

74HC165-Q100; 74HCT165-Q100

8-bit parallel-in/serial out shift register

Rev. 1 — 17 July 2012

Product data sheet

1. General description

The 74HC165-Q100; 74HCT165-Q100 are high-speed Si-gate CMOS devices that comply with JEDEC standard no. 7A. They are pin compatible with Low-power Schottky TTL (LSTTL).

The 74HC165-Q100; 74HCT165-Q100 are 8-bit parallel-load or serial-in shift registers with complementary serial outputs (Q_7 and $\overline{Q_7}$) available from the last stage. When the parallel load ($\overline{PL}$) input is LOW, parallel data from the D0 to D7 inputs are loaded into the register asynchronously.

When $\overline{PL}$ is HIGH, data enters the register serially at the DS input and shifts one place to the right ($Q_0 \rightarrow Q_1 \rightarrow Q_2$, etc.) with each positive-going clock transition. This feature allows parallel-to-serial converter expansion by tying the Q_7 output to the DS input of the succeeding stage.

The clock input is a gated-OR structure which allows one input to be used as an active LOW clock enable ($\overline{CE}$) input. The pin assignment for the CP and $\overline{CE}$ inputs is arbitrary and can be reversed for layout convenience. The LOW-to-HIGH transition of input $\overline{CE}$ should only take place while CP HIGH for predictable operation. Either the CP or the $\overline{CE}$ should be HIGH before the LOW-to-HIGH transition of PL to prevent shifting the data when PL is activated.

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 $+125\text{ }^{\circ}\text{C}$
- Asynchronous 8-bit parallel load
- Synchronous serial input
- 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

- Parallel-to-serial data conversion

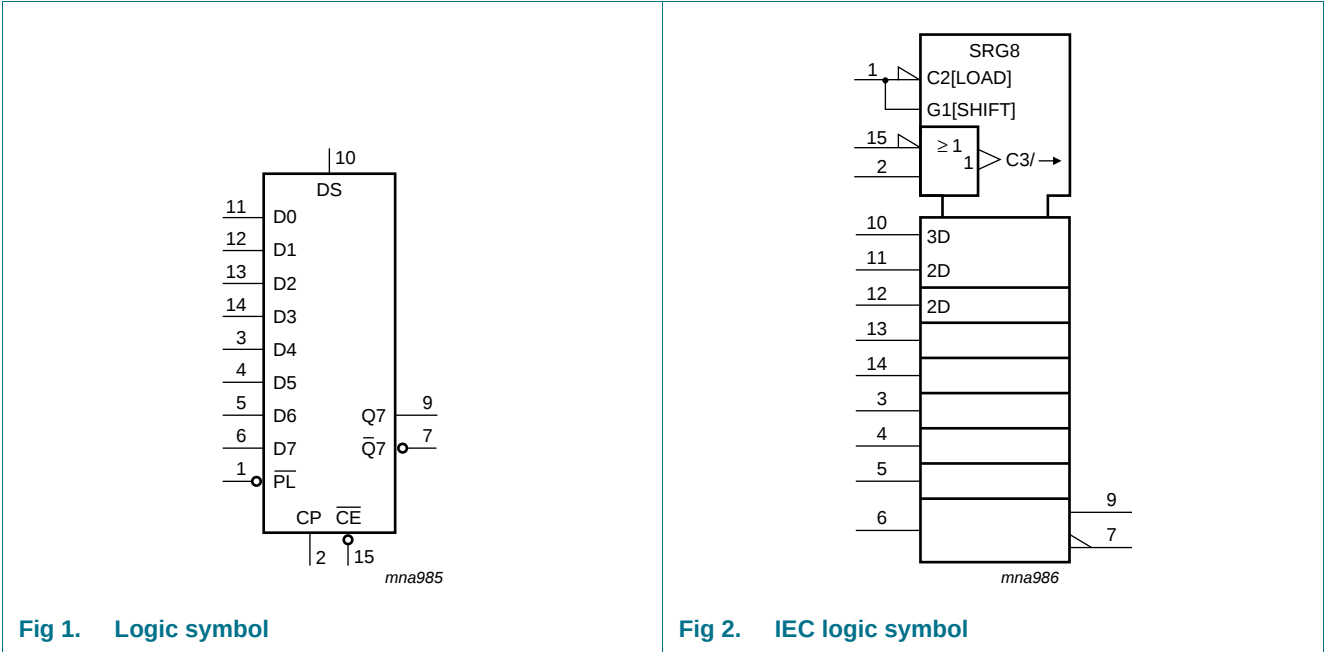


4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC165D-Q100 74HCT165D-Q100	−40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC165PW-Q100 74HCT165PW-Q100	−40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HC165BQ-Q100 74HCT165BQ-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



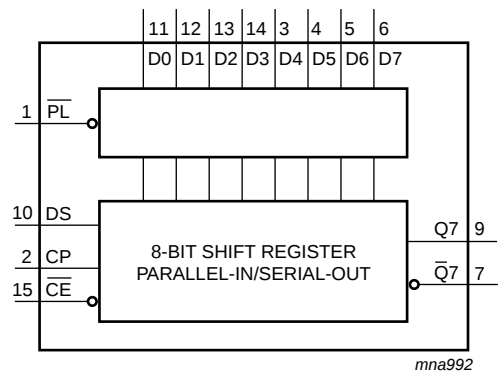


Fig 3. Functional diagram

6. Pinning information

6.1 Pinning

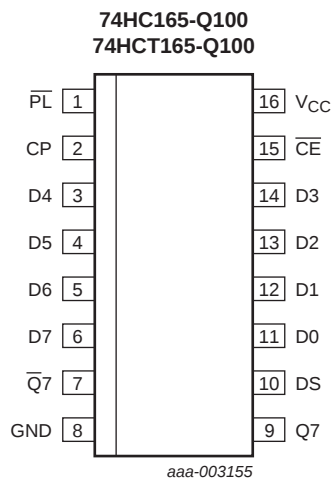


Fig 4. Pin configuration SO16 and TSSOP16

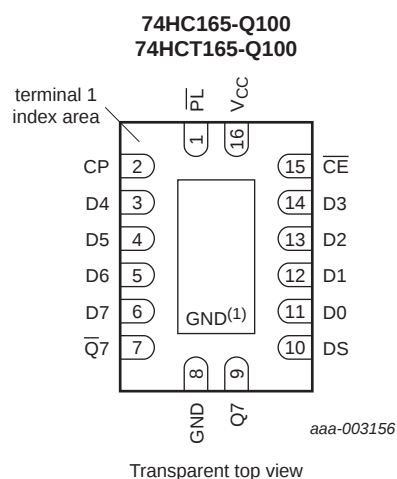


Fig 5. Pin configuration DHVQFN16

6.2 Pin description

Table 2. Pin description

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

7. Functional description

Table 3. Function table^[1]

Operating modes	Inputs					Qn registers		Outputs	
	$\overline{\text{PL}}$	$\overline{\text{CE}}$	CP	DS	D0 to D7	Q0	Q1 to Q6	Q7	$\overline{\text{Q}}7$
parallel load	L	X	X	X	L	L	L to L	L	H
	L	X	X	X	H	H	H to H	H	L
serial shift	H	L	↑	l	X	L	q0 to q5	q6	$\overline{\text{q}}6$
	H	L	↑	h	X	H	q0 to q5	q6	$\overline{\text{q}}6$
	H	↑	L	l	X	L	q0 to q5	q6	$\overline{\text{q}}6$
	H	↑	L	h	X	H	q0 to q5	q6	$\overline{\text{q}}6$
hold "do nothing"	H	H	X	X	X	q0	q1 to q6	q7	$\overline{\text{q}}7$
	H	X	H	X	X	q0	q1 to q6	q7	$\overline{\text{q}}7$

- [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.

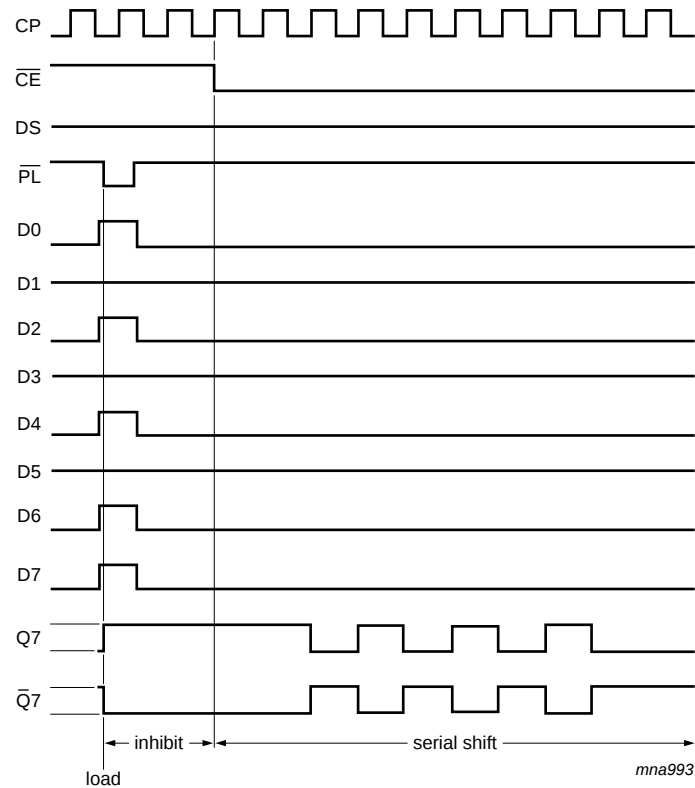


Fig 6. Timing diagram

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 $V_I > V_{CC} + 0.5 \text{ V}$	[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	$T_{amb} = -40 \text{ °C to } +125 \text{ °C}$	[2] -	500	mW

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

[2] 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

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC165-Q100			74HCT165-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
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	
74HC165-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
74HCT165-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} = 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
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, $\overline{\text{CE}}$, and $\overline{\text{PL}}$ inputs	-	65	234	-	292.5	-	318.5	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 12](#)

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC165-Q100										
t _{pd}	propagation delay	CP or $\overline{CE}$ to Q7, $\overline{Q7}$; see Figure 7 [1]								
		V _{CC} = 2.0 V	-	52	165	-	205	-	250	ns
		V _{CC} = 4.5 V	-	19	33	-	41	-	50	ns
		V _{CC} = 6.0 V	-	15	28	-	35	-	43	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	16	-	-	-	-	-	ns
		$\overline{PL}$ to Q7, $\overline{Q7}$; see Figure 8								
		V _{CC} = 2.0 V	-	50	165	-	205	-	250	ns
		V _{CC} = 4.5 V	-	18	33	-	41	-	50	ns
		V _{CC} = 6.0 V	-	14	28	-	35	-	43	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	15	-	-	-	-	-	ns
		D7 to Q7, $\overline{Q7}$; see Figure 9								
		V _{CC} = 2.0 V	-	36	120	-	150	-	180	ns
		V _{CC} = 4.5 V	-	13	24	-	30	-	36	ns
		V _{CC} = 6.0 V	-	10	20	-	26	-	31	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	11	-	-	-	-	-	ns
t _t	transition time	Q7, $\overline{Q7}$ 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
		$\overline{PL}$ input 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		
t _{rec}	recovery time	$\overline{PL}$ to CP, $\overline{CE}$; see Figure 8								
		V _{CC} = 2.0 V	100	22	-	125	-	150	-	ns
		V _{CC} = 4.5 V	20	8	-	25	-	30	-	ns
		V _{CC} = 6.0 V	17	6	-	21	-	26	-	ns

Table 7. Dynamic characteristics ...continuedGND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit, see [Figure 12](#)

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t_{su}	set-up time	DS to CP, $\overline{CE}$; see Figure 10								
		$V_{CC} = 2.0$ V	80	11	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	4	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	3	-	17	-	20	-	ns
		$\overline{CE}$ to CP and CP to $\overline{CE}$; see Figure 10								
		$V_{CC} = 2.0$ 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
		Dn to $\overline{PL}$; see Figure 11								
		$V_{CC} = 2.0$ 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_h	hold time	DS to CP, $\overline{CE}$ and Dn to $\overline{PL}$; see Figure 10								
		$V_{CC} = 2.0$ V	5	6	-	5	-	5	-	ns
		$V_{CC} = 4.5$ V	5	2	-	5	-	5	-	ns
		$V_{CC} = 6.0$ V	5	2	-	5	-	5	-	ns
		$\overline{CE}$ to CP and CP to $\overline{CE}$; see Figure 10								
		$V_{CC} = 2.0$ V	5	–17	-	5	-	5	-	ns
		$V_{CC} = 4.5$ V	5	–6	-	5	-	5	-	ns
		$V_{CC} = 6.0$ V	5	–5	-	5	-	5	-	ns
		CP input; see Figure 7								
		$V_{CC} = 2.0$ V	6	17	-	5	-	4	-	MHz
		$V_{CC} = 4.5$ V	30	51	-	24	-	20	-	MHz
		$V_{CC} = 6.0$ V	35	61	-	28	-	24	-	MHz
f_{max}	maximum frequency	$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	56	-	-	-	-	-	MHz
C_{PD}	power dissipation capacitance	per package; $V_I = \text{GND to } V_{CC}$	[3]	-	35	-	-	-	-	pF

Table 7. Dynamic characteristics ...continuedGND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit, see [Figure 12](#)

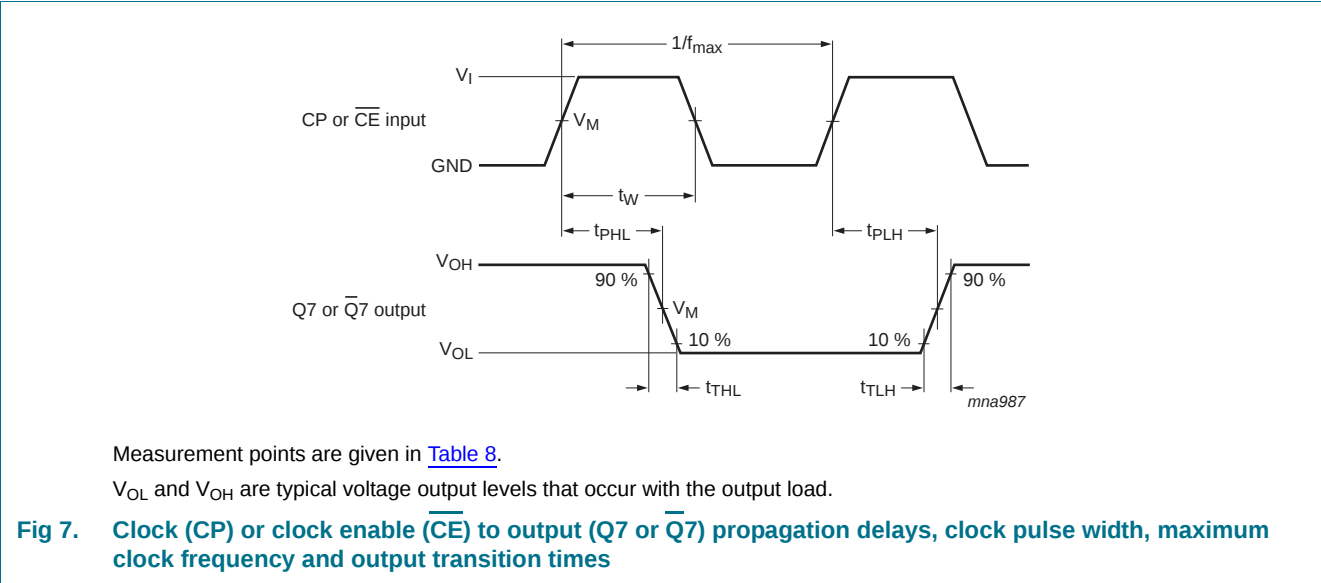
Symbol	Parameter	Conditions	25 °C			−40 °C to +85 °C		−40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HCT165-Q100										
t _{pd}	propagation delay	$\overline{CE}$, CP to Q7, $\overline{Q7}$; see Figure 7 [1]								
		V _{CC} = 4.5 V	-	17	34	-	43	-	51	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	14	-	-	-	-	-	ns
		$\overline{PL}$ to Q7, $\overline{Q7}$; see Figure 8								
		V _{CC} = 4.5 V	-	20	40	-	50	-	60	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	17	-	-	-	-	-	ns
		D7 to Q7, $\overline{Q7}$; see Figure 9								
		V _{CC} = 4.5 V	-	14	28	-	35	-	42	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	11	-	-	-	-	ns	
t _t	transition time	Q7, $\overline{Q7}$ output; see Figure 7 [2]								
		V _{CC} = 4.5 V	-	7	15	-	19	-	22	ns
t _w	pulse width	CP input; see Figure 7								
		V _{CC} = 4.5 V	16	6	-	20	-	24	-	ns
		$\overline{PL}$ input; see Figure 8								
		V _{CC} = 4.5 V	20	9	-	25	-	30	-	ns
t _{rec}	recovery time	$\overline{PL}$ to CP, $\overline{CE}$; see Figure 8								
		V _{CC} = 4.5 V	20	8	-	25	-	30	-	ns
t _{su}	set-up time	DS to CP, $\overline{CE}$; see Figure 10								
		V _{CC} = 4.5 V	20	2	-	25	-	30	-	ns
		$\overline{CE}$ to CP and CP to $\overline{CE}$; see Figure 10								
		V _{CC} = 4.5 V	20	7	-	25	-	30	-	ns
		Dn to $\overline{PL}$; see Figure 11								
		V _{CC} = 4.5 V	20	10	-	25	-	30	-	ns
t _h	hold time	DS to CP, $\overline{CE}$ and Dn to $\overline{PL}$; see Figure 10								
		V _{CC} = 4.5 V	7	−1	-	9	-	11	-	ns
		$\overline{CE}$ to CP and CP to $\overline{CE}$; see Figure 10								
		V _{CC} = 4.5 V	0	−7	-	0	-	0	-	ns
f _{max}	maximum frequency	CP input; see Figure 7								
		V _{CC} = 4.5 V	26	44	-	21	-	17	-	MHz
		V _{CC} = 5.0 V; C _L = 15 pF	-	48	-	-	-	-	-	MHz

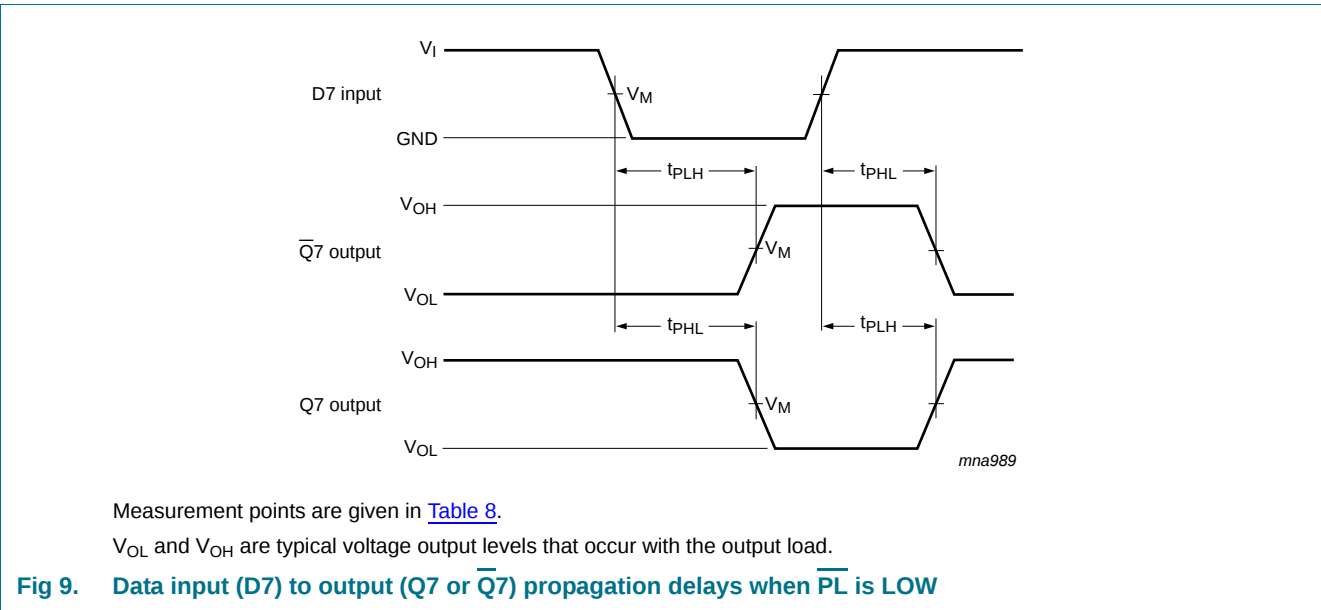
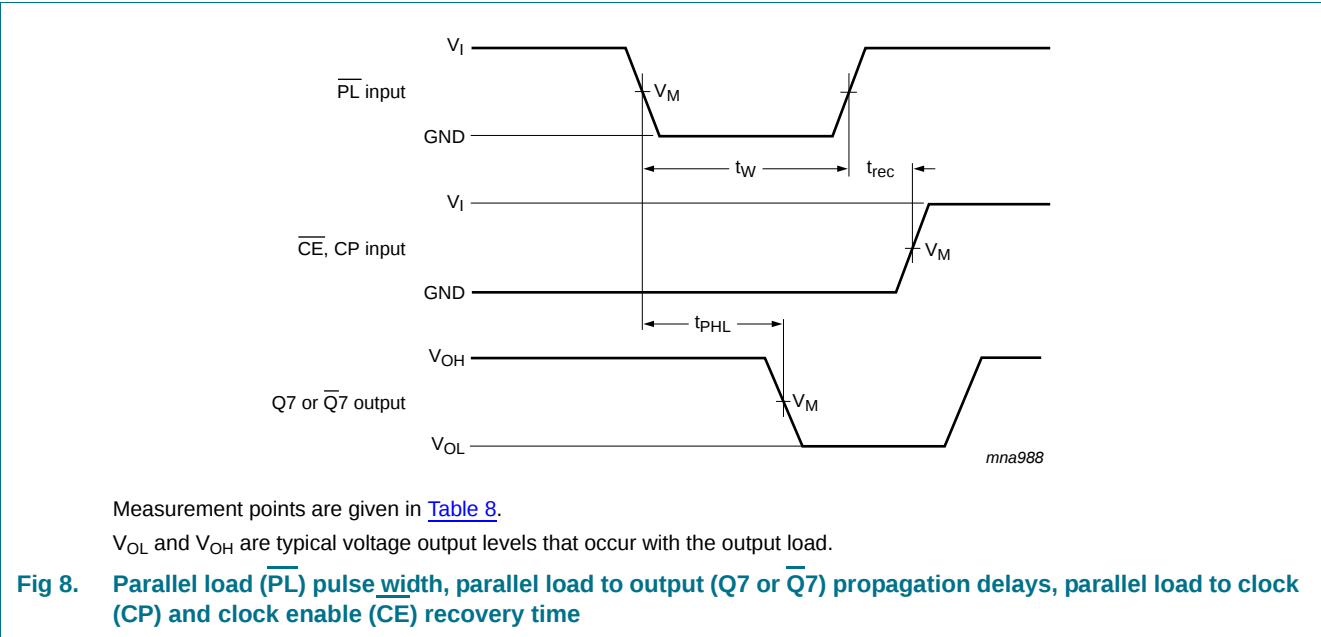
Table 7. Dynamic characteristics ...continued
GND (ground = 0 V); C_L = 50 pF unless otherwise specified; for test circuit, see [Figure 12](#)

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	per package; V _I = GND to V _{CC} − 1.5 V	3	-	35	-	-	-	-	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;
Σ (C_L × V_{CC}² × f_o) = sum of outputs;
C_L = output load capacitance in pF;
V_{CC} = supply voltage in V.

12. Waveforms





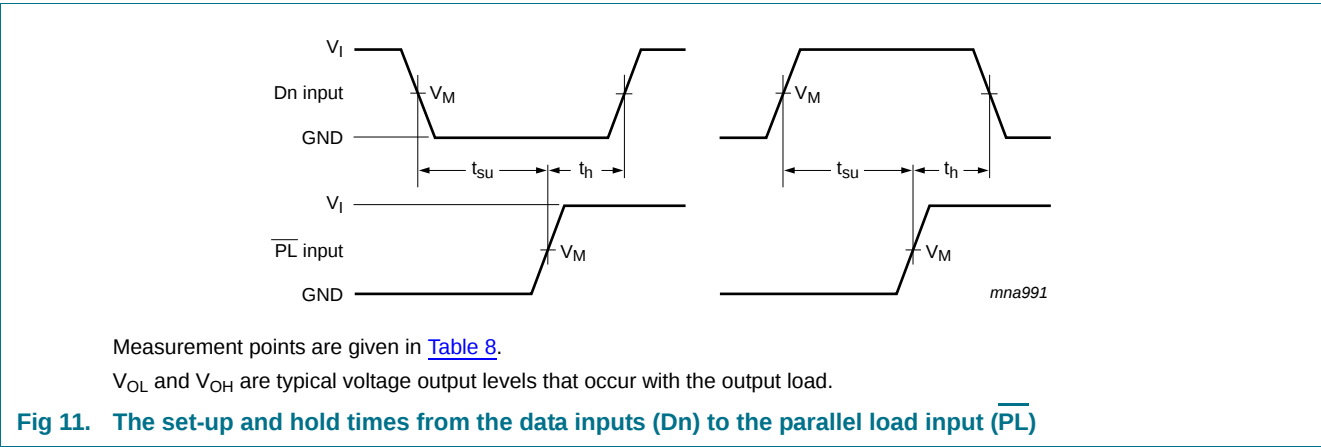
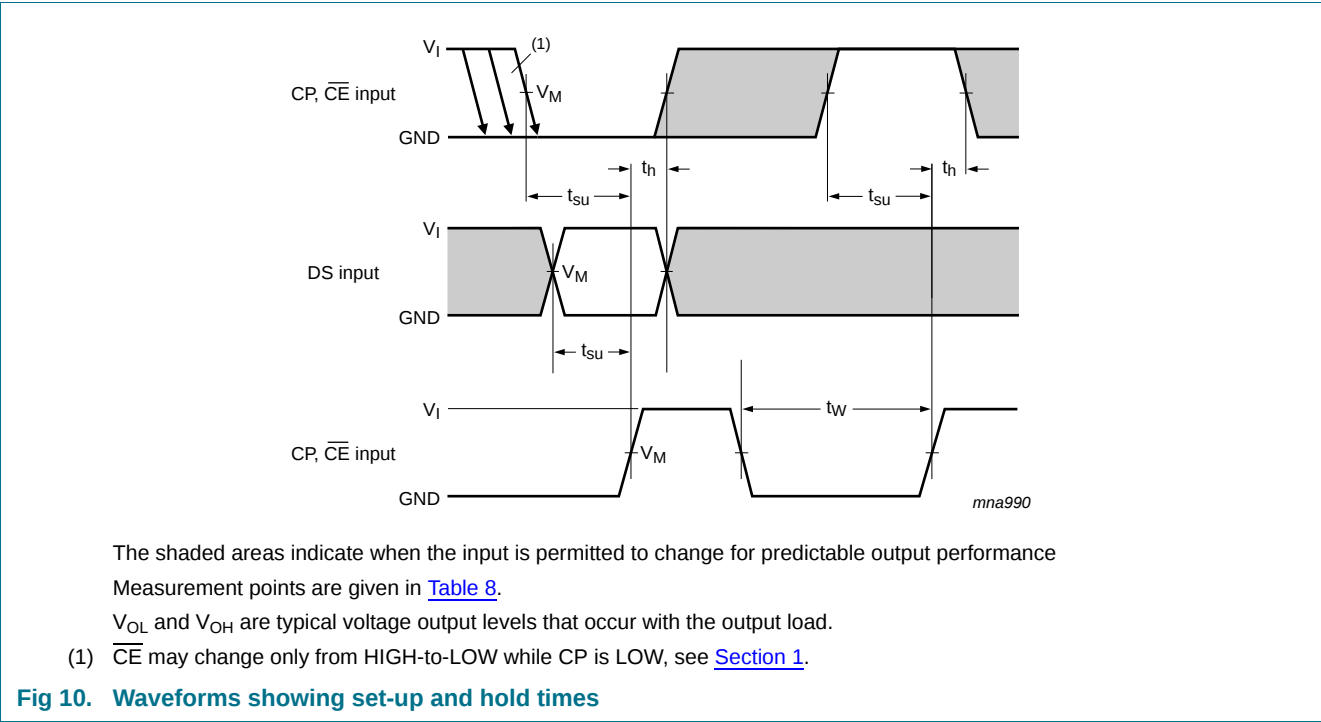


Table 8. Measurement points

Type	Input		Output
	V_I	V_M	V_M
74HC165-Q100	V_{CC}	$0.5V_{CC}$	$0.5V_{CC}$
74HCT165-Q100	3 V	1.3 V	1.3 V

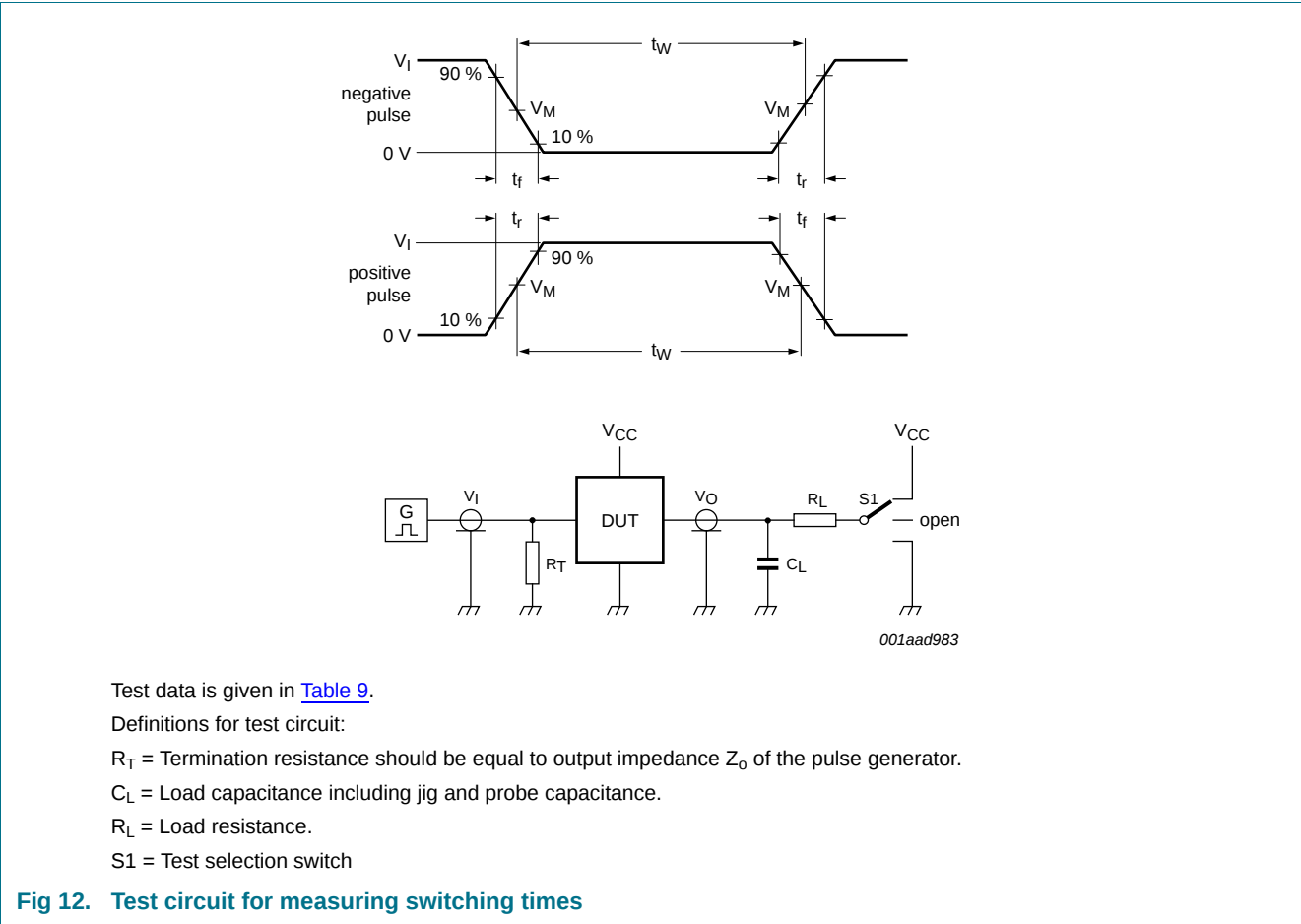


Table 9. Test data

Type	Input		Load		S1 position
	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}
74HC165-Q100	V_{CC}	6 ns	15 pF, 50 pF	1 k Ω	open
74HCT165-Q100	3 V	6 ns	15 pF, 50 pF	1 k Ω	open

13. Package outline

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

SOT109-1

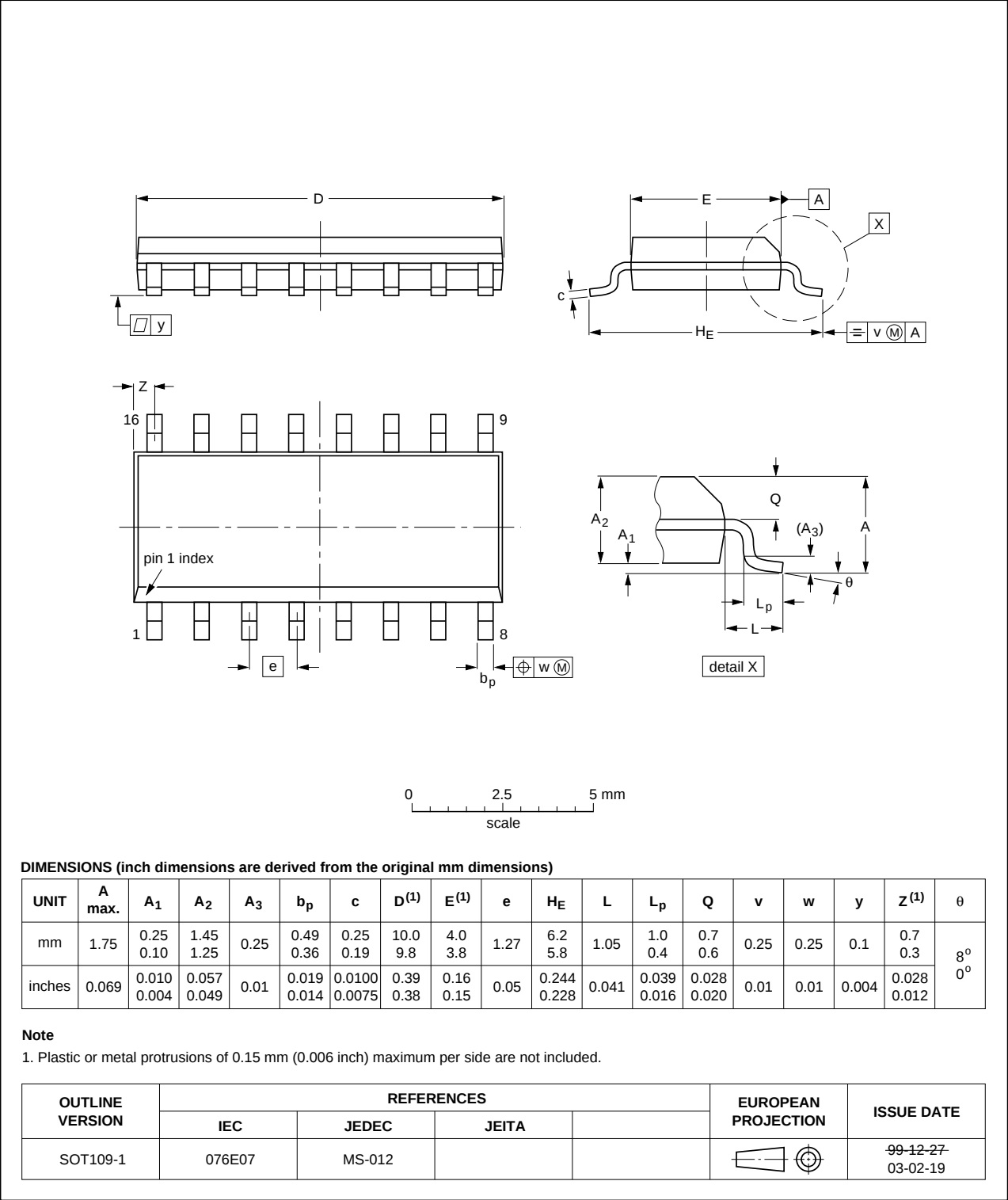


Fig 13. Package outline SOT109-1 (SO16)

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

SOT403-1

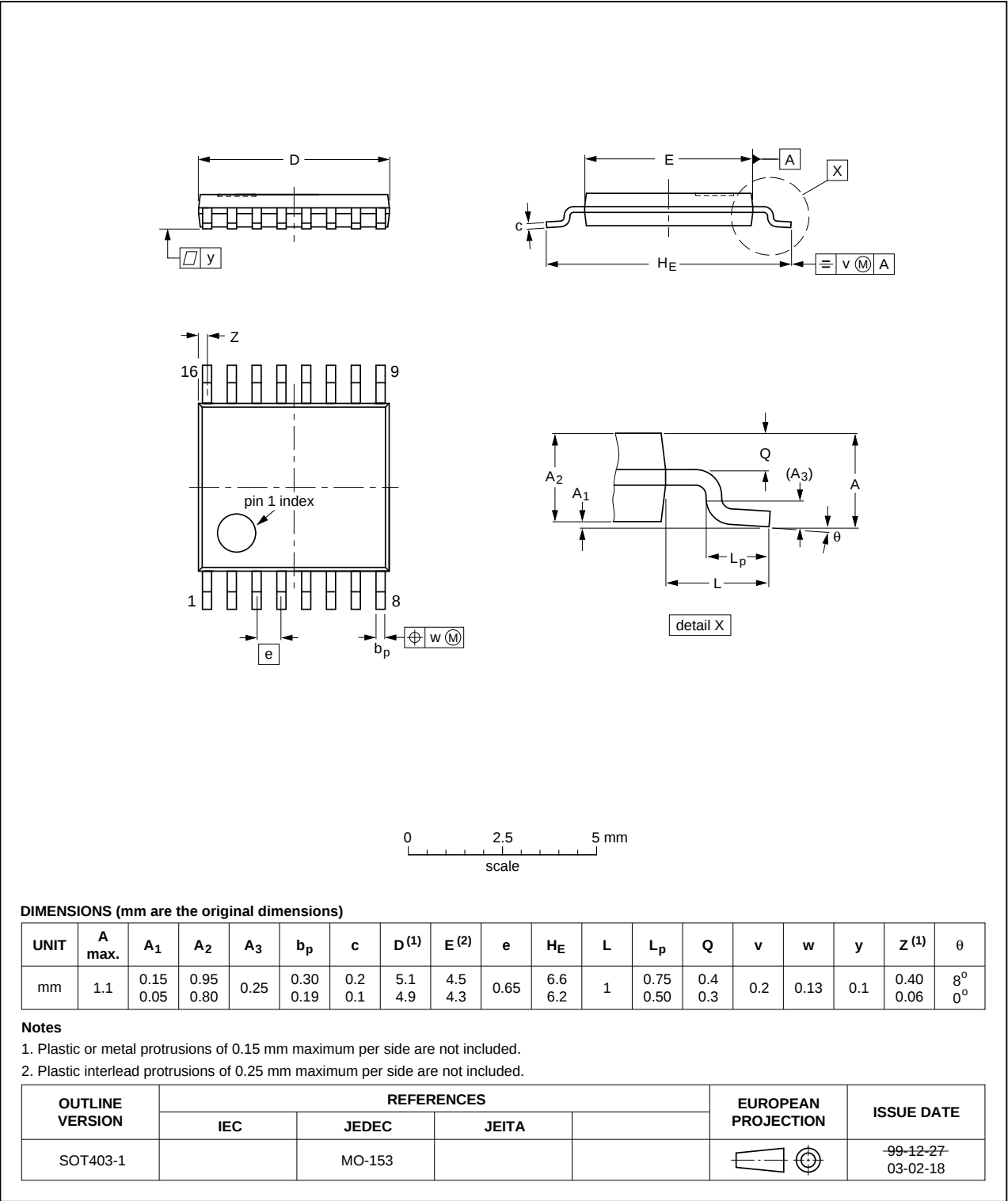


Fig 14. Package outline SOT403-1 (TSSOP16)

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

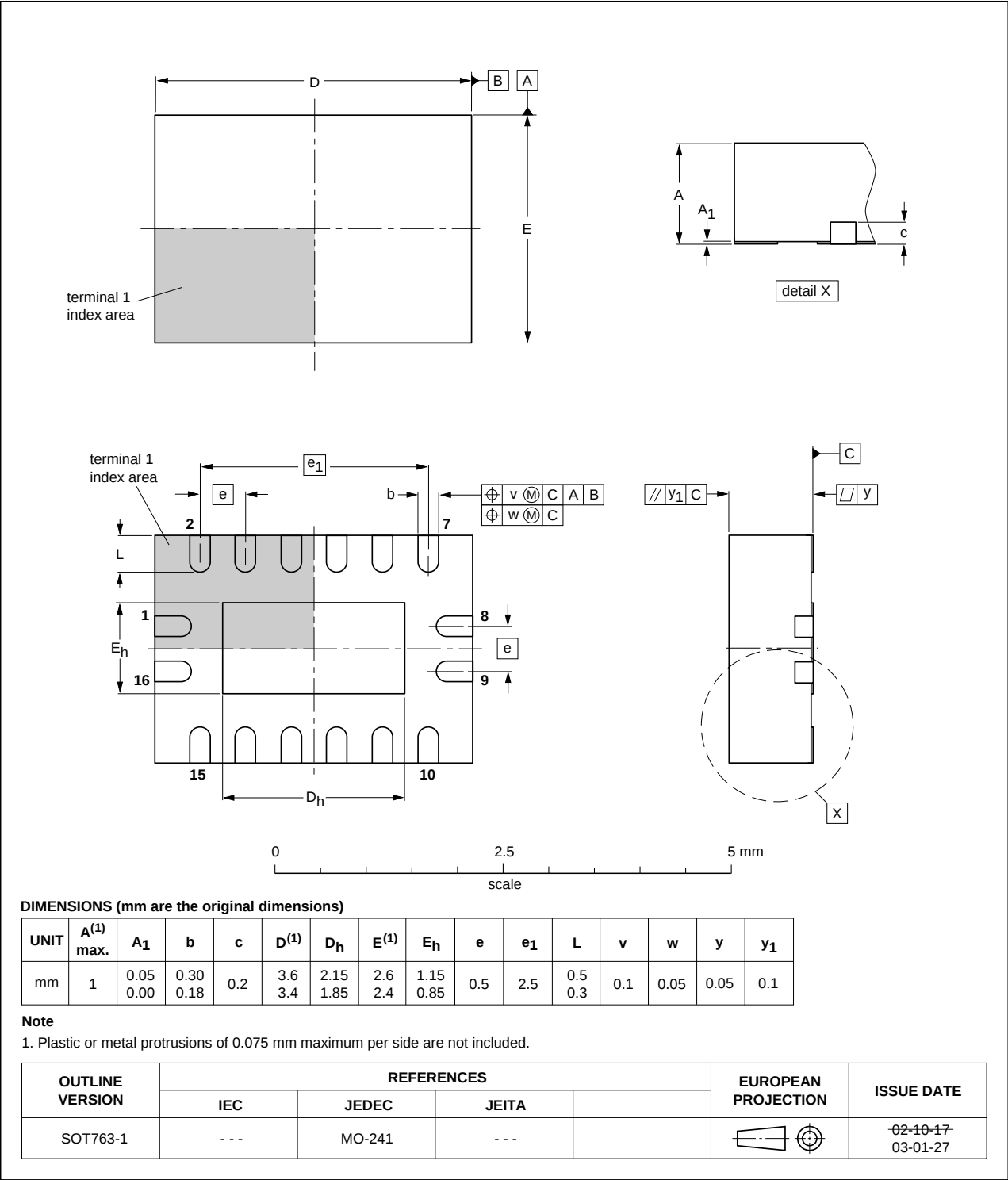


Fig 15. Package outline SOT763-1 (DHVQFN16)

14. Abbreviations

Table 10. Abbreviations

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

15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT165_Q100 v.1	20120717	Product data sheet	-	-

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".

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