

74HC175-Q100; 74HCT175-Q100

Quad D-type flip-flop with reset; positive-edge trigger

Rev. 1 — 19 May 2014

Product data sheet

1. General description

The 74HC175-Q100; 74HCT175-Q100 are quad positive edge-triggered D-type flip-flops with individual data inputs (D_n) and both Q_n and \bar{Q}_n outputs. The common clock (CP) and master reset (\bar{MR}) inputs load and reset all flip-flops simultaneously. The D-input that meets the set-up and hold time requirements on the LOW-to-HIGH clock transition is stored in the flip-flop and appears at the Q output. A LOW on \bar{MR} causes the flip-flops and outputs to be reset LOW.

The device is useful for applications where both the true and complement outputs are required and the clock and master reset are common to all storage elements.

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 $+125\text{ }^{\circ}\text{C}$
- Input levels:
 - ◆ For 74HC175-Q100: CMOS level
 - ◆ For 74HCT175-Q100: TTL level
- Four edge-triggered D-type flip-flops
- Asynchronous master reset
- 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. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC175D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT175D-Q100				
74HC175PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT175PW-Q100				

4. Functional diagram

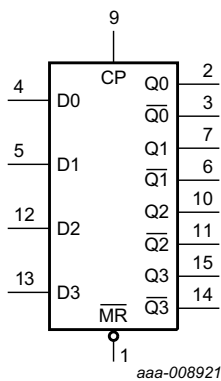


Fig 1. Logic symbol

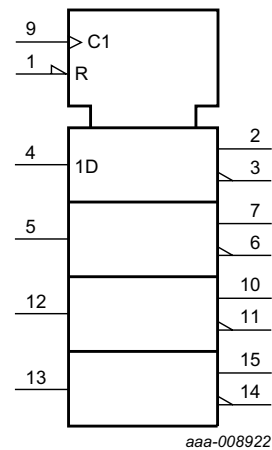


Fig 2. IEC logic symbol

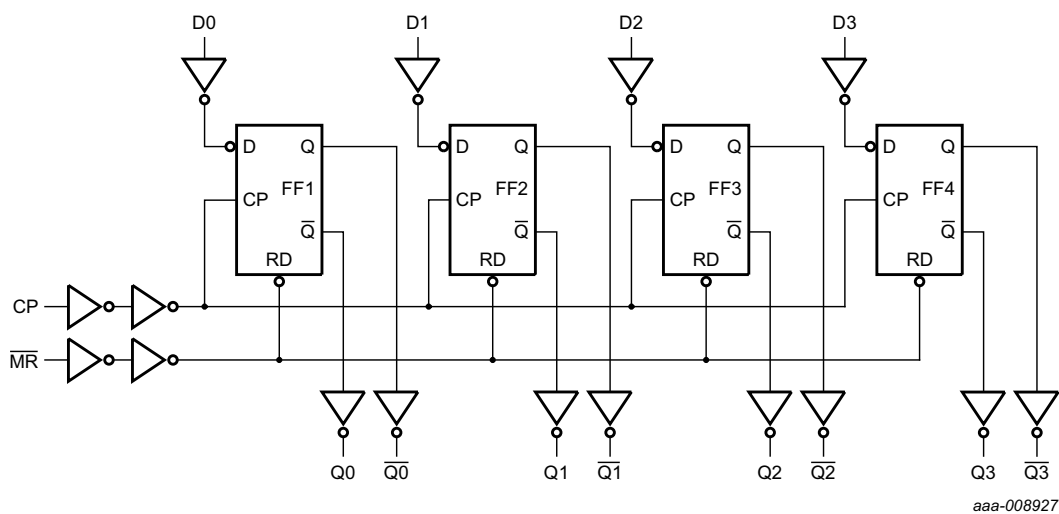


Fig 3. Logic diagram

5. Pinning information

5.1 Pinning

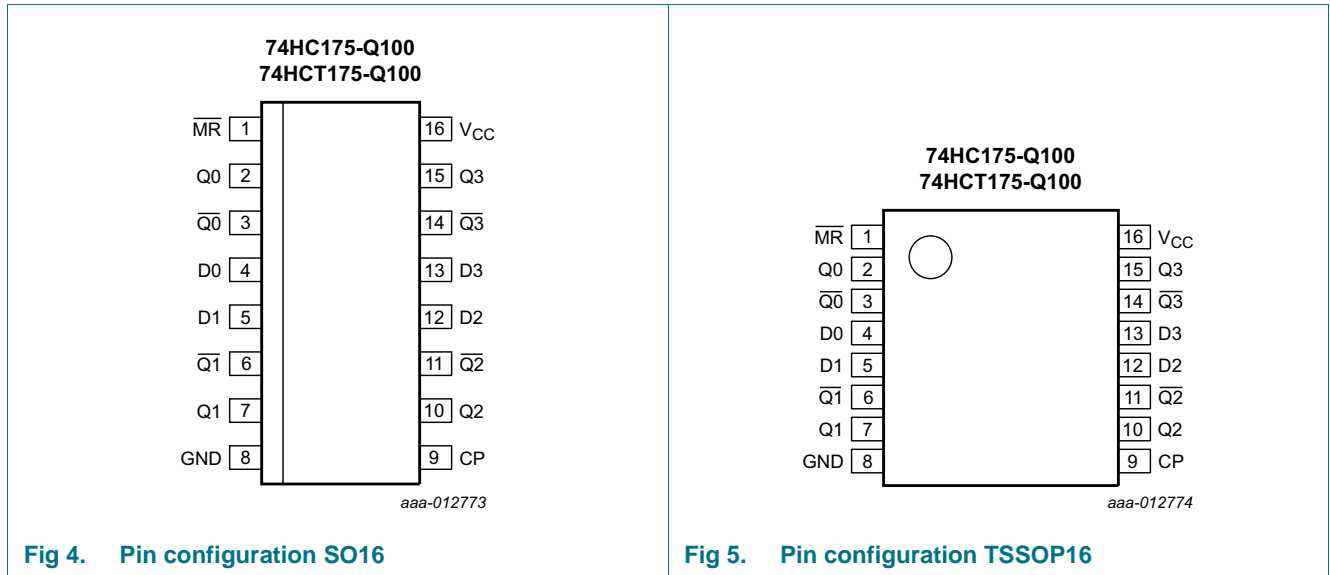


Fig 4. Pin configuration SO16

Fig 5. Pin configuration TSSOP16

5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$\overline{\text{MR}}$	1	asynchronous master reset input (active LOW)
Q0 to Q3	2, 7, 10, 15	flip-flop output
$\overline{\text{Q0}}$ to $\overline{\text{Q3}}$	3, 6, 11, 14	complementary flip-flop output
D0 to D3	4, 5, 12, 13	data input
GND	8	ground (0 V)
CP	9	clock input (LOW-to-HIGH edge-triggered)
V _{CC}	16	positive supply voltage

6. Functional description

Table 3. Function table^[1]

Operating modes	Inputs			Outputs	
	$\overline{\text{MR}}$	CP	Dn	Qn	$\overline{\text{Qn}}$
reset (clear)	L	X	X	L	H
load "1"	H	↑	h	H	L
load "0"	H	↑	l	L	H

- [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;
- X = don't care;
- ↑ = LOW-to-HIGH clock transition.

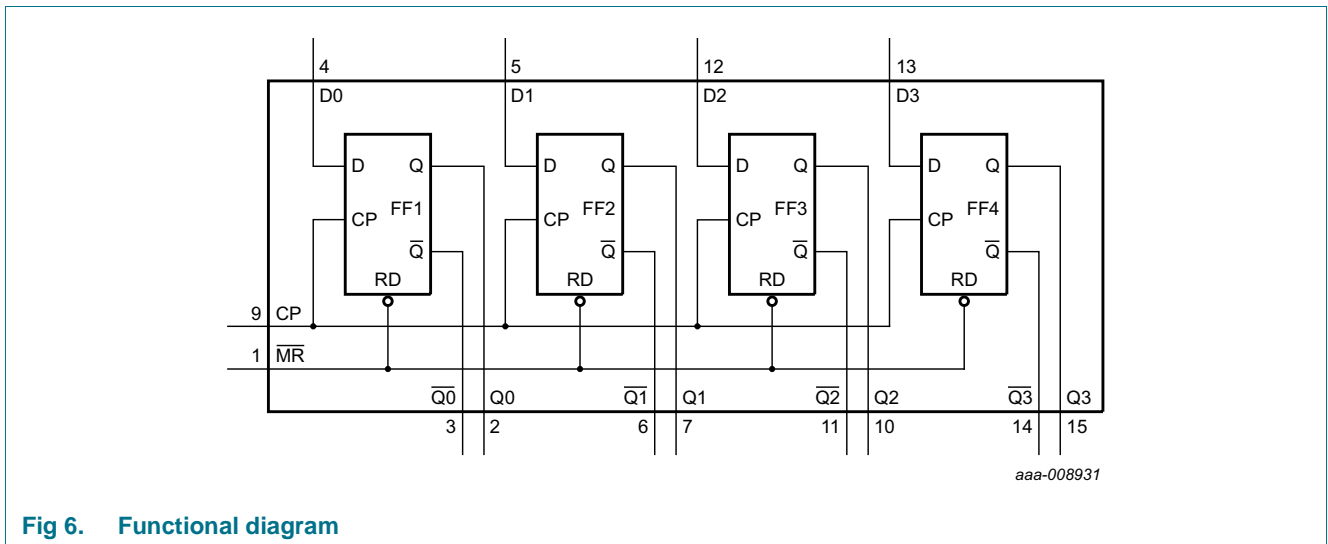


Fig 6. Functional diagram

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)

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
I _{OK}	output clamping current	V _O < -0.5 V or V _O > V _{CC} + 0.5 V	-	±20	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 [1]	-	500	mW

- [1] For SO16 package: above 70 °C the value of P_{tot} derates linearly with 8 mW/K.
 For TSSOP16 packages: above 60 °C the value of P_{tot} derates linearly with 5.5 mW/K.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC175-Q100			74HCT175-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

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					
74HC175-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				
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 _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		
		C _I		input capacitance		-	3.5	-	-	-	-	pF		
		74HCT175-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} = 5.5 V	-	0.15	0.26	-	0.33	-	0.4	V				
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±0.1	-	±1	-	±1	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	
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 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 input	-	40	144	-	180	-	196	μA
		CP input	-	60	216	-	270	-	294	μA
		MR input	-	100	360	-	450	-	490	μA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

10. 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	
74HC175-Q100										
t _{pd}	propagation delay	CP to Qn, \overline{Qn} ; see Figure 7 ^[1]								
		V _{CC} = 2.0 V	-	55	175	-	220	-	265	ns
		V _{CC} = 4.5 V	-	20	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF	-	17	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	16	30	-	37	-	45	ns
t _{PHL}	HIGH to LOW propagation delay	MR to Qn, \overline{Qn} ; see Figure 9								
		V _{CC} = 2.0 V	-	50	150	-	190	-	225	ns
		V _{CC} = 4.5 V	-	18	30	-	38	-	45	ns
		V _{CC} = 5 V; C _L = 15 pF	-	15	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	14	26	-	33	-	38	ns
t _t	transition time	Qn 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

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	CP input HIGH or LOW; see Figure 7								
		$V_{CC} = 2.0$ 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
		\overline{MR} input LOW; see Figure 9								
		$V_{CC} = 2.0$ V	80	19	-	100	-	120	-	ns
t_{rec}	recovery time	\overline{MR} to CP; see Figure 9								
		$V_{CC} = 2.0$ V	5	-33	-	5	-	5	-	ns
		$V_{CC} = 4.5$ V	5	-12	-	5	-	5	-	ns
t_{su}	set-up time	Dn to CP; see Figure 7								
		$V_{CC} = 2.0$ V	80	3	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	1	-	20	-	24	-	ns
t_h	hold time	Dn to CP; see Figure 7								
		$V_{CC} = 2.0$ V	25	2	-	30	-	40	-	ns
		$V_{CC} = 4.5$ V	5	0	-	6	-	8	-	ns
f_{max}	maximum frequency	CP input; see Figure 7								
		$V_{CC} = 2.0$ V	6	25	-	4.8	-	4	-	MHz
		$V_{CC} = 4.5$ V	30	75	-	24	-	20	-	MHz
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	83	-	-	-	-	-	MHz
C_{PD}	power dissipation capacitance	per package; $V_I = GND$ to V_{CC}	^[3] -	32	-	-	-	-	-	pF
		74HCT175-Q100								
t_{pd}	propagation delay	CP to Q_n , $\overline{Q_n}$; see Figure 7								
		$V_{CC} = 4.5$ V	-	19	33	-	41	-	50	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	16	-	-	-	-	-	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 _{PHL}	HIGH to LOW propagation delay	\overline{MR} to Qn; see Figure 9								
		V _{CC} = 4.5 V	-	22	38	-	48	-	57	ns
		V _{CC} = 5 V; C _L = 15 pF	-	19	-	-	-	-	-	ns
		\overline{MR} to \overline{Qn} ; see Figure 9								
		V _{CC} = 4.5 V	-	19	35	-	44	-	53	ns
		V _{CC} = 5 V; C _L = 15 pF	-	16	-	-	-	-	ns	
t _t	transition time	Qn 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	20	12	-	25	-	30	-	ns
		\overline{MR} input LOW; see Figure 9								
		V _{CC} = 4.5 V	20	11	-	25	-	30	-	ns
t _{rec}	recovery time	\overline{MR} to CP; see Figure 9								
		V _{CC} = 4.5 V	5	-10	-	5	-	5	-	ns
t _{su}	set-up time	Dn to CP; see Figure 7								
		V _{CC} = 4.5 V	16	5	-	20	-	24	-	ns
t _h	hold time	Dn to CP; see Figure 7								
		V _{CC} = 4.5 V	5	0	-	5	-	5	-	ns
f _{max}	maximum frequency	CP input; see Figure 7								
		V _{CC} = 4.5 V	25	49	-	20	-	17	-	MHz
		V _{CC} = 5 V; C _L = 15 pF	-	54	-	-	-	-	-	MHz
C _{PD}	power dissipation capacitance	per package; V _I = GND to V _{CC} - 1.5 V [3]	-	34	-	-	-	-	-	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).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz;

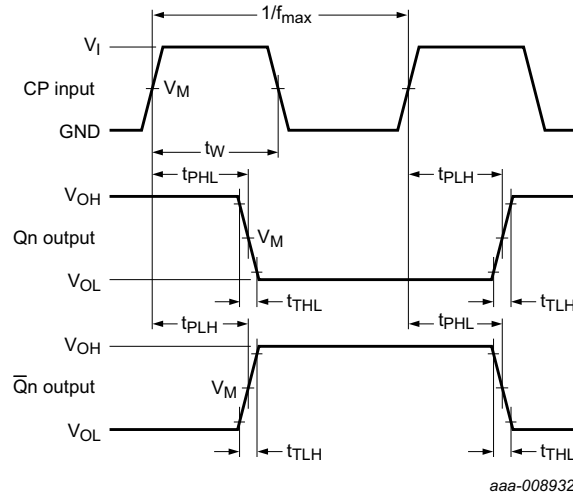
f_o = output frequency in MHz;

∑ (C_L × V_{CC}² × f_o) = sum of outputs;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V.

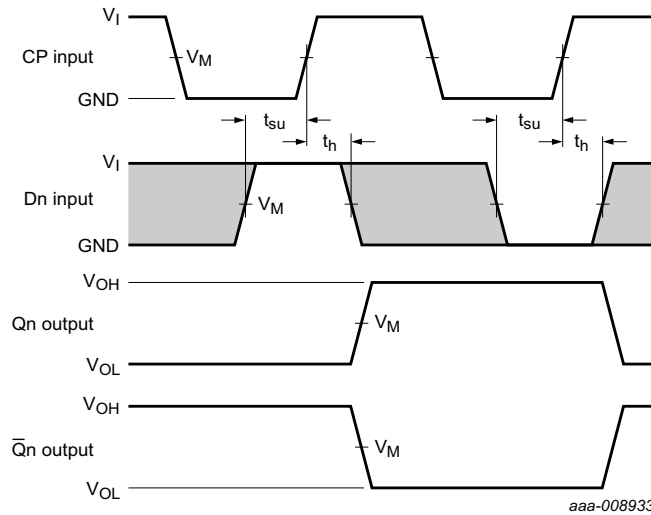
11. Waveforms



aaa-008932

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

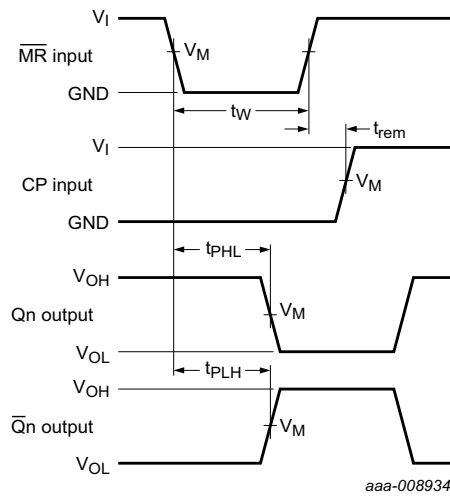
Fig 7. Input to output propagation delay, output transition time, clock input pulse width and maximum frequency



aaa-008933

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

Fig 8. Data set-up and hold times for data input

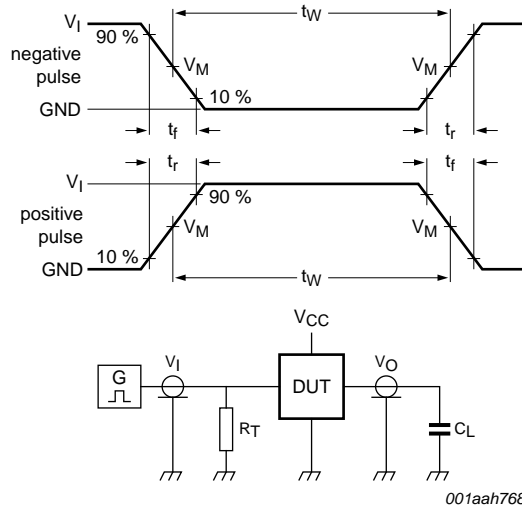


Measurement points are given in [Table 8](#).

Fig 9. Master reset to output propagation delays, master reset pulse width and master reset to clock recovery time

Table 8. Measurement points

Type	Input		Output
	V_I	V_M	V_M
74HC175-Q100	V_{CC}	$0.5V_{CC}$	$0.5V_{CC}$
74HCT175-Q100	3 V	1.3 V	1.3 V



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

Definitions for 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.

R_L = Load resistance.

Fig 10. Test circuit for measuring switching times

Table 9. Test data

Type	Input		Load		Test
	V_I	t_r, t_f	C_L	R_L	
74HC175-Q100	V_{CC}	6 ns	15 pF, 50 pF	1 k Ω	t_{PLH}, t_{PHL}
74HCT175-Q100	3 V	6 ns	15 pF, 50 pF	1 k Ω	t_{PLH}, t_{PHL}

12. Package outline

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

SOT109-1

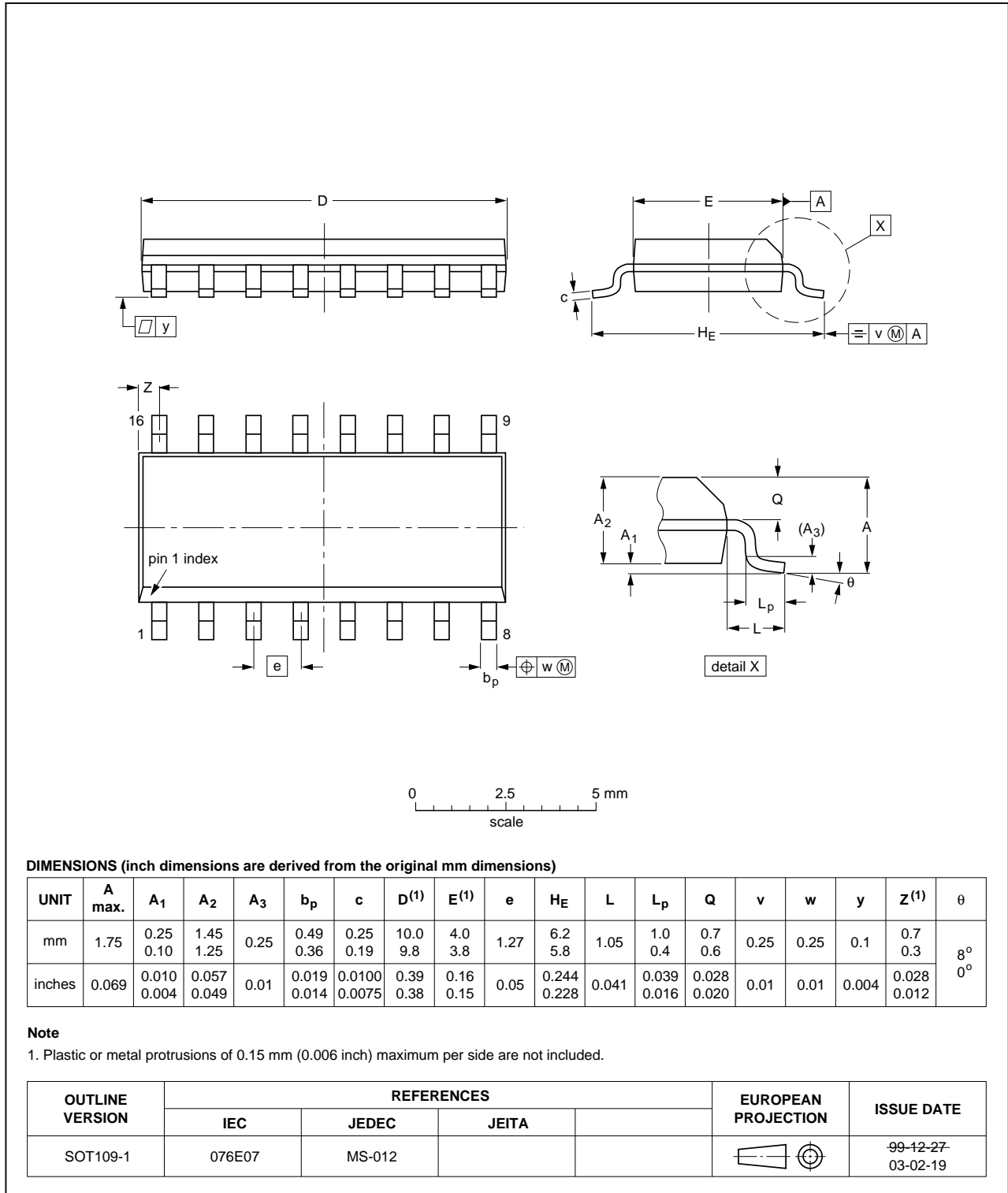


Fig 11. Package outline SOT109-1 (SO16)

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

SOT403-1

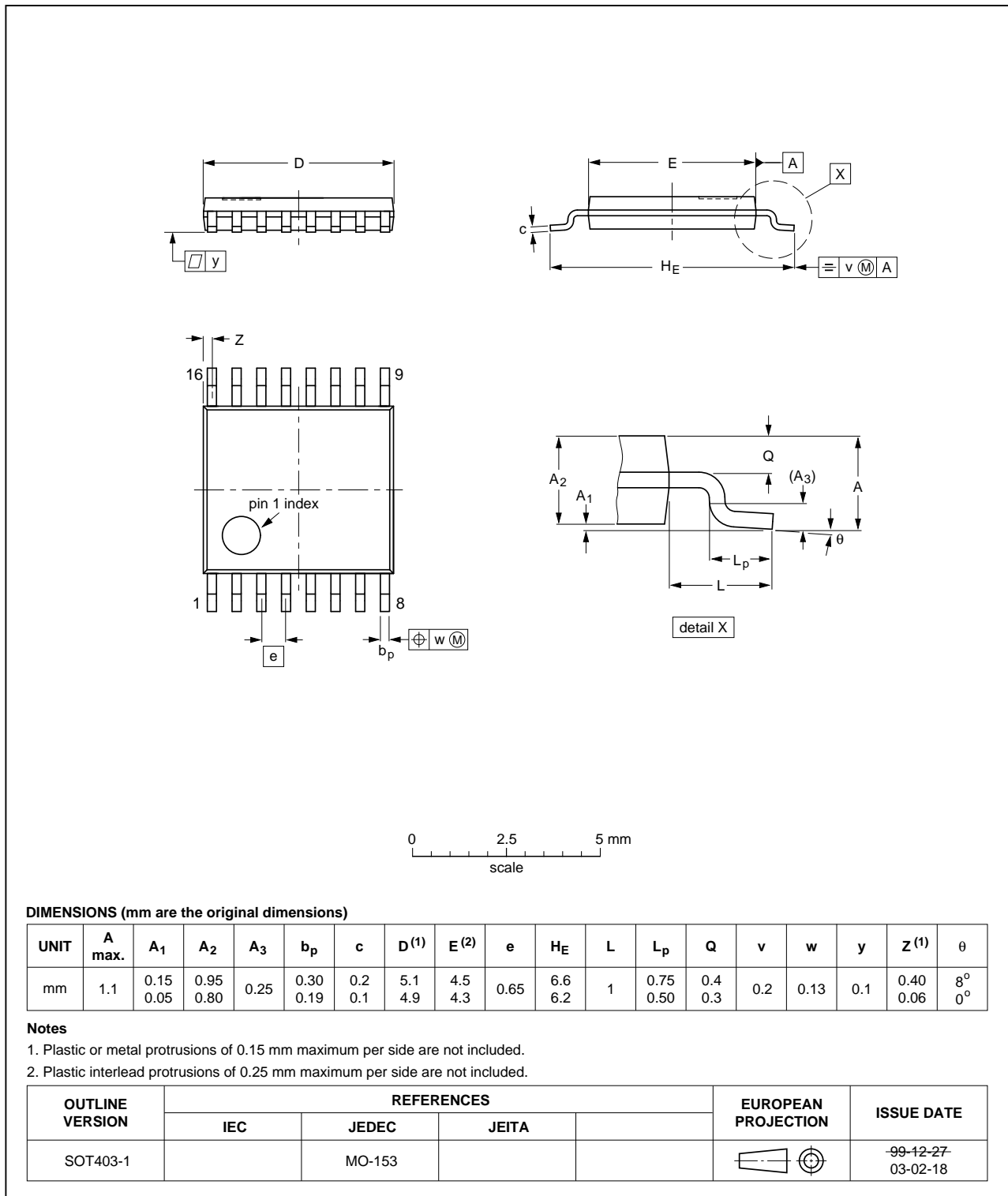


Fig 12. Package outline SOT403-1 (TSSOP16)

13. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
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_HCT175_Q100 v.1	20140519	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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