

# 74HC193-Q100; 74HCT193-Q100

Presettable synchronous 4-bit binary up/down counter

Rev. 2 — 5 February 2021

Product data sheet

## 1. General description

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 (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 (Q0 to 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 (MR) input disables the parallel load gates. It overrides both clock inputs and sets all outputs (Q0 to 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

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - Specified from -40 °C to +85 °C and from -40 °C to +125 °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

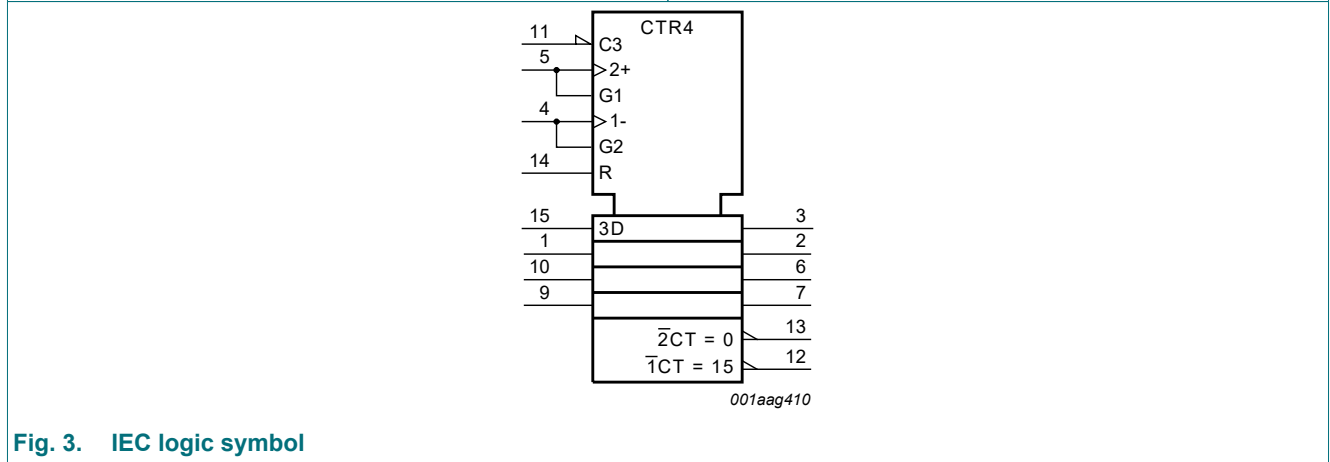
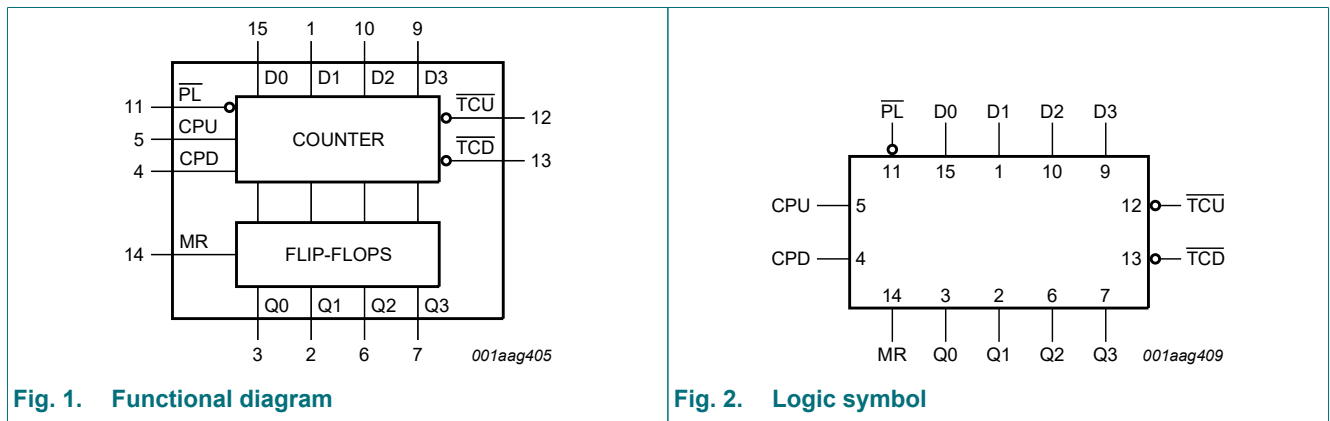
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### 3. Ordering information

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
74HCT193D-Q100				
74HCT193DB-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
74HCT193PW-Q100				

### 4. Functional diagram



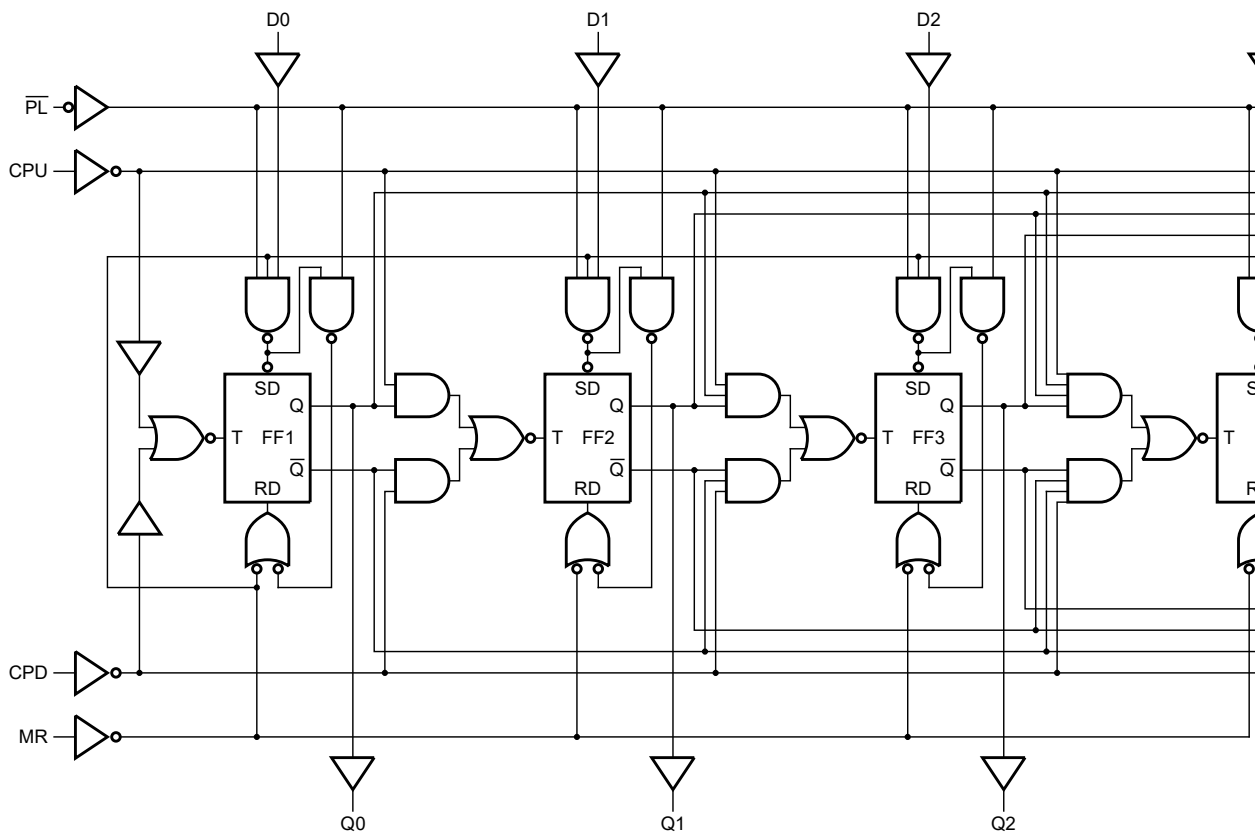
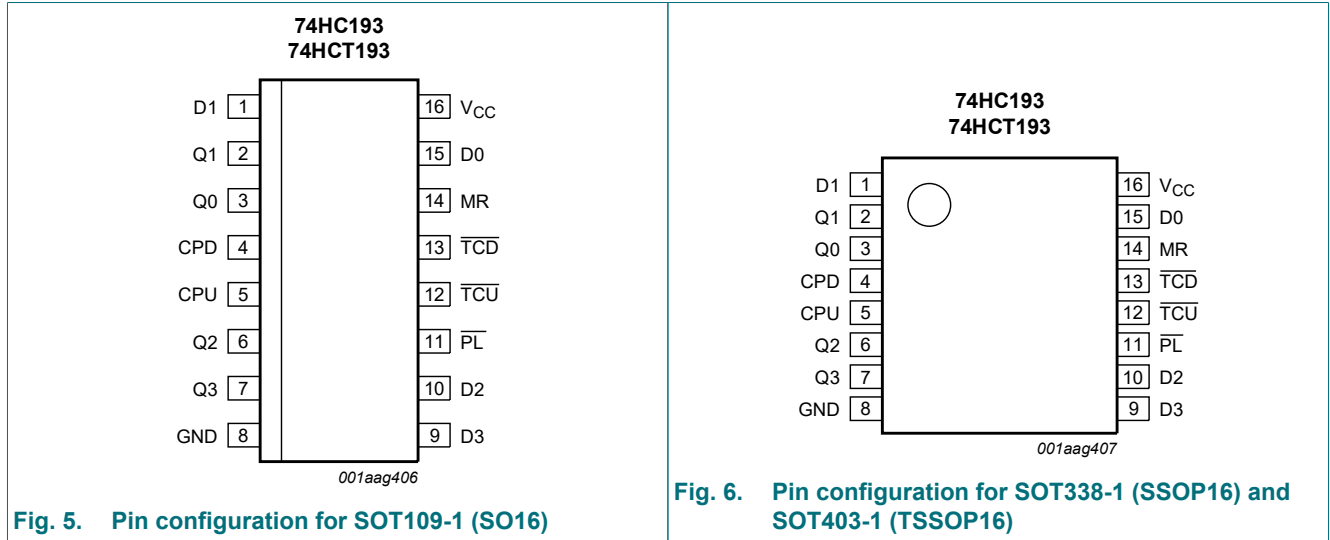


Fig. 4. Logic diagram

## 5. Pinning information

### 5.1. Pinning



### 5.2. Pin description

Table 2. Pin description

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

## 6. Functional description

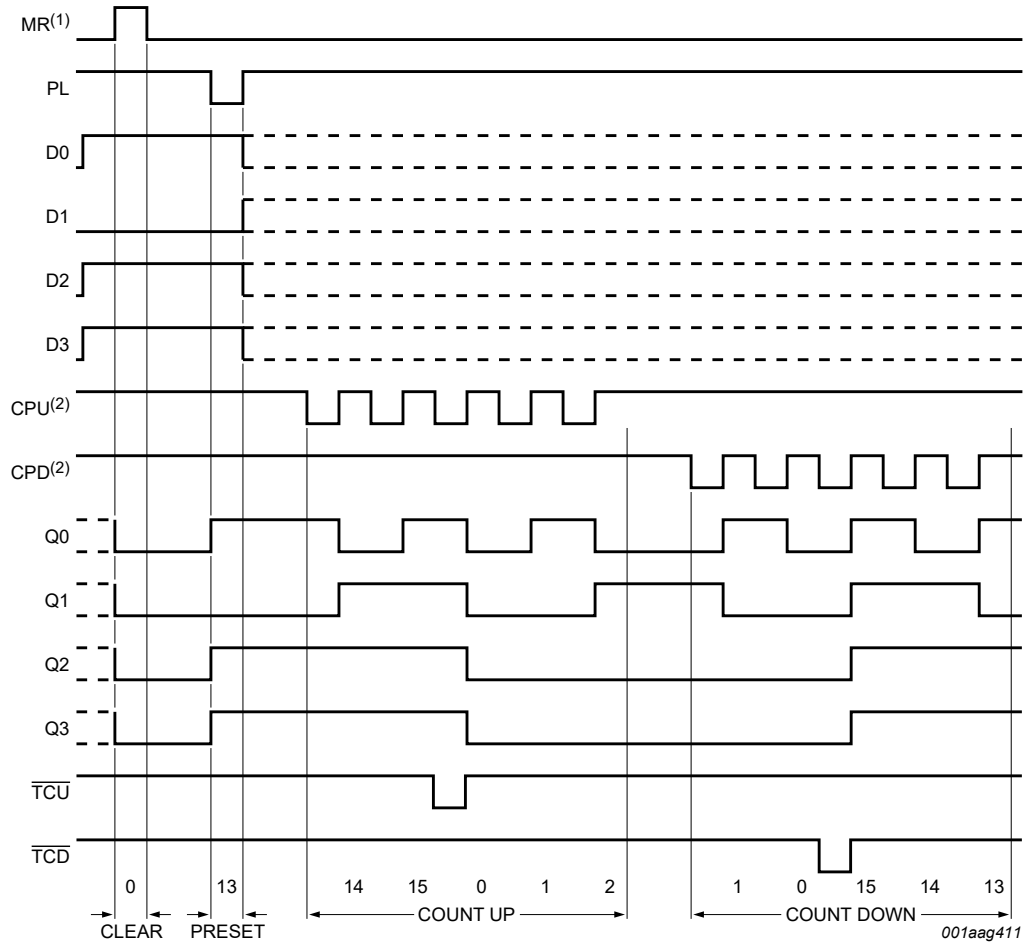
**Table 3. Function table**

*H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = LOW-to-HIGH clock transition.*

Operating mode	Inputs								Outputs					
	MR	PL	CPU	CPD	D0	D1	D2	D3	Q0	Q1	Q2	Q3	TCU	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 [1]	H
Count down	L	H	H	↑	X	X	X	X	count down				H	H [2]

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

[2]  $\overline{\text{TCD}}$  = 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]	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1]	-	$\pm 20$	mA
$I_O$	output current	$V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$	-	$\pm 25$	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	[2]	-	500	mW

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

[2] For SOT109-1 (SO16) package:  $P_{tot}$  derates linearly with 12.4 mW/K above 110 °C.

For SOT338-1 (SSOP16) package:  $P_{tot}$  derates linearly with 8.5 mW/K above 91 °C.

For SOT403-1 (TSSOP16) package:  $P_{tot}$  derates linearly with 8.5 mW/K above 91 °C.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC193-Q100			74HCT193-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	+25	+125	-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	-	1.67	139	ns/V
		$V_{CC} = 6.0\text{ V}$	-	-	83	-	-	-	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>T<sub>amb</sub> = 25 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.5	1.2	-	V
		V <sub>CC</sub> = 4.5 V	3.15	2.4	-	V
		V <sub>CC</sub> = 6.0 V	4.2	3.2	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	0.8	0.5	V
		V <sub>CC</sub> = 4.5 V	-	2.1	1.35	V
		V <sub>CC</sub> = 6.0 V	-	2.8	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	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.98	4.32	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.48	5.81	-	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	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	0	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.26	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	0.16	0.26	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	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	μA
C <sub>i</sub>	input capacitance		-	3.5	-	pF



Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
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	3.84	-	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.34	-	-	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	-	-	0.33	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
<b>T<sub>amb</sub> = -40 °C to +125 °C</b>						
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; 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; 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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +125 °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	3.7	-	-	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	-	-	0.4	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	-	-	160	µA
ΔI <sub>CC</sub>	additional supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; 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	-	-	171.5	µA
		pins CPU, CPD	-	-	686	µA
		pin PL	-	-	318.5	µA
		pin MR	-	-	514.5	µA

## 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 <sub>pd</sub>	propagation delay	CPU, CPD to Qn; see Fig. 8 [1]	-							
		V <sub>CC</sub> = 2.0 V	-	63	215	-	270	-	325	ns
		V <sub>CC</sub> = 4.5 V	-	23	43	-	54	-	65	ns
		V <sub>CC</sub> = 6.0 V	-	18	37	-	46	-	55	ns
		CPU to TCU; see Fig. 9								
		V <sub>CC</sub> = 2.0 V	-	39	125	-	155	-	190	ns
		V <sub>CC</sub> = 4.5 V	-	14	25	-	31	-	38	ns
		V <sub>CC</sub> = 6.0 V	-	11	21	-	26	-	32	ns
		CPD to TCD; see Fig. 9								
		V <sub>CC</sub> = 2.0 V	-	39	125	-	155	-	190	ns
		V <sub>CC</sub> = 4.5 V	-	14	25	-	31	-	38	ns
		V <sub>CC</sub> = 6.0 V	-	11	21	-	26	-	32	ns
		PL to Qn; see Fig. 10								
		V <sub>CC</sub> = 2.0 V	-	69	220	-	275	-	330	ns
		V <sub>CC</sub> = 4.5 V	-	25	44	-	55	-	66	ns
		V <sub>CC</sub> = 6.0 V	-	20	37	-	47	-	56	ns
		MR to Qn; see Fig. 11								
		V <sub>CC</sub> = 2.0 V	-	58	200	-	250	-	300	ns
		V <sub>CC</sub> = 4.5 V	-	21	40	-	50	-	60	ns
		V <sub>CC</sub> = 6.0 V	-	17	34	-	43	-	51	ns
		Dn to Qn; see Fig. 10								
		V <sub>CC</sub> = 2.0 V	-	69	210	-	265	-	315	ns
		V <sub>CC</sub> = 4.5 V	-	25	42	-	53	-	63	ns
		V <sub>CC</sub> = 6.0 V	-	20	36	-	45	-	54	ns
		PL to TCU, PL to TCD; see Fig. 13								
		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
MR to TCU, MR to TCD; see Fig. 13										
V <sub>CC</sub> = 2.0 V	-	74	285	-	355	-	430	ns		
V <sub>CC</sub> = 4.5 V	-	27	57	-	71	-	86	ns		
V <sub>CC</sub> = 6.0 V	-	22	48	-	60	-	73	ns		
Dn to TCU, Dn to TCD; see Fig. 13										
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		

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

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>THL</sub>	HIGH to LOW output transition time	see Fig. 11								
		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 Fig. 11								
		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 Fig. 8								
		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 Fig. 11								
		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
		PL LOW; see Fig. 10								
		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	PL to CPU, CPD; see Fig. 10								
		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 Fig. 11								
		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		
t <sub>su</sub>	set-up time	Dn to PL; see Fig. 12; 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 PL; see Fig. 12								
		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 Fig. 14								
		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		

Presetable synchronous 4-bit binary up/down counter

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
f <sub>max</sub>	maximum frequency	CPU, CPD; see Fig. 8								
		V <sub>CC</sub> = 2.0 V	4.0	13.5	-	3.2	-	2.6	-	MHz
		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> ; V <sub>CC</sub> = 5 V; [2] f <sub>i</sub> = 1 MHz	-	24	-	-	-	-	-	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):  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  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;  
 Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = 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 Fig. 8 [1]								
		V <sub>CC</sub> = 4.5 V	-	23	43	-	54	-	65	ns
		CPU to TCU; see Fig. 9								
		V <sub>CC</sub> = 4.5 V	-	15	27	-	34	-	41	ns
		CPD to TCD; see Fig. 9								
		V <sub>CC</sub> = 4.5 V	-	15	27	-	34	-	41	ns
		PL to Qn; see Fig. 10								
		V <sub>CC</sub> = 4.5 V	-	26	46	-	58	-	69	ns
		MR to Qn; see Fig. 11								
		V <sub>CC</sub> = 4.5 V	-	22	40	-	50	-	60	ns
		Dn to Qn; see Fig. 10								
		V <sub>CC</sub> = 4.5 V	-	27	46	-	58	-	69	ns
		PL to TCU, PL to TCD; see Fig. 13								
V <sub>CC</sub> = 4.5 V	-	31	55	-	69	-	83	ns		
MR to TCU, MR to TCD; see Fig. 13										
V <sub>CC</sub> = 4.5 V	-	29	55	-	69	-	83	ns		
Dn to TCU, Dn to TCD; see Fig. 13										
V <sub>CC</sub> = 4.5 V	-	32	58	-	73	-	87	ns		
t <sub>THL</sub>	HIGH to LOW output transition time	see Fig. 11								
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns
t <sub>TLH</sub>	LOW to HIGH output transition time	see Fig. 11								
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns

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

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>w</sub>	pulse width	CPU, CPD; HIGH or LOW; see Fig. 8								
		V <sub>CC</sub> = 4.5 V	25	11	-	31	-	38	-	ns
		MR HIGH; see Fig. 11								
		V <sub>CC</sub> = 4.5 V	20	7	-	25	-	30	-	ns
		$\overline{\text{PL}}$ LOW; see Fig. 10								
V <sub>CC</sub> = 4.5 V	20	8	-	25	-	30	-	ns		
t <sub>rec</sub>	recovery time	$\overline{\text{PL}}$ to CPU, CPD; see Fig. 10								
		V <sub>CC</sub> = 4.5 V	10	2	-	13	-	15	-	ns
		MR to CPU, CPD; see Fig. 11								
		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 Fig. 12; 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 Fig. 12								
		V <sub>CC</sub> = 4.5 V	0	-6	-	0	-	0	-	ns
		CPU to CPD, CPD to CPU; see Fig. 14								
V <sub>CC</sub> = 4.5 V	16	7	-	20	-	24	-	ns		
f <sub>max</sub>	maximum frequency	CPU, CPD; see Fig. 8								
		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> - 1.5 V; [2] 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;

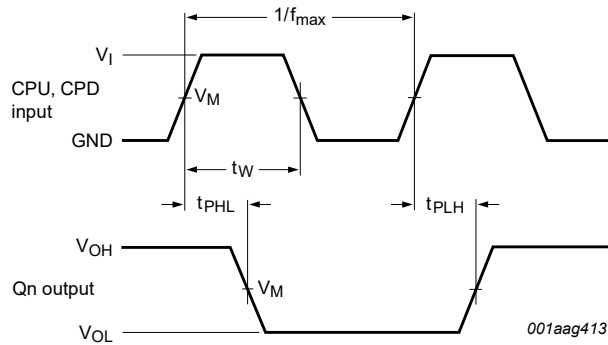
C<sub>L</sub> = output load capacitance in pF;

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.

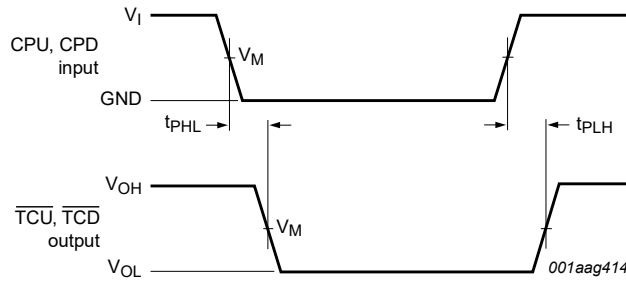
10.1. Waveforms and test circuit



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

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

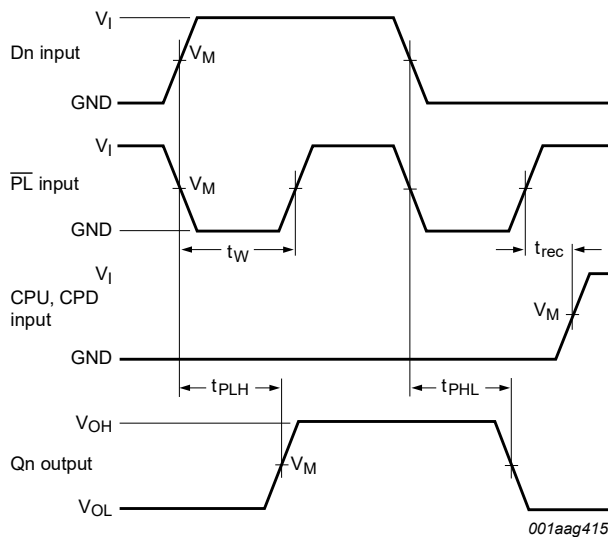
**Fig. 8. The clock (CPU, CPD) to output (Qn) propagation delays, the clock pulse width, and the maximum clock pulse frequency**



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

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

**Fig. 9. The clock (CPU, CPD) to terminal count output (TCU, TCD) propagation delays**

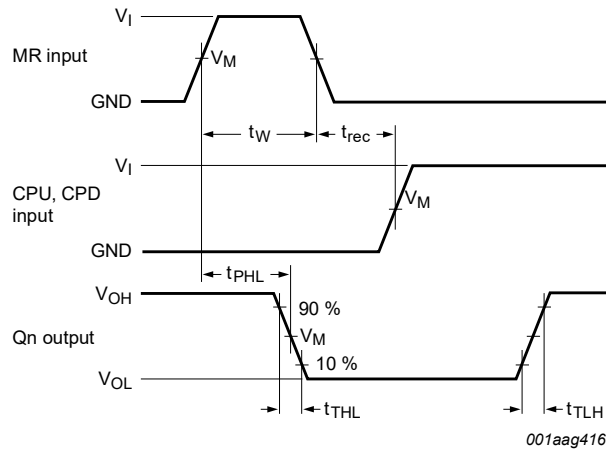


Measurement points are given in [Table 10](#).

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

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

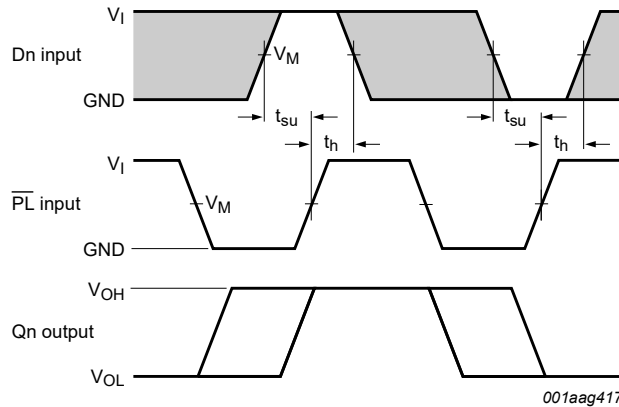




Measurement points are given in [Table 10](#).

$V_{OL}$  and  $V_{OH}$  are typical voltage output 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**

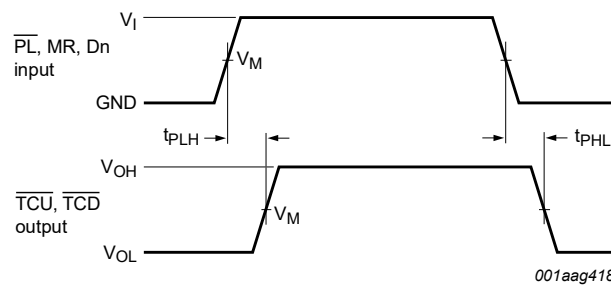


Measurement points are given in [Table 10](#).

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

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

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



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

$V_{OL}$  and  $V_{OH}$  are typical voltage output 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**

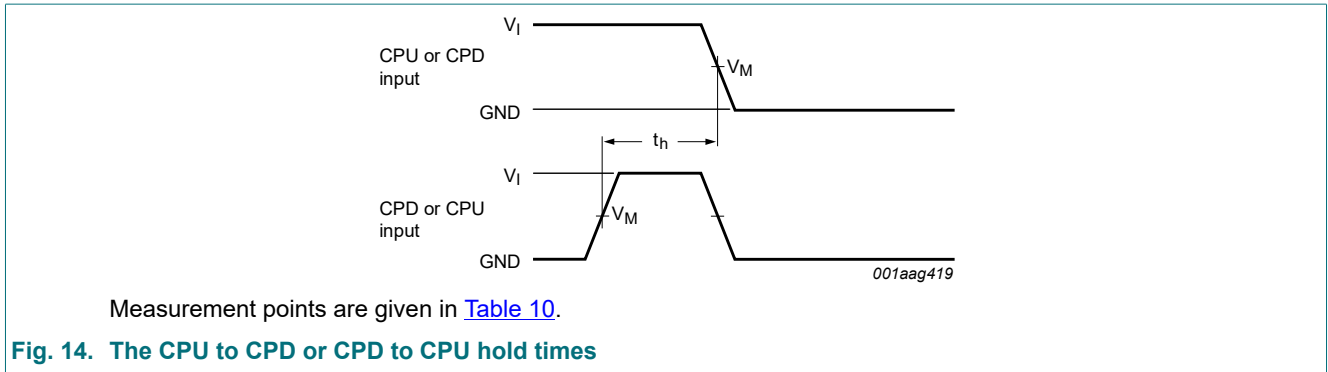


Table 10. Measurement points

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

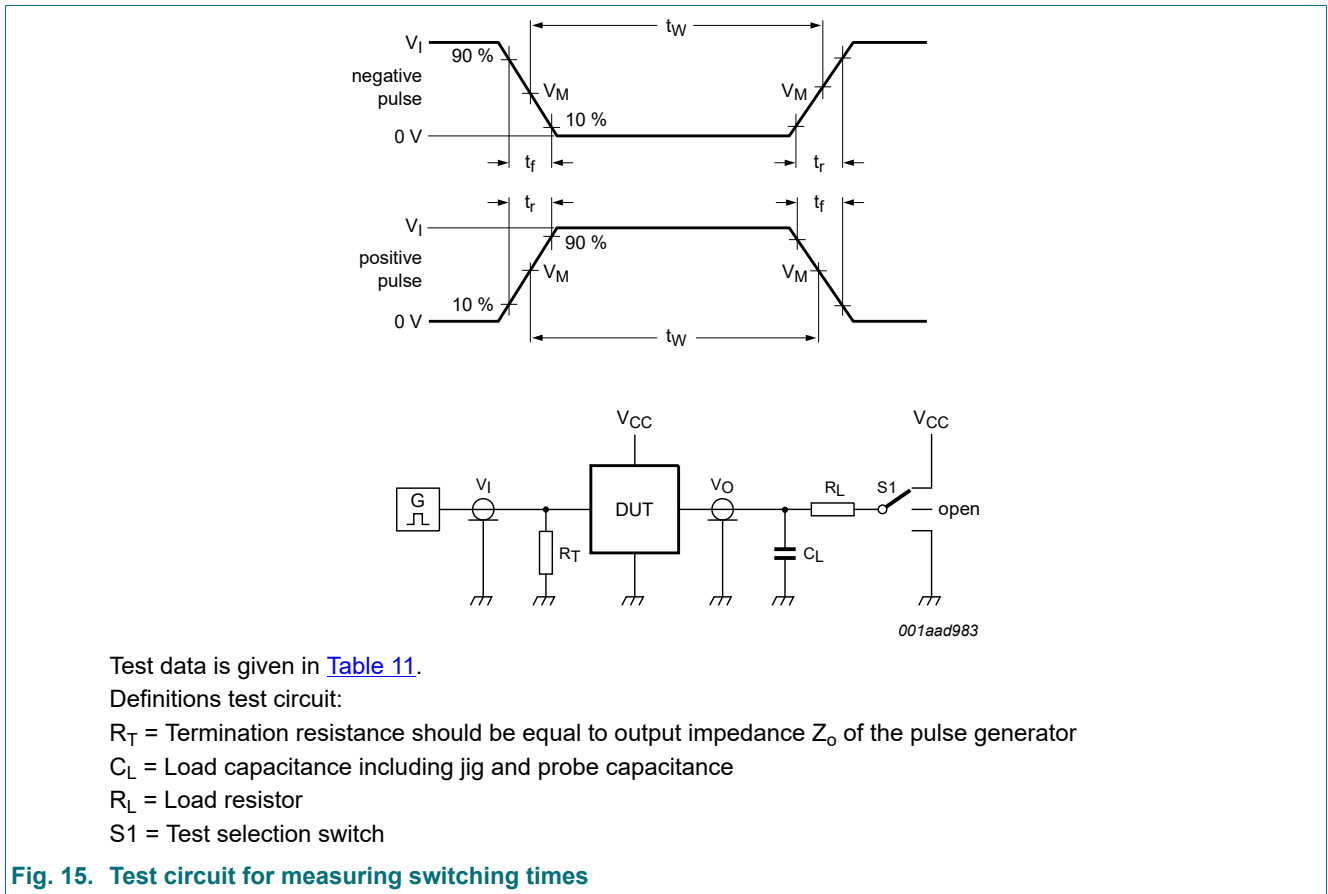


Table 11. Test data

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 kΩ	open
74HCT193-Q100	3 V	6 ns	15 pF, 50 pF	1 kΩ	open

## 11. Application information

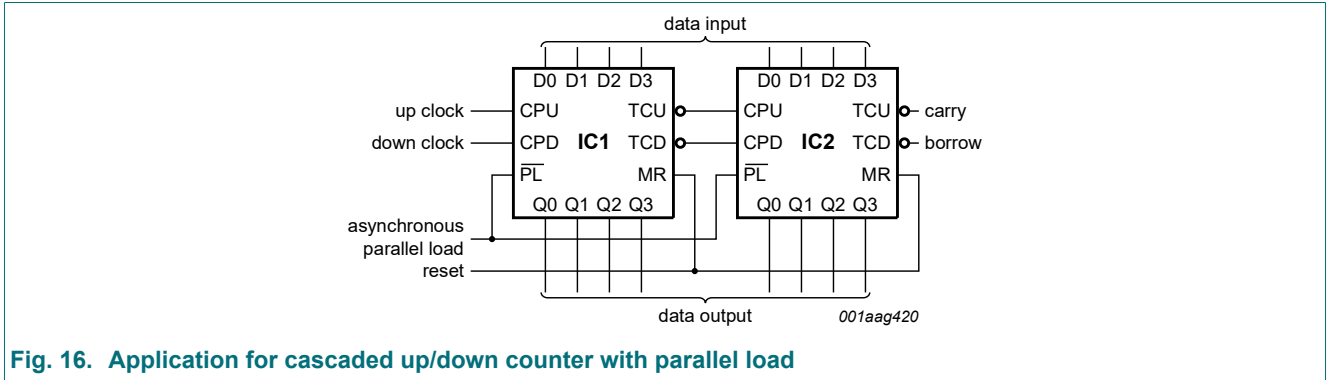


Fig. 16. Application for cascaded up/down counter with parallel load

12. Package outline

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

SOT109-1

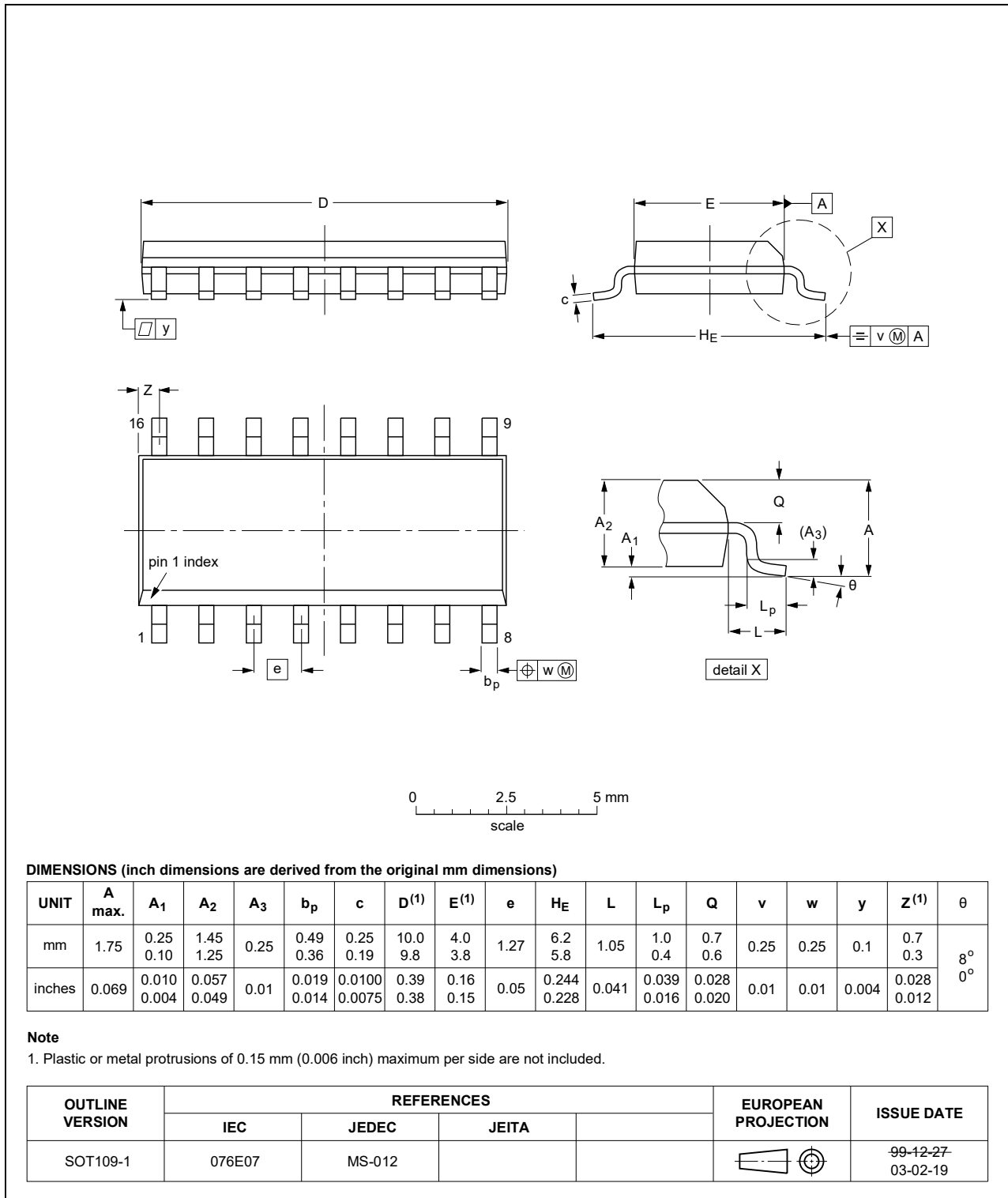


Fig. 17. Package outline SOT109-1 (SO16)

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

SOT338-1

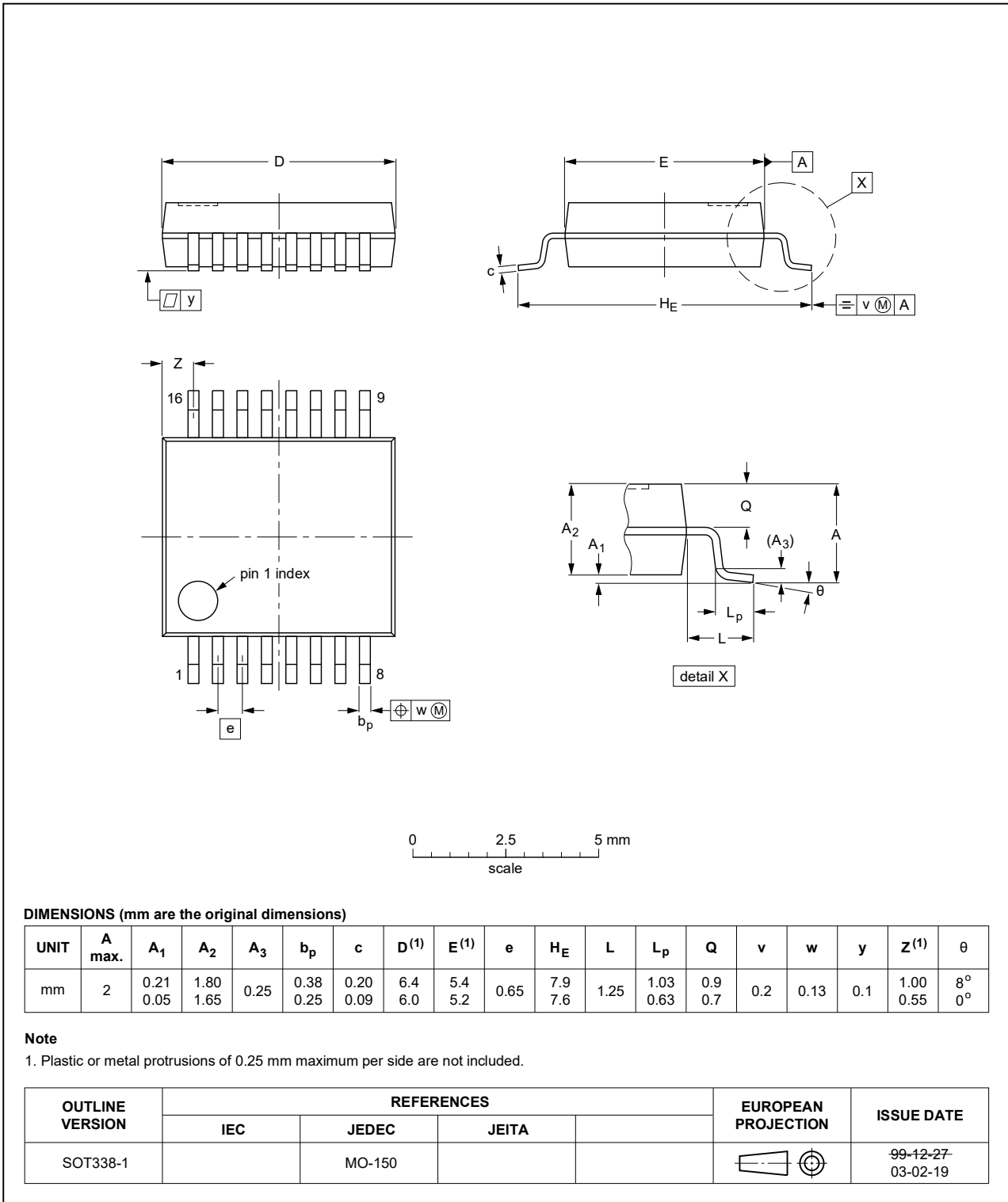


Fig. 18. Package outline SOT338-1 (SSOP16)

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

SOT403-1

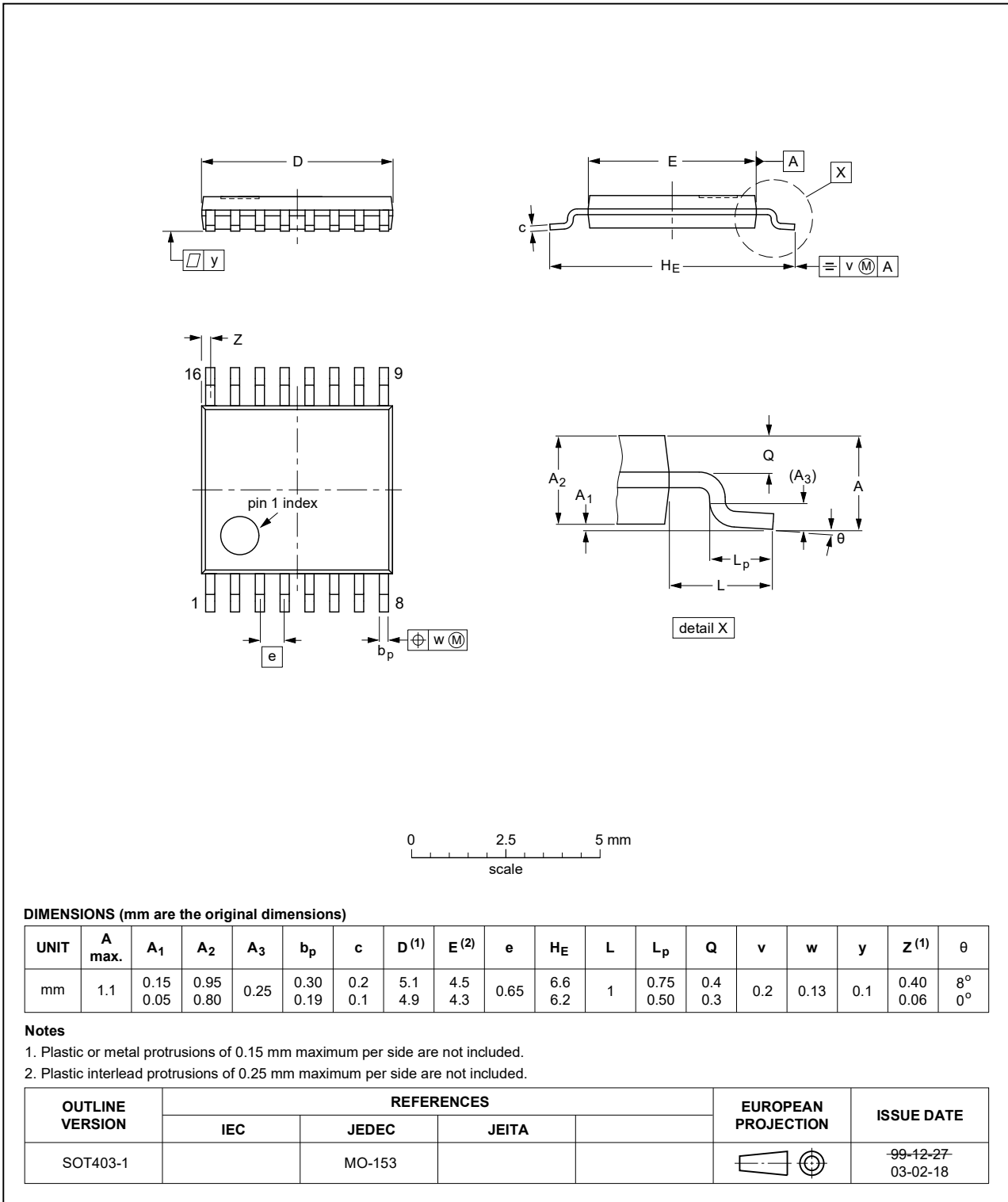


Fig. 19. Package outline SOT403-1 (TSSOP16)

## 13. Abbreviations

Table 12. 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 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT193_Q100 v.2	20210205	Product data sheet	-	74HC_HCT193_Q100 v.1
Modifications:	<ul style="list-style-type: none"> <li>Type number 74HC193DB-Q100 (SOT338-1 / SSOP16) removed.</li> <li><a href="#">Section 7</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> </ul>			
74HC_HCT193_Q100 v.1	20130712	Product data sheet	-	-

## 15. Legal information

### 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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