

74HC123-Q100; 74HCT123-Q100

Dual retriggerable monostable multivibrator with reset

Rev. 3.1 — 3 September 2020

Product data sheet

1. General description

The 74HC123-Q100; 74HCT123-Q100 is a dual retriggerable monostable multivibrator with reset. The basic output pulse width is programmed by selection of external components (R_{EXT} and C_{EXT}). Once triggered this basic pulse width may be extended by retriggering either of the edge triggered inputs (nA or nB). By repeating this process, the output pulse period ($nQ = HIGH$, $n\bar{Q} = LOW$) can be made as long as desired. Alternatively, an output delay can be terminated at any time by a LOW-going edge on input $n\bar{RD}$. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

Schmitt-trigger action in the $n\bar{A}$ and nB inputs, makes the circuit highly tolerant to slower input rise and fall times.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Wide supply voltage range from 2.0 V to 6.0 V
- CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Complies with JEDEC standards:
 - JESD8C (2.7 V to 3.6 V)
 - JESD7A (2.0 V to 6.0 V)
- Input levels:
 - For 74HC123-Q100: CMOS level
 - For 74HCT123-Q100: TTL level
- DC triggered from active HIGH or active LOW inputs
- Retriggerable for very long pulses up to 100 % duty factor
- Direct reset terminates output pulse
- Schmitt-trigger action on all inputs except for the reset input
- 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
- DHVQFN package with Side-Wettable Flanks enabling Automatic Optical Inspection (AOI) of solder joints

3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC123D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT123D-Q100				
74HC123PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT123PW-Q100				
74HC123BQ-Q100	-40 °C to +125 °C	DHVQFN16	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 × 3.5 × 0.85 mm	SOT763-1

4. Functional diagram

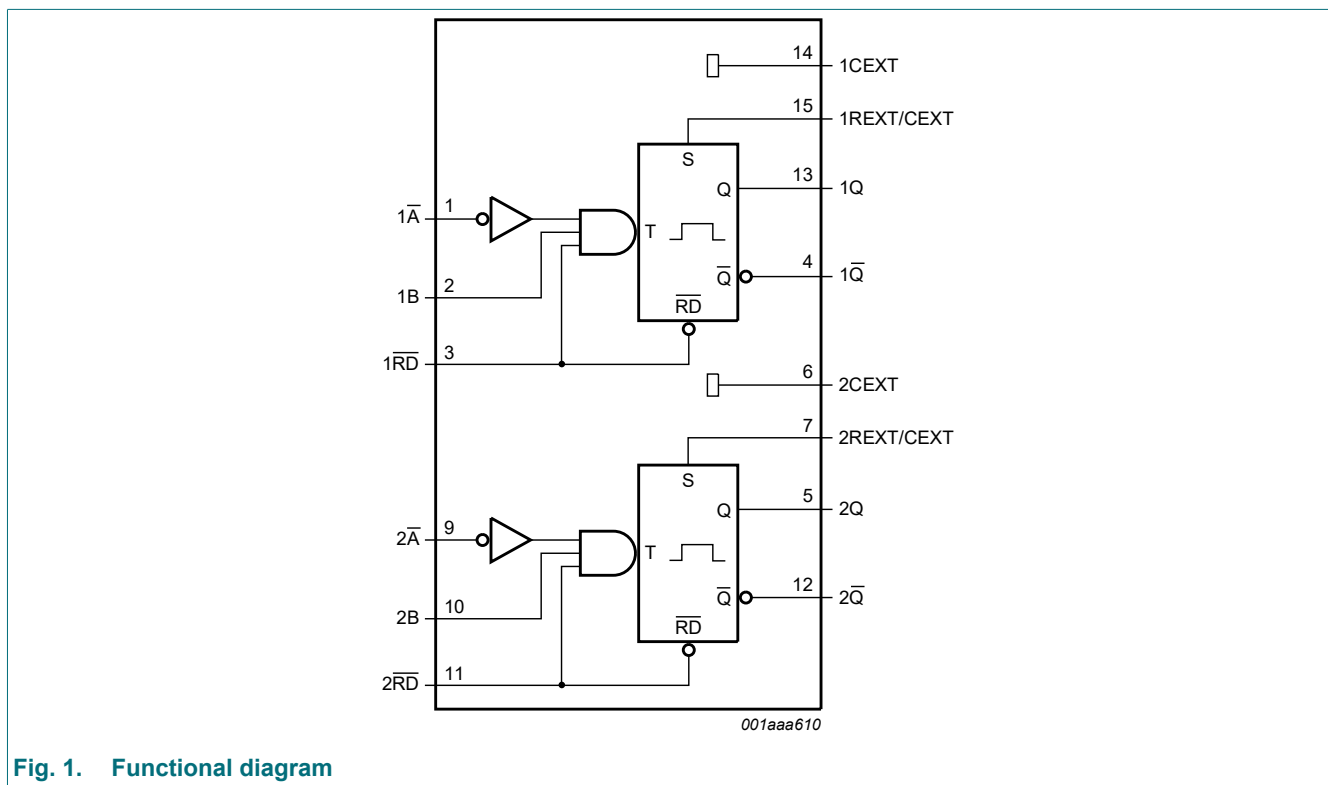


Fig. 1. Functional diagram

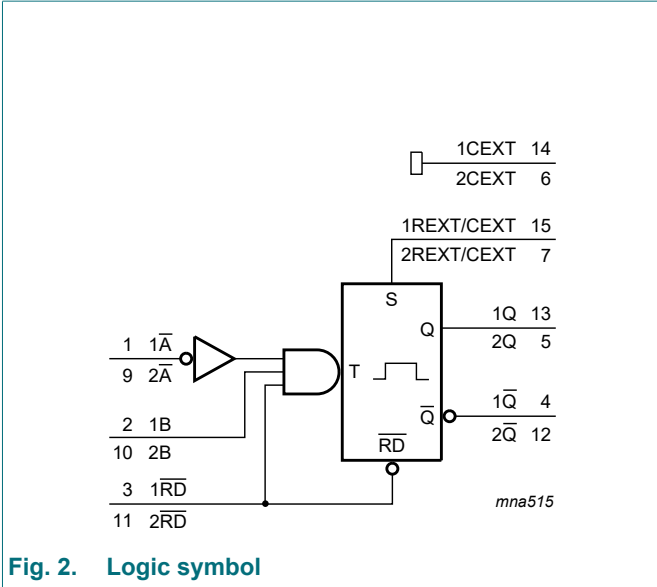


Fig. 2. Logic symbol

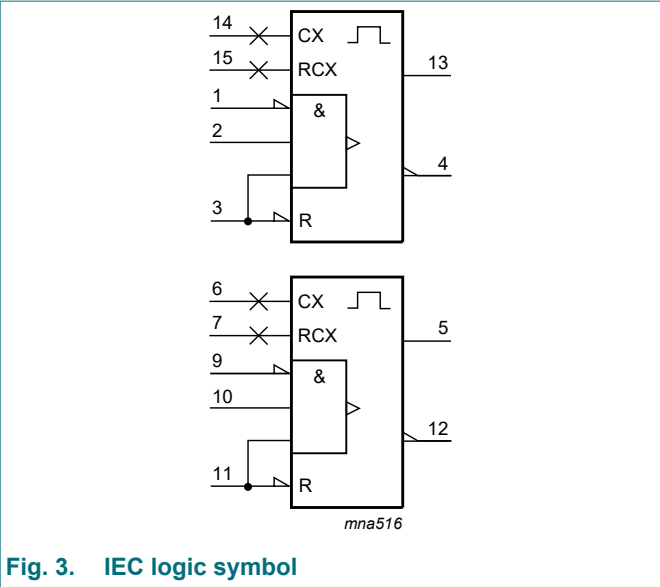


Fig. 3. IEC logic symbol

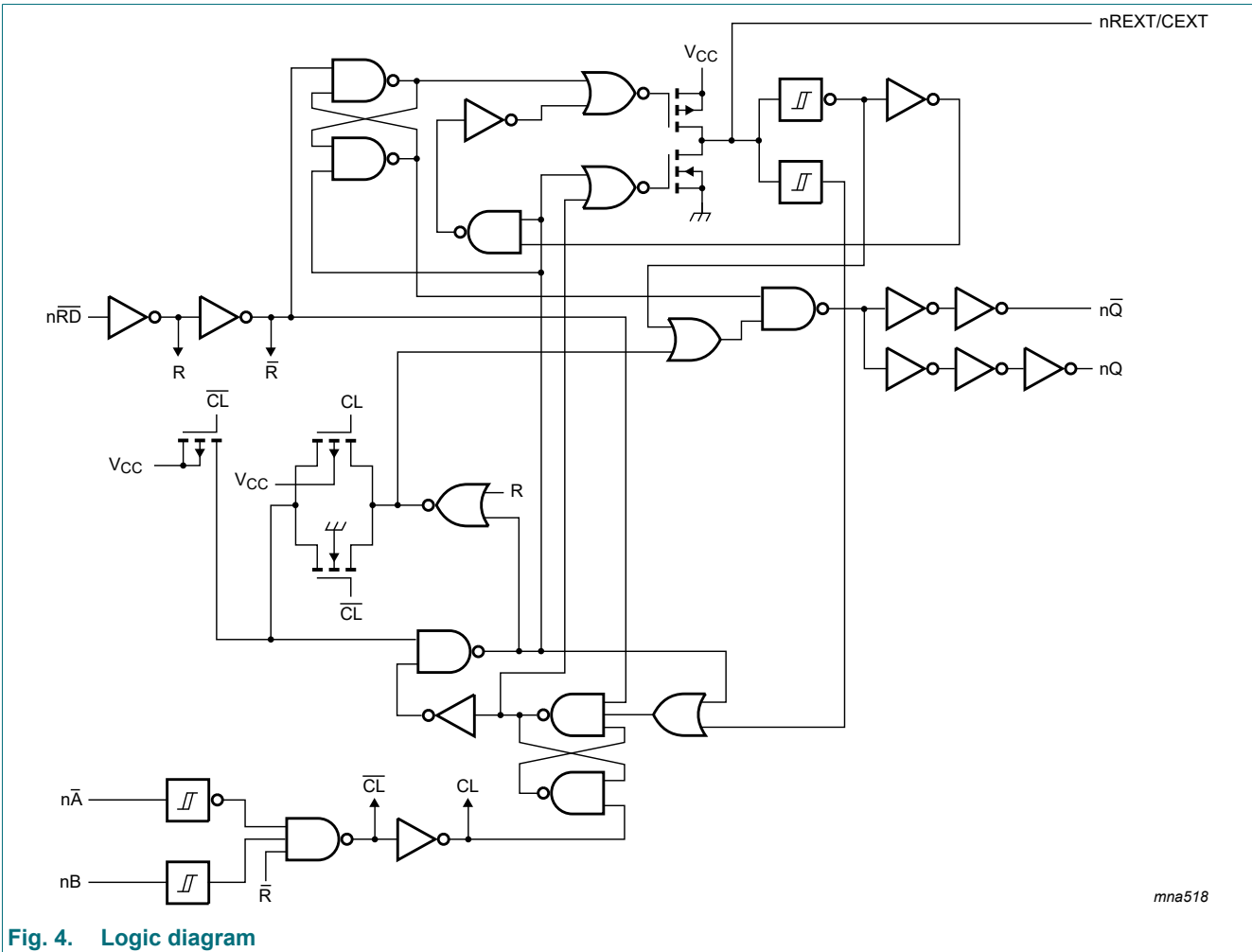
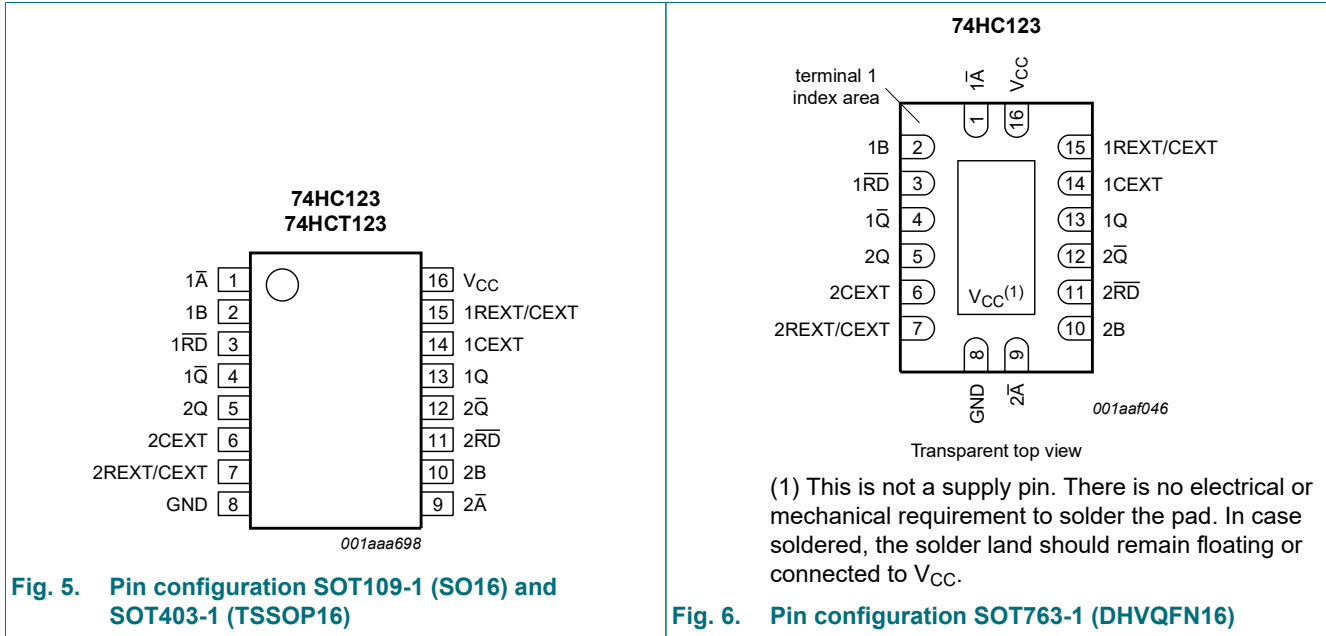


Fig. 4. Logic diagram

5. Pinning information

5.1. Pinning





5.2. Pin description







Table 2. Pin description

Symbol	Pin	Description
1 \bar{A}	1	negative-edge triggered input 1
1B	2	positive-edge triggered input 1
1 \bar{RD}	3	direct reset LOW and positive-edge triggered input 1
1 \bar{Q}	4	active LOW output 1
2Q	5	active HIGH output 2
2CEXT	6	external capacitor connection 2
2REXT/CEXT	7	external resistor and capacitor connection 2
GND	8	ground (0 V)
2 \bar{A}	9	negative-edge triggered input 2
2B	10	positive-edge triggered input 2
2 \bar{RD}	11	direct reset LOW and positive-edge triggered input 2
2 \bar{Q}	12	active LOW output 2
1Q	13	active HIGH output 1
1CEXT	14	external capacitor connection 1
1REXT/CEXT	15	external resistor and capacitor connection 1
V _{CC}	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 transition; ↓ = HIGH-to-LOW transition;  = one HIGH level output pulse;  = one LOW level output pulse.

Input			Output	
nRD	nA	nB	nQ	nQ
L	X	X	L	H
X	H	X	L [1]	H [1]
X	X	L	L [1]	H [1]
H	L	↑		
H	↓	H		
↑	L	H		

[1] If the monostable was triggered before this condition was established, the pulse will continue as programmed.

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	except for pins nREXT/CEXT; V _O = -0.5 V to (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		[1]	500	mW

[1] For SOT109-1 (SO16) package: P_{tot} derates linearly with 12.4 mW/K above 110 °C.
 For SOT403-1 (TSSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C.
 For SOT763-1 (DHVQFN16) package: P_{tot} derates linearly with 11.2 mW/K above 106 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	74HC123-Q100			74HCT123-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
Δt/ΔV	input transition rise and fall rate	nRD input							
		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
T _{amb}	ambient temperature		-40	+25	+125	-40	+25	+125	°C

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	
74HC123-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 mA; V _{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
I _O = -5.2 mA; V _{CC} = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	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 mA; V _{CC} = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
I _O = 5.2 mA; V _{CC} = 6.0 V	-	0.16	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	-	±1.0	-	±1.0	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

Dual retriggerable monostable multivibrator with reset

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HCT123-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 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	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA	-	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	-	±1.0	-	±1.0	µA
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; I _O = 0 A; V _I = V _{CC} - 2.1 V; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V								
		pins n \bar{A} , nB	-	35	125	-	160	-	170	µA
		pin nRD	-	50	180	-	225	-	245	µA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit see Fig. 12.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC123-Q100										
t_{pd}	propagation delay	nRD, nA, nB to nQ or nQ; $C_{EXT} = 0$ pF; $R_{EXT} = 5$ kΩ; see Fig. 9 [1]								
		$V_{CC} = 2.0$ V	-	83	255	-	320	-	385	ns
		$V_{CC} = 4.5$ V	-	30	51	-	64	-	77	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	26	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	24	43	-	54	-	65	ns
		nRD (reset) to nQ or nQ; $C_{EXT} = 0$ pF; $R_{EXT} = 5$ kΩ; see Fig. 9								
		$V_{CC} = 2.0$ V	-	66	215	-	270	-	325	ns
		$V_{CC} = 4.5$ V	-	24	43	-	54	-	65	ns
t_t	transition time	see Fig. 9 [1]								
		$V_{CC} = 2.0$ 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
t_w	pulse width	nA LOW; see Fig. 10								
		$V_{CC} = 2.0$ V	100	8	-	125	-	150	-	ns
		$V_{CC} = 4.5$ V	20	3	-	25	-	30	-	ns
		$V_{CC} = 6.0$ V	17	2	-	21	-	26	-	ns
		nB HIGH; see Fig. 10								
		$V_{CC} = 2.0$ V	100	17	-	125	-	150	-	ns
		$V_{CC} = 4.5$ V	20	6	-	25	-	30	-	ns
		$V_{CC} = 6.0$ V	17	5	-	21	-	26	-	ns
		nRD LOW; see Fig. 11								
		$V_{CC} = 2.0$ V	100	14	-	125	-	150	-	ns
		$V_{CC} = 4.5$ V	20	5	-	25	-	30	-	ns
		$V_{CC} = 6.0$ V	17	4	-	21	-	26	-	ns
		nQ HIGH and nQ LOW; $V_{CC} = 5.0$ V; see Fig. 10 and Fig. 11 [2]								
$C_{EXT} = 100$ nF; $R_{EXT} = 10$ kΩ	-	450	-	-	-	-	-	μs		
$C_{EXT} = 0$ pF; $R_{EXT} = 5$ kΩ	-	75	-	-	-	-	-	ns		
t_{trig}	retrigger time	nA, nB; $C_{EXT} = 0$ pF; $R_{EXT} = 5$ kΩ; $V_{CC} = 5.0$ V; see Fig. 10 [3] [4]	-	110	-	-	-	-	-	ns

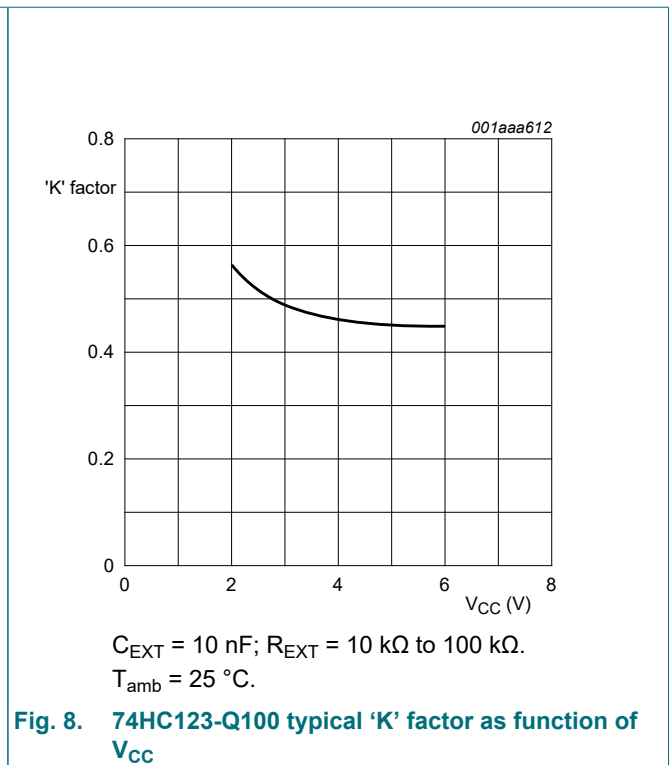
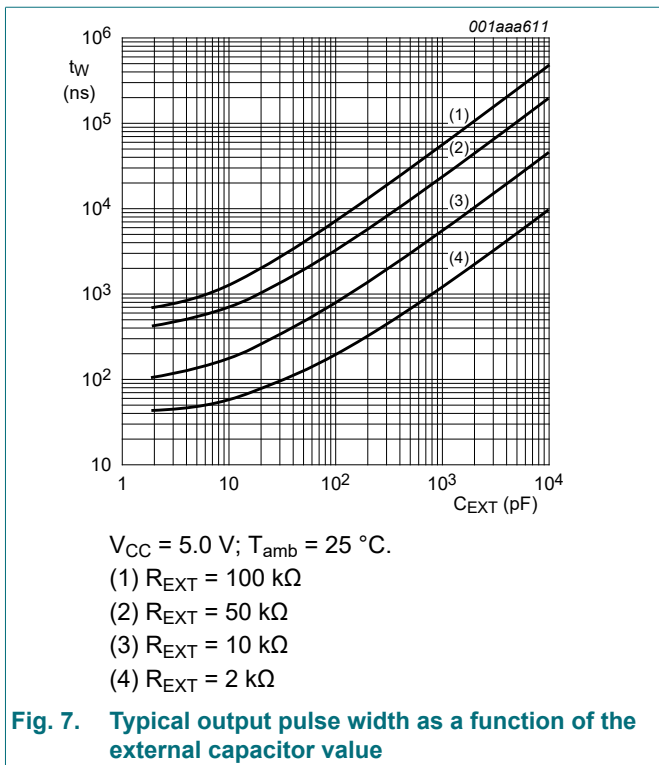
Dual retriggerable monostable multivibrator with reset

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit	
			Min	Typ	Max	Min	Max	Min	Max		
R _{EXT}	external timing resistor	see Fig. 7									
		V _{CC} = 2.0 V	10	-	1000	-	-	-	-	kΩ	
		V _{CC} = 5.0 V	2	-	1000	-	-	-	-	kΩ	
C _{EXT}	external timing capacitor	V _{CC} = 5.0 V; see Fig. 7	[4]	-	-	-	-	-	-	pF	
C _{PD}	power dissipation capacitance	per monostable; V _I = GND to V _{CC}	[5]	-	54	-	-	-	-	pF	
74HCT123-Q100											
t _{PHL}	HIGH to LOW propagation delay	nRD, nA, nB to nQ or nQ; C _{EXT} = 0 pF; R _{EXT} = 5 kΩ; see Fig. 9									
		V _{CC} = 4.5 V	-	30	51	-	64	-	77	ns	
		V _{CC} = 5 V; C _L = 15 pF	-	26	-	-	-	-	-	-	ns
		nRD (reset) to nQ or nQ; C _{EXT} = 0 pF; R _{EXT} = 5 kΩ; see Fig. 9									
		V _{CC} = 4.5 V	-	27	46	-	58	-	69	ns	
		V _{CC} = 5 V; C _L = 15 pF	-	23	-	-	-	-	-	ns	
t _{PLH}	LOW to HIGH propagation delay	nRD, nA, nB to nQ or nQ; C _{EXT} = 0 pF; R _{EXT} = 5 kΩ; see Fig. 9									
		V _{CC} = 4.5 V	-	28	51	-	64	-	77	ns	
		V _{CC} = 5 V; C _L = 15 pF	-	26	-	-	-	-	-	-	ns
		nRD (reset) to nQ or nQ; C _{EXT} = 0 pF; R _{EXT} = 5 kΩ; see Fig. 9									
		V _{CC} = 4.5 V	-	23	46	-	58	-	69	ns	
		V _{CC} = 5 V; C _L = 15 pF	-	23	-	-	-	-	-	ns	
t _t	transition time	V _{CC} = 4.5 V; see Fig. 9	[1]	-	7	15	-	19	-	22	ns
t _w	pulse width	V _{CC} = 4.5 V									
		nA LOW; see Fig. 10	20	3	-	25	-	30	-	ns	
		nB HIGH; see Fig. 10	20	5	-	25	-	30	-	ns	
		nRD LOW; see Fig. 11	20	7	-	25	-	30	-	ns	
		nQ HIGH and nQ LOW; V _{CC} = 5.0 V; see Fig. 10 and Fig. 11	[2]								
		C _{EXT} = 100 nF; R _{EXT} = 10 kΩ	-	450	-	-	-	-	-	-	μs
		C _{EXT} = 0 pF; R _{EXT} = 5 kΩ	-	75	-	-	-	-	-	ns	
t _{trig}	retrigger time	nA, nB; C _{EXT} = 0 pF; R _{EXT} = 5 kΩ; V _{CC} = 5.0 V; see Fig. 10	[3] [4]	-	110	-	-	-	-	-	ns
R _{EXT}	external timing resistor	V _{CC} = 5.0 V; see Fig. 7		2	-	1000	-	-	-	-	kΩ
C _{EXT}	external timing capacitor	V _{CC} = 5.0 V; see Fig. 7	[4]	-	-	-	-	-	-	-	pF

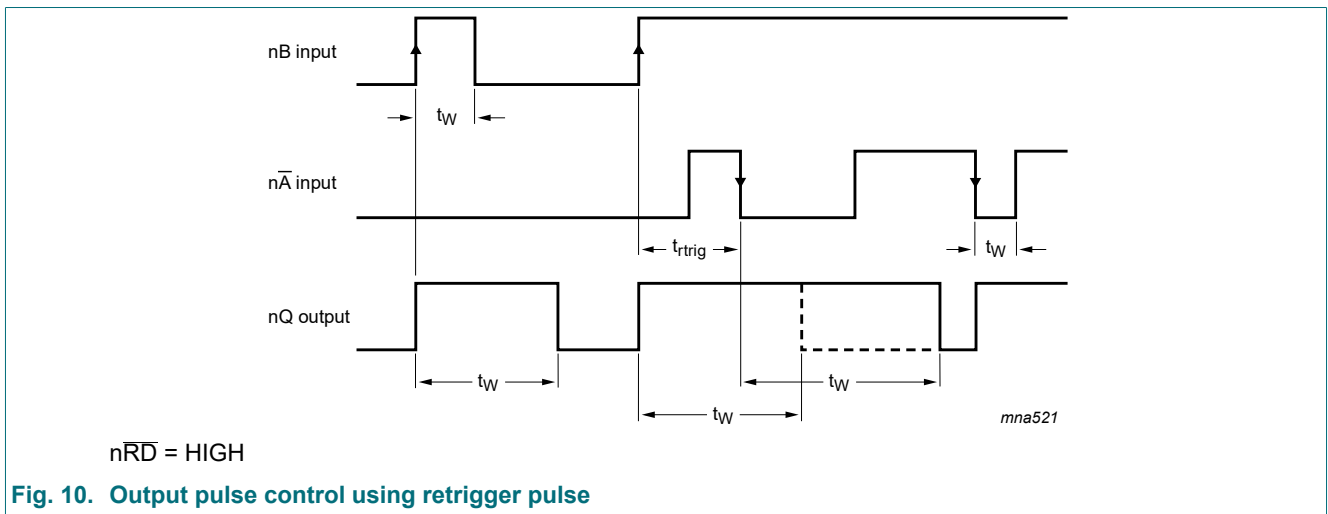
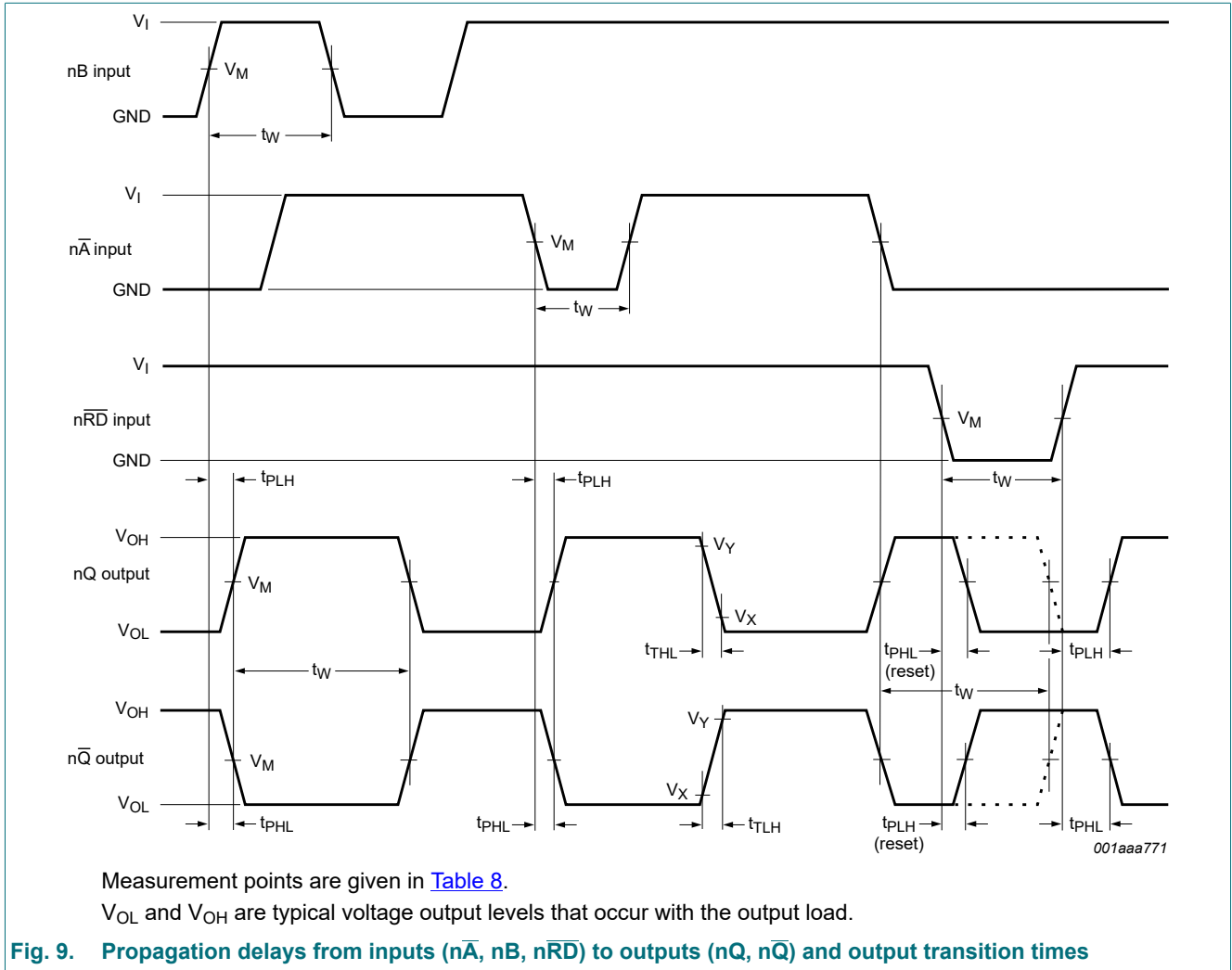
Dual retriggerable monostable multivibrator with reset

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
C _{PD}	power dissipation capacitance	per monostable; V _I = GND to V _{CC} - 1.5 V	[5]	-	56	-	-	-	-	pF

- [1] t_{pd} is the same as t_{PHL} and t_{PLH}; t_i is the same as t_{THL} and t_{TLH}
- [2] For other R_{EXT} and C_{EXT} combinations see Fig. 7. If C_{EXT} > 10 nF, the next formula is valid.
 $t_W = K \times R_{EXT} \times C_{EXT}$, where:
 t_W = typical output pulse width in ns;
 R_{EXT} = external resistor in kΩ;
 C_{EXT} = external capacitor in pF;
 K = constant = 0.45 for V_{CC} = 5.0 V and 0.55 for V_{CC} = 2.0 V.
 The inherent test jig and pin capacitance at pins 15 and 7 (nR_{EXT}/C_{EXT}) is approximately 7 pF.
- [3] The time to retrigger the monostable multivibrator depends on the values of R_{EXT} and C_{EXT}. The output pulse width will only be extended when the time between the active-going edges of the trigger input pulses meets the minimum retrigger time. If C_{EXT} > 10 pF, the next formula (at V_{CC} = 5.0 V) for the setup time of a retrigger pulse is valid:
 $t_{trig} = 30 + 0.19 \times R_{EXT} \times C_{EXT}^{0.9} + 13 \times R_{EXT}^{1.05}$, where:
 t_{trig} = retrigger time in ns;
 C_{EXT} = external capacitor in pF; R_{EXT} = external resistor in kΩ.
 The inherent test jig and pin capacitance at pins 15 and 7 (nR_{EXT}/C_{EXT}) is 7 pF.
- [4] When the device is powered-up, initiate the device via a reset pulse, when C_{EXT} < 50 pF.
- [5] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma(C_L \times V_{CC}^2 \times f_o) + 0.75 \times C_{EXT} \times V_{CC}^2 \times f_o + D \times 16 \times V_{CC}$ where:
 f_i = input frequency in MHz;
 f_o = output frequency in MHz;
 D = duty factor in %;
 C_L = output load capacitance in pF;
 V_{CC} = supply voltage in V;
 C_{EXT} = timing capacitance in pF;
 Σ(C_L × V_{CC}² × f_o) sum of outputs.



10.1. Waveforms and test circuit



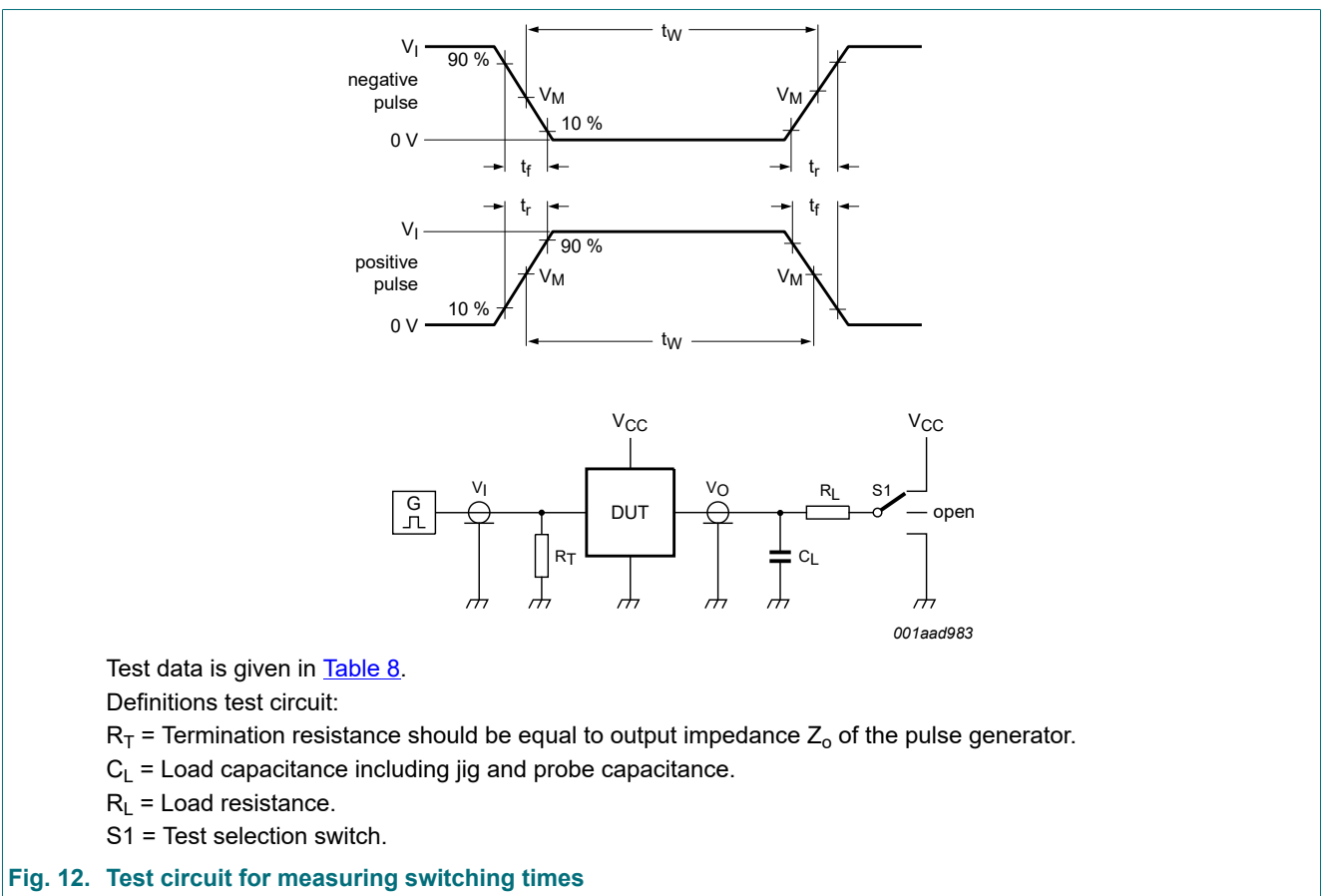
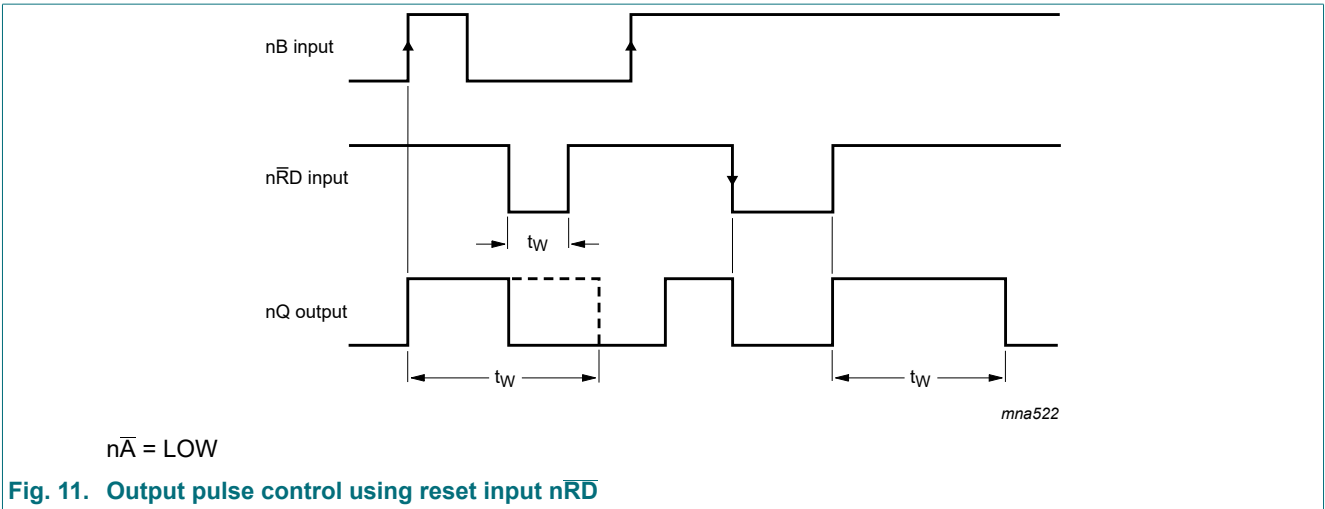


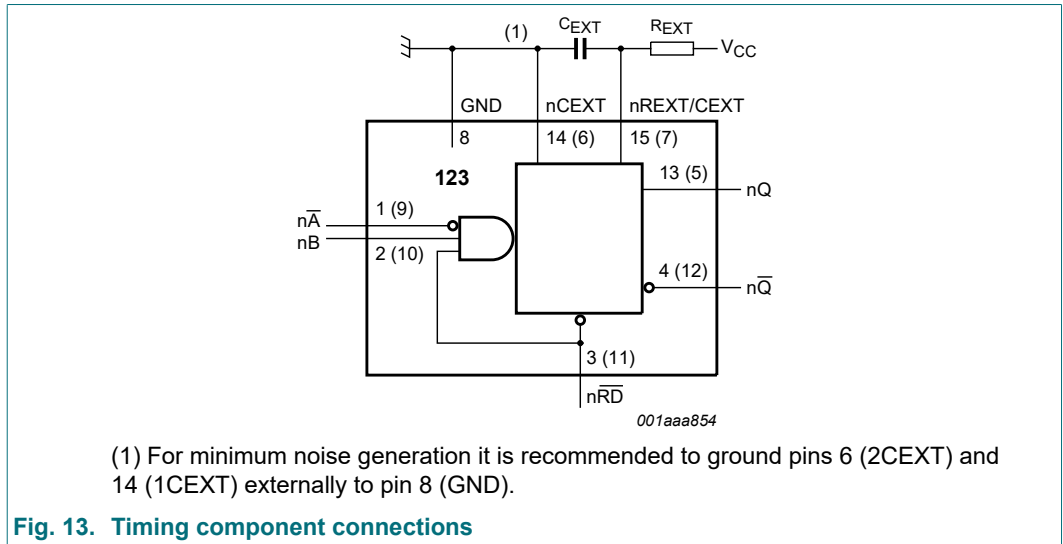
Table 8. Test data

Type	Input		Load		S1 position
	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}
74HC123-Q100	V_{CC}	6 ns	15 pF, 50 pF	1 k Ω	open
74HCT123-Q100	3 V	6 ns	15 pF, 50 pF	1 k Ω	open

11. Application information

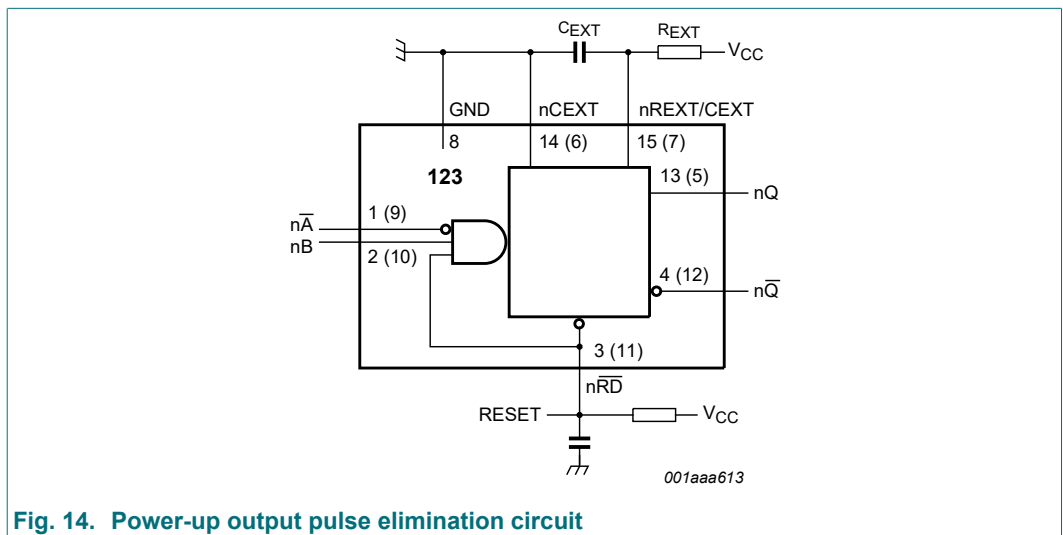
11.1. Timing component connections

The basic output pulse width is essentially determined by the values of the external timing components R_{EXT} and C_{EXT} .



11.2. Power-up considerations

When the monostable is powered-up it may produce an output pulse, with a pulse width defined by the values of R_{EXT} and C_{EXT} . This output pulse can be eliminated using the circuit shown in [Fig. 14](#).



11.3. Power-down considerations

A large capacitor C_{EXT} may cause problems when powering-down the monostable due to the energy stored in this capacitor. When a system containing this device is powered-down or a rapid decrease of V_{CC} to zero occurs, the monostable may sustain damage, due to the capacitor discharging through the input protection diodes. To avoid this possibility, use a damping diode (D_{EXT}) preferably a germanium or Schottky type diode able to withstand large current surges and connect as shown in [Fig. 15](#).

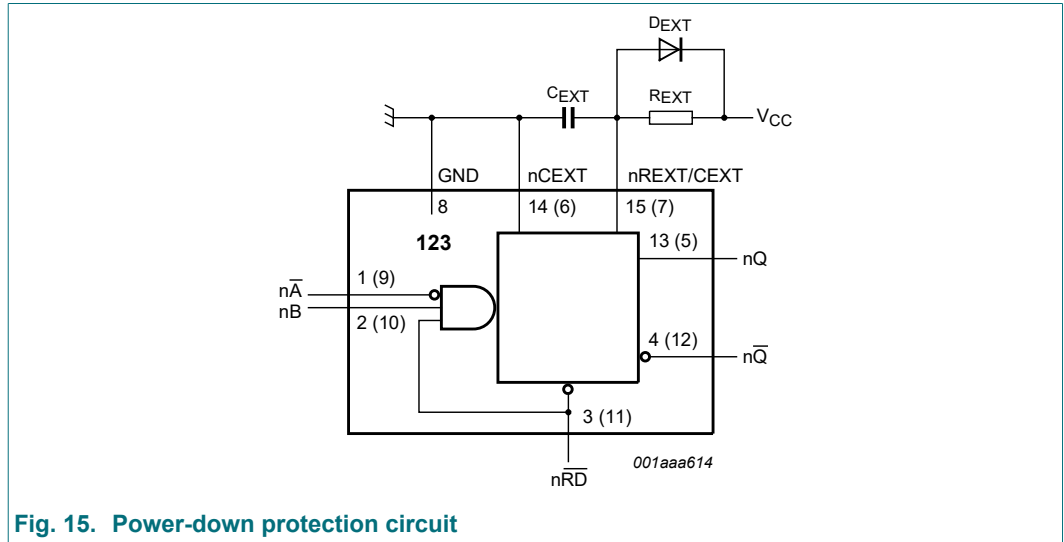


Fig. 15. Power-down protection circuit

12. Package outline

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

SOT109-1

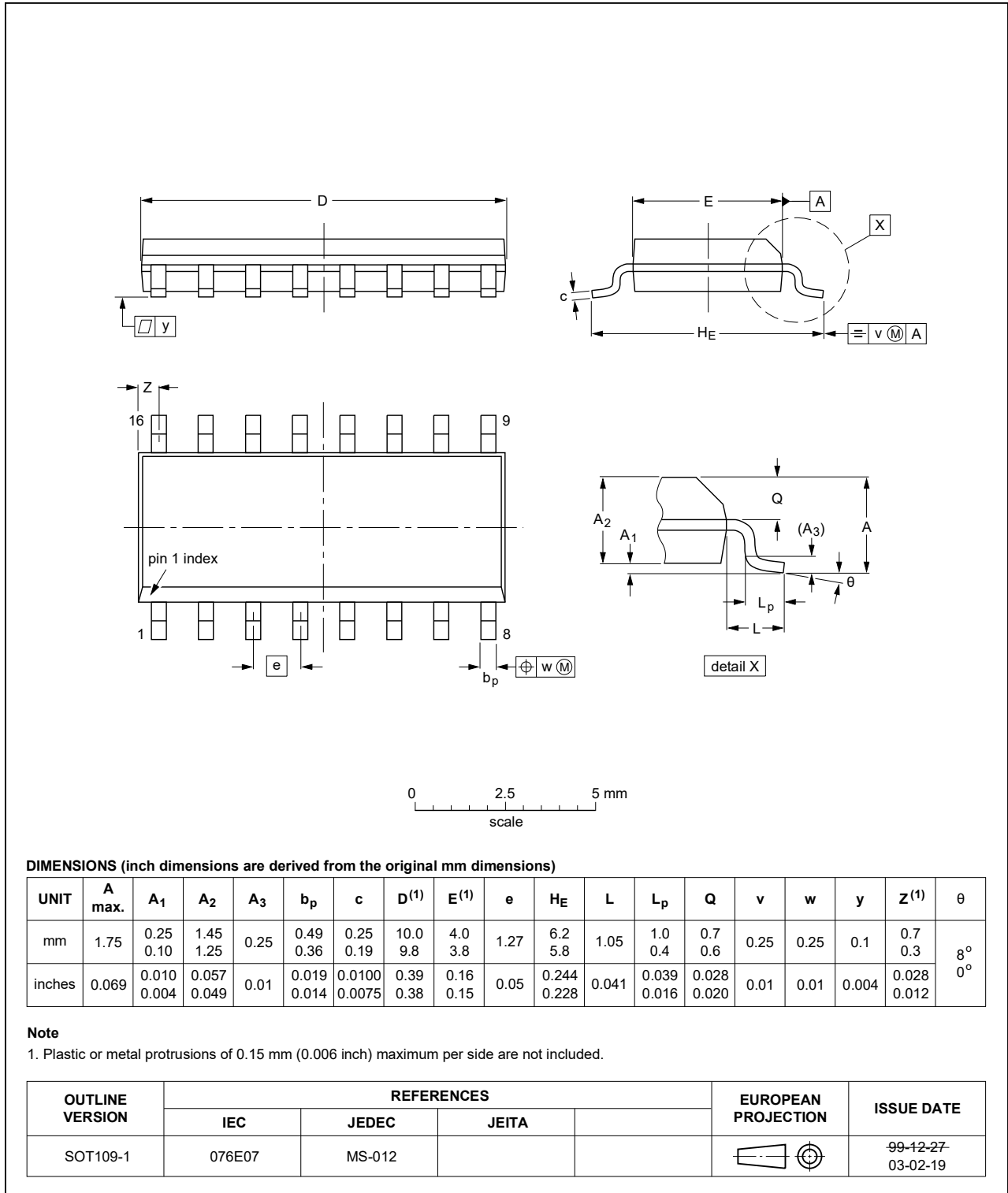


Fig. 16. Package outline SOT109-1 (SO16)

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

SOT403-1

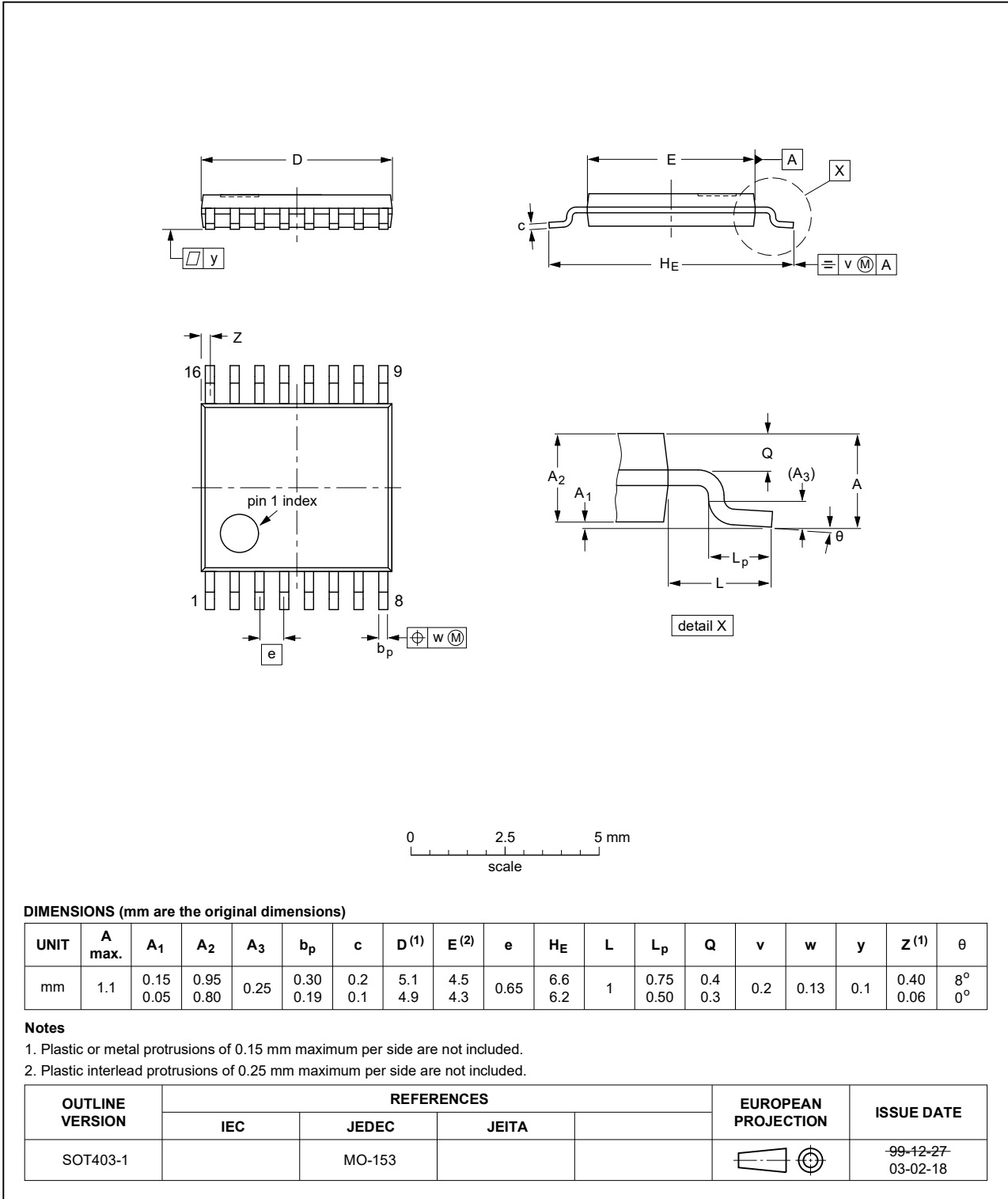


Fig. 17. Package outline SOT403-1 (TSSOP16)

DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 x 3.5 x 0.85 mm

SOT763-1

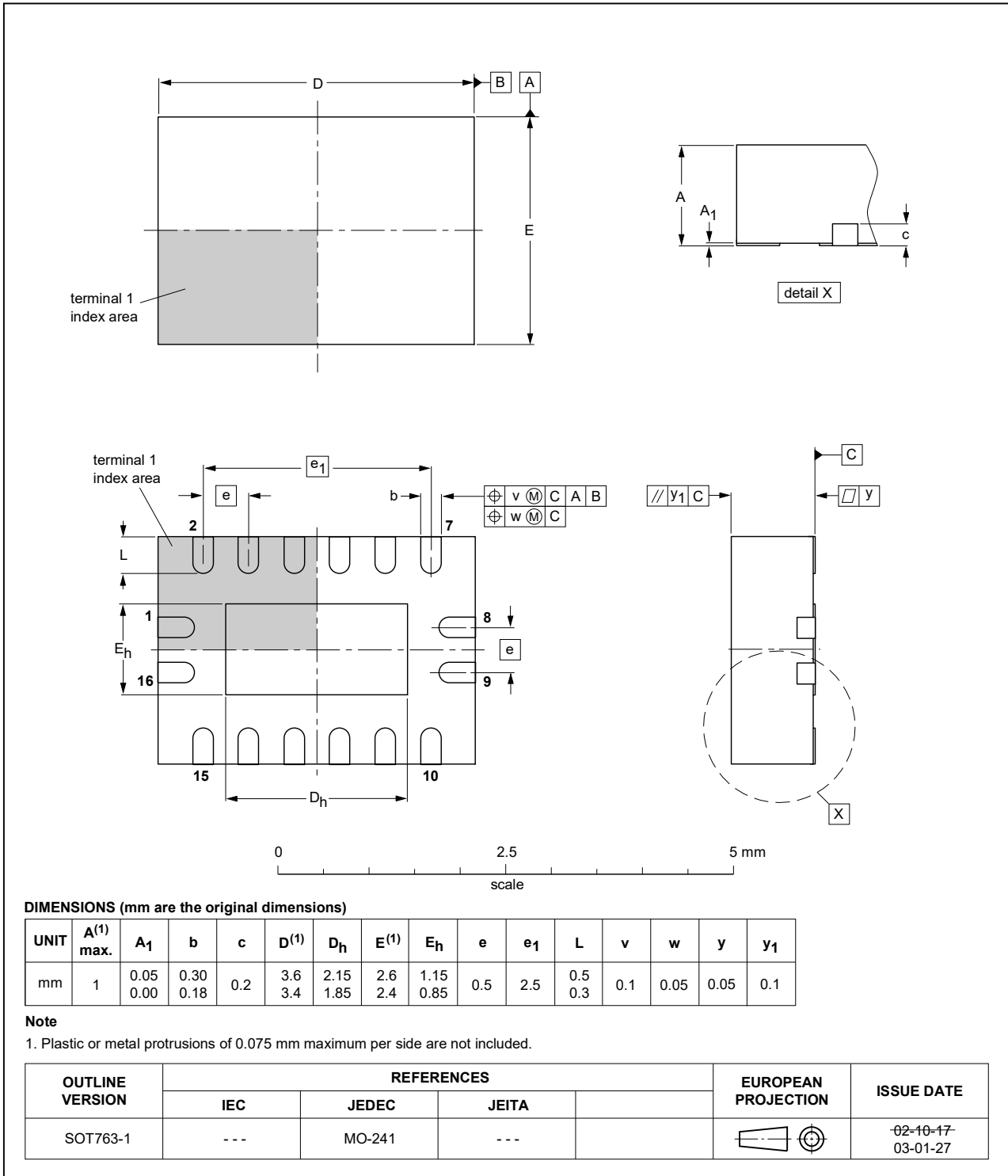


Fig. 18. Package outline SOT763-1 (DHVQFN16)

13. Abbreviations

Table 9. Abbreviations

Acronym	Abbreviation
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 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT123_Q100 v.3	20200903	Product data sheet	-	74HC_HCT123_Q100 v.2
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Section 1 and Section 2 updated. Table 4: Derating values for P_{tot} total power dissipation have been updated. 			
74HC_HCT123_Q100 v.2	20150119	Product data sheet	-	74HC_HCT123_Q100 v.1
Modifications:	<ul style="list-style-type: none"> Table 7: Power dissipation capacitance condition for 74HCT123-Q100 is corrected. 			
74HC_HCT123_Q100 v.1	20120801	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".
- [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 <https://www.nexperia.com>.

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Contents

1. General description	1
2. Features and benefits	1
3. Ordering information	2
4. Functional diagram	2
5. Pinning information	4
5.1. Pinning.....	4
5.2. Pin description.....	4
6. Functional description	5
7. Limiting values	5
8. Recommended operating conditions	6
9. Static characteristics	6
10. Dynamic characteristics	8
10.1. Waveforms and test circuit.....	11
11. Application information	13
11.1. Timing component connections.....	13
11.2. Power-up considerations.....	13
11.3. Power-down considerations.....	14
12. Package outline	15
13. Abbreviations	18
14. Revision history	18
15. Legal information	19

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