74AUP1T14

Low-power inverter with voltage-level translator

Rev. 3 — 25 January 2022

**Product data sheet** 

### 1. General description

The 74AUP1T14 provides a single inverting function. This device ensures a very low static and dynamic power consumption across the entire  $V_{CC}$  range from 2.3 V to 3.6 V.

The 74AUP1T14 is designed for logic-level translation applications with input switching levels that accept 1.8 V low-voltage CMOS signals, while operating from either a single 2.5 V or 3.3 V supply voltage.

The wide supply voltage range ensures normal operation as battery voltage drops from 3.6 V to 2.3 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.

Schmitt trigger inputs make the circuit tolerant to slower input rise and fall times across the entire  $V_{\text{CC}}$  range.

### 2. Features and benefits

- Wide supply voltage range from 2.3 V to 3.6 V
- High noise immunity
- ESD protection:
  - HBM JESD22-A114F Class 3A exceeds 5000 V
  - CDM JESD22-C101E exceeds 1000 V
- Low static power consumption;  $I_{CC} = 1.5 \,\mu\text{A}$  (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<sub>CC</sub>
- · IOFF circuitry provides partial power-down mode operation
- 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				
74AUP1T14GW	-40 °C to +125 °C	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	SOT353-1				
74AUP1T14GX	-40 °C to +125 °C	X2SON5	plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 × 0.8 × 0.32 mm	SOT1226-3				

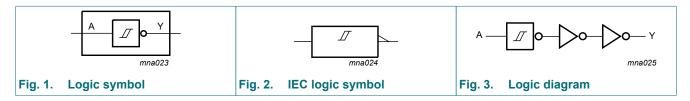
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### 4. Marking

Table 2. Marking					
Type number	Marking code[1]				
74AUP1T14GW	56				
74AUP1T14GX	56				

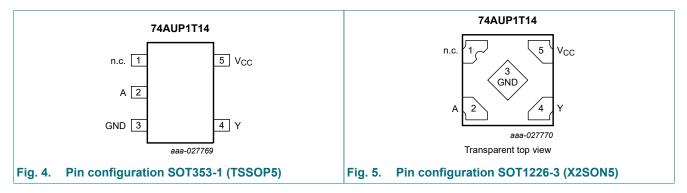
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

### 5. Functional diagram



### 6. Pinning information

### 6.1. Pinning



### 6.2. Pin description

#### Table 3. Pin description

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

### 7. Functional description

#### Table 4. Function table

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

Input	Output
A	Y
L	Н
Н	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 <sub>CC</sub>	supply voltage			-0.5	+4.6	V
I <sub>IK</sub>	input clamping current	V <sub>1</sub> < 0 V		-50	-	mA
VI	input voltage		[1]	-0.5	+4.6	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < 0 V		-50	-	mA
Vo	output voltage	Active mode and Power-down mode	[1]	-0.5	+4.6	V
lo	output current	$V_{O} = 0 V$ to $V_{CC}$		-	±20	mA
I <sub>CC</sub>	supply current			-	50	mA
I <sub>GND</sub>	ground current			-50	-	mA
T <sub>stg</sub>	storage temperature			-65	+150	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -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 SOT353-1 (TSSOP5) package: P<sub>tot</sub> derates linearly with 3.3 mW/K above 74 °C.

For SOT1226-3 (X2SON5) package: P<sub>tot</sub> derates linearly with 3.0 mW/K above 67 °C.

### 9. Recommended operating conditions

#### Table 6. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC</sub>	supply voltage		2.3	3.6	V
VI	input voltage		0	3.6	V
Vo	output voltage	Active mode	0	V <sub>CC</sub>	V
		Power-down mode; $V_{CC} = 0 V$	0	3.6	V
T <sub>amb</sub>	ambient temperature		-40	+125	°C

## **10. Static characteristics**

#### Table 7. Static characteristics

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

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
T <sub>amb</sub> = 2	5 °C					- 1
V <sub>T+</sub> positive-going threshold		positive-going threshold $V_{CC} = 2.3 \text{ V}$ to 2.7 V		-	1.10	V
	voltage	V <sub>CC</sub> = 3.0 V to 3.6 V	0.75	-	1.16	V
V <sub>T-</sub>	negative-going threshold	V <sub>CC</sub> = 2.3 V to 2.7 V	0.35	-	0.60	V
	voltage	V <sub>CC</sub> = 3.0 V to 3.6 V	0.50	-	0.85	V
V <sub>H</sub>	hysteresis voltage	$(V_{H} = V_{T+} - V_{T-})$				
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.23	-	0.60	V
		V <sub>CC</sub> = 3.0 V to 3.6 V	0.25	-	0.56	V
V <sub>OH</sub>	HIGH-level output voltage	$V_{I} = V_{T+}$ or $V_{T-}$				
011		$I_{O}$ = -20 µA; $V_{CC}$ = 2.3 V to 3.6 V	V <sub>CC</sub> - 0.1	-	-	V
		I <sub>O</sub> = -2.3 mA; V <sub>CC</sub> = 2.3 V	2.05	-	-	V
		I <sub>O</sub> = -3.1 mA; V <sub>CC</sub> = 2.3 V	1.9	-	-	V
		I <sub>O</sub> = -2.7 mA; V <sub>CC</sub> = 3.0 V	2.72	-	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 3.0 V	2.6	-	-	V
V <sub>OL</sub>	LOW-level output voltage	$V_{I} = V_{T+}$ or $V_{T-}$				
		$I_0$ = 20 µA; $V_{CC}$ = 2.3 V to 3.6 V	-	-	0.10	V
		I <sub>O</sub> = 2.3 mA; V <sub>CC</sub> = 2.3 V	-	-	0.31	V
		I <sub>O</sub> = 3.1 mA; V <sub>CC</sub> = 2.3 V	-	-	0.44	V
		I <sub>O</sub> = 2.7 mA; V <sub>CC</sub> = 3.0 V	-	-	0.31	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 3.0 V	-	-	0.44	V
l <sub>l</sub>	input leakage current	$V_I$ = GND to 3.6 V; $V_{CC}$ = 0 V to 3.6 V	-	-	±0.1	μA
I <sub>OFF</sub>	power-off leakage current	$V_{1} \text{ or } V_{0} = 0 \text{ V to } 3.6 \text{ V; } V_{CC} = 0 \text{ V}$	-	-	±0.1	μA
ΔI <sub>OFF</sub>	additional power-off leakage current	$V_{I}$ or $V_{O}$ = 0 V to 3.6 V; $V_{CC}$ = 0 V to 0.2 V	-	-	±0.1	μA
I <sub>CC</sub>	supply current	$V_I$ = GND or $V_{CC}$ ; $I_O$ = 0 A; $V_{CC}$ = 2.3 V to 3.6 V	-	-	1.2	μA
CI	input capacitance	$V_{CC}$ = 0 V to 3.6 V; $V_{I}$ = GND or $V_{CC}$	-	0.8	-	pF
Co	output capacitance	V <sub>O</sub> = GND; V <sub>CC</sub> = 0 V	-	1.7	-	pF

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V<sub>T+</sub>

V<sub>T-</sub>

V<sub>H</sub>

VOL

I<sub>L</sub>

IOFF

 $I_{CC}$ 

#### Symbol Parameter Conditions Min Тур Max Unit T<sub>amb</sub> = -40 °C to +85 °C V<sub>CC</sub> = 2.3 V to 2.7 V positive-going threshold 0.60 1.10 V voltage V V<sub>CC</sub> = 3.0 V to 3.6 V 0.75 1.19 \_ V<sub>CC</sub> = 2.3 V to 2.7 V 0.60 V negative-going threshold 0.35 \_ voltage V<sub>CC</sub> = 3.0 V to 3.6 V 0.50 0.85 V \_ $(V_{H} = V_{T+} - V_{T-})$ hysteresis voltage $V_{CC}$ = 2.3 V to 2.7 V 0.10 0.60 V \_ $V_{CC}$ = 3.0 V to 3.6 V 0.56 V 0.15 - $V_I = V_{T+}$ or $V_{T-}$ VOH HIGH-level output voltage v $I_O$ = -20 $\mu$ A; $V_{CC}$ = 2.3 V to 3.6 V V<sub>CC</sub> - 0.1 \_ \_ $I_0$ = -2.3 mA; $V_{CC}$ = 2.3 V V 1.97 \_ \_ $I_0$ = -3.1 mA; $V_{CC}$ = 2.3 V 1.85 v -- $I_0$ = -2.7 mA; $V_{CC}$ = 3.0 V V 2.67 \_ $I_{O}$ = -4.0 mA; $V_{CC}$ = 3.0 V 2.55 V \_ \_ LOW-level output voltage $V_I = V_{T+} \text{ or } V_{T-}$ $I_{O}$ = 20 µA; $V_{CC}$ = 2.3 V to 3.6 V V 0.1 -- $I_{O}$ = 2.3 mA; $V_{CC}$ = 2.3 V 0.33 v \_ \_ $I_0 = 3.1 \text{ mA}; V_{CC} = 2.3 \text{ V}$ V 0.45 -- $I_0$ = 2.7 mA; $V_{CC}$ = 3.0 V 0.33 V -- $I_0 = 4.0 \text{ mA}; V_{CC} = 3.0 \text{ V}$ V 0.45 -\_ $V_{I}$ = GND to 3.6 V; $V_{CC}$ = 0 V to 3.6 V input leakage current ±0.5 μA -power-off leakage current $V_{I}$ or $V_{O}$ = 0 V to 3.6 V; $V_{CC}$ = 0 V μA ±0.5 -- $V_{1}$ or $V_{0} = 0$ V to 3.6 V; additional power-off ±0.5 Δl<sub>OFF</sub> μΑ V<sub>CC</sub> = 0 V to 0.2 V leakage current $V_I = GND \text{ or } V_{CC}; I_O = 0 \text{ A};$ supply current -1.5 μA \_ $V_{CC} = 2.3 \text{ V}$ to 3.6 V $\Delta I_{CC}$ additional supply current $V_{CC}$ = 2.3 V to 2.7 V; $I_{O}$ = 0 A [1] 0.6 μA -

 $V_{CC}$  = 3.0 V to 3.6 V;  $I_{O}$  = 0 A

#### Low-power inverter with voltage-level translator

-

10

μΑ

[2]

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Symbol	Parameter	Conditions	Min	Тур	Мах	Unit
T <sub>amb</sub> = -4	10 °C to +125 °C		J		1	_
V <sub>T+</sub>	positive-going threshold	V <sub>CC</sub> = 2.3 V to 2.7 V	0.60	-	1.10	V
	voltage	V <sub>CC</sub> = 3.0 V to 3.6 V	0.75	-	1.19	V
V <sub>T-</sub>	negative-going threshold	V <sub>CC</sub> = 2.3 V to 2.7 V	0.33	-	0.64	V
voltage		V <sub>CC</sub> = 3.0 V to 3.6 V	0.46	-	0.85	V
V <sub>H</sub>	hysteresis voltage	$(V_{H} = V_{T+} - V_{T-})$				
		$V_{CC}$ = 2.3 V to 2.7 V	0.10	-	0.60	V
		V <sub>CC</sub> = 3.0 V to 3.6 V	0.15	-	0.56	V
V <sub>OH</sub>	HIGH-level output voltage	$V_{I} = V_{T+}$ or $V_{T-}$				
		$I_{O}$ = -20 µA; $V_{CC}$ = 2.3 V to 3.6 V	V <sub>CC</sub> - 0.11	-	-	V
		I <sub>O</sub> = -2.3 mA; V <sub>CC</sub> = 2.3 V	1.77	-	-	V
		I <sub>O</sub> = -3.1 mA; V <sub>CC</sub> = 2.3 V	1.67	-	-	V
		I <sub>O</sub> = -2.7 mA; V <sub>CC</sub> = 3.0 V	2.40	-	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 3.0 V	2.30	-	-	V
V <sub>OL</sub>	LOW-level output voltage	$V_{I} = V_{T+}$ or $V_{T-}$				
		$I_{O}$ = 20 µA; $V_{CC}$ = 2.3 V to 3.6 V	-	-	0.11	V
		I <sub>O</sub> = 2.3 mA; V <sub>CC</sub> = 2.3 V	-	-	0.36	V
		I <sub>O</sub> = 3.1 mA; V <sub>CC</sub> = 2.3 V	-	-	0.50	V
		I <sub>O</sub> = 2.7 mA; V <sub>CC</sub> = 3.0 V	-	-	0.36	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 3.0 V	-	-	0.50	V
l <sub>l</sub>	input leakage current	$V_{I}$ = GND to 3.6 V; $V_{CC}$ = 0 V to 3.6 V	-	-	±0.75	μA
I <sub>OFF</sub>	power-off leakage current	$V_{I}$ or $V_{O}$ = 0 V to 3.6 V; $V_{CC}$ = 0 V	-	-	±0.75	μA
ΔI <sub>OFF</sub>	additional power-off leakage current	$V_1 \text{ or } V_0 = 0 \text{ V to } 3.6 \text{ V};$ $V_{CC} = 0 \text{ V to } 0.2 \text{ V}$	-	-	±0.75	μA
I <sub>CC</sub>	supply current	$V_{I}$ = GND or $V_{CC}$ ; $I_{O}$ = 0 A; $V_{CC}$ = 2.3 V to 3.6 V	-	-	3.5	μA
ΔI <sub>CC</sub>	additional supply current	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}; I_{O} = 0 \text{ A}$ [1]	-	-	1.8	μA
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}; I_0 = 0 \text{ A}$ [2]	-	-	18	μA

One input at 0.3 V or 1.1 V, other input at  $V_{CC}$  or GND. One input at 0.45 V or 1.2 V, other input at  $V_{CC}$  or GND. [1] [2]

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# **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 +85 °C		-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Мах	Min	Max	
V <sub>CC</sub> = 2.	3 V to 2.7 V; V	= 1.65 V to 1.95 V		_		1				
t <sub>pd</sub>	propagation delay	A to Y; see Fig. 6	[2]							
		C <sub>L</sub> = 5 pF	1.8	3.3	5.1	0.5	6.8	0.5	7.5	ns
		C <sub>L</sub> = 10 pF	2.2	3.8	5.9	1.0	7.9	1.0	8.7	ns
		C <sub>L</sub> = 15 pF	2.6	4.3	6.4	1.0	8.7	1.0	9.6	ns
		C <sub>L</sub> = 30 pF	3.6	5.5	7.8	1.5	10.8	1.5	11.9	ns
V <sub>CC</sub> = 2.	3 V to 2.7 V; V	= 2.3 V to 2.7 V								
t <sub>pd</sub>	propagation	A to Y; see Fig. 6	[2]							
	delay	C <sub>L</sub> = 5 pF	1.4	3.1	5.3	0.5	6.0	0.5	6.6	ns
		C <sub>L</sub> = 10 pF	1.8	3.7	6.0	1.0	7.1	1.0	7.9	ns
		C <sub>L</sub> = 15 pF	2.1	4.2	6.5	1.0	7.9	1.0	8.7	ns
		C <sub>L</sub> = 30 pF	3.1	5.4	8.0	1.5	10.0	1.5	11.0	ns
V <sub>CC</sub> = 2.	3 V to 2.7 V; V	= 3.0 V to 3.6 V								
t <sub>pd</sub>	propagation delay	A to Y; see Fig. 6	[2]							
		C <sub>L</sub> = 5 pF	1.1	2.9	4.8	0.5	5.5	0.5	6.1	ns
		C <sub>L</sub> = 10 pF	1.5	3.4	5.5	1.0	6.5	1.0	7.2	ns
		C <sub>L</sub> = 15 pF	1.8	3.9	6.1	1.0	7.4	1.0	8.2	ns
		C <sub>L</sub> = 30 pF	2.8	5.1	7.5	1.5	9.5	1.5	10.5	ns
V <sub>CC</sub> = 3.	0 V to 3.6 V; V	l = 1.65 V to 1.95 V								
t <sub>pd</sub>	propagation	A to Y; see Fig. 6	[2]							
	delay	C <sub>L</sub> = 5 pF	1.8	2.7	3.8	0.5	8.0	0.5	8.8	ns
		C <sub>L</sub> = 10 pF	2.2	3.3	4.5	1.0	8.5	1.0	9.4	ns
		C <sub>L</sub> = 15 pF	2.5	3.7	5.1	1.0	9.1	1.0	10.1	ns
		C <sub>L</sub> = 30 pF	3.3	4.9	6.5	1.5	9.8	1.5	10.8	ns
V <sub>CC</sub> = 3.	0 V to 3.6 V; V	= 2.3 V to 2.7 V								
t <sub>pd</sub>	propagation	A to Y; see Fig. 6	[2]							
	delay	C <sub>L</sub> = 5 pF	1.3	2.6	4.2	0.5	5.3	0.5	5.9	ns
		C <sub>L</sub> = 10 pF	1.7	3.2	4.9	1.0	6.1	1.0	6.8	ns
		C <sub>L</sub> = 15 pF	2.1	3.7	5.5	1.0	6.8	1.0	7.5	ns
		C <sub>L</sub> = 30 pF	3.1	4.8	6.9	1.5	8.5	1.5	9.4	ns
V <sub>CC</sub> = 3.	0 V to 3.6 V; V	= 3.0 V to 3.6 V								
t <sub>pd</sub>	propagation	A to Y; see Fig. 6	[2]							
	delay	C <sub>L</sub> = 5 pF	1.0	2.5	4.3	0.5	4.7	0.5	5.2	ns
		C <sub>L</sub> = 10 pF	1.4	3.1	5	1.0	5.7	1.0	6.3	ns
		C <sub>L</sub> = 15 pF	1.8	3.6	5.6	1.0	6.2	1.0	6.9	ns
		C <sub>L</sub> = 30 pF	2.7	4.7	6.9	1.5	7.8	1.5	8.6	ns

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Symbol	Parameter	Conditions	25 °C		-40 °C to	o +85 °C	-40 °C to	+125 °C	Unit	
			Min	Typ[1]	Max	Min	Max	Min	Мах	1
T <sub>amb</sub> = 25 °C										
C <sub>PD</sub>	power	$f_i = 1 \text{ MHz}; V_I = \text{GND to } V_{\text{CC}}$ [3]								
	dissipation capacitance	V <sub>CC</sub> = 2.3 V to 2.7 V	-	4	-	-	-		-	pF
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	5	-	-	-		-	pF

All typical values are measured at nominal  $V_{CC}$ . [1]

[2] [3]

 $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$   $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu$ W).  $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma (C_L \times V_{CC}^2 \times f_o)$  where:

 $f_i$  = input frequency in MHz;

 $f_o = output$  frequency in MHz;

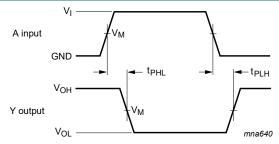
 $C_L$  = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

 $\Sigma(C_L \times V_{CC}^2 \times f_0) = \text{sum of the outputs.}$ 

### 11.1. Waveforms and test circuit



Measurement points are given in Table 9

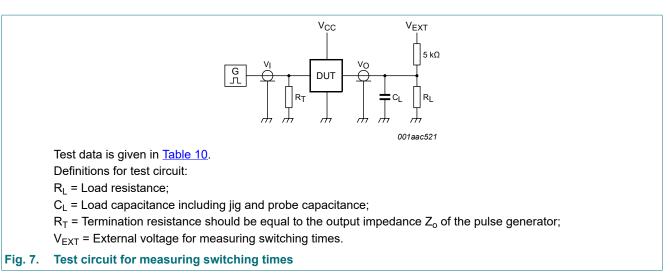
 $V_{\text{OL}}$  and  $V_{\text{OH}}$  are typical output voltage levels that occur with the output load.

#### Fig. 6. Input A to output Y propagation delay times

#### **Table 9. Measurement points**

Supply voltage	Output	Input				
V <sub>cc</sub>	V <sub>M</sub>	V <sub>M</sub>	VI	t <sub>r</sub> = t <sub>f</sub>		
2.3 V to 3.6 V	0.5 × V <sub>CC</sub>	0.5 × V <sub>I</sub>	1.65 V to 3.6 V	≤ 3.0 ns		

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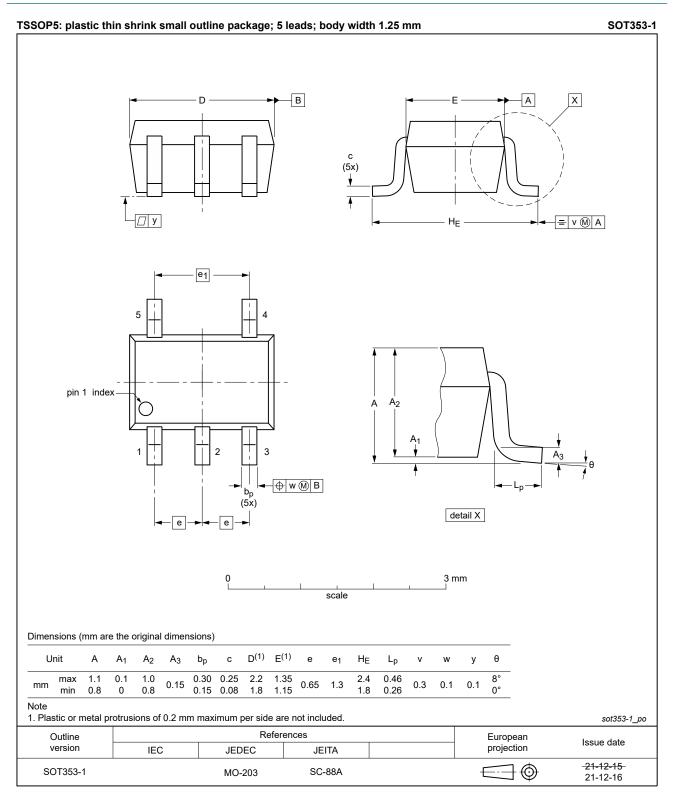
#### Table 10. Test data

Supply voltage	Load	V <sub>EXT</sub>			
V <sub>cc</sub>	CL	R <sub>L</sub> [1]	t <sub>PLH</sub> , t <sub>PHL</sub>	t <sub>PZH</sub> , t <sub>PHZ</sub>	t <sub>PZL</sub> , t <sub>PLZ</sub>
2.3 V to 3.6 V	5 pF, 10 pF, 15 pF and 30 pF	5 kΩ or 1 MΩ	open	GND	2 × V <sub>CC</sub>

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

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

### 12. Package outline



#### Fig. 8. Package outline SOT353-1 (TSSOP5)

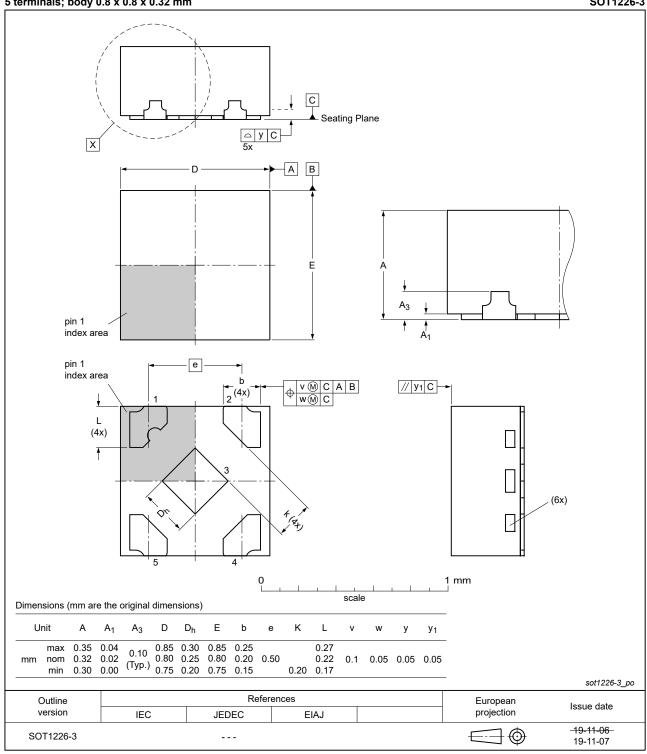
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### 74AUP1T14

#### Low-power inverter with voltage-level translator

#### 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





### 13. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
НВМ	Human Body Model

### 14. Revision history

Table 12. Revision history						
Document ID	Release date	Data sheet status	Change notice	Supersedes		
74AUP1T14 v.3	20220125	Product data sheet	-	74AUP1T14 v.2		
Modifications:	• Fig. 8: Package outline drawing for SOT353-1 (TSSOP5) has changed.					
74AUP1T14 v.2	20210719	Product data sheet	-	74AUP1T14 v.1		
Modifications:	<ul> <li>SOT1226 (X2SON5) package changed to SOT1226-3 (X2SON5) package.</li> <li><u>Table 5</u>: Derating values for P<sub>tot</sub> total power dissipation updated.</li> </ul>					
74AUP1T14 v.1	20171128	Product data sheet	-	-		

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### 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.
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