

# 74LVC109

Dual  $\overline{J}\overline{K}$  flip-flop with set and reset; positive-edge trigger

Rev. 5 — 29 November 2012

Product data sheet

## 1. General description

The 74LVC109A is a dual positive edge triggered  $\overline{J}\overline{K}$  flip-flop featuring:

- individual J and  $\overline{K}$  inputs
- clock (CP) inputs
- set ( $\overline{SD}$ ) and reset ( $\overline{RD}$ ) inputs
- complementary Q and  $\overline{Q}$  outputs

The set and reset are asynchronous active LOW inputs and operate independently of the clock input.

The J and  $\overline{K}$  inputs control the state changes of the flip-flops as described in the mode select function table. The J and  $\overline{K}$  inputs must be stable one set-up time before the LOW-to-HIGH clock transition for predictable operation. The  $\overline{J}\overline{K}$  design allows operation as a D-type flip-flop by tying the J and  $\overline{K}$  inputs together.

Schmitt trigger action in the clock input makes the circuit highly tolerant of slower clock rise and fall times.

## 2. Features and benefits

- 5 V tolerant inputs for interfacing with 5 V logic
- Wide supply voltage range from 1.2 V to 3.6 V
- CMOS low power consumption
- Direct interface with TTL levels
- Complies with JEDEC standard:
  - ◆ JESD8-7A (1.65 V to 1.95 V)
  - ◆ JESD8-5A (2.3 V to 2.7 V)
  - ◆ JESD8-C/JESD36 (2.7 V to 3.6 V)
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-B exceeds 200 V
  - ◆ CDM JESD22-C101E exceeds 1000 V
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

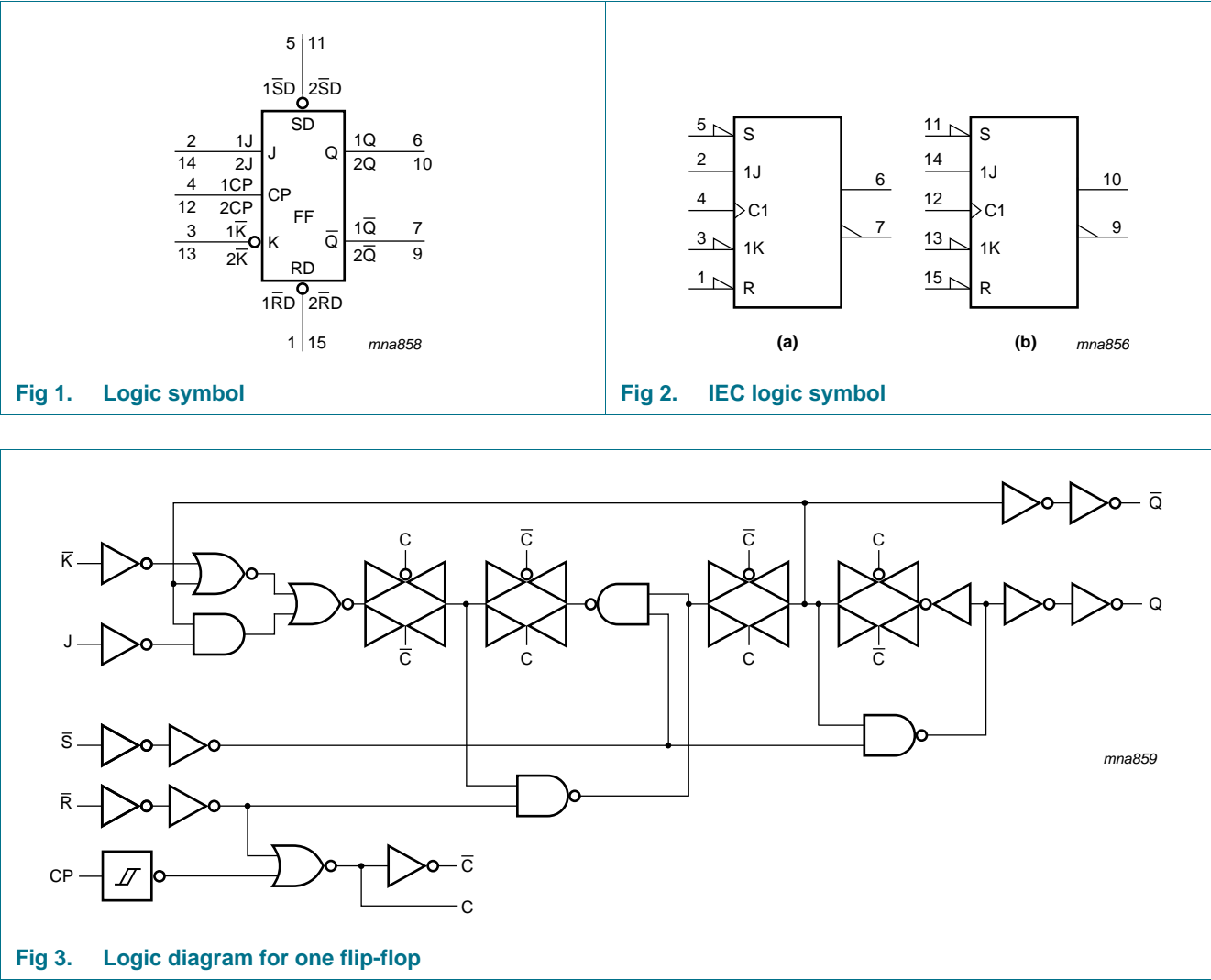


3. Ordering information

Table 1. Ordering information
All types are specified from -40 °C to +125 °C.

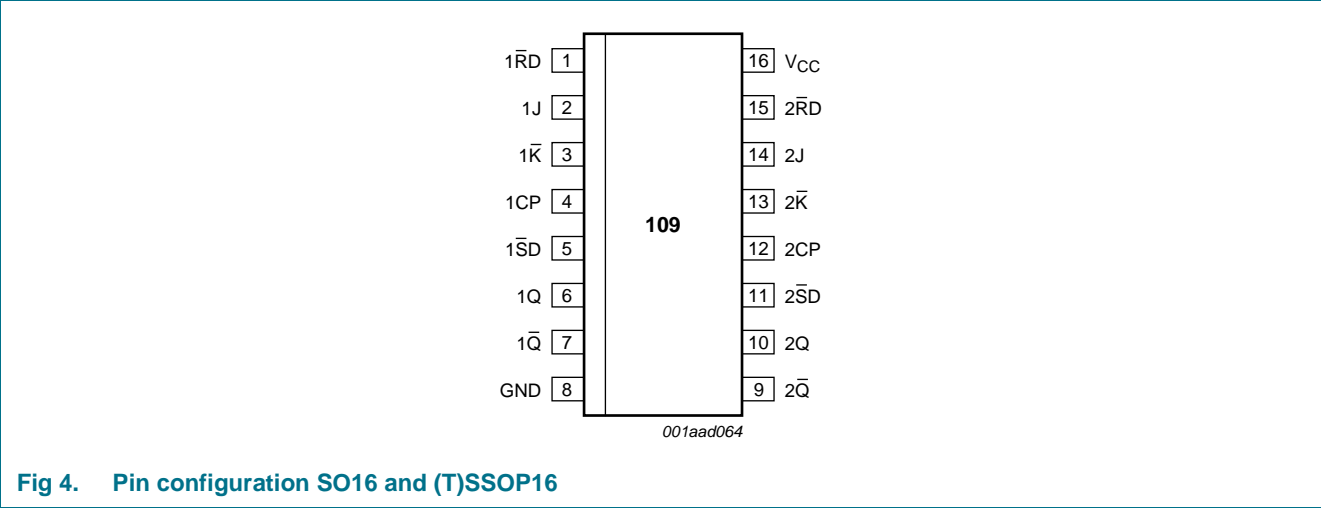
Table with 4 columns: Type number, Package Name, Description, Version. Rows include 74LVC109D (SO16), 74LVC109DB (SSOP16), and 74LVC109PW (TSSOP16).

4. Functional diagram



5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1RD	1	asynchronous reset input (active LOW)
1J	2	synchronous input
1K	3	synchronous input
1CP	4	clock input (LOW-to-HIGH; edge-triggered)
1SD	5	asynchronous set input (active LOW)
1Q	6	true flip-flop output
1Q	7	complement flip-flop output
GND	8	ground (0 V)
2Q	9	complement flip-flop output
2Q	10	true flip-flop output
2SD	11	asynchronous set input (active LOW)
2CP	12	clock input (LOW-to-HIGH; edge-triggered)
2K	13	synchronous input
2J	14	synchronous input
2RD	15	asynchronous reset input (active LOW)
V <sub>CC</sub>	16	supply voltage

## 6. Functional description

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

Operating modes	Input					Output	
	nSD	nRD	nCP	nJ	nK	nQ	nQ
Asynchronous set	L	H	X	X	X	H	L
Asynchronous reset	H	L	X	X	X	L	H
Undetermined	L	L	X	X	X	H	H
Toggle	H	H	↑	h	l	$\bar{q}$	q
Load 0 (reset)	H	H	↑	l	l	L	H
Load 1 (set)	H	H	↑	h	h	H	L
Hold no change	H	H	↑	l	h	q	$\bar{q}$

[1] H = HIGH voltage level

h = HIGH voltage level one set-up time before the LOW-to-HIGH CP transition

L = LOW voltage level

l = LOW voltage level one set-up time before the LOW-to-HIGH CP transition

q = lower case letters indicate the state of the referenced output one set-up time before the LOW-to-HIGH CP transition

X = don't care

↑ = LOW-to-HIGH CP transition

## 7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC</sub>	supply voltage		−0.5	+6.5	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < 0 V	−50	-	mA
V <sub>I</sub>	input voltage		<sup>[1]</sup> −0.5	+6.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> > V <sub>CC</sub> or V <sub>O</sub> < 0 V	-	±50	mA
V <sub>O</sub>	output voltage		<sup>[2]</sup> −0.5	V <sub>CC</sub> + 0.5	V
I <sub>O</sub>	output current	V <sub>O</sub> = 0 V to V <sub>CC</sub>	-	±50	mA
I <sub>CC</sub>	supply current		-	100	mA
I <sub>GND</sub>	ground current		−100	-	mA
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = −40 °C to +125 °C	<sup>[3]</sup> -	500	mW
T <sub>stg</sub>	storage temperature		−65	+150	°C

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

[2] The output voltage ratings may be exceeded if the output current ratings are observed.

[3] For SO16 packages: above 70 °C the value of P<sub>tot</sub> derates linearly with 8 mW/K.

For (T)SSOP16 packages: above 60 °C the value of P<sub>tot</sub> derates linearly with 5.5 mW/K.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	supply voltage		1.65	-	3.6	V
		functional	1.2	-	-	V
V <sub>I</sub>	input voltage		0	-	5.5	V
V <sub>O</sub>	output voltage		0	-	V <sub>CC</sub>	V
T <sub>amb</sub>	ambient temperature	in free air	-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	V <sub>CC</sub> = 1.65 V to 2.7 V	0	-	20	ns/V
		V <sub>CC</sub> = 2.7 V to 3.6 V	0	-	10	ns/V

## 9. Static characteristics

**Table 6. Static characteristics**

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

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 1.2 V	1.08	-	-	1.08	-	V
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>	-	-	0.65 × V <sub>CC</sub>	-	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.7	-	-	1.7	-	V
		V <sub>CC</sub> = 2.7 V to 3.6 V	2.0	-	-	2.0	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 1.2 V	-	-	0.12	-	0.12	V
		V <sub>CC</sub> = 1.65 V to 1.95 V	-	-	0.35 × V <sub>CC</sub>	-	0.35 × V <sub>CC</sub>	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	-	0.7	-	0.7	V
		V <sub>CC</sub> = 2.7 V to 3.6 V	-	-	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>						
		I <sub>O</sub> = -100 µA; V <sub>CC</sub> = 1.65 V to 3.6 V	V <sub>CC</sub> - 0.2	-	-	V <sub>CC</sub> - 0.3	-	V
		I <sub>O</sub> = -4 mA; V <sub>CC</sub> = 1.65 V	1.2	-	-	1.05	-	V
		I <sub>O</sub> = -8 mA; V <sub>CC</sub> = 2.3 V	1.8	-	-	1.65	-	V
		I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 2.7 V	2.2	-	-	2.05	-	V
		I <sub>O</sub> = -18 mA; V <sub>CC</sub> = 3.0 V	2.4	-	-	2.25	-	V
V <sub>OL</sub>	LOW-level output voltage	I <sub>O</sub> = -24 mA; V <sub>CC</sub> = 3.0 V	2.2	-	-	2.0	-	V
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>						
		I <sub>O</sub> = 100 µA; V <sub>CC</sub> = 1.65 V to 3.6 V	-	-	0.2	-	0.3	V
		I <sub>O</sub> = 4 mA; V <sub>CC</sub> = 1.65 V	-	-	0.45	-	0.65	V
		I <sub>O</sub> = 8 mA; V <sub>CC</sub> = 2.3 V	-	-	0.6	-	0.8	V
		I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 2.7 V	-	-	0.4	-	0.6	V
I <sub>I</sub>	input leakage current	I <sub>O</sub> = 24 mA; V <sub>CC</sub> = 3.0 V	-	-	0.55	-	0.8	V
		V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = 5.5 V or GND	-	±0.1	±5	-	±20	µA

**Table 6.** Static characteristics ...continued

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

Symbol	Parameter	Conditions	–40 °C to +85 °C			–40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
I <sub>CC</sub>	supply current	V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A	-	0.1	10	-	40	μA
ΔI <sub>CC</sub>	additional supply current	per input pin; V <sub>CC</sub> = 2.7 V to 3.6 V; V <sub>I</sub> = V <sub>CC</sub> – 0.6 V; I <sub>O</sub> = 0 A	-	5	500	-	5000	μA
C <sub>I</sub>	input capacitance	V <sub>CC</sub> = 0 V to 3.6 V; V <sub>I</sub> = GND to V <sub>CC</sub>	-	5.0	-	-	-	pF

[1] All typical values are measured at V<sub>CC</sub> = 3.3 V (unless stated otherwise) and T<sub>amb</sub> = 25 °C.

## 10. Dynamic characteristics

**Table 7.** Dynamic characteristicsVoltages are referenced to GND (ground = 0 V). For test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	–40 °C to +85 °C			–40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
t <sub>pd</sub>	propagation delay	nCP to nQ, nQ̄; see <a href="#">Figure 5</a> <sup>[2]</sup>						
		V <sub>CC</sub> = 1.2 V	-	15	-	-	-	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.7	6.8	15.0	1.7	17.4	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	2.7	3.9	8.1	2.7	9.4	ns
		V <sub>CC</sub> = 2.7 V	1.5	3.9	7.3	1.5	9.5	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.0	3.5	6.8	1.0	8.5	ns
t <sub>PLH</sub>	LOW to HIGH propagation delay	nSD̄, nRD̄ to nQ, nQ̄; see <a href="#">Figure 6</a>						
		V <sub>CC</sub> = 1.2 V	-	16	-	-	-	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.0	6.2	15.6	1.0	18.0	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.5	3.6	8.3	1.5	9.7	ns
		V <sub>CC</sub> = 2.7 V	1.5	4.5	8.2	1.5	10.5	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.0	3.3	7.0	1.0	9.0	ns
t <sub>PHL</sub>	HIGH to LOW propagation delay	nSD̄, nRD̄ to nQ, nQ̄; see <a href="#">Figure 6</a>						
		V <sub>CC</sub> = 1.2 V	-	13	-	-	-	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.5	6.7	14.4	1.5	16.7	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	2.0	3.8	7.7	2.0	9.0	ns
		V <sub>CC</sub> = 2.7 V	1.5	4.1	7.1	1.5	9.0	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.0	3.5	6.5	1.0	8.5	ns

**Table 7. Dynamic characteristics ...continued**Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
$t_W$	pulse width	clock HIGH or LOW; see <a href="#">Figure 5</a>						
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	5.0	-	-	5.0	-	ns
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	4.0	-	-	4.0	-	ns
		$V_{CC} = 2.7 \text{ V}$	3.3	-	-	3.3	-	ns
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$	3.3	2.0	-	3.3	-	ns
		set or reset HIGH or LOW; see <a href="#">Figure 6</a>						
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	5.0	-	-	5.0	-	ns
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	4.0	-	-	4.0	-	ns
$t_{rec}$	recovery time	$\overline{nSD}$ , $\overline{nRD}$ to nCP; see <a href="#">Figure 6</a>						
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	5.5	-	-	5.5	-	ns
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	4.0	-	-	4.0	-	ns
		$V_{CC} = 2.7 \text{ V}$	3.2	-	-	3.2	-	ns
$t_{su}$	set-up time	nJ and $\overline{nK}$ to CP; see <a href="#">Figure 5</a>						
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	5.0	-	-	5.0	-	ns
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	3.5	-	-	3.5	-	ns
		$V_{CC} = 2.7 \text{ V}$	2.7	-	-	2.7	-	ns
$t_h$	hold time	$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$	2.5	-	-	2.5	-	ns
		nJ and $\overline{nK}$ to nCP; see <a href="#">Figure 5</a>						
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	3.0	-	-	3.0	-	ns
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	2.5	-	-	2.5	-	ns
$f_{max}$	maximum frequency	$V_{CC} = 2.7 \text{ V}$	2.2	-	-	2.2	-	ns
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$	2.0	-	-	2.0	-	ns
		see <a href="#">Figure 5</a>						
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	100	-	-	80	-	MHz
$t_{sk(o)}$	output skew time	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	125	-	-	100	-	MHz
		$V_{CC} = 2.7 \text{ V}$	150	-	-	120	-	MHz
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$	150	330	-	120	-	MHz
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$ <sup>[3]</sup>	-	-	1.0	-	1.5	ns
$C_{PD}$	power dissipation capacitance	$V_I = \text{GND to } V_{CC}$ <sup>[4]</sup>						
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	-	11.4	-	-	-	pF
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	-	17.6	-	-	-	pF
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$	-	23.1	-	-	-	pF

[1] Typical values are measured at  $T_{amb} = 25 \text{ °C}$  and  $V_{CC} = 1.2 \text{ V}, 1.8 \text{ V}, 2.5 \text{ V}, 2.7 \text{ V}$  and  $3.3 \text{ V}$  respectively.[2]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .

[3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

[4]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu W$ ).

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

$f_i$  = input frequency in MHz;  $f_o$  = output frequency in MHz

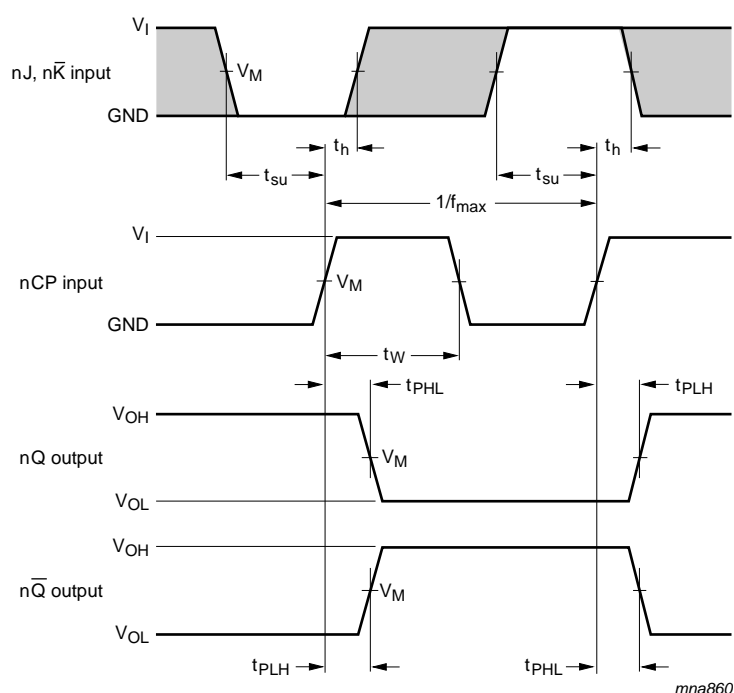
$C_L$  = output load capacitance in pF

$V_{CC}$  = supply voltage in Volts

$N$  = number of inputs switching

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

## 11. AC waveforms



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

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

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

**Fig 5. Clock propagation delays, pulse width, set-up, hold times, and maximum frequency**



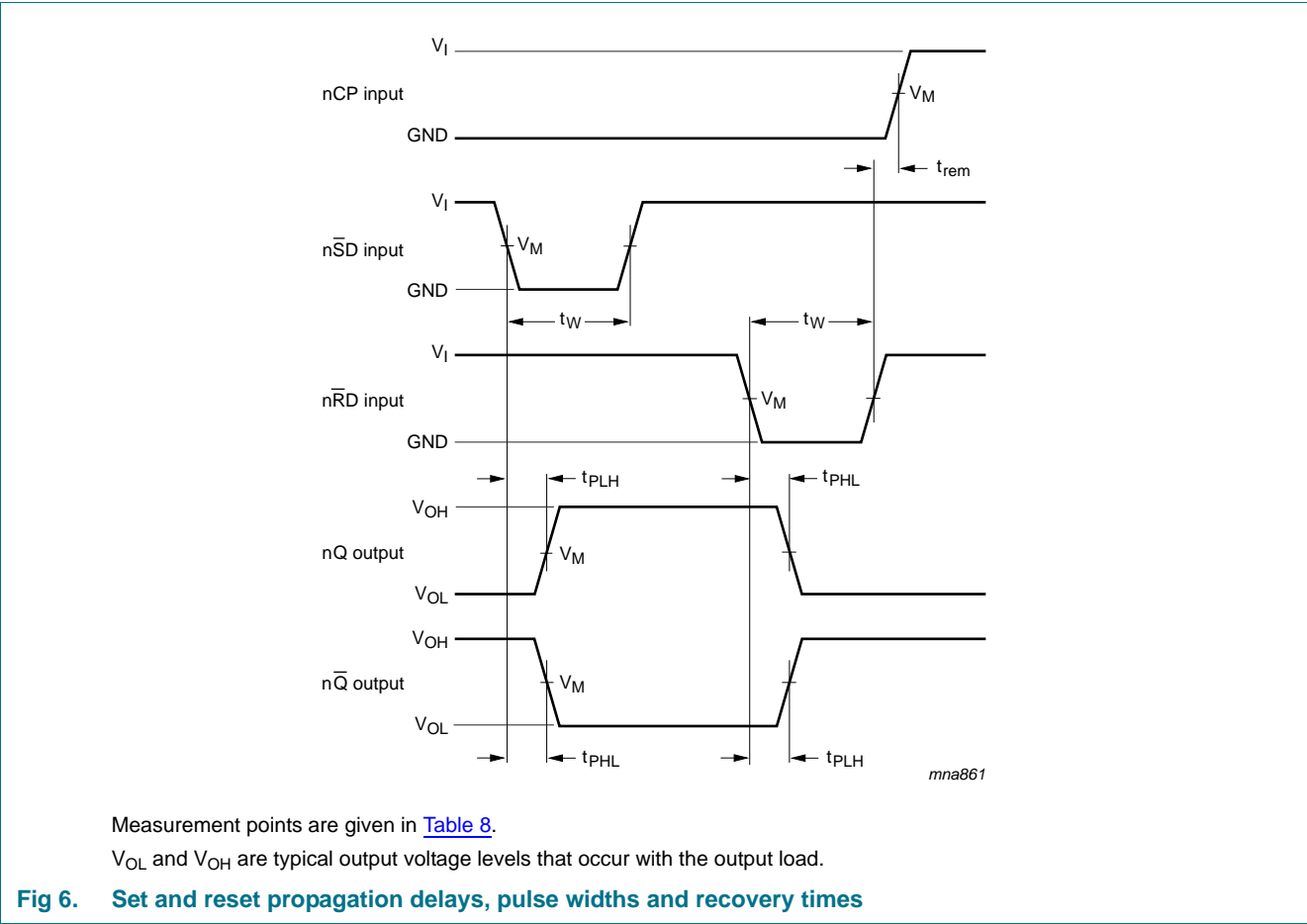
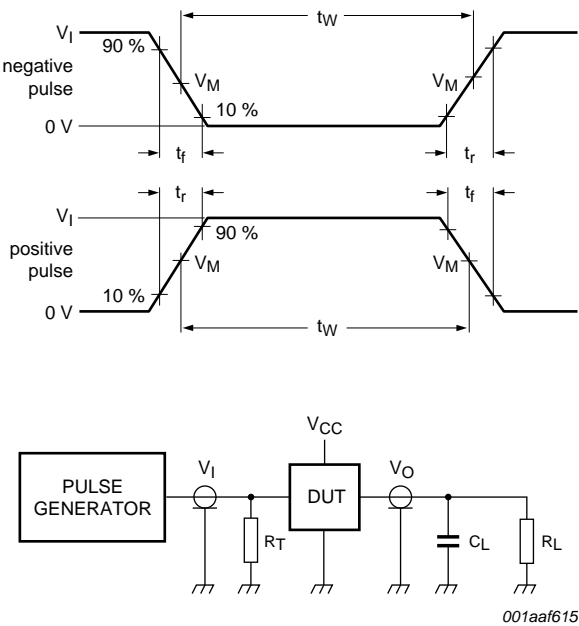


Table 8. Measurement points

Supply voltage	Input		Output
$V_{CC}$	$V_I$	$V_M$	$V_M$
1.2 V	$V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
1.65 V to 1.95 V	$V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
2.3 V to 2.7 V	$V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
2.7 V	2.7 V	1.5 V	1.5 V
3.0 V to 3.6 V	2.7 V	1.5 V	1.5 V



Test data is given in [Table 9](#).  
Definitions for test circuit:  
 $R_L$  = Load resistance.  
 $C_L$  = Load capacitance including jig and probe capacitance.  
 $R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

Fig 7. Load circuitry for switching times

Table 9. Test data

Supply voltage	Input		Load	
	$V_I$	$t_r, t_f$	$C_L$	$R_L$
1.2 V	$V_{CC}$	$\leq 2 \text{ ns}$	30 pF	1 k $\Omega$
1.65 V to 1.95 V	$V_{CC}$	$\leq 2 \text{ ns}$	30 pF	1 k $\Omega$
2.3 V to 2.7 V	$V_{CC}$	$\leq 2 \text{ ns}$	30 pF	500 $\Omega$
2.7 V	2.7 V	$\leq 2.5 \text{ ns}$	50 pF	500 $\Omega$
3.0 V to 3.6 V	2.7 V	$\leq 2.5 \text{ ns}$	50 pF	500 $\Omega$

12. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm SOT109-1

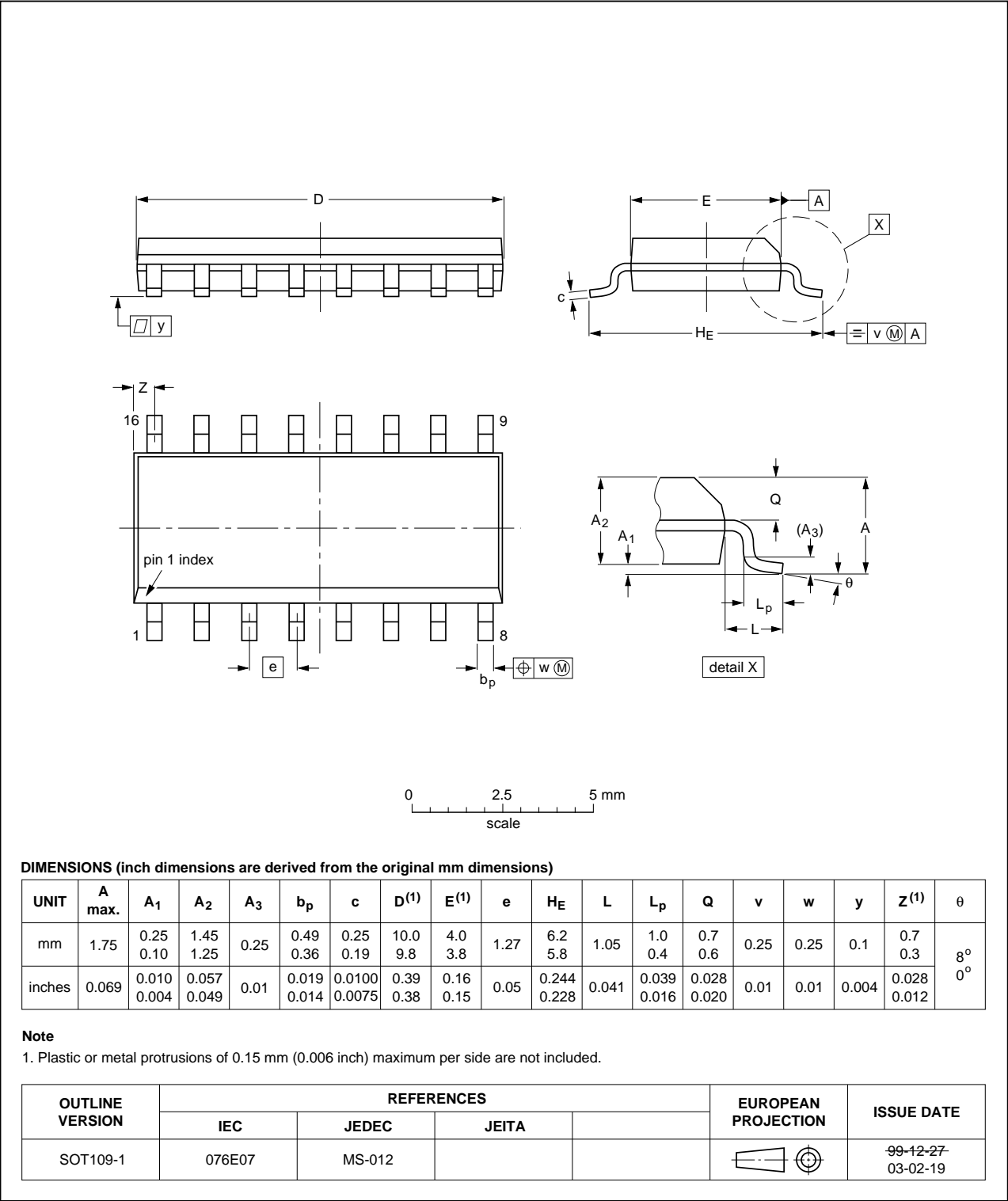


Fig 8. Package outline SOT109-1 (SO16)

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

SOT338-1

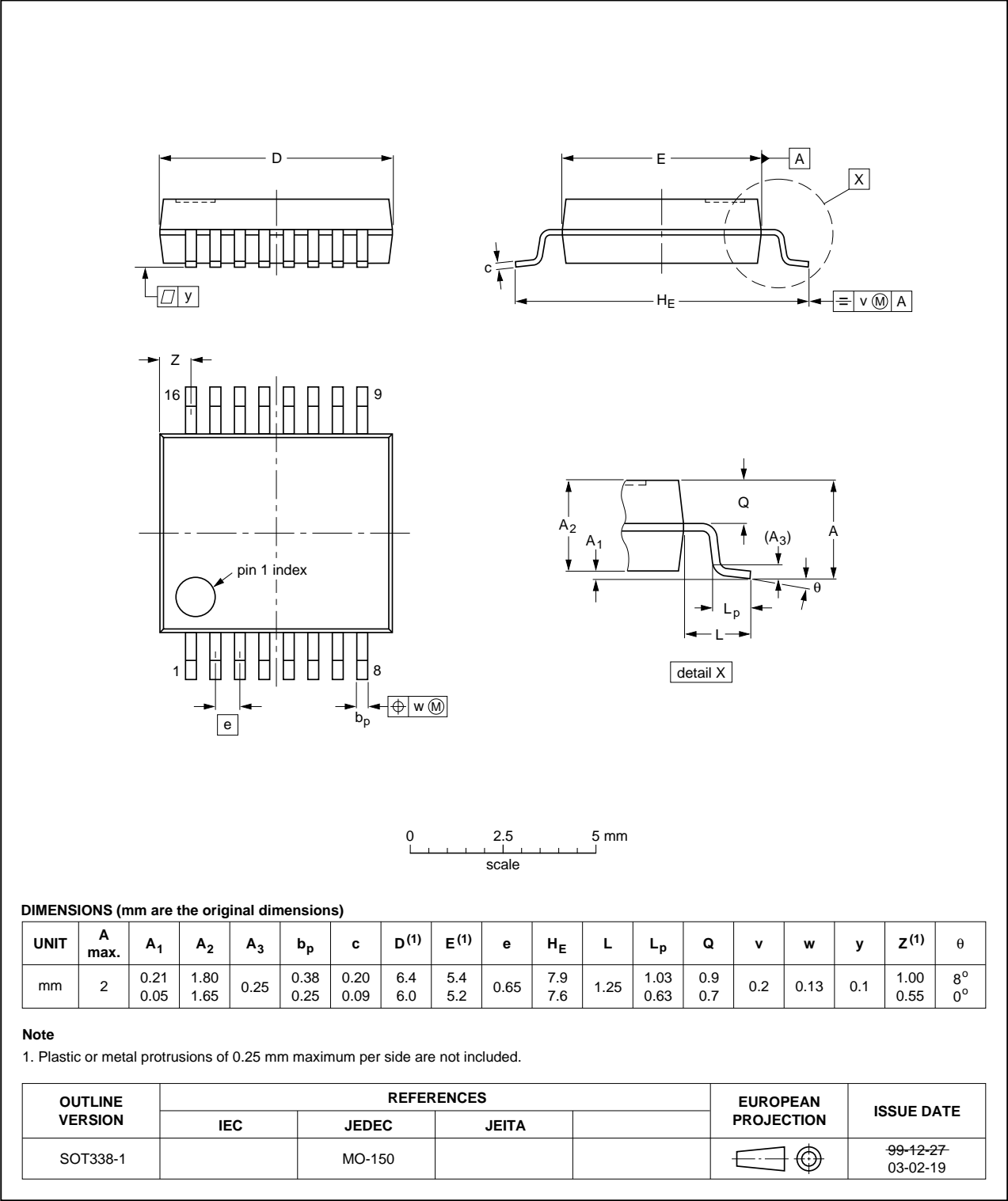


Fig 9. Package outline SOT338-1 (SSOP16)

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

SOT403-1

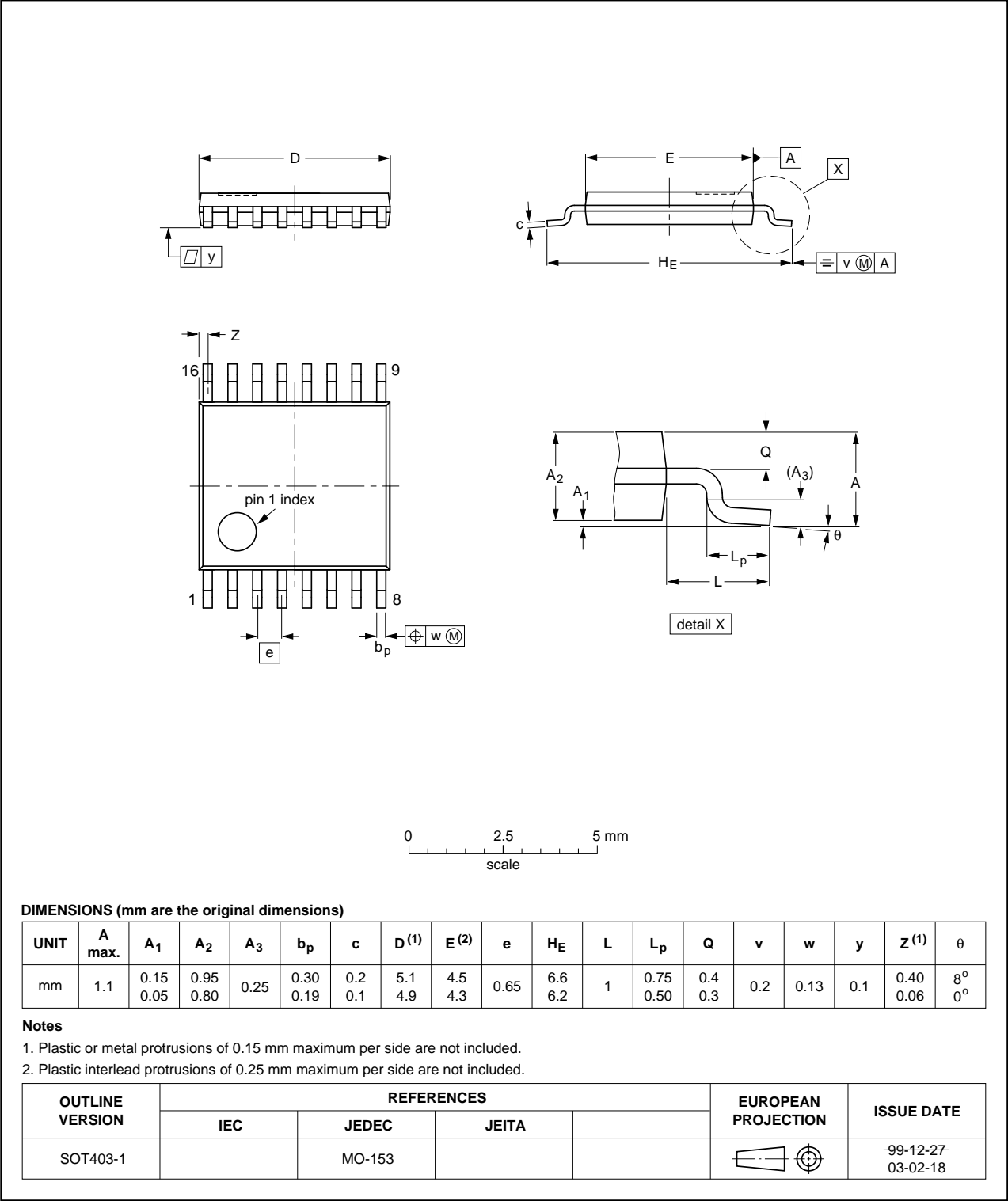


Fig 10. Package outline SOT403-1 (TSSOP16)

## 13. Abbreviations

Table 10. Abbreviations

Acronym	Description
CDM	Charged Device Model
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model
TTL	Transistor-Transistor Logic

## 14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74LVC109 v.5	20121129	Product data sheet	-	74LVC109 v.4
Modifications:	<ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li><li>• <a href="#">Table 4</a>, <a href="#">Table 5</a>, <a href="#">Table 6</a>, <a href="#">Table 7</a> and <a href="#">Table 8</a>: values added for lower voltage ranges.</li></ul>			
74LVC109 v.4	20040318	Product specification	-	74LVC109 v.3
74LVC109 v.3	19980428	Product specification	-	74LVC109 v.2
74LVC109 v.2	19970318	Product specification	-	74LVC109 v.1
74LVC109 v.1	-	-	-	-

## 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

### 15.2 Definitions

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