BRD8025/D
Rev. 14, Mar-2019

Energy Efficient Innovations

Computing Solutions

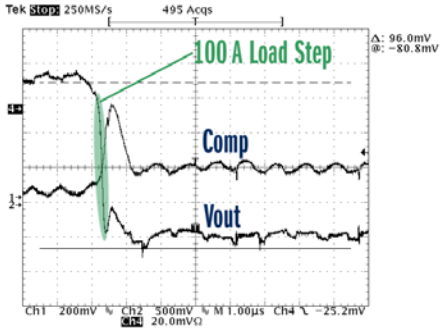
Comprehensive power management, switching, timing, USB-C, and protection solutions for computing platforms from ON Semiconductor.

Dual-Edge & RPM Modulation Vcore Controllers

for IMVP8 Designs

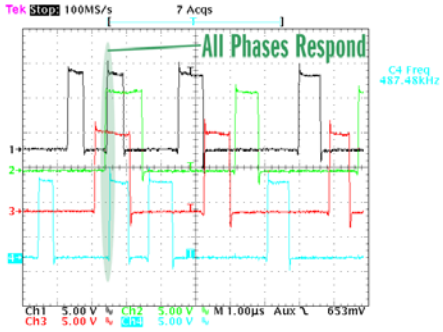
Features of Multi-Phase Dual Edge Architecture

- 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 IOUT monitor
- Dynamic VID feed-forward
- Programmable droop gain
- Zero droop capable
- Thermal monitor
- Ultra-sonic operation
- Digitally controlled operating frequency



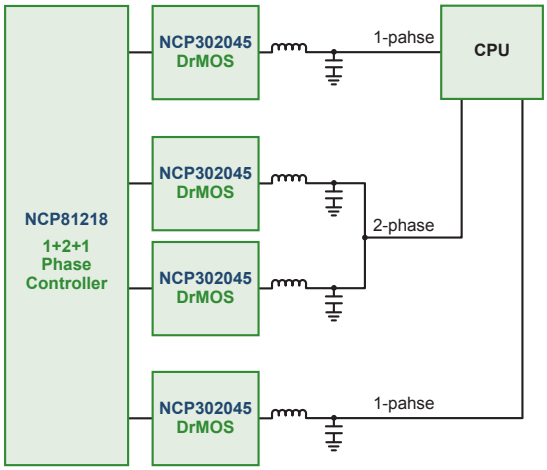
Device	Market	Function	VR Spec	Controller Architecture	Number of Rails	CPU Phases	Integrated Drivers	Interface	Package
NCP81111	Microserver	Controller	VR12.5	Hybrid	1	1/2/3	–	SVID	QFN-32
NCP81213	Desktop	Controller	IMVP8	Dual Edge	2	3/2/1+2/1	–	SVID	QFN-52
NCP81220	Desktop	Controller	IMVP8	Dual Edge	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

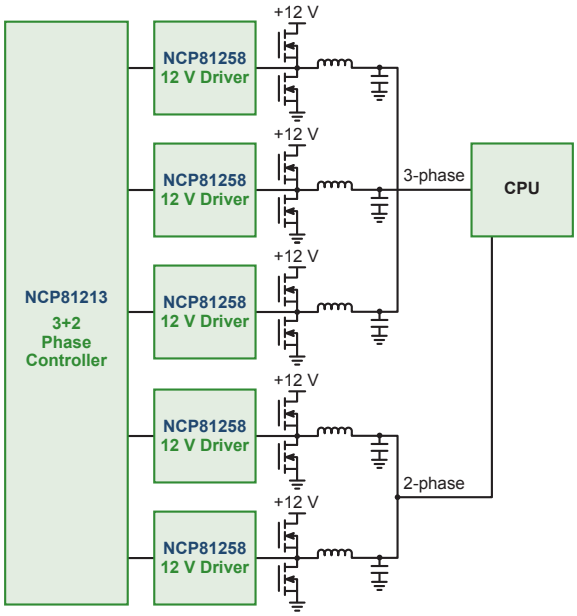
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



Desktop Solutions

NCP81213 3+2 Phase Controller

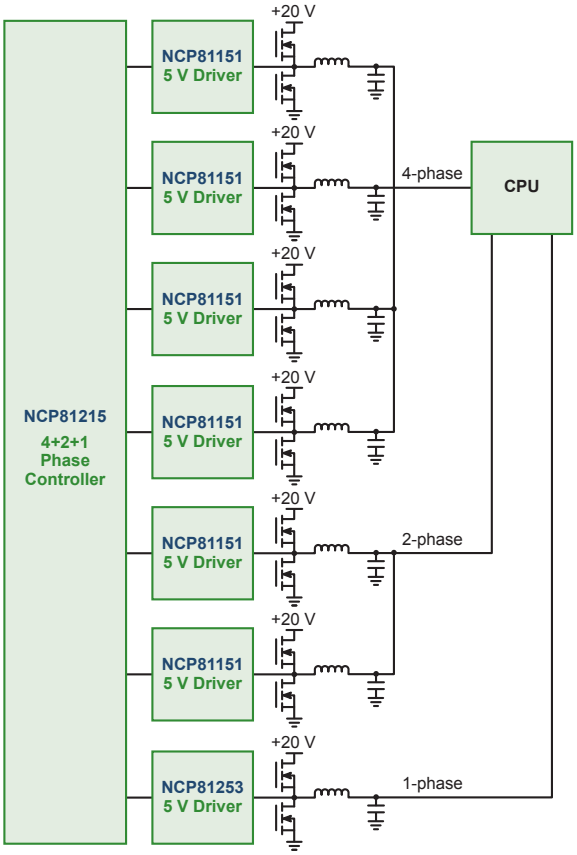
- Dual Edge for fast transient response
- Constant on-time for light load efficiency
- Supports all MLCC output capacitor solutions
- IMVP8 compliant



Notebook Solutions

NCP81215 4+2+1 Phase Controiler

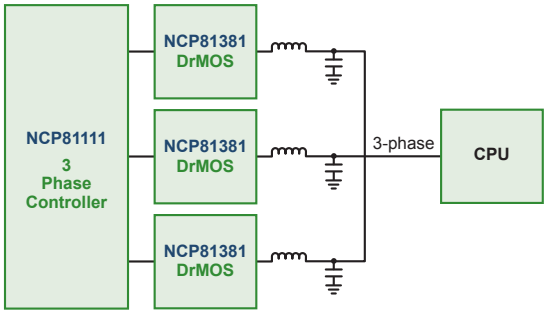
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



Microserver Solutions

NCP81111 3-Phase Digital Controller

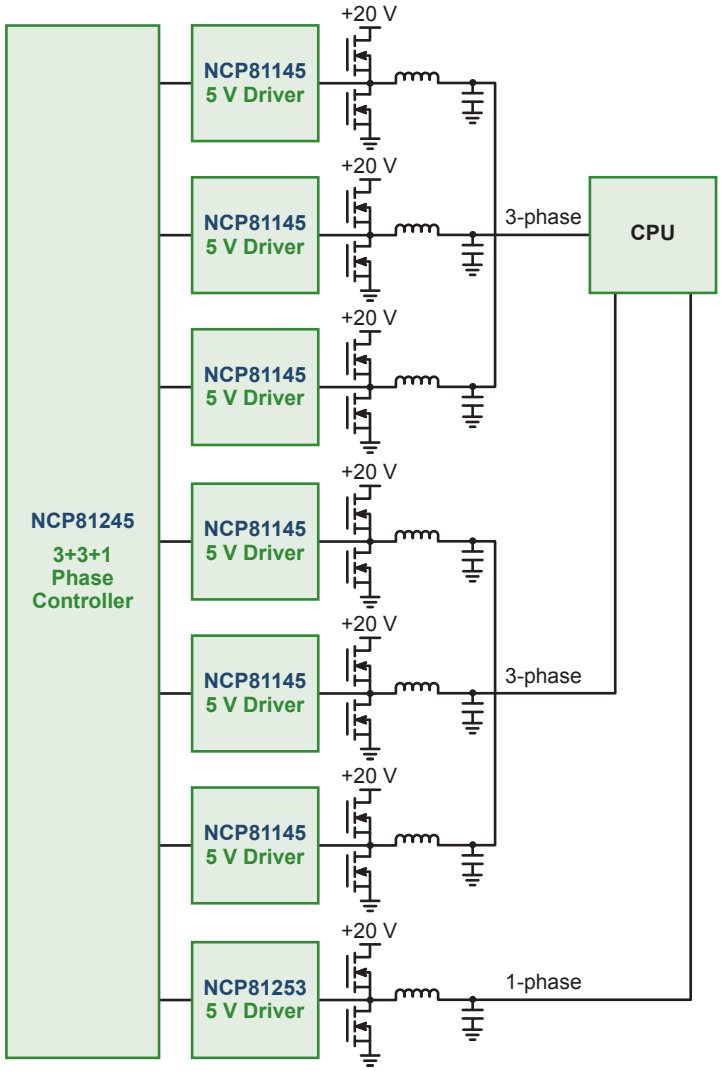
- Optimised to operate at 5 MHz using DrMOS
- Can operate as general purpose I2C controller regulator
- Internal compensation using GUI interface
- VR12.5/6 compliant



IMVP8 Multiphase Controllers for Embedded Applications

NCP81245 3+3+1 Phase Controller

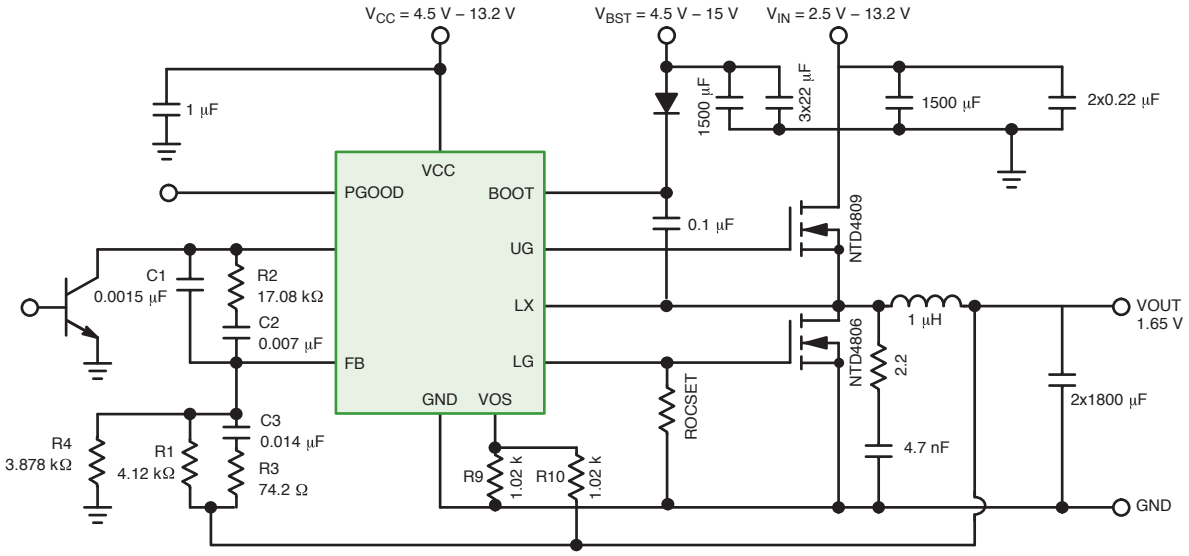
- Dual Edge & DCR current sensing for fast transient response
- EN RPM for fast transition between DCM and CCM mode
- True Differential Current Balancing
- IMVP8 compliant



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

System Power

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



NCP1589A Application Diagram

Device	Description	Topology	V_{CC} Min (V)	V_{CC} Max (V)	f_{SW} Typ (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	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
NCP5212A	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
NCP3235	15 A Synchronous Buck Converter with Intergrated MOSFETs	Step-Down	4.5	21	500	QFN-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

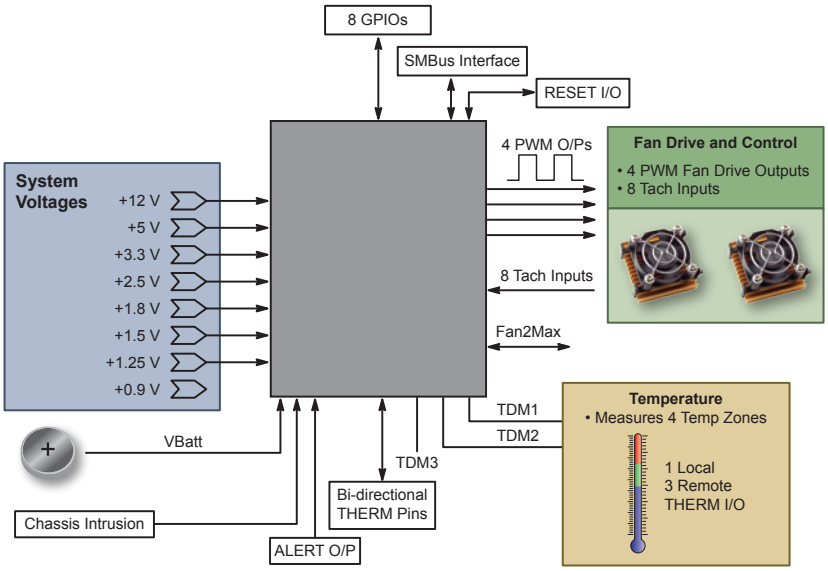
Thermal Management

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

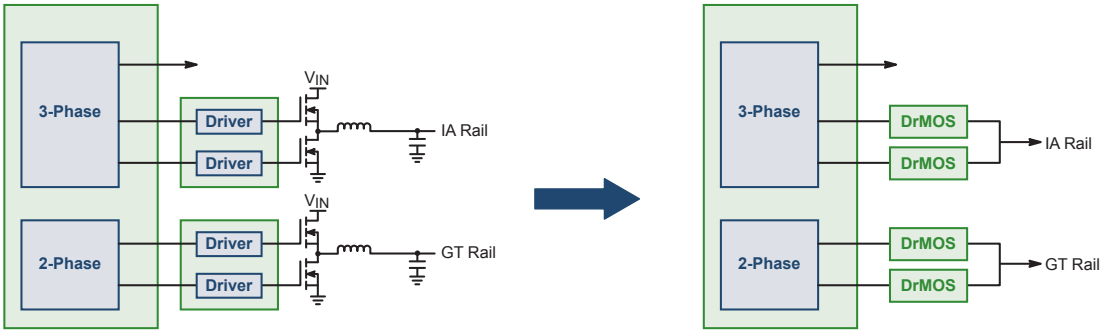


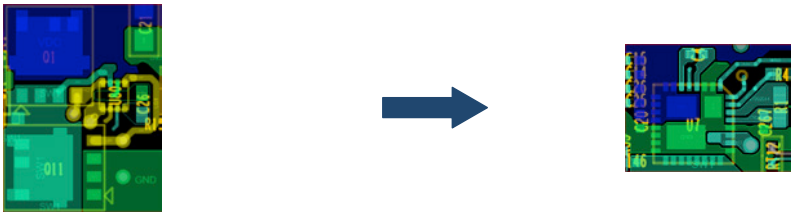
	Device	Supply Range (V)	Temperature Range (°C)	Local Accuracy (°C)	Interface	Number of Addresses	SRC (Ω)	Remote Accuracy	Remote Channels	Fan Channels	TACH Channels	Voltage Monitoring Channels	GPIOs	Package
System Monitors	ADM1026	3 - 5.5	-40 to +120	±3	I2C/SMBUS	3	–	±3	2	8	8	19	17	LQFP-48
	ADT7462	3 - 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





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
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.

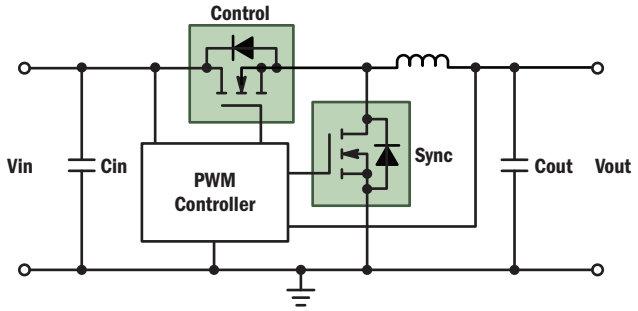
Device	Drivers	V_{CC} Typ (V)	Integrated Bootstrap Diode	Zero Crossover Detection	Package
NCP5901	Single	12	N	Y	DFN-8
NCP5901B	Single	12	Y	Y	DFN-8
NCP81258	Single	12	Y	Y	DFN-8
NCP81161	Single	12	Y	Y	DFN-8
NCP81151	Single	5	Y	Y	DFN-8
NCP81253	Single	5	Y	N	DFN-8
NCP81152	Dual	5	Y	Y	QFN-16

N-Channel MOSFETs for Power Conversion

Non-Isolated Topology "Buck" DC-DC

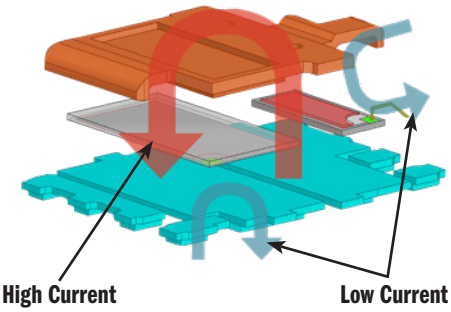
Features

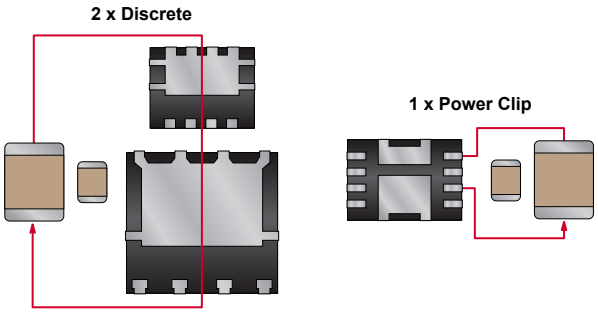
- Low $R_{DS(ON)}$ for low conduction loss
- Low capacitance for low switching loss
- Integrated Schottky for enhanced light load efficiency



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





High Frequency Switching Loop Size Reduction

Device	Package	I_{max} (A)	BV_{DSS} (V)	V_{GS} Max (V)	$R_{DS(ON)}$ Max @ V_{GS}= 4.5 V (mΩ)		Q_g Typ @ V_{GS}= 4.5 V (nC)		C_{oss} 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
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

Asymetric Dual MOSFETs

Device	Package	I_{max} (A)	BV_{DSS} (V)	V_{GS} Max (V)	$R_{DS(ON)}$ Max @ V_{GS}= 4.5 V (mΩ)		Q_g Typ @ V_{GS}= 4.5 V (nC)		C_{oss} 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	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_{DS}/V_{GS} (V)	$R_{DS(ON)}$ Max @ V_{GS}= 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

Dual N-Channel MOSFETs

Common Drain FDPC4044

- 30 V, 27 A
- Max $r_{S1S2(on)}$ = 4.3 mΩ at V_{GS} = 10 V, I_{S1S2} = 27 A
- MLP 33 package

Specific Applications

- V_{BUS} 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 $r_{DS(on)}$ = 1 mΩ
- PQFN-8 package

Specific Applications

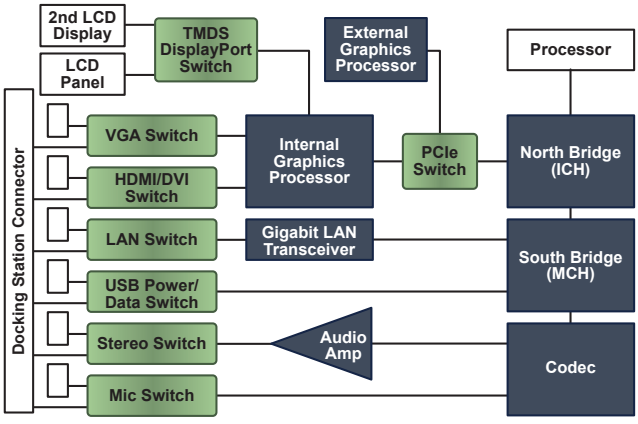
- Synchronous Rectification
- Synchronous buck for ~50% duty cycle (12 V to 5 V)

N-Channel MOSFETs

Device	Package	Polarity	Maximum Ratings				Q_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						
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.



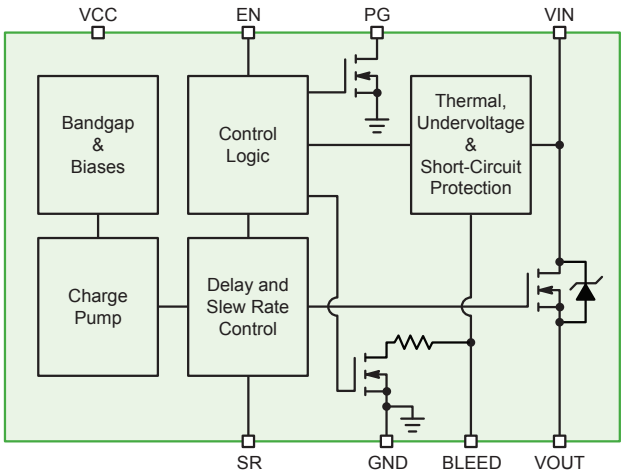
Device	Interface	Data Rate	No Channels	Quiescent Current
NCN1188	USB 2.0 / MHL	2.25 Gb/s	2	21 µA
NS5S1153	USB 2.0	480 Mb/s	2	21 µA
NLAS7242	USB 2.0	480 Mb/s	2	1 µA
NLAS4684	Audio	9.5 MHz	2	180 nA

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

ecoSWITCH™
ADVANCED LOAD MANAGEMENT



NCP45xxx Integrated Load Switch Key Features

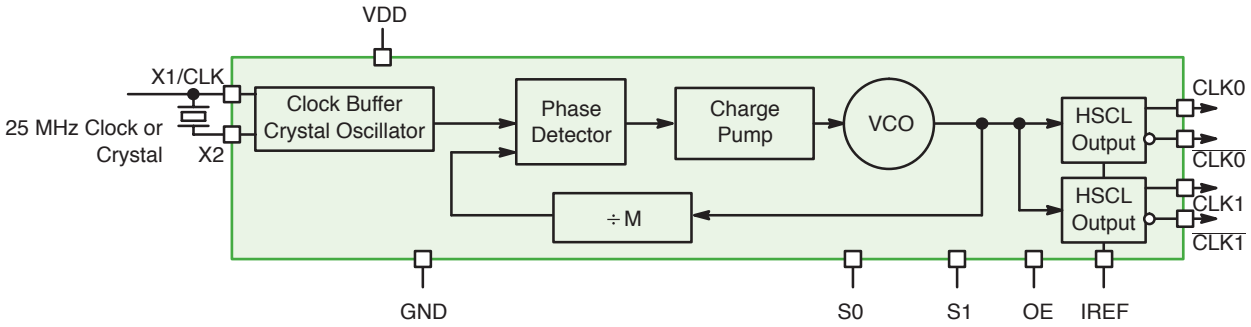
- Simple/clean design
- No current consumption in standby power mode
- Small PCB footprint
- Low $R_{DS(ON)}$ due to charge pump driving NMOS
- Adjustable soft-start time (SR)
- Adjustable integrated discharge
- Fault protection
- Power rail monitoring & sequencing

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	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



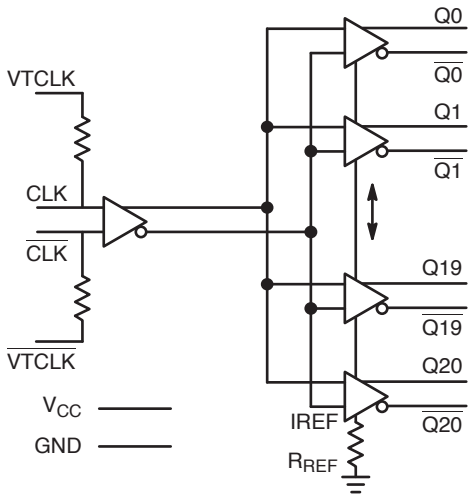
NB3N5573 Simplified Logic Diagram

Device	Number of Inputs	Input Type	f_{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	Yes	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 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 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
- Additive phase jitter 80 fs maximum @ 156.25 MHz with NB3L208K, NB3L204K, NB3L202K; DB800H, DB400H, DB200H compliant



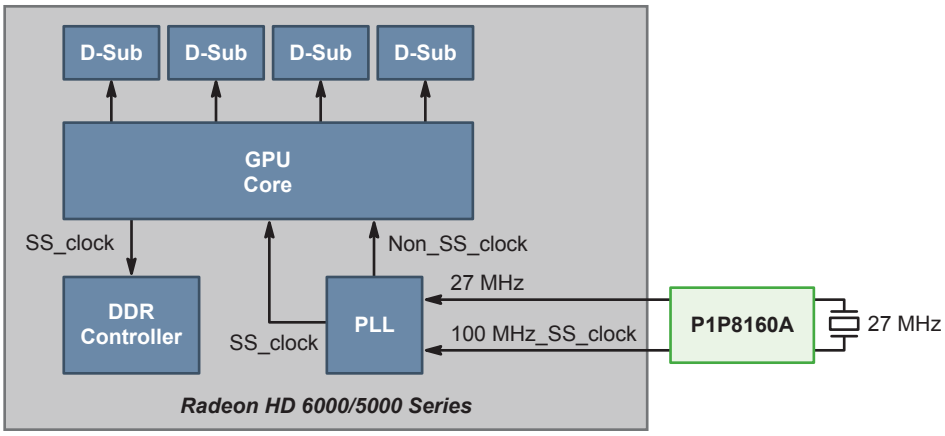
NB3N121K Logic Diagram

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
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 ±10%
- WDFN-10 package



P1P8160A for AMD Graphics Card Application

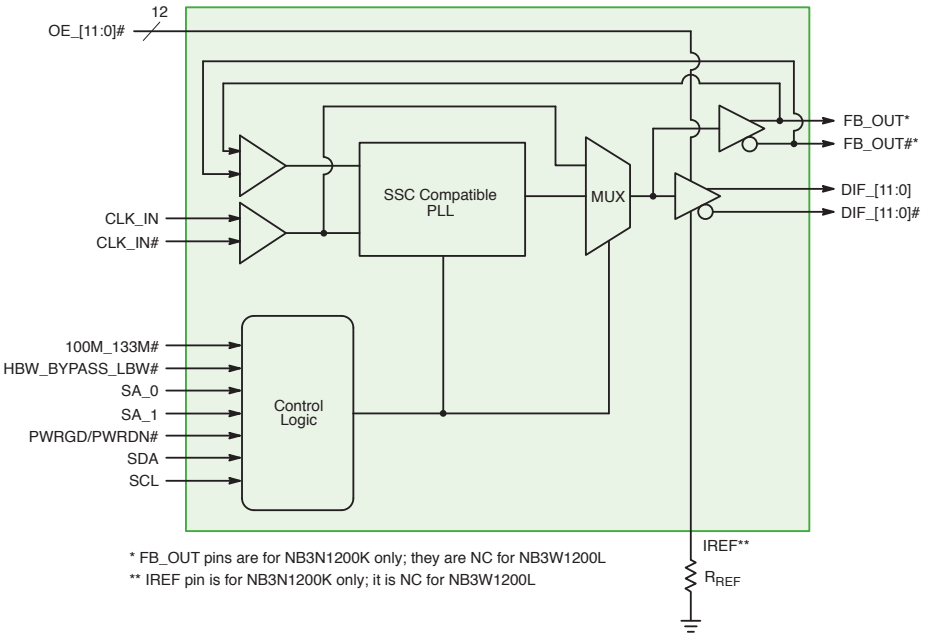
NB3N51054 Features

- 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 ± 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



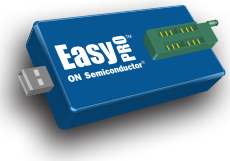
NB3N1200K Simplified Block Diagram

Device	Ratio	Output	$t_{Jitter(Cy-Cy)}$ Typ (ps)	$t_{skew(I-o)}$ Max (ps)	$t_{skew(o-o)}$ 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^2C, SPI, Microwire)

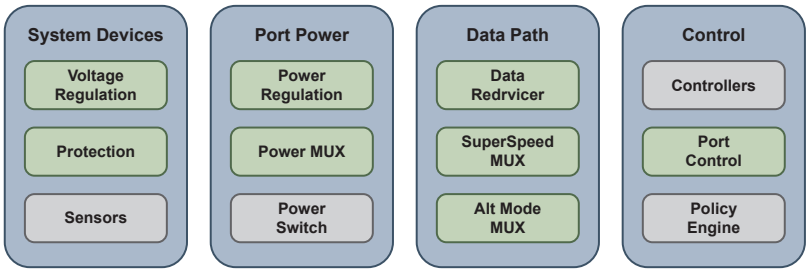
EEPROMs

Data Transmission Standard	Density	Organization*	V_{CC} Min (V)	V_{CC} Max (V)	f_{CLK} Max (MHz)	Package(s)
I^2C	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 μV Offset
	NCS211	Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 μV Offset
	NCS213	Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 100 μV Offset
	NCS214	Current Sense Amplifier, Bidirectional Zero-Drift, 1% Max. Gain Error, 60 μV 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

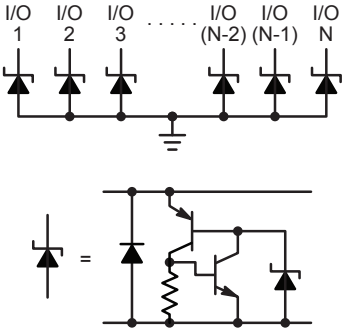
Two SuperSpeed Pairs, One High Speed Pair, V_{CC}, Low Capacitance ESD Protection

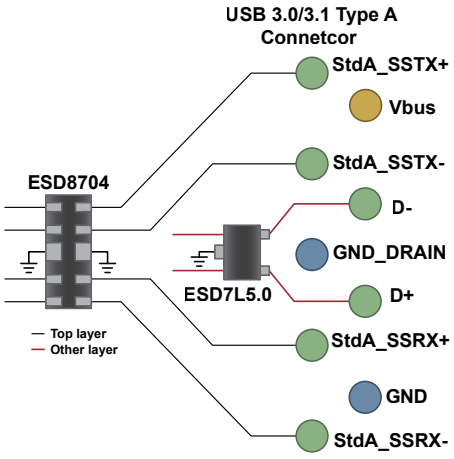
Key Requirement

- Cap < 0.7 pF

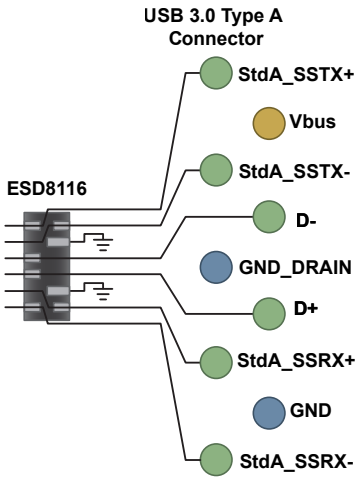
Features

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





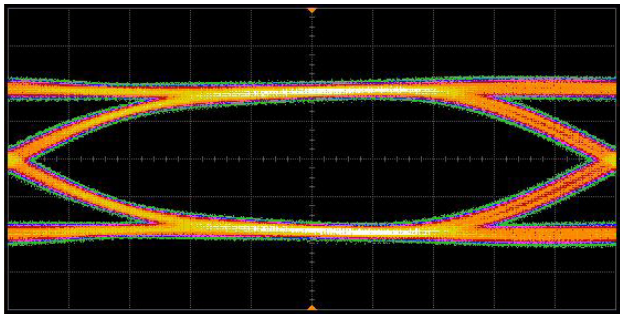
ESD8704 – 0.35 pF, 2 Layer Routing
(ESD8704; ESD7L5.0 for D+, D- Lines)



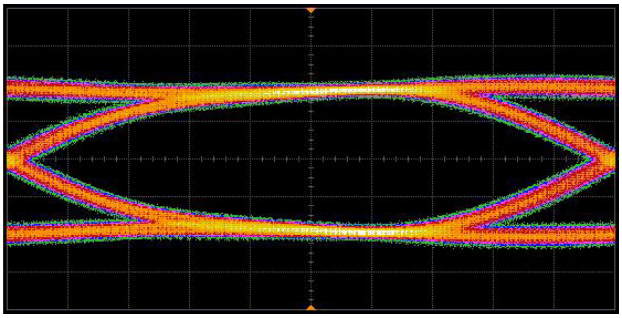
ESD8116 – 0.30 pF, 1 Layer Routing

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.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
ESDL1531*	USB.3x	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

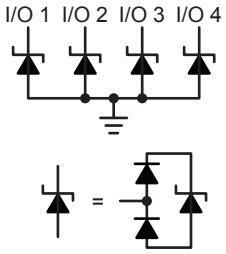
One High Speed Pair, V_{CC}, Low Capacitance ESD Protection

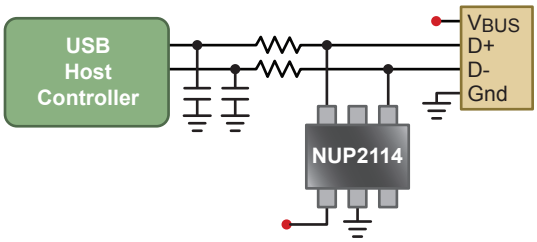
Key Requirement

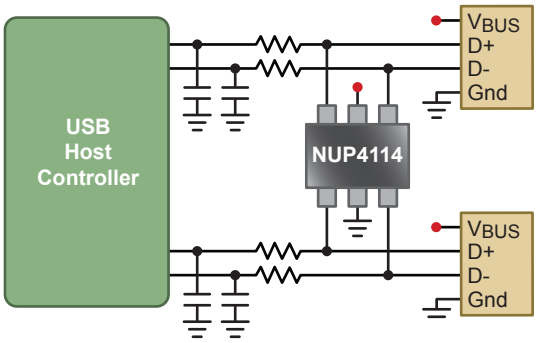
- Cap < 5 pF

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.

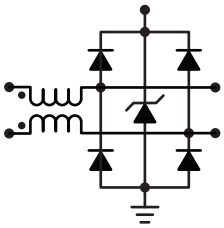
One High Speed Pair, V_{CC}, Common Mode Filter + ESD Protection

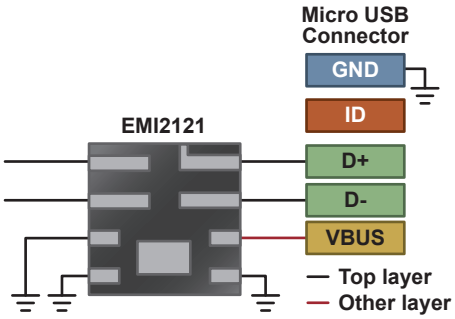
Key Requirement

- Cap < 5 pF
- Common Mode Filtering

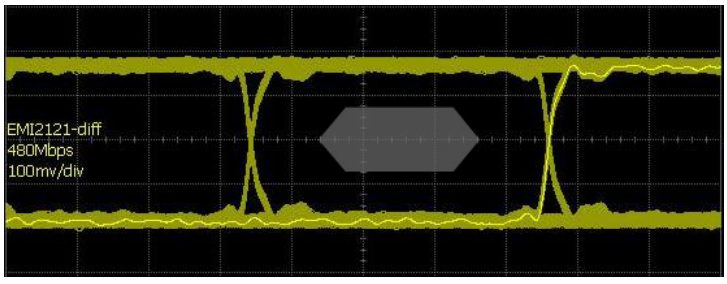
Features

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

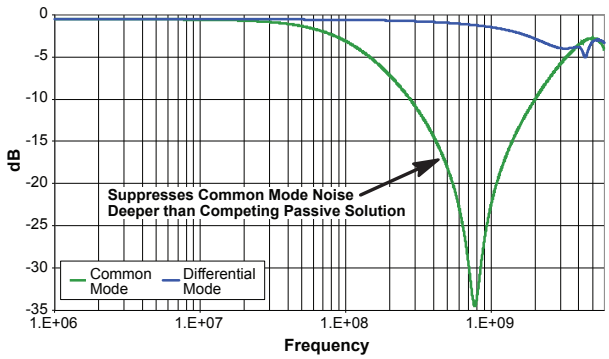




Device	Pairs	Capacitance @ 2.5 V (pF)	CM Attenuation @ 800 MHz (-dB)	DM Bandwidth F3dB (GHz)	Package	Size (mm)
EMI2121	1	0.9	-25	2.5	WQFN-8	2.2 x 2.0 x 0.75



USB 2.0 @ 480 Mb/s



Thunderbolt

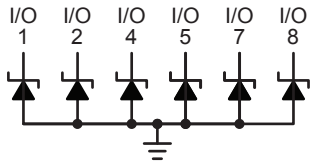
Four High Speed Pairs, up to Six Additional Lines, Low Capacitance ESD

Key Requirement

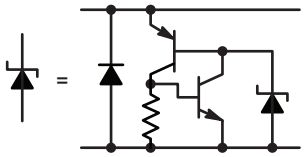
- Capacitance < 0.4 pF

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



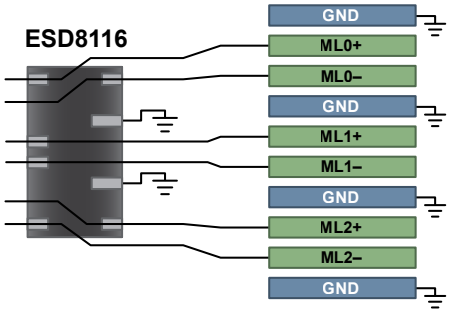
Common GND = Pins 2, 3



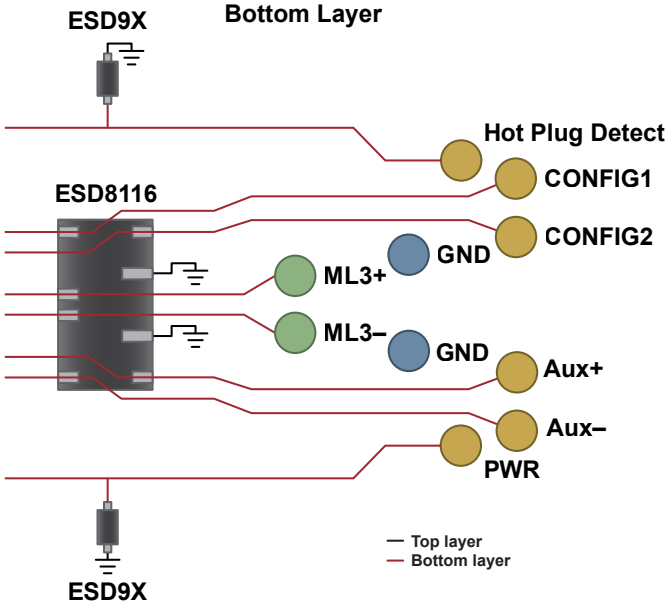
Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESD8006	3 Pair	0.25	UDFN-8	3.3 x 1.0
ESD8116	3 Pair	0.30	UDFN-8	2.0 x 1.2
ESD8011	Single Line	0.10	X3DFN-2	0.62 x 0.32
ESDL2011	Single Line	0.17	X4DFN-2	0.6 x 0.3
ESDL1531*	Single Line	0.20	X4DFN-2	0.445 x 0.24

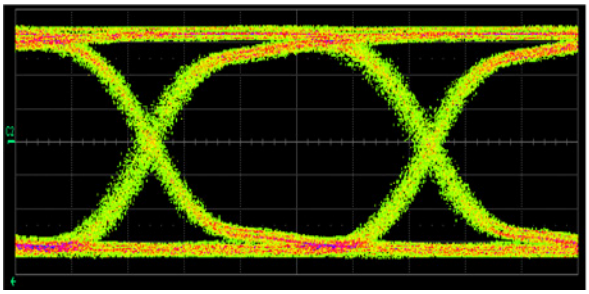
* Pending 2Q19.

Thunderbolt Connetctor Top Layer

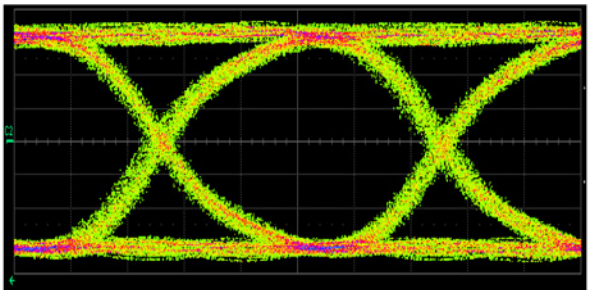


Thunderbolt Connetctor Bottom Layer





Without ESD8116



With ESD8116

Thunderbolt @ 10 Gb/s

HDMI, Display Port

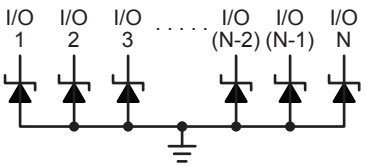
Four High Speed Pairs, Up to Six Additional Interface Lines, Low Capacitance ESD

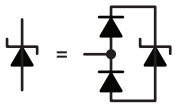
Key Requirement

- Cap < 0.5 pF

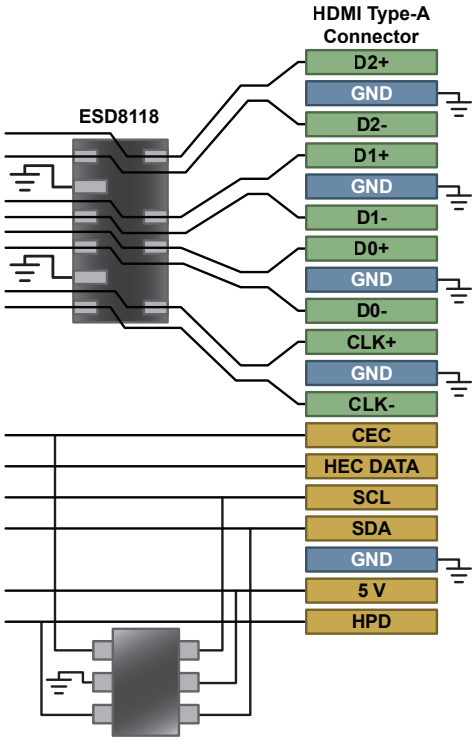
Features

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

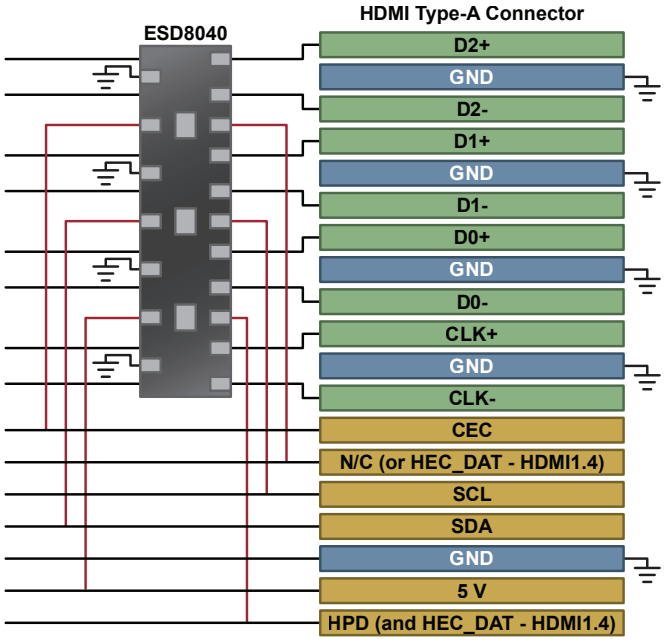




Device	Data Lines	Capacitance (pF)	Package	Size (mm)
ESDL2031	1 (TMDS)	0.4	X4DFN-2	0.6 x 0.3
ESD8104	4 (TMDS)	0.3	UDFN-10	2.5 x 1.0
ESD8118	8 (TMDS)	0.3	UDFN-10	3.2 x 1.2
ESD8040	14 (TMDS + Low Speed + Power)	0.3	UDFN-18	5.5 x 1.5
NUP4114UPX	5 (4 Low Speed + Power)	0.5	SOT-563	1.6 x 1.6
NUP4114UCL	5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

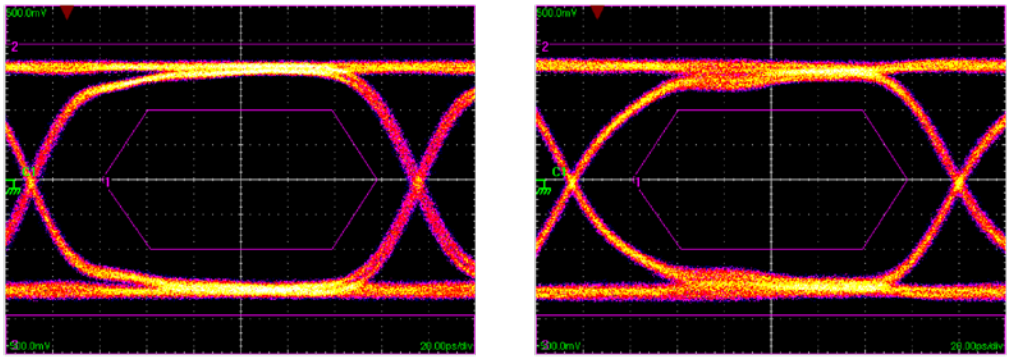


ESD8118



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

ESD8040



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.

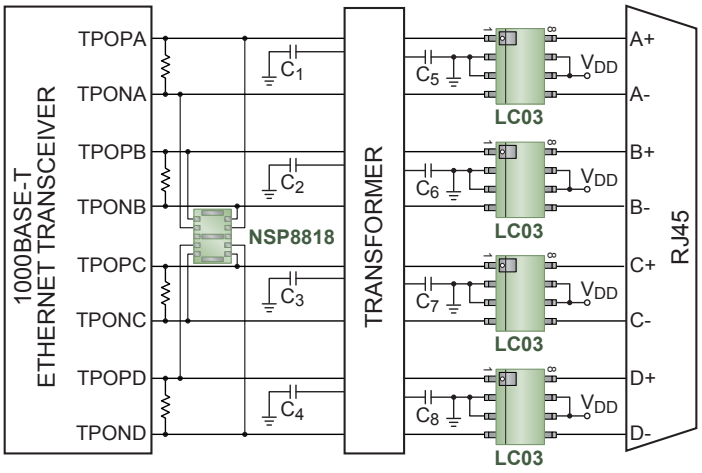
Features

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

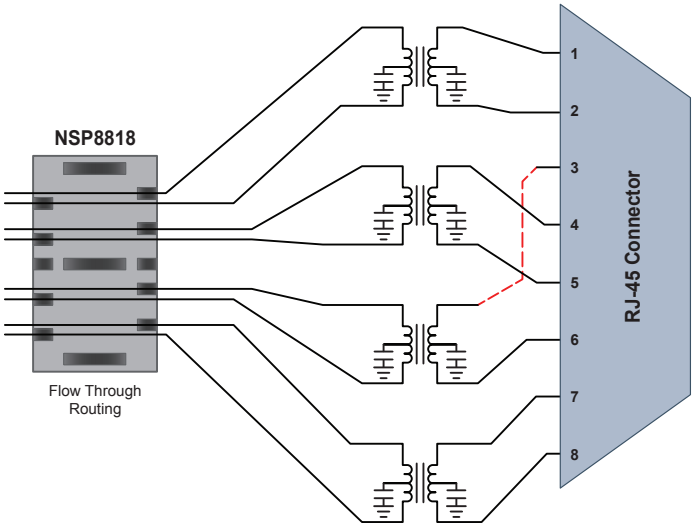
Benefits

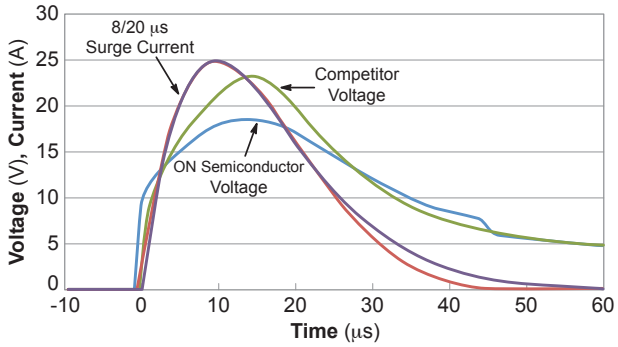
- Compatible with Gb Ethernet and beyond
- Enhanced protection for downstream electronics
- Accommodates operating transients above 3.3 V
- Small form-factor allows integration into connectors

Typical Application



Line Side : LC03-6 (optional)
Transformer Side: NSP8818
Protection against metallic (transverse) strikes





Line-to-Line Surge

Surge Protection Devices

Device	V_{DC} Max (V)	Line Transient Max (V)	Surge I_{PP}, 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

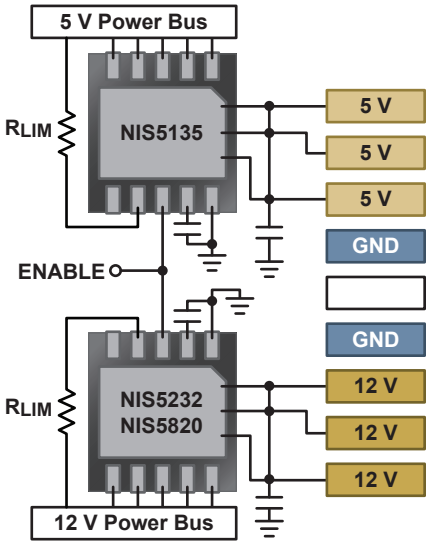
* Pending 2Q19. ** On Pin 5.

Electronic Fuses

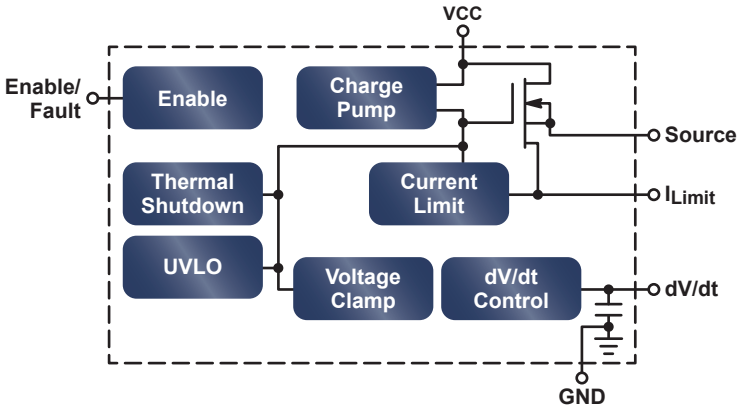
5 – 12 V Power Bus Hot Plug Protection

Features

- Low $R_{DS(ON)}$, high operating and trip currents (I_{OP}, I_{TRIP})
- Overvoltage protection
- Precise I_{TRIP} 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 I_{OP} and I_{TRIP}



Application Diagram



Typical Feature Set for eFuse

Device	Nominal Voltage (V)	Input Voltage (V)	Output Clamping Voltage (V)	Continuous Current (A)	Trip Current (A)	$R_{DS(ON)}$ (mΩ)	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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