

# 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

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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 ( $\overline{MR}$ ) 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  $\overline{MR}$  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

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- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - ◆ Specified from  $-40\text{ °C}$  to  $+85\text{ °C}$  and from  $-40\text{ °C}$  to  $+125\text{ °C}$
- 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 ( $C = 200\text{ pF}$ ,  $R = 0\ \Omega$ )
- 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

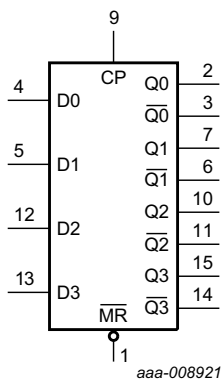


Fig 1. Logic symbol

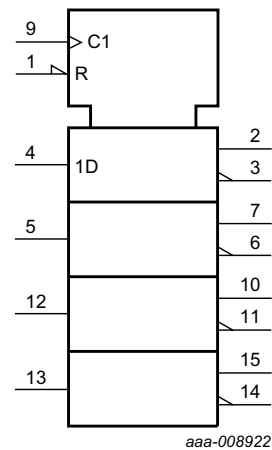


Fig 2. IEC logic symbol

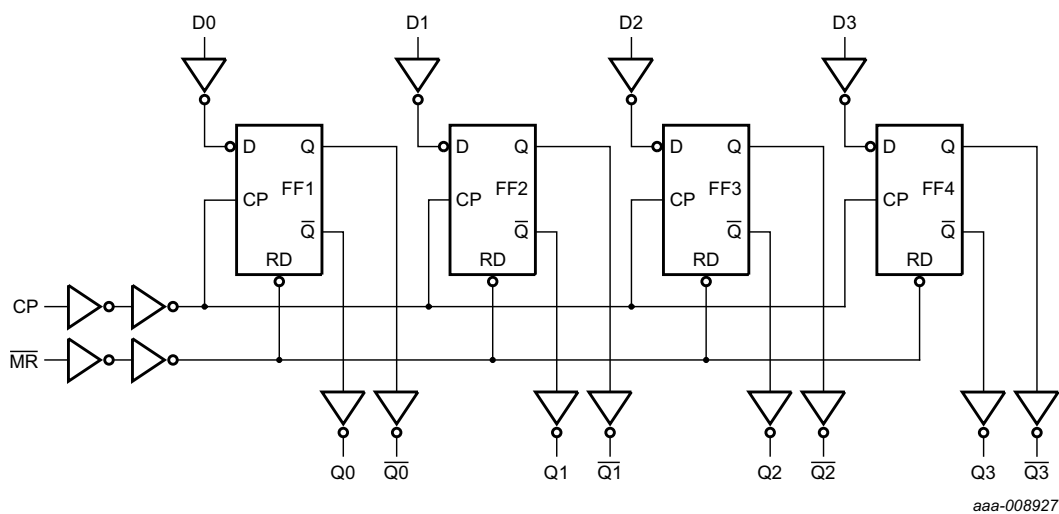
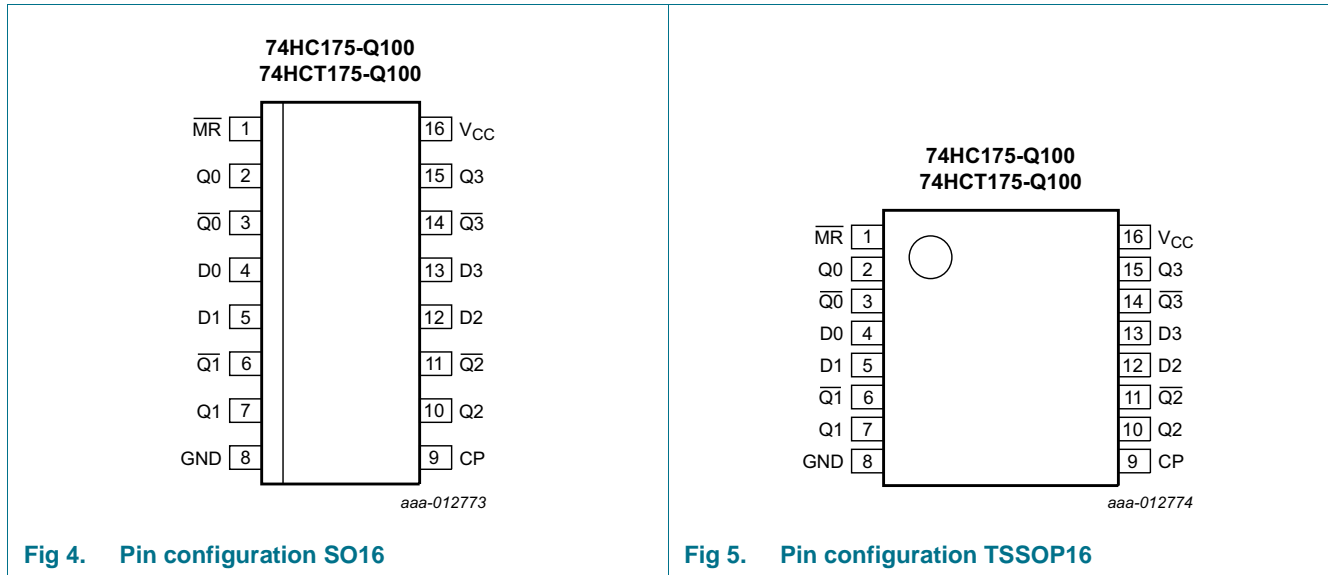


Fig 3. Logic diagram

## 5. Pinning information

### 5.1 Pinning



### 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 <sub>CC</sub>	16	positive supply voltage

## 6. Functional description

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

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.

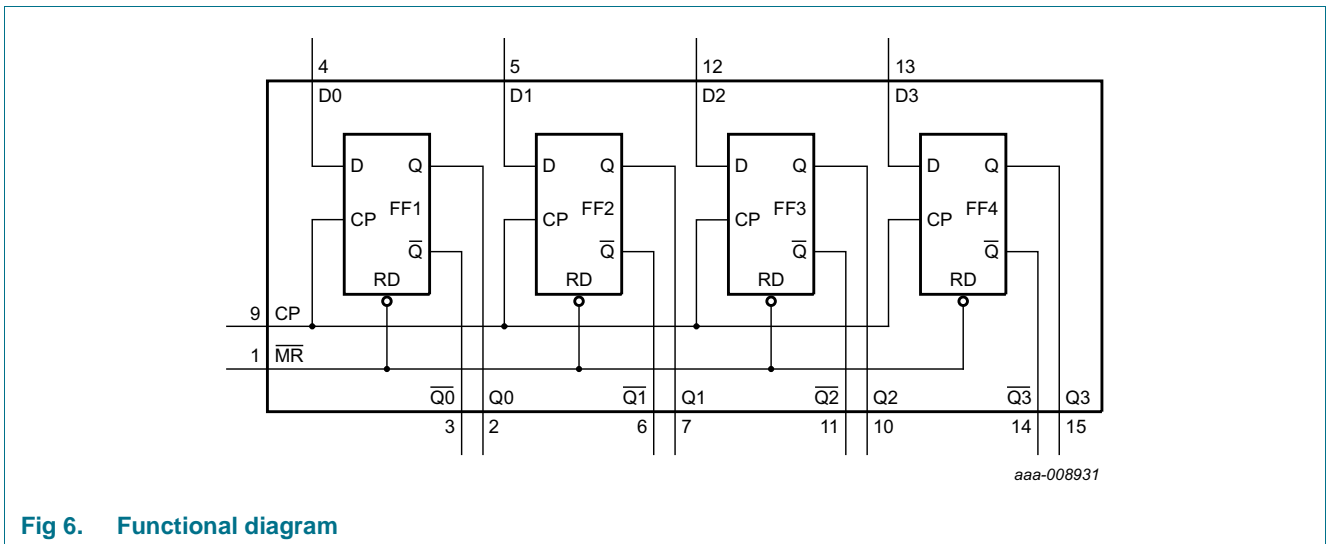


Fig 6. Functional diagram

## 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	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	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 $+125\text{ °C}$ <a href="#">[1]</a>	-	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
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 2.0\text{ V}$	-	-	625	-	-	-	ns/V
		$V_{CC} = 4.5\text{ V}$	-	1.67	139	-	1.67	139	ns/V
		$V_{CC} = 6.0\text{ V}$	-	-	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>74HC175-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
		I <sub>CC</sub>	supply current	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	-
C <sub>I</sub>	input capacitance		-	3.5	-	-	-	-	-	pF
<b>74HCT175-Q100</b>										
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V								
		I <sub>O</sub> = -20 μA	4.4	4.5	-	4.4	-	4.4	-	V
V <sub>OL</sub>	LOW-level output voltage	I <sub>O</sub> = -4.0 mA	3.98	4.32	-	3.84	-	3.7	-	V
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V								
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
I <sub>I</sub>	input leakage current	I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 5.5 V	-	0.15	0.26	-	0.33	-	0.4	V
		V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 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	$\mu$ A
$\Delta I_{CC}$	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	$\mu$ A
		CP input	-	60	216	-	270	-	294	$\mu$ A
		$\overline{MR}$ input	-	100	360	-	450	-	490	$\mu$ A
$C_I$	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	
<b>74HC175-Q100</b>										
$t_{pd}$	propagation delay	CP to $Q_n, \overline{Q}_n$ ; see <a href="#">Figure 7</a> <sup>[1]</sup>								
		$V_{CC} = 2.0$ 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	$\overline{MR}$ to $Q_n, \overline{Q}_n$ ; see <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ 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	$Q_n$ 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

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 <a href="#">Figure 7</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ V	80	19	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	7	-	20	-	24	-	ns
$t_{rec}$	recovery time	$\overline{MR}$ to CP; see <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ V	5	-33	-	5	-	5	-	ns
		$V_{CC} = 4.5$ V	5	-12	-	5	-	5	-	ns
		$V_{CC} = 6.0$ V	5	-10	-	5	-	5	-	ns
$t_{su}$	set-up time	Dn to CP; see <a href="#">Figure 7</a>								
		$V_{CC} = 2.0$ V	80	3	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	1	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	1	-	17	-	20	-	ns
$t_h$	hold time	Dn to CP; see <a href="#">Figure 7</a>								
		$V_{CC} = 2.0$ V	25	2	-	30	-	40	-	ns
		$V_{CC} = 4.5$ V	5	0	-	6	-	8	-	ns
		$V_{CC} = 6.0$ V	4	0	-	5	-	7	-	ns
$f_{max}$	maximum frequency	CP input; see <a href="#">Figure 7</a>								
		$V_{CC} = 2.0$ 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
		$V_{CC} = 6.0$ V	35	89	-	28	-	24	-	MHz
$C_{PD}$	power dissipation capacitance	per package; $V_I = \text{GND to } V_{CC}$	<sup>[3]</sup> -	32	-	-	-	-	-	pF
<b>74HCT175-Q100</b>										
$t_{pd}$	propagation delay	CP to $Q_n$ , $\overline{Q_n}$ ; see <a href="#">Figure 7</a>								
		$V_{CC} = 4.5$ 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](#)

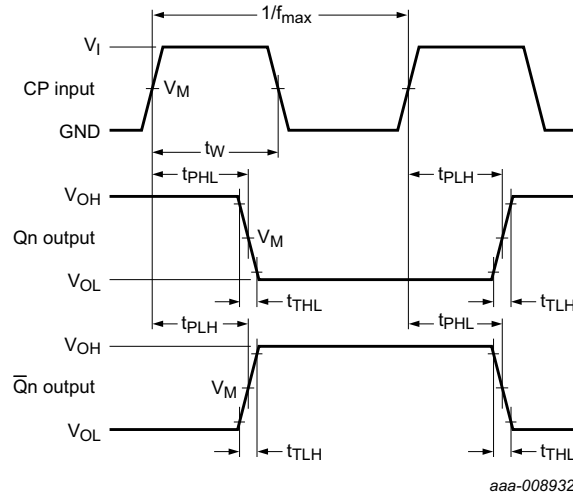
Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$t_{PHL}$	HIGH to LOW propagation delay	$\overline{MR}$ to Qn; see <a href="#">Figure 9</a>								
		$V_{CC} = 4.5$ V	-	22	38	-	48	-	57	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	19	-	-	-	-	-	ns
		$\overline{MR}$ to $\overline{Qn}$ ; see <a href="#">Figure 9</a>								
		$V_{CC} = 4.5$ V	-	19	35	-	44	-	53	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	16	-	-	-	-	ns	
$t_t$	transition time	Qn output; see <a href="#">Figure 7</a> <sup>[2]</sup>								
		$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns
$t_W$	pulse width	CP input; see <a href="#">Figure 7</a>								
		$V_{CC} = 4.5$ V	20	12	-	25	-	30	-	ns
		$\overline{MR}$ input LOW; see <a href="#">Figure 9</a>								
		$V_{CC} = 4.5$ V	20	11	-	25	-	30	-	ns
$t_{rec}$	recovery time	$\overline{MR}$ to CP; see <a href="#">Figure 9</a>								
		$V_{CC} = 4.5$ V	5	-10	-	5	-	5	-	ns
$t_{su}$	set-up time	Dn to CP; see <a href="#">Figure 7</a>								
		$V_{CC} = 4.5$ V	16	5	-	20	-	24	-	ns
$t_h$	hold time	Dn to CP; see <a href="#">Figure 7</a>								
		$V_{CC} = 4.5$ V	5	0	-	5	-	5	-	ns
$f_{max}$	maximum frequency	CP input; see <a href="#">Figure 7</a>								
		$V_{CC} = 4.5$ 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 <sup>[3]</sup>	-	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  $\mu$ W).

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

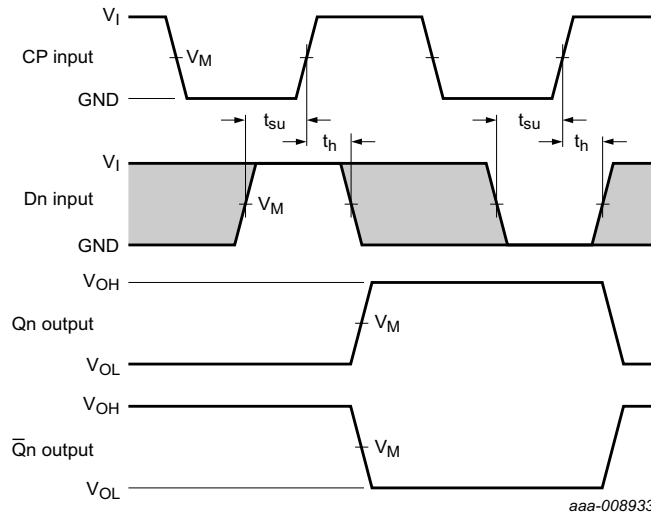
 $f_i$  = input frequency in MHz; $f_o$  = output frequency in MHz; $\Sigma (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs; $C_L$  = output load capacitance in pF; $V_{CC}$  = supply voltage in V.

## 11. Waveforms



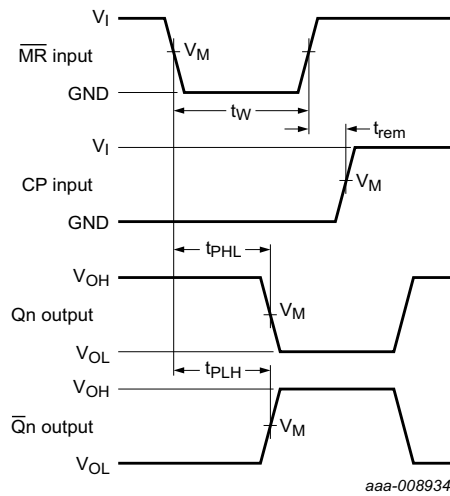
Measurement points are given in [Table 8](#).

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



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

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

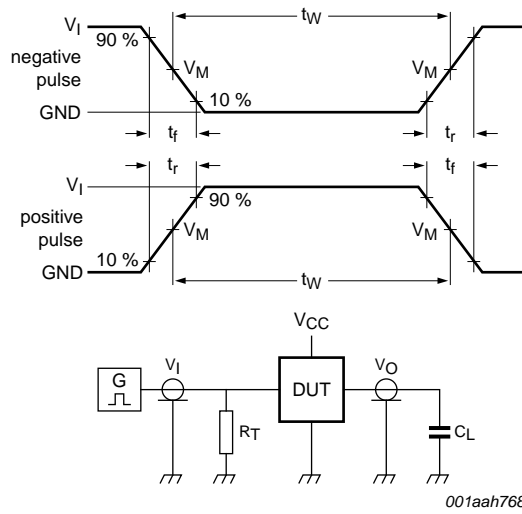


Measurement points are given in [Table 8](#).

**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 $\Omega$	$t_{PLH}, t_{PHL}$
74HCT175-Q100	3 V	6 ns	15 pF, 50 pF	1 k $\Omega$	$t_{PLH}, t_{PHL}$

## 12. Package outline

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

SOT109-1

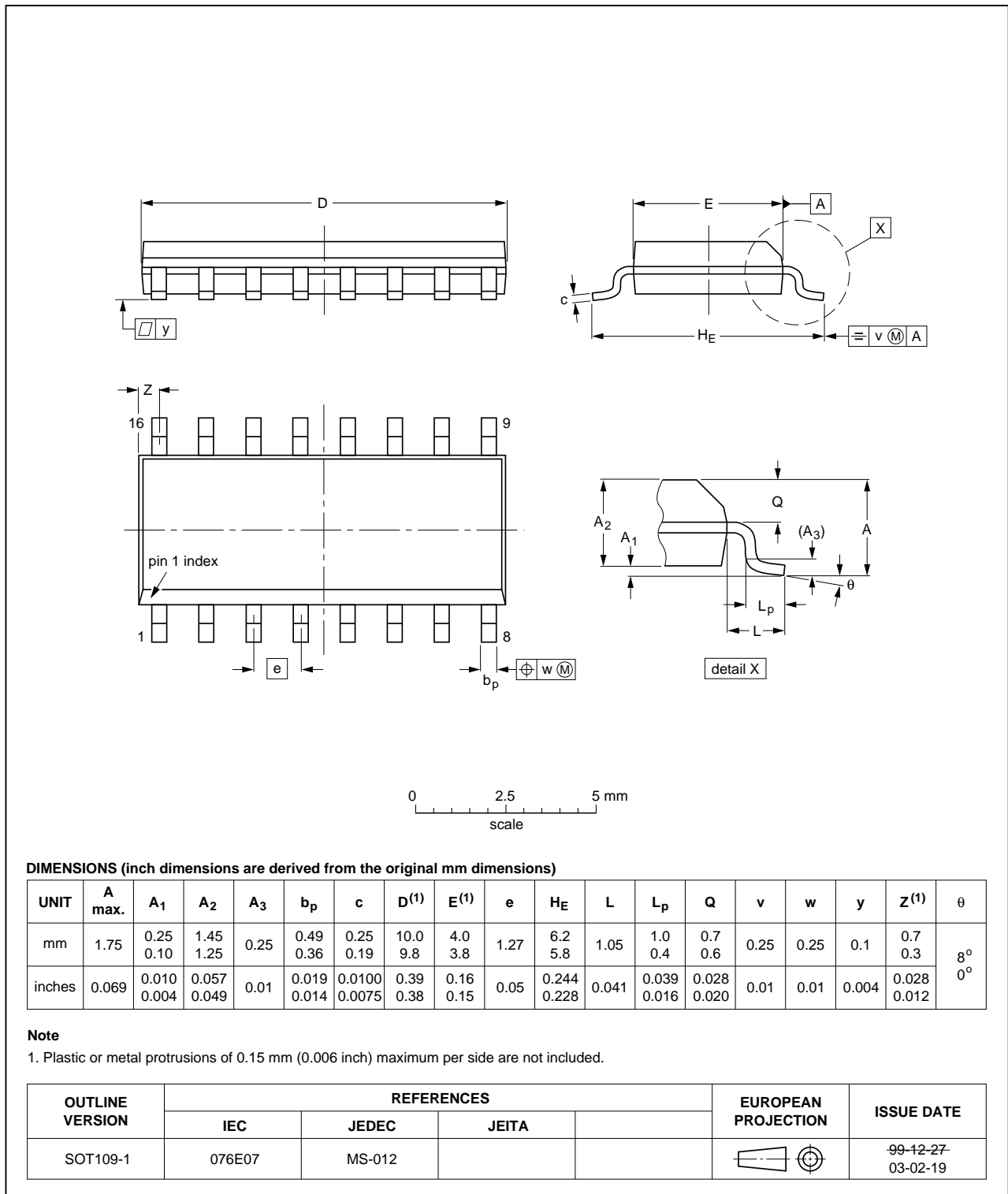


Fig 11. Package outline SOT109-1 (SO16)

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

SOT403-1

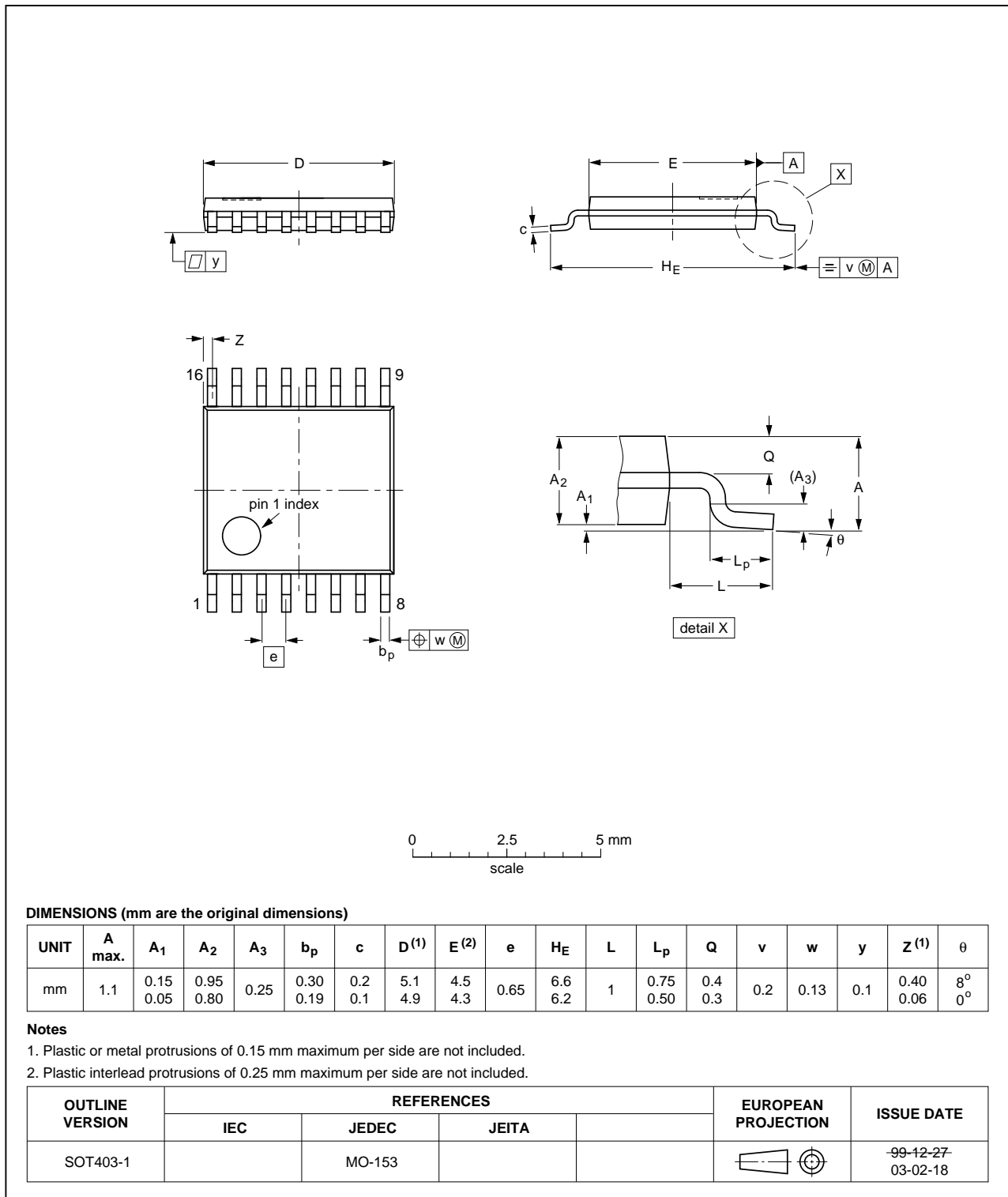


Fig 12. Package outline SOT403-1 (TSSOP16)

## 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 <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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