

# NCS2200 Series

## Advance Information Low Voltage Comparators

The NCS2200 series is an industry first sub-one volt, low power comparator family. These devices consume only 10  $\mu\text{A}$  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 is fully operational up to 6.0 V which makes it convenient to be used in both 3.0 V and 5.0 V systems. Additional features include no output phase inversion when transitioning in/out of tri-state mode, internal hysteresis which allows for clean output switching, and rail-to-rail input performance. The NCS2200 series are available in the tiny SOT23-5 and SOT23-6 package and feature two industry standard pinouts.

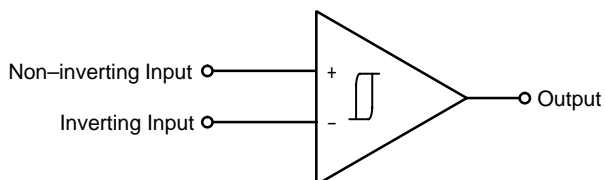
The NCS22201/3 Series in the SOT23-6 package features an enable function which can be externally controlled. This lowers current consumption to 1.8  $\mu\text{A}$  and allows for users to implement these devices in power sensitive applications such as portable electronics.

### Features

- Operating Voltage of 0.85 V to 6.0 V
- Rail-to-rail Input/Output Performance
- Low Supply Current of 10  $\mu\text{A}$
- No Phase Inversion/Glitchless transitioning in or out of Tri-State Mode
- Complementary or Open Drain Output Configuration
- Available with the Enable Function
- Tiny SOT23-5 and SOT23-6 Package

### Typical Applications

- Single Cell NiCd/NiMH Battery Powered Applications
- Window Comparator
- Portable Electronics
- Voltage Detector
- Zero-Crossing Detectors
- Personal Digital Assistants



This device contains 93 active transistors.

This document contains information on a new product. Specifications and information herein are subject to change without notice.



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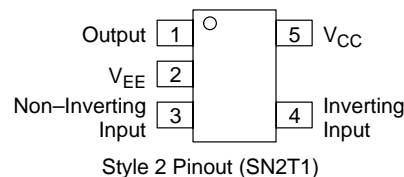
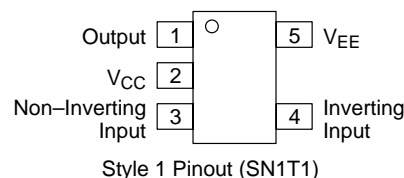


**SOT23-5**  
(TSOP-5, SC59-5)  
SN SUFFIX  
CASE 483

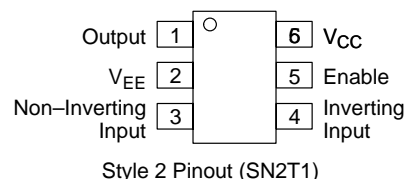
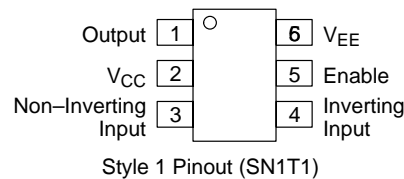


**SOT23-6**  
(TSOP-6, SC59-6)  
SN SUFFIX  
CASE 318G

### PIN CONNECTIONS



**SOT23-5**  
(NCS2200, NCS2202)



**SOT23-6**  
(NCS2201, NCS2203)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 10 of this data sheet.

# NCS2200 Series

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage Range ( $V_{CC}$ to $V_{EE}$ )	$V_S$	6.0	V
Non-inverting/Inverting Input to $V_{EE}$	–	–0.1 to ( $V_{CC} + 0.1$ )	V
Thermal Resistance, Junction to Air	$R_{\theta JA}$	238	°C/W
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) Human Body Model Machine Model	–	2000 200	V

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.

## ELECTRICAL CHARACTERISTICS (For all values $V_{CC} = 0.85$ V to 6.0 V, $T_A = 25^\circ\text{C}$ , unless otherwise noted.) (Note 3)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Hysteresis $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$	$V_{HYS}$	–	$\pm 3.0$	–	mV
Input Offset Voltage $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$	$V_{IO}$	–	$\pm 0.5$	$\pm 5.0$	mV
Common Mode Voltage Range	$V_{CM}$	$V_{EE} - 0.1$	–	$V_{CC} + 0.1$	V
Output Leakage Current	$I_{LEAK}$	–	TBD	–	$\mu\text{A}$
Common Mode Rejection $V_{CM} = V_{CC}$	CMRR	–	80	–	dB
Input Bias Current	$I_{IB}$	–	0.001	10	nA
Power Supply Rejection $\Delta V_S = 2.575$	PSRR	–	–	–	dB
Supply Current $V_{CC} = 0.85$ V $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$ $V_{CC} = 3.0$ V $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$ $V_{CC} = 6.0$ V $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$	$I_{CC}$	–	10	–	$\mu\text{A}$
Output Voltage High $I_{source} = 7.0$ mA $V_{CC} = 0.85$ V $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$ $V_{CC} = 3.0$ V $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$ $V_{CC} = 6.0$ V $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$	$V_{OH}$	–	$V_{CC} - 0.2$	–	V

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

## NCS2200 Series

### ELECTRICAL CHARACTERISTICS (For all values $V_{CC} = 0.85\text{ V}$ to $6.0\text{ V}$ , $T_A = 25^\circ\text{C}$ , unless otherwise noted.) (Note 4)

Characteristics	Symbol	Min	Typ	Max	Unit
Output Voltage Low $I_{\text{sink}} = 7.0\text{ mA}$ $V_{CC} = 0.85\text{ V}$ $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$ $V_{CC} = 3.0\text{ V}$ $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$ $V_{CC} = 6.0\text{ V}$ $T_A = 25^\circ\text{C}$ $T_A = -40^\circ\text{C}$ to $105^\circ\text{C}$	$V_{OL}$	–	0.2	–	V
Propagation Delay 10 mV Overdrive, $C_L = 50\text{ pF}$	$t_{PHL}$ $t_{PLH}$	– –	1.1 1.1	– –	$\mu\text{s}$
Output Voltage Fall Time $C_L = 50\text{ pF}$	$t_{FALL}$	–	50	–	ns
Output Voltage Rise Time $C_L = 50\text{ pF}$	$t_{RISE}$	–	50	–	ns
Power-up Time	$t_{PU}$	–	50	100	$\mu\text{s}$
Tri-state Leakage Current	$I_{TRI-LEAK}$	–	3.0	–	nA

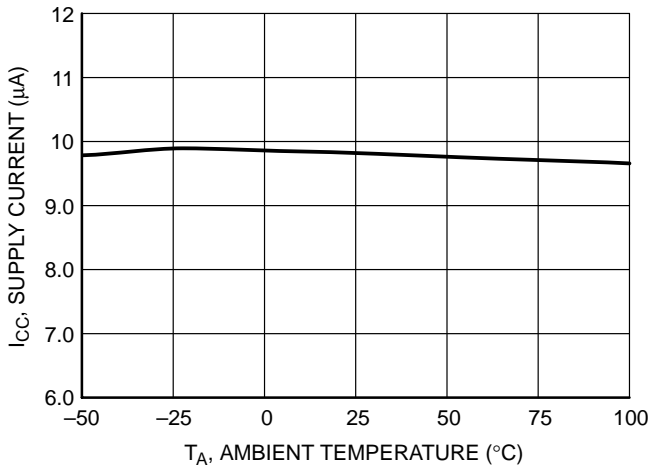
### ENABLE FUNCTION (NCS2201/3 only) ELECTRICAL CHARACTERISTICS

(For all values  $V_{CC} = 0.85\text{ V}$  to  $6.0\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.) (Note 4)

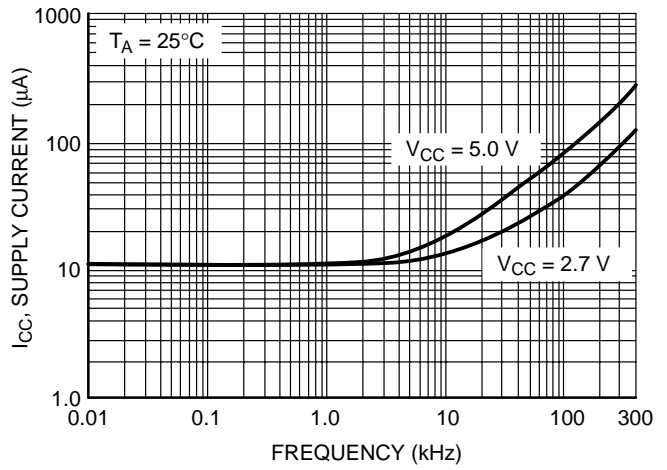
Enable Voltage (High)	$V_{EN(HIGH)}$	–	–	2.2	V
Enable Voltage (Low)	$V_{EN(LOW)}$	1.1	–	–	V
Enable Hysteresis	$V_{ENHYS}$	–	75	–	mV
Enable Current	$I_{EN}$	–	275	–	nA
Enable Settling Time	$t_{EN(ON)}$	–	45	–	$\mu\text{s}$
Disable Settling Time	$t_{EN(OFF)}$	–	2.0	–	$\mu\text{s}$

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

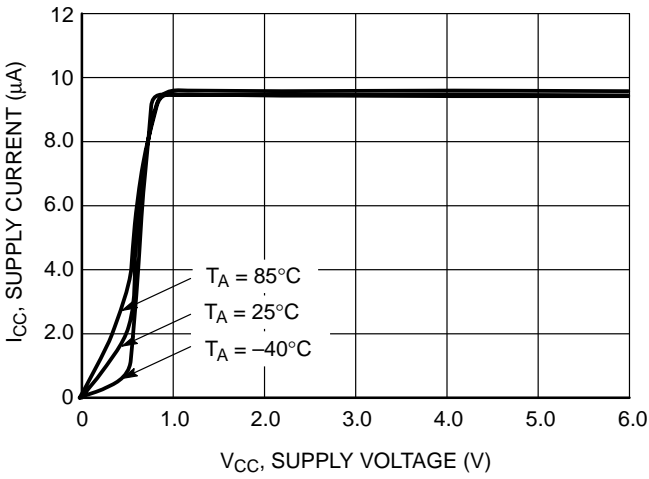
# NCS2200 Series



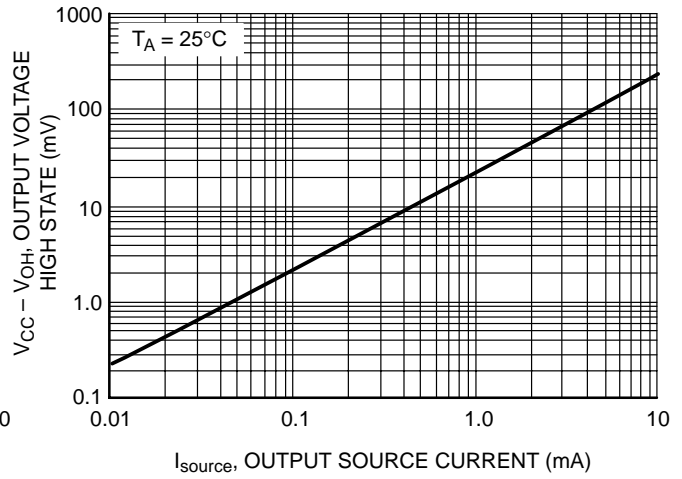
**Figure 1. NCS2200 Series Supply Current vs. Temperature**



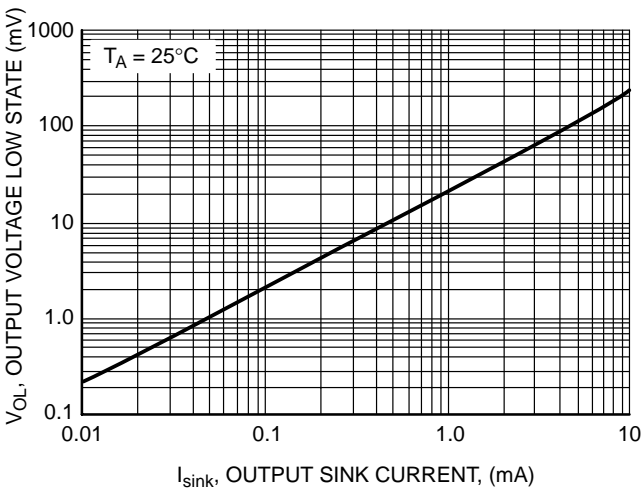
**Figure 2. NCS2200 Series Supply Current vs. Output Transition Frequency**



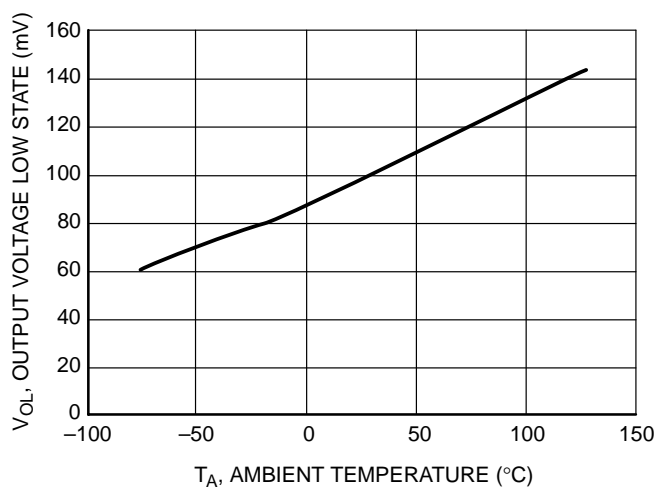
**Figure 3. NCS2200 Series Supply Current vs. Supply Voltage**



**Figure 4. NCS2200/1 Output Voltage High State vs. Output Source Current**

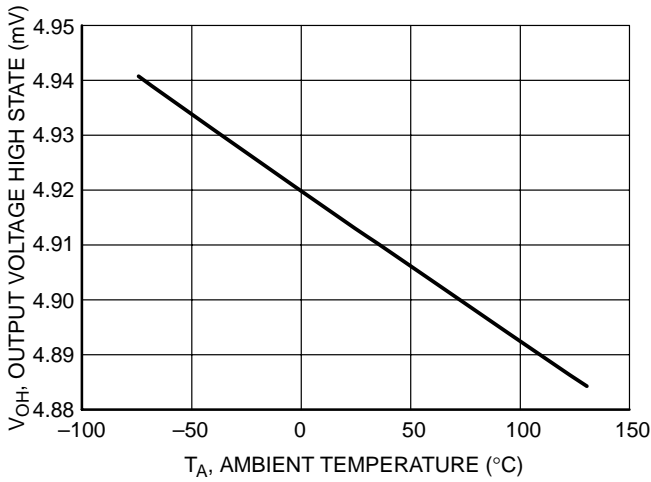


**Figure 5. NCS2200 Series Output Voltage Low State vs. Output Sink Current**

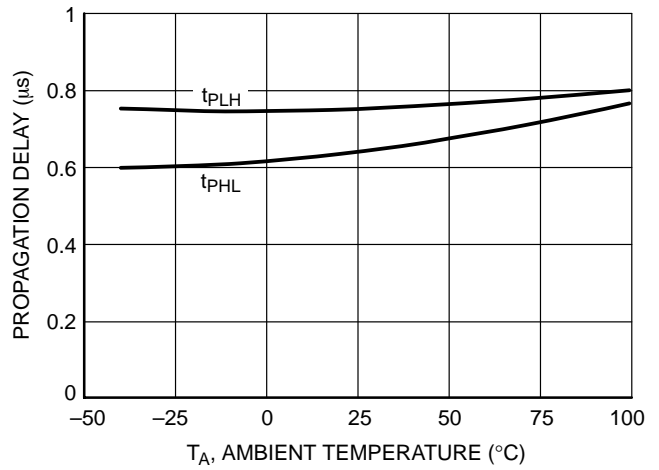


**Figure 6. NCS2200 Series Output Voltage Low State vs. Temperature**

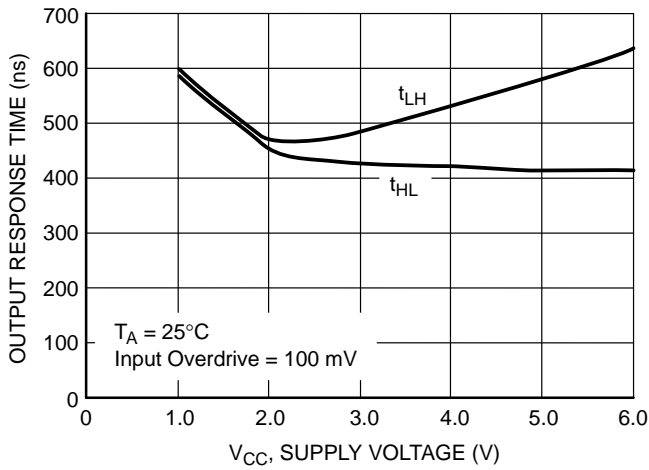
# NCS2200 Series



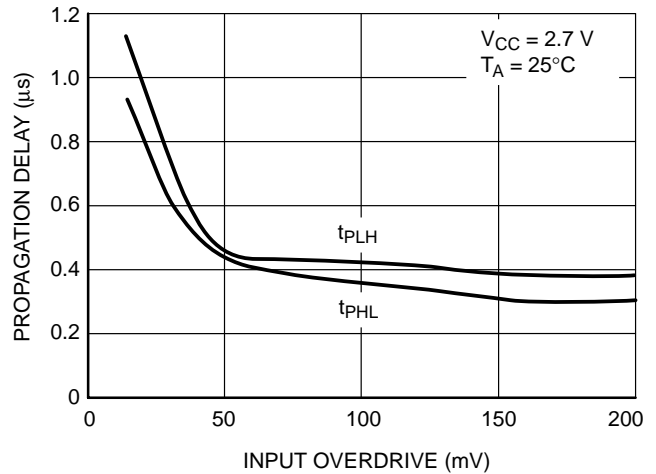
**Figure 7. NCS2200 Series Output Voltage High State vs. Temperature**



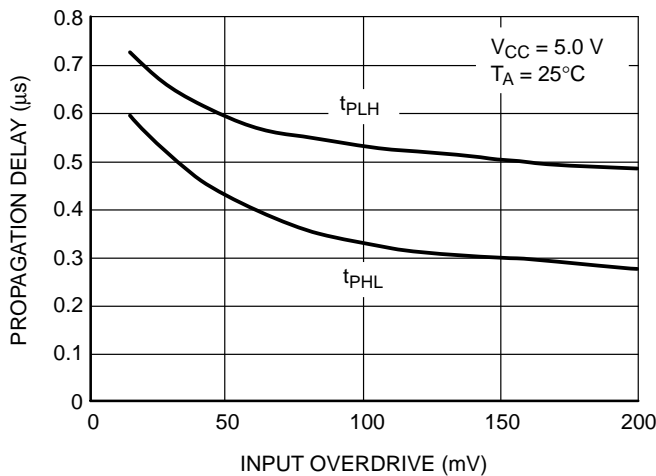
**Figure 8. NCS2200 Series Propagation Delay vs. Temperature**



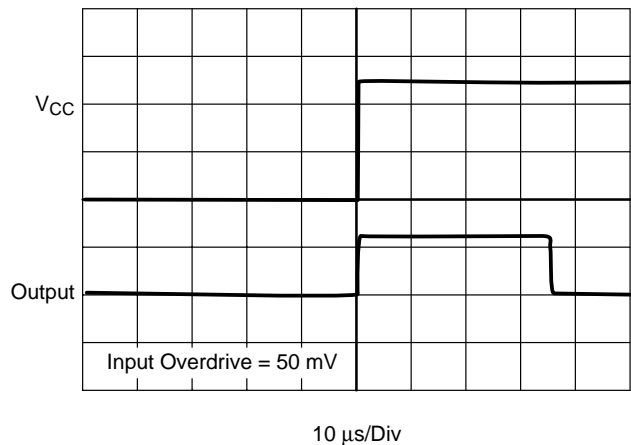
**Figure 9. NCS2200 Series Output Response Time vs. Supply Voltage**



**Figure 10. NCS2200 Series Propagation Delay vs. Input Overdrive**

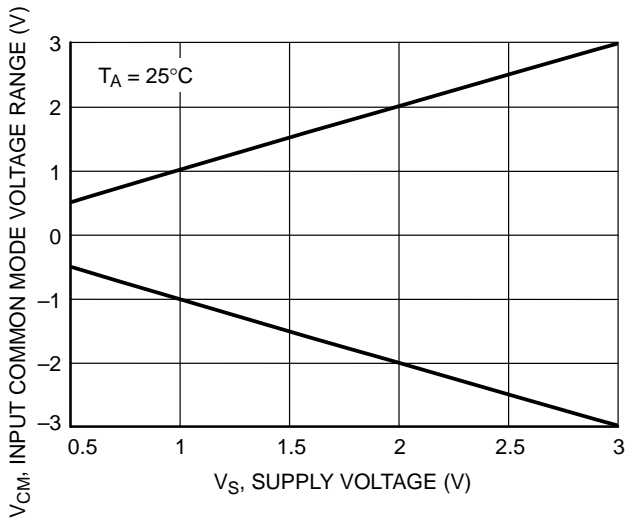


**Figure 11. NCS2200 Series Propagation Delay vs. Input Overdrive**

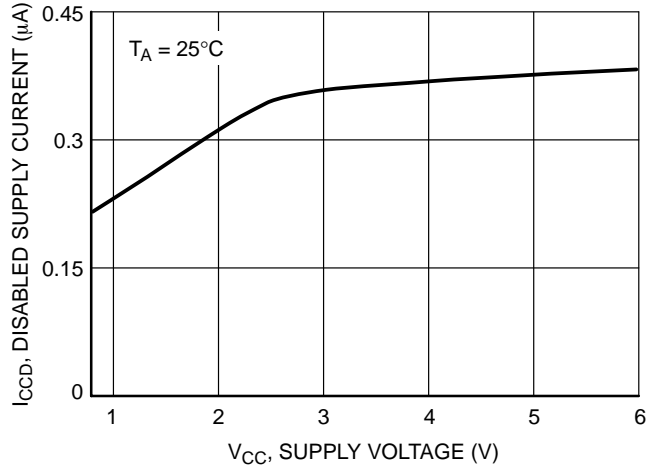


**Figure 12. NCS2200 Series Power-Up Delay**

# NCS2200 Series



**Figure 13. NCS2200 Series Input Common Mode Voltage Range vs. Supply Voltage**



**Figure 14. NCS2200 Series Disabled Supply Current**

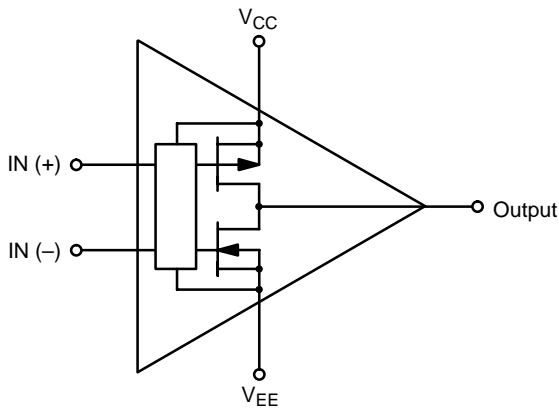
## OPERATING DESCRIPTION

The NCS2200 Series is an industry first sub-one volt, low power comparators. These devices consume only 10  $\mu\text{A}$  of supply current while achieving a typical propagation delay of 1.1  $\mu\text{s}$  at 10 mV overdrive. They are 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 which implements depletion MOSFET devices. The common-mode input voltage range extends 0.1 V above the upper and lower rail. They are available in SOT23-5 (compatible with the TSOP-5) and SOT23-6 packages. The SOT23-6 has the enable function which can be externally controlled. It allows for lower current consumption of 1.8  $\mu\text{A}$ . This makes the devices suitable for implementation in power sensitive applications such as portable electronics. When the enable pin is at a low level, the output will remain at a high or low level. The output will not respond to any changes at the input pins.

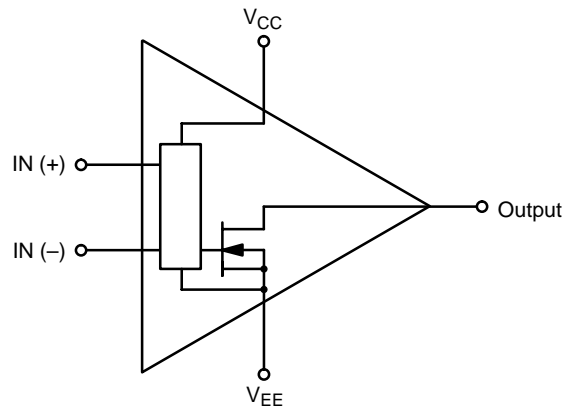
Conversely, when the enable pin is at a high level, the output will respond to change at the input pins. The enable pin should be connected to VCC when not in use. In addition, with the added feature of internal hysteresis, this allows for greater noise immunity and clean output switching.

## Output Stage

The NCS2200/1 has a complementary output which drives rail-to-rail output swing. The NCS2202/3 has an open drain N-channel output that can be pulled up to 6.0 V (max) with an external pull-up resistor. This allows for mixed-voltage system applications. These devices can operate up to an 7.0 mA load. The output stage is designed so that shoot through current is minimized while switching. This enhancement eliminates the need for bypass capacitors. There is no output phase reversal when switching in or out of tri-state mode.

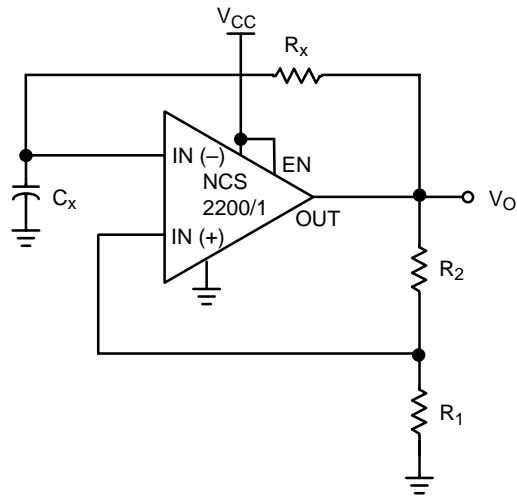


**Figure 15. NCS230xSNxT1 Complementary Output Configuration**



**Figure 16. NCS230xSNxT1 Open Drain Output Configuration**

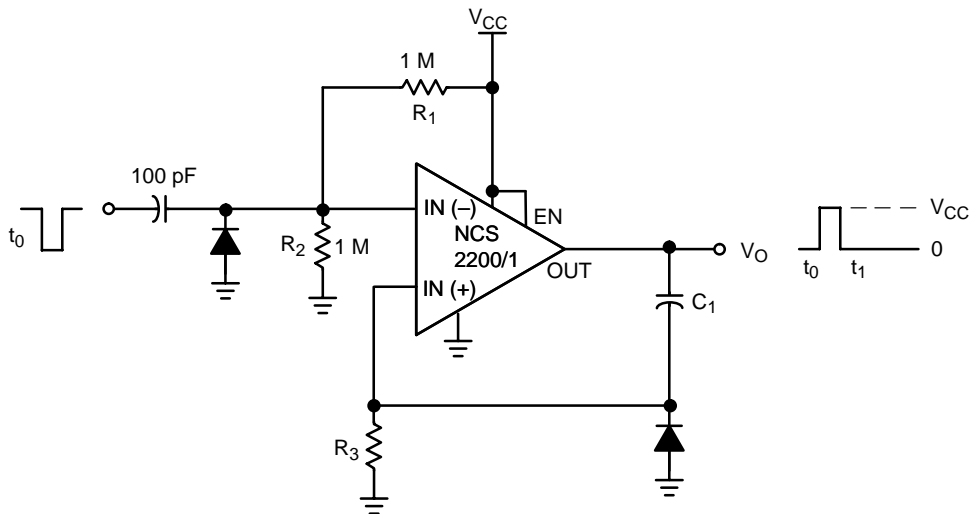
## NCS2200 Series



The oscillation frequency can be programmed as follows:

$$f = \frac{1}{T} = \frac{1}{2.2 R_x C_x}$$

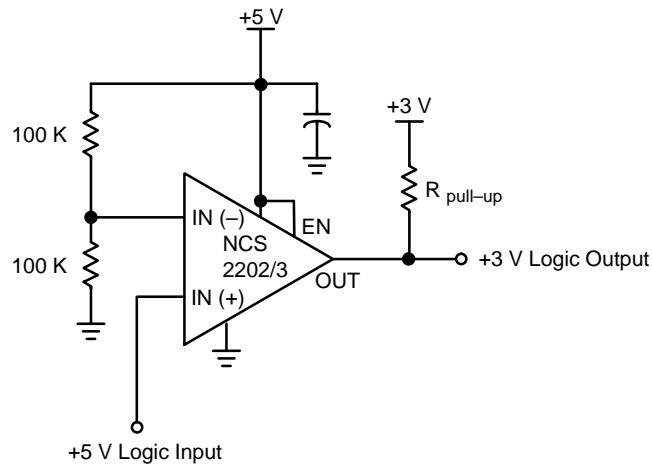
**Figure 17. Schmitt Trigger Oscillator**



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  $R_3$ .

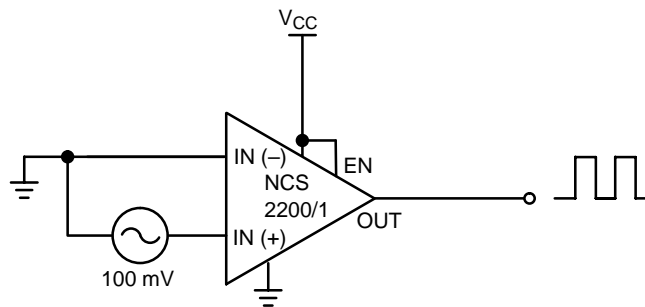
**Figure 18. One-Shot Multivibrator**

## NCS2200 Series



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**



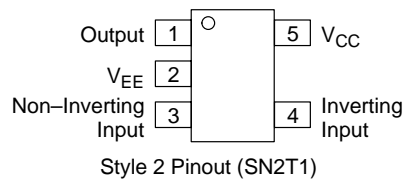
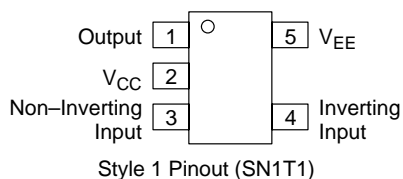


# NCS2200 Series

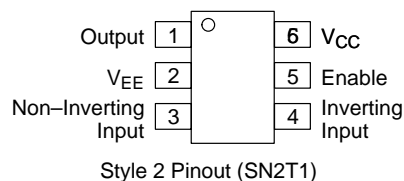
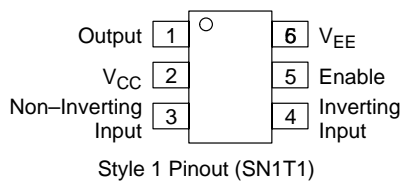
## ORDERING INFORMATION

Device	Pinout Style	Output Type	Package	Shipping
NCS2200SN1T1	1	Complementary	SOT23-5	3000 Tape & Reel
NCS2200SN2T1	2	Complementary	SOT23-5	
NCS2201SN1T1	1	Complementary, Enable	SOT23-6	
NCS2201SN2T1	2	Complementary, Enable	SOT23-6	
NCS2202SN1T1	1	Open Drain	SOT23-5	
NCS2202SN2T1	2	Open Drain	SOT23-5	
NCS2203SN1T1	1	Open Drain, Enable	SOT23-6	
NCS2203SN2T1	2	Open Drain, Enable	SOT23-6	

## PIN CONNECTIONS



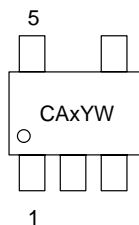
### SOT23-5 (NCS2200, NCS2202)



### SOT23-6 (NCS2201, NCS2203)

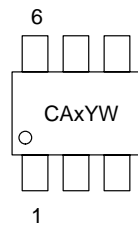
## MARKING DIAGRAMS

### SOT23-5 SN SUFFIX CASE 483



x = I for NCS2200SN1T1  
 J for NCS2200SN2T1  
 M for NCS2202SN1T1  
 N for NCS2202SN2T1  
 Y = Year  
 W = Work Week

### SOT23-6 SN SUFFIX CASE 318G

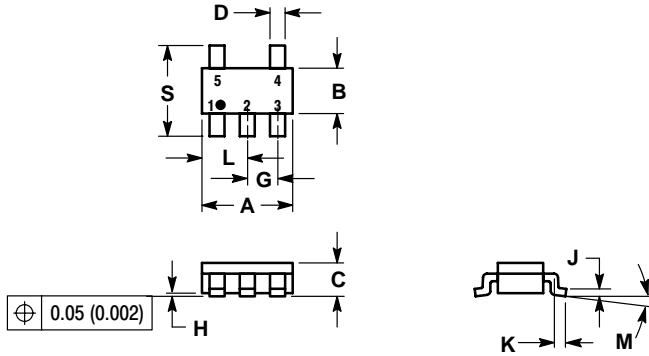


x = K for NCS2201SN1T1  
 L for NCS2201SN2T1  
 O for NCS2203SN1T1  
 P for NCS2203SN2T1  
 Y = Year  
 W = Work Week

# NCS2200 Series

## PACKAGE DIMENSIONS

**SOT23-5**  
**(TSOP-5, SC59-5)**  
**SN SUFFIX**  
 PLASTIC PACKAGE  
 CASE 483-01  
 ISSUE B

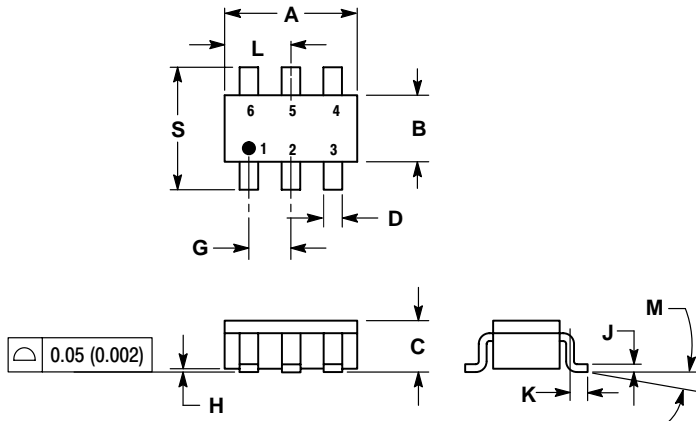


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.90	3.10	0.1142	0.1220
B	1.30	1.70	0.0512	0.0669
C	0.90	1.10	0.0354	0.0433
D	0.25	0.50	0.0098	0.0197
G	0.85	1.05	0.0335	0.0413
H	0.013	0.100	0.0005	0.0040
J	0.10	0.26	0.0040	0.0102
K	0.20	0.60	0.0079	0.0236
L	1.25	1.55	0.0493	0.0610
M	0°	10°	0°	10°
S	2.50	3.00	0.0985	0.1181

**SOT23-6**  
**(TSOP-6, SC59-6)**  
**SN SUFFIX**  
 PLASTIC PACKAGE  
 CASE 318G-02  
 ISSUE H




**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.90	3.10	0.1142	0.1220
B	1.30	1.70	0.0512	0.0669
C	0.90	1.10	0.0354	0.0433
D	0.25	0.50	0.0098	0.0197
G	0.85	1.05	0.0335	0.0413
H	0.013	0.100	0.0005	0.0040
J	0.10	0.26	0.0040	0.0102
K	0.20	0.60	0.0079	0.0236
L	1.25	1.55	0.0493	0.0610
M	0°	10°	0°	10°
S	2.50	3.00	0.0985	0.1181

## NCS2200 Series

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