

DATA SHEET

**LM139/239/239A/339/339A/
LM2901/MC3302**
Quad voltage comparator

Product data
Supersedes data of 2001 Aug 03
File under Integrated Circuits, IC11 Handbook

2002 Jan 22

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 2.0 mV 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

- Wide single supply voltage range 2.0 V_{DC} to 36 V_{DC} or dual supplies ± 1.0 V_{DC} to ± 18 V_{DC}
- Very low supply current drain (0.8 mA) independent of supply voltage (1.0 mW/comparator at 5.0 V_{DC})
- Low input biasing current 25 nA
- Low input offset current ± 5 nA and offset voltage
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Low output 250 mV at 4 mA 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

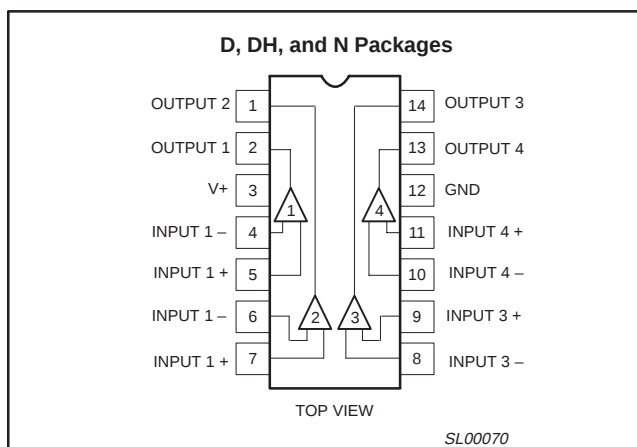


Figure 1. Pin Configuration

EQUIVALENT CIRCUIT

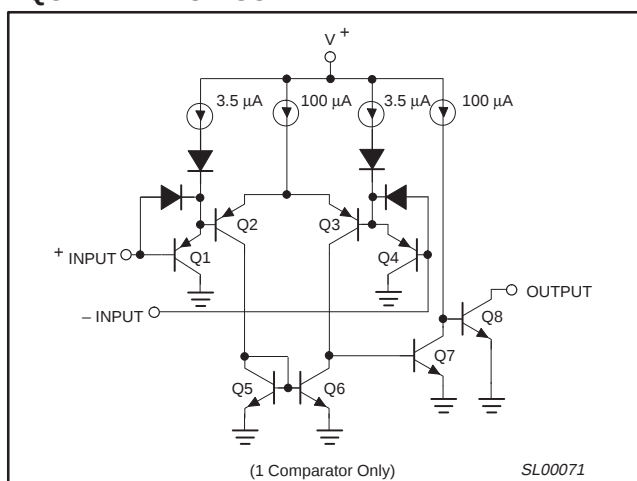


Figure 2. Equivalent Circuit

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
14-Pin Plastic Dual In-Line Package (DIP)	-55 °C to +125 °C	LM139N	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)	-25 °C to +85 °C	LM239N	SOT27-1
14-Pin Plastic Dual In-Line Package (DIP)	-25 °C to +85 °C	LM239AN	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)	-40 °C to +125 °C	LM2901N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	0 °C to +70 °C	LM339AD	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	LM339AN	SOT27-1
14-Pin Plastic Small Outline (SO) Package	0 °C to +70 °C	LM339D	SOT108-1
14-Pin Plastic Thin Shrink Small Outline Package (TSSOP)	0 °C to +70 °C	LM339DH	SOT402-1
14-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	LM339N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	-40 °C to +85 °C	MC3302D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	-40 °C to +85 °C	MC3302N	SOT27-1

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ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	V_{CC} supply voltage	36 or ± 18	V_{DC}
V_{DIFF}	Differential input voltage	36	V_{DC}
V_{IN}	Input voltage	-0.3 to $+36$	V_{DC}
P_D	Maximum power dissipation, $T_{amb} = 25\text{ }^{\circ}\text{C}$ (still-air) ¹		
	N package	1420	mW
	D package	1040	mW
	LM339DH package	762	mW
	Output short-circuit to ground ²	Continuous	
I_{IN}	Input current ($V_{IN} < -0.3 V_{DC}$) ³	50	mA
T_{amb}	Operating temperature range		
	LM139	-55 to $+125$	$^{\circ}\text{C}$
	LM239/239A	-25 to $+85$	$^{\circ}\text{C}$
	LM339/339A	0 to $+70$	$^{\circ}\text{C}$
	LM2901	-40 to $+125$	$^{\circ}\text{C}$
	MC3302	-40 to $+85$	$^{\circ}\text{C}$
T_{stg}	Storage temperature range	-65 to $+150$	$^{\circ}\text{C}$
T_{sld}	Lead soldering temperature (10 sec max)	230	$^{\circ}\text{C}$

NOTES:

- Derate above $25\text{ }^{\circ}\text{C}$, at the following rates:
 N Package at $11.4\text{ mW}/^{\circ}\text{C}$
 D Package at $8.3\text{ mW}/^{\circ}\text{C}$
 DH Package at $6.1\text{ mW}/^{\circ}\text{C}$
- Short circuits from the output to $V+$ can cause excessive heating and eventual destruction. The maximum output current is approximately 20 mA independent of the magnitude of $V+$.
- 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 $-0.3 V_{DC}$.

Quad voltage comparator

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DC AND AC ELECTRICAL CHARACTERISTICS

$V_+ = 5 V_{DC}$; LM139: $-55\text{ }^{\circ}\text{C} \leq T_{amb} \leq +125\text{ }^{\circ}\text{C}$; LM239/239A: $-25\text{ }^{\circ}\text{C} \leq T_{amb} \leq +85\text{ }^{\circ}\text{C}$; LM339/339A: $0\text{ }^{\circ}\text{C} \leq T_{amb} \leq +70\text{ }^{\circ}\text{C}$;

LM2901: $-40\text{ }^{\circ}\text{C} \leq T_{amb} \leq +125\text{ }^{\circ}\text{C}$; MC3302: $-40\text{ }^{\circ}\text{C} \leq T_{amb} \leq +85\text{ }^{\circ}\text{C}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM239A/339A			UNIT
			Min	Typ	Max	
V_{OS}	Input offset voltage ²	$T_{amb} = 25\text{ }^{\circ}\text{C}$		± 1.0	± 2.0	mV
		Over temp.			± 4.0	mV
V_{CM}	Input common-mode voltage range ³	$T_{amb} = 25\text{ }^{\circ}\text{C}$	0		$V_+ - 1.5$	V
		Over temp.	0		$V_+ - 2.0$	V
V_{IDR}	Differential input voltage ¹	Keep all $V_{IN} \geq 0 V_{DC}$ (or V_- if needed)			V_+	V
I_{BIAS}	Input bias current ⁴	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range		25	250	nA
		$T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.			400	nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		± 5.0	± 50 ± 150	nA nA
I_{OL}	Output sink current	$V_{IN(-)} \geq 1 V_{DC}$; $V_{IN(+)} = 0$; $V_O \leq 1.5 V_{DC}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$	6.0	16		mA
	Output leakage current	$V_{IN(+)} \geq 1 V_{DC}$; $V_{IN(-)} = 0$ $V_O = 5 V_{DC}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$ $V_O = 30 V_{DC}$; over temp.		0.1	1.0	nA μA
I_{CC}	Supply current	$R_L = \infty$ on comparators; $V_+ = 30\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		0.8	2.0	mA
A_V	Voltage gain	$R_L \geq 15\text{ k}\Omega$; $V_+ = 15 V_{DC}$	50	200		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \geq 1 V_{DC}$; $V_{IN(+)} = 0$; $I_{SINK} \leq 4\text{ mA}$ $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		250	400 700	mV mV
t_{LSR}	Large-signal response time	$V_{IN} = \text{TTL logic swing}$; $V_{REF} = 1.4 V_{DC}$; $V_{RL} = 5 V_{DC}$; $R_L = 5.1\text{ k}\Omega$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		300		ns
t_R	Response time ⁵	$V_{RL} = 5 V_{DC}$; $R_L = 5.1\text{ k}\Omega$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		1.3		μs

See notes at the end of the Electrical Characteristics.

Quad voltage comparator

LM139/239/239A/339/339A/
LM2901/MC3302**DC AND AC ELECTRICAL CHARACTERISTICS** (continued)

$V_+ = 5 V_{DC}$; LM139: $-55\text{ }^{\circ}\text{C} \leq T_{amb} \leq +125\text{ }^{\circ}\text{C}$; LM239/239A: $-25\text{ }^{\circ}\text{C} \leq T_{amb} \leq +85\text{ }^{\circ}\text{C}$; LM339/339A: $0\text{ }^{\circ}\text{C} \leq T_{amb} \leq +70\text{ }^{\circ}\text{C}$;

LM2901: $-40\text{ }^{\circ}\text{C} \leq T_{amb} \leq +125\text{ }^{\circ}\text{C}$; MC3302: $-40\text{ }^{\circ}\text{C} \leq T_{amb} \leq +85\text{ }^{\circ}\text{C}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM139			LM239/339			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage ²	$T_{amb} = 25\text{ }^{\circ}\text{C}$		± 2.0	± 5.0		± 2.0	± 5.0	mV
		Over temp.			± 9.0			± 9.0	mV
V_{CM}	Input common-mode voltage range ³	$T_{amb} = 25\text{ }^{\circ}\text{C}$	0		$V_+ - 1.5$	0		$V_+ - 1.5$	V
		Over temp.	0		$V_+ - 2.0$	0		$V_+ - 2.0$	V
V_{IDR}	Differential input voltage ¹	Keep all $V_{IN} \geq 0 V_{DC}$ (or V_- if needed)			V_+			V_+	V
I_{BIAS}	Input bias current ⁴	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		25	100 300		25	250 400	nA nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		± 3.0	± 25 ± 100		± 5.0	± 50 ± 150	nA nA
I_{OL}	Output sink current	$V_{IN(+)} \geq 1 V_{DC}$; $V_{IN(-)} = 0$; $V_O \leq 1.5 V_{DC}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$	6.0	16		6.0	16		mA
	Output leakage current	$V_{IN(+)} \geq 1 V_{DC}$; $V_{IN(-)} = 0$ $V_O = 5 V_{DC}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$ $V_O = 30 V_{DC}$; Over temp.		0.1	1.0		0.1	1.0	nA μA
I_{CC}	Supply current	$R_L = \infty$ on comparators; $V_+ = 30\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		0.8	2.0		0.8	2.0	mA
A_V	Voltage gain	$R_L \geq 15\text{ k}\Omega$; $V_+ = 15 V_{DC}$	50	200		50	200		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \geq 1 V_{DC}$; $V_{IN(+)} = 0$; $I_{SINK} \leq 4\text{ mA}$ $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		250	400 700		250	400 700	mV mV
t_{LSR}	Large-signal response time	$V_{IN} = \text{TTL logic swing}$; $V_{REF} = 1.4 V_{DC}$; $V_{RL} = 5 V_{DC}$; $R_L = 5.1\text{ k}\Omega$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		300			300		ns
t_R	Response time ⁵	$V_{RL} = 5 V_{DC}$; $R_L = 5.1\text{ k}\Omega$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		1.3			1.3		μs

See notes on following page.

Quad voltage comparator

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DC AND AC ELECTRICAL CHARACTERISTICS (continued)

$V_+ = 5 V_{DC}$; LM139: $-55\text{ }^{\circ}\text{C} \leq T_{amb} \leq +125\text{ }^{\circ}\text{C}$; LM239/239A: $-25\text{ }^{\circ}\text{C} \leq T_{amb} \leq +85\text{ }^{\circ}\text{C}$; LM339/339A: $0\text{ }^{\circ}\text{C} \leq T_{amb} \leq +70\text{ }^{\circ}\text{C}$;

LM2901: $-40\text{ }^{\circ}\text{C} \leq T_{amb} \leq +125\text{ }^{\circ}\text{C}$; MC3302: $-40\text{ }^{\circ}\text{C} \leq T_{amb} \leq +85\text{ }^{\circ}\text{C}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM2901			MC3302			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage ²	$T_{amb} = 25\text{ }^{\circ}\text{C}$		± 2.0	± 7.0		± 3.0	± 20	mV
		Over temp.		± 9	± 15			± 40	mV
V_{CM}	Input common-mode voltage range ³	$T_{amb} = 25\text{ }^{\circ}\text{C}$	0		$V_+ - 1.5$	0		$V_+ - 1.5$	V
		Over temp.	0		$V_+ - 2.0$	0		$V_+ - 2.0$	V
V_{IDR}	Differential input voltage ¹	Keep all $V_{IN} \geq 0 V_{DC}$ (or V_- if needed)			V_+			V_+	V
I_{BIAS}	Input bias current ⁴	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		25 200	250 500		25 500	500 1000	nA nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		± 5 ± 50	± 50 ± 200		± 5	± 100 ± 300	nA nA
I_{OL}	Output sink current	$V_{IN(-)} \geq 1 V_{DC}$; $V_{IN(+)} = 0$; $V_O \leq 1.5 V_{DC}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$	6.0	16		6	16		mA
	Output leakage current	$V_{IN(+)} \geq 1 V_{DC}$; $V_{IN(-)} = 0$ $V_O = 5 V_{DC}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$ $V_O = 30 V_{DC}$; Over temp.		0.1	1.0		0.1	1.0	nA μA
I_{CC}	Supply current	$R_L = \infty$ on all comparators, $T_{amb} = 25\text{ }^{\circ}\text{C}$		0.8	2.0		0.8	1.8	mA
		$R_L = \infty$ on all comparators, $V_+ = 30\text{ V}$		1.0	2.5				mA
A_V	Voltage gain	$R_L \geq 15\text{ k}\Omega$; $V_+ = 15 V_{DC}$	25	100		2	100		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \geq 1 V_{DC}$; $V_{IN(+)} = 0$; $I_{SINK} \leq 4\text{ mA}$ $T_{amb} = 25\text{ }^{\circ}\text{C}$ Over temp.		400	400 700		150	400 700	mV mV
t_{LSR}	Large-signal response time	$V_{IN} = \text{TTL logic swing}$; $V_{REF} = 1.4 V_{DC}$; $V_{RL} = 5 V_{DC}$; $R_L = 5.1\text{ k}\Omega$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		300			300		ns
t_R	Response time ⁵	$V_{RL} = 5 V_{DC}$; $R_L = 5.1\text{ k}\Omega$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		1.3			1.3		μs

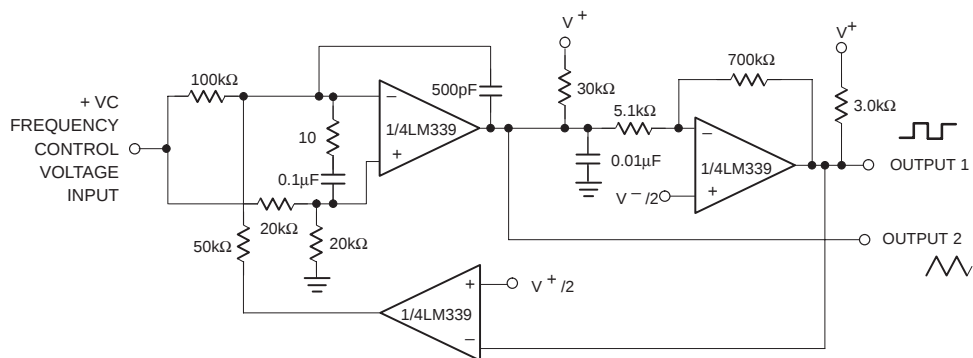
NOTES:

- Positive excursions of input voltage may exceed the power supply level by 17 V. 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 output switch point, $V_O \approx 1.4 V_{DC}$, $R_S = 0\text{ }\Omega$ with V_+ from $5 V_{DC}$ to $30 V_{DC}$; and over the full input common-mode range ($0 V_{DC}$ to $V_+ - 1.5 V_{DC}$). 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 0.3 V . The upper end of the common-mode voltage range is $V_+ - 1.5\text{ V}$, but either or both inputs can go to $30 V_{DC}$ without damage.
- 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.
- The response time specified is for a 100 mV input step with a 5 mV overdrive. For larger overdrive signals, 300 ns can be obtained (see Figure 4, Typical performance characteristics).

Quad voltage comparator

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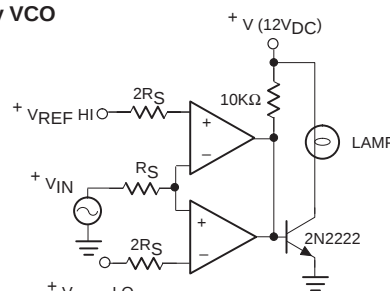
EQUIVALENT CIRCUIT



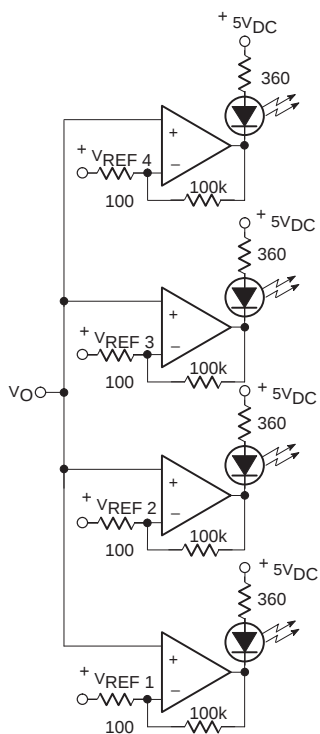
NOTES:

V₊ = 30V_{DC}
 + 250m V_{DC} ≤ V_C = 50V_{DC}
 700Hz ≤ f_O = 100kHz

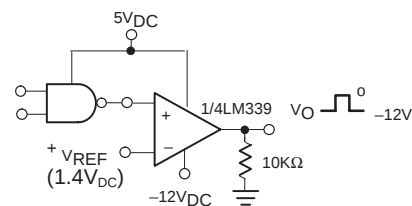
Two-Decade High Frequency VCO



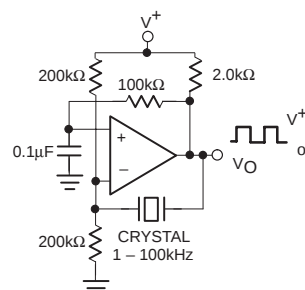
Limit Comparator



Visible Voltage Indicator



TTL-to-MOS Logic Converter



Crystal-Controlled Oscillator

NOTE:
 Input of unused comparators should be grounded.

SL00072

Figure 3. Equivalent circuit.

Quad voltage comparator

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TYPICAL PERFORMANCE CHARACTERISTICS

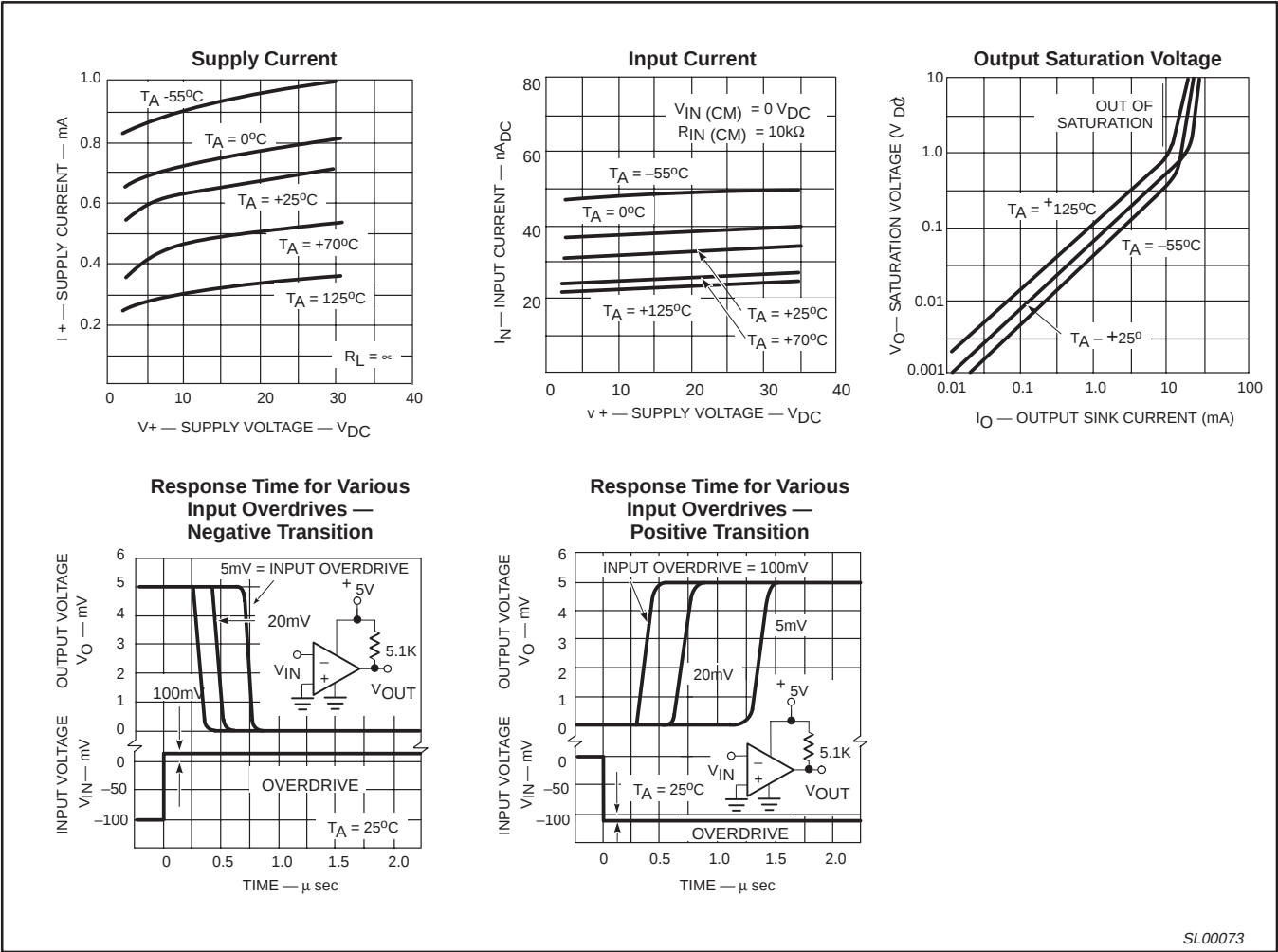


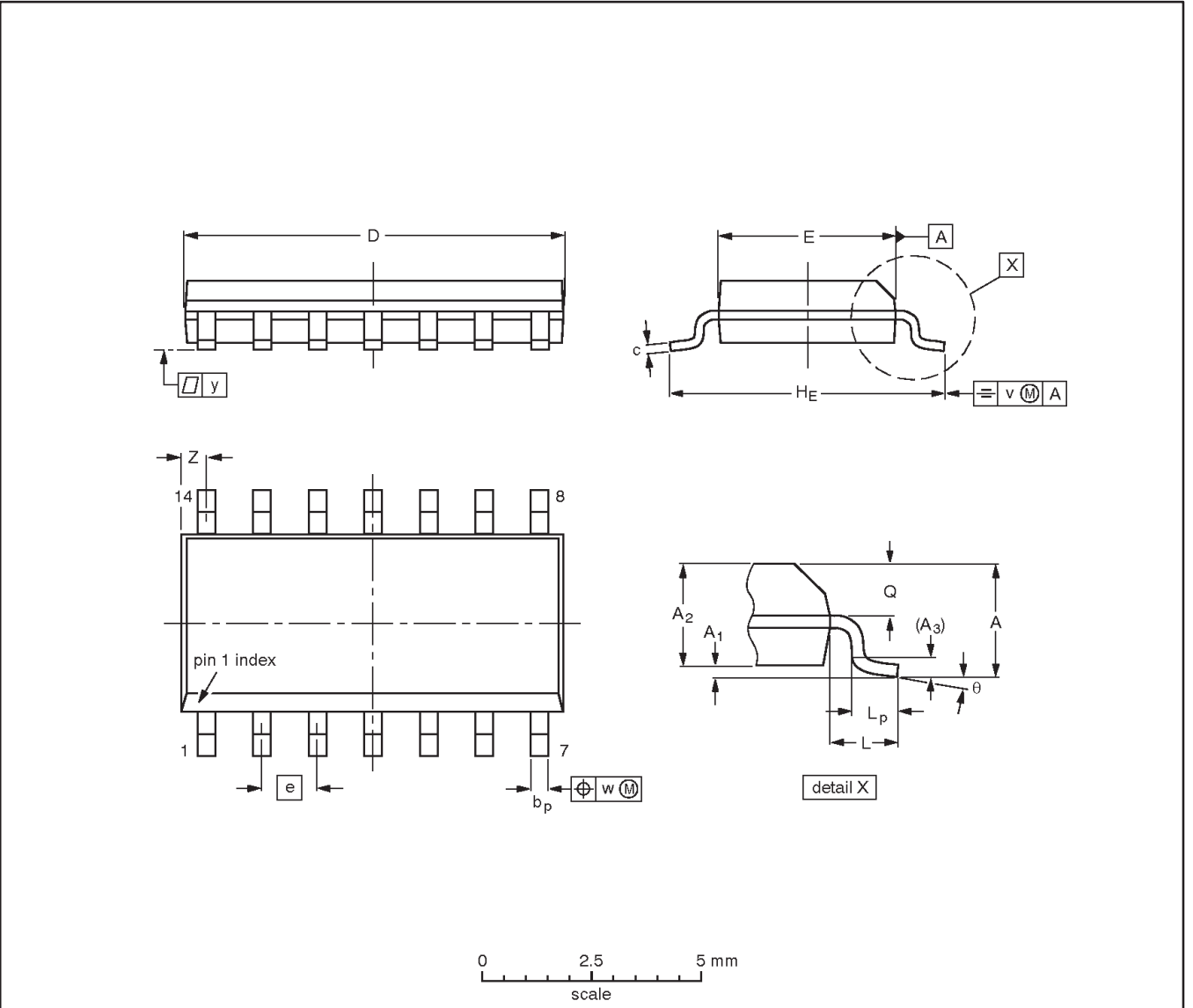
Figure 4. Typical performance characteristics.

Quad voltage comparator

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SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Note
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

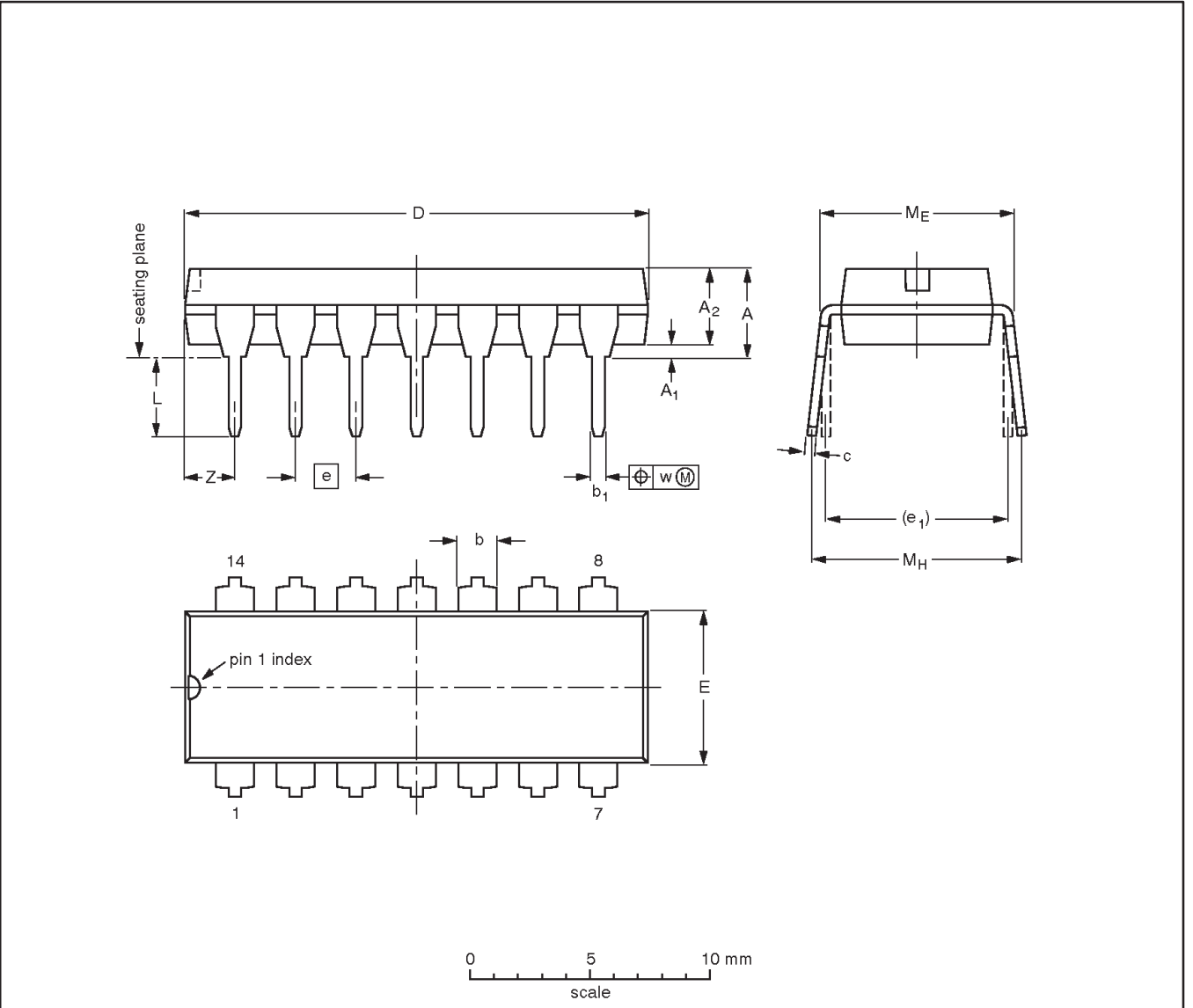
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT108-1	076E06	MS-012				97-05-22 99-12-27

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DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.020	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.087

Note
1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

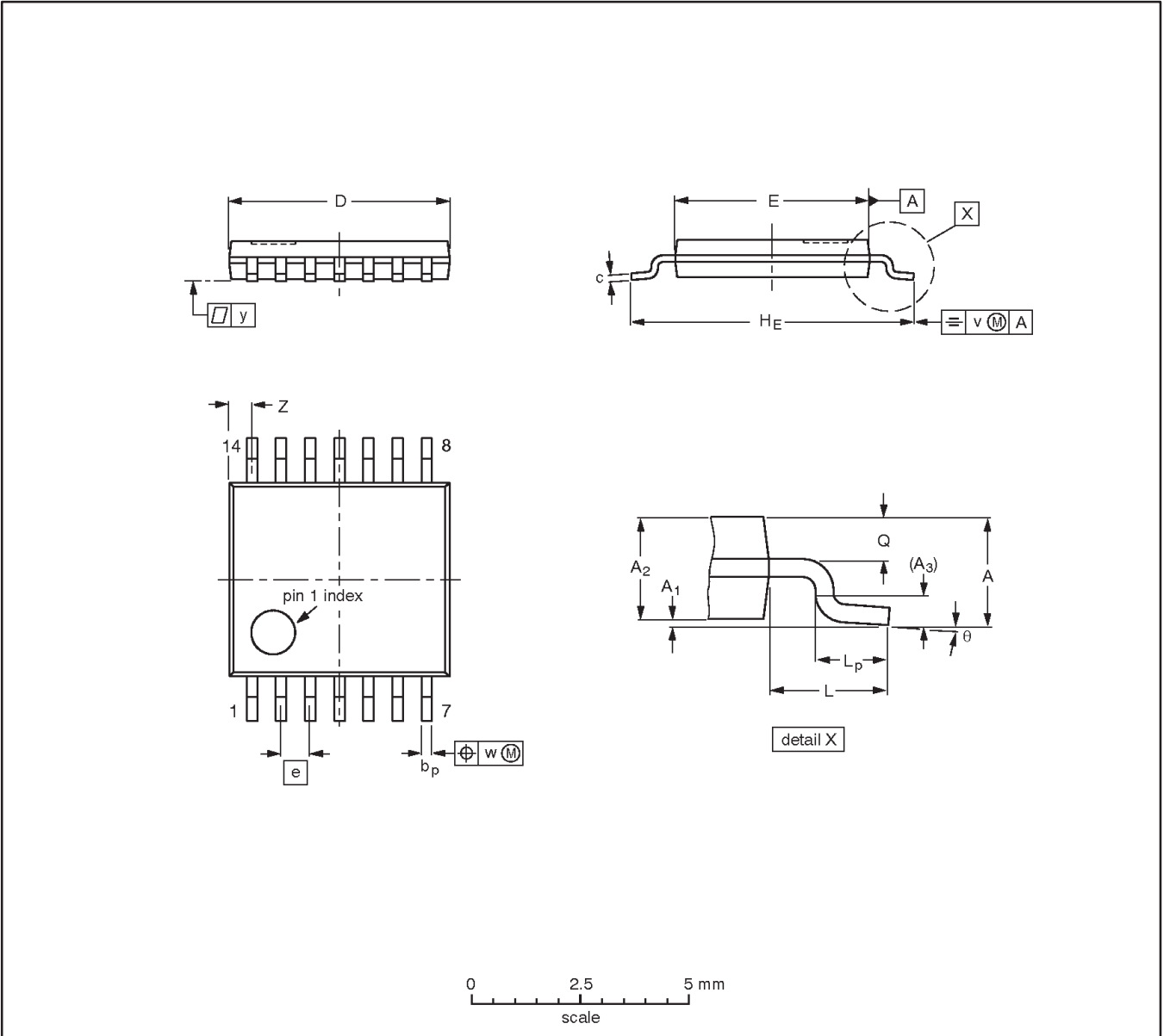
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT27-1	050G04	MO-001	SC-501-14			95-03-11+ 99-12-27

Quad voltage comparator

LM139/239/239A/339/339A/
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TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	1.10	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.72 0.38	8° 0°

- Notes**
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
 2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT402-1		MO-153				-95-04-04- 99-12-27

Quad voltage comparator

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Data sheet status

Data sheet status ^[1]	Product status ^[2]	Definitions
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A.

[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

Definitions

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