

# 74AXP1G09

## Low-power 2-input AND gate with open-drain

Rev. 3 — 7 July 2021

Product data sheet

### 1. General description

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The 74AXP1G09 is a single 2-input AND gate with open-drain output. The output of the device is an open-drain and can be connected to other open-drain outputs to implement active-LOW wired-OR or active-HIGH wired-AND functions.

This device ensures very low static and dynamic power consumption across the entire  $V_{CC}$  range from 0.7 V to 2.75 V. It is fully specified for partial power down applications using  $I_{OFF}$ . The  $I_{OFF}$  circuitry disables the output, preventing the potentially damaging backflow current through the device when it is powered down.

### 2. Features and benefits

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- Wide supply voltage range from 0.7 V to 2.75 V
- Low input capacitance;  $C_I = 0.5$  pF (typical)
- Low output capacitance;  $C_O = 0.7$  pF (typical)
- Low dynamic power consumption;  $C_{PD} = 1.0$  pF at  $V_{CC} = 1.2$  V (typical)
- Low static power consumption;  $I_{CC} = 0.6$   $\mu$ A (85 °C maximum)
- High noise immunity
- Complies with JEDEC standard:
  - JESD8-12A.01 (1.1 V to 1.3 V)
  - JESD8-11A.01 (1.4 V to 1.6 V)
  - JESD8-7A (1.65 V to 1.95 V)
  - JESD8-5A.01 (2.3 V to 2.7 V)
- ESD protection:
  - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV
  - CDM JESD22-C101E exceeds 1000 V
- Latch-up performance exceeds 100 mA per JESD 78 Class II
- Input accepts voltages up to 2.75 V
- Low noise overshoot and undershoot < 10 % of  $V_{CC}$
- $I_{OFF}$  circuitry provides partial Power-down mode operation
- Multiple package options
- Specified from -40 °C to +85 °C

### 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74AXP1G09GM	-40 °C to +85 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm	SOT886
74AXP1G09GN	-40 °C to +85 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body 0.9 × 1.0 × 0.35 mm	SOT1115
74AXP1G09GS	-40 °C to +85 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body 1.0 × 1.0 × 0.35 mm	SOT1202
74AXP1G09GX	-40 °C to +85 °C	X2SON5	plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 × 0.8 × 0.32 mm	SOT1226-3

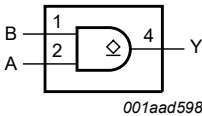
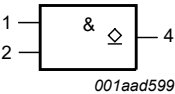
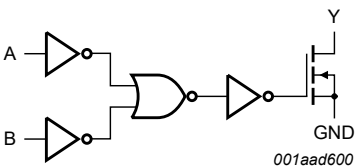
### 4. Marking

Table 2. Marking

Type number	Marking code[1]
74AXP1G09GM	r9
74AXP1G09GN	r9
74AXP1G09GS	r9
74AXP1G09GX	r9

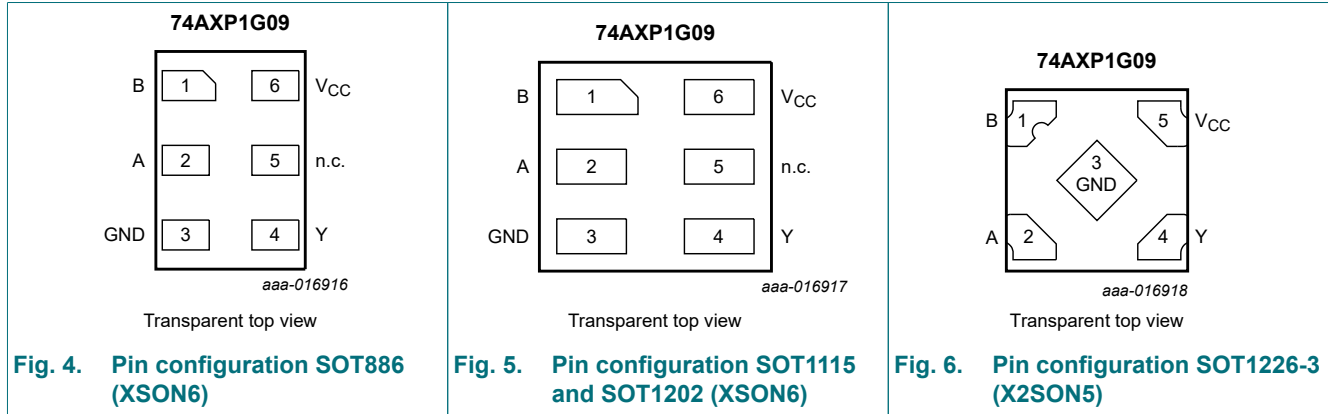
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

### 5. Functional diagram

 <p>001aad598</p>	 <p>001aad599</p>	 <p>001aad600</p>
<b>Fig. 1. Logic symbol</b>	<b>Fig. 2. IEC logic symbol</b>	<b>Fig. 3. Logic diagram</b>

## 6. Pinning information

### 6.1. Pinning



### 6.2. Pin description

Table 3. Pin description

Symbol	Pin		Description
	XSON6	X2SON5	
B	1	1	data input
A	2	2	data input
GND	3	3	ground (0 V)
Y	4	4	data output
n.c.	5	-	not connected
V <sub>CC</sub>	6	5	supply voltage

## 7. Functional description

Table 4. Function table

H = HIGH voltage level; L = LOW voltage level; Z = high-impedance OFF state.

Input		Output
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	Z

## 8. Limiting values

**Table 5. 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	+3.3	V
$I_{IK}$	input clamping current	$V_I < 0$ V	-50	-	mA
$V_I$	input voltage		-0.5	+3.3	V
$I_{OK}$	output clamping current	$V_O < 0$ V	-50	-	mA
$V_O$	output voltage		-0.5	+3.3	V
$I_O$	output current	$V_O = 0$ V to $V_{CC}$	-	$\pm 20$	mA
$I_{CC}$	supply current		-	50	mA
$I_{GND}$	ground current		-50	-	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +85 °C	-	250	mW

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

[2] For SOT886 (XSON6) package:  $P_{tot}$  derates linearly with 3.3 mW/K above 74 °C.

For SOT1115 (XSON6) package:  $P_{tot}$  derates linearly with 3.2 mW/K above 71 °C.

For SOT1202 (XSON6) package:  $P_{tot}$  derates linearly with 3.3 mW/K above 74 °C.

For SOT1226-3 (X2SON5) package:  $P_{tot}$  derates linearly with 3.0 mW/K above 67 °C.

## 9. Recommended operating conditions

**Table 6. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC}$	supply voltage		0.7	2.75	V
$V_I$	input voltage		0	2.75	V
$V_O$	output voltage	Active mode	0	$V_{CC}$	V
		Power-down mode; $V_{CC} = 0$ V	0	2.75	V
$T_{amb}$	ambient temperature		-40	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 0.7$ V to 2.75 V	0	200	ns/V

## 10. Static characteristics

**Table 7. Static characteristics**

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

Symbol	Parameter	Conditions	T <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		Unit
			Min	Typ	Max	Min	Max	
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 0.75 V to 0.85 V	0.75V <sub>CC</sub>	-	-	0.75V <sub>CC</sub>	-	V
		V <sub>CC</sub> = 1.1 V to 1.95 V	0.65V <sub>CC</sub>	-	-	0.65V <sub>CC</sub>	-	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.6	-	-	1.6	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 0.75 V to 0.85 V	-	-	0.25V <sub>CC</sub>	-	0.25V <sub>CC</sub>	V
		V <sub>CC</sub> = 1.1 V to 1.95 V	-	-	0.35V <sub>CC</sub>	-	0.35V <sub>CC</sub>	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	-	0.7	-	0.7	V
V <sub>OL</sub>	LOW-level output voltage	I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 0.7 V	-	0.01	-	-	-	V
		I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 0.75 V	-	-	0.1	-	0.1	V
		I <sub>O</sub> = 2 mA; V <sub>CC</sub> = 1.1 V	-	-	0.275	-	0.275	V
		I <sub>O</sub> = 3 mA; V <sub>CC</sub> = 1.4 V	-	-	0.35	-	0.35	V
		I <sub>O</sub> = 4.5 mA; V <sub>CC</sub> = 1.65 V	-	-	0.45	-	0.45	V
		I <sub>O</sub> = 8 mA; V <sub>CC</sub> = 2.3 V	-	-	0.7	-	0.7	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 0 V to 2.75 V; V <sub>CC</sub> = 0 V to 2.75 V [1]	-	0.001	±0.1	-	±0.5	μA
I <sub>OZ</sub>	OFF-state output current	V <sub>I</sub> = V <sub>IL</sub> ; V <sub>O</sub> = 0 V to 2.75 V [1]	-	0.02	±0.1	-	±0.5	μA
I <sub>OFF</sub>	power-off leakage current	V <sub>I</sub> or V <sub>O</sub> = 0 V to 2.75 V; V <sub>CC</sub> = 0 V [1]	-	0.01	±0.1	-	±0.5	μA
ΔI <sub>OFF</sub>	additional power-off leakage current	V <sub>I</sub> or V <sub>O</sub> = 0 V or 2.75 V; V <sub>CC</sub> = 0 V to 0.1 V [1]	-	0.02	±0.1	-	±0.5	μA
I <sub>CC</sub>	supply current	V <sub>I</sub> = 0 V or V <sub>CC</sub> ; I <sub>O</sub> = 0 A [1]	-	0.01	0.3	-	0.6	μA
ΔI <sub>CC</sub>	additional supply current	V <sub>I</sub> = V <sub>CC</sub> - 0.5 V; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 2.5 V	-	2	100	-	150	μA

[1] All typical values are measured at V<sub>CC</sub> = 1.2 V.

## 11. Dynamic characteristics

**Table 8. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit, see [Fig. 13](#).

Symbol	Parameter	Conditions	T <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		Unit
			Min	Typ[1]	Max	Min	Max	
t <sub>pd</sub>	propagation delay	A, B to Y; see <a href="#">Fig. 7</a> [2] [3]						
		V <sub>CC</sub> = 0.75 V to 0.85 V	4	11	37	3	88	ns
		V <sub>CC</sub> = 1.1 V to 1.3 V	2.2	4.9	8.0	2.1	8.3	ns
		V <sub>CC</sub> = 1.4 V to 1.6 V	1.7	3.7	5.6	1.6	5.9	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.4	3.5	5.7	1.4	6.1	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.2	2.6	4.1	1.1	4.4	ns
t <sub>t</sub>	transition time	V <sub>CC</sub> = 2.7 V; see <a href="#">Fig. 7</a> [4]	-	-	-	0.9	-	ns
C <sub>I</sub>	input capacitance	V <sub>I</sub> = 0 V or V <sub>CC</sub> ; V <sub>CC</sub> = 0 V to 2.75 V	-	0.5	-	-	-	pF
C <sub>O</sub>	output capacitance	V <sub>O</sub> = 0 V; V <sub>CC</sub> = 0 V	-	0.7	-	-	-	pF
C <sub>PD</sub>	power dissipation capacitance	f <sub>i</sub> = 1 MHz; V <sub>I</sub> = 0 V to V <sub>CC</sub> [5]						
		V <sub>CC</sub> = 0.75 V to 0.85 V	-	0.9	-	-	-	pF
		V <sub>CC</sub> = 1.1 V to 1.3 V	-	1.0	-	-	-	pF
		V <sub>CC</sub> = 1.4 V to 1.6 V	-	1.0	-	-	-	pF
		V <sub>CC</sub> = 1.65 V to 1.95 V	-	1.1	-	-	-	pF
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	1.3	-	-	-	pF

[1] All typical values are measured at nominal V<sub>CC</sub>.

[2] t<sub>pd</sub> is the same as t<sub>PZL</sub> and t<sub>PLZ</sub>.

[3] For additional propagation delay (t<sub>PZL</sub>) values at different load capacitances see [Fig. 8](#) to [Fig. 12](#).

[4] t<sub>t</sub> is the same as t<sub>THL</sub>.

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

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

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.

11.1. Waveforms, graphs and test circuit

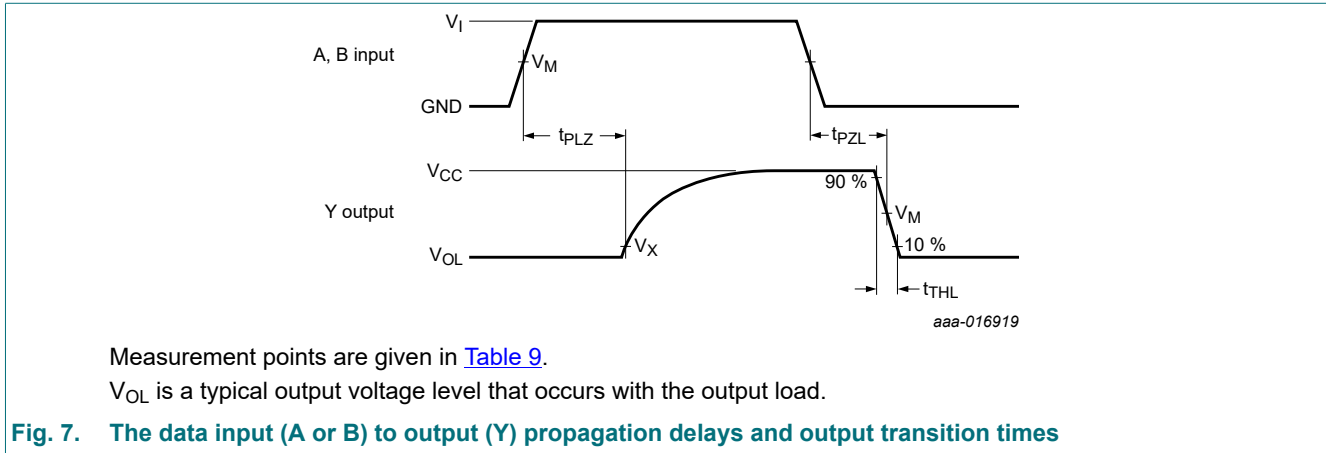
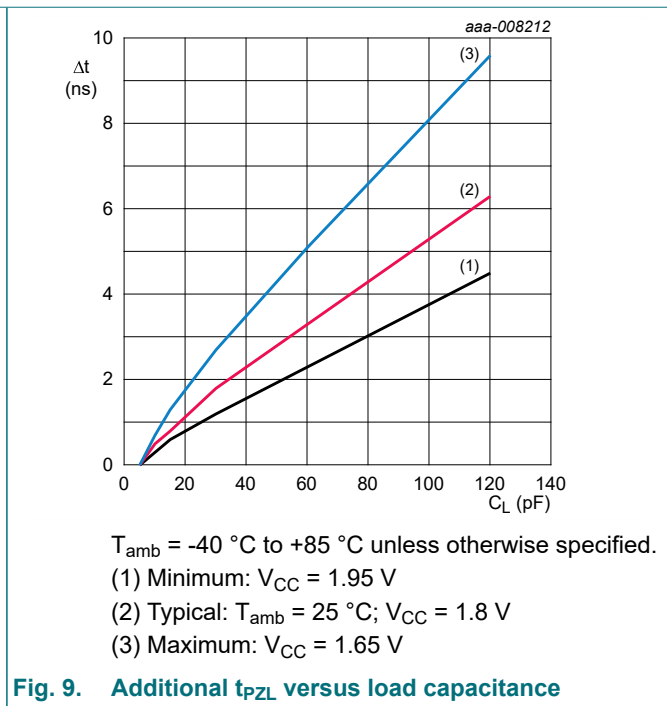
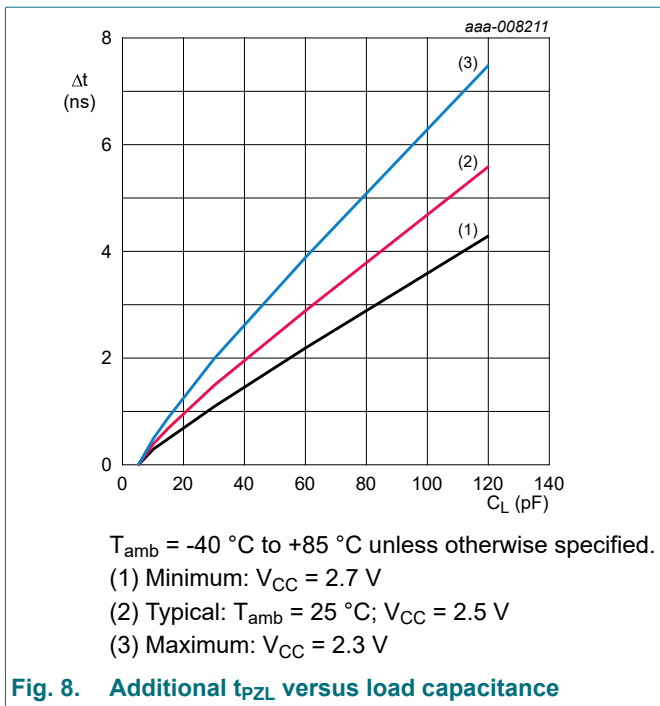


Table 9. Measurement points

Supply voltage	Input			Output	
$V_{CC}$	$V_M$	$V_I$	$t_r = t_f$	$V_M$	$V_X$
0.75 V to 1.6 V	$0.5V_{CC}$	$V_{CC}$	$\leq 3.0$ ns	$0.5V_{CC}$	$V_{OL} + 0.1$ V
1.65 V to 2.7 V	$0.5V_{CC}$	$V_{CC}$	$\leq 3.0$ ns	$0.5V_{CC}$	$V_{OL} + 0.15$ V



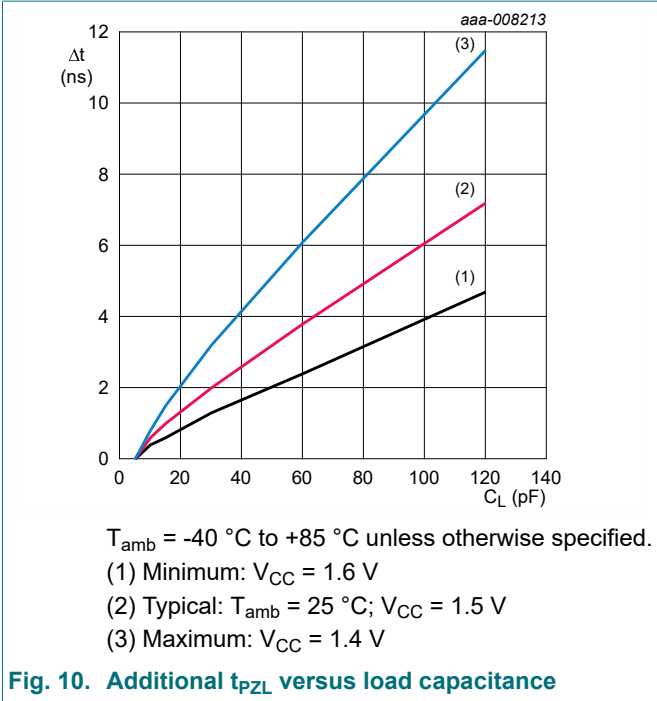


Fig. 10. Additional  $t_{pZL}$  versus load capacitance

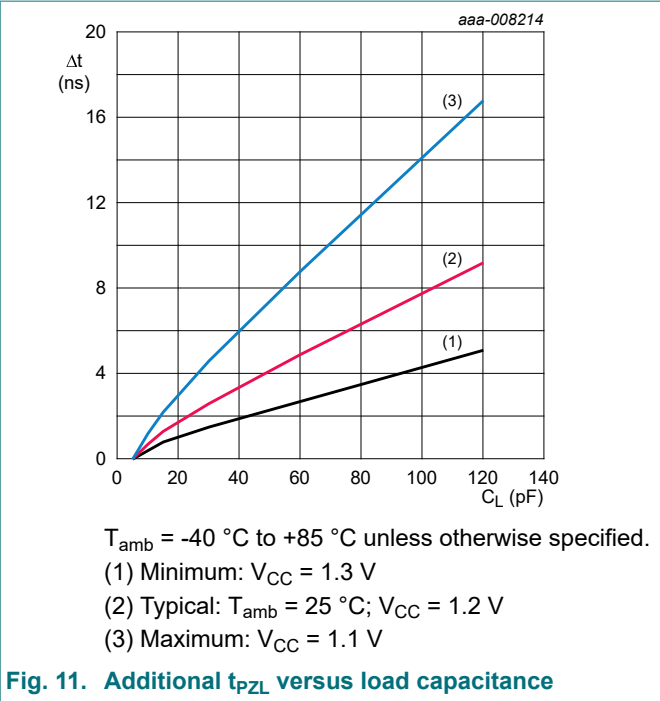


Fig. 11. Additional  $t_{pZL}$  versus load capacitance

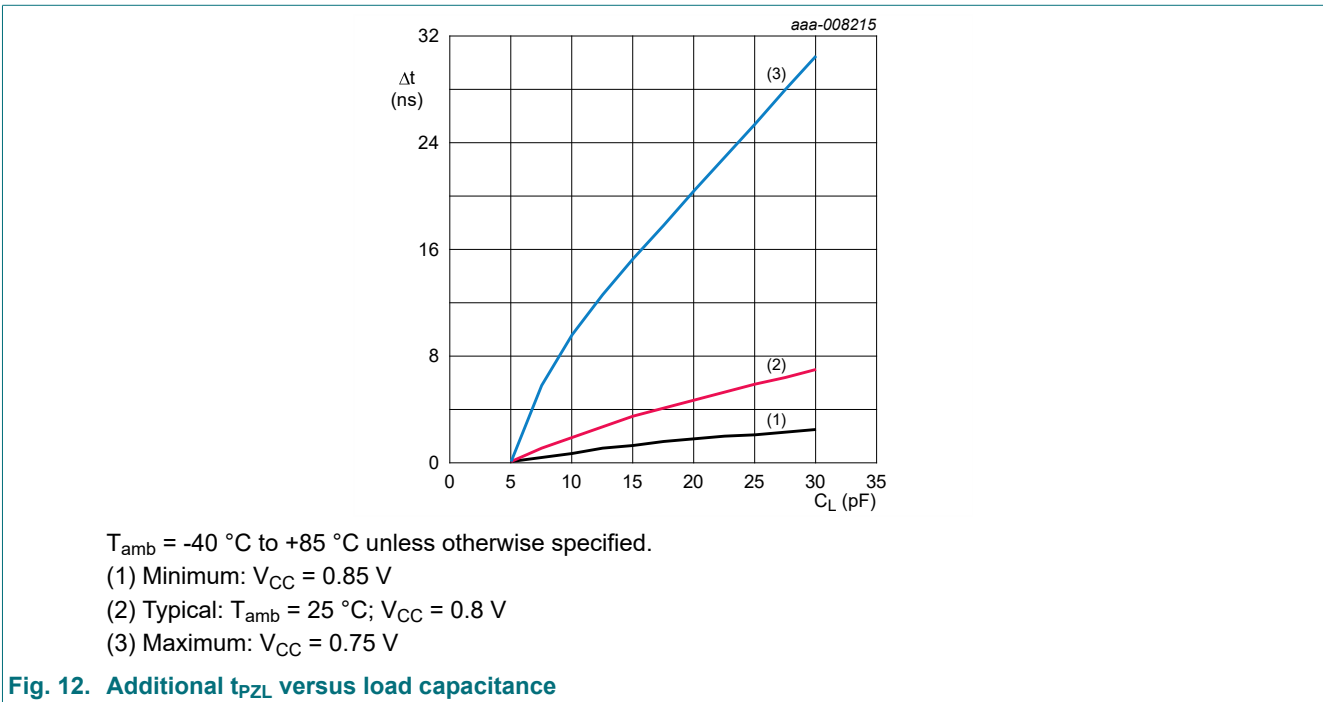
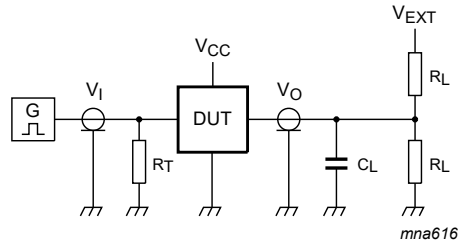


Fig. 12. Additional  $t_{pZL}$  versus load capacitance





Test data is given in [Table 10](#).

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 the output impedance  $Z_o$  of the pulse generator.

$V_{EXT}$  = External voltage for measuring switching times.

**Fig. 13. Test circuit for measuring switching times**

**Table 10. Test data**

Supply voltage	Load		$V_{EXT}$
$V_{CC}$	$C_L$	$R_L$	$t_{PZL}$ , $t_{PLZ}$
0.75 V to 2.7 V	5 pF	10 kΩ	$2V_{CC}$

## 12. Package outline

XSON6: plastic extremely thin small outline package; no leads; 6 terminals; body 1 x 1.45 x 0.5 mm

SOT886

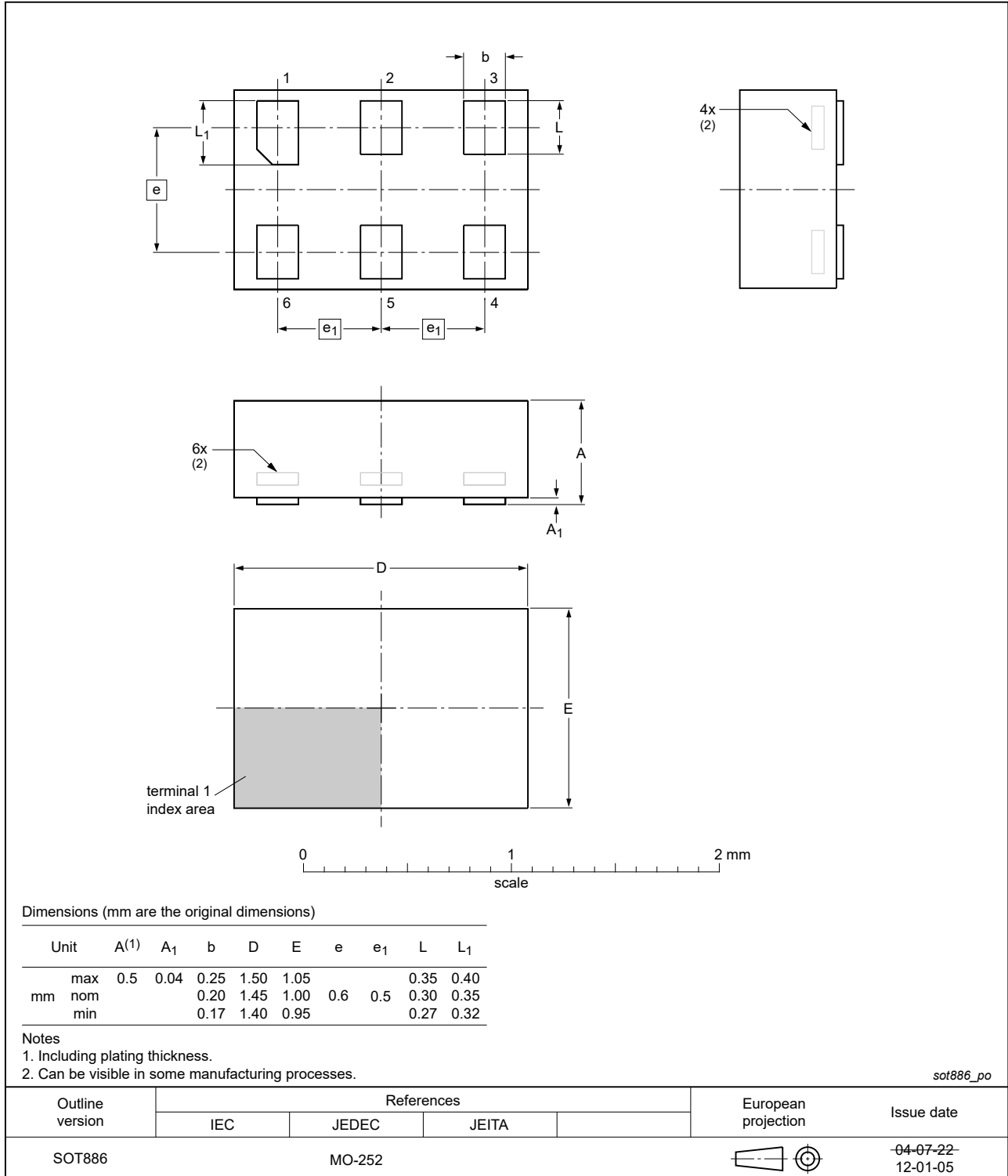


Fig. 14. Package outline SOT886 (XSON6)

XSON6: extremely thin small outline package; no leads;  
6 terminals; body 0.9 x 1.0 x 0.35 mm

SOT1115

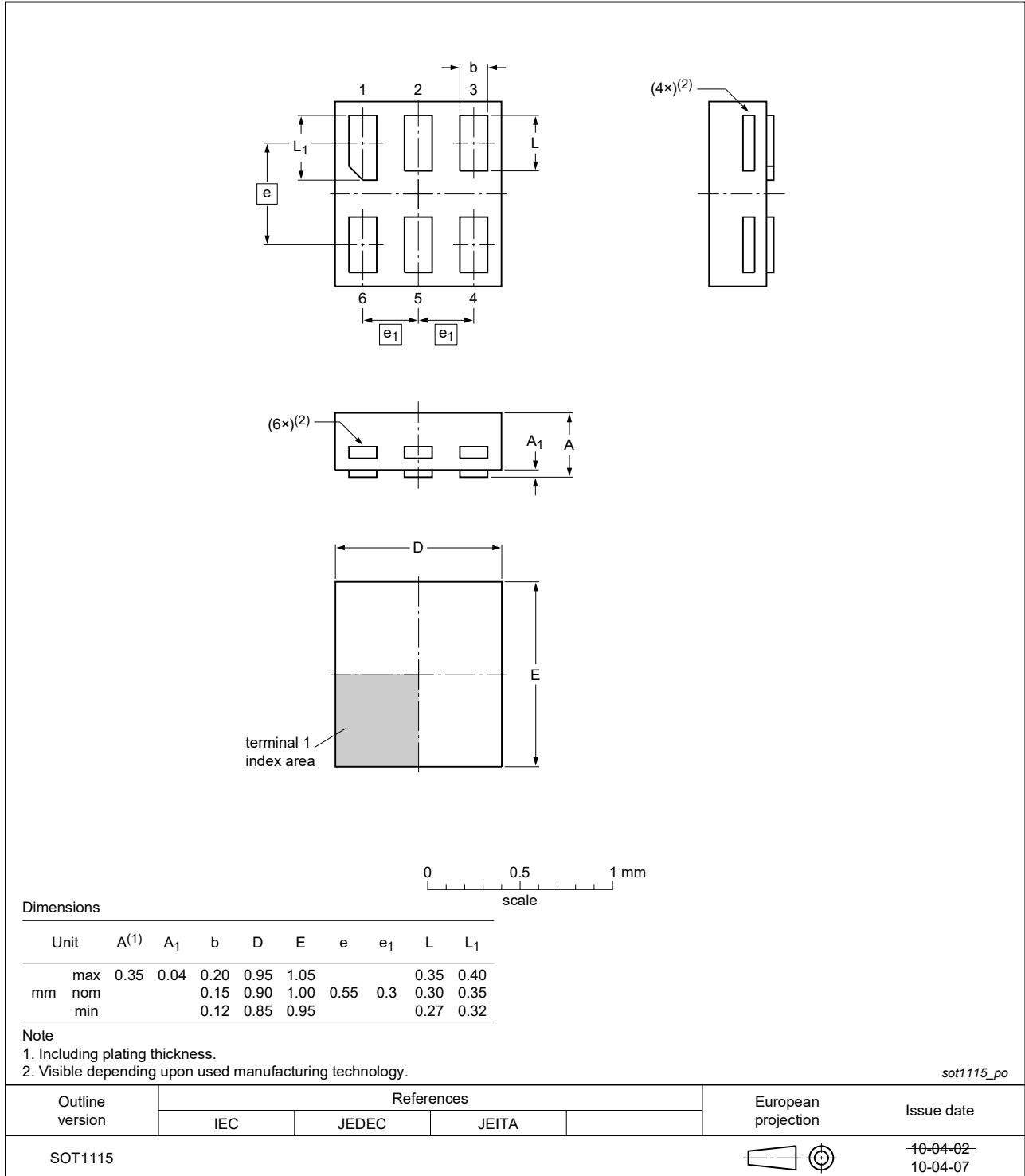


Fig. 15. Package outline SOT1115 (XSON6)

XSON6: extremely thin small outline package; no leads;  
6 terminals; body 1.0 x 1.0 x 0.35 mm

SOT1202

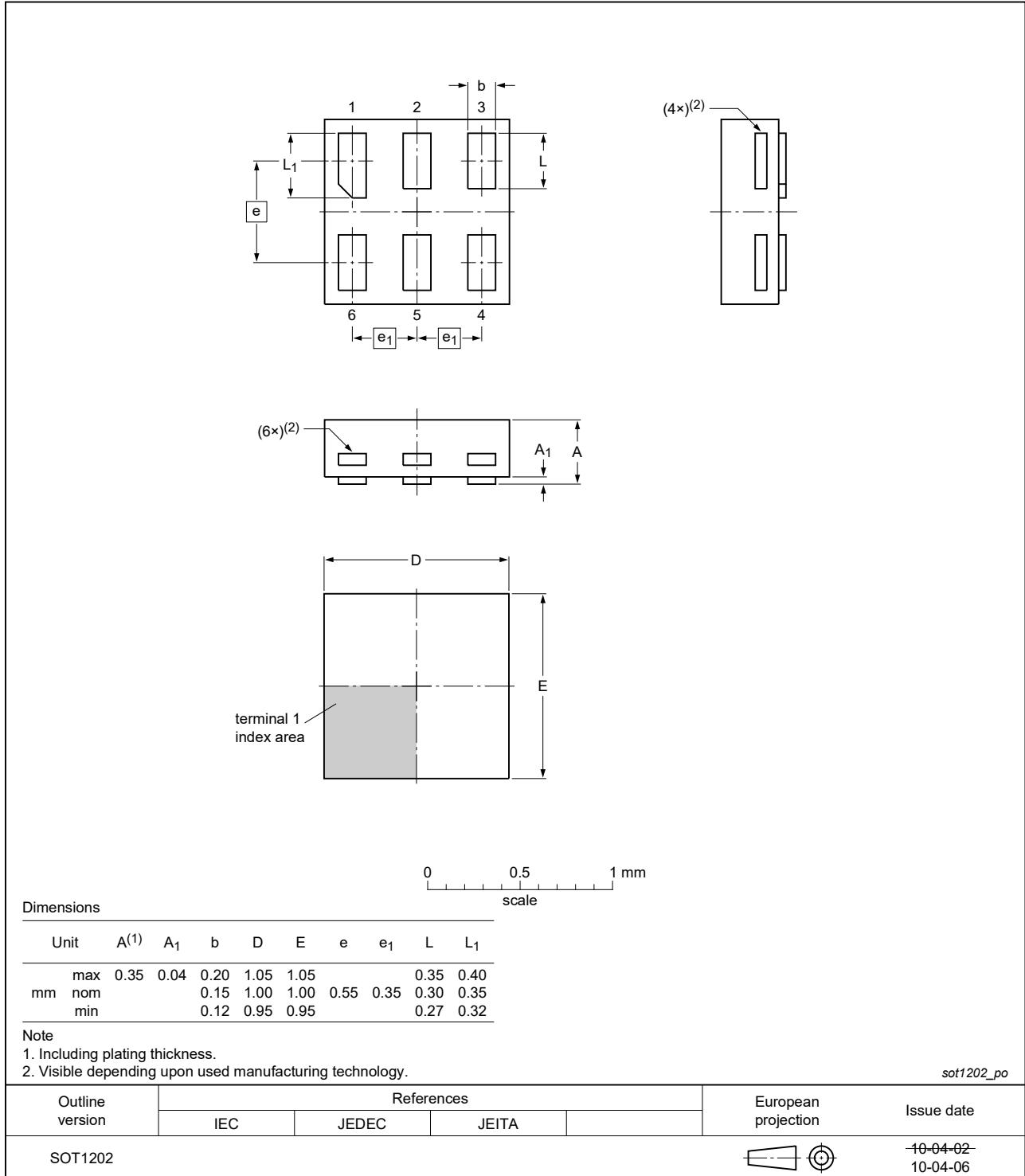


Fig. 16. Package outline SOT1202 (XSON6)

X2SON5: plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 x 0.8 x 0.32 mm

SOT1226-3

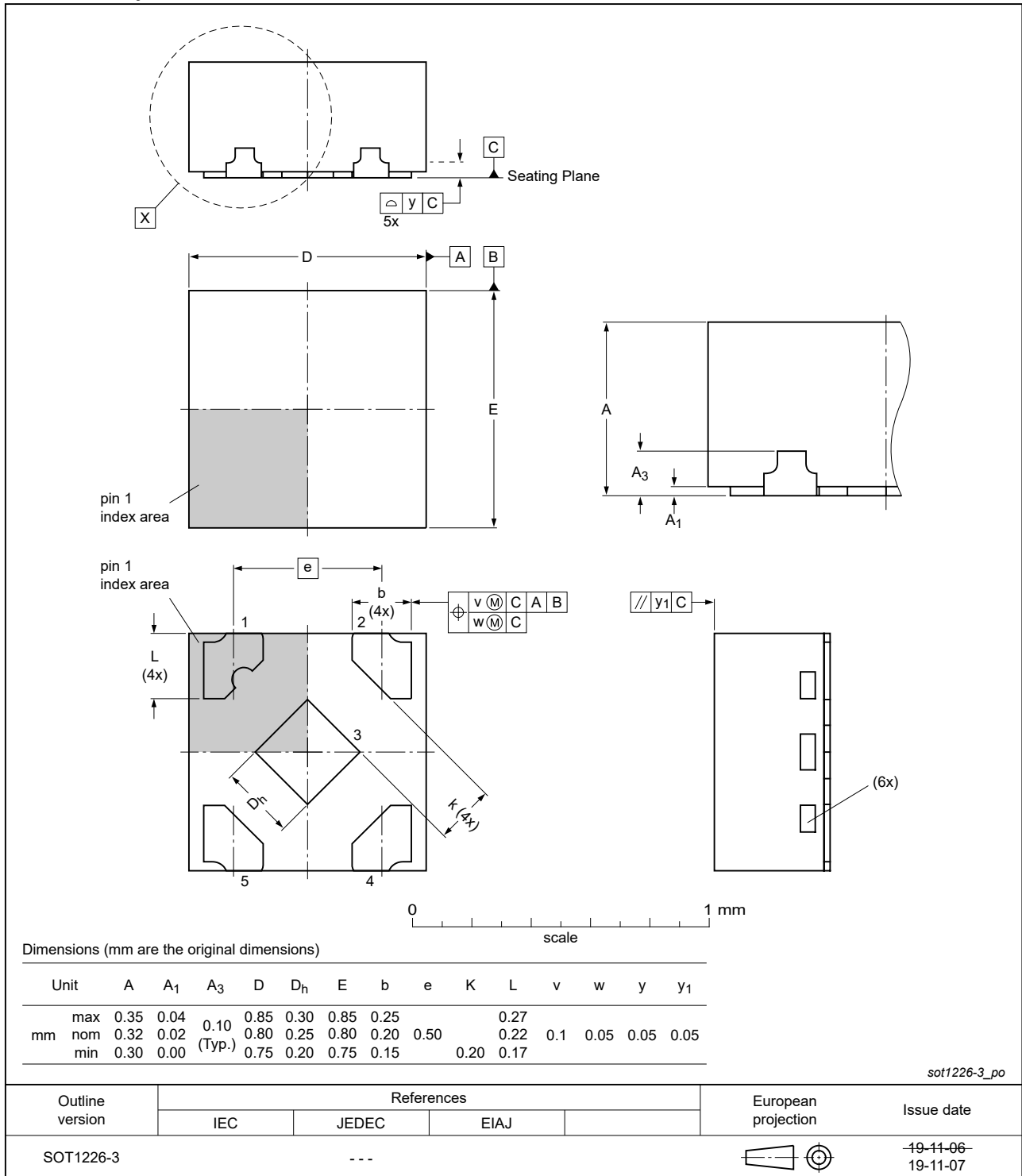


Fig. 17. Package outline SOT1226-3 (X2SON5)

## 13. Abbreviations

Table 11. Abbreviations

Acronym	Description
CDM	Charged Device Model
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model

## 14. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74AXP1G09 v.3	20210707	Product data sheet	-	74AXP1G09 v.2
Modifications:	<ul style="list-style-type: none"> <li>SOT1226 (X2SON5) package changed to SOT1226-3 (X2SON5) package.</li> <li><a href="#">Table 5</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> </ul>			
74AXP1G09 v.2	20151217	Product data sheet	-	74AXP1G09 v.1
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Table 8</a>: <math>C_{PD}</math> formula corrected (errata).</li> </ul>			
74AXP1G09 v.1	20151005	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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For sales office addresses, please send an email to: [salesaddresses@nexperia.com](mailto:salesaddresses@nexperia.com)

Date of release: 7 July 2021