

74HC4040; 74HCT4040

12-stage binary ripple counter

Rev. 4 — 20 March 2014

Product data sheet

1. General description

The 74HC4040; 74HCT4040 is a 12-stage binary ripple counter with a clock input (\overline{CP}), an overriding asynchronous master reset input (MR) and twelve parallel outputs (Q0 to Q11). 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. Inputs include clamp diodes that enable the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

2. Features and benefits

- Complies with JEDEC standard no. 7A
- Input levels:
 - ◆ For 74HC4040: CMOS level
 - ◆ For 74HCT4040: TTL level
- ESD protection:
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$

3. Applications

- Frequency dividing circuits
- Time delay circuits
- Control counters

4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC4040N	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	DIP16	plastic dual in-line package; 16 leads (300 mil); long body	SOT38-1
74HCT4040N				
74HC4040D	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT4040D				
74HC4040DB	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HCT4040DB				



Table 1. Ordering information ...continued

Type number	Package			Version
	Temperature range	Name	Description	
74HC4040PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT4040PW				
74HC4040BQ	-40 °C to +125 °C	DHVQFN16	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 × 3.5 × 0.85 mm	SOT763-1
74HCT4040BQ				

5. Functional diagram

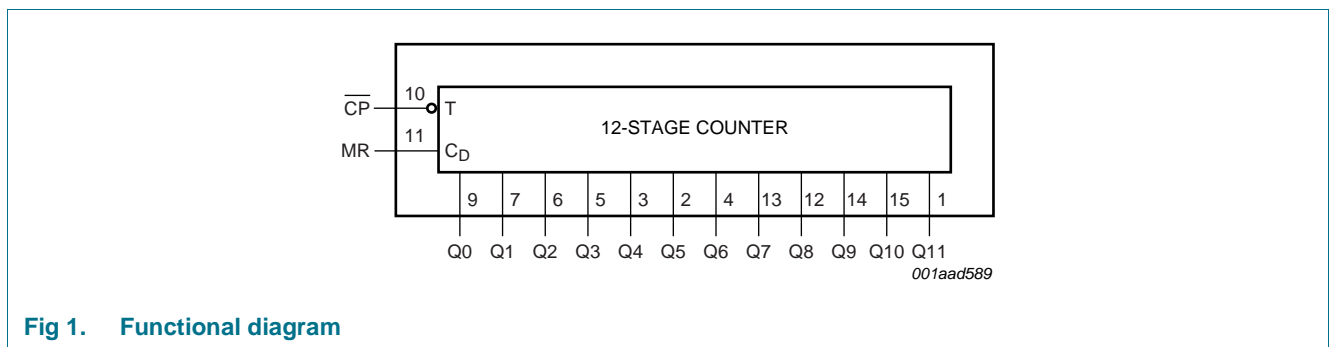


Fig 1. Functional diagram

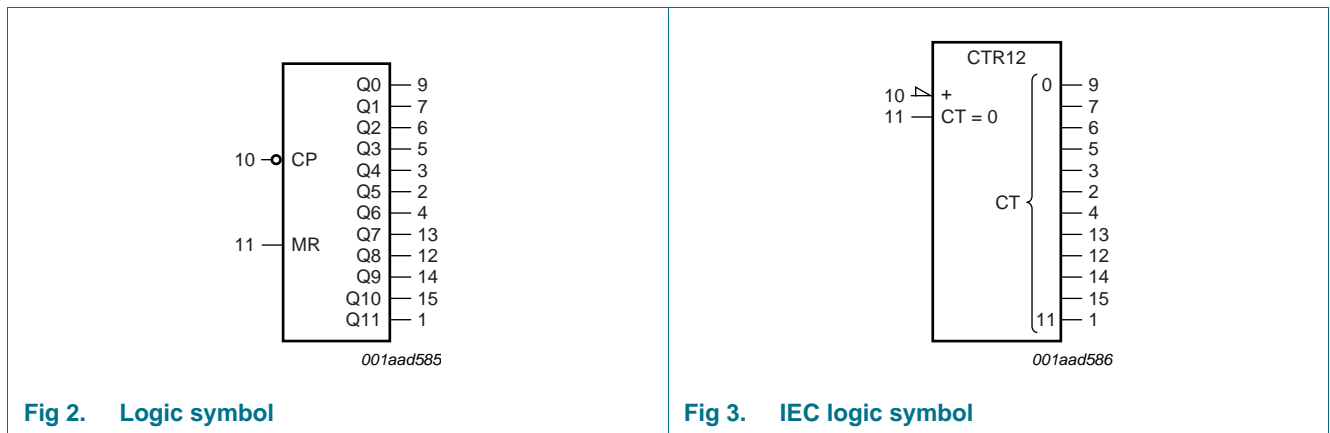


Fig 2. Logic symbol

Fig 3. IEC logic symbol

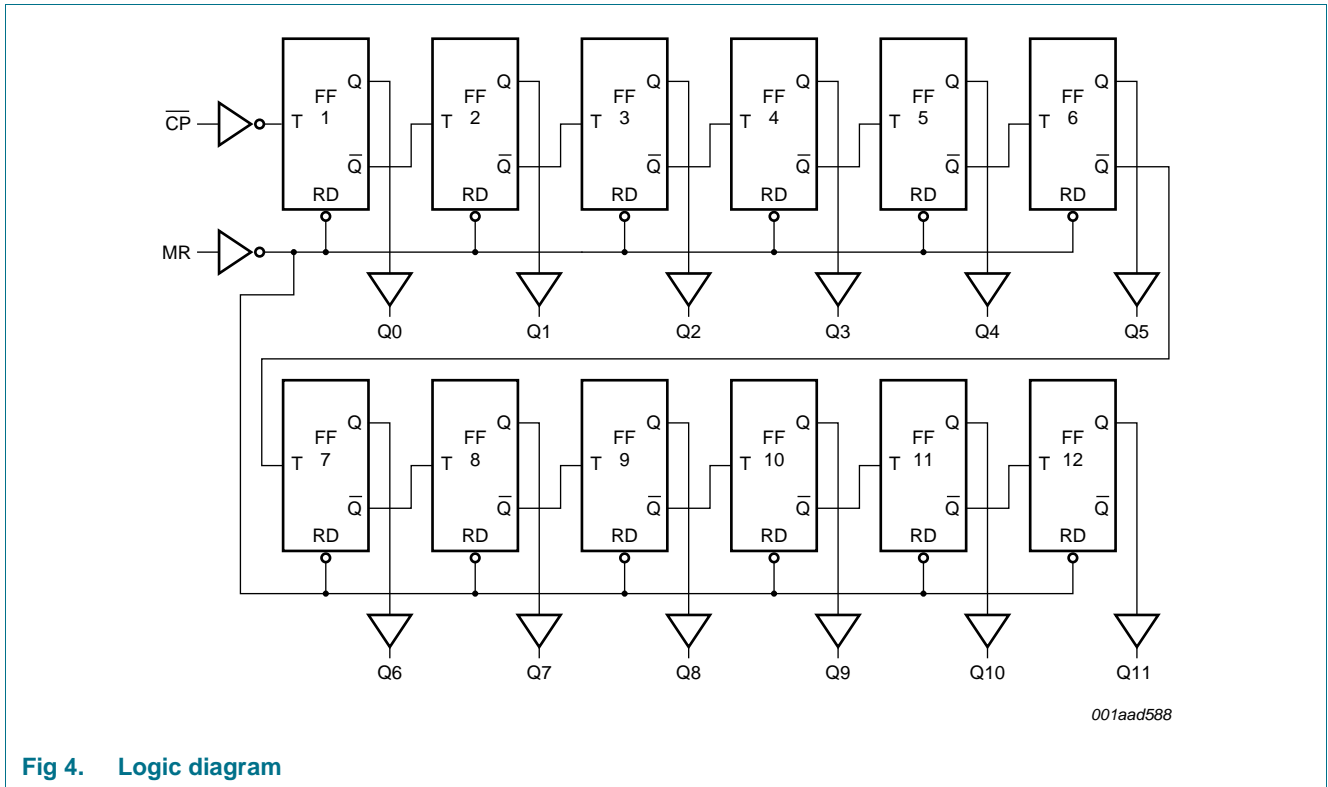


Fig 4. Logic diagram

6. Pinning information

6.1 Pinning

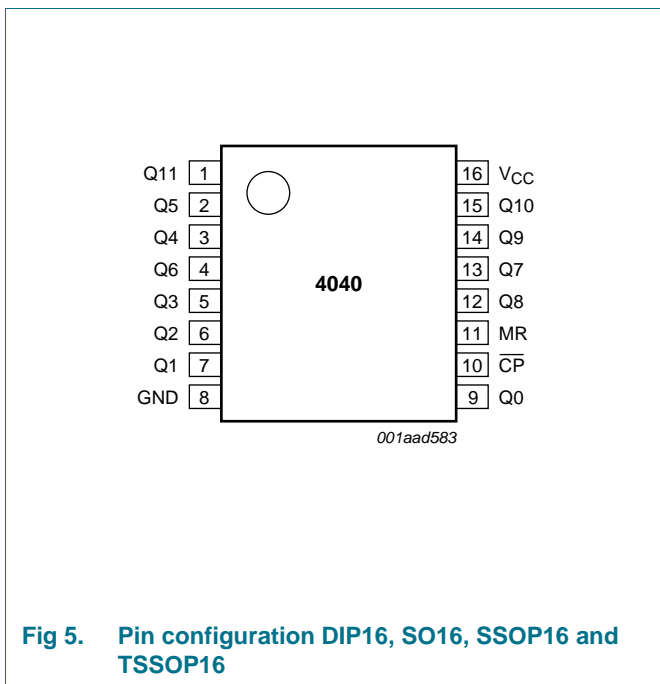


Fig 5. Pin configuration DIP16, SO16, SSOP16 and TSSOP16

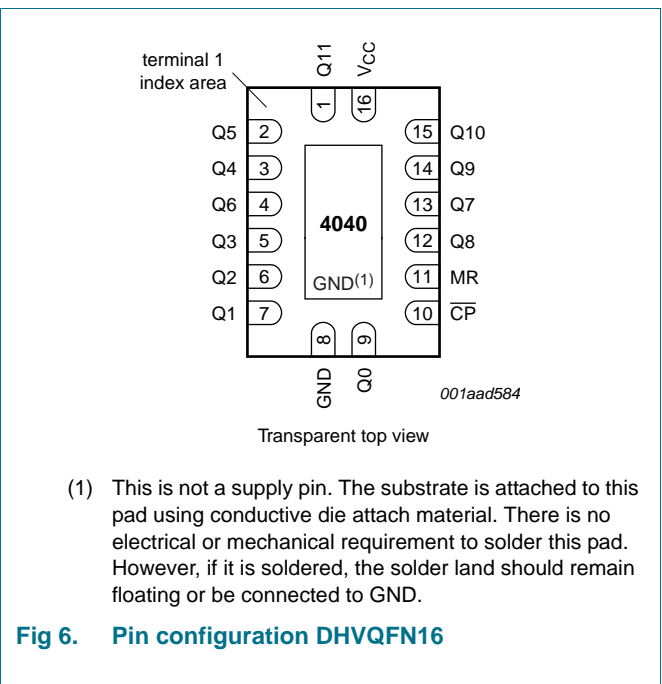


Fig 6. Pin configuration DHVQFN16

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Q11	1	output 11
Q5	2	output 5
Q4	3	output 4
Q6	4	output 6
Q3	5	output 3
Q2	6	output 2
Q1	7	output 1
GND	8	ground (0 V)
Q0	9	output 0
$\overline{\text{CP}}$	10	clock input (HIGH-to-LOW, edge-triggered)
MR	11	master reset input (active HIGH)
Q8	12	output 8
Q7	13	output 7
Q9	14	output 9
Q10	15	output 10
V _{CC}	16	positive supply voltage

7. Functional description

7.1 Function table

Table 3. Function table

Input		Output
$\overline{\text{CP}}$	MR	Q0 to Q11
↑	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.

7.2 Timing diagram

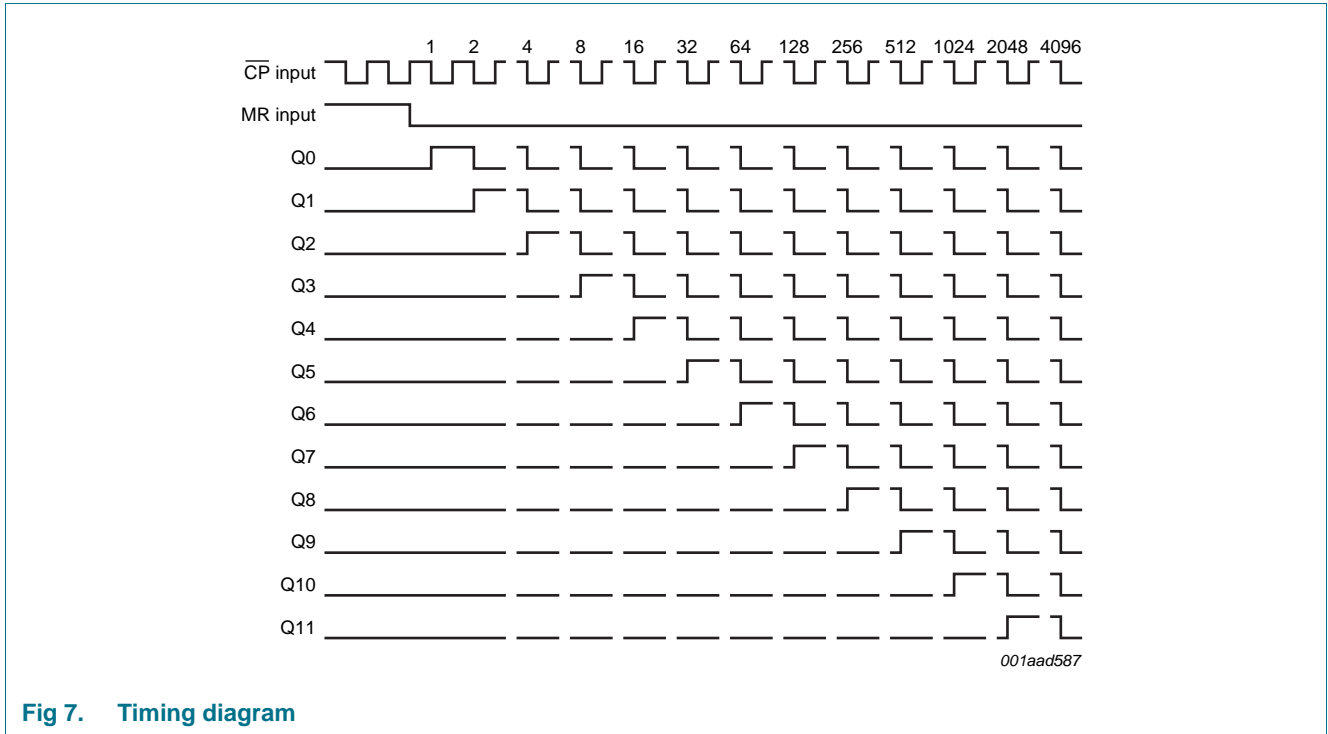


Fig 7. Timing diagram

8. Limiting values

Table 4. 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 V or V _I > V _{CC} + 0.5 V	-	±20	mA
I _{OK}	output clamping current	V _I < -0.5 V or V _I > V _{CC} + 0.5 V	-	±20	mA
I _O	output current	-0.5 V < V _O < V _{CC} + 0.5 V	-	±25	mA
I _{CC}	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 °C to +125 °C	[1]		
	DIP16 package		-	750	mW
	SO16, SSOP16, TSSOP16 and DHVQFN16 packages		-	500	mW

[1] For DIP16 packages: above 70 °C, P_{tot} derates linearly with 12 mW/K.

For SO16, SSOP16, TSSOP16 and DHVQFN16 packages, above 70 °C, P_{tot} derates linearly with 8 mW/K.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC4040			74HCT4040			Unit
			Min	Typ	Max	Min	Typ	Max	
V _{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V _I	input voltage		0	-	V _{CC}	0	-	V _{CC}	V
V _O	output voltage		0	-	V _{CC}	0	-	V _{CC}	V
T _{amb}	ambient temperature		-40	+25	+125	-40	+25	+125	°C
Δt/ΔV	input transition rise and fall rate	V _{CC} = 2.0 V	-	-	625	-	-	-	ns/V
		V _{CC} = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V _{CC} = 6.0 V	-	-	83	-	-	-	ns/V

10. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC4040										
V _{IH}	HIGH-level input voltage	V _{CC} = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V _{CC} = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V _{CC} = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V _{CC} = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V _{CC} = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = -20 μA; V _{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I _O = -20 μA; V _{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -20 μA; V _{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I _O = -4.0 mA; V _{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = 20 μA; V _{CC} = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA; V _{CC} = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
I _l	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±1.0	-	±1.0	μA
		V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	8.0	-	80	-	160	μA

Table 6. Static characteristics ...continued

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

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
C _I	input capacitance		-	3.5	-					pF
74HCT4040										
V _{IH}	HIGH-level input voltage	V _{CC} = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = -20 μA	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -4 mA	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = 20 μA	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA	-	0.15	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±0.1	-	±1.0	-	±1.0	μA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	8.0	-	80	-	160	μA
ΔI _{CC}	additional supply current	per input pin; V _I = V _{CC} - 2.1 V; I _O = 0 A; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V								
		pin CP	-	85	306	-	383	-	417	μA
		pin MR	-	110	396	-	495	-	539	μA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics

GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit, see [Figure 9](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC4040										
t_{pd}	propagation delay	\overline{CP} to Q0; see Figure 8 ^[1]								
		$V_{CC} = 2.0$ V	-	47	150	-	190	-	225	ns
		$V_{CC} = 4.5$ V	-	17	30	-	38	-	45	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	14	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	14	26	-	33	-	38	ns
		Qn to Qn+1; see Figure 8								
		$V_{CC} = 2.0$ V	-	28	100	-	125	-	150	ns
		$V_{CC} = 4.5$ V	-	10	20	-	25	-	30	ns
t_{PHL}	HIGH to LOW propagation delay	MR to Qn; see Figure 8								
		$V_{CC} = 2.0$ V	-	61	185	-	230	-	280	ns
		$V_{CC} = 4.5$ V	-	22	37	-	46	-	56	ns
		$V_{CC} = 6.0$ V	-	18	31	-	39	-	48	ns
t_t	transition time	Qn; see Figure 8 ^[2]								
		$V_{CC} = 2.0$ V	-	19	75	-	95	-	110	ns
		$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns
		$V_{CC} = 6.0$ V	-	6	13	-	16	-	19	ns
t_w	pulse width	\overline{CP} input, HIGH or LOW; see Figure 8								
		$V_{CC} = 2.0$ V	80	14	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	5	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	4	-	17	-	20	-	ns
		MR input, HIGH; see Figure 8								
		$V_{CC} = 2.0$ V	80	22	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	8	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	6	-	17	-	20	-	ns
t_{rec}	recovery time	MR to \overline{CP} ; see Figure 8								
		$V_{CC} = 2.0$ V	50	8	-	65	-	75	-	ns
		$V_{CC} = 4.5$ V	10	3	-	13	-	15	-	ns
		$V_{CC} = 6.0$ V	9	2	-	11	-	13	-	ns
f_{max}	maximum frequency	\overline{CP} input; see Figure 8								
		$V_{CC} = 2.0$ V	6	27	-	4.8	-	4	-	MHz
		$V_{CC} = 4.5$ V	30	82	-	24	-	20	-	MHz
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	90	-	-	-	-	-	MHz
		$V_{CC} = 6.0$ V	35	98	-	28	-	24	-	MHz

Table 7. Dynamic characteristics ...continued

GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit, see [Figure 9](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
C_{PD}	power dissipation capacitance	$V_I = \text{GND to } V_{CC}$ [3]	-	20	-	-	-	-	-	pF
74HCT4040										
t_{pd}	propagation delay	$\overline{\text{CP}}$ to Q0; see Figure 8 [1]								
		$V_{CC} = 4.5$ V	-	19	40	-	50	-	60	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	16	-	-	-	-	-	ns
		Qn to Qn+1; see Figure 8								
		$V_{CC} = 4.5$ V	-	10	20	-	25	-	30	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	8	-	-	-	-	ns	
t_{PHL}	HIGH to LOW propagation delay	MR to Qn; see Figure 8								
		$V_{CC} = 4.5$ V	-	23	45	-	56	-	68	ns
t_t	transition time	Qn; see Figure 8 [2]								
		$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns
t_W	pulse width	$\overline{\text{CP}}$ input, HIGH or LOW; see Figure 8								
		$V_{CC} = 4.5$ V	16	7	-	20	-	24	-	ns
		MR input, HIGH; see Figure 8								
		$V_{CC} = 4.5$ V	16	6	-	20	-	24	-	ns
t_{rec}	recovery time	MR to $\overline{\text{CP}}$; see Figure 8								
		$V_{CC} = 4.5$ V	10	2	-	13	-	15	-	ns
f_{max}	maximum frequency	$\overline{\text{CP}}$ input; see Figure 8								
		$V_{CC} = 4.5$ V	30	72	-	24	-	20	-	MHz
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	79	-	-	-	-	-	MHz
C_{PD}	power dissipation capacitance	$V_I = \text{GND to } V_{CC}$ [3]	-	20	-	-	-	-	-	pF

[1] t_{pd} is the same as t_{PHL} , t_{PLH} .

[2] t_t is the same as t_{THL} , t_{TLH} .

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

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

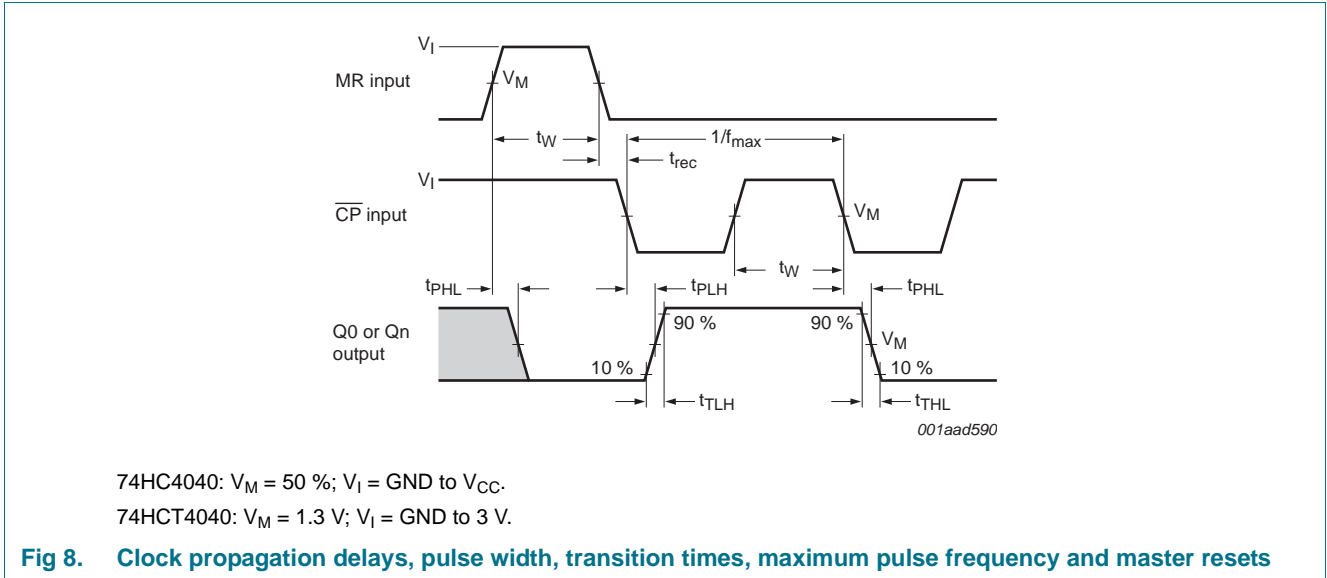
C_L = output load capacitance in pF;

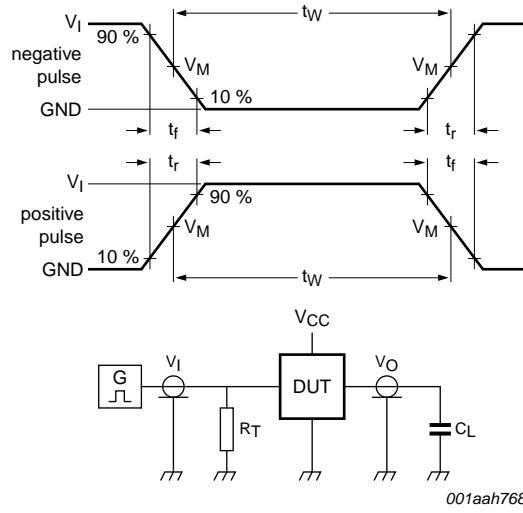
V_{CC} = supply voltage in V;

N = number of inputs switching;

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

12. Waveform and test circuit





Test data is given in [Table 8](#).

Definitions test circuit:

R_T = termination resistance should be equal to output impedance Z_o of the pulse generator.

C_L = load capacitance including jig and probe capacitance.

Fig 9. Test circuit for measuring switching times

Table 8. Test data

Type	Input		Load	Test
	V_I	t_r, t_f	C_L	
74HC4040	V_{CC}	6.0 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}
74HCT4040	3.0 V	6.0 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}

13. Package outline

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

SOT38-1

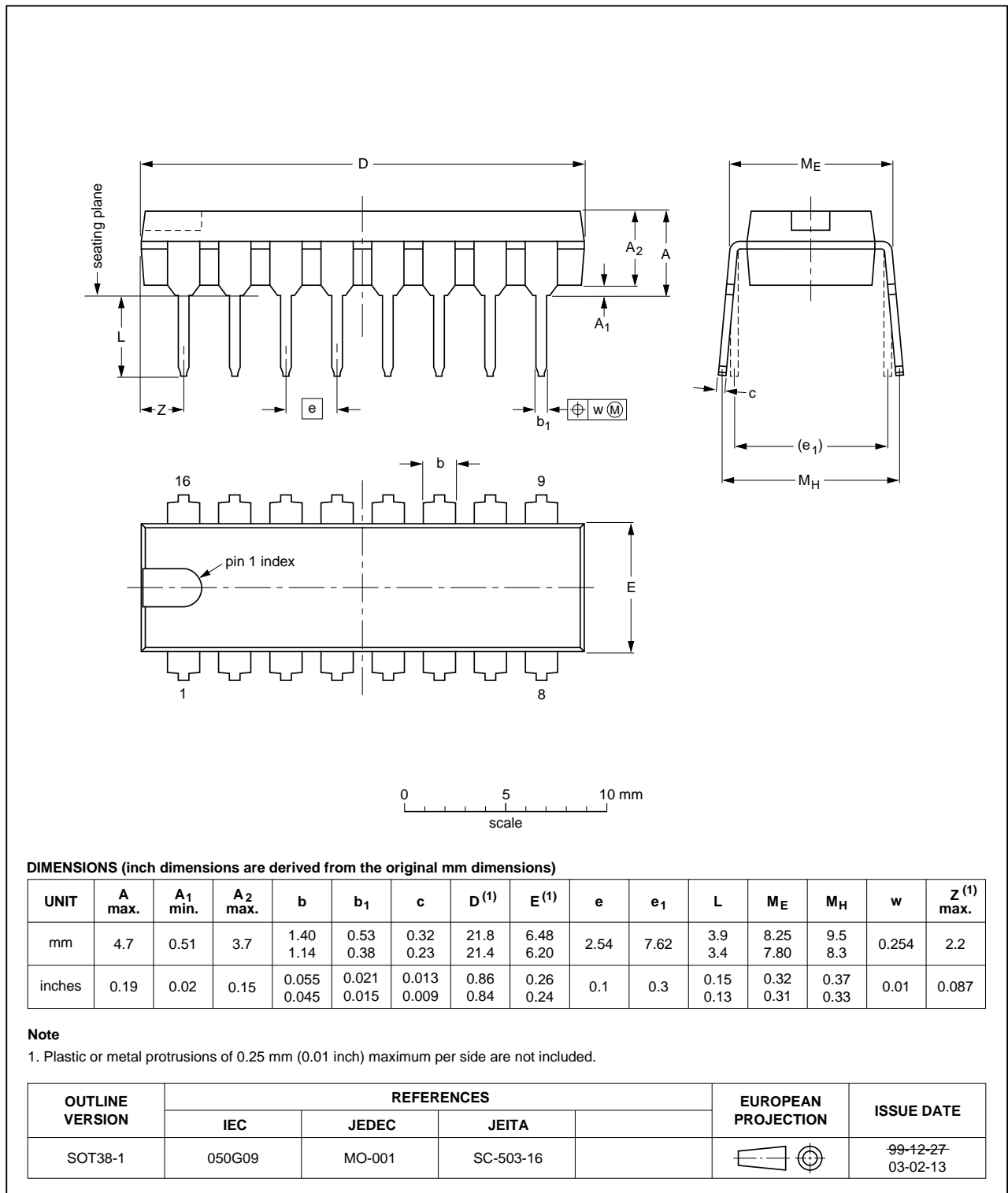


Fig 10. Package outline SOT38-1 (DIP16)

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

SOT109-1

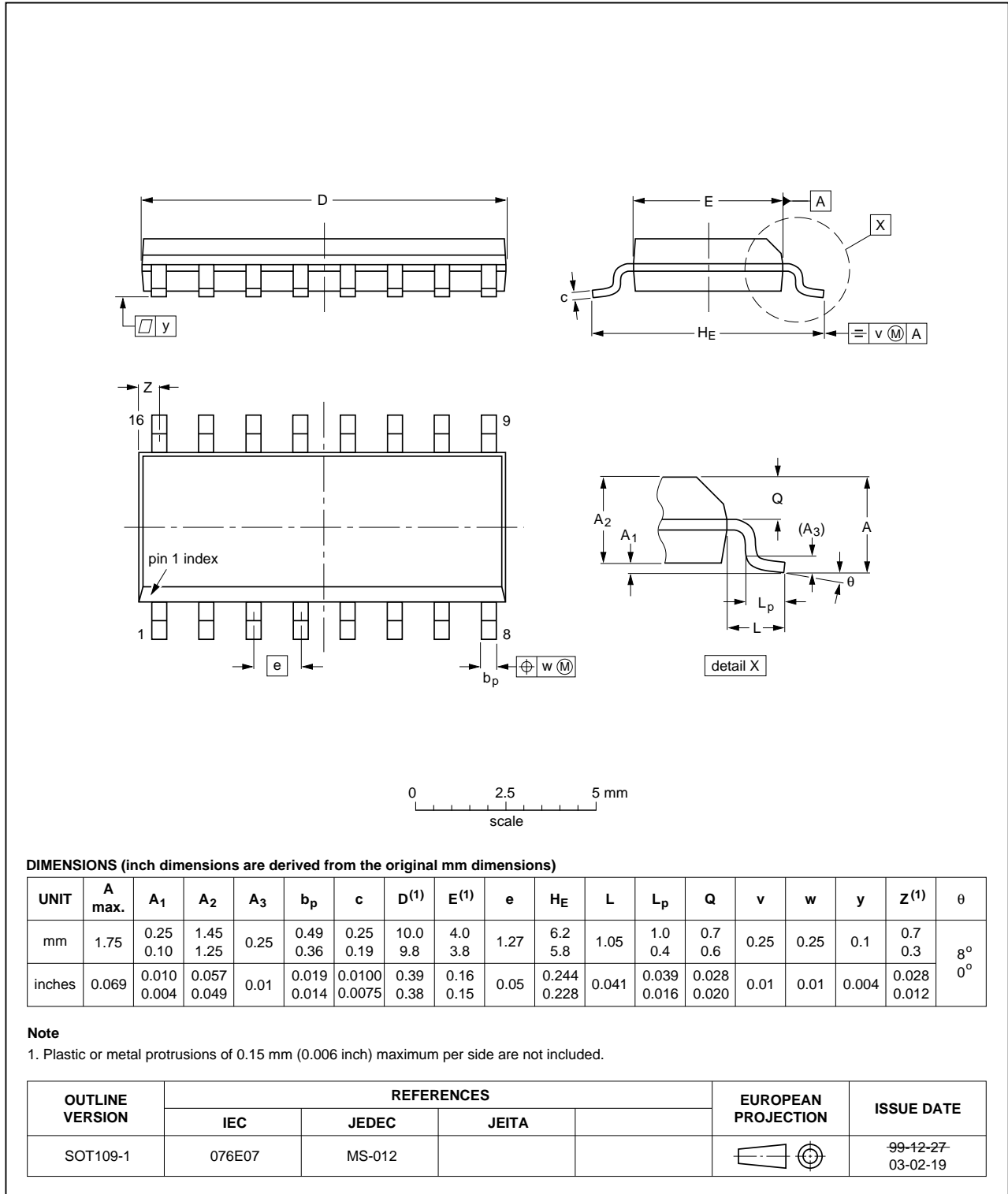


Fig 11. Package outline SOT109-1 (SO16)

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

SOT338-1

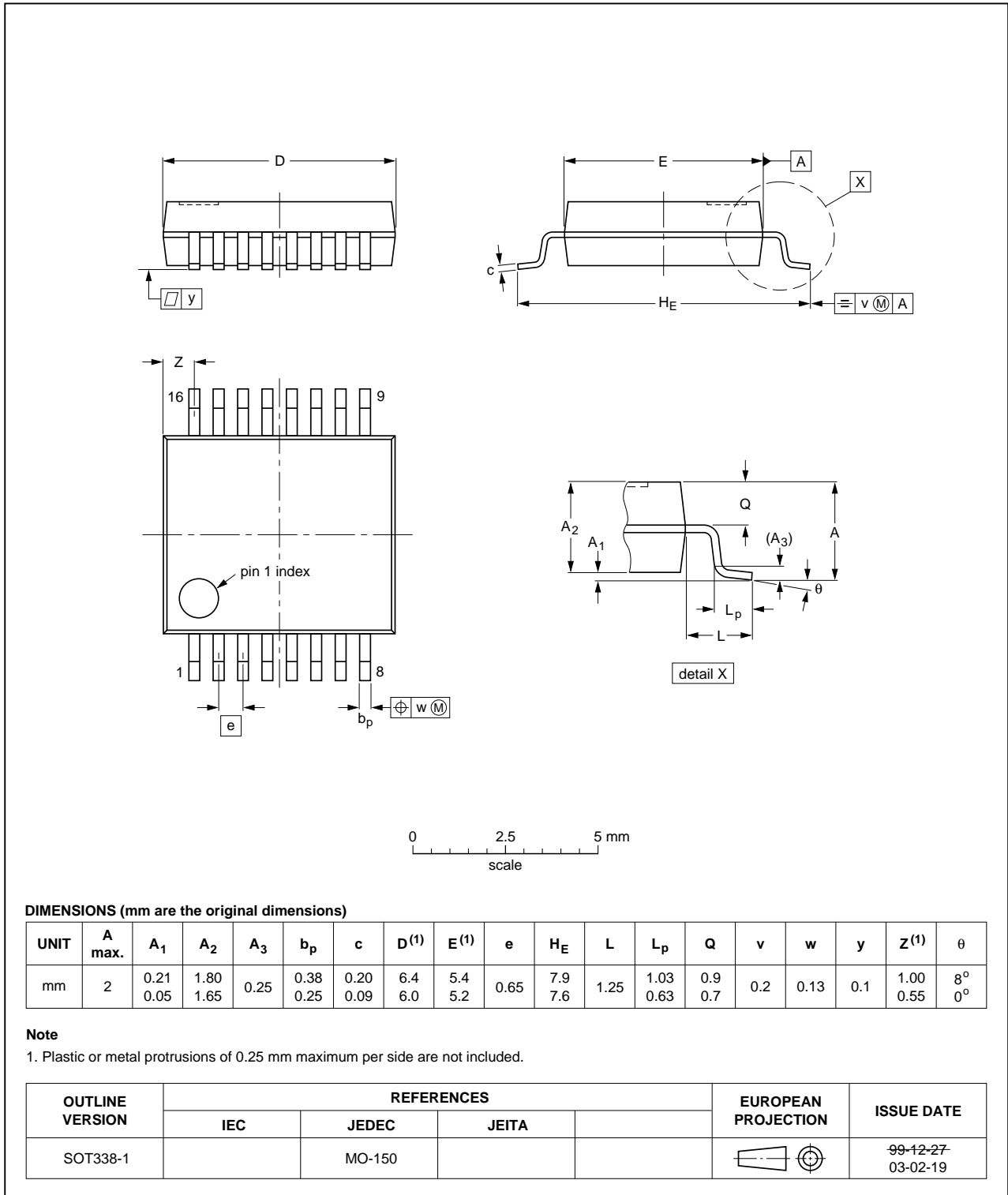


Fig 12. Package outline SOT338-1 (SSOP16)

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

SOT403-1

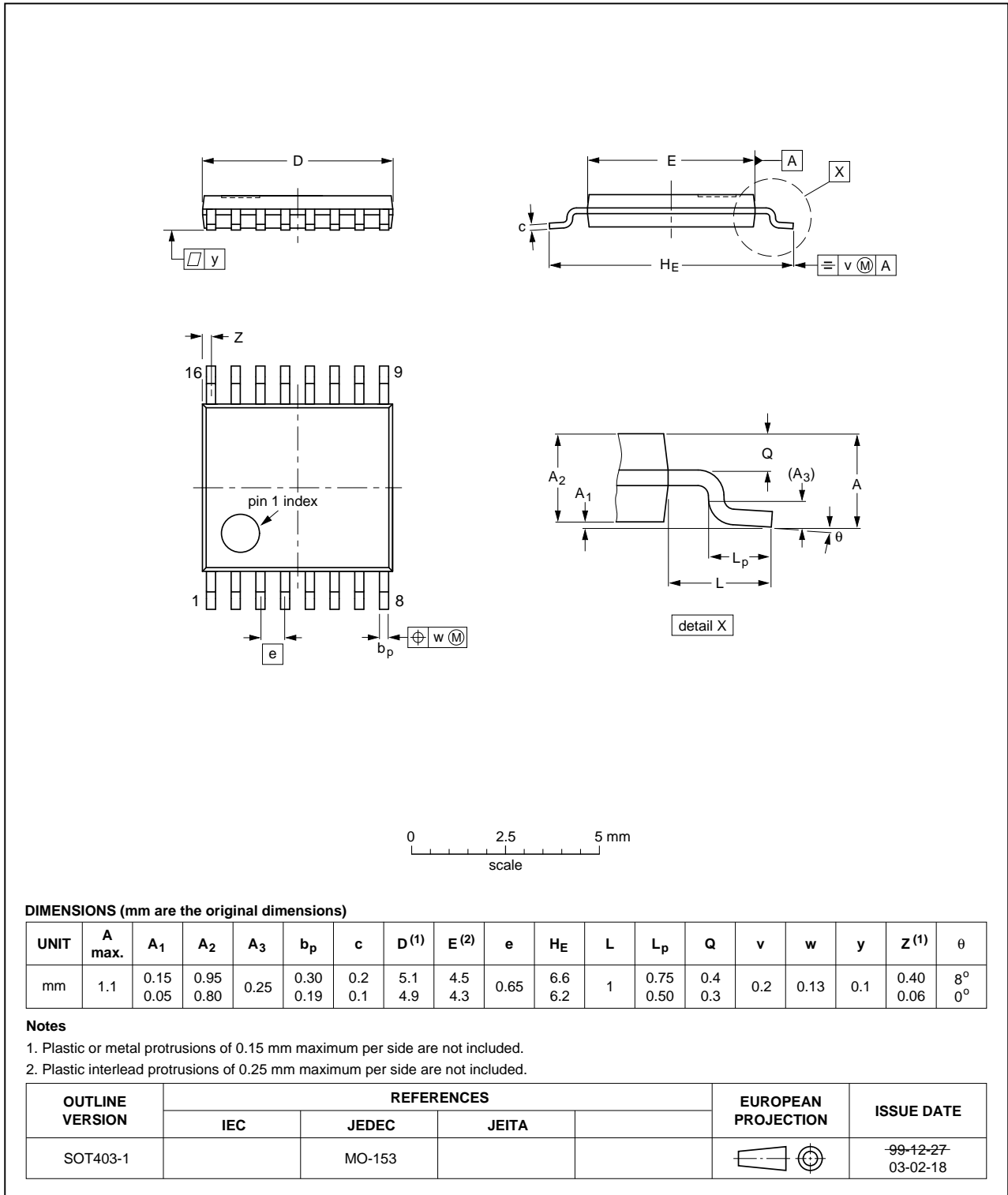


Fig 13. Package outline SOT403-1 (TSSOP16)

DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 x 3.5 x 0.85 mm

SOT763-1

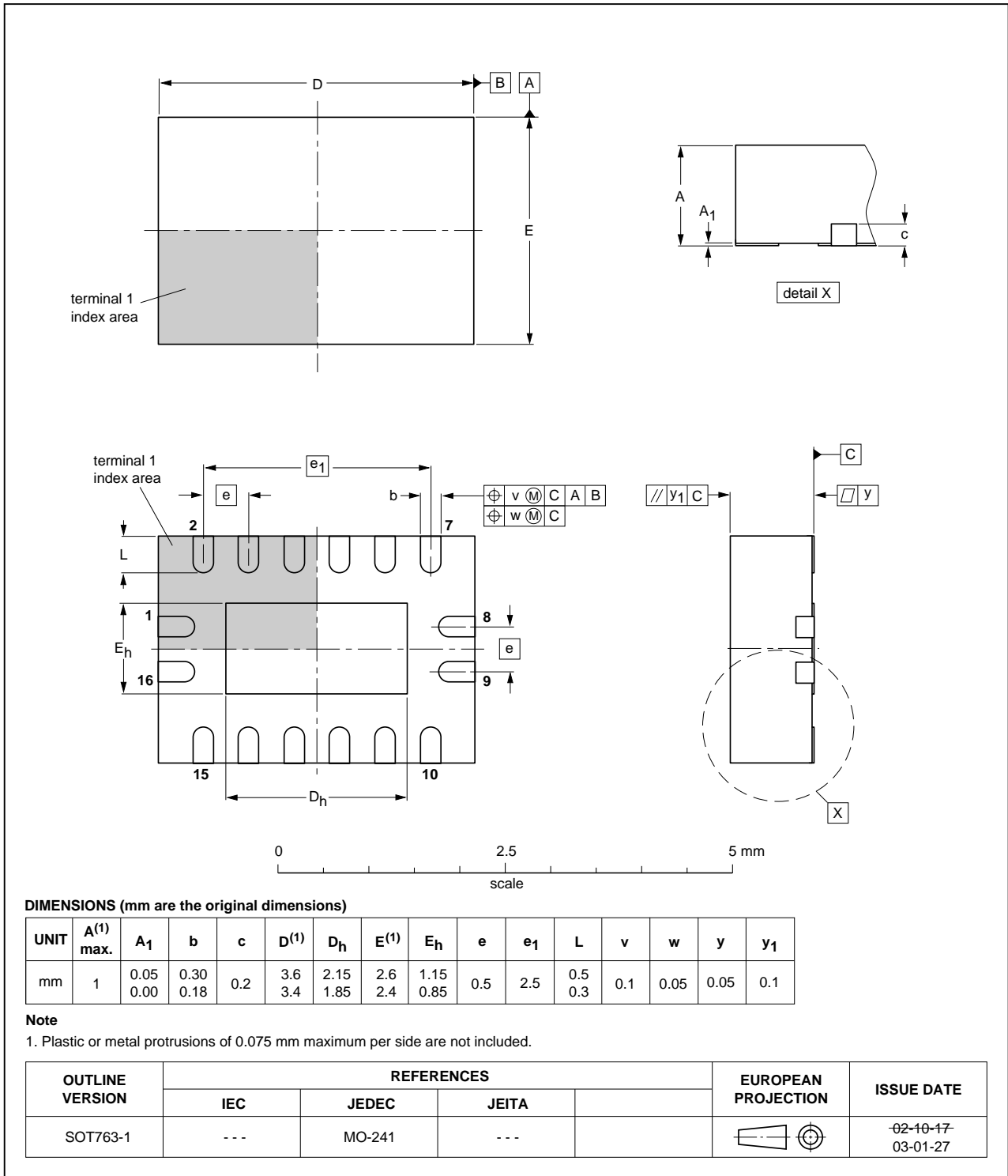


Fig 14. Package outline SOT763-1 (DHVQFN16)

14. Abbreviations

Table 9. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model
CDM	Charge-Device Model
TTL	Transistor-Transistor Logic

15. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT4040 v.4	20140320	Product data sheet	-	74HC_HCT4040 v.3
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. Legal texts have been adapted to the new company name where appropriate. 			
74HC_HCT4040 v.3	20050914	Product data sheet	-	74HC_HCT4040_CNV v.2
74HC_HCT4040_CNV v.2	19901231	Product specification	-	-

16. Legal information

16.1 Data sheet status

Document status ^{[1][2]}	Product status ^[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

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

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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