

# DATA SHEET

## LM139/239/239A/339/339A/LM2901/MC 3302

Quad voltage comparator

Product specification

1995 Nov 27

IC11 Data Handbook





## **Quad voltage comparator**

## LM139/239/239A/339/339A /LM2901/MC3302

#### **DESCRIPTION**

The LM139 series consists of four independent precision voltage comparators, with an offset voltage specification as low as 2.0mV max for each comparator, which 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 they are operated from a single power supply voltage.

The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM139 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

#### **FEATURES**

- $\bullet$  Wide single supply voltage range 2.0V  $_{DC}$  to 36V  $_{DC}$  or dual supplies  $\pm 1.0$  V  $_{DC}$  to  $\pm 18$  V  $_{DC}$
- Very low supply current drain (0.8mA) independent of supply voltage (1.0mW/comparator at 5.0V<sub>DC</sub>)
- Low input biasing current 25nA
- Low input offset current ±5nA and offset voltage
- Input common–mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Low output 250mV at 4mA saturation voltage
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems

#### **APPLICATIONS**

- A/D converters
- Wide range VCO
- MOS clock generator
- High voltage logic gate
- Multivibrators

#### **PIN CONFIGURATION**

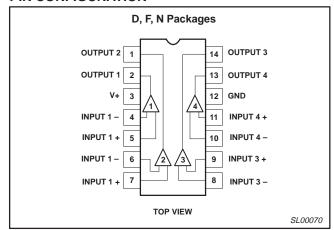


Figure 1. Pin Configuration

#### **EQUIVALENT CIRCUIT**

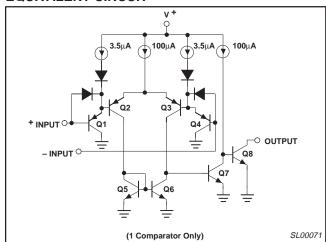


Figure 2. Equivalent Circuit

#### ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
14-Pin Ceramic Dual In-Line Package (Cerdip)	−55 to +125°C	LM139F	0581B
14-Pin Plastic Dual In-Line Package (DIP)	−25°C to +85°C	LM239AN	SOT27-1
14-Pin Plastic Dual In-Line Package (DIP)	−25°C to +85°C	LM239N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	−25°C to +85°C	LM239D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	-40°C to +125°C	LM2901N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	-40°C to +125°C	LM2901D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	LM339AN	SOT27-1
14-Pin Plastic Small Outline (SO) Package	0 to +70°C	LM339D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	LM339N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	−40°C to +85°C	MC3302D	SOT108-1
14-Pin Ceramic Dual In-Line Package (Cerdip)	-40°C to +85°C	MC3302F	0581B
14-Pin Plastic Dual In-Line Package (DIP)	-40°C to +85°C	MC3302N	SOT27-1
14-Pin Plastic Dual In-Line Package (DIP)	−55 to +125°C	LM139N	SOT27-1

## Quad voltage comparator

### LM139/239/239A/339/339A/ LM2901/MC3302

#### **ABSOLUTE MAXIMUM RATINGS**

SYMBOL	PARAMETER	RATING	UNIT	
V <sub>CC</sub>	V <sub>CC</sub> supply voltage	36 or ±18	$V_{DC}$	
$V_{DIFF}$	Differential input voltage	36	V <sub>DC</sub>	
V <sub>IN</sub>	Input voltage	-0.3 to +36	V <sub>DC</sub>	
$P_{D}$	Maximum power dissipation, $T_A=25^{\circ}C \text{ (still-air)}^1$			
	F package	1190	mW	
	N package	1420	mW	
	D package	1040	mW	
	Output short–circuit to ground <sup>2</sup>	Continuous		
I <sub>IN</sub>	Input current (V <sub>IN</sub> <-0.3V <sub>DC</sub> ) <sup>3</sup>	50	mA	
T <sub>A</sub>	Operating temperature range			
	LM139	-55 to +125	°C	
	LM239/239A	−25 to +85	°C	
	LM339/339A	0 to +70	°C	
	LM2901	-40 to +125	°C	
	MC3302	-40 to +85	°C	
T <sub>STG</sub>	Storage temperature range	-65 to +150	°C	
T <sub>SOLD</sub>	Lead soldering temperature (10sec max)	300	°C	

#### NOTES:

- 1. Derate above 25°C, at the following rates:
  - F Package at 9.5mW/°C
  - N Package at 11.4mW/°C
  - D Package at 8.3mW/°C
- 2. Short circuits from the output to V+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA independent of the magnitude of V+.
- 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 reestablish when the input voltage, which was negative, again returns to a value greater than -0.3V<sub>DC</sub>.

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## Quad voltage comparator

LM139/239/239A/339/339A/ LM2901/MC3302

#### DC AND AC ELECTRICAL CHARACTERISTICS

 $V + = 5 \\ V_{DC}, \\ LM139: \\ -55^{\circ}C \leq T_{A} \leq 125^{\circ}C; \\ LM239/239A: \\ -25^{\circ}C \leq T_{A} \leq 85^{\circ}C; \\ LM339/339A: \\ 0^{\circ}C \leq T_{A} \leq 70^{\circ}C; \\ LM2901: \\ -40^{\circ}C \leq T_{A} \leq 125^{\circ}C, \\ MC3302: \\ -40^{\circ}C \leq T_{A} \leq 85^{\circ}C, \\ \\ unless otherwise specified.$ 

SYMBOL	DADAMETED	TEST CONDITIONS		LM239A/339A		
STWBUL	PARAMETER	TEST CONDITIONS	Min	Тур	Max	UNIT
V <sub>OS</sub>	Input offset voltage <sup>2</sup>	T <sub>A</sub> =25°C Over temp.		±1.0	±2.0 ±4.0	mV mV
V <sub>CM</sub>	Input common-mode voltage range <sup>3</sup>	T <sub>A</sub> =25°C Over temp.	0		V+-1.5 V+-2.0	V
$V_{IDR}$	Differential input voltage <sup>1</sup>	Keep all V <sub>IN</sub> <sup>s</sup> ≥0V <sub>DC</sub> (or V– if need)			V+	V
I <sub>BIAS</sub>	Input bias current <sup>4</sup>	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range $T_A$ =25°C Over temp.		25	250 400	nA nA
Ios	Input offset current	I <sub>IN(+)</sub> -I <sub>IN(-)</sub> T <sub>A</sub> =25°C		±5.0	±50	nA
		Over temp.			±150	nA
I <sub>OL</sub>	Output sink current	$V_{IN(-)} \ge 1V_{DC}, V_{IN}(+) = 0,$ $V_{O} \le 1.5V_{DC},$ $T_{A} = 25^{\circ}C$	6.0	16		mA
	Output leakage current	V <sub>IN(+)</sub> ≥1V <sub>DC</sub> , V <sub>IN</sub> (-)=0 V <sub>O</sub> =5V <sub>DC</sub> , T <sub>A</sub> =25°C V <sub>O</sub> =30V <sub>DC</sub> , over temp.		0.1	1.0	nA μA
I <sub>CC</sub>	Supply current	$R_L=\infty$ on comparators, $T_A=25^{\circ}C$ $V+=30V$		0.8	2.0	mA
A <sub>V</sub>	Voltage gain	R <sub>L</sub> ≥15kΩ, V+=15V <sub>DC</sub>	50	200		V/mV
V <sub>OL</sub>	Saturation voltage			400 700	mV mV	
t <sub>LSR</sub>	Large-signal response time	$V_{IN}$ =TTL logic swing, $V_{REF}$ =1.4 $V_{DC}$ , $V_{RL}$ =5 $V_{DC}$ , $R_L$ =5.1 $k\Omega$ , $T_A$ =25°C			ns	
t <sub>R</sub>	Response time <sup>5</sup>	$V_{RL}$ =5 $V_{DC}$ , $R_L$ =5.1 $k\Omega$ , $T_A$ =25°C		1.3		μs

See notes at the end of the Electrical Characteristics.

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#### DC AND AC ELECTRICAL CHARACTERISTICS

 $V+=5V_{DC}, LM139: -55^{\circ}C \leq T_{A} \leq 125^{\circ}C; LM239/239A: -25^{\circ}C \leq T_{A} \leq 85^{\circ}C; LM339/339A: 0^{\circ}C \leq T_{A} \leq 70^{\circ}C; LM2901: -40^{\circ}C \leq T_{A} \leq 125^{\circ}C, MC3302: -40^{\circ}C \leq T_{A} \leq 85^{\circ}C, unless otherwise specified.$ 

SYMBOL	PARAMETER	TEST CONDITIONS	LM139			LM239/339			UNIT
STWIBUL	PARAMETER	TEST CONDITIONS		Тур	Max	Min	Тур	Max	UNII
V <sub>OS</sub>	Input offset voltage <sup>2</sup>	T <sub>A</sub> =25°C Over temp.		±2.0	±5.0 ±9.0		±2.0	±5.0 ±9.0	mV mV
V <sub>CM</sub>	Input common–mode voltage range <sup>3</sup>	T <sub>A</sub> =25°C Over temp.	0 0		V+-1.5 V+-2.0	0 0		V+-1.5 V+-2.0	V
V <sub>IDR</sub>	Differential input voltage <sup>1</sup>	Keep all V <sub>IN</sub> S≥0V <sub>DC</sub> (or V– if need)			V+			V+	V
I <sub>BIAS</sub>	Input bias current <sup>4</sup>			250 400	nA nA				
I <sub>OS</sub>	Input offset current	$I_{IN(+)}^{-I}I_{IN(-)}$ $T_A=25^{\circ}C$ Over temp.		±3.0	±25 ±100		±5.0	±50 ±150	nA nA
I <sub>OL</sub>	Output sink current	V <sub>IN(-)</sub> ≥1V <sub>DC</sub> , V <sub>IN</sub> (+)=0, V <sub>O</sub> ≤1.5V <sub>DC</sub> , T <sub>A</sub> =25°C	6.0	16		6.0	16		mA
	Output leakage current	$V_{IN(+)} \ge 1V_{DC}$ , $V_{IN}(-) = 0$ $V_{O} = 5V_{DC}$ , $T_{A} = 25^{\circ}C$ $V_{O} = 30V_{DC}$ , over temp.		0.1	1.0		0.1	1.0	nA μA
I <sub>CC</sub>	Supply current	$R_L=\infty$ on comparators, $T_A=25^{\circ}C$ V+=30V		0.8	2.0		0.8	2.0	mA
A <sub>V</sub>	Voltage gain	R <sub>L</sub> ≥15kΩ, V+=15V <sub>DC</sub>	50	200		50	200		V/mV
V <sub>OL</sub>	Saturation voltage	$V_{IN(-)} \ge 1V_{DC}, V_{IN(+)} = 0,$ $I_{SINK} \le 4mA$ $T_A = 25^{\circ}C$ Over temp.		250	400 700		250	400 700	mV mV
t <sub>LSR</sub>	Large-signal response time	$\begin{array}{c cccc} V_{\text{IN}} = \text{TTL logic swing, } V_{\text{REF}} = 1.4 V_{\text{DC}}, \\ V_{\text{RL}} = 5 V_{\text{DC}}, \ R_{\text{L}} = 5.1 \text{k}\Omega, \ T_{\text{A}} = 25^{\circ}\text{C} \end{array} \qquad 300 \qquad 300$			ns				
t <sub>R</sub>	Response time <sup>5</sup>	$V_{RL}$ =5 $V_{DC}$ , $R_L$ =5.1 $k\Omega$ , $T_A$ =25° $C$		1.3			1.3		μs

See notes on following page.

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#### DC AND AC ELECTRICAL CHARACTERISTICS

 $V + = 5V_{DC}, LM139: -55^{\circ}C \leq T_{A} \leq 125^{\circ}C; LM239/239A: -25^{\circ}C \leq T_{A} \leq 85^{\circ}C; LM339/339A: 0^{\circ}C \leq T_{A} \leq 70^{\circ}C; LM2901: -40^{\circ}C \leq T_{A} \leq 125^{\circ}C, MC3302: -40^{\circ}C \leq T_{A} \leq 85^{\circ}C, unless otherwise specified.$ 

OVMDOL	PARAMETER	TEST CONDITIONS	LM2901			MC3302			
SYMBOL		TEST CONDITIONS	Min	Тур	Max	Min	Тур	Max	UNIT
Vos	Input offset voltage <sup>2</sup>	T <sub>A</sub> =25°C		±2.0	±7.0		±3.0	±20	mV
VOS		Over temp.		±9	±15			±40	mV
$V_{CM}$	Input common–mode voltage	T <sub>A</sub> =25°C	0		V+-1.5	0		V+-1.5	V
- CIVI	range <sup>3</sup>	Over temp.	0		V+-2.0	0		V+-2.0	
\ /	Differential import value and	Keep all			\ \/.			\/.	\ ,,
$V_{IDR}$	Differential input voltage <sup>1</sup>	V <sub>IN</sub> s≥0V <sub>DC</sub> (or V– if need)			V+			V+	V
		$I_{IN(+)}$ or $I_{IN(-)}$ with output in							
		linear range							
I <sub>BIAS</sub>	Input bias current <sup>4</sup>	T <sub>A</sub> =25°C		25	250		25	500	nA
		Over temp.		200	500			1000	nA
		I <sub>IN(+)</sub> —I <sub>IN(-)</sub>							
Ios	Input offset current	T <sub>A</sub> =25°C		±5	±50		±5	±100	nA
		Over temp.		±50	±200			±300	nA
I <sub>OL</sub> Outp		$V_{IN(-)} \ge 1V_{DC}, V_{IN}(+) = 0,$	6.0 16 6		16				
	Output sink current	V <sub>O</sub> ≤1.5V <sub>DC</sub> ,							mA
		T <sub>A</sub> =25°C					<u> </u>		
		$V_{IN(+)} \ge 1 V_{DC}, V_{IN}(-) = 0$							
		V <sub>O</sub> =5V <sub>DC</sub> ,							
	Output leakage current	T <sub>A</sub> =25°C		0.1			0.1		nA
		$V_O=30V_{DC}$							
		over temp.			1.0			1.0	μΑ
		R <sub>L</sub> =∞ on all comparators,					.8	1.8	mA
Icc	Supply current	T <sub>A</sub> =25°C		0.8	2.0				
		R <sub>L</sub> =∞ on all comparators, V+=30V		1.0	2.5				mA
A <sub>V</sub>	Voltage gain	R <sub>L</sub> ≥15kΩ,	25	100		2	100		V/mV
/ \v	Voltage gain	V+=15V <sub>DC</sub>	20	100			100		V/111V
		$V_{IN(-)} \ge 1 V_{DC}, V_{IN(+)} = 0,$							
V <sub>OL</sub>	Saturation voltage	I <sub>SINK</sub> ≤4mA T <sub>A</sub> =25°C			400		150	400	mV
		Over temp.		400	700		150	700	mV
		V <sub>IN</sub> =TTL logic swing, V <sub>REF</sub> =1.4V <sub>DC</sub> ,			, , , ,			700	
$t_{LSR}$	Large-signal response time	$V_{RL}=5V_{DC}$ , $R_{L}=5.1k\Omega$ , $T_{A}=25^{\circ}C$		300			300	ns	
t <sub>R</sub>	Response time <sup>5</sup>	$V_{RL}=5V_{DC}$ , $R_{L}=5.1k\Omega$ ,			μs				
*/\	. toop one and	T <sub>A</sub> =25°C					10		س ا

#### NOTES:

- Positive excursions of input voltage may exceed the power supply level by 17V. 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 -0.3V<sub>DC</sub> (or 0.3V<sub>DC</sub> below the magnitude of the negative power supply, if used).
- 2. At output switch point,  $V_O \approx 1.4 V_{DC}$ ,  $R_S = 0 \Omega$  with V+ from 5V<sub>DC</sub> to 30V<sub>DC</sub>; and over the full input common—mode range (0V<sub>DC</sub> to V+  $-1.5 V_{DC}$ ). Inputs of unused comparators should be grounded.
- 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, but either or both inputs can go to 30V<sub>DC</sub> without damage.
- 4. 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.
- 5. The response time specified is for a 100mV input step with a 5mV overdrive. For larger overdrive signals, 300ns can be obtained (see typical performance characteristics section).

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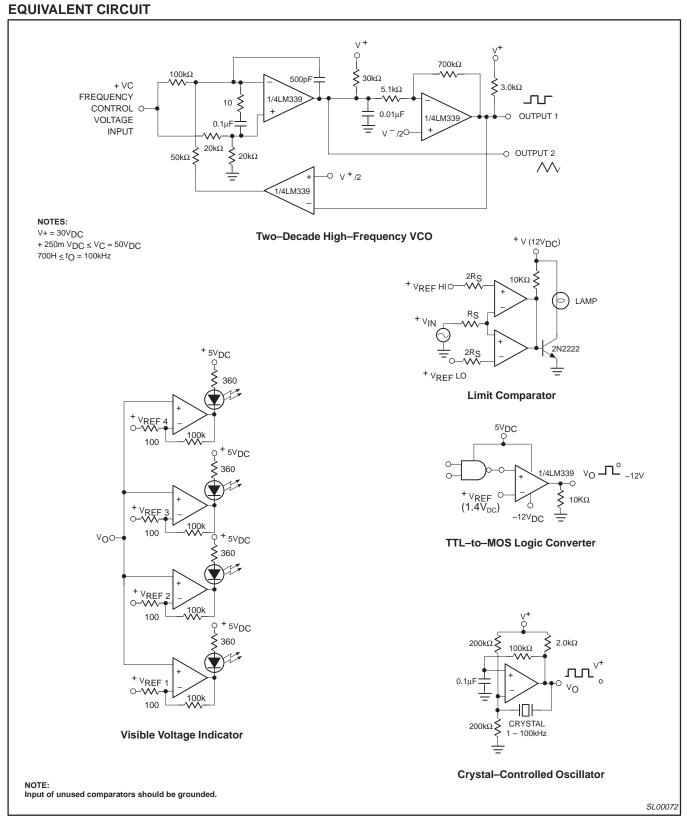


Figure 3. Equivalent Circuit

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#### TYPICAL PERFORMANCE CHARACTERISTICS

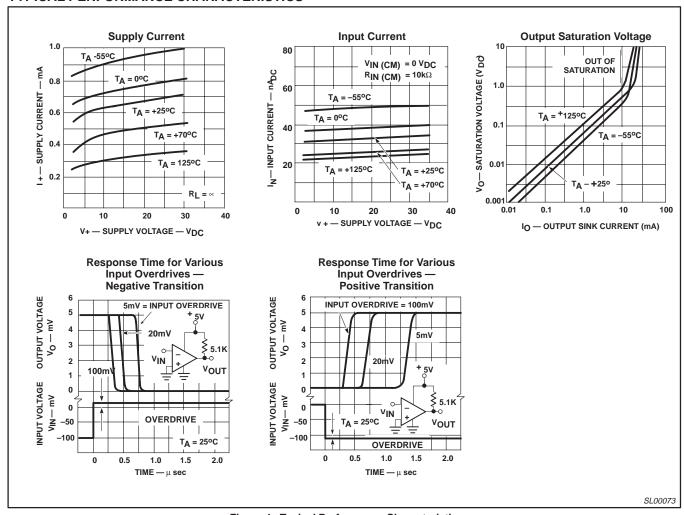


Figure 4. Typical Performance Characteristics

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## Quad voltage comparator

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