DATA SHEET

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

Quad voltage comparator

Product data
Supersedes data of 2002 Jul 12

2002 Sep 17

Philips
Semiconductors

PHILIPS

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 32 V_{DC} or dual supplies ±1.0 V_{DC} to ±16 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

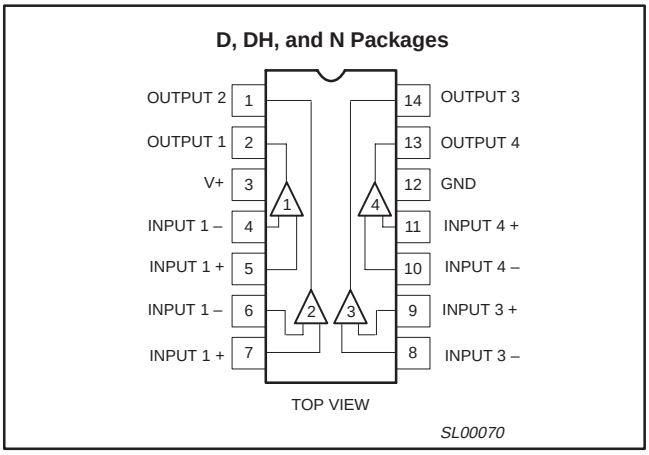


Figure 1. Pin Configuration

EQUIVALENT CIRCUIT

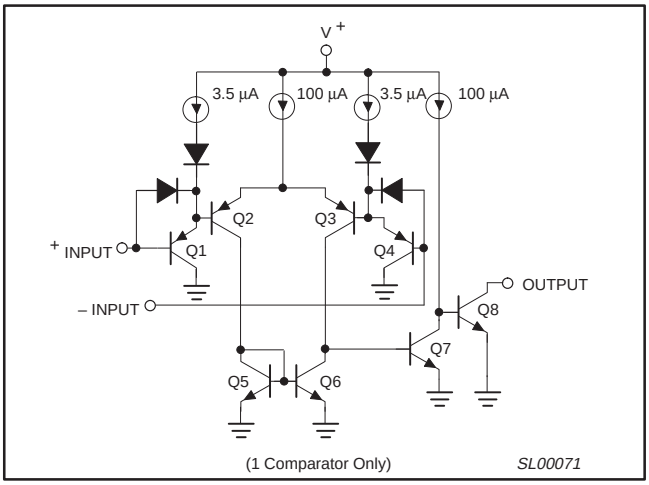


Figure 2. Equivalent Circuit

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 Thin Shrink Small Outline Package (TSSOP)	–40 °C to +125 °C	LM2901DH	SOT402-1
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

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	V_{CC} supply voltage	32 or ±16	V_{DC}
V_{DIFF}	Differential input voltage	32	V_{DC}
V_{IN}	Input voltage	–0.3 to +32	V_{DC}
P_D	Maximum power dissipation, T_{amb} = 25 °C (still–air)[1]		
	N package	1420	mW
	D package	1040	mW
	DH 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	°C
	LM239/239A	–25 to +85	°C
	LM339/339A	0 to +70	°C
	LM2901	–40 to +125	°C
	MC3302	–40 to +85	°C
T_{stg}	Storage temperature range	–65 to +150	°C
T_{sld}	Lead soldering temperature (10 sec max)	230	°C

NOTES:

1. Derate above 25 °C, at the following rates:
   N Package at 11.4 mW/°C
   D Package at 8.3 mW/°C
   DH Package at 6.1 mW/°C
2. 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+.
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 –0.3 V_{DC}.

DC AND AC ELECTRICAL CHARACTERISTICS

V+ = 5 V_{DC}; LM139: –55 °C ≤ T_{amb} ≤ +125 °C; LM239/239A: –25 °C ≤ T_{amb} ≤ +85 °C; LM339/339A: 0 °C ≤ T_{amb} ≤ +70 °C; LM2901: –40 °C ≤ T_{amb} ≤ +125 °C; MC3302: –40 °C ≤ T_{amb} ≤ +85 °C, unless otherwise specified.

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

See notes at the end of the Electrical Characteristics.

DC AND AC ELECTRICAL CHARACTERISTICS (continued)

$V+ = 5\ V_{DC}$; LM139: $-55\ °C \le T_{amb} \le +125\ °C$; LM239/239A: $-25\ °C \le T_{amb} \le +85\ °C$; LM339/339A: $0\ °C \le T_{amb} \le +70\ °C$; LM2901: $-40\ °C \le T_{amb} \le +125\ °C$; MC3302: $-40\ °C \le T_{amb} \le +85\ °C$, 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 °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 °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 $V_{IN} \ge 0\ V_{DC}$ (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 °C Over temp.		25	100 300		25	250 400	nA nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ T_{amb} = 25 °C Over temp.		±3.0	±25 ±100		±5.0	±50 ±150	nA nA
I_{OL}	Output sink current	$V_{IN(-)} \ge 1\ V_{DC}$; $V_{IN(+)} = 0$; $V_O \le 1.5\ V_{DC}$; T_{amb} = 25 °C	6.0	16		6.0	16		mA
	Output leakage current	$V_{IN(+)} \ge 1\ V_{DC}$; $V_{IN(-)} = 0$ $V_O = 5\ V_{DC}$; T_{amb} = 25 °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 V; T_{amb} = 25 °C		0.8	2.0		0.8	2.0	mA
A_V	Voltage gain	$R_L \ge 15\ k\Omega$; V+ = 15 V_{DC}	50	200		50	200		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \ge 1\ V_{DC}$; $V_{IN(+)} = 0$; $I_{SINK} \le 4\ mA$ T_{amb} = 25 °C Over temp.		250	400 700		250	400 700	mV mV
t_{LSR}	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_{amb} = 25 °C		300			300		ns
t_R	Response time[5]	$V_{RL} = 5\ V_{DC}$; $R_L = 5.1\ k\Omega$; T_{amb} = 25 °C		1.3			1.3		µs

See notes on following page.

DC AND AC ELECTRICAL CHARACTERISTICS (continued)

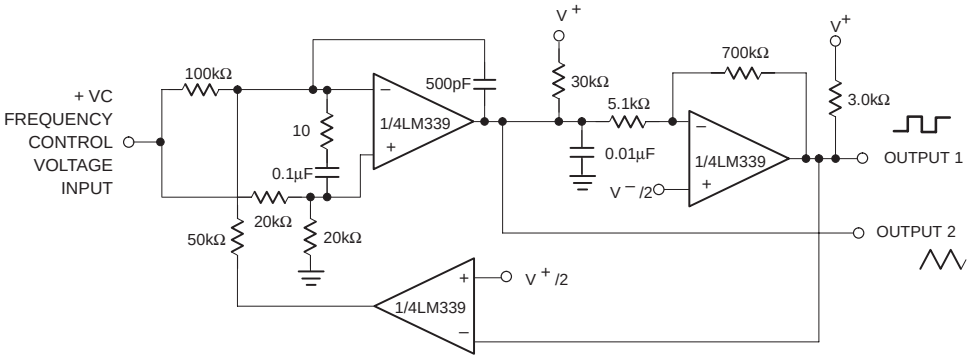
V+ = 5 V_{DC}; LM139: –55 °C ≤ T_{amb} ≤ +125 °C; LM239/239A: –25 °C ≤ T_{amb} ≤ +85 °C; LM339/339A: 0 °C ≤ T_{amb} ≤ +70 °C; LM2901: –40 °C ≤ T_{amb} ≤ +125 °C; MC3302: –40 °C ≤ T_{amb} ≤ +85 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM2901			MC3302			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage[2]	T_{amb} = 25 °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 °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 °C Over temp.		 25 200	 250 500		 25	 500 1000	 nA nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ T_{amb} = 25 °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 °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 °C V_O = 30 V_{DC}; Over temp.		 0.1	 1.0		 0.1	 1.0	 nA µA
I_{CC}	Supply current	R_L = ∞ on all comparators,					0.8	1.8	mA
		T_{amb} = 25 °C		0.8	2.0				
		R_L = ∞ on all comparators, V+ = 30 V		1.0	2.5				mA
A_V	Voltage gain	$R_L \geq 15$ kΩ; V+ = 15 V_{DC}	25	100		2	100		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \geq 1$ V_{DC}; $V_{IN(+)}$ = 0; $I_{SINK} \leq$ 4mA T_{amb} = 25 °C Over temp.		 400	 400 700		 150	 400 700	 mV mV
t_{LSR}	Large-signal response time	V_{IN} = TTL logic swing; V_{REF} = 1.4 V_{DC}; V_{RL} = 5 V_{DC}; R_L = 5.1 kΩ; T_{amb} = 25 °C		300			300		ns
t_R	Response time[5]	V_{RL} = 5 V_{DC}; R_L = 5.1 kΩ; T_{amb} = 25 °C		1.3			1.3		µs

NOTES:

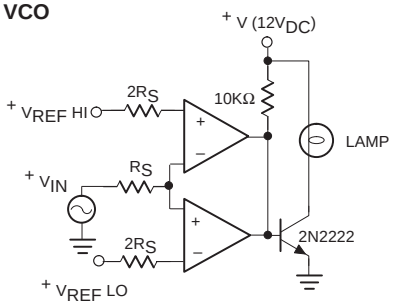
1. Positive excursions of input voltage may exceed the power supply level by 17 V. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than –0.3 V_{DC} (or 0.3 V_{DC} below the magnitude of the negative power supply, if used).
2. At output switch point, $V_O \approx 1.4$ V_{DC}, R_S = 0 Ω 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.
3. 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 V, but either or both inputs can go to 30 V_{DC} 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 100 mV input step with a 5 mV overdrive. For larger overdrive signals, 300 ns can be obtained (see Figure 4, Typical performance characteristics).

EQUIVALENT CIRCUIT

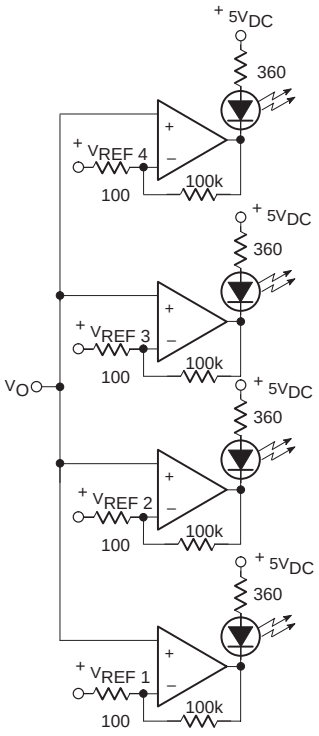


NOTES:
V+ = $30V_{DC}$
+ 250m $V_{DC} \leq V_C = 50V_{DC}$
$700H \leq f_O = 100kHz$

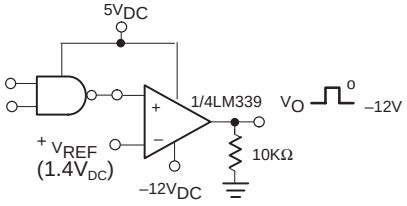
Two-Decade High Frequency VCO



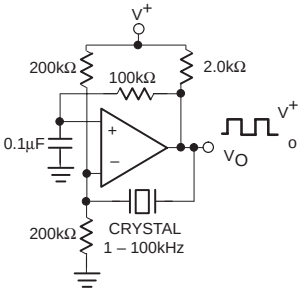
Limit Comparator



Visible Voltage Indicator



TTL–to–MOS Logic Converter



Crystal–Controlled Oscillator

NOTE:
Input of unused comparators should be grounded.

SL00072

Figure 3. Equivalent circuit.

TYPICAL PERFORMANCE CHARACTERISTICS

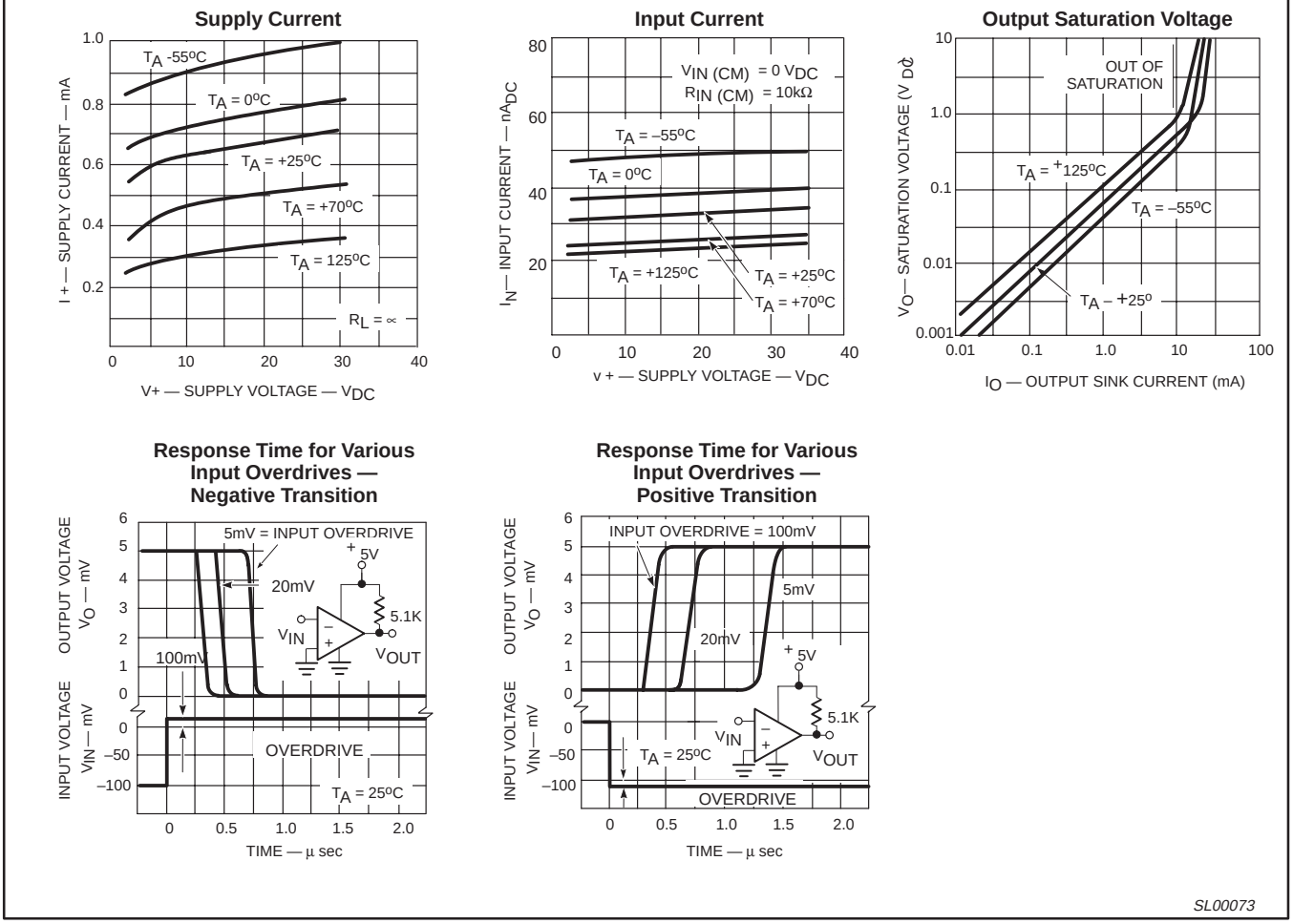
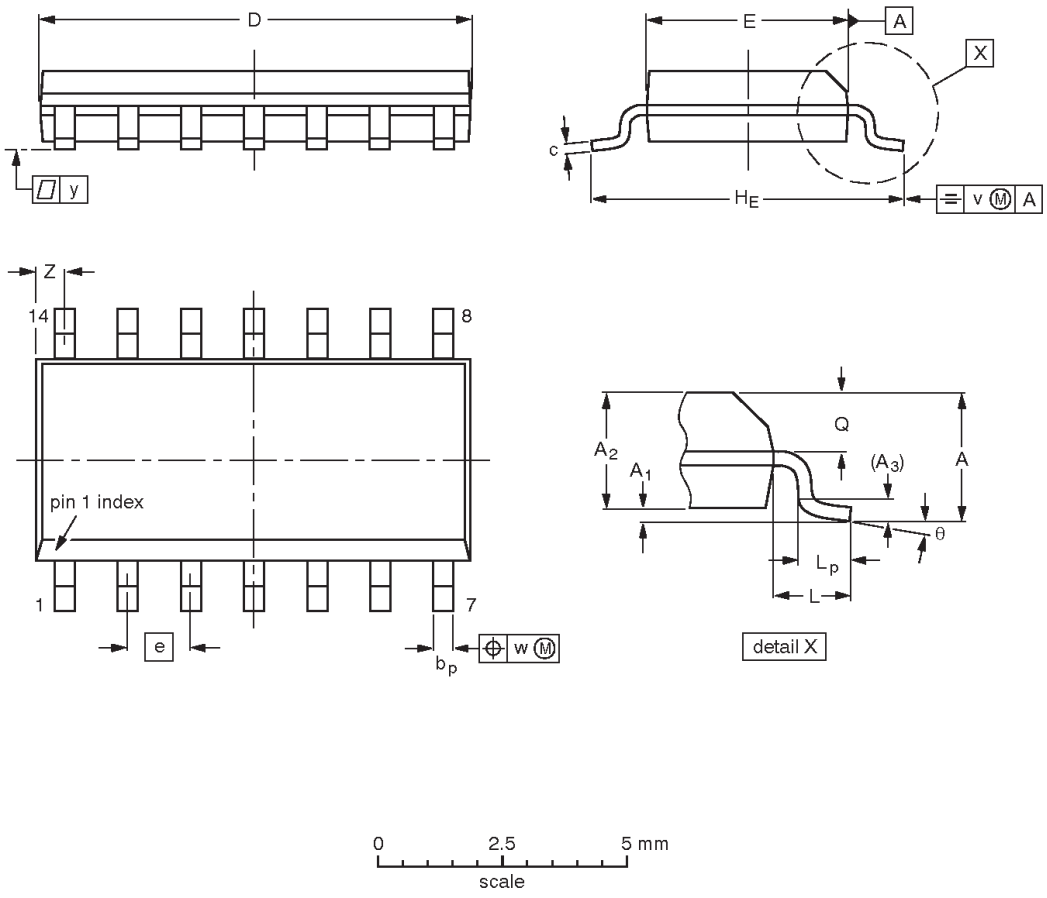


Figure 4. Typical performance characteristics.

SO14: plastic small outline package; 14 leads; body width 3.9 mm **SOT108-1**



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

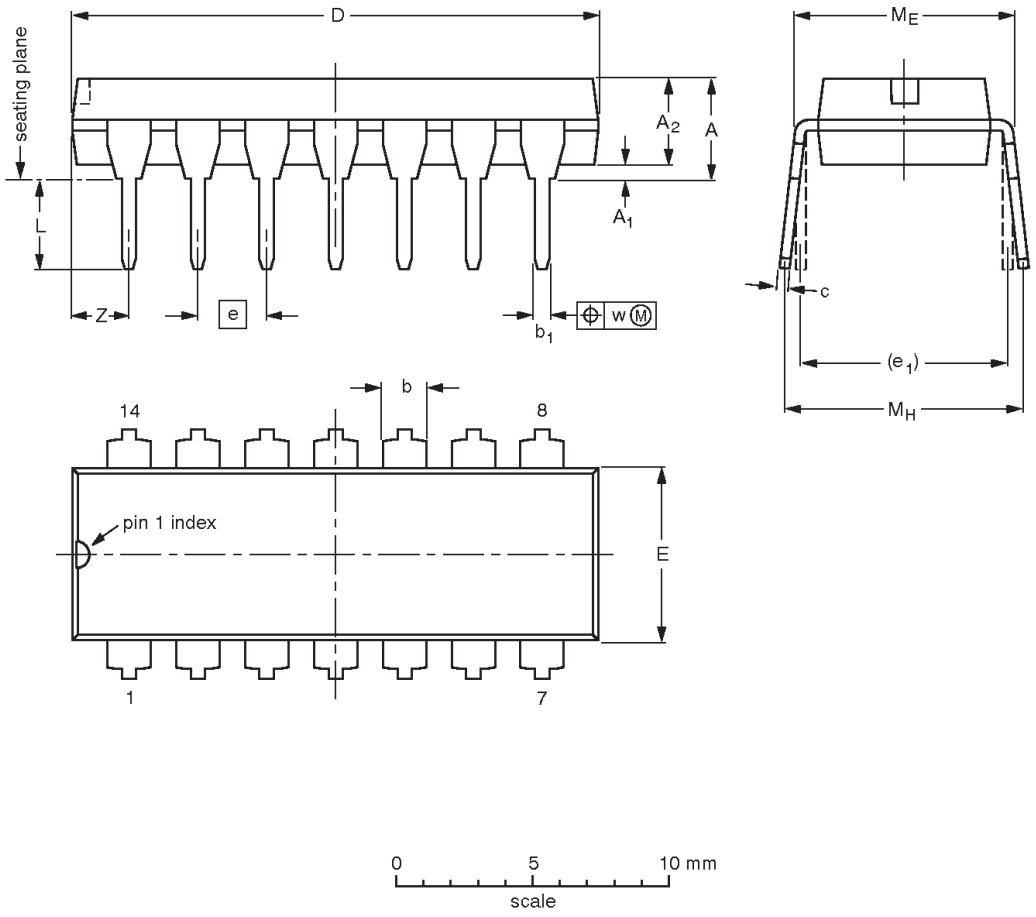
UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	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

DIP14: plastic dual in-line package; 14 leads (300 mil) **SOT27-1**



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

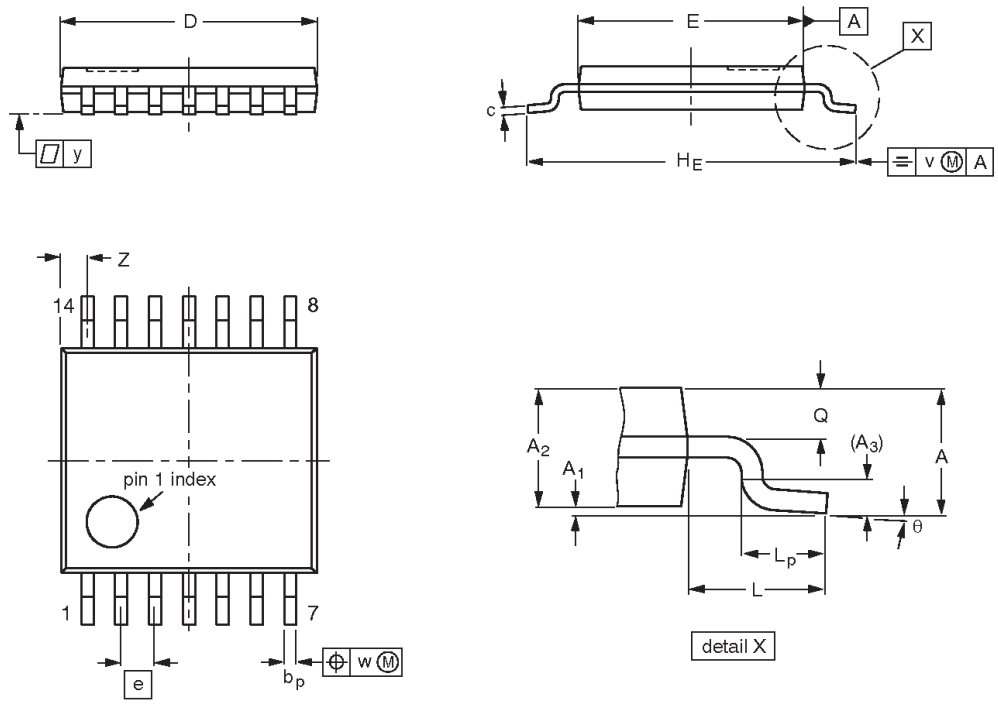
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.020	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.087

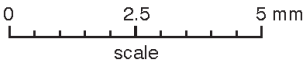
Note

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

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^o 0^o

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

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.

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Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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Date of release: 09-02

Document order number: 9397 750 10406

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