

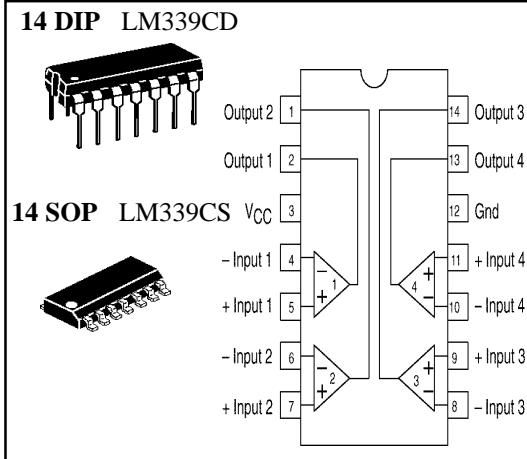
## QUAD VOLTAGE COMPARATORS

These comparators are designed for use in level detection, low-level sensing and memory applications in consumer automotive and industrial electronic applications.

### FEATURES

- Single or dual supplies
- Low Input Bias Current - 25nA(Typ)
- Low Input Offset Voltage -  $\pm 1.0\text{mV}$ (Typ)
- Low Input Offset Current -  $\pm 5.0\text{nA}$ (Typ)
- Input common-mode voltage range to GND
- Output Compatible with TTL, MOS, and CMOS
- Low output saturation voltage - 130mV(Typ) @ 4.0mA

### PIN ARRANGEMENT



### ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Power Supply Voltage	$V_{CC}$	+36 or $\pm 18$	V
Input Differential Voltage Range	$V_{IDR}$	36	V
Input Common Mode Voltage Range	$V_{ICR}$	-0.3 to +36	V
Output Short Circuit-to-Ground	$I_{SC}$	Continuous	mA
Power Dissipation @ 25°C Derate above 25°C	$P_D$	1.0 8.0	W mW/°C
Operating Ambient Temperature Range	$T_A$	0 to 70	°C
Storage Temperature Range	$T_S$	-65 to 150	°C

- Notes:
1. The max. output current may be as high as 20 mA, independent of the magnitude of  $V_{CC}$ , output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.
  2. This magnitude of input current will only occur if the leads are driven more negative than ground or the negative supply voltage. This is due to the input PNP collector base junction becoming forward biased, acting as an input clamp diode. There is also a lateral PNP parasitic transistor action which can cause the output voltage of the comparators to go to the  $V_{CC}$  voltage level (or ground if overdrive is large) during the time that an input is driven negative. This will not destroy the device when limited to the max rating and normal output states will recover when inputs become  $\geq$  ground or negative supply.
  3. At output switch point,  $V_O = 1.4\text{ Vdc}$ ,  $R_s = 100\ \Omega$  with  $V_{CC}$  from 5.0 Vdc to 30 Vdc, and over the full input common mode range (0V to  $V_{CC} = -1.5\text{V}$ ).
  4. Due to the PNP transistor inputs, bias current will flow out of the inputs. This current is essentially constant, independent of the output state, therefore, no loading changes will exist on the input lines.
  5. Response time is specified with a 100mV step and 5.0mV of overdrive. For larger signals, 300ns is typical.
  6. Positive excursions of input voltage may exceed the power supply level. As long as one of the inputs remain within the common-mode range, the comparator will provide the proper output state.



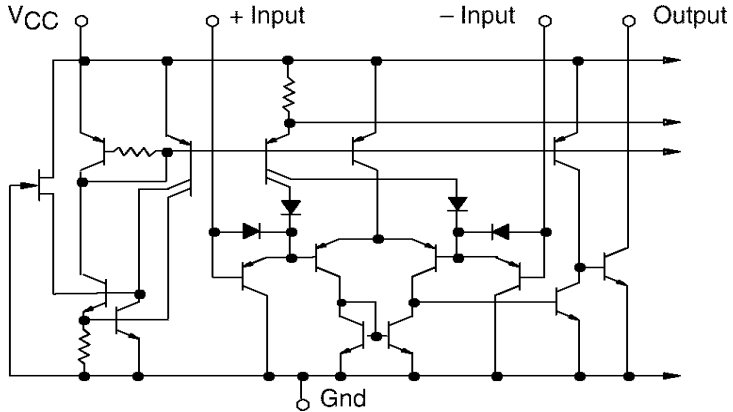
# LM339 Quad Voltage Comparator

## ELECTRICAL CHARACTERISTICS

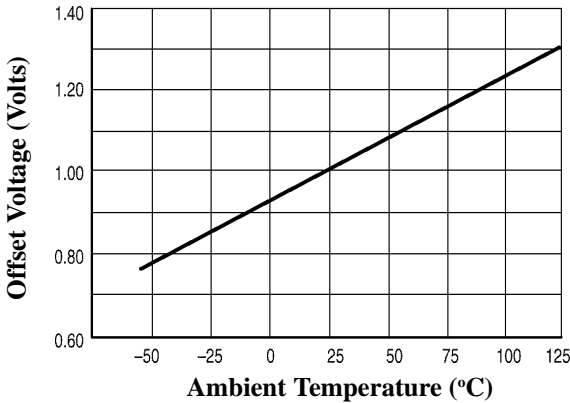
$V_{CC} = 5.0\text{Vdc}$ ,  $0^\circ\text{C} \leq T_A \leq 25^\circ\text{C}$  (unless otherwise noted)

Item	Symbol	Min	Typ	Max	Unit
Input Offset Voltage (3) $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$	$V_{IO}$	---	+2.0 ---	+5.0 +9.0	mV
Input Bias Current (3,4) $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$	$I_{IB}$	---	25 ---	250 400	nA
Input Offset Current (3) $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$	$I_{IO}$	---	$\pm 50$ ---	$\pm 50$ $\pm 150$	nA
Input Common Mode Voltage Range (6) $T_A = 25^\circ\text{C}$ $T_A = 0^\circ\text{C to } 70^\circ\text{C}$	$V_{ICR}$	0 0	---	$V_{CC}-1.5$ $V_{CC}-2.0$	V
Supply Current $R_L = \infty$ , $T_A = 25^\circ\text{C}$ $R_L = \infty$ , $V_{CC} = 30\text{Vdc}$	$I_{CC}$	---	0.8 ---	2.0 ---	mA
Voltage Gain $R_L \geq 15\text{K}$ , $V_{CC} = 15\text{Vdc}$	$A_{VOL}$	---	200	---	V/mV
Large Signal Response Time V1 = TTL Logic Swing. Vref = 1.4 Vdc VRL = 5.0 Vdc, RL = 5.1K	---	---	300	---	ns
Response Time (6) VRL = 5.0 Vdc, RL = 5.1K	$t_{TLH}$	---	13	---	$\mu\text{s}$
Output Sink Current V1(-) $\geq 1.0\text{Vdc}$ , V1(+) = 0 Vdc Vo $\leq 1.5\text{Vdc}$	$I_{Sink}$	6.0	16	---	mA
Saturation Voltage V1(-) $\geq 1.0\text{Vdc}$ , V1(+) = 0 Vdc $I_{Sink} \leq 4.0\text{mA}$ , $T_A = 25^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$	$V_{SAT}$	---	130 ---	400 700	mV
Output Leakage Current V1(-) = 0 Vdc, V1(+) $\geq 1.0\text{Vdc}$ Vo = 5.0 Vdc, $T_A = 25^\circ\text{C}$ V1(-) = 0 Vdc, V1(+) $\geq 1.0\text{Vdc}$ Vo = 30 Vdc, $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$	$I_{OL}$	---	0.1 ---	---	nA
Input Differential Voltage (6) All Vin $\geq \text{GND}$ or V-Supply $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$	$V_{ID}$	---	---	$V_{CC}$	V

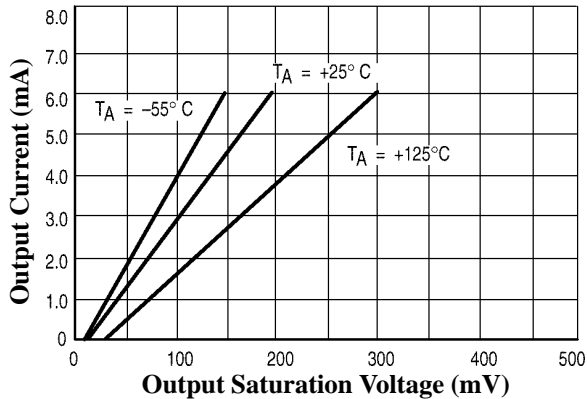
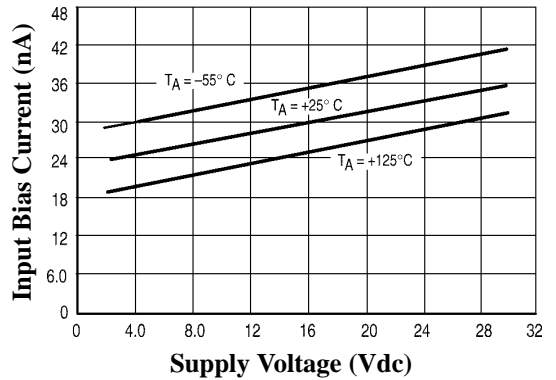
## CIRCUIT SCHEMATIC (Diagram shown is for 1 comparator)



### NORMALIZED INPUT OFFSET VOLTAGE



### INPUT BIAS CURRENT



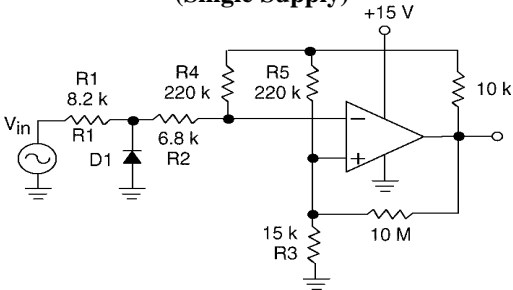
## APPLICATIONS INFORMATION

These dual comparators feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitively coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions ( $V_{OL}$  to  $V_{OH}$ ). To alleviate this situation, input resistors  $< 10\text{ k}\Omega$  should be used.

The addition of positive feedback ( $< 10\text{ mV}$ ) is also recommended. It is good design practice to ground all unused pins.

Differential input voltages may be larger than supply voltage without damaging the comparator's inputs. Voltages more negative than  $-0.3\text{ V}$  should not be used.

### Zero Crossing Detector (Single Supply)

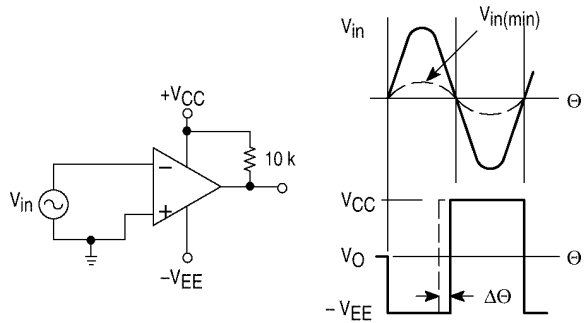


D1 prevents input from going negative by more than  $0.6\text{ V}$ .

$$R1 + R2 = R3$$

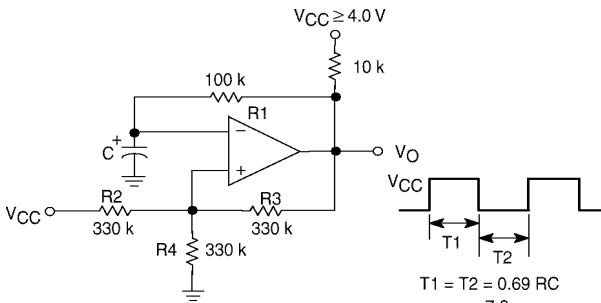
$$R3 \leq \frac{R5}{10} \text{ for small error in zero crossing.}$$

### Zero Crossing Detector (Split Supply)



$$V_{in(min)} \approx 0.4\text{ V peak for } 1\% \text{ phase distortion } (\Delta\Theta).$$

### Square Wave Oscillator



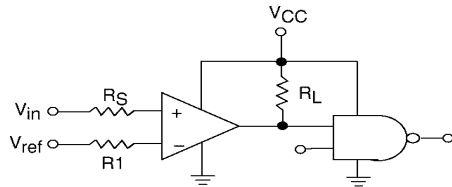
$$T1 = T2 = 0.69 RC$$

$$f \approx \frac{7.2}{C(\mu F)}$$

$$R2 = R3 = R4$$

$$R1 \approx R2 // R3 // R4$$

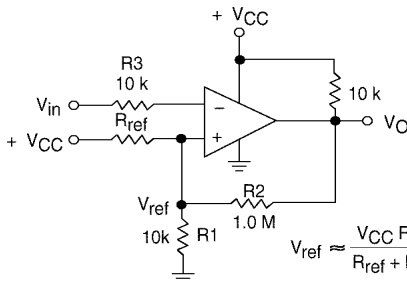
### Driving Logic



$R_S$  = Source Resistance  
 $R1 \approx R_S$

Logic	Device	VCC (V)	RL kΩ
CMOS	1/4 MC14001	+15	100
TTL	1/4 MC7400	+5.0	1.0

### Inverting Comparator With Hysteresis



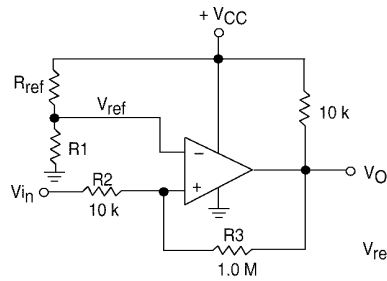
$$V_{ref} \approx \frac{V_{CC} R1}{R_{ref} + R1}$$

$$R3 \approx R1 // R_{ref} // R2$$

$$V_H = \frac{R1 // R_{ref}}{R1 // R_{ref} + R2} [V_{O(max)} - V_{O(min)}]$$

$$R2 \gg R_{ref} // R1$$

### Non-Inverting Comparator With Hysteresis



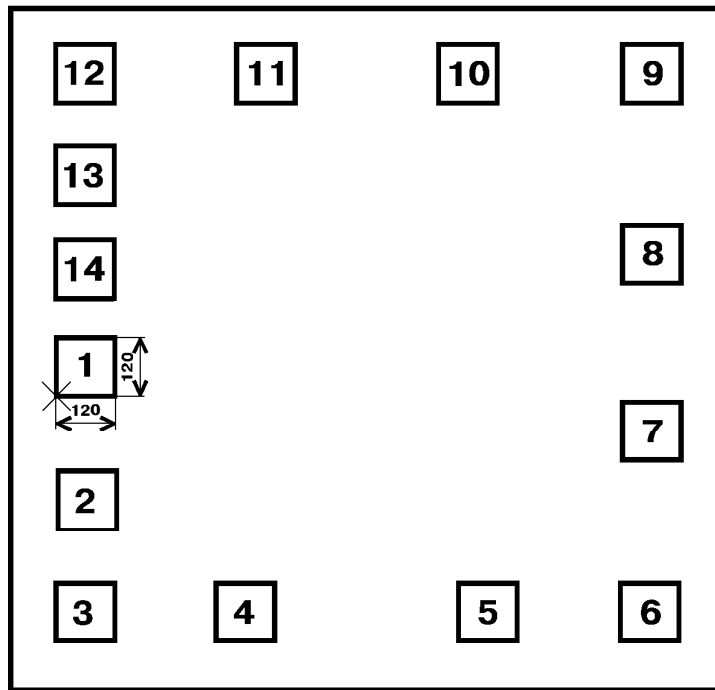
$$V_{ref} = \frac{V_{CC} R1}{R_{ref} + R1}$$

$$R2 \approx R1 // R_{ref}$$

Amount of Hysteresis  $V_H$

$$V_H = \frac{R2}{R2 + R3} [V_{O(max)} - V_{O(min)}]$$

## Pad Location



Chip Size: 1.55 x 1.6 mm

Pad N	Pad Name	Coordinates, mkm		Pad N	Pad Name	Coordinates, mkm	
		X	Y			X	Y
1	#1 OUT	105	718	8	#3 IN-	1325	949
2	#2 OUT	105	333	9	#3 IN+	1325	1369
3	V <sub>CC</sub>	105	110	10	#4 IN-	900	1369
4	#2 IN	480	110	11	#4 IN+	480	1369
5	#2 IN+	990	110	12	GND	105	1369
6	#1 IN-	1325	110	13	#4 OUT	105	1118
7	#1 IN+	1325	530	14	#3 OUT	105	928