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ON Semiconductor

Energy Efficient Innovations

Computing Solutions

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

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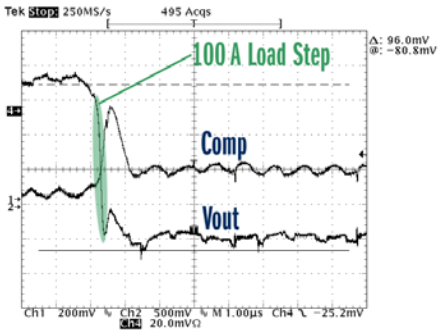
Dual-Edge & Flex-Mode Modulation Vcore Controllers

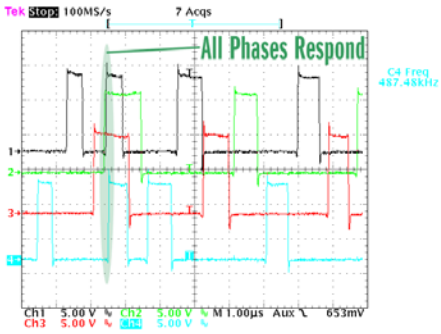
for VR11.0 to VR12.6+ Designs

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



Features

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



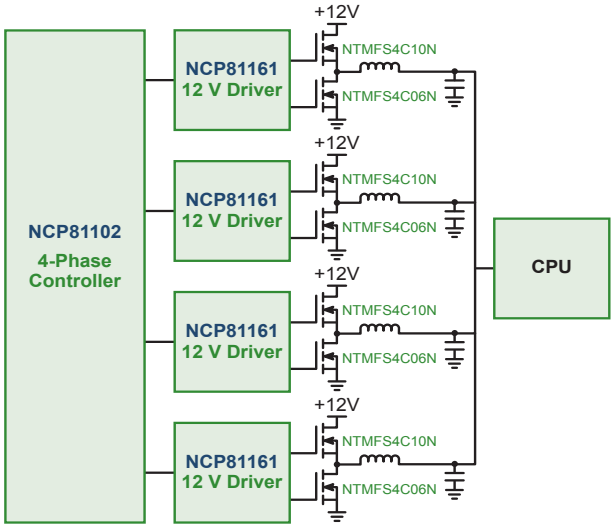
Device	VR Spec	Controller Architecture	CPU Phases	GPU Phases	Integrated Drivers	Interface	SM-Bus	Package
NCP81101	VR12.6+	RPM	1	–	1 x 5 V	SVID	–	QFN-28
NCP81105	VR12.6	Dual Edge	2/3	–	–	SVID	–	QFN-36
NCP81108	VR12.6	Dual Edge	2/3	–	2	SVID	–	QFN-36
NCP81109	VR12.6	RPM	1	–	1 + FETs	SVID	–	QFN-48
NCP81110	VR12.6	RPM	1	–	1 + FETs	SVID	–	QFN-48
NCP81118	VR12.6	Dual Edge	2/3	–	2 x 5 V	SVID	–	QFN-36
NCP81102	VR12.5	Dual Edge	2/3/4	–	–	SVID	–	QFN-32
NCP81103	VR12.5	Dual Edge	2/3	–	2 x 5 V	SVID	–	QFN-36
NCP81106	VR12.5	Dual Edge	2/3	–	2 x 12 V	SVID	–	QFN-40
NCP81116	VR12.5	Dual Edge	2/3	–	2 x 12 V	SVID	Y	QFN-36
NCP81119	VR12.5	Dual Edge	2/3/4	–	–	SVID	–	QFN-32
NCP6121	VR12	Flex Mode + Dual Edge	2/3	1	–	SVID	–	QFN-56
NCP6151	VR12	Flex Mode + Dual Edge	3/4	1	–	SVID	–	QFN-56
NCP6153	VR11.1	Dual Edge	2/3/4	–	–	PVID	–	QFN-40
NCP5395	VR11.1	Dual Edge	2/3/4	–	3 CPU	PVID	–	QFN-48
NCP6133	VR11.1	Flex Mode	2/3/4	–	–	PVID	–	LFCSP-40
NCP4206	VR11.1	Dual Edge	1/2/3/4/5/6	–	–	PVID	Y	QFN-48
NCP4208	VR11.1	Dual Edge	1/2/3/4/5/6/7/8	–	–	PVID	Y	QFN-48
NCP81022	SV12	Dual Edge	4	1	–	SVI2	–	QFN-52
NCP81128	SV12	Dual Edge	2	2	2 x 5 V	SVI2	–	QFN-52

Please contact ON Semiconductor for product datasheets.

Desktop Solutions

NCP81102 1/2/3/4-phase controller

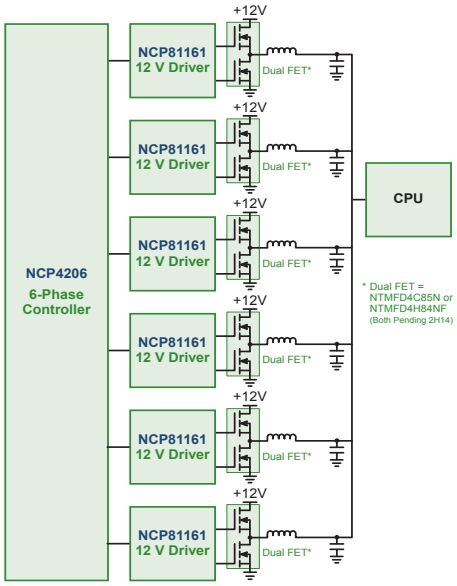
- Dual edge modulation for fast transient response
- Constant on-time for light load efficiency
- Supports all MLCC output capacitor solutions
- VR12.5 compliant



Server Solutions

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

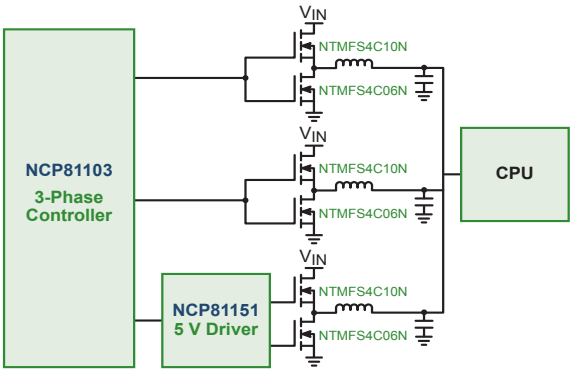
- Highly efficient, multiphase, synchronous buck switching regulator controller
- Supports PSI, to reduce the number of operating phases at light loads
- SMBus interface enables digital programming of key system parameters to optimize system performance and provide feedback
- NCP4206 has built in shunt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



Notebook Solutions

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

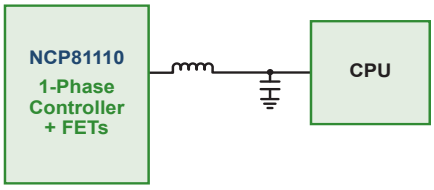
- High performance notebook solutions
- Dual edge modulation for fast transient response
- Features 2 integrated 5 V drivers
- VR12.5 (NCP81103) & VR12.6 (NCP81108) compliant



Integrated Ultrabook/Notebook Solution

NCP81110 1-phase converter

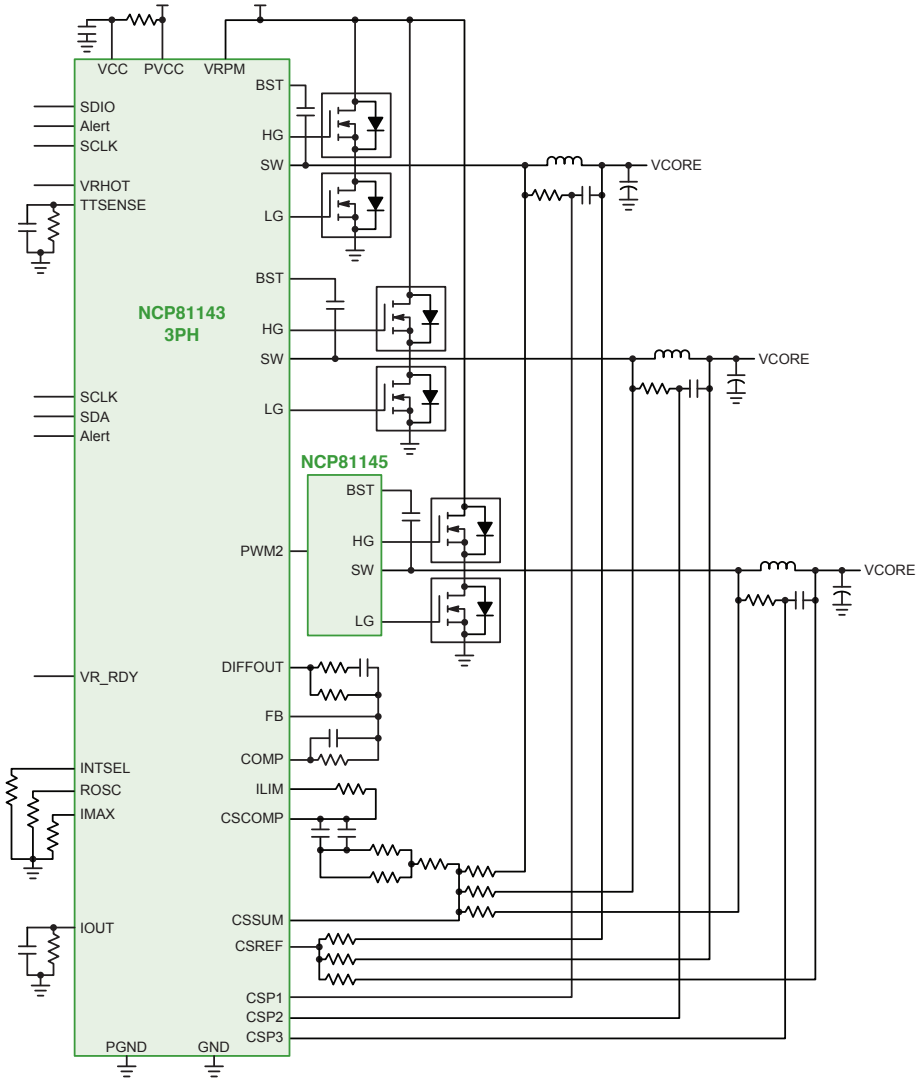
- Integrated solution with drivers and 14 A TDC MOSFETs
- Smallest solution footprint for compact design
- Higher efficiency for longer battery life
- VR12.6 compliant



VR12.5/6 Multiphase Controllers for Embedded Applications

Features

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

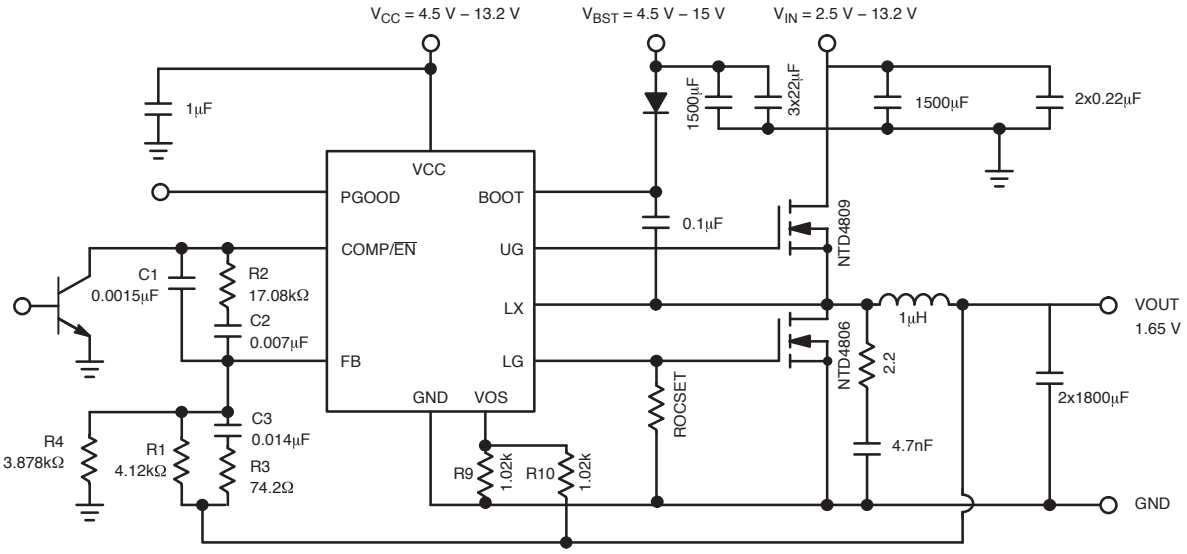


Device	Description	Driver / MOSFETs	Package
NCP81140	4-Phase Controller	–	QFN-32
NCP81141	1-Phase VR12.6 Controller	Integrated 5 V Driver	QFN-28
NCP81142	4-Phase VR12.5 Controller	–	QFN-32
NCP81143	3-Phase VR12.5 Controller	2x Integrated 5 V Drivers	QFN-36
NCP81145	5 V Driver	–	DFN-8
NCP81146	12 V Driver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

* Pending 2H14

System Power

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



NCP1589A Application Diagram

Device	Description	Topology	VCC Min (V)	VCC Max (V)	fSW Typ (MHz)	Package
NCP1579	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	275	SOIC-8
NCP1587	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	250 - 300	SOIC-8
NCP1587A	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	180 - 220	SOIC-8
NCP1589A	Synchronous Buck Controller, Low Voltage	Step-Down	4.5	13.2	–	DFN-10
NCP1589D	Snychronous Buck Controller	Step-Down	4.5	13.2	–	DFN-10
NCP1589L	Synchronous Buck Controller, Low Voltage, with Light Load Efficiency and Transient Enhancement	Step-Down	4.5	13.2	–	DFN-10
NCP5212	Single Synchronous Step Down Controller	Step-Down	4.5	27	300	QFN-16
NCP5212T	Single Synchronous Step Down Controller	Step-Down	4.5	27	300	QFN-16
NCP5217	Synchronous Buck Controller, Single	Step-Down	4.5	27	300	QFN-14
NCP5222	Synchronous Buck Controller, 2-Channel, 2-Phase	Step-Down	4.5	27	300	QFN-28
NCP5230	Low Voltage Synchronous Buck Controller	Step-Down	4.5	13.2	–	QFN-16
NCP5269	System Agent Controller with 2-bit VID	Step-Down	3.3	28	300 - 600	QFN-20

Thermal Management and System Monitoring

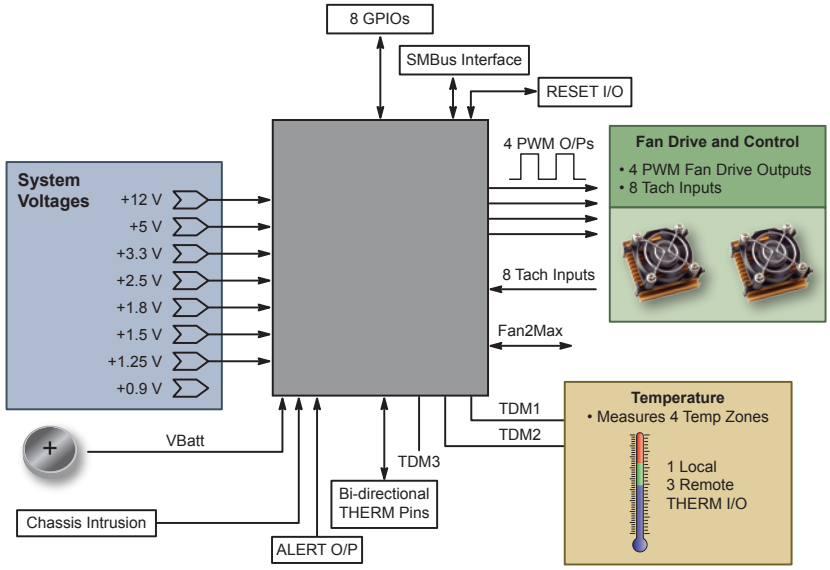
Extensive Portfolio

Local Sensors provide temperature information at the device location

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

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

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



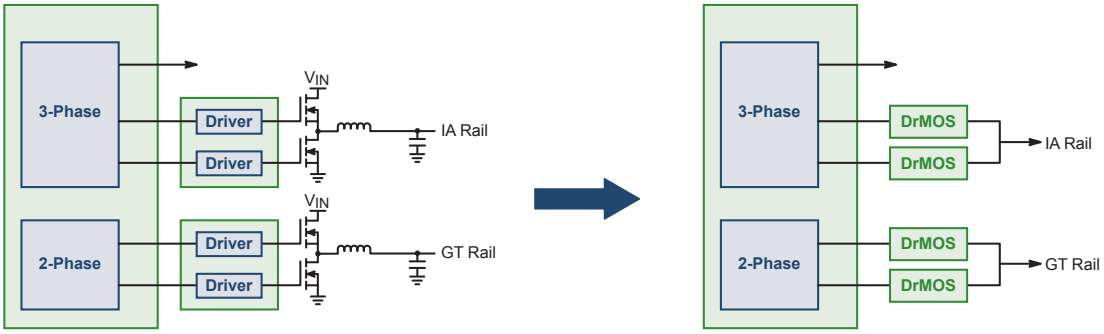
	Device	Supply Range (V)	Temperature Range (°C)	Local Accuracy (°C)	Interface	Number of Addresses	SRC (Ω)	Remote Accuracy	Remote Channels	Fan Channels	TACH Channels	Voltage Monitoring Channels	GPIOs	Package
System Monitors	ADM1026	3 - 5.5	-40 to +120	±3	I2C/SMBUS	3	–	±3	2	8	8	19	17	LQFP-48
	ADT7462	3 - 5.5	-40 to +125	±2.25	I2C/SMBUS	2	2 k	±2.25	3	4	8	13	8	LFCSP-32
	NCT80	2.8 - 5.75	-40 to +125	±2	I2C/SMBUS	8	–	–	–	–	2	7	1	TSSOP-24
	ADT7476	3 - 3.6	-40 to +120	±1.5	I2C/SMBUS	3	–	±1.5	2	3	4	5	–	QSOP-24
Fan Controllers	ADT7473	3 - 3.6	-40 to +120	±1.5	I2C/SMBUS	3	3 k	±1.5	2	3	4			QSOP-16
	ADT7475	3 - 3.6	-40 to +120	±1.5	I2C/SMBUS	1	–	±1.5	2	3	4			QSOP-16
	ADM1033	3 - 3.6	-40 to +120	±1	I2C/SMBUS	8	1 k	±1	1	1	1			QSOP-16
	ADM1034	3 - 3.6	-40 to +120	±1	I2C/SMBUS	8	1 k	±1	2	2	2			QSOP-16
Remote Sensors	NCT72	2.8 - 3.6	-40 to +125	±1	I2C/SMBUS	2	1.5 k	±1	1					DFN-8, WDFN-8
	NCT218	1.4 - 2.75	-40 to +125	±1.75	I2C/SMBUS	2	150	±1	1					WDFN-8, WLCSP-8
	NCT210	3 - 5.5	-55 to +125	±1	I2C/SMBUS	9	–	±3	2					QSOP-16
	ADM1032	3 - 5.5	-40 to +125	±3	I2C/SMBUS	2	–	±1	1					SOIC-8, MSOP-8
	ADT7461	3 - 5.5	-40 to +125	±3	I2C/SMBUS	2	3 k	±1	1					SOIC-8, MSOP-8
	ADT7481	3 - 3.6	-40 to +125	±1	I2C/SMBUS	2	–	±1	2					MSOP-10
	ADT7483	3 - 3.6	-40 to +125	±1	I2C/SMBUS	9	–	±1	2					QSOP-16
Local Sensors	NCT75	3 - 5.5	-55 to +125	±1	I2C/SMBUS	8								DFN-8, SOIC-8, Micro8
	NCT275*	3 - 5.5	-55 to +125	±1	I2C/SMBUS	4								CSP-6
	NCT203	1.4 - 2.75	-40 to +125	±1.75	I2C/SMBUS	1								DFN-8, SOIC-8, Micro8

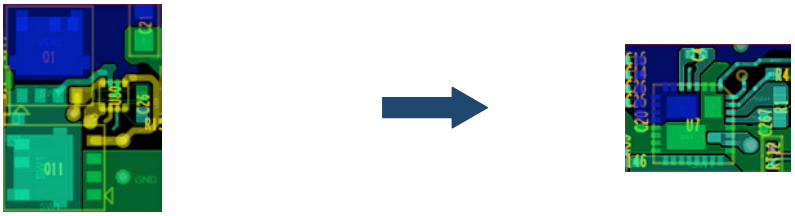
* Pending 2H14.

Integrated MOSFET and Drivers

Features

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





Discrete **versus** **Integrated**

Device	PWM Input	V_{IN} Max (V)	Freq Max (MHz)	I_{OUT} Continuous Max (A)	Package
NCP5369	5 V Tri-state	25	1	40	QFN-40
NCP81081	3.3 V Tri-state	25	1	40	QFN-40
NCP5338	5 V Tri-state	20	1	40	QFN-40
NCP5368*	5 V Tri-state	15	2	35	QFN-40

* Pending 2H14.

Drivers for Discrete MOSFET Implementations

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

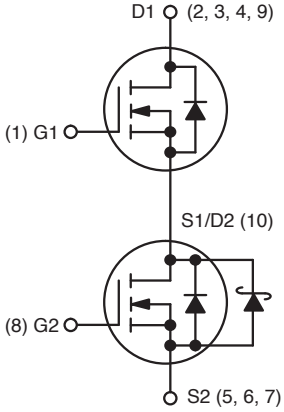
Device	Drivers	V_{CC} Typ (V)	Integrated Bootstrap Diode	ZCD*	Package
NCP5901	Single	12	N	Y	DFN-8
NCP5901B	Single	12	Y	Y	DFN-8
NCP81161	Single	12	Y	Y	DFN-8
NCP81151	Single	5	Y	Y	DFN-8
NCP81253	Single	5	Y	N	DFN-8
NCP81061	Dual	12	Y	Y	QFN-16
NCP81152	Dual	5	Y	Y	QFN-16

* Zero Crossover Detection.

MOSFETs Provide Optimized Efficiency

Asymmetric Dual

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



Device	Package	Config	Polarity	Maximum Rating				Q_g (nC)	Q_{gd} (nC)	C_{iss} (pF)	C_{rss} (pF)	R_G (Ω)	Applications
				V_{DS} (V)	V_{GS} (V)	$R_{DS(ON)}$ (mΩ) V_{GS}= 10 V	$R_{DS(ON)}$ (mΩ) V_{GS}= 4.5 V						
NTMFD4C85N*	PowerPhase	Asym Dual	N	30	20	3.0	4.3	15.0	5.2	1960	102	1.0	Control Side
			N	30	20	0.8	1.2	45.2	11.8	6660	126	1.0	Synchronous Side
NTMFD4H84NF*	PhaseFET	Asym Dual	N	25	20	3.3	4.8	8.9	2.6	1222	36	1.0	Control Side
			N + Int Sch	25	20	0.8	1.3	28.5	9.0	3893	164	1.0	Synchronous Side
NTMFD4H85NF*	PhaseFET	Asym Dual	N	25	20	3.6	4.7	8.5	1.9	1194	35	1.0	Control Side
			N + Int Sch	30	20	1.5	2.1	33.9	7.9	4896	180	1.0	Synchronous Side
NTMFD4C86N*	PowerPhase	Asym Dual	N	30	20	5.4	8.1	10.9	5.4	1252	126	1.0	Control Side
			N	30	20	2.1	3.0	21.6	5.5	3040	77	1.0	Synchronous Side
NTMFD4901NF	SO-8FL	Asym Dual	N	30	20	6.5	10.0	9.7	3.7	1150	105	0.8	Control Side
			N + Int Sch	30	20	2.4	3.5	20.0	5.3	2950	82	0.8	Synchronous Side
NTMFD4C87N*	PowerPhase	Asym Dual	N	30	20	5.0	7.7	10.9	5.4	1252	129	1.0	Control Side
			N	30	20	3.1	4.3	13.8	3.6	1939	49	1.0	Synchronous Side
NTMFD4C88N*	PowerPhase	Asym Dual	N	30	20	5.0	7.7	10.9	5.4	1252	126	1.0	Control Side
			N	30	20	3.4	5.0	11.0	2.9	1546	39	1.0	Synchronous Side
NTMFD4C20N	SO-8FL	Asym Dual	N	30	20	7.0	10.8	9.3	4.2	970	125	1.0	Control Side
			N	30	20	3.4	5.2	13.0	3.0	1950	50	1.0	Synchronous Side
NTMFD4902NF	SO-8FL	Asym Dual	N	30	20	6.5	10.0	9.7	3.7	1150	105	0.8	Control Side
			N + Int Sch	30	20	4.1	6.2	11.5	3.4	1510	83	0.8	Synchronous Side
NTLLD4901NF	µ8-FL/ WDFN-8	Asym Dual	N	30	20	20.0	30.0	5.5	1.4	605	100	0.8	Control Side
			N + Int Sch	30	20	15.0	22.0	5.9	2.9	645	16	0.8	Synchronous Side

* Pending 3Q14.

MOSFETs Provide Optimized Efficiency

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

MOSFETs Provide Optimized Efficiency

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

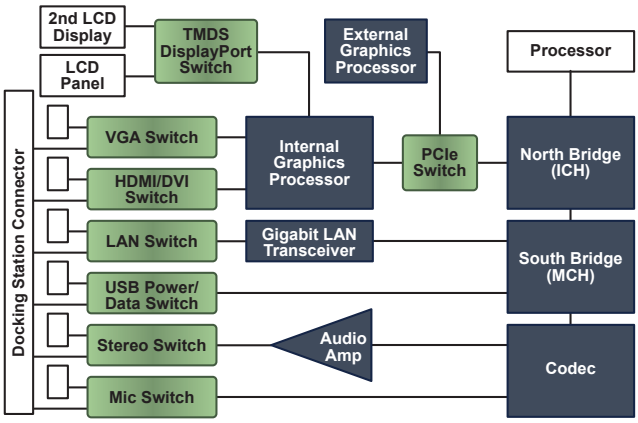
- High Efficiency DC-DC Conversion
- Integrated Schottky Lowsides
- Lowest RDS(on) in the industry

Device	Package	Config	Polarity	Maximum Rating				Q_g (nC)	Q_{gd} (nC)	C_{iss} (pF)	C_{rss} (pF)	R_G (Ω)	Applications
				V_{DS} (V)	V_{GS} (V)	$R_{DS(ON)}$ (mΩ) V_{GS}= 10 V	$R_{DS(ON)}$ (mΩ) V_{GS}= 4.5 V						
NTMFS4H01N	SO-8FL	Single	N	25	20	0.7	1.0	39.0	8.5	5693	212	1.2	Synchronous Side
NTMFS4H01NF	SO-8FL	Integ Sch	N	25	20	0.7	1.0	37.8	8.0	5538	175.3	1.3	Synchronous Side
NTMFS4H013NF*	SO-8FL	Integ Sch	N	25	20	0.9	1.3	28.0	7.5	3780	150	1.0	Synchronous Side
NTMFS4H02N	SO-8FL	Single	N	25	20	1.4	2.2	18.0	4.2	2651	103	1.0	Synchronous Side
NTMFS4H02NF	SO-8FL	Integ Sch	N	25	20	1.4	2.3	18.7	4.3	2652	94	1.0	Synchronous Side
NTTFS4H05N	µ8-FL	Single	N	25	20	3.3	4.8	8.7	1.9	1205	45	1.0	Control Side
NTTFS4H07N	µ8-FL	Single	N	25	20	4.8	7.1	5.7	1.3	771	34	1.0	Control Side

* Pending 2H14.

Switching Devices

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

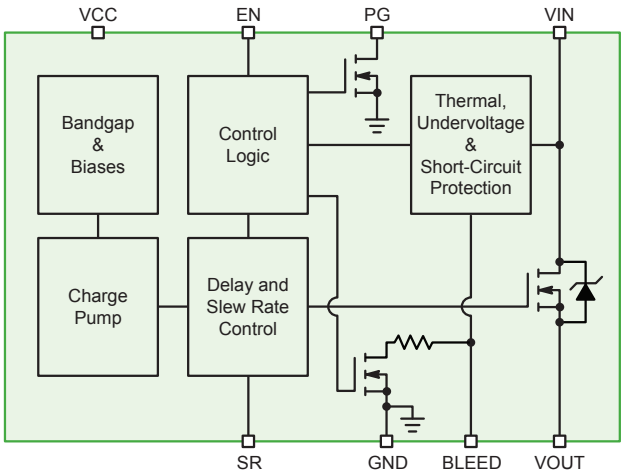


Server Implementation

Device	Interface	Data Rate	No Channels	Quiescent Current
NCN3612B	PCIe 3.0, DisplayPort 1.2	8 Gb/s	12	250 µA
NCN3411	PCIe 3.0	8 Gb/s	8	200 µA
NCN2612B	PCIe 2.0, DisplayPort 1.1	5 Gb/s	12	250 µA
NCN2411	PCIe 2.0	5 Gb/s	8	200 µA
NS3L500	Gigabit Ethernet	1 Gb/s	11	250 µA
NCN7200	Gigabit Ethernet	1 Gb/s	11	380 µA
NCN1188	USB 2.0 / MHL	2.25 Gb/s	2	21 µA
NS5S1153	USB 2.0	480 Mb/s	2	21 µA
NLAS7242	USB 2.0	480 Mb/s	2	1 µA
NLAS52231	Audio	36 MHz	2	1 µA
NLAS4684	Audio	9.5 MHz	2	180 nA

Advanced Load Switches

ecoSWITCH™
ADVANCED LOAD MANAGEMENT



NCP45xxx Integrated Load Switch Feature

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

Type	Device	r_{on} (mΩ)	I Max (A)	V_I Min (V)	V_I Max (V)	I_Q (μA)	Discharge	Slew Rate (μs)	Features	Package(s)
Smart Load Switch	NCP330	26 at 3.3 V	3	1.8	5.5	100	-	2000	Reverse blocking	TDFN-4
	NCP333	55 at 3.3 V	1.5	1.2	5.5	1	Auto	95	-	WLCSP-4
	NCP334	47 at 3.3 V	2	1.2	5.5	1	-	71	-	WLCSP-4
	NCP335	47 at 3.3 V	2	1.2	5.5	1	Auto	71	-	WLCSP-4
	NCP336	23 at 3.3 V	3	1.2	5.5	1	-	810	-	WLCSP-6
	NCP337	23 at 3.3 V	3	1.2	5.5	1	Auto	810	-	WLCSP-6
	NCP338	27 at 1.8 V	2	1	3.6	0.6	Auto	20	-	WLCSP-6
	NCP339	26 at 3.3 V	3	1.2	5.5	2	-	2700	Reverse blocking	WLCSP-6
	NCP432	50 at 1.8 V	1.5	1	3.6	0.6	-	20	-	WLCSP-4
	NCP433	50 at 1.8 V	1.5	1	3.6	0.6	Auto	20	-	WLCSP-4
	NCP434	43 at 1.8 V	2	1	3.6	0.6	-	61	-	WLCSP-4
	NCP435	43 at 1.8 V	2	1	3.6	0.6	Auto	61	-	WLCSP-4
	NCP436	23 at 1.8 V	3	1	3.6	1	-	27	-	WLCSP-6
	NCP437	23 at 1.8 V	3	1	3.6	1	Auto	27	-	WLCSP-6
ecoSWITCH™ Integrated Load Switch	NCP45524	18.0	6	0.5	13.5	-	Adj	-	Power good	DFN-8
	NCP45525	18.0	6	0.5	13.5	-	Adj	Adj	-	DFN-8
	NCP45560	2.4	24	0.5	13.5	-	Adj	Adj	Power good; Fault	DFN-12
	NCP45540	3.9	20	0.5	13.5	-	Adj	Adj	Power good; Fault	DFN-12
	NCP4543	10.2	7.3	0.5	6	-	Adj	Adj	-	QFN-18
	NCP4545	4.7	10.5	0.5	6	-	Adj	Adj	-	QFN-18
	NCP45520	9.5	10.5	0.5	13.5	-	Adj	-	Power good; Fault	DFN-8
	NCP45521	9.5	10.5	0.5	13.5	-	Adj	Adj	Fault	DFN-8

Evaluating ESD Protection Effectiveness

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

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

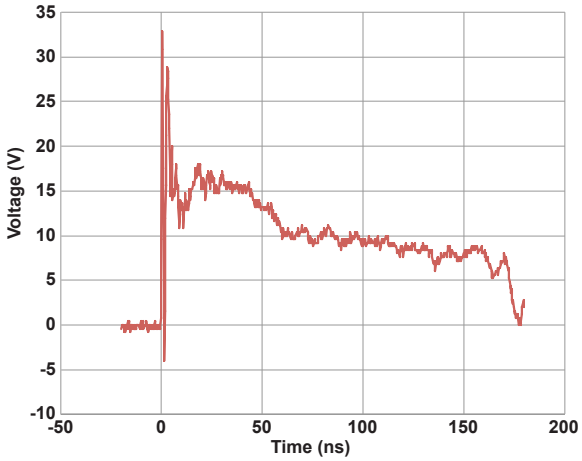


Figure 1. ESD clamping screenshot

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

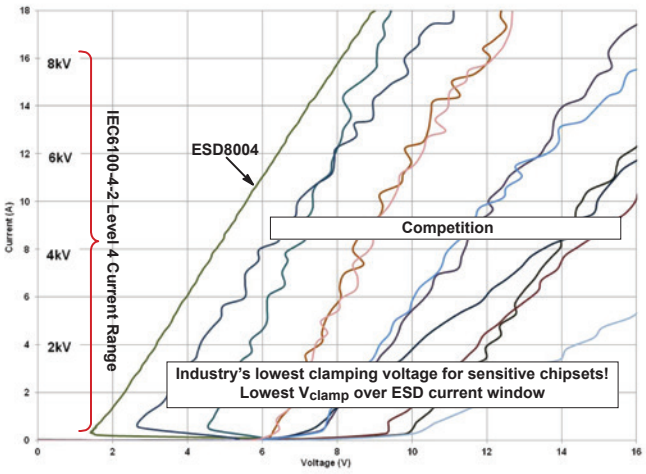


Figure 2. Typical TLP I-V curves from TLP measurements

Maintaining Signal Integrity

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

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

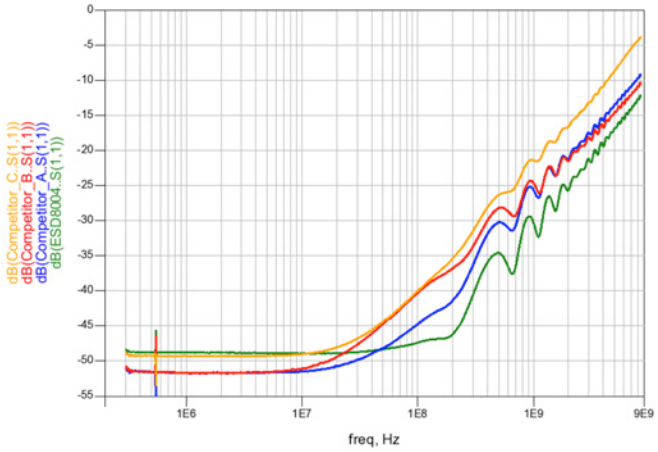


Figure 3. Return loss (S11) characteristics of ESD protection solutions

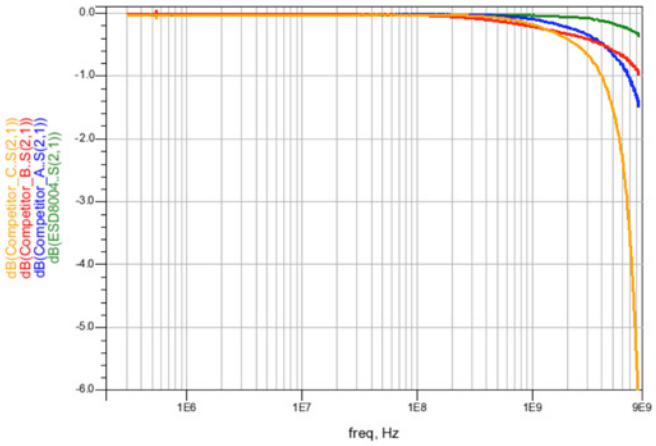


Figure 4. Insertion loss (S21) characteristics of ESD protection solutions

Surge Protection

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

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

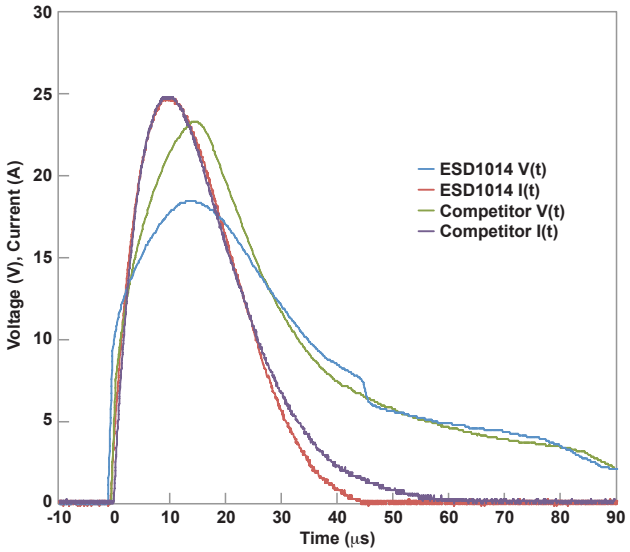


Figure 5. Example of V & I plots in an 8/20 µs surge

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

USB 3.0/3.1

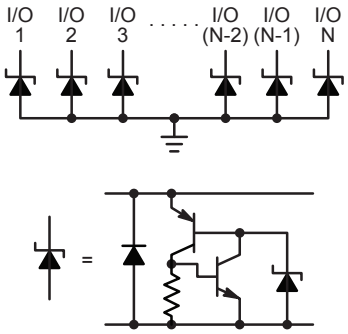
Two SuperSpeed Pairs, One High Speed Pair, V_{CC}, Low Capacitance ESD Protection

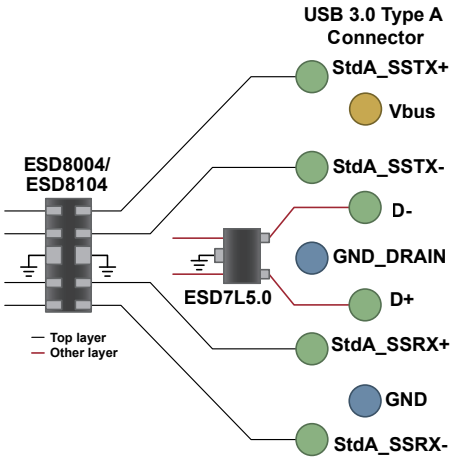
Key Requirement

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

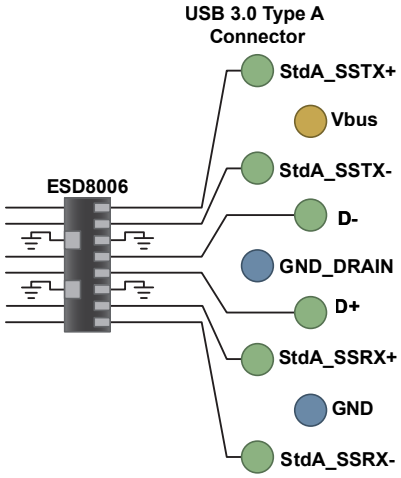
Features

- 0.37 pF or less
- Flow through routing
- Industry leading low clamping voltage versus competitors



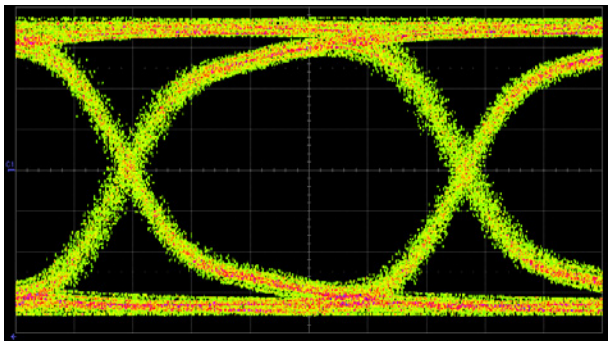


ESD8004/8104 – 0.30 pF, 2 Layer Routing
(ESD7L5.0 for D+, D- Lines)

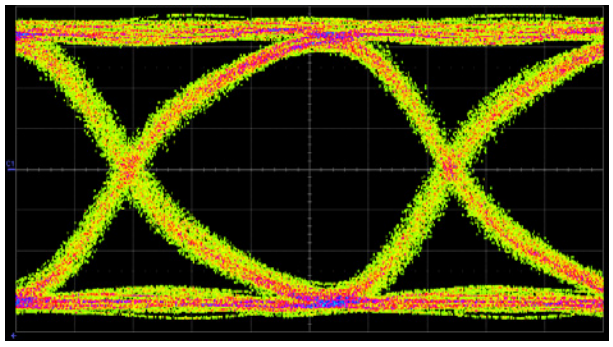


ESD8006 – 0.25 pF, 1 Layer Routing

Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESD8006	3 Pair (Tx, Rx, D+, D-)	0.25	UDFN-8	3.3 x 1.0
ESD8004	2 Pair (Tx, Rx)	0.30	UDFN-10	2.5 x 1.0
ESD8104	2 Pair (Tx, Rx)	0.30	UDFN-10	2.5 x 1.0
ESD7L	1 Pair (D+, D-)	0.50	SOT-723	1.2 x 1.2
ESD8351	Single Line 0201	0.37	X3DFN-2	0.62 x 0.32



Without ESD



With ESD

USB 3.1 @ 10 Gb/s

Thunderbolt

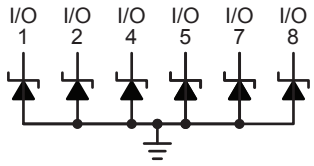
Four High Speed Pairs, up to Six Additional Lines, Low Capacitance ESD

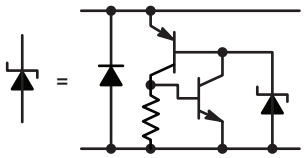
Key Requirement

- Cap < 0.4 pF

Features

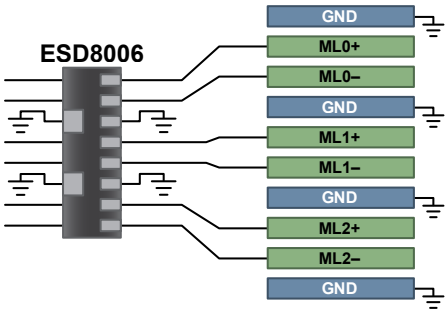
- 0.25 pF
- Flow through routing
- Grounds between pairs for reduced cross talk
- Industry leading clamping voltage



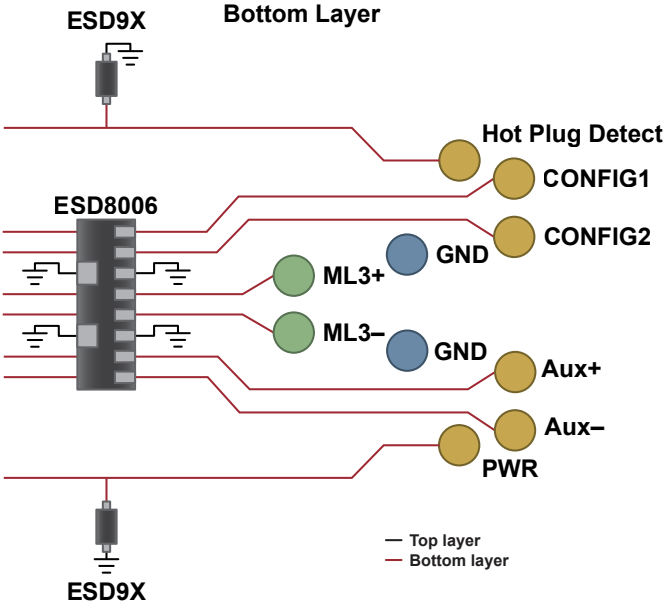


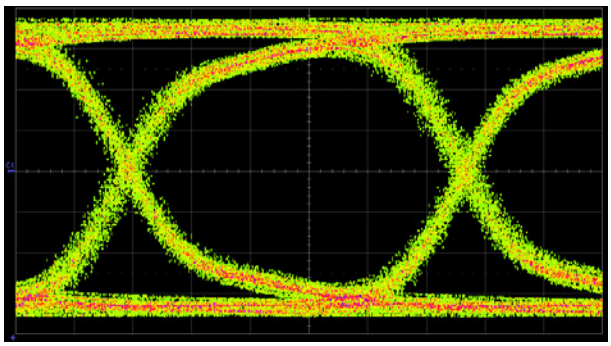
Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESD8006	3 Pair	0.25	UDFN-8	3.3 x 1.0
ESD8351	Single Line 0201	0.37	X3DFN2	0.62 x 0.32

Thunderbolt Connetctor
Top Layer

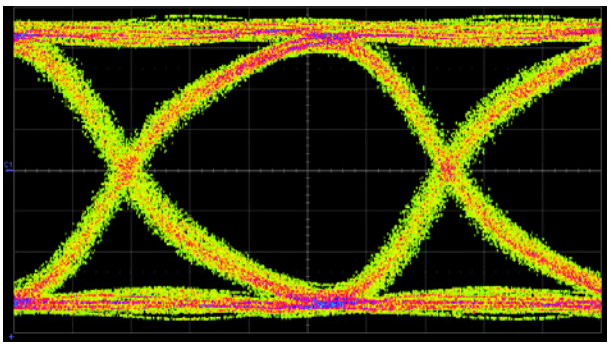


Thunderbolt Connetctor
Bottom Layer





Without ESD8006



With ESD8006

Thunderbolt @ 10 Gb/s

USB 2.0

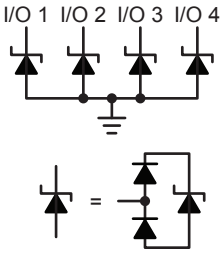
One High Speed Pair, V_{CC}, Low Capacitance ESD Protection

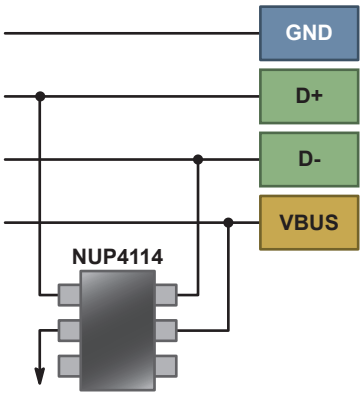
Key Requirement

- Cap < 1.5 pF

Features

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





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

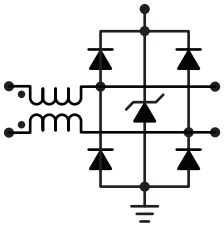
One High Speed Pair, V_{CC}, Common Mode Filter + ESD Protection

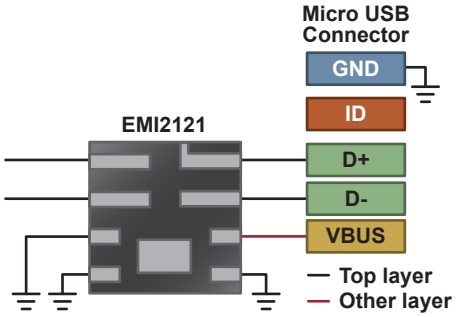
Key Requirement

- Cap < 1.5 pF
- Common Mode Filtering

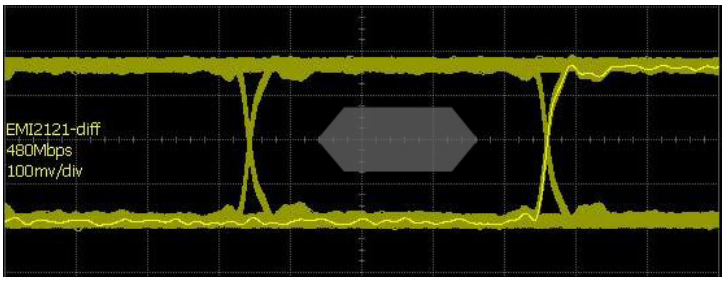
Features

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

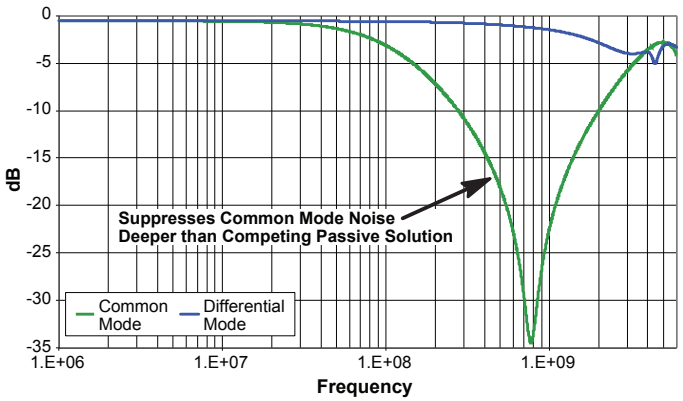




Device	Data Lines	Capacitance @ 2.5 V (pF)	CM Attenuation @ 800 MHz (-dB)	DM Bandwidth F3dB (GHz)	Package	Size (mm)
EMI2121	1 Pair + Power (D+, D-, VBUS)	0.9	-25	2.5	WQFN	2.2 x 2.0 x 0.75
EMI2124	1 Pair + ID + Power (D+, D-, ID, VBUS)	0.9	-25	2.5	WQFN	2.2 x 2.0 x 0.75



USB 2.0 @ 480 Mb/s



HDMI, Display Port

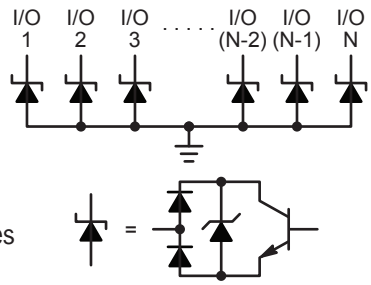
Four High Speed Pairs, Up to Six Additional Interface Lines, Low Capacitance ESD

Key Requirement

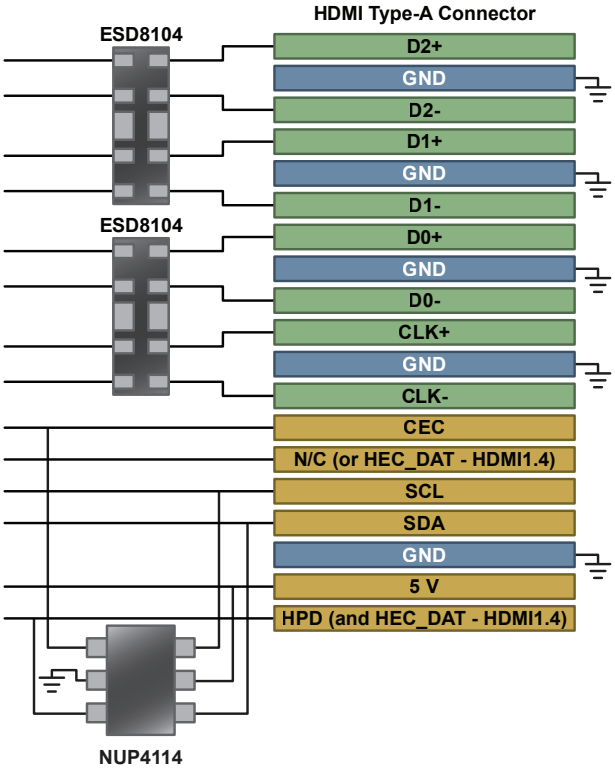
- Cap < 0.5 pF (HDMI 1.3/1.4)
- Cap < 0.4 pF (HDMI 2.0)

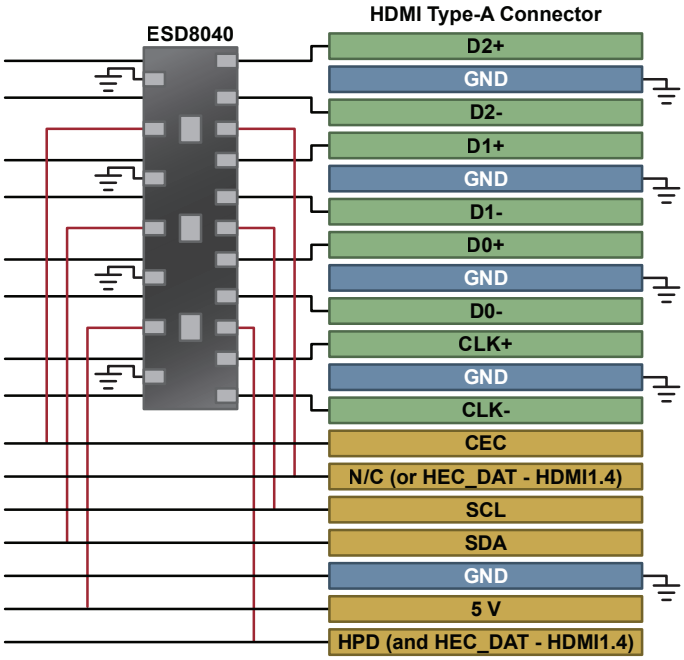
Features

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

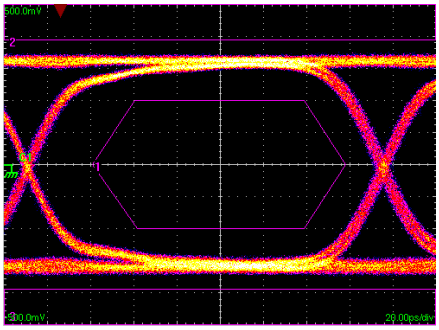


Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESD8104	2 Pair	0.30	UDFN-10	2.5 x 1.0
ESD8040	4 Pair + CEC, SDL, SDA, 5V,HPD	0.30	UDFN-18	5.5 x 1.5
ESD7451	Single Line 0402	0.25	XDFN-2	1.0 x 0.6
ESD7481	Single Line 0201	0.25	X3DFN-2	0.62 x 0.32

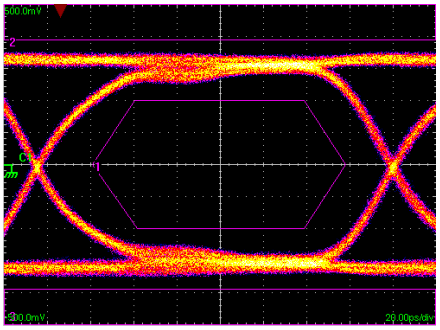




- MediaGuard fully integrated solution
- Includes ethernet protection (HDMI1.4)
- Backdrive current protection



Without ESD



With ESD

HDMI 2.0 @ 6.0 Gb/s

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

Four Pairs, Low Capacitance Surge and ESD Protection

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

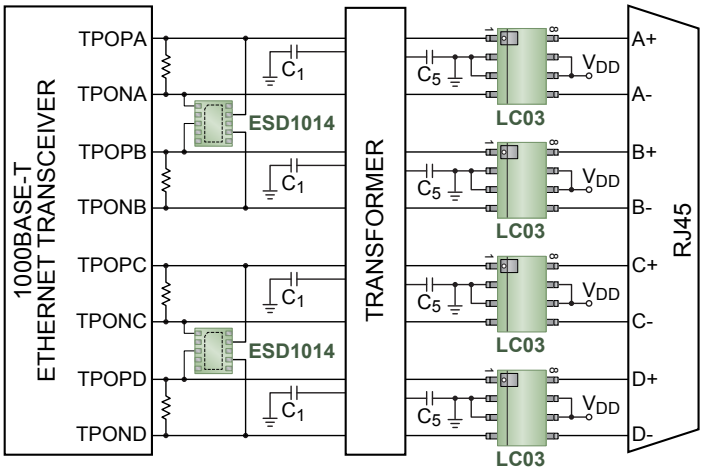
Features

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

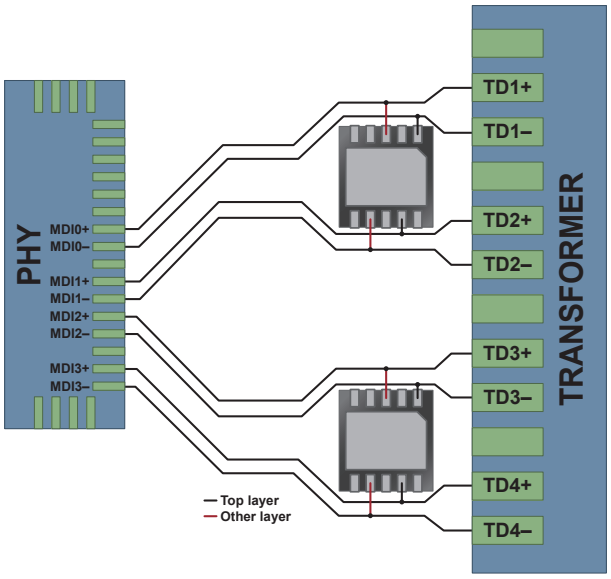
Benefits

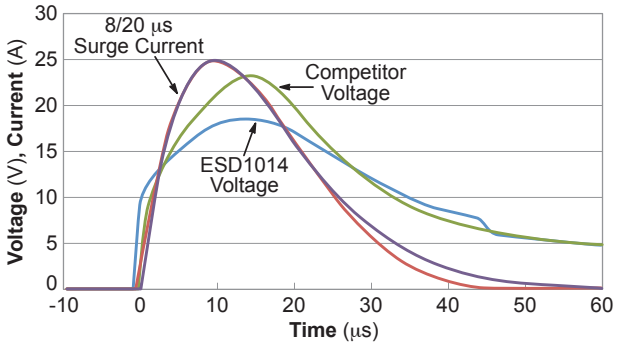
- Compatible with Gb Ethernet and beyond
- Enhanced protection for downstream electronics
- Accommodates operating transients above 3.3 V
- Small form-factor allows integration into connectors

Typical Application

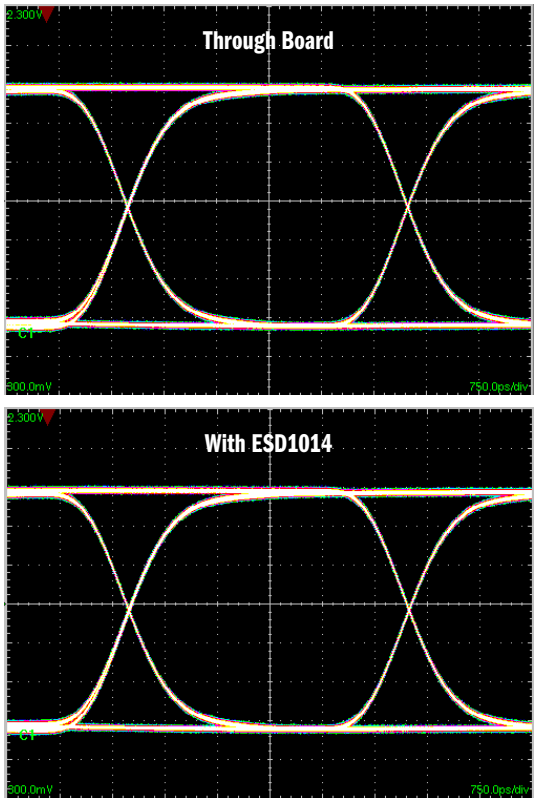


Line Side : LC03-6 (optional)
Transformer Side: ESD1014
Protection against metallic (transverse) strikes





Line-to-Line Surge

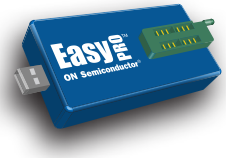


Signal Integrity for Gigabit Ehternet

Serial EEPROMs

Features

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



EasyPRO™ is a user-friendly, portable programming tool for ON Semiconductor serial EEPROMs (I2C, SPI, Microwire)

EEPROMs

Data Transmission Standard	Device	Density	Organization*	Vcc Min (V)	Vcc Max (V)	fCLK Max (MHz)	Package(s)
I2C	CAT24M01	1 Mb	128k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C512	512 kb	64k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C256	256 kb	32k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C128	128 kb	16k x 8	1.8	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C64	64 kb	8k x 8	1.7	5.5	1	SOIC-8, TSSOP-8, UDFN-8
	CAT24C32	32 kb	4k x 8	1.7	5.5	1	SOIC-8, TSSOP-8, UDFN-8; WLCSP-5
	CAT24C16	16 kb	2k x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5
	CAT24C08	8 kb	1k x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5
	CAT24C04	4 kb	512 x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5
	CAT24C02	2 kb	256 x 8	1.7	5.5	0.4	SOIC-8, TSSOP-8, UDFN-8, TSOT23-5, WLCSP-4, WLCSP-5
SPI	CAT25M02	2 Mb	256k x 8	1.7	5.5	10	SOIC-8
	CAT25M01	1 Mb	128k x 8	1.8	5.5	10	SOIC-8, TSSOP-8
	CAT25512	512 kb	64k x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25256	256 kb	32k x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25128	128 kb	16k x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25640	64 kb	8k x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25320	32 kb	4k x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25160	16 kb	2k x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25080	8 kb	1k x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25040	4 kb	512 x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25020	2 kb	256 x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
	CAT25010	1 kb	128 x 8	1.8	5.5	20	SOIC-8, TSSOP-8, UDFN-8
Microwire	CAT93C86	16 kb	2k x 8 / 1k x 16	1.8	5.5	3	SOIC-8
	CAT93C86B	16 kb	2k x 8 / 1k x 16	1.8 / 1.65	5.5	4	SOIC-8, TSSOP-8, UDFN-8
	CAT93C76	8 kb	1k x 8 / 512 x 16	1.8	5.5	3	SOIC-8, TSSOP-8
	CAT93C76B	8 kb	1k x 8 / 512 x 16	1.8 / 1.65	5.5	4	SOIC-8, TSSOP-8, UDFN-8
	CAT93C66	4 kb	512 x 8 / 256 x 16	1.8	5.5	2	SOIC-8, TSSOP-8
	CAT93C56	2 kb	256 x 8 / 128 x 16	1.8	5.5	2	SOIC-8, TSSOP-8
	CAT93C46	1 kb	128 x 8 / 64 x 16	1.8	5.5	2	SOIC-8, TSSOP-8
	CAT93C46B	1 kb	128 x 8 / 64 x 16	1.8 / 1.65	5.5	4	SOIC-8, TSSOP-8, UDFN-8

* Organization for Microwire devices is selectable.

Application Specific EEPROMs

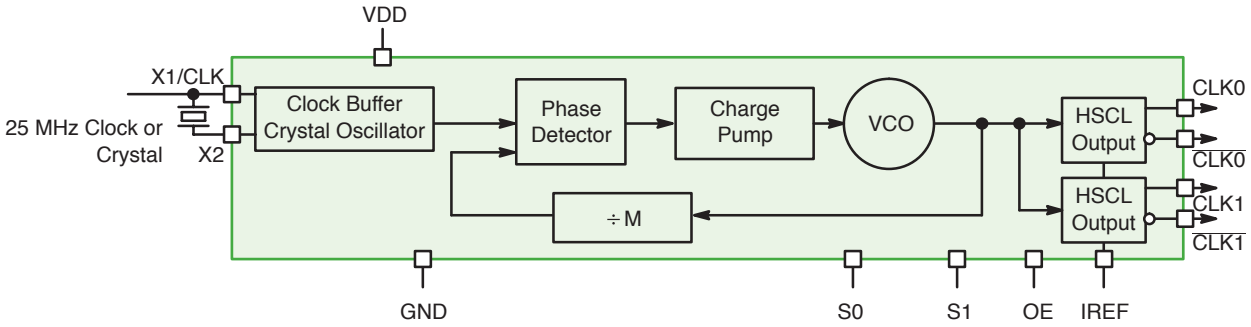
Data Transmission Standard	Device	Density	Organization	Vcc Min (V)	Vcc Max (V)	fCLK Max (MHz)	Package(s)	Notes
I2C	CAT24C208	8 kb	1024 x 8	2.5	5.5	0.4	SOIC-8	VESA™ dual-port serial EEPROM
I2C	CAT34C04*	4 kb	512 x 8	1.7	5.5	1	UDFN-8	Serial Presence Detect (SPD) I2C EEPROM for DDR4 DIMM
I2C/SMBus	CAT34TS04	4 kb	512 x 8	2.2	5.5	1	TDFN-8, UDFN-8	4 kb SPD EEPROM w/ Temperature Sensor for DDR4 DIMM
I2C	CAT34C02	2 kb	256 x 8	1.7	5.5	0.4	UDFN-8, TDFN-8, TSSOP-8	Serial Presence Detect (SPD) I2C EEPROM for DDR3 DIMM
I2C/SMBus	CAT34TS02	2 kb	256 x 8	3.0	3.6	0.4	TDFN-8, UDFN-8	2 kb SPD EEPROM w/ Temperature Sensor for DDR3 DIMM

* Pending 3Q14.

Clock Synthesizers for High Performance Computing

Features

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



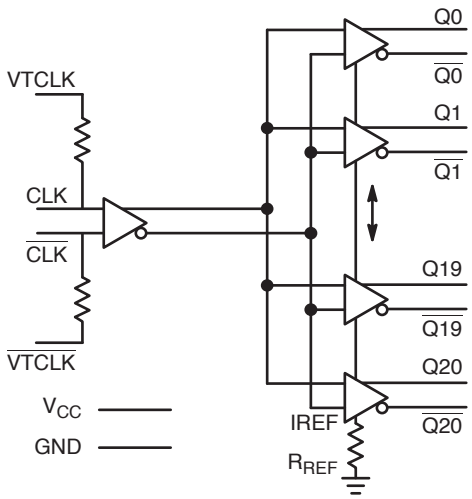
NB3N5573 Simplified Logic Diagram

Device	Number of Inputs	Input Type	f_{in} Typ (MHz)	Number of Outputs	Output Type	f_{out} Typ (MHz)	Spread Spectrum Outputs	Package
NB3N3002	1	Crystal; LVCMOS; LVTTL	25	1	HCSL	25; 100; 125; 200	No	TSSOP-16
NB3N5573	1	Crystal; LVCMOS; LVTTL	25	2	HCSL	25; 100; 125; 200	No	TSSOP-16
NB3N51032	1	Crystal; LVCMOS; LVTTL	25	2	HCSL	25; 100; 125; 200	No	TSSOP-16
NB3N51034	1	Crystal; LVCMOS; LVTTL	25	4	HCSL	100: 200	Yes	TSSOP-20
NB3N51044	2	Crystal; LVCMOS; LVTTL	25	4	HCSL	100: 125	No	TSSOP-28
NB3N51054	1	Crystal; LVCMOS; LVTTL	25	4	HCSL	100	Yes	TSSOP-24

Fanout Buffers for High Performance Computing

Features

- DC to 400 MHz
- Single ended input: LVPECL, LVDS, HCSL
- Typical input clock frequencies: 100, 133, 166, or 400 MHz
- Typical propagation delay: 800 ps
- HCSL differential outputs
- Integrated 50 Ω input termination resistors
- IREF pin enables setting of output drive
- Additive phase jitter 0.1 ps typical @ 100 MHz; PCI-e Gen 3 jitter complaint



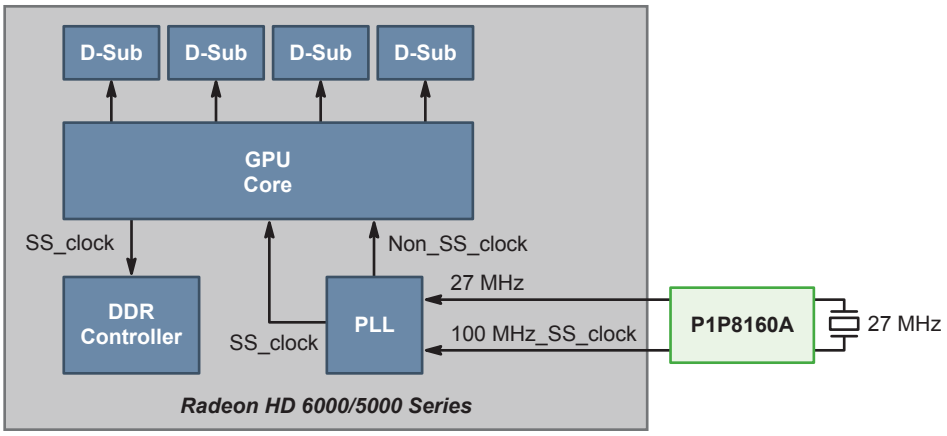
NB3N121K Logic Diagram

Device	Ratio	Additive $t_{Jitter(RMS)}$ Typ (ps)	$t_{skew(o-o)}$ Max (ps)	t_{pd} Typ (ns)	t_R & t_F Max (ps)	$f_{maxClock}$ Typ (MHz)	Package
NB3N106K	1:6	0.1	100	0.8	400	400	QFN-24
NB3N108K	1:8	0.1	100	0.8	400	400	QFN-32
NB3N111K	1:10	0.1	100	0.8	400	400	QFN-32
NB3N121K	1:21	0.1	100	0.8	700	400	QFN-52
NB4N111K	1:10	<1	100	0.8	700	400	QFN-32
NB4N121K	1:21	<1	50	0.8	700	200	QFN-52

Computing Clock for Graphics

P1P8160A Features

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

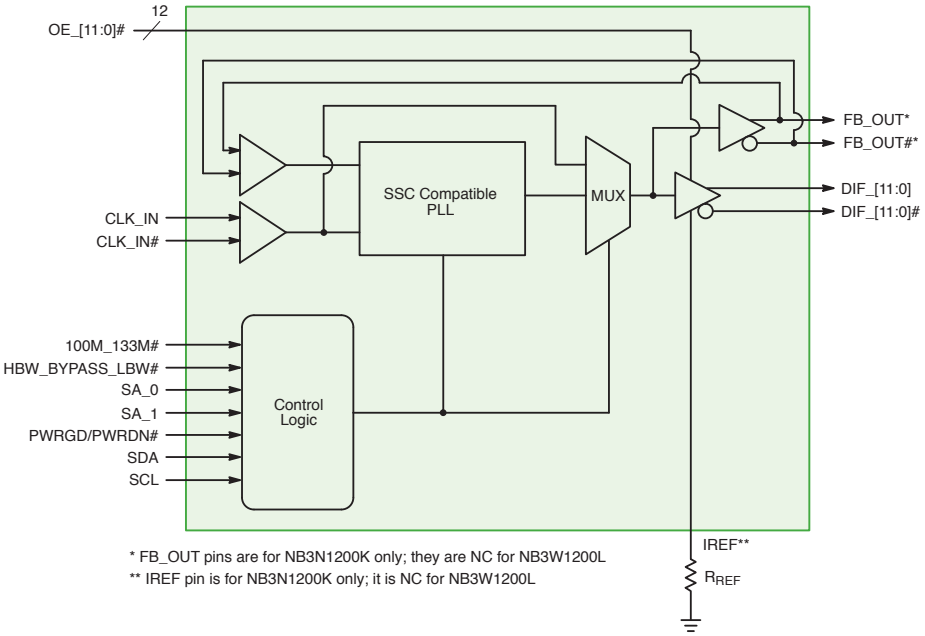


P1P8160A for AMD Graphics Card Application

Zero Delay Buffers Compliant with DB1200Z/ZL Specifications

Features

- Differential SRC clock support
- NB3N1200K: DB1200Z compliant 12 differential clock output pairs @ 0.7 V
- NB3W1200L: DB1200ZL compliant 12 low power NMOS push-pull output pairs
- Optimized for 100 MHz and 133 MHz to meet PCIe* Gen 2/Gen 3 and Intel QPI phase jitter specifications
- Spread spectrum compatible for low EMI
- Pseudo-external fixed-feedback for low input-to-output delay variation
- Individual OE control pin for each output
- SMBUS programmability for power down mode, PLL BW modes, PLL/Bypass mode & frequency selection



NB3N1200K Simplified Block Diagram

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

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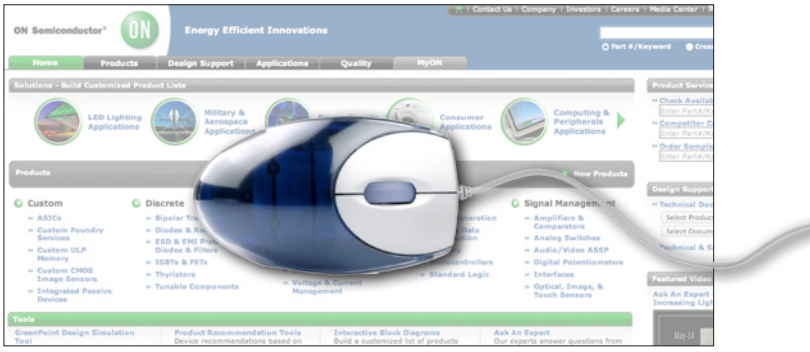

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