# Computing Solutions

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

www.onsemi.com

# 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.
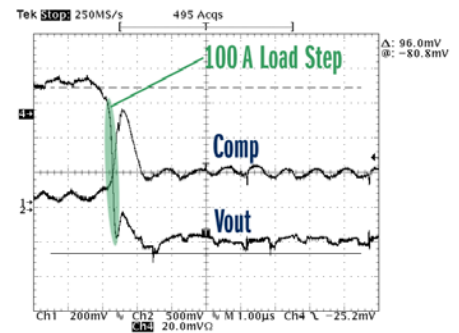
## Features

- 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)
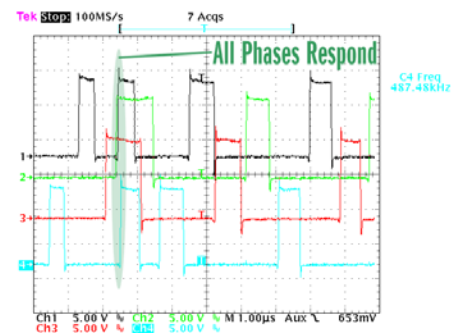
| Device | VR Spec | Controller Architecture | CPU Phases | GPU Phases | Integrated Drivers | Interface | SM-Bus | Package |
|---|---|---|---|---|---|---|---|---|
| NCP81101 | VR12.6+ | RPM | 1 | – | 1 x 5 V | SVID | – | QFN-28 |
| NCP81105 | VR12.6 | Dual Edge | 2/3 | – | – | SVID | – | QFN-36 |
| NCP81108 | 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 |
| NCP5395 | VR11.1 | Dual Edge | 2/3/4 | – | 3 CPU | PVID | – | QFN-48 |
| 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
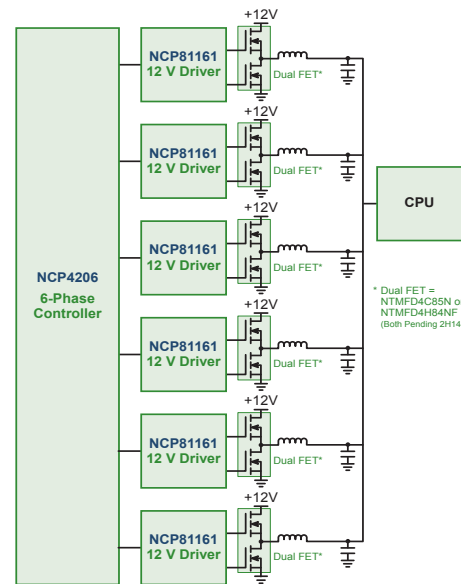
### NCP81102 1/2/3/4-phase controller

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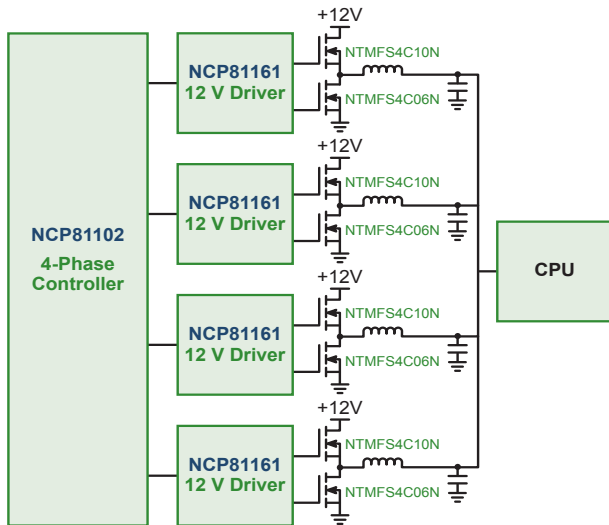


## Server Solutions

### 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
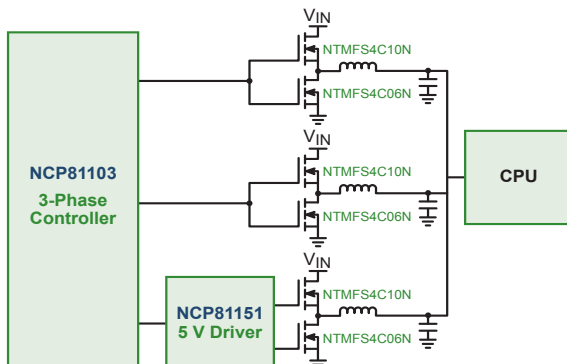- NCP4206 has built in shunt regulator, enabling it to be powered from +12 V system supply through series resistor



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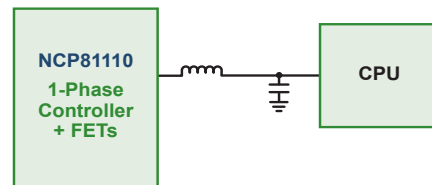
# VR12.5/6 Multiphase Controllers for Embedded Applications

## 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
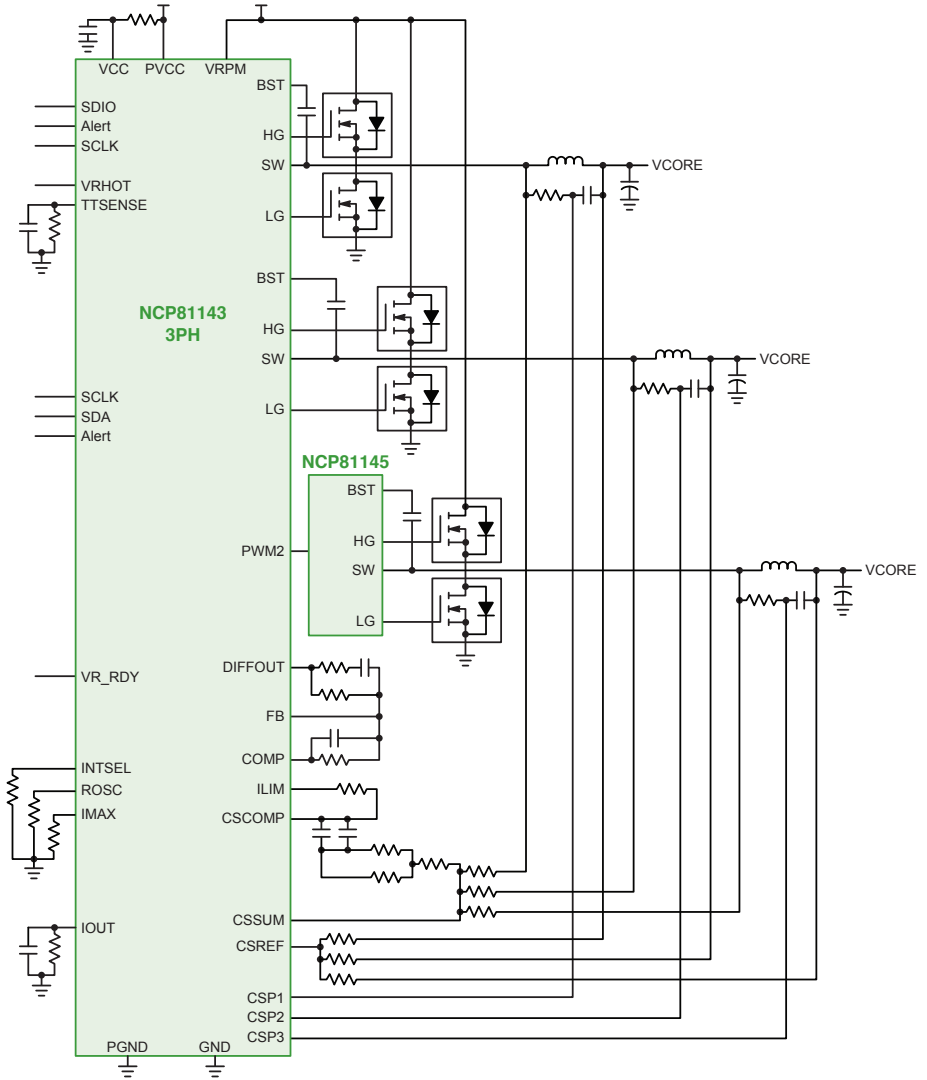
| Device | Description | Driver / MOSFETs | Package |
|--------|-------------|------------------|---------|
| NCP81140 | 4-Phase Controller | – | QFN-32 |
| NCP81141 | 1-Phase VR12.6 Controller | Integrated 5 V Driver | QFN-28 |
| NCP81142 | 4-Phase VR12.5 Controller | – | QFN-32 |
| NCP81143 | 3-Phase 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 2H14

# System Power

System power management devices provide additional rails in computing applications, beyond Vcore and graphics. They are available with single or dual channel operation, and also in multi-phase configurations.
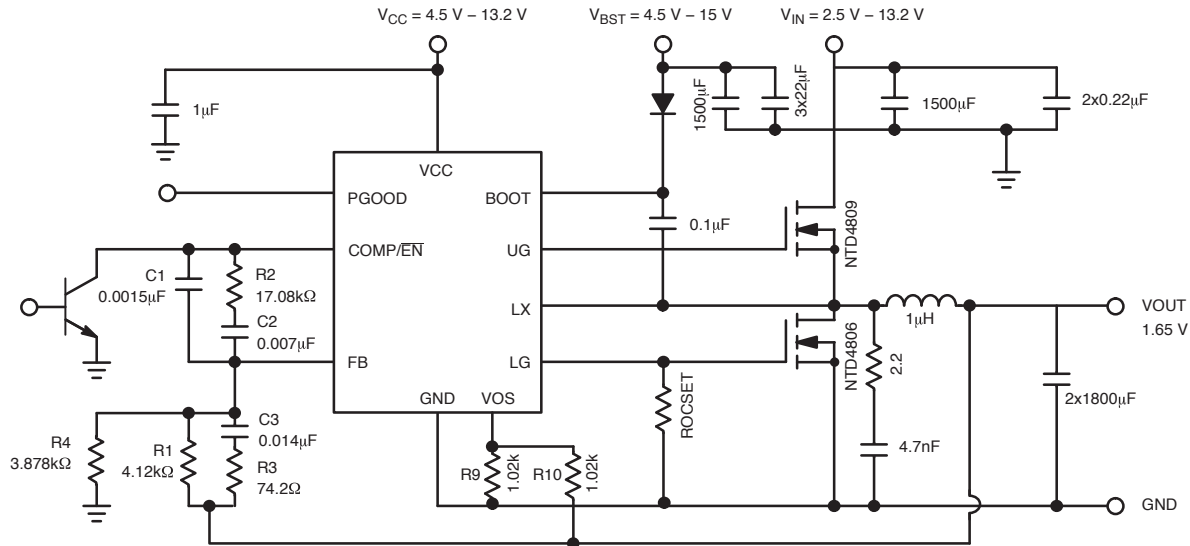


**NCP1589A Application Diagram**

| Device | Description | Topology | $V_{CC}$ Min (V) | $V_{CC}$ Max (V) | $f_{SW}$ Typ (MHz) | 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 | Snychronous 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 |

# 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
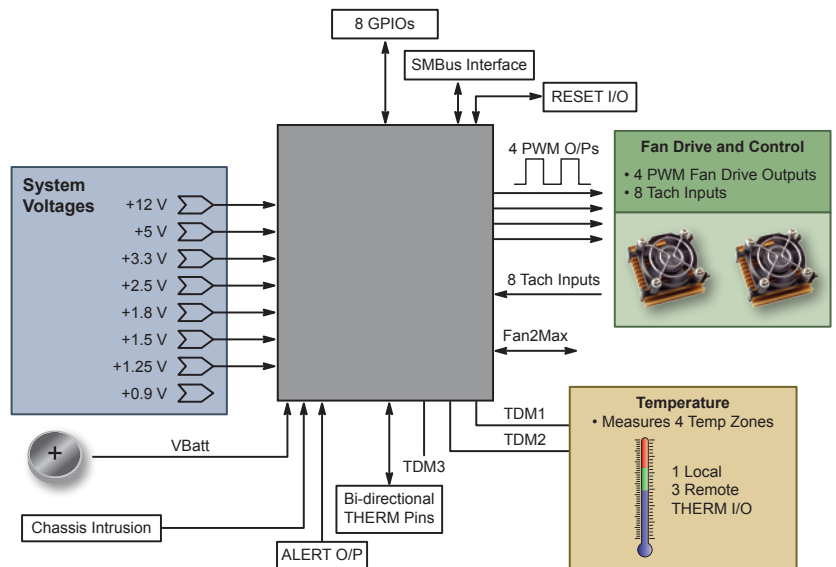


| | Device | Supply Range (V) | Temperature Range (°C) | Local Accuracy (°C) | Interface | Number of Addresses | SRC (Ω) | Remote Accuracy | Remote Channels | Fan Channels | TACH Channels | Voltage Monitoring Channels | GPIOs | Package |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| | 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 |
| **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 |
| | 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 |
| **Local Sensors** | 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 |

* Pending 2H14.

# 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
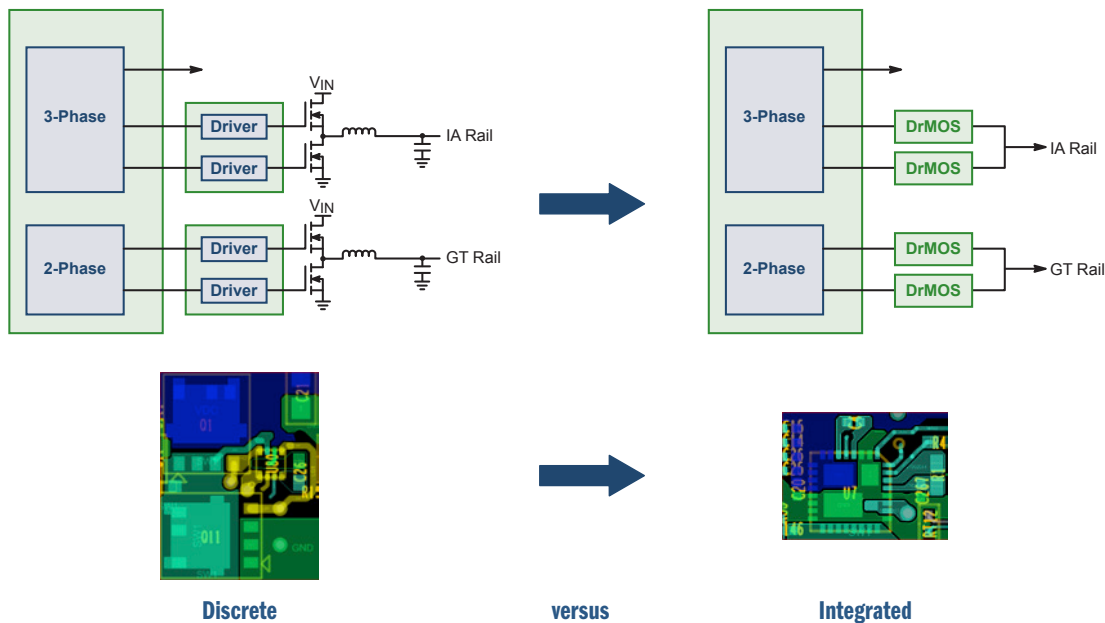


**Discrete** versus **Integrated**

| Device | PWM Input | $V_{IN}$ Max (V) | Freq Max (MHz) | $I_{OUT}$ 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 2H14.

# Drivers for Discrete MOSFET Implementations

Drivers specifically designed to work with controller solutions, and optimized for 5 V or 12 V gate applications.
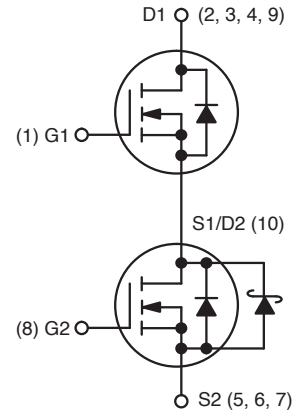
| Device | Drivers | $V_{CC}$ Typ (V) | Integrated Bootstrap Diode | ZCD* | Package |
|---|---|---|---|---|---|
| NCP5901 | Single | 12 | N | Y | DFN-8 |
| NCP5901B | Single | 12 | Y | Y | DFN-8 |
| NCP81161 | Single | 12 | Y | Y | DFN-8 |
| NCP81151 | Single | 5 | Y | Y | DFN-8 |
| NCP81253 | Single | 5 | Y | N | DFN-8 |
| NCP81061 | Dual | 12 | Y | Y | QFN-16 |
| NCP81152 | Dual | 5 | Y | Y | QFN-16 |

* Zero Crossover Detection.

# MOSFETs Provide Optimized Efficiency

D1 ○ (2, 3, 4, 9)

**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

(1) G1

S1/D2 (10)

(8) G2

S2 (5, 6, 7)

| Device | Package | Config | Polarity | $V_{DS}$ (V) | $V_{GS}$ (V) | $R_{DS(ON)}$ (mΩ) $V_{GS}$= 10 V | $R_{DS(ON)}$ (mΩ) $V_{GS}$= 4.5 V | $Q_g$ (nC) | $Q_{gd}$ (nC) | $C_{iss}$ (pF) | $C_{rss}$ (pF) | $R_G$ (Ω) | Applications |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| NTMFD4H84NF* | PhaseFET | Asym Dual | N | 25 | 20 | 3.3 | 4.8 | 8.9 | 2.6 | 1222 | 36 | 1.0 | Control Side |
| | | | N + Int Sch | 25 | 20 | 0.8 | 1.3 | 28.5 | 9.0 | 3893 | 164 | 1.0 | Synchronous Side |
| NTMFD4H85NF* | PhaseFET | Asym Dual | N | 25 | 20 | 3.6 | 4.7 | 8.5 | 1.9 | 1194 | 35 | 1.0 | Control Side |
| | | | N + Int Sch | 30 | 20 | 1.5 | 2.1 | 33.9 | 7.9 | 4896 | 180 | 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 |
| NTMFD4C88N* | PowerPhase | Asym Dual | N | 30 | 20 | 5.0 | 7.7 | 10.9 | 5.4 | 1252 | 126 | 1.0 | Control Side |
| | | | N | 30 | 20 | 3.4 | 5.0 | 11.0 | 2.9 | 1546 | 39 | 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/ 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 |

* Pending 3Q14.

# MOSFETs Provide Optimized Efficiency

| Device | Package | Configuration | Polarity | Maximum Rating | | | | | | | | | | Applications |
|--------|---------|---------------|----------|----------------|---|---|---|---|---|---|---|---|---|--------------|
| | | | | $V_{DS}$ (V) | $V_{GS}$ (V) | $R_{DS(ON)}$ (mΩ) | | $Q_g$ (nC) | $Q_{gd}$ (nC) | $C_{iss}$ (pF) | $C_{rss}$ (pF) | $R_G$ (Ω) | | |
| | | | | | | $V_{GS}=$ 10 V | $V_{GS}=$ 4.5 V | | | | | | | |
| 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 |
| 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 |
| 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 |
| 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 |

**SO-8FL**
**5 x 6 mm**

**µ8FL**
**3.3 x 3.3 mm**

**DPAK**

**SOIC-8**
**5 x 6 mm**

# 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
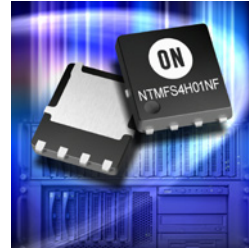
| Device | Package | Config | Polarity | Maximum Rating | | | | $Q_g$ (nC) | $Q_{gd}$ (nC) | $C_{iss}$ (pF) | $C_{rss}$ (pF) | $R_G$ ($\Omega$) | Applications |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{DS}$ (V) | $V_{GS}$ (V) | $R_{DS(ON)}$ (m$\Omega$) | | | | | | | |
| | | | | | | $V_{GS}=$ 10 V | $V_{GS}=$ 4.5 V | | | | | | |
| NTMFS4H01N | SO-8FL | Single | N | 25 | 20 | 0.7 | 1.0 | 39.0 | 8.5 | 5693 | 212 | 1.2 | Synchronous Side |
| NTMFS4H01NF | SO-8FL | Integ Sch | N | 25 | 20 | 0.7 | 1.0 | 37.8 | 8.0 | 5538 | 175.3 | 1.3 | Synchronous Side |
| NTMFS4H013NF* | SO-8FL | Integ Sch | N | 25 | 20 | 0.9 | 1.3 | 28.0 | 7.5 | 3780 | 150 | 1.0 | Synchronous Side |
| NTMFS4H02N | SO-8FL | Single | N | 25 | 20 | 1.4 | 2.2 | 18.0 | 4.2 | 2651 | 103 | 1.0 | Synchronous Side |
| NTMFS4H02NF | SO-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 2H14.

# 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.
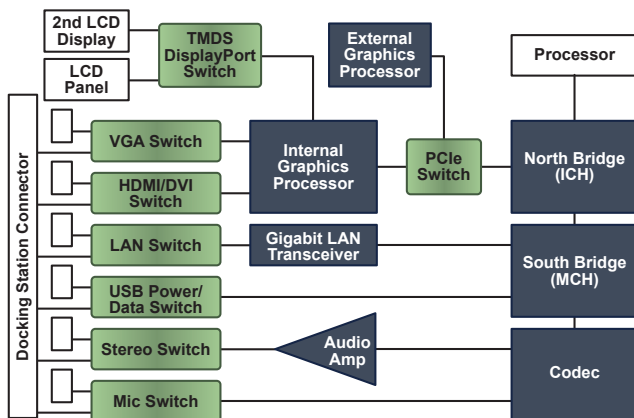


**Server Implementation**

| 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 |
| NCN2411 | PCIe 2.0 | 5 Gb/s | 8 | 200 µA |
| NS3L500 | Gigabit Ethernet | 1 Gb/s | 11 | 250 µA |
| NCN7200 | Gigabit Ethernet | 1 Gb/s | 11 | 380 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

**ecoSWITCH™**
ADVANCED LOAD MANAGEMENT
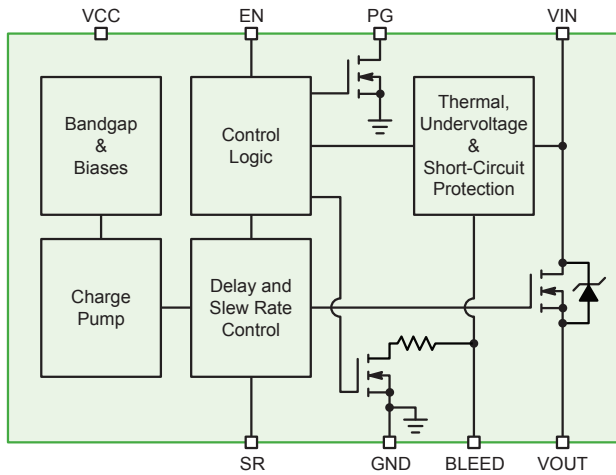


**NCP45xxx Integrated Load Switch Feature**
- Simple/clean design
- No current consumption in standby power mode
- Small PCB footprint
- Low $R_{DS(ON)}$ due to charge pump driving NMOS
- Adjustable soft-start time (SR)
- Adjustable integrated discharge
- Fault protection
- Power rail monitoring & sequencing

| Type | Device | $r_{on}$ (mΩ) | I Max (A) | $V_I$ Min (V) | $V_I$ Max (V) | $I_Q$ (μA) | Discharge | Slew Rate (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 | 3.9 | 20 | 0.5 | 13.5 | - | Adj | Adj | Power good; Fault | DFN-12 |
| | NCP4543 | 10.2 | 7.3 | 0.5 | 6 | - | Adj | Adj | - | QFN-18 |
| | NCP4545 | 4.7 | 10.5 | 0.5 | 6 | - | Adj | Adj | - | QFN-18 |
| | 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 |

## Evaluating ESD Protection Effectiveness

As the design window for protection shrinks, choosing ESD protection products with low Rdyn becomes more important to ensure that clamping voltages do not exceed the safe protection window of new chipsets. Suppliers of ESD protection products must therefore provide information on the effectiveness of the product for protection, not just self-survival levels.

ON Semiconductor demonstrates ESD protection effectiveness using two methods: ESD screen shots and Transmission Line Pulse (TLP) measurements. ESD screen shots capture the voltage across the protector when an IEC 61000-4-2 ESD stress is forced through it; typically for an 8 kV contact stress. The screen shot shown in Figure 1 demonstrates how an ON Semiconductor protection device clamps the voltage to below 20 V within 10 ns for an 8 kV stress. Screen shots provide a graphic and intuitive view of a protection product's effectiveness, especially when comparing two products intended for the same application. Application Note AND8307/D describes the capture of screen shot data. Screen shots do not, however, allow the extraction of fundamental parameters describing the performance of a protection product. Transmission Line Pulse (TLP) provides a more quantitative measurement of ESD protection device effectiveness.
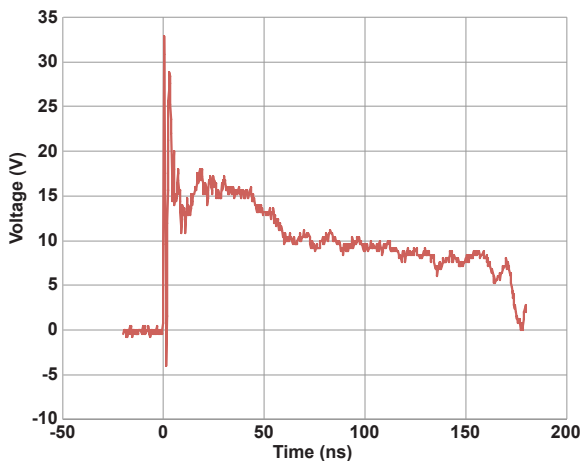


**Figure 1.  ESD clamping screenshot**

TLP creates I-V curves in which each data point is obtained with a square pulse that closely matches an ESD event in terms of current shape and pulse width. TLP pulse lengths are typically 100 ns, with pulse amplitudes up to 40 A. Sample TLP I-V curves are shown in Figure 2, comparing an ON Semiconductor product with a competitor's product intended for the same application. The ON Semiconductor product turns on at a lower voltage and has significantly lower dynamic resistance than the competitor's device. The TLP I-V curves and parameters extracted from them can be used to compare the properties of different ESD protection devices and can be used to predict a circuit's ESD clamping performance. Parameters that can be extracted from TLP data include clamping voltage values for specified current levels, as well as dynamic resistance and voltage intercepts. Application Note AND9006/D gives a full explanation of the TLP technique, and Application Note AND9007/D describes datasheet parameters extracted from TLP measurements.
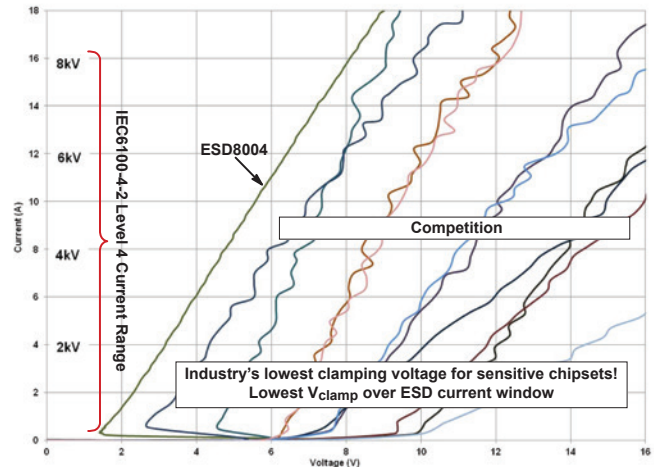


**Figure 2.  Typical TLP I-V curves from TLP measurements**

## Maintaining Signal Integrity

ESD and EMI solutions protect against unwanted signals that interfere with the overall system performance. During a system's normal operation, these protection devices must not degrade signal integrity, as they must be completely transparent. As the data rates on serial interfaces increase, it is important to demonstrate that protection products do not degrade signal integrity. ON Semiconductor uses several methods to demonstrate that these products do not degrade signal integrity.

One way in which to measure signal integrity effects is with the S-parameter return and insertion loss plots, such as the ones in Figures 3 and 4. S11 plots measure signal power return loss over frequency, where a small amount of loss shows up as a large –dB value due to the matched impedance of the interconnect. Lower return loss translates into more of the signal, both amplitude and phase, being transferred through the interconnect which can be seen in the S21 plot where the signal power insertion loss is being measured. Both S-parameter plots below show how an ON Semiconductor ESD protection device maintains the lowest loss and best transparency among other top competitor devices. Application Note AND9114/D explains these signal integrity measurements and the ESD device characteristics that affect them in more detail.
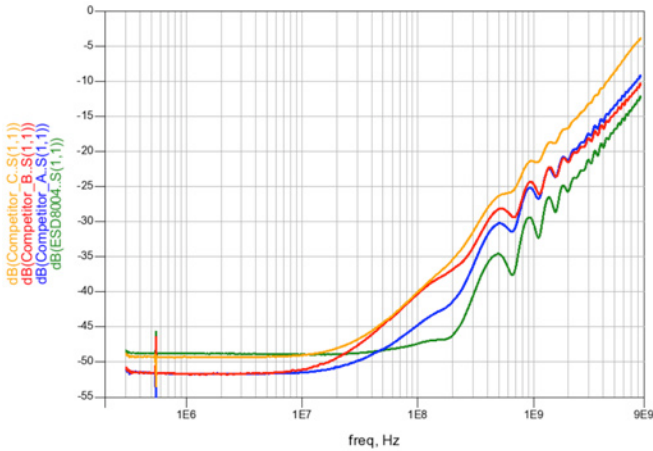
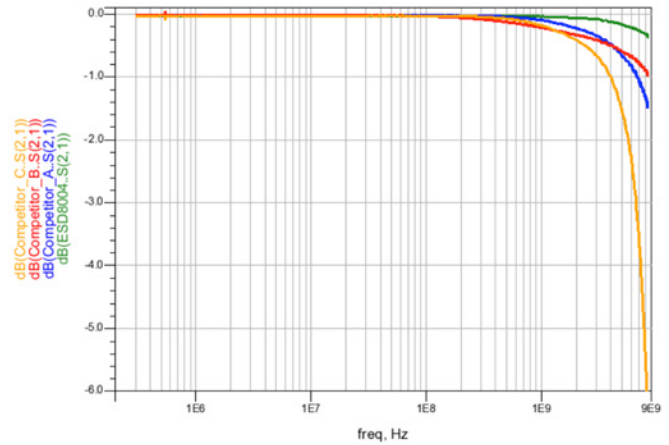Figure 3. Return loss (S11) characteristics of ESD protection solutions



Figure 4. Insertion loss (S21) characteristics of ESD protection solutions

## Surge Protection

ON Semiconductor provides solutions for protecting against surge strikes, induced by a lighting strike or power-cross fault. Common interfaces found in a wide variety of consumer and telecommunications/networking equipment are the RJ45 interface for the 10/100BASE-T and 1000BASE-T Ethernet protocols and the RJ11 interface for xDSL protocols. RJ45 consists of four pairs of differential data lines, each carrying a maximum data rate of 250 Mbps in a 1000BASE-T configuration, while RJ11 consists of a single differential data pair. These interfaces are often surge rated to an intra-building standard. Protection for these interfaces mainly consist of ensuring that transverse (metallic or differential) surge strikes do not damage sensitive downstream chips such as PHYs. Differential protection is achieved by connecting shunt protection elements from line-to-line (for each pair of lines) that transfer the incoming hostile surge energy back towards the source. This is different from common mode protection as elements are connected line-to-GND and shunt the surge energy to GND.

For lower data-rates (10/100BASE-T, xDSL), ON Semiconductor offers a combination of crowbar devices known as thyristor surge protector devices (TSPD), and transient voltage suppressor (TVS) devices similar to those used in ESD protection. TSPDs offer the advantage of lower clamping voltages and possess higher surge current capability, for both common and differential mode protection.
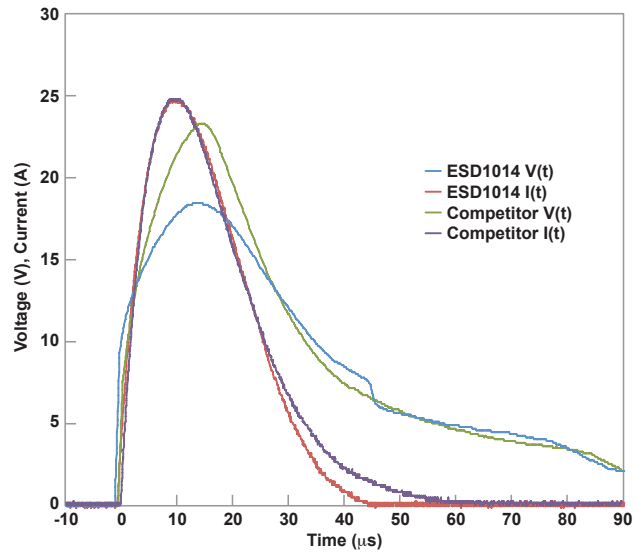


Figure 5. Example of V & I plots in an 8/20 μs surge

TVS clamping devices support surge levels for the 8/20 μs pulse and are commonly used on the tertiary or PHY-side to capture and safely dissipate any residual surge pulses. Pictured in Figure 1 is a time-domain plot of the 8/20 μs surge current applied to the ESD1014 TVS from ON Semiconductor. Also shown are time-domain response voltages, clearly showing the superiority of the ON Semiconductor solution in comparison to a competing device.

# *USB 3.0/3.1*

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

### Key Requirement

- Cap < 0.5 pF (USB 3.0)
- Cap < 0.4 pF (USB 3.1)

### Features

- 0.37 pF or less
- Flow through routing
- Industry leading low clamping voltage versus competitors
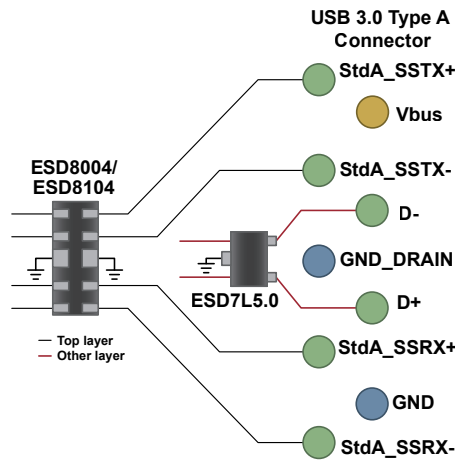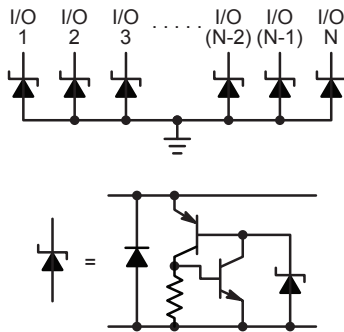
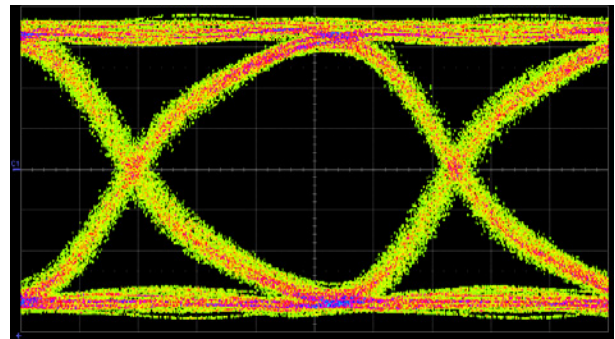**ESD8004/8104 — 0.30 pF, 2 Layer Routing**
(ESD7L5.0 for D+, D- Lines)
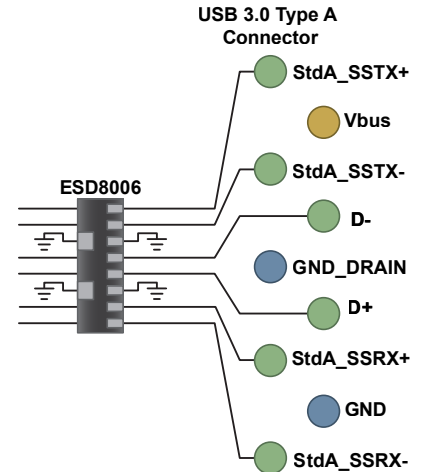
**ESD8006 — 0.25 pF, 1 Layer Routing**

| Device | Data Lines | Capacitance (pF) | Package | Size (mm) |
|---|---|---|---|---|
| ESD8006 | 3 Pair (Tx, Rx, D+, D-) | 0.25 | UDFN-8 | 3.3 x 1.0 |
| ESD8004 | 2 Pair (Tx, Rx) | 0.30 | UDFN-10 | 2.5 x 1.0 |
| ESD8104 | 2 Pair (Tx, Rx) | 0.30 | UDFN-10 | 2.5 x 1.0 |
| ESD7L | 1 Pair (D+, D-) | 0.50 | SOT-723 | 1.2 x 1.2 |
| ESD8351 | Single Line 0201 | 0.37 | X3DFN-2 | 0.62 x 0.32 |
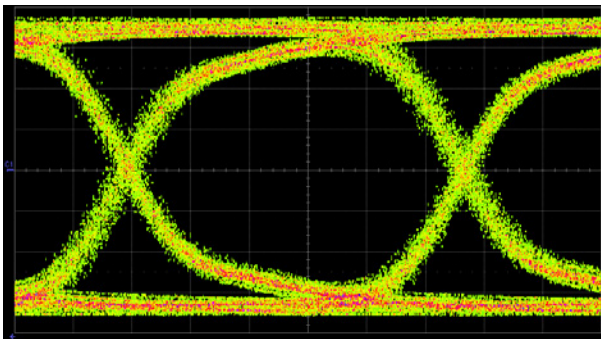
**Without ESD**

**With ESD**

**USB 3.1 @ 10 Gb/s**

# Thunderbolt

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

**Key Requirement**

- Cap < 0.4 pF

**Features**

- 0.25 pF
- Flow through routing
- Grounds between pairs for reduced cross talk
- Industry leading clamping voltage

**Thunderbolt Connectctor Top Layer**

ESD8006

GND
ML0+
ML0−
GND
ML1+
ML1−
GND
ML2+
ML2−
GND

I/O 1   I/O 2   I/O 4   I/O 5   I/O 7   I/O 8

Pins 3, 6, 9, 10
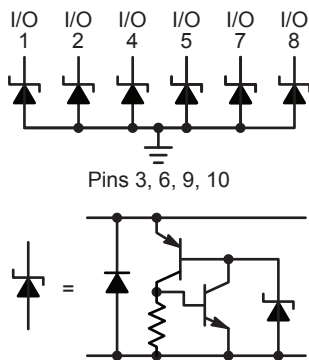
| Device | Data Lines | Capacitance (pF) | Package | Size (mm) |
|---|---|---|---|---|
| ESD8006 | 3 Pair | 0.25 | UDFN-8 | 3.3 x 1.0 |
| ESD8351 | Single Line 0201 | 0.37 | X3DFN2 | 0.62 x 0.32 |

**Thunderbolt Connetctor Bottom Layer**

ESD9X

ESD8006

Hot Plug Detect
CONFIG1
CONFIG2
GND
ML3+
ML3−
GND
Aux+
Aux−
PWR

— Top layer
— Bottom layer

ESD9X
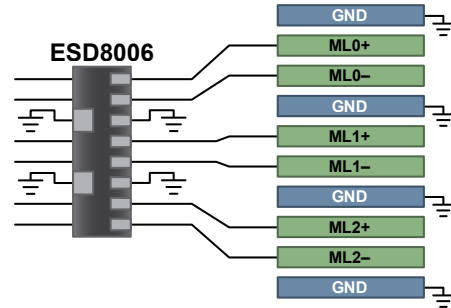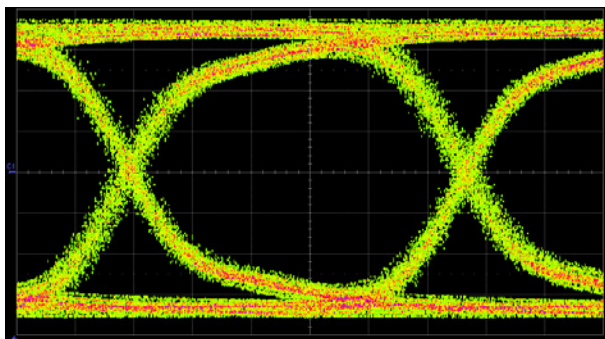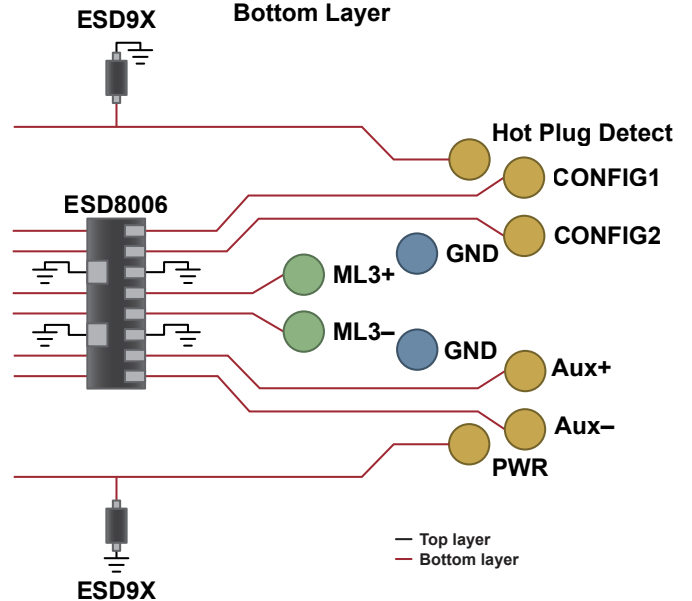
Without ESD8006
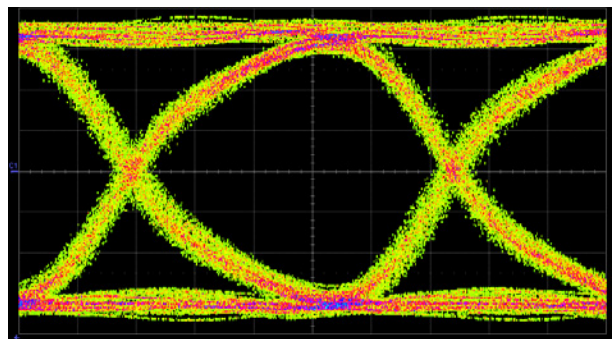
With ESD8006

**Thunderbolt @ 10 Gb/s**

# USB 2.0

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

### Key Requirement

- Cap < 1.5 pF

### Features

- 0.5 - 0.8 pF
- 4 low speed + 1 VBUS integrated – can protect up to 2 USB ports
- Industry leading low clamping voltage
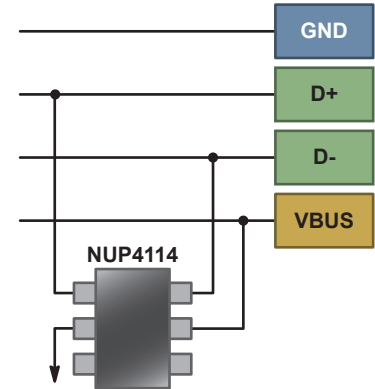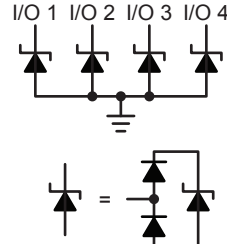
| Device | Data Lines | Capacitance (pF) | Package | Size (mm) |
|---|---|---|---|---|
| NUP4114UCL | 2 Pair + Power | 0.50 | SC-88 | 2.0 x 2.1 |
| NUP4114UPX | 2 Pair + Power | 0.80 | SOT-563 | 1.6 x 1.6 |
| NUP4114H | 2 Pair + Power | 0.80 | TSOP-6 | 3.0 x 2.75 |
| NUP3115 | 1 Pair + ID + Power (D+, 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
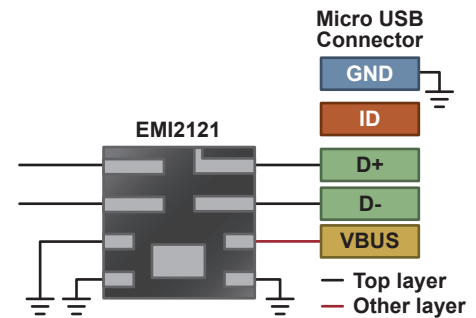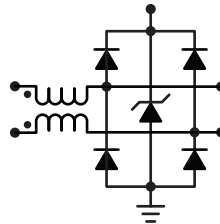
| Device | Data Lines | Capacitance @ 2.5 V (pF) | CM Attenuation @ 800 MHz (−dB) | DM Bandwidth F3dB (GHz) | Package | Size (mm) |
|---|---|---|---|---|---|---|
| EMI2121 | 1 Pair + Power (D+, D-, VBUS) | 0.9 | −25 | 2.5 | WQFN | 2.2 x 2.0 x 0.75 |
| EMI2124 | 1 Pair + ID + Power (D+, D-, ID, VBUS) | 0.9 | −25 | 2.5 | WQFN | 2.2 x 2.0 x 0.75 |

**USB 2.0 @ 480 Mb/s**

Suppresses Common Mode Noise
Deeper than Competing Passive Solution
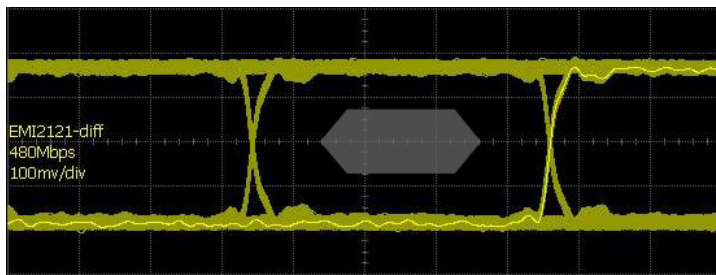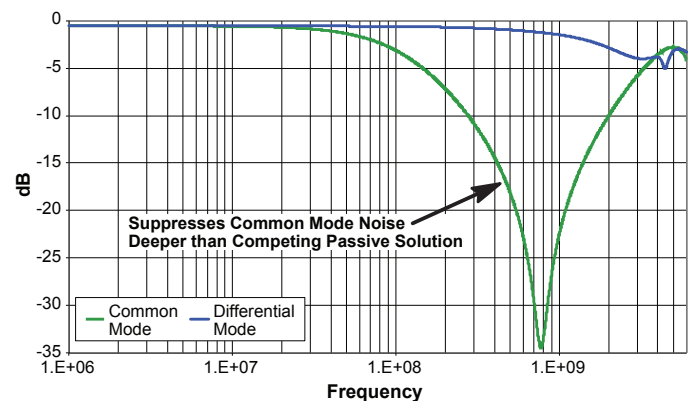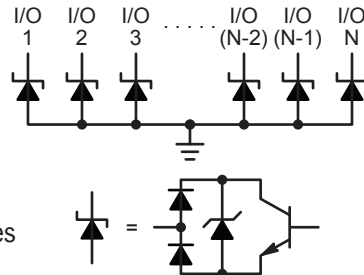
# HDMI, Display Port

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

## Key Requirement

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

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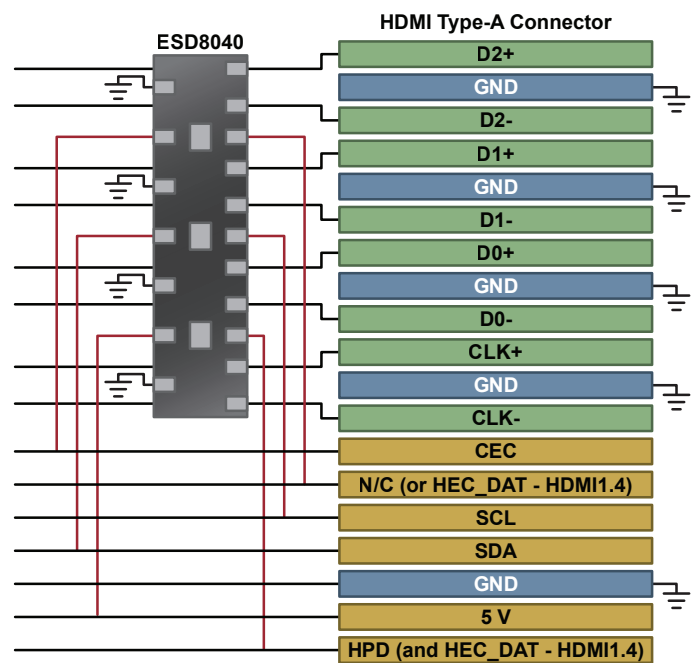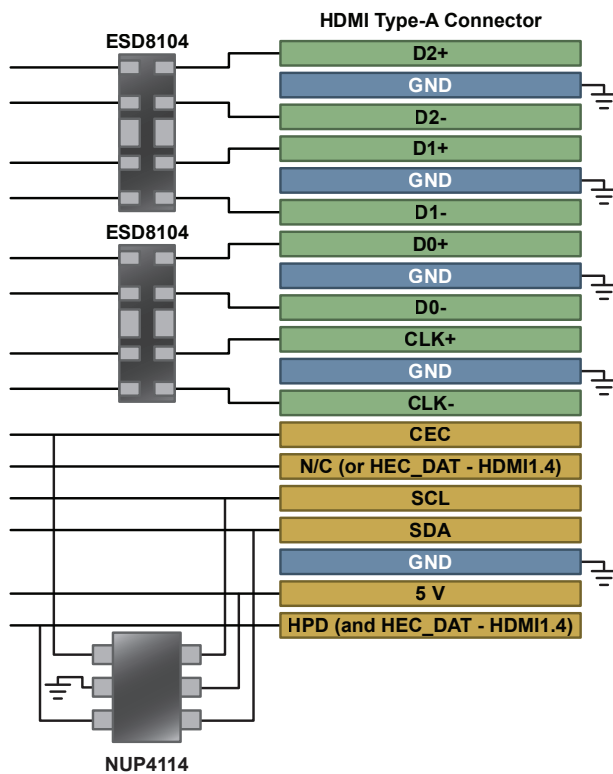
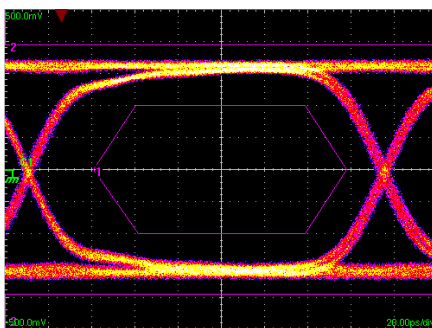- 0.3 pF ESD protection
- Flow through routing in high speed lines
- Industry leading low clamping voltage

| Device | Data Lines | Capacitance (pF) | Package | Size (mm) |
|---|---|---|---|---|
| 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

— Top layer
— Other layer

**Without ESD**
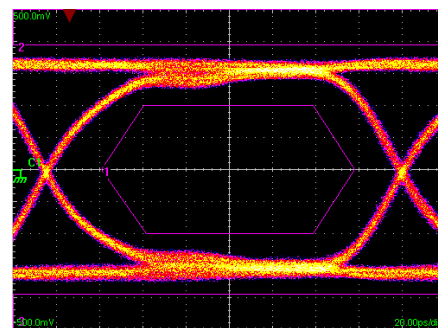
**With ESD**

**HDMI 2.0 @ 6.0 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
- $V_{clamp}$ (25 A surge) < 11 V
- IEC 61000-4-2 rating > 30 kV
- No latching danger
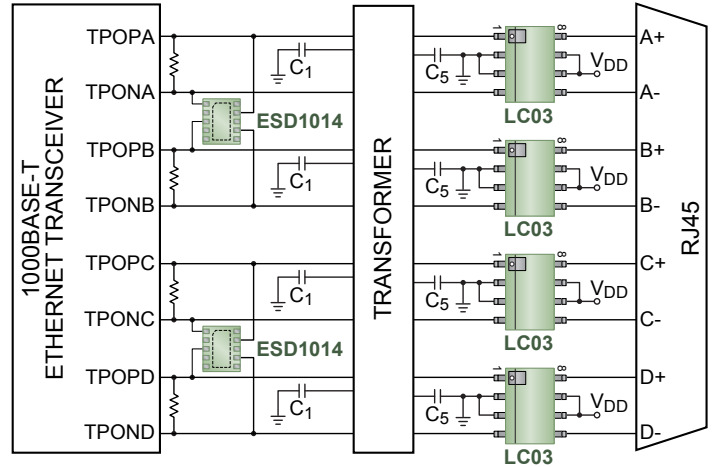- Surge rating maintained to 125°C

### 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
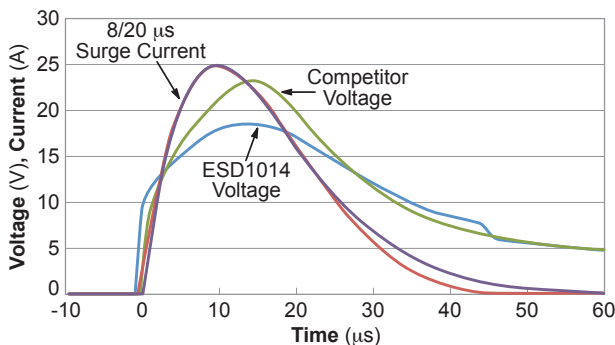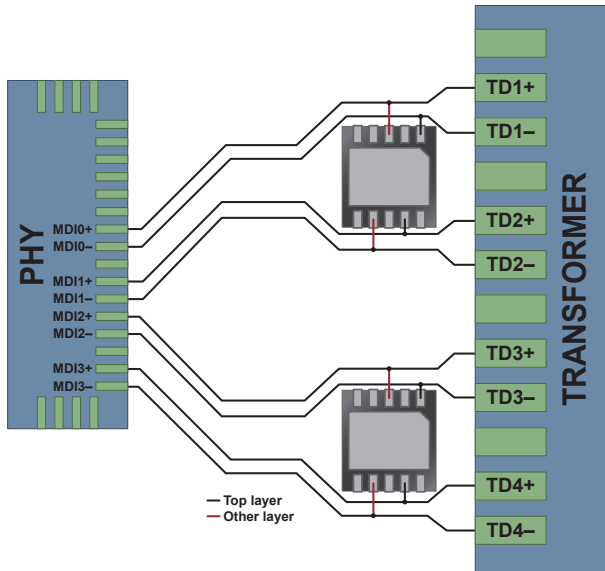
**Typical Application**
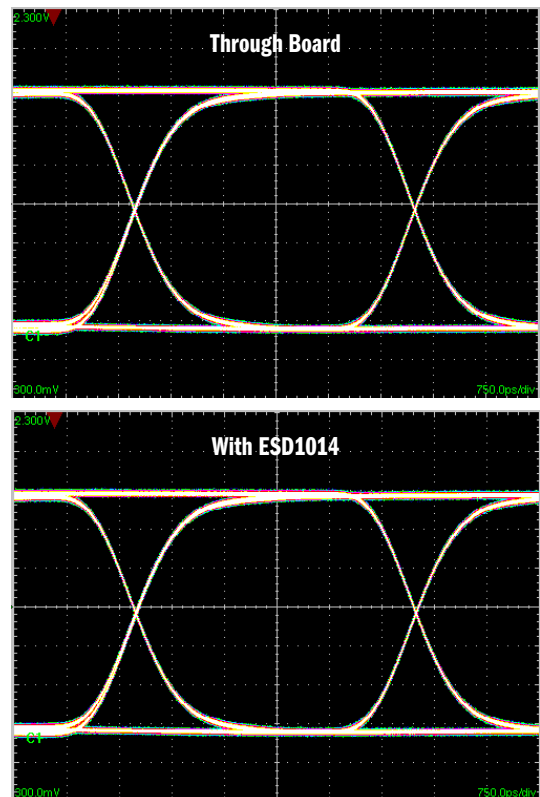


**Line Side : LC03-6 (optional)**
**Transformer Side: ESD1014**
**Protection against metallic (transverse) strikes**
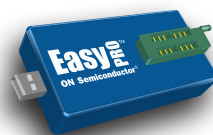




**Line-to-Line Surge**

**Signal Integrity for Gigabit Ehternet**

# 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$^2$C, SPI, Microwire)

### EEPROMs

| Data Transmission Standard | Device | Density | Organization* | V$_{CC}$ Min (V) | V$_{CC}$ Max (V) | f$_{CLK}$ Max (MHz) | Package(s) |
|---|---|---|---|---|---|---|---|
| I$^2$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 |
| | CAT24C32 | 32 kb | 4k x 8 | 1.7 | 5.5 | 1 | SOIC-8, TSSOP-8, UDFN-8; 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 |
| | CAT24C02 | 2 kb | 256 x 8 | 1.7 | 5.5 | 0.4 | SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5 |
| SPI | 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 |
| | CAT25010 | 1 kb | 128 x 8 | 1.8 | 5.5 | 20 | SOIC-8, TSSOP-8, UDFN-8 |
| Microwire | 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 | V$_{CC}$ Min (V) | V$_{CC}$ Max (V) | f$_{CLK}$ Max (MHz) | Package(s) | Notes |
|---|---|---|---|---|---|---|---|---|
| I$^2$C | CAT24C208 | 8 kb | 1024 x 8 | 2.5 | 5.5 | 0.4 | SOIC-8 | VESA™ dual-port serial EEPROM |
| I$^2$C | CAT34C04* | 4 kb | 512 x 8 | 1.7 | 5.5 | 1 | UDFN-8 | Serial Presence Detect (SPD) I2C EEPROM for DDR4 DIMM |
| I$^2$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$^2$C | CAT34C02 | 2 kb | 256 x 8 | 1.7 | 5.5 | 0.4 | UDFN-8, TDFN-8, TSSOP-8 | Serial Presence Detect (SPD) I2C EEPROM for DDR3 DIMM |
| I$^2$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 3Q14.

# Clock Synthesizers for High Performance Computing

## Features

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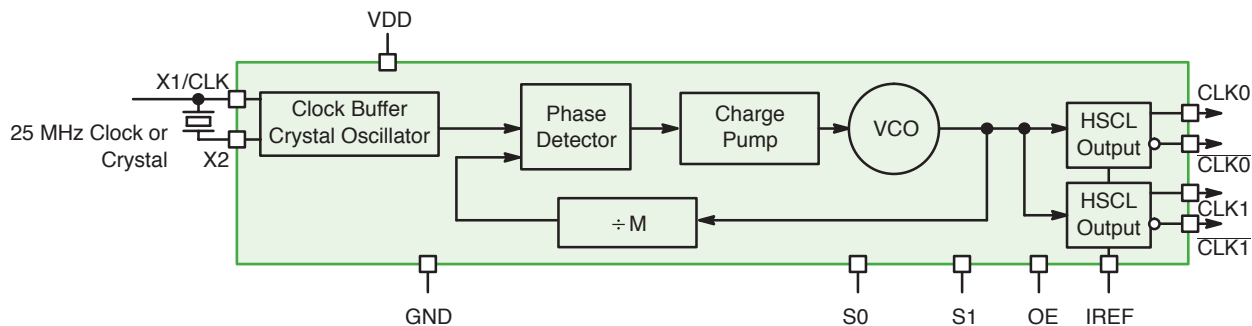


**NB3N5573 Simplified Logic Diagram**

| 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; LVTTL | 25 | 1 | HCSL | 25; 100; 125; 200 | No | TSSOP-16 |
| NB3N5573 | 1 | Crystal; LVCMOS; LVTTL | 25 | 2 | HCSL | 25; 100; 125; 200 | No | TSSOP-16 |
| NB3N51032 | 1 | Crystal; LVCMOS; LVTTL | 25 | 2 | HCSL | 25; 100; 125; 200 | No | TSSOP-16 |
| NB3N51034 | 1 | Crystal; LVCMOS; LVTTL | 25 | 4 | HCSL | 100: 200 | Yes | TSSOP-20 |
| NB3N51044 | 2 | Crystal; LVCMOS; LVTTL | 25 | 4 | HCSL | 100: 125 | No | TSSOP-28 |
| NB3N51054 | 1 | Crystal; LVCMOS; LVTTL | 25 | 4 | HCSL | 100 | Yes | TSSOP-24 |

# Fanout Buffers for High Performance Computing

**Features**

- DC to 400 MHz
- Single ended input: LVPECL, LVDS, HCSL
- Typical input clock frequencies: 100, 133, 166, or 400 MHz
- Typical propagation delay: 800 ps
- HCSL differential outputs
- Integrated 50 Ω 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
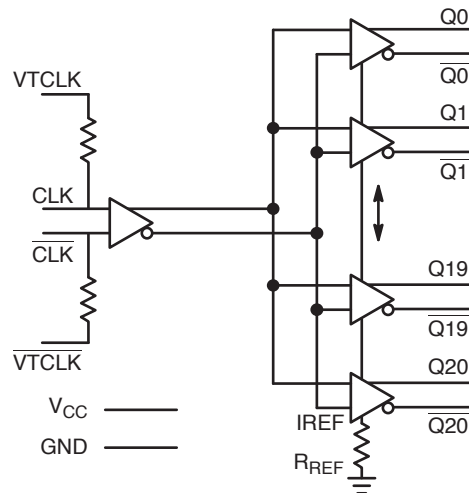
**NB3N121K Logic Diagram**

| Device | Ratio | Additive $t_{Jitter(RMS)}$ Typ (ps) | $t_{skew(o-o)}$ Max (ps) | $t_{pd}$ Typ (ns) | $t_R$ & $t_F$ Max (ps) | $f_{maxClock}$ Typ (MHz) | Package |
|--------|-------|------|------|------|------|------|---------|
| NB3N106K | 1:6 | 0.1 | 100 | 0.8 | 400 | 400 | QFN-24 |
| NB3N108K | 1:8 | 0.1 | 100 | 0.8 | 400 | 400 | QFN-32 |
| NB3N111K | 1:10 | 0.1 | 100 | 0.8 | 400 | 400 | QFN-32 |
| NB3N121K | 1:21 | 0.1 | 100 | 0.8 | 700 | 400 | QFN-52 |
| NB4N111K | 1:10 | <1 | 100 | 0.8 | 700 | 400 | QFN-32 |
| 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
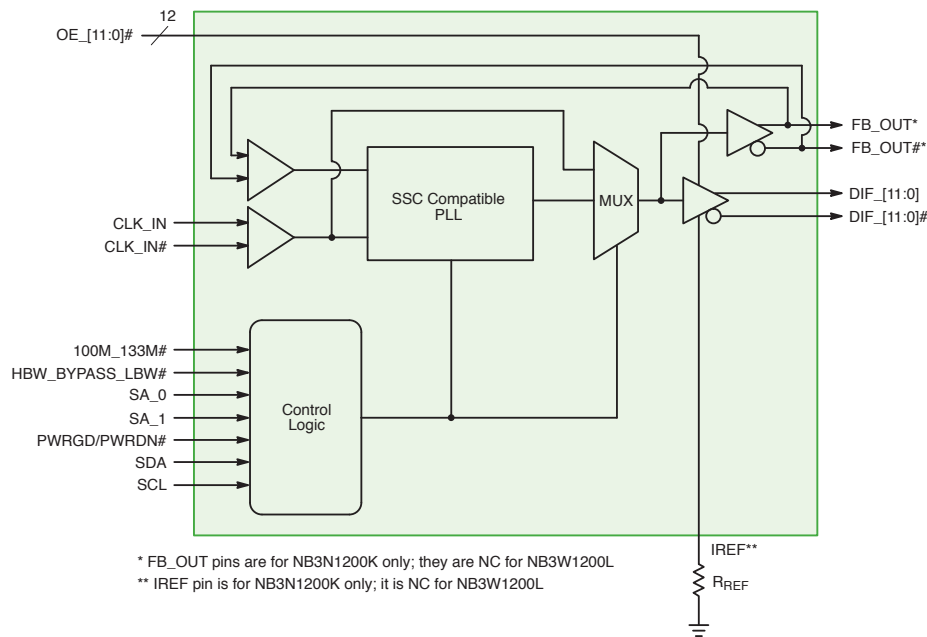- Supply voltage: 3.3 V ±10%
- WDFN-10 package
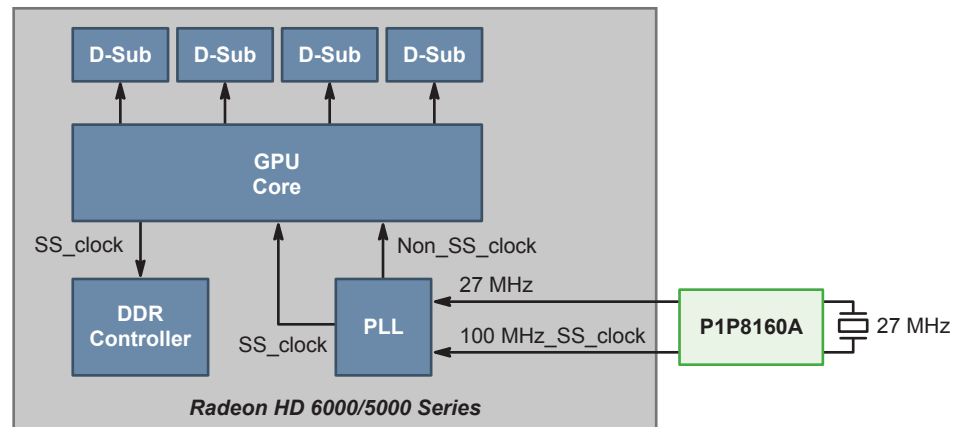
P1P8160A for AMD Graphics Card Application

# Zero Delay Buffers Compliant with DB1200Z/ZL Specifications

## Features

- Differential SRC clock support
- NB3N1200K: DB1200Z compliant 12 differential clock output pairs @ 0.7 V
- NB3W1200L: DB1200ZL compliant 12 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



* FB_OUT pins are for NB3N1200K only; they are NC for NB3W1200L
** IREF pin is for NB3N1200K only; it is NC for NB3W1200L

**NB3N1200K Simplified Block Diagram**

| Device | Ratio | Output | $t_{Jitter(Cy-Cy)}$ Typ (ps) | $t_{skew(I-o)}$ Max (ps) | $t_{skew(o-o)}$ Max (ps) | Edge Rate Max (V/ns) | Package |
|---|---|---|---|---|---|---|---|
| NB3N1200K | 1:12 | HCSL | 50 | ±100 | 50 | 4 | QFN-64 |
| NB3W1200L | 1:12 | Low power NMOS push-pull | 50 | ±100 | 50 | 4 | QFN-64 |

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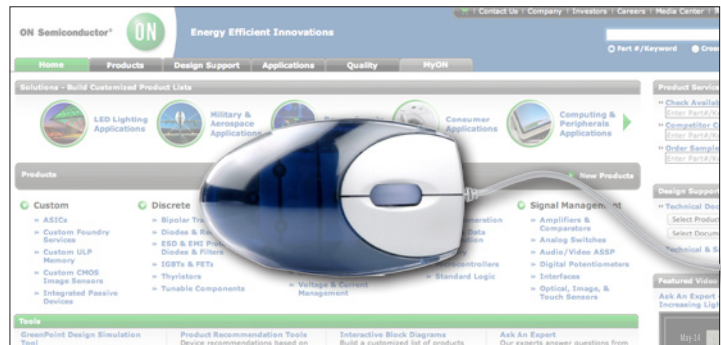| | | |
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