System Solution Guide - Preview

Zonal Architecture

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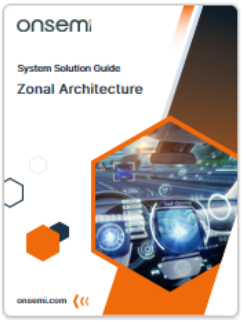

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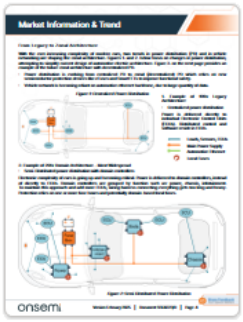

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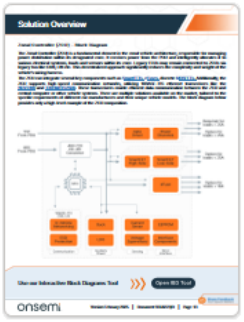

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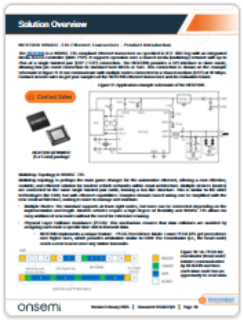

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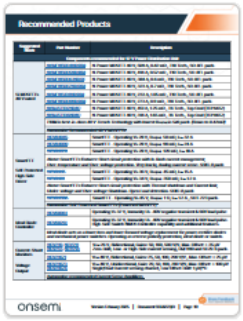

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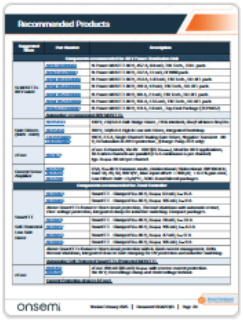

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Block Diagram

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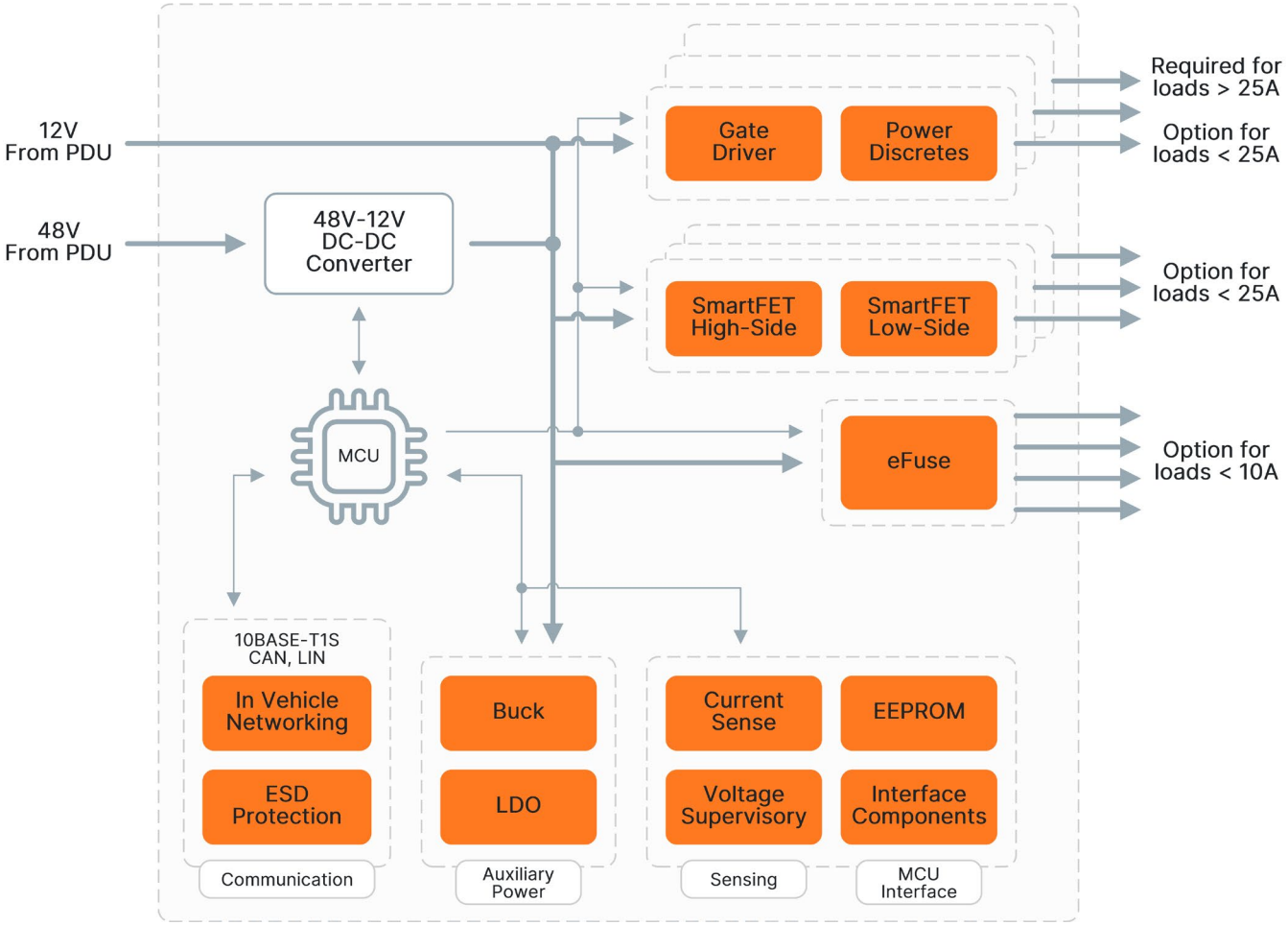
Zonal Controller – Block Diagram

The Zonal Controller (ZCU) is a fundamental element in the zonal vehicle architecture, responsible for managing power distribution within its designated zone. It receives power from a power distribution unit and intelligently allocates it to various electrical systems, loads and sensors within its zone. ZCUs can also act as vehicle's data and networking gateways, relying on automotive ethernet. They communicate upstream with the central computer via a 100/1000BASE-T1 ethernet backbone. Communication downstream with edge nodes like cameras, sensors, LiDAR is built on 10BASE-T1S ethernet. Legacy ECUs may remain connected to ZCUs via legacy bus like CAN, LIN etc.

The key components in ZCU can include SmartFETs, eFuses, discrete MOSFETs. Additionally, the ZCU supports high-speed communication networks, utilizing 10BASE-T1S ethernet transceivers like the NCV7410 and T30HM1TS2500. These transceivers enable efficient data communication between the ZCU and central computer or other vehicle systems. The block diagram below provides only a high-level example of the ZCU composition. Click "Open IBD Tool" at the bottom, to access the online interactive block diagram



Use our Interactive Block Diagrams Tool

Open IBD Tool

From Legacy to Zonal Architecture

As the electronic content in automobiles grows, power distribution becomes more complex, and the design challenges of wiring harnesses increase substantially. The traditional domain approach to cabling, which connects similar functions such as power, chassis, infotainment, body and comfort, is no longer efficient or flexible enough. The industry is shifting from centralized power distribution to a more distributed zonal approach. Many ECUs traditionally scattered throughout the car can be replaced by zonal controllers (ZCUs).

A single Power Distribution Unit (PDU) acts as the primary level of power distribution tree. The PDU connects to the vehicle's low-voltage (LV) battery, or alternatively to the output of HV-LV DC-DC converter, which steps down the voltage from high-voltage (HV) battery. The PDU provides primary protection with high-current fuses and intelligently distributes power to each individual zone within the vehicle, ensuring efficient and reliable power management. ZCUs further distribute power and manage electrical components in their respective zones, significantly reducing the weight and complexity of the wiring harness.

ZCUs can also act as vehicle's data and networking gateways, relying on automotive ethernet. They communicate upstream with the central computer via a 100/1000BASE-T1 ethernet backbone. Communication downstream with edge nodes like cameras, sensors, LiDAR is built on 10BASE-T1S ethernet. Legacy ECUs may remain connected to ZCUs via legacy bus like CAN, LIN and FlexRay.

Example of 2025+ Zonal Architecture

In this example, the vehicle is divided into four zones, one at each corner (figure 3), managed by ZCUs. The PDU distributes power to each zone, where the ZCU further manages the second level of power distribution tree. This decentralized model includes added redundancy. Each ZCU distributes power and manages electrical components grouped by location. Protected semiconductor switches, such as eFuses and SmartFETs, enhance functional safety and fail-functional situations by safeguarding loads, sensors, and actuators.

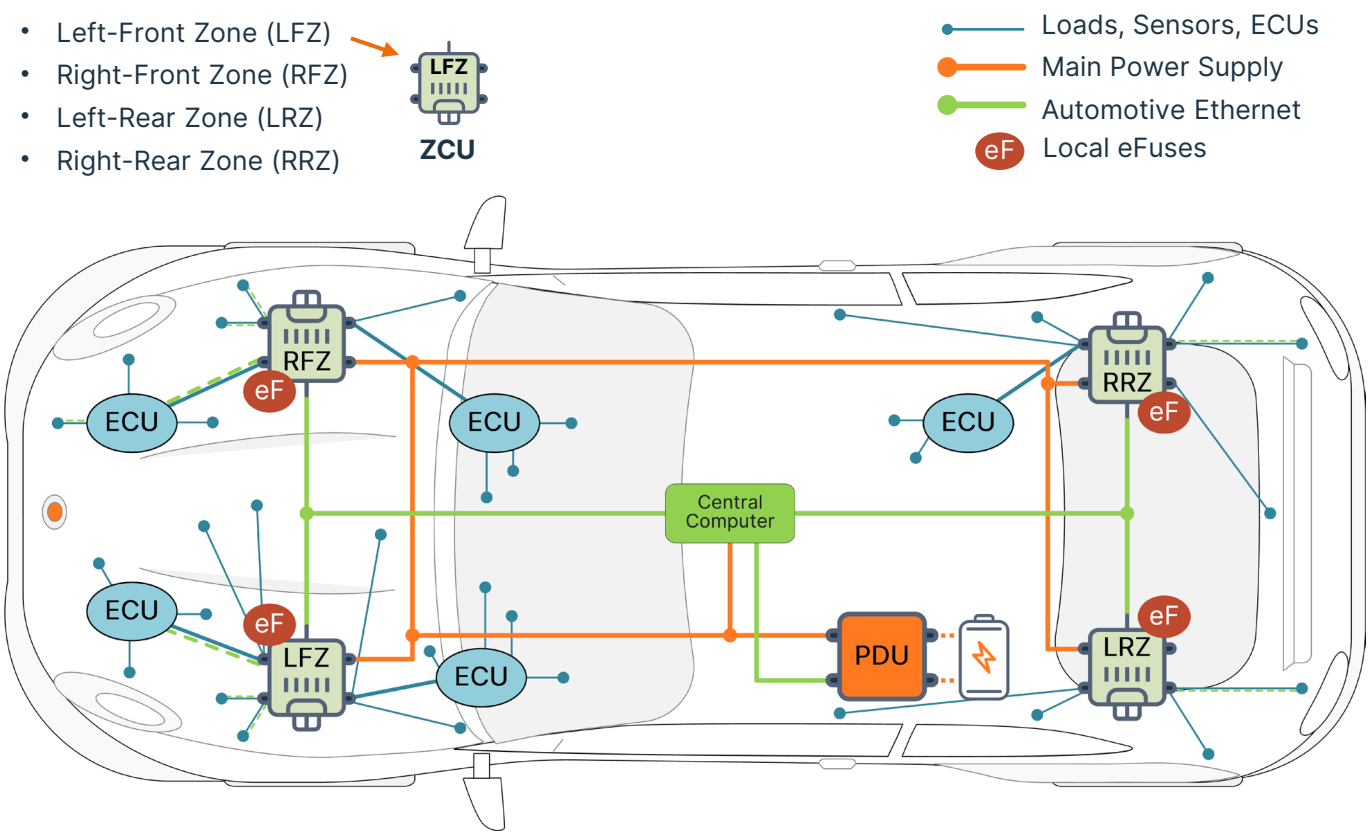


Figure 3: Zonal (Distributed) Power Distribution

Products for Zonal Architecture

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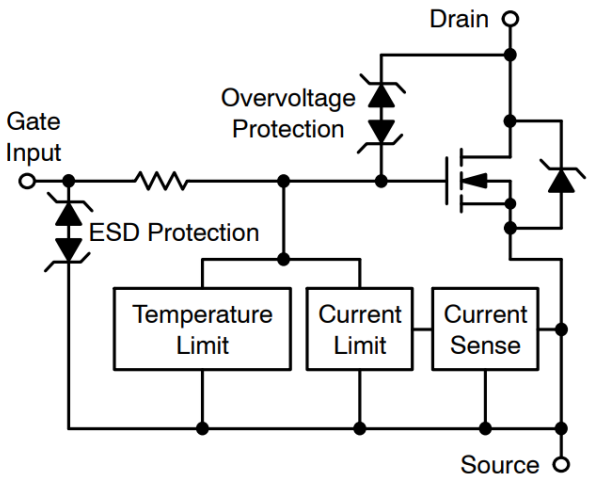
SmartFETs for Low-Side Protection NCV841x “F” Family

onsemi offers two families of low-side SmartFETs: the baseline **NCV840x** and the enhanced **NCV841x**. Both families are pin-for-pin compatible and come in the same packages. The NCV841x offers improved RSC and short circuit performance that significantly extend the device lifetime. With the implementation of differential thermal shutdown, the NCV841x SmartFET can effectively protect itself against device-killing high thermal transients, ensuring Grade-A RSC performance.

Very flat temperature coefficient of the NCV841x family sets a consistent current limit from -40°C to 125°C. This temperature independence means you don’t need to oversize your wire for higher currents in cold weather conditions. By reducing wire size, you can save on both cost and space in the vehicle wire harness. Over-current, Over-voltage protection with integrated Drain to Gate clamping, ESD protection

Explore SmartFET Portfolio

Download Application Note



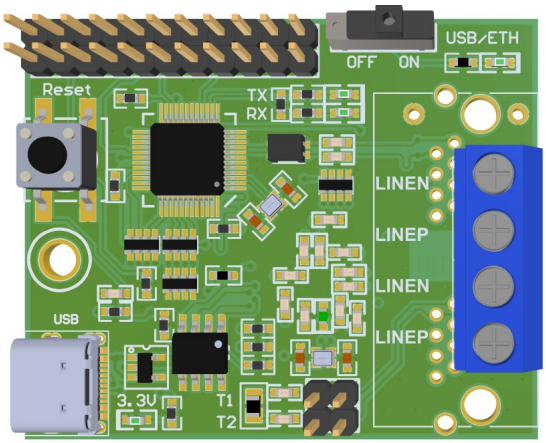
Block Diagram of a NCV841x SmartFET, including self−diagnostic and protection circuitry.

Evaluation Boards - 10BASE-T1S Ethernet Transceiver

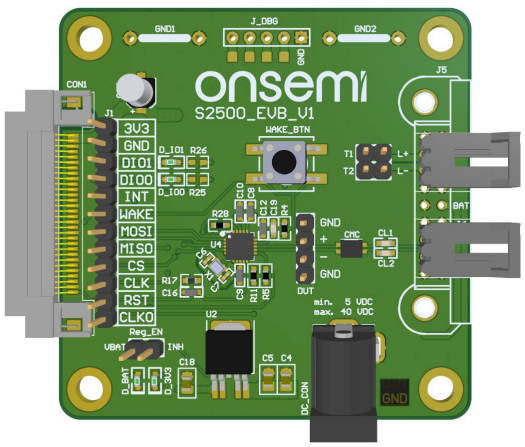
Two evaluation boards (EVBs) are ready for evaluation of the NCV7410 **10BASE-T1S Ethernet Transceiver.** Contact **onsemi** sales to get your EVBs and accompanying software graphical user interface (GUI). EVBs are available in two connection variants:

- MAC-PHY (SPI interface) compatible with MCUs via SPI interface.
- 10BASE-T1S to USB dongle that works in two different use cases:
  - Connect a PC to 10BASE-T1S via USB-C port. Control the board with **onsemi’s** GUI. Pin header can be connected to an oscilloscope or signal analyzer, which allows monitoring of the MII interface traffic.
  - Connect to a remote MCU via pin header to evaluate 10BASE-T1S PHY.

EVB 10BASE-T1S to USB dongle



EVB with SPI interface



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