

# 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

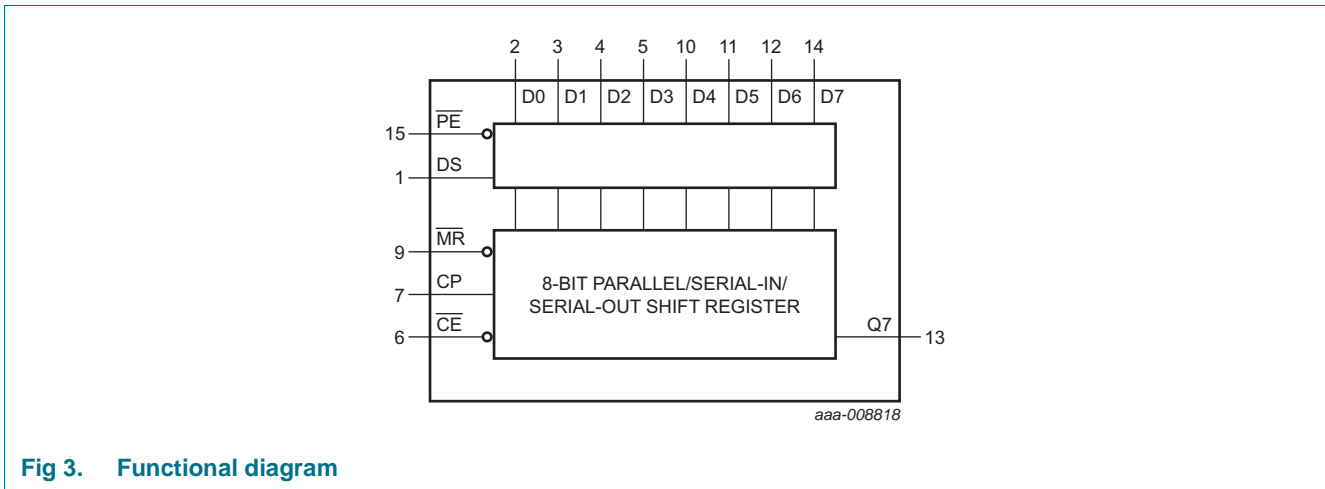
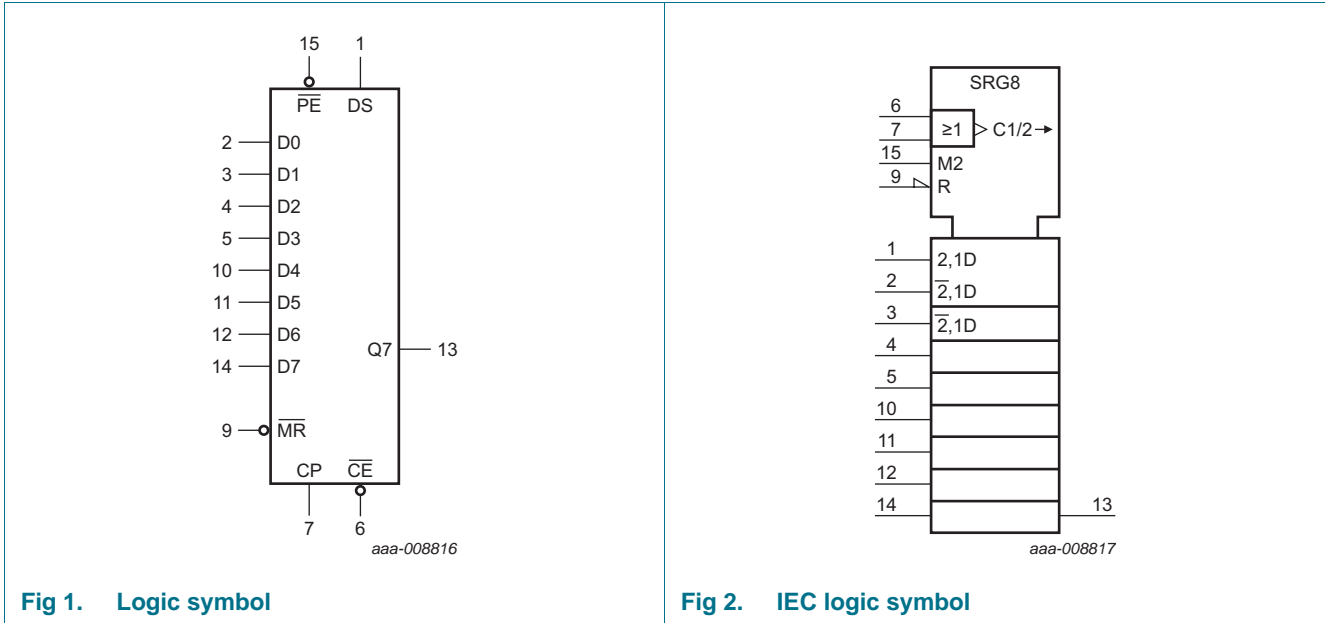
- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Synchronous parallel-to-serial applications
- Synchronous serial 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 pF, R = 0  $\Omega$ )
- Multiple package options

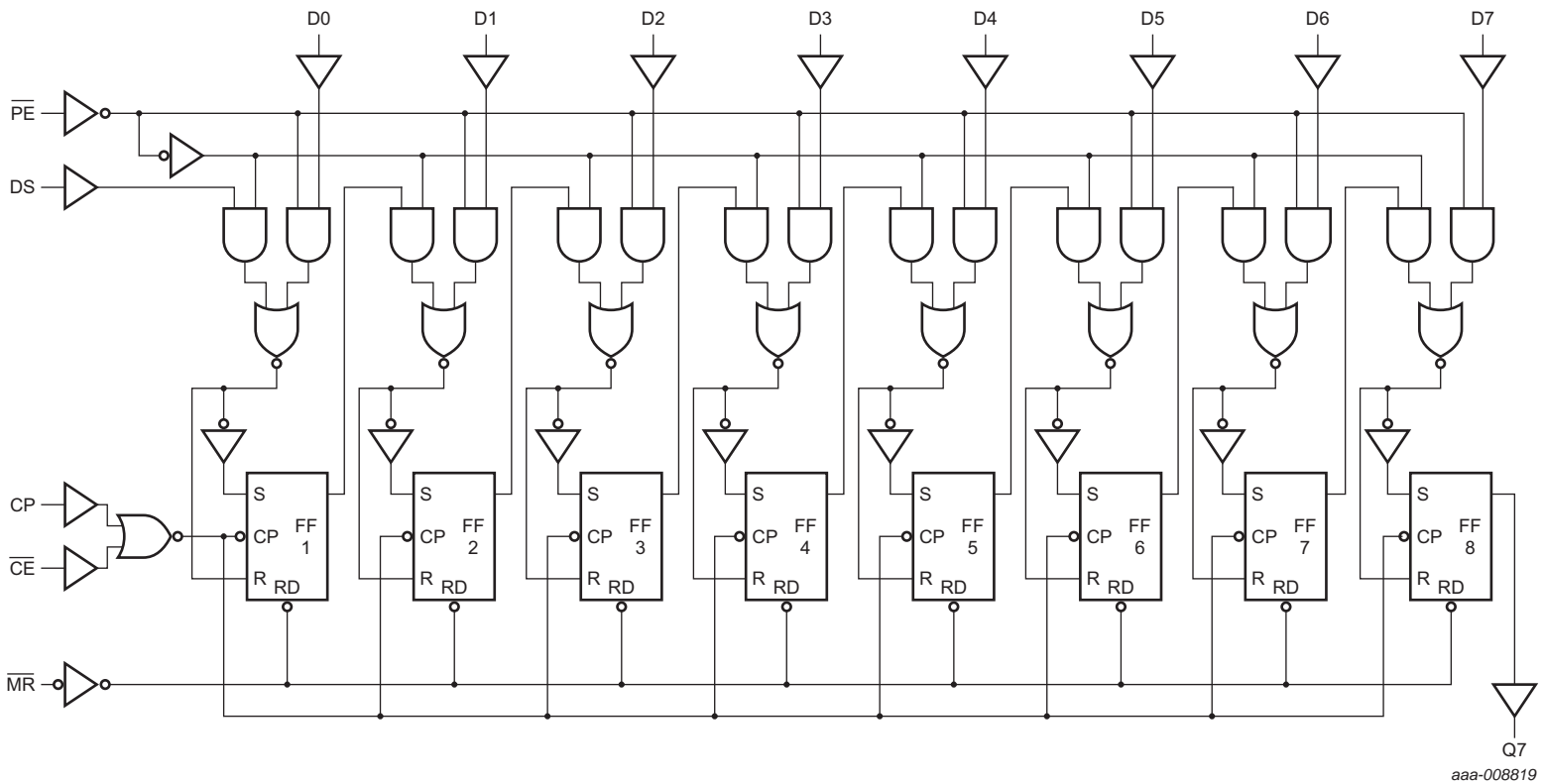
### 3. Ordering information

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



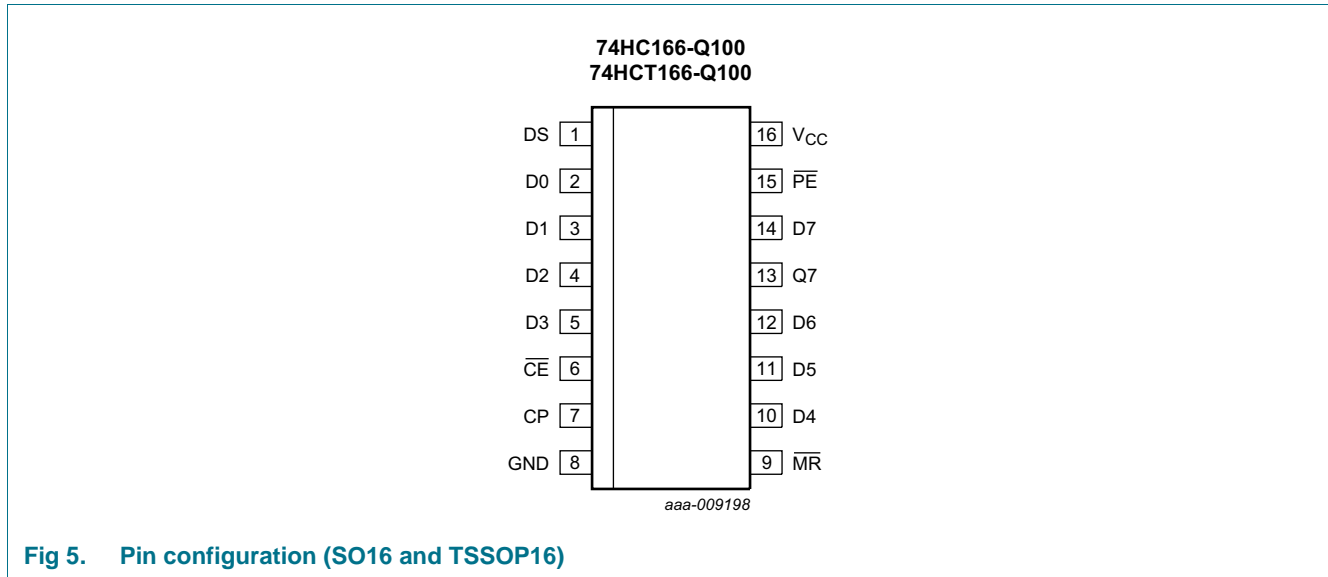


Q7  
aaa-008819

Fig 4. Logic diagram

## 5. Pinning information

### 5.1 Pinning



### 5.2 Pin description

**Table 2. Pin description**

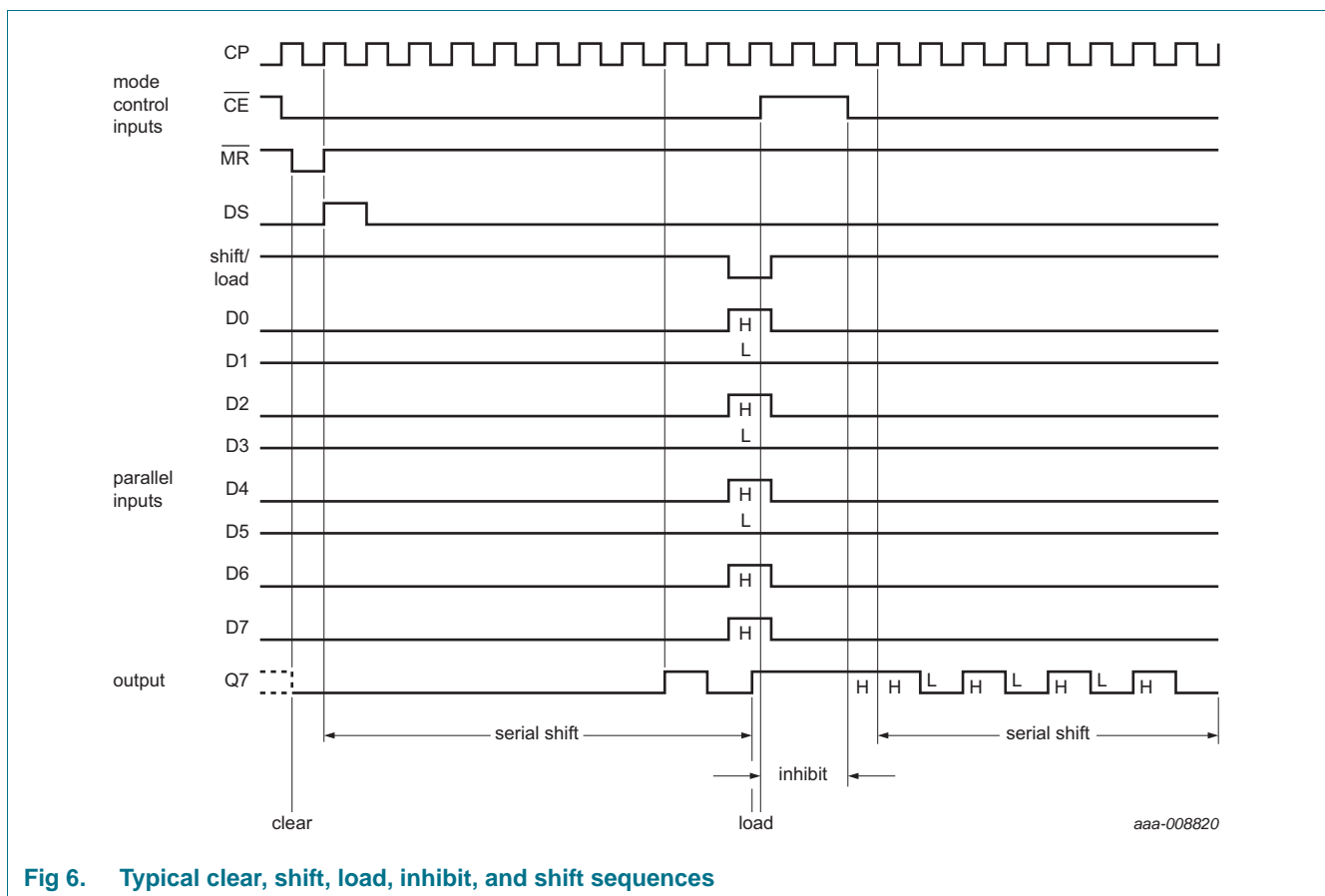
Symbol	Pin	Description
DS	1	serial data input
D0 to D7	2, 3, 4, 5, 10, 11, 12, 14	parallel data inputs
$\overline{CE}$	6	clock enable input (active LOW)
CP	7	clock input (LOW-to-HIGH edge-triggered)
GND	8	ground (0 V)
$\overline{MR}$	9	asynchronous master reset (active LOW)
Q7	13	serial output from the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

## 6. Functional description

Table 3. Function table<sup>[1]</sup>

Operating modes	Inputs					Qn registers		Output
	$\overline{PE}$	$\overline{CE}$	CP	DS	D0 to D7	Q0	Q1 to Q6	Q7
parallel load	L	L	↑	X	L	L	L to L	L
	h	h	↑	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.



## 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]	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1]	-	$\pm 20$	mA
$I_O$	output current	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	$\pm 25$	mA
$I_{CC}$	supply current		-	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 <sub>CC</sub>	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V <sub>I</sub>	input voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
V <sub>O</sub>	output voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
T <sub>amb</sub>	ambient temperature		-40	-	+125	-40	-	+125	°C
Δt/ΔV	input transition rise and fall rate	V <sub>CC</sub> = 2.0 V	-	-	625	-	-	-	ns/V
		V <sub>CC</sub> = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V <sub>CC</sub> = 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	
<b>74HC166-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
		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	-	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
<b>74HCT166-Q100</b>										
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	2.0	1.6	-	2.0	-	2.0	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	-	1.2	0.8	-	0.8	-	0.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH} \text{ or } V_{IL}; V_{CC} = 4.5 \text{ V}$								
		$I_O = -20 \mu\text{A}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -4.0 \text{ mA}$	3.98	4.32	-	3.84	-	3.7	-	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH} \text{ or } V_{IL}; V_{CC} = 4.5 \text{ V}$								
		$I_O = 20 \mu\text{A}; V_{CC} = 4.5 \text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 5.2 \text{ mA}; V_{CC} = 4.5 \text{ V}$	-	0.16	0.26	-	0.33	-	0.4	V
$I_I$	input leakage current	$V_I = V_{CC} \text{ or } \text{GND}; V_{CC} = 4.5 \text{ V}$	-	-	$\pm 0.1$	-	$\pm 1$	-	$\pm 1$	$\mu\text{A}$
$I_{CC}$	supply current	$V_I = V_{CC} \text{ or } \text{GND}; I_O = 0 \text{ A}; V_{CC} = 4.5 \text{ V}$	-	-	8.0	-	80	-	160	$\mu\text{A}$
$\Delta I_{CC}$	additional supply current	per input pin; $V_I = V_{CC} - 2.1 \text{ V};$ other inputs at $V_{CC} \text{ or } \text{GND};$ $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$								
		Dn and DS inputs	-	35	126	-	157.5	-	171.5	$\mu\text{A}$
		CP and $\overline{\text{CE}}$ inputs	-	80	288	-	360	-	392	$\mu\text{A}$
		$\overline{\text{MR}}$ input	-	40	144	-	180	-	196	$\mu\text{A}$
		$\overline{\text{PE}}$ input	-	60	216	-	270	-	294	$\mu\text{A}$
$C_I$	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	
<b>74HC166-Q100</b>										
$t_{pd}$	propagation delay	CP to Q7; see <a href="#">Figure 7</a> <sup>[1]</sup>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ V	-	47	160	-	200	-	240	ns
		$V_{CC} = 4.5$ V	-	17	32	-	40	-	48	ns
$t_t$	transition time	output; see <a href="#">Figure 7</a> <sup>[2]</sup>								
		$V_{CC} = 2.0$ 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
$t_{pw}$	pulse width	CP input HIGH or LOW; see <a href="#">Figure 7</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ 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 ...continued**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		
$t_h$	hold time	Dn, $\overline{CE}$ to CP; see <a href="#">Figure 9</a>									
		$V_{CC} = 2.0$ 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
	$f_{max}$	maximum frequency	$\overline{PE}$ to CP; see <a href="#">Figure 9</a>								
			$V_{CC} = 2.0$ V	0	-28	-	0	-	0	-	ns
			$V_{CC} = 4.5$ V	0	-10	-	0	-	0	-	ns
$V_{CC} = 6.0$ V			0	-8	-	0	-	0	-	ns	
$f_{max}$	maximum frequency	CP input; see <a href="#">Figure 7</a>									
		$V_{CC} = 2.0$ 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	
$C_{PD}$	power dissipation capacitance	$V_{CC} = 6.0$ V	35	68	-	28	-	24	-	MHz	
		per package; $V_I = \text{GND to } V_{CC}$	[3]	-	41	-	-	-	-	-	pF
<b>74HCT166-Q100</b>											
$t_{pd}$	propagation delay	CP to Q7; see <a href="#">Figure 7</a>									
		$V_{CC} = 4.5$ V	-	23	40	-	50	-	60	ns	
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	20	-	-	-	-	-	ns	
		$\overline{MR}$ to Q7; see <a href="#">Figure 8</a>									
		$V_{CC} = 4.5$ V	-	22	40	-	50	-	60	ns	
$t_t$	transition time	$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	19	-	-	-	-	-	ns	
		output; see <a href="#">Figure 7</a>									
$t_w$	pulse width	$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns	
		CP input HIGH or LOW; see <a href="#">Figure 7</a>									
$t_{rec}$	recovery time	$V_{CC} = 4.5$ V	20	9	-	25	-	30	-	ns	
		$\overline{MR}$ input LOW; see <a href="#">Figure 8</a>									
$t_{su}$	set-up time	$V_{CC} = 4.5$ V	25	11	-	31	-	38	-	ns	
		$\overline{MR}$ to CP; see <a href="#">Figure 8</a>									
$t_h$	hold time	$V_{CC} = 4.5$ V	0	-7	-	0	-	0	-	ns	
		Dn, $\overline{CE}$ to CP; see <a href="#">Figure 9</a>									
		$V_{CC} = 4.5$ V	16	8	-	20	-	24	-	ns	
$t_h$	hold time	$\overline{PE}$ to CP; see <a href="#">Figure 9</a>									
		$V_{CC} = 4.5$ V	30	15	-	38	-	45	-	ns	
		$\overline{PE}$ to CP; see <a href="#">Figure 9</a>									
$t_h$	hold time	$V_{CC} = 4.5$ V	0	-3	-	0	-	0	-	ns	
		$V_{CC} = 4.5$ V	0	-13	-	0	-	0	-	ns	

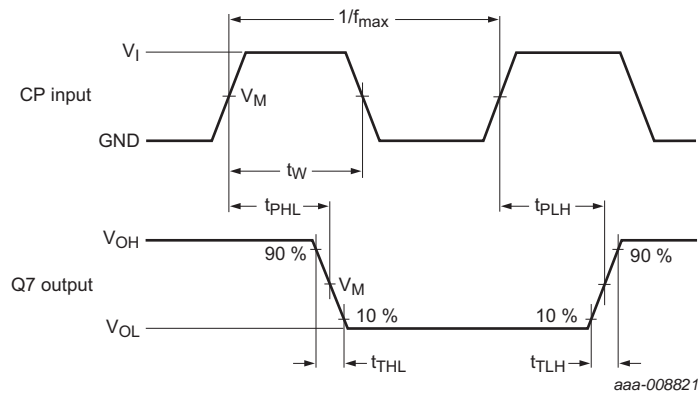
**Table 7. Dynamic characteristics ...continued**

GND (ground = 0 V);  $t_r = t_f = 6 \text{ ns}$ ;  $C_L = 50 \text{ pF}$  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	CP input; see <a href="#">Figure 7</a>								
		$V_{\text{CC}} = 4.5 \text{ V}$	25	45	-	20	-	17	-	MHz
		$V_{\text{CC}} = 5.0 \text{ V}$ ; $C_L = 15 \text{ pF}$	-	50	-	-	-	-	-	MHz
$C_{\text{PD}}$	power dissipation capacitance	per package; $V_1 = \text{GND to } V_{\text{CC}}$	[3]	-	41	-	-	-	-	pF

- [1]  $t_{\text{pd}}$  is the same as  $t_{\text{PHL}}$  and  $t_{\text{PLH}}$ .
- [2]  $t_t$  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.

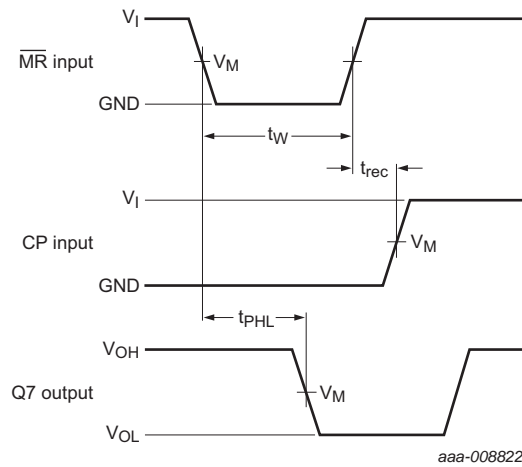
## 11. Waveforms



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.

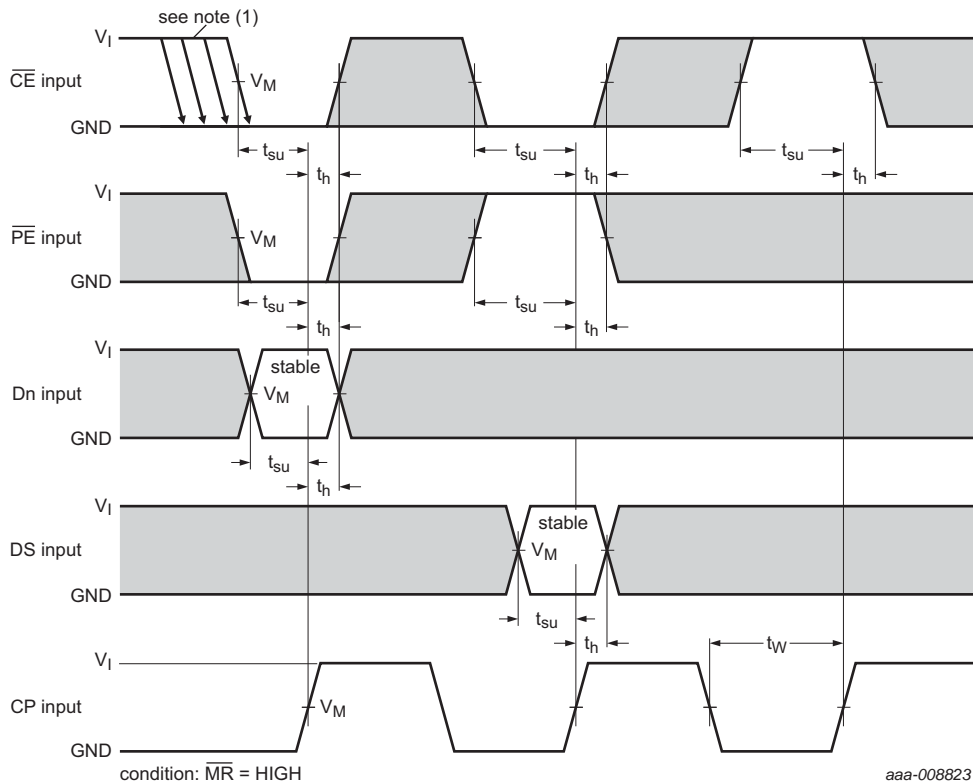
**Fig 7. Clock (CP) to output (Q7) propagation delays, pulse width, output transition times and maximum frequency**



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

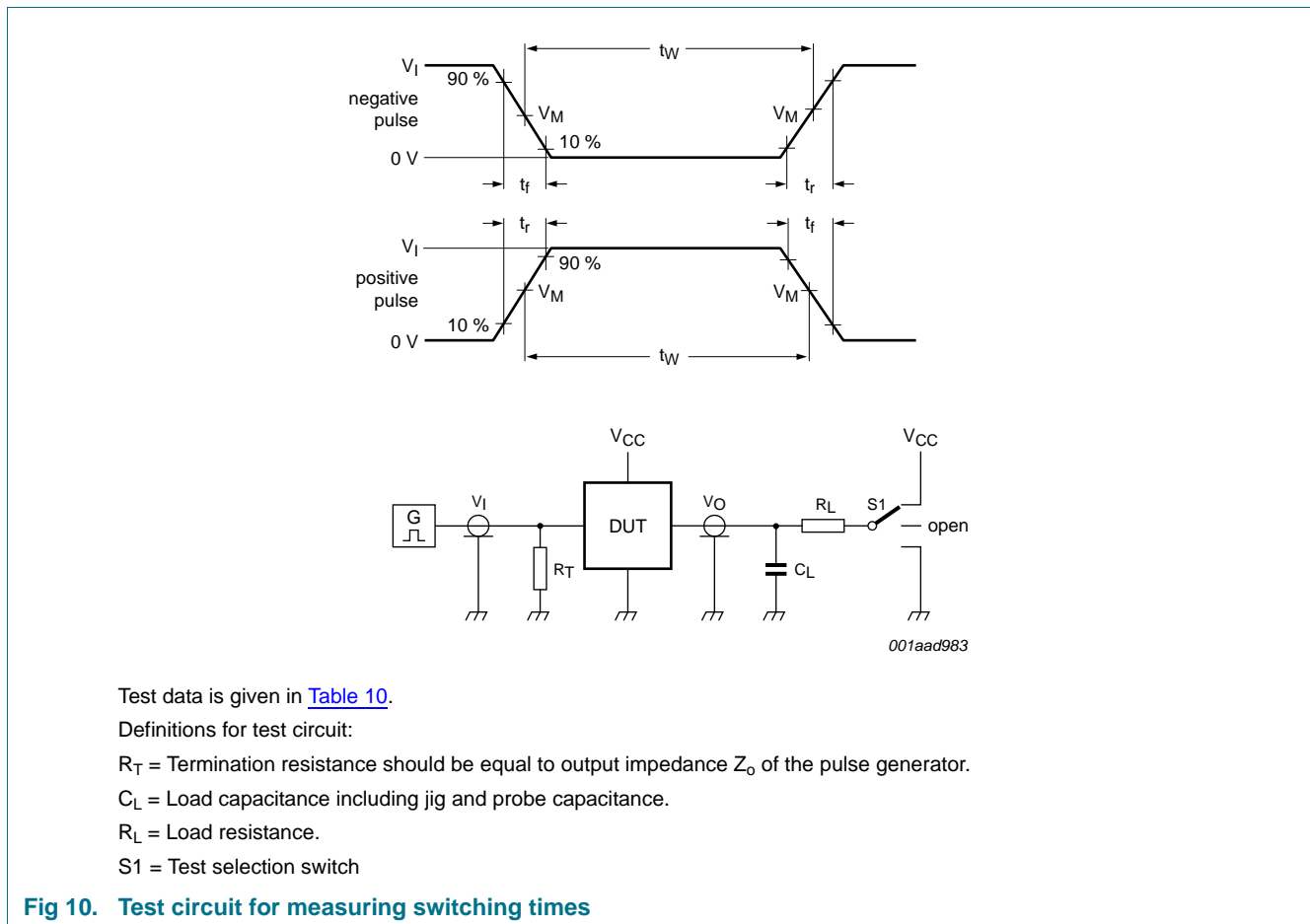
Measurement points are given in [Table 8](#).

(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 $\Omega$	open
74HCT166-Q100	3 V	6 ns	15 pF, 50 pF	1 k $\Omega$	open

## 12. Package outline

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

SOT109-1

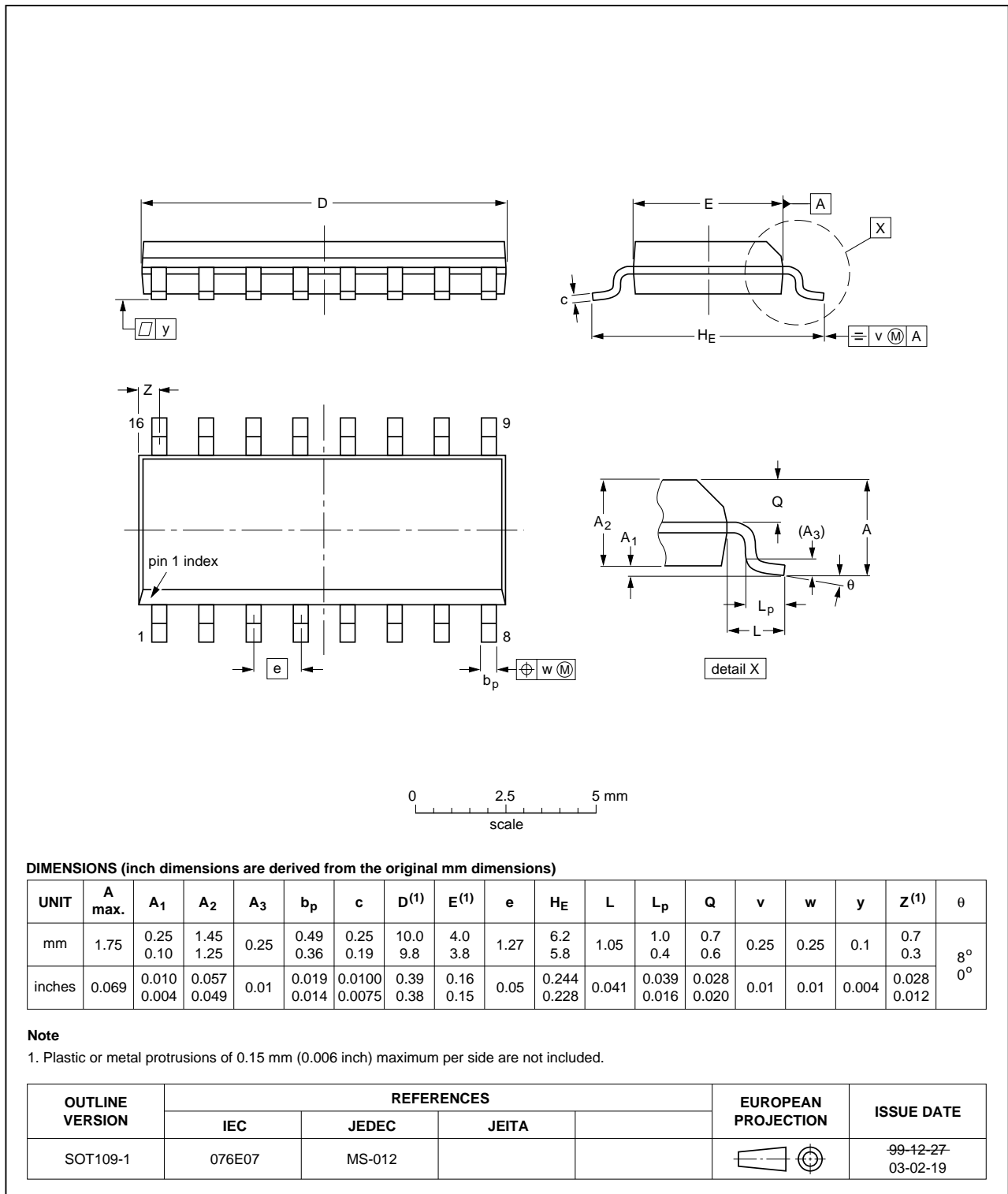


Fig 11. Package outline SOT109-1 (SO16)

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

SOT403-1

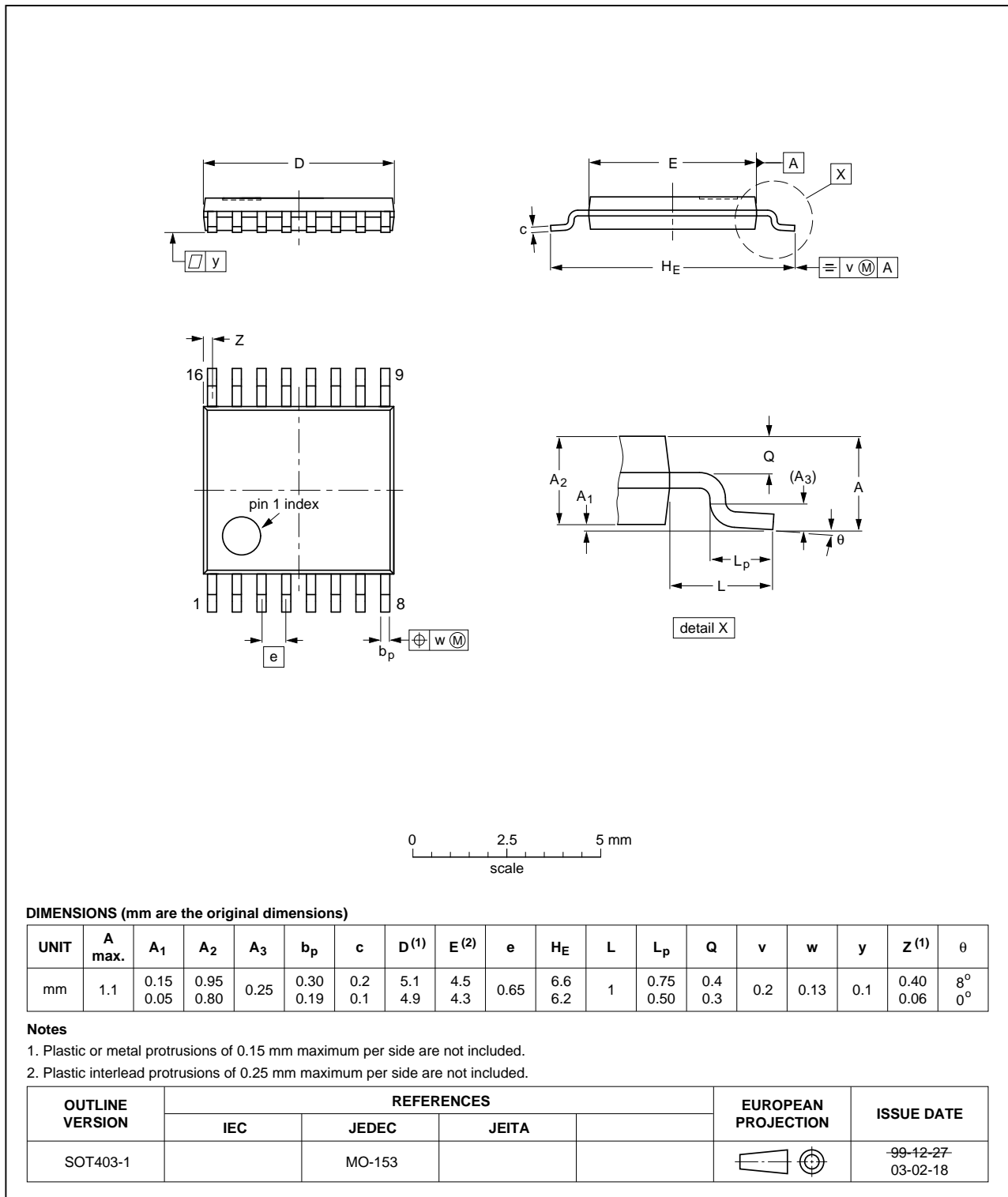


Fig 12. Package outline SOT403-1 (TSSOP16)

## 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 <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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