NCS2200 Series, NCS2200A

Low Voltage Comparators

The NCS2200 Series is an industry first sub−one volt, low power comparator family. These devices consume only 10 μA of supply current. They are guaranteed to operate at a low voltage of 0.85 V which allows them to be used in systems that require less than 1.0 V and are fully operational up to 6.0 V which makes them convenient for use in both 3.0 V and 5.0 V systems. Additional features include no output phase inversion with overdriven inputs, internal hysteresis, which allows for clean output switching, and rail−to−rail input and output performance. The NCS2200 Series is available in the tiny SOT−23−5 package. There are four options featuring two industry standard pinouts. Additionally, the NCS2200 and NCS2202 are available in the SC70−5 package. The NCS2200 is also available in the tiny DFN 2x2.2 package. The NCS2200A is available in UDFN 1.2x1.0 package. (Table 1)

Features

- Operating Voltage of 0.85 V to 6.0 V
- Rail−to−Rail Input/Output Performance
- Low Supply Current of 10 μA
- No Phase Inversion with Overdriven Input Signals
- Glitchless Transitioning in or out of Tri−State Mode
- Complementary or Open Drain Output Configuration
- Internal Hysteresis
- Propagation Delay of 1.1 μs
- Pb−Free Packages are Available

Typical Applications

- Single Cell NiCd/NiMH Battery Powered Applications
- Cellular Telephones
- Alarm and Security Systems
- Personal Digital Assistants

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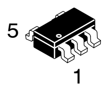
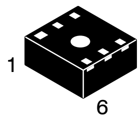
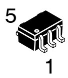


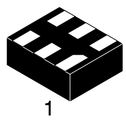
SOT−23−5 (TSOP−5)
SN SUFFIX
CASE 483



DFN 2x2.2
SQL SUFFIX
CASE 488



SC70−5
SQ SUFFIX
CASE 419A



UDFN 1.2x1.0
MU SUFFIX
CASE 517AA

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 12 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 13 of this data sheet.

Table 1. Comparator Selector Guide

Output Type	Device	Package	Pinout Style
Complementary	NCS2200SN1T1	SOT−23−5	1
Complementary	NCS2200SN2T1	SOT−23−5	2
Complementary	NCS2200SQ2T2	SC70−5	2
Open Drain	NCS2202SN1T1	SOT−23−5	1
Open Drain	NCS2202SQ1T2	SC70−5	1
Open Drain	NCS2202SN2T1	SOT−23−5	2
Open Drain	NCS2202SQ2T2	SC70−5	2
Complementary	NCS2200SQLT1	DFN, 2x2.2	N/A
Complementary	NCS2200AMUT1	UDFN, 1.2x1.0	N/A

PIN CONNECTIONS

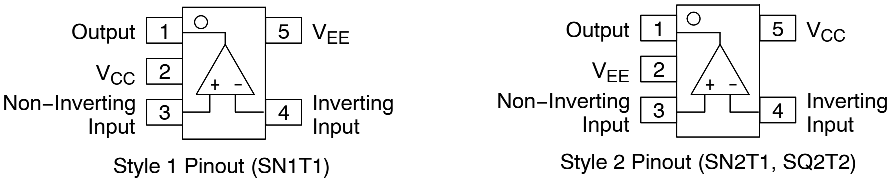


Figure 1. SOT−23−5 (NCS2200, NCS2202), SC70−5 (NCS2200, NCS2202)

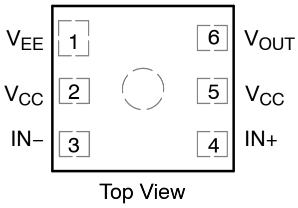


Figure 2. DFN 2x2.2 (NCS2200)
UDFN 1.2x1.0 (NCS2200A)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage Range (V_{CC} to V_{EE})	V_S	6.0	V
Non−inverting/Inverting Input to V_{EE}	–	−0.2 to (V_{CC} + 0.2)	V
Operating Junction Temperature	T_J	150	°C
Operating Ambient Temperature	T_A	−40 to +105	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Output Short Circuit Duration Time (Note 1)	t_S	Indefinite	s
ESD Tolerance (Note 2) NCS2200 Human Body Model Machine Model NCS2202 Human Body Model Machine Model NCS2200A Human Body Model Machine Model	–	 2000 200 1000 200 1900 200	V
Thermal Resistance, Junction−to−Ambient TSOP−5 DFN (Note 3) SC70−5 UDFN	$R_{\theta JA}$	 238 215 283 350	°C/W

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. The maximum package power dissipation limit must not be exceeded.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

2. ESD data available upon request.
3. For more information, refer to application note, AND8080/D.

ELECTRICAL CHARACTERISTICS (For all values V_{CC} = 0.85 V to 6.0 V, V_{EE} = 0 V, T_A = 25°C, unless otherwise noted.) (Note 4)

Characteristics	Symbol	NCS2200 Series Min	Typ	Max	Unit
Input Hysteresis T_A = 25°C	V_{HYS}	2.0	8.0	20	mV
Input Offset Voltage	V_{IO}				mV
V_{CC} = 0.85 V					
T_A = 25°C		−10	0.5	+10	
T_A = −40°C to 105°C		−12	–	+12	
V_{CC} = 3.0 V					
T_A = 25°C		−6.0	0.5	+6.0	
T_A = −40°C to 105°C		−8.0	–	+8.0	
V_{CC} = 6.0 V					
T_A = 25°C		−5.0	0.5	+5.0	
T_A = −40°C to 105°C		−7.0	–	+7.0	
Common Mode Voltage Range	V_{CM}	–	V_{EE} to V_{CC}	–	V
Output Leakage Current (NCS2202) V_{CC} = 6.0 V	I_{LEAK}	–	3.3	–	nA
Output Short−Circuit Sourcing or Sinking (V_{out} = GND)	I_{SC}	–	70	–	mA
Common Mode Rejection Ratio V_{CM} = V_{CC}	CMRR	53	65	–	dB
Input Bias Current	I_{IB}	–	1.0	–	pA
Power Supply Rejection Ratio ΔV_S = 2.575 V	PSRR	45	55	–	dB
Supply Current	I_{CC}				μA
V_{CC} = 0.85 V					
T_A = 25°C		–	10	15	
T_A = −40°C to 105°C			–	17	
V_{CC} = 3.0 V					
T_A = 25°C		–	10	15	
T_A = −40°C to 105°C			–	17	
V_{CC} = 6.0 V					
T_A = 25°C		–	10	15	
T_A = −40°C to 105°C			–	17	
Output Voltage High (NCS2200)	V_{OH}				V
V_{CC} = 0.85 V, I_{source} = 0.5 mA					
T_A = 25°C		V_{CC} − 0.2	V_{CC} − 0.10	–	
T_A = −40°C to 105°C		V_{CC} − 0.225	–		
V_{CC} = 3.0 V, I_{source} = 3.0 mA					
T_A = 25°C		V_{CC} − 0.2	V_{CC} − 0.12	–	
T_A = −40°C to 105°C		V_{CC} − 0.25	–		
V_{CC} = 6.0 V, I_{source} = 5.0 mA					
T_A = 25°C		V_{CC} − 0.2	V_{CC} − 0.12	–	
T_A = −40°C to 105°C		V_{CC} − 0.25	–		
Output Voltage Low	V_{OL}				V
V_{CC} = 0.85 V, I_{sink} = 0.5 mA					
T_A = 25°C		–	V_{EE} + 0.10	V_{EE} + 0.2	
T_A = −40°C to 105°C			–	V_{EE} + 0.225	
V_{CC} = 3.0 V, I_{sink} = 3.0 mA					
T_A = 25°C		–	V_{EE} + 0.12	V_{EE} + 0.2	
T_A = −40°C to 105°C			–	V_{EE} + 0.25	
V_{CC} = 6.0 V, I_{sink} = 5.0 mA					
T_A = 25°C		–	V_{EE} + 0.12	V_{EE} + 0.2	
T_A = −40°C to 105°C			–	V_{EE} + 0.25	
Propagation Delay 20 mV Overdrive, C_L = 15 pF					μs
	t_{PHL}	–	0.7	–	
	t_{PLH}	–	1.1	–	
Output Fall Time V_{CC} = 6.0 V, C_L = 50 pF	t_{FALL}	–	20	–	ns
Output Rise Time V_{CC} = 6.0 V, C_L = 50 pF	t_{RISE}	–	16	–	ns
Powerup Time	t_{PU}	–	35	–	μs

4. The limits over the extended temperature range are guaranteed by design only.

ELECTRICAL CHARACTERISTICS (For all values V_{CC} = 0.85 V to 6.0 V, V_{EE} = 0 V, T_A = 25°C, unless otherwise noted.) (Note 5)

Characteristics	Symbol	NCS2200A			Unit
		Min	Typ	Max	
Input Hysteresis T_A = 25°C	V_{HYS}	2.0	4.5	20	mV
Input Offset Voltage	V_{IO}				mV
V_{CC} = 0.85 V					
T_A = 25°C		−10	0.5	+10	
T_A = −40°C to 105°C		−12	–	+12	
V_{CC} = 3.0 V					
T_A = 25°C		−6.0	0.5	+6.0	
T_A = −40°C to 105°C		−8.0	–	+8.0	
V_{CC} = 6.0 V					
T_A = 25°C		−5.0	0.5	+5.0	
T_A = −40°C to 105°C		−7.0	–	+7.0	
Common Mode Voltage Range	V_{CM}	–	V_{EE} to V_{CC}	–	V
Output Short−Circuit Sourcing or Sinking (V_{out} = GND)	I_{SC}	–	60	–	mA
Common Mode Rejection Ratio V_{CM} = V_{CC}	CMRR	53	70	–	dB
Input Bias Current	I_{IB}	–	1.0	–	pA
Power Supply Rejection Ratio ΔV_S = 2.575 V	PSRR	45	80	–	dB
Supply Current	I_{CC}				μA
V_{CC} = 0.85 V					
T_A = 25°C		–	7.5	15	
T_A = −40°C to 105°C			–	17	
V_{CC} = 3.0 V					
T_A = 25°C		–	8.0	15	
T_A = −40°C to 105°C			–	17	
V_{CC} = 6.0 V					
T_A = 25°C		–	9.0	15	
T_A = −40°C to 105°C			–	17	
Output Voltage High	V_{OH}				V
V_{CC} = 0.85 V, I_{source} = 0.5 mA					
T_A = 25°C		V_{CC} − 0.25	V_{CC} − 0.10	–	
T_A = −40°C to 105°C		V_{CC} − 0.275	–		
V_{CC} = 3.0 V, I_{source} = 3.0 mA					
T_A = 25°C		V_{CC} − 0.3	V_{CC} − 0.12	–	
T_A = −40°C to 105°C		V_{CC} − 0.35	–		
V_{CC} = 6.0 V, I_{source} = 5.0 mA					
T_A = 25°C		V_{CC} − 0.3	V_{CC} − 0.12	–	
T_A = −40°C to 105°C		V_{CC} − 0.35	–		
Output Voltage Low	V_{OL}				V
V_{CC} = 0.85 V, I_{sink} = 0.5 mA					
T_A = 25°C		–	V_{EE} + 0.10	V_{EE} + 0.25	
T_A = −40°C to 105°C			–	V_{EE} + 0.275	
V_{CC} = 3.0 V, I_{sink} = 3.0 mA					
T_A = 25°C		–	V_{EE} + 0.12	V_{EE} + 0.3	
T_A = −40°C to 105°C			–	V_{EE} + 0.35	
V_{CC} = 6.0 V, I_{sink} = 5.0 mA					
T_A = 25°C		–	V_{EE} + 0.12	V_{EE} + 0.3	
T_A = −40°C to 105°C			–	V_{EE} + 0.35	
Propagation Delay 20 mV Overdrive, C_L = 15 pF					μs
	t_{PHL}	–	0.5	–	
	t_{PLH}	–	0.5	–	
Output Fall Time V_{CC} = 6.0 V, C_L = 50 pF (Note 6)	t_{FALL}	–	20	–	ns
Output Rise Time V_{CC} = 6.0 V, C_L = 50 pF (Note 6)	t_{RISE}	–	16	–	ns

5. The limits over the extended temperature range are guaranteed by design only.
6. Input signal: 1 kHz, squarewave signal with 10 ns edge rate.

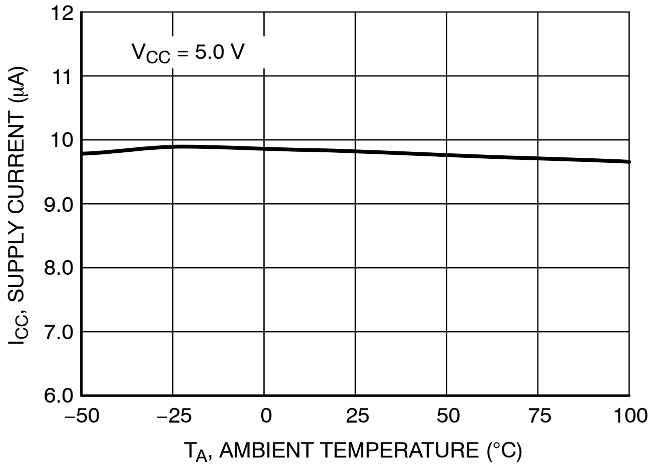


Figure 1. NCS2200 Series Supply Current versus Temperature

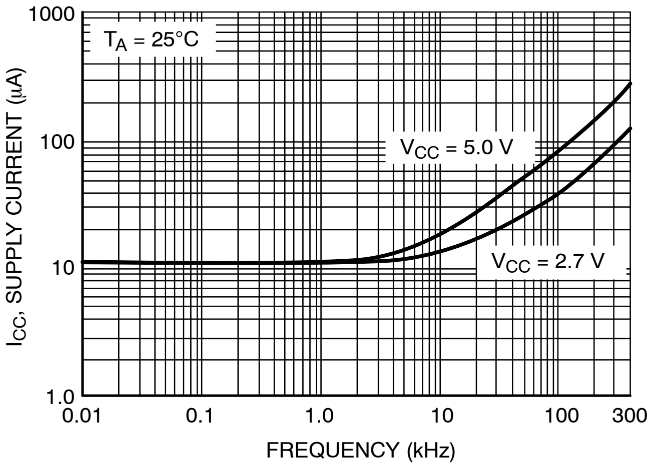


Figure 2. NCS2200 Series Supply Current versus Output Transition Frequency

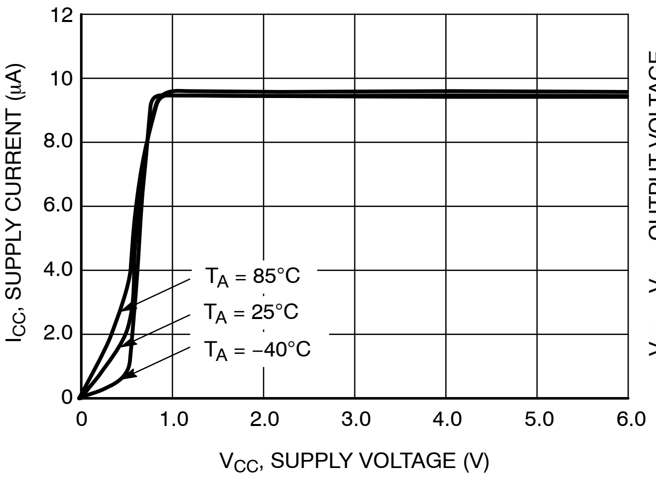


Figure 3. NCS2200 Series Supply Current versus Supply Voltage

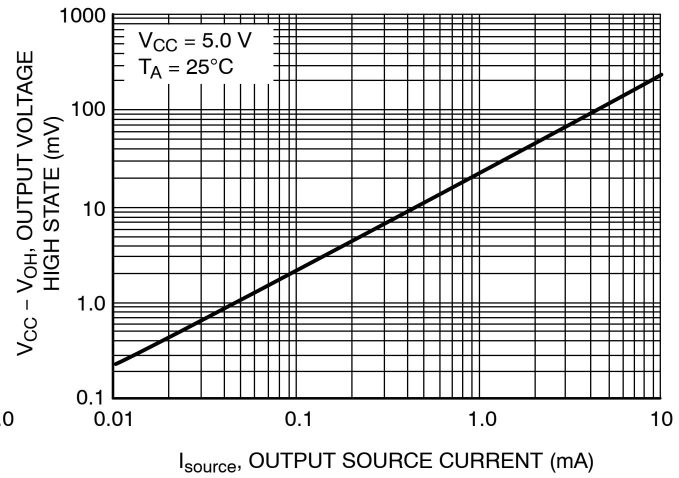


Figure 4. NCS2200 Output Voltage High State versus Output Source Current

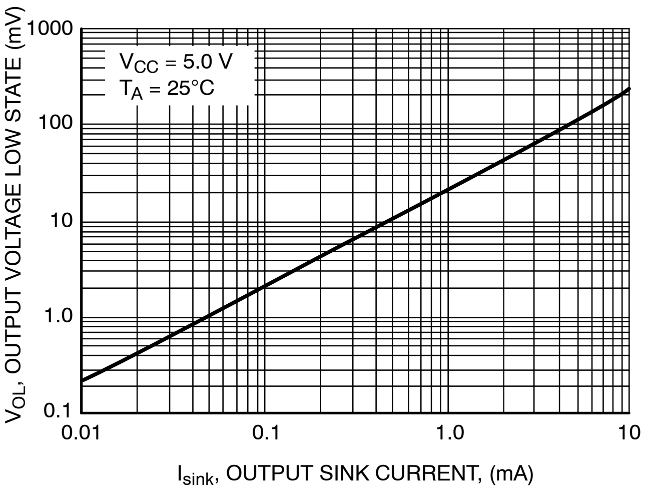


Figure 5. NCS2200 Series Output Voltage Low State versus Output Sink Current

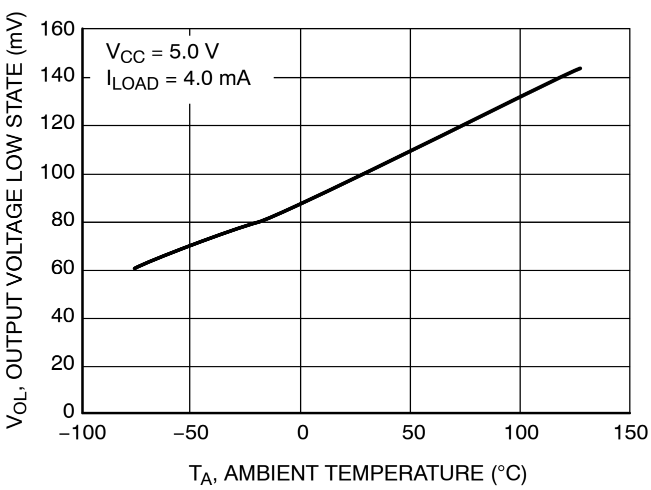


Figure 6. NCS2200 Series Output Voltage Low State versus Temperature

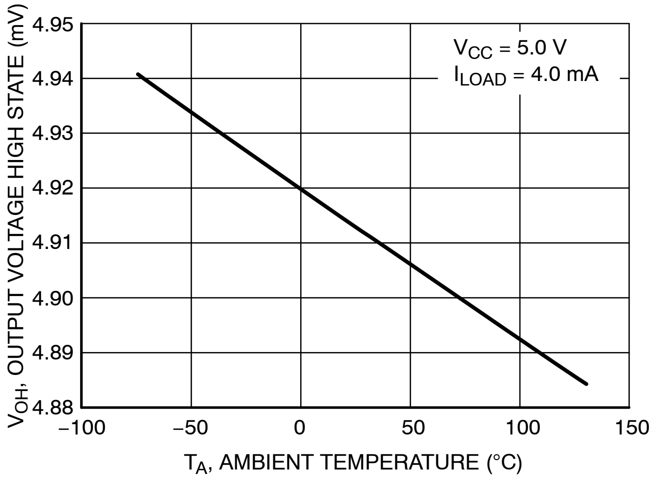


Figure 7. NCS2200 Series Output Voltage High State versus Temperature

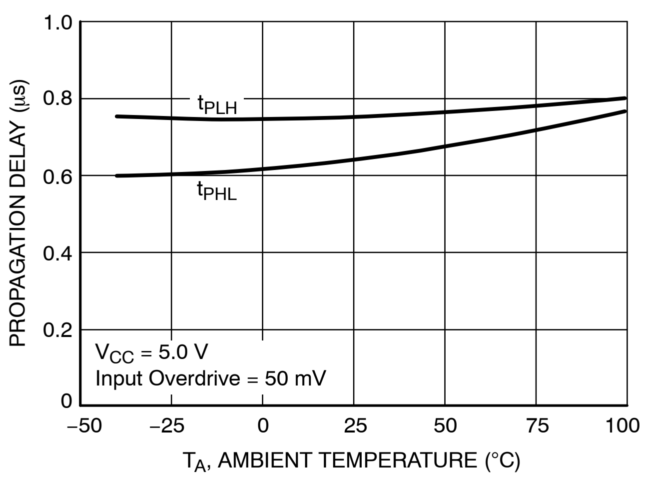


Figure 8. NCS2200 Series Propagation Delay versus Temperature

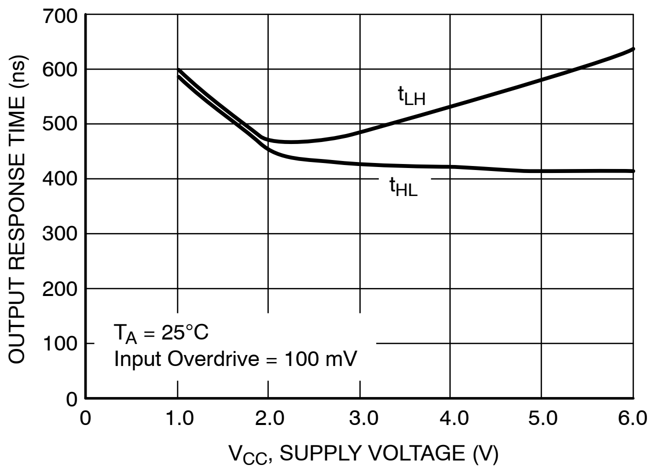


Figure 9. NCS2200 Series Output Response Time versus Supply Voltage

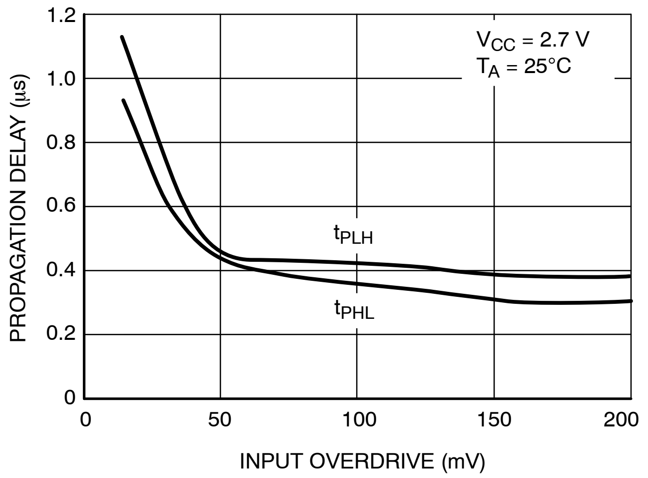


Figure 10. NCS2200 Series Propagation Delay versus Input Overdrive

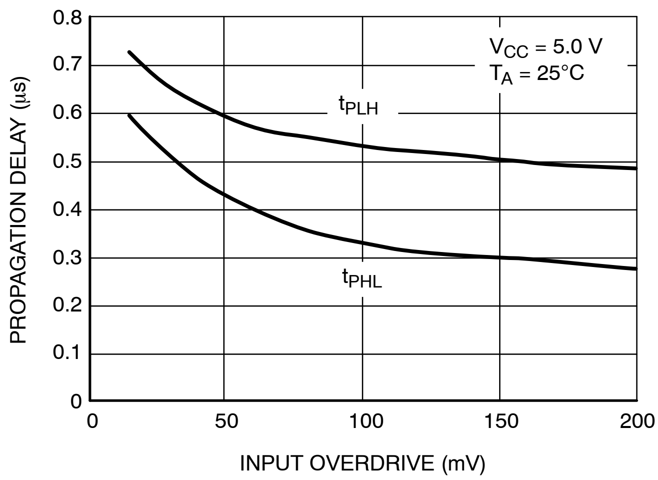


Figure 11. NCS2200 Series Propagation Delay versus Input Overdrive

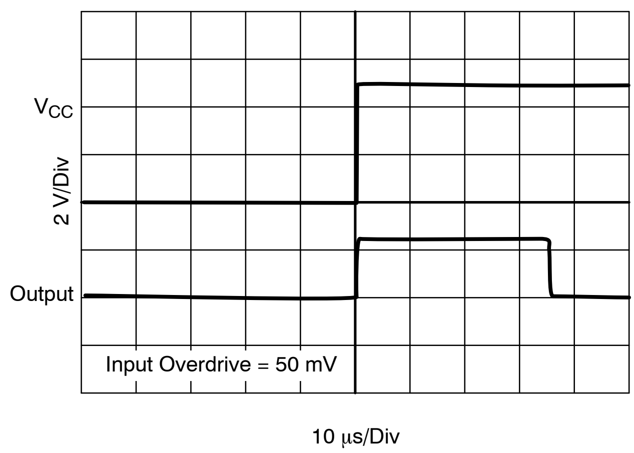


Figure 12. NCS2200 Series Powerup Delay

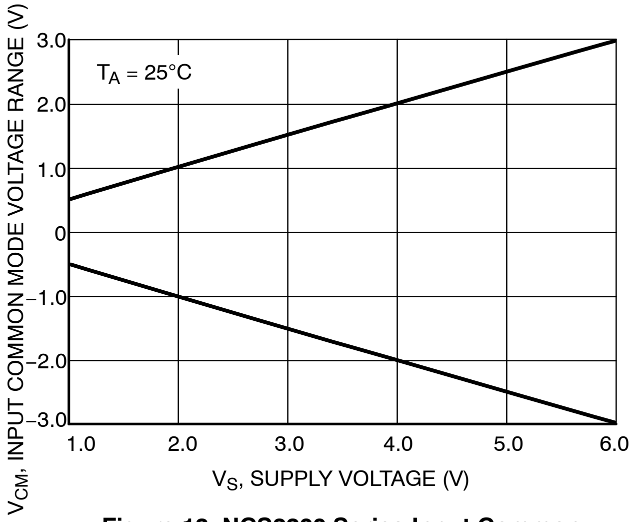


Figure 13. NCS2200 Series Input Common Mode Voltage Range versus Supply Voltage

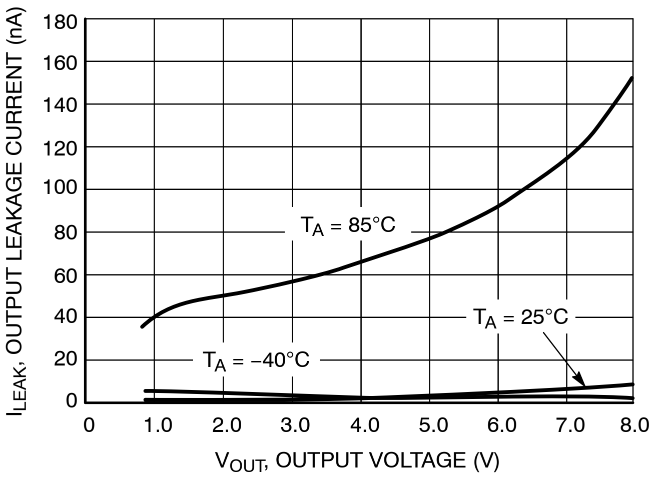


Figure 14. NCS2202 Output Leakage Current versus Output Voltage

OPERATING DESCRIPTION

The NCS2200 Series is an industry first sub−one volt, low power comparator family. This series is designed for rail−to−rail input and output performance. These devices consume only 10 μA of supply current while achieving a typical propagation delay of 1.1 μs at a 20 mV input overdrive. Figures 10 and 11 show propagation delay with various input overdrives. This comparator family is guaranteed to operate at a low voltage of 0.85 V up to 6.0 V. This is accomplished by the use of a modified analog CMOS process that implements depletion MOSFET devices. The common−mode input voltage range extends 0.1 V beyond the upper and lower rail without phase inversion or other adverse effects. This series is available in the SOT−23−5 package. Additionally, the NCS2200 device is available in the tiny DFN 2x2.2 package and the SC70−5 package. NCS2200A is available in UDFN package.

Output Stage

The NCS2200 has a complementary P and N Channel output stage that has capability of driving a rail−to−rail output swing with a load ranging up to 5.0 mA. It is designed such that shoot−through current is minimized while switching. This feature eliminates the need for bypass capacitors under most circumstances.

The NCS2202 has an open drain N−channel output stage that can be pulled up to 6.0 V (max) with an external resistor. This facilitates mixed voltage system applications.

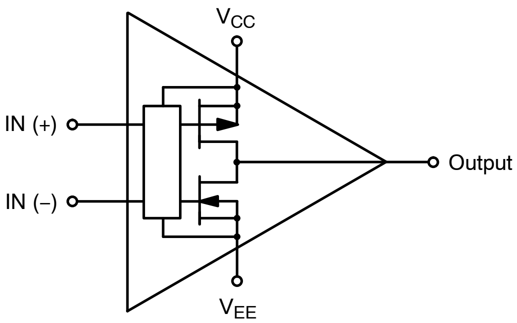


Figure 15. NCS2200SNxT1/NCS2200A Complementary Output Configuration

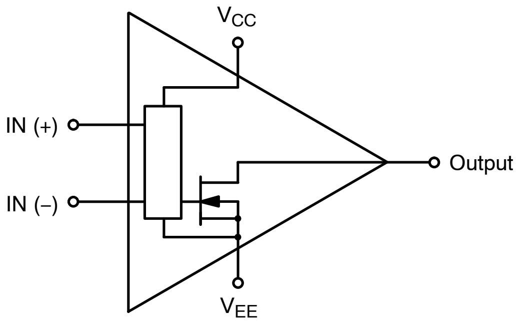
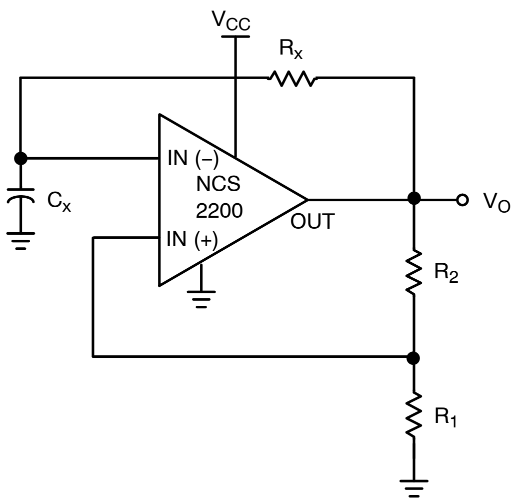


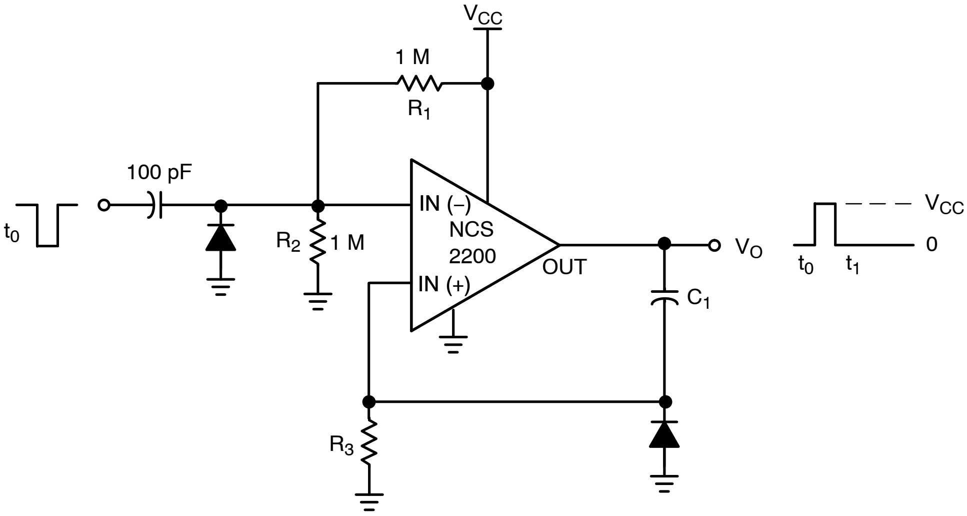
Figure 16. NCS2202SNxT1 Open Drain Output Configuration



The oscillation frequency can be programmed as follows:

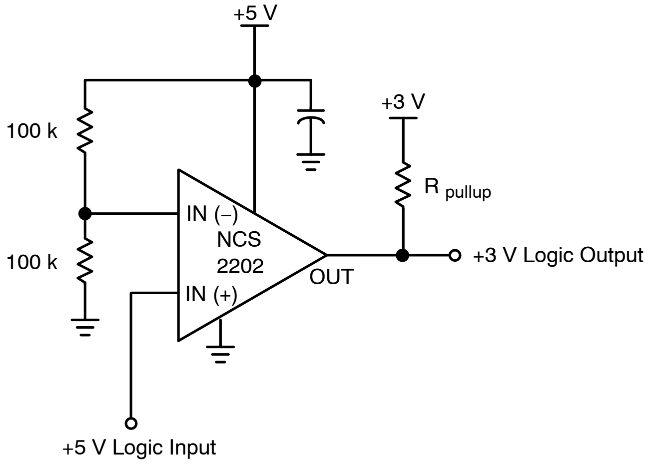
$$f = \frac{1}{T} = \frac{1}{2.2\,R_X C_X}$$

Figure 17. Schmitt Trigger Oscillator



The resistor divider R_1 and R_2 can be used to set the magnitude of the input pulse. The pulse width is set by adjusting C_1 and R_3.

Figure 18. One−Shot Multivibrator



This circuit converts 5 V logic to 3 V logic. Using the NCS2202/3 allows for full 5 V logic swing without creating overvoltage on the 3 V logic input.

Figure 19. Logic Level Translator

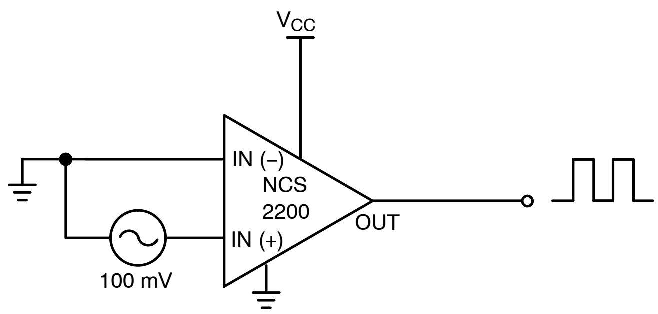


Figure 20. Zero−Crossing Detector

ORDERING INFORMATION

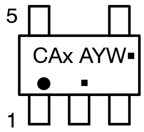
Device	Pinout Style	Output Type	Package	Shipping†
NCS2200AMUT1G	N/A	Complementary	UDFN (Pb−Free)	3000 / Tape & Reel
NCS2200SN1T1	1	Complementary	SOT−23−5 (TSOP−5)	3000 / Tape & Reel
NCS2200SN1T1G	1	Complementary	SOT−23−5 (TSOP−5) (Pb−Free)	3000 / Tape & Reel
NCS2200SN2T1	2	Complementary	SOT−23−5 (TSOP−5)	3000 / Tape & Reel
NCS2200SN2T1G	2	Complementary	SOT−23−5 (TSOP−5) (Pb−Free)	3000 / Tape & Reel
NCS2200SQ2T2	2	Complementary	SC70−5	3000 / Tape & Reel
NCS2200SQ2T2G	2	Complementary	SC70−5 (Pb−Free)	3000 / Tape & Reel
NCS2200SQLT1	N/A	Complementary	DFN, 2x2.2	3000 / Tape & Reel
NCS2200SQLT1G	N/A	Complementary	DFN, 2x2.2 (Pb−Free)	3000 / Tape & Reel
NCS2202SN1T1	1	Open Drain	SOT−23−5 (TSOP−5)	3000 / Tape & Reel
NCS2202SN1T1G	1	Open Drain	SOT−23−5 (TSOP−5) (Pb−Free)	3000 / Tape & Reel
NCS2202SQ1T2G	1	Open Drain	SC70−5 (Pb−Free)	3000 / Tape & Reel
NCS2202SN2T1	2	Open Drain	SOT−23−5 (TSOP−5)	3000 / Tape & Reel
NCS2202SN2T1G	2	Open Drain	SOT−23−5 (TSOP−5) (Pb−Free)	3000 / Tape & Reel
NCS2202SQ2T2G	2	Open Drain	SC70−5 (Pb−Free)	3000 / Tape & Reel

This device contains 93 active transistors.

†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.

MARKING DIAGRAMS

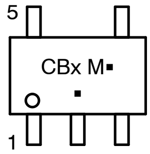
SOT−23−5
(TSOP−5)
SN SUFFIX
CASE 483



x = I for NCS2200SN1T1
J for NCS2200SN2T1
M for NCS2202SN1T1
N for NCS2202SN2T1
A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

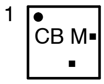
SC70−5
SQ SUFFIX
CASE 419A



CBx = Specific Device Code
x = A for NCS2200SQ2T2
D for NCS2202SQ1T2G
E for NCS2202SQ2T2G
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)
*Date Code orientation, position, and underbar may vary depending upon manufacturing location.

DFN6 2x2.2
SQL SUFFIX
CASE 488

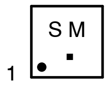


CB = Specific Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code overbar and underbar may vary depending upon manufacturing location.

UDFN6 1.2x1.0
MU SUFFIX
CASE 517AA

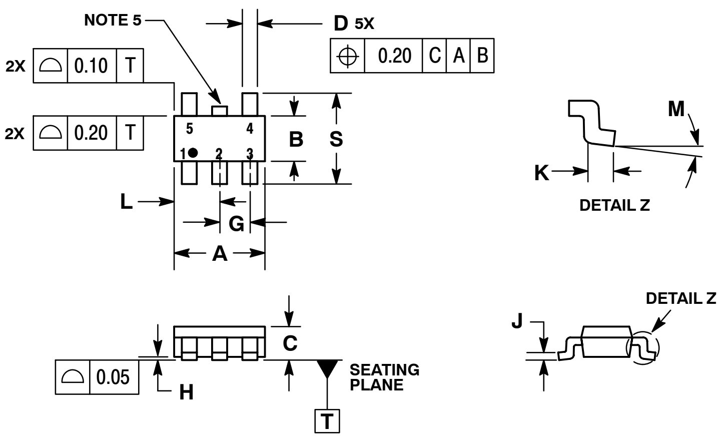


(Top View)

S = Specific Device Code
M = Date Code
▪ = Pb−Free Package

PACKAGE DIMENSIONS

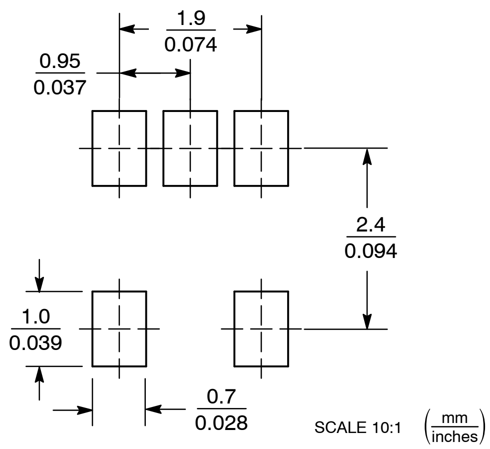
SOT−23−5 / TSOP−5 / SC59−5
SN SUFFIX
PLASTIC PACKAGE
CASE 483−02
ISSUE H



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

	MILLIMETERS	
DIM	MIN	MAX
A	3.00 BSC	
B	1.50 BSC	
C	0.90	1.10
D	0.25	0.50
G	0.95 BSC	
H	0.01	0.10
J	0.10	0.26
K	0.20	0.60
L	1.25	1.55
M	0 °	10 °
S	2.50	3.00

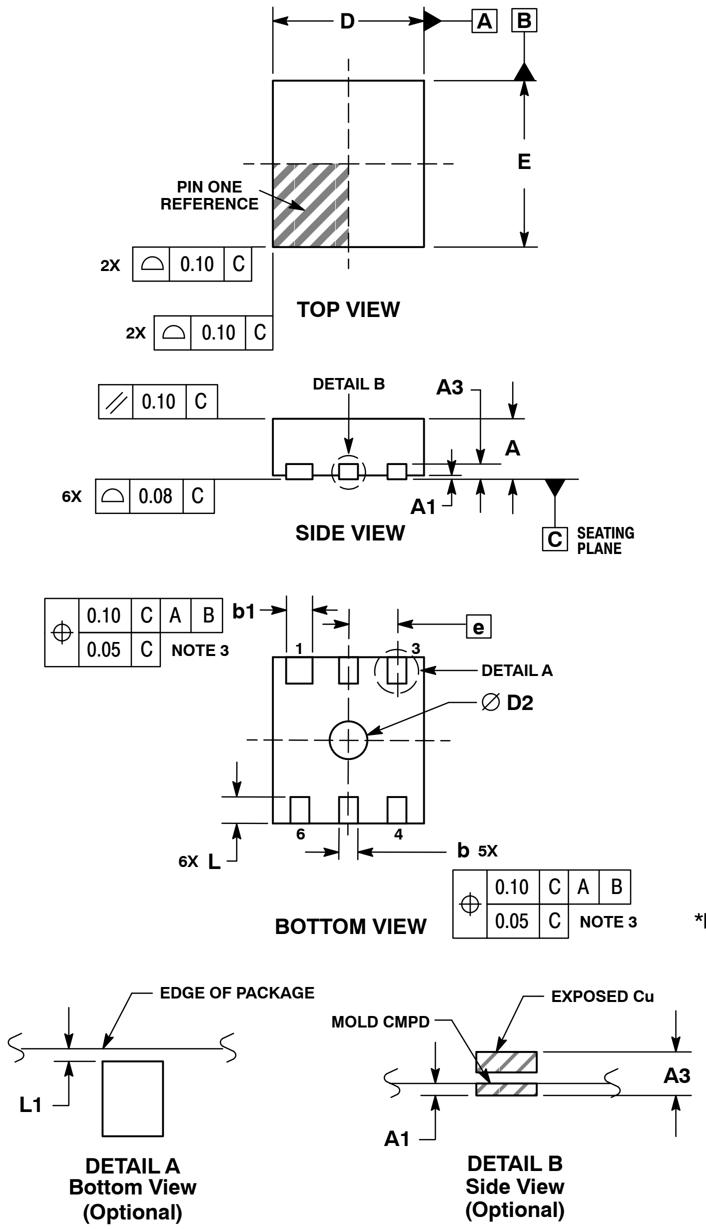
SOLDERING FOOTPRINT*



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

PACKAGE DIMENSIONS

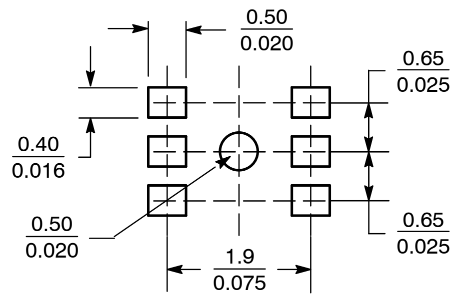
DFN6, 2x2.2
SQL SUFFIX
CASE 488−03
ISSUE G



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30mm FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. TERMINAL b MAY HAVE MOLD COMPOUND MATERIAL ALONG SIDE EDGE.
6. DETAILS A AND B SHOW OPTIONAL VIEWS FOR END OF TERMINAL LEAD AT EDGE OF PACKAGE AND SIDE EDGE OF PACKAGE.

	MILLIMETERS		
DIM	MIN	NOM	MAX
A	0.80	0.90	1.00
A1	0.00	0.03	0.05
A3	0.20 REF		
b	0.20	0.25	0.30
b1	0.30	0.35	0.40
D	2.00 BSC		
D2	0.40	0.50	0.60
E	2.20 BSC		
e	0.65 BSC		
L	0.30	0.35	0.40
L1	0.00	0.05	0.10

SOLDERING FOOTPRINT*

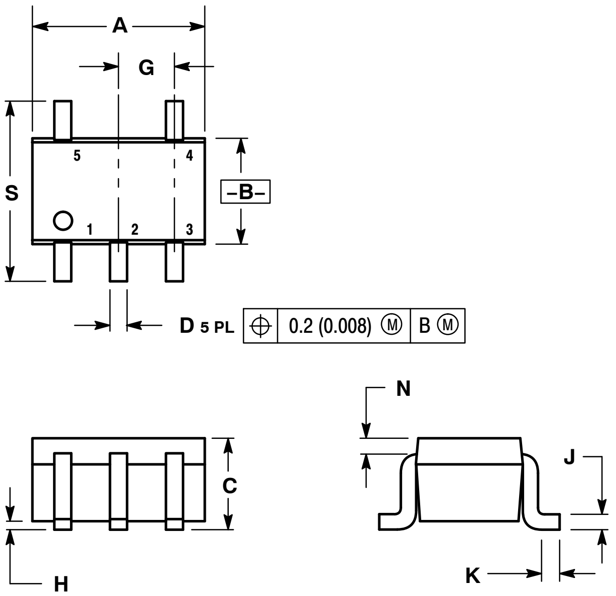


SCALE 10:1

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

PACKAGE DIMENSIONS

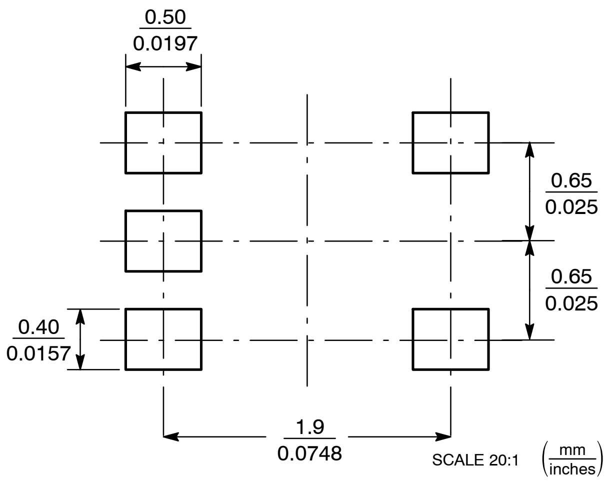
SC70−5/SC88A (SOT−353)
SQ SUFFIX
CASE 419A−02
ISSUE J



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A−01 OBSOLETE. NEW STANDARD 419A−02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20

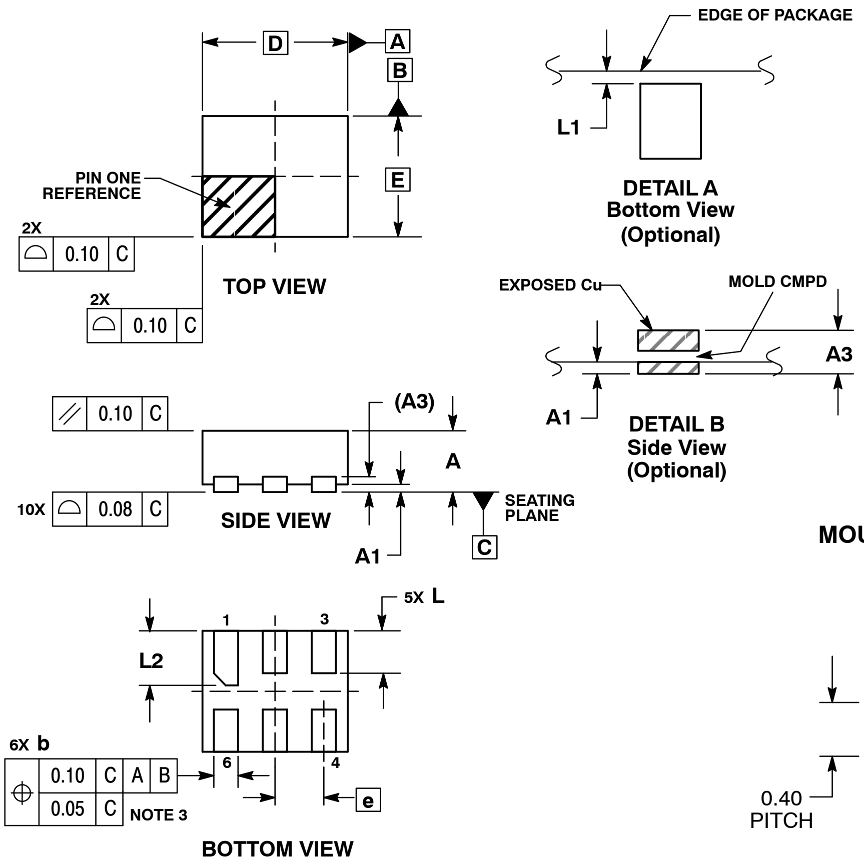
SOLDERING FOOTPRINT*



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

PACKAGE DIMENSIONS

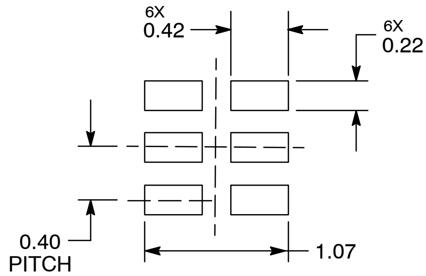
UDFN6, 1.2x1.0, 0.4P
CASE 517AA−01
ISSUE C



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 mm FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS	
DIM	MIN	MAX
A	0.45	0.55
A1	0.00	0.05
A3	0.127 REF	
b	0.15	0.25
D	1.20 BSC	
E	1.00 BSC	
e	0.40 BSC	
L	0.30	0.40
L1	0.00	0.15
L2	0.40	0.50

MOUNTING FOOTPRINT*



DIMENSIONS: MILLIMETERS

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

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