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Team Nexperia

# 74HC4020-Q100; 74HCT4020-Q100

## 14-stage binary ripple counter

Rev. 1 — 23 May 2013

Product data sheet

## 1. General description

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The 74HC4020-Q100; 74HCT4020-Q100 are 14-stage binary ripple counters with a clock input ( $\overline{CP}$ ), an overriding asynchronous master reset input (MR) and 12 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. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

## 2. Features and benefits

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- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Input levels:
  - ◆ For 74HC4020-Q100: CMOS level
  - ◆ For 74HCT4020-Q100: TTL level
- Complies with JEDEC standard no. 7A
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ,  $R = 0\text{ }\Omega$ )
- Multiple package options

## 3. Applications

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- Frequency dividing circuits
- Time delay circuits
- Control counters



## 4. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC4020D-Q100 74HCT4020D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC4020PW-Q100 74HCT4020PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HC4020BQ-Q100 74HCT4020BQ-Q100	-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

## 5. Functional diagram

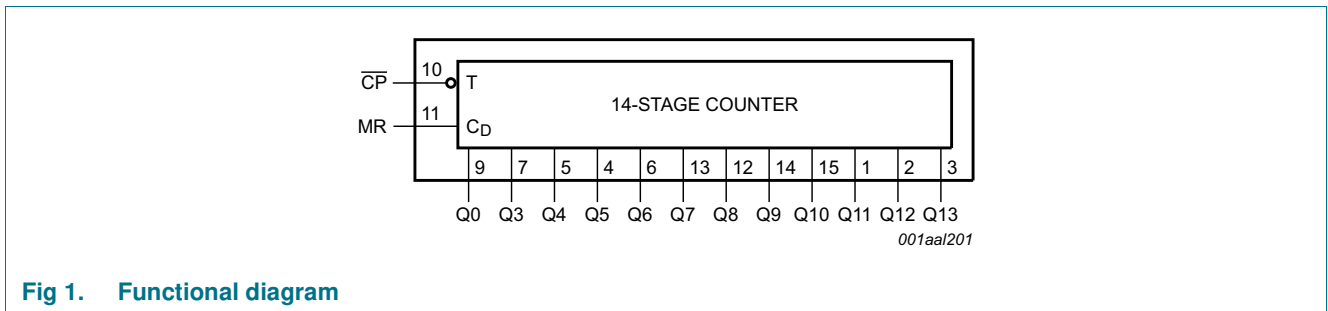


Fig 1. Functional diagram

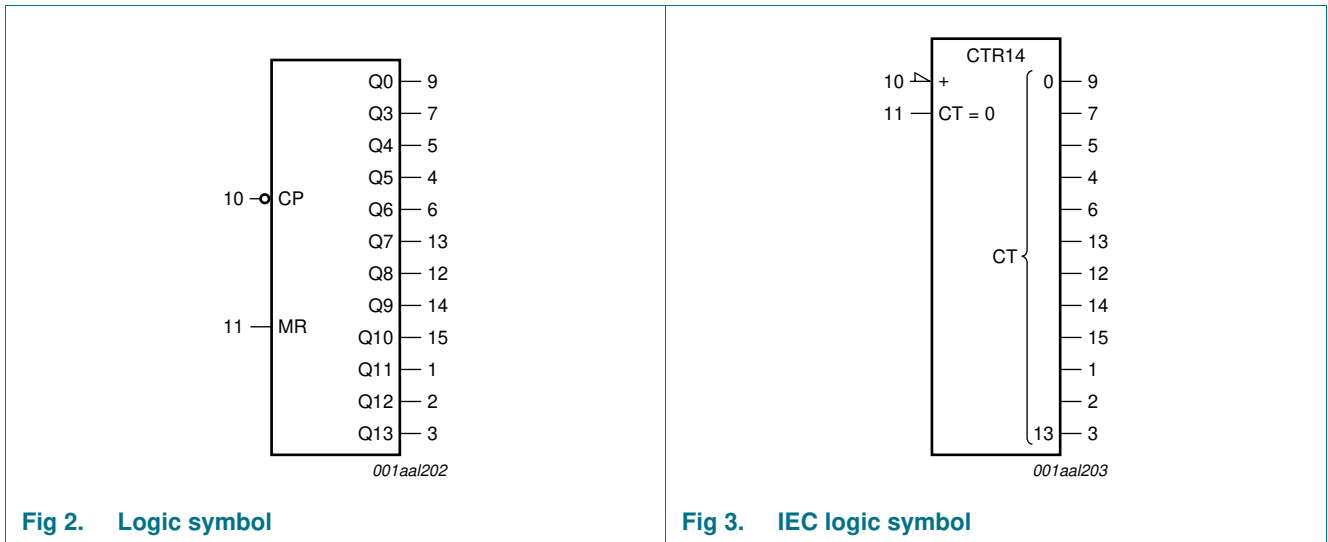


Fig 2. Logic symbol

Fig 3. IEC logic symbol

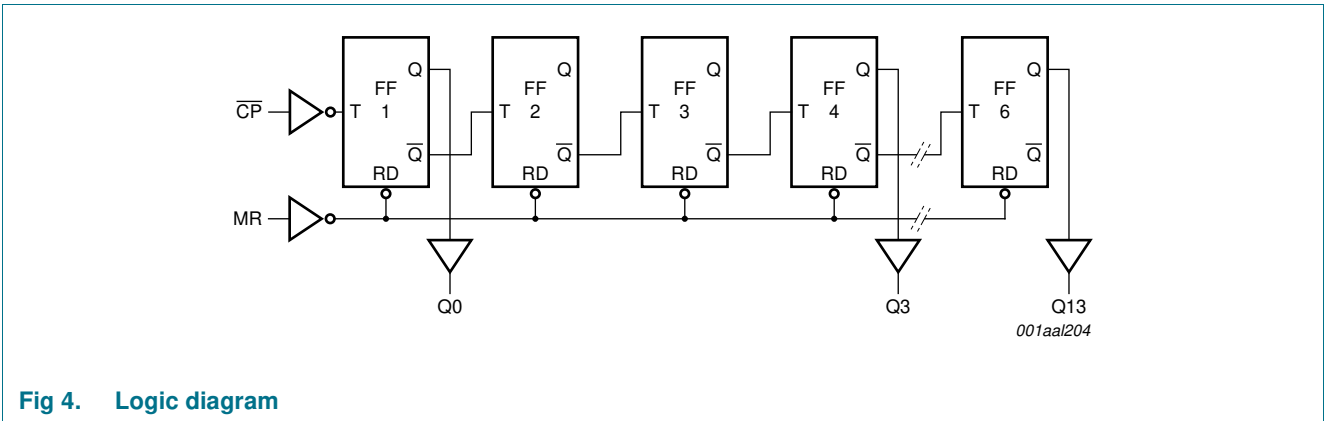


Fig 4. Logic diagram

## 6. Pinning information

### 6.1 Pinning

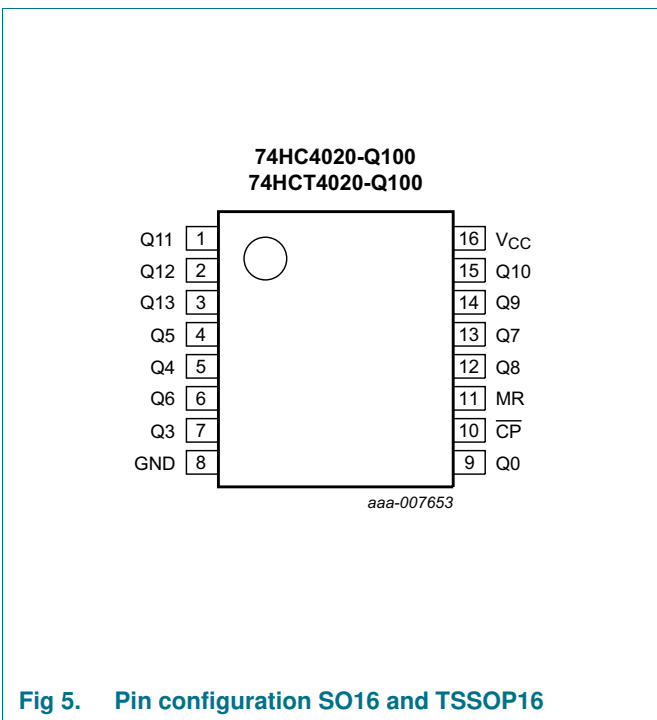


Fig 5. Pin configuration SO16 and TSSOP16

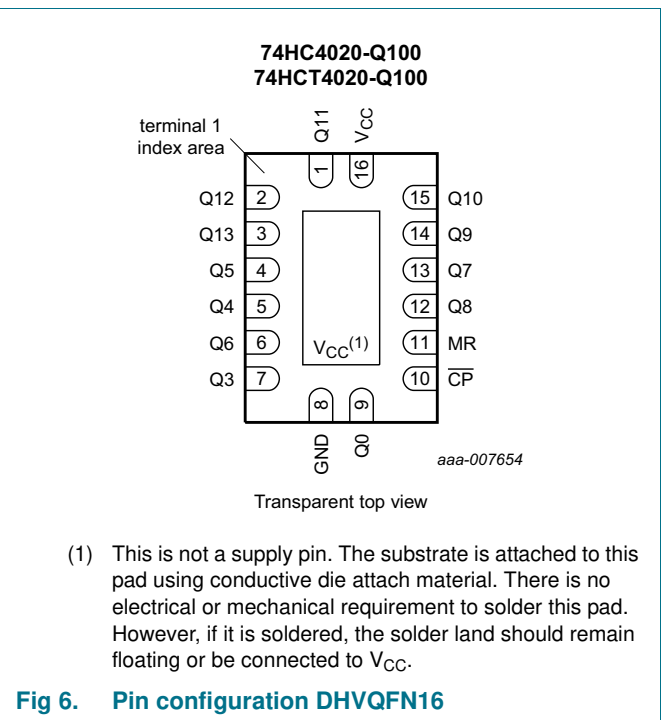


Fig 6. Pin configuration DHVQFN16

## 6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Q0, Q3 to Q13	9, 7, 5, 4, 6, 13, 12, 14, 15, 1, 2, 3	output
GND	8	ground (0 V)
$\overline{CP}$	10	clock input (HIGH-to-LOW, edge-triggered)
MR	11	master reset input (active HIGH)
V <sub>CC</sub>	16	positive supply voltage

## 7. Functional description

Table 3. Function table

Input		Output
$\overline{CP}$	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.

### 7.1 Timing diagram

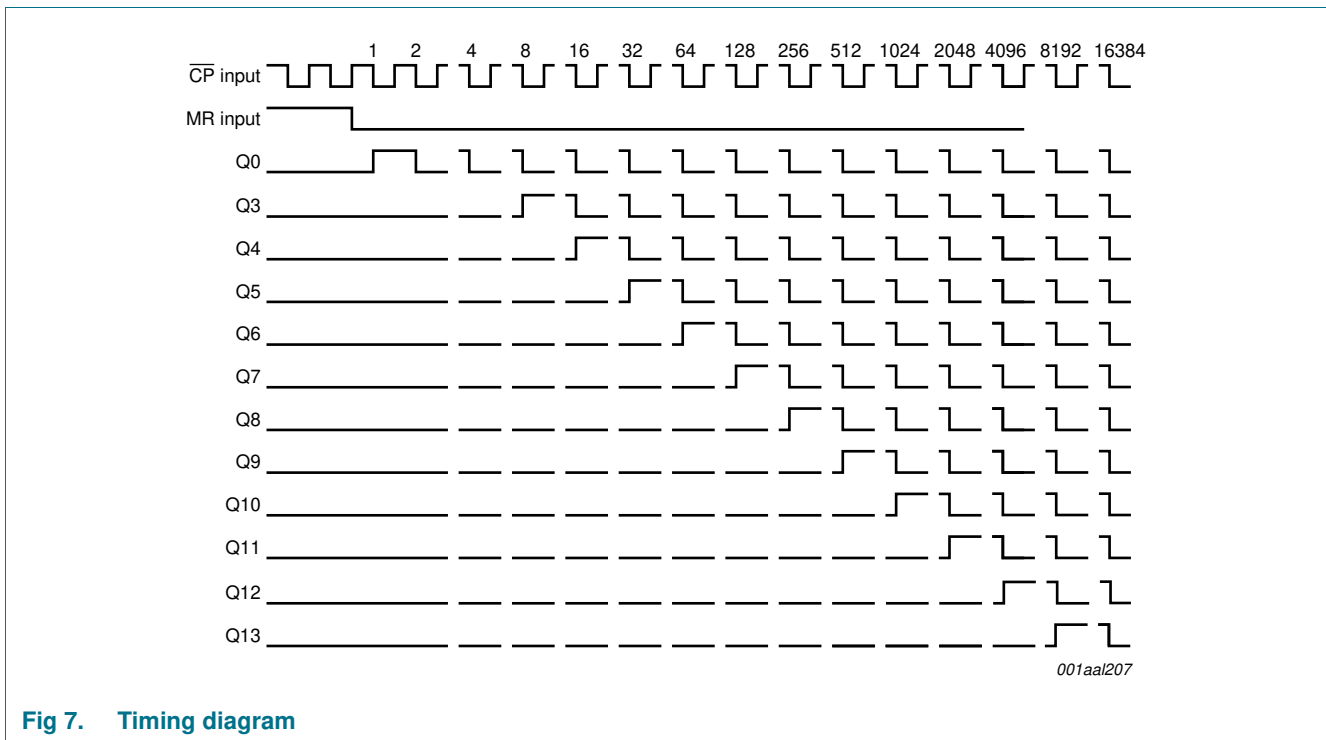


Fig 7. Timing diagram

## 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	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	mA
$I_O$	output current	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	$\pm 25$	mA
$I_{CC}$	supply current		-	$\pm 50$	mA
$I_{GND}$	ground current		-	$\pm 50$	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$	[1] -	500	mW

- [1] For SO16 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.  
 For TSSOP16 package:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.  
 For DHVQFN16 package:  $P_{tot}$  derates linearly with 4.5 mW/K above 60 °C.

## 9. Recommended operating conditions

**Table 5. Recommended operating conditions**

Symbol	Parameter	Conditions	74HC4020-Q100			74HCT4020-Q100			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
$\Delta t/\Delta V$	input transition rise and fall rate	except for Schmitt trigger inputs							
		$V_{CC} = 2.0\text{ V}$	-	-	625	-	-	-	ns/V
		$V_{CC} = 4.5\text{ V}$	-	1.67	139	-	1.67	139	ns/V
		$V_{CC} = 6.0\text{ V}$	-	-	83	-	-	-	ns/V
$T_{amb}$	ambient temperature		-40	+25	+125	-40	+25	+125	°C

## 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	
<b>74HC4020-Q100</b>										
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V <sub>CC</sub> = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V <sub>CC</sub> = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V <sub>CC</sub> = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V <sub>CC</sub> = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>								
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>								
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V	-	-	±0.1	-	±1	-	±1	μA
		I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	8.0	-	80	-
C <sub>I</sub>	input capacitance		-	3.5	-	-	-	-	-	pF
<b>74HCT4020-Q100</b>										
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V								
		I <sub>O</sub> = -20 μA	4.4	4.5	-	4.4	-	4.4	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V								
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	±0.1	-	±1	-	±1	μA
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V



**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		
$I_{CC}$	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5$ V	-	-	8.0	-	80	-	160	$\mu$ A	
$\Delta I_{CC}$	additional supply current	$V_I = V_{CC} - 2.1$ V; $I_O = 0$ A; other inputs at $V_{CC}$ or GND; $V_{CC} = 4.5$ V to 5.5 V	pin MR	-	110	396	-	495	-	539	$\mu$ A
			pin $\overline{CP}$	-	85	306	-	383	-	417	$\mu$ A
			$C_I$	input capacitance	-	3.5	-	-	-	-	-

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit, see [Figure 10](#)

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
<b>74HC4020-Q100</b>										
$t_{pd}$	propagation delay	$\overline{CP}$ to Q0; see <a href="#">Figure 8</a> <a href="#">[1]</a>	-	-	-	-	-	-	-	-
		$V_{CC} = 2.0$ V; $C_L = 50$ pF	-	39	140	-	175	-	210	ns
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	14	28	-	35	-	42	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	11	-	-	-	-	-	ns
	$V_{CC} = 6.0$ V; $C_L = 50$ pF	-	11	24	-	30	-	36	ns	
	Qn to Qn+1; see <a href="#">Figure 9</a>	$V_{CC} = 2.0$ V; $C_L = 50$ pF	-	22	75	-	95	-	110	ns
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	8	15	-	19	-	22	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	6	-	-	-	-	-	ns
$V_{CC} = 6.0$ V; $C_L = 50$ pF		-	6	13	-	16	-	19	ns	
$t_{PHL}$	HIGH to LOW propagation delay	MR to Qn; see <a href="#">Figure 8</a>	-	-	-	-	-	-	-	-
		$V_{CC} = 2.0$ V; $C_L = 50$ pF	-	55	170	-	215	-	225	ns
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	20	34	-	43	-	51	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	17	-	-	-	-	-	ns
$t_t$	transition time	Qn; see <a href="#">Figure 8</a> <a href="#">[2]</a>	-	-	-	-	-	-	-	-
		$V_{CC} = 2.0$ V; $C_L = 50$ pF	-	19	75	-	95	-	110	ns
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	7	15	-	19	-	22	ns
		$V_{CC} = 6.0$ V; $C_L = 50$ pF	-	6	13	-	16	-	19	ns

**Table 7. Dynamic characteristics ...continued**  
 GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit, see [Figure 10](#)

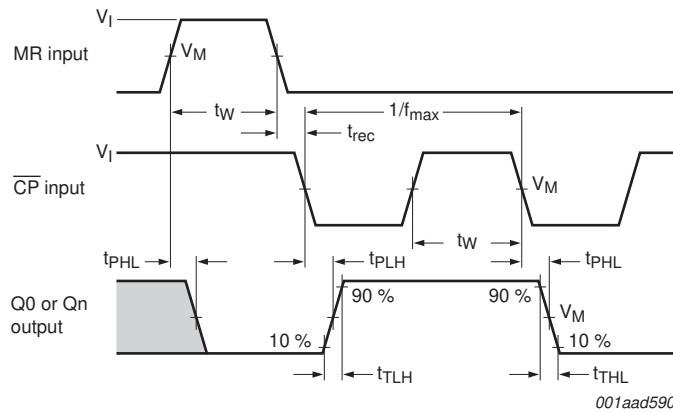
Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$t_w$	pulse width	$\overline{CP}$ HIGH or LOW; see <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ V; $C_L = 50$ pF	80	14	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	16	4	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V; $C_L = 50$ pF	14	3	-	17	-	20	-	ns
		MR HIGH; see <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ V; $C_L = 50$ pF	80	17	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	16	6	-	20	-	24	-	ns
$t_{rec}$	recovery time	MR to $\overline{CP}$ ; see <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ V; $C_L = 50$ pF	50	6	-	65	-	75	-	ns
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	10	2	-	13	-	15	-	ns
$f_{max}$	maximum frequency	$V_{CC} = 6.0$ V; $C_L = 50$ pF	9	2	-	11	-	13	-	ns
		see <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ V; $C_L = 50$ pF	6.0	30	-	4.8	-	4.0	-	MHz
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	30	92	-	24	-	20	-	MHz
$C_{PD}$	power dissipation capacitance	$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	101	-	-	-	-	-	MHz
		$V_{CC} = 6.0$ V; $C_L = 50$ pF	35	109	-	28	-	24	-	MHz
		[3]	-	19	-	-	-	-	-	pF
<b>74HCT4020-Q100</b>										
$t_{pd}$	propagation delay	$\overline{CP}$ to Q0; see <a href="#">Figure 8</a>	[1]							
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	18	36	-	45	-	54	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	15	-	-	-	-	-	ns
		Qn to Qn+1; see <a href="#">Figure 9</a>								
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	8	15	-	19	-	22	ns
$t_{PHL}$	HIGH to LOW propagation delay	$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	6	-	-	-	-	-	ns
		MR to Qn; see <a href="#">Figure 8</a>								
$t_t$	transition time	$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	22	45	-	56	-	68	ns
		Qn; see <a href="#">Figure 8</a>	[2]							
$t_w$	pulse width	$V_{CC} = 4.5$ V; $C_L = 50$ pF	-	7	15	-	19	-	22	ns
		$\overline{CP}$ HIGH or LOW; see <a href="#">Figure 8</a>								
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	20	7	-	25	-	30	-	ns
$t_{rec}$	recovery time	MR HIGH; see <a href="#">Figure 8</a>								
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	20	8	-	25	-	30	-	ns
$t_{rec}$	recovery time	MR to $\overline{CP}$ ; see <a href="#">Figure 8</a>								
		$V_{CC} = 4.5$ V; $C_L = 50$ pF	10	2	-	13	-	15	-	ns

**Table 7. Dynamic characteristics ...continued**  
 GND (ground = 0 V);  $C_L = 50 \text{ pF}$  unless otherwise specified; for test circuit, see [Figure 10](#)

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$f_{\text{max}}$	maximum frequency	see <a href="#">Figure 8</a>								
		$V_{\text{CC}} = 4.5 \text{ V}; C_L = 50 \text{ pF}$	25	47	-	20	-	17	-	MHz
		$V_{\text{CC}} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	52	-	-	-	-	-	MHz
$C_{\text{PD}}$	power dissipation capacitance	[3]	-	20	-	-	-	-	-	pF

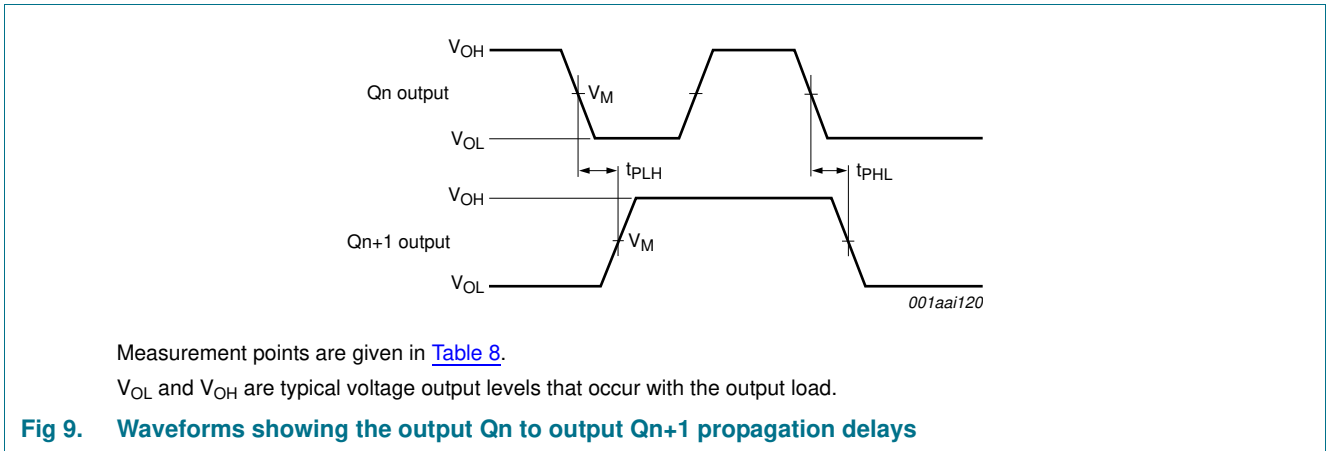
- [1]  $t_{\text{pd}}$  is the same as  $t_{\text{PHL}}$  and  $t_{\text{PLH}}$ .
- [2]  $t_i$  is the same as  $t_{\text{THL}}$  and  $t_{\text{TLH}}$ .
- [3]  $C_{\text{PD}}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).  
 $P_D = C_{\text{PD}} \times V_{\text{CC}}^2 \times f_i + \Sigma (C_L \times V_{\text{CC}}^2 \times f_o)$  where:  
 $f_i$  = input frequency in MHz;  
 $f_o$  = output frequency in MHz;  
 $\Sigma (C_L \times V_{\text{CC}}^2 \times f_o)$  = sum of outputs;  
 $C_L$  = output load capacitance in pF;  
 $V_{\text{CC}}$  = supply voltage in V.

## 12. Waveforms



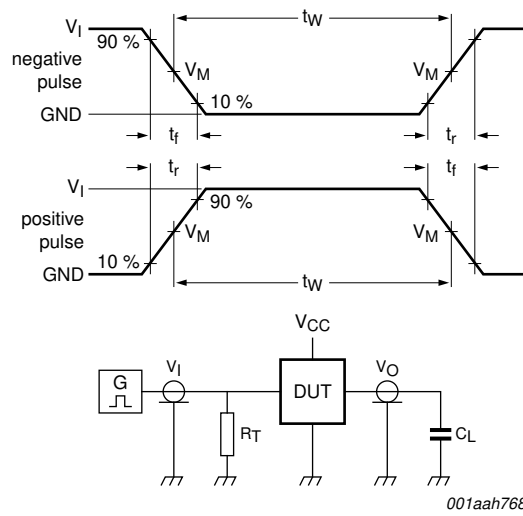
Measurement points are given in [Table 8](#).  
 $V_{\text{OL}}$  and  $V_{\text{OH}}$  are typical voltage output levels that occur with the output load.

**Fig 8. Clock timing, propagation delays, pulse widths and measurement points**



**Table 8. Measurement points**

Type	Input	Output
	$V_M$	$V_M$
74HC4020-Q100	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
74HCT4020-Q100	1.3 V	1.3 V



001aah768

Test data is given in [Table 9](#).

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 10. Test circuit for measuring switching times**

**Table 9. Test data**

Type	Input		Load
	$V_I$	$t_r, t_f$	$C_L$
74HC4020-Q100	$V_{CC}$	6 ns	15 pF, 50 pF
74HCT4020-Q100	3 V	6 ns	15 pF, 50 pF

13. Package outline

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

SOT109-1

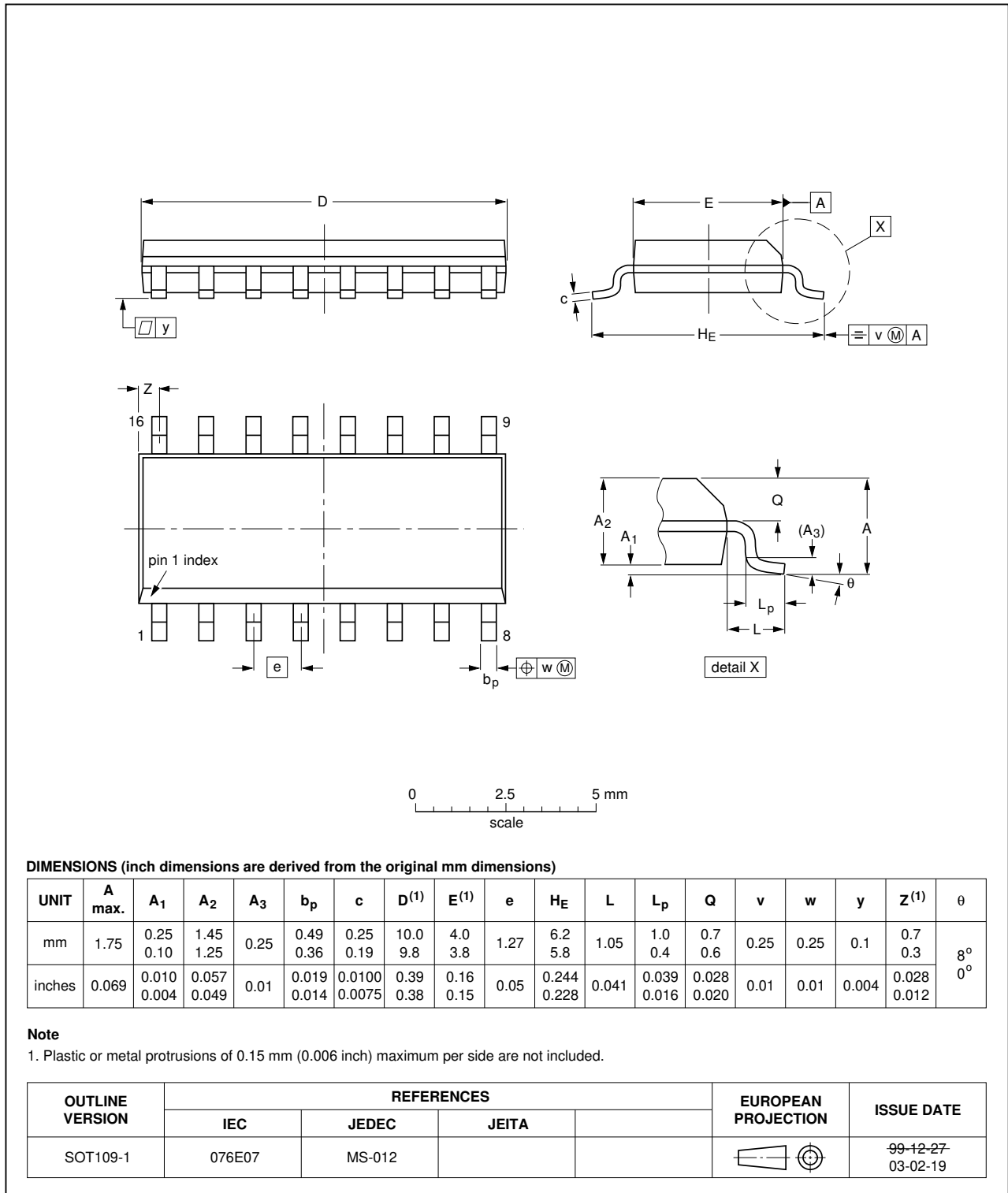


Fig 11. Package outline SOT109-1 (SO16)

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

SOT403-1

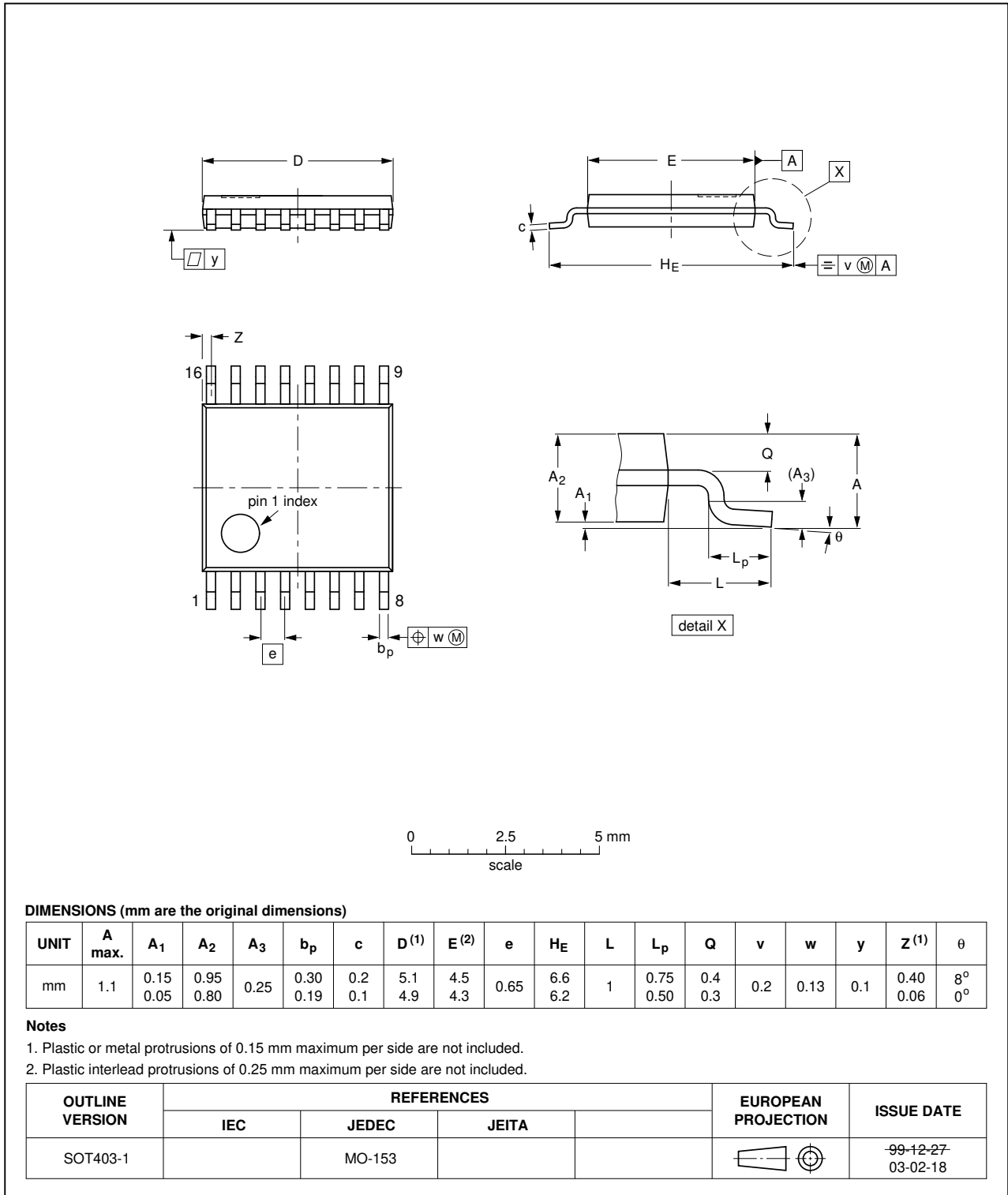


Fig 12. Package outline SOT403-1 (TSSOP16)

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

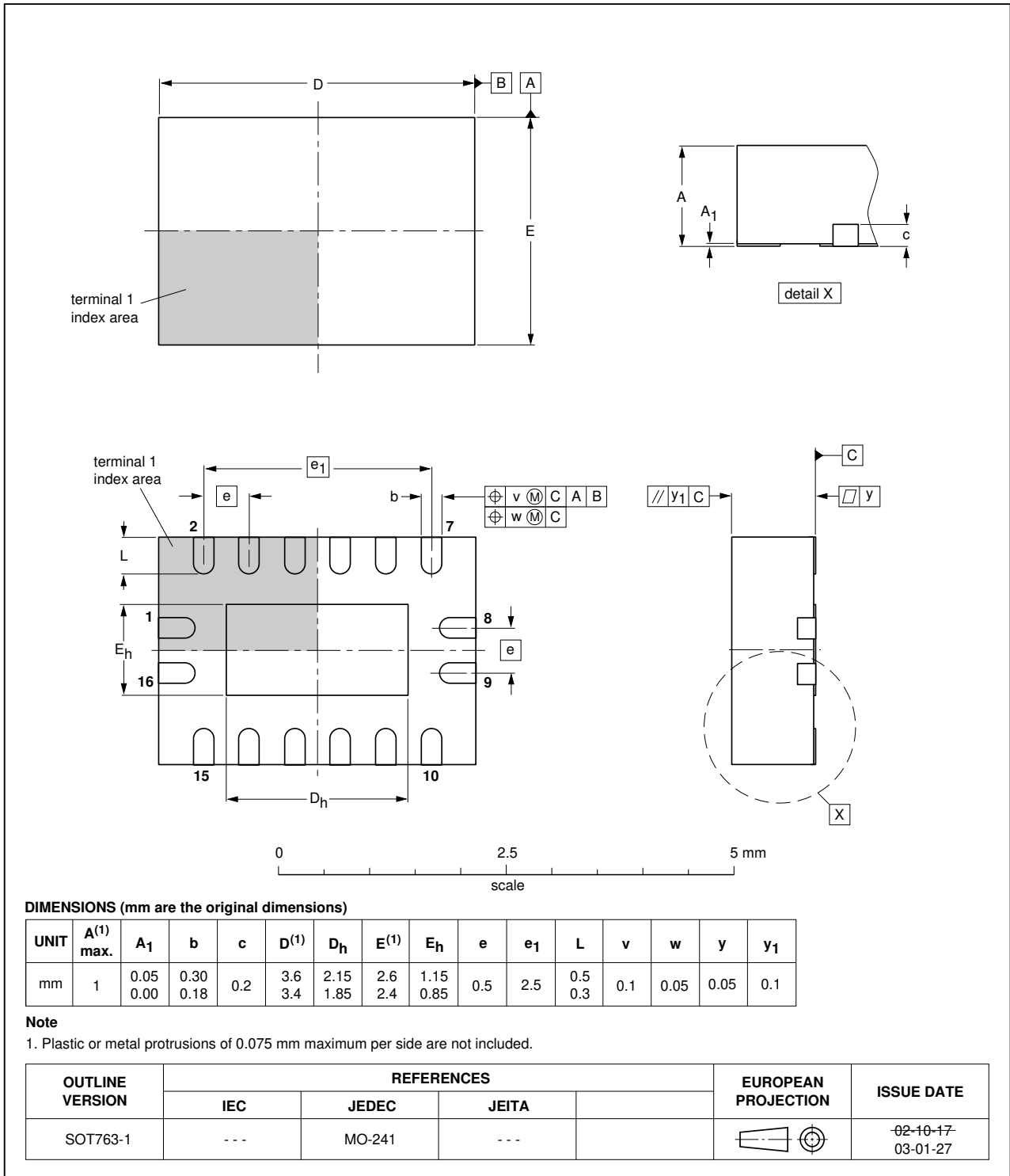


Fig 13. Package outline SOT763-1 (DHVQFN16)



## 14. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model
TTL	Transistor-Transistor Logic

## 15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT4020_Q100 v.1	20130523	Product data sheet	-	-

## 16. Legal information

### 16.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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".

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