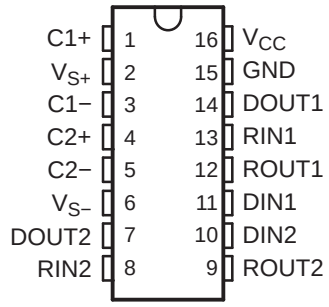
DUAL RS-232 DRIVER/RECEIVER WITH IEC61000-4-2 PROTECTION

Check for Samples: MAX232E

FEATURES

- **Meets or Exceeds TIA/RS-232-F and ITU Recommendation V.28**
- **Operates From a Single 5-V Power Supply With 1.0-µF Charge-Pump Capacitors**
- **Operates up to 250 kbit/s**
- **Two Drivers and Two Receivers**
- **±30-V Input Levels**
- **Low Supply Current . . . 8 mA Typical**
- **ESD Protection for RS-232 Bus Pins**
  - **±15-kV Human-Body Model (HBM)**
  - **±8-kV IEC61000-4-2, Contact Discharge**
  - **±15-kV IEC61000-4-2, Air-Gap Discharge**

D, DW, N, NS, OR PW PACKAGE
(TOP VIEW)



APPLICATIONS

- **TIA/RS-232-F**
- **Battery-Powered Systems**
- **Terminals**
- **Modems**
- **Computers**

DESCRIPTION/ORDERING INFORMATION

The MAX232E is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/RS-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/RS-232-F inputs to 5-V TTL/CMOS levels. This receiver has a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/RS-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

Table 1. ORDERING INFORMATION(1)

T_A	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP – N	Tube of 25	MAX232ECN	MAX232ECN
	SOIC – D	Tube of 40	MAX232ECD	MAX232EC
		Reel of 2500	MAX232ECDR	
	SOIC – DW	Tube of 40	MAX232ECDW	MAX232EC
		Reel of 2000	MAX232ECDWR	
	TSSOP – PW	Tube of 25	MAX232ECPW	MA232EC
		Reel of 2000	MAX232ECPWR	
–40°C to 85°C	PDIP – N	Tube of 25	MAX232EIN	MAX232EIN
	SOIC – D	Tube of 40	MAX232EID	MAX232EI
		Reel of 2500	MAX232EIDR	
	SOIC – DW	Tube of 40	MAX232EIDW	MAX232EI
		Reel of 2000	MAX232EIDWR	
	TSSOP – PW	Tube of 25	MAX232EIPW	MB232EI
		Reel of 2000	MAX232EIPWR	

(1) 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.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

Table 2. FUNCTION TABLES

Each Driver(1)

INPUT DIN	OUTPUT DOUT
L	H
H	L

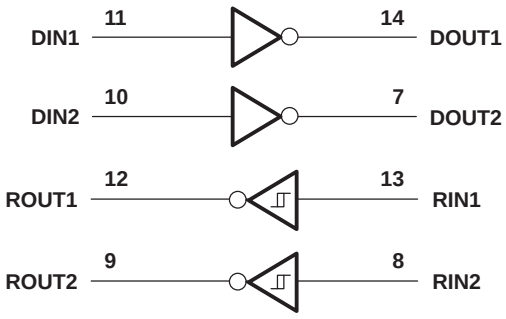
(1) H = high level, L = low level

Table 3. Each Receiver(1)

INPUT RIN	OUTPUT ROUT
L	H
H	L

(1) H = high level, L = low level

LOGIC DIAGRAM (POSITIVE LOGIC)



Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{CC}	Input supply voltage range(2)		–0.3	6	V
V_{S+}	Positive output supply voltage range		V_{CC} – 0.3	15	V
V_{S-}	Negative output supply voltage range		–0.3	–15	V
V_I	Input voltage range	Driver	–0.3	V_{CC} + 0.3	V
		Receiver		±30	
V_O	Output voltage range	DOUT	V_{S-} – 0.3	V_{S+} + 0.3	V
		ROUT	–0.3	V_{CC} + 0.3	
	Short-circuit duration	DOUT		Unlimited	
θ_{JA}	Package thermal impedance(3) (4)	D package		73	°C/W
		DW package		57	
		N package		67	
		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 $T_J(max)$, θ_{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

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage (DIN1, DIN2)		2			V
V_{IL}	Low-level input voltage (DIN1, DIN2)				0.8	V
	Receiver input voltage (RIN1, RIN2)				±30	V
T_A	Operating free-air temperature	MAX232EC	0		70	°C
		MAX232EI	–40		85	

Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP(2)	MAX	UNIT
I_{CC}	Supply current	V_{CC} = 5.5 V, All outputs open, T_A = 25°C		8	10	mA

(1) Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 5 V and T_A = 25°C.

DRIVER SECTION

Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature range

PARAMETER			TEST CONDITIONS		MIN	TYP(2)	MAX	UNIT
V_{OH}	High-level output voltage	DOUT	R_L = 3 kΩ to GND		5	7		V
V_{OL}	Low-level output voltage(3)	DOUT	R_L = 3 kΩ to GND			–7	–5	V
r_o	Output resistance	DOUT	V_{S+} = V_{S-} = 0,	V_O = ±2 V	300			Ω
I_{OS} (4)	Short-circuit output current	DOUT	V_{CC} = 5.5 V,	V_O = 0		±10		mA
I_{IS}	Short-circuit input current	DIN	V_I = 0				200	µA

(1) Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 5 V and T_A = 25°C.
(3) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
(4) Not more than one output should be shorted at a time.

Switching Characteristics(1)

V_{CC} = 5 V, T_A = 25°C (see Note 4)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Driver slew rate	R_L = 3 kΩ to 7 kΩ, See Figure 2			30	V/µs
SR(t)	Driver transition region slew rate	See Figure 3		3		V/µs
	Data rate	One DOUT switching		250		kbit/s

(1) Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.

ESD protection

PARAMETER	TEST CONDITIONS	TYP	UNIT
DOUT, RIN	HBM	±15	kV
	IEC61000-4-2, Air-Gap Discharge	±15	kV
	IEC61000-4-2, Contact Discharge	±8	kV

RECEIVER SECTION

Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature range

PARAMETER			TEST CONDITIONS		MIN	TYP(2)	MAX	UNIT
V_{OH}	High-level output voltage	ROUT	I_{OH} = –1 mA		3.5			V
V_{OL}	Low-level output voltage(3)	ROUT	I_{OL} = 3.2 mA				0.4	V
V_{IT+}	Receiver positive-going input threshold voltage	RIN	V_{CC} = 5 V,	T_A = 25°C		1.7	2.4	V
$V_{IT–}$	Receiver negative-going input threshold voltage	RIN	V_{CC} = 5 V,	T_A = 25°C	0.8	1.2		V
V_{hys}	Input hysteresis voltage	RIN	V_{CC} = 5 V		0.2	0.5	1	V
r_i	Receiver input resistance	RIN	V_{CC} = 5 V,	T_A = 25°C	3	5	7	kΩ

(1) Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 5 V and T_A = 25°C.
(3) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.

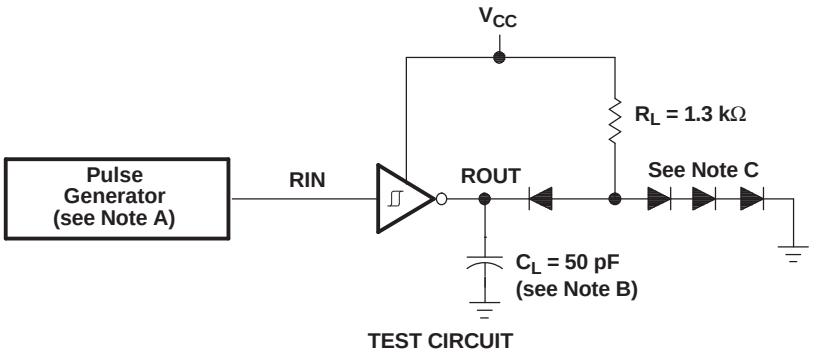
Switching Characteristics(1)

V_{CC} = 5 V, T_A = 25°C (see Figure 1)

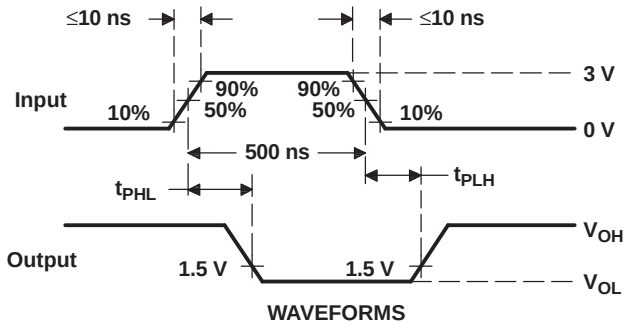
PARAMETER		TYP	UNIT
$t_{PLH(R)}$	Receiver propagation delay time, low- to high-level output	500	ns
$t_{PHL(R)}$	Receiver propagation delay time, high- to low-level output	500	ns

(1) Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



WAVEFORMS

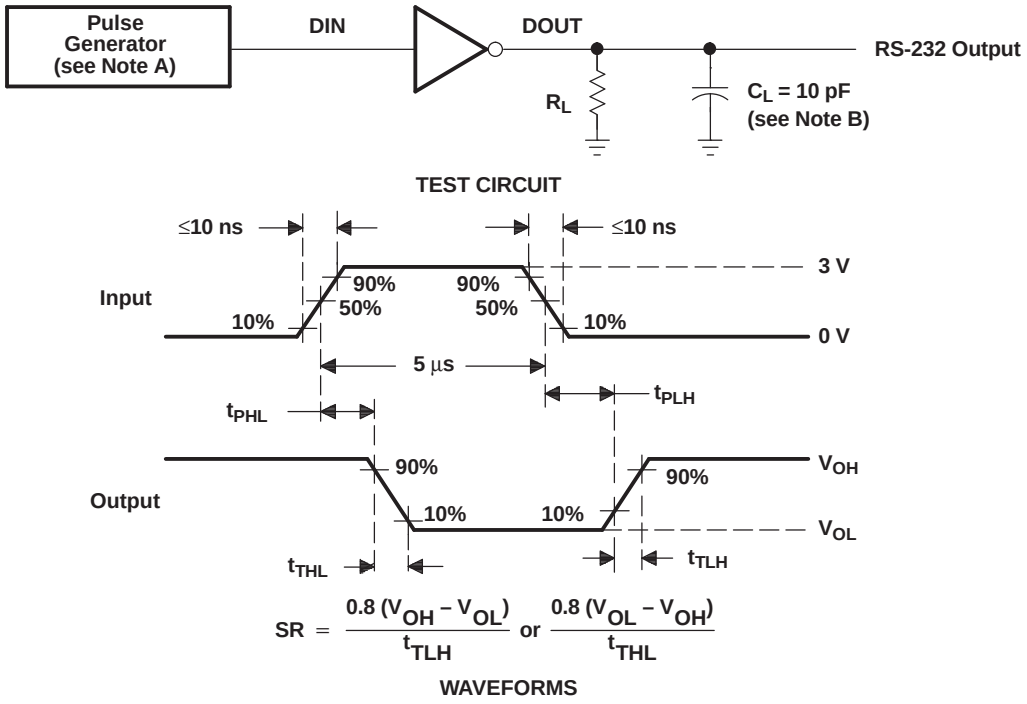
A. The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.

B. C_L includes probe and jig capacitance.

C. All diodes are 1N3064 or equivalent.

Figure 1. Receiver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements

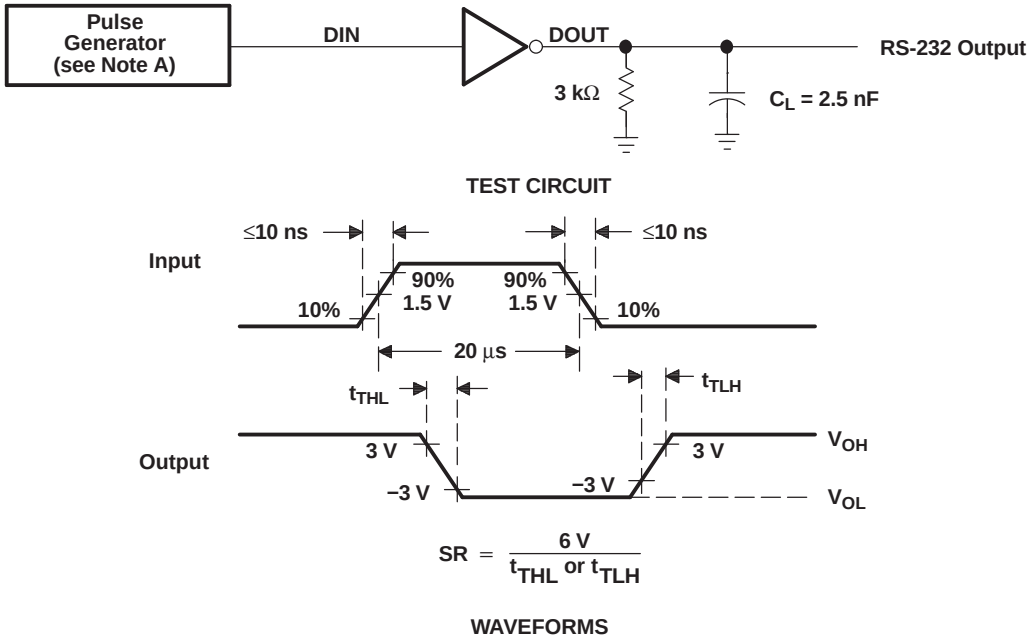
PARAMETER MEASUREMENT INFORMATION (continued)



A. The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.

B. C_L includes probe and jig capacitance.

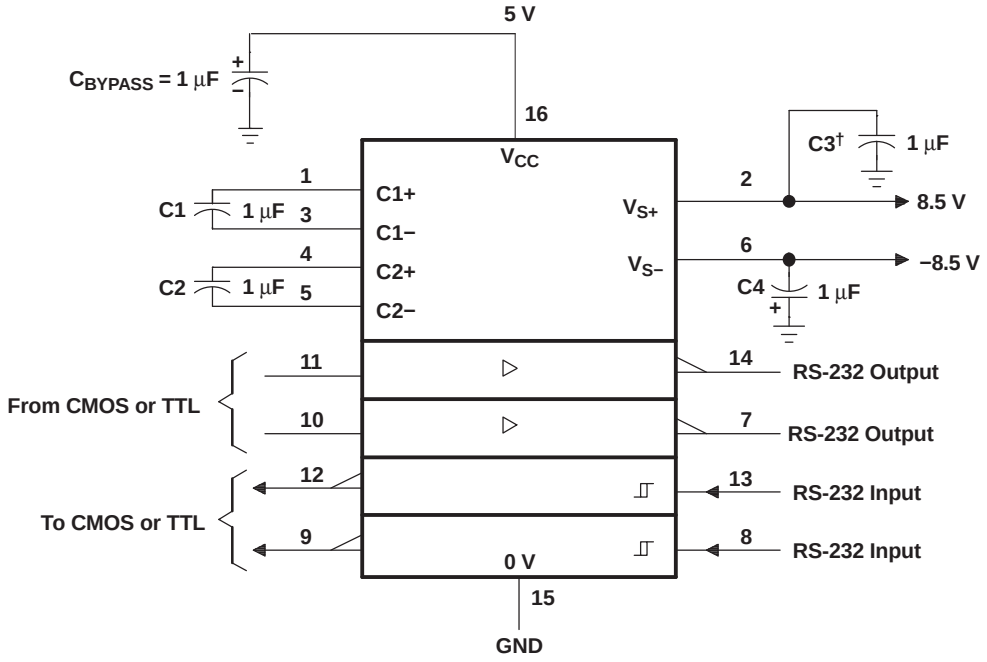
Figure 2. Driver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements (5-μs Input)



A. The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.

Figure 3. Test Circuit and Waveforms for t_{THL} and t_{TLH} Measurements (20-μs Input)

APPLICATION INFORMATION



† C3 can be connected to V_{CC} or GND.

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. In addition to the 1-µF capacitors shown, the MAX202E can operate with 0.1-µF capacitors.

Figure 4. Typical Operating Circuit

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
MAX232ECD	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX232EC	Samples
MAX232ECDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX232EC	Samples
MAX232ECDW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX232EC	Samples
MAX232ECDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU | CU SN	Level-1-260C-UNLIM	0 to 70	MAX232EC	Samples
MAX232ECDWRE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX232EC	Samples
MAX232ECDWRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX232EC	Samples
MAX232ECN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	MAX232ECN	Samples
MAX232ECNE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	MAX232ECN	Samples
MAX232ECPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MA232EC	Samples
MAX232ECPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU | CU SN	Level-1-260C-UNLIM	0 to 70	MA232EC	Samples
MAX232ECPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MA232EC	Samples
MAX232EID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX232EI	Samples
MAX232EIDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX232EI	Samples
MAX232EIDRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX232EI	Samples
MAX232EIDW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX232EI	Samples
MAX232EIDWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX232EI	Samples
MAX232EIDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX232EI	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
MAX232EIDWRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX232EI	Samples
MAX232EIN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	MAX232EIN	Samples
MAX232EINE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	MAX232EIN	Samples
MAX232EIPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB232EI	Samples
MAX232EIPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB232EI	Samples
MAX232EIPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB232EI	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.

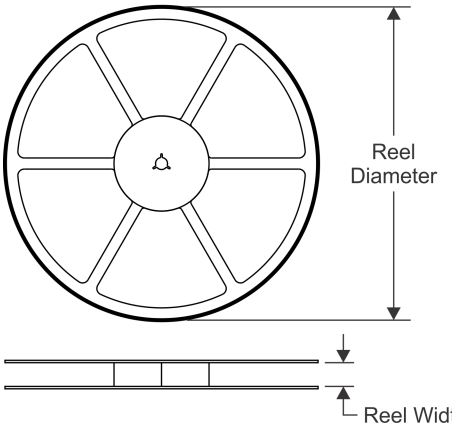
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

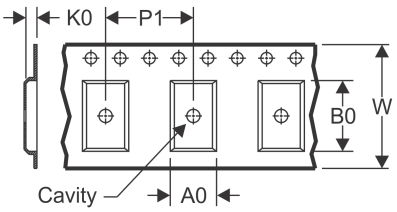
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

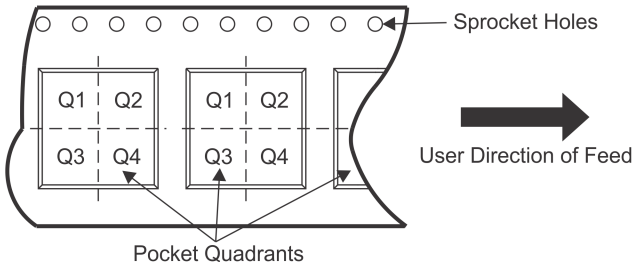


TAPE DIMENSIONS



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

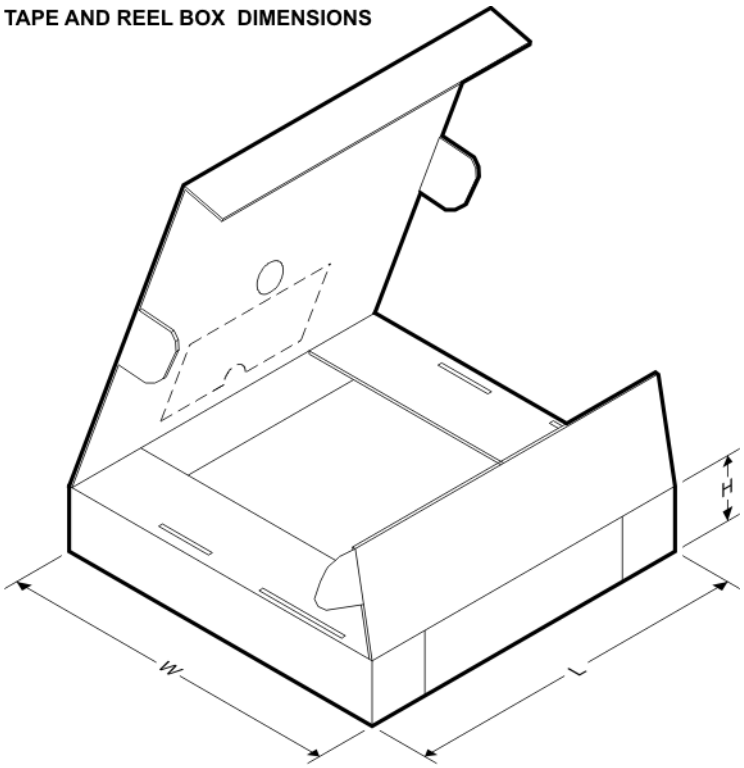
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
MAX232ECDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
MAX232ECDWRG4	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
MAX232ECPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX232EIDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
MAX232EIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

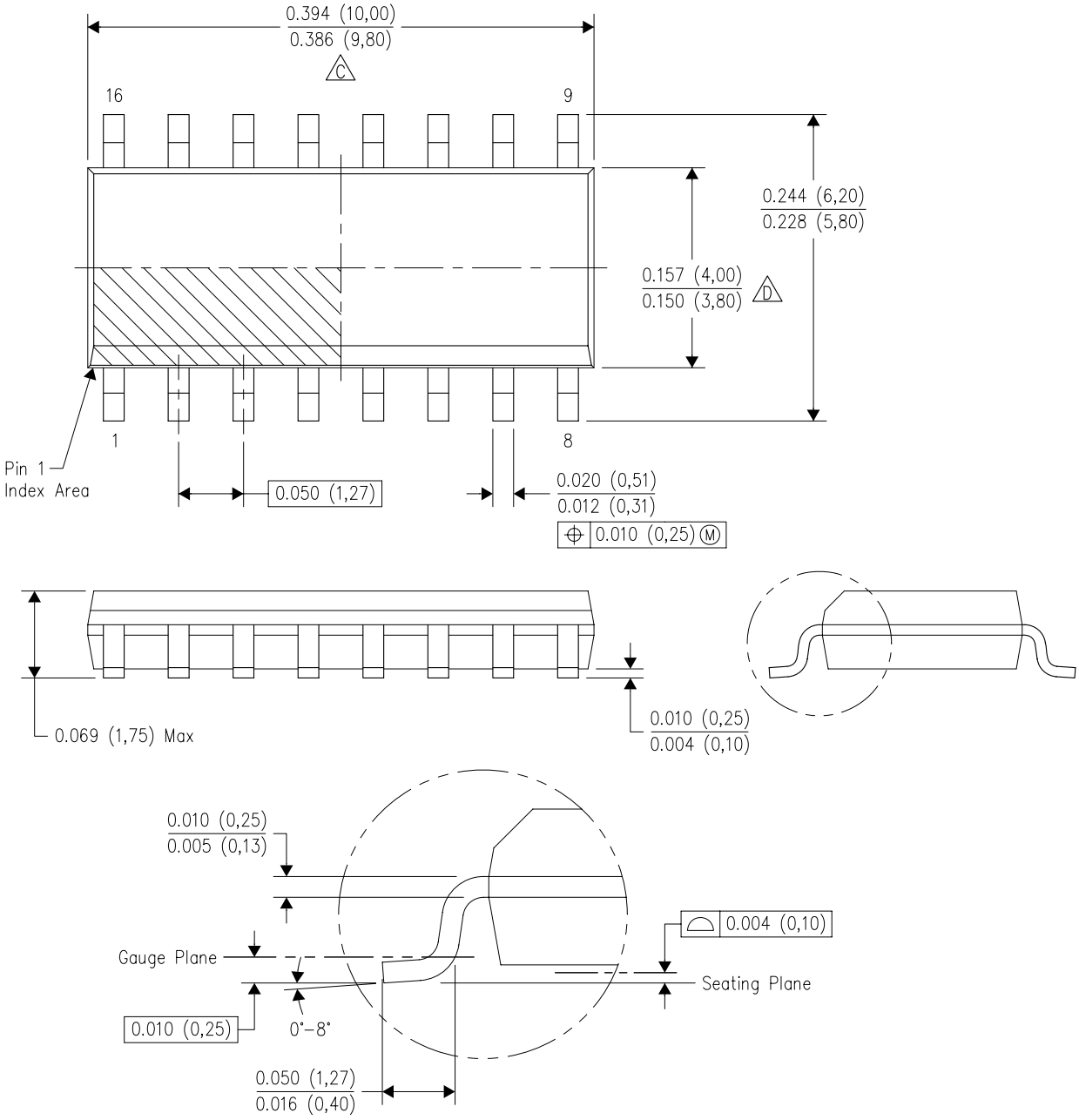
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

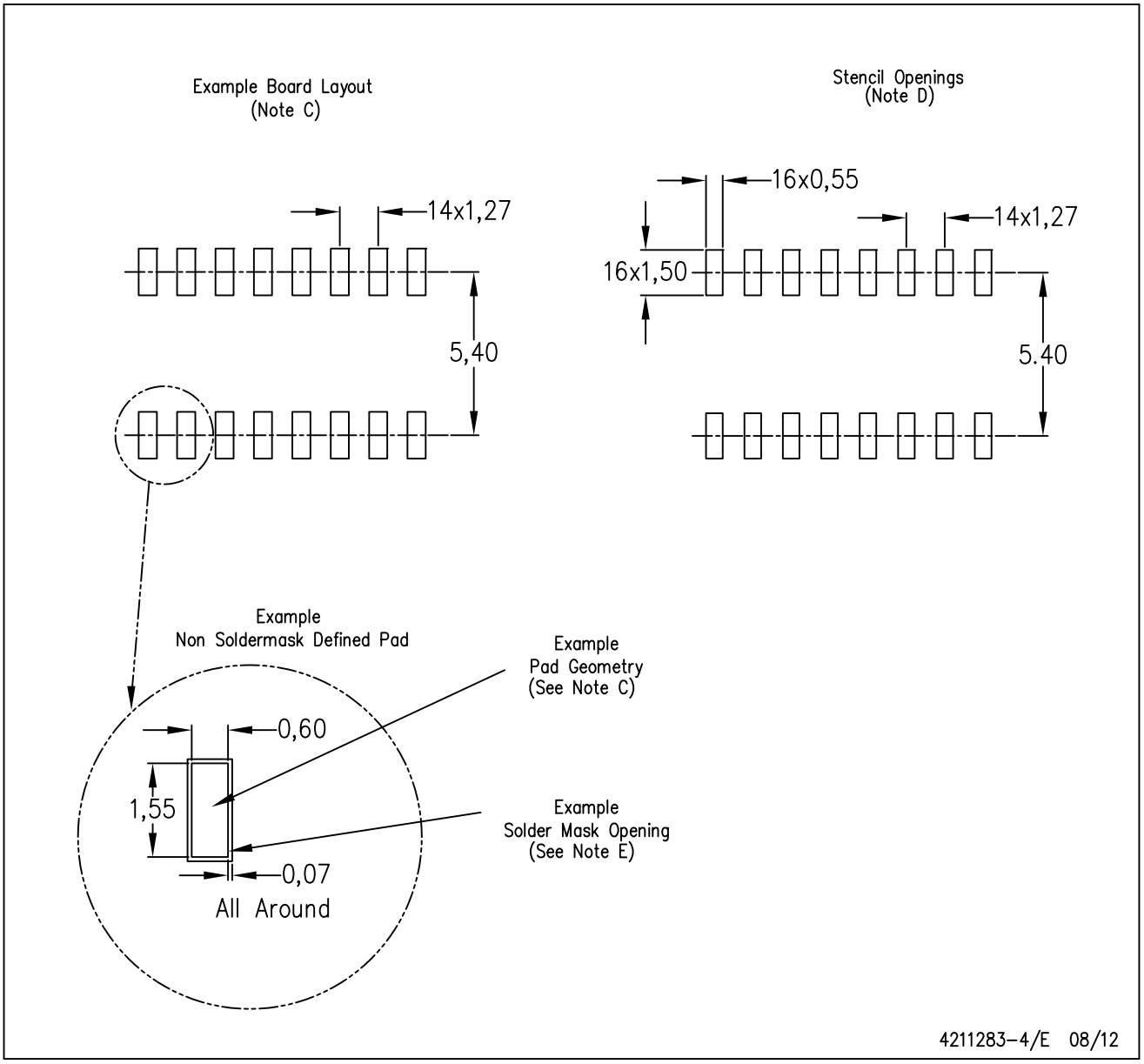
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX232ECDWR	SOIC	DW	16	2000	366.0	364.0	50.0
MAX232ECDWRG4	SOIC	DW	16	2000	367.0	367.0	38.0
MAX232ECPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
MAX232EIDWR	SOIC	DW	16	2000	367.0	367.0	38.0
MAX232EIPWR	TSSOP	PW	16	2000	367.0	367.0	35.0

D (R–PDSO–G16) PLASTIC SMALL OUTLINE



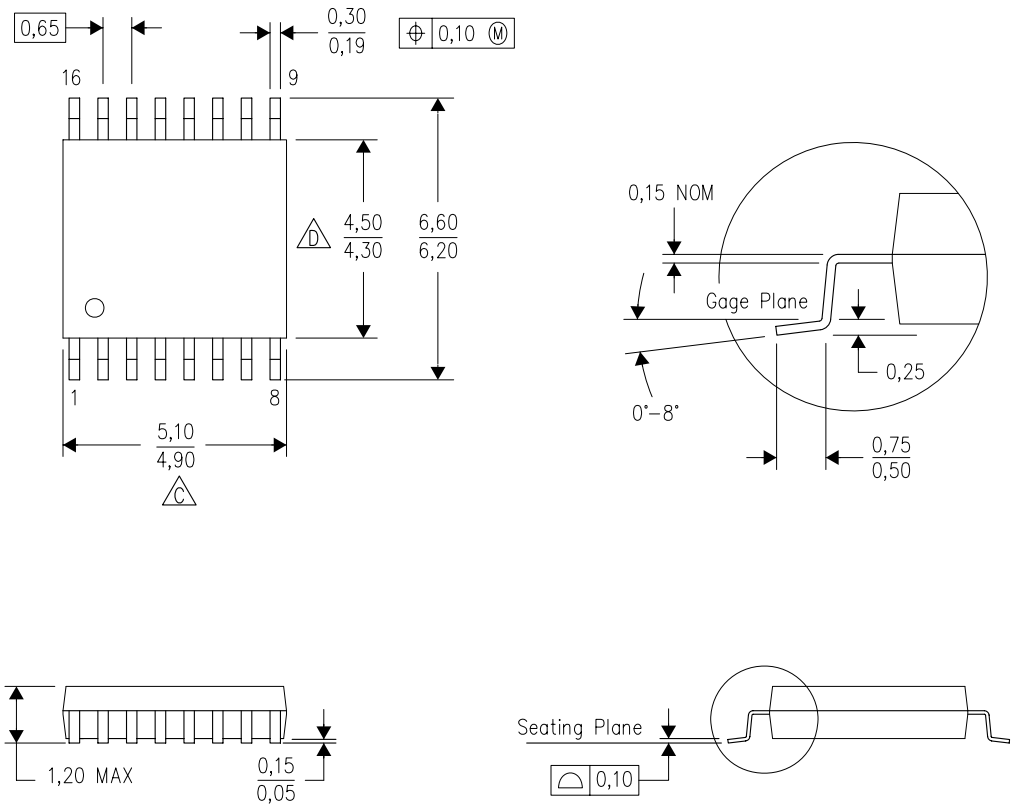
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AC.

D (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.

PW (R–PDSO–G16) PLASTIC SMALL OUTLINE



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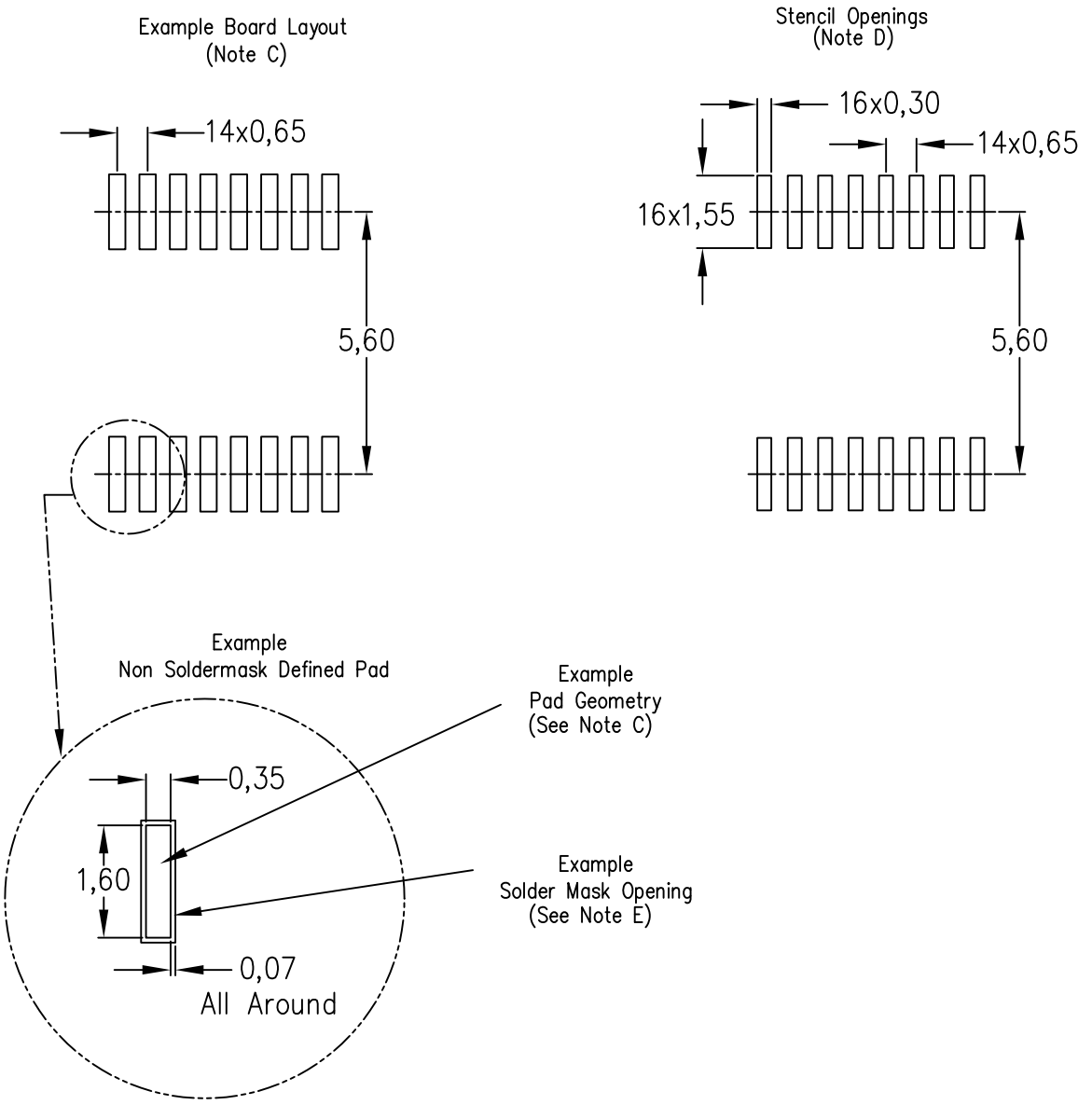
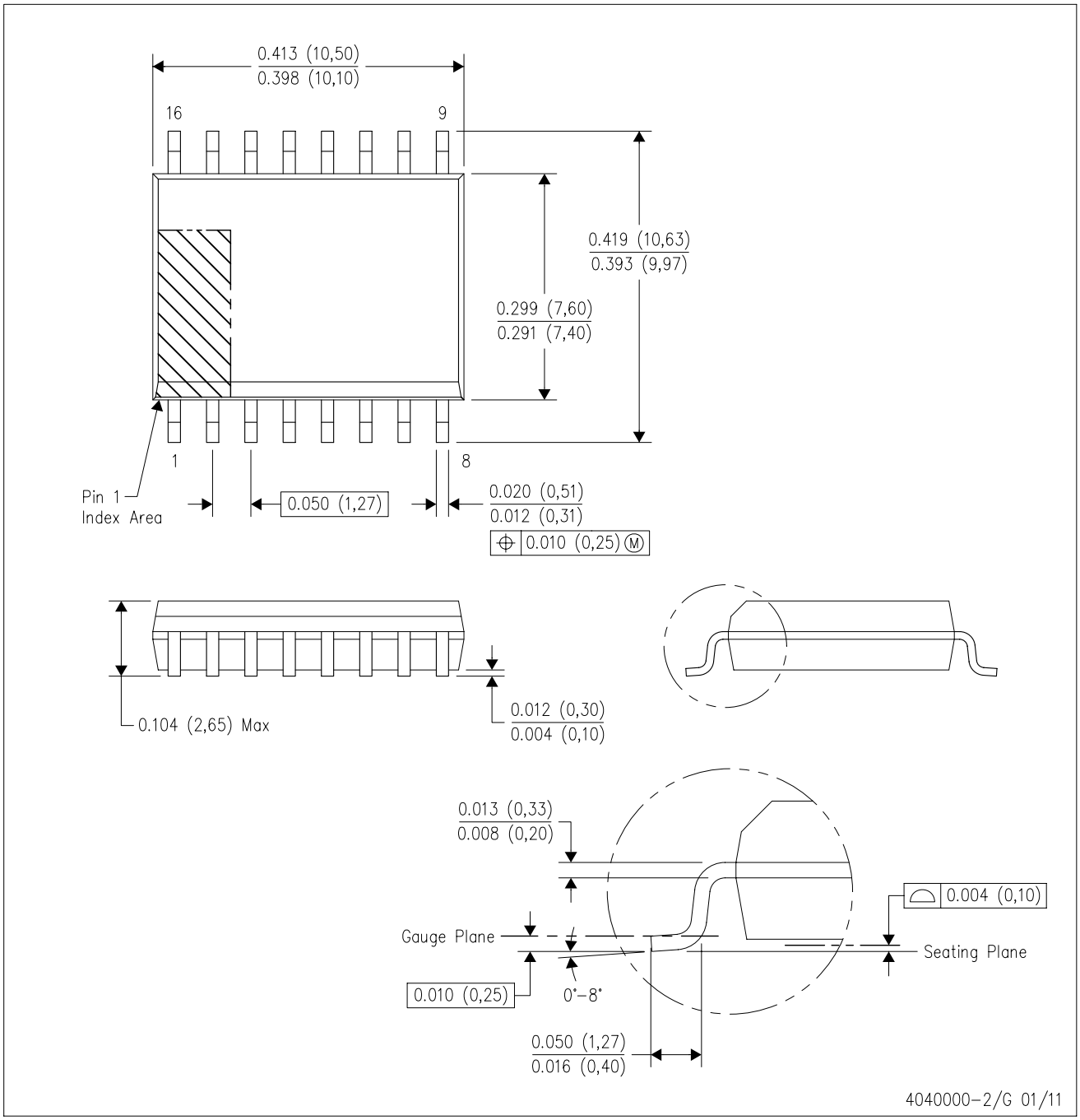
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. 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



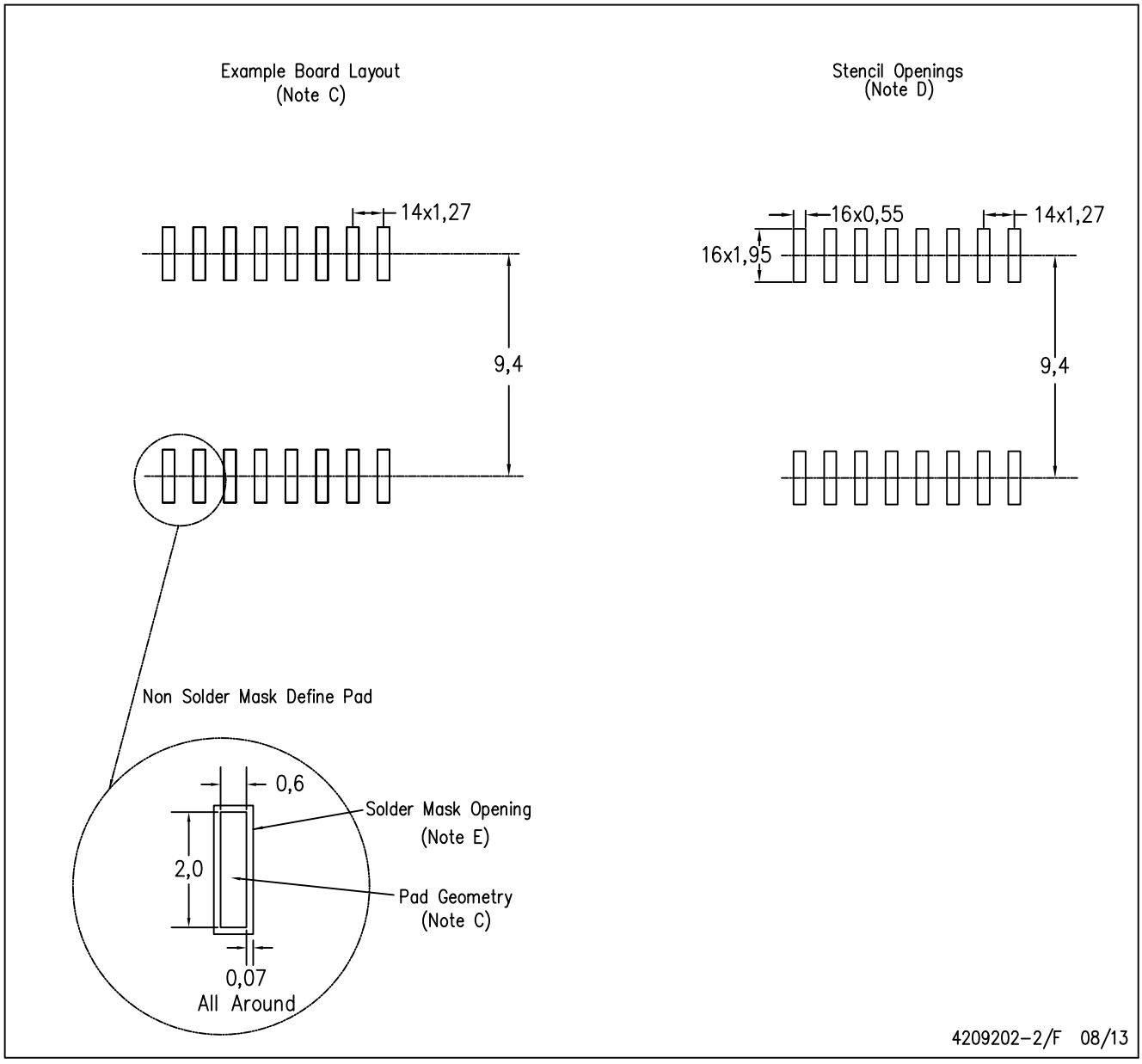
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

DW (R–PDSO–G16) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–013 variation AA.

DW (R–PDSO–G16) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Refer to IPC7351 for alternate board design.
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
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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