National Semiconductor

July 2002

LMV761/LMV762
Low Voltage, Precision Comparator with Push-Pull Output

General Description

The LMV761/762 are precision comparators intended for applications requiring low noise and low input offset voltage. The LV761 single has a shutdown pin that can be used to disable the device and reduce the supply current. The LMV761 is available in a space saving SOT23-6 or SOIC–8 package. The LMV762 dual is available in SOIC–8 or MSOP-8 package.

They feature a CMOS input and Push-Pull output stage. The Push-Pull output stage eliminates the need for an external pull-up resistor.

The LMV761/762 are designed to meet the demands of small size, low power and high performance required by portable and battery operated electronics.

The input offset voltage has a typical value of 200µV at room temp and a 1mV limit over temp.

Features

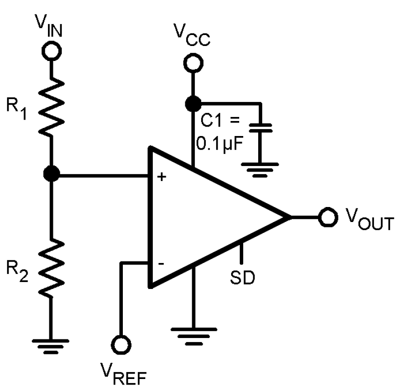
(V_S = 5V, T_A = 25˚C, Typical values unless specified)

- Input offset voltage 0.2mV
- Input offset voltage (max over temp) **1mV**
- Input bias current 0.2pA
- Propagation delay (OD = 50mV) 120 nsec
- Low supply current 300µA
- CMRR 100dB
- PSRR 110dB
- Extended Temperature Range −40˚C to 125˚C
- Push-pull output
- Ideal for 2.7V and 5V single supply applications
- Available in space-saving packages:
  - 6-Pin SOT23 (single w/shutdown)
  - 8-Pin SOIC (single w/shutdown)
  - 8-Pin SOIC/MSOP (dual without shutdown)

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 Circuit



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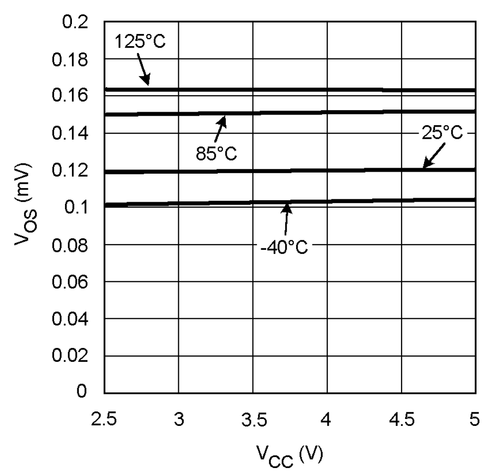
Threshold Detector

V_{OS} vs. V_{CC}



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 DS200370 www.national.com

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)	
Human Body Model	2000V
Machine Model	200V
Supply Voltage ($V^+ - V^-$)	5.5V
Differential Input Voltage	Supply Voltage
Voltage between any two pins	Supply Voltage
Output Short Circuit to V^+ - V^-	
Soldering Information	
Infrared or Convection (20 sec.)	235˚C
Wave Soldering (10 sec.)	260˚C (Lead Temp)
Junction Temperature	150˚C
Storage Temperature Range	−65˚C to 150˚C

Operating Ratings

Supply Voltage ($V^+ - V^-$)	2.7V to 5.0V
Temperature Range	−40˚C to +125˚C
Package Thermal Resistance (Note 4)	
SOT23-6	265˚C/W
SOIC-8	190˚C/W
MSOP-8	235˚C/W

2.7V Electrical Characteristics

Unless otherwise specified, all limited guaranteed for T_J = 25˚C, $V_{CM} = V^+/2$, V^+ = 2.7V, V^- = 0V−. **Boldface** limits apply at the temperature extremes. (Note 5)

Symbol	Parameter	Condition	Min (Note 7)	Typ (Note 6)	Max (Note 7)	Units
V_{OS}	Input Offset Voltage			0.2	**1.0**	mV
I_B	Input Bias Current (Note 8)			0.2	50	pA
I_{OS}	Input Offset Current (Note 8)			.001	5	pA
CMRR	Common Mode Rejection Ratio	0V < V_{CM} < V_{CC} - 1.3V	80	100		dB
PSRR	Power Supply Rejection Ratio	V^+ = 2.7V to 5V	80	110		dB
CMVR	Input Common Mode Voltage Range	CMRR > 50dB			−0.3 1.5	V
V_O	Output Swing High	I_L = 2mA, V_{ID} = 200mV	V^+ − 0.35	V^+ − 0.1		V
	Output Swing Low	I_L = −2mA, V_{ID} = −200mV		90	250	mV
I_{SC}	Output Short Circuit Current (Note 3)	Sourcing, V_O = 1.35V, V_{ID} = 200mV	6.0	20		mA
		Sinking, V_O = 1.35V, V_{ID} = −200mV	6.0	15		mA
I_S	Supply Current LMV761 (Single Comparator)			275	700	µA
	LMV762 (Both Comparators)			550	1400	µA
$I_{OUT\ LEAKAGE}$	Output Leakage I @ Shutdown	$\overline{SD}$ = GND, V_O = 2.7V		0.20		µA
$I_{S\ LEAKAGE}$	Supply Leakage I @ Shutdown	$\overline{SD}$ = GND, V_{CC} = 2.7V		0.20	2	µA
t_{PD}	Propagation Delay R_L = 5.1kΩ C_L = 50pF	Overdrive = 5mV		270		ns
		Overdrive = 10mV		205		ns
		Overdrive = 50mV		120		ns
t_{SKEW}	Propagation Delay Skew			5		ns
t_r	Output Rise Time	10% to 90%		1.7		ns
t_f	Output Fall Time	90% to 10%		1.8		ns
t_{on}	Turn On Time From Shutdown			6		µs

5.0V Electrical Characteristics

Unless otherwise specified, all limited guaranteed for T_J = 25˚C, $V_{CM} = V^+/2$, V^+ = 5.0V, V^- = 0V−. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Condition	Min (Note 7)	Typ (Note 6)	Max (Note 7)	Units
V_{OS}	Input Offset Voltage			0.2	**1.0**	mV
I_B	Input Bias Current (Note 8)			0.2	50	pA

5.0V Electrical Characteristics (Continued)

Unless otherwise specified, all limited guaranteed for $T_J = 25^\circ C$, $V_{CM} = V^+/2$, $V^+ = 5.0V$, $V^- = 0V^-$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Condition	Min (Note 7)	Typ (Note 6)	Max (Note 7)	Units
I_{OS}	Input Offset Current (Note 8)			0.01	5	pA
CMRR	Common Mode Rejection Ratio	$0V < V_{CM} < V_{CC}$ - 1.3V	80	100		dB
PSRR	Power Supply Rejection Ratio	V^+ = 2.7V to 5V	80	110		dB
CMVR	Input Common Mode Voltage Range	CMRR > 50dB			–.3 3.8	V
V_O	Output Swing High	I_L = 4mA, V_{ID} = 200mV	V^+ – 0.35	V^+ – 0.1		V
	Output Swing Low	I_L = –4mA, V_{ID} = –200mV		120	250	mV
I_{SC}	Output Short Circuit Current (Note 3)	Sourcing, V_O = 2.5V, V_{ID} = 200mV	6.0	60		mA
		Sinking, V_O = 2.5V, V_{ID} = –200mV	6.0	40		
I_S	Supply Current LMV761 (Single Comparator)			225	700	µA
	LMV762 (Both Comparators)			450	1400	
$I_{OUT\ LEAKAGE}$	Output Leakage I @ Shutdown	$\overline{SD}$ = GND, V_O = 5.0V		0.20		µA
$I_{S\ LEAKAGE}$	Supply Leakage I @ Shutdown	$\overline{SD}$ = GND, V_{CC} = 5.0V		0.20	2	µA
t_{PD}	Propagation Delay R_L = 5.1kΩ C_L = 50pF	Overdrive = 5mV		225		ns
		Overdrive = 10mV		190		
		Overdrive = 50mV		120		
t_{SKEW}	Propagation Delay Skew			5		ns
t_r	Output Rise Time	10% to 90%		1.7		ns
t_f	Output Fall Time	90% to 10%		1.5		ns
t_{on}	Turn On Time from Shutdown			4		µs

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 condition, see the Electrical Characteristics.

Note 2: Unless otherwise specified human body model is 1.5kΩ in series with 100pF. Machine model 200pF.

Note 3: Electrical Table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device such that $T_J = T_A$. No guarantee of parametric performance is indicated in the electrical tables under conditions of internal self-heating where $T_J > T_A$. See Application section for information on temperature de-rating of this device. Absolute Maximum Rating indicate junction temperature limits beyond which the device may be permanently degraded, either mechanically or electrically.

Note 4: The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{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: Maximum temperature guarantee range is –40°C to 125°C.

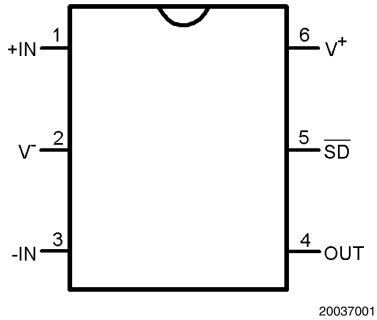
Note 6: Typical values represent the most likely parametric norm.

Note 7: All limits are guaranteed by testing or statistical analysis.

Note 8: Guaranteed by design

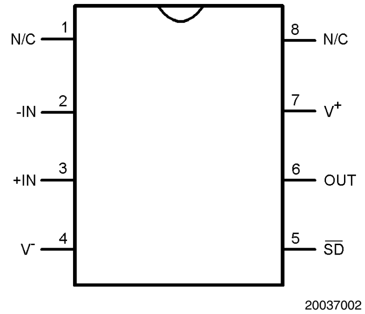
Connection Diagrams

LMV761
Single 6-Pin SOT23



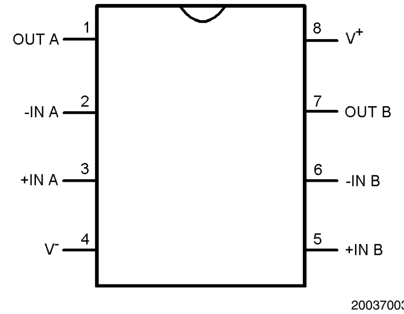
Top View

LMV761
Single 8-Pin SOIC



Top View

LMV762
Dual 8-Pin SOIC & MSOP



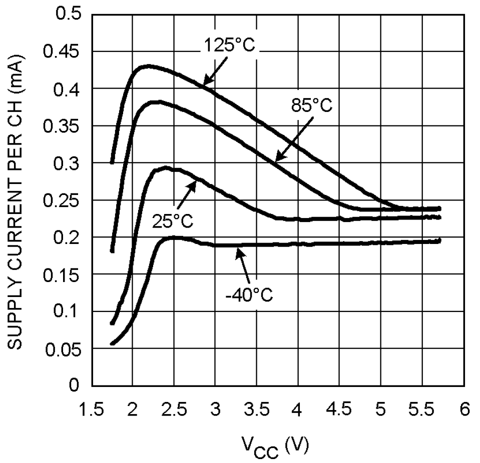
Top View

Ordering Information

Package	Part Number	Package Marking	Transport Media	NSC Drawing
6-Pin SOT23	LMV761MF	C22A	1k units Tape and Reel	MF06A
	LMV761MFX		3k units Tape and Reel	
8-Pin SOIC	LMV761MA	LMV761MA	Rail	M08A
	LMV761MAX		2.5k Units Tape and Reel	
8-Pin SOIC	LMV762MA	LMV762MA	Rail	M08A
	LMV762MAX		2.5k Units Tape and Reel	
8-Pin MSOP	LMV762MM	C23A	1k Units Tape and Reel	MUA08A
	LMV762MMX		3.5k Units Tape and Reel	

Typical Performance Characteristics

PSI vs. V_{CC} (V_O = High)



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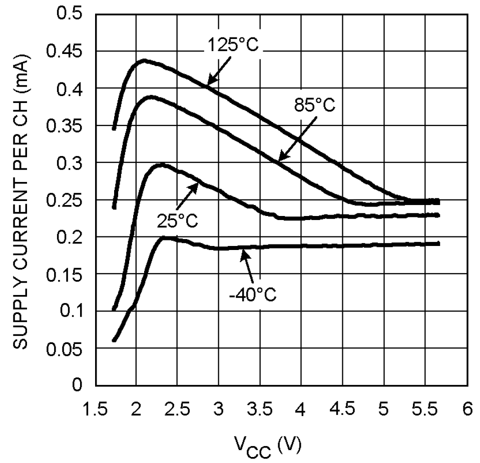
PSI vs. V_{CC} (V_O = Low)



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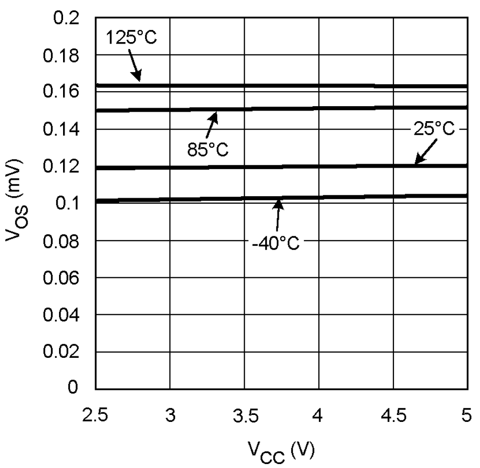
V_{OS} vs. V_{CC}



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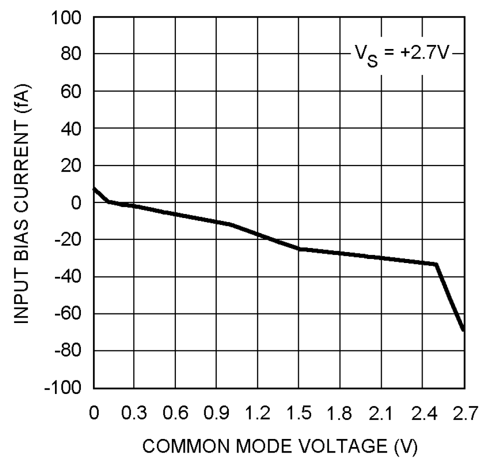
Input Bias vs. Common Mode @ 25˚C



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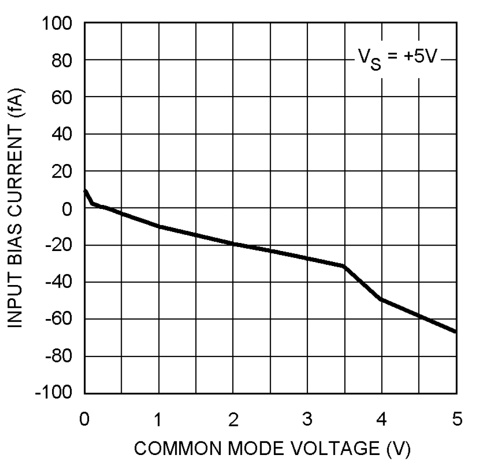
Input Bias vs. Common Mode @ 25˚C



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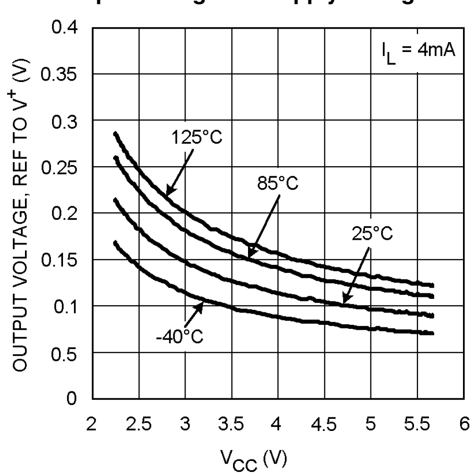
Output Voltage vs. Supply Voltage



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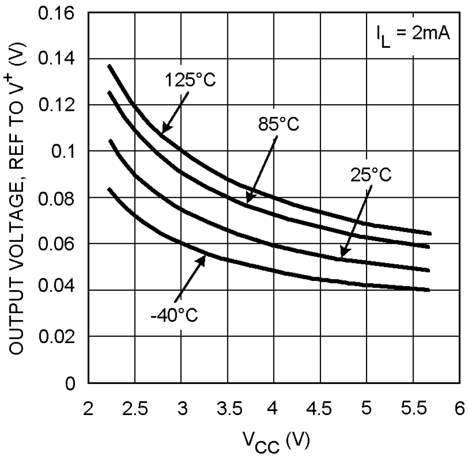
Typical Performance Characteristics (Continued)

Output Voltage vs. Supply Voltage



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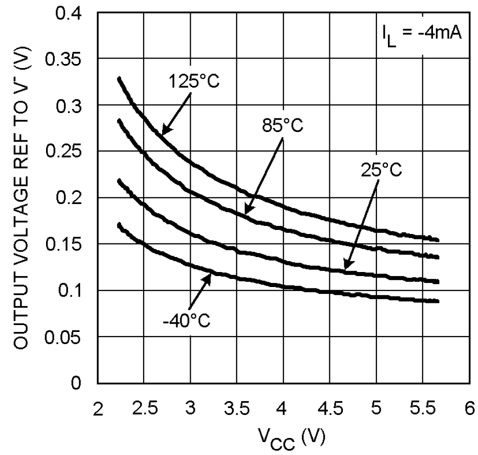
Output Voltage vs. Supply Voltage



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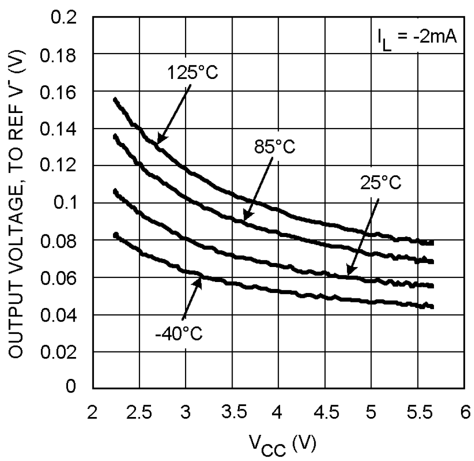
Output Voltage vs. Supply Voltage



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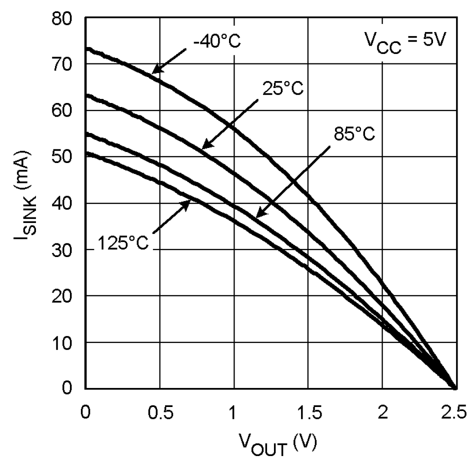
I_{SOURCE} vs. V_{OUT}



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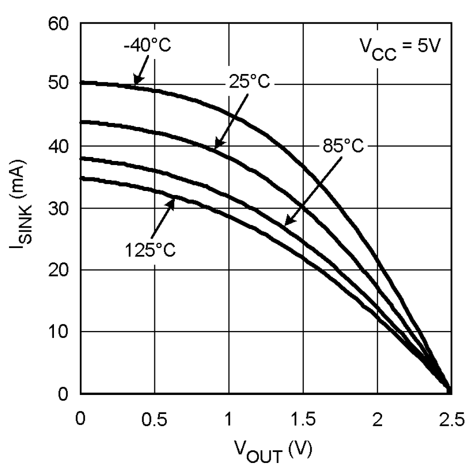
I_{SINK} vs. V_{OUT}



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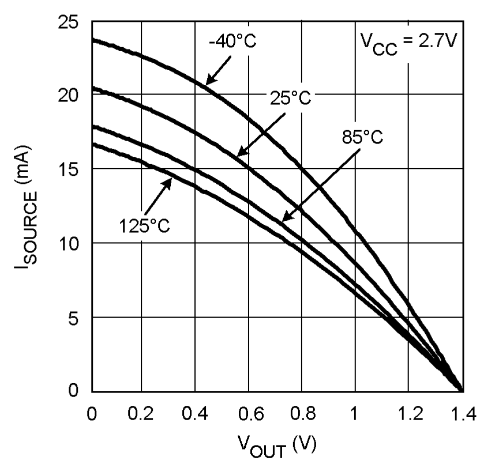
I_{SOURCE} vs. V_{OUT}



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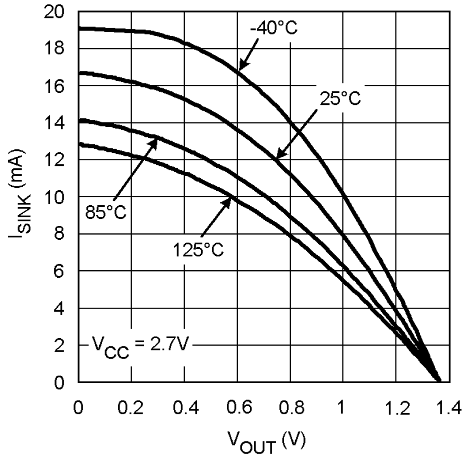
Typical Performance Characteristics (Continued)

I_{SINK} vs. V_{OUT}



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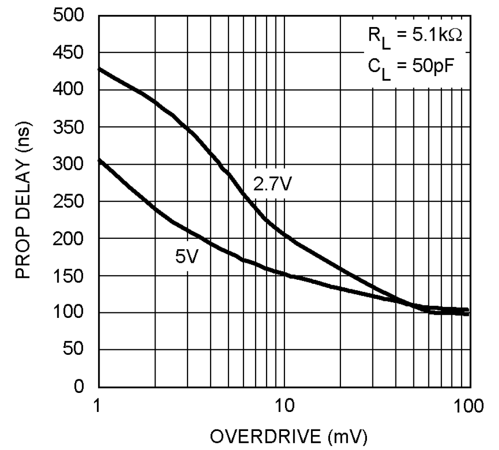
Prop Delay vs. Overdrive



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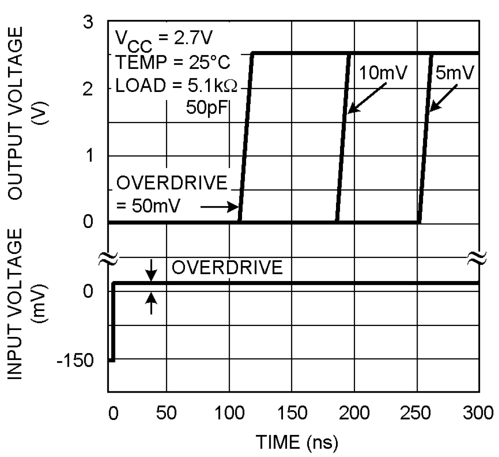
Response Time vs. Input Overdrives Positive Transition



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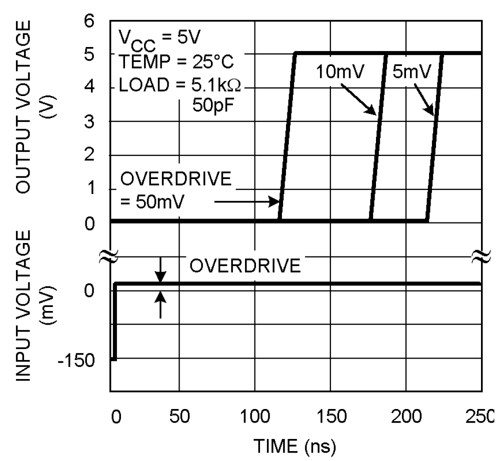
Response Time vs. Input Overdrives Positive Transition



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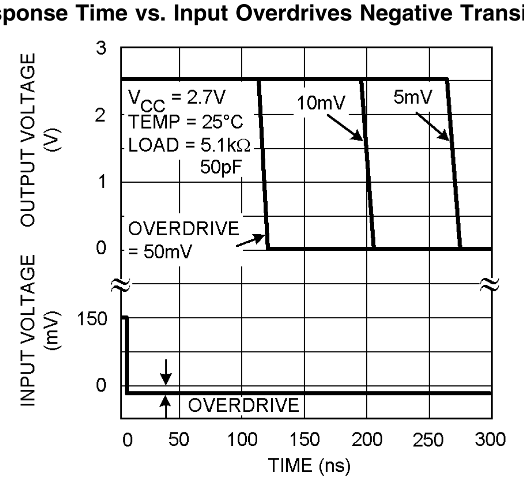
Response Time vs. Input Overdrives Negative Transition



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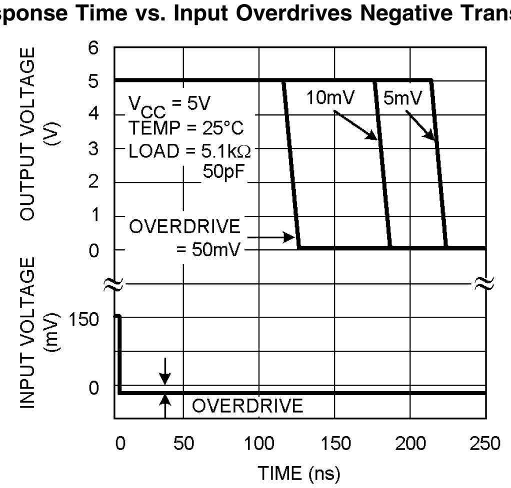
Response Time vs. Input Overdrives Negative Transition



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Application Hints

Basic Comparator

A basic comparator circuit is used to convert analog input signals to digital output signals. The comparator compares an input voltage (V_{IN}) at the non-inverting input to the reference voltage (V_{REF}) at the inverting pin. If V_{IN} is less than V_{REF} the output (V_O) is low (V_{OL}). However, if V_{IN} is greater than V_{REF}, the output voltage (V_O) is high (V_{OH}).

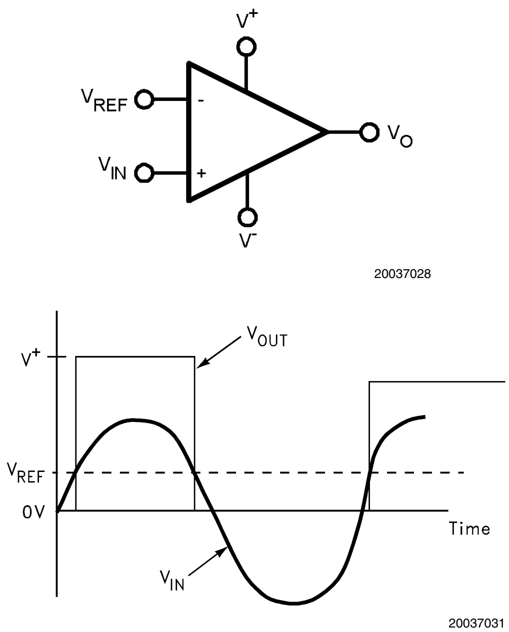


FIGURE 1. Basic Comparator

Hysteresis

The basic comparator configuration may oscillate or produce a noisy output if the applied differential input is near the comparator's input offset voltage. This tends to occur when the voltage on one input is equal or very close to the other input voltage. Adding hysteresis can prevent this problem. Hysteresis creates two switching thresholds (one for the rising input voltage and the other for the falling input voltage). Hysteresis is the voltage difference between the two switching thresholds. When both inputs are nearly equal, hysteresis causes one input to effectively move quickly past the other. Thus, moving the input out of the region in which oscillation may occur.

Hysteresis can easily be added to a comparator in a non-inverting configuration with two resistors and positive feedback *Figure 2*. The output will switch from low to high when V_{IN} rises up to V_{IN1}, where V_{IN1} is calculated by

$$V_{IN1} = (V_{REF}(R_1+R_2))/R_2$$

The output will switch from high to low when V_{IN} falls to V_{IN2}, where V_{IN2} is calculated by

$$V_{IN2} = (V_{REF}(R_1+R_2) - V_{CC}\ R_1)/R_2$$

The Hysteresis is the difference between V_{IN1} and V_{IN2}.

$$\Delta V_{IN} = V_{IN1} - V_{IN2}$$
$$= ((V_{REF}(R_1+R_2))/R_2)-((V_{REF}(R_1+R_2)) - (V_{CC}\ R_1))/R_2)$$
$$= V_{CC}\ R_1/R_2$$

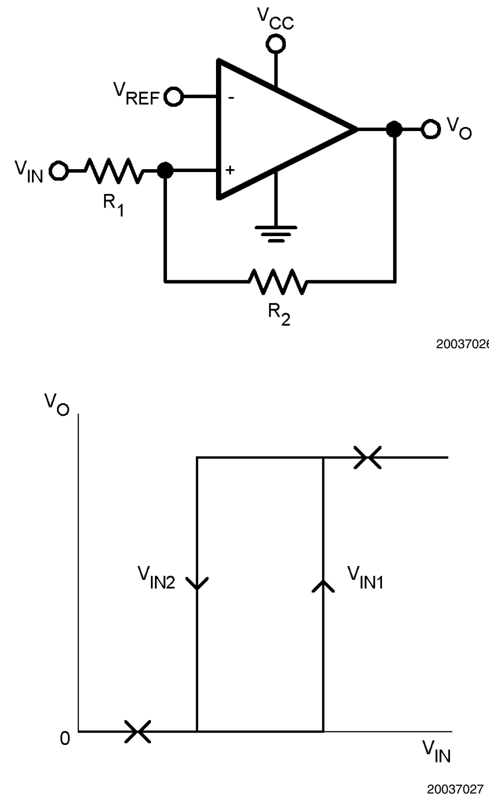


FIGURE 2. Non-Inverting Comparator Configuration

Input

The LMV761/762 have near zero input bias current. This allows very high resistance circuits to be used without any concern for matching input resistances. This also allows the use of very small capacitors in R-C type timing circuits. This reduces the cost of the capacitors and amount of board space used.

Shutdown Mode

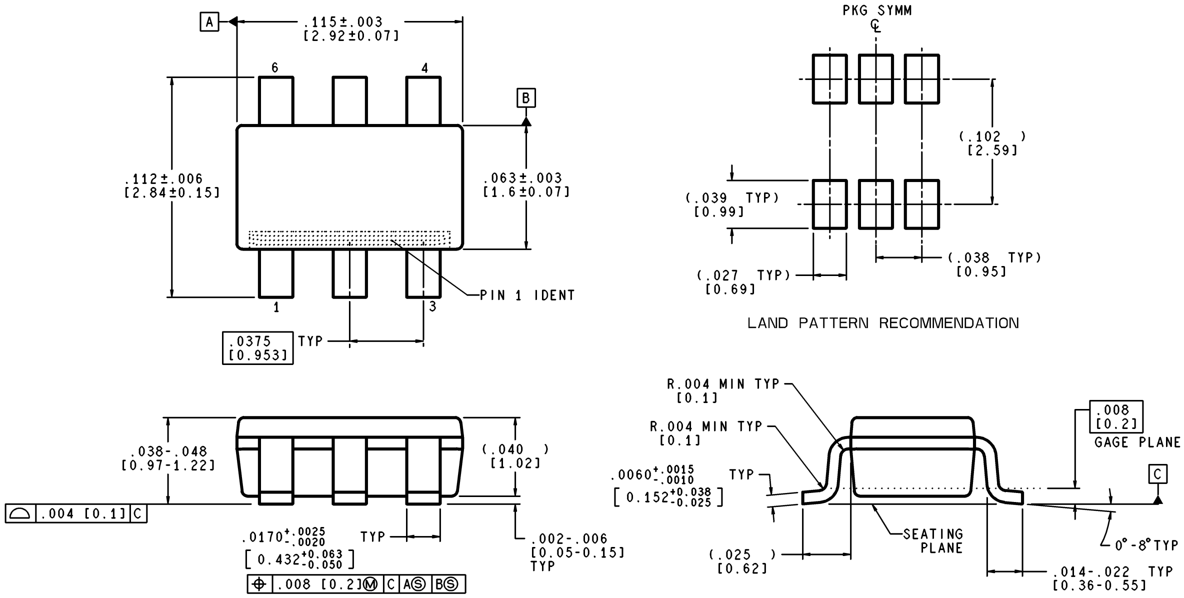
The LMV761 features a low-power shutdown pin that is activated by driving $\overline{SD}$ low. In shutdown mode, the output is in a high impedance state, supply current is reduced to 20nA and the comparator is disabled. Driving $\overline{SD}$ high will turn the comparator on. The $\overline{SD}$ pin should not be left unconnected due to the fact that it is a high impedance input. When left unconnected, the output will be at an unknown voltage. Also do not three-state the $\overline{SD}$ pin.

The maximum input voltage for $\overline{SD}$ is 5.5V, referred to ground and is not limited by V_{CC}. This allows the use of 5V logic to drive $\overline{SD}$ while V_{CC} operates at a lower voltage, such as 3V. The logic threshold limits for $\overline{SD}$ are proportional to V_{CC}.

Board Layout and Bypassing

The LMV761/762 is designed to be stable and oscillation free, but it is still important to include the proper bypass capacitors and ground pickups. Ceramic 0.1µF capacitors should be placed at both supplies to provide clean switching. Minimize the length of signal traces to reduce stray capacitance.

Physical Dimensions inches (millimeters) unless otherwise noted



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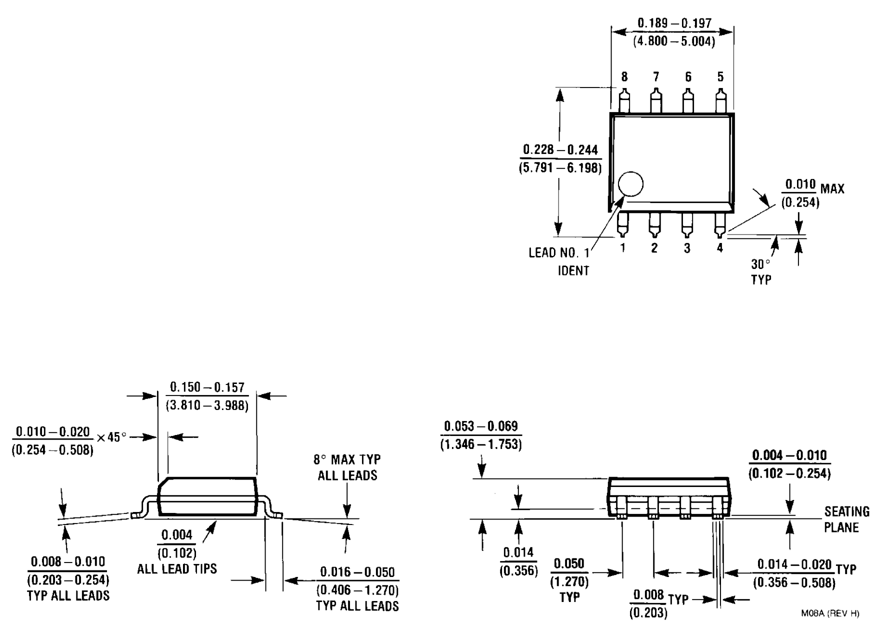
VALUES IN [ ] ARE MILLIMETERS

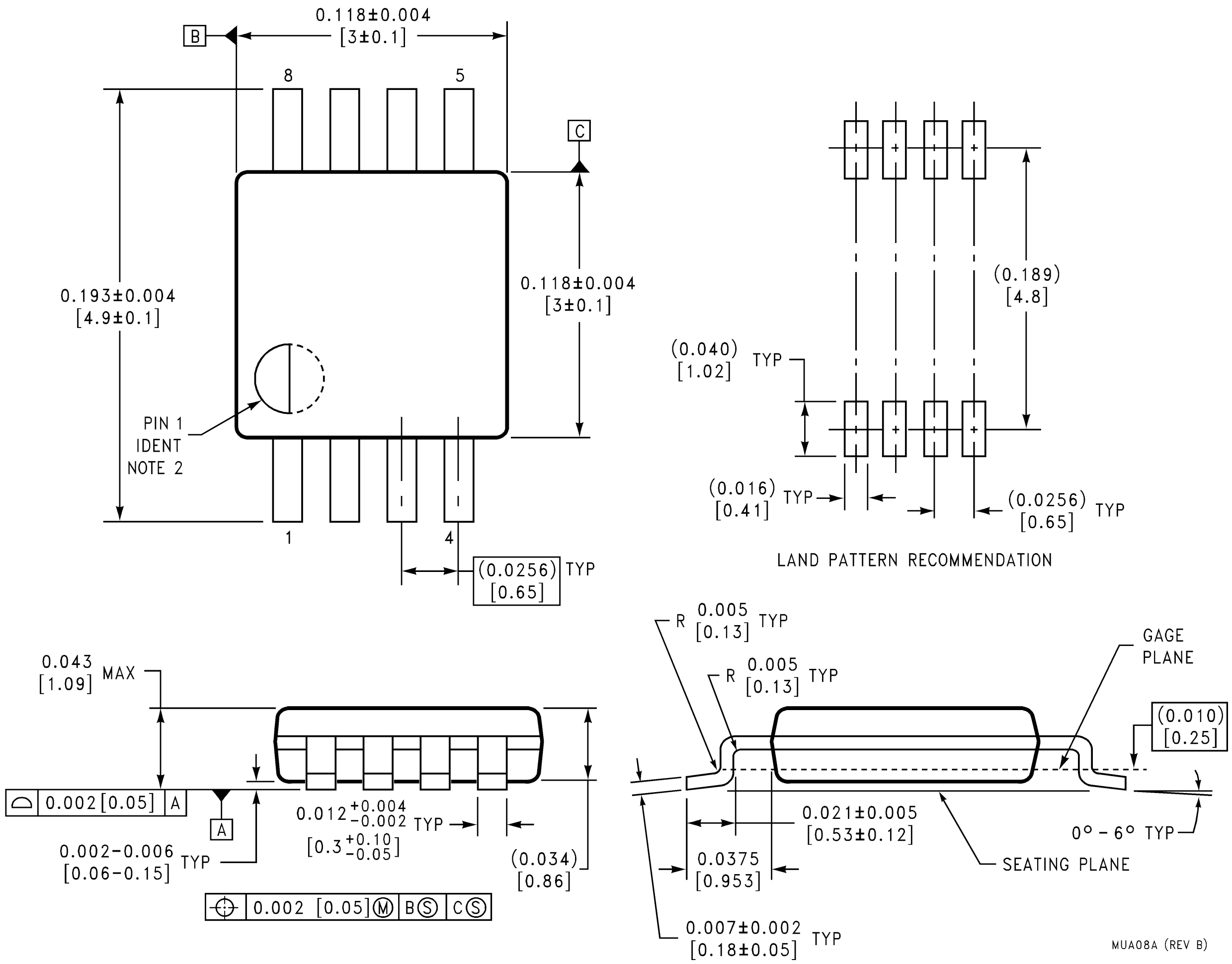
MF06A (Rev A)

6-Pin SOT23
NS Package Number MF06A



8-Pin SOIC
NS Package Number M08A

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



8-Pin MSOP
NS Package Number MUA08A

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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