

# LMV7219

## 7 nsec, 2.7V to 5V Comparator with Rail-to-Rail Output

### General Description

The LMV7219 is a low-power, high-speed comparator with internal hysteresis. The LMV7219 operating voltage ranges from 2.7V to 5V with push/pull rail-to-rail output. This device achieves a 7ns propagation delay while consuming only 1.1mA of supply current at 5V.

The LMV7219 inputs have a common mode voltage range that extends 200mV below ground, allowing ground sensing. The internal hysteresis ensures clean output transitions even with slow-moving inputs signals.

The LMV7219 is available in the SC70-5 and SOT23-5 packages, which are ideal for systems where small size and low power are critical.

### Features

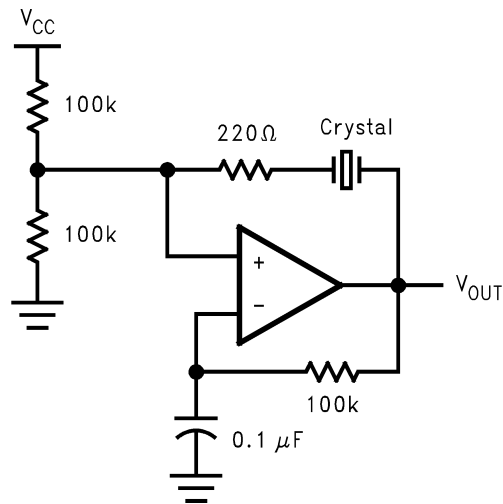
( $V_S = 5V$ ,  $T_A = 25^\circ C$ , Typical values unless specified)

- Propagation delay 7ns
- Low supply current 1.1mA
- Input common mode voltage range extends 200mV below ground
- Ideal for 2.7V and 5V single supply applications
- Internal hysteresis ensures clean switching
- Fast rise and fall time 1.3ns
- Available in space-saving packages: 5-pin SC70-5 and SOT23-5

### Applications

- Portable and battery-powered systems
- Scanners
- Set top boxes
- High speed differential line receiver
- Window comparators
- Zero-crossing detectors
- High-speed sampling circuits

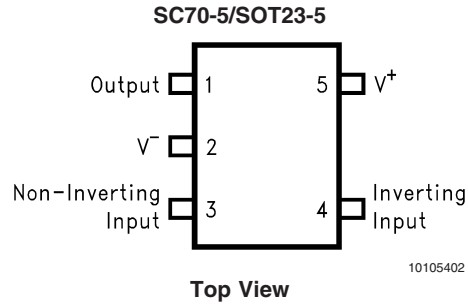
### Typical Application



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LMV7219 7 nsec, 2.7V to 5V Comparator with Rail-to-Rail Output

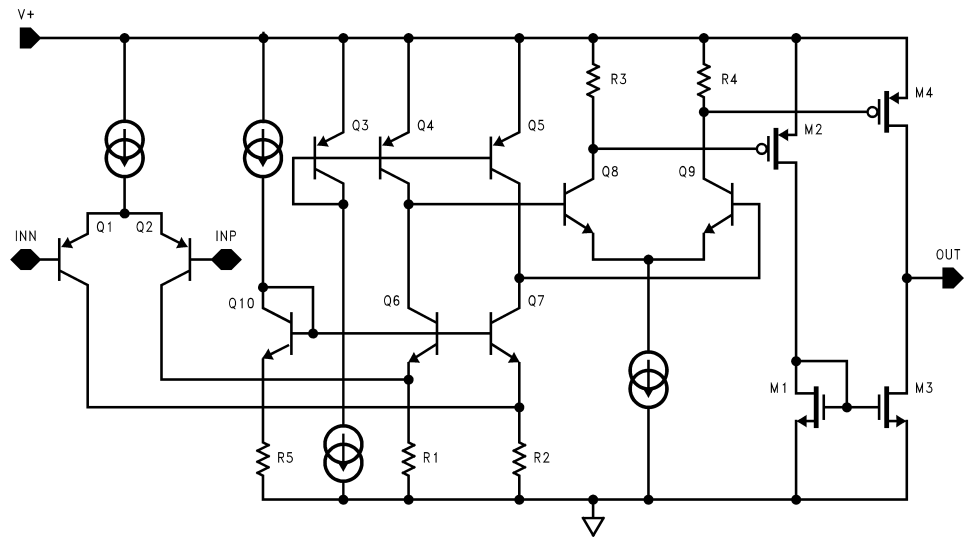
## Connection Diagram



## Ordering Information

Package	Part Number	Marking	Supplied as	NSC Drawing
5-pin SC70-5	LMV7219M7	C15	1k Units Tape and Reel	MAA05A
	LMV7219M7X	C15	3k Units Tape and Reel	
5-pin SOT23-5	LMV7219M5	C14A	1k Units Tape and Reel	MF05A
	LMV7219M5X	C14A	3k Units Tape and Reel	

## Simplified Schematic



**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

ESD Tolerance (Note 2)	
Machine Body	150V
Human Model Body	2000V
Differential Input Voltage	± Supply Voltage
Output Short Circuit Duration	(Note 3)
Supply Voltage ( $V^+ - V^-$ )	5.5V
Soldering Information	
Infrared or Convection (20 sec)	235°C
Wave Soldering (10 sec)	260°C (lead temp)

Voltage at Input/Output pins	( $V^+$ ) + 0.4V ( $V^-$ ) - 0.4V
Current at Input Pin (Note 9)	±10mA

**Operating Ratings**

Supply voltages ( $V^+ - V^-$ )	2.7V to 5V
Operating Temperature Range (Note 4)	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Package Thermal Resistance	
SC70-5	478°C/W
SOT23-5	265°C/W

**2.7V Electrical Characteristics**

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V_{CM} = V^+/2$ ,  $V^+ = 2.7\text{V}$ ,  $V^- = 0\text{V}$ ,  $C_L = 10\text{ pF}$  and  $R_L > 1\text{ M}\Omega$  to  $V^-$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	Limit (Note 6)	Units
$V_{OS}$	Input Offset Voltage		1	6 <b>8</b>	mV max
$I_B$	Input Bias Current		450	950 <b>2000</b>	nA max
$I_{OS}$	Input Offset Current		50	200 <b>400</b>	nA max
CMRR	Common Mode Rejection Ratio	$0\text{V} < V_{CM} < 1.50\text{V}$	85	62 <b>55</b>	dB min
PSRR	Power Supply Rejection Ratio	$V^+ = 2.7\text{V to } 5\text{V}$	85	65 <b>55</b>	dB min
$V_{CM}$	Input Common-Voltage Range	CMRR > 50 dB	$V_{CC} - 1$	$V_{CC} - 1.2$ <b><math>V_{CC} - 1.3</math></b>	V min
			-0.2	-0.1 <b>0</b>	V max
$V_O$	Output Swing High	$I_L = 4\text{ mA}$ , $V_{ID} = 500\text{ mV}$	$V_{CC} - 0.22$	$V_{CC} - 0.3$ <b><math>V_{CC} - 0.4</math></b>	V min
		$I_L = 0.4\text{ mA}$ , $V_{ID} = 500\text{ mV}$	$V_{CC} - 0.02$	$V_{CC} - 0.05$ <b><math>V_{CC} - 0.15</math></b>	V min
	Output Swing Low	$I_L = -4\text{ mA}$ , $V_{ID} = -500\text{ mV}$	130	200 <b>300</b>	mV max
		$I_L = -0.4\text{ mA}$ , $V_{ID} = -500\text{ mV}$	15	50 <b>150</b>	mV max
$I_{SC}$	Output Short Circuit Current	Sourcing, $V_O = 0\text{V}$ (Note 3)	20		mA
		Sinking, $V_O = 2.7\text{V}$ (Note 3)	20		
$I_S$	Supply Current	No Load	0.9	1.6 <b>2.2</b>	mA max
$V_{HYST}$	Input Hysteresis Voltage	(Note 10)	7		mV
$V_{TRIP^+}$	Input Referred Positive Trip Point	(see Figure 1)	3	8	mV max
$V_{TRIP^-}$	Input Referred Negative Trip Point	(see Figure 1)	-4	-8	mV min

## 2.7V Electrical Characteristics (Continued)

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V_{CM} = V^+/2$ ,  $V^+ = 2.7\text{V}$ ,  $V^- = 0\text{V}$ ,  $C_L = 10\text{ pF}$  and  $R_L > 1\text{ M}\Omega$  to  $V^-$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	Limit (Note 6)	Units
$t_{PD}$	Propagation Delay	Overdrive = 5 mV $V_{CM} = 0\text{V}$ (Note 7)	12		ns max
		Overdrive = 15 mV $V_{CM} = 0\text{V}$ (Note 7)	11		
		Overdrive = 50 mV $V_{CM} = 0\text{V}$ (Note 7)	10	20	
$t_{SKEW}$	Propagation Delay Skew	(Note 8)	1		ns
$t_r$	Output Rise Time	10% to 90%	2.5		ns
$t_f$	Output Fall Time	90% to 10%	2		ns

## 5V Electrical Characteristics

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V_{CM} = V^+/2$ ,  $V^+ = 5\text{V}$ ,  $V^- = 0\text{V}$ ,  $C_L = 10\text{ pF}$  and  $R_L > 1\text{ M}\Omega$  to  $V^-$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	Limit (Note 6)	Units
$V_{OS}$	Input Offset Voltage		1	6 <b>8</b>	mV max
$I_B$	Input Bias Current		500	950 <b>2000</b>	nA max
$I_{OS}$	Input Offset Current		50	200 <b>400</b>	nA max
CMRR	Common Mode Rejection Ratio	$0\text{V} < V_{CM} < 3.8\text{V}$	85	65 <b>55</b>	dB min
PSRR	Power Supply Rejection Ratio	$V^+ = 2.7\text{V}$ to $5\text{V}$	85	65 <b>55</b>	dB min
$V_{CM}$	Input Common-Mode Voltage Range	CMRR > 50 dB	$V_{CC} - 1$	$V_{CC} - 1.2$ $V_{CC} - 1.3$	V min
			-0.2	-0.1 0	V max
$V_O$	Output Swing High	$I_L = 4\text{ mA}$ , $V_{ID} = 500\text{ mV}$	$V_{CC} - 0.13$	$V_{CC} - 0.2$ $V_{CC} - 0.3$	V min
		$I_L = 0.4\text{ mA}$ , $V_{ID} = 500\text{ mV}$	$V_{CC} - 0.02$	$V_{CC} - 0.05$ $V_{CC} - 0.15$	V min
	Output Swing Low	$I_L = -4\text{ mA}$ , $V_{ID} = -500\text{ mV}$	80	180 <b>280</b>	mV max
		$I_L = -0.4\text{ mA}$ , $V_{ID} = -500\text{ mV}$	10	50 <b>150</b>	mV max
$I_{SC}$	Output Short Circuit Current	Sourcing, $V_O = 0\text{V}$ (Note 3)	68	30 <b>20</b>	mA min
		Sinking, $V_O = 5\text{V}$ (Note 3)	65	30 <b>20</b>	
$I_S$	Supply Current	No Load	1.1	1.8 <b>2.4</b>	mA max
$V_{HYST}$	Input Hysteresis Voltage	(Note 10)	7.5		mV
$V_{TRIP^+}$	Input Referred Positive Trip Point	(See figure 1)	3.5	8	mV max
$V_{TRIP^-}$	Input Referred Negative Trip Point	(See figure 1)	-4	-8	mV min

## 5V Electrical Characteristics (Continued)

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V_{CM} = V^+/2$ ,  $V^+ = 5\text{V}$ ,  $V^- = 0\text{V}$ ,  $C_L = 10\text{ pF}$  and  $R_L > 1\text{ M}\Omega$  to  $V^-$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	Limit (Note 6)	Units
$t_{PD}$	Propagation Delay	Overdrive = 5 mV $V_{CM} = 0\text{V}$ (Note 7)	9		ns max
		Overdrive = 15mV $V_{CM} = 0\text{V}$ (Note 7)	8	20	
		Overdrive = 50 mV $V_{CM} = 0\text{V}$ (Note 7)	7	19	
$t_{SKEW}$	Propagation Delay Skew	(Note 8)	0.4		ns
$t_r$	Output Rise Time	10% to 90%	1.3		ns
$t_f$	Output Fall Time	90% to 10%	1.25		ns

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical characteristics.

**Note 2:** Human body model, 1.5 k $\Omega$  in series with 100 pF. Machine model, 200 $\Omega$  in series with 100 pF.

**Note 3:** Applies to both single-supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C. Output currents in excess of  $\pm 30\text{mA}$  over long term may adversely affect reliability.

**Note 4:** The maximum power dissipation is a function of  $T_{J(MAX)}$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$ . All numbers apply for packages soldered directly into a PC board.

**Note 5:** Typical Values represent the most likely parametric norm.

**Note 6:** All limits are guaranteed by testing or statistical analysis.

**Note 7:** Propagation delay measurements made with 100 mV steps. Overdrive is measure relative to  $V_{TRIP}$ .

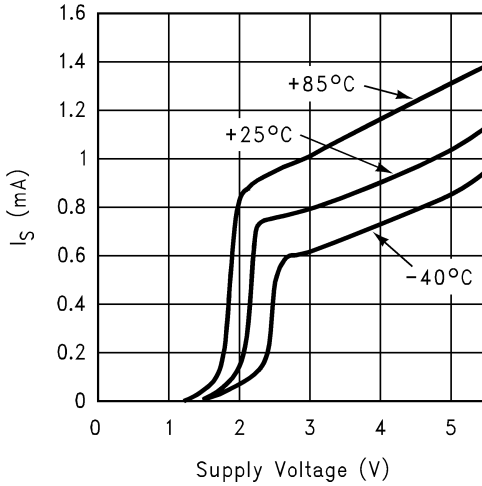
**Note 8:** Propagation Delay Skew is defined as absolute value of the difference between  $t_{PDLH}$  and  $t_{PDHL}$ .

**Note 9:** Limiting input pin current is only necessary for input voltages that exceed absolute maximum input voltage ratings.

**Note 10:** The LMV7219 comparator has internal hysteresis. The trip points are the input voltage needed to change the output state in each direction. The offset voltage is defined as the average of  $V_{TRIP+}$  and  $V_{TRIP-}$ , while the hysteresis voltage is the difference of these two.

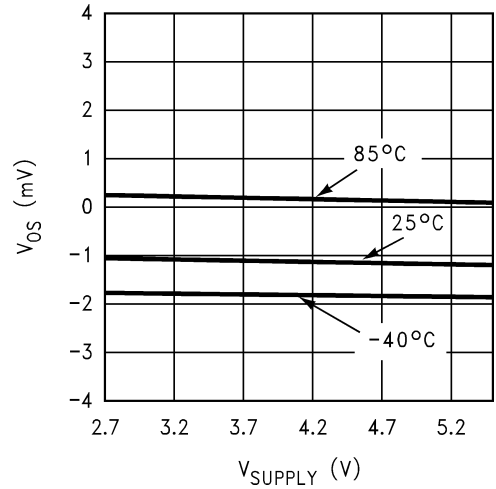
**Typical Performance Characteristics** Unless otherwise specified,  $V_S = 5V$ ,  $C_L = 10\text{ pF}$ ,  $T_A = 25^\circ\text{C}$

**Supply Current vs. Supply Voltage**



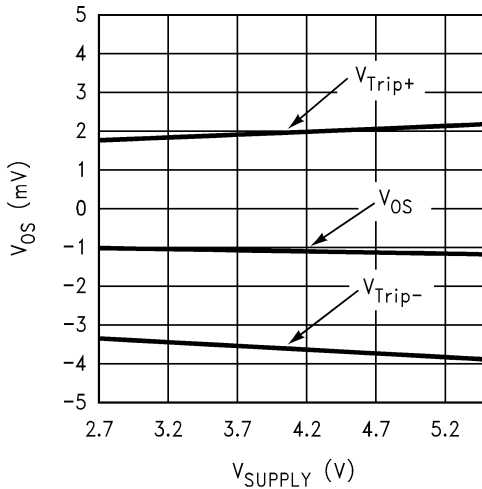
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**$V_{OS}$  vs. Supply Voltage**



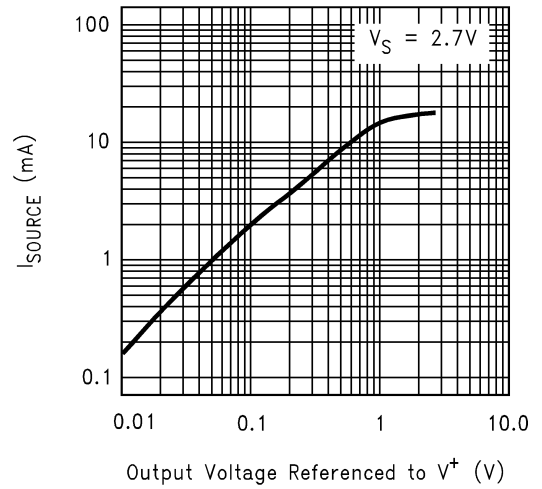
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**Input Offset and Trip Voltage vs. Supply Voltage**



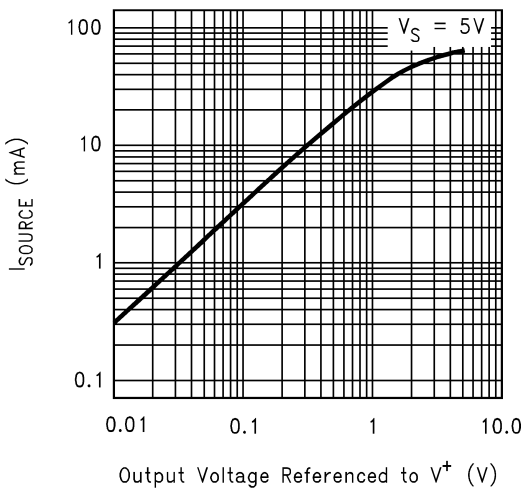
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**Sourcing Current vs. Output Voltage**



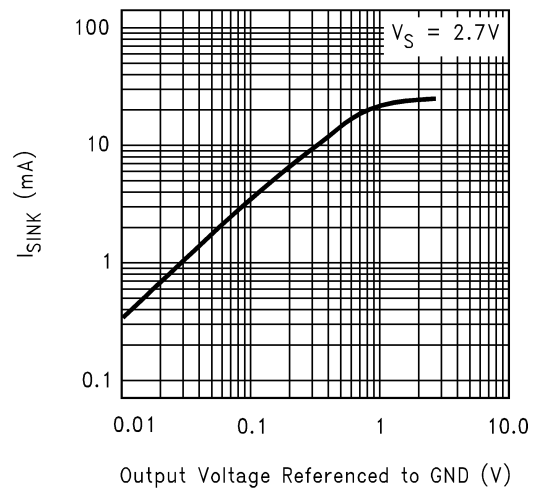
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**Sourcing Current vs. Output Voltage**



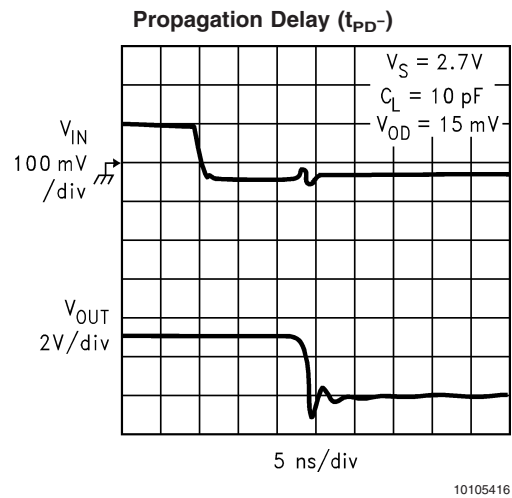
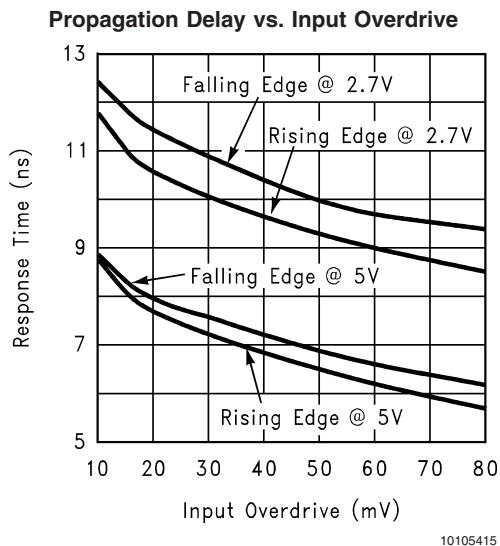
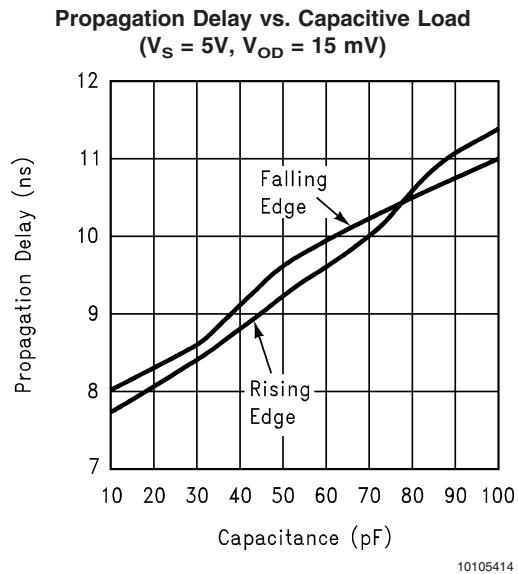
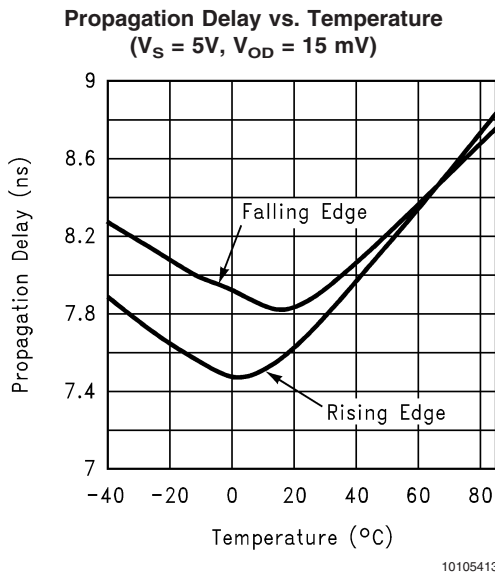
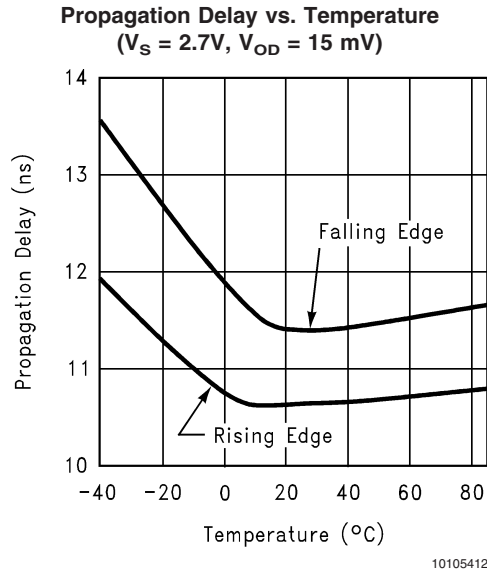
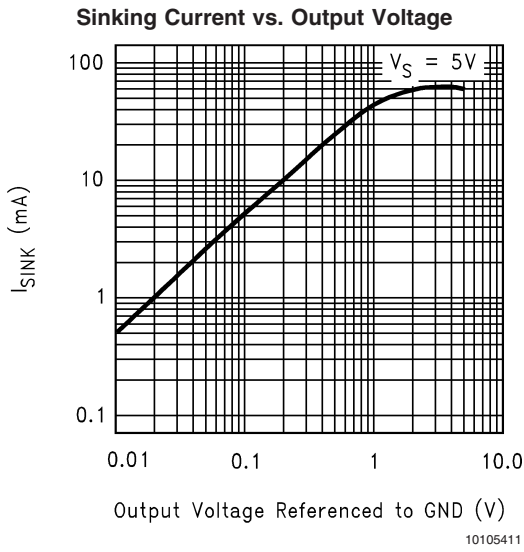
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**Sinking Current vs. Output Voltage**



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**Typical Performance Characteristics** Unless otherwise specified,  $V_S = 5V$ ,  $C_L = 10\text{ pF}$ ,  $T_A = 25^\circ\text{C}$  (Continued)







## Additional Hysteresis

If additional hysteresis is desired, this can be done with the addition of three resistors using positive feedback, as shown in *Figure 2*. The positive feedback method slows the comparator response time. Calculate the resistor values as follows:

1) Select R3. The current through R3 should be greater than the input bias current to minimize errors. The current through R3 ( $I_F$ ) at the trip point is  $(V_{REF} - V_{OUT}) / R3$ . Consider the two possible output states when solving for R3, and use the smaller of the two resulting resistor values. The two formulas are:

$$R3 = V_{REF} / I_F \quad (\text{when } V_{OUT} = 0)$$

$$R3 = V_{CC} - V_{REF} / I_F \quad (V_{OUT} = V_{CC})$$

2) Choose a hysteresis band required ( $V_{HB}$ ).

3) Calculate R1, where  $R1 = R3 \times (V_{HB} / V_{CC})$

4) Choose the trip point for  $V_{IN}$  rising. This is the threshold voltage ( $V_{THR}$ ) at which the comparator switches from low to high as  $V_{IN}$  rises about the trip point.

5) Calculate R2 as follows:

$$R_2 = \frac{1}{\left(\frac{V_{THR}}{V_{REF} \times R_1}\right) - \frac{1}{R_1} - \frac{1}{R_3}}$$

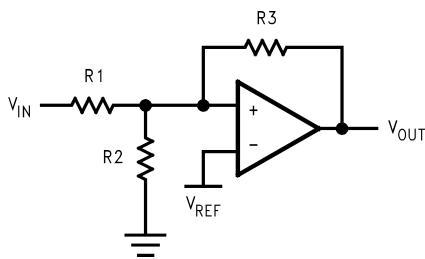
6) Verify the trip voltage and hysteresis as follows:

$$V_{IN} \text{ rising: } V_{THR} = V_{REF} \times R_1 \times \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$V_{IN} \text{ falling: } V_{THF} = V_{THR} - \left(\frac{R_1 \times V_{CC}}{R_3}\right)$$

$$\text{Hysteresis} = V_{THR} - V_{THF}$$

This method is recommended for additional hysteresis of up to a few hundred millivolts. Beyond that, the impedance of R3 is low enough to affect the bias string and adjustment of R1 may be also required.



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FIGURE 2. Additional Hysteresis

## Circuit Layout and Bypassing

The LMV7219 requires high-speed layout. Follow these layout guidelines:

1. Power supply bypassing is critical, and will improve stability and transient response. A decoupling capacitor such as

0.1 $\mu$ F ceramic should be placed as close as possible to V<sup>+</sup> pin. An additional 2.2 $\mu$ F tantalum capacitor may be required for extra noise reduction.

2. Keep all leads short to reduce stray capacitance and lead inductance. It will also minimize unwanted parasitic feedback around the comparator.

3. The device should be soldered directly to the PC board instead of using a socket.

4. Use a PC board with a good, unbroken low inductance ground plane. Make sure ground paths are low-impedance, especially where heavier currents are flowing.

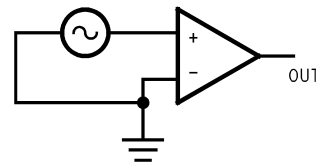
5. Input traces should be kept away from output traces. This can be achieved by running a topside ground plane between the output and inputs.

6. Run the ground trace under the device up to the bypass capacitor to shield the inputs from the outputs.

7. To prevent parasitic feedback when input signals are slow-moving, a small capacitor of 1000pF or less can be placed between the inputs. It can also help eliminate oscillations in the transition region. However, this capacitor can cause some degradation to tpd when the source impedance is low.

## Zero-Crossing Detector

The inverting input is connected to ground and the non-inverting input is connected to 100mVp-p signal. As the signal at the non-inverting input crosses 0V, the comparator's output changes state.

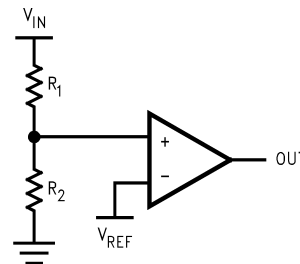


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FIGURE 3. Zero-Crossing Detector

## Threshold Detector

Instead of tying the inverting input to 0V, the inverting input can be tied to a reference voltage. The non-inverting input is connected to the input. As the input passes the  $V_{REF}$  threshold, the comparator's output changes state.

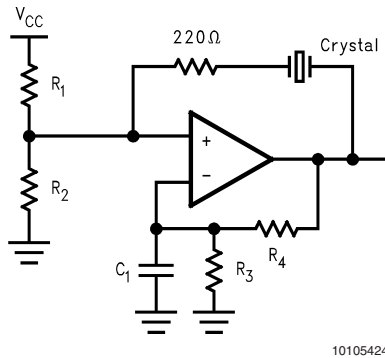


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FIGURE 4. Threshold Detector

## Crystal Oscillator

A simple crystal oscillator using the LMV7219 is shown below. Resistors R1 and R2 set the bias point at the comparator's non-inverting input. Resistors R3, R4 and C1 sets the inverting input node at an appropriate DC average level based on the output. The crystal's path provides resonant positive feedback and stable oscillation occurs. The output duty cycle for this circuit is roughly 50%, but it is affected by resistor tolerances and to a lesser extent by the comparator offset.

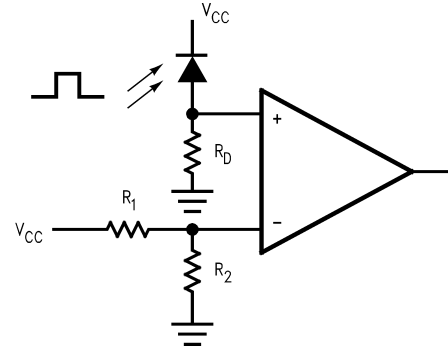


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FIGURE 5. Crystal Oscillator

## IR Receiver

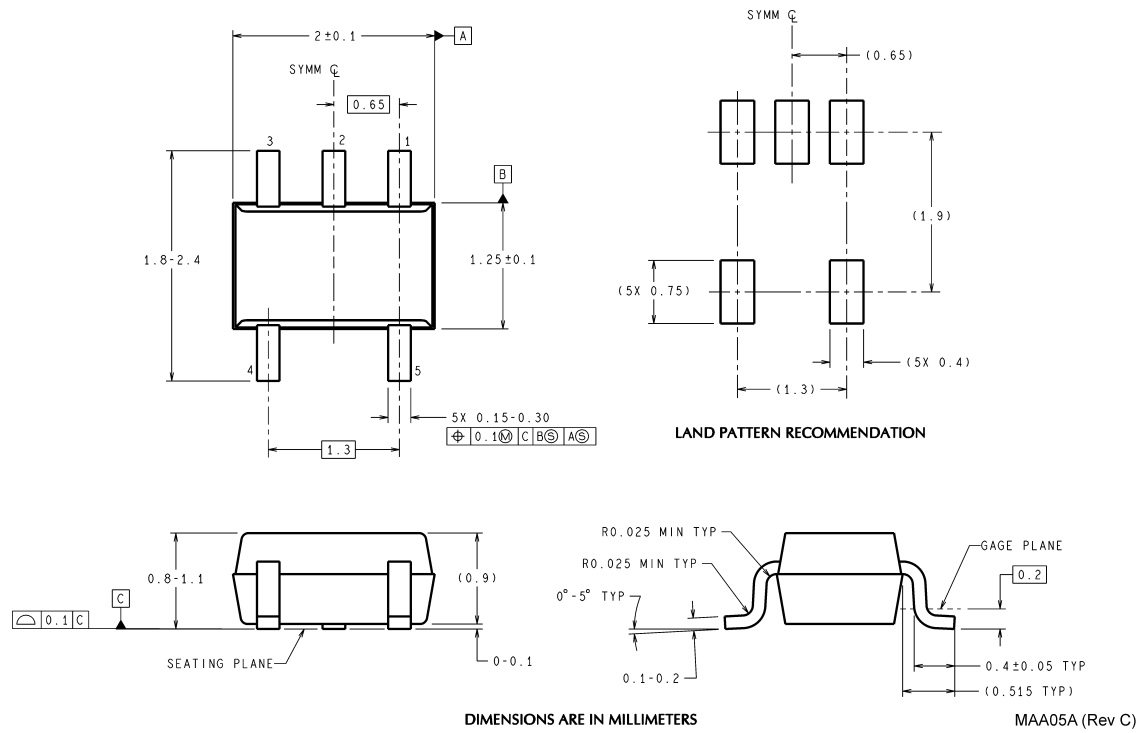
The LMV7219 is an ideal candidate to be used as an infrared receiver. The infrared photo diode creates a current relative to the amount of infrared light present. The current creates a voltage across RD. When this voltage level cross the voltage applied by the voltage divider to the inverting input, the output transitions.



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FIGURE 6. IR Receiver

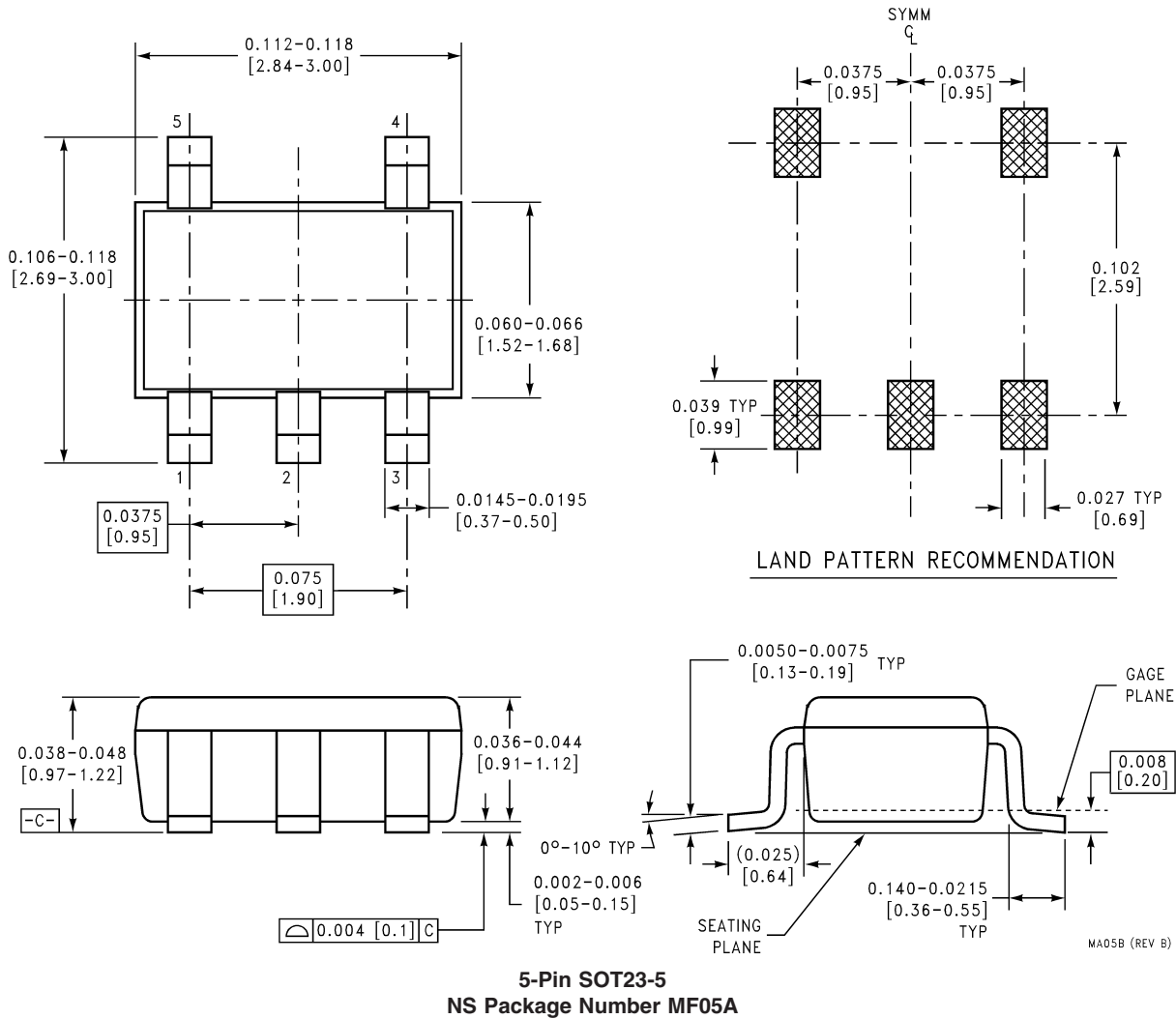
**Physical Dimensions** inches (millimeters) unless otherwise noted



DIMENSIONS ARE IN MILLIMETERS  
**5-Pin SC70-5**  
**NS Package Number MAA05A**

MAA05A (Rev C)

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



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