

# NCS3402

## Dual Nano-power Open Drain Output Comparator

The NCS3402 is a nano-power comparator consuming only 470 nA per channel supply current, which make this device ideal for battery power and wireless handset applications.

The NCS3402 has a minimum operating supply voltage of 2.7 V over the extended industrial temperature range ( $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ), while having an input common-mode range of  $-0.1$  to  $V_{DD} + 5$  V.

The ultra low supply current makes the NCS3402 an ideal choice for battery powered and portable applications where quiescent current is the primary concern. Reverse battery protection guards the amplifier from an over-current condition due to improper battery installation. For harsh environments, the inputs can be taken 5 V above the positive supply rail without damage to the device.

### Features

- Low Supply Current: 470 nA/Per Channel
  - ◆ Input Common-Mode Range exceeds the rails
  - ◆  $-0.1$  V to  $V_{DD} + 5$  V
- Supply Voltage Range: 2.7 V to 16 V
- Reverse Battery Protection Up to 18 V
- Open Drain CMOS Output Stage
- Specified Temperature Range
  - ◆  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- This is a Pb-Free Device

### Typical Applications

- Voltage Sense Circuit
- PSU Monitoring Circuit
- Wireless Handsets
- Portable Medical Equipment



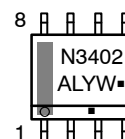
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### MARKING DIAGRAMS



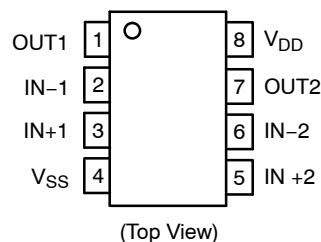
**SOIC-8  
D SUFFIX  
CASE 751**



A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

# NCS3402

## PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	Description
1	OUT1	Channel 1 Output
2	IN-1	Channel 1 Inverting Input
3	IN+2	Channel 2 Non-Inverting Input
4	V <sub>SS</sub>	Negative Power Supply
5	IN+2	Channel 2 Non-Inverting Input
6	IN-2	Channel 2 Inverting Input
7	OUT2	Channel 2 Output
8	V <sub>DD</sub>	Positive Power Supply

## ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>DD</sub>	17	V
Differential Input Voltage	V <sub>ID</sub>	±20	V
Input Voltage Range (Notes 1 and 2)	V <sub>IN</sub>	0 to V <sub>CC</sub> + 5	V
Input Current Range	I <sub>IN</sub>	±10	mA
Output Current Range	I <sub>O</sub>	±10	mA
Operating Free-Air Temperature Range	T <sub>A</sub>	-40 to +125	°C
Maximum Junction Temperature	T <sub>J</sub>	150	°C
Storage Temperature Range	T <sub>STG</sub>	-65 to 150	°C
Lead Temperature 1.6 mm (1/16 inch) from case for 10 seconds	T <sub>SLD</sub>	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. All voltage values, except differential voltages, are respect to GND
2. Input voltage range is limited to 20V or V<sub>CC</sub> +5 V whichever is smaller

## ESD RATINGS

Rating	Symbol	Value	Unit
Human Body Model	HBM	2000	V
Machine Model	MM	200	V

## THERMAL CHARACTERISTICS (Note 3)

Rating	Symbol	Value	Unit
Thermal Characteristics Thermal Resistance, Junction-to-Air SOIC8	R <sub>θJA</sub>	176	°C/W

3. Power dissipation must be considered to ensure the maximum junction temperature (θ<sub>JA</sub>) is not exceeded.

## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Max	Unit	
Supply voltage	V <sub>DD</sub>	Single supply	2.7	16	V
		Split supply	±1.35	±8	
Common-mode input voltage range	V <sub>ICR</sub>	-0.1	V <sub>DD</sub> +5	V	
Operating free-air temperature	T <sub>A</sub>	- 40	125	°C	

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## DC PERFORMANCE ELECTRICAL CHARACTERISTICS AT SPECIFIED OPERATING FREE-AIR TEMPERATURE,

$V_S = 2.7\text{ V}, 5\text{ V}, 15\text{ V}$  (unless otherwise noted)

Parameter	Symbol	Testing Conditions	$T_A$	Min	Typ	Max	Unit
Input offset voltage	$V_{IO}$	$V_{CM} = V_S/2, R_S = 50\ \Omega, R_P = 1\text{ M}\Omega$	25°C		250	3600	$\mu\text{V}$
			Full range			4400	
Offset voltage drift	$\Delta V_{IO}$		25°C		3		$\mu\text{V}/^\circ\text{C}$
Common-mode rejection ratio	CMRR	$V_{CM} = 0\text{ to }2.7\text{ V}, R_S = 50\ \Omega$	25°C	55	72		dB
			Full range	50			
		$V_{CM} = 0\text{ to }5\text{ V}, R_S = 50\ \Omega$	25°C	60	76		
			Full range	55			
		$V_{CM} = 0\text{ to }15\text{ V}, R_S = 50\ \Omega$	25°C	65	88		
			Full range	60			
Large-signal differential voltage amplification	$A_{VD}$	$R_P = 1\text{ M}\Omega$	25°C		1000		V/mV

## INPUT/OUTPUT CHARACTERISTICS SPECIFIED OPERATING FREE-AIR TEMPERATURE,

$V_S = 2.7\text{ V}, 5\text{ V}, 15\text{ V}$  (unless otherwise noted)

Input offset current (Note 4)	$I_{IO}$	$V_{CM} = V_S/2, R_P = 1\text{ M}\Omega, R_S = 50\ \Omega$	25°C		20	100	pA
			Full range			1000	
Input bias current (Note 4)	$I_{IB}$		25°C		80	250	pA
			Full range			3000	
Differential input resistance	$R_{ID}$	$V_{in} = V_S/2$	25°C		300		M $\Omega$
High-impedance output leakage current	$I_{OZ}$	$V_{CM} = V_S/2, V_O = V_{CC}, V_{ID} = 1\text{ V}$	25°C		50		pA
Low-level output voltage	$V_{OL}$	$V_{CM} = V_S/2, I_{OL} = 2\ \mu\text{A}, V_{ID} = -1\text{ V}$	25°C		8		mV
			25°C		80	200	
			Full range			300	

## POWER SUPPLY SPECIFIED OPERATING FREE-AIR TEMPERATURE, $V_{CC} = 2.7\text{ V}, 5\text{ V}, 15\text{ V}$ (unless otherwise noted)

Supply current (per channel)	$I_{CC}$	$R_P = \text{No pullup}$	Output state low	25°C		470	550	nA
				Full range			750	
			Output state high	25°C		560	640	
				Full range			950	
Power supply rejection ratio	PSRR	$V_{CM} = V_S/2, \text{No load}$	$V_{CC} = 2.7\text{ V to }5\text{ V}$	25°C	75	100		dB
				Full range	70			
			$V_{CC} = 5\text{ V to }15\text{ V}$	25°C	85	105		
				Full range	80			

4. Guaranteed by design or characterization.

# NCS3402

## SWITCHING CHARACTERISTICS AT RECOMMENDED OPERATING CONDITIONS,

$V_{CC} = 2.7\text{ V}, 5\text{ V}, 15\text{ V}, T_A = 25^\circ\text{C}$  (unless otherwise noted)

Parameter	Symbol	Testing Conditions	$T_A$	Min	Typ	Max	Unit	
Propagation delay time, low-to-high-level	$t_{(PLH)}$	$f = 10\text{ kHz},$ $V_{STEP} = 100\text{ mV},$ $R_P = 1\text{ M}\Omega,$ $C_L = 10\text{ pF}$	25°C		220		$\mu\text{s}$	
					85			
					30			
Propagation delay time, high-to-low-level output	$t_{(PHL)}$		$f = 10\text{ kHz},$ $V_{STEP} = 100\text{ mV},$ $R_P = 1\text{ M}\Omega,$ $C_L = 10\text{ pF}$	25°C		250		
						55		
						18		
Fall time	$t_f$	$R_P = 1\text{ M}\Omega, C_L = 10\text{ pF}$		25°C		5		$\mu\text{s}$

TYPICAL CHARACTERISTICS

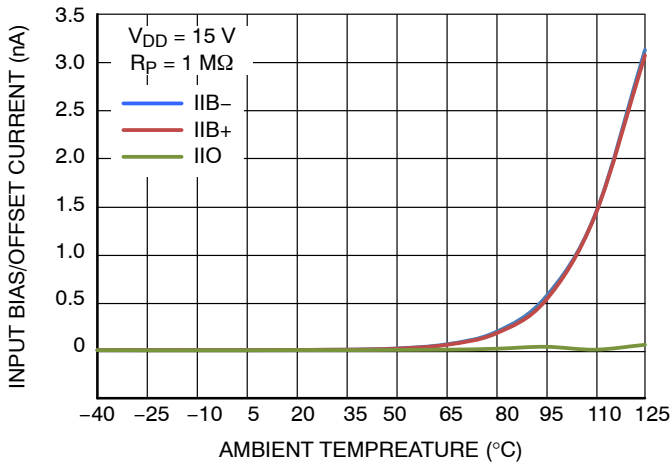


Figure 1. Input Bias/Offset Current vs. Temperature

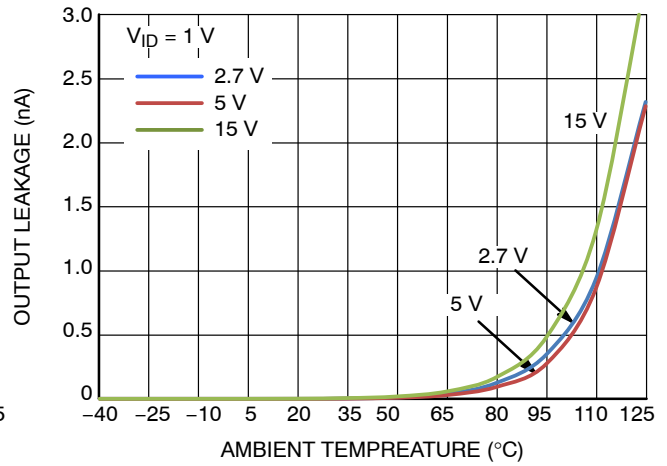


Figure 2. Open Drain Leakage Current vs. Temperature

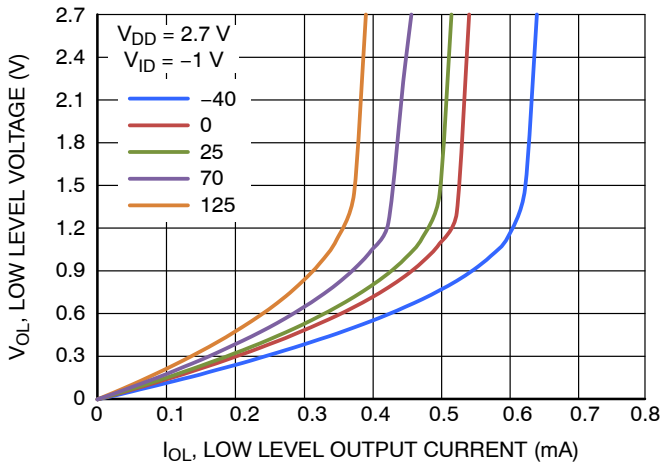


Figure 3. Low Level Output Voltage vs. Low Level Output Current

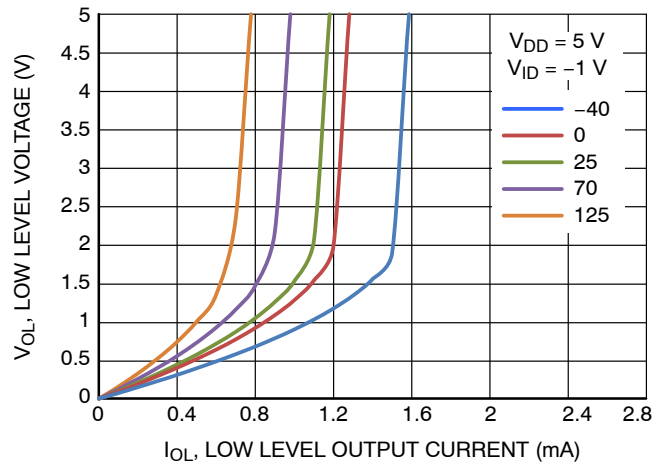


Figure 4. Low Level Output Voltage vs. Low Level Output Current

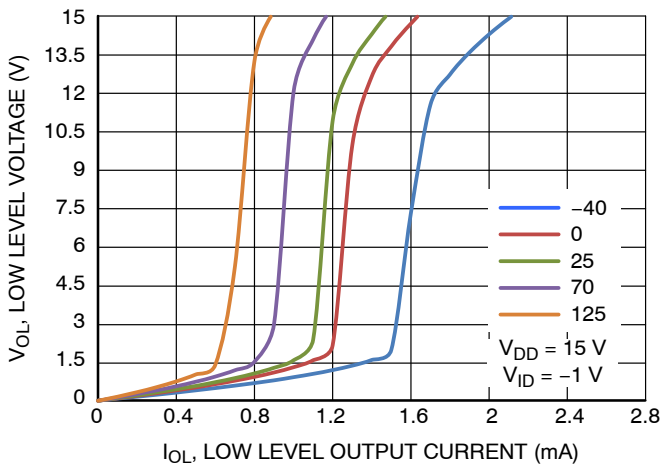


Figure 5. Low Level Output Voltage vs. Low Level Output Current

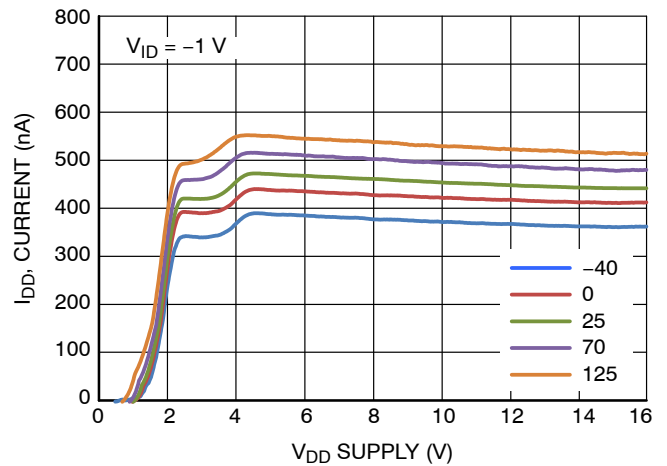


Figure 6.  $I_{DD}$  vs.  $V_{DD}$  vs. Temperature

TYPICAL CHARACTERISTICS

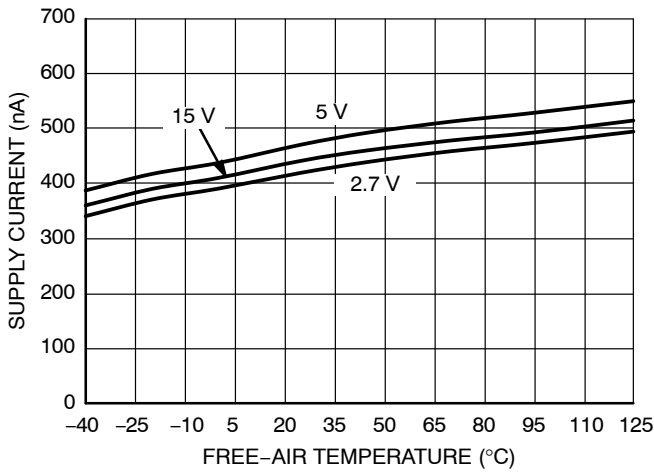


Figure 7. Supply Current vs. Free-Air Temperature

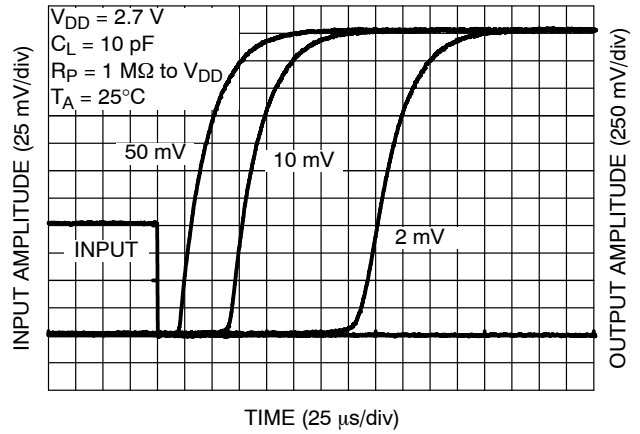


Figure 8. Propagation Delay L-H (2.7 V)

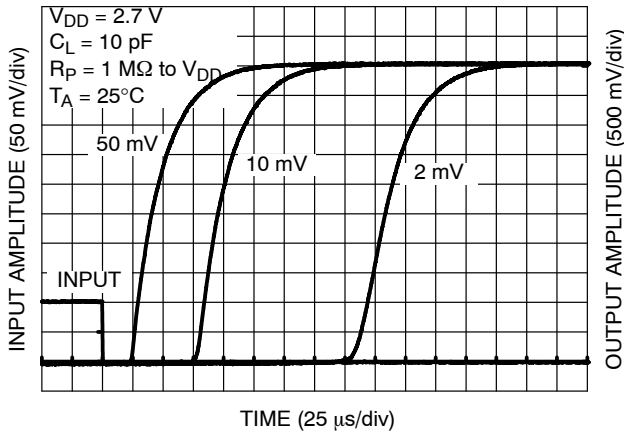


Figure 9. Propagation Delay L-H (5 V)

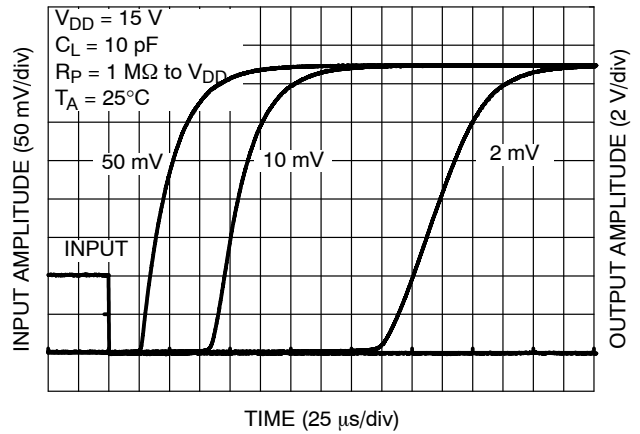


Figure 10. Propagation Delay L-H (15 V)

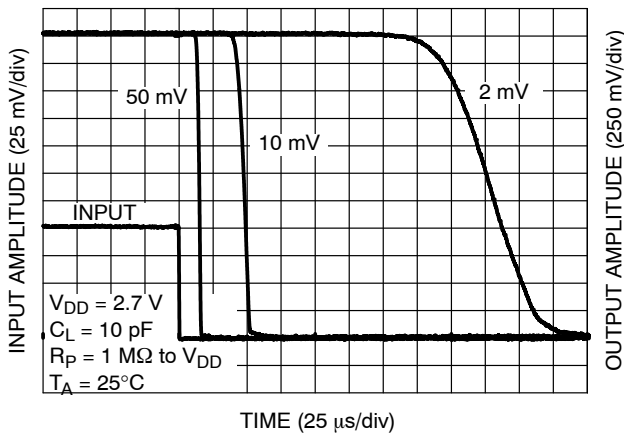


Figure 11. Propagation Delay H-L (2.7 V)

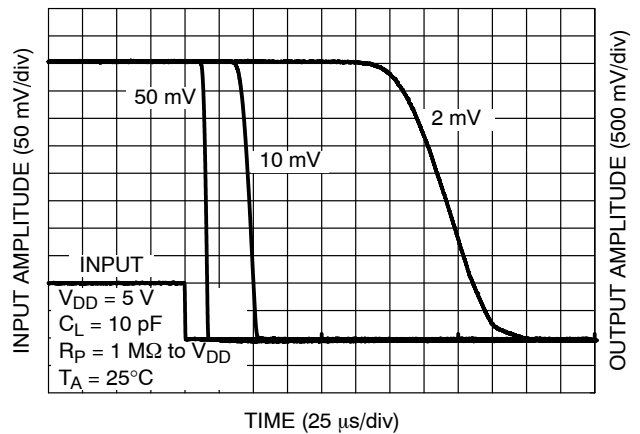


Figure 12. Propagation Delay H-L (5 V)

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## TYPICAL CHARACTERISTICS

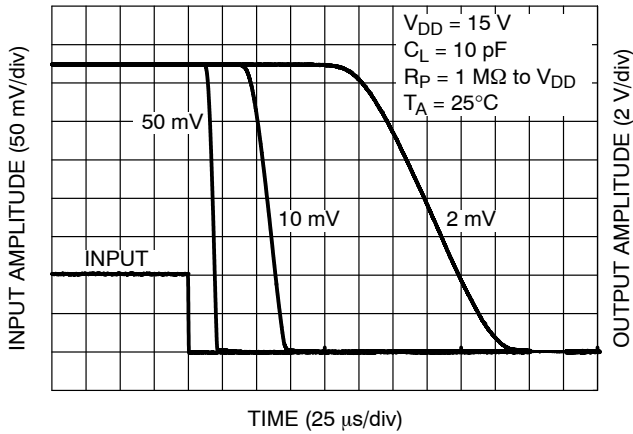


Figure 13. Propagation Delay H-L (15 V)

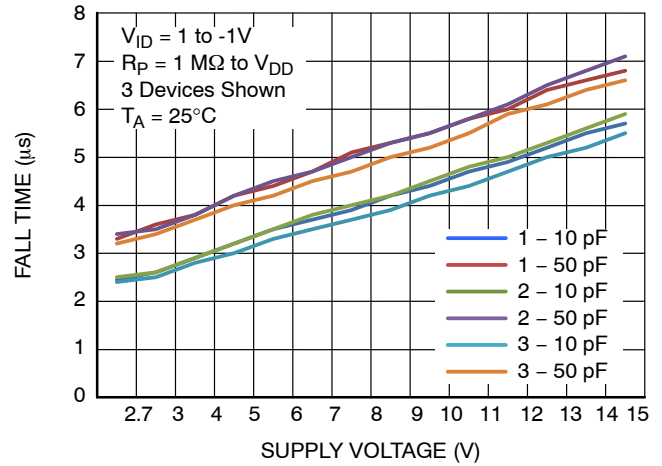


Figure 14. Output Fall Time vs. Power Supply

### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NCS3402DR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

DATE 16 FEB 2011



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### GENERIC MARKING DIAGRAM\*



XXXXX = Specific Device Code  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 W = Work Week  
 ■ = Pb-Free Package

XXXXXX = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 ■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

### STYLES ON PAGE 2

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DESCRIPTION:	SOIC-8 NB	PAGE 1 OF 2

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**SOIC-8 NB**  
**CASE 751-07**  
**ISSUE AK**

DATE 16 FEB 2011

- |   |  |  |  |
|---|--|--|--|
| <p>STYLE 1:<br/>         PIN 1. EMITTER<br/>         2. COLLECTOR<br/>         3. COLLECTOR<br/>         4. EMITTER<br/>         5. EMITTER<br/>         6. BASE<br/>         7. BASE<br/>         8. EMITTER</p>   | <p>STYLE 2:<br/>         PIN 1. COLLECTOR, DIE, #1<br/>         2. COLLECTOR, #1<br/>         3. COLLECTOR, #2<br/>         4. COLLECTOR, #2<br/>         5. BASE, #2<br/>         6. EMITTER, #2<br/>         7. BASE, #1<br/>         8. EMITTER, #1</p>               | <p>STYLE 3:<br/>         PIN 1. DRAIN, DIE #1<br/>         2. DRAIN, #1<br/>         3. DRAIN, #2<br/>         4. DRAIN, #2<br/>         5. GATE, #2<br/>         6. SOURCE, #2<br/>         7. GATE, #1<br/>         8. SOURCE, #1</p>                            | <p>STYLE 4:<br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. ANODE<br/>         4. ANODE<br/>         5. ANODE<br/>         6. ANODE<br/>         7. ANODE<br/>         8. COMMON CATHODE</p>   |
| <p>STYLE 5:<br/>         PIN 1. DRAIN<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. DRAIN<br/>         5. GATE<br/>         6. GATE<br/>         7. SOURCE<br/>         8. SOURCE</p>   | <p>STYLE 6:<br/>         PIN 1. SOURCE<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. SOURCE<br/>         5. SOURCE<br/>         6. GATE<br/>         7. GATE<br/>         8. SOURCE</p>  | <p>STYLE 7:<br/>         PIN 1. INPUT<br/>         2. EXTERNAL BYPASS<br/>         3. THIRD STAGE SOURCE<br/>         4. GROUND<br/>         5. DRAIN<br/>         6. GATE 3<br/>         7. SECOND STAGE Vd<br/>         8. FIRST STAGE Vd</p>                    | <p>STYLE 8:<br/>         PIN 1. COLLECTOR, DIE #1<br/>         2. BASE, #1<br/>         3. BASE, #2<br/>         4. COLLECTOR, #2<br/>         5. COLLECTOR, #2<br/>         6. EMITTER, #2<br/>         7. EMITTER, #1<br/>         8. COLLECTOR, #1</p>                              |
| <p>STYLE 9:<br/>         PIN 1. EMITTER, COMMON<br/>         2. COLLECTOR, DIE #1<br/>         3. COLLECTOR, DIE #2<br/>         4. EMITTER, COMMON<br/>         5. EMITTER, COMMON<br/>         6. BASE, DIE #2<br/>         7. BASE, DIE #1<br/>         8. EMITTER, COMMON</p> | <p>STYLE 10:<br/>         PIN 1. GROUND<br/>         2. BIAS 1<br/>         3. OUTPUT<br/>         4. GROUND<br/>         5. GROUND<br/>         6. BIAS 2<br/>         7. INPUT<br/>         8. GROUND</p>  | <p>STYLE 11:<br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. DRAIN 2<br/>         7. DRAIN 1<br/>         8. DRAIN 1</p>   | <p>STYLE 12:<br/>         PIN 1. SOURCE<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p>STYLE 13:<br/>         PIN 1. N.C.<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>  | <p>STYLE 14:<br/>         PIN 1. N-SOURCE<br/>         2. N-GATE<br/>         3. P-SOURCE<br/>         4. P-GATE<br/>         5. P-DRAIN<br/>         6. P-DRAIN<br/>         7. N-DRAIN<br/>         8. N-DRAIN</p>   | <p>STYLE 15:<br/>         PIN 1. ANODE 1<br/>         2. ANODE 1<br/>         3. ANODE 1<br/>         4. ANODE 1<br/>         5. CATHODE, COMMON<br/>         6. CATHODE, COMMON<br/>         7. CATHODE, COMMON<br/>         8. CATHODE, COMMON</p>               | <p>STYLE 16:<br/>         PIN 1. EMITTER, DIE #1<br/>         2. BASE, DIE #1<br/>         3. EMITTER, DIE #2<br/>         4. BASE, DIE #2<br/>         5. COLLECTOR, DIE #2<br/>         6. COLLECTOR, DIE #2<br/>         7. COLLECTOR, DIE #1<br/>         8. COLLECTOR, DIE #1</p> |
| <p>STYLE 17:<br/>         PIN 1. VCC<br/>         2. V2OUT<br/>         3. V1OUT<br/>         4. TXE<br/>         5. RXE<br/>         6. VEE<br/>         7. GND<br/>         8. ACC</p>  | <p>STYLE 18:<br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. CATHODE<br/>         8. CATHODE</p>   | <p>STYLE 19:<br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. MIRROR 2<br/>         7. DRAIN 1<br/>         8. MIRROR 1</p>   | <p>STYLE 20:<br/>         PIN 1. SOURCE (N)<br/>         2. GATE (N)<br/>         3. SOURCE (P)<br/>         4. GATE (P)<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p>STYLE 21:<br/>         PIN 1. CATHODE 1<br/>         2. CATHODE 2<br/>         3. CATHODE 3<br/>         4. CATHODE 4<br/>         5. CATHODE 5<br/>         6. COMMON ANODE<br/>         7. COMMON ANODE<br/>         8. CATHODE 6</p>  | <p>STYLE 22:<br/>         PIN 1. I/O LINE 1<br/>         2. COMMON CATHODE/VCC<br/>         3. COMMON CATHODE/VCC<br/>         4. I/O LINE 3<br/>         5. COMMON ANODE/GND<br/>         6. I/O LINE 4<br/>         7. I/O LINE 5<br/>         8. COMMON ANODE/GND</p> | <p>STYLE 23:<br/>         PIN 1. LINE 1 IN<br/>         2. COMMON ANODE/GND<br/>         3. COMMON ANODE/GND<br/>         4. LINE 2 IN<br/>         5. LINE 2 OUT<br/>         6. COMMON ANODE/GND<br/>         7. COMMON ANODE/GND<br/>         8. LINE 1 OUT</p> | <p>STYLE 24:<br/>         PIN 1. BASE<br/>         2. EMITTER<br/>         3. COLLECTOR/ANODE<br/>         4. COLLECTOR/ANODE<br/>         5. CATHODE<br/>         6. CATHODE<br/>         7. COLLECTOR/ANODE<br/>         8. COLLECTOR/ANODE</p>                                      |
| <p>STYLE 25:<br/>         PIN 1. VIN<br/>         2. N/C<br/>         3. REXT<br/>         4. GND<br/>         5. IOUT<br/>         6. IOUT<br/>         7. IOUT<br/>         8. IOUT</p>   | <p>STYLE 26:<br/>         PIN 1. GND<br/>         2. dv/dt<br/>         3. ENABLE<br/>         4. ILIMIT<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. VCC</p>  | <p>STYLE 27:<br/>         PIN 1. ILIMIT<br/>         2. OVLO<br/>         3. UVLO<br/>         4. INPUT+<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. DRAIN</p>  | <p>STYLE 28:<br/>         PIN 1. SW_TO_GND<br/>         2. DASIC_OFF<br/>         3. DASIC_SW_DET<br/>         4. GND<br/>         5. V_MON<br/>         6. VBULK<br/>         7. VBULK<br/>         8. VIN</p>  |
| <p>STYLE 29:<br/>         PIN 1. BASE, DIE #1<br/>         2. EMITTER, #1<br/>         3. BASE, #2<br/>         4. EMITTER, #2<br/>         5. COLLECTOR, #2<br/>         6. COLLECTOR, #2<br/>         7. COLLECTOR, #1<br/>         8. COLLECTOR, #1</p>                        | <p>STYLE 30:<br/>         PIN 1. DRAIN 1<br/>         2. DRAIN 1<br/>         3. GATE 2<br/>         4. SOURCE 2<br/>         5. SOURCE 1/DRAIN 2<br/>         6. SOURCE 1/DRAIN 2<br/>         7. SOURCE 1/DRAIN 2<br/>         8. GATE 1</p>                           |  |  |

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