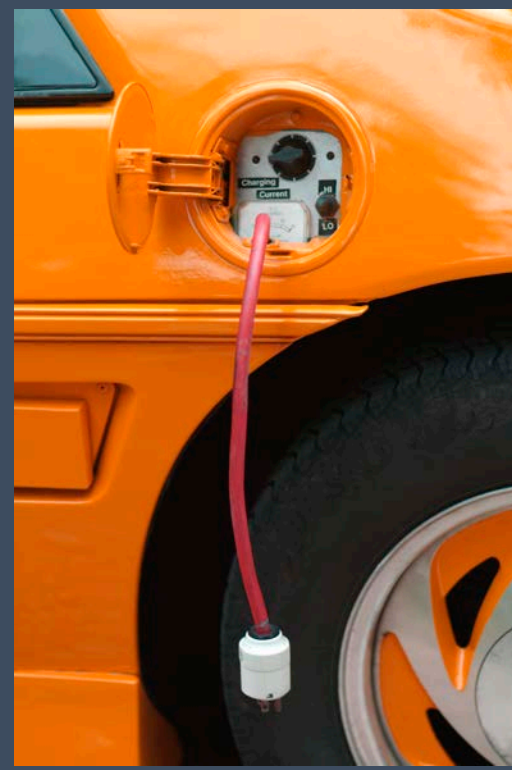
# DC/DC Converter

Function	Description	Image
Load Switching, Freewheeling Diode	1 A to 30 A, 600 V to 650 V FRED Pt® hyperfast rectifier	<p>(SMF) (SlimDPAK) (SMPC) (SMPD)</p>
Signal Conditioning	500 mW Zener diodes in the low profile MicroSMF (DO-219AC) package provide voltage stabilization	<p>(MicroSMF)</p>
Surge Protection	Surface-mount PAR® TVS for stability in high temperature, high reliability conditions	<p>(SlimSMA)</p>
Rail to Rail Protection	100 V to 600 V, 1 A rectifiers with high ESD capability for rail to rail signal line protection	<p>(MicroSMP)</p>

## Block Diagram



# On-Board Charger (OBC)



# On-Board Charger

## Main Features

- At the heart of any EV or plug-in HEV vehicle lies the high voltage ( $200 V_{DC}$  to  $450 V_{DC}$ ) battery and its associated charging system. The On-Board Charger (OBC) provides the means to recharge the battery from the AC mains, either at home or from outlets found in private or public charging stations
- From a 3.6 kW single-phase to a 22 kW three-phase high power converter, today's OBCs must have the highest possible efficiency and reliability to ensure rapid charging times as well as meet limited space and weight requirements



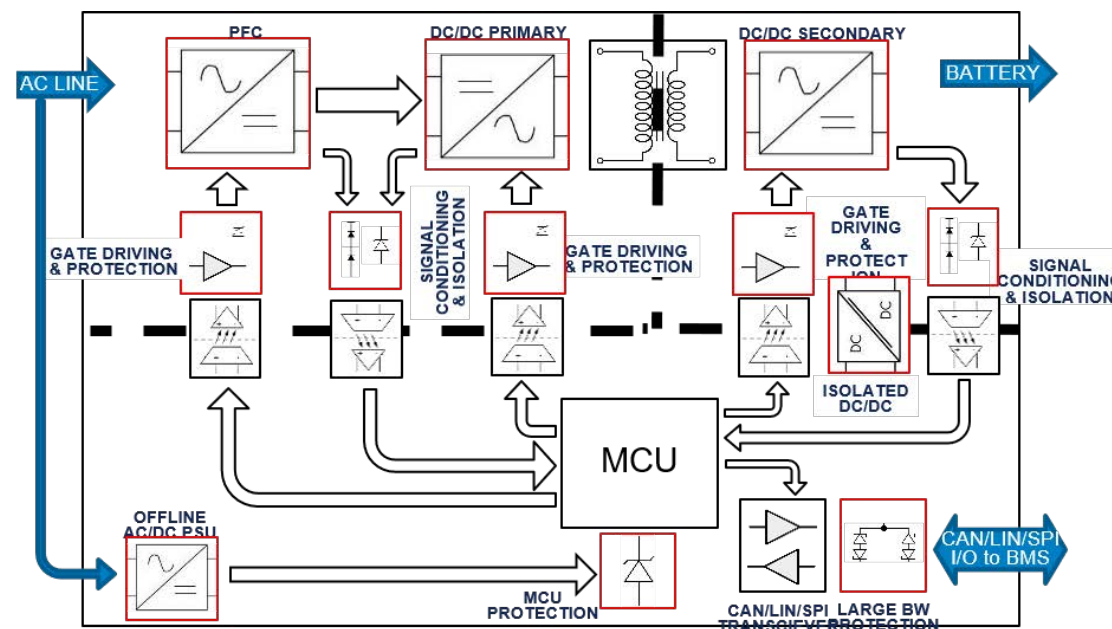


# On-Board Charger

## System Benefits

- 600 V and 1200 V ultrafast FRED Pt® technology is optimized for load switching and high frequency rectification. The devices offer high stability and robustness for surge current up to 175 °C
- 500 mW Zener diodes in the low profile MicroSMF (DO-219AC) package provide voltage stabilization
- Surface-mount TRANSZORB® TVS used in sensitive electronics for protection against voltage transients induced by inductive load switching and lightning on ICs, MOSFETs, and signal lines
- Vishay's eSMP® package platform is the vehicle for all these silicon technologies. Thanks to its internal design, it improves thermal performance while its smaller footprint reduces PCB space requirements and enables higher integration

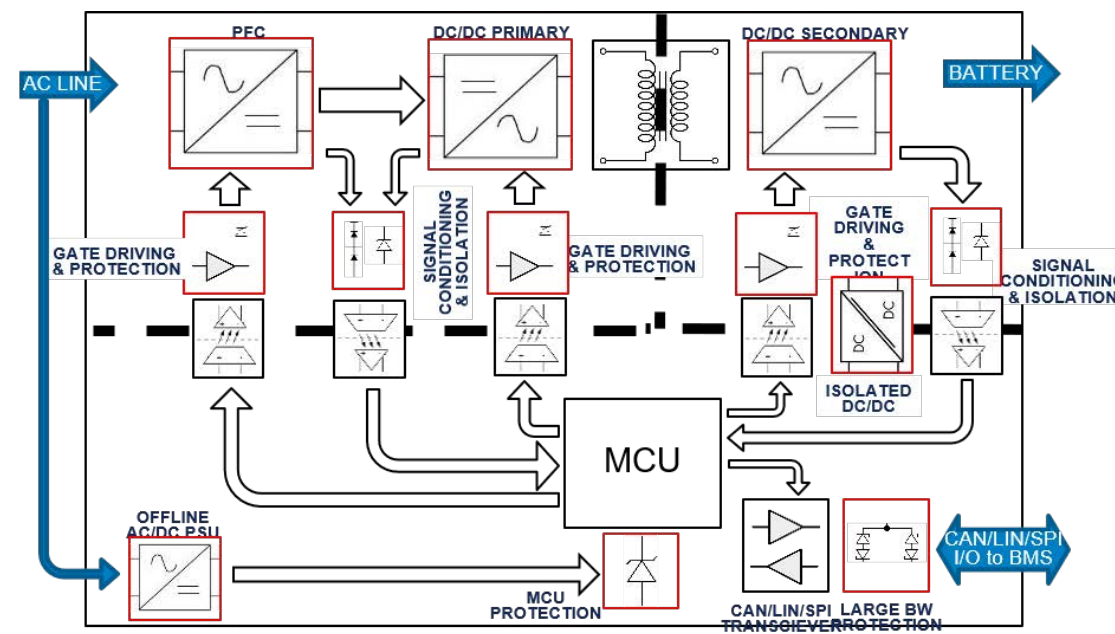
## Block Diagram



# On-Board Charger

Function	Description	Image
PFC, HF Output Rectification	Up to 30 A, 650 V to 1200 V FRED Pt® hyperfast rectifier	 (TO-220)
Signal Conditioning	500 mW Zener diodes in the low profile MicroSMF (DO-219AC) package provide voltage stabilization	 (MicroSMF)
Surge Protection	Surface-mount TRANSZORB® TVS, uni- and bidirectional	 (SMB)  (SMC)
Rail to Rail Protection	100 V to 600 V, 1 A rectifiers with high ESD capability for rail-to-rail signal line protection	 (MicroSMP)

## Block Diagram



# DIODES APPLICATIONS

