

74AUP2GU04

Low-power dual unbuffered inverter

Rev. 01 — 15 December 2006

Product data sheet

1. General description

The 74AUP2GU04 is a high-performance, low-power, low-voltage, Si-gate CMOS device, superior to most advanced CMOS compatible families.

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.

The 74AUP2GU04 provides two unbuffered inverting gates.

2. Features

- Wide supply voltage range from 0.8 V to 3.6 V
- High noise immunity
- ESD protection:
 - ◆ HBM JESD22-A114D Class 3A exceeds 5000 V
 - ◆ MM JESD22-A115-A exceeds 200 V
 - ◆ CDM JESD22-C101C 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
- 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			
	Temperature range	Name	Description	Version
74AUP2GU04GW	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SC-88	plastic surface-mounted package; 6 leads	SOT363
74AUP2GU04GM	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body $1 \times 1.45 \times 0.5\text{ mm}$	SOT886
74AUP2GU04GF	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body $1 \times 1 \times 0.5\text{ mm}$	SOT891

4. Marking

Table 2. Marking

Type number	Marking code
74AUP2GU04GW	aD
74AUP2GU04GM	aD
74AUP2GU04GF	aD

5. Functional diagram

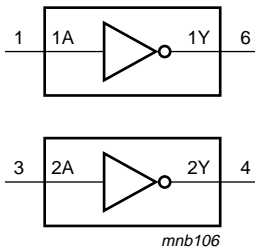


Fig 1. Logic symbol

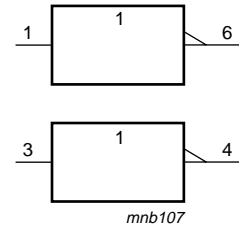


Fig 2. IEC logic symbol

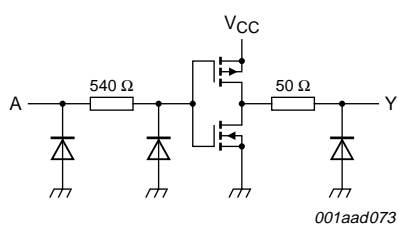


Fig 3. Logic diagram (one gate)

6. Pinning information

6.1 Pinning

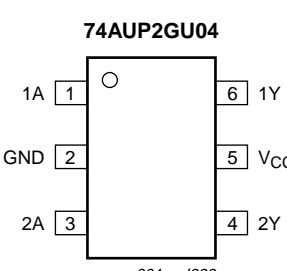


Fig 4. Pin configuration SOT363 (SC-88)

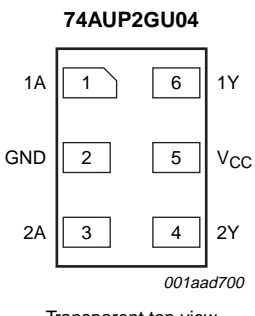


Fig 5. Pin configuration SOT886 (XSON6)

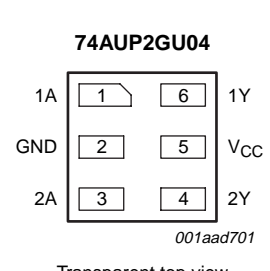


Fig 6. Pin configuration SOT891 (XSON6)

6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
1A	1	data input
GND	2	ground (0 V)
2A	3	data input
2Y	4	data output
V _{CC}	5	supply voltage
1Y	6	data output

7. Functional description

Table 4. Function table^[1]

Input	Output
nA	nY
L	H
H	L

- [1] H = HIGH voltage level;
L = LOW voltage level.

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 > V _{CC} or V _O < 0 V	-	±50	mA
V _O	output voltage		^[2] -0.5	V _{CC} + 0.5	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	^[3] -	250	mW

- [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 SC-88 packages: above 87.5 °C the value of P_{tot} derates linearly with 4.0 mW/K.
 For XSON6 packages: above 45 °C the value of P_{tot} derates linearly with 2.4 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		0	V_{CC}	V
T_{amb}	ambient temperature		-40	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 0.8 \text{ V to } 3.6 \text{ V}$	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
$T_{amb} = 25 \text{ °C}$						
V_{IH}	HIGH-level input voltage	$V_{CC} = 0.8 \text{ V to } 3.6 \text{ V}$	$0.75 \times V_{CC}$	-	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 0.8 \text{ V to } 3.6 \text{ V}$	-	-	$0.25 \times V_{CC}$	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH} \text{ or } V_{IL}$				
		$I_O = -20 \text{ }\mu\text{A}; V_{CC} = 0.8 \text{ V to } 3.6 \text{ V}$	$V_{CC} - 0.1$	-	-	V
		$I_O = -1.1 \text{ mA}; V_{CC} = 1.1 \text{ V}$	$0.75 \times V_{CC}$	-	-	V
		$I_O = -1.7 \text{ mA}; V_{CC} = 1.4 \text{ V}$	1.11	-	-	V
		$I_O = -1.9 \text{ mA}; V_{CC} = 1.65 \text{ V}$	1.32	-	-	V
		$I_O = -2.3 \text{ mA}; V_{CC} = 2.3 \text{ V}$	2.05	-	-	V
		$I_O = -3.1 \text{ mA}; V_{CC} = 2.3 \text{ V}$	1.9	-	-	V
		$I_O = -2.7 \text{ mA}; V_{CC} = 3.0 \text{ V}$	2.72	-	-	V
		$I_O = -4.0 \text{ mA}; V_{CC} = 3.0 \text{ V}$	2.6	-	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH} \text{ or } V_{IL}$				
		$I_O = 20 \text{ }\mu\text{A}; V_{CC} = 0.8 \text{ V to } 3.6 \text{ V}$	-	-	0.1	V
		$I_O = 1.1 \text{ mA}; V_{CC} = 1.1 \text{ V}$	-	-	$0.3 \times V_{CC}$	V
		$I_O = 1.7 \text{ mA}; V_{CC} = 1.4 \text{ V}$	-	-	0.31	V
		$I_O = 1.9 \text{ mA}; V_{CC} = 1.65 \text{ V}$	-	-	0.31	V
		$I_O = 2.3 \text{ mA}; V_{CC} = 2.3 \text{ V}$	-	-	0.31	V
		$I_O = 3.1 \text{ mA}; V_{CC} = 2.3 \text{ V}$	-	-	0.44	V
		$I_O = 2.7 \text{ mA}; V_{CC} = 3.0 \text{ V}$	-	-	0.31	V
	$I_O = 4.0 \text{ mA}; V_{CC} = 3.0 \text{ V}$	-	-	0.44	V	
I_I	input leakage current	$V_I = \text{GND to } 3.6 \text{ V}; V_{CC} = 0 \text{ V to } 3.6 \text{ V}$	-	-	± 0.1	μA
I_{CC}	supply current	$V_I = \text{GND or } V_{CC}; I_O = 0 \text{ A}; V_{CC} = 0.8 \text{ V to } 3.6 \text{ V}$	-	-	0.5	μA
C_I	input capacitance	$V_{CC} = 0 \text{ V to } 3.6 \text{ V}; V_I = \text{GND or } V_{CC}$	-	1.5	-	pF
C_O	output capacitance	$V_O = \text{GND}; V_{CC} = 0 \text{ V}$	-	1.8	-	pF

Table 7. Static characteristics ...continued

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{amb} = -40 °C to +85 °C						
V _{IH}	HIGH-level input voltage	V _{CC} = 0.8 V to 3.6 V	0.75 × V _{CC}	-	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 0.8 V to 3.6 V	-	-	0.25 × V _{CC}	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = -20 μA; V _{CC} = 0.8 V to 3.6 V	V _{CC} - 0.1	-	-	V
		I _O = -1.1 mA; V _{CC} = 1.1 V	0.7 × V _{CC}	-	-	V
		I _O = -1.7 mA; V _{CC} = 1.4 V	1.03	-	-	V
		I _O = -1.9 mA; V _{CC} = 1.65 V	1.30	-	-	V
		I _O = -2.3 mA; V _{CC} = 2.3 V	1.97	-	-	V
		I _O = -3.1 mA; V _{CC} = 2.3 V	1.85	-	-	V
		I _O = -2.7 mA; V _{CC} = 3.0 V	2.67	-	-	V
		I _O = -4.0 mA; V _{CC} = 3.0 V	2.55	-	-	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	-	-	0.3 × V _{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 _{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
T_{amb} = -40 °C to +125 °C						
V _{IH}	HIGH-level input voltage	V _{CC} = 0.8 V to 3.6 V	0.75 × V _{CC}	-	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 0.8 V to 3.6 V	-	-	0.25 × V _{CC}	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = -20 μA; V _{CC} = 0.8 V to 3.6 V	V _{CC} - 0.11	-	-	V
		I _O = -1.1 mA; V _{CC} = 1.1 V	0.6 × V _{CC}	-	-	V
		I _O = -1.7 mA; V _{CC} = 1.4 V	0.93	-	-	V
		I _O = -1.9 mA; V _{CC} = 1.65 V	1.17	-	-	V
		I _O = -2.3 mA; V _{CC} = 2.3 V	1.77	-	-	V
		I _O = -3.1 mA; V _{CC} = 2.3 V	1.67	-	-	V
		I _O = -2.7 mA; V _{CC} = 3.0 V	2.40	-	-	V
		I _O = -4.0 mA; V _{CC} = 3.0 V	2.30	-	-	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	-	-	0.11	V
		I _O = 1.1 mA; V _{CC} = 1.1 V	-	-	0.33 × V _{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 _I	input leakage current	V _I = GND to 3.6 V; V _{CC} = 0 V to 3.6 V	-	-	±0.75	μA
		V _I = GND or V _{CC} ; I _O = 0 A; V _{CC} = 0.8 V to 3.6 V	-	-	1.4	μA

11. Dynamic characteristics

Table 8. Dynamic characteristics

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

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	nA to nY; see Figure 7 ^[2]							
		V _{CC} = 0.8 V	-	6.2	-	-	-	-	ns
		V _{CC} = 1.1 V to 1.3 V	0.9	2.3	4.4	0.9	4.8	5.3	ns
		V _{CC} = 1.4 V to 1.6 V	0.7	1.7	3.1	0.6	3.4	3.8	ns
		V _{CC} = 1.65 V to 1.95 V	0.5	1.4	2.6	0.5	2.9	3.2	ns
		V _{CC} = 2.3 V to 2.7 V	0.4	1.1	2.0	0.4	2.3	2.6	ns
		V _{CC} = 3.0 V to 3.6 V	0.3	1.0	1.8	0.3	2.1	2.4	ns

C_L = 10 pF

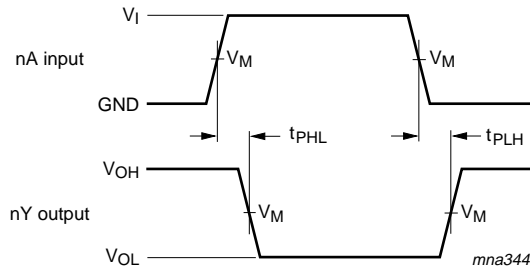
t _{pd}	propagation delay	nA to nY; see Figure 7 ^[2]							
		V _{CC} = 0.8 V	-	9.6	-	-	-	-	ns
		V _{CC} = 1.1 V to 1.3 V	1.2	3.1	6.1	1.2	6.8	7.5	ns
		V _{CC} = 1.4 V to 1.6 V	1.0	2.3	4.0	0.9	4.6	5.1	ns
		V _{CC} = 1.65 V to 1.95 V	0.8	1.9	3.3	0.7	3.8	4.2	ns
		V _{CC} = 2.3 V to 2.7 V	0.6	1.5	2.7	0.6	3.1	3.5	ns
		V _{CC} = 3.0 V to 3.6 V	0.5	1.3	2.4	0.5	2.7	3.0	ns

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

Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C			Unit
			Min	Typ ^[1]	Max	Min	Max (85 °C)	Max (125 °C)	
C_L = 15 pF									
t _{pd}	propagation delay	nA to nY; see Figure 7	[2]						
		V _{CC} = 0.8 V	-	13.0	-	-	-	-	ns
		V _{CC} = 1.1 V to 1.3 V	1.6	3.8	7.9	1.4	8.8	9.7	ns
		V _{CC} = 1.4 V to 1.6 V	1.3	2.8	4.9	1.1	5.7	6.3	ns
		V _{CC} = 1.65 V to 1.95 V	1.0	2.3	4.0	0.9	4.7	5.2	ns
		V _{CC} = 2.3 V to 2.7 V	0.8	1.9	3.2	0.8	3.7	4.1	ns
		V _{CC} = 3.0 V to 3.6 V	0.7	1.6	2.9	0.7	3.3	3.7	ns
C_L = 30 pF									
t _{pd}	propagation delay	nA to nY; see Figure 7	[2]						
		V _{CC} = 0.8 V	-	23.2	-	-	-	-	ns
		V _{CC} = 1.1 V to 1.3 V	2.4	6.0	13.1	2.2	14.8	16.3	ns
		V _{CC} = 1.4 V to 1.6 V	2.0	4.2	7.6	1.8	9.0	9.9	ns
		V _{CC} = 1.65 V to 1.95 V	1.7	3.6	6.1	1.5	7.2	8.0	ns
		V _{CC} = 2.3 V to 2.7 V	1.4	2.9	4.8	1.3	5.7	6.3	ns
		V _{CC} = 3.0 V to 3.6 V	1.2	2.5	4.3	1.1	5.1	5.7	ns
C_L = 5 pF, 10 pF, 15 pF and 30 pF									
C _{PD}	power dissipation capacitance	f _i = 1 MHz; V _I = GND to V _{CC}	[3][4]						
		V _{CC} = 0.8 V	-	1.7	-	-	-	-	pF
		V _{CC} = 1.1 V to 1.3 V	-	1.6	-	-	-	-	pF
		V _{CC} = 1.4 V to 1.6 V	-	1.6	-	-	-	-	pF
		V _{CC} = 1.65 V to 1.95 V	-	1.8	-	-	-	-	pF
		V _{CC} = 2.3 V to 2.7 V	-	3.3	-	-	-	-	pF
		V _{CC} = 3.0 V to 3.6 V	-	5.3	-	-	-	-	pF

- [1] All typical values are measured at nominal V_{CC}.
- [2] t_{pd} is the same as t_{PLH} and t_{PHL}.
- [3] All specified values are the average typical values over all stated loads.
- [4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:
 f_i = input frequency in MHz;
 f_o = output frequency in MHz;
 C_L = load capacitance in pF;
 V_{CC} = supply voltage in V;
 N = number of inputs switching;
 Σ(C_L × V_{CC}² × f_o) = sum of the outputs.

12. Waveforms



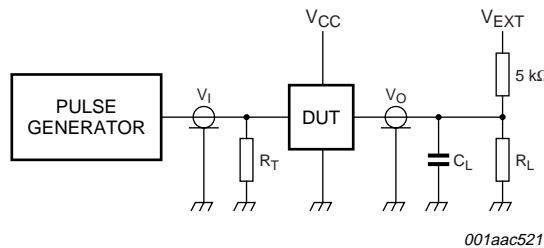
Measurement points are given in [Table 9](#).

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

Fig 7. The data input (nA) to output (nY) propagation delays

Table 9. Measurement points

Supply voltage	Output	Input		
V_{CC}	V_M	V_M	V_I	$t_r = t_f$
0.8 V to 3.6 V	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	V_{CC}	≤ 3.0 ns



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.

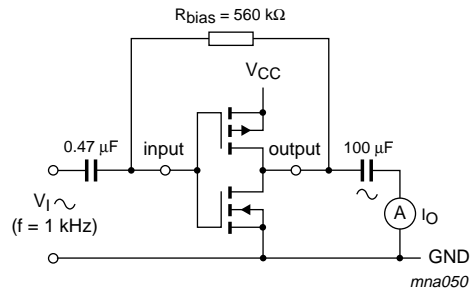
Fig 8. Load circuitry for switching times

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	$2 \times V_{CC}$

[1] For measuring enable and disable times $R_L = 5$ kΩ, for measuring propagation delays, set-up and hold times and pulse width $R_L = 1$ MΩ.

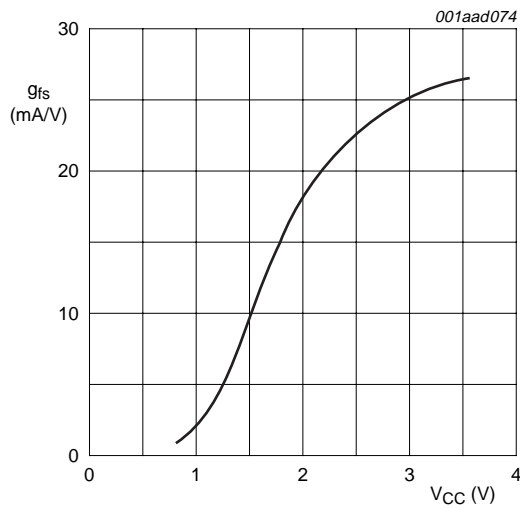
13. Additional characteristics



$$g_{fs} = \frac{\Delta I_O}{\Delta V_i}$$

V_O is constant.

Fig 9. Test set-up for measuring forward transconductance



T_{amb} = 25 °C.

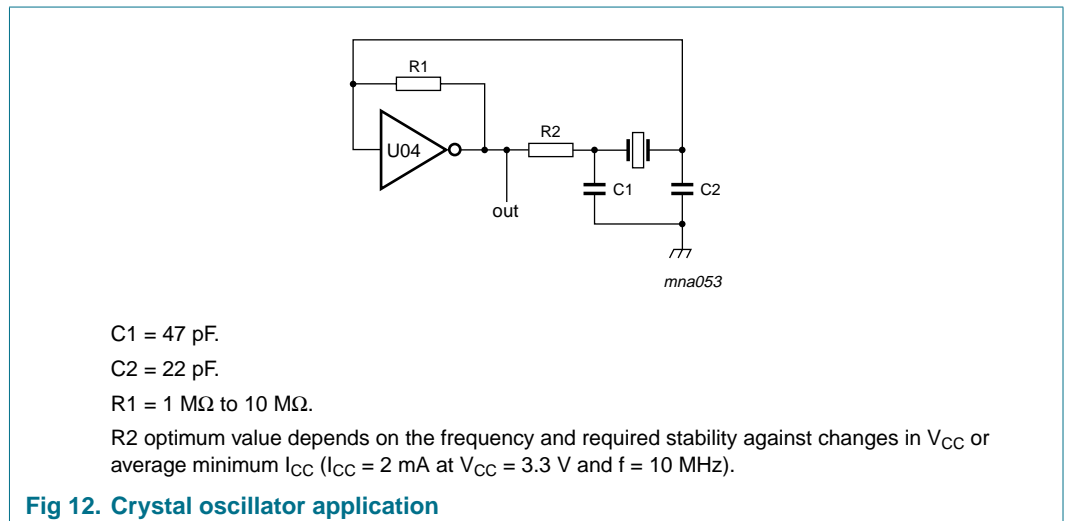
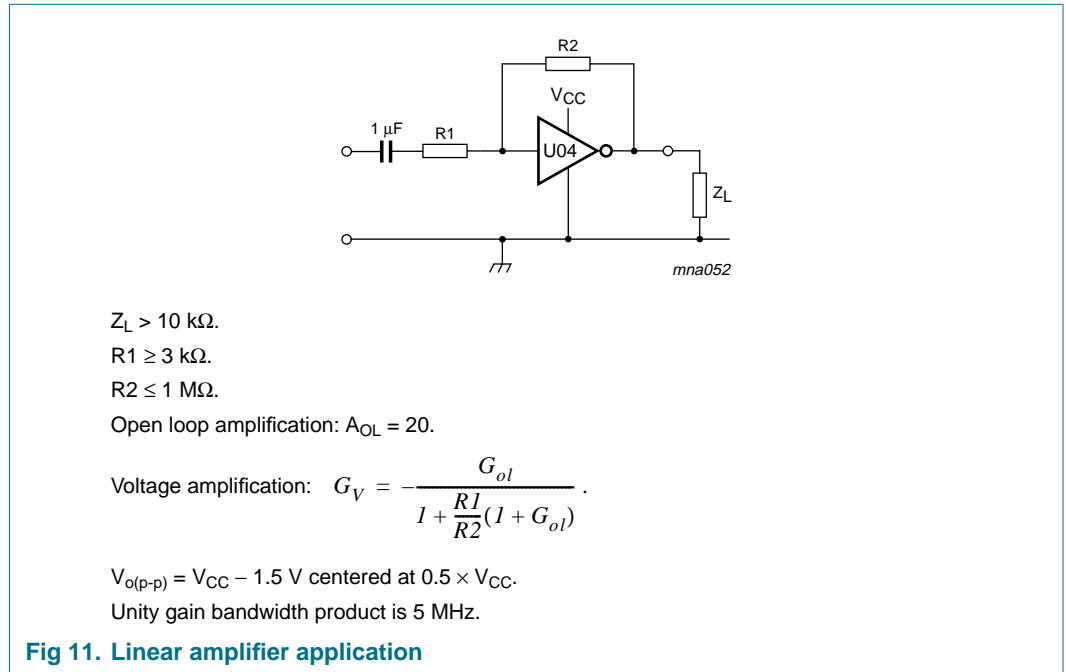
Fig 10. Typical forward transconductance as a function of supply voltage

14. Application information

Some applications for the 74AUP2GU04 are:

- Linear amplifier (see [Figure 11](#))
- Crystal oscillator (see [Figure 12](#)).

Remark: All values given are typical values unless otherwise specified.



15. Package outline

Plastic surface-mounted package; 6 leads

SOT363

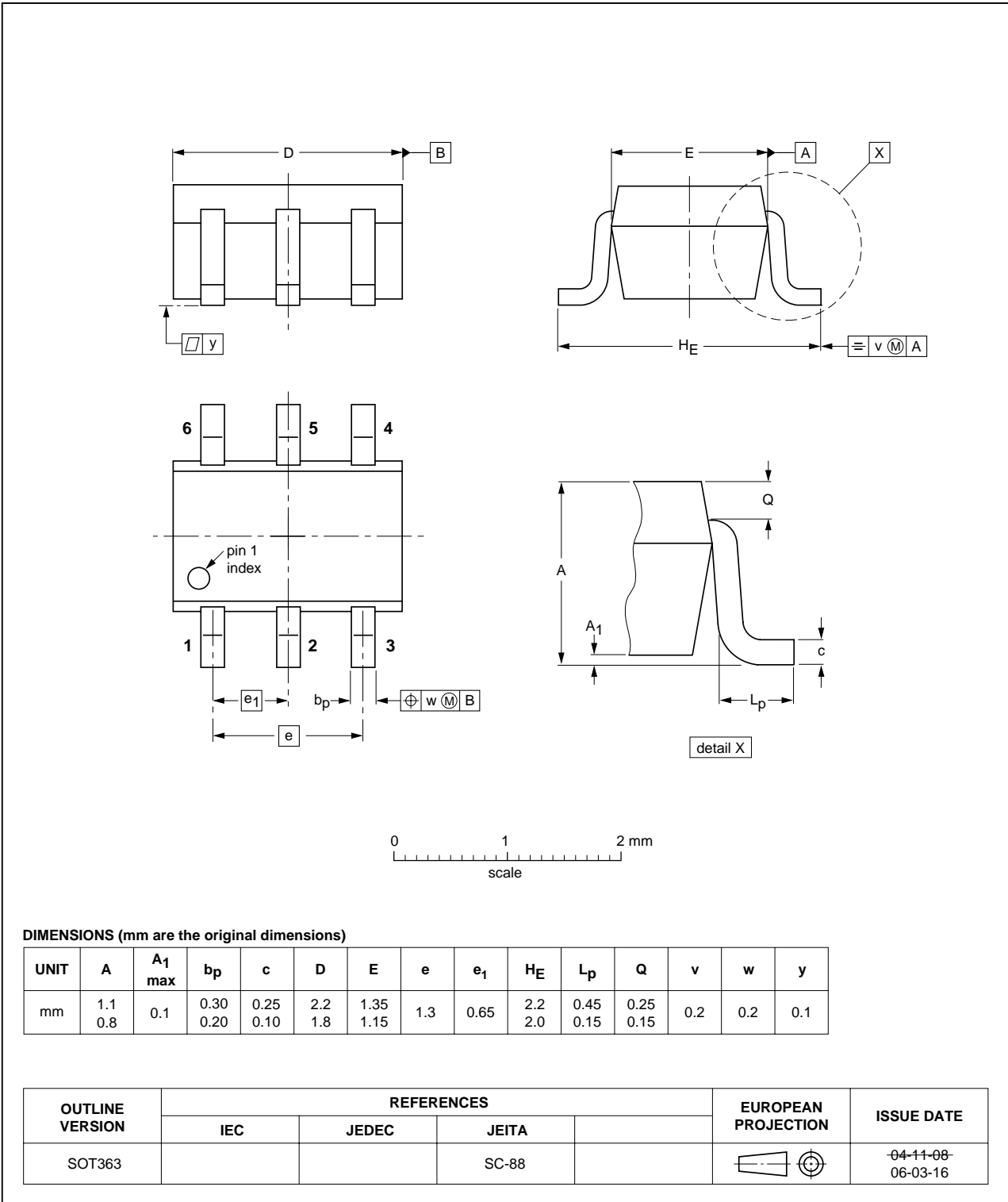


Fig 13. Package outline SOT363 (SC-88)

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

SOT891

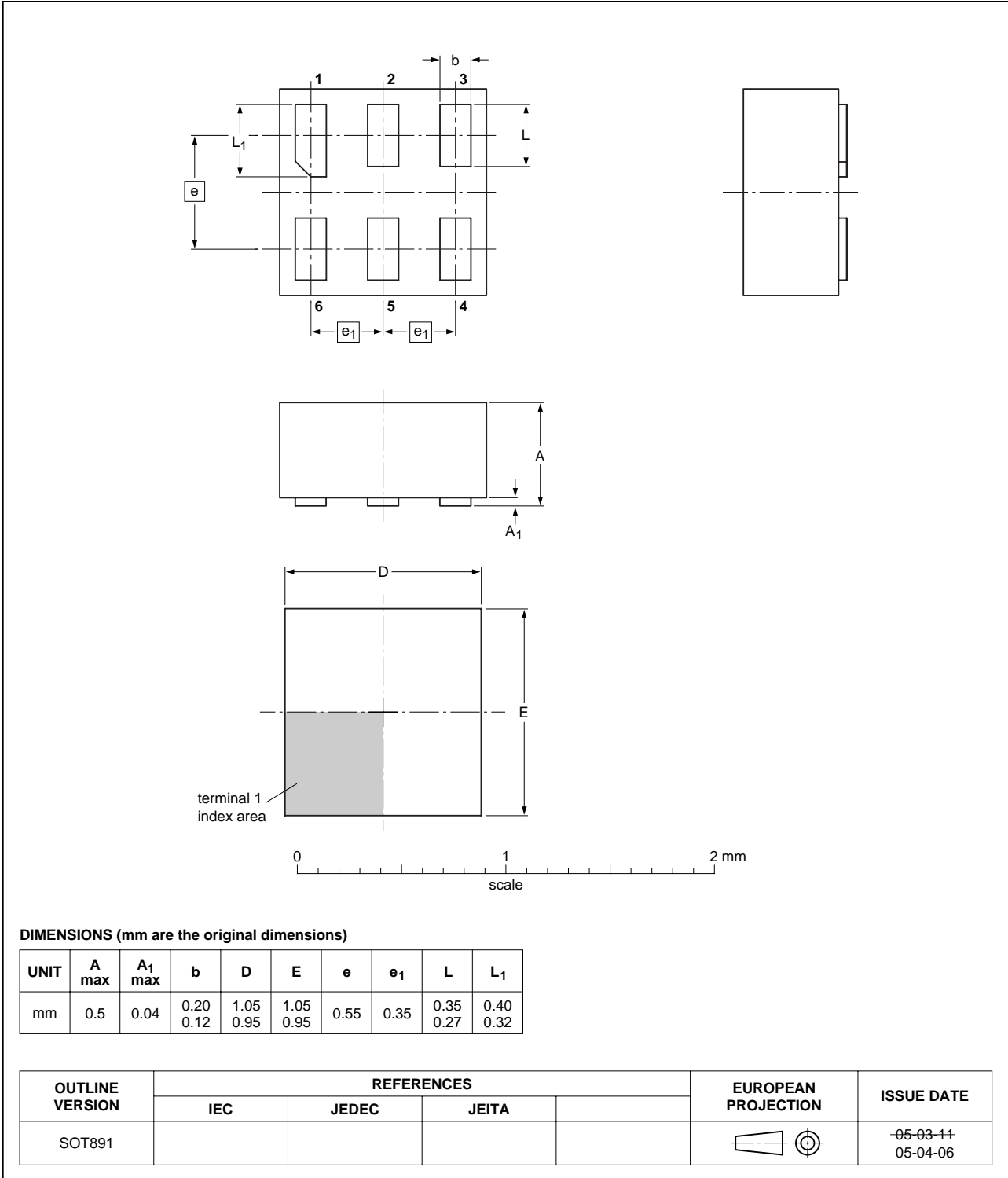


Fig 15. Package outline SOT891 (XSON6)

16. Abbreviations

Table 11. Abbreviations

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

17. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74AUP2GU04_1	20061215	Product data sheet	-	-

18. Legal information

18.1 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.
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[2] The term 'short data sheet' is explained in section "Definitions".

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20. Contents

1 **General description** 1

2 **Features** 1

3 **Ordering information** 1

4 **Marking** 2

5 **Functional diagram** 2

6 **Pinning information** 2

6.1 Pinning 2

6.2 Pin description 3

7 **Functional description** 3

8 **Limiting values** 3

9 **Recommended operating conditions** 4

10 **Static characteristics** 4

11 **Dynamic characteristics** 6

12 **Waveforms** 8

13 **Additional characteristics** 9

14 **Application information** 10

15 **Package outline** 11

16 **Abbreviations** 14

17 **Revision history** 14

18 **Legal information** 15

18.1 Data sheet status 15

18.2 Definitions 15

18.3 Disclaimers 15

18.4 Trademarks 15

19 **Contact information** 15

20 **Contents** 16

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