NTSX2102

Dual supply translating transceiver; open-drain; auto direction sensing

Rev. 2.2 — 21 March 2022 Product data sheet

1 General description

The NTSX2102 is a 2-bit, dual supply translating transceiver with auto direction sensing, that enables bidirectional voltage level translation. It features two 2-bit input-output ports (An and Bn), one output enable input (OE) and two supply pins ($V_{CC(A)}$ and $V_{CC(B)}$). Both supplies can be supplied at any voltage between 1.65 V and 5.5 V. This flexibility makes the device suitable for translating between any of the voltage nodes (1.8 V, 2.5 V, 3.3 V, and 5.0 V). Pins An and OE are referenced to $V_{CC(A)}$ and pins Bn are referenced to $V_{CC(B)}$. A LOW level at pin OE causes the outputs to assume a high-impedance OFF-state. 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.

2 Features and benefits

- Wide supply voltage range:
  - $V_{CC(A)}$: 1.65 V to 5.5 V and $V_{CC(B)}$: 1.65 V to 5.5 V
- Maximum data rates:
  - 50 Mbit/s
- I_{OFF} circuitry provides partial power-down mode operation
- Inputs accept voltages up to 5.5 V
- ESD protection:
  - HBM JS-001 Class 2 exceeds 2000 V
  - CDM JESD22-C101E exceeds 2000 V
- Latch-up performance exceeds 100 mA per JESD 78B Class II
- Multiple package options
- Specified from –40 °C to +85 °C

3 Applications

- I^2C/SMBus
- UART
- GPIO

4 Ordering information

Table 1. Ordering information

Type number	Topside marking	Package		
		Name	Description	Version
NTSX2102GU8	sX	XQFN8	plastic, extremely thin quad flat package; no leads; 8 terminals; body 1.4 × 1.2 × 0.5 mm	SOT1309-1
NTSX2102GD	sX2	XSON8	plastic extremely thin small outline package; no leads; 8 terminals; body 3 × 2 × 0.5 mm	SOT996-2
NTSX2102TL	tX2	XSON8	plastic extremely thin small outline package; no leads; 8 terminals; body 3 × 2 × 0.5 mm	SOT1052-2

4.1 Ordering options

Table 2. Ordering options

Type number	Orderable part number	Package	Packing method[1]	Minimum order quantity	Temperature
NTSX2102GU8	NTSX2102GU8H	XQFN8	Reel 7" Q3 NDP	4000	–40 °C to +85 °C
NTSX2102GD[2]	NTSX2102GDH	XSON8	Reel 7" Q3 NDP	3000	–40 °C to +85 °C
NTSX2102TL	NTSX2102TLH	XSON8	Reel 7" Q3 NDP	3000	–40 °C to +85 °C

[1] Standard packing quantities and other packaging data are available at www.nxp.com/packages/.

[2] Discontinuation Notice 202111012DN - drop in replacement is NTSX0102TLH.

The TL package has a center pad vs no center pad for the GD package. The TL package pad is not electrically connected to the silicon and is not required to connect to the PCB so it can drop onto the GD package PCB layout. If the existing GD package has a trace underneath the risk is low since the TL package center pad is not connected to the silicon. If there are multiple traces there could be EMI and cross talk. In both cases the customer needs to evaluate risk.

5 Functional diagram

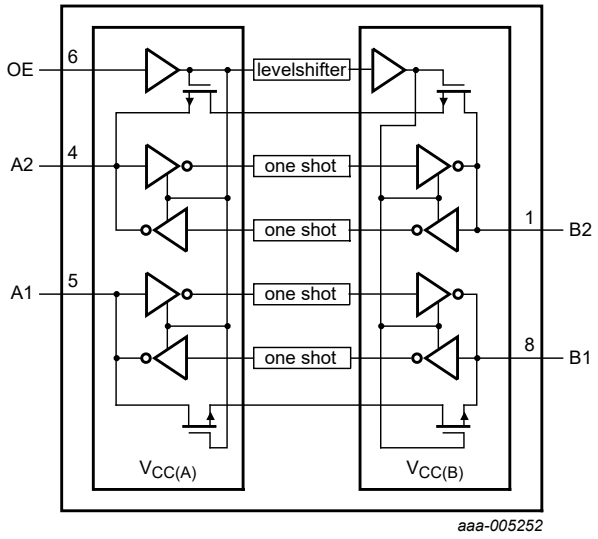
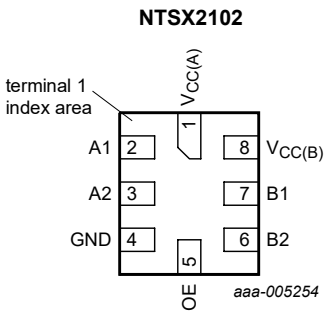


Figure 1. Logic symbol

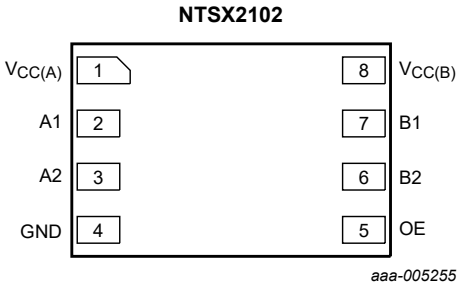
6 Pinning information

6.1 Pinning



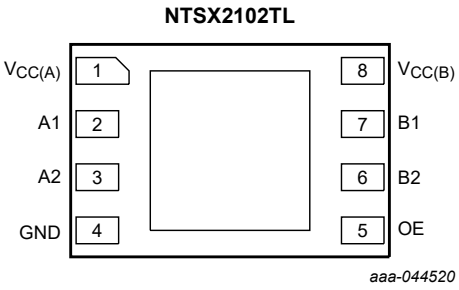
Transparent top view

Figure 2. Pin configuration SOT1309-1 (XQFN8)



Transparent top view

Figure 3. Pin configuration SOT996-2 (XSON8)



Transparent top view

Figure 4. Pin configuration SOT1052-2 (XSON8)

6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
B2, B1	6, 7	data input or output (referenced to $V_{CC(B)}$)
GND	4	ground (0 V)
$V_{CC(A)}$	1	supply voltage A
A2, A1	3, 2	data input or output (referenced to $V_{CC(A)}$)
OE	5	output enable input (active HIGH; referenced to $V_{CC(A)}$)
$V_{CC(B)}$	8	supply voltage B

7 Functional description

Table 4. Function table[1]

Supply voltage		Input	Input/output	
$V_{CC(A)}$	$V_{CC(B)}$	OE	An	Bn
1.65 V to 5.5 V	1.65 V to 5.5 V	L	Z	Z
1.65 V to 5.5 V	1.65 V to 5.5 V	H	input or output	output or input
GND[2]	GND[2]	X	Z	Z

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state.
[2] When either $V_{CC(A)}$ or $V_{CC(B)}$ is at GND level, the device goes into power-down mode.

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
$V_{CC(A)}$	supply voltage A		–0.5	+6.5	V
$V_{CC(B)}$	supply voltage B		–0.5	+6.5	V
V_I	input voltage	A port and OE input [1] [2]	–0.5	+6.5	V
		B port [1] [2]	–0.5	+6.5	V
V_O	output voltage	Active mode [1] [2]			
		A or B port	–0.5	V_{CCO} + 0.5	V
		Power-down or 3-state mode [1]			
		A or B port	–0.5	+6.5	V
I_{IK}	input clamping current	V_I < 0 V	–50	—	mA
I_{OK}	output clamping current	V_O < 0 V	–50	—	mA
I_O	output current	V_O = 0 V to V_{CCO} [2]	—	±50	mA
I_{CC}	supply current	$I_{CC(A)}$ or $I_{CC(B)}$	—	100	mA
I_{GND}	ground current		–100	—	mA
T_{stg}	storage temperature		–65	+150	°C
P_{tot}	total power dissipation	T_{amb} = –40 °C to +85 °C	—	250	mW

[1] If the input and output current ratings are observed, the minimum input and minimum output voltage ratings may be exceeded.
[2] V_{CCO} is the supply voltage associated with the output.

9 Recommended operating conditions

Table 6. Recommended operating conditions[1]

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC(A)}$	supply voltage A		1.65	5.5	V
$V_{CC(B)}$	supply voltage B		1.65	5.5	V
T_{amb}	ambient temperature		–40	+85	°C
Δt/ΔV	input transition rise and fall rate	A, B or OE port			
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	—	10	ns/V

[1] Hold the A and B sides of an unused I/O pair in the same state, both at V_{CCI} or both at GND.

10 Static characteristics

Table 7. Typical static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); T_{amb} = 25 °C.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_I	input capacitance	OE input; $V_{CC(A)}$ = $V_{CC(B)}$ = 0 V	—	2.2	—	pF
$C_{I/O}$	input/output capacitance	A or B port; $V_{CC(A)}$ = 5.0 V; $V_{CC(B)}$ = 5.0 V	—	10	—	pF

Table 8. Static characteristics

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

Symbol	Parameter	Conditions	-40 °C to +85 °C		Unit
			Min	Max	
V_{IH}	HIGH-level input voltage	A or B port			
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V [1]	V_{CCI} – 0.4	—	V
		OE input			
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	0.65$V_{CC(A)}$	—	V
V_{IL}	LOW-level input voltage	A or B port			
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	—	0.4	V
		OE input			
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	—	0.35$V_{CC(A)}$	V
V_{OL}	LOW-level output voltage	A or B port; I_O = 6 mA [2]			
		V_I ≤ 0.15 V; $V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	—	0.4	V
I_I	input leakage current	OE input; V_I = 0 V to $V_{CC(A)}$; $V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	—	±1	µA
I_{OZ}	OFF-state output current	A or B port; V_O = 0 V or V_{CCO}; $V_{CC(A)}$ = 0 V to 5.5 V; $V_{CC(B)}$ = 0 V to 5.5 V [2]	—	±2	µA
I_{OFF}	power-off leakage current	A port; V_I or V_O = 0 V to 5.5 V; $V_{CC(A)}$ = 0 V; $V_{CC(B)}$ = 0 V to 5.5 V	—	±2	µA
		B port; V_I or V_O = 0 V to 5.5 V; $V_{CC(B)}$ = 0 V; $V_{CC(A)}$ = 0 V to 5.5 V	—	±2	µA
I_{CC}	supply current	V_I = 0 V or V_{CCI}; I_O = 0 A [1]			
		$I_{CC(A)}$			
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V; OE = LOW or HIGH	—	5	µA
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 0 V	—	2	µA
		$V_{CC(A)}$ = 0 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	—	–2	µA
		$I_{CC(B)}$			

Table 8. Static characteristics...*continued*

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

Symbol	Parameter	Conditions	-40 °C to +85 °C		Unit
			Min	Max	
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 1.65 V to 5.5 V; OE = LOW	—	5	µA
		$V_{CC(A)}$ = 1.65 V to 5.5 V; $V_{CC(B)}$ = 0 V	—	–2	µA
		$V_{CC(A)}$ = 0 V; $V_{CC(B)}$ = 1.65 V to 5.5 V	—	2	µA

[1] V_{CCI} is the supply voltage associated with the input.
[2] V_{CCO} is the supply voltage associated with the output.

11 Dynamic characteristics

Table 9. Typical dynamic characteristics for temperature 25 °C

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 7; for waveforms see Figure 5 and Figure 6.

Symbol	Parameter	Conditions	V_{CCO}[1]				Unit
			1.8 V	2.5 V	3.3 V	5.0 V	
t_{TLH}	LOW to HIGH output transition time	A or B port	7	5	4	3	ns
t_{THL}	HIGH to LOW output transition time	A or B port	4	6	8	11	ns
C_{PD}	power dissipation capacitance	OE = $V_{CC(A)}$; $V_{CC(A)}$ = $V_{CC(B)}$; f_I = 400 kHz; V_I = V_{CCI}[2] [3]	—	—	—	13.5	pF

[1] V_{CCO} is the supply voltage associated with the output.
[2] V_{CCI} is the supply voltage associated with the input.
[3] C_{PD} is used to determine the dynamic power dissipation (P_D in µW).
$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:
f_i = input frequency in MHz;
f_o = output frequency in MHz;
C_L = 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.

Table 10. Dynamic characteristics for temperature range -40 °C to +85 °C[1]

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 7; for wave forms see Figure 5 and Figure 6.

Symbol	Parameter	Conditions	$V_{CC(B)}$								Unit
			1.8 V ± 0.15 V		2.5 V ± 0.2 V		3.3 V ± 0.3 V		5.0 V ± 0.5 V		
			Typ	Max	Typ	Max	Typ	Max	Typ	Max	
$V_{CC(A)}$ = 1.8 V ± 0.15 V											
t_{PHL}	HIGH to LOW propagation delay	A to B	3	7	3	6	3	5	5	7	ns
t_{PLH}	LOW to HIGH propagation delay	A to B	5	12	5	8	4	8	4	7	ns
t_{PHL}	HIGH to LOW propagation delay	B to A	3	7	3	6	3	5	5	7	ns
t_{PLH}	LOW to HIGH propagation delay	B to A	5	12	1	3	1	2	1	2	ns
t_{PZL}	OFF-state to LOW propagation delay	OE to A	9	16	9	18	10	14	10	15	ns
		OE to B	9	16	6	12	6	12	6	14	ns
t_{PLZ}	LOW to OFF-state propagation delay	OE to A	100	120	100	120	100	120	100	120	ns
		OE to B	100	120	100	120	100	120	100	120	ns
$t_{sk(o)}$	output skew time	between channels [2]	—	1	—	1	—	1	—	1	ns
f_{data}	data rate		—	18	—	18	—	18	—	18	Mbit/s

Table 10. Dynamic characteristics for temperature range -40 °C to +85 °C[1]*...continued*

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 7; for wave forms see Figure 5 and Figure 6.

Symbol	Parameter	Conditions	$V_{CC(B)}$								Unit
			1.8 V ± 0.15 V		2.5 V ± 0.2 V		3.3 V ± 0.3 V		5.0 V ± 0.5 V		
			Typ	Max	Typ	Max	Typ	Max	Typ	Max	
$V_{CC(A)}$ = 2.5 V ± 0.2 V											
t_{PHL}	HIGH to LOW propagation delay	A to B	3	6	2	5	2	5	2	5	ns
t_{PLH}	LOW to HIGH propagation delay	A to B	1	3	2	4	2.5	7	2.5	5	ns
t_{PHL}	HIGH to LOW propagation delay	B to A	3	6	2	5	2	5	2	5	ns
t_{PLH}	LOW to HIGH propagation delay	B to A	5	8	2	4	1.5	3	1	3	ns
t_{PZL}	OFF-state to LOW propagation delay	OE to A	6	12	5	10	8	10	5	8	ns
		OE to B	9	18	5	10	4.5	9	4	8	ns
t_{PLZ}	LOW to OFF-state propagation delay	OE to A	100	120	100	120	100	120	100	120	ns
		OE to B	100	120	100	120	100	120	100	120	ns
$t_{sk(o)}$	output skew time	between channels [2]	—	1	—	1	—	1	—	1	ns
f_{data}	data rate		—	18	—	32	—	32	—	32	Mbit/s
$V_{CC(A)}$ = 3.3 V ± 0.3 V											
t_{PHL}	HIGH to LOW propagation delay	A to B	3	5	2	5	2	4	2	4	ns
t_{PLH}	LOW to HIGH propagation delay	A to B	1	2	1.5	3	1.5	3	2	4	ns
t_{PHL}	HIGH to LOW propagation delay	B to A	3	5	2	5	2	4	2	4	ns
t_{PLH}	LOW to HIGH propagation delay	B to A	4	8	2.5	7	1.5	3	1	3	ns
t_{PZL}	OFF-state to LOW propagation delay	OE to A	6	12	4.5	9	6	9	4	7	ns
		OE to B	10	14	5	10	6	9	4	8	ns
t_{PLZ}	LOW to OFF-state propagation delay	OE to A	100	120	100	120	100	120	100	120	ns
		OE to B	100	120	100	120	100	120	100	120	ns
$t_{sk(o)}$	output skew time	between channels [2]	—	1	—	1	—	1	—	1	ns
f_{data}	data rate		—	18	—	32	—	40	—	40	Mbit/s
$V_{CC(A)}$ = 5.0 V ± 0.5 V											
t_{PHL}	HIGH to LOW propagation delay	A to B	5	7	2	5	2	4	2	4	ns
t_{PLH}	LOW to HIGH propagation delay	A to B	1	2	1	3	1	3	1	3	ns

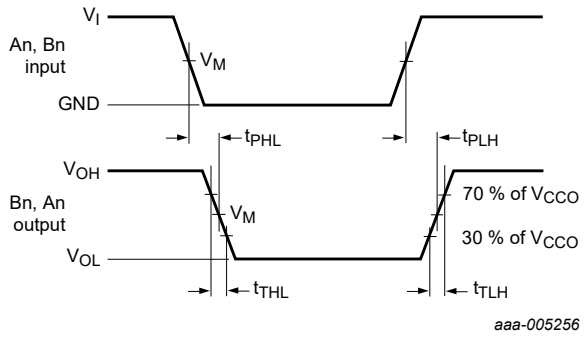
Table 10. Dynamic characteristics for temperature range -40 °C to +85 °C[1] *...continued*

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 7; for wave forms see Figure 5 and Figure 6.

Symbol	Parameter	Conditions	$V_{CC(B)}$								Unit
			1.8 V ± 0.15 V		2.5 V ± 0.2 V		3.3 V ± 0.3 V		5.0 V ± 0.5 V		
			Typ	Max	Typ	Max	Typ	Max	Typ	Max	
t_{PHL}	HIGH to LOW propagation delay	B to A	5	7	2	5	2	4	2	4	ns
t_{PLH}	LOW to HIGH propagation delay	B to A	4	7	2.5	5	2	4	1	3	ns
t_{PZL}	OFF-state to LOW propagation delay	OE to A	6	14	4	8	4	8	3	5	ns
		OE to B	10	15	5	8	4	7	4	5	ns
t_{PLZ}	LOW to OFF-state propagation delay	OE to A	100	120	100	120	100	120	100	120	ns
		OE to B	100	120	100	120	100	120	100	120	ns
$t_{sk(o)}$	output skew time	between channels [2]	—	1	—	1	—	1	—	1	ns
f_{data}	data rate		—	18	—	32	—	40	—	52	Mbit/s

[1] All typical values are measured at nominal V_{CC} and T_{amb} = 25 °C.
[2] Skew between any two outputs of the same package switching in the same direction.

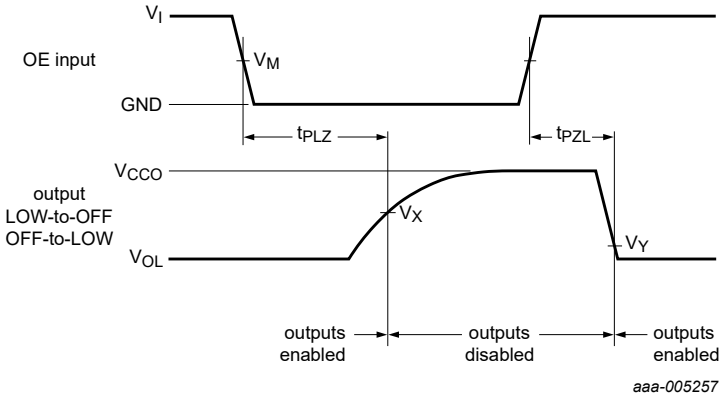
12 Waveforms



Measurement points are given in Table 11.

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

Figure 5. The data input (An, Bn) to data output (Bn, An) propagation delay times



Measurement points are given in Table 11.

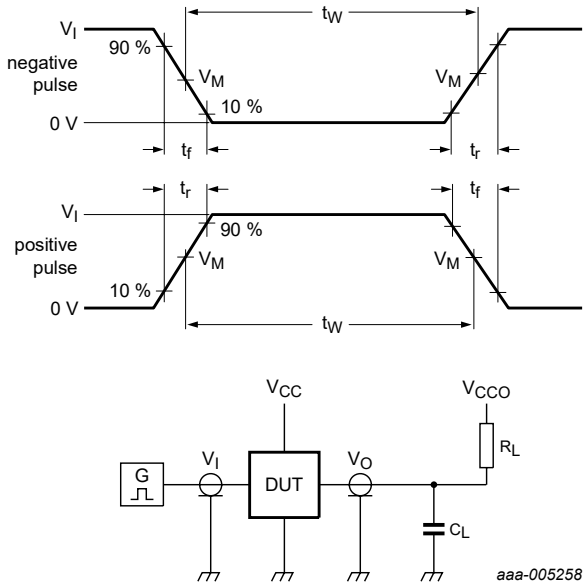
V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Figure 6. Enable and disable times

Table 11. Measurement points[1][2]

Supply voltage	Input	Output		
V_{CCO}	V_M	V_M	V_X	V_Y
1.65 V to 5.5 V	$0.5V_{CCI}$	$0.5V_{CCO}$	$0.5V_{CCO}$	$0.1V_{CCO}$

[1] V_{CCI} is the supply voltage associated with the input.
[2] V_{CCO} is the supply voltage associated with the output.



Test data is given in Table 12.

All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz; Z_O = 50 Ω; dV/dt ≥ 1.0 V/ns.

R_L = Load resistance.

C_L = Load capacitance including jig and probe capacitance.

V_{CC0} = Supply voltage associated with the output.

Figure 7. Test circuit for measuring switching times

Table 12. Test data

Supply voltage		Input		Load	
$V_{CC(A)}$	$V_{CC(B)}$	V_I[1]	t_r/t_f	C_L	R_L
1.65 V to 1.95 V	1.65 V to 1.95 V	V_{CCI}	≤ 2.0 ns	50 pF	2.2 kΩ
2.3 V to 2.7 V	2.3 V to 2.7 V	V_{CCI}	≤ 2.0 ns	50 pF	2.2 kΩ
3.0 V to 3.6 V	3.0 V to 3.6 V	V_{CCI}	≤ 2.5 ns	50 pF	2.2 kΩ
4.5 V to 5.5 V	4.5 V to 5.5 V	V_{CCI}	≤ 2.5 ns	50 pF	2.2 kΩ

[1] V_{CCI} is the supply voltage associated with the input.

13 Application information

13.1 Applications

The NTSX2102 can be used in point-to-point applications to interface between devices or systems operating at different supply voltages. The device is targeted at I^2C or 1-wire buses which use open-drain drivers.

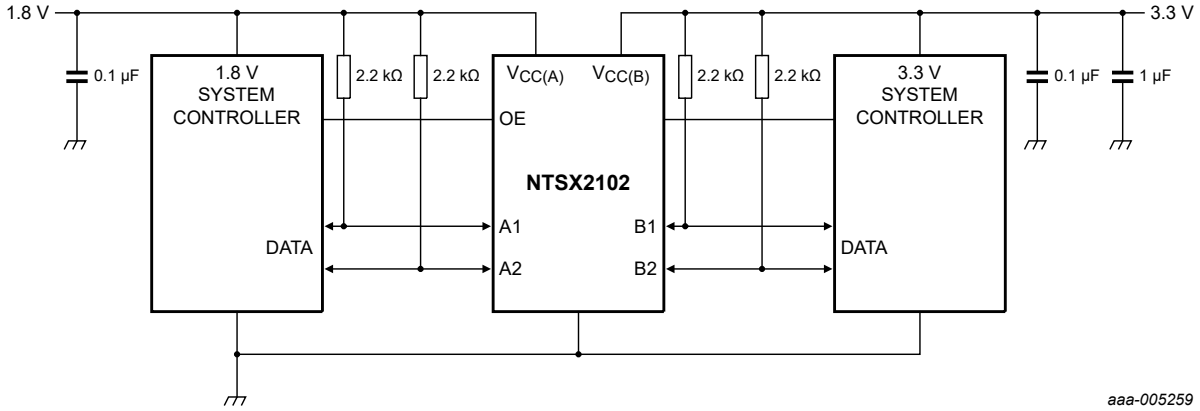


Figure 8. Typical voltage level-translation circuit

13.2 Architecture

The architecture of the NTSX2102 is shown in Figure 9. The device does not require an extra input signal to control the direction of data flow from A to B or B to A. The NTSX2102 is a "switch" type voltage translator, it employs two key circuits to enable voltage translation:

1. Two pass-gate transistors (N-channel) that tie the ports together.
2. An output edge-rate accelerator that detects and accelerates rising and falling edges on the I/O pins (see Figure 10).

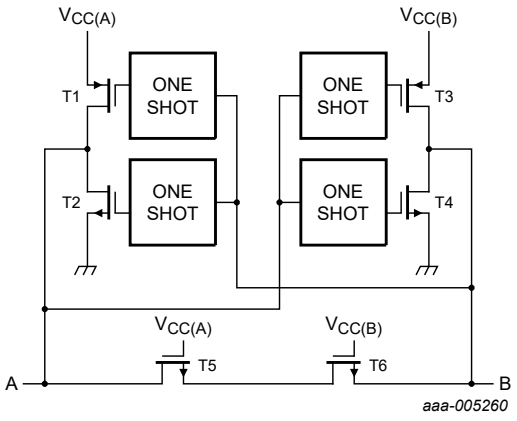
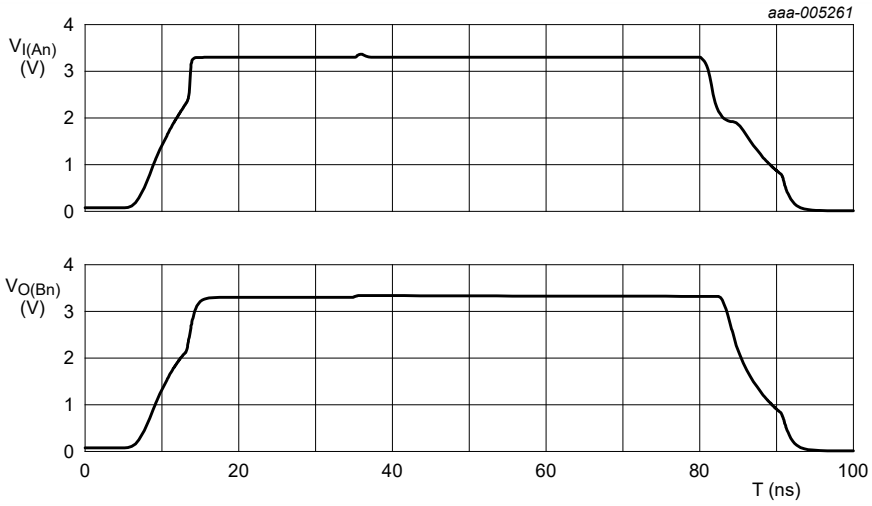


Figure 9. Architecture of NTSX2102 I/O cell (one channel)

During an input transition, a one-shot accelerates the output transition by switching on the PMOS transistors (T1, T3) for a LOW-to-HIGH transition. Alternatively, it switches on the NMOS transistors (T2, T4) for a HIGH-to-LOW transition. Once activated, the one-

shot is de-activated after approximately 25 ns (see Figure 11). During the acceleration time, the driver output resistance is between approximately 10 Ω and 35 Ω. To avoid signal contention, the application must not exceed the maximum data rate or wait for the one-shot circuit to turn-off, before applying a signal in the opposite direction.



$V_{CC(A)}$ = 3.3 V; $V_{CC(B)}$ = 3.3 V.

Figure 10. Input and output waveforms showing edge-rate acceleration

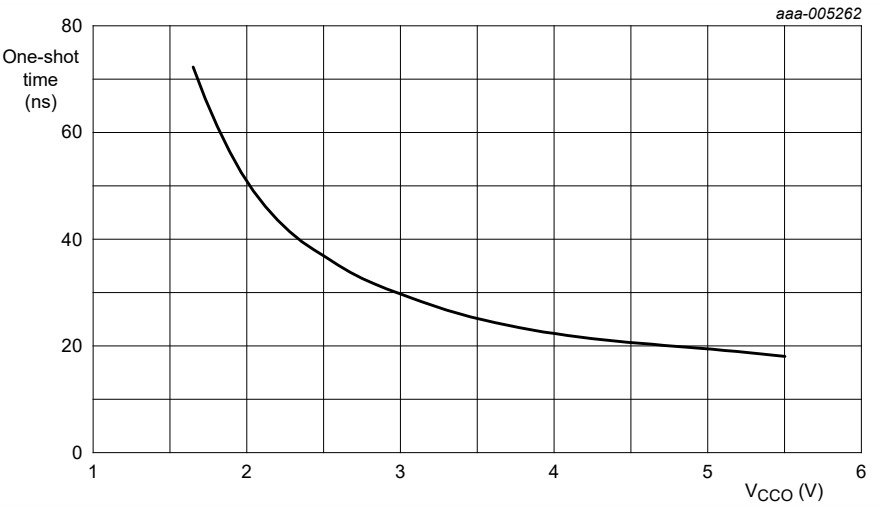


Figure 11. One-shot pulse time versus V_{CCO}

13.3 Input driver requirements

As the NTSX2102 is a switch type translator, properties of the input driver directly affect the output signal. The external open-drain driver applied to an I/O, determines the static current sinking capability of the system. The maximum data rate, output transition times (t_{THL}, t_{TLH}) and propagation delays (t_{PHL}, t_{PLH}) are dependent upon the output impedance and edge-rate of the external driver.

13.4 Output load considerations

The maximum lumped capacitive load that can be driven is dependent upon the one-shot pulse duration and has been tuned to 600 pF. In cases with higher capacitive loading, there is a risk that the output does not reach the positive rail within the one-shot pulse duration. To avoid excessive capacitive loading and to ensure correct triggering of the one-shot, use short trace lengths and low capacitance connectors on NTSX2102 PCB layouts. The length of the PCB trace should be such that the round-trip delay of any reflection is within the one-shot pulse duration. Such a length ensures low impedance termination and avoids output signal oscillations and one-shot retriggering.

13.5 Output enable (OE)

An output enable input (OE) is used to disable the device. Setting OE = LOW causes all I/Os to assume the high-impedance OFF-state.

13.6 Power-up

When either of the supplies $V_{CC(n)}$ is at 0 V, outputs are in the high-impedance OFF-state. One of the advantages of NTSX translators is that either $V_{CC(A)}$ or $V_{CC(B)}$ may be powered up first. To reduce dissipation during power-up, ensure that output enable (OE) is defined. Connect it via a pulldown resistor to GND or, if the application allows, hardwired to $V_{CC(A)}$. If the OE pin is hardwired to $V_{CC(A)}$, either supply can be powered up or down first. If a pulldown is used, the following sequences are recommended.

For power-up:

1. Apply power to either supply pin
2. Apply power to other supply pin
3. Enable the device by driving OE HIGH

For power down:

1. Disable the device by driving OE LOW
2. Remove power from either supply pin
3. Remove power from other supply pin

13.7 Pull-up resistors on I/O lines

Each A port I/O requires a pull-up resistor to $V_{CC(A)}$, and each B port I/O requires a pull-up resistor to $V_{CC(B)}$. Choose the magnitude of the pull-up resistors to ensure that the output voltage levels meet the application requirement.

13.8 GD package vs TL package

Due to differences in package construction the TL package has a center pad vs no center pad for the GD package. The following section provides guidance in replacement vs new applications.

- **No trace under GD package**
  1. Replacement of GD package: The pad is not electrically connected to the silicon (no wire bond and epoxy is not conductive) and can be left floating. It is not

required to be connected to the PCB. Simply place the TL package on the same PCB traces as the existing GD package.

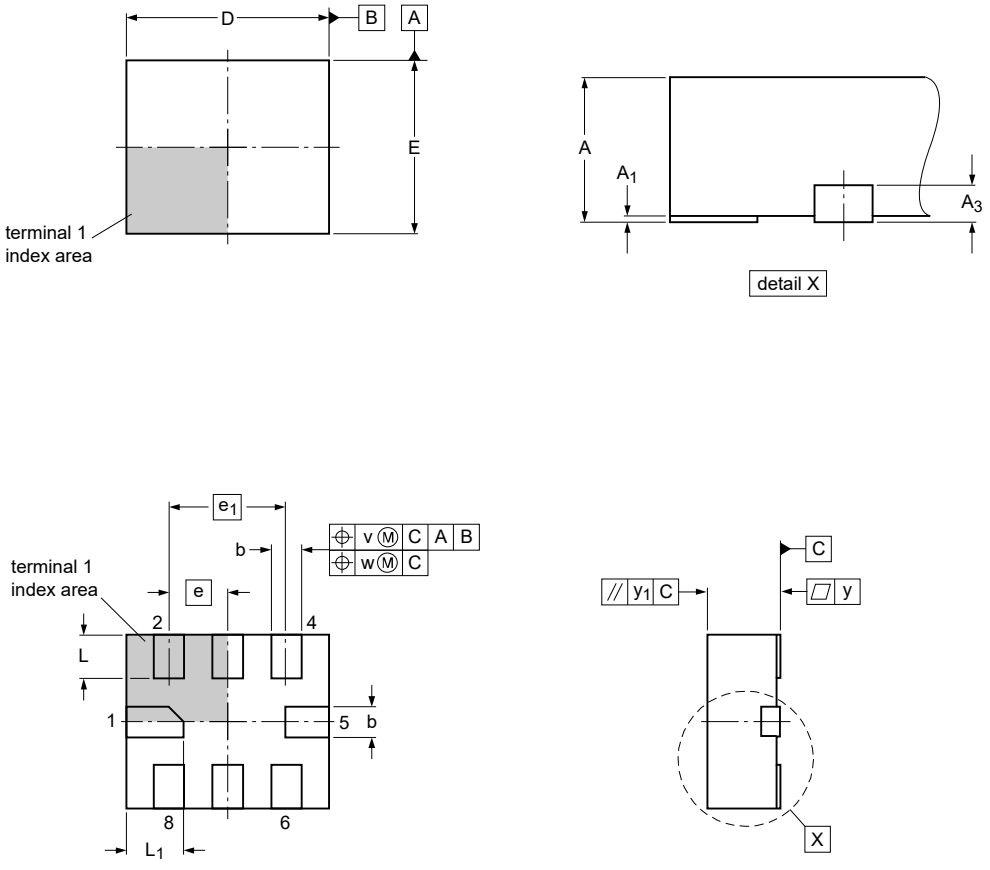
2. New use of the TL package: Place PCB trace for soldering of the center pad based on PCB layout recommendations for better mechanical connection and thermal conductivity. The PCB center pad can be connect to GND or left floating.

- **Trace under the GD package**
  1. Replacement of GD package: It is not best practice to have center pad over the trace but since the TL package center pad is not connected to the silicon the risk is low. If there are multiple traces there could be EMI and cross talk. In both cases the customer needs to evaluate risk.
  2. New use of the TL package: Do not route traces under the package

14 Package outline

XQFN8: plastic, extremely thin quad flat package; no leads;
8 terminals; body 1.4 x 1.2 x 0.5 mm

SOT1309-1



Dimensions

Unit		A	A_1	A_3	b	D	E	e	e_1	L	L_1	v	w	y	y_1
mm	max	0.50	0.025		0.25	1.45	1.25			0.35	0.45				
	nom			0.127	0.20	1.40	1.20	0.4	0.8	0.30	0.40	0.10	0.05	0.05	0.05
	min		0.00		0.15	1.35	1.15			0.25	0.35				

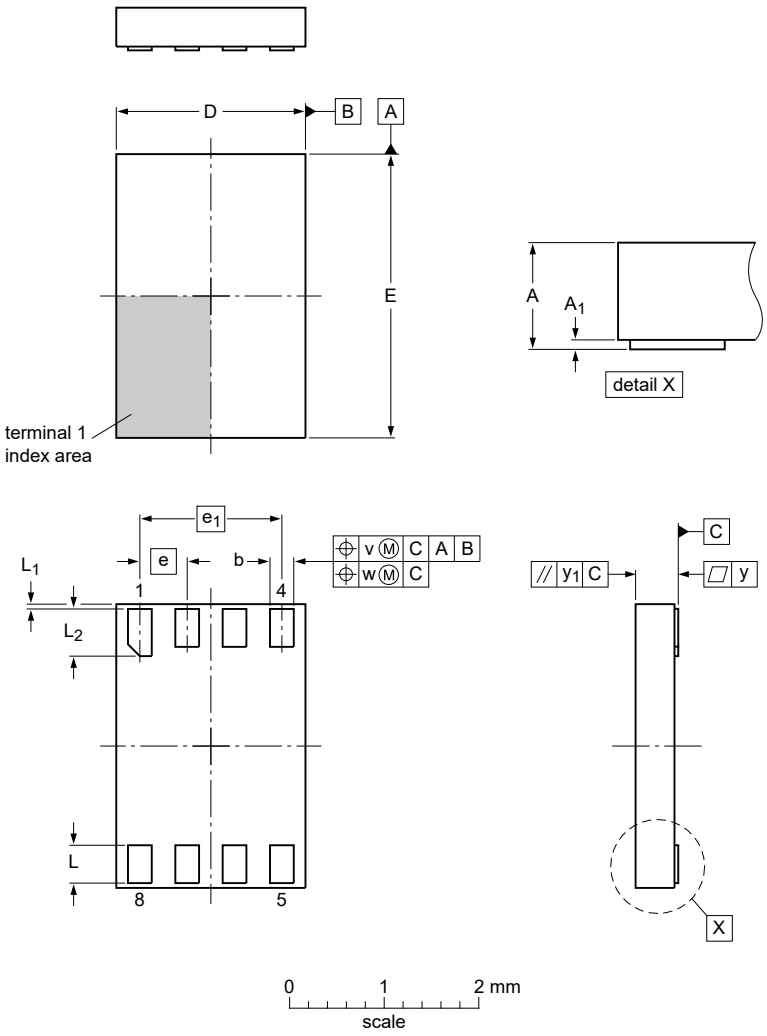
Note
1. Plastic or metal protrusions of 0.075 mm maximum per side are not included

sot1309-1_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1309-1		MO-255				~~11-08-18~~ 11-08-23

Figure 12. Package outline SOT1309-1 (XQFN8)

XSON8: plastic extremely thin small outline package; no leads; 8 terminals; body 3 x 2 x 0.5 mm **SOT996-2**



Dimensions (mm are the original dimensions)

Unit(1)		A	A_1	b	D	E	e	e_1	L	L_1	L_2	v	w	y	y_1
mm	max		0.05	0.35	2.1	3.1			0.5	0.15	0.6				
	nom	0.5					0.5	1.5				0.1	0.05	0.05	0.1
	min		0.00	0.15	1.9	2.9			0.3	0.05	0.4				

sot996-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT996-2						~~07-12-21~~ 12-11-20

Figure 13. Package outline SOT996-2 (XSON8)

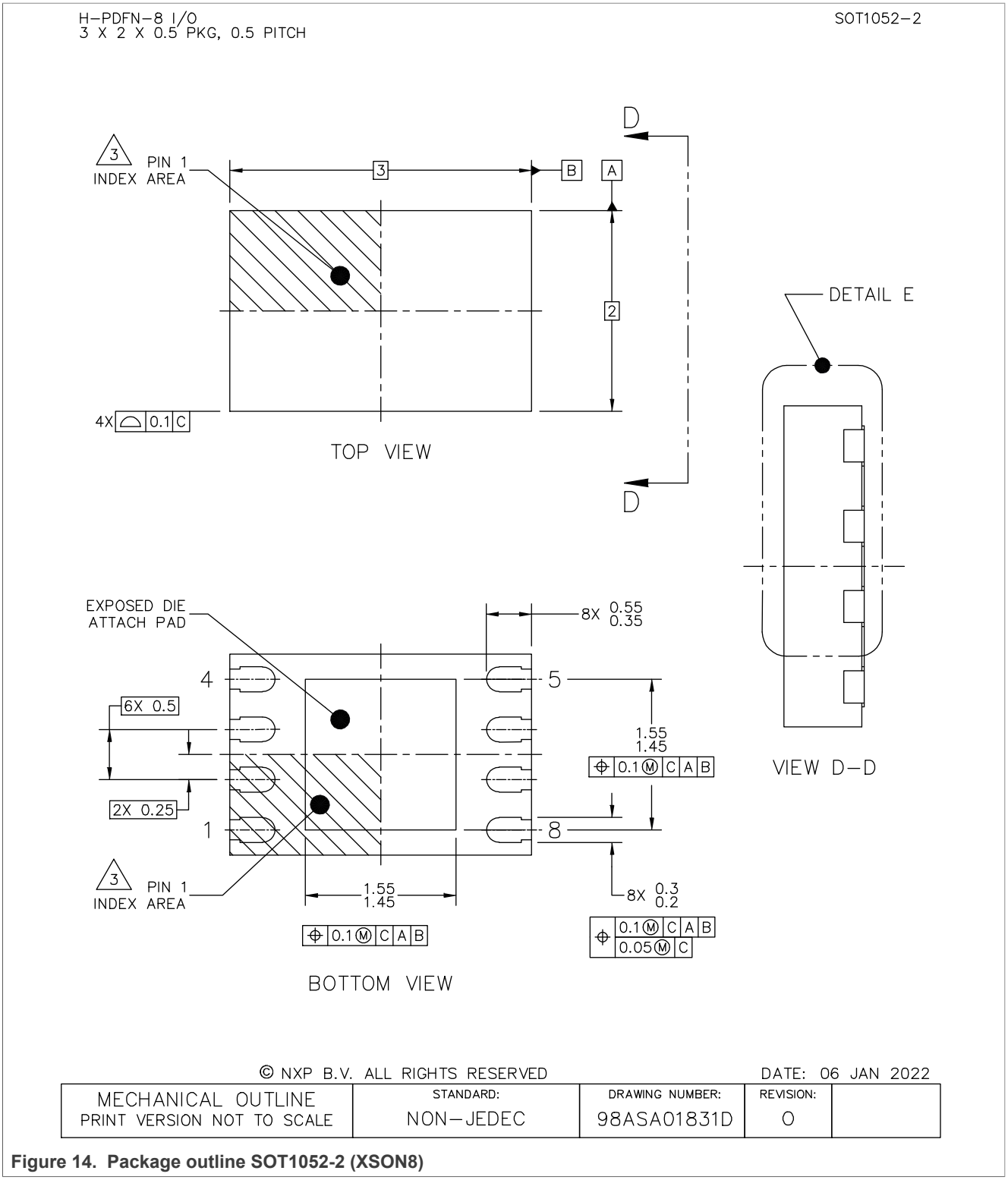


Figure 14. Package outline SOT1052-2 (XSON8)

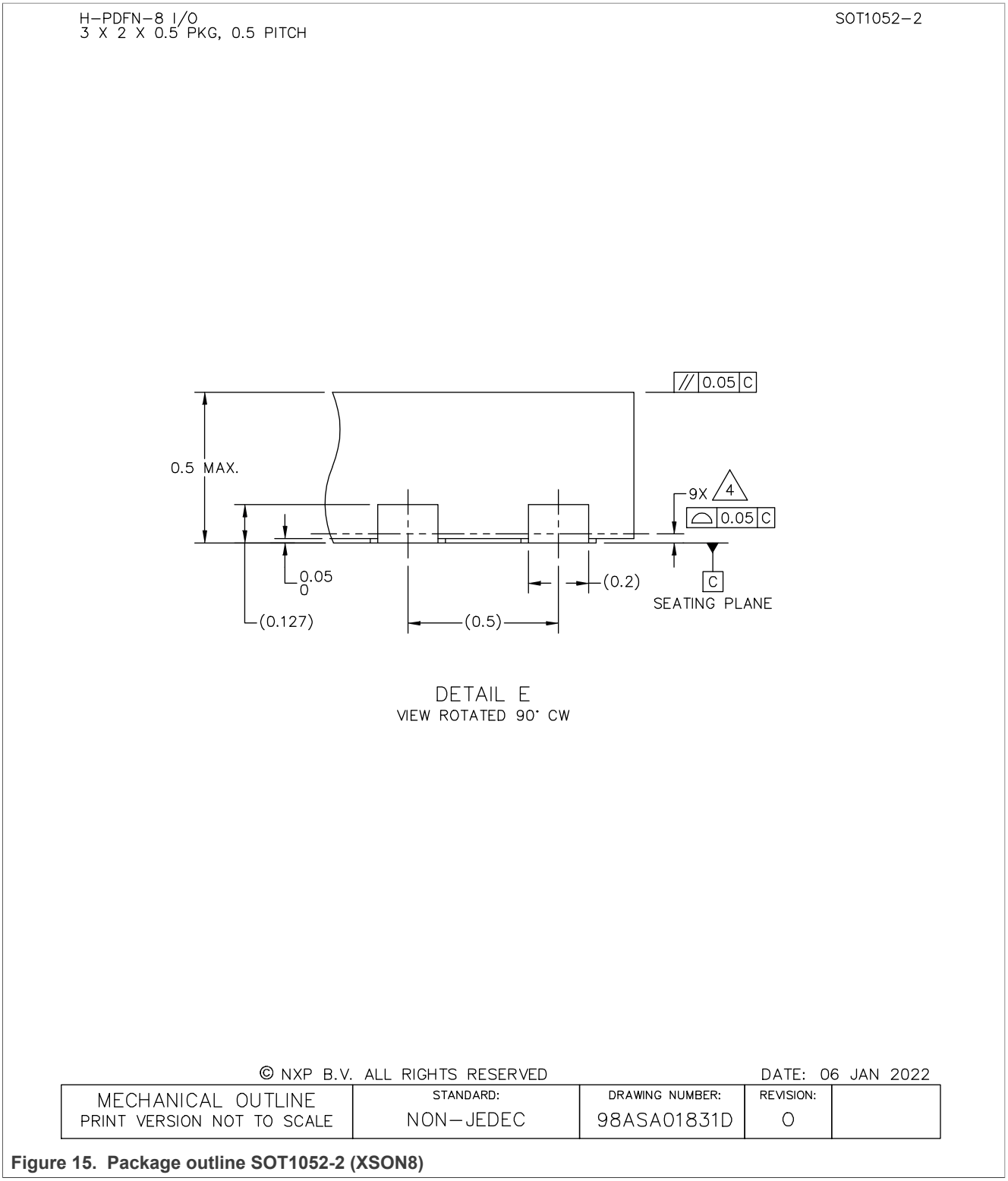


Figure 15. Package outline SOT1052-2 (XSON8)

15 Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

15.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

15.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

15.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

15.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see Figure 16) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with Table 13 and Table 14

Table 13. SnPb eutectic process (from J-STD-020D)

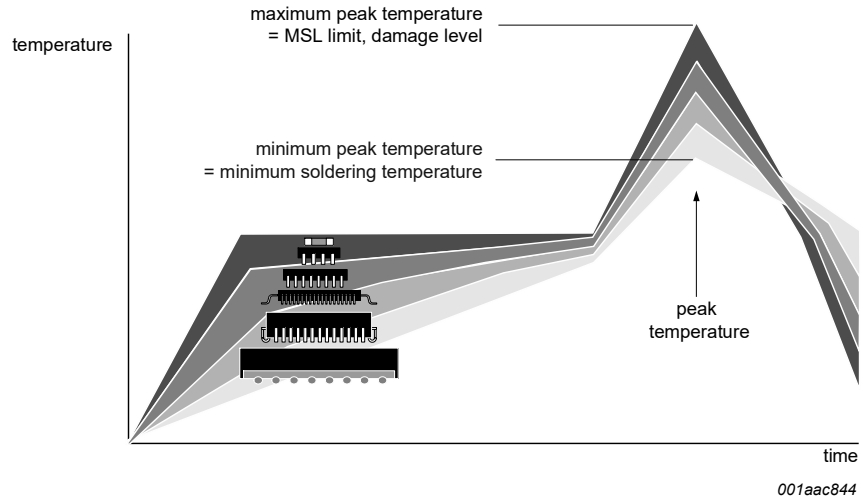
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm³)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

Table 14. Lead-free process (from J-STD-020D)

Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm³)		
	< 350	350 to 2000	> 2000
< 1.6	260	260	260
1.6 to 2.5	260	250	245
> 2.5	250	245	245

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see Figure 16.



MSL: Moisture Sensitivity Level

Figure 16. Temperature profiles for large and small components

For further information on temperature profiles, refer to Application Note *AN10365 "Surface mount reflow soldering description"*.

16 Soldering: PCB footprints

Footprint information for reflow soldering of SOT1309 package **SOT1309-1**

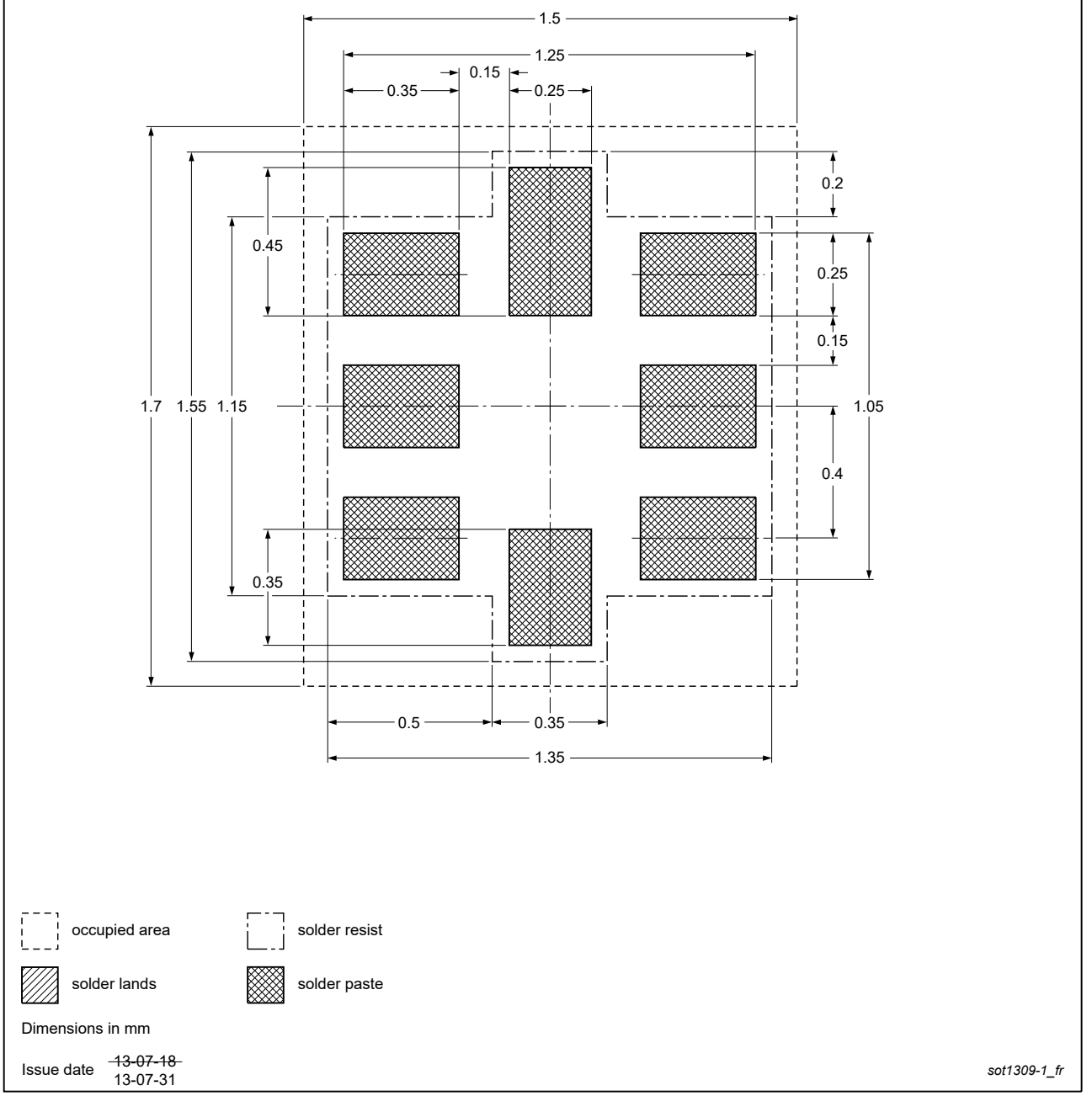


Figure 17. PCB footprint for SOT1309-1 (XQFN8); reflow soldering

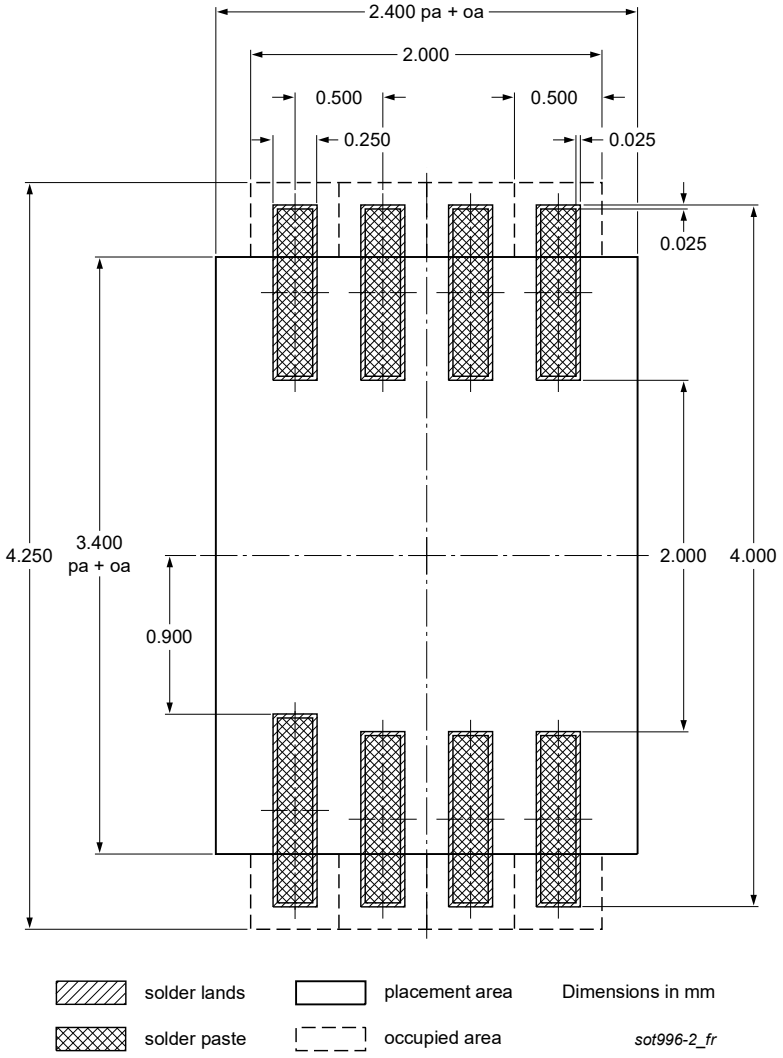
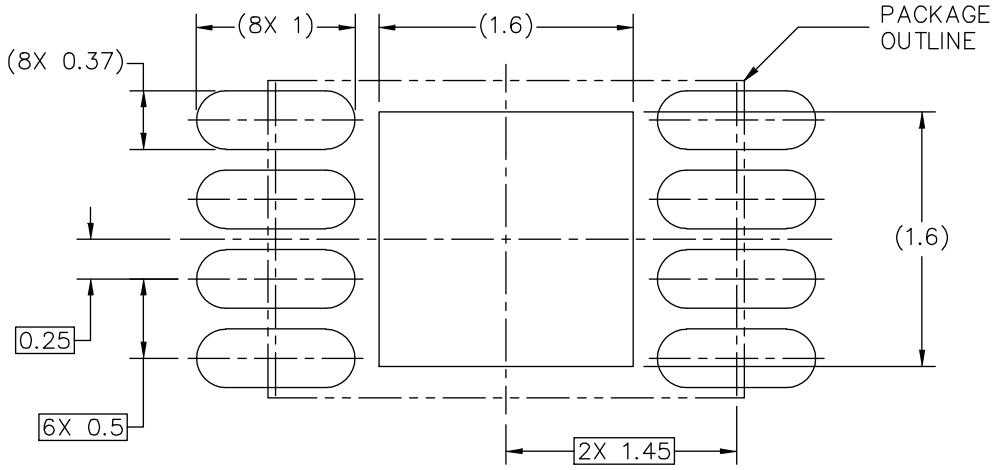


Figure 18. PCB footprint for SOT996-2 (XSON8U); reflow soldering

H−PDFN−8 I/O
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052−2



PCB DESIGN GUIDELINES
RECOMMENDED SOLDER MASK OPENING PATTERN

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DATE: 06 JAN 2022

MECHANICAL OUTLINE PRINT VERSION NOT TO SCALE	STANDARD: NON−JEDEC	DRAWING NUMBER: 98ASA01831D	REVISION: O	

Figure 19. PCB footprint for SOT1052-2 (XSON8); recommended solder mask opening pattern

H–PDFN–8 I/O
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052–2

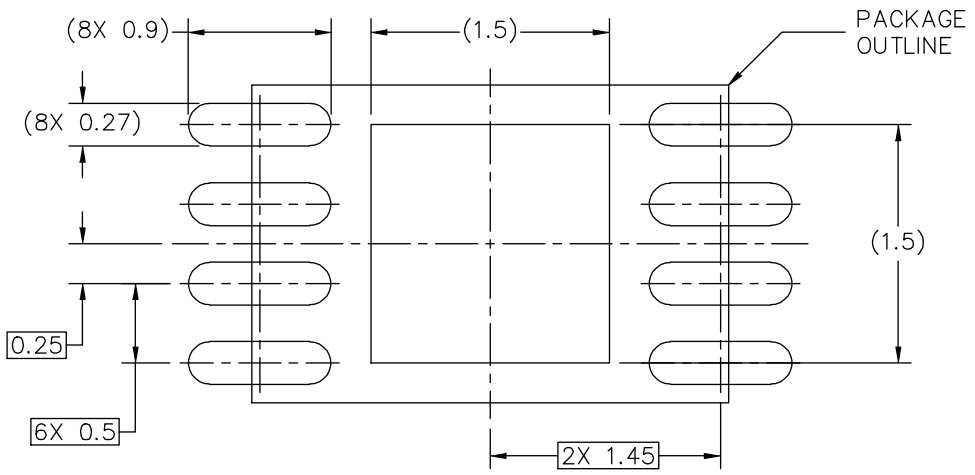

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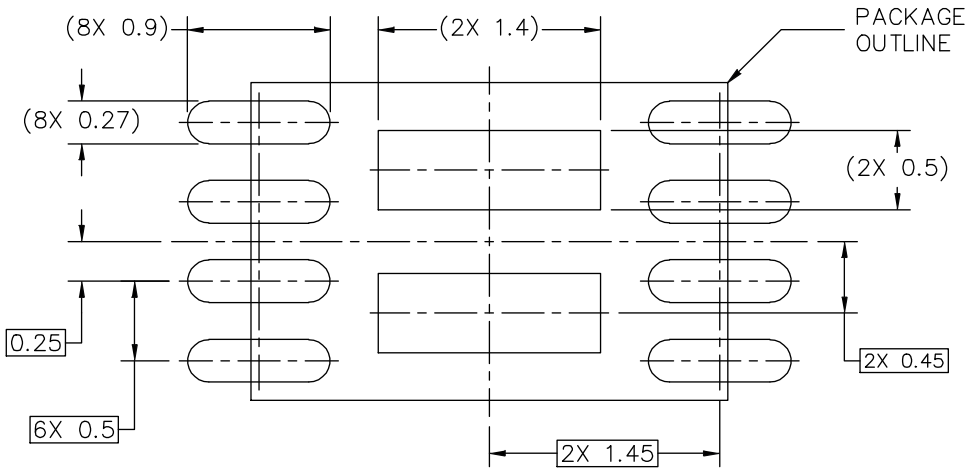
Figure 20. PCB footprint for SOT1052-2 (XSON8); recommended I/O pads and solderable area

H−PDFN−8 I/O
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052−2



RECOMMENDED STENCIL THICKNESS 0.125

PCB DESIGN GUIDELINES − RECOMMENDED SOLDER PASTE STENCIL

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Figure 21. PCB footprint for SOT1052-2 (XSON8); recommended solder paste stencil

H−PDFN−8 I/O
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052−2

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M−1994.
3. PIN 1 FEATURE SHAPE, SIZE AND LOCATION MAY VARY.
4. COPLANARITY APPLIES TO LEADS, DIE ATTACH FLAG.
5. MIN. METAL GAP FOR LEAD TO EXPOSED PAD SHALL BE 0.2 MM.

DATE: 06 JAN 2022

MECHANICAL OUTLINE PRINT VERSION NOT TO SCALE	STANDARD: NON−JEDEC	DRAWING NUMBER: 98ASA01831D	REVISION: O	

Figure 22. PCB footprint for SOT1052-2 (XSON8); notes

17 Abbreviations

Table 15. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
GPIO	General Purpose Input Output
HBM	Human Body Model
I^2C	Inter-Integrated Circuit
PCB	Printed-circuit board
PMOS	Positive Metal Oxide Semiconductor
SMBus	System Management Bus
UART	Universal Asynchronous Receiver Transmitter
UTLP	Ultra Thin Leadless Package

18 Revision history

Table 16. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NTSX2102 v.2.2	20220321	Product data sheet	—	NTSX2102 v.2.1
Modifications:	• Section 4, Table 2: Updated table note [2] • Section 14: Updated SOT1052-2 (XSON8) • Added Section 13.8, Section 15 and Section 16			
NTSX2102 v.2.1	20211112	Product data sheet	—	NTSX2102 v.2
NTSX2102 v.2	20130211	Product data sheet	—	NTSX2102 v.1.1
NTSX2102 v.1.1	20121121	Product data sheet	—	NTSX2102 v.1
NTSX2102 v.1	20121119	Product data sheet	—	—

19 Legal information

19.1 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".
[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 URL http://www.nxp.com.

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Date of release: 21 March 2022
Document identifier: NTSX2102