TEXAS INSTRUMENTS

MAX3221 3-V to 5.5-V RS-232 Line Driver and Receiver With ±15-kV ESD Protection

1 Features

- RS-232 Bus-pin ESD protection exceeds ±15 kV using human body model (HBM)
- Meets or exceeds the requirements of TIA/EIA-232-F and ITU V.28 standards
- Operates with 3-V to 5.5-V V_{CC} supply
- Operates up to 250 kbps
- One driver and one receiver
- Low standby current: 1 µA typical
- External capacitors: 4 × 0.1 µF
- Accepts 5-V logic input with 3.3-V supply
- Alternative high-speed pin-compatible device (1 Mbps)
  - SNx5C3221
- Automatic power-down feature automatically disables drivers for power savings

2 Applications

- Industrial PCs
- Wired networking
- Data center and enterprise computing
- Battery-powered systems
- PDAs
- Notebooks
- Laptops
- Palmtop PCs
- Hand-held equipment

3 Description

The MAX3221 device consists of one line driver, one line receiver with dedicated enable pin, and a dual charge-pump circuit with ±15-kV ESD protection pin to pin (serial-port connection pins, including GND). The device meets the requirements of TIA/EIA-232-F and provides 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 250 kbps and a maximum of 30-V/µs driver output slew rate.
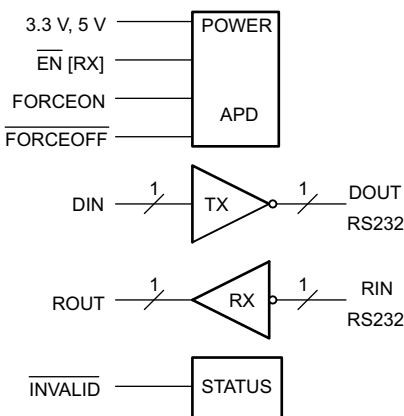
Flexible control options for power management are available when the serial port is inactive. The automatic power-down feature functions when FORCEON is low and FORCEOFF is high. During this mode of operation, if the device does not sense a valid RS-232 signal on the receiver input, the driver output is disabled and the supply current is reduced to 1 µA. The INVALID output notifies the user if an RS-232 signal is present at the receiver input.

Device Information

PART NUMBER	PACKAGE[1]	BODY SIZE (NOM)
MAX3221	SSOP (DB) (32)	6.20 mm × 5.30 mm
	TSSOP (PW) (32)	5.00 mm × 4.40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Diagram

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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

5 Pin Configuration and Functions

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        ┌────∪────┐
 EN   1 │         │ 16  FORCEOFF
 C1+  2 │         │ 15  VCC
 V+   3 │         │ 14  GND
 C1−  4 │         │ 13  DOUT
 C2+  5 │         │ 12  FORCEON
 C2−  6 │         │ 11  DIN
 V−   7 │         │ 10  INVALID
 RIN  8 │         │ 9   ROUT
        └─────────┘
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Figure 5-1. DB or PW Package, 16-Pin SSOP or TSSOP, Top View

Table 5-1. Pin Functions

PIN NAME	NO.	I/O	DESCRIPTION
C1+	2	—	Positive terminals of the voltage-doubler charge-pump capacitors
C2+	5		
C1−	4	—	Negative terminals of the voltage-doubler charge-pump capacitors
C2−	6		
DIN	11	I	Driver input
DOUT	13	O	RS-232 driver output
EN	1	I	Low input enables receiver ROUT output. High input sets ROUT to high impedance.
FORCEOFF	16	I	Automatic power-down control input
FORCEON	12	I	Automatic power-down control input
GND	14	—	Ground
INVALID	10	O	Invalid output pin. Output low when all RIN inputs are unpowered.
RIN	8	I	RS-232 receiver input
ROUT	9	O	Receiver output
VCC	15	—	3-V to 5.5-V supply voltage
V+	3	O	5.5-V supply generated by the charge pump
V−	7	O	–5.5-V supply generated by the charge pump

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)[1]

			MIN	MAX	UNIT
	V_{CC} to GND		−0.3	6	V
	V+ to GND		−0.3	7	
	V− to GND		0.3	−7	
	V+ + |V−|[2]			13	
V_I	Input voltage	DIN, $\overline{EN}$, $\overline{FORCEOFF}$, and FORCEON to GND	−0.3	6	V
		RIN to GND		±25	
V_O	Output voltage	DOUT to GND		±13.2	V
		ROUT to GND	−0.3	V_{CC} + 0.3	
T_J	Junction temperature[3]			150	°C
T_{stg}	Storage temperature range		−65	150	

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the Recommended Operating Conditions but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) V+ and V− can have maximum magnitudes of 7 V, but their absolute difference cannot exceed 13 V.
(3) Maximum power dissipation is a function of T_J(max), $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) − T_A) / R_{\theta JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

6.2 ESD Ratings

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001[1]	All pins except 8, 13	±3000	V
			Pins 8, 13	±15,000	
		Charged-device model (CDM), per JEDEC specification JESD22-C101[2]		±1500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

(see Figure 9-1)[1]

				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 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 low-level input voltage	DIN, $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$				0.8	V
V_I	Driver input voltage	DIN, $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$		0		5.5	V
	Receiver input voltage			−25		25	
T_A	Operating free-air temperature		MAX3221C	0		70	°C
			MAX3221I	−40		85	

(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.

Product Folder Links: *MAX3221*

6.4 Thermal Information

THERMAL METRIC[1]		MAX3221 DB (SSOP) 16 PINS	MAX3221 PW (TSSOP) 16 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	105.8	110.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	51.9	41.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	57.6	57.2	°C/W
ψ_{JT}	Junction-to-top characterization parameter	14.1	4.2	°C/W
ψ_{JB}	Junction-to-board characterization parameter	56.8	56.6	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

6.5 Electrical Characteristics – Power

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)[2]

PARAMETER			TEST CONDITIONS		MIN	TYP[1]	MAX	UNIT
I_I	Input leakage current	$\overline{FORCEOFF}$, FORCEON, $\overline{EN}$				±0.01	±1	µA
I_{CC}	Supply current	Automatic power-down disabled	No load, V_{CC} = 3.3 V to 5 V	No load, $\overline{FORCEOFF}$ and FORCEON at V_{CC}		0.3	1	mA
		Powered off		No load, $\overline{FORCEOFF}$ at GND		1	10	µA
		Automatic power-down enabled		No load, $\overline{FORCEOFF}$ at V_{CC}, FORCEON at GND, All RIN are open or grounded		1	10	

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) 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.

6.6 Electrical Characteristics – Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)[3]

PARAMETER		TEST CONDITIONS		MIN	TYP[1]	MAX	UNIT
V_{OH}	High-level output voltage	D_{OUT} at R_L = 3 kΩ to GND,	D_{IN} = GND	5	5.4		V
V_{OL}	Low-level output voltage	D_{OUT} at R_L = 3 kΩ to GND,	D_{IN} = 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[2]	V_{CC} = 3.6 V	V_O = 0 V		±35	±60	mA
		V_{CC} = 5.5 V	V_O = 0 V		±35	±60	
r_O	Output resistance	V_{CC}, V+, and V− = 0 V	V_O = ±2 V	300	10M		Ω
I_{off}	Output leakage current	$\overline{FORCEOFF}$ = GND	V_O = ±12 V, V_{CC} = 3 V to 3.6 V			±25	µA
			V_O = ±12 V, V_{CC} = 4.5 V to 5.5 V			±25	

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) 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.
(3) 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

6.7 Electrical Characteristics – Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)[2]

	PARAMETER	TEST CONDITIONS	MIN	TYP[1]	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = −1 mA	V_{CC} − 0.6	V_{CC} − 0.1		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		1.5	2.4	V
		V_{CC} = 5 V		1.8	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)   All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2)   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.

6.8 Electrical Characteristics – Status

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)[2]

	PARAMETER	TEST CONDITIONS	MIN	TYP[1]	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_{OH} = −1 mA, FORCEON = GND, $\overline{FORCEOFF}$ = V_{CC}			0.4	V

(1)   All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2)   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.

6.9 Switching Characteristics – Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)[3]

	PARAMETER	TEST CONDITIONS		MIN	TYP[1]	MAX	UNIT
	Maximum data rate	C_L = 1000 pF, R_L = 3 kΩ, see Figure 7-1		150	250		kbps
$t_{sk(p)}$	Pulse skew[2]	C_L = 150 to 2500 pF, R_L = 3 kΩ to 7 kΩ, see Figure 7-2			100		ns
SR(tr)	Slew rate, transition region (see Figure 7-1)	V_{CC} = 3.3 V, R_L = 3 kΩ to 7 kΩ	C_L = 150 to 1000 pF	6		30	V/μs
			C_L = 150 to 2500 pF	4		30	

(1)   All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2)   Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.
(3)   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.

Product Folder Links: *MAX3221*

6.10 Switching Characteristics – Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)[3]

	PARAMETER	TEST CONDITIONS	MIN	TYP[1]	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	C_L = 150 pF, see Figure 7-3		150		ns
t_{PHL}	Propagation delay time, high- to low-level output	C_L = 150 pF, see Figure 7-3		150		ns
t_{en}	Output enable time	C_L = 150 pF, R_L = 3 kΩ, see Figure 7-4		200		ns
t_{dis}	Output disable time	C_L = 150 pF, R_L = 3 kΩ, see Figure 7-4		200		ns
$t_{sk(p)}$	Pulse skew[2]	See Figure 7-3		50		ns

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.
(3) 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.

6.11 Switching Characteristics – Status

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)[2]

	PARAMETER	MIN	TYP[1]	MAX	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.
(2) 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.

6.12 Typical Characteristics

V_{CC} = 3.3 V
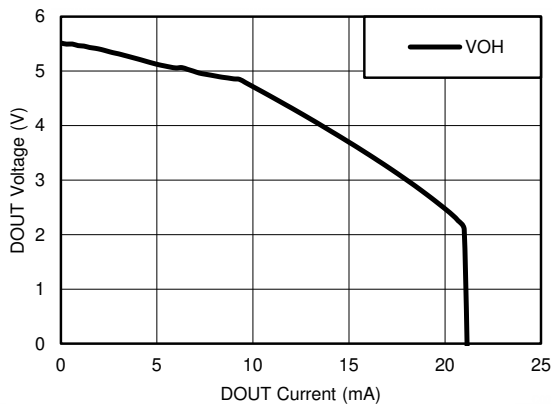
Figure 6-1. DOUT V_{OH} vs Load Current
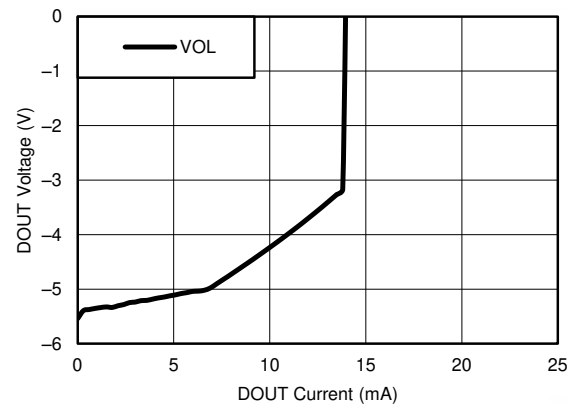
Figure 6-2. DOUT V_{OL} vs Load Current

7 Parameter Measurement Information
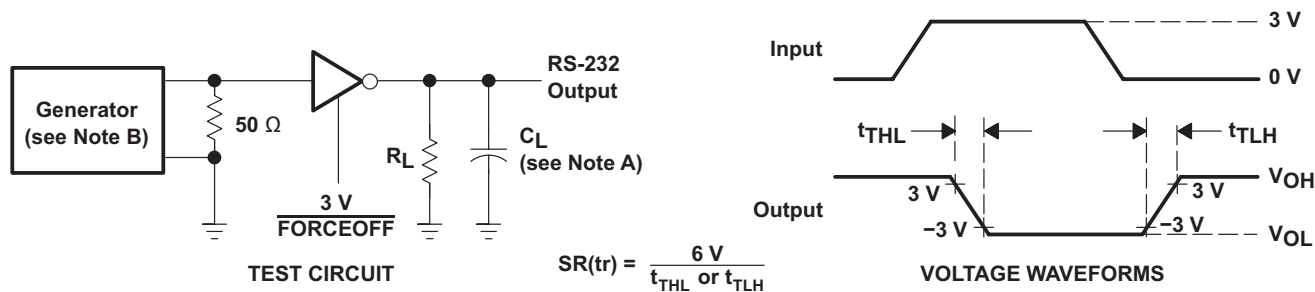
$$SR(tr) = \frac{6\ V}{t_{THL}\ or\ t_{TLH}}$$

A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbps, Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns.

Figure 7-1. Driver Slew Rate
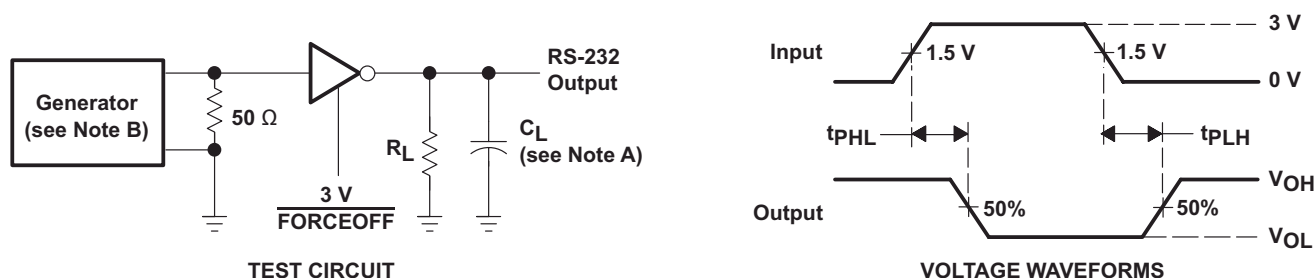
A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbps, Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns.

Figure 7-2. Driver Pulse Skew
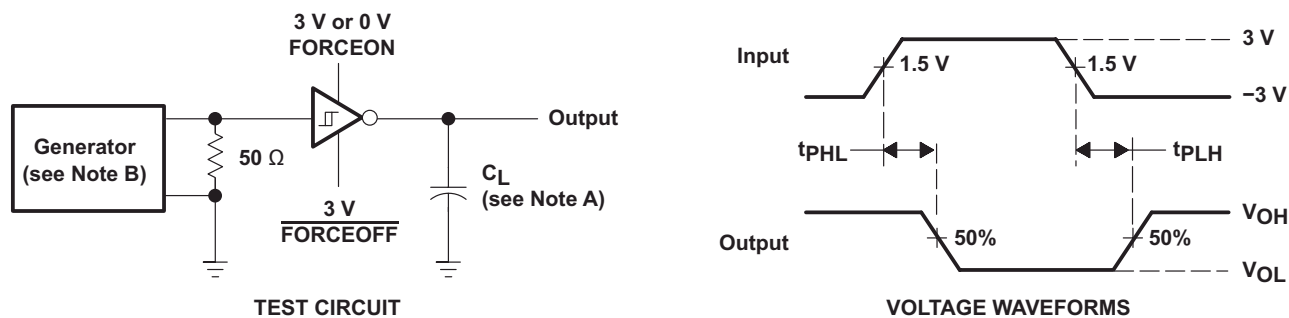
A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns.

Figure 7-3. Receiver Propagation Delay Times

Product Folder Links: *MAX3221*
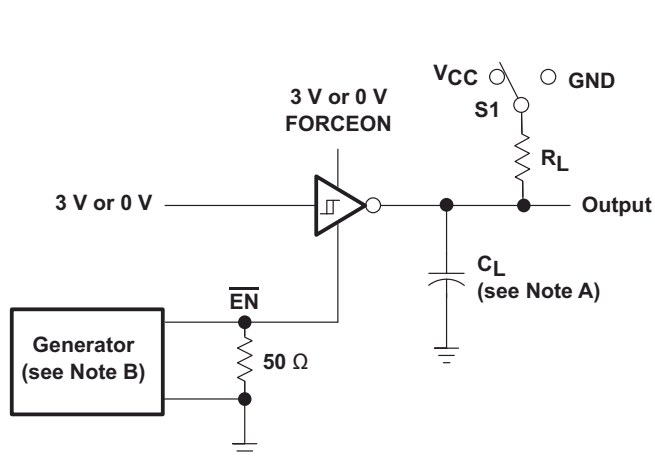
TEST CIRCUIT
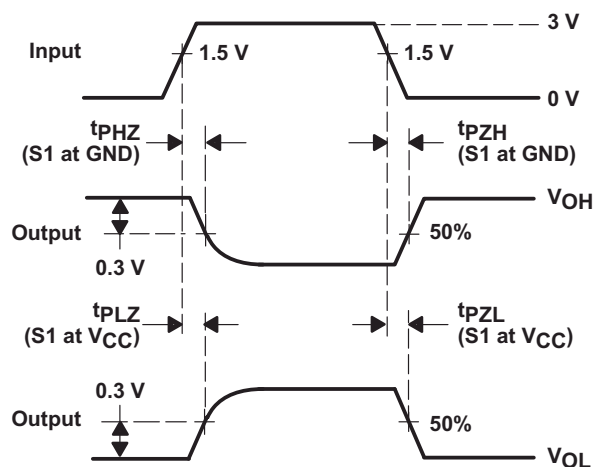
VOLTAGE WAVEFORMS

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 ≤ 10 ns, t_f ≤ 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 7-4. Receiver Enable and Disable Times

Product Folder Links: MAX3221

TEST CIRCUIT

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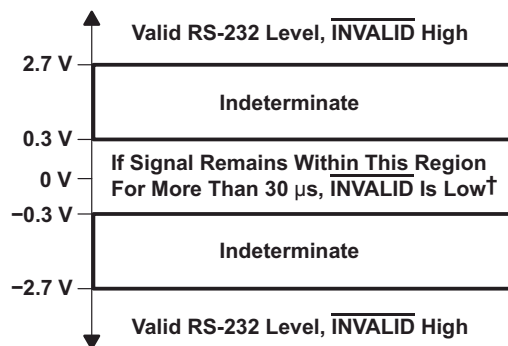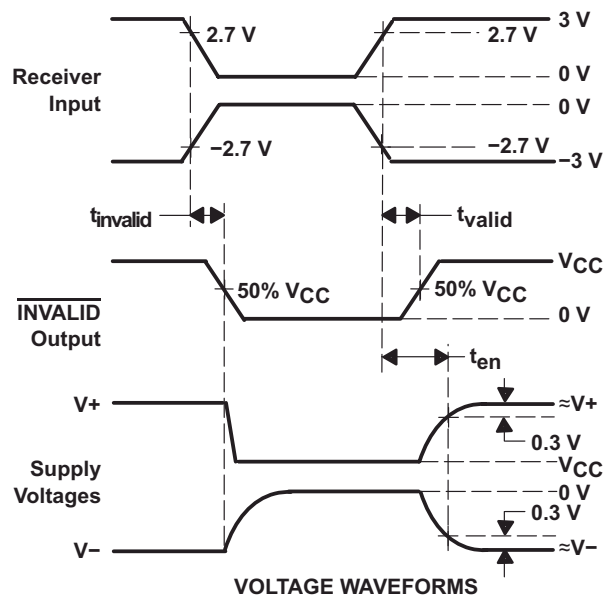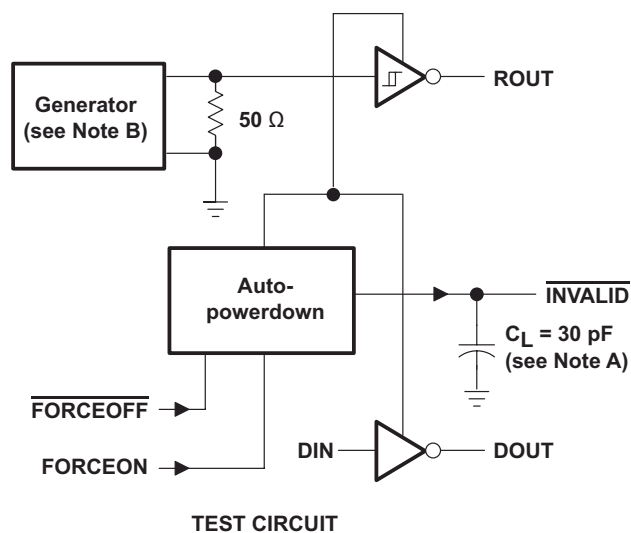
† Auto-powerdown disables drivers and reduces supply
current to 1 µA.

Figure 7-5. INVALID Propagation Delay Times and Driver Enabling Time

Product Folder Links: *MAX3221*

8 Detailed Description

8.1 Overview

The MAX3221 device is a one-driver and one-receiver RS-232 interface device. All RS-232 inputs and outputs are protected to ±15 kV using the Human Body Model. The charge pump requires only four small 0.1-µF capacitors for operation from a 3.3-V supply. The MAX3221 is capable of running at data rates up to 250 kbps, while maintaining RS-232-compliant output levels.

Automatic power-down can be disabled when FORCEON and FORCEOFF are high. With automatic power-down plus enabled, the device activates automatically when a valid signal is applied to any receiver input. The device can automatically power down the driver to save power when the RIN input is unpowered.

INVALID is high (valid data) if 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. INVALID is low (invalid data) if receiver input voltages are between –0.3 V and 0.3 V for more than 30 µs. Refer to Figure 7-5 for receiver input levels.

8.2 Functional Block Diagram
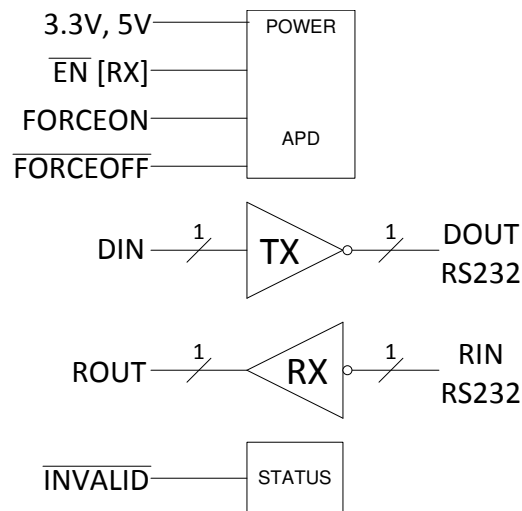
8.3 Feature Description

8.3.1 Power

The power block increases, inverts, and regulates voltage at V+ and V- pins using a charge pump that requires four external capacitors. Auto-power-down feature for driver is controlled by FORCEON and FORCEOFF inputs. Receiver is controlled by EN input. See Table 8-1 and Table 8-2

When MAX3221 is unpowered, it can be safely connected to an active remote RS232 device.

8.3.2 RS232 Driver

One driver interfaces standard logic level to RS232 levels. DIN input must be valid high or low.

8.3.3 RS232 Receiver

One receiver interfaces RS232 levels to standard logic levels. An open input will result in a high output on ROUT. RIN input includes an internal standard RS232 load. A logic high input on the EN pin will shutdown the receiver output.

8.3.4 RS232 Status

The INVALID output goes low when RIN input is unpowered for more than 30 µs. The INVALID output goes high when receiver has a valid input. The INVALID output is active when V_{cc} is powered irregardless of FORCEON and FORCEOFF inputs (see Table 8-3).

Product Folder Links: *MAX3221*

8.4 Device Functional Modes

Table 8-1, Table 8-2, and Table 8-3 show the behavior of the driver, receiver, and INVALID(activelow) features under all possible relevant combinations of inputs.

Table 8-1. Driver[1]

INPUTS				OUTPUT	DRIVER STATUS
DIN	FORCEON	FORCEOFF	VALID RIN RS-232 LEVEL	DOUT	
X	X	L	X	Z	Powered off
L	H	H	X	H	Normal operation with automatic power down disabled
H	H	H	X	L	
L	L	H	Yes	H	Normal operation with automatic power down enabled
H	L	H	Yes	L	
L	L	H	No	Z	Powered off by automatic power down feature
H	L	H	No	Z	

(1)   H = high level, L = low level, X = irrelevant, Z = high impedance, Yes = |RIN| > 2.7 V, No = |RIN| <0.3 V

Table 8-2. Receiver[1]

INPUTS			OUTPUT	RECEIVER STATUS
RIN	$\overline{EN}$	VALID RIN RS-232 LEVEL	ROUT	
X	H	X	Z	Output off
L	L	X	H	Normal operation
H	L	X	L	
Open	L	No	H	

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

Table 8-3. $\overline{INVALID}$ [1]

INPUTS				OUTPUT
RIN	FORCEON	$\overline{FORCEOFF}$	$\overline{EN}$	$\overline{INVALID}$
L	X	X	X	H
H	X	X	X	H
Open	X	X	X	L

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

Figure 8-1. Logic Diagram

Product Folder Links: *MAX3221*
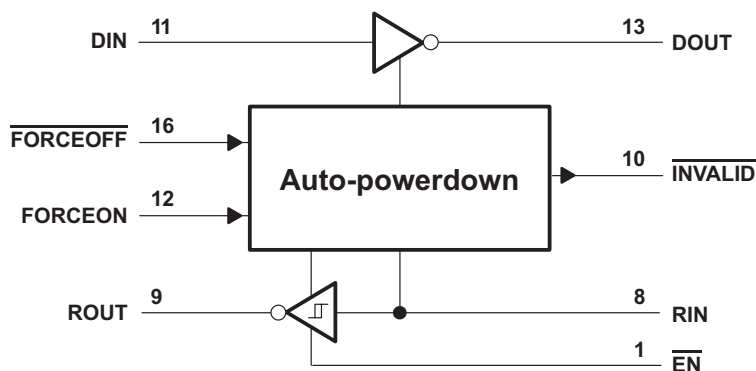
9 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

9.1 Application Information

The MAX3221 line driver and receiver is a specialized device for 3-V to 5.5-V RS-232 communication applications. This application is a generic implementation of this device with all required external components. For proper operation, add capacitors as shown in Figure 9-1.

9.2 Typical Application

ROUT and DIN connect to UART or general purpose logic lines. FORCEON and $\overline{\text{FORCEOFF}}$ may be connected general purpose logic lines or tied to ground or V_{CC}. $\overline{\text{INVALID}}$ may be connected to a general purpose logic line or left unconnected. RIN and DOUT lines connect to a RS232 connector or cable. DIN, FORCEON, and $\overline{\text{FORCEOFF}}$ inputs must not be left unconnected.
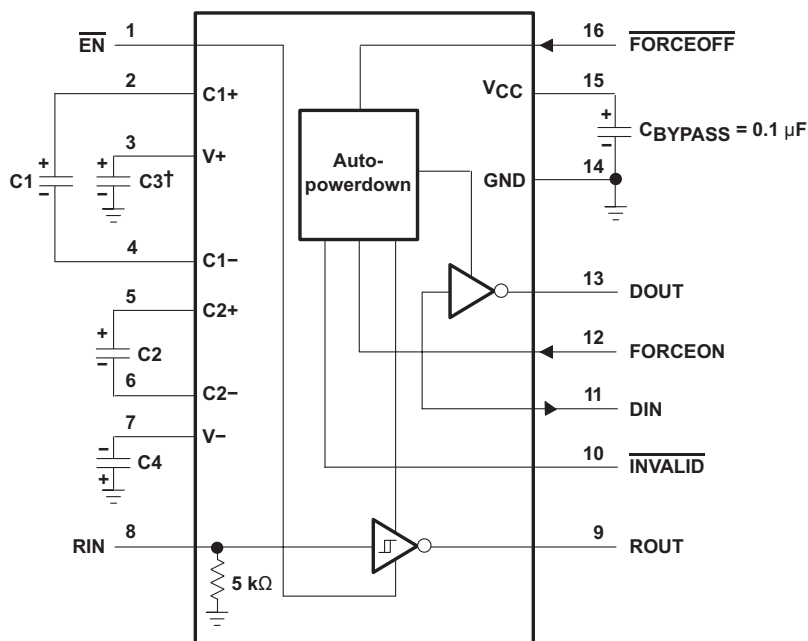
† C3 can be connected to V_{CC} or GND.
NOTES: A. Resistor values shown are nominal.
          B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

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 9-1. Typical Operating Circuit and Capacitor Values

Product Folder Links: *MAX3221*

9.2.1 Design Requirements

- Recommended V_{CC} is 3.3 V or 5 V.
  - 3 V to 5.5 V is also possible
- Maximum recommended bit rate is 250 kbps.
- Use capacitors as shown in Figure 9-1.

9.2.2 Detailed Design Procedure

- DIN, $\overline{\text{FORCEOFF}}$ and FORCEON inputs must be connected to valid low or high logic levels.
- Select capacitor values based on VCC level for best performance.

9.2.3 Application Curve

Curves for V_{CC} of 3.3 V and 250 kbps alternative bit data stream.
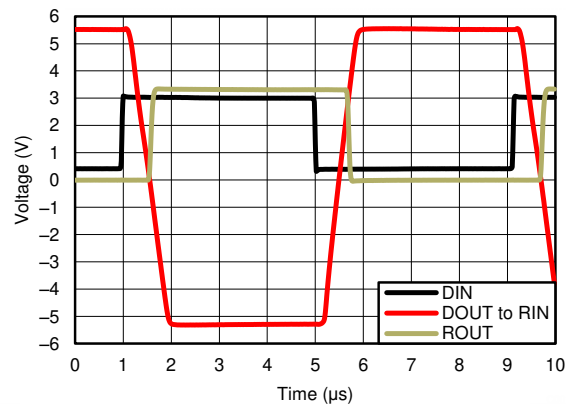
Figure 9-2. 250-kbps Driver to Receiver Loopback Timing Waveform, V_{CC} = 3.3 V

10 Power Supply Recommendations

TI recommends a 0.1-µF capacitor to filter noise on the power supply pin. For additional filter capability, a 0.01-µF capacitor may be added in parallel as well. Power supply input voltage is recommended to be any valid level in *Recommended Operating Conditions*.

Product Folder Links: *MAX3221*

11 Layout

11.1 Layout Guidelines

Keep the external capacitor traces short. This is more important on C1 and C2 nodes that have the fastest rise and fall times.

11.2 Layout Example
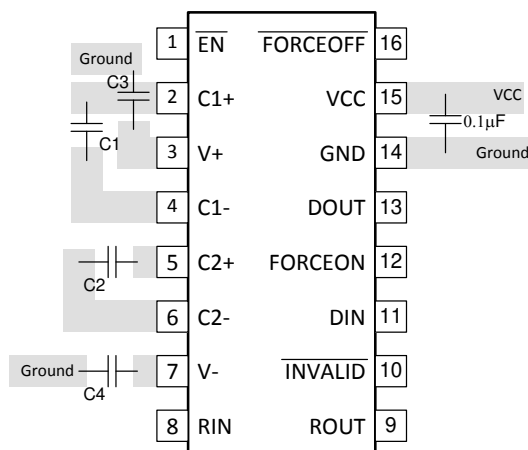
Figure 11-1. Layout Diagram

Product Folder Links: *MAX3221*

12 Device and Documentation Support

12.1 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

12.2 Trademarks

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12.3 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.4 Glossary

TI Glossary   This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

Product Folder Links: *MAX3221*

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
MAX3221CDBR	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C	Samples
MAX3221CDBRG4	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C	Samples
MAX3221CPWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C	Samples
MAX3221CPWRE4	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C	Samples
MAX3221CPWRG4	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C	Samples
MAX3221IDBR	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I	Samples
MAX3221IDBRE4	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I	Samples
MAX3221IDBRG4	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I	Samples
MAX3221IPWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	SN	Level-1-260C-UNLIM	-40 to 85	MB3221I	Samples
MAX3221IPWRG4	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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OTHER QUALIFIED VERSIONS OF MAX3221 :

● Enhanced Product : MAX3221-EP

NOTE: Qualified Version Definitions:

● Enhanced Product - Supports Defense, Aerospace and Medical Applications

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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

*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
MAX3221CDBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
MAX3221CPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221CPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IDBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
MAX3221IPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IPWRG4	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IPWRG4	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS
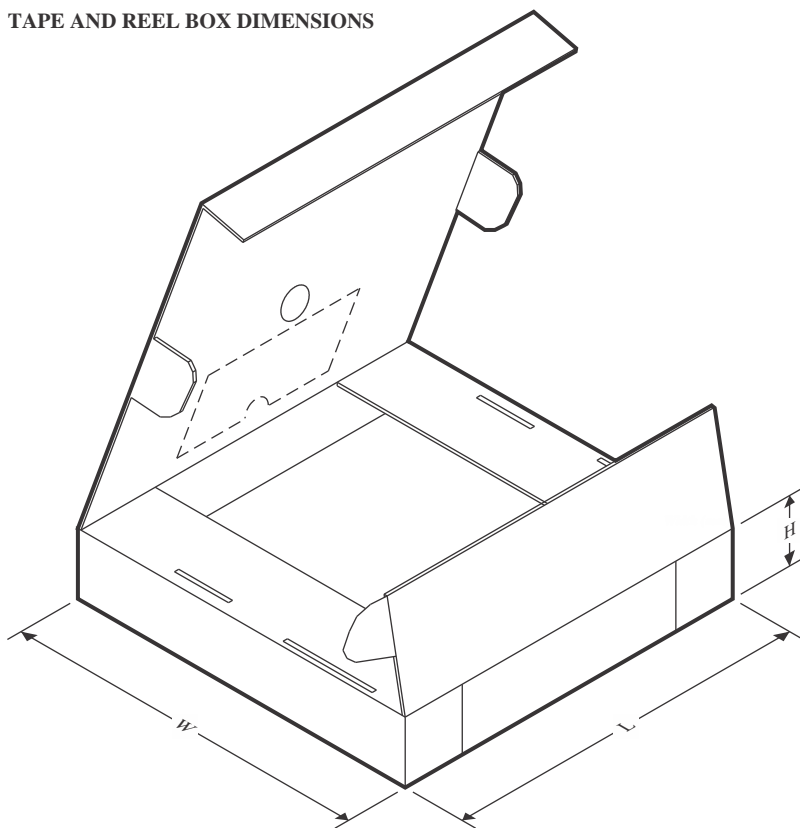
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX3221CDBR	SSOP	DB	16	2000	356.0	356.0	35.0
MAX3221CPWR	TSSOP	PW	16	2000	356.0	356.0	35.0
MAX3221CPWR	TSSOP	PW	16	2000	356.0	356.0	35.0
MAX3221IDBR	SSOP	DB	16	2000	356.0	356.0	35.0
MAX3221IPWR	TSSOP	PW	16	2000	364.0	364.0	27.0
MAX3221IPWR	TSSOP	PW	16	2000	356.0	356.0	35.0
MAX3221IPWR	TSSOP	PW	16	2000	356.0	356.0	35.0
MAX3221IPWRG4	TSSOP	PW	16	2000	356.0	356.0	35.0
MAX3221IPWRG4	TSSOP	PW	16	2000	356.0	356.0	35.0

6.6
6.2 TYP

A

PIN 1 INDEX AREA

1

16

14X 0.65

2X
4.55

5.1
4.9
NOTE 3

8

9

16X 0.30
0.19

B

4.5
4.3
NOTE 4

⊕ 0.1 Ⓜ C A B

SEATING
PLANE

C

⌒ 0.1 C

1.2 MAX

SEE DETAIL A

(0.15) TYP

0.25
GAGE PLANE

0.15
0.05

0.75
0.50

0° -8°

DETAIL A
TYPICAL
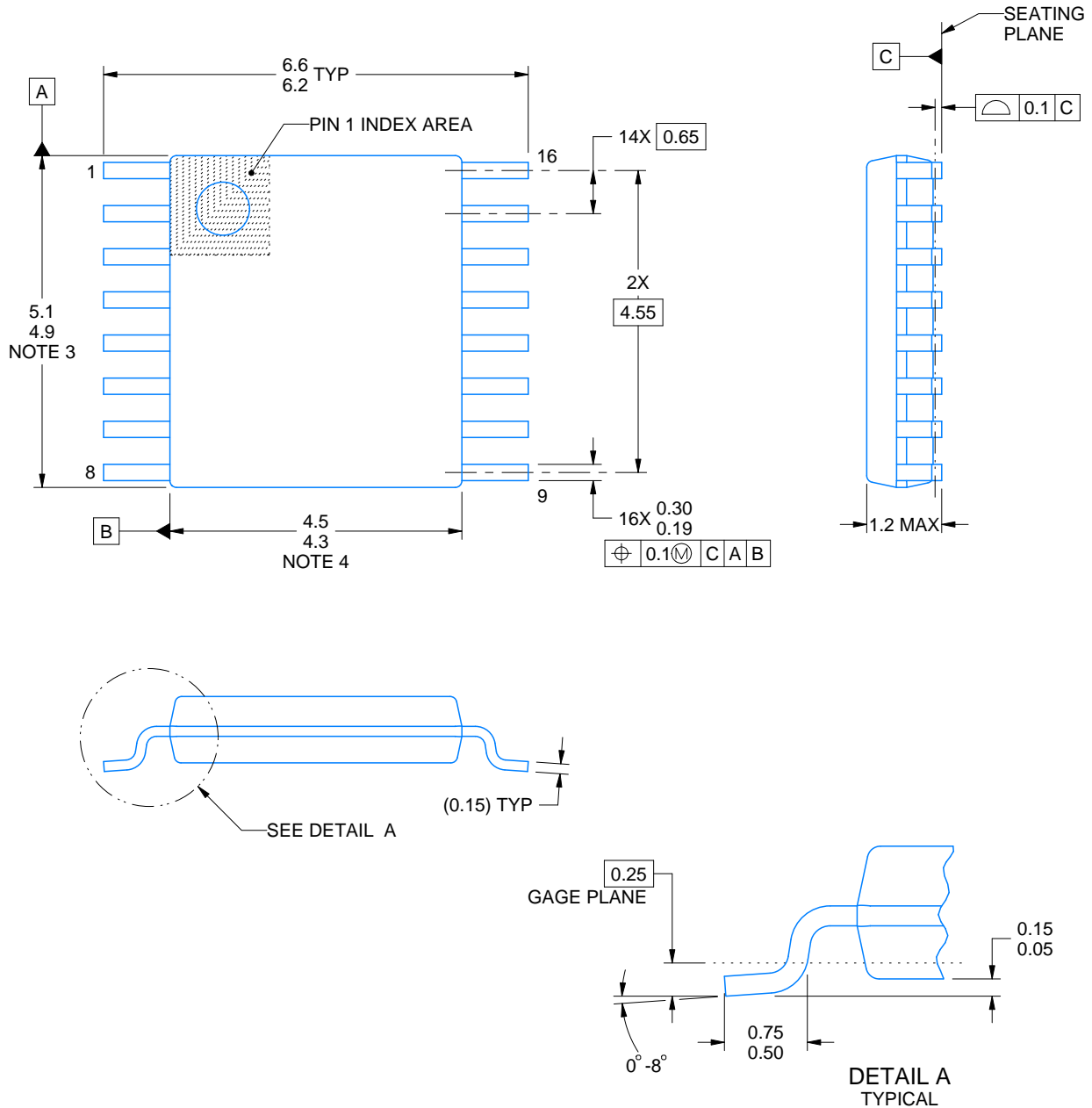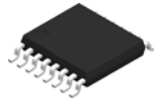
4220204/A   02/2017

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

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16X (1.5)

SYMM

1

16X (0.45)

(R0.05) TYP

16

SYMM

14X (0.65)

8

9

(5.8)

LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

SOLDER MASK
OPENING

METAL

EXPOSED METAL

0.05 MAX
ALL AROUND

NON-SOLDER MASK
DEFINED
(PREFERRED)

METAL UNDER
SOLDER MASK

SOLDER MASK
OPENING

EXPOSED METAL

0.05 MIN
ALL AROUND

SOLDER MASK
DEFINED

SOLDER MASK DETAILS
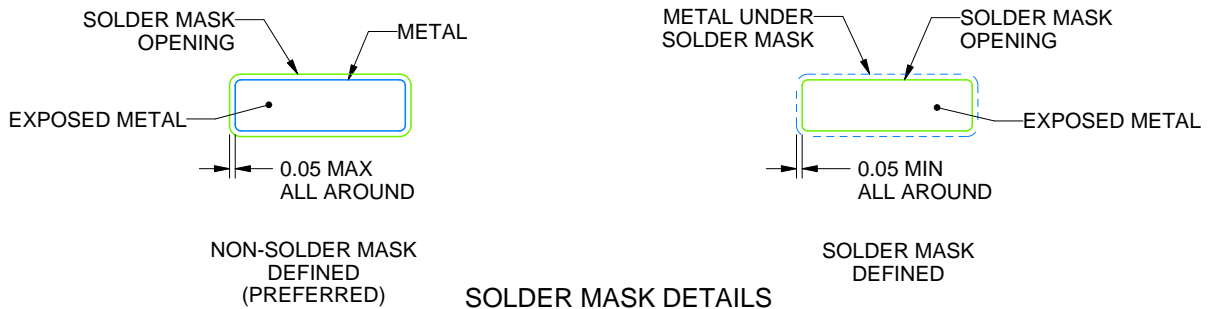
4220204/A   02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

TEXAS
INSTRUMENTS
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16X (1.5)

SYMM

1

16X (0.45)

(R0.05) TYP

16

SYMM

14X (0.65)

8

9

(5.8)
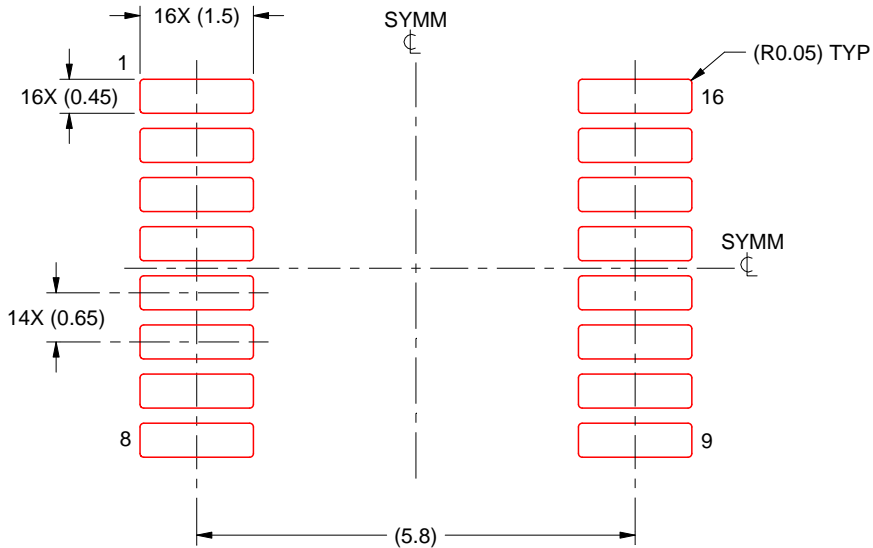
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/A   02/2017

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate
   design recommendations.
9. Board assembly site may have different recommendations for stencil design.

TEXAS
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PIN 1 INDEX AREA

8.2 / 7.4 TYP

A

B

1

16

8

9

6.5 / 5.9 NOTE 3

5.6 / 5.0 NOTE 4

14X 0.65

2X 4.55

16X 0.38 / 0.22

⊕ 0.1 Ⓜ C A B

C

⌒ 0.1 C

SEATING PLANE

SEE DETAIL A

0.25 / 0.09

GAGE PLANE

0.25

0° -8°

0.95 / 0.55

2 MAX

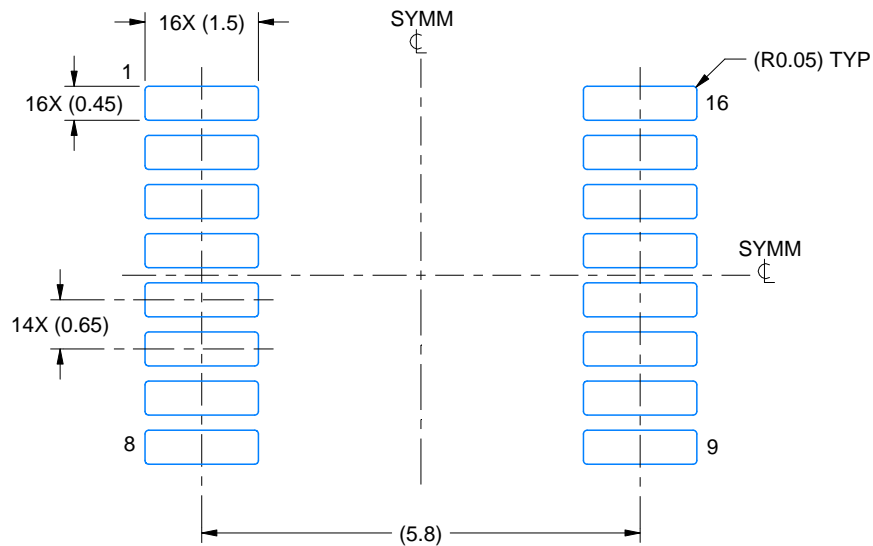0.05 MIN

DETAIL A
TYPICAL

4220763/A 05/2022

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-150.

TEXAS INSTRUMENTS
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16X (1.85)

1

16X (0.45)

SYMM

(R0.05) TYP

16

SYMM

14X (0.65)

8

9

(7)

LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

SOLDER MASK OPENING

METAL

EXPOSED METAL

0.05 MAX
ALL AROUND

NON-SOLDER MASK DEFINED (PREFERRED)

METAL UNDER SOLDER MASK

SOLDER MASK OPENING

EXPOSED METAL

0.05 MIN
ALL AROUND

SOLDER MASK DEFINED

SOLDER MASK DETAILS

4220763/A 05/2022

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220763/A   05/2022

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
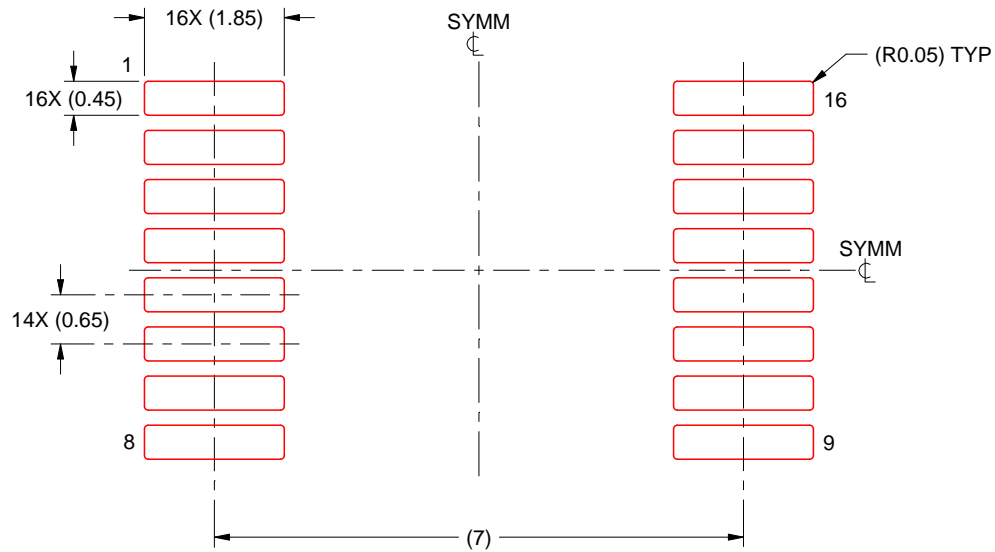8. Board assembly site may have different recommendations for stencil design.

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