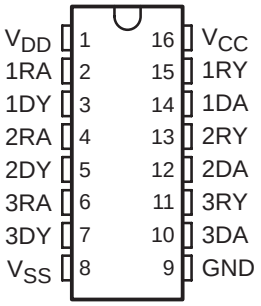
SLLS185D − DECEMBER 1994 − REVISED JULY 2001

- **Meets or Exceeds the Requirements of ANSI TIA/EIA-232-F and ITU V.28**
- **Designed to Support Data Rates up to 120 kbit/s Over 3-m Cable**
- **ESD Protection Exceeds 5 kV on All Pins**
- **Flow-Through Design**
- **Wide-Driver Supply Voltage . . . ±7.5 V to ±15 V**
- **Functionally Interchangeable With Motorola MC145406 and Texas Instruments SN75C1406**

DW OR N PACKAGE
(TOP VIEW)



description

The TL145406 is a bipolar device containing three independent drivers and receivers that are used to interface data terminal equipment (DTE) with data circuit-terminating equipment (DCE). The drivers and receivers of the TL145406 are similar to those of the SN75188 quadruple driver and SN75189A quadruple receiver, respectively. The pinout matches the flow-through design of the SN75C1406 to reduce the board space required and to allow easy interconnection. The bipolar circuits and processing of the TL145406 provide a rugged low-cost solution for this function at the expense of quiescent power and external passive components relative to the SN75C1406.

The TL145406 complies with the requirements of TIA/EIA-232-F and ITU (formerly CCITT) V.28 standards. These standards are for data interchange between a host computer and peripheral at signaling rates up to 20 kbit/s. The switching speeds of the TL145406 are fast enough to support rates up to 120 kbit/s with lower capacitive loads (shorter cables). Interoperability at the higher signaling rates cannot be assured unless the designer has design control of the cable and of the interface circuits at both ends. For interoperability at signaling rates to 120 kbit/s, use of TIA/EIA-423-B (ITU V.10) and TIA/EIA-422-B (ITU V.11) standards is recommended.

The TL145406 is characterized for operation from 0°C to 70°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES	
	PLASTIC DIP (N)	PLASTIC SMALL OUTLINE (DW)
0°C to 70°C	TL145406N	TL145406DW

The DW package also is available taped and reeled. Add the suffix R to the device type (e.g., TL145406DWR).

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.

PRODUCTION DATA information is 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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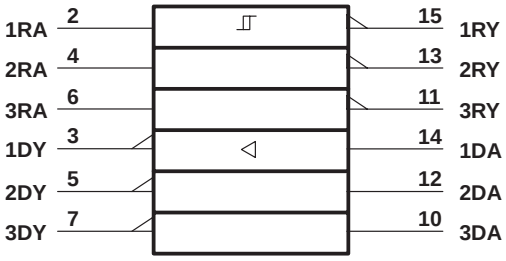
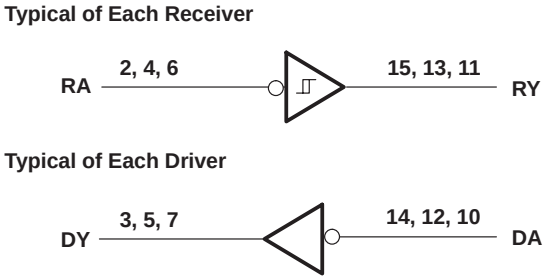
logic symbol†

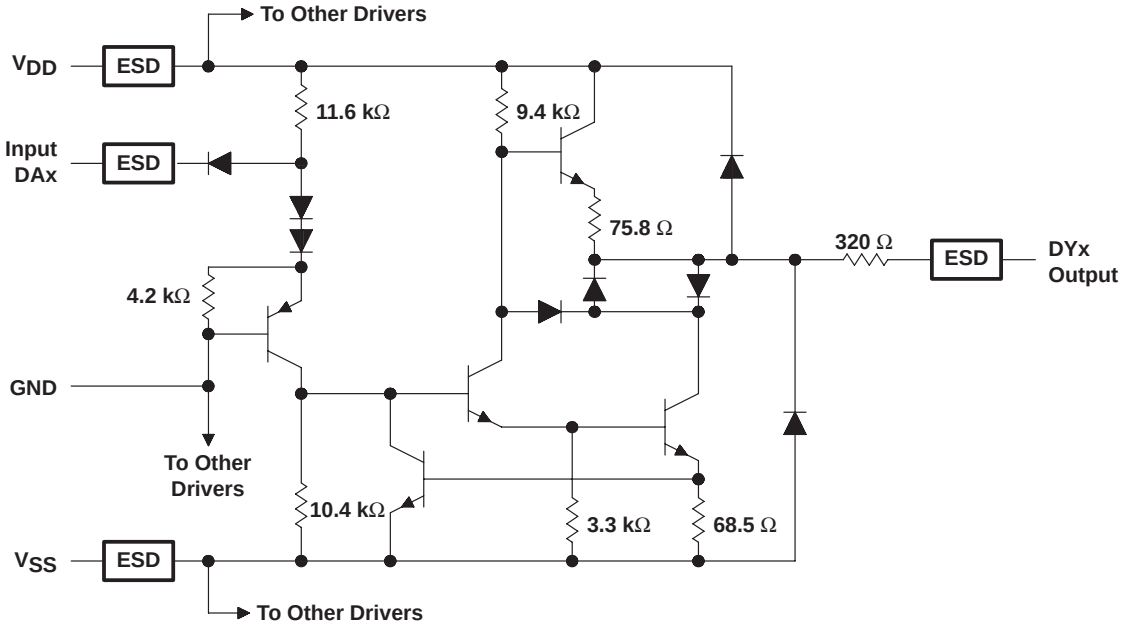


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic diagram (positive logic)

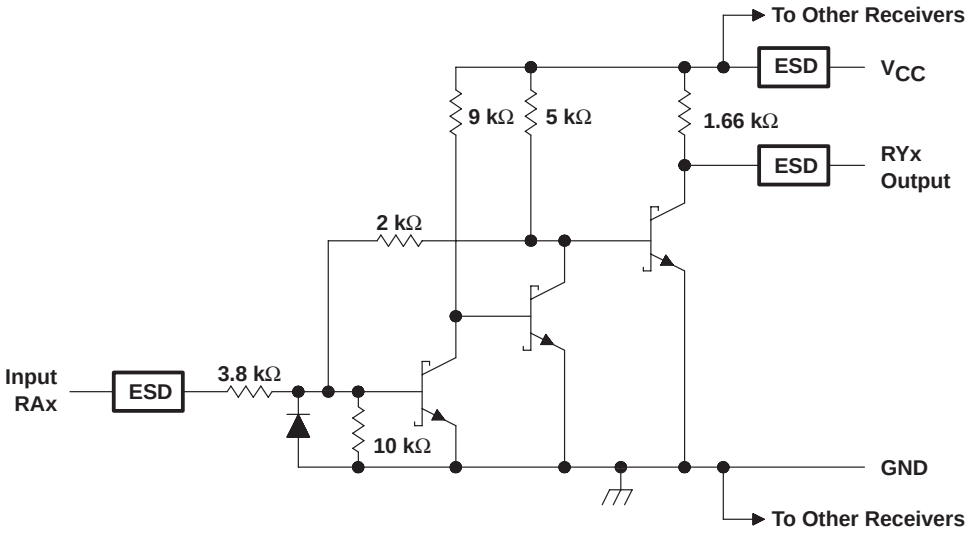


schematic (each driver)



Resistor values shown are nominal.

schematic (each receiver)



Resistor values shown are nominal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage (see Note 1): V_{CC}	10 V
V_{DD}	15 V
V_{SS}	−15 V
Input voltage range: Driver	−15 V to 7 V
Receiver	−30 V to 30 V
Driver output voltage range	−15 V to 15 V
Receiver low-level output current	20 mA
Package thermal impedance, θ_{JA} (see Note 2): DW package	57°C/W
N package	67°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C
Storage temperature range, T_{stg}	−65°C to 150°C

† 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.

NOTES: 1. All voltages are with respect to the network ground terminal.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

			MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage		7.5	9	15	V
V_{SS}	Supply voltage		−7.5	−9	−15	V
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage (driver only)		1.9			V
V_{IL}	Low-level input voltage (driver only)				0.8	V
I_{OH}	High-level output current	Driver			−6	mA
		Receiver			−0.5	
I_{OL}	Low-level output current	Driver			6	mA
		Receiver			16	
T_A	Operating free-air temperature		0		70	°C

supply currents

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
I_{DD}	Supply current from V_{DD}	All inputs at 1.9 V,	No load	V_{DD} = 9 V,	V_{SS} = −9 V			15	mA
				V_{DD} = 12 V,	V_{SS} = −12 V			19	
				V_{DD} = 15 V,	V_{SS} = −15 V			25	
		All inputs at 0.8 V,	No load	V_{DD} = 9 V,	V_{SS} = −9 V			4.5	
				V_{DD} = 12 V,	V_{SS} = −12 V			5.5	
				V_{DD} = 15 V,	V_{SS} = −15 V			9	
I_{SS}	Supply current from V_{SS}	All inputs at 1.9 V,	No load	V_{DD} = 9 V,	V_{SS} = −9 V			−15	mA
				V_{DD} = 12 V,	V_{SS} = −12 V			−19	
				V_{DD} = 15 V,	V_{SS} = −15 V			−25	
		All inputs at 0.8 V,	No load	V_{DD} = 9 V,	V_{SS} = −9 V			−3.2	
				V_{DD} = 12 V,	V_{SS} = −12 V			−3.2	
				V_{DD} = 15 V,	V_{SS} = −15 V			−3.2	
I_{CC}	Supply current from V_{CC}	All inputs at 5 V,	No load,	V_{CC} = 5 V			13.2	20	mA

DRIVER SECTION

electrical characteristics over recommended operating free-air temperture range, V_{DD} = 9 V, V_{SS} = −9 V, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage	V_{IL} = 0.8 V,	R_L = 3 kΩ,	See Figure 1	6	7.5		V
V_{OL}	Low-level output voltage (see Note 3)	V_{IH} = 1.9 V,	R_L = 3 kΩ,	See Figure 1		−7.5	−6	V
I_{IH}	High-level input current	V_I = 5 V,	See Figure 2				10	μA
I_{IL}	Low-level input current	V_I = 0,	See Figure 2				−1.6	mA
$I_{OS(H)}$	High-level short-circuit output current (see Note 4)	V_{IL} = 0.8 V,	V_O = 0 or V_{SS},	See Figure 1	−4.5	−10	−19.5	mA
$I_{OS(L)}$	Low-level short-circuit output current	V_{IH} = 2 V,	V_O = 0 or V_{DD},	See Figure 1	4.5	10	19.5	mA
r_O	Output resistance (see Note 5)	V_{CC} = V_{DD} = V_{SS} = 0, V_O = −2 V to 2 V			300			Ω

NOTES: 3. The algebraic convention, where the more positive (less negative) limit is designated as maximum, is used in this data sheet for logic levels only (e.g., if −10 V is maximum, the typical value is a more negative voltage).
4. Output short-circuit conditions must maintain the total power dissipation below absolute maximum ratings.
5. Test conditions are those specified by TIA/EIA-232-F and as listed above.

switching characteristics, V_{CC} = 5 V, V_{DD} = 12 V, V_{SS} = −12 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	R_L = 3 kΩ to 7 kΩ, C_L = 15 pF, See Figure 3		315	500	ns
t_{PHL}	Propagation delay time, high- to low-level output	R_L = 3 kΩ to 7 kΩ, C_L = 15 pF, See Figure 3		75	175	ns
t_{TLH}	Transition time, low- to high-level output	R_L = 3 kΩ to 7 kΩ, C_L = 15 pF, See Figure 3		60	100	ns
		R_L = 3 kΩ to 7 kΩ, C_L = 2500 pF, See Figure 3 and Note 6		1.7	2.5	μs
t_{THL}	Transition time, high- to low-level output	R_L = 3 kΩ to 7 kΩ, C_L = 15 pF, See Figure 3		40	75	ns
		R_L = 3 kΩ to 7 kΩ, C_L = 2500 pF, See Figure 3 and Note 7		1.5	2.5	μs

NOTES: 6. Measured between −3-V and 3-V points of the output waveform (TIA/EIA-232-F conditions). All unused inputs are tied.
7. Measured between 3-V and −3-V points of the output waveform (TIA/EIA-232-F conditions). All unused inputs are tied.

RECEIVER SECTION

electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IT+}	Positive-going threshold voltage	See Figure 5	T_A = 25°C	1.75	1.9	2.3	V
			T_A = 0°C to 70°C	1.55		2.3	
V_{IT-}	Negative-going threshold voltage			0.75	0.97	1.25	V
V_{hys}	Input hysteresis ($V_{IT+} - V_{IT-}$)			0.5			V
V_{OH}	High-level output voltage	I_{OH} = −0.5 mA	V_{IH} = 0.75 V	2.6	4	5	V
			Inputs open	2.6			
V_{OL}	Low-level output voltage	I_{OL} = 10 mA,	V_I = 3 V		0.2	0.45	V
I_{IH}	High-level input current	V_I = 25 V,	See Figure 5	3.6		8.3	mA
		V_I = 3 V,	See Figure 5	0.43			
I_{IL}	Low-level input current	V_I = −25 V,	See Figure 5	−3.6		−8.3	mA
		V_I = −3 V,	See Figure 5	−0.43			
I_{OS}	Short-circuit output current				−3.4	−12	mA

† All typical values are at T_A = 25°C, V_{CC} = 5, V_{DD} = 9 V, and V_{SS} = −9 V.

switching characteristics, V_{CC} = 5 V, V_{DD} = 12 V, V_{SS} = −12 V, T_A = 25°C

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	C_L = 50 pF,	R_L = 5 kΩ,	See Figure 6		107	425	ns
t_{PHL}	Propagation delay time, high- to low-level output	C_L = 50 pF,	R_L = 5 kΩ,	See Figure 6		42	150	ns
t_{TLH}	Transition time, low- to high-level output	C_L = 50 pF,	R_L = 5 kΩ,	See Figure 6		175	400	ns
t_{THL}	Transition time, high- to low-level output	C_L = 50 pF,	R_L = 5 kΩ,	See Figure 6		16	60	ns

PARAMETER MEASUREMENT INFORMATION

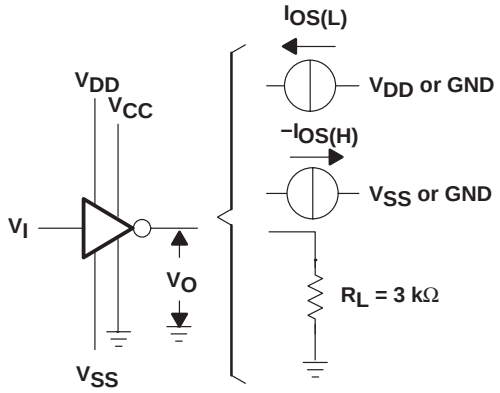


Figure 1. Driver Test Circuit for V_{OH}, V_{OL}, $I_{OS(H)}$, and $I_{OS(L)}$

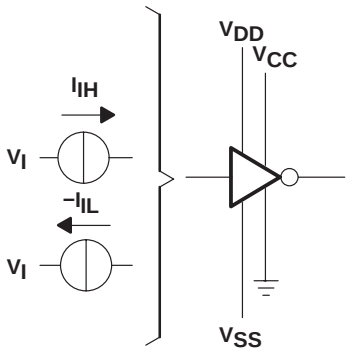
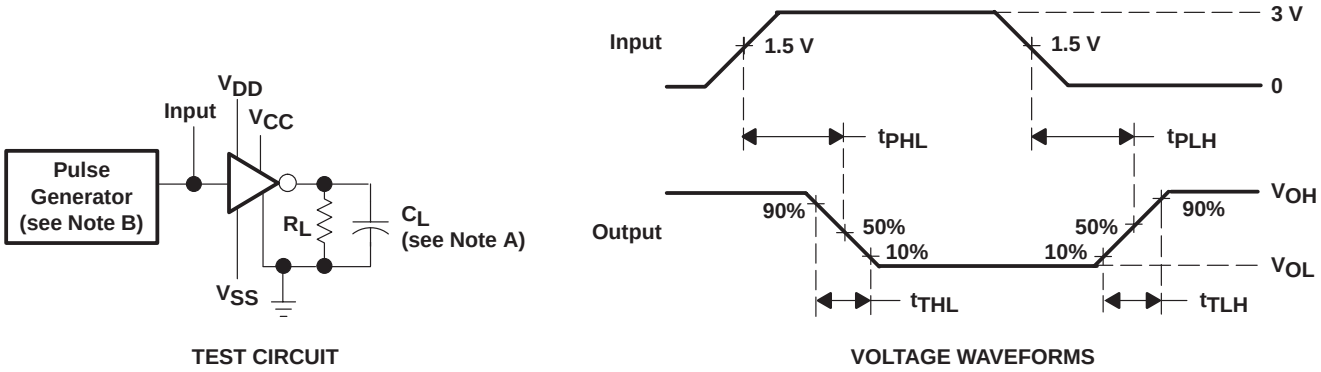


Figure 2. Driver Test Circuit for I_{IH} and I_{IL}

PARAMETER MEASUREMENT INFORMATION



NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: t_w = 25 µs, PRR = 20 kHz, Z_O = 50 Ω, $t_r = t_f$ < 50 ns.

Figure 3. Driver Test Circuit and Voltage Waveforms

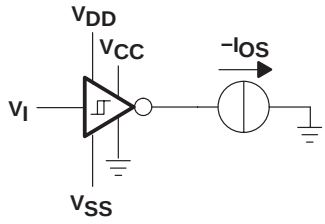


Figure 4. Receiver Test Circuit for I_{OS}

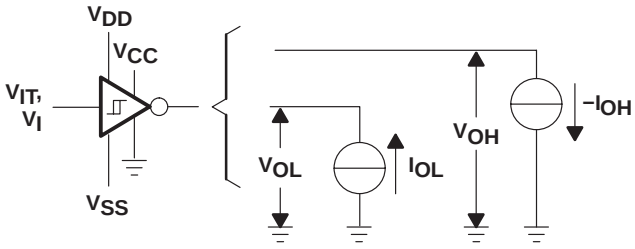
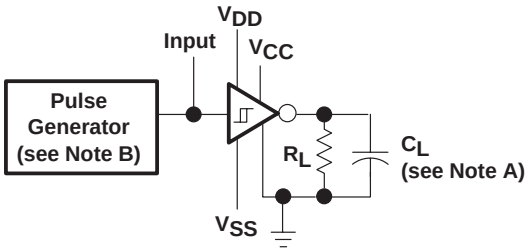


Figure 5. Receiver Test Circuit for V_{IT}, V_{OH}, and V_{OL}



NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: t_w = 25 µs, PRR = 20 kHz, Z_O = 50 Ω, $t_r = t_f$ < 50 ns.

Figure 6. Receiver Propagation and Transition Times

TYPICAL CHARACTERISTICS

DRIVER
VOLTAGE TRANSFER CHARACTERISTICS

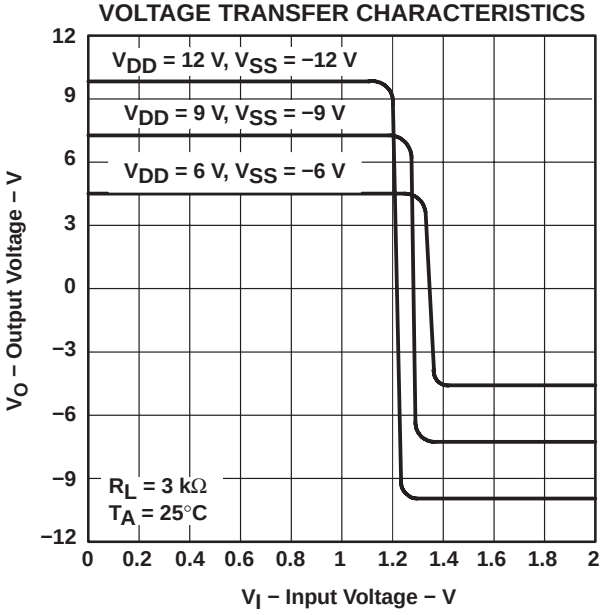


Figure 7

DRIVER
OUTPUT CURRENT
vs
OUTPUT VOLTAGE

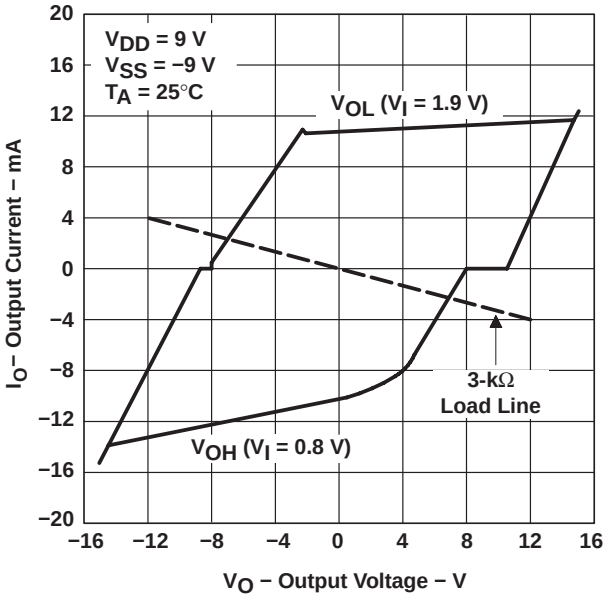


Figure 8

DRIVER
SHORT-CIRCUIT OUTPUT CURRENT
vs
FREE-AIR TEMPERATURE

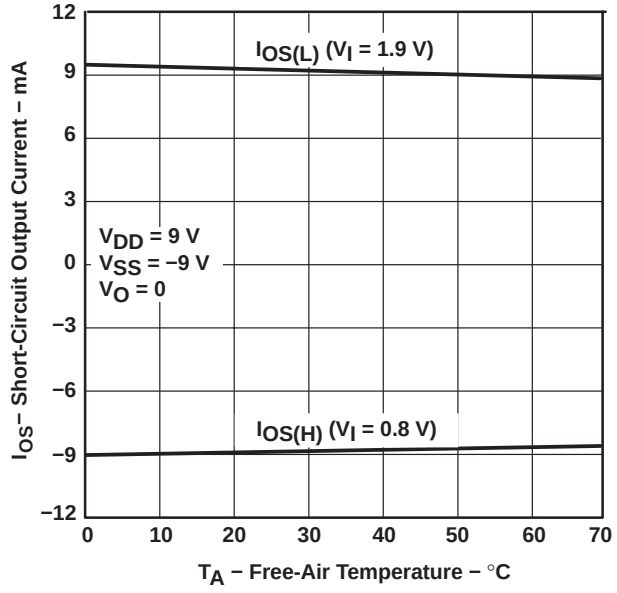


Figure 9

DRIVER
SLEW RATE
vs
LOAD CAPACITANCE

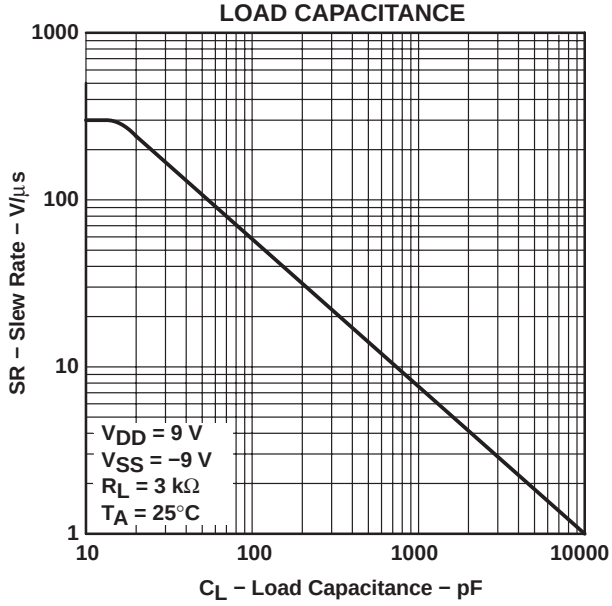


Figure 10

TYPICAL CHARACTERISTICS

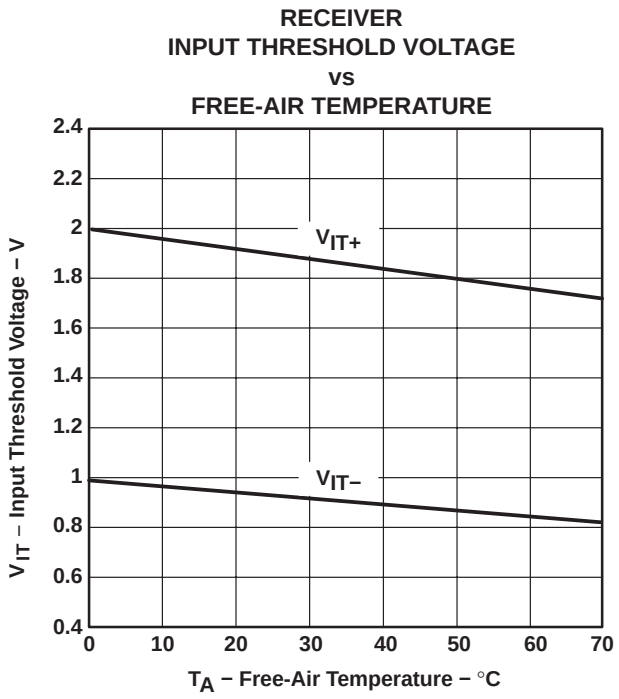


Figure 11

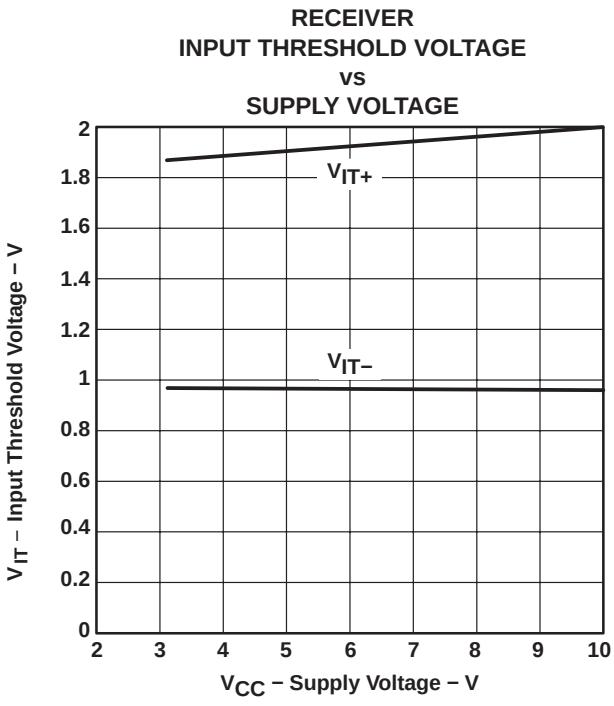
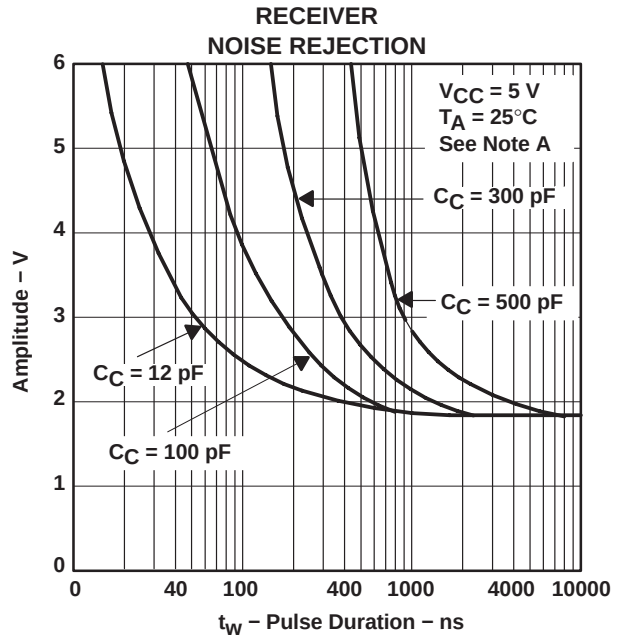


Figure 12



NOTE A: This figure shows the maximum amplitude of a positive-going pulse that, starting from 0, does not cause a change of the output level.

Figure 13

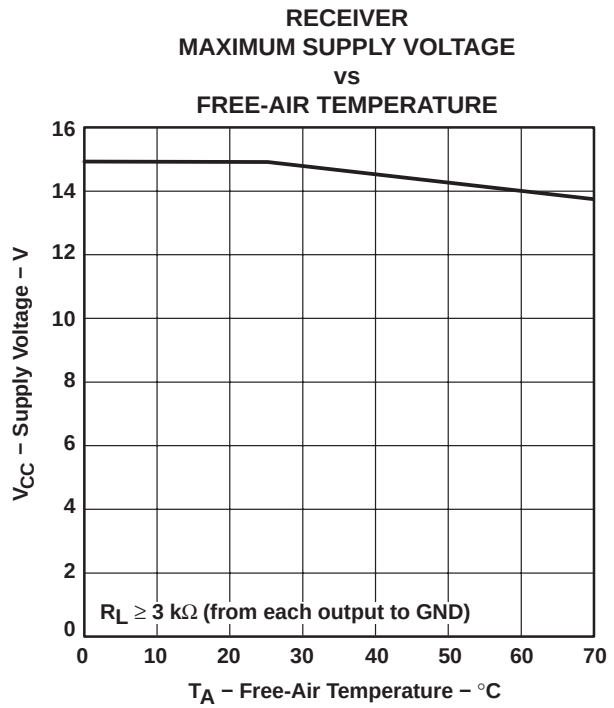


Figure 14

APPLICATION INFORMATION

Diodes placed in series with the V_{DD} and V_{SS} leads protect the TL145406 during the fault condition in which the device outputs are shorted to ±15 V and the power supplies are at low. Diodes also provide low-impedance paths to ground (see Figure 15).

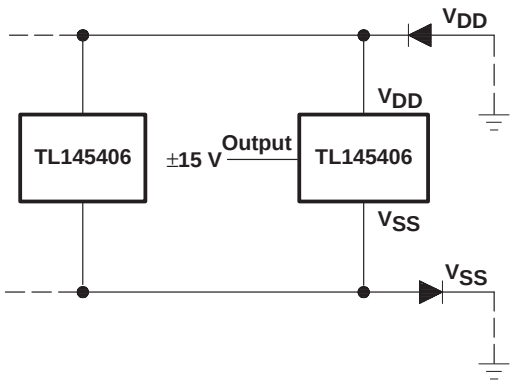


Figure 15. Power-Supply Protection to Meet Power-Off Fault Conditions of ANSI TIA/EIA-232-F

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
TL145406DW	ACTIVE	SOIC	DW	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	TL145406	Samples
TL145406DWE4	ACTIVE	SOIC	DW	16	40	TBD	Call TI	Call TI	0 to 70		Samples
TL145406DWR	ACTIVE	SOIC	DW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	TL145406	Samples
TL145406N	ACTIVE	PDIP	N	16	25	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	TL145406N	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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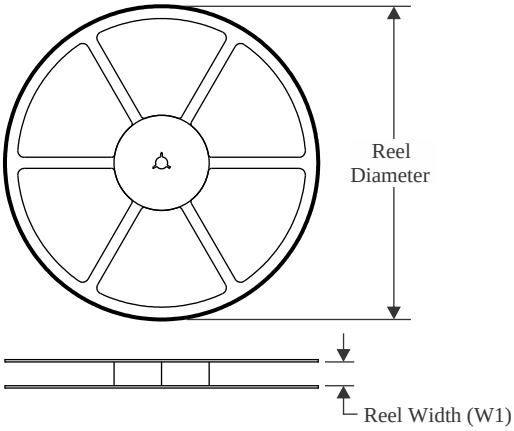
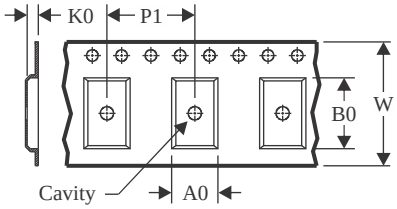
TAPE AND REEL INFORMATION

REEL DIMENSIONS

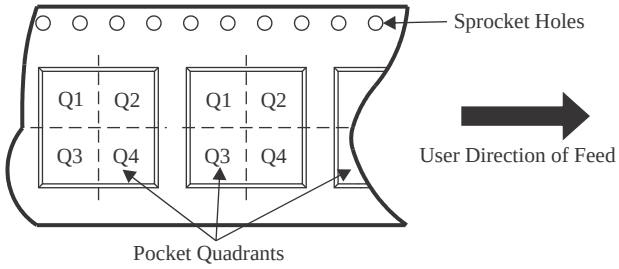


TAPE DIMENSIONS



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

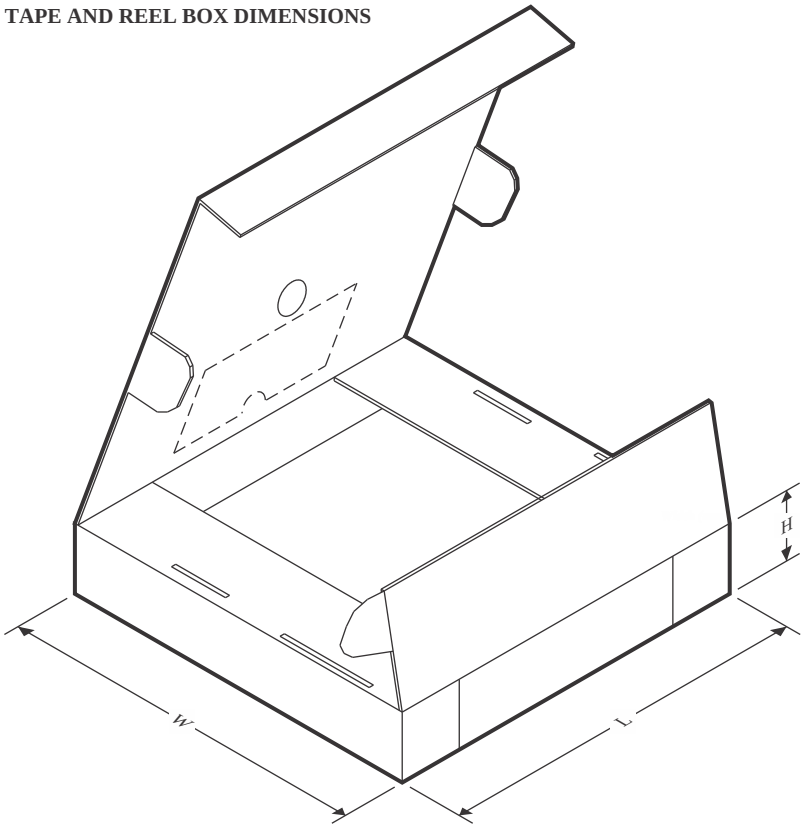
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TL145406DWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

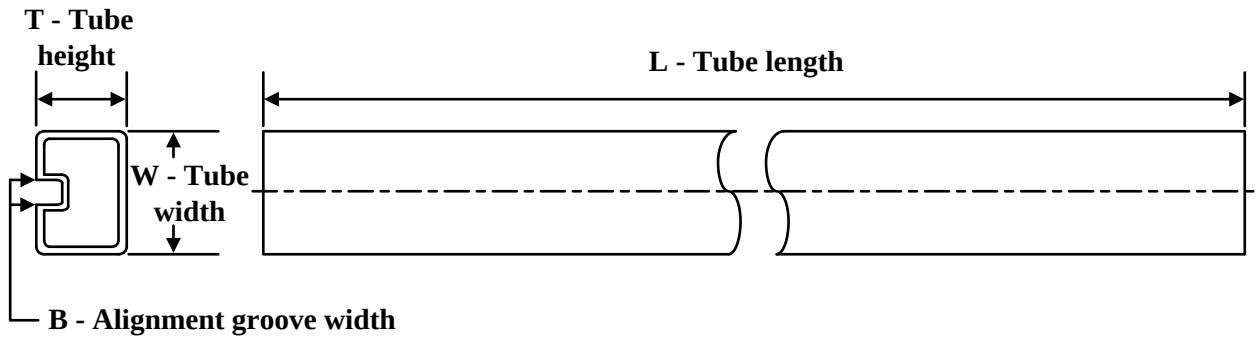
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL145406DWR	SOIC	DW	16	2000	350.0	350.0	43.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
TL145406DW	DW	SOIC	16	40	506.98	12.7	4826	6.6
TL145406N	N	PDIP	16	25	506	13.97	11230	4.32

GENERIC PACKAGE VIEW

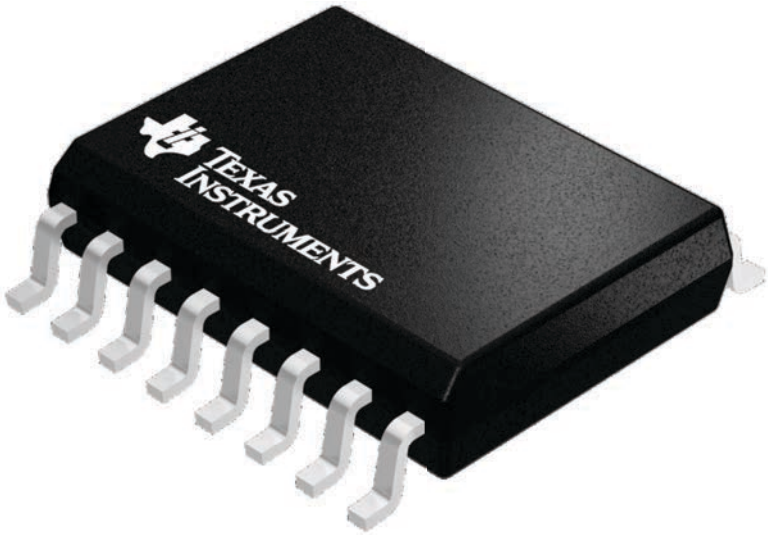
DW 16

SOIC - 2.65 mm max height

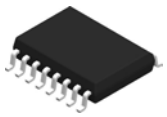
7.5 x 10.3, 1.27 mm pitch

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

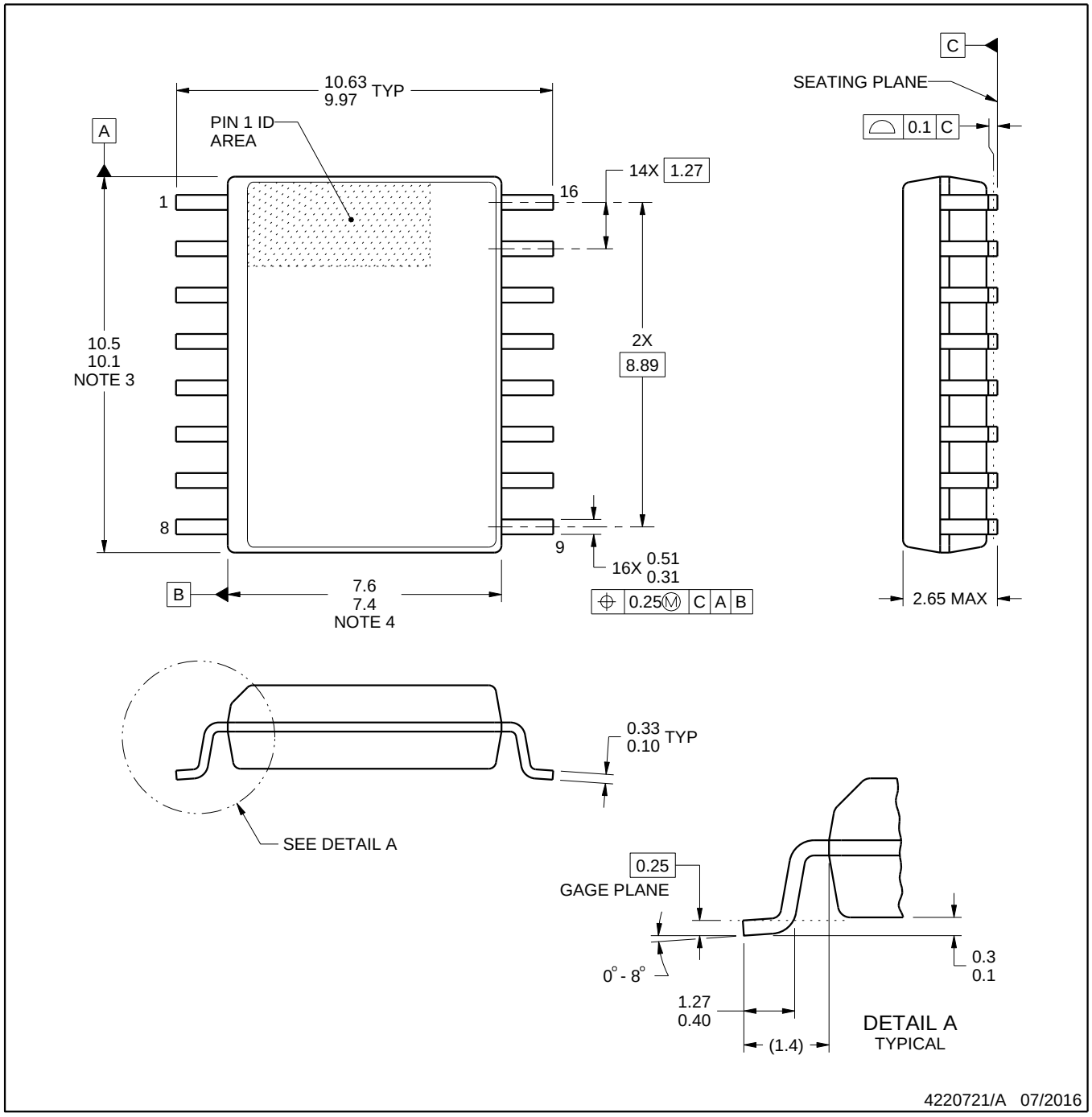


PACKAGE OUTLINE

DW0016A

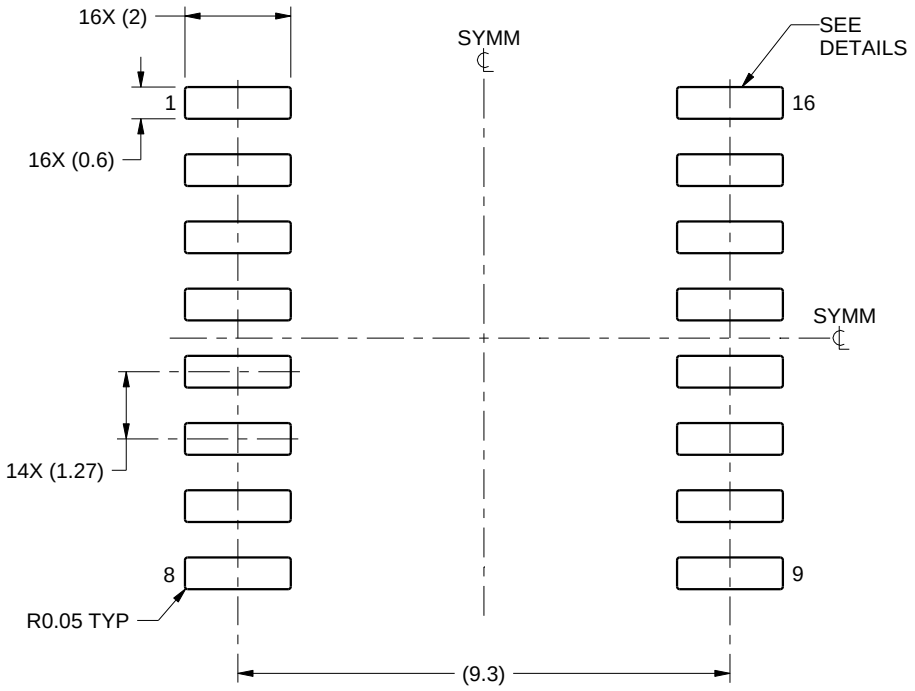
SOIC - 2.65 mm max height

SOIC

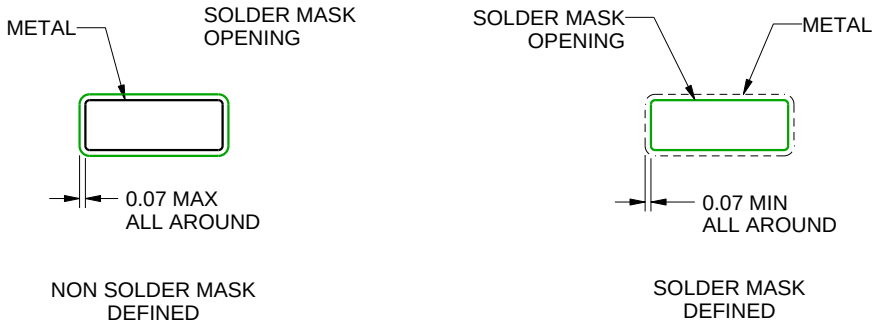


NOTES:

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

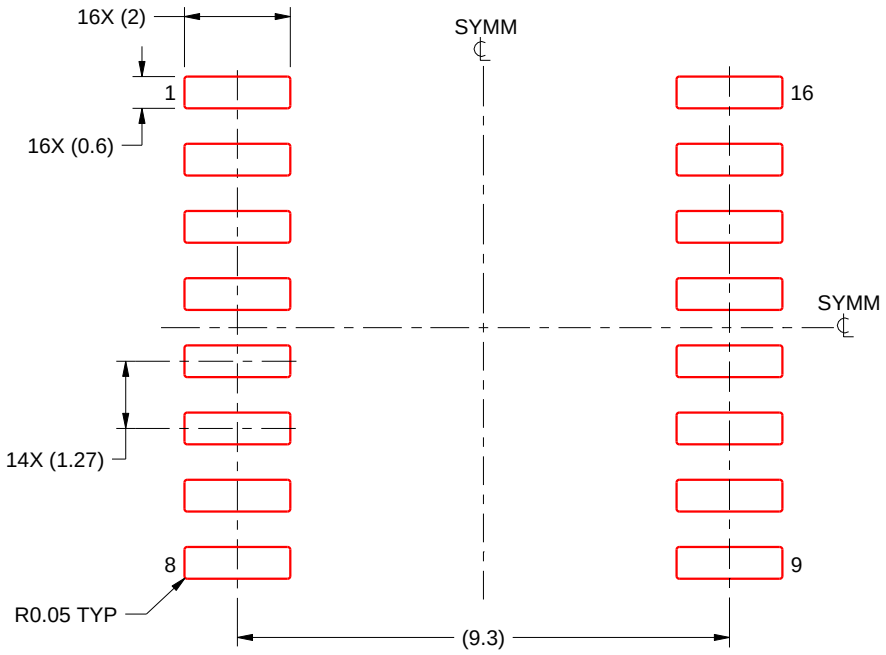


SOLDER MASK DETAILS

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

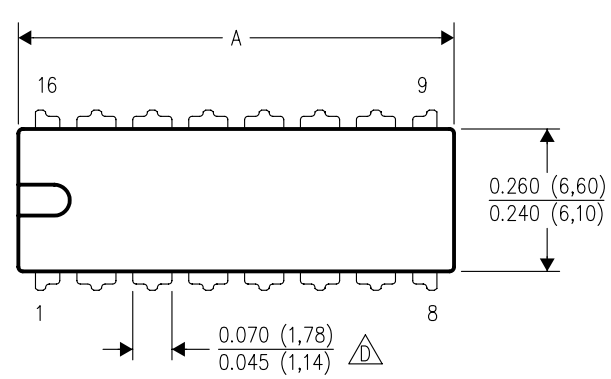
NOTES: (continued)

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.

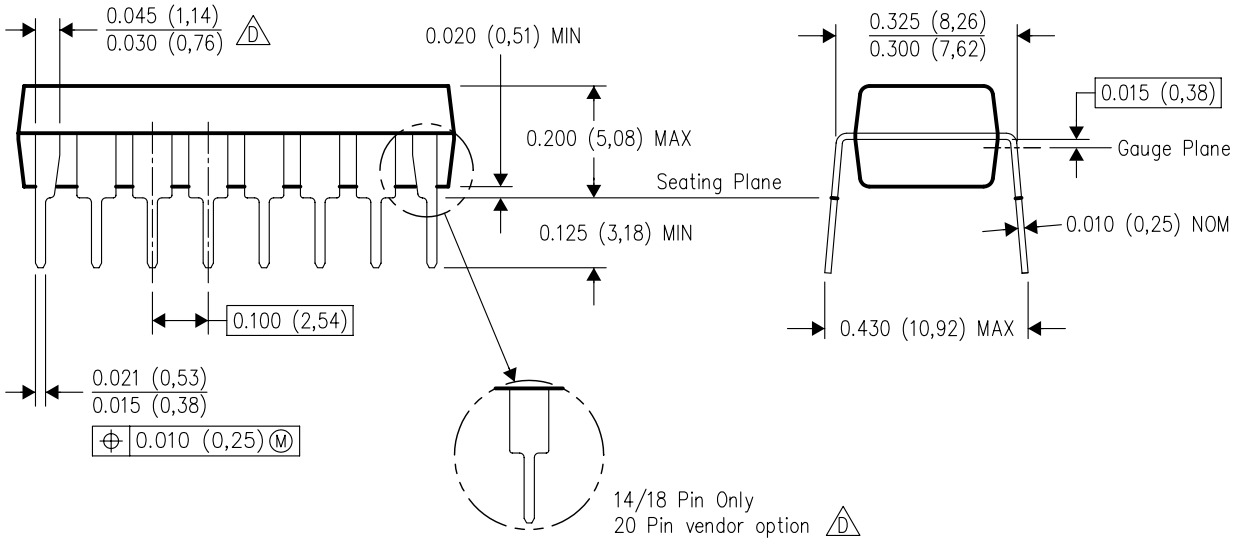
N (R–PDIP–T**)

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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