# Comparators, 0.85 V to 6 V, 10 μA, 1 μs, Rail-to-Rail, Open Drain and Push-Pull Outputs

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 complementary push—pull and open drain outputs and a variety of packages. There are two industry standard pinouts for SOT–23–5 and SC70–5 packages. The NCS2200 is also available in the tiny DFN 2x2.2 package. The NCS2200A and NCS2202A are available in a UDFN 1.2x1.0 package. See package option information in Table 1 on page 2 for more information.

#### 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 1.0 μs for NCS2200
- 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 and are RoHS Compliant

## Typical Applications

- Single Cell NiCd/NiMH Battery Powered Applications
- Automotive

#### **End Products**

- · Cellphones, Smart Phones
- 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 13 of this data sheet.

#### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 14 of this data sheet.

Table 1. COMPARATOR SELECTOR GUIDE

Output Type	Package	Pinout Style	Automotive	Device		
	LIDEN 4 2-4 0	N/A	No	NCS2200AMUT1G		
	UDFN, 1.2x1.0	N/A	Yes	NCV2200AMUTBG*		
		4	No	NCS2200SN1T1G		
	COT 22 F	'	Yes	NCV2200SN1T1G*		
Complementary Push-Pull	SOT-23-5			NCS2200SN2T1G		
		2	Yes	NCV2200SN2T1G*		
	0070 5	2	No	NCS2200SQ2T2G		
	SC70-5	2	Yes	NCV2200SQ2T2G*		
	DFN, 2x2.2	N/A	No	NCS2200SQLT1G		
		1	No	NCS2202SN1T1G		
	SOT-23-5	2	No	NCS2202SN2T1G		
On an Drain		2	2 Yes NCV22			
Open Drain	CC70 F	1	No	NCS2202SQ1T2G		
	SC70-5	2	No	NCS2202SQ2T2G		
	UDFN, 1.2 x 1.0	N/A	No	NCS2202AMUTBG		

<sup>\*</sup>NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

### **PIN CONNECTIONS**



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

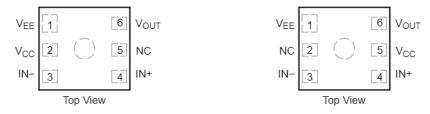


Figure 2. DFN 2x2.2 (NCS2200)

Figure 3. UDFN 1.2x1.0 (NCS2200A/NCS2202A)

#### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage Range (V <sub>CC</sub> to V <sub>EE</sub> )	V <sub>S</sub>	6.0	V
Non-inverting/Inverting Input to V <sub>EE</sub>	V <sub>CM</sub>	-0.2 to (V <sub>CC</sub> + 0.2)	V
Operating Junction Temperature	TJ	150	°C
Operating Ambient Temperature Range NCS2200, NCS2202, NCS2200A, NCS2202A NCV2200, NCV2200, NCV2200A	T <sub>A</sub>	-40 to +105 -40 to +125	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Output Short Circuit Duration Time (Note 1)	t <sub>S</sub>	Indefinite	s
ESD Tolerance (Note 2) NCS2200 Human Body Model Machine Model NCS2202 Human Body Model Machine Model NCS2200A Human Body Model Machine Model NCS2202A Human Body Model NCS2202A Human Body Model – all pins except output Human Body Model – output pin Machine Model	ESD HBM MM HBM MM HBM HBM HBM HBM HBM	2000 200 2000 2000 1900 200 1500 500 150	V
Thermal Resistance, Junction-to-Ambient TSOP-5 DFN (Note 3) SC70-5 UDFN	R <sub>0JA</sub>	238 215 283 350	°C/W

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. The maximum package power dissipation limit must not be exceeded.  $P_D = \frac{T_J(max) - T_A}{R_{\theta JA}}$ 

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

- $$\begin{split} &P_D = \frac{R_{\theta}JA}{R_{\theta}JA} \\ &2. \ \ \text{ESD data available upon request.} \\ &3. \ \ \text{For more information, refer to application note, AND8080/D.} \end{split}$$

NCS2200 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)

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
V <sub>HYS</sub>	Input Hysteresis	T <sub>A</sub> = 25°C	2.0	8.0	20	mV
V <sub>IO</sub>	Input Offset Voltage	V <sub>CC</sub> = 0.85 V T <sub>A</sub> = 25°C	-10	0.5	+10	mV
		T <sub>A</sub> = T <sub>Low</sub> to T <sub>High</sub> (Note 5)	-12	-	+12	
		$V_{CC} = 3.0 \text{ V}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{Low} \text{ to } T_{High}$	-6.0 -8.0	0.5 -	+6.0 +8.0	
		V <sub>CC</sub> = 6.0 V T <sub>A</sub> = 25°C T <sub>A</sub> = T <sub>Low</sub> to T <sub>High</sub>	-5.0 -7.0	0.5 -	+5.0 +7.0	
V <sub>CM</sub>	Common Mode Voltage Range		-	V <sub>EE</sub> to V <sub>CC</sub>	-	V
I <sub>LEAK</sub>	Output Leakage Current	V <sub>CC</sub> = 6.0 V	-	3.3	-	nA
I <sub>SC</sub>	Output Short-Circuit Sourcing or Sinking	V <sub>out</sub> = GND	-	70	-	mA
CMRR	Common Mode Rejection Ratio	V <sub>CM</sub> = V <sub>CC</sub>	53	65	-	dB
I <sub>IB</sub>	Input Bias Current		-	1.0	-	pА
PSRR	Power Supply Rejection Ratio	ΔV <sub>S</sub> = 2.575 V	45	55	-	dB
Icc	Supply Current	$V_{CC} = 0.85 \text{ V}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{Low} \text{ to } T_{High} \text{ (Note 5)}$	-	10 -	15 17	μА
		V <sub>CC</sub> = 3.0 V T <sub>A</sub> = 25°C T <sub>A</sub> = T <sub>Low</sub> to T <sub>High</sub>	-	10 -	15 17	
		$V_{CC}$ = 6.0 V $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$	-	10 -	15 17	
V <sub>OH</sub>	Output Voltage High	$V_{CC}$ = 0.85 V, $I_{source}$ = 0.5 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$ (Note 5)	V <sub>CC</sub> - 0.2 V <sub>CC</sub> - 0.225	V <sub>CC</sub> - 0.10	-	V
		$V_{CC}$ = 3.0 V, $I_{source}$ = 3.0 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$	V <sub>CC</sub> - 0.2 V <sub>CC</sub> - 0.25	V <sub>CC</sub> - 0.12	-	
		$V_{CC}$ = 6.0 V, $I_{source}$ = 5.0 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$	V <sub>CC</sub> - 0.2 V <sub>CC</sub> - 0.25	V <sub>CC</sub> - 0.12	-	
V <sub>OL</sub>	Output Voltage Low	$V_{CC}$ = 0.85 V, $I_{Sink}$ = 0.5 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$ (Note 5)	-	V <sub>EE</sub> + 0.10	V <sub>EE</sub> + 0.2 V <sub>EE</sub> + 0.225	V
		$V_{CC}$ = 3.0 V, $I_{sink}$ = 3.0 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$	-	V <sub>EE</sub> + 0.12	V <sub>EE</sub> + 0.2 V <sub>EE</sub> + 0.25	
		$V_{CC} = 6.0 \text{ V, } I_{sink} = 5.0 \text{ mA}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{Low} \text{ to } T_{High}$	-	V <sub>EE</sub> + 0.12	V <sub>EE</sub> + 0.2 V <sub>EE</sub> + 0.25	
t <sub>PHL</sub>	Propagation Delay, High-to-Low	20 mV Overdrive, C <sub>L</sub> = 15 pF	-	1080	-	ns
t <sub>PLH</sub>	Propagation Delay, Low-to-High	20 mV Overdrive, C <sub>L</sub> = 15 pF	-	900	-	ns
t <sub>FALL</sub>	Output Fall Time	$V_{CC} = 6.0 \text{ V}, C_L = 50 \text{ pF}$	-	13	-	ns
t <sub>RISE</sub>	Output Rise Time	$V_{CC} = 6.0 \text{ V}, C_L = 50 \text{ pF}$	-	8.0	-	ns
tpu	Powerup Time		-	35	-	μS

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

The limits over the extended temperature range are guaranteed by design only.
 NCS2200: T<sub>Low</sub> = -40°C, T<sub>High</sub> = +105°C; NCV2200: T<sub>Low</sub> = -40°C, T<sub>High</sub> = +125°C

 $\textbf{NCS2202 ELECTRICAL CHARACTERISTICS} \text{ (For all values V}_{CC} = 0.85 \text{ V to } 6.0 \text{ V, V}_{EE} = 0 \text{ V, T}_{A} = 25^{\circ}\text{C, R}_{pullup} = 10 \text{ k}\Omega \text{, unless } 10.0 \text{ M}_{\odot} = 10.0 \text{$ otherwise noted.) (Note 6)

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
V <sub>HYS</sub>	Input Hysteresis	T <sub>A</sub> = 25°C	2.0	8.0	20	mV
V <sub>IO</sub>	Input Offset Voltage	$V_{CC} = 0.85 \text{ V}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{Low} \text{ to } T_{High} \text{ (Note 7)}$	-10 -12	0.5	+10 +12	mV
		V <sub>CC</sub> = 3.0 V T <sub>A</sub> = 25°C T <sub>A</sub> = T <sub>Low</sub> to T <sub>High</sub>	-6.0 -8.0	0.5	+6.0 +8.0	
		$V_{CC}$ = 6.0 V $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$	-5.0 -7.0	0.5 -	+5.0 +7.0	
$V_{CM}$	Common Mode Voltage Range		-	V <sub>EE</sub> to V <sub>CC</sub>	-	V
I <sub>LEAK</sub>	Output Leakage Current	V <sub>CC</sub> = 6.0 V	-	3.3	-	nA
I <sub>SC</sub>	Output Short-Circuit Sourcing or Sinking	V <sub>out</sub> = GND	-	70	-	mA
CMRR	Common Mode Rejection Ratio	V <sub>CM</sub> = V <sub>CC</sub>	53	65	-	dB
I <sub>IB</sub>	Input Bias Current		-	1.0	-	pА
PSRR	Power Supply Rejection Ratio	ΔV <sub>S</sub> = 2.575 V	45	55	-	dB
Icc	Supply Current	$V_{CC} = 0.85 \text{ V}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{Low} \text{ to } T_{High} \text{ (Note 7)}$	-	10 –	15 17	μА
		V <sub>CC</sub> = 3.0 V T <sub>A</sub> = 25°C T <sub>A</sub> = T <sub>Low</sub> to T <sub>High</sub>	-	10	15 17	
		V <sub>CC</sub> = 6.0 V T <sub>A</sub> = 25°C T <sub>A</sub> = T <sub>Low</sub> to T <sub>High</sub>	-	10 –	15 17	
V <sub>OL</sub>	Output Voltage Low	$V_{CC}$ = 0.85 V, $I_{Sink}$ = 0.5 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$ (Note 7)	-	V <sub>EE</sub> + 0.10	V <sub>EE</sub> + 0.2 V <sub>EE</sub> + 0.225	V
		$V_{CC}$ = 3.0 V, $I_{Sink}$ = 3.0 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$	-	V <sub>EE</sub> + 0.12	V <sub>EE</sub> + 0.2 V <sub>EE</sub> + 0.25	
		$V_{CC}$ = 6.0 V, $I_{Sink}$ = 5.0 mA $T_A$ = 25°C $T_A$ = $T_{Low}$ to $T_{High}$	-	V <sub>EE</sub> + 0.12	V <sub>EE</sub> + 0.2 V <sub>EE</sub> + 0.25	
t <sub>PHL</sub>	Propagation Delay, High-to-Low	20 mV Overdrive, C <sub>L</sub> = 15 pF	-	1000	-	ns
t <sub>PLH</sub>	Propagation Delay, Low-to-High	20 mV Overdrive, C <sub>L</sub> = 15 pF	-	800	-	ns
t <sub>FALL</sub>	Output Fall Time	V <sub>CC</sub> = 6.0 V, C <sub>L</sub> = 50 pF	-	6.0	-	ns
t <sub>RISE</sub>	Output Rise Time	V <sub>CC</sub> = 6.0 V, C <sub>L</sub> = 50 pF	-	260	-	ns
t <sub>PU</sub>	Powerup Time		-	35	-	μS

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

The limits over the extended temperature range are guaranteed by design only.
 NCS2202: T<sub>Low</sub> = -40°C, T<sub>High</sub> = +105°C; NCV2202: T<sub>Low</sub> = -40°C, T<sub>High</sub> = +125°C

NCS2200A ELECTRICAL CHARACTERISTICS (For all values  $V_{CC} = 0.85 \text{ V}$  to 6.0 V,  $V_{EE} = 0 \text{ V}$ ,  $T_A = 25^{\circ}\text{C}$ , unless otherwise noted.) (Note 8)

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
V <sub>HYS</sub>	Input Hysteresis	T <sub>A</sub> = 25°C	2.0	4.5	20	mV
V <sub>IO</sub>	Input Offset Voltage	V <sub>CC</sub> = 0.85 V T <sub>A</sub> = 25°C	-10	0.5	+10	mV
		$T_A = T_{LOW}$ to $T_{HIGH}$	-12	-	+12	
		$V_{CC} = 3.0 \text{ V}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{LOW} \text{ to } T_{HIGH}$	-6.0 -8.0	0.5 -	+6.0 +8.0	
		$V_{CC} = 6.0 \text{ V}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{LOW} \text{ to } T_{HIGH}$	-5.0 -7.0	0.5	+5.0 +7.0	
V <sub>CM</sub>	Common Mode Voltage Range		-	V <sub>EE</sub> to V <sub>CC</sub>	-	V
I <sub>SC</sub>	Output Short-Circuit Sourcing or Sinking	V <sub>out</sub> = GND	-	60	-	mA
CMRR	Common Mode Rejection Ratio	V <sub>CM</sub> = V <sub>CC</sub>	53	70	-	dB
I <sub>IB</sub>	Input Bias Current		-	1.0	-	pА
PSRR	Power Supply Rejection Ratio	ΔV <sub>S</sub> = 2.575 V	45	80	-	dB
Icc	Supply Current	$V_{CC}$ = 0.85 V $T_A$ = 25°C $T_A$ = $T_{LOW}$ to $T_{HIGH}$	-	7.5 -	15 17	μА
		V <sub>CC</sub> = 3.0 V T <sub>A</sub> = 25°C T <sub>A</sub> = T <sub>LOW</sub> to T <sub>HIGH</sub>	-	8.0 -	15 17	
		$V_{CC}$ = 6.0 V $T_A$ = 25°C $T_A$ = $T_{LOW}$ to $T_{HIGH}$	-	9.0 -	15 17	
V <sub>OH</sub>	Output Voltage High	$V_{CC}$ = 0.85 V, $I_{source}$ = 0.5 mA $T_A$ = 25°C $T_A$ = $T_{LOW}$ to $T_{HIGH}$	V <sub>CC</sub> - 0.25 V <sub>CC</sub> - 0.275	V <sub>CC</sub> - 0.10	-	V
		$V_{CC}$ = 3.0 V, $I_{source}$ = 3.0 mA $T_A$ = 25°C $T_A$ = $T_{LOW}$ to $T_{HIGH}$	V <sub>CC</sub> - 0.3 V <sub>CC</sub> - 0.35	V <sub>CC</sub> - 0.12	-	
		$V_{CC}$ = 6.0 V, $I_{source}$ = 5.0 mA $T_A$ = 25°C $T_A$ = $T_{LOW}$ to $T_{HIGH}$	V <sub>CC</sub> - 0.3 V <sub>CC</sub> - 0.35	V <sub>CC</sub> - 0.12	-	
V <sub>OL</sub>	Output Voltage Low	V <sub>CC</sub> = 0.85 V, I <sub>sink</sub> = 0.5 mA T <sub>A</sub> = 25°C T <sub>A</sub> = T <sub>LOW</sub> to T <sub>HIGH</sub>	-	V <sub>EE</sub> + 0.10	V <sub>EE</sub> + 0.25 V <sub>EE</sub> + 0.275	V
		$V_{CC}$ = 3.0 V, $I_{sink}$ = 3.0 mA $T_A$ = 25°C $T_A$ = $T_{LOW}$ to $T_{HIGH}$	-	V <sub>EE</sub> + 0.12	V <sub>EE</sub> + 0.3 V <sub>EE</sub> + 0.35	
		$V_{CC} = 6.0 \text{ V}, I_{sink} = 5.0 \text{ mA}$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{LOW} \text{ to } T_{HIGH}$	-	V <sub>EE</sub> + 0.12	V <sub>EE</sub> + 0.3 V <sub>EE</sub> + 0.35	
t <sub>PHL</sub>	Propagation Delay, High-to-Low	20 mV Overdrive, C <sub>L</sub> = 15 pF,	_	625	_	ns
t <sub>PLH</sub>	Propagation Delay, Low-to-High	V <sub>CC</sub> = 2.85 V	-	750	-	ns
t <sub>FALL</sub>	Output Fall Time	V <sub>CC</sub> = 6.0 V, C <sub>L</sub> = 50 pF (Note 9)	-	22	-	ns
t <sub>RISE</sub>	Output Rise Time	V <sub>CC</sub> = 6.0 V, C <sub>L</sub> = 50 pF (Note 9)	-	20	_	ns

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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

<sup>10.</sup> NCS2200A: T<sub>LOW</sub> = -40°C, T<sub>HIGH</sub> = +105°C; NCV2200A: T<sub>LOW</sub> = -40°C, T<sub>HIGH</sub> = +125°C.

NCS2202A ELECTRICAL CHARACTERISTICS (For all values  $V_{CC}$  = 0.85 V to 6.0 V,  $V_{EE}$  = 0 V,  $T_{A}$  = 25°C,  $R_{pullup}$  = 10 k $\Omega$ , unless otherwise noted.) (Note 11)

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
V <sub>HYS</sub>	Input Hysteresis	T <sub>A</sub> = 25°C	2.0	4.5	20	mV
V <sub>IO</sub>	Input Offset Voltage	V <sub>CC</sub> = 0.85 V				mV
		T <sub>A</sub> = 25°C	-10	0.3	+10	l
		$T_A = -40^{\circ}\text{C to } 105^{\circ}\text{C}$	-12	-	+12	]
		V <sub>CC</sub> = 3.0 V				
		T <sub>A</sub> = 25°C	-6.0	0.4	+6.0	
		T <sub>A</sub> = -40°C to 105°C	-8.0	-	+8.0	1
		V <sub>CC</sub> = 6.0 V T <sub>A</sub> = 25°C	-5.0	0.4	+5.0	
		$T_A = -40^{\circ}\text{C}$ to 105°C	-3.0 -7.0	0.4	+7.0	
V <sub>CM</sub>	Common Mode Voltage Range	1A - 40 0 to 100 0	-	V <sub>EE</sub> to V <sub>CC</sub>	-	V
	Output Short-Circuit Sourcing or	V <sub>out</sub> = GND	_	60	_	mA
I <sub>SC</sub>	Sinking	Vout - GIND		00	_	l IIIA
CMRR	Common Mode Rejection Ratio	V <sub>CM</sub> = V <sub>CC</sub>	53	80		dB
	Input Bias Current	VCM - VCC	-	1.0	_	pA
I <sub>IB</sub> PSRR	Power Supply Rejection Ratio	ΔV <sub>S</sub> = 2.575 V	45	80	_	dB
		$V_{CC} = 0.85 \text{ V}$	40	00		
Icc	Supply Current	V <sub>CC</sub> = 0.65 V T <sub>A</sub> = 25°C	_	7.5	15	μА
		T <sub>A</sub> = -40°C to 105°C		-	17	
		V <sub>CC</sub> = 3.0 V		+		┨
		T <sub>Δ</sub> = 25°C	_	8.0	15	
		T <sub>A</sub> = -40°C to 105°C		-	17	
		V <sub>CC</sub> = 6.0 V				1
		T <sub>A</sub> = 25°C	-	9.0	15	
		$T_A = -40^{\circ}C \text{ to } 105^{\circ}C$		-	17	
V <sub>OL</sub>	Output Voltage Low	V <sub>CC</sub> = 0.85 V, I <sub>sink</sub> = 0.5 mA				V
		T <sub>A</sub> = 25°C	-	V <sub>EE</sub> + 0.14	V <sub>EE</sub> + 0.25	
		$T_A = -40^{\circ}\text{C to } 105^{\circ}\text{C}$		-	V <sub>EE</sub> + 0.275	]
		$V_{CC} = 3.0 \text{ V}, I_{sink} = 3.0 \text{ mA}$		1,,		
		T <sub>A</sub> = 25°C	_	V <sub>EE</sub> + 0.18	V <sub>EE</sub> + 0.3	
		T <sub>A</sub> = -40°C to 105°C			V <sub>EE</sub> + 0.35	-
		$V_{CC} = 6.0 \text{ V}, I_{sink} = 5.0 \text{ mA}$ $T_A = 25^{\circ}\text{C}$	_	V <sub>EE</sub> + 0.20	V <sub>EE</sub> + 0.3	
		$T_A = -40^{\circ}\text{C} \text{ to } 105^{\circ}\text{C}$		-	V <sub>EE</sub> + 0.35	
t <sub>PHL</sub>	Propagation Delay - High to Low	20 mV Overdrive, C <sub>L</sub> = 15 pF,	_	580		ns
PHL	Tropagation Bolay Trigit to Low	V <sub>CC</sub> = 2.85 V				""
		50 mV Overdrive, C <sub>L</sub> = 15 pF,	-	350	-	1
		V <sub>CC</sub> = 2.85 V				
		100 mV Overdrive, C <sub>L</sub> = 15 pF,	-	220	-	1
		V <sub>CC</sub> = 2.85 V				
t <sub>PLH</sub>	Propagation Delay - Low to High	20 mV Overdrive, C <sub>L</sub> = 15 pF,	-	550	-	ns
		V <sub>CC</sub> = 2.85 V				
		50 mV Overdrive, C <sub>I</sub> = 15 pF,	-	400	-	1
		V <sub>CC</sub> = 2.85 V				
		100 mV Overdrive, C <sub>L</sub> = 15 pF,	-	340	-	1
		V <sub>CC</sub> = 2.85 V				
t <sub>FALL</sub>	Output Fall Time	V <sub>CC</sub> = 6.0 V, C <sub>L</sub> = 50 pF (Note	-	5.0	-	ns
		12)				
t <sub>RISE</sub>	Output Rise Time	V <sub>CC</sub> = 6.0 V, C <sub>L</sub> = 50 pF (Note	-	235	-	ns
		12)		1		

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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

<sup>12.</sup> Input signal: 1 kHz, squarewave signal with 10 ns edge rate.

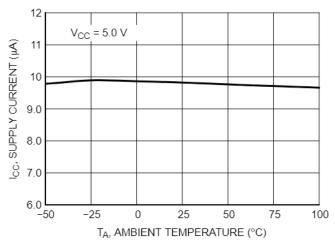


Figure 1. NCS2200 Series Supply Current versus Temperature

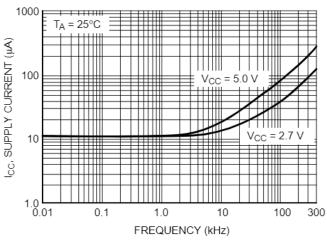


Figure 2. NCS2200 Series Supply Current versus Output Transition Frequency

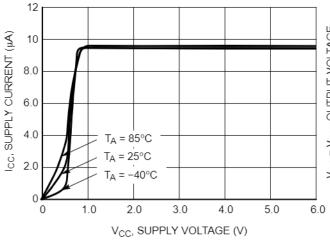
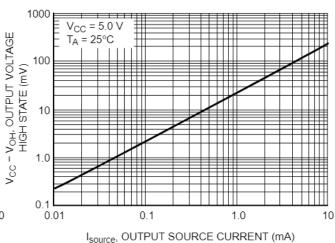


Figure 3. NCS2200 Series Supply Current versus Supply Voltage



E'----- 4 NGC0000 C------ 1/-1/----

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

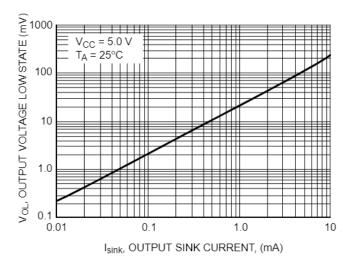


Figure 5. NCS2200 Series Output Voltage Low State versus Output Sink Current

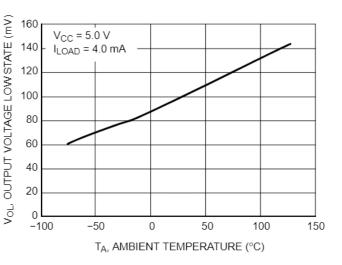


Figure 6. NCS2200 Series Output Voltage Low State versus Temperature

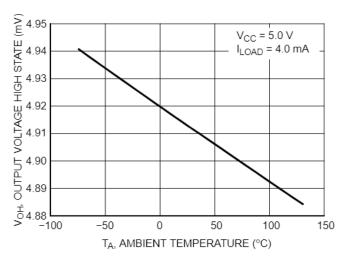


Figure 7. NCS2200 Series Output Voltage High State versus Temperature

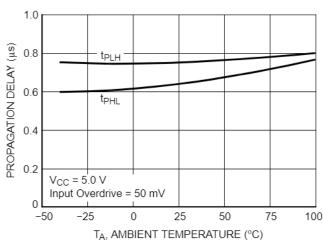


Figure 8. NCS2200 Series Propagation Delay versus Temperature

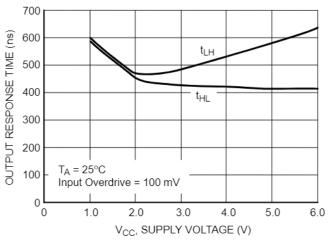


Figure 9. NCS2200 Series Output Response Time versus Supply Voltage

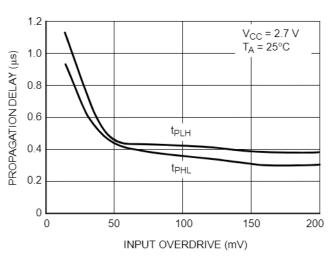


Figure 10. NCS2200 Series Propagation Delay versus Input Overdrive

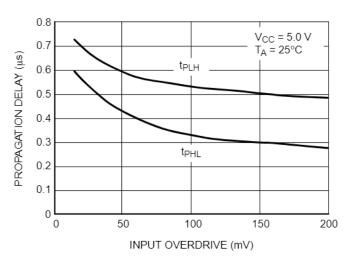


Figure 11. NCS2200 Series Propagation Delay versus Input Overdrive

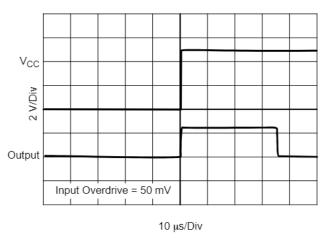
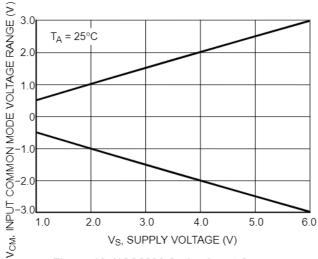


Figure 12. NCS2200 Series Powerup Delay



I<sub>LEAK</sub>, OUTPUT LEAKAGE CURRENT (nA) 180 160 140 120 100 T<sub>A</sub> = 85°C 80 60 40 20 T<sub>A</sub> = -40°C 0 1.0 4.0 5.0 7.0 8.0 0 2.0 3.0 6.0 V<sub>OUT</sub>, OUTPUT VOLTAGE (V)

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

Figure 14. NCS2202 Output Leakage Current versus Output Voltage

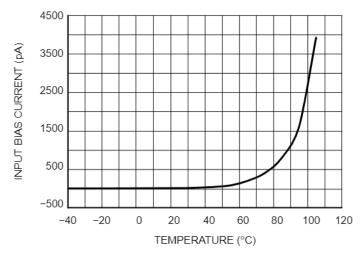


Figure 15. Input Bias Current versus Temperature

#### 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  $6.0\,\mathrm{V}$  (max) with an external resistor. This facilitates mixed voltage system applications.

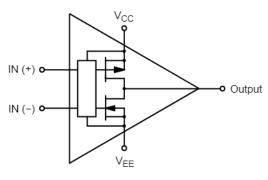


Figure 16. NCS2200/NCS2200A Complementary Push-Pull Output

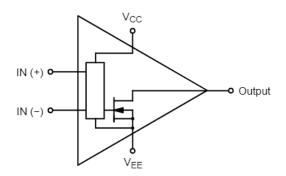
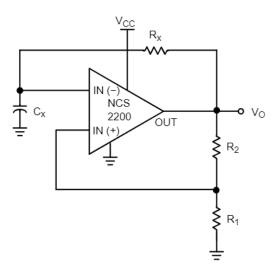


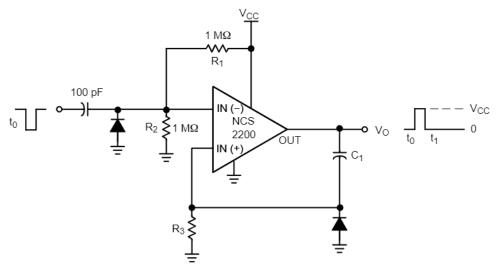
Figure 17. NCS2202/NCS2202A Open Drain
Output Configuration



The oscillation frequency can be programmed as follows:

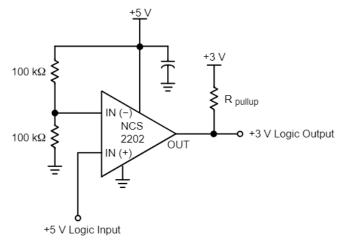
$$f = \frac{1}{T} = \frac{1}{2.2 \text{ RyCy}}$$

Figure 18. 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 19. One-Shot Multivibrator



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

Figure 20. Logic Level Translator

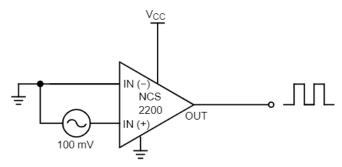


Figure 21. Zero-Crossing Detector

# ORDERING INFORMATION

Device	Pinout Style	Output Type	Package	Shipping <sup>†</sup>
NCS2200AMUT1G	N/A	Complementary Push-Pull	UDFN (Pb-Free)	3000 / Tape & Reel
NCV2200AMUTBG*	N/A	Complementary Push-Pull	UDFN (Pb-Free)	3000 / Tape & Reel
NCS2200SN1T1G	1	Complementary Push-Pull	SOT-23-5 (TSOP-5) (Pb-Free)	3000 / Tape & Reel
NCV2200SN1T1G*	1	Complementary Push-Pull	SOT-23-5 (TSOP-5) (Pb-Free)	3000 / Tape & Reel
NCS2200SN2T1G	2	Complementary Push-Pull	SOT-23-5 (TSOP-5) (Pb-Free)	3000 / Tape & Reel
NCV2200SN2T1G*	2	Complementary Push-Pull	SOT-23-5 (TSOP-5) (Pb-Free)	3000 / Tape & Reel
NCS2200SQ2T2G	2	Complementary Push-Pull	SC70-5 (Pb-Free)	3000 / Tape & Reel
NCV2200SQ2T2G*	2	Complementary Push-Pull	SC70-5 (Pb-Free)	3000 / Tape & Reel
NCS2200SQLT1G	N/A	Complementary Push-Pull	DFN, 2x2.2 (Pb-Free)	3000 / Tape & Reel
NCS2202SN1T1G	1	Open Drain	SOT-23-5 (TSOP-5) (Pb-Free)	3000 / Tape & Reel
NCS2202SN2T1G	2	Open Drain	SOT-23-5 (TSOP-5) (Pb-Free)	3000 / Tape & Reel
NCV2202SN2T1G*	2	Open Drain	SOT-23-5 (TSOP-5) (Pb-Free)	3000 / Tape & Reel
NCS2202SQ1T2G	1	Open Drain	SC70-5 (Pb-Free)	3000 / Tape & Reel
NCS2202SQ2T2G	2	Open Drain	SC70-5 3000 / Tape (Pb-Free)	
NCS2202AMUTBG	N/A	Open Drain	UDFN (Pb-Free)	3000 / Tape & Reel

This device contains 93 active transistors.

<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.

<sup>\*</sup>NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

### 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)

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.

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.

> UDFN6 1.2x1.0 MU SUFFIX CASE 517AA



(Top View)

x S for Specific Device Code

V for NCS2202A (V with 180° Rotation)

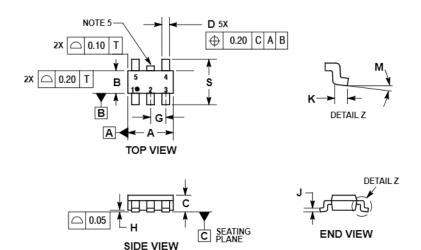
M = Date Code

= Pb-Free Package

#### PACKAGE DIMENSIONS

### SOT-23-5 / TSOP-5 / SC59-5 SN SUFFIX

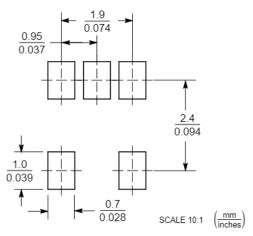
CASE 483-02 ISSUE M



- 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. MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE DIMENSION A.
  5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.
  - FROM BODY.

	MILLIMETERS			
DIM	MIN	MAX		
Α	2.85	3.15		
В	1.35	1.65		
С	0.90	1.10		
D	0.25	0.50		
G	0.95	BSC		
Н	0.01	0.10		
J	0.10	0.26		
K	0.20	0.60		
M	0 °	10°		
S	2.50	3.00		

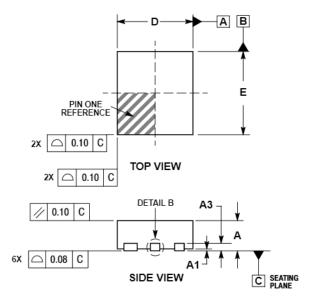
#### SOLDERING FOOTPRINT\*

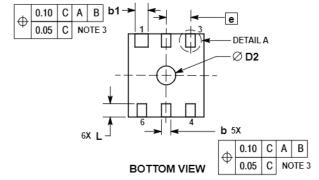


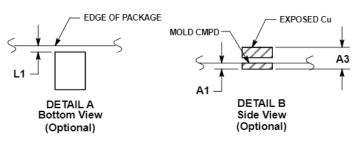
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# PACKAGE DIMENSIONS

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



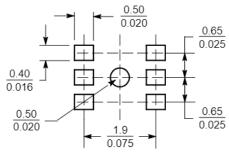




- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: MILLIMETERS.
- DIMENSION & APPLIES TO PLATED
  TERMINAL AND IS MEASURED BETWEEN
- 1EHMINAL AND IS MEASURED BETWEEN
  0.25 AND 0.30mm FROM TERMINAL
  COPLANARITY APPLIES TO THE EXPOSED
  PAD AS WELL AS THE TERMINALS.
  TERMINAL 5 MAY HAVE MOLD COMPOUND
  MATERIAL ALONG SIDE EDGE.
- 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					
Α	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				
е	0.65 BSC					
L	0.30	0.35	0.40			
L1	0.00	0.05	0.10			

# **SOLDERING FOOTPRINT\***



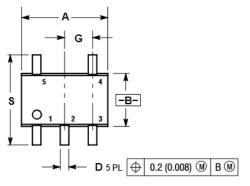
SCALE 10:1

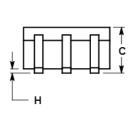
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

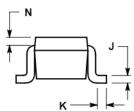
# PACKAGE DIMENSIONS

## SC-88A (SC-70-5/SOT-353) SQ SUFFIX

CASE 419A-02 ISSUE L



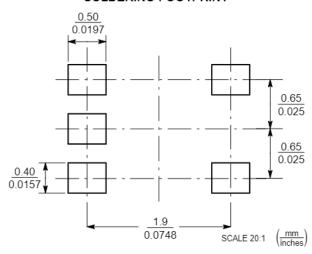




- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
  4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. BURRS

	INCHES		MILLIN	IETERS
DIM	MIN	MAX	MIN	MAX
Α	0.071	0.087	1.80	2.20
В	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
Н		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

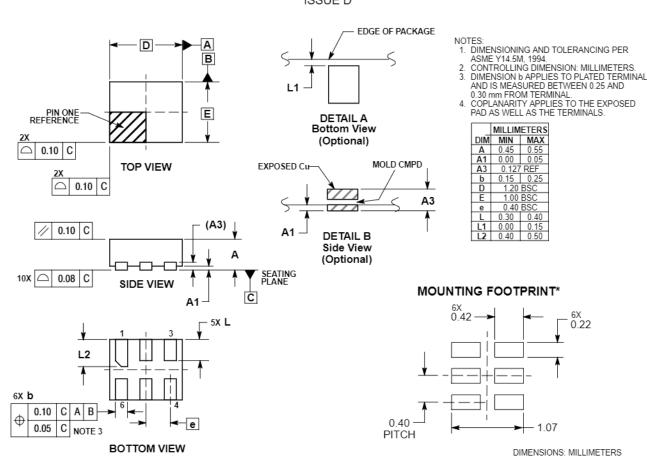
### **SOLDERING FOOTPRINT\***



\*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 ISSUE D



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