

74AUP1T02

Low-power 2-input NOR gate with voltage-level translator

Rev. 4 — 21 July 2023

Product data sheet

1. General description

The 74AUP1T02 provides the single 2-input NOR 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 74AUP1T02 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_{CC} range.

2. Features and benefits

- Wide supply voltage range from 2.3 V to 3.6 V
- High noise immunity
- 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_{CC}
- I_{OFF} circuitry provides partial power-down mode operation
- ESD protection:
 - HBM: ANSI/ESDA/JEDEC JS-001 class 3A exceeds 5000 V
 - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

3. Ordering information

Table 1. Ordering information

| Type number | Package | | | Version |
|-----------------------------|-------------------|--------|--|---------------------------|
| | Temperature range | Name | Description | |
| 74AUP1T02GW | -40 °C to +125 °C | TSSOP5 | plastic thin shrink small outline package; 5 leads; body width 1.25 mm | SOT353-1 |
| 74AUP1T02GX | -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 |

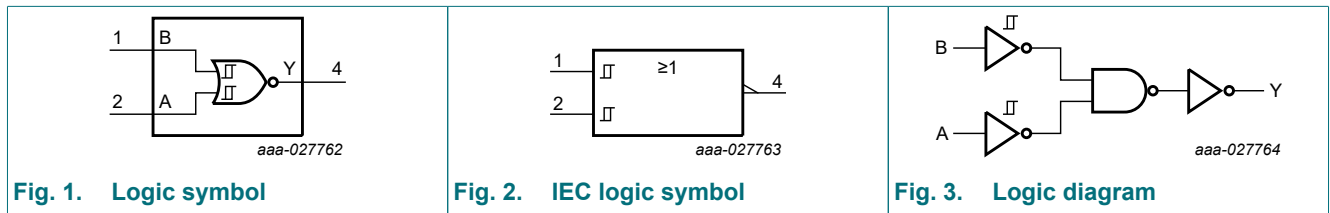
4. Marking

Table 2. Marking

| Type number | Marking code[1] |
|-------------|-----------------|
| 74AUP1T02GW | 5F |
| 74AUP1T02GX | 5F |

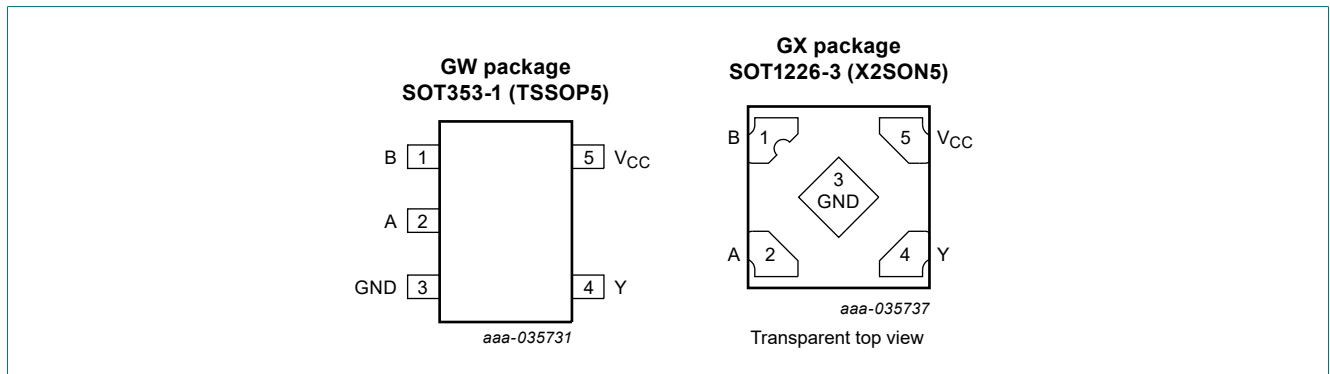
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

5. Functional diagram



6. Pinning information

6.1. Pinning



6.2. Pin description

Table 3. Pin description

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

7. Functional description

Table 4. Function table

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

| Input | | Output |
|-------|---|--------|
| A | B | Y |
| L | L | H |
| L | H | L |
| H | L | 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 | 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 SOT353-1 (TSSOP5) package: P_{tot} derates linearly with 3.3 mW/K above 74 °C.
For SOT1226-3 (X2SON5) package: P_{tot} 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_{CC} | supply voltage | | 2.3 | 3.6 | V |
| V_I | input voltage | | 0 | 3.6 | V |
| V_O | output voltage | Active mode | 0 | V_{CC} | V |
| | | Power-down mode; $V_{CC} = 0$ V | 0 | 3.6 | V |
| T_{amb} | 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 | Typ | Max | Unit |
|--------------------------------|--------------------------------------|--|-----------------------|-----|------|------|
| T_{amb} = 25 °C | | | | | | |
| V _{T+} | positive-going threshold voltage | V _{CC} = 2.3 V to 2.7 V | 0.60 | - | 1.10 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.75 | - | 1.16 | V |
| V _{T-} | negative-going threshold voltage | V _{CC} = 2.3 V to 2.7 V | 0.35 | - | 0.60 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.50 | - | 0.85 | V |
| V _H | hysteresis voltage | (V _H = V _{T+} - V _{T-}) | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | 0.23 | - | 0.60 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.25 | - | 0.56 | V |
| V _{OH} | 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 _{CC} - 0.1 | - | - | 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 = V _{T+} or V _{T-} | | | | |
| | | I _O = 20 μA; V _{CC} = 2.3 V to 3.6 V | - | - | 0.10 | 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 _{OFF} | power-off leakage current | V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V | - | - | ±0.1 | 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 | - | - | ±0.1 | μA |
| I _{CC} | supply current | V _I = GND or V _{CC} ; I _O = 0 A; V _{CC} = 2.3 V to 3.6 V | - | - | 1.2 | 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 | V _O = GND; V _{CC} = 0 V | - | 1.7 | - | pF |

Low-power 2-input NOR gate with voltage-level translator

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|--------------------------------------|---|-----------------------|-----|------|------|
| T_{amb} = -40 °C to +85 °C | | | | | | |
| V _{T+} | positive-going threshold voltage | V _{CC} = 2.3 V to 2.7 V | 0.60 | - | 1.10 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.75 | - | 1.19 | V |
| V _{T-} | negative-going threshold voltage | V _{CC} = 2.3 V to 2.7 V | 0.35 | - | 0.60 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.50 | - | 0.85 | V |
| V _H | hysteresis voltage | (V _H = V _{T+} - V _{T-}) | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | 0.10 | - | 0.60 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.15 | - | 0.56 | V |
| V _{OH} | 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 _{CC} - 0.1 | - | - | 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 _{T+} or V _{T-} | | | | |
| | | I _O = 20 µA; V _{CC} = 2.3 V to 3.6 V | - | - | 0.1 | 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 _{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 | - | - | ±0.5 | µA |
| I _{CC} | supply current | V _I = GND or V _{CC} ; I _O = 0 A; V _{CC} = 2.3 V to 3.6 V | - | - | 1.5 | µA |
| ΔI _{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 [2] | - | - | 10 | µA |

Low-power 2-input NOR gate with voltage-level translator

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|--------------------------------------|--|------------------------|-----|-------|------|
| T_{amb} = -40 °C to +125 °C | | | | | | |
| V _{T+} | positive-going threshold voltage | V _{CC} = 2.3 V to 2.7 V | 0.60 | - | 1.10 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.75 | - | 1.19 | V |
| V _{T-} | negative-going threshold voltage | V _{CC} = 2.3 V to 2.7 V | 0.33 | - | 0.64 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.46 | - | 0.85 | V |
| V _H | hysteresis voltage | (V _H = V _{T+} - V _{T-}) | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | 0.10 | - | 0.60 | V |
| | | V _{CC} = 3.0 V to 3.6 V | 0.15 | - | 0.56 | V |
| V _{OH} | 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 _{CC} - 0.11 | - | - | 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 = V _{T+} or V _{T-} | | | | |
| | | I _O = 20 μA; V _{CC} = 2.3 V to 3.6 V | - | - | 0.11 | 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 _{OFF} | power-off leakage current | V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V | - | - | ±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 | - | - | ±0.75 | μA |
| I _{CC} | 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 _{CC} | additional supply current | V _{CC} = 2.3 V to 2.7 V; I _O = 0 A [1] | - | - | 1.8 | μA |
| | | V _{CC} = 3.0 V to 3.6 V; I _O = 0 A [2] | - | - | 18 | μA |

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

11. Dynamic characteristics

Table 8. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 5.

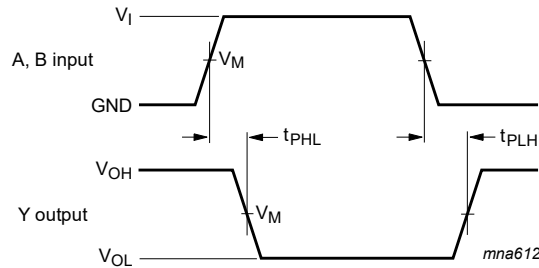
| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|--|-------------------|---------------------------|-------|--------|-----|------------------|------|-------------------|------|------|
| | | | Min | Typ[1] | Max | Min | Max | Min | Max | |
| V_{CC} = 2.3 V to 2.7 V; V_I = 1.65 V to 1.95 V | | | | | | | | | | |
| t _{pd} | propagation delay | A, B to Y; see Fig. 4 [2] | | | | | | | | |
| | | C _L = 5 pF | 1.9 | 3.3 | 5.1 | 0.5 | 6.8 | 0.5 | 7.5 | ns |
| | | C _L = 10 pF | 2.4 | 3.9 | 5.8 | 1.0 | 7.9 | 1.0 | 8.7 | ns |
| | | C _L = 15 pF | 2.8 | 4.4 | 6.3 | 1.0 | 8.7 | 1.0 | 9.6 | ns |
| | | C _L = 30 pF | 4.0 | 5.6 | 7.7 | 1.5 | 10.8 | 1.5 | 11.9 | ns |

Low-power 2-input NOR gate with voltage-level translator

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|--|-------------------------------|---|-------|--------|-----|------------------|------|-------------------|------|------|
| | | | Min | Typ[1] | Max | Min | Max | Min | Max | |
| V_{CC} = 2.3 V to 2.7 V; V_I = 2.3 V to 2.7 V | | | | | | | | | | |
| t _{pd} | propagation delay | A, B to Y; see Fig. 4 [2] | | | | | | | | |
| | | C _L = 5 pF | 1.5 | 3.2 | 5.1 | 0.5 | 6.0 | 0.5 | 6.6 | ns |
| | | C _L = 10 pF | 2.0 | 3.8 | 5.8 | 1.0 | 7.1 | 1.0 | 7.9 | ns |
| | | C _L = 30 pF | 3.4 | 5.4 | 7.7 | 1.5 | 10.0 | 1.5 | 11.0 | ns |
| V_{CC} = 2.3 V to 2.7 V; V_I = 3.0 V to 3.6 V | | | | | | | | | | |
| t _{pd} | propagation delay | A, B to Y; see Fig. 4 [2] | | | | | | | | |
| | | C _L = 5 pF | 1.2 | 2.9 | 4.7 | 0.5 | 5.5 | 0.5 | 6.1 | ns |
| | | C _L = 10 pF | 1.7 | 3.5 | 5.4 | 1.0 | 6.5 | 1.0 | 7.2 | ns |
| | | C _L = 30 pF | 3.1 | 5.2 | 7.4 | 1.5 | 9.5 | 1.5 | 10.5 | ns |
| V_{CC} = 3.0 V to 3.6 V; V_I = 1.65 V to 1.95 V | | | | | | | | | | |
| t _{pd} | propagation delay | A, B to Y; see Fig. 4 [2] | | | | | | | | |
| | | C _L = 5 pF | 1.9 | 2.8 | 4.0 | 0.5 | 8.0 | 0.5 | 8.8 | ns |
| | | C _L = 10 pF | 2.0 | 3.3 | 4.5 | 1.0 | 8.5 | 1.0 | 9.4 | ns |
| | | C _L = 30 pF | 3.5 | 4.9 | 6.6 | 1.5 | 9.8 | 1.5 | 10.8 | ns |
| V_{CC} = 3.0 V to 3.6 V; V_I = 2.3 V to 2.7 V | | | | | | | | | | |
| t _{pd} | propagation delay | A, B to Y; see Fig. 4 [2] | | | | | | | | |
| | | C _L = 5 pF | 1.4 | 2.7 | 4.1 | 0.5 | 5.3 | 0.5 | 5.9 | ns |
| | | C _L = 10 pF | 1.9 | 3.2 | 4.8 | 1.0 | 6.1 | 1.0 | 6.8 | ns |
| | | C _L = 30 pF | 3.3 | 4.9 | 6.7 | 1.5 | 8.5 | 1.5 | 9.4 | ns |
| V_{CC} = 3.0 V to 3.6 V; V_I = 3.0 V to 3.6 V | | | | | | | | | | |
| t _{pd} | propagation delay | A, B to Y; see Fig. 4 [2] | | | | | | | | |
| | | C _L = 5 pF | 1.1 | 2.6 | 4.2 | 0.5 | 4.7 | 0.5 | 5.2 | ns |
| | | C _L = 10 pF | 1.6 | 3.2 | 4.9 | 1.0 | 5.7 | 1.0 | 6.3 | ns |
| | | C _L = 30 pF | 3.0 | 4.8 | 6.8 | 1.5 | 7.8 | 1.5 | 8.6 | ns |
| T_{amb} = 25 °C | | | | | | | | | | |
| C _{PD} | power dissipation capacitance | f _i = 1 MHz; V _I = GND to V _{CC} [3] | | | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | 4 | - | - | - | - | - | pF |
| | | V _{CC} = 3.0 V to 3.6 V | - | 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] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$ 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;
 $\sum(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.

11.1. Waveforms and test circuit



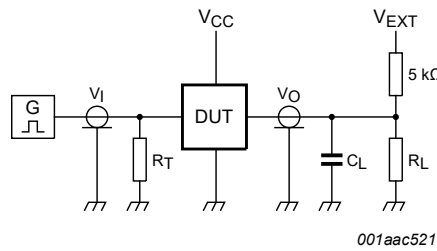
Measurement points are given in [Table 9](#).

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

Fig. 4. Input A and B to output Y propagation delay times

Table 9. Measurement points

| Supply voltage | Output | Input | | |
|----------------|---------------------|------------------|-----------------|---------------|
| V_{CC} | V_M | V_M | V_I | $t_r = t_f$ |
| 2.3 V to 3.6 V | $0.5 \times V_{CC}$ | $0.5 \times V_I$ | 1.65 V to 3.6 V | ≤ 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. 5. 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} |
| 2.3 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, setup and hold times and pulse width $R_L = 1$ MΩ.

12. Package outline

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

SOT353-1



Fig. 6. Package outline SOT353-1 (TSSOP5)

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



Fig. 7. Package outline SOT1226-3 (X2SON5)

13. 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 |

14. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|--|--------------------|---------------|---------------|
| 74AUP1T02 v.4 | 20230721 | Product data sheet | - | 74AUP1T02 v.3 |
| Modifications: | <ul style="list-style-type: none"> Section 2: ESD specification updated according to the latest JEDEC standard. | | | |
| 74AUP1T02 v.3 | 20220222 | Product data sheet | - | 74AUP1T02 v.2 |
| Modifications: | <ul style="list-style-type: none"> Package SOT1226 (X2SON5) changed to SOT1226-3 (X2SON5). | | | |
| 74AUP1T02 v.2 | 20220210 | Product data sheet | - | 74AUP1T02 v.1 |
| Modifications: | <ul style="list-style-type: none"> Table 5: Derating values for P_{tot} total power dissipation updated. Fig. 6: Package outline drawing for SOT353-1 (TSSOP5) has changed. | | | |
| 74AUP1T02 v.1 | 20171128 | Product data sheet | - | - |

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. |
| 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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Contents

| | |
|--|-----------|
| 1. General description | 1 |
| 2. Features and benefits | 1 |
| 3. Ordering information | 1 |
| 4. Marking | 2 |
| 5. Functional diagram | 2 |
| 6. Pinning information | 2 |
| 6.1. Pinning..... | 2 |
| 6.2. Pin description..... | 2 |
| 7. Functional description | 3 |
| 8. Limiting values | 3 |
| 9. Recommended operating conditions | 3 |
| 10. Static characteristics | 4 |
| 11. Dynamic characteristics | 6 |
| 11.1. Waveforms and test circuit..... | 8 |
| 12. Package outline | 9 |
| 13. Abbreviations | 11 |
| 14. Revision history | 11 |
| 15. Legal information | 12 |

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