System Solution Guide

48 V Powernet Trends

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Industry	Automotive – Vehicle Electrification
Applications	While early cars relied solely on the 12 V electrical system for basic functions like ignition and headlights, the cars of today are very different. Today's vehicles are packed with power-hungry features like electric power steering, pumps, HVAC compressor for heating/cooling of vehicle cabin and battery pack. This ever-growing demand for electricity strains the traditional 12 V systems. To address these limitations, the automotive industry is transitioning to 48 V electrical systems. Compared to 12 V, 48 V systems increase available power to support additional electrical content and higher power consumption. Additionally, allowing for thinner wires and smaller connectors. This translates to weight and cost savings, and frees up space for additional electrical components within the vehicle.

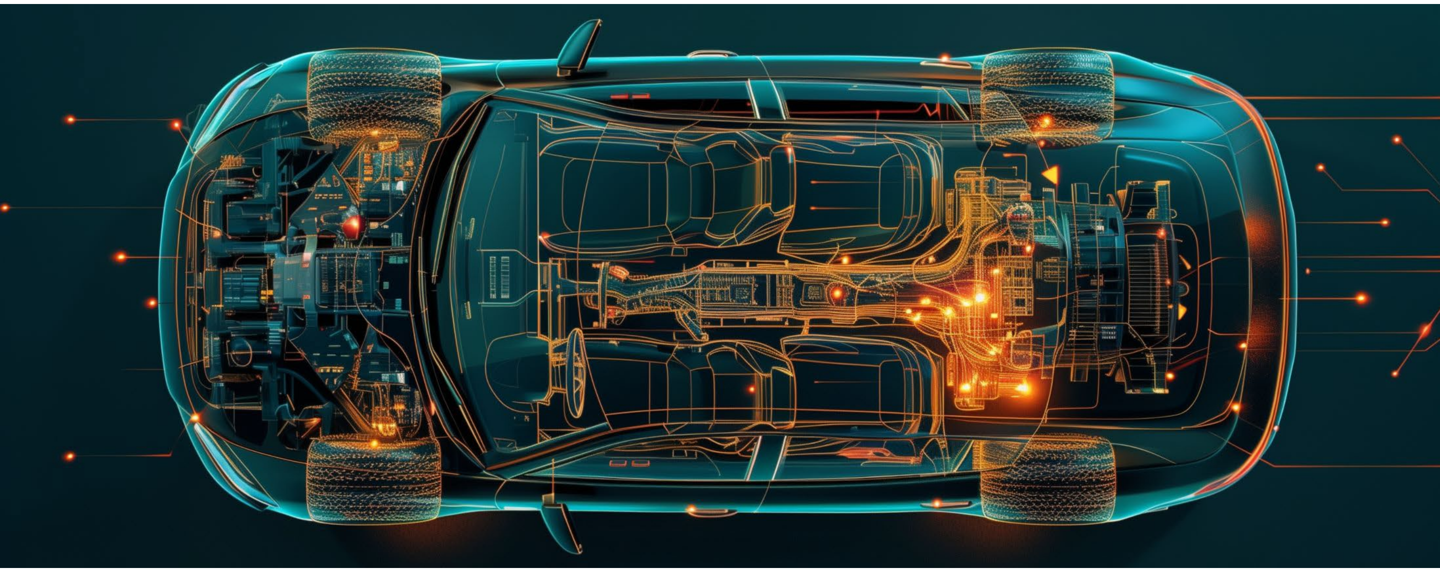
System Purpose

Initially, 48 V systems found a home in gasoline-powered cars with mild hybrid technology (MHEVs). These systems use a starter generator, a dual purpose small electric motor alongside the combustion engine to improve fuel efficiency and reduce emissions.

The benefits of 48 V are extending beyond MHEVs. Battery Electric Vehicles (BEVs) are also starting to incorporate 48 V components. While BEVs have a high-voltage battery pack (typically 400 V or 800 V architectures) to power the electric motor, 48 V proves advantageous for certain applications:

- **Reduced cable size:** 48 V allows for thinner wires to power existing features like cooling fans, cabin ventilation systems, and heated seats. This translates to weight savings and improved efficiency when lower electric current is needed to perform the same function.
- **Impracticality of high voltage (HV):** For functions like seat heating, using the high voltage from the main battery pack would be impractical and require additional safety measures. 48 V offers a good balance between power saving and safety for these applications.

Furthermore, 48 V systems pave the way for advanced driver-assistance systems (ADAS) and potentially fully autonomous vehicles. Electric power steering, steer-by-wire, and brake-by-wire (x-by-wire) all require significant power. However, x-by-wire systems also demand exceptional reliability, safety, and redundancy. At 48 V, redundant actuators for high-power components like steer-by-wire can be lighter and more cost-effective compared to 12 V systems.



Market Information & Trend

The Future is a Multi-Voltage Electrical Architecture

As 48 V systems become more widespread, vehicles will likely have a mix of 12 V, 48 V, and high voltage (typically 400 V or 800 V) power networks. With 48 V readily available, traditional 12 V accessories will gradually migrate to the 48 V systems, starting with the most power-hungry components. Some examples are electrical power steering (EPS), suspension systems, HVAC compressor for heating/cooling of vehicle cabin and battery pack.

Existing 12 V systems will still be supported by DC-DC converters, powered either from the HV bus or the 48 V battery. However, as more components shift to 48 V, the size and complexity of these DC-DC converters are expected to decrease as 48 V becomes the dominant electrical system for non-propulsion functions within the car. While the 48 V trend is gaining momentum, it's still far from being universally adopted. US automakers are leading the change, while Asian and European markets are exploring the potential of 48 V, but haven't yet established a clear direction. Other larger manufacturers are taking a more cautious approach and sticking with the 12 V system for now.

Zonal Architecture

Next to the shift from 12 V to 48 V electrical systems in EVs, another transition in vehicle power architecture is happening simultaneously. The industry is moving away from centralized power distribution towards a more distributed approach called zonal architecture.

In a zonal architecture, the vehicle is divided into distinct zones. A single primary distribution unit (PDU) acts as the first level of power distribution tree. The PDU connects directly to the 48 V or 12 V battery and intelligently distributes power to each individual zone within the vehicle.

The many Electronic Control Units (ECUs) traditionally scattered throughout the car can be replaced by zonal controllers. Zonal Controllers distribute power and manage electrical components in their respective zones. A key benefit of zonal controllers is the ability to replace traditional fuses with semiconductor-based protected switches. They can be turned on and off by a microcontroller (MCU), which means that they can be reset after a fault event rather than having to be replaced. Additionally, semiconductor protected switches can provide diagnostic information to the car's computer, which can be helpful for troubleshooting electrical problems.

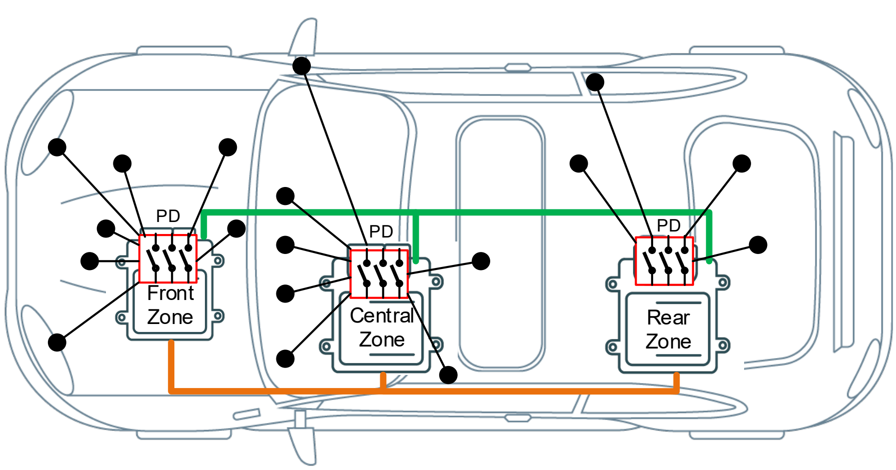


Figure 1 : Example of zonal architecture with 3 zones: Front, Central, Rear.

Market Information & Trend

Low Voltage Power Distribution in Zonal Vehicle Architecture

The low voltage powernet is a critical element within the zonal architecture for EVs. As depicted in the accompanying block diagram, power originates from the high voltage (HV) battery pack (typically 400 V or 800 V battery architecture). An HV-LV DC-DC converter steps down the high voltage to supply LV network: either 48 V or 12 V battery. Depending on the manufacturer and car model, the car can have just one LV battery or both the batteries with separate converters.

Main Components of Low Voltage Power Distribution

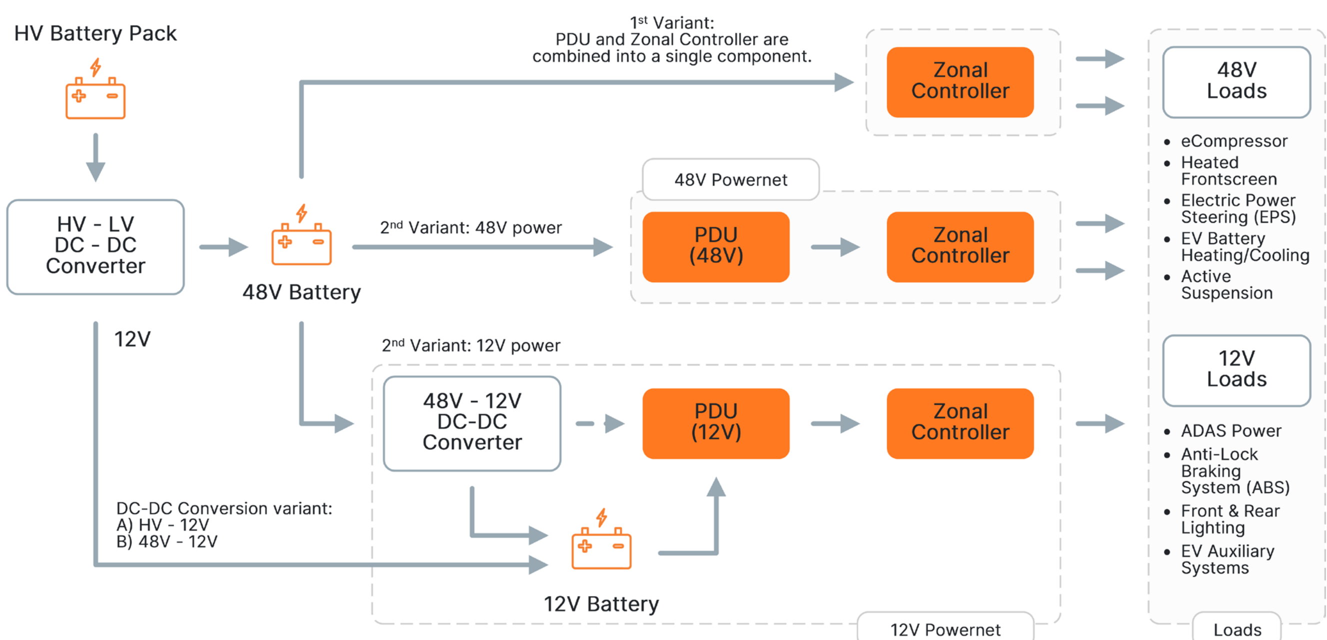
Since the 48 V and 12 V can co-exist in the same car, the HV-LV converter can directly power the 48 V battery and additional 48V - 12V converter can act as an intermediary step-down stage. In a centralized model of power distribution, a single larger 48V – 12V converter (approx. 3 kW) powers the 12 V battery. In contrast, zonal architecture leverages a more distributed approach with multiple, smaller DC-DC converters embedded within **zonal controllers (ZCUs).**

In the approach with a separate **primary distribution unit (PDU)** and ZCU, electricity flows from a power source through the PDU and ZCU before reaching individual loads within specific zones. Placed before the ZCU, PDU typically also supplies power to high current loads directly. The ZCU then handles power distribution to most loads within its assigned vehicle zone.

Currently, two main approaches exist in the market:

- **Combined PDU and ZCU**: In this first variant, a single module integrates both PDU and ZCU functionality.
- **Separate PDU and ZCU**: This second approach utilizes distinct PDU and ZCU units.

This high-level overview clarifies the role of the low voltage powernet within a zonal vehicle architecture. The block diagram below provides a visual representation of this power flow and its implementation variants.



Find Interactive Block Diagram on the Web

System Description

Electric Vehicle Power Flow: A Focus on Efficiency

EVs rely on a well-managed flow of energy. We can analyze this through three main aspects: power generation, conversion, and consumption. Optimizing these stages is key to maximizing driving range and minimizing energy cost per kilometer.

48 V transformation was introduced with MHEV, where it is generated by a starter generator. In today's BEV, a DC-DC converter steps down voltage from the HV battery to a lower voltage. Conversion can be centralized with one larger converter or distributed with multiple smaller converters, as in zonal architecture.

- The challenge is to distribute power efficiently throughout the vehicle while minimizing the mass of the wiring harness and cables.
- Loads in the car are the power consumers. Therefore, high power loads are expected to migrate to 48 V, starting with the highest loads in the system.
- Autonomous cars will require additional power for their central computing units, advanced driver-assistance systems (ADAS) and complex AI-based solutions.

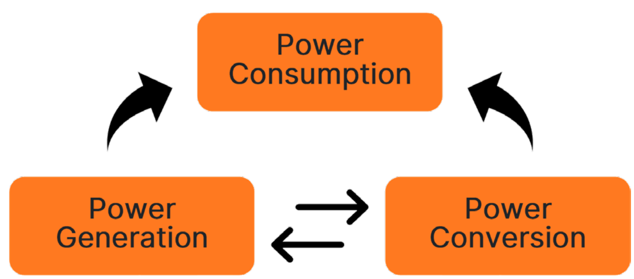


Table 1 : Power generation and conversion with two battery types.

Battery Type	Power Generation	Power Conversion
HV Battery Pack	EV Charging	HV-LV DC-DC Converter
	Regenerative Breaking	
48 V Battery	Starter-Generator (MHEV)	48V – 12V DC-DC Converter

Find more information in System Solution Guides on the web:

On Board Charger (OBC)

EVs rely on OBC to convert AC current from a charging station or home outlet into DC current for their batteries. This internal "on board" unit essentially acts as a hidden gas station. Learn more about its design, various PFC and DC-DC topologies in the proposed SSG. Additionally find content related to SiC MOSFETs, power modules and galvanically isolated gate drivers.

48V - 12V DC-DC Converter

The 48V - 12V DC-DC converter ties together the 12 V and 48 V power nets. It is most often designed as bidirectional converter with power levels ranging from 1 kW up to 3 kW. This SSG focuses on MHEV vehicles for the application example.

48 V Starter Generator

The 48 V starter Generator is a hybrid power solution for mild hybrid electric vehicles (MHEVs), which are powered by a 48 V battery. Starter generator effectively combines the functionality of the starter motor and alternator, enabling additional functionality as it complements vehicle's internal combustion engine. Find more about its topologies and design in our System Solution Guide.

On Board Charger (OBC)
48V - 12V DC-DC Converter
48 V Starter Generator

Solution Overview

MOSFETs for 48 V and 12 V Systems

From the simplest electronic controller inside traditional cars to the silent hum of electric vehicles, MOSFETs play a crucial role under the hood of any car. Small yet powerful silicon discretes can control electric motors, ensure battery charging, distribute power and ensure system safety. **onsemi** offers wide variety of LV and MV MOSFETs for 12 V and 48 V applications. Designers can choose from multiple component technologies that offer different features.

T10 MOSFET Technology: 40 V and 80 V Low & Medium Voltage MOSFETs

T10 is **onsemi's** latest technology node after the successful T6 and T8 generations. T10-M features an application-specific architecture with the lowest $R_{DS(ON)}$ and a soft body diode, specifically optimized for motor control and load switching. On the other hand, T10-S is designed for switching applications, prioritizing lower output capacitance. While this does mean it sacrifices a small amount of $R_{DS(ON)}$, the overall efficiency is better, particularly at higher frequencies.

*Table 2 : Recommended **onsemi** MOSFETs for 12 V and 48 V systems.*

30V MOSFET	Explore
40V MOSFET	Explore
60V MOSFET	Explore
80V MOSFET	Explore
100V MOSFET	Explore

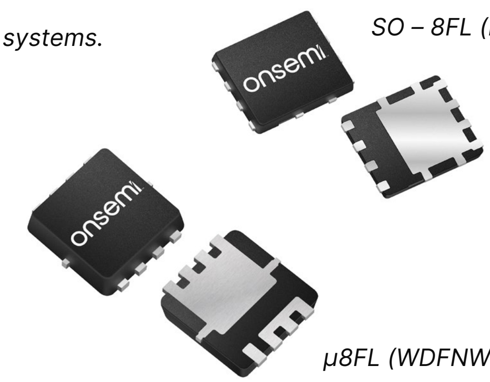


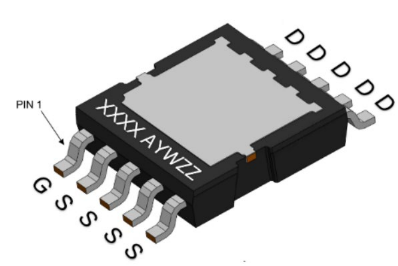
Figure 2 : Typical packages for T10 MOSFET.

Top Side Cooling Packages (TCPAK57)

MOSFETs are often chosen for their power capabilities and compact size. However, the heat dissipation with traditional SMDs is not ideal, with heat being dissipated from bottom of the package primarily through the PCB.

To address this issue and further improve application size, a new Top Cool MOSFET package has been developed that exposes the lead frame (drain) of the MOSFET on the top side of the package. This method avoids cooling through the PCB. The TCPAK57 is compact 5.1 x 7.5 mm package. Read more in Top Cool Package for Power Discrete MOSFETs Application Note.

- NVMJST0D9N04C 40V version with the lowest $R_{DS(ON)}$ 1.07 mΩ .
- NVMJST2D6N08H 80V version with the lowest $R_{DS(ON)}$ 2.8 mΩ .



TCPAK57 with exposed drain on top of the MOSFET package.

Solution Overview

MOSFET Technology – From Successful T8 and T6 to the Latest T10 Generation

The new T10 shielded gate trench technology improves efficiency, low output capacitance and figures of merit with lower $R_{DS(ON)}$ and gate charge Q_G. Improved Figure of Merit FOM (R_{DS} x $Q_{OSS}/Q_G/Q_{GD}$) enhances performance and overall efficiency.

- Industry leading soft recovery body diode (Qrr, Trr) reduces ringing, overshoots and noise.
- T10 technology managed to reduce wafer thickness which cuts down the substrate contribution to $R_{DS(ON)}$ from approximately 50% to 22% in the case of 40 V MOSFET.

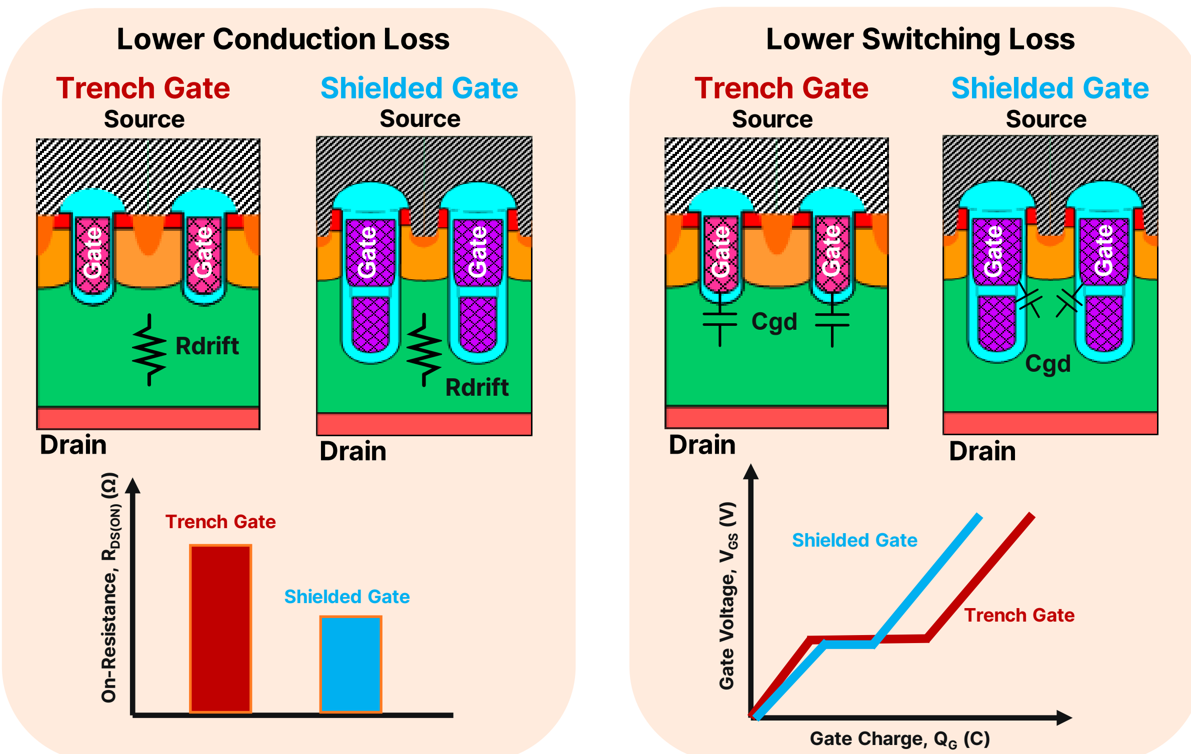


Figure 3 : Comparison of T8 Trench Gate (Legacy) with new T10 Shielded Gate.

Gate Drivers – Reducing Power Losses with Efficient Switching

Gate driver design plays its own role in minimizing power losses within 48 V automotive systems. **onsemi** gate drivers for 48 V applications can rapidly charge and discharge MOSFET gate, thus significantly reducing losses.

- The FAD3151MXA and FAD3171MXA are versatile **single channel floating automotive gate drivers 110 V, 2.5 A**, suitable for driving high−speed power MOSFETs up to 110 V.
- The NCV51513 and NCV51511 are automotive high and low side gate drivers with high drive current capabilities and options, optimized for DC-DC power supplies and inverters. Drivers are designed to drive MOSFETs in a half bridge or synchronous buck configuration.

Solution Overview

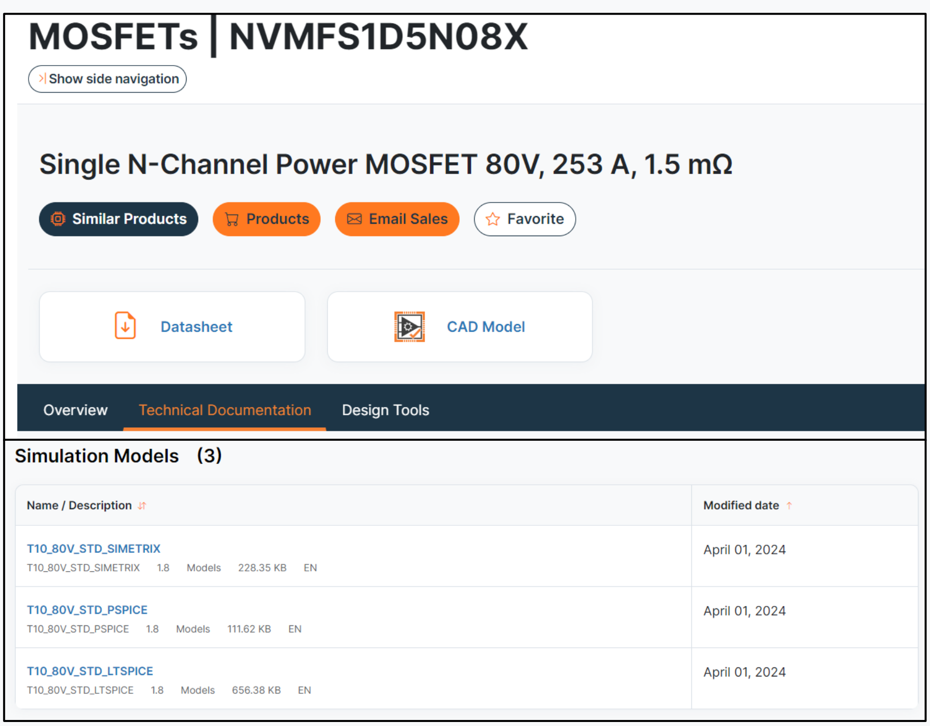
Support for onsemi Components – Simulation Models

Reduce development time and cost by virtually testing your circuits with **onsemi**'s MOSFET simulation models. Compatible with industry-leading software like **SIMetrix**, **PSpice**, and **LTspice**, these models empower you to accurately predict MOSFET behavior within your designs.

Having high quality models straight from the component manufacturer can benefit you:

- **Faster Design Iterations**: Eliminate the need to physically build and test multiple prototypes by simulating circuit performance virtually. This saves you valuable development time and resources.
- **Enhanced Design Accuracy: onsemi** models provide a realistic representation of MOSFET parameters. Predicting circuit behavior with more accuracy leads to designs that perform closer to expectations from the start. This minimizes costly errors during production.
- **Optimized for Various Conditions**: Simulate circuit performance under a wide range of conditions (e.g. temperature variations, different loads) to identify potential weaknesses and ensure robust designs.

How to find the onsemi's simulation models?



Explore Technical Documentation of a MOSFET product page

Download one of 3 models: SIMetrix, PSpice or LTspice

Solution Overview

Low Power DC -DC Conversion

NCV8730 Wide Input Voltage Range LDO

The NCV8730 is a next generation CMOS LDO regulator designed for up to 38 V input voltage and 150 mA output current. It provides ultra–low quiescent current of only 1 µA, which makes this device ideal solution for applications that are always on. Additionally offering excellent load/line transient regulation and output Power-Good function to reset MCU. Available packages : TSOP-5 and WDFN-6.

- Support automotive transients
- Can suppress inrush current to protect IC
- Fixed & Adjustable voltage options available: 1.2 V to 24 V
- Ideal for always-on applications
- Can reset MCU to avoid malfunction
- 290 mV typical dropout at 150 mA of output current, 3.3 V_{OUT}

Explore automotive recommended LDOs (V_{IN} > 12 V)

Explore automotive DC-DC power management ICs

NCV68261 Ideal Diode and High Side Switch NMOS Controller

The NCV68261 is a reverse polarity protection and Ideal Diode NMOS controller with optional High-Side switch function, intended as a lower loss and lower forward voltage replacement for power rectifier diodes and mechanical power switches. It is intended for automotive battery regulation and protection, with operating voltage V_{IN} up to 32 V and maximum immunity to 60 V load dump pulses.

With easy **control via drain pin**, the controller can operate either in ideal diode mode or reverse polarity protection mode. Find out more about reverse polarity protection and ideal diode applications in the application note: AND90146 - MOSFET Selection for Reverse Polarity Protection.

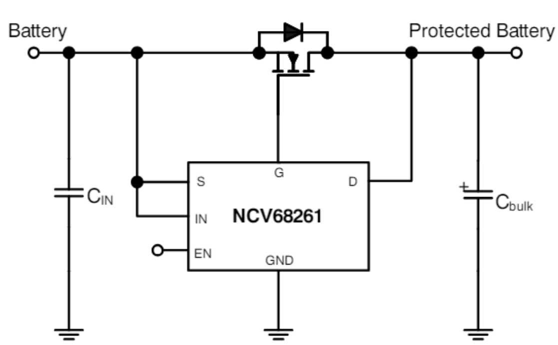


Figure 4 : NCV68261 Application Schematic (Ideal Diode)

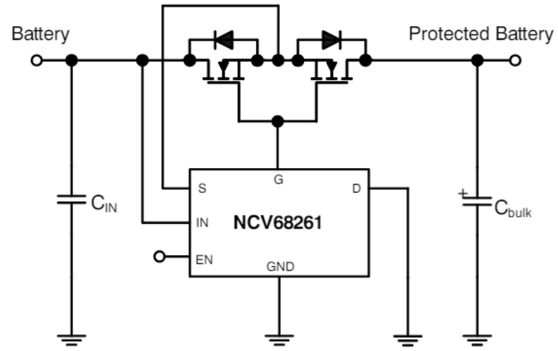


Figure 5 : NCV68261 Application Schematic (Reverse Polarity Protection + High-Side Switch)

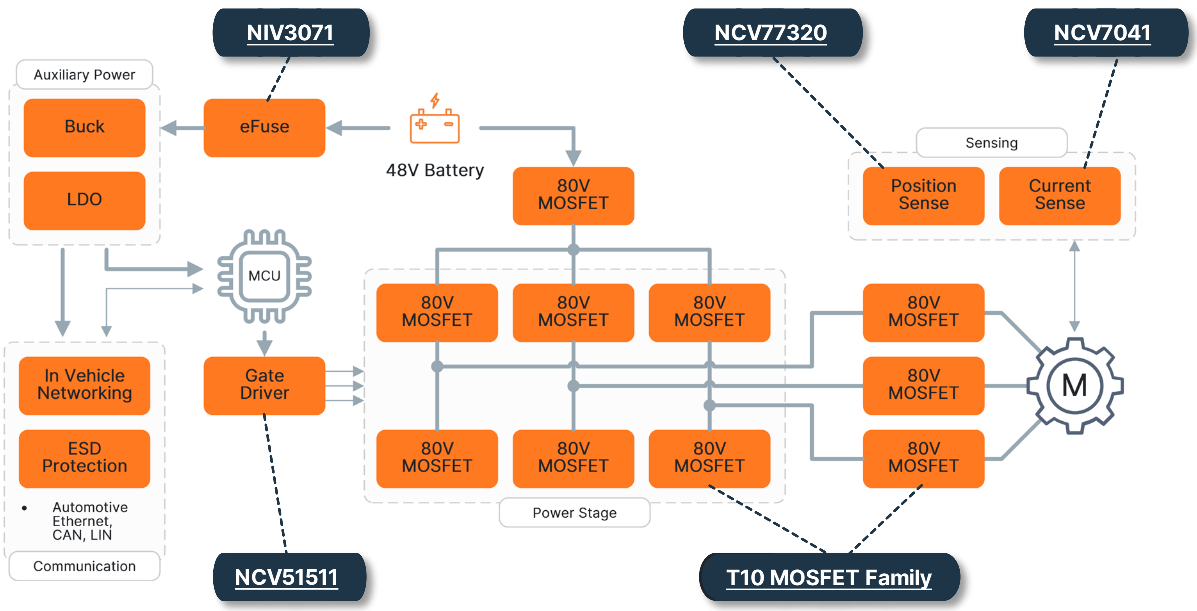
Solution Overview

Steer by Wire – Application Example

The future of transportation lies in advanced driver-assistance systems (ADAS) and potentially fully autonomous vehicles. These systems are enabled by 48 V as they rely heavily on electric power for power intensive accessories like:

- **Electric Power Steering**: A traditional hydraulic power steering system is replaced with an electric motor, offering improved responsiveness and fuel efficiency.
- **X-by-Wire systems**: X-by-Wire is a common name for steer-by-wire and brake-by-wire systems. These systems replace traditional mechanical linkages (steering wheel, brake pedal) with electrical signals for control. X-by-Wire systems offer greater flexibility for autonomous vehicle development.

However, X-by-Wire systems also demand a high level of reliability, functional safety, and redundancy. Redundant actuation for high-peak load devices, like steer-by-wire are enabled to be lighter and more cost effective at 48 V compared to 12 V systems.



NCV77320 – Inductive Position Sensor

The NCV77320 is an inductive position sensor interface that, in combination with a PCB, forms a **system for the accurate measurement of angular or linear positions**. It can meet up to **ASIL D safety in redundancy applications** and serve as **steer-by-wire sensor.** NCV77320 can be used in any rotary & linear application that requires an accurate position sensing if there is a match in speed (max 10 800 RPM) and output protocol.

- The implementation of **onsemi** inductive technology improves the EMC robustness, particularly in the DC domain. Unlike a magnet based solution, inductive technology is immune to stray magnetic fields by its construction. This is an important advantage over solutions using a magnet, as strong DC currents become more and more present with the vehicle electrification.
- NCV77320 system is insensitive to temperature variations.
- Easy to implement redundancy: Two sensors can be stacked with perfect alignment.

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Solution Overview

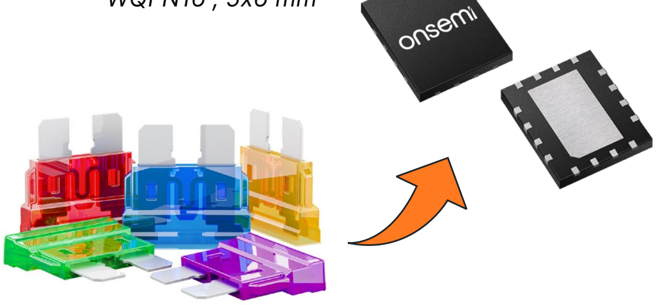
Moving from Fuses to Protected Semiconductor Switches

Every car relies on a network of electrical circuits to power everything from the headlights to the radio. Automotive fuses safeguard those circuits and downstream loads from overcurrents and potentially causing a fire. Fuses operate on a simple yet crucial principle. They contain a calibrated filament designed to melt under excessive current in a given period (I^2t), thus opening the circuit and interrupting current flow. The selection of the filament material and its cross-sectional area determines the current rating of the fuse.

After the fuse is blown, it must be replaced to resume operation. Car's fuse box usually contains more than 40 1st level and 2nd level fuses. Replacing traditional fuses with protected semiconductor switches brings key benefits in zonal architecture of the low voltage powernet. **onsemi** offers devices such eFuse, SmartFET and Ideal Diode. Some of the benefits are:

- Connection and disconnection controllable by MCU.
- Resettable, no need to replace the fuse after a trip event. Flexible protection schemes and thresholds.
- Smaller size, can be integrated into zonal architecture.
- Diagnostic and status reporting to controller possible; Build-in functional safety (FuSa) features and compliance possible.

NIV3071 eFuse
WQFN16 , 5x6 mm



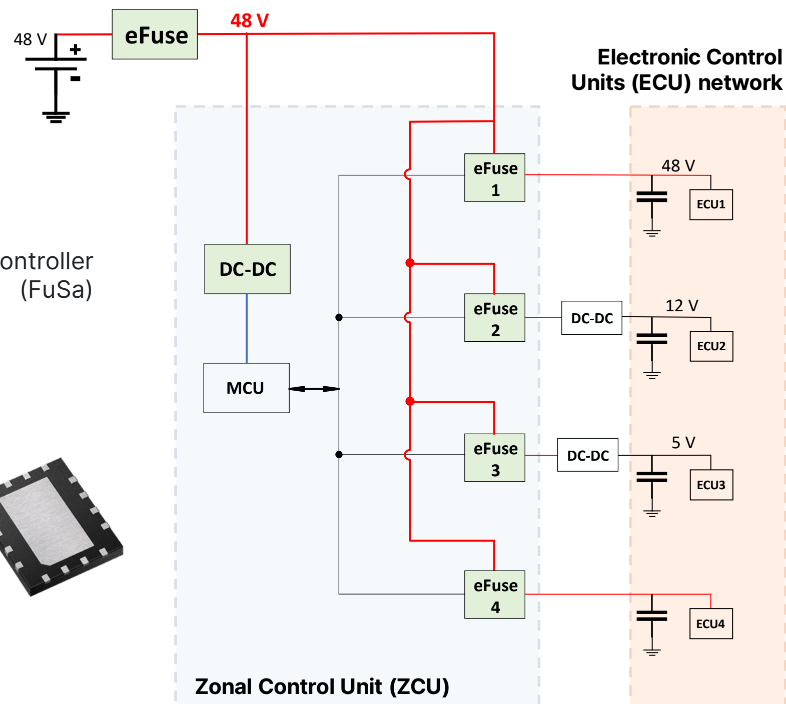


Figure 6 : Example of 4 ECUs protected by eFuses.

Table 3 : Example of SmartFET and eFuse solutions.

	Solution for 12V systems	Solution for 48V systems
Part Number - Type	NCV8415 - SmartFET	NIV3071 - eFuse
Features	• Ideal for switching a variety of loads in automotive systems • Short Circuit Protection with inrush current handling • Delta Thermal Shutdown • Evaluation Board	• 8 V to 60 V DC operating V_{IN} range • 4 Independent integrated eFuses in one package • 2.5 A Continuous current operation for each channel • 80 mΩ R_{DSon} TYP @ 25 °C (at 1 A); each channel
Explore Device Family	Available automotive SmartFETs	Available automotive eFuses

Solution Overview

Moving from Fuses to Protected Semiconductor Switches

NIV3071 65 V_{AbsMax}, 10 A, 4-Channel Integrated eFuse

NIV3071 is a 60 V_{DC}, 65 V_{TR}, eFuse integrating 4 independent channels in one package. The eFuse supports up to 10 A continuous output current. Small 5x6 mm package. Each integrated eFuse has a fixed soft start time. Configurable current limit common for all channels. The device also has control and status monitoring pins targeting wide range of automotive applications from 12 V to 48 V.

- Protect up to 4 independent 2.5 A loads or configure the eFuse into a single channel protection to drive a single continuous load current of up to 10 A.
- Good for implementing **automotive zonal control units** (zonal architecture), guarantee protection and robustness of the localized ECUs throughout the vehicle.
- **Protect 12 V and 48 V downstream loads** from output shorts, overloads and overcurrent events. Improve robustness and reliability of the 48 V electrical architecture by building redundant networks.
- Explore the application note: The NIV3071 eFuse Advantages in Automotive Applications
- Evaluation board NIV3071MTW4GEVB allows design prototyping and testing.

NCV84120 Self-Protected High-Side SmartFET

The NCV84120 is a fully protected single channel High-Side SmartFET that can be used to switch a wide variety of automotive loads.

The NCV84120 incorporates advanced protection features such as active inrush current management, over–temperature shutdown with automatic restart and an overvoltage active clamp.

Dedicated Current Sense pin provides precise analog current monitoring of the output as well as fault indication of short to V_D, short circuit to ground and OFF state open-load detection.

NCV8415 Self-Protected Low-Side SmartFET

The NCV8415 is a three terminal protected Low–Side Smart Discrete FET. The protection features include Delta Thermal Shutdown, overcurrent, overtemperature, ESD and integrated Drain–to–Gate clamping for overvoltage protection. The device also offers fault indication via the gate pin. This device is suitable for harsh automotive environments.

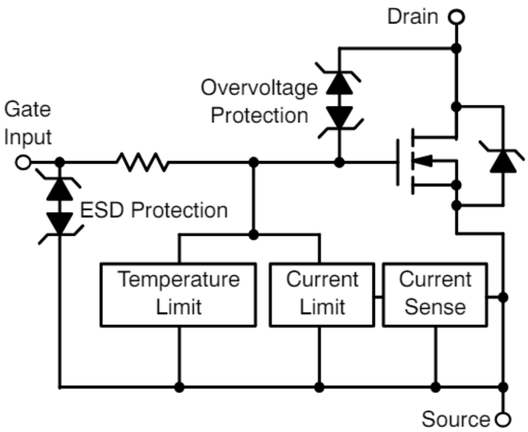


Figure 7: Generic Block Diagram of a Low Side SmartFET, including integrated self–diagnostic and protection circuitry.

Explore onsemi SmartFET portfolio

System Redundancy in 48 V Systems

In the event of a single component failure, redundant elements serve as backup, preventing system-wide disruptions. This is particularly significant in safety-critical systems such as those controlling braking, steering, and airbags. The automotive environment poses various challenges, including vibrations, temperature fluctuations, potential component failures and risk of short circuit. Implementing redundant elements contributes to the overall robustness of the vehicle's electrical architecture.

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Recommended Products

Suggested Block	Part Number (PN)	PN Description, Comments
Components designed for 48 V systems solutions		
Si MOSFETs 100 V rated	FDBL86062_F085	N-Power MOSFET 100 V, 300 A, 2.0 mΩ , TOLL
	NVMTS1D6N10MC	N-Power MOSFET 100 V, 273 A, 1.7 mΩ , PWR88
	NVMFS3D6N10MCL	N-Power MOSFET 100 V, 132 A, 3.6 mΩ , SO-8FL pack.
	Automotive recommended 100V-120V MOSFETs	
Si MOSFETs 80 V rated	NVBLS0D8N08X	N-Power MOSFET 80 V, 457 A, 0.8 mΩ, T10 Technology, TOLL pack.
	FDBL86361_F085	N-Power MOSFET 80 V, 300 A, 1.4 mΩ, PowerTrench, TOLL pack.
	NVMFWS1D9N08X	N-Power MOSFET 80 V, 201 A, 1.9 mΩ, T10 Technology, SO-8FL pack.
	NVMFWS6D2N08X	N-Power MOSFET 80 V, 71 A, 6.2 mΩ, T10 Technology, SO-8FL pack.
	NVMFWS3D5N08X	N-Power MOSFET 80 V, 119 A, 3.5 mΩ, T10 Technology, SO-8FL pack.
	NVMJST2D6N08H	N-Power MOSFET 80 V, 131 A, 2.8 mΩ , Top Cool Package (TCPAK57)
	T10 Shielded Gate Technology features significantly lower $R_{DS(ON)}$ in smaller packages, further improved soft reverse recovery diode. Increased power capability and figure of merit ($Q_G/R_{DS(ON)}$).	
	Automotive recommended 80V MOSFETs	
Gate Drivers (100V -130V)	NCV51513	130 V, 2.0/3.0 A Half-Bridge Driver , EN & Interlock, Rise/Fall times 9ns/7ns
	NCV51511	100 V, 3.0/6.0 A High & Low side Driver, Integrated Bootstrap, Ideal for Half bridge or Synchronous Buck Configuration.
	FAD3151MXA FAD3171MXA	110 V, 2.5 A, Single Channel Floating Gate Driver, Negative Transient –80 V, Desaturation & UVLO protection , (Charge Pump 3171 only)
eFuse	NIV3071	eFuse 4 channels. Vin 8V - 60V (65 V_{AbsMax}), Ideal for 48 V applications, 10 A when channels are parallel (2.5 A continuous current per channel)
Automotive Power Modules (APM)	NXV08B800DT1	2-Channel back-to-back MOSFET Module, 80 V, $R_{DS(ON)}$ 0.59 mΩ. Optimized for battery or load switch, replacing mechanical Relay.
	FTC03V85A1	Integrated 3-phase MOSFET bridge, 80 V, $R_{DS(ON)}$ 2.6 mΩ, Optimized for interleaved DC-DC Converter. Integrated Shunt resistor, NTC, Snubber C
	NXV08V080DB1 NXV08V110DB1	Integrated 3-phase MOSFET bridge, 80 V, $R_{DS(ON)}$ 1.7 - 3.5 mΩ (Max per FET) Optimized for 48 V Auxiliaries. Integrated shunt, NTC and RC snubber
	NXV10V160ST1	Integrated 3-phase MOSFET bridge, 100 V, $R_{DS(ON)}$ 1.8 mΩ (Max per FET) Optimized for 48 V high-power Auxiliaries.
	Automotive APMs designed for 48 V applications.	
Current Sense Amplifier	NCV7041 NCV7030	CSA, V_{CM} 80 V common mode, Bidirectional or Unidirectional. BW 100 kHz, Gains : 14, 20, 50, 100 V/V , Zero-Drift amplifier architecture

Recommended Products

Suggested Block	Part Number (PN)	PN Description, Comments
Medium Voltage MOSFETs 60 V, 40 V		
Si MOSFETs 60 V rated	NVMTS0D7N06C	N-Power MOSFET 60 V, 464 A, 0.72 mΩ , TDFNW8 pack.
	NVMJS1D4N06CL	N-Power MOSFET 60 V, 262 A, 1.3 mΩ, LFPAK8 pack.
	NVMYS2D2N06CL	N-Power MOSFET 60 V, 185 A, 2.0 mΩ, LFPAK4 pack.
Si MOSFETs 40 V rated	NVMFWS0D4N04XM	N-Power MOSFET 40 V, 509 A, 0.42 mΩ , T10 Tech., SO-8FL pack.
	NVMFWS0D5N04XM	N-Power MOSFET 40 V, 414 A, 0.52 mΩ , T10 Tech., SO-8FL pack.
	NVMFWS1D1N04XM	N-Power MOSFET 40 V, 233 A, 1.05 mΩ , T10 Tech., SO-8FL pack.
	NVMFWS004N04XM	N-Power MOSFET 40 V, 66 A, 4.7 mΩ, T10 Tech., SO-8FL pack.
	NVMJST1D2N04C	N-Power MOSFET 40 V, 451 A, 1.25 mΩ , T6 Tech., Top Cool (TCPAK57)
	NVMJST3D3N04C	N-Power MOSFET 40 V, 157 A, 3.3 mΩ , T6 Tech., Top Cool (TCPAK57)
	NVMJST1D6N04C	N-Power MOSFET 40 V, 314 A, 1.65 mΩ , T6 Tech., Top Cool (TCPAK57)
	T10M is best-in-class 40 V Trench Technology with lowest $R_{DS(ON)}$ in 5x6 package (Down to 0.42mΩ)	
	Automotive Recommended 40 V MOSFETs	
Gate Drivers & Digital Isolation		
Gate Drivers Additional	NCV51313	130 V, 2.0/3.0 A High side Driver, 20 ns Fast Propagation Delay, High dv/dt immunity up to 50 V/ns and negative transient immunity
	FAN7171 FAD7191	600 V, 4 A, SOIC-8, High-Side (Low-Side) Gate Drive
	NCV5183	600 V, 4.3 A, SOIC-8, High & Low-Side Gate Drive
	Automotive Recommended Gate Drivers Medium Voltage (100V-130V)	
Digital Isolation	NCIV9210 NCIV9211 NCIV9311 NCIV9401 NCIV9411	Galvanically isolated 2 kV, high speed, bidirectional 2/3/4 Channels Digital Isolators. Allows Isolated PWM control, Communication / Diagnostics. Utilizing onsemi patented galvanic off−chip capacitor isolation technology and optimized IC design for high insulation and noise immunity.
	Automotive Recommended Digital Isolators	
Circuit Protection		
eFuse	NIV6150 NIV6350	eFuse 200 mΩ (85 mΩ) $R_{DS(ON)}$ Reverse current protection. Vin 10 V, Overvoltage clamp and Undervoltage lockout.
	NIV3071	eFuse 4 channels. Vin 8V - 60V, Ideal for 48 V applications, 10 A when channels are parallel (2.5 A continuous current per channel)
	Current Protection devices (eFuse)	
Protected Power Switches	FPF2895V	28 V, 5 A Power switch, Features OCP, OVP, Reverse current protection
	NCV47722 NCV47822	40 V, 350 mA, High Side Switch : Single / Dual version, Adjustable Limit
	Application recommended Protected Power Switches	

Complementary Products

Suggested Block	Part Number (PN)	PN Description, Comments
		Auxiliary Power
Buck Converter and Controller	NCV891330	Dual-Mode Step-Down Regulator, 3 A, 2 MHz, Low-Iq. (Max V_{IN-DC} = 45 V) It can operate either as PWM Buck converter or Low-Iq linear regulator.
	NCV6324	Synchronous Buck Converter, 3 MHz, 2 A, low profile 2 x 2 x 0.75 mm pack.
	NCV890104	Buck Switching Regulator, 1.2 A, 2 MHz, Programmable Spread Spectrum, Adjustable RSTB
	NCV6323F	Buck converter, Synchronous, PWM. Up to 1.6 A DC. Various Fixed Output Voltages. Optimized to supply sub-systems.
	NCV881930	Low Quiescent Current 30 uA, 410 kHz Synchronous Buck Controller, Integrated Spread Spectrum, up to 38V , Protection features
	NCV891930	Low Quiescent Current 30 uA, 2 MHz Synchronous Buck Controller, Integrated Spread Spectrum, up to 38V , Protection features
	Automotive recommended ICs for Step-Down DC-DC conversion.	
	Automotive DC-DC Converters, Step-Up and Step-Down.	
Controllers for DC-DC Power Conversion	NCV1362	Primary side Flyback Controller. Integrated features for easy control of Low Power automotive auxiliary power supplies.
	NCV97400	Automotive multi-output PMIC for safety applications. (Ideal for ADAS) Consisting of 3 buck and 1 boost regulators with supervisory functions.
	NCV8871	Non-Synchronous Boost Controller. Can be used in Flyback configuration.
	NCV898031	Non-Synchronous SEPIC / Boost Controller, 2 MHz. Peak Current Mode Control, UVLO, Internal Soft-Start.
	NCV12711	Peak current-mode PWM controller: 4-45 Vin DC. Rich features. Suitable for 12 V & 24 V Auxiliary Power and Flyback topology.
	Automotive DC-DC Controllers, Step-Up and Step-Down.	
LDO Regulator	NCV8163	250 mA, High PSRR, Very Low Noise, 1 uF COUT, TSOP-5 & XDFN4
	NCV8164 NCV8189 NCV59801	300 mA, 500 mA, 1 A Version, High PSRR, Very Low Noise, Power Good, Fixed & Adjustable output options, WDFNW6 & DFNW8 packages
	NCV8718	300 mA, 24 Vin max, 4 uA Iq, Fixed & Adjustable Vout options WDFN6 package
	NCV1117	1 A, High PSRR, (up to 20 Vin), Adjustable and fixed output options.
	NCV8730	150 mA, Low Iq 1 uA (2.7-38 Vin range) Adjustable and fixed output options, PG ideal for power sequencing.
	Automotive recommended LDOs (V_{IN}>12V)	

Complementary Products

Suggested Block	Part Number (PN)	PN Description, Comments
Diodes , Miscellaneous Components		
Diodes	NRVB1240MFS	40 V, 12 A $I_{F(AV)}$, 150 A $I_{FSM(max)}$ Schottky Power Rectifier, SO-8FL
	NRTS15100PFS	100 V, 15 A $I_{F(AV)}$, 200 A $I_{FSM(max)}$ Trench Schottky Rectifier , TO-277
	NSVBASH16MX2WT NSVBAV99W	100 V Small Signal switching diode, Single (Dual), General automotive applications (Steering, Protection, Control units)
	Automotive recommended discrete power diodes (V_{RRM} > 40V)	
	Automotive recommended small signal diodes (V_R > 40V)	
Zener Diodes	1SMB59 1SMA59	3 W (1.5 W) Zener Diode, Zener Voltage Range up to 200 V (68 V)
	Automotive recommended zener diodes (Vz > 15V)	
Voltage Reference and Supervisors	SC432BVSNT1G NCV431	Programmable Voltage Reference, Temperature compensated Low Cathode Current, Shunt Regulator
	NCV308	Voltage Supervisor with programable delay and reset
	High and low voltage detectors, and voltage supervisors	
Analog Signal Chain		
Inductive Position Sensor	NCV77320	Highly accurate inductive measurement of angular and linear positions. Max speed 10 800 RPM, ASIL B (D) safety, improved EMC.
Low Power & Precision **Operational Amplifier**	NCV21874	Zero-Drift OpAmp, 45 µV Offset, 0.4 µV/°C
	NCV21911x	Precision OpAmp 36 V, 2 MHz GBW, Low Noise, Zero-Drift, 25 µV Offset
	NCV2007x	OpAmp 36 V, 480 uA supply, 3MHz, 4mV offset, Rail-to-rail output
	NCV333x NCV2333 , NCV4333	Low Power Zero-Drift Op-Amp, 10 µV (30 µV) Offset, 0.07 µV/°C low offset drift, space saving packages. Single, Dual and Quad channel configuration.
	Automotive recommended Op-amps (Low Power + Precision)	
Low Voltage **Comparator**	NCV2250, NCV2252	High Speed, 50 ns propagation delay, Push-Pull or Open Drain variant.
	NCV2901, NCV2903	36 V, Low Offset Current +/- 5.0 nA, Single or Split Supply,
Current Sense Amplifier (CSA)	NCV7041 NCV7030	CSA, V_{CM} 80 V, Bi- or Uni-directional. BW 100 kHz, Gains : 14, 20, 50, 100 V/V
	NCV21674	V_{CM} 40 V, Uni-directional, Low Offset Voltage 100 µV and Drift 1 µV/C
	NCV210, NCV211 NCV213, NCV214	Low offset & zero drift architecture. Bidirectional. For both Low-side and High-side sensing. Multiple Gain Options: 50, 100, 200, 500 V/V
	Automotive recommended Current Sense Amplifiers	
Temperature Sensing	NVT211CMx	Digital Temperature monitor ±1°C with series resistance cancelation. Under/Over-temperature alarm. Serial Interface (i2c, SMBus)

Complementary Products

Suggested Block	Part Number (PN)	PN Description, Comments
In Vehicle Networking (Automotive Ethernet & Bluetooth)		
Automotive Ethernet	SZESD9901MX2 SZESD9902M	ESD Protection TVS Diode: Single (Double). Compliance with 100/1000 BASE−T1 Ethernet, and other high speed data networks.
Automotive Bluetooth	NCV-RSL15	Bluetooth 5.2 Wireless MCU based on ARM Cortex-M33.
	onsemi supports its Bluetooth ICs with a comprehensive yet easy−to−use Software Development Kit (SDK) that provides sample code and applications, tools, IDE.	
In Vehicle Networking (CAN, LIN) , System Basis Chip (SBC)		
CAN (CAN-FD) Transceivers	NCV7343	Low Power & High-Speed, INH, Wake-up, Error Detection.
	NCV7342 , NCV7349	Low Power & High-Speed Transceivers. Various packages and features.
	NCV7446	Dual Transceiver, Low Power & High Speed . Wake-up
	Automotive CAN Transceivers for In Vehicle networking.	
LIN Transceivers	NCV7329 NCV7422	Single (Dual) LIN Transceiver, Transmission up to 20 kbps. Integrated Slope Control. Undervoltage, Transient, Thermal protection. TxD Timeout
	Automotive LIN Transceivers for In Vehicle networking.	
CAN, LIN Protection, ESD Protection	SZNUP3125 SZNUP2125	Protects CAN, LIN transceivers from ESD and other harmful surge events. Bidirectional protection for each data line.
	SZESD8704	Unidirectional High Speed Data Line Protection. (USB 3.1 , USB-PD)
	Automotive ESD and surge protection for CAN, LIN bus	
System Basis Chip (SBC)	NCV7450	SBC with CAN FD transceiver, LDO (5V/250mA) & HS Driver
	NCV7451	SBC with CAN FD transceiver, LDO (5V/250mA) & Wake Function
	NCV7471C	SBC with CAN/CAN-FD + 2 LIN transceivers, Boost-Buck DC-DC (5V/500mA) and LDO (5V/50mA)
Ideal Diode Controller, SmartFET		
Ideal Diode Controller	NCV68261	Ideal Diode and High-Side Switch NMOS Controller, 32 V operating voltage
	NCV68061	Reverse Polarity Protection and Ideal Diode NMOS Controller.
	Automotive recommended Ideal Diode Controllers	
SmartFET (Protected MOSFET)	NCV8415	Low-Side SmartFET , 11 A I_D max, Various protection features
	NCV84120	High-Side SmartFET , Protection and diagnostics, Analog current sense
	Automotive recommended SmartFETs (Protected MOSFET)	
MCU Interface		
Voltage Level Translator	MC14504B	Hex non-inverting level shifter, CMOS/TTL to CMOS. Shifting any supply between 5 and 15 V.
	NLVSX5004	Level Translator, 4-Bit, 100 Mbps
EEPROM	Automotive Recommended EEPROM	

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Technical Documents

Note that reference designs may contain non-automotive parts to support functionality.

Type	Description & Link
Reference Design (Evaluation Board)	LDO Regulator NCV59801 Demo Board
Reference Design (Evaluation Board)	NCV77320 Inductive Position Sensor chip
Reference Design (Evaluation Board)	NIV3071 eFuse Testing and Evaluation Board
Reference Design (Evaluation Board)	NCV68261 Ideal Diode and High Side Switch NMOS Controller Evaluation Board
Webinar	Automotive 48 V Systems enabled by onsemi solutions
Blog	Generative AI and the Impact on Automotive Industry
Blog	Using e-Fuses to Overcome the Limitations of Legacy Protection Devices
Blog	The Revolution Driving In-Vehicle Networking
Application Note	Low-Side SmartFETs [AND8202/D]
Application Note	High-Side SmartFETs with Analog Current Sense [AND9733/D]
Application Note	The NIV3071 eFuse Advantages in Automotive Applications [AND90247/D]
Application Note	FAD3151MXA, FAD3171MXA Gate Driver Applications [AND90251/D]
Application Note (Web Login is Required)	Top Cool Package for Power Discrete MOSFETs [AND90190/D]
White Paper	Approaching a Scalable and Reliable Automotive Design with Smart Power Switching [TND6430/D]
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