DS3695A/DS3695AT/DS3696A Multipoint RS485/RS422 Transceivers

Check for Samples: DS3695A, DS3695AT, DS3696A

FEATURES

- **Meets EIA Standard RS485 for Multipoint Bus Transmission and is Compatible with RS-422**
- **10 Ns Driver Propagation Delays (Typical)**
- **Single +5V Supply**
- **−7V to +12V Bus Common Mode Range Permits ±7V Ground Difference between Devices on the Bus**
- **Thermal Shutdown Protection**
- **High Impedance to Bus with Driver in TRI-STATE or with Power Off, over the Entire Common Mode Range Allows the Unused Devices on the Bus to be Powered Down**
- **Combined Impedance of a Driver Output and Receiver Input is less than One RS485 Unit Load, Allowing up to 32 Transceivers on the Bus**
- **70 mV Typical Receiver Hysteresis**
- **Available in SOIC Packaging**

DESCRIPTION

The DS3695A and DS3696A are high speed differential TRI-STATE bus/line transceivers designed to meet the requirements of EIA standard RS485 with extended common mode range (+12V to −7V), for multipoint data transmission. In addition they are compatible with requirements of RS-422.

The driver and receiver outputs feature TRI-STATE capability. The driver outputs remain in over the entire common mode range of +12V to −7V. Bus faults that cause excessive power dissipation within the device trigger a thermal shutdown circuit, which forces the driver outputs into the high impedance state. The DS3696A provides an output pin (TS) which reports the thermal shutdown of the device. TS is an “open collector” pin with an internal 10 kΩ pull-up resistor. This allows the TS outputs of several devices to be wire OR-ed.

Both AC and DC specifications are guaranteed over the 0°C to 70°C temperature and 4.75V to 5.25V supply voltage range.

Connection and Logic Diagrams

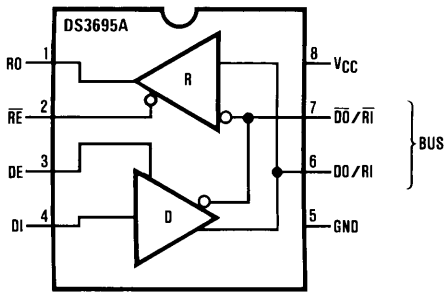


Figure 1. Molded Package, Small Outline (D0008A)
Top View

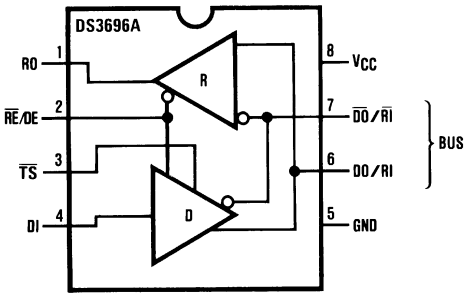


Figure 2. Top View
(See Package Number D0008A)

$\overline{TS}$ was $\overline{LF}$ (Line Fault) on previous datasheets, $\overline{TS}$ goes low upon thermal shutdown.

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.

Absolute Maximum Ratings (1)(2)

Supply Voltage, V_{CC}	7V
Control Input Voltages	7V
Driver Input Voltage	7V
Driver Output Voltages	+15V/−10V
Receiver Input Voltages	+15V/−10V
Receiver Output Voltage	5.5V
Continuous Power Dissipation @ 25°C	
D0008A Package	630 mW (3)
Storage Temp. Range	−65°C to +150°C
Lead Temp. (Soldering 4 seconds)	260°C

(1) "Absolute maximum ratings" are those beyond which the safety of the device cannot be verified. They are not meant to imply that the device should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(3) Derate linearly at 6.5 mW/°C to 337 mW at 70°C.

Recommended Operating Conditions

	Min	Max	Units
Supply Voltage, V_{CC}	4.75	5.25	V
Bus Voltage	−7	+12	V
Operating Free Air Temperature (T_A)			
Commercial (DS3695AM)	0	+70	°C
Industrial (DS3695ATM)	−40	+85	°C
Commercial (DS3696AM)	0	+70	°C

Electrical Characteristics (1) (2)

0°C ≤ T_A ≤ 70°C, 4.75V < V_{CC} < 5.25V unless otherwise specified

Parameter			Test Conditions	Min	Typ	Max	Units
V_{OD1}	Differential Driver Output Voltage (Unloaded)		I_O = 0			5	V
V_{OD2}	Differential Driver Output Voltage (with Load)		R = 50Ω; (RS-422) (3)	2			V
			R = 27Ω; (RS-485)	1.5			V
ΔV_{OD}	Complementary Output States Differential Output Voltage For Change in Magnitude of Driver		R = 27Ω			0.2	V
V_{OC}	Driver Common Mode Output Voltage					3.0	V
$\Delta\|V_{OC}\|$	Change in Magnitude of Driver Common Mode Output Voltage For Complementary Output States					0.2	V
V_{IH}	Input High Voltage	DI, DE, $\overline{RE}$, RE/DE		2			V
V_{IL}	Input Low Voltage					0.8	V
V_{CL}	Input Clamp Voltage		I_{IN} = −18 mA			−1.5	V
I_{IL}	Input Low Current		V_{IL} = 0.4V			−200	µA
I_{IH}	Input High Current		V_{IH} = 2.4V			20	µA

(1) All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.
(2) All typicals are given for V_{CC} = 5V and T_A = 25°C.
(3) All limits for which this note is applied must be derated by 10% for DS3695AT. Other parameters remain the same for this extended temperature range device (−40°C ≤ T_A ≤ +85°C).

Electrical Characteristics (1) (2) (continued)

0°C ≤ T_A ≤ 70°C, 4.75V < V_{CC} < 5.25V unless otherwise specified

Parameter			Test Conditions		Min	Typ	Max	Units
I_{IN}	Input Current	RI, $\overline{RI}$, DO/RI, $\overline{DO/RI}$	V_{CC} = 0V or 5.25V, DE or $\overline{RE}$ /DE = 0V	V_{IN} = 12V			+1.0	mA
				V_{IN} = −7V			−0.8	mA
V_{TH}	Differential Input Threshold Voltage for Receiver		−7V ≤ V_{CM} ≤ +12V		−0.2		+0.2	V
ΔV_{TH}	Receiver Input Hysteresis		V_{CM} = 0V			70		mV
V_{OH}	Receiver Output High Voltage		I_{OH} = −400 µA		2.4			V
V_{OL}	Output Low Voltage	RO	I_{OL} = 16 mA (3)				0.5	V
		$\overline{TS}$	I_{OL} = 8 mA				0.45	V
I_{OZR}	Output Current at Receiver OFF-State (High Impedance)		0.4V ≤ V_O ≤ 2.4V, V_{CC} = Max,				±20	µA
R_{IN}	Receiver Input Resistance		−7V ≤ V_{CM} ≤ +12V		12			kΩ
I_{CC}	Supply Current		No Load (3)	Driver Outputs Enabled		42	60	mA
				Driver Outputs Disabled		27	40	mA
I_{OSD}	Output Current Driver Short-Circuit		V_O = −7V (3)				−250	mA
			V_O = +12V (3)				+250	mA
I_{OSR}	Output Current Receiver Short-Circuit		V_O = 0V		−15		−85	mA

Receiver Switching Characteristics

0°C ≤ T_A ≤ 70°C, 4.75V < V_{CC} < 5.25V unless otherwise specified (4)

Symbol	Test Conditions	Min	Typ	Max	Units
t_{PLH}	C_L = 15 pF	15	28	42	ns
t_{PHL}	S1 and S2	15	28	42	ns
$\lvert t_{PLH} - t_{PHL} \rvert$	Closed	0	3		ns
t_{PLZ}	C_L = 15 pF, S2 Open	5	29	35	ns
t_{PHZ}	C_L = 15 pF, S1 Open	5	12	16	ns
t_{PZL}	C_L = 15 pF, S2 Open	7	15	28	ns
t_{PZH}	C_L = 15 pF, S1 Open	7	15	20	ns

(4) All typicals are given for V_{CC} = 5V and T_A = 25°C.

Driver Switching Characteristics

0°C ≤ T_A ≤ 70°C, 4.75V < V_{CC} < 5.25V unless otherwise specified (1)

Symbol	Test Conditions	Min	Typ	Max	Units
SINGLE ENDED CHARACTERISTICS (Figure 7, Figure 8, and Figure 10)					
t_{PLH}	R_{LDIFF} = 60Ω	9	15	22	ns
t_{PHL}	C_{L1} = C_{L2} = 100 pF	9	15	22	ns
$t_{SKEW} \lvert t_{PLH} - t_{PHL} \rvert$		0	2	8	ns
t_{PLZ}	C_L = 15 pF, S2 Open	7	15	30	ns
t_{PHZ}	C_L = 15 pF, S1 Open	7	15	30	ns
t_{PZL}	C_L = 100 pF, S2 Open	30	35	50	ns
t_{PZH}	C_L = 100 pF, S1 Open	30	35	50	ns
DIFFERENTIAL SWITCHING CHARACTERISTICS (Figure 10)					
t_r, t_f	R_{LDIFF} = 60Ω C_{L1} = C_{L2} = 100 pF	6	10	18	ns

(1) All typicals are given for V_{CC} = 5V and T_A = 25°C.

AC TEST CIRCUITS AND SWITCHING WAVEFORMS

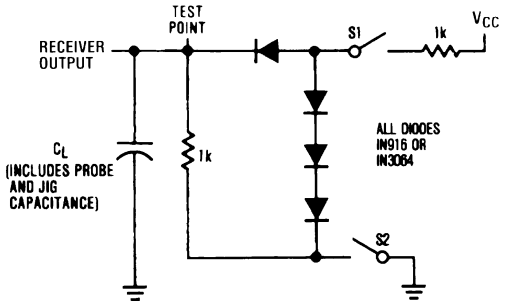
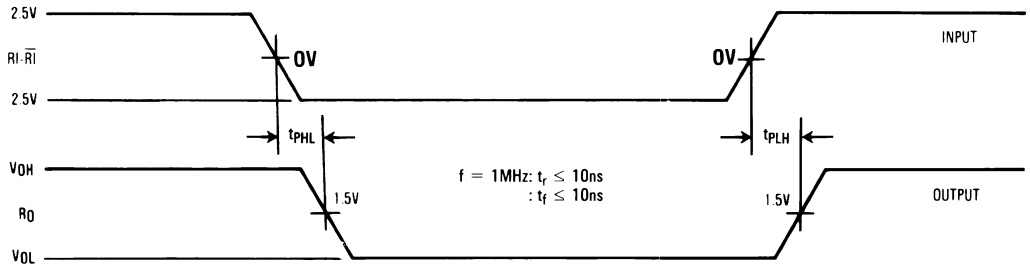


Figure 3. Receiver Propagation Delay Test Circuit



Differential input voltage may be realized by grounding $\overline{RI}$ and pulsing RI between +2.5V and −2.5V

Figure 4. Receiver Input-to-Output Propagation Delay Timing

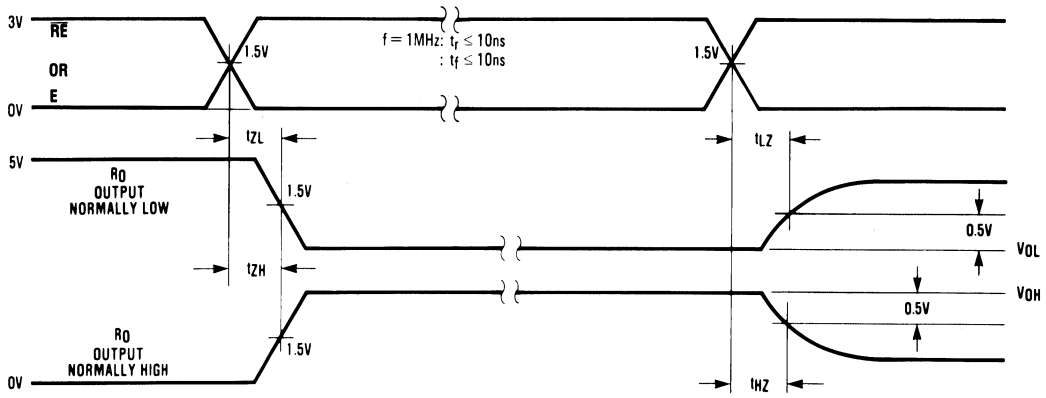


Figure 5. Receiver Enable/Disable Propagation Delay Timing

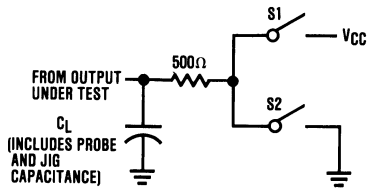


Figure 6. Unless Otherwise Specified the Switches are Closed

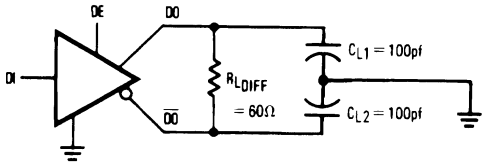
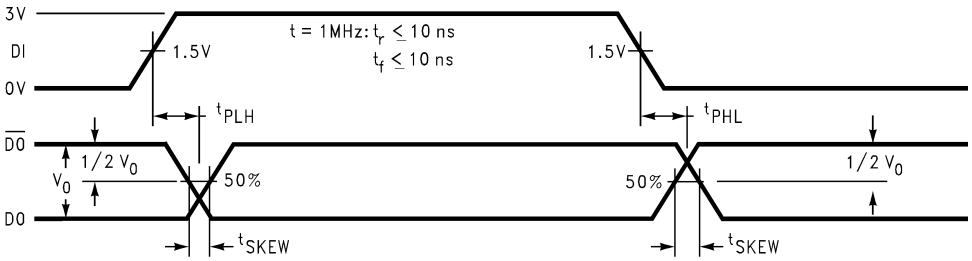


Figure 7. Driver Propagation Delay Test Circuits



t_{PLH} and t_{PHL} are measured to the respective 50% points. t_{SKEW} is the difference between propagation delays of the complementary outputs.

Figure 8. Driver Input-to-Output Propagation Delay Timing (Single-Ended)

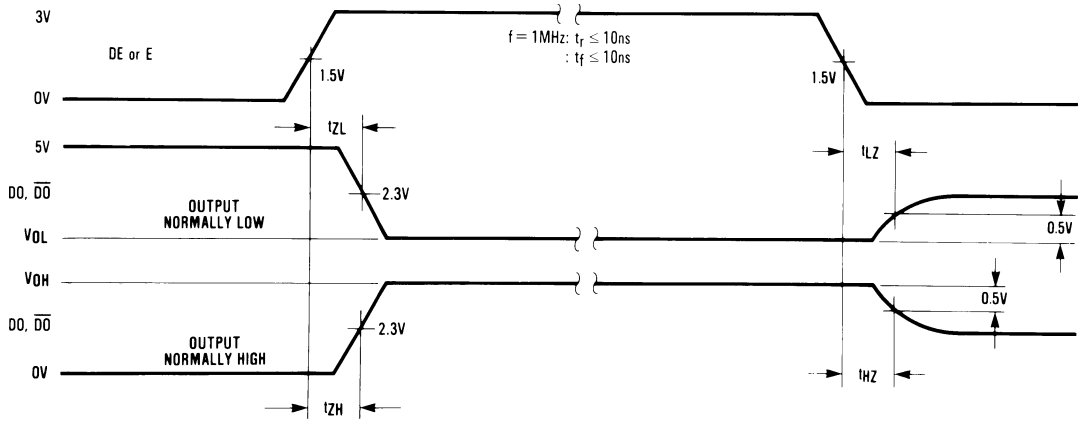


Figure 9. Driver Enable/Disable Propagation Delay Timing

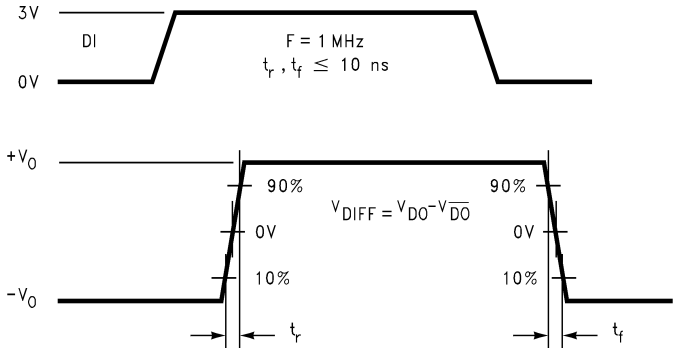


Figure 10. Driver Differential Transition Timing

Table 1. Function Tables DS3695A/DS3696A Transmitting(1)

Inputs			Line	Outputs		
$\overline{RE}$	DE	DI	Condition	$\overline{DO}$	DO	$\overline{TS}$ * (DS3696A Only)
X	1	1	No Fault	0	1	H
X	1	0	No Fault	1	0	H
X	0	X	X	Z	Z	H
X	1	X	Fault	Z	Z	L

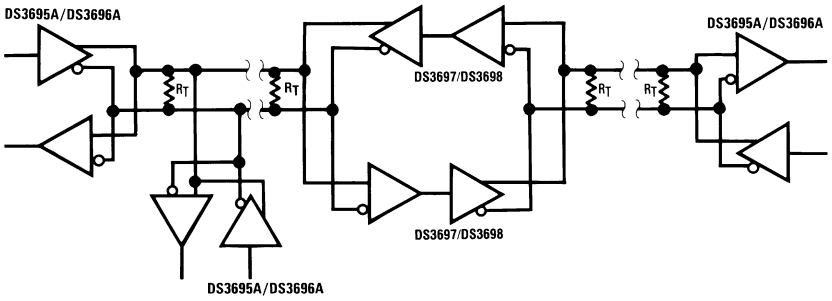
Table 2. Function Tables DS3695A/DS3696A Receiving(1)

Inputs			Outputs	
$\overline{RE}$	DE	RI–$\overline{RI}$	RO	$\overline{TS}$ * (DS3696A Only)
0	0	≥+0.2V	1	H
0	0	≤−0.2V	0	H
0	0	Inputs Open**	1	H
1	0	X	Z	H

(1) X — Don't care condition
Z — High impedance state
Fault — Improper line conditions causing excessive power dissipation in the driver, such as shorts or bus contention situations
* $\overline{TS}$ is an “open collector” output with an on-chip 10 kΩ pull-up resistor.
** **This is a fail safe condition**

(1) X — Don't care condition
Z — High impedance state
Fault — Improper line conditions causing excessive power dissipation in the driver, such as shorts or bus contention situations
* $\overline{TS}$ is an “open collector” output with an on-chip 10 kΩ pull-up resistor.
** **This is a fail safe condition**

Typical Application



Repeater control logic not shown.

Figure 11.

REVISION HISTORY

Changes from Revision B (April 2013) to Revision C	Page
• Changed layout of National Data Sheet to TI format	6

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
DS3695AM/NOPB	ACTIVE	SOIC	D	8	95	RoHS & Green	SN	Level-1-260C-UNLIM	0 to 70	DS36 95AM	Samples
DS3695AMX/NOPB	ACTIVE	SOIC	D	8	2500	RoHS & Green	SN	Level-1-260C-UNLIM	0 to 70	DS36 95AM	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.

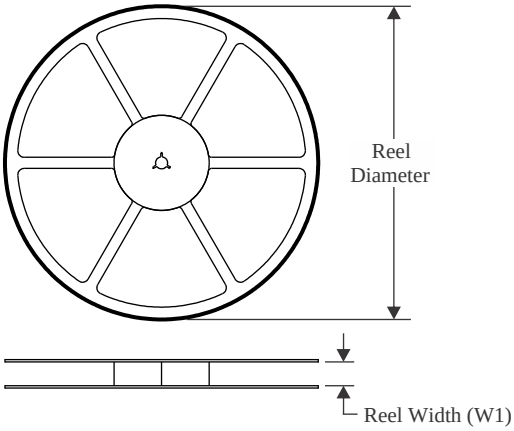
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

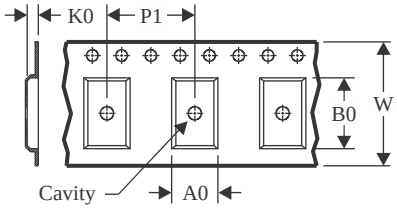
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

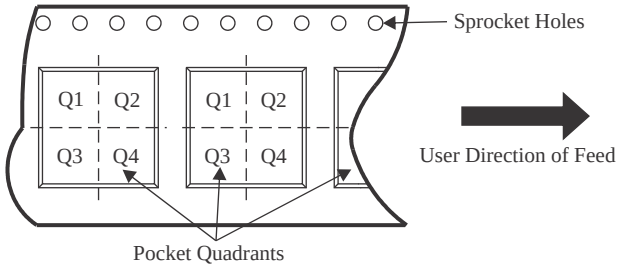


TAPE DIMENSIONS



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

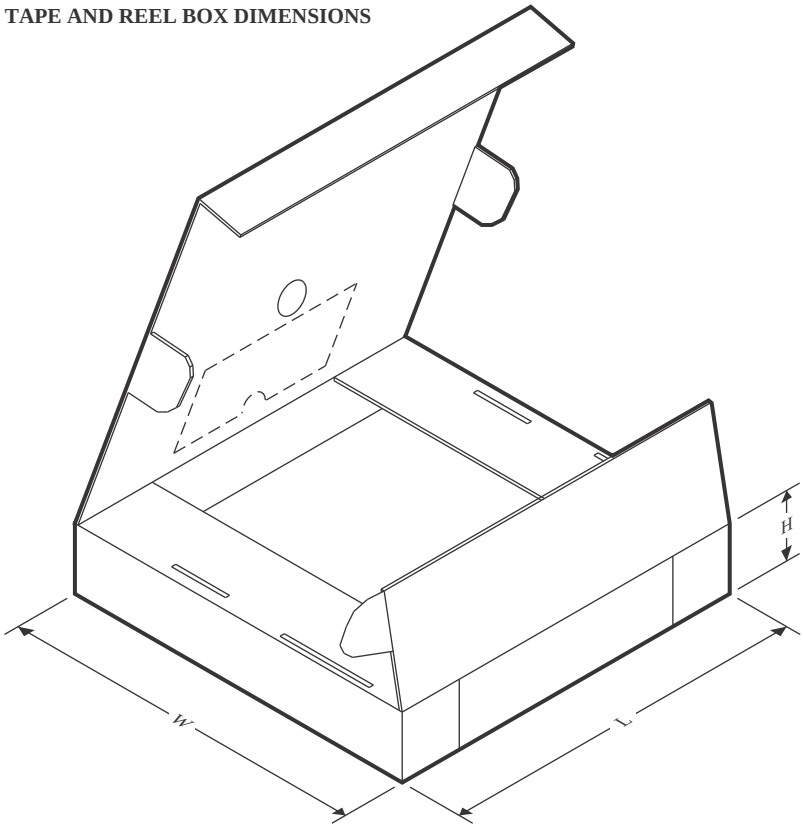
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
DS3695AMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

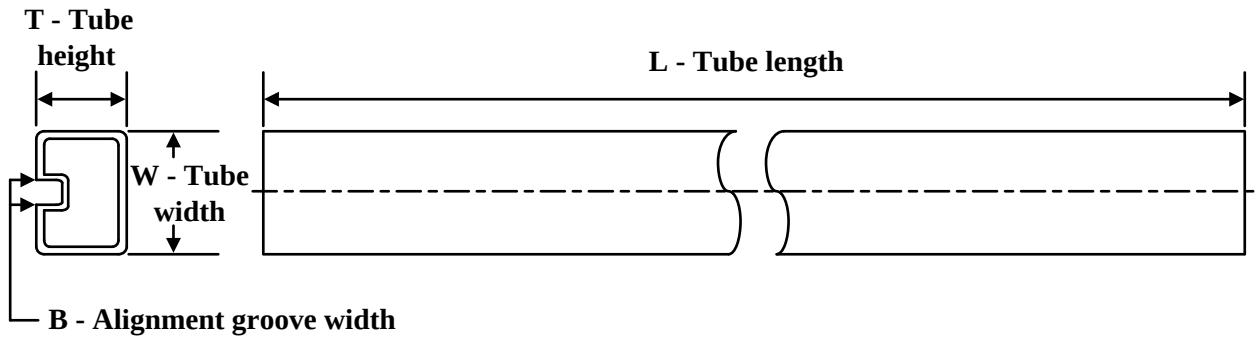
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

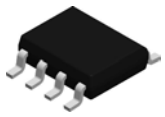
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS3695AMX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
DS3695AM/NOPB	D	SOIC	8	95	495	8	4064	3.05

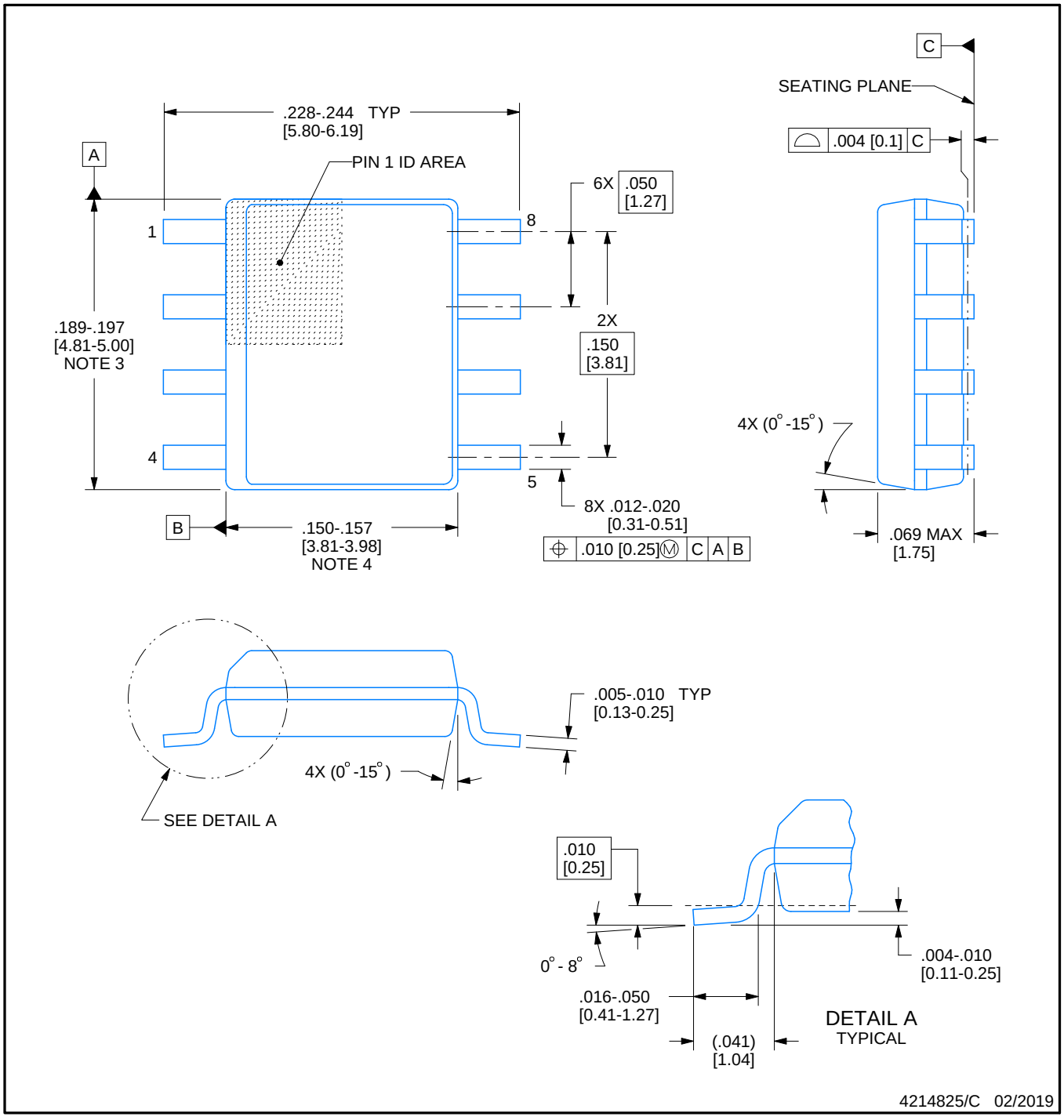


PACKAGE OUTLINE

D0008A

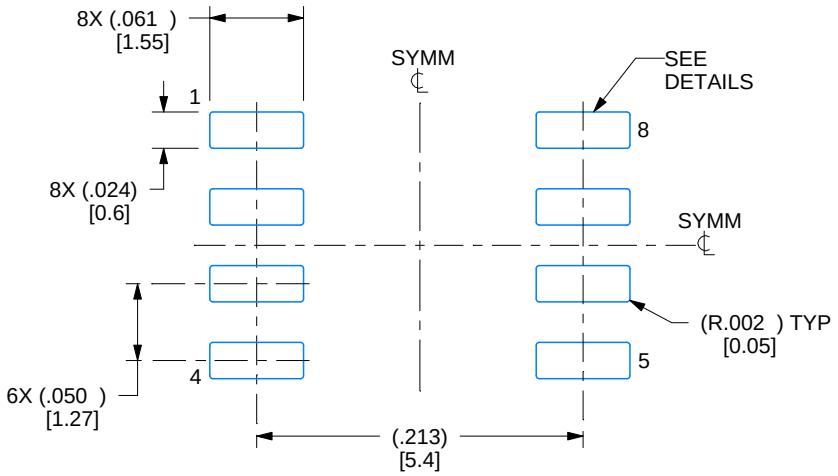
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

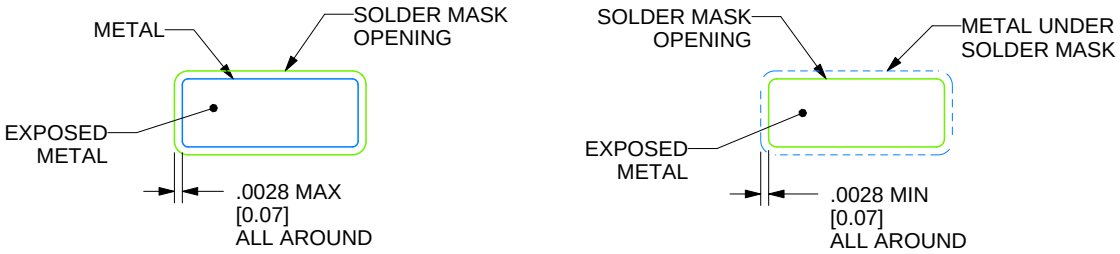


NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. 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 .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

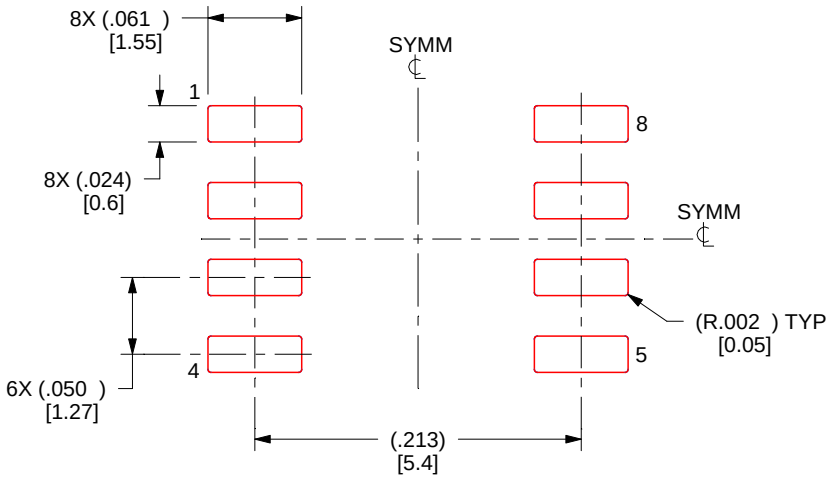
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

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.

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