

4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR WITH AUTOMATIC DIRECTION SENSING

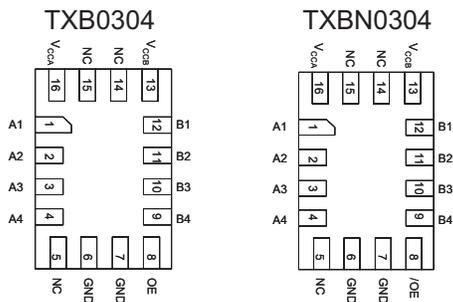
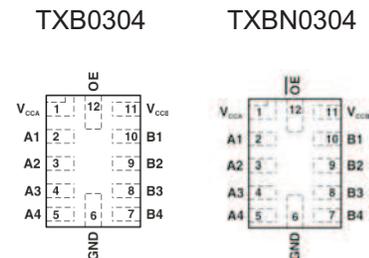
Check for Samples: [TXB0304](#)

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- μ A Max (I_{CCA} or I_{CCB})
- I_{off} Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 8000-V Human-Body Model (A114-B)
 - 1000-V Charged-Device Model (C101)

DESCRIPTION

This 4-bit non-inverting translator uses two separate configurable power-supply rails. The A port is designed to track V_{CCA} . V_{CCA} accepts any supply voltage from 0.9 V to 3.6 V. The B port is designed to track V_{CCB} . V_{CCB} 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 TXB0304, 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 TXB0304 is designed so that the OE input circuit is supplied by V_{CCA} . 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.

**RSV PACKAGE
(TOP VIEW)**

**RUT PACKAGE
(TOP VIEW)**


ORDERING INFORMATION⁽¹⁾

| T_A | PACKAGE ⁽²⁾ | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|-------------|------------------------|-----------------------|------------------|
| -40 to 85°C | RUT – MicroQFN | TXB0304RUTR | 73R |
| | RSV – QFN | TXB0304RSVR | ZTJ |
| | RUT – MicroQFN | TXBN0304RUTR | 74R |
| | RSV – QFN | TXBN0304RSVR | ZTK |

- (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.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

DEVICE INFORMATION

Table 1. SIGNAL DESCRIPTIONS

| PIN NO. | | NAME | | FUNCTION |
|---------|-----|------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RSV | RUT | TXB0304 | TXBN0304 | |
| 16 | 1 | V _{CCA} | | A-port supply voltage $0.9V \leq V_{CCA} \leq 3.6V$ |
| 1 | 2 | A1 | | Input/output 1 |
| 2 | 3 | A2 | | Input/output 2 |
| 3 | 4 | A3 | | Input/output 3 |
| 4 | 5 | A4 | | Input/output 4 |
| 5 | – | NC | | No connection; not internally connected |
| 6,7 | 6 | GND | | Ground |
| 8 | 12 | OE | \overline{OE} | 3-state output-mode enable. Pull OE (TXB0304) low to place all outputs in 3-state mode. 3-state output-mode enable. Pull \overline{OE} (TXBN0304) high to place all outputs in 3-state mode. Referenced to V _{CCA} . |
| 9 | 7 | B4 | | Input/output 1 |
| 10 | 8 | B3 | | Input/output 2 |
| 11 | 9 | B2 | | Input/output 3 |
| 12 | 10 | B1 | | Input/output 4 |
| 13 | 11 | V _{CCB} | | B-port supply voltage $0.9V \leq V_{CCB} \leq 3.6V$ |
| 14 | – | NC | | No connection; not internally connected |
| 15 | – | NC | | No connection; not internally connected |

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 | 4.6 | |
| 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 | 4.6 | |
| V _O | Voltage range applied to any output in the high or low state ⁽²⁾ | A port | –0.5 | V _{CCA} + 0.5 | V |
| | | B port | –0.5 | V _{CCB} + 0.5 | |
| I _{IK} | Input clamp current | V _I < 0 | | –50 | mA |
| I _{OK} | Output clamp current | V _O < 0 | | –50 | mA |
| I _O | Continuous output current | | | ±50 | mA |
| | Continuous current through V _{CCA} , V _{CCB} , 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.
- (2) The value of V_{CCA} and V_{CCB} are provided in the recommended operating conditions table.

THERMAL IMPEDANCE RATINGS

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

| | | | UNIT | |
|---------------|---------------------------|----------------------------|------|------|
| θ_{JA} | Package thermal impedance | RUT package ⁽¹⁾ | 87 | °C/W |
| | | RSV package ⁽²⁾ | 184 | |

(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⁾⁽²⁾

| | | V_{CCA} | V_{CCB} | 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 | $V_{CCI} \times 0.65$ | V_{CCI} | V |
| | | OE | 0.9 V to 3.6 V | 0.9 V to 3.6 V | $V_{CCA} \times 0.65$ | 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 | $V_{CCI} \times 0.35$ | V |
| | | OE | 0.9 V to 3.6 V | 0.9 V to 3.6 V | 0 | $V_{CCA} \times 0.35$ | |
| 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 | |
| $\Delta t/\Delta v$ | 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 | V _{CCA} | V _{CCB} | 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 × V _{CCA} | | | V |
| V _{OLA} | I _{OL} = 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 × V _{CCB} | | | 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 _{CCB} 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} | | V _I = 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} | | V _I = V _{CCB} 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 | | 6.7 | | | pF |
| | B port | | | | | 6.7 | | | |

TIMING REQUIREMENTS

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

| | | | V _{CCA} | V _{CCB} | MIN | MAX | UNIT |
|-----------|-------------------------|-------------------------|------------------|------------------|-----|------|------|
| Data rate | | C _L = 15 pF | 0.9 to 3.6 V | 0.9 to 3.6 V | | 50 | 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 | | 130 | Mbps |
| | | C _L = 50 pF | 1.2 to 3.6 V | 1.2 to 3.6 V | | 80 | Mbps |
| | | C _L = 50 pF | 1.8 to 3.6 V | 1.8 to 3.6 V | | 120 | Mbps |
| | | C _L = 100 pF | 1.2 to 3.6 V | 1.2 to 3.6 V | | 70 | Mbps |
| | C _L = 100 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 | 30 | ns |
| | A | B | C _L = 15 | 1.2-3.6 | 1.2-3.6 | | 7.5 | 11.5 | |
| | A | B | C _L = 15 | 1.8-3.6 | 1.8-3.6 | | 3.7 | 4.8 | |
| | A | B | C _L = 30 | 0.9-3.6 | 0.9-3.6 | | 19.5 | 34 | |
| | A | B | C _L = 30 | 1.2-3.6 | 1.2-3.6 | | 7.8 | 11.9 | |
| | A | B | C _L = 30 | 1.8-3.6 | 1.8-3.6 | | 3.8 | 5.2 | |
| | A | B | C _L = 50 | 1.2-3.6 | 1.2-3.6 | | 8 | 12.3 | |
| | A | B | C _L = 50 | 1.8-3.6 | 1.8-3.6 | | 4 | 5.4 | |
| | A | B | C _L = 100 | 1.2-3.6 | 1.2-3.6 | | 8.6 | 13.5 | |
| | A | B | C _L = 100 | 1.8-3.6 | 1.8-3.6 | | 4.5 | 6 | |
| | B | A | C _L = 15 | 0.9-3.6 | 0.9-3.6 | | 18.9 | 30 | ns |
| | B | A | C _L = 15 | 1.2-3.6 | 1.2-3.6 | | 7.5 | 11.5 | |
| | B | A | C _L = 15 | 1.8-3.6 | 1.8-3.6 | | 3.7 | 5 | |
| | B | A | C _L = 30 | 0.9-3.6 | 0.9-3.6 | | 19.5 | 34 | |
| | B | A | C _L = 30 | 1.2-3.6 | 1.2-3.6 | | 7.8 | 11.9 | |
| | 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 | 12.3 | |
| | B | A | C _L = 50 | 1.8-3.6 | 1.8-3.6 | | 4 | 5.4 | |
| B | A | C _L = 100 | 1.2-3.6 | 1.2-3.6 | | 8.6 | 13.5 | | |
| B | A | C _L = 100 | 1.8-3.6 | 1.8-3.6 | | 4.5 | 6 | | |
| t _{en} | OE | A | C _L = 15 | 0.9-3.6 | 0.9-3.6 | | | 173 | ns |
| | | B | C _L = 15 | 0.9-3.6 | 0.9-3.6 | | | 213 | |
| t _{dis} | OE | A | C _L = 15 | 0.9-3.6 | 0.9-3.6 | | | 172 | ns |
| | | B | C _L = 15 | 0.9-3.6 | 0.9-3.6 | | | 169 | 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 _{rA} , t _{fA} | 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 | | | 0.15 | ns |

OPERATING CHARACTERISTICS

 T_A = 25°C

| PARAMETER | | TEST CONDITIONS | V _{CCA} , V _{CCB} 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) | 34 | pF |
| | B-port input, A-port output | | 34 | |
| C _{pdB} | A-port input, B-port output | | 34 | pF |
| | B-port input, A-port output | | 34 | |
| 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 | |

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) |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|----------------------|------------------------------|-----------------------------|
| TXB0304RSVR | ACTIVE | UQFN | RSV | 16 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| TXB0304RUTR | ACTIVE | UQFN | RUT | 12 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| TXBN0304RSVR | ACTIVE | UQFN | RSV | 16 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| TXBN0304RUTR | ACTIVE | UQFN | RUT | 12 | 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.

OBSELETE: 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.

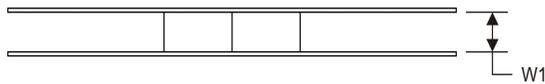
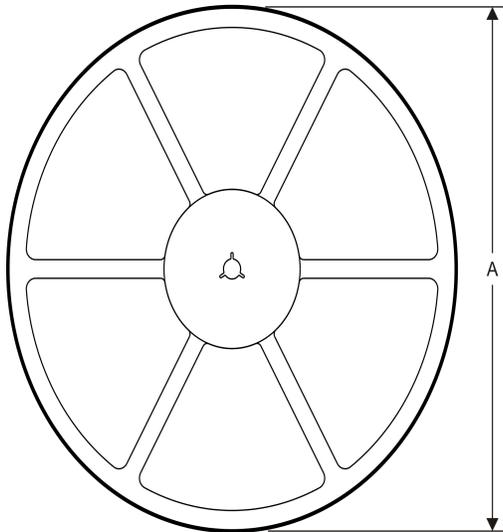
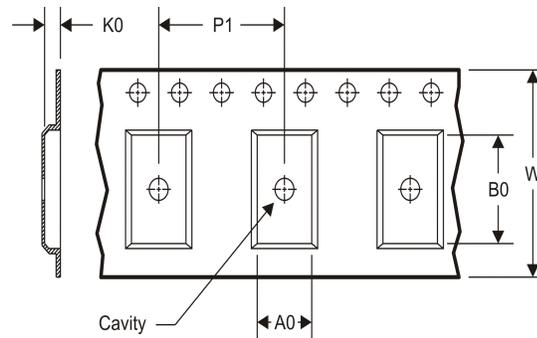
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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.

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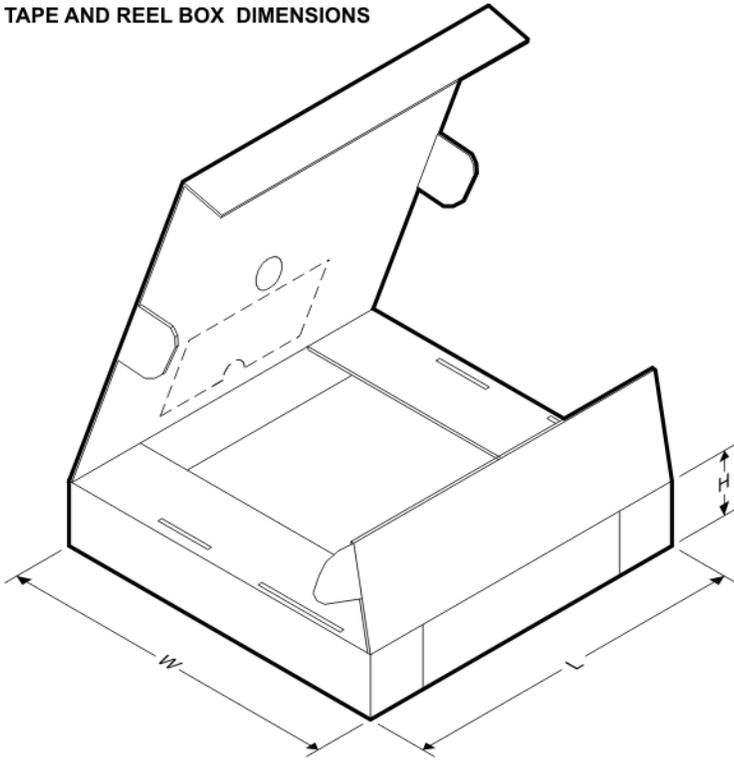
TAPE AND REEL INFORMATION
REEL DIMENSIONS

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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TXB0304RSVR | UQFN | RSV | 16 | 3000 | 177.8 | 12.4 | 2.0 | 2.8 | 0.7 | 4.0 | 12.0 | Q1 |
| TXB0304RUTR | UQFN | RUT | 12 | 3000 | 180.0 | 8.4 | 1.95 | 2.3 | 0.75 | 4.0 | 8.0 | Q1 |
| TXBN0304RSVR | UQFN | RSV | 16 | 3000 | 177.8 | 12.4 | 2.0 | 2.8 | 0.7 | 4.0 | 12.0 | Q1 |
| TXBN0304RUTR | UQFN | RUT | 12 | 3000 | 180.0 | 8.4 | 1.95 | 2.3 | 0.75 | 4.0 | 8.0 | Q1 |

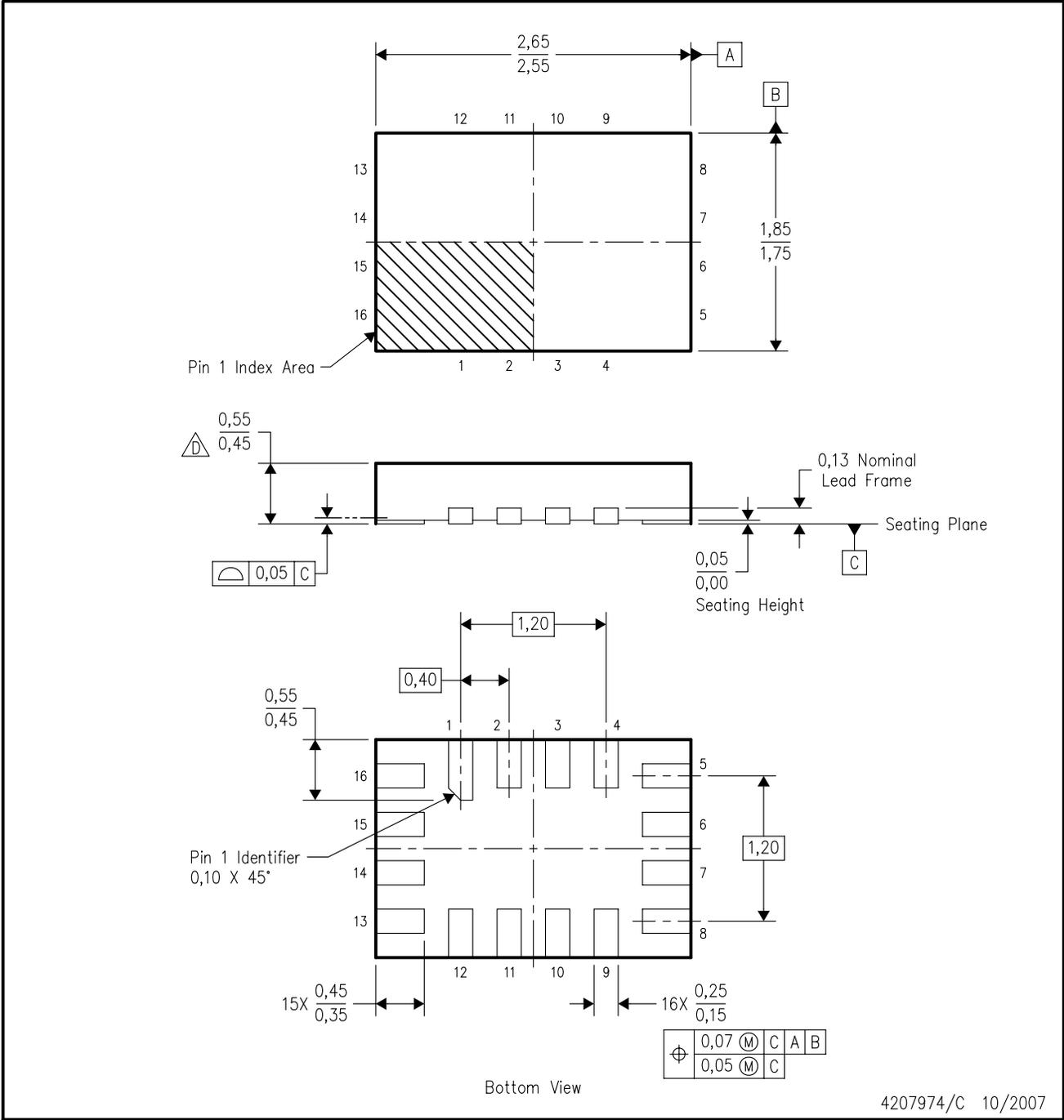
TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TXB0304RSVR | UQFN | RSV | 16 | 3000 | 202.0 | 201.0 | 28.0 |
| TXB0304RUTR | UQFN | RUT | 12 | 3000 | 202.0 | 201.0 | 28.0 |
| TXBN0304RSVR | UQFN | RSV | 16 | 3000 | 202.0 | 201.0 | 28.0 |
| TXBN0304RUTR | UQFN | RUT | 12 | 3000 | 202.0 | 201.0 | 28.0 |

RSV (R-PQFP-N16)

PLASTIC QUAD FLATPACK



4207974/C 10/2007

- 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. QFN (Quad Flatpack No-Lead) package configuration.
 - This package complies to JEDEC MO-288 variation UFHE, except minimum package thickness.

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