



BRD8087/D  
Rev. 0, Nov-2019

Energy Efficient Innovations

# High Density Computing Solutions



*Comprehensive solutions for servers, cloud computing, edge computing, 5G networks, and communications infrastructure from ON Semiconductor.*



## Expertise, Solutions, Products

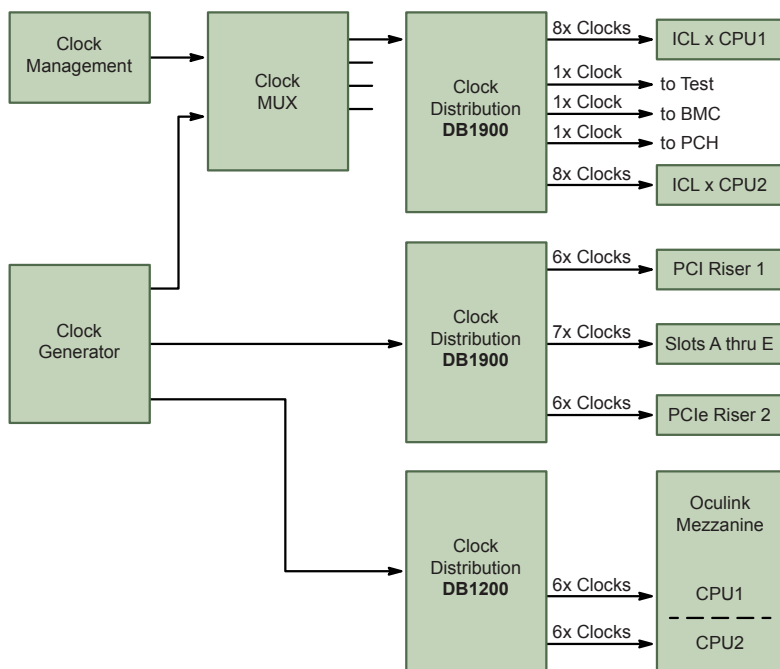
ON Semiconductor provides a comprehensive portfolio of semiconductor devices for a wide range of high density computing and communications infrastructure. The company provides solutions for power management, data integrity, and sensing and feedback.

Our power devices are built around our best-in-class medium voltage MOSFET technology to deliver the lowest losses for the application. Our MOSFETs are available in different versions to trade-off switching loss and conductor loss, to optimize for the power conversion topology, algorithm, and load profile. Additionally, we provide MOSFETs in a wide variety of packaging to provide flexibility to the designer to optimize heatsinking, size, or cost.

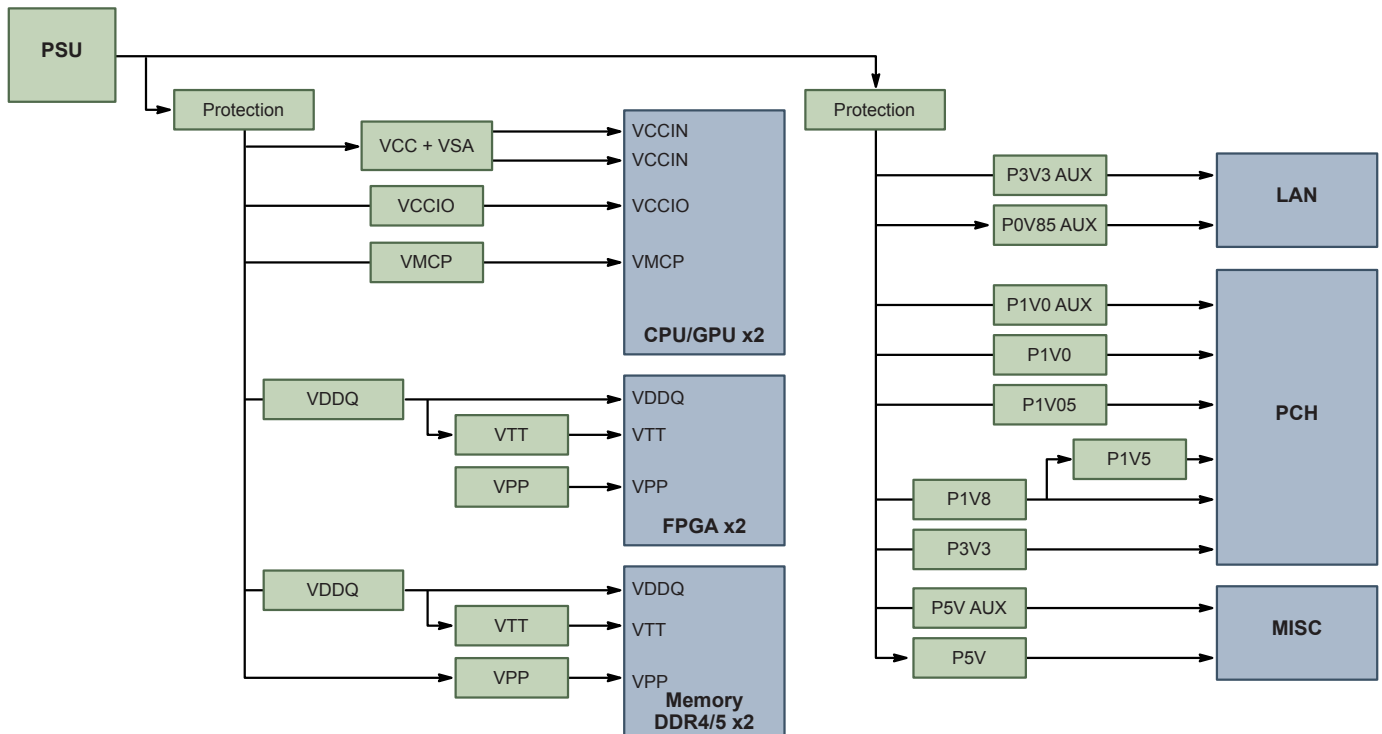
Multiphase and buck controllers, power stages, and point-of-load devices for every voltage and power level fill out the core of ON Semiconductor DC-DC products. Additionally, eFuses and load switches provide hot swap and bus protection to power rails for a variety of voltages.

Clock generation, clock distribution, and redriivers support high-speed data integrity and timing throughout any design. Finally, high precision op-amps and standard logic are available to fill out the sensing and feedback needed to monitor and control a system.

## Timing Solutions for Servers

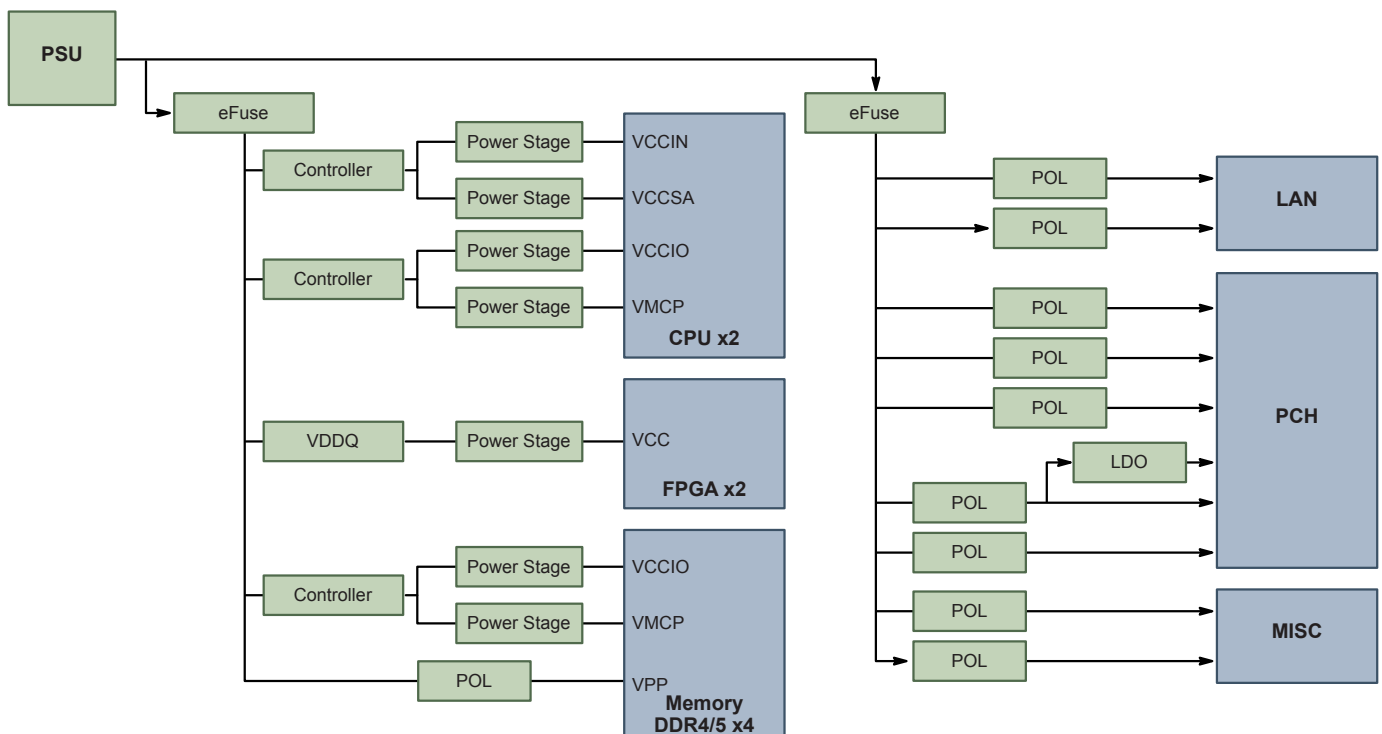


## Power Management Solutions for Server Racks



EXPERTISE

## Power Management Solutions for Servers



Ultra High Density AC-DC Solutions for <150 W Designs

Features

- High integration with high-voltage startup and X2 capacitor discharge
- High switching frequency options enable high power density
- Achieve high efficiency with SJ FETs or GaN HEMTs
- Integrated protection features: SCP, BO, OPP, OTP, OVP
- Highly configurable with many options available



- Output Power: 60 W
- Power Density: 29 W/in<sup>3</sup>
- Transformer: RM 8 LP
- Dimensions: 42 x 45 x 18 mm

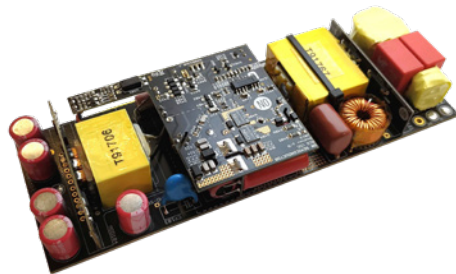
Ultra-high Density 60-W USB PD Adapter using the NCP1568 ACF Controller

| Device   | Controller Type           | Switching Frequency (kHz) | Vcc Max (V) | HV Startup (V) | Additional Features            | Packages              |
|----------|---------------------------|---------------------------|-------------|----------------|--------------------------------|-----------------------|
| NCP12601 | Multi-Mode                | 65/100/130/200            | 37          | 750            | Low Loss DSS, Auto-tune OCP    | SOIC-7, SOIC-9 NB     |
| NCP1342  | Quasi-Resonant            | Up to 500                 | 30          | 700            | Rapid Frequency Foldback       | SOIC-8, SOIC-9 NB     |
| NCP1568  | Active Clamp              | Up to 1,000               | 30          | 700            | Zero-Voltage Switching         | TSSOP-16              |
| NCP1622  | PFC                       | Variable                  | 30          | No             | Critical Conduction Mode (CrM) | TSOP-6                |
| NCP4306  | Synchronous Rectification | Up to 1,000               | 37          | No             | For DCM/CCM/QR Flyback, LLC    | TSOP-6, SOIC-8, DFN-8 |

## Ultra High Density AC-DC Solutions for >150 W Designs

### Features

- Ideal for 150 W to 1 kW power supplies and power adapters
- High integration with high-voltage startup and X2 cap discharge along with high switching frequency up to 500 kHz for LLC, enabling simple, low BOM count design
- High speed half bridge driver optimized for driving GaN and achieving high power density
- Integrated protection features: SCP, OVP, OPP, BO, OTP
- Highly configurable with many options available



- Output Power: 300 W
- Power Density: 32 W/in<sup>3</sup>
- Topology: PFC + LLC + SR
- Dimensions: 55 x 159 x 18 mm

Ultra-high Density 300 W GaN Based Gaming Power Adapter

| Device   | Controller Type                    | Switching Frequency (kHz) | V <sub>CC</sub> Max (V) | HV Startup (V) | Drive Capability (mA) | Packages              |
|----------|------------------------------------|---------------------------|-------------------------|----------------|-----------------------|-----------------------|
| NCP1616  | Critical Conduction (CrM) Mode PFC | Variable                  | 30                      | 700            | 500/800               | SOIC-9                |
| NCP1632  | CrM Interleaved PFC                | Variable                  | 20                      | No             | 500/500               | SOIC-16               |
| NCP13992 | Current Mode Resonant              | Variable                  | 20                      | 600            | 500/1000              | SOIC-16               |
| NCP51820 | GaN Half Bridge Driver             | Up to 1 MHz               | 20                      | 650            | 1000/2000             | QFN15                 |
| NCP4306  | 2nd side Synchronous Rectification | Up to 1 MHz               | 37                      | No             | 2000/7000             | TSOP-6, SOIC-8, DFN-8 |

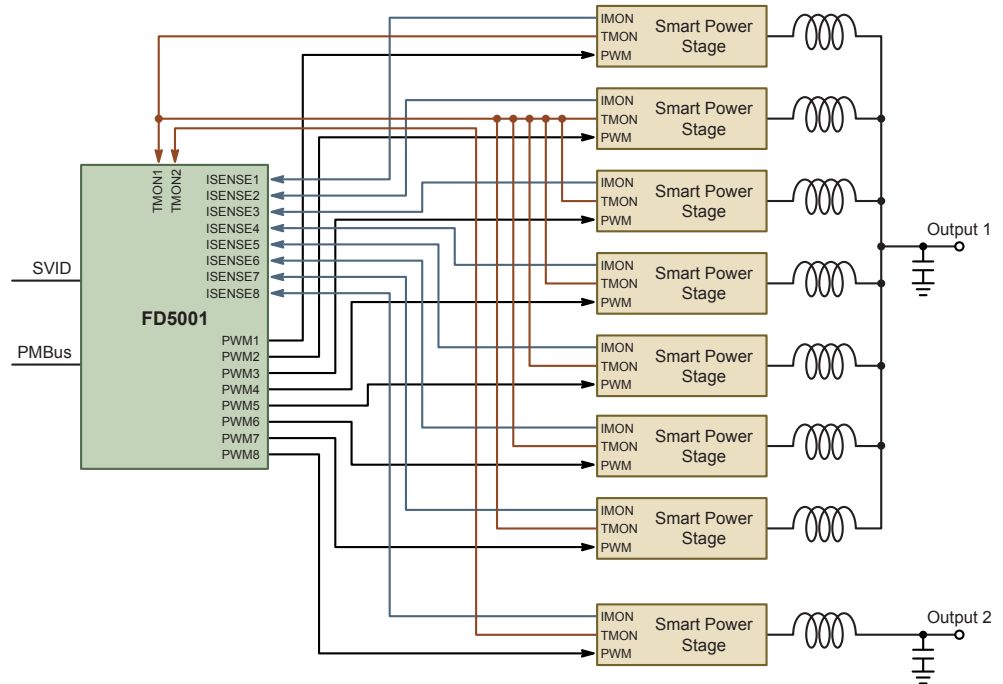


## Multiphase Controllers

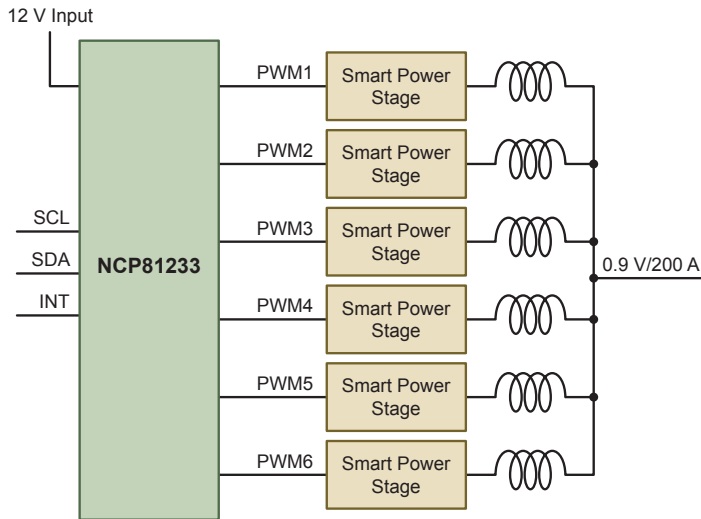
for Core Processors, DDR Memory, FPGAs

### Features

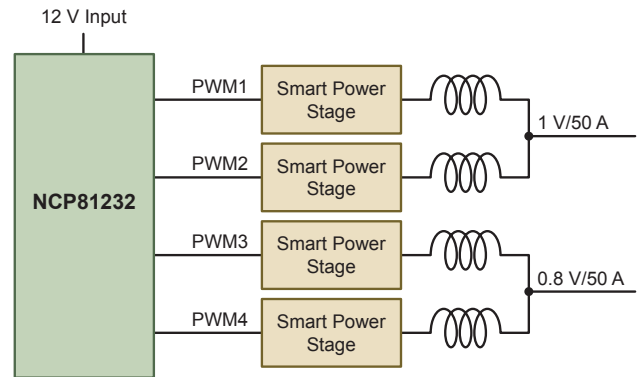
- Support up to 8 phases
- Remote sense for output accuracy
- Dual-edge modulation for good load transient
- Supports DCR or IMON sensing from power stage



Multiphase Voltage Regulator Block Diagram



NCP81233 Supports Up to 6 Phase Solution, I2C Interface for Configuration and Telemetry



NCP81232 Supports Up to 4 Phases with 2 Control Loops (Can Be Paralleled for Single Output)

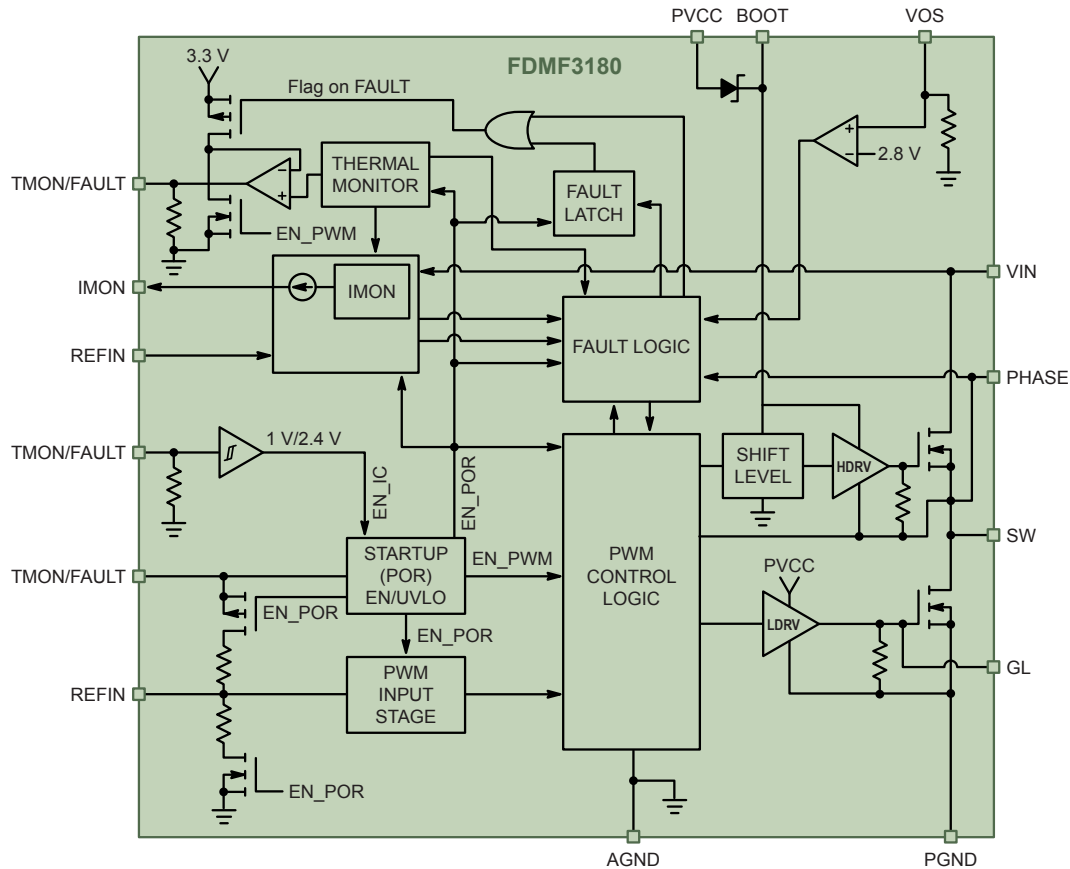
| Device   | Phases    | VR Compatibility    | Controller Algorithm | Digital Interface | Package |
|----------|-----------|---------------------|----------------------|-------------------|---------|
| FD5001*  | M + N = 8 | VR14, VR13.HC, VR13 | Constant On Time     | SVID, PMBus       | QFN-40  |
| FD5003*  | M + N = 5 | VR14, VR13.HC, VR13 | Constant On Time     | SVID, PMBus       | QFN-40  |
| FD5005*  | M + N = 2 | VR14, VR13.HC, VR13 | Constant On Time     | SVID, PMBus       | QFN-40  |
| NCP81233 | Up to 6   | Universal           | Dual-Edge            | I2C               | QFN-52  |
| NCP81232 | Up to 4   | Universal           | Dual-Edge            | I2C               | QFN-40  |
| NCP81234 | Up to 2   | Universal           | Dual-Edge            | I2C               | QFN-28  |

\* Pending 2020.

## Power Stages for Efficient Power Conversion

### Features

- Integrated driver with high- and low-side MOSFETs
- Integrated bootstrap diode
- Higher switching frequency enables use of smaller inductors and capacitors
- 65% lower BOM, 45% smaller footprint, simplified layout, compared to discrete solutions

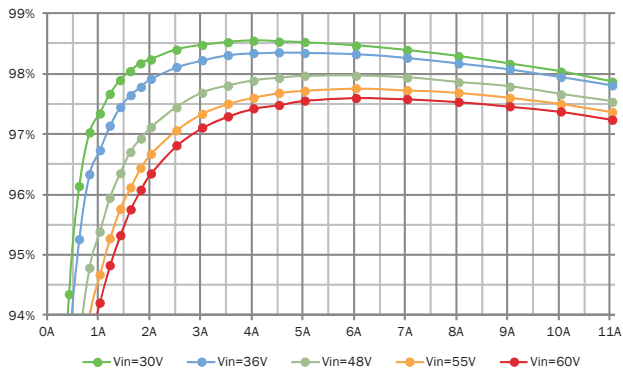


FDMF3180 Functional Block Diagram

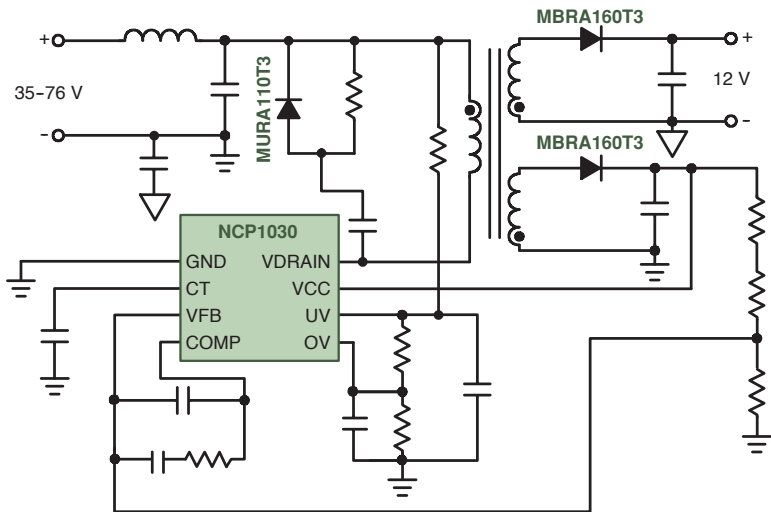
| Device    | Integrated Current Sensing | IOUT (A)        | Package  |
|-----------|----------------------------|-----------------|----------|
| NCP303150 | IMON                       | 80 (peak)       | PQFN-39  |
| FDMF3170  | IMON                       | 70 (peak)       | PQFN-39* |
| FDMF3180  | IMON                       | 70 (peak)       | PQFN-39* |
| NCP302155 | DCR                        | 55 (average)    | PQFN-31  |
| NCP302150 | DCR                        | 45 (average)    | PQFN-31  |
| NCP302045 | —                          | 45 (average)    | PQFN-31  |
| NCP302040 | —                          | 40 (average)    | PQFN-31  |
| NCP5369   | —                          | 40 (continuous) | QFN-40   |
| NCP302035 | —                          | 35 (average)    | PQFN-31  |

\* Universal footprint.

DC-DC Power Conversion



FAN65008B Efficiency – VOUT = 28 V, Fsw = 300 kHz

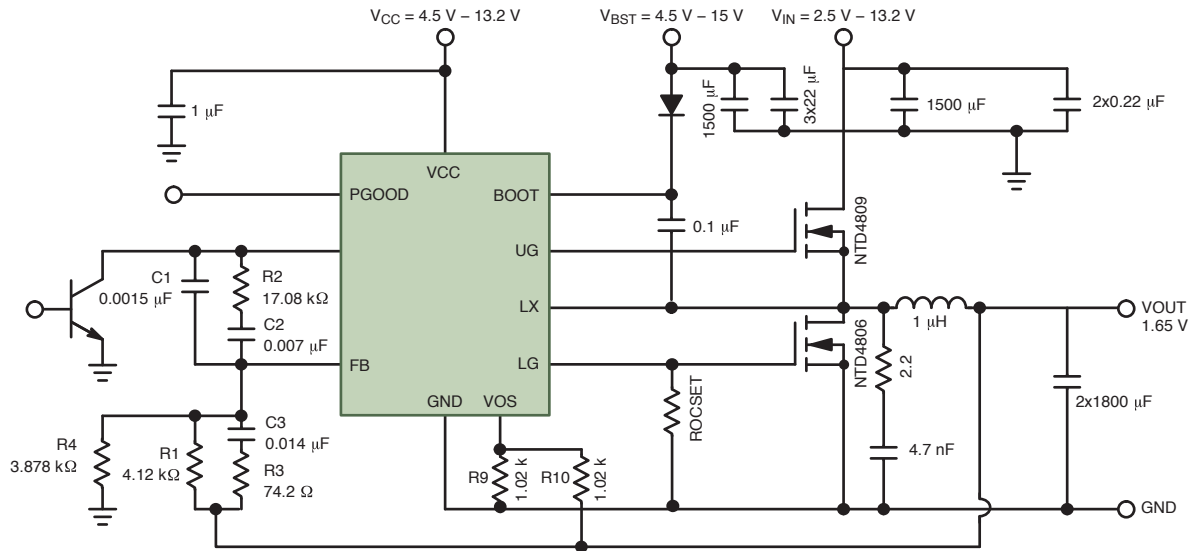


Isolated Bias Supply

48 V DC-DC Power Conversion

| Device    | Topology                    | Control Mode | Vcc Min (V) | Vcc Max (V) | Io Typ (A) | fsw Typ (kHz) | Package(s)    |
|-----------|-----------------------------|--------------|-------------|-------------|------------|---------------|---------------|
| FAN65004B | Step-Down                   | Voltage Mode | 4.5         | 65          | 6          | 100 - 1000    | PQFN-35       |
| FAN65005A | Step-Down                   | Voltage Mode | 4.5         | 65          | 8          | 100 - 1000    | PQFN-35       |
| FAN65008B | Step-Down                   | Voltage Mode | 4.5         | 65          | 10         | 100 - 1000    | PQFN-35       |
| NCP1030   | Flyback, Step-Down, Step-Up | Voltage Mode | 8           | 200         | 0.5        | 300           | Micro8        |
| NCP1031   | Flyback, Step-Down, Step-Up | Voltage Mode | 8           | 200         | 1          | Up to 1000    | DFN-8, SOIC-8 |
| NCP1032   | Flyback                     | Voltage Mode | 8           | 200         |            | 1000          | WDFN-8        |
| NCP1034   | Step-Down                   | Voltage Mode | 8           | 100         |            | 500           | SOIC-16       |

## DC-DC Power Conversion



NCP1589A Application Diagram

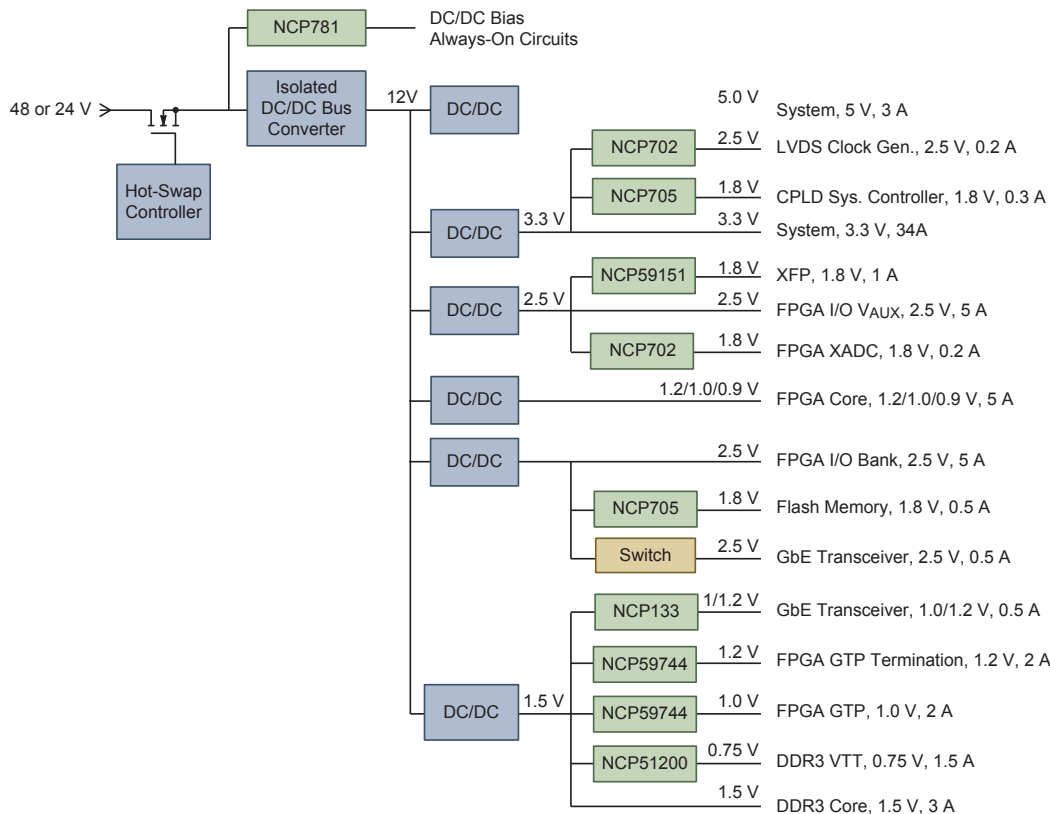
### 12 V DC-DC Power Conversion

| Device     | Topology  | V <sub>CC</sub> Min (V) | V <sub>CC</sub> Max (V) | I <sub>O</sub> Typ (A) | f <sub>sw</sub> Typ (kHz) | Package(s) |
|------------|-----------|-------------------------|-------------------------|------------------------|---------------------------|------------|
| NCP5269    | Step-Down | 3.3                     | 28                      | —                      | 300 - 600                 | QFN-20     |
| NCP5212    | Step-Down | 4.5                     | 27                      | —                      | 300                       | QFN-16     |
| NCP5212T   | Step-Down | 4.5                     | 27                      | —                      | 300                       | QFN-16     |
| NCP5217    | Step-Down | 4.5                     | 27                      | —                      | 300                       | QFN-14     |
| NCP5222    | Step-Down | 4.5                     | 27                      | —                      | 300                       | QFN-28     |
| NCP3235    | Step-Down | 4.5                     | 23                      | 15                     | 500                       | QFN-40     |
| NCP3232N   | Step-Down | 4.5                     | 21                      | 15                     | 500                       | QFN-40     |
| NCP3284    | Step-Down | 4.5                     | 18                      | 30                     | 600                       | PQFN-37    |
| NCP3230    | Step-Down | 4.5                     | 18                      | 30                     | 500                       | QFN-40     |
| NCP3231    | Step-Down | 4.5                     | 18                      | 25                     | 500                       | QFN-40     |
| NCP3170A/B | Step-Down | 4.5                     | 18                      | 3                      | 500/1000                  | SOIC-8     |
| NCP3233    | Step-Down | 3.0                     | 16                      | 20                     | 500                       | QFN-40     |
| NCP1579    | Step-Down | 4.5                     | 13.2                    | —                      | 275                       | SOIC-8     |
| NCP1587    | Step-Down | 4.5                     | 13.2                    | —                      | 250 - 300                 | SOIC-8     |
| NCP1587A   | Step-Down | 4.5                     | 13.2                    | —                      | 180 - 220                 | SOIC-8     |
| NCP1589A   | Step-Down | 4.5                     | 13.2                    | —                      | —                         | DFN-10     |
| NCP1589D   | Step-Down | 4.5                     | 13.2                    | —                      | —                         | DFN-10     |
| NCP1589L   | Step-Down | 4.5                     | 13.2                    | —                      | —                         | DFN-10     |
| NCP5230    | Step-Down | 4.5                     | 13.2                    | —                      | —                         | QFN-16     |

### Low V DC-DC Power Conversion

| Device   | Topology  | V <sub>CC</sub> Min (V) | V <sub>CC</sub> Max (V) | I <sub>O</sub> Typ (A) | f <sub>sw</sub> Typ (kHz) | Package(s) |
|----------|-----------|-------------------------|-------------------------|------------------------|---------------------------|------------|
| NCP3135  | Step-Down | 2.9                     | 5.5                     | 5                      | 1100                      | QFN-16     |
| NCP3136  | Step-Down | 2.9                     | 5.5                     | 5                      | 1100                      | QFN-16     |
| NCP1594A | Step-Down | 2.9                     | 5.5                     | 4                      | 200 - 2000                | WQFN-24    |
| NCP3133A | Step-Down | 2.9                     | 5.5                     | 3                      | 1100                      | QFN-16     |

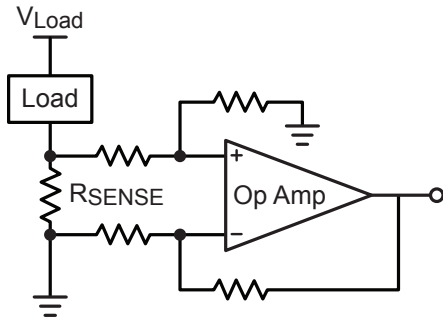
## Linear Voltage Regulators



| Device   | I <sub>O</sub> Typ | Function                                           | Features                                                                  | Package           |
|----------|--------------------|----------------------------------------------------|---------------------------------------------------------------------------|-------------------|
| TPS2399  | —                  | Hot Swap                                           | -36 to -80 V Supply Voltage                                               | MSOP-8            |
| TPS2398  | —                  | Hot Swap                                           | -36 to -80 V Supply Voltage                                               | MSOP-8            |
| NCP785A  | 10 mA              | High Voltage LDO                                   | Up to 450 V V <sub>IN</sub> ; High PSRR                                   | SC-89             |
| NCP715   | 50 mA              | Ultra-low Quiescent Current LDO                    | Ultra-low quiescent current; Wide input voltage range                     | SC-70-5, DFN-6    |
| NCP716   | 80 mA              | Ultra-low Quiescent Current LDO                    | Ultra-low quiescent current; Wide input voltage range                     | WDFN-6            |
| NCP781   | 100 mA             | High Voltage LDO                                   | Up to 150 V V <sub>IN</sub> ; High PSRR                                   | DFN-6             |
| NCP702   | 200 mA             | Ultra-low Noise LDO                                | High PSRR; Ultra-low noise                                                | SOT-23-5, WDFN-6  |
| NCP160   | 250 mA             | Ultra-high PSRR                                    | 92 db PSRR; Low Noise                                                     | WLCS-4, XDFN-4    |
| NCP163   | 250 mA             | Ultra-low Noise                                    | 92 db PSRR; 6.5 $\mu$ Vrms Noise                                          | WLCS-4, XDFN-4    |
| NCP703   | 300 mA             | Ultra-low Noise LDO                                | Ultra-low noise; High PSRR                                                | SOT-23-5, WDFN-6  |
| NCP718   | 300 mA             | Ultra-low Quiescent Current LDO                    | Ultra-low quiescent current; Wide input voltage range                     | WDFN-6, TSOT-23-5 |
| NCP161   | 450 mA             | Ultra-high PSRR                                    | 92 db PSRR; Low Noise                                                     | WLCS-4, XDFN-4    |
| NCP133   | 500 mA             | Ultra-Low Dropout Voltage Regulator with Bias Rail | Typical dropout: 140 mV @ 500 mA; High PSRR; Very fast transient response | XDFN-6            |
| NCP705   | 500 mA             | Ultra-low Noise LDO                                | Ultra-low noise; High PSRR                                                | WDFN-6            |
| NCP708   | 1 A                | Precision LDO                                      | 1% Accuracy, Soft start                                                   | UDFN-6            |
| NCP186   | 1 A                | Precision LDO                                      | 1% Accuracy, Fast transient response, Ultra low VDO                       | XDFN-8            |
| NCP59800 | 1 A                | Low Noise, RF LDO                                  | Typical dropout: 200 mV @ 1 A; High PSRR; Ultra-low noise                 | DFN-8             |
| NCP59748 | 1.5 A              | Ultra-Low Dropout Voltage Regulator with Bias Rail | Typical dropout: 60 mV @ 500 mA; High PSRR; Very fast transient response  | DFN-10, QFN-20    |
| NCP51200 | 3 A                | DDR3 Termination Regulator                         | Fast load transient response; Soft start; Remote sensing                  | DFN-10            |
| NCP51401 | 3 A                | DDR4 Termination Regulator                         | Fast load transient response; Soft start; Remote sensing                  | DFN-10            |
| NCP59744 | 3 A                | Ultra-Low Dropout Voltage Regulator with Bias Rail | Typical dropout: 115 mV @ 3 A; High PSRR; Very fast transient response    | QFN-20            |
| NCP59749 | 3 A                | Ultra-Low Dropout Voltage Regulator with Bias Rail | Typical dropout: 120 mV @ 3 A; High PSRR; Very fast transient response    | DFN-10, QFN-20    |

## Current Sensing Solutions Using Amplifiers

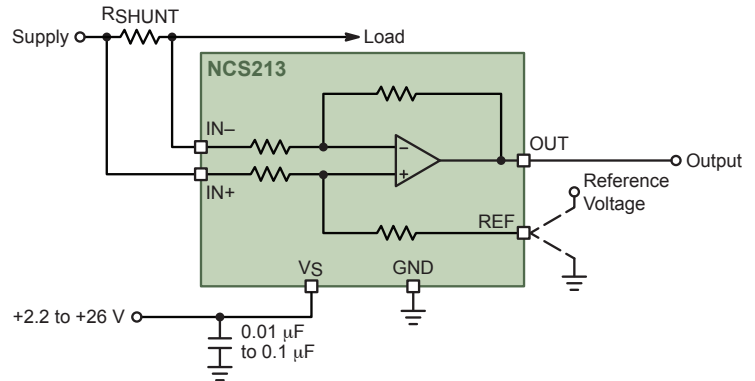
As part of an expansive portfolio, amplifiers from ON Semiconductor offer precision performance over time and temperature, making them ideal for current sensing in system monitoring and protection circuits.



Current Sensing Solution with External Gain Setting Resistors

**NCSx333 Zero Drift Op Amp**  
 $V_{OS} = 10 \mu V$   
 50 mV Shunt Drop  
 Only 0.02% Offset Error

**NCS200xx Low Power Op Amp**  
 $V_{OS} = 4 mV$   
 50 mV Shunt Drop  
 8% Offset Error



Current Sensing Solution with Integrated Gain Setting Resistors

**NCS21x Current Sense Amplifiers**  
 $V_{OS} = 35 \mu V$   
 50 mV Shunt Drop  
 0.07% Offset Error

### Zero Drift Current Sense Amplifiers (Integrated and Precision Performance)

| Device | Channels | $V_S$ Min (V) | $V_S$ Max (V) | Input CM Range (V) | GBW (kHz) | $V_{OS}$ Max ( $\mu V$ ) | $V_{OS}$ Drift ( $\mu V/^\circ C$ ) | Gain Error (%) | CMRR (dB) | Features     | Package |
|--------|----------|---------------|---------------|--------------------|-----------|--------------------------|-------------------------------------|----------------|-----------|--------------|---------|
| NCS21x | 1        | 2.2           | 26            | 2.2 to 26          | 14        | 35                       | 0.5                                 | 1              | 140       | Low $V_{OS}$ | SOT-363 |

### Low Voltage, Zero Drift Amplifiers (High Precision)

| Device   | Channels | $V_S$ Min (V) | $V_S$ Max (V) | $I_Q$ /Channel ( $\mu A$ ) | GBW (kHz) | $V_{OS}$ Max ( $\mu V$ ) | $V_{OS}$ Drift ( $\mu V/^\circ C$ ) | CMRR (dB) | Features                 | Package                                           |
|----------|----------|---------------|---------------|----------------------------|-----------|--------------------------|-------------------------------------|-----------|--------------------------|---------------------------------------------------|
| NCS21911 | 1        | 4             | 36            | 600                        | 2000      | 2.5                      | 0.085                               | 120       | Low $V_{OS}$ , Low Drift | TSOP-5/SOT-23-5                                   |
| NCS325   | 1        | 1.8           | 5.5           | 21                         | 350       | 50                       | 0.02                                | 110       | Low $V_{OS}$             | SOT-23                                            |
| NCSx333  | 1, 2, 4  | 1.8           | 5.5           | 21                         | 350       | 10                       | 0.03                                | 120       | Low $V_{OS}$             | SOT-23-5, SC-70-5, DFN-8, Micro8, SOIC-8, SOIC-14 |

### Low Voltage Amplifiers (Standard)

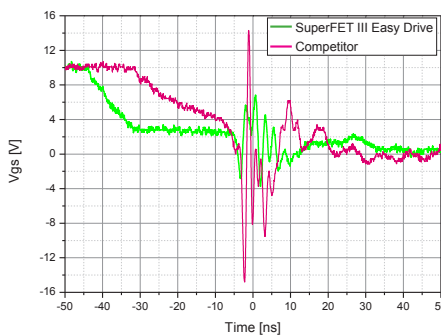
| Device   | Channels | $V_S$ Min (V) | $V_S$ Max (V) | $I_Q$ /Channel ( $\mu A$ ) | GBW (MHz) | $V_{OS}$ Max (mV) | $V_{OS}$ Drift ( $\mu V/^\circ C$ ) | $I_B$ (nA) | CMRR (dB) | Rail-to-Rail | Features                          | Package                                          |
|----------|----------|---------------|---------------|----------------------------|-----------|-------------------|-------------------------------------|------------|-----------|--------------|-----------------------------------|--------------------------------------------------|
| NCS2009x | 1, 2     | 1.8           | 5.5           | 20                         | 0.35      | 4                 | 1                                   | 0.001      | 80        | I/O          | Low $I_Q$ & $V_{OS}$              | SOT-23-5, SC-70-5, UDFN-6, Micro8, TSSOP-8, SO-8 |
| NCS2008x | 1, 2     | 1.8           | 5.5           | 50                         | 1.2       | 4                 | 1                                   | 0.001      | 80        | I/O          | Low $I_Q$ & $V_{OS}$              | SOT-23-5, SC-70-5, UDFN-6, Micro8, TSSOP-8, SO-8 |
| NCS2006x | 1, 2     | 1.8           | 5.5           | 140                        | 3         | 4                 | 1                                   | 0.001      | 80        | I/O          | Low $I_Q$ & $V_{OS}$              | SOT-23-5, SC-70-5, UDFN-6, Micro8, TSSOP-8, SO-8 |
| NCS2003x | 1, 2, 4  | 1.7           | 5.5           | 275                        | 7         | 5                 | 2                                   | 0.001      | 80        | Output       | Fast Slew Rate, Low $V_S$ & $I_B$ | SOT-23-5, SOT-553, Micro8, SOIC-8, TSSOP-8       |
| NCS2007x | 1, 2, 4  | 2.7           | 36            | 400                        | 3         | 4                 | 2                                   | 0.005      | 110       | Output       | Wide $V_S$ range                  | SOT-553, TSOP-5, Micro8, SO-8, TSSOP-8           |

## Wide Selection of High Voltage Power MOSFETs

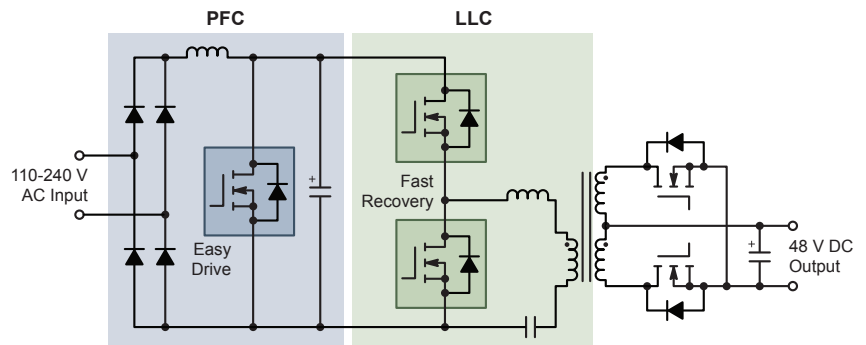
ON Semiconductor offers an expansive portfolio of Power MOSFETs, utilizing advanced SuperJunction technology. Devices enable increased system level efficiency through low switching and low conduction losses, and are available in a range of standard and innovative packages.

### Features

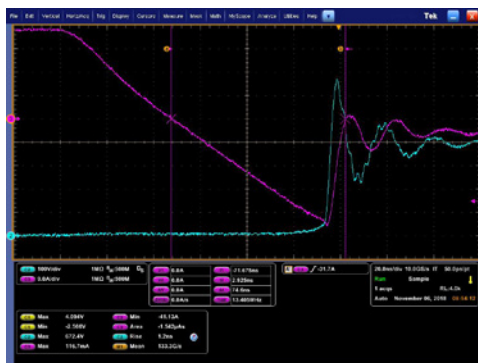
- SuperFET® III Easy Drive
  - Outstanding ease of use and low EMI
  - Excellent Figure-of-Merit ( $R_{DS(ON)}$  Max X  $Q_g$  Typ)
  - Well balanced switching behavior
  - $V_{(BR)DSS}$  of 650 V at  $T_j = 25^\circ\text{C}$ , 700 V at  $T_j = 150^\circ\text{C}$
  - Robust body diode
- SuperFET® III FRFET®
  - No need additional circuit in LLC resonant converter
  - Improving system reliability
  - Best in class body diode performance ( $t_{rr}$ ,  $Q_{rr}$ , robustness)
  - Soft recovery and low peak  $V_{DS}$  during body diode turn-off transient
  - $V_{(BR)DSS}$  of 650 V at  $T_j = 25^\circ\text{C}$ , 700 V at  $T_j = 150^\circ\text{C}$



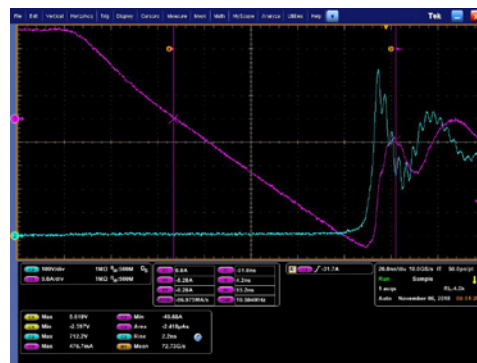
Gate oscillation during turn-off transient



AC-DC Rectifier Typical Block Diagram



SuperFET III Fast Recovery



Best Competitor

### Body Diode Performance

| Device               | Voltage Range | Current Range | Features                                                                                                                                                                                                                                                                                                          | Functions                                       | Packages                                            |
|----------------------|---------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------|
| SuperJunction MOSFET | 600 – 800 V   | 1.6 – 75 A    | <ul style="list-style-type: none"> <li>• Outstanding ease of use and low EMI</li> <li>• Excellent FOM (<math>R_{DS(ON)}</math> max. X <math>Q_g</math> typ.)</li> <li>• Well balanced switching behavior</li> <li>• Robust body diode</li> <li>• Soft recovery and small <math>Q_{rr}</math> for FRFET</li> </ul> | High voltage switch for industrial power supply | D2PAK, DPAK, IPAK, TO-220, TO-220F, TO-247, Power88 |

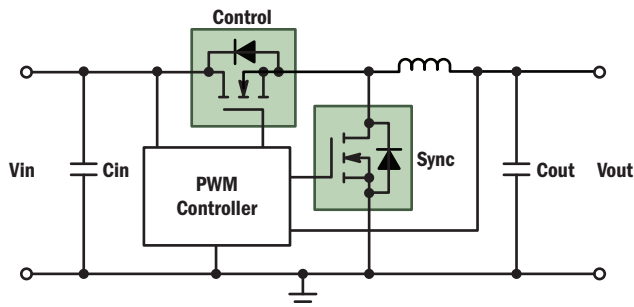


## N-Channel MOSFETs for Power Conversion

### Non-Isolated Topology "Buck" DC-DC

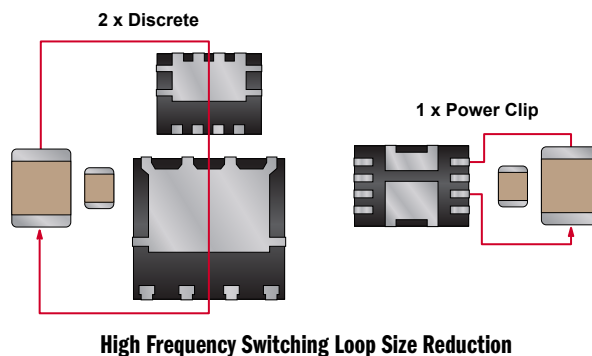
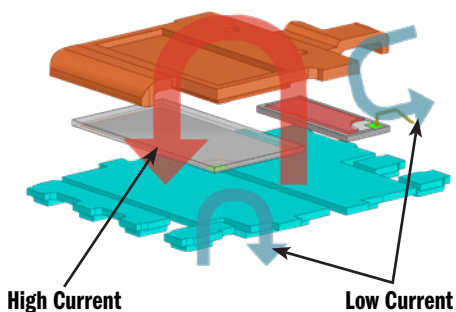
#### Features

- Low  $R_{DS(ON)}$  for low conduction loss
- Low capacitance for low switching loss
- Integrated Schottky for enhanced light load efficiency



#### Increasing Power Density with PowerClip Dual MOSFETs

- Single optimized clip reduces interconnect parasitics
  - Up to 40 A in 5x6 mm & 25 A in 3x3 mm
- Flipped low side die reduces source inductance & improves thermals



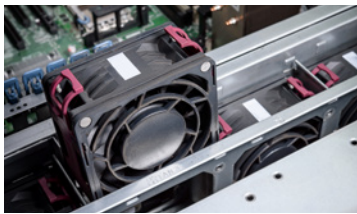
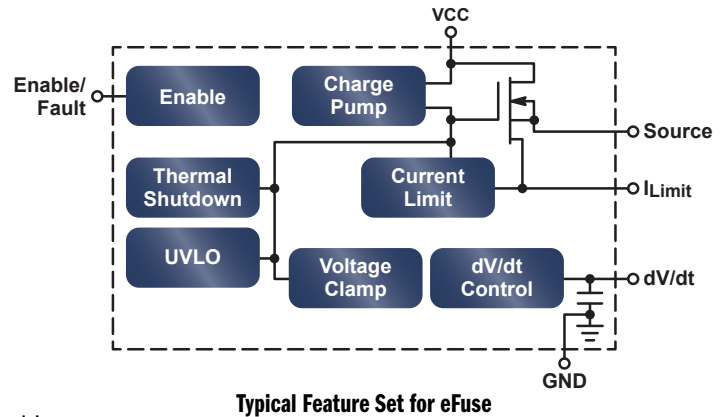
| Device         | Package       | $I_{max}$<br>(A) | $BV_{DSS}$<br>(V) | $V_{GS\ Max}$<br>(V) | $R_{DS(ON)}\ Max\ @\ V_{GS}=4.5\ V$<br>(m $\Omega$ ) |          | $Q_g\ Typ\ @\ V_{GS}=4.5\ V$<br>(nC) |          | $C_{oss}\ Typ$<br>(pF) |
|----------------|---------------|------------------|-------------------|----------------------|------------------------------------------------------|----------|--------------------------------------|----------|------------------------|
|                |               |                  |                   |                      | High Side                                            | Low Side | High Side                            | Low Side | Low Side               |
| FDPC8012S      | Power Clip 33 | 15-20            | 25                | 12                   | 7                                                    | 2.2      | 8                                    | 25       | 885                    |
| FDPC8013S      |               | 10-15            | 30                | 20                   | 9.6                                                  | 2.7      | 6                                    | 21       | 997                    |
| FDPC3D5N025X9D |               | 10               | 25                | 12                   | 3.7                                                  | 3.7      | 17                                   | 17       | 612                    |
| FDPC8016S      | Power Clip 56 | 20-30            | 25                | 12                   | 4.7                                                  | 1.7      | 11                                   | 31       | 1195                   |
| FDPC8014S      |               | >30              | 25                | 12                   | 4.7                                                  | 1.4      | 11                                   | 43       | 1720                   |
| FDPC8014AS     |               | >30              | 25                | 12                   | 4.7                                                  | 1.2      | 11                                   | 44       | 2170                   |
| FDMS001N025DSD |               | >30              | 25                | 16                   | 4                                                    | 1.1      | 10                                   | 35       | 1810                   |
| NTMFD0D9N02P1E |               | >30              | 25                | 16                   | 3.8                                                  | 0.95     | 9                                    | 30       | 1355                   |
| FDMS1D2N03DSD  |               | >30              | 30                | 16                   | 4                                                    | 1.2      | 11                                   | 39       | 1845                   |
| FDPC5018SG     |               | 25               | 30                | 12                   | 6.5                                                  | 2        | 8                                    | 28       | 1210                   |
| FDPC5030SG     |               | 20               | 30                | 12                   | 6.5                                                  | 3        | 8                                    | 18       | 801                    |

# Electronic Fuses for Inrush Current Limiting on Power Buses

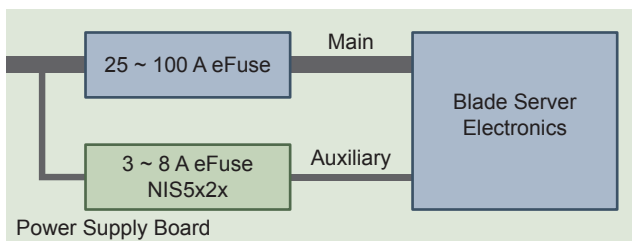
## 3-12 V Power Bus Hot Plug Protection

### Features

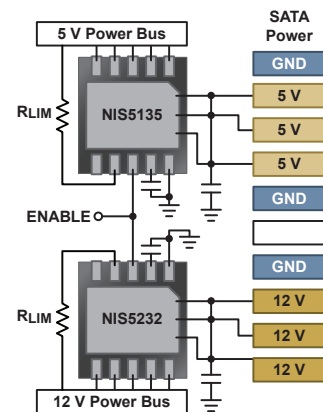
- Low  $R_{DS(ON)}$ , high operating and trip currents ( $I_{OP}$ ,  $I_{TRIP}$ )
- Overvoltage protection
- Precise  $I_{TRIP}$  control
- Slew rate control
- Thermal shut-down
- EN pin for synchronizing multiple eFuses
- Outperforms poly-fuses:
  - Tighter spec tolerances
  - Lower resistance
  - Shorter trip-time
  - Superior repeatability
- High efficiency with high current capability
- eFuses in parallel achieve practically any desired level of  $I_{OP}$  and  $I_{TRIP}$



Hot-Plugged Fans



Servers



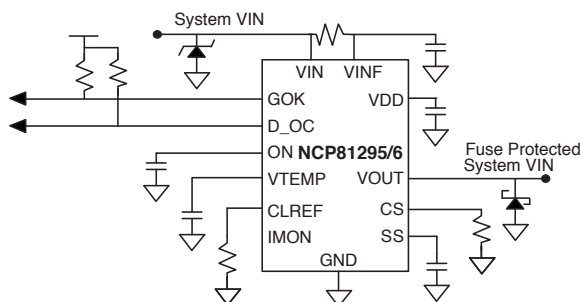
Hard Drive/Solid State Drive or Backplane Application

| Device  | Nominal Voltage (V) | Input Voltage (V) | Output Clamping Voltage (V) | Continuous Current (A) | Trip Current (A) | $R_{DS(ON)}$ (m $\Omega$ ) | Auto-Retry | Latching | Package |
|---------|---------------------|-------------------|-----------------------------|------------------------|------------------|----------------------------|------------|----------|---------|
| NIS5135 | 5                   | -0.6 to 18        | 6.65                        | 3.6                    | Adjustable       | 68                         | ✓          | ✓        | DFN-10  |
| NIS5132 | 12                  | -0.6 to 18        | 15                          | 4.2                    | Adjustable       | 44                         | ✓          | ✓        | DFN-10  |
| NIS5232 | 12                  | -0.6 to 18        | 15                          | 4.2                    | Adjustable       | 44                         | ✓          | ✓        | DFN-10  |
| NIS5820 | 12                  | -0.3 to 20        | 14                          | 8                      | Adjustable       | 24                         | ✓          | ✓        | WDFN-10 |
| NIS5020 | 12                  | -0.3 to 20        | 14                          | 10                     | Adjustable       | 14                         | ✓          | ✓        | WDFN-10 |
| NIS5021 | 12                  | -0.3 to 20        | 14                          | 12                     | Adjustable       | 14                         | ✓          | ✓        | WDFN-10 |
| NIS6150 | 5                   | -0.3 to 10        | 6.1/6.9                     | 1                      | Adjustable       | 190                        | ✓          | ✓        | WDFN-10 |
| NIS6350 | 5                   | -0.3 to 10        | 6.1/6.9                     | 3                      | Adjustable       | 50                         | ✓          | ✓        | WDFN-10 |

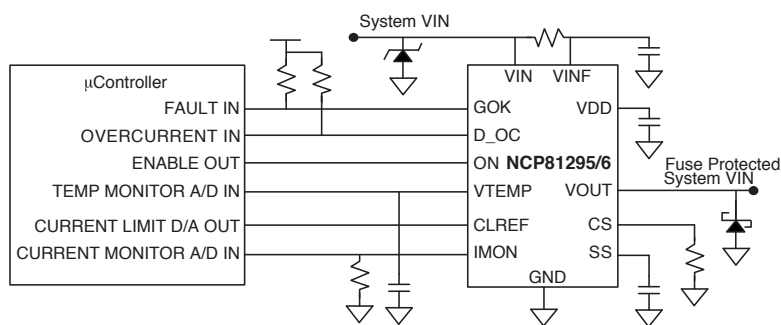
## Hot Swap with Internal MOSFET and IMON Output

## Features

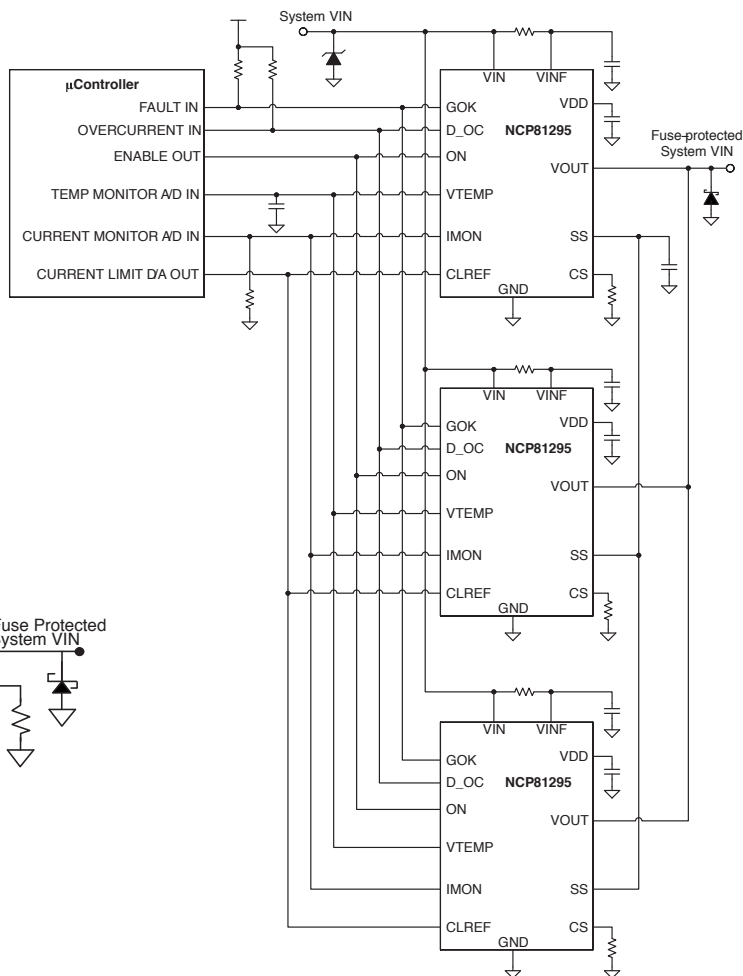
- Hot swap controller with integrated 0.65 mΩ MOSFET for reduced footprint
- IMON output provides proportional current signal with SENSEFET technology, eliminating sensing resistor and associated power losses
- Able to parallel devices for higher current with added SOA production during soft start



## Stand-Alone Single eFuse



### Single eFuse with Controller



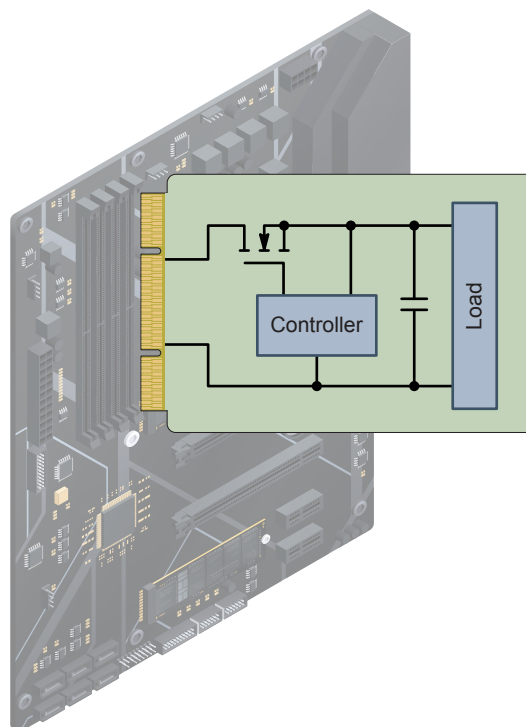
### Parallel Fuse Operation with Controller

| Device   | Fault      | Vcc Max (V) | Io Typ (A) | Package(s) |
|----------|------------|-------------|------------|------------|
| NCP81295 | Latch Off  | 18          | 50         | LQFN-32    |
| NCP81296 | Auto-Retry | 18          | 50         | LQFN-32    |

## Hot Swap MOSFETs

### Features

- Wide SOA to improve inrush current management
- Ultra-low  $R_{DS(ON)}$  to improve system efficiency
- Advanced SO-8 FL package, 5 x 6 mm, to improve thermal performance



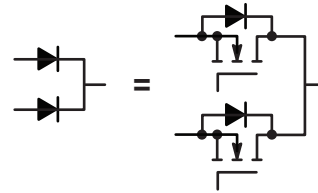
| Device          | Configuration | V <sub>DS</sub><br>(V) | V <sub>GS</sub><br>(V) | R <sub>DS(ON)</sub>                |                                     | C <sub>iss</sub><br>(pF) | Q <sub>g</sub><br>(nC) | Package |
|-----------------|---------------|------------------------|------------------------|------------------------------------|-------------------------------------|--------------------------|------------------------|---------|
|                 |               |                        |                        | V <sub>GS</sub> @ 10 V Max<br>(mΩ) | V <sub>GS</sub> @ 4.5 V Max<br>(mΩ) |                          |                        |         |
| NTMFS0D55N03CG* | Single        | 30                     | ±20                    | 0.55                               | 0.8                                 | 13786                    | 201                    | SO-8 FL |
| NTMFS0D7N03CG*  | Single        | 30                     | ±20                    | 0.65                               | 1                                   | 12300                    | 147                    | SO-8 FL |
| NTMFS0D9N03CG   | Single        | 30                     | ±20                    | 0.9                                | 1.4                                 | 9550                     | 131                    | SO-8 FL |
| NTMFS1D15N03CG  | Single        | 30                     | ±20                    | 1.15                               | 1.7                                 | 7300                     | 94                     | SO-8 FL |
| NTMFS1D7N03CG*  | Single        | 30                     | ±20                    | 1.7                                | 2.4                                 | 3590                     | 92                     | SO-8 FL |

\* Pending 4Q19.

## ORing MOSFETs

### Features

- Ultra low  $R_{DS(ON)}$  for low conduction loss
- 25 V and 30 V for IM bus ORing
- 100 V for 48 V bus ORing
- Much more efficient and reliable solution than power diodes



MOSFETs as ORing Diodes

| Device       | Configuration | $V_{DS}$<br>(V) | $V_{GS}$<br>(V) | $R_{DS(ON)}$           |                         | $Q_g$<br>(nC) | $Q_{gd}$<br>(nC) | Package |
|--------------|---------------|-----------------|-----------------|------------------------|-------------------------|---------------|------------------|---------|
|              |               |                 |                 | $V_{GS} @ 10\text{ V}$ | $V_{GS} @ 4.5\text{ V}$ |               |                  |         |
|              |               |                 |                 | Max<br>(mΩ)            | Max<br>(mΩ)             |               |                  |         |
| NTMFS4H01N   | Single        | 25              | 20              | 0.7                    | 0.9                     | 39            | 8.5              | S08-FL  |
| NTMFS4H02N   | Single        | 25              | 20              | 1.3                    | 1.9                     | 26            | 5.8              | S08-FL  |
| FDMS8050     | Single        | 30              | 20              | 0.65                   | 0.9                     | 93            | 18               | Power56 |
| NTMFS4C020N  | Single        | 30              | 20              | 0.7                    | 1                       | 63            | 13               | S08-FL  |
| FDMC8010     | Single        | 30              | 20              | 1.3                    | 1.8                     | 32            | 9.5              | Power33 |
| NTTFS4C02N   | Single        | 30              | 20              | 2.3                    | 3.1                     | 20            | 4                | U8FL    |
| NTMFS5C404NL | Single        | 40              | 20              | 0.67                   | 1                       | 81            | 23.8             | S08-FL  |
| NTMFS5H400NL | Single        | 40              | 20              | 0.8                    | 1.1                     | 54            | 13               | S08-FL  |
| NTMFS5C604NL | Single        | 60              | 20              | 1.2                    | 1.7                     | 52            | 12.7             | S08-FL  |
| NTMFS5H600NL | Single        | 60              | 20              | 1.3                    | 1.7                     | 40            | 6.5              | S08-FL  |
| NTMFS6H800N  | Single        | 80              | 20              | 2.1                    | —                       | 85            | 16               | S08-FL  |
| FDMS86180    | Single        | 100             | 20              | 3.2                    | —                       | 60            | 12               | Power56 |



## Advanced P-Channel MOSFETs for Power Load Switch

### Features

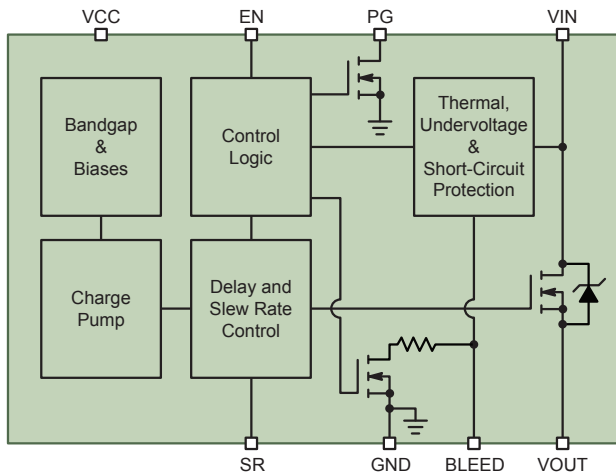
- Ultra low  $R_{DS(ON)}$  to improve system efficiency
- Advanced package technology for space saving and excellent thermal conduction

| Device       | Configuration | Polarity | $V_{DS}$<br>(V) | $V_{GS}$<br>(V) | $R_{DS(ON)}$           |                         | $Q_g$<br>(nC) | $C_{iss}$<br>(pF) | Package |
|--------------|---------------|----------|-----------------|-----------------|------------------------|-------------------------|---------------|-------------------|---------|
|              |               |          |                 |                 | $V_{GS} @ 10\text{ V}$ | $V_{GS} @ 4.5\text{ V}$ |               |                   |         |
|              |               |          |                 |                 | Max<br>(mΩ)            | Max<br>(mΩ)             |               |                   |         |
| FDMC610P     | Single        | P        | 12              | 8               | —                      | 3.9                     | 71            | 890               | Power33 |
| NTLUS3C18PZ  | Single        | P        | 12              | 10              | —                      | 24                      | 16            | 1570              | UDFN-6  |
| FDMC4D9P20X8 | Single        | P        | 20              | 12              | —                      | 4.9                     | 78            | 7535              | PQFN-8  |
| FDMA008P20LZ | Single        | P        | 20              | 8               | —                      | 13                      | 28            | 3131              | PQFN-6  |
| FDMA6676PZ   | Single        | P        | 30              | 25              | 13.5                   | 27                      | 20            | 1440              | PQFN-6  |
| NTLUD3A50PZ  | Dual          | P        | 20              | 8               | —                      | 48                      | 10.4          | 920               | UDFN-6  |

## Advanced Load Switches

ON Semiconductor provides a comprehensive range of load switches, suitable for a variety of different power trees.

- Copackaged MOSFET plus CMOS controllers – value-added features plus high performance
- Monolithic CMOS smart load switches – value added features, low cost
- Discrete MOSFETs – simple, high performance



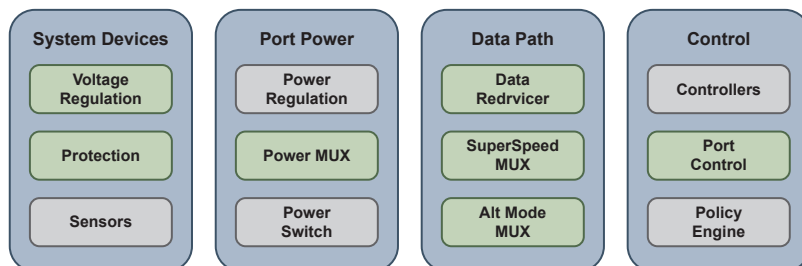
### NCP45xxx Integrated Load Switch Features

- Simple/clean design
- No current consumption in standby power mode
- Small PCB footprint
- Low RDS(ON) due to charge pump driving NMOS
- Adjustable soft-start time (SR)
- Adjustable integrated discharge
- Fault protection
- Power rail monitoring & sequencing

| Type                              | Device   | r <sub>on</sub><br>(mΩ) | I Max<br>(A) | V <sub>I</sub> Min<br>(V) | V <sub>I</sub> Max<br>(V) | I <sub>Q</sub><br>(μA) | Discharge | Slew Rate<br>(μs) | Features          | Package(s) |
|-----------------------------------|----------|-------------------------|--------------|---------------------------|---------------------------|------------------------|-----------|-------------------|-------------------|------------|
| Smart Load Switch                 | NCP333   | 55 at 3.3 V             | 1.5          | 1.2                       | 5.5                       | 1                      | Auto      | 95                | —                 | WLCSP-4    |
|                                   | FPF1504  | 15 at 3.3 V             | 1.5          | 1                         | 3.6                       | 0.1                    | Auto      | 130               | —                 | WLCSP-4    |
|                                   | NCP433   | 50 at 1.8 V             | 1.5          | 1                         | 3.6                       | 0.6                    | Auto      | 20                | —                 | WLCSP-4    |
|                                   | NCP334   | 47 at 3.3 V             | 2            | 1.2                       | 5.5                       | 1                      | —         | 71                | —                 | WLCSP-4    |
|                                   | NCP335   | 47 at 3.3 V             | 2            | 1.2                       | 5.5                       | 1                      | Auto      | 71                | —                 | WLCSP-4    |
|                                   | NCP435   | 43 at 1.8 V             | 2            | 1                         | 3.6                       | 0.6                    | Auto      | 61                | —                 | WLCSP-4    |
|                                   | FPF1204  | 45 at 5.5 V             | 2.2          | 1.2                       | 5.5                       | 1.5                    | Auto      | 100               | —                 | WLCSP-4    |
|                                   | NCP330   | 26 at 3.3 V             | 3            | 1.8                       | 5.5                       | 100                    | —         | 2000              | Reverse blocking  | TDFN-4     |
|                                   | NCP336   | 23 at 3.3 V             | 3            | 1.2                       | 5.5                       | 1                      | —         | 810               | —                 | WLCSP-6    |
|                                   | NCP337   | 23 at 3.3 V             | 3            | 1.2                       | 5.5                       | 1                      | Auto      | 810               | —                 | WLCSP-6    |
|                                   | NCP339   | 26 at 3.3 V             | 3            | 1.2                       | 5.5                       | 2                      | —         | 2700              | Reverse blocking  | WLCSP-6    |
|                                   | FPF1038  | 20 at 5.5 V             | 3.5          | 1.2                       | 5.5                       | 5.5                    | —         | 2700              | —                 | WLCSP-6    |
|                                   | FPF1039  | 20 at 5.5 V             | 3.5          | 1.2                       | 5.5                       | 5.5                    | Auto      | 2700              | —                 | WLCSP-6    |
|                                   | FPF2411  | 10 at 5.0 V             | 6            | 2.3                       | 5.5                       | 1                      | —         | 3000              | Reverse blocking  | WLCSP-12   |
| ecoSWITCH™ Integrated Load Switch | NCP45524 | 18.0                    | 6            | 0.5                       | 13.5                      | —                      | Adj       | —                 | Power good        | DFN-8      |
|                                   | NCP45525 | 18.0                    | 6            | 0.5                       | 13.5                      | —                      | Adj       | Adj               | —                 | DFN-8      |
|                                   | NCP45560 | 2.4                     | 24           | 0.5                       | 13.5                      | —                      | Adj       | Adj               | Power good; Fault | DFN-12     |
|                                   | NCP45540 | 3.3                     | 20           | 0.5                       | 13.5                      | —                      | Adj       | Adj               | Power good; Fault | DFN-12     |
|                                   | NCP45541 | 3.3                     | 20           | 0.5                       | 13.5                      | —                      | Adj       | Adj               | Power good        | DFN-12     |
|                                   | NCP45520 | 9.5                     | 10.5         | 0.5                       | 13.5                      | —                      | Adj       | —                 | Power good; Fault | DFN-8      |
|                                   | NCP45521 | 9.5                     | 10.5         | 0.5                       | 13.5                      | —                      | Adj       | Adj               | Fault             | DFN-8      |

## USB-C for PC/Laptop

PC/Laptop form factors are getting smaller, thinner, and lighter with the adaptation of the USB Type-C connectors. ON Semiconductor offers multiport solutions compatible with the USB Type-C Port Controller Protocol and Power Delivery 3.0.



Block Diagram

### System Devices

| Function           | Device   | Description                                                                               |
|--------------------|----------|-------------------------------------------------------------------------------------------|
| Voltage Regulation | NCP81231 | Buck Controller, USB Power Delivery and Type-C Applications                               |
|                    | NCP81239 | Buck-Boost Controller, USB Power Delivery and Type-C Applications                         |
| Protection         | ESD8704  | High Speed Data Line Protection, Unidirectional (3.3 V - USB 3.x)                         |
|                    | ESDL1531 | High Speed Data Line Protection, Bidirectional (4 V - USB), 0.2 pF                        |
|                    | ESDL2011 | High Speed Data Line Protection, Bidirectional (1 V - Thunderbolt 3.0), 0.2 pF            |
|                    | ESDL2031 | High Speed Data Line Protection, Bidirectional (4 V - USB), 0.35 pF                       |
|                    | ESDM1051 | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF                      |
|                    | ESDM1131 | High Speed Data Line Protection, Bidirectional (3.3 V - USB 2.0), 4 pF                    |
|                    | ESDM3551 | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF                      |
|                    | FSUSB242 | USB Type-C Port Protection Switch                                                         |
|                    | FUSB252  | High Speed Digital (HSD) Port Protection Switch with Type-C CC                            |
|                    | NIS6350  | Electronic Fuse, 5 V                                                                      |
|                    | NSPM2052 | ESD and Surge Protection Device, Vbat and Vbus Applications, 5 V                          |
|                    | NSPU3051 | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF                      |
|                    | NSPU5201 | ESD and Surge Protection, Unidirectional, 20 V, 140 A                                     |
|                    | NCS210   | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 $\mu$ V Offset  |
|                    | NCS211   | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 $\mu$ V Offset  |
|                    | NCS213   | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 100 $\mu$ V Offset |
|                    | NCS214   | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 $\mu$ V Offset  |

### Port Power

| Function  | Device   | Description                                                                                                |
|-----------|----------|------------------------------------------------------------------------------------------------------------|
| Power MUX | FPF2595  | Load Switch, Over-Voltage, Over-Current Protection with Adjustable Current-Limit Control, IntelliMAX™ 28 V |
|           | FPF2895C | Current Limit Load Switch with OVP and TRCB, 28 V, 5 A                                                     |



### Data Path

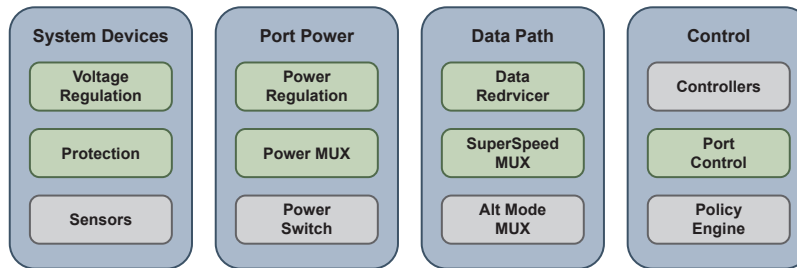
| Function       | Device      | Description                                              |
|----------------|-------------|----------------------------------------------------------|
| Data Redriver  | NB7NPQ7021M | USB 3.1, One Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ7022M | USB 3.1, One Port Linear High Gain Redriver, 3.3 V       |
|                | NB7NPQ7041M | USB 3.1, Two Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ7042M | USB 3.1, Two Port Linear High Gain Redriver, 3.3 V       |
|                | NB7NPQ1002M | USB 3.1, One Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ1102M | USB 3.1, One Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ1004M | USB 3.1, Two Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ1104M | USB 3.1, Two Port Linear Redriver, 3.3 V                 |
|                | NB7VPQ904M  | USB Type-C, DisplayPort™ Linear Redriver, 1.8 V, 10 Gbps |
| SuperSpeed Mux | FUSB340     | USB 3.1 SuperSpeed Switch, 10 Gbps                       |
| Alt Mode MUX   | FSA4476     | Analog Audio Switch with Protection Function, USB Type-C |
|                | FSA4480     | Analog Audio Switch with Protection Function, USB Type-C |

### Control

| Function     | Device   | Description                                                |
|--------------|----------|------------------------------------------------------------|
| Port Control | FUSB302T | Programmable USB Type-C Controller with PD (Default SRC)   |
|              | FUSB303  | Autonomous USB Type-C Controller with I2C and GPIO Control |
|              | FUSB307B | USB Type-C Port Controller with USB-PD                     |

## USB-C for Docking Station

Greater adaptation of USB-C (Type-C) has caused manufactures to introduce many USB-C devices, including for mobile PCs, tablets, and docking stations. There are various USB-C universal docking stations to connect multiple laptop platforms and peripherals. ON Semiconductor provides docking station solutions including the USB-C Data Hub (USB protocol & signal conditioning), as well as the charging capability for the USB-C systems that support USB Power Delivery/Alternate mode protocol.



### System Devices

### Block Diagram

| Function           | Device   | Description                                                                    |
|--------------------|----------|--------------------------------------------------------------------------------|
| Voltage Regulation | NCP81239 | 4-Switch Buck Boost Controller, USB Power Delivery and Type C Applications     |
|                    | NCP81231 | Buck Controller, USB Power Delivery and Type-C Applications                    |
| Protection         | FUSB252  | High Speed Digital (HSD) Port Protection Switch with Type-C CC                 |
|                    | ESD8704  | High Speed Data Line Protection, Unidirectional (3.3 V - USB 3.x)              |
|                    | ESD8708  | High Speed Data Line Protection, Unidirectional (3.3 V - Ethernet)             |
|                    | ESDL2011 | High Speed Data Line Protection, Bidirectional (1 V - Thunderbolt 3.0), 0.2 pF |
|                    | ESDL2031 | High Speed Data Line Protection, Bidirectional (4 V - USB), 0.35 pF            |
|                    | ESDL1531 | High Speed Data Line Protection, Bidirectional (4 V - USB), 0.2 pF             |
|                    | ESDM1131 | High Speed Data Line Protection, Bidirectional (3.3 V, USB 2.0) 4 pF           |
|                    | ESDM3551 | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF           |
|                    | ESDM1051 | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF           |
|                    | NSPU3051 | ESD and Surge Protection, CC, SBU and Vbus Lines, (5.5V - USB 3.x), 80 pF      |
|                    | NSPM2052 | ESD and Surge Protection Device, Vbat and Vbus Applications, 5 V               |
|                    | NSPU5132 | ESD and Surge Protection Device, Unidirectional, 13.5 V, 200 A                 |
|                    | NSPU5201 | ESD and Surge Protection, Unidirectional, 20 V, 140 A                          |
|                    | NIS6350  | Electronic Fuse, 5 V, 46 mΩ                                                    |
|                    | NIS5020  | Electronic Fuse, 12 V, 14 mΩ                                                   |

### Data Path

| Function       | Device      | Description                                              |
|----------------|-------------|----------------------------------------------------------|
| Data Redriver  | NB7NPQ7021M | USB 3.1, One Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ7022M | USB 3.1, One Port Linear High Gain Redriver, 3.3 V       |
|                | NB7NPQ7041M | USB 3.1, Two Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ7042M | USB 3.1, Two Port Linear High Gain Redriver, 3.3 V       |
|                | NB7NPQ1002M | USB 3.1, One Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ1102M | USB 3.1, One Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ1004M | USB 3.1, Two Port Linear Redriver, 3.3 V                 |
|                | NB7NPQ1104M | USB 3.1, Two Port Linear Redriver, 3.3 V                 |
|                | NB7VPQ904M  | USB Type-C, DisplayPort™ Linear Redriver, 1.8 V, 10 Gbps |
| SuperSpeed Mux | FUSB340     | USB 3.1 SuperSpeed Switch, 10 Gbps                       |

### Port Power

| Function         | Device    | Description                                                                                                |
|------------------|-----------|------------------------------------------------------------------------------------------------------------|
| Power Regulation | NCP1342   | High Frequency Quasi-Resonant Flyback Controller                                                           |
|                  | NCP1568   | Active Clamp Flyback Controller with ZVS                                                                   |
|                  | NCP4306   | Secondary Side Synchronous Rectification Driver                                                            |
|                  | NCP12601  | Multi-mode PWM Controller for USB PD                                                                       |
|                  | FAN65008B | Synchronous PWM Buck Regulator, Voltage Mode, 65 V, 10 A                                                   |
| Power MUX        | FPP2595   | Load Switch, Over-Voltage, Over-Current Protection with Adjustable Current-Limit Control, IntelliMAX™ 28 V |
|                  | FPP2895C  | Current Limit Load Switch with OVP and TRCB, 28 V, 5 A                                                     |

### Control

| Function     | Device    | Description                                                |
|--------------|-----------|------------------------------------------------------------|
| Port Control | FUSB302B  | Programmable USB Type-C Controller with PD (Default SRK)   |
|              | FUSB302T  | Programmable USB Type-C Controller with PD (Default SRC)   |
|              | FUSB303   | Autonomous USB Type-C Controller with I2C and GPIO Control |
|              | FUSB307B  | USB Type-C Port Controller with USB-PD                     |
|              | FUSB308BV | USB Type-C Port Controller with USB-PD                     |

## USB 3.x Type A Connector

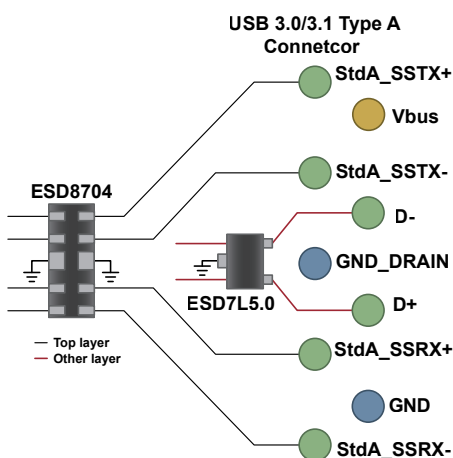
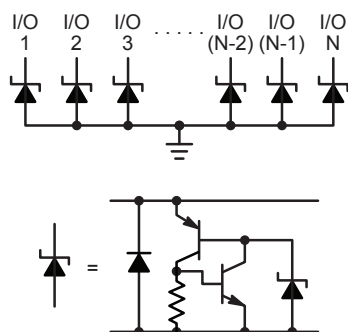
Two SuperSpeed Pairs, One High Speed Pair,  $V_{CC}$ , Low Capacitance ESD Protection

### Key Requirement

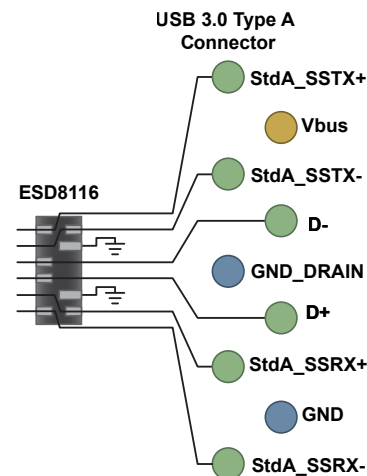
- Cap < 0.7 pF

### Features

- 0.35 pF
- Flow through routing
- Industry leading low clamping voltage versus competitors

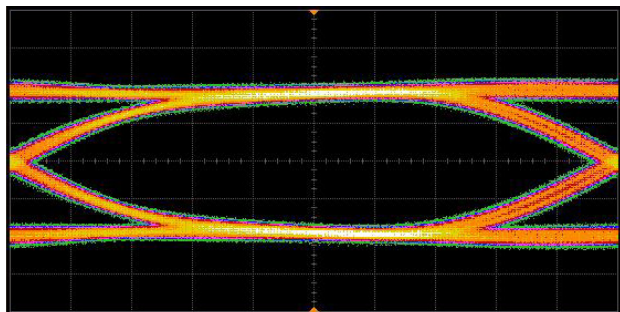


**ESD8704 – 0.35 pF, 2 Layer Routing**  
(ESD8704; ESD7L5.0 for D+, D- Lines)

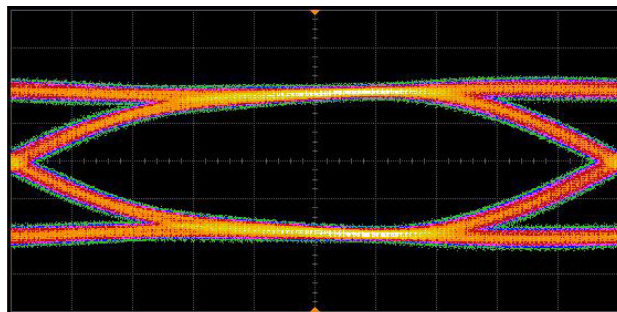


**ESD8116 – 0.30 pF, 1 Layer Routing**

| Device   | Interface | Data Lines                 | Capacitance (pF) | Package | Size (mm)    |
|----------|-----------|----------------------------|------------------|---------|--------------|
| ESD8704  | USB 3.x   | 2 Pair (Tx, Rx)            | 0.35             | UDFN-10 | 2.5 x 1.0    |
| ESD7L    | USB 3.x   | 1 Pair (D+/-)              | 0.5              | SOT-723 | 1.2 x 1.2    |
| ESD8504  | USB 3.0   | 2 Pair (Tx, Rx)            | 0.4              | UDFN-10 | 2.5 x 1.0    |
| ESD8104  | USB 3.0   | 2 Pair (Tx, Rx)            | 0.3              | UDFN-10 | 2.5 x 1.0    |
| ESD8116  | USB 3.0   | 3 Pair (Tx, Rx, D+/-)      | 0.3              | UDFN-8  | 2.0 x 1.2    |
| ESDL3552 | USB 3.x   | 1 Pair (Tx, Rx, D+/-)      | 0.25             | X4DFN-3 | 0.62 x 0.32  |
| ESDL2011 | USB 3.x   | Single Line (Tx, Rx)       | 0.17             | DSN-2   | 0.6 x 0.3    |
| ESDL2031 | USB 3.x   | Single Line (Tx, Rx, D+/-) | 0.4              | X4DFN-2 | 0.6 x 0.3    |
| ESD8011  | USB 3.x   | Single Line                | 0.10             | X3DFN-2 | 0.62 x 0.32  |
| ESD8111  | USB 3.x   | Single Line                | 0.20             | WLCSP-2 | 0.6 x 0.3    |
| ESD8006  | USB 3.0   | 3 Pair (Tx, Rx, D+/-)      | 0.25             | UDFN-8  | 3.3 x 1.0    |
| ESDL1531 | USB 3.x   | Single Line (Tx, Rx, D+/-) | 0.15             | X4DFN-2 | 0.445 x 0.24 |



Without ESD



With ESD

USB 3.0 @ 5 Gb/s

## USB 2.0

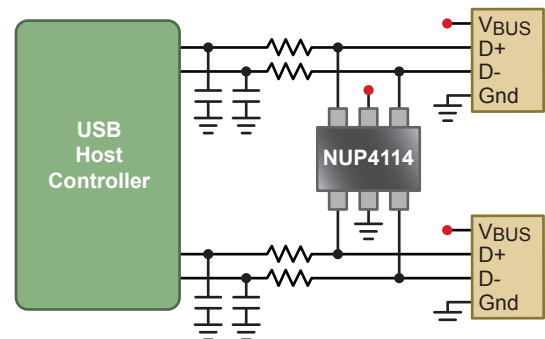
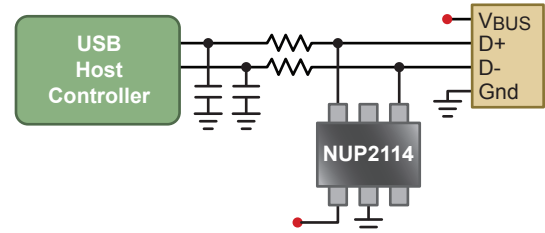
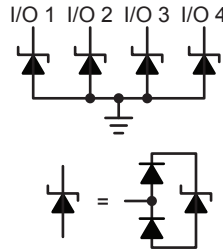
One High Speed Pair,  $V_{CC}$ , Low Capacitance ESD Protection

### Key Requirement

- Cap < 5 pF

### Features

- 0.35 - 3.0 pF
- Multi-part solutions available
- Industry leading low clamping voltage



| Device     | Data Lines                 | Capacitance (pF) | Package | Size (mm)    |
|------------|----------------------------|------------------|---------|--------------|
| NUP2114UPX | 1 Pair (D+/-) + Vbus       | 0.8              | SOT-553 | 1.2 x 1.6    |
| NUP2114UCM | 1 Pair (D+/-) + Vbus       | 0.8              | TSOP-6  | 3.0 x 2.75   |
| ESDL3552   | 1 Pair (Tx, Rx, D+/-)      | 0.25             | X4DFN-3 | 0.62 x 0.32  |
| NUP4114UPX | 2 Pair (D+/-) + Vbus       | 0.5              | SOT-563 | 1.6 x 1.6    |
| NUP4114UCL | 2 Pair (D+/-) + Vbus       | 0.5              | SC-88   | 2.0 x 2.1    |
| NUP4114H   | 2 Pair (D+/-) + Vbus       | 0.5              | TSOP-6  | 3.0 x 2.75   |
| ESDL2031   | Single Line (Tx, Rx, D+/-) | 0.4              | X4DFN-2 | 0.6 x 0.3    |
| ESDL1531   | Single Line (Tx, Rx, D+/-) | 0.2              | X4DFN-2 | 0.445 x 0.24 |
| ESD7L5.0   | 2                          | 0.5              | SOT-723 | 1.2 x 1.2    |
| ESD8351MUT | 1                          | 0.37             | X3DFN-2 | 0.6 x 0.3    |
| ESD8351P2T | 1                          | 0.37             | SOD-923 | 1.0 x 0.6    |
| ESD9L5.0   | 1                          | 0.5              | SOD-923 | 1.0 x 0.6    |

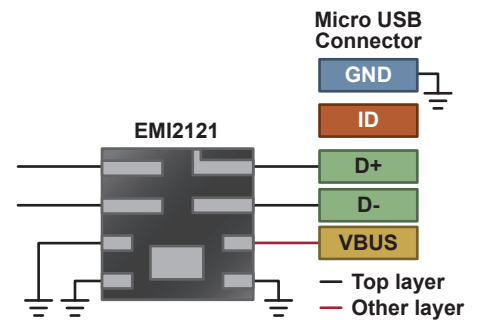
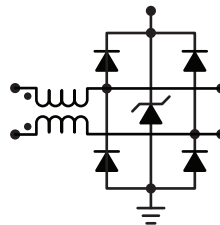
One High Speed Pair,  $V_{CC}$ , Common Mode Filter + ESD Protection

### Key Requirement

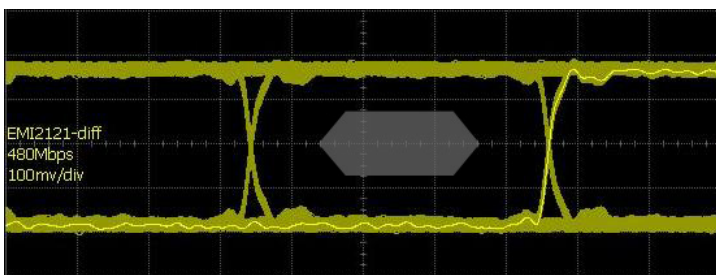
- Cap < 5 pF
- Common Mode Filtering

### Features

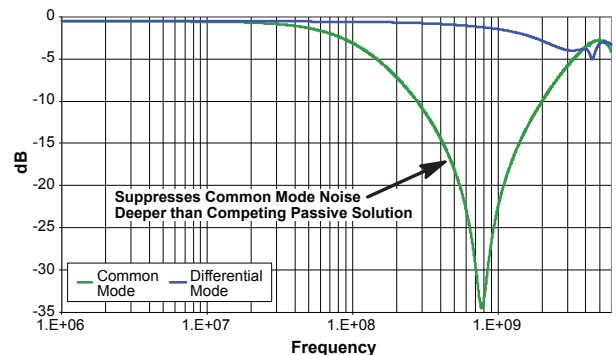
- 0.5 - 0.8 pF
- Integrated EMI suppression with ESD protection
- Industry leading low clamping voltage



| Device  | Pairs | Capacitance @ 2.5 V (pF) | CM Attenuation @ 800 MHz (-dB) | DM Bandwidth F3dB (GHz) | Package | Size (mm)        |
|---------|-------|--------------------------|--------------------------------|-------------------------|---------|------------------|
| EMI2121 | 1     | 0.9                      | -25                            | 2.5                     | WQFN-8  | 2.2 x 2.0 x 0.75 |



USB 2.0 @ 480 Mb/s



## Thunderbolt

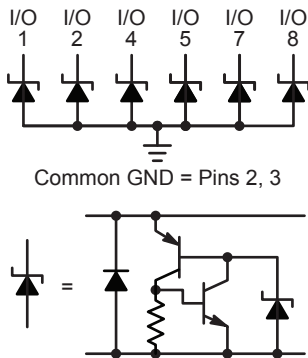
Four High Speed Pairs, up to Six Additional Lines, Low Capacitance ESD

### Key Requirement

- Capacitance < 0.4 pF

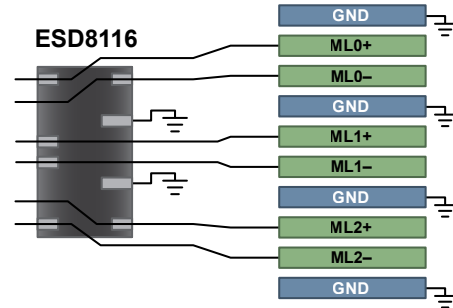
### Features

- Capacitance of 0.35 pF or lower
- Integrated solution in 2.0 x 1.2 mm package
- Grounds between pairs to reduce cross-talk
- Flow-through routing
- Industry leading clamping voltage

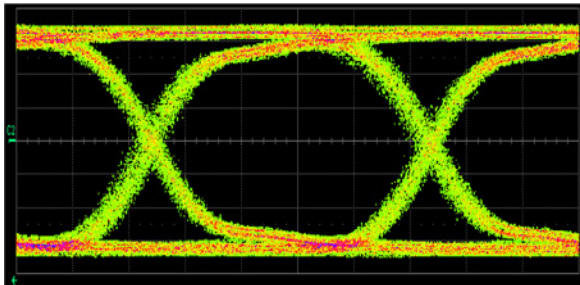
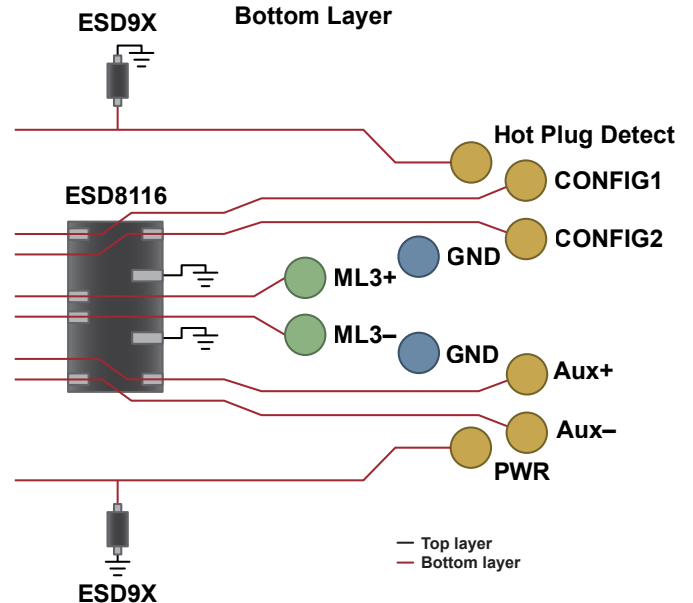


| Device   | Data Lines  | Capacitance (pF) | Package | Size (mm)    |
|----------|-------------|------------------|---------|--------------|
| ESD8006  | 3 Pair      | 0.25             | UDFN-8  | 3.3 x 1.0    |
| ESD8116  | 3 Pair      | 0.30             | UDFN-8  | 2.0 x 1.2    |
| ESD8011  | Single Line | 0.10             | X3DFN-2 | 0.62 x 0.32  |
| ESDL2011 | Single Line | 0.17             | X4DFN-2 | 0.6 x 0.3    |
| ESDL531  | Single Line | 0.20             | X4DFN-2 | 0.445 x 0.24 |

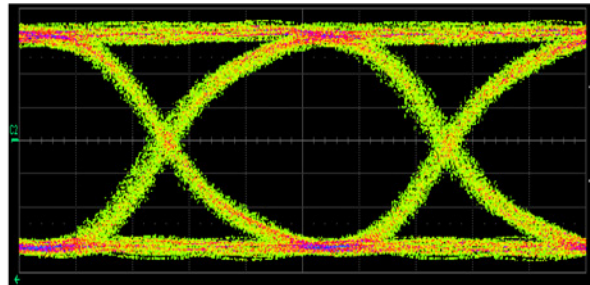
### Thunderbolt Connector Top Layer



### Thunderbolt Connector Bottom Layer



Without ESD8116



With ESD8116

Thunderbolt @ 10 Gb/s

## HDMI, Display Port

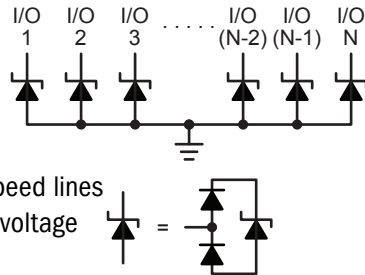
Four High Speed Pairs, Up to Six Additional Interface Lines, Low Capacitance ESD

### Key Requirement

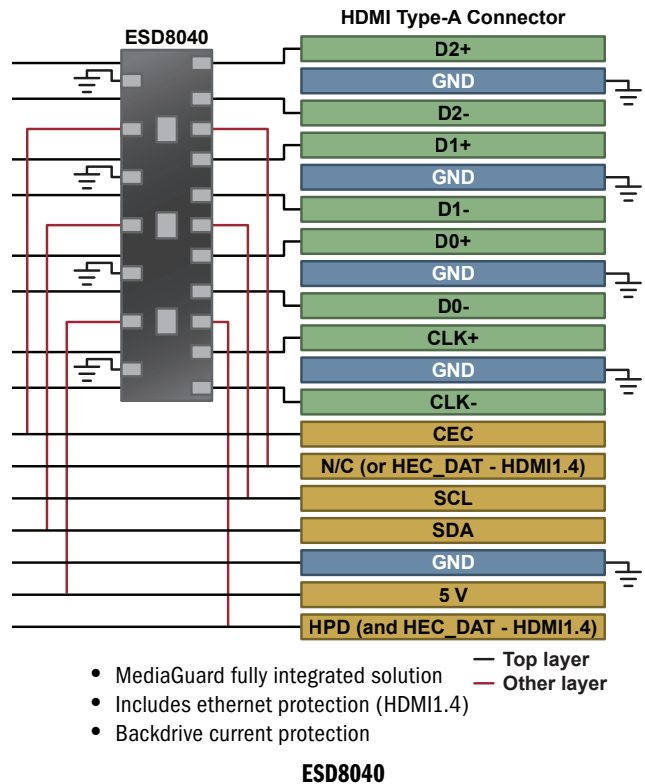
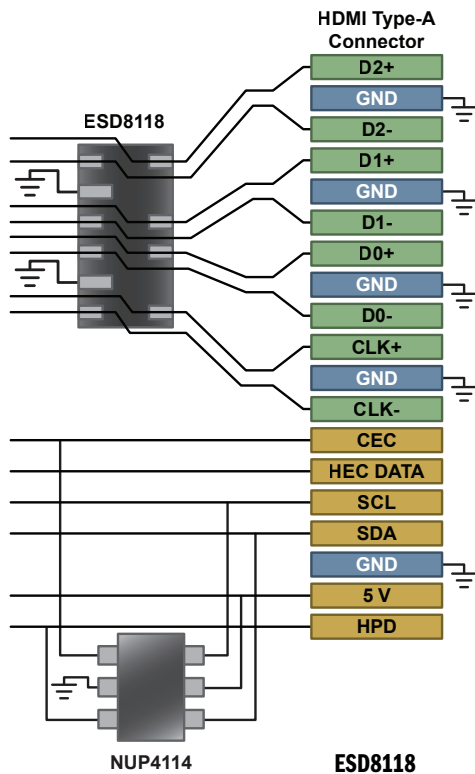
- Cap < 0.5 pF

### Features

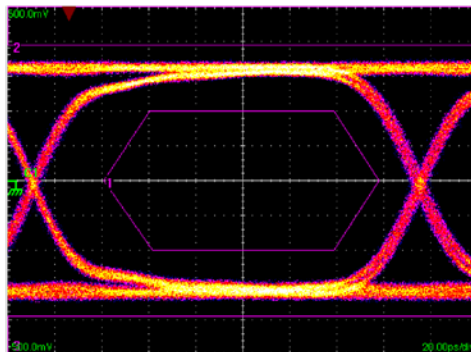
- 0.3 pF ESD protection
- Flow through routing in high speed lines
- Industry leading low clamping voltage



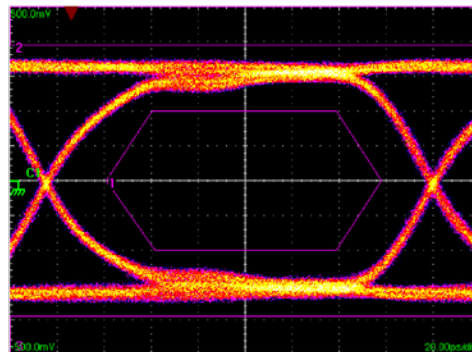
| Device     | Data Lines                    | Capacitance (pF) | Package | Size (mm)  |
|------------|-------------------------------|------------------|---------|------------|
| ESDL2031   | 1 (TMDS)                      | 0.4              | X4DFN-2 | 0.6 x 0.3  |
| ESD8104    | 4 (TMDS)                      | 0.3              | UDFN-10 | 2.5 x 1.0  |
| ESD8118    | 8 (TMDS)                      | 0.3              | UDFN-10 | 3.2 x 1.2  |
| ESD8040    | 14 (TMDS + Low Speed + Power) | 0.3              | UDFN-18 | 5.5 x 1.5  |
| NUP4114UPX | 5 (4 Low Speed + Power)       | 0.5              | SOT-563 | 1.6 x 1.6  |
| NUP4114UCL | 5 (4 Low Speed + Power)       | 0.5              | SC-88   | 2.0 x 2.1  |
| NUP4114H   | 5 (4 Low Speed + Power)       | 0.5              | TSOP-6  | 3.0 x 2.75 |



- MediaGuard fully integrated solution
- Includes ethernet protection (HDMI1.4)
- Backdrive current protection



Without ESD



With ESD

HDMI 2.0 @ 6 Gb/s

## Ethernet: 10/100BASE-T, 1000BASE-TX, and Gigabit

Four Pairs, Low Capacitance Surge and ESD Protection

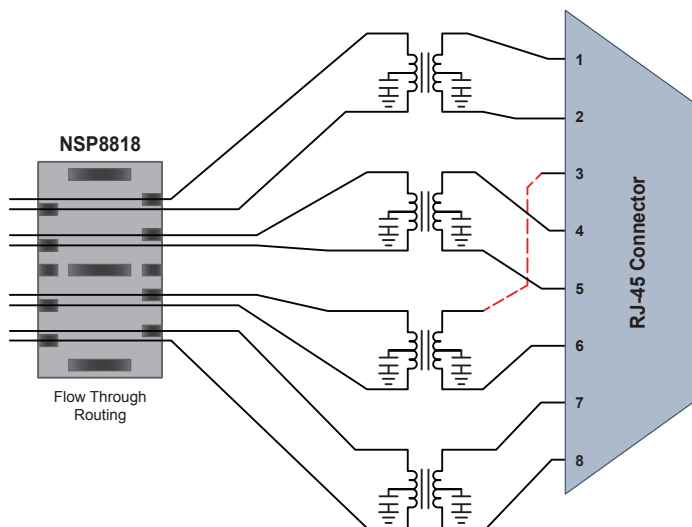
The 1000BASE-T or Gigabit Ethernet interface operating at higher bitrates is susceptible to ESD strikes, cable-discharge events and lightning-induced transients. Our products help meet IEC 61000-4-5, GR-1089-CORE and other Standards.

### Features

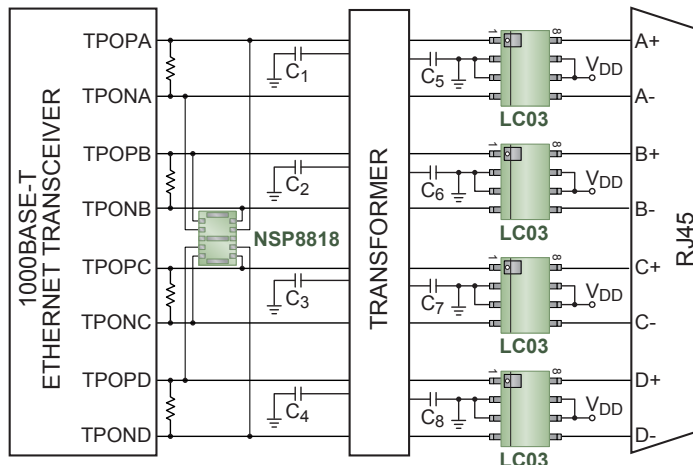
- Line-to-line capacitance < 3 pF
- $V_{\text{clamp}}$  (25 A surge) < 11 V
- IEC 61000-4-2 rating > 30 kV
- No latching danger
- Surge rating maintained to 125°C

### Benefits

- Compatible with Gb Ethernet and beyond
- Enhanced protection for downstream electronics
- Accommodates operating transients above 3.3 V
- Small form-factor allows integration into connectors



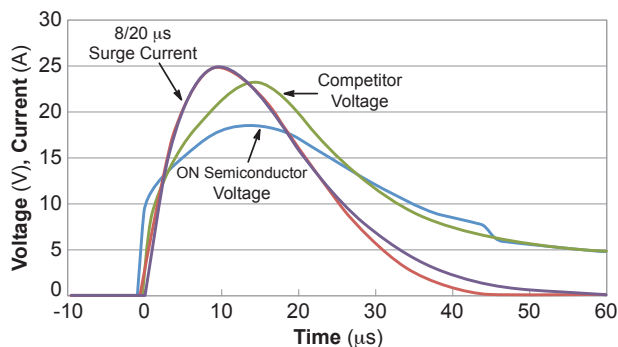
### Typical Application



Line Side : LC03-6 (optional)

Transformer Side: NSP8818

Protection against metallic (transverse) strikes



Line-to-Line Surge

### Surge Protection Devices

| Device   | V <sub>DC</sub> Max (V) | Line Transient Max (V) | Surge I <sub>PP</sub> , 8/20 μs (A) | Typical Line-Line Capacitance (pF) | ESD Contact Rating (kV) | Package |
|----------|-------------------------|------------------------|-------------------------------------|------------------------------------|-------------------------|---------|
| LC03-6   | 6.7                     | 7                      | 100                                 | 8                                  | ±30                     | SOIC-8  |
| NSP4201  | 5                       | 6                      | 25                                  | 1.5                                | ±30                     | TSOP-6  |
| NUP4114H | 5                       | 5                      | 12*                                 | 0.4                                | ±13                     | TSOP-6  |
| SRDA05   | 5                       | 7                      | 23                                  | 5                                  | ±8                      | SOIC-8  |
| ESD8708  | 3.3                     | 6                      | 7.5                                 | 0.18                               | ±30                     | UDFN-14 |
| SRDA3.3  | 3.3                     | 5                      | 25                                  | 4                                  | ±8                      | SOIC-8  |
| NSP8814  | 3                       | 3.2                    | 35                                  | 1.5                                | ±30                     | UDFN-8  |
| NSP8818  | 3                       | 3.2                    | 35                                  | 1.5                                | ±30                     | UDFN-10 |

\* On Pin 5.

## T1/E1, T3/E3, and xDSL Ports

*Surge protection for GR-1089, TIA-968-A, ITU-T and IEC 61000-4-5*

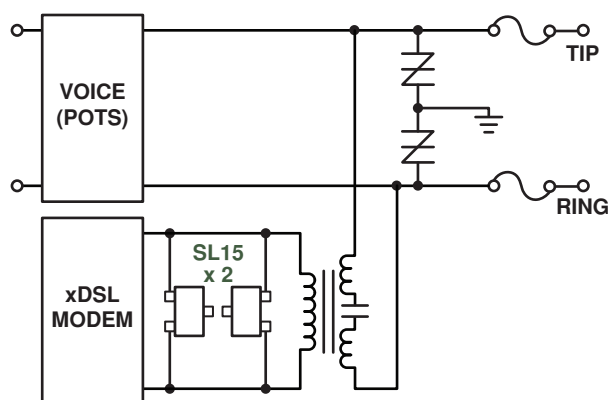
T1/E1 links (< 2 Mbps), T3/E3 links (< 43 Mbps) and xDSL lines (< 52 Mbps) are susceptible to ESD strikes, cable-discharge events and lightning-induced transients.

### Surge Protection Features

- Capable of all T1/E1 and xDSL voltages with a variety of capacitance values, for driver-side protection

### Benefits

- Surge protection devices provide high levels of tertiary protection without latching

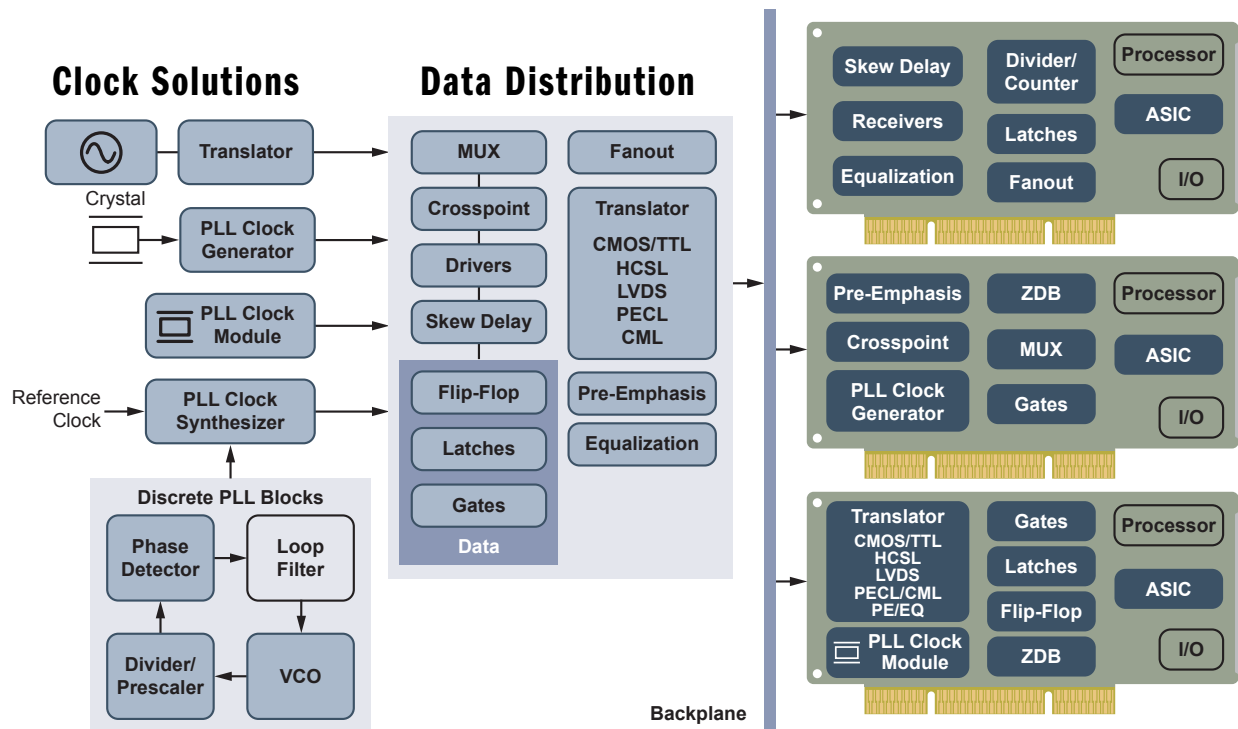


Typical xDSL + POTS Application

### Surge Protection Devices

| Device       | V <sub>DC</sub> Max (V) | Surge I <sub>pp</sub> , 8/20 μs (A) | Line-Line Capacitance (pF) | ESD Contact Rating (kV) | Package |
|--------------|-------------------------|-------------------------------------|----------------------------|-------------------------|---------|
| SRDA3.3      | 3.3                     | 25                                  | 4.0                        | ±8                      | SOIC-8  |
| SRDA05       | 5.0                     | 23                                  | 5.0                        | ±8                      | SOIC-8  |
| LC03-6       | 5.0                     | 100                                 | 8.0                        | ±30                     | SOIC-8  |
| SL05 to SL24 | 5 to 24                 | 5 to 17                             | 3.5                        | ±8                      | SOT-23  |

## Timing and Data Distribution Subsystem



ON Semiconductor provides a complete portfolio of timing and data management solutions for all aspects of the clock tree. System designers can optimize their clock circuits with industry leading clock distribution devices, demonstrating the industry's lowest jitter and skew. A broad product portfolio, with multiple output and interface options, allows system designers to build clock circuits that satisfy their specific application requirements. ON Semiconductor utilizes CMOS, Bipolar, and SiGe technology to leverage the best performance for any given application.

Expanding on more than 30 years of experience as the world's leader in high performance ECL-based clock distribution, ON Semiconductor has extended its expertise into ultra low jitter PLL clock synthesis and generation. PureEdge™ PLL devices utilize a fully differential architecture that enables performance that satisfies the timing requirements for the most demanding applications.

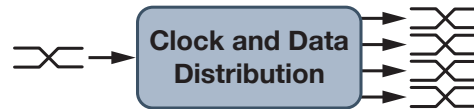
### Performance Capabilities

- Differential design for reduced noise
- ECL, PECL, CML, LVDS, M-LVDS, HSTL, HCSL, LVTTTL/LVCMOS outputs for flexible interfacing
- Maximum clock rates >10 GHz
- Maximum data rates >12 Gbps
- Typical additive phase RMS jitter, as low as 30 fs for buffers
- Typical phase RMS jitter of 200 fs for clock generators
- Integrated termination resistors for simplified circuit design
- Edge rates as low as 28 ps
- Low phase noise floor  $\leq -174$  dBc/Hz
- Low output-output skew

## Clock and Data Distribution

### Features

- Complete portfolio of fanout buffers, multiplexers, cross point switches
- Supporting frequencies from DC to 12 GHz/Gbps
- PCIe buffers with 1:2, 1:4, 1:6, 1:8, 1:10 and 1:21 fanouts
- PCIe Gen 1, Gen 2, Gen 3, Gen 4 Jitter Compliant
- Pre-Emphasis and Equalization blocks available
- Offer new direct X-tal interface capabilities
- Industry leading additive jitter as low as 30 fs typical
- Device noise floor as low as -174 dBc
- Industry leading output-to-output skew as low as 3 ps minimum
- Direct device interface eliminates external termination components and simplifies BOM

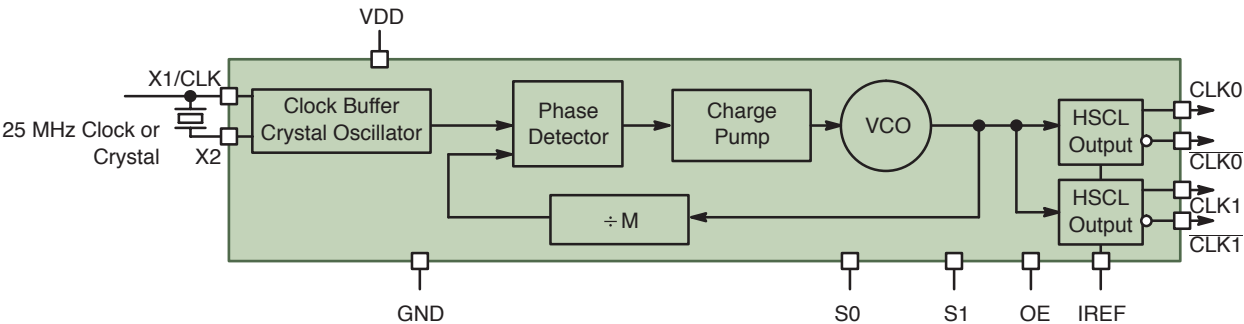


| Device                                          | Outputs per Channel  | Output Level          | Input Level |      |        |      |      |      |      |     | Vcc Typ (V)        | tSkew 0-0 (ps) | fMax Typ (GHz) | Package(s)                |
|-------------------------------------------------|----------------------|-----------------------|-------------|------|--------|------|------|------|------|-----|--------------------|----------------|----------------|---------------------------|
|                                                 |                      |                       | CML         | CMOS | LVPECL | HCSL | HSTL | LVDS | XTAL | TTL |                    |                |                |                           |
| NB3N106K/108K<br>NB3N111K/121K<br>NB3L202K/204K | 6, 8, 10, 21<br>2, 4 | HCSL                  |             | ✓    | ✓      | ✓    | ✓    | ✓    |      | ✓   | 3.3                | 100            | 0.4            | QFN-52, QFN-32, QFN-24    |
| NB3L208K                                        | 8                    | HCSL                  |             | ✓    | ✓      | ✓    | ✓    | ✓    |      | ✓   | 2.5, 3.3           | 100            | 0.35           | QFN-32                    |
| NB3M8T3910G                                     | 10                   | HCSL, CMOS, LVDS, ECL |             |      | ✓      | ✓    |      | ✓    |      |     | 2.5, 3.3           | 50             | 1.4            | QFN-48                    |
| NB6L11S                                         | 2                    | LVDS                  | ✓           | ✓    | ✓      |      | ✓    | ✓    |      | ✓   | 2.5                | 25             | 2              | QFN-16                    |
| NB6L14S/6N14S                                   | 4                    | LVDS                  | ✓           | ✓    | ✓      | ✓    | ✓    | ✓    |      | ✓   | 2.5/3.3            | 20             | 2              | QFN-16                    |
| NB3L8504S                                       | 4                    | LVDS                  |             |      | ✓      | ✓    | ✓    | ✓    |      |     | 2.5, 3.3           | 50             | 0.7            | TSSOP-16                  |
| NB3L8543S                                       | 4                    | LVDS                  | ✓           |      | ✓      | ✓    | ✓    | ✓    |      |     | 2.5, 3.3           | 40             | 0.65           | TSSOP-20                  |
| NB3V1102C/1103C<br>NB3V1104C/1106C              | 2, 3, 4, 6           | CMOS                  |             | ✓    |        |      |      |      |      |     | 1.8, 2.5, 3.3      | 50             | 0.25           | TSSOP-14, TSSOP-8         |
| NB3M8302C/8304C                                 | 2, 4                 | CMOS, LVTTTL          |             | ✓    |        |      |      |      |      | ✓   | 2.5, 3.3           | 45, 85         | 0.2            | SOIC-8                    |
| NB3U1548C                                       | 4                    | CMOS, LVTTTL          |             | ✓    |        |      |      |      |      | ✓   | 1.5, 1.8, 2.5, 3.3 | 250            | 0.16           | TSSOP-8, SOIC-8           |
| NB3N4666C                                       | 4                    | CMOS, LVTTTL          |             |      | ✓      | ✓    |      | ✓    |      |     | 3.3                | 250            | 0.2            | TSSOP-16                  |
| NB3F8L3005C                                     | 5                    | CMOS                  |             | ✓    | ✓      | ✓    | ✓    | ✓    | ✓    | ✓   | 1.5, 1.8, 2.5, 3.3 | 55             | 0.2            | QFN-24                    |
| NB3H83905C                                      | 6                    | CMOS, LVTTTL          |             | ✓    |        |      |      |      | ✓    | ✓   | 1.8, 2.5, 3.3      | 80             | 100            | TSSOP-16, SOIC-16, QFN-20 |
| NB3F8L3010C                                     | 10                   | CMOS                  |             | ✓    | ✓      | ✓    | ✓    | ✓    | ✓    | ✓   | 1.5, 1.8, 2.5, 3.3 | 55             | 0.2            | QFN-32                    |
| NB3L83948C                                      | 12                   | CMOS                  |             | ✓    | ✓      | ✓    | ✓    | ✓    |      | ✓   | 2.5, 3.3           | 100            | 0.35           | LQFP-32                   |
| NB3V8312C                                       | 12                   | CMOS                  |             | ✓    |        |      |      |      |      | ✓   | 1.8, 2.5, 3.3      | 150            | 0.25           | LQFP-32, QFN-32           |
| NB4N11M                                         | 2                    | CML                   | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 3.3                | 25             | 2.5            | TSSOP-8                   |
| NB6L11M                                         | 2                    | CML                   | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 2.5, 3.3           | 15             | 4              | QFN-16                    |
| NB7L72M                                         | 2                    | CML                   | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 2.5, 3.3           | 10             | 7              | QFN-16                    |
| NB7VQ572M                                       | 2                    | CML                   | ✓           |      | ✓      |      |      | ✓    |      |     | 1.8, 2.5, 3.3      | 15             | 6              | QFN-32                    |
| NB6HQ14M                                        | 4                    | CML                   | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 2.5                | 15             | 5              | QFN-16                    |
| NB7HQ14M                                        | 4                    | CML                   | ✓           |      | ✓      |      |      | ✓    |      |     | 2.5                | 15             | 7              | QFN-16                    |
| NB7V585M                                        | 6                    | CML                   | ✓           |      | ✓      |      |      | ✓    |      |     | 1.8, 2.5           | 30             | 7              | QFN-32                    |
| NB7V586M                                        | 6                    | CML                   | ✓           |      | ✓      |      |      | ✓    |      |     | 1.8                | 30             | 6              | QFN-32                    |
| NB7VQ1006M                                      | 6                    | CML                   | ✓           |      | ✓      |      |      | ✓    |      |     | 1.8, 2.5           | 25             | 7.5            | QFN-24                    |
| NB6L14/6L14M                                    | 4                    | ECL/CML               | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 2.5, 3.3           | 20             | 3              | QFN-16                    |
| NB7L14                                          | 4                    | ECL/CML               | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 2.5, 3.3           | 15             | 7/8            | QFN-16                    |
| NB7L1008/7L1008M                                | 8                    | ECL/CML               | ✓           |      | ✓      |      |      | ✓    |      |     | 2.5, 3.3           | 20/25          | 7/8            | QFN-32                    |
| NB6L56                                          | 1                    | ECL                   | ✓           |      | ✓      |      |      | ✓    |      |     | 2.5, 3.3           | 25             | 2.5            | QFN-32                    |
| NB6L611                                         | 2                    | ECL                   | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 2.5, 3.3           | 15             | 3              | QFN-16                    |
| NB7L572                                         | 2                    | ECL                   | ✓           | ✓    | ✓      |      |      | ✓    |      | ✓   | 2.5, 3.3           | 15             | 7              | QFN-32                    |
| NB3N853501E                                     | 4                    | ECL                   |             | ✓    |        |      |      |      |      | ✓   | 3.3                | 30             | 0.266          | TSSOP-20                  |
| NB3N853531E                                     | 4                    | ECL                   |             | ✓    |        |      |      |      | ✓    | ✓   | 3.3                | 30             | 0.266          | TSSOP-20                  |
| NB4L339                                         | 4                    | ECL                   | ✓           |      | ✓      |      |      | ✓    |      |     | 2.5, 3.3           | 60             | 0.7            | QFN-32                    |
| NB3L8533                                        | 4                    | ECL                   | ✓           |      | ✓      | ✓    | ✓    | ✓    |      |     | 2.5, 3.3           | 30             | 0.65           | TSSOP-20                  |
| NB3L853141                                      | 5                    | ECL                   |             | ✓    | ✓      | ✓    | ✓    | ✓    |      | ✓   | 2.5, 3.3           | 30             | 700            | TSSOP-20                  |

Clock Synthesizers for High Performance Computing

Features

- Uses 25 MHz fundamental mode parallel resonant crystal
- PCI-e Gen 1, 2, 3, and 4 jitter complaint HCSL differential outputs
- NB3N50134 features configurable spread spectrum outputs
- NB3N51044 features individual OE control signal for each output, PLL bypass mode and an Input multiplexer
- NB3N51054 features I<sup>2</sup>C interface for OE control and configurable spread spectrum outputs
- 3.3 V supply



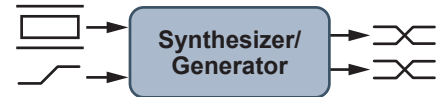
NB3N5573 Simplified Logic Diagram

| Device    | Number of Inputs | Input Type              | f <sub>in</sub> Typ (MHz) | Number of Outputs | Output Type | f <sub>out</sub> Typ (MHz) | Spread Spectrum Outputs | Package  |
|-----------|------------------|-------------------------|---------------------------|-------------------|-------------|----------------------------|-------------------------|----------|
| NB3N3002  | 1                | Crystal; LVCMOS; LVTTTL | 25                        | 1                 | HCSL        | 25; 100; 125; 200          | No                      | TSSOP-16 |
| NB3N5573  | 1                | Crystal; LVCMOS; LVTTTL | 25                        | 2                 | HCSL        | 25; 100; 125; 200          | No                      | TSSOP-16 |
| NB3N51032 | 1                | Crystal; LVCMOS; LVTTTL | 25                        | 2                 | HCSL        | 25; 100; 125; 200          | Yes                     | TSSOP-16 |
| NB3N51034 | 1                | Crystal; LVCMOS; LVTTTL | 25                        | 4                 | HCSL        | 100; 200                   | Yes                     | TSSOP-20 |
| NB3N51044 | 2                | Crystal; LVCMOS; LVTTTL | 25                        | 4                 | HCSL        | 100; 125                   | No                      | TSSOP-28 |
| NB3N51054 | 1                | Crystal; LVCMOS; LVTTTL | 25                        | 4                 | HCSL        | 100                        | Yes                     | TSSOP-24 |

## PLL Clock Synthesizers/Generators

### Features

- Based on phase-locked-loop techniques with zero PPM synthesis error
- Low jitter for high accuracy clock signals
- Available in industrial temperature range -40°C to +85°C
- Supports output interfaces: LVPECL, LVDS, HCSL, LVTTTL/LVCMOS
- Multiple PLLs and multiple output options

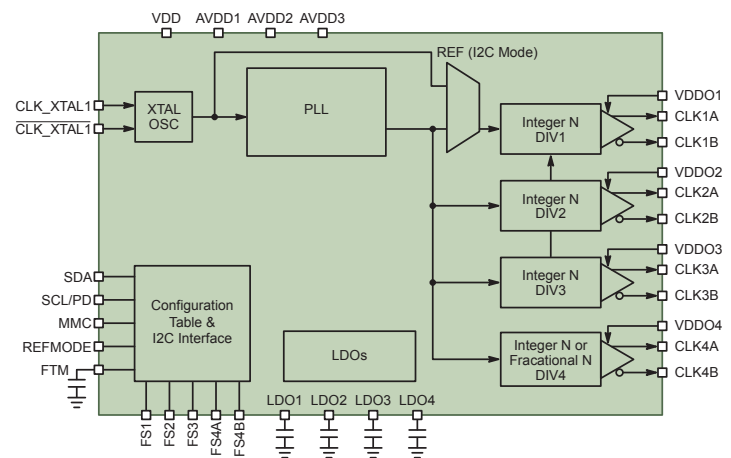


| Device      | Input (MHz) | Output (MHz) | Application               | Input Level |     |      |        |     | Output Level | Vcc Typ (V) | Package(s) |
|-------------|-------------|--------------|---------------------------|-------------|-----|------|--------|-----|--------------|-------------|------------|
|             |             |              |                           | XTAL        | CML | CMOS | LVPECL | TTL |              |             |            |
| NB3N3020    | 5 to 27     | 5 to 210     | Network GigE              | ✓           | ✓   | ✓    | ✓      |     | ECL, LVTTTL  | 3.3         | TSSOP-16   |
| NB3N502     | 5 to 27     | 14 to 120    | Networking, Consumer, STB | ✓           |     | ✓    |        |     | LVC MOS      | 3.3         | SOIC-8     |
| NB4N507A    | 10 to 27    | 50 to 200    | Networking, Consumer, STB | ✓           |     | ✓    |        |     | ECL          | 3.3, 5      | SOIC-16    |
| NB3N508S    | 27          | 216          | VCXO Set Top Box          | ✓           |     | ✓    |        |     | LVDS         | 3.3, 5      | TSSOP-16   |
| NB3N511     | 1 to 50     | 14 to 200    | Networking, Consumer, STB | ✓           |     |      |        |     | CMOS         | 3.3, 5      | SOIC-8     |
| NB3H5150    | 25          | 25 to 250    | Networking, Telecom       | ✓           | ✓   | ✓    | ✓      | ✓   | ECL, CMOS    | 3.3, 2.5    | QFN-32     |
| NB3H5150-01 | 25          | 25 to 250    | Networking, Telecom       | ✓           | ✓   | ✓    | ✓      | ✓   | ECL, CMOS    | 3.3, 2.5    | QFN-32     |

## Programmable Multi-Rate Clock Generators

### NB3H5150, NB3H5150-01 Features

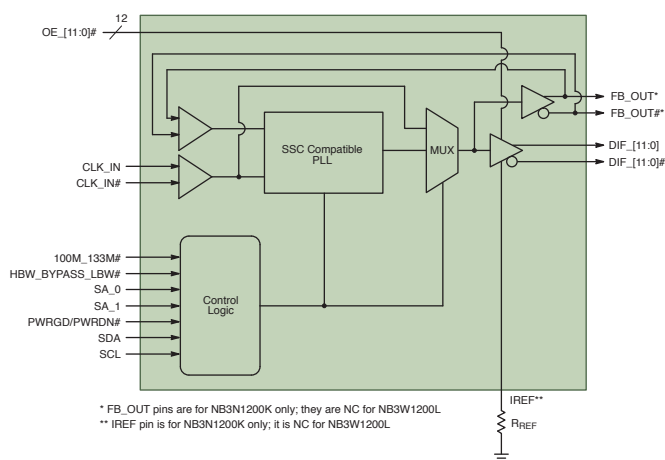
- Uses 25 MHz Crystal or reference input
- External Loop Filter is not required
- User programmable frequencies with four independent output pairs
- Each output pair can be configured either as two LVCMOS outputs (or) a differential LVPECL pair
- Supports 3.3 V or 2.5 V supply voltage operation
- Each output pair has an independent supply voltage rail (VDDOx); 3.3 V, 2.5 V, 1.8 V
- I2C enabled PLL Bypass Mode and Power Down Mode
- Free GUI software to configure device for different frequencies and output types using evaluation board
- Each device preconfigured with different default frequencies, that may be overridden using I2C/SMBus interface



## PCIe-Compliant Zero Delay Buffers

### Features

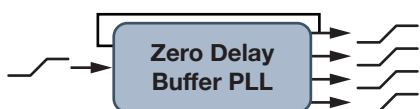
- Differential SRC clock support
- NB3N1900K, NB3N1200K: DB1900Z and DB1200Z compliant with 19 and 12 HCSL output pairs respectively
- NB3W1900L, NB3W1200L, NB3W800L: DB1900ZL, DB1200ZL, and DB800ZL compliant with 19, 12, and 8 low power NMOS push-pull output pairs respectively
- Optimized for 100 MHz and 133 MHz to meet PCIe Gen 2, Gen 3, Gen 4, and Intel QPI and UPI phase jitter specifications
- Spread spectrum compatible for low EMI
- Pseudo-external fixed-feedback for low input-to-output delay variation
- Individual OE control pin for each output
- SMBUS programmability for power down mode, PLL BW modes, PLL/Bypass mode & frequency selection



NB3N1200K/NB3W1200L Simplified Block Diagram

| Device    | Channels | Output                   | tJitter(Cy-Cy) Typ (ps) | tSkew(I-o) Max (ps) | tSkew(o-o) Max (ps) | Edge Rate Max (V/ns) | Package |
|-----------|----------|--------------------------|-------------------------|---------------------|---------------------|----------------------|---------|
| NB3W800L  | 8        | Low power NMOS push-pull | 34                      | ±100                | 50                  | 4                    | QFN-48  |
| NB3N1200K | 12       | HCSL                     | 50                      | ±100                | 50                  | 4                    | QFN-64  |
| NB3W1200L | 12       | Low power NMOS push-pull | 50                      | ±100                | 50                  | 4                    | QFN-64  |
| NB3N1900K | 19       | HCSL                     | 50                      | ±100                | 85                  | 4                    | QFN-72  |
| NB3W1900L | 19       | Low power NMOS push-pull | 50                      | ±100                | 85                  | 4                    | QFN-72  |

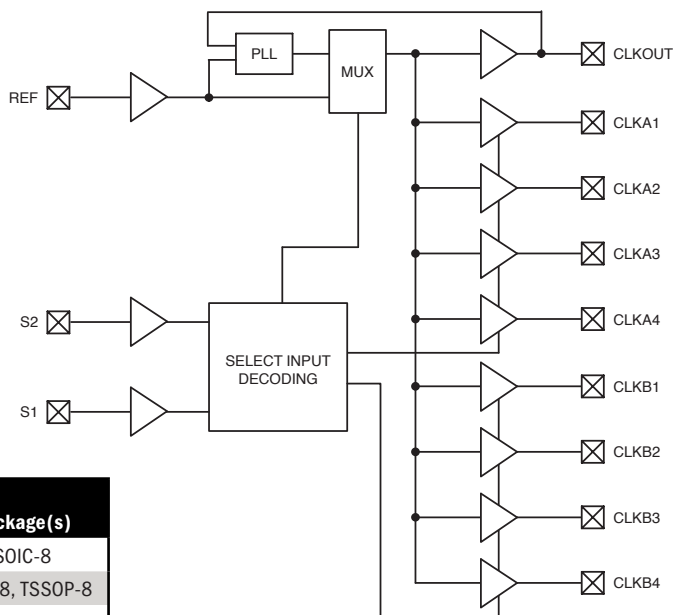
## General Purpose Zero Delay Buffers



### Features

- Industry standard functions and pin-outs
- Zero input-output propagation delay, adjustable by capacitive load
- Multiple configurations available for maximum flexibility
- Operating frequency to 133 MHz for CPU and PCI compatibility

| Device  | Input Level | Output Level | VCC Typ (V) | fMax Typ (MHz) | Channels | tSkew 0-0 Max (ps) | Package(s)        |
|---------|-------------|--------------|-------------|----------------|----------|--------------------|-------------------|
| NB2304A | CMOS        | CMOS         | 3.3         | 133.3          | 4        | 200                | SOIC-8            |
| NB2305A | CMOS        | CMOS         | 3.3         | 133.3          | 5        | 250                | SOIC-8, TSSOP-8   |
| NB2309A | CMOS        | CMOS         | 3.3         | 133.3          | 9        | 250                | SOIC-16, TSSOP-16 |

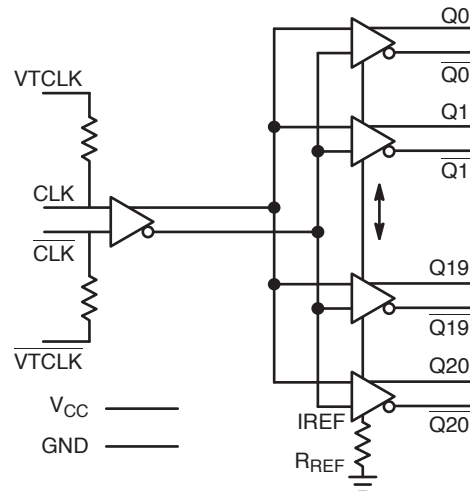


NB2309A Functional Diagram

## Fanout Buffers for High Performance Computing

### Features

- DC up to 400 MHz
- Accepts LVPECL, LVDS, HCSL, and single-ended inputs
- Typical input clock frequencies: 100, 133, 156.25, 166, 322.26, or 400 MHz
- Typical propagation delay: 800 ps
- HCSL differential outputs
- Integrated 50  $\Omega$  input termination resistors
- IREF pin enables setting of output drive
- Additive phase jitter 0.1 ps typical @ 100 MHz; PCI-e Gen 4 jitter complaint
- Additive phase jitter 80 fs maximum @ 156.25 MHz with NB3L208K, NB3L204K, NB3L202K; DB800H, DB400H, DB200H compliant



NB3N121K Logic Diagram

| Device      | Ratio  | Additive $t_{\text{jitter(RMS) Typ}}$ (ps) | $t_{\text{skew(o-o) Max}}$ (ps) | $t_{\text{pd Typ}}$ (ns) | $t_{\text{r}} \& t_{\text{f Max}}$ (ps) | $f_{\text{maxClock Typ}}$ (MHz) | Package |
|-------------|--------|--------------------------------------------|---------------------------------|--------------------------|-----------------------------------------|---------------------------------|---------|
| NB3L202K    | 1:2    | 0.046                                      | 30                              | 1                        | 125                                     | 350                             | QFN-16  |
| NB3L204K    | 1:4    | 0.046                                      | 30                              | 1                        | 125                                     | 350                             | QFN-24  |
| NB3N106K    | 1:6    | 0.1                                        | 100                             | 0.8                      | 400                                     | 400                             | QFN-24  |
| NB3L208K    | 1:8    | 0.046                                      | 30                              | 1                        | 125                                     | 350                             | QFN-32  |
| NB3N108K    | 1:8    | 0.1                                        | 100                             | 0.8                      | 400                                     | 400                             | QFN-32  |
| NB3N111K    | 1:10   | 0.1                                        | 100                             | 0.8                      | 400                                     | 400                             | QFN-32  |
| NB4N111K    | 1:10   | <1                                         | 100                             | 0.8                      | 700                                     | 400                             | QFN-32  |
| NB3N121K    | 1:21   | 0.1                                        | 100                             | 0.8                      | 700                                     | 400                             | QFN-52  |
| NB4N121K    | 1:21   | <1                                         | 50                              | 0.8                      | 700                                     | 200                             | QFN-52  |
| NB3M8T3910G | 3:1:10 | 0.05                                       | 50                              | 1                        | 300                                     | 1400                            | QFN-48  |

## EEPROMs for Configuration and Calibration

### Features

- Broad density range: 1 kb to 2 Mb
- Wide operating V<sub>CC</sub> range: 1.7 V to 5.5 V
- High endurance: 1 million program/erase cycles
- Wide temperature range: industrial and extended

### EEPROMs

| Data Transmission Standard | Density | Organization*      | V <sub>CC</sub> Min (V) | V <sub>CC</sub> Max (V) | f <sub>CLK</sub> Max (MHz) | Package(s)                                               |
|----------------------------|---------|--------------------|-------------------------|-------------------------|----------------------------|----------------------------------------------------------|
| I <sup>2</sup> C           | 1 Mb    | 128k x 8           | 1.7, 1.8                | 5.5                     | 0.4, 1                     | US8, SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5 |
|                            | 512 kb  | 64k x 8            |                         |                         |                            |                                                          |
|                            | 256 kb  | 32k x 8            |                         |                         |                            |                                                          |
|                            | 128 kb  | 16k x 8            |                         |                         |                            |                                                          |
|                            | 64 kb   | 8k x 8             |                         |                         |                            |                                                          |
|                            | 32 kb   | 4k x 8             |                         |                         |                            |                                                          |
|                            | 16 kb   | 2k x 8             |                         |                         |                            |                                                          |
|                            | 8 kb    | 1k x 8             |                         |                         |                            |                                                          |
|                            | 4 kb    | 512 x 8            |                         |                         |                            |                                                          |
|                            | 2 kb    | 256 x 8            |                         |                         |                            |                                                          |
| SPI                        | 2 Mb    | 256k x 8           | 1.7, 1.8                | 5.5                     | 10, 20                     | SOIC-8, TSSOP-8, UDFN-8                                  |
|                            | 1 Mb    | 128k x 8           |                         |                         |                            |                                                          |
|                            | 512 kb  | 64k x 8            |                         |                         |                            |                                                          |
|                            | 256 kb  | 32k x 8            |                         |                         |                            |                                                          |
|                            | 128 kb  | 16k x 8            |                         |                         |                            |                                                          |
|                            | 64 kb   | 8k x 8             |                         |                         |                            |                                                          |
|                            | 32 kb   | 4k x 8             |                         |                         |                            |                                                          |
|                            | 16 kb   | 2k x 8             |                         |                         |                            |                                                          |
|                            | 8 kb    | 1k x 8             |                         |                         |                            |                                                          |
|                            | 4 kb    | 512 x 8            |                         |                         |                            |                                                          |
|                            | 2 kb    | 256 x 8            |                         |                         |                            |                                                          |
|                            | 1 kb    | 128 x 8            |                         |                         |                            |                                                          |
|                            |         |                    |                         |                         |                            |                                                          |
| Microwire                  | 16 kb   | 2k x 8 / 1k x 16   | 1.65, 1.8               | 5.5                     | 2, 3, 4                    | SOIC-8, TSSOP-8, UDFN-8                                  |
|                            | 16 kb   | 2k x 8 / 1k x 16   |                         |                         |                            |                                                          |
|                            | 8 kb    | 1k x 8 / 512 x 16  |                         |                         |                            |                                                          |
|                            | 8 kb    | 1k x 8 / 512 x 16  |                         |                         |                            |                                                          |
|                            | 4 kb    | 512 x 8 / 256 x 16 |                         |                         |                            |                                                          |
|                            | 2 kb    | 256 x 8 / 128 x 16 |                         |                         |                            |                                                          |
|                            | 1 kb    | 128 x 8 / 64 x 16  |                         |                         |                            |                                                          |
|                            | 1 kb    | 128 x 8 / 64 x 16  |                         |                         |                            |                                                          |

\* Organization for Microwire devices is selectable.

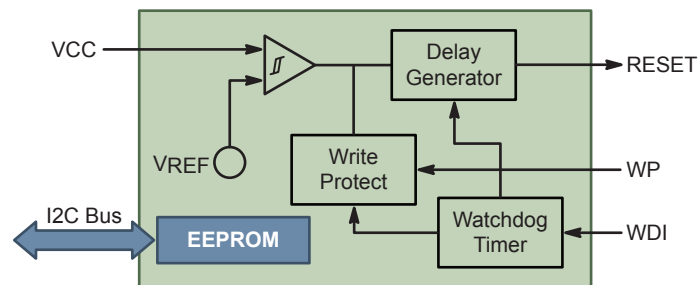
## Voltage Supervisors with I2C Serial EEPROM and Watchdog Timer

### Supervisory Features

- Precision power supply voltage monitor
- Available voltage thresholds: 4.50 V, 4.25 V, 3.0 V, 2.85 V, 2.55 V
- Active High or Low Reset, Manual Reset
- Watchdog Timer (N84C161, N84C163)

### 16 kb Serial EEPROM Features

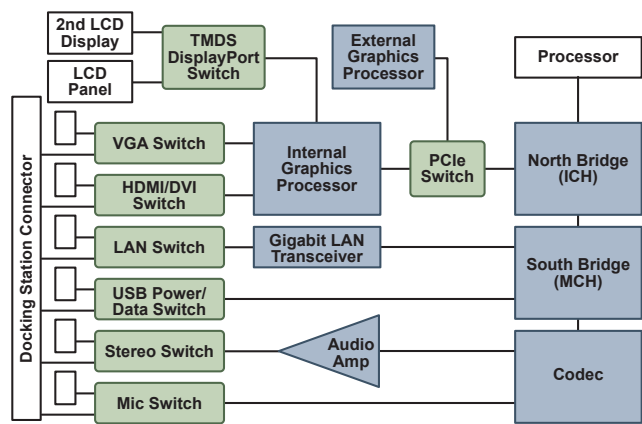
- Supply Voltage:  $V_{CC} = 2.7$  to  $6.0$  V
- 400 KHz, 100 KHz I2C Serial Protocol
- Endurance: 1 million Write cycles
- Retention: 100 years
- Hardware Write Protect



| Device  | Watchdog Timer | Manual Reset | Write Protect | Package |
|---------|----------------|--------------|---------------|---------|
| N84C161 | SDA            | ✓            | ✓             | SOIC-8  |
| N84C162 | —              | ✓            | ✓             | SOIC-8  |
| N84C163 | —              | ✓            | ✓             | SOIC-8  |

High Speed Data Switching

ON Semiconductor offers a range of switching devices for high speed interface in servers, desktop computing, notebook and netbook computers. Applications include PCI Express, DisplayPort, Gigabit Ethernet and USB 2.0.



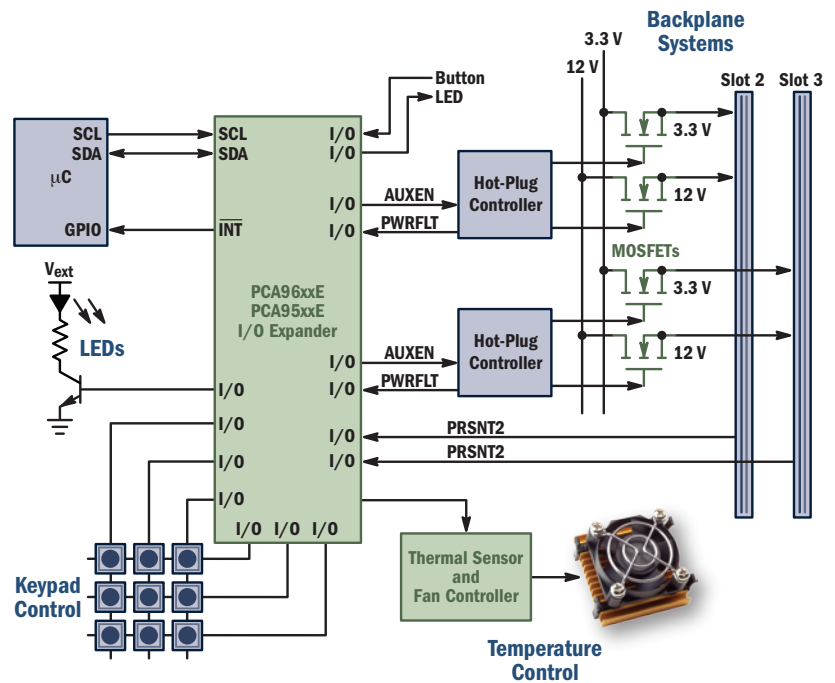
| Device   | Interface              | Data Rate | No Channels | Quiescent Current | Package(s)                    |
|----------|------------------------|-----------|-------------|-------------------|-------------------------------|
| FUSB340  | USB 3.1 Superspeed     | 10 Gb/s   | 2           | 12 $\mu$ A        | X2QFN-18                      |
| NCN1188  | USB 2.0 / MHL          | 2.25 Gb/s | 2           | 21 $\mu$ A        | UQFN-12                       |
| FSA4476  | Audio                  | 950 MHz   | 2           | 25 $\mu$ A        | WLCSP-25                      |
| FSA1153  | USB 2.0 / Audio / UART | 650 MHz   | 2           | 21 $\mu$ A        | WLCSP-12                      |
| FSA4480  | Audio                  | 600 MHz   | 2           | 60 $\mu$ A        | WLCSP-25                      |
| NS5S1153 | USB 2.0                | 480 Mb/s  | 2           | 21 $\mu$ A        | UQFN-10                       |
| NLAS7242 | USB 2.0                | 480 Mb/s  | 2           | 1 $\mu$ A         | UQFN-10                       |
| NLAS4684 | Audio                  | 9.5 MHz   | 2           | 180 nA            | Flip-Chip-10, DFN-10, Micro10 |



## Cascadable I/O Expanders

### Features

- I2C and SMBus interfaces
- 1 MHz SCL clock frequency
- 30 mA SDA sink capability



| Device   | I/O | Cascadable                      | Vcc Min (V) | Vcc Max (V) | Interrupt Output | I/O Pullups | Package                    |
|----------|-----|---------------------------------|-------------|-------------|------------------|-------------|----------------------------|
| PCA9535E | 16  | 64 Programmable Slave Addresses | 1.65        | 5.5         | ✓                |             | QFN-24, SOIC-24, TSSOP-24  |
| PCA9655E | 16  | 64 Programmable Slave Addresses | 1.65        | 5.5         | ✓                |             | QFN-24, SOIC-24, TSSOP-24  |
| PCA9654E | 8   | 8 Slave ID Addresses            | 1.65        | 5.5         | ✓                | ✓           | SOIC-16, WQFN-16, TSSOP-16 |

## Standard Logic and MiniGate™

### Available logic functions

- Logic Gates, Buffers, Flip-Flops
- Arithmetic Functions
- Bus Transceivers
- Latches and Registers
- Multiplexers and Analog Switches
- Logic Level Translators

| Standard Logic Family | Device Prefix   | V <sub>CC</sub> |         | t <sub>pd</sub> (nS)          | I <sub>OUT</sub> (mA)                                                               | Input Logic Level | Packages         |
|-----------------------|-----------------|-----------------|---------|-------------------------------|-------------------------------------------------------------------------------------|-------------------|------------------|
|                       |                 | Min (V)         | Max (V) |                               |                                                                                     |                   |                  |
| Metal Gate            | MC14            | 3               | 18      | 50 @ V <sub>CC</sub> = 15 V   | ±4.2 @ V <sub>CC</sub> = 15 V                                                       | CMOS              | SOIC, TSSOP, QFN |
| AC                    | MC74AC/74AC     | 2               | 6       | 6 @ V <sub>CC</sub> = 5 V     | ±24 @ V <sub>CC</sub> = 4.5 V                                                       | CMOS              |                  |
| ACT                   | MC74ACT/74ACT   | 4.5             | 5.5     | 5.5 @ V <sub>CC</sub> = 5 V   | ±24 @ V <sub>CC</sub> = 4.5 V                                                       | TTL               |                  |
| HC                    | MC74HC/MM74HC   | 2               | 6       | 13 @ V <sub>CC</sub> = 6 V    | ±5.2 @ V <sub>CC</sub> = 6 V (Std)<br>±7.8 @ V <sub>CC</sub> = 6 V (Bus Driver)     | CMOS              |                  |
| HCT                   | MC74HCT/MM74HCT | 4.5             | 5.5     | 15 @ V <sub>CC</sub> = 5 V    | ±4.0 @ V <sub>CC</sub> = 4.5 V (Std)<br>±6.0 @ V <sub>CC</sub> = 4.5 V (Bus Driver) | TTL               |                  |
| LCX                   | MC74LCX/74LCX   | 2.3             | 3.6     | 5.5 @ V <sub>CC</sub> = 3 V   | ±24 @ V <sub>CC</sub> = 3 V                                                         | LVTTL             |                  |
| LVX                   | MC74LVX/74LVX   | 2               | 3.6     | 6.6 @ V <sub>CC</sub> = 3 V   | ±4 @ V <sub>CC</sub> = 3 V                                                          | LVTTL             |                  |
| VCX                   | MC74VCX/74VCX   | 1.65            | 3.6     | 3.5 @ V <sub>CC</sub> = 3 V   | ±24 @ V <sub>CC</sub> = 3 V                                                         | LVTTL             |                  |
| VHC                   | MC74VHC/74VHC   | 2               | 5.5     | 5.2 @ V <sub>CC</sub> = 4.5 V | ±8 @ V <sub>CC</sub> = 4.5 V                                                        | CMOS              |                  |
| VHCT                  | MC74VHCT/74VHCT | 4.5             | 5.5     | 3.6 @ V <sub>CC</sub> = 4.5 V | ±8 @ V <sub>CC</sub> = 4.5 V                                                        | TTL               |                  |
| LVT                   | 74LVT           | 2.7             | 3.6     | 3.6 @ V <sub>CC</sub> = 3.0 V | -32/64 @ V <sub>CC</sub> = 3.0 V                                                    | TTL               |                  |

| MiniGate Family | Number of Gates | Device Prefix             | V <sub>CC</sub> |         | t <sub>PD</sub> (nS)          | I <sub>OUT</sub> (mA)        | Input Logic Level | Packages                                                        |
|-----------------|-----------------|---------------------------|-----------------|---------|-------------------------------|------------------------------|-------------------|-----------------------------------------------------------------|
|                 |                 |                           | Min (V)         | Max (V) |                               |                              |                   |                                                                 |
| HC              | 1               | MC74HC1G/NC7S             | 2               | 6       | 6.5 @ V <sub>CC</sub> = 5 V   | ±5.2 @ V <sub>CC</sub> = 6 V | CMOS              | TSOP, SC-88, SC-74, SOT-553, SOT-953, US8, UDFN, UQFN, MicroPak |
| HCT             | 1               | NC7ST                     | 4.5             | 5.5     | 6.5 @ V <sub>CC</sub> = 5 V   | ±2 @ V <sub>CC</sub> = 6 V   | TTL               |                                                                 |
| VHC             | 1               | MC74VHC1G/NLU1G/NL17SH    | 1.65            | 5.5     | 3.8 @ V <sub>CC</sub> = 4.5 V | ±8 @ V <sub>CC</sub> = 4.5 V | CMOS              |                                                                 |
|                 | 2               | NLU2G                     |                 |         |                               |                              |                   |                                                                 |
|                 | 3               | NLU3G                     |                 |         |                               |                              |                   |                                                                 |
| VHCT            | 1               | MC74VHCT1G/NLU1GT/NL17SHT | 4.5             | 5.5     | 3.6 @ V <sub>CC</sub> = 4.5 V | ±8 @ V <sub>CC</sub> = 4.5 V | TTL               |                                                                 |
|                 | 2               | NLU2GT                    |                 |         |                               |                              |                   |                                                                 |
|                 | 3               | NLU3GT                    |                 |         |                               |                              |                   |                                                                 |
| LCX             | 1               | NL17SZ/NC7SZ/NLX1G        | 1.65            | 5.5     | 2.4 @ V <sub>CC</sub> = 3 V   | ±24 @ V <sub>CC</sub> = 3 V  | CMOS              |                                                                 |
|                 | 2               | NC27WZ/NC7WZ/NLX2G        |                 |         |                               |                              |                   |                                                                 |
|                 | 3               | NL37WZ/NC7NZ/NLX3G        |                 |         |                               |                              |                   |                                                                 |
| VCX             | 1               | NL17SV/NC7SV              | 0.9             | 3.6     | 1.0 @ V <sub>CC</sub> = 3 V   | ±24 @ V <sub>CC</sub> = 3 V  | LVTTL             |                                                                 |
| SG              | 1               | NL17SGxx                  | 0.9             | 3.6     | 2.2 @ V <sub>CC</sub> = 3 V   | ±8 @ V <sub>CC</sub> = 3 V   | LVTTL             |                                                                 |
| SP              | 1               | NC7SP                     | 0.9             | 3.6     | 3.0 @ V <sub>CC</sub> = 3 V   | ±2.6 @ V <sub>CC</sub> = 3 V | LVTTL             |                                                                 |
|                 | 2               | NC7WP                     |                 |         |                               |                              |                   |                                                                 |
|                 | 3               | NC7NP                     |                 |         |                               |                              |                   |                                                                 |
| AUP             | 1               | 74AUP1G                   | 0.8             | 3.6     | 2.9 @ V <sub>CC</sub> = 3 V   | ±4 @ V <sub>CC</sub> = 3 V   | Schmitt           |                                                                 |
|                 | 1               | 74AUP1T                   | 2.3             | 3.6     | 3.3 @ V <sub>CC</sub> = 3 V   | ±4 @ V <sub>CC</sub> = 3 V   | Schmitt           |                                                                 |

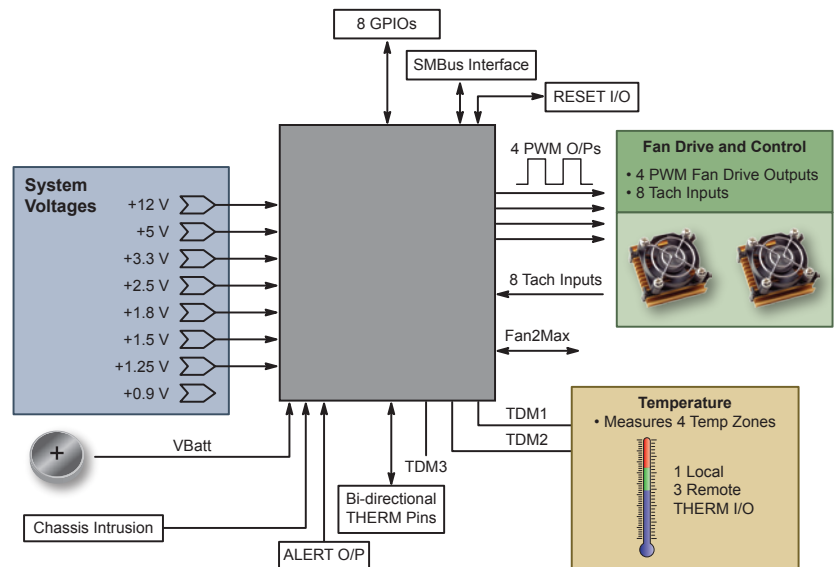
# Thermal Management

## Extensive Portfolio

Remote Sensors provide temperature information of a transistor located at a different position on the board; also includes local sensor capability

Fan Controllers integrate the temperature sensor with a fan controller/monitor

System Monitors integrate combinations of remote and/or local temperature sensing, voltage monitoring, fan control & monitoring, reset control, and GPIO functions



|                 | Device  | Supply Range (V) | Temperature Range (°C) | Local Accuracy (°C) | Interface | Number of Addresses | SRC (Ω) | Remote Accuracy | Remote Channels | Fan Channels | TACH Channels | Voltage Monitoring Channels | GPIOs | Package         |
|-----------------|---------|------------------|------------------------|---------------------|-----------|---------------------|---------|-----------------|-----------------|--------------|---------------|-----------------------------|-------|-----------------|
| System Monitors | ADM1026 | 3 - 5.5          | -40 to +120            | ±3                  | I2C/SMBUS | 3                   | —       | ±3              | 2               | 8            | 8             | 19                          | 17    | LQFP-48         |
|                 | ADT7462 | 3 - 5.5          | -40 to +125            | ±2.25               | I2C/SMBUS | 2                   | 2 k     | ±2.25           | 3               | 4            | 8             | 13                          | 8     | LFCSP-32        |
|                 | NCT80   | 2.8 - 5.75       | -40 to +125            | ±2                  | I2C/SMBUS | 8                   | —       | —               | —               | —            | 2             | 7                           | 1     | TSSOP-24        |
|                 | ADT7476 | 3 - 3.6          | -40 to +120            | ±1.5                | I2C/SMBUS | 3                   | —       | ±1.5            | 2               | 3            | 4             | 5                           | —     | QSOP-24         |
| Fan Controllers | ADT7473 | 3 - 3.6          | -40 to +120            | ±1.5                | I2C/SMBUS | 3                   | 3 k     | ±1.5            | 2               | 3            | 4             |                             |       | QSOP-16         |
|                 | ADT7475 | 3 - 3.6          | -40 to +120            | ±1.5                | I2C/SMBUS | 1                   | —       | ±1.5            | 2               | 3            | 4             |                             |       | QSOP-16         |
| Remote Sensors  | NCT72   | 2.8 - 3.6        | -40 to +125            | ±1                  | I2C/SMBUS | 2                   | 1.5 k   | ±1              | 1               |              |               |                             |       | DFN-8, WDFN-8   |
|                 | NCT218  | 1.4 - 2.75       | -40 to +125            | ±1.75               | I2C/SMBUS | 2                   | 150     | ±1              | 1               |              |               |                             |       | WDFN-8, WLCSP-8 |
|                 | ADM1032 | 3 - 5.5          | -40 to +125            | ±3                  | I2C/SMBUS | 2                   | —       | ±1              | 1               |              |               |                             |       | SOIC-8, MSOP-8  |
|                 | ADT7461 | 3 - 5.5          | -40 to +125            | ±3                  | I2C/SMBUS | 2                   | 3 k     | ±1              | 1               |              |               |                             |       | SOIC-8, MSOP-8  |
|                 | ADT7481 | 3 - 3.6          | -40 to +125            | ±1                  | I2C/SMBUS | 2                   | —       | ±1              | 2               |              |               |                             |       | MSOP-10         |
|                 | ADT7483 | 3 - 3.6          | -40 to +125            | ±1                  | I2C/SMBUS | 9                   | —       | ±1              | 2               |              |               |                             |       | QSOP-16         |

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