



System Solution Guide - Preview

Zonal Architecture



onsemi.com



Table of Contents

[Get Latest Version](#)

Overview	03
Market Information & Trend	
From Legacy to Zonal Architecture	04
Software Defined Vehicle (SDV)	06
System Description	
Low Voltage Power Distribution in Electric Vehicles	07
Solution Overview	
Power Distribution Unit (PDU) – Block Diagram	09
SmartFETs for High-Side and Low-Side Protection	10
Ideal Diode and High Side Switch NMOS Controller	11
T10 MOSFET Technology: 40V-80V Low & Medium Voltage MOSFETs	12
Zonal Controller (ZCU) – Block Diagram	13
NCV7410 10BASE-T1S Ethernet Transceiver – Product Introduction	14
Treo Platform – Technology Overview	16
4-Channel 10A Integrated eFuse	17
Evaluation Boards - 10BASE-T1S Ethernet Transceiver	18
Recommended Products	19
Complementary Products	22
Development Tools and Resources	23



Register now to unlock all System Solution Guides



1



2



3



4



5



6



7



8



9



10



11



12



13



14



15



16



17



18



19



20

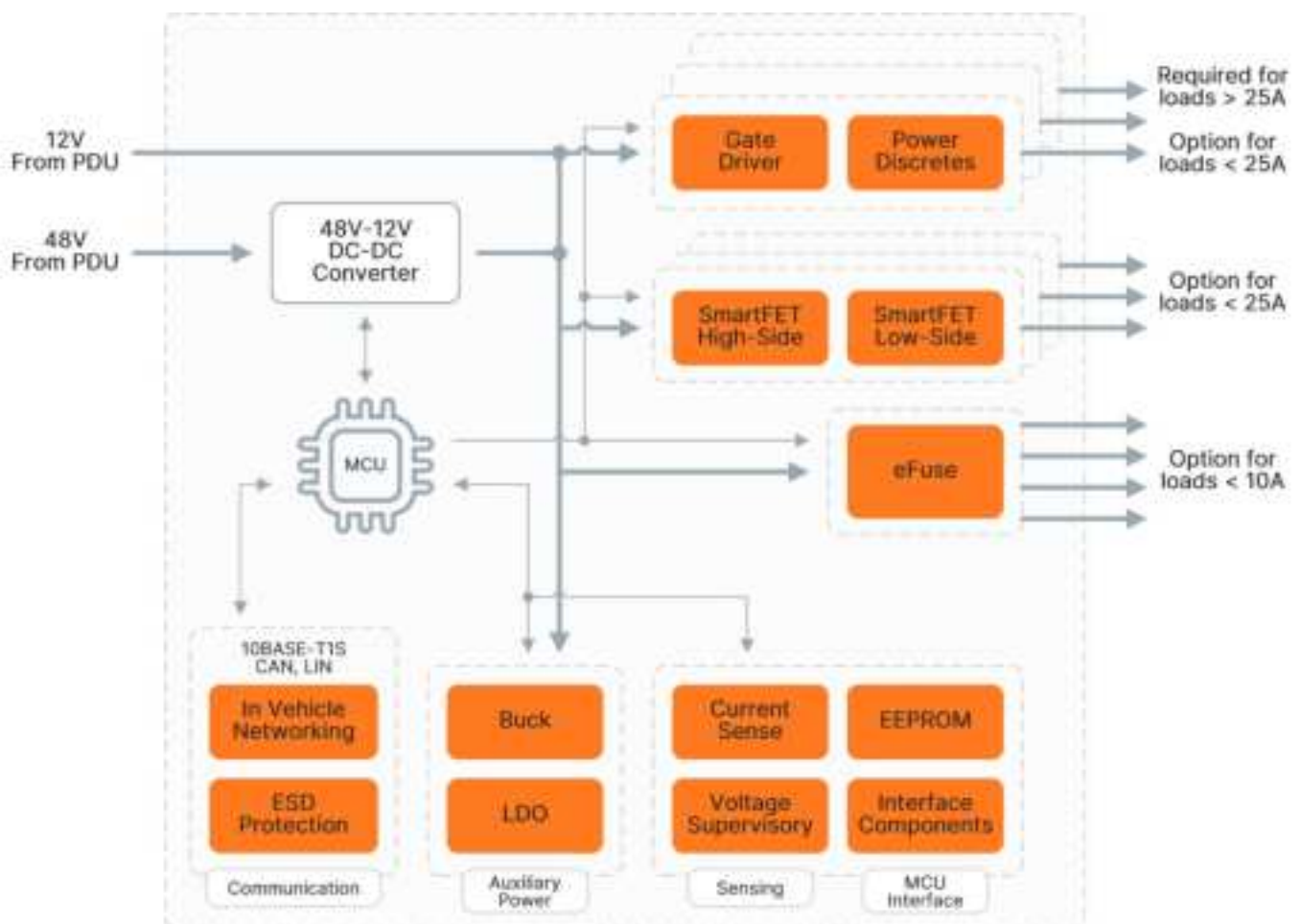
Block Diagram

Get Latest
Version

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.

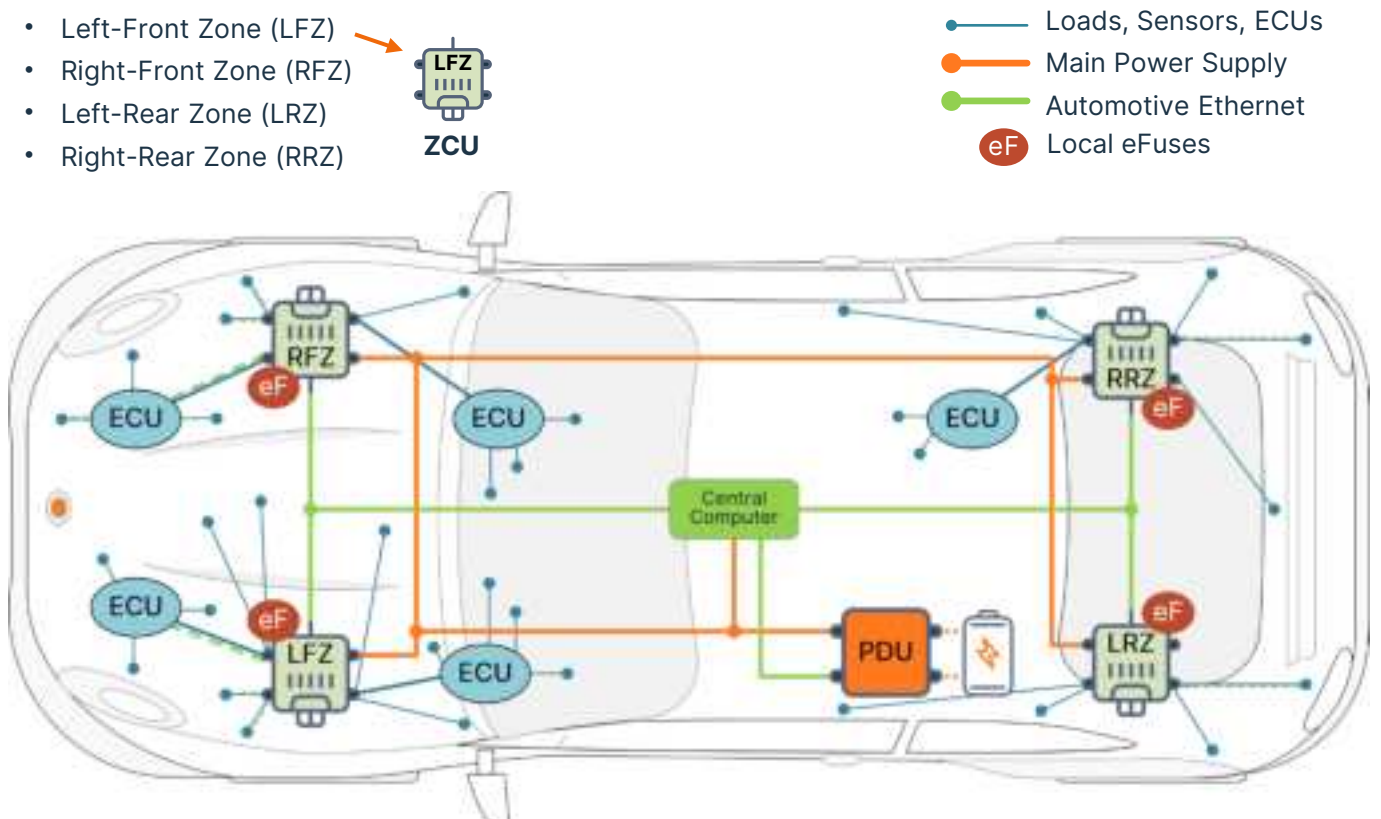
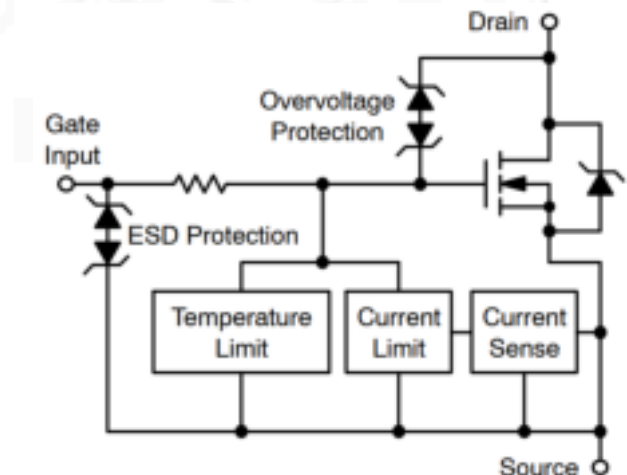


Figure 3: Zonal (Distributed) Power Distribution

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



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

Explore SmartFET Portfolio

Download Application Note

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



onsemi™

Intelligent Technology. Better Future.

Register now to unlock all System Solution Guides and get additional exclusive benefits!

-  Join the conversation on community forum.
-  Utilize Elite Power Simulator & other developer tools.
-  Watch exclusive webinars and seminars.

Open full System Solution Guide



onsemi, the onsemi logo, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries. onsemi owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of onsemi's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. onsemi reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and onsemi makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using onsemi products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by onsemi. "Typical" parameters which may be provided in onsemi data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. onsemi does not convey any license under any of its intellectual property rights nor the rights of others. onsemi products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use onsemi products for any such unintended or unauthorized application, Buyer shall indemnify and hold onsemi and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that onsemi was negligent regarding the design or manufacture of the part. onsemi is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.