

74HC166-Q100; 74HCT166-Q100

8-bit parallel-in/serial out shift register

Rev. 1 — 25 September 2013

Product data sheet

1. General description

The 74HC166-Q100; 74HCT166-Q100 is an 8-bit serial or parallel-in/serial-out shift register. The device features a serial data input (DS), eight parallel data inputs (D0 to D7) and a serial output (Q7). When the parallel enable input ($\overline{PE}$) is LOW, the data from D0 to D7 is loaded into the shift register on the next LOW-to-HIGH transition of the clock input (CP). When $\overline{PE}$ is HIGH, data enters the register serially at DS with each LOW-to-HIGH transition of CP. When the clock enable input ($\overline{CE}$) is LOW data is shifted on the LOW-to-HIGH transitions of CP. A HIGH on $\overline{CE}$ disables the CP input. Inputs include clamp diodes which enable 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

- 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 $+125\text{ }^{\circ}\text{C}$
- Synchronous parallel-to-serial applications
- Synchronous serial input for easy expansion
- Complies with JEDEC standard no. 7A
- Input levels:
 - ◆ For 74HC166-Q100: CMOS level
 - ◆ For 74HCT166-Q100: TTL level
- 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

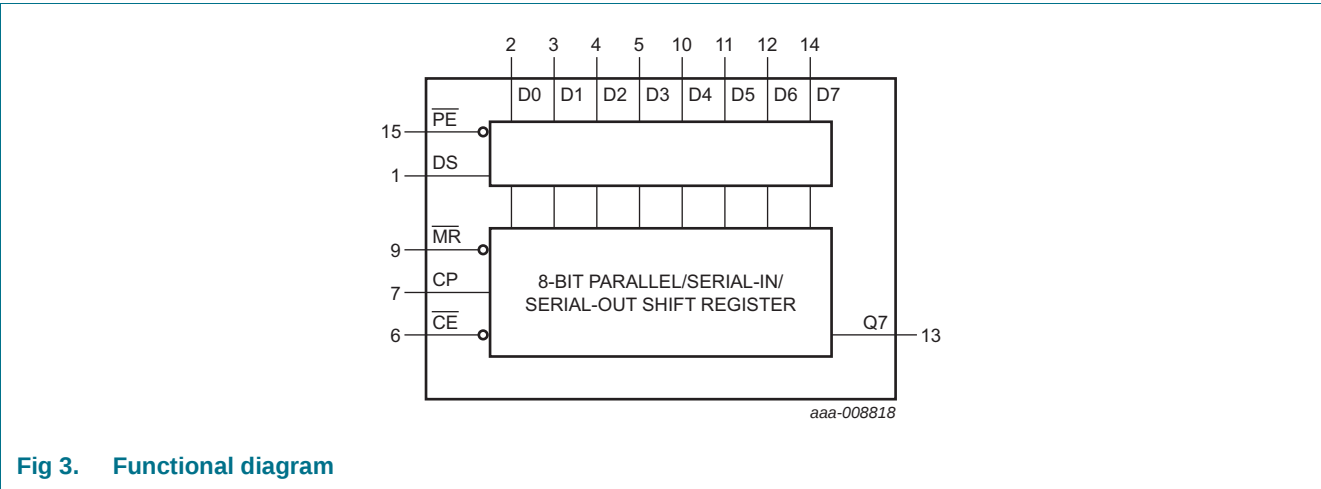
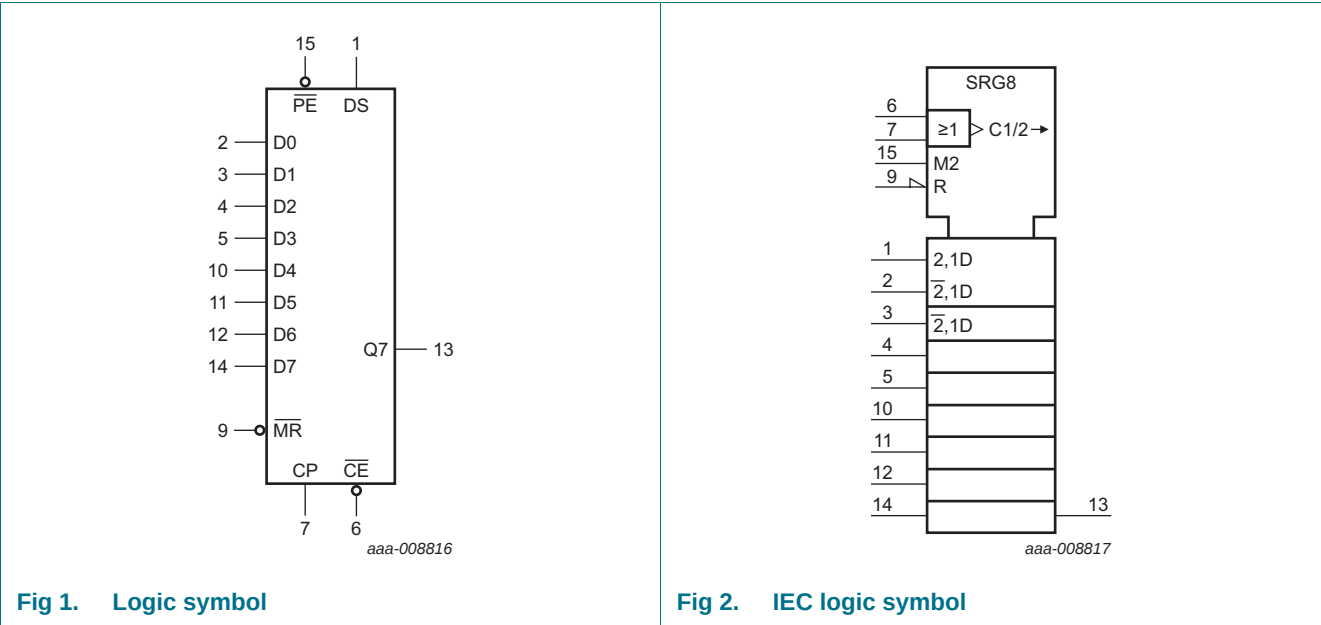
3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC166D-Q100 74HCT166D-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC166PW-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1



4. Functional diagram



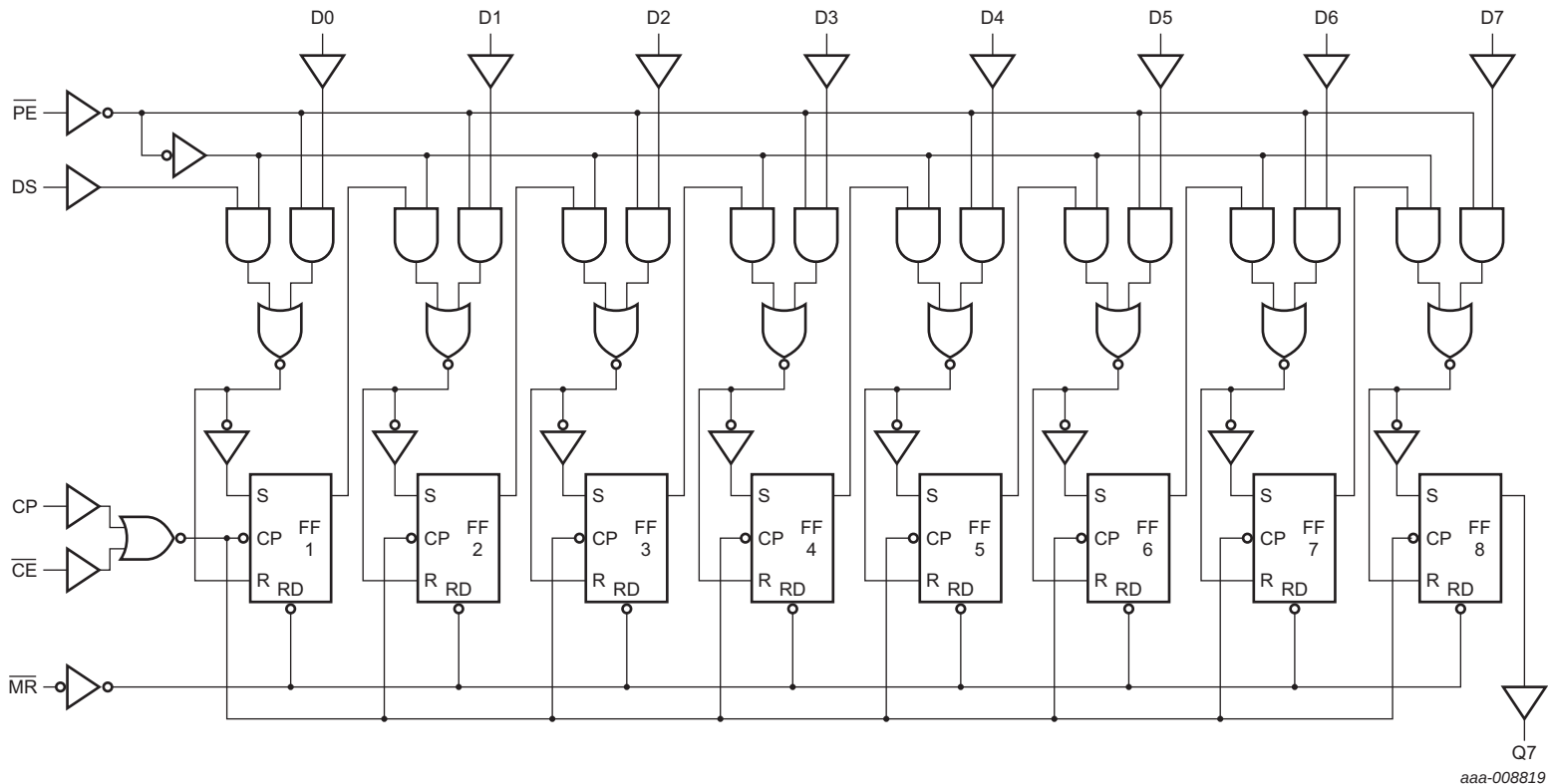
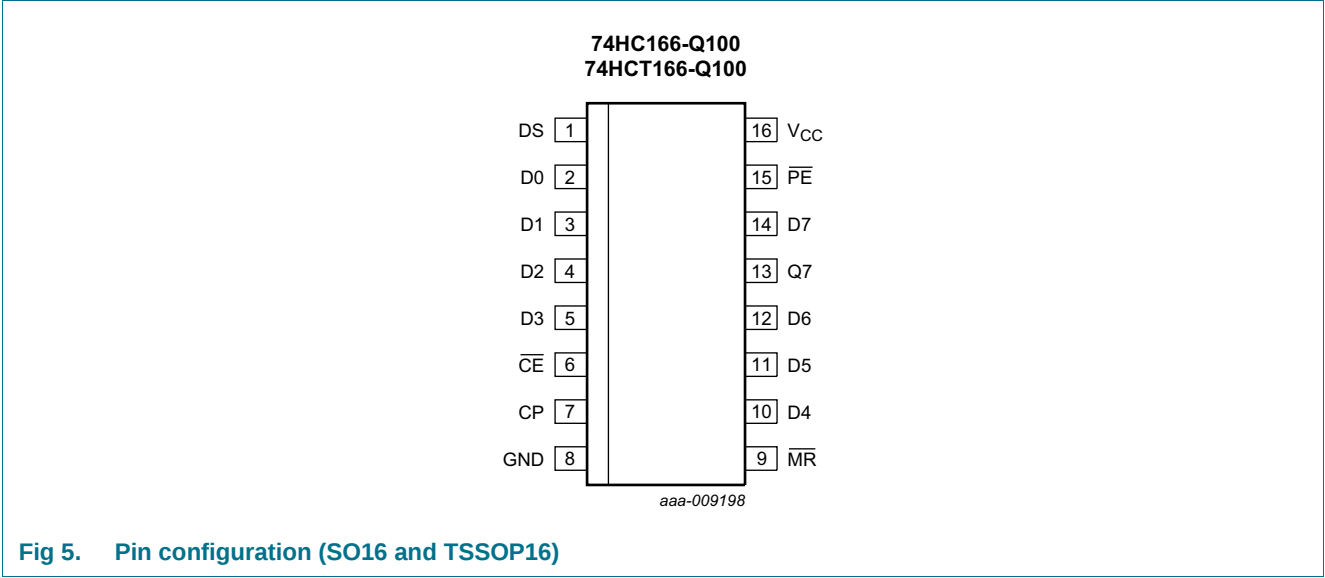


Fig 4. Logic diagram

5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

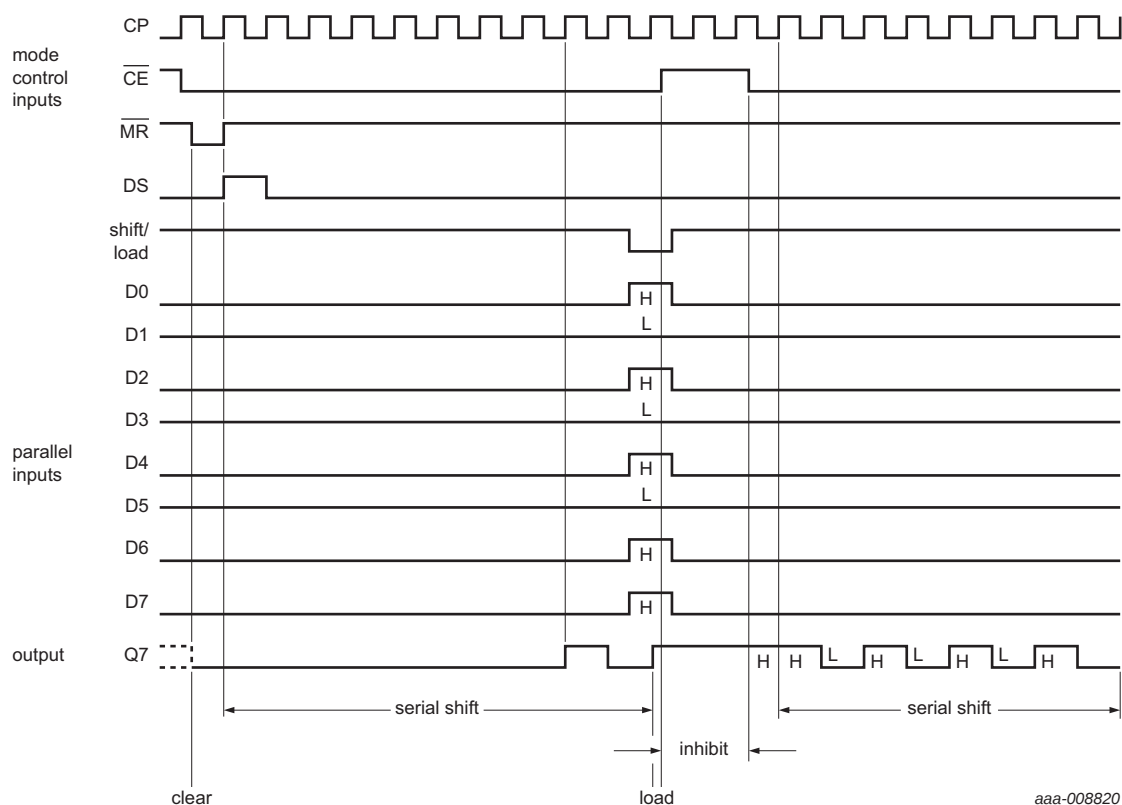
Symbol	Pin	Description
DS	1	serial data input
D0 to D7	2, 3, 4, 5, 10, 11, 12, 14	parallel data inputs
$\overline{CE}$	6	clock enable input (active LOW)
CP	7	clock input (LOW-to-HIGH edge-triggered)
GND	8	ground (0 V)
$\overline{MR}$	9	asynchronous master reset (active LOW)
Q7	13	serial output from the last stage
$\overline{PE}$	15	parallel enable input (active LOW)
V _{CC}	16	positive supply voltage

6. Functional description

Table 3. Function table^[1]

Operating modes	Inputs					Qn registers		Output
	PE	CE	CP	DS	D0 to D7	Q0	Q1 to Q6	
parallel load	L	L	↑	X	L	L	L to L	L
	L	L	↑	X	h	H	H to H	H
serial shift	h	L	↑	L	X	L	q0 to q5	q6
	h	L	↑	h	X	H	q0 to q5	q6
hold "do nothing"	X	H	X	X	X	q0	q1 to q6	q7

- [1] H = HIGH voltage level;
h = HIGH voltage level one set-up time prior to the LOW-to-HIGH clock transition;
L = LOW voltage level;
l = LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition;
q = state of the referenced output one set-up time prior to the LOW-to-HIGH clock transition;
X = don't care;
↑ = LOW-to-HIGH clock transition.



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Fig 6. Typical clear, shift, load, inhibit, and shift sequences

7. 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 $V_I > V_{CC} + 0.5\text{ V}$ [1]	-	± 20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1]	-	± 20	mA
I_O	output current	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	± 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	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$			
		SO16 package [2]	-	500	mW
		TSSOP16 package [3]	-	500	mW

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] P_{tot} derates linearly with 8 mW/K above 70 °C.

[3] P_{tot} derates linearly with 5.5 mW/K above 60 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC166-Q100			74HCT166-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
T _{amb}	ambient temperature		-40	-	+125	-40	-	+125	°C
$\Delta t/\Delta V$	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

9. 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	
74HC166-Q100										
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
		I _O = −5.2 mA; V _{CC} = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	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 _O = 5.2 mA; V _{CC} = 6.0 V	-	0.16	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±1	-	±1	μA
I _{CC}	supply current	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
74HCT166-Q100										
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 = –4.0 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; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 5.2 mA; V _{CC} = 4.5 V	-	0.16	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 4.5 V	-	-	±0.1	-	±1	-	±1	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 4.5 V	-	-	8.0	-	80	-	160	µA
ΔI _{CC}	additional supply current	per input pin; V _I = V _{CC} – 2.1 V; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V								
		Dn and DS inputs	-	35	126	-	157.5	-	171.5	µA
		CP and $\overline{\text{CE}}$ inputs	-	80	288	-	360	-	392	µA
		$\overline{\text{MR}}$ input	-	40	144	-	180	-	196	µA
		$\overline{\text{PE}}$ input	-	60	216	-	270	-	294	µA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

GND (ground = 0 V); $t_r = t_f = 6$ ns; $C_L = 50$ 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	
74HC166-Q100										
t _{pd}	propagation delay	CP to Q7; see Figure 7 ^[1]								
		V _{CC} = 2.0 V	-	50	150	-	190	-	225	ns
		V _{CC} = 4.5 V	-	18	30	-	38	-	45	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	15	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	14	26	-	33	-	38	ns
		MR to Q7; see Figure 8								
		V _{CC} = 2.0 V	-	47	160	-	200	-	240	ns
		V _{CC} = 4.5 V	-	17	32	-	40	-	48	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	14	-	-	-	-	-	ns
V _{CC} = 6.0 V	-	14	27	-	34	-	41	ns		
t _t	transition time	output; see Figure 7 ^[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	CP input HIGH or LOW; see Figure 7								
		V _{CC} = 2.0 V	80	17	-	100	-	120	-	ns
		V _{CC} = 4.5 V	16	6	-	20	-	24	-	ns
		V _{CC} = 6.0 V	14	5	-	17	-	20	-	ns
		MR input LOW; see Figure 8								
		V _{CC} = 2.0 V	100	25	-	125	-	150	-	ns
		V _{CC} = 4.5 V	20	9	-	25	-	30	-	ns
V _{CC} = 6.0 V	17	7	-	21	-	26	-	ns		
t _{rec}	recovery time	MR to CP; see Figure 8								
		V _{CC} = 2.0 V	0	–19	-	0	-	0	-	ns
		V _{CC} = 4.5 V	0	–7	-	0	-	0	-	ns
		V _{CC} = 6.0 V	0	–6	-	0	-	0	-	ns
t _{su}	set-up time	Dn, $\overline{CE}$ to CP; see Figure 9								
		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
		$\overline{PE}$ to CP; see Figure 9								
		V _{CC} = 2.0 V	100	33	-	125	-	150	-	ns
		V _{CC} = 4.5 V	20	12	-	25	-	30	-	ns
V _{CC} = 6.0 V	17	10	-	21	-	26	-	ns		

Table 7. Dynamic characteristics ...continuedGND (ground = 0 V); $t_r = t_f = 6$ ns; $C_L = 50$ 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_h	hold time	Dn, $\overline{CE}$ to CP; see Figure 9								
		$V_{CC} = 2.0$ V	2	–8	-	2	-	2	-	ns
		$V_{CC} = 4.5$ V	2	–3	-	2	-	2	-	ns
		$V_{CC} = 6.0$ V	2	–2	-	2	-	2	-	ns
		$\overline{PE}$ to CP; see Figure 9								
		$V_{CC} = 2.0$ V	0	–28	-	0	-	0	-	ns
		$V_{CC} = 4.5$ V	0	–10	-	0	-	0	-	ns
f_{max}	maximum frequency	CP input; see Figure 7								
		$V_{CC} = 2.0$ V	6	19	-	4.8	-	4	-	MHz
		$V_{CC} = 4.5$ V	30	57	-	24	-	20	-	MHz
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	63	-	-	-	-	-	MHz
		$V_{CC} = 6.0$ V	35	68	-	28	-	24	-	MHz
C_{PD}	power dissipation capacitance	per package; $V_I = \text{GND to } V_{CC}$	[3]	-	41	-	-	-	-	pF

74HCT166-Q100

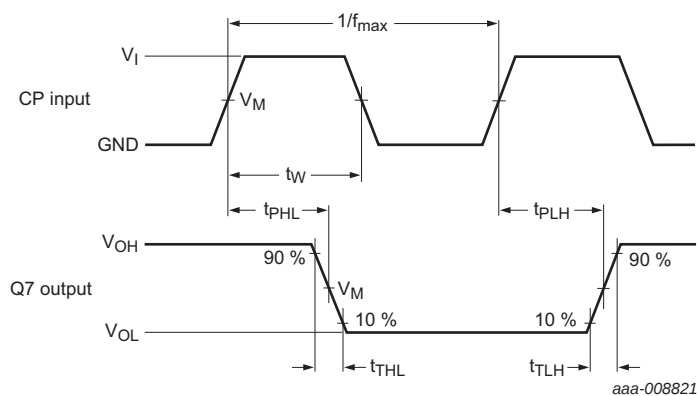
t_{pd}	propagation delay	CP to Q7; see Figure 7	[1]							
		$V_{CC} = 4.5$ V	-	23	40	-	50	-	60	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	20	-	-	-	-	-	ns
		$\overline{MR}$ to Q7; see Figure 8								
		$V_{CC} = 4.5$ V	-	22	40	-	50	-	60	ns
t_t	transition time	output; see Figure 7	[2]							
		$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns
t_w	pulse width	CP input HIGH or LOW; see Figure 7								
		$V_{CC} = 4.5$ V	20	9	-	25	-	30	-	ns
		$\overline{MR}$ input LOW; see Figure 8								
t_{rec}	recovery time	$V_{CC} = 4.5$ V	25	11	-	31	-	38	-	ns
		$\overline{MR}$ to CP; see Figure 8								
t_{su}	set-up time	$V_{CC} = 4.5$ V	0	–7	-	0	-	0	-	ns
		Dn, $\overline{CE}$ to CP; see Figure 9								
		$V_{CC} = 4.5$ V	16	8	-	20	-	24	-	ns
t_h	hold time	$\overline{PE}$ to CP; see Figure 9								
		$V_{CC} = 4.5$ V	30	15	-	38	-	45	-	ns
		Dn, $\overline{CE}$ to CP; see Figure 9								
t_h	hold time	$V_{CC} = 4.5$ V	0	–3	-	0	-	0	-	ns
		$\overline{PE}$ to CP; see Figure 9								
t_h	hold time	$V_{CC} = 4.5$ V	0	–13	-	0	-	0	-	ns

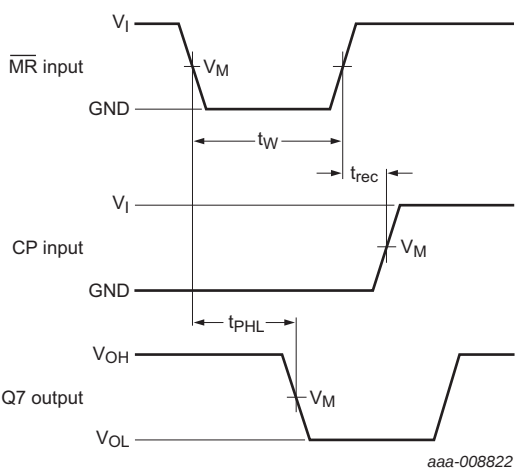
Table 7. Dynamic characteristics ...continuedGND (ground = 0 V); $t_r = t_f = 6$ ns; $C_L = 50$ pF unless otherwise specified; for test circuit, see [Figure 10](#)

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$f_{\max}$	maximum frequency	CP input; see Figure 7								
		$V_{CC} = 4.5$ V	25	45	-	20	-	17	-	MHz
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	50	-	-	-	-	-	MHz
C_{PD}	power dissipation capacitance	per package; $V_I = \text{GND to } V_{CC}$	[3]	-	41	-	-	-	-	pF

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

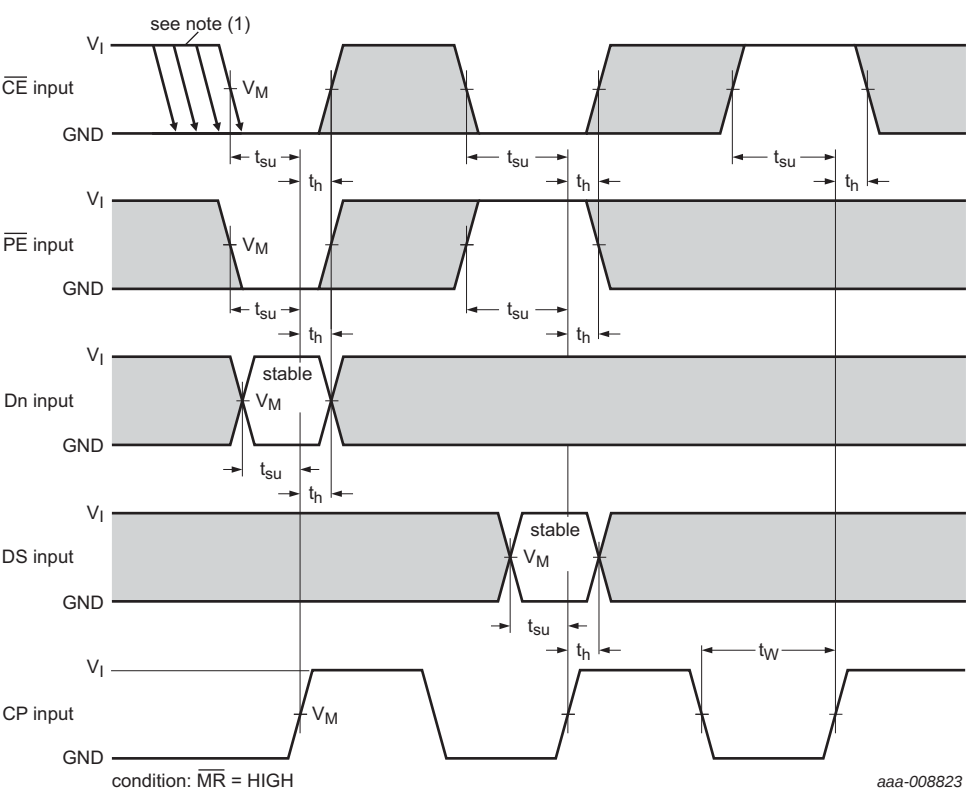
11. Waveforms

Measurement points are given in [Table 8](#). V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.**Fig 7. Clock (CP) to output (Q7) propagation delays, pulse width, output transition times and maximum frequency**



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

Fig 8. Master reset (MR) pulse width, MR to output (Q7) propagation delay and MR to clock (CP) recovery time.



The shaded areas indicate when the input is permitted to change for predictable output performance
Measurement points are given in [Table 8](#).

(1) $\overline{CE}$ may change only from HIGH-to-LOW while CP is LOW

Fig 9. Set-up and hold times

Table 8. Measurement points

Type	Input		Output
	V_I	V_M	V_M
74HC166-Q100	V_{CC}	$0.5V_{CC}$	$0.5V_{CC}$
74HCT166-Q100	3 V	1.3 V	1.3 V

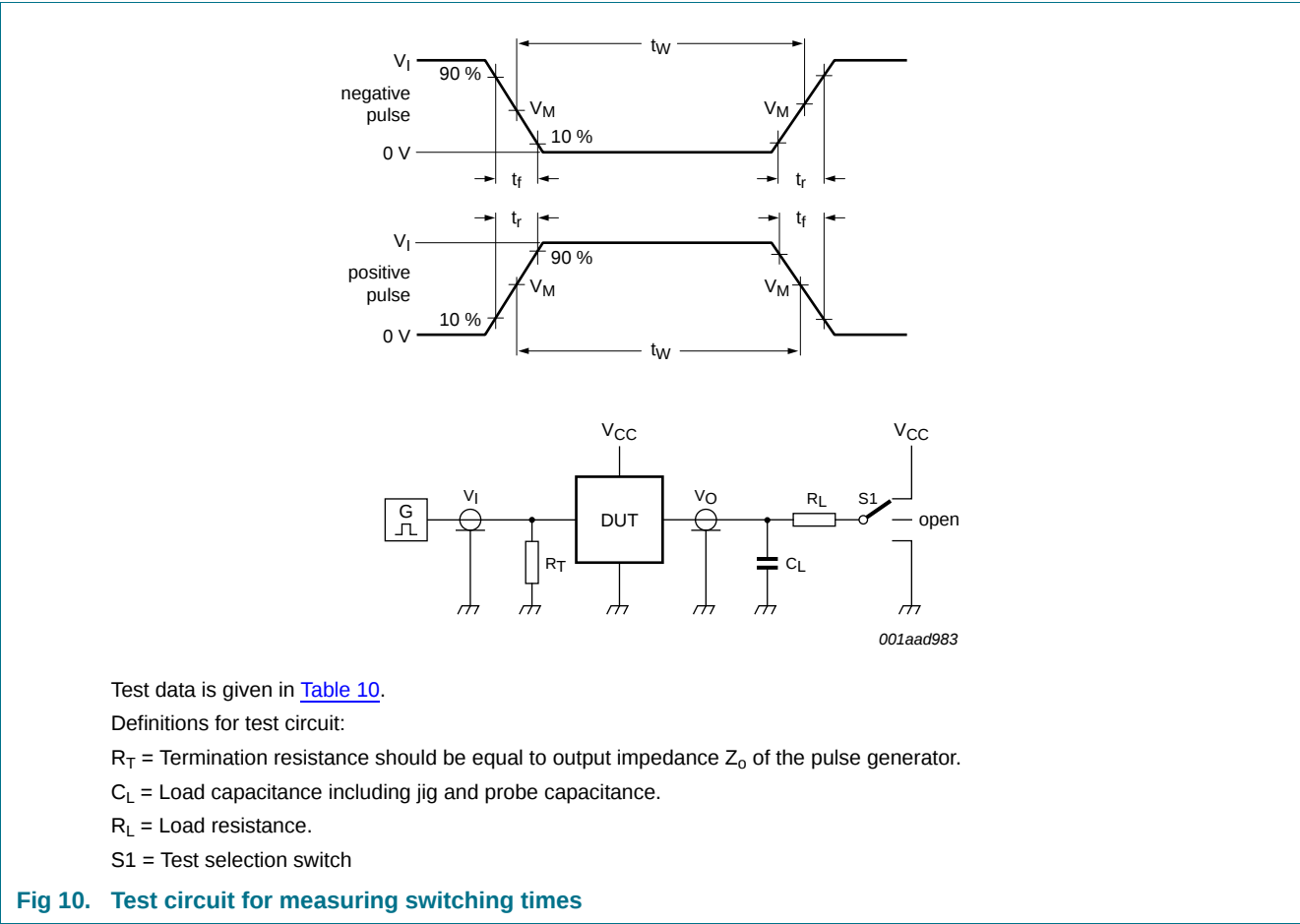


Fig 10. Test circuit for measuring switching times

Table 9. Test data

Type	Input		Load		S1 position
	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}
74HC166-Q100	V_{CC}	6 ns	15 pF, 50 pF	1 k Ω	open
74HCT166-Q100	3 V	6 ns	15 pF, 50 pF	1 k Ω	open

12. Package outline

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

SOT109-1

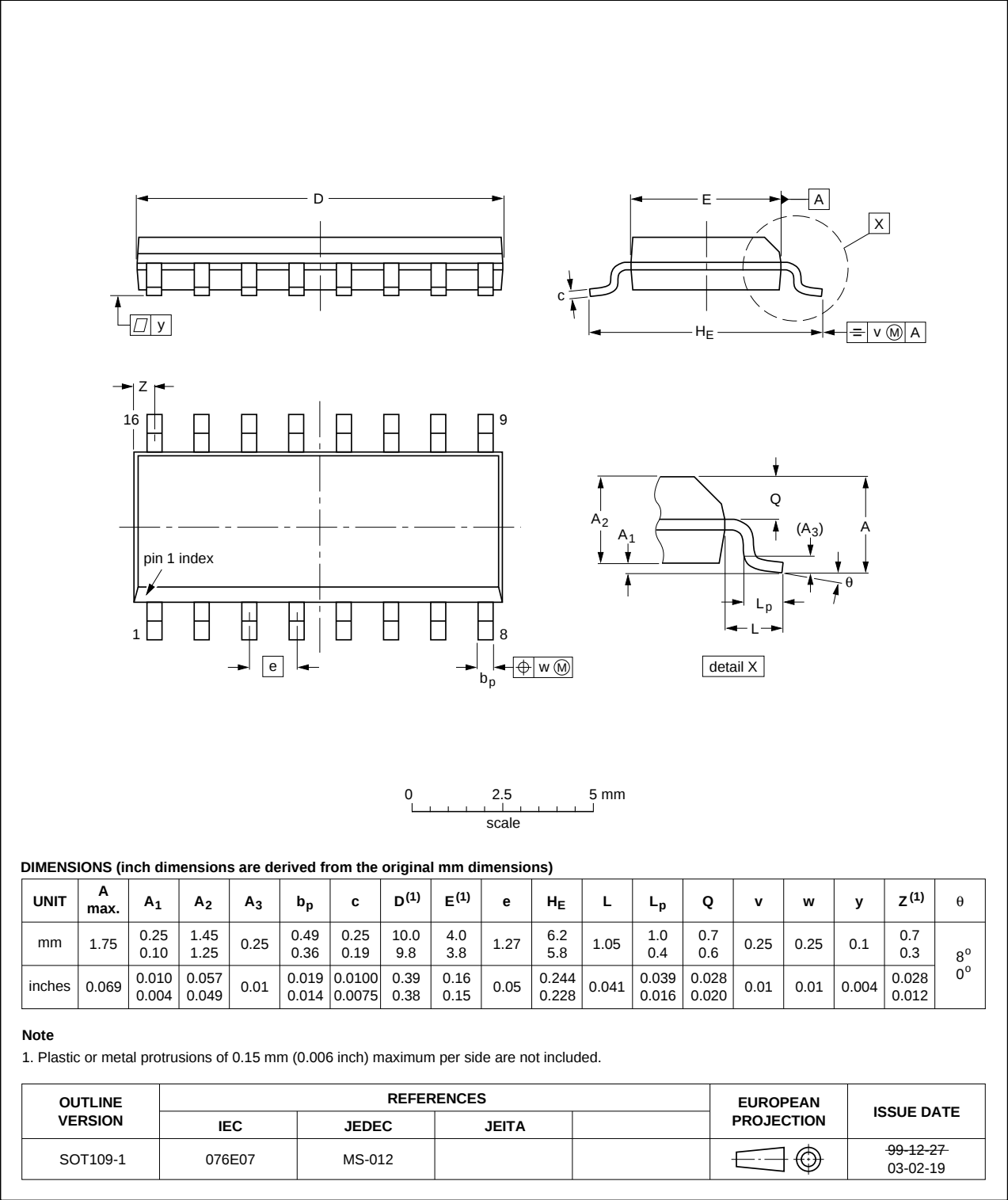


Fig 11. Package outline SOT109-1 (SO16)

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

SOT403-1

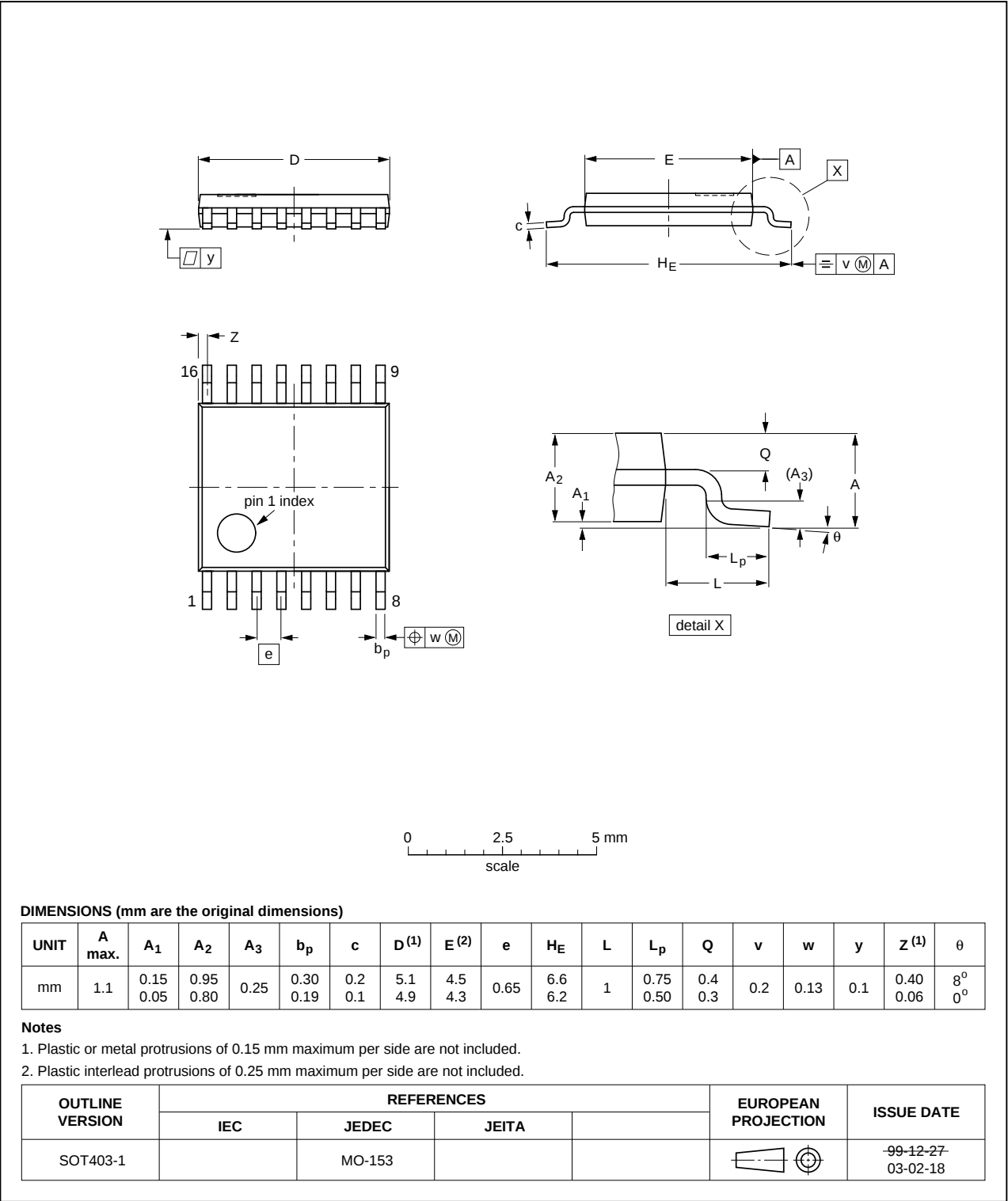


Fig 12. Package outline SOT403-1 (TSSOP16)

13. Abbreviations

Table 10. Abbreviations

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

14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT166_Q100 v.1	20130925	Product data sheet	-	-

15. Legal information

15.1 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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