LM139 LM139A
LM239 LM239A
LM339 LM339A

MOTOROLA

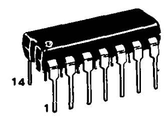
QUAD SINGLE-SUPPLY COMPARATORS

These comparators are designed for use in level detection and low-level sensing applications in Consumer, Automotive and Industrial electronic applications.

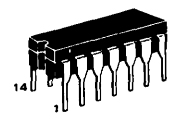
- Power Supply Options –
  Single Supply = 2.0 to 36 Vdc
  Split Supplies = ± 1.0 - ±18 Vdc
- Wide Operating Temperature Range – -55 to +125°C
- Low Supply Current Drain – 2.0 mA (Max)
- Low Input Biasing Current – 25 nA (Typ)
- Low Input Offset Voltage – 5.0 mV (Max) LM139, 239, 339
  2.0 mV (Max) LM139A, 239A, 339A
- TTL and CMOS Compatible

QUAD COMPARATORS

SILICON MONOLITHIC INTEGRATED CIRCUIT



N SUFFIX
PLASTIC PACKAGE
CASE 646
LM239/239A,
LM339/339A only

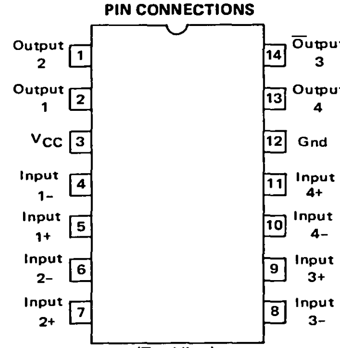


J SUFFIX
CERAMIC PACKAGE
CASE 632
TO-116

MAXIMUM RATINGS

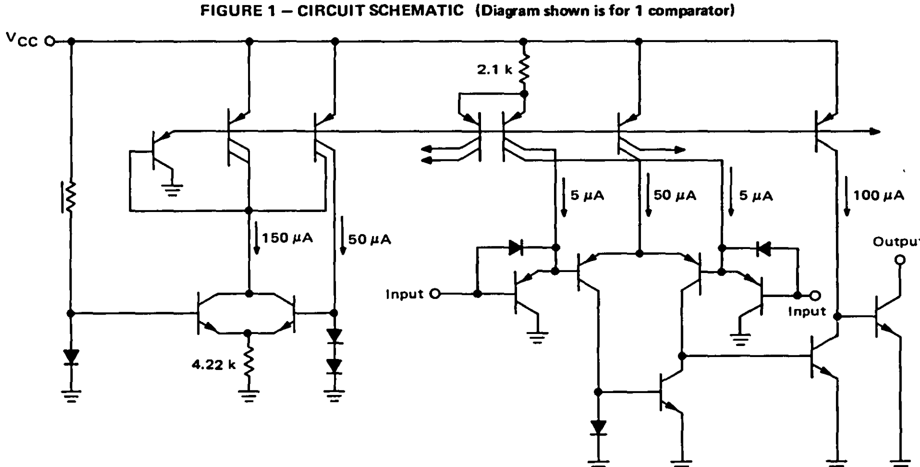
Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	+36 or ±18	Vdc
Input Differential Voltage Range	V_{IDR}	36	Vdc
Input Common Mode Voltage Range	V_{ICR}	-0.3 to +36	Vdc
Output Sink Current	I_{sink}	20	mA
Power Dissipation @ T_A = 25°C	P_D		
Ceramic Package		1.25	Watts
Derate above 25°C		10	mW/°C
Plastic Package		1.25	Watts
Derate above 25°C		10	mW/°C
Operating Ambient Temperature Range	T_A		°C
LM139, 139A		-55 to +125	
LM239, 239A		-40 to +85	
LM339, 339A		0 to +70	
Storage Temperature Range	T_{stg}	-65 to +150	°C

PIN CONNECTIONS



(Top View)

FIGURE 1 – CIRCUIT SCHEMATIC (Diagram shown is for 1 comparator)



7

ELECTRICAL CHARACTERISTICS (V_{CC} = +5.0 Vdc, T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	LM139, A			LM239, A			LM339, A			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (V_{ref} = 1.4 Vdc, V_O = 1.4 Vdc, R_S = 0) LM139, 239, 339 LM139A, 239A, 339A	V_{IO}	 – –	 ±2.0 ±1.0	 ±5.0 ±2.0	 – –	 ±2.0 ±1.0	 ±5.0 ±2.0	 – –	 ±2.0 ±1.0	 ±5.0 ±2.0	mVdc
Input Offset Current	I_{IO}	–	±3.0	±25	–	±5.0	±50	–	±5.0	±50	nA
Input Bias Current	I_{IB}	–	25	100	–	25	250	–	25	250	nA
Input Common Mode Voltage Range (Note 1)	V_{ICR}	0	–	V_{CC} -1.5	0	–	V_{CC} -1.5	0	–	V_{CC} -1.5	V
Supply Current (R_L = ∞)	I_{CC} I_{EE}	–	0.8	2.0	–	0.8	2.0	–	0.8	2.0	mA
Response Time (Note 2) (V_{RL} = 5.0 Vdc, R_L = 5.1 kΩ)	–	–	1.3	–	–	1.3	–	–	1.3	–	μs
Output Sink Current ($V_{I(-)}$ ≥ +1.0 Vdc, $V_{I(+)}$ = 0, V_O ≤ +1.5 Vdc) ($V_{I(-)}$ ≥ +1.0 Vdc, $V_{I(+)}$ = 0, V_O ≤ 500 mVdc)	I_{sink}	 6.0 6.0	 16 –	 – –	 6.0 6.0	 16 –	 – –	 6.0 6.0	 16 –	 – –	mA
Saturation Voltage ($V_{I(-)}$ ≥ +1.0 Vdc, $V_{I(+)}$ = 0, I_{sink} ≤ 4.0 mAdc) ($V_{I(-)}$ ≥ +1.0 Vdc, $V_{I(+)}$ = 0, I_{sink} ≤ 6.0 mAdc)	V_{sat}	 – –	 – –	 400 500	 – –	 – –	 400 500	 – –	 – –	 400 500	mV
Voltage Gain (V_{CC} = 15 V) (R_L ≥15 kΩ) LM139, 239, 339 LM139A, 239A, 339A	A_V	 – 50	 200 200	 – –	 – 50	 200 200	 – –	 – 50	 200 200	 – –	k
Output Leakage Current ($V_{I(+)}$ ≥ +1.0 Vdc, $V_{I(-)}$ = 0, V_O = 5.0 Vdc)	I_{OL}	–	0.1	–	–	0.1	–	–	0.1	–	μA

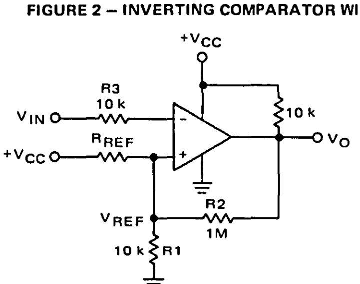
PERFORMANCE CHARACTERISTICS — Guaranteed Over Temperature Range (V_{CC} = +5.0 Vdc)

Characteristic	Symbol	-55 to +125°C			-40°C to +85°C			0° to 70°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (V_{ref} = +1.4 Vdc, V_O = 1.4 Vdc, R_S = 0) LM139, 239, 339 LM139A, 239A, 339A	V_{IO}	 – –	 – –	 ±9.0 ±4.0	 – –	 – –	 ±9.0 ±4.0	 – –	 – –	 ±9.0 ±4.0	mV
Input Offset Current	I_{IO}	–	–	±100	–	–	±150	–	–	±150	nA
Input Bias Current	I_{IB}	–	–	300	–	–	400	–	–	400	nA
Input Common Mode Voltage Range	V_{ICR}	0	–	V_{CC} -2.0	0	–	V_{CC} -2.0	0	–	V_{CC} -2.0	Vdc
Saturation Voltage ($V_{I(-)}$ ≥ 1.0 Vdc, $V_{I(+)}$ = 0, I_{sink} ≤ 4.0 mAdc)	V_{sat}	–	–	700	–	–	700	–	–	700	mV
Output Leakage Current ($V_{I(+)}$ ≥ 1.0 Vdc, $V_{I(-)}$ = 0, V_O = 30 Vdc)	I_{OL}	–	–	1.0	–	–	1.0	–	–	1.0	μA
Input Differential Voltage (All V_I ≥ 0 Vdc)	V_{ID}	–	–	36	–	–	36	–	–	36	Vdc

Notes 1. The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 300 mV. The upper end of the common-mode voltage range is V_{CC} -1.5 V, but either or both inputs can go to +30 Vdc without damage.
2. The response time specified is for a 100 mV input step with 5 mV overdrive For larger signals, 300 ns is typical.

7

FIGURE 2 — INVERTING COMPARATOR WITH HYSTERESIS

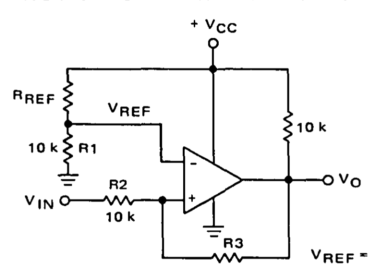


$$V_{REF} \approx \frac{V_{CC}\,R1}{R_{REF} + R1}$$

$$R3 \approx R1 \,//\, R_{REF} \,//\, R1$$

$$V_H = \frac{R1//R_{REF}}{R1//R_{REF} + R2}\,(V_{Omax} - V_{Omin})$$

FIGURE 3 — NON-INVERTING COMPARATOR WITH HYSTERESIS



$$V_{REF} = \frac{V_{CC}\,R1}{R_{REF} + R1}$$

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

Amount of Hysteresis V_M

$$V_H = \frac{R2}{R2 + R3}\,(V_{Omax} - V_{Omin})$$

TYPICAL CHARACTERISTICS

(V_{CC} = +15 Vdc, T_A = +25°C (each comparator) unless otherwise noted.)

FIGURE 4 — NORMALIZED INPUT OFFSET VOLTAGE

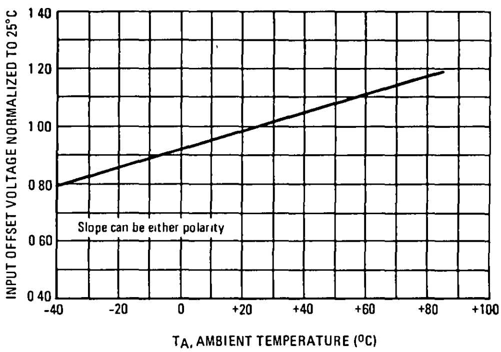


FIGURE 5 — INPUT BIAS CURRENT

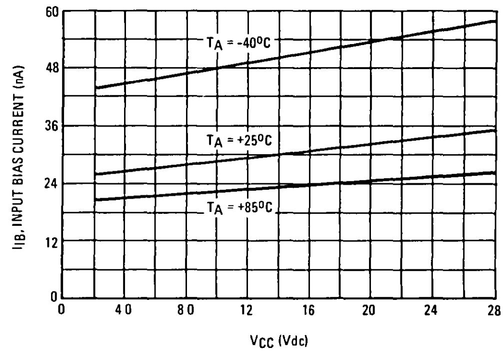


FIGURE 6 — NORMALIZED INPUT OFFSET CURRENT

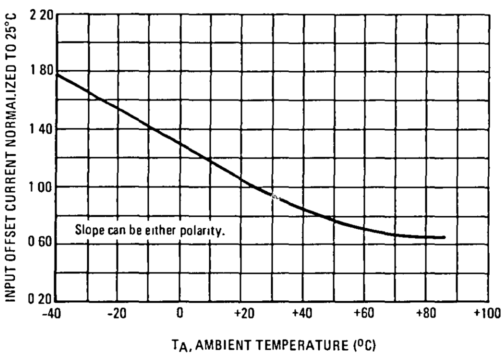


FIGURE 7 — OUTPUT SINK CURRENT versus OUTPUT VOLTAGE

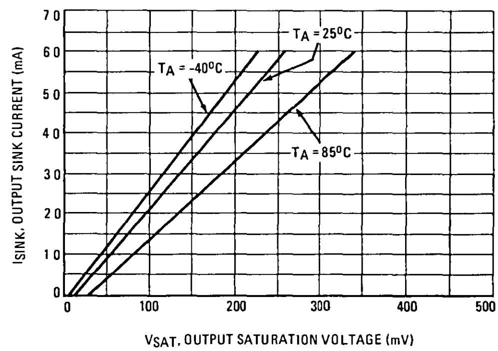
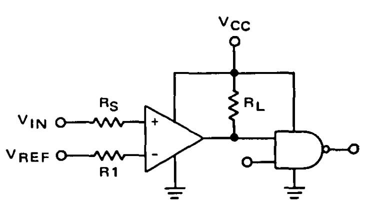


FIGURE 8 — DRIVING LOGIC



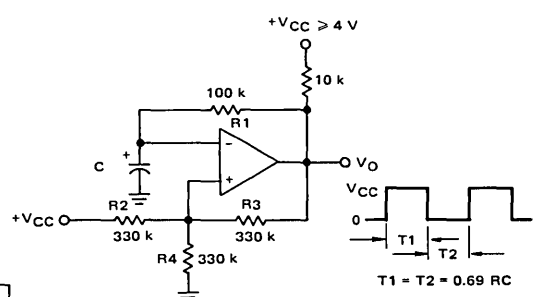
1/4 LM139, 139A

R_S = Source Resistance

R1 ≈ R_S

LOGIC	DEVICE	V_{CC} Volts	R_L kΩ
CMOS	1/4 MC14001	+15	100
TTL	1/4 MC7400	+5	10

FIGURE 9 — SQUAREWAVE OSCILLATOR



T1 = T2 = 0.69 RC

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

R2 = R3 = R4

R1 ≈ R2//R3//R4

7

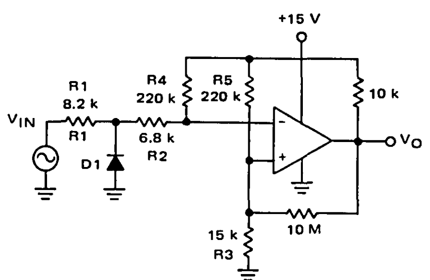
APPLICATIONS INFORMATION

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 kΩ should be used. The addition of positive feedback (<10 mV) is also recommended.

It is good design practive to ground all unused pins.

Differential input voltages may be larger than supply voltage without damaging the comparator's input voltages. More negative than −300 mV should not be used.

FIGURE 10 – ZERO CROSSING DETECTOR
(Single Supply)



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

$R1 + R2 = R3$

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

FIGURE 11 – ZERO CROSSING DETECTOR
(Split Supplies)

V_{INmin} ≈0.4 V peak for 1% phase distortion (ΔΘ).