

MAX3221E 3-V to 5.5-V Single-Channel RS-232 Line Driver/Receiver

With ± 15 -kV IEC ESD Protection

1 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)
- 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 kbit/s
- One Driver and One Receiver
- Low Standby Current: 1 μ A Typical
- Accepts 5-V Logic Input With 3.3-V Supply
- Auto-Power-Down Feature Automatically Disables Drivers for Power Savings
- Alternative High-Speed Device (1 Mbit/s)
 - SN75C3221E and SN65C3221E

2 Applications

- Battery-Powered, Hand-Held, and Portable Equipment
- Notebooks and Laptops
- Mobile Phones and Wireless Devices

3 Description

The MAX3221E is a single driver, single receiver RS-232 solution operating from a single V_{CC} supply. The RS-232 pins provide IEC 61000-4-2 ESD protection. 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 kbit/s and a maximum of 30-V/ μ s driver output slew rate.

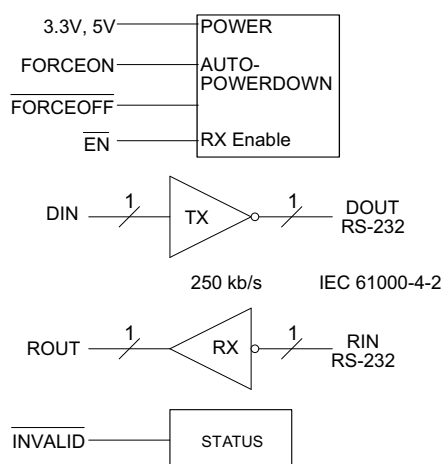
Flexible control options for power management are available. Auto-power down disables driver and charge pump when the receiver is disconnected or the remote driver is power down. The drivers can be manually enabled or disabled. INVALID output goes low when receiver input is unconnected or power off.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
MAX3221ECDB, MAX3221EIDB	SSOP (16)	6.20 mm $\times$ 5.30 mm
MAX3221ECPW, MAX3221EIPW	TSSOP (16)	5.00 mm $\times$ 4.40 mm

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

Block Diagram



Copyright © 2016, Texas Instruments Incorporated



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

Table of Contents

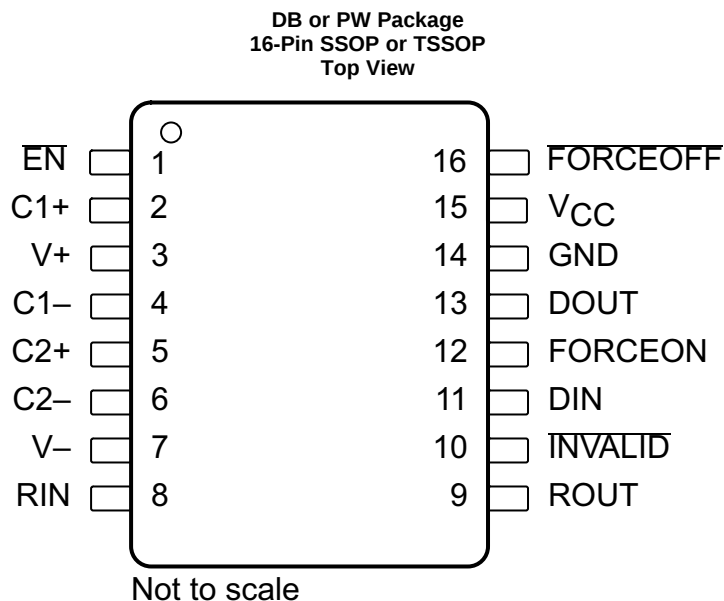
1 Features	1	8 Detailed Description	11
2 Applications	1	8.1 Overview	11
3 Description	1	8.2 Functional Block Diagram	11
4 Revision History	2	8.3 Feature Description	11
5 Pin Configuration and Functions	3	8.4 Device Functional Modes	12
6 Specifications	4	9 Application and Implementation	13
6.1 Absolute Maximum Ratings	4	9.1 Application Information	13
6.2 ESD Ratings	4	9.2 Typical Application	13
6.3 Recommended Operating Conditions	4	10 Power Supply Recommendations	16
6.4 Thermal Information	5	11 Layout	16
6.5 Electrical Characteristics	5	11.1 Layout Guidelines	16
6.6 Electrical Characteristics: Driver	5	11.2 Layout Example	16
6.7 Electrical Characteristics: Receiver	6	12 Device and Documentation Support	17
6.8 Electrical Characteristics: Auto-Power Down	6	12.1 Receiving Notification of Documentation Updates	17
6.9 Switching Characteristics: Driver	6	12.2 Community Resource	17
6.10 Switching Characteristics: Receiver	6	12.3 Trademarks	17
6.11 Switching Characteristics: Auto-Power Down	7	12.4 Electrostatic Discharge Caution	17
6.12 Typical Characteristics	7	12.5 Glossary	17
7 Parameter Measurement Information	8	13 Mechanical, Packaging, and Orderable Information	17

4 Revision History

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

Changes from Revision A (May 2006) to Revision B	Page
• Added ESD Ratings table, Feature Description section, Device Functional Modes, Application and Implementation section, Power Supply Recommendations section, Layout section, Device and Documentation Support section, and Mechanical, Packaging, and Orderable Information section	1
• Deleted Ordering Information table; see the POA at the end of the data sheet	1
• Changed R _{θJA} thermal values: 82 to 92 for DB package and 108 to 100.3 for PW Package	5

5 Pin Configuration and Functions



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
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
$\overline{\text{EN}}$	1	I	Low input enables receiver ROUT output. High input sets ROUT to high impedance.
$\overline{\text{FORCEOFF}}$	16	I	Automatic power-down control input
FORCEON	12	I	Automatic power-down control input
GND	14	—	Ground
$\overline{\text{INVALID}}$	10	O	Invalid output pin. Output low when RIN input is unpowered.
RIN	8	I	RS-232 receiver input
ROUT	9	O	Receiver output
V _{CC}	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}	Supply voltage ⁽²⁾		−0.3	6	V
V+	Positive output supply voltage ⁽²⁾		−0.3	7	V
V−	Negative output supply voltage ⁽²⁾		0.3	−7	V
V+ − V−	Supply voltage difference ⁽²⁾		13		V
V _I	Input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON, $\overline{\text{EN}}$	−0.3	6	V
		RIN	−25	25	
V _O	Output voltage	DOUT	−13.2	13.2	V
		ROUT, $\overline{\text{INVALID}}$	−0.3	V _{CC} + 0.3	
T _J	Operating virtual junction temperature		150		°C
T _{stg}	Storage temperature		−65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to network GND.

6.2 ESD Ratings

				VALUE	UNIT	
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	Pins 8 and 11	±15000	V	
			All other pins	±2000		
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	All pins	±1500		
			IEC 61000-4-2 Contact Discharge, DOUT and RIN	Pins 8 and 11		±8000
						IEC 61000-4-2 Air-Gap Discharge, DOUT and RIN

- (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 11](#) ⁽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 and control high-level input voltage	V _{CC} = 3.3 V	2			V
		V _{CC} = 5 V	2.4			
V _{IL}	Driver and control low-level input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON, $\overline{\text{EN}}$			0.8	V
V _I	Driver and control input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON	0		5.5	V
V _I	Receiver input voltage		−25		25	V
T _A	Operating free-air temperature	MAX3221EC	0		70	°C
		MAX3221EI	−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.

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		MAX3221E		UNIT
		DB (SSOP)	PW (TSSOP)	
		16 PINS	16 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	92	100.3	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	42.8	35.6	°C/W
R _{θJB}	Junction-to-board thermal resistance	42.4	45.1	°C/W
ψ _{JT}	Junction-to-top characterization parameter	9.1	2.5	°C/W
ψ _{JB}	Junction-to-board characterization parameter	41.9	44.6	°C/W

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

6.5 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)⁽¹⁾

PARAMETER		TEST CONDITIONS		MIN	TYP ⁽²⁾	MAX	UNIT
I _I	Input leakage current	FORCEOFF, FORCEON, EN			±0.01	±1	μA
I _{CC}	Supply current	Auto-power down disabled	No load, FORCEOFF and FORCEON at V _{CC}		0.3	1	mA
		Powered off	No load, FORCEOFF at GND		1	10	μA
		Auto-power down enabled	No load, 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.

6.6 Electrical Characteristics: Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)⁽¹⁾

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 = 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	±60	
r _o	Output resistance	V _{CC} , V+, and V– = 0 V, V _O = ±2 V		300	10M		Ω
I _{off}	Output leakage current	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.

6.7 Electrical Characteristics: Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽²⁾	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		1.6	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	$\overline{\text{EN}} = V_{CC}$		±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.

6.8 Electrical Characteristics: Auto-Power Down

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

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

6.9 Switching Characteristics: Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
Maximum data rate	C _L = 1000 pF, R _L = 3 kΩ,	150	250		kbit/s
t _{sk(p)} Pulse skew ⁽³⁾	C _L = 150 pF to 2500 pF, R _L = 3 kΩ to 7 kΩ, See Figure 6		100		ns
SR(tr) Slew rate, transition region (see Figure 5)	V _{CC} = 3.3 V, R _L = 3 kΩ to 7 kΩ, C _L = 150 pF to 1000 pF	6		30	V/μs
	C _L = 150 pF to 2500 pF	4		30	

(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.

6.10 Switching Characteristics: Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)⁽¹⁾

PARAMETER	TEST CONDITIONS	TYP ⁽²⁾	UNIT
t _{PLH} Propagation delay time, low- to high-level output	C _L = 150 pF, See Figure 7	150	ns
t _{PHL} Propagation delay time, high- to low-level output	C _L = 150 pF, See Figure 7	150	ns
t _{en} Output enable time	C _L = 150 pF, R _L = 3 kΩ, See Figure 8	200	ns
t _{dis} Output disable time	C _L = 150 pF, R _L = 3 kΩ, See Figure 8	200	ns
t _{sk(p)} Pulse skew ⁽³⁾	See Figure 7	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.

6.11 Switching Characteristics: Auto-Power Down

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

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 $V_{\text{CC}} = 3.3 \text{ V}$ or $V_{\text{CC}} = 5 \text{ V}$, and $T_A = 25^\circ\text{C}$.

6.12 Typical Characteristics

$T_A = 25^\circ\text{C}$; $V_{\text{CC}} = 3.3\text{V}$

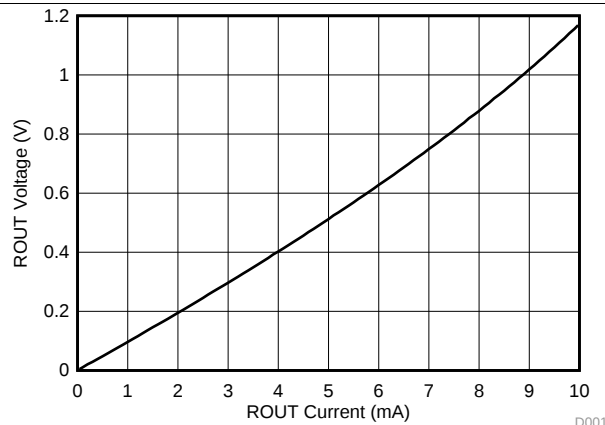


Figure 1. Receiver VOL vs Load Current

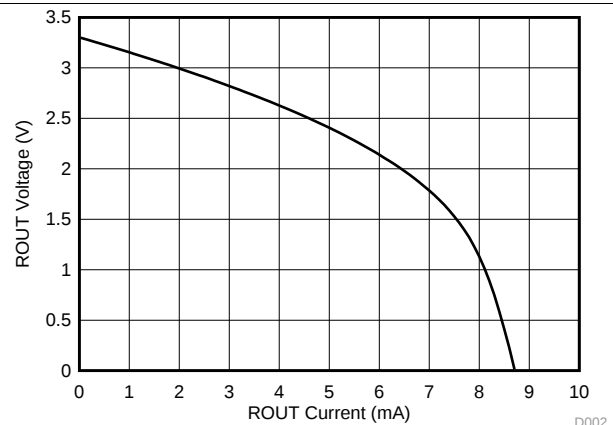


Figure 2. Receiver VOH vs Load Current

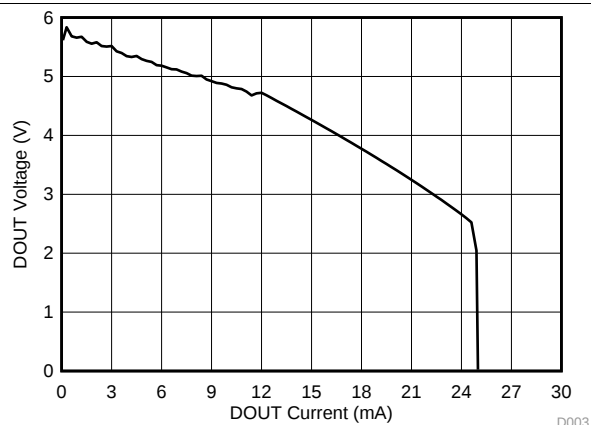


Figure 3. Driver VOH vs Load Current

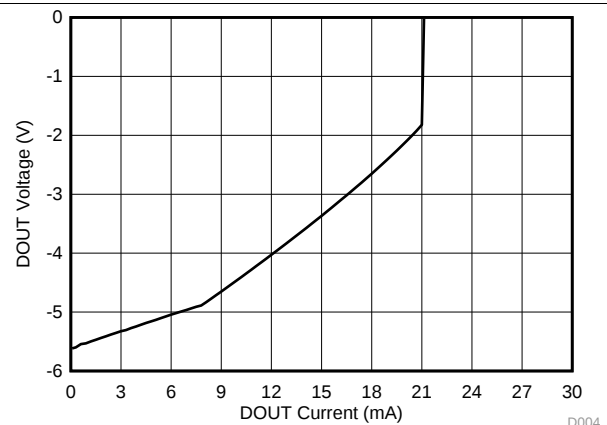
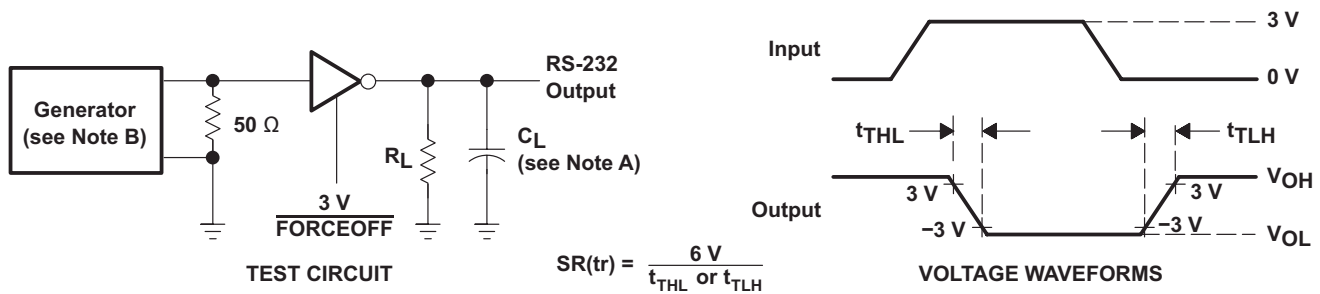


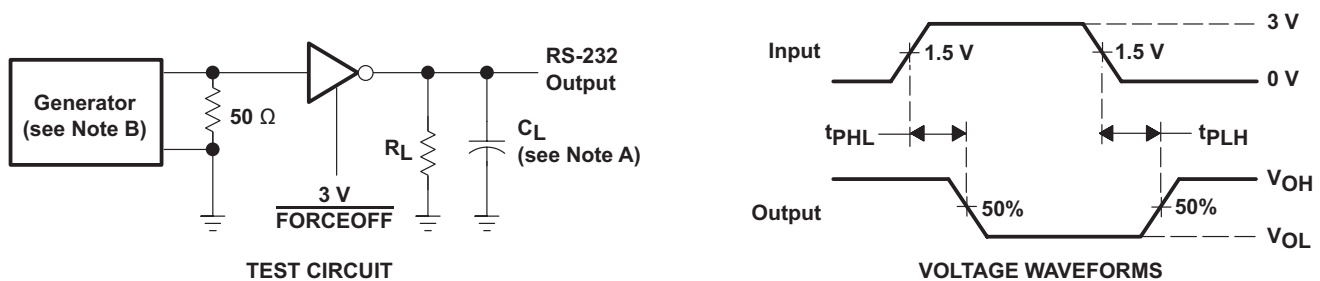
Figure 4. Driver VOL vs Load Current

7 Parameter Measurement Information



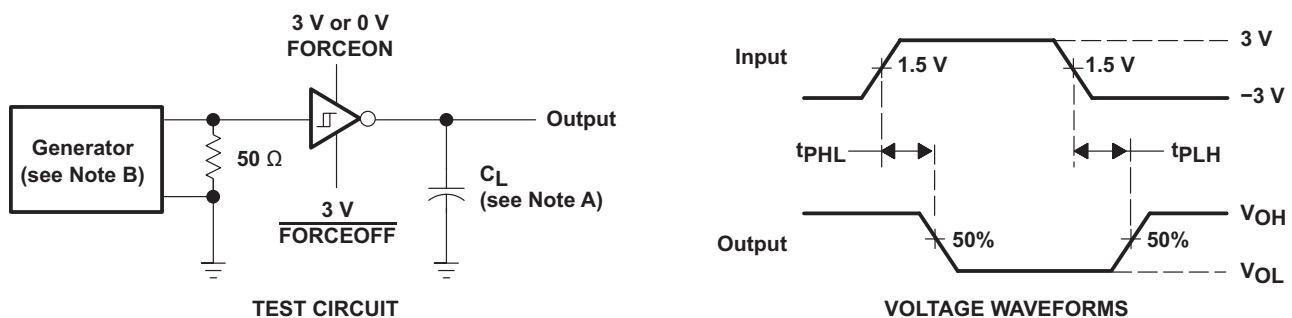
- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: PRR = 250 kbps, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 5. Driver Slew Rate



- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: PRR = 250 kbps, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 6. Driver Pulse Skew



- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 7. Receiver Propagation Delay Times

Parameter Measurement Information (continued)

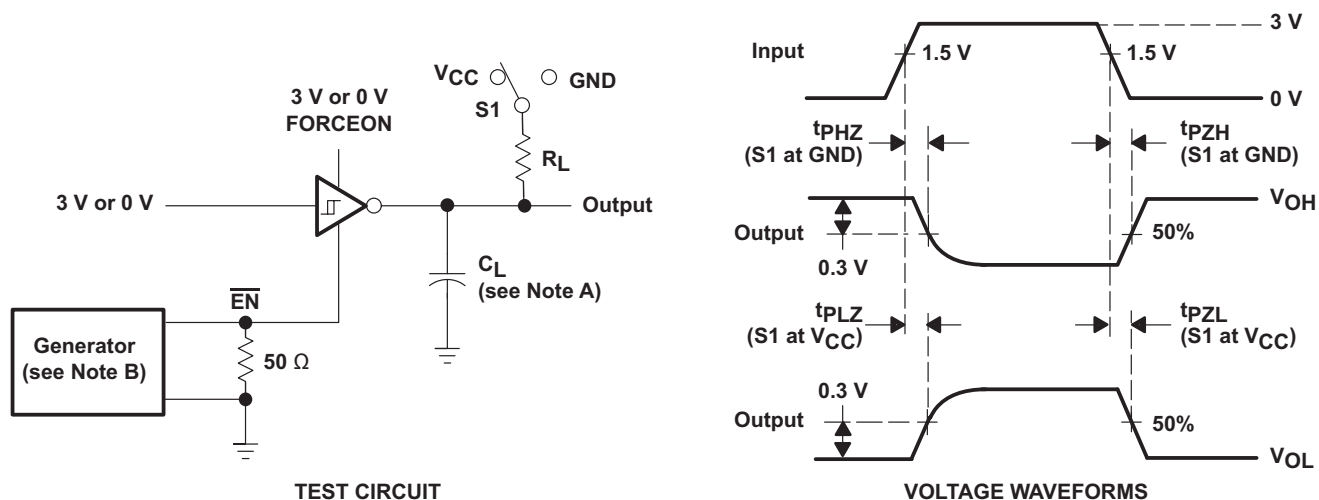


Figure 8. Receiver Enable and Disable Times

Parameter Measurement Information (continued)

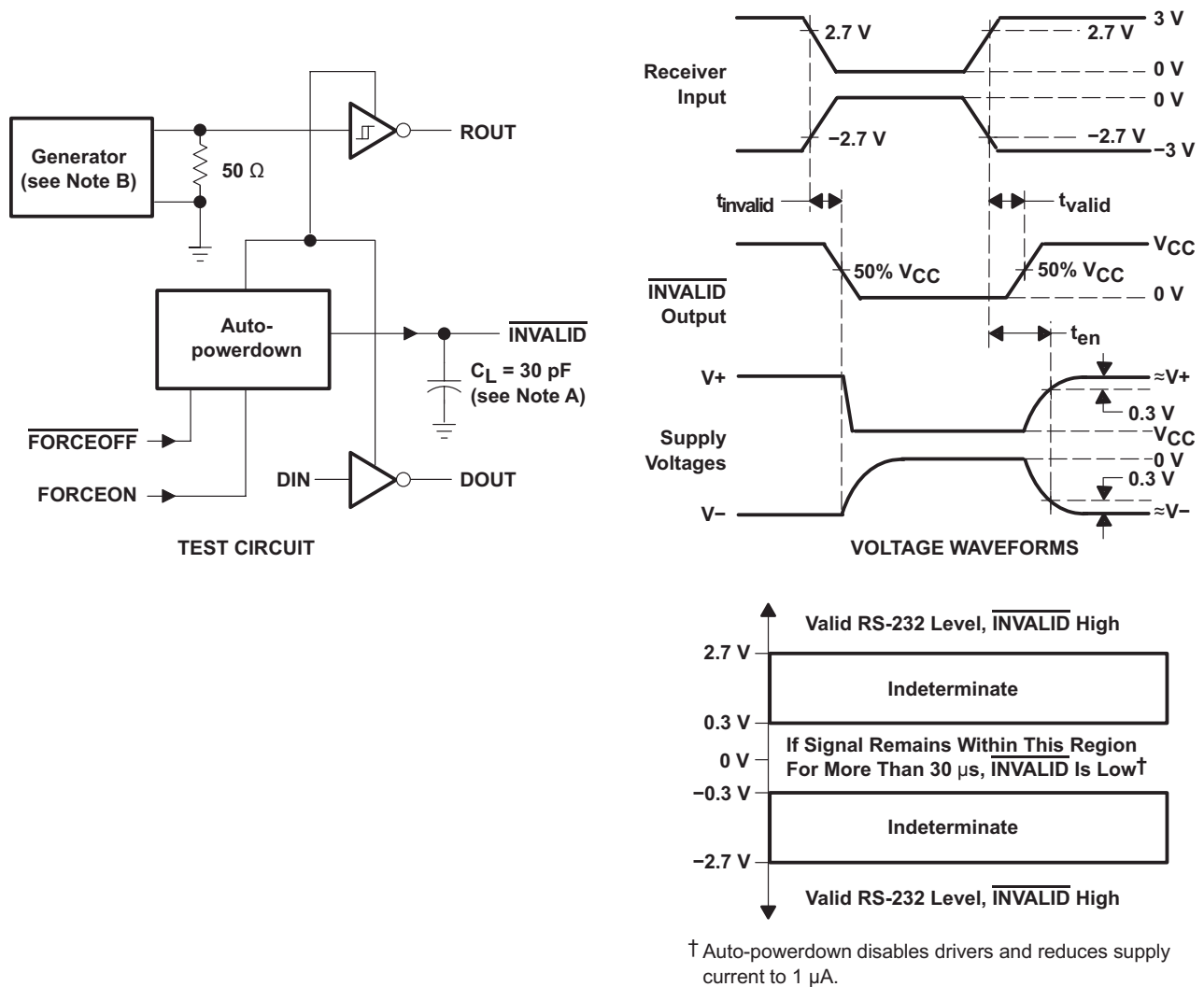


Figure 9. $\overline{\text{INVALID}}$ Propagation Delay Times and Driver Enabling Time

8 Detailed Description

8.1 Overview

The MAX3221E is a single driver, single receiver RS-232 solution operating from a single V_{CC} supply. The RS-232 pins provide IEC 61000-4-2 ESD protection. 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 kbit/s and a maximum of 30-V/ μ s driver output slew rate.

Flexible control options for power management are available when the serial port is inactive. The auto-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. If FORCEOFF is set low and $\overline{EN}$ is high, both the driver and receiver are shut off, and the supply current is reduced to 1 μ A. Disconnecting the serial port or turning off the peripheral drivers causes the auto-power-down condition to occur. Auto-power down can be disabled when FORCEON and FORCEOFF are high. With auto-power down enabled, the device is activated automatically when a valid signal is applied to the receiver input. INVALID output notifies the user if an RS-232 signal is present at the receiver input. 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 μ s. INVALID is low (invalid data) if the receiver input voltage is between -0.3 V and 0.3 V for more than 30 μ s. See Figure 5 for receiver input levels.

8.2 Functional Block Diagram

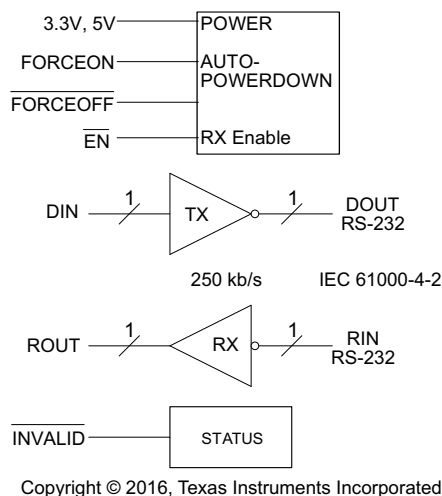


Figure 10. Logic Diagram (Positive Logic)

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 $\overline{EN}$ input. When MAX3221E is unpowered, it can be safely connected to an active remote RS-232 device.

8.3.2 RS-232 Driver

One driver interfaces standard logic levels to RS-232 levels. DIN input must be valid high or low.

Feature Description (continued)

8.3.3 RS-232 Receiver

One receiver interfaces RS-232 levels to standard logic levels. An open input results in a high output on ROUT. RIN input includes an internal standard RS-232 load. A logic high input on the $\overline{\text{EN}}$ pin shuts down the receiver output.

8.3.4 RS-232 Status

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

8.4 Device Functional Modes

Table 1, Table 2, and Table 3 show the behavior of the driver, receiver, and $\overline{\text{INVALID}}$ features under all possible relevant combinations of inputs.

Table 1. 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-power down disabled
H	H	H	X	L	
L	L	H	Yes	H	Normal operation with auto-power down enabled
H	L	H	Yes	L	
L	L	H	No	Z	Powered off by auto-power down feature
H	L	H	No	Z	

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

Table 2. 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

Table 3. $\overline{\text{INVALID}}$ ⁽¹⁾

INPUTS				OUTPUT $\overline{\text{INVALID}}$
RIN	FORCEON	$\overline{\text{FORCEOFF}}$	$\overline{\text{EN}}$	
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

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. Customers should validate and test their design implementation to confirm system functionality.

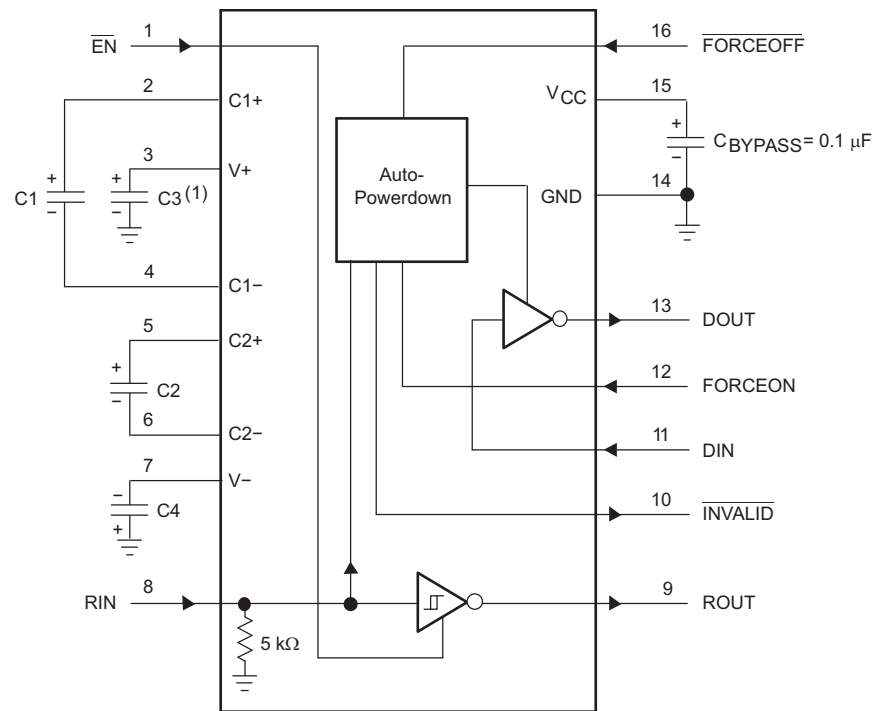
9.1 Application Information

The MAX3221E 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 11](#).

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} . INVALID may be connected to a general purpose logic line or left unconnected. RIN and DOUT lines connect to a RS-232 connector or cable. DIN, FORCEON, and $\overline{\text{FORCEOFF}}$ inputs must not be left unconnected.

Typical Application (continued)



(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 $\pm$ 0.3 V	0.1 μ F	0.1 μ F
5 V $\pm$ 0.5 V	0.047 μ F	0.33 μ F
3 V to 5.5 V	0.1 μ F	0.47 μ F

Copyright © 2016, Texas Instruments Incorporated

Figure 11. Typical Operating Circuit and Capacitor Values

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 11](#).

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 V_{CC} level for best performance.

Typical Application (continued)

9.2.3 Application Curves

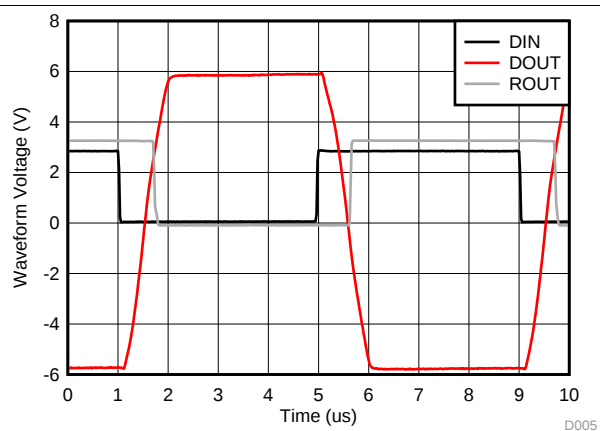


Figure 12. Loopback Waveforms
 $V_{CC} = 3.3 \text{ V}$, Data Rate 250 kbit/s

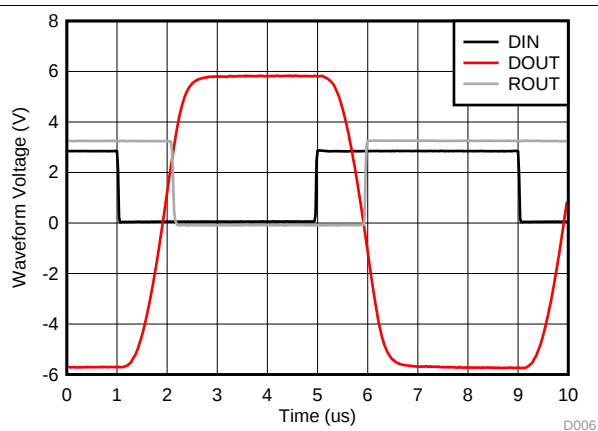


Figure 13. Loopback Waveforms with 1-nF load
 $V_{CC} = 3.3 \text{ V}$, Data Rate 250 kbit/s

10 Power Supply Recommendations

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

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. Make the impedance from MAX3221E ground pin and circuit board's ground plane as low as possible for best ESD performance. Use wide metal and multiple vias on both sides of ground pin.

11.2 Layout Example

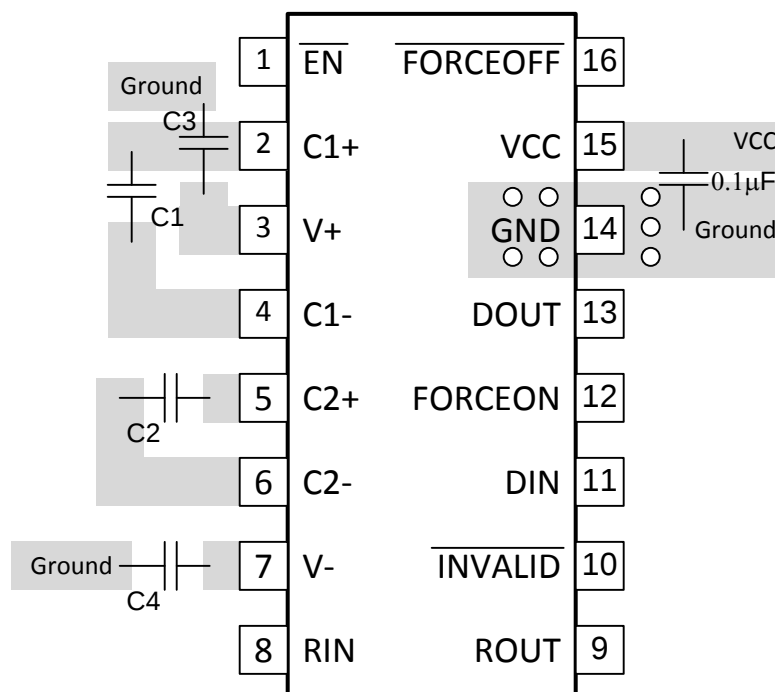


Figure 14. MAX3221E Layout Example

12 Device and Documentation Support

12.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.2 Community Resource

The following links connect to TI community resources. Linked contents are 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](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.3 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.4 Electrostatic Discharge Caution



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.

12.5 Glossary

[SLYZ022](#) — *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.

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
MAX3221ECDB	ACTIVE	SSOP	DB	16	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECDBG4	ACTIVE	SSOP	DB	16	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECDBR	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECDBRG4	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECPWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP221EC	Samples
MAX3221ECPWRG4	ACTIVE	TSSOP	PW	16		TBD	Call TI	Call TI	0 to 70		Samples
MAX3221EIDB	ACTIVE	SSOP	DB	16	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIDBG4	ACTIVE	SSOP	DB	16	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIDBR	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIDBRG4	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIPWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU CU SN	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples

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
MAX3221EIPWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	Samples
MAX3221EIPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP221EI	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.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

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
MAX3221ECDBR	SSOP	DB	16	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
MAX3221ECPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221EIDBR	SSOP	DB	16	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
MAX3221EIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221EIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221EIPWRG4	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

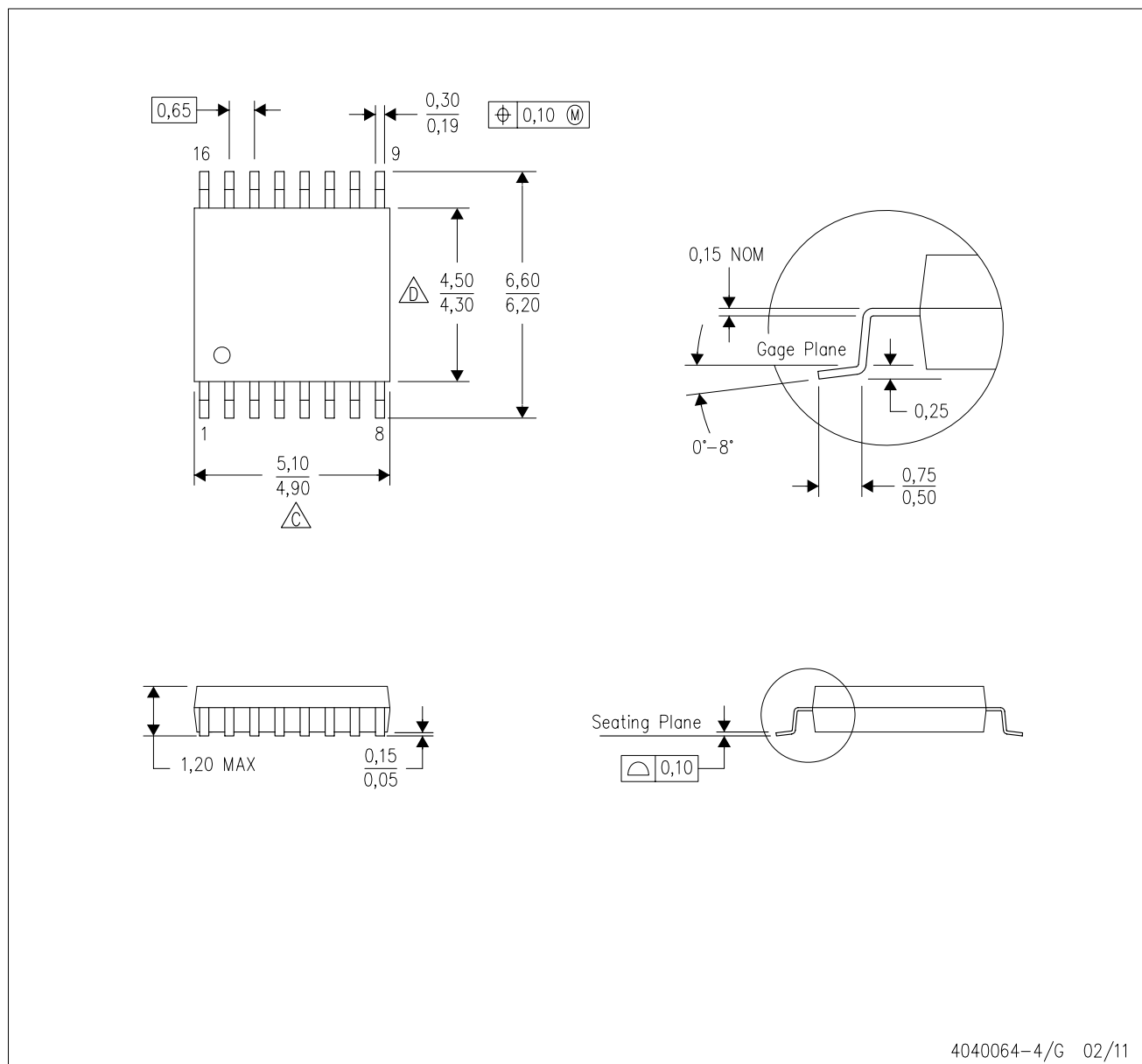


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX3221ECDBR	SSOP	DB	16	2000	367.0	367.0	38.0
MAX3221ECPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
MAX3221EIDBR	SSOP	DB	16	2000	367.0	367.0	38.0
MAX3221EIPWR	TSSOP	PW	16	2000	364.0	364.0	27.0
MAX3221EIPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
MAX3221EIPWRG4	TSSOP	PW	16	2000	367.0	367.0	35.0

PW (R-PDSO-G16)

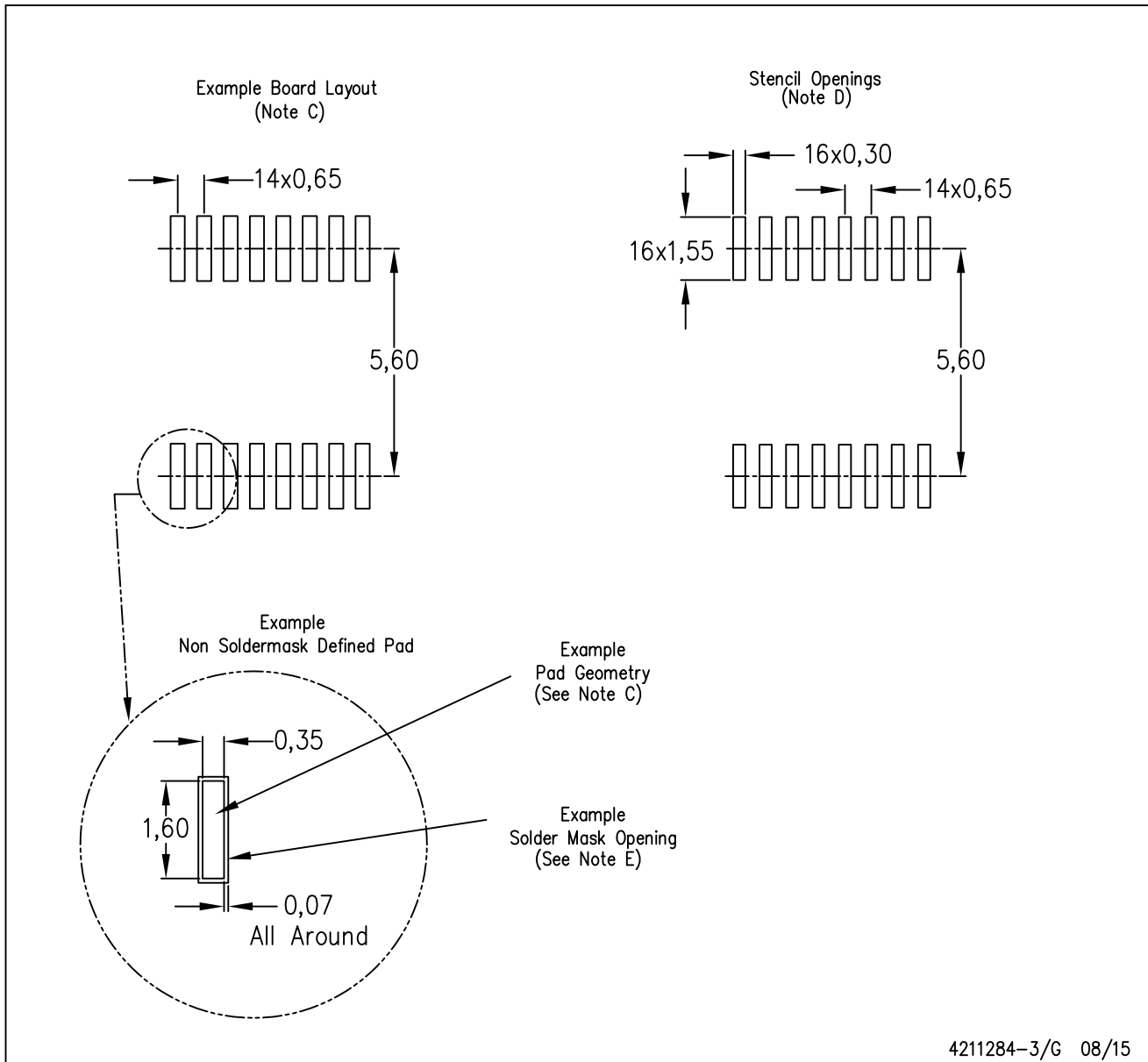
PLASTIC SMALL OUTLINE



- 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)

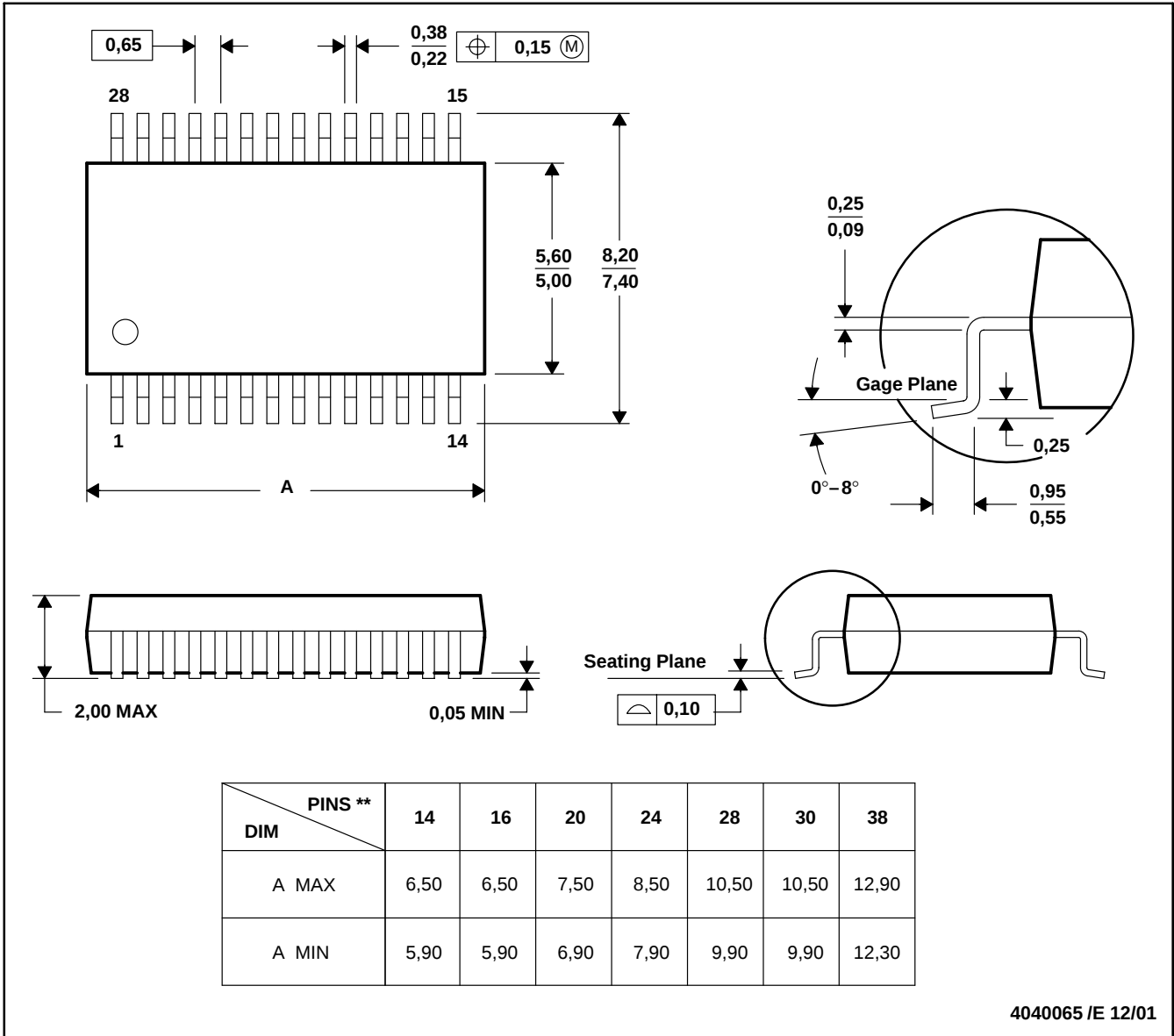
PLASTIC SMALL OUTLINE



- 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.

DB (R-PDSO-G**)
28 PINS SHOWN

PLASTIC SMALL-OUTLINE



- 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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2016, Texas Instruments Incorporated