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 (\overline{E}) . When \overline{E} is HIGH, the analog switch is turned off.

Schmitt trigger action at the enable input (E) makes the circuit tolerant to slower input rise and fall times. A low input voltage threshold allows pin \overline{E} to be driven by lower level logic signals without a significant increase in supply current $I_{C\,C}$. 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 $V_{CC} = 1.4 \text{ V}$
 - 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



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3. Applications

- Cell phone
- PDA
- Portable media player

4. Ordering information

Table 1. Ordering information

Type number	Package	^a ckage							
	Temperature range	Name	Description	Version					
NX3L1T384GM	–40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 \times 1.45 \times 0.5 mm	SOT886					

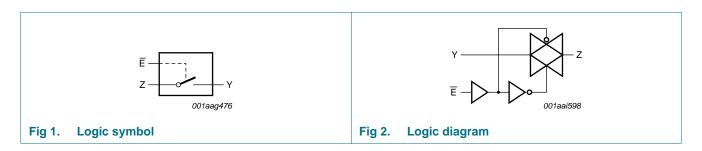
5. Marking

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.

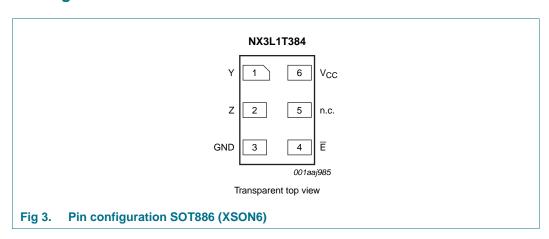
6. Functional diagram



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7. Pinning information

7.1 Pinning



7.2 Pin description

Table 3. Pin description

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

8. Functional description

Table 4. Function table [1]

Input E	Switch
L	ON-state
Н	OFF-state

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

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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
VI	input voltage	enable input E	-0.5	+4.6	V
V _{SW}	switch voltage	[2]	-0.5	$V_{CC} + 0.5$	V
I _{IK}	input clamping current	$V_{I} < -0.5 \text{ V}$	-50	-	mA
I _{SK}	switch clamping current	$V_{I} < -0.5 \text{ V or } V_{I} > V_{CC} + 0.5 \text{ V}$	-	±50	mA
I _{SW}	switch current	$V_{SW} > -0.5 \text{ V or } V_{SW} < V_{CC} + 0.5 \text{ V};$ 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	$T_{amb} = -40 ^{\circ}\text{C} \text{ to } +125 ^{\circ}\text{C}$	-	250	mW

^[1] The minimum input voltage rating may be exceeded if the input current rating is observed.

10. Recommended operating conditions

Table 6. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V _{CC}	supply voltage		1.4	4.3	V
VI	input voltage	enable input E	0	4.3	V
V_{SW}	switch voltage	[1]	0	V _{CC}	V
T _{amb}	ambient temperature		-40	+125	°C
Δt/ΔV	input transition rise and fall rate	$V_{CC} = 1.4 \text{ V to } 4.3 \text{ V}$ [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] 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.

^[2] Applies to control signal levels.

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11. Static characteristics

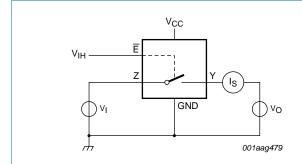
Table 7. Static characteristics

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

Symbol	Parameter	Conditions		25 °C			-40 °C to +125 °C		
			Min	Тур	Max	Min	Max (85 °C)	Max (125 °C)	
V _{IH}	HIGH-level	V _{CC} = 1.4 V to 1.6 V	0.9	-	-	0.9	-	-	V
	input voltage	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	V _{CC} = 1.4 V to 1.6 V	-	-	0.3	-	0.3	0.3	V
	input voltage	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 \overline{E} ; V _I = GND to 4.3 V; V _{CC} = 1.4 V to 4.3 V	-	-	-	-	±0.5	±1	μА
I _{S(OFF)}	OFF-state	Y port; see Figure 4							
	leakage	V _{CC} = 1.4 V to 3.6 V	-	-	±5	-	±50	±500	nA
	current	V _{CC} = 3.6 V to 4.3 V	-	-	±10	-	±50	±500	nA
I _{S(ON)}	ON-state	Z port; see Figure 5							
	leakage	V _{CC} = 1.4 V to 3.6 V	-	-	±5	-	±50	±500	nA
	current	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	$V_{SW} = GND \text{ or } V_{CC}$							
	supply current	V _I = 2.6 V; V _{CC} = 4.3 V	-	2.0	4.0	-	7	7	μΑ
		V _I = 2.6 V; V _{CC} = 3.6 V	-	0.35	0.7	-	1	1	μΑ
		V _I = 1.8 V; V _{CC} = 4.3 V	-	7.0	10.0	-	15	15	μΑ
		V _I = 1.8 V; V _{CC} = 3.6 V	-	2.5	4.0	-	5	5	μΑ
		V _I = 1.8 V; V _{CC} = 2.5 V	-	50	200	-	300	500	nA
Cı	input capacitance		-	1.0	-	-	-	-	pF
C _{S(OFF)}	OFF-state capacitance		-	35	-	-	-	-	pF
C _{S(ON)}	ON-state capacitance		-	110	-	-	-	-	pF

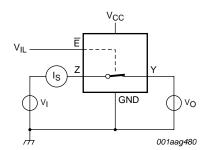
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11.1 Test circuits



 V_{I} = 0.3 V or V_{CC} – 0.3 V; V_{O} = V_{CC} – 0.3 V or 0.3 V.

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



 V_{I} = 0.3 V or V_{CC} – 0.3 V; V_{O} = 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.

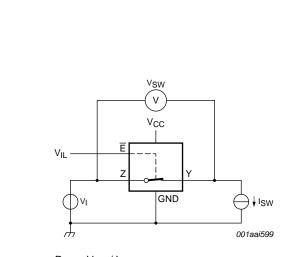
Symbol Parameter		Conditions	$T_{amb} = -40 ^{\circ}\text{C} \text{ to } +85 ^{\circ}\text{C}$			T _{amb} = -40 °0	Unit	
			Min	Typ[1]	Max	Min	Max	
R _{ON(peak)}	ON resistance (peak)	$V_I = GND$ to V_{CC} ; $I_{SW} = 100$ mA; see Figure 6						
		V _{CC} = 1.4 V	-	1.6	3.7	-	4.1	Ω
		V _{CC} = 1.65 V	-	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)	$V_I = GND \text{ to } V_{CC};$ $I_{SW} = 100 \text{ mA}$						
		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.

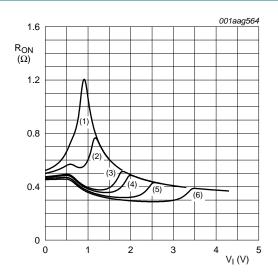
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11.3 ON resistance test circuit and graphs



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

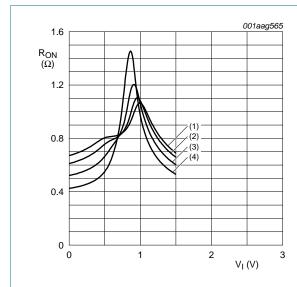
Fig 6. Test circuit for measuring ON resistance



- (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 $T_{amb} = 25 \, ^{\circ}C$.

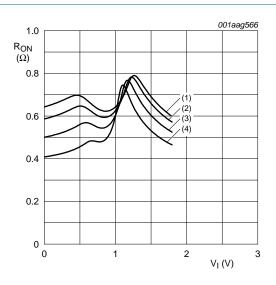
Fig 7. Typical ON resistance as a function of input voltage

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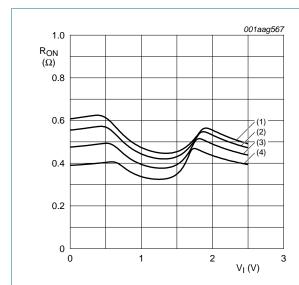
- (1) $T_{amb} = 125 \, ^{\circ}C$.
- (2) $T_{amb} = 85 \, ^{\circ}C$.
- (3) $T_{amb} = 25 \, ^{\circ}C$.
- (4) $T_{amb} = -40 \, ^{\circ}C$.

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



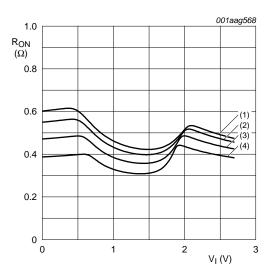
- (1) $T_{amb} = 125 \, ^{\circ}C$.
- (2) $T_{amb} = 85 \, ^{\circ}C$.
- (3) $T_{amb} = 25 \, ^{\circ}C$.
- (4) $T_{amb} = -40 \, ^{\circ}C$.

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



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

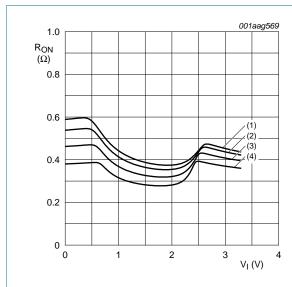
Fig 10. ON resistance as a function of input voltage; $V_{CC} = 2.5 \text{ V}$



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

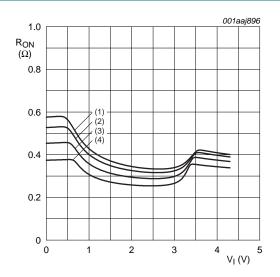
Fig 11. ON resistance as a function of input voltage; $V_{CC} = 2.7 \text{ V}$

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

Fig 12. ON resistance as a function of input voltage; $V_{CC} = 3.3 \text{ V}$



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

Fig 13. ON resistance as a function of input voltage; $V_{CC} = 4.3 \text{ V}$

12. Dynamic characteristics

Table 9. Dynamic characteristics

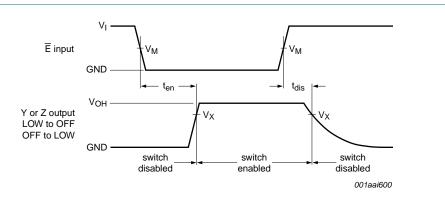
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for load circuit see Figure 15.

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

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

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12.1 Waveform and test circuits



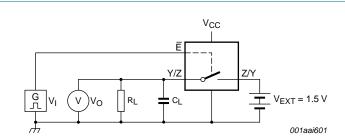
Measurement points are given in Table 10.

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 I		Load		
V _{CC}	V _I	t _r , t _f	CL	R _L	
1.4 V to 4.3 V	V _{CC}	≤ 2.5 ns	35 pF	50 Ω	

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12.2 Additional dynamic characteristics

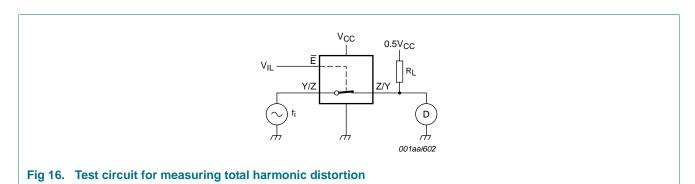
Table 12. Additional dynamic characteristics

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

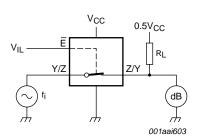
Symbol	Parameter	Conditions		Ta	T _{amb} = 25 °C		Unit
				Min	Тур	Max	
THD	total harmonic	f_i = 20 Hz to 20 kHz; R_L = 32 Ω ; see Figure 16	[1]			<u>'</u>	
	distortion	V _{CC} = 1.4 V; V _I = 1 V (p-p)		-	0.15	-	%
		V _{CC} = 1.65 V; V _I = 1.2 V (p-p)		-	0.10	-	%
		$V_{CC} = 2.3 \text{ V}; V_I = 1.5 \text{ V (p-p)}$		-	0.02	-	%
		$V_{CC} = 2.7 \text{ V}; V_I = 2 \text{ V (p-p)}$		-	0.02	-	%
		$V_{CC} = 4.3 \text{ V}; V_I = 2 \text{ V (p-p)}$		-	0.02	-	%
f _(-3dB)	-3 dB frequency	$R_L = 50 \Omega$; see Figure 17	[1]				
	response	V _{CC} = 1.4 V to 4.3 V		-	60	-	MHz
α_{iso}	isolation (OFF-state)	$f_i = 100 \text{ kHz}$; $R_L = 50 \Omega$; see Figure 18	[1]				
		V _{CC} = 1.4 V to 4.3 V		-	-90	-	dB
V _{ct}	crosstalk voltage	between digital inputs and switch; $f_i = 1 \text{ MHz}$; $C_L = 50 \text{ pF}$; $R_L = 50 \Omega$; 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 Ω ; see Figure 20					
		V _{CC} = 1.5 V		-	3	-	рC
		V _{CC} = 1.8 V		-	3	-	рС
		V _{CC} = 2.5 V		-	3	-	рС
		V _{CC} = 3.3 V		-	3	-	рС
		V _{CC} = 4.3 V		-	6	-	рС

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

12.3 Test circuits

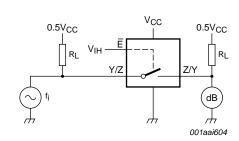


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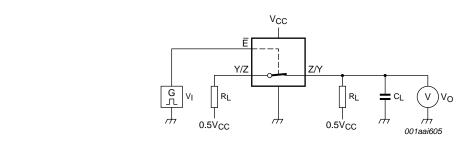
Adjust f_i voltage to obtain 0 dBm level at output. Increase f_i frequency until dB meter reads -3 dB.

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

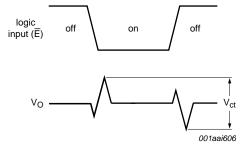


Adjust fi voltage to obtain 0 dBm level at input.

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



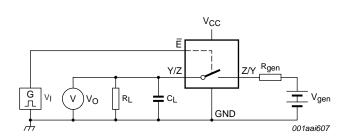
a. Test circuit



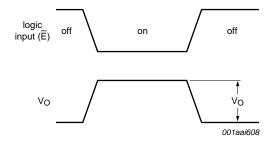
b. Input and output pulse definitions

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

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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

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13. Package outline

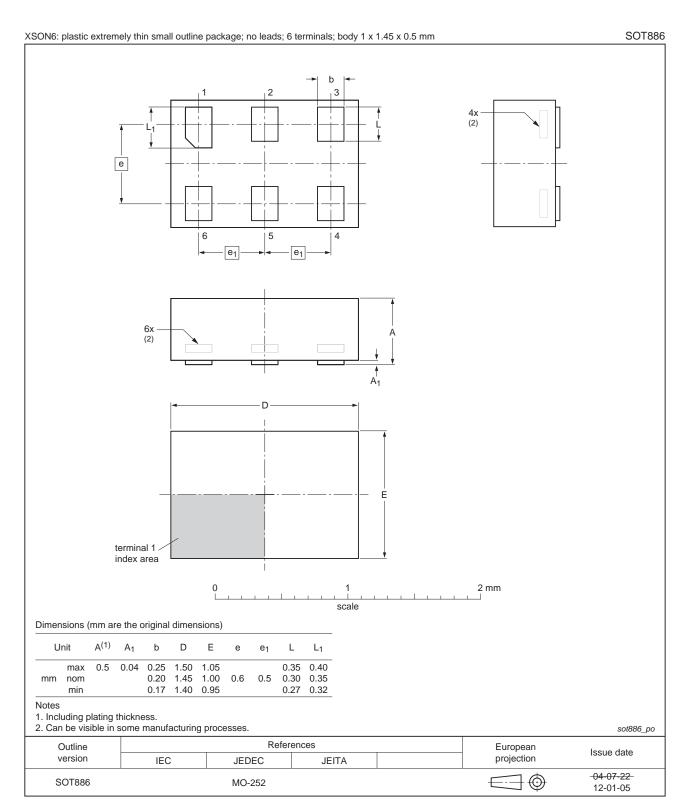


Fig 21. Package outline SOT886 (XSON6)

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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:	Removed	NX3L1T384GW			
NX3L1T384 v.3	20111109	Product data sheet	-	NX3L1T384 v.2	
Modifications:	Legal page	Legal pages updated			
NX3L1T384 v.2	20110107	Product data sheet	-	NX3L1T384 v.1	
NX3L1T384 v.1	20090929	Product data sheet	-	-	

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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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