

## 1.8 V, NANOPOWER, PUSH/PULL OUTPUT COMPARATORS

### FEATURES

- **Very Low Supply Current: 0.8  $\mu$ A (Typical)**
- **Input Common Mode Range 200 mV Beyond Supply Rails**
- **Supply Voltage: 1.8 V to 5.5 V**
- **High Speed: 6  $\mu$ s**
- **Push/Pull CMOS Output Stage**
- **Controlled Baseline**
  - **One Assembly/Test Site, One Fabrication Site**
- **Extended Temperature Performance of  $-55^{\circ}$ C to  $125^{\circ}$ C**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product Change Notification**
- **Qualification Pedigree**

Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

### APPLICATIONS

- **Portable Medical Equipment**
- **Wireless Security Systems**
- **Remote Control Systems**
- **Handheld Instruments**
- **Ultra-Low Power Systems**

### DESCRIPTION/ORDERING INFORMATION

The TLV349x family of push/pull output comparators features a fast 6 $\mu$ s response time and <1.2  $\mu$ A (max) nanopower capability, allowing operation from 1.8 V to 5.5 V. Input common-mode range beyond supply rails make the TLV349x an ideal choice for low-voltage applications.

The TLV349x is excellent for power-sensitive, low-voltage (2-cell) applications.

#### TLV349x RELATED PRODUCTS

PRODUCT	FEATURES
TLV370x	550 nA, 2.5 V to 16 V, Push-Pull CMOS Output Stage Comparator
TLV340x	550 nA, 2.5 V to 16 V, Open-Drain Output Stage Comparator

### ORDERING INFORMATION<sup>(1)</sup>

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR <sup>(2)</sup>	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERABLE PART NUMBER	TRANSPORT MEDIA, QUANTITY
TLV3491	SO-8	D	$-55^{\circ}$ C to $125^{\circ}$ C	3491EP	TLV3491AMDREP <sup>(3)</sup>	Tape and Reel, 2500
TLV3492	SO-8	D	$-55^{\circ}$ C to $125^{\circ}$ C	3492EP	TLV3492AMDREP	Tape and Reel, 2500
TLV3494	SO-14	D	$-55^{\circ}$ C to $125^{\circ}$ C	3494EP	TLV3494AMDREP <sup>(3)</sup>	Tape and Reel, 2500

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).
- (2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).
- (3) Product Preview. Contact your Texas Instruments Sales Representative for availability.



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

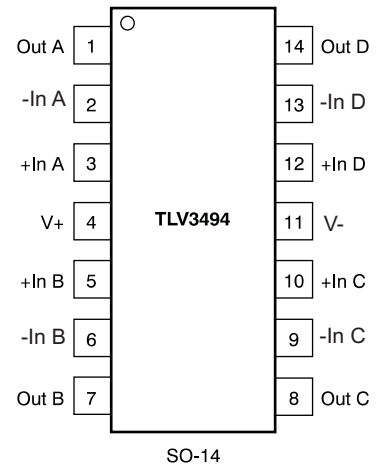
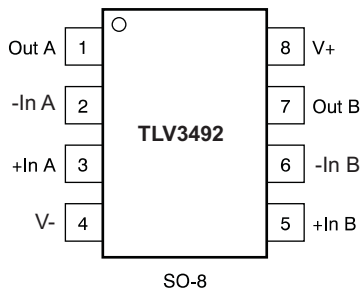
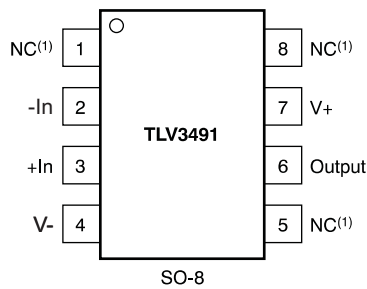
**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

		VALUE	UNIT
Supply Voltage		5.5	V
Signal Input Terminals	Voltage <sup>(2)</sup>	(V-) – 0.5 to (V+) + 0.5	V
	Current <sup>(2)</sup>	±10	mA
Output Short-Circuit <sup>(3)</sup>		Continuous	
Operating Temperature		–55 to 125	°C
Storage Temperature		–65 to 150	°C
Junction Temperature		150	°C
Lead Temperature (soldering, 10s)		300	°C
ESD Rating (Human Body Model)		3000	V

- (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
- (2) Input terminals are diode clamped to the power-supply rails. Input signals that can swing more than 0.5 V beyond the supply rails should be current limited to 10 mA or less.
- (3) Short-circuit to ground, one amplifier per package.

**PIN CONFIGURATIONS**

Top View



**ELECTRICAL CHARACTERISTICS**

 At  $T_A = 25^\circ\text{C}$ , and  $V_S = 1.8\text{ V to }5.5\text{ V}$ , unless otherwise noted.

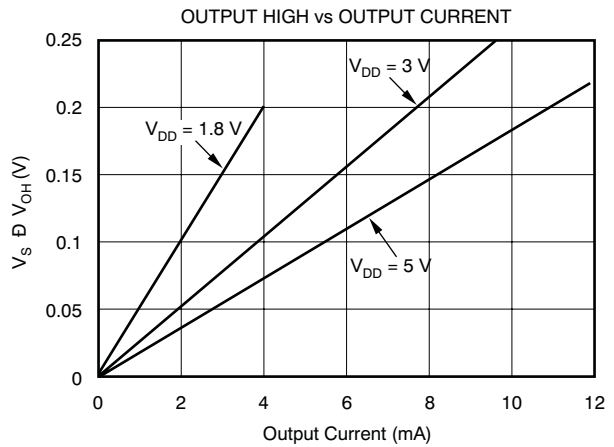
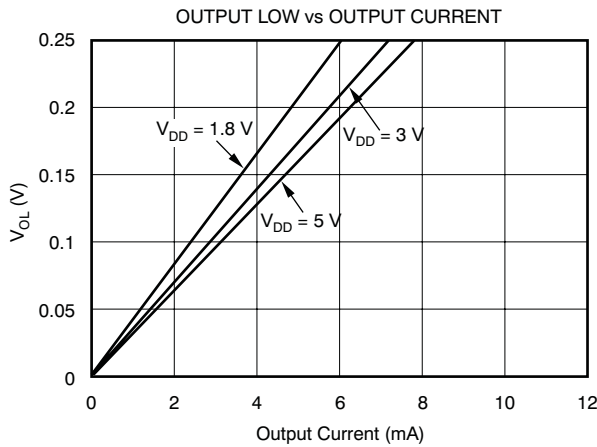
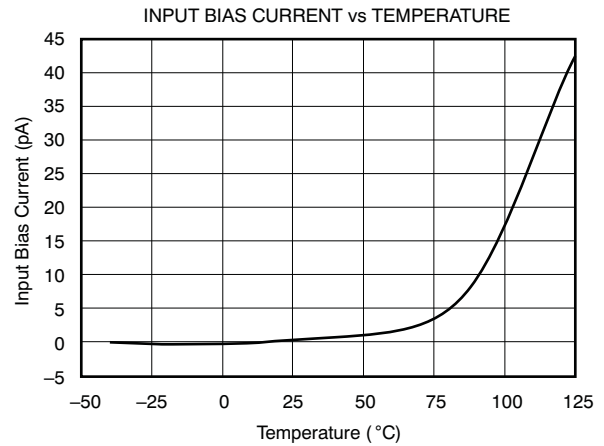
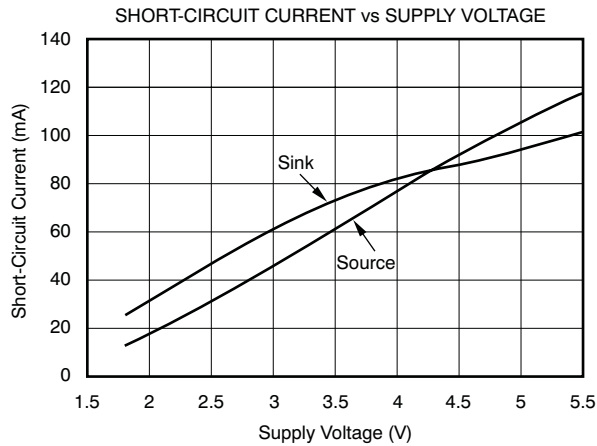
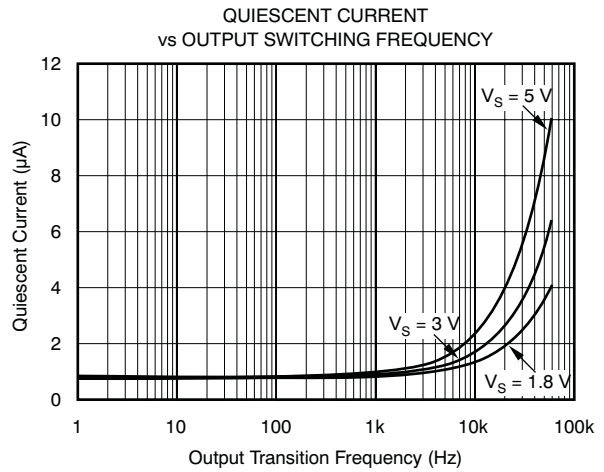
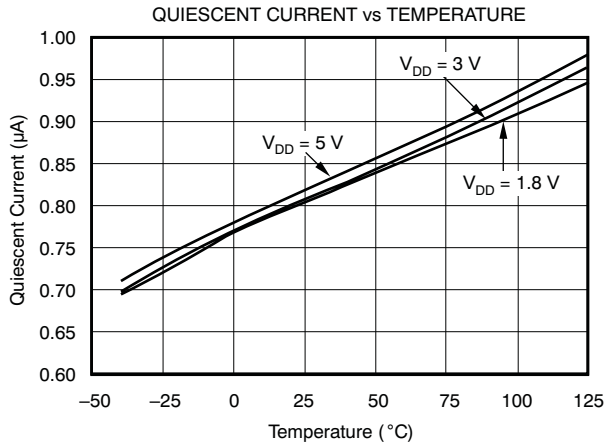
PARAMETER		TEST CONDITIONS	$T_A$ <sup>(1)</sup>	MIN	TYP	MAX	UNIT
<b>OFFSET VOLTAGE</b>							
Input Offset Voltage	$V_{OS}$	$V_{CM} = 0\text{ V}, I_O = 0\text{ mA}$	25°C		±3	±15	mV
			Full Range			±25	
vs Temperature	$dV_{OS}/dT$	$T_A = -55^\circ\text{C to }125^\circ\text{C}$			±12		$\mu\text{V}/^\circ\text{C}$
vs Power Supply	PSRR	$V_S = 1.8\text{ V to }5.5\text{ V}$	25°C		350	1000	$\mu\text{V/V}$
			Full Range			1600	
<b>INPUT BIAS CURRENT</b>							
Input Bias Current	$I_B$	$V_{CM} = V_{CC}/2$	25°C		±1	±50	pA
			Full Range			±1600	
Input Offset Current	$I_{OS}$	$V_{CM} = V_{CC}/2$	25°C		±1	±50	pA
			Full Range			±200	
<b>INPUT VOLTAGE RANGE</b>							
Common-Mode Voltage Range	$V_{CM}$			$(V_-) - 0.2$		$(V_+) + 0.2$	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -0.2\text{ V to } (V_+) - 1.5\text{ V}$	25°C	60	74		dB
			Full Range	55			
		$V_{CM} = -0.2\text{ V to } (V_+) + 0.2\text{ V}$	25°C	54	62		
			Full Range	50			
<b>INPUT CAPACITANCE</b>							
Common-Mode					2		pF
Differential					4		pF
<b>SWITCHING CHARACTERISTICS</b>							
Propagation Delay Time, Low-to-High	$t_{(PLH)}$	$f = 10\text{ kHz}, V_{STEP} = 1\text{ V}$	Input Overdrive = 10 mV		12		$\mu\text{s}$
			Input Overdrive = 100 mV		6		$\mu\text{s}$
Propagation Delay Time, High-to-Low	$t_{(PHL)}$	$f = 10\text{ kHz}, V_{STEP} = 1\text{ V}$	Input Overdrive = 10 mV		13.5		$\mu\text{s}$
			Input Overdrive = 100 mV		6.5		$\mu\text{s}$
Rise Time	$t_R$	$C_L = 10\text{ pF}$			100		ns
Fall Time	$t_F$	$C_L = 10\text{ pF}$			100		ns
<b>OUTPUT</b>							
Voltage Output High from Rail	$V_{OH}$	$V_S = 5\text{ V}, I_{OUT} = -5\text{ mA}$	Full Range		90	300	mV
Voltage Output Low from Rail	$V_{OL}$	$V_S = 5\text{ V}, I_{OUT} = 5\text{ mA}$	Full Range		160	300	mV
Short-Circuit Current	$I_{SC}$			See Typical Characteristics			
<b>POWER SUPPLY</b>							
Specified Voltage Range	$V_S$			1.8		5.5	V
Quiescent Current <sup>(2)</sup>	$I_Q$	$V_S = 5.5\text{ V}, V_O = \text{High}$	25°C		0.85	1.2	$\mu\text{A}$
			Full Range			2.1	
<b>TEMPERATURE RANGE</b>							
Specified Range	$T_A$			-55		125	$^\circ\text{C}$
Storage Range				-65		150	$^\circ\text{C}$
Thermal Resistance, $\theta_{JA}$							
	SO-8					165	$^\circ\text{C/W}$
	SO-14					133	$^\circ\text{C/W}$

 (1) Full Range is  $-55^\circ\text{C to }125^\circ\text{C}$ .

 (2)  $I_Q$  per channel.

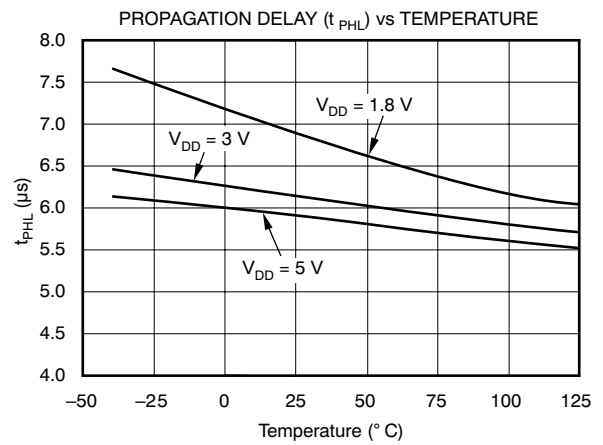
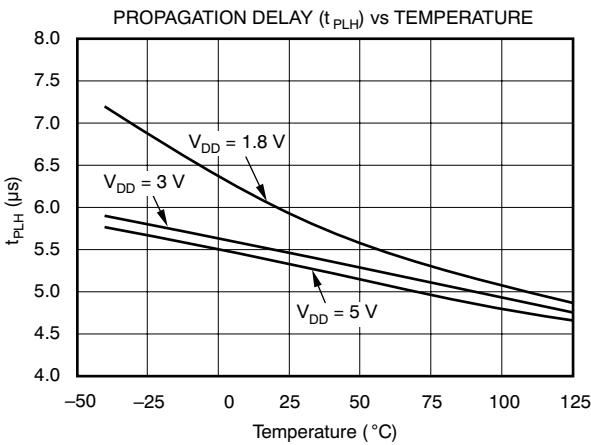
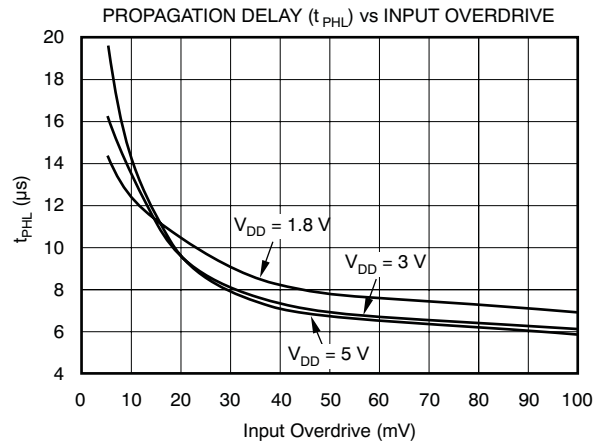
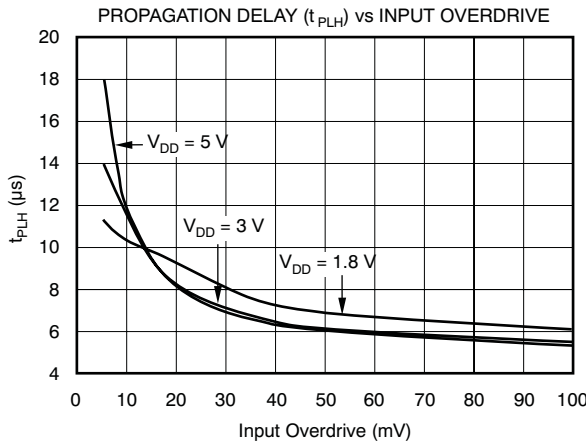
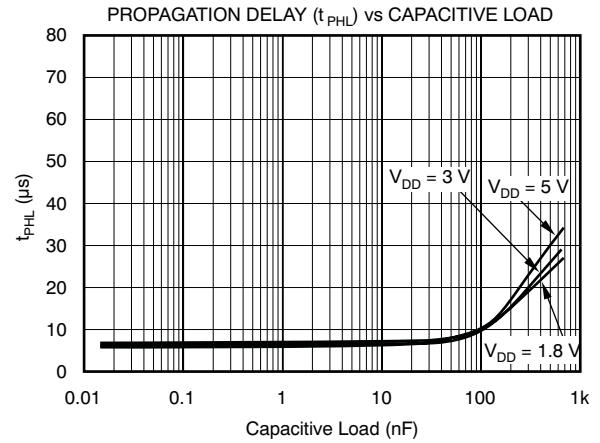
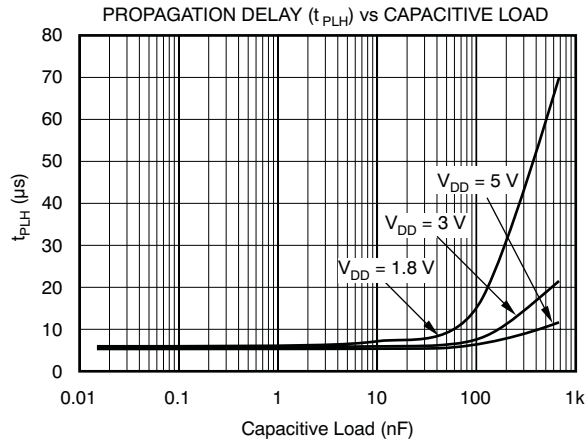
**TYPICAL CHARACTERISTICS**

At  $T_A = 25^\circ\text{C}$ ,  $V_S = 1.8\text{ V}$  to  $5.5\text{ V}$ , and Input Overdrive =  $100\text{ mV}$ , unless otherwise noted.



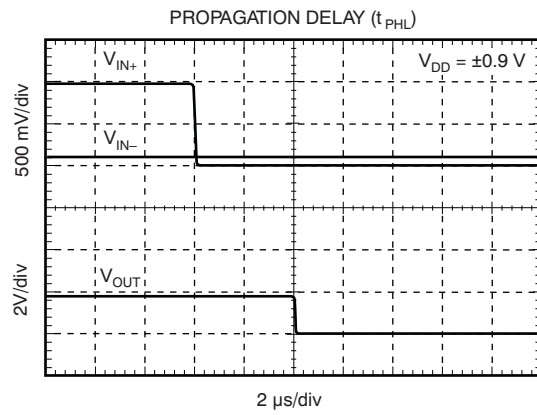
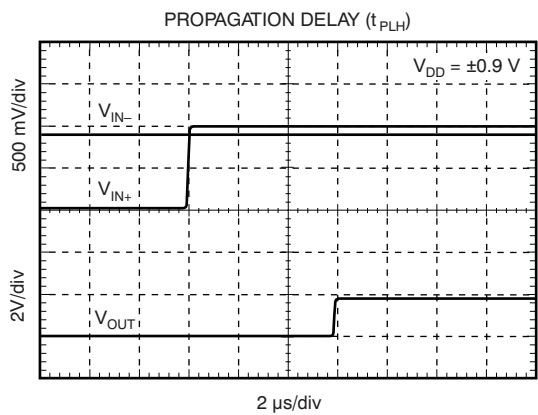
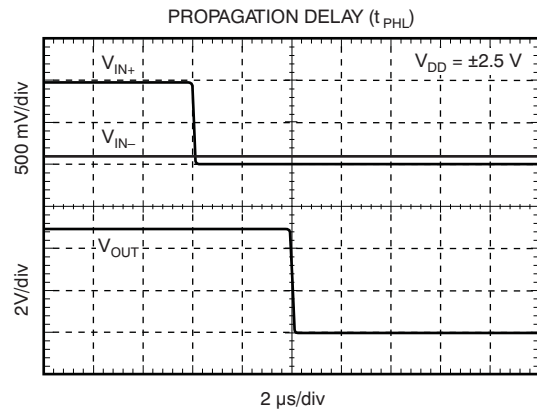
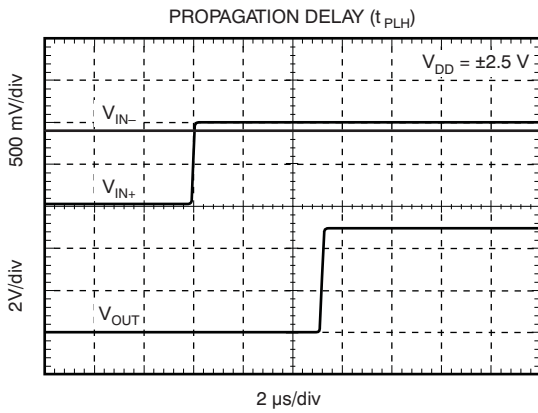
**TYPICAL CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $V_S = 1.8\text{ V}$  to  $5.5\text{ V}$ , and Input Overdrive =  $100\text{ mV}$ , unless otherwise noted.



**TYPICAL CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $V_S = 1.8\text{ V}$  to  $5.5\text{ V}$ , and Input Overdrive =  $100\text{ mV}$ , unless otherwise noted.



## APPLICATION INFORMATION

The TLV349x family of comparators features rail-to-rail input and output on supply voltages as low as 1.8 V. The push/pull output stage is optimal for reduced power budget applications and features no shoot-through current. Low supply voltages, common-mode input range beyond supply rails, and a typical supply current of 0.8  $\mu\text{A}$  make the TLV349x family an excellent candidate for battery-powered applications with single-cell operation.

### BOARD LAYOUT

Figure 1 shows the typical connections for the TLV349x. To minimize supply noise, power supplies should be capacitively decoupled by a 0.01  $\mu\text{F}$  ceramic capacitor in parallel with a 10  $\mu\text{F}$  electrolytic capacitor. Comparators are very sensitive to input noise. Proper grounding (use of ground plane) will help maintain specified performance of the TLV349x family.

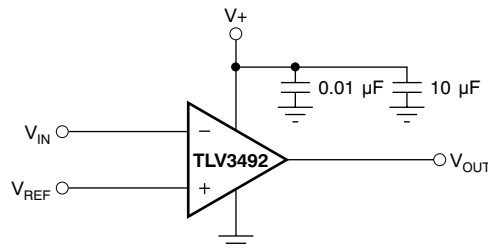


Figure 1. Basic Connections of the TLV3492

### SETTING REFERENCE VOLTAGE

It is important to use a stable reference when setting the transition point for the TLV349x. The REF1004 provides a 1.25-V reference voltage with low drift and only 8  $\mu\text{A}$  of quiescent current.

### EXTERNAL HYSTERESIS

Comparator inputs have no noise immunity within the range of specified offset voltage ( $\pm 15$  mV). For noisy input signals, the comparator output may display multiple switching as input signals move through the switching threshold. The typical comparator threshold of the TLV349x is  $\pm 15$  mV. To prevent multiple switching within the comparator threshold of the TLV349x, external hysteresis may be added by connecting a small amount of feedback to the positive input. Figure 2 shows a typical topology used to introduce hysteresis, described by the equation:

$$V_{\text{HYST}} = \frac{V^+ \times R_1}{R_1 + R_2}$$

$V_{\text{HYST}}$  will set the value of the transition voltage required to switch the comparator output by increasing the threshold region, thereby reducing sensitivity to noise.

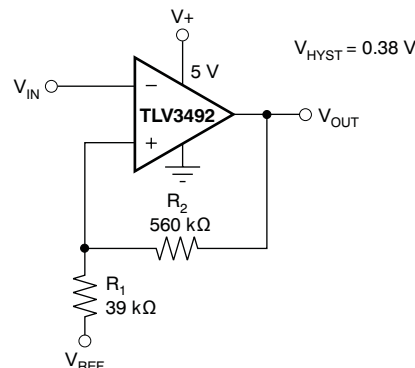


Figure 2. Adding Hysteresis to the TLV3492

### RELAXATION OSCILLATOR

The TLV3492 can be configured as a relaxation oscillator to provide a simple and inexpensive clock output (see Figure 3). The capacitor is charged at a rate of  $0.69 RC$ . It also discharges at a rate of  $0.69 RC$ . Therefore, the period is  $1.38 RC$ .  $R_1$  may be a different value than  $R_2$ .

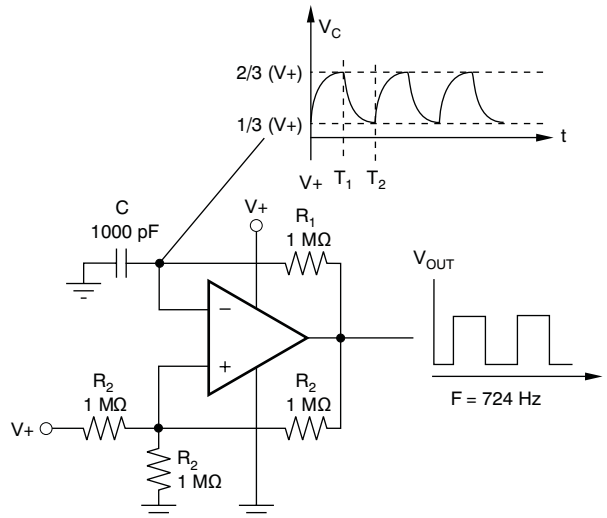


Figure 3. TLV3492 Configured as a Relaxation Oscillator

### POWER-ON RESET

The reset circuit shown in Figure 4 provides a time delayed release of reset to the MSP430 microcontroller. Operation of the circuit is based on a stabilization time constant of the supply voltage, rather than on a predetermined voltage value. The negative input is a reference voltage created by a simple resistor divider. These resistor values should be relatively high to reduce the current consumption of the circuit. The positive input is an RC circuit that provides a power-up delay. When power is applied, the output of the comparator is low, holding the processor in the reset condition. Only after allowing time for the supply voltage to stabilize does the positive input of the comparator become higher than the negative input, resulting in a high output state and releasing the processor for operation. The stabilization time required for the supply voltage is adjustable by the selection of the RC component values. Use of a lower-valued resistor in this portion of the circuit will not increase current consumption because no current flows through the RC circuit after the supply has stabilized. The reset delay time needed depends on the power-up characteristics of the system power supply.  $R_1$  and  $C_1$  are selected to allow enough time for the power supply to stabilize. D1 provides rapid reset if power is lost. In this example, the  $R_1 \cdot C_1$  time constant is 10 ms.

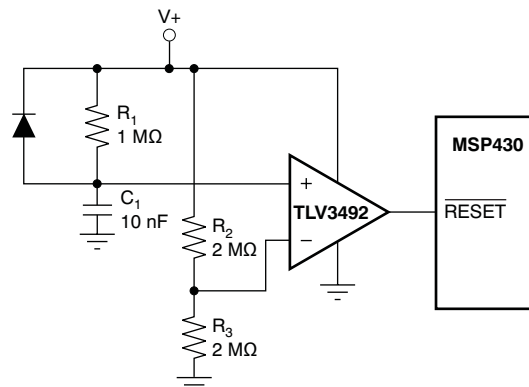


Figure 4. The TLV349x Configured as a Reset Circuit for the MSP430.



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TLV3492AMDREP	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	3492EP	<a href="#">Samples</a>
V62/07635-02XE	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	3492EP	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLV3492AMDREP	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV3492AMDREP	SOIC	D	8	2500	340.5	336.1	25.0



D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

# EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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