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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

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Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



# 74HC193-Q100; 74HCT193-Q100

## Presettable synchronous 4-bit binary up/down counter

Rev. 1 — 12 July 2013

Product data sheet

### 1. General description

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The 74HC193-Q100; 74HCT193-Q100 is a 4-bit synchronous binary up/down counter. Separate up/down clocks, CPU and CPD respectively, simplify operation. The outputs change state synchronously with the LOW-to-HIGH transition of either clock input. If the CPU clock is pulsed while CPD is held HIGH, the device counts up. If the CPD clock is pulsed while CPU is held HIGH, the device counts down. Only one clock input can be held HIGH at any time to guarantee predictable behavior. The device can be cleared at any time by the asynchronous master reset input ( $\overline{MR}$ ). It may also be loaded in parallel by activating the asynchronous parallel load input ( $\overline{PL}$ ). The terminal count up ( $\overline{TCU}$ ) and terminal count down ( $\overline{TCD}$ ) outputs are normally HIGH. When the circuit has reached the maximum count state of 15, the next HIGH-to-LOW transition of CPU causes  $\overline{TCU}$  to go LOW.  $\overline{TCU}$  remains LOW until CPU goes HIGH again, duplicating the count up clock. Likewise, the  $\overline{TCD}$  output goes LOW when the circuit is in the zero state and the CPD goes LOW. The terminal count outputs duplicate the clock waveforms and can be used as the clock input signals to the next higher-order circuit in a multistage counter. Multistage counters are not fully synchronous, since there is a slight delay time difference added for each stage that is added. The counter may be preset by the asynchronous parallel load capability of the circuit. Information on the parallel data inputs (D0 to D3), is loaded into the counter. This information appears on the outputs ( $\overline{Q0}$  to  $\overline{Q3}$ ) regardless of the conditions of the clock inputs when the parallel load ( $\overline{PL}$ ) input is LOW. A HIGH level on the master reset ( $\overline{MR}$ ) input disables the parallel load gates. It overrides both clock inputs and sets all outputs ( $\overline{Q0}$  to  $\overline{Q3}$ ) LOW. If one of the clock inputs is LOW during and after a reset or load operation, the next LOW-to-HIGH transition of that clock is interpreted as a legitimate signal and it is counted. Inputs include clamp diodes that 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

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- 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 74HC193-Q100: CMOS level
  - ◆ For 74HCT193-Q100: TTL level
- Synchronous reversible 4-bit binary counting
- Asynchronous parallel load
- Asynchronous reset
- Expandable without external logic
- 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 pF, R = 0 Ω)
- Multiple package options

## 3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC193D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC193DB-Q100	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HC193PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT193D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT193DB-Q100	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HCT193PW-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

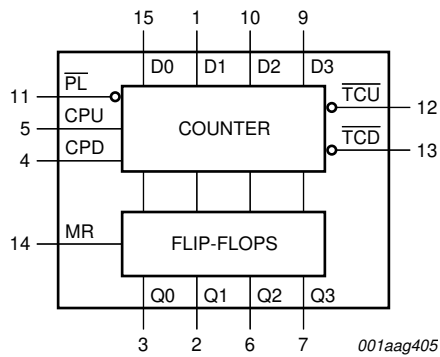


Fig 1. Functional diagram

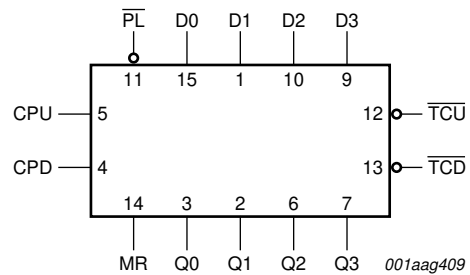


Fig 2. Logic symbol

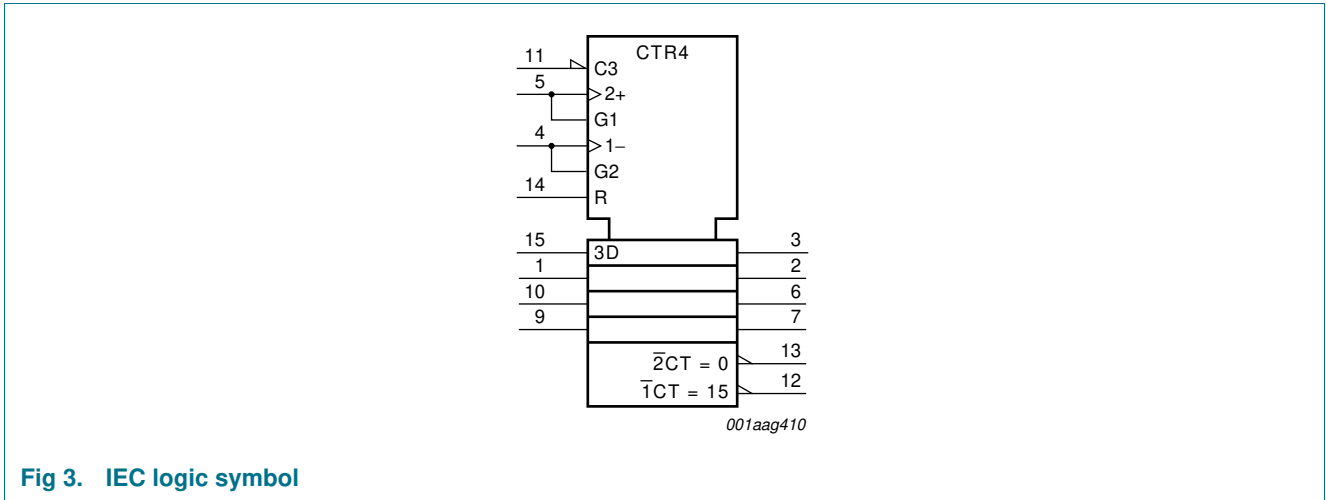
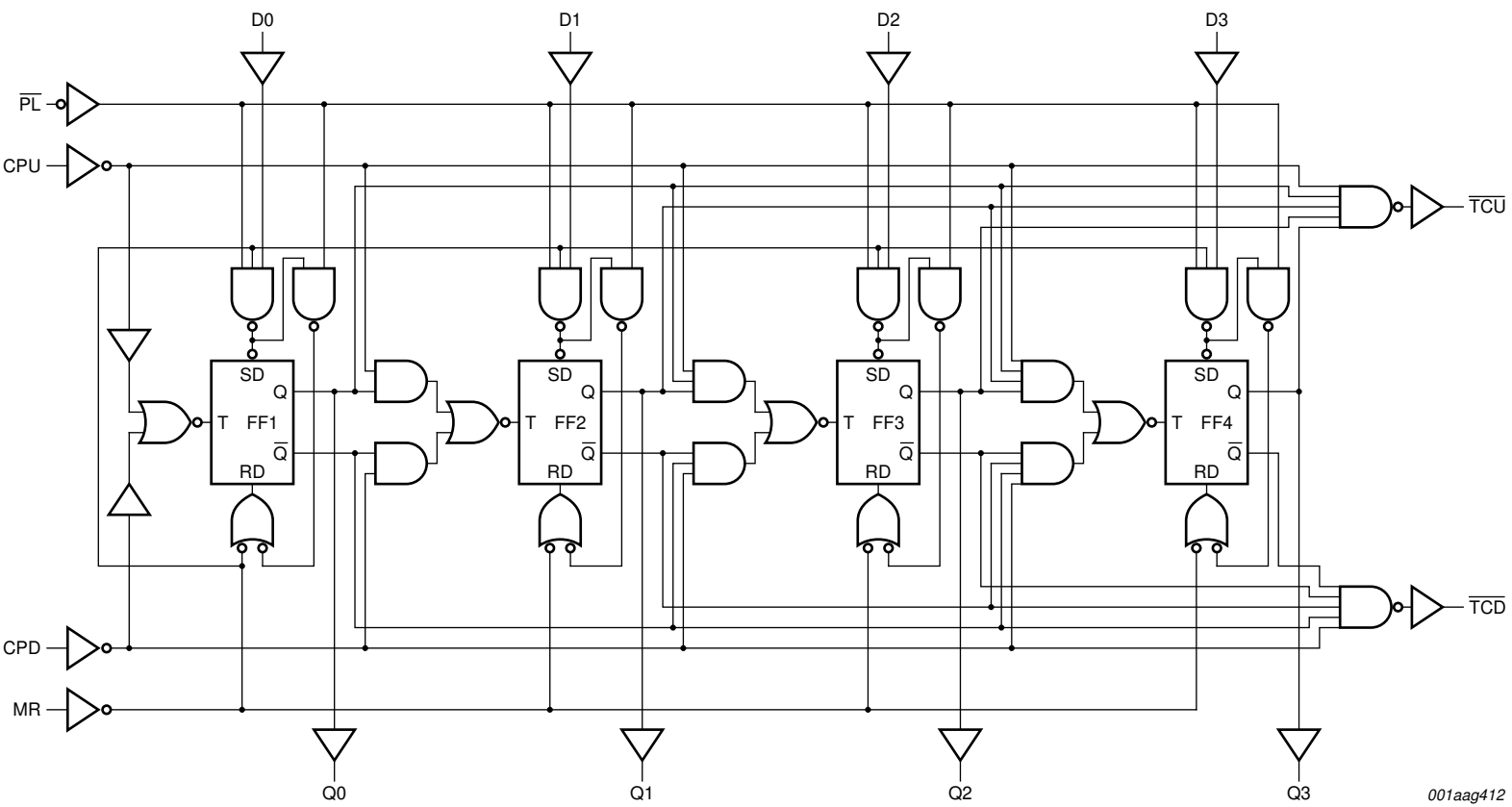


Fig 3. IEC logic symbol



001aag412

Fig 4. Logic diagram

## 5. Pinning information

### 5.1 Pinning

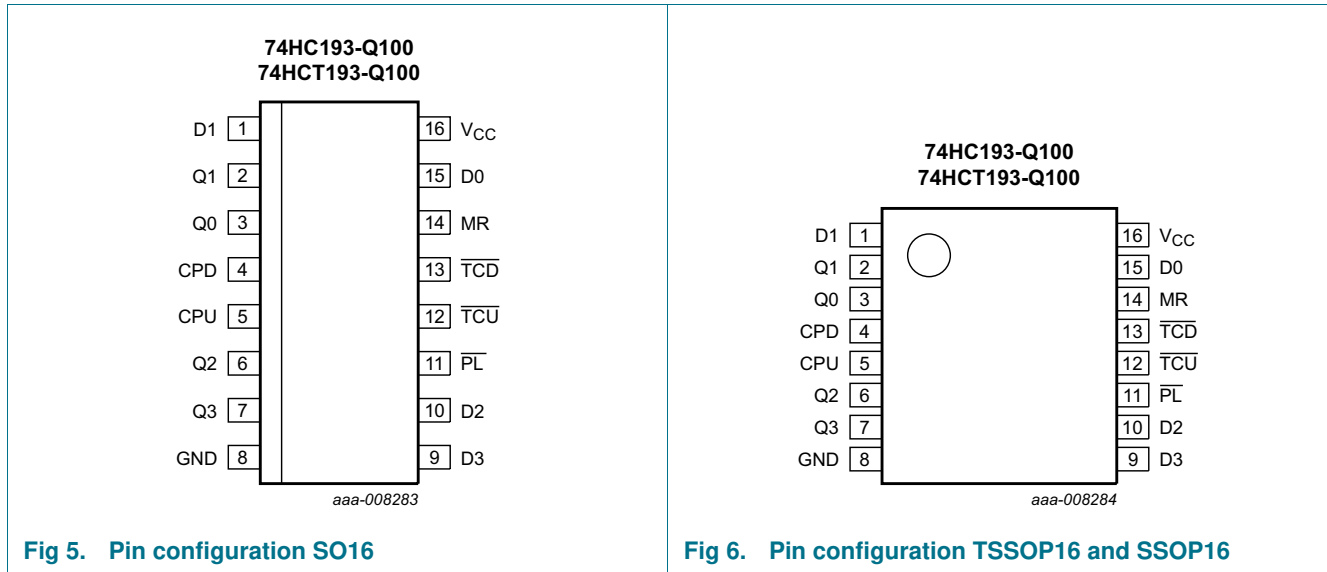


Fig 5. Pin configuration SO16

Fig 6. Pin configuration TSSOP16 and SSOP16

### 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
D0	15	data input 0
D1	1	data input 1
D2	10	data input 2
D3	9	data input 3
Q0	3	flip-flop output 0
Q1	2	flip-flop output 1
Q2	6	flip-flop output 2
Q3	7	flip-flop output 3
CPD	4	count down clock input <sup>[1]</sup>
CPU	5	count up clock input <sup>[1]</sup>
GND	8	ground (0 V)
$\overline{\text{PL}}$	11	asynchronous parallel load input (active LOW)
$\overline{\text{TCU}}$	12	terminal count up (carry) output (active LOW)
$\overline{\text{TCD}}$	13	terminal count down (borrow) output (active LOW)
MR	14	asynchronous master reset input (active HIGH)
V <sub>CC</sub>	16	supply voltage

[1] LOW-to-HIGH, edge triggered.

## 6. Functional description

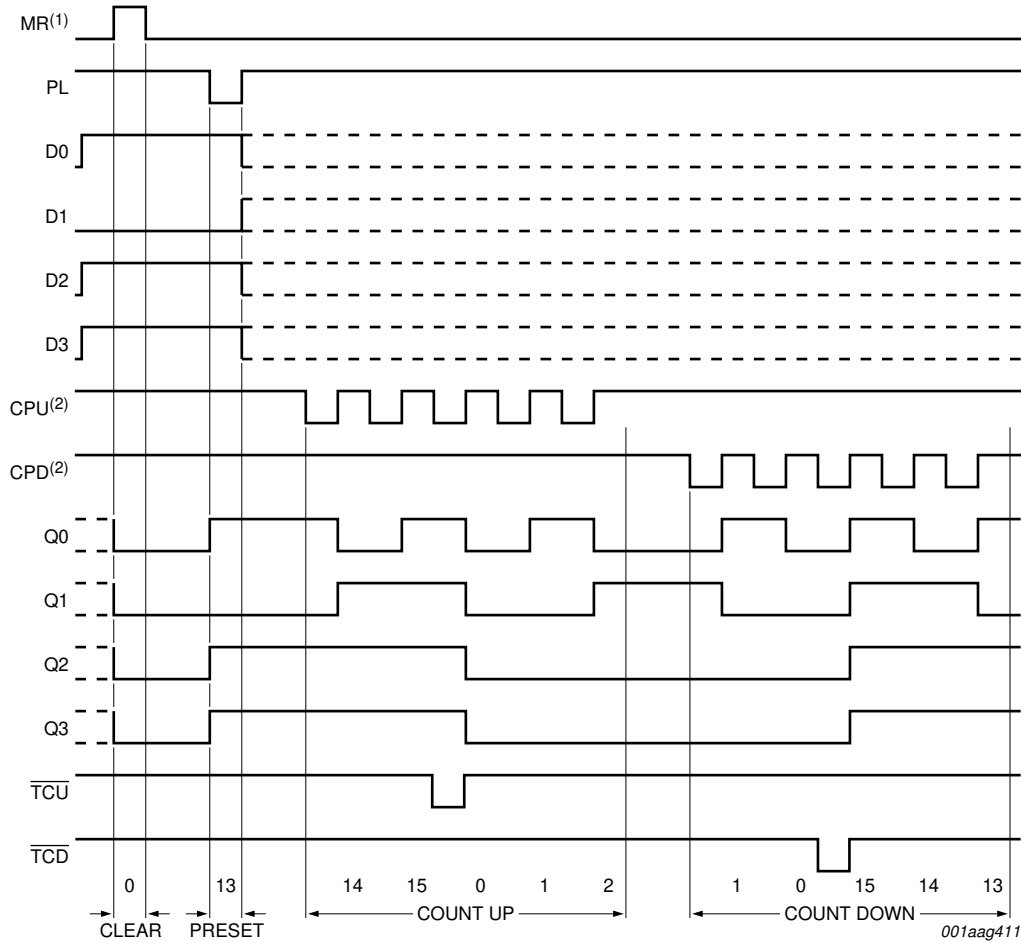
Table 3. Function table<sup>[1]</sup>

Operating mode	Inputs								Outputs					
	MR	$\overline{\text{PL}}$	CPU	CPD	D0	D1	D2	D3	Q0	Q1	Q2	Q3	$\overline{\text{TCU}}$	$\overline{\text{TCD}}$
Reset (clear)	H	X	X	L	X	X	X	X	L	L	L	L	H	L
	H	X	X	H	X	X	X	X	L	L	L	L	H	H
Parallel load	L	L	X	L	L	L	L	L	L	L	L	L	H	L
	L	L	X	H	L	L	L	L	L	L	L	L	H	H
	L	L	L	X	H	H	H	H	H	H	H	H	L	H
	L	L	H	X	H	H	H	H	H	H	H	H	H	H
Count up	L	H	↑	H	X	X	X	X	count up				H <sup>[2]</sup>	H
Count down	L	H	H	↑	X	X	X	X	count down				H	H <sup>[3]</sup>

- [1] H = HIGH voltage level  
 L = LOW voltage level  
 X = don't care  
 ↑ = LOW-to-HIGH clock transition.

[2]  $\overline{\text{TCU}}$  = CPU at terminal count up (HHHH)

[3]  $\overline{\text{TCD}}$  = CPD at terminal count down (LLLL).



- (1) Clear overrides load, data and count inputs.
- (2) When counting up, the count down clock input (CPD) must be HIGH, when counting down the count up clock input (CPU) must be HIGH.

**Sequence**

Clear (reset outputs to zero);  
 load (preset) to binary thirteen;  
 count up to fourteen, fifteen, terminal count up, zero, one and two;  
 count down to one, zero, terminal count down, fifteen, fourteen and thirteen.

**Fig 7. Typical clear, load and count sequence**



## 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	+7.0	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	$V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$	-	±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		[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 packages: above 70 °C the value of  $P_{tot}$  derates linearly at 8 mW/K.

For SSOP16 and TSSOP16 packages: above 60 °C the value of  $P_{tot}$  derates linearly at 5.5 mW/K.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>74HC193-Q100</b>						
$V_{CC}$	supply voltage		2.0	5.0	6.0	V
$V_I$	input voltage		0	-	$V_{CC}$	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+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	ns/V
		$V_{CC} = 6.0\text{ V}$	-	-	83	ns/V
<b>74HCT193-Q100</b>						
$V_{CC}$	supply voltage		4.5	5.0	5.5	V
$V_I$	input voltage		0	-	$V_{CC}$	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 4.5\text{ V}$	-	1.67	139	ns/V

## 9. Static characteristics

**Table 6. Static characteristics type 74HC193-Q100**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b><math>T_{amb} = 25\text{ °C}</math></b>						
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 2.0\text{ V}$	1.5	1.2	-	V
		$V_{CC} = 4.5\text{ V}$	3.15	2.4	-	V
		$V_{CC} = 6.0\text{ V}$	4.2	3.2	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 2.0\text{ V}$	-	0.8	0.5	V
		$V_{CC} = 4.5\text{ V}$	-	2.1	1.35	V
		$V_{CC} = 6.0\text{ V}$	-	2.8	1.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$	-	-	-	
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 2.0\text{ V}$	1.9	2.0	-	V
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 4.5\text{ V}$	4.4	4.5	-	V
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 6.0\text{ V}$	5.9	6.0	-	V
		$I_O = -4.0\text{ mA}$ ; $V_{CC} = 4.5\text{ V}$	3.98	4.32	-	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$	-	-	-	
		$I_O = 20\text{ }\mu\text{A}$ ; $V_{CC} = 2.0\text{ V}$	-	0	0.1	V
		$I_O = 20\text{ }\mu\text{A}$ ; $V_{CC} = 4.5\text{ V}$	-	0	0.1	V
		$I_O = 20\text{ }\mu\text{A}$ ; $V_{CC} = 6.0\text{ V}$	-	0	0.1	V
		$I_O = 4.0\text{ mA}$ ; $V_{CC} = 4.5\text{ V}$	-	0.15	0.26	V
$I_I$	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 6.0\text{ V}$	-	-	$\pm 0.1$	$\mu\text{A}$
		$V_I = V_{CC}$ or GND; $I_O = 0\text{ A}$ ; $V_{CC} = 6.0\text{ V}$	-	-	8.0	$\mu\text{A}$
$C_i$	input capacitance		-	3.5	-	pF
<b><math>T_{amb} = -40\text{ °C to }+85\text{ °C}</math></b>						
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 2.0\text{ V}$	1.5	-	-	V
		$V_{CC} = 4.5\text{ V}$	3.15	-	-	V
		$V_{CC} = 6.0\text{ V}$	4.2	-	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 2.0\text{ V}$	-	-	0.5	V
		$V_{CC} = 4.5\text{ V}$	-	-	1.35	V
		$V_{CC} = 6.0\text{ V}$	-	-	1.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$	-	-	-	
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 2.0\text{ V}$	1.9	-	-	V
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 4.5\text{ V}$	4.4	-	-	V
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 6.0\text{ V}$	5.9	-	-	V
		$I_O = -4.0\text{ mA}$ ; $V_{CC} = 4.5\text{ V}$	3.84	-	-	V
		$I_O = -5.2\text{ mA}$ ; $V_{CC} = 6.0\text{ V}$	5.34	-	-	V

**Table 6. Static characteristics type 74HC193-Q100 ...continued**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
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	-	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.33	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	-	0.33	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	-	-	±1.0	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	-	-	80	μA
T <sub>amb</sub> = -40 °C to +125 °C						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.5	-	-	V
		V <sub>CC</sub> = 4.5 V	3.15	-	-	V
		V <sub>CC</sub> = 6.0 V	4.2	-	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	-	0.5	V
		V <sub>CC</sub> = 4.5 V	-	-	1.35	V
		V <sub>CC</sub> = 6.0 V	-	-	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	-	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	-	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V	5.9	-	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.7	-	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.2	-	-	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	-	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.4	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	-	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	-	-	±1.0	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	-	-	160	μA

**Table 7. Static characteristics type 74HCT193-Q100**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>T<sub>amb</sub> = 25 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	1.6	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	1.2	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	-	V
		I <sub>O</sub> = -4.0 mA	3.98	4.32	-	V
V <sub>OL</sub>	LOW-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	-	0	0.1	V
		I <sub>O</sub> = 4.0 mA	-	0.15	0.26	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	±0.1	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> = 5.5 V	-	-	8.0	µA
ΔI <sub>CC</sub>	additional supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V and other inputs at V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 4.5 V to 5.5 V				
		pin Dn	-	35	126	µA
		pins CPU, CPD	-	140	504	µA
		pin $\overline{PL}$	-	65	234	µA
		pin MR	-	105	378	µA
C <sub>i</sub>	input capacitance		-	3.5	-	pF
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	-	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	-	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	-	-	V
		I <sub>O</sub> = -4.0 mA	3.84	-	-	V
V <sub>OL</sub>	LOW-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	-	-	0.1	V
		I <sub>O</sub> = 4.0 mA	-	-	0.33	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	±1.0	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> = 5.5 V	-	-	80	µA
ΔI <sub>CC</sub>	additional supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V and other inputs at V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 4.5 V to 5.5 V				
		pin Dn	-	-	157.5	µA
		pins CPU, CPD	-	-	630	µA
		pin $\overline{PL}$	-	-	292.5	µA
		pin MR	-	-	472.5	µA

**Table 7. Static characteristics type 74HCT193-Q100 ...continued**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b><math>T_{amb} = -40\text{ °C to }+125\text{ °C}</math></b>						
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	2.0	-	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	-	-	0.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5\text{ V}$				
		$I_O = -20\text{ }\mu\text{A}$	4.4	-	-	V
		$I_O = -4.0\text{ mA}$	3.7	-	-	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5\text{ V}$				
		$I_O = 20\text{ }\mu\text{A}$	-	-	0.1	V
		$I_O = 4.0\text{ mA}$	-	-	0.4	V
$I_I$	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5\text{ V}$	-	-	$\pm 1.0$	$\mu\text{A}$
$I_{CC}$	supply current	$V_I = V_{CC}$ or GND; $I_O = 0\text{ A}$ ; $V_{CC} = 5.5\text{ V}$	-	-	160	$\mu\text{A}$
$\Delta I_{CC}$	additional supply current	per input pin; $V_I = V_{CC} - 2.1\text{ V}$ and other inputs at $V_{CC}$ or GND; $I_O = 0\text{ A}$ ; $V_{CC} = 4.5\text{ V to }5.5\text{ V}$				
		pin Dn	-	-	171.5	$\mu\text{A}$
		pins CPU, CPD	-	-	686	$\mu\text{A}$
		pin $\overline{\text{PL}}$	-	-	318.5	$\mu\text{A}$
		pin MR	-	-	514.5	$\mu\text{A}$

## 10. Dynamic characteristics

Table 8. Dynamic characteristics type 74HC193 -Q100

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$t_{pd}$	propagation delay	CPU, CPD to Qn; see <a href="#">Figure 8</a>	-							
		$V_{CC} = 2.0\text{ V}$	-	63	215	-	270	-	325	ns
		$V_{CC} = 4.5\text{ V}$	-	23	43	-	54	-	65	ns
		$V_{CC} = 6.0\text{ V}$	-	18	37	-	46	-	55	ns
		CPU to TCU; see <a href="#">Figure 9</a>								
		$V_{CC} = 2.0\text{ V}$	-	39	125	-	155	-	190	ns
		$V_{CC} = 4.5\text{ V}$	-	14	25	-	31	-	38	ns
		$V_{CC} = 6.0\text{ V}$	-	11	21	-	26	-	32	ns
		CPD to TCD; see <a href="#">Figure 9</a>								
		$V_{CC} = 2.0\text{ V}$	-	39	125	-	155	-	190	ns
		$V_{CC} = 4.5\text{ V}$	-	14	25	-	31	-	38	ns
		$V_{CC} = 6.0\text{ V}$	-	11	21	-	26	-	32	ns
		PL to Qn; see <a href="#">Figure 10</a>								
		$V_{CC} = 2.0\text{ V}$	-	69	220	-	275	-	330	ns
		$V_{CC} = 4.5\text{ V}$	-	25	44	-	55	-	66	ns
		$V_{CC} = 6.0\text{ V}$	-	20	37	-	47	-	56	ns
		MR to Qn; see <a href="#">Figure 11</a>								
		$V_{CC} = 2.0\text{ V}$	-	58	200	-	250	-	300	ns
		$V_{CC} = 4.5\text{ V}$	-	21	40	-	50	-	60	ns
		$V_{CC} = 6.0\text{ V}$	-	17	34	-	43	-	51	ns
		Dn to Qn; see <a href="#">Figure 10</a>								
$V_{CC} = 2.0\text{ V}$	-	69	210	-	265	-	315	ns		
$V_{CC} = 4.5\text{ V}$	-	25	42	-	53	-	63	ns		
$V_{CC} = 6.0\text{ V}$	-	20	36	-	45	-	54	ns		
$\overline{PL}$ to $\overline{TCU}$ , $\overline{PL}$ to TCD; see <a href="#">Figure 13</a>										
$V_{CC} = 2.0\text{ V}$	-	80	290	-	365	-	435	ns		
$V_{CC} = 4.5\text{ V}$	-	29	58	-	73	-	87	ns		
$V_{CC} = 6.0\text{ V}$	-	23	49	-	62	-	74	ns		
$\overline{MR}$ to $\overline{TCU}$ , $\overline{MR}$ to TCD; see <a href="#">Figure 13</a>										
$V_{CC} = 2.0\text{ V}$	-	74	285	-	355	-	430	ns		
$V_{CC} = 4.5\text{ V}$	-	27	57	-	71	-	86	ns		
$V_{CC} = 6.0\text{ V}$	-	22	48	-	60	-	73	ns		

Table 8. Dynamic characteristics type 74HC193 ...continued-Q100

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit		
			Min	Typ	Max	Min	Max	Min	Max			
t <sub>pd</sub>	propagation delay	Dn to $\overline{\text{TCU}}$ , Dn to TCD; see <a href="#">Figure 13</a>										
		V <sub>CC</sub> = 2.0 V	-	80	290	-	365	-	435	ns		
		V <sub>CC</sub> = 4.5 V	-	29	58	-	73	-	87	ns		
		V <sub>CC</sub> = 6.0 V	-	23	49	-	62	-	74	ns		
t <sub>THL</sub>	HIGH to LOW output transition time	see <a href="#">Figure 11</a>										
		V <sub>CC</sub> = 2.0 V	-	19	75	-	95	-	110	ns		
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns		
		V <sub>CC</sub> = 6.0 V	-	6	13	-	16	-	19	ns		
t <sub>TLH</sub>	LOW to HIGH output transition time	see <a href="#">Figure 11</a>										
		V <sub>CC</sub> = 2.0 V	-	19	75	-	95	-	110	ns		
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns		
		V <sub>CC</sub> = 6.0 V	-	6	13	-	16	-	19	ns		
t <sub>w</sub>	pulse width	CPU, CPD (HIGH or LOW); see <a href="#">Figure 8</a>										
		V <sub>CC</sub> = 2.0 V	100	22	-	125	-	150	-	ns		
		V <sub>CC</sub> = 4.5 V	20	8	-	25	-	30	-	ns		
		V <sub>CC</sub> = 6.0 V	17	6	-	21	-	26	-	ns		
		MR (HIGH); see <a href="#">Figure 11</a>										
		V <sub>CC</sub> = 2.0 V	100	25	-	125	-	150	-	ns		
		V <sub>CC</sub> = 4.5 V	20	9	-	25	-	30	-	ns		
		V <sub>CC</sub> = 6.0 V	17	7	-	21	-	26	-	ns		
		$\overline{\text{PL}}$ (LOW); see <a href="#">Figure 10</a>										
		V <sub>CC</sub> = 2.0 V	100	19	-	125	-	150	-	ns		
		V <sub>CC</sub> = 4.5 V	20	7	-	25	-	30	-	ns		
		V <sub>CC</sub> = 6.0 V	17	6	-	21	-	26	-	ns		
		t <sub>rec</sub>	recovery time	$\overline{\text{PL}}$ to CPU, CPD; see <a href="#">Figure 10</a>								
				V <sub>CC</sub> = 2.0 V	50	8	-	65	-	75	-	ns
V <sub>CC</sub> = 4.5 V	10			3	-	13	-	15	-	ns		
V <sub>CC</sub> = 6.0 V	9			2	-	11	-	13	-	ns		
MR to CPU, CPD; see <a href="#">Figure 11</a>												
V <sub>CC</sub> = 2.0 V	50			0	-	65	-	75	-	ns		
V <sub>CC</sub> = 4.5 V	10			0	-	13	-	15	-	ns		
V <sub>CC</sub> = 6.0 V	9			0	-	11	-	13	-	ns		

Table 8. Dynamic characteristics type 74HC193 ...continued-Q100

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit	
			Min	Typ	Max	Min	Max	Min	Max		
t <sub>su</sub>	set-up time	Dn to $\overline{\text{PL}}$ ; see <a href="#">Figure 12</a> ; note: CPU = CPD = HIGH									
			V <sub>CC</sub> = 2.0 V	80	22	-	100	-	120	-	ns
			V <sub>CC</sub> = 4.5 V	16	8	-	20	-	24	-	ns
			V <sub>CC</sub> = 6.0 V	14	6	-	17	-	20	-	ns
t <sub>h</sub>	hold time	Dn to $\overline{\text{PL}}$ ; see <a href="#">Figure 12</a>	V <sub>CC</sub> = 2.0 V	0	-14	-	0	-	0	-	ns
			V <sub>CC</sub> = 4.5 V	0	-5	-	0	-	0	-	ns
			V <sub>CC</sub> = 6.0 V	0	-4	-	0	-	0	-	ns
		CPU to CPD, CPD to CPU; see <a href="#">Figure 14</a>	V <sub>CC</sub> = 2.0 V	80	22	-	100	-	120	-	ns
			V <sub>CC</sub> = 4.5 V	16	8	-	20	-	24	-	ns
			V <sub>CC</sub> = 6.0 V	8	6	-	17	-	20	-	ns
			f <sub>max</sub>	maximum frequency	CPU, CPD; see <a href="#">Figure 8</a>	V <sub>CC</sub> = 2.0 V	4.0	13.5	-	3.2	-
V <sub>CC</sub> = 4.5 V	20	41				-	16	-	13	-	MHz
V <sub>CC</sub> = 6.0 V	24	49				-	19	-	15	-	MHz
C <sub>PD</sub>	power dissipation capacitance	V <sub>I</sub> = GND to V <sub>CC</sub> ; <a href="#">[2]</a> V <sub>CC</sub> = 5 V; f <sub>i</sub> = 1 MHz				-	24	-	-	-	-

[1] t<sub>pd</sub> is the same as t<sub>PHL</sub> and t<sub>PLH</sub>.

[2] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW):

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

f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

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



Table 9. Dynamic characteristics type 74HCT193 -Q100

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>pd</sub>	propagation delay	CPU, CPD to Qn; see <a href="#">Figure 8</a> <sup>[1]</sup>								
		V <sub>CC</sub> = 4.5 V	-	23	43	-	54	-	65	ns
		CPU to $\overline{\text{TCU}}$ ; see <a href="#">Figure 9</a>								
		V <sub>CC</sub> = 4.5 V	-	15	27	-	34	-	41	ns
		CPD to $\overline{\text{TCD}}$ ; see <a href="#">Figure 9</a>								
		V <sub>CC</sub> = 4.5 V	-	15	27	-	34	-	41	ns
		PL to Qn; see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	-	26	46	-	58	-	69	ns
		MR to Qn; see <a href="#">Figure 11</a>								
		V <sub>CC</sub> = 4.5 V	-	22	40	-	50	-	60	ns
t <sub>THL</sub>	HIGH to LOW output transition time	Dn to Qn; see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	-	27	46	-	58	-	69	ns
		$\overline{\text{PL}}$ to $\overline{\text{TCU}}$ , $\overline{\text{PL}}$ to $\overline{\text{TCD}}$ ; see <a href="#">Figure 13</a>								
		V <sub>CC</sub> = 4.5 V	-	31	55	-	69	-	83	ns
		MR to $\overline{\text{TCU}}$ , MR to $\overline{\text{TCD}}$ ; see <a href="#">Figure 13</a>								
		V <sub>CC</sub> = 4.5 V	-	29	55	-	69	-	83	ns
		Dn to $\overline{\text{TCU}}$ , Dn to $\overline{\text{TCD}}$ ; see <a href="#">Figure 13</a>								
		V <sub>CC</sub> = 4.5 V	-	32	58	-	73	-	87	ns
		see <a href="#">Figure 11</a>								
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns
t <sub>TLH</sub>	LOW to HIGH output transition time	see <a href="#">Figure 11</a>								
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns
t <sub>w</sub>	pulse width	CPU, CPD (HIGH or LOW); see <a href="#">Figure 8</a>								
		V <sub>CC</sub> = 4.5 V	25	11	-	31	-	38	-	ns
		MR (HIGH); see <a href="#">Figure 11</a>								
		V <sub>CC</sub> = 4.5 V	20	7	-	25	-	30	-	ns
t <sub>w</sub>	pulse width	PL (LOW); see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	20	8	-	25	-	30	-	ns

Table 9. Dynamic characteristics type 74HCT193 ...continued-Q100

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>rec</sub>	recovery time	$\overline{\text{PL}}$ to CPU, CPD; see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	10	2	-	13	-	15	-	ns
		MR to CPU, CPD; see <a href="#">Figure 11</a>								
		V <sub>CC</sub> = 4.5 V	10	0	-	13	-	15	-	ns
t <sub>su</sub>	set-up time	Dn to $\overline{\text{PL}}$ ; see <a href="#">Figure 12</a> ; note: CPU = CPD = HIGH								
		V <sub>CC</sub> = 4.5 V	16	8	-	20	-	24	-	ns
t <sub>h</sub>	hold time	Dn to $\overline{\text{PL}}$ ; see <a href="#">Figure 12</a>								
		V <sub>CC</sub> = 4.5 V	0	-6	-	0	-	0	-	ns
		CPU to CPD, CPD to CPU; see <a href="#">Figure 14</a>								
		V <sub>CC</sub> = 4.5 V	16	7	-	20	-	24	-	ns
f <sub>max</sub>	maximum frequency	CPU, CPD; see <a href="#">Figure 8</a>								
		V <sub>CC</sub> = 4.5 V	20	43	-	16	-	13	-	MHz
C <sub>PD</sub>	power dissipation capacitance	V <sub>I</sub> = GND to V <sub>CC</sub> - <a href="#">[2]</a> 1.5 V; V <sub>CC</sub> = 5 V; f <sub>i</sub> = 1 MHz	-	26	-	-	-	-	-	pF

[1] t<sub>pd</sub> is the same as t<sub>PHL</sub> and t<sub>PLH</sub>.

[2] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW):

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

f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

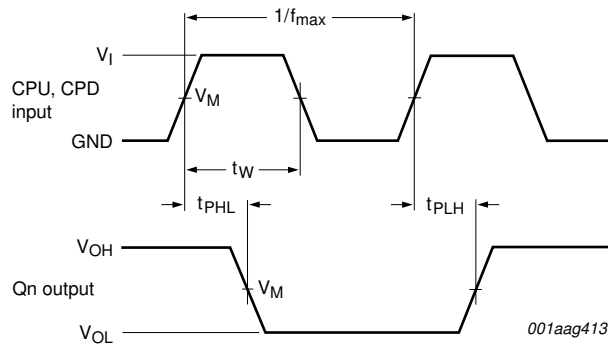
C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

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

## 11. Waveforms

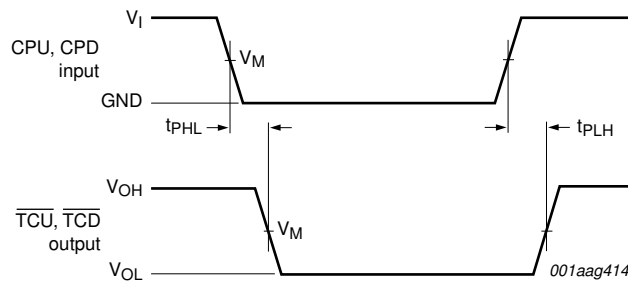


Measurement points are given in [Table 10](#).

$t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 8.** The clock (CPU, CPD) to output (Qn) propagation delays, the clock pulse width, and the maximum clock pulse frequency

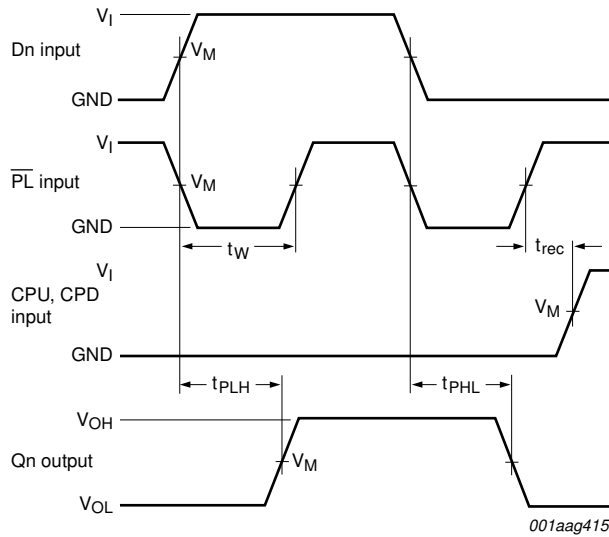


Measurement points are given in [Table 10](#).

$t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 9.** The clock (CPU, CPD) to terminal count output ( $\overline{TCU}$ ,  $\overline{TCD}$ ) propagation delays



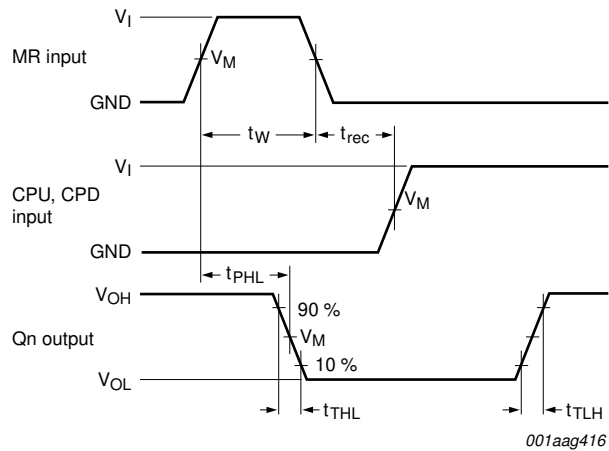
001aag415

Measurement points are given in [Table 10](#).

$t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 10. The parallel load input ( $\overline{PL}$ ) and data (Dn) to Qn output propagation delays and  $\overline{PL}$  removal time to clock input (CPU, CPD)**



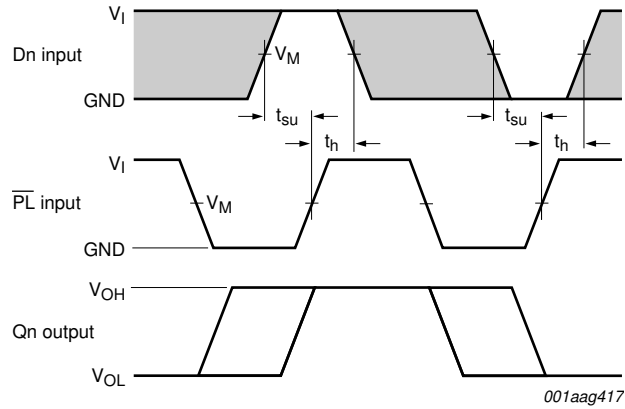
001aag416

Measurement points are given in [Table 10](#).

$t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 11. The master reset input (MR) pulse width, MR to Qn propagation delays, MR to CPU, CPD removal time and output transition times**

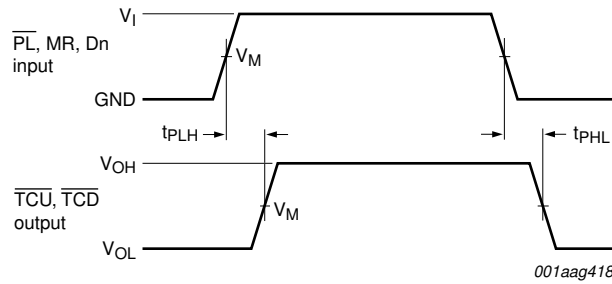


The shaded areas indicate when the input is permitted to change for predictable output performance.

Measurement points are given in [Table 10](#).

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 12. The data input (Dn) to parallel load input (PL) set-up and hold times**

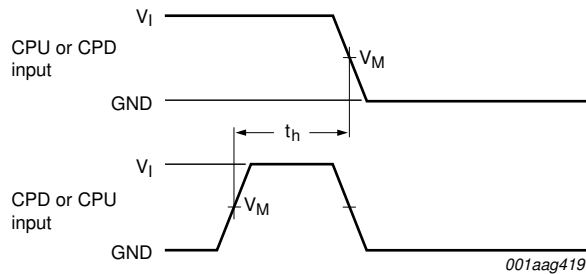


Measurement points are given in [Table 10](#).

$t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 13. The data input (Dn), parallel load input (PL) and the master reset input (MR) to the terminal count outputs (TCU, TCD) propagation delays**

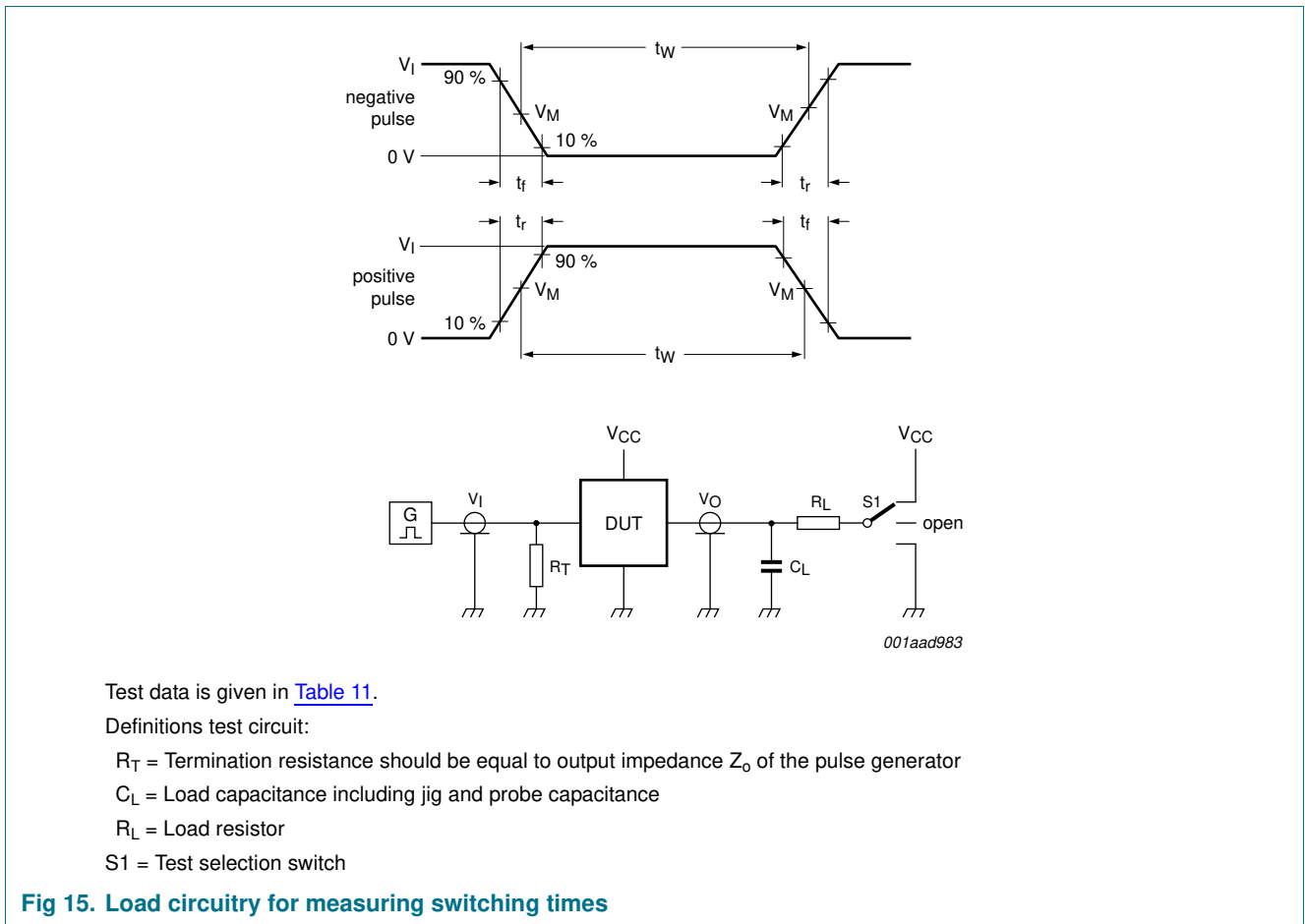


Measurement points are given in [Table 10](#).

**Fig 14. The CPU to CPD or CPD to CPU hold times**

**Table 10. Measurement points**

Type	Input		Output
	$V_M$	$V_I$	$V_M$
74HC193-Q100	$0.5 \times V_{CC}$	GND to $V_{CC}$	$0.5 \times V_{CC}$
74HCT193-Q100	1.3 V	GND to 3 V	1.3 V

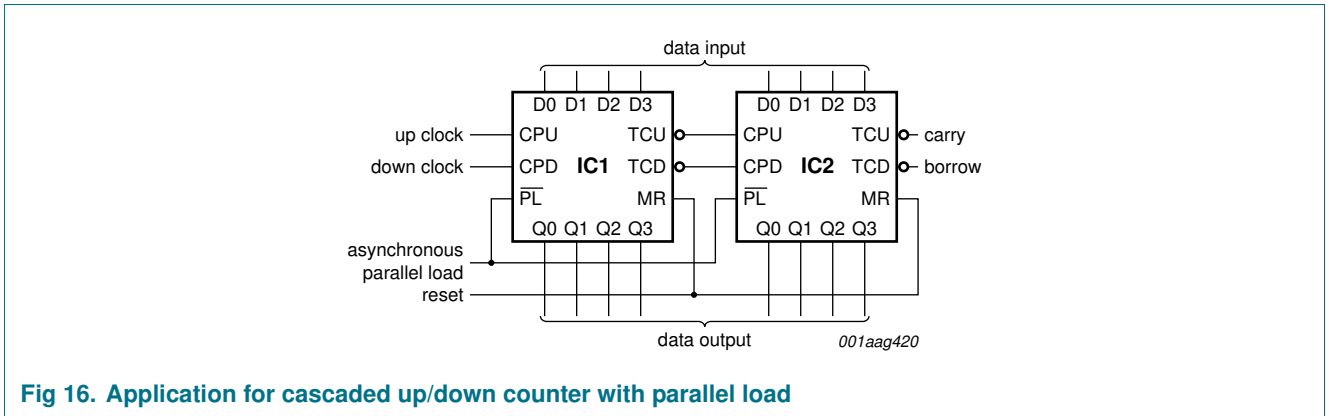


**Fig 15. Load circuitry for measuring switching times**

**Table 11. Test data**

Type	Input		Load		S1 position
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PHL}, t_{PLH}$
74HC193-Q100	$V_{CC}$	6 ns	15 pF, 50 pF	1 k $\Omega$	open
74HCT193-Q100	3 V	6 ns	15 pF, 50 pF	1 k $\Omega$	open

## 12. Application information



**Fig 16. Application for cascaded up/down counter with parallel load**

## 13. Package outline

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

SOT109-1

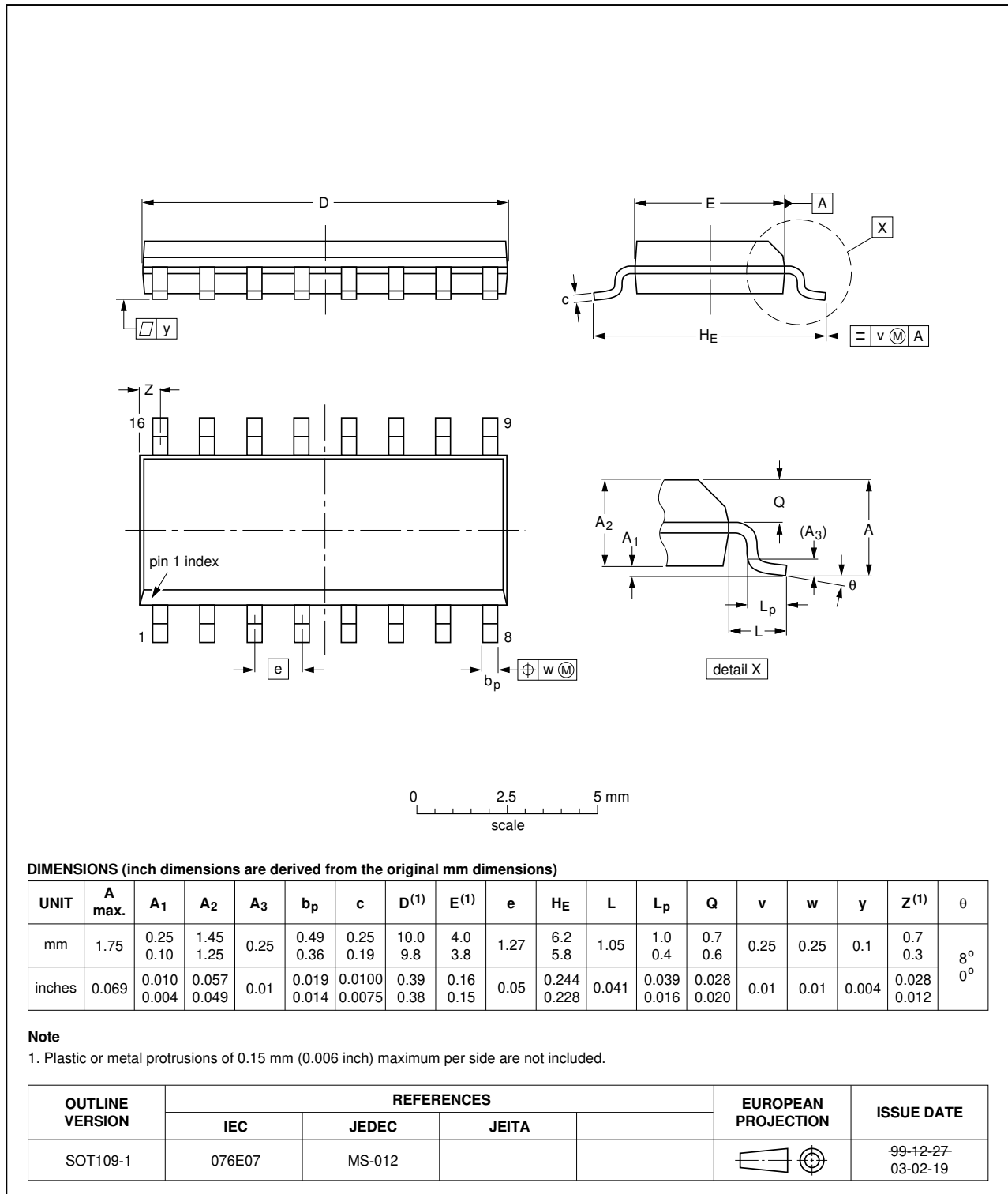


Fig 17. Package outline SOT109-1 (SO16)



SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

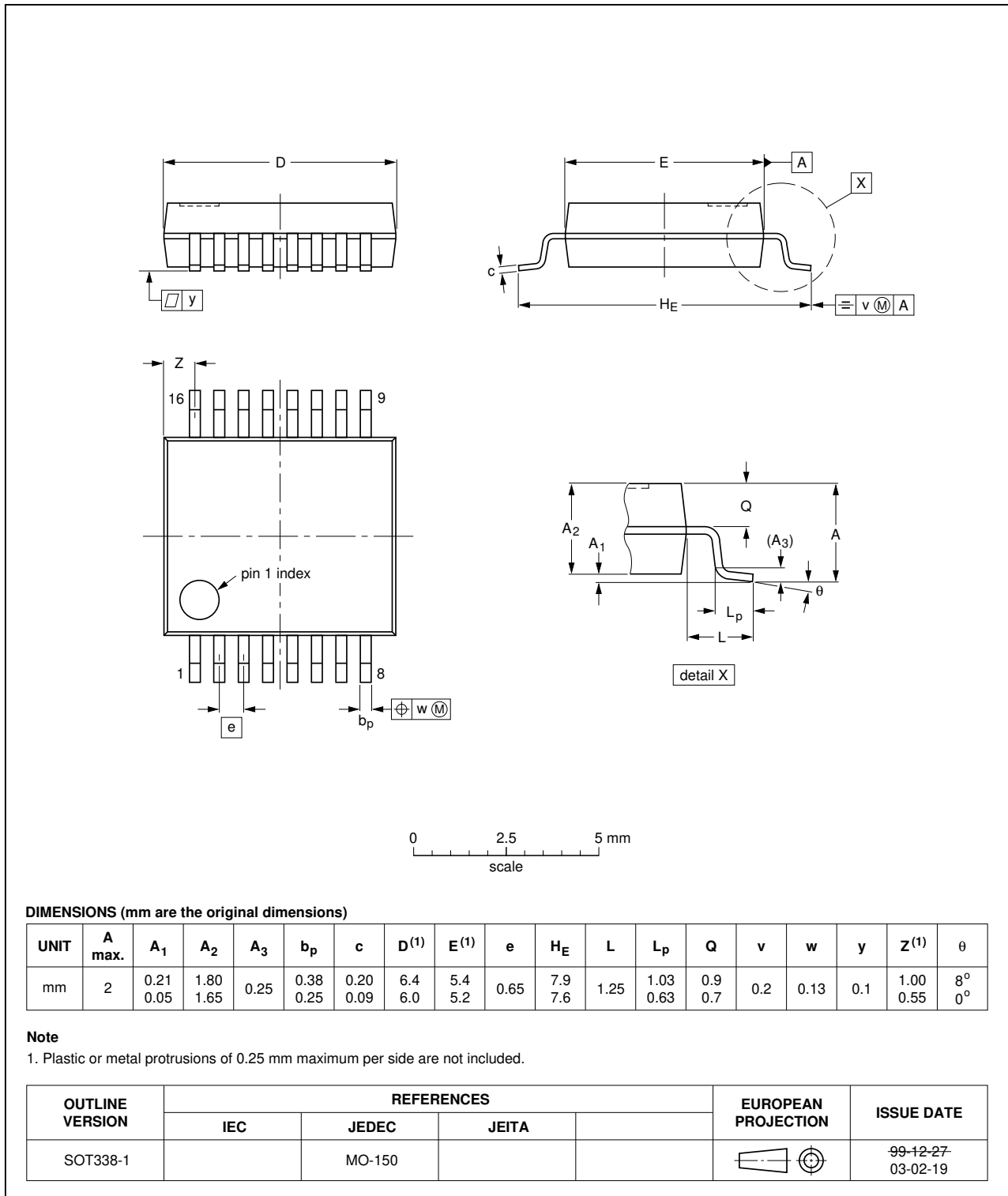


Fig 18. Package outline SOT338-1 (SSOP16)

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

SOT403-1

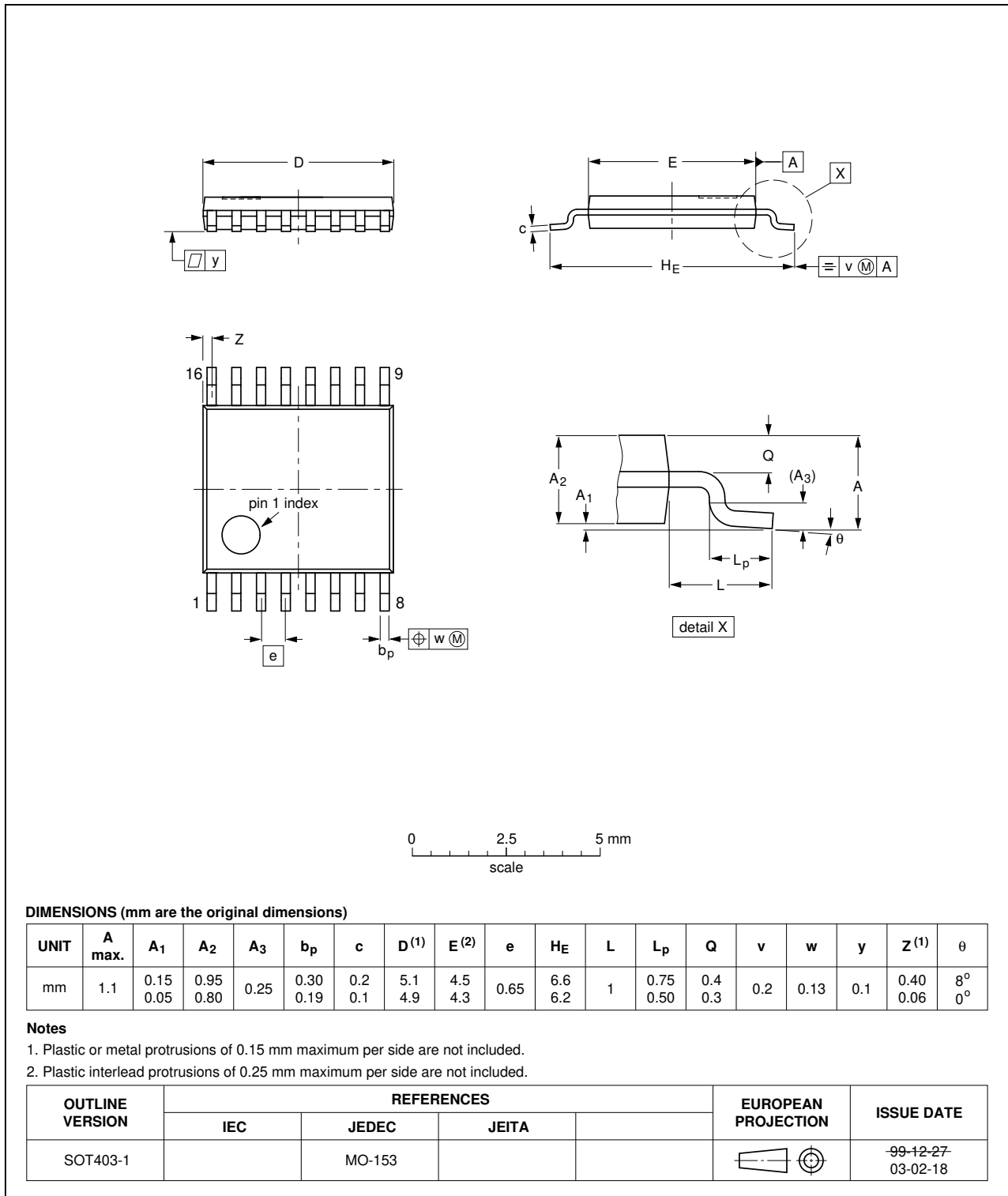


Fig 19. Package outline SOT403-1 (TSSOP16)