



# Computing Solutions



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



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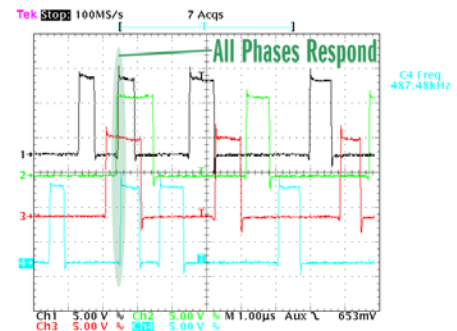
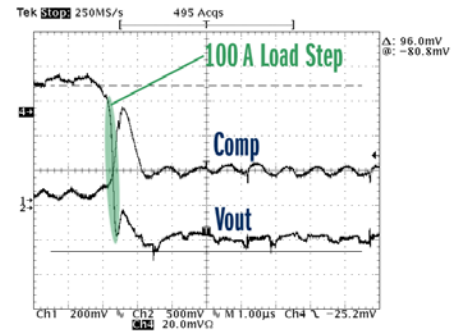
## Dual-Edge & RPM Modulation Vcore Controllers for IMVP8 Designs

### 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 IOUUT 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
NCP81201	Tablet	Controller	VR12.1	RPM	1	1	–	SVID	QFN-28
NCP81111	Microserver	Controller	VR12.5	Hybrid	1	1/2/3	–	SVID	QFN-32
NCP81203	Desktop	Controller	IMVP8	Dual Edge	2	3/2/1+2/1	–	SVID	QFN-52
NCP81203P	Notebook	Controller	IMVP8	Dual Edge	2	3/2/1+2/1	–	SVID	QFN-52
NCP81205	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

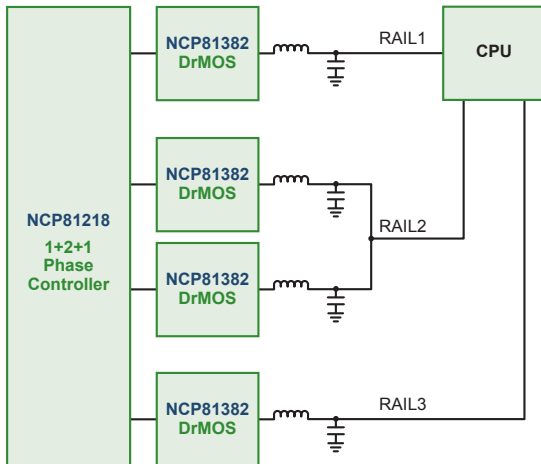
Please contact ON Semiconductor for product datasheets.



## Ultrabook Solution

### NCP81218 1+2+1 Phase Controller

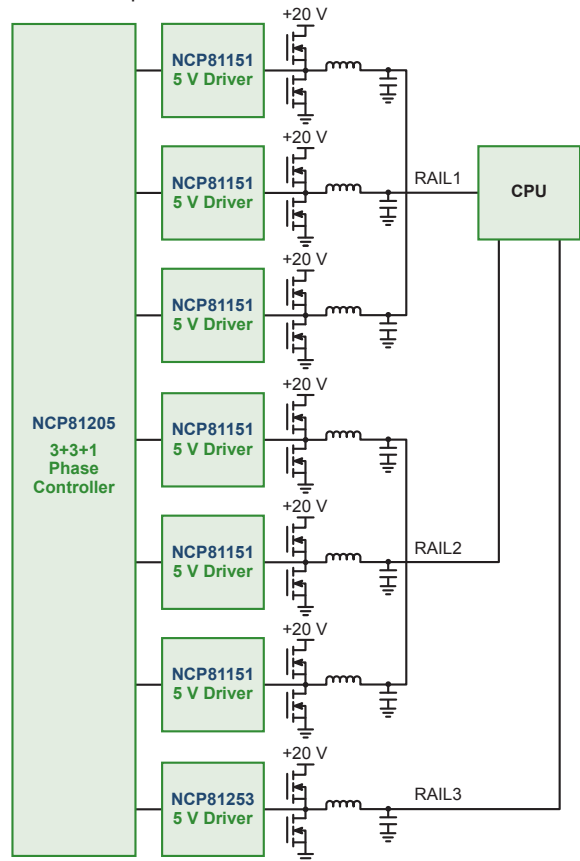
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



## Notebook Solutions

### NCP81205 3+3+1 Phase Controller

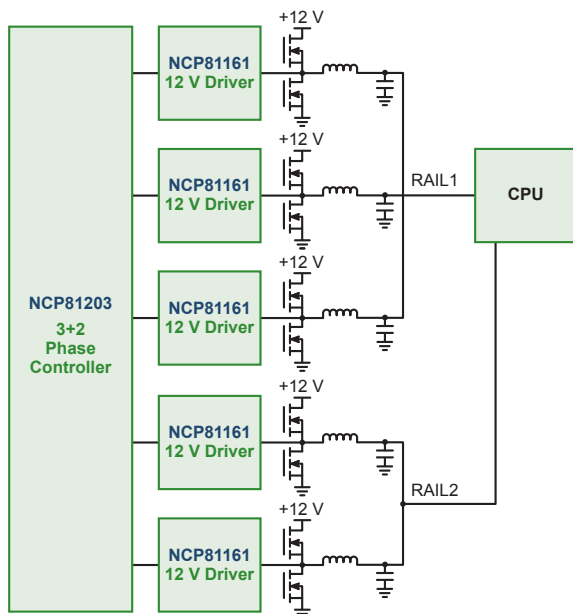
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



## Desktop Solutions

### NCP81203 3+2 Phase Controller

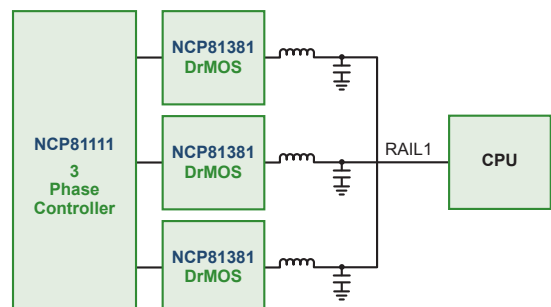
- Dual Edge for fast transient response
- Constant on-time for light load efficiency
- Supports all MLCC output capacitor solutions
- IMVP8 compliant



## Microserver Solutions

### NCP81111 3-Phase Digital Controller

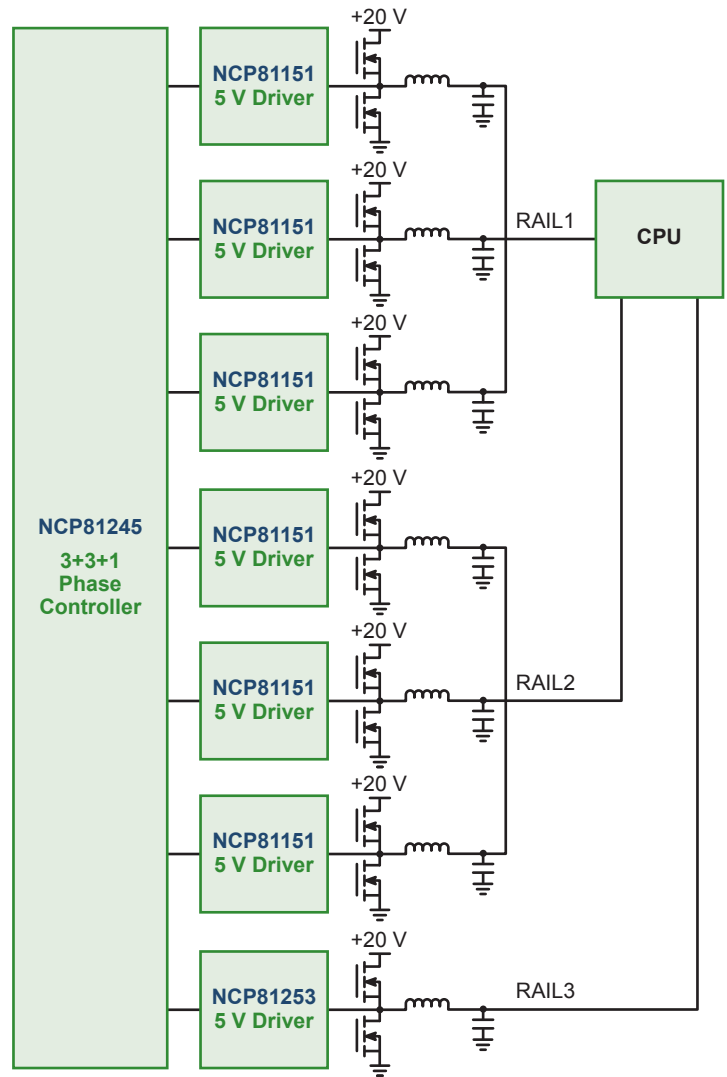
- Optimised to operate at 5MHz using DrMOS
- Can operate as general purpose I2C controller regulator
- Internal compensation using GUI interface
- VR12.5/6 compliant



## IMVP8 Multiphase Controllers for Embedded Applications

### NCP81245 3+3+1 Phase Controller

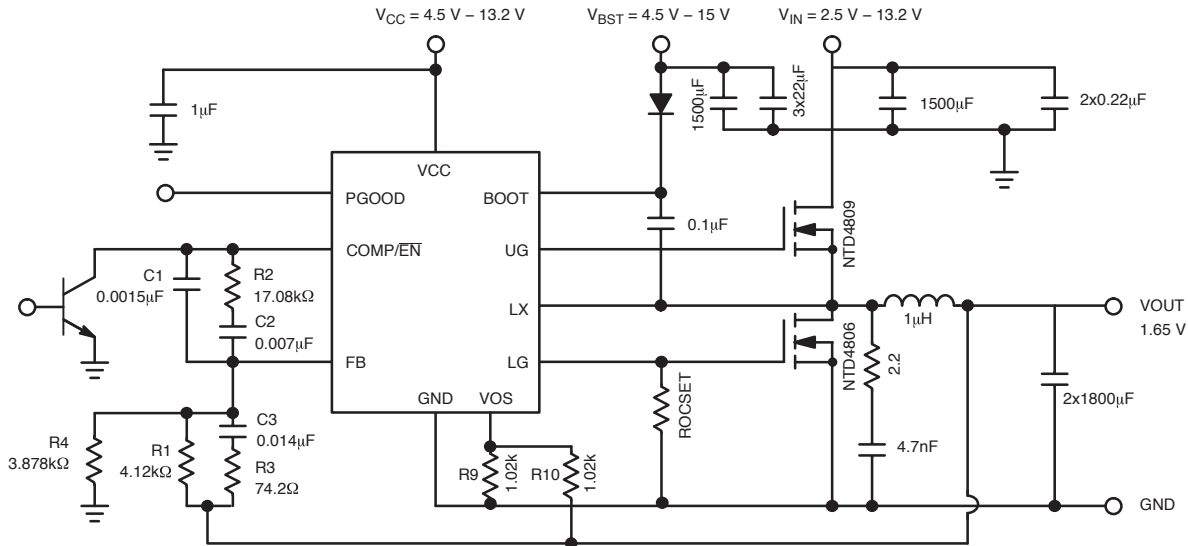
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



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

## 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 <sub>CC</sub> Min (V)	V <sub>CC</sub> Max (V)	f <sub>sw</sub> Typ (kHz)	Package
NCP1579	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	275	SOIC-8
NCP1587	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	250 - 300	SOIC-8
NCP1587A	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	180 - 220	SOIC-8
NCP1589A	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	—	DFN-10
NCP1589D	Synchronous Buck Controller	Step-Down	4.5	13.2	—	DFN-10
NCP1589L	Synchronous Buck Controller, Low Voltage, with Light Load Efficiency and Transient Enhancement	Step-Down	4.5	13.2	—	DFN-10
NCP5212	Single Synchronous Step Down Controller	Step-Down	4.5	27	300	QFN-16
NCP5217	Synchronous Buck Controller, Single	Step-Down	4.5	27	300	QFN-14
NCP5230	Low Voltage Synchronous Buck Controller	Step-Down	4.5	13.2	—	QFN-16
NCP5269	System Agent Controller with 2-bit VID	Step-Down	3.3	28	300 - 600	QFN-20
NCP3231	25 A Synchronous Buck Converter with Intergrated MOSFETs	Step-Down	4.5	18	500	TQFN-40
NCP3232N	15 A Synchronous Buck Converter with Intergrated MOSFETs	Step-Down	4.5	21	500	TQFN-40
NCP3133A	3 A Synchronous Buck Converter with Intergrated MOSFETs	Step-Down	2.9	5.5	1100	QFN-16
NCP3135	5 A Synchronous Buck Converter with Intergrated MOSFETs	Step-Down	2.9	5.5	1100	QFN-16

## Thermal Management and System Monitoring

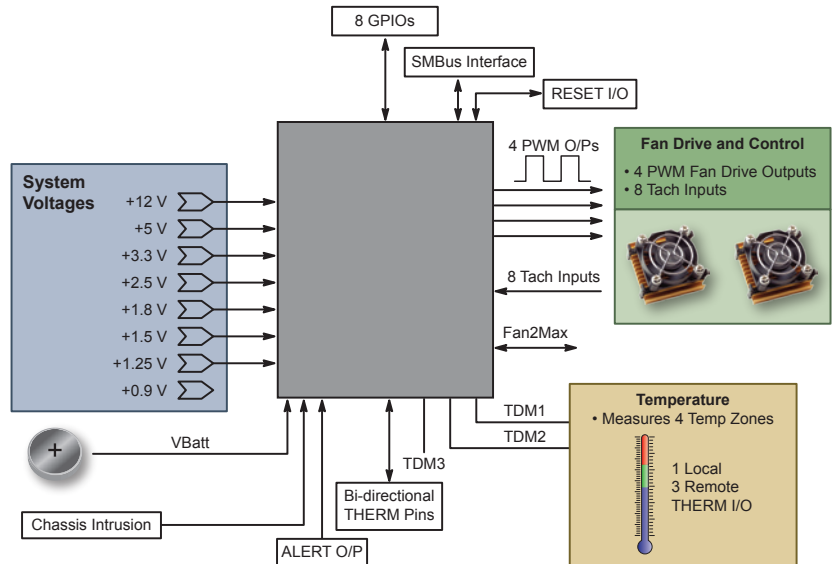
### Extensive Portfolio

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

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

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

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

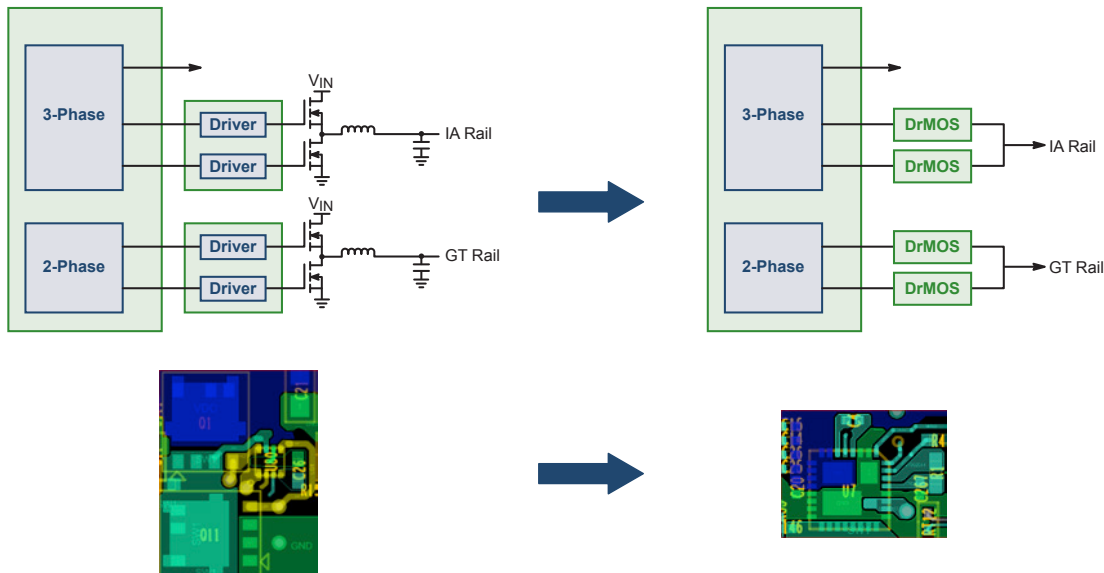


	Device	Supply Range (V)	Temperature Range (°C)	Local Accuracy (°C)	Interface	Number of Addresses	SRC (Ω)	Remote Accuracy	Remote Channels	Fan Channels	TACH Channels	Voltage Monitoring Channels	GPIOs	Package
<b>System Monitors</b>	ADM1026	3 - 5.5	-40 to +120	±3	I2C/SMBUS	3	—	±3	2	8	8	19	17	LQFP-48
	ADT7462	3 - 5.5	-40 to +125	±2.25	I2C/SMBUS	2	2 k	±2.25	3	4	8	13	8	LFCSOP-32
	NCT80	2.8 - 5.75	-40 to +125	±2	I2C/SMBUS	8	—	—	—	—	2	7	1	TSSOP-24
	ADT7476	3 - 3.6	-40 to +120	±1.5	I2C/SMBUS	3	—	±1.5	2	3	4	5	—	QSOP-24
<b>Fan Controllers</b>	ADT7473	3 - 3.6	-40 to +120	±1.5	I2C/SMBUS	3	3 k	±1.5	2	3	4			QSOP-16
	ADT7475	3 - 3.6	-40 to +120	±1.5	I2C/SMBUS	1	—	±1.5	2	3	4			QSOP-16
	ADM1033	3 - 3.6	-40 to +120	±1	I2C/SMBUS	8	1 k	±1	1	1	1			QSOP-16
	ADM1034	3 - 3.6	-40 to +120	±1	I2C/SMBUS	8	1 k	±1	2	2	2			QSOP-16
<b>Remote Sensors</b>	NCT72	2.8 - 3.6	-40 to +125	±1	I2C/SMBUS	2	1.5 k	±1	1					DFN-8, WDFN-8
	NCT218	1.4 - 2.75	-40 to +125	±1.75	I2C/SMBUS	2	150	±1	1					WDFN-8, WLCSOP-8
	NCT210	3 - 5.5	-55 to +125	±1	I2C/SMBUS	9	—	±3	2					QSOP-16
	ADM1032	3 - 5.5	-40 to +125	±3	I2C/SMBUS	2	—	±1	1					SOIC-8, MSOP-8
	ADT7461	3 - 5.5	-40 to +125	±3	I2C/SMBUS	2	3 k	±1	1					SOIC-8, MSOP-8
	ADT7481	3 - 3.6	-40 to +125	±1	I2C/SMBUS	2	—	±1	2					MSOP-10
	ADT7483	3 - 3.6	-40 to +125	±1	I2C/SMBUS	9	—	±1	2					QSOP-16
<b>Local Sensors</b>	NCT375	3 - 5.5	-55 to +125	±1	SMBUS	8								DFN-8, SOIC-8, Micro8
	NCT475	3 - 5.5	-55 to +125	±1	SMBUS	4								WLCSOP-6
	NCT203	1.4 - 2.75	-40 to +125	±1.75	I2C/SMBUS	1								DFN-8, SOIC-8, Micro8

## Integrated MOSFET and Drivers

### Features

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



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
NCP81380	5 V Tri-state	30	2	15	QFN-32
NCP81381	5 V Tri-state	30	2	25	QFN-32
NCP81382	5 V Tri-state	30	2	35	QFN-28

## Drivers for Discrete MOSFET Implementations

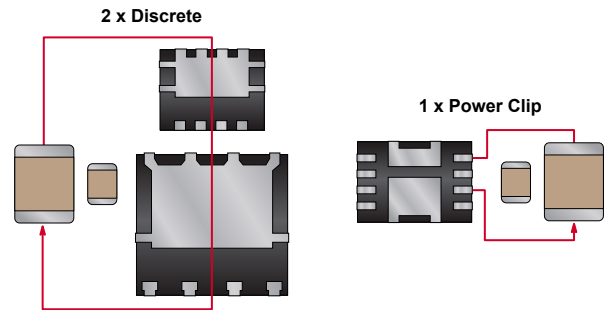
Drivers specifically designed to work with controller solutions, and optimized for 5 V or 12 V gate applications.

Device	Drivers	$V_{CC}$ Typ (V)	Integrated Bootstrap Diode	Zero Crossover Detection	Package
NCP5901	Single	12	N	Y	DFN-8
NCP5901B	Single	12	Y	Y	DFN-8
NCP81161	Single	12	Y	Y	DFN-8
NCP81151	Single	5	Y	Y	DFN-8
NCP81253	Single	5	Y	N	DFN-8
NCP81061	Dual	12	Y	Y	QFN-16
NCP81152	Dual	5	Y	Y	QFN-16

## High Performance Dual MOSFETs (Power Clip)

### Features

- Co-packaged high-side & low-side MOSFETs reduces board space
- Optimized for low Figure-of-Merit =  $R_{DS(ON)} \times Q_g$
- Improved clip for faster switching & improved efficiency
- Flipped low-side MOSFET improves thermal performance
- Parasitic inductance loops minimized for improved efficiency



High Frequency Switching Loop Size Reduction

### Specific Applications

- GPU rails in VGA cards and gaming motherboards
- Vcore & system rails in notebooks

Device	Package	I <sub>max</sub> (A)	BV <sub>DSS</sub> (V)	V <sub>GS</sub> Max (V)	R <sub>DS(ON)</sub> Max @ V <sub>GS</sub> = 4.5 V (mΩ)		Q <sub>g</sub> Typ @ V <sub>GS</sub> = 4.5 V (nC)		C <sub>oss</sub> Typ (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
FDMC2D2N025DSD*		15-20	25	16	7	2.2	5	15	886
FDMC2D3N03DSD*		15-20	30	16	7	2.4	5	15	1063
FDPC3D5N025X9D		10	25	12	3.7	3.7	17	17	612
FDPC8900*	Power Clip 35	14	30	12	5	6.5	12	8.8	356
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
NTMFD4H088NF*	Power Phase 56	25	30	12	11.3	2	3	21	1530
NTMFD4C85N*		>30	30	20	4.3	1.2	15	45	3660
NTMFD4C86N*		>30	30	20	8.1	3.4	11	22	1650

\* Pending 1Q17.



## Asymmetric Dual MOSFETs

Device	Package	I <sub>max</sub> (A)	BV <sub>DSS</sub> (V)	V <sub>GS</sub> Max (V)	R <sub>DS(on)</sub> Max @ V <sub>GS</sub> = 4.5 V (mΩ)		Q <sub>g</sub> Typ @ V <sub>GS</sub> = 4.5 V (nC)		C <sub>oss</sub> Typ (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	S08-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> (V)	R <sub>DS(on)</sub> Max @ V <sub>GS</sub> = 4.5 V (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

## Common Drain Dual N-Channel MOSFET

### FDPC4044

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

### Specific Applications

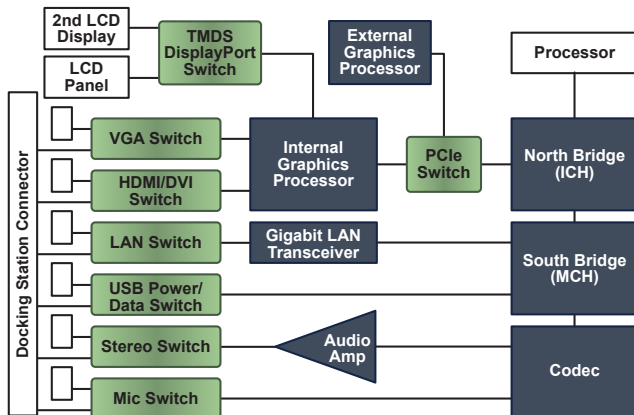
- VBUS back-back protection switch for USB Type-C
- Replace two discrete back-back MOSFETs with single compact solution

## N-Channel MOSFETs

Device	Package	Polarity	Maximum Ratings				Q <sub>g</sub> (nC)	Q <sub>gd</sub> (nC)	C <sub>iss</sub> (pF)	C <sub>rss</sub> (pF)	R <sub>G</sub> (Ω)	Applications
			V <sub>DS</sub> (V)	V <sub>GS</sub> (V)	R <sub>DS(ON)</sub> (mΩ)							
					V <sub>GS</sub> =10 V	V <sub>GS</sub> =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.



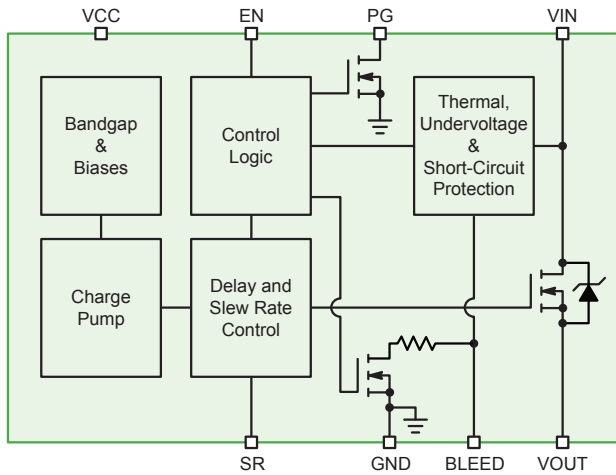
### Server Implementation

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

## Advanced Load Switches

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

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



### NCP45xxx Integrated Load Switch Feature

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

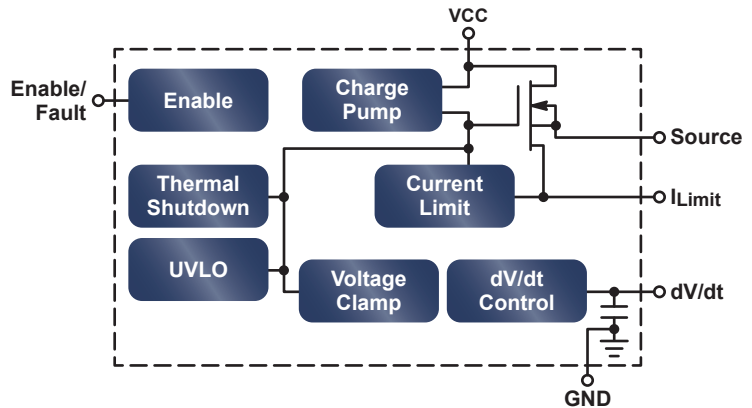
Type	Device	r <sub>on</sub> (mΩ)	I Max (A)	V <sub>I</sub> Min (V)	V <sub>I</sub> Max (V)	I <sub>q</sub> (μA)	Discharge	Slew Rate (μs)	Features	Package(s)
Smart Load Switch	NCP330	26 at 3.3 V	3	1.8	5.5	100	-	2000	Reverse blocking	TDFN-4
	NCP333	55 at 3.3 V	1.5	1.2	5.5	1	Auto	95	-	WLCSP-4
	NCP334	47 at 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	3.3	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

## Electronic Fuse for SATA, eSATA, USB

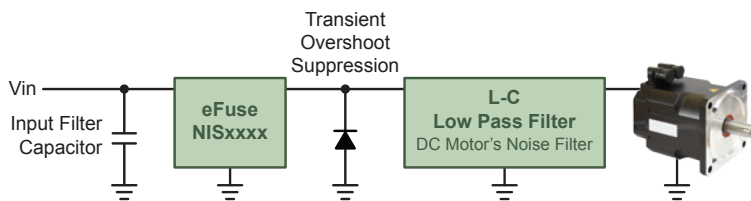
### 3 - 12 V Power Bus Hot Plug Protection

#### Features

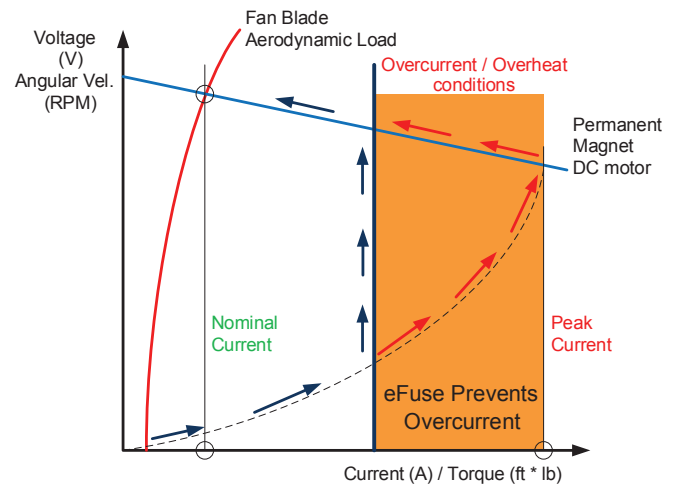
- Low  $R_{DS(ON)}$ , high operating and trip currents (IOP, ITRIP)
- Overvoltage protection
- Precise ITRIP control
- Slew rate control
- Thermal shut-down
- EN pin for synchronizing multiple eFuses
- Outperforms poly-fuses:
  - Tighter spec tolerances
  - Lower resistance
  - Shorter trip-time
  -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



Typical Feature Set for eFuse



Typical Application Block Diagram



DC Motor I/V Characteristics

Device	Input Voltage (V)	Output Clamping Voltage (V)	ITRIP Trip Current (A)	$R_{DS(ON)}$ (m $\Omega$ )	Adjustable ITRIP	Auto Recovery	Latching	Package
NIS5112	-0.6 to 18	15	2.5	28	Yes	Yes	Yes	SOIC-8
NIS5132	-0.6 to 18	15	3.5	44	Yes	Yes	Yes	DFN-10
NIS5232	-0.6 to 18	15	4	44	Yes	No	Yes	DFN-10
NIS5135	-0.6 to 18	6.65	3.5	68	Yes	Yes	Yes	DFN-10
NIS5452	-0.6 to 14	5.85	2.1	40	Yes	No	Yes	WDFN-10
NIS5431	-0.6 to 14	3.85	1.6	45	Yes	No	Yes	WDFN-10



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

Four Pairs, Low Capacitance Surge and ESD Protection

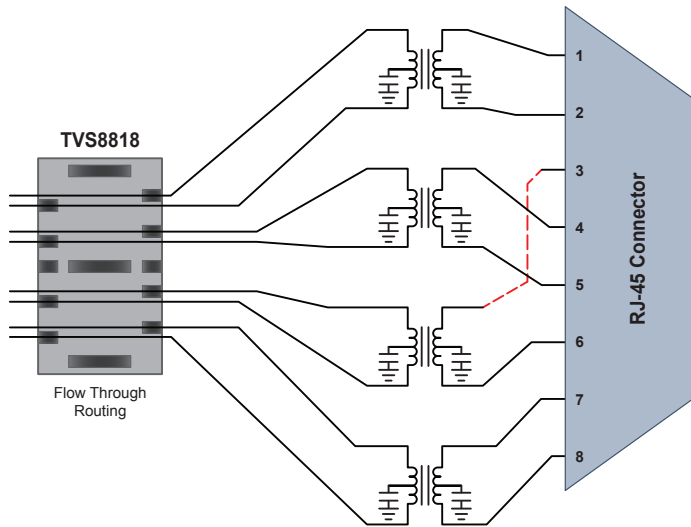
The 1000BASE-T or Gigabit Ethernet interface operating at higher bitrates is susceptible to ESD strikes, cable-discharge events and lightning-induced transients. Our products help meet IEC 61000-4-5, GR-1089-CORE and other Standards.

### Features

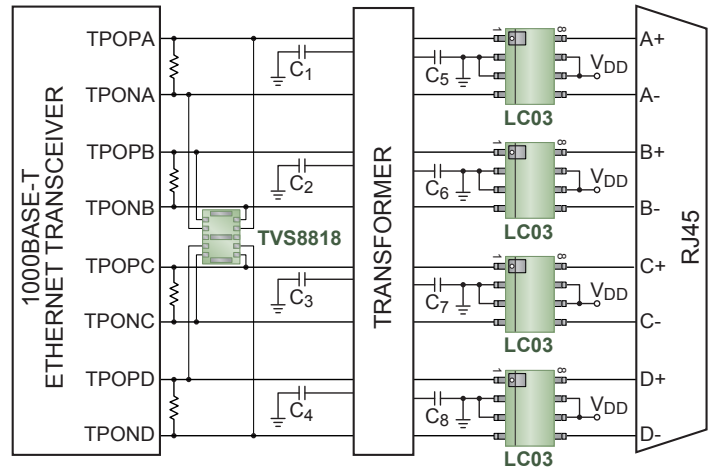
- Line-to-line capacitance < 3 pF
- $V_{clamp}$  (25 A surge) < 11 V
- IEC 61000-4-2 rating > 30 kV
- No latching danger
- Surge rating maintained to 125°C

### Benefits

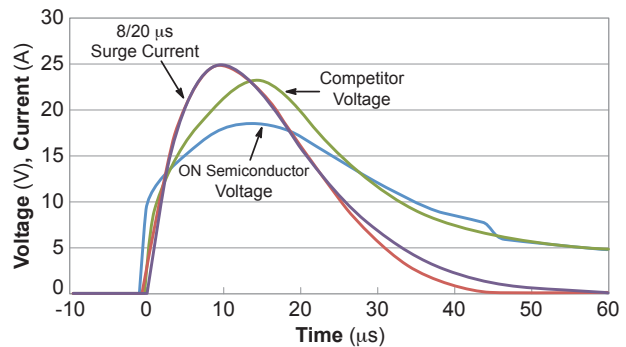
- Compatible with Gb Ethernet and beyond
- Enhanced protection for downstream electronics
- Accommodates operating transients above 3.3 V
- Small form-factor allows integration into connectors



### Typical Application



Line Side : LC03-6 (optional)  
Transformer Side: TVS8818  
Protection against metallic (transverse) strikes



Line-to-Line Surge

### Surge Protection Devices

Device	$V_{DC}$ Max (V)	Line Transient Max (V)	Surge $I_{PP}$ , 8/20 $\mu$ s (A)	Typical Line-Line Capacitance (pF)	ESD Contact Rating (kV)	Package
LC03-6	6.7	7.0	100	8.0	$\pm 30$	SOIC-8
TVS4201	5.0	6.0	25	1.5	$\pm 30$	TSOP-6
TVS8814	3.0	3.2	35	1.5	$\pm 30$	UDFN-8
TVS8818	3.0	3.2	35	1.5	$\pm 30$	UDFN-10
NUP4114H	5.0	5.0	12*	0.4	$\pm 13$	TSOP-6
SRDA3.3	3.3	5.0	25	4.0	$\pm 8$	SOIC-8
SRDA05	5.0	7.0	23	5.0	$\pm 8$	SOIC-8

\* On Pin 5.

## USB 3.x Type A Connector

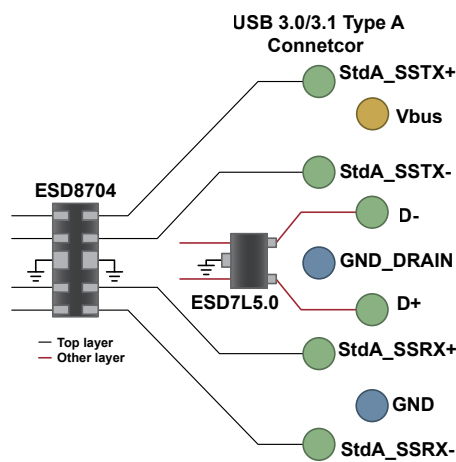
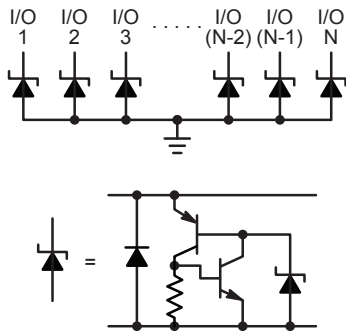
Two SuperSpeed Pairs, One High Speed Pair, V<sub>CC</sub>, Low Capacitance ESD Protection

### Key Requirement

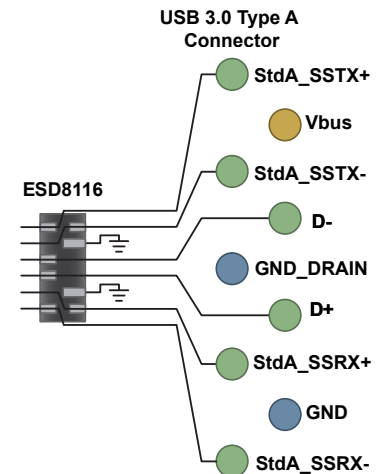
- Cap < 0.7 pF

### Features

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

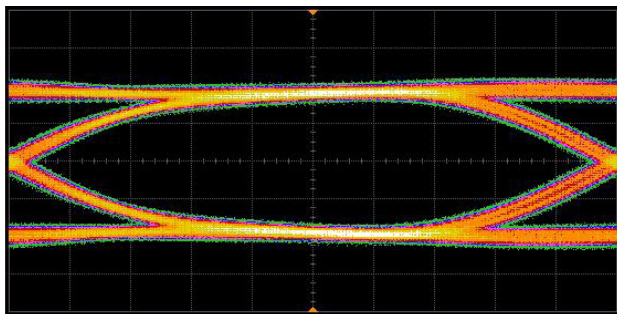


**ESD8704 – 0.35 pF, 2 Layer Routing**  
(ESD8704; ESD7L5.0 for D+, D- Lines)

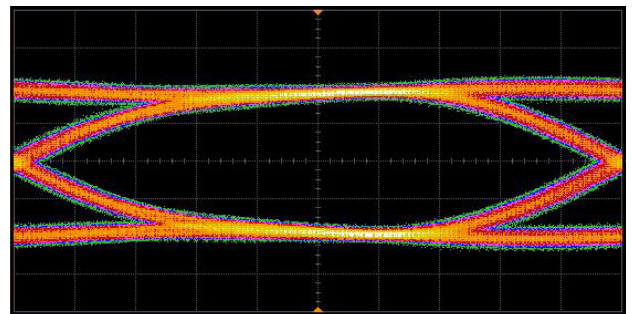


**ESD8116 – 0.30 pF, 1 Layer Routing**

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
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.x	Single Line	0.20	WLCSP-2	0.6 x 0.3
ESD8006	USB 3.0	3 Pair (Tx, Rx, D+/-)	0.25	UDFN-8	3.3 x 1.0



Without ESD



With ESD

USB 3.0 @ 5 Gb/s

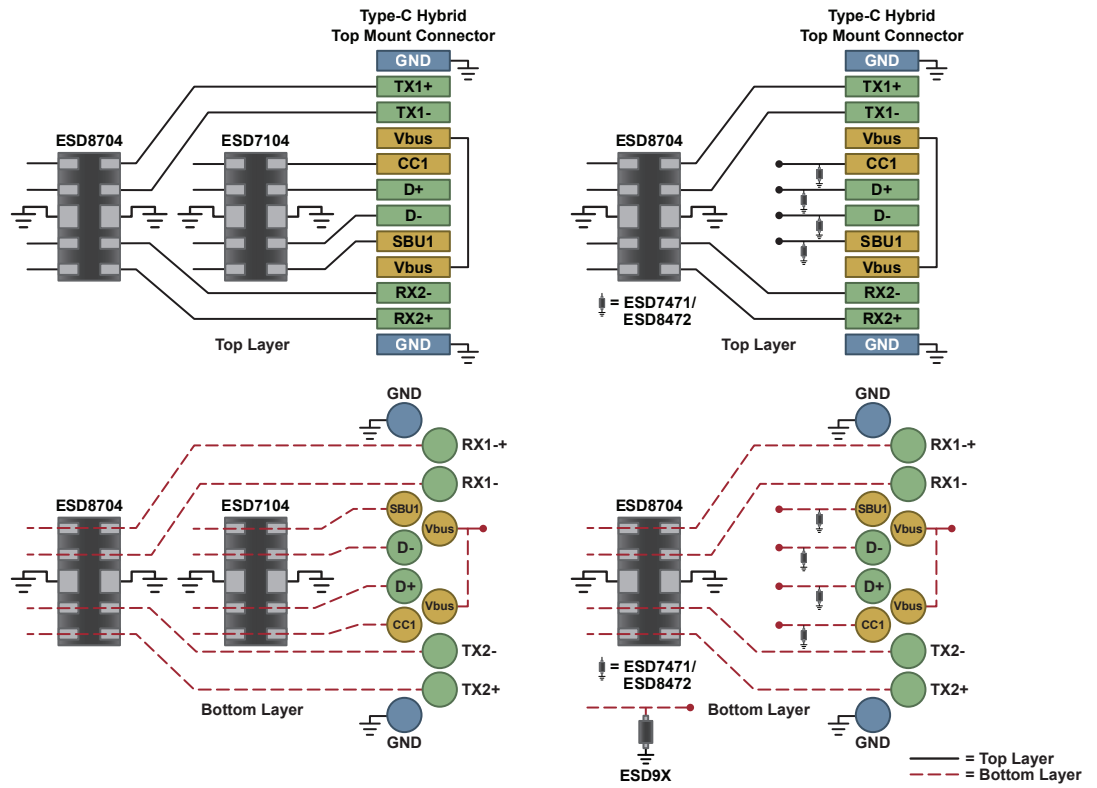
## USB 3.x Type C Connector

### Key Requirement

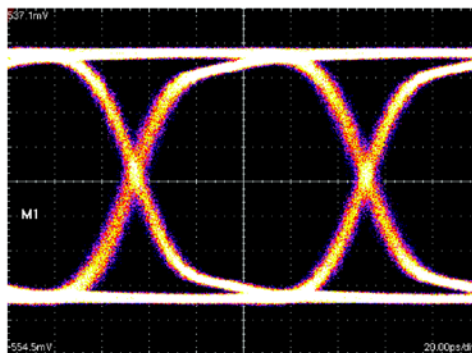
- Cap < 0.5 pF

### Features

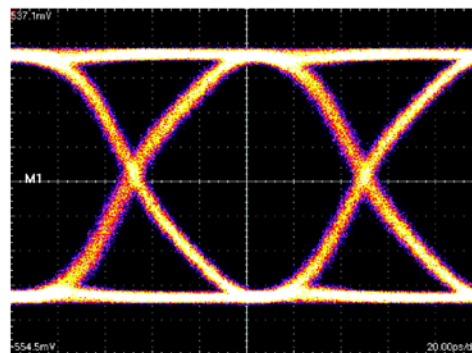
- 0.35 pF
- Flow through routing
- Industry leading low clamping voltage versus competitors



Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESD8704	2 Pair (Tx, Rx)	0.37	UDFN-10	2.5 x 1.0
ESD7104	2 Pair (CC, SBU, D+/-)	0.30	UDFN-10	2.5 x 1.0
ESD8011	Single Line (Tx, Rx)	0.10	X3DFN-2	0.62 x 0.32
ESD8101	Single Line (Tx, Rx)	0.20	DSN-2	0.43 x 0.23
ESD8111	Single Line (Tx, Rx)	0.20	WL CSP-2	0.6 x 0.3
ESD8472	Single Line (CC, SBU, D+/-)	0.20	X3DFN-2	0.62 x 0.32
ESD7471	Single Line (CC, SBU, D+/-)	0.24	XDFN-2 (SOD-882)	1.0 x 0.6



Without ESD



With ESD

USB3.1 Eye Diagram with and without ESD8704. 10 Gb/s

## USB 2.0

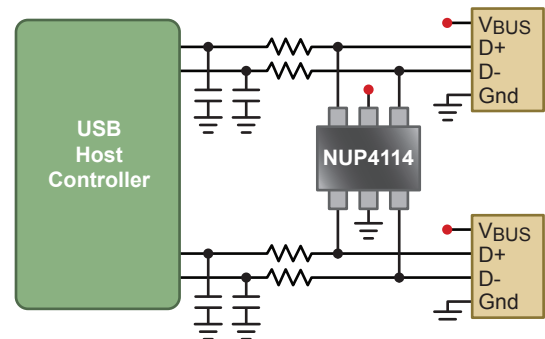
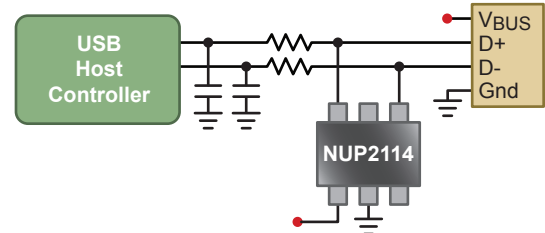
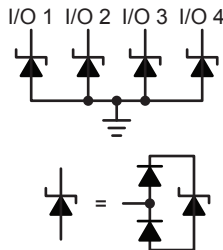
One High Speed Pair, V<sub>CC</sub>, Low Capacitance ESD Protection

### 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
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
TVS4201MR6	2 Pair (D+/-) + Vbus	3	TSOP-6	3.0 x 2.75
ESD7L5.0	2	0.5	SOT-723	1.2 x 1.2
ESD8351MUT	1	0.37	X3DFN-2	0.6 x 0.3
ESD8351P2T	1	0.37	SOD-923	1.0 x 0.6
ESD9L5.0	1	0.5	SOD-923	1.0 x 0.6

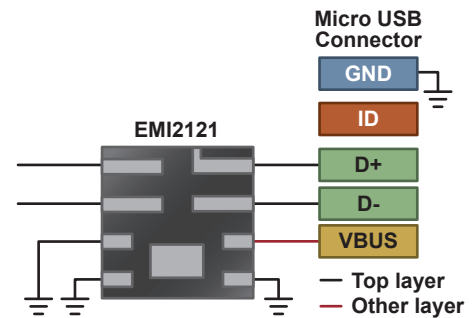
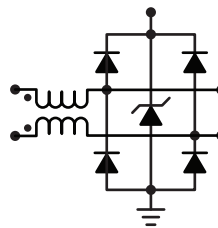
One High Speed Pair, V<sub>CC</sub>, Common Mode Filter + ESD Protection

### Key Requirement

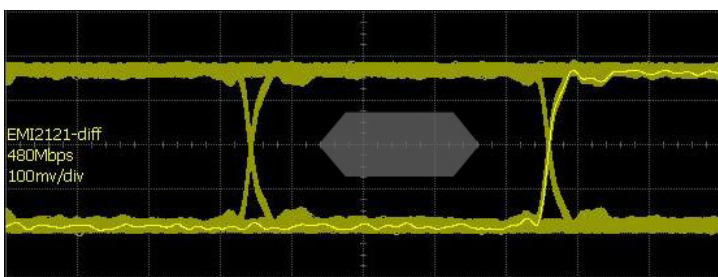
- Cap < 5 pF
- Common Mode Filtering

### Features

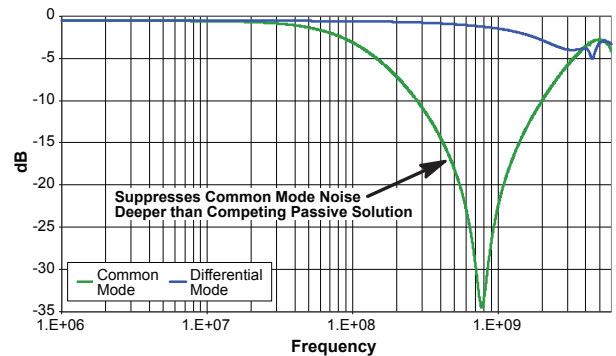
- 0.5 - 0.8 pF
- Integrated EMI suppression with ESD protection
- Industry leading low clamping voltage



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	2.2 x 2.0 x 0.75



USB 2.0 @ 480 Mb/s





# Thunderbolt

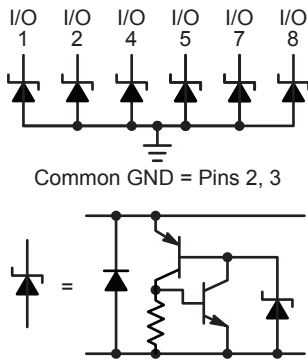
Four High Speed Pairs, up to Six Additional Lines, Low Capacitance ESD

### Key Requirement

- Capacitance < 0.4 pF

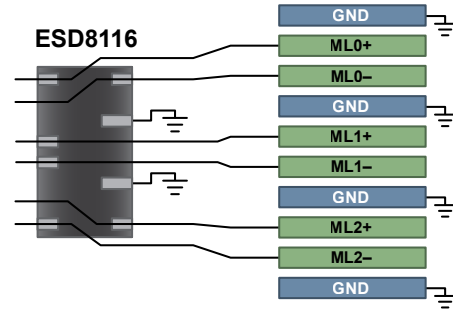
### Features

- 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

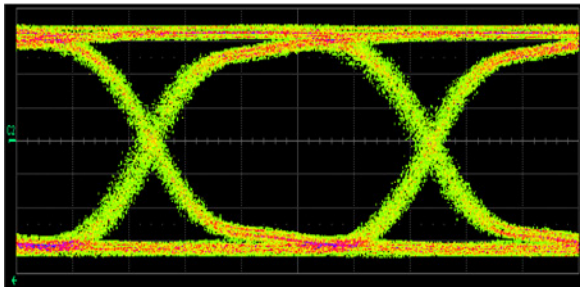
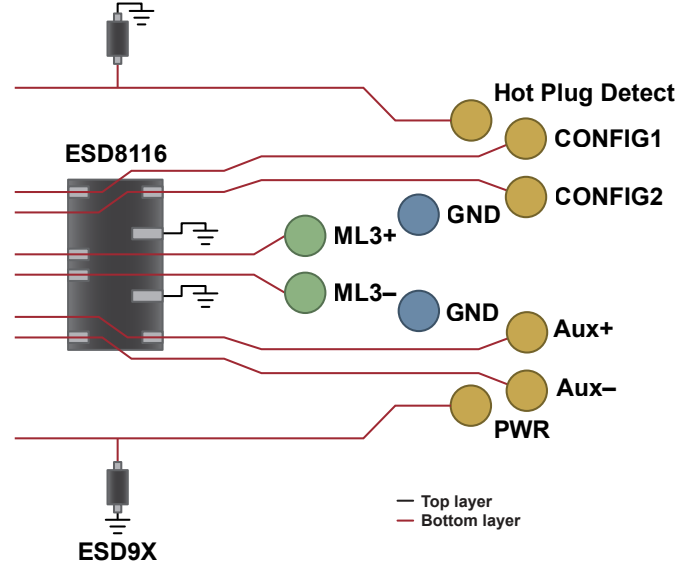


Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESD8006	3 Pair	0.25	UDFN-8	3.3 x 1.0
ESD8116	3 Pair	0.30	UDFN-8	2.0 x 1.2
ESD8011	Single Line	0.10	X3DFN-2	0.62 x 0.32
ESD8101	Single Line	0.20	DSN-2	0.43 x 0.23

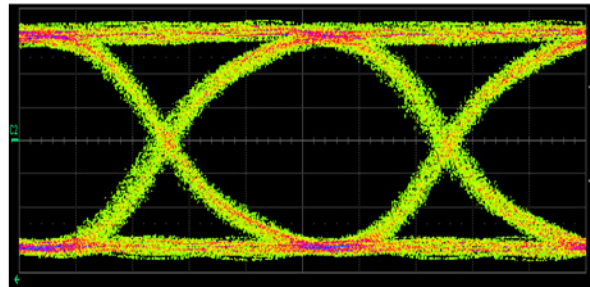
### Thunderbolt Connector Top Layer



### Thunderbolt Connector Bottom Layer



Without ESD116



With ESD116

Thunderbolt @ 10 Gb/s

## HDMI, Display Port

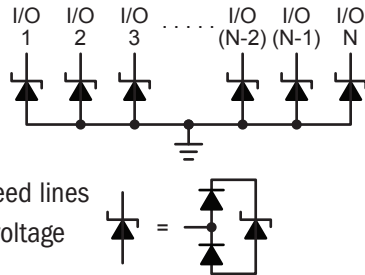
Four High Speed Pairs, Up to Six Additional Interface Lines, Low Capacitance ESD

### Key Requirement

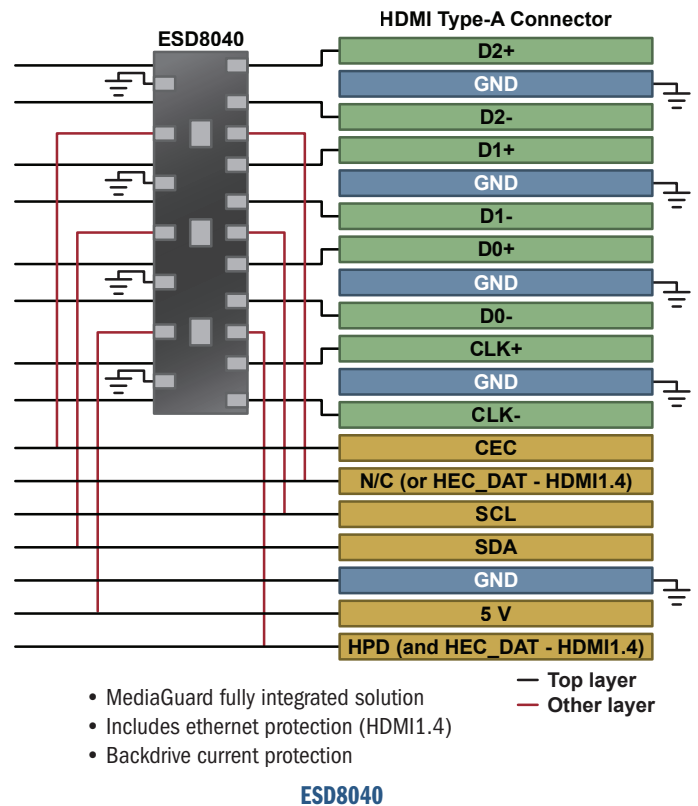
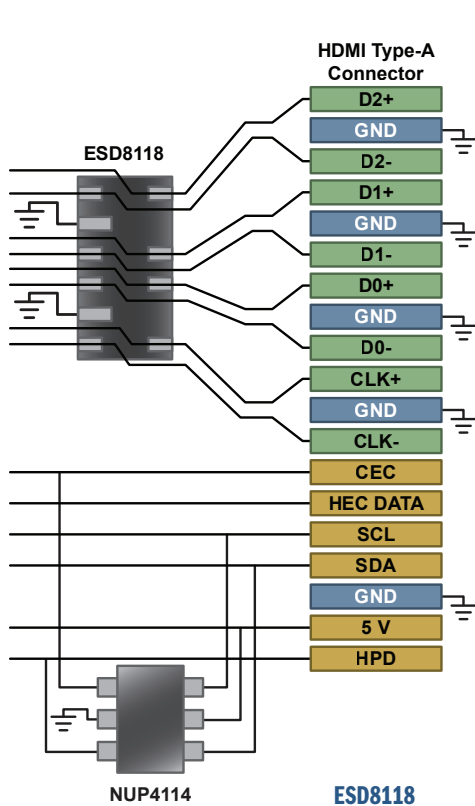
- Cap < 0.5 pF

### Features

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

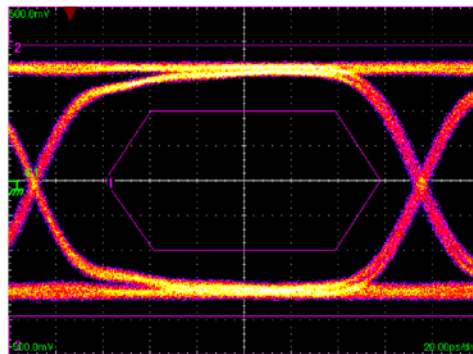


Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESD8104	4 (TMDS)	0.3	UDFN-10	2.5 x 1.0
ESD8118	8 (TMDS)	0.3	UDFN-10	3.2 x 1.2
ESD8040	14 (TMDS + Low Speed + Power)	0.3	UDFN-18	5.5 x 1.5
NUP4114UPX	5 (4 Low Speed + Power)	0.5	SOT-563	1.6 x 1.6
NUP4114UCL	5 (4 Low Speed + Power)	0.5	SC-88	2.0 x 2.1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

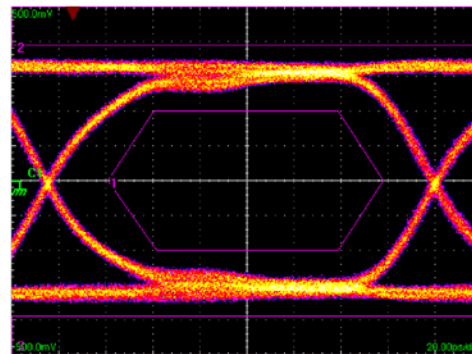


- MediaGuard fully integrated solution
- Includes ethernet protection (HDMI1.4)
- Backdrive current protection

— Top layer  
— Other layer



Without ESD



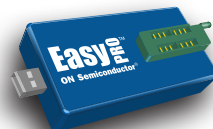
With ESD

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

## EEPROMs for Configuration and Calibration

### Features

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



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

### EEPROMs

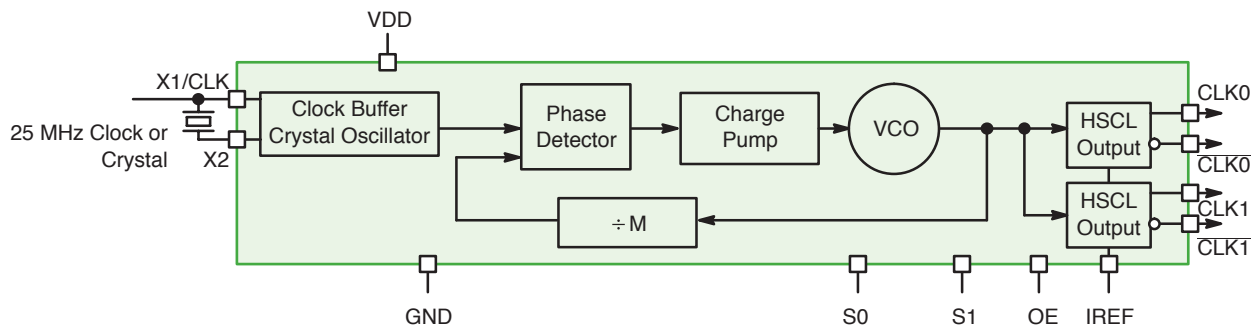
Data Transmission Standard	Device	Density	Organization*	Vcc Min (V)	Vcc Max (V)	fCLK Max (MHz)	Package(s)
I <sup>2</sup> C	CAT24M01	1 Mb	128k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C512	512 kb	64k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C256	256 kb	32k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C128	128 kb	16k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C64	64 kb	8k x 8	1.7	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	N24C64	64 kb	8k x 8	1.7	5.5	1	US-8
	LE2464	64 kb	8k x 8	1.7	3.6	1	WLCSP-6
	CAT24C32	32 kb	4k x 8	1.7	5.5	1	SOIC-8, TSSOP-8, UDFN-8; WLCSP-5
	N24C32	32 kb	4k x 8	1.7	5.5	1	US-8
	LE2432	32 kb	4k x 8	1.7	3.6	1	WLCSP-6
	CAT24C16	16 kb	2k x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5
	LE2416	16 kb	2k x 8	1.7	3.6	1	WLCSP-6
	N24C16	16 kb	2k x 8	1.7	5.5	0.4	US-8
	CAT24C08	8 kb	1k x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5
	N24C08	8 kb	1k x 8	1.7	5.5	0.4	US-8
	CAT24C04	4 kb	512 x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5
	N24C04	4 kb	512 x 8	1.7	5.5	0.4	US-8
CAT24C02	2 kb	256 x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5	
N24C02	2 kb	256 x 8	1.7	5.5	0.4	US-8	
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.

## Clock Synthesizers for High Performance Computing

### Features

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



NB3N5573 Simplified Logic Diagram

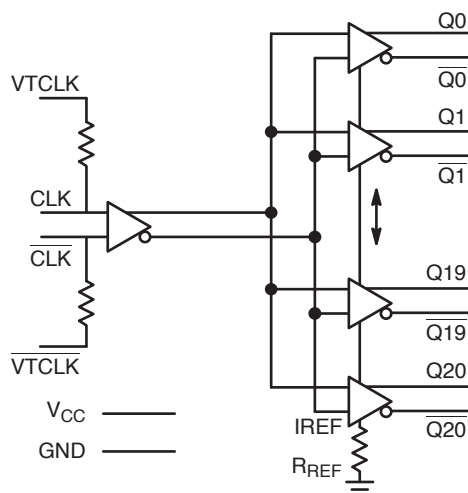
Device	Number of Inputs	Input Type	$f_{in}$ Typ (MHz)	Number of Outputs	Output Type	$f_{out}$ Typ (MHz)	Spread Spectrum Outputs	Package
NB3N3002	1	Crystal; LVCMOS; LVTTTL	25	1	HCSL	25; 100; 125; 200	No	TSSOP-16
NB3N5573	1	Crystal; LVCMOS; LVTTTL	25	2	HCSL	25; 100; 125; 200	No	TSSOP-16
NB3N51032	1	Crystal; LVCMOS; LVTTTL	25	2	HCSL	25; 100; 125; 200	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 compliant
- Additive phase jitter 80 fs maximum @ 156.25 MHz with NB3L208K, NB3L204K, NB3L202K; DB800H, DB400H, DB200H compliant



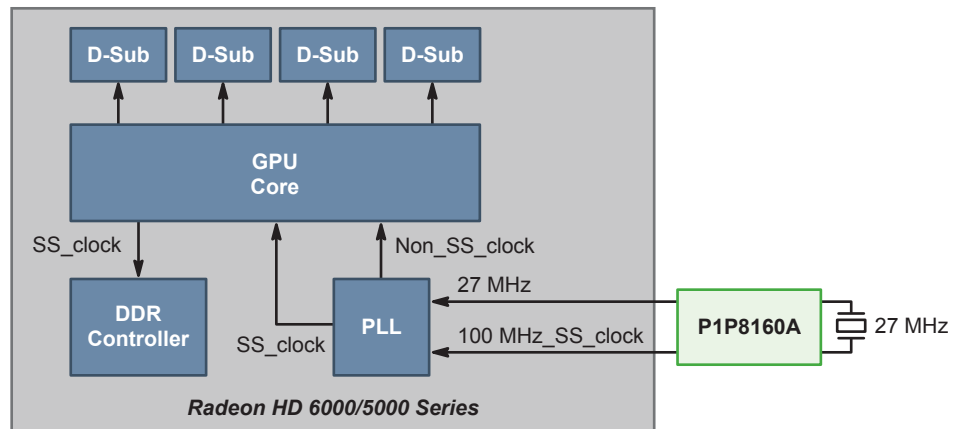
NB3N121K Logic Diagram

Device	Ratio	Additive 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
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

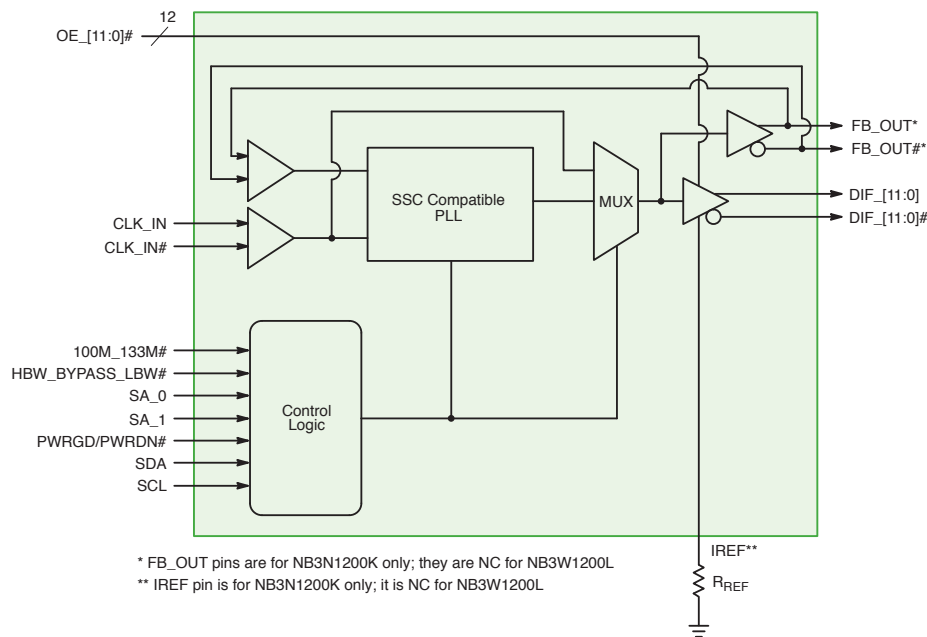


P1P8160A for AMD Graphics Card Application

## 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(Cy-Cy)</sub> Typ (ps)	t <sub>skew(I-o)</sub> Max (ps)	t <sub>skew(o-o)</sub> 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

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