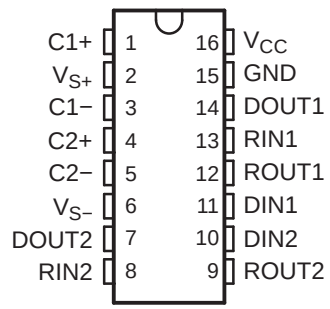
DUAL RS-232 DRIVER/RECEIVER WITH IEC61000-4-2 PROTECTION

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 TRS232E 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.

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

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

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ORDERING INFORMATION

T_A	PACKAGE(1)(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP – N	Tube of 25	TRS232ECN	TRS232ECN
	SOIC – D	Tube of 40	TRS232ECD	TRS232EC
		Reel of 2500	TRS232ECDR	
	SOIC – DW	Tube of 40	TRS232ECDW	TRS232EC
		Reel of 2000	TRS232ECDWR	
	SOP – NS	Reel of 2000	TRS232ECNSR	PREVIEW
	TSSOP – PW	Tube of 25	TRS232ECPW	RU32EC
		Reel of 2000	TRS232ECPWR	
–40°C to 85°C	PDIP – N	Tube of 25	TRS232EIN	TRS232EIN
	SOIC – D	Tube of 40	TRS232EID	TRS232EI
		Reel of 2500	TRS232EIDR	
	SOIC – DW	Tube of 40	TRS232EIDW	TRS232EI
		Reel of 2000	TRS232EIDWR	
	SOP – NS	Reel of 2000	TRS232EINSR	PREVIEW
	TSSOP – PW	Tube of 25	TRS232EIPW	RU32EI
		Reel of 2000	TRS232EIPWR	

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

FUNCTION TABLES

Each Driver(1)

INPUT DIN	OUTPUT DOUT
L	H
H	L

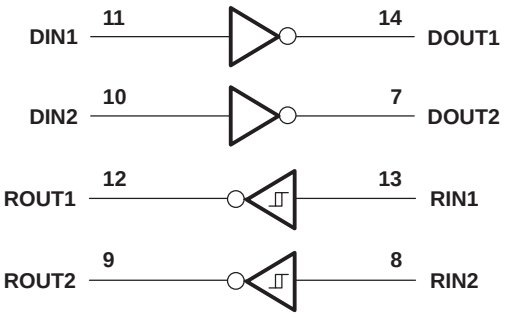
(1) H = high level, L = low level

Each Receiver(1)

INPUT RIN	OUTPUT ROUT
L	H
H	L

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

LOGIC DIAGRAM (POSITIVE LOGIC)



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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	
		NS package		64	
		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	TRS232EC	0		70	°C
		TRS232EI	–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.

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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

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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)

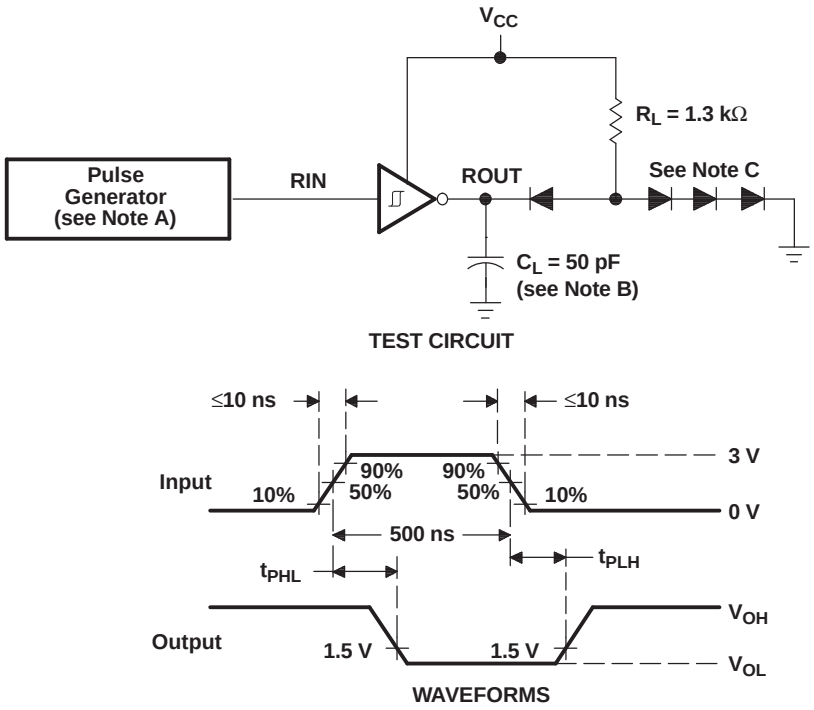
V_{CC} = 5 V, T_A = 25°C (see Figure 1)

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.

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PARAMETER MEASUREMENT INFORMATION



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

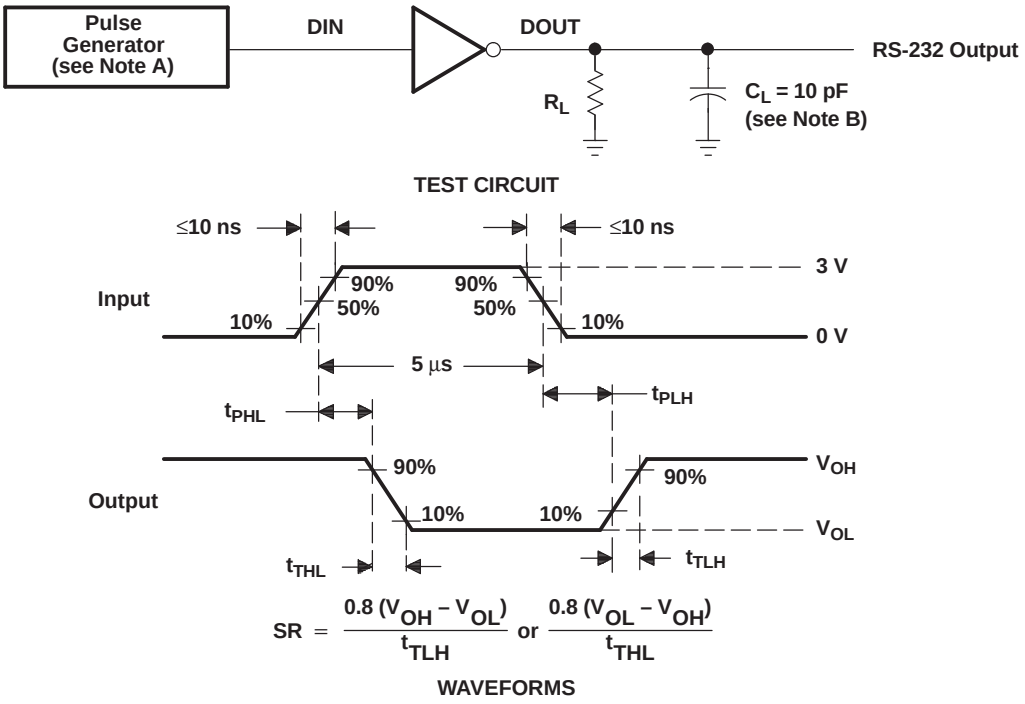
B. C_L includes probe and jig capacitance.

C. All diodes are 1N3064 or equivalent.

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

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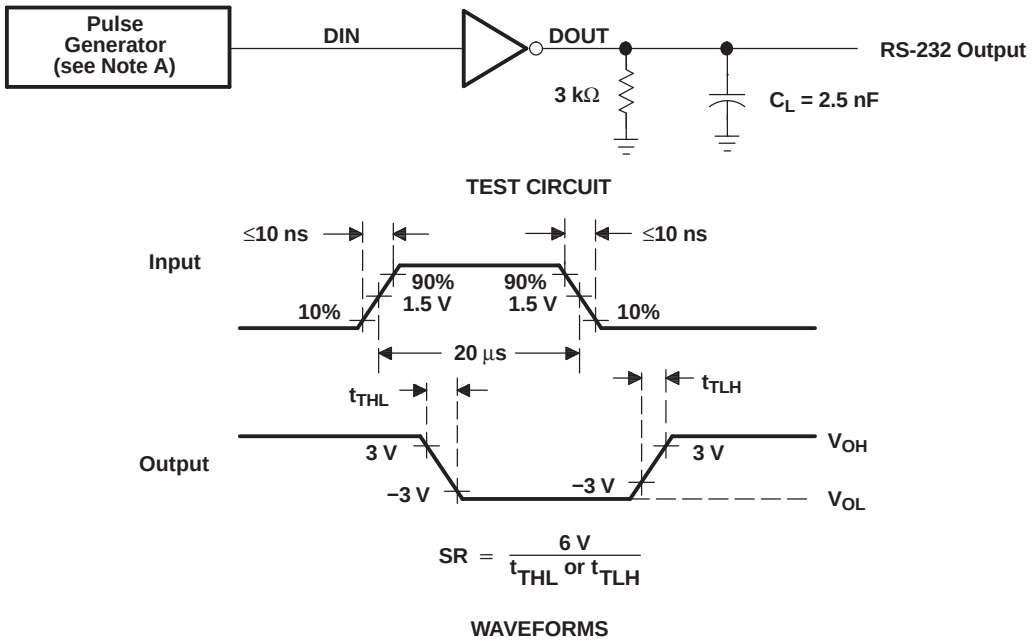
PARAMETER MEASUREMENT INFORMATION (continued)



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

B. C_L includes probe and jig capacitance.

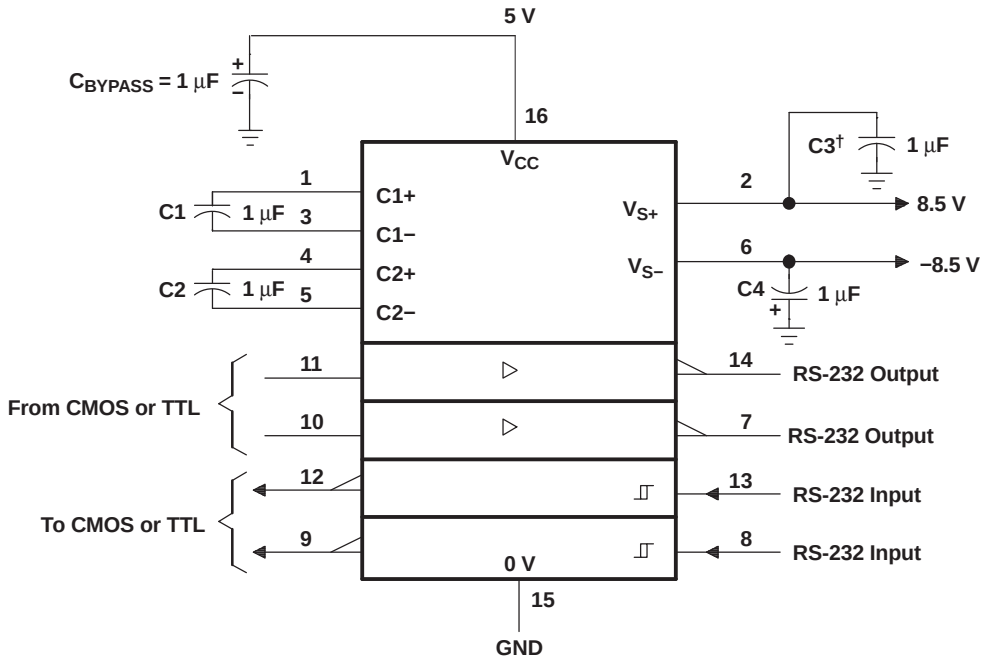
Figure 2. Driver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements (5-μs Input)



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 TRS202E can operate with 0.1-µF capacitors.

Figure 4. Typical Operating Circuit

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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
TRS232ECD	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS232EC	Samples
TRS232ECDR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS232EC	Samples
TRS232ECDWR	ACTIVE	SOIC	DW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS232EC	Samples
TRS232ECN	ACTIVE	PDIP	N	16	25	RoHS & Non-Green	NIPDAU	N / A for Pkg Type	0 to 70	TRS232ECN	Samples
TRS232ECPW	ACTIVE	TSSOP	PW	16	90	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	RU32EC	Samples
TRS232ECPWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	RU32EC	Samples
TRS232EID	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS232EI	Samples
TRS232EIDR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS232EI	Samples
TRS232EIDWR	ACTIVE	SOIC	DW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS232EI	Samples
TRS232EIN	ACTIVE	PDIP	N	16	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-40 to 85	TRS232EIN	Samples
TRS232EIPW	ACTIVE	TSSOP	PW	16	90	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RU32EI	Samples
TRS232EIPWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RU32EI	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.

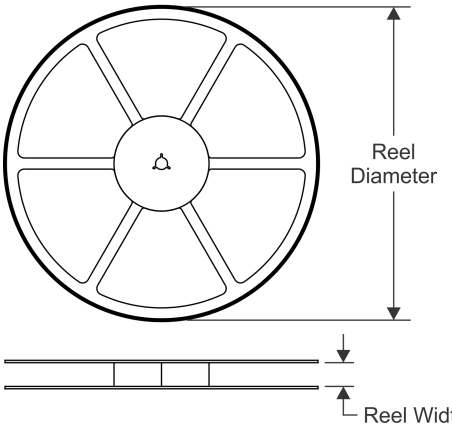
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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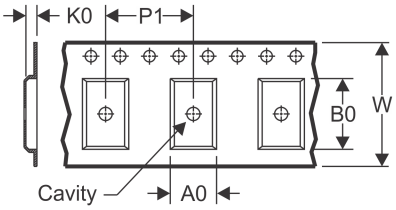
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

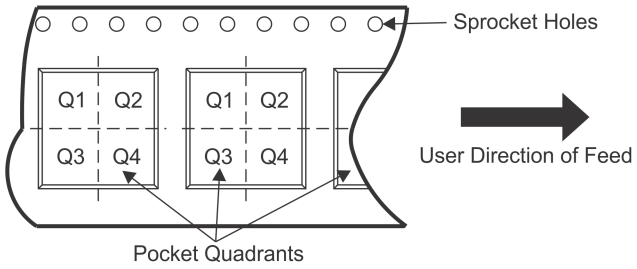


TAPE DIMENSIONS



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

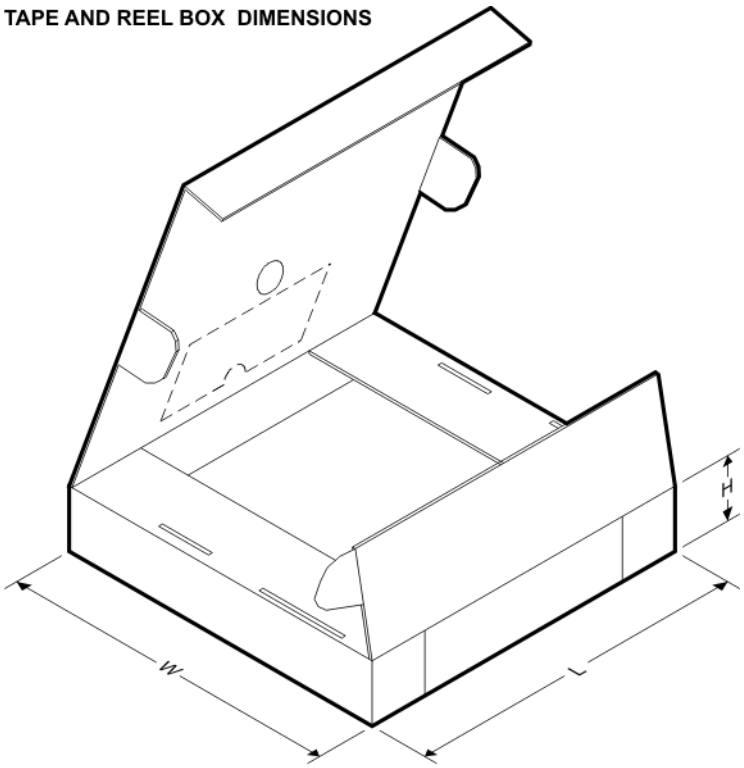
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TRS232ECDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TRS232ECDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TRS232ECDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
TRS232ECPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TRS232EIDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TRS232EIDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
TRS232EIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

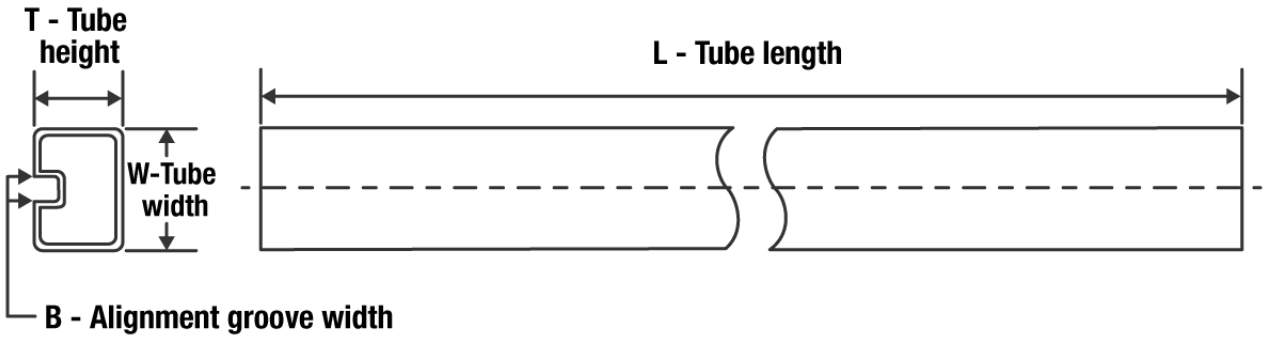
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRS232ECDR	SOIC	D	16	2500	340.5	336.1	32.0
TRS232ECDR	SOIC	D	16	2500	853.0	449.0	35.0
TRS232ECDWR	SOIC	DW	16	2000	350.0	350.0	43.0
TRS232ECPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
TRS232EIDR	SOIC	D	16	2500	853.0	449.0	35.0
TRS232EIDWR	SOIC	DW	16	2000	350.0	350.0	43.0
TRS232EIPWR	TSSOP	PW	16	2000	367.0	367.0	35.0

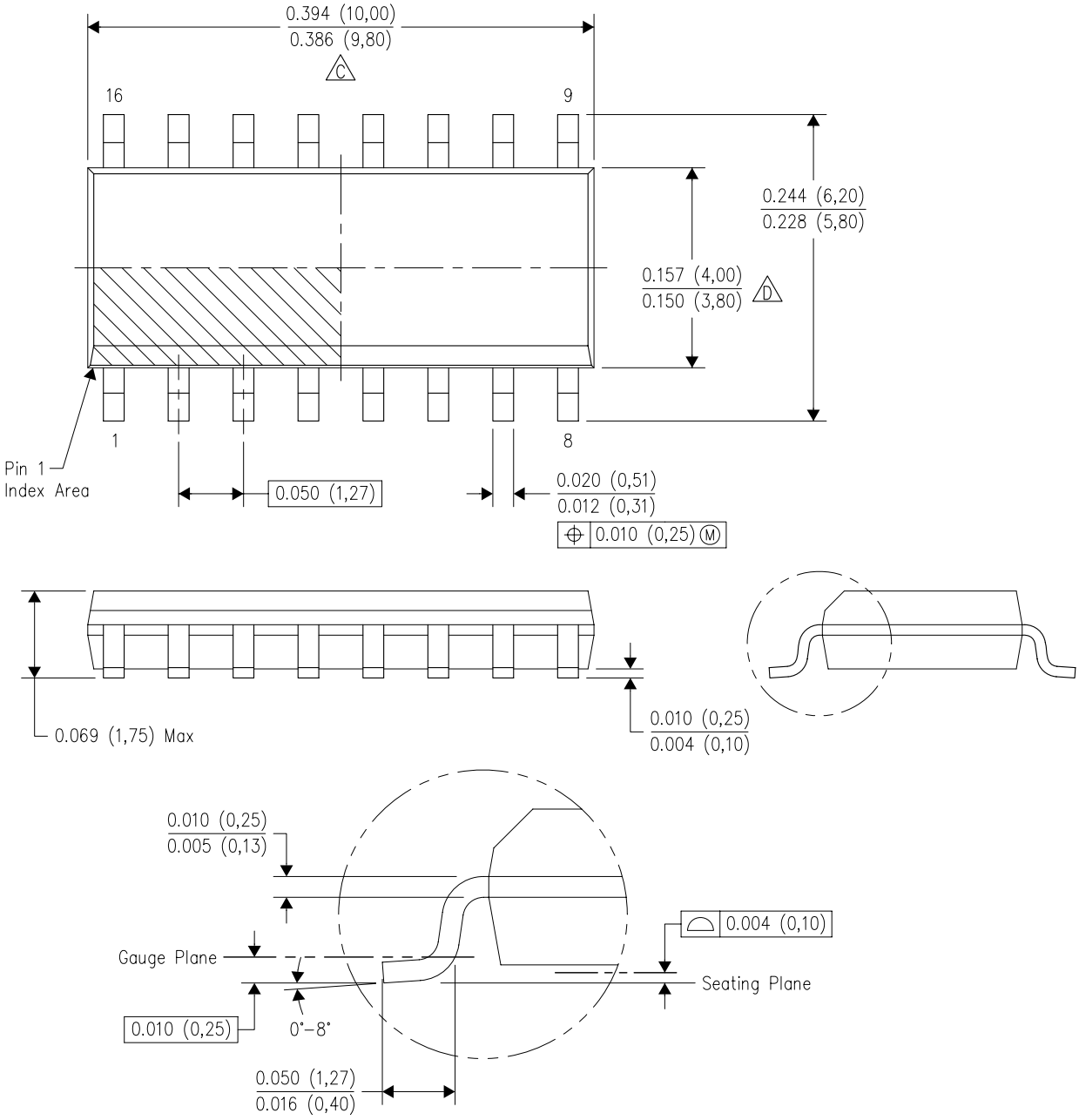
TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
TRS232ECD	D	SOIC	16	40	506.6	8	3940	4.32
TRS232ECN	N	PDIP	16	25	506	13.97	11230	4.32
TRS232ECPW	PW	TSSOP	16	90	530	10.2	3600	3.5
TRS232EID	D	SOIC	16	40	506.6	8	3940	4.32
TRS232EIN	N	PDIP	16	25	506	13.97	11230	4.32
TRS232EIN	N	PDIP	16	25	506	13.97	11230	4.32
TRS232EIPW	PW	TSSOP	16	90	530	10.2	3600	3.5

D (R–PDSO–G16) PLASTIC SMALL OUTLINE



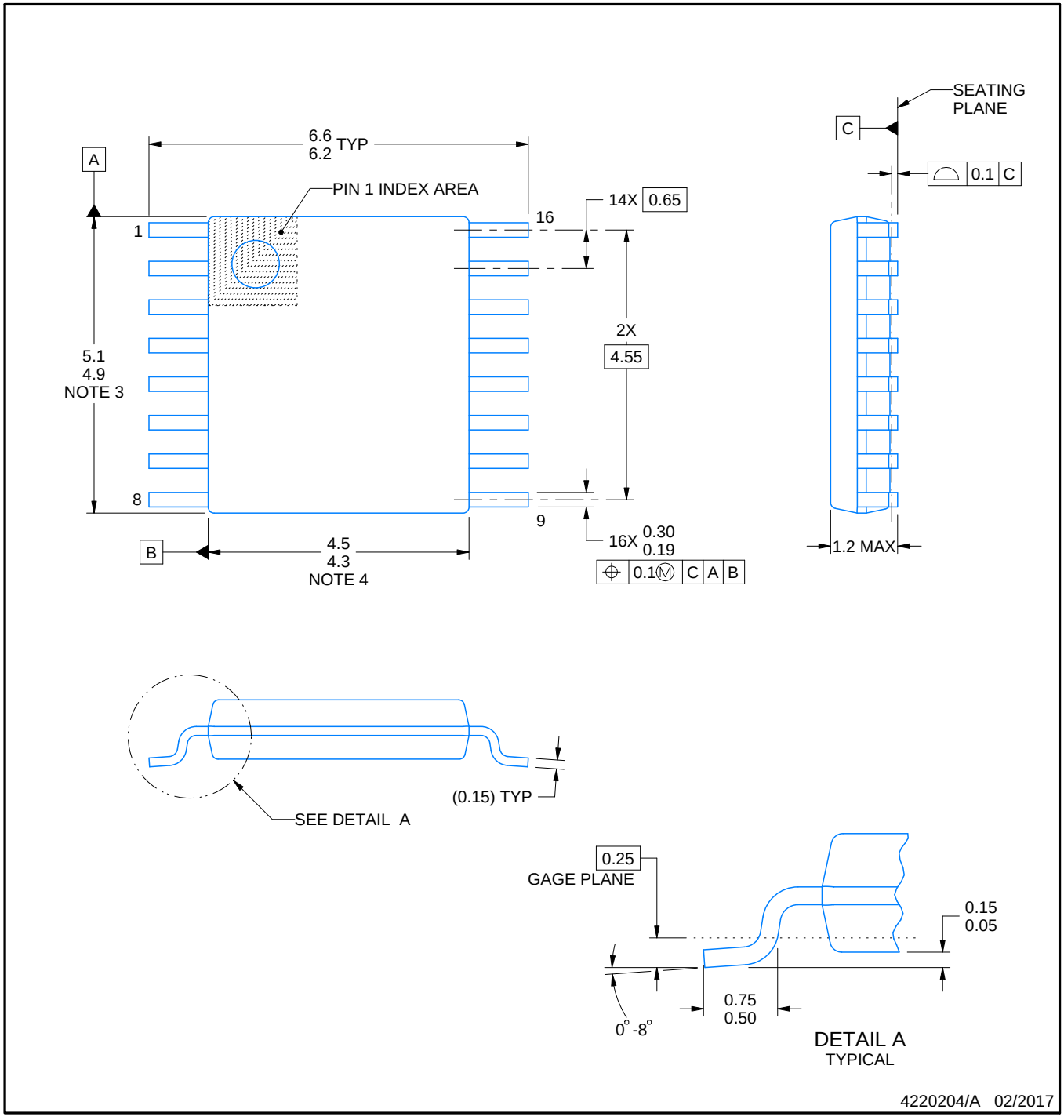
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead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

PACKAGE OUTLINE

PW0016A

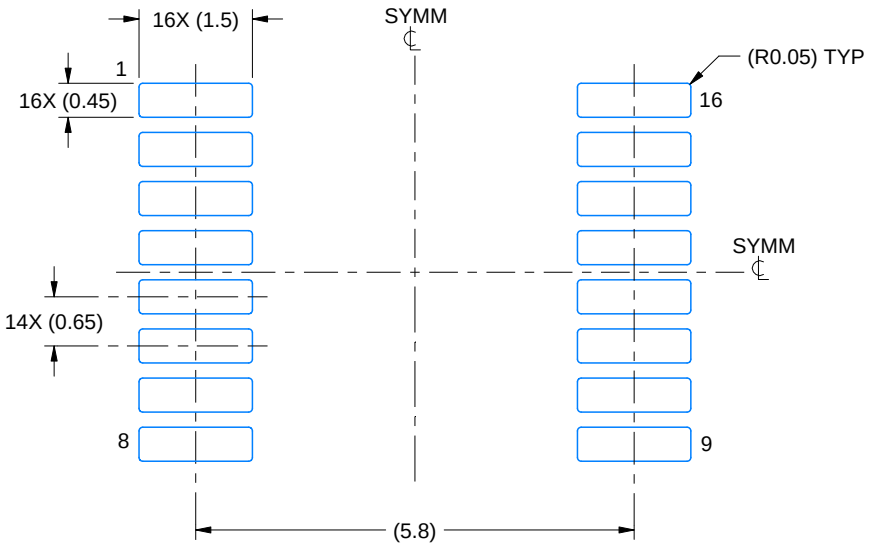
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

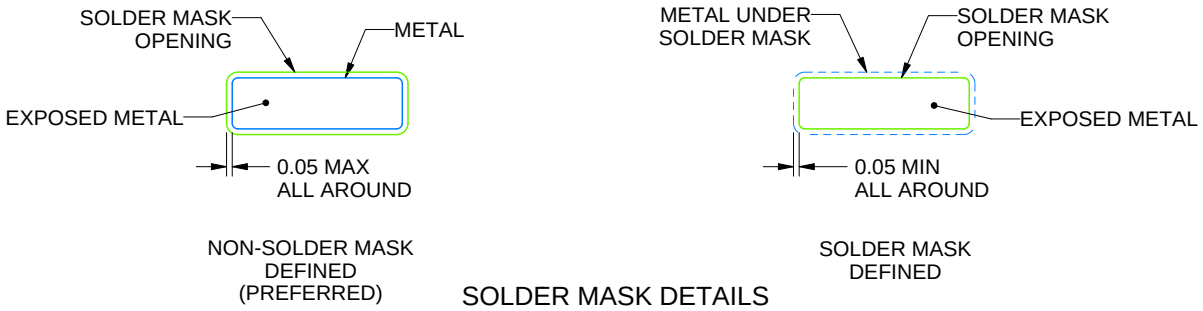


NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

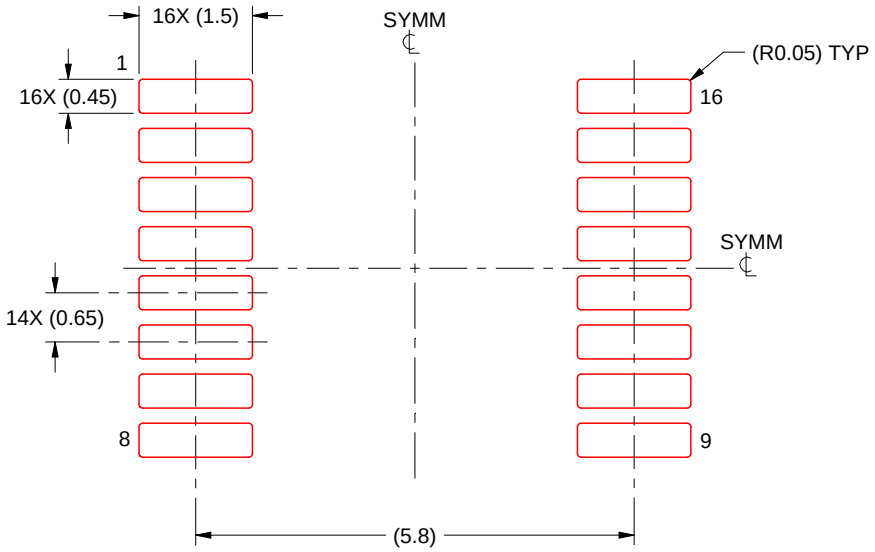


SOLDER MASK DETAILS

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.



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.

GENERIC PACKAGE VIEW

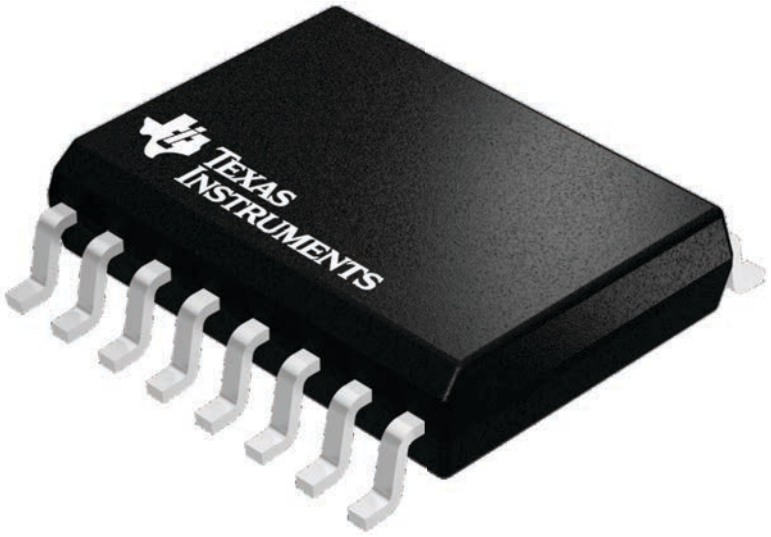
DW 16

SOIC - 2.65 mm max height

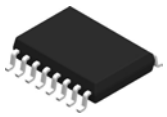
7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4224780/A

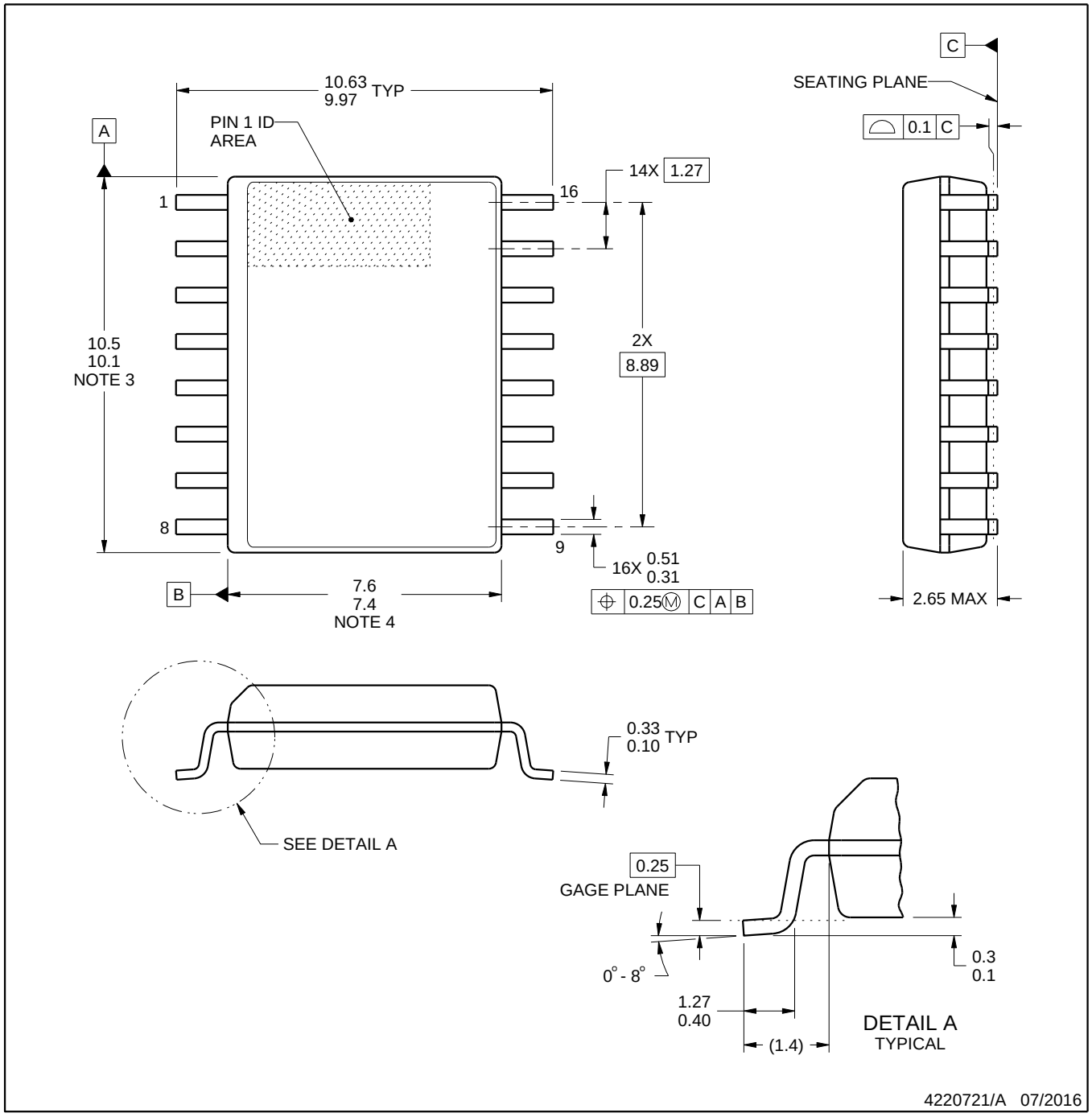


PACKAGE OUTLINE

DW0016A

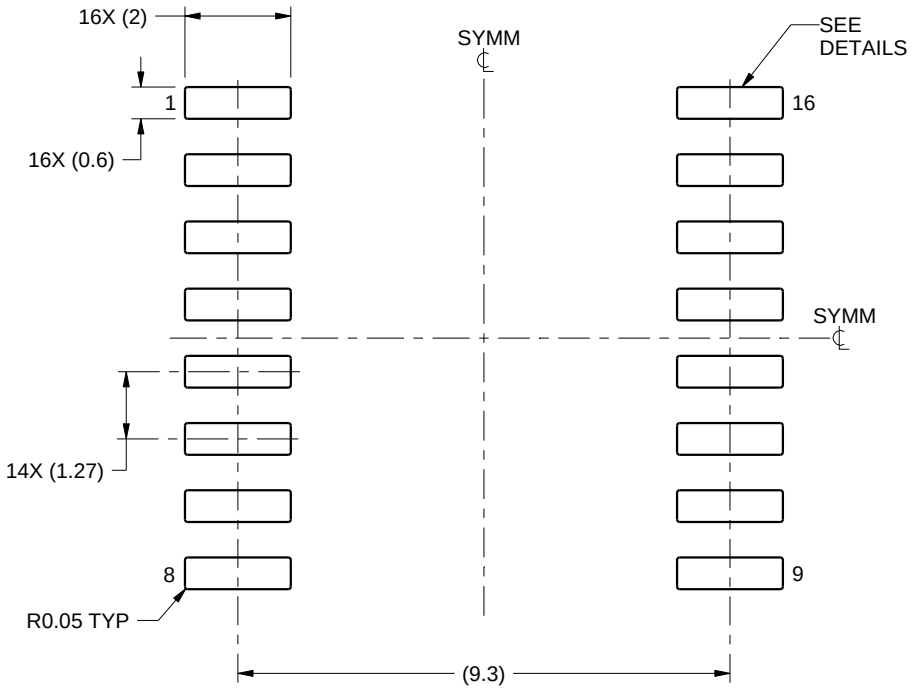
SOIC - 2.65 mm max height

SOIC

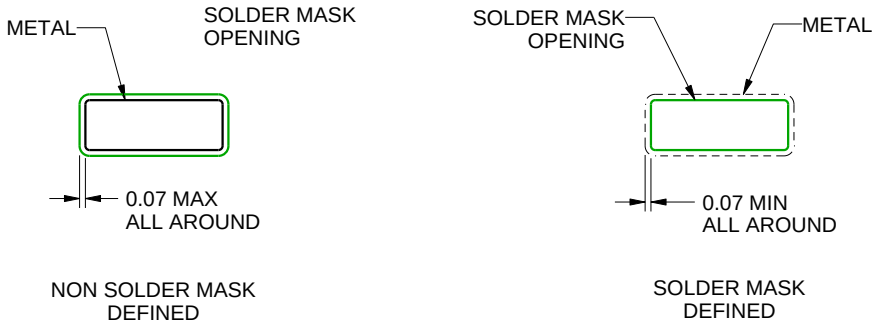


NOTES:

1. All linear dimensions are in millimeters. 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 MS-013.



LAND PATTERN EXAMPLE
SCALE:7X

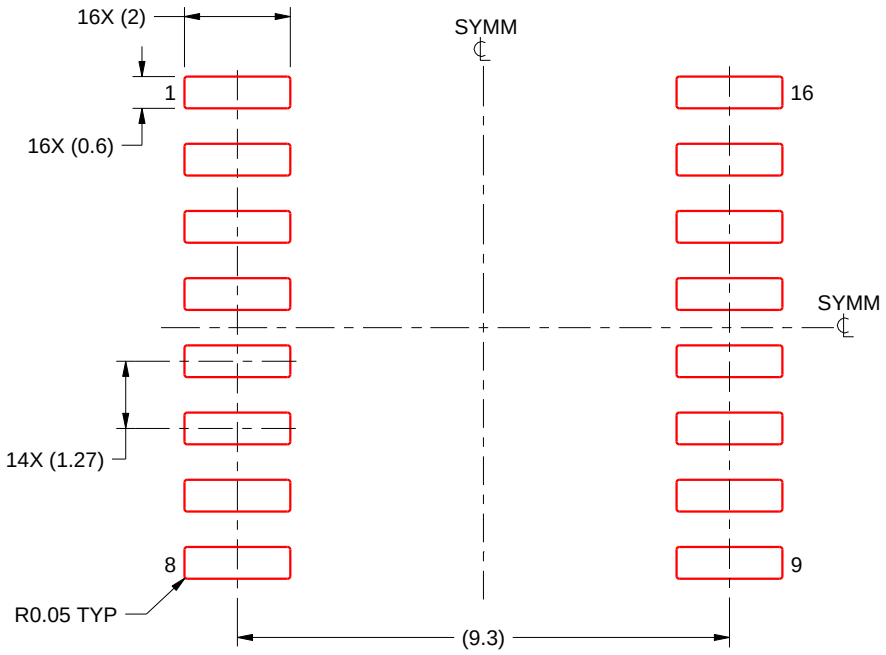


SOLDER MASK DETAILS

4220721/A 07/2016

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.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220721/A 07/2016

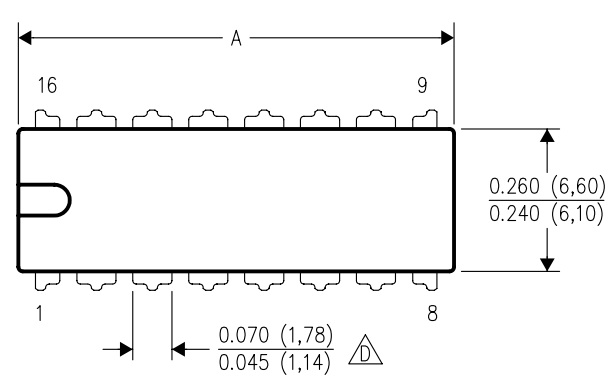
NOTES: (continued)

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.

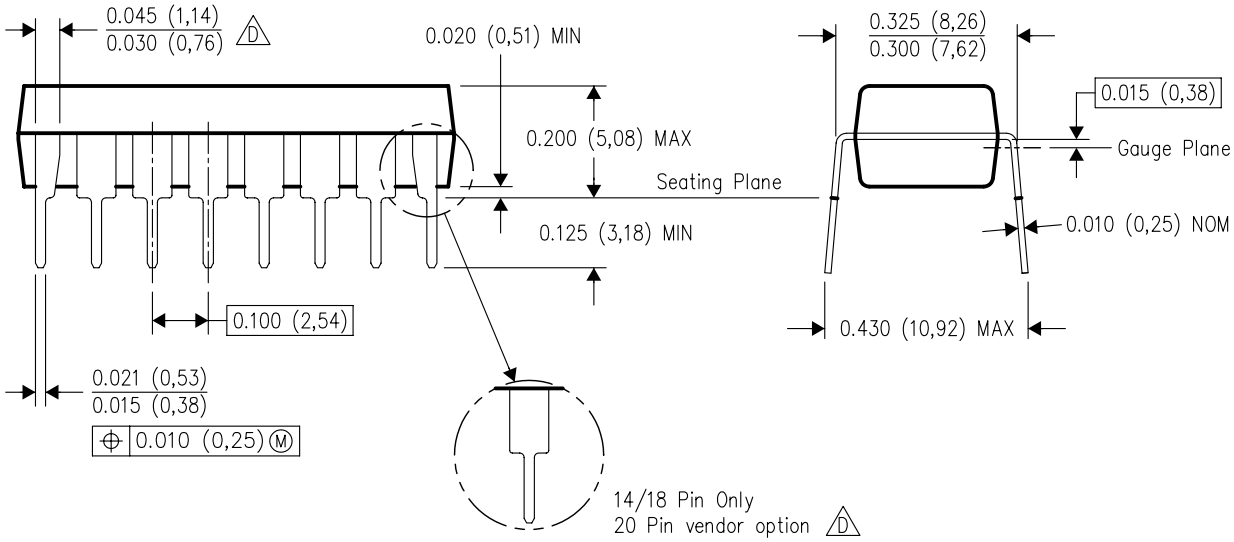
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

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