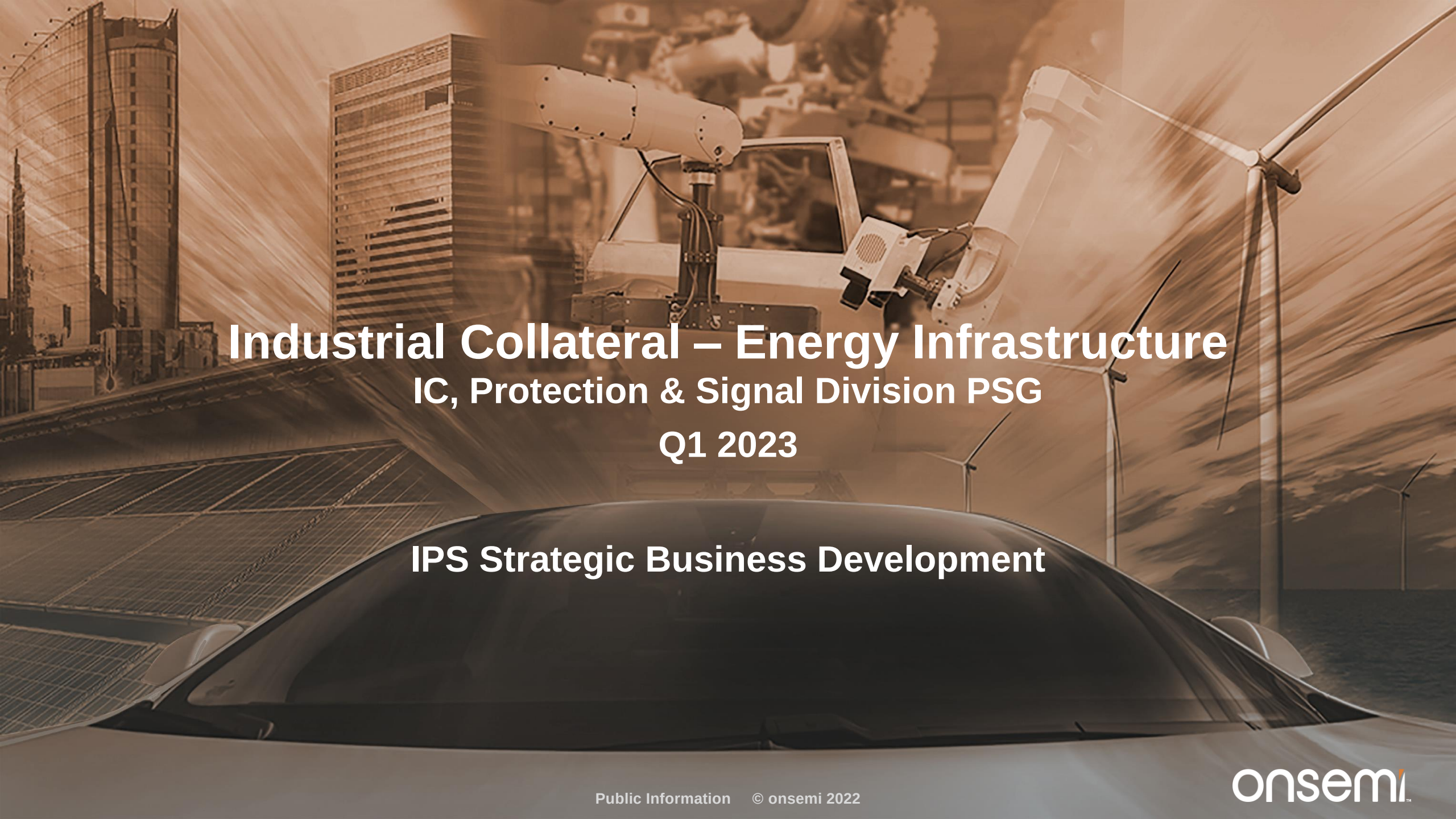


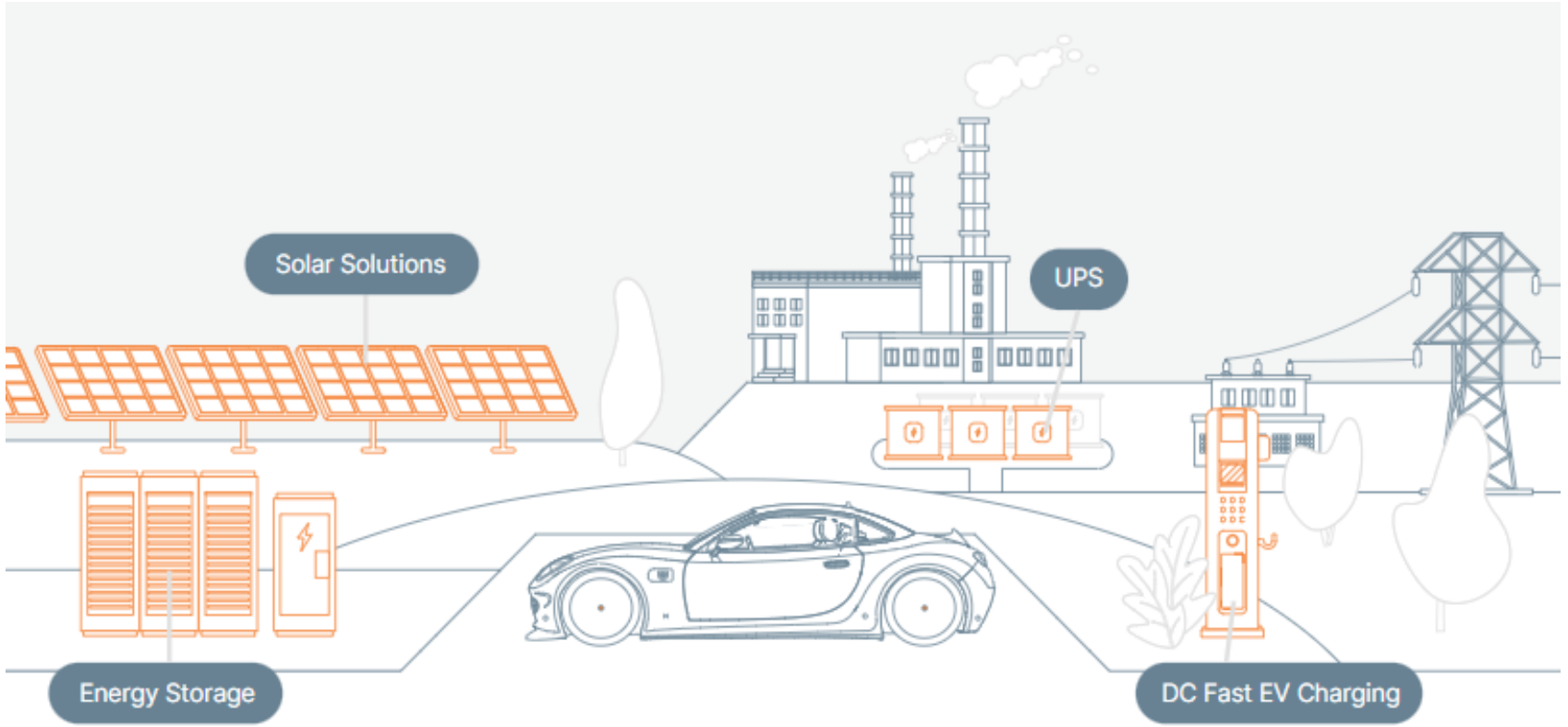
Industrial Collateral – Energy Infrastructure

IC, Protection & Signal Division PSG

Q1 2023

IPS Strategic Business Development

Energy Infrastructure



ON Semiconductor Technologies Enabler

- 650 – 1200 V SiC MOSFET
- 650 – 1200 V SiC Diode
- 650 – 1200 V IGBT
- Low – Mid – High Voltage Si FET
- Rectifier
- Module
- High Voltage Gate Driver
- Digital Isolator
- Current sense OpAmp
- LDO
- eFuse
- EEPROM
- Temp sensor
- ESD Protection
- Switching Diode
- Zener Diode
- Power BJT

onsemi is your Value-added Partner for Fast DC EV Charging Solutions

System solution expertise and long experience

- 5+ years focus on EV Charging with dedicated expert application teams
- An array of reference design developments including SiC driver optimization

Development tools and support

- Thermal and electrical simulation models
- Physical scalable models
- Evaluation boards and reference designs

Leading power modules and SiC technologies with a comprehensive overall portfolio

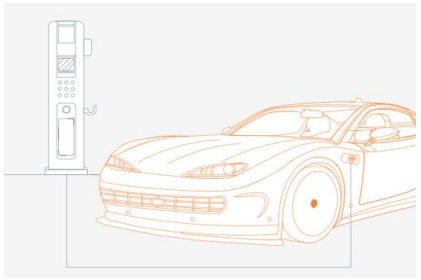
- Continuous investment in enhanced packaging technology
- Superior SiC features with patented termination for ruggedness
- Power devices, analog ICs, auxiliary power, sensing protections and connectivity portfolio

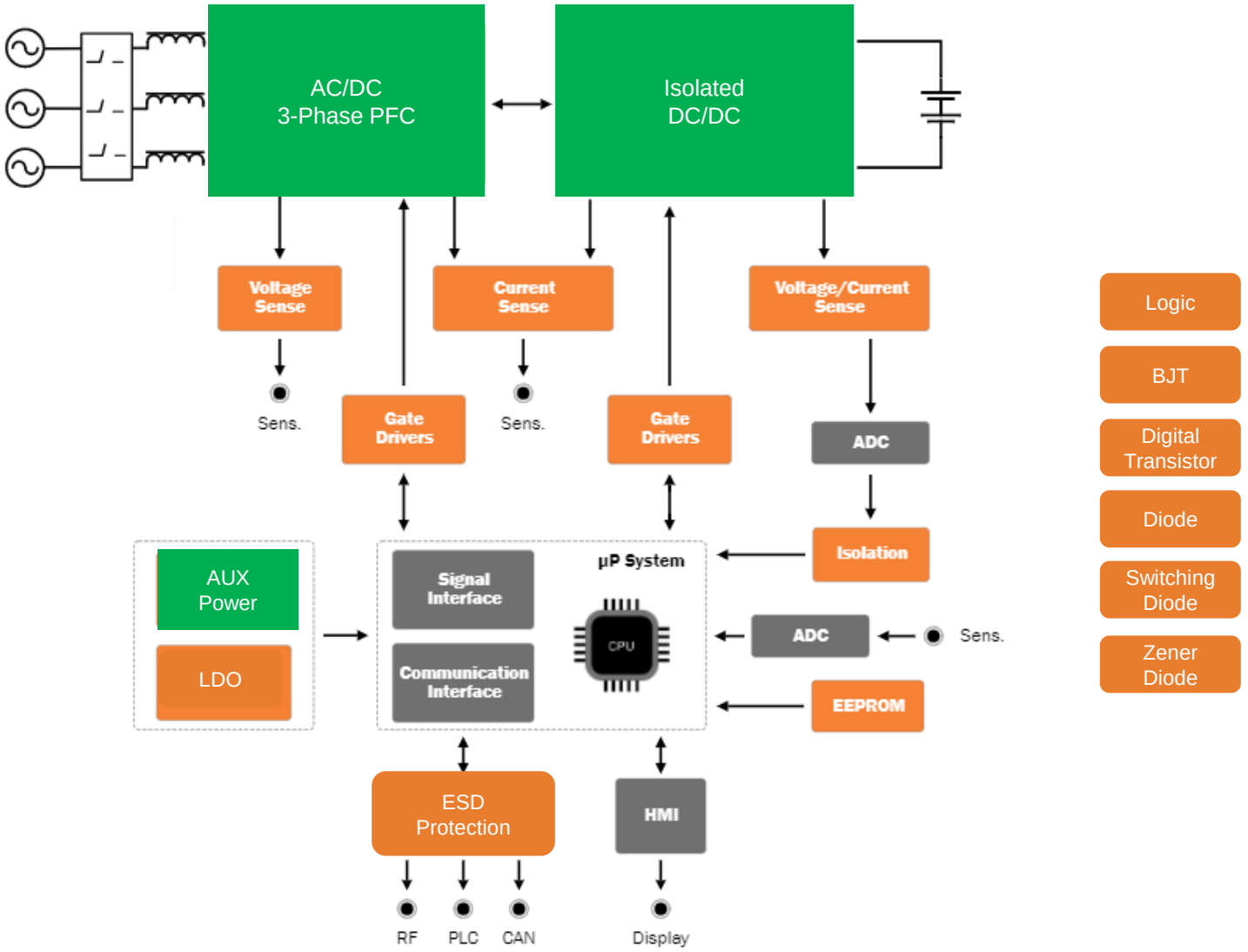
Fully integrated supply value chain

- In-house raw wafers
- Wafer manufacturing and assembly

EV Charging Station

IC, Protection & Signal Solution

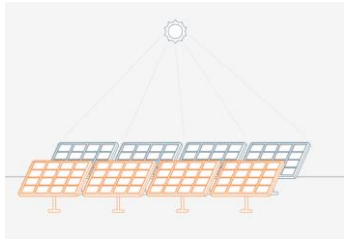


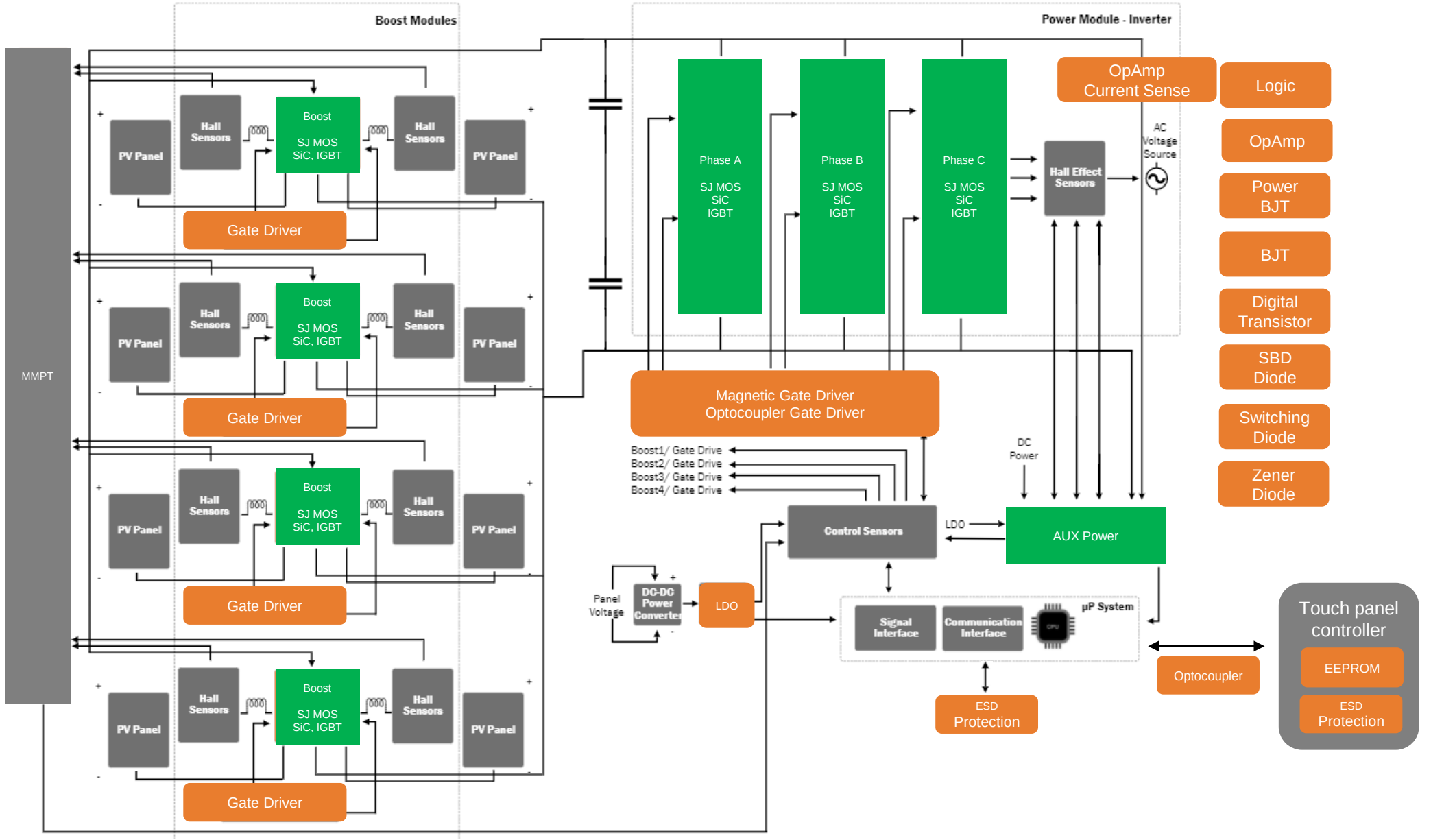


- Logic
- BJT
- Digital Transistor
- Diode
- Switching Diode
- Zener Diode

Solar Power Solutions

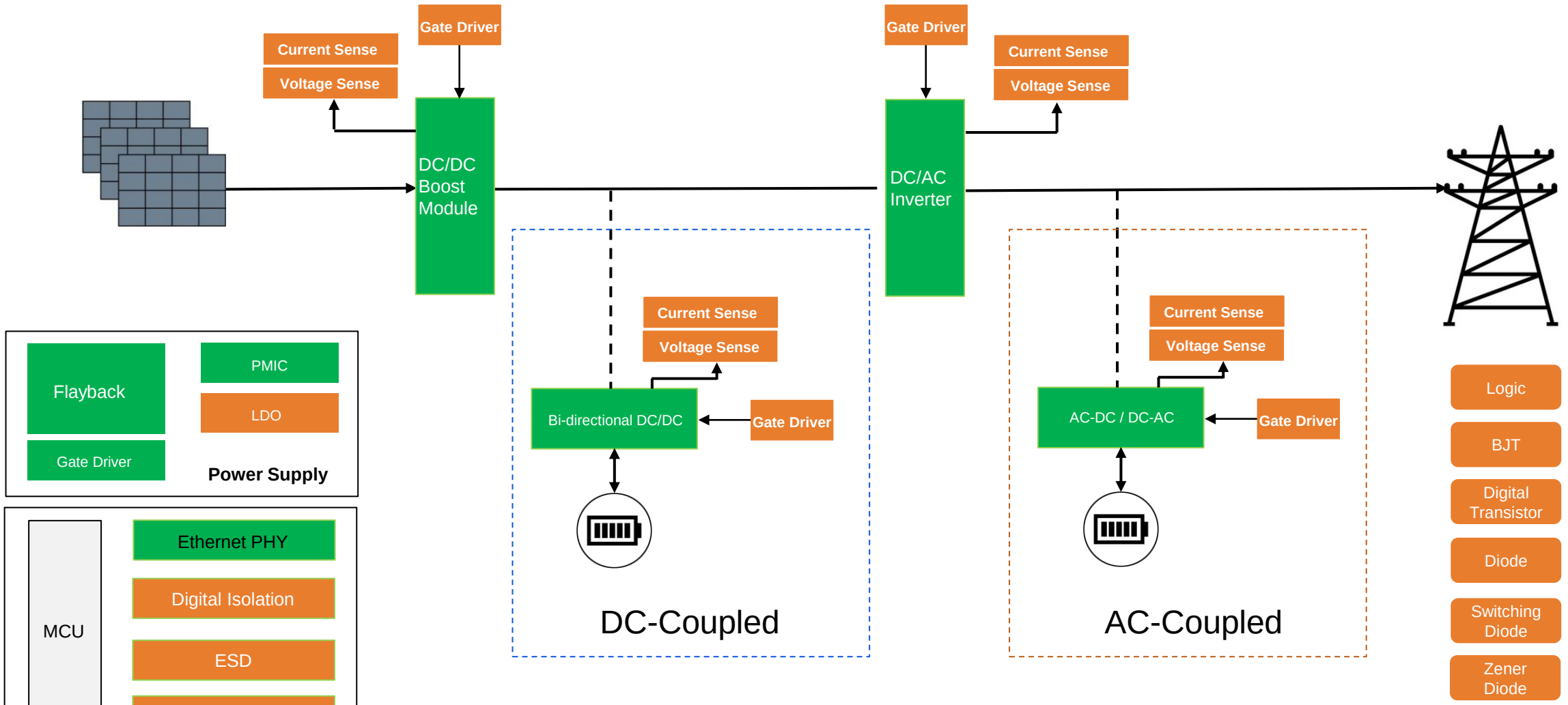
IC, Protection & Signal Solution





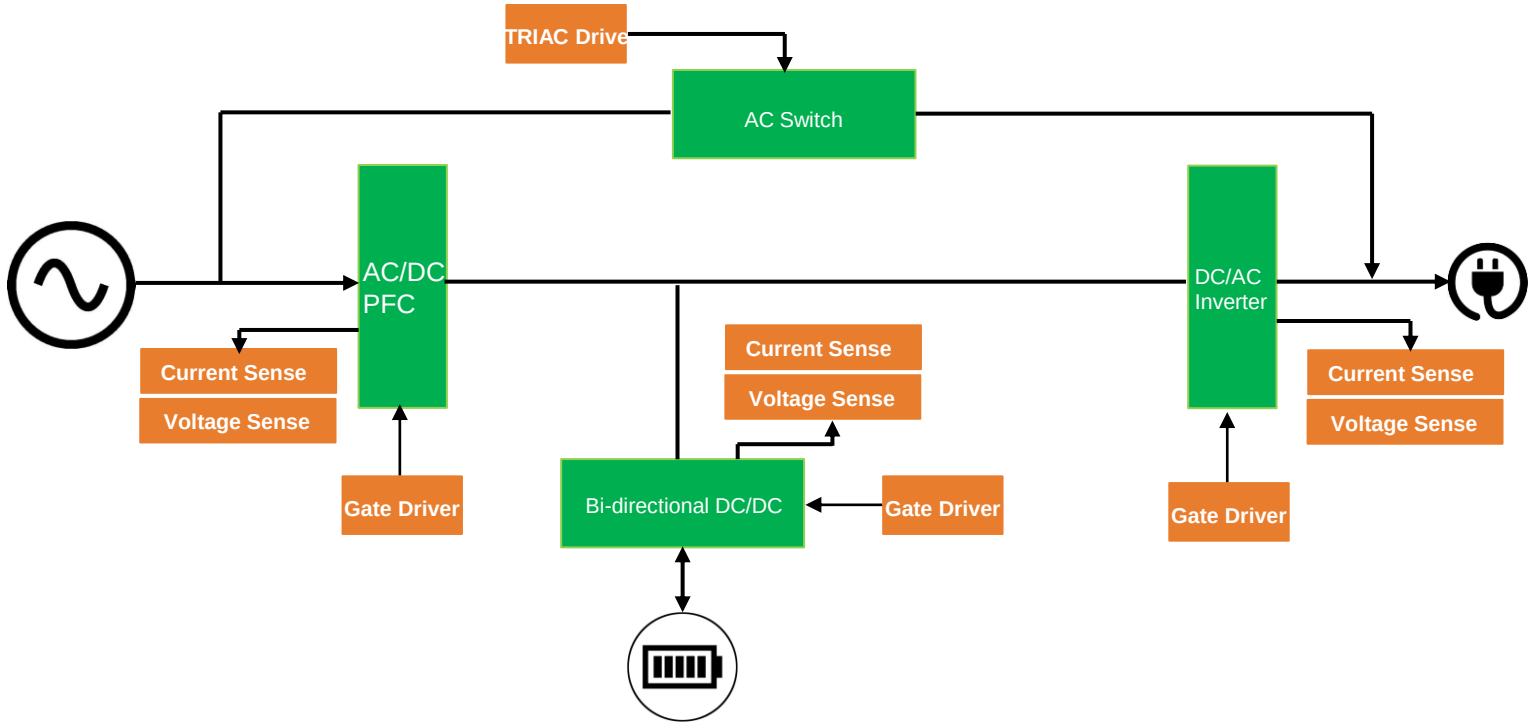
ESS Solutions

IC, Protection & Signal Solution



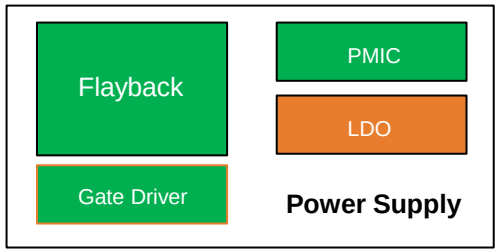
Offline UPS

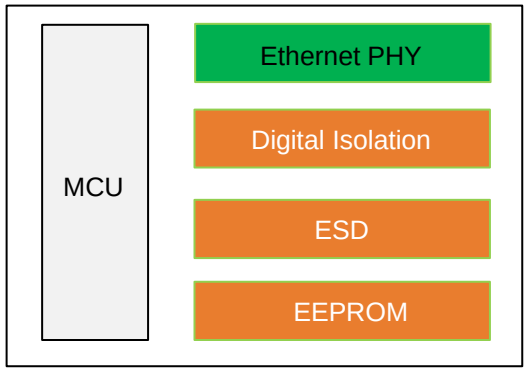
IC, Protection & Signal Solution



- Logic
- BJT
- Digital Transistor
- Diode
- Switching Diode
- Zener Diode

*DC/DC Battery Charger can disappears in architectures where batteries tie directly to the DC bus.

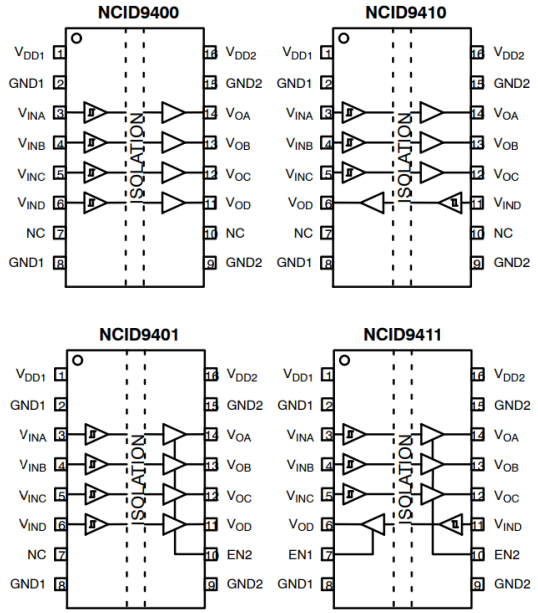




Products Line up – HV GDs, Digital Isolators

HV Gate Driver	Description	# of Ch	Isolation	Output Source/Sink	UVLO	Package
NCD57100/1	Isolated High Current and High Efficiency, with Internal Galvanic Isolation./ Single output source/sink.	1	Y	+7A/-7A	12 to 13	SOIC16 Wide
NCD57252	Isolated Dual-Channel IGBT/MOSFET Gate Driver	2	Y	+6.5A/-6.5A	12 to 12.9	SOIC16 Wide
NCD57080	Isolated High Current	1	Y	+6.5A/-6.5A	12 to 12.9	SOIC8
NCD57084/5	Isolated Compact IGBT Gate Driver with DESAT/ Current Sense	1	Y	+7A/-7.5A	12 to 12.9	SOIC8
NCD57090	Isolated Compact IGBT Gate Driver with Miller Clamp/VEE/Split output	1	Y	+6.5A/-6.5A	12 to 12.9	SOIC8
NCD57530/40	Isolated Dual-Channel IGBT/MOSFET Gate Driver	2	Y	+6.5A/-6.5A	12 to 12.9	SOIC14 Wide

Digital Isolator	# of Ch	Output Enable	VISO Min. (kV)	VIOTM Mim. (kV)	CMTI Min. (kV/us)	Data Rate Max (Mbps)	Package
NCID9210R2	2	N	5	8	150	50	SOIC16W
NCID9211R2	2	Y	5	8	100	50	SOIC16W
NCID9301R2	3	Y	5	8	100	15	SOIC16W
NCID9311R2	3	Y	5	8	100	15	SOIC16W
NCID9400R2	4	N	5	8	100	10	SOIC16W
NCID9401R2	4	Y	5	8	100	10	SOIC16W
NCID9410R2	4	N	5	8	100	10	SOIC16W
NCID9411R2	4	Y	5	8	100	10	SOIC16W



Products Line up – LDOs

LDO	I Load (mA)	Vin (V)	Vo (V)	PSRR @ 1kHz (dB)	Noise (µVrms)	Iq Max (µA)	Package
NCP711	100	18	3.0, 3.3, 5.0, ADJ	75	240	2.5	TSOP-5, WDFNW6_2x2
NCP715	50	24	1.2, 1.5, 1.8, 2.5, 3.0, 3.3, 5.0, 5.3	60@100kHz	65	5.8	TSOP-5, SC70-5, XDFN6
NCP716	80	24	1.2, 1.5, 1.8, 2.5, 3.0, 3.3, 5.0	60@100kHz	120	5.8	WDFN6_2x2
NCP716BC	250	24	3.0, 3.3, 3.45, 5.0,	55	80	4.7	TSOP-5
NCP718	300	24	1.2, 1.5, 1.8, 2.5, 3.0, 3.3, 5.0, ADJ	60	36	8.0	TSOT23-5, WDFN6_2x2
NCP730	150	38	2.5, 2.8, 3.0, 3.3, 5.0, 15, ADJ	70@10kHz	195	2.5	TSOP-5, WDFNW6_2x2
NCP731 *NEW*	150	38	3.3, 5.0, ADJ	70@10kHz	8.1	100	WSOP8
LP2950	100	30	3.0, 3.3, 5.0	-	56	-	DPAK, TO92
LM2931	100	40	5.0, ADJ	-	700	-	SOIC-8, DPAK, D2PAK, TO220-3, TO92
NCP1117	1,000	20	1.2, 1.5, 1.8, 2.5, 3.3, 5.0, ADJ	-	-	-	SOT223-4, DPAK
NCP781	100	150	3.3, 5.0, 15.0, ADJ	83	130	55	DFN6
NCP170	150	5.5	1.2, 1.35, 1.5, 1.8, 1.9, 2.1, 2.5, 2.8, 2.85, 3.0, 3.1, 3.3, 3.6	63	85	0.9	TSOP-5, XDFN-4, SOT563-6
NCP163	250	5.5	1.2, 1.3, 1.5,1.8, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.3, 5.0	92	6.5	20	XDFN-4, TSOP-5, WLCSP-4
NCP164 (150°C)	300	5.5	1.2, 1.8, 2.8, 3.3, ADJ	85	9	40	WDFN-6_2x2, TSOP-5
NCP177	500	5.5	1.5, 1.8, 3.3	75	54	90	XDFN-4
NCP187	1,200	5.5	0.8, 1.2, 3.3, ADJ	75	15	45	WDFN-6, WDFNW-6
NCP189 *NEW* (150°C)	500	5.5	1.2, 1.8, 3.3, ADJ	85	10	35	WDFNW-6_2x2
NCP59801 *NEW* (150°C)	1,000	5.5	1.8, 3.3, ADJ	85	10	55	DFNW-8_2x2

Products Line up – OpAmps

OP AMP	# of Ch	VS Max (V)	VOS Max (mV)	GBW Typ (MHz)	SR Typ (V/us)	Package
NCS2187x	1/2/4	5.5	0.045	0.35	0.1	TSOP5, SC70, UDFN8, Micro8, SOIC8, SOIC14, TSSOP14
NCSx333	1/2/4	5.5	0.01	0.35	0.15	TSOP5, SC70, Micro8, SOIC8, UDFN8, SOIC14, TSSOP14
NCS2180x	1/2/4	5.5	0.01	1.5	0.7	TSOP5, SC70, UDFN8, Micro8, TSSOP14
NCS20166	1	5.5	1.05	10	0.5	SOT23-5
NCS2003x	1/2/4	5.5	4	5	6	TSOP5, Micro8, SOIC8, TSSOP8, SOIC14
NCS2006x	1/2/4	5.5	3.5	3	1.2	TSOP5, SC70, UDFN6, Micro8, SOIC8, TSSOP8, SOIC14, TSSOP14
NCS2008x	1/2/4	5.5	3.5	1.2	0.4	TSOP5, SC70, UDFN6, Micro8, SOIC8, TSSOP8, SOIC14, TSSOP14
NCS2007x	1/2/4	36	3.5	3	2.7	TSOP5, SOT553, Micro8, SOIC8, TSSOP8, SOIC14, TSSOP14
NCS2191x	1/2/4	36	0.025	2	1.6	TSOP5, Micro8™, SOIC8, SOIC14, TSSOP14
NCS2023x	1/2/4	36	1.50	3	2.7	TSOP5, SC70, SOT553, SOIC8, UDFN8, SOIC14, TSSOP14

Current Sense	VCM (V)	VS Max (V)	VOS Max (mV)	GBW Typ (kHz)	SR Typ (V/us)	Gain (V/V)	Package
NCS21xR	26	26	0.035	90	1	50, 100, 200, 500	SC70-6, UQFN10
NCS2167x	40	5.5	0.5	350	2	20, 50, 100, 200	SC70-6, UQFN10
NCS703x	80	5.5	0.3	100	1	14, 20	SOIC8, Micro8™
NCS704x	80	5.5	0.3	100	1	14, 20, 50, 100	SOIC8, Micro8™

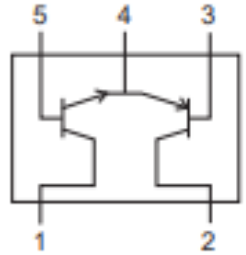
Products Line up – EEPROMs

EEPROM	Interface	Density	Vcc	Operation Temperature	Package Type
CAT24C08	I2C	8 kb	1.7V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8, TSOT23, WLCSP4/5
CAT24C16	I2C	16 kb	1.7V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8, TSOT23, WLCSP4/5
CAT24C32	I2C	32 kb	1.7V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8, WLCSP4/5
CAT24C64	I2C	64 kb	1.7V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8, WLCSP4/5
CAT24C128	I2C	128 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT24C256	I2C	256 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT24C512	I2C	512 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT24M01	I2C	1 Mb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
N24C08UDTG	I2C	8 kb	1.7V to 5.5V	125℃	US8
N24C16UDTG	I2C	16 kb	1.7V to 5.5V	125℃	US8
N24C32UDTG	I2C	32 kb	1.7V to 5.5V	125℃	US8
N24C64UDTG	I2C	64 kb	1.7V to 5.5V	125℃	US8

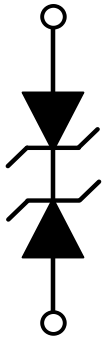
EEPROM	Interface	Density	Vcc	Operation Temperature	Package Type
CAT25080	SPI	8 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT25160	SPI	16 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT25320	SPI	32 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT25640	SPI	64 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT25128	SPI	128 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8, TDFN8
CAT25256	SPI	256 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT25512	SPI	512 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT25M01	SPI	1 Mb	1.8V to 5.5V	125℃	SOIC8,TSSOP8
CAT93C76B	Micro Wire	8 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8
CAT93C86B	Micro Wire	16 kb	1.8V to 5.5V	125℃	SOIC8,TSSOP8, UDFN8

Products Line up – Buffer BJTs, ESD Protections

Buffer BJT	Polarity	VCEO (V)	IC (A)	ICP (A)	VCESAT Max (mV)	PKG
CPH5520-TL-E	Complementary	±50	±2	±5	-330(PNP) 260(NPN)	CPH5 (SOT25)
CPH5524-TL-E	Complementary	±50	±3	±6	-230(PNP) 130(NPN)	CPH5 (SOT25)
NSS40302PD	Complementary	±40	±3	±6	-95(PNP) 60(NPN)	SOIC8



ESD Protection for CAN	Package Size (mm)	Package Type	Lines	Polarity	V_{RWM} (V)	Cap (pF)	I_{PP} (8x20µs) (A)	V_C @ I_{PP} (V)	V_C @ 8 A TLP (V)
ESDL4151	1.0 x 0.60	X4DFN2	1	Bidirectional	15	0.8	11	23	21.3
NUP2124	1.0 x 1.0	XDFNW3	2	Bidirectional	24	8	3	39	37
NUP2105	2.9 x 2.4	SOT-23	2	Bidirectional	24	25	10	42	NA
NUP2125	2.1 x 2.1	SOT-323-3	2	Bidirectional	24	7	3	44	NA
NUP2128	2.1 x 2.1	SOT-323-3	2	Bidirectional	26.5	11	3	46	42
NUP3105	2.9 x 2.4	SOT-23	2	Bidirectional	32	13	10	62	NA
NUP3125	2.1 x 2.1	SOT-323-3	2	Bidirectional	32	6	2	57	NA



LDOs

Why Drop the Vregs?

OPN	Iout (mA)	VIN_ABS max (V)	VOUT_max (V)	Iq max (µA)	Ignd (µA)	Min Load (µA)	Accuracy (%)	Dropout (V)	Enable/ PowerGood
NCP730	150	40	24	1.5	450	N/A	1	0.48	Y/Y
LM317L	100	40	37	100*	105	2500	4**	1.5	N/N
LM317M	500	40	37	100*	105	10000	4**	1.5	N/N
LM317	1500	40	37	100*	105	10000	4**	1.5	N/N
MC78M	500	35	15	3200	6000	N/A	4	2	N/N
MC78L	100	40	24	4400	6500	N/A	5	1.7	N/N

*In addition to minimum load requirements
**Voltage reference accuracy

Power Savings

- Low self consumption with and without load: 5x – 20x reduction
  - Fun math: Install base of 1MU means savings of 100 to 400 kW!
- True Idle/Sleep implementation
  - No minimum load requirement means new chipsets with ultra low power consumption can be used
- Single device covers all conversion needs, minimizing BOM
  - Wide Vin with low dropout allows usage for all rails from 3V to 24V+
- Enables use of modern MCUs, ADCs and sensors without risk of brownout
  - High accuracy combined with exceptional load/line transient regulation provides stable output voltage
- Allow complex power supplies with sequencing and improved brownout protection with fewer components
  - On-chip Enable and Power Good functions

Linear Regulator Key Performance Evolution

High Temperature | Low Iq | High PSRR | Wide-Vin + Low Iq

Higher Operating Junction Temperature

- Transistors specifically designed for these higher temperatures of operation
- Exposed Pad improving power density

- Tj = Ta + 25C for high Pd
  - Tj=Ta + Pd * Rθja

Improved Efficiency

- Lower voltage dropout & tighter accuracy
- Ultra-low Quiescent Currents down
- Reduce standby and sleep mode current in battery operated systems

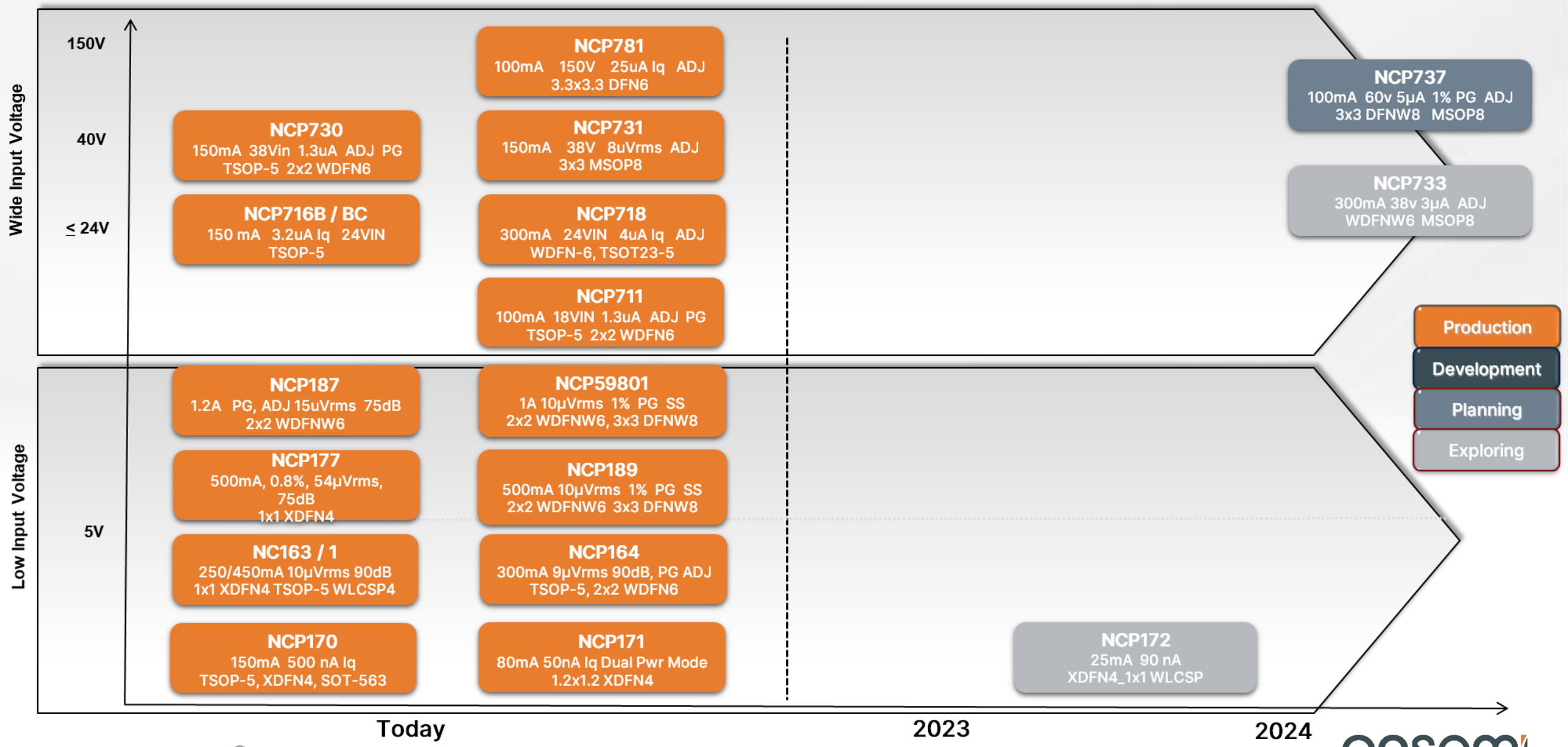
High PSRR, Low Noise

- Improved Image Quality with High PSRR
- Low noise interference with Ultra-low noise ≤ 10uVrms, reducing number of external components

Wide-Vin + Low Iq

- Battery life for battery connected applications
- Ultra-low Iq to support power budget requirements

Industrial LDO Roadmap



NCP731 – 38V, 150mA, Ultralow Noise LDO

Value Proposition: Wide-Input Voltage, Ultralow Noise

The NCP731 device is based on unique combination of features – very low noise, fast transient response, and high input / output voltage ranges. The NCP731 LDO regulator designed for up to 38 V input voltage and 150 mA output current. Ultralow noise (8 µVRMS) makes this device an ideal solution for application where clean voltage rails are critical for system performance (power operational amplifiers, analog-to-digital / digital-to-analog converters and other precision analog circuitry). The device (version B) implements power good circuit (PG) which indicates that output voltage is in regulation. This signal could be used for power sequencing (with delay function) or as a microcontroller reset.

Unique Features

- 2.7V to 38V input voltage
- Ultra-low Noise - 8µVrms
- Vout Accuracy ±0.6% (25C)
- Capacitor programmed soft start

Benefits

- Extra head room for power rail
- Clean power for noise sensitive systems
- Improved output voltage sensing
- Limit high current inrush

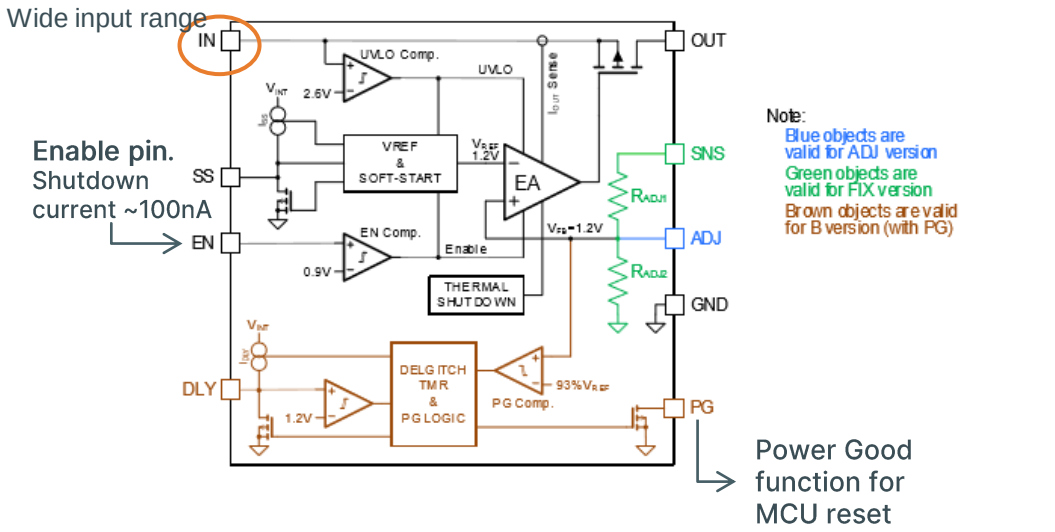
Other Features

- Fixed Voltage Options at 3.3V & 5.0V (other voltages available on request) with an Adjustable Output Voltage to 35V
- 290mV typical dropout @ 150mA of output current, 3.3Vout
- Power Supply Ripple Rejection (PSRR) 70dB @ 10kHz
- Stable with ≥ 1µF ceramic capacitor
- Available in MSOP-8 (Micro-8 with exposed pad) for improved thermals

Market & Applications

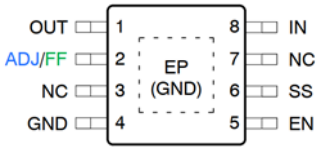
- Power rail for ADC, DAC, and precision analog circuitry
- Instrumentation Amplifiers (INAs) and Precision Operational Amplifiers
- Post DCDC regulation ripple filtering
- Noise sensitive RF circuitry including PA, RX, TX, and Antenna
- Telecom Infrastructure

Application Data



Ordering & Package Information

- Web Visible
- Released to Production
- Samples: Now
- DFN8_3x3 is available upon request



onsemi NCP731 to TI TPS7A49 Comparison

For: Vin=Vout-nom+1V and Vin>=2.7V, Iout=1mA, FB-to-OUT, Ven=1.2V, Css=10n, Cout=Min, Tj=see table, unless o

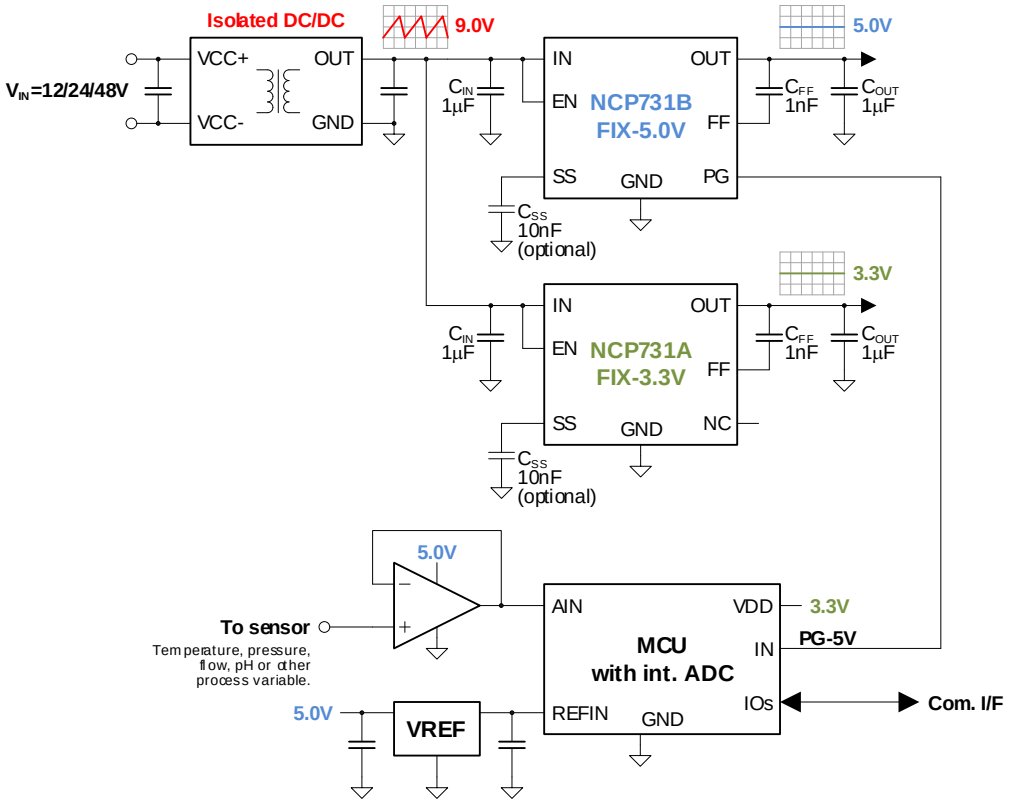
Parameter	Common Conditions	Units	NCP731			TPS7A49			ADP7142		
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
Vin oper.		V	2.7-38			3-36			2.7-40		
Vin max. rating		V	40			36			44		
Ven max. rating		V	40			36			44		
Iout nom		mA	150			150			200		
Vout range	FIX	V	1.2-15			No FIX			1.2-5.0		
Vout range	ADJ	V	1.2-35			1.194-33			1.2-39		
Vout Acc (overLineLoad)	25degC	%				-1.5	-	1.5	-0.8		0.8
	-40/85degC	%	-1	-	1				-1.2		1.5
	Full temp range	%	-1.5	-	1	-2.5	-	2.5	-1.8		1.8
Iq	No load	uA	-	40	80		49	100		50	140
Ignd	Iout=Inom	uA	-				800			180	320
Isd		uA	-	0.1	1		0.8	3		3	10
Ilim		mA	200	280	360	220	309	500	250	360	460
Vdrop@ -100mV	Vout=3.3V, Inom	mV	-	250	420		333	600		200	420
Load transients	1-150mA, tr=tf=1us	mV	-50/+50			-30/30@10uF			-45/40@2.2uF		
PSRR @ Inom, Vin=Vnom+1V, Co=10u	10Hz	dB	-	72	-		65			80	
	1kHz		-	75	-		70			80	
	10kHz		-	68	-		60			75	
	100kHz		-	40	-		55			55	
	1MHz		-	50	-		35			38	
	Min PSRR point		-	37	-		52			38	
Noise	10Hz-100kHz	uVrms	8			15.4			11		
Cout range			1-100uF / 0-0.2Ohm			Min 2.2u, nom 10u			Min 1.5uF, nom 2.2uF		
Tj oper. range		degC	-40 to 125°C			-40 to 125°C			-40 to 125°C		
Package			Micro-8 EP			HVSSOP-8 EP (uSO-8 VSON-8 (DFN) 3x3			SO-8 EP LFCSP-6 (DFN) 2x2 TSOP-5		
Extras			EN pin			EN pin			ecision EN (UVLO) +-6		
			SS pin			NR/SS pin			SS pin		
			PG pin (Version B)								

What is the value of the NCP731?

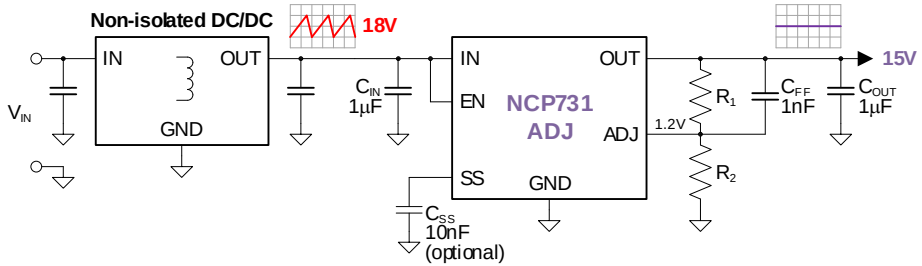
- ✓ VIN operating up to 38V
- ✓ Vout 3.3V & 5V fixed; adjustable from 1.2V up to 35V
- ✓ Ultralow Noise at 10uVrms w/o external noise reduction capacitor!
- ✓ Soft-start set with external capacitor. Can be left floating.
- ✓ Available with Power Good (PG) along with PG delay
- ✓ Stable with 1uF capacitors
- ✓ Available in MSOP-8. Other packages available on request
- ✓ Direct drop-in, P2P, to TI's TPS7A49 HVSSOP-8EP package with improved performance!

NCP731 – Applications

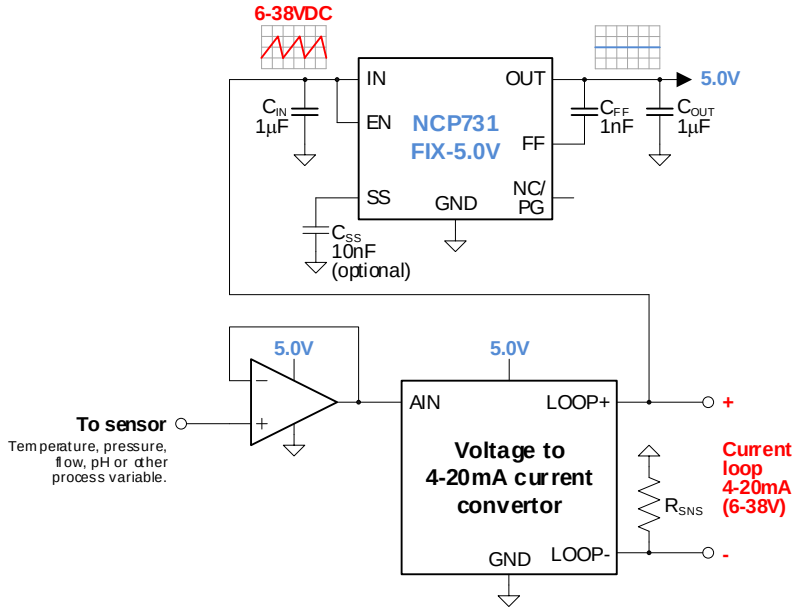
Sensor application, isolated power supply



Non-isolated DC/DC power filtering, general app



Current loop 4-20mA application



Note: Current consumption of all blocks (LDO, OpAmp and Convertor) must be lower than 4mA and flows through the R_{SNS} resistor to be included in transmitted current 4-20mA.

NCP716BC – 150mA, Wide Input Voltage, Ultra-Low IQ LDO Regulator

Value Proposition: 24V, 150mA

The NCP716BC is 150 mA LDO Linear Voltage Regulator. It is a very stable and accurate device with ultra−low ground current consumption (4.7μA over the full output load range) and a wide input voltage range(up to 24V). The regulator incorporates several protection features such as Thermal Shutdown and Current Limiting.

Unique Features

- 2.5 V to 24 V input voltage
- 4.7μA typ. quiescent current
- ±2% Accuracy over full load / line / temperature
- TSOP-5 package

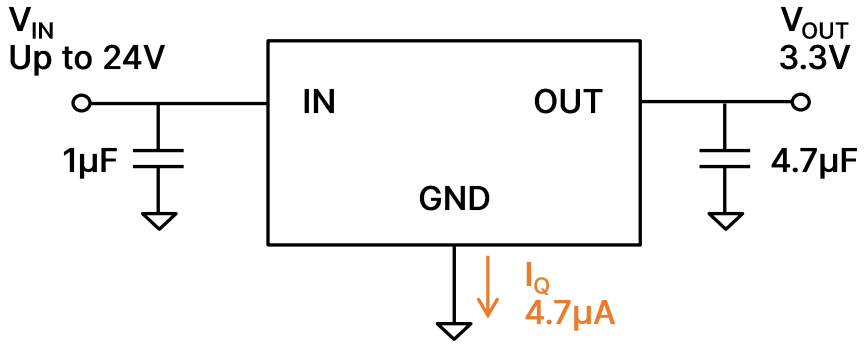
Benefits

- Supports wide input range
- Greatly reduces power consumption
- Provides solid voltage rail
- Leaded, small footprint, cost

Other Features

- Fixed Voltage Options Available: 3.0V, 3.3V, 5.0 V
- ±2% Accuracy Over Full Load, Line and Temperature
- PSRR: 53 dB at 100 kHz
- Over-current Protection
- Thermal Shutdown Protection

Application Data



- P2P to TLV704
- More robust than the TI TLV704. NCP716B survives output short up to 24V VIN

Market & Applications

- MCU Power Supplies
- Home automation equipment
- Industrial measurement systems
- Always-on Applications

3.0x1.5mm TSOP-5 package

Product Availability Information

Samples: Now
RTM: Now

NCP711 – 18V, 100mA, 1uA Iq LDO with Power Good

Value Proposition: Wide-Input Voltage, Low Iq, Low Dropout

The NCP711 is a next generation CMOS LDO regulator designed for up to 18V input voltage and 100mA output current. Designed to meet the requirements for industrial wide-input voltage circuits. The NCP711 device provides ultra−low quiescent current of only 1uA up to 125°C, which makes this device ideal solution for battery powered application. Output voltage can be set from 1.2 to 17V. The device also offer excellent load/line transient regulation and output Power Good function to reset MCU. This device is available in TSOP-5 and WDFN6_2x2 packages.

Unique Features

- 2.7V to 18V input voltage
- Ultra-Low Iq : 1μA typ
- Built-in Soft Start Circuit
- Power Good function (Ver B)

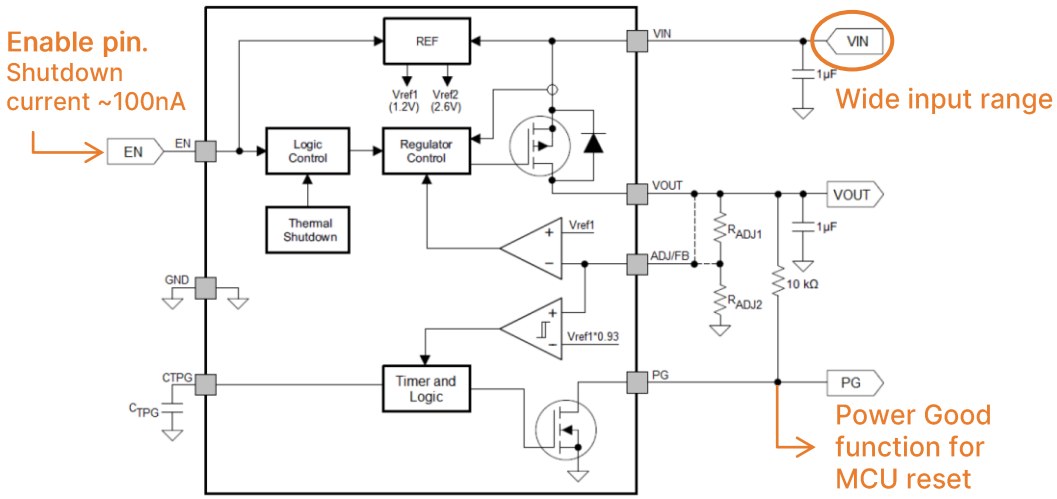
Benefits

- Can support multi-cell battery application
- Extend battery life / save power
- Can suppress inrush current to protect IC
- Can reset MCU to avoid malfunction

Other Features

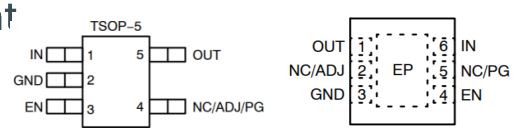
- Fixed & Adjustable Voltage Options Available: 1.2V to 17V
- ±1% Accuracy @ Tj : -40°C ~ +85°C
- 215mV typical dropout @ 100mA of output current, 3.3Vout
- Short Circuit Protection, Thermal Shutdown Protection
- Stable with 1uF ceramic capacitor

Application Data (WDFN-6)



Market & Applications

- Battery-Powered Power Tool and Equipment
- Smart Metering, Smoke Detector
- Industrial Automation, Home Automation
- IT, Home Appliances
- Telecom Infrastructure



DFN-6 (2*2)

Ordering & Package Information

- Samples: Now
- Release to Production: Now

NCP718 – 300 mA Wide Input Voltage, Adjustable LDO, w Enable

Value Proposition:

The NCP718 is 300 mA LDO Linear Voltage Regulator. It is a very stable and accurate device with ultra−low quiescent current consumption (typ. 4 A over the full temperature range) and a wide input voltage range (up to 24 V). The regulator incorporates several protection features such as Thermal Shutdown and Current Limiting.

Unique Features

- Vin 24V Max & Operating
- Iq over LLT ~4 uA
- Adjustable Vout from 1.2V to 5V
- Low dropout (~1mV/mA)
  ~ 300mV/300mA
- PSRR -60dB@1kHz
- Noise 90uVrms

Benefits

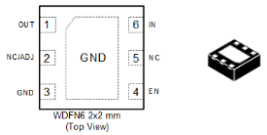
- Soft Start to reduce inrush current
- Active Discharge
- SOA Limiting for High Vin/ High Iout
- Thermal and current limit protection

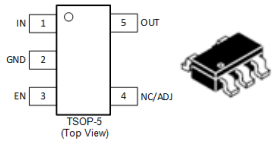
Other Features

- TSOP-5 and WDFN6 packages
- ±2% Accuracy Over Line and Temperature
- Over-current and Short-Circuit Protection
- Thermal Shutdown Protection, Soft-Start

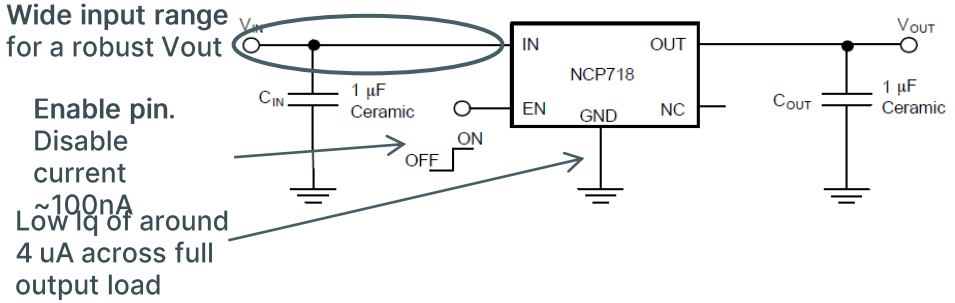
Market & Applications

- Telecom: Zigbee, NB-IoT,
- Industrial: Smart Meter, LED Dimming Control
- Consumer: Set Top Box, Medical Equipment





Application Data



Ordering & Package Information

Device	Voltage Option	Marking	Option	Package	Shipping
NCP718AMTADJTBG	Adj.	GA	w/ Active Discharge	WDFN6	3K / T&R
NCP718BMTADJTBG	Adj.	GC	w/o Active Discharge	WDFN6	3K / T&R
NCP718ASNADJT1G	Adj.	GAA	w/ Active Discharge	TSOP-5	3K / T&R
NCP718BSNADJT1G	Adj.	GAC	w/o Active Discharge	TSOP-5	3K / T&R

NCP730 – 38V, 150mA, 1uA Iq LDO with Power Good

Value Proposition: Wide-Input Voltage, Low Iq, Low Dropout

The NCP730 is a next generation CMOS LDO regulator designed for up to 38V input voltage and 150mA output current. Designed to meet the requirements for industrial wide-input voltage circuits. The NCP730 device provides ultra–low quiescent current of only 1uA, which makes this device ideal solution for battery powered application. Output voltage can be set from 1.2 to 24V, adjustable or fixed. The device also offer excellent load/line transient regulation and output Power Good function to reset MCU. The device is available in TSOP-5 and WDFN-6 packages.

Unique Features

- 2.7V to 38V input voltage
- Ultra-Low Iq : 1μA typ
- Built-in Soft Start Circuit
- Power Good function (Ver B)

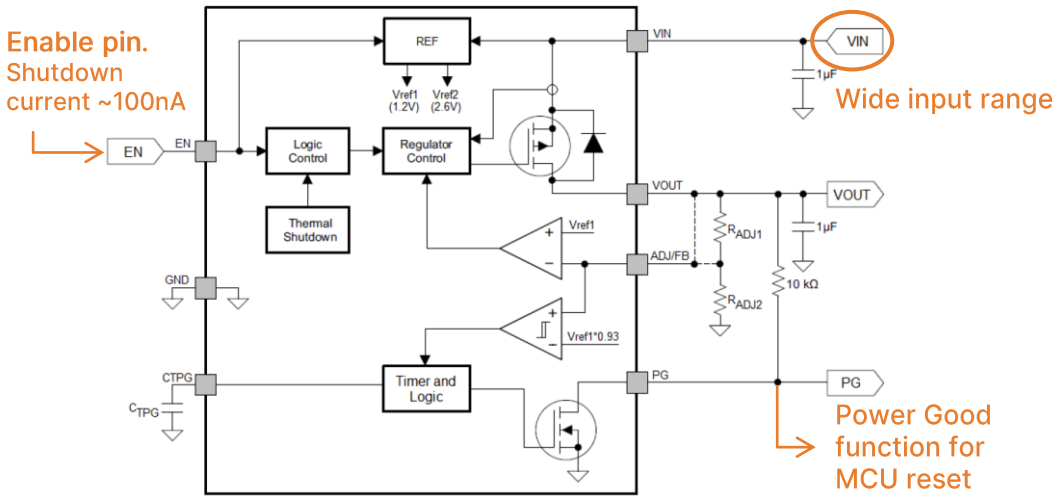
Benefits

- Can support multi-cell battery application
- Extend battery life / save power
- Can suppress inrush current to protect IC
- Can reset MCU to avoid malfunction

Other Features

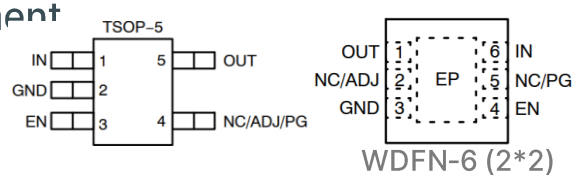
- Fixed & Adjustable Voltage Options Available: 1.2V to 24V
- ±1% Accuracy @ Tj : -40 ~ +85°C
- 290mV typical dropout @ 150mA of output current, 3.3Vout
- Short Circuit Protection, Thermal Shutdown Protection
- Stable with 1uF ceramic capacitor

Application Data (WDFN-6)



Market & Applications

- Battery-Powered Power Tool and Equipment
- Smart Metering, Smoke Detector
- Industrial Automation, Home Automation
- IT, Home Appliances
- Combination Arc-Fault Circuit Breakers (CAFI)



Ordering & Package Information

- Datasheet: Now
- Samples: Now
- Release to Production: Now

NCP781 – 150V Wide Input Voltage Linear Regulator with Low Iq

Value Proposition:

The NCP781 is high-performance linear regulator with very **wide operating input operating voltage range** 6 .. 150V DC, matching the input voltage range for **bus voltages**. This part is capable to deliver up to 100mA of output current and offers ±3% accuracy over full operating temperature range. The NCP781 is optimized for high-voltage inputs, and ideal for usage in **harsh environment**.

Unique Features

- Vin up to 150 V
- Adjustable Vout 1.23-15 V
- Fixed Vout 1.5-15 V
- Very High PSRR 80dB@1kHz
- Noise 130uVrms @ 1.23V
- ±3% Vout accuracy over load/line/temp

Other Features

- Enable pin
- Current limiter 110 (140) mA
- Short circuit limiter
- Thermal shutdown 150C with hysteresis

Market & Applications

- Telecom & Plugged IoT
- Industrial equipment

Package

- u8LL (3.3 x 3.3 x 1mm)

Application Data

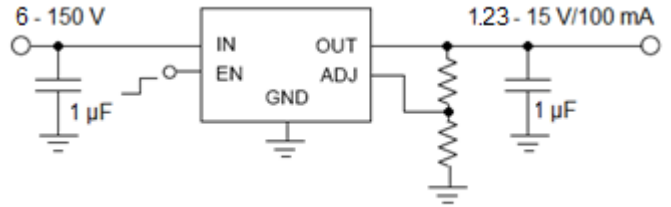


Figure 2. Typical Application for Adjustable Voltage Option

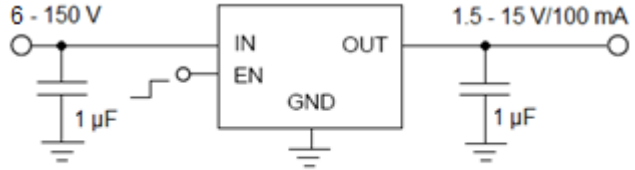
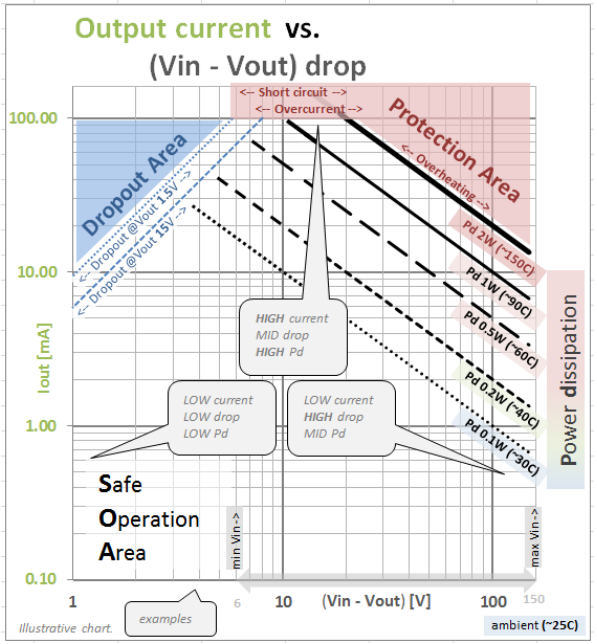


Figure 1. Typical Application for Fixed Voltage Option

150V capable package & fits to required standards !!!

IPC2221A
IEC60664
IEC60730



Ordering Information

Device	Enable pin	Predefined voltages
NCP781	**Yes**	**ADJ** /1.5/3.3/5/9/10/12/15 V (customized voltages upon request)

Wide & High Input Voltage LDO

P/N	ILoad	V_{IN}	V_{OUT}	I_Q	Vdrop (V)	PSRR	Package
NCP502	80mA	12V	1.5 ~ 5.0	40uA	0.6~1.5	55dB	SOT23, SC-70
NCP623	150mA	12V	2.5 ~ 5.0	170uA	0.18	70dB	DFN-6
NCP3335A	500mA	12V	1.5~5, Adj	31uA	0.34	55dB	DFN-10, Micro8
NCP711 New	100mA	18V	2.5, 2.8, 3, 3.3 5, ADJ	1.3uA	0.215	70dB	TSOP-5, WDFN6_2x2
NCP715	50mA	24V	1.2 ~ 5.0	3.2uA	0.23	60dB @ 100kHz	SC-75, SOT-323, SC-88, XDFN
NCP716	80mA	24V	1.2 ~ 5.0	3.2uA	0.35	60dB @ 100kHz	WDFN6
NCP716BC	150mA	24V	3 ~ 5.0	3.2uA	0.7	55dB	TSOP-5 (2 pinouts)
NCP718	300mA	24V	1.5 ~ 5.0	4uA	0.3	60dB	TSOP-5, WDFN6
LP2950	100mA	30V	3, 3.3 ,5.0	93uA	0.35	48dB	DPAK3, TO-92
NCP730	150mA	38V	2.5, 2.8, 3, 3.3 5, 15, ADJ	1.3uA	0.290	70dB	TSOP-5, WDFN6_2x2
LM2931	100mA	40V	5, Adj	400uA	0.16	90dB	TO-220, DPAK3/5 TO-92, SOT-223
NCP781	100mA	150V	0.8 ~ 3.6	-	-	-	DFN-6
NCP785A	10mA	450V	1.5 ~ 15	10uA	-	70dB	SOT-89
NCP786L	5mA	450V	1.5 ~ 15	10uA	-	70dB	SOT-223
NCP786A	10mA	450V	1.27 ~ 15	10uA	-	70dB	DFN6 5*6

Sorted by VIN Max, Low to High

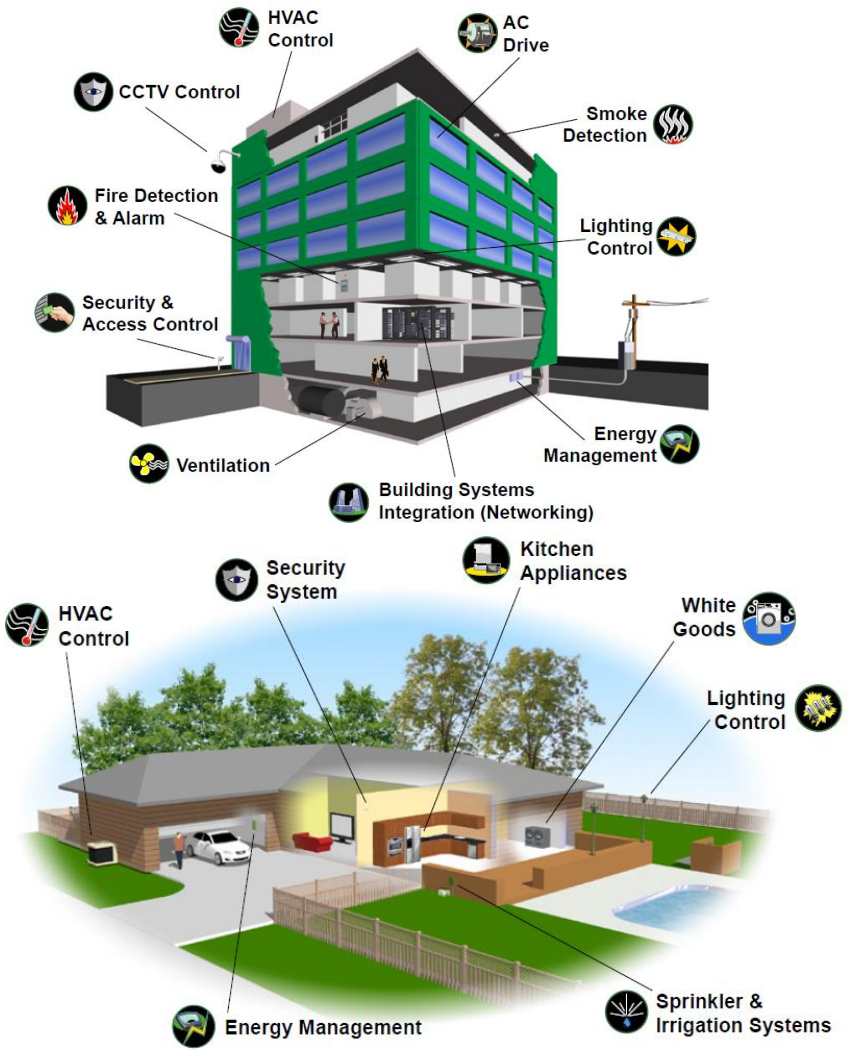
TI to onsemi Wide Input Voltage LDO Crosses

TI PN's	ON PN's	Drop-In Status	Iout (mA)	V_{IN} max (V)	V_{OUT} (V)	I_Q typ (µA)	Noise (μV_{RMS})	Package	Status
TPS769	NCP711 New	P2P Better	100	22	1.2 – 17, ADJ	1.3	240	TSOP-5 (PG Option)	Active
TLV701	NCP716B	P2P Direct	150	24	3, 3.3, 5	3.2	115	TSOP-5	Active
TLV704	NCP716BC	P2P Direct	150	24	3, 3.3, 3.45, 5	3.2	115	TSOP-5	Active
TPS7A25	NCP718	Similar	300	24V	1.2 – 5, ADJ	4	36	TSOP-5, WDFN6_2x2 (No PG Option)	Active
TPS709	NCP730	P2P Better	150	40	1.2 – 24, ADJ	1.3	240	TSOP-5, WDFN6_2x2 (PG Option)	Active
TPS7A49	NCP731 New	P2P Direct	150	40	3.3, 5	50	10	MSOP8_EP_3x3	Active

Sorted by VIN Max, Low to High

OpAmps

Industrial Applications



It's still an Analog World !

White Goods

- Washing Machine (Low Side Current Sense)
- Refrigerator (Low Side Current Sense & 12V Motor Driver)
- Dishwasher (Low Side Current Sense & 12V Motor Driver)
- Outside Air Conditioner (Low Side Current Sense)
- Air Purifier (Precision Signal Conditioning)
- Vacuum Cleaner (Low Side Current Sense)
- Water Heater (Various Signal Conditioning)

Building Automation

- Smoke Detector (Various Signal Conditioning)
- Flow Meter (Various Signal Conditioning)
- Thermostat Control (Various Signal Conditioning)
- Smart Meter (Low Side Current Sense)
- LED Lighting

Process Automation & Measurement

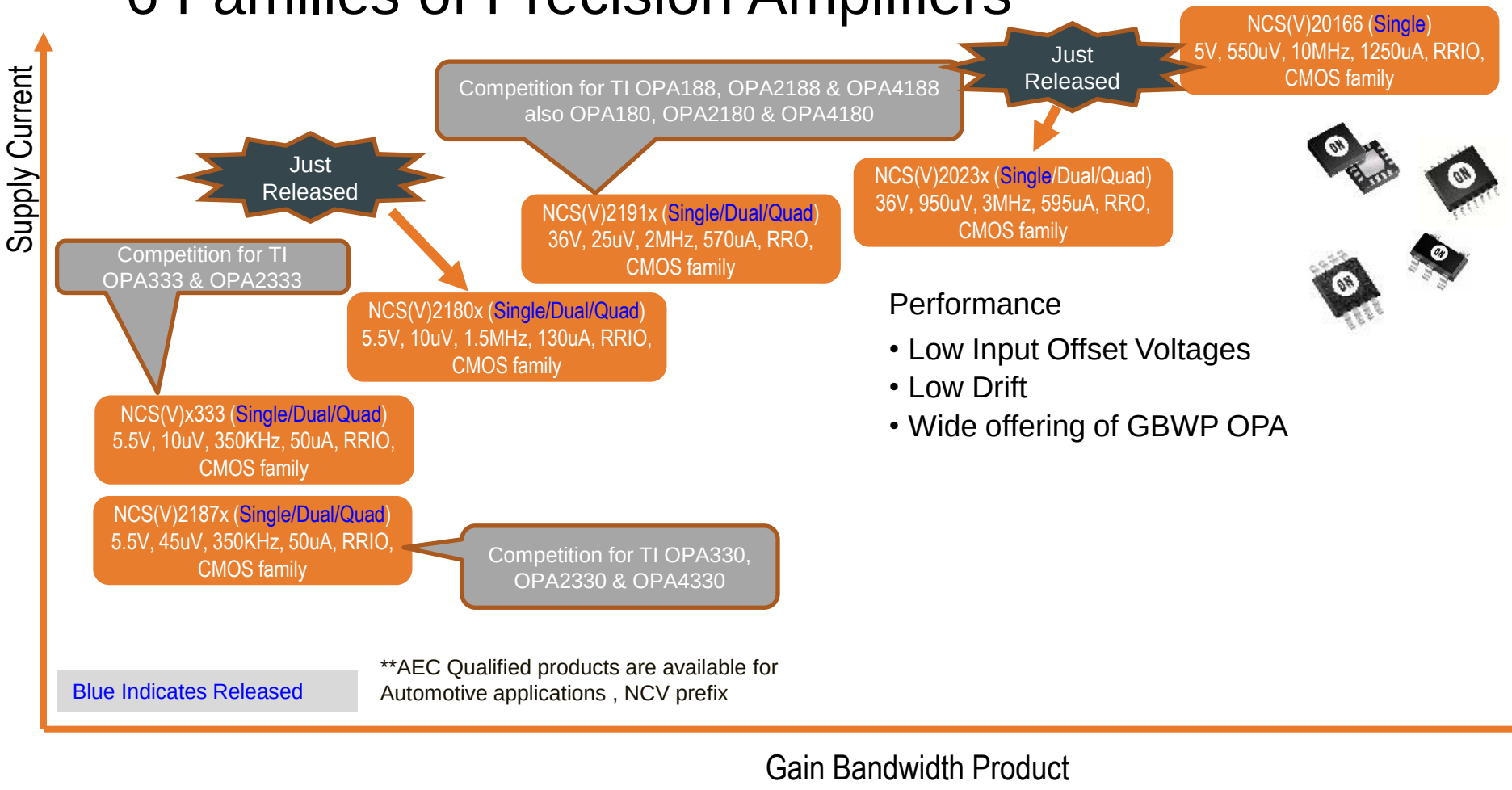
- AC Induction Motors (Low Side Current Sense)
- Brush DC Motors (Low Side Current Sense)
- Industrial Weigh Scales (Precision Signal Conditioning)
- Digital Multi-meter (Precision Signal Conditioning)

Medical

- Blood Glucose Meter (Precision Signal Conditioning)
- Blood Pressure Monitor (Precision Signal Conditioning)

Precision Op Amp (1mV or lower Offset Voltage)

6 Families of Precision Amplifiers



Performance

- Low Input Offset Voltages
- Low Drift
- Wide offering of GBWP OPA

Space Saving Package

- Single, Dual and Quad
- Small packages (SOT23, SC-70, SOIC 8, SOIC 14)

Good Price to Performance Balance

Sampling: NCS(V)20231/2. In Dev: NCS20234

http://www.onsemi.com/NCS20232

Value Proposition

The NCS20231/2/4 family of op amps feature a wide supply range of 2.7 V to 36 V with an input offset voltage as low as ±0.95 mV max @ 25°C . These op amps are available in single, dual, and quad channel configurations. Automotive qualified options are available under the NCV prefix. Automotive grade 0 versions have an extended operating temperature range from -40 °C to 150 °C. All other versions are specified over the operating temperature range from -40 °C to 125 °C.

Unique Features

- Offset Voltage: ±0.95 mV max (25°C)
- Offset Drift: ±2 μV/°C max
- Supply Voltage Range: 2.7 V to 36 V
- Unity Gain Bandwidth: 3 MHz
- CMRR: VSS to (VDD–1.35)V

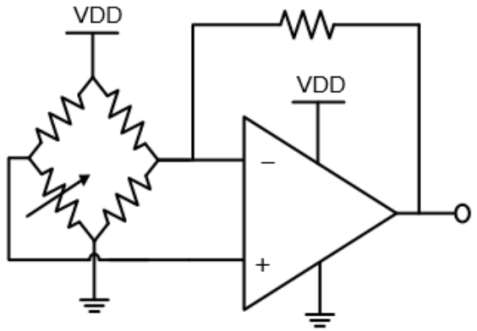
Others Features

- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These devices are Pb-free, Halogen free/BFR free and are RoHS compliant
- Available in Single, Dual, and Quad Packages

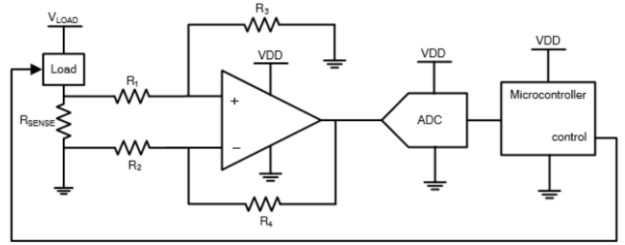
Market & Applications

- Telecom Equipment
- Power Supply Designs
- Diesel Injection Control
- Automotive
- Motor Control

Typical Application diagram



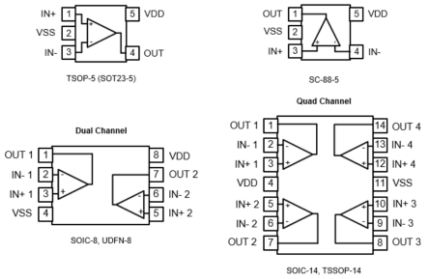
Bridge Circuit Amplification



Low−Side Current Sensing

Packages/ Pin Outs

Temperature	Channels	Package	Device Part Number
Industrial and Commercial			
−40°C to 125°C	Single	TSOP−5	NCS20231SN2T1G
		SC−88	NCS20231SQ3T2G
		SOT−553	NCS20231
	Dual	SOIC−8	NCS20232DR2G
		UDFN−8	NCS20232
	Quad	SOIC−14	NCS20234DR2G
		TSSOP−14	NCS20234DBR2G
Automotive Qualified, Grade 1			
−40°C to 150°C	Single	TSOP−5	NCV20231SN2T1G
		SC−88	NCV20231SQ3T2G
		SOT−553	NCV20231
	Dual	SOIC−8	NCV20232DR2G
	Quad	SOIC−14	NCV20234DR2G
		TSSOP−14	NCV20234DBR2G



NCS(V)21871/2/4

http://www.onsemi.com/NCS21871

Value Proposition

This family of single, dual and quad zero-drift amplifiers provide excellent precision. This is achieved with continuous calibration of the input offset voltage over time and temperature.

Unique Features

- Gain-Bandwidth Product: 270 to 350 kHz
- Low Supply Current/ Channel: 17 µA (typ., at 3.3V)
- Low Offset Voltage: 45 µV max
- Low Offset Drift: 0.4 µV/°C max
- Wide Supply Range: 1.8V to 5.5 V
- Wide Temperature Range: −40°C to +125°C
- AEC- Q100 Qualified are available

Benefits

- Offset error is inherent to all amplifiers. This error tends to increase with time and temperature. Op amps amplify both the signal and the error. Among the various architectures employed to lower the offset, Zero-Drift is one such, which provides exceptionally low offset and drift, resulting in high accuracy sensor measurements and amplification, especially when the input of the op amp is a small signal.

Market & Applications

- Thermal Management Circuits
- Transducer Applications
- Current Sensing in Motor Control, Lighting etc.
- Power Supplies
- Battery Powered/ Portable Applications
- Electronic Scales, Wheatstone Bridges
- Instrumentation in Medical and Industrial
- Automotive
- Telecom
- Industrial
- Computing
- Medical

Typical Application diagram

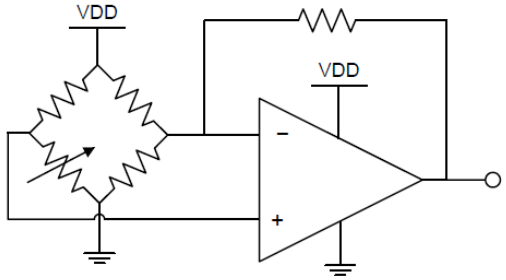
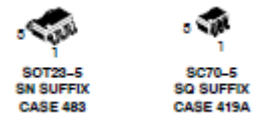
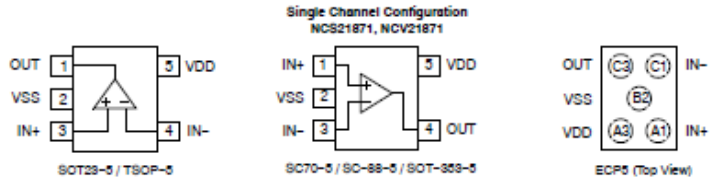
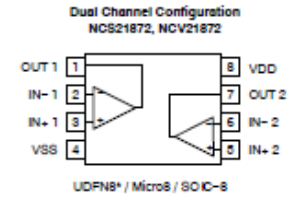


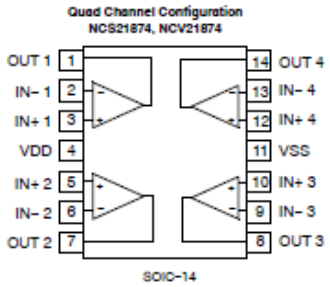
Figure 18. Bridge Circuit Amplification

Packages/ Pin Outs









NCS21801/2/3/4

Value Proposition

The NCS21801/3, NCS21802, and NCS21804 are precision op amps featuring low input offset voltage and low offset drift over time and temperature. The NCS2180x is available in single, dual, and quad channel configurations. All versions are specified for operation from -40°C to +125°C. NCV prefix parts are automotive grade 1 qualified. The single channel option is also available with an enable (/shutdown) pin which powers down the part to a low power state and the output is in high impedance. The part is powered on and functional when this pin is pulled high.

Unique Features

- Gain-Bandwidth: 1.5 MHz
- Quiescent Current: 75 typ, 130 max over temp
- Input Offset Voltage: 10 µV max @ 25 °C
- Offset Drift Over Temperature: 5 nV/°C
- Supply Range: 1.8 to 5.5 (-40 to 125C)
- CMRR: 110 dB min over temp
- PSRR: 110 dB min over temp
- Integrated EMI Filters

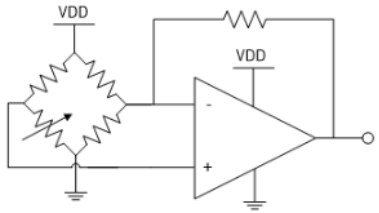
Benefits

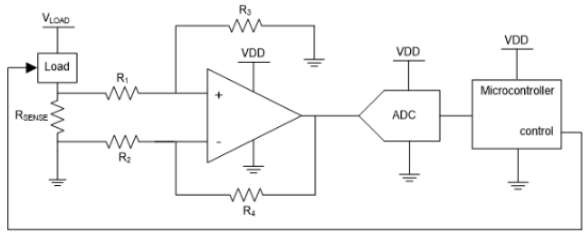
- Enable Pin
- Rail-to-Rail Input and Output
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

Market & Applications

- Thermal Management Circuits
- Transducer Applications
- Current Sensing in Motor Control, Lighting etc.
- Power Supplies
- Battery Powered/ Portable Applications
- Electronic Scales, Wheatstone Bridges
- Instrumentation in Medical and Industrial
- Automotive
- Telecom
- Industrial
- Computing
- Medical

Typical Application diagram





Packages/ Pin Outs

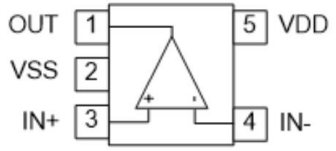


Figure 1. Single Pinout, TSOP-5/SOT23-5

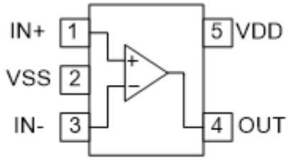


Figure 2. Single Pinout, SC70-5 / SC-88-5 / SOT-353-5

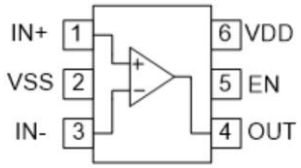


Figure 3. Single Pinout with Enable, SC−88/SC70−6/SOT−363

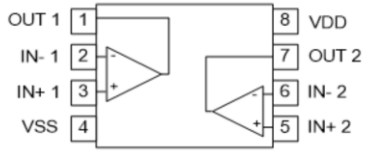


Figure 4. Dual Pinout

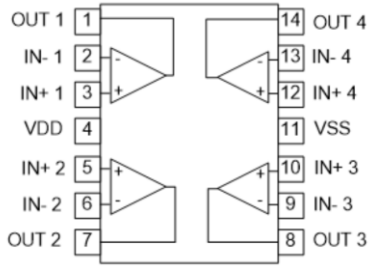


Figure 5. Quad Pinout

Precision Portfolio

Product	# of Ch.	VS Min (V)	VS Max (V)	Iq Typ (mA)	VOS Max (mV)	GBW Typ (MHz)	SR Typ (V/µs)	Temperature Range (°C)	Package Type
NCSx325	1/2/4	1.8	5.5	0.021	0.05	0.27/ 0.35	0.1	-40 to 125	SOT-23-5 Micro8™ SOIC-8 SOIC-14
NCSx333	1/2/4	1.8	5.5	0.017 0.021 0.028	0.01/0.03	0.27/ 0.35	0.1	-40 to 125	SC-70-5 SOT-23-5 Micro8™ SOIC-8 UDFN-8 SOIC-14
NCS/V21871/2/4	1/2/4	1.8	5.5	0.017	0.045	0.35	0.1	-40 to 125	TSOP-5, SC705, UDFN8, Micro8, SOIC-14
NCS21911/2/4	1/2/4	4	36	0.475	0.025	2	1.6	-40 to 125	SOT-23-5, Micro8™ SOIC-8, SOIC14, TSSOP14
NCS20166	1	3	5.5	1.2	1.05	10	0.5	-40 to 125	SOT-23-5
NCS21801/2/3/4	1/2/4	1.8	5.5	0.95	0.01	1.5	0.7	-40 to 125	SC-70-5 SOT-23-5 Micro8™ UDFN-8 TSSOP-14
NCS2023x1/2/4	1/2/4	2.7	36	0.475	1.50	3	2.7	-40 to 150	SC-70-5 SOT-23-5 SOT553-5 SOIC-8 UDFN-8 SOIC-14 TSSOP-14

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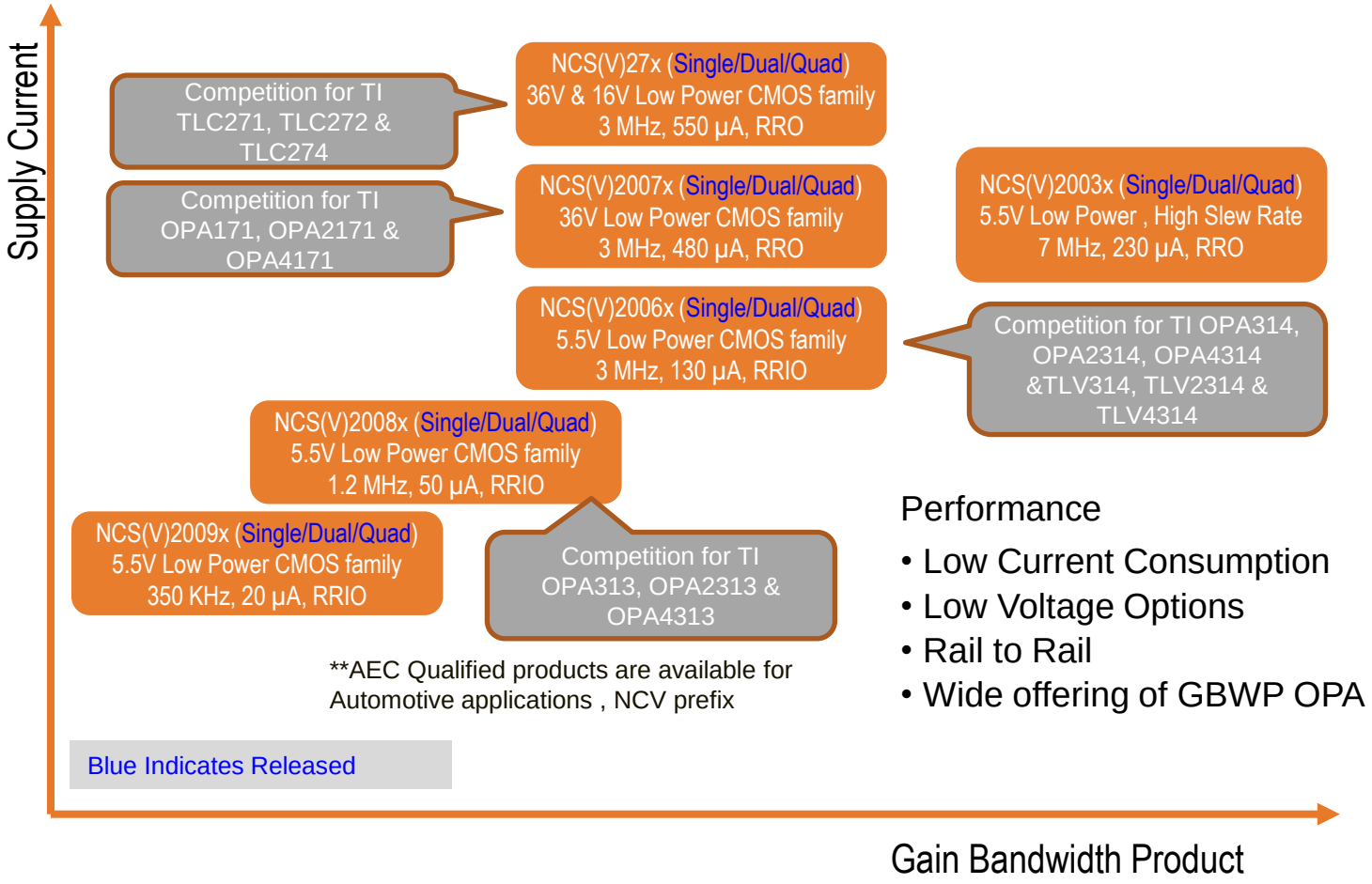
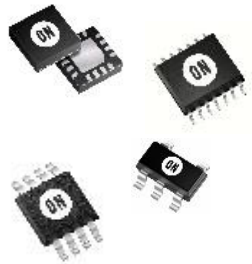
Low Power Op Amp (Less than 1mA current consumption)

6 Families of Low Power Amplifiers



Performance

- Low Current Consumption
- Low Voltage Options
- Rail to Rail
- Wide offering of GBWP OPA



Space Saving Package

- Single, Dual and Quad
- Small packages (SOT23, SC-70, SOIC 8, SOIC 14)

Good Price to Performance Balance

- Migration Path for next generation designs

Available Now: NCS(V)20071, NCS(V)20072 and NCS(V)20074

Value Proposition

The NCS2007x series operational amplifiers provide rail-to-rail output operation, 3 MHz bandwidth, and are available in single, dual, and quad configurations. Rail-to-Rail operation enables the user to make optimal use of the entire supply voltage range while taking advantage of 3 MHz bandwidth. The NCS2007x can operate on supply voltages as low as 2.7 V over the temperature range of -40°C to 125°C. At a 2.7 V supply, the high bandwidth provides a slew rate of 2.8 V/μs while only consuming 405 μA of quiescent current per channel. The wide supply range allows the NCS2007x to run on supply voltages as high as 36 V, making it ideal for a broad range of applications. Since this is a CMOS device, high input impedance and low bias currents make it ideal for interfacing to a wide variety of signal sensors. The NCS2007x devices are available in a variety of compact packages. Automotive qualified options are available under the NCV prefix. No output phase reversal.

Unique Features

- Wide Supply Range: 2.7 V to 36 V
- Rail-To-Rail Output
- Wide Bandwidth: 3 MHz typical
- Low Supply Current: 405 μA 2.7V
- Low Input Bias Current: 5 pA typical
- High Slew Rate: 2.8 V/μs typical
- NCV parts for Automotive

Benefits

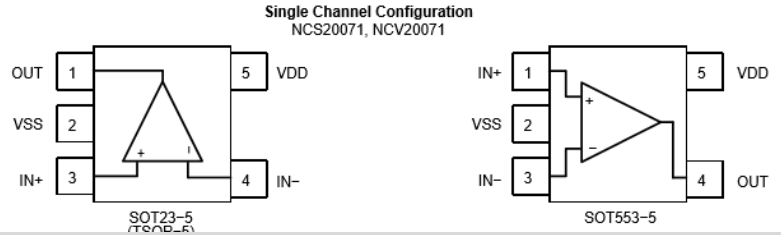
- Wide supply range suitable for a wide variety of applications
- Wide output range
- Compatible with high speed signals 3 MHz
- Low current consumption
- High input impedance
- Meets automotive standards

Market & Applications

- Sensor Signal Conditioning
- Current Sensing
- Air Conditioning Systems
- Filter Circuits
- Unity Gain Buffer
- White Goods

Typical Applications / Pin Outs

- Motor Current Sense
- Current Shunt Monitor
- Sensor Conditioning
- Automotive
- Industrial



Packages


SOT−553
CASE 463B

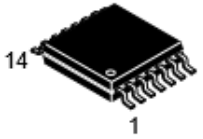

Micro8™
CASE 846A

SOIC−8
CASE 751

ON Part Number	Phase
NCS20071	Launched
NCS20072	Launched
NCS20074	Launched

TSOP−5
CASE 483


TSSOP−8
CASE 948S



TSSOP−14
CASE 948G

SOIC−14 NB
CASE 751A

Available Now: NCS(V)20081, 2 & 4

Value Proposition

The NCS20081/2/4 is a family of single, dual and quad Operational Amplifiers (Op Amps) with 1.2 MHz of Gain−Bandwidth Product (GBWP) and draws only 42 μA of Quiescent current. The NCS2008x has Input Offset Voltage of 4 mV and operates from 1.8 V to 5.5 V supply voltage over a wide temperature range (−40°C to +125°C). The Rail−to−Rail In/Out operation allows the use of the entire supply voltage range while taking advantage of the 1.2 MHz GBWP. Thus, this family offers superior performance over many industry standard

parts. These devices are AEC−Q100 qualified which is denoted by the NCV prefix. NCS2008x's low current consumption and low supply voltage performance in space saving packages, makes them ideal for sensor signal conditioning and low voltage current sensing applications in Automotive, Consumer and Industrial markets.

Unique Features

- Wide Bandwidth: 1.2 MHz
- Low Supply Current/ Channel: 42 μA typ (VS = 1.8 V)
- Low Input Offset Voltage: 4 mV max
- Wide Supply Range: 1.8 V to 5.5 V
- Available in Single, Dual, and Quad Packages

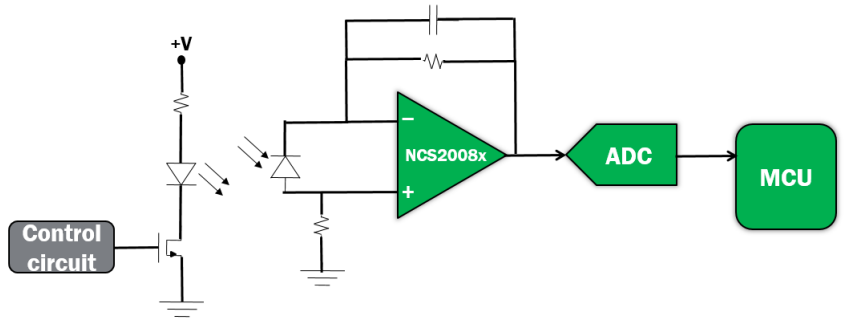
Others Features

- Wide Temperature Range: −40°C to +125°C
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant
- Unity Gain Stable
- Rail−to−Rail Input and Output

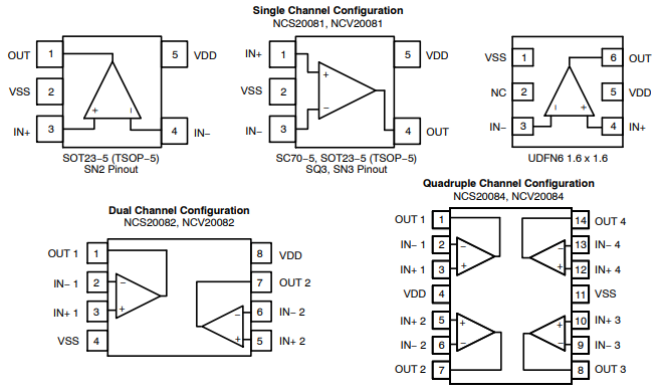
Market & Applications

- Automotive
- Battery Powered/ Portable
- Sensor Signal Conditioning
- Low Voltage Current Sensing
- Filter Circuits
- Unity Gain Buffer

Typical Application diagram



Packages/ Pin Outs



ON Part Number	Phase
NCS20081	Launched
NCS20082	Launched
NCS20084	Launched

In Development: NCS(V)20161/2/4, 8MHz, RRIO Operational Amplifier

Value Proposition

The NCS20161/2/4 is a family of single, dual and quad Operational Amplifiers (Op Amps) featuring 8 MHz Gain-Bandwidth Product (GBWP) while consuming a low 800uA of quiescent current. The NCS2016x has an Input Offset Voltage of 2.0 mV and operates from 1.8 V to 5.5 V supply voltage. They also feature full rail-to-rail input and output.

Unique Features

- High Bandwidth: 8 MHz
- Input Offset Voltage: 2.0 mV
- Supply Voltage: 1.8 V to 5.5 V

Benefits

- The Bandwidth supports fast data acquisition systems.
- The low offset voltage improves precision over general purpose devices.
- The supply voltage allows use from standard 5V supplies and from low 1.8V to conserve energy.

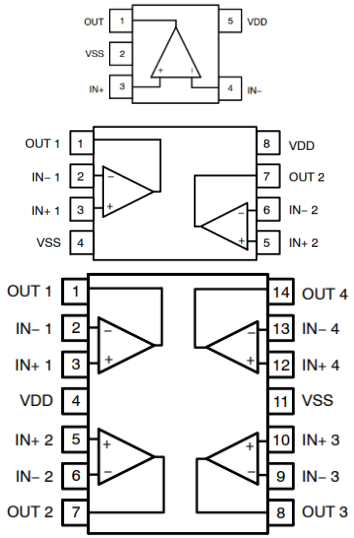
Specifications:

- CMRR : Typically 103dB
- PSRR: Typically 103dB
- Slew Rate: 6.5V/µs
- Noise 10kHz: 10nV/rtHz
- Quiescent Current: 800 uA

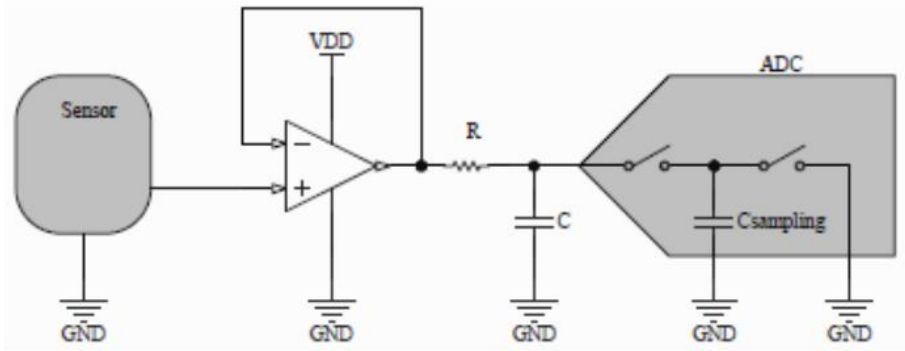
Market & Applications

- Sensor Signal Conditioning
- Active Filter Circuits high-Impedance Buffers
- High-Impedance Buffers
- Automotive Q1 Qualification
- Solenoid applications

Industry Standard Pin Outs



Applications

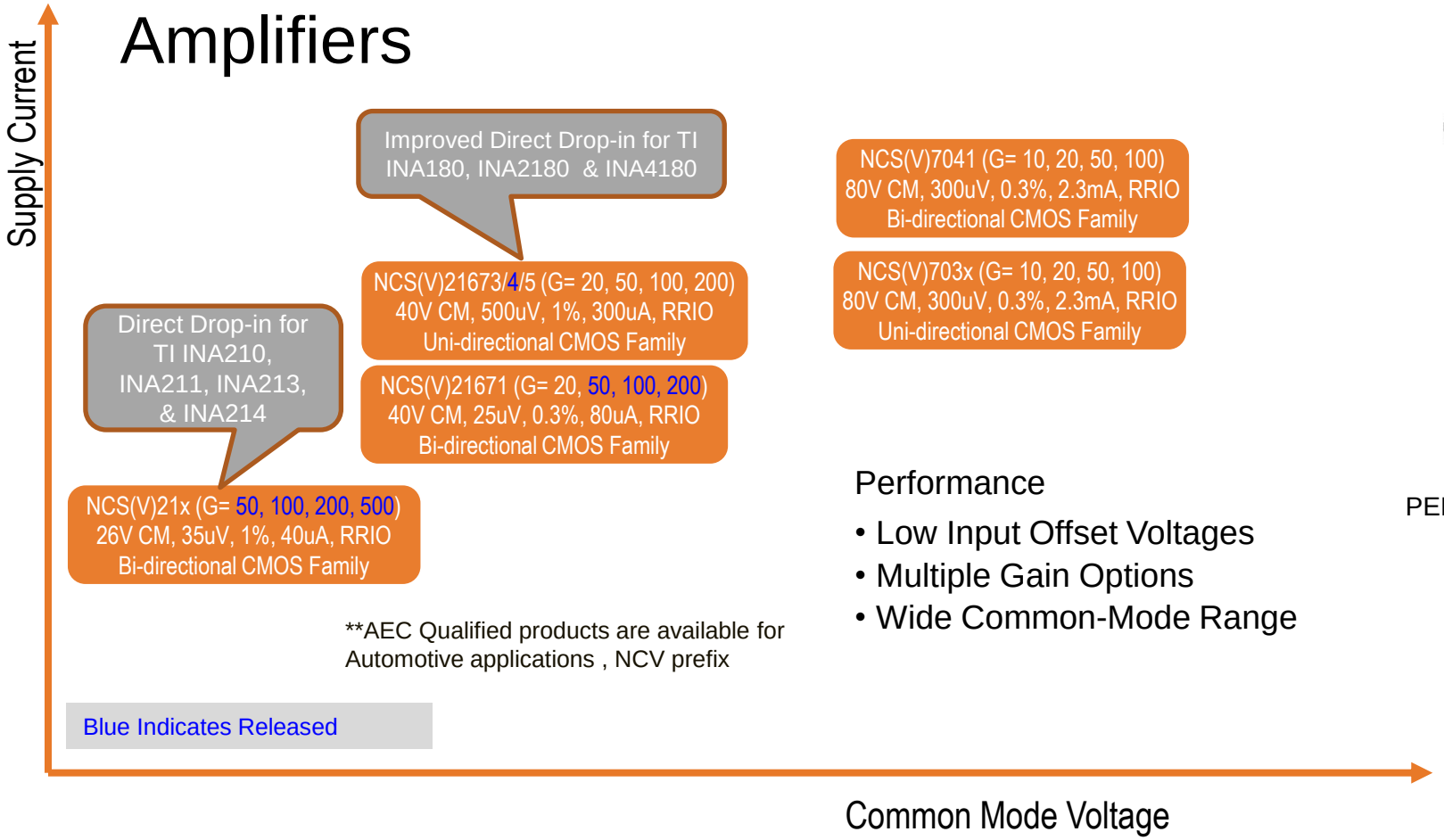


Unity Gain Buffer Stage for ADC Sampling and signal conditioning.

NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

Current Sense Amplifiers (Integrated Resistors)

5 Families of Current Sense Amplifiers

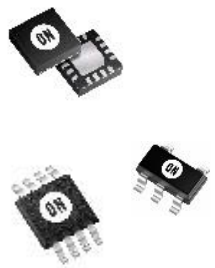


**AEC Qualified products are available for Automotive applications , NCV prefix

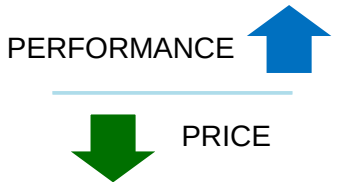
Blue Indicates Released

Performance

- Low Input Offset Voltages
- Multiple Gain Options
- Wide Common-Mode Range



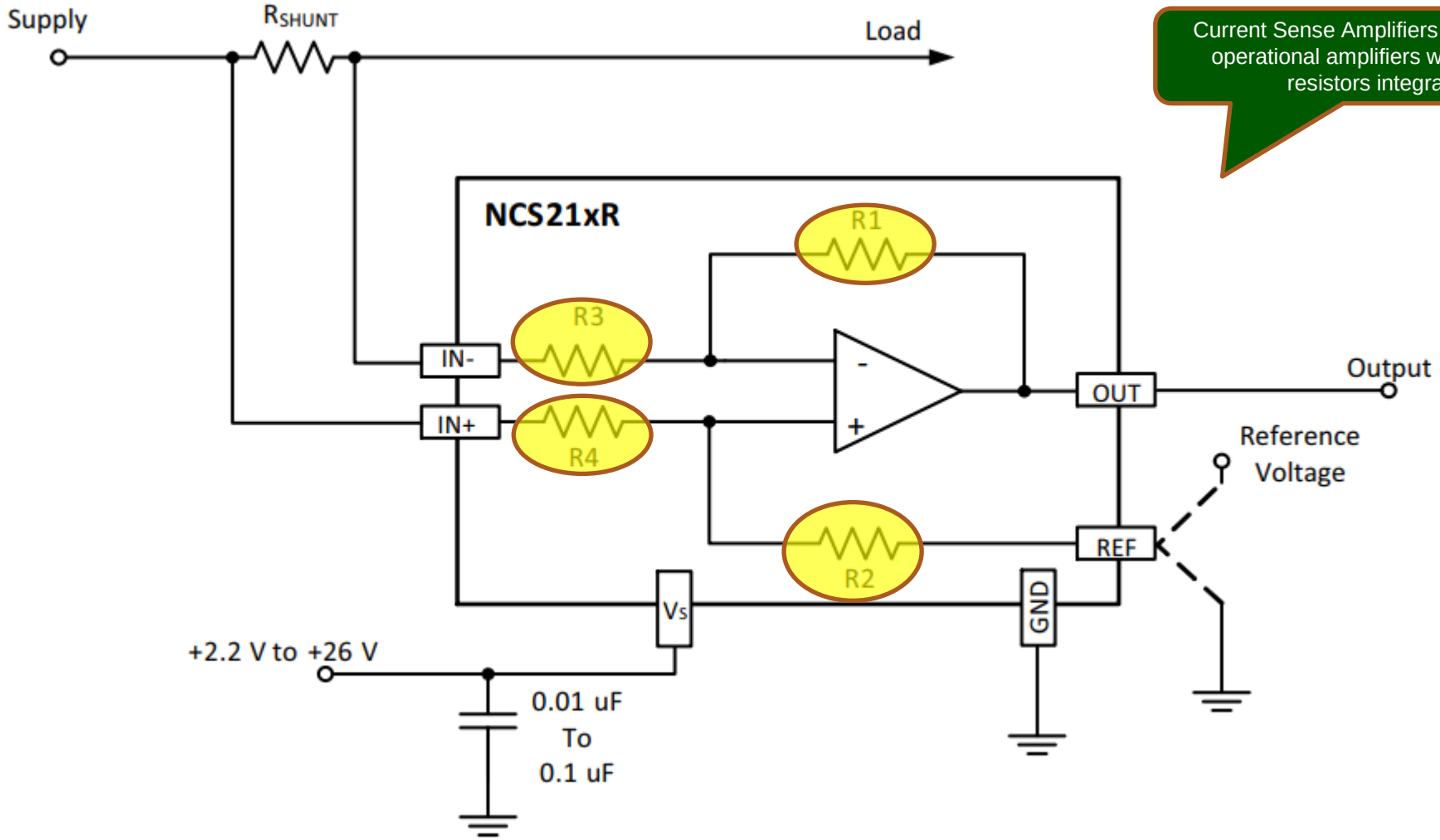
Space Saving Packages



Good Price to Performance Balance

Current Sense Amplifiers

Architecture



Design Considerations– Low Side or High Side?

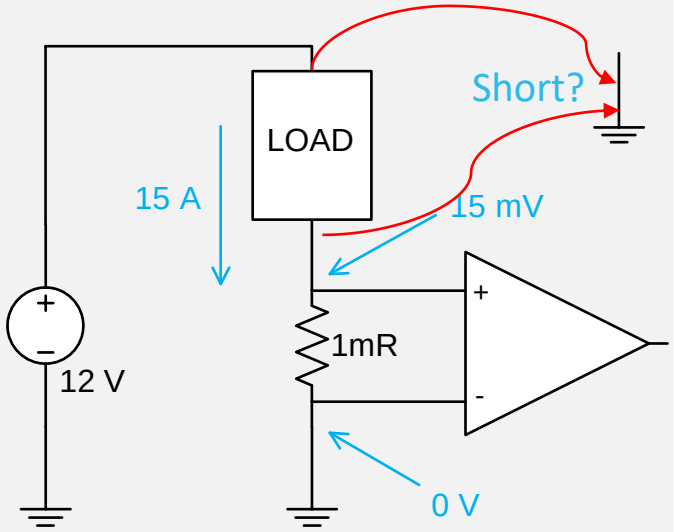
Low Side Sensing

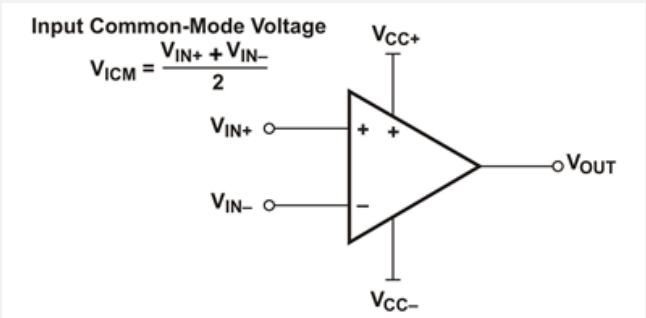
PROs

- Simple, Inexpensive
- Standard Op Amps can be used, current sense amplifiers have advantages

CONs

- Cannot detect Load & high side shorts
- Cannot be used if load's ground is the device's metal body/fixing screws/shielding case
- Opamp's common mode range must include GND





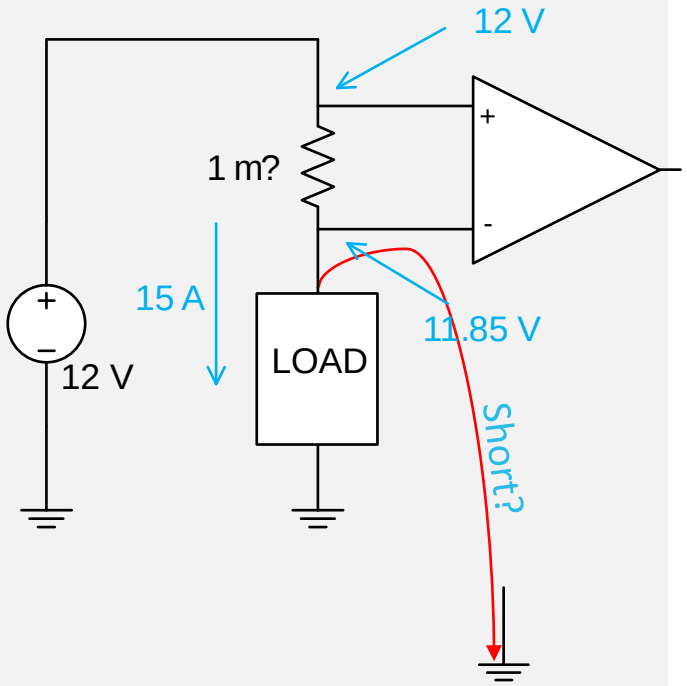
High Side Sensing (High CM Voltage)

PROs

- Detects load shorts and Grounded Load

CONs

- More difficult than low side sensing…until the advent of current sense amplifiers!
- Opamp's common mode range must include GND and Supply voltage



Input Bias Current	V_{SENSE} = 0 mV	I_{IB}			60	µA
Common-Mode Input Voltage Range		V_{CM}	-0.3		26	V

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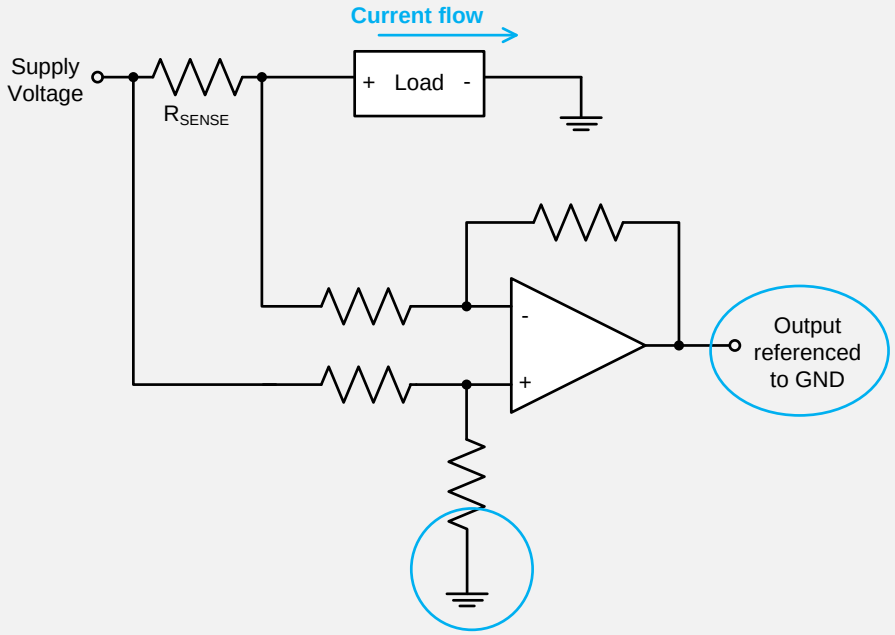
Design Considerations: Current Sensing Direction

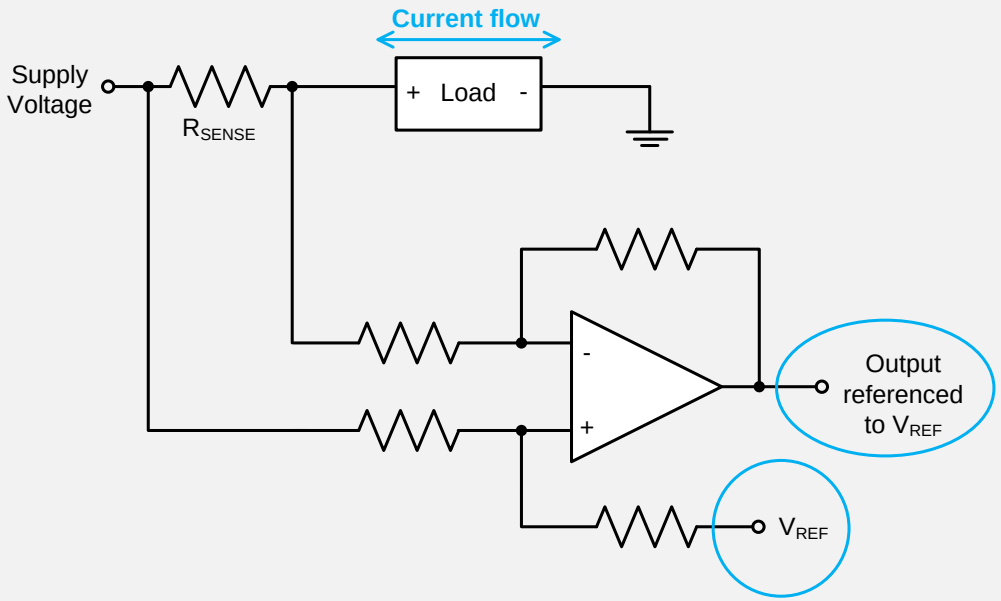
Unidirectional

- Current flows only one direction
- Used to measure load current
- Output voltage swings from zero to positive values



Bidirectional

- Battery charge/discharge
- Output voltage must swing two directions from origin
- Current flows in both directions



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Precision Amplifiers and Current Sense Amplifiers

Precision Amplifiers	Current Sense Amplifiers
Very low input offset voltage (10µV)	Low input offset voltage (35µV)
Precision, matched resistors must be used to set the gain in order to minimize V_{OS} and gain error	Integrates gain resistors, minimizing V_{OS} and gain error
Larger PCB footprint after adding external resistors	Smaller PCB footprint (e.g. SC70-6)
Gain can be adjusted with external resistors	Gain is usually fixed

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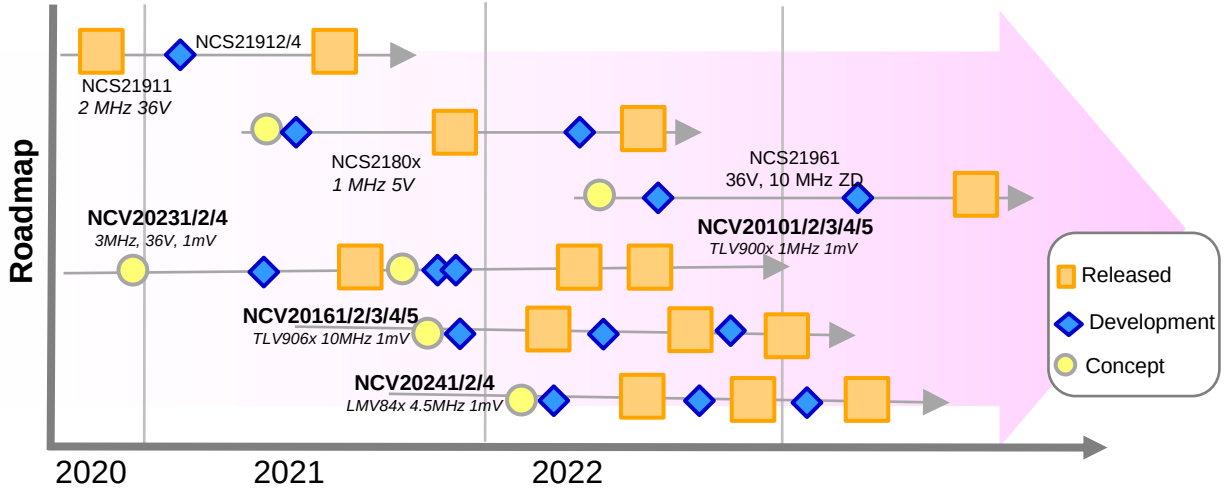
Low Power / Precision Opamp

- Higher precision to meet higher accuracy signal conditioning for ADC
- Performance advantage of Zero-Drift and Trimmed Amplifiers provide customers with varied choices for different price points
- Small Form Factors to address small board sizes
- Competitive landscape shows a growing presence in the 200uV to 950 uV Offset voltage range
- TI offering ZD in higher bandwidths targeting niche markets, nonetheless, have developed IP to set the trend for Zero-Drift Amps

PRODUCT ROADMAP



Low Power & Precision Op Amp Summary

Strategy:

- Fill portfolio gaps in 1mV offset amplifiers for both 5V and 36V.
- Promote and push the "*Super 8*" products to existing customers
- Expand the Zero-Drift and ONIPP Portfolio by addressing sweet spots targeted to meet broad application needs

Competitive Enablers

- We would offer the best cost to performance value (also true for Precison and CSA)
- Smaller package offering
  - Leadless package offering

Support Needed

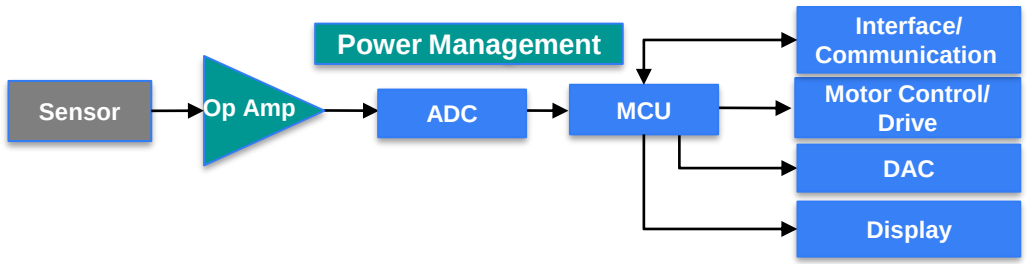
- PUSH Super-8 products and Zero Drift in Current Sensing in BMS, OBC, Seat/Mirror/ Peddle Positioning, Climate control, Automotive Sensor Applications, Infotainment,

New Product Introduction

Family	Status	OPN	Description
Low Power	Released	NCV272/274	36V, 3 MHz General Purpose Amplifiers
	Released	NCV20166	5V, 10 MHz, 1 mV Offset, Op Amp
	Sampling	NCV20064/84/94	5V, 350kHz to 3 MHz, Op Amps
Precision	In Dev	NCS2023x	36V, 3 MHz, 1mV Offset Op Amp
	Released	NCV21911/2/4	36V, 3 MHz Zero-Drift Amplifiers
	Released	NCV21871/2/4	5V, 350 kHz, Zero-Drift Amplifiers
	Sampling	NCV21802	5V, 1.5 MHz Zero-Drift Amplifiers

Expanding the Portfolio with New Op Amps

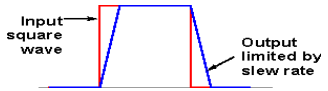
Addressing signal conditioning needs in wide variety of applications



Low Power Op Amps

P/N	Product Description
NCS2005	1.3mA, 8.5MHz, **RRIO**, 6mV Max V_{IO}, **V_S=2.2V – 32V**
NCS2006x[NEW]	**140µA**, 3MHz, RRIO, 3mV Max V_{IO}, V_S=1.8V – 5.5V
NCS2007x	400µA, 3MHz, RRO, 3mV Max V_{IO}, **V_S=2.7V – 36V**
NCS2008x [NEW]	**50µA**, 1MHz, RRIO, 3mV Max V_{IO}, V_S=1.8V – 5.5V
NCS2009x[NEW]	**20µA**, 350KHz, RRIO, 3mV Max V_{IO}, V_S=1.8V – 5.5V
LM7301	600µA, 4MHz, **RRIO**, 6mV Max V_{IO}, **V_S=1.8V – 32V**
NCV952	750µA, 3.5MHz, **RRIO**, 8mV Max V_{IO}, **V_S=2.7V – 26V**

High Slew Rate Op-Amps



P/N	Product Description
NCS2003x	**8.5V/µs SR**, 7MHz, RRO, 20nV/rtHz Noise, V_S=1.8V – 5.5V

Low Power Comparators

P/N	Product Description
NCS3402	18µs tPHL, **0.47µA Icc**, Open Drain, Dual, V_S=2.5V – 16V
TS391	0.35µs tPHL, 0.5mA Icc, Open Drain, Single, **V_S=2V – 36V**
TS393	0.8µs tPHL, **9µA Icc**, Open Drain, Dual, **V_S=2.7V – 16V**
NCS2202A	0.5µs tPHL, **9µA Icc**, Open Drain, Single, RRIO, V_S=0.85V – 6V
NCS2250[NEW]	**74ns tPHL**, 80µA Icc, Push Pull, Single, RRIO, V_S=1.8V – 5.5V

Zero Drift Precision Op-Amps

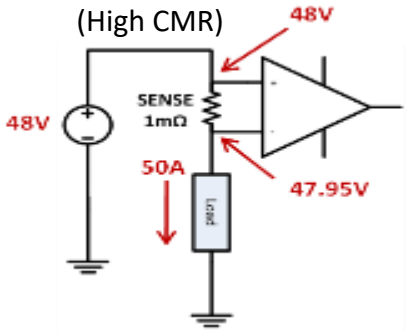
P/N	Product Description
NCS325	**50µV Max V_{IO}, 0.250µV/°C**, 350 kHz, RRIO, V_S=1.8V – 5.5V
NCSx333[NEW]	**30µV Max V_{IO}, 0.070µV/°C**, 350 kHz, RRIO, V_S=1.8V – 5.5V
NCS21911[NEW]	**25µV Max V_{IO}, 0.085µV/°C**, 2 MHz, RRO, V_S=4.0V – 36V

Current Sense Amplifiers with Wide CMV

P/N	Product Description
NCS21xR[NEW]	**V_{CMR} = -0.3V to 26V**, Gain Error = 1.0%, 140dB CMRR, 35 µV V_{IO}
NCS199AxR[NEW]	**V_{CMR} = -0.3V to 26V**, Gain Error = 1.5%, 120dB CMRR, 150µV V_{IO}

High Side Current Sensing

(High CMR)



Advantages

- Detects load shorts
- No ground path resistance

Disadvantages

- More expensive than low side sensing (primarily due to high voltage process)

New Products released within past 18 months

In Development: NCS(V)7041 - Bidirectional

Value Proposition

The NCS(V)7041 is a high voltage, high resolution, bidirectional current sense amplifier. It features gain options of 14/20/50/100 V/V, with a max. ±0.3% gain error over -40 °C to 125 °C . The part consists of a preamplifier and buffer with access to output and input via A1 and A2 pins for an intermediate filter network or modified gain. The NCS(V)704x can perform bi- or unidirectional current measurements across a sense resistor with excellent common-mode rejection from -5 V to 80 V.

Unique Features

- Common-Mode Range: -5 V to 80 V
  -14 to 85 V survivable
- Offset Voltage: 300 µV (Max.)
- Offset Drift: 3 µV/°C
- Gain Error: ±0.3% (Max.)
- Supply: 4.5 V to 5.5 V

Benefits

- The wide Common-Mode Range which includes ground provides for better transient response from inputs.
- The Vref pin allows the output signal to be ground, Vs referenced for bi-directional operation.

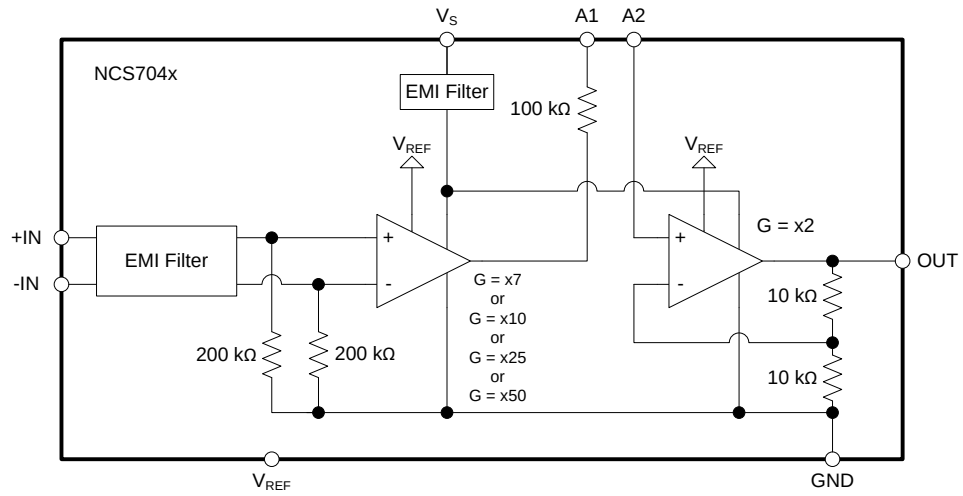
Others Features

- CMRR (DC): 90dB, (AC): 90dB up to 20kHz
- Bandwidth: 100 kHz
- Slew Rate: 1 V/µs
- Gain Options: 14 V/V, 20 V/V, 50 V/V, and 100 V/V
- Quiescent Current: 3 mA

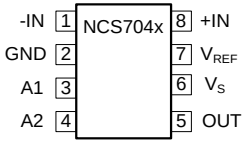
Market & Applications

- Telecom Equipment
- Power Supply Designs
- Diesel Injection Control
- Automotive
- Motor Control
- Solenoid applications

Device Block Diagram



Packages/ Pin Outs



MICRO-8
SOIC-8

Product	Gain
NCS(V)7041xxG14	14 V/V
NCS(V)7041xxG20	20 V/V
NCS(V)7041Gxx50	50 V/V
NCS (V)7041xxG100	100 V/V

*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

Just Released!!! NCS(V)21673/4/5 (Multiple Channels)

Value Proposition

The NCS21673/4 are precision current sense amplifiers featuring low input offset voltage and low offset drift over time and temperature. With gains of 20, 50, 100 and 200V/V, these devices can measure voltage across shunts at common mode voltages from -0.1V to 40V. They operate from 2.7V to 5.5V and are available in space saving packages.

Unique Features

- Wide common mode input range: -0.1 V to 40 V
- Supply voltage range: 2.7 V to 5.5 V
- Low offset voltage: ±100 μV
- Low offset drift: ±1 μV/°C max
- Low gain error: ±1 % max
- Low current consumption: 300 μA max per channel

NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

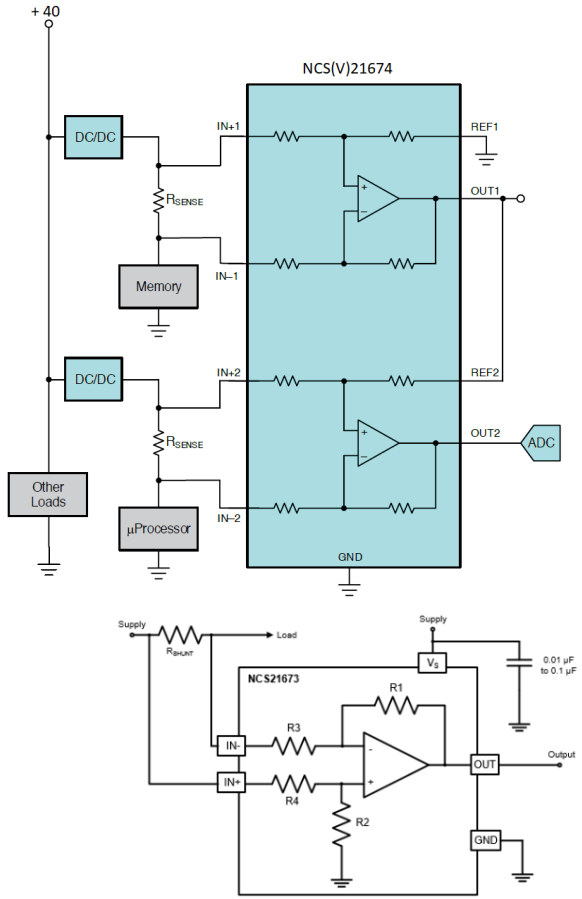
Benefits

- High bandwidth of 350 kHz and slew rate which allows for fast detection in the changes of current
- When current is sensed in multiple points in a system, a multichannel solution offers space and cost savings
- Wide common mode ranges independent of the supply voltage is helpful to measure not only fast transients but also be used for both high side and low side current sensing.

Market & Applications

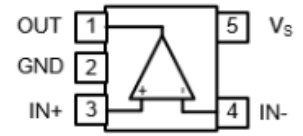
- Thermal Management Circuits
- Transducer Applications
- Current Sensing in Motor Control, Lighting etc.
- Power Supplies
- Battery Powered/ Portable Applications
- Electronic Scales, Wheatstone Bridges
- Instrumentation in Medical and Industrial
- Automotive
- Telecom
- Industrial
- Computing
- Medical

Typical Application diagram



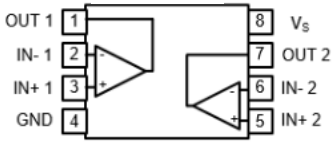
Packages/ Pin Outs

NCS21673



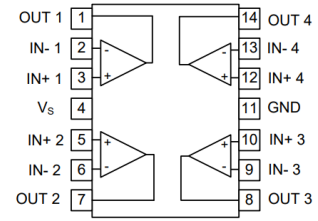
Single Channel

NCS21674



Dual Channel

NCS21675



Quad Channel

In Development: NCS(V)21671 (Integrated Filtering)

Value Proposition

The NCS21671 are a series of voltage output current sense amplifiers offered in gains of 25, 50, 100, and 200 V/V. These parts can measure voltage across shunts at common mode voltages from −0.1 V to 40 V, independent of supply voltage. The low offset of the zero−drift architecture enables current sensing with maximum drops across the shunt as low as 10 mV full−scale. These devices can operate from a single +1.7 V to +5.5 V power supply, drawing a maximum of 40 μA of supply current.

Unique Features

- Wide Common Mode Input Range: - 0.1 V to 40 V
- Supply Voltage Range: 1.7 V to 5.5 V
- Low Offset Voltage: ±25 μV max
- Low Offset Drift: 0.5 μV/ºC
- Low Gain Error: ±0.3% max

Benefits

- An enable function is provided to reduce current drain through the input pins and power supply pins to negligible levels.

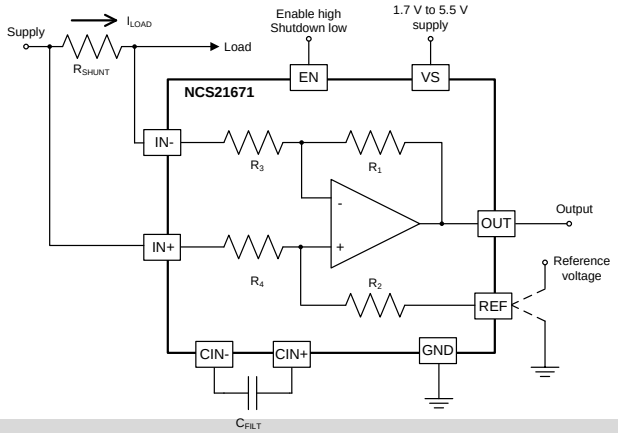
Others Features

- CMRR (DC): 114
- Bandwidth: 20, 30, 40 kHz
- Slew Rate: Typ 0.4 V/μs
- Gain Options: 25, 50, 100, and 200 V/V
- Quiescent Current: 50 μA max
- Optional Input Filtering: Add External Capacitor to Set Cutoff Frequency
- Enable

Market & Applications

- High−Side Current Sensing
- Low−Side Current Sensing
- Difference Amplifier
- Telecom
- Power Management
- Battery Charging and Discharging
- Automotive

Typical Application diagram



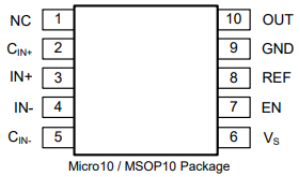
Packages/ Pin Outs

Industrial and Consumer

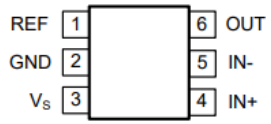
Package	GAIN	Enable	Filter Pins	Part Number
SC70-6	25	No	No	NCS21671SQ025T2G
	50			NCS21671SQ050T2G
	100			NCS21671SQ100T2G
	200			NCS21671SQ200T2G
Micro10	25	Yes	Yes	NCS21671DM025R2G
	50			NCS21671DM050R2G
	100			NCS21671DM100R2G
	200			NCS21671DM200R2G

Automotive Grade1 Qualified

Package	GAIN	Enable	Filter Pins	Part Number
SC70-6	25	No	No	NCV21671SQ025T2G
	50			NCV21671SQ050T2G
	100			NCV21671SQ100T2G
	200			NCV21671SQ200T2G
Micro10	25	Yes	Yes	NCV21671DM025R2G
	50			NCV21671DM050R2G
	100			NCV21671DM100R2G
	200			NCV21671DM200R2G



Micro10 / MSOP10 Package



SC70-6 Package

NC denotes no internal connection. Pins can be left floating/connected to voltage between VS and GND.

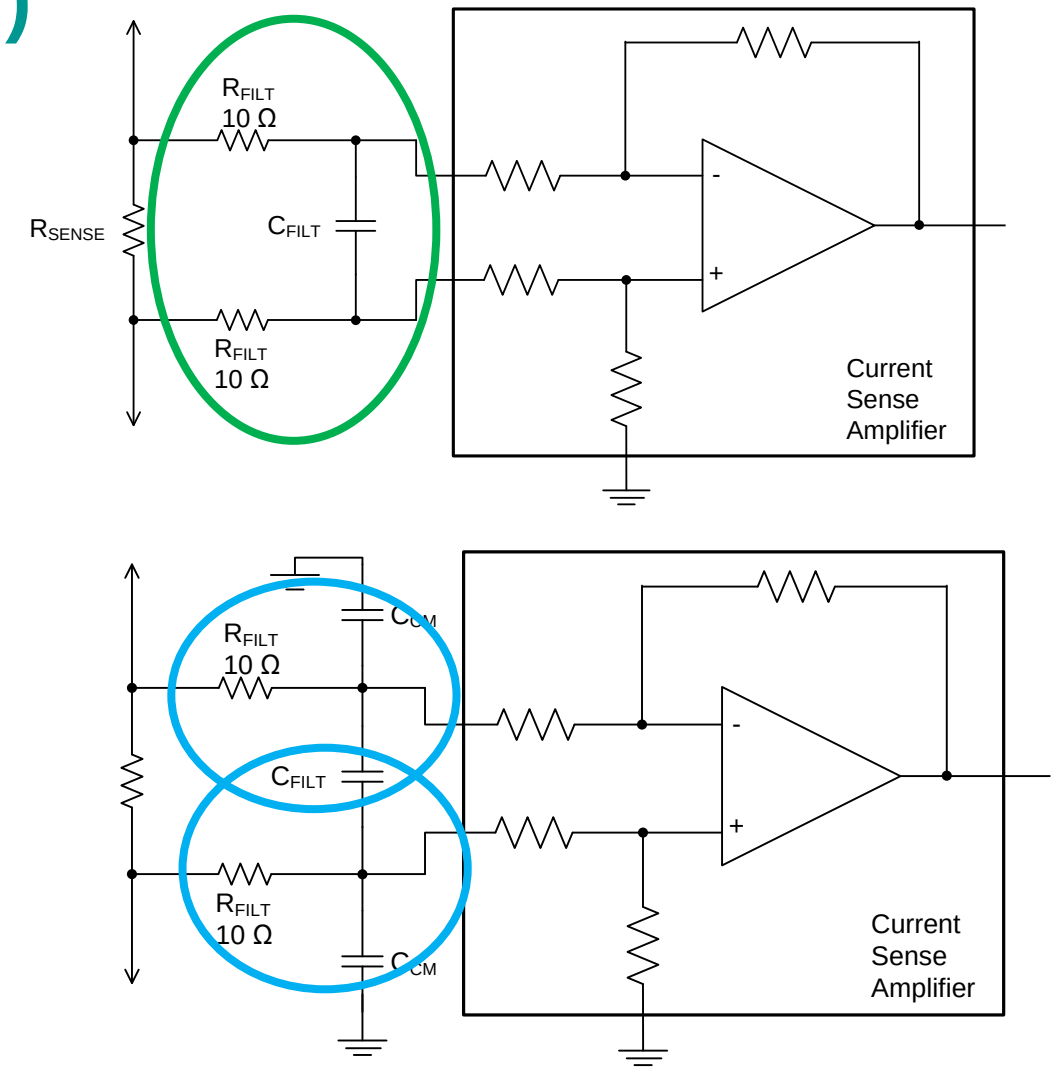
NCS21671 (Integrated Input Filtering)

Differential Mode Filtering is often necessary because of noise

- Eliminates unwanted high frequency signals before entering the amplifier
  - Prevents input overload
  - Prevents aliasing
- Requires a differential configuration with 2 resistors
- Resistor values are restricted to low values, e.g. 10Ω

Common-Mode Filtering is most often needed for very high frequency and RF suppression (EMI)

- Not as frequently needed as differential mode
- At low frequencies, requires matched capacitors



External input filtering resistors mismatch could potentially add additional offset at the inputs and also degrade the CMRR performance.

NCS21671 takes advantage of the precision SiCr process to provide highly matched input filter and gain setting resistors integrated on-chip improving CMRR.

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In Development: NCS(V)7041 - Bidirectional

Value Proposition

The NCS(V)7041 is a high voltage, high resolution, bidirectional current sense amplifier. It features gain options of 14/20/50/100 V/V, with a max. ±0.3% gain error over -40 °C to 125 °C . The NCS(V)704x can perform bi- or unidirectional current measurements across a sense resistor with excellent common-mode rejection from -5 V to 80 V. The wide Common-Mode Range which includes ground provides for better transient response.

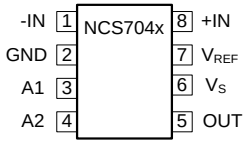
Unique Features

- Common-Mode Range: -5 V to 80 V
  -14 to 85 V survivable
- Offset Voltage: 300 µV (Max.)
- Offset Drift: 3 µV/°C
- Gain Error: ±0.3% (Max.)
- Supply: 4.5 V to 5.5 V
- CMRR (DC): 90 dB
- Bandwidth: 100 kHz
- Slew Rate: 1 V/µs
- Quiescent Current: 3 mA

Market & Applications

- Telecom Equipment
- Power Supply Designs
- Diesel Injection Control
- Automotive
- Motor Control
- Solenoid applications

Packages/ Pin Outs



MICRO-8
SOIC-8

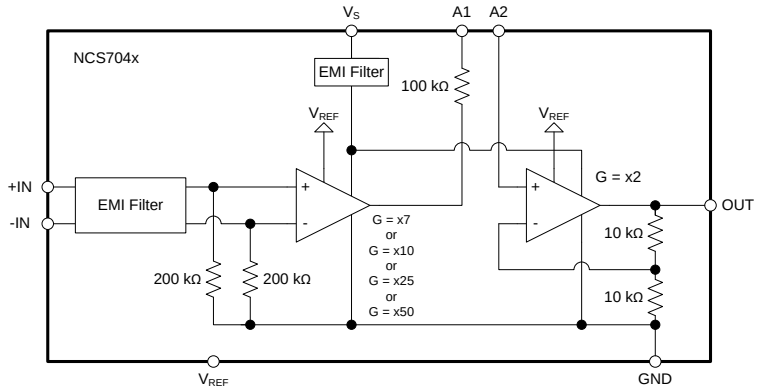
*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

Benefits

A1 and A2 pins also allow gains to be adjusted between fixed gain options

A1 and A2 pins allow an intermediate filtering network. A single or dual pole filter can be created to eliminate noise from the output gain stage, increasing the overall accuracy of the current measurements

The EMI filtering on the supply rails and the inputs eliminates the noise before it enters the signal chain

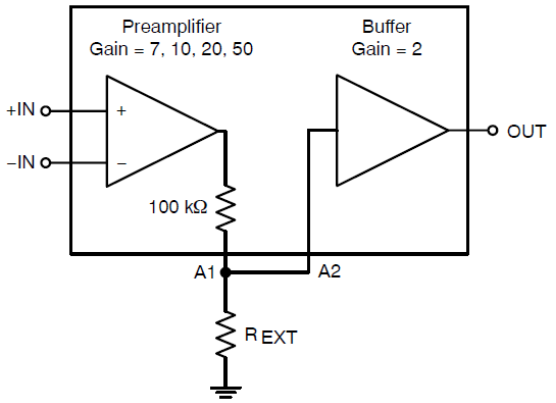


The Vref pin allows the output signal to be ground, Vs referenced for bi-directionality

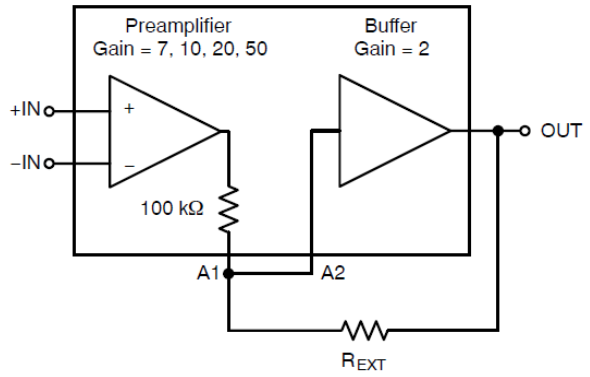
NCS(V)703x & NCS(V)7041 “80V Common Mode”

Device Functionality Overview

- Separated Amplifier Stages Gain Adjustment:
  - By separating the two stages the gain can be decreased are increase with a single resistor. This is similar to setting gains using feedback resistors in classic op-amps.
  - When fixed gains meet application requirements pins A1 & A2 are simply tied together.

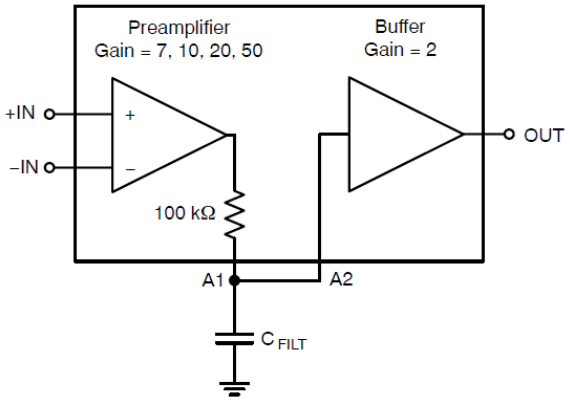


Lower Gain

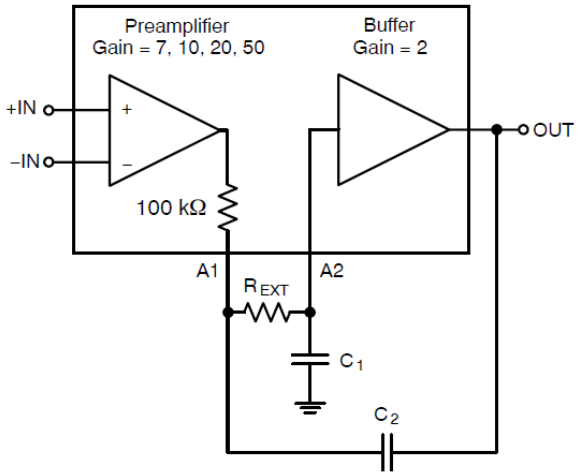


Higher Gain

- Separated Amplifier Stages Filtering:
  - By separating the two stages filtering can be added before the buffer stage to improve precision by improving the signal to nise ratio.
  - When the application does not require filtering pins A1 & A2 are tied together.



Single-Pole Low Pass



Two-Pole Low Pass

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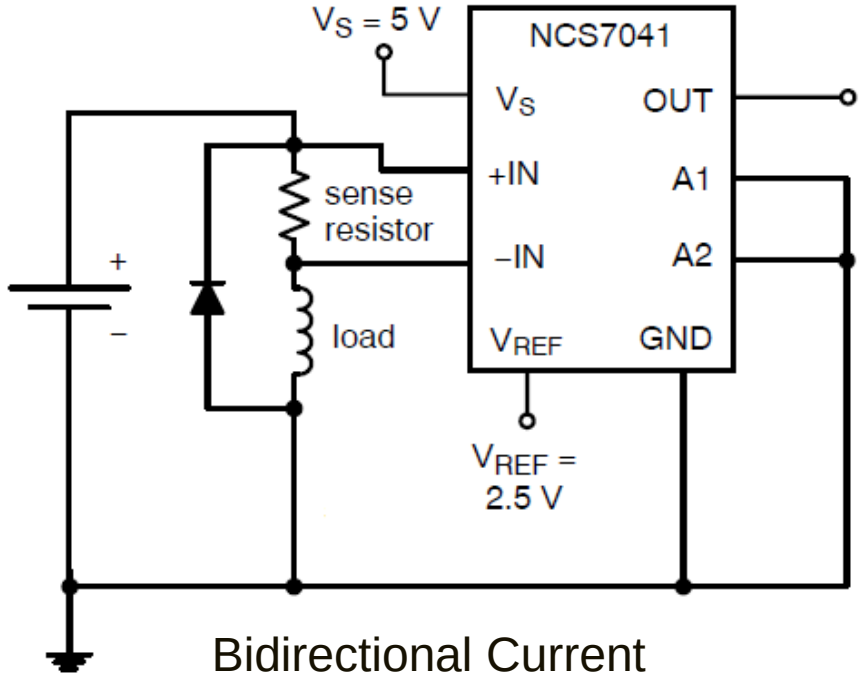
NCS(V)703x & NCS(V)7041 “80V Common Mode”

Device Functionality Overview

- NCS(V)7041 Bidirectional Capability:
  - In many systems and applications, the requirement is to measure current flowing in both directions. Example: Electric Vehicle charging and discharging.
  - The voltage reference pin (Vref) can be set halfway between the positive supply (Vs) and ground (GND) This allows the polarity of the input to swing positive and negative.
- Performance Improvements of both NCS(V)703x & NCS(V)7041
  - These devices utilize Zero-Drift amplifier architecture providing significant improvements in precision vs similar competition devices. Input offset voltage is improved and input offset voltage drift with temperature is minimized.
  - This architecture also improves precision over time and operating voltage changes. Providing system designers with stable operation for the life of their system design.
  - The improved bandwidth provides faster response to current level changes improving system level performance.



Bidirectional Current Sense

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NCS210R/211R/213R/214R

www.onsemi.com/NCS210

Value Proposition

The NCS21x and NCV21x are voltage output current shunt monitors that can measure voltage across shunts at common−mode voltages from −0.3 V to 26 V, independent of supply voltage. Four fixed gains are available: 50 V/V, 100 V/V, 200 V/V 500V/V. The low offset of the zero−drift architecture enables current sensing with maximum drops across the shunt as low as 10 mV full−scale

Unique Features

- Wide Common−Mode Input Range: −0.3 V to 26 V
- Supply Voltage Range: 2.2 V to 26 V
- Low Offset Voltage: ±35 μV max
- Low Offset Drift: 0.5 μV/°C
- Low Gain Error: 0.2% typ., 1% max
- Load dump capability up to 30 V

Benefits

- The wide Common-Mode Range which includes ground provides for better transient response at the inputs.

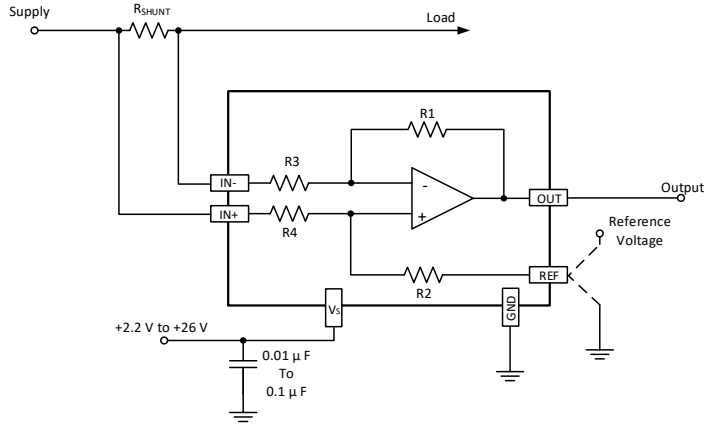
Others Features

- CMRR (DC): >100 dB, (AC): >90 dB up to 20kHz
- Bandwidth: 90 kHz
- Slew Rate: 1 V/μs
- Gain Options: 50 V/V, 100 V/V, 200 V/V and 500 V/V
- Quiescent Current: 80 μA max

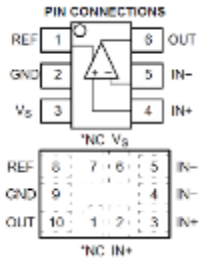
Market & Applications

- Telecom Equipment
- Automotive
- Sensors
- Power Management
- Battery Charging and Discharging

Typical Application diagram



Packages/ Pin Outs

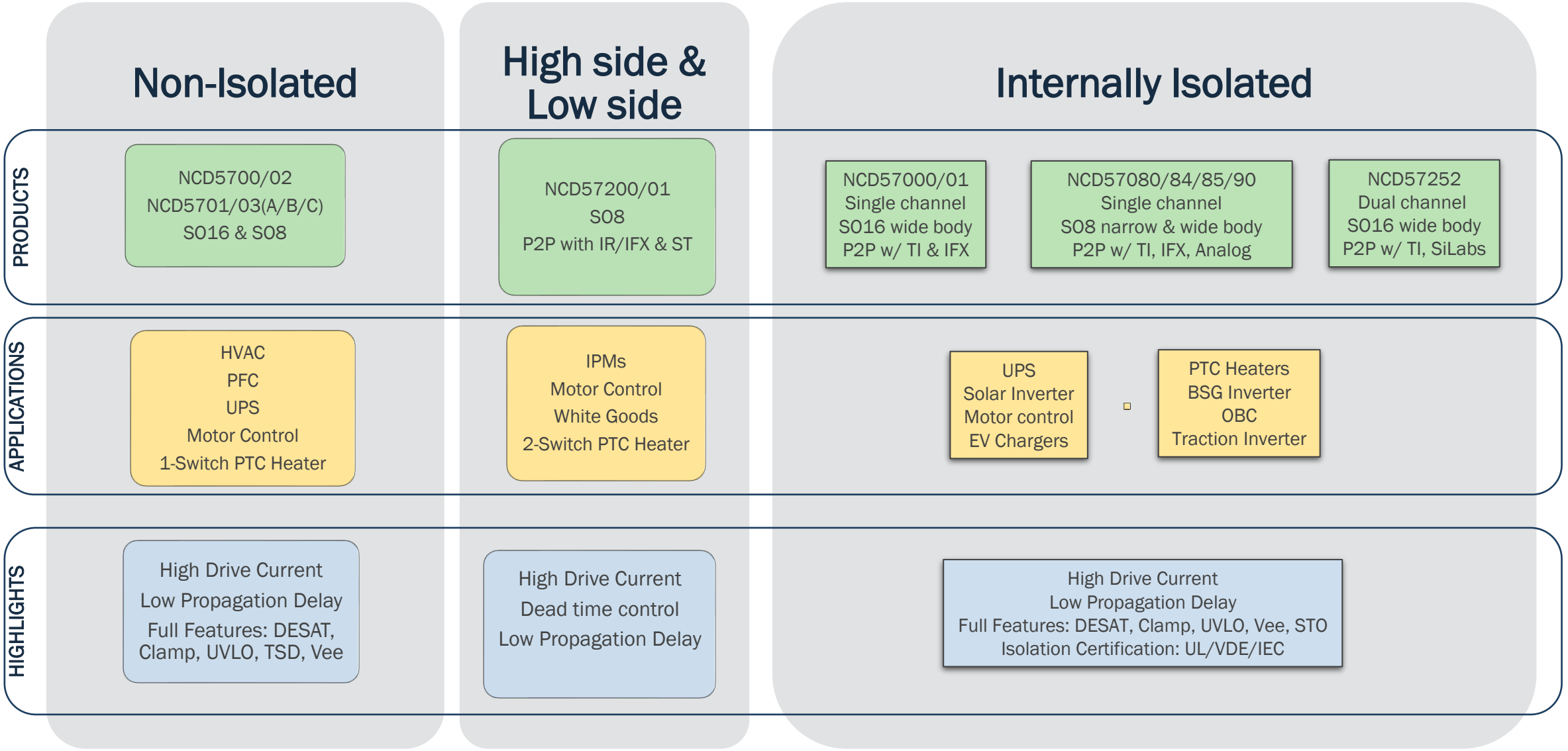


Product	Gain	R3-R4	R1-R2
NCS210	200	5 kΩ	1 MΩ
NCV210	200	5 kΩ	1 MΩ
NCS211	500	2 kΩ	1 MΩ
NCS213	50	20 kΩ	1 MΩ
NCV213	50	20 kΩ	1 MΩ
NCS214	100	10 kΩ	1 MΩ
NCV214	100	10 kΩ	1 MΩ

- *NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

Gate Drivers

High Voltage IGBT Gate Drivers



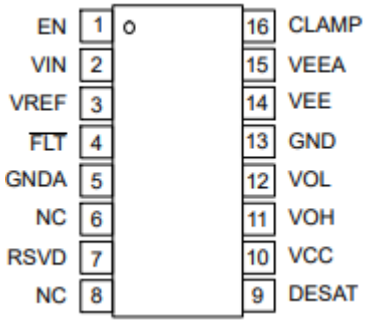
Gate Drivers OPN Selection Guide

	Specs/Features							Target Applications								
								Automotive				Industrial/Consumer				
	No. of channels	Isolation	Differential Input	DESAT w/ FLT	Miller Clamp	VEE	Split output	Traction	PTC	OBC	HV DC-DC	IH	UPS	Solar	Motor Control	HVAC
NCDV)5700/2	1			V	V	V	V	V	V							
NCD(V)5701/3A	1			V	V			V	V	V	V	V	V		V	
NCD(V)5701/3B	1			V		V		V	V	V	V	V	V		V	
NCD(V)5701/3C	1			V			V	V	V	V	V	V	V		V	
NCD(V)57000/1	1	V	V	V	V			V	V					V	V	V
NCD(V)57080A	1	V	V		V					V	V	V	V			V
NCD(V)57080B	1	V	V			V				V	V	V	V			V
NCD(V)57080C	1	V	V				V			V	V	V	V			V
NCD(V)57090A	1	V	V		V								V	V	V	
NCD(V)57090B	1	V	V			V							V	V	V	
NCD(V)57090C	1	V	V				V						V	V	V	
NCD(V)57084	1	V		V					V				V			
NCD(V)57085	1	V		CS w/FLT					V				V			
NCD(V)57252	2	V								V	V			V		V
NCD(V)57200/1	2									V	V	V	V			V

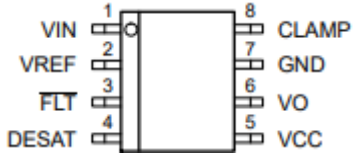
1/17/2023

Non-Isolated 1-Channel Gated Drivers

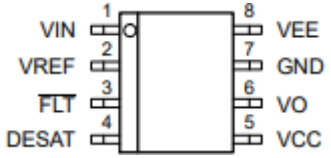
IGBT Gate Drivers (Non-Isolated)								
OPN	**Versions**	**Key Feature(s)**	**Package Type**	**Samples**	**Release Date**	**Datasheet**	**App Note**	**Demo Board**
NCD(V)5700		**High Current IGBT Gate Driver, Full Featured**	**SOIC 16-Narrow Body**	**Production**	**Released**	**onsemi.com**	**Released**	**Available**
NCD(V)5701	A / B / C	IGBT 8-pin driver, narrow body	SOIC 8-pin Narrow Body	Production	Released	onsemi.com	Released	Available
NCD(V)5702		**5700 with open-drain (vs. active low) FAULT output**	**SOIC 16-Narrow Body**	**Production**	**Released**	**onsemi.com**	**Released**	**Available**
NCD(V)5703	A / B / C	5701 with open-drain (vs. active low) FAULT output	SOIC 8-pin Narrow Body	Production	Released	onsemi.com	Released	Available
NCD(V)5703	D	5703C with Enable	SOIC 8-pin Narrow Body	Production	Released	onsemi.com	Released	Available
NCD(V)5705B		5703B with Lower UVLO	SOIC 8-pin Narrow Body	Production	Released	onsemi.com	Released	Available
NC(V)5707	A / B / C	IGBT 8V/7V UVLO	SOIC 8-pin Narrow Body	Production	Released	onsemi.com	Released	Available



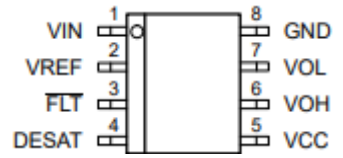
NCD(V)5700/5702/5706



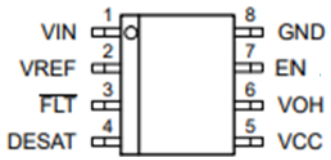
NCD(V)5701/5703
A: Active Miller Clamp



NCD(V)5701/5703
B: Negative Output Voltage



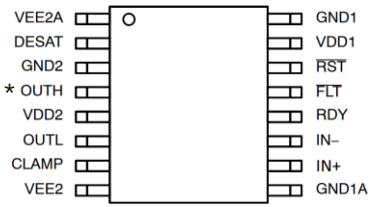
NCD(V)5701/5703/5707
C: Separate V_{OL}/V_{OH} Outputs



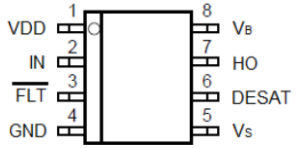
NCD(V)5703
D: With Enable Pin

Isolated 1-Channel Gated Drivers

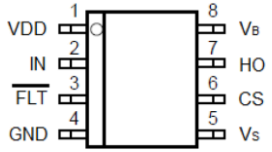
IGBT Gate Drivers (1-Ch Isolated)							
OPN	**Key Feature(s)**	**Pkg Type**	**UVLO (V)**	**T_{PD} (ns)***	**Samples**	**RTM Status**	**Demo Board**
NCD(V)57000	**Full Featured IGBT Driver w/ DeSat**	**SOIC-16 Wide**	**12.2 to 12.8**	**60**	**Available**	**Released**	**Available**
NCD(V)57001	**Full Featured IGBT Driver w/ Current Sense**	**SOIC-16 Wide**	**12.2 to 12.8**	**60**	**Available**	**Released**	**Available**
NCD(V)57080 A/B/C	Single Feature IGBT Driver in (Wide Body) *Active Miller Clamp, Negative Output, Separate Vol / Voh Outputs*	SOIC-8 Wide	11.5 to 12.5	60	Available	Released	Available
NCD(V)57090 A/B/C D/E/F	Single Feature IGBT Driver in (Narrow Body) *Active Miller Clamp, Negative Output, Separate Vol / Voh Outputs*	SOIC-8 Narrow	11.5 to 12.5	60	Available	Released	Available
NCD(V)57084	Single Feature IGBT Driver in (Wide Body) *DeSat Protection*	SOIC 8 Narrow	11.5 to 12.5	60	Available	Released	Available
NCD(V)57085	Single Feature IGBT Driver in (Wide Body) *Current Sense Protection*	SOIC 8 Narrow	11.5 to 12.5	60	Available	Released	Available



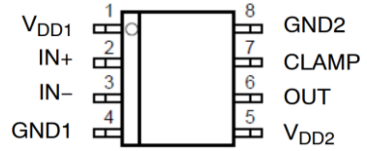
NCD(V)57000/01
*NCD(V)57000 only



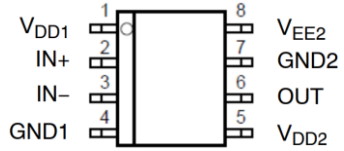
NCD(V)57084



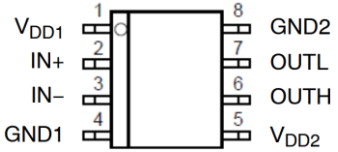
NCD(V)57085



Option A: Active Miller Clamp



Option B: Negative Output Supply



Option C: Separate V_{OL}/V_{OH} Outputs

Alternate Pinouts

Option D: Active Miller Clamp

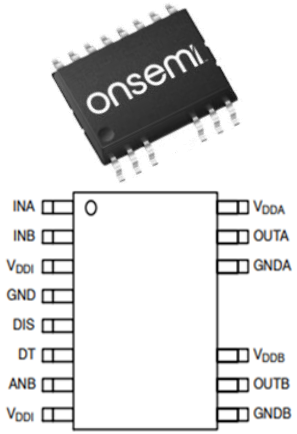
Option E: Separate V_{OL}/V_{OH} Outputs

Option F: Active Miller Clamp

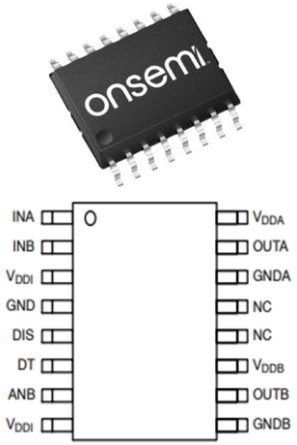
Isolated 2-Channel Gated Drivers

IGBT Gate Drivers (2-Ch Isolated)							
OPN	**Key Feature(s)**	**Package Type**	**UVLO (V)**	**T_{PD} (ns)***	**Samples**	**RTM Status**	**Demo Board**
NCD(V)57200	Half-Bridge with deadtime & interlocks	SOIC-8 Narrow	11.0 to 12.0	90 ns	Available	Production	Available
NCD(V)57201	Half-Bridge with two independent inputs	SOIC-8 Narrow	11.0 to 12.0	90 ns	Available	Production	Available
NCD(V)57252	Two-Channel Output IGBT Driver	SOIC-16 Wide	11.5 to 12.5	60 ns	Available	Production	Available
NCD(V)57255	Two-Channel Output IGBT Driver	SOIC-16 Narrow	11.5 to 12.5	60 ns	Available	Production	Available
NCD(V)57530	Two-Channel Output IGBT Driver	**SOIC-14 Wide**	11.5 to 12.5	60 ns	Available	Production	Available
NCD(V)57540	Two-Channel Output IGBT Driver	**SOIC-14 Wide**	11.5 to 12.5	60 ns	Available	Production	Available

***T_{PD} (ns, Out-H Typ @ 25C)**

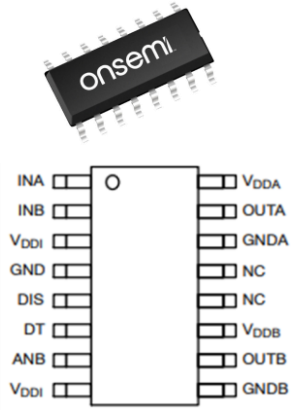


SOIC 14 Wide



SOIC 16 Wide

Length x Width	
10.3 x 7.5 mm	9.9 x 6.0 mm
V_{IORM} (Max Working Insulation Voltage)	
1200 V_{PK}	1200 V_{PK}
V_{IOTM} (Max Allowable Over Voltage)	
8400 V_{PK}	4200 V_{PK}
Creepage & Clearance	
8 mm	4 mm



SOIC 16 Narrow

NCD(V)57100/101 16-pin Isolated Gate Driver

Features

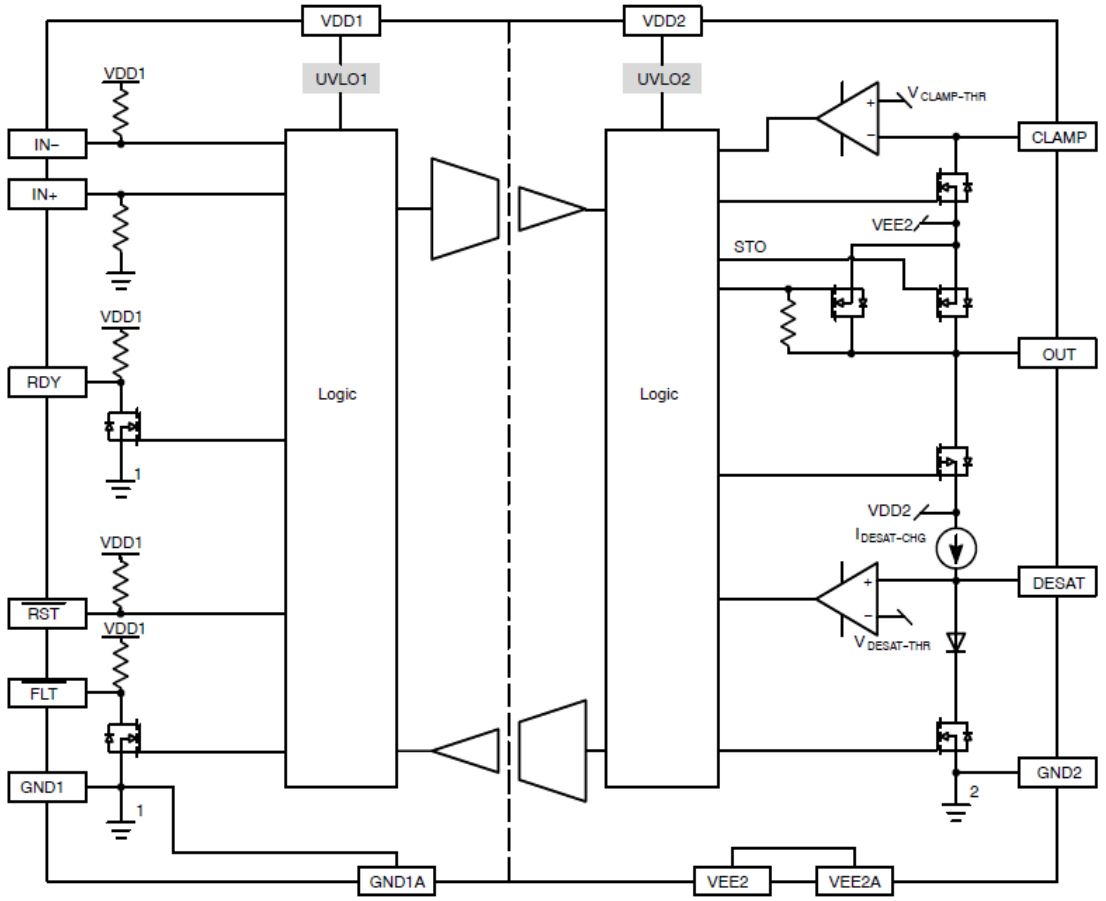
- High current (7 A / 7 A src/snk) at Miller Plateau Voltage
- Galvanic Isolation with >5 kV withstand & 1400 V working voltage
- CMTI > 100 kV/us @ 1300 V
- Typical 66 ns propagation delays
- Soft turn-off(2.4 us or 1 us options)
- Desat detect with programmable delay
- IGBT gate clamp during short circuit
- Miller clamp with high sink current
- Tight UVLO for IGBT safety
- Diagnostics
- UL1577 Recognized: File No. E509109, Vol .1

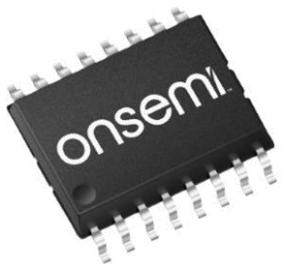
Markets & Applications

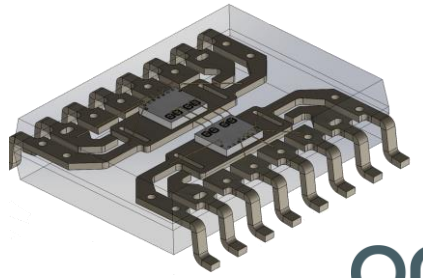
- Solar Inverters, Motor Drives, EV Chargers, Automotive Powertrain

Package / Options

- SOIC-16 Wide Body



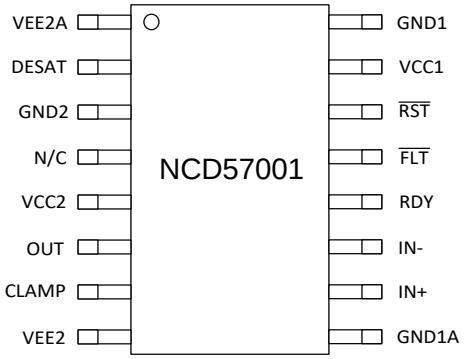


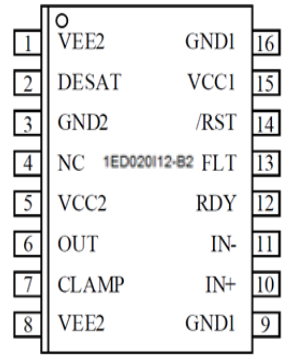


16 pin wide body isolated drivers – Specs & Pin-out

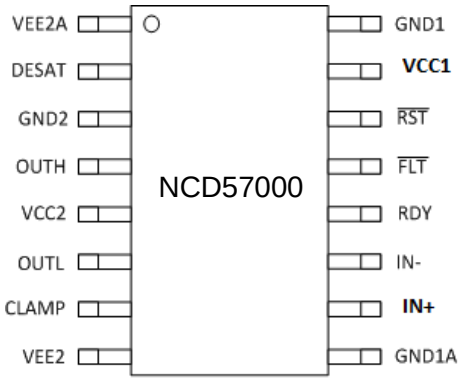
Parameter	Digital Isolated Drivers				Opto-Drivers
	ON NCD57000	Infineon 1ED020I12	TI ISO5852S	Analog ADuM4135	Avago ACPL-333J
Source Current	7.8Apk	2Apk	2.5Apk	4Apk	2.5Apk
Sink Current	7.1Apk	2Apk	5Apk	4Apk	2.5Apk
Prop. Delay	66ns	170ns	76ns	55ns	180ns
Delay Distortion (tpdoff-tpdon)	15ns	25ns	20ns	15ns	150ns
Isolation Voltage	5 KV	4.5 KV	5.7 KV	5 KV	5 KV
CMTI	100kV/us	50kV/us	100kV/us	100kV/us	50kV/us
Operating Temp	+125	+105	+125	+125	+105

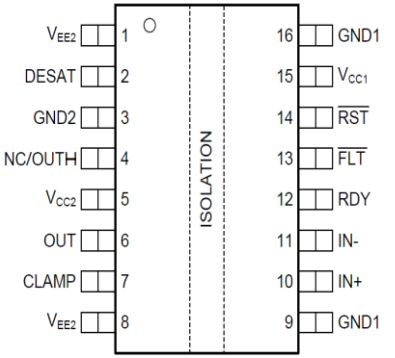
P2P w/ Infineon





P2P w/ TI





ISO5852S/ISO5851/ISO5452/ISO5451

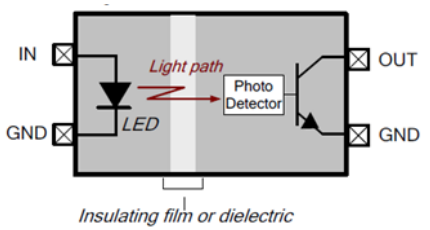
Digi-Max™

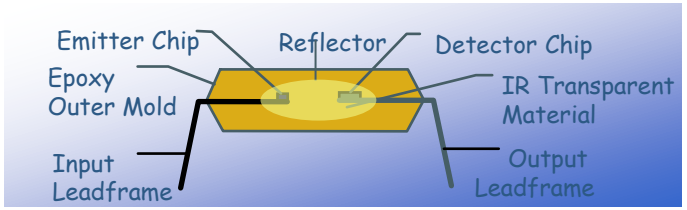
- Logic-2-Logic Digital Isolators

Common Isolation Techniques and Main Issues

Optical -> Optical transmission (fiber optics), optical coupling (optocoupler)

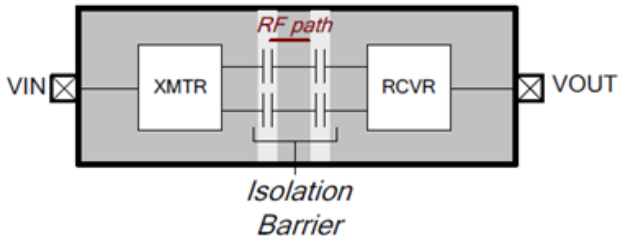
- LED degradation over time/temperature
- Slow (<25Mbit/s)
- Not economical for high-channel count

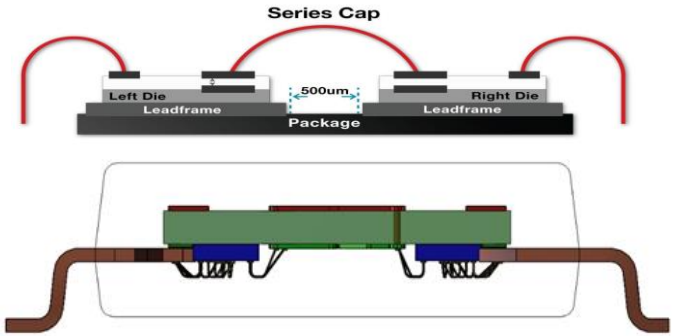




Capacitive (on-chip/off-chip)

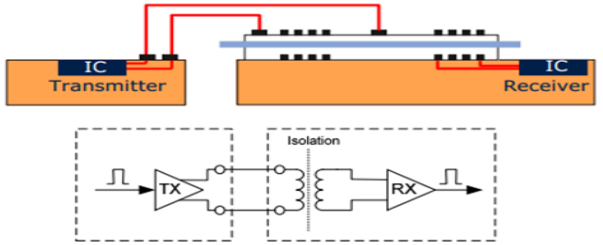
- Thin insulation barrier (on-chip)
- Insulating materials susceptible to damage from EOS/ESD (on-chip)
- Higher power consumption (off-chip)
- EMI/EMC challenges

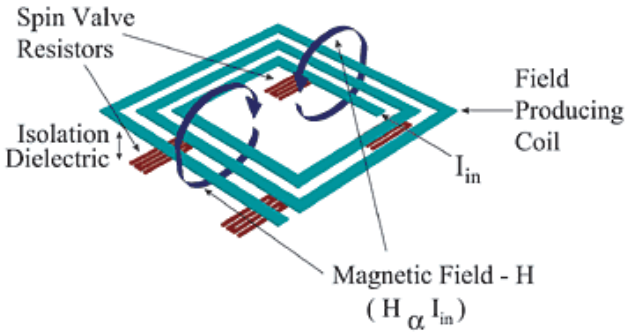




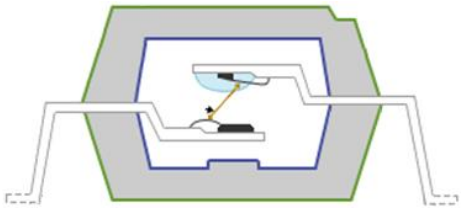
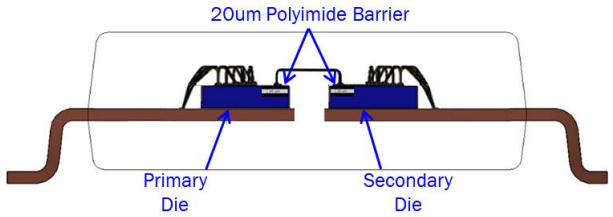
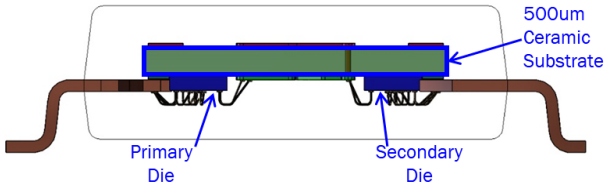
Magnetic -> Coreless transformer, magneto resistive, hall effect

- Magnetic interference
- EMI susceptibility
- Thin insulation barrier





Isolation Market & Technologies

Optocouplers	Digital Isolators (DI)	Digi-Max™ (DM)
		
Technology		
Optical: LED + Photodiode	Digital: On-Chip	Digital: Off-chip with Ceramic Insulator
Benefits		
Lowest Cost EMI / EMC Immunity Isolation Reliability / Safety	Low Cost Stable over Temp & Time	EMI / EMC Immunity Isolation Reliability / Safety Stable over Temp & Time
Primary Markets		
Power Supplies Industrial HP Drives	Automotive (EV/HEV) Telecom	Industrial HP Drives
Lead Suppliers		
BROADCOM. TOSHIBA ON Semiconductor®	Texas Instruments SILICON LABS ANALOG DEVICES	Unique to ON Semiconductor®

Comparison of Isolation Techniques

Attribute		Opto-Coupler	On-chip Magnetic	On-chip Capacitive	Digi-Max™ Off-chip Capacitive
Isolation Materials		Epoxy/Silicone gel	Polyimide	SiO_2 or equivalent	Ceramic Substrate/ Epoxy
Signal Coupling		Optical (LED +diode)	Magnetic field	Electric field	Electric field
Performance Across Temp & Time		Varies	Consistent	Consistent	Consistent
Life Expectancy		~10 Yrs	~ 20 Yrs	~ 20 Years	~20 Years
Speed		Slow	Fast	Fast	Fast
Distance Through Insulation (DTI)		> 400 µm	~20 µm	~20 µm	**> 500 µm**
Meets EN60950 >0.4mm DTI		Yes	No	No	**Yes**
Common Mode Transient Immunity (CMTI)		~25 kV/µs	> 100 kV/µs	> 100 kV/µs	> 100 kV/µs
EMI EMC	Susceptibility	Non-issue – too slow	Design techniques	Signal level dependent	Signal level dependent
	Radiation	Non-issue (light transmission)	Design techniques	Design techniques	Design techniques
Junction Temperature		Up to 125°C	Wide range (150 °C)	Wide range (150 °C)	Wide range (150 °C)
Standards		UL1577 IEC60747-5-5	UL1577 VDE0884-11	UL1577 VDE0884-11	UL1577 VDE0884-11
Modulation Method for Internal Signal Xfer		No modulation required	On-Off Keying	On-Off Keying	On-Off Keying
AEC Qualified Portfolio		Limited	Yes	Yes	Yes

NCID(V)9xxx

Description:

- Full Duplex Communications
- Low Power Consumption
- 150 KV/µs Minimum Common Mode Rejections
- High Speed:
  - 75 Mbit/s Data Rate (NRZ)
  - 18 ns Maximum Propagation Delay
  - 10 ns Maximum Pulse Width Distortion
  - 4 ns Maximum Propagation Delay Skew
- 2.5 V to 5 V Level Translation
- Extended Industrial Temperature Range: -40°C to 125°C
- Safety and Regulatory Approvals
  - UL1577 (5,000K VRM for 1 Minute)
  - DIN 0884-11 (pending)

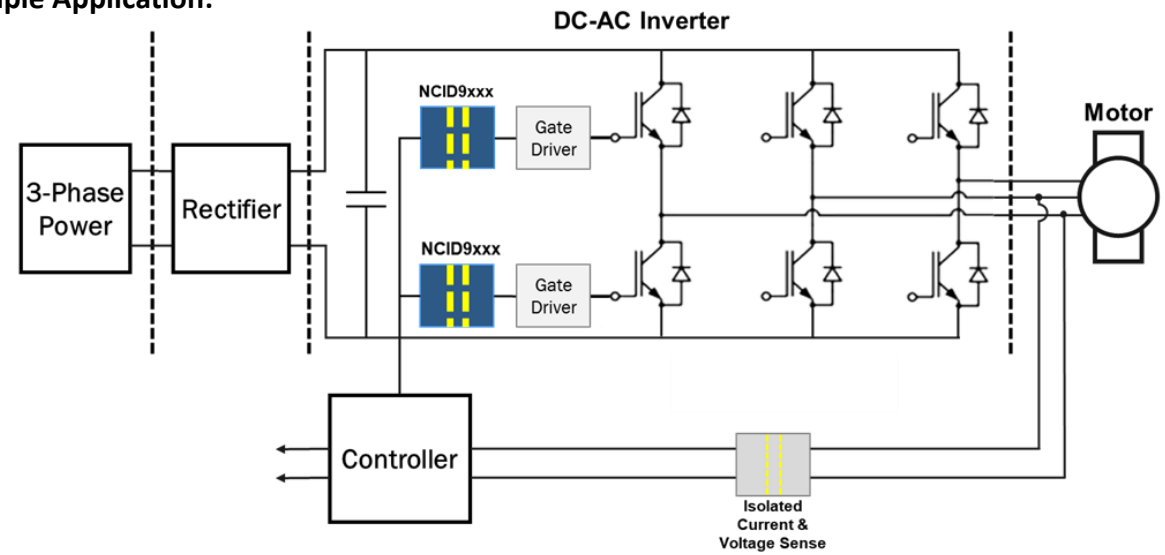
Applications:

- Isolated PWM Control
- Industrial Field-bus Communications
- Microprocessor System Interface
- SPI
- Programmable Logic Control
- Isolated Data Acquisition System
- Voltage Level Translator

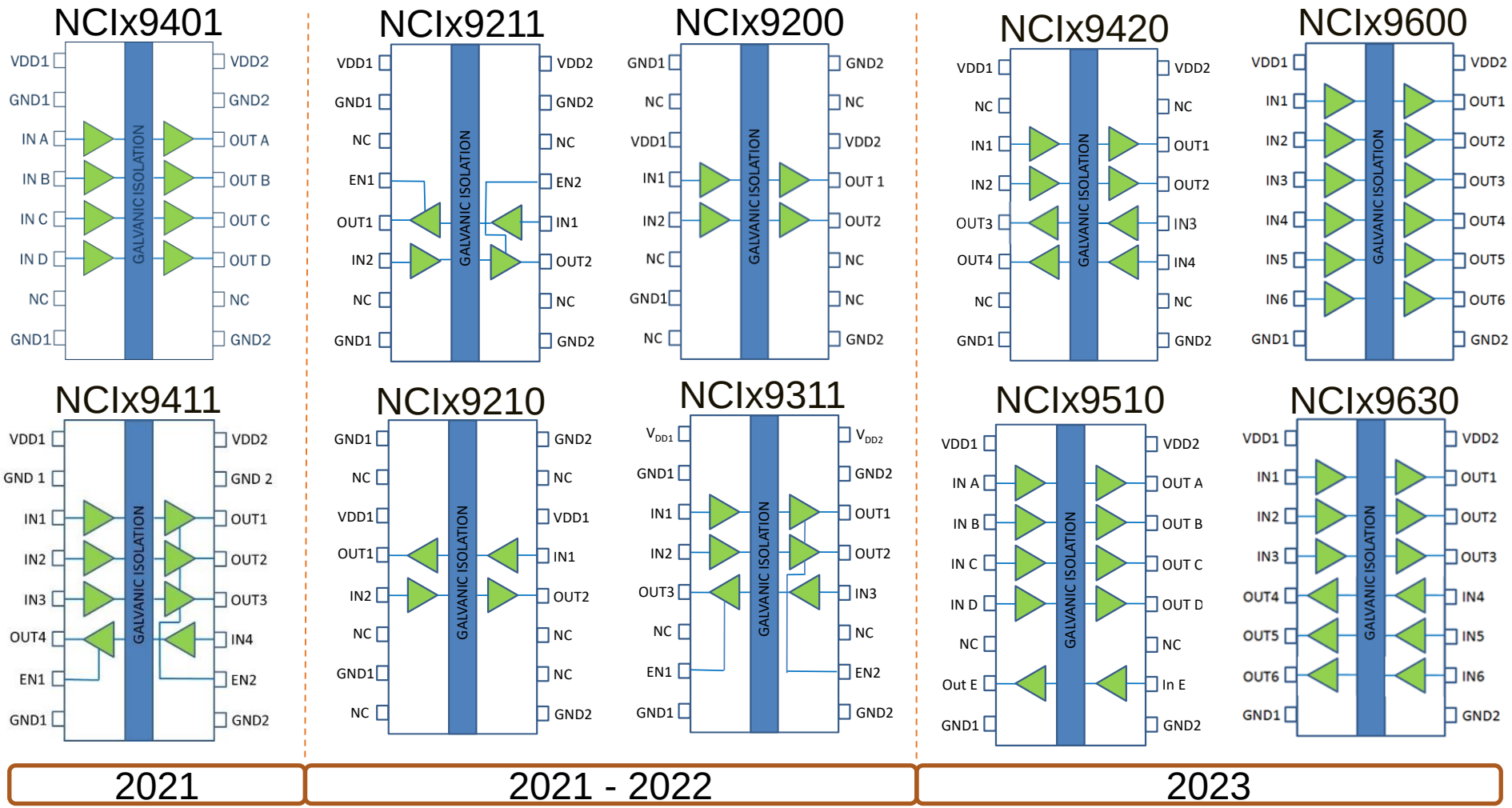
Benefits:

- Off-Chip Capacitive Isolation vs. On-Chip Capacitive or Electro-Magnetic Isolation
  - Distance Through Insulation (DTI): 500um (Off-Chip) vs. 20um (On Chip / Magnetic)
  - Meets EN60950 >0.4mm DTI requirement
  - Double Protection Status for UL1577 Approvals (vs. Basic Protection for On-Chip & Magnetic)
  - Better Long Term Reliability (500 hrs+ on sustained 5.5kVACrms)
- Off-Chip Capacitive Digital Isolation vs. Opto Couplers
  - Higher Data Rates: Up to 100 Mbps vs. 25 Mbps
  - CMTI (Common Mode Transient Immunity): 150 kV/us Minimum vs. 25 kV/us
  - Higher Max Channel Count: Up to 6-Channels per device vs. 1 or 2

Example Application:

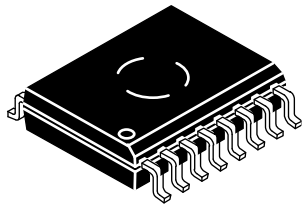


Digi-Max™ Family of Hi-Speed Digital Logic-to-Logic Isolators



Other Configurations Available

x = D for Industrial
x = V for Automotive



SO-16 WB Package

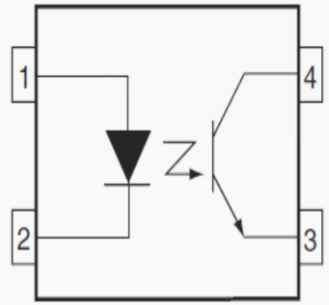
Optocouplers

Optoelectronics Portfolio

More than 1,000 active Optocouplers part numbers!!

Phototransistor

- 4PB, 6PW, SO8, MFP, SO-4



Application Segments

- All

Key Features

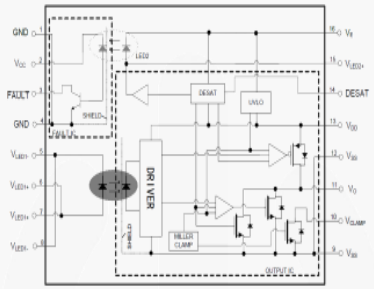
- CTR (gain), VISO, T(OFF), I(F)
- Low cost, all-purpose optocoupler

ON Advantage

- FODM8801 (OptoHiT) – Better CTR vs. Temp

IGBT/MOSFET Gate Drivers

- 8PW, SO16, SO-5, SO-6



Application Segments

- Motor drives, Solar, IH,
- Welding

Key Features

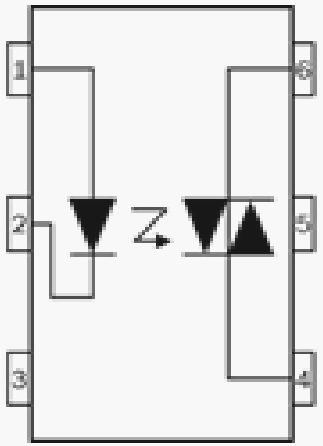
- Basic and smart MOSFET/IGBT gate drive
- UVLO, CMTi, I(O), PWD, Skew, Vdesat, VDD-VSS

ON Advantage

- Lower RDSON (Faster ON/ON), better noise immunity

Photo TRIAC Drivers

- 6PW, 6PB, MFP



Application Segments

- White goods
- Welding

Key Features

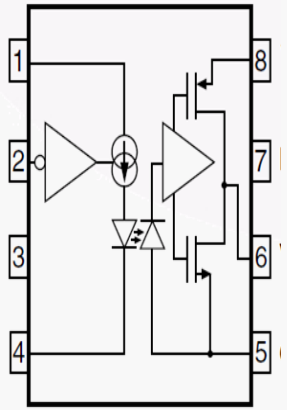
- AC Mains control
- IDRM, VDRM, IFT, VINH, dv/dt

ON Advantage

- Better quality (competitors have known reliability issues)

High Performance

- MFP-5, SO-5, SO-6, SO-8, 8PW



Application Segments

- PLC, Industrial field bus, consumer

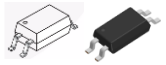
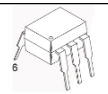
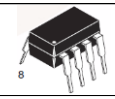
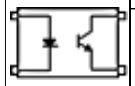
Key Features

- High bandwidth or very high gain
- TPHL/TPLH, IFT, CMTi, PWD

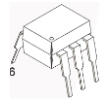
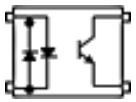
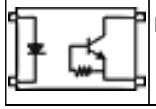
ON Advantage

- Compete on price vs. Broadcom/Avago

On Semiconductor Phototransistor Portfolio

ON_Semi PhotoTransistor Optocoupler Portfolio (1)										
Functional Diagram	Creepage & Clearance Distance		5 mm	5 mm	8 mm	4 mm		7 or 8 mm	7 or 8 mm	
	Package Type		MFP4(HP)	MFP4(FP)	LSOP4	SO8 1-Ch	SO8 2-Ch	DIP4	DIP6	DIP8 2-Ch
	Features	Isolation Voltage (Vrms)								
	General Purpose	3,750	FODM217x	FODM121x, FODM124, FODM2701						
		4,170							CNY17FxM, MOC8106M	
		5,000			FODM1007, FODM1008, FODM1009			FOD817		MCT6x, MCT9001
	Low Input Current, High Temp	3,750	FODM8801x							
	With/Without Base Pin	2,500				MOC20xM, MOC21xM	MOCD20xM, MOCD21xM			
	With Base Pin	4,170							4N2xM, 4N3xM, CNY17xM, H11AV1M, MCT2EM, TIL111M, TIL117M	
	Low Input Current With Base Pin	2,500				MOC216M, MOC217M	MOCD217M (no base)			
		4,170							H11AG1M, MCT5210M, MCT5211M	
	High Vceo With Base Pin	4,170							4N38M, H11D1M, H11D3M, MOC8204M	

On Semiconductor Phototransistor Portfolio (Cont)

ON_Semi PhotoTransistor Optocoupler Portfolio (2)								
Functional Diagram	Creepage & Clearance Distance		5 mm	5 mm	4 mm		7 or 8 mm	7 or 8 mm
	Package Type		MFP4(HP)	MFP4(FP)	SO8 1-Ch	SO8 2-Ch	DIP4	DIP6
	Features	Isolation Voltage (Vrms)						
AC input 	General Purpose	2,500			MOC256M			
		3,750	FODM214	FODM2705				
		4,170						H11AA1M, H11AA4M
		5,000					FOD814, FOD814A,	
Darlington 	High CTR%	2,500			MOC223M	MOCD223M		
		3,750		FODM352				
		4,170						4N29M, 4N30M, 4N32M, 4N33M, H11B1M, TIL113M, MOC8021M, MOC8050M
	Low Input Current With High CTR%	4,170						H11G1M, H11G2M
	Low Input Current With High CTR%	5,000					FOD852	
On-chip RBE 	High-Speed, Low Input Current	5,000					FOD819	

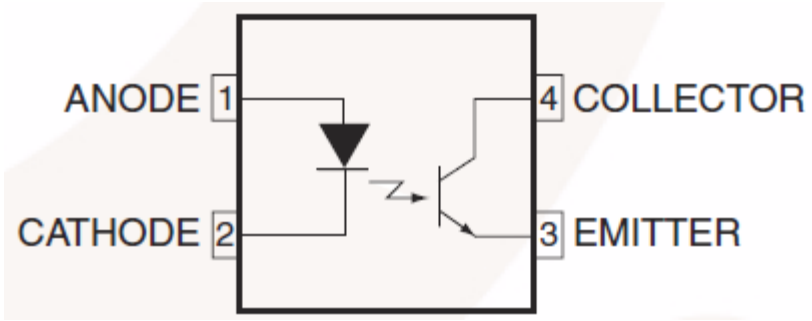
FODM8801 OptoHiT Features

- High efficiency emitter and tight hfe binning of transistor result in Guaranteed Current Transfer Ratio (CTR) specifications across full temperature range from -40ºC to +125ºC
  - Excellent CTR linearity at high temperature
  - CTR at very low input current, I_F (1mA, 1.6mA, and 3mA)
- Guaranteed switching specifications over extended operating temperature range as compared to the existing optocouplers
- Owing to its small footprint, this half-pitch Mini-Flat Package (MFP) can further save on board real estate giving hardware designers more flexibility and allowing for overall systems cost savings
- High isolation voltage certified by UL1577 (3,750V_{AC}RMS for 1 min.) and DIN_EN/IEC60747-5-2(VDE) certification for increased reliability

FODM100x, Low Input Current Phototransistor Optocoupler in Stretched Black 4-Pin MFP

Features

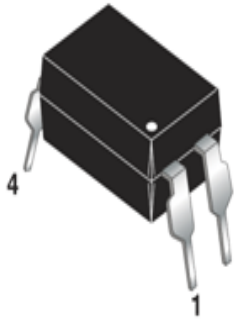
- ≥ 8 mm Creepage and Clearance Distance, and ≥ 0.4 mm insulation distance to achieve reliable and high voltage insulation
- Low Input Current, High Collector Emitter Voltage, V_{CE} = 70 V
- Extended industrial temperate range, -40 to 110°C
- Safety and regulatory approvals
  - UL1577, 5,000 VAC_{RMS} for 1 min.
  - DIN_EN/IEC60747-5-5, 890 Vpeak working voltage



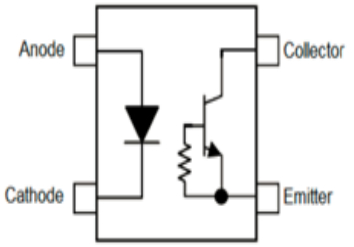
High Speed Transistor FOD819 in 4-Pin DIP

Main Features

- High Speed Performance ~30kbit/sec or 15kHz
- CTR of 100 to 600%, With I_F=1.5mA
- BV_{CEO} of 80V Guaranteed
- 4-Pin DIP as of FOD817 for ease of migration
- Safety and Regulatory Approvals:
  - ➢ UL1577, 5000 VAC_{RMS} for 1 Minute
  - ➢ DIN EN/IEC60747-5-5,



DIP 4 PINS



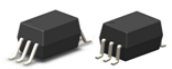
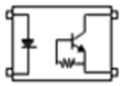
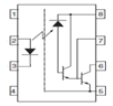
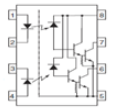
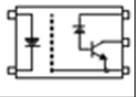
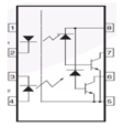
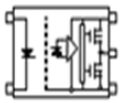
Target Applications

- Digital Logic Inputs
- Microprocessor Inputs
- Power Supply Monitor
- Twisted Pair Line Receiver
- Telephone Line Receiver

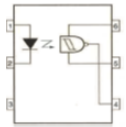
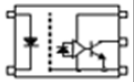
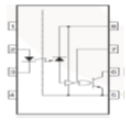
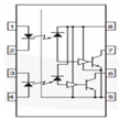
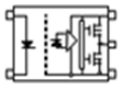
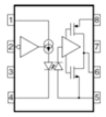
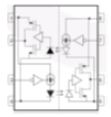
Ordering Information

Part Number	Package	Packing Method
FOD819	DIP 4-Pin	Tube (100 units per tube)
FOD819S	SMT 4-Pin (Lead Bend)	Tube (100 units per tube)
FOD819SD	SMT 4-Pin (Lead Bend)	Tape and Reel (1,000 units per reel)
FOD819V	DIP 4-Pin, DIN EN/IEC60747-5-5 option	Tube (100 units per tube)
FOD819SV	SMT 4-Pin (Lead Bend), DIN EN/IEC60747-5-5 option	Tube (100 units per tube)
FOD819SDV	SMT 4-Pin (Lead Bend), DIN EN/IEC60747-5-5 option	Tape and Reel (1,000 units per reel)
FOD819VW	DIP 4-Pin, 0.4" Lead Spacing, DIN EN/IEC60747-5-5 option	Tube (100 units per tube)

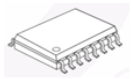
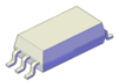
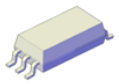
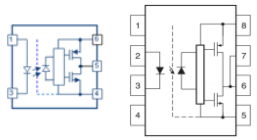
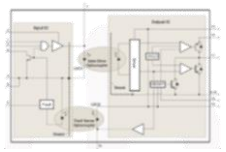
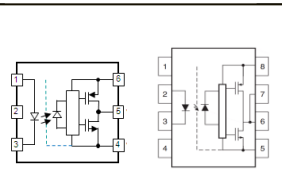
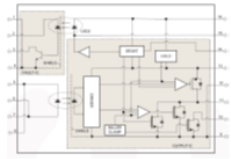
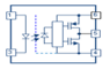
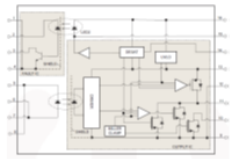
ON Semiconductor® High Speed Optocoupler Portfolio(1)

Clearance/Creepage Distance			10 mm	4 mm	4 mm		7 or 8 mm	7 or 8 mm			
Package Type			SO5L	SO5	SO8 1-Ch	SO8 2-Ch	SDIP6	DIP4	DIP6	DIP8 1-Ch	DIP8 2-Ch
Data Rate (Typ.)	Output Configuration	Function Diagram									
< 20 kbps	Transistor							FOD819			
< 100 kbps	Split Darlington				HCPL0700, HCPL0701					6N138M, 6N139M	
						HCPL0731					HCPL2731M
< 1 Mbps	Open collector			FODM452, FODM453							
					HCPL0453, HCPL0500. HCPL0501, FOD050L					HCPL4503M*, 6N135M, 6N136M	
						HCPL0534, HCPL0531, FOD053L					HCPL2530M, HCPL2531M
	Totem Pole						FOD8480, FOD8483 (Non-Inverting)				

ON Semiconductor® High Speed Optocoupler Portfolio(2)

Clearance/Creepage Distance			10 mm	4 mm	4 mm		7 or 8 mm	7 or 8 mm		
Package Type			SO5L	SO5	SO8 1-Ch	SO8 2-Ch	SDIP6	DIP6	DIP8 1-Ch	DIP8 2-Ch
Data Rate (Typ.)	Output Configuration	Function Diagram								
< 1 Mbps	Open collector							H11L1M, H11L2M, H11L3M		
< 5 Mbps								H11N1M, H11N2M		
< 10 ~ 20 Mbps	Open collector		FOD8160	FODM611, FODM8061			FOD8163, FOD8163T			
					HCPL0600, HCPL0601, HCPL0611, FOD060L				6N137M, HCPL2611M, FOD260L	
						HCPL0637, HCPL0638, HCPL0639, HCPL062N				HCPL2630M, HCPL2631M
	Totem pole			FODM8071			FOD8173, FOD8173T			
					FOD8001, FOD0710, FOD0720, FOD0721					
						FOD8012A				

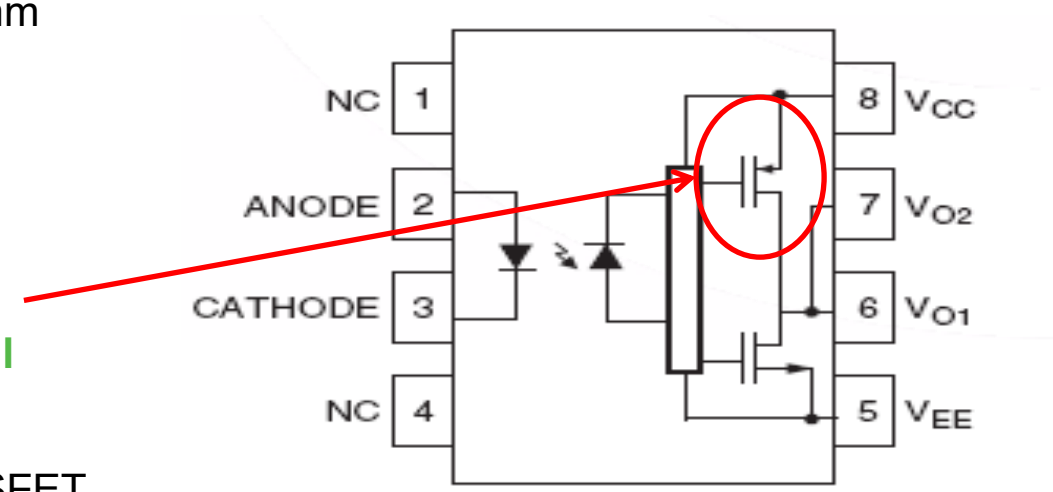
Isolated Gate Driver Optocouplers Portfolio Table

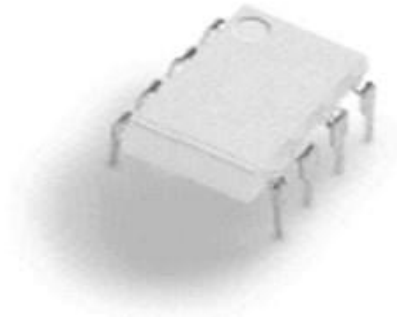
Clearance & Creepage Distance			8 mm	8 mm	10 mm	7 or 8 mm	7 or 8 mm
Package Type			SO16L	SO5L	SO5L	SDIP6	DIP8
Peak Output Current, I_{OP}	Prop Delay, t_{PHL}, t_{PLH}	Function Diagram					
0.6 A	500 ns						FOD3150
2.5 A	500 ns			FOD8321		FOD8314	FOD3150A
	500 ns		FOD8316, FOD8318				
	400 ns				FOD8320		FOD3120/5
	200 ns			FOD8384	FOD8383	FOD8342	FOD3180, FOD3182, FOD3184
	200 ns		FOD8332, FOD8333				
4.0 A	200 ns					FOD8343	
4.0 A	200 ns		FOD8334				

FOD3125 High Temp Isolated Gate Drive
2.5 A Output Current in 8-Pin Coplanar DIP

Features

- **Extended industrial temperate range, -40 to 125°C**
- ≥ 8 mm Creepage and Clearance Distance (‘T’ option), and ≥ 0.4 mm insulation distance to achieve reliable & high voltage insulation
- Safety and regulatory approvals
  - UL1577, 5,000 VACRMS for 1 min.
  - DIN_EN/IEC60747-5-5, 1.414K V_{peak} working voltage
- **Low RDS_{ON} P-Channel MOSFET pull-up transistor for rail-to-rail switching. 1.5 Ω compared to competitor’s 7.5 Ω.**
- 2.5 A output current driving capability for medium power IGBT/MOSFET
- 35 kV/µs Minimum Common Mode Rejection
- Fast Switching Speed over full operating temperature range
- 400 ns max. propagation delay
- 100 ns max. pulse width distortion
- UnderVoltage LockOut (UVLO) with hysteresis

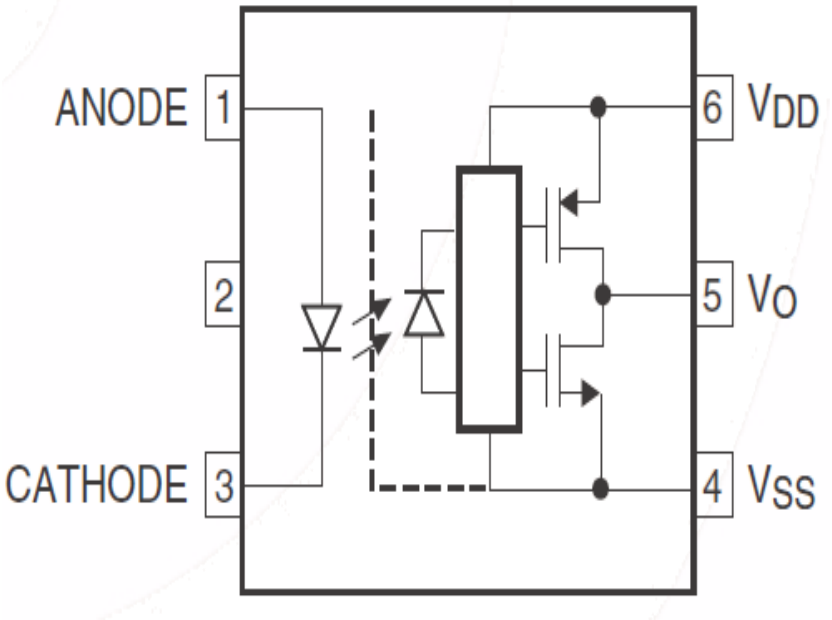


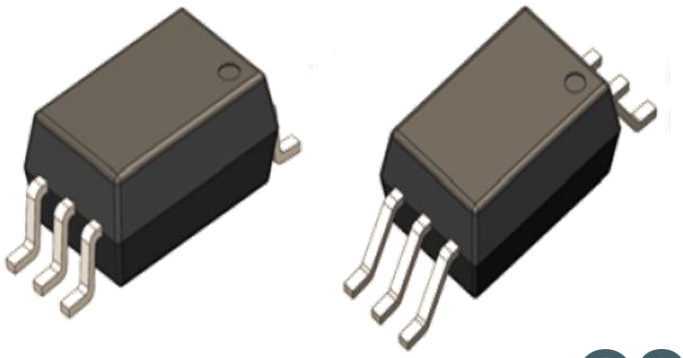


FOD8342 and FOD8342T, 3 A Output Current Isolated Gate Driver in Stretched Black 6-Pin SOP

Features

- ≥ 8 mm Creepage and Clearance Distance
- ≥ 0.4 mm insulation distance to achieve reliable & high voltage insulation
- 3 A output for driving medium power IGBT / MOSFETs
- Safety and regulatory approvals
  - UL1577, 5,000 VACRMS for 1 min.
  - DIN_EN/IEC60747-5-5, 1.140K V_{peak} working voltage
- Use of P- and N-Channel MOSFETs for rail-to-rail switching
- 20 kV/μs Minimum Common Mode Rejection
- Fast Switching Speed over full operating temperature range
- 210 ns max. propagation delay
- 65 ns max. pulse width distortion
- UnderVoltage LockOut (UVLO) with hysteresis
- Extended industrial temperate range, -40 to 100°C



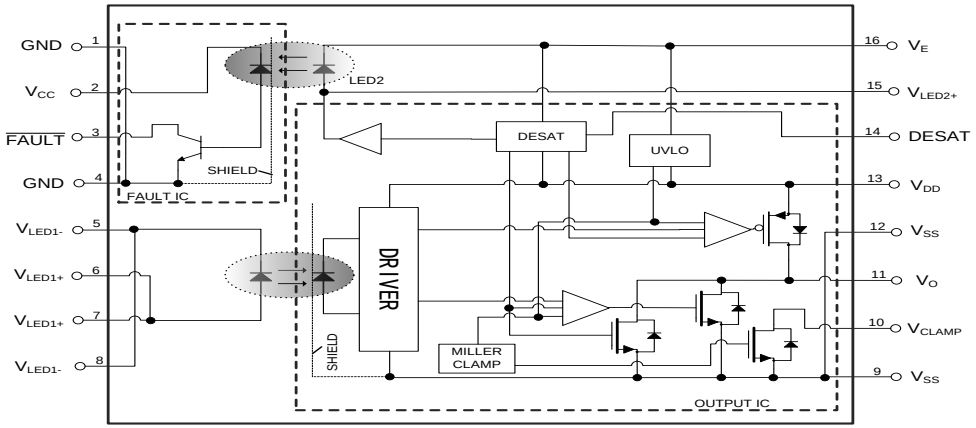


FOD8334, 4.0 A Smart Gate Driver Optocoupler with Direct LED Drive and Active Miller Clamp

Features

- Improved performance to FOD8332/ACPL-33xJ (functional and pin compatible)
- Input LED Drive to facilitate the ease of receiving digitally encoded signals from PWM output
- Desaturation Detection
- Programmable Fault Sensing
- Undervoltage Lockout

  Optimized for IGBTs
- Active Miller Clamp to shut off the IGBT during high dv/dt without needing a negative supply voltage
- Safety and regulatory approvals
  - UL1577, 4,243 VAC_{RMS} for 1 min.
  - IEC60747-5-5, 1,414 Vpeak working voltage



EEPROMs

High Performance EEPROM Overview

Densities

- 2 Kb
- 4 Kb
- 8 Kb
- 16 Kb
- 32 Kb
- 64 Kb
- 128 Kb
- 256 Kb
- 512 Kb
- 1 Mb
- 2 Mb

Endurance and Retention

- 4 million Write Cycles Endurance
- Up to 200 Years of Data Retention

Operating Temperature

- True Automotive Grade 0 to 150 °C
- Extended Industrial range from -40 °C to 125 °C

Supply Voltage

- 1.2 V to 5.5V Consumer
- 1.7 V to 5.5V Industrial & Automotive

Interface

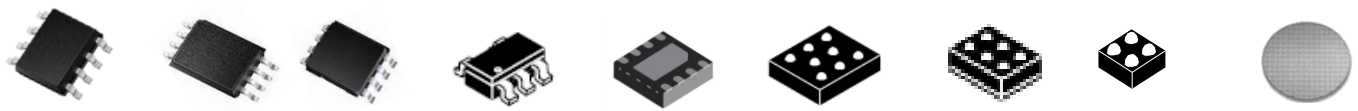
- 2-wire interface saves space on your board
- 4-wire interfaces provides speeds up to 20 MHz

I²C BUS

SPI µWire

NFC RFID

Packages

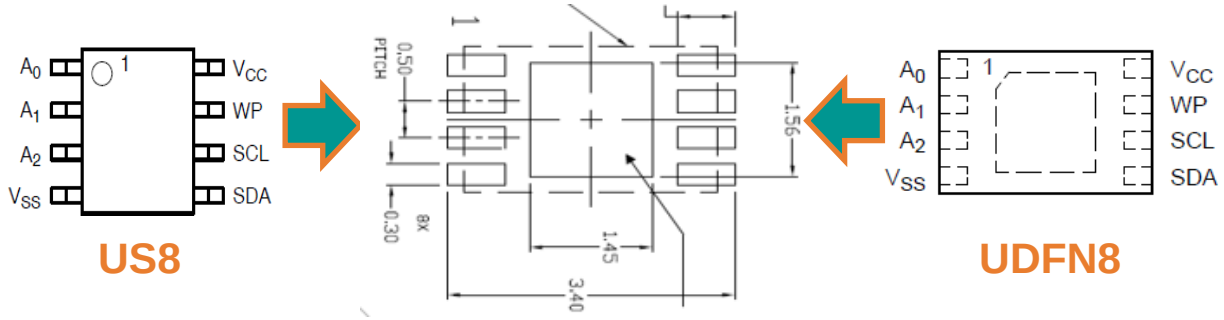


SOIC 8 | TSSOP 8 | US 8 | TSOT 23 | UDFN 8 (WF) | WLCSP 8 | WLCSP 6 | WLCSP 4/5 | Wafer

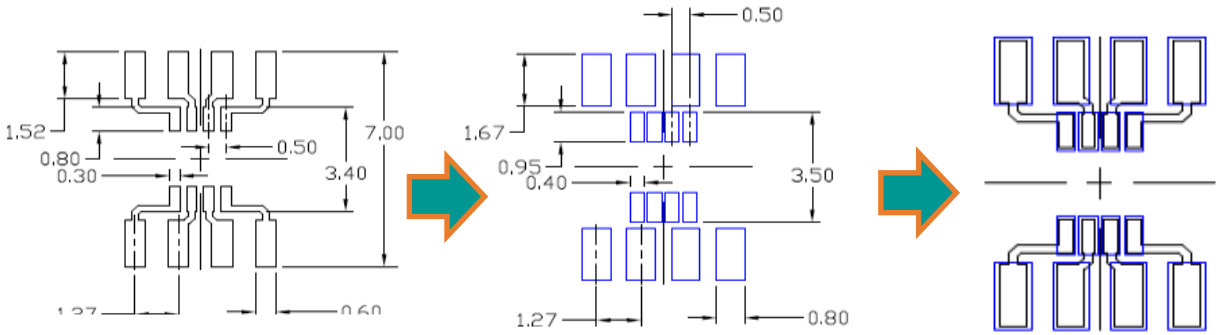
onsemi

Small – Size Package Advantages

Package	Leaded	Small Size	AOI Support	AEC Q100	Wettable Flank	Footprint Compatibility
US 8	√	√ (2.0x2.3mm)	√	√		√ (uDFN 8, SOIC 8)
TSOP 5	√	√ (1.5 x 3.0mm)	√	√		√ (SOT 23)
UDFN8 WF		√ (2.0x3.0mm)	√	√	√	√ (US 8, SOIC 8)



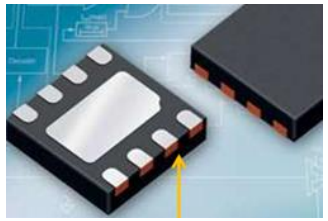
US8 UDFN8



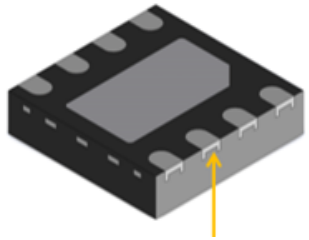
SOIC 8 UDFN 8 Inner Layout Double Layout

Wettable Flank

- ✓ 100% Sn Plated Leads
- ✓ Better Soldering & Connection
- ✓ Stronger Mold Lock for U-Shape Leads



Copper Sidewall



Wettable Flank

High Performance Industrial Standard EEPROM Device List

Density	Interface	SOIC 8	TSSOP 8	uDFN 8	TSOT 23	US8	Wafer
2kb	I²C	–	–	–	CAT24C02TDI-GT3A	N24C02UDTG	–
3kb	I²C	CAT24C03WI-GT3	–	–	–	–	–
4kb	I²C	CAT24C04WI-GT3	CAT24C04YI-GT3	CAT24C04HU4I-GT3	CAT24C04TDI-GT3	N24C04UDTG	CAT24C04DWFA
8kb	I²C	CAT24C08WI-GT3	CAT24C08YI-GT3	CAT24C08HU4I-GT3	CAT24C08TDI-GT3	N24C08UDTG	CAT24C08DWFA
16kb	I²C	CAT24C16WI-GT3	CAT24C16YI-GT3	CAT24C16HU4I-GT3	CAT24C16TDI-GT3	N24C16UDTG	CAT24C16DWFA
32kb	I²C	CAT24C32WI-GT3	CAT24C32YI-GT3	CAT24C32HU4I-GT3	–	N24C32UDTG	CAT24C32DWFA
64kb	I²C	CAT24C64WI(XE)-GT3	CAT24C64YI-GT3	CAT24C64HU4I-GT3	–	N24C64UDTG	CAT24C64DWFA
128kb	I²C	CAT24C128WI-GT3	CAT24C128YI-GT3	CAT24C128HU4IGT3	–	–	CAT24C128DWFA
256kb	I²C	CAT24C256WI-GT3	CAT24C256YI-GT3	CAT24C256HU4IGT3	–	–	CAT24C256DWFA
512kb	I²C	CAT24C512WI-GT3	CAT24C512YI(E)-GT3	CAT24C512HU4I(E)GT3	–	–	–
1Mb	I²C	CAT24M01WI(XI)-GT3	CAT24M01YI-GT3	CAT24M01HU5I-GT3	–	–	CAT24M01DWFA
1kb	SPI	CAT25010VI-GT3	CAT25010YI-GT3	CAT25010HU4I-GT3	–	–	–
2kb	SPI	CAT25020VI-GT3	CAT25020YI-GT3	CAT25020HU4I-GT3	–	–	CAT25020DWFA
4kb	SPI	CAT25040VI-GT3	CAT25040YI-GT3	CAT25040HU4I-GT3	–	–	–
8kb	SPI	CAT25080VI(E)-GT3	CAT25080YI(E)-GT3	CAT25080HU4I-GT3	–	–	–
16kb	SPI	CAT25160VI(E)-GT3	CAT25160YI-GT3	CAT25160HU4I-GT3	–	–	–
32kb	SPI	CAT25320VI-GT3	CAT25320YI-GT3	CAT25320HU4I-GT3	–	–	–
64kb	SPI	CAT25640VI-GT3	CAT25640YI-GT3	CAT25640HU4I-GT3	–	–	–
128kb	SPI	CAT25128VI(XE/I)-GT3	CAT25128YI-GT3	CAT25128HU4I-GT3	–	–	–
256kb	SPI	CAT25256VI(XE/I)-GT3	CAT25256YI-GT3	CAT25256HU4I-GT3	–	–	CAT25256DWFA/B/C
512kb	SPI	CAT25512VI(XE/I)-GT3	CAT25512YI(E)-GT3	CAT25512HU5I(E)-GT3	–	–	CAT25512DWFA
1Mb	SPI	CAT25M01VI(XE/I)–GT3	CAT25M01YI-GT3	–	–	–	–
1kb	µWire	CAT93C46(R)BVI(XE/I)-GT3	CAT93C46(R)BYI(XE/I)-GT3	CAT93C46(R)BHU4I(E-)GT3	–	–	–
2kb	µWire	–	–	–	–	–	–
4kb	µWire	CAT93C66VI-GT3	–	–	–	–	–
8kb	µWire	CAT93C76BVI(E)-GT3	CAT93C76BYI(E)-GT3	CAT93C76BHU4I-GT3	–	–	–
16kb	µWire	CAT93C86BVI(E)-GT3	CAT93C86BYI(E)-GT3	CAT93C86BHU4I(E)-GT3	–	–	–

E = Enhanced to 125C Auto Grade 1

I = Industrial Standard

R = Internal Instruction Clock Counter

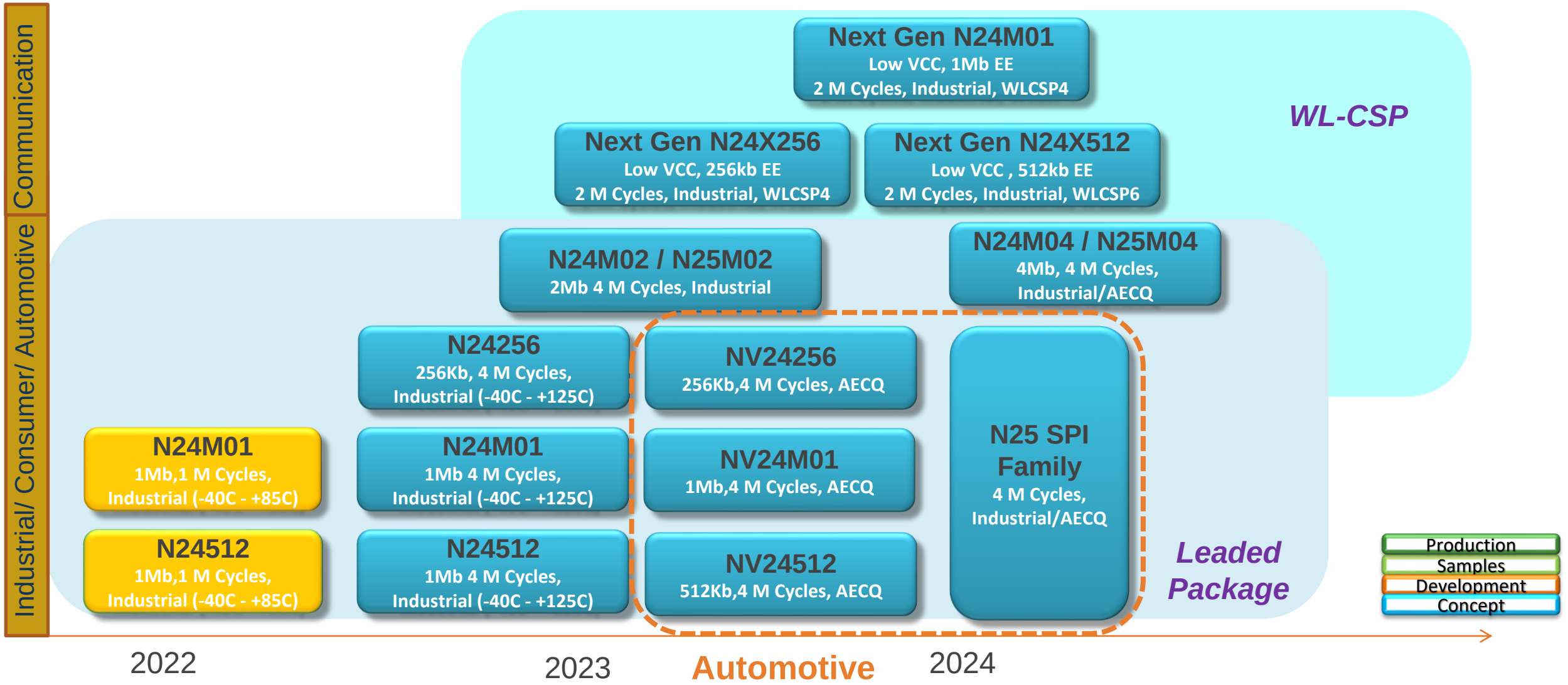
X = SOIC Wide Body (208 mils)

Consumer / Industrial WLCSP EEPROM Device List

Density	Interface	Part Number	Write Protect	I2C Slave Address	Package	Backside Coating	Ball Composition	Package mm	Supply Voltage
4 kb	I²C	CAT24C04C4ATR	No	4 Selectable I²C Address	WLCSP-4	No	SAC266	0.84 x 0.86 x 0.38	1.7 V to 5.5 V
8 kb	I²C	CAT24C08C4ATR	No	2 Selectable I²C Address	WLCSP-4	No	SAC266	0.84 x 0.86 x 0.38	1.7 V to 5.5 V
16 kb	I²C	CAT24C16C4ATR	No	1 - I²C Address	WLCSP-4	No	SAC266	0.84 x 0.86 x 0.38	1.7 V to 5.5 V
	I²C	CAT24C16C4UTR	No	1 - I²C Address	WLCSP-4	Yes		0.84 x 0.86 x 0.30	1.7 V to 5.5 V
32 kb	I²C	CAT24C32BC4CTR	No	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.77 x 0.77 x 0.35	1.7 V to 5.5 V
	I²C	CAT24C32BAC4CTR	No	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.77 x 0.77 x 0.35	1.7 V to 5.5 V
	I²C	CAT24C32C4CTR	No	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.77 x 0.77 x 0.35	1.7 V to 5.5 V
64 kb	I²C	CAT24S32C4ATR	Software	1 - I²C Address	WLCSP-4	No	SAC266	0.84 x 0.84 x 0.35	1.7 V to 5.5 V
	I²C	CAT24C64C4CTR	No	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.77 x 0.77 x 0.35	1.7 V to 5.5 V
	I²C	CAT24C64C4UTR	No	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.77 x 0.77 x 0.30	1.7 V to 5.5 V
	I²C	CAT24C64BC4CTR	No	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.77 x 0.77 x 0.35	1.7 V to 5.5 V
	I²C	CAT24C64BAC4CTR	No	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.77 x 0.77 x 0.35	1.7 V to 5.5 V
	I²C	N24S64C4DYT3G	Software	8 Selectable I²C Address	WLCSP-4	Yes	SAC305	0.77 x 0.77 x 0.30	1.7 V to 5.5 V
	I²C	N24S64BC4DYT3G	Software	8 Selectable I²C Address	WLCSP-4	Yes	SAC305	0.77 x 0.77 x 0.30	1.7 V to 5.5 V
	I²C	CAT24S64C4ATR	Software	1 - I²C Address	WLCSP-4	No	SAC266	0.84 x 0.84 x 0.35	1.7 V to 5.5 V
128 kb	I²C	CAT24S128C4UTR	Software	1 - I²C Address	WLCSP-4	Yes	SnAg1.8	0.84 x 0.84 x 0.30	1.7 V to 5.5 V
	I²C	CAT24S128C4ATR	Software	1 - I²C Address	WLCSP-4	No	SAC266	0.84 x 0.84 x 0.35	1.7 V to 5.5 V
	I²C	N24S128C4DYT3G	Software	8 Selectable I²C Address	WLCSP-4	Yes	SAC305	0.84 x 0.84 x 0.30	1.7 V to 5.5 V
256 kb	I²C	N24C256C6DYT3G	Hardware	2 Selectable I²C Address	WLCSP-6	Yes	SAC305	1.09 x 0.96 x 0.30	1.7 V to 5.5 V
	I²C	NS24LS256C4JYTRG	Software	1 - I²C Address	WLCSP-4	Yes	SAC305	1.00 x 1.00 x 0.30	1.6 V to 5.5 V
512 kb	I²C	CAT24C512C8UTR	Hardware	8 Selectable I²C Address	WLCSP-8	Yes	SnAg1.8	1.39 x 1.65 x 0.40	1.8 V to 5.5 V

Small / Thin

High Density Serial EEPROM Roadmap



Digital Temp Sensors (EEPROM+)

N34TS108 – Low Voltage Digital Temperature Sensor

Description:

The N34TS108 is a digital-output temperature sensor with a dynamically-programmable limit window, and under- and over temperature alert functions. These features provide optimized temperature control without the need for frequent readings by the controller.

The N34TS108 features SMBus™ and two-wire interface compatibility and allows up to four devices on one bus with the SMBus™ alert function.

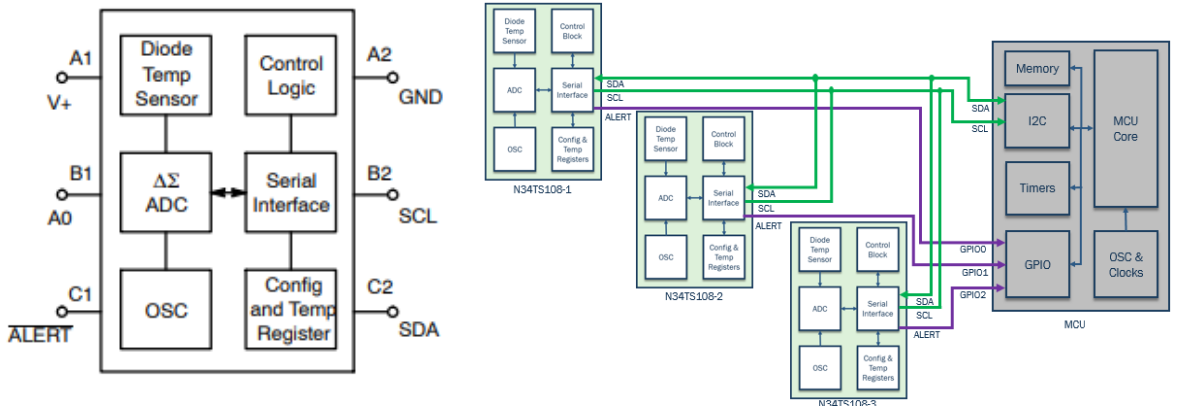
Features:

- Dynamically-Programmable Limit Window, and Under- and Over Temp. Alert
- Accuracy:
  - ±0.75°C (Max) from -20°C to +85°C
  - ±1.00°C (Max) from -40°C to +125°C
- Low Quiescent Current: 6µA Active from -40°C to +125°C
- Supply Range: 1.4 V to 3.6 V
- Resolution: 12 Bits (0.0625°C)
- Supports up to 3.4 MHz I^2C Frequency

Applications:

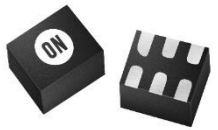
- Smartphone and Tablet Thermal Management
- Battery Management
- Thermal Control
- Under- and Over Temperature Protection
- Environmental Monitoring and HVAC

Block Diagram & Application:

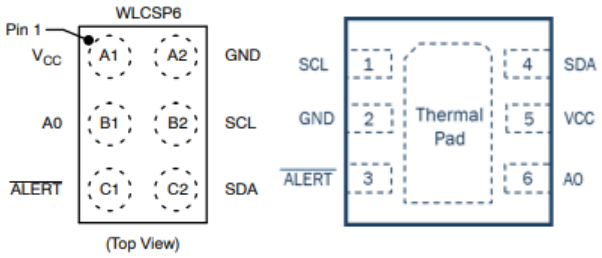


Packaging Info:

WLCSP6
1.2x0.8 mm



UDFN 6
2.0x2.0 mm



Pinout

Orderable Part Number

	Samples:	Production:
N34TS108C6ECT5G (WLCSP6)	Now!!	Now!!
N34TS108MUET3G (UDFN6)	Now!!	Now!!

(Competitor P/Ns: TMP108/116)

N34TS04 – Digital Temperature Sensor with SPD EEPROM

Description:

The N34TS04 is a combination Temperature Sensor (TS) and 42-Kb of Serial Presence Detect (SPD) EEPROM, which implements the JEDEC TSE2004av DDR4 specification and supports Standard (100 kHz), Fast (400 kHz) and Fast Plus (1 MHz) I²C protocols.

The TS measures temperature at least 10 times every second. Temperature readings can be retrieved by the host via the serial interface and are compared to high, low and critical trigger limits stored into internal registers.

Each of the four 1-Kb SPD EEPROM blocks can be Write Protected by software command.

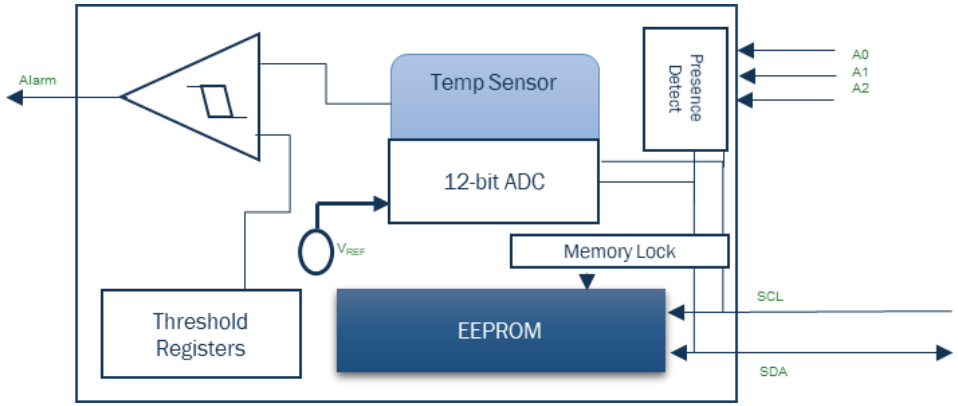
Features:

- JEDEC TSE2004av Compliant Temperature Sensor
- Accuracy:
  - ±1.0°C (typ.) from +75°C to +95°C
  - ±3.0°C (typ.) from -20°C to +125°C
- Temperature Sampling Rate: 100 ms max
- DDR4 DIMM Compliant SPD EEPROM
- Supply Range: 1.7 V to 5.5 V (SPD EEPROM) and 2.2 V to 5.5V (TS)
- Resolution: 12 Bits (0.0625°C)
- I²C / SMBus Interface: 100 kHz, 400 kHz and I MHz
- Pb – Free and RoHS Compliant TDFN 8 2x3x0.75mm UDFN packages

Applications:

- Solid State Drives
- Graphic Cards
- High Speed PCs, Laptops, DDR4
- Environmental Control Systems
- Process Control Equipment

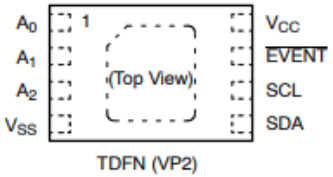
Application:



Packaging Info:

UDFN 8
2.0x3.0x 0.5 mm

TDFN 8
2.0x3.0x 075 mm



TDFN (VP2)

Pinout

Orderable Part Number	Samples:	Production:
N34TS04MU3ETG	Now!!	Now!!
N34TS04MT3ETG	Now!!	Now!!

Temperature Sensor Device List

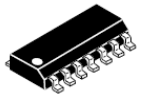
Device OPN	Accuracy	F_{CLK} (kHz)	Supply Range	Package (mm)	Temp. Range	SPD EEPROM
CAT34TS00VP2GT4A	±0.5°C	100 - 400	1.7 V to 1.9 V	TDFN 8 (2x3x0.75)	−20°C to +125°C	N/A
CAT34TS02VP2GT4C	±1°C	100 - 400	3.0 V to 3.6 V	TDFN 8 (2x3x0.75)	−20°C to +125°C	2 Kb
N34TS04MT3ETG	±1°C	100 – 1,000	1.7 V – 5.5 V	TDFN 8 (2x3x0.75)	−20°C to +125°C	4 Kb
N34TS04MU3ETG	±1°C	100 – 1,000	1.7 V – 5.5 V	UDFN 8 (2x3x0.5)	−20°C to +125°C	4 Kb
N34TS108C6ECT5G	±0.75°C	100 – 3,400	1.4 V to 3.6 V	WLCSP 6 (1.18x0.78x0.625)	−40°C to +125°C	N/A
N34TS108MUET3G	±0.75°C	100 – 3,400	1.4 V to 3.6 V	UDFN 6 (2x2x0.55)	−40°C to +125°C	N/A

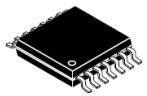
Standard Logic and MiniGates™

Standard Logic Families (≥14 Pins, ≥ 4 Gates)

Series	Part #	Operating Voltage V_{CC} (V)		Propagation Delay t_{PD} (nS)	Output Drive, I_{OUT} (mA)	Input Logic Level	Input Voltage Range (V)	Output Voltage Range (V)
		Min	Max					
VCX	MC74VCX / 74VCX	1.65	3.6	3.5 @ V_{CC} = 3 V	± 24 @ V_{CC} = 3.0 V	LVTTL	0 to V_{CC}	0 to V_{CC}
LVX	MC74LVX / 74LVX	2	3.6	6.6 @ V_{CC} = 3 V	± 4 @ V_{CC} = 3.0 V	LVTTL	0 to 5.5	0 to V_{CC}
VHC	MC74VHC / 74VHC	2	5.5	5.2 @ V_{CC} = 4.5 V	± 8 @ V_{CC} = 4.5 V	CMOS	0 to 5.5	0 to V_{CC}
AC	MC74AC / 74AC	2	6	6 @ V_{CC} = 5 V	± 24 @ V_{CC} = 4.5 V	CMOS	0 to V_{CC}	0 to V_{CC}
HC	MC74HC / 74HC	2	6	13 @ V_{CC} = 6 V	± 5.2 @ V_{CC} = 6 V (Std.), ± 7.8 @ V_{CC} = 6 V (Bus)	CMOS	0 to V_{CC}	0 to V_{CC}
LCX	MC74LCX / 74LCX	2.3	3.6	5.5 @ V_{CC} = 3 V	± 24 @ V_{CC} = 3.0 V	LVTTL	0 to 5.5	0 to 5.5
LVT	74LVT	2.7	3.6	3.6 @ V_{CC} = 3 V	-32/64 @ V_{CC} = 3.0 V	TTL	0 to 5.5	0 to 5.5
Metal Gate	MC14xxx	3	18	50 @ V_{CC} = 15 V	± 4.2 @ V_{CC} = 15 V	CMOS	0 to V_{CC}	0 to V_{CC}
ACT	MC74ACT / 74ACT	4.5	5.5	13 @ V_{CC} = 5 V	± 24 @ V_{CC} = 4.5 V	TTL	0 to V_{CC}	0 to V_{CC}
HCT	MC74HCT / 74HCT	4.5	5.5	15 @ V_{CC} = 5 V	± 4.0 @ V_{CC} = 4.5 V (Std.), ± 6.0 @ V_{CC} = 4.5 V (Bus)	TTL	0 to V_{CC}	0 to V_{CC}
VHCT	MC74VHCT / 74VHCT	4.5	5.5	3.6 @ V_{CC} = 4.5 V	± 8 @ V_{CC} = 4.5 V	TTL	0 to 5.5	0 to 5.5

Package Offerings: SOIC, TSSOP, QFN





MiniGates™ Logic Families (≤8 Pins, ≤ 3 Gates)

Series	Gate #	Part #	Operating Voltage V_{CC} (V)		Propagation Delay t_{PD} (nS)	Output Drive, I_{OUT} (mA)	Input Logic Level	Input Voltage Range (V)	Output Voltage Range (V)
			Min	Max					
SV	1-Gate	NL17SV/NC7SV	0.9	3.6	1.5 @ V_{CC} = 3.3 V	± 24 @ V_{CC} = 3.3 V	CMOS	0 to 3.6	0 to V_{CC}
WV	2-Gate	NC7WV	0.9	3.6	1.6 @ V_{CC} = 3.3 V	± 24 @ V_{CC} = 3.3 V	CMOS	0 to 3.6	0 to V_{CC}
SG	1-Gate	NL17SG/7SG	0.9	3.6	2.5 @ V_{CC} = 3 V	± 8 @ V_{CC} = 3.0 V	CMOS	0 to 3.6	0 to V_{CC}
SP	1-Gate	NC7SP	0.9	3.6	2.9 @ V_{CC} = 3 V	± 2.6 @ V_{CC} = 3.0 V	CMOS	0 to 3.6	0 to V_{CC}
WP	2-Gate	NC7WP	0.9	3.6	3.0 @ V_{CC} = 3 V	± 2.6 @ V_{CC} = 3.0 V	CMOS	0 to 3.6	0 to V_{CC}
NP	3-Gate	NC7NP	0.9	3.6	3.0 @ V_{CC} = 3 V	± 2.6 @ V_{CC} = 3.0 V	CMOS	0 to 3.6	0 to V_{CC}
SZ	1-Gate	NL17SZ/7SZ/NC7SZ	1.65	5.5	2.7 @ V_{CC} = 5 V	± 32 @ V_{CC} = 4.5 V	CMOS	0 to 5.5	0 to V_{CC}
WZ	2-Gate	NL27WZ/NC7WZ	1.65	5.5	2.3 @ V_{CC} = 5 V	± 32 @ V_{CC} = 4.5 V	CMOS	0 to 5.5	0 to V_{CC}
WZ/NZ	3-Gate	NL37WZ/NC7NZ	1.65	5.5	2.1 @ V_{CC} = 5 V	± 32 @ V_{CC} = 4.5 V	CMOS	0 to 5.5	0 to V_{CC}
VHC	1-Gate	MC74VHC1G	2.0	5.5	3.5 @ V_{CC} = 5 V	± 8 @ V_{CC} = 4.5 V	CMOS	0 to 5.5	0 to V_{CC}
VHCT	1-Gate	MC74VHC1GT	2.0	5.5	3.5 @ V_{CC} = 5 V	± 8 @ V_{CC} = 4.5 V	TTL	0 to 5.5	0 to V_{CC}
VHC	2-Gate	MC74VHC2G*	2.0	5.5	3.5 @ V_{CC} = 5 V	± 8 @ V_{CC} = 4.5 V	CMOS	0 to 5.5	0 to V_{CC}
VHC	3-Gate	MC74VHC3G*	2.0	5.5	3.5 @ V_{CC} = 5 V	± 8 @ V_{CC} = 4.5 V	CMOS	0 to 5.5	0 to V_{CC}
HC	1-Gate	MC74HC1G/NC7S	2.0	6.0	7.0 @ V_{CC} = 5 V	± 2.6 @ V_{CC} = 6.0 V	CMOS	0 to V_{CC}	0 to V_{CC}
HCT	1-Gate	NC7ST	4.5	6.0	7.0 @ V_{CC} = 5 V	± 2.0 @ V_{CC} = 4.5 V	TTL	0 to V_{CC}	0 to V_{CC}

Package Offerings: SOT9x3, SOT5x3, SC88(A), SC74(A), US8, xDFN, uDFN, uQFN

*In Development

MiniGates™ Logic Function Tables

#	Gates	1-Gate	2-Gate	3-Gate
00	NAND (2-Input)	•	•	
01	NAND (2-Input, Open Drain)	•	•	
02	NOR (2-Input)	•	•	
03	NOR (2-Input, Open Drain)	•	•	
08	AND (2-Input)	•	•	
09	AND (2-Input, Open Drain)	•	•	
10	NAND (3-Input)	•		
11	AND (3-Input)	•		
27	NOR (3-Input)	•		
32	OR (2-Input)	•	•	
38	NAND (2-Input, Open Drain)	•	•	
86	XOR (2-Input)	•	•	
87	XNOR Gate (2-Input)	•		
132	NAND (Schmitt Trigger)	•	•	
135	NAND (Schmitt /Open Drain)	•	•	
332	OR (3-Input)	•		
386	XOR (3-Input)	•		

#	Buffers / Inverters	1-Gate	2-Gate	3-Gate
04	Inverter	•	•	•
05/06	Inverter (Open Drain)	•	•	•
07	Buffer (Open Drain)	•	•	•
14	Inverter (Schmitt Trigger)	•	•	•
16/34/50	Buffer	•	•	•
17	Buffer (Schmitt Trigger)	•	•	•
125	3-State Buffer	•	•	
126	3-State Buffer	•	•	
U04	Un-buffered Inverter	•	•	•

#	Dual Function	1-Gate	2-Gate	3-Gate
0604	Dual Inverter (Open-Drain, Standard)	•		
3404	Inverter / Buffer	•	•	
3407	Dual Buffer (Standard, Open-Drain)	•		
0832	3-input AND-OR gate	•		
3208	3-Input OR-AND Gate	•		

#	Other Functions	1-Gate	2-Gate	3-Gate
X04	X-tal Driver	•		
18	1-of-2 Decoder (3-State)	•		
19	1-of-2 Decoder	•		
29	2-of-3 Decoder/Demultiplexer	•		
56/59	Configurable Logic (Open Drain)	•		
57/58	Configurable Logic	•		
74	Single D Flip-Flop	•		
79	Edge-Triggered D-Type Flip-Flop	•	•	
80	Edge-Triggered D-Type Flip-Flop	•	•	
95/96	Configurable Logic (Open Drain)	•		
97/98	Configurable Logic	•		
99	Configurable Logic	•		
157	2-Input Multiplexer	•		
158	2-Input Multiplexer; Inverting	•		
175	D-Type Flip-Flop with Reset	•		
240	Dual Inverter/Line Driver (3-State)	•	•	
241	Dual Buffer/Line Driver (3-State)		•	
373	D-Type Latch (3-State)	•		
374	D-Type Flip-Flop (3-State)	•		

Package Offerings:

Protection & Small Signal

Protection and Signal Product Portfolio

> 6,000 Part Numbers > 170 different Packages

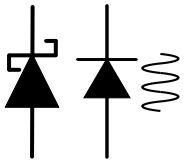
Zener Diodes

- 1.8 V to 200 V
- 0.2 W to 5 W
- Large Variety of Packages
- Devices as small as 0.62 x 0.32 mm^2

ESD & Surge Protection

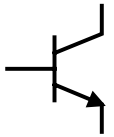
- Highest Power Density in the Industry
- Low Clamping Voltage
- 1 V to 70 V
- Singles, Duals and Arrays
- Optimized response for each interface: High Speed, Power Line, GPIO, Battery Line
- Guaranteed Max Insertion Loss on selected devices

Schottky & SS Diodes



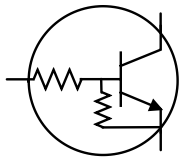
- Optimized V_F & I_R specs → Increase Power Efficiency, Reduce Footprint
- Low Recovery Times
- Singles, Duals and Bridge configurations available
- Wide selection of packages
- First 500 mA, 30 V Schottky in 01005 in the Industry

BJTs



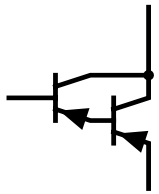
- 10 V to 800 V
- Packages as small as 1.0 x 0.6 mm^2
- Audio and Power devices handle > 10 A
- Low V_{CE} Sat devices available
  - Cost effective alternative to MOSFETS
  - R_{DSON} Eq of 30 mΩ
  - High ESD Tolerance

BRTs



- BJT with Integrated Biasing Resistors
- Save cost and board space
- 17 different resistor combinations
- Singles & Duals
- Over 350 options available!

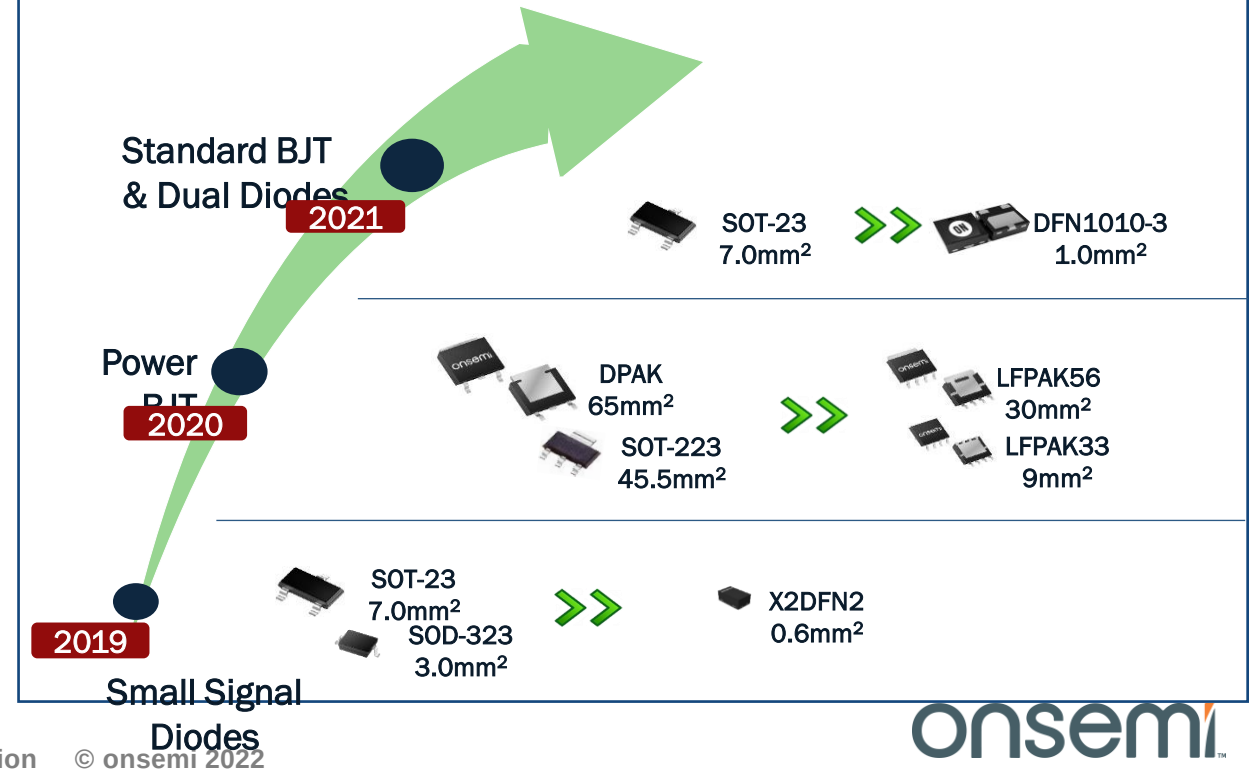
Darlington Transistors

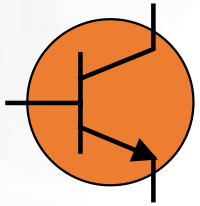


- 30 V to 400 V
- I_C of 0.3 A to 50 A
- Current Gains up to 30,000
- NPN & PNP Configurations available
- More than 80 devices to choose from

Package Migration

Utilizing >80% smaller, more efficient packages



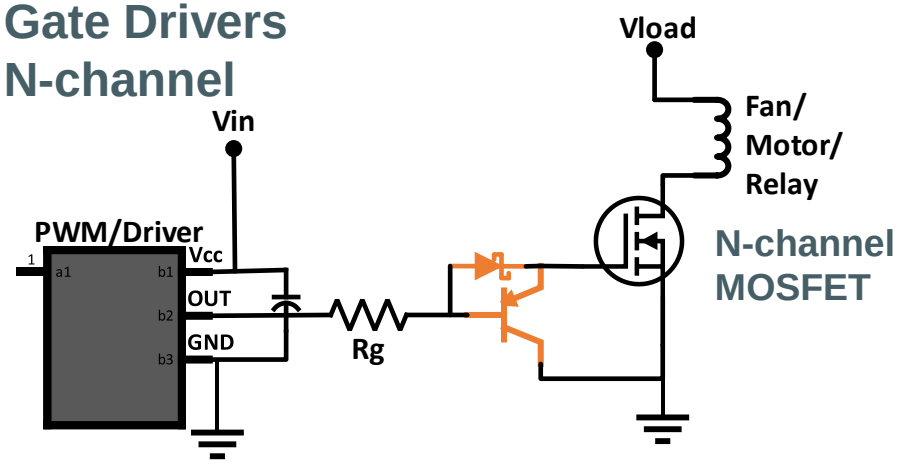


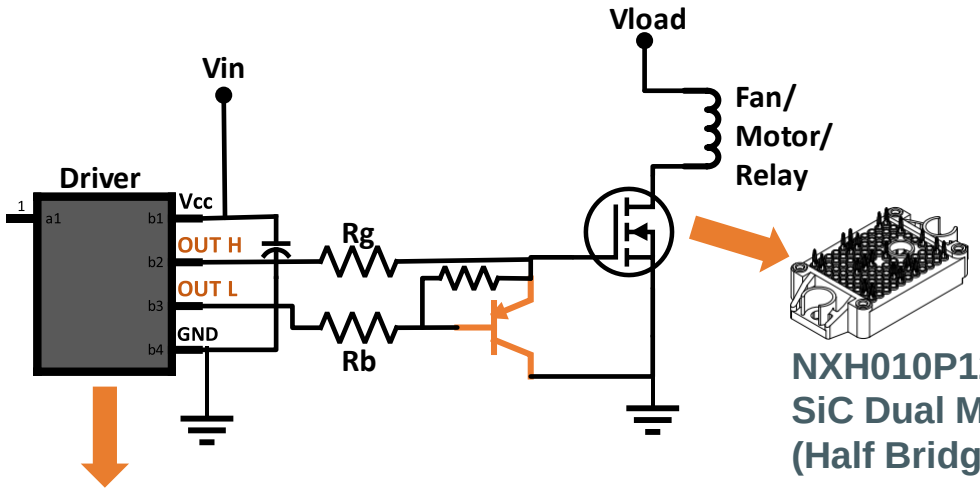
BJTs

Bipolar Junction Transistors

BJTs in Industrial Applications

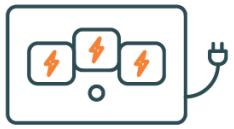
Gate Drivers N-channel





NCD57000
IGBT Gate Driver

NXH010P120MN
SiC Dual MOSFET Module
(Half Bridge)



UPS

Solar
Inverters

EV Charging
Stations

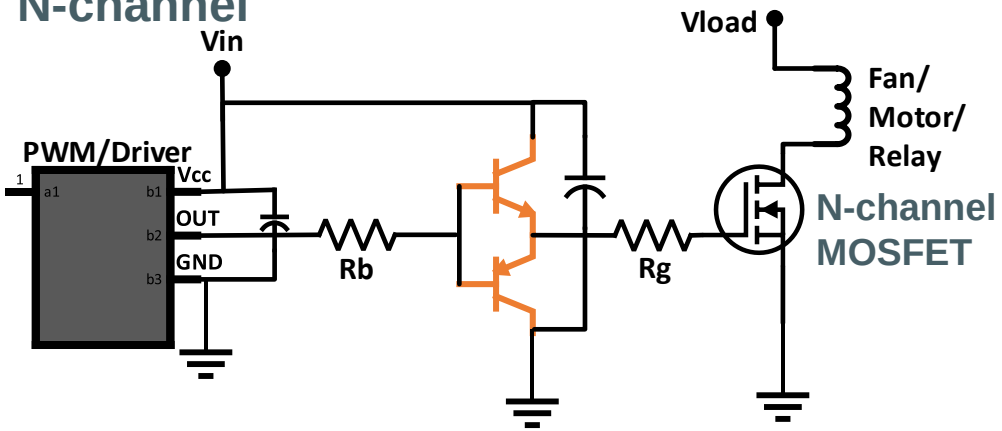
Turn-off speed enhancement

- Implemented using a PNP (and a Schottky Diode)
- Higher current turn-off circuit
  - Discharge Cin faster
  - Shorter switching times → Lower switching losses
  - Peak discharge current does not reach driver
    - Power dissipation of driver is reduced
    - Turn-off Current confined in small loop close to MOSFET
  - NXH010P120MN Cin ~5,000 pF
- For Drivers handling High and Low cycles on the same I/O
  - Schottky Diode Selection
    - High enough current
    - Thermals/power dissipation
    - Low trr (to avoid increasing turn-on time)

Any application that incorporate **Gate Drivers** and/or **Power MOSFETs/Modules/IGBTs** has potential for needing **BJTs!**

BJTs in Industrial Applications

Gate Drivers
N-channel

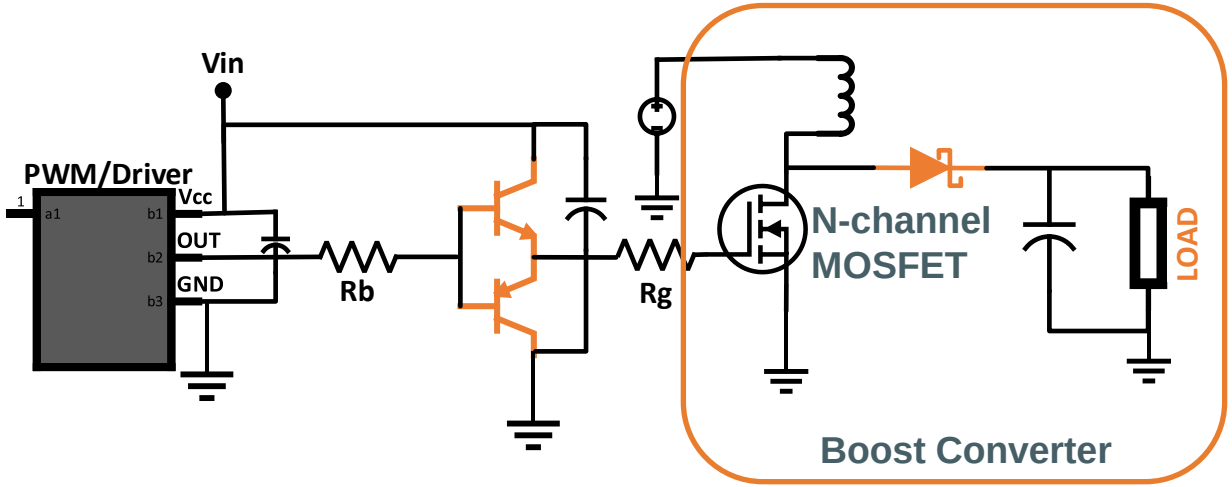


Power Supplies

Power Tools

Push-Pull Output Configuration (Totem Pole)

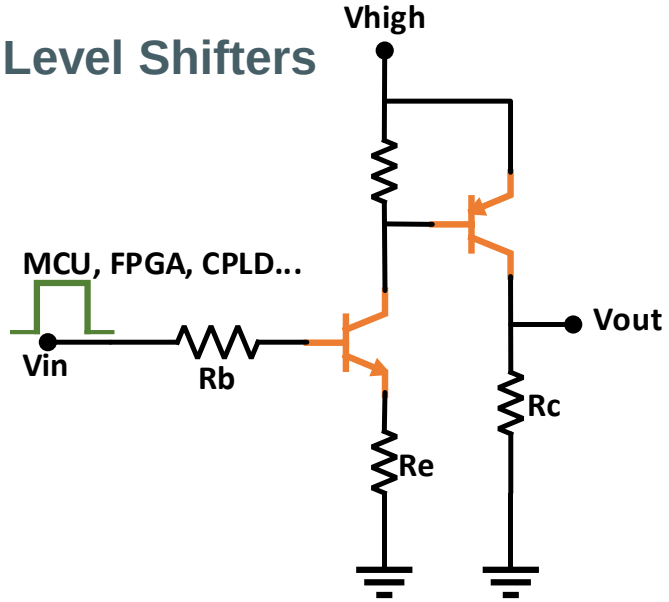
- Provides high output current and low Zout
- Ideal for driving high capacitive loads
  - **Power MOSFETs/IGBTs!**
- Use when the driver IC or MCU can't source enough current
- Used also in Switching Converters

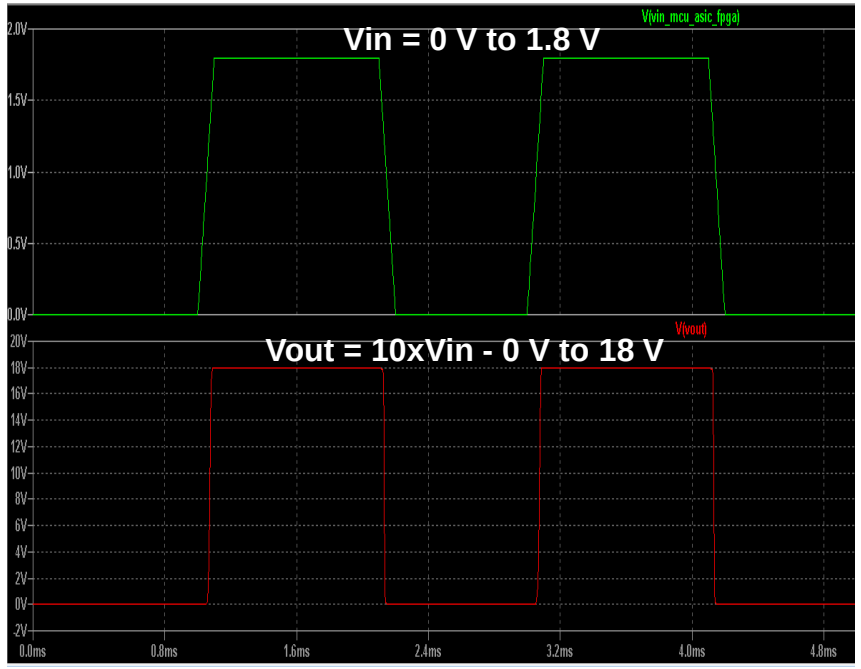


Any application that incorporate **Gate Drivers** and/or **Power MOSFETs/Modules/IGBTs** has potential for needing **BJTs!**

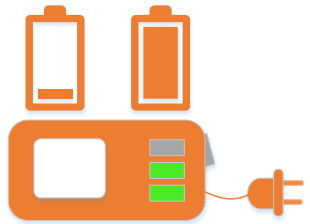
BJTs in Industrial Applications

Level Shifters



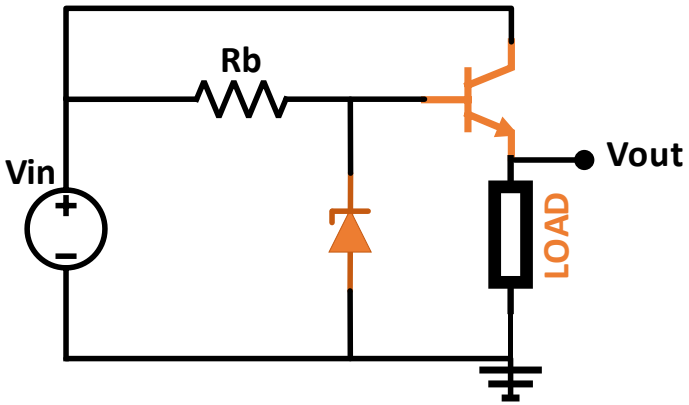


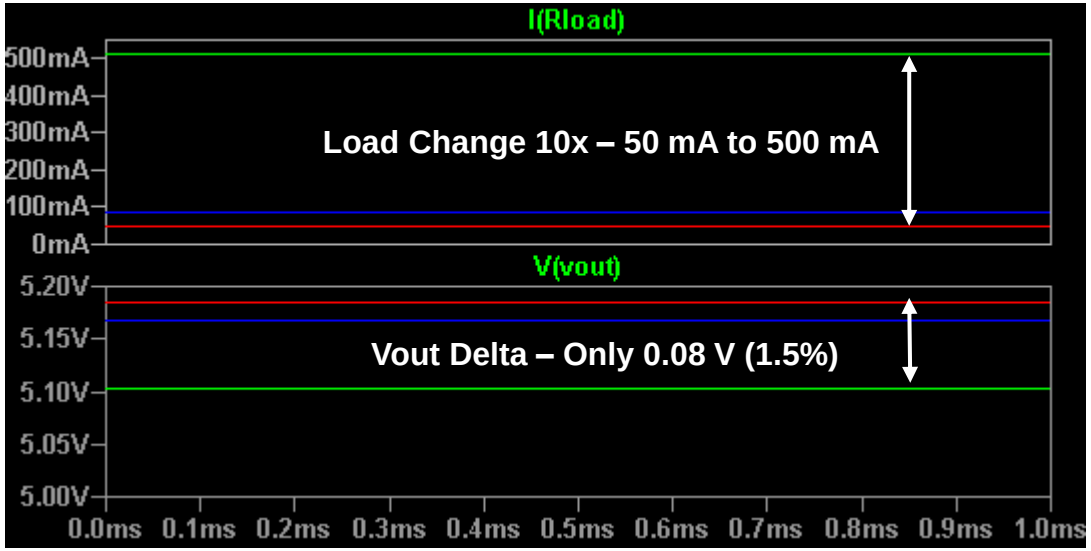
Power Tools



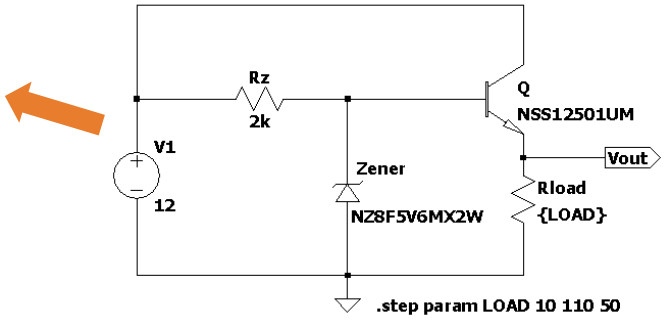
Battery Chargers

Cost Effective Voltage Regulators (Voltage Follower)



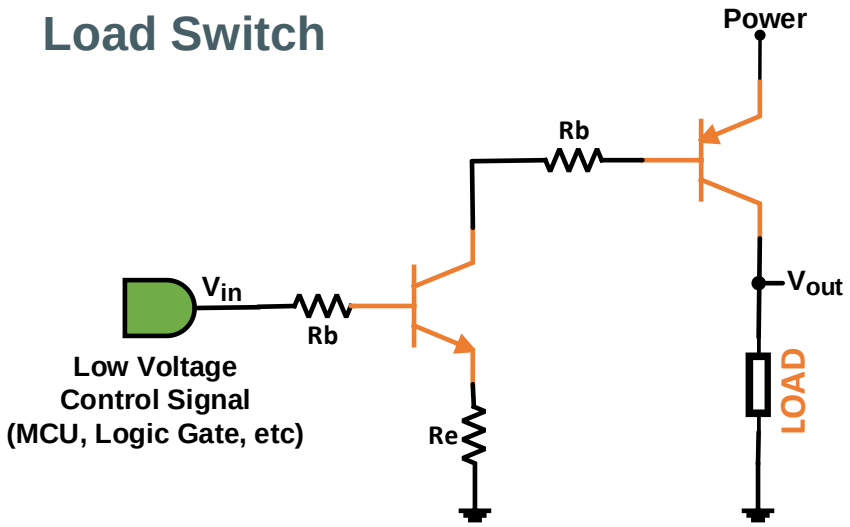


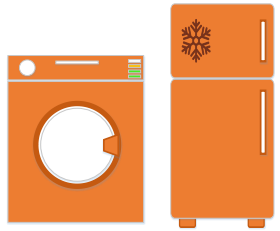
EV Charging Stations | Power Tools | Garage Door Openers



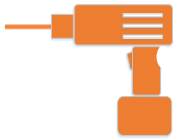
BJTs in Industrial Applications

Load Switch





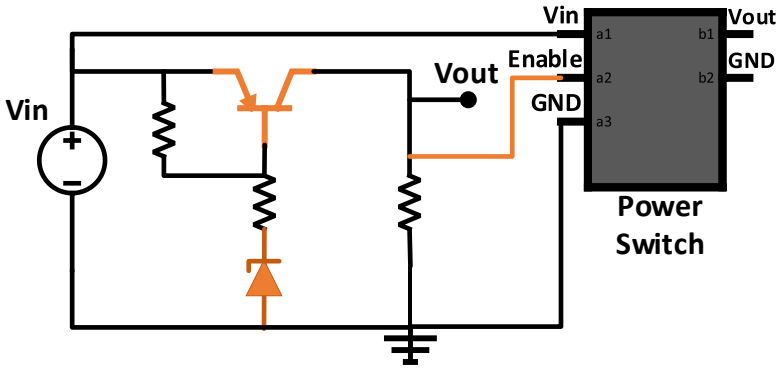
Appliances



Power Tools

Garage Door Openers

Voltage Monitors

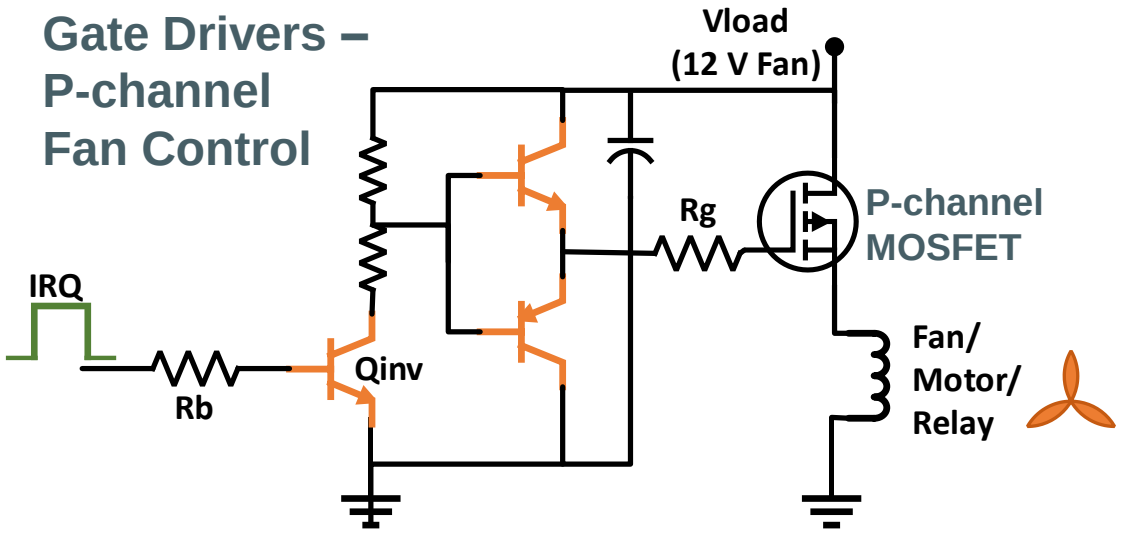


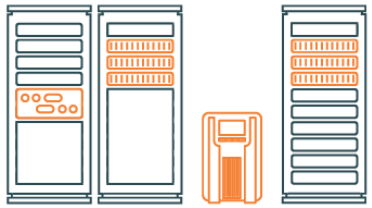
Garage Door Openers

EV Charging Stations

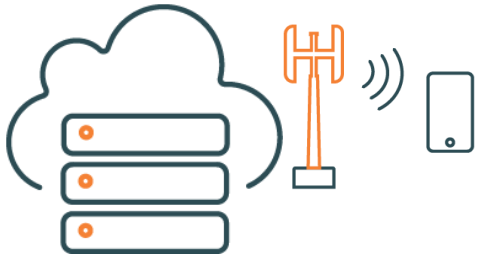
BJTs in Cloud Computing / Telecomm

Gate Drivers – P-channel Fan Control





Servers

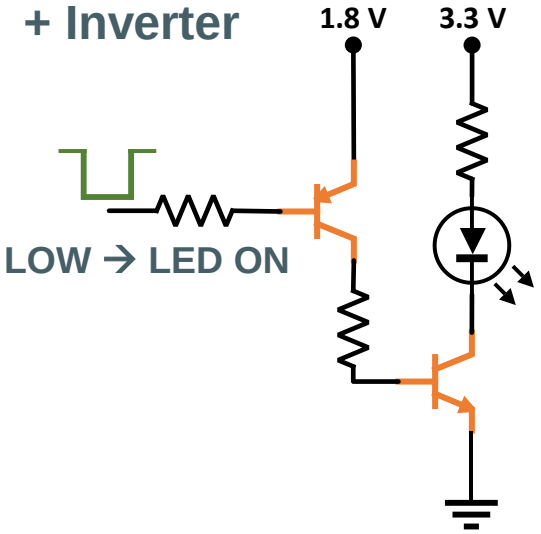


Telecom Eq

Push-Pull Output Configuration (Totem Pole) – P-channel

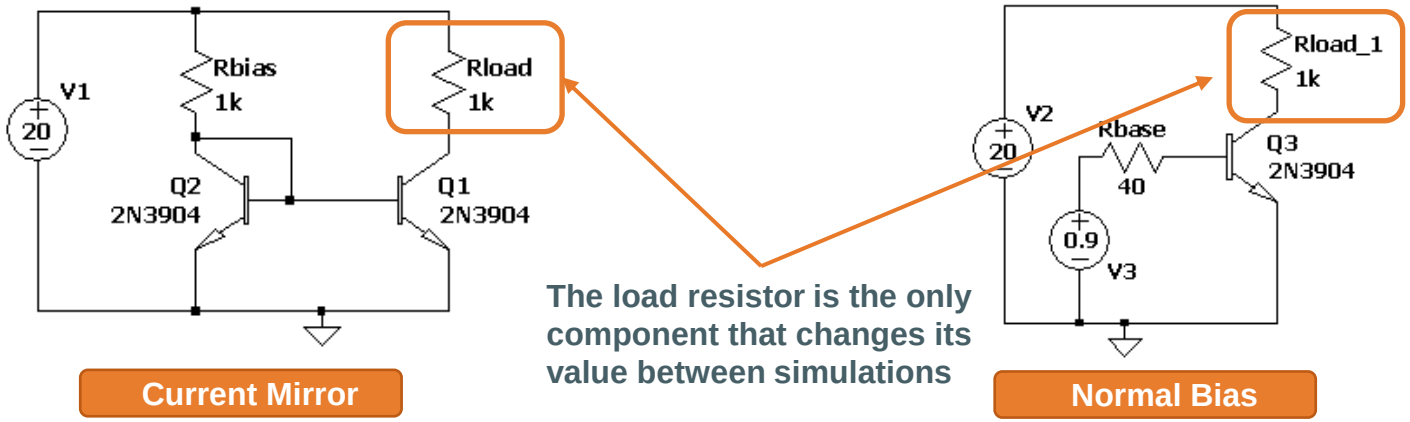
- Provides high output current and low Zout
- Ideal for driving high capacitive loads
  - **Power MOSFETs!**
- The MP/MCU will not provide enough current

LED Driver + Inverter

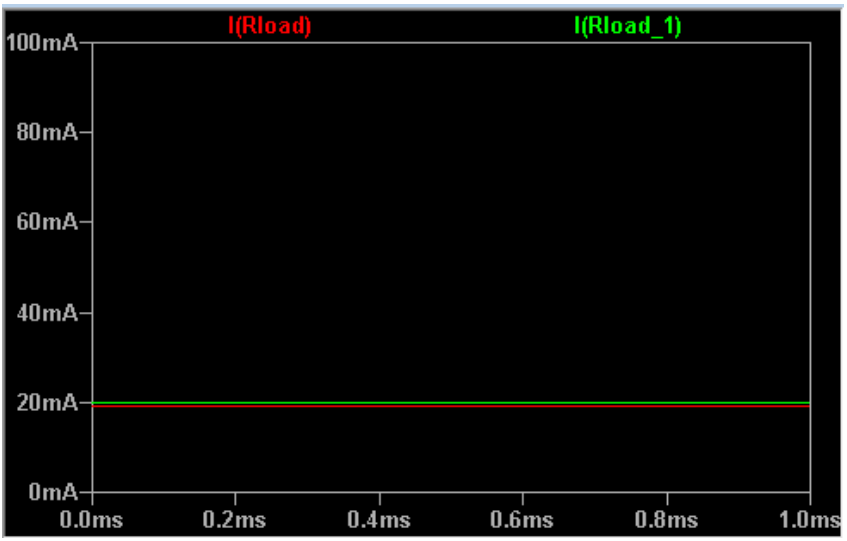


Any application that incorporate **Power MOSFETs** has potential for needing **BJTs!**

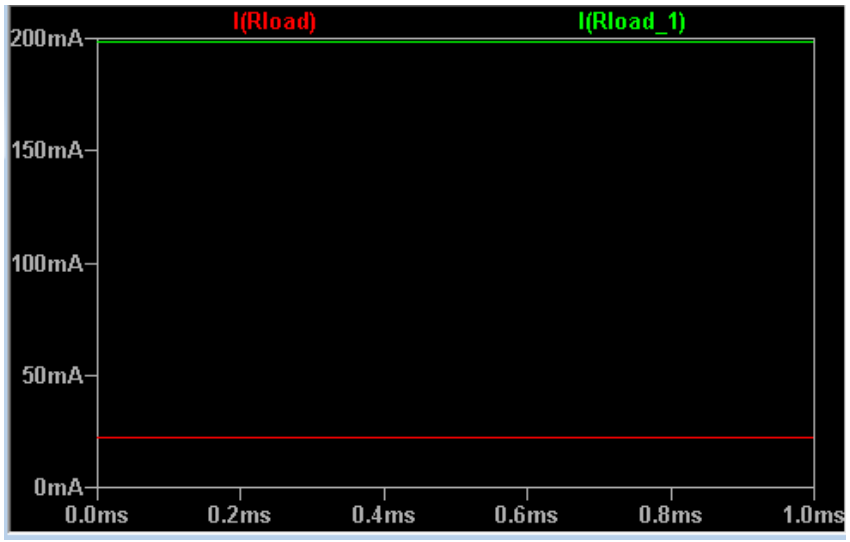
Current Mirror Example (Sinking) – Changing Loads



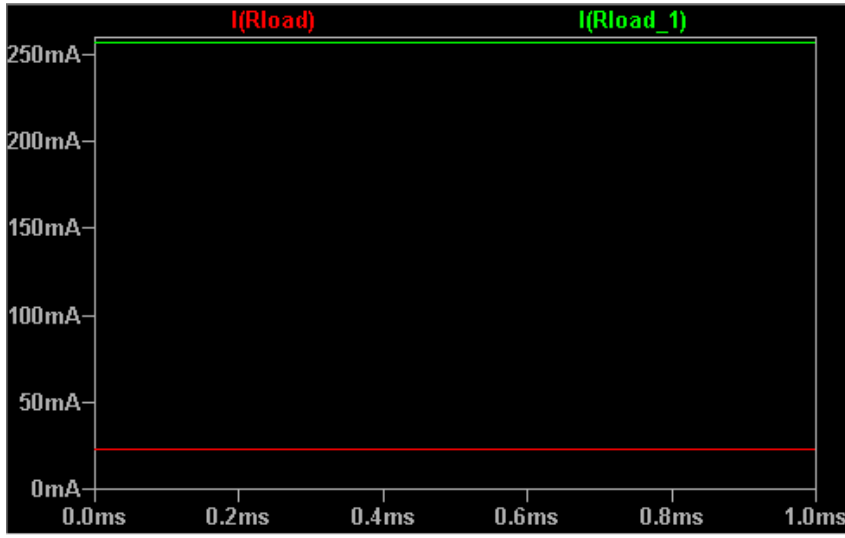
	Current on Load (mA)	
Load	Current Mirror	Normal Bias
1000 Ω	19.2	19.9
100 Ω	22.2	198.2
10 Ω	22.5	256.6



Rload == Rload_1 == 1kΩ

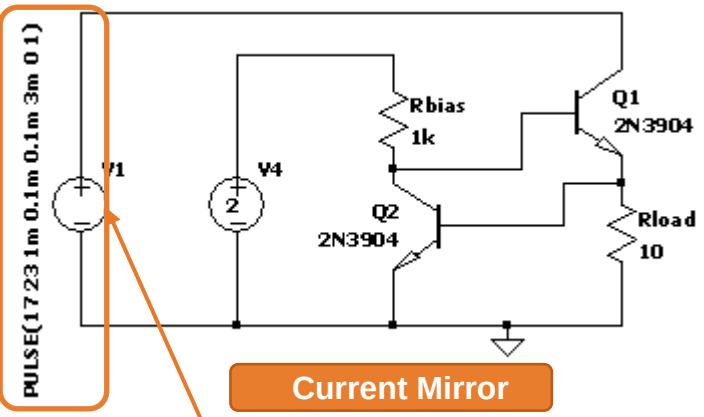


Rload == Rload_1 == 100Ω

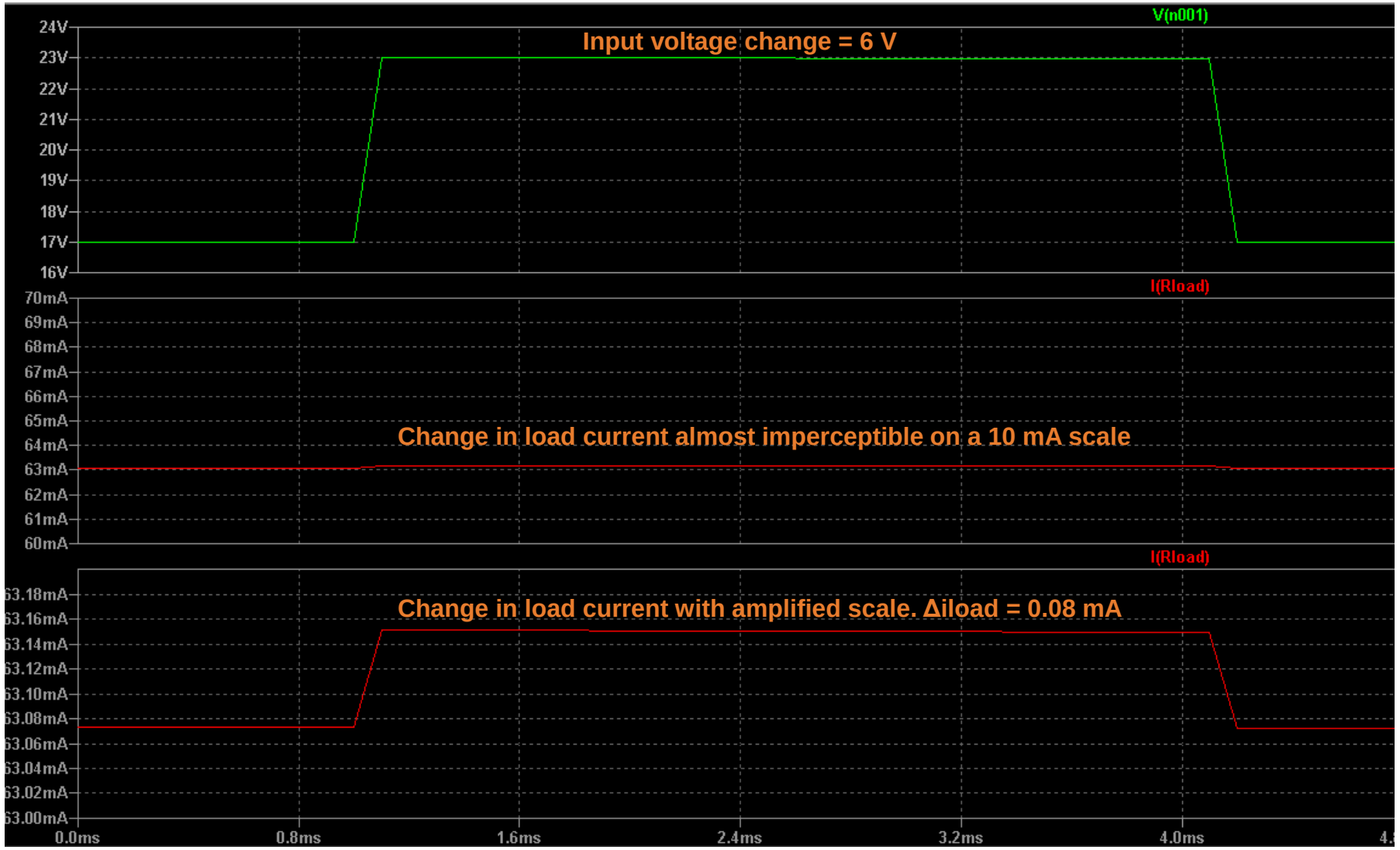


Rload == Rload_1 == 10Ω

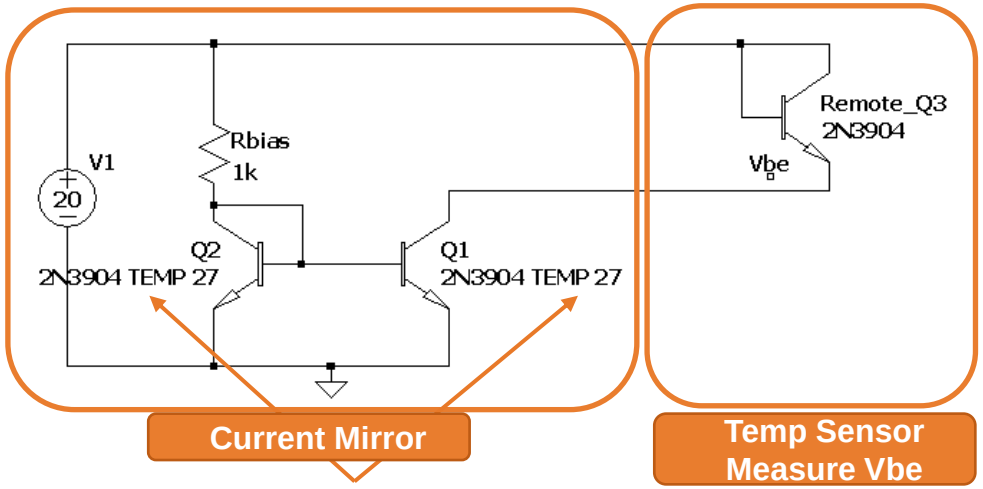
Current Mirror Example (Sinking) – Changing Input Voltage



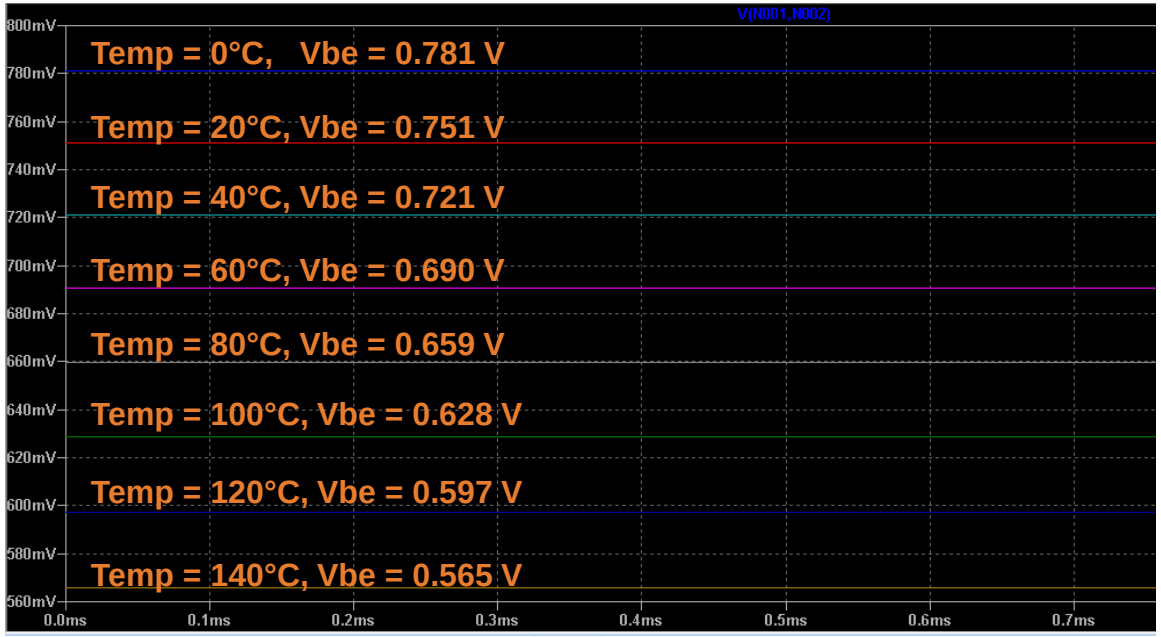
Input Voltage changes 6 V, from 17 V to 23 V. Current on load remains steady within 0.1mA

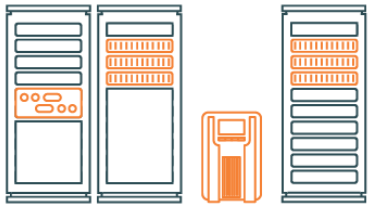


BJT as a Temperature Sensor

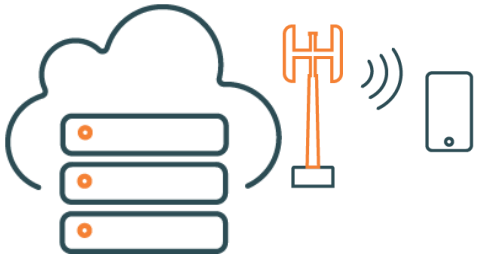


Constant Temperature on Q1 and Q2, as they are far from the Temp Source

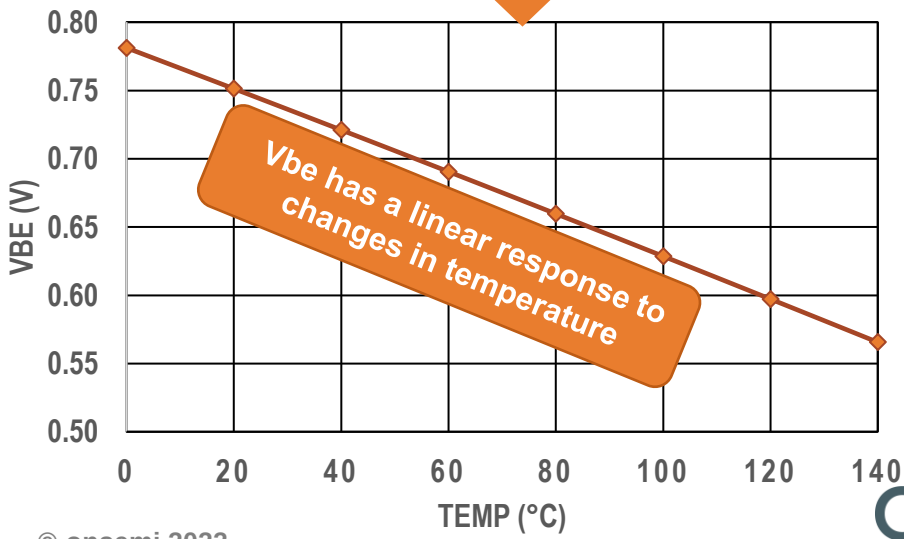




Servers

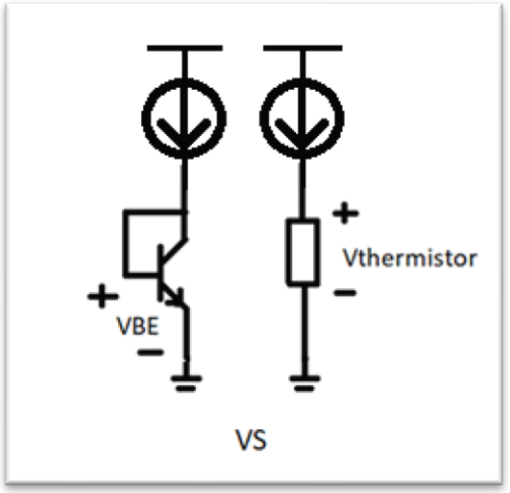


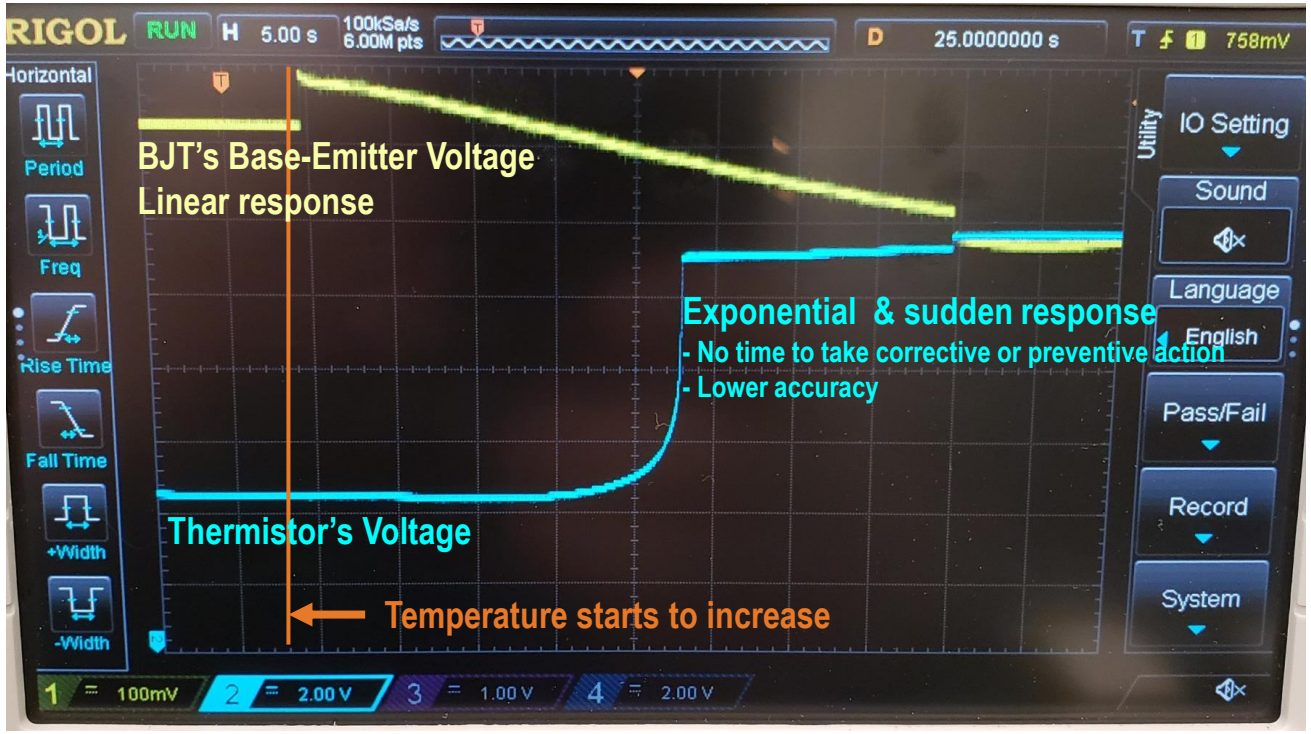
Telecom Eq



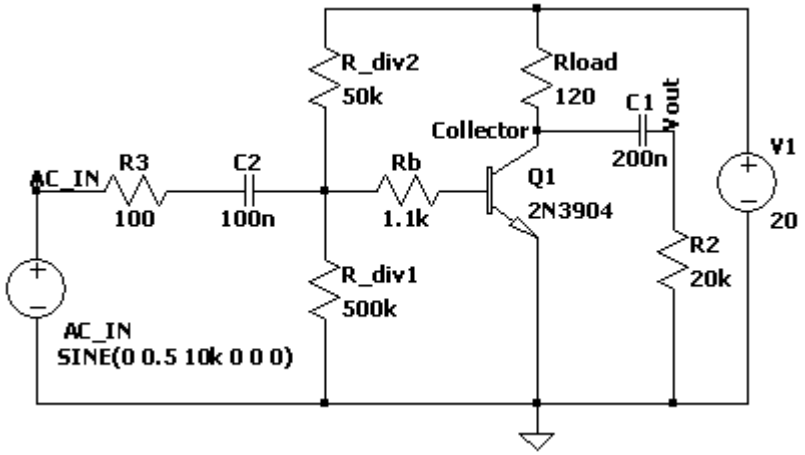
BJTs for Temp Sensing Applications – Advantages over Thermistors

- One of the commonly overlooked BJT applications is temperature sensing.
  - On a BJT, the Base-Emitter junction produces a voltage that is *linearly proportional to the temperature* when a current is applied, thus becoming a very precise temperature sensor.
- When compared to a traditional thermistor, a BJT temperature sensing implementation provides the following *advantages*:
  - ✓ **Linear voltage drop over temperature → accurate measurements**
  - ✓ **No look-up table required for voltage to temperature conversion**
  - ✓ **Lower power consumption**
  - ✓ **Significantly lower part-to-part variability**

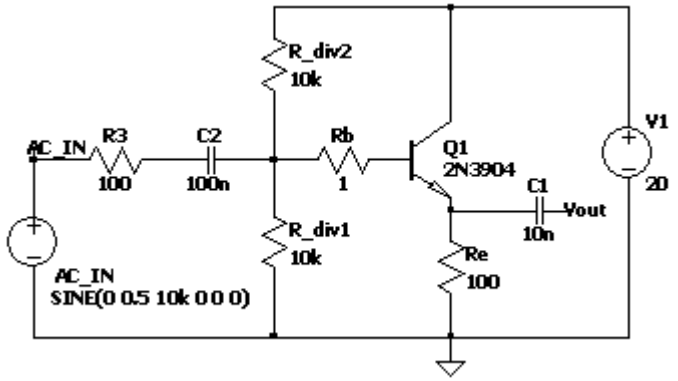




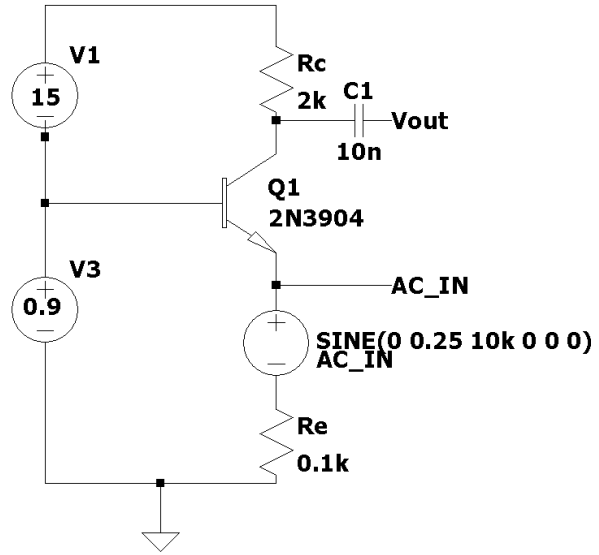
BJTs as Amplifiers – Configurations



Common Emitter



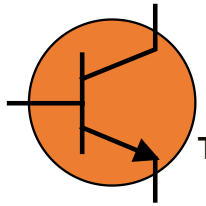
Common Collector



Common Base

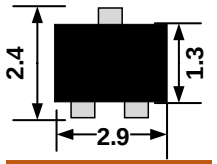
Characteristic	Common Emitter	Common Collector	Common Base
Voltage Gain	Medium	Low (A_V ~ 1)	High
Power Gain	High	Medium	Low (A_I ~ 1)
Phase Shift	180°	0°	0°
Z_{IN}	Medium	High	Low
Z_{OUT}	Low	Low	High

Comprehensive BJT Portfolio

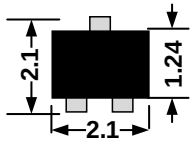


Bipolar Junction Transistors

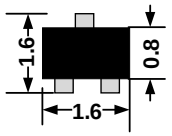
Note : All parts AEC-Q101 qualified



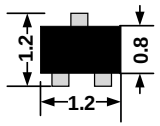
7.0 mm² 240 mW*



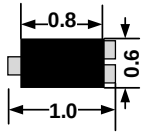
4.4 mm² 150 mW*



2.6 mm² 200 mW*

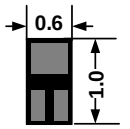


0.8 mm² 300 mW*



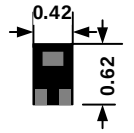
0.6 mm² 250 mW*

NEW!!



0.6 mm² 250 mW*

Exploring



0.26 mm2 175 mW*

I_C (A)	V_{CE} (V)	Polarity	SOT-23	SC-70	SC-75	SOT-723	SOT-1123	SOT-883	XDFN3
0.06	160	NPN	MMBT5551L			MMBT5551M3			
0.1	30	NPN	BC848BL	BC848BW			NST848BF3		
			BC848CL	BC848CW					
		PNP	BC858AL	BC858AW					
			BC858BL	BC858BW					
	45	NPN	BC847AL	BC847AW				NST847AMX2	NST847AMX3
			BC847BL	BC847BW	BC847BT	BC847BM3	NST847BF3	NST847BMX2	NST847BMX3
			BC847CL	BC847CW	BC847CT				
		PNP	BC857BL	BC857BW	BC857BT		NST857BF3	NST857A/BMX2	NST857A/BMX3
			BC857CL	BC857CW					
	50	NPN			2SC4617	2SC5658M3		NST4617MX2	NST4617MX3
		PNP			2SA1774	2SA2029M3			
	65	NPN	BC846BL	BC846BW		BC846BM3	NST846BF3	NST846BMX2	NST846BMX3
		PNP	BC856BL	BC856BW		BC856BM3	NST856BF3		
0.2	40	NPN	MMBT3904L	MMBT3904W	MMBT3904T		NST3904F3	NST3904MX2	NST3904MX3
		PNP	MMBT3906L	MMBT3906W	MMBT3906T		NST3906F3	NST3906MX2	NST3906MX3
0.5	80	NPN	MMBTA06L	MMBTA06W					
		PNP	MMBTA56L	MMBTA56W					
0.6	40	NPN	MMBT2222AL	MMBT2222AW	MMBT2222AT	MMBT2222AM3			
			MMBT4401L	MMBT4401W		MMBT4401M3			
		PNP	MMBT4403L	MMBT4403W		MMBT4403M3			
	60	PNP	MMBT2907AL	MMBT2907AW		MMBT2907AM3			

*Copper traces of 25 mm²

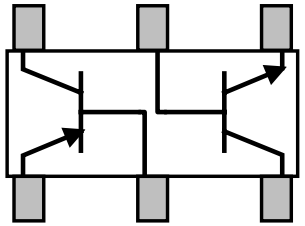
91% Smaller, 21% Higher Power

Complete Portfolio
- One of largest portfolios of parts in the industry
- Single, Dual, Complementary and Darlington configurations available

High Levels of Quality
- Very low (<7 ppb) product defect rate
- Extensive AEC-Q101 Qualified portfolio

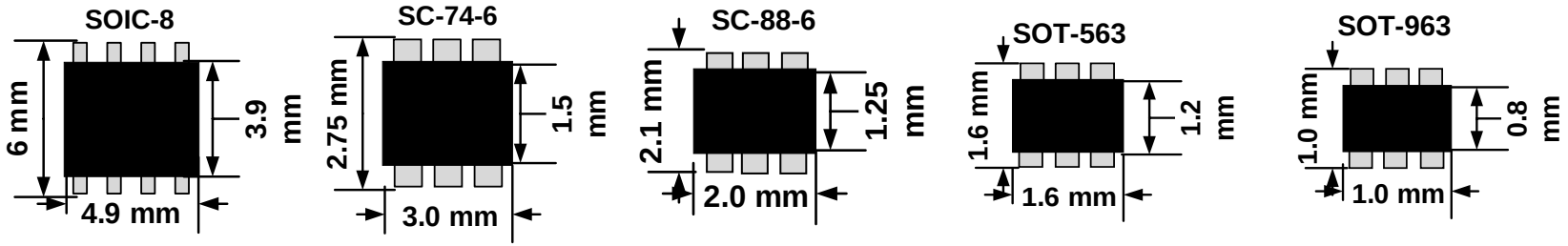
Reliable Supply
- Global supply chain with one of largest production footprints in the industry.

Complementary BJTs - Level Shifters, Gate Drivers, Load Switches

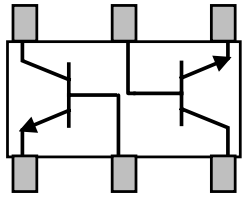


Complementary BJT Portfolio

Part No.	VCEO Min (V)	VCE(sat) Max (V)	IC Cont. (A)	VCBO (V)	VBE(sat) (V)	PTM Max (W)	Package
BC848CPD	30	0.6	0.1	30	0.7	0.38	SC-88-6 / SC-70-6
CPH5506	30	0.375	1.5	40	0.85	1.2	CPH-5 / SC-74A
CPH5541	30	0.19	0.7	40	0.9	0.6	CPH-5 / SC-74A
FMB2227A	30	1.4	0.5	60	1.3	0.7	TSOT-23-6
MCH6541	30	0.19	0.7	40	0.9	0.55	SC-88FL / MCPH-6
FMB3946	40	0.25	0.2	40	0.9	0.7	TSOT-23-6
MBT3946DW1T1	40	0.3-NPN 0.4-PNP	0.2	60	0.65	0.15	SC-88-6 / SC-70-6
MMPQ6700	40	0.25	0.2	40	0.9	1	SOIC-16
NSS40302PD	40	0.06	3	40	0.9	0.576	SOIC-8
NST3946DP6	40	0.3 (NPN) 0.4 (PNP)	0.2	60	0.95	0.42	SOT-963
NST3946DXV6	40	0.3 (NPN) 0.4 (PNP)	0.2	60	0.95	0.5	SOT-563
BC847BP	45	0.6	0.1	50	0.7	0.38	SC-88-6 / SC-70-6
BC847BPDXV6	45	0.25	0.1	50	0.7	0.5	SOT-563
NST847BPDP6T5G	45	0.6 (NPN) 0.7 (PNP)	0.1	50	0.9	0.42	SOT-963
CPH5517	50	0.43	1	60	0.81	0.9	CPH-5 / SC-74A
CPH5520	50	0.33	2	80	0.9	1.2	CPH-5 / SC-74A
CPH5524	50	0.23	3	100	0.88	1.2	CPH-5 / SC-74A
HN1B01FDW1	50	0.3	0.2	60	-	0.38	SC-74
UMZ1N	50	0.25, 0.3	0.2	60	-	0.25	SC-88-6 / SC-70-6
BC846BPDW1	65	0.6	0.1	80	0.7	0.38	SC-88-6 / SC-70-6



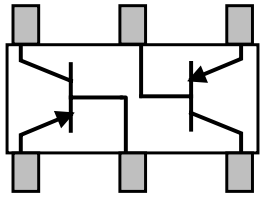
BJTs - Dual NPNs and Dual PNPs – Current Mirrors



Dual NPN Portfolio

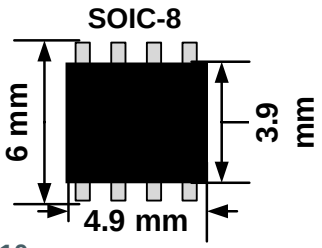
Part No.	VCEO Min (V)	VCE(sat) Max (V)	IC Cont. (A)	VCBO (V)	VEBO (V)	hFE Min	hFE Max	PD Max (W)	Package
BC848CDW1	30	0.25	0.1	30	5	420	800	0.38	SC-88-6
MBT2222ADW1T1	40	1	0.6	75	6	100	300	0.15	SC-88-6
MBT3904DW1	40	0.3	0.2	60	6	100	300	0.15	SC-88-6
NSS40301MD	40	0.06	3	40	6	200	-	0.576	SOIC-8
NST3904DP6	40	0.3	0.2	60	6	100	300	0.42	SOT-963
NST3904DXV6	40	0.3	0.2	60	6	100	300	0.357	SOT-563
BC847BDW1	45	0.25	0.1	50	6	200	450	0.38	SC-88-6
BC847CDW1	45	0.25	0.1	50	6	420	800	0.38	SC-88-6
BC847CDXV6	45	0.25	0.1	50	6	420	800	0.357	SOT-563
MBT6429DW1	45	0.6	0.2	55	6	500	1250	0.15	SC-88-6
NST45011MW6T1G	45	6	0.1	50	6	200	500	0.38	SC-88-6
NST847BDP6	45	0.6	0.1	50	6	200	450	0.42	SOT-963
EMX2DXV6	50	0.4	0.1	60	7	120	560	0.357	SOT-563
EMX1	50	0.4	0.1	60	7	120	560	0.357	SOT-563
MCH6544	50	0.1	0.5	60	5	300	800	0.55	SC-88FL
NSS60101DMR	60	0.2	1	60	6	100		0.4	SC-74-6
NSS60101DMT	60	0.18	1	60	6	90	-	2.27	WDFN-6
BC846BDW1	65	0.25	0.1	80	6	200	450	0.38	SC-88-6
NST65011M	65	6	0.1	80	6	200	500	0.38	SC-88-6
FFB5551	160	0.2	0.2	180	6	30	250	0.2	SC-88-6

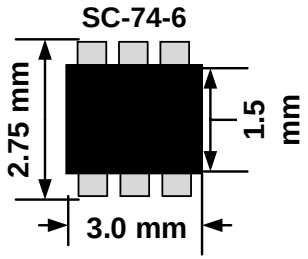
Denotes Low V_{CESAT} option

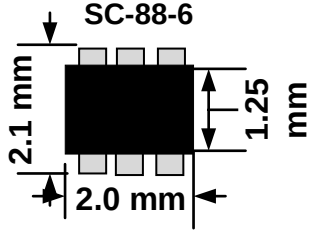


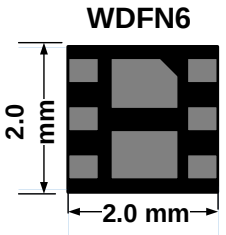
Dual PNP Portfolio

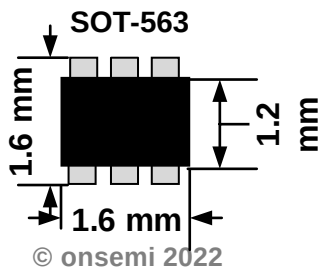
Part No.	VCEO Min (V)	VCE(sat) Max (V)	IC Cont. (A)	VCBO (V)	VEBO (V)	hFE Min	hFE Max	PD Max (W)	Package
NSS20200DM	20	0.39	2	20	7	100		2.1	WDFN-6
BC858CDXV6	30	0.3	0.1	30	5	420	800	0.35	SOT-563
NST30010MXV6	30	0.6	0.1	30	5	420	800	0.5	SOT-563
MBT3906DW1	40	0.4	0.2	40	5	100	300	0.15	SC-88-6
MBT3906DW3	40	0.4	0.2	40	5	100	300	0.15	SC-88-6
NSS40300DD	40	0.095	3	40	7	220	-	0.57	SOIC-8
NSS40300MD	40	0.095	3	40	7	220	-	0.57	SOIC-8
NST3906DP6	40	0.4	0.2	40	5	100	300	0.42	SOT-963
NST3906DXV6	40	0.4	0.2	40	5	100	300	0.35	SOT-563
BC857BDW1	45	0.3	0.1	50	5	220	475	0.38	SC-88-6
BC857CDW1	45	0.3	0.1	50	5	420	800	0.38	SC-88-6
NST45010	45	0.65	0.1	50	5	220	475	0.38	SC-88-6
NST857BDP6	45	0.7	0.1	50	6	220	475	420	SOT-963
EMT1DX	50	0.5	0.1	60	6	120	560	0.35	SOT-563
NSS60100DMT	60	0.3	1	80	6	90	-	2.27	WDFN-6
NSS60200DM	60	0.45	2	60	6	40		2.27	WDFN-6
BC856B	65	0.3	0.1	80	5	220	475	0.38	SC-88-6
NST65010M	65	0.65	0.1	80	5	220	475	0.38	SC-88-6

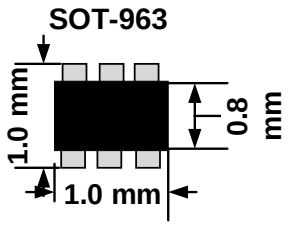












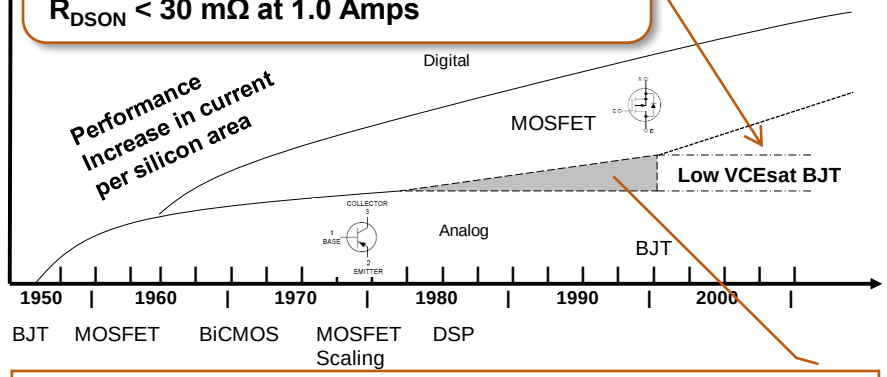
Low V_{CESAT} Bipolar Transistors

Low $V_{CE(sat)}$ Bipolar Transistors

> 190 Low $V_{CE(SAT)}$ devices available!

Technology Evolution

Low $V_{CE(sat)}$ BJTs provide an alternative to MOSFETs and have equivalent R_{DSON} < 30 mΩ at 1.0 Amps



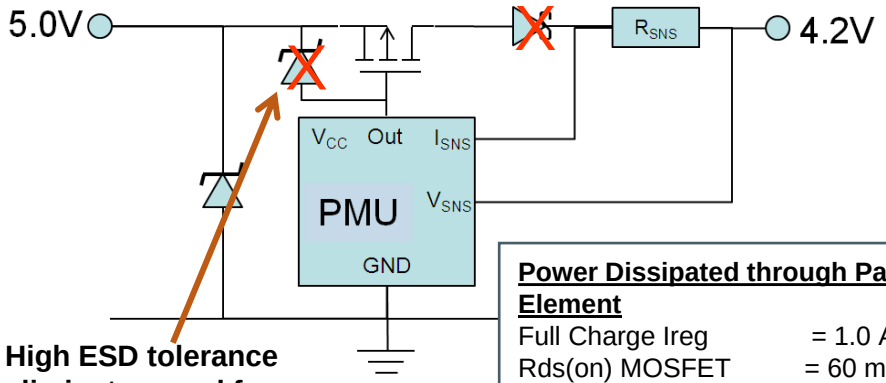
Low $V_{CE(sat)}$ blurs the performance line between BJT & MosFET

Standard BJT	Low $V_{CE(sat)}$ BJT	MOSFET
Lower Efficiency	**Moderate Efficiency**	High Efficiency
Low ASP	**Medium ASP** ✓	High ASP
High ESD tolerance Bi-Directional	**High ESD tolerance** **Bi-Directional** ✓	Low ESD Tolerance Mono-Directional
High & Low Voltage Switching Low Turn on Voltage	**High & Low Voltage** **Switching** **Low Turn on Voltage** ✓	Med Voltage Switching High Turn on Voltage
High Switching Speed At Low Currents	**Medium Switching Speed** **Low Harmonics**	Higher Switching Speed At High Currents

Low $V_{CE(sat)}$ transistors combine many of the performance features of MOSFETs with the attractive price of BJTs

Fewer Components = Lower cost + Less PCB Space ✓

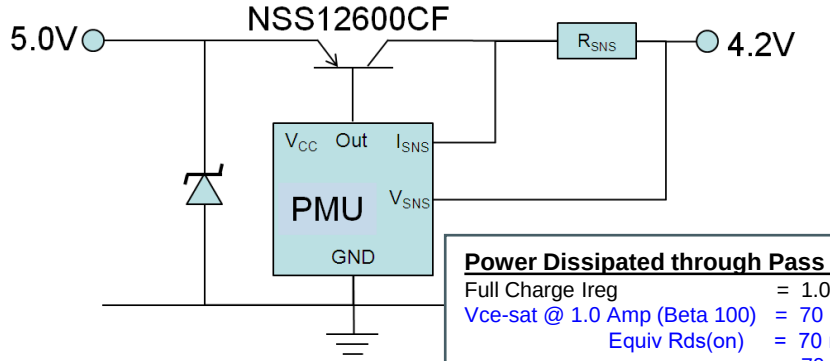
Charge Circuit Comparison



High ESD tolerance eliminates need for protection

Power Dissipated through Pass Element

Full Charge Ireg	= 1.0 A
Rds(on) MOSFET	= 60 mΩ
Vf Schottky	= 360 mV
Power Dissipated	**= 420 mW**

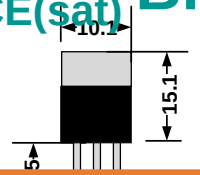


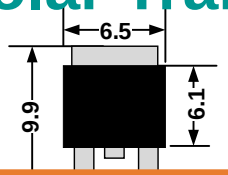
300 mW Power Savings!

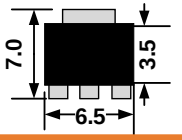
Power Dissipated through Pass Element

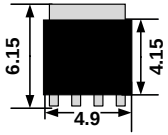
Full Charge Ireg	= 1.0 A
Vce-sat @ 1.0 Amp (Beta 100)	= 70 mV
Equiv Rds(on)	= 70 mΩ
	= 70 mW
BJT Sink Current in PMU	= 10 mA
	= 50 mW
Power Dissipated	**= 120 mW**

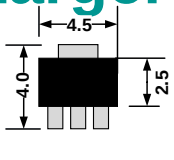
Low $V_{CE(sat)}$ Bipolar Transistors Portfolio – Larger packages

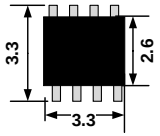


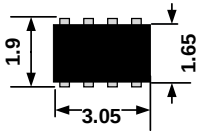


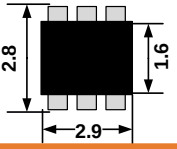


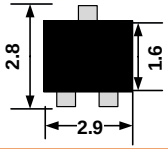








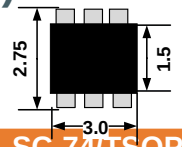


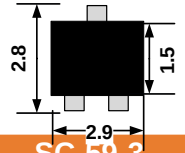


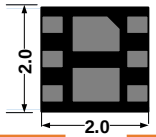
VCEO	Polarity	TO-220-3	DPAK	SOT-223-4	LFPAK-4	SOT-89	LFPAK-8	ChipFET-8	CPH-6	CPH-3
20	NPN		2SD1805 - 0.5			2SD1628 - 0.5		NSS20601CF8 - 0.065		
	PNP					2SB1302 - 0.5				
30	NPN									
	PNP					2SA2012 - 0.21			CPH6122 - 0.18	30A02CH - 0.22 CPH3115 - 0.375
40	NPN			NSS40301MZ4 - 0.2	NSS40301CT - 0.2			NSS40601CF8 - 0.075		
	PNP			NSS40300MZ4 - 0.4	NSS40300CT - 0.4			NSS40600CF8 - 0.075		
50	NPN	2SC6082 - - 2SC6144SG - 0.36 2SD1060 - 0.3	2SC5707 - 0.24 2SD1802 - 0.5 2SD1803 - 0.4			2SC5566 - 0.13 2SC5569 - 0.24 2SC5964 - 0.15 2SC5994 - 0.3			CPH6223 - 0.13	50C02CH - 0.1 CPH3216 - 0.19 NSVS50031SB3 - 0.12
	PNP	2SA2210 - 0.5 2SA2222SG - 0.5	2SA2039 - 0.195 2SA2040 - 0.39 2SA2126 - 0.27 2SB1201 - 0.7			2SA2013 - 0.18 2SA2016 - 0.39 2SA2125 - 0.23 2SA2153 - 0.4			CPH6123 - 0.23	CPH3116 - 0.43 NSVS50030SB3 - 0.2
60	NPN		2SC6097 - 0.15	NSS60601MZ4 - 0.06 NZT560A - 0.4						
	PNP			NSS60600 - 0.35 NZT660A - 0.5						
80	NPN				MJK44H11T - 1	2SC6095 - 0.15				
	PNP				MJK45H11T - -1					
100	NPN		2SC4135 - 0.4 2SC5706 - 0.135 2SD1815 - 0.4 2SD1816 - 0.4 NSS1C301E - 0.25	NSS1C201MZ4 - 0.1	NSS1C301CT - 0.25	2SC3646 - 0.4 2SC3647 - 0.4 2SC6096 - 0.15	NSS1002CL - 0.15			CPH3240 - 0.4
	PNP		2SA1593 - 0.6 2SB1215 - 0.5 NSS1C300E - 0.4	NSS1C200 - 0.125	NSS1C300CT - -0.4	2SA1416 - 0.6 2SA1417 - 0.6 2SA2202 - 0.24	NSS1001CL - 0.16			CPH3140 - 0.6
160	NPN		2SC4027 - 0.45			2SC3648 - 0.4 2SC3649 - 0.45	NST1602CL - 0.08			
	PNP		2SA1552 - 0.5			2SA1418 - 0.5 2SA1419 - 0.5	NST1601CL - 0.12			

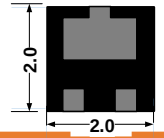
OPN – V_{CESAT} Max

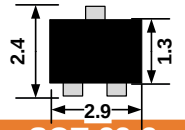
Low $V_{CE(sat)}$ Bipolar Transistors Portfolio – Smaller Packages

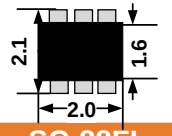


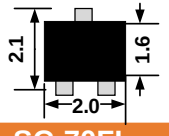












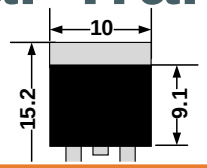
VCEO	Polarity	SC-74/TSOP-6	SC-59-3	WDFN-6	WDFN-3	SOT-23-3	SC-88FL	SC-70FL
12	NPN				NSS12501UW3 - 0.035	NSS12201L - 0.05		
	PNP				NSS12100UW - 0.44 NSS12500UW3 - 0.26	NSS12200L - 0.09		
15	NPN		2SD1048 - 0.025					
	PNP		2SB815 - 0.035					
20	NPN	NSS20201MR6 - 0.15		NSS20201DM - 0.1	NSS20501UW3 - 0.04	NSS20201L - 0.05		
	PNP	NSS20300MR6 - 0.015			NSS20500UW3 - 0.26	NSS20200L - 0.09		
25	NPN					FSB649 - 0.6		
	PNP					FSB749 - 0.6		
30	NPN	NSS30071MR6T1G - 0.25 NSS30201MR6 - 0.2 NST489 - 0.075				NSS30101L - 0.2		30C02MH - 0.19
	PNP	NSS30070MR6T1G - 0.25				FMMT549 - 0.75 MMBT589L - 0.3 NSS30100L - 0.25		30A02MH - 0.22
40	NPN				NSS40501UW3 - 0.045	NSS40201L - 0.06		
	PNP			NSS40200UW6T1G - 0.12	NSS40500UW3 - 0.22	NSS40200L - 0.095		
50	NPN						MCH6203 - 0.19	
	PNP						MCH6103 - 0.43	50A02MH - 0.12
60	NPN			NSS60201SMT - 0.25		FSB560 - 0.35 FSB560A - 0.3 NSS60201L - 0.14		
	PNP			NSS60200SMT - 0.45		FSB660A - 0.3 NSS60200L - 0.22		
80	NPN							
	PNP							
100	NPN					NSS1C201L - 0.09		
	PNP					NSS1C200L - 0.115		
160	NPN							
	PNP					NSVT1418L - 0.13		

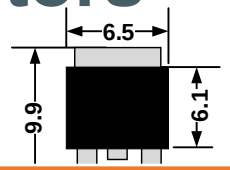
OPN – V_{CESAT} Max

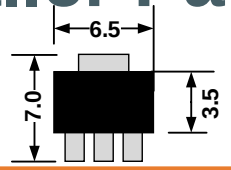
Power
BJTs

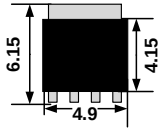
High Power Bipolar Transistors

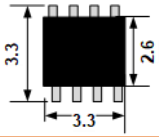
Power Bipolar Transistors – Smaller Packages







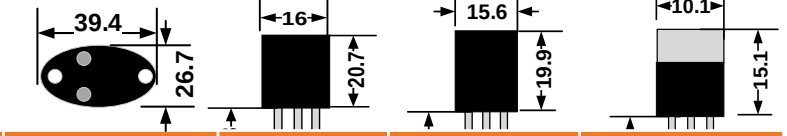




VCEO	Polarity	D²PAK	DPAK	SOT-223-4	LFPAK-4	LFPAK-8
20	NPN		2SD1805 - 5	BCP68T - 1		
	PNP			BCP69 - 1		
25	NPN		MJD200 - 5	FZT649 - 3		
	PNP		MJD210 - 5			
40	NPN		MJD31 - 3	NSS40301MZ4, NJT4031N - 3	NSS40301CT - 3	
	PNP		MJD32 - 3	NSS40300MZ4, NJT4030P - 3	NSS40300CT - 3	
50	NPN		2SC5707 - 8 2SD1803 - 5 2SD1802 - 3			
	PNP		2SA2040 - 8 2SA2039 - 5 2SA2126 - 3			
60	NPN		MJD3055 – 10 2SC6097 – 3	NSS60601MZ4 - 6 NZT560 – 3 PZT651 – 2		
	PNP	KSB834W - 3	MJD2955 - 10	NSS60600 – 6 NZT660 – 3 PZT751 - 2		
80	NPN	MJB44H11 - 10	MJD44H11 - 8	BCP56 – 1	MJK44H11T - 8	
	PNP	MJB45H11 - 10	MJD45H11 - 8	BCP53 - 1.5	MJK45H11T - 8	
100	NPN	FJB102 - 8 MJB41C - 6	MJD41C – 6 2SC5706 – 5 MJD243 - 4 NSS1C301E, MJD31C – 3	NSS1C201MZ4 - 2	MJK31CT - 3 NSS1C301CT - 3	NSS1002CL - 2.5
	PNP	MJB42C - 6	MJD42C – 6 MJD253 - 4 NSS1C300E, MJD32C - 3	NSS1C200 - 2 NZT753 - 4	MJK32CT - 3 NSS1C300CT - 3	NSS1001CL - 2.5
160	NPN		2SC4027 - 1.5			NST1602CL - 1.5
	PNP		2SA1552 - 1.5			NST1601CL - 1.5
250	NPN		MJD47 - 1			
350	PNP		MJD5731 - 1			
400	NPN	FJB5555 - 5	FJD5555 - 5 FJD5304D, FJD3305H1 - 4 FJD5553 - 3			
450	NPN		KSC5402D - 2			
300	NPN		KSC5502D - 2			
800	NPN	FJI5603D - 3				

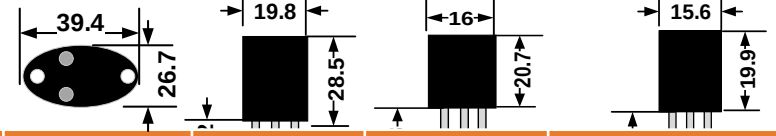
OPN – I_C Cont (A)

Power Bipolar Transistors – Larger Packages



VCEO	Polarity	TO-204-2	TO-247	TO-3P-3L	TO-220-3
30	NPN				2N6288 - 7
50	NPN				2SC6082 - 15 2SC6144SG - 10 2SD1060 - 5
	PNP				2SA2210 - 20 2SA2222SG - 10
60	NPN	2N3055 - 15 2N3055A - 15	TIP35A - 25 TIP3055 - 15		2N6487 - 15 D44H8 - 10 MJE3055T - 10 KSD1588 - 7 KSD2012 - 3 KSD880 - 3 TIP31A - 3
	PNP	MJ2955 - 15	TIP36A - 25 TIP2955 - 15		D45H8 - 10 MJE2955T - 10 KSB1015 - 3 KSB1366 - 3 TIP32A - 3
70	NPN				2N6292 - 7
80	NPN	MJ14002 - 60 2N5686 - 50		NJW44H11 - 10	D44VH - 15 2N6488 - 15 D44H11 - 10 KSE44H - 10 MJF44H11 - 10 KSD1408 - 4 KSD526 - 4 TIP31B - 3
	PNP	2N5684 - 50			2N6491 - 15 D45VH - 15 D45H11 - 10 MJF45H11 - 10 KSB1017 - 4 KSB596 - 4 BD242B - 3 TIP32B - 3
90	NPN	MJ802 - 30 2N5038 - 20			MJF3055 - 10
	PNP	MJ4502 - 30			MJF2955 - 10

OPN – I_C Cont (A)



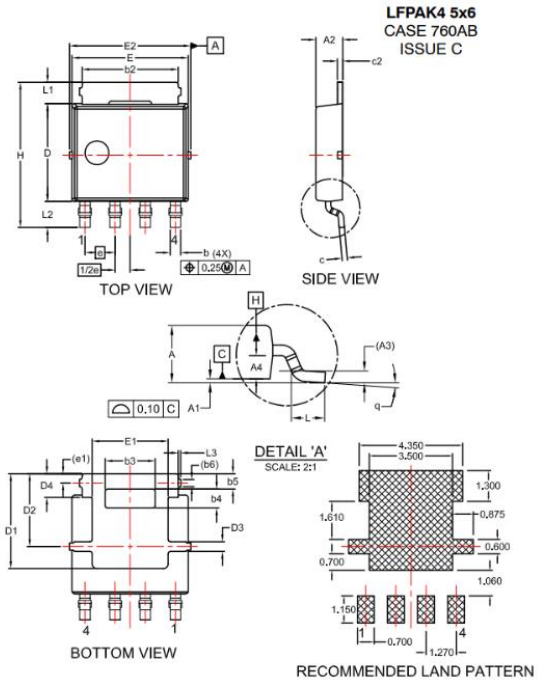
VCEO	Polarity	TO-204-2	TO-264-3	TO-247	TO-3P-3L	TO-220-3
100	NPN	2N6338 - 25		TIP35C - 25 TIP33C - 10		KSC2334 - 7 BD243C, TIP41 - 6 BD241C, MJF31C, TIP31C - 3
	PNP			TIP36C - 25		KSA1010 - 7 BD244C, TIP42 - 6 TIP42 - 6 BD242C, MJF32C, TIP32C - 3
120	NPN					KSD363 - 6
140	NPN	2N3773 - 16			FJA4310 - 10	
	PNP				FJA4210 - 10	
150	NPN	2N6341 - 25		MJE4343 - 16		MJF15030 - 8 KSC2073 - 1.5
	PNP					MJF15031 - 8 KSB546 - 2 KSA940 - 1.5
200	NPN	BUV21 - 40				BU406 - 7
250	NPN	BUV22 - 40	2SC5200 - 17 FJL4315 - 17		2SC5242, FJA4313 - 17 NJW21194 - 16 NJW0281G - 15	MJF47 - 1 TIP47 - 1
	PNP		2SA1943 - 17 FJL4215 - 17		FJA4213, 2SA1962 - 17 NJW21193 - 16 NJW0302G - 15	MJE15033 - 8
300	NPN					TIP48 - 1
	PNP					MJE5730 - 1
350	PNP					MJE5731 - 1
375	PNP					MJE5731A - 1
400	NPN					FJP13009 - 12 MJE13007 - 8 BUL45D2, FJP5555 - 5 FJP3305 – 4
	PNP					MJE5852 - 8
450	NPN			MJW18020		MJE18008 - 8 BUT11A, KSC5338D - 5 MJE18004 - 5
500	NPN					FJPF5021 - 5
600	NPN					KSC5502 - 2
800	NPN		FJL6920 - 20			FJPF2145 - 5 FJP5027 - 3 KSC5603D - 3

BJTs – Latest Power Devices - LFPAK 5x6 and 3x3 BJTs

Power BJTs

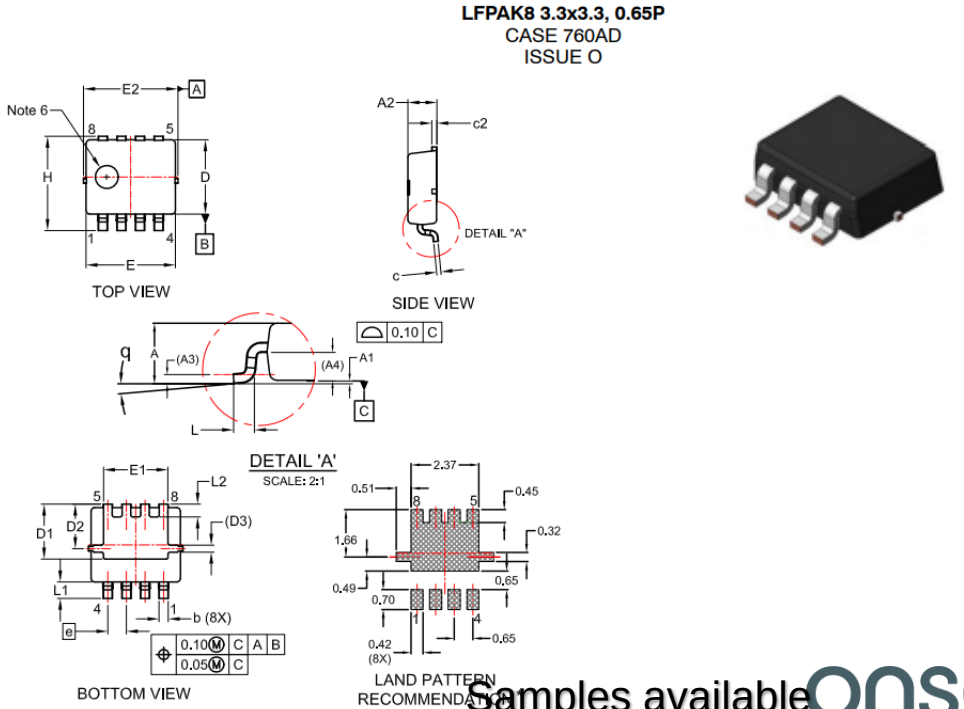
LFPAK 5x6

Part Number	Technology	Polarity	V_{CEO} (V)	I_C (A)
NSS1C300CTW	Low $V_{CE(sat)}$	PNP	100	3
NSS1C3001TW	Low $V_{CE(sat)}$	NPN	100	3
NSS60600CTW	Low $V_{CE(sat)}$	PNP	60	6
NSS40300CTW	Low $V_{CE(sat)}$	PNP	40	3
MJK31CTW	Standard	NPN	100	3
MJK32CTW	Standard	PNP	100	3

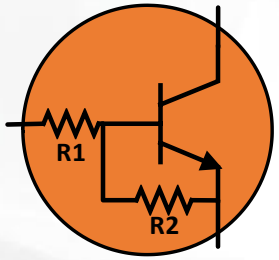


LFPAK 3x3

Part Number	Technology	Polarity	V_{CEO} (V)	I_C (A)	h_{FE}
BCP53CLTW	Standard	PNP	80	1	40 – 250
BCP53-10CLTW	Standard	PNP	80	1	63 – 160
BCP53-16CLTW	Standard	PNP	80	1	100 – 250
BCP56CLTW	Standard	NPN	80	1	40 – 250
BCP56-10CLTW	Standard	NPN	80	1	63 – 160
BCP56-16CLTW	Standard	NPN	80	1	100 – 250



Samples available

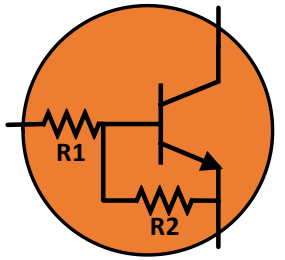


Digital Transistors

BRTs

(Bias Resistor Transistors)

BRTs (Digital Transistors) in Summary

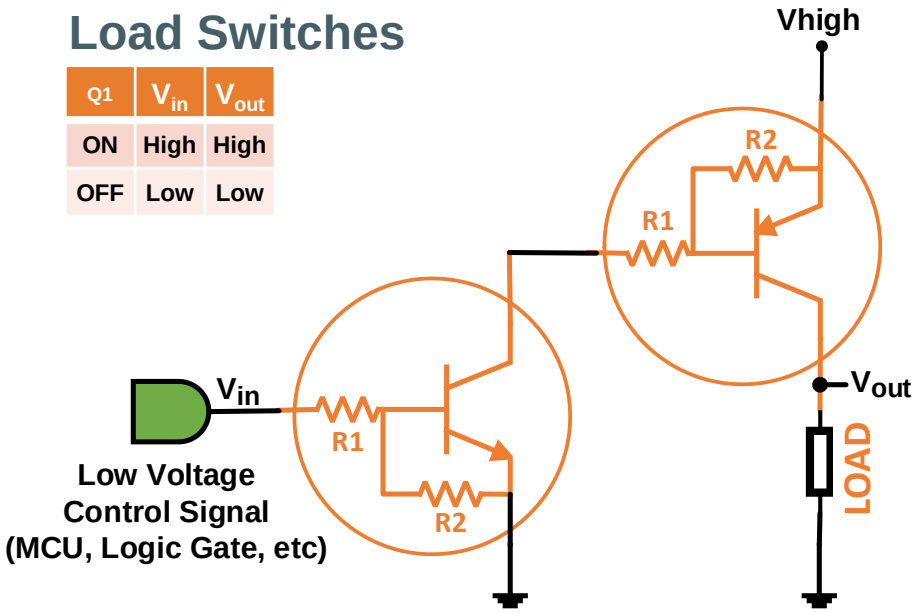


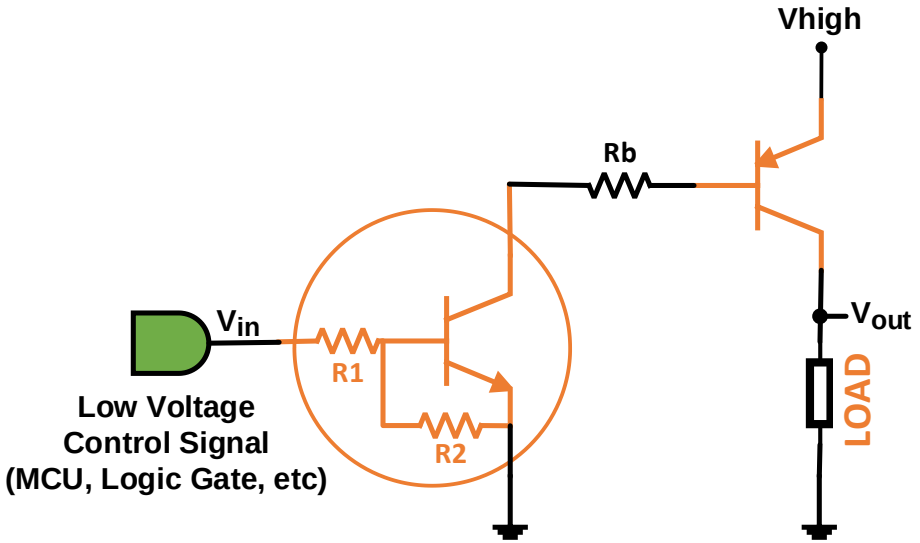
- BJTs with integrated bias resistor network
- Allows to use a BJT as a MOSFET
  - BJT is intrinsically a current-controlled device
  - MOSFETs are voltage-controlled devices
  - A resistor network allows the BJT to be operated with an external voltage
- Available in NPN, PNP, Duals and Complementary configurations
- Input voltage ratings, Turn-on voltages and Turn-off voltages depend on the R1 and R2 values and the corresponding ratio of these two resistors
- A typical BRT handles up to 100 mA, 12-40 V input and 50 V output (V_{CEO})
- Typical on voltage: 1.5 V; Typical off voltage: 1.2 V
- Allows to interface small voltages (from MCUs, CPLDs, etc) with large voltages, and also large voltages with large voltages
- Meant to be used mainly for switching applications
  - BJT operating in cutoff and saturation modes (not in active mode)
  - Use NPN for low-side switch implementation (to switch the ground)
  - Use PNP for high-side switch implementation (to switch the input voltage/power supply)
    - Note that even when the transistor is fully on (operating in the Saturation region) there will be a small voltage drop across it
    - Thus, if the load needs real ground (an MCU, for example), use a high switch/PNP BRT.

BRTs in Industrial Applications

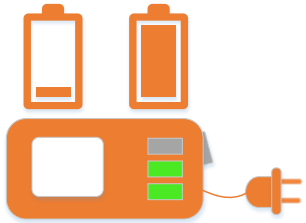
Load Switches

Q1	V_{in}	V_{out}
ON	High	High
OFF	Low	Low

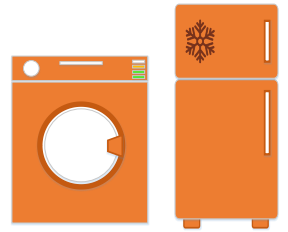




Power Tools



Battery Modules and Chargers



Appliances

Used to interface low voltage control signal to high voltage lines

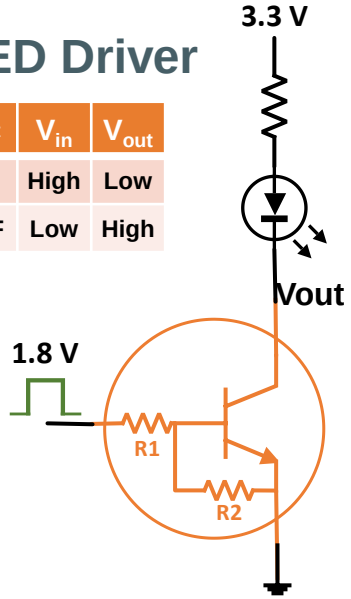
- Look for applications using
  - MCUs, FPGAs, CPLDs, ASICs
  - That need to interface with higher voltage lines
- Or anywhere a BJT is used as a switch
- Use a complementary or two singles
- Saves PCB Space and facilitates routing
- Cost effective solution
- Any application that has an external switch / interface has a potential to use BRTs
- Used as Gate Drivers as well
  - Battery modules to enable/disable **power MOSFETS controlling input power**
- **If the resistor combination needed is not available, OR**
- **If the device with the Current Handling Capabilities is no in the portfolio**
  - **We could create a Mixed Element Array**

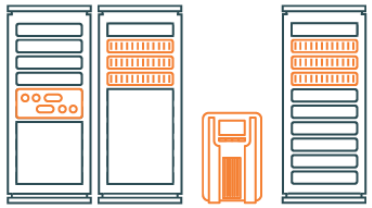
Any application with a Switch or with a controller needing to interface with higher voltages could potentially use BRTs

BRTs – Other Applications

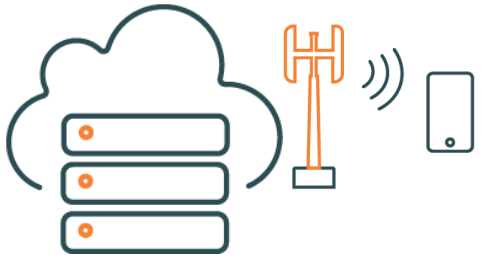
LED Driver

Q St	V_{in}	V_{out}
ON	High	Low
OFF	Low	High



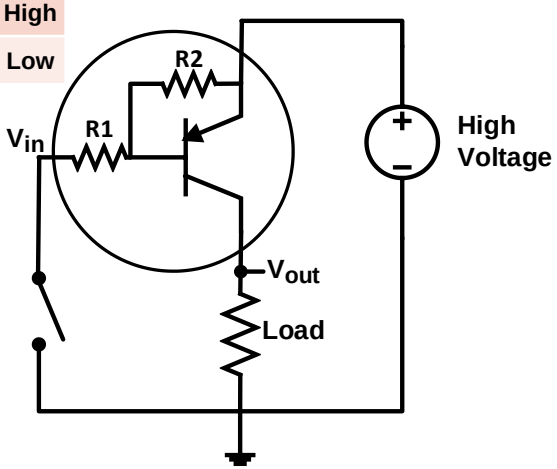


Servers



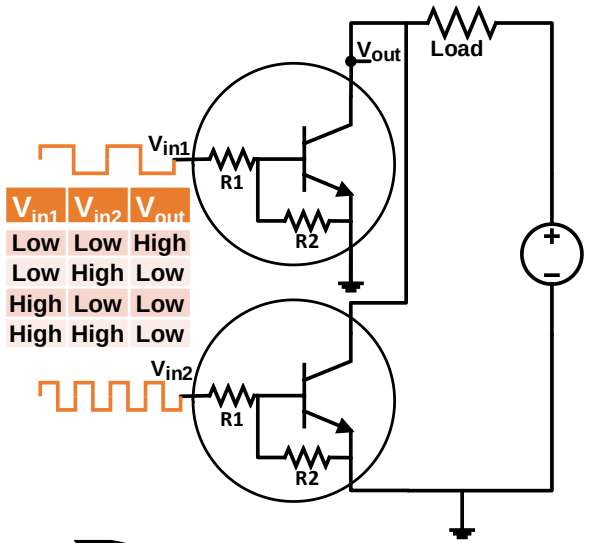
Telecom Eq

Q St	V_{in}	V_{out}
ON	Low	High
OFF	High	Low



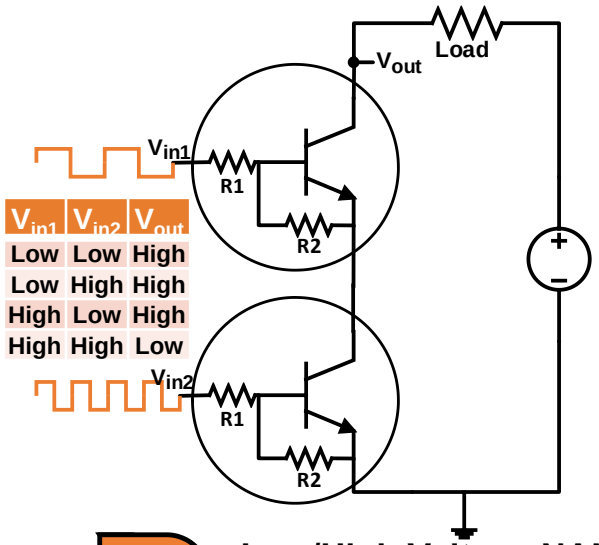
Low to High Voltage Interface
(High Side Switch)

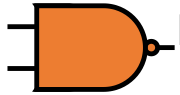
V_{in1}	V_{in2}	V_{out}
Low	Low	High
Low	High	Low
High	Low	Low
High	High	Low



Low/High Voltage NOR
(Dual BRT)

V_{in1}	V_{in2}	V_{out}
Low	Low	High
Low	High	High
High	Low	High
High	High	Low

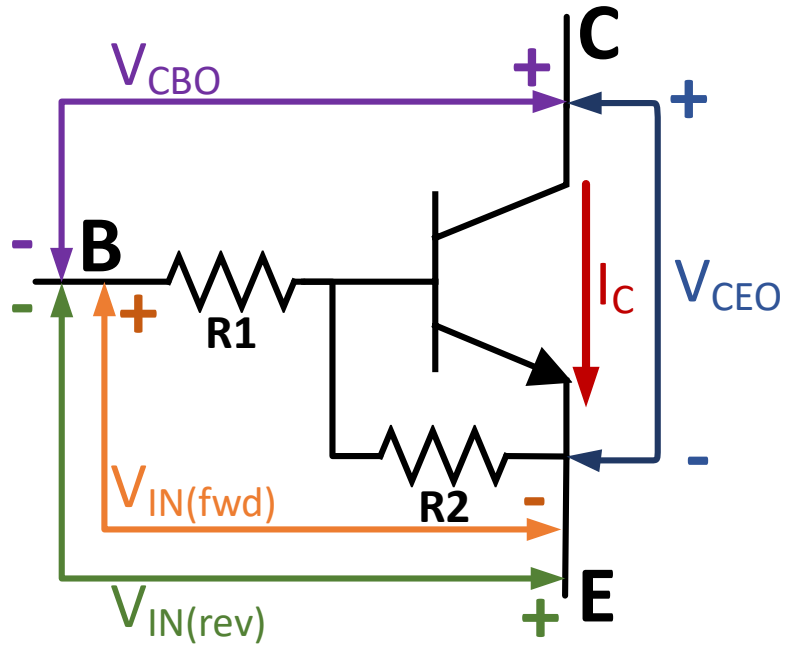




Low/High Voltage NAND
(Dual BRT)

Datasheet Parameters – Maximum Ratings

Rating	Symbol	Max	Unit
Collector−Base Voltage	V_{CBO}	50	Vdc
Collector−Emitter Voltage	V_{CEO}	50	Vdc
Collector Current – Continuous	I_C	100	mAdc
Input Forward Voltage	$V_{IN(fwd)}$	40	Vdc
Input Reverse Voltage	$V_{IN(rev)}$	10	Vdc



V_{CBO} – Maximum voltage that can be applied from Collector to Base (with the emitter open)
V_{CEO} – Maximum voltage that can be applied from Collector to Emitter (with the base open)
I_C – Maximum continuous current that the BRT can handle from Collector to Emitter
$V_{IN(fwd)}$ – Maximum voltage that can be applied from the Base to the Emitter

- Normally the power handling capability of R1 is the limiting factor
- The higher the R1 value, the higher $V_{IN(fwd)}$ will be

$$P_{R1} = \frac{V_{R1}^2}{R_1} \rightarrow V_{R1} = \sqrt{P_{R1} \, x \, R_1}$$

$V_{IN(rev)}$ – Maximum voltage that can be applied from Emitter to the Base

- It's a function of the resistor network and of the V_{EB} of the transistor
- The resistor network allows the breakdown voltage (V_{EBO})to be higher of a stand-alone BJT
- If a large reverse voltage is expected on the application, choose a BRT with higher R1/R2 ratio
  - Since R_{EB} is >> R2, a voltage divider between R1 and R2 is formed
  - If R1>R2, most of the voltage will be dropped across R1

Use this summary table to facilitate the BRT selection process in regard to $V_{IN(fwd)}$ and $V_{IN(rev)}$

Note: The maximum ratings are obtained in isolation, thus there's no guarantee that getting to the limits of more than one at the same time will not damage the device.
Please refer to the Power Dissipation curves and the thermal characteristics for each package contained in the datasheet to compute the maximum power a device can handle under different temperatures and board conditions

BRT's higher BV_{EBO} than BJT's via Resistor Network

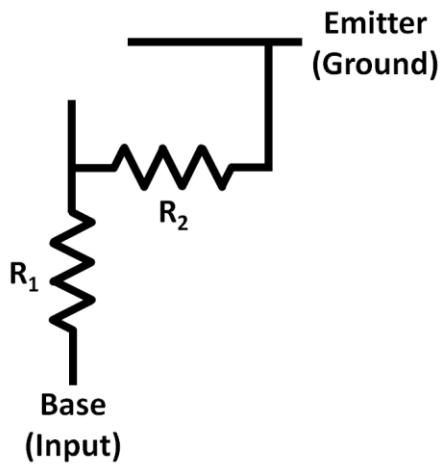
$$R_{Equivalent} = R_{BE}//R_2 = \left(\frac{1}{R_{BE}} + \frac{1}{R_2}\right)^{-1}$$

$$When\ R_{BE} \gg R_2, \quad \frac{1}{R_{BE}} + \frac{1}{R_2} \cong \frac{1}{R_2}$$

$$R_{Equivalent} = \left(\frac{1}{R_2}\right)^{-1} = R_2$$

$$V_{EB} = V_{E-IN} \times \left(\frac{R_2}{R_1 + R_2}\right)$$

$$V_{E-IN} = V_{EB} \times \left(\frac{R_1 + R_2}{R_2}\right)$$



Theoretical $V_{IN(REV)}$ values as a function of R1 and R2, with BJT's V_{EBO} = 6 V

R_1 (kΩ)	R_2 (kΩ)	R_1/R_2	$V_{IN\ (REV)}$
2.2	∞	-	6.0
4.7	∞	-	6.0
10	∞	-	6.0
47	∞	-	6.0
100	∞	-	6.0
2.2	47	0.047	6.3
4.7	47	0.100	6.6
10	47	0.213	7.3
22	47	0.468	8.8
4.7	10	0.470	8.8
1	1	1.000	12.0
2.2	2.2	1.000	12.0
4.7	4.7	1.000	12.0
10	10	1.000	12.0
22	22	1.000	12.0
47	47	1.000	12.0
100	100	1.000	12.0
47	22	2.136	18.8

Datasheet Parameters – ON Characteristics

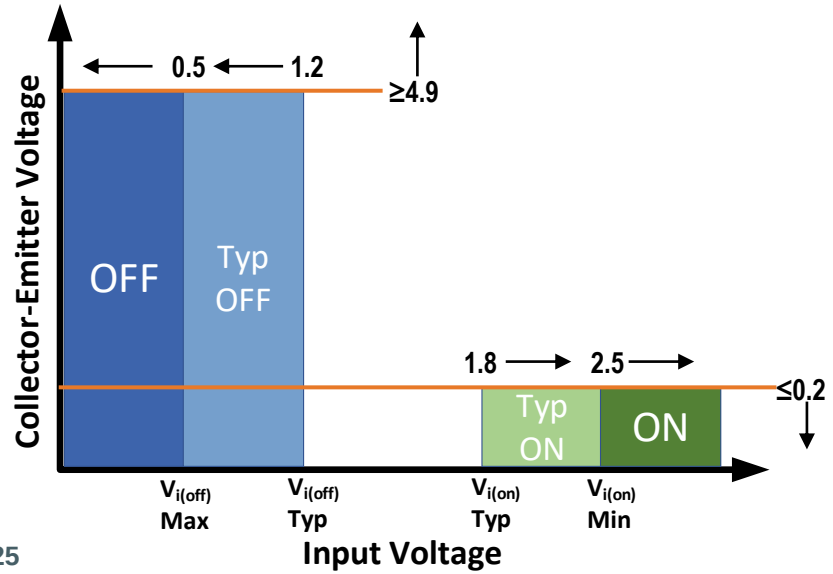
Characteristics	Symbol	Min	Typ	Max	Unit
DC Current Gain (I_C = 5.0 mA, V_{CE} = 10 V)	h_{FE}	35	60	–	
Collector−Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA)	$V_{CE(sat)}$	–	–	0.25	Vdc
Input Voltage (off) (V_{CE} = 5.0 V, I_C = 100 μA)	$V_{i(off)}$	–	1.2	0.5	Vdc
Input Voltage (on) (V_{CE} = 0.3 V, I_C = 10 mA)	$V_{i(on)}$	2.5	1.8	–	Vdc
Output Voltage (on) (V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	V_{OL}	–	–	0.2	Vdc
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)	V_{OH}	4.9	–	–	Vdc

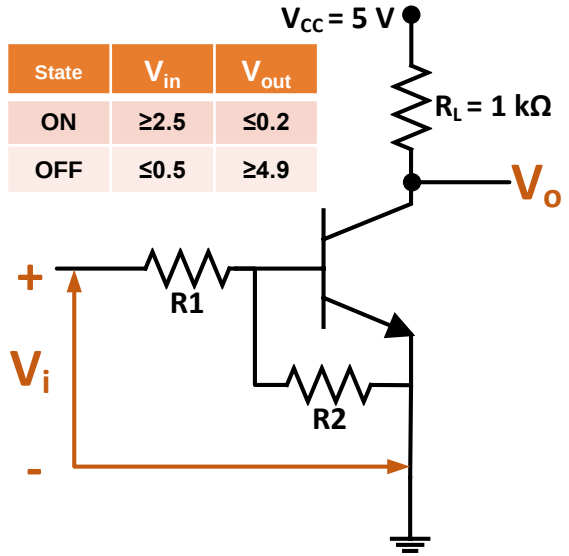
BRT Switch Specifications

State	V_{in}	V_{out}
ON	High	Low
OFF	Low	High

h_{FE} – DC Current Gain. Ratio of the collector current to the base current. Also known as β. Useful if target is to use the BRT in the Active Region for small signal amplification, to compute the needed I_B for a required I_C ($I_C = h_{FE} \times I_B$)
h_{FE} spec is also used to determine the threshold base current needed to drive the BRT into saturation, thus achieving a drop in the collector-emitter voltage ($I_B > I_C/h_{FE}$)

$V_{CE(sat)}$ - Largest possible voltage drop between collector and emitter when the BRT is ON (under the given conditions). The lower this parameter is the better, as this will result in lower power dissipation for a given current level





State	V_{in}	V_{out}
ON	≥2.5	≤0.2
OFF	≤0.5	≥4.9

- Typical values for Input Voltage (off) and (on) specifications are measured voltages when the device is exactly at the ON and OFF conditions and are provided for reference purposes.
- It is not recommended to design targeting these values and instead use the Vi(off) max and the Vi(on) min to ensure proper device state transition

Datasheet Parameters – ON Characteristics (Cont)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Voltage (off) (V_{CE} = 5.0 V, I_C = 100 μA)	$V_{i(off)}$	–	1.2	0.5	Vdc
Input Voltage (on) (V_{CE} = 0.3 V, I_C = 10 mA)	$V_{i(on)}$	2.5	1.8	–	Vdc
Input Resistor	R_1	7.0	10	13	kΩ
Resistor Ratio	R_1/R_2	0.8	1.0	1.2	

BRT Switch Specifications

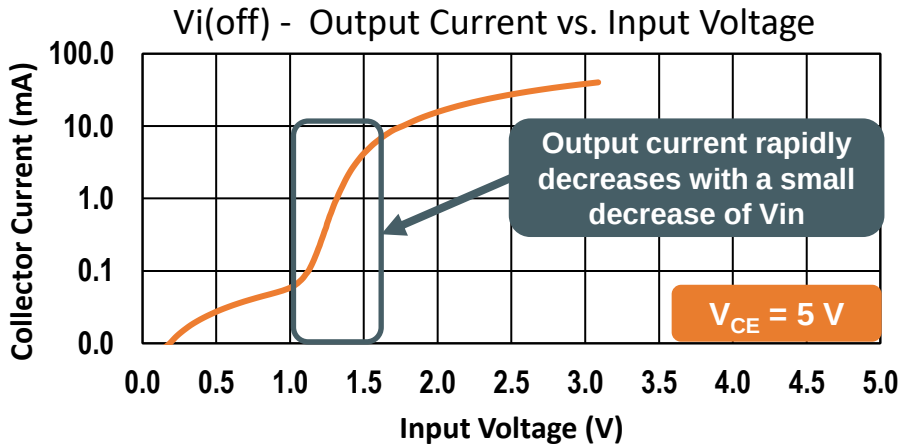
$V_{i(off)}$ max – is a function of the resistor ratio and the h_{FE}
- The lower the resistor ratio, the lower the $V_{i(off)}$ min
- The lower the h_{FE} (or β), the lower the $Vi_{(off)}$ min
- Note that V_i decreases, I_C will fall abruptly as it approaches the $V_{i(off)}$ spec.
- **Use the "Output Current vs. Input Voltage" plot to determine the input voltage at which I_C rapidly decreases**

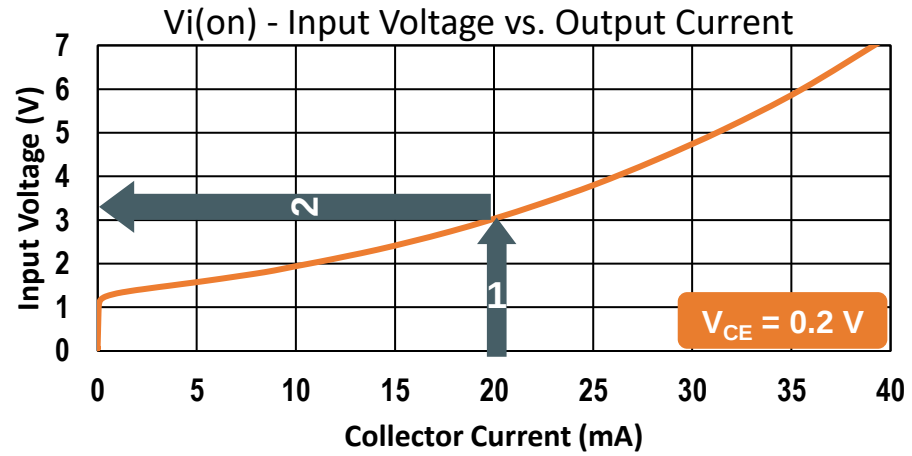
$V_{i(on)}$ min – is a function of the resistor ratio and the R1 value
- The lower the R1/R2 ratio, the lower the $V_{i(on)}$
- The lower the R1, the lower the $V_{i(on)}$
- The collector (or output) current is a function of the input voltage
  - The higher the Vi, the higher the I_C
- **Use the "Input Voltage vs. Output Current" plot to determine the necessary Vi level for a target collector current**

R_1 – Resistor connected in series to the Base, aka Input Resistor
- Normally has ±30% tolerance

R_1/R_2 – Resistor connected in series with the Base, aka Input Resistor
- Normally has ±20% tolerance
- If needed, the range of R2 values can be computed in the following manner

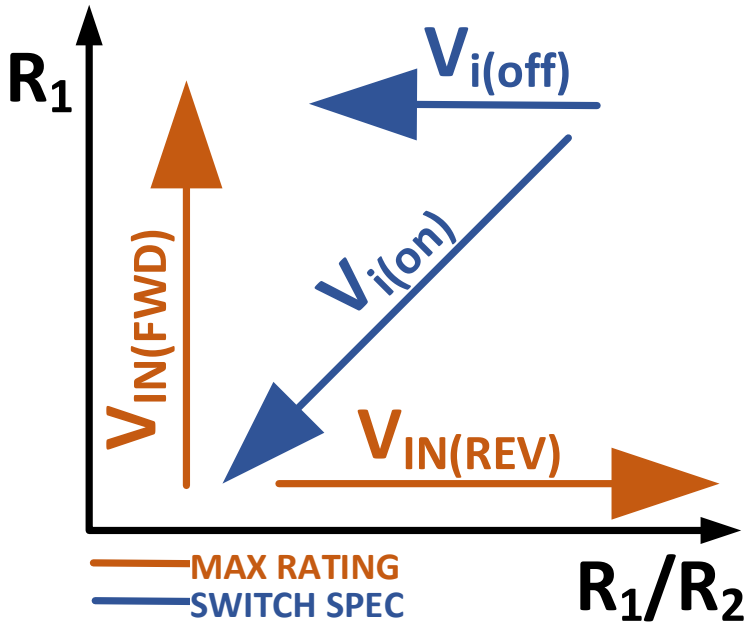
$$R_2min = \frac{R_1min}{R_1/R_2\ max} = \frac{7\ k\Omega}{1.2} = 5.83\ k\Omega \qquad R_2max = \frac{R_1max}{R_1/R_2\ min} = \frac{13\ k\Omega}{0.8} = 16.25\ k\Omega$$



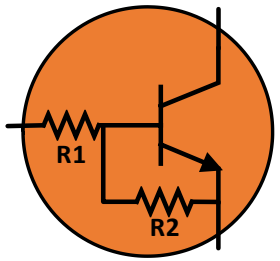


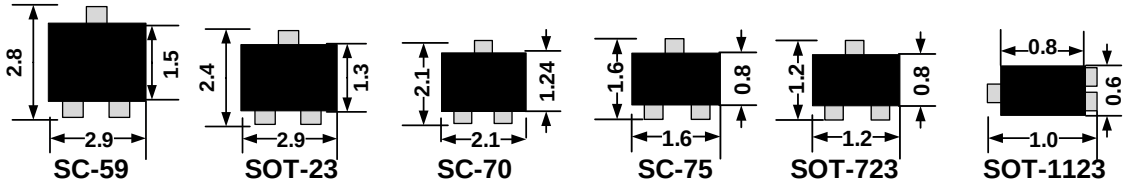
Device Selection Table

R1 (kΩ)	R2 (kΩ)	Ratio R1/R2	$V_{IN(fwd)}$ (V) PNP	$V_{IN(fwd)}$ (V) NPN	$V_{IN(rev)}$ (V) PNP	$V_{IN(rev)}$ (V) NPN	$V_{i(on)}$ (V) PNP	$V_{i(on)}$ (V) NPN	$V_{i(off)}$ @ 0.1 mA (V) PNP	$V_{i(off)}$ @ 0.1 mA (V) NPN
1	1	1	10	10	10	10	2.0 @ 20 mA	2.0 @ 20 mA	0.5	0.5
2.2	2.2	1	12	12	10	10	2.0 @ 20 mA	2.0 @ 20 mA	0.5	0.5
4.7	4.7	1	30	30	10	10	3.0 @ 20 mA	2.5 @ 20 mA	0.5	0.5
10	10	1	40	40	10	10	2.5 @ 10 mA	2.5 @ 10 mA	0.8	0.8
22	22	1	40	40	10	10	2.5 @ 5 mA	2.5 @ 5 mA	0.8	0.8
47	47	1	40	40	10	10	3.0 @ 2 mA	3.0 @ 2 mA	0.8	0.8
100	100	1	40	40	10	10	3.0 @ 1 mA	3.0 @ 1 mA	0.5	0.5
2.2	47	0.05	12	12	5	6	1.1 @ 5 mA	1.1 @ 5 mA	0.5	0.5
4.7	47	0.10	30	30	5	6	1.3 @ 5 mA	1.3 @ 5 mA	0.5	0.5
10	47	0.21	40	40	6	7	1.4 @ 1 mA	1.4 @ 1 mA	0.5	0.5
22	47	0.47	40	40	7	8	2.0 @ 2 mA	2.0 @ 2 mA	0.5	0.5
47	22	2.14	40	40	10	10	4.0 @ 2 mA	4.0 @ 2 mA	1.2	1.2
2.2	Inf.	0	12	12	5	6	1.3 @ 10 mA	1.1 @ 10 mA	0.5	0.5
4.7	Inf.	0	30	30	5	6	1.3 @ 10 mA	1.3 @ 10 mA	0.5	0.5
10	Inf.	0	40	40	5	6	1.7 @ 10 mA	1.7 @ 10 mA	0.5	0.5
47	Inf.	0	40	40	5	6	4.0 @ 10 mA	4.0 @ 10 mA	0.5	0.5
100	Inf.	0	40	40	5	6	1.5 @ 1 mA	1.5 @ 1 mA	0.5	0.5



Digital Transistors / BRTs (Bias Resistor Transistor) - Singles





8.1 mm² 230mW*	7.0 mm² 240mW*	4.4 mm² 150mW*	2.56 mm² 200mW*	0.8 mm² 300mW*	0.6 mm² 250mW*

R1	R2	Polarity	SC-59	SOT-23	SC-70	SC-75	SOT-723	SOT-1123
1k	1k	NPN	MUN2230	MMUN2230L	MMUN5230	DTC113EE	DTC113EM3	NSBC113EF3
		PNP	MUN2130	MMUN2130L	MMUN5130	DTA113EE	DTA113EM3	NSBA113EF3
4.7K	47K	NPN	MUN2233	MMUN2233L	MUN5233	DTC143ZE	DTC143ZM3	NSBC143ZF3
		PNP	MUN2133	MMUN2133L	MUN5133	DTA143ZE	DTA143ZM3	NSBA143ZF3
10K	47K	NPN	MUN2214	MMUN2214L	MUN5214	DTC114YE	DTC114YM3	NSBC114YF3
		PNP	MUN2114	MMUN2114L	MUN5114	DTA114YE	DTA114YM3	NSBA114YF3
22K	47K	NPN	MUN2234	MMUN2234L	MUN5234	DTC124XE	DTC124XM3	NSBC124XM3
		PNP	MUN2134	MMUN2134L	MUN5134	DTA124XE	DTA124XM3	NSBA124XM3
47K	22K	NPN	MUN2237	MMUN2237L	MUN5237	DTC144WE	DTC144WM3	NSBC144WF3
		PNP	MUN2137	MMUN2137L	MUN5137	DTA144WE	DTA144WM3	NSBA144WF3
2.2K	Inf.	NPN	MUN2238	MMUN2238L	MUN5238	DTC123TE	DTC123TM3	NSBC123TF3
		PNP	MUN2138	MMUN2138L	MUN5138	DTA123TE	DTA123TM3	NSBA123TF3
4.7K	Inf.	NPN	MUN2216	MMUN2216L	MUN5216	DTC143TE	DTC143TM3	NSBC143TF3
		PNP	MUN2116	MMUN2116L	MUN5116	DTA143TE	DTA143TM3	NSBA143TF3
10K	Inf.	NPN	MUN2215	MMUN2215L	MUN5215	DTC114TE	DTC114TM3	NSBC114TF3
		PNP	MUN2115	MMUN2115L	MUN5115	DTA114TE	DTA114TM3	NSBA114TF3
47K	Inf.	NPN	MUN2240	MMUN2240L	MUN5240	DTC144TE	DTC144TM3	NSBC144TF3
		PNP	MUN2140	MMUN2140L	MUN5140	DTA144TE	DTA144TM3	NSBA144TF3
100K	Inf	NPN	MUN2241	MMUN2241L	MUN5241	DTC115TE	DTC115TM3	NSBC115TF3
		PNP	MUN2141	MMUN2141L	MUN5141	DTA115TE	DTA115TM3	NSBA115TF3

95% smaller, similar power

Some examples shown above

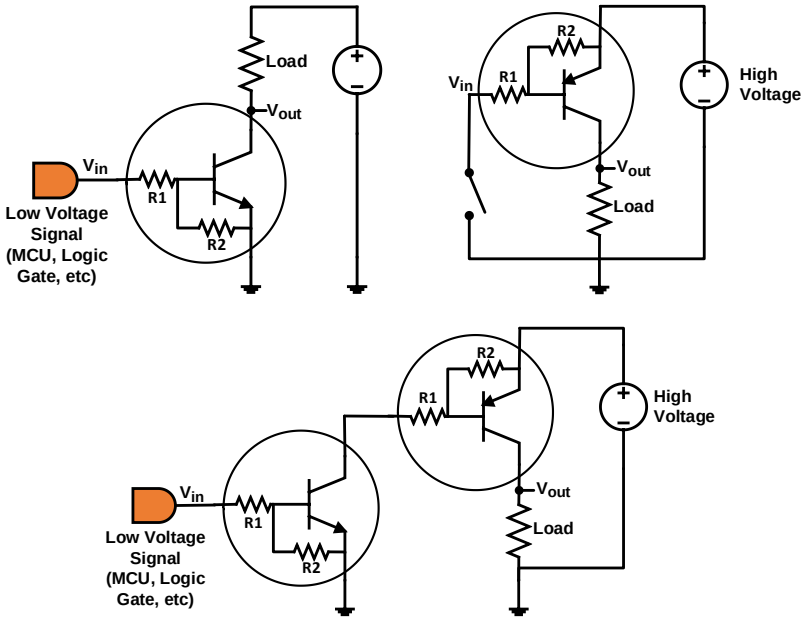
More than 360 BRTs to choose from!

Integrated Biasing Resistors

Board Space Savings!

Cost Savings!

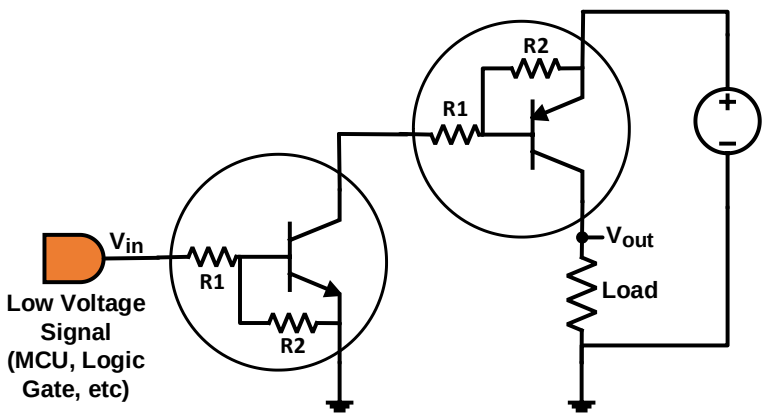
Typical Applications

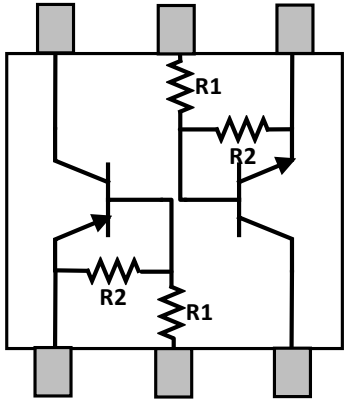


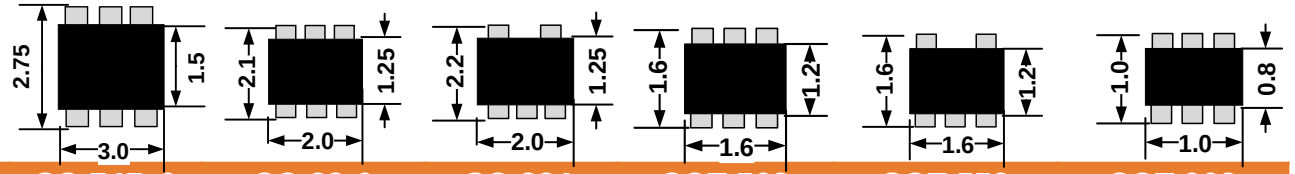
Complementary BRTs

Complementary BJTs with Integrated Bias Resistors

- Reduces Board Space
- Simplifies Designs
- Decreases Component Count
- Cost efficient
- Implements Level Shifters with a single part





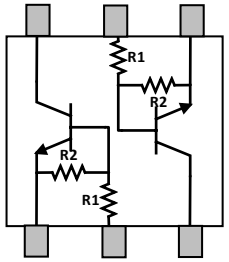


R1 (kΩ)	R2 (kΩ)	SC-74R-6	SC-88-6	SC-88A	SOT-563	SOT-553	SOT-963
0.1	10	IMD10A					
0.175	Infinity	NUS2401					
1	1		MUN5330DW1		NSBC113EPD		
2.2	2.2		MUN5331DW1		NSBC123EPD		
2.2	47		MUN5335DW1		NSBC123JPD		NSBC123JPD
2.2	Infinity						NSBC123TPD
4.7	4.7		MUN5332DW1		NSBC143EPD		NSBC143EPD
4.7	10		MUN5338DW1	UMC5	EMD5DX	EMD5DX	
4.7	47		MUN5333DW1		NSBC143ZPD		NSBC143ZPD
4.7	Infinity		MUN5316DW1		NSBC143TPD		
10	10		MUN5311DW1	UMC3	NSBC114EPD	EMC3DX	NSBC114EPD
10	47		MUN5314DW1		NSBC114YPD	EMC4DX	NSBC114YPD
10	Infinity		MUN5315DW1		NSBC114TPD		
22	22		MUN5312DW1	UMC2	NSBC124EPD	EMC2DX	NSBC124EPD
22	47		MUN5334DW1		NSBC124XPD		
47	22						NSBC144WPD
47	47		MUN5313DW1		NSBC144EPD	NSTB1005DX	NSBC144EPD
100	100		MUN5336DW1		NSBC155EPD		
100	Infinity						NSBC155TPD

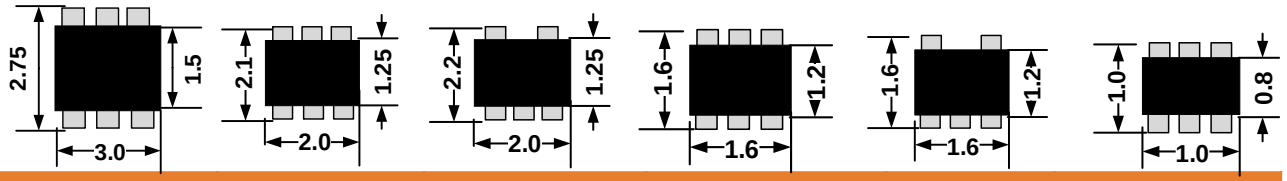
Dual NPN and PNP BRTs

Dual BJTs with Integrated Bias Resistors

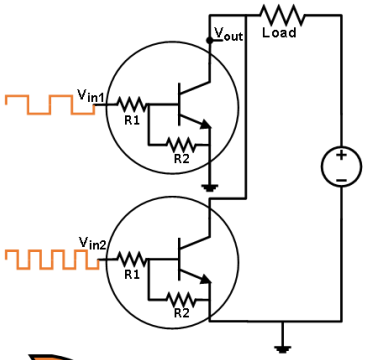
- Reduces Board Space
- Simplifies Designs
- Decreases Component Count
- Cost efficient



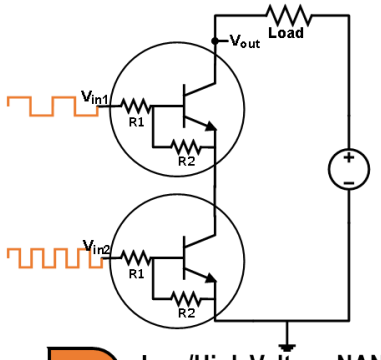
Dual NPN



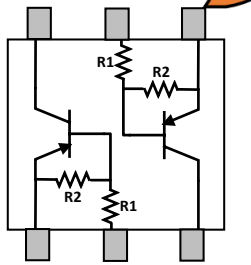
R1 (kΩ)	R2 (kΩ)	SC-74R-6	SC-88-6	SC-88A	SOT-563	SOT-553	SOT-963
1	1		MUN5230DW1		NSBC113EDXV6		
2.2	2.2		MUN5231DW1		NSBC123EDXV6		
2.2	47		MUN5235DW1		NSBC123JDXV6		NSBC123JDP6
2.2	Infinity	IMH20TR1					NSBC123TDP6
4.7	4.7		MUN5232DW1		NSBC143EDXV6		NSBC143EDP6
4.7	47		MUN5233DW1	NSB1706DMW5	NSBC143ZDXV6		NSBC143ZDP6
4.7	Infinity		MUN5216DW1		NSBC143TDXV6		
10	10		MUN5211DW1		NSBC114EDXV6		NSBC114EDP6
10	47		MUN5214DW1		NSBC114YDXV6		NSBC114YDP6
10	Infinity		MUN5215DW1		NSBC114TDXV6		NSBC114TDP6
22	22		MUN5212DW1		NSBC124EDXV6		NSBC124EDP6
22	47		MUN5234DW1		NSBC124XDXV6		
47	22		MUN5237DW1		NSBC144WDXV6		NSBC144WDP6
47	47		MUN5213DW1		NSBC144EDXV6	EMG2DXV5	NSBC144EDP6
100	100		MUN5236DW1		NSBC115EDXV6		
100	Infinity						NSBC115TDP6



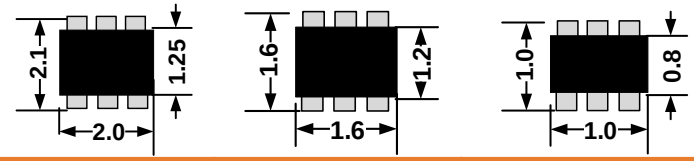
Low/High Voltage NOR (Dual BRT)



Low/High Voltage NAND (Dual BRT)



Dual PNP

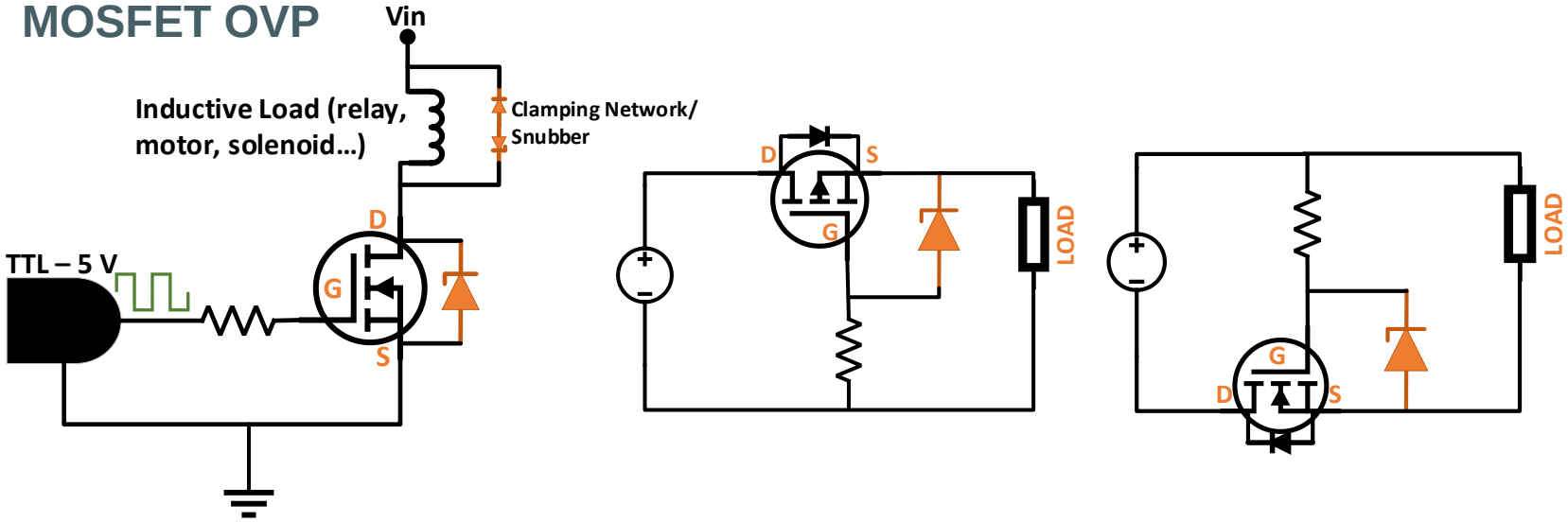


R1 (kΩ)	R2 (kΩ)	SC-88-6	SOT-563	SOT-963
1	1	MUN5130DW1		
2.2	2.2	MUN5131DW1	NSBA123EDXV6	
2.2	47	MUN5135DW1	NSBA123JDXV6	NSBA123JDP6
2.2	Infinity			NSBA123TDP6
4.7	4.7	MUN5132DW1	NSBA143EDXV6	NSBA143EDP6
4.7	47	MUN5133DW1	NSBA143ZDXV6	NSBA143ZDP6
4.7	Infinity	MUN5116DW1	NSBA143TDXV6	
10	10	MUN5111DW1	NSBA114EDXV6	NSBA114EDP6
10	47	MUN5114DW1	NSBA114YDXV6	NSBA114YDP6
10	Infinity	MUN5115DW1	NSBA114TDXV6	NSBA114TDP6
22	22	MUN5112DW1	NSBA124EDXV6	NSBA124EDP6
22	47	MUN5134DW1	NSBA124XDXV6	
47	22	MUN5137DW1	NSBA144WDXV6	NSBA144WDP6
47	47	MUN5113DW1	NSBA144EDXV6	NSBA144EDP6
100	100	MUN5136DW1	NSBA115EDXV6	
100	Infinity			NSBA115TDP6

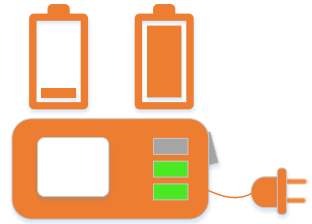
Zener Diodes

Zener Diodes in Industrial Applications

MOSFET OVP

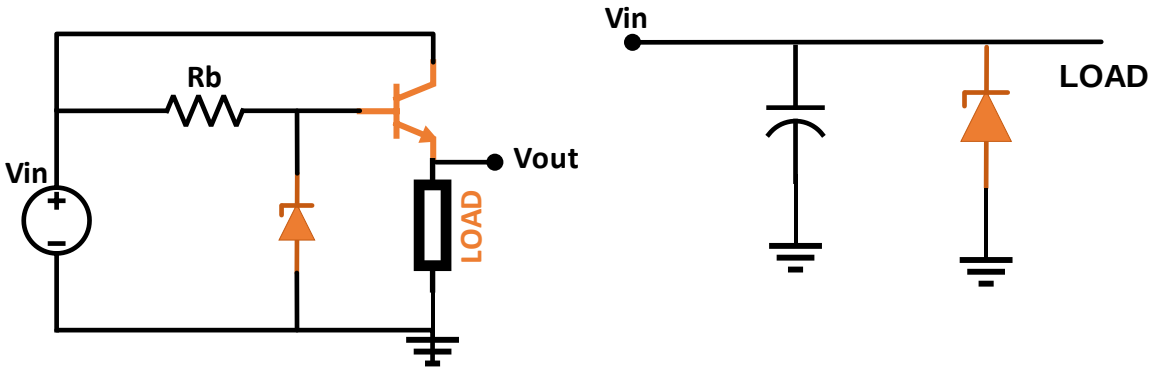


Power Tools

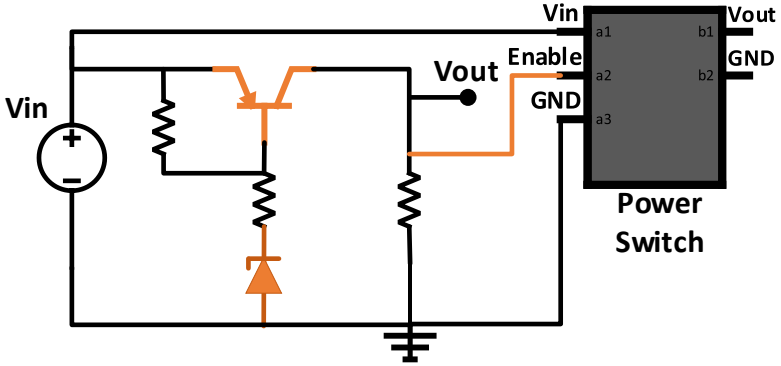


Battery Modules and Chargers

Voltage Regulators



Voltage Monitors



Garage Door Openers

EV Charging Stations

Zener Diodes – 01005 DSN2 → In Progress!

Similar P_D, >75% PCB space savings with SOD-523 (vs SOD123)

2.5 x 1.3 mm (3.2 mm²) 300mW*

1.6 x 0.8 mm (1.28 mm²) 500mW*

1.0 x 0.6 mm (0.6 mm²) 200mW*

NEW!

1.0 x 0.6mm (0.6 mm2) 250mW*

0.6 x 0.3 mm (0.2 mm²) 200mW**

Exploring

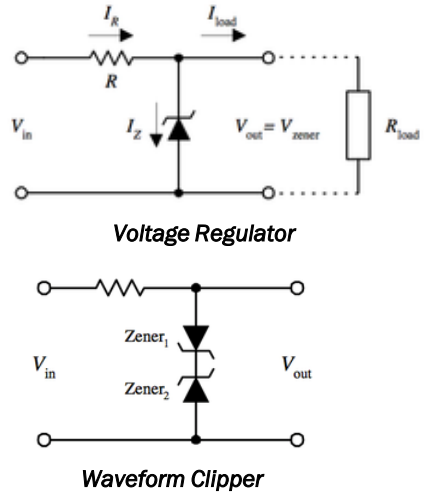
0.44 x 0.23 mm (0.1mm²) 200mW**

V_Z	SOD-323 (Tight Tol)	SOD-523 (Tight Tol)	SOD-923 (Tight Tol)	X2DFN2W2 (Tight Tol)	X3DFN	DSN2 01005
2.4V	MM3Z2V4T1G	MM5Z2V4T1G	NZ9F2V4T5G	NZ8F2V4SMX2WT5G	NZD2V4MUT5G	NZE2V4FCT5G
2.7V	MM3Z2V7T1G	MM5Z2V7T1G	NZ9F2V7T5G	NZ8F2V7SMX2WT5G	NZD2V7MUT5G	NZE2V7FCT5G
3.3V	MM3Z3V3T1G	MM5Z3V3T1G	NZ9F3V3T5G	NZ8F3V3SMX2WT5G	NZD3V3MUT5G	NZE3V3FCT5G
3.9V	MM3Z3V9T1G	MM5Z3V9T1G	NZ9F3V9T5G	NZ8F3V9SMX2WT5G	NZD3V9MUT5G	NZE3V9FCT5G
4.3V	MM3Z4V3T1G	MM5Z4V3T1G	NZ9F4V3T5G	NZ8F4V3SMX2WT5G	NZD4V3MUT5G	NZE4V3FCT5G
4.7V	MM3Z4V7T1G	MM5Z4V7T1G	NZ9F4V7T5G	NZ8F4V7SMX2WT5G	NZD4V7MUT5G	NZE4V7FCT5G
5.1V	MM3Z5V1T1G	MM5Z5V1T1G	NZ9F5V1T5G	NZ8F5V1SMX2WT5G	NZD5V1MUT5G	NZE5V1FCT5G
5.6V	MM3Z5V6T1G	MM5Z5V6T1G	NZ9F5V6T5G	NZ8F5V6SMX2WT5G	NZD5V6MUT5G	NZE5V6FCT5G
6.2V	MM3Z6V2T1G	MM5Z6V2T1G	NZ9F6V2T5G	NZ8F6V2SMX2WT5G	NZD6V2MUT5G	NZE6V2FCT5G
6.8V	MM3Z6V8T1G	MM5Z6V8T1G	NZ9F6V8T5G	NZ8F6V8SMX2WT5G	NZD6V8MUT5G	NZE6V8FCT5G
7.5V	MM3Z7V5T1G	MM5Z7V5T1G	NZ9F7V5T5G	NZ8F7V5SMX2WT5G	NZD7V5MUT5G	NZE7V5FCT5G
8.2V	MM3Z8V2T1G	MM5Z8V2T1G	NZ9F8V2T5G	NZ8F8V2SMX2WT5G	NZD8V2MUT5G	NZE8V2FCT5G
12V	MM3Z12VT1G	MM5Z12VT1G	NZ9F12VT5G	NZ8F12VSMX2WT5G	NZD12VMUT5G	-
15V	MM3Z15VT1G	MM5Z15VT1G	NZ9F15VT5G	NZ8F15VSMX2WT5G	NZD15VMUT5G	-
16V	MM3Z16VT1G	MM5Z16VT1G	NZ9F16VT5G	NZ8F16VSMX2WT5G	NZD16VMUT5G	-
18V	MM3Z18VT1G	MM5Z18VT1G	NZ9F18VT5G	NZ8F18VSMX2WT5G	NZD18VMUT5G	-
27V	MM3Z27VT1G	MM5Z27VT1G	-	NZ8F27VSMX2WT5G	-	-
33V	MM3Z33VT1G	MM5Z33VT1G	-	NZ8F33VSMX2WT5G	-	-

Smaller Footprint, Similar Power Ratings

Industry's smallest Zener diodes!

50% smaller than X3DFN Same Power!



Typical Applications

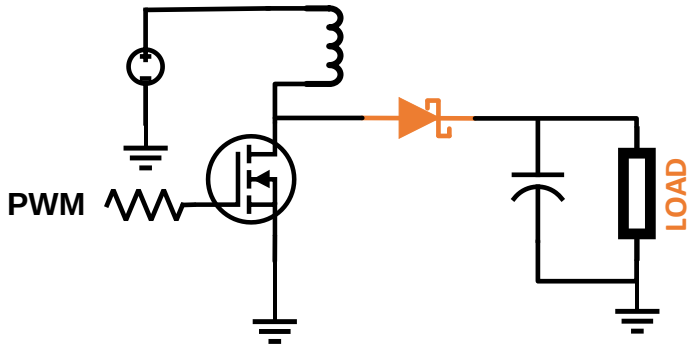
Higher Power Rated Devices Also Available

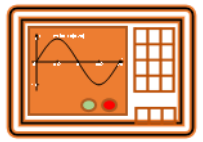
Family	P Max (W)	Package
1N53	5	Surmetic™
1PMT	3.2	Powermite
1N59	3	Surmetic™
1SMB59	3	SMB
1SMA59	1.5	SMA
1N47	1	Axial Leaded
BZX85	1	Axial Leaded
MMSZ	0.5	SOD-123
BZX79	0.5	Axial Leaded
MM5Z	0.5	SOD-523

Schottky Diodes

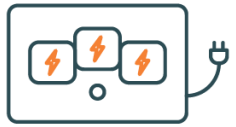
Schottky Diodes in Industrial Applications

Boost (up) Converter



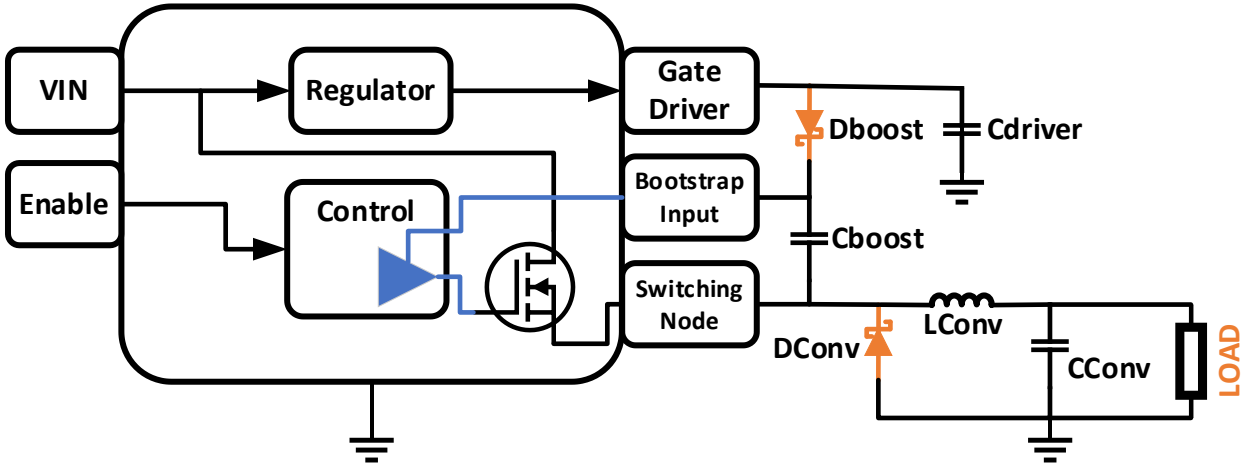


HMIs/
Terminals
(Displays)

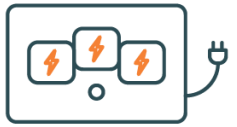


UPS

Buck (down) Converter



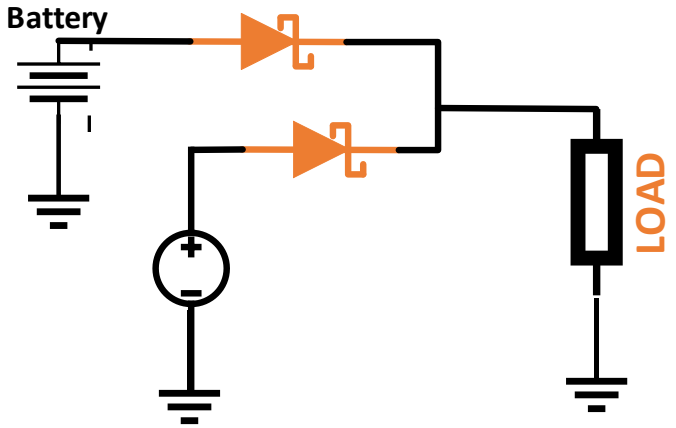
EV Charging
Stations

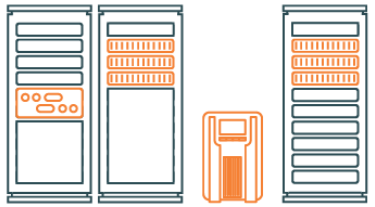


UPS

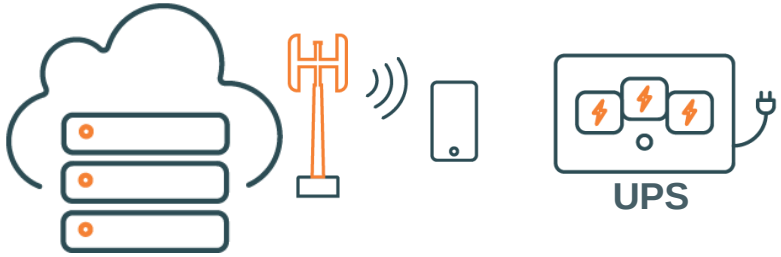
Schottky Diodes in Industrial Applications

OR-ing Voltages /Power Supplies





Servers

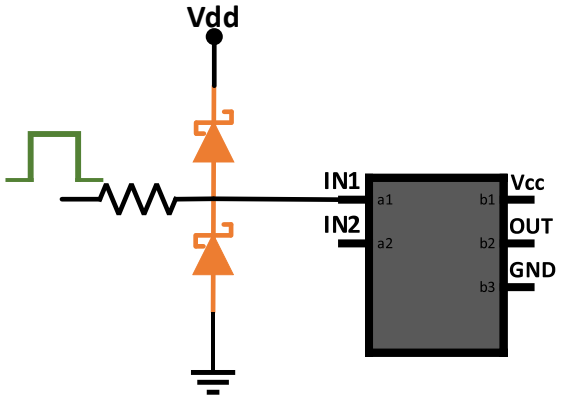


Telecom Eq

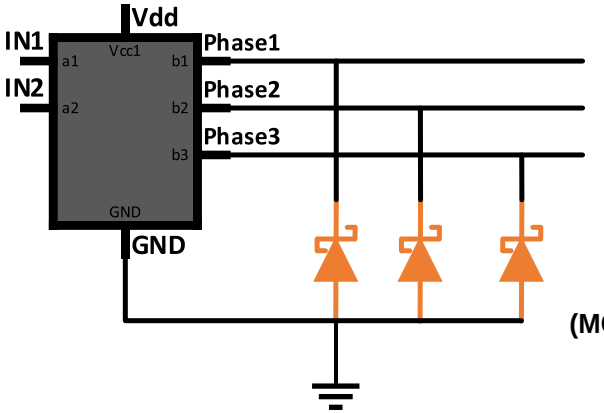
Power Tools

Voltage Clamping

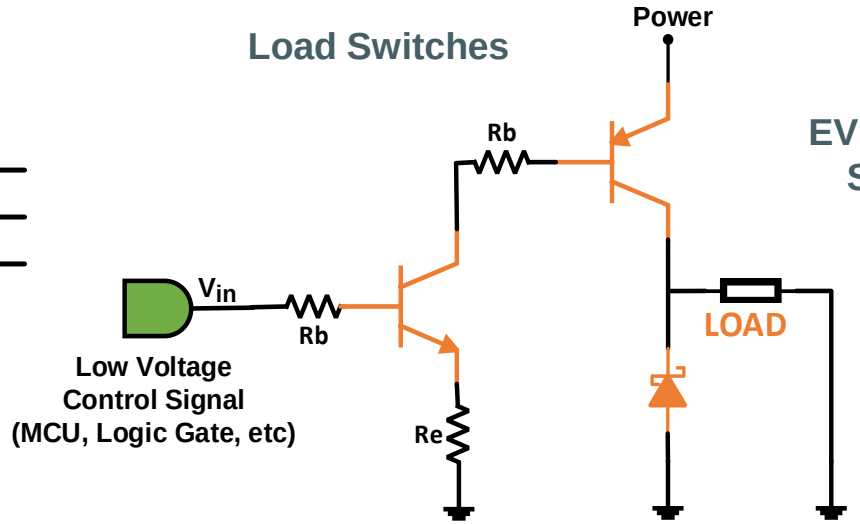
MCU, Low Voltage Inputs…



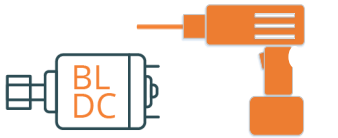
3-Phase Gate Drivers



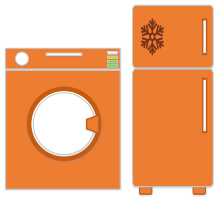
Load Switches



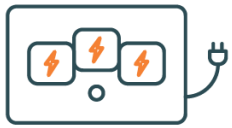
EV Charging Stations



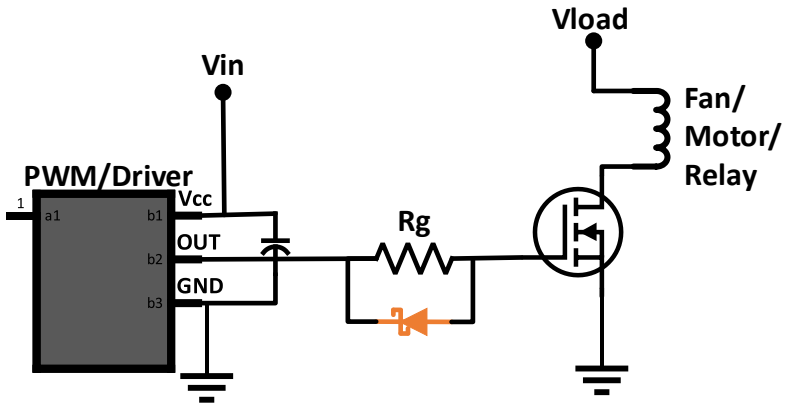
Power Tools



Appliances



Schottky Diodes on Gate Drivers

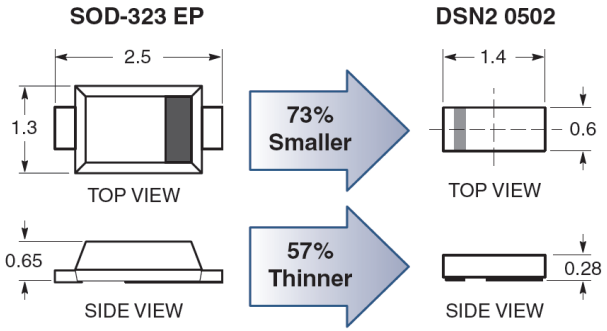


Small Signal Schottky Diodes

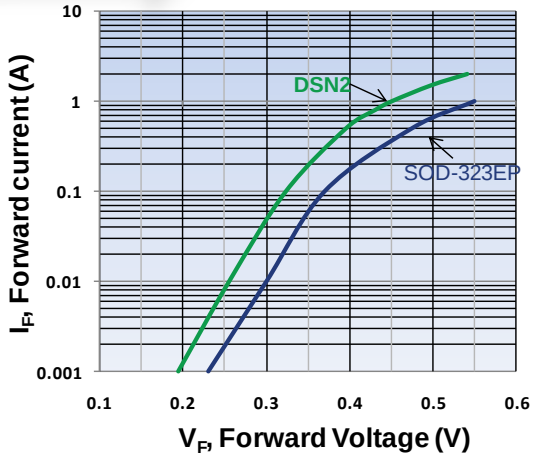
High Performance Schottky Diodes in Industry's Smallest Form Factors

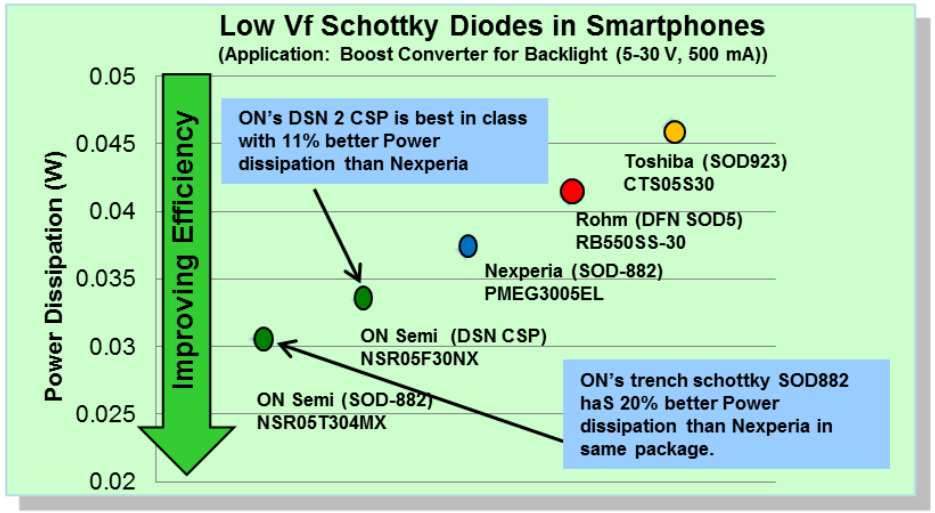
	SOD-323	SOD-523	SOD-923	DSN2 0201	X4DFN2 01005
20 V, 500 mA	-	NSR0520V2	NSR0620P2	-	NSR05201MX4
30 V, 30 mA	RB751V40	RB751S40	-	-	-
30 V, 70 mA	-	-	NSR0140P2	-	-
30 V, 100 mA	-	-	NSR0130P2	NSR01L30NX	NSR01301MX4
30 V, 200 mA	-	RB521S30	NSR0230P2	NSR02F30NX	NSR02301MX4
30 V, 200 mA	-	RB520S30	-	NSR02L30NX	-
30 V, 200 mA	BAT54H	BAT54X	-	-	-
30 V, 500 mA	NSR0530H	NSR05T30XV2	NSR0530P2	NSR05402NX	NSR05301MX
40 V, 200 mA	NSR0240H	NSR0240V2	NSR0240P2	-	-
40 V, 200 mA	NSR0340H	NSR0340V2	NSR0340P2	-	-
70 V, 70 mA	NSR0170H	-	NSR0170P2	-	-

94% smaller, 75% higher power



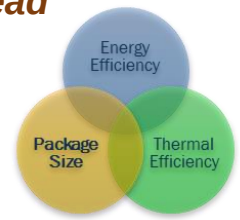
Dimensions in mm. Not to scale.





Continued Innovation to Maintain Lead

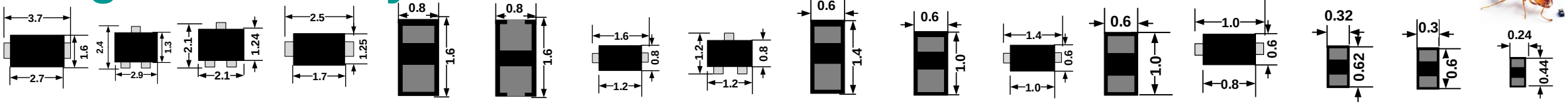
New: Industry's smallest 0.5A Schottkys!



Features / Benefits

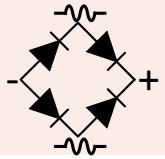
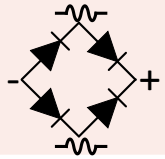
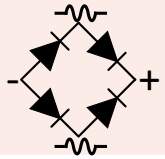
- Industry leading size → Less board space
- 0.18 mm height → Thinner board profile
- Shortest possible thermal path → Reduces power dissipation
- Low forward voltage drop, V_F → Increases circuit efficiency
- Pb and Halogen free → Environmentally friendly

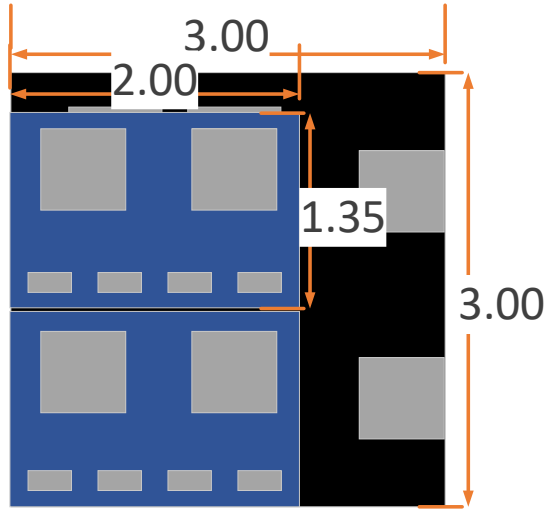
Small Signal Schottky Diodes



V_R	I_F(A)	SOD-123	SOT-23	SC-70	SOD-323	DSN2 0603	X2DFNW2 0603	SOD-523	SOT-723	DSN2 0502	DSN2 0402	SOD-723	X2DFN2 0402	SOD-923	X3DFN2	DSN2 0201	X4DFN 01005
20	0.5							NSR0520V2			NSR05F20NX			NSR0620P2			NSR05201
	0.6													NSR0620SP2			
	1.0				NSR0320 NSR1020M					NSR10F20NX							
	2.0					NSR20F20NX											
30	0.03				RB751V40			RB751S40T						RB751S40P2			
	0.07													NSR0140P2			
	0.1				MMDL301									NSR0130P2 NSR01L30P2	NSR01F30M NSR01L30M	NSR01F30NX NSR01L30NX	NSR01301
	0.2	BAT54T MMSD301	BAT54L MMBD301L	BAT54W MMBD330	BAT54H			BAT43XV2 BAT54XV2 NSRLL30 RB520S30 RB521S30	BAT54M3 MMBD301M3			NSR0230M2		NSR0230P2	NSR02F30M	NSR02F30NX NSR02L30NX	NSR02301
	0.5				NSR0530H			NSR05T30XV2			NSR05F30NX			NSR0530P2 NSR05T30P2			NSR05301
	0.6													NSR0630P2			
	1.0									NSR10F30NX							
	2.0					NSR20F30NX											
40	0.12		BAS40L											BAS40P2			
	0.2												NSR0240MX NSR02L40MX	NSR0240P2 NSR0340P2			
	0.25				NSR0240H NSR0340H			NSR0240V2 NSR0340V2									
	0.5							NSR05T40XV2			NSR05F40NX		NSR05T404MX	NSR05T40P2			
	0.75		NSR07540														
	1.0						NSR10T406			NSR10F40NX							
	2.0					NSR20406NX NSR20F40NX											
70	-		MMBD701L														
	0.07		BAS70L		NSR0170HT									NSR0170P2			
	0.1				MMDL770												
	0.2	MMSD701		MMBD770													
100	0.2				NSR02100												

Full and Half Bridge High Efficiency Schottky Rectifiers

Spec	NSR1030 QMU	NSR2030 QMU	NSR2030 QMX	NSR2030 DMX
V_R	30 V	30 V	30 V	30 V
I_F	1.0 A	2.0 A	2.0 A	2.0 A
V_F @ 0.5 A	415 mV	400 mV	410 mV	410 mV
V_F @ 1 A	475 mV	455 mV	455 mV	455 mV
V_F @ 2 A	-	545 mV	545 mV	545 mV
I_R @ 30 V	6 µA	7 µA	5 µA	5 µA
Size (mm)	3 x 3 x 0.5	3.5 x 3.5 x 0.5	3 x 3 x 0.39	2 x 1.35 x 0.39
Configuration				

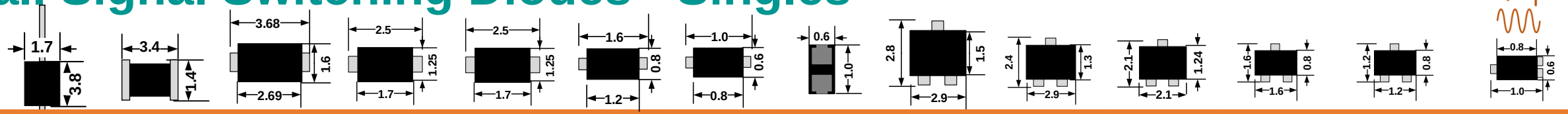


2.0 x 2.7 (5.4 mm²)
Half Bridge x 2

- **Ultra Low V_F**
  - 410 mV @ 500 mA Typ
  - 450 mV @ 500 mA Max
- **Full and half bridge configurations**
- **DFN packages ideal for space constrained applications**
- **Half bridge provides high degree of routing flexibility**

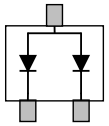
Small Signal Switching Diodes

Small Signal Switching Diodes - Singles



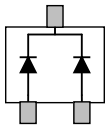
VR (V)	Axial Lead	SOD-80	SOD-123	SOD-323	SOD-323FL	SOD-523-2	SOD-923-2	X2DFNW2	SC-59-3	SOT-23-3	SC-70-3	SC-75-3	SOT-723-3	SOT-1123-3
20	FJH1101							New!!						
30	1N456A FJH1100													
40									M1MA151K		M1MA141K			
70	1N457			MMDL6050						BAL99L MMBD6050L				
75	1N4454	FDLL4150			1N4148WS	1N4148WT 1N4448WT 1N914BWT				BAS116L		BAS116T		NSD16F3T5G
80	1N5282								M1MA152K					
85		FDLL457A												
100	1N4148 1N4149 1N4447 1N4448 1N914 1N916	FDLL4148 FDLL4448 FDLL914 LL4148	MMSD4148 MMSD4448 MMSD914	BAS16H MMDL914	1N4448WS 1N914BWS	1SS400 BAS16XV2 NSD914XV2	BAS16P2	BASH16MX2W		BAS16L MMBD1201 MMBD914L	BAS16W	BAS16T	BAS16M3	NSD914F3T5G
120	BAV19							BASH19MX2W		BAS19L BAS29 BASH19				
125	BAY72 BAY73													
150	1N3595 1N458A FDH300 FDH333 FDH3595 FDH444	FDLL300A FDLL333 FDLL3595												
180	BAX16													
200	1N3070 1N459 1N459A 1N485B FDH400	BAV102 FDLL400 FDLL485B	MMSD3070	BAS20HT1				BASH20MX2W		BAS20L MMBD1401 MMBD1501A				
250		BAV103	MMSD103	BAS21AH BAS21HT		BAS21XV2		BASH21MX2W		BAS21L			BAS21M3	
350				NSD350H										

Small Signal Switching Diodes – Duals & Triples



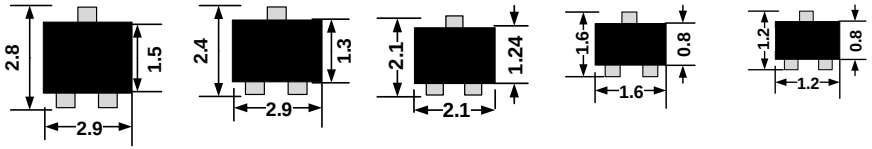
Common Anode

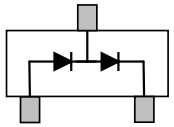
VR	SC-59-3	SOT-23-3	SOT-323-3	SC-75-3	SOT-723-3
35		MMBD2835L			
40	M1MA151WA		M1MA141WA		
70		BAW56L NSD070AL	BAW56W BAWH56	BAW56T	BAW56M3
75		MMBD2836L			
80	M1MA152WA		M1MA142WA	DAP222	DAP222M3T5G
100		MMBD1205 MMBD4148CA			
120		BAS35			
200		MMBD1405 MMBD1405A MMBD1505A			



Common Cathode

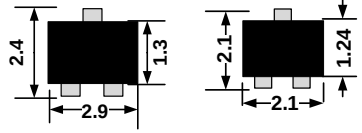
VR	SC-59-3	SOT-23-3	SOT-323-3	SC-75-3	SOT-723-3
35		MMBD2837L			
40	M1MA151WK				
50		BAV74L			
70		MMBD6100L			
75		MMBD2838L			
80	M1MA152WK		M1MA142WK	DAN222	DAN222M3T5G
100		BAV70L MMBD1204 MMBD4148CC	BAV70W	BAV70T	BAV70M3T5G
200		MMBD1404 MMBD1404A MMBD1504A			
250		BAV23CL			

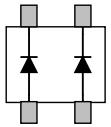




Series

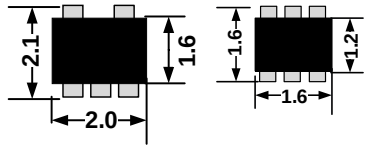
VR	SOT-23-3	SOT-323-3
70	BAV199L	
100	BAV99L MMBD1203 MMBD4148SE MMBD7000L	BAV99W BAV99RW
120	BAS31	
200	MMBD1403 MMBD1503A	
250	BAS21SL BAV23S MMBD1401AL	

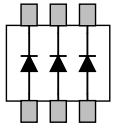




Duals (Independent)

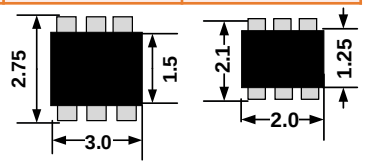
VR	SC-88A	SOT-563
100		BAS16DXV6
250	BAS21DW5	





Triples

VR	SC-74	SC-88-6
80		HN2D02FUTW1
100		BAS16W1
250	BAS21TMR6	



Area Savings Reference Table

From/To	SOT-23	SOT-323 SC-70	SC-75	SOT-723	SOT-1123
SOT-23	0%	37%	63%	79%	91%
SC-70		0%	42%	67%	86%
SC-75			0%	44%	77%
SOT-723				0%	58%
SOT-1123					0%

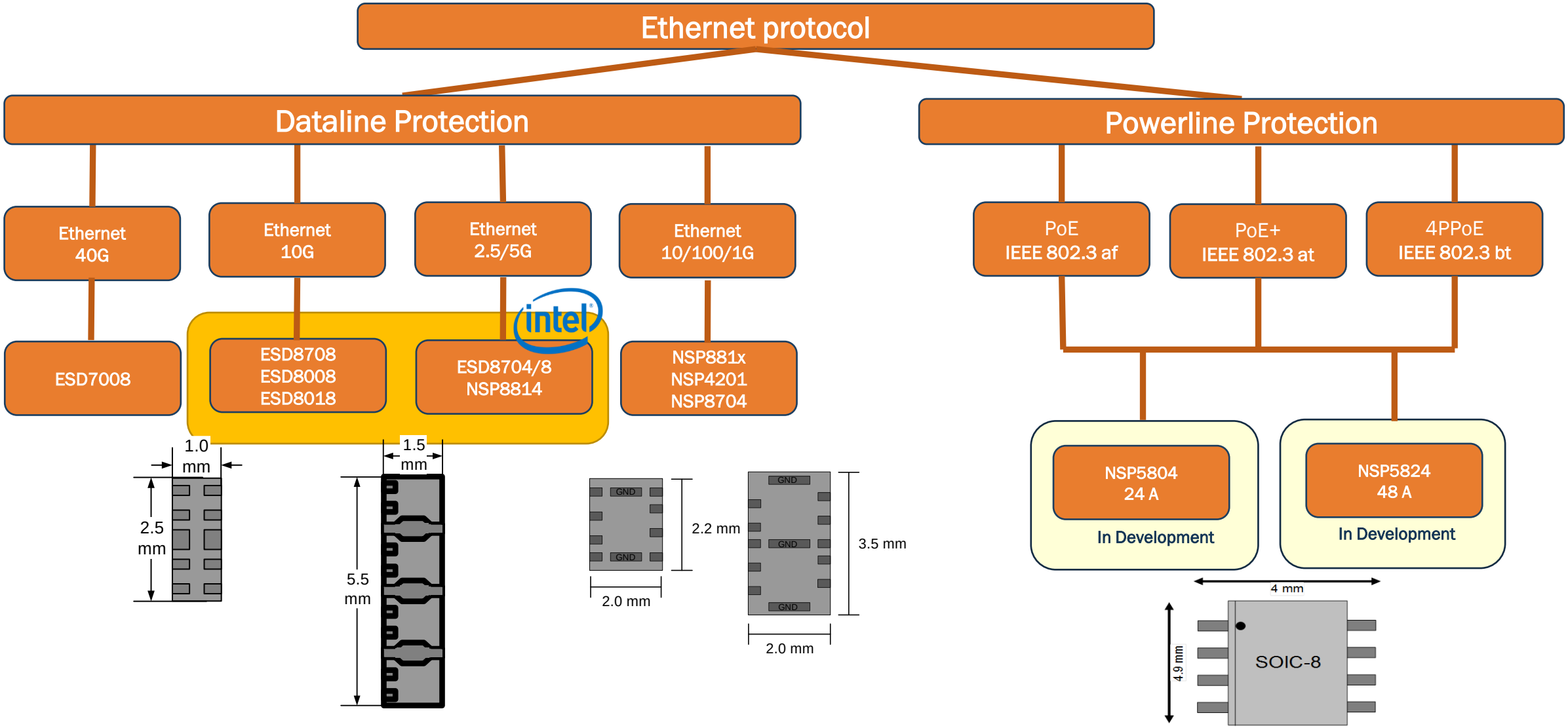
ESD & Surge Protection

ESD/Surge Protection Selection Guide

Interface Details			Protection Solution Details		
Interface	**Data Pairs**	**Max Data Rate**	**Data Pairs**	**ESD Only**	**ESD + Filter**
USB3.x, 4.0	4 (+1 USB 2.0)	20 Gbps	Single Line 01005	ESDL1531, ESDL1012	
			Single Line 0201	ESDL2011, ESDL2012, ESDL2031, ESD8011	
			3 pair (Tx, Rx, D+, D-)	ESD8116, ESD8006	
			2 pair (Tx, Rx)*	ESD8704, ESD8504G, ESD8104	EMI8x42
USB2.0	1	480 Mbps	Single Line 01005	ESDL1531, ESDM1131	
			Single Line 0201	ESDL2031, ESD8011, ESD8472, ESD7331	
			Single Line 0402	ESDL4151. ESD8551, ESD7551	
			2 pair + Power	NSP4201, NUP4114	EMI2121
			1 pair + ID + Power	NUP2114	
			1 pair*	ESD7L5.0	
Thunderbolt	4	40 Gbps (2x20)	Single Line 01005	ESDL1531	
			Single Line 0201	ESDL2011, ESDL2012, ESD8011	
			2 pair*	ESD8004	
			3 pair	ESD8006, ESD8116	
HDMI 1.x, 2.x	4	48 Gbps (12x4 FRL Mode)	Single Line 0201	ESDL2031, ESD8472	
			4 pair + CEC, SDL, SDA, Power, HPD	ESD8040	
			2 pair*	ESD8104 + NUP4114	EMI8x42*
			4 pair*	ESD8118 + NUP4114	
DisplayPort	4	25.9 Gbps (8.1 x 4)	Single Line 01005	ESDL1531	
			Single Line 0201	ESDL2011, ESDL2012, ESDL2031, ESD8011	
			2 pair*	ESD8704 (2) + NUP4114	EMI8x42*
			4 pair*	ESD8118 + NUP4114	
Micro SD Card		208 MHz	5 pair + CLK, Vcc		EMI6316
			4 pair + CLK, CMD		CM1624-08DE
			8 line	CM1230-08CP	
			4 line	ESD5004, CM1230-04CP	
			2 line	ESDL3552, CM1230-02CP	
			single line 0201	ESDL1531, ESDL2031, ESDM2033	
eSATA 1.0	2	1.5 Gbps	2 pair	ESD7004	
eSATA 2.0/3.0	2	3.0 Gbps	2 pair	ESD8704, ESD8104	
		6.0 Gbps			
PCIe 3.0	16	8 Gbps (x1)	Single Line 01005	ESDL1531	
			Singe Line 0201	ESDL2011, ESDL2012, ESDL2031, ESD8011	
			2 pair	ESD8704	
			4 pair	ESD8708, ESD8118	
PCIe 4.0	16	16 Gbps (x1)	Single Line 01005	ESDL1531	
			Singe Line 0201	ESDL2011, ESDL2012, ESD8011	
			2 pair	ESD8104, ESD8004	
			4 pair	ESD8118	
10/100 Ethernet	2	50 Mbps	2 pair	NSP8814, NSP4201	
Gigabit Ethernet	4	250 Mbps	2 pair	NSP8814, NSP4201	
			4 pair	NSP8818, ESD8708	
10G Ethernet	4	2.5 Gbps	4 pair	ESD8708, ESD8018, ESD8008, ESD8118	

Ethernet Protection

Ethernet Portfolio

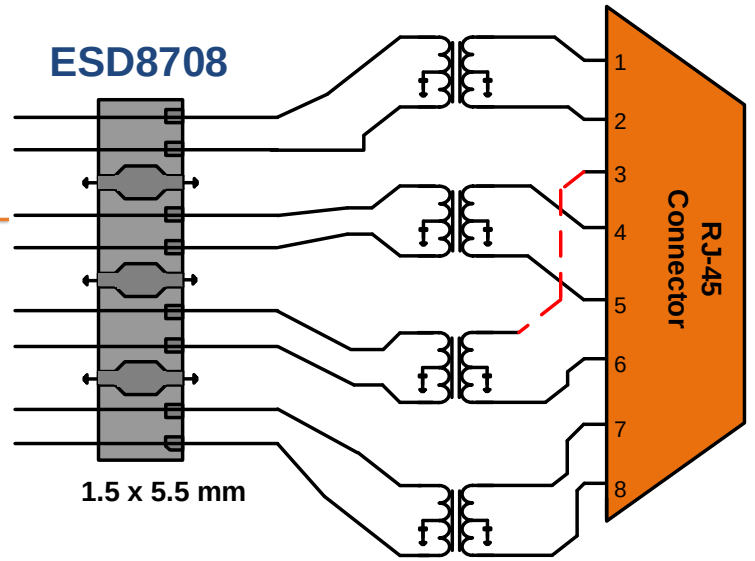


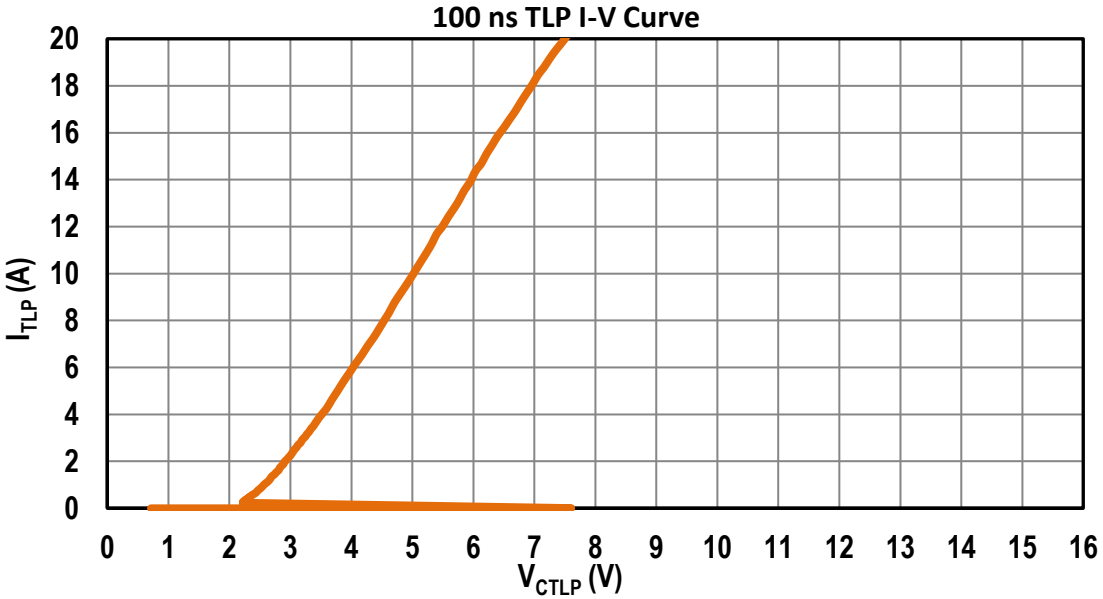
ESD8708 – 2.5 & 5 Gbps Ethernet Protection

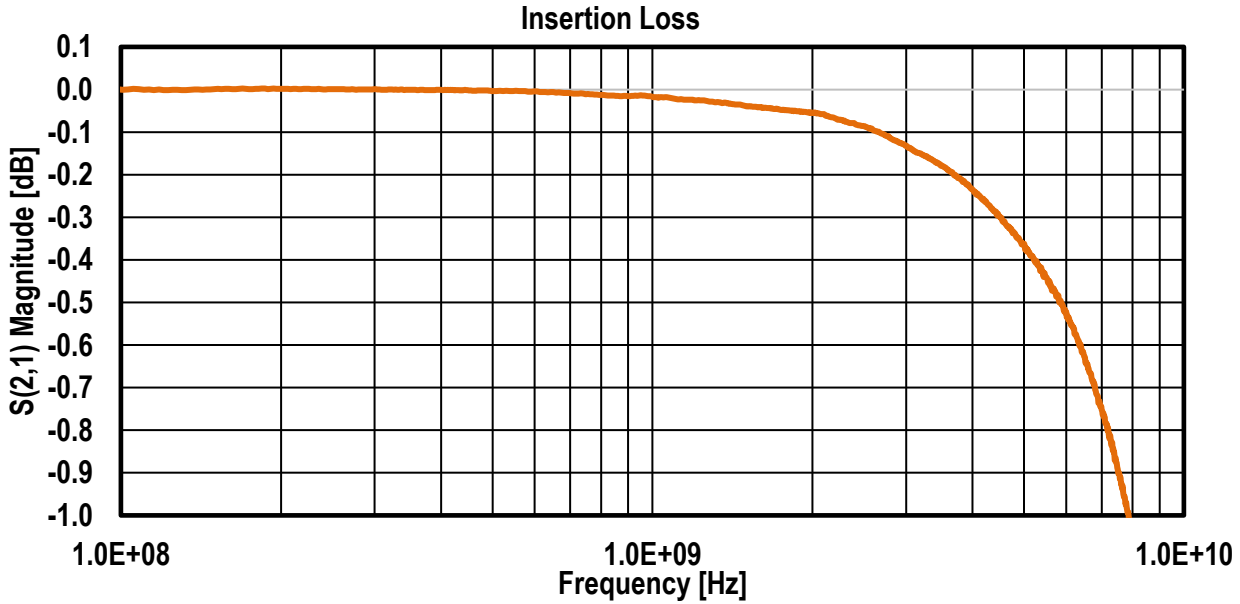
ESD8708

- 8 Channel Protection – Flow-through package
- 3.3 V V_{RWM}
- < 1 µA Leakage
- Unidirectional
- 0.35 pF Typ, 0.50 pF Max
- Insertion Loss (pin to ground)
  - 0.001 dBs @ 200 MHz
  - 0.025 dB @ 1.25 GHz
  - 0.085 dB @ 2.5 GHz
- 6.5 V Clamping @ 16 A, 100 ns TLP
- 7.1 V Clamping @ 8 A, tp=8/20µs, Req = 2 Ω

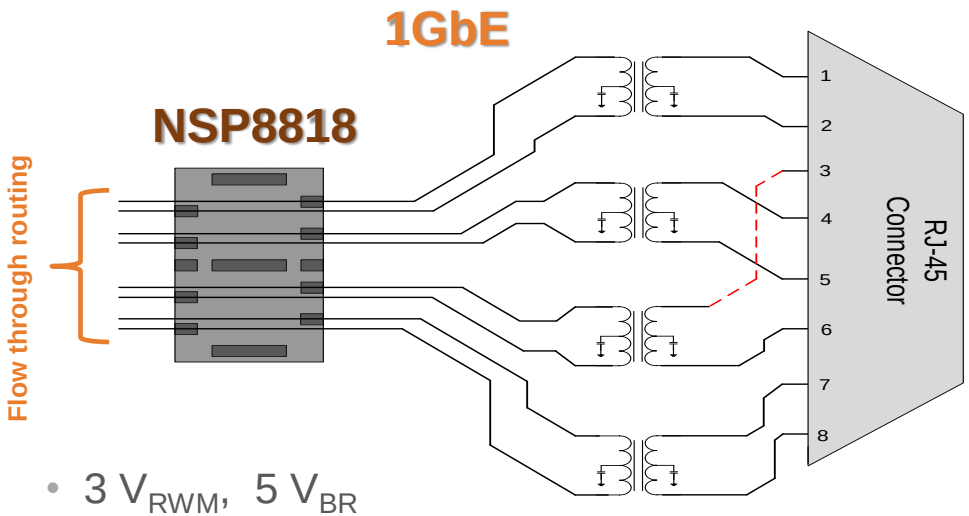
Intel Ref. Design
2.5 GbE
Foxville (I225-V) NIC, Dock, Switch & Dongle

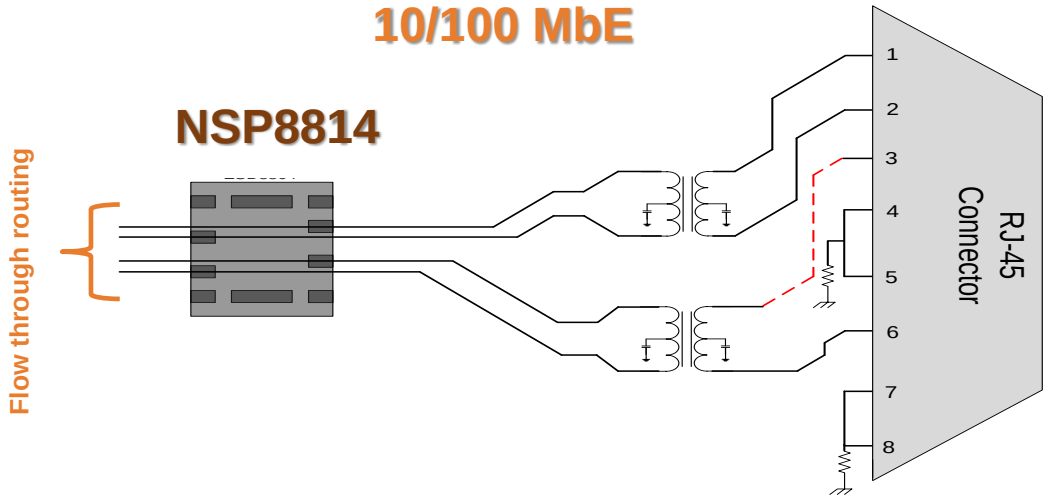




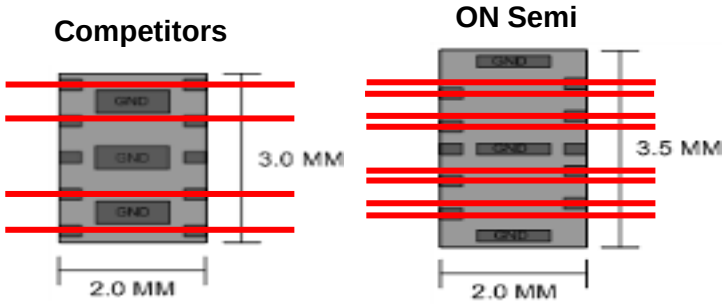


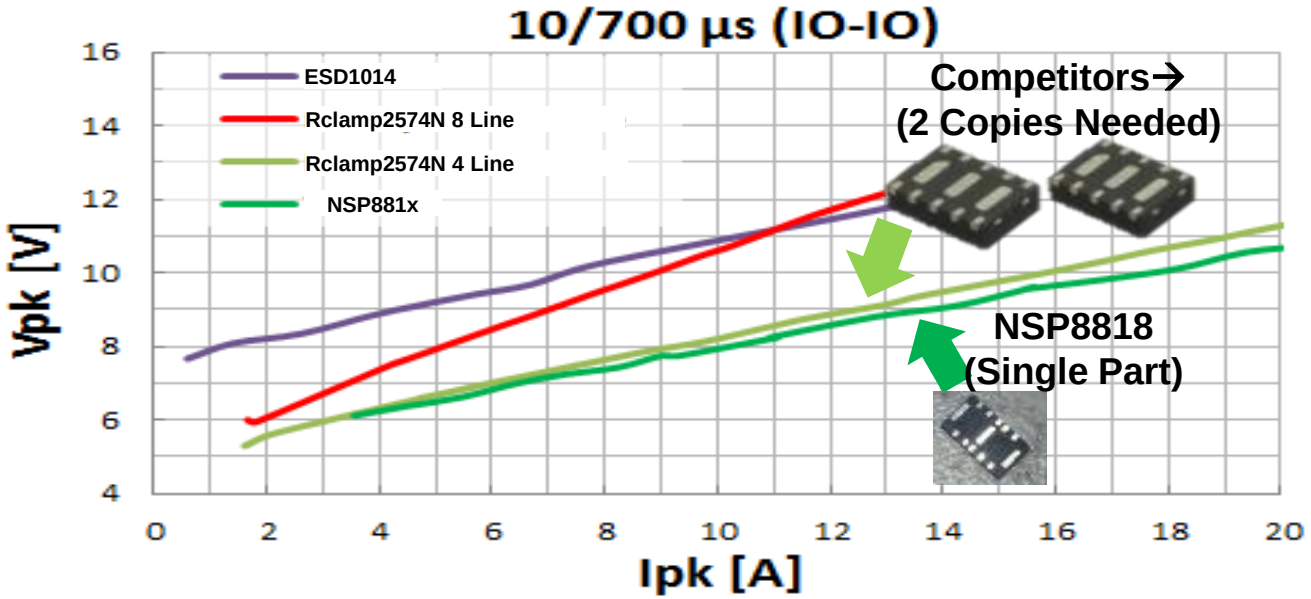
NSP881x - 10/100/1000 Ethernet Data Line Protection





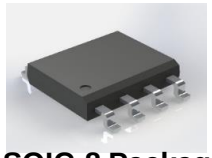
- 3 V_{RWM}, 5 V_{BR}
- 35 A Peak Current (8 x 20 µs)
- 1.5 pF I/O to I/O @ 1 MHz
- ± 30 kV Contact IEC61000-4-2 Level 4 rated
- **< 15 V clamping voltage @ 35 A (8 x 20 µs)**
- 4/8 ch flow through package



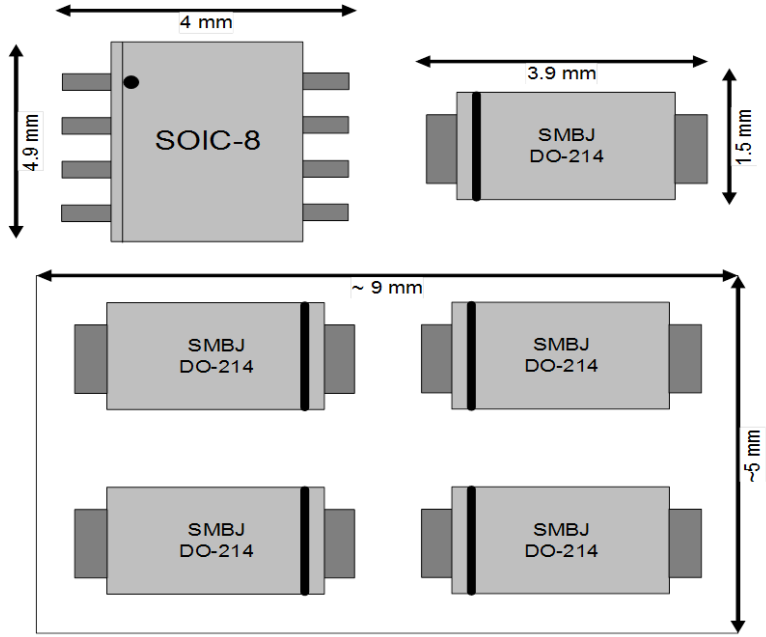


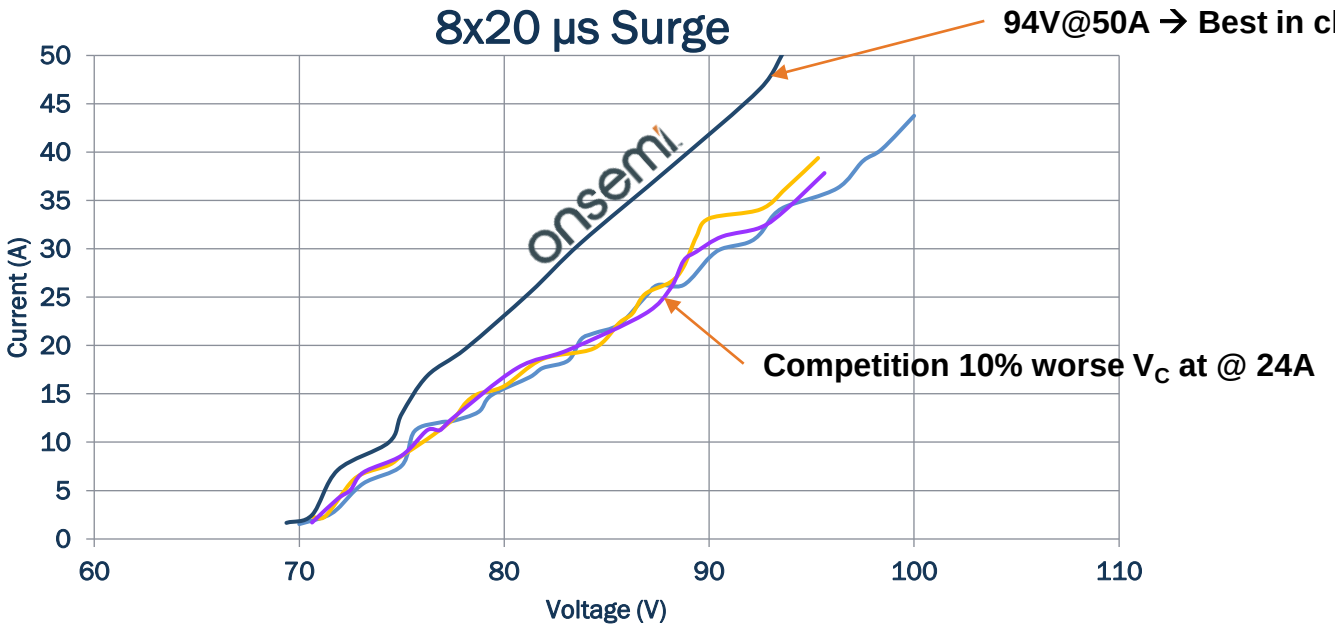
NSP58x4 - Power Over Ethernet Protection – In Development

- Every PoD Equipment needs Surge/ESD protection
- Often recommended protectors:
  - SMBJ58A , SMBJ51A, SMBJ60A
  - S1B
- NSP58x4 offers
  - Smaller footprint
  - Easier routing
  - Lower leakage
  - Similar clamp voltage at 24 A Surge
  - Better protection against Surge and ESD if used in front of bridge rectifiers
  - Can be used in 2-line configuration with better performance than SMBJ58A



SOIC-8 Package





NSP58x4 benefits:

- Lower clamping voltage
- Higher surge robustness
- Smaller or same Form Factor

Device	Vrwm[V]	Ir[uA]	Ipp[A]	Vcl @ 24A	Package
NSP5824	**58**	**0.1**	**45**	**<80**	**SOIC-8**
Competitor A	58	0.2	24	>85	SOIC-8
Competitor B	58	0.2	24	>85	SOIC-8
Competitor C	58	0.2	24	>85	SOIC-8

Surge Protection Roadmap – Power Lines

USB PD SPR
5 V, 9V, 15 V, 20 V

USB PD EPR
28 V, 36 V, 48 V

OPN
Package - Polarity
Vrwm | 8x20 Ipp | Vc @ I_{pp}

Power Line

NSPM6201 2020 DFN3 Bi: 20 Vrwm | 100 Ipp | 35 Vc

NSPU6201 2020 DFN3 Uni: 20 Vrwm | 260 Ipp | 27.5 Vc

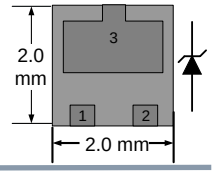
NSPU6221 2020 DFN3 Uni: 22 Vrwm | 240 Ipp | 28 Vc

NSPU6301 2020 DFN3 Uni: 30 Vrwm | 200 Ipp | 36 Vc

NSPU6381 2020 DFN3 Uni: 38 Vrwm | 135 Ipp | 50 Vc

NSPU6511 2020 DFN3 Uni: 51 Vrwm | 120 Ipp | 70 Vc

NSPM6581 2020 DFN3 Bi: 58 Vrwm | 90 Ipp | 80 Vc



ESD7124 UDFN6 1.8x2.0 Uni: 12 Vrwm | 100 Ipp | 27 Vc

NSPM5131 UDFN6 1.8x2.0 Uni: 13.5 Vrwm | 100 Ipp | 20.5 Vc

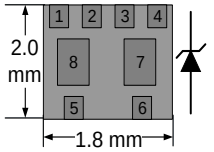
NSPU5132 UDFN6 1.8x2.0 Uni: 13.5 Vrwm | 200 Ipp | 22 Vc

NSPM8151 UDFN6 1.8x2.0 Uni: 15 Vrwm | 110 Ipp | 28 Vc

NSPM8181 UDFN6 1.8x2.0 Uni: 18 Vrwm | 119 Ipp | 31 Vc

NSPU5201 UDFN6 1.8x2.0 Uni: 20 Vrwm | 140 Ipp | 32.5 Vc

NSPU5221 UDFN6 1.8x2.0 Uni: 22 Vrwm | 130 Ipp | 35 Vc



NSPM2051 0603 UDFN2 Uni: 5 Vrwm | 100 Ipp | 9 Vc

NSPM2052 0603 UDFN2 Uni: 5 Vrwm | 120 Ipp | 8 Vc

NSPM0101 0603 DFN Uni: 10 Vrwm | 60 Ipp | 20 Vc

NSPU2101 UDFN0603 Uni: 10 Vrwm | 110 Ipp | 16.5 Vc

2x

NSPU2131 UDFN0603 Uni: 13 Vrwm | 90 Ipp | 18 Vc

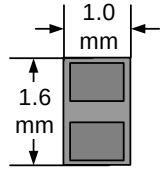
NSPU7221 0603 DSN Uni: 22 Vrwm | 140 Ipp | 31 Vc

NSPU7281 0603 DSN Uni: 28 Vrwm | 115 Ipp | 35 Vc

NSPU7301 0603 DSN Uni: 30 Vrwm | 90 Ipp | 36 Vc

NSPU7381 0603 DSN Uni: 38 Vrwm | 60 Ipp | 49 Vc

NSPU7511 0603 DSN Uni: 51 Vrwm | 40 Ipp | 64 Vc



NSPU4072 0402 DSN Uni: 7.9 Vrwm | 70 Ipp | 12.5 Vc

NSPU4201 0402 DSN Uni: 20 Vrwm | 40 Ipp | 25.5 Vc

NSPM4241 0402 DSN Bi: 24 Vrwm | 35 Ipp | 34 Vc

NSPU4281 0402 DSN Bi: 28 Vrwm | 38 Ipp | 35 Vc

NSPU4331 0402 DSN Bi: 33 Vrwm | 30 Ipp | 41 Vc

NSPU4051 0402 DSN Uni: 5 Vrwm | 130 Ipp | 10.5 Vc

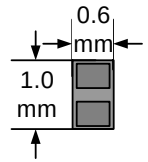
NSPU4361 0402 DSN Uni: 38 Vrwm | 25 Ipp | 46 Vc

NSPU4101 0402 DSN Uni: 10 Vrwm | 65 Ipp | 16.2 Vc

NSPU4221 0402 DSN Uni: 22 Vrwm | 40 Ipp | 26.5 Vc

NSPU4301 0402 DSN Bi: 30 Vrwm | 33 Ipp | 38 Vc

NSPU4091 0402 DSN Uni: 9 Vrwm | 70 Ipp | 15.5 Vc



Production | Development | Concept | Exploring

Increasing Power Density, Lower Clamping

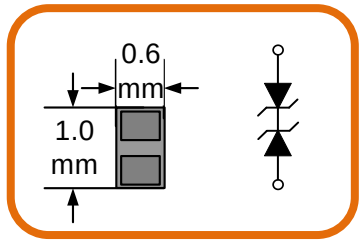
RS-232 / Serial Port

High and Low Speed Data Lines

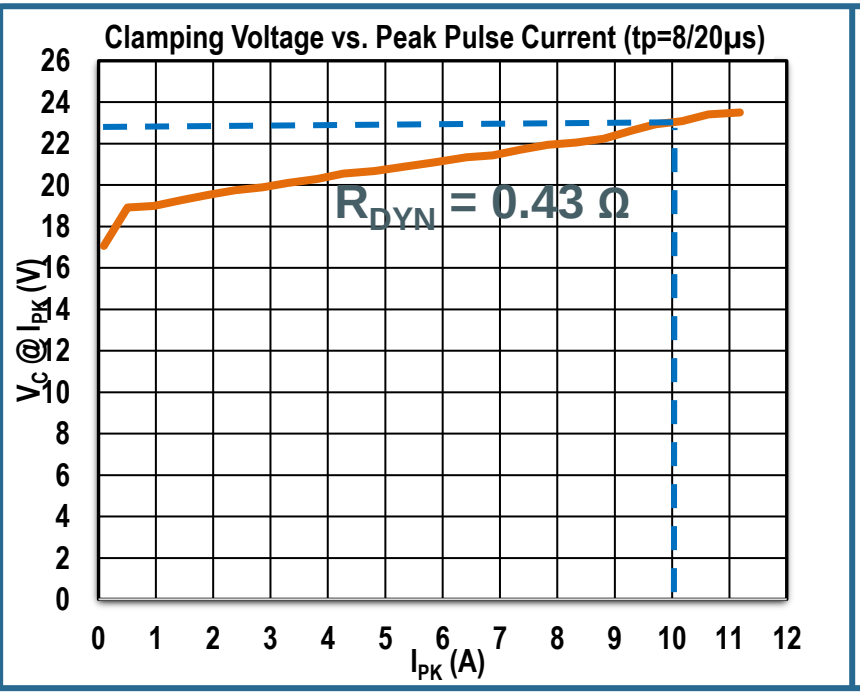
ESDL4151 – 15 V Bidirectional Protection in 1.0 x 0.6 mm

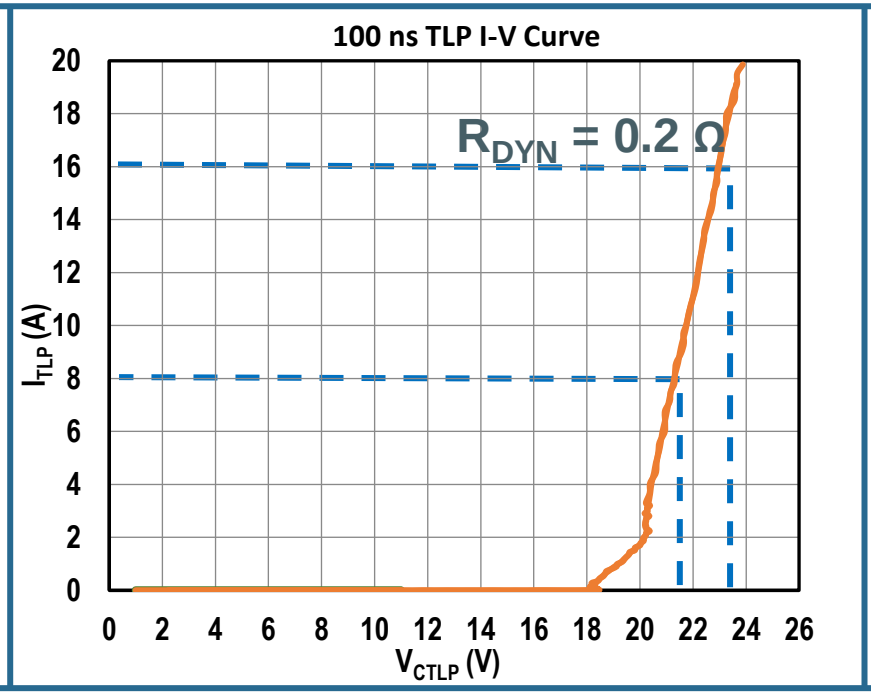
ESDL4151

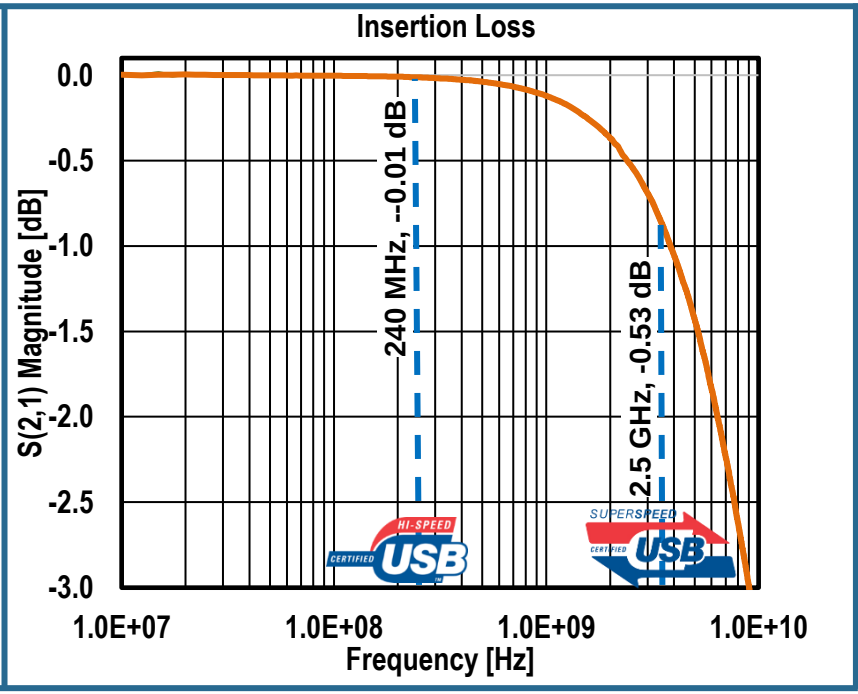
- High Speed Data Line Protection
- 15 V V_{RWM} Protects against shorts to VBUS lines
- X4DFN2 (0402) 1.0x0.6, 0.26 mm max thickness
- High Surge Capability (8x20 μs)
  - > 10 A I_{PP}
  - Excellent clamping: 23 V @ 10 A
- Fc = 9 GHz
- 0.8 pF Capacitance @ 1 MHz

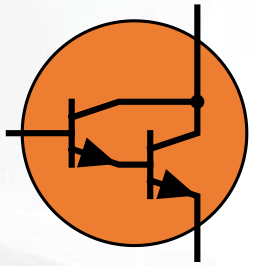


RS-232/Serial Port



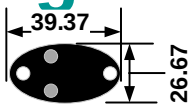


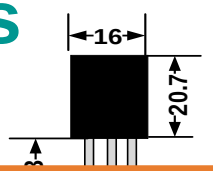


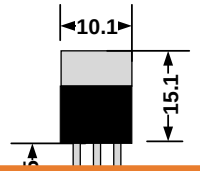


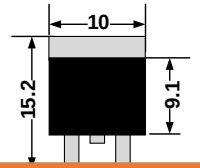
Darlingtons

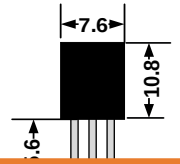
Darlingtons

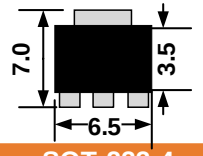


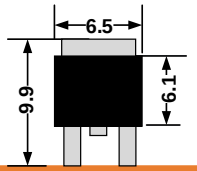


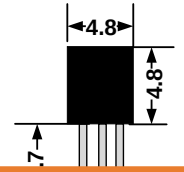


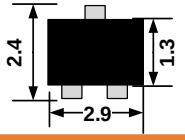












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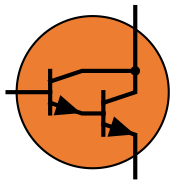
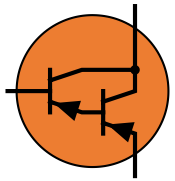
30						PZTA14-20000		BC517-30000 KSP13-10000	MMBTA13L-10000 MMBTA14L-20000
40									MMBT6427L-20000
60	MJ11012-1000 MJ11028-1000		2N6043-1000 2N6388-1000 TIP120-1000						
80			BDX33B-750 BDX53B-750 TIP121-1000			BSP52-2000 PZTA28-10000	MJD44E3-1000 MJD6039-1000		MMBTA28-10000
100	2N6284-750	MJH6284-750 TIP142-500	2N6045-1000 BDX33C-750 KSD560-2000 MJF122-2000 MJF6388-3000 TIP102-1000		BD681-750 MJE270-1500	NZT7053-1000 PZTA29-10000	MJD112-1000 MJD122-1000	MPSA29-10000	
110						NZT605-2000			
120	MJ11016-1000 MJ11032-1000								
200		MJH11020-400							
250	MJ11022-400	MJH11022-400							
350				BUB323Z-500			NJD35N04-2000		
400			MJE5742-200	MJB5742-200					
30						PZTA64-20000		BC516-30000	BCV26-10000 MMBTA63L-10000 MMBTA64L-20000
100		BDV64B-1000 MJH6287-750 TIP147-500	BDW94C-750 MJF127-2000 TIP107-1000 TIP127-1000		BD682-750		MJD117-1000 MJD127-1000		
120	MJ11015-1000 MJ11033-1000						MJD128-1000		
150		MJH11017-400							
200		MJH11019-400							
250	MJ11021-400	MJH11021-400							

OPN – hFE min



NPN



PNP

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