



BRD8025/D  
Rev. 14, Mar-2019

Energy Efficient Innovations

# Computing Solutions



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

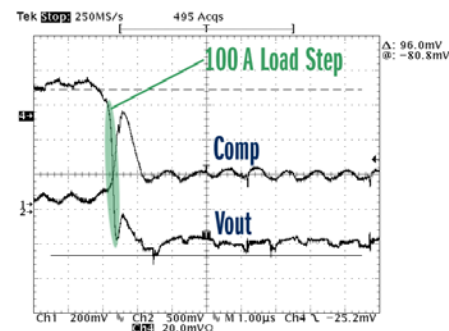


## Dual-Edge & RPM Modulation Vcore Controllers

for IMVP8 Designs

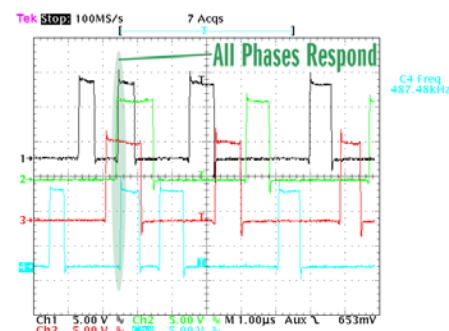
### Features of Multi-Phase Dual Edge Architecture

- Current-mode dual-edge modulation for fast initial response to transient loading
- High-performance operational error amplifier
- Accurate total summing current amplifier
- High-impedance differential voltage and total current sense amplifiers
- Phase-to-phase dynamic current balancing
- “Lossless” DCR current sensing for current balancing



### Features of Enhanced Single-Phase RPM Architectures

- High performance RPM control system
- Ultralow offset IOU monitor
- Dynamic VID feed-forward
- Programmable droop gain
- Zero droop capable
- Thermal monitor
- Ultra-sonic operation
- Digitally controlled operating frequency



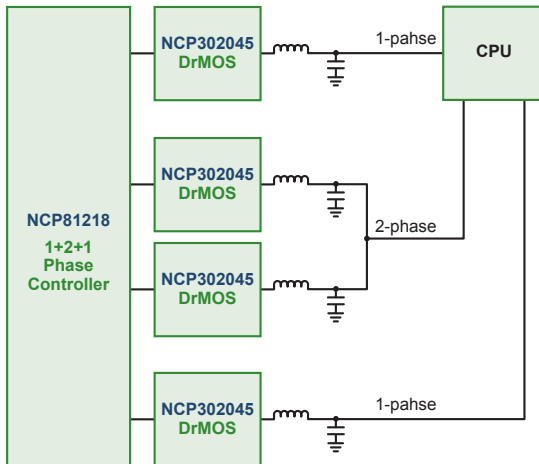
| Device    | Market               | Function   | VR Spec | Controller Architecture | Number of Rails | CPU Phases          | Integrated Drivers | Interface | Package |
|-----------|----------------------|------------|---------|-------------------------|-----------------|---------------------|--------------------|-----------|---------|
| NCP81111  | Microserver          | Controller | VR12.5  | Hybrid                  | 1               | 1/2/3               | —                  | SVID      | QFN-32  |
| NCP81213  | Desktop              | Controller | IMVP8   | Dual Edge               | 2               | 3/2/1+2/1           | —                  | SVID      | QFN-52  |
| NCP81220  | Desktop              | Controller | IMVP8   | Dual Edge               | 2               | 4/3/2/1+2/1         | —                  | SVID      | QFN-52  |
| NCP81266  | Desktop              | Controller | IMVP8   | Dual Edge               | 2               | 6/5/4/3/2/1+2/1     | —                  | SVID      | QFN-52  |
| NCP81228  | Desktop              | Controller | IMVP8   | Dual Edge               | 2               | 8/7/6/5/4/3/2/1+2/1 | —                  | SVID      | QFN-52  |
| NCP81229  | Desktop              | Controller | IMVP8   | Dual Edge               | 2               | 8/7/6/5/4/3/2/1+1   | —                  | SVID, I2C | QFN-52  |
| NCP81203P | Notebook             | Controller | IMVP8   | Dual Edge               | 2               | 3/2/1+2/1           | —                  | SVID      | QFN-52  |
| NCP81215  | Notebook             | Controller | IMVP8   | Dual Edge & EN RPM      | 3               | 1/2/3+1/2/3+1       | —                  | SVID      | QFN-52  |
| NCP81216  | Ultrabook            | Controller | IMVP8   | Dual Edge & EN RPM      | 3               | 1+1/2+1             | 3 x 5 V            | SVID      | QFN-52  |
| NCP81236  | Ultrabook            | Controller | IMVP8   | Dual Edge & EN RPM      | 3               | 1/2+1+1             | 3 x 5 V            | SVID      | QFN-52  |
| NCP81218  | Ultrabook            | Controller | IMVP8   | Dual Edge & EN RPM      | 3               | 1+1/2+1             | —                  | SVID      | QFN-48  |
| NCP81210  | Ultrabook & Notebook | Controller | IMVP8   | EN RPM                  | 1               | 1                   | 1 + FETs           | SVID      | QFN-40  |

Please contact ON Semiconductor for product datasheets.

## Ultrabook Solution

### NCP81218 1+2+1 Phase Controller

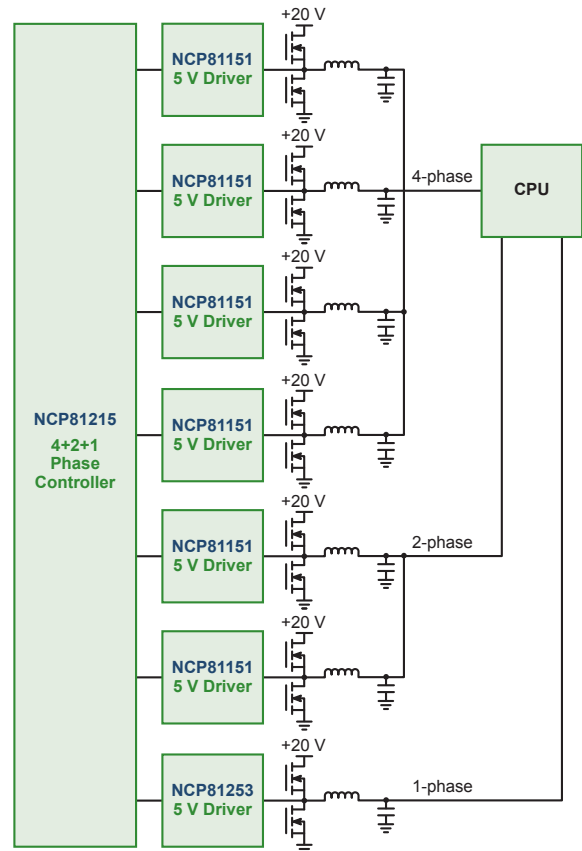
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



## Notebook Solutions

### NCP81215 4+2+1 Phase Controller

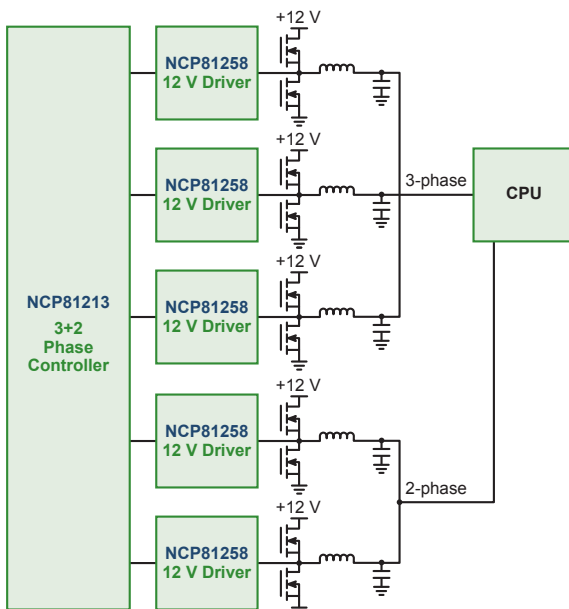
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



## Desktop Solutions

### NCP81213 3+2 Phase Controller

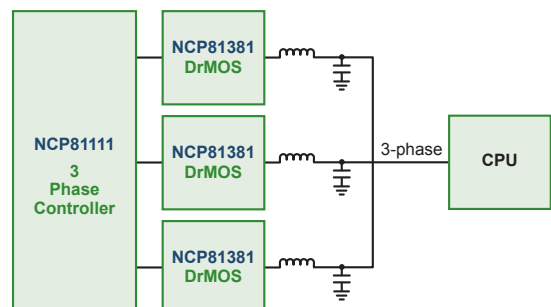
- Dual Edge for fast transient response
- Constant on-time for light load efficiency
- Supports all MLCC output capacitor solutions
- IMVP8 compliant



## Microserver Solutions

### NCP81111 3-Phase Digital Controller

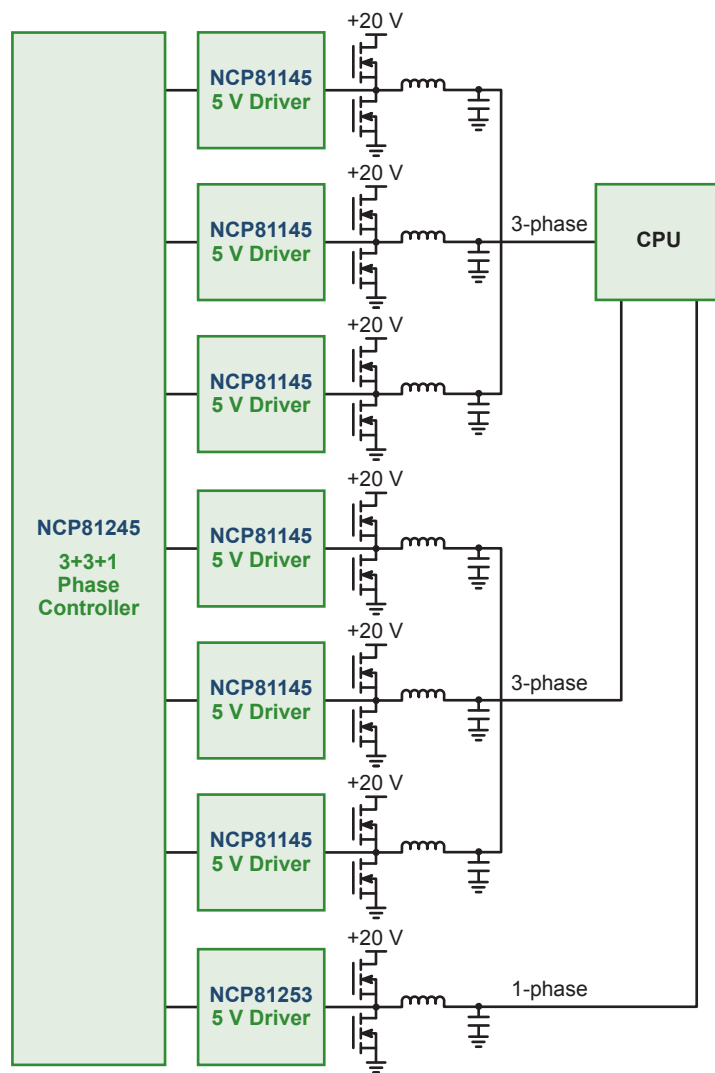
- Optimised to operate at 5 MHz using DrMOS
- Can operate as general purpose I2C controller regulator
- Internal compensation using GUI interface
- VR12.5/6 compliant



## IMVP8 Multiphase Controllers for Embedded Applications

### NCP81245 3+3+1 Phase Controller

- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



| Device   | Market               | Function    | VR Spec | Controller Architecture | Number of Rails | CPU Phases    | Integrated Drivers | Interface | Package |
|----------|----------------------|-------------|---------|-------------------------|-----------------|---------------|--------------------|-----------|---------|
| NCP81243 | Desktop              | Controller  | IMVP8   | Dual Edge               | 2               | 3/2/1+2/1     | –                  | SVID      | QFN-52  |
| NCP81245 | Notebook             | Controller  | IMVP8   | Dual Edge & EN RPM      | 3               | 1/2/3+1/2/3+1 | –                  | SVID      | QFN-52  |
| NCP81246 | Ultrabook            | Controller  | IMVP8   | Dual Edge & EN RPM      | 3               | 1+1/2+1       | 3 x 5 V            | SVID      | QFN-52  |
| NCP81248 | Ultrabook            | Controller  | IMVP8   | Dual Edge & EN RPM      | 3               | 1+1/2+1       | -                  | SVID      | QFN-48  |
| NCP81255 | Ultrabook & Notebook | Controller  | IMVP8   | EN RPM                  | 1               | 1             | 1 + FETs           | SVID      | QFN-40  |
| NCP81145 | Ultrabook & Notebook | 5 V Driver  | –       | for Dual Edge Rail      | –               | –             | –                  | –         | DFN-8   |
| NCP81146 | Desktop              | 12 V Driver | –       | for Dual Edge Rail      | –               | –             | –                  | –         | DFN-8   |
| NCP81253 | Ultrabook & Notebook | 5 V Driver  | –       | for EN RPM rail         | –               | –             | –                  | –         | DFN-8   |



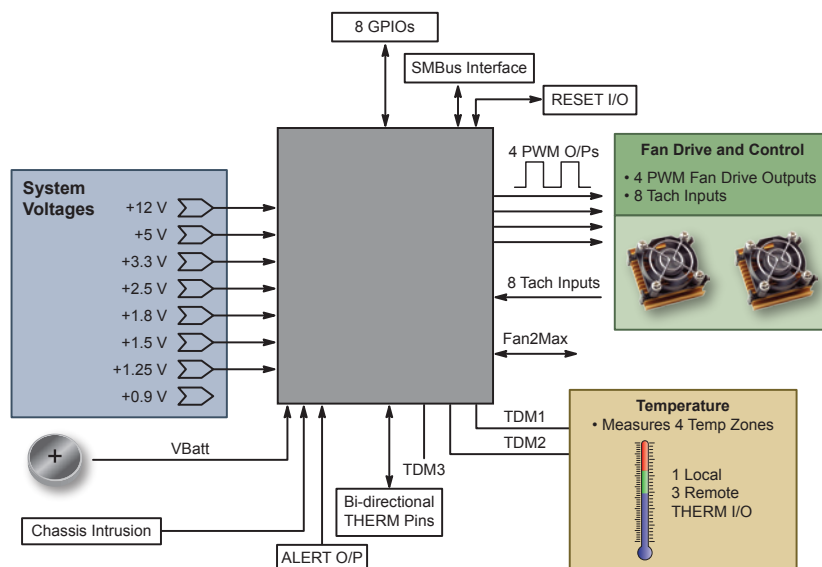
## Thermal Management

### Extensive Portfolio

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

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

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

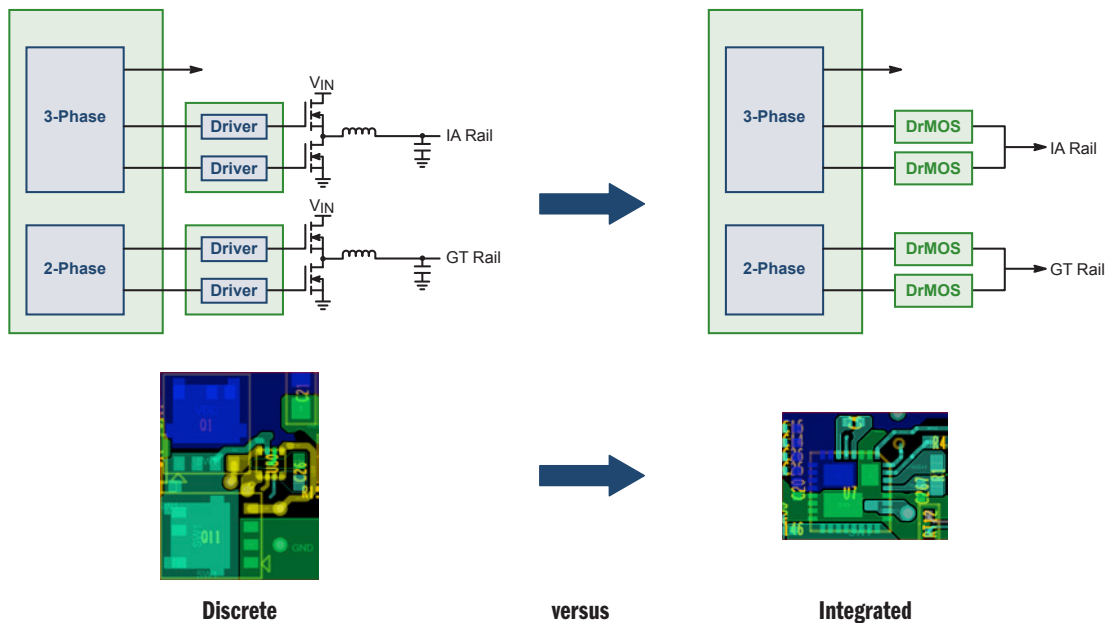


|                 | Device  | Supply Range (V) | Temperature Range (°C) | Local Accuracy (°C) | Interface | Number of Addresses | SRC (Ω) | Remote Accuracy | Remote Channels | Fan Channels | TACH Channels | Voltage Monitoring Channels | GPIOs | Package         |
|-----------------|---------|------------------|------------------------|---------------------|------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

## 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  |
| NCP302035 | 3.3 V or 5 V Tri-state | 20                      | 2              | 35                                  | PQFN-31 |
| NCP302040 | 3.3 V or 5 V Tri-state | 20                      | 2              | 40                                  | PQFN-31 |
| NCP302045 | 3.3 V or 5 V Tri-state | 20                      | 2              | 45                                  | PQFN-31 |
| NCP302155 | 3.3 V or 5 V Tri-state | 24                      | 2              | 60                                  | PQFN-31 |

## Drivers for Discrete MOSFET Implementations

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

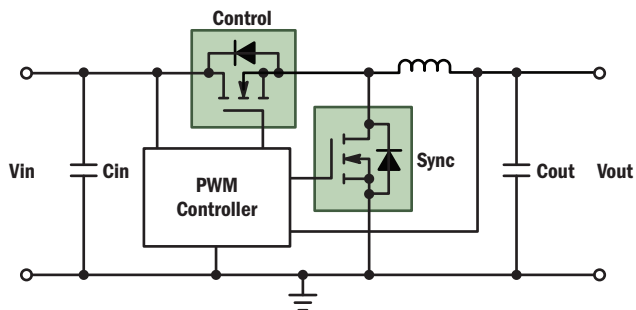
| Device   | Drivers | V <sub>CC</sub> Typ (V) | Integrated Bootstrap Diode | Zero Crossover Detection | Package |
|----------|---------|-------------------------|----------------------------|--------------------------|---------|
| NCP5901  | Single  | 12                      | N                          | Y                        | DFN-8   |
| NCP5901B | Single  | 12                      | Y                          | Y                        | DFN-8   |
| NCP81258 | 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   |
| NCP81152 | Dual    | 5                       | Y                          | Y                        | QFN-16  |

## N-Channel MOSFETs for Power Conversion

Non-Isolated Topology "Buck" DC-DC

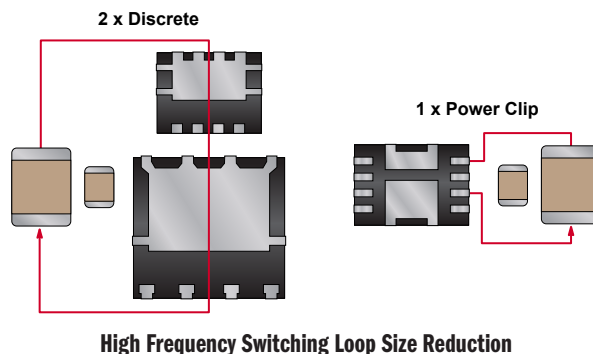
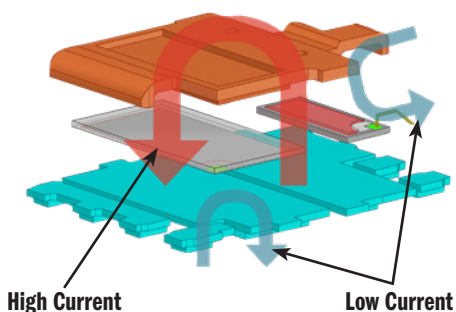
### Features

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



### Increasing Power Density with PowerClip Dual MOSFETs

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



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

## Asymmetric Dual MOSFETs

| Device      | Package       | I <sub>max</sub><br>(A) | BV <sub>DSS</sub><br>(V) | V <sub>GS</sub> Max<br>(V) | R <sub>DS(on)</sub> Max @ V <sub>GS</sub> = 4.5 V<br>(mΩ) |          | Q <sub>g</sub> Typ @ V <sub>GS</sub> = 4.5 V<br>(nC) |          | C <sub>oss</sub> Typ<br>(pF) |
|-------------|---------------|-------------------------|--------------------------|----------------------------|-----------------------------------------------------------|----------|------------------------------------------------------|----------|------------------------------|
|             |               |                         |                          |                            | High Side                                                 | Low Side | High Side                                            | Low Side | Low Side                     |
| FDMS3620S   | Power 56 Dual | >30A                    | 25                       | 12                         | 5.2mΩ                                                     | 1.2mΩ    | 12                                                   | 50       | 1828                         |
| FDMS3622S   |               | 25-30A                  |                          |                            | 5.7mΩ                                                     | 1.6mΩ    | 12                                                   | 40       | 1405                         |
| FDMS3624S   |               | 20-25A                  |                          |                            | 5.7mΩ                                                     | 2.2mΩ    | 12                                                   | 27       | 946                          |
| FDMS3626S   |               | 15-20A                  |                          |                            | 5.7mΩ                                                     | 3.2mΩ    | 12                                                   | 19       | 716                          |
| NTMFD4901NF | SO8-FL Dual   | 25-30A                  | 30                       | 20                         | 10.0mΩ                                                    | 3.5mΩ    | 10                                                   | 20       | 1100                         |
| NTMFD4902NF |               | 25-30A                  |                          |                            | 10.0mΩ                                                    | 6.2mΩ    | 10                                                   | 12       | 813                          |
| NTMFD4C20N  |               | 25-30A                  |                          |                            | 10.8mΩ                                                    | 5.2mΩ    | 9                                                    | 13       | 990                          |
| FDMC007N30D | Power 33 Dual | <13A                    |                          | 12                         | 13.3mΩ                                                    | 7.0mΩ    | 6.4                                                  | 14       | 413                          |
| FDMC8200S   |               | <6A                     |                          | 20                         | 32.0mΩ                                                    | 13.5mΩ   | 3.1                                                  | 7.2      | 373                          |

## 30 V P-Channel MOSFETs

| Device       | Package | Configuration    | Breakdown V <sub>DS</sub> /V <sub>GS</sub><br>(V) | R <sub>DS(on)</sub> Max @ V <sub>GS</sub> = 4.5 V<br>(mΩ) |
|--------------|---------|------------------|---------------------------------------------------|-----------------------------------------------------------|
| FDMC013P030Z | MLP 33  | Single P-Channel | 30/25                                             | 13.2                                                      |
| FDMC6675BZ   |         | Single P-Channel | 30/25                                             | 27                                                        |
| FDMC6679AZ   |         | Single P-Channel | 30/25                                             | 18                                                        |
| FDMA6676PZ   | MLP 22  | Single P-Channel | 30/25                                             | 27                                                        |
| FDMA530PZ    |         | Single P-Channel | 30/25                                             | 65                                                        |

## Dual N-Channel MOSFETs

### Common Drain FDPC4044

- 30 V, 27 A
- Max r<sub>DS(on)</sub> = 4.3 mΩ at V<sub>GS</sub> = 10 V, I<sub>S1S2</sub> = 27 A
- MLP 33 package

### Specific Applications

- V<sub>BUS</sub> back-back protection switch for USB Type-C
- Replace two discrete back-back MOSFETs with single compact solution

### Common Source FDMD8630

- 30 V, 167 A
- Max r<sub>DS(on)</sub> = 1 mΩ
- PQFN-8 package

### Specific Applications

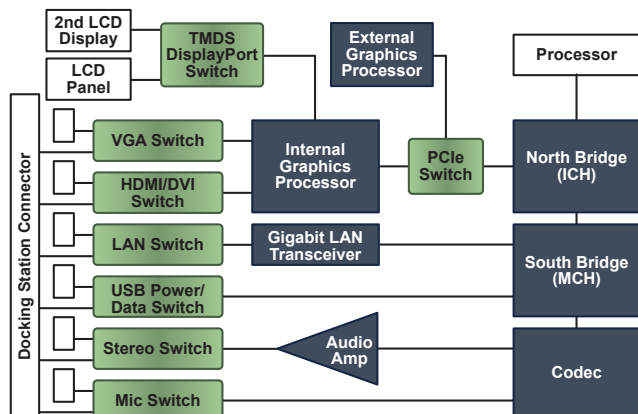
- Synchronous Rectification
- Synchronous buck for ~50% duty cycle (12 V to 5 V)

## N-Channel MOSFETs

| Device      | Package | Polarity  | Maximum Ratings        |                        |                           |                            | 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 |                        |                         |                          |                          |                       |                  |
| NTMFS4C020N | SO-8FL  | N-Channel | 30                     | 20                     | 0.7                       | 1                          | 63                     | 13                      | 10144                    | 148                      | 1                     | HPPC             |
| NTMFS4C01N  |         | N-Channel | 30                     | 20                     | 0.9                       | 1.2                        | 65                     | 18                      | 9200                     | 231                      | 1                     | HPPC             |
| NTMFS4C022N |         | N-Channel | 30                     | 20                     | 1.7                       | 2.4                        | 20.8                   | 4.7                     | 3071                     | 67                       | 1                     | HPPC             |
| NTMFS4C03N  |         | N-Channel | 30                     | 20                     | 2.3                       | 3.3                        | 19.8                   | 5.3                     | 2789                     | 71                       | 1                     | HPPC             |
| NTMFS4C024N |         | N-Channel | 30                     | 20                     | 2.8                       | 4                          | 14                     | 5                       | 1972                     | 59                       | 1                     | Synchronous Side |
| NTMFS4C35N  |         | N-Channel | 30                     | 20                     | 3.2                       | 4.2                        | 15                     | 5.5                     | 2300                     | 46                       | 1                     | Synchronous Side |
| NTMFS4C025N |         | N-Channel | 30                     | 20                     | 3.4                       | 4.9                        | 11.6                   | 4                       | 1683                     | 40                       | 1                     | Synchronous Side |
| NTMFS4C05N  |         | N-Channel | 30                     | 20                     | 3.4                       | 5                          | 13                     | 3                       | 1950                     | 50                       | 1                     | Synchronous Side |
| NTMFS4C06N  |         | N-Channel | 30                     | 20                     | 4                         | 6                          | 14.5                   | 5.5                     | 1988                     | 71                       | 1                     | Synchronous Side |
| NTMFS4C028N |         | N-Channel | 30                     | 20                     | 4.7                       | 7                          | 10.9                   | 5.4                     | 1252                     | 126                      | 1                     | Synchronous Side |
| NTMFS4C08N  |         | N-Channel | 30                     | 20                     | 5.8                       | 8.5                        | 8.7                    | 2.8                     | 1100                     | 38                       | 1                     | Synchronous Side |
| NTMFS4C09N  |         | N-Channel | 30                     | 20                     | 6                         | 8.8                        | 10.9                   | 5.4                     | 1252                     | 126                      | 1                     | Control Side     |
| NTMFS4C029N |         | N-Channel | 30                     | 20                     | 5.9                       | 9                          | 9.7                    | 4.8                     | 987                      | 162                      | 1                     | Control Side     |
| NTMFS4C10N  |         | N-Channel | 30                     | 20                     | 7                         | 10.8                       | 9.3                    | 4.2                     | 970                      | 125                      | 1                     | Control Side     |
| NTMFS4C032N |         | N-Channel | 30                     | 20                     | 7.4                       | 11.1                       | 7.8                    | 3.7                     | 770                      | 127                      | 1                     | Control Side     |
| NTMFS4C13N  |         | N-Channel | 30                     | 20                     | 9.1                       | 13.8                       | 6.6                    | 2.7                     | 720                      | 95                       | 1                     | Control Side     |
| NTTFS4C02N  | μ8-FL   | N-Channel | 30                     | 20                     | 2                         | 3                          | 20                     | 7                       | 2800                     | 66                       | 0.8                   | HPPC             |
| NTTFS4C05N  |         | N-Channel | 30                     | 20                     | 3.6                       | 5.1                        | 13                     | 3                       | 1950                     | 50                       | 1                     | Synchronous Side |
| NTTFS4C06N  |         | N-Channel | 30                     | 20                     | 4                         | 6                          | 14.5                   | 5.5                     | 1988                     | 71                       | 1                     | Synchronous Side |
| NTTFS4C08N  |         | N-Channel | 30                     | 20                     | 5.8                       | 8.5                        | 8.7                    | 2.8                     | 1100                     | 38                       | 1                     | Synchronous Side |
| NTTFS4C10N  |         | N-Channel | 30                     | 20                     | 7.4                       | 11                         | 9.3                    | 4.2                     | 970                      | 125                      | 1                     | Control Side     |
| NTTFS4C13N  |         | N-Channel | 30                     | 20                     | 9.1                       | 13.8                       | 6.6                    | 2.7                     | 720                      | 95                       | 1                     | Control Side     |
| NTTFS4C25N  |         | N-Channel | 30                     | 20                     | 17                        | 26.5                       | 4                      | 1.3                     | 455                      | 60                       | 1                     | Control Side     |

## 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.

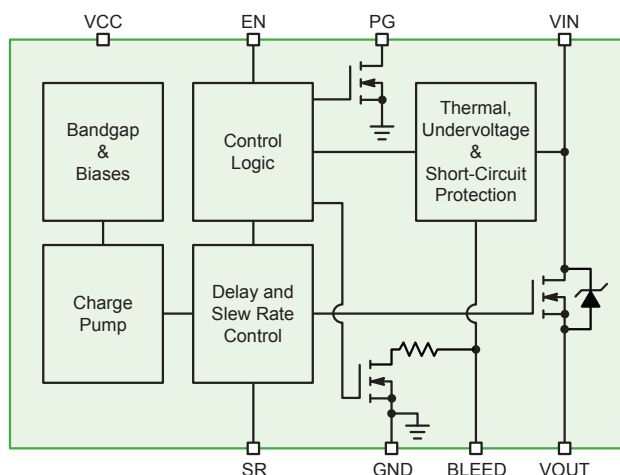


| Device   | Interface     | Data Rate | No Channels | Quiescent Current |
|----------|---------------|-----------|-------------|-------------------|
| NCN1188  | USB 2.0 / MHL | 2.25 Gb/s | 2           | 21 μA             |
| NS5S1153 | USB 2.0       | 480 Mb/s  | 2           | 21 μA             |
| NLAS7242 | USB 2.0       | 480 Mb/s  | 2           | 1 μA              |
| 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



### NCP45xx Integrated Load Switch Key Features

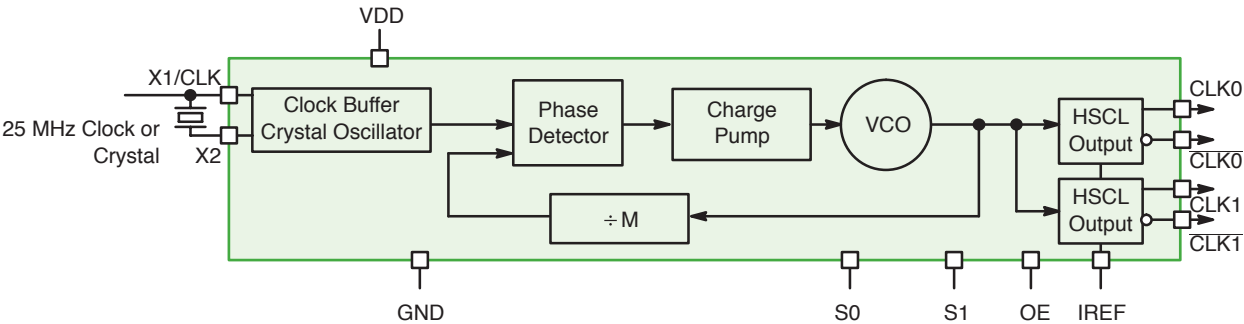
- Simple/clean design
- No current consumption in standby power mode
- Small PCB footprint
- Low RDS(ON) due to charge pump driving NMOS
- Adjustable soft-start time (SR)
- Adjustable integrated discharge
- Fault protection
- Power rail monitoring & sequencing

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

Clock Synthesizers for High Performance Computing

Features

- Uses 25 MHz fundamental mode parallel resonant crystal
- PCI-e Gen 1, 2, 3, and 4 jitter complaint HCSL differential outputs
- NB3N50134 features configurable spread spectrum outputs
- NB3N51044 features individual OE control signal for each output, PLL bypass mode and an Input multiplexer
- NB3N51054 features I2C interface for OE control and configurable spread spectrum outputs
- 3.3 V supply



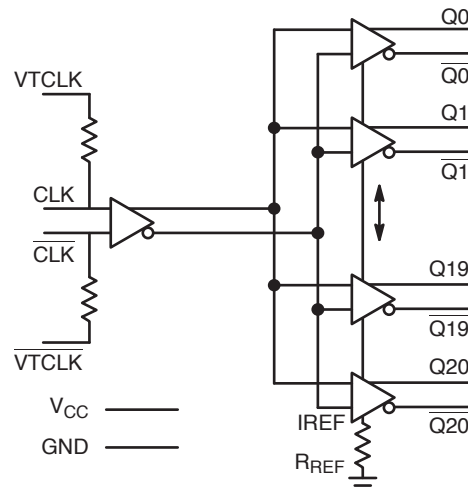
NB3N5573 Simplified Logic Diagram

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

## 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, NB3L204K, NB3L202K; DB800H, DB400H, DB200H compliant



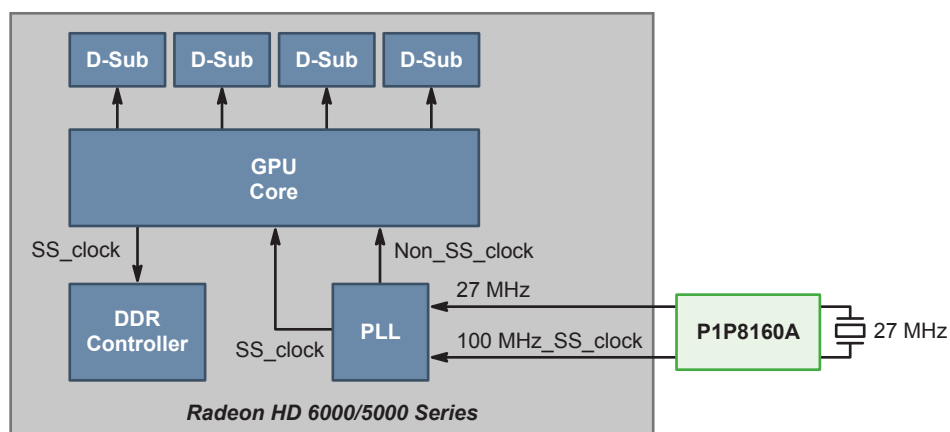
NB3N121K Logic Diagram

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

## 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

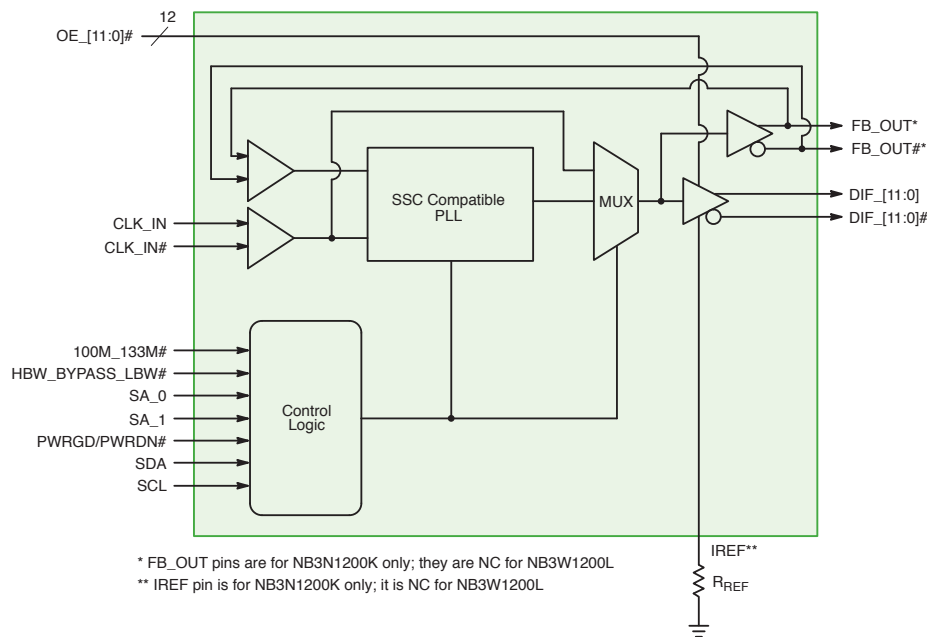
### NB3N51054 Features

- Uses 25 MHz Fundamental Crystal or Reference Clock Input
- Four Low Skew HCSL or LVDS Outputs
- I2C Support with Read Back Capability
- Spread of -0.35%, -0.5% and No Spread
- Individual Output Enable/Disable Control through I2C
- PCIe Gen 1, Gen 2, Gen 3, Gen 4 Compliant
- Typical Phase Jitter @ 100 MHz (Integrated 12 kHz to 20 MHz): 0.5 ps
- Typical Cycle-Cycle Jitter @ 100 MHz (10k cycles): 20 ps
- Operating Power Supply: 3.3 V  $\pm$  5%

## Zero Delay Buffers Compliant with DB Specifications

### Features

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



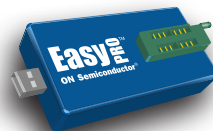
NB3N1200K Simplified Block Diagram

| 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  | Low power NMOS push-pull | 50                                   | ±100                             | 85                               | 4                    | QFN-72  |

## EEPROMs for Configuration and Calibration

### Features

- Broad density range: 1 kb to 2 Mb
- Wide operating Vcc range: 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)

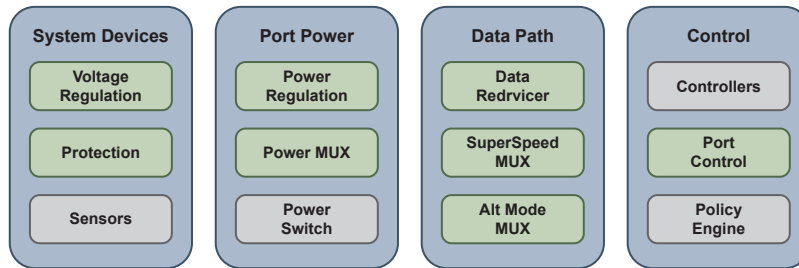
### EEPROMs

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

\* Organization for Microwire devices is selectable.

## USB-C for PC/Laptop

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



Block Diagram



### System Devices

| Function           | Device      | Description                                                                               |
|--------------------|-------------|-------------------------------------------------------------------------------------------|
| Voltage Regulation | NCP81231    | Buck Controller, USB Power Delivery and Type-C Applications                               |
|                    | NCP81239    | Buck-Boost Controller, USB Power Delivery and Type-C Applications                         |
| Protection         | ESD8704     | High Speed Data Line Protection, Unidirectional (3.3 V - USB 3.x)                         |
|                    | ESDL1531*   | High Speed Data Line Protection, Bidirectional (4 V - USB), 0.2 pF                        |
|                    | ESDL2011    | High Speed Data Line Protection, Bidirectional (1 V - Thunderbolt 3.0), 0.2 pF            |
|                    | ESDL2031    | High Speed Data Line Protection, Bidirectional (4 V - USB), 0.35 pF                       |
|                    | ESDM1051*   | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF                      |
|                    | ESDM1131    | High Speed Data Line Protection, Bidirectional (3.3 V - USB 2.0), 4 pF                    |
|                    | ESDM3551    | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF                      |
|                    | FSUSB242UCX | USB Type-C Port Protection Switch                                                         |
|                    | FUSB252UMX  | High Speed Digital (HSD) Port Protection Switch with Type-C CC                            |
|                    | NIS6351*    | Electronic Fuse, 5 V                                                                      |
|                    | NSPM2052    | ESD and Surge Protection Device, Vbat and Vbus Applications, 5 V                          |
|                    | NSPU3051    | ESD Protection Diode, CC and SBU Protection (5.5 V - USB 3.x), 21 pF                      |
|                    | NSPU5201    | ESD and Surge Protection, Unidirectional, 20 V, 140 A                                     |
|                    | NCS210      | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 $\mu$ V Offset  |
|                    | NCS211      | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 $\mu$ V Offset  |
|                    | NCS213      | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 100 $\mu$ V Offset |
|                    | NCS214      | Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 $\mu$ V Offset  |

\* Pending 2Q19.

### Power Port

| Function         | Device      | Description                                                                                                |
|------------------|-------------|------------------------------------------------------------------------------------------------------------|
| Power Regulation | NCP1342     | Quasi-Resonant Flyback Controller with Valley Lock-Out Switching                                           |
|                  | NCP4305     | Secondary Side Synchronous Rectification Driver for High Efficiency SMPS Topologies                        |
|                  | NCP4306     | Secondary Side Synchronous Rectification Driver for High Efficiency SMPS Topologies                        |
|                  | NCP43080    | Synchronous Rectifier Controller with LLD Function                                                         |
| Power MUX        | FPF2595UCX  | Load Switch, Over-Voltage, Over-Current Protection with Adjustable Current-Limit Control, IntelliMAX™ 28 V |
|                  | FPF2895CUCX | Current Limit Load Switch with OVP and TRCB, 28 V, 5 A                                                     |

### Data Path

| Function       | Device      | Description                                              |
|----------------|-------------|----------------------------------------------------------|
| Data Redriver  | NB7NPQ7021M | USB 3.1 Dual Channel Linear Redriver, 3.3 V              |
|                | NB7NPQ701M  | USB 3.1 Single Channel Redriver, 3.3 V                   |
|                | NB7NPQ702M  | USB 3.1 Dual Channel Redriver, 3.3 V                     |
|                | NB7VPQ701M  | USB 3.1 Single Channel Redriver, 1.8 V                   |
|                | NB7VPQ702M  | USB 3.1 Dual Channel Redriver, 1.8 V                     |
| SuperSpeed Mux | FUSB340TMX  | USB 3.1 SuperSpeed Switch, 10 Gbps                       |
| Alt Mode MUX   | FSA4476UCX  | Analog Audio Switch with Protection Function, USB Type-C |

### Control

| Function     | Device      | Description                                                |
|--------------|-------------|------------------------------------------------------------|
| Port Control | FUSB302TMPX | Programmable USB Type-C Controller with PD (Default SRC)   |
|              | FUSB303TMX  | Autonomous USB Type-C Controller with I2C and GPIO Control |
|              | FUSB307BMPX | USB Type-C Port Controller with USB-PD                     |

## USB 3.x Type A Connector

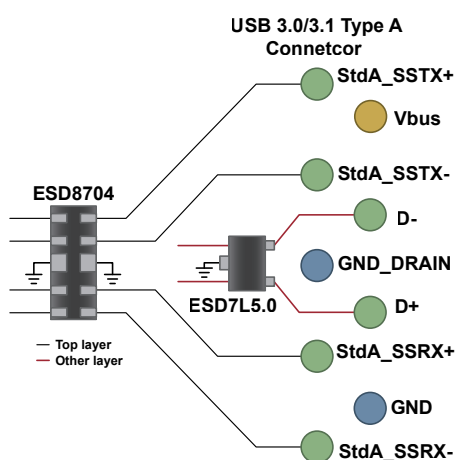
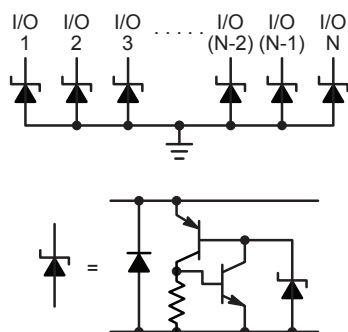
Two SuperSpeed Pairs, One High Speed Pair, V<sub>CC</sub>, Low Capacitance ESD Protection

### Key Requirement

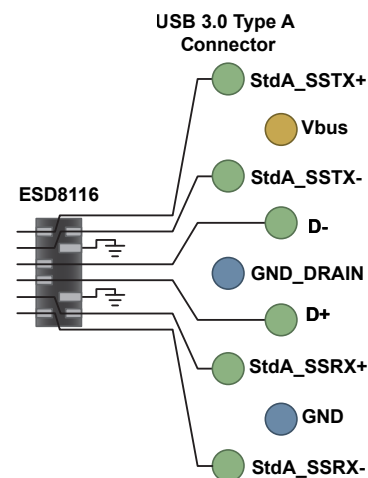
- Cap < 0.7 pF

### Features

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



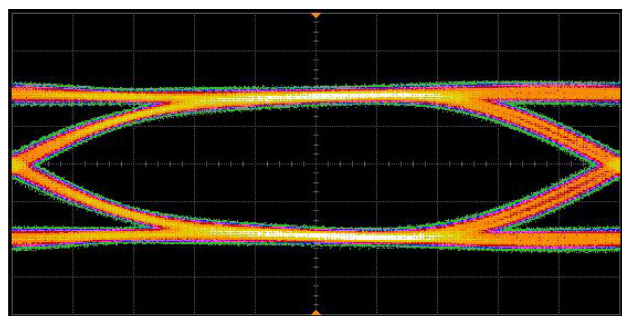
**ESD8704 – 0.35 pF, 2 Layer Routing**  
(ESD8704; ESD7L5.0 for D+, D- Lines)



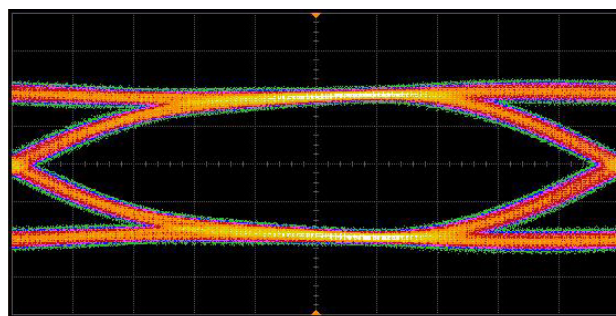
**ESD8116 – 0.30 pF, 1 Layer Routing**

| Device    | Interface | Data Lines                 | Capacitance (pF) | Package | Size (mm)    |
|-----------|-----------|----------------------------|------------------|---------|--------------|
| ESD8704   | USB 3.x   | 2 Pair (Tx, Rx)            | 0.35             | UDFN-10 | 2.5 x 1.0    |
| ESD7L     | USB 3.x   | 1 Pair (D+/-)              | 0.5              | SOT-723 | 1.2 x 1.2    |
| ESD8504   | USB 3.0   | 2 Pair (Tx, Rx)            | 0.4              | UDFN-10 | 2.5 x 1.0    |
| ESD8104   | USB 3.0   | 2 Pair (Tx, Rx)            | 0.3              | UDFN-10 | 2.5 x 1.0    |
| ESD8116   | USB 3.0   | 3 Pair (Tx, Rx, D+/-)      | 0.3              | UDFN-8  | 2.0 x 1.2    |
| ESDL3552  | USB 3.x   | 1 Pair (Tx, Rx, D+/-)      | 0.25             | X4DFN-3 | 0.62 x 0.32  |
| ESDL2011  | USB 3.x   | Single Line (Tx, Rx)       | 0.17             | DSN-2   | 0.6 x 0.3    |
| ESDL2031  | USB 3.x   | Single Line (Tx, Rx, D+/-) | 0.4              | X4DFN-2 | 0.6 x 0.3    |
| ESD8011   | USB 3.x   | Single Line                | 0.10             | X3DFN-2 | 0.62 x 0.32  |
| ESD8101   | USB 3.x   | Single Line                | 0.20             | DSN-2   | 0.43 x 0.23  |
| ESD8111   | USB 3.0   | Single Line                | 0.20             | WLCSP-2 | 0.6 x 0.3    |
| ESD8006   | USB 3.0   | 3 Pair (Tx, Rx, D+/-)      | 0.25             | UDFN-8  | 3.3 x 1.0    |
| ESDL1531* | USB 3.x   | Single Line (Tx, Rx, D+/-) | 0.15             | X4DFN-2 | 0.445 x 0.24 |

\* Pending 2Q19.



Without ESD



With ESD

USB 3.0 @ 5 Gb/s

## USB 2.0

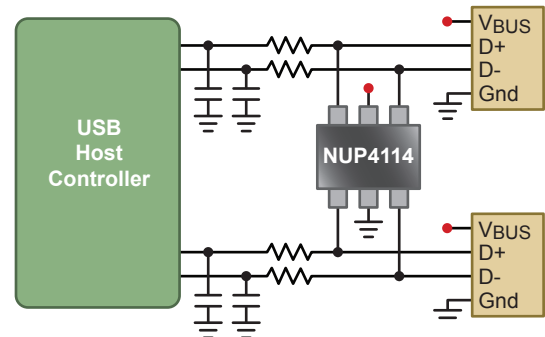
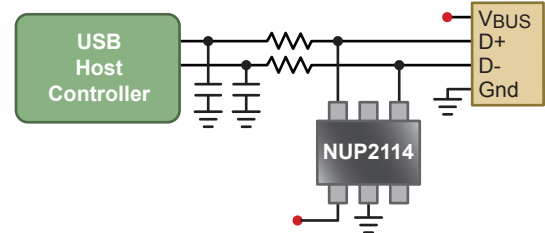
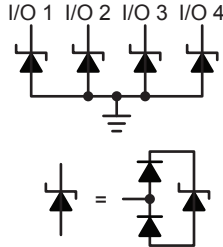
One High Speed Pair,  $V_{CC}$ , Low Capacitance ESD Protection

### Key Requirement

- Cap < 5 pF

### Features

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



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

\* Pending 2Q19.

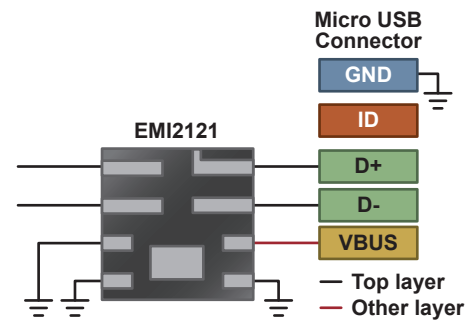
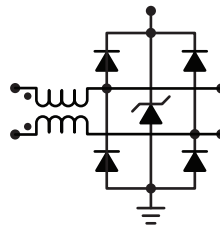
One High Speed Pair,  $V_{CC}$ , Common Mode Filter + ESD Protection

### Key Requirement

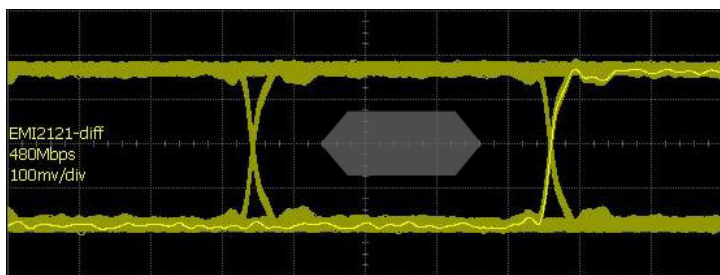
- Cap < 5 pF
- Common Mode Filtering

### Features

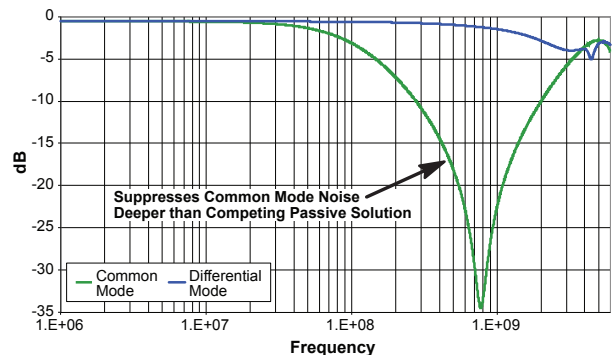
- 0.5 - 0.8 pF
- Integrated EMI suppression with ESD protection
- Industry leading low clamping voltage



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



USB 2.0 @ 480 Mb/s



## Thunderbolt

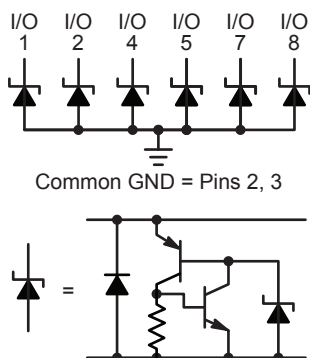
*Four High Speed Pairs, up to Six Additional Lines, Low Capacitance ESD*

### Key Requirement

- Capacitance < 0.4 pF

### Features

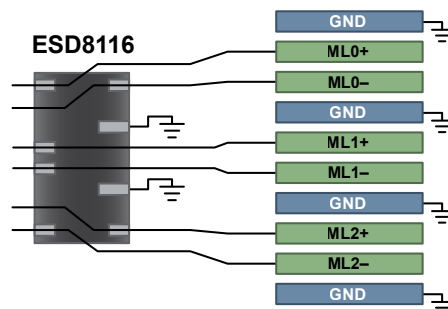
- Capacitance of 0.35 pF or lower
- Integrated solution in 2.0 x 1.2 mm package
- Grounds between pairs to reduce cross-talk
- Flow-through routing
- Industry leading clamping voltage



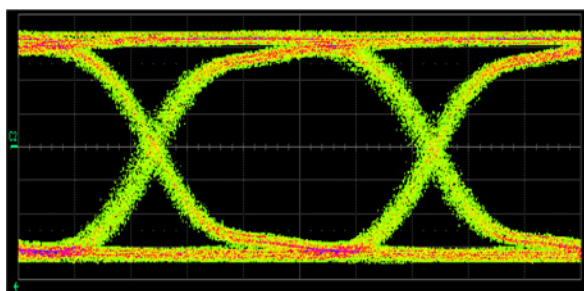
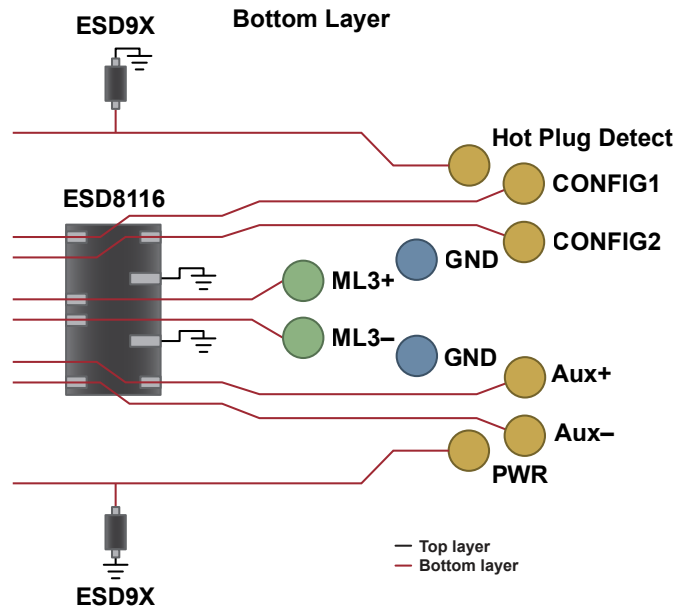
| Device    | Data Lines  | Capacitance (pF) | Package | Size (mm)    |
|-----------|-------------|------------------|---------|--------------|
| ESD8006   | 3 Pair      | 0.25             | UDFN-8  | 3.3 x 1.0    |
| ESD8116   | 3 Pair      | 0.30             | UDFN-8  | 2.0 x 1.2    |
| ESD8011   | Single Line | 0.10             | X3DFN-2 | 0.62 x 0.32  |
| ESDL2011  | Single Line | 0.17             | X4DFN-2 | 0.6 x 0.3    |
| ESDL1531* | Single Line | 0.20             | X4DFN-2 | 0.445 x 0.24 |

\* Pending 2Q19.

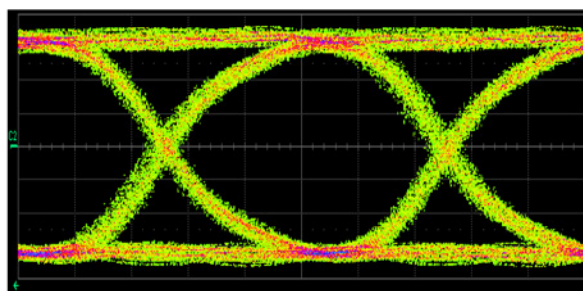
### Thunderbolt Connector Top Layer



### Thunderbolt Connector Bottom Layer



Without ESD8116



With ESD8116

Thunderbolt @ 10 Gb/s

## HDMI, Display Port

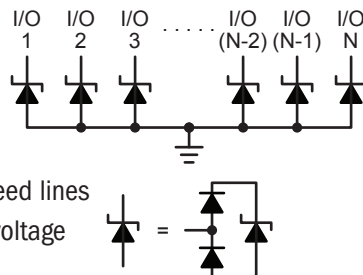
Four High Speed Pairs, Up to Six Additional Interface Lines, Low Capacitance ESD

### Key Requirement

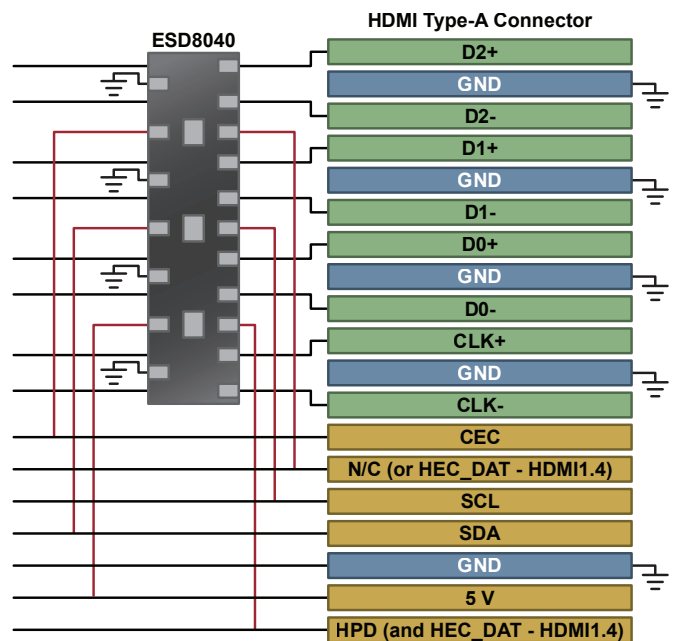
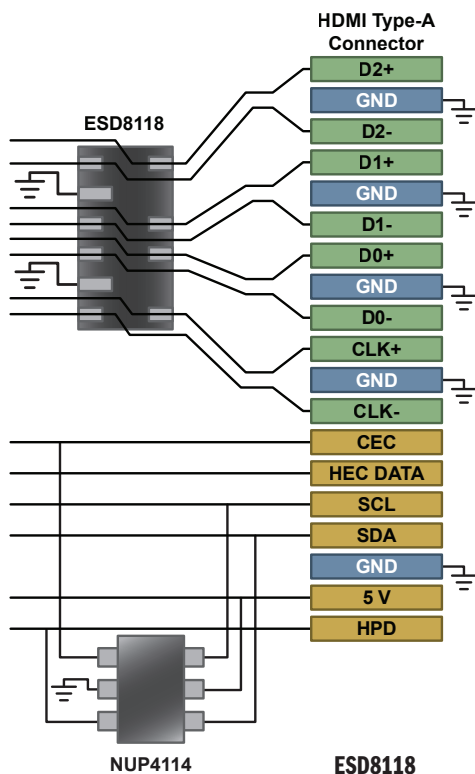
- Cap < 0.5 pF

### Features

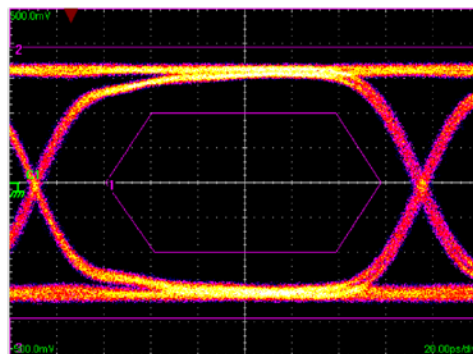
- 0.3 pF ESD protection
- Flow through routing in high speed lines
- Industry leading low clamping voltage



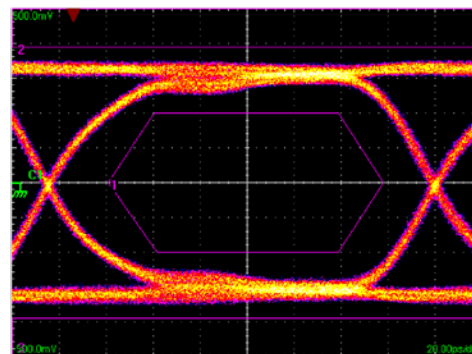
| Device     | Data Lines                    | Capacitance (pF) | Package | Size (mm)  |
|------------|-------------------------------|------------------|---------|------------|
| ESDL2031   | 1 (TMDS)                      | 0.4              | X4DFN-2 | 0.6 x 0.3  |
| ESD8104    | 4 (TMDS)          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



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



Without ESD



With ESD

HDMI 2.0 Eye Diagram with and without ESD8104. 6 Gb/s

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

*Four Pairs, Low Capacitance Surge and ESD Protection*

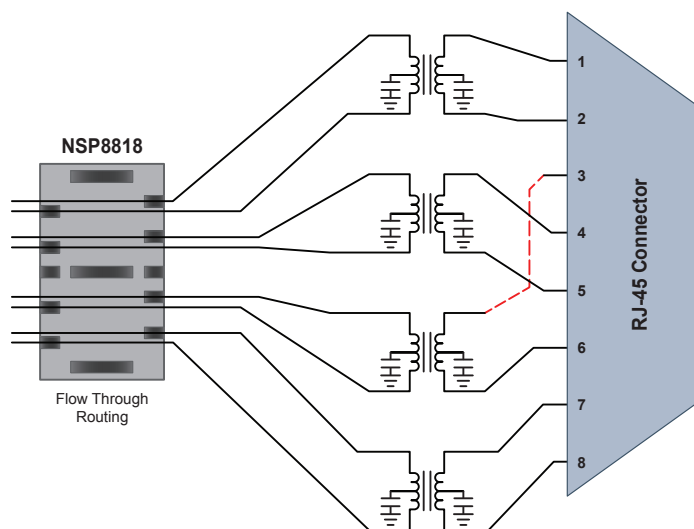
The 1000BASE-T or Gigabit Ethernet interface operating at higher bitrates is susceptible to ESD strikes, cable-discharge events and lightning-induced transients. Our products help meet IEC 61000-4-5, GR-1089-CORE and other Standards.

### Features

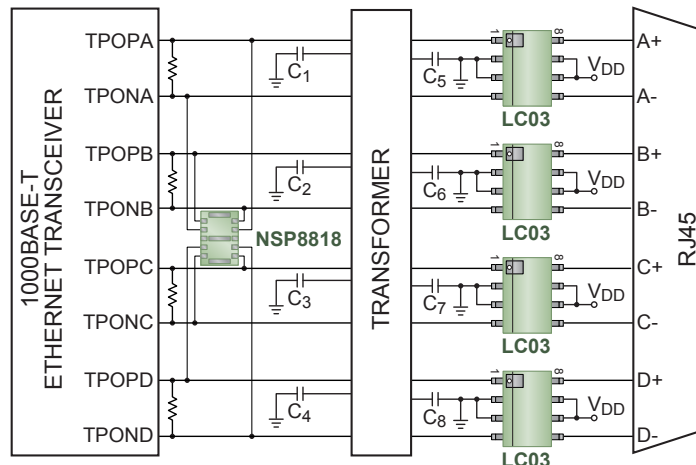
- Line-to-line capacitance < 3 pF
- $V_{\text{clamp}}$  (25 A surge) < 11 V
- IEC 61000-4-2 rating > 30 kV
- No latching danger
- Surge rating maintained to 125°C

### Benefits

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



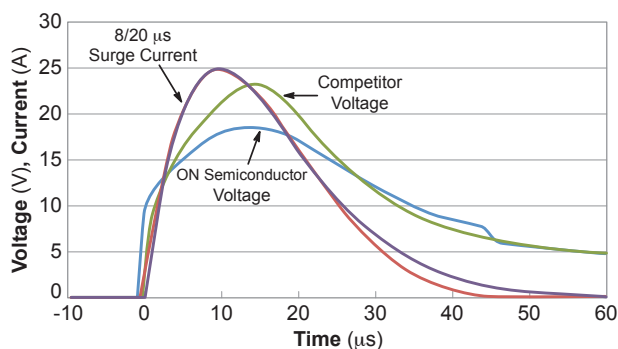
### Typical Application



Line Side : LC03-6 (optional)

Transformer Side: NSP8818

Protection against metallic (transverse) strikes



Line-to-Line Surge

### Surge Protection Devices

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

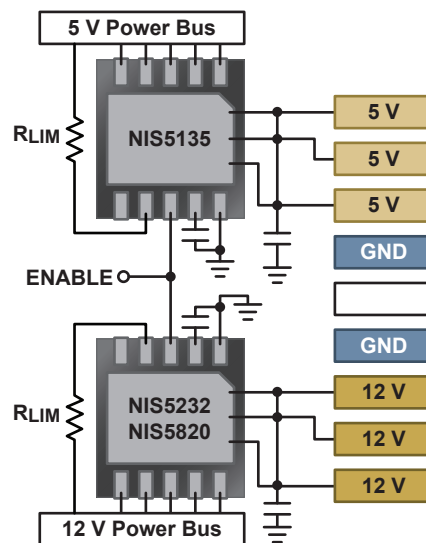
\* Pending 2Q19. \*\* On Pin 5.

## Electronic Fuses

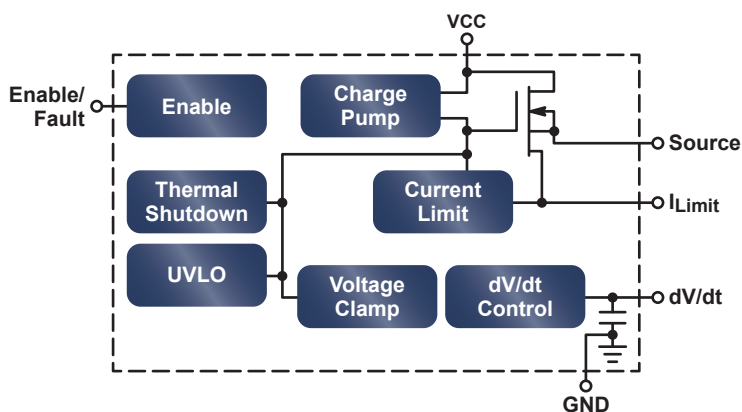
### 5 – 12 V Power Bus Hot Plug Protection

#### Features

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



Application Diagram



Typical Feature Set for eFuse

| Device   | Nominal Voltage (V) | Input Voltage (V) | Output Clamping Voltage (V) | Continuous Current (A) | Trip Current (A) | $R_{DS(ON)}$ (m $\Omega$ ) | Auto-Retry | Latching | Package |
|----------|---------------------|-------------------|-----------------------------|------------------------|------------------|----------------------------|------------|----------|---------|
| NIS5135  | 5                   | -0.6 to 18        | 6.65                        | 3.6                    | Adjustable       | 68                         | ✓          | ✓        | DFN-10  |
| NIS5132  | 12                  | -0.6 to 18        | 15                          | 4.2                    | Adjustable       | 44                         | ✓          | ✓        | DFN-10  |
| NIS5232  | 12                  | -0.6 to 18        | 15                          | 4.2                    | Adjustable       | 44                         |            | ✓        | DFN-10  |
| NIS5820* | 12                  | -0.3 to 20        | 14                          | 8                      | Adjustable       | 24                         | ✓          | ✓        | WDFN-10 |
| NIS5020* | 12                  | -0.3 to 20        | 14                          | 10                     | Adjustable       | 14                         | ✓          | ✓        | WDFN-10 |
| NIS5021* | 12                  | -0.3 to 20        | 14                          | 12                     | Adjustable       | 14                         | ✓          | ✓        | WDFN-10 |
| NIS6150* | 5                   | -0.3 to 20        | 6.1/6.9                     | 1                      | Adjustable       | 190                        | ✓          | ✓        | WDFN-10 |
| NIS6351* | 5                   | -0.3 to 20        | 6.1/6.9                     | 3                      | Adjustable       | 39                         | ✓          | ✓        | WDFN-10 |

\* Pending 2Q19.

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