74AUP1Z04

Low-power X-tal driver with enable and internal resistor

Rev. 7 — 27 January 2022 Product data sheet

1. General description

The 74AUP1Z04 is a crystal driver with enable and internal resistor. When not in use the $\overline{EN}$ input can be driven HIGH, putting the device in a low power disable mode with X1 pulled HIGH via R_{PU}, X2 set LOW and Y set HIGH. Schmitt trigger action on the $\overline{EN}$ input 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. Schmitt-trigger action at all inputs makes the circuit tolerant of slower input rise and fall times.

2. Features and benefits

- Wide supply voltage range from 0.8 V to 3.6 V
- CMOS low power dissipation
- High noise immunity
- Overvoltage tolerant inputs to 3.6 V
- Low noise overshoot and undershoot < 10 % of V_{CC}
- I_{OFF} circuitry provides partial Power-down mode operation at output Y
- Latch-up performance exceeds 100 mA per JESD78B Class II
- Complies with JEDEC standards:
  - JESD8-12 (0.8 V to 1.3 V)
  - JESD8-11 (0.9 V to 1.65 V)
  - JESD8-7 (1.65 V to 1.95 V)
  - JESD8-5 (2.3 V to 2.7 V)
  - JESD8C (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
- Multiple package options
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74AUP1Z04GW	-40 °C to +125 °C	TSSOP6	plastic thin shrink small outline package; 6 leads; body width 1.25 mm	SOT363-2
74AUP1Z04GM	-40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm	SOT886
74AUP1Z04GN	-40 °C to +125 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body 0.9 × 1.0 × 0.35 mm	SOT1115
74AUP1Z04GS	-40 °C to +125 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body 1.0 × 1.0 × 0.35 mm	SOT1202

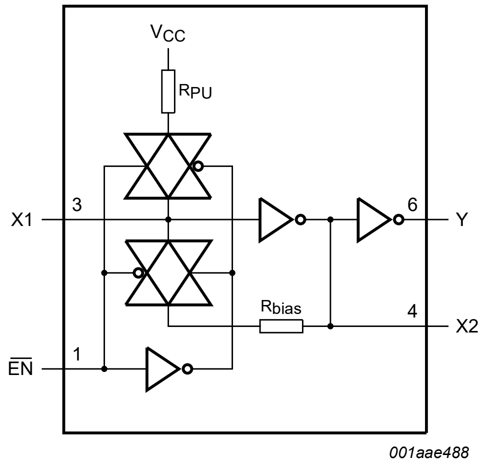
4. Marking

Table 2. Marking

Type number	Marking code [1]
74AUP1Z04GW	a4
74AUP1Z04GM	a4
74AUP1Z04GN	a4
74AUP1Z04GS	a4

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

5. Functional diagram



R_{PU}= pull-up resistance.

R_{bias}= bias resistance.

Fig. 1. Logic symbol

6. Pinning information

6.1. Pinning

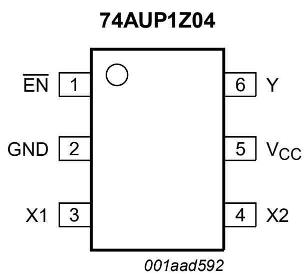


Fig. 2. Pin configuration SOT363-2 (TSSOP6)

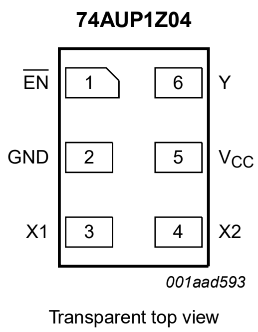


Fig. 3. Pin configuration SOT886 (XSON6)

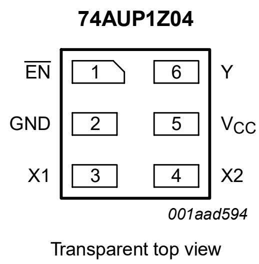


Fig. 4. Pin configuration SOT1115 and SOT1202 (XSON6)

6.2. Pin description

Table 3. Pin description

Symbol	Pin	Description
$\overline{EN}$	1	enable input (active LOW)
GND	2	ground (0 V)
X1	3	data input
X2	4	data output
V_{CC}	5	supply voltage
Y	6	data output

7. Functional description

Table 4. Function table

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

Input		Output	
$\overline{EN}$	**X1**	**X2**	**Y**
L	L	H	L
L	H	L	H
H	L	H	L
H	H	L	H

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	[1]	-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 [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 SOT363-2 (TSSOP6) package: P_{tot} derates linearly with 3.7 mW/K above 83 °C.
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.

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
Δt/ΔV	input transition rise and fall rate	V_{CC} = 0.8 V to 3.6 V	-	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	X1 input				
		V_{CC} = 0.8 V to 3.6 V	0.75 × V_{CC}	-	-	V
		$\overline{EN}$ input				
		V_{CC} = 0.8 V	0.70 × V_{CC}	-	-	V
		V_{CC} = 0.9 V to 1.95 V	0.65 × V_{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	X1 input				
		V_{CC} = 0.8 V to 3.6 V	-	-	0.25 × V_{CC}	V
		$\overline{EN}$ input				
		V_{CC} = 0.8 V	-	-	0.30 × V_{CC}	V
		V_{CC} = 0.9 V to 1.95 V	-	-	0.35 × V_{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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OH}	HIGH-level output voltage	Y output; V_I at X1 input = 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	0.75 × 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
		X2 output; 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	Y output; V_I at X1 input = 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	-	-	0.31	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
		X2 output; 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

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_I	input leakage current	X1 input					
		V_I = $\overline{EN}$ = V_{CC}; V_{CC} = 0 V to 3.6 V		-	-	±0.1	μA
		$\overline{EN}$ input					
		V_I = GND to 3.6 V; V_{CC} = 0 V to 3.6 V		-	-	±0.1	μA
I_{pu}	pull-up current	X1 input; $\overline{EN}$ = V_{CC}					
		V_I = GND; V_{CC} = 0.8 V to 3.6 V		-	-	15	μA
I_{OFF}	power-off leakage current	V_I or V_O = 0 V to 3.6 V; V_{CC} = 0 V	[1]	-	-	±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	[1]	-	-	±0.2	μA
I_{CC}	supply current	V_I = GND or V_{CC}; I_O = 0 A; $\overline{EN}$ = GND; V_{CC} = 0.8 V to 3.6 V		-	-	75	μA
ΔI_{CC}	additional supply current	$\overline{EN}$ input					
		V_I = V_{CC} - 0.6 V; I_O = 0 A; V_{CC} = 3.3 V		-	-	40	μA
C_I	input capacitance	X1 input					
		V_{CC} = 0 V to 3.6 V; V_I = GND or V_{CC}		-	1.3	-	pF
		$\overline{EN}$ input					
		V_{CC} = 0 V to 3.6 V; V_I = GND or V_{CC}		-	0.8	-	pF
C_O	output capacitance	X2 output					
		V_O = GND; V_{CC} = 0 V		-	1.5	-	pF
		Y output					
		V_O = GND; V_{CC} = 0 V		-	1.7	-	pF
g_{fs}	forward transconductance	see Fig. 10 and Fig. 11					
		V_{CC} = 0.8 V		-	-	-	mA/V
		V_{CC} = 1.1 V to 1.3 V		0.2	-	9.9	mA/V
		V_{CC} = 1.4 V to 1.6 V		3.9	-	17.7	mA/V
		V_{CC} = 1.65 V to 1.95 V		7.9	-	24.3	mA/V
		V_{CC} = 2.3 V to 2.7 V		18	-	30.7	mA/V
		V_{CC} = 3.0 V to 3.6 V		20.5	-	32.4	mA/V
R_{bias}	bias resistance	$\overline{EN}$ = GND; f_i = 0 Hz; V_I = 0 V or V_{CC}; see Fig. 5; for frequency behavior see Fig. 6		1.08	1.62	3.08	MΩ
T_{amb} = -40 °C to +85 °C							
V_{IH}	HIGH-level input voltage	X1 input					
		V_{CC} = 0.8 V to 3.6 V		0.75 × V_{CC}	-	-	V
		$\overline{EN}$ input					
		V_{CC} = 0.8 V		0.70 × V_{CC}	-	-	V
		V_{CC} = 0.9 V to 1.95 V		0.65 × V_{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

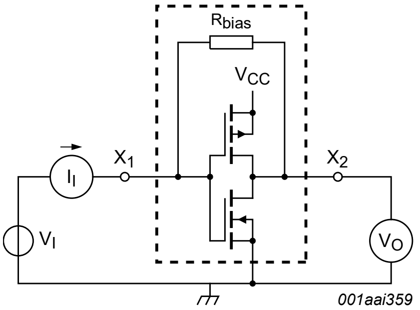
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	LOW-level input voltage	X1 input				
		V_{CC} = 0.8 V to 3.6 V	-	-	0.25 × V_{CC}	V
		$\overline{EN}$ input				
		V_{CC} = 0.8 V	-	-	0.30 × V_{CC}	V
		V_{CC} = 0.9 V to 1.95 V	-	-	0.35 × V_{CC}	V
		V_{CC} = 2.3 V to 2.7 V	-	-	0.7	V
		V_{CC} = 3.0 V to 3.6 V	-	-	0.9	V
V_{OH}	HIGH-level output voltage	Y output; V_I at X1 input = 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_I at X1 input = 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	Y output; V_I at X1 input = 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
		X2 output; 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

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_I	input leakage current	X1 input					
		$V_I = \overline{EN} = V_{CC}$; V_{CC} = 0 V to 3.6 V		-	-	±0.5	μA
		$\overline{EN}$ input					
		V_I = GND to 3.6 V; V_{CC} = 0 V to 3.6 V		-	-	±0.5	μA
I_{pu}	pull-up current	X1 input; $\overline{EN} = V_{CC}$					
		V_I = GND; V_{CC} = 0.8 V to 3.6 V		-	-	15	μA
I_{OFF}	power-off leakage current	V_I or V_O = 0 V to 3.6 V; V_{CC} = 0 V	[1]	-	-	±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	[1]	-	-	±0.6	μA
I_{CC}	supply current	V_I = GND or V_{CC}; I_O = 0 A; $\overline{EN}$ = GND; V_{CC} = 0.8 V to 3.6 V		-	-	75	μA
ΔI_{CC}	additional supply current	$\overline{EN}$ input					
		$V_I = V_{CC}$ - 0.6 V; I_O = 0 A; V_{CC} = 3.3 V		-	-	50	μA
g_{fs}	forward transconductance	see Fig. 10 and Fig. 11					
		V_{CC} = 0.8 V		-	-	-	mA/V
		V_{CC} = 1.1 V to 1.3 V		-	-	10.8	mA/V
		V_{CC} = 1.4 V to 1.6 V		1.8	-	21.2	mA/V
		V_{CC} = 1.65 V to 1.95 V		7.5	-	29.9	mA/V
		V_{CC} = 2.3 V to 2.7 V		15.0	-	38.0	mA/V
		V_{CC} = 3.0 V to 3.6 V		17.8	-	39.2	mA/V
R_{bias}	bias resistance	$\overline{EN}$ = GND; f_i = 0 Hz; V_I = 0 V or V_{CC}; see Fig. 5; for frequency behavior see Fig. 6		1.07	-	3.11	MΩ
T_{amb} = -40 °C to +125 °C							
V_{IH}	HIGH-level input voltage	X1 input					
		V_{CC} = 0.8 V to 3.6 V		0.75 × V_{CC}	-	-	V
		$\overline{EN}$ input					
		V_{CC} = 0.8 V		0.75 × V_{CC}	-	-	V
		V_{CC} = 0.9 V to 1.95 V		0.70 × V_{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	X1 input					
		V_{CC} = 0.8 V to 3.6 V		-	-	0.25 × V_{CC}	V
		$\overline{EN}$ input					
		V_{CC} = 0.8 V		-	-	0.25 × V_{CC}	V
		V_{CC} = 0.9 V to 1.95 V		-	-	0.30 × V_{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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OH}	HIGH-level output voltage	Y output; V_I at X1 input = V_{IH} or V_{IL}				V
		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
		X2 output; V_I = GND or V_{CC}				V
		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	Y output; V_I at X1 input = 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_O = 4.0 mA; V_{CC} = 3.0 V	-	-	0.50	V
		X2 output; 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

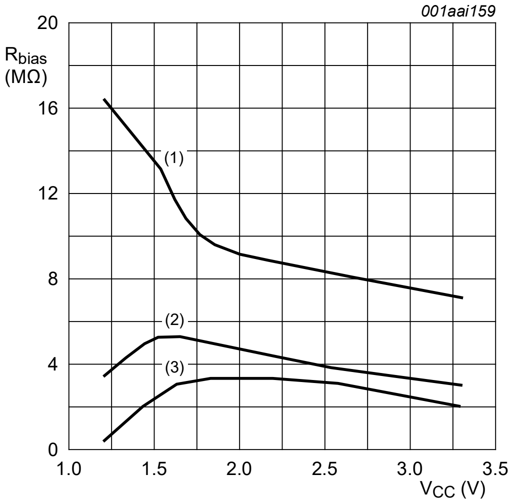
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_I	input leakage current	X1 input					
		$V_I = \overline{EN} = V_{CC}$; V_{CC} = 0 V to 3.6 V		-	-	±0.75	μA
		$\overline{EN}$ input					
		V_I = GND to 3.6 V; V_{CC} = 0 V to 3.6 V		-	-	±0.75	μA
I_{pu}	pull-up current	X1 input; $\overline{EN} = V_{CC}$					
		V_I = GND; V_{CC} = 0.8 V to 3.6 V		-	-	15	μA
I_{OFF}	power-off leakage current	V_I or V_O = 0 V to 3.6 V; V_{CC} = 0 V	[1]	-	-	±0.75	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	[1]	-	-	±0.75	μA
I_{CC}	supply current	V_I = GND or V_{CC}; I_O = 0 A; $\overline{EN}$ = GND; V_{CC} = 0.8 V to 3.6 V		-	-	75	μA
ΔI_{CC}	additional supply current	$\overline{EN}$ input					
		$V_I = V_{CC}$ - 0.6 V; I_O = 0 A; V_{CC} = 3.3 V		-	-	75	μA
g_{fs}	forward transconductance	see Fig. 10 and Fig. 11					
		V_{CC} = 0.8 V		-	-	-	mA/V
		V_{CC} = 1.1 V to 1.3 V		-	-	10.8	mA/V
		V_{CC} = 1.4 V to 1.6 V		1.8	-	21.2	mA/V
		V_{CC} = 1.65 V to 1.95 V		6.9	-	29.9	mA/V
		V_{CC} = 2.3 V to 2.7 V		13.4	-	38.0	mA/V
		V_{CC} = 3.0 V to 3.6 V		15.8	-	39.2	mA/V
R_{bias}	bias resistance	$\overline{EN}$ = GND; f_i = 0 Hz; V_I = 0 V or V_{CC}; see Fig. 5; for frequency behavior see Fig. 6		1.07	-	3.11	MΩ

[1] Only for output Y and input $\overline{EN}$.



$$R_{bias} = \left| \frac{V_O - V_I}{I_I} \right|$$

Fig. 5. Test circuit for measuring bias resistance



(1) f_i = 30 kHz.
(2) f_i = 1 MHz.
(3) f_i = 10 MHz.

Fig. 6. Typical bias resistance versus supply voltage

11. Dynamic characteristics

Table 8. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 9.

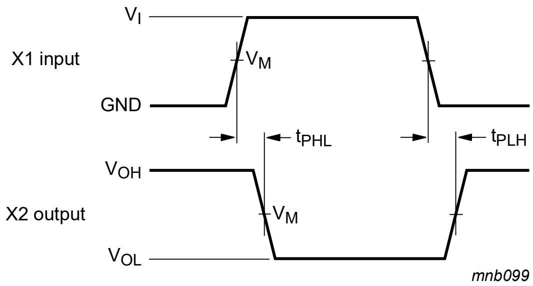
Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = -40 °C to +85 °C		T_{amb} = -40 °C to +125 °C		Unit
			Min	Typ [1]	Max	Min	Max	Min	Max	
C_L = 5 pF										
t_{pd}	propagation delay	X1 to X2; see Fig. 7 [2]								
		V_{CC} = 0.8 V	-	12.8	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	1.2	3.0	3.9	1.2	3.9	1.2	3.9	ns
		V_{CC} = 1.4 V to 1.6 V	1.0	2.2	2.6	1.0	2.7	1.0	2.7	ns
		V_{CC} = 1.65 V to 1.95 V	0.8	1.9	2.3	0.8	2.4	0.8	2.5	ns
		V_{CC} = 2.3 V to 2.7 V	0.7	1.6	1.9	0.7	2.0	0.7	2.0	ns
		V_{CC} = 3.0 V to 3.6 V	0.7	1.4	1.6	0.7	1.7	0.7	1.7	ns
		X1 to Y; see Fig. 8 [2]								
		V_{CC} = 0.8 V	-	39.2	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	2.5	8.0	10.7	2.3	10.8	2.3	10.9	ns
		V_{CC} = 1.4 V to 1.6 V	2.2	5.5	6.6	2.0	7.0	2.0	7.0	ns
		V_{CC} = 1.65 V to 1.95 V	1.8	4.4	5.5	1.7	5.9	1.7	6.0	ns
		V_{CC} = 2.3 V to 2.7 V	1.5	3.5	4.1	1.4	4.4	1.4	4.5	ns
		V_{CC} = 3.0 V to 3.6 V	1.5	3.1	3.5	1.4	3.8	1.4	3.8	ns

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = -40 °C to +85 °C		T_{amb} = -40 °C to +125 °C		Unit
			Min	Typ [1]	Max	Min	Max	Min	Max	
C_L = 10 pF										
t_{pd}	propagation delay	X1 to X2; see Fig. 7 [2]								
		V_{CC} = 0.8 V	-	20.9	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	1.4	4.1	5.4	1.3	5.6	1.3	5.6	ns
		V_{CC} = 1.4 V to 1.6 V	1.3	2.9	3.6	1.2	3.8	1.2	3.8	ns
		V_{CC} = 1.65 V to 1.95 V	1.2	2.5	3.0	1.1	3.2	1.1	3.2	ns
		V_{CC} = 2.3 V to 2.7 V	0.9	2.0	2.4	0.8	2.5	0.8	2.5	ns
		V_{CC} = 3.0 V to 3.6 V	0.9	1.8	2.1	0.8	2.3	0.8	2.3	ns
		X1 to Y; see Fig. 8 [2]								
		V_{CC} = 0.8 V	-	46.6	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	2.7	9.2	12.4	2.5	12.7	2.5	12.7	ns
		V_{CC} = 1.4 V to 1.6 V	2.5	6.3	7.8	2.2	8.2	2.2	8.2	ns
		V_{CC} = 1.65 V to 1.95 V	2.3	5.0	6.2	2.2	6.7	2.2	6.7	ns
		V_{CC} = 2.3 V to 2.7 V	1.8	4.0	4.7	1.7	5.0	1.7	5.1	ns
		V_{CC} = 3.0 V to 3.6 V	1.9	3.6	4.2	1.8	4.5	1.8	4.5	ns
C_L = 15 pF										
t_{pd}	propagation delay	X1 to X2; see Fig. 7 [2]								
		V_{CC} = 0.8 V	-	28.9	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	1.7	5.2	7.1	1.6	7.2	1.6	7.3	ns
		V_{CC} = 1.4 V to 1.6 V	1.6	3.6	4.4	1.6	4.7	1.6	4.8	ns
		V_{CC} = 1.65 V to 1.95 V	1.3	3.0	3.7	1.3	3.9	1.3	4.0	ns
		V_{CC} = 2.3 V to 2.7 V	1.0	2.4	2.9	1.0	3.1	1.0	3.1	ns
		V_{CC} = 3.0 V to 3.6 V	1.1	2.2	2.5	1.0	2.7	1.0	2.7	ns
		X1 to Y; see Fig. 8 [2]								
		V_{CC} = 0.8 V	-	53.9	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	3.1	10.4	14.2	2.8	14.6	2.8	14.7	ns
		V_{CC} = 1.4 V to 1.6 V	2.9	7.0	8.5	2.7	9.2	2.7	9.3	ns
		V_{CC} = 1.65 V to 1.95 V	2.5	5.6	6.9	2.3	7.4	2.3	7.5	ns
		V_{CC} = 2.3 V to 2.7 V	2.1	4.5	5.4	2.0	5.7	2.0	5.7	ns
		V_{CC} = 3.0 V to 3.6 V	2.3	4.1	4.7	2.1	5.1	2.1	5.1	ns

Symbol	Parameter	Conditions	T_{amb} = 25 °C			T_{amb} = -40 °C to +85 °C		T_{amb} = -40 °C to +125 °C		Unit
			Min	Typ [1]	Max	Min	Max	Min	Max	
C_L = 30 pF										
t_{pd}	propagation delay	X1 to X2; see Fig. 7 [2]								
		V_{CC} = 0.8 V	-	52.8	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	2.4	8.5	11.8	2.3	12.2	2.3	12.4	ns
		V_{CC} = 1.4 V to 1.6 V	2.2	5.6	6.8	2.0	7.5	2.0	7.6	ns
		V_{CC} = 1.65 V to 1.95 V	2.0	4.5	5.6	1.9	6.2	1.9	6.2	ns
		V_{CC} = 2.3 V to 2.7 V	1.5	3.7	4.2	1.4	4.6	1.4	4.6	ns
		V_{CC} = 3.0 V to 3.6 V	1.7	3.3	3.7	1.6	4.0	1.6	4.2	ns
		X1 to Y; see Fig. 8 [2]								
		V_{CC} = 0.8 V	-	77.6	-	-	-	-	-	ns
		V_{CC} = 1.1 V to 1.3 V	3.7	13.8	19.2	3.3	19.8	3.3	20.1	ns
		V_{CC} = 1.4 V to 1.6 V	3.4	9.2	11.2	3.1	12.2	3.1	12.3	ns
		V_{CC} = 1.65 V to 1.95 V	3.4	7.4	8.8	3.1	9.7	3.1	9.7	ns
		V_{CC} = 2.3 V to 2.7 V	2.6	5.9	6.7	2.4	7.4	2.4	7.4	ns
		V_{CC} = 3.0 V to 3.6 V	3.2	5.4	6.2	2.9	6.7	2.9	6.9	ns
C_L = 5 pF, 10 pF, 15 pF and 30 pF										
C_{PD}	power dissipation capacitance	f_i = 1 MHz; $\overline{EN}$ = GND; V_I = GND to V_{CC} [3][4][5]								
		V_{CC} = 0.8 V	-	6.8	-	-	-	-	-	pF
		V_{CC} = 1.1 V to 1.3 V	-	12.0	-	-	-	-	-	pF
		V_{CC} = 1.4 V to 1.6 V	-	18.2	-	-	-	-	-	pF
		V_{CC} = 1.65 V to 1.95 V	-	19.2	-	-	-	-	-	pF
		V_{CC} = 2.3 V to 2.7 V	-	21.9	-	-	-	-	-	pF
		V_{CC} = 3.0 V to 3.6 V	-	24.9	-	-	-	-	-	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 = output 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.
[5] Feedback current is included in the C_{PD}.

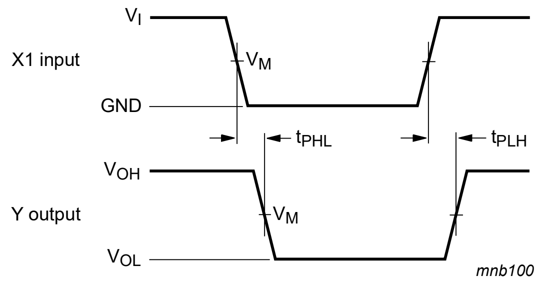
11.1. Waveforms and test circuit



Measurement points are given in Table 9.

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

Fig. 7. The input (X1) to output (X2) propagation delays



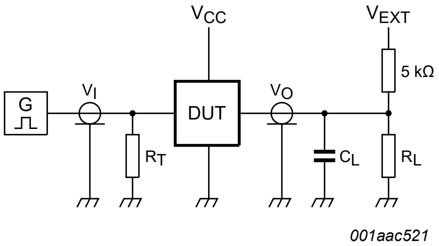
Measurement points are given in Table 9.

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

Fig. 8. The input (X1) to output (Y) 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;

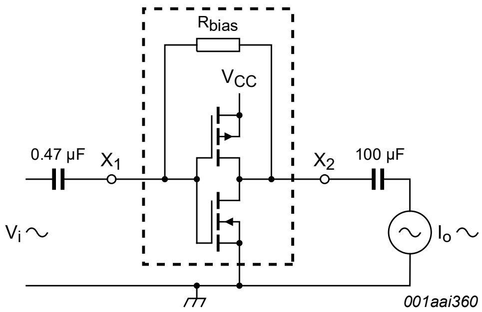
V_{EXT} = External voltage for measuring switching times.

Fig. 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	2 × V_{CC}

[1] For measuring enable and disable times R_L = 5 kΩ.
For measuring propagation delays, setup and hold times and pulse width R_L = 1 MΩ.

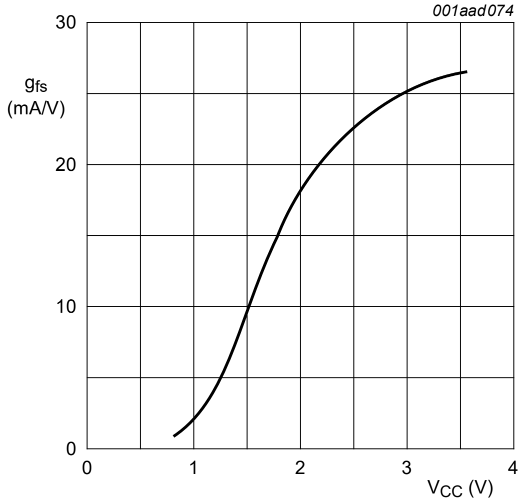


$$g_{fs} = \frac{\Delta I_O}{\Delta V_I}$$

f_i = 1 kHz.

V_O is constant.

Fig. 10. Test set-up for measuring forward transconductance



T_{amb} = 25°C.

Fig. 11. Typical forward transconductance as a function of supply voltage

12. Application information

Crystal controlled oscillator circuits are widely used in clock pulse generators because of their excellent frequency stability and wide operating frequency range. The use of the 74AUP1Z04 provides the additional advantages of low power dissipation, stable operation over a wide range of frequency and temperature and a very small footprint. This application information describes crystal characteristics, design and testing of crystal oscillator circuits based on the 74AUP1Z04.

12.1. Crystal characteristics

Fig. 12 is the equivalent circuit of a quartz crystal.

The reactive and resistive component of the impedance of the crystal alone and the crystal with a series and a parallel capacitance is shown in Fig. 13.

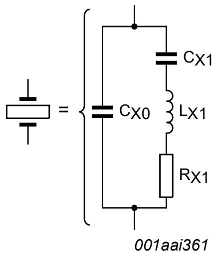
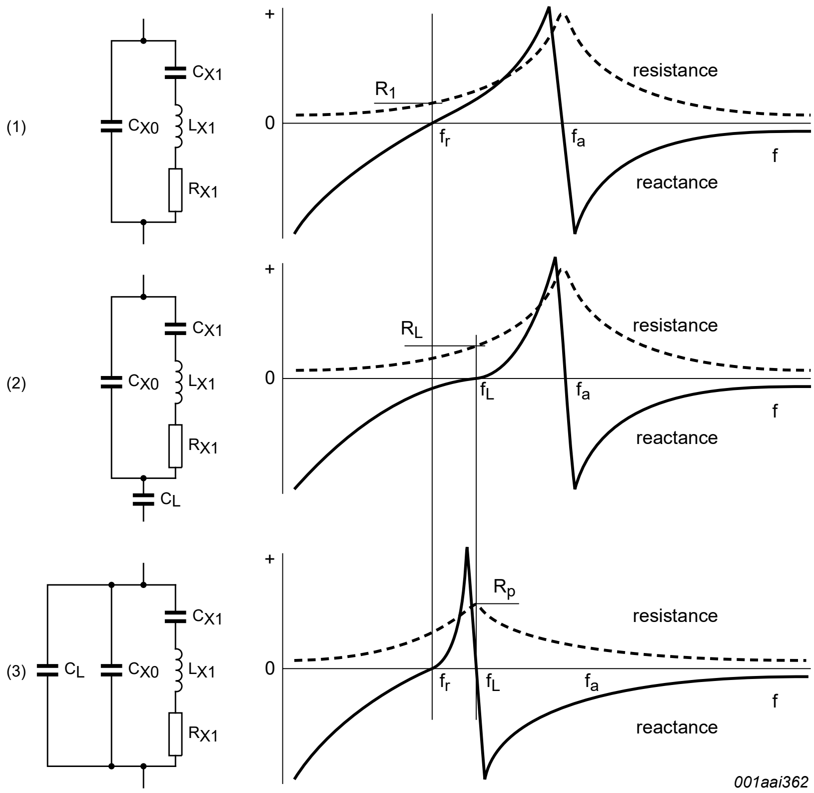


Fig. 12. Equivalent circuit of a crystal



(1) resonance
(2) anti-resonance
(3) load resonance

Fig. 13. Reactance and resistance characteristics of a crystal

12.1.1. Design

Fig. 14 shows the recommended way to connect a crystal to the 74AUP1Z04. This circuit is basically a Pierce oscillator circuit in which the crystal is operating at its fundamental frequency and is tuned by the parallel load capacitance of C_1 and C_2. C_1 and C_2 are in series with the crystal. They should be approximately equal. R_1 is the drive-limiting resistor and is set to approximately the same value as the reactance of C_1 at the crystal frequency ($R_1 = X_{C1}$). This will result in an input to the crystal of 50 % of the rail-to-rail output of X2. This keeps the drive level into the crystal within drive specifications (the designer should verify this). Overdriving the crystal can cause damage.

The internal bias resistor provides negative feedback and sets a bias point of the inverter near mid-supply, operating the 74AUP1GU04 portion in the high gain linear region.

To calculate the values of C_1 and C_2, the designer can use the formula:

$$C_L = \frac{C_1 \times C_2}{C_1 + C_2} + C_s$$

C_L is the load capacitance as specified by the crystal manufacturer, C_s is the stray capacitance of the circuit (for the 74AUP1Z04 this is equal to an input capacitance of 1.5 pF).

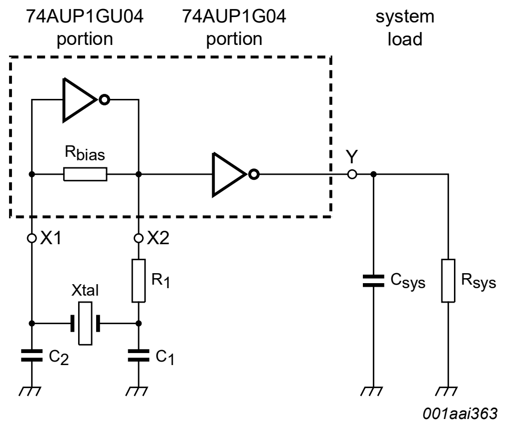


Fig. 14. Crystal oscillator configuration for the 74AUP1Z04

12.1.2. Testing

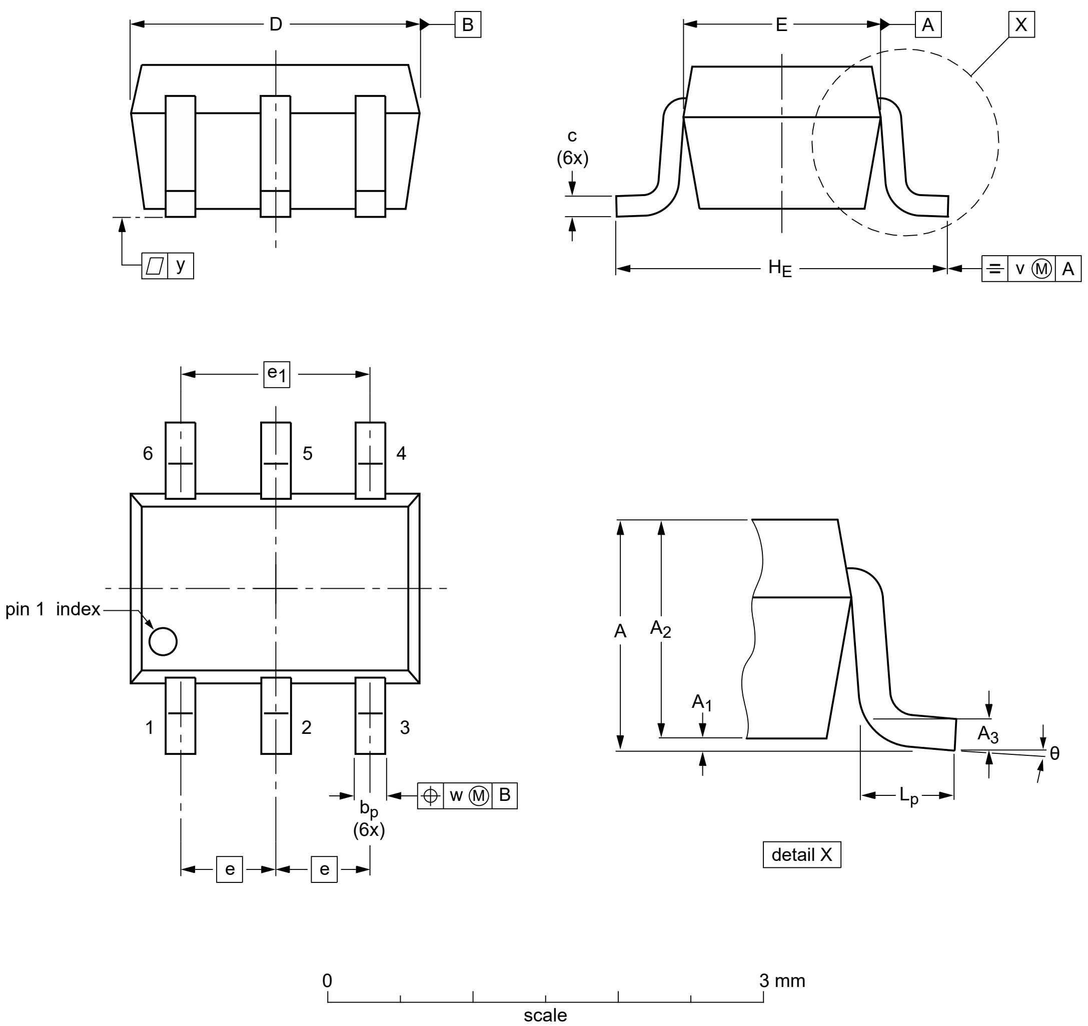
After the calculations are performed for a particular crystal, the oscillator circuit should be tested. The following simple checks will verify the prototype design of a crystal controlled oscillator circuit. Perform them after laying out the board:

- Test the oscillator over worst-case conditions (lowest supply voltage, worst-case crystal and highest operating temperature). Adding series and parallel resistors can simulate a worst-case crystal.
- Insure that the circuit does not oscillate without the crystal.
- Check the frequency stability over a supply range greater than that which is likely to occur during normal operation.
- Check that the start-up time is within system requirements.

As the 74AUP1Z04 isolates the system loading, once the design is optimized, the single layout may work in multiple applications for any given crystal.

13. Package outline

TSSOP6: plastic thin shrink small outline package; 6 leads; body width 1.25 mm **SOT363-2**



Dimensions (mm are the original dimensions)

Unit		A	A_1	A_2	A_3	b_p	c	D[(1)]	E[(1)]	e	e_1	H_E	L_p	v	w	y	θ
mm	max	1.1	0.1	1.0	0.15	0.30	0.25	2.2	1.35	0.65	1.3	2.4	0.46	0.3	0.1	0.1	8°
	min	0.8	0	0.8		0.15	0.08	1.8	1.15			1.8	0.26				0°

Note

1. Plastic or metal protrusions of 0.2 mm maximum per side are not included.

sot363-2_po

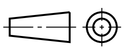
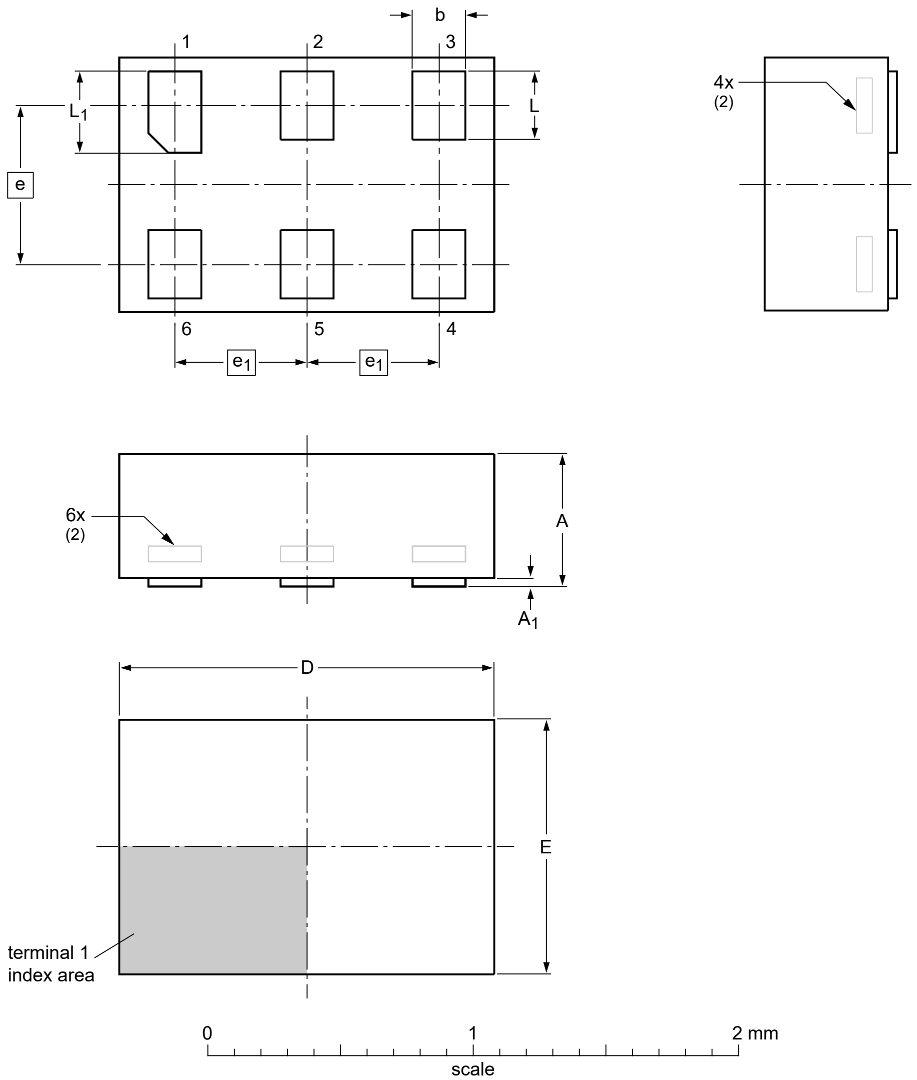
Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT363-2		MO-203	SC-88A			~~21-12-15~~ 21-12-16

Fig. 15. Package outline SOT363-2 (TSSOP6)

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	0.5	0.30	0.35
	min			0.17	1.40	0.95			0.27	0.32

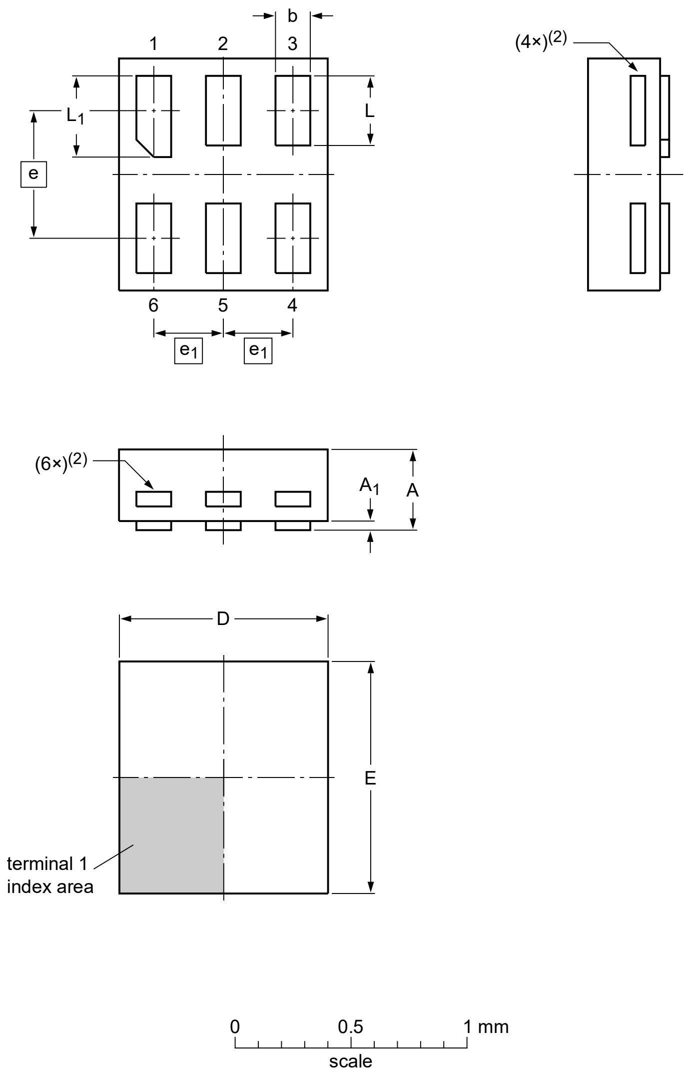
Notes
1. Including plating thickness.
2. Can be visible in some manufacturing processes.

sot886_po

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

Fig. 16. 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**



Dimensions

Unit		$A^{(1)}$	A_1	b	D	E	e	e_1	L	L_1
	max	0.35	0.04	0.20	0.95	1.05			0.35	0.40
mm	nom			0.15	0.90	1.00	0.55	0.3	0.30	0.35
	min			0.12	0.85	0.95			0.27	0.32

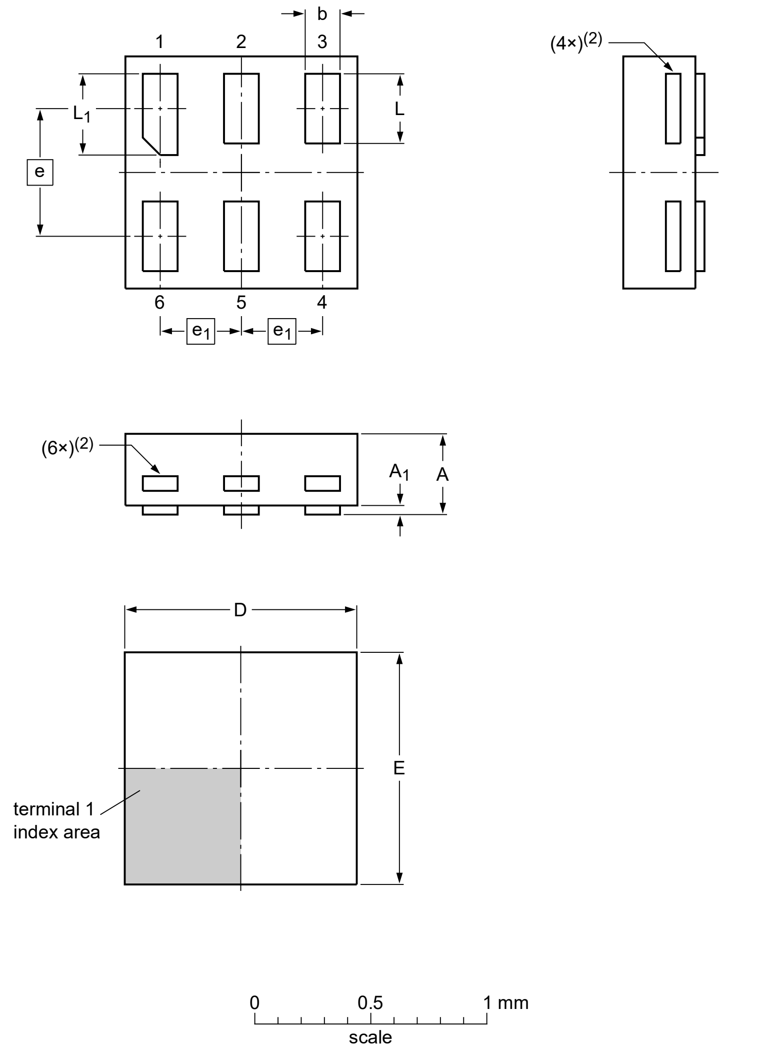
Note
1. Including plating thickness.
2. Visible depending upon used manufacturing technology.

sot1115_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1115						~~10-04-02~~ 10-04-07

Fig. 17. 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**



Dimensions

Unit		$A^{(1)}$	A_1	b	D	E	e	e_1	L	L_1
mm	max	0.35	0.04	0.20	1.05	1.05			0.35	0.40
	nom			0.15	1.00	1.00	0.55	0.35	0.30	0.35
	min			0.12	0.95	0.95			0.27	0.32

Note
1. Including plating thickness.
2. Visible depending upon used manufacturing technology.

sot1202_po

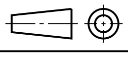
Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1202						~~10-04-02~~ 10-04-06

Fig. 18. Package outline SOT1202 (XSON6)

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
74AUP1Z04 v.7	20220127	Product data sheet	-	74AUP1Z04 v.6
Modifications:	• SOT363 (SC-88) package changed to SOT363-2 (TSSOP6) package.			
74AUP1Z04 v.6	20200717	Product data sheet	-	74AUP1Z04 v.5
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. • Type number 74AUP1Z04GF (SOT891) removed. • Section 1 and Section 2 updated. • Table 5: Derating values for P_{tot} total power dissipation updated.			
74AUP1Z04 v.5	20120809	Product data sheet	-	74AUP1Z04 v.4
Modifications:	• Package outline drawing of SOT886 (Fig. 16) modified.			
74AUP1Z04 v.4	20111201	Product data sheet	-	74AUP1Z04 v.3
Modifications:	• Legal pages updated.			
74AUP1Z04 v.3	20100722	Product data sheet	-	74AUP1Z04 v.2
74AUP1Z04 v.2	20080703	Product data sheet	-	74AUP1Z04 v.1
74AUP1Z04 v.1	20061212	Product data sheet	-	-

16. 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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