



BRD8044/D  
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Energy Efficient Innovations

# Automotive Solutions



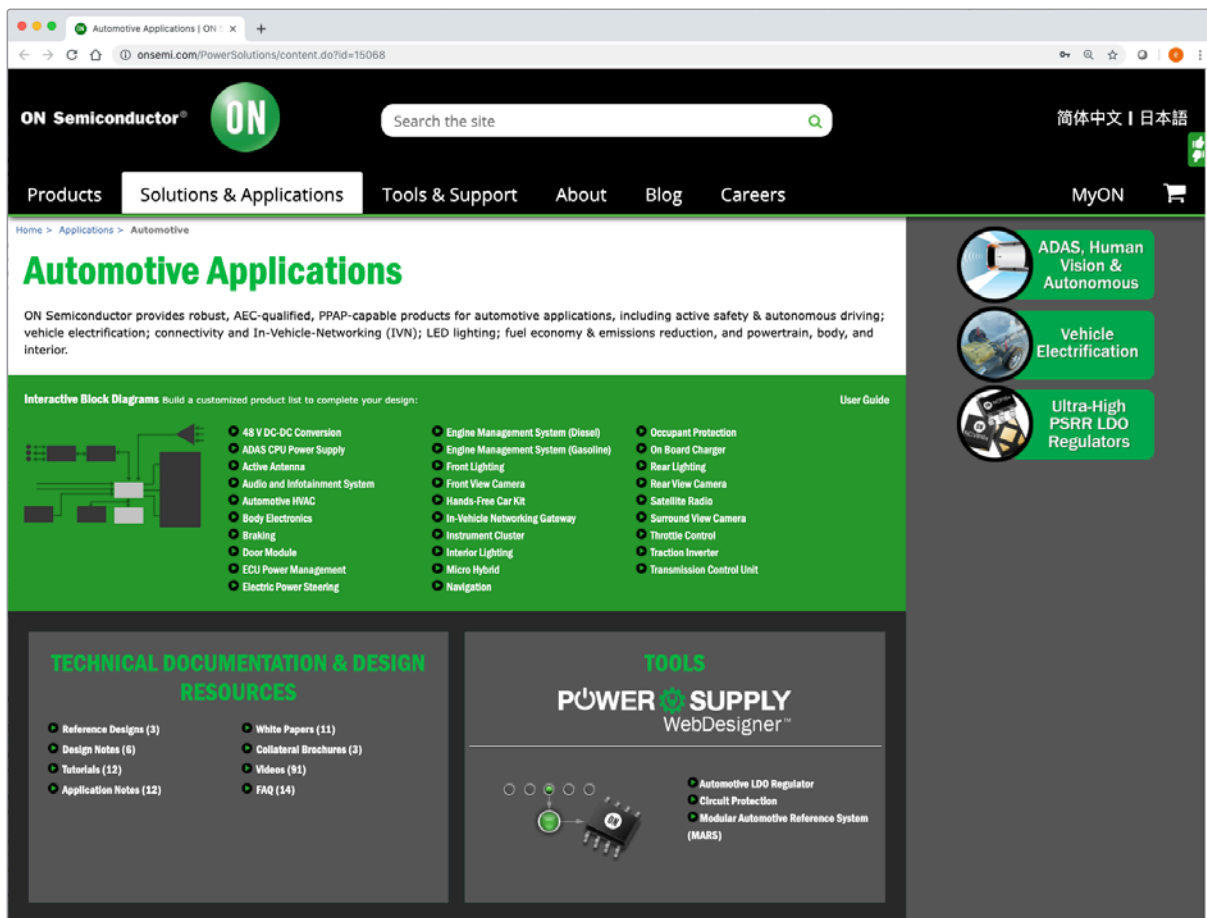
*Comprehensive solutions for advanced automotive subsystems from ON Semiconductor.*



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For More Information, Visit the Automotive Applications Page  
at [www.onsemi.com/automotive](http://www.onsemi.com/automotive)





## Viewing, ADAS, and Autonomous Driving

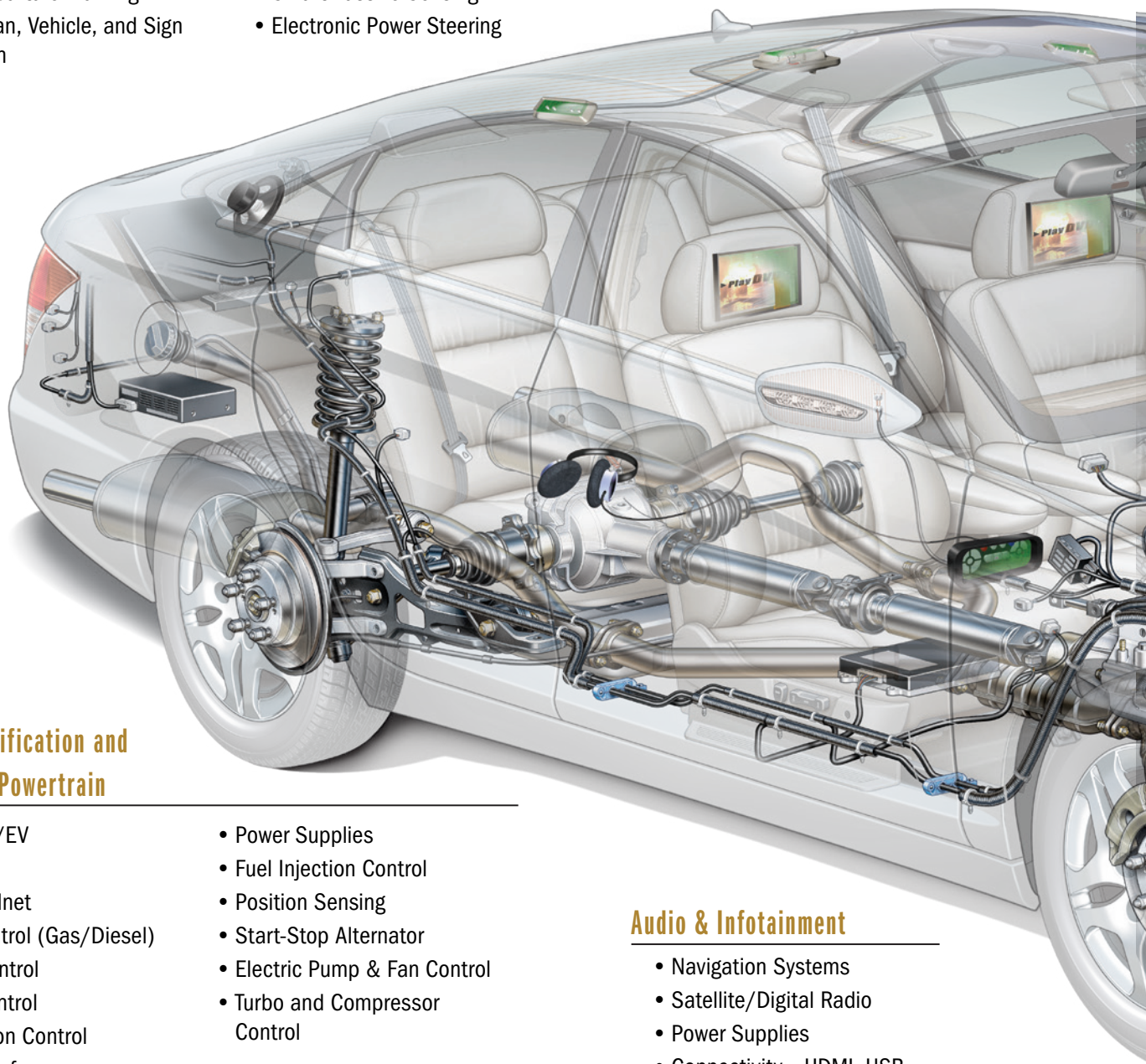
- Viewing – Forward & Surround
- ADAS & Autonomous Driving
  - Adaptive Cruise Control
  - Blind Spot Monitoring
  - Auto-Braking
  - Lane Departure Warning
  - Pedestrian, Vehicle, and Sign Detection
  - eMirror
- Gesture Control
- Driver/Passenger Monitoring
- Ultra-Sonic Park Assist
- Power Supplies
- Electronic Parking Brake
- Smart Passive Sensing
- Electronic Power Steering

## Vehicle Electrification and Conventional Powertrain

- HEV/PHEV/EV
- Fuel Cell
- 48 V Boardnet
- Engine Control (Gas/Diesel)
- Throttle Control
- Ignition Control
- Transmission Control
- Sensor Interface
- Power Supplies
- Fuel Injection Control
- Position Sensing
- Start-Stop Alternator
- Electric Pump & Fan Control
- Turbo and Compressor Control

## Audio & Infotainment

- Navigation Systems
- Satellite/Digital Radio
- Power Supplies
- Connectivity – HDMI, USB, Bluetooth® Low Energy



ON Semiconductor enables energy efficient automotive solutions that reduce emissions, improve fuel economy, and enhance lighting, safety, connectivity, and infotainment power delivery systems. The company provides a broad array of image sensors, power discretes, power management, protection, processing, signal conditioning and control products that deliver solutions focused on areas such as; powertrain, viewing, ADAS, led lighting, climate control, door zone, park assist, IVN, body control and infotainment applications.

### Body & Convenience

- Climate Control
- Instrument Clusters
- Smart Junction Boxes
- Power Supplies
- Electric-Chromic Mirrors
- Seat Positioning, Heating & Cooling
- Door/Mirror/Window Control
- Steering Wheel Sensors
- Smart Passive Sensing
- Body Computers & Gateways

### LED Lighting

- Interior: Door, Dome, RGB Accent, Puddle
- Exterior: CHMSLs, RCLs, Accent
- Advanced Front Lighting & Motor Control
  - ♦ Pixel Lighting
  - ♦ OLED Lighting

### In-Vehicle Networking

- LIN
- CAN
- System Basis Chips
- FlexRay™
- PSi5
- SENT
- Ethernet
- USB



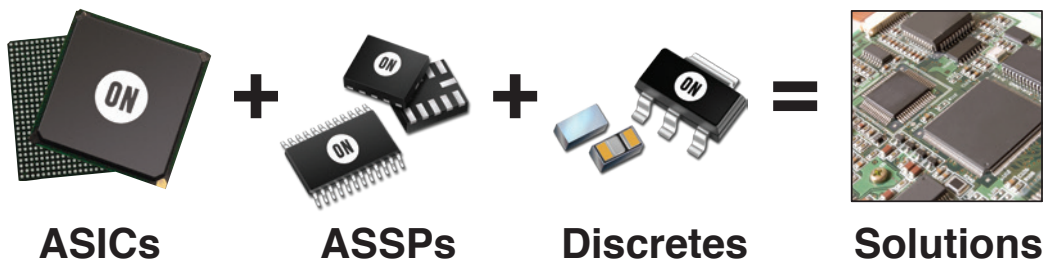
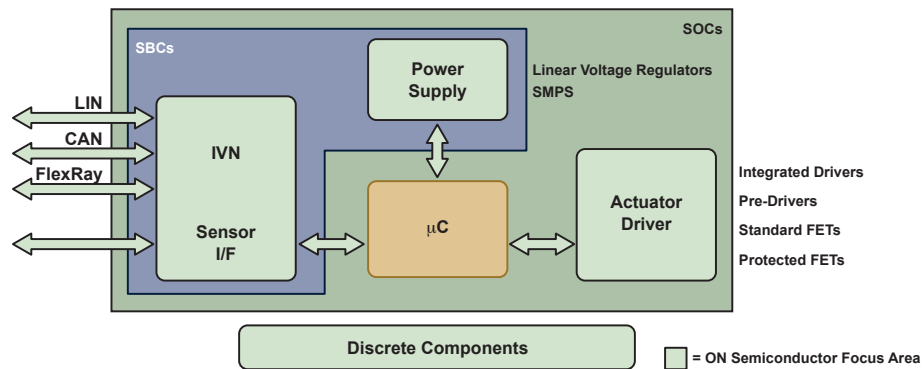
ON Semiconductor®



## Automotive Solutions

Automotive solutions from ON Semiconductor provide an optimized architecture, matched to customer requirements. The company provides multiple options, based on technology and application:

- Application Specific Integrated Circuits (ASIC)
- Application Specific Standard Products (ASSP)
- Image sensors and co-processors
- In-vehicle networking
- Standard integrated circuits
- Discrete components
- Analog
- Mixed-signal
- SBCs and SoCs
- Sensor interfaces



## Automotive Excellence

### *Automotive Expertise*

ON Semiconductor provides energy efficient silicon solutions to the global automotive industry. The company has developed a wide range of automotive components, by applying advanced technology and extensive R&D expertise, in the fields of high-voltage interfacing, smart power management, in-vehicle networking, system level integration, and sensor interfaces.

#### **In-house expertise includes:**

- ASIC, ASSP, standard IC, and discrete capability
- Mixed-signal technologies
- High-voltage processes
- Directly owned and operated fabrication facilities
- Class A clean rooms
- High temperature wafer testing
- Burn-in capability
- Wafers and die

### *Solutions Engineering Centers*

ON Semiconductor operates Solution Engineering Centers in Munich, Germany; Shanghai, China; and Tokyo, Japan. These SECs, located in automotive industry centers, provide local customer support, including application knowledge and system integration skills. Together with local technical field teams and product specialists, the automotive SECs provide the following services:

- Local technical support (system and device)
- Reference designs and demonstration boards
- Global application architecture consultation
- Optimization of system costs and performances
- Design integration support (ON Semiconductor devices into customer applications)
- Component specification and customer/application test specifications

### *Global Supply Chain Operations*

#### **Advanced Capability**

ON Semiconductor invests in EDI, VMI, and other logistics agreements.

#### **Global Locations**

Worldwide, ON Semiconductor employs ~32,000 people. Headquartered in Phoenix, Arizona, U.S.A., the company owns and operates multiple development centers and manufacturing facilities located in the U.S.A., Europe, and Asia.

#### **Global Supply Chain**

ON Semiconductor operates a flexible, reliable, responsive supply chain that supports complex manufacturing networks and dynamic global market conditions. This includes multiple manufacturing and logistics sites located near our customers to ensure supply continuity.

### *Automotive Long-Term Availability Statement*

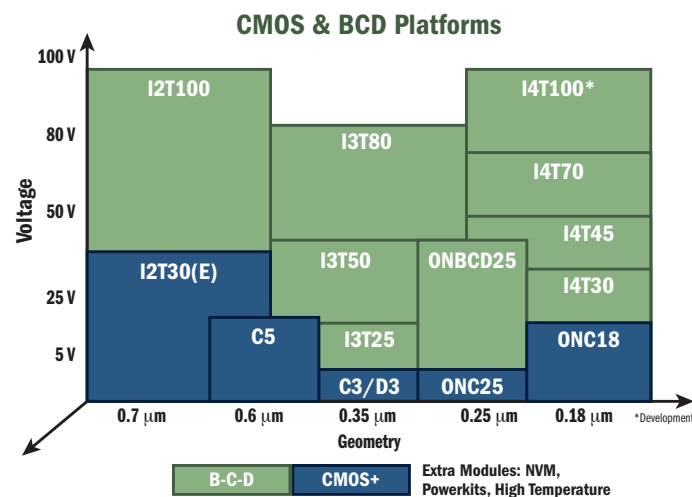
ON Semiconductor is 100% committed to the long-term supply of products in concert with the automotive industry's supply benchmark requirement. The company works with customers to meet their specific supply requirements. ON Semiconductor will make all commercially reasonable efforts to provide automotive customers with advance notice of phase-outs and provide compatible product renewals, when technically feasible and within certain cost constraints, to help ensure long-term supply considerations and requirements are fully achieved.



## Automotive Technology

### Proven Automotive Technical Capabilities

ON Semiconductor has developed a set of dedicated, high-voltage automotive power technologies. With parasitic signals running through automobiles, 80 V spikes can occur and must be accounted for by the design team. Modules and components need to be able to sustain such peaks and remain functional. ON Semiconductor technology enables complex, high-voltage system-on-chip (SoC) solutions that meet requirements for maximum voltage and digital gate integration.



### Electro Magnetic Compatibility

In-Vehicle-Networking (IVN) applications require extended immunity against ESD pulses and EMI. Growing vehicle electronic content makes this even more important, and automobile

manufacturers set performance standards accordingly. ON Semiconductor offers best-in-class devices using I3T50/80 and I4T30/45/70 technologies, that provide advanced capabilities. Robust designs are achieved, for example, by deep trench isolation, which reduces the interference between the voltage domains on the chip.

ON Semiconductor offers a range of technologies that allow up to 100 V supply, and enables component integration – including embedded microprocessor cores.

ON Semiconductor technologies serve as the basis for automotive ASIC and application specific standard product (ASSP) solutions for powertrain (including high temperature applications with ambient temperatures  $\geq 150^{\circ}\text{C}$ ), safety, body, dashboard, in-vehicle-networking (IVN), sensors, and actuator applications.

### High Temperature Capability

ON Semiconductor offers a broad portfolio of products that operate in extended temperature ranges, up to  $150^{\circ}\text{C}$ . The company has also launched an initiative to extend high temperature capabilities to  $200^{\circ}\text{C}$ . This initiative includes enhancements to:

- Packaging and Bonding
- High Temperature Testing
- Component Test Vehicles
- Product Test Vehicles
- CAD Tools
- Libraries
- Spice Device Models

Extended high temperature capabilities may be applied to ASICs and ASSPs.

## Automotive Quality

### Automotive Grade Quality and Control Processes

For over 40 years, ON Semiconductor has been developing and delivering robust, high-performance solutions that allow designers to meet the demanding environmental and performance requirements of automotive applications.

**Quality Policy:** *"We will exceed Customer Expectations with our Superior Products and Services."*

**Quality Statement:** *"Every ON employee is personally responsible for ensuring the highest Quality in the products and services delivered to internal and external customers. Continuous improvement in the Quality of our processes, products and service is fundamental to the achievement of customer satisfaction."*

For certification documents, visit the Quality page on our Web site.

### ON Semiconductor Quality Processes

- Certified to ISO 9001:2015
- Certified to IATF 16949:2016
- Implemented ISO 26262 Functional Safety Standard
- Quality System and Business Operating System are synonymous and are documented to meet the requirements of the Automotive Standards
- Corrective action systems use various methodologies to ensure we identify and correct the root cause of non-conformance. Preventive action is also used to ensure we eliminate potential non-conformances
- Quality System/Business Processes are documented and controlled

### Production Part Approval Process (PPAP)

Our documented process provides the methods, procedures, and forms to initiate PPAP submission; prepare the documents required for submission; and document customer approval when required. This process ensures that ON Semiconductor components comply with design specifications, and that customer designs will maintain desired quality levels.

### Zero-Defect Program

Focused Parts "Non-Zero" devices (bottoms-up approach)

- Problem solving methodology
- Adequate Failure Analysis facilities
- Incident ownership

Prevent Recurrence Systemic Improvement (top-down approach)

- Process characterization, control plan, and Failure Mode Effect Analysis
- Maverick lot initiative
- Quarterly detailed Horizon Reports

ON Semiconductor's commitment to the automotive market extends beyond the delivery of great products, to ensuring that our manufacturing and quality processes meet the industry's need for reliability and robustness. The demanding standards of the automotive industry drive the company's design, manufacturing, and delivery processes. ON Semiconductor delivered over 78 billion parts in 2018, with average defect rates of less than 140 parts-per-billion.

### Change Management Processes

ON Semiconductor proactively manages product changes to ensure Safe Customer Passage and Flawless Execution.

- ON Semiconductor follows the JEDEC 46D and JEDEC 48C for all markets except automotive. For the automotive market we follow ZVEI – Guideline for Customer Notifications of Product and/or Process Changes (PCN) of Electronic Components for Automotive Market for our change management process.
- Automotive Reliability Testing performed per Automotive Electronic Council (AEC) Q100/Q101/Q104 and AQG324 Power Module Qualification Standard
- Use of detailed Process/Parameter Matching Checklist
- Use of detailed changes process flow, with various checkpoints during and after the change implementation
- Use of program management methodology
- Customers notified through Product Change Notifications



## Functional Safety Management: Development According to ISO 26262

### Functional Safety at ON Semiconductor

ON Semiconductor has a long and successful history of mixed signal integrated circuit developments targeting safety critical applications. Following the release of the ISO 26262 standard in November 2011, ON Semiconductor created a dedicated Functional Safety structure and implemented a dedicated design flow to support the development of devices targeting safety critical applications according to this new standard. This initiative has proven to be successful, as today the company has experience with the development of mixed-signal integrated circuits targeting applications with safety goals up to ASIL D.

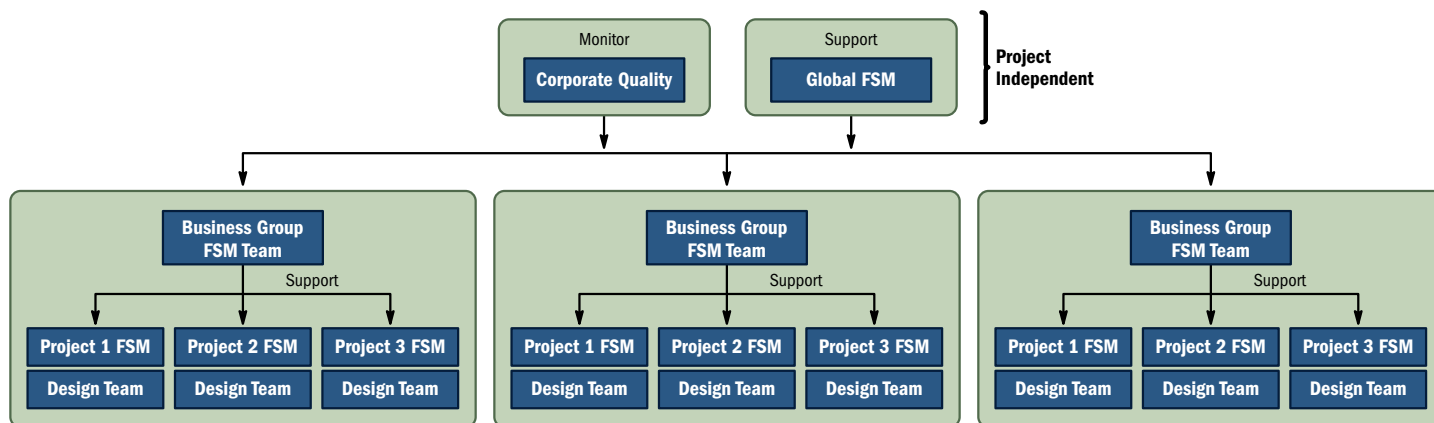
ON Semiconductor is highly involved in the Functional Safety community, especially in ISO 26262. The company is a member of the ISO 26262 work group (TC22/SC32/WG8), as well as part of the ISO 26262 related semiconductor sub-work group that clarified the standard for semiconductor developments and resulted in the release of ISO 26262-11:2018.

### Creation of Dedicated and Independent Team

The purpose of the project independent team is to create a safety culture in the company and to guarantee an independent and critical look on the way functional safety will be guaranteed during the development of the devices. This independent team, driven partly by the quality department and partly by product development, has responsibility to monitor and guide the project Functional Safety Managers as well as the development teams assigned to the different developments, and provide the tools needed to follow the flow as described by the ISO 26262 standard.

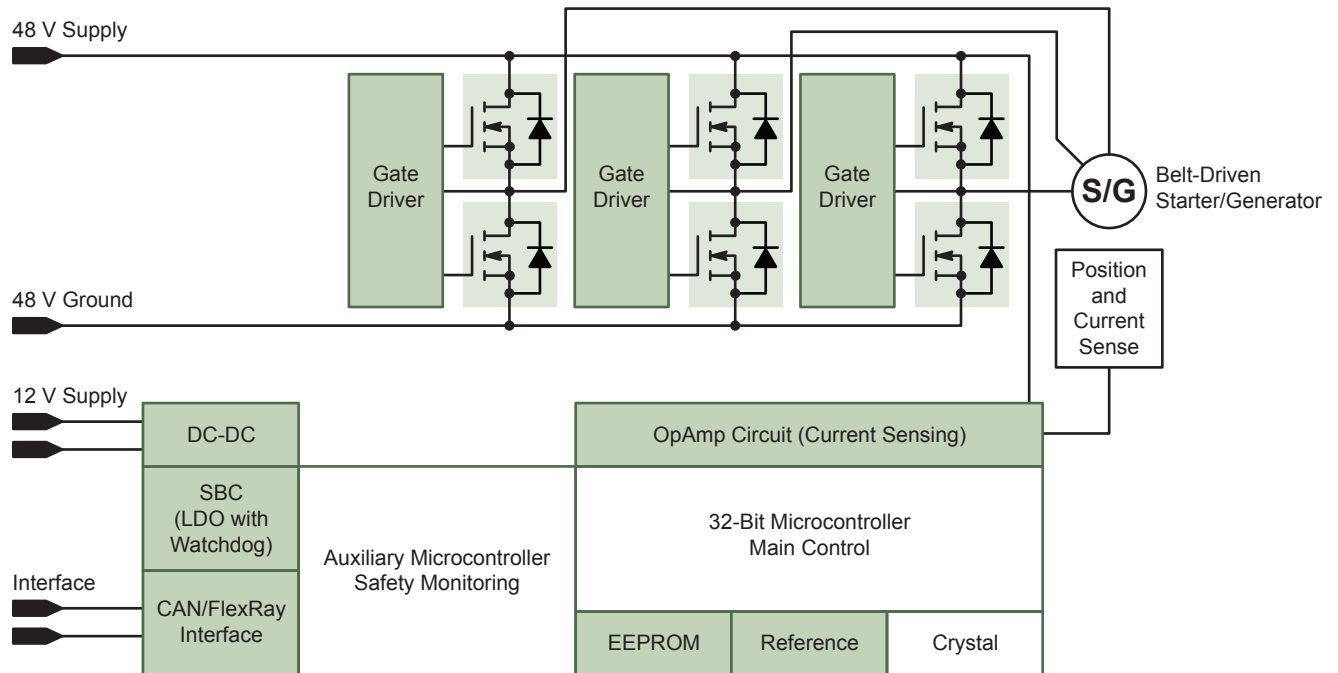
### Enhancing Experience

Through the ongoing developments and the dedicated Functional Safety Structure, ON Semiconductor is attaining even more significant experience, and is ready to support customers for automotive Functional Safety related projects.



Dedicated and Independent Team

## 48 V Starter/Generator



## Key Products & Features

### Current Sense Amplifiers: NCV2007x, NCV21x

- High-side and low-side current sensing
- Low offset zero-drift architecture
- Flexible system supply voltage
- Low value current sense resistors for better power efficiency
- Temperature sensitive applications
- AEC-Q100 Qualified

### Medium Voltage MOSFETs: FDBL863xx-F085, FDBL860xx-F085 & NVMFS6H8xx

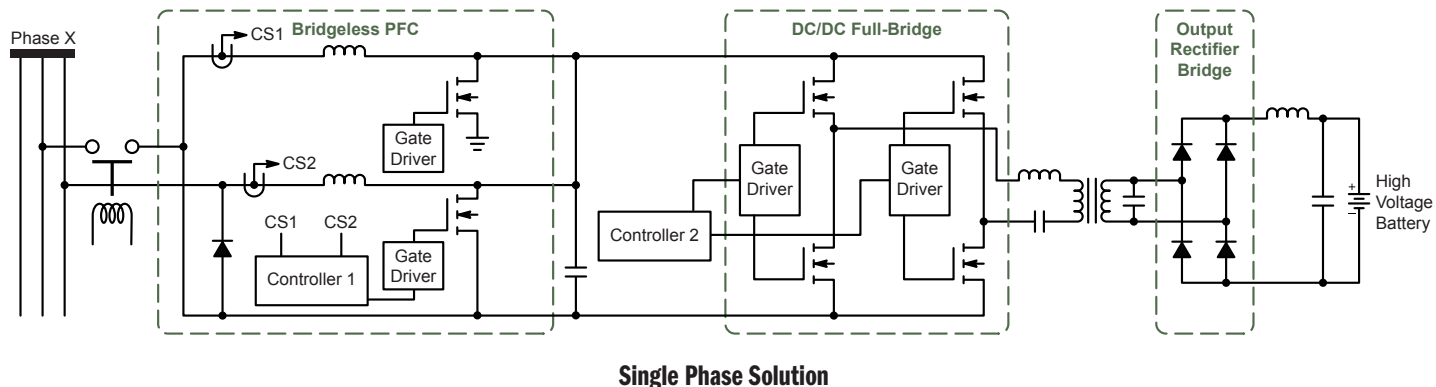
- Flat-lead performance packages (SO-8 FL & TOLL)
- Very low  $R_{DS(ON)}$
- Small footprint, high current
- Superior reliability/robustness
- AEC-Q101 Qualified

### High/Low Side MOSFET Drivers: NCV51511, FAN7191-F085, NCV5183

- High current capabilities
- Down to 30 ns Propagation delay
- Pin-to-pin compatible with industry standards
- AEC-Q100 Qualified



## On-Board Charger



## Key Products & Features

### High Voltage MOSFETs (SuperFET®): NVxyyyyN65S3F

- Low on-resistance and low gate charge performance
- Low conduction loss
- Fast Switching speeds
- Withstand extreme dv/dt rate and higher avalanche energy
- AEC-Q101 Qualified

### Discrete IGBTs: AFGB30/40T65SQDN, FGB/H40T65SPD-F085, FGH40/60N60SMD-F085, FGH40/60N60SFDTU-F085, AFGHL50T65SQDC

- Fast switching
- Low cost
- AEC-Q101 Qualified

### High Voltage Gate Drivers: NCV570x, NCV51xx and FAN71xx-F085

- Family of rail-to-rail high current drivers for lower system losses
- External (opto/silicon) or built-in galvanic isolation in multiple packages for design flexibility
- Short propagation delays for faster switching
- Suitable for single ended, half bridge, and full bridge topologies
- Operate in conjunction with high-speed switching NSVS5003xSB buffer BJTs for high current IGBT control
- AEC-Q100 Qualified

### MOSFET Modules: FAM65CRxx, FAM65HRxx

- High thermal performance
- Enhanced EMI, isolation, and current capabilities
- System level cost reduction
- Enable compact system solution with proven reliability

### High Voltage Rectifiers: RURGxxxx-F085, RHRGxxxx-F085, ISL9R3060G2-F085, FFH50US60S-F085

- Both low VCE(sat) and high speed version available for rectification and fast switching
- Avalanche energy rated
- AEC-Q101 Qualified

### SiC Rectifiers: FFSPxxxxB-F085, FFShxxxxB-F085\*, FFSDxxxB-F085\*

- Superior switching performance in comparison to silicon
- Excellent thermal performance
- Fast operating frequency
- Increase power density and reduced EMI

### SiC MOSFETs

- NVHL080N120SC1 – 1200 V, 44 A, TO-247
- NVBG020N120SC1 – 1200 V, 98 A, D2PAK

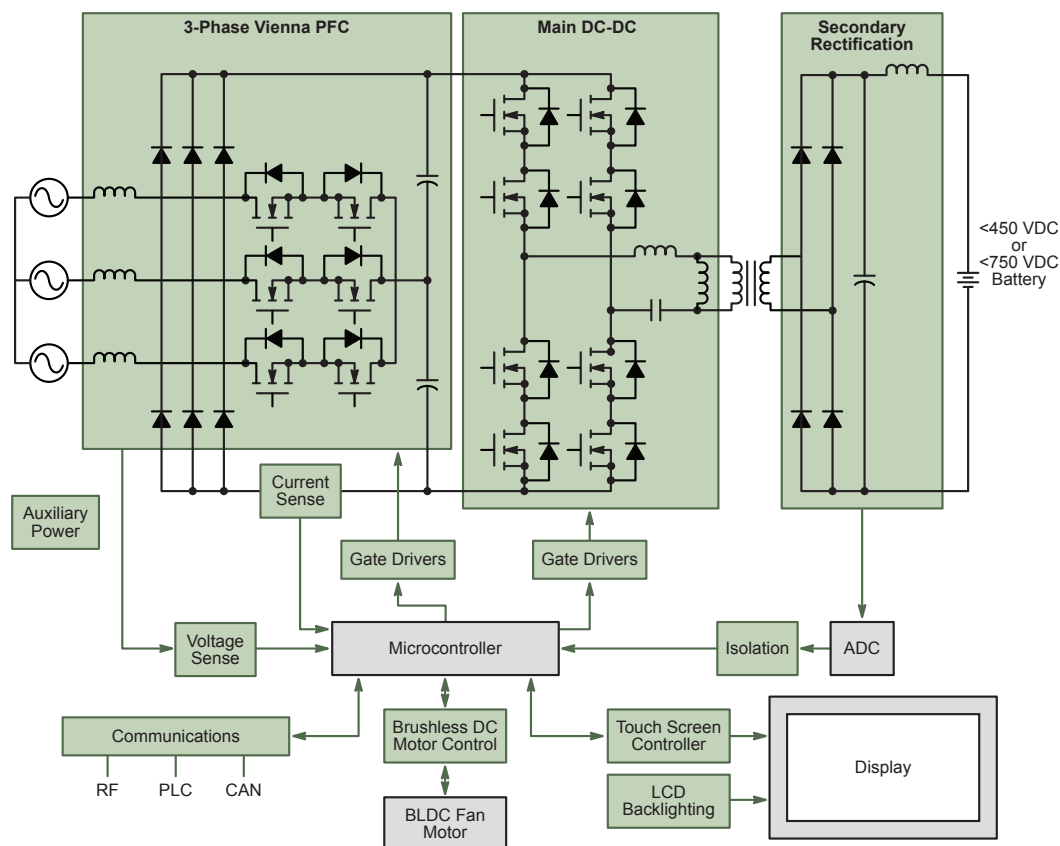
### 670 V Flyback Converters: NCV106x, NCV107x

- Enables compact designs for isolated and non-isolated systems
- Output power from 2 W to 15 W
- AEC-Q100 Qualified

\* Pending 4Q19.

## EV Charging Stations

ON Semiconductor has a wide portfolio of products and solutions to cover the different topologies, approaches, and architectures that come with this emerging market. SiC Diodes & MOSFETs complement traditional Super-Junction and IGBT solutions, and modules can bring further benefits in terms of system integration and performance.



### 650 V SuperFET® III MOSFETs

- FCH023N65S3 – 23 mΩ, TO-247
- FCH040N65S3 – 40 mΩ, TO-247
- FCP067N65S3 – 67 mΩ, TO-220

### High Voltage Rectifiers

- FFP30S60S – 600 V, 30 A, STEALTH II
- FFPF10UP60S – 600 V, 10 A, Ultrafast II
- RHRG75120 – 1200 V, 75 A, Hyperfast

### High Voltage Gate Drivers

- FOD8342 – 3 A Optocoupler Gate Driver
- NCD5700 – High Current Gate Driver
- NCP51705 – 6 A SiC MOSFET Driver

### Silicon Carbide Diodes

- FFSH40120ADN – 1200 V, 40 A, TO-247
- FFSH20120A – 1200 V, 20 A, TO-247
- FFS2065A – 650 V, 20 A, TO-220

### 650 & 1200 V IGBTs

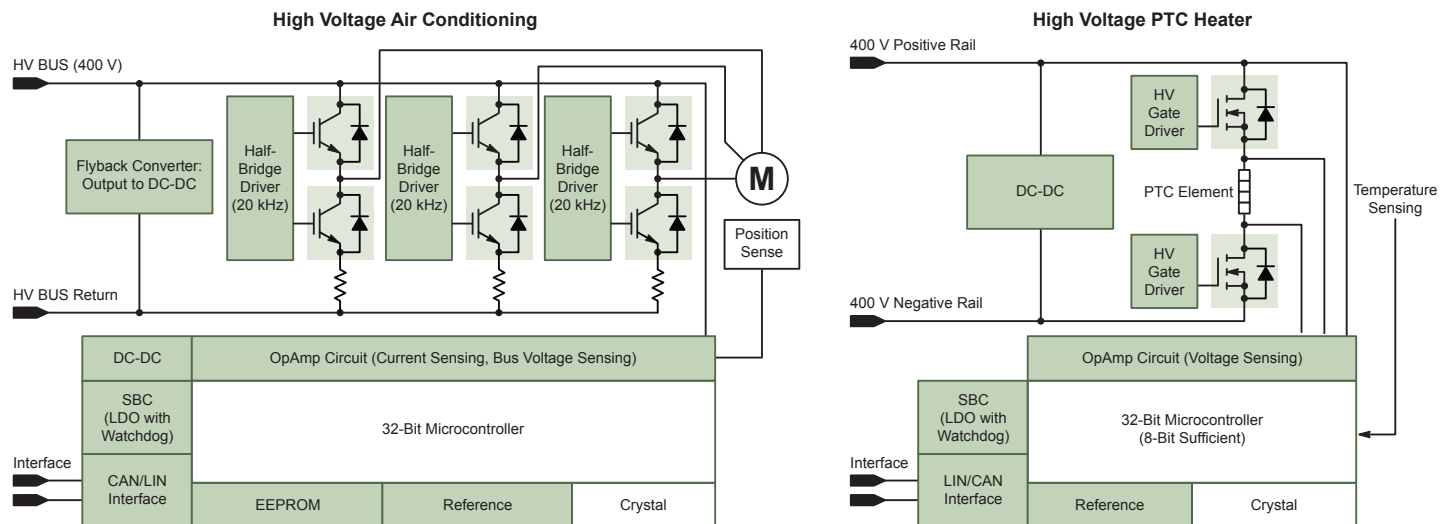
- FGH75T65SQD – 650 V, 75 A, TO-247
- FGH50T65SQD – 650 V, 50 A, TO-274
- NGTB40N120FL3 – 1200 V, 40 A

### Current Sense Amplifiers

- NCS210R – 26 V, 1% Gain Error, Amplifier
- NCS20074 – 3 MHz, Low Noise Op Amp



## High Voltage Auxiliary



## Key Products & Features

**Discrete IGBTs:** AFGHL40T65SPD, FGB/H40T65SPD-F085, FGH20/60N60UFDTU-F085, FGH40N65UFDTU-F085, AFGHL50T65SQDC

- Low saturation voltage
- Fast switching
- Tight parameter distribution
- AEC-Q101 Qualified

**High Voltage Gate Drivers:** NCV570x, NCV5700x, NCV51xx and FAN71xx-F085

- High drive current
- Short propagation delays
- Fault detection and reporting
- Designed for reliability
- AEC-Q100 Qualified

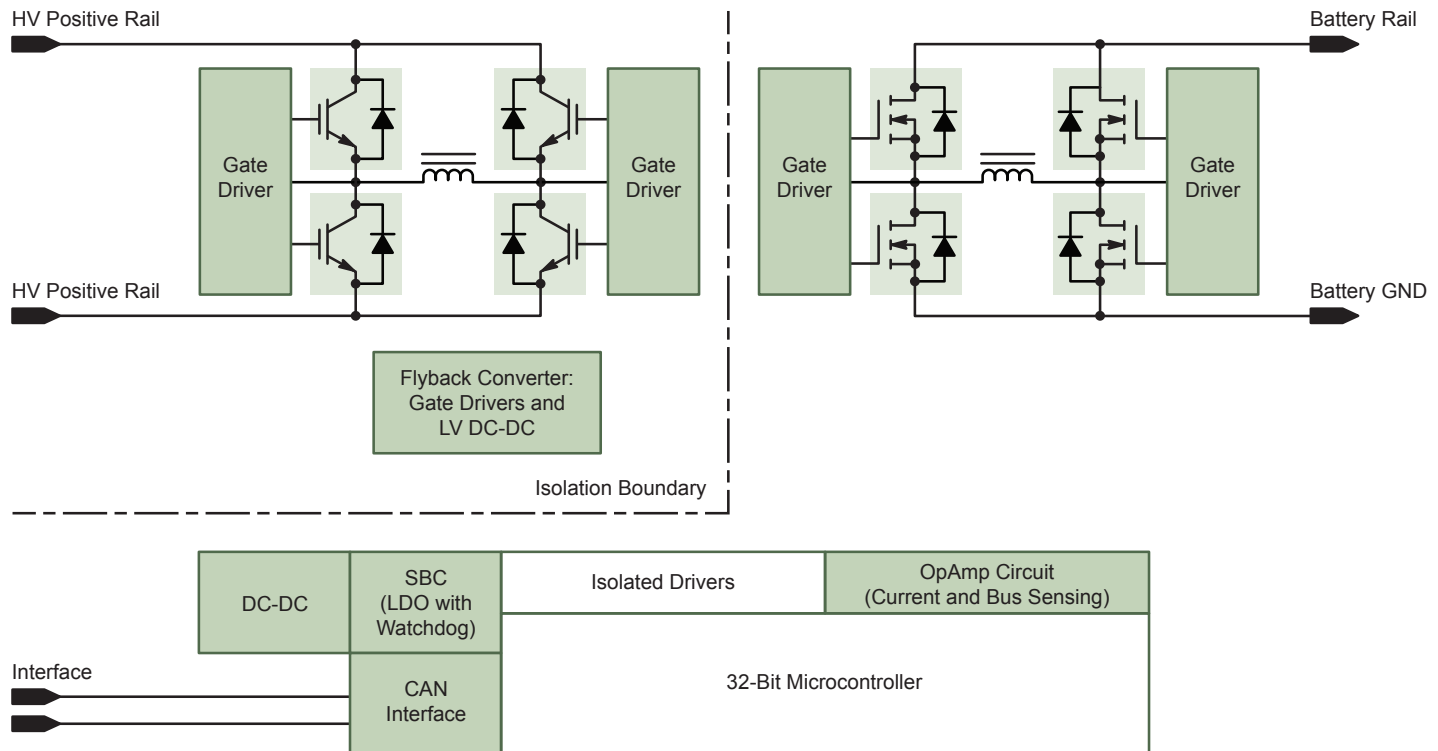
**670 V Flyback Converters:** NCV106x, NCV107x

- Enables compact designs for isolated and non-isolated systems
- Output power from 2 W to 15 W
- AEC-Q100 Qualified

**High Voltage Integrated Power Module:** NFVA3x065L32 (650 V, 30/40/50 A), NFVA23512NP (1200 V, 35 A)

- AEC-Q100/101 qualified module & support AQG324
- 3-phase IGBT IPM with low loss IGBTs and soft recovery diodes optimized for auxiliary inverter in hybrid & electric vehicle applications
- Electrically isolated DBC substrate (AlN/Al<sub>2</sub>O<sub>3</sub>) with low thermal resistance (0.34°C/W & 650 V/50 A) and high isolation voltage (2.5 kVac)
- Adopted rugged Short Circuit Withstand Time FS Trench IGBT; over 5 μs & 400 V/175°C/15 V
- Integrated gate drivers with internal VS connection, under-voltage lockout, over-current shutdown, temperature sensing unit, and fault out

## High Voltage–Low Voltage DC-DC Conversion



### Key Products & Features

#### High Voltage MOSFETs (SuperFET®): NVxyyyyN65S3F

- Low on-resistance and low gate charge performance
- Low conduction loss
- Fast switching speeds
- Withstand extreme dv/dt rate and higher avalanche energy
- AEC-Q101 Qualified

#### High Voltage Gate Drivers: NCV570x, NCV5700x, NCV51xx and FAN71xx-F085

- Family of rail-to-rail high current drivers for lower switching losses
- External (opto/silicon) or built-in galvanic isolation in multiple packages for design flexibility
- Short propagation delays for faster switching
- Signal conditioning and noise immunity for reliable operation
- AEC-Q100 Qualified

#### Discrete IGBTs: FGB/H40T65SPD-F085, FGH40/60N60SMD-F085, FGH40/60N60SFDTU-F085, AFGHL50T65SQDC

- Fast switching
- AEC-Q101 Qualified

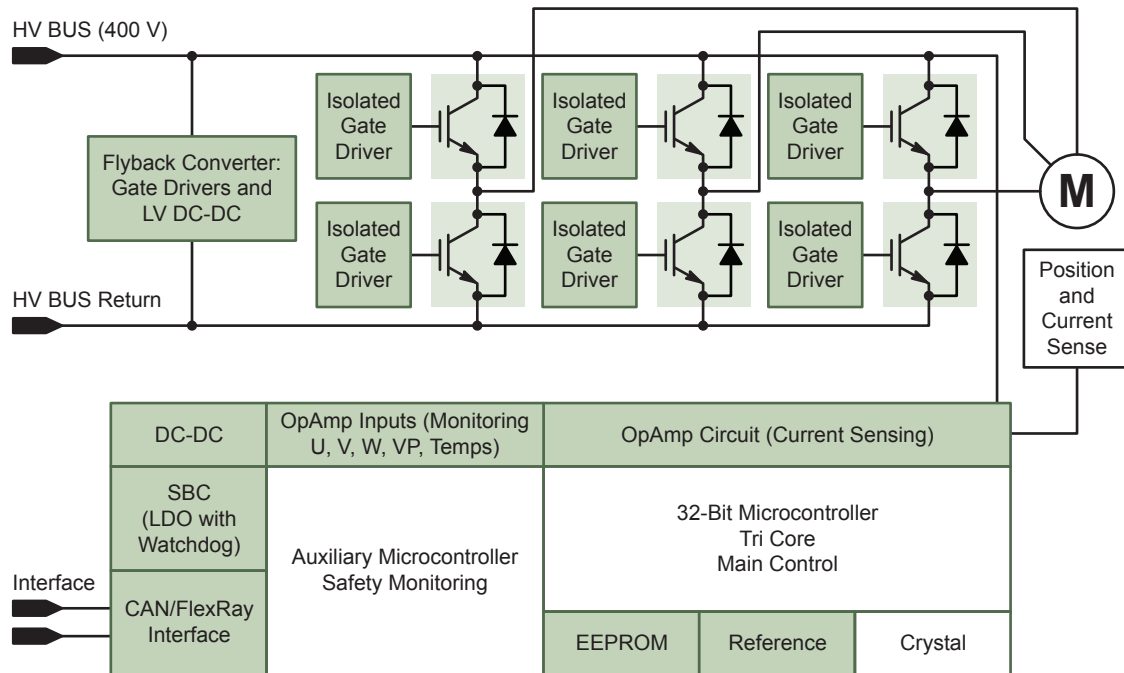
#### Medium Voltage MOSFETs: FDBL863xx-F085, FDBL860xx-F085, NVMFS6H8xx

- Flat-lead performance packages (SO-8 FL & TOLL)
- Very low  $R_{DS(ON)}$
- Small footprint, high current
- Superior reliability/robustness
- AEC-Q101 Qualified

#### 670 V Flyback Converters: NCV106x, NCV107x

- Enables compact designs for isolated and non-isolated systems
- Output power from 2 W to 15 W
- AEC-Q100 Qualified

## Traction Inverter for HEV/EV



## Key Products & Features

### Discrete IGBTs: FGY160T65SPD-F085, FGY120T65SPD-F085

- Very low saturation voltage
- Tight parameter distribution
- 100% transient immunity tested
- Short circuit ruggedness > 6  $\mu$ s
- AEC-Q101 Qualified

### High Voltage Gate Drivers: NCV570x, NCV5700x, NCV51705

- Family of rail to rail high current drivers for lower system losses
- External (opto/silicon) or built-in galvanic isolation in multiple packages for design flexibility
- DESAT, Miller Clamp, TSD and fault reporting to prevent catastrophic failures
- Input signal conditioning and high noise immunity for reliable operation
- Operate in conjunction with high-speed switching NSVS5003xSB buffer BJTs for high current IGBT control
- AEC-Q100 Qualified

### IGBT Modules: AHPM Dual Side Cooling Modules

- Dual-side cooling for best in class power density & thermal performance
- Ultra low stray inductance (7 nH)
- On die temperature and current sense
- Best in class Trench Fieldstop IGBT with low recovery diodes

### Bare Die IGBT and FRD

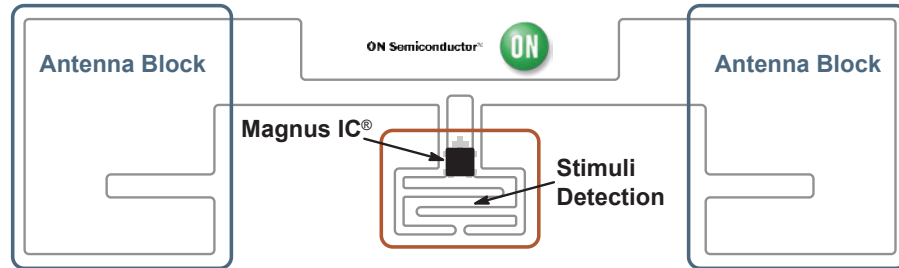
- 650 V and 750 V rated
- Very low saturation voltage
- Ease of paralleling
- Monolithic Temperature Sensor and Current Sensor
- Solderable top metal available
- AEC-Q101 Qualified

### 670 V Flyback Converters: NCV106x, NCV107x

- Enables compact designs for isolated and non-isolated systems
- Output power from 2 W to 15 W
- AEC-Q100 Qualified



## Smart Passive Sensors



### Features

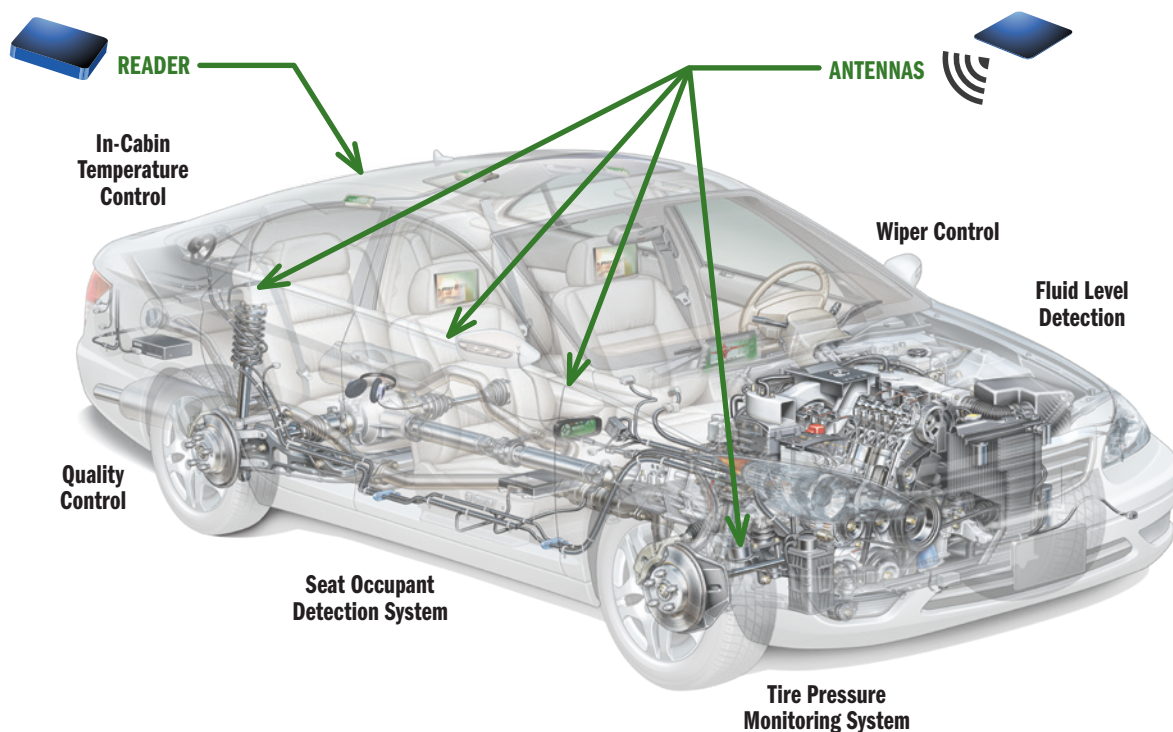
- **Smart** – Magnus® sensor IC with adaptable RF front end
- **Passive** – UHF energy harvesting antenna blocks
- **Sensor** – Stimuli detection for temperature, moisture, pressure, & proximity

### Automotive Benefits

- Safety
- Comfort
- Convenience
- Wire & weight reduction
- Improved fuel economy
- Highly scalable

### Devices

- SPS1M001/M002 for moisture
- SPSXT001 for temperature
- SPSDEVR1-8 for sensor reader hub



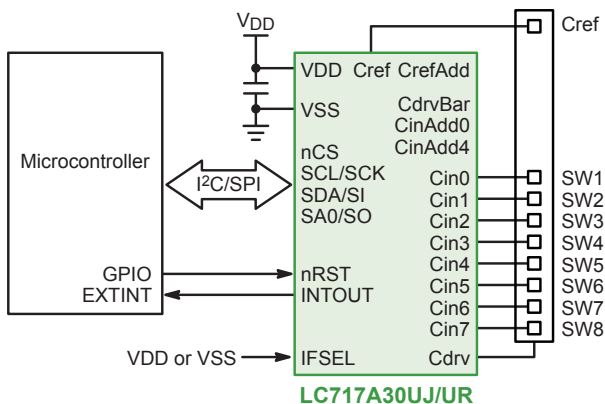
## Capacitive Touch Sensors

LC717A capacitive touch sensors are high performance, cost-effective, highly usable capacitance converters for use in touch switch applications and replacing mechanical switches.

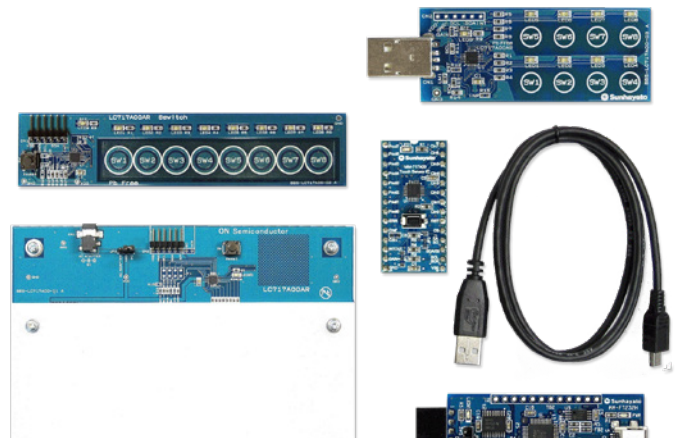
The LC717A30UJ/UR has superior sensitivity performance, so it can detect hands with wearing multiple layers of gloves, and hands within 15 cm of distance. It can also perform gesture recognition.

### Features

- Differential capacitive detection using mutual capacitance, to femto-Farad level
- High sensibility performance - even wearing multiple layers of gloves, air gap, or thick material
- High adaptability - calibration function, noise reduction, wide range temperature operation
- Design friendly - adhesive free, various circuit board (PCB/FPC) design, minimal external components
- 8 sensing inputs
- SPI/I2C interface control
- Voltage ranges of 2.6 – 5.5 V



LC717A30UJ/UR Application Diagram



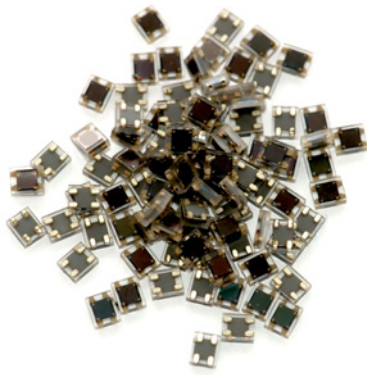
LC717A30UJ Evaluation Kit



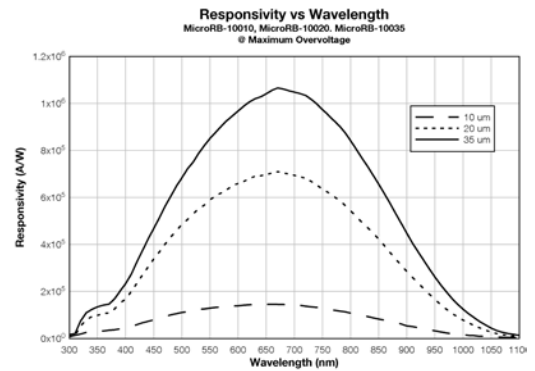
## NIR-Enhanced Silicon Photomultipliers for Long Range Automotive LiDAR Applications

### Features

- High responsivity of >100 kA/W @ 905 nm due to combination of high gain and detection efficiency
- PDE of >10 % at 905 nm
- Ultra-fast rise times and pulse widths from unique 'fast output' terminal
- Single photon sensitivity



MicroRB sensors – 1 mm sensor in a robust molded leadframe package

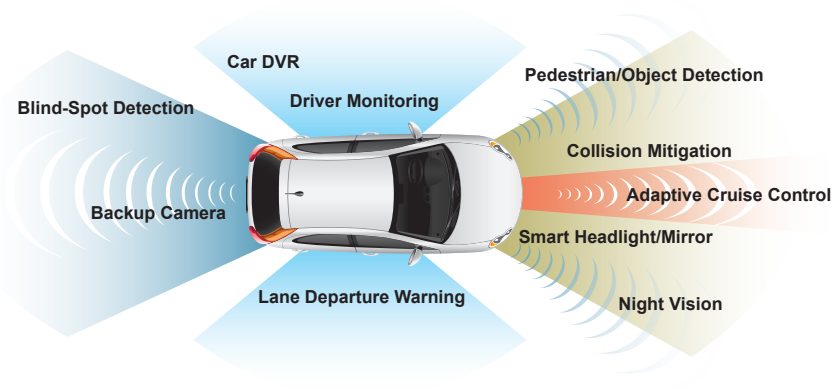


ArrayRA – 1 x 16 monolithic array in a DFN package

| Device              | Description  | Pixel Size<br>(mm x mm) | Microcell<br>(μm) | Package |
|---------------------|--|-------------------------|-------------------|---------|
| Single Sensors      |  |                         |                   |         |
| MicroRB-10010-MLP   | NIR-enhanced SiPM in a molded leadframe package                      | 1 x 1                   | 10                | MLP     |
| MicroRB-10020-MLP   |  |                         | 20                |         |
| MicroRB-10035-MLP   |  |                         | 35                |         |
| Monolithic Array    |  |                         |                   |         |
| ArrayRA-0116A20-DFN | Monolithic array of 1 x 16 NIR-enhanced SiPM pixels in a DFN package | 0.49 x 0.17             | 20                | DFN     |

## Imaging Products for Automotive Applications

ON Semiconductor image sensors and co-processors enhance driver experience and safety. Since 2004, we have been the leading supplier of imaging solutions for human viewing (backup, surround view and night vision) and machine vision applications (ADAS – advanced driver assistance systems including lane departure warning, adaptive cruise control, pedestrian detection and more.) Recent innovations targeted at the automotive market optimize our products for these, and other emerging applications include smart headlights and driver monitoring.



### CMOS Image Sensors

| Device   | Sensor/<br>SOC | Resolution<br>(MP) | Optical<br>Format | Frame Rate  | Pixel<br>Size<br>(µm) | Shutter Type               | CFA                                 | Operating<br>Temp<br>(°C) |
|----------|----------------|--------------------|-------------------|---|-----------------------|----------------------------|-------------------------------------|---------------------------|
| AR0140AT | Sensor         | 1                  | 1/4"              | 60 fps  | 3                     | Electronic Rolling Shutter | Color                               | -40 to +105               |
| AR0132AT | Sensor         | 1.2                | 1/3"              | 1.2 45 fps, 720p 60 fps                                   | 3.8                   | Electronic Rolling Shutter | Color, Mono, RCCC                   | -40 to +105               |
| AR0135AT | Sensor         | 1.2                | 1/3"              | 60 fps @ 720p, 54 fps @ full res                          | 3.8                   | Global Shutter             | Mono                                | -40 to +105               |
| AR0138AT | Sensor         | 1.2                | 1/2.6"            | 69 fps @ 720p   | 4.2                   | Electronic Rolling Shutter | RGB, RCCC                           | -40 to +105               |
| AR0143AT | Sensor         | 1.3                | 1/4"              | 30 fps  | 3.0                   | Electronic Rolling Shutter | RGB, RCCB                           | -40 to +105               |
| AR0144AT | Sensor         | 1                  | 1/4"              | 60 fps @ 720p   | 3.0                   | Global Shutter             | Mono                                | -40 to +105               |
| AR0147AT | Sensor         | 1.3                | 1/4"              | 60 fps  | 3.0                   | Electronic Rolling Shutter | RGB                                 | -40 to +110               |
| AR0220AT | Sensor         | 1.7                | 1/1.8"            | 60 fps  | 4.2                   | Electronic Rolling Shutter | RGB, RCCC, RCCB                     | -40 to +105               |
| AR0230AT | Sensor         | 2                  | 1/3"              | 30 @ fps 1080p  | 3.0                   | Electronic Rolling Shutter | Mono, RGB                           | -40 to +105               |
| AR0231AT | Sensor         | 2.3                | 1/2.7"            | 60 fps full res @ 2 exp,<br>40 fps full res @ 3 exp       | 3.0                   | Electronic Rolling Shutter | RGB                                 | -40 to +125               |
| AR0233AT | Sensor         | 2.6                | 1/2.5"            | 60 fps  | 3.0                   | Electronic Rolling Shutter | RGB, RCCB                           | -40 to +105               |
| AR0234AT | Sensor         | 2.3                | 1/2.6"            | 120 fps   | 3.0                   | Global Shutter             | Mono, RGB                           | -40 to +85                |
| AR0237AT | Sensor         | 2.1                | 1/2.7"            | 60 fps  | 3.0                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| AR0239AT | Sensor         | 2.3                | 1/2.7"            | 30 fps @ 3 exp, 90 fps @ 1080p                            | 3.0                   | Electronic Rolling Shutter | RGB                                 | -30 to +85                |
| AR0323AT | Sensor         | 3.1                | 1/2"              | 60 fps  | 3.0                   | Electronic Rolling Shutter | RGB, RCCB                           | -40 to +105               |
| AR0820AT | Sensor         | 8.3                | 1/2"              | 40 fps  | 2.1                   | Electronic Rolling Shutter | RGB, RCCC, RCCB                     | -40 to +105               |
| ARX550AT | Sensor         | VGA                | 1/5"              | 66.37 fps @ full res                                      | 3.8                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| MT9V024  | Sensor         | WVGA               | 1/3"              | 60 fps  | 6.0                   | Global Shutter             | Color, Mono, RCCC                   | -40 to +105               |
| AS0140AT | SOC            | 1                  | 1/4"              | 60 fps  | 3.0                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| AS0142AT | SOC            | 1                  | 1/4"              | 45 fps at 1.0 MP, 60 fps at 720p                          | 3.0                   | Electronic Rolling Shutter | RGB888, RGB565,<br>YUV422 8-/10-bit | -40 to +105               |
| AS0147AT | SOC            | 1.3                | 1/4"              | 45 fps @ full res (3 exposure), 60 fps @ 720p             | 3.0                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| AS0148AT | SOC            | 1.3                | 1/4"              | 45 fps @ full res (3 exposure), 60 fps @ 720p             | 3.0                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| AS0149AT | SOC            | 1.3                | 1/4"              | 30 fps @ 1280 x 960                                       | 3.0                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| ASX340AT | SOC            | VGA                | 1/4"              | 60 fps digital, 30 fps analog                             | 5.6                   | Electronic Rolling Shutter | Color                               | -40 to +105               |
| ASX342AT | SOC            | VGA                | 1/4"              | 50/60 fps   | 5.6                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| ASX344AT | SOC            | VGA                | 1/4"              | 60 fps NTSC, 50 fps PAL interlaced,<br>60 fps progressive | 5.6                   | Electronic Rolling Shutter | RGB                                 | -40 to +105               |
| ASX350AT | SOC            | VGA                | 1/5"              | 60 fps digital, 30 fps analog                             | 3.8                   | Electronic Rolling Shutter | Color                               | -40 to +105               |



## Co-Processors for Image Sensors

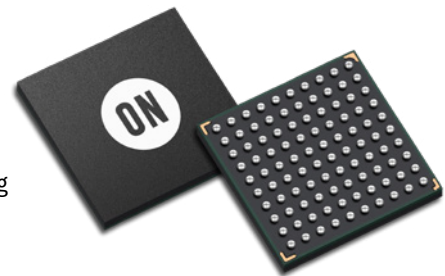
### Image Co-Processors

| Device   | Maximum Resolution | Supported Sensors                      | Frame Rate                                    | HDR with ALTm | Dewarp          | Spatial Transform Engine Software Add-on | Overlays | GPIOs   | Sensor Interfaces             | Output Interfaces         | Input Clock (MHz) | Output Clock                      | Operating Temp (°C)                              | Package   |
|----------|--------------------|--|---|---------------|-----------------|--|----------|---------|-------------------------------|---------------------------|-------------------|-----------------------------------|--|-----------|
| AP0100   | 1.2 MP             | AR0132AT, AR0140AT, ARX550AT           | 1.2 MP 45 fps 720p60                          | Yes           | Yes, Up to 165° | Yes, Multiple viewing options, PTZ       | Yes      | Up to 5 | 2-lane HiSPi, 12-bit parallel | NTSC/PAL, 16-bit parallel | 6-30              | 27 MHz (NTSC/PAL) 84 MHz parallel | -30 to +70 (CS Version) -40 to +105 (AT Version) | VFBGA-100 |
| AP0101   | 1.2 MP             | AR0132AT, AR0140AT, ARX550AT           | 1.2 MP 45 fps                                 | Yes           | No              | No                                       | No       | Up to 5 | 12-bit parallel               | 16-bit parallel           | 6-30              | 84 MHz parallel                   | -30 to +70 (CS Version) -40 to +105 (AT Version) | VFBGA-81  |
| AP0102AT | 2.0 MP             | AR0132AT, AR0140AT, AR0136AT           | 30 fps @ 1080p, 45 fps @ 1.2Mp, 60 fps @ 720p | Yes           | No              | Yes                                      | Yes      | Up to 7 | Parallel and HiSPi            | Up to 24-bit parallel     | 6-30 MHz          | 125 MHz                           | -40°C to +105°C                                  | VFBGA-100 |
| AP0200AT | 2.0 MP             | AR0132AT, AR0136AT, AR0140AT, AR0230AT | 30 fps @ 1080p, 45 fps @ 1.2Mp, 60 fps @ 720p | Yes           | No              | Yes                                      | Yes      | Up to 7 | 12-bit Parallel and HiSPi     | Ethernet-MII, RMII, GMII  | 10-29 MHz         | 125 MHz                           | -40°C to +105°C                                  | VFBGA-100 |
| AP0201AT | 2.0 MP             | AR0132AT, AR0136AT, AR0140AT, AR0230AT | 30 fps @ 1080p, 45 fps @ 1.2Mp, 60 fps @ 720p | Yes           | No              | No                                       | No       | Up to 7 | 12-bit Parallel and HiSPi     | Ethernet-MII, RMII, GMII  | 10-29 MHz         | 125 MHz                           | -40°C to +105°C                                  | VFBGA-100 |
| AP0202AT | 2.0 MP             | AR0132AT, AR0136AT                     | 30 fps @ 1080p, 45 fps @ 1.2Mp, 60 fps @ 720p | Yes           | No              | No                                       |          | Up to 7 | 12-bit Parallel and HiSPi     | Up to 24-bit Parallel     | 10-29 MHz         | 125 MHz                           | -40°C to +105°C                                  | VFBGA-100 |

### Available SOC and Co-Processor Functionality\*

- Spatial Transform Engine (STE) with dual transform support/software add-on
- Optimized for use with HDR (High Dynamic Range) sensors/HDR with ALTm
- Full auto-functions support (AWB and AE) and ALTm (Adaptive Local Tone Mapping) to enhance HDR images
- Pre-rendered graphical overlays
- Multi-camera synchronization support
- LED flicker detection and avoidance
- Dewarp, up to 165 degrees
- Overlays
- GPIOs, up to 5
- Next generation color pipe with improved noise filtering & reduced chromatic aliasing
  - Demosaic
  - Gamma correction
  - Auto white balance
  - Defect correction
  - Noise reduction
  - Auto exposure

\* See product information for device-specific functionality.



### Modular Automotive Reference System

The Modular Automotive Reference System (MARS) is a complete imaging solution for camera system developers and software developers working on automotive imaging applications. MARS gives engineers and software developers the fundamental building blocks needed to create next generation imaging systems, while reducing the design effort and resources required to develop a working solution.

Using the modular mix & match approach offered by this unique compact form factor platform, designers can bring together different combinations of image sensors, co-processors (Image Signal Processor) and communication standards. The component boards have consistent signal/power interconnect definitions to enable users to swap individual boards, creating a wide range of options for experimenting, while eliminating the need for constructing custom boards. The result is a highly flexible solution where the various modules are fully interchangeable.

For videos, tools and more information visit [www.onsemi.com/MARS](http://www.onsemi.com/MARS)

#### Features

- Ready to use camera solution
- Compact form factor
- Modular and interchangeable building blocks
- Supported by comprehensive ecosystem
  - Software development platforms
  - Lens partners
  - Schematic, gerbers, BOM

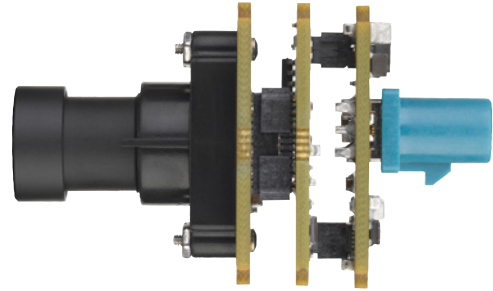
#### Benefits

- Accelerates development cycles
- Reduces need for technical resources
- Reduces development costs
- Eliminates redundant work



## Modular Automotive Reference System

- ADAS
- Autonomous driving
- Viewing systems
- Backup cameras
- Surround view systems
- Electronic mirrors
- In-cabin cameras for
  - Gesture recognition
  - Driver eye monitoring
  - Light level inspection



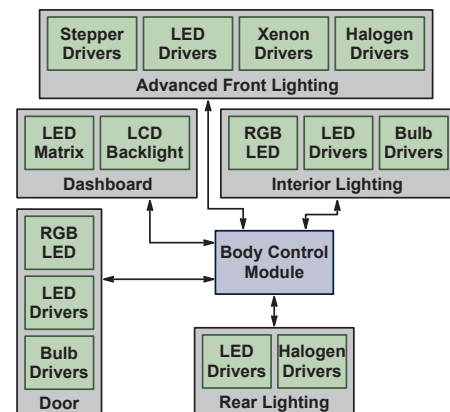
### Individual MARS Board Order Descriptions

| Sensor Board OPNs        | Short Description                          | Sensor Board Description   |
|--------------------------|--|--|
| MARS1-AR0230ATS-GEVB     | 2.1 MP, 1/2.7" MARS Sensor Board           | MARS sensor board with 2.1 MP, 1/2.7" high-dynamic range color AR0230AT image sensor   |
| MARS1-AR0231AT6-GEVB     | 2.3 MP, 1/2.7" MARS Sensor Board           | MARS sensor board with 2.3 MP, 1/2.7" high-dynamic range color AR0231AT image sensor with LED Flicker Mitigation and BSI pixel technology for superior low-light performance |
| MARS1-AR0132AT6-GEVB     | 1.2 MP, 1/3" MARS Sensor Board             | MARS sensor board with 1.2 MP, 1/3" high-dynamic range color AR0132AT image sensor   |
| MARS1-AR0136AT3-GEVB     | 1.2 MP, 1/3" MARS Sensor Board             | MARS sensor board with 1.2 MP, 1/3" high-dynamic range color AR0136AT image sensor and BSI pixel technology  |
| MARS1-AR0140AT3-GEVB     | 1.0 MP, 1/4" MARS Sensor Board             | MARS sensor board with 1.0 MP, 1/4" high-dynamic range color AR0140AT image sensor   |
| MARS1-AR0135AT2-GEVB     | 1.2 MP, 1/3" MARS Sensor Board             | MARS sensor board with 1.2 MP, 1/3" global shutter AR0135AT image sensor with high global shutter efficiency and superior NIR performance                                    |
| Co-Processor Board OPNs  |  | Image Co-Processor Description   |
| MARS1-AP0200AT2-GEVB     | Up to 2.0 MP MARS Image Co-processor Board | MARS Image Co-Processor (ICP)AP0200AT High-Dynamic Range (HDR) ICP with built-in MJPEG and H.264 encoder and Ethernet-MII, RMII, GMII output interface                       |
| MARS1-AP0202AT2-GEVB     | Up to 2.0 MP MARS Image Co-processor Board | MARS Image Co-Processor (ICP) with AP0202AT High-Dynamic Range (HDR) ICP with parallel output  |
| MARS1-AP0100AT2-GEVB     | Up to 1.2 MP MARS Image Co-processor Board | MARS Image Co-Processor (ICP) with AP0100AT High-Dynamic Range (HDR) ICP with sophisticated lens distortion correction and integrated video encoder for NTSC/PAL output      |
| MARS1-AP0101AT2-GEVB     | Up to 1.2 MP MARS Image Co-processor Board | MARS Image Co-Processor (ICP) with AP0101AT High-Dynamic Range (HDR) ICP and parallel output   |
| MARS1-AP0102AT2-GEVB     | Up to 1.2 MP MARS Image Co-processor Board | MARS Image Co-Processor (ICP) with AP0102AT High-Dynamic Range (HDR) ICP with sophisticated lens distortion correction and parallel output                                   |
| Serializer OPNs          |  | Serializer Description   |
| MARS1-TI913-GEVK         | MARS Serializer Board                      | Texas Instruments DS90UB913 Parallel to LVDS FPD-Link Serializer   |
| MARS1-MAX96705-GEVB      | MARS Serializer Board                      | Maxim MAX96705 Parallel to LVDS GMSL Serializer  |
| Deserializer OPNs        |  | Deserializer Description   |
| MARS1-TI914              | MARS Deserializer Board                    | Texas Instruments DS90UB914 LVDS to Parallel FPD-Link Deserializer   |
| MARS1-MAX9706            | MARS Deserializer Board                    | Maxim MAX96706 LVDS to Parallel GMSL Deserializer  |
| Ethernet PHY OPNs        |  | Ethernet PHY Description   |
| MARS1-KSZ8081MNX-GEVB    | MARS Ethernet PHY Board                    | MARS Micrel KSZ8081MNX-GEVB Ethernet PHY Board   |
| Demo3 Adapter Board OPNs |  | Demo3 Adapter Board Description  |
| MARS1-DEMO3-ADAPTER-GEVB | MARS Parallel to Demo3 Adapter             | MARS Adapter for adapting the parallel serializer boards into Demo3 Demo Kit Tool  |
| Demo3 Board OPNs         |  | Demo3 Board Description  |
| AGB1NOCS-GEVK            | Demo3                                      | Demo3 Demo Kit Tool  |

## Automotive Lighting Systems



ON Semiconductor offers standard products and custom devices for automotive lighting applications. The company plays a prominent role in the market for Xenon driver ASICs, developed the defacto standard stepper driver for headlight leveling and swiveling, and is a leader in LED exterior lighting solutions.



## Front Lighting

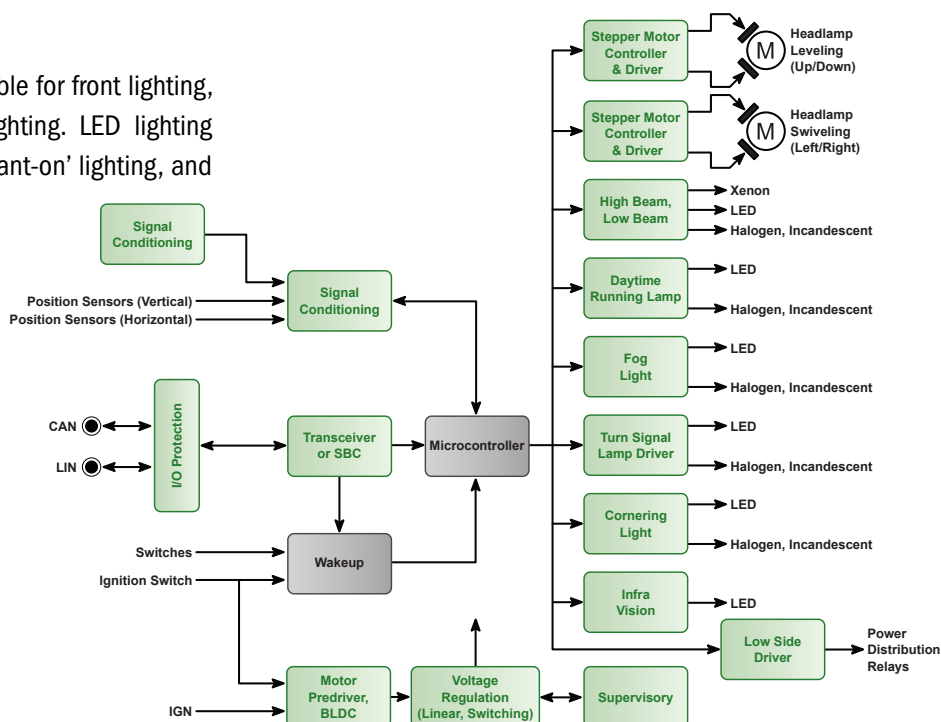
The majority of automobiles on the road today are equipped with halogen lights for the high-beam (HB) and low-beam (LB) functions - the main front lighting functions. Halogen LB typically consumes 55 W, and provides ~1,000 lumen. HID technology - introduced over ten years ago - consumes 35 W, and provides ~3,500 lumen. Because of the high intensity and risk of glare to approaching traffic, some countries require automatic leveling of the LB, plus a high pressure cleaning device.

visibility in curves, and Adaptive Driving Beam (ADB), to adapt the beam to real-time situations. Stepper motors provide the primary controls for AFS and ADB.

ON Semiconductor offers a full range of products, from generic bulb driver solutions to stepper drivers, LED drivers, and Xenon drivers, that are specifically designed for front lighting.

While halogen technology continues to be viable for front lighting, automotive designs increasingly use LED lighting. LED lighting offers enhanced styling options, enables 'instant-on' lighting, and allows brightness control from 0% to 100% power.

Another important aspect for automotive front lighting is beam swiveling for Advanced Frontlighting Systems (AFS), to optimize the





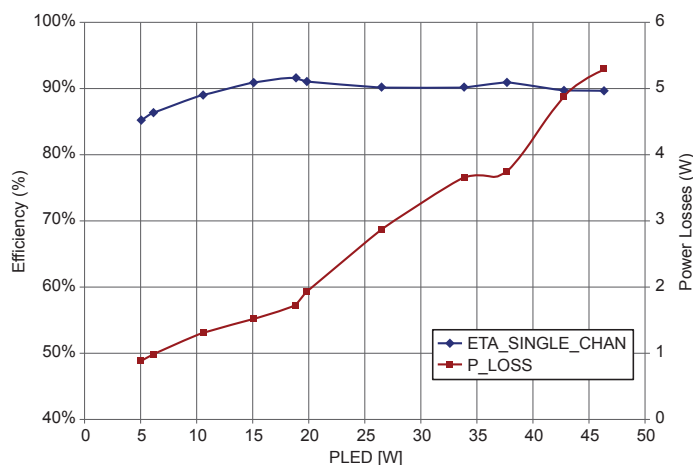
## Front Lighting – Power Ballast and Dual LED Driver for Advanced LED

The NCV78763 single-chip, intelligent LED driver for front lighting enables single-module control of high beams, low beams, daytime running lights, position lights, cornering lights, turn indicators, and fog lights. With integrated digital dimming, SPI

programmable settings, and build-in diagnostics, the NCV78763 offers integrated, energy efficient solutions for comprehensive front lighting control.

## Features – NCV78763

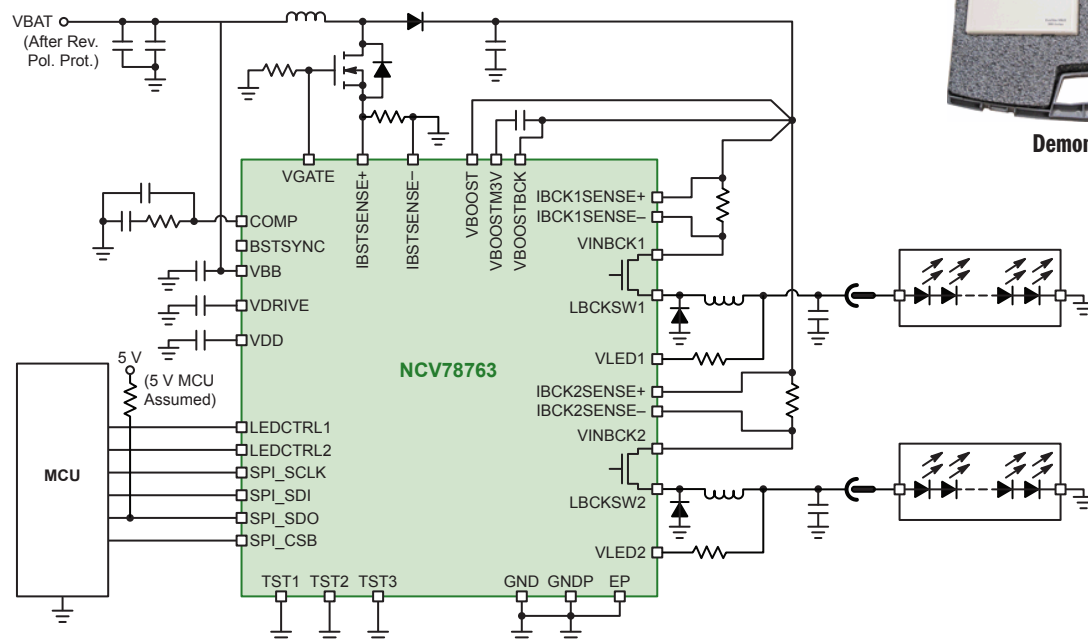
- System integrated solution with few external components.
- Buck-boost topology
- LED current regulator
  - Constant average current
  - Efficient integrated buck switches (high-side)
  - Current per output up to 1.6 A
  - Extended diagnostics: detection of open circuit or failing driver, short, over-current protection, single LED failures
  - Thermal protection
- System customization by SPI interface
  - Multiple system configurations with one device
  - Fewer module versions for OEM
- Better EMC behavior, without extra filtering
  - Low EMC from battery
  - Low EMC to LED string
- High overall efficiency (>90%)



## NCV78763 Demonstration Board Efficiency



## Demonstration Kit

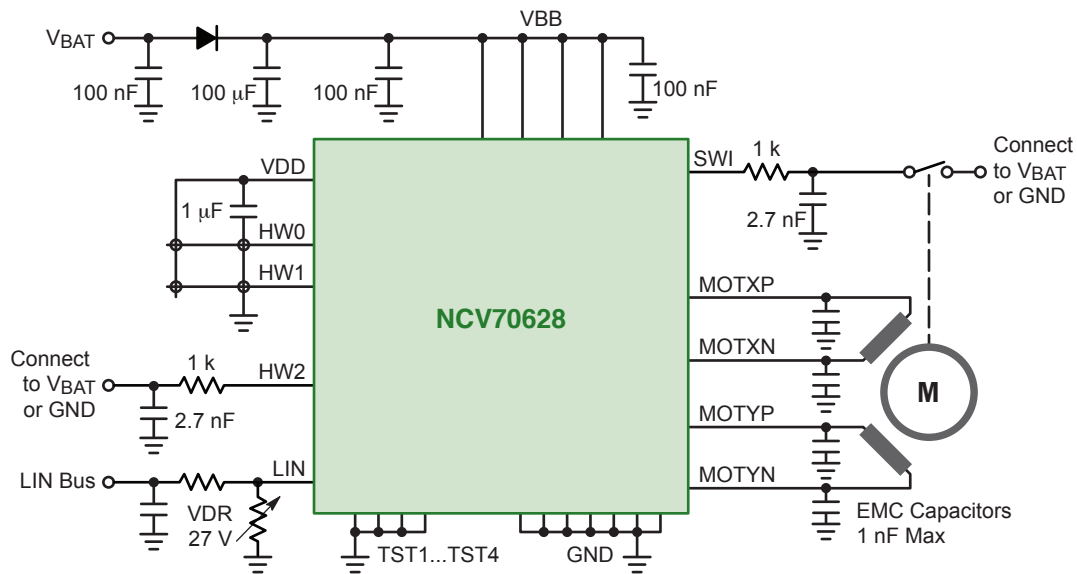


## NCV78763 Application Diagram

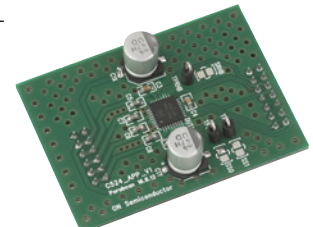
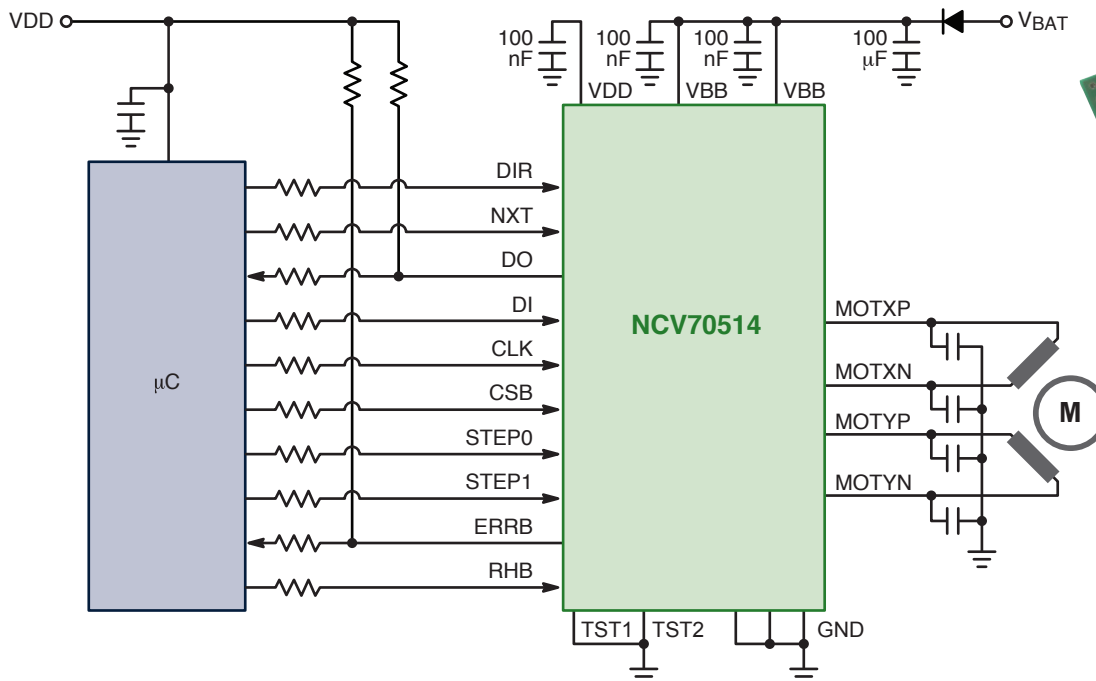


## Front Lighting – Leveling and Swiveling

The NCV70628 is a single-chip micro-stepping motor driver with position controller and control/diagnostic interface, making it ideal for dedicated mechatronics solutions, connected remotely through a LIN master.



The NCV70514 is a micro-stepping motor driver that is fully compatible with automotive voltage requirements, and is especially well-suited for use in applications with fluctuating battery supplies.



**Evaluation Board  
NV705143R1DBGVB**

## Front Lighting – Small Signal Solutions for Pixel (Matrix) Control

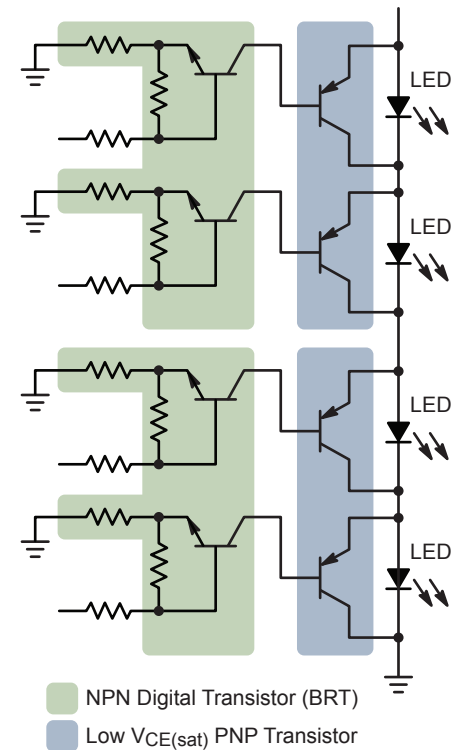
Today's adaptive front lighting systems (AFLS) utilize a combination of sensors, motors, and a LED matrix to adjust the direction and intensity of the light beam. One AFLS method involves blanking of certain LED strings within the matrix, which can be controlled by a combination of small signal components such as Low  $V_{CE(sat)}$  bipolar transistors and digital transistors (BRT – bias resistor transistor).

The collector of the NPN digital transistor is connected to the base of the Low  $V_{CE(sat)}$  PNP transistor, thereby forming an ultra-low saturation voltage ( $V_{CE(sat)}$ ) and high current gain capability of the combination. The high current gain allows this combination to be driven directly from an MCU or PMU's control outputs, reducing overall system complexity and cost.



### Features

- AEC-Q101 discrete & Mixed Element Array (MEA) components
- Low  $V_{CE(sat)}$  ensures shunting of LED
- Simplifies circuit design & reduces component count
- PCB space saving with 2 mm x 2 mm wettable flank DFN packaging



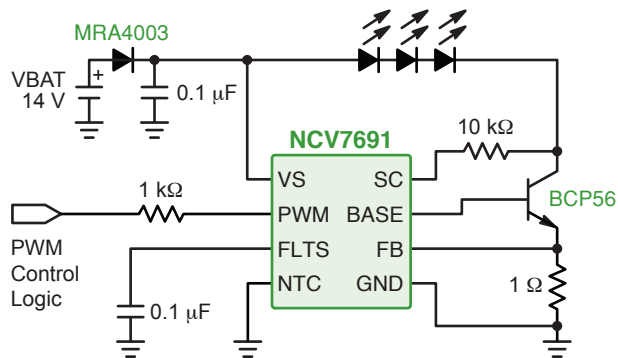
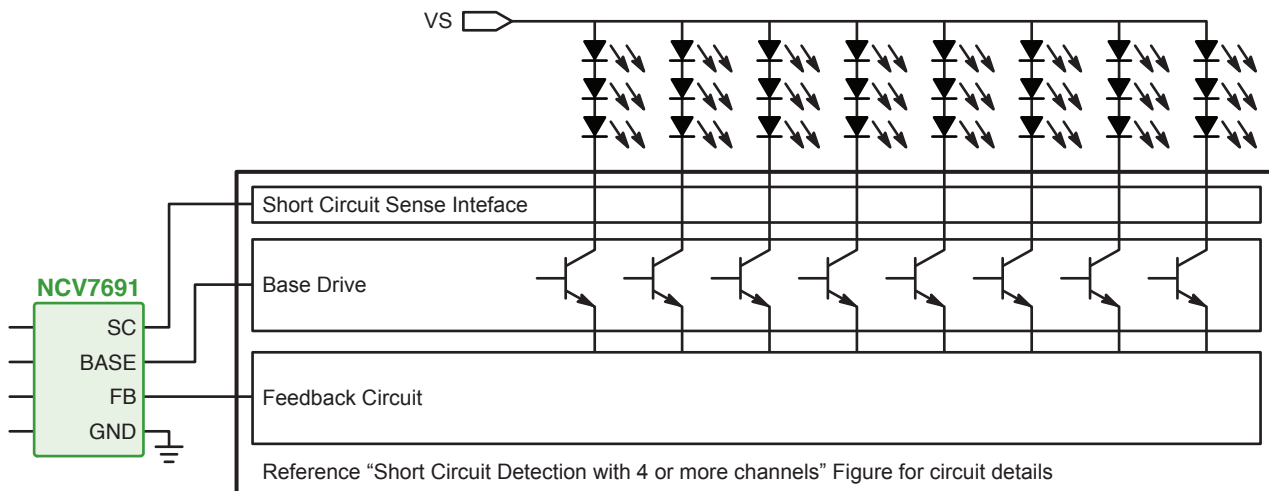
| Device       | $V_{CE0}$<br>(V) | $I_C$<br>(A) | $V_{CE(sat)}$<br>(V) | Description   | Package(s)      |
|--------------|------------------|--------------|----------------------|---|-----------------|
| NSV60100DMTW | -60              | 1.0          | -0.35                | 60 V, 1 A Dual PNP Low $V_{CE(sat)}$ BJT            | WDFN-6 WF       |
| NSV60200DMTW | -60              | 2.0          | -0.45                | 60 V, 2 A Dual PNP Low $V_{CE(sat)}$ BJT            |                 |
| NSV20200DMTW | -20              | 2.0          | -0.39                | 20 V, 2 A Dual PNP Low $V_{CE(sat)}$ BJT            |                 |
| NSVMUN5214D  | 50               | 0.1          | 0.25                 | Dual NPN BRT, R1 = 10k $\Omega$ , R2 = 47k $\Omega$ | SC-88 (SOT-363) |

## RCL, DRL, CHMSL Lighting – Linear LED Pre-Driver

NCV7691 and NCV7692 are pre-drivers intended for linear drive of LEDs. They can operate from the car battery, and multiple LED strings can be driven by a single device.

### Features

- NCV7691 Open Load detection threshold level: 9.5 V rising, 8.8 V falling
- NCV7692 Open Load detection threshold level: 5.1 V rising, 4.95 V falling
- Constant Current Output for LED String Drive External Programming Current Resistor
- Wide Current Range using External Bipolar Device
- Multiple LED String Control
- Pulse Width Modulation (PWM) Control
- Negative Temperature Coefficient (NTC) Current Control
- Open LED String & Short-Circuit LED String Diagnostic
- Overvoltage Set Back Power Limitation





*For Rear Combination Lamps, Daytime Running Lights, Fog Lights, CHMSLs, Turn Signals*

- Allow for 128 duty cycle levels, adjustable with I2C-programmable PWM
- 3.3 V voltage reference for loads up to 1 mA
- OTP bank for stand-alone operation (2 configurations)



- Allow for two programmed levels for Stop and Tail illumination, or optional external PWM
- Slew rate control to eliminate EMI concerns
- Sequencing functionality

| Device  | Channels | V <sub>I</sub> Max (V) | I <sub>O</sub> Max (mA) | Max LEDs in Series | Max LEDs in Parallel | Package(s)    |
|---------|----------|------------------------|-------------------------|--------------------|----------------------|---------------|
| NCV7683 | 8        | 40                     | 200                     | 4                  | 24                   | SSOP-24 NB EP |
| NCV7685 | 12       | 40                     | 60                      | 4                  | 12                   | SSOP-24 NB EP |

Interior Lighting and Center High Mount Stop Lamp (CHMSL) – Constant Current Regulators

The two-terminal linear constant current regulators (CCRs) are simple, economical, and robust devices that provide an effective solution for regulating current in cost-sensitive LED applications. The devices require no external components, allowing them to be implemented as high or low-side regulators. These

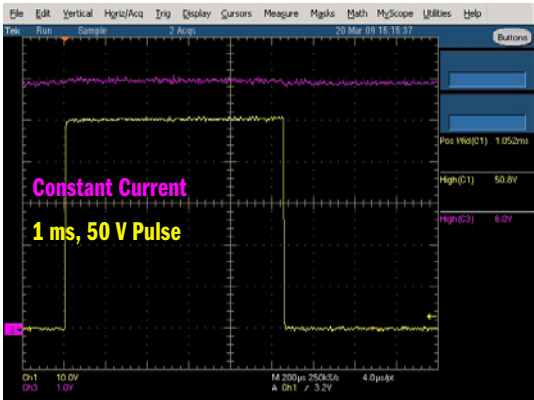
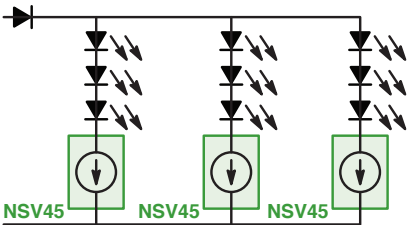
devices regulate output current over a wide range of input voltage, and are designed with a negative temperature coefficient to protect LEDs from thermal runaway at extreme voltage and operating temperature.

Features

- Regulated current provides constant brightness over wide voltage range
- Negative temperature coefficient protects LEDs in high ambient conditions
- Available with multiple maximum operating voltages (45 V, 50 V, and 120 V) to withstand battery load dump

Resources

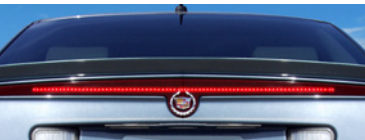
- Sample Kit: CCR2KIT/S



Constant Current Supply During Vehicle Battery Load Dump

| Device    | Max Anode-to-Cathode Voltage (V <sub>AK</sub> ) (V) | Voltage Overhead (V <sub>in</sub> - V <sub>LEDs</sub> ) (V) | Constant Current I <sub>reg</sub> (@ V <sub>AK</sub> = 7.5 V) (mA) | Current Tolerance Over Voltage | Max Junction Temperature (°C) | Packages         |
|-----------|---|---|--|--------------------------------|-------------------------------|------------------|
| NSV45xxx  | 45  | 1.8   | Fixed: 15, 20, 25, 30  | ±15%, ±10%                     | 150                           | SOD-123, SOT-223 |
| NSV50xxx  | 50  | 2.0   | Fixed: 10, 350   | ±10%                           | 175                           | SMC, DPAK        |
| NSVC20xx  | 120   | 1.8   | Fixed: 20, 30, 50  | ±15%                           | 175                           | SMB              |
| NSV45xxxJ | 45  | 1.8   | Adjustable: 20 to 40, 35 to 70, 60 to 100, 90 to 160, 150 to 350   | ±15%                           | 150                           | SOT-223, DPAK    |

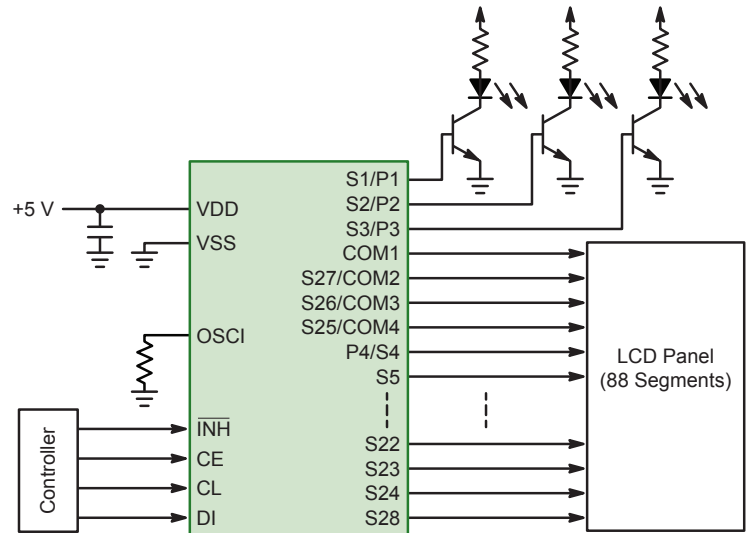
NOTE: xxx in the device number represents the current level.



## LCD Drivers for Information Display Panels

### Features

- LCD driver (common drive and segment drive) controlled by external microprocessor
- Serial data input supports CCB format communication
- Many additional functions around the display application
  - Key input function
  - LED driver output port
  - General purpose output port
  - PWM output function for brightness adjustment of the backlight
  - LCD display contrast adjustment
- Wide operating temperature ( $T_A = -40$  to  $+85/+105\text{ }^{\circ}\text{C}$ )



LC75843 Application Diagram, 1/4 Duty, 3-Channel PWM

### LCD Drivers

| Device  | Segments*                    |                              |                              | V <sub>DD</sub><br>(V) | Interface Voltage<br>(V) | V <sub>LCD</sub><br>(V) | Output<br>Ports | PWM<br>Channels | Package(s) |
|---------|------------------------------|------------------------------|------------------------------|------------------------|--------------------------|-------------------------|-----------------|-----------------|------------|
|         | Static, 1/2 Duty             | 1/3 Duty, 1/4 Duty           |                              |                        |                          |                         |                 |                 |            |
| LC75843 | 24 to 28, 46 to 54           | 66 to 78, 84 to 100          |                              | 4.0 - 6.3              | 3.3 or 5.0               | V <sub>DD</sub>         | 4               | 3               | TSSOP-36   |
|         | 1/3 Duty                     | 1/4 Duty                     |                              |                        |                          |                         |                 |                 |            |
| LC75829 | 147 to 159                   | 192 to 208                   |                              | 4.5 - 6.0              | 3.3 or 5.0               | V <sub>DD</sub>         | 4               | —               | SQFP-64    |
| LC75806 | 198 to 231                   | 260 to 304                   |                              | 4.5 - 6.0              | 3.3 or 5.0               | V <sub>DD</sub>         | 9               | —               | TQFP-100   |
|         | 1/8 Duty                     | 1/9 Duty                     | 1/10 Duty                    |                        |                          |                         |                 |                 |            |
| LC75818 | Dot matrix (5 x 7) x 16 + 80 | Dot matrix (5 x 8) x 16 + 80 | Dot matrix (5 x 9) x 16 + 80 | 2.7 - 3.6              | 3.3 or 5.0               | 4.5 - 10.0              | 4               | —               | TQFP-120   |
| LC75812 | Dot matrix (5 x 7) x 13 + 65 | Dot matrix (5 x 8) x 12 + 64 | —                            | 2.7 - 3.6              | 3.3 or 5.0               | 4.5 - 10.0              | 3               | 3               | TQFP-100   |
|         | Static, 1/2 Duty             | 1/3 Duty, 1/4 Duty           | LED Driver                   |                        |                          |                         |                 |                 |            |
| LC75805 | 38, 74                       | 108, 140                     | 48 channel                   | 4.5 - 5.5              | V <sub>DD</sub>          | V <sub>DD</sub>         | —               | 7               | QIP-100E   |

\* Number of segments depends on 'common v segment' configuration.



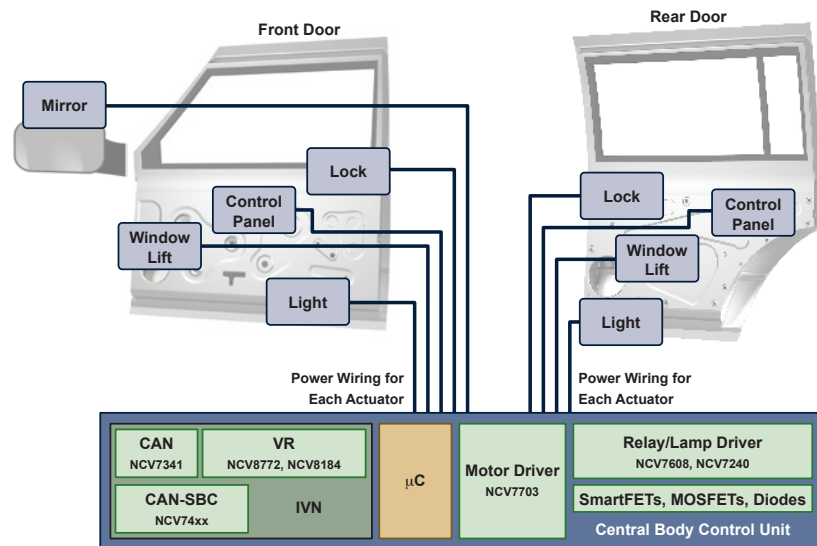
## Door Electronics Systems

Door electronics are prevalent in modern vehicles, with most automobiles containing electronic window lifts and central locks. Additional safety features, like pinch protection and child-proof locks, increase the electronic content in door modules. Additional available features include side mirror positioning, folding, and defrosting; and for high-end models, electrochromic mirror control, that darkens the mirror depending on the brightness of the irradiated beam of oncoming traffic. Some lamp applications, like flashers in the mirror or some LEDs for interior lights, are also being adopted.

There are different door electronic topologies available:

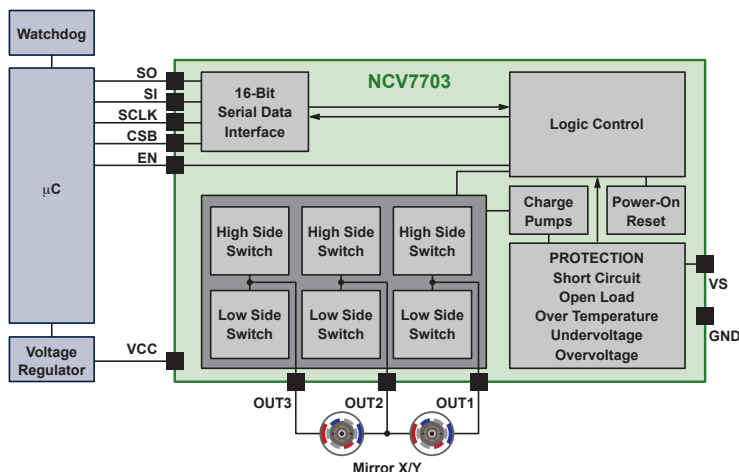
- Centralized door electronics
- De-centralized door electronics
- Mixed door electronics

### Centralized Door Electronics System



The most common topology is centralized electronics, where the electronics system is implemented in the Body Control Unit (BCU). ON Semiconductor offers:

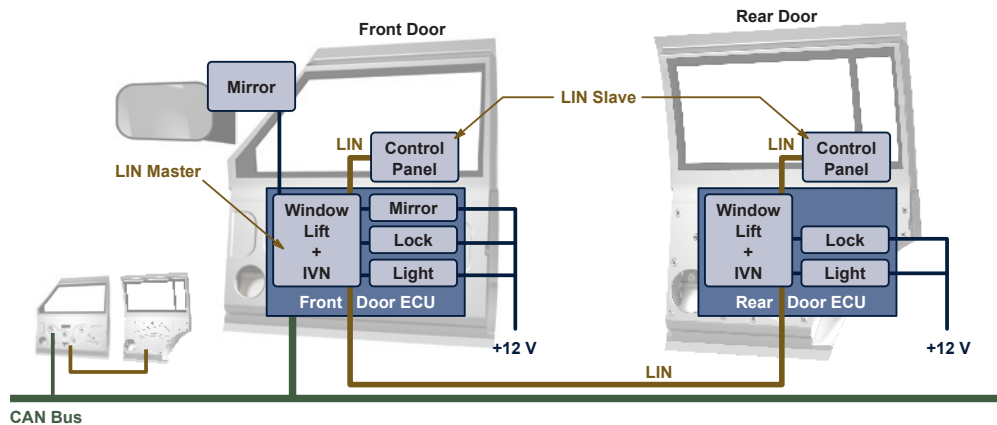
- In-Vehicle-Networking - CAN transceivers, LIN transceivers, system-basis-chips
- Voltage regulators
- Load drivers for motors, lamps, and relay controls
- Logic functions
- Discrete components - diodes, transistors, protection devices



For mirror positioning, two motors adjust the glass along x and y axes. The NCV7703 features three integrated half-bridge drivers. The output stages are controlled by a 16-bit SPI interface. Complete diagnostic information is provided to the microcontroller through the SPI.

## Door Electronics Systems

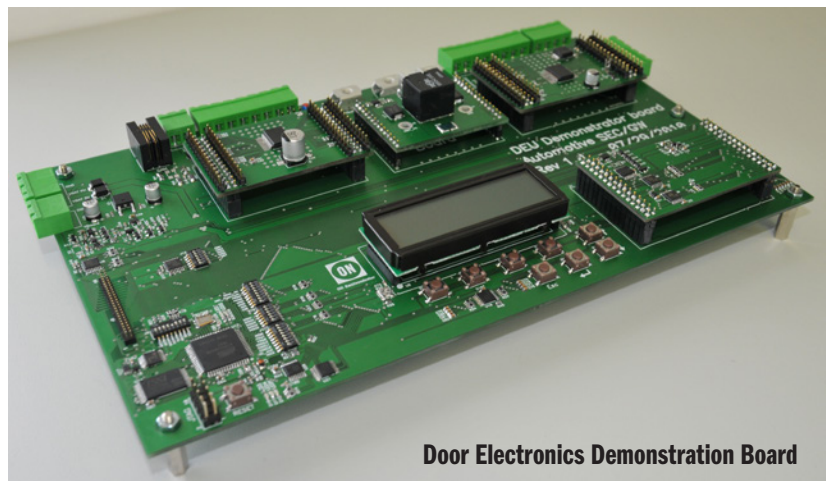
### De-Centralized Door Electronics System



As the electronics content becomes more complex, the large amount of wires drives designs toward a de-centralized topology. The de-centralized door modules communicate over a CAN or LIN bus system.

Benefits of de-centralized door module topologies:

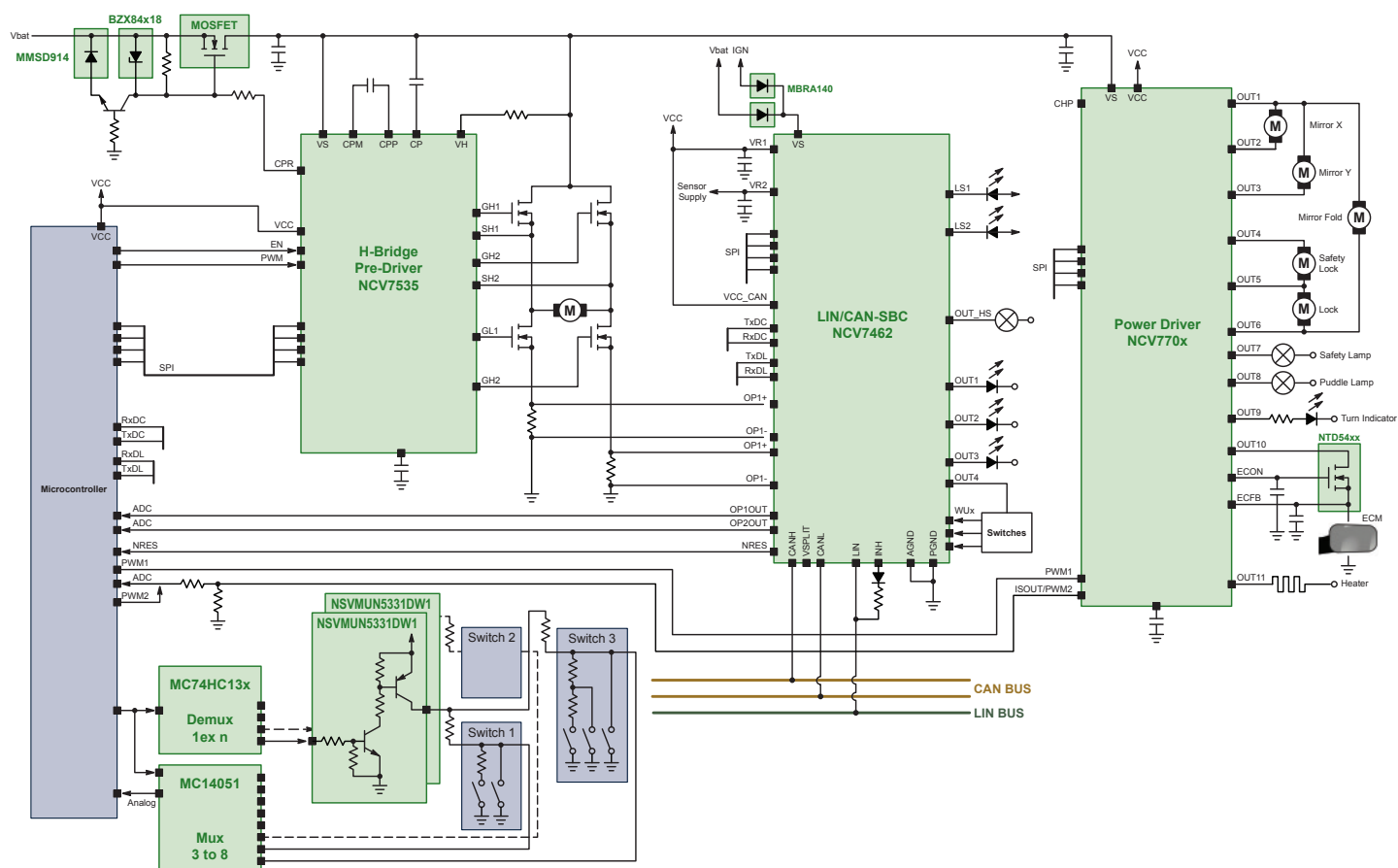
- Reduced use of wiring harness
- Reduced weight and power consumption positively impact fuel consumption
- Enables modular architectures through use of sub-modules





## Solution for De-Centralized Front Door Electronics Systems

ON Semiconductor supplies ASSPs for door module electronics, including CAN- and LIN-enabled SBCs designed specifically for door modules. Smart Power BCD Technology enables the integration of powerful driver stages, that may be used for door locks, mirror folding and heating, and lamp drivers. The integration of complex state machines and PWM control units creates components that are flexible enough to drive different types of lamps and motors. Standard products like multiplex devices, amplifiers, MOSFETs, bus and supply protection components, allows ON Semiconductor the opportunity to support complete customer designs.



## Control, Communication, and Power for Body HVAC

*The HVAC system includes several subsystems*

### Vehicle heating & ventilation systems

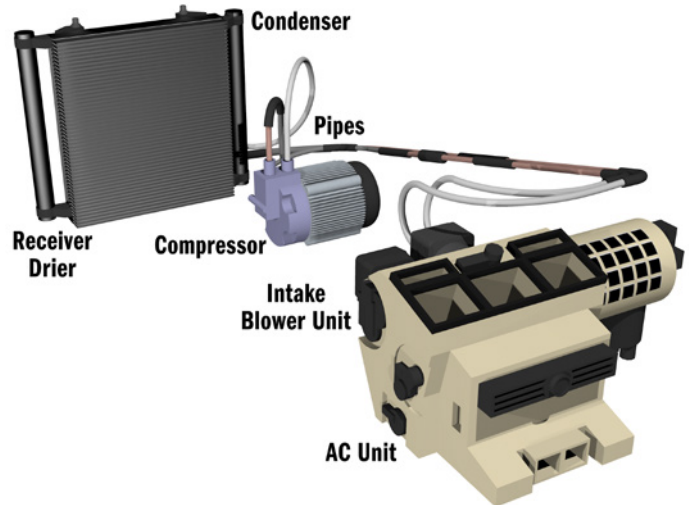
To improve passenger comfort and safety, fresh air is drawn from outside ducts and directed to the passenger compartment. Incoming air can be heated by passing over a small heating core connected to the engine's cooling system.

### Air conditioning refrigerant

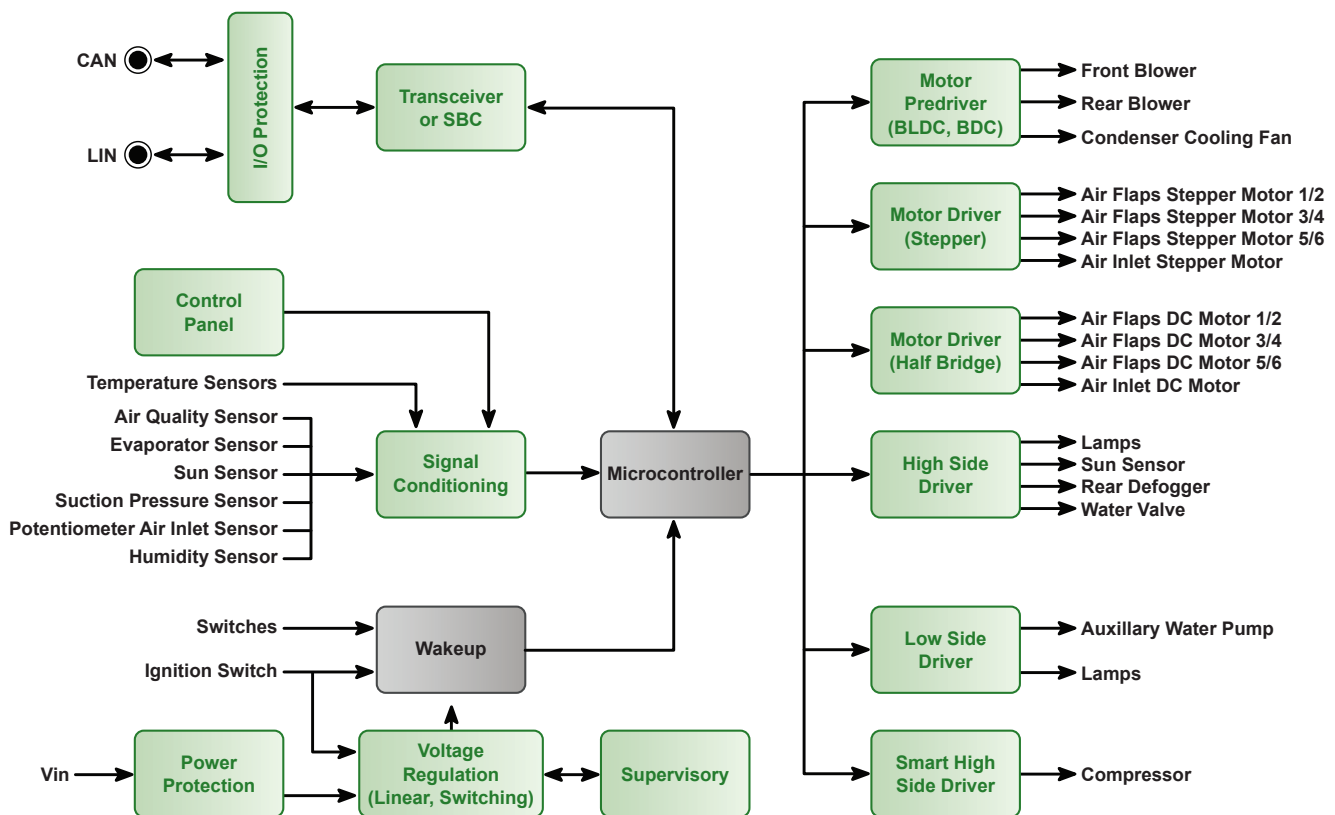
The refrigerant removes heat from the vehicle interior and transfers it to the outside air in a continuous cycle of vaporization and condensation. Reducing the temperature of the air also reduces its humidity. Cold air will not hold as much water vapor as warm air.

### Control head

ECU (Electronic Control Unit) with user interface.



Interior Air Conditioning Unit



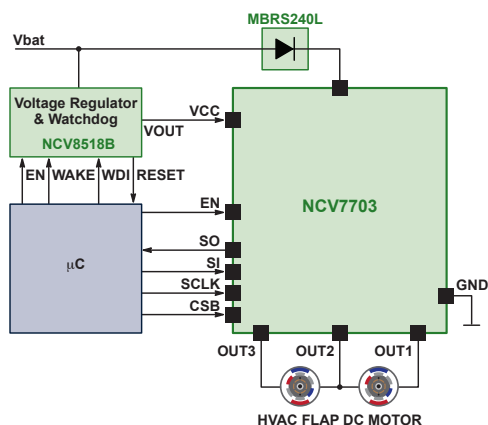
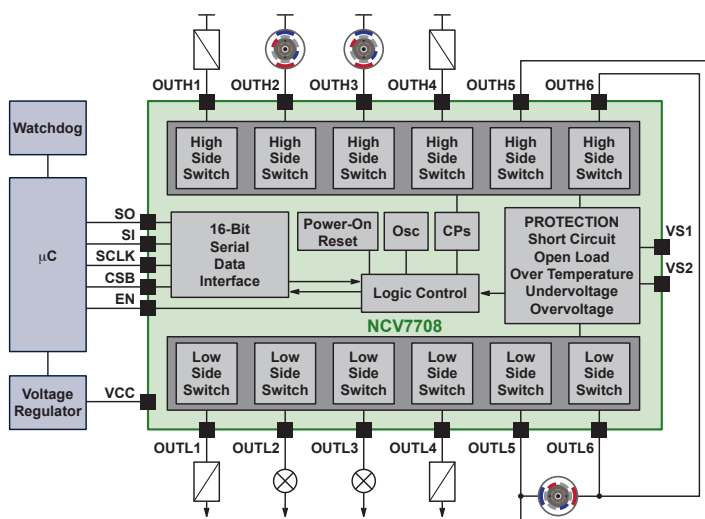
## DC Motor Drivers for Body HVAC

The most popular flap actuators are simple DC motors with position signal feedback to the microcontroller. To control a DC motor in forward and reverse direction, two high-side and two low-side power stages are necessary, in full-bridge configuration. Typically, these drivers integrate required features such as overvoltage, overload, and over temperature protection. In addition, the SPI interface provides diagnostics to the microcontroller.

Integrated pulse count technology combined with an extra signal conditioning block replaces the discrete position potentiometer. In pulse count applications, the circuit detects the DC motor commutation pulses and creates a pulse for every detected commutation pulse. These pulses are generally fed back to a microcontroller for position sensing and control. ON Semiconductor has custom ASICs for these types of circuits, in production today.

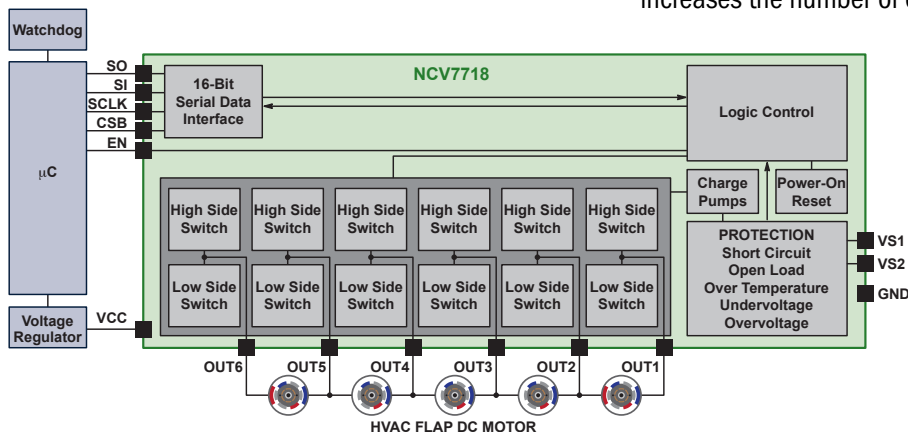
### Dual Hex High/Low-Side Driver

The NCV7708 is a flexible, single sided high/low-side driver. The six high and low-side channels are specifically designed for motor control configurations, like half or full bridges. NCV7708 will control five DC motors via a 16-bit SPI interface. The device can also control relays or LEDs.



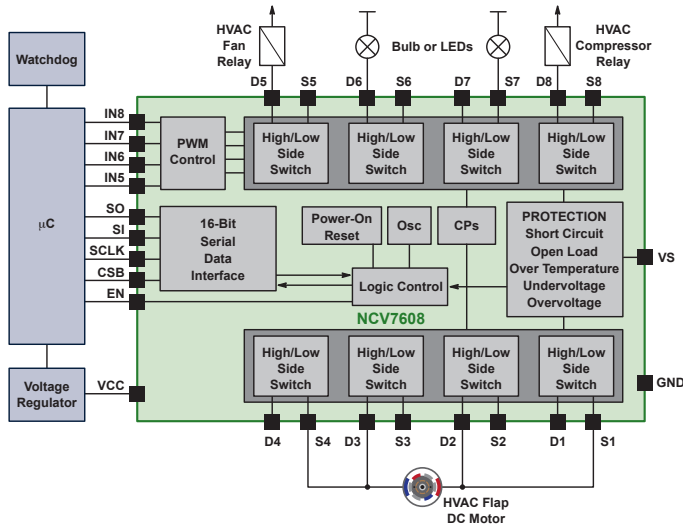
### Half-Bridge Drivers

NCV7703 triple half-bridge driver controls two DC Motors. The power stages are internally connected as half-bridges, which allows a pin-count reduction to the SOIC-14 package. NCV7718 hex half-bridge driver controls up to 5 DC motors, and is offered in the SSOP-24 package. NCV7719 and NCV7720 increases the number of outputs to 8-channel and 10-channel, respectively.

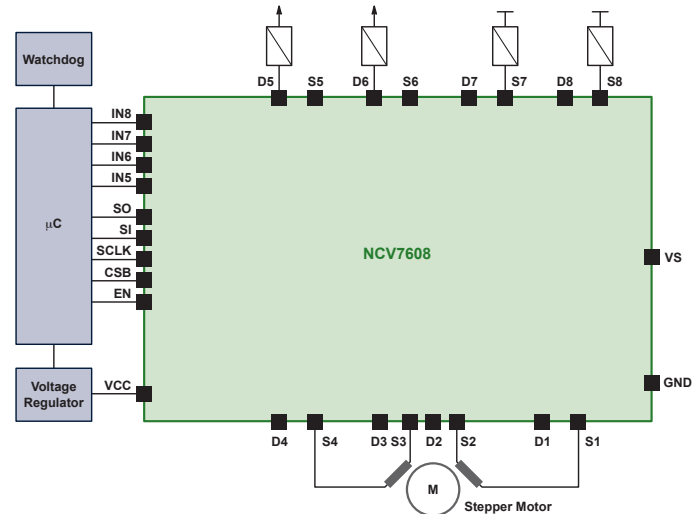


## Configurable Motor, Relay, and LED Driver for Body HVAC

The NCV7608 drives different types of motors and various loads, such as bulbs, LEDs, and relays. The eight integrated output drivers are configurable in any combination of high-side, low-side, or half-bridge. This enables connection to DC, unipolar, or bipolar stepper motors. In addition, four channels include external PWM control capability. NCV7608 includes a special diagnostic current disable bit to prevent LED-glowing, as well as standard diagnostic features.

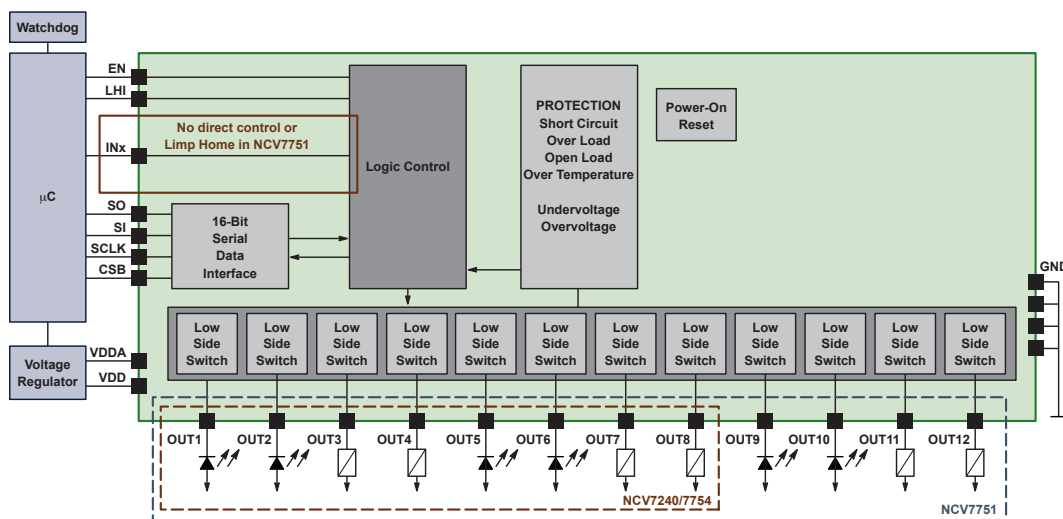


**Highest Flexibility with NCV7608**



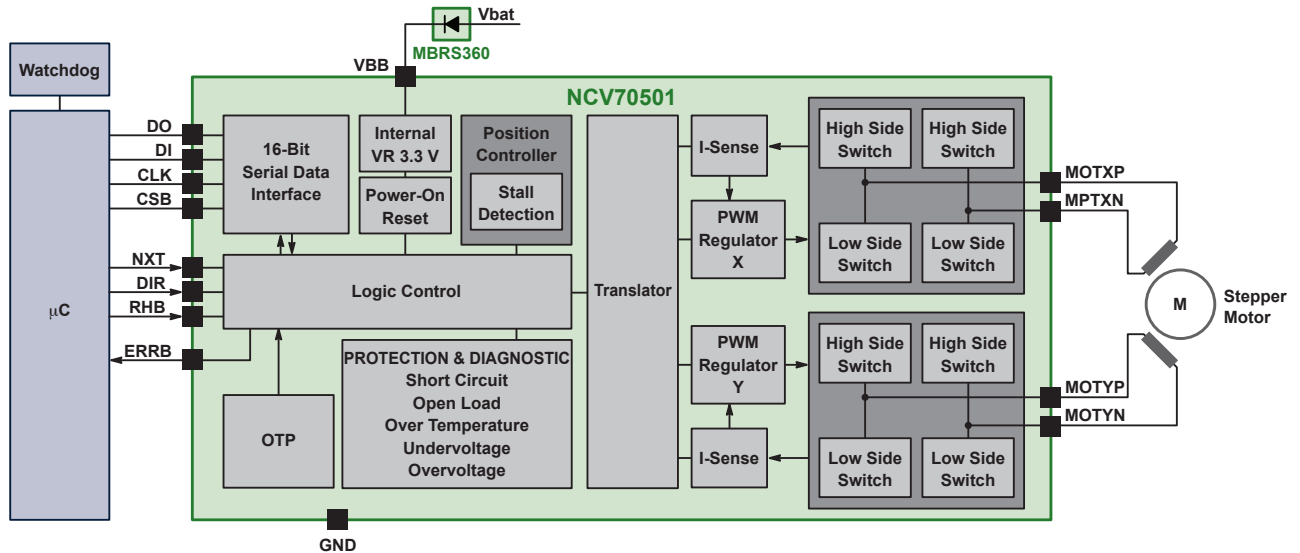
**NCV7608 Supports Unipolar and Bipolar Stepper Motor Control**

The NCV7240 and NCV7754 eight channel low-side drivers, and NCV7751 twelve channel low-side driver, provide drive capability up to 600 mA per channel. Output control via SPI port offers convenient reporting of faults. Additionally, parallel control of the outputs is addressable (in pairs) via the INx pins. A dedicated limp-home mode pin (LHI) enables OUT1-OUT4 while disabling OUT5-OUT8. The devices are able to drive loads like LEDs, relays, or unipolar stepper motors.

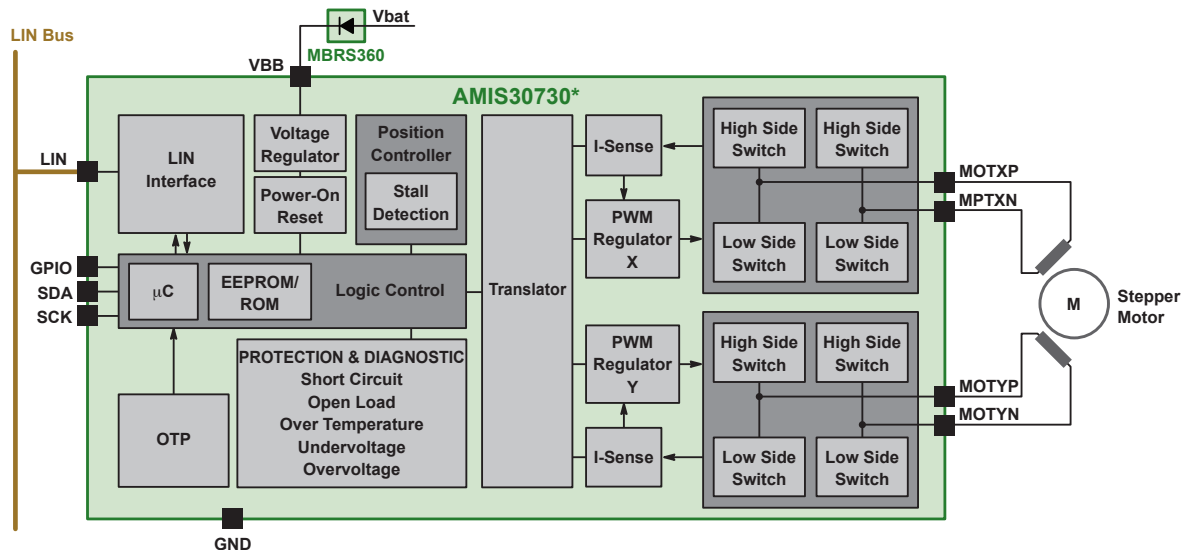


## Bipolar Stepper Motor Drivers for HVAC

In climate control systems unipolar and bipolar stepper actuators are used. For unipolar solutions the control electronic is more simple compared to bipolar ones. Instead of four low-side switches for unipolar motors, the bipolar requires two full-bridges.



Air-inlet flaps require low acoustic noise because the actuator operates in a continuous manner. Low acoustic noise can be achieved by using stepper motors, such as the NCV70501 micro-stepping stepper motor driver for bipolar stepper motors. NCV70501 controls the current through the windings of the bipolar stepper motor, contains a current-translation table and takes the next micro-step depending on the clock signal on the “NXT” input pin and the status of the “DIR” (=direction) register or input pin. An external microcontroller can work in interrupt mode, so there is no need to monitor the status registers continuously.



\* Customer specific embedded software

AMIS-30730 is a single-chip platform for intelligent stepper motor drivers with embedded microcontroller and LIN interfaces. The device may be customized with embedded software for dedicated mechatronic solutions connected remotely with a LIN master.

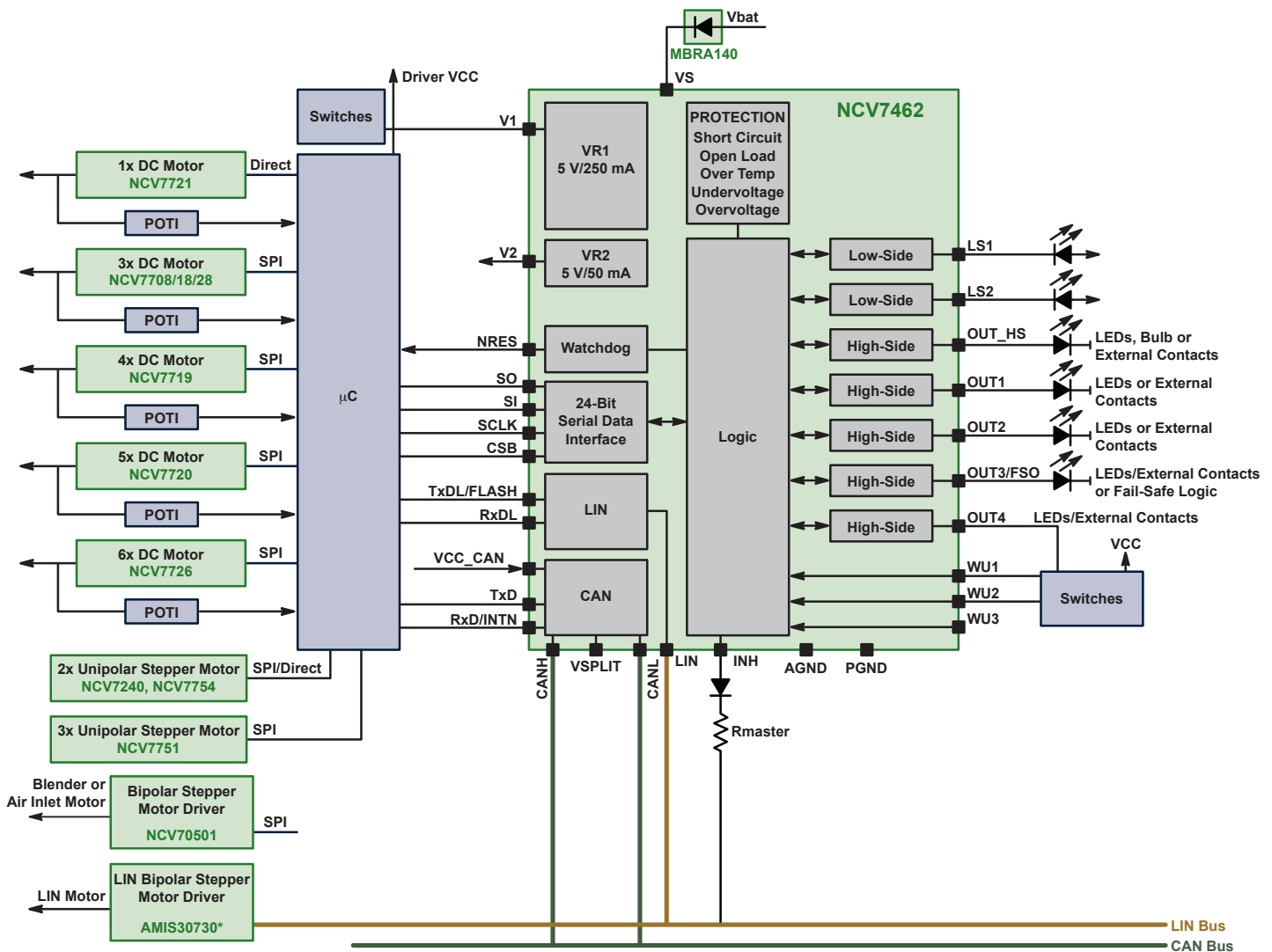


## Air Flap Actuator Driver Topologies for HVAC

Climate control systems may operate with different system topologies - driven by the different regional and OEM requirements.

### Actuator Types

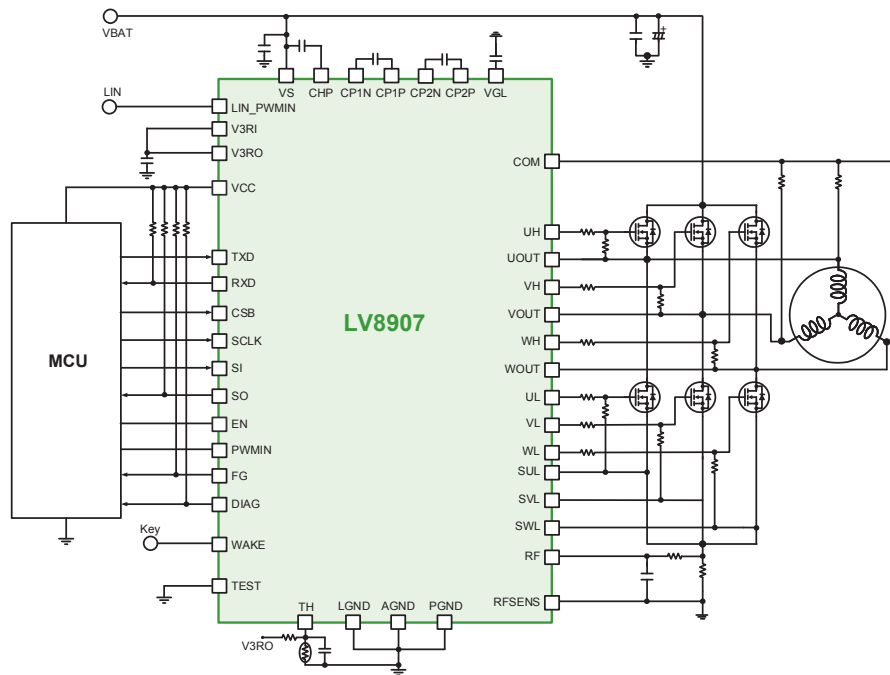
- Direct controlled actuators
  - DC motors (with and without position feedback)
  - Unipolar stepper motors
  - Bipolar stepper motors
- Bus connected mechatronic actuators
  - LIN bipolar stepper motors



\* Customer specific embedded software

## BLDC Motor Drivers for Fans & Auxiliary Pumps

BLDC motors enable higher efficiency and torque, and are therefore increasingly being adapted into automotive applications. Designs can be optimized with specialized pre-drivers and gate drivers.



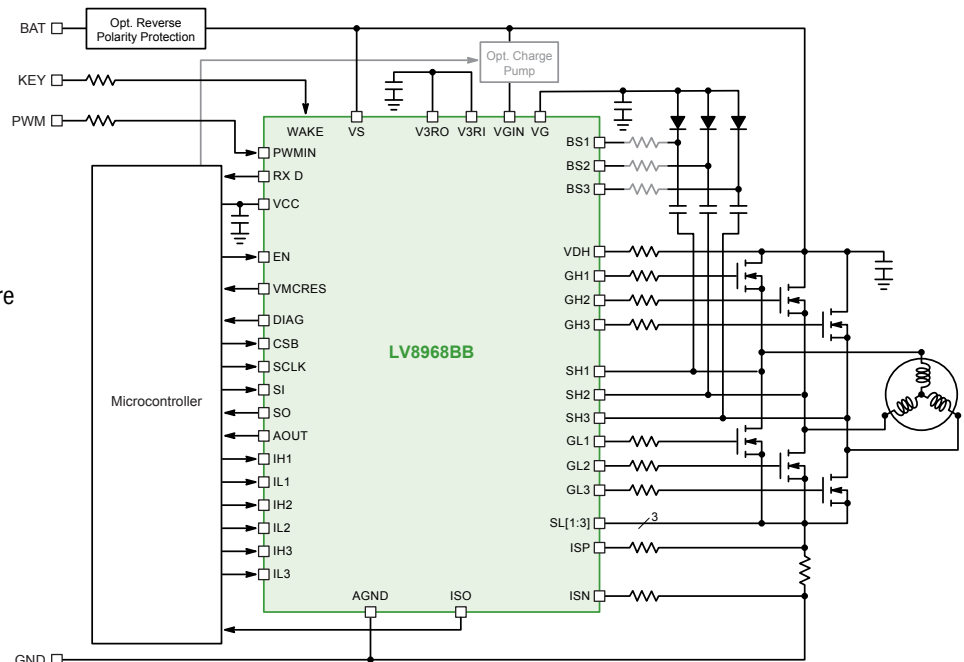
LIN-Based Control Configuration Application Diagram

### LV8907UW Features

- Integrated sensor-less control
- Gate drivers for external power MOSFETs
- Protection (under-voltage, over-temperature, over-current, locked rotor, PWM fault)
- $V_{IN}$  of 5.5 – 20 V
- Operation up to 175°C junction temperature
- LIN transceiver with UART ports and LDO
- SPI for MCU control
- Built-in OTP memory for configuration and standalone operation without MCU

### LV8968BB Features

- AEC-Q100 Qualified; ASIL B product developed in compliance with ISO 26262
- Operation up to 175°C junction temperature
- Separate power-stage supply for optional charge pump
- Integrated 3.3/5 V, 50 mA LDO
- SPI for real time configuration, control and diagnostics
- Supports multiple commutation algorithms (BEMF detection type and hall input)
- VBAT operating: 8-25 V using standard MOSFET; 6-33 V using logic level MOSFET

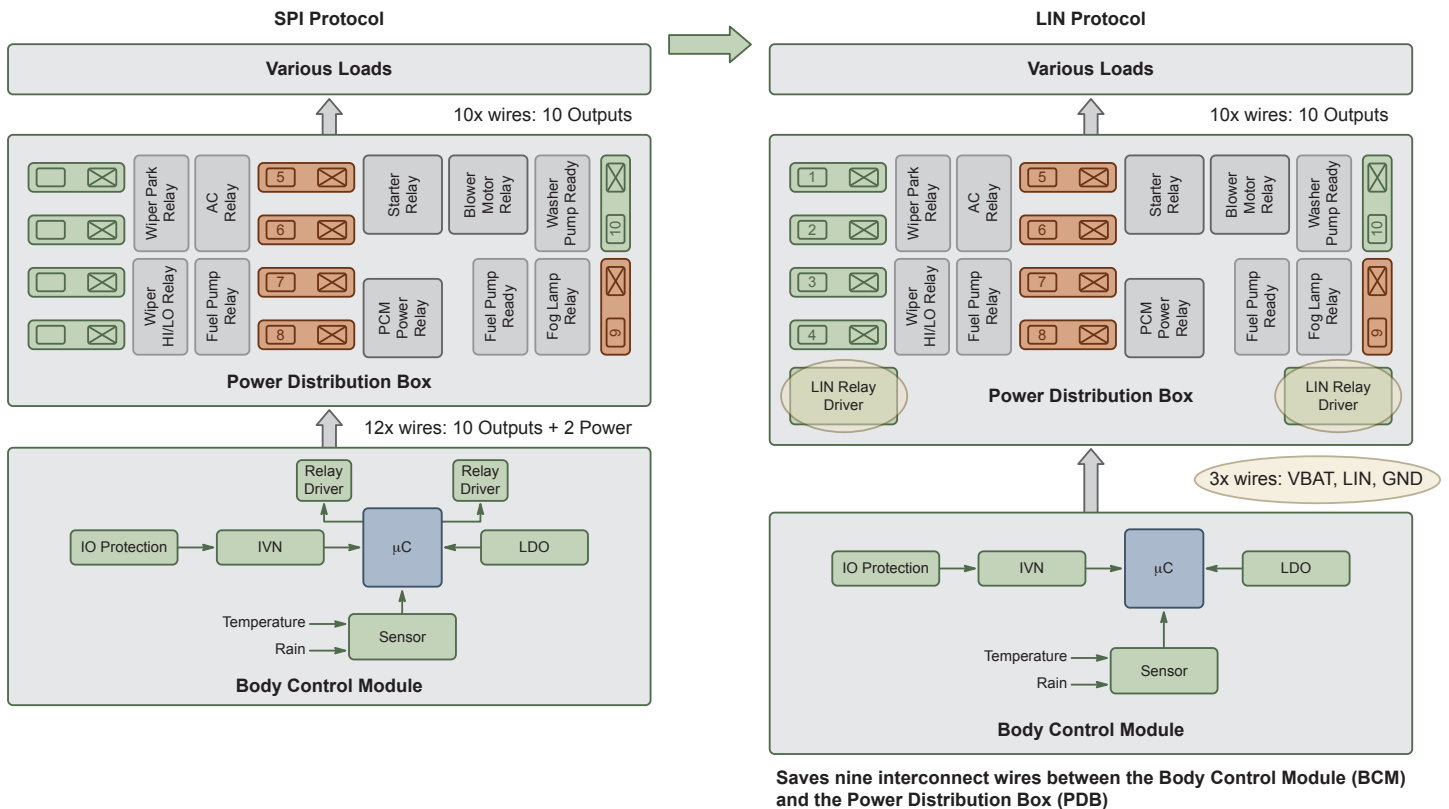


Typical Application Diagram

## LIN-Based Low-Side Relay Drivers for Automotive Power Distribution Relays

### NCV7748 Features

- Reduce harness complexity for Power Distribution Boxes
- Scalable between 4 or 8 channels
- Ability to control up to 32 relays with Virtual Node concept
- Diagnostics for abnormal load conditions
- Integrated clamps for inductive loads
- Designed for both PCB mounted or socketed relays
- Reduce PCB area and weight

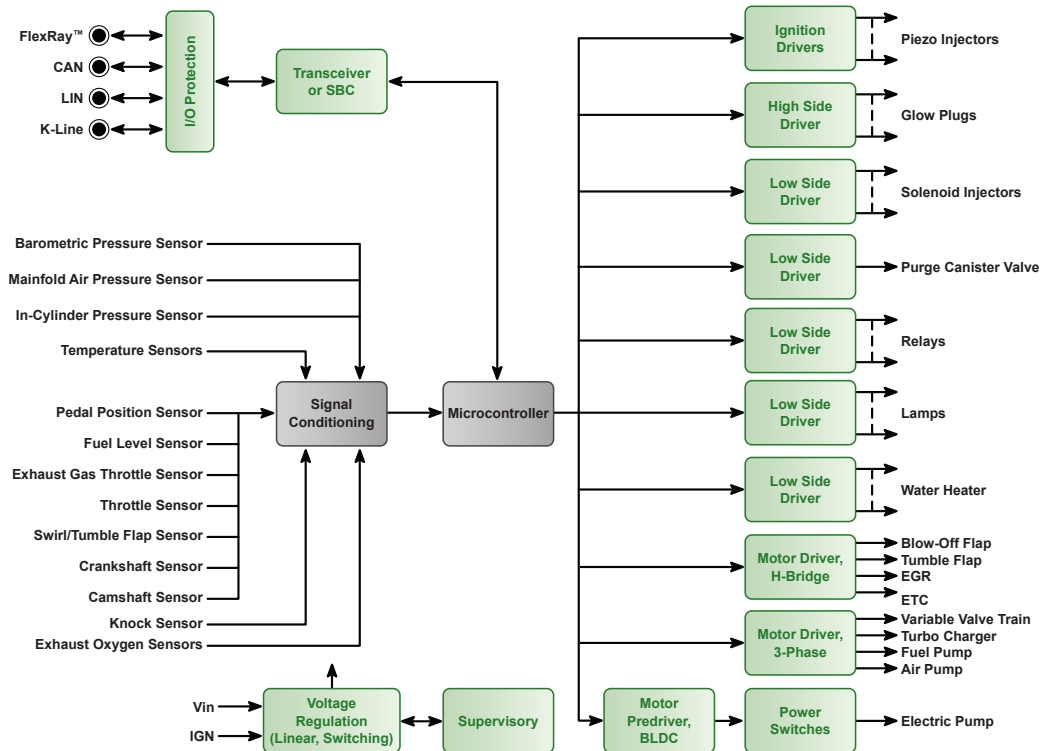


## Engine Management Systems

Approximately 80% of engines in the world are gasoline engines. Gasoline engines are starting to incorporate direct injection and turbo charging, to improve the efficiency of the simple and cost-effective engine. Gasoline engines will continue to be the predominant power source world wide; however, diesel engines have achieved ~40% penetration in Europe and have additional potential in North America.

Automotive electronics contributes to the drive for efficiency through control, sensing and actuation of the engine. Critical components, such as injectors and valves, are carefully controlled to reach the maximum efficiency. To improve control, pressure in the combustion chamber is measured and processed in real time, in order to reduce fuel consumption of the gasoline engine by 30%.

ON Semiconductor has developed numerous custom solutions and standard products for gasoline, bi/flexfuel, and diesel engines. The company's expertise covers the full spectrum of applications, ranging from air and fuel supply over ignition control, to exhaust after-treatment subsystems.



**Diesel Engine Management System**

### Product Portfolio

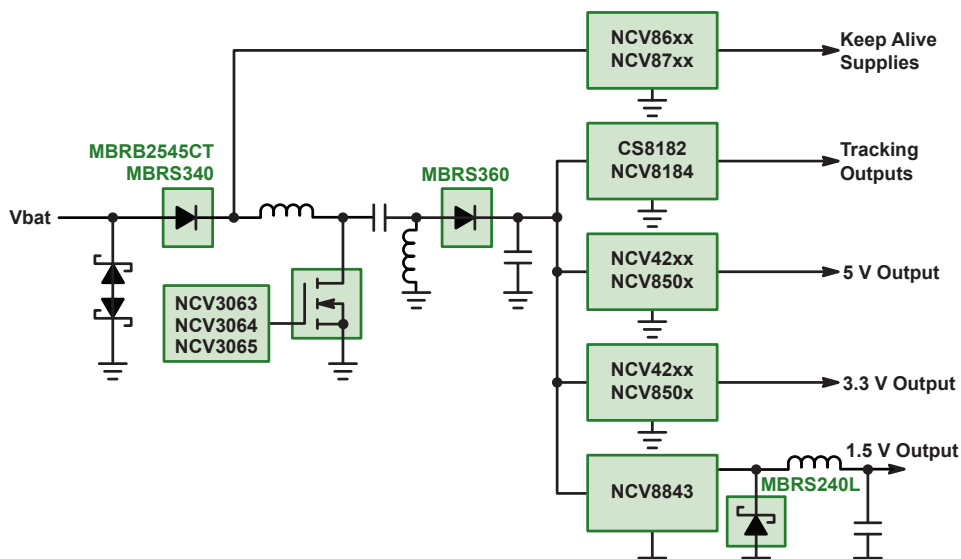
- Inductive angular sensor interfaces
- Pressure sensor interfaces
- Knock- and wheel-speed detection circuits
- Oil-, urea- and air-flow interfaces
- In-vehicle networking components
- Actuator drivers and pre-drivers for throttle and flaps, solenoid- and piezo-fuel injection systems, spark ignition, fans, pumps, and hydraulic controls



## Power Management Rails for Powertrain

Increasing demand for lower emissions, higher fuel economy, higher efficiency engines, and higher performance vehicles drive the need for precise control of ignition, fuel systems, and exhaust control. In order to efficiently perform all these functions, the latest generation of engine controllers need high-end 32-bit multi-core processors. These high-end microprocessors require efficient and reliable power management subsystems.

The power management subsystem must be able to handle various battery transients, such as load dump, double battery, reverse battery, and other inductive and capacity coupled transients. The subsystem typically provides regulated 5 V, 3.3 V, 1.0-1.5 V, and other tracking outputs, to power microcontrollers, sensors, memories, and other peripheral devices in the ECU.



ON Semiconductor offers a wide selection of highly efficient power supply solutions that can handle harsh powertrain battery transients. The portfolio includes multi-topology controllers, such as NCV8871 and NCV3063, to provide regulated voltage greater than 5 V with a battery operating voltage between 4 V to 18 V; as well as buck regulators and controllers, like NCV8851 and NCV8843, to supply the high current, low voltage microcontroller cores.

To support 'keep alive' 5 V and 3.3 V voltage rails in an ECU, ON Semiconductor offers a wide selection of low  $I_q$  and standard linear voltage regulators. In addition, fully protected tracking regulators – such as NCV4250-2C, NCV8184, CS8182, and CS8361 – that can power external sensors, complete the portfolio.

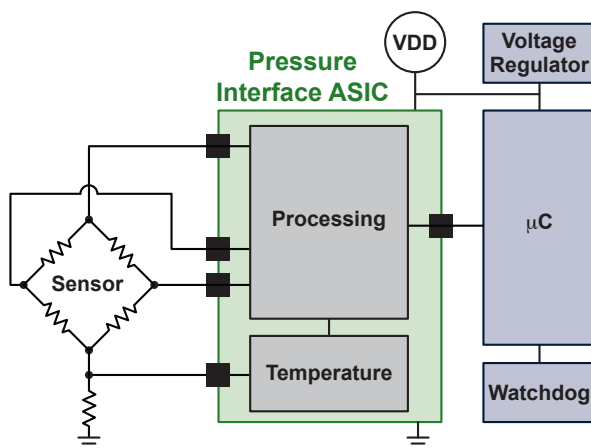
Along with the linear regulators and switch mode power supplies, ON Semiconductors also offers power MOSFETs for SEPIC and BUCK applications, as well as low  $V_f$  rectifiers and TVS diodes for reverse battery and load dump applications.



## ASICs for Powertrain

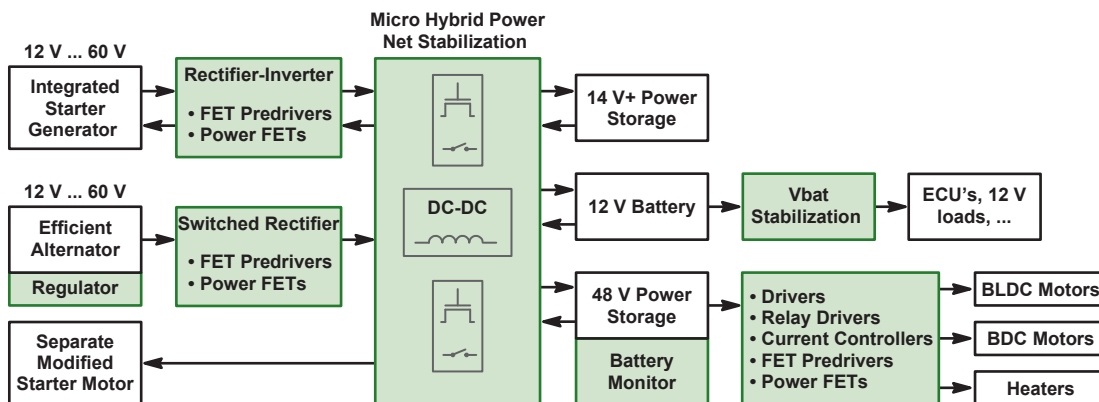
### Cylinder Pressure Sensing

Monitoring and measuring pressure is an integral part of engine management. Pressure sensors keep track of conditions within the manifold (MAP and TMAP), monitor diesel particle filters, and control the high pressures involved in both diesel and gasoline direct injection. In-cylinder pressure sensing (ICPS) enables even more accurate combustion control, to allow further reduction in NOx and CO2 emissions, for cleaner diesels and other advanced internal combustion engines of the future.



### Micro-Hybrid

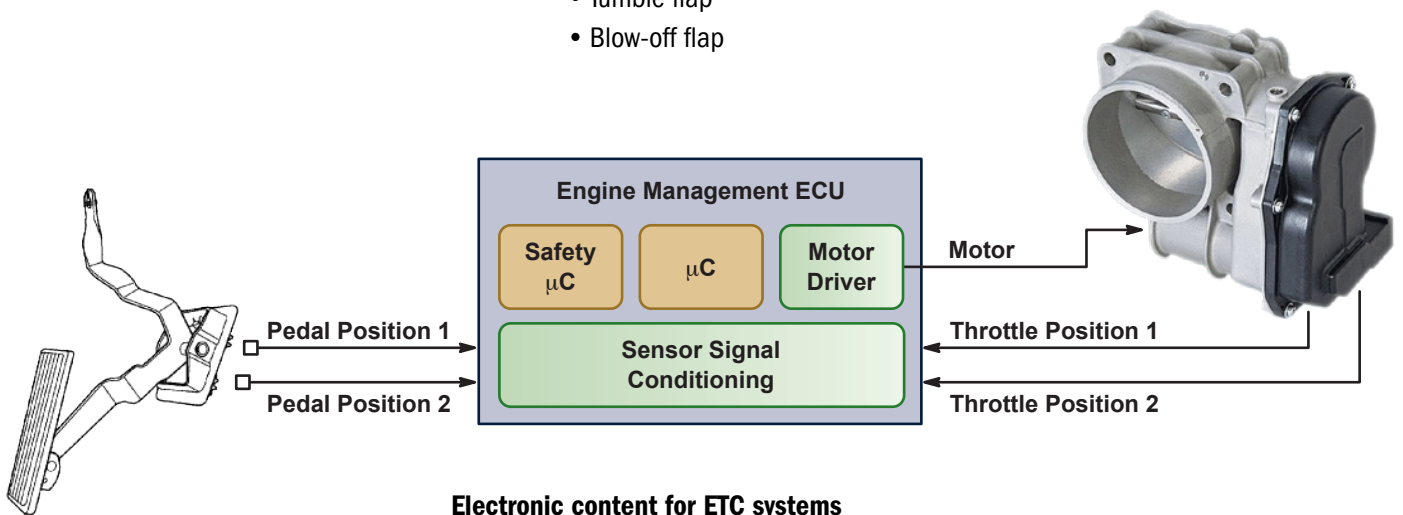
Micro-Hybrids are start-stop vehicles with additional features to reduce CO2 emissions: the internal combustion engine is switched-off while the vehicle is still moving; regenerative brake energy can be captured in a dedicated power-storage system; and electricity generation is avoided during acceleration. An efficient alternator or an Integrated Starter Generator (ISG) replaces the standard alternator while dedicated integrated circuits control the power net stability. Some of the 12 V high power loads (such as electric power steering and window defrosters) and some belt-driven ancillary loads (such as water pump, compressor, fan) can be replaced by electric drives from a 48 V battery. ON Semiconductor offers robust technologies, key intellectual property, and production proven solutions that address the harsh environments in these emerging applications.



## Flap Control

To reduce fuel consumption and meet the strict requirements for the different regulations in the automotive industry - e.g., Euro-4 (2005), Euro-5 (2009), and Euro-6 (2014) - modern engine management systems must optimize the engine's efficiency, and reduce emissions of soot, NO<sub>x</sub> (Nitrogen Oxide), HC (Hydrocarbon), and CO (Carbon Monoxide). Therefore, the engine control unit needs to control the combustion process in an extremely precise manner. Flap control systems include several air and exhaust gas flaps:

- Electronic throttle
- Exhaust recirculation flap
- Tumble flap
- Blow-off flap

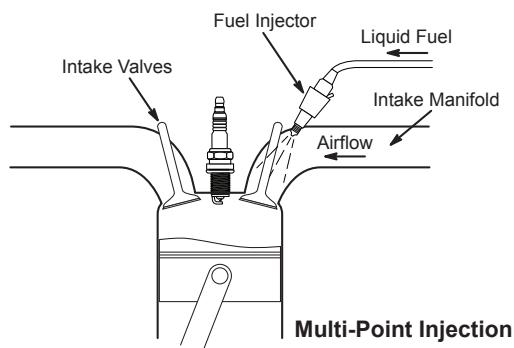


### Electronic content for ETC systems

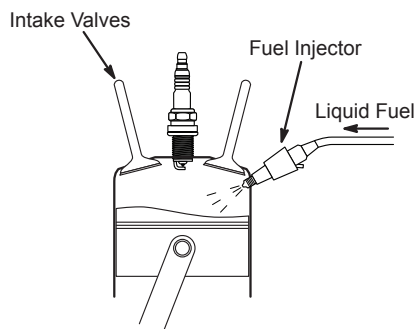
- Pedal position sensor (inductive or Hall effect)
- Throttle position sensor (potentiometer, inductive, or Hall effect)
- DC motor control

## Injection Systems

Fuel injection systems carefully meter the amount and timing of fuel to each cylinder. Fully integrated multi-point (MPI) gasoline engine management systems remain by far the most popular solution. However, the gasoline direct injection (GDI) system has the strongest growth rate.



Multi-Point Injection



Direct Injection

### Multi-point Indirect Injection

Gasoline engines are typically equipped with indirect injection systems. They may be single point (SPI) where the fuel is injected in the throttle housing; or multi point (MPI) where each cylinder has its own injector in the inlet manifold.

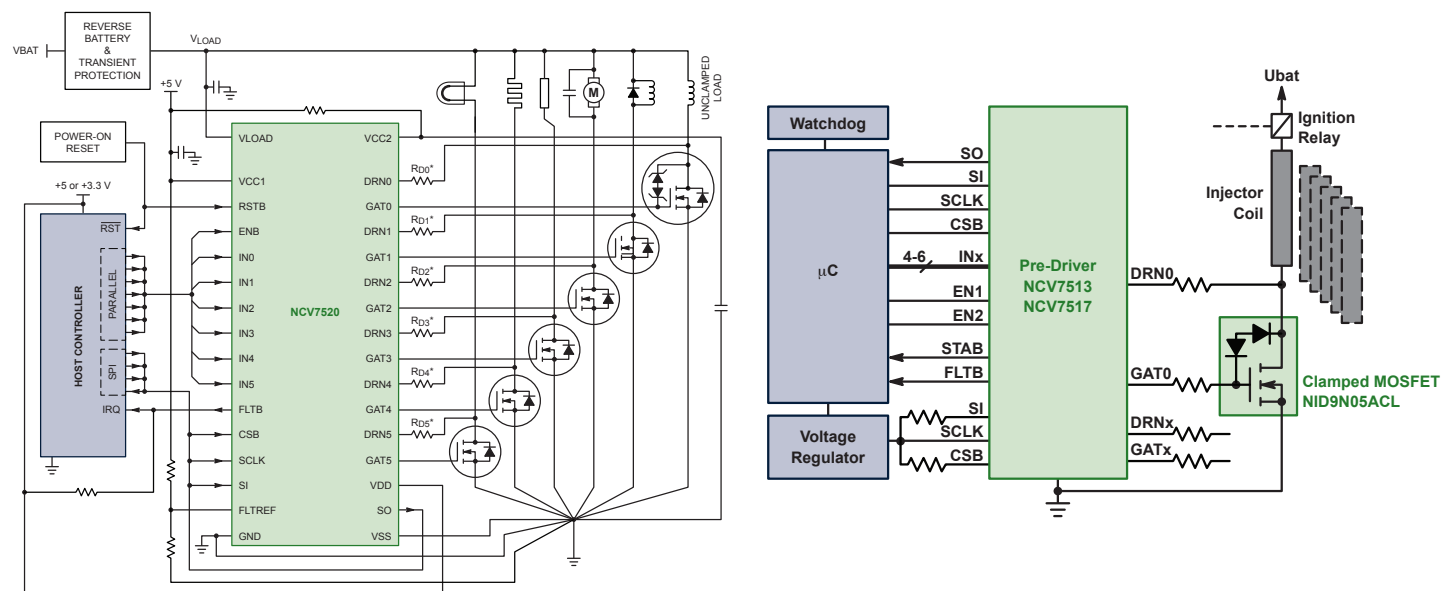
### Direct Injection

Many diesel engines feature direct injection (DI) technology. The injector nozzle is placed inside the combustion chamber itself. The gasoline direct injection engine (GDI) utilizes this system as

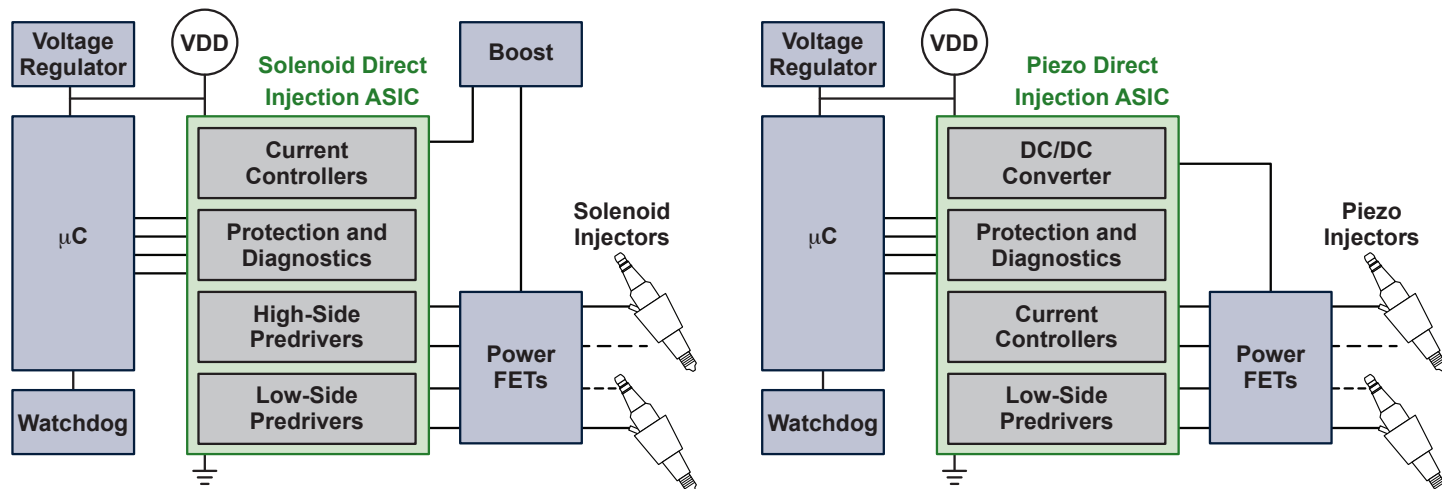
well, since it gives a better volumetric efficiency as only air is drawn in through the induction system, increasing the amount of air induced and minimizing fuel losses. The injector also features several spray modes, so the fuel is better distributed and a powerful air-fuel mixture is created. The injector actuator is implemented as a solenoid or a piezo based solution. With piezo technology, fuel can be more precisely dosed when injected into an engine's combustion chamber, considerably reducing fuel consumption and exhaust emissions.



The FLEXMOS™ family from ON Semiconductor offers application specific scalability through the choice of external MOSFETs. These low-side pre-drivers are programmable six channel products for driving logic-level MOSFETs. The devices are controllable by a combination of serial SPI and parallel inputs. They feature programmable fault management modes and allow power-limiting PWM operation with programmable refresh time. Each channel independently monitors its external MOSFET's drain voltage for fault conditions. Shorted load fault detection thresholds are fully programmable. Fault information for each channel is encoded by fault type and is available through SPI communication.

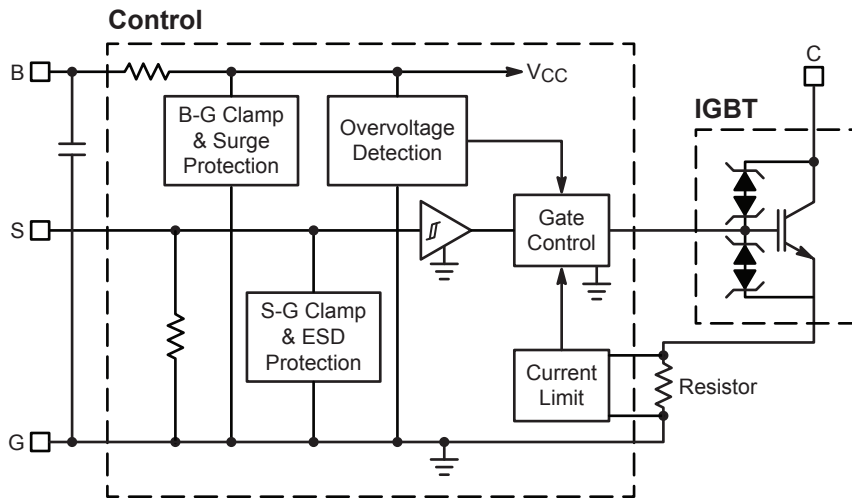


Engine management systems - in particular, injection functions - are subject to extensive qualification cycles, due to the harsh operating conditions of wide temperature and voltage ranges, and switching of inductive and capacitive loads. ON Semiconductor has developed multiple drivers for injection systems, using proprietary design techniques, combined with high-voltage manufacturing processes.



## Igniters for Ignition Systems

Provides the power electronic circuit to energize an ignition coil for creating a spark across the spark plug.



### Features

- Overcurrent protection
- Overvoltage shutdown
- B input resistor & B-G clamp
- B-G capacitor (filter)
- Clamp voltages 350 - 600 V
- Output current 8 - 20 A

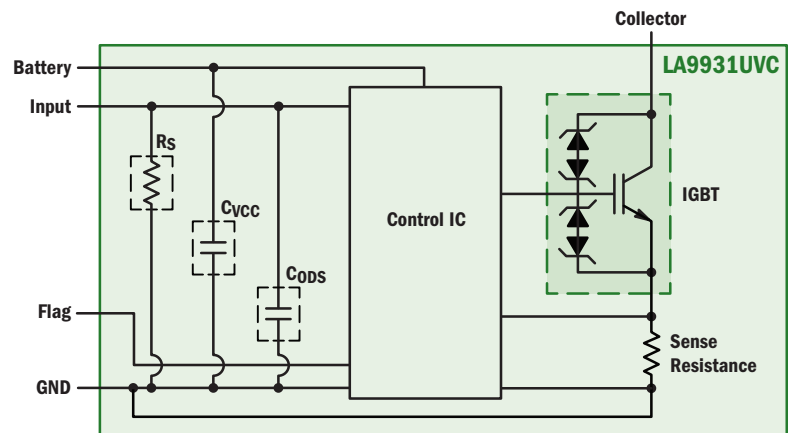
### Igniter Module Requirements

- Compact - space constraint in coil head
- Highly robust and reliable - life time > 15 years, under hood

## LA9931UVC Igniter Module

### Features

- Complete solution for coil-on-plug applications
- Integrates control circuit, IGBT, passives
- 400 V clamp voltage; 12 A IGBT collector current
- 250 mJ IGBT collector-emitter avalanche energy
- ESD, EMC, ISO pulse: ISO7637-2
- SIP-5J package

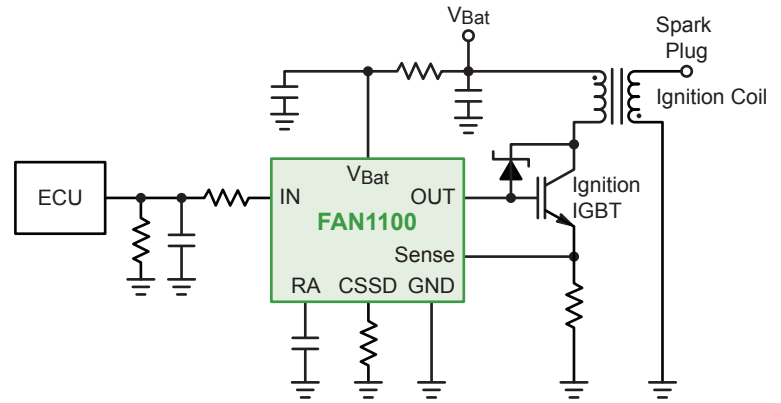




## Ignition IGBTs

### Features

- Stand alone Ignition IGBTs with integrated collector – gate clamp and ESD protection
- Wide product portfolio including customized die/ wafer solutions
- Smart Ignition solutions including
  - Current sense IGBT
  - Integrated control IC
  - Stand alone Ignition control IC
  - Fully integrated Igniter custom solutions

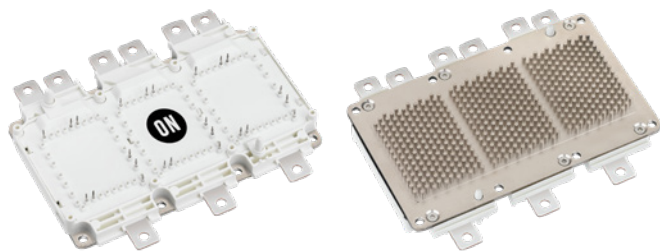


### Ignition IGBTs

| Device             | Clamp Voltage (V) | SCIS Energy (mJ) | I <sub>C</sub> @110°C (A) | V <sub>CE(sat)</sub> Max @25°C (V) | Package(s) |
|--------------------|-------------------|------------------|---------------------------|------------------------------------|------------|
| FGD3325G2-F085     | 250               | 330              | 25                        | 1.25                               | T0-252     |
| ISL9V5036P3-F085   | 360               | 500              | 31                        | 1.6                                | T0-220     |
| ISL9V5036S3        | 360               | 500              | 31                        | 1.6                                | T0-262     |
| FGB3236-F085       | 360               | 320              | 26                        | 1.4                                | T0-263     |
| FGI3236-F085       | 360               | 320              | 26                        | 1.4                                | T0-263     |
| ISL9V3036S3ST      | 360               | 300              | 17                        | 1.6                                | T0-263     |
| ISL9V5036S3ST      | 360               | 500              | 31                        | 1.6                                | T0-263     |
| FGD2736G3-F085     | 360               | 270              | 18                        | 1.35                               | T0-252     |
| FGD1240G2-F085     | 400               | 100              | 20                        | 1.1                                | T0-252     |
| FGP3040G2-F085     | 400               | 330              | 25                        | 1.25                               | T0-220     |
| FGP3440G2-F085     | 400               | 335              | 25                        | 1.2                                | T0-220     |
| ISL9V3040P3        | 400               | 300              | 17                        | 1.6                                | T0-220     |
| FGD3040G2-F085     | 400               | 330              | 25                        | 1.25                               | T0-252     |
| FGD3440G2-F085     | 400               | 335              | 25                        | 1.2                                | T0-252     |
| FGI3040G2-F085     | 400               | 330              | 25                        | 1.25                               | T0-252     |
| ISL9V2040D3ST      | 400               | 200              | 10                        | 1.9                                | T0-252     |
| ISL9V3040D3ST      | 400               | 300              | 17                        | 1.6                                | T0-252     |
| FGB3040G2-F085     | 400               | 330              | 25                        | 1.25                               | T0-263     |
| FGB3440G2-F085     | 400               | 335              | 25                        | 1.2                                | T0-263     |
| ISL9V2040S3ST      | 400               | 200              | 10                        | 1.45                               | T0-263     |
| ISL9V2540S3ST      | 400               | 250              | 10                        | 1.8                                | T0-263     |
| ISL9V3040S3ST      | 400               | 300              | 17                        | 1.6                                | T0-263     |
| FGB3040CS          | 400               | 300              | 19                        | 1.6                                | T0-263-6   |
| FGD3245G2-F085     | 450               | 320              | 23                        | 1.25                               | T0-252     |
| FGB3245G2-F085     | 450               | 320              | 23                        | 1.25                               | T0-263     |
| ISL9V5045S3ST-F085 | 450               | 500              | 43                        | 1.6                                | T0-263     |
| FGD3050G2-F085     | 500               | 300              | 27                        | 1.2                                | T0-252     |
| FGB3056-F085       | 560               | 300              | 24                        | 1.1                                | T0-263     |

## VE-Trac™ Power Integrated Modules for Traction Inverters

### VE-Trac Direct Six-Pack

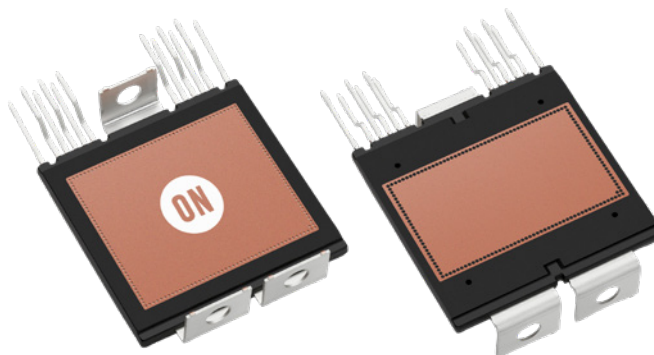


- Six-pack integrated power module with highly compact footprints for Hybrid (HEV) and Electric Vehicle (EV) traction inverter applications
- Press-fit signal pins for improved vibration, temperature shock, contact resistance and mechanical performance
- Direct liquid cooling for class-leading low thermal impedance
- $T_{jmax} = 175^{\circ}\text{C}$  continuous operation

| Device          | Current Rating (A) | Voltage Rating (V) | Package        |
|-----------------|--------------------|--------------------|----------------|
| NVH820S75L4SPB* | 820                | 750                | VE-Trac Direct |
| NVH820S75L4SPC* | 820                | 750                | VE-Trac Direct |

\* Pending 4Q19.

### VE-Trac Dual Half-Bridge



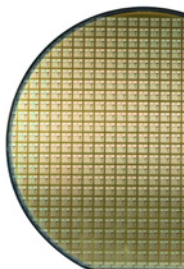
- High-power transfer molded half-bridge modules with Dual-Side Cooling (DSC) technology offers unparalleled value in traction drives for EV/HEVs
- Scalable design for best-in-class \$/kW
- Chip level current and temperature sensors
- Ultra-low package inductance ( $< 7 \text{ nH}$ )
- Wire-bond free for extended lifetime
- $T_{jmax} = 175^{\circ}\text{C}$  continuous operation

| Device          | Current Rating (A) | Voltage Rating (V) | Package      |
|-----------------|--------------------|--------------------|--------------|
| NVG800A75L4DSC* | 800                | 750                | VE-Trac Dual |

\* Pending 4Q19.

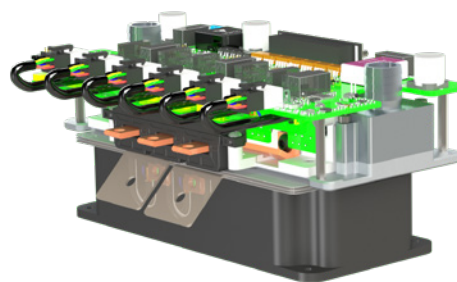
### VE-Trac Chip 750 V

- $T_{jmax} = 175^{\circ}\text{C}$  continuous operation
- Low conduction losses
- Solderable top and back metal option
- Optimized for traction modules
- AEC-Q101 Qualified



| Device         | Die Size (mm x mm) | Current Rating (A) | Top Metal | Package |
|----------------|--------------------|--------------------|-----------|---------|
| PCGLA200T75NF8 | 10 x 10            | 200                | Al        | Sawn on |
| PCRKA200T75F8  | 10 x 5             | 200                | Al        | Foil    |

### Inverter Evaluation Kits



#### Dual 750 V/800 A Half-Bridge Reference Inverter

- Direct (750 V/820 A) and dual (750 V/800 A) inverter kits
- Ultra-low inductance design
- Versatile assembly for efficient evaluation
- NCV57000 isolated gate driver with protection features

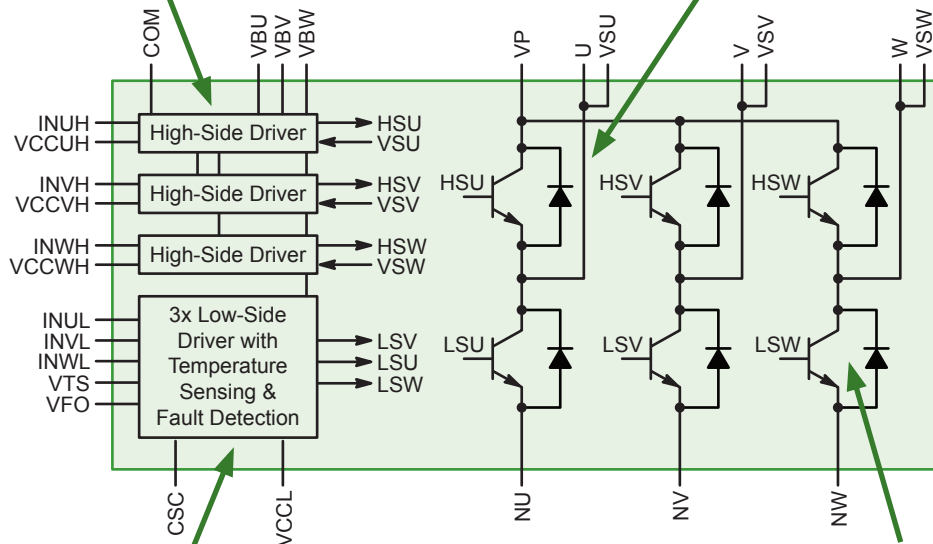
## High Voltage Power Modules

### HVIC

- 2 A source / 4 A sink
- fpwm up to 20 kHz
- UVLO protection

### Diode

- Soft recovery for easy drive and low EMI



### LVIC

- 2 A source / 4 A sink
- fpwm up to 20 kHz
- Protection UVLO, OCP, TSU Fault out
- Thermal Sensing 0°C~150°C via Vts

### IGBT

- Low conduction and switching losses
- Optimized switching dv/dt for motor control
- Short circuit rated

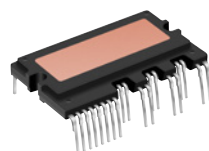
### Features

- Ultra low Rth (<0.34°C/W) via outstanding substrate DBC
- Guaranteed Tj = 175°C
- Outstanding ruggedness via SCWT is over 5 μs @ worst case
- Reduced design cycle & assembly process as IPM fully optimized for stable EMI & thermal performance

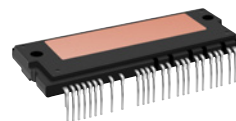
### Motor Driver Modules

| Device         | Description   | V <sub>B</sub> Max (V) | I <sub>out</sub> Max (A) | R <sub>S</sub> (mΩ) | Pre-Driver | Current Limit | Thermal Shutdown | UVLO | Package(s) |
|----------------|---|------------------------|--------------------------|---------------------|------------|---------------|------------------|------|------------|
| STK984-190-E   | Power MOSFET Module                                   | 40                     | 30                       |                     |            |               |                  |      | SPCM24     |
| FTC03V455A1    | 3-Phase MOSFET Inverter Power Module                  | 40                     | 150                      | 0.53                |            |               |                  |      | APMCB-A19  |
| NFVA35065L32   | 3-Phase IGBT Intelligent Power Module (IPM), Inverter | 650                    | 50                       |                     | ✓          | ✓             | ✓                | ✓    | ASPM27-CAA |
| NFVA34065L32   | 3-Phase IGBT IPM, Inverter                            | 650                    | 40                       |                     | ✓          | ✓             | ✓                | ✓    | ASPM27-CAA |
| NFVA33065L32   | 3-Phase IGBT IPM, Inverter                            | 650                    | 30                       |                     | ✓          | ✓             | ✓                | ✓    | ASPM27-CAA |
| NFVA23512NP2T  | 3-Phase IGBT IPM, Inverter                            | 1200                   | 35                       |                     | ✓          | ✓             | ✓                | ✓    | ASPM34     |
| NFVA22512NP2T* | 3-Phase IGBT IPM, Inverter                            | 1200                   | 25                       |                     | ✓          | ✓             | ✓                | ✓    | ASPM34     |
| NFVA25012NP2T* | 3-Phase IGBT IPM, Inverter                            | 1200                   | 50                       |                     | ✓          | ✓             | ✓                | ✓    | ASPM34     |

\* Pending 4Q19.



SPM-27



SPM-34

## Charge Pumps for Power Supplies

Charge Pump Regulators are flexible devices providing buck, boost or buck/boost conversion. The main advantage of using charge pump architectures is an inductor is not required, reducing application cost and design effort compared to SMPS converters utilizing an inductor. Charge pumps are suitable for applications where an LDO dissipates too much power or boost (or buck/boost) operation is mandatory.

### Main Features of Automotive Charge Pumps

#### Small components count and PCB area

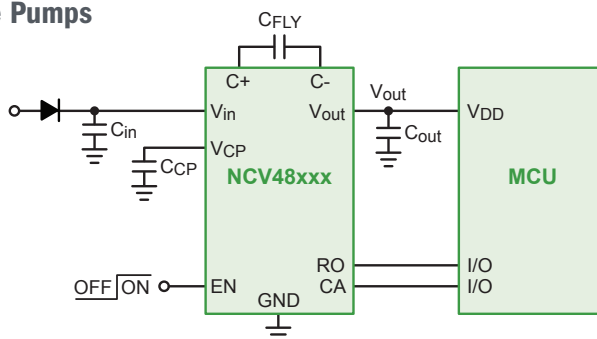
- No inductor needed
- Works with ceramic capacitors

#### Variable topology

- Buck or Pass mode (LDO)
- Boost
- Buck/Boost

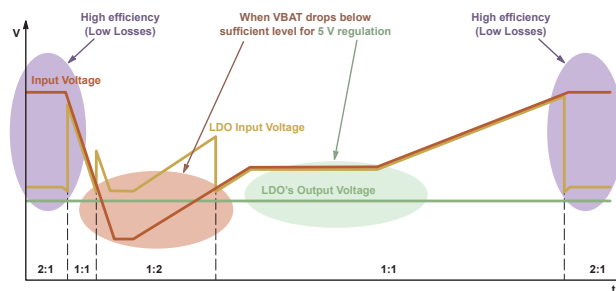
#### Efficiency

- Twice as efficient compared to LDO solution

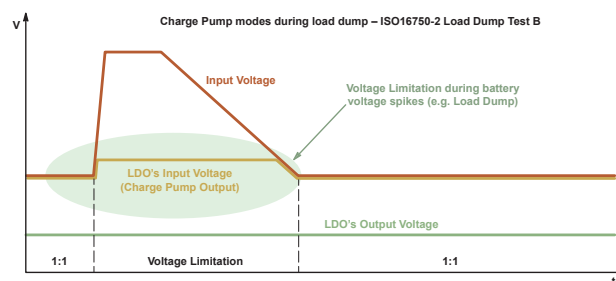


The NCV48xxx charge pump portfolio includes buck, boost, and buck/boost architectures with various output current and features. Compared to charge pumps on market, specific feature of used architectures is access to charge pump output allowing its voltage limitation during battery voltage transients (e.g. Load Dump). This feature enables placing lower voltage rating bulk capacitor at the charge pump output, and reduces overall application cost. Current limitation function inrush current charging reduces the bulk capacitor size as well.

Additional features such as Reset Output (RO) and Charge Pump Active Output (CA, optional feature) are available for communication with MCU.



Buck, Boost and Pass (LDO) Operation Modes



Charge Pump Output Voltage Limitation during Load Dump

### Comparison of Battery Connected LDO, Charge Pump and SMPS

| Converter Type | Efficiency | Output Current | Inductor | Buck (or LDO) | Boost | Buck/Boost |
|----------------|------------|----------------|----------|---------------|-------|------------|
| LDO            | Low        | Low            |          | ✓             |       |            |
| Charge Pump    | Middle     | Middle         |          | ✓             | ✓     | ✓          |
| SMPS           | High       | High           | ✓        | ✓             | ✓     | ✓          |

### Charge Pumps

| Device   | Buck | Boost | Pass Mode (LDO) | Output Current In Buck Mode | Output Current In Boost Mode | Output Current In Pass Mode | FSW     | Output Voltage | Tolerance | Sleepmode Current (Typ) | Quiescent Current (Max) @ Low Load (Load) | Enable | Reset | Charge Pump Active Output | TSD | UVLO | Overvoltage | Short Circuit | Current Limit | Peak Transient (V) | Package(s)            |
|----------|------|-------|-----------------|-----------------------------|------------------------------|-----------------------------|---------|----------------|-----------|-------------------------|---|--------|-------|---------------------------|-----|------|-------------|---------------|---------------|--------------------|-----------------------|
| NCV48220 | ✓    | ✓     | —               | Up to 150 mA                | Up to 150 mA                 | Up to 150 mA                | 450 kHz | 5 V            | ±2 %      | 1 µA                    | 40 µA (100 µA)                            | ✓      | ✓     | ✓                         | ✓   | ✓    | ✓           | ✓             | ✓             | 45                 | SOIC-16W              |
| NCV48920 | ✓    | ✓     | Up to 600 mA    | Up to 300 mA                | Up to 300 mA                 | Up to 300 mA                | 450 kHz | 5 V            | ±2 %      | 1 µA                    | 50 µA (100 µA)                            | ✓      | ✓     | ✓                         | ✓   | ✓    | ✓           | ✓             | ✓             | 45                 | TSSOP-14<br>Epad, DFN |

## Switch Mode Power Supplies (SMPS)

### Boost SMPS

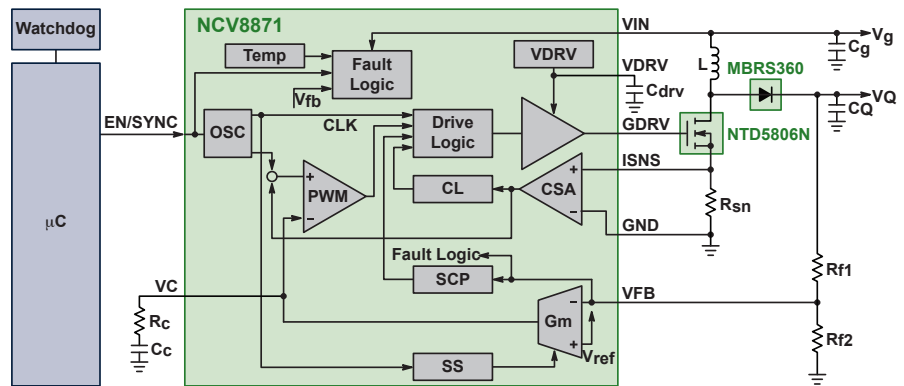
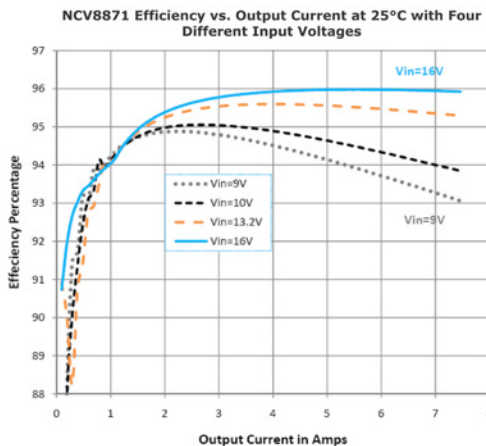
- Standard Regulators
- Standard Controllers

### Buck SMPS

- Standard Regulators
- Low Iq Regulators
- Multi-Megahertz Regulators
- Standard Controllers
- Low Iq Controllers

### Boost SMPS

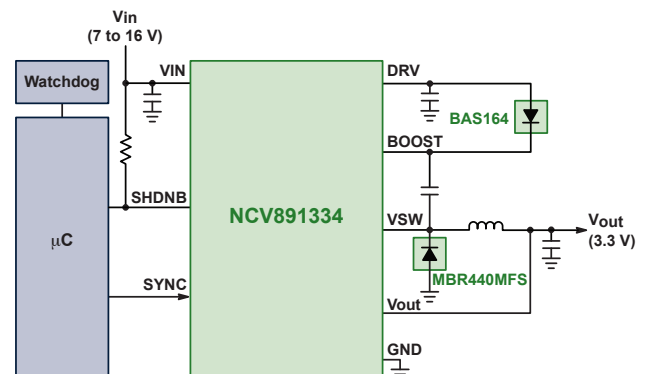
The NCV887x and NCV89803x boost family (with adjustable output and non-synchronous boost controllers) drive an external N-channel MOSFET. The devices use peak current mode control with internal slope compensation. These boost products incorporate an internal regulator that supplies charge to the gate driver. Designed for powertrain, start-stop, and display applications, the devices can be configured as a SEPIC converter to regulate the car battery voltage, which can vary from 4.5-18 V to a regulated output of 6 V in an engine ECU. Any boost controller can also be configured as a boost converter, to boost the battery voltage from 4.5-18 V to an output voltage of 55-65 V, to power the injectors of direct gasoline injection systems.



### Buck SMPS

ON Semiconductor is developing high efficiency, high frequency switch mode power supplies that can withstand automotive load transients up to 45 V. The high switching frequencies enable the devices to provide the entire buck solution in a very small foot print, by meeting the stringent EMC/EMI performance required in powertrain applications. The SMPS buck regulator portfolio has expanded for 2 MHz operation with high output current capability (up to 3A for regulators and much more for controllers).

The NCV891x34 is a dual mode regulator intended for battery-connected applications that must operate up to a 45 V input supply. Hybrid Low Power Mode allows the NCV891x34 to operate either as a PWM buck converter, or as a low drop-out linear regulator, and the NCV891x34 is suitable for systems with low noise and low quiescent current requirements, often encountered in automotive driver information systems. In addition to synchronization and protection features, the high switching frequency produces low output voltage ripple, even when using small inductor values and an all-ceramic output filter capacitor – forming a space-efficient switching regulator solution.



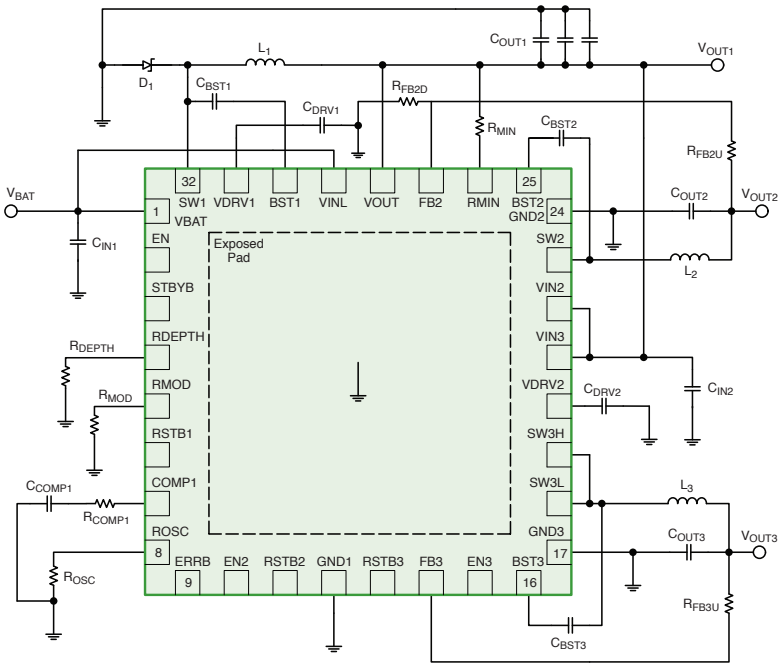


Battery-Connected SMPS Power Management Units (PMUs)

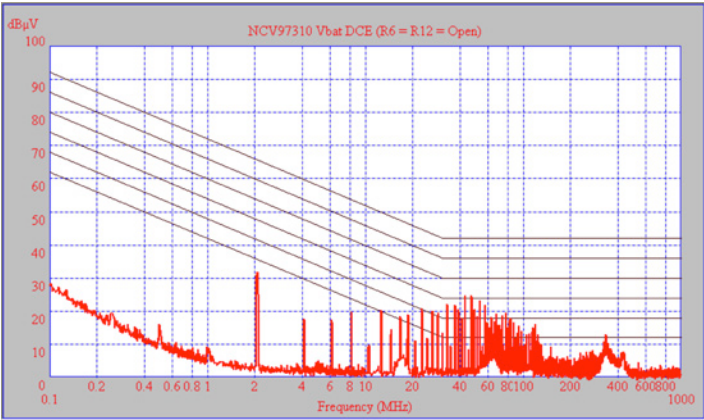
The NCV9731x is a high-frequency multi-output regulator consisting of one battery-connected non-synchronous buck regulator with a user-selected low- $I_q$  linear standby mode, and two low-voltage synchronous buck regulators.

Features

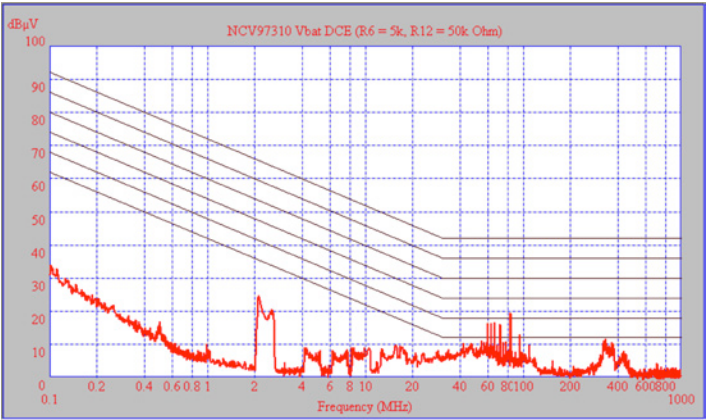
- 2 MHz switching frequency
- Operation down to 4.1 V input
- Withstands 45 V load dump
- Downstream buck regulators adjustable from 1.2 V to 3.3 V
- 3 independent reset pins
- -40 °C to 150°C operation



| Device   | Type      | I <sub>q</sub> Max (V) | Outputs | Primary Output (V) | Spread Spectrum | OVSD Threshold Max (A) | Package(s) |
|----------|-----------|------------------------|---------|--------------------|-----------------|------------------------|------------|
| NCV97310 | Switching | 25                     | 3       | 3.3 or 5.0         | Yes             | 36                     | QFN-32 EP  |
| NCV97311 | Switching | 25                     | 3       | 3.3 or 5.0         | Yes             | 40                     | QFN-32 EP  |



Typical Emissions Profile



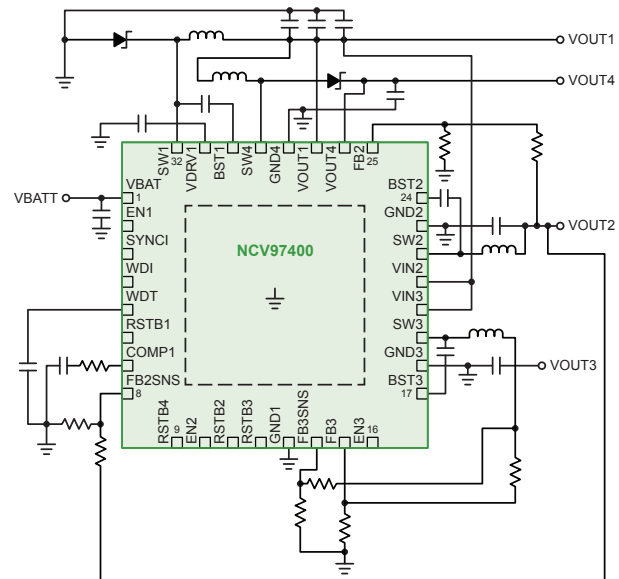
Emissions with Spread Spectrum

## Battery-Connected SMPS Power Management Units (PMUs)

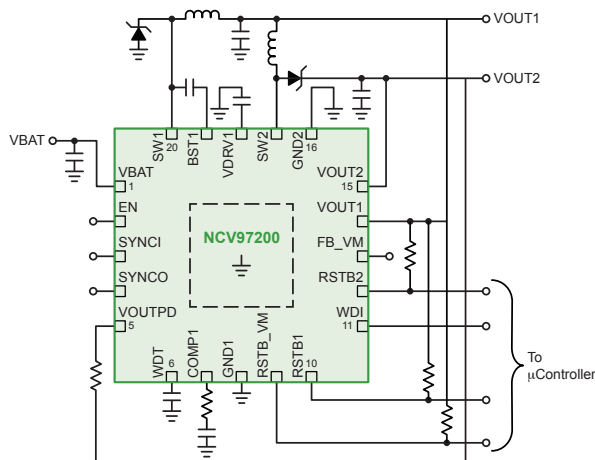
The NCV97400 is a 4-output monolithic regulator consisting of 3 buck regulators and 1 boost regulator, with supervisory functions including window voltage monitoring on all outputs and a window watchdog. This device is ideal for ADAS (Advanced Driver Assistance Systems) applications, and utilizes an independent voltage reference and an adjustable independent oscillator to realize the supervisory functions.

### Features

- 4 outputs
  - 3.3 V primary buck which delivers up to 3 A
  - 5 V boost to supply, for example, IVN circuits
  - 2 adjustable secondary bucks (0.8 - 2.5 V) which deliver up to 2 A
- 3 Enabled Buck Converters
- Voltage monitoring
- Wide input of 4.1 to 40 V with Undervoltage Lockout (UVLO)
- 2 MHz operation with spread spectrum capability
- Window Watchdog with independent references
- Safety Design – ASIL B



The NCV97200 is a 2-output monolithic regulator consisting of 1 buck regulator and 1 boost regulator, with supervisory functions including window voltage monitoring on all outputs and a window watchdog. This device is ideal for ADAS (Advanced Driver Assistance Systems) applications and utilizes an independent voltage reference and an adjustable independent oscillator to realize the supervisory functions.



### Features

- 3.3 V primary buck which delivers up to 3 A
- 5 V boost to supply, for example, IVN circuits
- 1 Boost Converter for IVN supply
- Wide input of 4.1 to 40 V with Undervoltage Lockout (UVLO)
- 2 MHz operation with spread spectrum capability
- Window Watchdog with independent references
- Safety Design – ASIL B

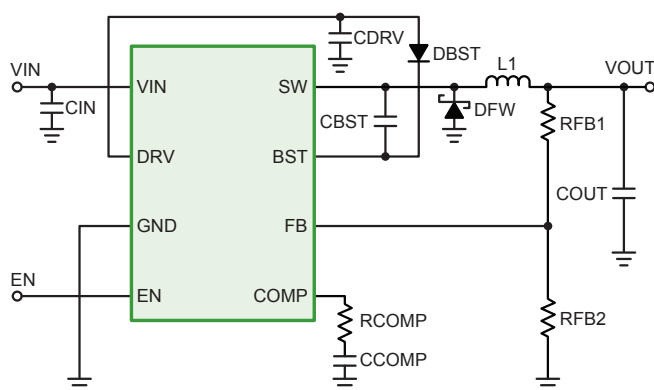
## Battery-Connected Buck SMPS for Primary Power Conversion

The 2 MHz NCV890xxx and NCV891xxx portfolio removes the need for EMI countermeasures and reduces the number of required external components in automotive power supplies. The devices achieve output as low as 3.3 V from an 18 V input, without pulse skipping. A wide range of output currents and features is available.

### Features

- Maximum DC current from 0.6 A to 3 A
- Load dump capability: 40 V and 45 V versions
- Synchronization input: use an external clock or synchronization output in order to override internal switching frequency
- Synchronization output: allows the synchronization of another power supply or other device
- Power Good: Open drain output; high when output voltage is above power good threshold
- Reset: Open drain output; high when output voltage is above reset threshold, and has a programmable delay
- Spread spectrum: Internally generated spread spectrum, with both the modulation frequency and modulation depth externally programmable
- Low  $I_q$ : some versions have low  $I_q$  in light load conditions
- Standard features: Under-voltage lock-out, frequency fold back, peak current limit, thermal shut down, and low  $I_q$  sleep mode

| Device    | DC Current Max (A) | Sync | Load Dump (V) | $I_q$ ( $\mu$ A) | Package(s)       |
|-----------|--------------------|------|---------------|------------------|------------------|
| NCV891330 | 3.0                | Yes  | 45            | 30               | SOIC-8           |
| NCV890201 | 2.0                | Yes  | 40            | —                | DFN-10           |
| NCV890231 | 2.0                | Yes  | 45            | —                | DFN-10           |
| NCV890131 | 1.2                | Yes  | 45            | —                | DFN-10           |
| NCV890130 | 1.2                | No   | 45            | —                | DFN-8            |
| NCV890101 | 1.2                | Yes  | 40            | —                | DFN-10           |
| NCV891130 | 1.2                | No   | 45            | 30               | SOIC-8           |
| NCV890100 | 1.2                | No   | 40            | —                | DFN-8, SOIC-8 EP |
| NCV890430 | 0.6                | Yes  | 45            | —                | DFN-8            |



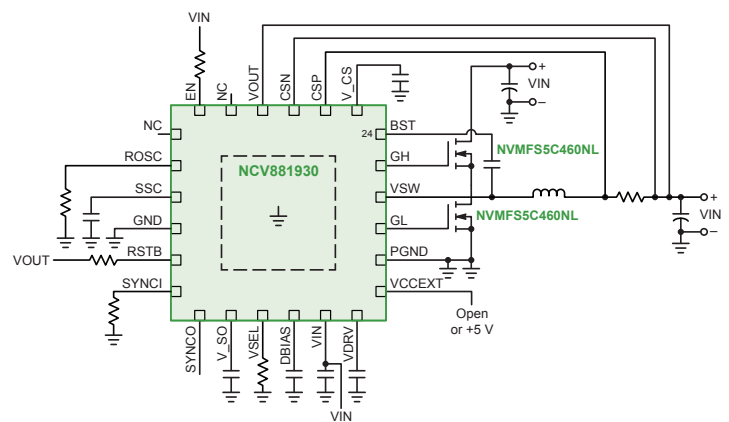
## Battery-Connected Low Iq Buck SMPS Controllers

The NCV891930 is a 2 MHz fixed-frequency, low quiescent current, synchronous buck controller with spread spectrum that operates up to 38 V (typical). The NCV891930 is capable of converting from an automotive input voltage range of 3.5 V (4.5 V during startup) to 18 V at a constant base switching frequency, eliminating the need for costly filters and EMI countermeasures. Several protection features such as UVLO, current limit, short circuit protection, and thermal shutdown are provided.

High switching frequency produces low output voltage ripple even when using small inductor values and an all-ceramic output filter capacitor, forming a space-efficient switching solution.

### Features

- Fixed output : 3.3, 3.65, 4.0 or 5.0 V
- 30  $\mu$ A operating current at no load
- 75 mV current limit sensing
- Wide input of 3.5 to 38 V with Over- and Undervoltage Lockout
- Input and output synchronization
- 2 MHz operation with spread spectrum capability
- Adaptive non-overlap circuitry
- Short Circuit Protection; Thermal Shutdown

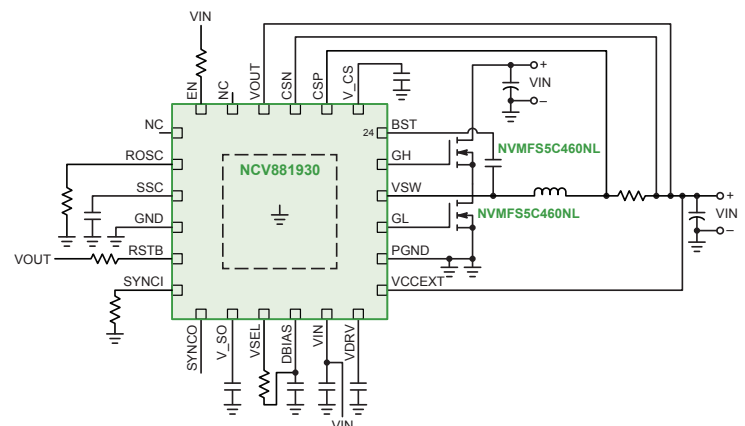


3.3 V Application Schematic Example

The NCV881930 is a 410 kHz fixed-frequency, low quiescent current, synchronous buck controller with spread spectrum that operates up to 38 V (typical). The NCV881930 is capable of converting from an automotive input voltage range of 3.5 V (4.5 V during startup) to 18 V at a constant base switching frequency. Several protection features such as UVLO, current limit, short circuit protection, and thermal shutdown are provided.

### Features

- Fixed output: 3.3 or 5.0 V
- 30  $\mu$ A operating current at no load
- 50 mV current limit sensing
- Wide input of 3.5 to 38 V with Over- and Undervoltage Lockout
- Input and output synchronization
- 410 kHz operation with spread spectrum capability
- Adaptive non-overlap circuitry
- Short Circuit Protection; Thermal Shutdown



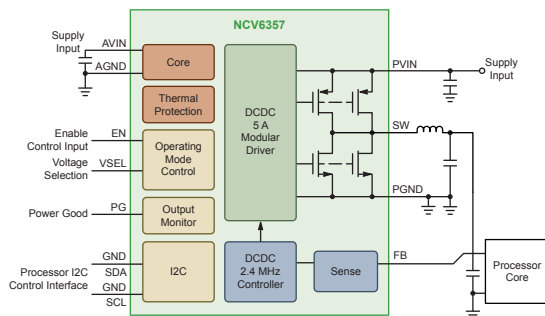
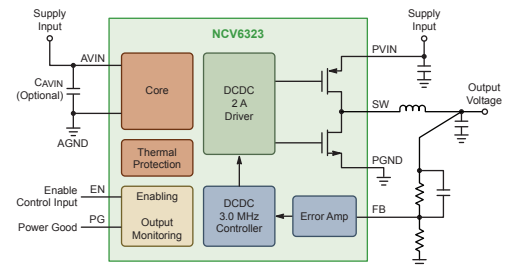
5 V Application Schematic Example

## Low Voltage Buck SMPS and PMU for Secondary Power Conversion

Supplied from a pre-regulated voltage rail, the low voltage buck SMPS and PMU support a wide variety of end applications such as clusters, cameras, radars and other peripherals.

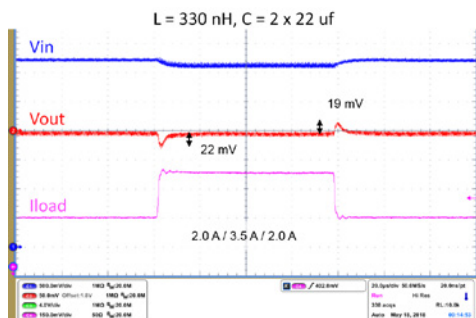
### NCV6323, NCV6324 – 2 A PFM/PWM Buck

NCV6323 and NCV6324 are adjustable monolithic synchronous buck converters with integrated power stage. They are able to deliver up to 2 A DC and operate in forced PWM (NCV6323) or in automatic PFM/PWM (NCV6324) for optimized low load efficiency. The devices come in a small DFN package, and the 3 MHz switching frequency allows the use of small size inductors and capacitors. They are therefore ideally suited for space constrained applications.



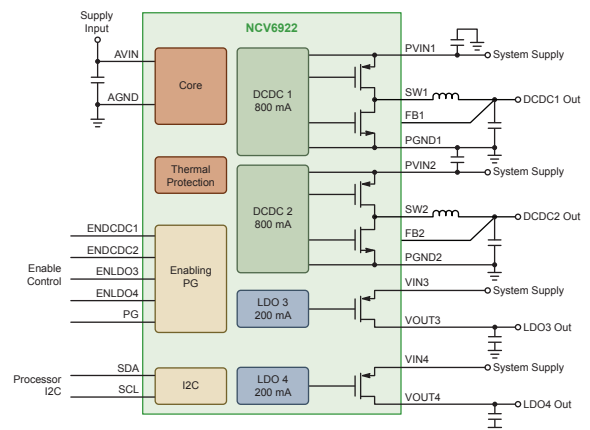
### NCV6356, NCV6357 – 5 A AOT Buck

NCV6356 and NCV6357 are programmable monolithic synchronous buck converters with integrated power stage and dynamic voltage scaling support. They are able to deliver up to 3 A DC at 105°C ambient and up to 6 A of peak current. Their adaptive constant-on-time architecture allows for the use of low valued inductors and provides a very fast transient load response (20 mV/1.5 A/500 ns) which makes them ideally suited for high performance applications. The NCV6356 comes with I2C and Interrupt pin; the NCV6357 with I2C and Power Good pin.



### NCV6922 – PMU 2 Buck 2 LDO

The NCV6922 is a low voltage PMU including 2 buck converters of 800 mA and 2 low dropout, low noise regulators of 200 mA. The device is fully programmable through I2C and also through factory programming. Virtually any power up sequence and output voltage combination can be created. The NCV6922 is ideally suited for surround and rearview camera designs in conjunction with ON Semiconductor image sensors.

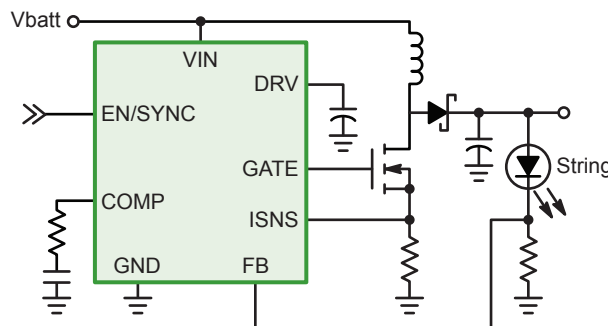


## Boost/Flyback/SEPIC SMPS Controllers

The highly flexible NCV8871, NCV8873, and NCV89803x controllers provide compact, easy to use, cost effective lighting solutions for boost, flyback, and SEPIC topologies. The devices operate over a wide input battery voltage range (3.2 V to 45 V), and feature a low shutdown current of under 10  $\mu$ A.

The NCV8871 and NCV8873 devices have factory programmable switching frequencies from 170 kHz to 1 MHz. The NCV8873 feedback voltage is set to 0.2 V in order to better fit applications where constant current regulation is desired, such as LED drivers. The NCV89803x has a set switching frequency of 2 MHz, which permits the use of smaller filter components for a lower cost system solution.

These devices provide integrated current limit, thermal shutdown, and under-voltage lockout, and are rated from -40°C to 150°C junction temperature.



**NCV8871xx Backlighting PWM Deep Dimming Application - Minimal External Components**

Additional performance combinations available with rapid prototyping. Factory programmable features:

- Fsw: 170 kHz to 1 MHz for NCV887x;  
170 kHz to 2 MHz for NCV89803x
- Minimum on-time
- Max duty cycle
- Slope compensation
- Current limit
- Gate drive voltage
- Gate drive strength



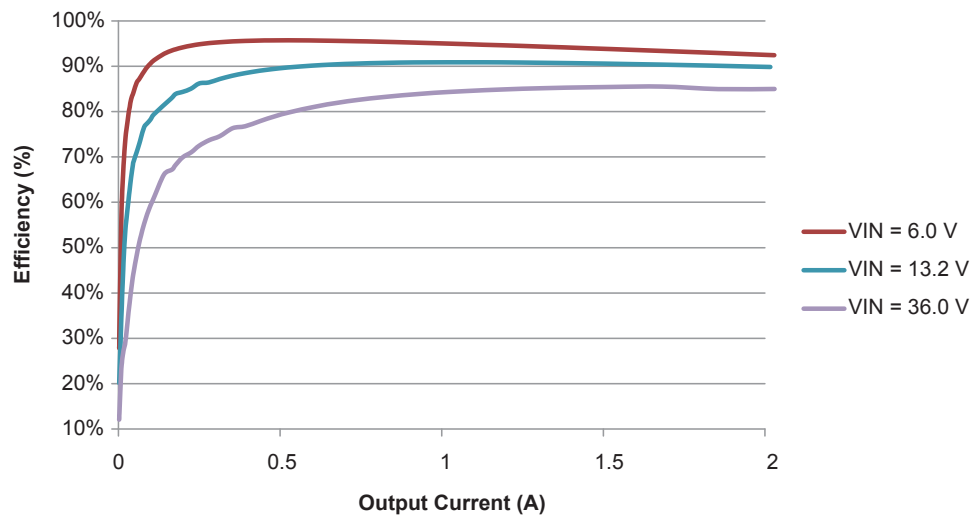
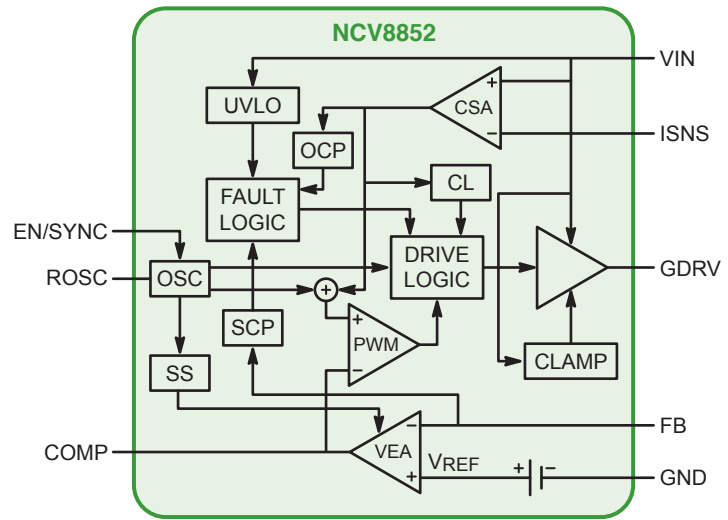


## Low Dropout Buck SMPS for System Supply

NCV8852 and NCV8853 adjustable-output non-synchronous buck controllers drive an external P-channel MOSFET. The devices use peak current mode control with internal slope compensation, and incorporate an internal regulator that supplies charge to the gate driver.

### Features

- Ultra low Iq sleep mode
- Adjustable output with 800 mV  $\pm 2\%$  reference voltage
- Wide input of 3.1 to 44 V
- Internal Soft-Start
- Undervoltage lockout
- External frequency synchronization
- 100% max duty cycle
- Programmable cycle-by-cycle current limit
- Hiccup overcurrent protection
- Hiccup short circuit protection



The NCV887xx portfolio comprises a Non-Synchronous Pre-Boost controller family designed to supply a minimum output voltage during Start-Stop vehicle operation and other battery voltage sags. The controllers drive an external N-channel MOSFET.

- Wide Input Voltage Range of 2 V to 40 V, 45 V Load Dump
- Automatic Enable Below Wake Up Threshold Voltage (Factory Programmable)
- Factory programmable frequency options or frequency adjust resistor option
- Boost Mode Operation at Regulation Set Point
- 2% Output Accuracy Over Temperature Range
- Peak Current Mode Control with Internal Slope Compensation
- Low Quiescent Current in Sleep Mode ( $<12 \mu\text{A}$  Typical)



| Device    | V <sub>out</sub> (V) | Frequency (kHz) | Slope Compensation (mV/μs) | Current Limit (mV) | Osc Frequency Adjust | Status Pin | Disable Pin | Package(s) |
|-----------|----------------------|-----------------|----------------------------|--------------------|----------------------|------------|-------------|------------|
| NCV887600 | 6.8                  | 170             | 34                         | 400                | ✓                    | ✓          |             | SOIC-8     |
| NCV887601 | 6.8                  | 170             | 53                         | 200                | ✓                    | ✓          |             | SOIC-8     |
| NCV887700 | 6.8                  | 170             | 34                         | 400                | ✓                    |            | ✓           | SOIC-8     |
| NCV887701 | 6.8                  | 170             | 53                         | 200                | ✓                    |            | ✓           | SOIC-8     |
| NCV887720 | 10                   | 170             | 53                         | 200                | ✓                    |            | ✓           | SOIC-8     |
| NCV887740 | 12                   | 170             | 53                         | 200                | ✓                    |            | ✓           | SOIC-8     |
| NCV887801 | 6.8                  | 450             | 53                         | 200                |                      | ✓          | ✓           | SOIC-8     |



## Current Sense LDO and High Side Switch Applications

Current sense LDO linear voltage regulators and High Side Switches (HSS) provide precise current limiting, which can be adjusted for particular application requirements. These devices provide diagnostic information to control MCUs, either as analog or digital outputs, enabling the MCU to implement required steps (e.g., switch off the LDO or HSS with overloaded or unloaded output, or short to battery). Both current sense and diagnostic features are particularly useful for off-the-module loads, when it is necessary to know the status of an external load and take appropriate actions. Typical applications are: active antenna, camera module and microphone. Current sense LDOs and HSS also provide reverse battery, reverse bias, short-to-battery, short-to-ground, and thermal shutdown protection features.

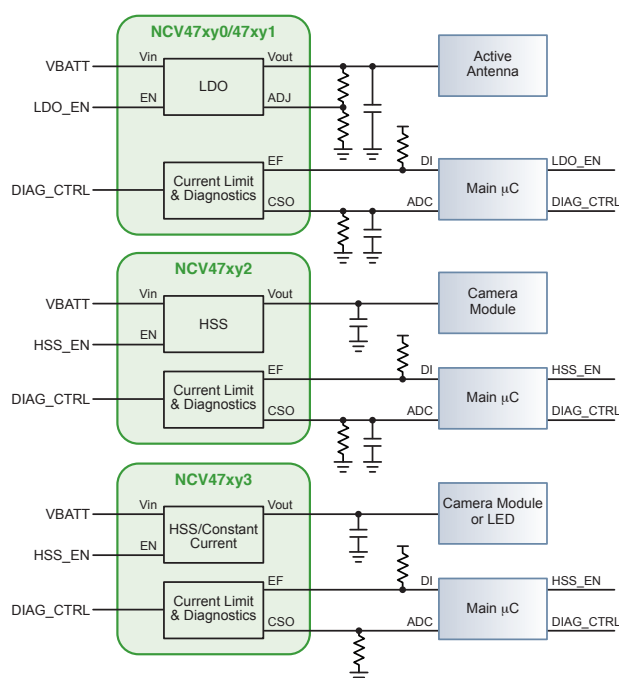


The current limit of the device is adjustable by a resistor connected to CSO pin. The current flowing out of CSO pin is proportional to the output current, and its guaranteed ratio and precision is shown in the table Current Sense Regulators/Switches. This information can be processed by ADC converter of MCU. Error Flag is open collector output and it provides digital signal to MCU indicating open load, overcurrent, short to ground or short to battery information, and it can be processed by digital input of MCU.

The NCV47xx0 and NCV47xx1 product families are Current Sense LDOs with analog or analog/digital diagnostics. These are primarily used for supplying active antennae or microphones.

The NCV47xx2 product families are Current Sense HSS parts with analog and digital diagnostics. These are primarily used for supplying out of module loads (e.g. camera module).

The NCV47xx3 product families are Current Sense HSS/Constant Current parts with analog and digital diagnostics. These parts have enhanced current limitation features eliminating input inrush current and very low reverse bias currents, and are primarily used for supplying out of module loads (e.g. camera module) or constant current loads (e.g. LEDs). Only RCSO is required for current limitation.



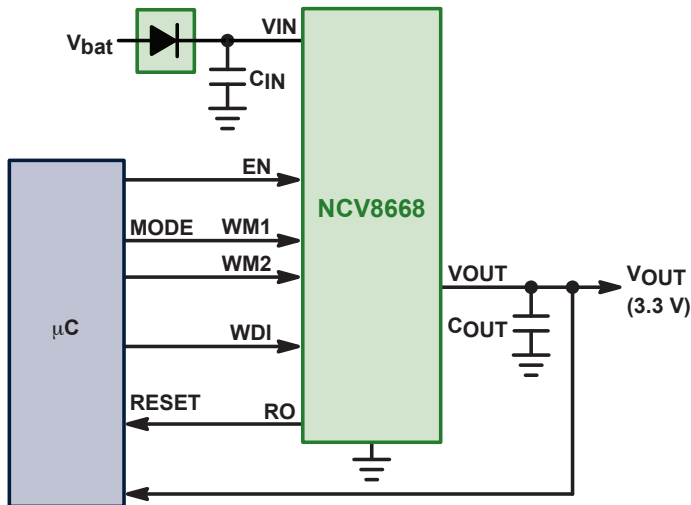
### Current Sense Regulators/Switches

| Device            | Output Current (mA) | Output Voltage (V)        | Dropout Max (mV) | Sleepmode Current Max (µA) | Quiescent Current (Max) @ Low Load (Load) | Current Mirror Precision | Current Mirror Ratio | Error Flag | Package(s)        |
|-------------------|---------------------|---------------------------|------------------|----------------------------|---|--------------------------|----------------------|------------|-------------------|
| NCV47551          | 20                  | Adj                       | 500              | 10                         | 380 µA (100 µA)                           | ±10%                     | 1:1                  |            | SOIC-8            |
| NCV47411          | 2x 100              | Dual Adj                  | 550              | 10                         | 370 µA (500 µA)                           | ±10%                     | 50:1                 |            | TSSOP-14 EP       |
| NCV47721          | 200                 | Adj                       | 500              | 10                         | 1 mA (500 µA)                             | ±5%                      | 100:1                | ✓          | TSSOP-14 EP       |
| NCV47821          | 2x 200              | Dual Adj                  | 500              | 10                         | 1 mA (500 µA)                             | ±5%                      | 100:1                | ✓          | TSSOP-14 EP       |
| NCV47722          | 250                 | High Side Switch          | 400              | 10                         | 1.3 mA (500 µA)                           | ±5%                      | 300:1                | ✓          | TSSOP-14 EP       |
| NCV47822          | 2x 250              | Dual High Side Switch     | 400              | 10                         | 1.5 mA (500 µA)                           | ±5%                      | 300:1                | ✓          | TSSOP-14 EP       |
| NCV47823          | 2x 250              | Dual HSS/Constant Current | 400              | 20                         | 1.5 mA (500 µA)                           | ±5%                      | 300:1                | ✓          | TSSOP-14 EP       |
| NCV47700/10/01/11 | 350                 | Adj                       | 500              | 10                         | 230 µA (1 mA)                             | ±10%                     | 100:1                |            | SOIC-8, SOIC-8 EP |

## Watchdog and Tracking LDOs for Power Supplies

### Watchdog LDOs

Watchdog LDOs from ON Semiconductor deliver 150 to 250 mA load current, and provide supervision of an external single sided or window watchdog, for microcontroller-based automotive applications. The portfolio provides integrated protection features, such as peak transients, current limit, thermal shutdown, and in most cases allows -40°C to 150°C operating junction temperature.

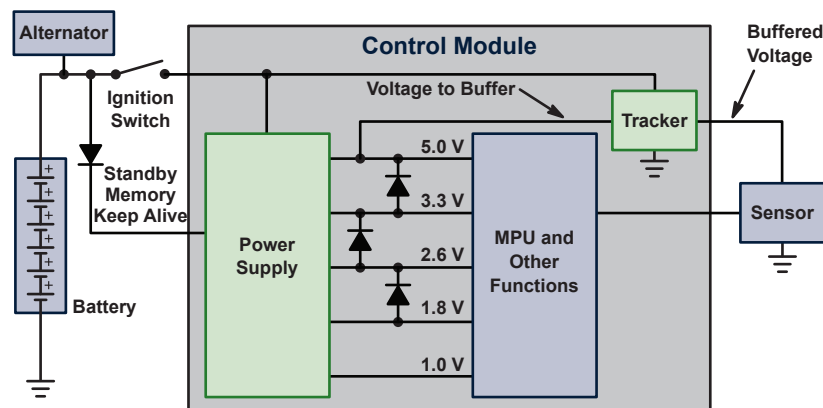


The NCV8518B 250 mA LDO voltage regulator incorporates a watchdog feature which continuously monitors the WDI input from the microprocessor in order to determine the output state.

The NCV8668 and NCV8768 are 150 mA LDO regulators that feature low typical  $I_q$  of 38  $\mu$ A and 31  $\mu$ A respectively during sleep mode, and include window watchdog functionality.

### Tracking LDOs

Engine controllers must provide fully regulated, buffered power supply rails to power external sensors. Also known as tracking regulators, these devices must be fully protected from external faults, such as short to GND, short to battery, and reverse battery; and should still provide regulated output with very close tracking of the reference voltage. ON Semiconductor offers a wide range of single and dual tracking regulators – including CS8182, CS8361, NCV8184, and NCV4250-2C – with various output current and package options for automotive engine controller applications.



Buffering Voltage to Send it Outside of a Module to a Sensor

## Wide Selection of Automotive Qualified Linear Regulators

### Post Regulation Linear Regulators

| Device    | Output Current | Output Voltage (V)                                  | Dropout Max | Sleepmode Current Max (μA) | Quiescent Current (Max) @ Low Load (Load) | Tolerance (%) | Enable | Package(s)              |
|-----------|----------------|---|-------------|----------------------------|---|---------------|--------|-------------------------|
| NCV8715   | 50 mA          | 1.2, 1.5, 1.8, 2.5, 3.0, 3.3, 5.0                   | 260 mV      | —                          | 4.7 μA                                    | ±2            |        | XDFN-6                  |
| NCV8716   | 80 mA          | 1.5, 1.8, 2.5, 3.0, 3.3, 5.0                        | 400 mV      | —                          | 4.7 μA                                    | ±2            |        | WDFN-6                  |
| NCV662    | 100 mA         | 1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5                | 300 mV      | 1                          | 6 μA (1 mA)                               | ±4            | ✓      | SC-82                   |
| NCV663    | 100 mA         | 1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.3, 5                | 300 mV      | —                          | 6 μA (1 mA)                               | ±4            |        | SC-82                   |
| NCV78LxxA | 100 mA         | 5, 8, 12, 15, 24                                    | 1.7 V (Typ) | —                          | —   | ±4            |        | SOIC-8, TO-92           |
| NCV551    | 150 mA         | 1.4, 1.5, 1.8, 2.5, 2.7, 2.8, 3.0, 3.1, 3.2, 3.3, 5 | 220 mV      | 1                          | 8 μA (1 mA)                               | ±3            | ✓      | TSOP-5                  |
| NCV571    | 150 mA         | 0.8, 0.9, 1.0, 1.2                                  | 450 mV      | 1                          | 8 μA (150 mA)                             | ±4            | ✓      | TSOP-5, DFN-6           |
| NCV8560   | 150 mA         | Adj., 1.3, 1.5, 1.8, 2.5, 2.8, 3.0, 3.3, 3.5, 5     | 125 mV      | 1                          | 180 μA (150 mA)                           | ±2            | ✓      | DFN-6, TSOP-5           |
| NCV8152   | 150 mA         | 1.8/2.8, 2.8/1.8, 3.0/1.8, 3.3/1.8                  | 140 mV      | 1                          | 50 μA (100 μA)                            | ±3            | ✓      | XDFN-6                  |
| NCV8170   | 150 mA         | 1.2, 1.5, 1.8, 2.5, 2.8, 3.0, 3.1, 3.3, 3.3         | 350 mV      | 1                          | 50 μA (90 μA)                             | ±2            | ✓      | XDFN-4, SOT-563         |
| NCV8702   | 200 mA         | 1.8, 2.8, 3.0, 3.3                                  | 140 mV      | 1                          | 60 μA (1 mA)                              | ±2            | ✓      | DFN-6, TSOP-5           |
| NCV8570B  | 200 mA         | 1.8, 2.5, 2.8, 3.0, 3.3                             | 155 mV      | 1                          | 75 μA (1 mA)                              | ±2            | ✓      | DFN-6, TSOP-5           |
| NCV8752   | 200 mA         | 1.8, 2.8, 3.0, 3.3                                  | 140 mV      | 1                          | 12 μA                                     | ±2            | ✓      | XDFN-6, TSOP-6          |
| NCV8160   | 250 mA         | 1.8, 2.5, 2.8, 2.9, 3.0, 3.3                        | 90 mV       | 1                          | 18 μA                                     | ±2            | ✓      | XDFN-4                  |
| NCV8163   | 250 mA         | 1.2, 1.5, 1.8, 2.1, 2.5, 2.8, 3.0, 3.3              | 80 mV       | 1                          | 12 μA                                     | ±2            | ✓      | XDFN-2                  |
| NCV8703   | 300 mA         | 1.8, 2.8, 3.0, 3.3                                  | 180 mV      | 1                          | 60 μA (1 mA)                              | ±2            | ✓      | DFN-6, TSOP-5           |
| NCV8114   | 300 mA         | 1.2, 1.5, 1.8, 2.5, 2.8, 3.0, 3.3                   | 135 mV      | 1                          | 55 μA (95 μA)                             | ±2            | ✓      | TSOP-5                  |
| NCV8154   | 300 mA         | 3.0/3.0, 3.3/1.8, 1.8/2.8, 3.3/3.3                  | 140 mV      | 1                          | 55 μA (100 μA)                            | ±3            | ✓      | DFN-10                  |
| NCV8718   | 300 mA         | Adj.  | 300 mV      | 1                          | 4 μA                                      | ±2            | ✓      | WDFN-6                  |
| NCV8130   | 300 mA         | 0.8, 1.0, 1.1, 1.2, 1.3, 1.5, 1.8                   | 150 mV      | 1                          | 80 μA                                     | ±1.5          | ✓      | XDFN-6                  |
| NCV8720   | 350 mA         | 1.0, 1.05, 1.10, 1.15, 1.2, 1.25, 1.3, 1.4, 1.45    | 110 mV      | 1                          | —   | ±2            | ✓      | WDFN-6                  |
| NCV8161   | 450 mA         | 1.8, 2.5, 2.8, 2.9, 3.0, 3.3                        | 225 mV      | 1                          | 18 μA                                     | ±2            | ✓      | XDFN-4                  |
| NCV78MxxA | 500 mA         | 5   | **          | —                          | **  | ±4            |        | DPAK-3                  |
| NCV5501   | 500 mA         | 1.5, 3.3, 5   | 700 mV      | —                          | 500 μA (100 μA)                           | ±4.9          |        | DPAK-3                  |
| NCV5500   | 500 mA         | Adj, 1.5, 3.3, 5                                    | 700 mV      | 50                         | 500 μA (100 μA)                           | ±4.9          | ✓      | SOIC-8, DPAK-5          |
| NCV8133   | 500 mA         | 0.8, 1.0, 1.1, 1.2, 1.3, 1.5, 1.8                   | 140 mV      | 1                          | 80 μA                                     | ±1.5          | ✓      | XDFN-6                  |
| NCV8535   | 500 mA         | Adj, 1.5, 1.8, 2.5, 2.8, 2.85, 3.0, 3.3, 5          | 340 mV      | 1                          | 190 μA (100 μA)                           | ±1.5          | ✓      | DFN-10                  |
| NCV8537   | 500 mA         | Adj, 1.8, 2.5, 3.3, 5.0                             | 340 mV      | 1                          | 190 μA (100 μA)                           | ±1.5          | ✓      | DFN-10                  |
| NCV8177   | 500 mA         | 0.75, 1.2, 1.5, 1.8, 2.5, 3.3,                      | 200 mV      | —                          | 60 μA (90 μA)                             | ±2            | ✓      | XDFN-4                  |
| NCV33269  | 800 mA         | Adj, 3.3, 5, 12                                     | 1.35 V      | —                          | —   | ±2            |        | DPAK-3                  |
| NCV78xxA  | 1 A            | 5, 12   | **          | —                          | —   | ±4            |        | D2PAK-3, TO-220         |
| NCV8186   | 1 A            | 1.2, 1.75, 1.8, 1.85, 2.5, 2.8, 3.3, 3.5, 3.9       | 100 mV      | —                          | 90 μA (140 μA)                            | ±1            | ✓      | XDFN-8                  |
| NCV1117   | 1 A            | Adj, 1.5, 1.8, 2, 2.5, 3.3, 5, 12                   | 1.2 V       | —                          | —   | ±2            |        | DPAK-3, SOT-223         |
| NCV5661   | 1 A            | Adj, 1.2, 1.5, 1.8, 2.5, 2.8, 3.0, 3.3              | 1.3 V       | 300                        | —   | ±2            | ✓      | DPAK-5, DFN-6           |
| NCV59152  | 1.5 A          | Adj, 1.8, 2.5, 2.8, 3.0, 3.3, 5.0                   | 500 mV      | 5                          | —   | ±1.5          | ✓      | DFN-8, D2PAK-3, D2PAK-5 |
| NCV59748  | 1.5 A          | Adj.  | 60 mV       | —                          | —   | ±2            | ✓      | DFN-10                  |
| NCV5662   | 2 A            | Adj, 1.5  | 1.3 V       | 300                        | —   | ±2            | ✓      | D2PAK-5                 |
| NCV59744  | 3 A            | Adj.  | 115 mV      | —                          | —   | ±2            | ✓      | QFN20                   |
| NCV59302  | 3 A            | Adj, 1.8, 2.5, 2.8, 3.0, 3.3, 5.0                   | 500 mV      | 5                          | —   | ±2            | ✓      | D2PAK-5                 |
| NCV5663   | 3 A            | Adj, 1.5  | 1.3 V       | 300                        | —   | ±2            | ✓      | D2PAK-5                 |

\*\* See data sheet for details.

### Tracking Regulators

| Device     | Output Voltage | Tolerance      | Output Current   | Dropout Max    | Sleepmode Current Max | Quiescent Current [Max] @ Low Load (Load) | Enable | Reset | Current Limit | Overvoltage Shutdown | Overtemperature | Peak Transient (V) | Package(s)                    |
|------------|----------------|----------------|------------------|----------------|-----------------------|---|--------|-------|---------------|----------------------|-----------------|--------------------|-------------------------------|
| NCV4250-2C | Tracking       | ±5 mV          | 50 mA            | 0.3 V          | 20 μA                 | 150 μA (1 mA)                             | ✓      |       | ✓             |                      | ✓               | 45                 | TSOP-5                        |
| CS8182     | Tracking       | ±10 mV         | 200 mA           | 0.6 V          | 55 μA                 | 150 μA (100 μA)                           | ✓      |       | ✓             |                      | ✓               | 45                 | DPAK-5, D2PAK-5, SOIC-8 Fused |
| CS8361     | Tracking 5 V   | ±25 mV<br>±2 % | 250 mA<br>100 mA | 0.7 V<br>0.6 V | 200 μA                | 200 μA (300 μA)                           | ✓      | ✓     | ✓             | ✓                    | ✓               | 60                 | D2PAK-7,<br>SOIC-16 Fused     |
| NCV4254C   | Tracking       | ±3 mV          | 70 mA            | 0.4 V          |                       | 80 μA (100 μA)                            | ✓      |       | ✓             |                      | ✓               | 45                 | SOIC-8, SOIC-8 ePad           |

## Wide Selection of Automotive Qualified Linear Regulators

### Battery Connected Linear Regulators

| Device     | Output Current | Output Voltage (V)      | Dropout Max (V) | Sleepmode Current Max (μA) | Quiescent Current (Max) @ Low Load (Load) | Tolerance (%) | Enable | Package(s)                              |
|------------|----------------|-------------------------|-----------------|----------------------------|---|---------------|--------|---|
| NCV4294C   | 30 mA          | 3.3, 5                  | 0.25            | —                          | 170 μA (100 μA)                           | ±4            |        | TSOP-5                                  |
| NCV4295C   | 30 mA          | 3.3, 5                  | 0.25            | —                          | 170 μA (100 μA)                           | ±4            |        | TSOP-5                                  |
| NCV4296-2C | 30 mA          | 3.3, 5                  | 0.25            | 1                          | 170 μA (100 μA)                           | ±4            | ✓      | TSOP-5                                  |
| NCV4949C   | 100 mA         | 5                       | 0.5             | —                          | 260 μA (300 μA)                           | ±2            |        | SOIC-8, SOIC-8 EP                       |
| NCV2951A   | 100 mA         | Adj, 3.3, 5             | 0.45            | —                          | 120 μA (100 μA)                           | ±1.5          | ✓      | SOIC-8                                  |
| NCV317L    | 100 mA         | Adj                     | 1.9 (Typ)       | —                          | —   | ±4            |        | SOIC-8, TO-92                           |
| NCV4299C   | 150 mA         | 3.3, 5                  | 0.5             | 1                          | 95 μA (100 μA)                            | ±2            | ✓      | SOIC-8, SOIC-14                         |
| NCV4279C   | 150 mA         | 5                       | 0.5             | —                          | 250 μA (1 mA)                             | ±2            |        | SOIC-14                                 |
| NCV4269C   | 150 mA         | 5                       | 0.5             | —                          | 250 μA (1 mA)                             | ±2            |        | SOIC-8, SOIC-8 EP, SOIC-14, TSSOP-14 EP |
| NCV4266-2C | 150 mA         | 3.3, 5                  | 0.5             | 1                          | 70 μA (100 μA)                            | ±2            | ✓      | SOT-223                                 |
| NCV4264-2C | 150 mA         | 3.3, 5                  | 0.5             | —                          | 70 μA (100 μA)                            | ±2            |        | SOT-223                                 |
| NCV8669    | 150 mA         | 5                       | 0.6             | —                          | 50 μA (150 mA)                            | ±2            |        | SOIC-14                                 |
| NCV8668    | 150 mA         | 3.3, 5                  | 0.6             | 1                          | 44 μA (100 μA)                            | ±2            | ✓      | SOIC-8, SOIC-8 EP, SOIC-14              |
| NCV8664C   | 150 mA         | 3.3, 5                  | 0.6             | —                          | 30 μA (100 μA)                            | ±2            |        | SOT-223, DPAK-3                         |
| NCV8660B   | 150 mA         | 3.3, 5                  | 0.6             | —                          | 40 μA (150 mA)                            | ±2            |        | DPAK-5, SOIC-8                          |
| NCV8502    | 150 mA         | Adj, 2.5, 3.3, 5, 8, 10 | 0.6             | —                          | 75 μA (100 μA)                            | ±2            |        | SOIC-8, SOIC-16 EP                      |
| NCV8501    | 150 mA         | Adj, 2.5, 3.3, 5, 8, 10 | 0.6             | 30                         | 75 μA (100 μA)                            | ±2            | ✓      | SOIC-8, SOIC-16 EP                      |
| NCV8508B   | 250 mA         | 3.3, 5                  | 0.9             | —                          | 150 μA (150 mA)                           | ±3            |        | SOIC-8 EP, D2PAK-7                      |
| NCV8518B   | 250 mA         | 5                       | 0.75            | 1                          | 150 μA (150 mA)                           | ±2            | ✓      | SOIC-8 EP, SOIC-16 EP                   |
| NCV8674    | 350 mA         | 5                       | 0.6             | —                          | 38 μA (100 μA)                            | ±2            |        | D2PAK-3                                 |
| NCV8675    | 350 mA         | 3.3, 5                  | 0.6             | —                          | 50 μA (100 μA)                            | ±2, ±2.5      |        | DPAK-5, D2PAK-5                         |
| NCV8772    | 350 mA         | 3.3, 5                  | 0.875           | 1                          | 30 μA (350 mA)                            | ±1.5          | ✓      | D2PAK-7, D2PAK-5, DPAK-5                |
| NCV4274C   | 400 mA         | 3.3, 5                  | 0.5             | —                          | 250 μA (1 mA)                             | ±2            |        | SOT-223, DPAK-3, D2PAK-3                |
| NCV4276C   | 400 mA         | Adj, 3.3, 5             | 0.5             | 10                         | 220 μA (1 mA)                             | ±2            | ✓      | DPAK-4, D2PAK-5                         |
| NCV8506    | 400 mA         | Adj, 2.5, 3.3, 5        | 0.6             | —                          | 150 μA (100 μA)                           | ±2            |        | D2PAK-7                                 |
| NCV8505    | 400 mA         | Adj, 2.5, 3.3, 5        | 0.6             | 1                          | 350 μA (100 μA)                           | ±2            | ✓      | D2PAK-7                                 |
| NCV8504    | 400 mA         | Adj, 2.5, 3.3, 5        | 0.6             | —                          | 150 μA (100 μA)                           | ±2            |        | SOIC-16 EP                              |
| NCV8503    | 400 mA         | Adj, 2.5, 3.3, 5        | 0.6             | 1                          | 350 μA (100 μA)                           | ±2            | ✓      | SOIC-16 EP                              |
| NCV4275C   | 450 mA         | 3.3, 5                  | 0.5             | —                          | 200 μA (1 mA)                             | ±2            |        | DPAK-5, D2PAK-5                         |
| NCV8141    | 500 mA         | 5                       | 1.5             | 50                         | **  | ±3            | ✓      | D2PAK-7                                 |
| NCV317M    | 500 mA         | Adj                     | 2.2 (Typ)       | —                          | —   | ±4            |        | DPAK-3                                  |
| NCV33269   | 800 mA         | Adj, 3.3, 5, 12         | 1.35            | —                          | —   | ±2            |        | DPAK-3                                  |
| NCV317     | 1.5 A          | Adj                     | 2.25 (Typ)      | —                          | —   | ±4            | ✓      | D2PAK-3, TO-220                         |

\*\* See data sheet for details.

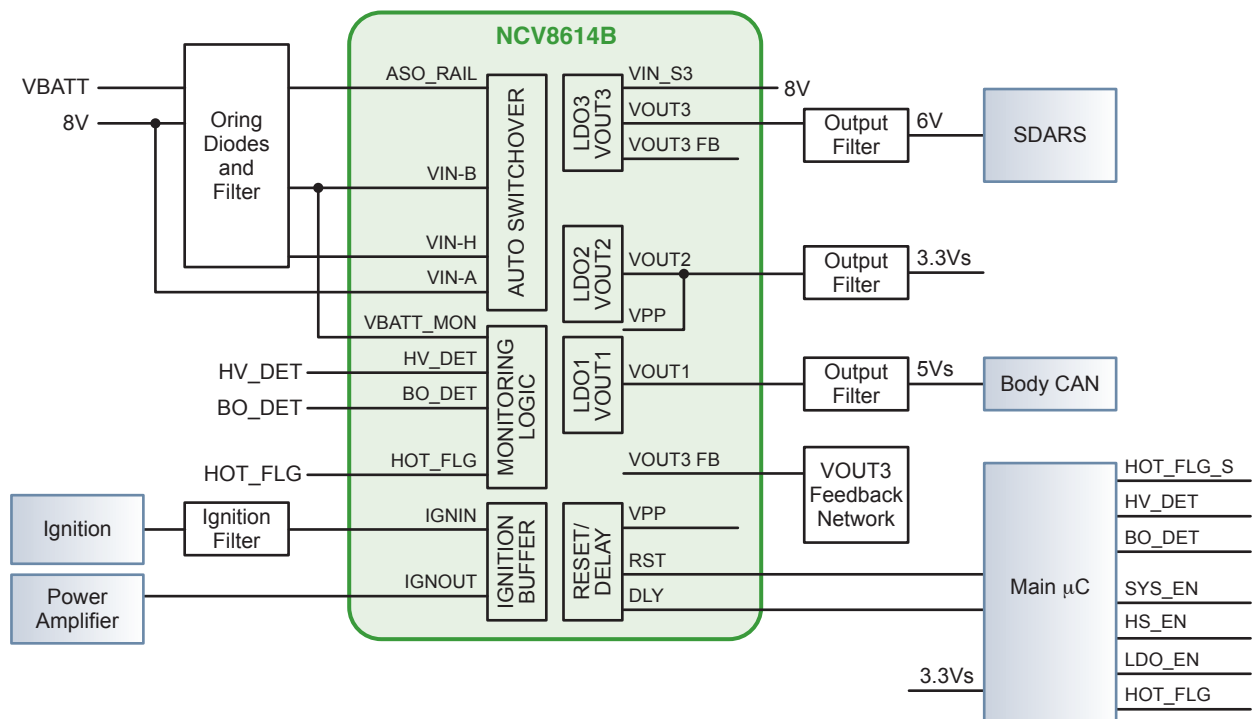


## Chipsets for Audio Power Management

The NCV8614B power management unit is optimized for power supplies - integrating LDOs, SMPSSs, high side switches, buffers, and I/Os - delivering solution cost and size reductions.

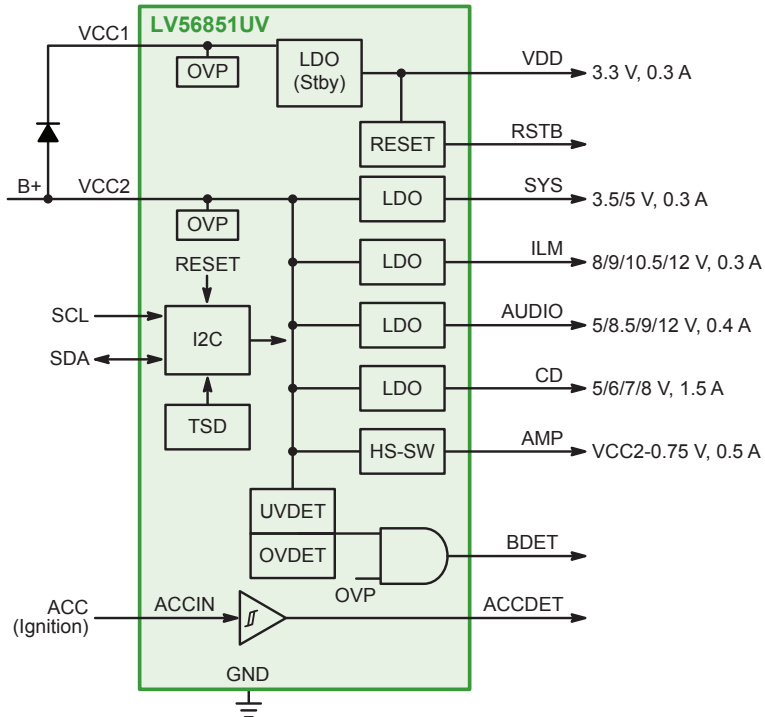
The NCV8614B multiple output linear regulator with Automatic Switchover (ASO) input voltage selector is specifically designed to address automotive radio systems power supply requirements. The NCV8614B supplies power to various “always on” loads such as the CAN transceivers and microcontrollers (core, memory and I/O). The ASO circuit selects between three different input voltage sources to reduce power dissipation.

There are possible different output voltages, currents and feature configurations customized for particular applications.



## Multiple Voltage Regulators for Audio Subsystems

The LV56851UV multiple power supply for audio systems incorporates five LDOs and one high-side switch. Integrated accessory detector, battery voltage detector, and reset function reduce system parts count.



### LV56851UV Features

- 5 Regulators, 1 VCC high-side switches
- Maximum surge peak voltage 50 V
- Low consumption current
- Battery voltage detector
- Accessory voltage detector
- Reset function
- Thermal warning
- Over-current, over-voltage, and over-heat protection
- I2C-bus communication interface
  - Output enable/disable
  - Detector voltage setting
  - Read back
- Low thermal resistance HZIP-15 ( $\theta_{jc} = 2.5^{\circ}\text{C/W}$ )

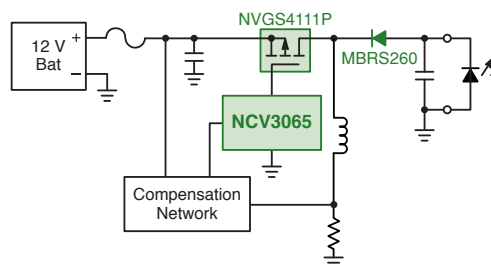
### Multiple Output Power Supplies

| Device     | Operating Voltage (V) | Istby Max (μA)    | Vstby             | REG1             | REG2                   | REG3                  | REG4            | REG5 | REG6           | High Side (mA)            | Package(s) |          |
|------------|-----------------------|-------------------|-------------------|------------------|------------------------|-----------------------|-----------------|------|----------------|---------------------------|------------|----------|
| LV5680NPVC | 10 - 16               | 800               | 5.0 V, 200 mA     | 8 V, 1.3 A       | 8-9 V (Adj), 300 mA    | 8-12 V (Adj), 300 mA  | —               | —    | —              | 350, 300                  | HZIP-15J   |          |
| LV5681P    |                       |                   | 5.7 V, 200 mA     | 7 V, 1.3 A       |                        |                       |                 |      |                |                           |            |          |
| LV56801P   |                       |                   | 3.3 V, 200 mA     | 8 V, 1.3 A       |                        |                       |                 |      |                |                           |            |          |
| LV5683P    |                       | 100               | 3.3/5.0 V, 300 mA | 5/8 V, 1.1 A     | 8.5 V, 400 mA          | —                     | 3.3 V, 500 mA   | —    | —              | —                         | HZIP-15    |          |
| LV56831P   |                       |                   |                   | —                |                        | 12 V, 500 mA          | 3.3/5 V, 500 mA |      |                |                           |            |          |
| LV5684NPVD |                       |                   | 3.3 V, 350 mA     | 5/8 V, 1.3 A     | 5-12 V (Adj), 250 mA   | 5-12 V (Adj), 300 mA  | 3.3 V, 450 mA   | —    | —              | 350, 300                  |            |          |
| LV56841PVD |                       |                   |                   | 6 V, 1.5 A       | 5-12 V (Adj), 300 mA   |                       | 3.3 V, 350 mA   |      |                | 500, 300                  |            |          |
| LV5685PV   |                       |                   | 3.3 V, 350 mA     | 5/6/7/8 V, 1.3 A | 5/8.5/9/11.5 V, 250 mA | 5/8/10.5/12 V, 300 mA | 3.3/5 V, 450 mA | —    | —              | 350, 300                  |            |          |
| LV56851UV  |                       |                   | 3.3 V, 300 mA     | 5/6/7/8 V, 1.5 A | 5/8.5/9/12 V, 400 mA   | 8/9/10.5/12 V, 300 mA | 3.3/5 V, 300 mA | —    | —              | 500                       |            |          |
| LV5686PVC  |                       |                   | 5.0 V, 300 mA     | —                | 9.0 V, 500 mA          | 9.85 V, 300 mA        | —               | —    | —              | 300 x 2, 350 x 1, 500 x 3 |            |          |
| LV5692P    |                       |                   | 3.3 V, 300 mA     | 8 V, 1.3 A       | 8.4 V, 500 mA          | 8.4 V, 500 mA         | 3.3 V, 300 mA   | —    | Ext FET Driver | 500                       |            | HZIP-15J |
| LV5693P    |                       |                   | 5.7 V, 300 mA     |                  |                        |                       |                 |      |                |                           |            |          |
| LV5694P    |                       | 3.3/5.0 V, 300 mA | 7.6/8.1 V, 2.0 A  | 8.45 V, 800 mA   | 9.0 V, 500 mA          | —                     | 5 V, 500 mA     | —    | 500, 350       |                           |            |          |
| LV5695P    |                       |                   | 8 V, 2.0 A        |                  | 8.5 V, 500 mA          |                       |                 |      |                |                           |            |          |
| LV5696P    |                       | 3.3/5.0 V, 200 mA | 8 V, 1.0 A        | 8.5 V, 300 mA    | 3-8 V (Adj), 200 mA    | 3.3 V, 800 mA         |                 |      |                | 200                       |            |          |

## Switching Regulators and Controllers

### Features

- >2 MHz Switching Frequency
- External Synchronization
- PowerGood & ENABLE
- Wide input voltage range
- Low quiescent current



### Switching Regulators

| Device    | I <sub>OUT</sub> (A) | f <sub>sw</sub> (kHz) | V <sub>in</sub> Min (V) | V <sub>in</sub> Max (V) | Comments   | Package                  |
|-----------|----------------------|-----------------------|-------------------------|-------------------------|--|--------------------------|
| NCV2574   | 0.5                  | 52                    | 4.75                    | 40                      | Internal compensation  | SOIC-16W                 |
| NCV2575   | 1.0                  | 52                    | 4.75                    | 40                      | Internal compensation  | D2PAK                    |
| NCV890100 | 1.2                  | 2000                  | 4.5                     | 40                      | —  | DFN-8                    |
| NCV890101 | 1.2                  | 2000                  | 4.5                     | 40                      | —  | DFN-10                   |
| NCV8843   | 1.5                  | Up to 700             | 4                       | 40                      | V <sup>2</sup>   | SOIC-8, SOIC-16W, DFN-18 |
| NCV3063   | 1.5                  | Up to 250             | 3                       | 40                      | High f <sub>sw</sub> for optimized size & efficiency         | DFN-8, SOIC-8, PDIP-8    |
| NCV3064   | 1.5                  | Up to 250             | 3                       | 40                      | High f <sub>sw</sub> for optimized size & efficiency; Enable | DFN-8, SOIC-8, PDIP-8    |
| NCV3065   | 1.5                  | Up to 250             | 3                       | 40                      | LED driver   | DFN-8, SOIC-8, PDIP-8    |
| NCV3066   | 1.5                  | Up to 250             | 3                       | 40                      | LED driver with ENABLE                                       | DFN-8, SOIC-8, PDIP-8    |
| NCV33063  | 1.5                  | 100                   | 3                       | 40                      | Buck, Boost SEPIC  | SOIC-8                   |
| NCV51411  | 1.5                  | 260                   | 4.5                     | 40                      | V <sup>2</sup> , SYNC  | DFN-18, SOIC-16W, SOIC-8 |
| NCV5171   | 1.5                  | 260                   | 2.7                     | 30                      | Boost, Flyback, SEPIC  | SOIC-8                   |
| NCV5173   | 1.5                  | 560                   | 2.7                     | 30                      | Boost, Flyback, SEPIC  | SOIC-8                   |
| NCV3163   | 3.4                  | Up to 300             | 2.5                     | 40                      | High f <sub>sw</sub> for optimized size & efficiency         | DFN-18, SOIC-16W         |
| NCV33163  | 3.4                  | Up to 150             | 2.5                     | 60                      | High input voltage   | SOIC-16W, PDIP-16        |

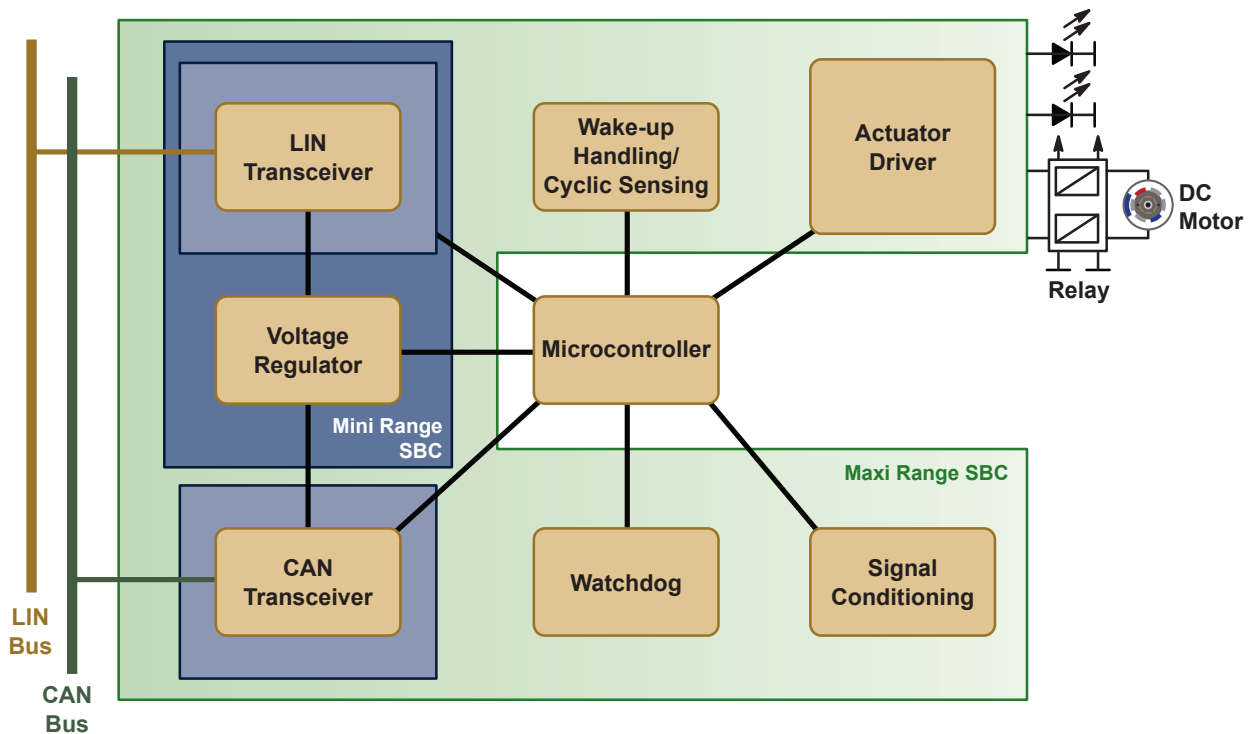
### Switching Controllers

| Device    | V <sub>OUT</sub> Min (V) | f <sub>sw</sub> (kHz) | V <sub>in</sub> Min (V) | V <sub>in</sub> Max (V) | Comments                            | Package  |
|-----------|--------------------------|-----------------------|-------------------------|-------------------------|-------------------------------------|----------|
| NCV494    | Down to 5.0              | Up to 200             | 7                       | 40                      | Single-ended or push-pull           | SOIC-16  |
| NCV8851B  | Down to 0.8              | 275                   | 4.5                     | 40                      | <1 $\mu$ A quiescent current        | SOIC-16W |
| NCV8852   | Down to 0.8              | 170 to 455            | 3.1                     | 44                      | For external P-channel MOSFET       | SOIC-8   |
| NCV8853   | Down to 0.8              | 340                   | 3.1                     | 44                      | For external P-channel MOSFET       | SOIC-8   |
| NCV881930 | 3.3, 5.5                 | 410                   | 3.5                     | 45                      | Low I <sub>q</sub> ; low frequency  | QFN-24   |
| NCV891930 | 3.3, 3.65, 4.0, 5.0      | 2000                  | 3.5                     | 45                      | Low I <sub>q</sub> ; high frequency | QFN-24   |
| NCV1034   | 1.25                     | Up to 500             | 10                      | 100                     | Synchronous Buck                    | SOIC-16  |

## In-Vehicle Networking Solutions



Automobile manufacturers today design decentralized, distributed systems, connected through industry interface standards. ON Semiconductor offers an innovative in-vehicle networking portfolio, including LIN, CAN, CANFD, and FlexRay™ transceivers – AEC qualified. The company also offers System Basis Chips that integrate transceivers with other circuits, including voltage regulators, drivers, and supervisory functions.



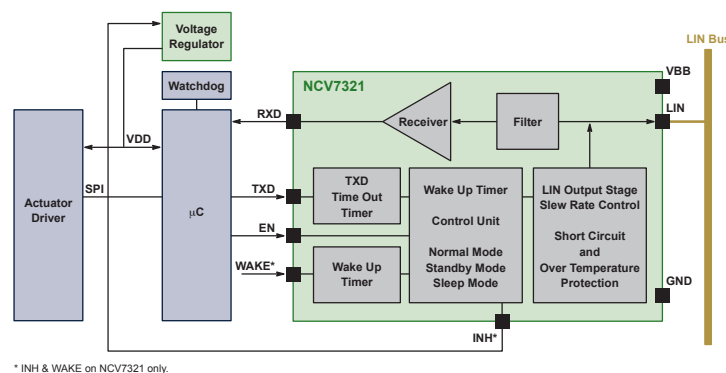
Typical System Partitioning with LIN and CAN Bus Connections

## Standalone LIN Transceivers

The LIN bus communicates low rate (up to 20 kBaud) data from control devices - such as door locks, mirrors, car seats, and sunroofs - for non-time-critical functions. The LIN bus protocol uses only a single wire in each node, minimizing wiring costs. Each node includes a slave MCU state-machine that recognizes and translates the instructions specific to that function. ON Semiconductor transceivers are compliant to ISO 17987-4 (backwards compatible to LIN specification rev 2.x, 1.3) and SAE J2602.

### NCV7321 Features

- Compliant to OEM requirements
- Outstanding EMC performance
- System ESD levels >12 kV
- Combines high voltage analog and digital functionality
- Transmission rate 1-20 kBaud



Standalone LIN Transceiver NCV7321/NCV7329

### LIN Transceivers

| Device     | Description  | Bus Speed (Baud) | ISO 9141 | LIN 2.0/2.1/2.2 | J2602 | Sleep Mode Current (µA) | ESD Protection IEC 61000-4-2 (LIN pin) | Package(s)    |
|------------|--|------------------|----------|-----------------|-------|-------------------------|--|---------------|
| AMIS-30600 | LIN Transceiver  | 20 k             | ✓        | ✓               | ✓     | 55                      | 6 kV                                   | SOIC-8        |
| NCV7321    | LIN Transceiver  | 20 k             | ✓        | ✓               | ✓     | 10                      | >12 kV                                 | SOIC-8, DFN-8 |
| NCV7424    | Quad LIN Transceiver   | 20 k             | ✓        | ✓               | ✓     | 30                      | >12 kV                                 | TSSOP-16      |
| NCV7329    | LIN Transceiver  | 20 k             | ✓        | ✓               | ✓     | 10                      | >12 kV                                 | SOIC-8, DFN-8 |
| NCV7327*   | LIN Transceiver  | 20 k             | ✓        | ✓               | ✓     | 10                      | >12 kV                                 | SOIC-8, DFN-8 |
| NCV7420    | LIN Transceiver with Voltage Regulator (50 mA, 3.3 or 5.0 V)                           | 20 k             | ✓        | ✓               | ✓     | 20                      | >12 kV                                 | SOIC-14       |
| NCV7425    | LIN Transceiver with Voltage Regulator (150 mA, 3.3 or 5.0 V)                          | 20 k             | ✓        | ✓               | ✓     | 20                      | >12 kV                                 | SOIC-16W EP   |
| NCV7428    | LIN (low slope, normal slope) Transceiver with Voltage Regulator (70 mA, 3.3 or 5.0 V) | 20 k             | ✓        | ✓               | ✓     | 25                      | >12 kV                                 | SOIC-8        |
| NCV7429    | System Basis Chip with LIN, LS and HS Switches   | 20k              | ✓        | ✓               | ✓     | 30                      | >6 kV                                  | TSSOP-20 EP   |

\* No time out for low speed communication.

## FlexRay™ Transceivers

### Features

- Compliant to FlexRay v3.0.1 physical layer
- Excellent EMC and ESD performance

### FlexRay™ Transceivers

| Product   | Description                  | Bus Speed (Baud) | FlexRay Standard | Host Interface | ESD Protection IEC61000-4-2 (CAN pins) | Package(s) |
|-----------|------------------------------|------------------|------------------|----------------|--|------------|
| NCV7381A  | Clamp-30 FlexRay Transceiver | 10 M             | v3.0.1.          | ERRN pin       | >10 kV                                 | SSOP-16    |
| NCV7381B  | Clamp-30 FlexRay Transceiver | 10 M             | v3.0.1.          | ERRN pin       | >10 kV                                 | SSOP-16    |
| NCV7381C* | Clamp-30 FlexRay Transceiver | 10 M             | v3.0.1.          | ERRN pin       | >10 kV                                 | SSOP-16    |
| NCV7383   | Clamp-15 FlexRay Transceiver | 10 M             | v3.0.1.          | SPI            | > 10 kV                                | TSSOP-14   |

\*High Temperature Class 0.



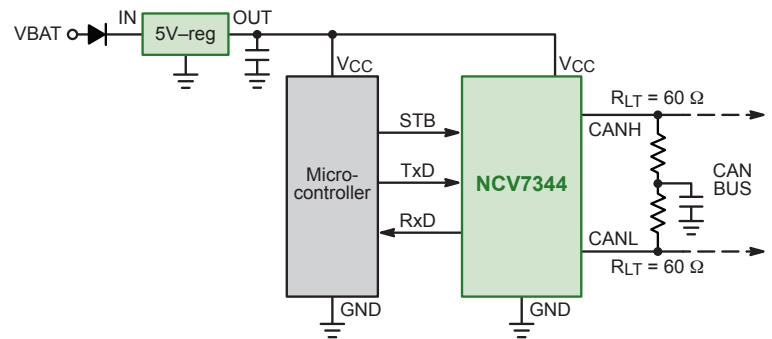
## Standalone CAN Transceivers

The latest generation CAN transceivers exhibit industry-leading performance on electromagnetic capabilities (ESD and EMI). These devices are designed in ON Semiconductor's proven, innovative I3T technology, that delivers highly robust, high quality components with failure rates measured in parts-per-billion.



### Features

- Portfolio includes transceivers specifically designed for:
  - Low Speed Fault Tolerant
  - High Speed
  - Low Power
  - Single Wire
  - Flexible Data Rate
- Conformance tested by external test house (ISO11898)
- System ESD protection according to IEC 61000-4-2
- Highly robust against EM fields (low Electro Magnetic Susceptibility – EMS)



NCV7344 Typical Application

### CAN Transceivers

| Device     | Description   | Standard        | Sleepmode Current Max (μA) | Bus Speed Max | ESD Protection IEC 61000-4-2 (CAN pins) | Package(s)    |
|------------|---|-----------------|----------------------------|---------------|---|---------------|
| NCV7349    | High Speed, Low Power CAN Transceiver**                   | ISO11898-5      | 15                         | 1 Mbps        | >12 kV                                  | SOIC-8        |
| NCV7342    | High Speed, Low Power CAN Transceiver                     | ISO11898-5      | 15                         | 1 Mbps        | >12 kV                                  | SOIC-8, DFN-8 |
| NCV7344    | High Speed Low Power CAN, CAN FD Transceiver              | ISO11898-2:2016 | 15                         | 5 Mbps        | >8 kV                                   | SOIC-8, DFN-8 |
| NCV7340    | High Speed, Low Power CAN Transceiver                     | ISO11898-5      | 15                         | 1 Mbps        | >12 kV                                  | SOIC-8        |
| AMIS-42665 | High Speed, Low Power CAN Transceiver                     | ISO11898-5      | 15                         | 1 Mbps        | 4 kV (HBM)                              | SOIC-8        |
| NCV7341    | High Speed, Low Power CAN Transceiver                     | ISO11898-5      | 35                         | 1 Mbps        | 8 kV                                    | SOIC-14       |
| NCV7441    | Dual High Speed, Low Power CAN Transceiver                | ISO11898-5      | 30                         | 1 Mbps        | 8 kV                                    | SOIC-14       |
| NCV7446    | Two channel High Speed, Low Power CAN, CAN FD Transceiver | ISO11898-2:2016 | 30                         | 5 Mbps        | 8 kV                                    | DFN-14        |
| AMIS-42700 | Dual High Speed CAN Transceiver                           | ISO11898-2      | N/A*                       | 1 Mbps        | 4 kV                                    | SOIC-20       |
| NCV7351    | High Speed CAN Transceiver                                | ISO11898-2      | N/A*                       | 1 Mbps        | >12 kV                                  | SOIC-8        |
| NCV7351F   | High Speed CAN, CANFD Transceiver                         | ISO11898-2:2016 | N/A*                       | 2 Mbps        | >12 kV                                  | SOIC-8        |
| NCV7357    | High Speed Low PowerCAN, CAN FD Transceiver               | ISO11898-2:2016 | 15                         | 5 Mbps        | >8 kV                                   | SOIC-8, DFN-8 |
| AMIS-30660 | High Speed CAN Transceiver                                | ISO11898-2      | N/A*                       | 1 Mbps        | 4 kV                                    | SOIC-8        |
| AMIS-30663 | High Speed CAN Transceiver                                | ISO11898-2      | N/A*                       | 1 Mbps        | 4 kV                                    | SOIC-8        |
| AMIS-41682 | Low Speed Fault Tolerant CAN Transceiver                  | ISO11898-3      | 60                         | 250 kpbs      | 6 kV (HBM)                              | SOIC-14       |
| AMIS-41683 | Low Speed Fault Tolerant CAN Transceiver                  | ISO11898-3      | 60                         | 250 kpbs      | 6 kV (HBM)                              | SOIC-14       |
| NCV7356    | Single Wire CAN Transceiver                               | J2411           | 60                         | 40 kpbs       | 4 kV (HBM)                              | SOIC-14       |

\* Sleepmode not featured/implemented. \*\*Meets VeLIO test requirements.



## System Basis Chips

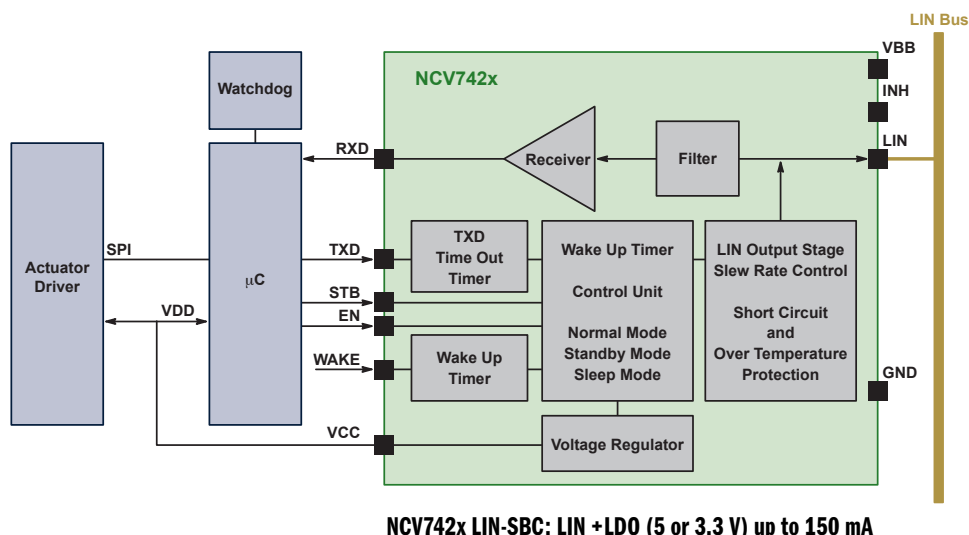
Integration of key system components, like LIN, CAN, and voltage regulators, within ECUs delivers:

- Improved system reliability
- Reduced power consumption
- Use of less board space
- Cost-optimized solutions

ON Semiconductor's IP, combined with years of experience designing integrated custom circuits, has led to successful development of a System Basis Chip portfolio.

### NCV742x Features

- Based on NCV7321
- Ideal solution for low BOM slave nodes
- 3.3 V and 5 V versions
- NCV7420 includes 50 mA voltage regulator
- NCV7425 includes 150 mA voltage regulator
- NCV7428 includes 70 mA voltage regulator



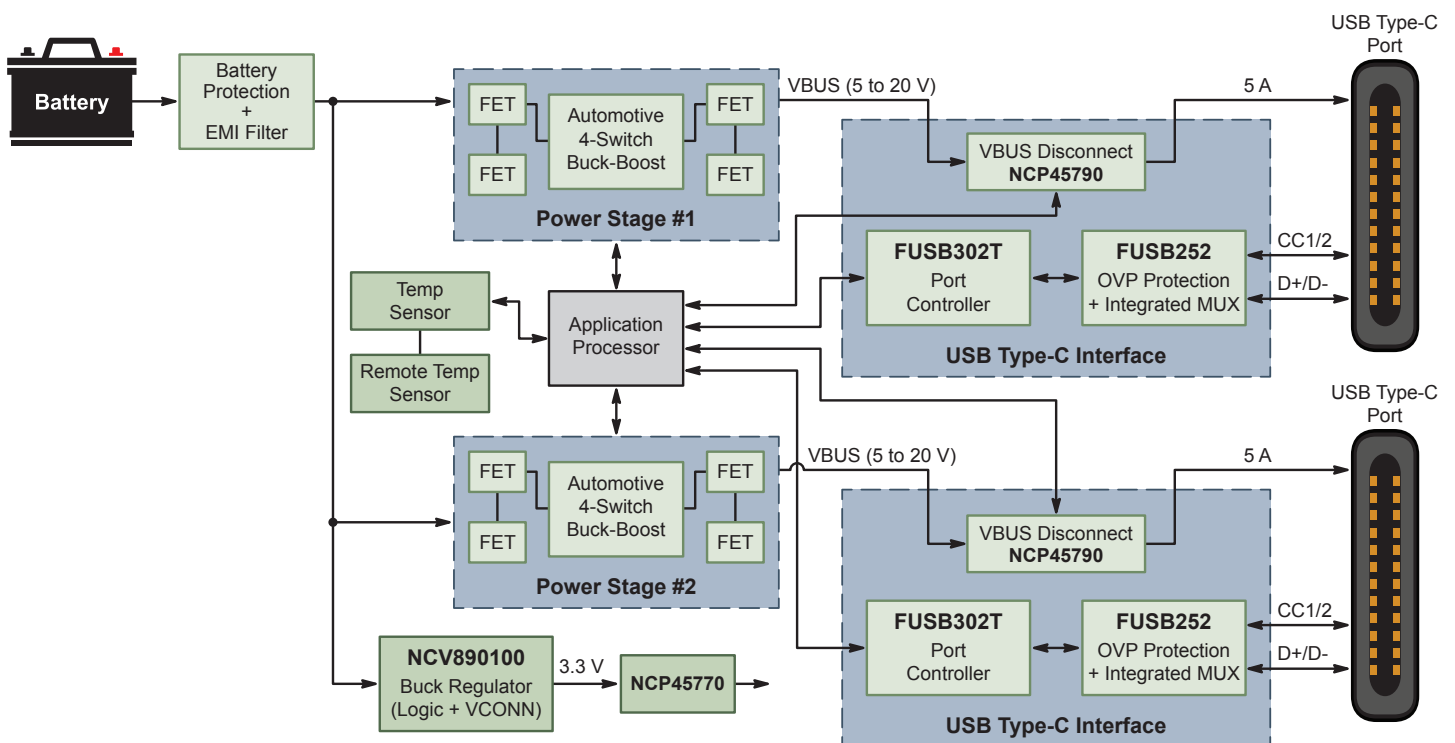
### System Basis Chips

| Device        | Description  | Data Transmission Standard | I <sub>O</sub> Max (mA) | Number of Drivers | Number of Transceivers | V <sub>CC</sub> Min (mA) | V <sub>CC</sub> Max (mA) | Package(s)    |
|---------------|--|----------------------------|-------------------------|-------------------|------------------------|--------------------------|--------------------------|---------------|
| NCV7420       | System Basis Chip with LIN and Voltage Regulator (WAKE, INH)                           | LIN                        | 50                      | 0                 | 1                      | 5                        | 26                       | SOIC-14       |
| NCV7425       | System Basis Chip with LIN and Voltage Regulator (WAKE, INH, RSTN)                     | LIN                        | 150                     | 0                 | 1                      | 5                        | 28                       | SOIC-16W EP   |
| NCV7428       | LIN (low slope, normal slope) Transceiver with Voltage Regulator (70 mA, 3.3 or 5.0 V) | LIN                        | 70                      | 0                 | 1                      | 3.234, 4.9               | 3.366, 5.1               | SOIC-8, DFN-8 |
| NCV7429       | System Basis Chip with LIN, LS and HS Switches   | LIN                        | 150                     | 5                 | 1                      | 4.9                      | 5.1                      | TSSOP-20 EP   |
| NCV7462       | System Basis Chip with LIN, CAN, 2 Voltage Regulators, and HS/LS Drivers               | LIN; CAN                   | 250                     | 7                 | 2                      | 5                        | 28                       | SSOP-36 EP    |
| NCV7471       | System Basis Chip with Dual LIN, CAN, Voltage Regulator, and Buck-Boost DC-DC          | LIN; CAN                   | 500                     | 0                 | 3                      | 2.5                      | 28                       | SSOP-36 EP    |
| NCV7441       | Dual High Speed, Low Power CAN Transceiver   | CAN                        | NA                      | 0                 | 2                      | NA                       | NA                       | SOIC-14       |
| NCV7450       | CAN + LDO + HS Driver System Basis Chip  | CAN                        | 250                     | 1                 | 1                      | 4.75                     | 5.25                     | TSSOP-16 EP   |
| NCV7446       | Two channel High Speed, Low Power CAN, CAN FD Transceiver                              | CAN/CANFD                  | NA                      | 0                 | 2                      | NA                       | NA                       | DFN-14        |
| AMIS-42700/70 | Dual High Speed CAN Transceiver  | CAN                        | NA                      | 0                 | 2                      | NA                       | NA                       | SOIC-20       |

## USB-PD Dual Port 100 W

### Features

- Complete solution = power + port + policy + management + protection + software
- Future ready = 100% voltage/power coverage
  - SW update = no hardware spin required
- Power management / metering
  - Input voltage monitoring
  - De-rate power based on input (battery) voltage – customizable limit
- Temperature protection
  - De-rate power based on temperature of PCB – customizable limit
- Scalable multi-port solution
  - 1 MCU = 2, 3, 4, etc. ports
  - Copy & paste power stage (power + port control)



## Protection for USB 2.0

*One High Speed Pair,  $V_{CC}$ , Low Capacitance ESD, Short-to-Battery (STB) and Short-to-Ground (STG) Protection*

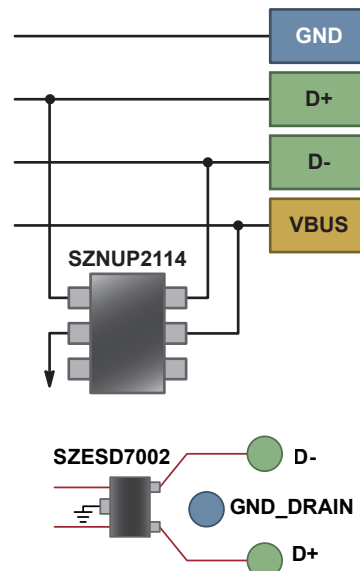
### Key Requirement

- Capacitance < 1.5 pF for data lines

### Features

- Capacitance 0.4 - 1.0 pF for data lines
- 4 low speed + 1 VBUS integrated – can protect up to 2 USB ports
- Industry leading low capacitance and clamping voltage with STB capability
- LVDS compatible

| Device     | V <sub>BR</sub> Min (V) | Lines | Capacitance (pF) | Protection Scheme        | Package                     |
|------------|-------------------------|-------|------------------|--------------------------|-----------------------------|
| SZESDM3551 | 5.6                     | 1     | 21               | VBUS ESD + Surge         | X2DFN-2 (SOD-882)           |
| SZESD7205  | 5.2                     | 2     | 0.55<br>0.85     | ESD                      | SOT-723,<br>SC-70 (SOT-323) |
| SZESD7002  | 16.5                    | 2     | 0.40             | ESD + STB Standoff       | SC-70                       |
| NIV1161    | 16.5                    | 2     | 0.65             | ESD + STB Limiting       | WDFN-6                      |
| NIV2161    | 16.5                    | 2     | 0.65             | ESD + STB & STG Limiting | WDFN-10                     |
| SZNUP2114  | 5.5                     | 3     | 1.00             | ESD                      | TSOP-6, SOT-553             |



*One High Speed Pair,  $V_{CC}$ , Common Mode Filter + ESD Protection*

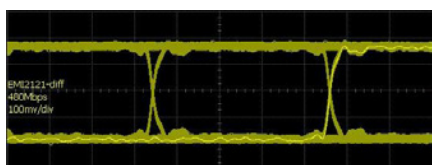
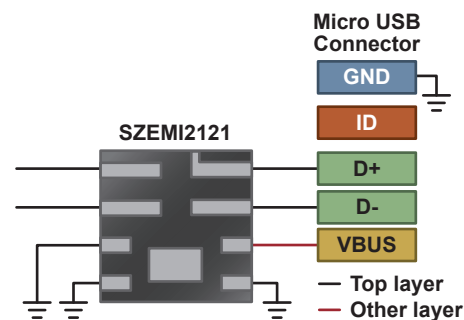
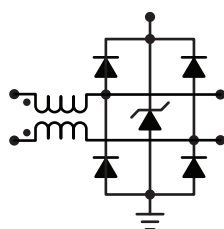
### Key Requirement

- Capacitance < 1.5 pF for data lines
- Common Mode Filtering

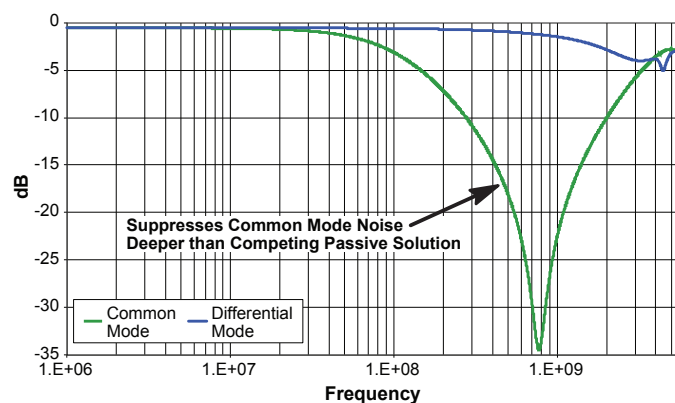
### Features

- Capacitance 0.9 pF for data lines
- Integrated EMI suppression with ESD protection
- Industry leading low clamping voltage

| Device    | Pairs | Capacitance @ 2.5 V (pF) | CM Attenuation @ 750 MHz (-dB) | DM Bandwidth F3dB (GHz) | Package |
|-----------|-------|--------------------------|--------------------------------|-------------------------|---------|
| SZEMI2121 | 1     | 0.9                      | -35                            | 2.5                     | WDFN-8  |



USB 2.0 @ 480 Mb/s

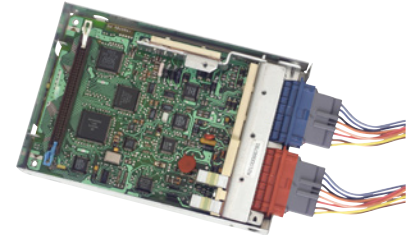


# Enhance Reliability of Electronic Modules with ESD Protection Devices

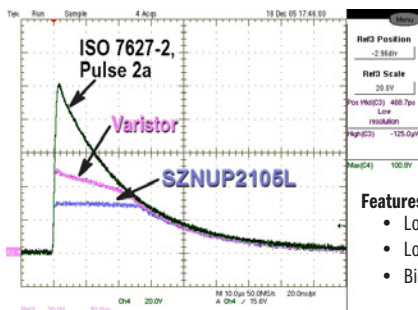
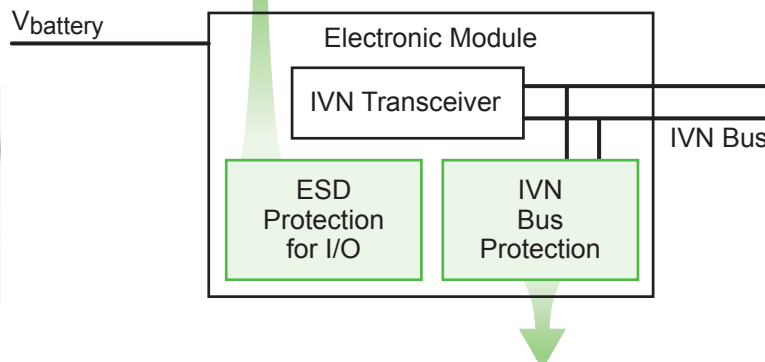
## I/O & Sensor Protection

| Device           | Diode Configuration   | VBR Range    | Ppk <sup>1</sup> | ESD Rating          | C <sub>j</sub> | Package           |
|------------------|-----------------------|--------------|------------------|---------------------|----------------|-------------------|
| SZMM5Z Series    | Single Unidirectional | 4.0 to 15 V  | 175 W            | >30 kV <sup>2</sup> | <150 pF        | SOD-523           |
| SZMM3Z Series    | Single Unidirectional | 2.4 to 75 V  | —                | >16 kV <sup>3</sup> | <300 pF        | SOD-323           |
| SZMMSZ Series    | Single Unidirectional | 1.8 to 110V  | —                | >16 kV <sup>3</sup> | <300 pF        | SOD-123           |
| SZMMSE Series    | Energy Rated Single   | 1.8 to 110V  | 225 W            | >16 kV <sup>3</sup> | <300 pF        | SOD-123           |
| SZMMBZ Series    | Single Unidirectional | 2.4 to 91 V  | —                | >16 kV <sup>3</sup> | <300 pF        | SOT-23            |
| SZMMBZ E Series  | Energy Rated Single   | 2.4V to 91 V | 225 W            | >16 kV <sup>3</sup> | <300 pF        | SOT-23            |
| SZMMBZ A Series  | Dual Common Anode     | 5.6 to 33 V  | —                | >16 kV <sup>3</sup> | <300 pF        | SOT-23            |
| SZBZX84 Series*  | Single Unidirectional | 2.4 to 75 V  | —                | >16 kV <sup>3</sup> | <450 pF        | SOT-23            |
| SZBZX84 E Series | Energy Rated Single   | 2.4 to 75 V  | 225 W            | >16 kV <sup>3</sup> | <450pF         | SOT-23            |
| SZLN8F Series*   | Single Unidirectional | 2.4 to 47 V  | —                | >16 kV <sup>3</sup> | <210 pF        | X2DFNW2 (SOD-882) |
| SZLN9F Series*   | Single Unidirectional | 2.4 to 24 V  | —                | >16 kV <sup>3</sup> | <210 pF        | SOD-923           |
| SZESD7272**      | Unidirectional        | 27 V         | —                | >15 kV <sup>2</sup> | <1 pF          | SOT-23            |

1. 8/20  $\mu$ s surge waveform. 2. IEC 61000-4-2 contact discharge. 3. Human body model. \* 2% and 5% tolerance available. \*\* MLCC Capacitor Replacement.



PROTECTION

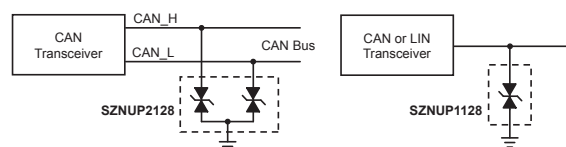


### Features

- Low Clamping Voltage
- Low Capacitance
- Bidirectional Clamping

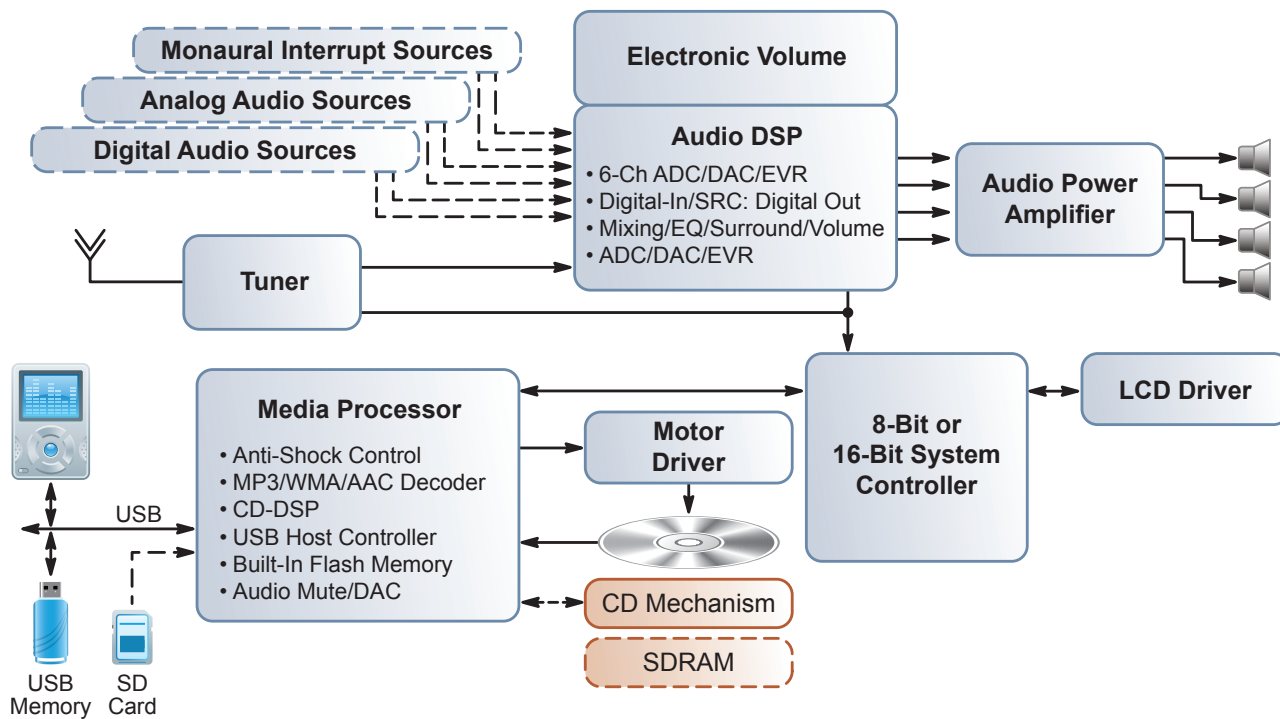
## In-Vehicle Networking Protection

| Device     | Network  | Diode Configuration   | VBR Min (V) | Vclamp Max (V) | Ipp (A) | Capacitance Max (pF) | Package                    |
|------------|----------|-----------------------|-------------|----------------|---------|----------------------|----------------------------|
| SZNUP2115  | FlexRay  | Dual Bi-Directional   | 26.2        | 50             | 3       | 10                   | SOT-23                     |
| SZNUP2105  | CAN      | Dual Bi-Directional   | 26.2        | 44             | 8       | 30                   | SOT-23                     |
| SZNUP3105  | CAN      | Dual Bi-Directional   | 35.6        | 66             | 8       | 30                   | SOT-23                     |
| SZNUP3125  | CAN      | Dual Bi-Directional   | 35.6        | 65             | 3       | 10                   | SC-70 (SOT-323)            |
| SESDONCAN1 | CAN-FD   | Dual Bi-Directional   | 26.2        | 50             | 3       | 10                   | SOT-23                     |
| SZNUP2125  | CAN-FD   | Dual Bi-Directional   | 26.2        | 50             | 3       | 10                   | SC-70 (SOT-323)            |
| SZNUP2128  | CAN      | Dual Bi-Directional   | 28.0        | 70             | 3       | 15                   | SC-70 (SOT-323)            |
| SZNUP1128  | LIN      | Single Bi-Directional | 28.0        | 70             | 3       | 15                   | SOD-323                    |
| SZESD1L001 | Ethernet | Quad Uni-Directional  | 16.5        | —              | —       | 1                    | SC-88 (SOT-363)            |
| SZESD7205  | Ethernet | Dual Uni-Directional  | 5.2         | —              | —       | 0.55<br>0.85         | SOT-723<br>SC-70 (SOT-323) |

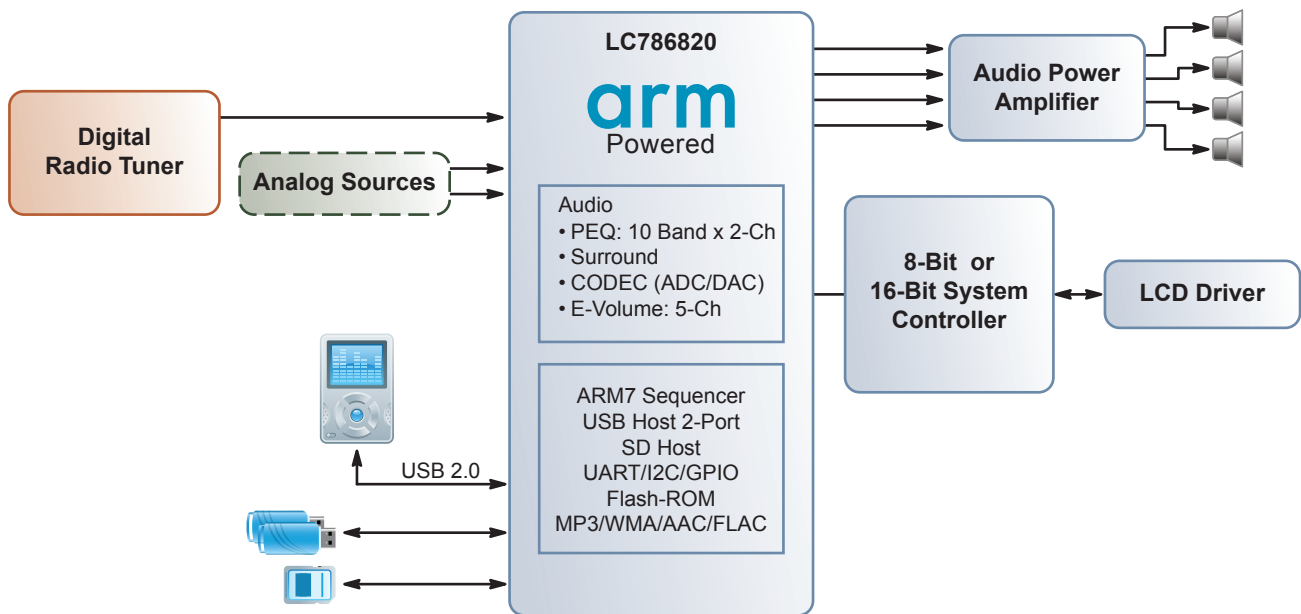


CAN and LIN protection devices improve the noise immunity and reliability of vehicular networks by suppressing overvoltage transients from conducted and radiated EMI and ESD.

## Audio System Solution



## Digital Media Receiver (Mechaless) Audio System Solution



AUDIO



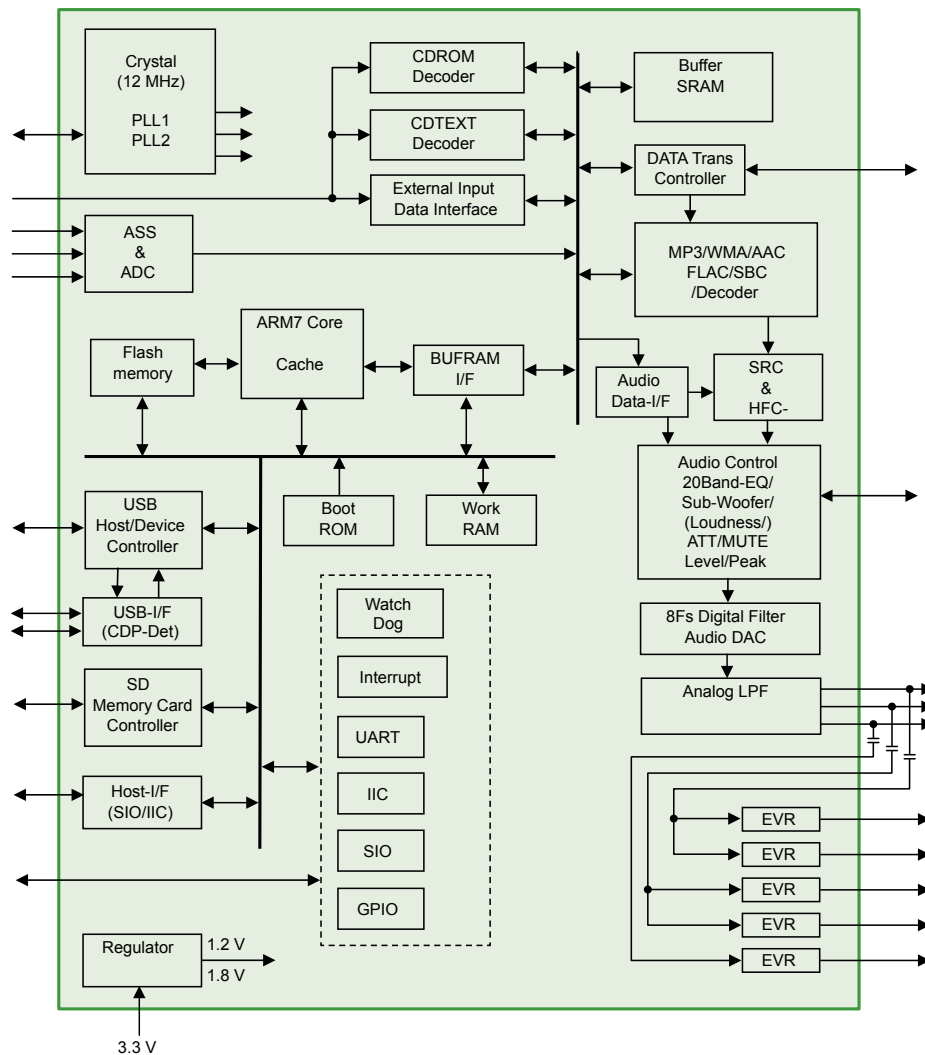


## Digital Media Processor (Mechaless)

*Compressed Audio Signal Processor with USB Host Controller and Bluetooth*

### LC786821E Features

- USB host/device function (Full speed: 12 Mbps), SD memory card host function
- MP3, WMA, AAC, FLAC, SBC decoder processing function
- Audio input: analog stereo 3-channel / digital 3-channel (sampling rate convertible)
- Audio processing: 20 band equalizer (stereo 1-channel), subwoofer processing, high-frequency range extendable filter
- Audio output: electronic volume output 5-channel (for LF, LR, RF, RR, SW), or DAC output 3-channel (Lch, Rch, SW)
- ARM7TDMI-S™ internal CPU core; flash memory for program and data storage
- Bluetooth audio processing/hands-free function

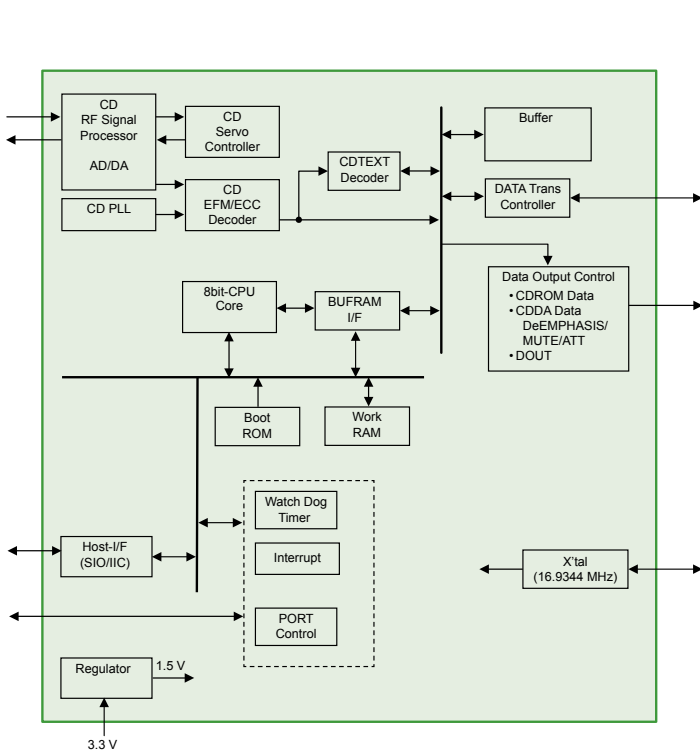


**LC786821E Block Diagram**

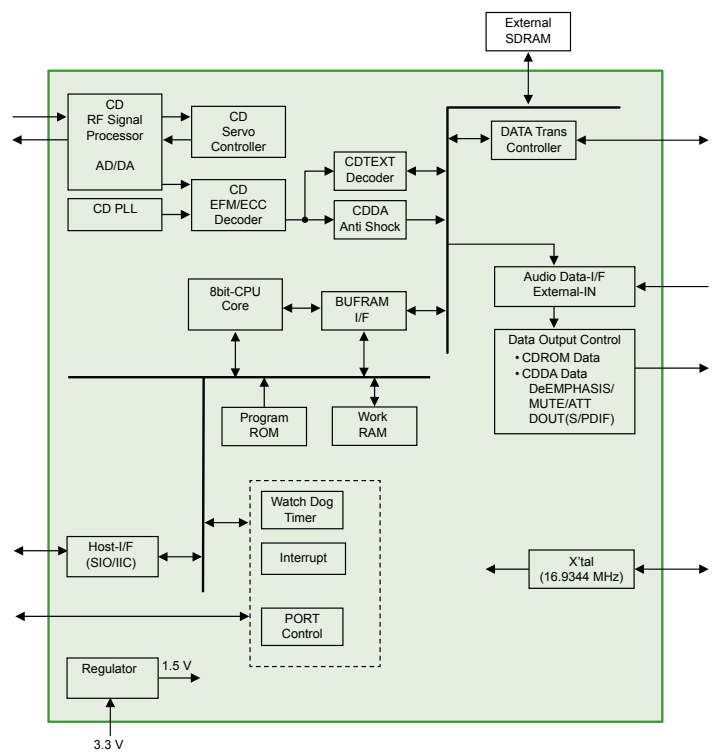
## Compact Disc Controllers

### LC78615E, LC78616PE Features

- RF signal processing for CD-DA/R/RW, servo control, EFM signal processing
- Outputs CDDA, CDRom data
- CD playback system realized with simple macro commands by external controller, due to internal sequencer (built in 8-bit CPU)
- Reduce audio-DAC, digital filter for reduction system cost
- LC78616PE includes shock protection with external DRAM



**LC78615E Block Diagram**  
QIP-64E Package



**LC78616PE Block Diagram**  
QIP-100E Package

AUDIO

Decoder of DARC Standard for Car Navigation System

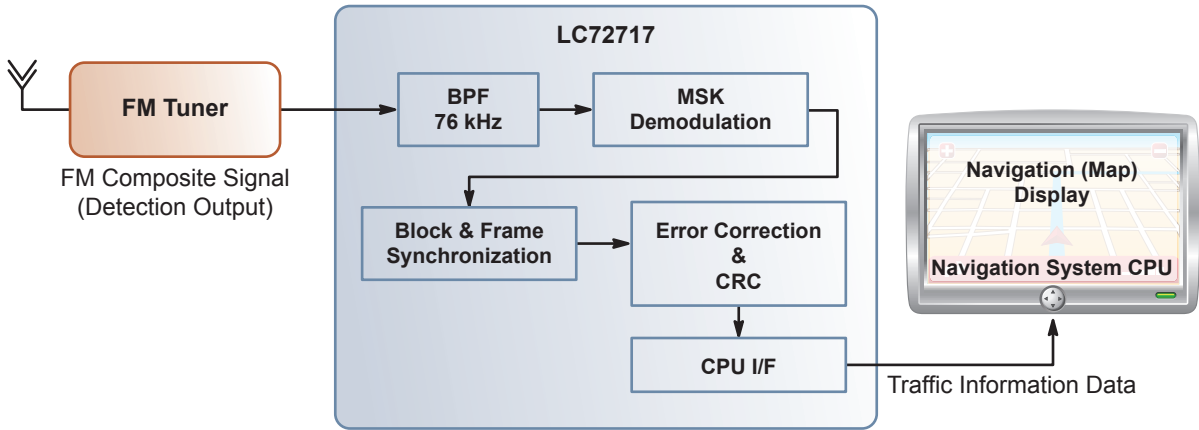
The LC72717 is a data demodulator and decoder for receiving FM multiplex broadcasts for mobile reception in the DARC format. LC72717 includes an on-chip band pass filter for extracting the DARC signal from the FM composite signal. The device also supports ITU-R recommended FM multiplex frame structures (methods A, A', B, and C) and enables design of a compact, multifunction DARC reception system.

LC72717 Features

- Integrates all DARC relevant functions
- Fully adjustable

Applications

- RTIC in China, Thailand and South East Asia
- DARC in Europe



LC72717 Block Diagram

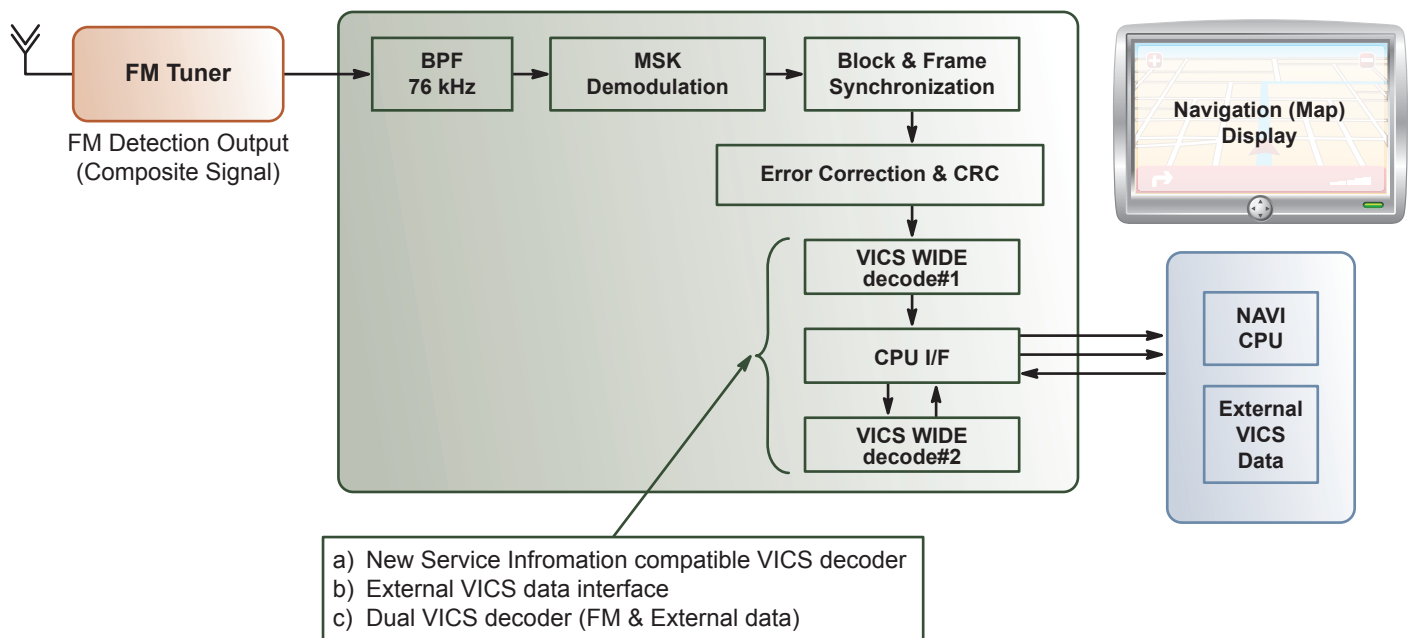
| Device  | Function     | Application  | V <sub>DD</sub> (V) | Packages |
|---------|--------------|--------------|---------------------|----------|
| LC72717 | DARC Decoder | RTIC (China) | 2.7 to 3.6          | SQFP-64  |

## Data Demodulation for Navigation Systems

The LC727103UJ\* is a data demodulation device for receiving FM multiplex broadcasts for mobile reception in the DARC format. LC727103UJ includes VICS WIDE decoders\*\* for new SI and a VICS data input-output interface for external VICS data. The device also includes an on-chip band-pass filter for extracting the DARC signal from the FM baseband signal, and can implement a compact, multifunction VICS reception system.

### LC727103UJ Features

- DARC signal reception
- Error correction function based on 2T delay in MSK detection stage
- On-chip 76 KHz band-pass filter
- MSK demodulation
- Block and Frame synchronization
- Error correction using (272,190) product code
- On-chip Frame memory and memory control circuit for vertical error correction of product code



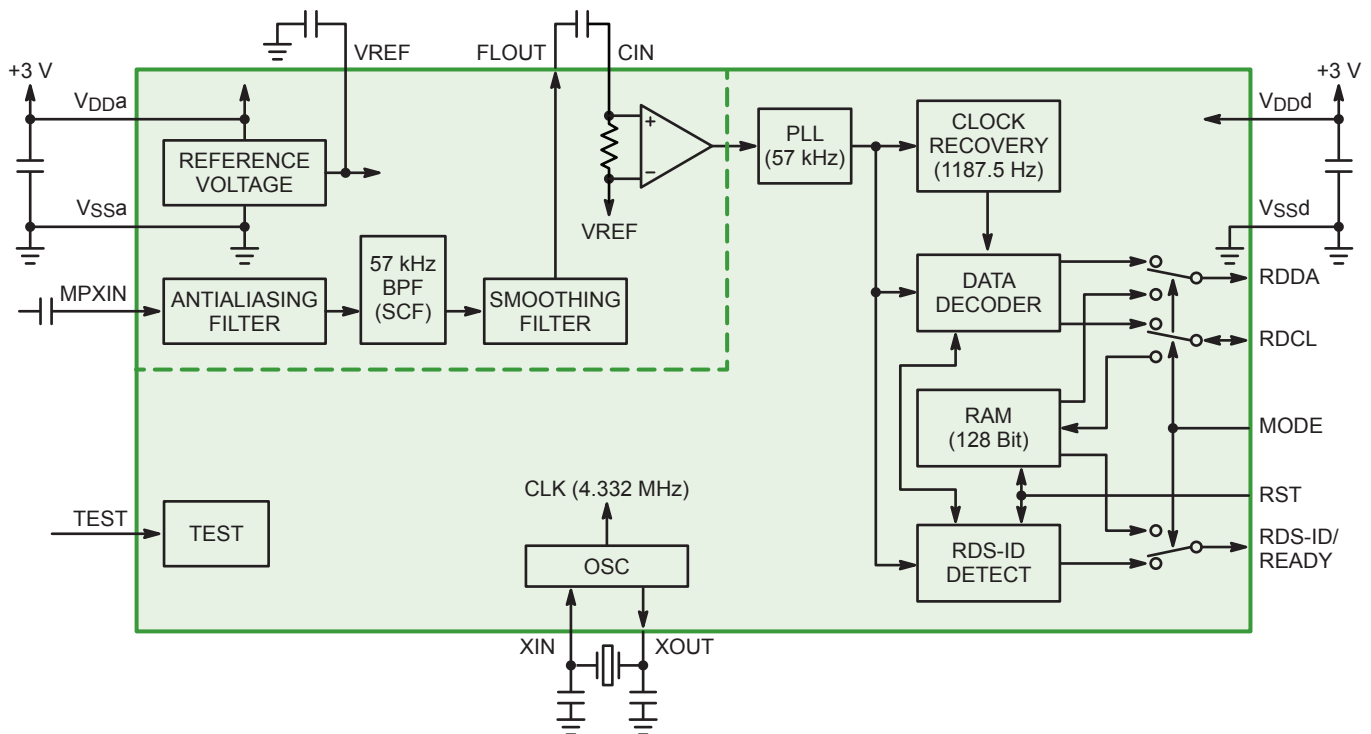
LC727103UJ Block Diagram

\* Pending 4Q19. \*\* VICS Center License required.

## Demodulator for RDS and RBDS Standards

### LC72725 Features

- RDS demodulation, 57 kHz carrier and data clock regeneration, bi-phase decode, differential decode
- RDS-ID detect signal with reset
- Switched capacitor bandpass filter
- 128-bit on-chip data buffer
- Standby control

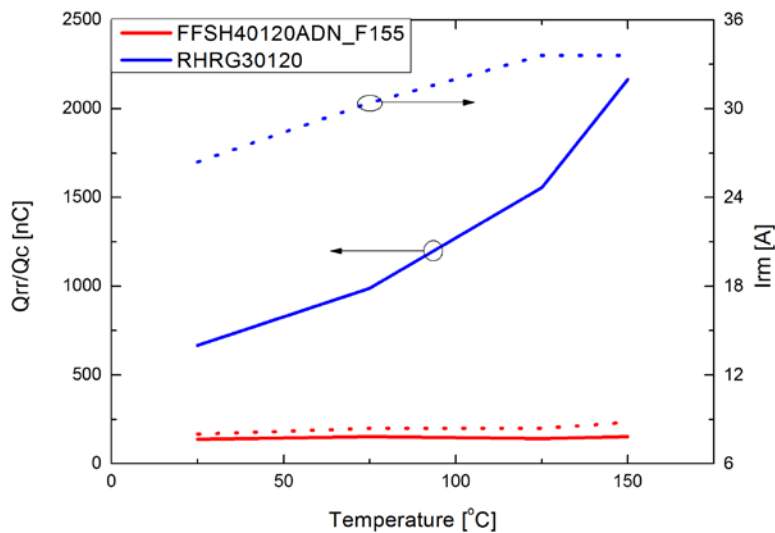


LC72725 Block Diagram

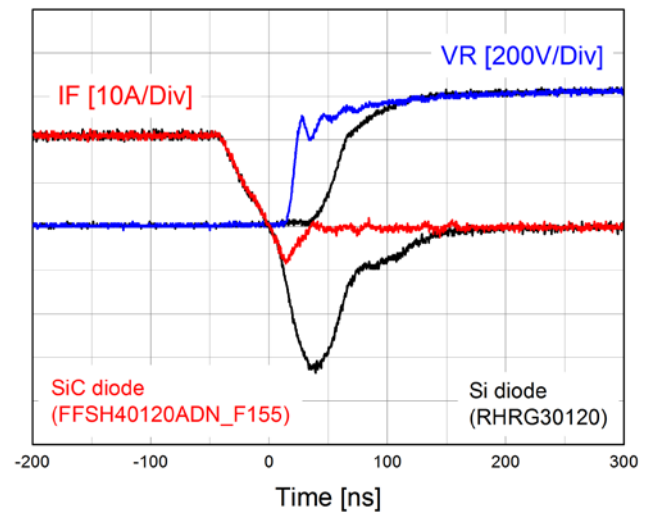
## Silicon Carbide Diodes

### Features

- High power density, efficiency, and reliability
- High surge and avalanche capability
- Low system losses via no reverse  $Q_{rr}$  recovery, no forward recovery, and low  $V_f$
- Minimized reverse recovery charge ( $Q_{rr}$ ) reduces switching losses & enables high speed switching
- Stable temperature characteristics enable high-temperature operation without increasing switching losses
- High temperature operation and life time for automotive applications



Reverse Recovery & Leakage vs Temperature



Reverse Recovery @ 20 A, 500 A/ $\mu$ s, 125°C

### SiC Diodes

| Device            | Configuration       | $V_{RRM}$ (V) | $I_F^{(ave)}$ (A) | $V_f$ Max (V) | $I_{FSM}$ (A) | $I_R$ Max ( $\mu$ A) | Package(s)         |
|-------------------|---------------------|---------------|-------------------|---------------|---------------|----------------------|--------------------|
| FFSB20120A-F085   | with Schottky Diode | 1200          | 20                | 1.75          | 135           | 400                  | D2PAK-3 / TO-263-2 |
| FFSH20120A-F085   | with Schottky Diode | 1200          | 20                | 1.75          | 135           | 200                  | TO-247-2           |
| FFSH40120ADN-F085 | Dual Common Cathode | 1200          | 20                | 1.75          | 135           | 200                  | TO-247-3           |
| FFSB10120A-F085   | with Schottky Diode | 1200          | 10                | 1.75          | 90            | 400                  | D2PAK-3 / TO-263-2 |
| FFSH10120A-F085   | with Schottky Diode | 1200          | 10                | 1.75          | 90            | 200                  | TO-247-2           |
| FFSH20120ADN-F085 | Dual Common Cathode | 1200          | 10                | 1.75          | 96            | 200                  | TO-247-3           |
| FFSH5065B-F085    | with Schottky Diode | 650           | 50                | 1.7           | 189           | 160                  | TO-247-2LD         |
| FFSH4065BDN-F085  | Dual Common Cathode | 650           | 40                | 1.7           | 127           | 160                  | TO-247-3LD         |
| FFSB3065B-F085    | with Schottky Diode | 650           | 30                | 1.7           | 120           | 120                  | D2PAK-3 / TO-263-2 |
| FFSH3065B-F085    | with Schottky Diode | 650           | 30                | 1.7           | 110           | 160                  | TO-247-2           |
| FFSP3065B-F085    | with Schottky Diode | 650           | 30                | 1.7           | 120           | 160                  | TO-220-2           |
| FFSB2065B-F085    | with Schottky Diode | 650           | 20                | 1.7           | 88            | 160                  | D2PAK-3 / TO-263-2 |
| FFSB2065BDN-F085  | with Schottky Diode | 650           | 20                | 1.75          | 45            | 160                  | D2PAK-3 / TO-263-2 |
| FFSH2065B-F085    | with Schottky Diode | 650           | 20                | 1.7           | 84            | 160                  | TO-247-2LD         |
| FFSP2065B-F085    | with Schottky Diode | 650           | 20                | 1.7           | 88            | 160                  | TO-220-2           |
| FFSH2065BDN-F085  | Dual Common Cathode | 650           | 20                | 1.7           | 42            | 160                  | TO-247-3           |
| FFSB1065B-F085    | with Schottky Diode | 650           | 10                | 1.7           | 49            | 160                  | D2PAK-3 / TO-263-2 |
| FFSD1065B-F085    | with Schottky Diode | 650           | 10                | 1.7           | 45            | 160                  | DPAK-3 / TO-252-3  |
| FFSH1065B-F085    | with Schottky Diode | 650           | 10                | 1.7           | 42            | 160                  | TO-247-2LD         |
| FFSP1065B-F085    | with Schottky Diode | 650           | 10                | 1.7           | 45            | 160                  | TO-220-2           |



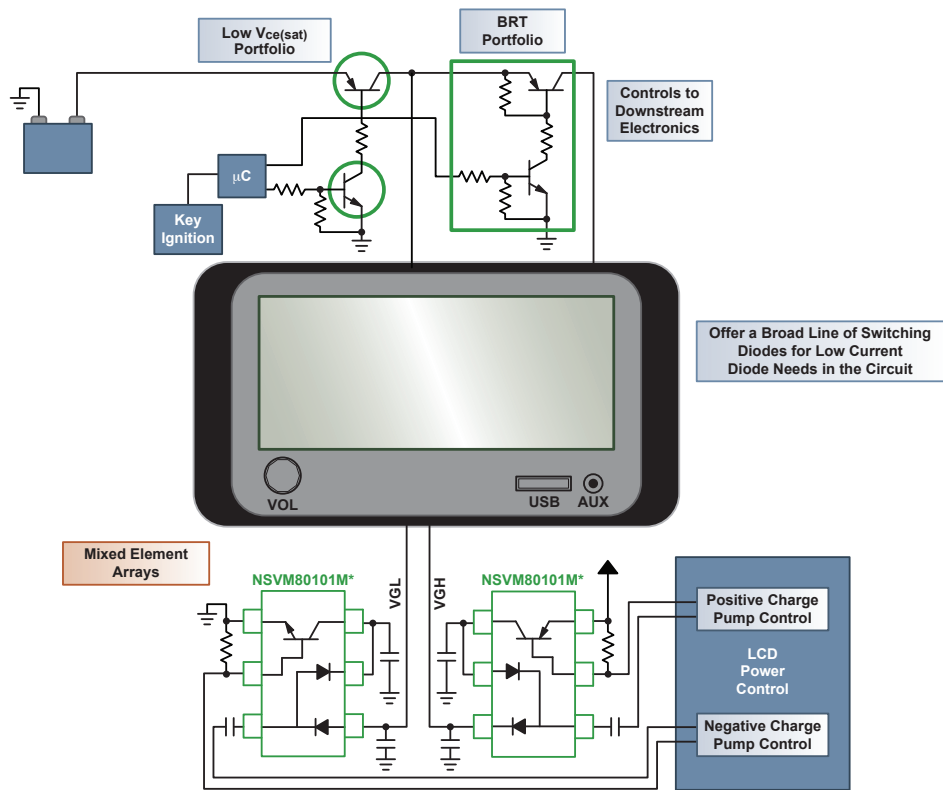
Wide Selection of Automotive Grade Small Signal Discretes

ON Semiconductor offers a wide range of devices that support infotainment systems, including diodes, JFETs, bipolar transistors, digital transistors (BRTs), and application specification discrete integration. Within these different technologies, the company offers a range of large to small packaging, meeting the smaller board space requirements of space constrained environments.

| Device                               | Voltage Range | Current Range | Key Features  | Functions  | Package(s)   |
|--------------------------------------|---------------|---------------|---|--|--|
| Schottky Diodes                      | 7 – 70 V      | 20 mA – 1 A   | Low Vf, Low Leakage, Duals                              | DC-DC converters, high-speed switching, Oring/rectifying | SOD-123, SOD-323, SOT-23, SC-70, SC-75, SOD-523, SOD-723, X2DFNW-2 (SOD-882)                           |
| Switching Diodes                     | 35 – 350 V    | –             | Switching speed, Low leakage                            | Broad range of applications                              | SC-59, SOT-23, SC-70, SC-88 6, SC-88A-5, SOT-563, SC-75, SOD-123, SOD-323, SOD-523, X2DFNW-2 (SOD-882) |
| Low V <sub>CE(sat)</sub> Transistors | 12 – 100 V    | 700 mA – 6 A  | Ultra-low V <sub>ce(sat)</sub> Broad portfolio          | Battery charging circuit, switching, fan control         | DPAK, SOT-223, TSOP-6, ChipFET, SOT-23, SOIC-8, WDFN*, LPAK  |
| JFETs                                | 25 – 30 V     | 20 – 150 mA   | Interchangeable Drain and Source, high input resistance | Ideal for applications sensitive to noise                | SOT-23, TSOP-6, SOT-363  |
| Darlington Transistors               | 30 – 350 V    | 300 mA – 10 A | High HFE  | –  | D2PAK, DPAK, SOT-23  |
| Audio Transistors                    | 50 – 350 V    | 2 – 8 A       | Linear gain Excellent SOA                               | High power audio amplifiers                              | DPAK   |
| Bipolar Power Transistors            | 45 – 450 V    | 500 mA – 60 A | Low leakage Low saturation                              | Lamp ballast   | SC-89, SOT-223, DPAK, D2PAK, SOT-23, SOT-723, WDFN, SOT-563  |
| General Purpose Transistors          | 7 – 300 V     | 50 mA – 10 A  | Broad product range                                     | Broad range of applications                              | Multiple surface mount packages available  |
| Digital Transistors (BRTs)           | 15 – 50 V     | 100 mA – 3 A  | Broad Portfolio of R1 and R2 combinations               | Power switching  | SC-59, SOT-23, SC-70, SC-88-5, SC-88A-6, SOT-563   |

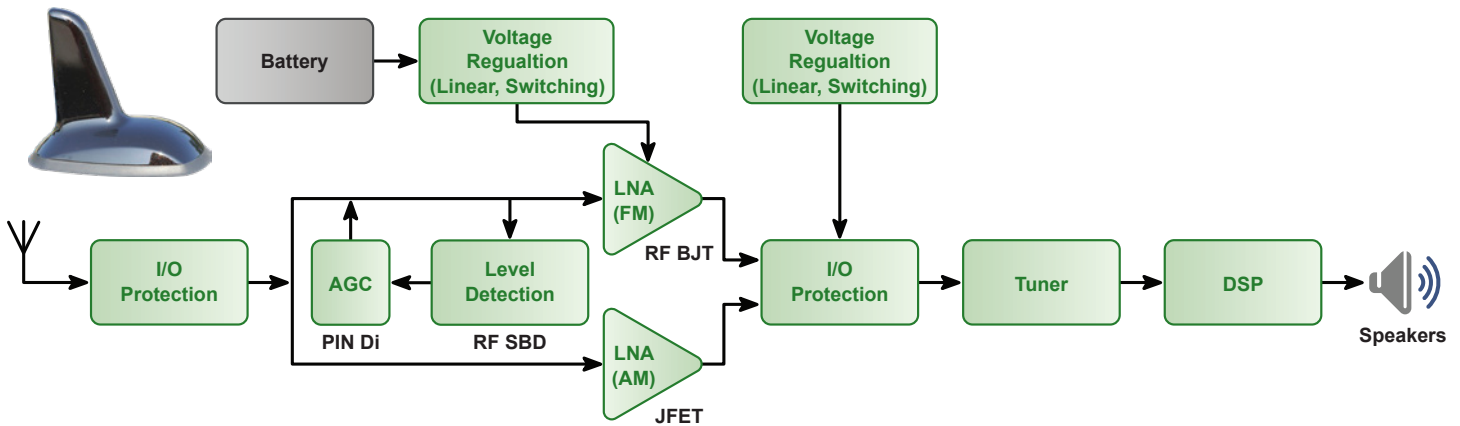
\* With wettable flanks.

COMPONENTS



\* Pending 4Q19

## Discrete Components for Antennas



### JFET Features

- Large forward transfer admittance and low noise figure enhance receiver sensitivity
- High ESD immunity
- High  $V_{GS}$  for robust circuit design
- Low capacitance improves receiver sensitivity
- High power density

### JFETs

| Device       | Configuration | $V_{GS}$ (V) | $I_{DSS}$ (mA) | $V_{GSoff}$ (V) | $g_m$ (mS) | $C_{iss}$ (pF) | Package(s)      |
|--------------|---------------|--------------|----------------|-----------------|------------|----------------|-----------------|
| NSVJ2394SA3  | Single        | 15           | 10-32          | -1.5 to -0.3    | 38         | 10             | SC-59           |
| NSVJ3557SA3  | Single        | 15           | 10-32          | -1.5 to -0.3    | 35         | 10             | SC-59           |
| NSVJ3910SB3  | Single        | 25           | 20-40          | -1.8 to -0.6    | 40         | 6              | SOT-346 (CPH-3) |
| NSVJ5908DSG5 | Dual          | 15           | 10-32          | -1.5 to -0.3    | 35         | 10             | MCPH-5          |
| NSVJ6904DSB6 | Dual          | 25           | 20-40          | -1.8 to -0.6    | 40         | 6              | SOT-26 (CPH-6)  |

### RF Transistors

| Device      | Max Ratings  |            | $f_T$ Typ (GHz)                      | Package(s)       |
|-------------|--------------|------------|--------------------------------------|------------------|
|             | $V_{CE}$ (V) | $I_C$ (mA) |                                      |                  |
| NSVF6003SB6 | 12           | 150        | 7 @ $V_{CE} = 5$ V, $I_C = 50$ mA    | SOT-26 (CPH-6)   |
| NSVF6001SB6 | 12           | 100        | 6.7 @ $V_{CE} = 5$ V, $I_C = 30$ mA  | SOT-26 (CPH-6)   |
| NSVF4015SG4 | 12           | 100        | 10 @ $V_{CE} = 3$ V, $I_C = 30$ mA   | SOT-343 (MCPH-4) |
| NSVF4017SG4 | 12           | 100        | 10 @ $V_{CE} = 3$ V, $I_C = 30$ mA   | SOT-343 (MCPH-4) |
| NSVF3007SG3 | 12           | 30         | 8 @ $V_{CE} = 5$ V, $I_C = 10$ mA    | SOT-323 (MCPH-3) |
| NSVF5501SK  | 10           | 70         | 5.5 @ $V_{CE} = 5$ V, $I_C = 20$ mA  | SC-81 (SSFP)     |
| NSVF4020SG4 | 8            | 150        | 16.5 @ $V_{CE} = 5$ V, $I_C = 50$ mA | SOT-343 (MCPH-4) |
| NSVF4009SG4 | 3.5          | 40         | 25 @ $V_{CE} = 3$ V, $I_C = 20$ mA   | SOT-343 (MCPH-4) |

### RF Transistor Features

- High gain and low noise for receiver sensitivity
- Low distortion input
- High power capability for use in high temperature applications

### Pin Diode Features

- Series connection of two elements in small package
- Low inter-terminal capacitance

### PIN Diodes

| Device       | $V_R$ (V) | $I_F$ (mA) | $C$ Typ <sup>1</sup> (pF) | $r_s$ Typ <sup>2</sup> ( $\Omega$ ) | Package(s)    |
|--------------|-----------|------------|---------------------------|-------------------------------------|---------------|
| NSVP249SDSF3 | 50        | 50         | 0.23                      | 4.5                                 | SOT-323 (MCP) |
| NSVP264SDSF3 | 50        | 50         | 0.23                      | 2.5                                 | SOT-323 (MCP) |

1.  $C$  Typ @  $V_R = 50$  V,  $f = 1$  MHz. 2.  $r_s$  Typ @  $I_F = 10$  mA,  $f = 100$  MHz.

### RF Schottky Barrier Diode Features

- Low forward voltage
- Low inter-terminal capacitance

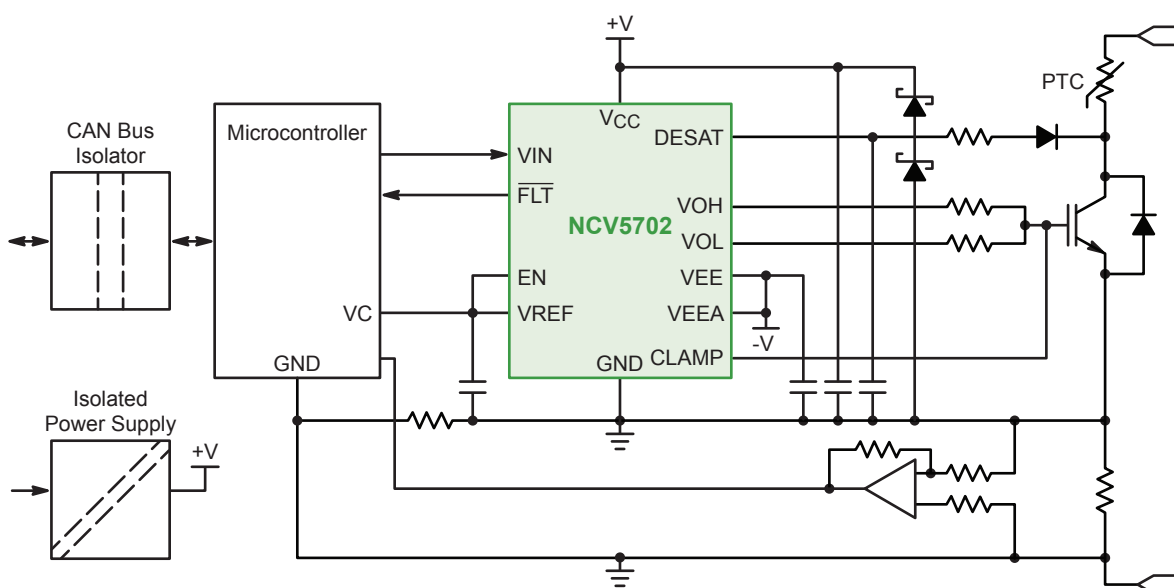
### Schottky Barrier Diodes

| Device       | $V_R$ (V) | $V_F$ <sup>1</sup> (mV) | $C$ Typ <sup>2</sup> (pF) | Package(s)   |
|--------------|-----------|-------------------------|---------------------------|--------------|
| NSVR201MX    | 2         | 320                     | 0.15                      | X2DFN-2      |
| NSVR351SDSA3 | 5         | 230                     | 0.69                      | SOT-346 (CP) |

1.  $V_F$  @  $I_F = 1$  mA. 2.  $C$  Typ @  $V_R = 50$  V,  $f = 1$  MHz.

## Features

- High current output (+4 A/-6 A) at Miller Plateau for higher system efficiency
- Short propagation delays with accurate matching for improved system reliability
- UVLO, DESAT, Miller Clamp, Negative VEE for system protection
- 5 V reference for external logic
- AEC-Q100 Qualified



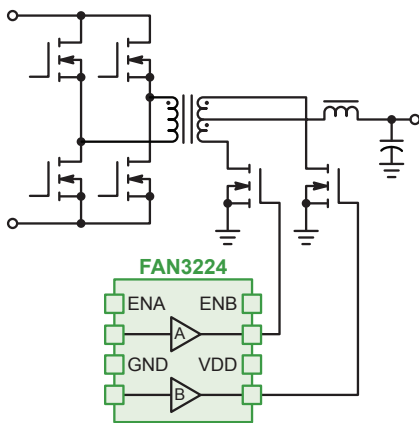
### PTC Heater Application Schematic

| Device   | Isolation     | Features + Options            | Inverted Output | Fault Output | V <sub>IN</sub> Max (V) | V <sub>CC</sub> Max (V) | Drive Source/<br>Sink Typ (A) | Rise/Fall Time (ns) | t <sub>pd</sub> Max (ns) | Package  |
|----------|---------------|-------------------------------|-----------------|--------------|-------------------------|-------------------------|-------------------------------|---------------------|--------------------------|----------|
| NCV57000 | Yes (5 kVRMS) | DESAT + CLAMP + VEE + VOH/VOL | No              | Open Drain   | 5.5                     | 24                      | 4/6                           | 10/15               | 90                       | SOIC-16W |
| NCV57001 | Yes (5 kVRMS) | DESAT + CLAMP + VEE           | No              | Open Drain   | 5.5                     | 24                      | 4/6                           | 10/15               | 90                       | SOIC-16W |
| NCV5700  | No            | DESAT + CLAMP + VEE + VOH/VOL | Yes             | Active Low   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-16  |
| NCV5701A | No            | DESAT + CLAMP                 | Yes             | Active Low   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-8   |
| NCV5701B | No            | DESAT + VEE                   | Yes             | Active Low   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-8   |
| NCV5701C | No            | DESAT + VOH/VOL               | Yes             | Active Low   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-8   |
| NCV5702  | No            | DESAT + CLAMP + VEE + VOH/VOL | No              | Open Drain   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-16  |
| NCV5703A | No            | DESAT + CLAMP                 | No              | Open Drain   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-8   |
| NCV5703B | No            | DESAT + VEE                   | No              | Open Drain   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-8   |
| NCV5703C | No            | DESAT + VOH/VOL               | No              | Open Drain   | 5.5                     | 35                      | 4/6                           | 30/30               | 75                       | SOIC-8   |

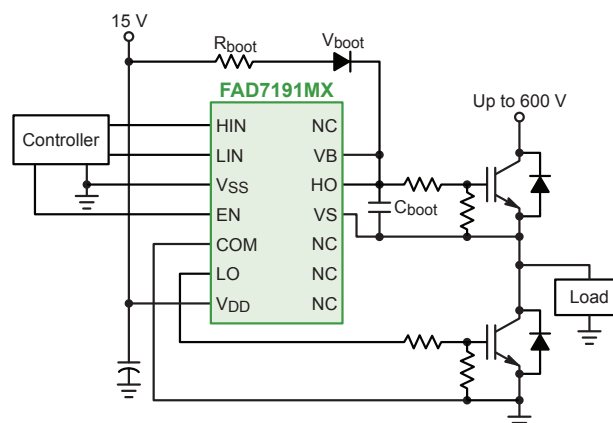
## MOSFET & IGBT Gate Drivers for ICE, EV/HEV, and 48 V

### Features

- Large sink and source current capability
- Fast drivers with short propagation delay
- SOIC-14 and SOIC-16 packages for applications with HV clearance requirements
- Separate power and signal ground for higher immunity against high  $di/dt$
- Various protection features such as UVLO and shoot-through prevention
- Custom options



Synchronous Rectification Application



Motor Drive Application

| Device         | Description   | Sink/Source Output Current | Undervoltage Lockout | Peak Transient (V) | Shoot Through Prevention | Enable/ Shut Down Pin | Input level                | Inverted Output | Package(s)        |
|----------------|---|----------------------------|----------------------|--------------------|--------------------------|-----------------------|----------------------------|-----------------|-------------------|
| FAN3229 (F085) | Dual Low Side Gate Driver   | 1.6/2.4 A                  | ✓                    | 20                 |                          |                       | CMOS/TTL**                 |                 | SOIC-8            |
| FAN3121 (F085) | Single Low Side Gate Driver   | 7.1/9.7 A                  | ✓                    | 20                 |                          | ✓                     | CMOS/TTL                   | ✓               | SOIC-8            |
| FAN3122 (F085) | Single Low Side Gate Driver   | 7.1/9.7 A                  | ✓                    | 20                 |                          | ✓                     | CMOS/TTL                   |                 | SOIC-8, SOIC-8 EP |
| FAN3213 (F085) | Dual Low Side Gate Driver   | 2.8/4.3 A                  | ✓                    | 20                 |                          |                       | TTL                        | ✓               | SOIC-8            |
| FAN3214 (F085) | Dual Low Side Gate Driver   | 2.8/4.3 A                  | ✓                    | 20                 |                          |                       | TTL                        |                 | SOIC-8            |
| FAN3216 (F085) | Dual Low Side Gate Driver   | 1.6/2.4 A                  | ✓                    | 20                 |                          |                       | TTL                        | ✓               | SOIC-8            |
| FAN3217 (F085) | Dual Low Side Gate Driver   | 1.6/2.4 A                  | ✓                    | 20                 |                          |                       | TTL                        |                 | SOIC-8            |
| FAN3223 (F085) | Dual Low Side Gate Driver   | 2.8/4.3 A                  | ✓                    | 20                 |                          | ✓                     | CMOS/TTL                   | ✓               | SOIC-8            |
| FAN3224 (F085) | Dual Low Side Gate Driver   | 2.8/4.3 A                  | ✓                    | 20                 |                          | ✓                     | CMOS/TTL                   |                 | SOIC-8, SOIC-8 EP |
| FAN3225 (F085) | Dual Low Side Gate Driver   | 2.8/4.3 A                  | ✓                    | 20                 |                          |                       | CMOS/TTL**                 |                 | SOIC-8            |
| FAN3226 (F085) | Dual Low Side Gate Driver   | 1.6/2.4 A                  | ✓                    | 20                 |                          | ✓                     | CMOS/TTL                   | ✓               | SOIC-8            |
| FAN3227 (F085) | Dual Low Side Gate Driver   | 1.6/2.4 A                  | ✓                    | 20                 |                          | ✓                     | CMOS/TTL                   |                 | SOIC-8            |
| FAN3228 (F085) | Dual Low Side Gate Driver   | 1.6/2.4 A                  | ✓                    | 20                 |                          |                       | CMOS/TTL**                 |                 | SOIC-8            |
| FAN1100 (F085) | Ignition IGBT Driver  | —                          |                      | 28                 |                          |                       | 1.2 V VINL / 2 V VINH      |                 | SOIC-8            |
| NCV51705       | Low side SiC Driver   | 6/6 A                      | Adjustable           | 28                 | ✓                        | ✓                     | TTL                        | ✓               | QFN-24            |
| NCV51511       | High Frequency, High Side and Low Side Gate Driver with Bootstrap Diode | 3/6 A                      |                      | 100                |                          |                       | TTL                        |                 | SOIC-8 EP         |
| FAN7085 (F085) | High Side Gate Driver with Cboot Recharge Path                          | 450/450 mA                 | ✓                    | 300                |                          | ✓                     | CMOS                       |                 | SOIC-8            |
| NCV5183        | High and Low Side Gate Driver   | 4.3/4.3 A                  | ✓                    | 600                |                          |                       | 3.3 & 5 V logic compatible |                 | SOIC-8            |
| NCV5106A       | High and Low Side Gate Driver   | 250/500 mA                 | ✓                    | 600                |                          |                       | 3.3 & 5 V logic compatible |                 | SOIC-8            |
| FAN7080 (F085) | Half Bridge Gate Driver   | 300/600 mA                 | ✓                    | 600                | ✓                        | ✓                     | 3.3 / 5 V logic compatible |                 | SOIC-8            |
| FAN7081 (F085) | High Side Gate Driver   | 250/500 mA                 | ✓                    | 600                |                          |                       | CMOS                       |                 | SOIC-8            |
| FAN7083 (F085) | High Side Gate Driver   | 200/400 mA                 | ✓                    | 600                |                          | ✓                     | CMOS                       |                 | SOIC-8            |
| NCV5104        | Single Input High and Low Side Gate Driver                              | 250/500 mA                 | ✓                    | 600                | ✓                        | ✓                     | 3.3 & 5 V logic compatible |                 | SOIC-8            |
| FAN7171 (F085) | High Side Gate Driver   | 4/4 A                      | ✓                    | 600                |                          |                       | 3.3 / 5 V logic compatible |                 | SOIC-8            |
| FAN7191 (F085) | High Side and Low Side High Gate Driver                                 | 4.5/4.5 A                  | ✓                    | 600                |                          |                       | 3.3 / 5 V logic compatible |                 | SOIC-8            |
| FAD7191M1X     | High Side and Low Side Gate Driver with Separate Grounds                | 4.5/4.5 A                  | ✓                    | 600                |                          | ✓                     | 3.3 / 5 V logic compatible |                 | SOIC-14           |
| FAD6263M1X     | Half Bridge Gate Driver with Separate Pullup and Pulldown Outputs       | 3/3 A                      | ✓                    | 600                | ✓                        | ✓                     | 3.3 / 5 V logic compatible |                 | SOIC-16           |
| FAD8253MX*     | Half Bridge Gate Driver with Separate Grounds                           | 2/2.5 A                    | ✓                    | 1200               | ✓                        | ✓                     | 3.3 / 5 V logic compatible |                 | SOIC-14           |

\* Pending 4Q19. \*\* Differential input.

## Smart Drivers & Bridges

In automotive systems, there are many different kind of actuators, including relays, bulbs, LEDs, motors, and other resistive and inductive loads. The variety of motor applications in modern vehicles is huge and is growing dramatically due to the increased demand for more efficiency. Comfort electronics – such as electrical window lifts, central door locks, and climate control systems – continue to increase automotive electronic content. The easiest to implement, DC brush motors are the most common electric motors used today. To reduce noise and to increase reliability, stepper motors are becoming more popular in position control applications, e.g. HVAC flaps.

ON Semiconductor provides drivers with integrated power stages; in addition, the company offers pre-drivers that control external MOSFETs in applications where the high load current makes MOSFET integration impractical.

### Product types in portfolio:

- Pre-Driver
  - Multi-channel pre-driver
  - Motor control pre-driver
- Multi-channel integrated driver
  - Multiple single-ended high-side and low-side driver
- Configurable high-side and low-side driver
- Half-bridge driver
- High current integrated H-bridge driver
- Stepper motor driver

### Pre-Drivers

| Device   | Description               | SPI    | Direct Control | Load Current    | 3.3 V / 5 V | V <sub>s</sub> Max      | Diagnostics |    | Package            |
|----------|---------------------------|--------|----------------|-----------------|-------------|-------------------------|-------------|----|--------------------|
|          |                           |        |                |                 |             |                         | OL/UL       | SC |                    |
| NCV7513B | Hex LS Pre-Driver         | 16-bit | ✓              | external MOSFET | ✓           | 40 V (drain)            | ✓           | ✓  | LQFP-32            |
| NCV7517B | Hex LS Pre-Driver         | 16-bit | ✓              | external MOSFET | ✓           | 40 V (drain)            | ✓           | ✓  | LQFP-32            |
| NCV7518  | Hex Low-Side              | 16-bit | ✓              | external MOSFET | ✓           | 48 V (load)             | ✓           | ✓  | QFN-32             |
| NCV7519  | Hex Low-Side              | 16-bit | ✓              | external MOSFET | ✓           | 48 V (load)             | ✓           | ✓  | QFN-32             |
| NCV7520  | Hex Low-Side              | 16-bit | ✓              | external MOSFET | ✓           | 48 V (load)             | ✓           | ✓  | QFN-32, TQFP-32 EP |
| NCV33152 | High Speed Dual PreDriver | –      | ✓              | external MOSFET |             | 20 V (V <sub>DD</sub> ) |             |    | SOIC-8             |
| NCV7535  | H-Bridge                  | 24-bit | ✓              | external MOSFET | 5 V         | 40 V                    |             | ✓  | TSSOP-20           |

## Smart Drivers & Bridges

### Multi-Channel Drivers

| Device   | Description                              | SPI          | Output Current | Current Limit Min (A) | R <sub>DS(on)</sub> @ 25°C | V <sub>s_op</sub> (V) | V <sub>s</sub> Peak Transient (V) | Sleep Mode | On-Chip Flyback Diode | Active Output Clamp | Parallel Inputs | Fault Reporting | Undervoltage Lockout | Open Load Detect | Current Limit | Overvoltage | Overtemperature | Low Duty Cycle Overcurrent Mode | Package(s)          |
|----------|--|--------------|----------------|-----------------------|----------------------------|-----------------------|-----------------------------------|------------|-----------------------|---------------------|-----------------|-----------------|----------------------|------------------|---------------|-------------|-----------------|---------------------------------|---------------------|
| NCV1413  | Darlington Transistor Array              | —            | 500 mA         | —                     | —                          | 30                    | 50                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SOIC-16             |
| NCV7608  | Configurable 8-Fold High/Low-Side Driver | 16-bit       | 350 mA         | 0.8                   | 1.2                        | 3 - 28                | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SOIC-28, SSOP-36 EP |
| NCV7702B | Dual Half-Bridge Driver                  | —            | —              | 1                     | —                          | 7 - 16                | 60                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SOIC-24             |
| NCV7721  | Dual Half-Bridge Driver                  | —            | 500mA          | 1                     | 0.8                        | 5.5 - 32              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SOIC-14             |
| NCV7703C | Triple Half-Bridge Driver                | 16-bit       | 499 mA         | 1                     | 0.8                        | 5.5 - 33              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SOIC-14             |
| NCV7708F | Dual Hex High/Low-Side Driver            | 16-bit       | 500 mA         | 1                     | 0.8                        | 4.5 - 28              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24             |
| NCV7718  | Hex Half-Bridge Driver                   | 16-bit       | 550 mA         | 0.8                   | 1                          | 4.5 - 28              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24             |
| NCV7719  | Octal Half-Bridge Driver                 | 16-bit       | 550 mA         | 0.8                   | 1                          | 4.5 - 28              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24 EP          |
| NCV7720  | Deca Half-Bridge Driver                  | 16-bit       | 550 mA         | 0.8                   | 1                          | 4.5 - 28              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24 EP          |
| NCV7726  | 12x Half-Bridge Driver                   | 16-bit       | —              | 1.1                   | 0.9                        | 4.5 - 32              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24 EP          |
| NCV7240  | 8x Low-Side Driver                       | 16-bit       | 300 mA         | 0.6                   | 1.5                        | (VDD) 4.5 - 5.5       | (VDD) 5.5                         | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24             |
| NCV7728  | Hex Half-Bridge Driver                   | 16-bit       | 550 mA         | 0.8                   | 1                          | 4.5 - 28              | 40                                | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24             |
| NCV7750  | 4x Low Side Driver                       | 16-bit       | 300 mA         | 0.6                   | 1.5                        | (VDD) 4.5 - 5.5       | (VDD) 5.5                         | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24             |
| NCV7751  | 12x Low-Side Driver                      | 16/24/32-bit | 300 mA         | 0.6                   | 1.3                        | (VDD) 4.5 - 5.5       | (VDD) 5.5                         | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24 EP          |
| NCV7754  | 8x Low-Side Driver                       | 16-bit       | 300 mA         | 0.5                   | 0.8                        | (VDD) 4.5 - 5.5       | (VDD) 5.5                         | ✓          | ✓                     | ✓                   | ✓               | ✓               | ✓                    | ✓                | ✓             | ✓           | ✓               | ✓                               | SSOP-24             |

### Door Drivers

|                   | Device  | SPI    | Safe Lock   | Door Locking | Mirror Fold | Mirror X-Axis | Mirror Y-Axis | ECM      | Mirror Defroster | LED Blinker | LED Floor Step Light (LED/Bulb) | Safety Light (LED/Bulb) | Protection (Over Voltage & Under Voltage) | Protection (Over Current, Under Load & Thermal) | Current Sense & PWM | Package(s) |
|-------------------|---------|--------|-------------|--------------|-------------|---------------|---------------|----------|------------------|-------------|---------------------------------|-------------------------|---|---|---------------------|------------|
| Front Door/Mirror | NCV7707 | 24-bit | 0.15, 0.3 Ω | 0.15 Ω       | 0.3 Ω       | 1.6 Ω         | 1.6 Ω         | DAC + LS | 0.1 Ω            | 1.4 Ω       | 0.3, 1.4 Ω                      | 1.4 Ω                   | ✓   | ✓   | ✓                   | SSOP-36    |
| Back Door Lock    | NCV7710 | 24-bit | —           | 0.15 Ω       | —           | —             | —             | —        | —                | —           | —                               | —                       | ✓   | ✓   | ✓                   | SSOP-36    |
| Mirror Module     | NCV7704 | 24-bit | —           | —            | —           | 1.6 Ω         | 1.6 Ω         | —        | 0.1 Ω            | 1.4 Ω       | 0.3, 1.4 Ω                      | —                       | ✓   | ✓   | ✓                   | SSOP-36    |
|                   | NCV7705 | 24-bit | —           | —            | 0.3 Ω       | 1.6 Ω         | 1.6 Ω         | —        | 0.1 Ω            | 1.4 Ω       | 0.3, 1.4 Ω                      | 0.6/1.4 Ω               | ✓   | ✓   | ✓                   | SSOP-36    |
|                   | NCV7714 | 24-bit | —           | —            | —           | 1.6 Ω         | 1.6 Ω         | DAC + LS | 0.1 Ω            | 1.4 Ω       | 0.3, 1.4 Ω                      | —                       | ✓   | ✓   | ✓                   | SSOP-36    |

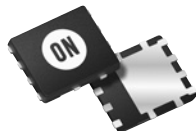


### Wide Selection of Automotive Grade Power MOSFETs

ON Semiconductor offers an expansive portfolio of Power MOSFETs, utilizing advanced Trench and SuperFET® Technology. Devices enable increased system level efficiency through low switching losses and low conduction losses, and are available in a range of standard and innovative packages.



TO-247



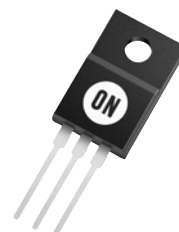
SO-8 FL



TO-Leadless



μ8FL



TO-220

#### Low to Medium Voltage

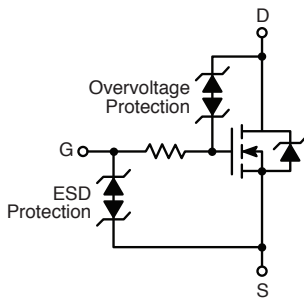
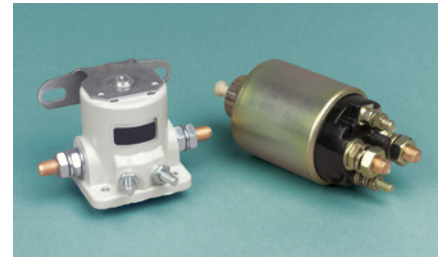
- 20 V to 200 V, Standard Gate & Logic Level
- N & P Channel, Singles & Duals
- Wide  $R_{DS(on)}$  range from 0.5 mΩ for 40 V in 5 x 6 mm package, to 7.5 Ω general purpose switches
- Planar & multiple Trench technologies
- Package types including:
  - Small footprint – SOT-23, SC-70/75/88, SSOT-3/6, TSSOP-6, SO-8
  - Traditional – DPAK, D2PAK, TO-220, SOT-223
  - Surface Mount – μ8FL, SO-8 FL, Power88, TO-Leadless
  - With Dual Cool, & DFN being introduced

#### High Voltage Fast Switching

- 600 V to 650 V, N Channel, Standard Gate Level
- 650 V SuperFET II – Typical  $R_{DS(on)}$  of 41 - 190 mΩ
- 650 V MOSFET KGD Dies SuperFET I and II – Typical  $R_{DS(on)}$  of 41, 77, and 190 mΩ
- New SuperFET III technology in development with typical  $R_{DS(on)}$  of 23 - 70 mΩ
- Lowest  $R_{DS(on)}$  for the Automotive Qualified Super junction HV MOSFET's in different thru hole packages – TO-247-3L and TO-220
- MOSFET Modules in development
  - High thermal performance
  - Enhanced EMI, isolation, and current capabilities
  - System level cost reduction
  - Enable compact system solution with proven reliability
- One of best-in-class Figure of Merit ( $Q_g^* R_{DS(on)}$ ) for automotive qualified MOSFETs

## Integrated Circuit Elements with Self-Protected MOSFET Solutions

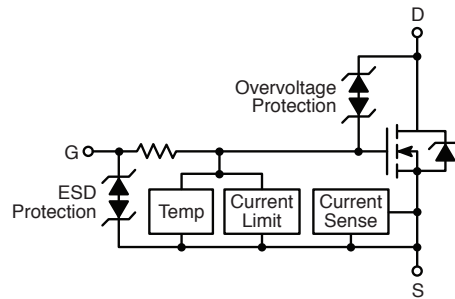
ON Semiconductor supplies self-protected MOSFETs that may include current limiting, temperature limiting, ESD protection, or a current mirror. The portfolio of smart MOSFETs integrates analog circuit elements for protection and diagnostics within power MOSFETs.



**Clamping MOSFET**

### Clamp FET Features (E-FET)

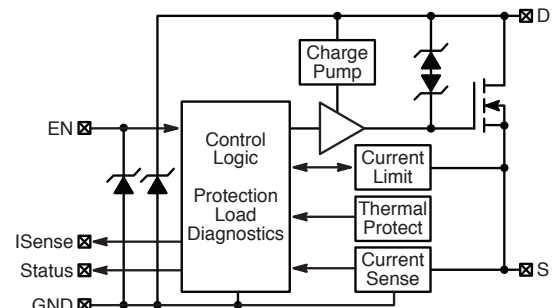
- Gate-to-Source protection
- Over-voltage protection
- Internal series Gate resistance
- Clamp voltage range 40-50 V



**Low-Side Protected MOSFET**

### Protected Low-Side Switch

- Short circuit protection
- Current limit
- Thermal shut-down with restart
- ESD protection
- Overvoltage clamped protection
- Best-in-class Repetitive Short Circuit robustness



**High-Side Protected MOSFET**

### Protected High-Side Switch

- Charge pump
- Short circuit protection
- Current limit
- Current sense output
- Temperature limit and shut-down
- ESD protection
- Overvoltage clamped protection
- Diagnostic output
- Loss of ground detection
- Open and underload detection
- Over and undervoltage detection

## Self-Protected MOSFETs

| Device           | Description   | Channels | Package(s)    |
|------------------|---|----------|---------------|
| <b>LOW SIDE</b>  |   |          |               |
| NCV8401B         | Low Side Protected MOSFET, 23 mΩ                                      | 1        | DPAK          |
| NCV8402A         | Low Side Protected MOSFET, 165 mΩ                                     | 1        | SOT-223       |
| NCV8402AD        | Dual Low Side Protected MOSFET, 165 mΩ                                | 2        | SOIC-8        |
| NCV8403A/B       | Low Side Protected MOSFET, 60 mΩ                                      | 1        | SOT-223, DPAK |
| NCV8405A         | Low Side Protected MOSFET, 60 mΩ                                      | 1        | SOT-223, DPAK |
| NCV8406A/B       | Low Side Protected MOSFET, 210 mΩ                                     | 1        | SOT-223, DPAK |
| NCV8408B         | Low Side Protected MOSFET, 65 mΩ                                      | 1        | DPAK          |
| NCV8440A         | Clamped MOSFET, 95 mΩ   | 1        | SOT-223       |
| NCV8411          | Low Side Protected MOSFET with Inrush Current Management, 23 mΩ       | 1        | DPAK          |
| NCV8413          | Low Side Protected MOSFET with Inrush Current Management, 60 mΩ       | 1        | SOT-223, DPAK |
| NCV8412          | Low Side Protected MOSFET with Inrush Current Management, 165 mΩ      | 1        | SOT-223       |
| NCV8412D         | Dual Low Side Protected MOSFET with Inrush Current Management, 165 mΩ | 2        | SOIC-8        |
| <b>HIGH SIDE</b> |   |          |               |
| NCV8450A         | High Side Protected MOSFET, 1 Ω                                       | 1        | SOT-223       |
| NCV8452          | High Side Protected MOSFET, 200 mΩ                                    | 1        | SOT-223       |
| NCV8445          | High Side Protected MOSFET w\Digital Diagnostics, 45 mΩ               | 1        | SOIC-8        |
| NCV8460A         | High Side Protected MOSFET w\Digital Diagnostics, 60 mΩ               | 1        | SOIC-8        |
| NCV8461          | High Side Protected MOSFET w\Digital Diagnostics, 350 mΩ              | 1        | SOIC-8        |
| NCV84160         | High Side Protected MOSFET w\Current Sense, 160 mΩ                    | 1        | SOIC-8        |
| NCV84140         | High Side Protected MOSFET w\Current Sense, 140 mΩ                    | 1        | SOIC-8        |

## Wide Selection of Automotive Grade Operational Amplifiers and Comparators

## Operational Amplifiers

| Device        | Channels | V <sub>S</sub> Range (V) | I <sub>Q</sub> /Channel (mA) | GBW (MHz) | Slew Rate (V/μs) | V <sub>OS</sub> Max (mV) | V <sub>OS</sub> Drift (μV/°C) | I <sub>B</sub> (nA) | CMRR (dB) | e <sub>N</sub> (nV/√Hz) | Rail to Rail | Features                                       | Package(s)                                 |
|---------------|----------|--------------------------|------------------------------|-----------|------------------|--------------------------|-------------------------------|---------------------|-----------|-------------------------|--------------|--|--|
| NCV2333       | 2        | 1.8 - 5.5                | 0.21                         | 0.27      | 0.1              | 0.03                     | 0.04                          | 60                  | 123       | 62                      | Input/Output | High Accuracy                                  | Micro8, SOIC-8, UDFN-8                     |
| NCV333A       | 1        | 1.8 - 5.5                | 0.21                         | 0.35      | 0.1              | 0.03                     | 0.03                          | 60                  | 123       | 62                      | Input/Output | High Accuracy                                  | SC-88A / SC-70-5<br>TSOP-5 / SOT-23-5      |
| NCV4333       | 4        | 1.8 - 5.5                | 0.21                         | 0.35      | 0.15             | 0.03                     | 0.095                         | 60                  | 123       | 62                      | Input/Output | High Accuracy                                  | SOIC-14                                    |
| NCV20091/2/4  | 1,2,4    | 1.8 - 5.5                | 0.02                         | 0.35      | 0.15             | 3                        | 1                             | 0.001               | 80        | 30                      | Input/Output | Low I <sub>Q</sub> & Rail-Rail Input/Output    | Micro8, SOIC-8, TSSOP-8                    |
| NCV5652       | 2        | 3.3 - 13.2               | 6                            | 0.35      | —                | 5                        | 2                             | 200                 | 80        | —                       | —            | 500 mA Output Current                          | UDFN-12                                    |
| NCV2002       | 1        | 0.9 - 7.0                | 0.48                         | 0.9       | 1.2              | 6                        | 8                             | 0.01                | 82        | 100                     | Input/Output | Shutdown, Ultra-Low V <sub>S</sub>             | TSOP-6                                     |
| NCV2902       | 4        | 3.0 - 32.0               | 1.2                          | 1         | —                | 7                        | 7                             | 90                  | 70        | —                       | —            | Low Cost                                       | SOIC-14, TSSOP-14                          |
| NCV2904       | 2        | 3.0 - 32.0               | 0.75                         | 1         | —                | 7                        | 7                             | 45                  | 70        | —                       | —            | Low Cost                                       | SOIC-8, Micro8                             |
| NCV7101       | 1        | 1.8 - 10.0               | 1                            | 1         | 1.2              | 9                        | 8                             | 0.001               | 60        | 140                     | Input/Output | Ultra-Low I <sub>B</sub>                       | SOT-23-5                                   |
| NCV20081/2/4  | 1,2,4    | 1.8 - 5.5                | 0.05                         | 1.2       | 1.2              | 3                        | 1                             | 0.001               | 80        | 30                      | Input/Output | Low I <sub>Q</sub> & Rail-Rail Input/Output    | Micro8, SOIC-8, TSSOP-8                    |
| NCV33172      | 2,4      | 3.0 - 44.0               | 0.18                         | 1.8       | 2.1              | 6.5                      | 10                            | 20                  | 90        | 32                      | —            | Low I <sub>Q</sub> & 44 V V <sub>S</sub> range | SOIC-8, TSSOP-14                           |
| NCV21911      | 1        | 4 - 36                   | 0.6                          | 2         | 1.6              | 0.025                    | 0.085                         | 3.5                 | 120       | 22                      | Output       | Low Noise Zero drift                           | TSOP-5, SOT23-5                            |
| NCV33202/4    | 2,4      | 1.8 - 12.0               | 0.9                          | 2.2       | 1                | 6                        | 2                             | 80                  | 90        | 20                      | Input/Output | High Output Current                            | SOIC-8, Micro8, SOIC-14, TSSOP-14          |
| NCV20061/2/4  | 1,2,4    | 1.8 - 5.5                | 0.14                         | 3         | 0.45             | 3                        | 1                             | 0.001               | 80        | 20                      | Input/Output | Low I <sub>Q</sub> & Rail-Rail Input/Output    | Micro8, SOIC-8, TSSOP-8                    |
| NCV20071/2/4  | 1,2,4    | 2.7 - 36.0               | 0.41                         | 3         | 2.7              | 3                        | 2                             | 0.005               | 111       | 20                      | Output       | 36 V Rail-to-rail Output                       | SOIC-8, Micro8, TSSOP-8, SOIC-14, TSSOP-14 |
| NCV952        | 2        | 2.7 - 26.0               | 0.9                          | 3         | 1                | 8                        | 2                             | 35                  | 80        | 25                      | Input/Output | 26 V Rail-to-rail Input/Output                 | TSSOP-8                                    |
| NCV33072/4    | 2,4      | 3.0 - 44.0               | 1.6                          | 4.5       | 10               | 3                        | 10                            | 100                 | 97        | 32                      | —            | 44 V V <sub>S</sub> Range                      | SOIC-8, TSSOP-14                           |
| NCV2003/32/34 | 1,2,4    | 1.7 - 5.5                | 0.3                          | 7         | 8                | 4                        | 2                             | 0.001               | 70        | 20                      | Output       | High GBW & Slew Rate                           | SOT-23-5, SOIC-8, Micro8, TSSOP-8, SOIC-14 |
| NCV833        | 2        | 10.0 - 36.0              | 2                            | 15        | 7                | 5                        | 2                             | 300                 | 100       | 4.5                     | —            | 44 V V <sub>S</sub> Range, Low e <sub>N</sub>  | SOIC-8                                     |
| NCV33078/9    | 2,4      | 5.0 - 18.0               | 2.1                          | 16        | 7                | 2                        | 2                             | 300                 | 100       | 4.5                     | —            | Wide GBW, Low V <sub>OS</sub> & e <sub>N</sub> | SOIC-8, SOIC-14                            |
| NCV33272/4A   | 2,4      | 3.0 - 36.0               | 2.2                          | 24        | 10               | 1                        | 2                             | 300                 | 100       | 18                      | —            | Wide GBW, V <sub>S</sub> range                 | SOIC-8, SOIC-14, TSSOP-14                  |

## Comparators

| Device  | Channels | V <sub>S</sub> Min (V) | V <sub>S</sub> Max (V) | I <sub>Q</sub> /Channel (μA) | t <sub>RESP</sub> (H-L) (μs) | V <sub>OS</sub> Max (mV) | Input Range (V)                         | I <sub>OUT</sub> (mA) | Output Type    | Features                      | Package(s)                  |
|---------|----------|------------------------|------------------------|------------------------------|------------------------------|--------------------------|---|-----------------------|----------------|-------------------------------|-----------------------------|
| NCV2393 | 2        | 2.7                    | 16                     | 6                            | 0.8                          | —                        | V <sub>ee</sub> to V <sub>DD</sub> -1.5 | 20                    | Open Drain     | Ultra-Low I <sub>Q</sub>      | SOIC-8                      |
| NCV2200 | 1        | 0.85                   | 6                      | 10                           | 0.5                          | 5                        | V <sub>ee</sub> to V <sub>DD</sub>      | 70                    | Complementary  | Low I <sub>Q</sub>            | SOT-23-5, SC-70             |
| NCV2202 | 1        | 0.85                   | 6                      | 10                           | 0.5                          | 5                        | V <sub>ee</sub> to V <sub>DD</sub>      | 70                    | Open Drain     | Low I <sub>Q</sub>            | SOT-23-5, SC-70             |
| NCV331  | 1        | 2.7                    | 5                      | 40                           | 0.6                          | 9                        | V <sub>ee</sub> to V <sub>DD</sub> -0.7 | 23                    | Open Drain     | Low I <sub>Q</sub> , Low Cost | SOT-23-5                    |
| NCV2903 | 2        | 2                      | 36                     | 200                          | 1.5                          | 7                        | V <sub>ee</sub> to V <sub>DD</sub> -1.5 | 16                    | Open Collector | 36 V, Low Cost                | SOIC-8, Micro8              |
| NCV2901 | 4        | 3                      | 36                     | 200                          | 1.3                          | 7                        | V <sub>ee</sub> to V <sub>DD</sub> -1.5 | 16                    | Open Collector | 36 V, Low Cost                | SOIC-14, TSSOP-14, Bare Die |
| NCV391  | 1        | 2                      | 36                     | 500                          | 0.5                          | 9                        | V <sub>ee</sub> to V <sub>DD</sub> -1.5 | 16                    | Open Collector | 36 V, Fast t <sub>RESP</sub>  | SOT-23-5                    |
| TL331V  | 1        | 2                      | 36                     | 500                          | 0.35                         | 9                        | V <sub>ee</sub> to V <sub>DD</sub> -1.5 | 16                    | Open Collector | 36 V, Fast t <sub>RESP</sub>  | TSOP-5 / SOT-23-5           |
| NCV2250 | 1        | 1.8                    | 5.5                    | 150                          | 74                           | 6                        | V <sub>ee</sub> to V <sub>DD</sub>      | 50                    | Push Pull      | Fast t <sub>RESP</sub>        | SOT-23-5, SC-70             |
| NCV2252 | 1        | 1.8                    | 5.5                    | 150                          | 74                           | 6                        | V <sub>ee</sub> to V <sub>DD</sub>      | 50                    | Open Collector | Fast t <sub>RESP</sub>        | SOT-23-5, SC-70             |

## EEPROMs for Personalization of Comfort and Entertainment Features

### Grade 0 EEPROMs

| Device  | Density | Vcc Min (V) | Vcc Max (V) | Temperature Range (°C) | Package(s)      |
|---------|---------|-------------|-------------|------------------------|-----------------|
| NV25010 | 1 kb    | 1.7 / 2.5   | 5.5         | -40 to +150            | SOIC-8, TSSOP-8 |
| NV25020 | 2 kb    | 1.7 / 2.5   | 5.5         | -40 to +150            | SOIC-8, TSSOP-8 |
| NV25040 | 4 kb    | 1.7 / 2.5   | 5.5         | -40 to +150            | SOIC-8, TSSOP-8 |
| NV25080 | 8 kb    | 1.7 / 2.5   | 5.5         | -40 to +150            | SOIC-8, TSSOP-8 |
| NV25160 | 16 kb   | 1.7 / 2.5   | 5.5         | -40 to +150            | SOIC-8, TSSOP-8 |
| NV25320 | 32 kb   | 1.7 / 2.5   | 5.5         | -40 to +150            | SOIC-8, TSSOP-8 |
| NV25640 | 64 kb   | 1.7 / 2.5   | 5.5         | -40 to +150            | SOIC-8, TSSOP-8 |

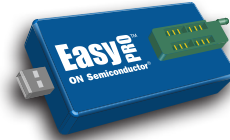
### Grade 0 Features

- -40 to +150°C
- SPI interface protocol
- Voltage supply range: 1.7 – 5.5 V up to +125°C;  
2.5 – 5.5 V up to +150°C

### Grade 1 Features

- -40°C to +125°C
- 1 kb to 1 Mb density range available
- 1 million cycle program/erase

**EasyPRO™ is a user-friendly, portable programming tool for ON Semiconductor serial EEPROMs (I2C, SPI, Microwire)**



### Grade 1 EEPROMs

| Interface Protocol | Device    | Density | Organization       | Vcc Min (V) | Vcc Max (V) | fclk Max (MHz) | Package(s)              |
|--------------------|-----------|---------|--------------------|-------------|-------------|----------------|-------------------------|
| I2C                | CAV24M01  | 1 Mb    | 128k x 8           | 2.5         | 5.5         | 1              | SOIC-8, TSSOP-8         |
|                    | CAV24C512 | 512 kb  | 64k x 8            | 2.5         | 5.5         | 1              | SOIC-8, TSSOP-8         |
|                    | CAV24C256 | 256 kb  | 32k x 8            | 2.5         | 5.5         | 1              | SOIC-8, TSSOP-8         |
|                    | CAV24C128 | 128 kb  | 16k x 8            | 2.5         | 5.5         | 1              | SOIC-8, TSSOP-8         |
|                    | CAV24C64  | 64 kb   | 8k x 8             | 2.5         | 5.5         | 0.4            | SOIC-8, TSSOP-8         |
|                    | CAV24C32  | 32 kb   | 4k x 8             | 2.5         | 5.5         | 0.4            | SOIC-8, TSSOP-8         |
|                    | CAV24C16  | 16 kb   | 2k x 8             | 2.5         | 5.5         | 0.4            | SOIC-8, TSSOP-8         |
|                    | CAV24C08  | 8 kb    | 1k x 8             | 2.5         | 5.5         | 0.4            | SOIC-8, TSSOP-8         |
|                    | CAV24C04  | 4 kb    | 512 x 8            | 2.5         | 5.5         | 0.4            | SOIC-8, TSSOP-8         |
| SPI                | CAV24C02  | 2 kb    | 256 x 8            | 2.5         | 5.5         | 0.4            | SOIC-8, TSSOP-8         |
|                    | CAV25M01  | 1 Mb    | 128k x 8           | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25512  | 512 kb  | 64k x 8            | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25256  | 256 kb  | 32k x 8            | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25128  | 128 kb  | 16k x 8            | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25640  | 64 kb   | 8k x 8             | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8, TDFN-8 |
|                    | CAV25320  | 32 kb   | 4k x 8             | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25160  | 16 kb   | 2k x 8             | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25080  | 8 kb    | 1k x 8             | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25040  | 4 kb    | 512 x 8            | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25020  | 2 kb    | 256 x 8            | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
|                    | CAV25010  | 1 kb    | 128 x 8            | 2.5         | 5.5         | 10             | SOIC-8, TSSOP-8         |
| Microwire          | CAV93C86  | 16 kb   | 2k x 8 / 1k x 16   | 2.5         | 5.5         | 2              | SOIC-8, TSSOP-8         |
|                    | CAV93C76  | 8 kb    | 1k x 8 / 512 x 16  | 2.5         | 5.5         | 2              | SOIC-8, TSSOP-8         |
|                    | CAV93C66  | 4 kb    | 512 x 8 / 256 x 16 | 2.5         | 5.5         | 2              | SOIC-8, TSSOP-8         |
|                    | CAV93C56  | 2 kb    | 256 x 8 / 128 x 16 | 2.5         | 5.5         | 2              | SOIC-8, TSSOP-8         |
|                    | CAV93C46  | 1 kb    | 128 x 8 / 64 x 16  | 2.5         | 5.5         | 2              | SOIC-8, TSSOP-8         |

## Micro-Stepping Motor Drivers for Enhanced Positioning Resolution

### Features

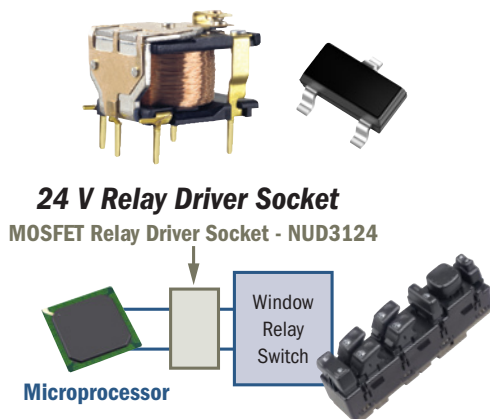
- Micro-stepping technology
- Embedded sensorless step-loss and stall detection
- Configurable for different motor types
- On-chip positioner – AMIS-30623

### Stepping Motor Drivers

| Device     | Interface        | Integrated Linear Regulator | Sensorless Stall Detection | Peak Transient (V) | Peak Current (mA) | Package          |
|------------|------------------|-----------------------------|----------------------------|--------------------|-------------------|------------------|
| AMIS-30621 | LIN              | ✓                           |                            | 40                 | 800               | SOIC-20, NQFP-32 |
| AMIS-30622 | I <sup>2</sup> C | ✓                           |                            | 40                 | 800               | SOIC-20          |
| AMIS-30623 | LIN              | ✓                           | ✓                          | 40                 | 800               | SOIC-20, NQFP-32 |

## Integrated, Reliable Drive Circuits for Motors and Electro-Mechanical Relays

*Most relays mounted to a PCB  
require a relay driver circuit!*



### Features

- Integrates diodes, resistors and capacitors into one circuit
- Delivers additional current to the relay coil and protects against ESD
- Meets IEC61000-4-4 Electrical Fast Transient (EFT) test standards

### Relay Drivers

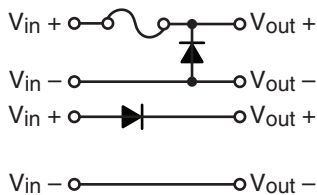
| Device     | Configuration | Circuit Type * | Voltage (V) | Current (mA) | Package(s) |
|------------|---------------|----------------|-------------|--------------|------------|
| SZNUD3124  | Single        | MOSFET         | 24          | 150          | SOT-23     |
| SZNUD3124D | Dual          | MOSFET         | 24          | 150          | SC-74      |
| SZNUD3160  | Single        | MOSFET         | 60          | 150          | SOT-23     |
| SZNUD3160D | Dual          | MOSFET         | 60          | 150          | SC-74      |
| NCV7750    | Quad          | MOSFET         | 40          | 300          | SSOP-24    |
| NCV7608    | Octal         | MOSFET         | 40          | 300          | SSOP36-EP  |
| NCV7240    | Octal         | MOSFET         | 40          | 300          | SSOP-24    |
| NCV7751    | 12x           | MOSFET         | 40          | 300          | SSOP24-EP  |
| NCV7754    | Octal         | MOSFET         | 40          | 300          | SSOP-24    |
| NCV7748    | Octal         | MOSFET         | 40          | 300          | SOIC-14    |

\* MOSFET: the driver circuit consists of a MOSFET combined with resistors and diodes.

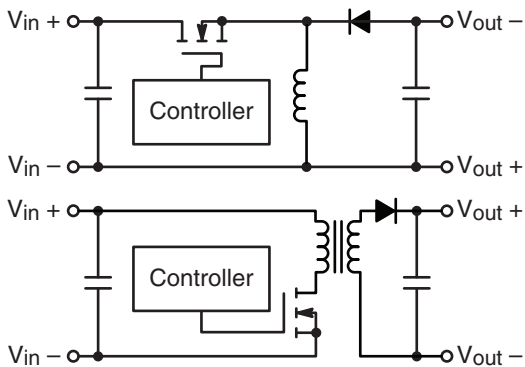
## New Rectifier Packaging Solutions for Automotive

### Features

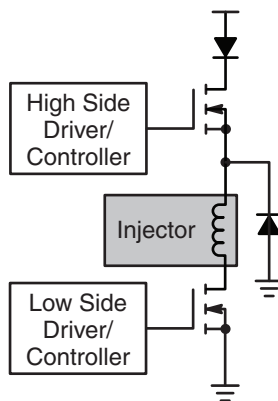
- Low forward voltage drop for improved efficiency
- High forward surge current capabilities
- Fast switching Schottky rectifiers can operate at high frequencies
- Small SOD-123FL, SMA, SMB, SMC and DPAK options to reduce board area
- Capable of use as freewheeling diodes, output rectifiers, energy recirculation diodes, and for polarity protection



Polarity Protection



Freewheeling and Output Rectification



Engine Control and Energy Recirculation Diodes

### Polarity Protection Rectifiers

| Device       | V <sub>RRM</sub> (V) | I <sub>O(rec)</sub> (A) | Package |
|--------------|----------------------|-------------------------|---------|
| NRVBS360     | 60                   | 3                       | SMC     |
| SBRD8360     | 60                   | 3                       | DPAK    |
| NRVBD660CT   | 60                   | 6                       | DPAK    |
| SBRD81045    | 45                   | 10                      | DPAK    |
| SBRB1045     | 45                   | 10                      | D2PAK   |
| NRVBB1645    | 45                   | 16                      | D2PAK   |
| NRVBB2060CT  | 60                   | 20                      | D2PAK   |
| SBRB2545CT   | 45                   | 30                      | D2PAK   |
| NRVBB30H60CT | 60                   | 30                      | D2PAK   |
| NTSB30100CT  | 100                  | 30                      | D2PAK   |
| NTSB30U100CT | 100                  | 30                      | D2PAK   |
| NRVBB4030    | 30                   | 40                      | D2PAK   |
| NTSB40120CT  | 120                  | 40                      | D2PAK   |
| NTSB60100CT  | 100                  | 60                      | D2PAK   |

### Freewheeling and Output Rectification Rectifiers

| Device        | V <sub>RRM</sub> (V) | I <sub>O(rec)</sub> (A) | Package   |
|---------------|----------------------|-------------------------|-----------|
| NRVBSS13HE    | 30                   | 1                       | SOD-323HE |
| NRVBSS16HE    | 60                   | 1                       | SOD-323HE |
| NRVB140SF     | 40                   | 1                       | SOD-123FL |
| NRVB140ESF    | 40                   | 1                       | SOD-123FL |
| NRVB1H60SF    | 60                   | 1                       | SOD-123FL |
| NRVHPRS1DFA   | 200                  | 0.8                     | SOD-123FL |
| NRVHPRS1KFA   | 800                  | 0.8                     | SOD-123FL |
| MBRAF1100     | 100                  | 1                       | SMA Flat  |
| NRVBAF1540    | 40                   | 1.5                     | SMA Flat  |
| NRVBS2040L    | 40                   | 2                       | SMB       |
| NRVBS240L     | 40                   | 2                       | SMB       |
| NRVTSM260EV2  | 60                   | 2                       | Powermite |
| NRVTS2H60ESF  | 60                   | 2                       | SOD-123FL |
| NRVBAF260     | 60                   | 2                       | SMA Flat  |
| NRVBS260      | 60                   | 2                       | SMB       |
| MBRAF2H100    | 100                  | 2                       | SMA Flat  |
| NRVBA340      | 40                   | 3                       | SMA       |
| SBRBS340      | 40                   | 3                       | SMC       |
| SBRD8340      | 40                   | 3                       | DPAK      |
| NRVBAF360     | 60                   | 3                       | SMA Flat  |
| NRVBAF3200    | 200                  | 3                       | SMA Flat  |
| MBRAF440      | 40                   | 4                       | SMA Flat  |
| NRVBS540      | 40                   | 5                       | SMC       |
| NRVTS360ETFS  | 60                   | 3                       | μ8FL      |
| NRVTS5100ETFS | 100                  | 5                       | μ8FL      |
| SBRB1545CT    | 45                   | 15                      | D2PAK     |
| NRVBB3030CTL  | 30                   | 30                      | D2PAK     |

### S0-8 Flat Lead Rectifiers

| Device         | V <sub>RRM</sub> (V) | I <sub>O(rec)</sub> (A) | Package |
|----------------|----------------------|-------------------------|---------|
| NRVB440MFS     | 40                   | 4                       | S0-8FL  |
| NRVB460MFS     | 60                   | 4                       | S0-8FL  |
| NRVB540MFS     | 40                   | 5                       | S0-8FL  |
| NRVB560MFS     | 60                   | 5                       | S0-8FL  |
| NRVB5100MFS    | 100                  | 5                       | S0-8FL  |
| NRVB5H100MFS   | 100                  | 5                       | S0-8FL  |
| NRVB860MFS     | 60                   | 8                       | S0-8FL  |
| NRVB8H100MFS   | 100                  | 8                       | S0-8FL  |
| NRVB1045MFS    | 45                   | 10                      | S0-8FL  |
| NRVB10100MFS   | 100                  | 10                      | S0-8FL  |
| NRVTS10100EMFS | 100                  | 10                      | S0-8FL  |
| NRVTS10120EMFS | 120                  | 10                      | S0-8FL  |
| NRVB1240MFS    | 40                   | 12                      | S0-8FL  |
| NTS12100EMFS   | 100                  | 12                      | S0-8FL  |
| NRVTS12120EMFS | 120                  | 12                      | S0-8FL  |
| NRVB2045MFS    | 45                   | 20                      | S0-8FL  |
| NRVB2045EMFS   | 45                   | 20                      | S0-8FL  |
| NRVB30H100MFS  | 100                  | 30                      | S0-8FL  |

### Energy Recirculation Rectifiers

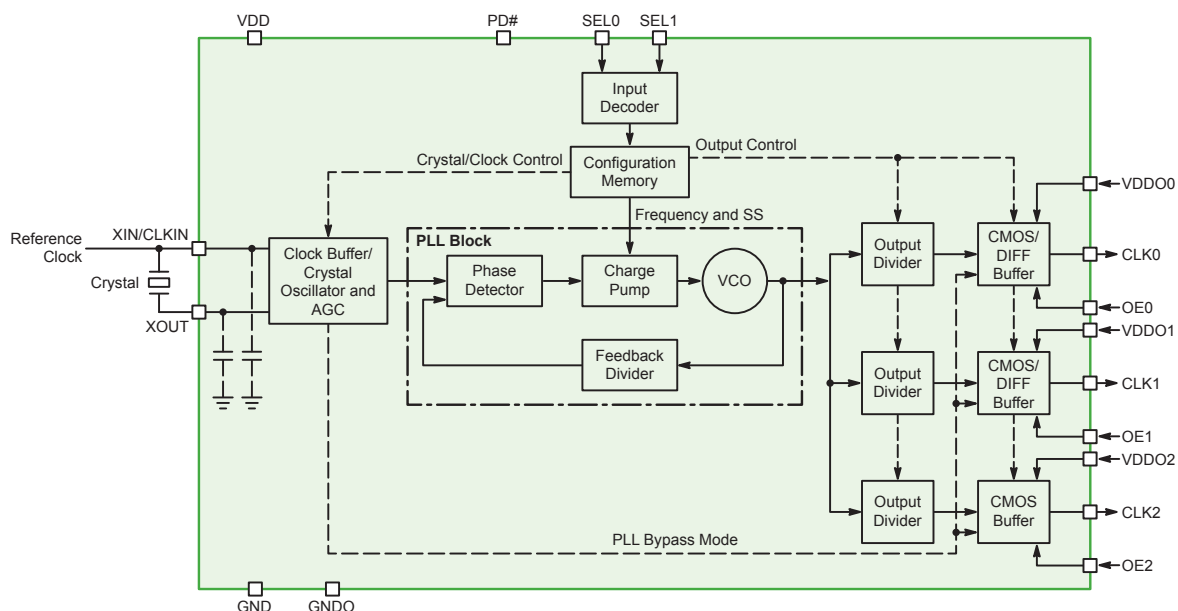
| Device      | V <sub>RRM</sub> (V) | I <sub>O(rec)</sub> (A) | Package   |
|-------------|----------------------|-------------------------|-----------|
| NRVB1H100SF | 100                  | 1                       | SOD-123FL |
| NRVBA1H100  | 100                  | 1                       | SMA       |
| SBRBS1100   | 100                  | 1                       | SMB       |
| SURA8110    | 100                  | 1                       | SMA       |
| SURS8110    | 100                  | 1                       | SMB       |
| SURA8120    | 200                  | 1                       | SMA       |
| SURS8120    | 200                  | 1                       | SMB       |
| NRVB2H100SF | 100                  | 2                       | SOD-123FL |
| NRVBA2H100  | 100                  | 2                       | SMA       |
| NBRS2H100   | 100                  | 2                       | SMB       |
| SURA8210    | 100                  | 2                       | SMA       |
| SURS8210    | 100                  | 2                       | SMB       |
| NRVHPM220   | 200                  | 2                       | Powermite |
| NRVHP220SF  | 200                  | 2                       | SOD-123FL |
| SURA8220    | 200                  | 2                       | SMA       |
| SURS8220    | 200                  | 2                       | SMB       |
| NRVBS3100   | 100                  | 3                       | SMC       |
| NRVBS3200   | 200                  | 3                       | SMB       |
| NRVBS3201   | 200                  | 3                       | SMC       |
| SURS8320    | 200                  | 3                       | SMC       |
| NRVHP420LFS | 200                  | 4                       | LFPK      |
| NRVHP820LFS | 200                  | 8                       | LFPK      |



## OmniClock Programmable Clock Synthesizers

### Features

- Single PLL
- Input Frequency Range:
  - Crystal: 3 – 50 MHz (low cost ESR crystal compatible)
  - Clock: 3 – 200 MHz (single-ended only)
- Up to 3 single-ended (LVCMOS/LVTTL) outputs, or up to 1 differential (LVPECL, LVDS, HCSL or CML) output + 1 single-ended (LVCMOS/LVTTL) output
- Output Frequency Range: 8 kHz (Min), 200 MHz (Max)
- Programmable Spread Spectrum Capabilities for EMI Suppression
  - Center Spread (0.125% steps):  $\pm 0.125\%$  to  $\pm 3\%$
  - Down Spread (0.25% steps):  $-0.25\%$  to  $-4\%$
  - Modulation Rate: 30 kHz – 130 kHz
- PLL Bypass mode
- Individual Output Enable pin for each output and Power Down Capability
- Individual Output Voltage pins per output, allowing setting of output voltage (1.8 V, 2.5 V or 3.3 V; equal to or less than VDD)
- Automatic Gain Control (Crystal Power Limiting)
- Programmable internal input crystal load capacitors
- Programmable Output Drive current
- Up to 4 independent configurations using SELx pins
- Supply Voltage:  $3.3\text{ V} \pm 10\%$ ;  $2.5\text{ V} \pm 10\%$ ;  $1.8\text{ V} \pm 0.1\text{ V}$
- Temperature Range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- Available in QFN-16 (3 mm x 3 mm) and WDFN-8 (2 mm x 2 mm) packages



Block Diagram

## OmniClock Programmable Clock Synthesizers

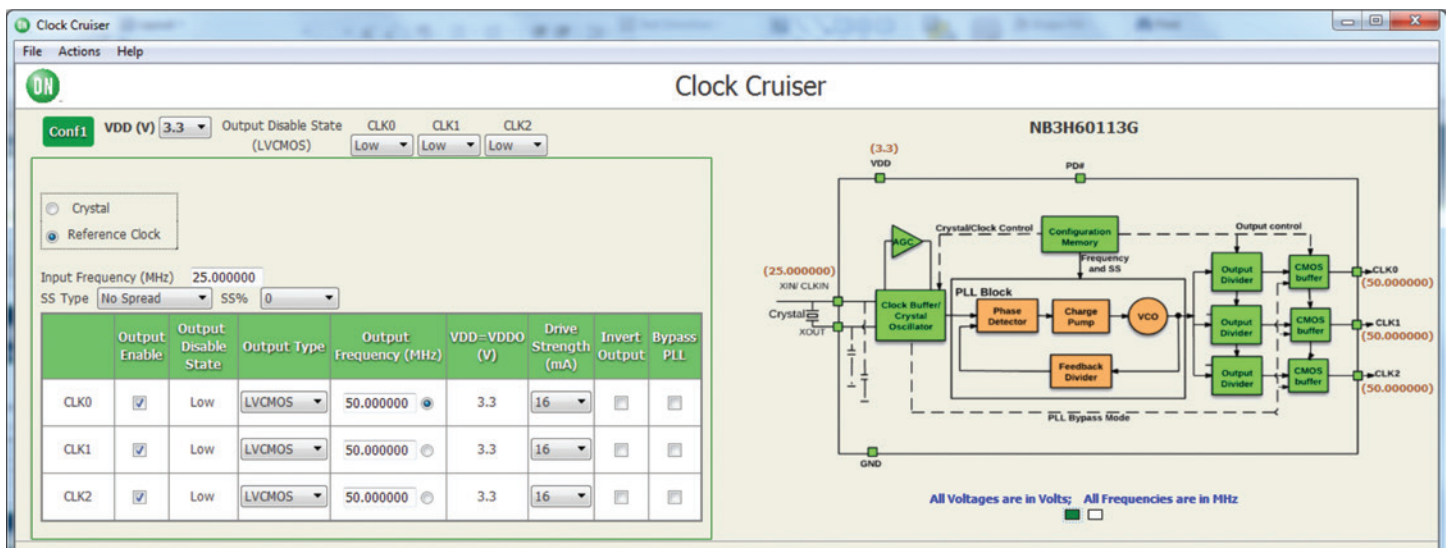
### Using Omniclock in Your System

Customer orders blank Omniclock devices

Customer uses free GUI and supplied evaluation board to configure the blank device to the desired parameters: frequency, drive strength, spread spectrum, etc.

Customer provides configuration file to ON Semiconductor sales channel

ON Semiconductor programs device in factory with desired customer configuration, and creates customer-specific part number

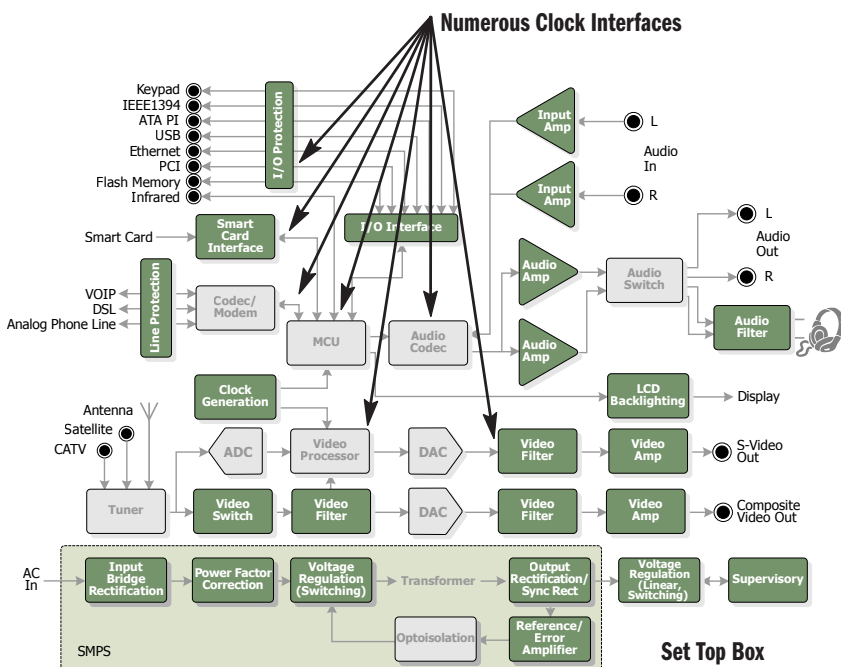


Configuration GUI

COMPONENTS

| Device     | Individual OE | Individual V <sub>DDO</sub> | Supply Voltage (V) | Number of Configurations | Number of Outputs | Package |
|------------|---------------|-----------------------------|--------------------|--------------------------|-------------------|---------|
| NB3H63143G | Yes           | Yes                         | 2.5 / 3.3          | 4                        | 3                 | QFN-16  |
| NB3H60113G | No            | No                          | 2.5 / 3.3          | 1                        | 3                 | DFN-8   |
| NB3V63143G | Yes           | Yes                         | 1.8                | 4                        | 3                 | QFN-16  |
| NB3V60113G | No            | No                          | 1.8                | 1                        | 3                 | DFN-8   |

## Clock Generation and Distribution



**Programmable PLL Clocks can satisfy all clock tree requirements in a single device**

- Replace all clock interfaces with one Multi-PLL Programmable Clock
- Maintain clock architecture flexibility by being able to program new clock configurations through software
- Key devices
  - Clock Multiplier: NB3N3020
  - Single PLL I2C: FS7140, FS7145
  - Three PLL I2C EEPROM: FS6370, FS6377

### Clock Buffers

| Device     | VCC (V)       | Output Freq (MHz) | Outputs | Type                   | Package           |
|------------|---------------|-------------------|---------|------------------------|-------------------|
| NB3N551    | 3.3, 5.0      | 180               | 4       | Fanout Buffer          | SOIC-8, DFN-8     |
| NB3L553    | 2.5, 3.3, 5.0 | 200               | 4       | Fanout Buffer          | SOIC-8, DFN-8     |
| NB3N2304NZ | 3.3           | 140               | 4       | Low Skew Fanout Buffer | TSSOP-8, DFN-8    |
| NB2305A    | 3.3           | 15-133            | 5       | Zero Delay Buffer      | TSSOP-8, SOIC-8   |
| NB2309A    | 3.3           | 15-133            | 9       | Zero Delay Buffer      | TSSOP-16, SOIC-16 |
| NB2304A    | 3.3           | 15-133            | 4       | Zero Delay Buffer      | SOIC-8            |
| NB3N200S   | 3.3           | 100               | 1       | M-LVDS Driver/Receiver | SOIC-8            |
| NB3N201S   | 3.3           | 100               | 1       | M-LVDS Driver/Receiver | SOIC-8            |
| NB3N206S   | 3.3           | 100               | 1       | M-LVDS Driver/Receiver | SOIC-8            |

### 3.3 V Clock Generators with Fixed Frequency Outputs

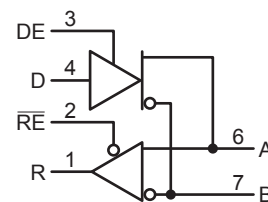
| Device    | Output Frequency (MHz)                   | Application   | Package  |
|-----------|--|---|----------|
| NB3N3002  | 25, 125, 200                             | PCI-e, Gigabit Ethernet                                 | TSSOP-16 |
| NB3N511   | 14-200 with selectable multiplier ratios | USB, PCI, PCI-e, SDRAM, Ethernet, Gigabit Ethernet, CPU | SOIC-8   |
| NB3N502   | 14-120                                   | CPU, USB, PCI, Network, Ethernet                        | SOIC-8   |
| NB3N5573  | 25, 100, 125, 200                        | PCI-e, DIMM, CPU  | TSSOP-16 |
| NBA3N5573 | 25-200                                   | PCI-e, DIMM, CPU  | QFNW-16  |

## Multipoint M-LVDS Drivers/Receivers

Low voltage (3.3 V) differential 30-55 ohm line drivers and receivers, for signaling rates up to 200 Mbps.

### Features

- Threshold to Detect Open-Circuit and Idle-Bus conditions
- Controlled driver output voltage transition times for improved signal quality
- -1 V to 3.4 V common-mode voltage range allows data transfer up to 2 V of ground noise
- Supports Simplex and Half Duplex bus configuration
- Temperature range -40°C to 125°C



### M-LVDS Drivers & Receivers

| Device    | V <sub>CC</sub> Typ (V) | Operating Temperature (°C) | Signaling Rate (Mbps) | Input/Output Type | Driver Propagation Delay Max (ns) | Driver Rise/Fall Time Max (ns) | Driver RMS Period Jitter Max (ps) | Receiver Type | Receiver Propagation Delay Max (ns) | Receiver Rise/Fall Time Max (ns) | Receiver RMS Period Jitter Max (ps) | Package(s) |
|-----------|-------------------------|----------------------------|-----------------------|-------------------|-----------------------------------|--------------------------------|-----------------------------------|---------------|-------------------------------------|----------------------------------|-------------------------------------|------------|
| NBA3N200S | 3.3                     | -40 to +125                | 200                   | LVC MOS/MLVDS     | 2.4                               | 1.6                            | 3.5                               | Type 1        | 6                                   | 2.3                              | 8                                   | SOIC-8     |
| NBA3N201S | 3.3                     | -40 to +125                | 200                   | LVC MOS/MLVDS     | 2.4                               | 1.6                            | 3.5                               | Type 1        | 6                                   | 2.3                              | 8                                   | SOIC-8     |
| NBA3N206S | 3.3                     | -40 to +125                | 200                   | LVC MOS/MLVDS     | 2.4                               | 1.6                            | 3.5                               | Type 2        | 6                                   | 2.3                              | 8                                   | SOIC-8     |
| NBA3N011S | 3.3                     | -40 to +125                | 400                   | LVC MOS/LVDS      | 1.5                               | 1.0                            | N/A                               | N/A           | N/A                                 | N/A                              | N/A                                 | SOT-23-5   |
| NBA3N012C | 3.3                     | -40 to +125                | 400                   | LVDS/LVC MOS      | 3.5                               | 0.8                            | N/A                               | N/A           | N/A                                 | N/A                              | N/A                                 | SOT-23-5   |

Robust Standard Logic Families

Standard CMOS

Metal Gate\*

- 3.0 to 18.0 V
- 3 mA Drive
- Typical Propagation Delay 35 ns
- -55 to +125°C

High Speed\*

- 2.0 to 6.0 V
- 4 mA Drive
- Typical Propagation Delay 25 ns
- -55 to +125°C

FACT

- 3.0 to 5.0 V
- 24 mA Drive
- Typical Propagation Delay 10 ns
- -40 to +85°C

MiniGate™\*

- 0.9 to 5.5 V
- 2 to 24 mA Drive\*\*
- Typical Propagation Delay 2 to 7 ns\*\*
- -55 to +125°C

Low Voltage CMOS

VHC\*

- 2.0 to 5.5 V
- 8 mA Drive
- Typical Propagation Delay 8 ns
- -55 to +125°C

LCX\*

- 1.65 to 5.5 V
- 24 mA Drive
- Typical Propagation Delay 5 ns
- -40 to +85°C

LVX\*

- 2.0 to 3.6 V
- 6 mA Drive
- Typical Propagation Delay 20 ns
- -40 to +85°C

Standard Logic Nomenclature

|             | Family     | Nomenclature                    |
|-------------|------------|---------------------------------|
| Standard    | Metal Gate | MC14xxx                         |
|             | High Speed | MC74HCxxx, 74HCxxx              |
|             | FACT       | MC74AC/Txxx                     |
| Low Voltage | VHC        | MC74VHC/Txxx                    |
|             | LCX        | MC74LCxxx                       |
|             | LVX        | MC74LVxxx                       |
| MiniGate™   | High Speed | MC74HC1Gxxx                     |
|             | VHC        | MC74VHC/T1Gxxx                  |
|             | LCX        | NL17SZxxx, NL27WZxxx, NL37WZxxx |
|             | NLU        | NLUnGxxx                        |



\* Automotive grade available. \*\*Specifications dependent on device type.

## Sales and Design Assistance from ON Semiconductor

**ON Semiconductor Technical Support**  
[www.onsemi.com/support](http://www.onsemi.com/support)

| ON SEMICONDUCTOR INTERNATIONAL SALES OFFICES |                |                     |
|--|----------------|---------------------|
| <b>GREATER CHINA</b>                         | Beijing        | 86-10-8577-8200     |
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