

NX3L1T384

Low-ohmic single-pole single-throw analog switch

Rev. 3.1 — 17 October 2016

Product data sheet

1. General description

The NX3L1T384 is a low-ohmic single-pole single-throw analog switch. It has two input/output terminals (Y and Z) and an active LOW enable input pin (\bar{E}). When \bar{E} is HIGH, the analog switch is turned off.

Schmitt trigger action at the enable input (\bar{E}) makes the circuit tolerant to slower input rise and fall times. A low input voltage threshold allows pin \bar{E} to be driven by lower level logic signals without a significant increase in supply current I_{CC} . This makes it possible for the NX3L1T384 to switch 4.3 V signals with a 1.8 V digital controller, eliminating the need for logic level translation.

The NX3L1T384 allows signals with amplitude up to V_{CC} to be transmitted from Y to Z; or from Z to Y. Its low ON resistance (0.5 Ω) and flatness (0.13 Ω) ensures minimal attenuation and distortion of transmitted signals.

2. Features and benefits

- Wide supply voltage range from 1.4 V to 4.3 V
- Very low ON resistance (peak):
 - ◆ 1.6 Ω (typical) at $V_{CC} = 1.4$ V
 - ◆ 1.0 Ω (typical) at $V_{CC} = 1.65$ V
 - ◆ 0.55 Ω (typical) at $V_{CC} = 2.3$ V
 - ◆ 0.50 Ω (typical) at $V_{CC} = 2.7$ V
 - ◆ 0.50 Ω (typical) at $V_{CC} = 4.3$ V
- High noise immunity
- ESD protection:
 - ◆ HBM JESD22-A114F Class 3A exceeds 7500 V
 - ◆ MM JESD22-A115-A exceeds 200 V
 - ◆ CDM AEC-Q100-011 revision B exceeds 1000 V
 - ◆ IEC61000-4-2 contact discharge exceeds 4000 V for switch ports
- CMOS low-power consumption
- Latch-up performance exceeds 100 mA per JESD78B Class II Level A
- 1.8 V control logic at $V_{CC} = 3.6$ V
- Control input accepts voltages above supply voltage
- Very low supply current, even when input is below V_{CC}
- High current handling capability (350 mA continuous current under 3.3 V supply)
- Specified from -40 °C to $+85$ °C and from -40 °C to $+125$ °C



3. Applications

- Cell phone
- PDA
- Portable media player

4. Ordering information

Table 1. Ordering information

| Type number | Package | | | Version |
|-------------|-------------------|-------|---|---------|
| | Temperature range | Name | Description | |
| NX3L1T384GM | -40 °C to +125 °C | XSON6 | plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm | SOT886 |

5. Marking

Table 2. Marking codes^[1]

| Type number | Marking code |
|-------------|--------------|
| NX3L1T384GM | M3 |

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

6. Functional diagram

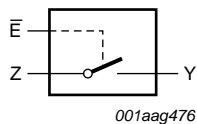


Fig 1. Logic symbol

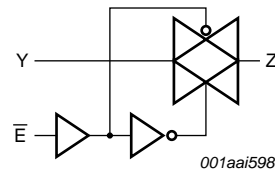
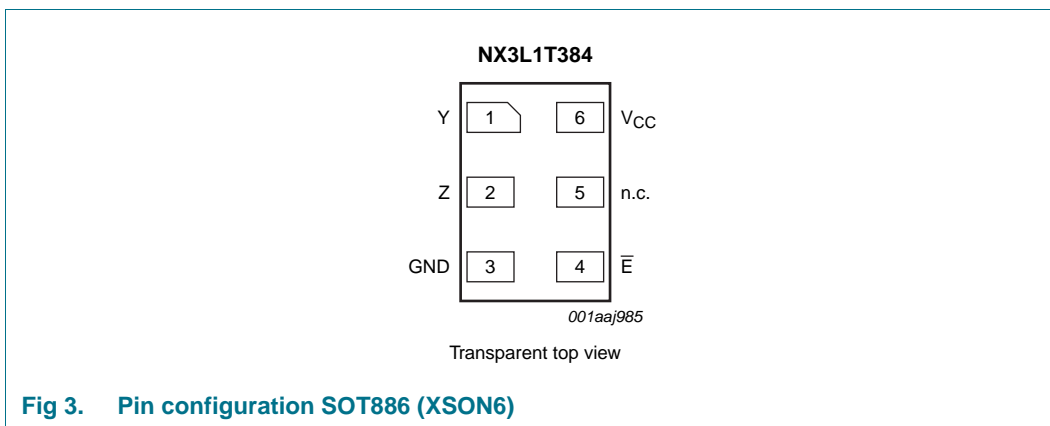


Fig 2. Logic diagram

7. Pinning information

7.1 Pinning



7.2 Pin description

Table 3. Pin description

| Symbol | Pin | Description |
|-----------------|-----|-----------------------------|
| Y | 1 | independent input or output |
| Z | 2 | independent output or input |
| GND | 3 | ground (0 V) |
| \bar{E} | 4 | enable input (active LOW) |
| n.c. | 5 | not connected |
| V _{CC} | 6 | supply voltage |

8. Functional description

Table 4. Function table^[1]

| Input \bar{E} | Switch |
|-----------------|-----------|
| L | ON-state |
| H | OFF-state |

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

9. 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 |
| V_I | input voltage | enable input \bar{E} | [1] -0.5 | +4.6 | V |
| V_{SW} | switch voltage | | [2] -0.5 | $V_{CC} + 0.5$ | V |
| I_{IK} | input clamping current | $V_I < -0.5$ V | -50 | - | mA |
| I_{SK} | switch clamping current | $V_I < -0.5$ V or $V_I > V_{CC} + 0.5$ V | - | ± 50 | mA |
| I_{SW} | switch current | $V_{SW} > -0.5$ V or $V_{SW} < V_{CC} + 0.5$ V; source or sink current | - | ± 350 | mA |
| | | $V_{SW} > -0.5$ V or $V_{SW} < V_{CC} + 0.5$ V; pulsed at 1 ms duration, < 10 % duty cycle; peak current | - | ± 500 | 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 rating may be exceeded if the input current rating is observed.
- [2] The minimum and maximum switch voltage ratings may be exceeded if the switch clamping current rating is observed but may not exceed 4.6 V.
- [3] For TSSOP5 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.

10. Recommended operating conditions

Table 6. Recommended operating conditions

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---------------------|-------------------------------------|---------------------------|-------|----------|------|
| V_{CC} | supply voltage | | 1.4 | 4.3 | V |
| V_I | input voltage | enable input \bar{E} | 0 | 4.3 | V |
| V_{SW} | switch voltage | | [1] 0 | V_{CC} | V |
| T_{amb} | ambient temperature | | -40 | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 1.4$ V to 4.3 V | [2] - | 200 | ns/V |

- [1] To avoid sinking GND current from of terminal Z when switch current flows in terminal Y, the voltage drop across the bidirectional switch must not exceed 0.4 V. If the switch current flows into terminal Z, no GND current will flow from terminal Y. In this case, there is no limit for the voltage drop across the switch.
- [2] Applies to control signal levels.

11. Static characteristics

Table 7. Static characteristics

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

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +125 °C | | | Unit |
|---------------------|---------------------------|--|-------|------|------|-------------------|-------------|--------------|------|
| | | | Min | Typ | Max | Min | Max (85 °C) | Max (125 °C) | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 1.4 V to 1.6 V | 0.9 | - | - | 0.9 | - | - | V |
| | | V _{CC} = 1.65 V to 1.95 V | 0.9 | - | - | 0.9 | - | - | V |
| | | V _{CC} = 2.3 V to 2.7 V | 1.1 | - | - | 1.1 | - | - | V |
| | | V _{CC} = 2.7 V to 3.6 V | 1.3 | - | - | 1.3 | - | - | V |
| | | V _{CC} = 3.6 V to 4.3 V | 1.4 | - | - | 1.4 | - | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 1.4 V to 1.6 V | - | - | 0.3 | - | 0.3 | 0.3 | V |
| | | V _{CC} = 1.65 V to 1.95 V | - | - | 0.4 | - | 0.4 | 0.3 | V |
| | | V _{CC} = 2.3 V to 2.7 V | - | - | 0.4 | - | 0.4 | 0.4 | V |
| | | V _{CC} = 2.7 V to 3.6 V | - | - | 0.5 | - | 0.5 | 0.5 | V |
| | | V _{CC} = 3.6 V to 4.3 V | - | - | 0.6 | - | 0.6 | 0.6 | V |
| I _I | input leakage current | enable input \bar{E} ; V _I = GND to 4.3 V; V _{CC} = 1.4 V to 4.3 V | - | - | - | - | ±0.5 | ±1 | µA |
| I _{S(OFF)} | OFF-state leakage current | Y port; see Figure 4 | | | | | | | |
| | | V _{CC} = 1.4 V to 3.6 V | - | - | ±5 | - | ±50 | ±500 | nA |
| | | V _{CC} = 3.6 V to 4.3 V | - | - | ±10 | - | ±50 | ±500 | nA |
| I _{S(ON)} | ON-state leakage current | Z port; see Figure 5 | | | | | | | |
| | | V _{CC} = 1.4 V to 3.6 V | - | - | ±5 | - | ±50 | ±500 | nA |
| | | V _{CC} = 3.6 V to 4.3 V | - | - | ±10 | - | ±50 | ±500 | nA |
| I _{CC} | supply current | V _I = V _{CC} or GND; V _{SW} = GND or V _{CC} | | | | | | | |
| | | V _{CC} = 3.6 V | - | - | 100 | - | 690 | 6000 | nA |
| | | V _{CC} = 4.3 V | - | - | 150 | - | 800 | 7000 | nA |
| ΔI _{CC} | additional supply current | V _{SW} = GND or V _{CC} | | | | | | | |
| | | V _I = 2.6 V; V _{CC} = 4.3 V | - | 2.0 | 4.0 | - | 7 | 7 | µA |
| | | V _I = 2.6 V; V _{CC} = 3.6 V | - | 0.35 | 0.7 | - | 1 | 1 | µA |
| | | V _I = 1.8 V; V _{CC} = 4.3 V | - | 7.0 | 10.0 | - | 15 | 15 | µA |
| | | V _I = 1.8 V; V _{CC} = 3.6 V | - | 2.5 | 4.0 | - | 5 | 5 | µA |
| C _I | input capacitance | V _I = 1.8 V; V _{CC} = 2.5 V | - | 50 | 200 | - | 300 | 500 | nA |
| | | | - | 1.0 | - | - | - | - | pF |
| C _{S(OFF)} | OFF-state capacitance | | - | 35 | - | - | - | - | pF |
| C _{S(ON)} | ON-state capacitance | | - | 110 | - | - | - | - | pF |

11.1 Test circuits

$V_I = 0.3 \text{ V or } V_{CC} - 0.3 \text{ V}; V_O = V_{CC} - 0.3 \text{ V or } 0.3 \text{ V}.$

Fig 4. Test circuit for measuring OFF-state leakage current

$V_I = 0.3 \text{ V or } V_{CC} - 0.3 \text{ V}; V_O = \text{open circuit}.$

Fig 5. Test circuit for measuring ON-state leakage current

11.2 ON resistance

Table 8. ON resistance

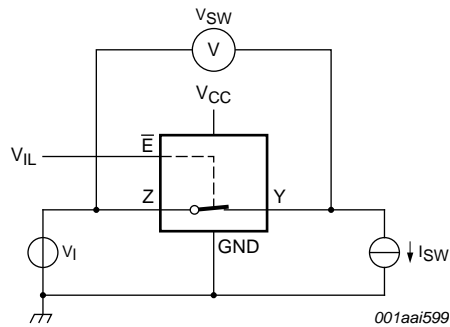
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for graphs see [Figure 7](#) to [Figure 13](#).

| Symbol | Parameter | Conditions | T _{amb} = -40 °C to +85 °C | | | T _{amb} = -40 °C to +125 °C | | Unit |
|-----------------------|--------------------------|---|-------------------------------------|--------------------|------|--------------------------------------|------|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| R _{ON(peak)} | ON resistance (peak) | V _I = GND to V _{CC} ; I _{SW} = 100 mA; see Figure 6 | | | | | | |
| | | V _{CC} = 1.4 V | - | 1.6 | 3.7 | - | 4.1 | Ω |
| | | V _{CC} = 1.65 V | - | 1.0 | 1.6 | - | 1.7 | Ω |
| | | V _{CC} = 2.3 V | - | 0.55 | 0.8 | - | 0.9 | Ω |
| | | V _{CC} = 2.7 V | - | 0.5 | 0.75 | - | 0.9 | Ω |
| | | V _{CC} = 4.3 V | - | 0.5 | 0.75 | - | 0.9 | Ω |
| R _{ON(flat)} | ON resistance (flatness) | V _I = GND to V _{CC} ; I _{SW} = 100 mA ^[2] | | | | | | |
| | | V _{CC} = 1.4 V | - | 1.0 | 3.3 | - | 3.6 | Ω |
| | | V _{CC} = 1.65 V | - | 0.5 | 1.2 | - | 1.3 | Ω |
| | | V _{CC} = 2.3 V | - | 0.15 | 0.3 | - | 0.35 | Ω |
| | | V _{CC} = 2.7 V | - | 0.13 | 0.3 | - | 0.35 | Ω |
| | | V _{CC} = 4.3 V | - | 0.2 | 0.4 | - | 0.45 | Ω |

[1] Typical values are measured at T_{amb} = 25 °C.

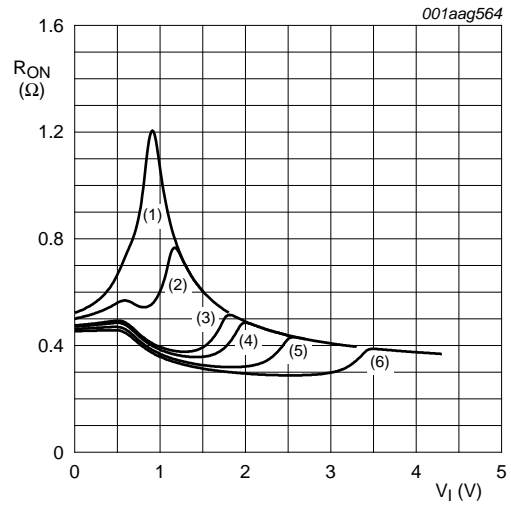
[2] Flatness is defined as the difference between the maximum and minimum value of ON resistance measured at identical V_{CC} and temperature.

11.3 ON resistance test circuit and graphs



$R_{ON} = V_{SW} / I_{SW}$.

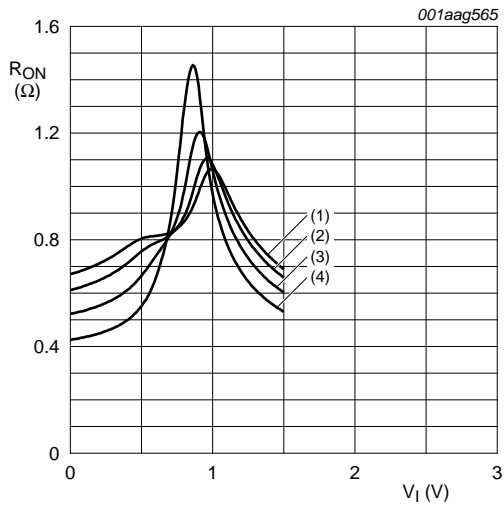
Fig 6. Test circuit for measuring ON resistance



- (1) $V_{CC} = 1.5\text{ V}$.
- (2) $V_{CC} = 1.8\text{ V}$.
- (3) $V_{CC} = 2.5\text{ V}$.
- (4) $V_{CC} = 2.7\text{ V}$.
- (5) $V_{CC} = 3.3\text{ V}$.
- (6) $V_{CC} = 4.3\text{ V}$.

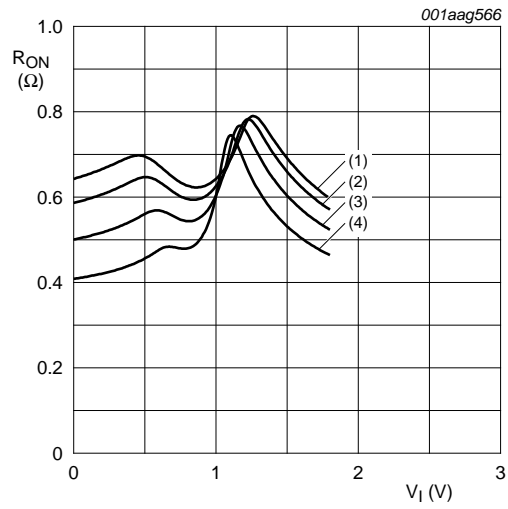
Measured at $T_{amb} = 25\text{ }^\circ\text{C}$.

Fig 7. Typical ON resistance as a function of input voltage



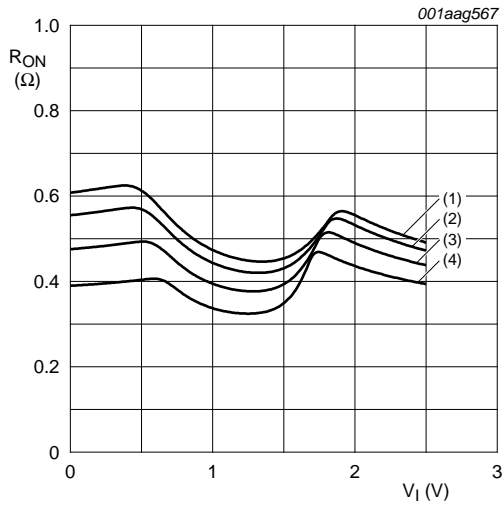
- (1) $T_{amb} = 125\text{ °C.}$
- (2) $T_{amb} = 85\text{ °C.}$
- (3) $T_{amb} = 25\text{ °C.}$
- (4) $T_{amb} = -40\text{ °C.}$

Fig 8. ON resistance as a function of input voltage;
 $V_{CC} = 1.5\text{ V}$



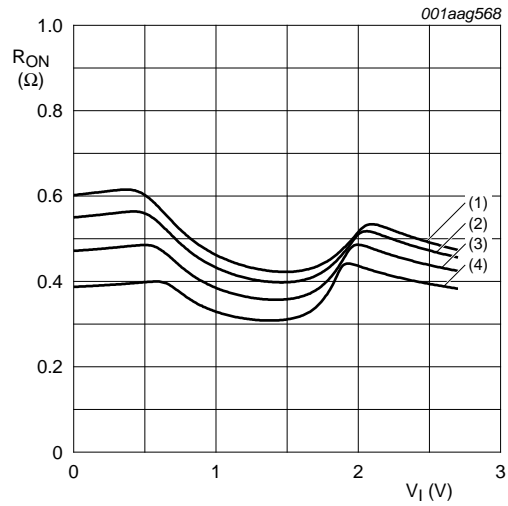
- (1) $T_{amb} = 125\text{ °C.}$
- (2) $T_{amb} = 85\text{ °C.}$
- (3) $T_{amb} = 25\text{ °C.}$
- (4) $T_{amb} = -40\text{ °C.}$

Fig 9. ON resistance as a function of input voltage;
 $V_{CC} = 1.8\text{ V}$



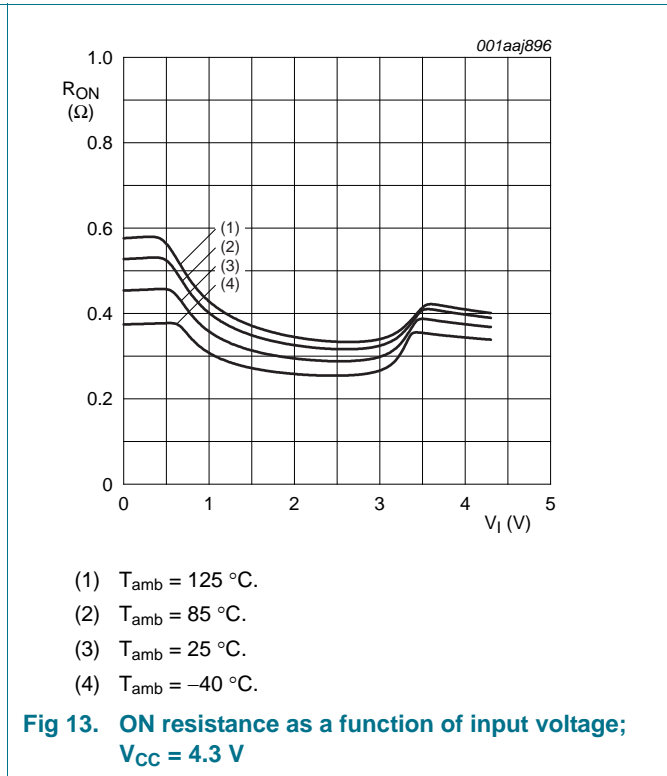
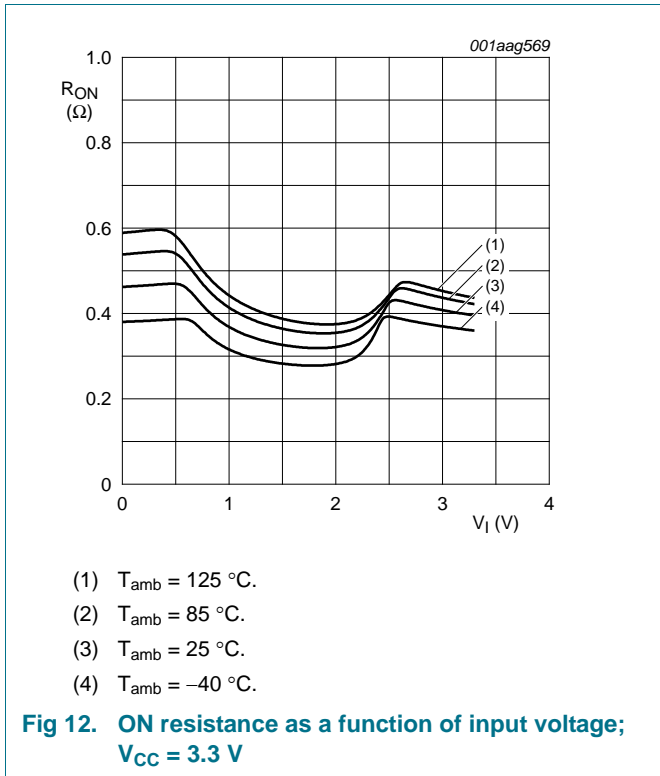
- (1) $T_{amb} = 125\text{ °C.}$
- (2) $T_{amb} = 85\text{ °C.}$
- (3) $T_{amb} = 25\text{ °C.}$
- (4) $T_{amb} = -40\text{ °C.}$

Fig 10. ON resistance as a function of input voltage;
 $V_{CC} = 2.5\text{ V}$



- (1) $T_{amb} = 125\text{ °C.}$
- (2) $T_{amb} = 85\text{ °C.}$
- (3) $T_{amb} = 25\text{ °C.}$
- (4) $T_{amb} = -40\text{ °C.}$

Fig 11. ON resistance as a function of input voltage;
 $V_{CC} = 2.7\text{ V}$



12. Dynamic characteristics

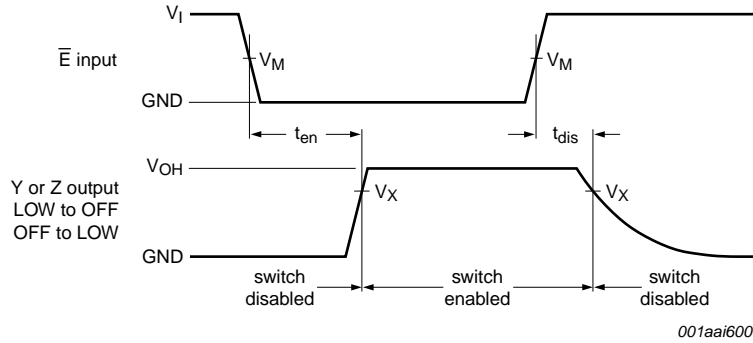
Table 9. Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for load circuit see [Figure 15](#).

| Symbol | Parameter | Conditions | $T_{amb} = 25\text{ }^\circ\text{C}$ | | | $T_{amb} = -40\text{ }^\circ\text{C to } +125\text{ }^\circ\text{C}$ | | | Unit |
|-----------|--------------|--|--------------------------------------|--------------------|-----|--|-------------|--------------|------|
| | | | Min | Typ ^[1] | Max | Min | Max (85 °C) | Max (125 °C) | |
| t_{en} | enable time | \bar{E} to Z or Y; see Figure 14 | | | | | | | |
| | | $V_{CC} = 1.4\text{ V to } 1.6\text{ V}$ | - | 50 | 90 | - | 120 | 120 | ns |
| | | $V_{CC} = 1.65\text{ V to } 1.95\text{ V}$ | - | 36 | 70 | - | 80 | 90 | ns |
| | | $V_{CC} = 2.3\text{ V to } 2.7\text{ V}$ | - | 24 | 45 | - | 50 | 55 | ns |
| | | $V_{CC} = 2.7\text{ V to } 3.6\text{ V}$ | - | 22 | 40 | - | 45 | 50 | ns |
| t_{dis} | disable time | \bar{E} to Z or Y; see Figure 14 | | | | | | | |
| | | $V_{CC} = 1.4\text{ V to } 1.6\text{ V}$ | - | 30 | 45 | - | 50 | 60 | ns |
| | | $V_{CC} = 1.65\text{ V to } 1.95\text{ V}$ | - | 20 | 30 | - | 35 | 40 | ns |
| | | $V_{CC} = 2.3\text{ V to } 2.7\text{ V}$ | - | 15 | 20 | - | 22 | 25 | ns |
| | | $V_{CC} = 2.7\text{ V to } 3.6\text{ V}$ | - | 11 | 15 | - | 18 | 22 | ns |
| | | $V_{CC} = 3.6\text{ V to } 4.3\text{ V}$ | - | 11 | 15 | - | 18 | 22 | ns |

[1] Typical values are measured at $T_{amb} = 25\text{ }^\circ\text{C}$ and $V_{CC} = 1.5\text{ V}, 1.8\text{ V}, 2.5\text{ V}, 3.3\text{ V}$ and 4.3 V respectively.

12.1 Waveform and test circuits

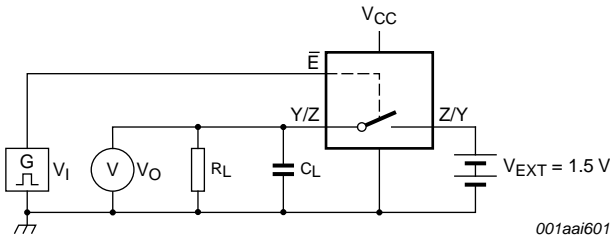


Measurement points are given in [Table 10](#).
 Logic level: V_{OH} is the typical output voltage that occurs with the output load.

Fig 14. Enable and disable times

Table 10. Measurement points

| Supply voltage | Input | Output |
|----------------|-------------|-------------|
| V_{CC} | V_M | V_X |
| 1.4 V to 4.3 V | $0.5V_{CC}$ | $0.9V_{OH}$ |



Test data is given in [Table 11](#).
 Definitions test circuit:
 R_L = Load resistance.
 C_L = Load capacitance including jig and probe capacitance.
 V_{EXT} = External voltage for measuring switching times.

Fig 15. Load circuit for switching times

Table 11. Test data

| Supply voltage | Input | | Load | |
|----------------|----------|-----------------------|-------|-------------|
| V_{CC} | V_I | t_r, t_f | C_L | R_L |
| 1.4 V to 4.3 V | V_{CC} | $\leq 2.5 \text{ ns}$ | 35 pF | 50 Ω |

12.2 Additional dynamic characteristics

Table 12. Additional dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); $V_I = GND$ or V_{CC} (unless otherwise specified); $t_r = t_f \leq 2.5$ ns.

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | Unit |
|----------------|---------------------------|--|--------------------------|------|-----|------|
| | | | Min | Typ | Max | |
| THD | total harmonic distortion | $f_i = 20$ Hz to 20 kHz; $R_L = 32 \Omega$; see Figure 16 [1] | | | | |
| | | $V_{CC} = 1.4$ V; $V_I = 1$ V (p-p) | - | 0.15 | - | % |
| | | $V_{CC} = 1.65$ V; $V_I = 1.2$ V (p-p) | - | 0.10 | - | % |
| | | $V_{CC} = 2.3$ V; $V_I = 1.5$ V (p-p) | - | 0.02 | - | % |
| | | $V_{CC} = 2.7$ V; $V_I = 2$ V (p-p) | - | 0.02 | - | % |
| | | $V_{CC} = 4.3$ V; $V_I = 2$ V (p-p) | - | 0.02 | - | % |
| $f_{(-3dB)}$ | -3 dB frequency response | $R_L = 50 \Omega$; see Figure 17 [1] | | | | |
| | | $V_{CC} = 1.4$ V to 4.3 V | - | 60 | - | MHz |
| α_{iso} | isolation (OFF-state) | $f_i = 100$ kHz; $R_L = 50 \Omega$; see Figure 18 [1] | | | | |
| | | $V_{CC} = 1.4$ V to 4.3 V | - | -90 | - | dB |
| V_{ct} | crosstalk voltage | between digital inputs and switch; $f_i = 1$ MHz; $C_L = 50$ pF; $R_L = 50 \Omega$; see Figure 19 | | | | |
| | | $V_{CC} = 1.4$ V to 3.6 V | - | 0.2 | - | V |
| | | $V_{CC} = 3.6$ V to 4.3 V | - | 0.2 | - | V |
| Q_{inj} | charge injection | $f_i = 1$ MHz; $C_L = 0.1$ nF; $R_L = 1$ M Ω ; $V_{gen} = 0$ V; $R_{gen} = 0 \Omega$; see Figure 20 | | | | |
| | | $V_{CC} = 1.5$ V | - | 3 | - | pC |
| | | $V_{CC} = 1.8$ V | - | 3 | - | pC |
| | | $V_{CC} = 2.5$ V | - | 3 | - | pC |
| | | $V_{CC} = 3.3$ V | - | 3 | - | pC |
| | | $V_{CC} = 4.3$ V | - | 6 | - | pC |

[1] f_i is biased at $0.5V_{CC}$.

12.3 Test circuits

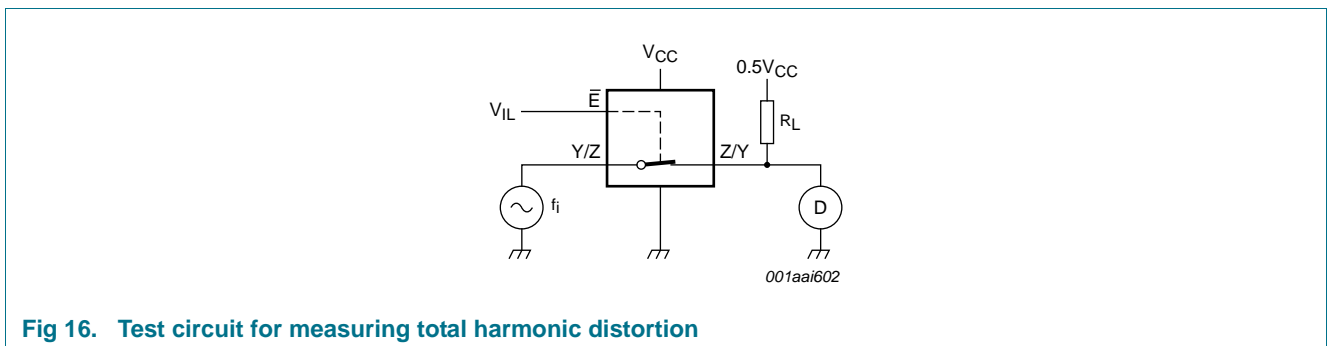
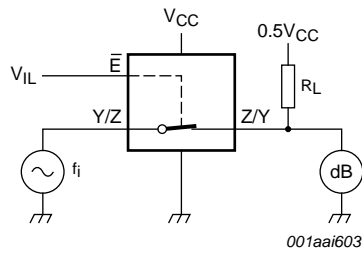
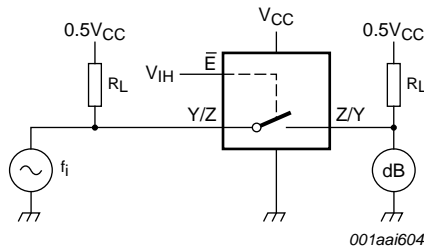


Fig 16. Test circuit for measuring total harmonic distortion



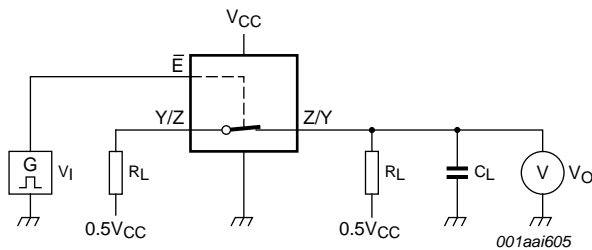
Adjust f_i voltage to obtain 0 dBm level at output. Increase f_i frequency until dB meter reads -3 dB.

Fig 17. Test circuit for measuring the frequency response when channel is in ON-state

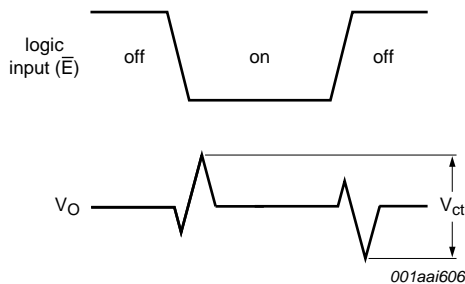


Adjust f_i voltage to obtain 0 dBm level at input.

Fig 18. Test circuit for measuring isolation (OFF-state)

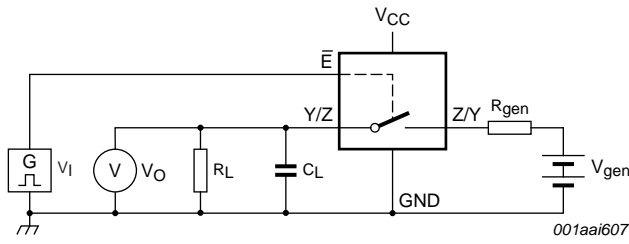


a. Test circuit

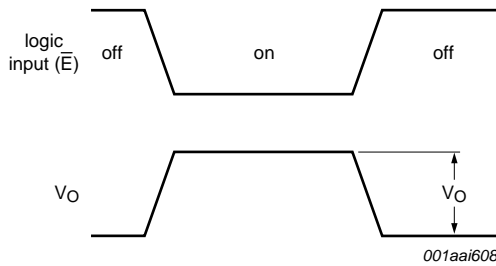


b. Input and output pulse definitions

Fig 19. Test circuit for measuring crosstalk voltage between digital inputs and switch



a. Test circuit



b. Input and output pulse definitions

Definition: $Q_{inj} = \Delta V_O \times C_L$.

ΔV_O = output voltage variation.

R_{gen} = generator resistance.

V_{gen} = generator voltage.

Fig 20. Test circuit for measuring charge injection

13. Package outline

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

SOT886

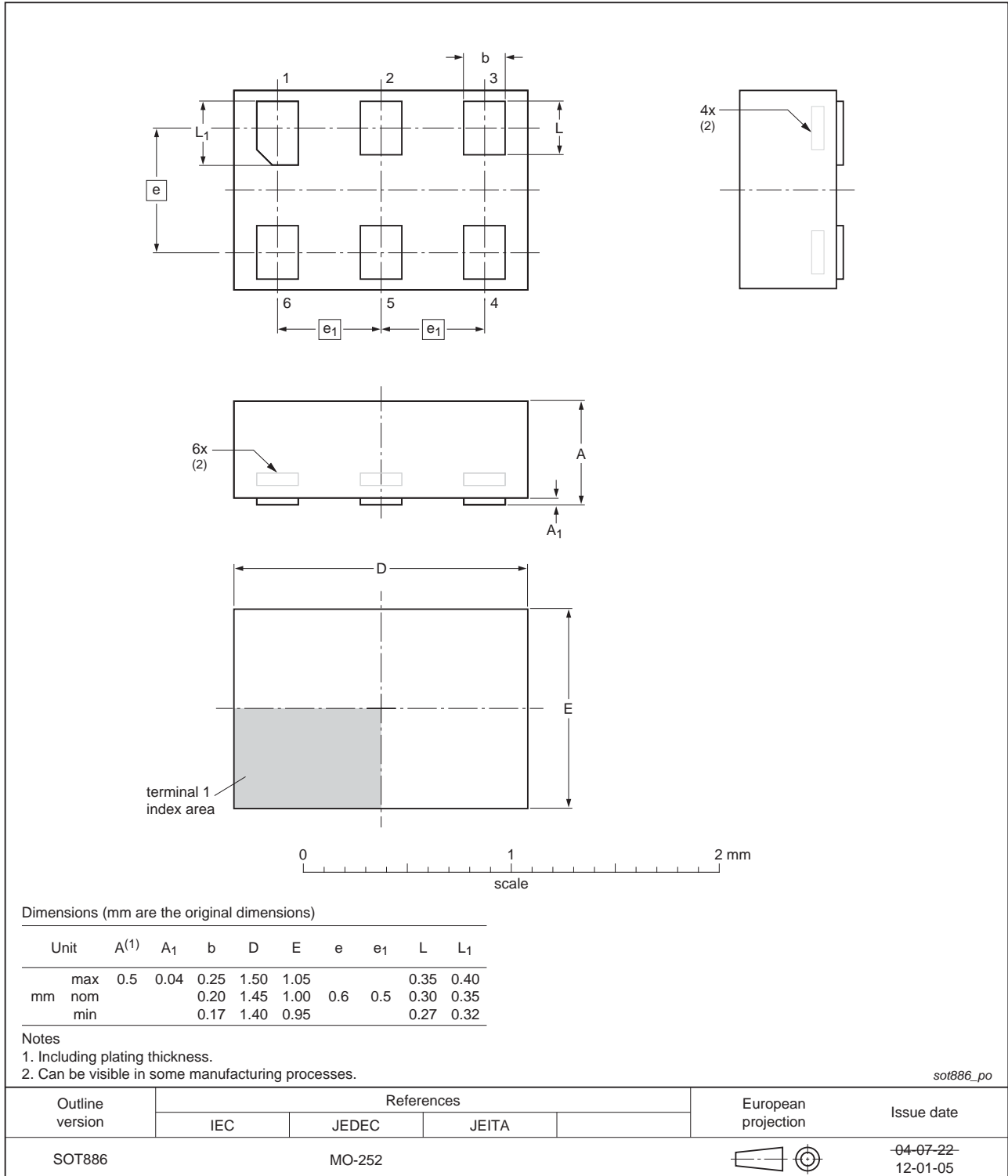


Fig 21. Package outline SOT886 (XSON6)

14. Abbreviations

Table 13. Abbreviations

| Acronym | Description |
|---------|---|
| CDM | Charged-Device Model |
| CMOS | Complementary Metal-Oxide Semiconductor |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |
| PDA | Personal Digital Assistant |

15. Revision history

Table 14. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|-----------------|---|--------------------|---------------|---------------|
| NX3L1T384 v.3.1 | 20161017 | Product data sheet | - | NX3L1T384 v.3 |
| Modifications: | <ul style="list-style-type: none"> Removed NX3L1T384GW | | | |
| NX3L1T384 v.3 | 20111109 | Product data sheet | - | NX3L1T384 v.2 |
| Modifications: | <ul style="list-style-type: none"> Legal pages updated | | | |
| NX3L1T384 v.2 | 20110107 | Product data sheet | - | NX3L1T384 v.1 |
| NX3L1T384 v.1 | 20090929 | Product data sheet | - | - |

16. Legal information

16.1 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. |
| 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".

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