

74AUP2GU04-Q100

Low-power dual unbuffered inverter

Rev. 2 — 28 January 2019

Product data sheet

1. General description

The 74AUP2GU04-Q100 provides two unbuffered inverting gates.

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 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 °C to +85 °C and from -40 °C to +125 °C
- Wide supply voltage range from 0.8 V to 3.6 V
- High noise immunity
- ESD protection:
 - MIL-STD-883, method 3015 Class 3A. Exceeds 5000 V
 - HBM JESD22-A114F Class 3A. Exceeds 5000 V
 - MM JESD22-A115-A exceeds 200 V ($C = 200$ pF; $R = 0$ Ω)
- Low static power consumption; $I_{CC} = 0.9$ μ A (maximum)
- Latch-up performance exceeds 100 mA per JESD 78 Class II
- Inputs accept voltages up to 3.6 V

3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74AUP2GU04GW-Q100	-40 °C to +125 °C	SC-88	plastic surface-mounted package; 6 leads	SOT363
74AUP2GU04GM-Q100	-40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 x 1.45 x 0.5 mm	SOT886

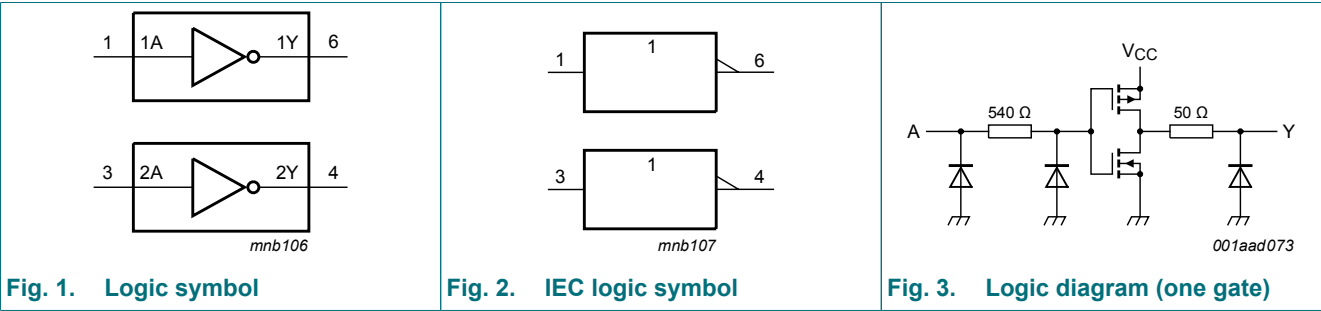
4. Marking

Table 2. Marking

Type number	Marking code ^[1]
74AUP2GU04GW-Q100	aD
74AUP2GU04GM-Q100	aD

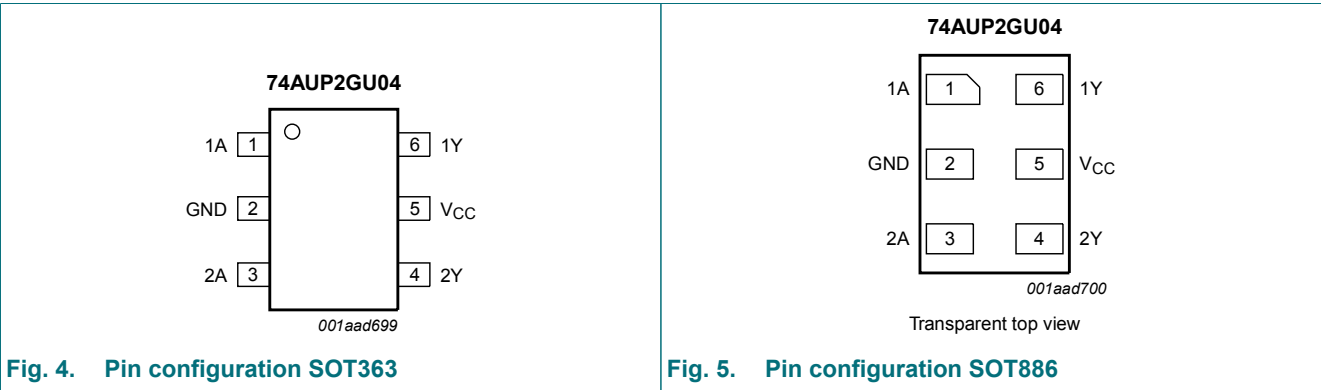
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

5. Functional diagram



6. Pinning information

6.1. Pinning



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

H = HIGH voltage level; L = LOW voltage level.

Input	Output
nA	nY
L	H
H	L

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	[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 package: above 87.5 °C the value of P_{tot} derates linearly with 4.0 mW/K.

For XSON6 package: 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		0	V_{CC}	V
T_{amb}	ambient temperature		-40	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 0.8$ 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 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 = GND or V _{CC}				
		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	0.75 × V _{CC}	-	-	V
		I _O = -1.7 mA; V _{CC} = 1.4 V	1.11	-	-	V
		I _O = -1.9 mA; V _{CC} = 1.65 V	1.32	-	-	V
		I _O = -2.3 mA; V _{CC} = 2.3 V	2.05	-	-	V
		I _O = -3.1 mA; V _{CC} = 2.3 V	1.9	-	-	V
		I _O = -2.7 mA; V _{CC} = 3.0 V	2.72	-	-	V
		I _O = -4.0 mA; V _{CC} = 3.0 V	2.6	-	-	V
V _{OL}	LOW-level output voltage	V _I = GND or V _{CC}				
		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	-	-	0.31	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 _{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
C _I	input capacitance	V _{CC} = 0 V to 3.6 V; V _I = GND or V _{CC}	-	1.5	-	pF
C _O	output capacitance	V _O = GND; V _{CC} = 0 V	-	1.8	-	pF
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 = GND or V _{CC}				
		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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V _{OL}	LOW-level output voltage	V _I = GND or V _{CC}				
		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 = GND or V _{CC}				
		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
V _{OL}	LOW-level output voltage	V _I = GND or V _{CC}				
		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 _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 _{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

11. Dynamic characteristics

Table 8. Dynamic characteristics

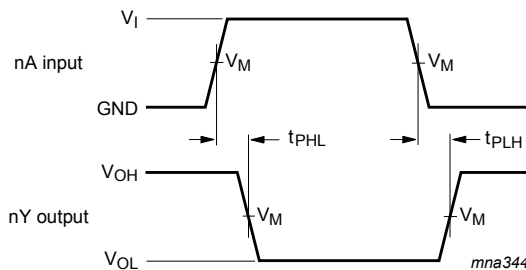
Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 7.

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 Fig. 6 [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 Fig. 6 [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
C _L = 15 pF									
t _{pd}	propagation delay	nA to nY; see Fig. 6 [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 Fig. 6 [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

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, 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	-	1.1	-	-	-	-	pF
		V _{CC} = 1.1 V to 1.3 V	-	1.1	-	-	-	-	pF
		V _{CC} = 1.4 V to 1.6 V	-	1.3	-	-	-	-	pF
		V _{CC} = 1.65 V to 1.95 V	-	1.5	-	-	-	-	pF
		V _{CC} = 2.3 V to 2.7 V	-	3.0	-	-	-	-	pF
		V _{CC} = 3.0 V to 3.6 V	-	4.5	-	-	-	-	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;
 $\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.

11.1. Waveforms and test circuit



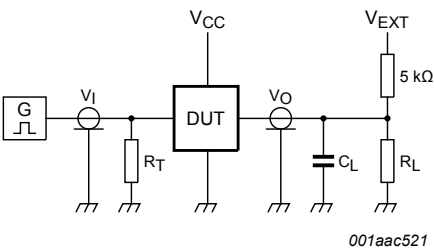
Measurement points are given in [Table 9](#).

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

Fig. 6. 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 × V _{CC}	0.5 × 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. 7. 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	$2 \times V_{CC}$

[1] For measuring enable and disable times $R_L = 5 \text{ k}\Omega$.
For measuring propagation delays, set-up and hold times and pulse width $R_L = 1 \text{ M}\Omega$.

12. Additional characteristics

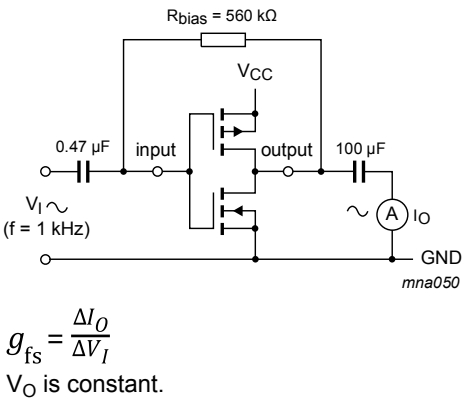


Fig. 8. Test set-up for measuring forward transconductance

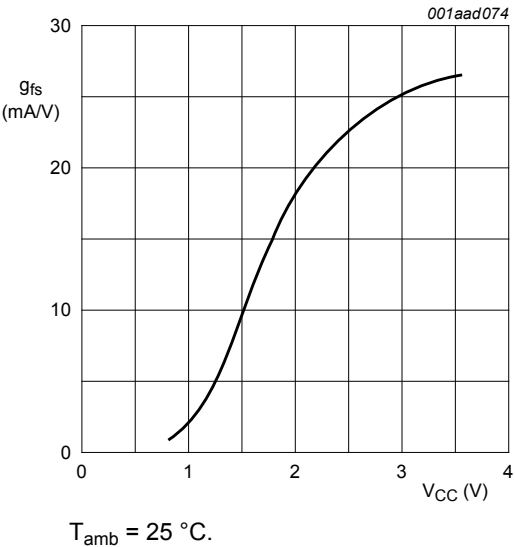


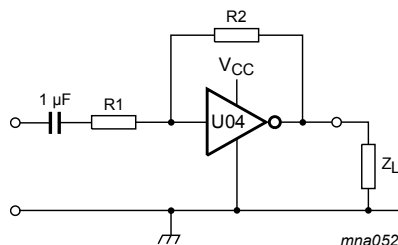
Fig. 9. Typical forward transconductance as a function of supply voltage

13. Application information

Some applications for the 74AUP2GU04-Q100 are:

- Linear amplifier (see [Fig. 10](#))
- Crystal oscillator (see [Fig. 11](#))

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



$$Z_L > 10 \text{ k}\Omega.$$

$$R1 \geq 3 \text{ k}\Omega.$$

$$R2 \leq 1 \text{ M}\Omega.$$

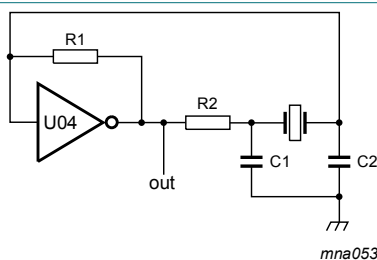
$$\text{Open loop amplification: } A_{OL} = 20.$$

$$\text{Voltage amplification: } A_V = -\frac{A_{OL}}{1 + \frac{R1}{R2}(1 + A_{OL})}.$$

$$V_{O(p-p)} = V_{CC} - 1.5 \text{ V centered at } 0.5 \times V_{CC}.$$

$$\text{Unity gain bandwidth product is } 5 \text{ MHz}.$$

Fig. 10. Linear amplifier application



$$C1 = 47 \text{ pF}.$$

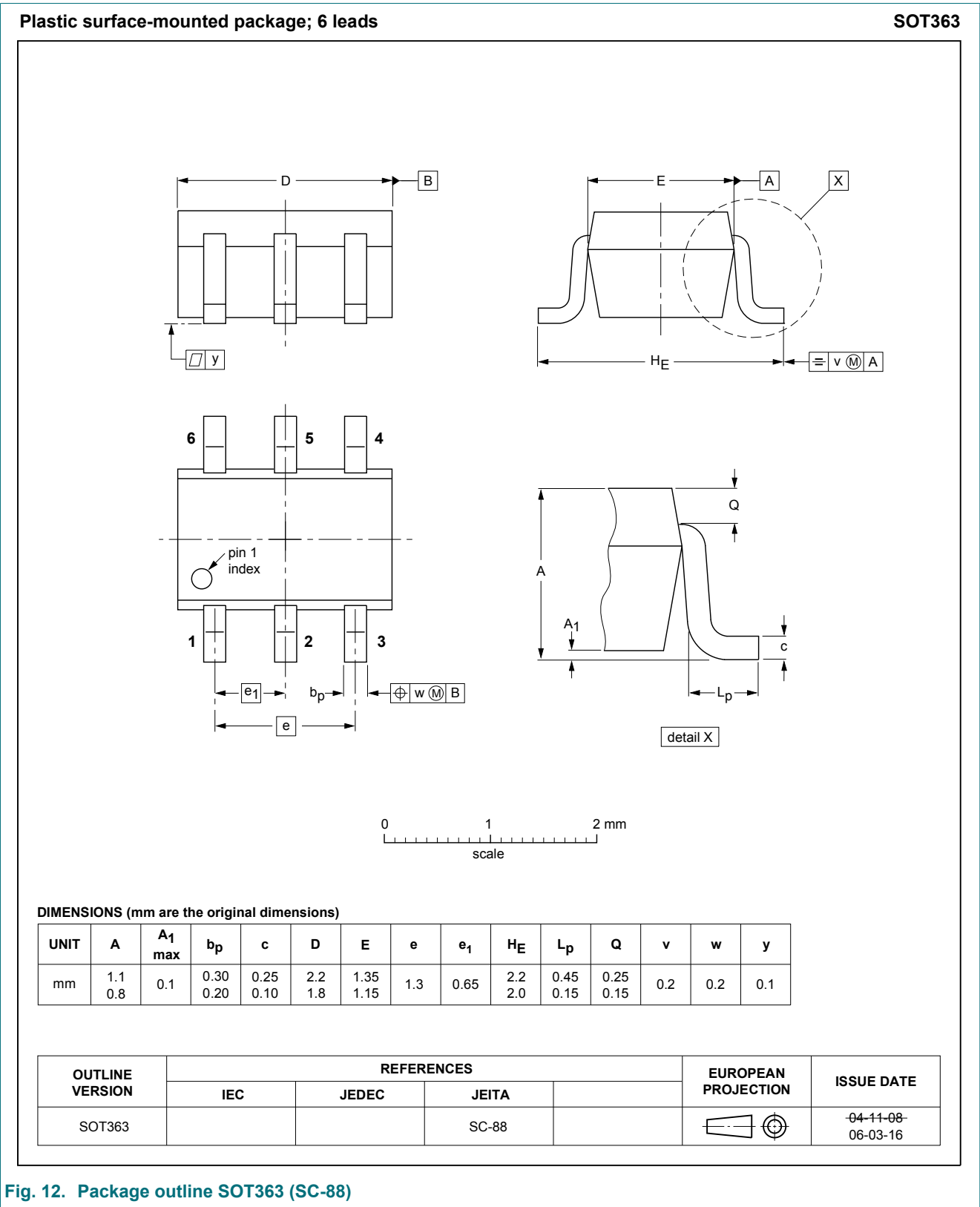
$$C2 = 22 \text{ pF}.$$

$$R1 = 1 \text{ M}\Omega \text{ to } 10 \text{ M}\Omega.$$

R2 optimum value depends on the frequency and required stability against changes in V_{CC} or average minimum I_{CC} ($I_{CC} = 2 \text{ mA}$ at $V_{CC} = 3.3 \text{ V}$ and $f = 10 \text{ MHz}$).

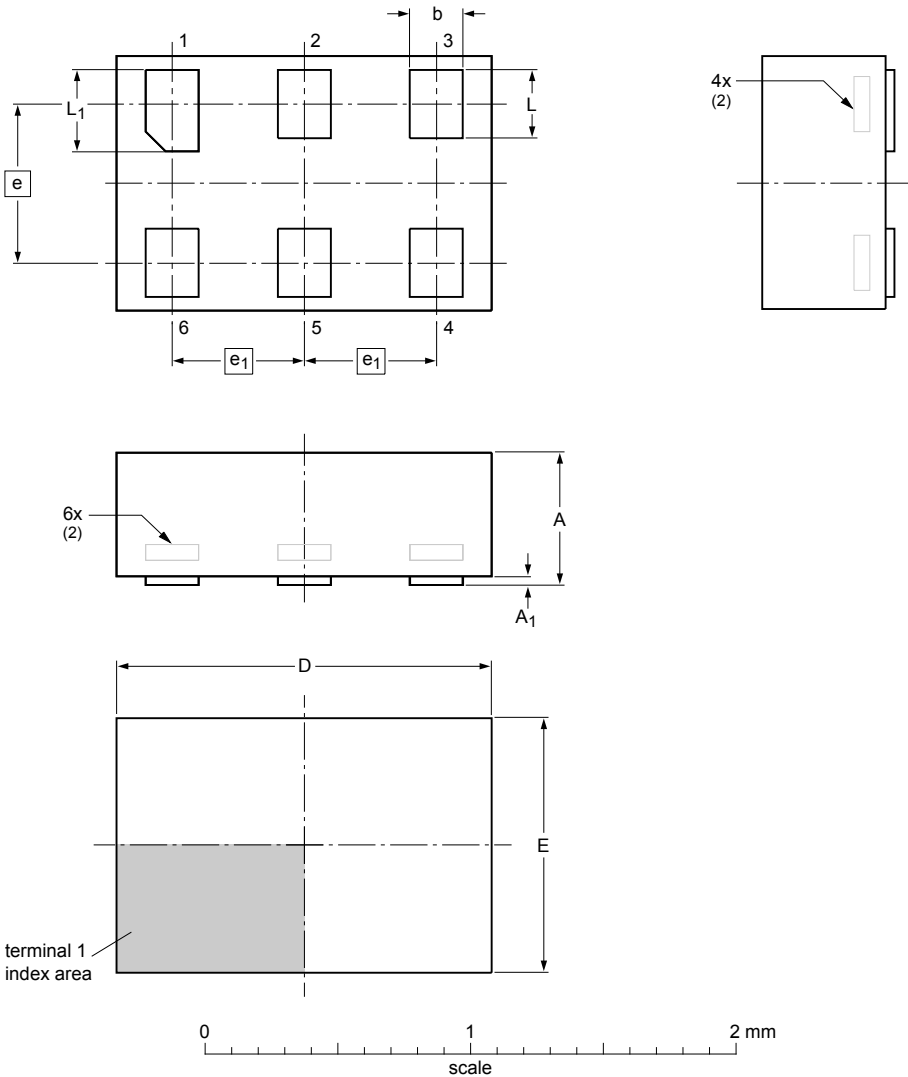
Fig. 11. Crystal oscillator application

14. Package outline



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

SOT886



Dimensions (mm are the original dimensions)

Unit	A ⁽¹⁾	A ₁	b	D	E	e	e ₁	L	L ₁
mm	max	0.5	0.04	0.25	1.50	1.05		0.35	0.40
	nom			0.20	1.45	1.00	0.6	0.30	0.35
	min			0.17	1.40	0.95		0.27	0.32

- Notes
- 1. Including plating thickness.
 - 2. Can be visible in some manufacturing processes.

sot886_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT886		MO-252				-04-07-22- 12-01-05

Fig. 13. Package outline SOT886 (XSON6)

15. Abbreviations

Table 11. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model

16. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74AUP2GU04_Q100 v.2	20190128	Product data sheet	-	74AUP2GU04_Q100 v.1
Modifications:	• 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. • Added type number 74AUP2GU04GM-Q100 (SOT886/XSON6).			
74AUP2GU04_Q100 v.1	20141020	Product data sheet	-	-

17. 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>.

Definitions

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Date of release: 28 January 2019