

## Quad Single Supply Comparators

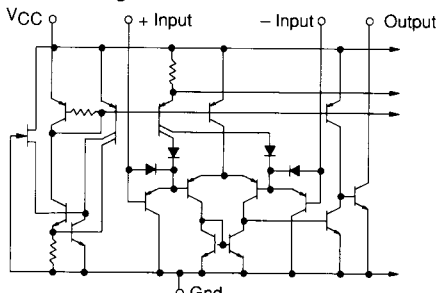
These comparators are designed for use in level detection, low-level sensing and memory applications in consumer automotive and industrial electronic applications.

- Single or Split Supply Operation
- Low Input Bias Current: 25 nA (Typ)
- Low Input Offset Current:  $\pm 5.0$  nA (Typ)
- Low Input Offset Voltage:  $\pm 1.0$  mV (Typ) LM139A Series
- Input Common Mode Voltage Range to Gnd
- Low Output Saturation Voltage: 130 mV (Typ) @ 4.0 mA
- TTL and CMOS Compatible
- ESD Clamps on the Inputs Increase Reliability without Affecting Device Operation

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage LM139, A/LM239, A/LM339A/LM2901 MC3302	V <sub>CC</sub>	+36 or $\pm 18$ +30 or $\pm 15$	Vdc
Input Differential Voltage Range LM139, A/LM239, A/LM339, A/LM2901 MC3302	V <sub>IDR</sub>	36 30	Vdc
Input Common Mode Voltage Range	V <sub>ICMR</sub>	-0.3 to V <sub>CC</sub>	Vdc
Output Short Circuit to Ground (Note 1)	I <sub>SC</sub>	Continuous	
Input Current (V <sub>in</sub> < -0.3 Vdc) (Note 2)	I <sub>in</sub>	50	mA
Power Dissipation @ T <sub>A</sub> = 25°C Ceramic Plastic Package Derate above 25°C	P <sub>D</sub>	1.0 8.0	W mW/°C
Junction Temperature Ceramic & Metal Package Plastic Package	T <sub>J</sub>	175 150	°C
Operating Ambient Temperature Range LM139, A LM239, A MC3302 LM2901 LM339, A	T <sub>A</sub>	-55 to +125 -25 to +85 -40 to +85 -40 to +105 0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

**Figure 1. Circuit Schematic**

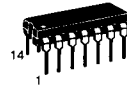


NOTE: Diagram shown is for 1 comparator.

## LM139,A LM239,A, LM2901, LM339,A, MC3302

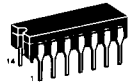
### QUAD COMPARATORS

#### SILICON MONOLITHIC INTEGRATED CIRCUIT



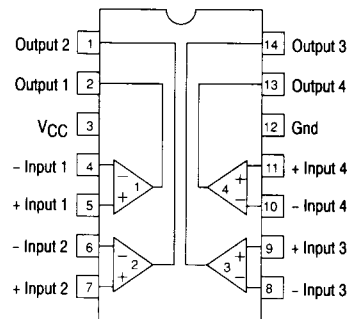
**N, P SUFFIX**  
PLASTIC PACKAGE  
CASE 646

**J, L SUFFIX**  
CERAMIC PACKAGE  
CASE 632



**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751A  
(SO-14)

### PIN CONNECTIONS



(Top View)

### ORDERING INFORMATION

Device	Temperature Range	Package
LM139J, AJ	-55° to +125°C	Ceramic DIP
LM239D, AD LM239J, AJ LM239N, AN	-25° to +85°C	SO-14 Ceramic DIP Plastic DIP
LM339D, AD LM339J, AJ LM339N, AN	0° to +70°C	SO-14 Ceramic DIP Plastic DIP
LM2901D LM2901N	-40° to +105°C	SO-14 Plastic DIP
MC3302L MC3302P	-40° to +85°C	Ceramic DIP Plastic DIP

# LM139,A, LM239,A, LM339,A, MC3302

## ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = +5.0 Vdc, T<sub>A</sub> = +25°C, unless otherwise noted)

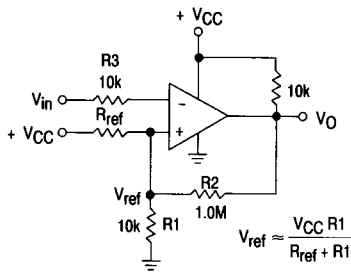
Characteristics	LM139A			LM239A/339A			LM139			LM239/339			LM2901			MC3302				
	Symbol	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Unit
Input Offset Voltage (Note 4)	V <sub>IO</sub>	-	±1.0	±2.0	-	±1.0	±2.0	-	±2.0	±5.0	-	±2.0	±5.0	-	±2.0	±7.0	-	±3.0	±20	mVdc
Input Bias Current (Notes 4, 5) (Output in Linear Range)	I <sub>B</sub>	-	25	100	-	25	250	-	25	100	-	25	250	-	25	250	-	25	500	nA
Input Offset Current (Note 4)	I <sub>IO</sub>	-	±3.0	±25	-	±5.0	±50	-	±3.0	±25	-	±5.0	±50	-	±5.0	±50	-	±3.0	±100	nA
Input Common Mode Voltage Range	V <sub>ICMR</sub>	0	-	V <sub>CC</sub> -1.5	0	-	V <sub>CC</sub> -1.5	0	-	V <sub>CC</sub> -1.5	0	-	V <sub>CC</sub> -1.5	0	-	V <sub>CC</sub> -1.5	0	-	V <sub>CC</sub> -1.5	V
Supply Current R <sub>L</sub> = ∞ (For All Comparators) R <sub>L</sub> = ∞, V <sub>CC</sub> = 30 Vdc	I <sub>CC</sub>	-	0.8	2.0	-	0.8	2.0	-	0.8	2.0	-	0.8	2.0	-	0.8	2.0	-	0.8	2.0	mA
Voltage Gain	A <sub>VOL</sub>	50	200	-	50	200	-	200	200	-	200	200	-	200	100	-	2	30	-	V/mV
Large Signal Response Time V <sub>I</sub> = TTL Logic Swing, V <sub>ref</sub> = 1.4 Vdc, V <sub>HL</sub> = 5.0 Vdc, R <sub>L</sub> = 5.1 kΩ	t <sub>RL</sub>	-	1.3	-	-	1.3	-	-	1.3	-	-	1.3	-	-	1.3	-	-	1.3	-	μs
Output Sink Current V <sub>I(-)</sub> ≥ +1.0 Vdc, V <sub>I(+)</sub> = 0, V <sub>O</sub> ≤ 1.5 Vdc	I <sub>SINK</sub>	6.0	16	-	6.0	16	-	6.0	16	-	6.0	16	-	6.0	16	-	6.0	16	-	mA
Saturation Voltage V <sub>I(-)</sub> ≥ +1.0 Vdc, V <sub>I(+)</sub> = 0, I <sub>sink</sub> ≤ 4.0 mA	V <sub>SAT</sub>	-	130	400	-	130	400	-	130	400	-	130	400	-	130	400	-	130	400	mV
Output Leakage Current V <sub>I(+)</sub> ≥ +1.0 Vdc, V <sub>I(-)</sub> = 0, V <sub>O</sub> = +5.0 Vdc	I <sub>OL</sub>	-	0.1	-	-	0.1	-	-	0.1	-	-	0.1	-	-	0.1	-	-	0.1	-	nA

## PERFORMANCE CHARACTERISTICS (V<sub>CC</sub> = +5.0 Vdc, T<sub>A</sub> = T<sub>low</sub> to T<sub>high</sub> [Note 3])

Characteristic	LM139A			LM239A/339A			LM139			LM239/339			LM2901			MC3302				
	Symbol	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Unit
Input Offset Voltage (Note 4)	V <sub>IO</sub>	-	±4.0	-	±4.0	-	±9.0	-	±9.0	-	±9.0	-	±15	-	±15	-	±40	-	±40	mVdc
Input Bias Current (Notes 4, 5) (Output in Linear Range)	I <sub>B</sub>	-	-	300	-	400	-	300	-	400	-	300	-	500	-	1000	-	-	-	nA
Input Offset Current (Note 4)	I <sub>IO</sub>	-	-	±100	-	±150	-	±100	-	±150	-	±100	-	±200	-	±300	-	-	-	nA
Input Common Mode Voltage Range	V <sub>ICMR</sub>	0	-	V <sub>CC</sub> -2.0	0	-	V <sub>CC</sub> -2.0	0	-	V <sub>CC</sub> -2.0	0	-	V <sub>CC</sub> -2.0	0	-	V <sub>CC</sub> -2.0	0	-	V <sub>CC</sub> -2.0	V
Saturation Voltage V <sub>I(-)</sub> ≥ +1.0 Vdc, V <sub>I(+)</sub> = 0, I <sub>sink</sub> ≤ 4.0 mA	V <sub>SAT</sub>	-	-	700	-	700	-	700	-	700	-	700	-	700	-	700	-	-	-	mV
Output Leakage Current V <sub>I(+)</sub> ≥ +1.0 Vdc, V <sub>I(-)</sub> = 0, V <sub>O</sub> = 30 Vdc	I <sub>OL</sub>	-	-	1.0	-	1.0	-	1.0	-	1.0	-	1.0	-	1.0	-	1.0	-	1.0	-	μA
Differential Input Voltage All V <sub>I</sub> ≥ 0 Vdc	V <sub>ID</sub>	-	-	V <sub>CC</sub>	-	V <sub>CC</sub>	-	V <sub>CC</sub>	-	V <sub>CC</sub>	-	V <sub>CC</sub>	-	V <sub>CC</sub>	-	V <sub>CC</sub>	-	-	-	Vdc

- NOTES:**
- The maximum output current may be as high as 20 mA, independent of the magnitude of V<sub>CC</sub>. Output short circuits to V<sub>CC</sub> can cause excessive heating and eventual destruction.
  - 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<sub>CC</sub> 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 the inputs become ≥ ground or negative supply.
  - (LM139/339A) T<sub>low</sub> = -55°C, T<sub>high</sub> = +125°C  
(LM239/339A) T<sub>low</sub> = -25°C, T<sub>high</sub> = +85°C  
(MC3302) T<sub>low</sub> = -40°C, T<sub>high</sub> = +105°C  
(LM2901) T<sub>low</sub> = -40°C, T<sub>high</sub> = +105°C
  - At the output switch point, V<sub>O</sub> = 1.4 Vdc, R<sub>S</sub> ≤ 100 Ω, I<sub>S</sub> ≤ 5.0 Vdc ≤ V<sub>CC</sub> ≤ 30 Vdc, with the inputs over the full common mode range (0 Vdc to V<sub>CC</sub> - 1.5 Vdc).
  - The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
  - The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.

Figure 2. Inverting Comparator with Hysteresis



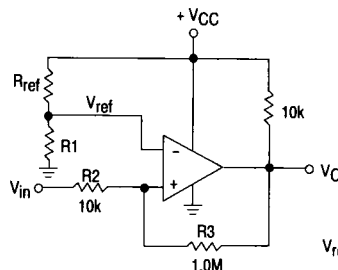
$$V_{ref} \approx \frac{V_{CC} R_1}{R_{ref} + R_1}$$

$$R_3 \approx R_1 // R_{ref} // R_2$$

$$V_H = \frac{R_1 // R_{ref}}{R_1 // R_{ref} + R_2} [V_{O(max)} - V_{O(min)}]$$

$$R_2 \gg R_{ref} // R_1$$

Figure 3. Noninverting Comparator with Hysteresis



$$V_{ref} = \frac{V_{CC} R_1}{R_{ref} + R_1}$$

$$R_2 \approx R_1 // R_{ref}$$

Amount of Hysteresis  $V_H$

$$V_H = \frac{R_2}{R_2 + R_3} [V_{O(max)} - V_{O(min)}]$$

Typical Characteristics

( $V_{CC} = 1.5$  Vdc,  $T_A = +25^\circ\text{C}$  (each comparator) unless otherwise noted.)

Figure 4. Normalized Input Offset Voltage

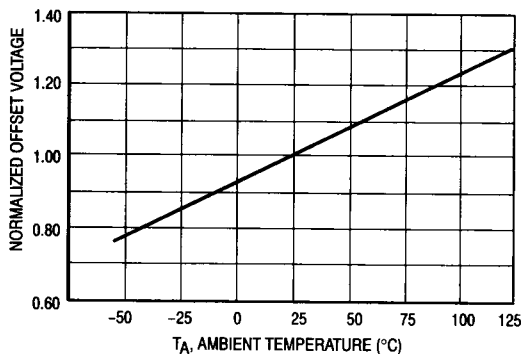


Figure 5. Input Bias Current

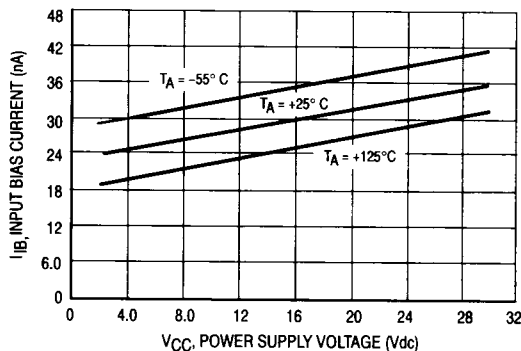
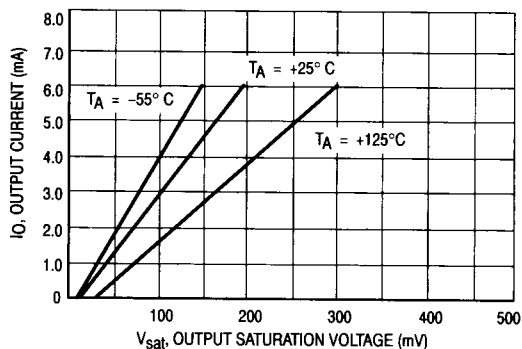
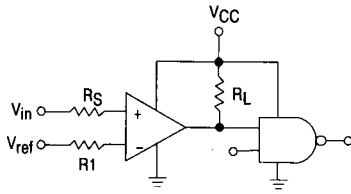


Figure 6. Output Sink Current versus Output Saturation Voltage



# LM139,A, LM239,A, LM339,A, LM2901, MC3302

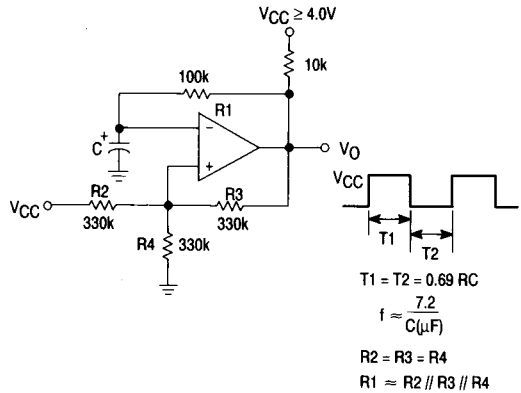
Figure 7. Driving Logic



$R_S$  = Source Resistance  
 $R_1 = R_S$

Logic	Device	VCC (V)	RL kΩ
CMOS	1/4 MC14001	+15	100
TTL	1/4 MC7400	+5.0	10

Figure 8. Squarewave Oscillator



$$T_1 = T_2 = 0.69 RC$$

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

$$R_2 = R_3 = R_4$$

$$R_1 \approx R_2 \parallel R_3 \parallel R_4$$

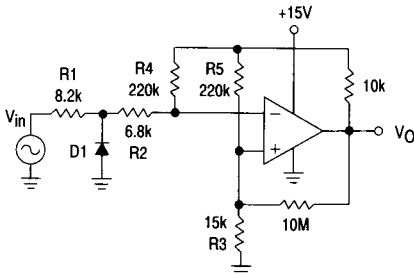
## APPLICATIONS INFORMATION

These quad 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 input pins.

Differential input voltages may be larger than supply voltages without damaging the comparator's inputs. Voltages more negative than  $-300 \text{ mV}$  should not be used.

Figure 9. Zero Crossing Detector (Single Supply)



D1 prevents input from going negative by more than 0.6 V.

$$R_1 + R_2 = R_3$$

$$R_3 \leq \frac{R_5}{10} \text{ for small error in zero crossing}$$

Figure 10. Zero Crossing Detector (Split Supplies)

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

