2-Bit Bidirectional Voltage-Level Translator with Automatic Direction Sensing

Check for Samples: TXB0302

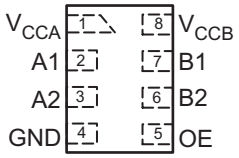
FEATURES

- **Fully Symmetric Supply Voltages.**
  0.9 V to 3.6 V on A Port and 0.9 V to 3.6 V
- **V_{CC} Isolation Feature — If Either V_{CC} Input Is at GND, All Outputs Are in the High-Impedance State**
- **OE Input Circuit Referenced to V_{CCA}**
- **Low Power Consumption, 5-µA Max I_{CC}**
- **Ioff Supports Partial-Power-Down Mode Operation**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Protection Exceeds JESD 22**
  - **4000-V Human-Body Model (A114-B)**
  - **1000-V Charged-Device Model (C101)**

DESCRIPTION

This 2-bit noninverting translator uses two separate configurable power-supply rails. The A port is designed to track VCCA. VCCA accepts any supply voltage from 0.9 V to 3.6 V. The B port is designed to track VCCB. VCCB accepts any supply voltage from 0.9 V to 3.6 V. This allows for low-voltage bidirectional translation between 1-V, 1.2-V, 1.5-V, 1.8-V, 2.5-V and 3.3-V voltage nodes. For the TXB0302, when the output-enable (OE) input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver. The TXB0302 is designed so that the OE input circuit is supplied by VCCA. This device is fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

DQM PACKAGE
(TOP VIEW)



A. Pull up resistors are not required on both sides for Logic I/O.

B. If pull up or pull down resistors are needed, the resistor value must be over 20 kΩ.

C. 20 kΩ is a safe recommended value, if the customer can accept higher Vol or lower Voh, smaller pull up or pull down resistor is allowed, the draft estimation is Vol = Vccout × 1.5k/(1.5k + Rpu) and Voh = Vccout × Rdw/(1.5k + Rdw).

D. If pull up resistors are needed, please refer to the TXS0102 or contact TI.

E. For detailed information, please refer to application note SCEA043.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	DQM – MicroQFN	TXB0302DQMR	77A

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

PIN DESCRIPTION

PIN NO.	NAME	FUNCTION
DQM	TXB0302	
1	VCCA	A-port supply voltage 0.9 V ≤ V_{CCA} ≤ 3.6 V
2	A1	Input/output 1. Referenced to V_{CCA}.
3	A2	Input/output 2. Referenced to V_{CCA}.
4	GND	Ground
5	OE	3-state output-mode enable. Pull OE (TXB0302) low to place all outputs in 3-state mode.
6	B2	Input/output 2. Referenced to V_{CCB}.
7	B1	Input/output 1. Referenced to V_{CCB}.
8	VCCB	B-port supply voltage 0.9 V ≤ V_{CCB} ≤ 3.6 V.

ABSOLUTE MAXIMUM RATINGS(1)

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CCA}	Supply voltage range		–0.5	4.6	V
V_{CCB}			–0.5	4.6	
V_I	Input voltage range	A port	–0.5	4.6	V
		B port	–0.5	6.5	
V_O	Voltage range applied to any output in the high-impedance or power-off state	A port	–0.5	4.6	V
		B port	-0.5	6.5	
V_O	Voltage range applied to any output in the high or low state(2)	A port	–0.5	VCCA + 0.5	V
		B port	–0.5	VCCB + 0.5	
I_{IK}	Input clamp current	VI < 0		–50	mA
I_{OK}	Output clamp current	VO < 0		–50	mA
I_O	Continuous output current			±50	mA
	Continuous current through VCCA, VCCB, or GND			±100	mA
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

THERMAL IMPEDANCE RATINGS(1)(2)

THERMAL METRIC		TXB0302 DQM 8 PINS	UNIT
θ_{JA}	Package thermal impedance	259	°C/W

(1) The package thermal impedance is calculated in accordance with JESD 51-7.
(2) The package thermal impedance is calculated in accordance with JESD 51-5.

RECOMMENDED OPERATING CONDITIONS(1)

			VCCA	VCCB	MIN	MAX	UNIT
V_{CCA}	Supply voltage				0.9	3.6	V
V_{CCB}					0.9	3.6	
V_{IH}	High-level input voltage	Data inputs	0.9 V to 3.6 V	0.9 V to 3.6 V	V_{CCI}(2) × 0.65	V_{CCI}(2)	V
		OE	0.9 V to 3.6 V	0.9 V to 3.6 V	V_{CCA} × 0.65	3.6	
V_{IL}	Low-level input voltage	Data inputs	0.9 V to 3.6 V	0.9 V to 3.6 V	0	V_{CCI} (2)× 0.35	V
		OE	0.9 V to 3.6 V	0.9 V to 3.6 V	0	V_{CCA} × 0.35	
V_O	Voltage range applied to any output in the high-impedance or power-off state	A-port	0.9 V to 3.6 V	0.9 V to 3.6 V	0	3.6	V
		B-port	0.9 V to 3.6 V	0.9 V to 3.6 V	0	3.6	
Δt/Δv	Input transition rise or fall rate	A-port inputs	0.9 V to 3.6 V	0.9 V to 3.6 V		40	ns/V
		B-port inputs	0.9 V to 3.6 V	0.9 V to 3.6 V		40	
T_A	Operating free-air temperature				–40	85	°C

(1) The A and B sides of an unused data I/O pair must be held in the same state, i.e., both at V_{CCI} or both at GND.
(2) V_{CCI} is the supply voltage associated with the input port.

ELECTRICAL CHARACTERISTICS

PARAMETER		TEST CONDITIONS	VCCA	VCCB	T_A = 25°C			–40°C to 85°C		UNIT
					MIN	TYP	MAX	MIN	MAX	
V_{OHA}		I_{OH} = –20 µA	0.9 V to 3.6 V				0.9 x VCCA			V
V_{OLA}		I_{O}L = 20 µA	0.9 V to 3.6 V					0.2		V
V_{OHB}		I_{OH} = –20 µA		0.9 V to 3.6 V			0.9 x VCCB			V
V_{OLB}		I_{OL} = 20 µA	0.9 V to 3.6 V					0.2		V
I_I	OE	V_I = V_{CCI} or GND	0.9 V to 3.6 V	0.9 V to 3.6 V			±1		±2	µA
I_{off}	A port	V_I or V_O = 0 to 3.6 V	0 V	0 V to 3.6 V			±1		±2	µA
	B port	V_I or V_O = 0 to 3.6 V	0.9 V to 3.6 V	0 V			±1		±2	
I_{OZ}	A or B port	OE = GND	0.9 V to 3.6 V	0.9 V to 3.6 V			±1		±2	µA
I_{CCA}		V_I = V_{CCI} or GND, I_O = 0	0.9 V to 3.6 V	0.9 V to 3.6 V					5	µA
I_{CCB}		V_I = V_{CCI} or GND, I_O = 0	0.9 V to 3.6 V	0.9 V to 3.6 V					5	µA
I_{CCA} + I_{CCB}		V_I = V_{CCI} or GND, I_O = 0	0.9 V to 3.6 V	0.9 V to 3.6 V					10	µA
I_{CCZA}		VI = V_{CCI} or GND, I_O = 0, OE = GND	0.9 V to 3.6 V	0.9 V to 3.6 V					5	µA
I_{CCZB}		VI = V_{CCI} or GND, I_O = 0, OE = GND	0.9 V to 3.6 V	0.9 V to 3.6 V					5	µA
C_i	OE		0.9 V to 3.6 V	0.9 V to 3.6 V		3				pF
C_{io}	A port		0.9 V to 3.6 V	0.9 V to 3.6 V		9				pF
	B port					12				

TIMING REQUIREMENTS

		VCCA	VCCB	MIN	MAX	UNIT
Data rate	C_L = 15 pF	0.9 to 3.6 V	0.9 to 3.6 V		40	Mbps
	C_L = 15 pF	1.2 to 3.6 V	1.2 to 3.6 V		100	Mbps
	C_L = 15 pF	1.8 to 3.6 V	1.8 to 3.6 V		140	Mbps
	C_L = 30 pF	0.9 to 3.6 V	0.9 to 3.6 V		40	Mbps
	C_L = 30 pF	1.2 to 3.6 V	1.2 to 3.6 V		90	Mbps
	C_L = 30 pF	1.8 to 3.6 V	1.8 to 3.6 V		120	Mbps
	C_L = 50 pF	1.2 to 3.6 V	1.2 to 3.6 V		70	Mbps
	C_L = 50 pF	1.8 to 3.6 V	1.8 to 3.6 V		100	Mbps

SWITCHING CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

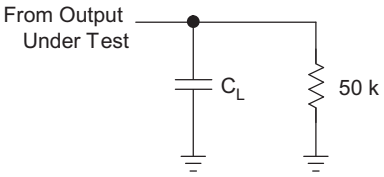
PARAMETER	FROM (INPUT)	TO (OUTPUT)		VCCA	VCCB	MIN	TYP T_A = 25°C	MAX	UNIT
t_{pd}	A	B	C_L = 15	0.9-3.6	0.9-3.6		18.9	62.5	ns
	A	B	C_L = 15	1.2-3.6	1.2-3.6		7.5	15.5	
	A	B	C_L = 15	1.8-3.6	1.8-3.6		3.7	5.8	
	A	B	C_L = 30	0.9-3.6	0.9-3.6		19.5	64.5	
	A	B	C_L = 30	1.2-3.6	1.2-3.6		7.8	16.1	
	A	B	C_L = 30	1.8-3.6	1.8-3.6		3.8	6.1	
	A	B	C_L = 50	1.2-3.6	1.2-3.6		8	16.8	
	A	B	C_L = 50	1.8-3.6	1.8-3.6		4	6.5	
	B	A	C_L = 15	0.9-3.6	0.9-3.6		18.9	62.6	ns
	B	A	C_L = 15	1.2-3.6	1.2-3.6		7.5	15.4	
	B	A	C_L = 15	1.8-3.6	1.8-3.6		3.7	5.8	
	B	A	C_L = 30	0.9-3.6	0.9-3.6		19.5	64.5	
	B	A	C_L = 30	1.2-3.6	1.2-3.6		7.8	16.1	
	B	A	C_L = 30	1.8-3.6	1.8-3.6		3.8	5.2	
	B	A	C_L = 50	1.2-3.6	1.2-3.6		8	16.9	
	B	A	C_L = 50	1.8-3.6	1.8-3.6		4	6.6	
t_{en}	OE	A	C_L = 15	0.9-3.6	0.9-3.6			504	ns
		B	C_L = 15	0.9-3.6	0.9-3.6			356	
t_{dis}	OE	A	C_L = 15	0.9-3.6	0.9-3.6			200	ns
		B	C_L = 15	0.9-3.6	0.9-3.6			200	ns
t_{rB}, t_{fB}	B-port rise and fall times		C_L = 15	0.9-3.6	0.9-3.6		2.95		ns
t_s, t_s	A-port rise and fall times		C_L = 15	0.9-3.6	0.9-3.6		3.1		ns
$t_{SK(O)}$	Channel-to-channel skew		C_L = 15	0.9-3.6	0.9-3.6			0.5	ns

OPERATING CHARACTERISTICS

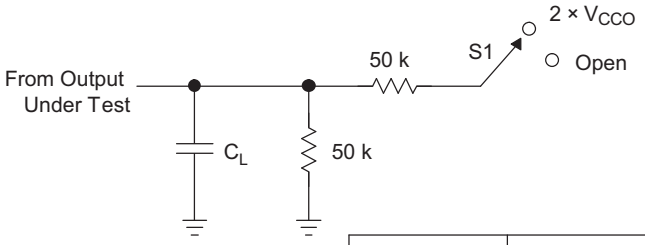
T_A = 25°C

PARAMETER		TEST CONDITIONS	VCCA, VCCB 0.9 V to 3.6 V	UNIT
			TYP	
C_{pdA}	A-port input, B-port output	C_L = 0, f = 10 MHz, t_r = t_f = 1 ns, OE = V_{CCA} (outputs enabled)	40	pF
	B-port input, A-port output		40	
C_{pdB}	A-port input, B-port output		40	pF
	B-port input, A-port output		40	
C_{pdA}	A-port input, B-port output	C_L = 0, f = 10 MHz, t_r = t_f = 1 ns, OE = GND (outputs disabled)	0.01	pF
	B-port input, A-port output		0.01	
C_{pdB}	A-port input, B-port output		0.01	pF
	B-port input, A-port output		0.01	

PARAMETER MEASUREMENT INFORMATION

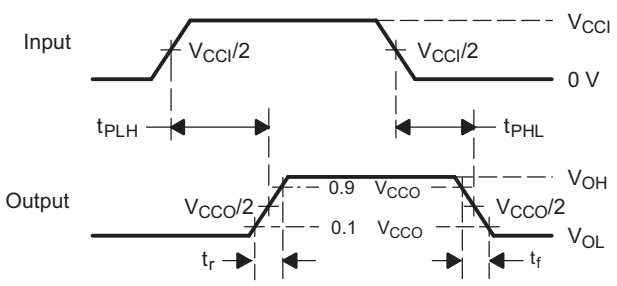


LOAD CIRCUIT FOR MAX DATA RATE, PULSE DURATION PROPAGATION DELAY OUTPUT RISE AND FALL TIME MEASUREMENT

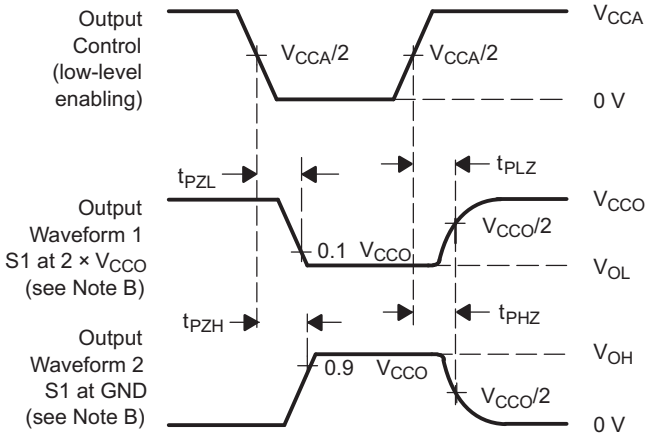


LOAD CIRCUIT FOR ENABLE/DISABLE TIME MEASUREMENT

TEST	S1
t_{PZL}/t_{PLZ} t_{PHZ}/t_{PZH}	2 × V_{CCO} Open



VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES

A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR 10 MHz, Z_O = 50 Ω, dv/dt ≥ 1 V/ns.
C. The outputs are measured one at a time, with one transition per measurement.
D. t_{PLH} and t_{PHL} are the same as t_{pd}.
E. V_{CCI} is the V_{CC} associated with the input port.
F. V_{CCO} is the V_{CC} associated with the output port.
G. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuits and Voltage Waveforms

REVISION HISTORY

Changes from Original (March 2012) to Revision A	Page
• Added package pin out diagram notes.	1

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/ Ball Finish	MSL Peak Temp [3]	Samples (Requires Login)
TXB0302DQMR	ACTIVE	X2SON	DQM	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

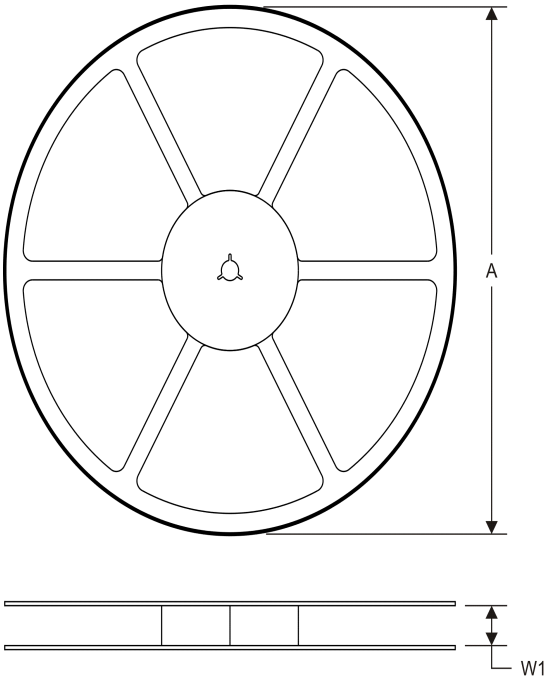
[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

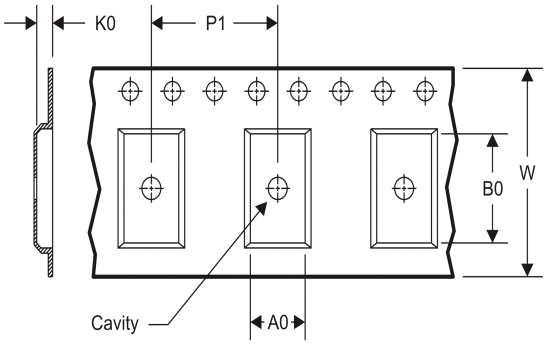
[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



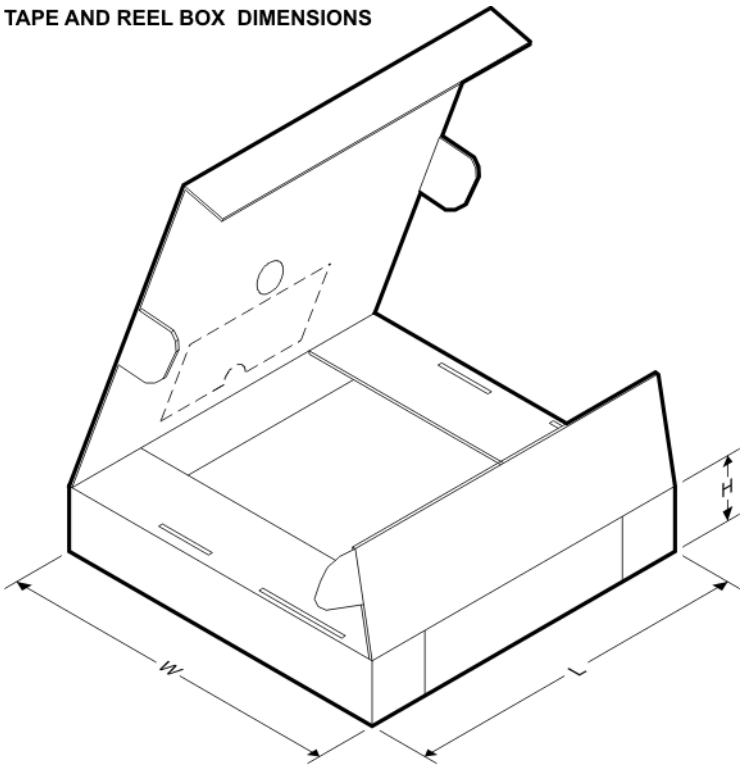
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TXB0302DQMR	X2SON	DQM	8	3000	180.0	9.5	1.4	2.0	0.5	4.0	8.0	Q1

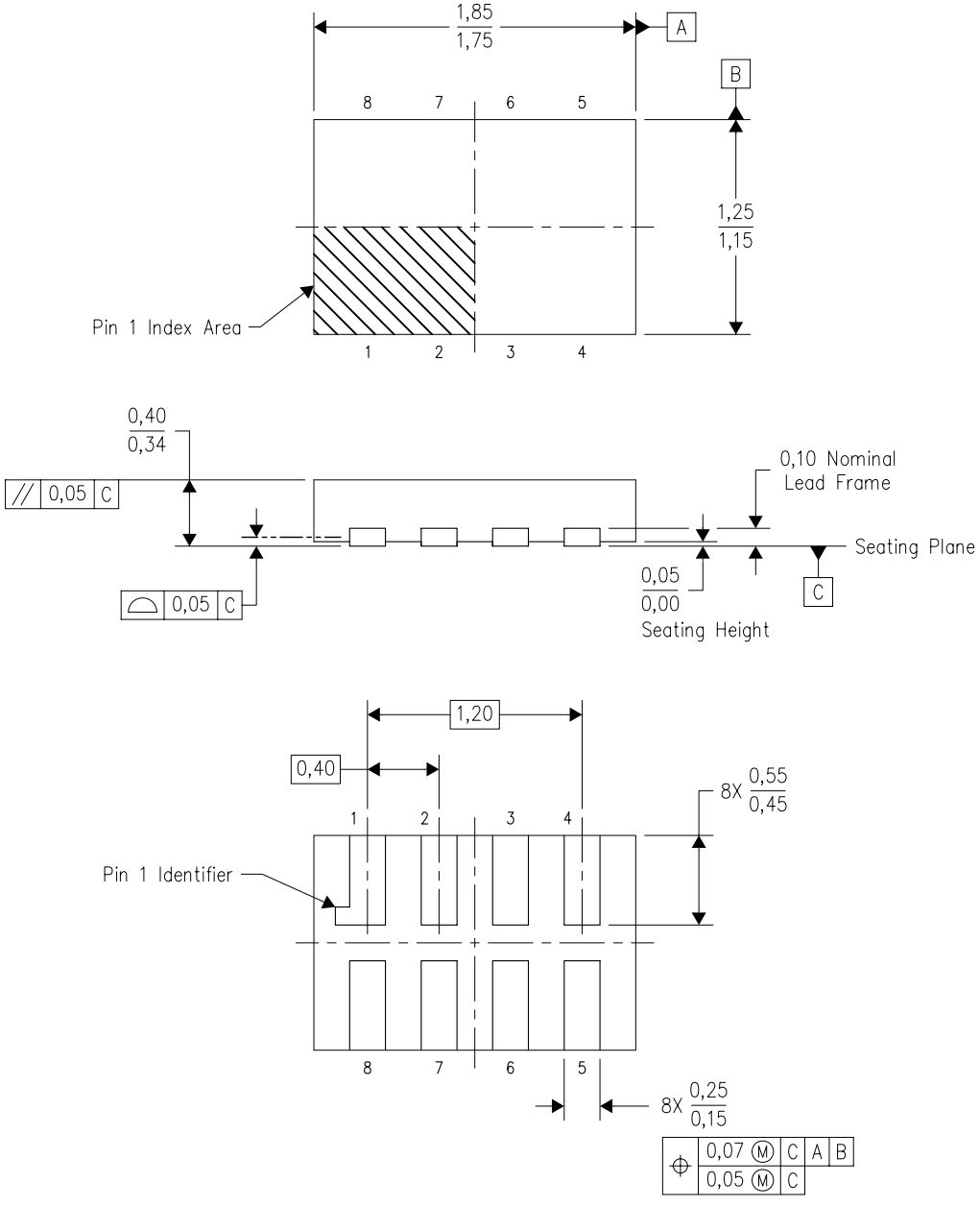
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXB0302DQMR	X2SON	DQM	8	3000	180.0	180.0	30.0

DQM (R–PX2SON–N8) PLASTIC SMALL OUTLINE NO–LEAD



4210302/A 06/2009

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. SON (Small Outline No–Lead) package configuration.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265