

74AUP1G09

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

Rev. 4 — 28 June 2012

Product data sheet

1. General description

The 74AUP1G09 provides the single 2-input AND gate with an 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.

Schmitt trigger action at all inputs makes the circuit tolerant to slower input rise and fall times across the entire V_{CC} range from 0.8 V to 3.6 V.

This device ensures a very low static and dynamic power consumption across the entire V_{CC} range from 0.8 V to 3.6 V.

This device is fully specified for partial Power-down applications using I_{OFF} . The I_{OFF} circuitry disables the output, preventing the damaging backflow current through the device when it is powered down.

2. Features and benefits

- Wide supply voltage range from 0.8 V to 3.6 V
- High noise immunity
- Complies with JEDEC standards:
 - ◆ JESD8-12 (0.8 V to 1.3 V)
 - ◆ JESD8-11 (0.9 V to 1.65 V)
 - ◆ JESD8-7 (1.2 V to 1.95 V)
 - ◆ JESD8-5 (1.8 V to 2.7 V)
 - ◆ JESD8-B (2.7 V to 3.6 V)
- ESD protection:
 - ◆ HBM JESD22-A114F Class 3A exceeds 5000 V
 - ◆ MM JESD22-A115-A exceeds 200 V
 - ◆ CDM JESD22-C101E exceeds 1000 V
- Low static power consumption; $I_{CC} = 0.9 \mu\text{A}$ (maximum)
- Latch-up performance exceeds 100 mA per JESD 78 Class II
- Inputs accept voltages up to 3.6 V
- Low noise overshoot and undershoot < 10 % of V_{CC}
- I_{OFF} circuitry provides partial Power-down mode operation
- Multiple package options
- Specified from $-40 \text{ }^\circ\text{C}$ 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

Type number	Package			Version
	Temperature range	Name	Description	
74AUP1G09GW	-40 °C to +125 °C	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	SOT353-1
74AUP1G09GM	-40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm	SOT886
74AUP1G09GF	-40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1 × 0.5 mm	SOT891
74AUP1G09GN	-40 °C to +125 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body 0.9 × 1.0 × 0.35 mm	SOT1115
74AUP1G09GS	-40 °C to +125 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body 1.0 × 1.0 × 0.35 mm	SOT1202
74AUP1G09GX	-40 °C to +125 °C	X2SON5	X2SON5: plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 × 0.8 × 0.35 mm	SOT1226

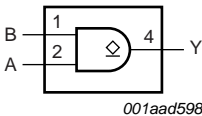
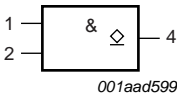
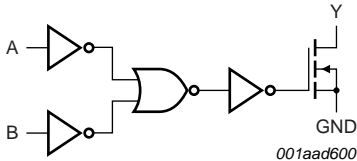
4. Marking

Table 2. Marking

Type number	Marking code ^[1]
74AUP1G09GW	p9
74AUP1G09GM	p9
74AUP1G09GF	p9
74AUP1G09GN	p9
74AUP1G09GS	p9
74AUP1G09GX	p9

[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>
Fig 1. Logic symbol	Fig 2. IEC logic symbol	Fig 3. Logic diagram

6. Pinning information

6.1 Pinning

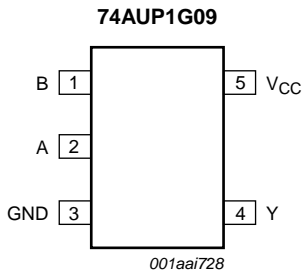


Fig 4. Pin configuration SOT353-1

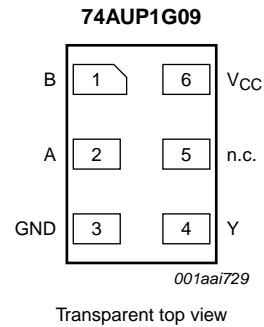


Fig 5. Pin configuration SOT886

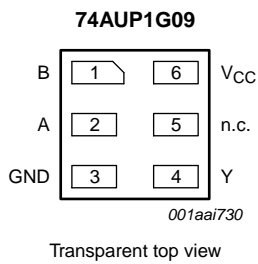


Fig 6. Pin configuration SOT891, SOT1115 and SOT1202

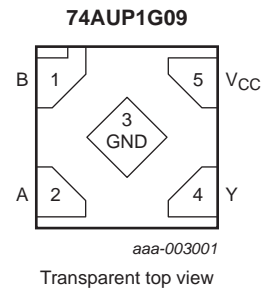


Fig 7. Pin configuration SOT1226 (X2SON5)

6.2 Pin description

Table 3. Pin description

Symbol	Pin		Description
	TSSOP5 and X2SON5	XSON6	
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 _{CC}	5	6	supply voltage

7. Functional description

Table 4. Function table^[1]

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

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

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	+4.6	V
I_{IK}	input clamping current	$V_I < 0$ V	-50	-	mA
V_I	input voltage		^[1] -0.5	+4.6	V
I_{OK}	output clamping current	$V_O < 0$ V	-50	-	mA
V_O	output voltage	Active mode and Power-down mode	^[1] -0.5	+4.6	V
I_O	output current	$V_O = 0$ V to V_{CC}	-	+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 +125 °C	^[2] -	250	mW

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

[2] For TSSOP5 packages: above 87.5 °C the value of P_{tot} derates linearly with 4.0 mW/K.

For XSON6 and X2SON5 packages: above 118 °C the value of P_{tot} derates linearly with 7.8 mW/K.

9. Recommended operating conditions

Table 6. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		0.8	3.6	V
V_I	input voltage		0	3.6	V
V_O	output voltage	Active mode and Power-down mode	0	3.6	V
T_{amb}	ambient temperature		-40	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 0.8$ V to 3.6 V	0	200	ns/V

10. Static characteristics

Table 7. Static characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{amb} = 25 °C						
V _{IH}	HIGH-level input voltage	V _{CC} = 0.8 V	0.7V _{CC}	-	-	V
		V _{CC} = 0.9 V to 1.95 V	0.65V _{CC}	-	-	V
		V _{CC} = 2.3 V to 2.7 V	1.6	-	-	V
		V _{CC} = 3.0 V to 3.6 V	2.0	-	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 0.8 V	-	-	0.3V _{CC}	V
		V _{CC} = 0.9 V to 1.95 V	-	-	0.35V _{CC}	V
		V _{CC} = 2.3 V to 2.7 V	-	-	0.7	V
		V _{CC} = 3.0 V to 3.6 V	-	-	0.9	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = 20 μA; V _{CC} = 0.8 V to 3.6 V	-	-	0.1	V
		I _O = 1.1 mA; V _{CC} = 1.1 V	-	-	0.3V _{CC}	V
		I _O = 1.7 mA; V _{CC} = 1.4 V	-	-	0.31	V
		I _O = 1.9 mA; V _{CC} = 1.65 V	-	-	0.31	V
		I _O = 2.3 mA; V _{CC} = 2.3 V	-	-	0.31	V
		I _O = 3.1 mA; V _{CC} = 2.3 V	-	-	0.44	V
		I _O = 2.7 mA; V _{CC} = 3.0 V	-	-	0.31	V
		I _O = 4.0 mA; V _{CC} = 3.0 V	-	-	0.44	V
I _I	input leakage current	V _I = GND to 3.6 V; V _{CC} = 0 V to 3.6 V	-	-	±0.1	μA
I _{OZ}	OFF-state output current	V _I = V _{IH} or V _{IL} ; V _O = 0 V to 3.6 V; V _{CC} = 3.6 V	-	-	±0.1	μA
I _{OFF}	power-off leakage current	V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V	-	-	±0.2	μA
ΔI _{OFF}	additional power-off leakage current	V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V to 0.2 V	-	-	±0.2	μA
I _{CC}	supply current	V _I = GND or V _{CC} ; I _O = 0 A; V _{CC} = 0.8 V to 3.6 V	-	-	0.5	μA
ΔI _{CC}	additional supply current	V _I = V _{CC} - 0.6 V; I _O = 0 A; V _{CC} = 3.3 V	-	-	40	μA
C _I	input capacitance	V _{CC} = 0 V to 3.6 V; V _I = GND or V _{CC}	-	0.8	-	pF
C _O	output capacitance	output enabled; V _O = GND; V _{CC} = 0 V	-	1.7	-	pF
		output disabled; V _O = GND; V _{CC} = 0 V	-	1.1	-	pF
T_{amb} = -40 °C to +85 °C						
V _{IH}	HIGH-level input voltage	V _{CC} = 0.8 V	0.7V _{CC}	-	-	V
		V _{CC} = 0.9 V to 1.95 V	0.65V _{CC}	-	-	V
		V _{CC} = 2.3 V to 2.7 V	1.6	-	-	V
		V _{CC} = 3.0 V to 3.6 V	2.0	-	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 0.8 V	-	-	0.3V _{CC}	V
		V _{CC} = 0.9 V to 1.95 V	-	-	0.35V _{CC}	V
		V _{CC} = 2.3 V to 2.7 V	-	-	0.7	V
		V _{CC} = 3.0 V to 3.6 V	-	-	0.9	V

Table 7. Static characteristics ...continued

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = 20 μA; V _{CC} = 0.8 V to 3.6 V	-	-	0.1	V
		I _O = 1.1 mA; V _{CC} = 1.1 V	-	-	0.3V _{CC}	V
		I _O = 1.7 mA; V _{CC} = 1.4 V	-	-	0.37	V
		I _O = 1.9 mA; V _{CC} = 1.65 V	-	-	0.35	V
		I _O = 2.3 mA; V _{CC} = 2.3 V	-	-	0.33	V
		I _O = 3.1 mA; V _{CC} = 2.3 V	-	-	0.45	V
		I _O = 2.7 mA; V _{CC} = 3.0 V	-	-	0.33	V
		I _O = 4.0 mA; V _{CC} = 3.0 V	-	-	0.45	V
I _I	input leakage current	V _I = GND to 3.6 V; V _{CC} = 0 V to 3.6 V	-	-	±0.5	μA
I _{OZ}	OFF-state output current	V _I = V _{IH} or V _{IL} ; V _O = 0 V to 3.6 V; V _{CC} = 3.6 V	-	-	±0.5	μA
I _{OFF}	power-off leakage current	V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V	-	-	±0.5	μA
ΔI _{OFF}	additional power-off leakage current	V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V to 0.2 V	-	-	±0.6	μA
I _{CC}	supply current	V _I = GND or V _{CC} ; I _O = 0 A; V _{CC} = 0.8 V to 3.6 V	-	-	0.9	μA
ΔI _{CC}	additional supply current	V _I = V _{CC} - 0.6 V; I _O = 0 A; V _{CC} = 3.3 V	-	-	50	μA
T_{amb} = -40 °C to +125 °C						
V _{IH}	HIGH-level input voltage	V _{CC} = 0.8 V	0.75V _{CC}	-	-	V
		V _{CC} = 0.9 V to 1.95 V	0.7V _{CC}	-	-	V
		V _{CC} = 2.3 V to 2.7 V	1.6	-	-	V
		V _{CC} = 3.0 V to 3.6 V	2.0	-	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 0.8 V	-	-	0.25V _{CC}	V
		V _{CC} = 0.9 V to 1.95 V	-	-	0.3V _{CC}	V
		V _{CC} = 2.3 V to 2.7 V	-	-	0.7	V
		V _{CC} = 3.0 V to 3.6 V	-	-	0.9	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = 20 μA; V _{CC} = 0.8 V to 3.6 V	-	-	0.11	V
		I _O = 1.1 mA; V _{CC} = 1.1 V	-	-	0.33V _{CC}	V
		I _O = 1.7 mA; V _{CC} = 1.4 V	-	-	0.41	V
		I _O = 1.9 mA; V _{CC} = 1.65 V	-	-	0.39	V
		I _O = 2.3 mA; V _{CC} = 2.3 V	-	-	0.36	V
		I _O = 3.1 mA; V _{CC} = 2.3 V	-	-	0.50	V
		I _O = 2.7 mA; V _{CC} = 3.0 V	-	-	0.36	V
		I _O = 4.0 mA; V _{CC} = 3.0 V	-	-	0.50	V
I _I	input leakage current	V _I = GND to 3.6 V; V _{CC} = 0 V to 3.6 V	-	-	±0.75	μA
I _{OZ}	OFF-state output current	V _I = V _{IH} or V _{IL} ; V _O = 0 V to 3.6 V; V _{CC} = 3.6 V	-	-	±0.75	μA
I _{OFF}	power-off leakage current	V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V	-	-	±0.75	μA

Table 7. Static characteristics ...continued

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
ΔI_{OFF}	additional power-off leakage current	V_I or $V_O = 0$ V to 3.6 V; $V_{CC} = 0$ V to 0.2 V	-	-	± 0.75	μA
I_{CC}	supply current	$V_I = GND$ or V_{CC} ; $I_O = 0$ A; $V_{CC} = 0.8$ V to 3.6 V	-	-	1.4	μA
ΔI_{CC}	additional supply current	$V_I = V_{CC} - 0.6$ V; $I_O = 0$ A; $V_{CC} = 3.3$ V	-	-	75	μA

11. Dynamic characteristics

Table 8. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V; for test circuit see [Figure 9](#))

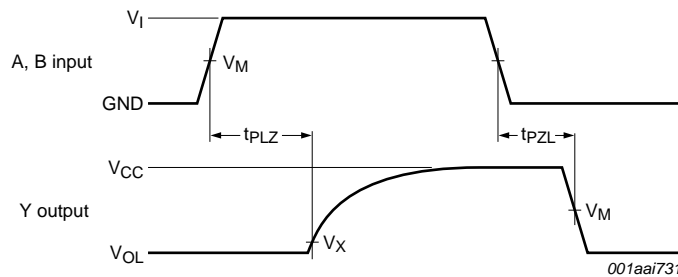
Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C			Unit
			Min	Typ ^[1]	Max	Min	Max (85 °C)	Max (125 °C)	
$C_L = 5$ pF									
t_{pd}	propagation delay	A or B to Y; see Figure 8 ^[2]							
		$V_{CC} = 0.8$ V	-	13.5	-	-	-	-	ns
		$V_{CC} = 1.1$ V to 1.3 V	1.9	4.6	10.4	1.8	11.4	12.6	ns
		$V_{CC} = 1.4$ V to 1.6 V	1.5	3.3	6.5	1.4	7.4	8.2	ns
		$V_{CC} = 1.65$ V to 1.95 V	1.2	2.9	5.1	1.1	5.9	6.5	ns
		$V_{CC} = 2.3$ V to 2.7 V	1.0	2.2	3.8	0.9	4.5	4.9	ns
		$V_{CC} = 3.0$ V to 3.6 V	0.9	2.3	4.0	0.8	4.5	4.9	ns
$C_L = 10$ pF									
t_{pd}	propagation delay	A or B to Y; see Figure 8 ^[2]							
		$V_{CC} = 0.8$ V	-	16.3	-	-	-	-	ns
		$V_{CC} = 1.1$ V to 1.3 V	2.3	5.6	12.3	2.1	13.7	15.1	ns
		$V_{CC} = 1.4$ V to 1.6 V	1.8	4.1	7.6	1.7	8.8	9.7	ns
		$V_{CC} = 1.65$ V to 1.95 V	1.6	3.8	6.1	1.4	7.1	7.8	ns
		$V_{CC} = 2.3$ V to 2.7 V	1.4	2.9	4.6	1.2	5.4	5.9	ns
		$V_{CC} = 3.0$ V to 3.6 V	1.3	3.2	5.7	1.1	6.4	7.0	ns
$C_L = 15$ pF									
t_{pd}	propagation delay	A or B to Y; see Figure 8 ^[2]							
		$V_{CC} = 0.8$ V	-	19.0	-	-	-	-	ns
		$V_{CC} = 1.1$ V to 1.3 V	2.6	6.6	14.2	2.4	15.8	17.4	ns
		$V_{CC} = 1.4$ V to 1.6 V	2.1	4.8	8.7	1.9	10.1	11.1	ns
		$V_{CC} = 1.65$ V to 1.95 V	1.9	4.6	7.6	1.7	8.5	9.3	ns
		$V_{CC} = 2.3$ V to 2.7 V	1.6	3.6	5.6	1.5	6.3	6.9	ns
		$V_{CC} = 3.0$ V to 3.6 V	1.6	4.1	7.5	1.4	8.3	9.1	ns
$C_L = 30$ pF									

Table 8. Dynamic characteristics ...continued
 Voltages are referenced to GND (ground = 0 V; for test circuit see [Figure 9](#))

Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C			Unit
			Min	Typ ^[1]	Max	Min	Max (85 °C)	Max (125 °C)	
t _{pd}	propagation delay	A or B to Y; see Figure 8 ^[2]							
		V _{CC} = 0.8 V	-	27.0	-	-	-	-	ns
		V _{CC} = 1.1 V to 1.3 V	3.6	9.5	19.5	3.2	21.8	24.0	ns
		V _{CC} = 1.4 V to 1.6 V	2.9	7.0	11.5	2.6	13.6	15.0	ns
		V _{CC} = 1.65 V to 1.95 V	2.6	7.0	12.1	2.3	13.3	14.6	ns
		V _{CC} = 2.3 V to 2.7 V	2.4	5.4	8.9	2.1	9.9	10.9	ns
		V _{CC} = 3.0 V to 3.6 V	2.3	6.5	12.7	2.1	13.9	15.3	ns
C_L = 5 pF, 10 pF, 15 pF and 30 pF									
C _{PD}	power dissipation capacitance	f _i = 1 MHz; ^[3] V _I = GND to V _{CC}							
		V _{CC} = 0.8 V	-	0.6	-	-	-	-	pF
		V _{CC} = 1.1 V to 1.3 V	-	0.7	-	-	-	-	pF
		V _{CC} = 1.4 V to 1.6 V	-	0.8	-	-	-	-	pF
		V _{CC} = 1.65 V to 1.95 V	-	0.9	-	-	-	-	pF
		V _{CC} = 2.3 V to 2.7 V	-	1.1	-	-	-	-	pF
		V _{CC} = 3.0 V to 3.6 V	-	1.4	-	-	-	pF	

- [1] All typical values are measured at nominal V_{CC}.
- [2] t_{pd} is the same as t_{pZL} and t_{pLZ}.
- [3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N$ where:
 f_i = input frequency in MHz;
 V_{CC} = supply voltage in V;
 N = number of inputs switching.

12. Waveforms

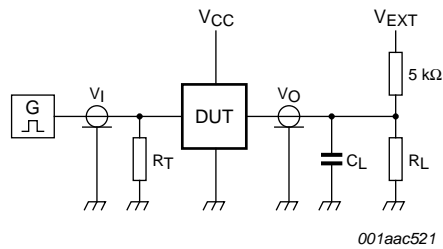


Measurement points are given in [Table 9](#).
 V_{OL} is a typical output voltage level that occurs with the output load.

Fig 8. The data input (A or B) to output (Y) propagation delays

Table 9. Measurement points

Supply voltage	Input	Output	
V_{CC}	V_M	V_M	V_X
0.8 V to 1.6 V	$0.5V_{CC}$	$0.5V_{CC}$	$V_{OL} + 0.1 V$
1.65 V to 2.7 V	$0.5V_{CC}$	$0.5V_{CC}$	$V_{OL} + 0.15 V$
3.0 V to 3.6 V	$0.5V_{CC}$	$0.5V_{CC}$	$V_{OL} + 0.3 V$



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 9. Test circuit for measuring switching times

Table 10. Test data

Supply voltage	Load		V_{EXT}		
V_{CC}	C_L	R_L [1]	t_{PLH} , t_{PHL}	t_{PZH} , t_{PHZ}	t_{PZL} , t_{PLZ}
0.8 V to 3.6 V	5 pF, 10 pF, 15 pF and 30 pF	5 kΩ or 1 MΩ	open	GND	$2V_{CC}$

[1] For measuring enable and disable times $R_L = 5 k\Omega$.

For measuring propagation delays, set-up and hold times, and pulse width, $R_L = 1 M\Omega$.

13. Package outline

TSSOP5: plastic thin shrink small outline package; 5 leads; body width 1.25 mm

SOT353-1

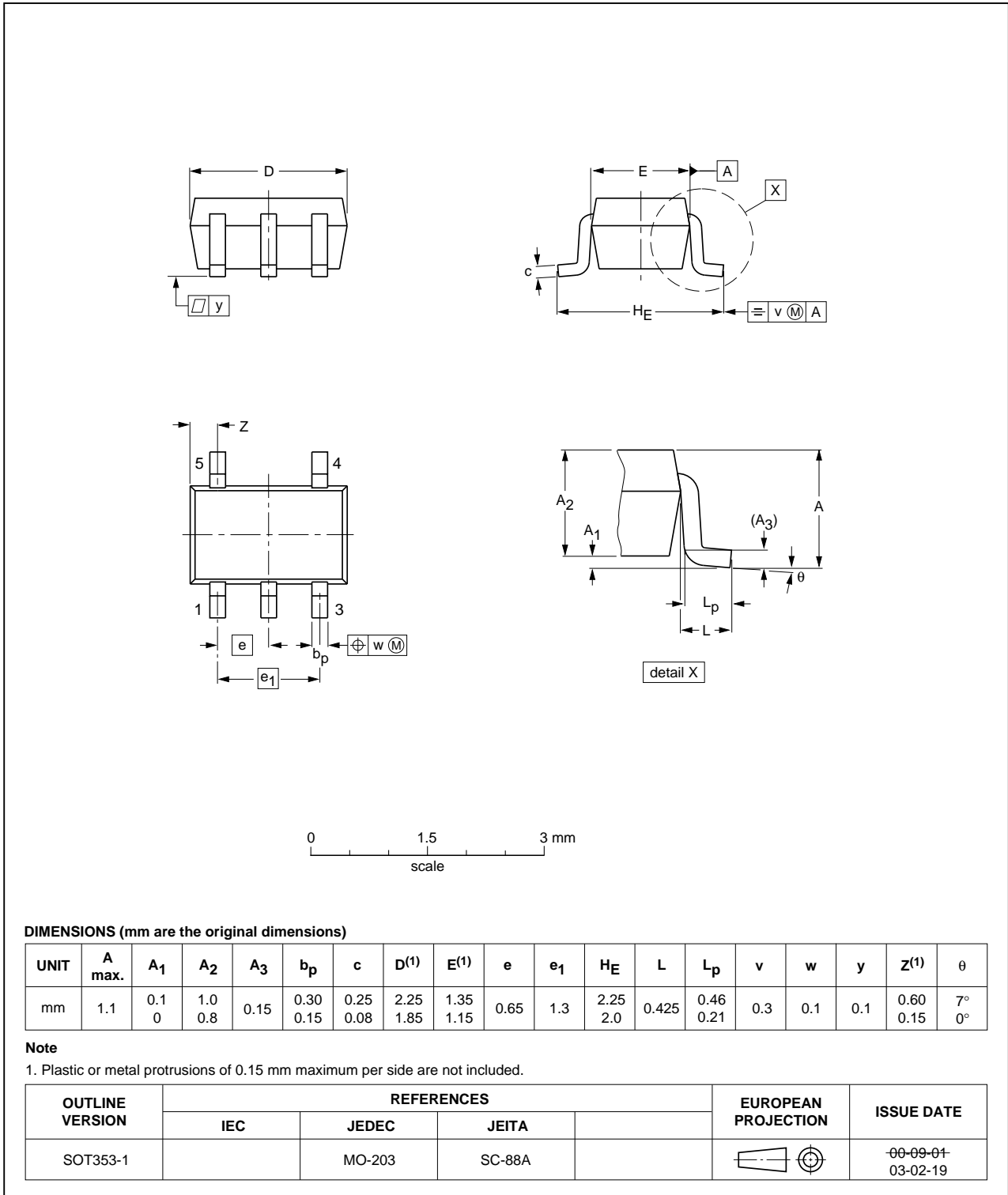


Fig 10. Package outline SOT353-1 (TSSOP5)

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

SOT886

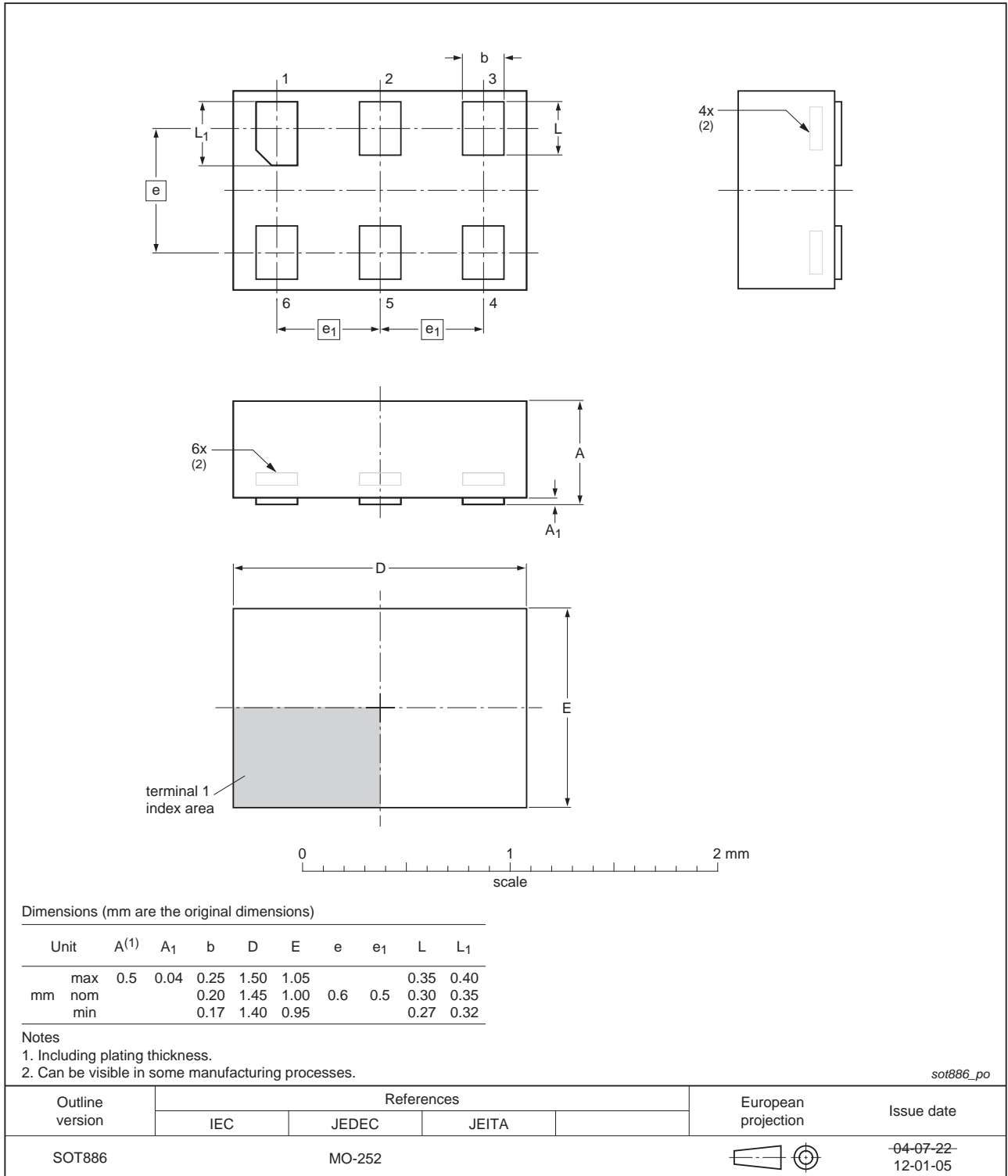


Fig 11. Package outline SOT886 (XSON6)

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

SOT891

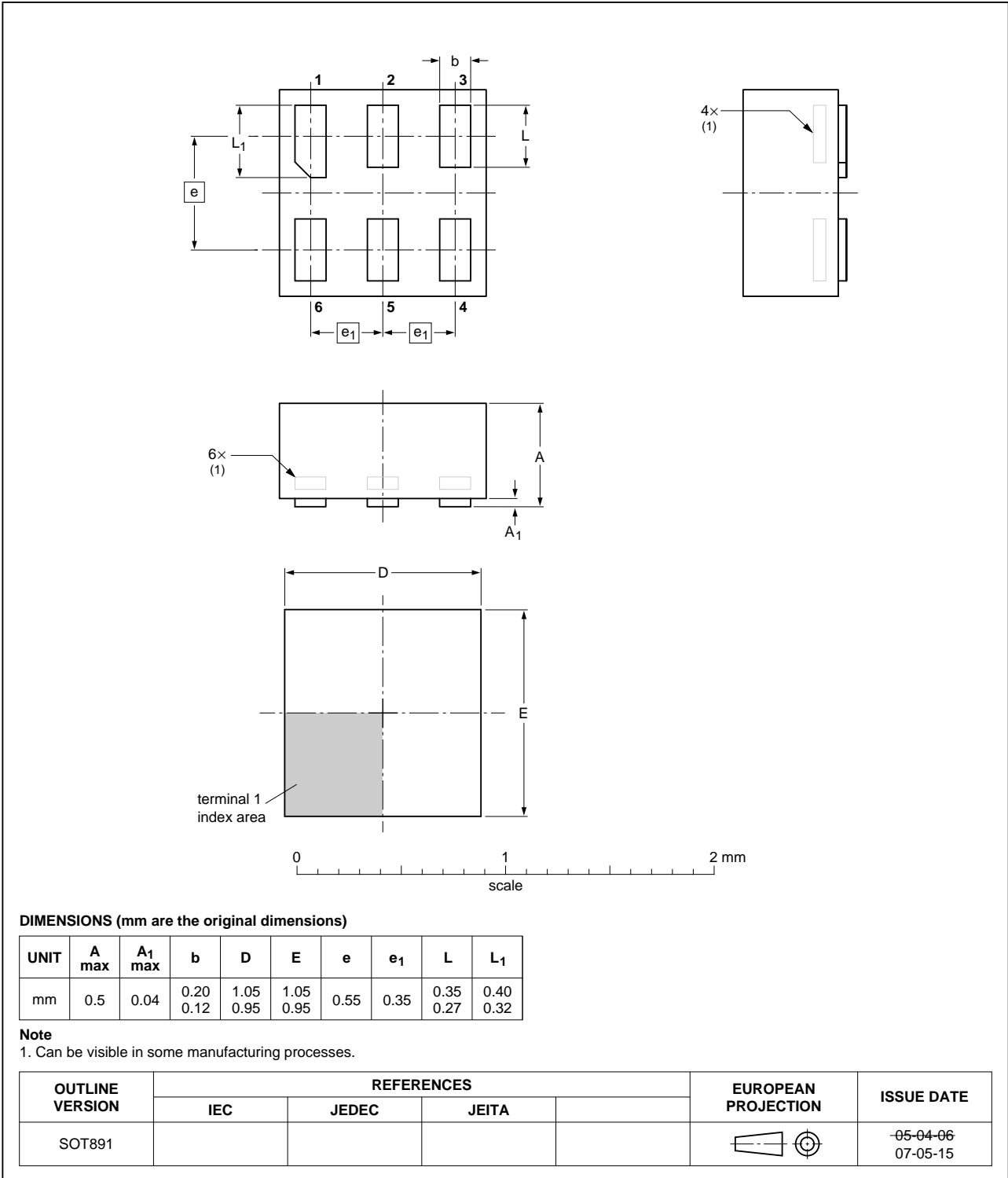


Fig 12. Package outline SOT891 (XSON6)

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

SOT1115

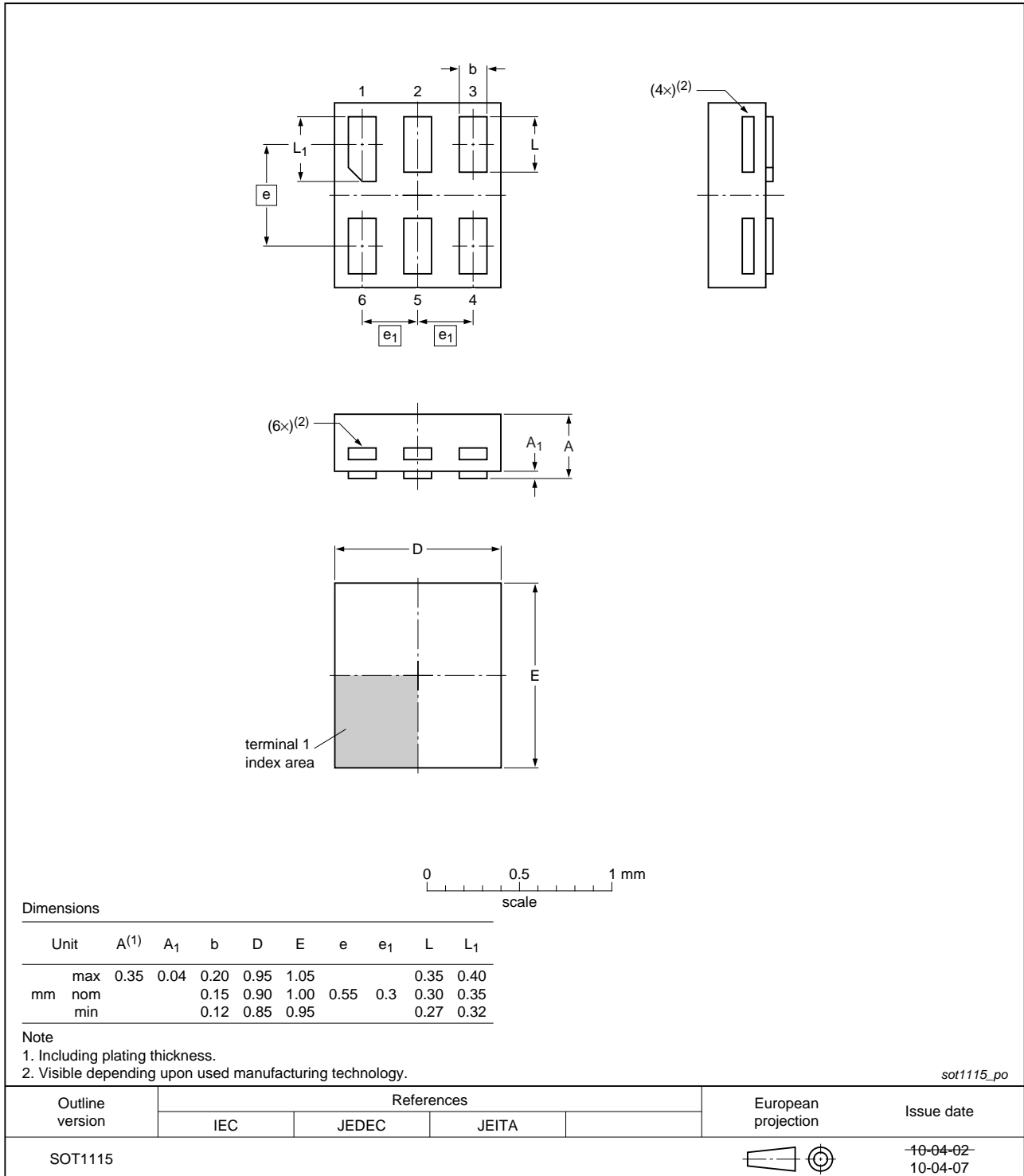


Fig 13. Package outline SOT1115 (XSON6)

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

SOT1202

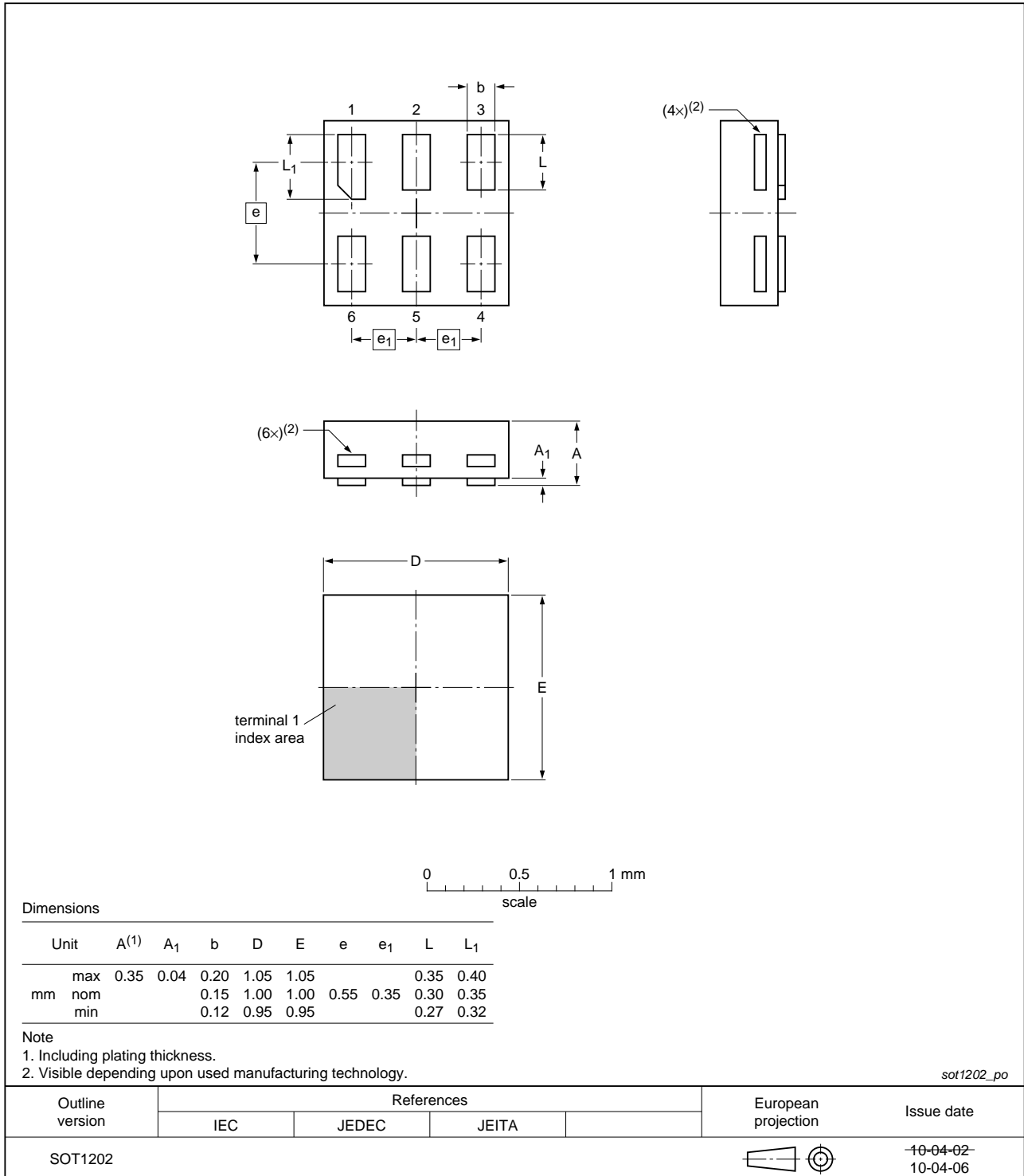


Fig 14. Package outline SOT1202 (XSON6)

X2SON5: plastic thermal enhanced extremely thin small outline package; no leads;
5 terminals; body 0.8 x 0.8 x 0.35 mm

SOT1226

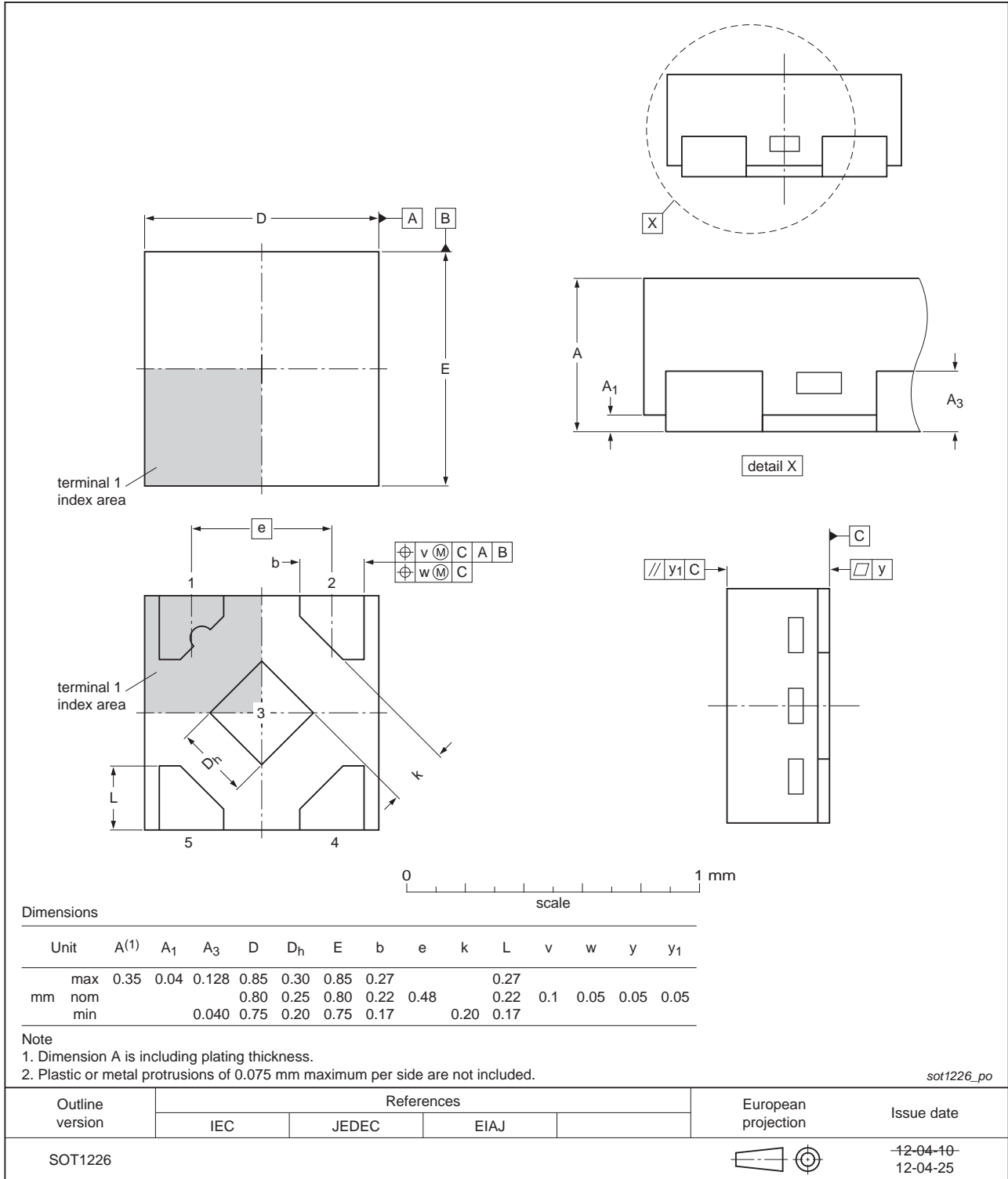


Fig 15. Package outline SOT1226 (X2SON5)

14. Abbreviations

Table 11. Abbreviations

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

15. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74AUP1G09 v.4	20120628	Product data sheet	-	74AUP1G09 v.3
Modifications:	<ul style="list-style-type: none"> Added type number 74AUP1G09GX (SOT1226) Package outline drawing of SOT886 (Figure 11) modified. 			
74AUP1G09 v.3	20111128	Product data sheet	-	74AUP1G09 v.2
Modifications:	<ul style="list-style-type: none"> Legal pages updated. 			
74AUP1G09 v.2	20100709	Product data sheet	-	74AUP1G09 v.1
74AUP1G09 v.1	20090115	Product data sheet	-	-

16. Legal information

16.1 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 URL <http://www.nxp.com>.

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18. Contents

1 General description 1

2 Features and benefits 1

3 Ordering information 2

4 Marking 2

5 Functional diagram 2

6 Pinning information 3

6.1 Pinning 3

6.2 Pin description 3

7 Functional description 4

8 Limiting values 4

9 Recommended operating conditions 4

10 Static characteristics 5

11 Dynamic characteristics 7

12 Waveforms 8

13 Package outline 10

14 Abbreviations 16

15 Revision history 16

16 Legal information 17

16.1 Data sheet status 17

16.2 Definitions 17

16.3 Disclaimers 17

16.4 Trademarks 18

17 Contact information 18

18 Contents 19

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