

74LV4020

14-stage binary ripple counter

Rev. 01 — 29 November 2005

Product data sheet

1. General description

The 74LV4020 is a low-voltage Si-gate CMOS device and is pin and function compatible with the 74HC4020 and 74HCT4020.

The 74LV4020 is a 14-stage binary ripple counter with a clock input (\overline{CP}), an overriding asynchronous master reset input (MR) and 12 fully buffered parallel outputs (Q0, and Q3 to Q13).

The counter advances on the HIGH-to-LOW transition of \overline{CP} . A HIGH on MR clears all counter stages and forces all outputs LOW, independent of the state of \overline{CP} .

Each counter stage is a static toggle flip-flop.

2. Features

- Optimized for low-voltage applications: 1.0 V to 5.5 V
- Accepts TTL input levels between $V_{CC} = 2.7$ V and $V_{CC} = 3.6$ V
- Typical LOW-level output voltage (peak) or output ground bounce: $V_{OL(p)} < 0.8$ V at $V_{CC} = 3.3$ V and $T_{amb} = 25$ °C
- Typical HIGH-level output voltage (valley) or output V_{OH} undershoot: $V_{OH(v)} > 2$ V at $V_{CC} = 3.3$ V and $T_{amb} = 25$ °C
- ESD protection:
 - ◆ HBM EIA/JESD22-A114-C exceeds 2000 V
 - ◆ MM EIA/JESD22-A115-A exceeds 200 V.
- Multiple package options
- Specified from -40 °C to $+80$ °C and from -40 °C to $+125$ °C.

3. Applications

- Frequency dividing circuits
- Time delay circuits
- Control counters

PHILIPS

4. Quick reference data

Table 1: Quick reference data

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{PHL}	propagation delay	$C_L = 15\text{ pF}$; $V_{CC} = 3.3\text{ V}$				
t_{PLH}	\overline{CP} to Q0		-	12	-	ns
	Qn to Q(n+1)		-	7	-	ns
t_{PHL}	propagation delay	$C_L = 15\text{ pF}$; $V_{CC} = 3.3\text{ V}$				
	MR to Qn		-	16	-	ns
f_{max}	maximum input clock frequency	$C_L = 15\text{ pF}$; $V_{CC} = 3.3\text{ V}$	-	100	-	MHz
C_i	input capacitance		-	3.5	-	pF
C_{PD}	power dissipation capacitance	per gate; $V_I = GND$ to V_{CC}	[1]	20	-	pF

[1] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$ where:

f_i = input frequency in MHz;

f_o = output frequency in MHz;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

$\sum(C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

5. Ordering information

Table 2: Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74LV4020N	-40 °C to +125 °C	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
74LV4020D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74LV4020DB	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74LV4020PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

6. Functional diagram

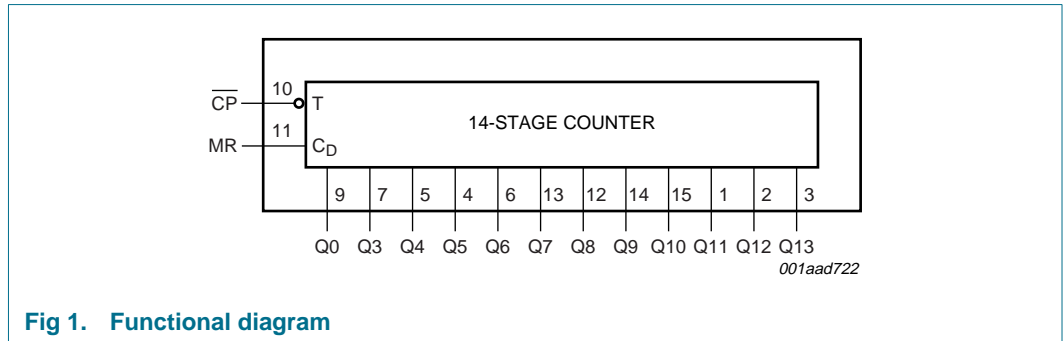


Fig 1. Functional diagram

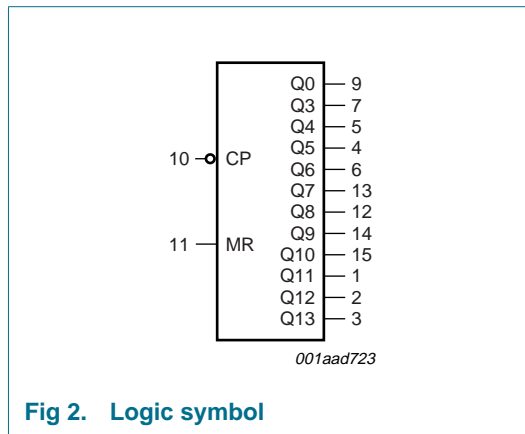


Fig 2. Logic symbol

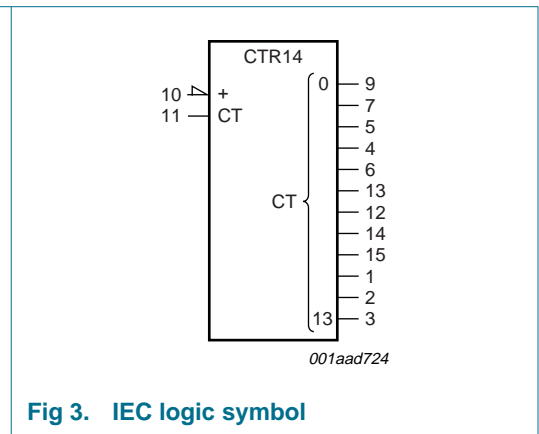


Fig 3. IEC logic symbol

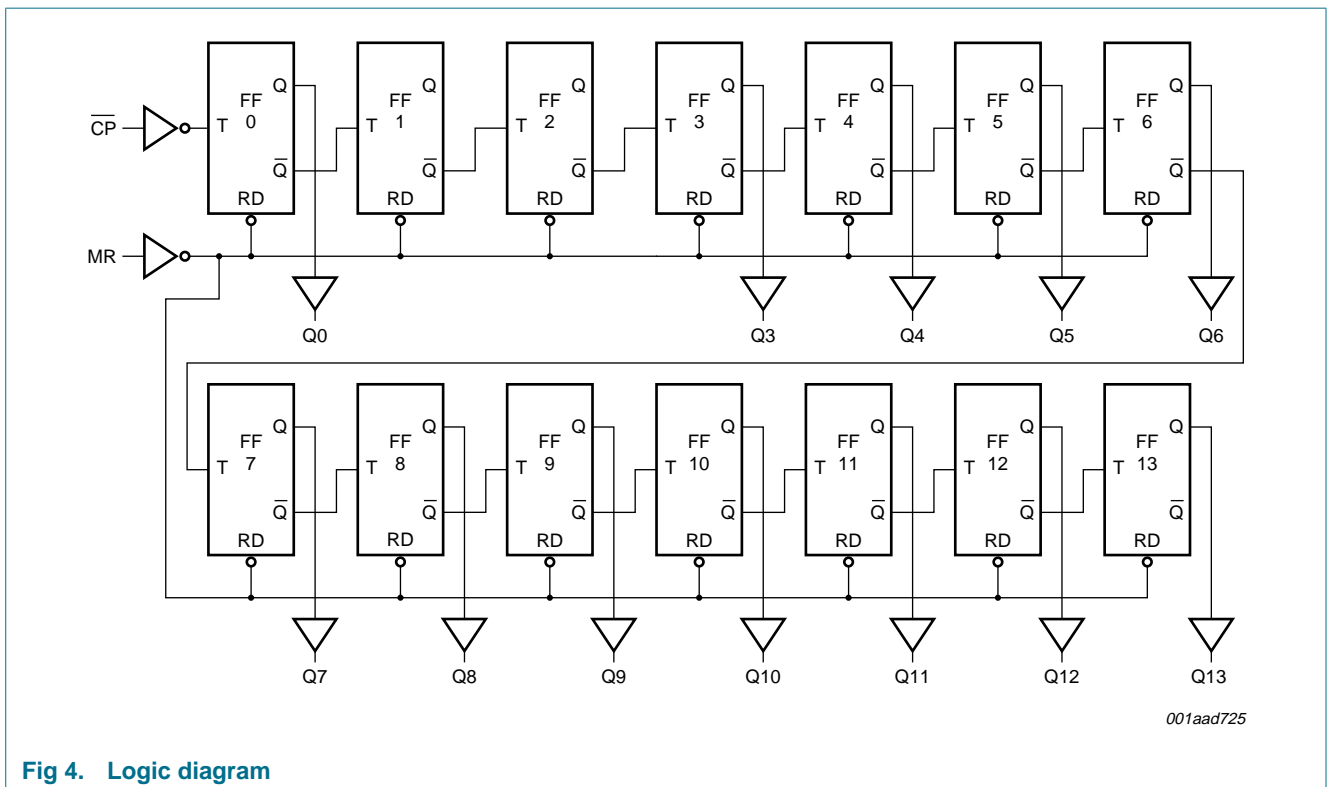
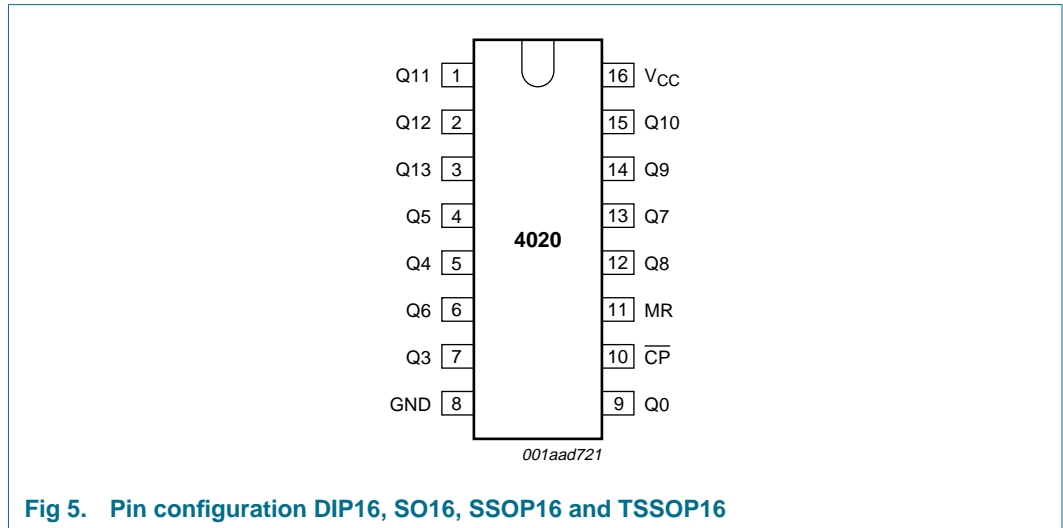


Fig 4. Logic diagram

7. Pinning information

7.1 Pinning



7.2 Pin description

Table 3: Pin description

Symbol	Pin	Description
Q11	1	parallel output 11
Q12	2	parallel output 12
Q13	3	parallel output 13
Q5	4	parallel output 5
Q4	5	parallel output 4
Q6	6	parallel output 6
Q3	7	parallel output 3
GND	8	ground (0 V)
Q0	9	parallel output 0
\overline{CP}	10	clock input (HIGH-to-LOW, edge-triggered)
MR	11	master reset input (active HIGH)
Q8	12	parallel output 8
Q7	13	parallel output 7
Q9	14	parallel output 9
Q10	15	parallel output 10
V _{CC}	16	supply voltage

8. Functional description

8.1 Function table

Table 4: Function table [1]

Input		Output
CP	MR	Q0, Q3 to Q13
↑	L	no change
↓	L	count
X	H	L

- [1] H = HIGH voltage level;
 L = LOW voltage level;
 X = don't care;
 ↑ = LOW-to-HIGH clock transition;
 ↓ = HIGH-to-LOW clock transition.

8.1.1 Timing diagram

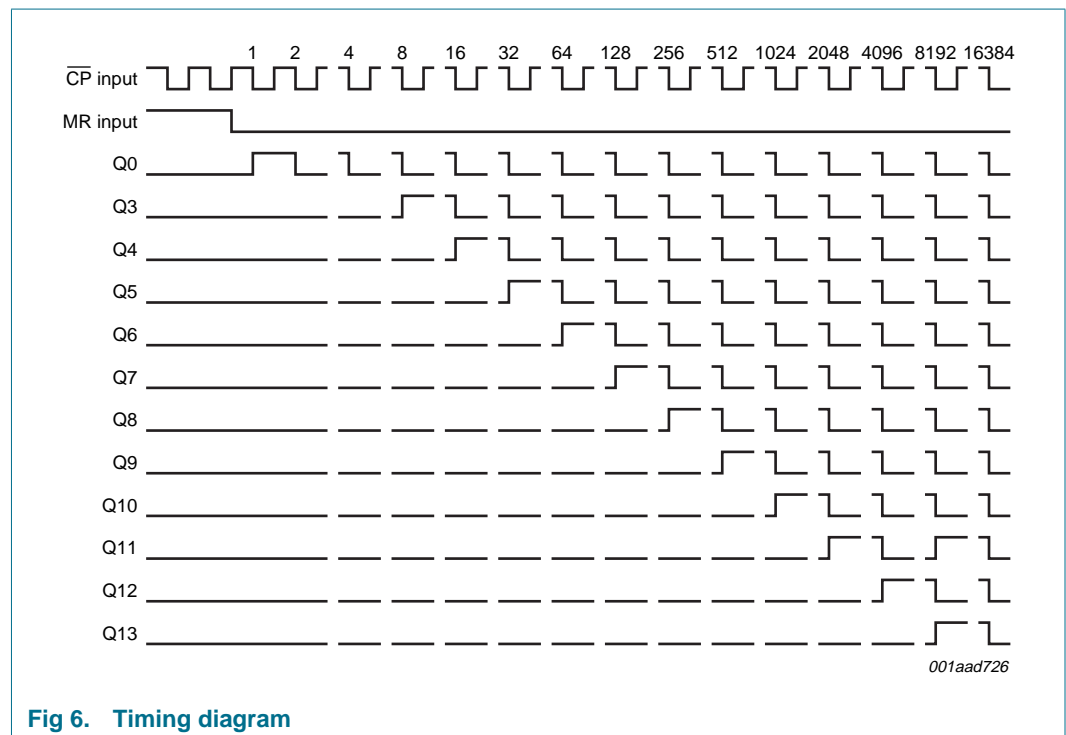


Fig 6. Timing diagram

9. Limiting values

Table 5: Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		-0.5	+7	V
I_{IK}	input clamping current	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	± 20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	-	± 50	mA
I_O	output current	$V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$	-	± 25	mA
I_{CC}	quiescent supply current		-	50	mA
I_{GND}	ground current		-	-50	mA
T_{stg}	storage temperature		-65	+150	°C
P_{tot}	total power dissipation	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$			
	DIP16 package		[1] -	750	mW
	SO16 package		[2] -	500	mW
	SSOP16 and TSSOP16 packages		[3] -	400	mW

[1] Above $T_{amb} = 70\text{ °C}$: P_{tot} derates linearly with 12 mW/K.

[2] Above $T_{amb} = 70\text{ °C}$: P_{tot} derates linearly with 8 mW/K.

[3] Above $T_{amb} = 60\text{ °C}$: P_{tot} derates linearly with 5.5 mW/K.

10. Recommended operating conditions

Table 6: Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		[1] 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}	ambient temperature		-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 1.0\text{ V}$ to 2.0 V	-	-	500	ns/V
		$V_{CC} = 2.0\text{ V}$ to 2.7 V	-	-	200	ns/V
		$V_{CC} = 2.7\text{ V}$ to 3.6 V	-	-	100	ns/V
		$V_{CC} = 3.6\text{ V}$ to 5.5 V	-	-	50	ns/V

[1] The static characteristics are guaranteed from $V_{CC} = 1.2\text{ V}$ to $V_{CC} = 5.5\text{ V}$, but LV devices are guaranteed to function down to $V_{CC} = 1.0\text{ V}$ (with input levels GND or V_{CC}).

11. Static characteristics

Table 7: Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{amb} = -40\text{ °C to }+85\text{ °C}$ [1]						
V_{IH}	HIGH-state input voltage	$V_{CC} = 1.2\text{ V}$	0.9	-	-	V
		$V_{CC} = 2.0\text{ V}$	1.4	-	-	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	2.0	-	-	V
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	$0.7 \times V_{CC}$	-	-	V
V_{IL}	LOW-state input voltage	$V_{CC} = 1.2\text{ V}$	-	-	0.3	V
		$V_{CC} = 2.0\text{ V}$	-	-	0.6	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	-	0.8	V
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	-	-	$0.3 \times V_{CC}$	V
V_{OH}	HIGH-state output voltage	$V_I = V_{IH}$ or V_{IL}				
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 1.2\text{ V}$	-	1.2	-	V
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 2.0\text{ V}$	1.8	2.0	-	V
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V}$	2.5	2.7	-	V
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 3.0\text{ V}$	2.8	3.0	-	V
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 4.5\text{ V}$	4.3	4.5	-	V
		$I_O = -6\text{ mA}; V_{CC} = 3.0\text{ V}$	2.40	2.82	-	V
		$I_O = -12\text{ mA}; V_{CC} = 4.5\text{ V}$	3.60	4.20	-	V
V_{OL}	LOW-state output voltage	$V_I = V_{IH}$ or V_{IL}				
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 1.2\text{ V}$	-	0	-	V
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 2.0\text{ V}$	-	0	0.2	V
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V}$	-	0	0.2	V
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 3.0\text{ V}$	-	0	0.2	V
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 4.5\text{ V}$	-	0	0.2	V
		$I_O = 6\text{ mA}; V_{CC} = 3.0\text{ V}$	-	0.25	0.40	V
		$I_O = 12\text{ mA}; V_{CC} = 4.5\text{ V}$	-	0.35	0.55	V
I_{LI}	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5\text{ V}$	-	-	1.0	μA
I_{CC}	quiescent supply current	$V_I = V_{CC}$ or GND; $I_O = 0\text{ A}; V_{CC} = 5.5\text{ V}$	-	-	20.0	μA
ΔI_{CC}	additional quiescent supply current	per input; $V_I = V_{CC} - 0.6\text{ V}; V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	-	500	μA
C_i	input capacitance		-	3.5	-	pF
$T_{amb} = -40\text{ °C to }+125\text{ °C}$						
V_{IH}	HIGH-state input voltage	$V_{CC} = 1.2\text{ V}$	0.9	-	-	V
		$V_{CC} = 2.0\text{ V}$	1.4	-	-	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	2.0	-	-	V
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	$0.7 \times V_{CC}$	-	-	V

Table 7: Static characteristics ...continued

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V _{IL}	LOW-state input voltage	V _{CC} = 1.2 V	-	-	0.3	V
		V _{CC} = 2.0 V	-	-	0.6	V
		V _{CC} = 2.7 V to 3.6 V	-	-	0.8	V
		V _{CC} = 4.5 V to 5.5 V	-	-	0.3 × V _{CC}	V
V _{OH}	HIGH-state output voltage	V _I = V _{IH} or V _{IL}				
		I _O = -100 μA; V _{CC} = 1.2 V	-	-	-	V
		I _O = -100 μA; V _{CC} = 2.0 V	1.8	-	-	V
		I _O = -100 μA; V _{CC} = 2.7 V	2.5	-	-	V
		I _O = -100 μA; V _{CC} = 3.0 V	2.8	-	-	V
		I _O = -100 μA; V _{CC} = 4.5 V	4.3	-	-	V
		I _O = -6 mA; V _{CC} = 3.0 V	2.20	-	-	V
		I _O = -12 mA; V _{CC} = 4.5 V	3.50	-	-	V
V _{OL}	LOW-state output voltage	V _I = V _{IH} or V _{IL}				
		I _O = 100 μA; V _{CC} = 1.2 V	-	-	-	V
		I _O = 100 μA; V _{CC} = 2.0 V	-	-	0.2	V
		I _O = 100 μA; V _{CC} = 2.7 V	-	-	0.2	V
		I _O = 100 μA; V _{CC} = 3.0 V	-	-	0.2	V
		I _O = 100 μA; V _{CC} = 4.5 V	-	-	0.2	V
		I _O = 6 mA; V _{CC} = 3.0 V	-	-	0.50	V
		I _O = 12 mA; V _{CC} = 4.5 V	-	-	0.65	V
I _{LI}	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	1.0	μA
I _{CC}	quiescent supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	160	μA
ΔI _{CC}	additional quiescent supply current	per input; V _I = V _{CC} - 0.6 V; V _{CC} = 2.7 V to 3.6 V	-	-	850	μA

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

12. Dynamic characteristics

Table 8: Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{amb} = -40$ °C to $+85$ °C [1]						
t_{PHL} , t_{PLH}	propagation delay CP to Q0	see Figure 7				
		$V_{CC} = 1.2$ V	-	60	-	ns
		$V_{CC} = 2.0$ V	-	27	43	ns
		$V_{CC} = 2.7$ V	-	19	31	ns
		$V_{CC} = 3.0$ V to 3.6 V	-	16	26	ns
		$V_{CC} = 4.5$ V to 5.5 V	-	11	17	ns
		$V_{CC} = 3.3$ V; $C_L = 15$ pF	-	12	-	ns
	Qn to Q(n+1)	see Figure 7				
		$V_{CC} = 1.2$ V	-	40	-	ns
		$V_{CC} = 2.0$ V	-	18	29	ns
		$V_{CC} = 2.7$ V	-	13	21	ns
		$V_{CC} = 3.0$ V to 3.6 V	-	11	18	ns
		$V_{CC} = 4.5$ V to 5.5 V	-	7	12	ns
		$V_{CC} = 3.3$ V; $C_L = 15$ pF	-	7	-	ns
t_{PHL}	propagation delay MR to Qn	see Figure 8				
		$V_{CC} = 1.2$ V	-	55	-	ns
		$V_{CC} = 2.0$ V	-	27	44	ns
		$V_{CC} = 2.7$ V	-	19	31	ns
		$V_{CC} = 3.0$ V to 3.6 V	-	16	26	ns
		$V_{CC} = 4.5$ V to 5.5 V	-	11	17	ns
		$V_{CC} = 3.3$ V; $C_L = 15$ pF	-	16	-	ns
t_w	pulse width CP (HIGH and LOW)	see Figure 7				
		$V_{CC} = 2.0$ V	35	7	-	ns
		$V_{CC} = 2.7$ V	25	5	-	ns
		$V_{CC} = 3.0$ V to 3.6 V	20	4	-	ns
		$V_{CC} = 4.5$ V to 5.5 V	15	3	-	ns
	MR (HIGH)	see Figure 8				
		$V_{CC} = 2.0$ V	35	11	-	ns
		$V_{CC} = 2.7$ V	25	9	-	ns
		$V_{CC} = 3.0$ V to 3.6 V	20	8	-	ns
		$V_{CC} = 4.5$ V to 5.5 V	15	7	-	ns

Table 8: Dynamic characteristics ...continued

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit		
t_{rec}	recovery time MR to \overline{CP}	see Figure 8						
		$V_{CC} = 1.2$ V	-	10	-	ns		
		$V_{CC} = 2.0$ V	22	5	-	ns		
		$V_{CC} = 2.7$ V	16	4	-	ns		
		$V_{CC} = 3.0$ V to 3.6 V	13	3	-	ns		
		$V_{CC} = 4.5$ V to 5.5 V	10	2	-	ns		
f_{max}	maximum input clock frequency	see Figure 7						
		$V_{CC} = 2.0$ V	14	60	-	MHz		
		$V_{CC} = 2.7$ V	19	76	-	MHz		
		$V_{CC} = 3.0$ V to 3.6 V	24	94	-	MHz		
		$V_{CC} = 4.5$ V to 5.5 V	36	112	-	MHz		
		$V_{CC} = 3.3$ V; $C_L = 15$ pF	-	100	-	MHz		
C_{PD}	power dissipation capacitance	per gate; $V_I = GND$ to V_{CC}	2 -	20	-	pF		
$T_{amb} = -40$ °C to $+125$ °C								
t_{PHL} , t_{PLH}	propagation delay \overline{CP} to Q0	see Figure 7						
		$V_{CC} = 1.2$ V	-	-	-	ns		
		$V_{CC} = 2.0$ V	-	-	54	ns		
		$V_{CC} = 2.7$ V	-	-	38	ns		
		$V_{CC} = 3.0$ V to 3.6 V	-	-	32	ns		
		$V_{CC} = 4.5$ V to 5.5 V	-	-	22	ns		
		Qn to Q(n+1)	see Figure 7					
			$V_{CC} = 1.2$ V	-	-	-	ns	
			$V_{CC} = 2.0$ V	-	-	37	ns	
			$V_{CC} = 2.7$ V	-	-	26	ns	
			$V_{CC} = 3.0$ V to 3.6 V	-	-	22	ns	
$V_{CC} = 4.5$ V to 5.5 V	-		-	15	ns			
t_{PHL}	propagation delay MR to Qn	see Figure 8						
		$V_{CC} = 1.2$ V	-	-	-	ns		
		$V_{CC} = 2.0$ V	-	-	55	ns		
		$V_{CC} = 2.7$ V	-	-	39	ns		
		$V_{CC} = 3.0$ V to 3.6 V	-	-	32	ns		
		$V_{CC} = 4.5$ V to 5.5 V	-	-	22	ns		

Table 8: Dynamic characteristics ...continued

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
t_W	pulse width						
		\overline{CP} (HIGH and LOW)	see Figure 7				
			$V_{CC} = 2.0$ V	41	-	-	ns
			$V_{CC} = 2.7$ V	30	-	-	ns
			$V_{CC} = 3.0$ V to 3.6 V	24	-	-	ns
			$V_{CC} = 4.5$ V to 5.5 V	18	-	-	ns
		MR (HIGH)	see Figure 8				
			$V_{CC} = 2.0$ V	41	-	-	ns
			$V_{CC} = 2.7$ V	30	-	-	ns
			$V_{CC} = 3.0$ V to 3.6 V	24	-	-	ns
		$V_{CC} = 4.5$ V to 5.5 V	18	-	-	ns	
t_{rec}	recovery time						
		MR to \overline{CP}	see Figure 8				
			$V_{CC} = 1.2$ V	-	-	-	ns
			$V_{CC} = 2.0$ V	26	-	-	ns
			$V_{CC} = 2.7$ V	19	-	-	ns
			$V_{CC} = 3.0$ V to 3.6 V	15	-	-	ns
		$V_{CC} = 4.5$ V to 5.5 V	12	-	-	ns	
f_{max}	maximum input clock frequency	see Figure 7					
			$V_{CC} = 2.0$ V	12	-	-	MHz
			$V_{CC} = 2.7$ V	16	-	-	MHz
			$V_{CC} = 3.0$ V to 3.6 V	20	-	-	MHz
			$V_{CC} = 4.5$ V to 5.5 V	30	-	-	MHz

[1] Typical values are measured at nominal V_{CC} and $T_{amb} = 25$ °C.

[2] C_{PD} is used to determine the dynamic power dissipation (P_D in μ W).

$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:

f_i = input frequency in MHz;

f_o = output frequency in MHz;

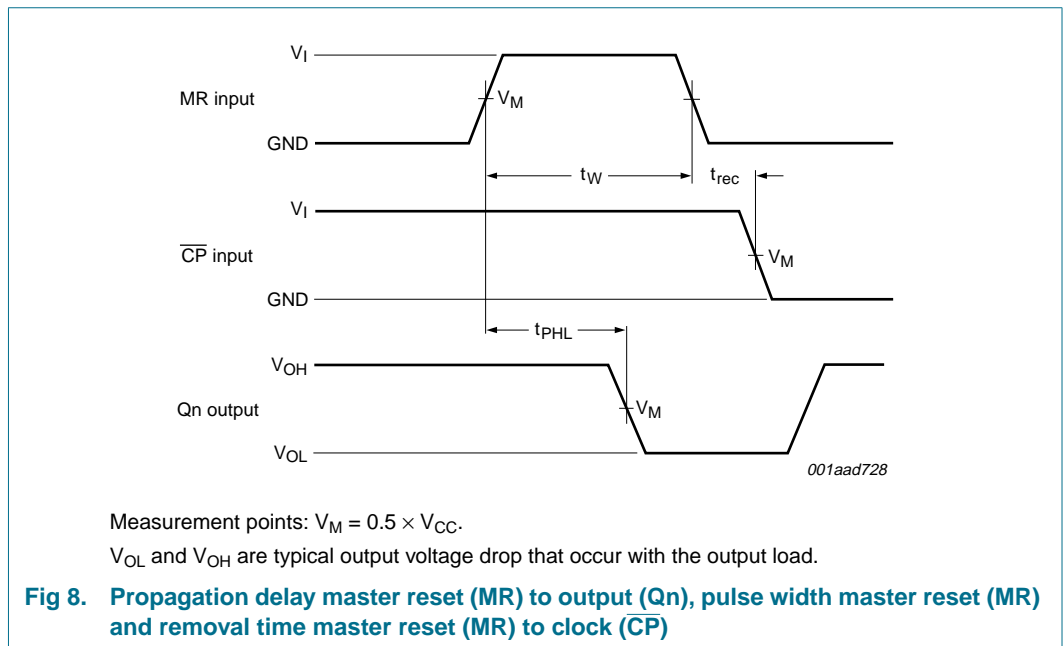
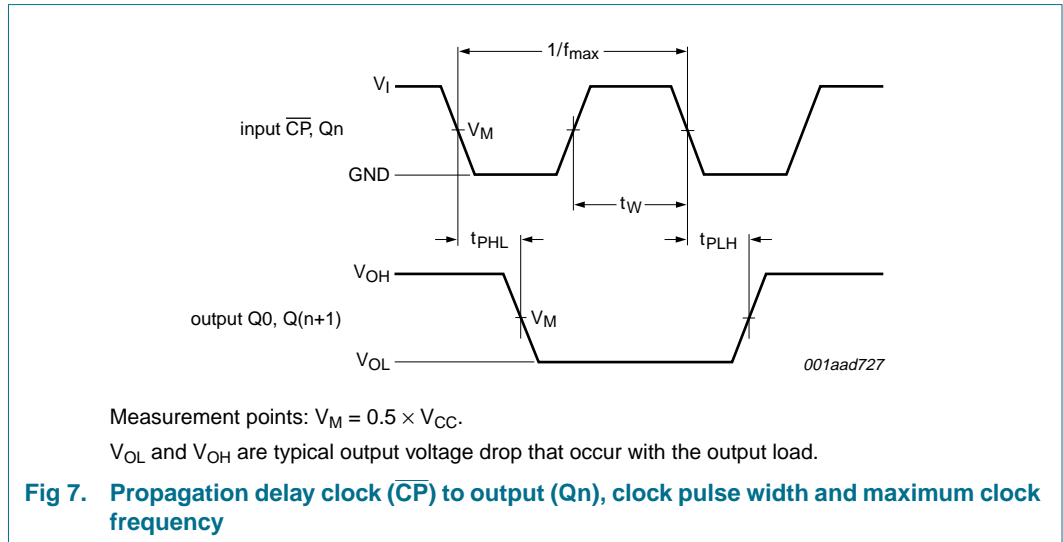
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

$\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.

13. Waveforms



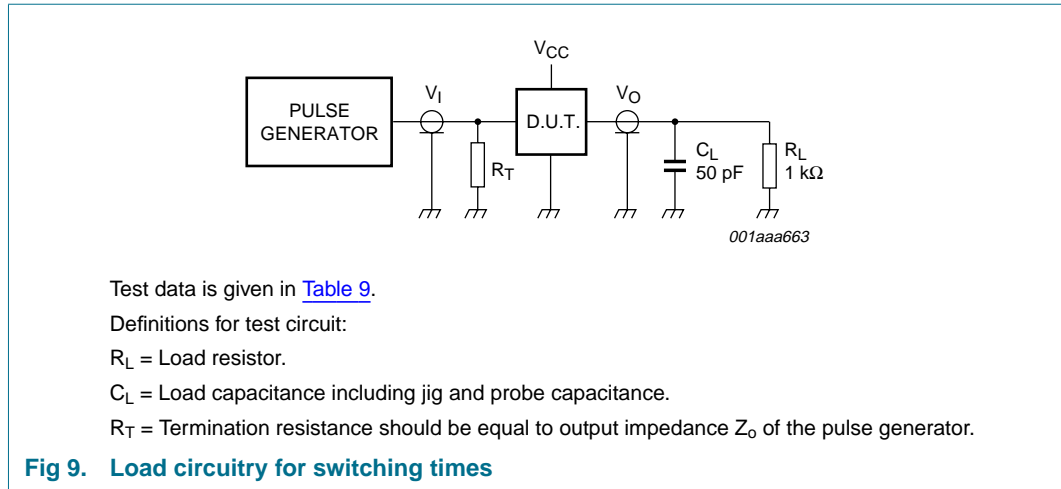


Table 9: Test data

Supply voltage	Input		Load		Test
V_{CC}	V_I	t_r, t_f	C_L	R_L	
1.2 V	V_{CC}	≤ 2.5 ns	50 pF	1 kΩ	t_{PHL}, t_{PLH}
2.0 V	V_{CC}	≤ 2.5 ns	50 pF	1 kΩ	t_{PHL}, t_{PLH}
2.7 V	2.7 V	≤ 2.5 ns	50 pF	1 kΩ	t_{PHL}, t_{PLH}
3.0 V to 3.6 V	2.7 V	≤ 2.5 ns	50 pF, 15 pF	1 kΩ	t_{PHL}, t_{PLH}
4.5 V to 5.5 V	V_{CC}	≤ 2.5 ns	50 pF	1 kΩ	t_{PHL}, t_{PLH}

14. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4

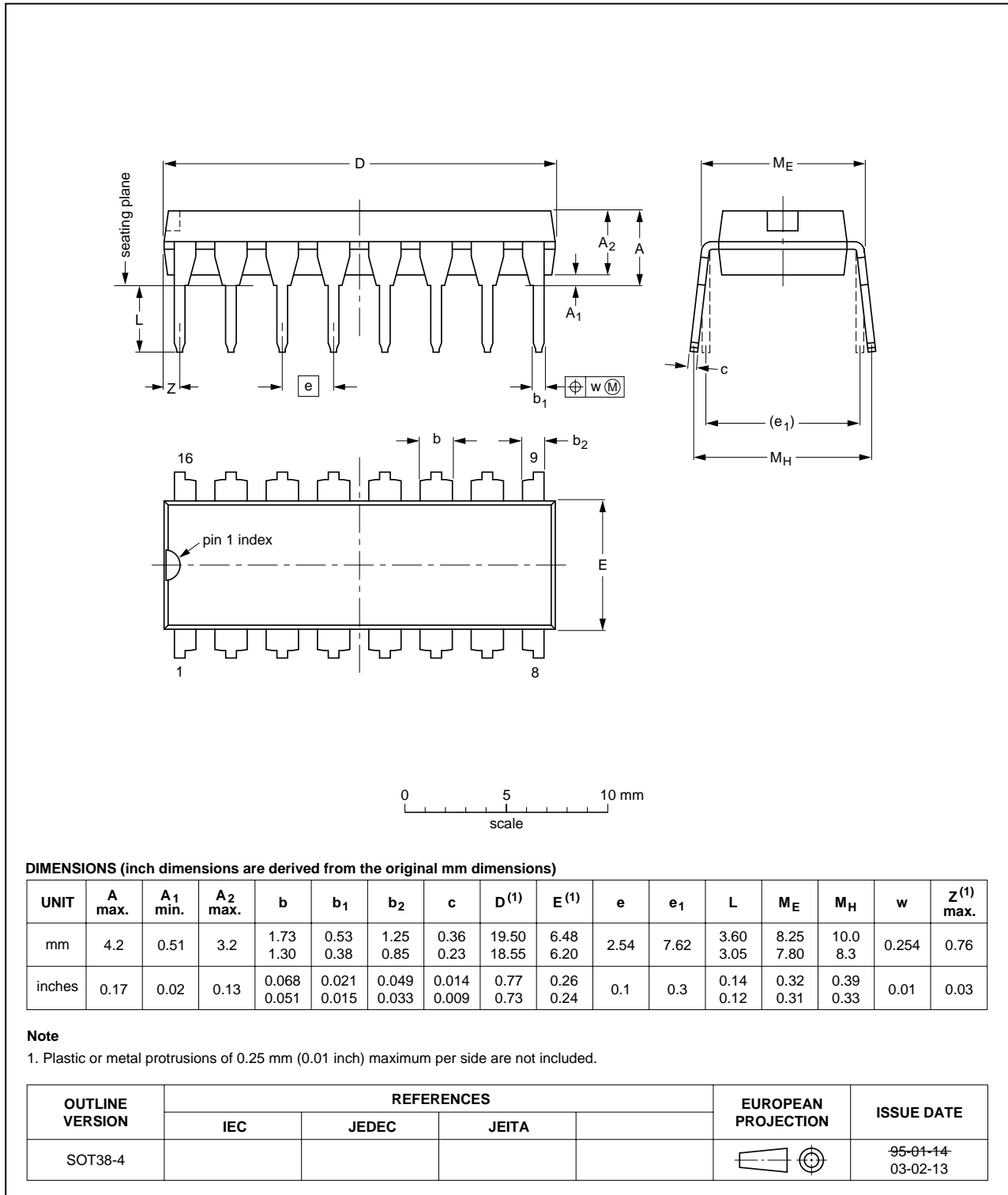


Fig 10. Package outline SOT38-1 (DIP16)

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

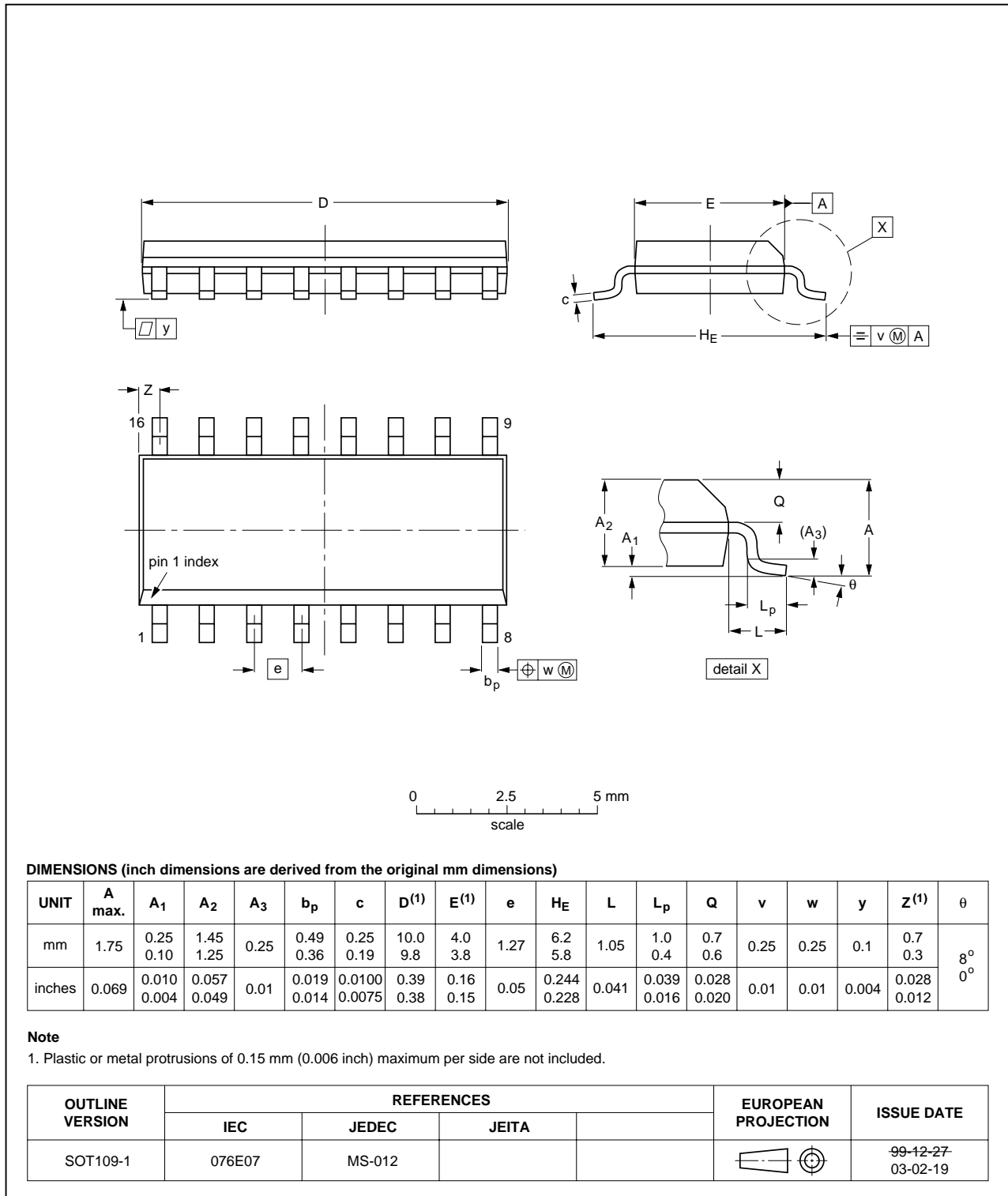


Fig 11. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

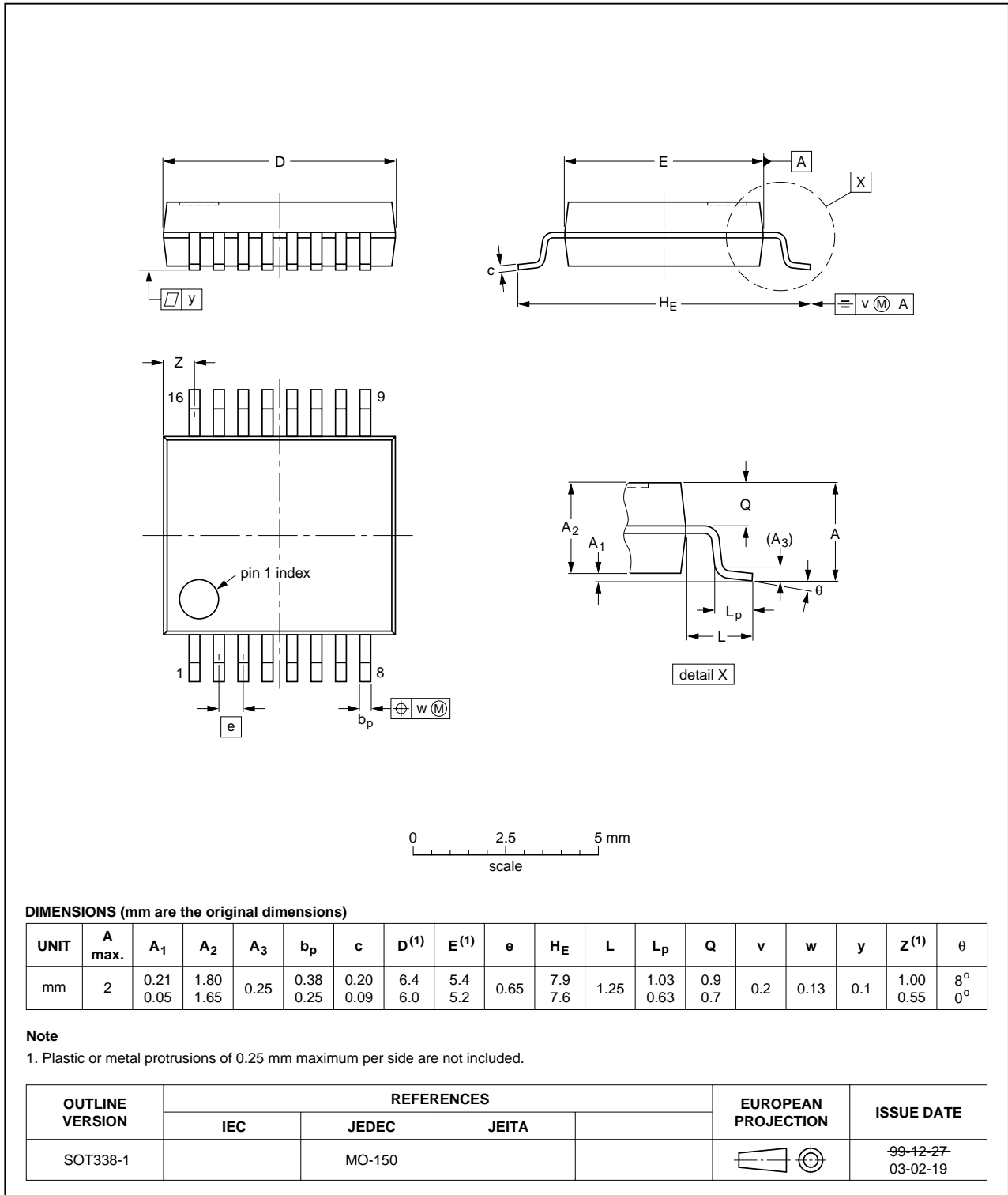


Fig 12. Package outline SOT338-1 (SSOP16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

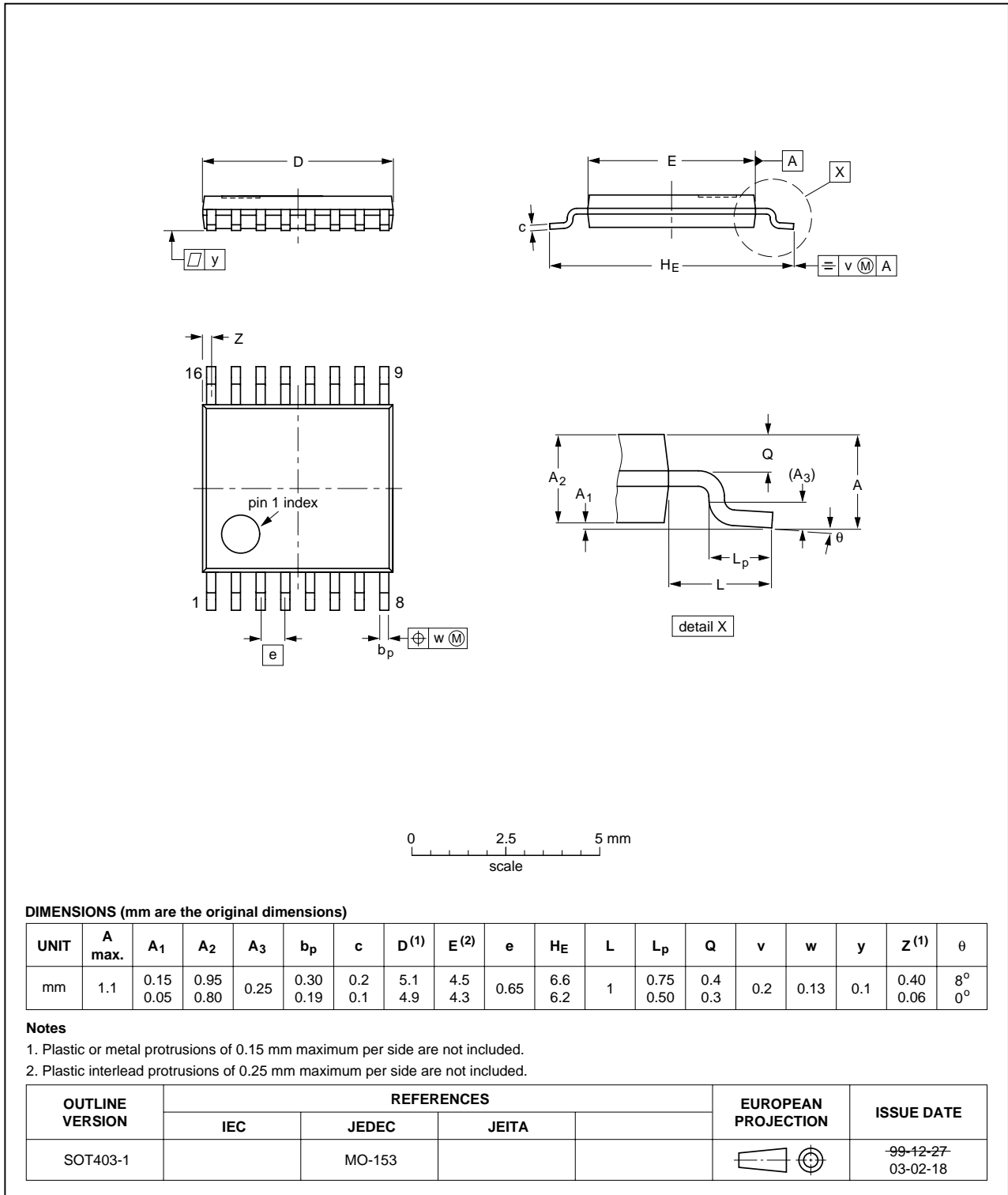


Fig 13. Package outline SOT403-1 (TSSOP16)

15. Abbreviations

Table 10: Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
TTL	Transistor Transistor Logic
HBM	Human Body Model
ESD	ElectroStatic Discharge
MM	Machine Model

16. Revision history

Table 11: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
74LV4020_1	20051129	Product data sheet	-	-	-

17. Data sheet status

Level	Data sheet status ^[1]	Product status ^{[2] [3]}	Definition
I	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.
II	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.
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[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>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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