DATA SHEET

74LVU04
Hex inverter

Product specification
Supersedes data of 1997 Feb 12
IC24 Data Handbook

1998 Apr 20

Philips
Semiconductors

PHILIPS

FEATURES

- Wide operating voltage: 1.0 to 5.5 V
- Optimized for Low Voltage applications: 1.0 to 3.6 V
- Accepts TTL input levels between V_{CC} = 2.7 V and V_{CC} = 3.6 V
- Typical V_{OLP} (output ground bounce) < 0.8 V at V_{CC} = 3.3 V, T_{amb} = 25°C.
- Typical V_{OHV} (output V_{OH} undershoot) > 2 V at V_{CC} = 3.3 V, T_{amb} = 25°C.
- Output capability: standard
- I_{CC} category: SSI

DESCRIPTION

The 74LVU04 is a low-voltage, Si-gate CMOS device and is pin compatible with the 74HCU04.

The 74LVU04 is a general purpose hex inverter. Each of the six inverters is a single stage with unbuffered outputs.

QUICK REFERENCE DATA

GND = 0 V; T_{amb} = 25°C; $t_r = t_f \leq 2.5$ ns

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
t_{PHL}/t_{PLH}	Propagation delay nA to nY	C_L = 15 pF; V_{CC} = 3.3 V	6	ns
C_I	Input capacitance		3.5	pF
C_{PD}	Power dissipation capacitance per gate	Notes 1, 2	18	pF

NOTES:

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW)
   $P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$ where:
   f_i = input frequency in MHz; C_L = output load capacitance in pF;
   f_o = output frequency in MHz; V_{CC} = supply voltage in V;
   $\sum (C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.
2. The condition is V_I = GND to V_{CC}.

ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	PKG. DWG. #
14-Pin Plastic DIL	–40°C to +125°C	74LVU04 N	74LVU04 N	SOT27-1
14-Pin Plastic SO	–40°C to +125°C	74LVU04 D	74LVU04 D	SOT108-1
14-Pin Plastic SSOP Type II	–40°C to +125°C	74LVU04 DB	74LVU04 DB	SOT337-1
14-Pin Plastic TSSOP Type I	–40°C to +125°C	74LVU04 PW	74LVU04PW DH	SOT402-1

PIN DESCRIPTION

PIN NUMBER	SYMBOL	NAME AND FUNCTION
1, 3, 5, 9, 11, 13	1A – 6A	Data inputs
2, 4, 6, 8, 10, 12	1Y – 6Y	Data outputs
7	GND	Ground (0 V)
14	V_{CC}	Positive supply voltage

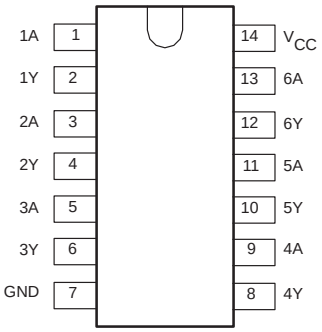
FUNCTION TABLE

INPUTS	OUTPUTS
nA	**nY**
L	H
H	L

NOTES:

H = HIGH voltage level
L = LOW voltage level

PIN CONFIGURATION



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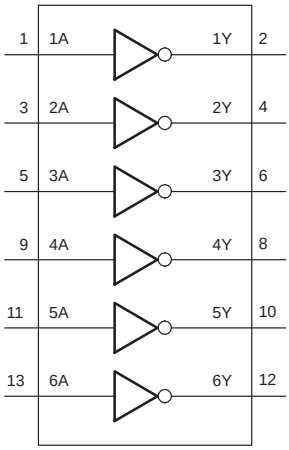
LOGIC SYMBOL



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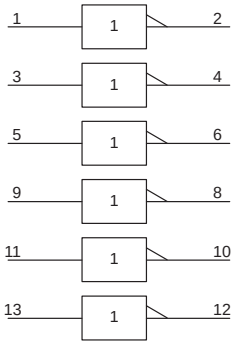
LOGIC SYMBOL (IEEE/IEC)



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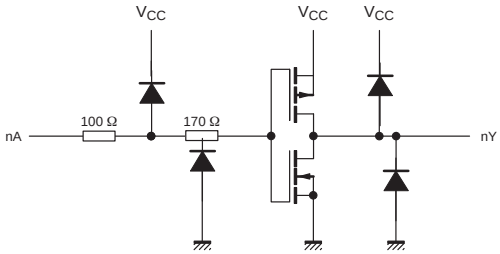
SCHEMATIC DIAGRAM (ONE INVERTER)



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RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT
V_{CC}	DC supply voltage	See Note1	1.0	3.3	5.5	V
V_I	Input voltage		0	–	V_{CC}	V
V_O	Output voltage		0	–	V_{CC}	V
T_{amb}	Operating ambient temperature range in free air	See DC and AC characteristics	–40 –40		+85 +125	°C
t_r, t_f	Input rise and fall times	V_{CC} = 1.0V to 2.0V V_{CC} = 2.0V to 2.7V V_{CC} = 2.7V to 3.6V V_{CC} = 3.6V to 5.5V	– – – –	– – – –	500 200 100 50	ns/V

NOTE:
1. The LV is guaranteed to function down to V_{CC} = 1.0V (input levels GND or V_{CC}); DC characteristics are guaranteed from V_{CC} = 1.2V to V_{CC} = 5.5V.

ABSOLUTE MAXIMUM RATINGS[1, 2]

In accordance with the Absolute Maximum Rating System (IEC 134).
Voltages are referenced to GND (ground = 0V).

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
V_{CC}	DC supply voltage		–0.5 to +7.0	V
$\pm I_{IK}$	DC input diode current	$V_I < –0.5$ or $V_I > V_{CC} + 0.5V$	20	mA
$\pm I_{OK}$	DC output diode current	$V_O < –0.5$ or $V_O > V_{CC} + 0.5V$	50	mA
$\pm I_O$	DC output source or sink current – standard outputs	$–0.5V < V_O < V_{CC} + 0.5V$	25	mA
$\pm I_{GND}$, $\pm I_{CC}$	DC V_{CC} or GND current for types with – standard outputs		50	mA
T_{stg}	Storage temperature range		–65 to +150	°C
P_{TOT}	Power dissipation per package – plastic DIL – plastic mini-pack (SO) – plastic shrink mini-pack (SSOP and TSSOP)	for temperature range: –40 to +125°C above +70°C derate linearly with 12 mW/K above +70°C derate linearly with 8 mW/K above +60°C derate linearly with 5.5 mW/K	 750 500 400	mW

NOTE:
1. Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions. Voltages are referenced to GND (ground = 0V).

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS					UNIT
			-40°C to +85°C			-40°C to +125°C		
			MIN	TYP[1]	MAX	MIN	MAX	
V_{IH}	HIGH level Input voltage	V_{CC} = 1.2V	1.0			1.0		V
		V_{CC} = 2.0V	1.6			1.6		
		V_{CC} = 2.7 to 3.6V	2.4			2.4		
		V_{CC} = 4.5 to 5.5V	$0.8 * V_{CC}$			$0.8 * V_{CC}$		
V_{IL}	LOW level Input voltage	V_{CC} = 1.2V			0.2		0.2	V
		V_{CC} = 2.0V			0.4		0.4	
		V_{CC} = 2.7 to 3.6V			0.5		0.5	
		V_{CC} = 4.5 to 5.5			$0.2 * V_{CC}$		$0.2 * V_{CC}$	
V_{OH}	HIGH level output voltage	V_{CC} = 1.2V; $V_I = V_{IH}$ or V_{IL}; $–I_O$ = 100µA		1.2				V
		V_{CC} = 2.0V; $V_I = V_{IH}$ or V_{IL}; $–I_O$ = 100µA	1.8	2.0		1.8		
		V_{CC} = 2.7V; $V_I = V_{IH}$ or V_{IL}; $–I_O$ = 100µA	2.5	2.7		2.5		
		V_{CC} = 3.0V; $V_I = V_{IH}$ or V_{IL}; $–I_O$ = 100µA	2.8	3.0		2.8		
		V_{CC} = 4.5V; $V_I = V_{IH}$ or V_{IL}; $–I_O$ = 100µA	4.3	4.5		4.3		
V_{OH}	HIGH level output voltage	V_{CC} = 3.0V; $V_I = V_{IH}$ or V_{IL}; $–I_O$ = 6mA	2.40	2.82		2.20		V
		V_{CC} = 4.5V; $V_I = V_{IH}$ or V_{IL}; $–I_O$ = 12mA	3.60	4.20		3.50		
V_{OL}	LOW level output voltage	V_{CC} = 1.2V; $V_I = V_{IH}$ or V_{IL}; I_O = 100µA		0				V
		V_{CC} = 2.0V; $V_I = V_{IH}$ or V_{IL}; I_O = 100µA		0	0.2		0.2	
		V_{CC} = 2.7V; $V_I = V_{IH}$ or V_{IL}; I_O = 100µA		0	0.2		0.2	
		V_{CC} = 3.0V; $V_I = V_{IH}$ or V_{IL}; I_O = 100µA		0	0.2		0.2	
		V_{CC} = 4.5V; $V_I = V_{IH}$ or V_{IL}; I_O = 100µA		0	0.2		0.2	

DC ELECTRICAL CHARACTERISTICS (Continued)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS					UNIT
			-40°C to +85°C			-40°C to +125°C		
			MIN	TYP[1]	MAX	MIN	MAX	
V_{OL}	LOW level output voltage	V_{CC} = 3.0V;V_I = V_{IH} or V_{IL}; I_O = 6mA		0.25	0.40		0.50	V
		V_{CC} = 4.5V;V_I = V_{IH} or V_{IL}; I_O = 12mA		0.35	0.55		0.65	
$\pm I_I$	Input leakage current	V_{CC} = 5.5V; V_I = V_{CC} or GND			1.0		1.0	µA
I_{CC}	Quiescent supply current	V_{CC} = 5.5V; V_I = V_{CC} or GND; I_O = 0			20.0		40.0	µA
ΔI_{CC}	Additional quiescent supply current per input	V_{CC} = 2.7V to 3.6V; V_I = V_{CC} –0.6V			500		850	µA

NOTE:
1. All typical values are measured at T_{amb} = 25°C.

AC CHARACTERISTICS

GND = 0V; t_r = t_f = 2.5ns; C_L = 50pF; R_L = 500Ω

SYMBOL	PARAMETER	WAVEFORM	CONDITION	LIMITS					UNIT
				–40 to +85 °C			–40 to +125 °C		
			V_{CC}(V)	MIN	TYP[1]	MAX	MIN	MAX	
$t_{PHL/PLH}$	Propagation delay nA to nY	Figure 1	1.2		35				ns
			2.0		12	14		17	
			2.7		9	10		13	
			3.0 to 3.6		7[2]	8		10	
			4.5 to 5.5			7		9	

NOTES:
1. Unless otherwise stated, all typical values are measured at T_{amb} = 25°C
2. Typical values are measured at V_{CC} = 3.3 V.

AC WAVEFORMS

V_M = 1.5 V at $V_{CC} \geq$ 2.7 V and $\leq$ 3.6 V
V_M = 0.5 × V_{CC} at V_{CC} < 2.7 V and ≥ 4.5 V
V_{OL} and V_{OH} are the typical output voltage drop that occur with the output load.

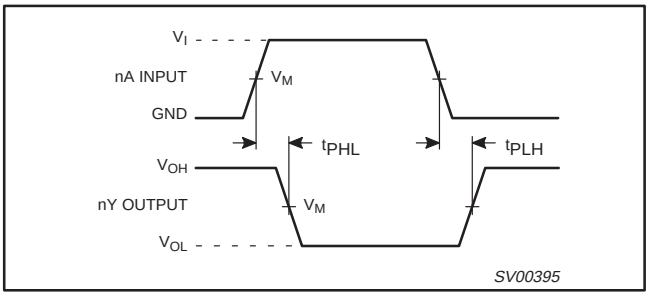


Figure 1. Input (nA) to output (nY) propagation delays and output transition times.

TYPICAL TRANSFER CHARACTERISTICS

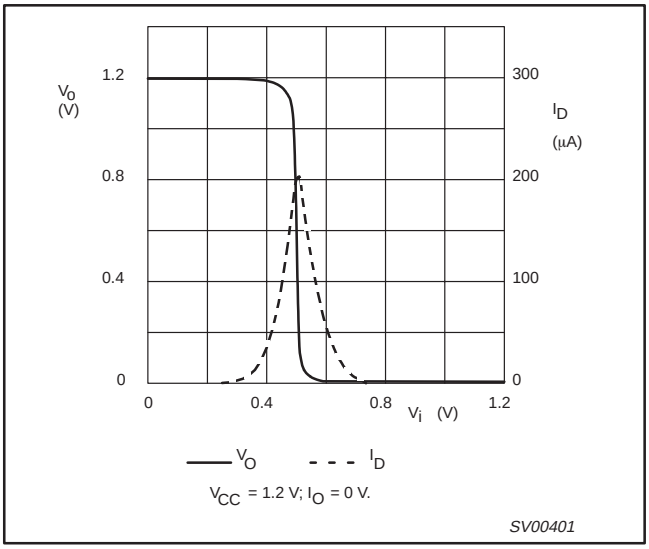


Figure 2.

TYPICAL TRANSFER CHARACTERISTICS (*Continued)*

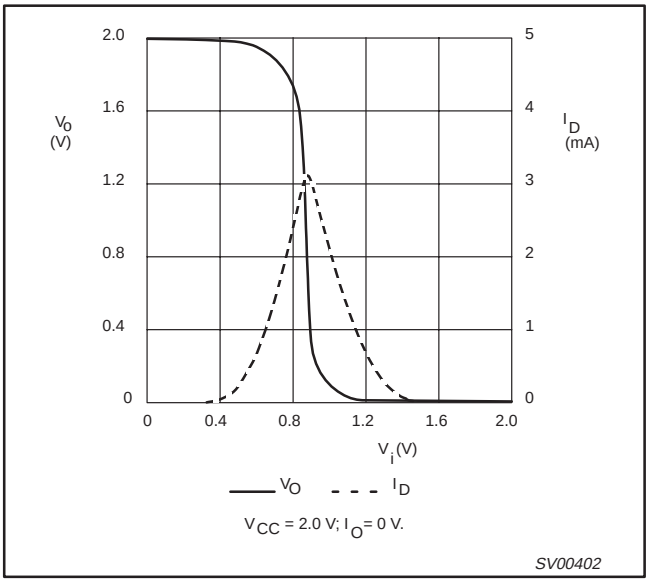


Figure 3.

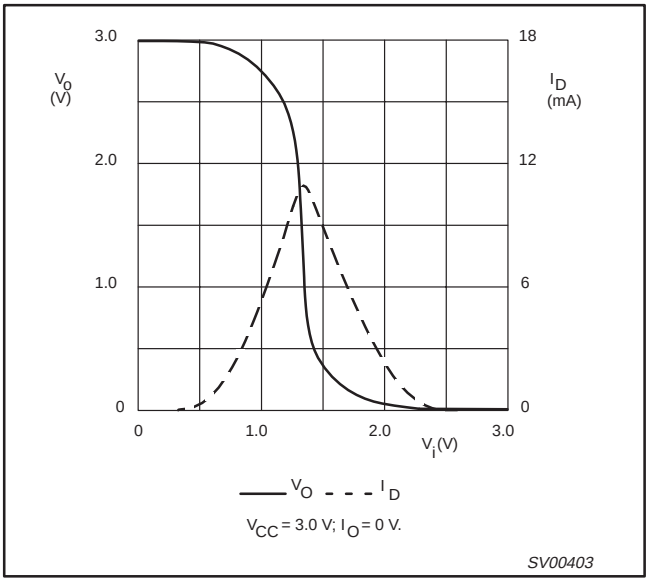


Figure 4.

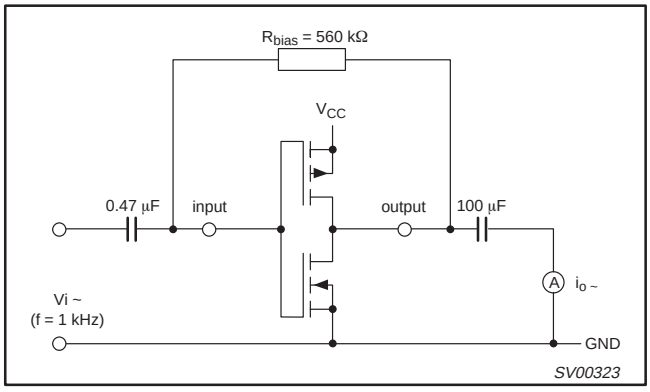


Figure 5. Test set-up for measuring forward transconductance $g_{fs} = di_O/dv_i$ at v_O is constant (see also graph Figure 6).

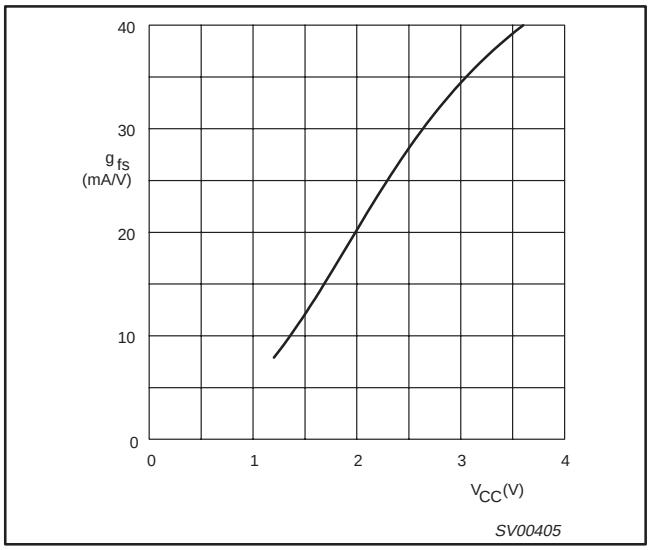
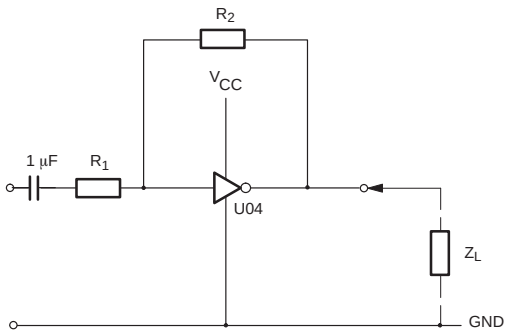


Figure 6. Typical forward transconductance g_{fs} as a function of the supply voltage V_{CC} at T_{amb} = 25°C.

APPLICATION INFORMATION

Some applications for the 74LVU04 are:

- Linear amplifier (see Figure 7)
- In crystal oscillator designs (see Figure 8)
- Astable multivibrator (see Figure 9)



Note:

Z_L > 10kΩ; A_{OL} = 20 (typical)

$$A_u = -\frac{A_{OL}}{1 + \frac{R_1}{R_2}(1 + A_{OL})}; V_{OMax(P-P)} \approx V_{CC} - 1.5\ V \text{ centered at } {}^1/_2\ V_{CC}$$

3 kΩ ≤ R1, R2 ≤ 1 MΩ

Typical unity gain bandwidth product is 5 MHz.

C_I, see Figure10

A_{OL} = open loop amplification

A_u = voltage amplification

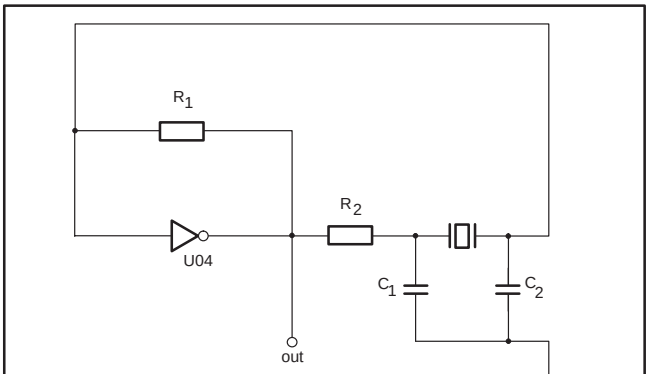
SV00404

Figure 7. LVU04 used as a linear amplifier.

EXTERNAL COMPONENTS FOR RESONATOR (f < 1 mHz)

FREQUENCY (kHz)	R_1(MΩ)	R_2 (KΩ)	C_1 (pF)	C_2 (pF)
10 .. 15.9	2.2	220	56	20
16 .. 24.9	2.2	220	56	10
25 .. 54.9	2.2	100	56	10
55 .. 129.9	2.2	100	47	5
130 .. 199.9	2.2	47	47	5
200 .. 349.9	2.2	47	47	5
350 .. 600	2.2	47	47	5

WHERE:
All values given are typical and must be used as an initial set-up.



Note:
C_1 = 47 pF (typ.)
C_2 = 22 pF (typ.)
R_1 = 1 to 10 MΩ (typ.)
R_2 optimum value depends on the frequency and required stability against changes in V_{CC} or average minimum I_{CC} (I_{CC} is typically 2 mA at V_{CC} = 3 V and f = 1 MHz).

SV00408

Figure 8. Crystal oscillator configuration.

OPTIMUM VALUE FOR R_2

FREQUENCY (MHz)	R_2 (kΩ)	Optimum
3	2.0 8.0	Minimum required I_{CC} Minimum influence due to change in V_{CC}
6	1.0 4.7	Minimum I_{CC} Minimum influence by V_{CC}
10	0.5 2.0	Minimum I_{CC} Minimum influence by V_{CC}
14	0.5 1.0	Minimum I_{CC} Minimum influence by V_{CC}
> 14	Replace R_2 by C_3 with a typical value of 35 pF	

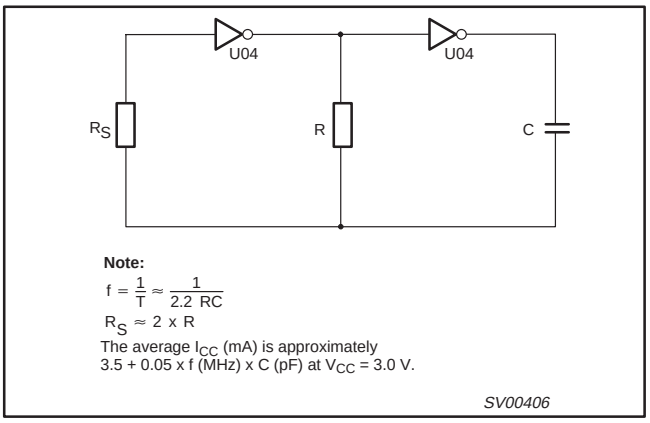


Figure 9. LVU04 used as an astable multivibrator.

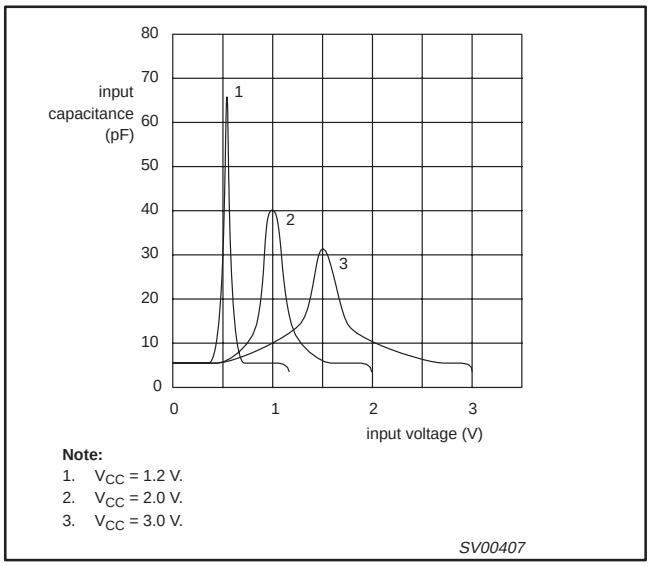
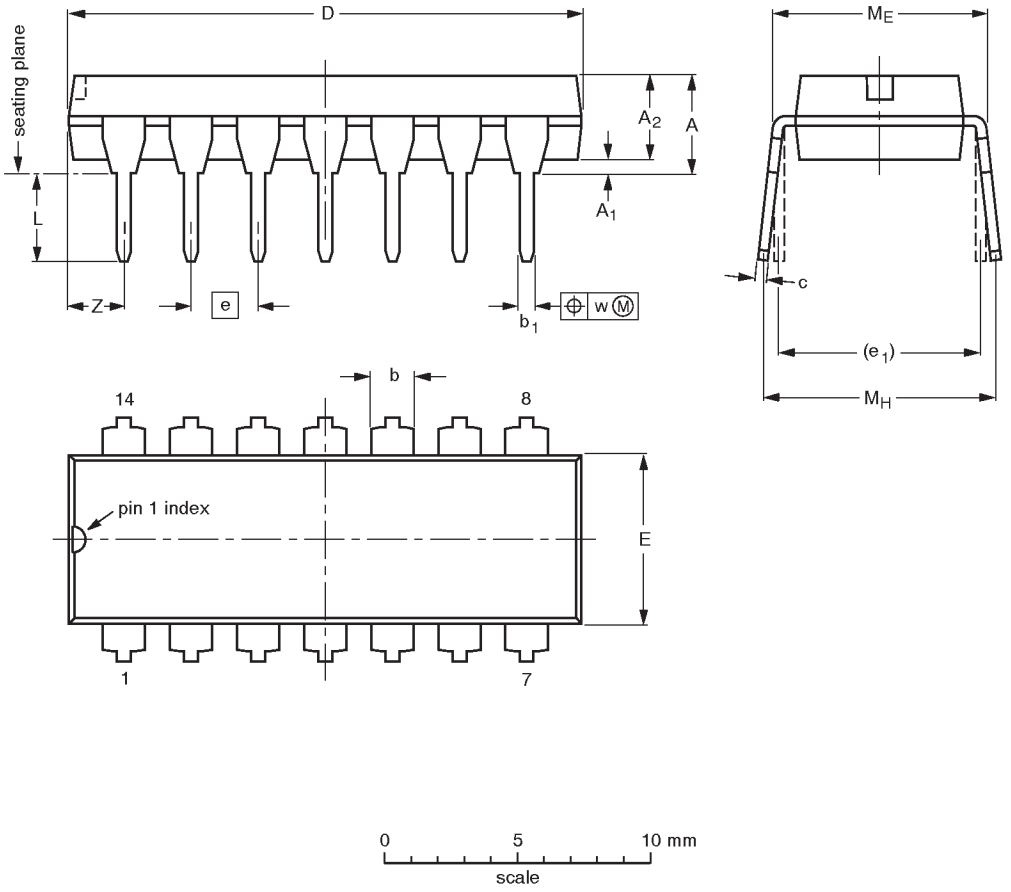


Figure 10. Typical input capacitance as function of input voltage.

Note for Application Information
All values given are typical unless otherwise specified.

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



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

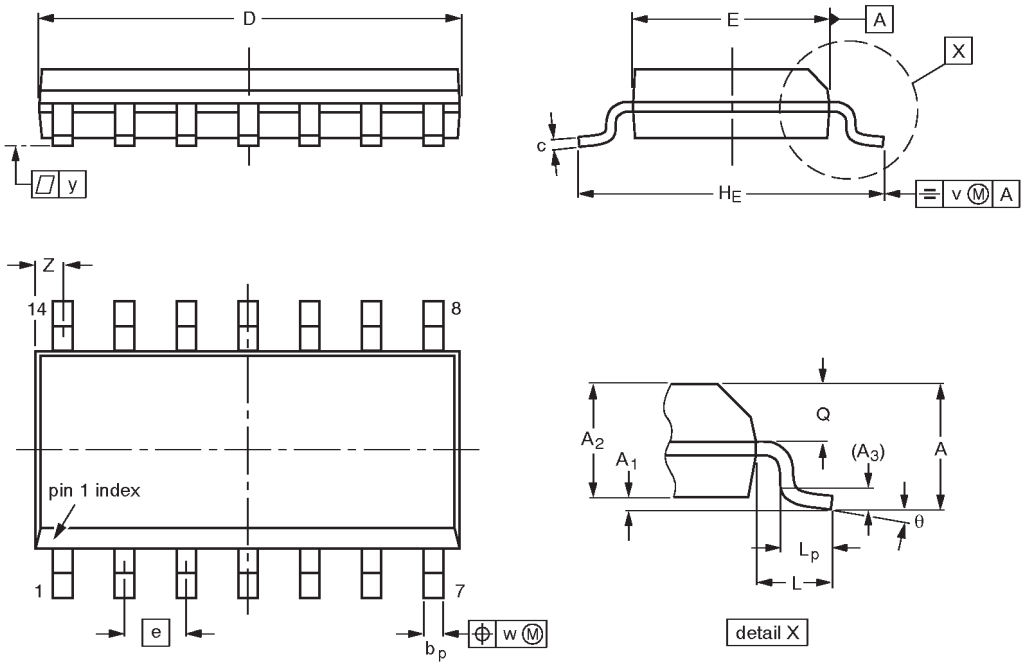
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.020	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31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

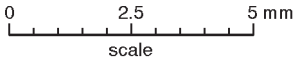
Note

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-001AA				~~92-11-17~~ 95-03-11

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





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

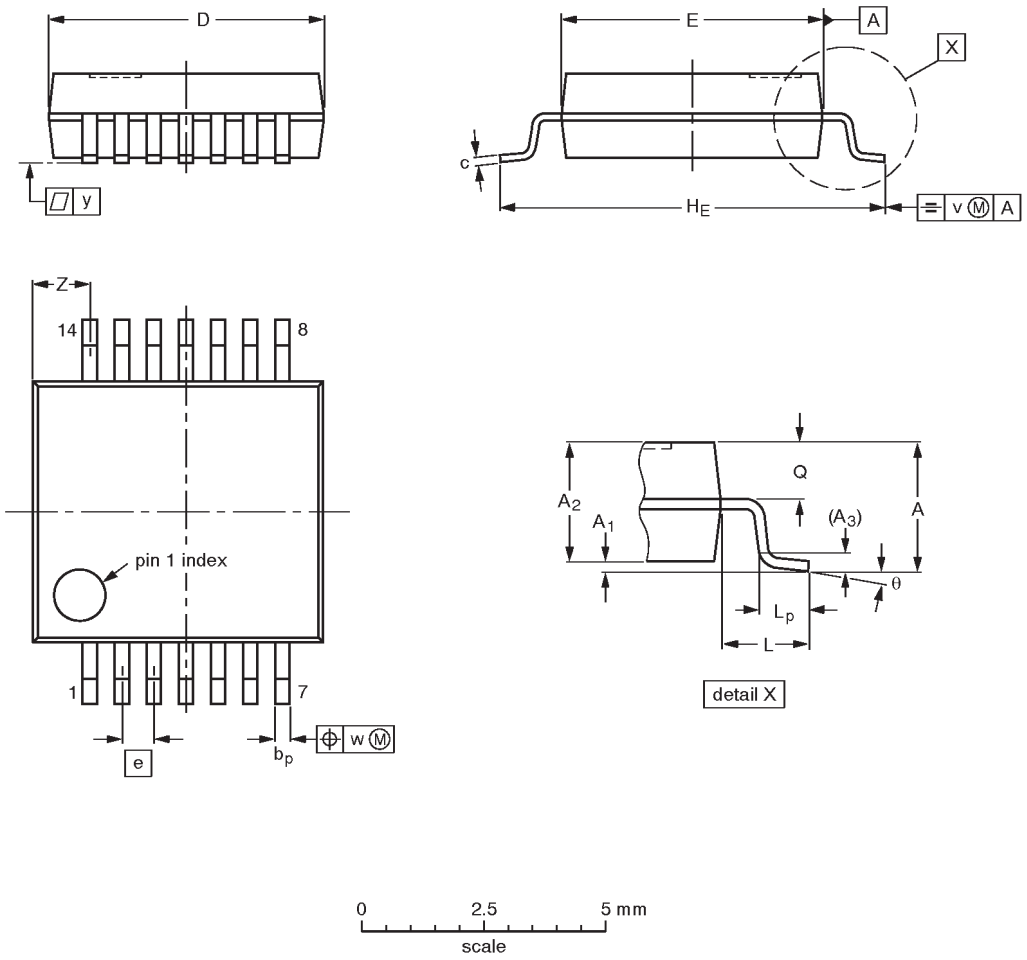
UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.35 0.34	0.16 0.15	0.050	0.24 0.23	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	076E06S	MS-012AB				~~91-08-13~~ 95-01-23

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm **SOT337-1**



DIMENSIONS (mm are the original dimensions)

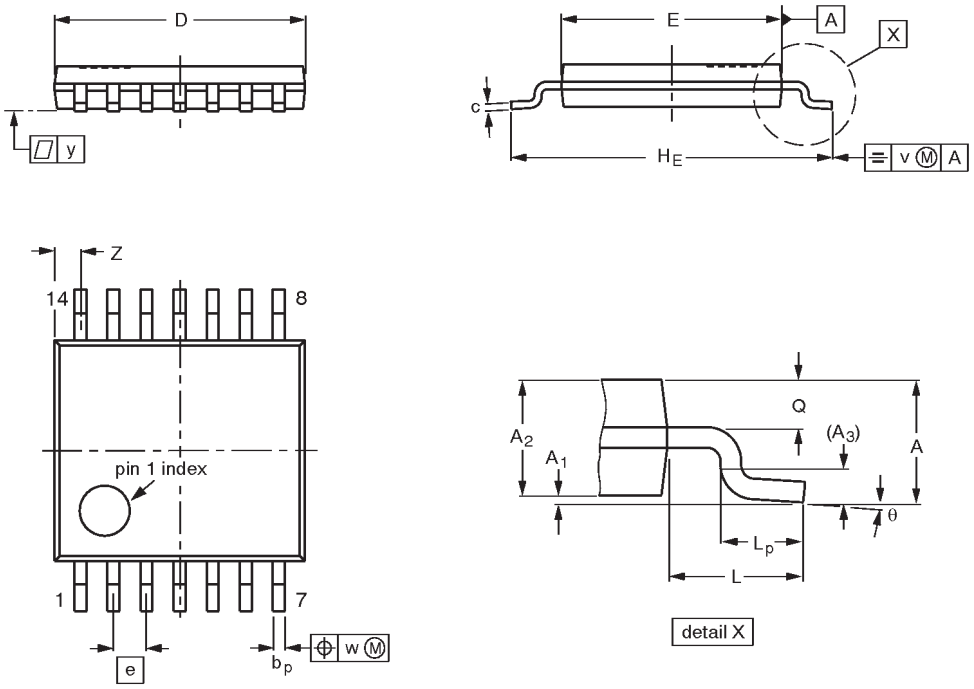
UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (1)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.4 0.9	8° 0°

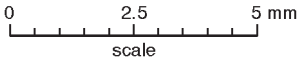
Note

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			
SOT337-1		MO-150AB				~~95-02-04~~ 96-01-18

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				~~94-07-12~~ 95-04-04

NOTES

DEFINITIONS

Data Sheet Identification	Product Status	Definition
Objective Specification	Formative or in Design	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
Preliminary Specification	Preproduction Product	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product Specification	Full Production	This data sheet contains Final Specifications. Philips Semiconductors reserves the right to make changes at any time without notice, in order to improve design and supply the best possible product.

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