

# NCS2300 Series

## Advance Information High Voltage Comparators

The NCS2300 Series are ultra-low power comparators. These devices consume only 11  $\mu$ A of supply current. They operate at a wide voltage range of 1.7 V to 12 V. 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 NCS2300 Series are available in the tiny SOT23-5 or SOT23-6 package with two industry standard pinouts.

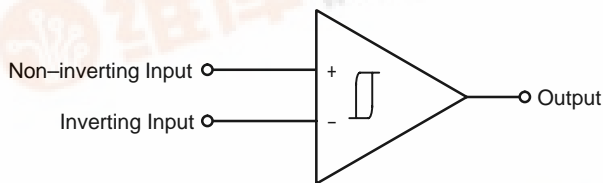
The NCS2301/3 Series in the SOT23-6 package features an enable function which can be externally controlled. This lowers current consumption to 1.8  $\mu$ A and allows for users to implement these devices in power sensitive applications such as portable electronics.

### Features

- Rail-to-Rail Input/Output Performance
- Low Supply Current of 11  $\mu$ 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

- Portable Electronics
- Window Comparator
- Voltage Detector
- Zero-Crossing Detectors
- Personal Digital Assistants



This device contains 121 active transistors.

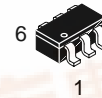


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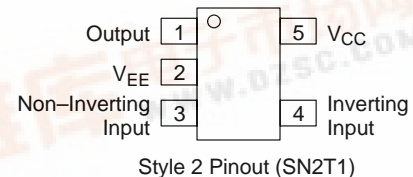
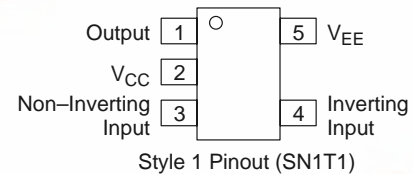


**SOT23-5**  
(TSOP-5, SC59-5)  
SN SUFFIX  
CASE 483

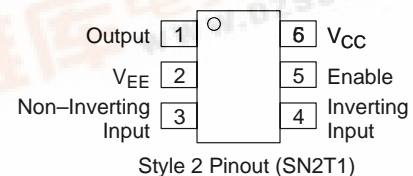
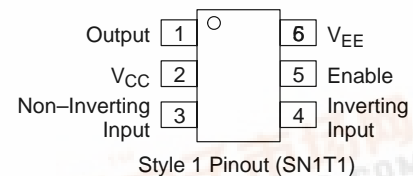


**SOT23-6**  
(TSOP-6, SC59-6)  
SN SUFFIX  
CASE 318G

### PIN CONNECTIONS



### SOT23-5



### SOT23-6

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 11 of this data sheet.

### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 11 of this data sheet.

## NCS2300 Series

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage Range ( $V_{CC}$ to $V_{EE}$ )	$V_S$	12	V
Non-inverting/Inverting Input to $V_{EE}$	–	–0.1 to ( $V_{CC} + 0.1$ )	V
Thermal Resistance, Junction to Air	$R_{\theta JA}$	248	°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	–	1000 120	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 $V_{CC} = 5.0$ V, $V_{EE} = 0$ V, $T_A = 25^\circ\text{C}$ , unless otherwise noted.) (Note 3)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Hysteresis $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$ $T_A = -40^\circ\text{C to } 105^\circ\text{C}$	$V_{HYS}$	–	$\pm 2.5$	–	mV
Input Offset Voltage $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$ $T_A = -40^\circ\text{C to } 105^\circ\text{C}$	$V_{IO}$	–	$\pm 0.5$	$\pm 5.0$	mV
Common Mode Voltage Range $V_{CC} > 2.5$ V	$V_{CM}$	$V_{EE} - 0.1$	–	$V_{CC} + 0.1$	V
Output Leakage Current	$I_{LEAK}$	–	–	1.0	$\mu\text{A}$
Common Mode Rejection	CMRR	–	80	–	dB
Input Bias Current	$I_{IB}$	–	0.001	10	nA
Power Supply Rejection	PSRR	–	80	–	dB
Supply Current $V_{IN+} > V_{IN-}$ $V_{CC} = 2.7$ V $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$ $T_A = -40^\circ\text{C to } 105^\circ\text{C}$ $V_{CC} = 5.0$ V $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$ $T_A = -40^\circ\text{C to } 105^\circ\text{C}$	$I_{CC}$	–	11	–	$\mu\text{A}$
Output Voltage High State $I_{source} = 8.0$ mA $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$ $T_A = -40^\circ\text{C to } 105^\circ\text{C}$	$V_{OH}$	–	$V_{CC} - 0.3$	–	V

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

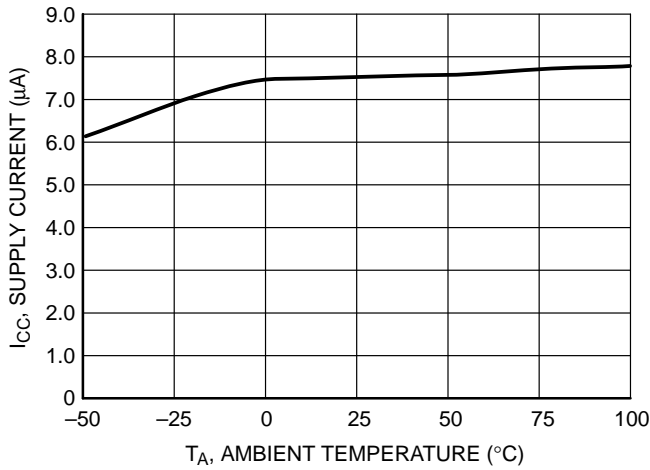
## NCS2300 Series

### ELECTRICAL CHARACTERISTICS (For all values $V_{CC} = 5.0\text{ V}$ , $V_{EE} = 0\text{ V}$ , $T_A = 25^\circ\text{C}$ , unless otherwise noted.) (Note 4)

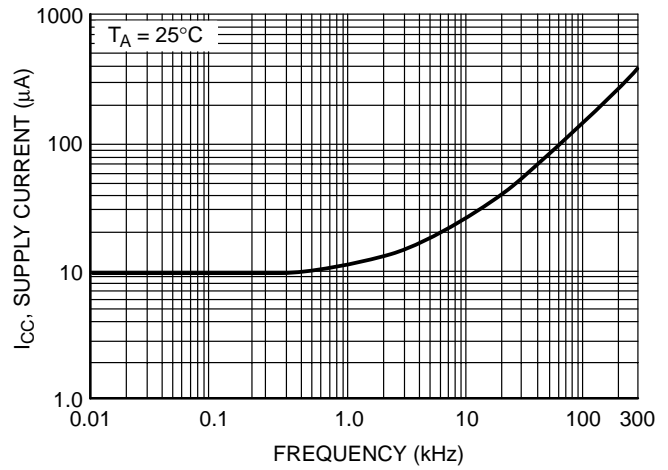
Characteristics	Symbol	Min	Typ	Max	Unit
Output Voltage Low State $I_{\text{sink}} = 8.0\text{ mA}$ $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$ $T_A = -40^\circ\text{C to } 105^\circ\text{C}$	$V_{OL}$	–	0.3	–	V
Propagation Delay 10 mV Overdrive, $C_L = 50\text{ pF}$	$t_{PHL}$ $t_{PLH}$	– –	1.4 1.2	– –	$\mu\text{s}$
Output Voltage Fall Time $C_L = 50\text{ pF}$	$t_{FALL}$	–	32	–	ns
Output Voltage Rise Time $C_L = 50\text{ pF}$	$t_{RISE}$	–	23	–	ns
Power-up Time	$t_{PU}$	–	35	100	$\mu\text{s}$
Disabled Supply Current Enable Pin = 0	$I_{CC(OFF)}$	–	1.8	–	$\mu\text{A}$
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 Pull-up Current	$I_{EN}$	–	275	–	nA
Tri-state Leakage Current	$I_{TRI-LEAK}$	–	3.0	–	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.

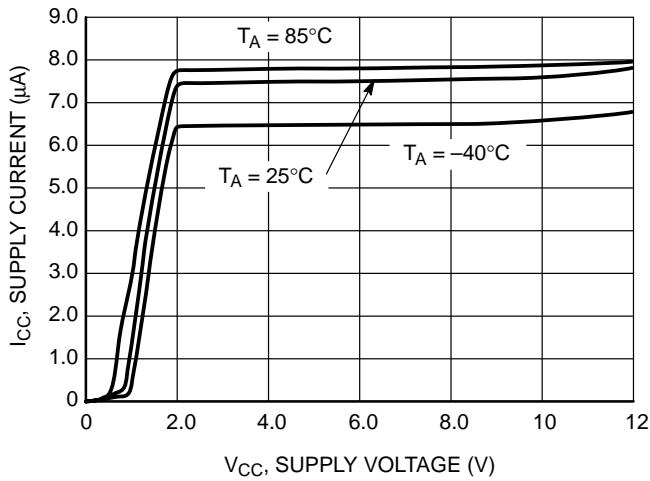
## NCS2300 Series



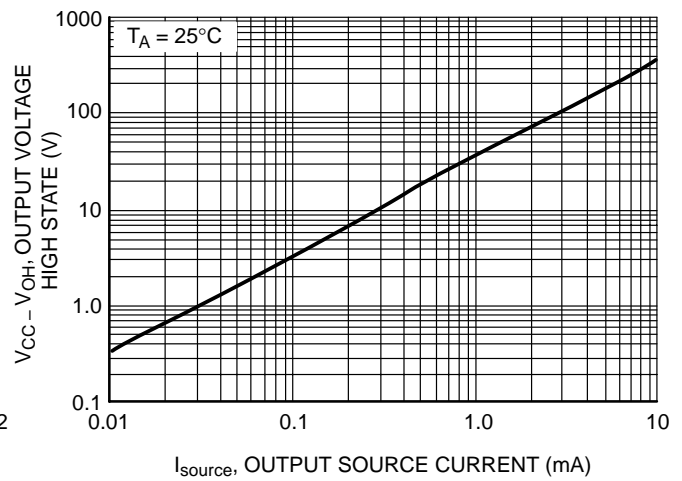
**Figure 1. NCS2300 Series Supply Current vs. Temperature**



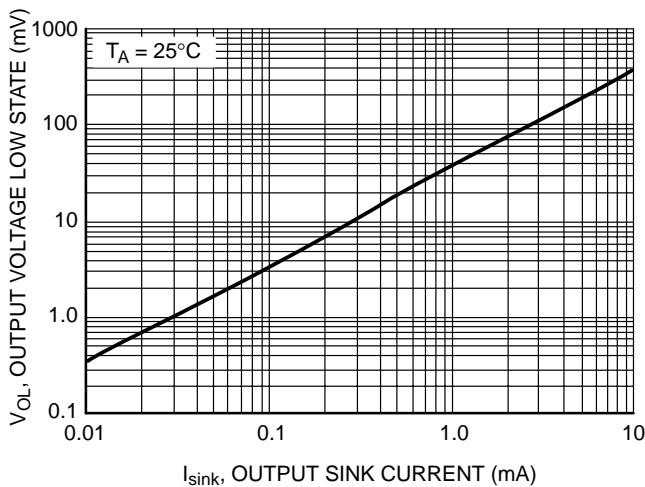
**Figure 2. NCS2300 Series Supply Current vs. Output Transition Frequency**



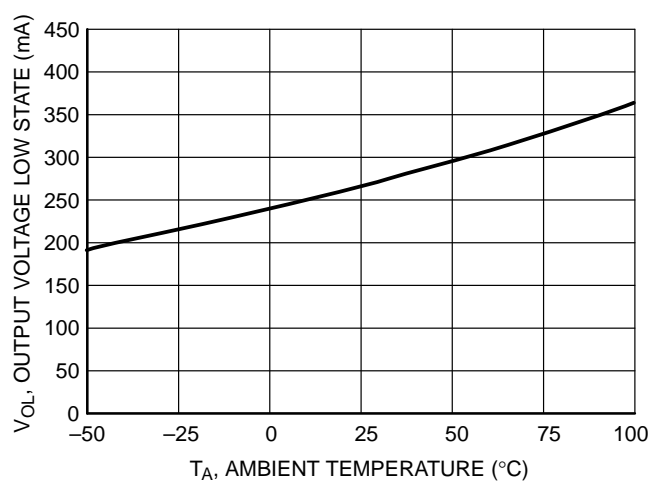
**Figure 3. NCS2300 Series Supply Current vs. Supply Voltage**



**Figure 4. NCS2300/1 Output Voltage High State vs. Output Source Current**

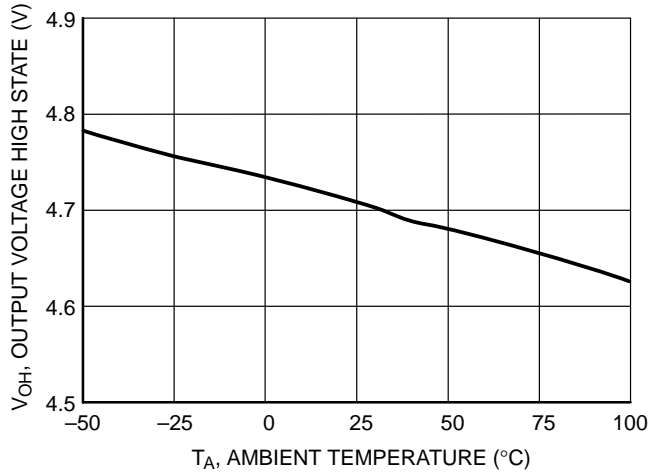


**Figure 5. NCS2300 Series Output Voltage Low State vs. Output Sink Current**

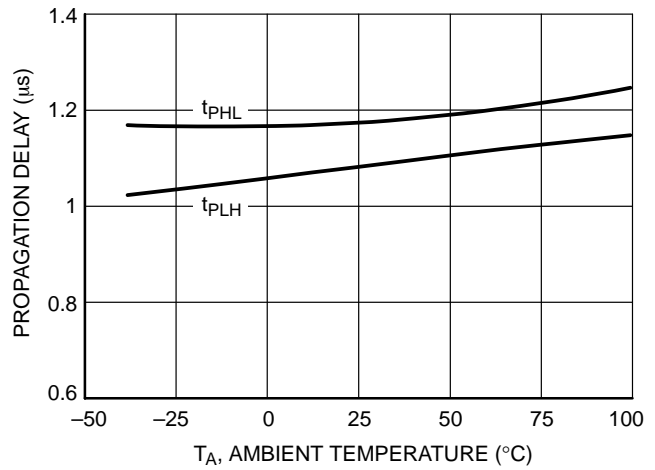


**Figure 6. NCS2300 Series Output Voltage Low State vs. Temperature**

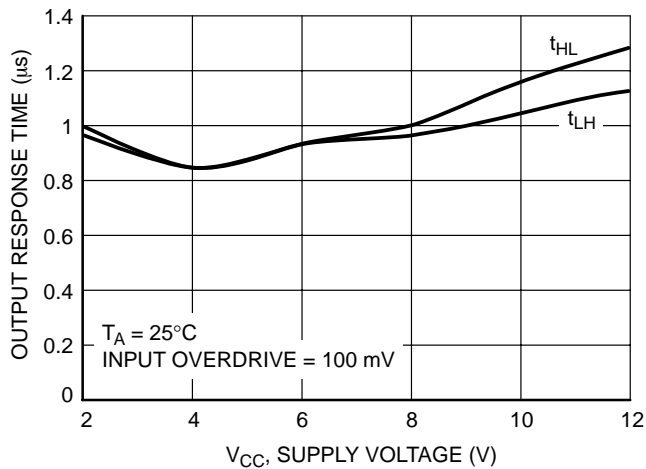
## NCS2300 Series



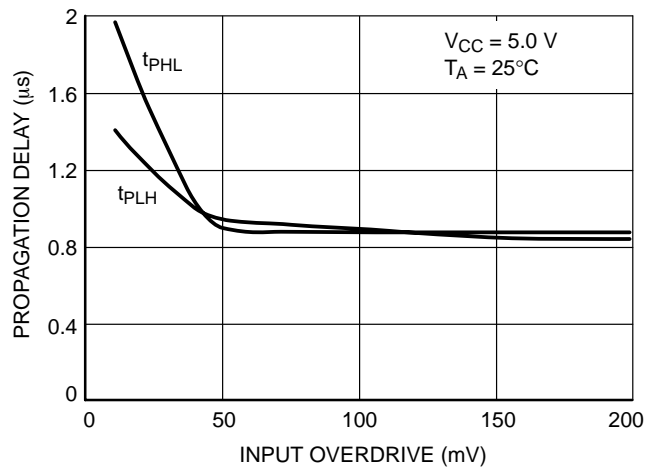
**Figure 7. NCS2300 Series Output Voltage High State vs. Temperature**



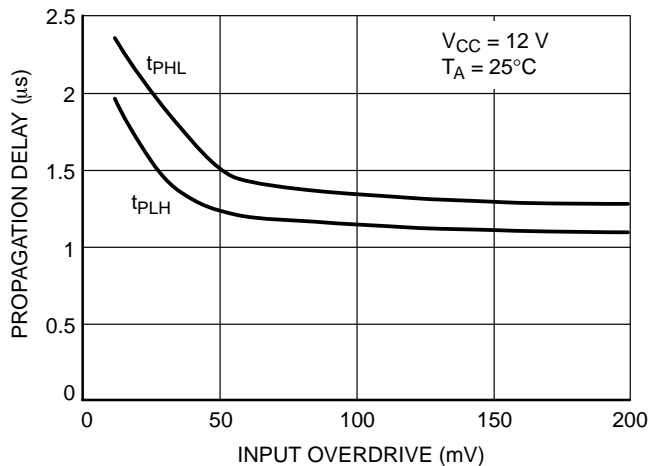
**Figure 8. NCS2300 Series Propagation Delay vs. Temperature**



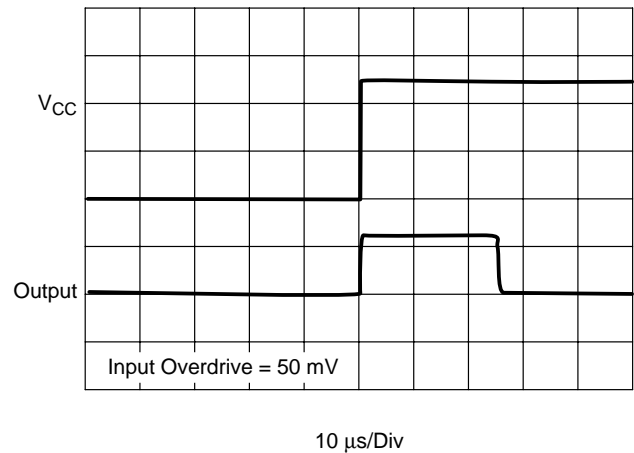
**Figure 9. NCS2300 Series Output Response Time vs. Supply Voltage**



**Figure 10. NCS2300 Series Propagation Delay vs. Input Overdrive**

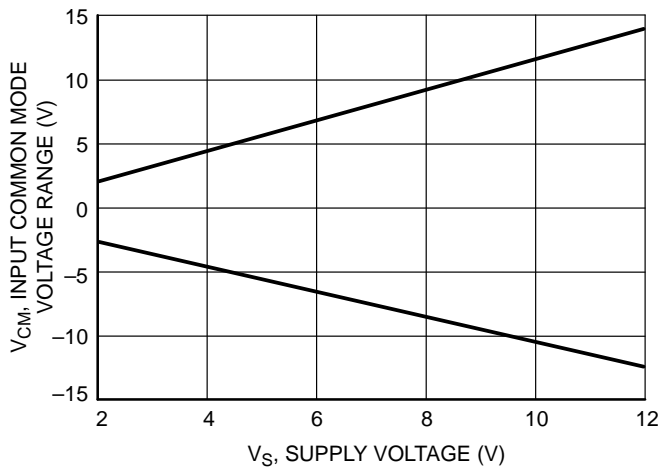


**Figure 11. NCS2300 Series Propagation Delay vs. Input Overdrive**

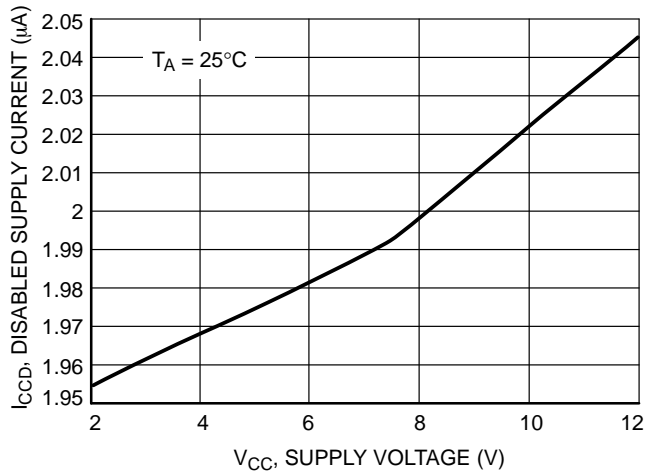


**Figure 12. NCS2300 Series Power-Up Delay**

## NCS2300 Series



**Figure 13. NCS2300 Series Input Common Mode Voltage vs. Supply Voltage**



**Figure 14. NCS2300 Series Disabled Supply Current**

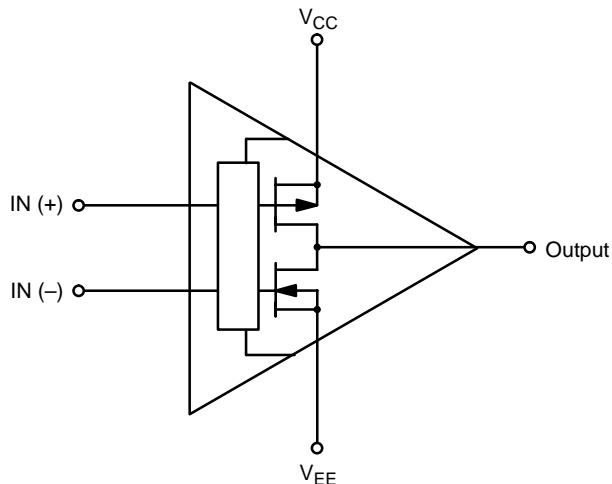
### OPERATING DESCRIPTION

The NCS2300 Series are ultra-low power comparators. These devices consume only 11 µA of supply current while achieving a typical propagation delay of 1.1 µs at 10 mV overdrive. They are guaranteed to operate at a low voltage of 1.7 V up to 12 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 µA. 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.

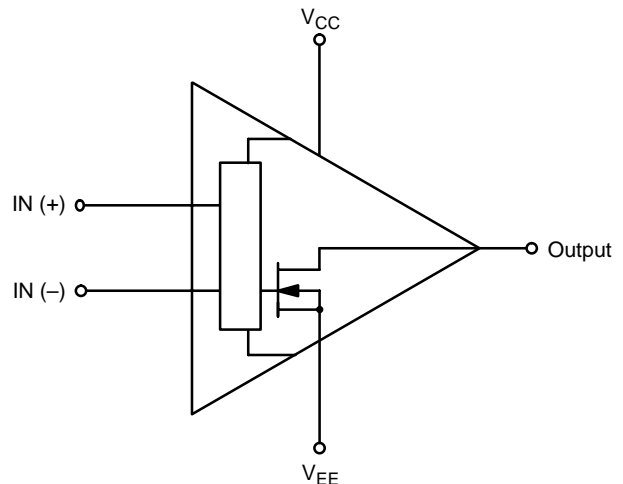
Conversely, when the enable pin is at a high level, the output will respond to change at the input pins. The enable pin should be connected to VCC when not in use. In addition, with the added feature of internal hysteresis, this allows for greater noise immunity and clean output switching.

### Output Stage

The NCS2300/1 has a complementary output which drives rail-to-rail output swing. The NCS2302/3 has an open drain N-channel output that can be pulled up to 12 V (max) with an external pull-up resistor. This allows for mixed-voltage system applications. These devices can operate up to an 8.0 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.

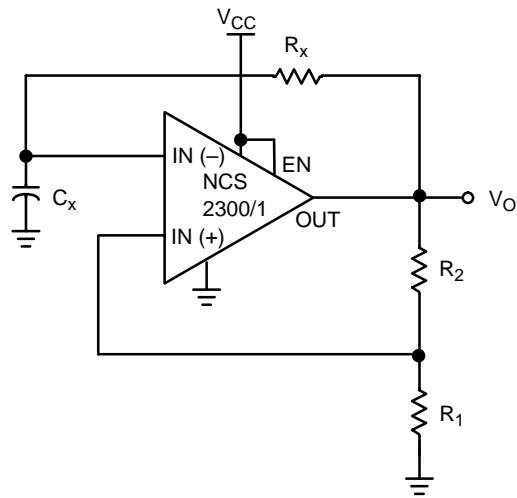


**Figure 15. NCS230xSNxT1 Complementary Output Configuration**



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

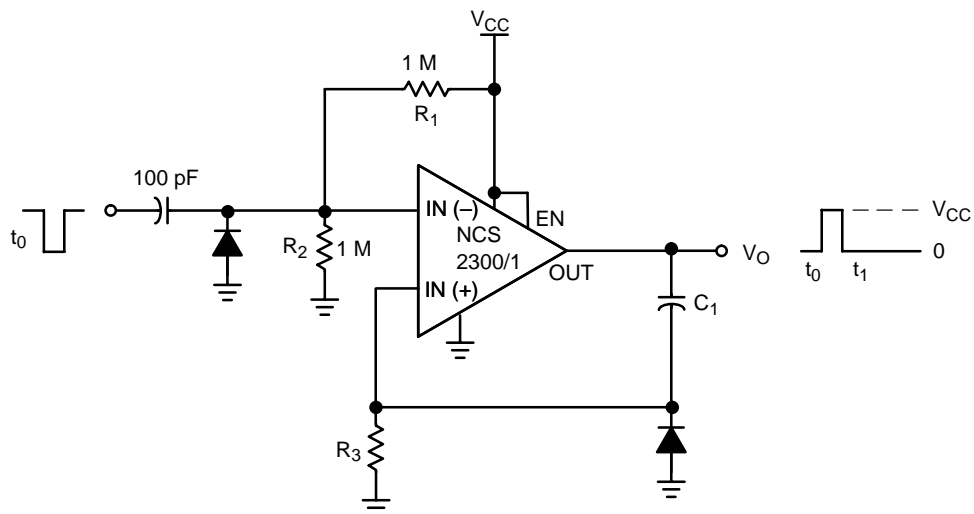
## NCS2300 Series



The oscillation frequency can be programmed as follows:

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

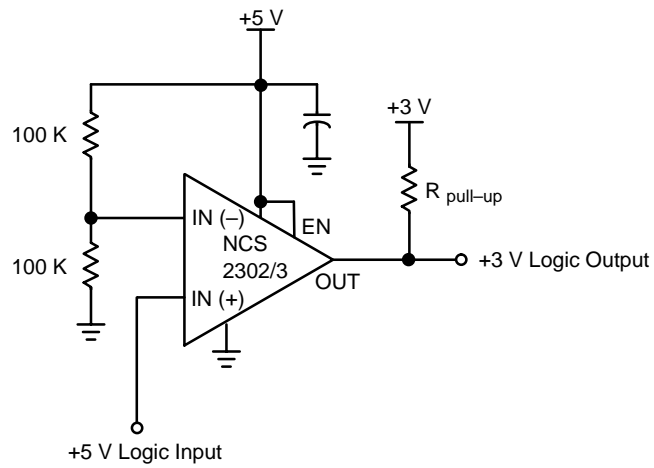
**Figure 17. Schmitt Trigger Oscillator**



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  $R_3$ .

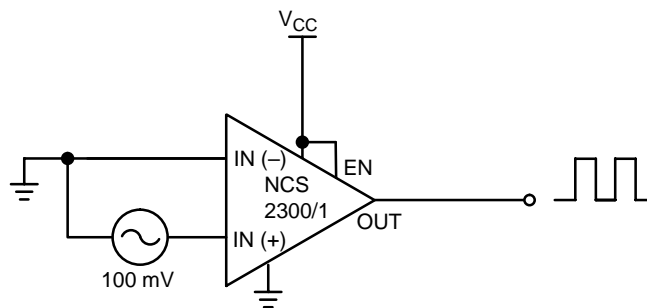
**Figure 18. One-Shot Multivibrator**

## NCS2300 Series



This circuit converts 5 V logic to 3 V logic. In 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**



## NCS2300 Series

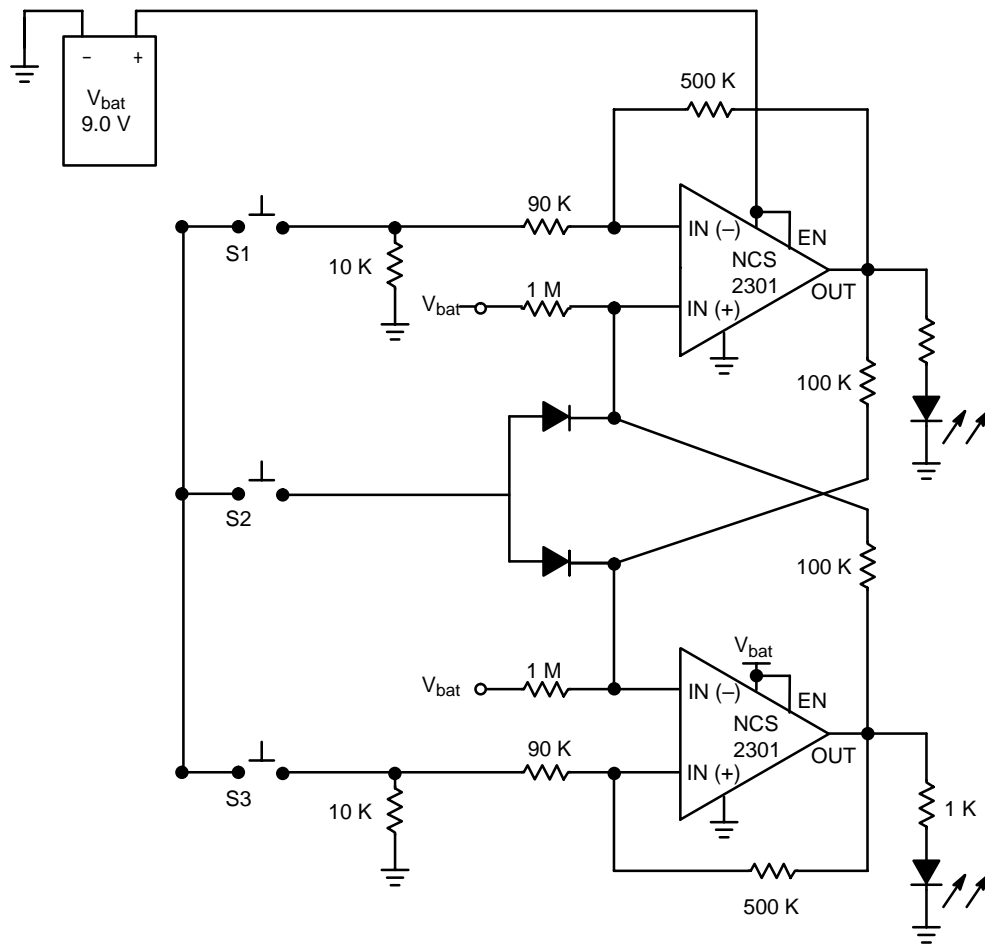


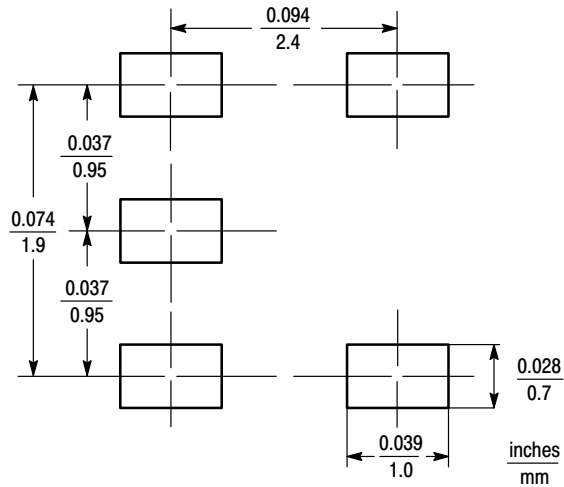
Figure 21. First-Event Detector

## NCS2300 Series

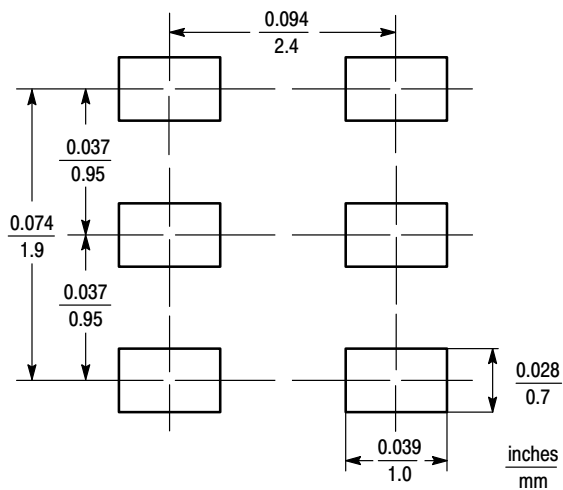
### MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection

interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



**SOT23-5**



**SOT23-6**

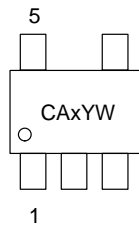
# NCS2300 Series

## ORDERING INFORMATION

Device	Pinout Style	Output Type	Package	Shipping
NCS2300SN1T1	1	Complementary	SOT23-5	3000 Tape & Reel
NCS2300SN2T1	2	Complementary	SOT23-5	
NCS2301SN1T1	1	Complementary, Enable	SOT23-6	
NCS2301SN2T1	2	Complementary, Enable	SOT23-6	
NCS2302SN1T1	1	Open Drain	SOT23-5	
NCS2302SN2T1	2	Open Drain	SOT23-5	
NCS2303SN1T1	1	Open Drain, Enable	SOT23-6	
NCS2303SN2T1	2	Open Drain, Enable	SOT23-6	

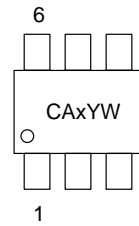
## MARKING DIAGRAMS

**SOT23-5  
SN SUFFIX  
CASE 483**



x = A for NCS2300SN1T1  
 B for NCS2300SN2T1  
 E for NCS2302SN1T1  
 F for NCS2302SN2T1  
 Y = Year  
 W = Work Week

**SOT23-6  
SN SUFFIX  
CASE 318G**

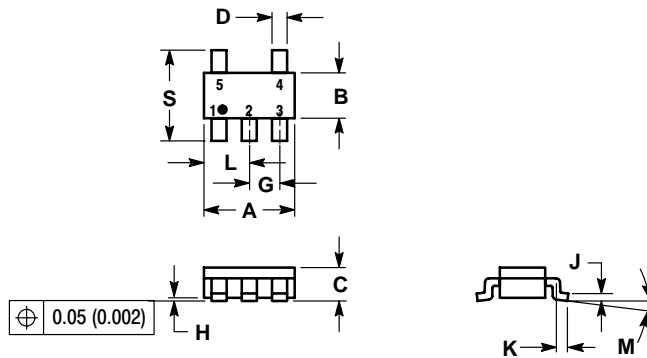


x = C for NCS2301SN1T1  
 D for NCS2301SN2T1  
 G for NCS2303SN1T1  
 H for NCS2303SN2T1  
 Y = Year  
 W = Work Week

# NCS2300 Series

## PACKAGE DIMENSIONS

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



### NOTES:

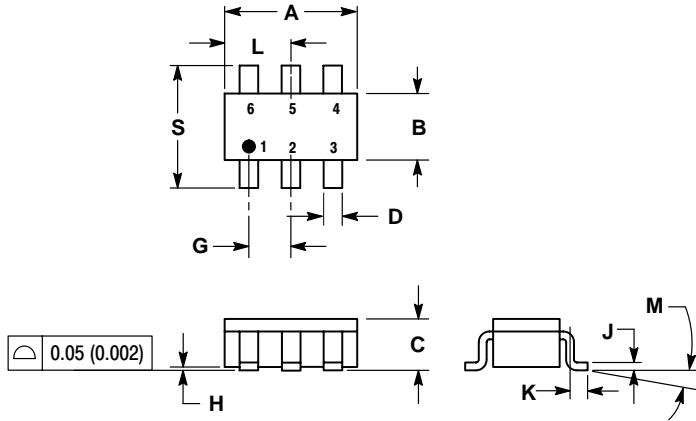
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

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

# NCS2300 Series

## PACKAGE DIMENSIONS

**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
E	0.85	1.05	0.0335	0.0413
F	0.013	0.100	0.0005	0.0040
G	0.10	0.26	0.0040	0.0102
H	0.20	0.60	0.0079	0.0236
I	1.25	1.55	0.0493	0.0610
J	0°	10°	0°	10°
K	2.50	3.00	0.0985	0.1181

**Notes**

**Notes**

## NCS2300 Series

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