

LM139/LM239/LM339/LM2901/LM3302 Low Power Low Offset Voltage Quad Comparators

General Description

The LM139 series consists of four independent precision voltage comparators with an offset voltage specification as low as 2 mV max for all four comparators. These were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

Application areas include limit comparators, simple analog to digital converters; pulse, squarewave and time delay generators; wide range VCO; MOS clock timers; multivibrators and high voltage digital logic gates. The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, they will directly interface with MOS logic— where the low power drain of the LM339 is a distinct advantage over standard comparators.

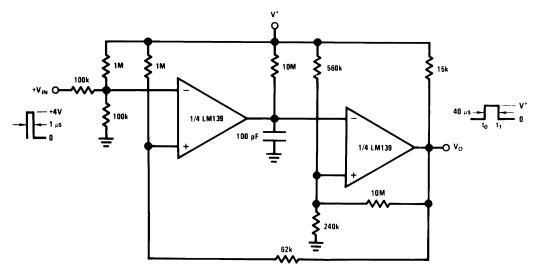
Features

- Wide supply voltage range
- LM139/139A Series
 2 to 36 V_{DC} or ±1 to ±18 V_{DC}
 LM2901:
 2 to 36 V_{DC} or ±1 to ±18 V_{DC}
- LM3302: 2 to 28 V_{DC} or ±1 to ±14 V_{DC}
- Very low supply current drain (0.8 mA) independent of supply voltage
- Low input biasing current: 25 nA
- Low input offset current: ±5 nA
- Offset voltage: ±3 mV
- Input common-mode voltage range includes GND
- Differential input voltage range equal to the power supply voltage
- Low output saturation voltage: 250 mV at 4 mA
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems

Advantages

- High precision comparators
- Reduced V_{OS} drift over temperature
- Eliminates need for dual supplies
- Allows sensing near GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

One-Shot Multivibrator with Input Lock Out



00570612

Absolute Maximum Ratings (Note 10)

Distributors for availability and specifications.

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/

LM139/LM239/LM339

LM139A/LM239A/LM339A LM3302 LM2901

Supply Voltage, V⁺ $36\ V_{DC}$ or $\pm 18\ V_{DC}$ $28\ V_{DC}$ or $\pm 14\ V_{DC}$ Differential Input Voltage (Note 8) $36\ V_{DC}$ $28\ V_{DC}$ $28\ V_{DC}$ Input Voltage $-0.3\ V_{DC}$ to $+36\ V_{DC}$ $-0.3\ V_{DC}$ to $+28\ V_{DC}$

Input Current (V_{IN} <-0.3 V_{DC}),

(Note 3) 50 mA 50 mA

Power Dissipation (Note 1)

Molded DIP 1050 mW 1050 mW

Cavity DIP 1190 mW Small Outline Package 760 mW

Output Short-Circuit to GND,

(Note 2) Continuous Continuous Storage Temperature Range -65°C to $+150^{\circ}\text{C}$ -65°C to $+150^{\circ}\text{C}$

Lead Temperature

(Soldering, 10 seconds) 260°C 260°C

Operating Temperature Range -40°C to +85°C

LM339/LM339A 0°C to +70°C
LM239/LM239A -25°C to +85°C
LM2901 -40°C to +85°C
LM139/LM139A -55°C to +125°C

Soldering Information

Dual-In-Line Package

Soldering (10 seconds) 260°C 260°C

Small Outline Package

Vapor Phase (60 seconds)215°C215°CInfrared (15 seconds)220°C220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

ESD rating (1.5 k Ω in series with 100 pF) 600V 600V

Electrical Characteristics

(V⁺=5 V_{DC} , $T_A = 25$ °C, unless otherwise stated)

Parameter	Conditions	LM139A		LM239A, LM339A			LM139			Units	
		Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	
Input Offset Voltage	(Note 9)		1.0	2.0		1.0	2.0		2.0	5.0	$\rm mV_{DC}$
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in		25	100		25	250		25	100	nA_{DC}
	Linear Range, (Note 5), V _{CM} =0V										
Input Offset Current	I _{IN(+)} -I _{IN(-)} , V _{CM} =0V		3.0	25		5.0	50		3.0	25	nA _{DC}
Input Common-Mode	V ⁺ =30 V _{DC} (LM3302,	0		V ⁺ -1.5	0		V+-1.5	0		V+-1.5	V _{DC}
Voltage Range	V ⁺ = 28 V _{DC}) (Note 6)										
Supply Current	R _L = ∞ on all Comparators,		0.8	2.0		0.8	2.0		0.8	2.0	mA_{DC}
	$R_L = \infty, V^+ = 36V,$					1.0	2.5		1.0	2.5	mA_DC
	(LM3302, $V^+ = 28 V_{DC}$)										
Voltage Gain	R _L ≥15 kΩ, V ⁺ = 15 V _{DC}	50	200		50	200		50	200		V/mV
	$V_O = 1 V_{DC}$ to 11 V_{DC}										
Large Signal	V _{IN} = TTL Logic Swing, V _{REF} =		300			300			300		ns
Response Time	$1.4 V_{DC}, V_{RL} = 5 V_{DC},$										

Electrical Characteristics (Continued)

(V⁺=5 V_{DC} , $T_A = 25^{\circ}C$, unless otherwise stated)

Parameter	Conditions	LM139A		LM239A, LM339A			LM139			Units
		Min Typ	Max	Min	Тур	Max	Min	Тур	Max	
	$R_L = 5.1 \text{ k}\Omega$									
Response Time	$V_{RL} = 5 \ V_{DC}, \ R_{L} = 5.1 \ k\Omega,$	1.3			1.3			1.3		μs
	(Note 7)									
Output Sink Current	$V_{IN(-)} = 1 \ V_{DC}, \ V_{IN(+)} = 0,$	6.0 16		6.0	16		6.0	16		mA _{DC}
	$V_{O} \le 1.5 V_{DC}$									
Saturation Voltage	$V_{IN(-)} = 1 V_{DC}, V_{IN(+)} = 0,$	250	400		250	400		250	400	mV_{DC}
	I _{SINK} ≤ 4 mA									
Output Leakage	$V_{IN(+)} = 1 \ V_{DC}, V_{IN(-)} = 0,$	0.1			0.1			0.1		nA _{DC}
Current	$V_O = 5 V_{DC}$									

Electrical Characteristics

(V⁺ = 5 V_{DC} , $T_A = 25$ °C, unless otherwise stated)

Parameter	Conditions	LM2	239, L	M339		LM29	01		LM33	02	Units
		Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	
Input Offset Voltage	(Note 9)		2.0	5.0		2.0	7.0		3	20	mV_{DC}
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in		25	250		25	250		25	500	nA_{DC}
	Linear Range, (Note 5), V _{CM} =0V										
Input Offset Current	$I_{IN(+)} - I_{IN(-)}, V_{CM} = 0V$		5.0	50		5	50		3	100	nA_{DC}
Input Common-Mode	$V^{+} = 30 V_{DC} (LM3302,$	0		V ⁺ -1.5	0		V ⁺ -1.5	0		V ⁺ -1.5	V_{DC}
Voltage Range	$V^{+} = 28 V_{DC}$) (Note 6)										
Supply Current	$R_L = \infty$ on all Comparators,		8.0	2.0		0.8	2.0		0.8	2.0	mA_{DC}
	$R_L = \infty, V^+ = 36V,$		1.0	2.5		1.0	2.5		1.0	2.5	mA_DC
	$(LM3302, V^+ = 28 V_{DC})$										
Voltage Gain	$R_L \ge 15 \text{ k}\Omega, V^+ = 15 V_{DC}$	50	200		25	100		2	30		V/mV
	$V_O = 1 V_{DC}$ to 11 V_{DC}										
Large Signal	V_{IN} = TTL Logic Swing, V_{REF} =		300			300			300		ns
Response Time	1.4 V_{DC} , $V_{RL} = 5 V_{DC}$,										
	$R_L = 5.1 \text{ k}\Omega,$										
Response Time	$V_{RL} = 5 V_{DC}, R_L = 5.1 k\Omega,$		1.3			1.3			1.3		μs
	(Note 7)										
Output Sink Current	$V_{IN(-)} = 1 V_{DC}, V_{IN(+)} = 0,$	6.0	16		6.0	16		6.0	16		mA_{DC}
	$V_O \le 1.5 V_{DC}$										
Saturation Voltage	$V_{IN(-)} = 1 V_{DC}, V_{IN(+)} = 0,$		250	400		250	400		250	500	${\rm mV_{DC}}$
	I _{SINK} ≤ 4 mA										
Output Leakage	$V_{IN(+)} = 1 \ V_{DC}, V_{IN(-)} = 0,$		0.1			0.1			0.1		nA_{DC}
Current	$V_O = 5 V_{DC}$										

Electrical Characteristics

 $(V^+ = 5.0 V_{DC}, (Note 4))$

Parameter	Conditions	LM1	LM239A, LM339A			LM1	Units		
		Min Typ	Max	Min	Тур	Max	Min Typ	Max	
Input Offset Voltage	(Note 9)		4.0			4.0		9.0	mV_{DC}
Input Offset Current	$I_{IN(+)} - I_{IN(-)}, V_{CM} = 0V$		100			150		100	nA _{DC}
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in		300			400		300	nA _{DC}
	Linear Range, V _{CM} = 0V (Note 5)								
Input Common-Mode	V ⁺ =30 V _{DC} (LM3302,	0	V+-2.0	0	,	V+-2.0	0	V+-2.0	V _{DC}
Voltage Range	V ⁺ = 28 V _{DC}) (Note 6)								

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Electrical Characteristics (Continued)

 $(V^+ = 5.0 V_{DC}, (Note 4))$

Parameter	Conditions	LM13	LM239A, LM339A			LM	Units		
		Min Typ	Max	Min	Тур	Max	Min Ty	o Max	
Saturation Voltage	$V_{IN(-)}=1 \ V_{DC}, \ V_{IN(+)}=0,$		700			700		700	mV_{DC}
	I _{SINK} ≤ 4 mA								
Output Leakage Current	$V_{IN(+)} = 1 V_{DC}, V_{IN(-)} = 0,$		1.0			1.0		1.0	μA _{DC}
	$V_{O} = 30 \ V_{DC}, \ (LM3302,$								
	$V_O = 28 V_{DC}$								
Differential Input Voltage	Keep all V_{IN} 's $\geq 0 V_{DC}$ (or V^- ,		36			36		36	V _{DC}
	if used), (Note 8)								

Electrical Characteristics

 $(V^+ = 5.0 V_{DC}, (Note 4))$

Parameter	Conditions	LM239, LM339		LM2901			LM3302			Units	
		Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	
Input Offset Voltage	(Note 9)			9.0		9	15			40	mV_{DC}
Input Offset Current	$I_{IN(+)} - I_{IN(-)}, V_{CM} = 0V$			150		50	200			300	nA _{DC}
Input Bias Current	I _{IN(+)} or I _{IN(-)} with Output in			400		200	500			1000	nA _{DC}
	Linear Range, V _{CM} = 0V (Note 5)										
Input Common-Mode	$V^{+} = 30 V_{DC} (LM3302, V^{+} = 28 V_{DC})$			V ⁺ -2.0	0		V ⁺ -2.0	0		V+-2.0	V _{DC}
Voltage Range	(Note 6)										
Saturation Voltage	$V_{IN(-)} = 1 V_{DC}, V_{IN(+)} = 0,$			700		400	700			700	mV_{DC}
	I _{SINK} ≤ 4 mA										
Output Leakage Current	$V_{IN(+)} = 1 \ V_{DC}, \ V_{IN(-)} = 0,$			1.0			1.0			1.0	μA _{DC}
	$V_{\rm O} = 30 \ V_{\rm DC}, \ (LM3302, \ V_{\rm O} = 28 \ V_{\rm DC})$										
Differential Input Voltage	Keep all V_{IN} 's $\geq 0 V_{DC}$ (or V^- ,			36			36			28	V _{DC}
	if used), (Note 8)										

Note 1: For operating at high temperatures, the LM339/LM339A, LM2901, LM3302 must be derated based on a 125°C maximum junction temperature and a thermal resistance of 95°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The LM239 and LM139 must be derated based on a 150°C maximum junction temperature. The low bias dissipation and the "ON-OFF" characteristic of the outputs keeps the chip dissipation very small (P_D≤100 mW), provided the output transistors are allowed to saturate.

Note 2: Short circuits from the output to V⁺ can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 20 mA independent of the magnitude of V⁺.

Note 3: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the comparators to go to the V⁺ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than -0.3 V_{DC} (at 25')C.

Note 4: These specifications are limited to $-55^{\circ}C \le T_A \le +125^{\circ}C$, for the LM139/LM139A. With the LM239/LM239A, all temperature specifications are limited to $-25^{\circ}C \le T_A \le +85^{\circ}C$, the LM339/LM339A temperature specifications are limited to $0^{\circ}C \le T_A \le +70^{\circ}C$, and the LM2901, LM3302 temperature range is $-40^{\circ}C \le T_A \le +85^{\circ}C$.

Note 5: The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.

Note 6: The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V⁺ –1.5V at 25°C, but either or both inputs can go to +30 V_{DC} without damage (25V for LM3302), independent of the magnitude of V⁺.

Note 7: The response time specified is a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained, see typical performance characteristics section.

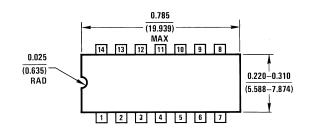
Note 8: Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than -0.3 V_{DC} (or 0.3 V_{DC}below the magnitude of the negative power supply, if used) (at 25°C).

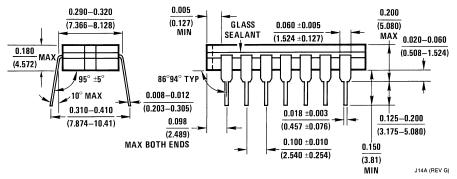
Note 9: At output switch point, $V_O \approx 1.4 \ V_{DC}$, $R_S = 0\Omega$ with V^+ from 5 V_{DC} to 30 V_{DC} ; and over the full input common-mode range (0 V_{DC} to V^+ –1.5 V_{DC}), at 25°C. For LM3302, V^+ from 5 V_{DC} to 28 V_{DC} .

Note 10: Refer to RETS139AX for LM139A military specifications and to RETS139X for LM139 military specifications.

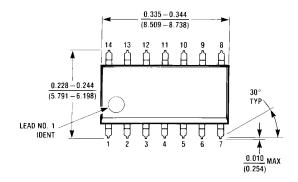
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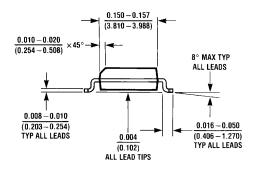
Physical Dimensions inches (millimeters) unless otherwise noted

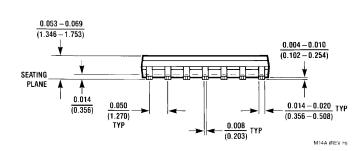




Ceramic Dual-In-Line Package (J) Order Number LM139J, LM139J/883, LM139AJ, LM139AJ/883, LM239J, LM239AJ, LM339J **NS Package Number J14A**

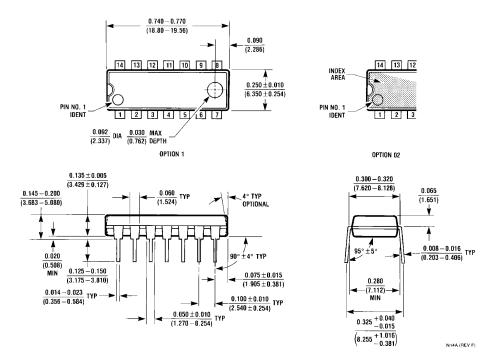




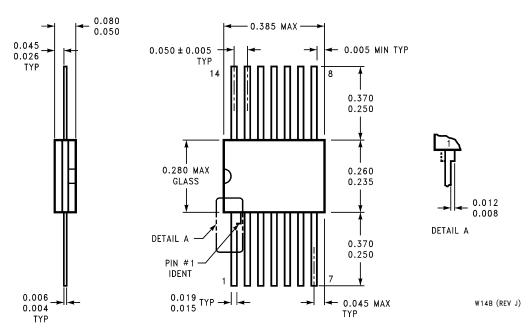


S.O. Package (M) Order Number LM339AM, LM339AMX, LM339M, LM339MX, LM2901M or LM2901MX **NS Package Number M14A**

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



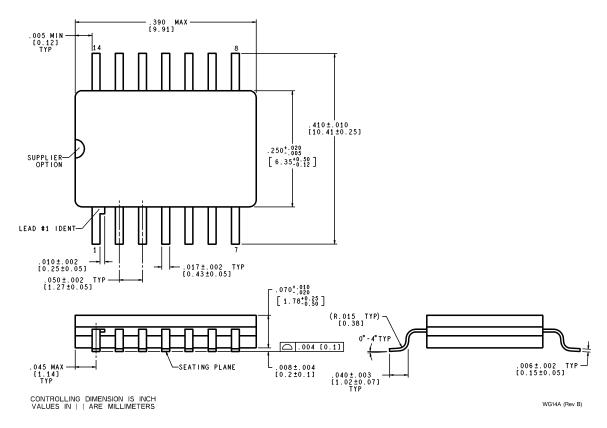
Molded Dual-In-Line Package (N)
Order Number LM339N, LM339AN, LM2901N or LM3302N
NS Package Number N14A



Order Number LM139AW/883, LM139W/883 NS Package Number W14B

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



Order Number LM139AWG/883, LM139WG/883 NS Package Number WG14A

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