



# Computing Solutions



*Comprehensive power management, switching, timing, and protection solutions for computing platforms from ON Semiconductor.*



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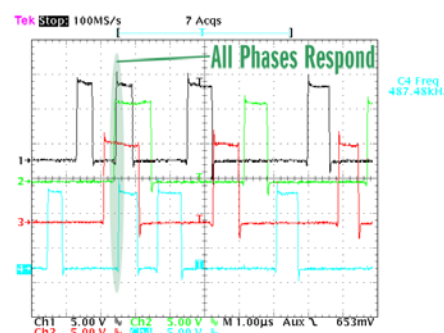
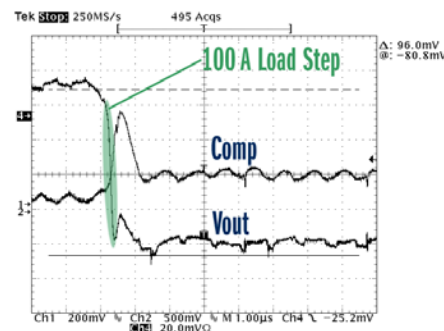


## Dual-Edge & Flex-Mode Modulation Vcore Controllers for VR11.0 to VR12.6+ Designs

Multi-phase buck controllers from ON Semiconductor combine differential voltage and current sensing, and adaptive voltage positioning to power the latest generation of microprocessors. Dual-edge and flex mode PWM, combined with inductor current sensing, reduces system cost by providing the fastest initial response to a transient, thereby requiring fewer bulk and ceramic output capacitors to satisfy transient load-line requirements. An integrated, high performance operational error amplifier enables easy compensation of the system. The proprietary Dynamic Reference Injection method makes the error amplifier compensation virtually independent of the system response to VID changes, eliminating tradeoffs between overshoot and dynamic VID performance.

### Features

- Meet VR11.0, 11.1, 12.0, 12.5, 12.6, 12.6+ specifications
- Pin programmable phase count configuration
- Current mode dual edge modulation for fast initial response to transient loading
- Phase-to-phase dynamic current balancing
- Dual high performance operational error amplifier
- Temperature compensated inductor current sensing
- Power saving phase shedding
- $V_{IN}$  feed forward ramp slope
- Programmable switching frequency range
- Startup into pre-charged loads while avoiding false OVP
- Over voltage, under voltage, and over current protection (OVP & UVP & OCP)



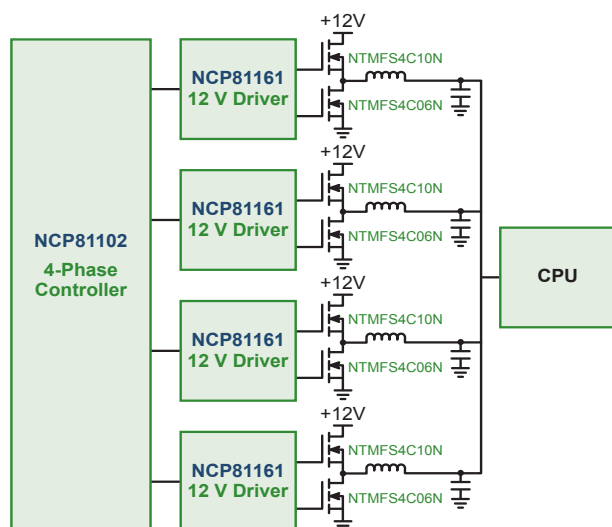
| Device   | VR Spec | Controller Architecture | CPU Phases      | GPU Phases | Integrated Drivers | Interface | SM-Bus | Package  |
|----------|---------|-------------------------|-----------------|------------|--------------------|-----------|--------|----------|
| NCP81101 | VR12.6+ | RPM                     | 1               | —          | 1 x 5 V            | SVID      | —      | QFN-28   |
| NCP81105 | VR12.6  | Dual Edge               | 2/3             | —          | —                  | SVID      | —      | QFN-36   |
| NCP81108 | VR12.6  | Dual Edge               | 2/3             | —          | 2                  | SVID      | —      | QFN-36   |
| NCP81109 | VR12.6  | RPM                     | 1               | —          | 1 + FETs           | SVID      | —      | QFN-48   |
| NCP81110 | VR12.6  | RPM                     | 1               | —          | 1 + FETs           | SVID      | —      | QFN-48   |
| NCP81118 | VR12.6  | Dual Edge               | 2/3             | —          | 2 x 5 V            | SVID      | —      | QFN-36   |
| NCP81102 | VR12.5  | Dual Edge               | 2/3/4           | —          | —                  | SVID      | —      | QFN-32   |
| NCP81103 | VR12.5  | Dual Edge               | 2/3             | —          | 2 x 5 V            | SVID      | —      | QFN-36   |
| NCP81106 | VR12.5  | Dual Edge               | 2/3             | —          | 2 x 12 V           | SVID      | —      | QFN-40   |
| NCP81116 | VR12.5  | Dual Edge               | 2/3             | —          | 2 x 12 V           | SVID      | Y      | QFN-36   |
| NCP81119 | VR12.5  | Dual Edge               | 2/3/4           | —          | —                  | SVID      | —      | QFN-32   |
| NCP6121  | VR12    | Flex Mode + Dual Edge   | 2/3             | 1          | —                  | SVID      | —      | QFN-56   |
| NCP6151  | VR12    | Flex Mode + Dual Edge   | 3/4             | 1          | —                  | SVID      | —      | QFN-56   |
| NCP6153  | VR11.1  | Dual Edge               | 2/3/4           | —          | —                  | PVID      | —      | QFN-40   |
| NCP6133  | VR11.1  | Flex Mode               | 2/3/4           | —          | —                  | PVID      | —      | LFCSP-40 |
| NCP4206  | VR11.1  | Dual Edge               | 1/2/3/4/5/6     | —          | —                  | PVID      | Y      | QFN-48   |
| NCP4208  | VR11.1  | Dual Edge               | 1/2/3/4/5/6/7/8 | —          | —                  | PVID      | Y      | QFN-48   |
| NCP81022 | SV12    | Dual Edge               | 4               | 1          | —                  | SVI2      | —      | QFN-52   |
| NCP81128 | SV12    | Dual Edge               | 2               | 2          | 2 x 5 V            | SVI2      | —      | QFN-52   |

Please contact ON Semiconductor for product datasheets.

## Desktop Solutions

### NCP81102 1/2/3/4-phase controller

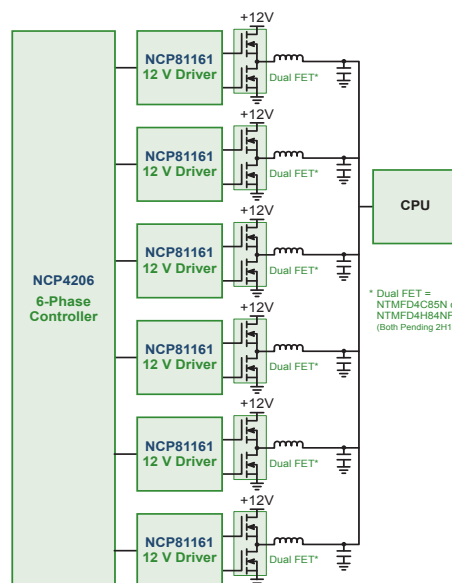
- Dual edge modulation for fast transient response
- Constant on-time for light load efficiency
- Supports all MLCC output capacitor solutions
- VR12.5 compliant



## Server Solutions

### NCP4206 1/2/3/4/5/6-phase controller

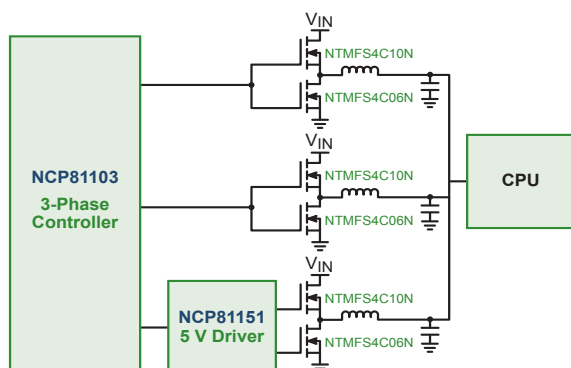
- Highly efficient, multiphase, synchronous buck switching regulator controller
- Supports PSI, to reduce the number of operating phases at light loads
- SMBus interface enables digital programming of key system parameters to optimize system performance and provide feedback
- NCP4206 has built in shunt regulator, enabling it to be powered from +12 V system supply through series resistor



## Notebook Solutions

### NCP81103/8 1/2/3-phase controller with drivers

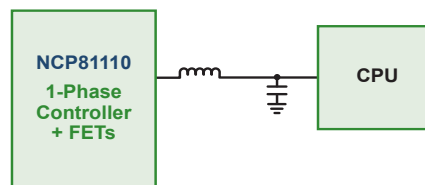
- High performance notebook solutions
- Dual edge modulation for fast transient response
- Features 2 integrated 5 V drivers
- VR12.5 (NCP81103) & VR12.6 (NCP81108) compliant



## Integrated Ultrabook/Notebook Solution

### NCP81110 1-phase converter

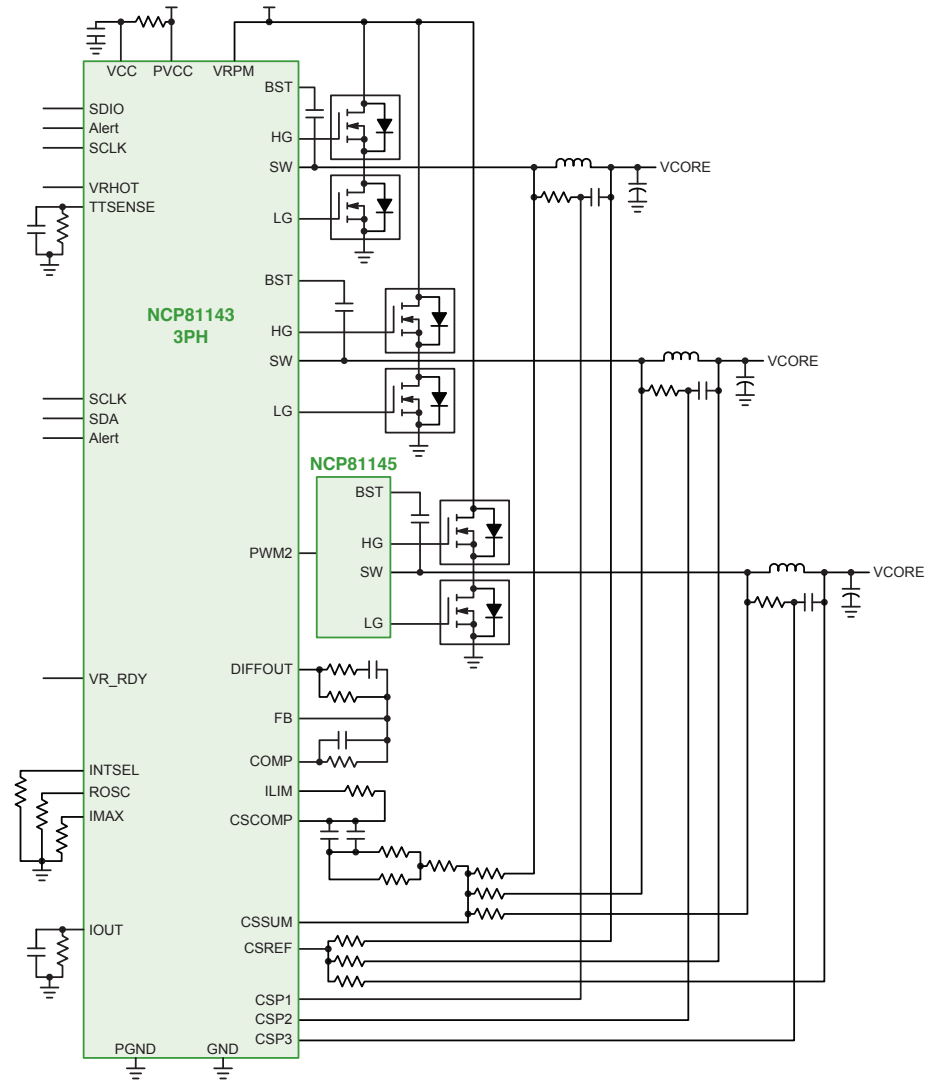
- Integrated solution with drivers and 14 A TDC MOSFETs
- Smallest solution footprint for compact design
- Higher efficiency for longer battery life
- VR12.6 compliant



## VR12.5/6 Multiphase Controllers for Embedded Applications

### Features

- Dual-edge pulse width modulation
- Fastest initial response to dynamic load events
- True differential voltage sensing
- Differential inductor DCR current sensing
- Input voltage feed forward
- Adaptive voltage positioning
- Pin-programmable controller configuration
- Integrated OVP, UVP, OCP
- Operating temperature range:  
-40°C to +125°C



| Device    | Description                | Driver / MOSFETs          | Package |
|-----------|----------------------------|---------------------------|---------|
| NCP81140  | 4-Phase Controller         | —                         | QFN-32  |
| NCP81141  | 1-Phase VR12.6 Controller  | Integrated 5 V Driver     | QFN-28  |
| NCP81142  | 4-Phase VR12.5 Controller  | —                         | QFN-32  |
| NCP81143  | 3-Phase VR12.5 Controller  | 2x Integrated 5 V Drivers | QFN-36  |
| NCP81145  | 5 V Driver                 | —                         | DFN-8   |
| NCP81146  | 12 V Driver                | —                         | DFN-8   |
| NCP81147  | 1-Phase Buck 0.8 V / 3.3 V | —                         | QFN-16  |
| NCP81148  | Dual Buck with LDOs        | —                         | QFN-28  |
| NCP81149* | 1-Phase VR12.6 Controller  | Integrated MOSFETs        | —       |

\* Pending 2Q15.

The schematic diagram illustrates the LT8602 buck converter circuit. The IC is configured as a buck converter with the following components and connections:

- Power Supply:**  $V_{CC} = 4.5\text{ V} - 13.2\text{ V}$ ,  $V_{BST} = 4.5\text{ V} - 15\text{ V}$ ,  $V_{IN} = 2.5\text{ V} - 13.2\text{ V}$ .
- IC Pins and Connections:**
  - VCC:** Connected to the input supply.
  - PGOOD:** Connected to the input supply.
  - BOOT:** Connected to the bootstrap capacitor (0.1μF).
  - UG:** Connected to the gate of the NTD4809 MOSFET.
  - LX:** Connected to the inductor (1μH).
  - LG:** Connected to the gate of the NTD4806 MOSFET.
  - FB:** Connected to the feedback network (R1, R2, C1, C2, R3, C3).
  - GND:** Connected to the common ground.
  - VOS:** Connected to the output supply.
- Components:**
  - Capacitors:** 1μF, 0.0015μF (C1), 17.08kΩ (R2), 0.007μF (C2), 0.014μF (C3), 74.2Ω (R3), 4.12kΩ (R1), 3.878kΩ (R4), 1500μF, 3x22μF, 2x0.22μF, 2x1800μF.
  - Resistors:** 1.02kΩ (R9), 1.02kΩ (R10), 2.2Ω.
  - Inductor:** 1μH.
  - MOSFETs:** NTD4809, NTD4806.
- Output:** VOUT = 1.65 V.

| Device   | Description                                                                                    | Topology  | Vcc Min (V) | Vcc Max (V) | fsw Typ (kHz) | Package |
|----------|------------------------------------------------------------------------------------------------|-----------|-------------|-------------|---------------|---------|
| NCP1579  | Synchronous Buck Controller, Low Voltage                                                       | Step-Down | 4.5         | 13.2        | 275           | SOIC-8  |
| NCP1587  | Synchronous Buck Controller, Low Voltage                                                       | Step-Down | 4.5         | 13.2        | 250 - 300     | SOIC-8  |
| NCP1587A | Synchronous Buck Controller, Low Voltage                                                       | Step-Down | 4.5         | 13.2        | 180 - 220     | SOIC-8  |
| NCP1589A | Synchronous Buck Controller, Low Voltage                                                       | Step-Down | 4.5         | 13.2        | –             | DFN-10  |
| NCP1589D | Synchronous Buck Controller                                                                    | Step-Down | 4.5         | 13.2        | –             | DFN-10  |
| NCP1589L | Synchronous Buck Controller, Low Voltage, with Light Load Efficiency and Transient Enhancement | Step-Down | 4.5         | 13.2        | –             | DFN-10  |
| NCP5212  | Single Synchronous Step Down Controller                                                        | Step-Down | 4.5         | 27          | 300           | QFN-16  |
| NCP5212T | Single Synchronous Step Down Controller                                                        | Step-Down | 4.5         | 27          | 300           | QFN-16  |
| NCP5217  | Synchronous Buck Controller, Single                                                            | Step-Down | 4.5         | 27          | 300           | QFN-14  |
| NCP5222  | Synchronous Buck Controller, 2-Channel, 2-Phase                                                | Step-Down | 4.5         | 27          | 300           | QFN-28  |
| NCP5230  | Low Voltage Synchronous Buck Controller                                                        | Step-Down | 4.5         | 13.2        | –             | QFN-16  |
| NCP5269  | System Agent Controller with 2-bit VID                                                         | Step-Down | 3.3         | 28          | 300 - 600     | QFN-20  |
| NCP3231  | 25 A Synchronous Buck Converter with Intergrated MOSFETs                                       | Step-Down | 4.5         | 18          | 500           | TQFN-40 |
| NCP3232N | 15 A Synchronous Buck Converter with Intergrated MOSFETs                                       | Step-Down | 4.5         | 21          | 500           | TQFN-40 |
| NCP3133A | 3 A Synchronous Buck Converter with Intergrated MOSFETs                                        | Step-Down | 2.9         | 5.5         | 1100          | QFN-16  |
| NCP3135  | 5 A Synchronous Buck Converter with Intergrated MOSFETs                                        | Step-Down | 2.9         | 5.5         | 1100          | QFN-16  |

## Thermal Management and System Monitoring

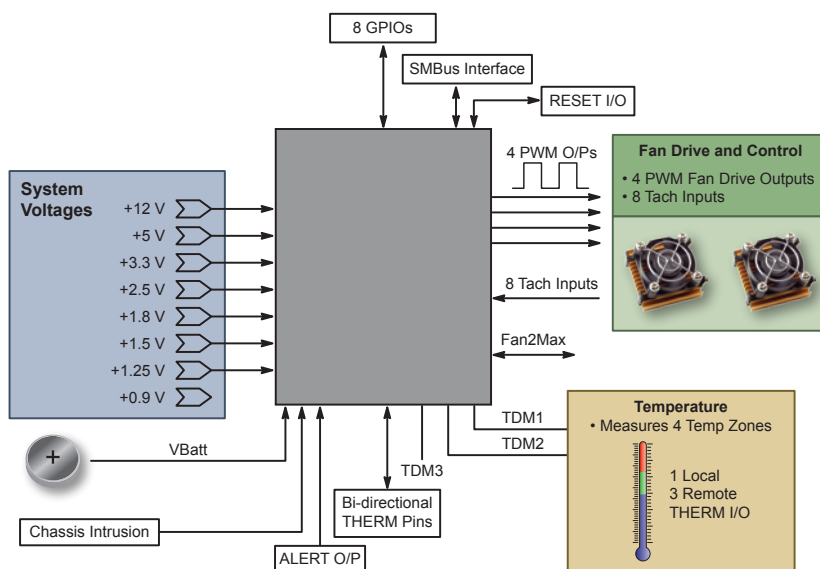
### Extensive Portfolio

**Local Sensors** provide temperature information at the device location

**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

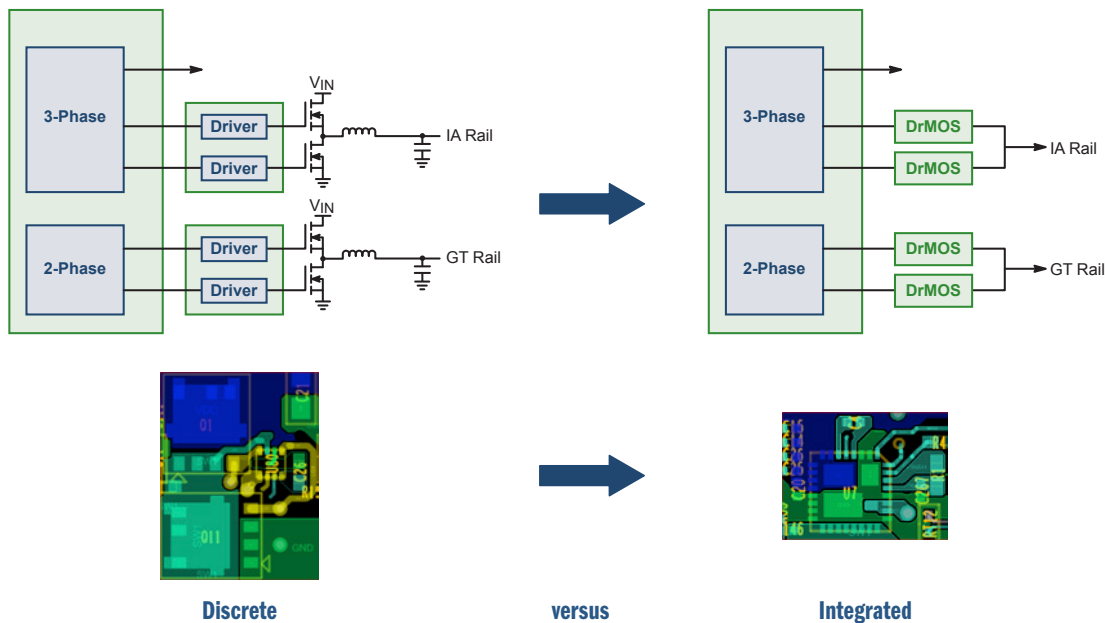


|                        | Device  | Supply Range (V) | Temperature Range (°C) | Local Accuracy (°C) | Interface | Number of Addresses | SRC (Ω) | Remote Accuracy | Remote Channels | Fan Channels | TACH Channels | Voltage Monitoring Channels | GPIOs | Package               |
|------------------------|---------|------------------|------------------------|---------------------|-----------|---------------------|---------|-----------------|-----------------|--------------|---------------|-----------------------------|-------|-----------------------|
| <b>System Monitors</b> | 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               |
| <b>Fan Controllers</b> | 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               |
|                        | ADM1033 | 3 - 3.6          | -40 to +120            | ±1                  | I2C/SMBUS | 8                   | 1 k     | ±1              | 1               | 1            | 1             |                             |       | QSOP-16               |
|                        | ADM1034 | 3 - 3.6          | -40 to +120            | ±1                  | I2C/SMBUS | 8                   | 1 k     | ±1              | 2               | 2            | 2             |                             |       | QSOP-16               |
| <b>Remote Sensors</b>  | 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       |
|                        | NCT210  | 3 - 5.5          | -55 to +125            | ±1                  | I2C/SMBUS | 9                   | —       | ±3              | 2               |              |               |                             |       | QSOP-16               |
|                        | 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               |
| <b>Local Sensors</b>   | NCT75   | 3 - 5.5          | -55 to +125            | ±1                  | I2C/SMBUS | 8                   |         |                 |                 |              |               |                             |       | DFN-8, SOIC-8, Micro8 |
|                        | NCT275  | 3 - 5.5          | -55 to +125            | ±1                  | I2C/SMBUS | 4                   |         |                 |                 |              |               |                             |       | CSP-6                 |
|                        | NCT203  | 1.4 - 2.75       | -40 to +125            | ±1.75               | I2C/SMBUS | 1                   |         |                 |                 |              |               |                             |       | DFN-8, SOIC-8, Micro8 |

## Integrated MOSFET and Drivers

### Features

- Integrated high- and low-side MOSFETs
- Integrated bootstrap diode
- Matched of driver and MOSFETs optimize switching performance
- Higher switching frequency enables use of smaller inductor and output capacitors
- Low-side MOSFET diode emulation mode provides asynchronous operation
- 65% lower BOM; 45% smaller footprint and simplified layout versus discrete solutions



| Device   | PWM Input       | V <sub>IN</sub> Max (V) | Freq Max (MHz) | I <sub>OUT</sub> Continuous Max (A) | Package |
|----------|-----------------|-------------------------|----------------|-------------------------------------|---------|
| NCP5369  | 5 V Tri-state   | 25                      | 1              | 40                                  | QFN-40  |
| NCP81081 | 3.3 V Tri-state | 25                      | 1              | 40                                  | QFN-40  |
| NCP5338  | 5 V Tri-state   | 20                      | 1              | 40                                  | QFN-40  |
| NCP5368* | 5 V Tri-state   | 15                      | 2              | 35                                  | QFN-40  |

\* Pending 2Q15.

## Drivers for Discrete MOSFET Implementations

Drivers specifically designed to work with controller solutions, and optimized for 5 V or 12 V gate applications.

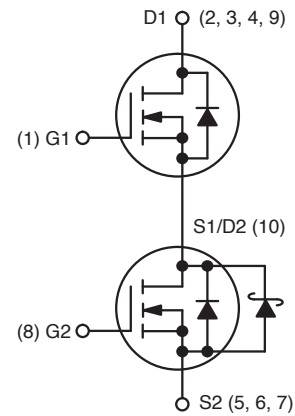
| Device    | Drivers | V <sub>CC</sub> Typ (V) | Integrated Bootstrap Diode | Zero Crossover Detection | Package |
|-----------|---------|-------------------------|----------------------------|--------------------------|---------|
| NCP5901   | Single  | 12                      | N                          | Y                        | DFN-8   |
| NCP5901B  | Single  | 12                      | Y                          | Y                        | DFN-8   |
| NCP81161  | Single  | 12                      | Y                          | Y                        | DFN-8   |
| NCP81151  | Single  | 5                       | Y                          | Y                        | DFN-8   |
| NCP81253  | Single  | 5                       | Y                          | N                        | DFN-8   |
| NCP81061* | Dual    | 12                      | Y                          | Y                        | QFN-16  |
| NCP81152  | Dual    | 5                       | Y                          | Y                        | QFN-16  |

\* Pending 2Q15.

## MOSFETs Provide Optimized Efficiency

### Asymmetric Dual

- Co-packaged Power Stage to minimize board space
- Low Side MOSFET with Integrated Schottky
- Parasitic Inductances Minimized
- Optimized Devices to Reduce Power Losses



| Device      | Package          | Config    | Polarity    | Maximum Rating         |                        |                           |                            | Q <sub>g</sub><br>(nC) | Q <sub>gd</sub><br>(nC) | C <sub>iss</sub><br>(pF) | C <sub>rss</sub><br>(pF) | R <sub>G</sub><br>(Ω) | Applications     |
|-------------|------------------|-----------|-------------|------------------------|------------------------|---------------------------|----------------------------|------------------------|-------------------------|--------------------------|--------------------------|-----------------------|------------------|
|             |                  |           |             | V <sub>DS</sub><br>(V) | V <sub>GS</sub><br>(V) | R <sub>DS(ON)</sub> (mΩ)  |                            |                        |                         |                          |                          |                       |                  |
|             |                  |           |             |                        |                        | V <sub>GS</sub> =<br>10 V | V <sub>GS</sub> =<br>4.5 V |                        |                         |                          |                          |                       |                  |
| NTMFD4C85N  | PowerPhase       | Asym Dual | N           | 30                     | 20                     | 3.0                       | 4.3                        | 15.0                   | 5.2                     | 1960                     | 102                      | 1.0                   | Control Side     |
|             |                  |           | N           | 30                     | 20                     | 0.8                       | 1.2                        | 45.2                   | 11.8                    | 6660                     | 126                      | 1.0                   | Synchronous Side |
| NTMFD4C86N  | PowerPhase       | Asym Dual | N           | 30                     | 20                     | 5.4                       | 8.1                        | 10.9                   | 5.4                     | 1252                     | 126                      | 1.0                   | Control Side     |
|             |                  |           | N           | 30                     | 20                     | 2.1                       | 3.0                        | 21.6                   | 5.5                     | 3040                     | 77                       | 1.0                   | Synchronous Side |
| NTMFD4901NF | SO-8FL           | Asym Dual | N           | 30                     | 20                     | 6.5                       | 10.0                       | 9.7                    | 3.7                     | 1150                     | 105                      | 0.8                   | Control Side     |
|             |                  |           | N + Int Sch | 30                     | 20                     | 2.4                       | 3.5                        | 20.0                   | 5.3                     | 2950                     | 82                       | 0.8                   | Synchronous Side |
| NTMFD4C87N  | PowerPhase       | Asym Dual | N           | 30                     | 20                     | 5.0                       | 7.7                        | 10.9                   | 5.4                     | 1252                     | 129                      | 1.0                   | Control Side     |
|             |                  |           | N           | 30                     | 20                     | 3.1                       | 4.3                        | 13.8                   | 3.6                     | 1939                     | 49                       | 1.0                   | Synchronous Side |
| NTMFD4C20N  | SO-8FL           | Asym Dual | N           | 30                     | 20                     | 7.0                       | 10.8                       | 9.3                    | 4.2                     | 970                      | 125                      | 1.0                   | Control Side     |
|             |                  |           | N           | 30                     | 20                     | 3.4                       | 5.2                        | 13.0                   | 3.0                     | 1950                     | 50                       | 1.0                   | Synchronous Side |
| NTMFD4902NF | SO-8FL           | Asym Dual | N           | 30                     | 20                     | 6.5                       | 10.0                       | 9.7                    | 3.7                     | 1150                     | 105                      | 0.8                   | Control Side     |
|             |                  |           | N + Int Sch | 30                     | 20                     | 4.1                       | 6.2                        | 11.5                   | 3.4                     | 1510                     | 83                       | 0.8                   | Synchronous Side |
| NTLLD4901NF | μ8-FL/<br>WDFN-8 | Asym Dual | N           | 30                     | 20                     | 20.0                      | 30.0                       | 5.5                    | 1.4                     | 605                      | 100                      | 0.8                   | Control Side     |
|             |                  |           | N + Int Sch | 30                     | 20                     | 15.0                      | 22.0                       | 5.9                    | 2.9                     | 645                      | 16                       | 0.8                   | Synchronous Side |

## MOSFETs Provide Optimized Efficiency

|                                                                                                                  | Device      | Package | Configuration | Polarity | Maximum Rating         |                        |                           |                            | Q <sub>g</sub><br>(nC) | Q <sub>gd</sub><br>(nC) | C <sub>iss</sub><br>(pF) | C <sub>rss</sub><br>(pF) | R <sub>G</sub><br>(Ω) | Applications       |
|------------------------------------------------------------------------------------------------------------------|-------------|---------|---------------|----------|------------------------|------------------------|---------------------------|----------------------------|------------------------|-------------------------|--------------------------|--------------------------|-----------------------|--------------------|
|                                                                                                                  |             |         |               |          | V <sub>DS</sub><br>(V) | V <sub>GS</sub><br>(V) | R <sub>DS(ON)</sub> (mΩ)  |                            |                        |                         |                          |                          |                       |                    |
|                                                                                                                  |             |         |               |          |                        |                        | V <sub>GS</sub> =<br>10 V | V <sub>GS</sub> =<br>4.5 V |                        |                         |                          |                          |                       |                    |
| <br><b>SO-8FL</b><br>5 x 6 mm   | NTMFS4C01N  | SO-8FL  | Single        | N        | 30                     | 20                     | 0.9                       | 1.2                        | 65.0                   | 18.0                    | 9200                     | 231                      | 1.0                   | HPPC               |
|                                                                                                                  | NTMFS4C03N  | SO-8FL  | Single        | N        | 30                     | 20                     | 2.1                       | 2.8                        | 43.7                   | 5.3                     | 2850                     | 72                       | 1.0                   | HPPC               |
|                                                                                                                  | NTMFS4983NF | SO-8FL  | Integ Sch     | N        | 30                     | 20                     | 2.1                       | 3.1                        | 22.6                   | 6.9                     | 3250                     | 90                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTMFS4C35N  | SO-8FL  | Single        | N        | 30                     | 20                     | 3.2                       | 4.2                        | 15.0                   | 5.5                     | 2300                     | 46                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTMFS4985NF | SO-8FL  | Integ Sch     | N        | 30                     | 20                     | 3.4                       | 5.0                        | 14.2                   | 4.2                     | 2100                     | 60                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTMFS4C05N  | SO-8FL  | Single        | N        | 30                     | 20                     | 3.4                       | 5.0                        | 13.0                   | 3.0                     | 1950                     | 50                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTMFS4C06N  | SO-8FL  | Single        | N        | 30                     | 20                     | 4.0                       | 6.0                        | 14.5                   | 5.5                     | 1988                     | 71                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTMFS4C08N  | SO-8FL  | Single        | N        | 30                     | 20                     | 5.8                       | 8.5                        | 8.7                    | 2.8                     | 1100                     | 38                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTMFS4C09N  | SO-8FL  | Single        | N        | 30                     | 20                     | 6.0                       | 8.8                        | 10.9                   | 5.4                     | 1252                     | 126                      | 1.0                   | Control Side       |
|                                                                                                                  | NTMFS4C10N  | SO-8FL  | Single        | N        | 30                     | 20                     | 7.0                       | 10.8                       | 9.3                    | 4.2                     | 970                      | 125                      | 1.0                   | Control Side       |
| NTMFS4C13N                                                                                                       | SO-8FL      | Single  | N             | 30       | 20                     | 9.1                    | 13.8                      | 6.6                        | 2.7                    | 720                     | 95                       | 1.0                      | Control Side          |                    |
| <br><b>μ8FL</b><br>3.3 x 3.3 mm | NTTFS4C05N  | μ8-FL   | Single        | N        | 30                     | 20                     | 3.6                       | 5.1                        | 13.0                   | 3.0                     | 1950                     | 50                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTTFS4C06N  | μ8-FL   | Single        | N        | 30                     | 20                     | 4.0                       | 6.0                        | 14.5                   | 5.5                     | 1988                     | 71                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTTFS4C08N  | μ8-FL   | Single        | N        | 30                     | 20                     | 5.8                       | 8.5                        | 8.7                    | 2.8                     | 1100                     | 38                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTTFS4C10N  | μ8-FL   | Single        | N        | 30                     | 20                     | 7.4                       | 11.0                       | 9.3                    | 4.2                     | 970                      | 125                      | 1.0                   | Control Side       |
|                                                                                                                  | NTTFS4C13N  | μ8-FL   | Single        | N        | 30                     | 20                     | 9.1                       | 13.8                       | 6.6                    | 2.7                     | 720                      | 95                       | 1.0                   | Control Side       |
|                                                                                                                  | NTTFS4C25N  | μ8-FL   | Single        | N        | 30                     | 20                     | 17.0                      | 26.5                       | 4.0                    | 1.3                     | 455                      | 60                       | 1.0                   | Control Side       |
| <br><b>DPAK</b>               | NTD4904N    | DPAK    | Single        | N        | 30                     | 20                     | 3.7                       | 5.5                        | 16.8                   | 3.0                     | 3052                     | 23.0                     | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTD4965N    | DPAK    | Single        | N        | 30                     | 20                     | 4.7                       | 7.0                        | 17.5                   | 8.5                     | 1684                     | 330                      | 0.8                   | Synchronous Side   |
|                                                                                                                  | NTD4906N    | DPAK    | Single        | N        | 30                     | 20                     | 5.5                       | 8.0                        | 11.0                   | 1.8                     | 1932                     | 19                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTD4969N    | DPAK    | Single        | N        | 30                     | 20                     | 9.0                       | 12.0                       | 8.7                    | 4.0                     | 835                      | 163                      | 0.7                   | Control Side       |
|                                                                                                                  | NTD4970N    | DPAK    | Single        | N        | 30                     | 20                     | 11.0                      | 15.0                       | 7.7                    | 3.7                     | 743                      | 330                      | 0.9                   | Control Side       |
| <br><b>SOIC-8</b><br>5 x 6 mm | NTMS4937N   | SOIC-8  | Single        | N        | 30                     | 20                     | 6.5                       | 8.7                        | 17.4                   | 3.3                     | 2563                     | 25                       | 1.0                   | Synchronous Side   |
|                                                                                                                  | NTMS4939N   | SOIC-8  | Single        | N        | 30                     | 20                     | 8.4                       | 11.0                       | 12.4                   | 1.9                     | 2000                     | 16                       | 0.7                   | Synchronous Side   |
|                                                                                                                  | NTMS4916N   | SOIC-8  | Single        | N        | 30                     | 20                     | 9.0                       | 12.0                       | 14.0                   | 7.0                     | 1468                     | 280                      | 0.7                   | Control Side       |
|                                                                                                                  | NTMS4917N   | SOIC-8  | Single        | N        | 30                     | 20                     | 11.0                      | 15.0                       | 10.8                   | 3.5                     | 1132                     | 216                      | 0.7                   | Control Side       |
|                                                                                                                  | NTMS4800N   | SOIC-8  | Single        | N        | 30                     | 20                     | 20.0                      | 27.0                       | 7.7                    | 3.2                     | 940                      | 125                      | 1.5                   | Control Side       |
|                                                                                                                  | NTMS4840N   | SOIC-8  | Single        | N        | 30                     | 20                     | 24.0                      | 36.0                       | 4.8                    | 1.9                     | 520                      | 70                       | 2.0                   | Control Side       |
|                                                                                                                  | NTMD4820N   | SOIC-8  | Dual          | N        | 30                     | 20                     | 20.0                      | 27.0                       | 7.7                    | 3.2                     | 940                      | 125                      | 1.5                   | DC-DC, Load Switch |
|                                                                                                                  | NTMD4840N   | SOIC-8  | Dual          | N        | 30                     | 20                     | 24.0                      | 36.0                       | 4.8                    | 1.9                     | 520                      | 70                       | 1.0                   | DC-DC, Load Switch |
|                                                                                                                  | NTMS4177P   | SOIC-8  | Single        | P        | -30                    | 20                     | 12.0                      | 19.0                       | 29.0                   | 13.0                    | 3100                     | 370                      | 2.0                   | Load Switch        |
|                                                                                                                  | NTMS4176P   | SOIC-8  | Single        | P        | -30                    | 25                     | 18.0                      | 30.0                       | 17.0                   | 8.4                     | 1720                     | 256                      | 2.9                   | Load Switch        |

## MOSFETs Provide Optimized Efficiency

### Trench 6 High Efficiency (T6HE) for Servers and Point-of-Load Modules

- High Efficiency DC-DC Conversion
- Integrated Schottky Lowsides
- Lowest RDS(on) in the industry

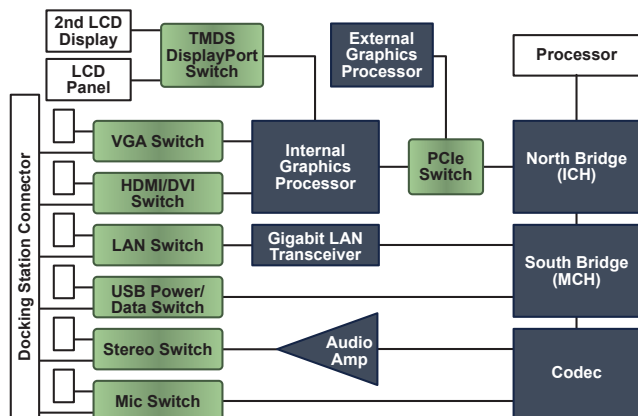


| Device        | Package | Config    | Polarity | Maximum Rating         |                        |                           |                            | Q <sub>g</sub><br>(nC) | Q <sub>gd</sub><br>(nC) | C <sub>iss</sub><br>(pF) | C <sub>rss</sub><br>(pF) | R <sub>G</sub><br>(Ω) | Applications     |
|---------------|---------|-----------|----------|------------------------|------------------------|---------------------------|----------------------------|------------------------|-------------------------|--------------------------|--------------------------|-----------------------|------------------|
|               |         |           |          | V <sub>DS</sub><br>(V) | V <sub>GS</sub><br>(V) | R <sub>DS(ON)</sub> (mΩ)  |                            |                        |                         |                          |                          |                       |                  |
|               |         |           |          |                        |                        | V <sub>GS</sub> =<br>10 V | V <sub>GS</sub> =<br>4.5 V |                        |                         |                          |                          |                       |                  |
| NTMFS4H01N    | S0-8FL  | Single    | N        | 25                     | 20                     | 0.7                       | 1.0                        | 39.0                   | 8.5                     | 5693                     | 212                      | 1.2                   | Synchronous Side |
| NTMFS4H01NF   | S0-8FL  | Integ Sch | N        | 25                     | 20                     | 0.7                       | 1.0                        | 37.8                   | 8.0                     | 5538                     | 175.3                    | 1.3                   | Synchronous Side |
| NTMFS4H013NF* | S0-8FL  | Integ Sch | N        | 25                     | 20                     | 0.9                       | 1.3                        | 28.0                   | 7.5                     | 3780                     | 150                      | 1.0                   | Synchronous Side |
| NTMFS4H02N    | S0-8FL  | Single    | N        | 25                     | 20                     | 1.4                       | 2.2                        | 18.0                   | 4.2                     | 2651                     | 103                      | 1.0                   | Synchronous Side |
| NTMFS4H02NF   | S0-8FL  | Integ Sch | N        | 25                     | 20                     | 1.4                       | 2.3                        | 18.7                   | 4.3                     | 2652                     | 94                       | 1.0                   | Synchronous Side |
| NTTFS4H05N    | μ8-FL   | Single    | N        | 25                     | 20                     | 3.3                       | 4.8                        | 8.7                    | 1.9                     | 1205                     | 45                       | 1.0                   | Control Side     |
| NTTFS4H07N    | μ8-FL   | Single    | N        | 25                     | 20                     | 4.8                       | 7.1                        | 5.7                    | 1.3                     | 771                      | 34                       | 1.0                   | Control Side     |

\* Pending 2Q15.

## Switching Devices

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.



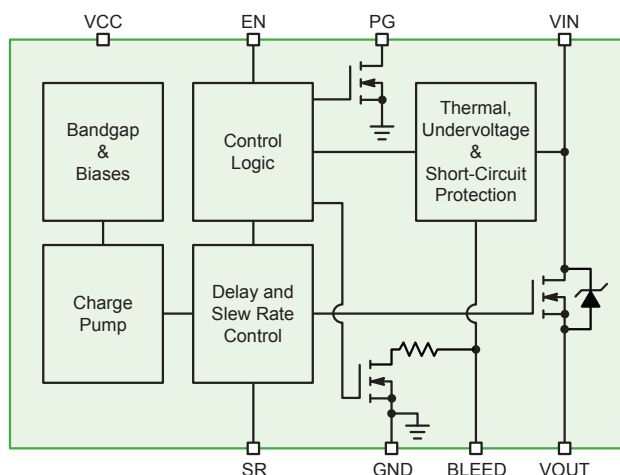
### Server Implementation

| Device    | Interface                 | Data Rate | No Channels | Quiescent Current |
|-----------|---------------------------|-----------|-------------|-------------------|
| NCN3612B  | PCIe 3.0, DisplayPort 1.2 | 8 Gb/s    | 12          | 250 μA            |
| NCN3411   | PCIe 3.0                  | 8 Gb/s    | 8           | 200 μA            |
| NCN2612B  | PCIe 2.0, DisplayPort 1.1 | 5 Gb/s    | 12          | 250 μA            |
| NS3L500   | Gigabit Ethernet          | 1 Gb/s    | 11          | 250 μA            |
| NCN1188   | USB 2.0 / MHL             | 2.25 Gb/s | 2           | 21 μA             |
| NS5S1153  | USB 2.0                   | 480 Mb/s  | 2           | 21 μA             |
| NLAS7242  | USB 2.0                   | 480 Mb/s  | 2           | 1 μA              |
| NLAS52231 | Audio                     | 36 MHz    | 2           | 1 μA              |
| NLAS4684  | Audio                     | 9.5 MHz   | 2           | 180 nA            |

## 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 Feature

- 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 <sub>Max</sub><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                 | NCP330   | 26 at 3.3 V             | 3                       | 1.8                       | 5.5                       | 100                    | -         | 2000              | Reverse blocking  | TDFN-4     |
|                                   | NCP333   | 55 at 3.3 V             | 1.5                     | 1.2                       | 5.5                       | 1                      | Auto      | 95                | -                 | 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    |
|                                   | 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    |
|                                   | NCP338   | 27 at 1.8 V             | 2                       | 1                         | 3.6                       | 0.6                    | Auto      | 20                | -                 | WLCSP-6    |
|                                   | NCP339   | 26 at 3.3 V             | 3                       | 1.2                       | 5.5                       | 2                      | -         | 2700              | Reverse blocking  | WLCSP-6    |
|                                   | NCP432   | 50 at 1.8 V             | 1.5                     | 1                         | 3.6                       | 0.6                    | -         | 20                | -                 | WLCSP-4    |
|                                   | NCP433   | 50 at 1.8 V             | 1.5                     | 1                         | 3.6                       | 0.6                    | Auto      | 20                | -                 | WLCSP-4    |
|                                   | NCP434   | 43 at 1.8 V             | 2                       | 1                         | 3.6                       | 0.6                    | -         | 61                | -                 | WLCSP-4    |
|                                   | NCP435   | 43 at 1.8 V             | 2                       | 1                         | 3.6                       | 0.6                    | Auto      | 61                | -                 | WLCSP-4    |
|                                   | NCP436   | 23 at 1.8 V             | 3                       | 1                         | 3.6                       | 1                      | -         | 27                | -                 | WLCSP-6    |
|                                   | NCP437   | 23 at 1.8 V             | 3                       | 1                         | 3.6                       | 1                      | Auto      | 27                | -                 | WLCSP-6    |
| 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      |

## Power Rail Over-Current and Over-Voltage Protection

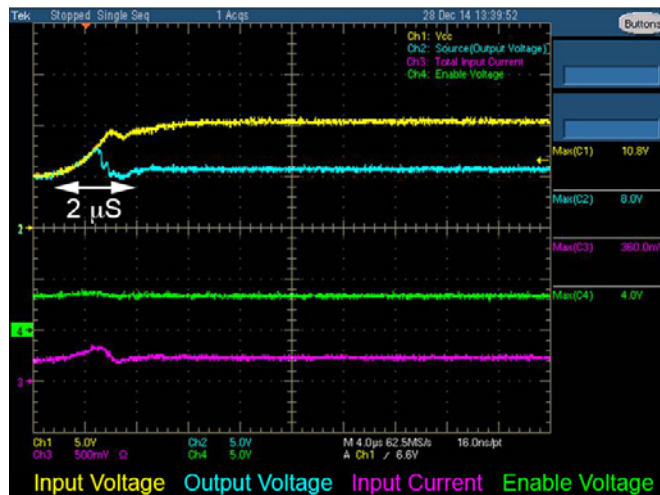
for SAS, SATA, mSATA, and  $\mu$ SATA Interfaces for HDDs/SSDs/Servers

### Key Requirement

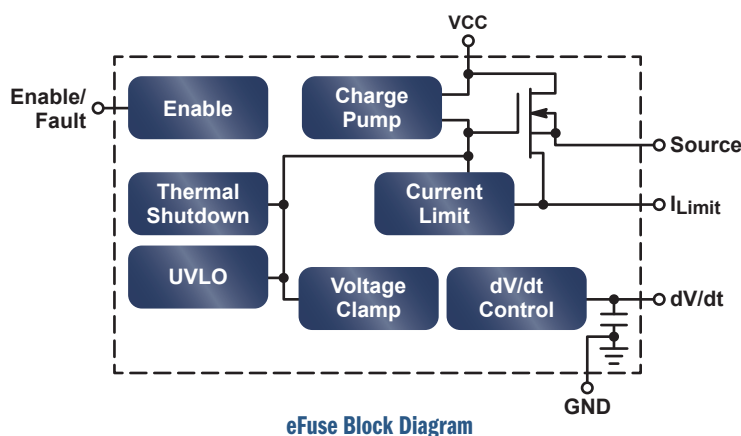
- Over-current and over-voltage protection
- $< 20 \mu\text{s}$  response time
- Sustained currents  $> 3 \text{ A}$

### Features

- Integrated OCP and OVP with best-in-class response time
- $< 50 \text{ m}\Omega$   $R_{\text{dson}}$
- Configurable current limit
- Thermally protected
- Auto-retry and Latching on Fault options



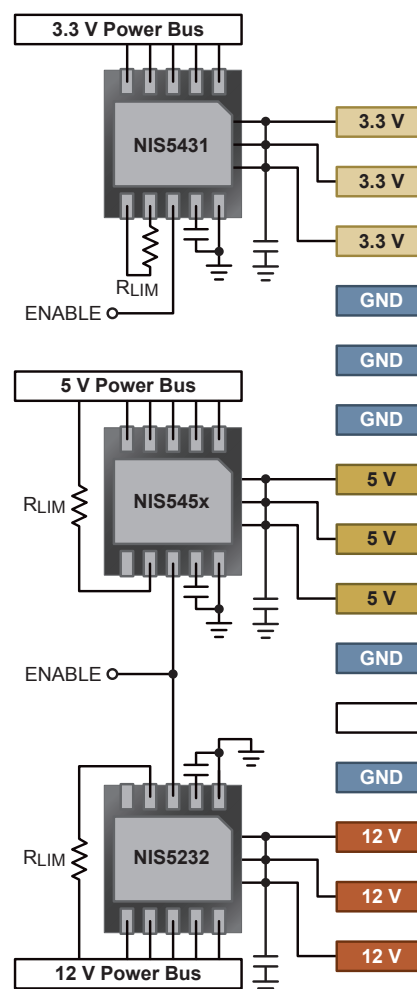
NIS5452 Over-Voltage Response Time



eFuse Block Diagram

| Device   | Nominal Voltage (V) | Input Voltage (V) | V <sub>clamp</sub> (V) | Continuous Current (A) | Trip Current (A) | R <sub>DS(ON)</sub> (m $\Omega$ ) | Auto-Retry | Latch | Package |
|----------|---------------------|-------------------|------------------------|------------------------|------------------|-----------------------------------|------------|-------|---------|
| NIS5112  | 12                  | -0.3 to 18        | 15                     | 5.3                    | Adjustable       | 28                                | Y          | Y     | SOIC-8  |
| NIS5232  | 12                  | -0.6 to 18        | 15                     | 4.2                    | Adjustable       | 44                                | N          | Y     | DFN-10  |
| NIS5451* | 5                   | -0.6 to 14        | 5.5                    | 4.5                    | Adjustable       | 33                                | N          | Y     | WDFN-10 |
| NIS5452* | 5                   | -0.6 to 14        | 5.85                   | 4.5                    | Adjustable       | 33                                | Y          | Y     | WDFN-10 |
| NIS5431* | 3.3                 | -0.6 to 14        | 3.85                   | 4.3                    | Adjustable       | 40                                | N          | Y     | WDFN-10 |

\* Pending 3Q15.



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

## Four Pairs, Low Capacitance Surge and ESD Protection

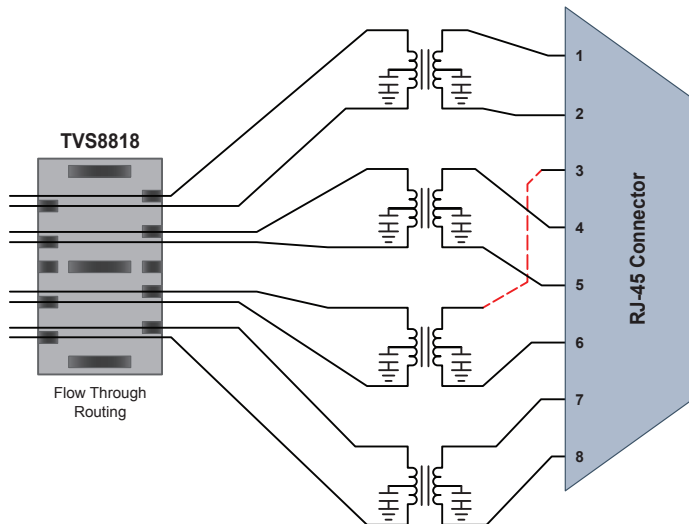
The 1000BASE-T or Gigabit Ethernet interface operating at higher bitrates is susceptible to ESD strikes, cable-discharge events and lightning-induced transients. Our products help meet IEC 61000-4-5, GR-1089-CORE and other Standards.

### Features

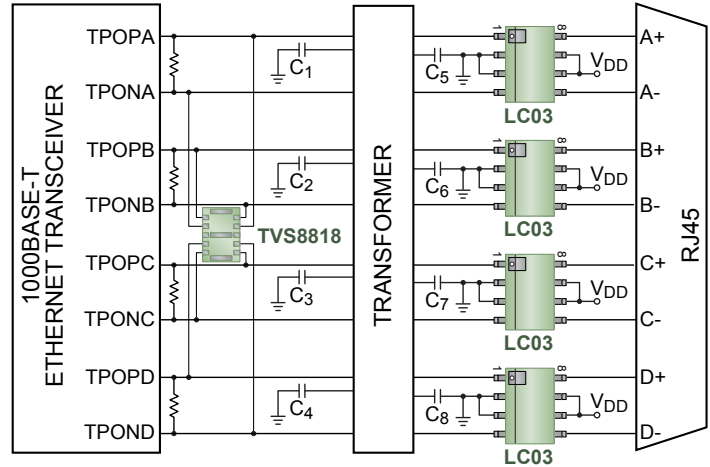
- Line-to-line capacitance < 3 pF
- $V_{\text{clamp}}$  (25 A surge) < 11 V
- IEC 61000-4-2 rating > 30 kV
- No latching danger
- Surge rating maintained to 125°C

### 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



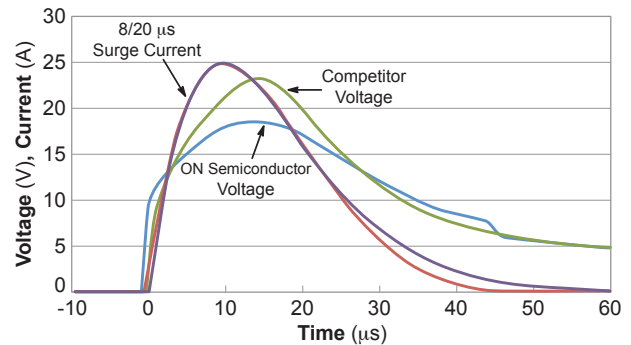
### Typical Application



Line Side : LC03-6 (optional)

Transformer Side: TVS8818

Protection against metallic (transverse) strikes



Line-to-Line Surge

### Transient Voltage Suppressors

| 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                     | 7.0                    | 100                                 | 8.0                                | ±30                     | SOIC-8  |
| TVS8814** | 3.0                     | 3.2                    | 35                                  | 1.5                                | ±30                     | UDFN-8  |
| TVS8818** | 3.0                     | 3.2                    | 35                                  | 1.5                                | ±30                     | UDFN-10 |
| SRDA3.3   | 3.3                     | 5.0                    | 25                                  | 4.0                                | ±8                      | SOIC-8  |
| SRDA05    | 5.0                     | 7.0                    | 23                                  | 5.0                                | ±8                      | SOIC-8  |
| NUP4114H  | 5.0                     | 5.0                    | 12*                                 | 0.4                                | ±13                     | TSOP-6  |

\* On Pin 5. \*\* Pending 3Q15.

## USB 3.0/3.1 Type A Connector

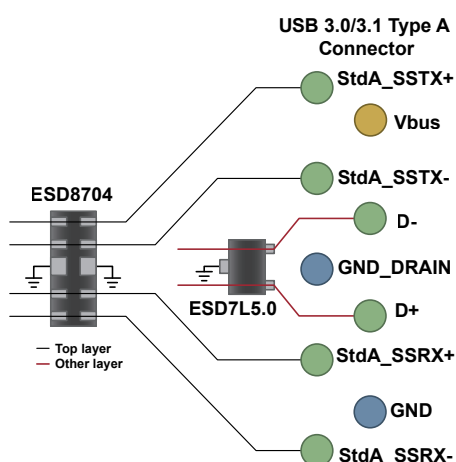
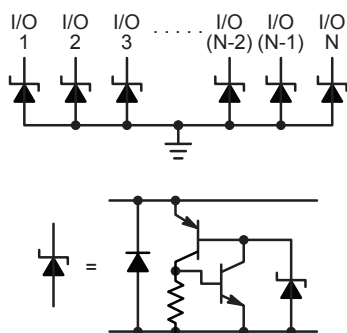
*Two Super Speed Pairs, One High Speed Pair, VBUS, Low Capacitance ESD Protection*

### Key Requirement

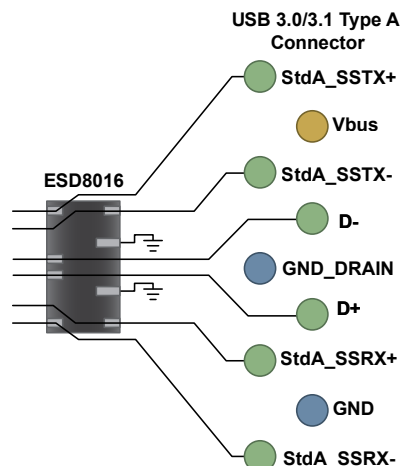
- Capacitance < 0.55 pF

### Features

- Capacitance as low as 0.25 pF
- Grounds between pairs to reduce cross-talk
- Flow-through routing
- Industry leading clamping voltage



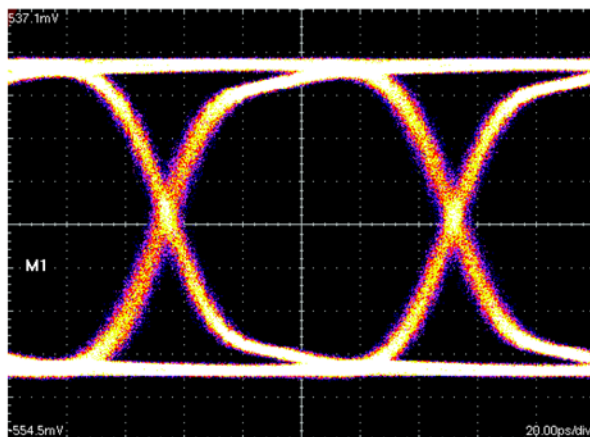
**ESD8704 – 0.30 pF, 2 Layer Routing**  
(ESD7L5.0 for D+, D- Lines)



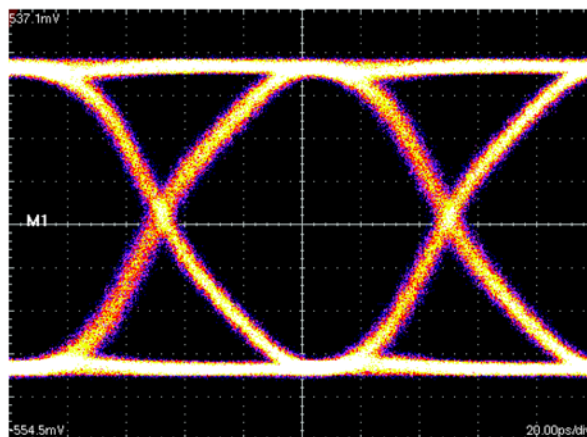
**ESD8016 – 0.25 pF, 1 Layer Routing**

| Device   | Data Lines  | Capacitance (pF) | Package | Size (mm)   |
|----------|-------------|------------------|---------|-------------|
| ESD8006  | 3 Pair      | 0.25             | UDFN-8  | 3.3 x 1.0   |
| ESD8016  | 3 Pair      | 0.25             | UDFN-8  | 2.0 x 1.0   |
| ESD8704* | 2 Pair      | 0.37             | UDFN-10 | 2.5 x 1.0   |
| ESD7L    | 1 Pair      | 0.50             | SOT-723 | 1.2 x 1.2   |
| ESD8351  | Single Line | 0.37             | X3DFN-2 | 0.62 x 0.32 |
| ESD8011  | Single Line | 0.10             | X3DFN-2 | 0.62 x 0.32 |

\* Pending 3Q15.



**Without ESD**



**With ESD**

**USB 3.1 @ 10 Gb/s**

## USB 3.1 Type C Connector

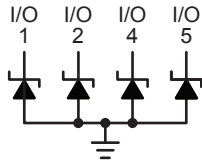
Two Super Speed Pairs, One High Speed Pair, VBUS, Low Capacitance ESD Protection

### Key Requirement

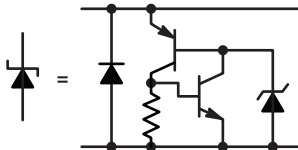
- Capacitance < 0.55 pF for High Speed lines
- Bi-directional protection for optional audio lines
- Support for Vconn through CC lines

### Features

- Capacitance of 0.37 pF or less
- Grounds between pairs to reduce cross-talk
- Flow-through routing
- Industry leading clamping voltage

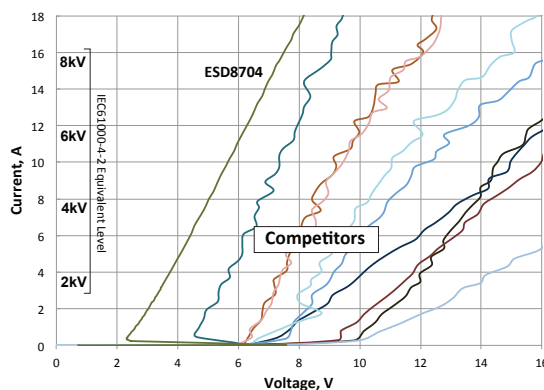


Note: Common GND – Only Minimum of 1 GND connection required

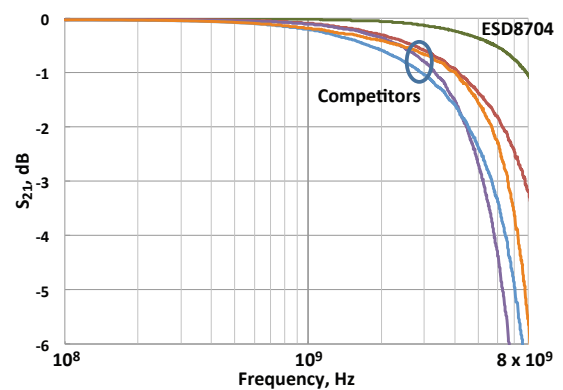


| Device   | Data Lines       | Capacitance (pF) | Package | Size (mm)   |
|----------|------------------|------------------|---------|-------------|
| ESD8704* | 2 Pair (Tx, Rx)  | 0.37             | UDFN-10 | 2.5 x 1.0   |
| ESD7471  | Single Line      | 0.24             | XDFN-2  | 1.0 x 0.6   |
| ESD8472  | Single Line      | 0.20             | X3DFN-2 | 0.62 x 0.32 |
| ESD7104  | 2 Pair (CC, SBU) | 0.30             | UDFN-10 | 2.5 x 1.0   |

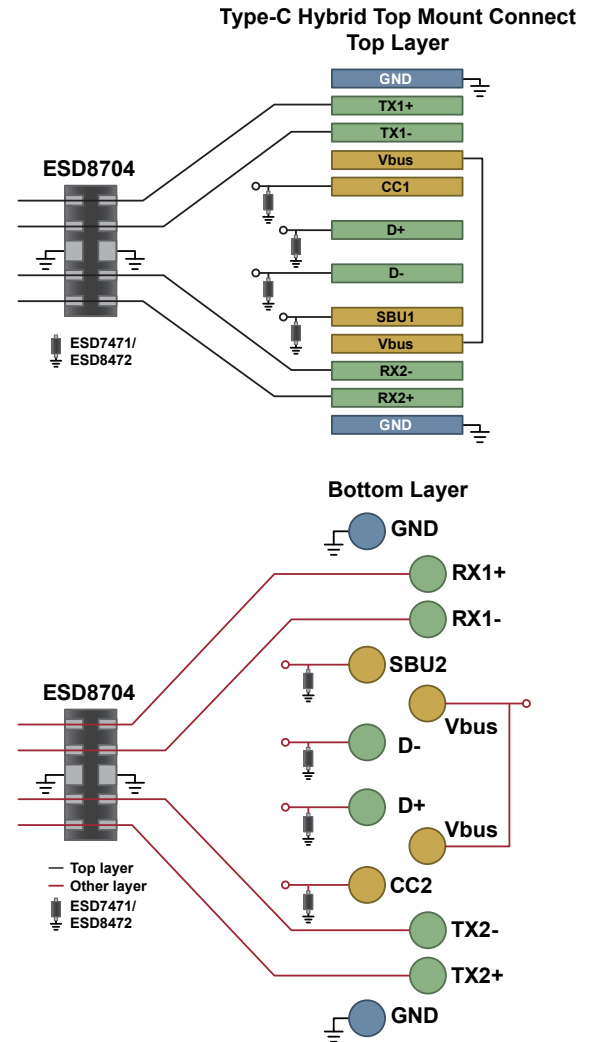
\* Pending 3Q15.



Benchmark for Positive TLP I-V Curve



Benchmark for Insertion Loss



## USB 2.0

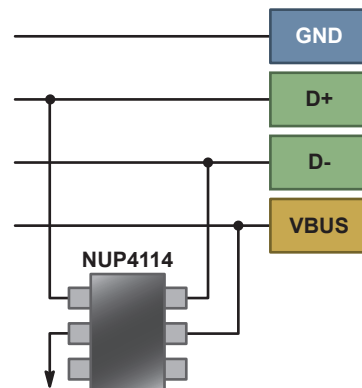
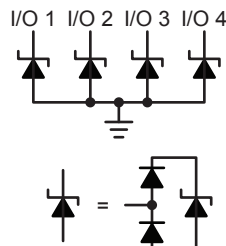
### One High Speed Pair, $V_{CC}$ , Low Capacitance ESD Protection

#### Key Requirement

- Capacitance < 1.5 pF

#### Features

- Capacitance of 0.5 - 0.8 pF
- 4 low speed + 1 VBUS integrated – can protect up to 2 USB ports
- Industry leading low clamping voltage



| Device     | Data Lines                             | Capacitance (pF) | Package | Size (mm)   |
|------------|----------------------------------------|------------------|---------|-------------|
| NUP4114UCL | 2 Pair + Power                         | 0.50             | SC-88   | 2.0 x 2.1   |
| NUP4114UPX | 2 Pair + Power                         | 0.80             | SOT-563 | 1.6 x 1.6   |
| NUP4114H   | 2 Pair + Power                         | 0.80             | TSOP-6  | 3.0 x 2.75  |
| NUP3115    | 1 Pair + ID + Power (D+, D-, ID, VBUS) | 0.80             | UDFN-6  | 1.6 x 1.6   |
| ESD7L5.0   | 1 Pair (D+, D-)                        | 0.50             | SOT-723 | 1.2 x 1.2   |
| ESD7451    | Single Line 0402                       | 0.25             | XDFN-2  | 1.0 x 0.6   |
| ESD7481    | Single Line 0201                       | 0.25             | X3DFN-2 | 0.62 x 0.32 |

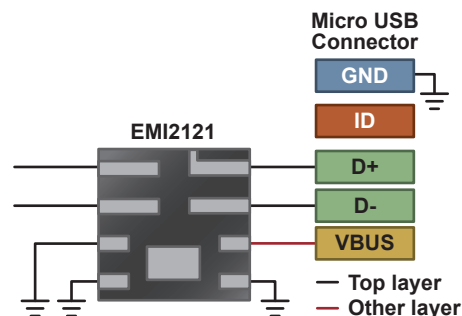
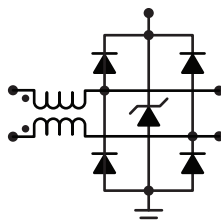
### One High Speed Pair, $V_{CC}$ , Common Mode Filter + ESD Protection

#### Key Requirement

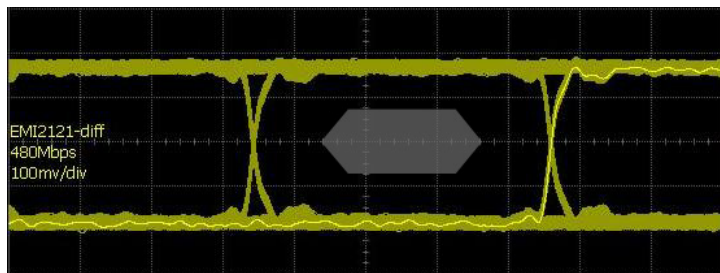
- Cap < 1.5 pF
- Common Mode Filtering

#### Features

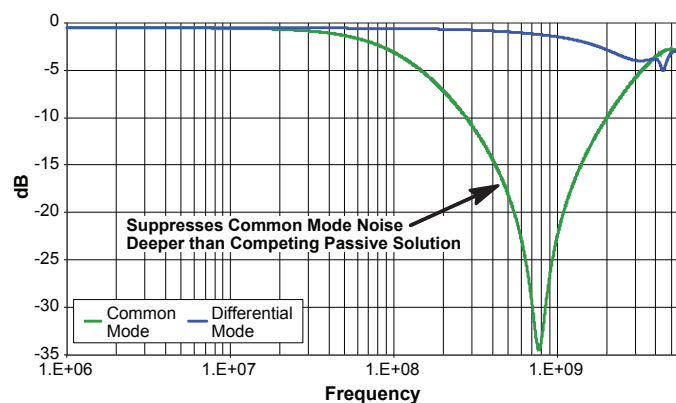
- 0.5 - 0.8 pF
- Integrated EMI suppression with ESD protection
- Industry leading low clamping voltage



| Device  | Data Lines                             | Capacitance @ 2.5 V (pF) | CM Attenuation @ 800 MHz (-dB) | DM Bandwidth F3dB (GHz) | Package | Size (mm)        |
|---------|----------------------------------------|--------------------------|--------------------------------|-------------------------|---------|------------------|
| EMI2121 | 1 Pair + Power (D+, D-, VBUS)          | 0.9                      | -25                            | 2.5                     | WQFN    | 2.2 x 2.0 x 0.75 |
| EMI2124 | 1 Pair + ID + Power (D+, D-, ID, VBUS) | 0.9                      | -25                            | 2.5                     | WQFN    | 2.2 x 2.0 x 0.75 |



USB 2.0 @ 480 Mb/s



## Thunderbolt

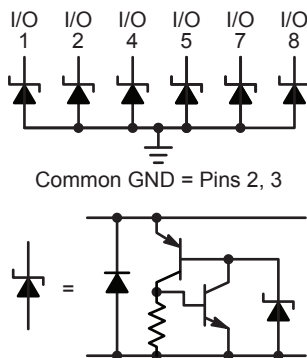
Four High Speed Pairs, up to Six Additional Lines, Low Capacitance ESD

### Key Requirement

- Capacitance < 0.4 pF

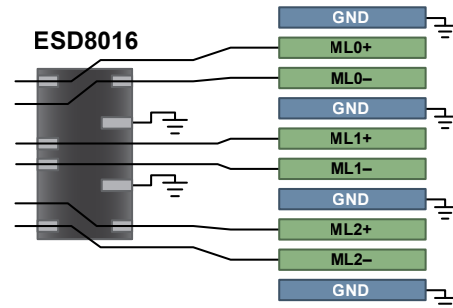
### Features

- Capacitance of 0.25 pF
- Integrated solution in 2.0 x 1.2 mm package
- Grounds between pairs to reduce cross-talk
- Flow-through routing
- Industry leading clamping voltage

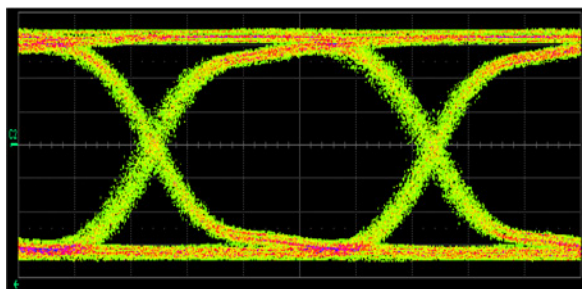
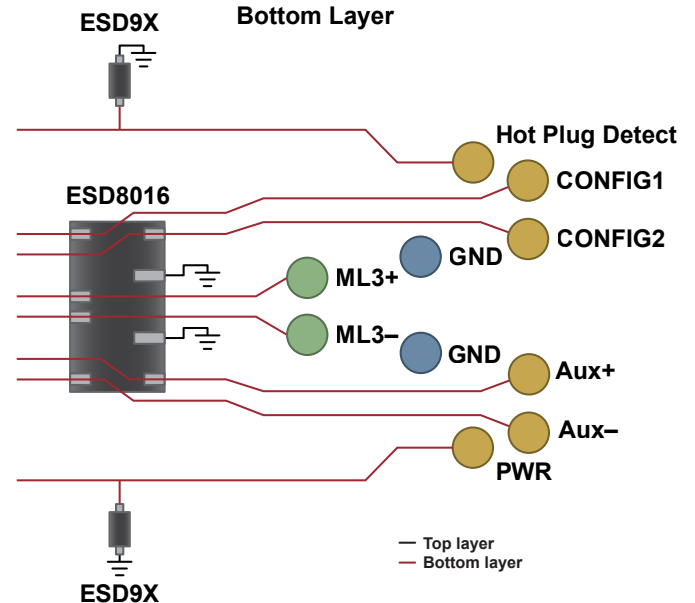


| Device  | Data Lines  | Capacitance (pF) | Package | Size (mm)   |
|---------|-------------|------------------|---------|-------------|
| ESD8006 | 3 Pair      | 0.25             | UDFN-8  | 3.3 x 1.0   |
| ESD8016 | 3 Pair      | 0.25             | UDFN-8  | 2.0 x 1.0   |
| ESD8351 | Single Line | 0.37             | X3DFN-2 | 0.62 x 0.32 |
| ESD8011 | Single Line | 0.10             | X3DFN-2 | 0.62 x 0.32 |

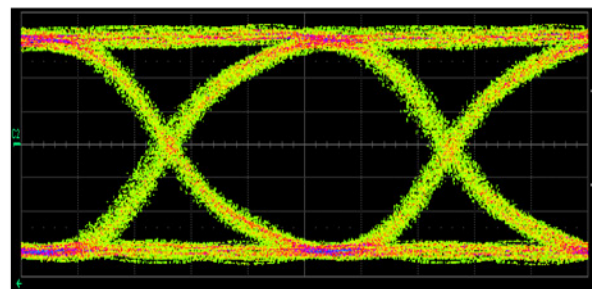
### Thunderbolt Connector Top Layer



### Thunderbolt Connector Bottom Layer



Without ESD8016



With ESD8016

Thunderbolt @ 10 Gb/s

## HDMI, Display Port

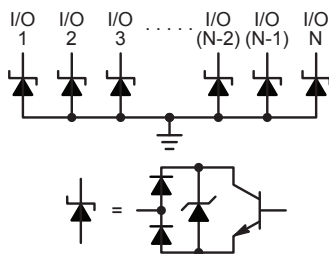
Four High Speed Pairs, Up to Six Additional Interface Lines, Low Capacitance ESD

### Key Requirement

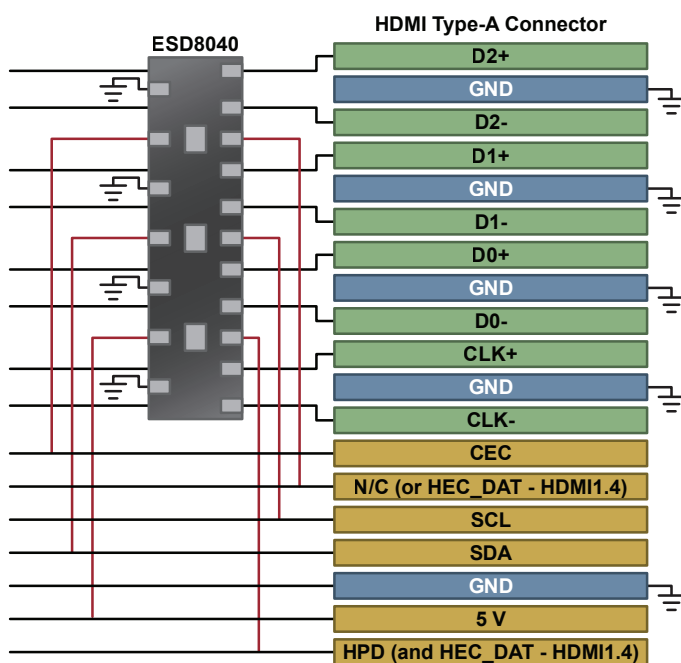
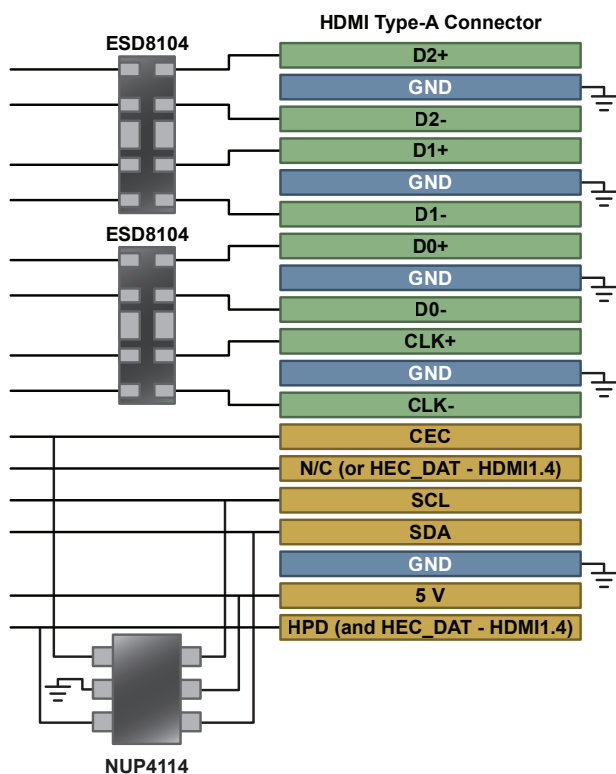
- Capacitance < 0.5 pF (HDMI 1.3/1.4)
- Capacitance < 0.4 pF (HDMI 2.0)

### Features

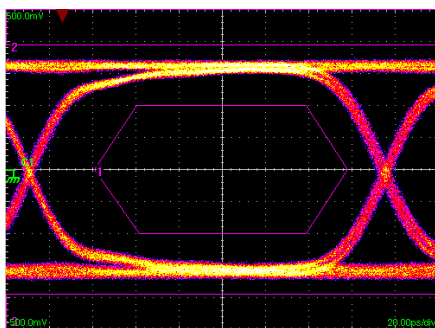
- Capacitance of 0.3 pF ESD protection
- Flow through routing in high speed lines
- Industry leading low clamping voltage



| Device  | Data Lines                      | Capacitance (pF) | Package | Size (mm)   |
|---------|---------------------------------|------------------|---------|-------------|
| ESD8104 | 2 Pair                          | 0.30             | UDFN-10 | 2.5 x 1.0   |
| ESD8040 | 4 Pair + CEC, SDL, SDA, 5V, HPD | 0.30             | UDFN-18 | 5.5 x 1.5   |
| ESD7451 | Single Line 0402                | 0.25             | XDFN-2  | 1.0 x 0.6   |
| ESD7481 | Single Line 0201                | 0.25             | X3DFN-2 | 0.62 x 0.32 |

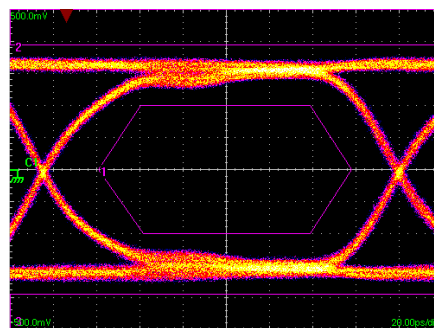


- MediaGuard fully integrated solution
- Includes ethernet protection (HDMI1.4)
- Backdrive current protection



Without ESD

HDMI 2.0 @ 6.0 Gb/s

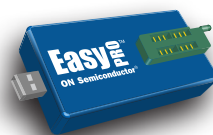


With ESD

## Serial EEPROMs

### Features

- Broad density range: 1 kb to 2 Mb
- Wide operating Vcc range: 1.8/1.7 V to 5.5 V
- High endurance: 1 million program/erase cycles
- Wide temperature range: industrial and extended



EasyPRO™ is a user-friendly, portable programming tool for ON Semiconductor serial EEPROMs (I<sup>2</sup>C, SPI, Microwire)

### EEPROMs

| Data Transmission Standard | Device    | Density | Organization*      | Vcc Min (V) | Vcc Max (V) | fCLK Max (MHz) | Package(s)                                          |
|----------------------------|-----------|---------|--------------------|-------------|-------------|----------------|-----------------------------------------------------|
| I <sup>2</sup> C           | CAT24M01  | 1 Mb    | 128k x 8           | 1.8         | 5.5         | 1              | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT24C512 | 512 kb  | 64k x 8            | 1.8         | 5.5         | 1              | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT24C256 | 256 kb  | 32k x 8            | 1.8         | 5.5         | 1              | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT24C128 | 128 kb  | 16k x 8            | 1.8         | 5.5         | 1              | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT24C64  | 64 kb   | 8k x 8             | 1.7         | 5.5         | 1              | SOIC-8, TSSOP-8, UDFN-8, WLCSP-4                    |
|                            | CAT24C32  | 32 kb   | 4k x 8             | 1.7         | 5.5         | 1              | SOIC-8, TSSOP-8, UDFN-8, WLCSP-4, WLCSP-5           |
|                            | CAT24C16  | 16 kb   | 2k x 8             | 1.7         | 5.5         | 0.4            | SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5 |
|                            | CAT24C08  | 8 kb    | 1k x 8             | 1.7         | 5.5         | 0.4            | SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5 |
|                            | CAT24C04  | 4 kb    | 512 x 8            | 1.7         | 5.5         | 0.4            | SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5 |
| SPI                        | CAT24C02  | 2 kb    | 256 x 8            | 1.7         | 5.5         | 0.4            | SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5 |
|                            | CAT25M02  | 2 Mb    | 256k x 8           | 1.7         | 5.5         | 10             | SOIC-8                                              |
|                            | CAT25M01  | 1 Mb    | 128k x 8           | 1.8         | 5.5         | 10             | SOIC-8, TSSOP-8                                     |
|                            | CAT25512  | 512 kb  | 64k x 8            | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25256  | 256 kb  | 32k x 8            | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25128  | 128 kb  | 16k x 8            | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25640  | 64 kb   | 8k x 8             | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25320  | 32 kb   | 4k x 8             | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25160  | 16 kb   | 2k x 8             | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25080  | 8 kb    | 1k x 8             | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25040  | 4 kb    | 512 x 8            | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT25020  | 2 kb    | 256 x 8            | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
| Microwire                  | CAT25010  | 1 kb    | 128 x 8            | 1.8         | 5.5         | 20             | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT93C86  | 16 kb   | 2k x 8 / 1k x 16   | 1.8         | 5.5         | 3              | SOIC-8                                              |
|                            | CAT93C86B | 16 kb   | 2k x 8 / 1k x 16   | 1.8 / 1.65  | 5.5         | 4              | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT93C76  | 8 kb    | 1k x 8 / 512 x 16  | 1.8         | 5.5         | 3              | SOIC-8, TSSOP-8                                     |
|                            | CAT93C76B | 8 kb    | 1k x 8 / 512 x 16  | 1.8 / 1.65  | 5.5         | 4              | SOIC-8, TSSOP-8, UDFN-8                             |
|                            | CAT93C66  | 4 kb    | 512 x 8 / 256 x 16 | 1.8         | 5.5         | 2              | SOIC-8, TSSOP-8                                     |
|                            | CAT93C56  | 2 kb    | 256 x 8 / 128 x 16 | 1.8         | 5.5         | 2              | SOIC-8, TSSOP-8                                     |
|                            | CAT93C46  | 1 kb    | 128 x 8 / 64 x 16  | 1.8         | 5.5         | 2              | SOIC-8, TSSOP-8                                     |
|                            | CAT93C46B | 1 kb    | 128 x 8 / 64 x 16  | 1.8 / 1.65  | 5.5         | 4              | SOIC-8, TSSOP-8, UDFN-8                             |

\* Organization for Microwire devices is selectable.

### Application Specific EEPROMs

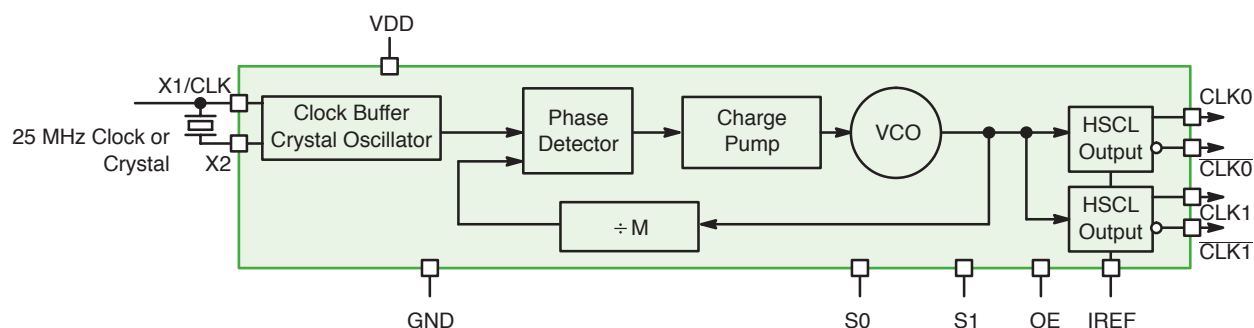
| Data Transmission Standard | Device    | Density | Organization | Vcc Min (V) | Vcc Max (V) | fCLK Max (MHz) | Package(s)              | Notes                                                              |
|----------------------------|-----------|---------|--------------|-------------|-------------|----------------|-------------------------|--------------------------------------------------------------------|
| I <sup>2</sup> C           | CAT24C208 | 8 kb    | 1024 x 8     | 2.5         | 5.5         | 0.4            | SOIC-8                  | VESA™ dual-port serial EEPROM                                      |
| I <sup>2</sup> C           | CAT34C04* | 4 kb    | 512 x 8      | 1.7         | 5.5         | 1              | UDFN-8                  | Serial Presence Detect (SPD) I <sup>2</sup> C EEPROM for DDR4 DIMM |
| I <sup>2</sup> C/SMBus     | CAT34TS04 | 4 kb    | 512 x 8      | 2.2         | 5.5         | 1              | TDFN-8, UDFN-8          | 4 kb SPD EEPROM w/ Temperature Sensor for DDR4 DIMM                |
| I <sup>2</sup> C           | CAT34C02  | 2 kb    | 256 x 8      | 1.7         | 5.5         | 0.4            | UDFN-8, TDFN-8, TSSOP-8 | Serial Presence Detect (SPD) I <sup>2</sup> C EEPROM for DDR3 DIMM |
| I <sup>2</sup> C/SMBus     | CAT34TS02 | 2 kb    | 256 x 8      | 3.0         | 3.6         | 0.4            | TDFN-8, UDFN-8          | 2 kb SPD EEPROM w/ Temperature Sensor for DDR3 DIMM                |

\* Pending 2Q15.

## Clock Synthesizers for High Performance Computing

### Features

- Uses 25 MHz fundamental mode parallel resonant crystal
- PCI-e Gen 1,2 & 3 jitter compliant 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 I2C interface for OE control and configurable spread spectrum outputs
- 3.3 V supply



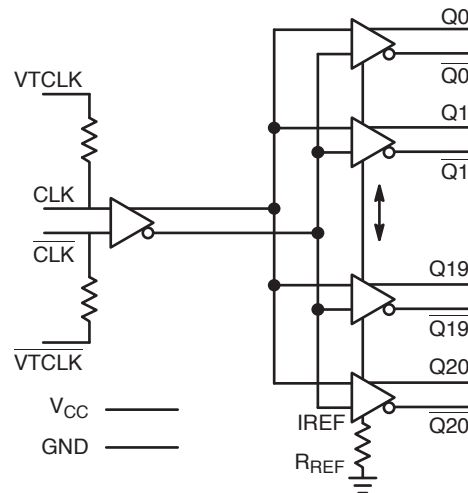
NB3N5573 Simplified Logic Diagram

| Device    | Number of Inputs | Input Type              | $f_{in}$ Typ (MHz) | Number of Outputs | Output Type | $f_{out}$ 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   | No                      | 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 |

## 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 3 jitter complaint
- Additive phase jitter 80 fs maximum @ 156.25 MHz with NB3L208K; D8800H compliant



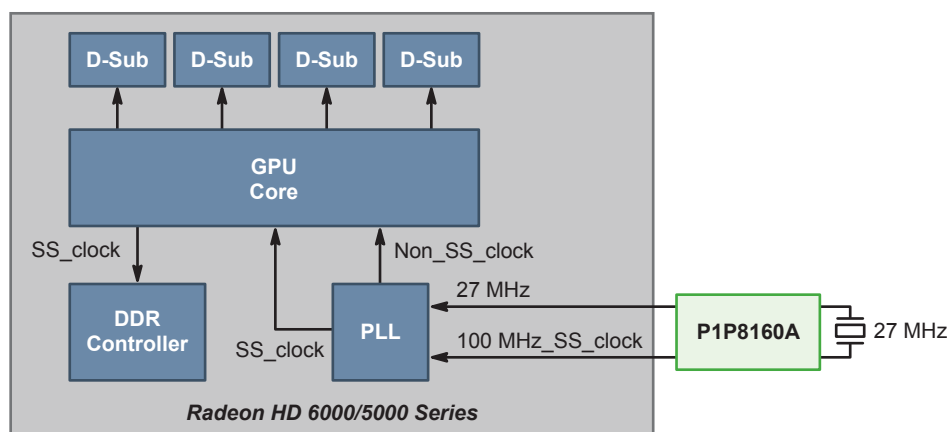
NB3N121K Logic Diagram

| 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 |
|----------|-------|--------------------------------------------|---------------------------------|--------------------------|-----------------------------------------|---------------------------------|---------|
| 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  |

### Computing Clock for Graphics

#### P1P8160A Features

- Provides reference clock to the GPU & reduces EMI in the GDDR interface
- Input frequency 27 MHz; crystal or reference clock
- Output frequency 100 MHz spread spectrum clock; 27 MHz RefOUT
- Two tri-level logic pins for selecting eight frequency deviations along with SSOFF
- Modulation rate at 100 MHz: 32 kHz
- Low cycle-cycle & long term jitter
- Supply voltage: 3.3 V  $\pm$ 10%
- WDFN-10 package

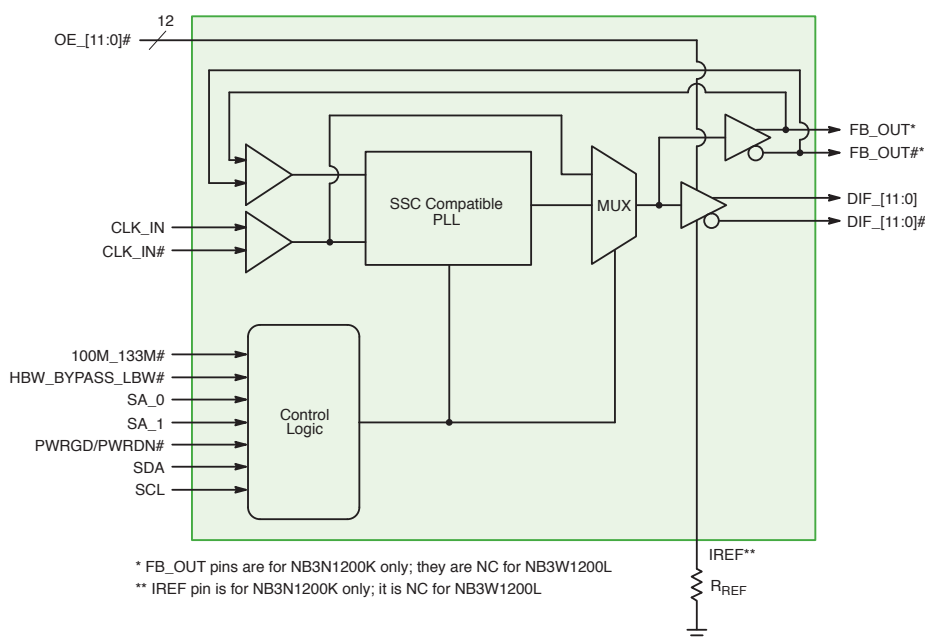


**P1P8160A for AMD Graphics Card Application**

## Zero Delay Buffers Compliant with DB Specifications

### Features

- Differential SRC clock support
- NB3N1900K, NB3N1200K: DB1900Z and DB1200Z compliant with 19 and 12 output pairs respectively
- NB3W1200L, NB3W800L: DB1200ZL and DB800ZL compliant with 12 and 8 low power NMOS push-pull output pairs respectively
- NB3W1900L: 19 low power NMOS push-pull output pairs
- Optimized for 100 MHz and 133 MHz to meet PCIe\* Gen 2/Gen 3 and Intel QPI 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 Simplified Block Diagram**

| Device    | Ratio | Output                   | t <sub>jitter</sub> (Cy-Cy) Typ (ps) | t <sub>skew</sub> (I-o) Max (ps) | t <sub>skew</sub> (o-o) Max (ps) | Edge Rate Max (V/ns) | Package |
|-----------|-------|--------------------------|--------------------------------------|----------------------------------|----------------------------------|----------------------|---------|
| NB3W800L* | 1:8   | Low power NMOS push-pull | 34                                   | ±100                             | 50                               | 4                    | QFN-48  |
| NB3N1200K | 1:12  | HCSL                     | 50                                   | ±100                             | 50                               | 4                    | QFN-64  |
| NB3W1200L | 1:12  | Low power NMOS push-pull | 50                                   | ±100                             | 50                               | 4                    | QFN-64  |
| NB3N1900K | 1:19  | HCSL                     | 50                                   | ±100                             | 65                               | 4                    | QFN-72  |
| NB3W1900L | 1:19  | HCSL                     | 50                                   | ±100                             | 85                               | 4                    | QFN-72  |

\* Pending 3Q15.

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