

74LV165-Q100

8-bit parallel-in/serial-out shift register

Rev. 1 — 11 November 2013

Product data sheet

1. General description

The 74LV165-Q100 is an 8-bit parallel-load or serial-in shift register with complementary serial outputs (Q_7 and $\overline{Q_7}$) available from the last stage. When the parallel-load input (\overline{PL}) is LOW, parallel data from the inputs D0 to D7 are loaded into the register asynchronously. When input \overline{PL} is HIGH, data enters the register serially at the input DS. It 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 output Q_7 to the input DS of the succeeding stage.

The clock input is a gate-OR structure which allows one input to be used as an active LOW clock enable input (\overline{CE}) input. The pin assignment for the inputs CP and \overline{CE} is arbitrary and can be reversed for layout convenience. The LOW-to-HIGH transition of the 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 \overline{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 $+125\text{ }^{\circ}\text{C}$
- Wide supply voltage range from 1.0 V to 5.5 V
- Synchronous parallel-to-serial applications
- Optimized for low voltage applications: 1.0 V to 3.6 V
- Synchronous serial input for easy expansion
- Latch-up performance exceeds 250 mA
- 5.5 V tolerant inputs/outputs
- Direct interface with TTL levels (2.7 V to 3.6 V)
- Power-down mode
- Complies with JEDEC standards:
 - ◆ JESD8-5 (2.3 V to 2.7 V)
 - ◆ JESD8B/JESD36 (2.7 V to 3.6 V)
 - ◆ JESD8-1A (4.5 V to 5.5 V)
- ESD protection:
 - ◆ MIL-STD-883C, method 3015 exceeds 2000 V
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V ($C = 200\text{ pF}$, $R = 0\text{ }\Omega$)

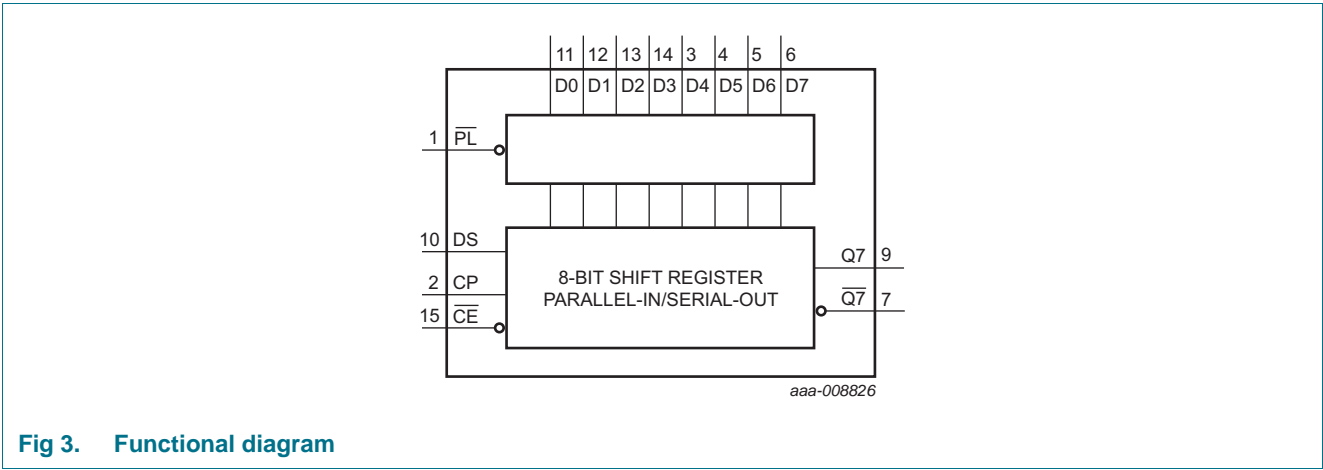
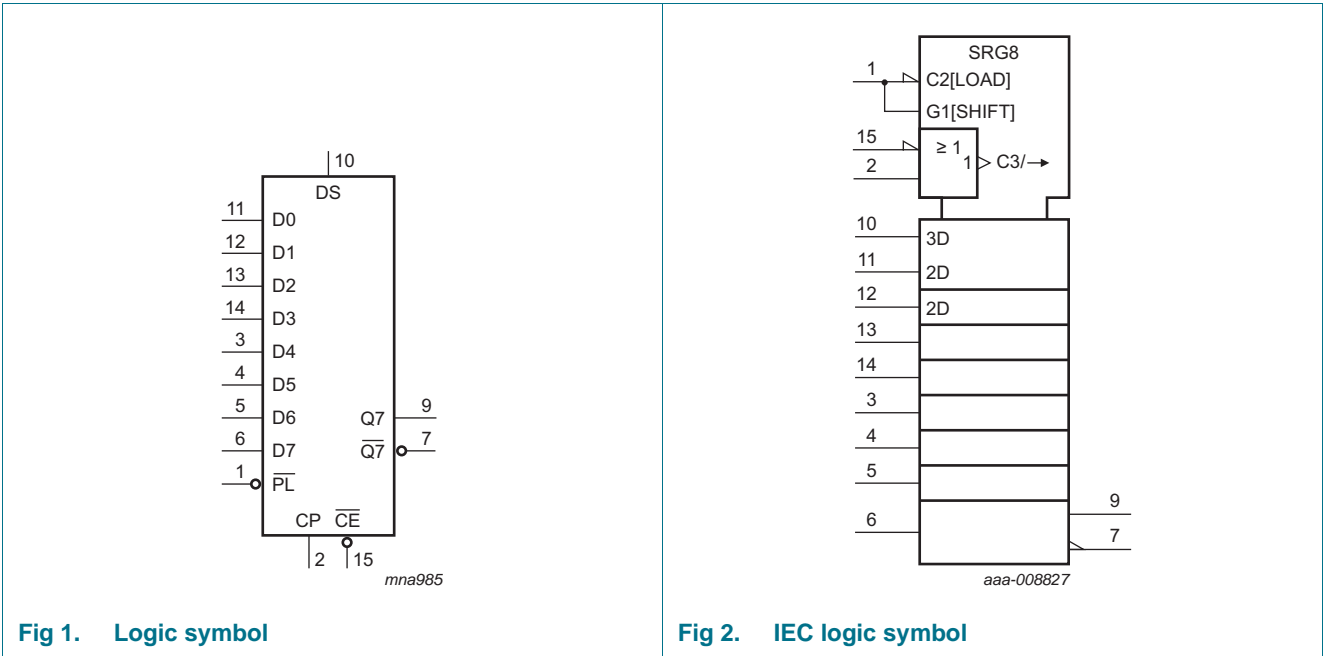


3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74LV165D-Q100	−40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74LV165PW-Q100	−40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

4. Functional diagram



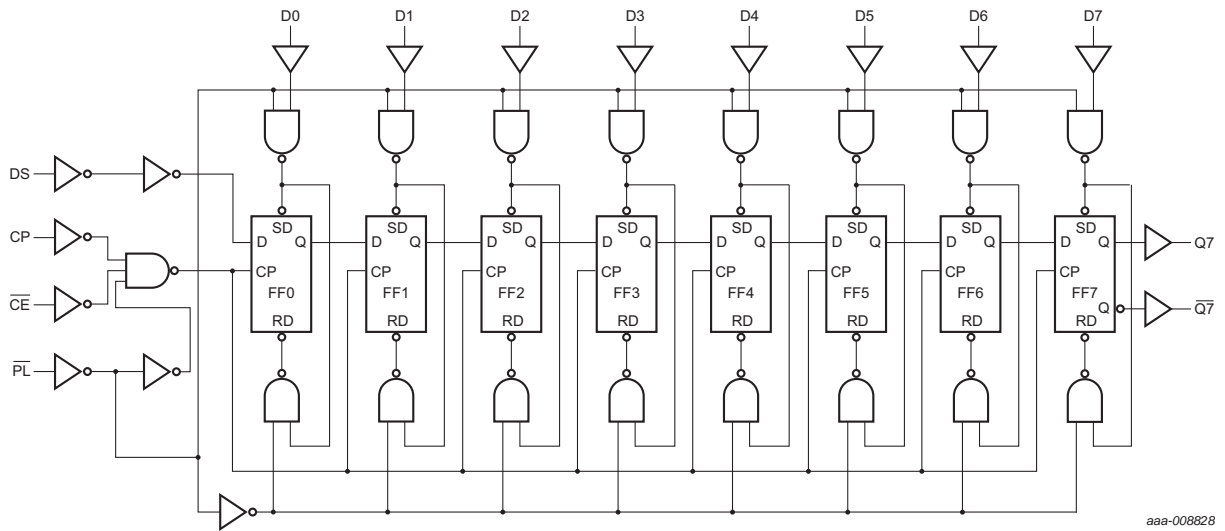


Fig 4. Logic diagram

5. Pinning information

5.1 Pinning

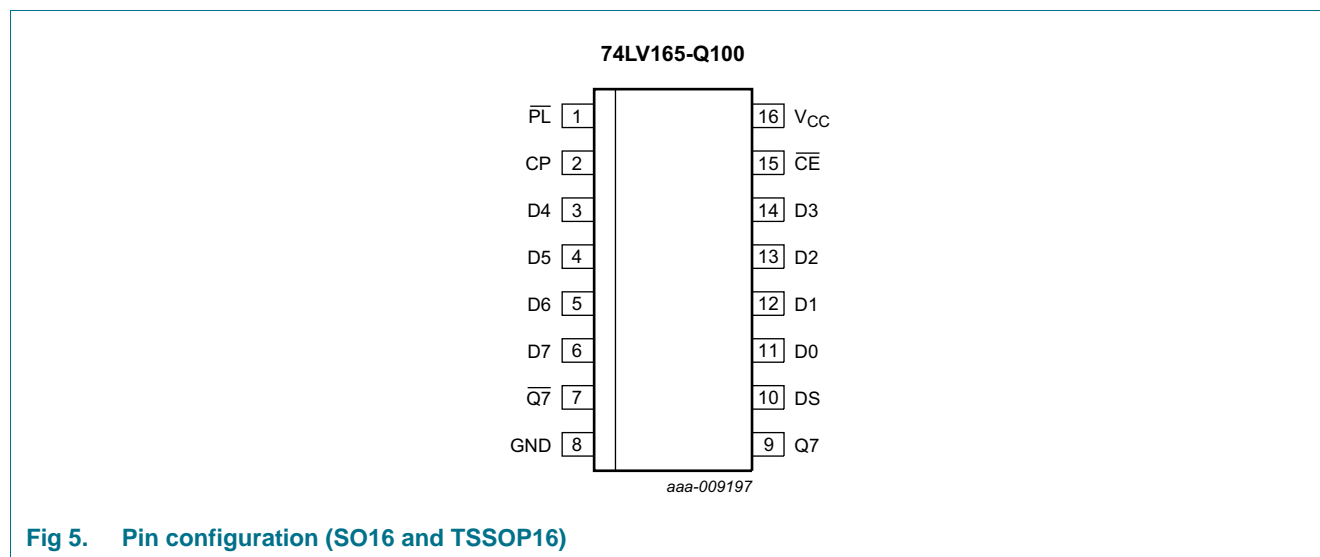


Fig 5. Pin configuration (SO16 and TSSOP16)

5.2 Pin description

Table 2. Pin description

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

6. Functional description

Table 3. Function table^[1]

Operating modes	Inputs					Qn registers		Output	
	PL	$\overline{\text{CE}}$	CP	DS	D0 to D7	Q0	Q1 to Q6	Q7	$\overline{\text{Q7}}$
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	$\overline{\text{q6}}$
	H	L	↑	h	X	H	q0 to q5	q6	$\overline{\text{q6}}$
hold "do nothing"	H	H	X	X	X	q0	q1 to q6	q7	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.

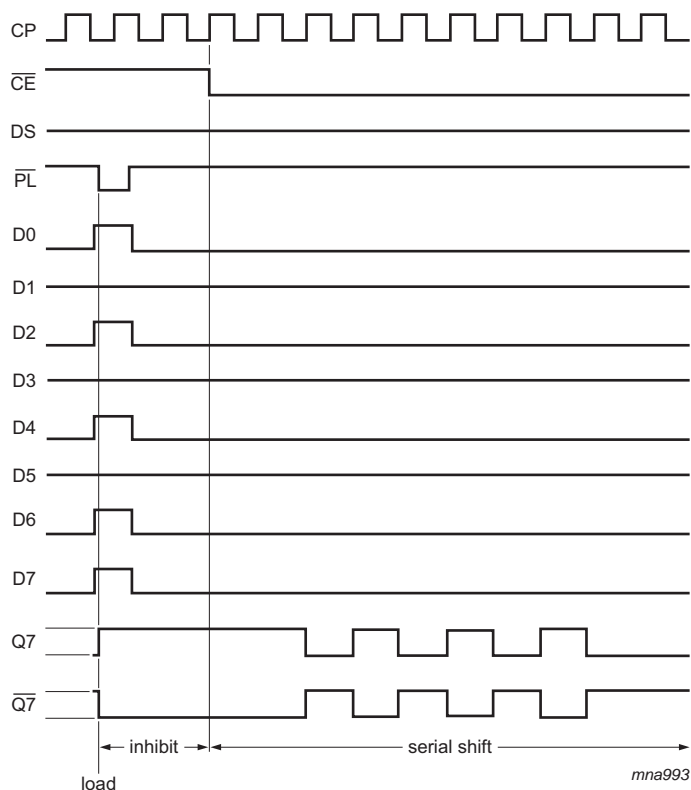


Fig 6. Timing diagram

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)^[1]

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
V _I	input voltage		-0.5	+7	V
I _{OK}	output clamping current	V _O > V _{CC} or V _O < 0	-	±50	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			
		SO16 package	^[2] -	500	mW
		TSSOP16 package	^[3] -	400	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	Min	Typ	Max	Unit
V _{CC}	supply voltage		1.0	3.3	5.5	V
V _I	input voltage		0	-	V _{CC}	V
V _O	output voltage		0	-	V _{CC}	V
T _{amb}	ambient temperature		-40	-	+85	°C
Δt/ΔV	input transition rise and fall rate	V _{CC} = 1.0 V to 2.0 V	0	-	500	ns/V
		V _{CC} = 2.0 V to 2.7 V	0	-	200	ns/V
		V _{CC} = 2.7 V to 3.6 V	0	-	100	ns/V
		V _{CC} = 3.6 V to 5.5 V	0	-	50	ns/V

9. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ ^[1]	Max	Min	Max	
V _{IH}	HIGH-level input voltage	V _{CC} = 1.2 V	0.9	-	-	0.9	-	V
		V _{CC} = 2.3 V to 2.7 V	1.4	-	-	1.4	-	V
		V _{CC} = 2.7 V to 3.6 V	2.0	-	-	2.0	-	V
		V _{CC} = 4.5 V to 5.5 V	0.7V _{CC}	-	-	0.7V _{CC}	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 1.2 V	-	-	0.3	-	0.3	V
		V _{CC} = 2.3 V to 2.7 V	-	-	0.6	-	0.6	V
		V _{CC} = 2.7 V to 3.6 V	-	-	0.8	-	0.8	V
		V _{CC} = 4.5 V to 5.5 V	-	-	0.3V _{CC}	-	0.3V _{CC}	
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL} ; I _O = -100 µA						
		V _{CC} = 1.2 V	-	1.2	-	-	-	
		V _{CC} = 2.0 V	1.8	2.0	-	1.8	-	V
		V _{CC} = 2.7 V	2.5	2.7	-	2.5	-	V
		V _{CC} = 3.0 V	2.8	3.0	-	2.8	-	V
		V _{CC} = 4.5 V	4.3	4.5	-	4.3	-	V
		standard outputs: V _I = V _{IH} or V _{IL}						
		V _{CC} = 3.0 V; I _O = -6 mA	2.40	2.82	-	2.20	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; I _O = 100 µA						
		V _{CC} = 1.2 V	-	0	-	-	-	
		V _{CC} = 2.0 V	-	0	0.2	1.8	0.2	V
		V _{CC} = 2.7 V	-	0	0.2	2.5	0.2	V
		V _{CC} = 3.0 V	-	0	0.2	2.8	0.2	V
		V _{CC} = 4.5 V	-	0	0.2	4.3	0.2	V
		standard outputs: V _I = V _{IH} or V _{IL}						
		V _{CC} = 3.0 V; I _O = 6 mA	-	0.25	0.40	-	0.50	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±1	-	±1	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	20	-	160	µA
ΔI _{CC}	additional supply current	V _I = V _{CC} - 0.6 V; V _{CC} = 2.7 V to 3.6 V	-	-	500	-	850	µA
C _I	input capacitance		-	3.5	-			pF

[1] Typical values are measured at T_{amb} = 25 °C.

10. Dynamic characteristics

Table 7. Dynamic characteristics

GND (ground = 0 V); for test circuit, see [Figure 12](#)

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ ^[1]	Max	Min	Max	
t_{pd}	propagation delay	\overline{CE} , CP to Q7, $\overline{Q7}$; see Figure 7 and Figure 8 ^[2]						
		$V_{CC} = 1.2\text{ V}$	-	115	-	-	-	ns
		$V_{CC} = 2.0\text{ V}$	-	38	61	-	76	ns
		$V_{CC} = 2.7\text{ V}$	-	27	43	-	54	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ^[3]	-	22	36	-	45	ns
		$V_{CC} = 3.3\text{ V}; C_L = 15\text{ pF}$	-	18	-	-	-	ns
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ^[4]	-	15	24	-	30	ns
		\overline{PL} to Q7, $\overline{Q7}$; see Figure 8						
		$V_{CC} = 1.2\text{ V}$	-	110	-	-	-	ns
		$V_{CC} = 2.0\text{ V}$	-	35	56	-	70	ns
		$V_{CC} = 2.7\text{ V}$	-	24	39	-	49	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ^[3]	-	20	33	-	41	ns
		$V_{CC} = 3.3\text{ V}; C_L = 15\text{ pF}$	-	18	-	-	-	ns
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ^[4]	-	14	22	-	27	ns
		D7 to Q7, $\overline{Q7}$; $C_L = 15\text{ pF}$; see Figure 9						
		$V_{CC} = 1.2\text{ V}$	-	90	-	-	-	ns
		$V_{CC} = 2.0\text{ V}$	-	28	45	-	56	ns
		$V_{CC} = 2.7\text{ V}$	-	20	32	-	40	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ^[3]	-	17	27	-	33	ns
		$V_{CC} = 3.3\text{ V}; C_L = 15\text{ pF}$	-	14	-	-	-	ns
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ^[4]	-	11	18	-	22	ns
t_W	pulse width	CP input HIGH to LOW; see Figure 7						
		$V_{CC} = 2.0\text{ V}$	34	10	-	41	-	ns
		$V_{CC} = 2.7\text{ V}$	25	8	-	30	-	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ^[3]	20	7	-	24	-	ns
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ^[4]	15	5	-	18	-	ns
		\overline{PL} input LOW; see Figure 8						
		$V_{CC} = 2.0\text{ V}$	34	10	-	41	-	ns
		$V_{CC} = 2.7\text{ V}$	25	8	-	30	-	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ^[3]	20	7	-	24	-	ns
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ^[4]	15	5	-	18	-	ns

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

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ ^[1]	Max	Min	Max	
t_{rec}	recovery time	$\overline{\text{PL}}$ to CP, $\overline{\text{CE}}$; see Figure 8						
		$V_{\text{CC}} = 1.2 \text{ V}$	-	40	-	-	-	ns
		$V_{\text{CC}} = 2.0 \text{ V}$	24	15	-	30	-	ns
		$V_{\text{CC}} = 2.7 \text{ V}$	18	11	-	23	-	ns
		$V_{\text{CC}} = 3.0 \text{ V to } 3.6 \text{ V}$ [3]	17	10	-	21	-	ns
		$V_{\text{CC}} = 4.5 \text{ V to } 5.5 \text{ V}$ [4]	12	7	-	15	-	ns
t_{su}	set-up time	DS to CP, $\overline{\text{CE}}$; see Figure 10						
		$V_{\text{CC}} = 1.2 \text{ V}$	-	-8	-	-	-	ns
		$V_{\text{CC}} = 2.0 \text{ V}$	+22	-2	-	+26	-	ns
		$V_{\text{CC}} = 2.7 \text{ V}$	+16	-1	-	+19	-	ns
		$V_{\text{CC}} = 3.0 \text{ V to } 3.6 \text{ V}$ [3]	+13	-1	-	+15	-	ns
		$V_{\text{CC}} = 4.5 \text{ V to } 5.5 \text{ V}$ [4]	9	0	-	10	-	ns
		$\overline{\text{CE}}$ to CP, CP to $\overline{\text{CE}}$; see Figure 10						
		$V_{\text{CC}} = 1.2 \text{ V}$	-	20	-	-	-	ns
		$V_{\text{CC}} = 2.0 \text{ V}$	22	7	-	26	-	ns
		$V_{\text{CC}} = 2.7 \text{ V}$	16	5	-	19	-	ns
		$V_{\text{CC}} = 3.0 \text{ V to } 3.6 \text{ V}$ [3]	13	4	-	15	-	ns
		$V_{\text{CC}} = 4.5 \text{ V to } 5.5 \text{ V}$ [4]	9	3	-	10	-	ns
		Dn to $\overline{\text{PL}}$; see Figure 11						
		$V_{\text{CC}} = 1.2 \text{ V}$	-	25	-	-	-	ns
		$V_{\text{CC}} = 2.0 \text{ V}$	22	8	-	26	-	ns
		$V_{\text{CC}} = 2.7 \text{ V}$	16	6	-	19	-	ns
		$V_{\text{CC}} = 3.0 \text{ V to } 3.6 \text{ V}$ [3]	13	5	-	15	-	ns
		$V_{\text{CC}} = 4.5 \text{ V to } 5.5 \text{ V}$ [4]	9	4	-	10	-	ns
t_{h}	hold time	DS to CP, $\overline{\text{CE}}$; Dn to $\overline{\text{PL}}$; see Figure 10 and Figure 11						
		$V_{\text{CC}} = 1.2 \text{ V}$	-	20	-	-	-	ns
		$V_{\text{CC}} = 2.0 \text{ V}$	22	7	-	26	-	ns
		$V_{\text{CC}} = 2.7 \text{ V}$	16	5	-	19	-	ns
		$V_{\text{CC}} = 3.0 \text{ V to } 3.6 \text{ V}$ [3]	13	4	-	15	-	ns
		$V_{\text{CC}} = 4.5 \text{ V to } 5.5 \text{ V}$ [4]	9	3	-	10	-	ns
		$\overline{\text{CE}}$ to CP, CP to $\overline{\text{CE}}$; see Figure 10						
		$V_{\text{CC}} = 1.2 \text{ V}$	-	-30	-	-	-	ns
		$V_{\text{CC}} = 2.0 \text{ V}$	+5	-8	-	+5	-	ns
		$V_{\text{CC}} = 2.7 \text{ V}$	+5	-6	-	+5	-	ns
		$V_{\text{CC}} = 3.0 \text{ V to } 3.6 \text{ V}$ [3]	+5	-5	-	+5	-	ns
		$V_{\text{CC}} = 4.5 \text{ V to } 5.5 \text{ V}$ [4]	+5	-4	-	+5	-	ns

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

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ ^[1]	Max	Min	Max	
f_{\max}	maximum frequency	see Figure 7						
		$V_{CC} = 2.0 \text{ V}$	14	40	-	12	-	MHz
		$V_{CC} = 2.7 \text{ V}$	19	60	-	16	-	MHz
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$ ^[3]	24	65	-	20	-	MHz
		$V_{CC} = 3.3 \text{ V}; C_L = 15 \text{ pF}$	-	78	-	-	-	MHz
		$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$ ^[4]	36	75	-	30	-	MHz
C_{PD}	power dissipation capacitance	$V_I = \text{GND to } V_{CC}; V_{CC} = 3.3 \text{ V}$ ^[5]	-	35	-			pF

[1] Typical values are measured at $T_{\text{amb}} = 25 \text{ °C}$.

[2] t_{pd} is the same as t_{PHL} and t_{PLH} .

[3] Typical values are measured at $V_{CC} = 3.3 \text{ V}$.

[4] Typical values are measured at $V_{CC} = 5.0 \text{ V}$.

[5] C_{PD} is used to determine the dynamic power dissipation $P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o)$ (P_D in μW), where:

f_i = input frequency in MHz;

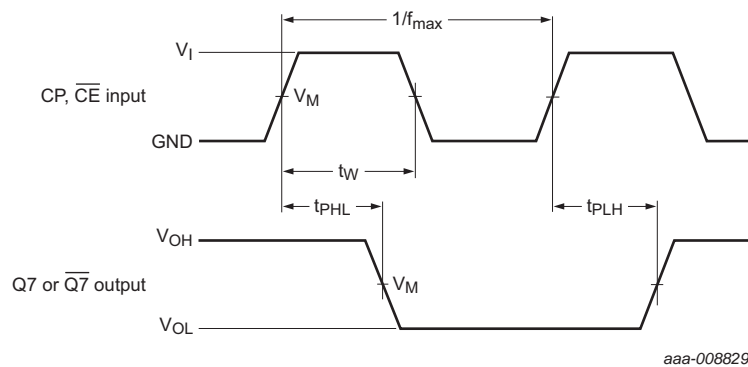
f_o = output frequency in MHz;

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

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V.

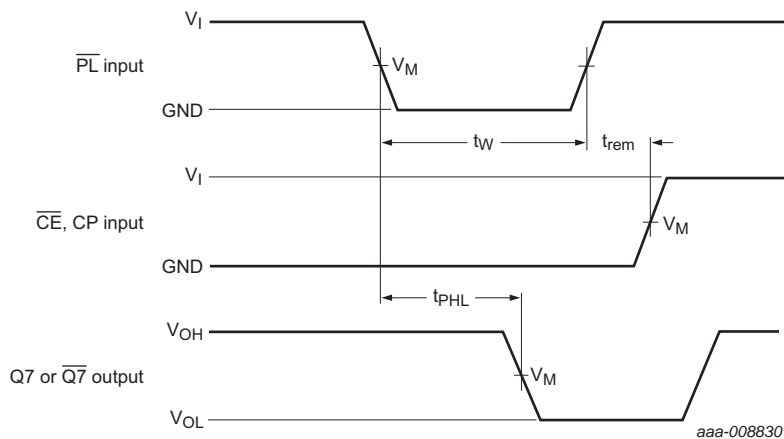
11. Waveforms



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

The changing to output assumes that internal Q6 is opposite state from Q7.

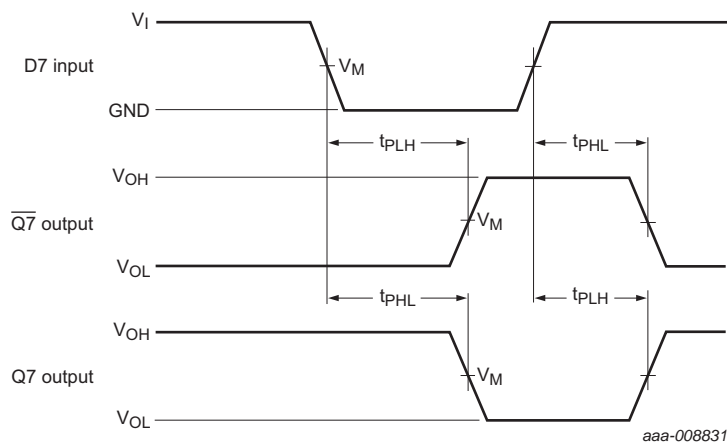
Fig 7. Clock pulse (CP) and clock enable (\overline{CE}) to output (Q7 or $\overline{Q7}$) propagation delays, clock pulse width and maximum clock frequency



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

The changing to output assumes that internal Q6 is opposite state from Q7.

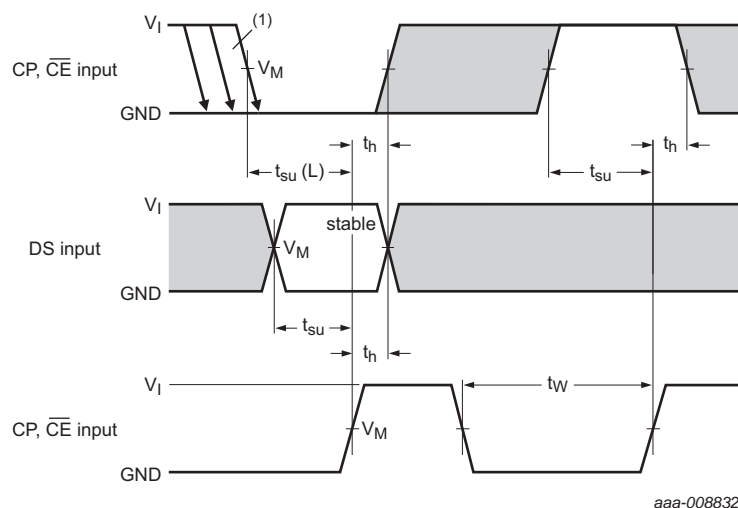
Fig 8. Parallel load (PL) pulse width, parallel load to output (Q7 or $\overline{\text{Q7}}$) propagation delays, parallel load to clock (CP) and clock enable (CE) recovery time



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

The changing to output assumes that internal Q6 is opposite state from Q7.

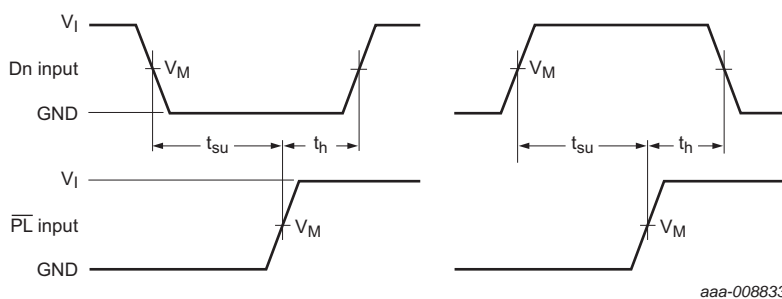
Fig 9. Data input (Dn) to output (Q7 or $\overline{\text{Q7}}$) propagation delays when PL is LOW



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

- (1) CE may change only from HIGH-to-LOW while CP is LOW. The shaded areas indicate when the input is permitted to change for predictable output performance.

Fig 10. Set-up and hold times

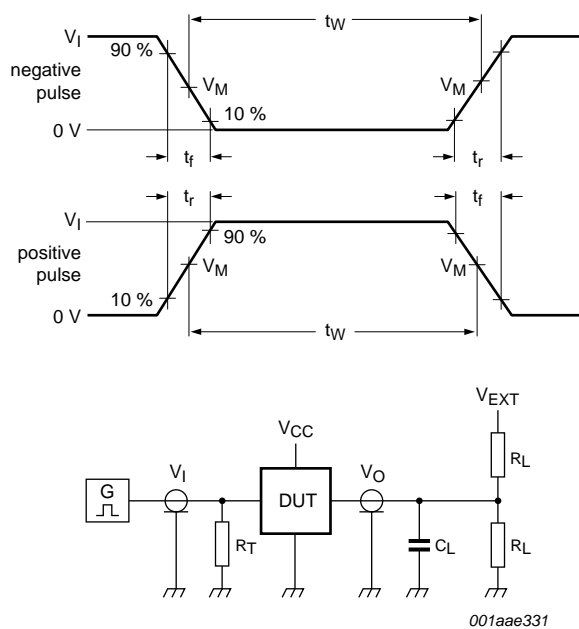


Measurement points are given in [Table 8](#).

Fig 11. Set-up and hold times from the data inputs (Dn) to the parallel load input (\overline{PL})

Table 8. Measurement points

Supply voltage	Input	Output
V_{CC}	V_M	V_M
< 2.7 V	$0.5V_{CC}$	$0.5V_{CC}$
2.7 V to 3.6 V	1.5 V	1.5 V
≥ 4.5 V	$0.5V_{CC}$	$0.5V_{CC}$



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

Definitions for test circuit:

R_L = Load resistance.

C_L = Load capacitance including jig and probe capacitance.

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

V_{EXT} = External voltage for measuring switching times.

Fig 12. Test circuit for measuring switching times

Table 9. Test data

Supply voltage	Input		Load		V_{EXT}
	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}
< 2.7 V	V_{CC}	2.5 ns	50 pF	1 k Ω	open
2.7 V to 3.6 V	2.7 V	2.5 ns	50 pF, 15 pF	1 k Ω	open
≥ 4.5 V	V_{CC}	2.5 ns	50 pF	1 k Ω	open

12. Package outline

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

SOT109-1

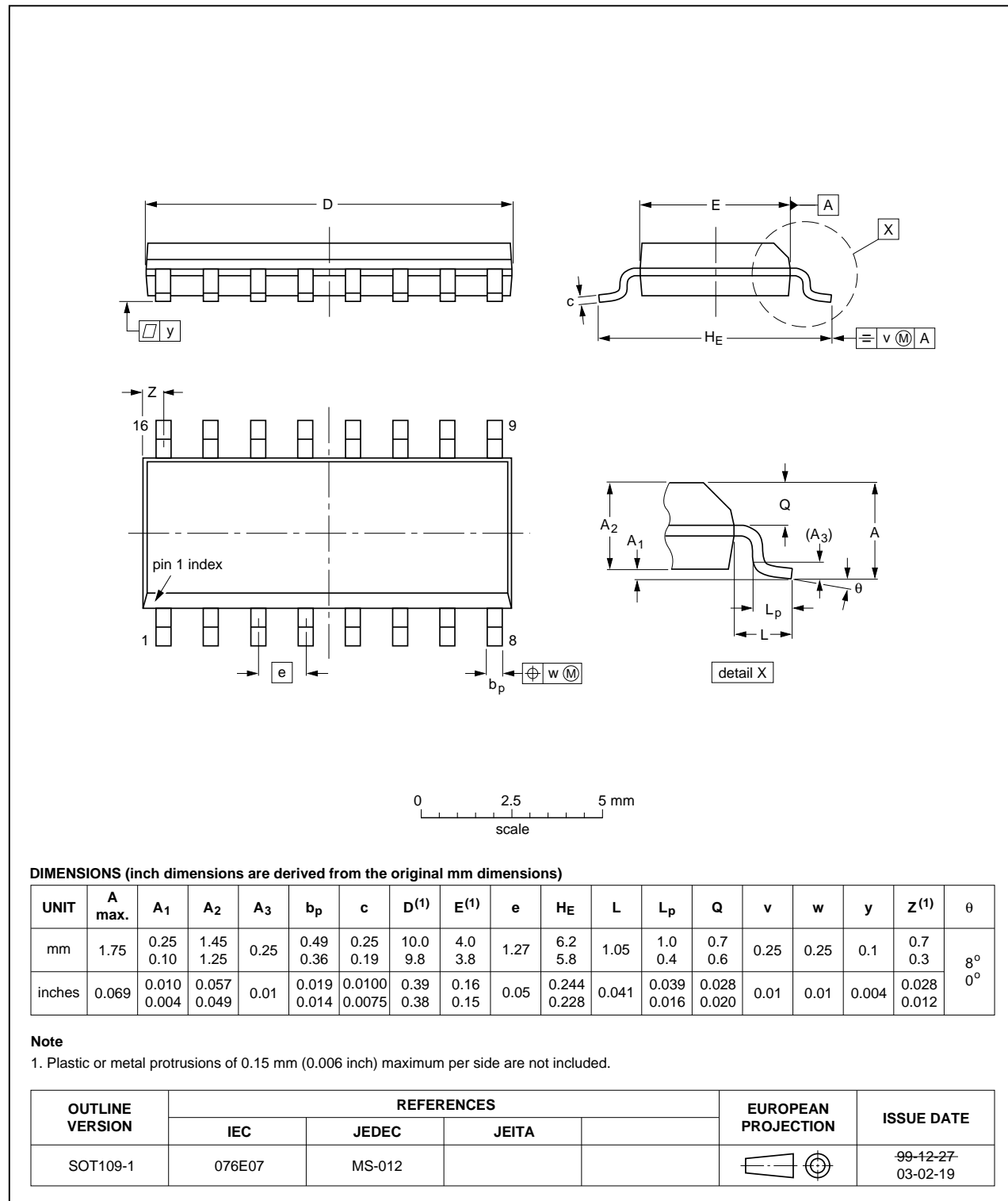


Fig 13. Package outline SOT109-1 (SO16)

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

SOT403-1

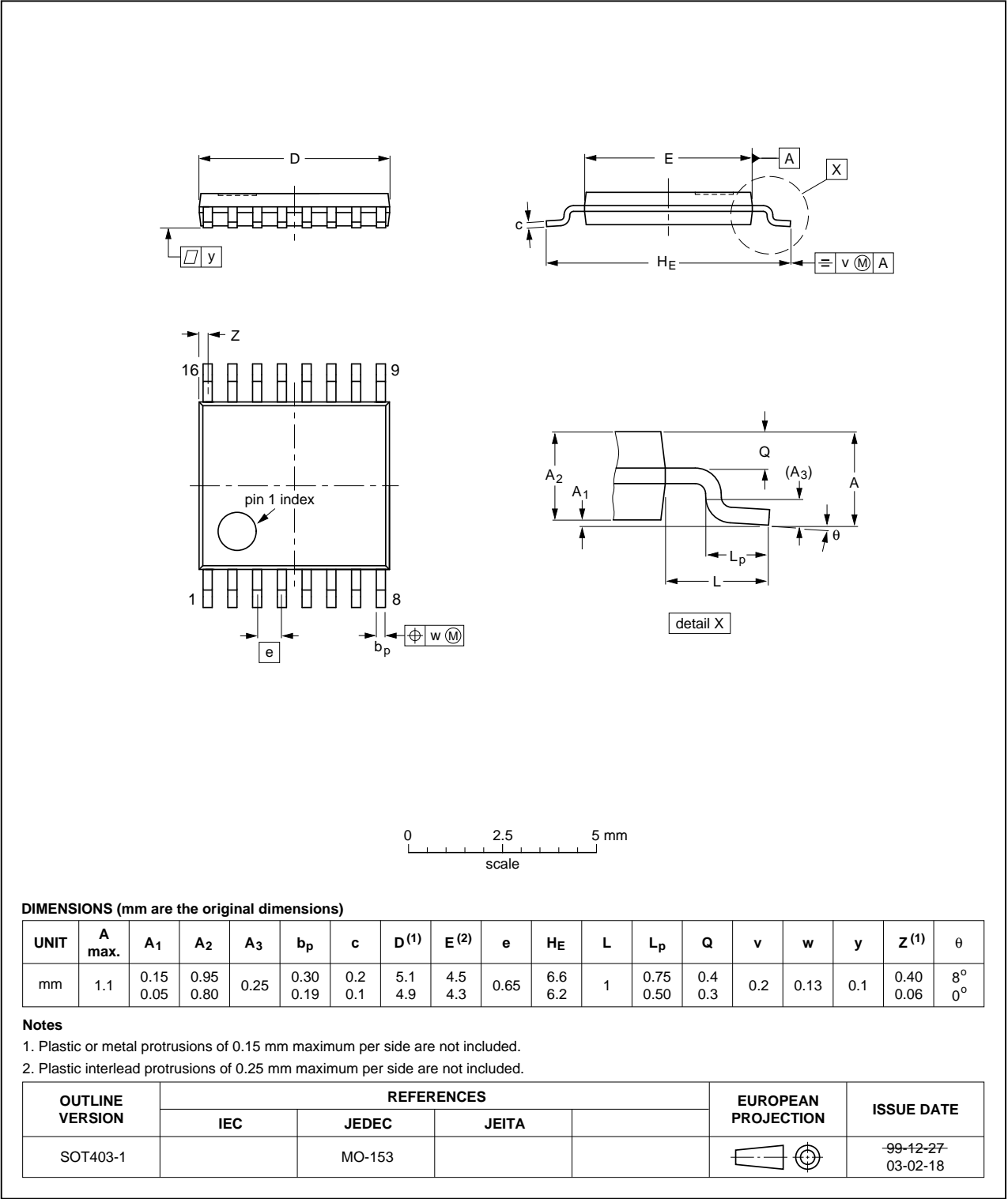


Fig 14. Package outline SOT403-1 (TSSOP16)

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
74LV165_Q100 v.1	20131111	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".

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