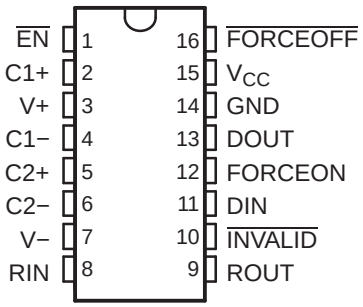
# 3-V TO 5.5-V SINGLE-CHANNEL RS-232 1-Mbit/s LINE DRIVER/RECEIVER WITH ±15-kV IEC ESD PROTECTION

## FEATURES

- **ESD Protection for RS-232 Pins**
  - **±15-kV Human-Body Model (HBM)**
  - **±8-kV IEC 61000-4-2 Contact Discharge**
  - **±15-kV IEC 61000-4-2 Air-Gap Discharge**
- **Operate With 3-V to 5.5-V $V_{CC}$ Supply**
- **Operate up to 1 Mbit/s**
- **Low Standby Current . . . 1 μA Typ**
- **External Capacitors . . . 4 × 0.1 μF**
- **Accepts 5-V Logic Input With 3.3-V Supply**
- **RS-232 Bus-Pin ESD Protection Exceeds ±15 kV Using Human-Body Model (HBM)**
- **Auto-Powerdown Feature Automatically Disables Drivers for Power Savings**

**DB OR PW PACKAGE**
**(TOP VIEW)**




## APPLICATIONS

- **Battery-Powered, Hand-Held, and Portable Equipment**
- **PDAs and Palmtop PCs**
- **Notebooks, Sub-Notebooks, and Laptops**
- **Digital Cameras**
- **Mobile Phones and Wireless Devices**

## DESCRIPTION/ORDERING INFORMATION

The SN65C3221E and SN75C3221E consist of one line driver, one line receiver, and a dual charge-pump circuit with ±15-kV IEC ESD protection pin to pin (serial-port connection pins, including GND). These devices provide the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. These devices operate at data signaling rates up to 1 Mbit/s and a driver output slew rate of 24 V/μs to 150 V/μs.

Flexible control options for power management are available when the serial port is inactive. The auto-powerdown feature functions when FORCEON is low and $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the devices do not sense a valid RS-232 signal on the receiver input, the driver output is disabled. If $\overline{\text{FORCEOFF}}$ is set low and $\overline{\text{EN}}$ is high, both the driver and receiver are shut off, and the supply current is reduced to 1 μA. Disconnecting the serial port or turning off the peripheral drivers causes the auto-powerdown condition to occur. Auto-powerdown can be disabled when FORCEON and $\overline{\text{FORCEOFF}}$ are high. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to the receiver input. The $\overline{\text{INVALID}}$ output notifies the user if an RS-232 signal is present at the receiver input. $\overline{\text{INVALID}}$ is high (valid data) if the receiver input voltage is greater than 2.7 V or less than –2.7 V, or has been between –0.3 V and 0.3 V for less than 30 μs. $\overline{\text{INVALID}}$ is low (invalid data) if the receiver input voltage is between –0.3 V and 0.3 V for more than 30 μs. See Figure 5 for receiver input levels.

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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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## ORDERING INFORMATION

| $T_A$ | PACKAGE(1)(2) | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| –0°C to 70°C | SSOP – DB | Reel of 2000 | SN75C3221EDBR | MY221E |
| | TSSOP – PW | Tube of 90 | SN75C3221EPW | MY221E |
| | | Reel of 2000 | SN75C3221EPWR | |
| –40°C to 85°C | SSOP – DB | Reel of 2000 | SN65C3221EDBR | MU221E |
| | TSSOP – PW | Tube of 90 | SN65C3221EPW | MU221E |
| | | Reel of 2000 | SN65C3221EPWR | |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

## FUNCTION TABLES

### EACH DRIVER(1)

| INPUTS | | | | OUTPUT DOUT | DRIVER STATUS |
|---|---|---|---|---|---|
| DIN | FORCEON | $\overline{\text{FORCEOFF}}$ | VALID RIN RS-232 LEVEL | | |
| X | X | L | X | Z | Powered off |
| L | H | H | X | H | Normal operation with auto-powerdown disabled |
| H | H | H | X | L | |
| L | L | H | Yes | H | Normal operation with auto-powerdown enabled |
| H | L | H | Yes | L | |
| L | L | H | No | Z | Powered off by auto-powerdown feature |
| H | L | H | No | Z | |

(1) H = high level, L = low level, X = irrelevant, Z = high impedance

### EACH RECEIVER(1)

| INPUTS | | | OUTPUT ROUT |
|---|---|---|---|
| RIN | $\overline{\text{EN}}$ | VALID RIN RS-232 LEVEL | |
| L | L | X | H |
| H | L | X | L |
| X | H | X | Z |
| Open | L | No | H |

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = disconnected input or connected driver off


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## LOGIC DIAGRAM (POSITIVE LOGIC)

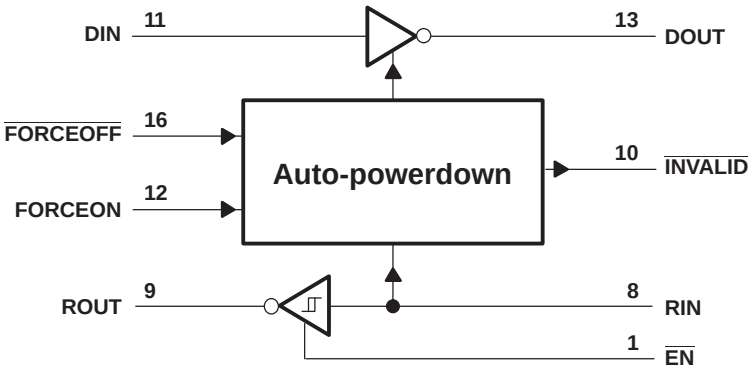


**Table 1. 1-Mbit/s RS-232 Parts**

| PART NO. | TEMPERATURE RANGE | DRIVER NO. | RECEIVER NO. | ESD | SUPPLY $V_{CC}$ (V) | FEATURE | PIN/PACKAGE |
|---|---|---|---|---|---|---|---|
| SN65C3221E | –40°C to 85°C | 1 | 1 | ±15-kV Air-Gap, ±8-kV Contact, ±15-kV HBM | 3.3 or 5 | Auto powerdown | 16-pin SOIC, SSOP, TSSOP |
| SN65C3232E | | 2 | 2 | ±15-kV Air-Gap, ±8-kV Contact, ±15-kV HBM | 3.3 or 5 | Low pin count | 16-pin SOIC, SSOP, TSSOP |
| MAX3227I | | 1 | 1 | ±8-kV Air-Gap, ±8-k V Contact, ±15-kV HBM | 3.3 or 5 | Auto powerdown plus, ready signal | 16-pin SSOP |
| SN65C3221 | | 1 | 1 | ±15-kV HBM | 3.3 or 5 | Auto powerdown | 16-pin SOIC, SSOP, TSSOP |
| SN65C3223 | | 2 | 2 | ±15-kV HBM | 3.3 or 5 | Auto powerdown, enable signal | 20-pin SOIC, SSOP, TSSOP |
| SN65C3222 | | 2 | 2 | ±15-kV HBM | 3.3 or 5 | Enable, powerdown signal | 20-pin SOIC, SSOP, TSSOP |
| SN65C3232 | | 2 | 2 | ±15-kV HBM | 3.3 or 5 | Low pin count | 16-pin SOIC, SSOP, TSSOP |
| SN65C3238 | | 5 | 3 | ±15-kV HBM | 3.3 or 5 | Auto powerdown plus | 28-pin SOIC, SSOP, TSSOP |
| SN65C3243 | | 3 | 5 | ±15-kV HBM | 3.3 or 5 | Auto powerdown | 28-pin SOIC, SSOP, TSSOP |
| SN75C3221E | 0°C to 70°C | 1 | 1 | ±15-kV Air-Gap, ±8-kV Contact, ±15-kV HBM | 3.3 or 5 | Auto powerdown | 16-pin SOIC, SSOP, TSSOP |
| SN75C3232E | | 2 | 2 | ±15-kV Air-Gap, ±8-kV Contact, ±15-kV HBM | 3.3 or 5 | Low pin count | 16-pin SOIC, SSOP, TSSOP |
| MAX3227C | | 1 | 1 | ±8-kV Air-Gap, ±8-kV Contact, ±15-kV HBM | 3.3 or 5 | Auto powerdown plus, ready signal | 16-pin SSOP |
| SN75C3221 | | 1 | 1 | ±15-kV HBM | 3.3 or 5 | Auto powerdown | 16-pin SOIC, SSOP, TSSOP |
| SN75C3223 | | 2 | 2 | ±15-kV HBM | 3.5 or 5 | Auto powerdown, enable signal | 20-pin SOIC, SSOP, TSSOP |
| SN75C3222 | | 2 | 2 | ±15-kV HBM | 3.3 or 5 | Enable, powerdown signal | 20-pin SOIC, SSOP, TSSOP |
| SN75C3232 | | 2 | 2 | ±15-kV HBM | 3.3 or 5 | Low pin count | 16-pin SOIC, SSOP, TSSOP |
| SN75C3238 | | 5 | 3 | ±15-kV HBM | 3.3 or 5 | Auto powerdown plus | 28-pin SOIC, SSOP, TSSOP |
| SN75C3243 | | 3 | 5 | ±15-kV HBM | 3.3 or 5 | Auto powerdown | 28-pin SOIC, SSOP, TSSOP |


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## Absolute Maximum Ratings(1)

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

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage range(2) | | –0.3 | 6 | V |
| V+ | Positive output supply voltage range(2) | | –0.3 | 7 | V |
| V– | Negative output supply voltage range(2) | | 0.3 | –7 | V |
| V+ – V– | Supply voltage difference(2) | | | 13 | V |
| $V_I$ | Input voltage range | Driver ($\overline{FORCEOFF}$, FORCEON, $\overline{EN}$) | –0.3 | 6 | V |
| | | Receiver | –25 | 25 | |
| $V_O$ | Output voltage range | Driver | –13.2 | 13.2 | V |
| | | Receiver ($\overline{INVALID}$) | –0.3 | $V_{CC}$ + 0.3 | |
| $\theta_{JA}$ | Package thermal impedance(3)(4) | DB package | | 82 | °C/W |
| | | PW package | | 108 | |
| $T_J$ | Operating virtual junction temperature | | | 150 | °C |
| $T_{stg}$ | 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) All voltages are with respect to network GND.
(3) Maximum power dissipation is a function of $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

## Recommended Operating Conditions(1)

See Figure 6

| | | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| | Supply voltage | | $V_{CC}$ = 3.3 V | 3 | 3.3 | 3.6 | V |
| | | | $V_{CC}$ = 5 V | 4.5 | 5 | 5.5 | |
| $V_{IH}$ | Driver and control high-level input voltage | DIN, $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$ | $V_{CC}$ = 3.3 V | 2 | | | V |
| | | | $V_{CC}$ = 5 V | 2.4 | | | |
| $V_{IL}$ | Driver and control low-level input voltage | DIN, $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$ | | | | 0.8 | V |
| $V_I$ | Driver and control input voltage | DIN, $\overline{FORCEOFF}$, FORCEON | | 0 | | 5.5 | V |
| $V_I$ | Receiver input voltage | | | –25 | | 25 | V |
| $T_A$ | Operating free-air temperature | | SN65C3221E | –40 | | 85 | °C |
| | | | SN75C3221E | 0 | | 70 | |

(1) Test conditions are C1–C4 = 0.1 µF at $V_{CC}$ = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at $V_{CC}$ = 5 V ± 0.5 V.

## Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 6)

| PARAMETER | | | TEST CONDITIONS | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_I$ | Input leakage current | $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$ | | | ±0.01 | ±1 | µA |
| $I_{CC}$ | Supply current ($T_A$ = 25°C) | Auto-powerdown disabled | No load, $\overline{FORCEOFF}$ and FORCEON at $V_{CC}$ | | 0.3 | 1 | mA |
| | | Powered off | No load, $\overline{FORCEOFF}$ at GND | | 1 | 10 | µA |
| | | Auto-powerdown enabled | No load, $\overline{FORCEOFF}$ at $V_{CC}$, FORCEON at GND, All RIN are open or grounded | | 1 | 10 | |

(1) Test conditions are C1–C4 = 0.1 µF at $V_{CC}$ = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 3.3 V or $V_{CC}$ = 5 V, and $T_A$ = 25°C.

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## DRIVER SECTION

### Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 6)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | DOUT at $R_L$ = 3 kΩ to GND, | DIN = GND | | 5 | 5.4 | | V |
| $V_{OL}$ | Low-level output voltage | DOUT at $R_L$ = 3 kΩ to GND, | DIN = $V_{CC}$ | | –5 | –5.4 | | V |
| $I_{IH}$ | High-level input current | $V_I$ = $V_{CC}$ | | | | ±0.01 | ±1 | µA |
| $I_{IL}$ | Low-level input current | $V_I$ at GND | | | | ±0.01 | ±1 | µA |
| $I_{OS}$ | Short-circuit output current(3) | $V_{CC}$ = 3.6 V, | $V_O$ = 0 V | | | ±35 | ±60 | mA |
| | | $V_{CC}$ = 5.5 V, | $V_O$ = 0 V | | | ±35 | ±90 | |
| $r_o$ | Output resistance | $V_{CC}$, V+, and V– = 0 V, | $V_O$ = ±2 V | | 300 | 10M | | Ω |
| $I_{off}$ | Output leakage current | $\overline{\text{FORCEOFF}}$ = GND | $V_O$ = ±12 V, | $V_{CC}$ = 3 V to 3.6 V | | | ±25 | µA |
| | | | $V_O$ = ±10 V, | $V_{CC}$ = 4.5 V to 5.5 V | | | ±25 | |

(1) Test conditions are C1–C4 = 0.1 µF at $V_{CC}$ = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 3.3 V or $V_{CC}$ = 5 V, and $T_A$ = 25°C.
(3) Short-circuit durations should be controlled to prevent exceeding the device absolute power-dissipation ratings, and not more than one output should be shorted at a time.

### Switching Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 6)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| Maximum data rate (see Figure 1) | | $R_L$ = 3 kΩ | $C_L$ = 1000 pF | | 250 | | | kbit/s |
| | | | $C_L$ = 250 pF, | $V_{CC}$ = 3 V to 4.5 V | 1000 | | | |
| | | | $C_L$ = 1000 pF, | $V_{CC}$ = 4.5 V to 5.5 V | 1000 | | | |
| $t_{sk(p)}$ | Pulse skew(3) | $C_L$ = 150 pF to 2500 pF, | $R_L$ = 3 kΩ to 7 kΩ, | See Figure 2 | | 100 | | ns |
| SR(tr) | Slew rate, transition region (see Figure 1) | $V_{CC}$ = 3.3 V, | $R_L$ = 3 kΩ to 7 kΩ, | $C_L$ = 150 pF to 1000 pF | 18 | | 150 | V/µs |

(1) Test conditions are C1–C4 = 0.1 µF at $V_{CC}$ = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 3.3 V or $V_{CC}$ = 5 V, and $T_A$ = 25°C.
(3) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.

### ESD Protection

| TERMINAL | | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| NAME | NO. | | | |
| DOUT | 13 | HBM | ±15 | kV |
| | | IEC 61000-4-2 Contact Discharge | ±8 | |
| | | IEC 61000-4-2 Air-Gap Discharge | ±15 | |


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## RECEIVER SECTION

### Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 6)

| PARAMETER | | TEST CONDITIONS | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = –1 mA | $V_{CC}$ – 0.6 V | $V_{CC}$ – 0.1 V | | V |
| $V_{OL}$ | Low-level output voltage | $I_{OL}$ = 1.6 mA | | | 0.4 | V |
| $V_{IT+}$ | Positive-going input threshold voltage | $V_{CC}$ = 3.3 V | | 1.6 | 2.4 | V |
| | | $V_{CC}$ = 5 V | | 1.9 | 2.4 | |
| $V_{IT–}$ | Negative-going input threshold voltage | $V_{CC}$ = 3.3 V | 0.6 | 1.1 | | V |
| | | $V_{CC}$ = 5 V | 0.8 | 1.4 | | |
| $V_{hys}$ | Input hysteresis ($V_{IT+}$ – $V_{IT–}$) | | | 0.5 | | V |
| $I_{off}$ | Output leakage current | $\overline{FORCEOFF}$ = 0 V | | ±0.05 | ±10 | µA |
| $r_i$ | Input resistance | $V_I$ = ±3 V to ±25 V | 3 | 5 | 7 | kΩ |

(1) Test conditions are C1–C4 = 0.1 µF at $V_{CC}$ = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 3.3 V or $V_{CC}$ = 5 V, and $T_A$ = 25°C.

### Switching Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 6)

| PARAMETER | | TEST CONDITIONS | TYP(2) | UNIT |
|---|---|---|---|---|
| $t_{PLH}$ | Propagation delay time, low- to high-level output | $C_L$ = 150 pF, See Figure 3 | 150 | ns |
| $t_{PHL}$ | Propagation delay time, high- to low-level output | $C_L$ = 150 pF, See Figure 3 | 150 | ns |
| $t_{en}$ | Output enable time | $C_L$ = 150 pF, $R_L$ = 3 kΩ, See Figure 4 | 200 | ns |
| $t_{dis}$ | Output disable time | $C_L$ = 150 pF, $R_L$ = 3 kΩ, See Figure 4 | 200 | ns |
| $t_{sk(p)}$ | Pulse skew(3) | See Figure 3 | 50 | ns |

(1) Test conditions are C1–C4 = 0.1 µF at $V_{CC}$ = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 3.3 V or $V_{CC}$ = 5 V, and $T_A$ = 25°C.
(3) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.

### ESD Protection

| TERMINAL | | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| NAME | NO. | | | |
| RIN | 8 | HBM | ±15 | kV |
| | | IEC 61000-4-2 Contact Discharge | ±8 | |
| | | IEC 61000-4-2 Air-Gap Discharge | ±15 | |

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## AUTO-POWERDOWN SECTION

### Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 5)

| PARAMETER | | TEST CONDITIONS | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{T+(valid)}$ | Receiver input threshold for $\overline{INVALID}$ high-level output voltage | FORCEON = GND, $\overline{FORCEOFF}$ = $V_{CC}$ | | 2.7 | V |
| $V_{T-(valid)}$ | Receiver input threshold for $\overline{INVALID}$ high-level output voltage | FORCEON = GND, $\overline{FORCEOFF}$ = $V_{CC}$ | –2.7 | | V |
| $V_{T(invalid)}$ | Receiver input threshold for $\overline{INVALID}$ low-level output voltage | FORCEON = GND, $\overline{FORCEOFF}$ = $V_{CC}$ | –0.3 | 0.3 | V |
| $V_{OH}$ | $\overline{INVALID}$ high-level output voltage | $I_{OH}$ = –1 mA, FORCEON = GND, $\overline{FORCEOFF}$ = $V_{CC}$ | $V_{CC}$ – 0.6 | | V |
| $V_{OL}$ | $\overline{INVALID}$ low-level output voltage | $I_{OL}$ = 1.6 mA, FORCEON = GND, $\overline{FORCEOFF}$ = $V_{CC}$ | | 0.4 | V |

### Switching Characteristics

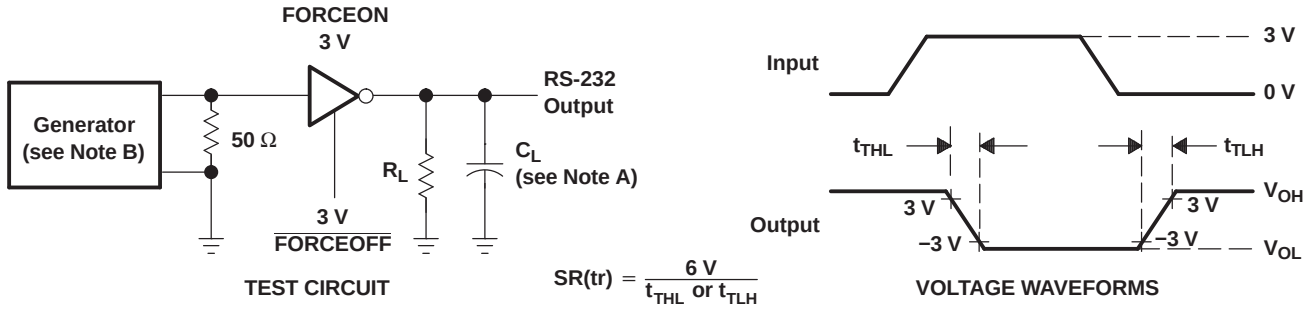
over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 5)

| PARAMETER | | TYP(1) | UNIT |
|---|---|---|---|
| $t_{valid}$ | Propagation delay time, low- to high-level output | 1 | µs |
| $t_{invalid}$ | Propagation delay time, high- to low-level output | 30 | µs |
| $t_{en}$ | Supply enable time | 100 | µs |

(1) All typical values are at $V_{CC}$ = 3.3 V or $V_{CC}$ = 5 V, and $T_A$ = 25°C.

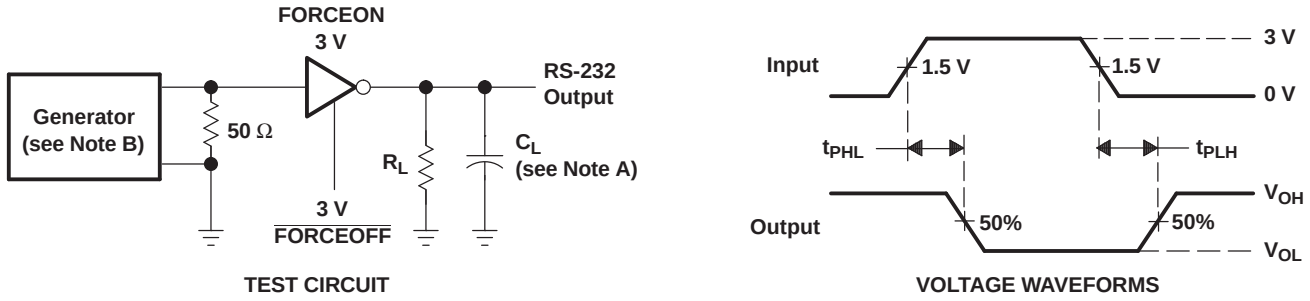

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## PARAMETER MEASUREMENT INFORMATION



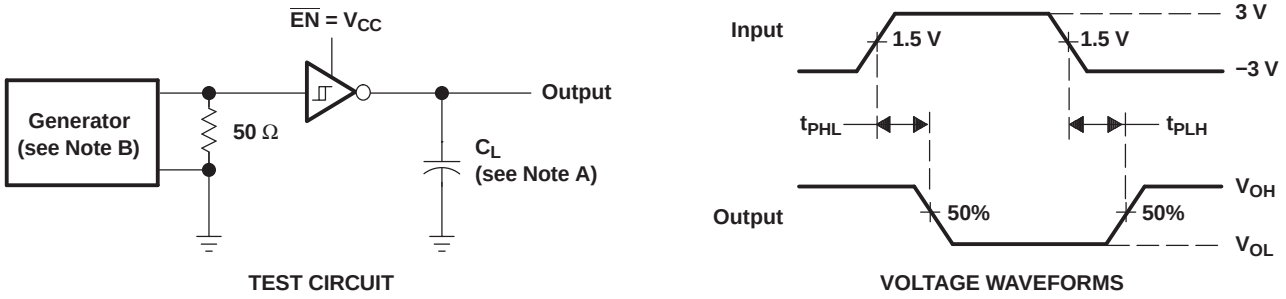

NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**Figure 1. Driver Slew Rate**




NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

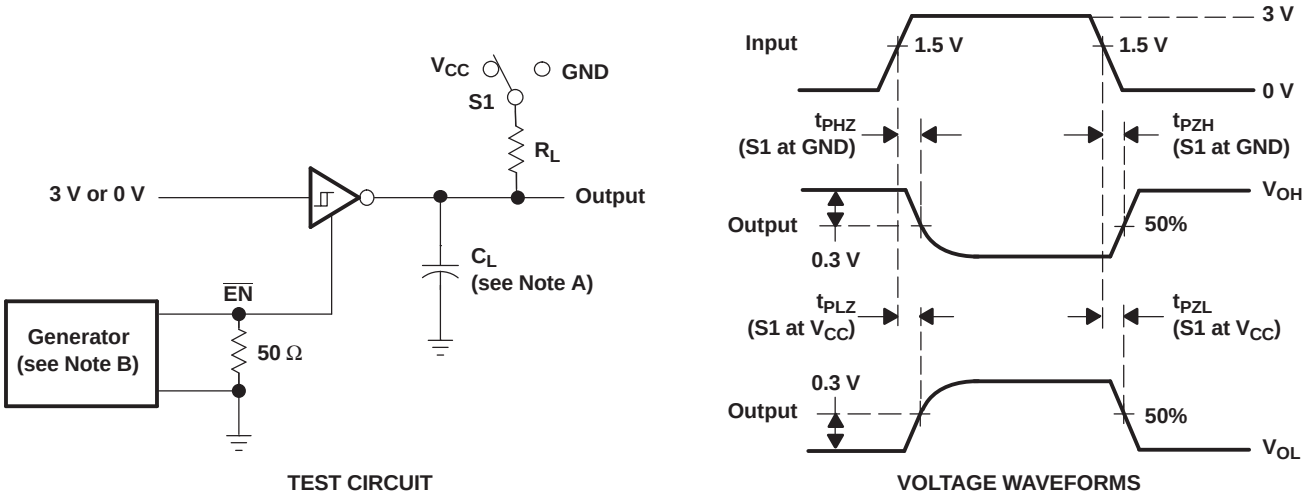
**Figure 2. Driver Pulse Skew**




NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**Figure 3. Receiver Propagation Delay Times**

## PARAMETER MEASUREMENT INFORMATION



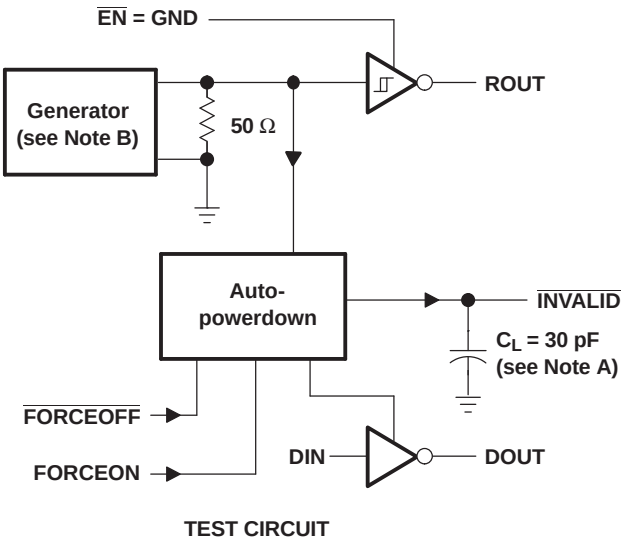

TEST CIRCUIT VOLTAGE WAVEFORMS

NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.
C. $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{dis}$.
D. $t_{PZL}$ and $t_{PZH}$ are the same as $t_{en}$.

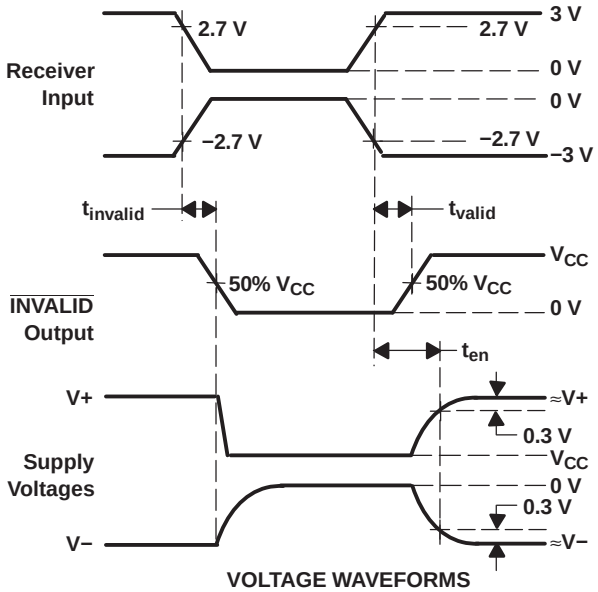
**Figure 4. Receiver Enable and Disable Times**


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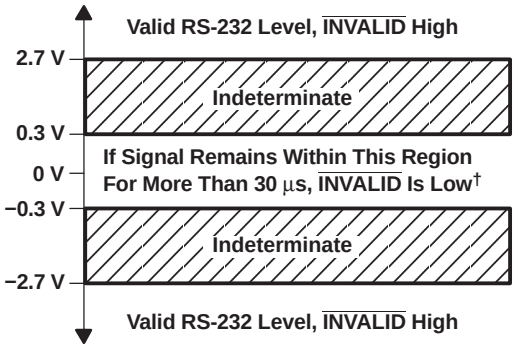
## PARAMETER MEASUREMENT INFORMATION




TEST CIRCUIT




VOLTAGE WAVEFORMS



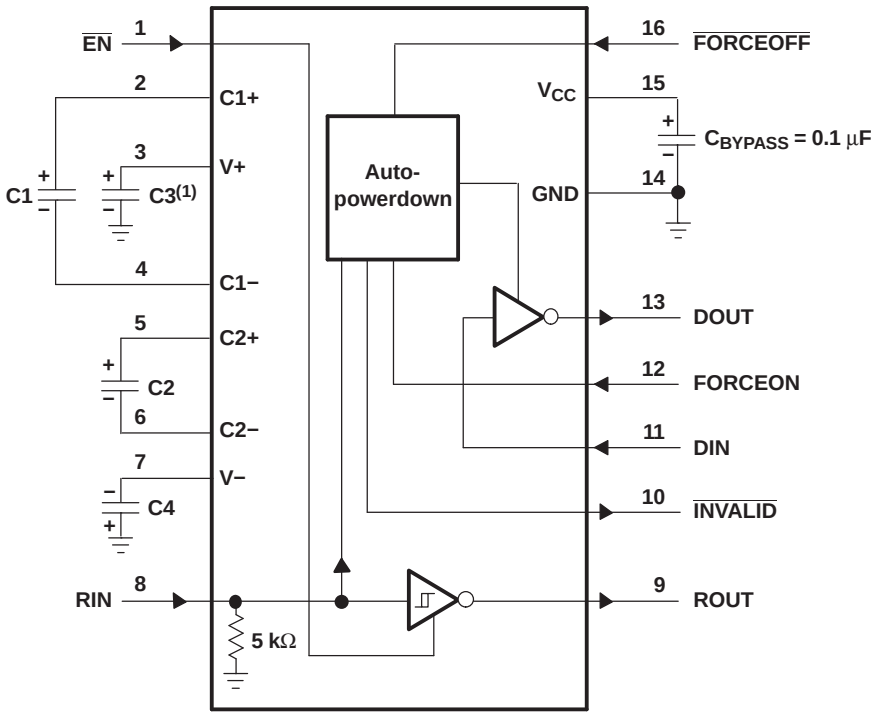

† Auto-powerdown disables drivers and reduces supply current to 1 μA.

NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 5 kbit/s, $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**Figure 5. $\overline{\text{INVALID}}$ Propagation Delay Times and Driver Enabling Time**

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## APPLICATION INFORMATION




(1) C3 can be connected to $V_{CC}$ or GND.

NOTES: A. Resistor values shown are nominal.

B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

**$V_{CC}$ vs CAPACITOR VALUES**

| $V_{CC}$ | C1 | C2, C3, and C4 |
|---|---|---|
| 3.3 V ± 0.3 V | 0.1 µF | 0.1 µF |
| 5 V ± 0.5 V | 0.047 µF | 0.33 µF |
| 3 V to 5.5 V | 0.1 µF | 0.47 µF |

**Figure 6. Typical Operating Circuit and Capacitor Values**


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## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SN65C3221EDB | ACTIVE | SSOP | DB | 16 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN65C3221EDBR | ACTIVE | SSOP | DB | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN65C3221EDBRG4 | ACTIVE | SSOP | DB | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN65C3221EPW | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN65C3221EPWE4 | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN65C3221EPWG4 | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN65C3221EPWR | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN65C3221EPWRE4 | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MU221E | Samples |
| SN75C3221EDB | ACTIVE | SSOP | DB | 16 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MY221E | Samples |
| SN75C3221EDBR | ACTIVE | SSOP | DB | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MY221E | Samples |
| SN75C3221EPW | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MY221E | Samples |
| SN75C3221EPWR | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MY221E | Samples |

(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.

**(4)** There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

**(5)** Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

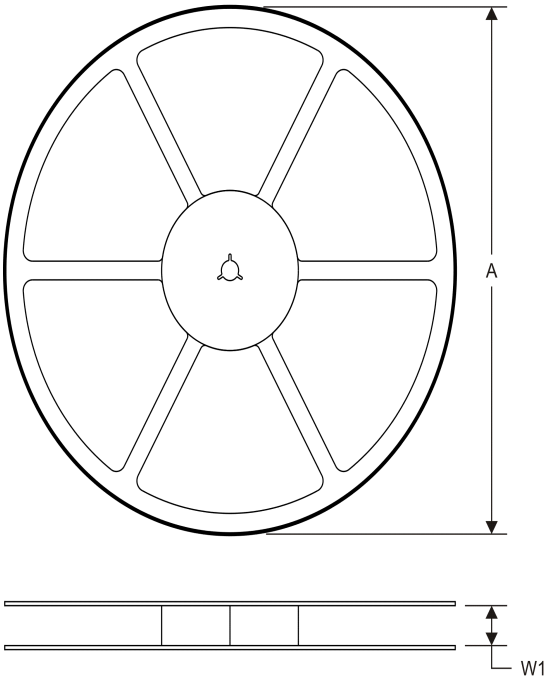
**(6)** Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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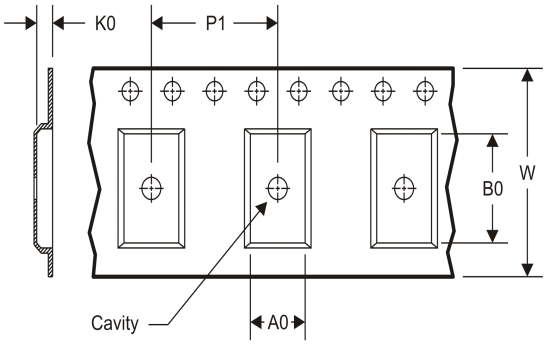
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## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**




**TAPE DIMENSIONS**



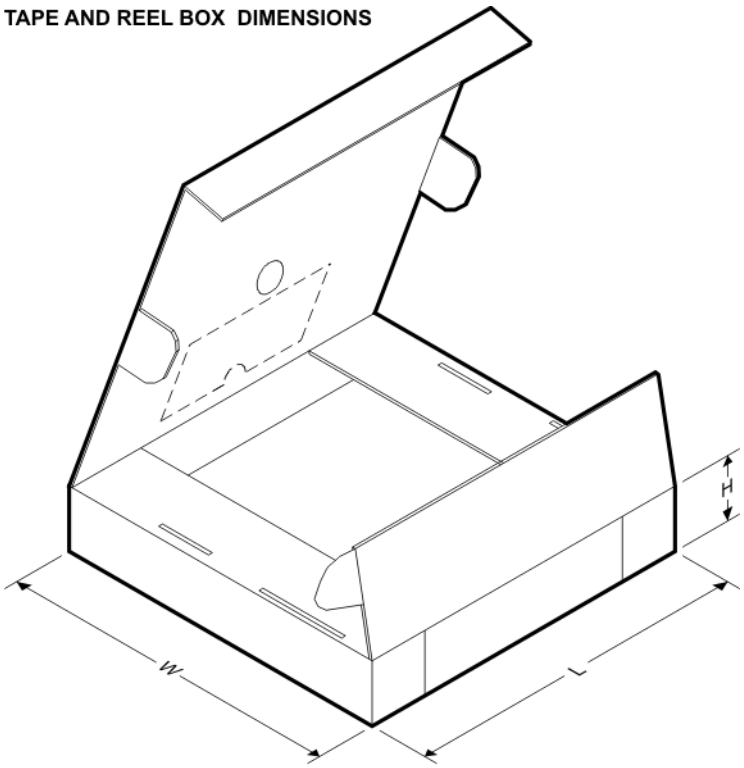

| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SN65C3221EDBR | SSOP | DB | 16 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| SN65C3221EPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| SN75C3221EDBR | SSOP | DB | 16 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| SN75C3221EPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

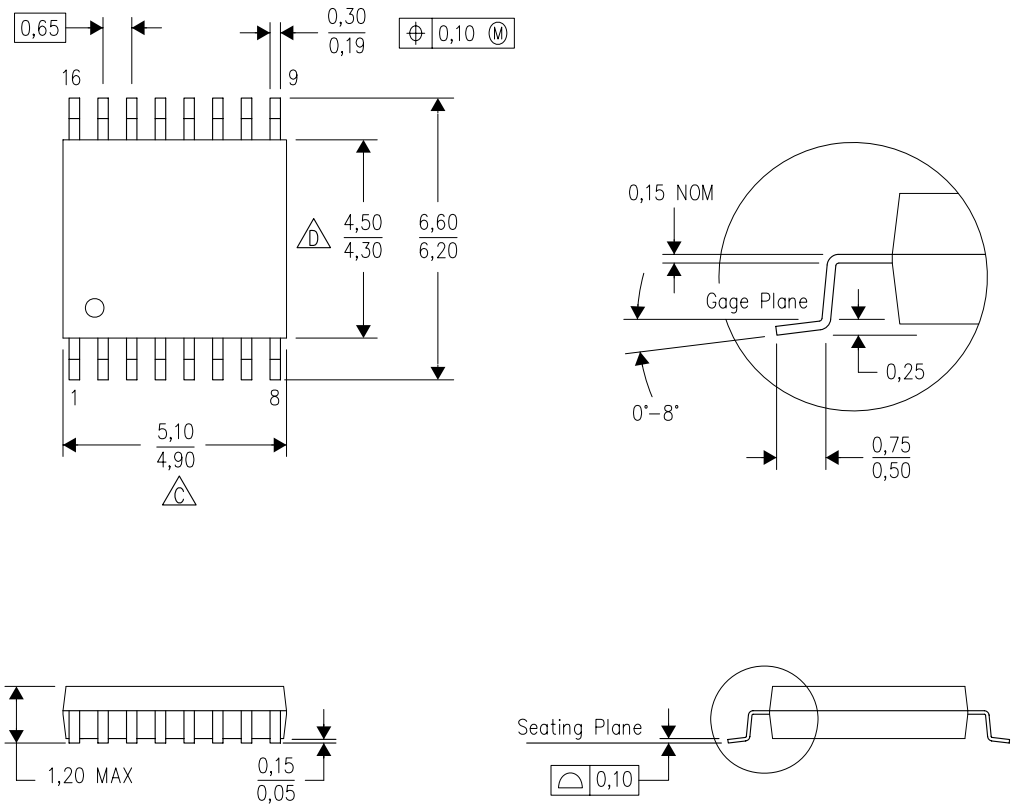
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| SN65C3221EDBR | SSOP | DB | 16 | 2000 | 367.0 | 367.0 | 38.0 |
| SN65C3221EPWR | TSSOP | PW | 16 | 2000 | 367.0 | 367.0 | 35.0 |
| SN75C3221EDBR | SSOP | DB | 16 | 2000 | 367.0 | 367.0 | 38.0 |
| SN75C3221EPWR | TSSOP | PW | 16 | 2000 | 367.0 | 367.0 | 35.0 |

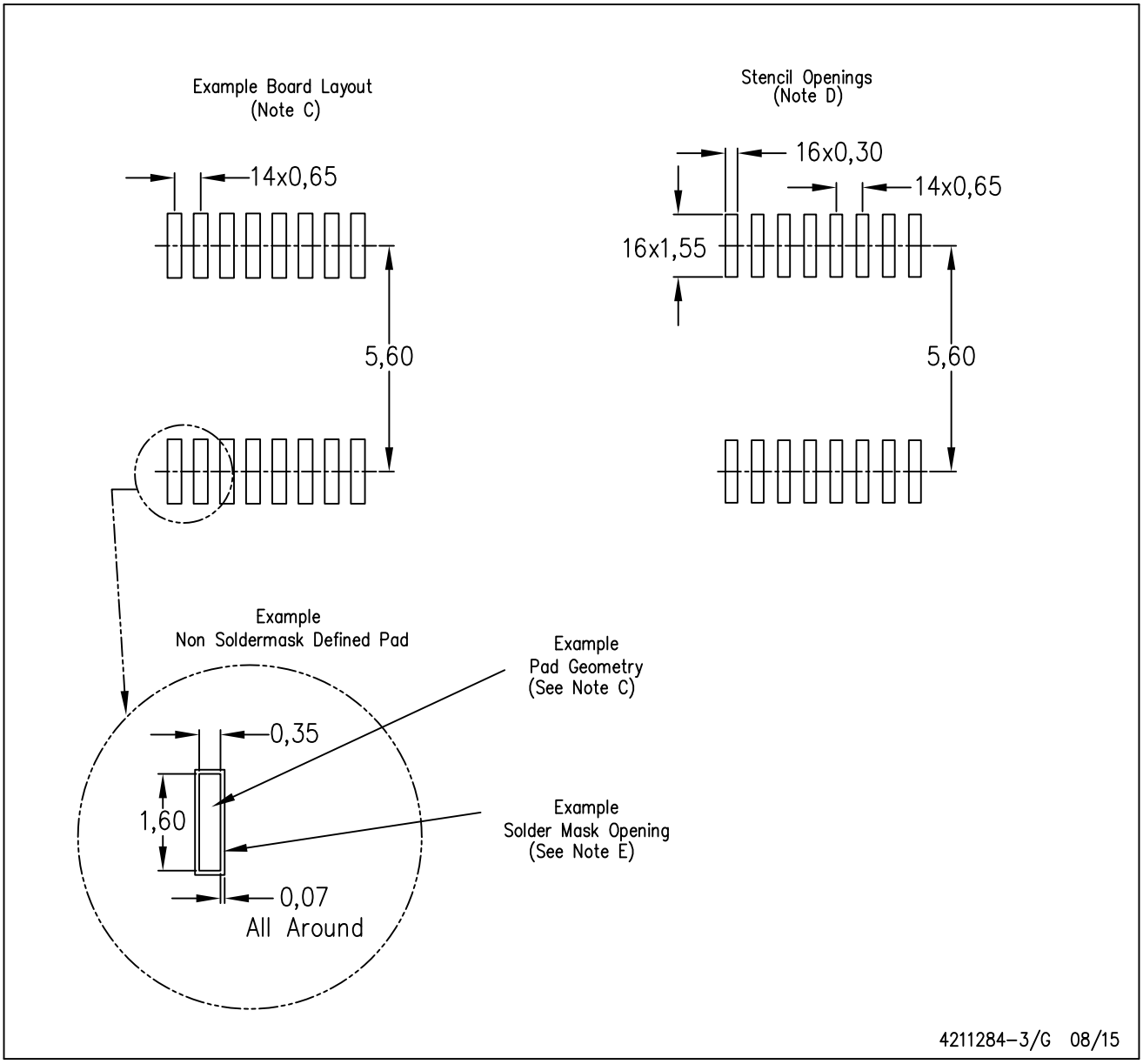
PW (R–PDSO–G16) PLASTIC SMALL OUTLINE




4040064–4/G 02/11

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. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

PW (R–PDSO–G16) PLASTIC SMALL OUTLINE

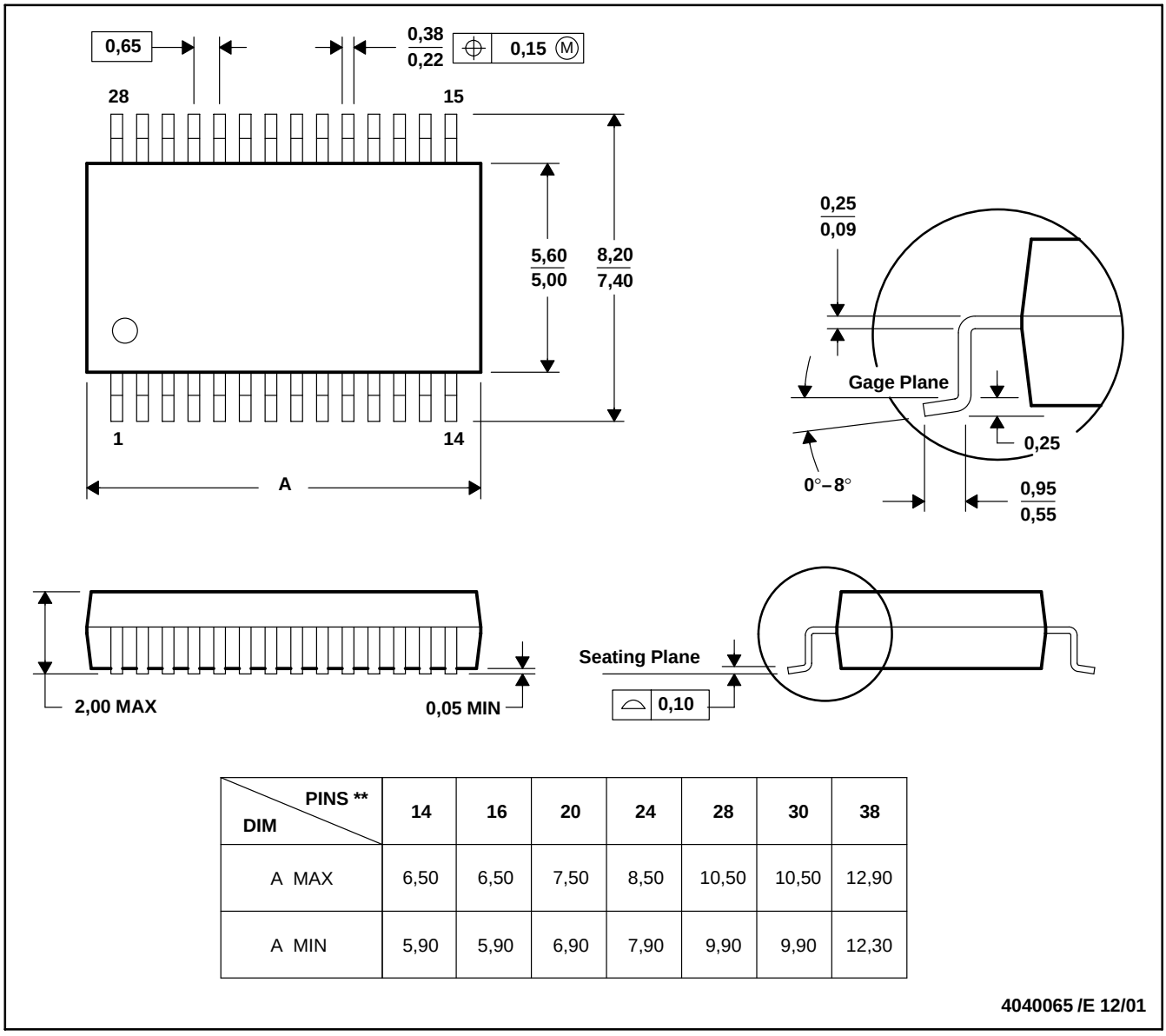



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

MSSO002E – JANUARY 1995 – REVISED DECEMBER 2001

**DB (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE**

**28 PINS SHOWN**




| DIM \ PINS ** | 14 | 16 | 20 | 24 | 28 | 30 | 38 |
|---|---|---|---|---|---|---|---|
| A MAX | 6,50 | 6,50 | 7,50 | 8,50 | 10,50 | 10,50 | 12,90 |
| A MIN | 5,90 | 5,90 | 6,90 | 7,90 | 9,90 | 9,90 | 12,30 |

**4040065 /E 12/01**

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-150

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