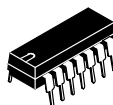




D-14



N-14



RSA-16

## LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIRS

### FEATURES

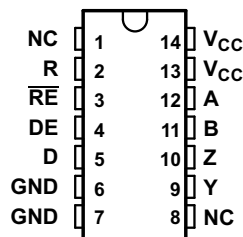
- Designed for High-Speed Multipoint Data Transmission Over Long Cables
- Operate With Pulse Durations as Low as 30 ns
- Low Supply Current . . . 5 mA Max
- Meet or Exceed the Requirements of ANSI Standard RS-485 and ISO 8482:1987(E)
- 3-State Outputs for Party-Line Buses
- Common-Mode Voltage Range of  $-7\text{ V}$  to  $12\text{ V}$
- Thermal Shutdown Protection Prevents Driver Damage From Bus Contention
- Positive and Negative Output Current Limiting
- Pin Compatible With the SN75ALS180

### DESCRIPTION

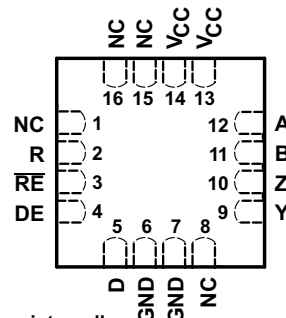
The SN65LBC180 and SN75LBC180 differential driver and receiver pairs are monolithic integrated circuits designed for bidirectional data communication over long cables that take on the characteristics of transmission lines. They are balanced, or differential, voltage mode devices that meet or exceed the requirements of industry standards ANSI RS-485 and ISO 8482:1987(E). Both devices are designed using TI's proprietary LinBiCMOS™ with the low-power consumption of CMOS and the precision and robustness of bipolar transistors in the same circuit.

Both the SN65LBC180 and SN75LBC180 combine a differential line driver and receiver with 3-state outputs and operate from a single 5-V supply. The driver and receiver have active-high and active-low enables, respectively, which can be externally connected to function as a direction control. The driver differential outputs and the receiver differential inputs are connected to separate terminals for full-duplex operation and are designed to present minimum loading to the bus whether disabled or powered off ( $V_{CC} = 0$ ). These parts feature a wide common-mode voltage range making them suitable for point-to-point or multipoint data-bus applications.

D OR N PACKAGE  
(TOP VIEW)



RSA PACKAGE  
(TOP VIEW)



NC – No internal connection

Pins 6 and 7 are connected together internally

Pins 13 and 14 are connected together internally

### Function Tables

#### DRIVER

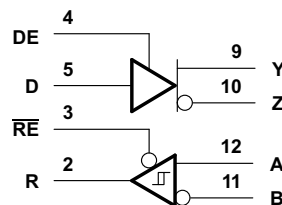
INPUT D	ENABLE DE	OUTPUTS	
		Y	Z
H	H	H	L
L	H	L	H
X	L	Z	Z

#### RECEIVER

DIFFERENTIAL INPUTS A–B	ENABLE RE	OUTPUT R
$V_{ID} \geq 0.2\text{ V}$	L	H
$-0.2\text{ V} < V_{ID} < 0.2\text{ V}$	L	?
$V_{ID} \leq -0.2\text{ V}$	L	L
X	H	Z
Open circuit	L	H

H = high level, L = low level, ? = indeterminate, x = irrelevant  
Z = high impedance (off)

### logic diagram (positive logic)



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.

LinBiCMOS is a trademark of Texas Instruments.



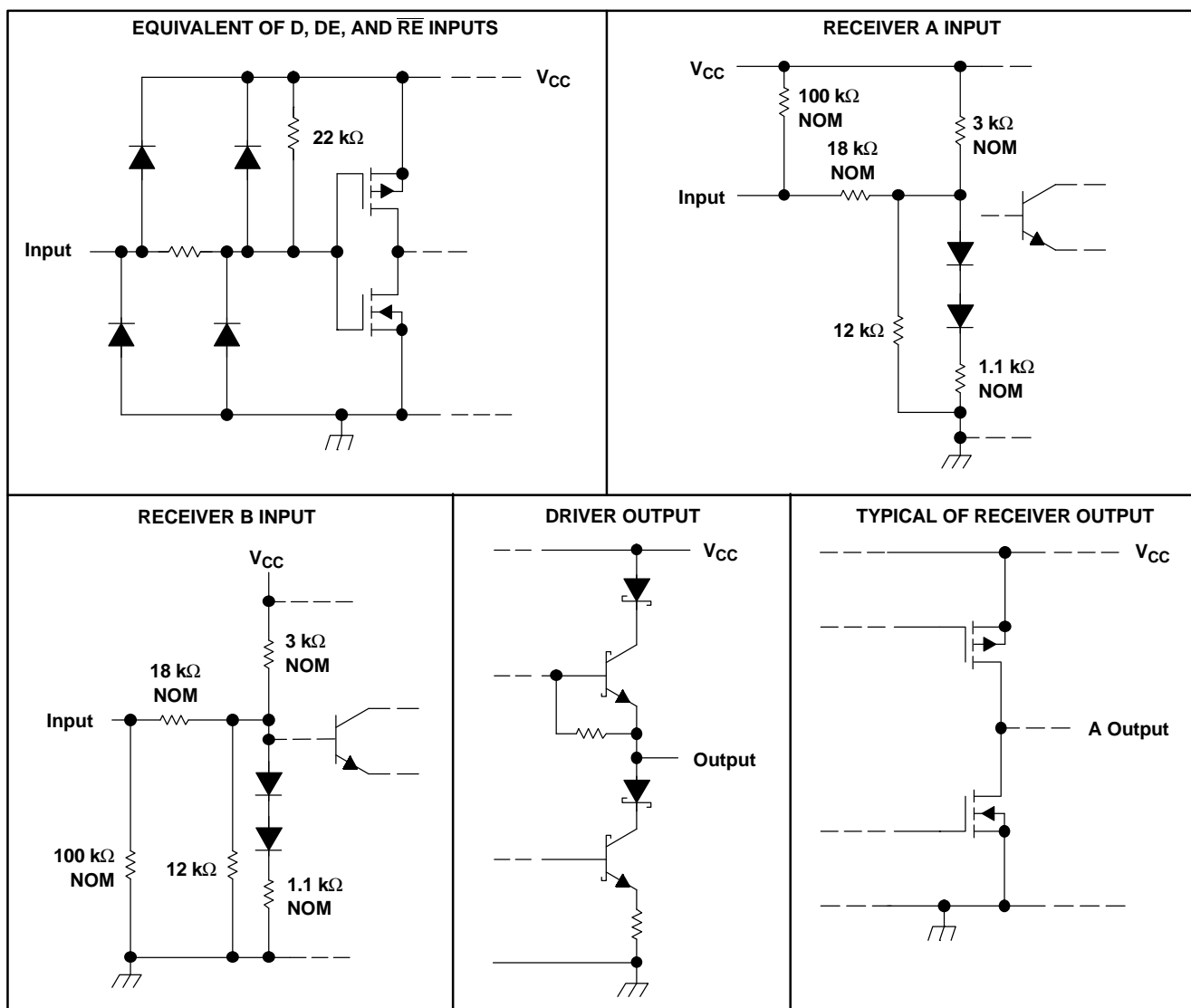
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## DESCRIPTION (CONTINUED)

The devices also provide positive and negative output-current limiting and thermal shutdown for protection from line fault conditions. The line driver shuts down at a junction temperature of approximately 172°C.

The SN65LBC180 and SN75LBC180 are available in the 14-pin dual-in-line and small-outline packages. The SN75LBC180 is characterized for operation over the commercial temperature range of 0°C to 70°C. The SN65LBC180 is characterized over the industrial temperature range of -40°C to 85°C.

## SCHEMATICS OF INPUTS AND OUTPUTS



## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

			UNIT
$V_{CC}$	Supply voltage range <sup>(2)</sup>	−0.3 to 7	V
$V_{BUS}$	Bus voltage range (A, B, Y, Z) <sup>(2)</sup>	−10 to 15	V
	Voltage range at D, R, DE, $\overline{RE}$ <sup>(2)</sup>	−0.3 to $V_{CC} + 0.5$	V
	Continuous total power dissipation <sup>(3)</sup>	Internally limited	
	Total power dissipation	See Dissipation Rating Table	
$T_A$	Operating free-air temperature range	SN65LBC180	−40 to 85 °C
		SN75LBC180	0 to 70 °C
$T_{stg}$	Storage temperature range	−65 to 150	°C
$I_O$	Receiver output current range	−50 to 50	mA
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260	°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 voltage values are with respect to GND.
- (3) The maximum operating junction temperature is internally limited. Use the dissipation rating table to operate below this temperature.

## DISSIPATION RATING TABLE

PACKAGE <sup>(1)</sup>	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/°C	608 mW	494 mW
N	1150 mW	9.2 mW/°C	736 mW	598 mW
RSA	3333 mW	26.67 mW/°C	2133 mW	1733 mW

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI Web site at [www.ti.com](http://www.ti.com).

## RECOMMENDED OPERATING CONDITIONS

			MIN	NOM	MAX	UNIT
$V_{CC}$	Supply voltage		4.75	5	5.25	V
$V_{IH}$	High-level input voltage	D, DE, and $\overline{RE}$	2			V
$V_{IL}$	Low-level input voltage	D, DE, and $\overline{RE}$			0.8	V
$V_{ID}$	Differential input voltage		−6 <sup>(1)</sup>		6	V
$V_O$ , $V_I$ , or $V_{IC}$	Voltage at any bus terminal (separately or common mode)	A, B, Y, or Z	−7 <sup>(1)</sup>		12	V
$I_{OH}$	High-level output current	Y or Z			−60	mA
		R			−8	
$I_{OL}$	Low-level output current	Y or Z			60	mA
		R			8	
$T_A$	Operating free-air temperature	SN65LBC180	−40		85	°C
		SN75LBC180	0		70	

- (1) The algebraic convention where the least positive (more negative) limit is designated minimum, is used in this data sheet for the differential input voltage, voltage at any bus terminal, operating temperature, input threshold voltage, and common-mode output voltage.

## DRIVER SECTION

### ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP <sup>(1)</sup>	MAX	UNIT
$V_{IK}$	Input clamp voltage	$I_I = -18 \text{ mA}$				-1.5	V
$ V_{OD} $	Differential output voltage magnitude <sup>(2)</sup>	$R_L = 54 \Omega$ , See <a href="#">Figure 1</a>	SN65LBC180	1.1	2.5	5	V
			SN75LBC180	1.5	2.5	5	
		$R_L = 60 \Omega$ , See <a href="#">Figure 2</a>	SN65LBC180	1.1	2	5	
			SN75LBC180	1.5	2	5	
$\Delta V_{OD} $	Change in magnitude of differential output voltage <sup>(3)</sup>	See <a href="#">Figure 1</a> and <a href="#">Figure 2</a>				$\pm 0.2$	V
$V_{OC}$	Common-mode output voltage	$R_L = 54 \Omega$ ,      See <a href="#">Figure 1</a>		1	2.5	3	V
$\Delta V_{OC} $	Change in magnitude of common-mode output voltage <sup>(3)</sup>					$\pm 0.2$	V
$I_O$	Output current with power off	$V_{CC} = 0$ , $V_O = -7 \text{ V to } 12 \text{ V}$				$\pm 100$	$\mu\text{A}$
$I_{OZ}$	High-impedance-state output current	$V_O = -7 \text{ V to } 12 \text{ V}$				$\pm 100$	$\mu\text{A}$
$I_{IH}$	High-level input current	$V_I = 2.4 \text{ V}$				100	$\mu\text{A}$
$I_{IL}$	Low-level input current	$V_I = 0.4 \text{ V}$				100	$\mu\text{A}$
$I_{OS}$	Short-circuit output current	$-7 \text{ V} \leq V_O \leq 12 \text{ V}$				$\pm 250$	mA
$I_{CC}$	Supply current	Receiver disabled	Outputs enabled			5	mA
			Outputs disabled			3	

(1) All typical values are at  $V_{CC} = 5 \text{ V}$  and  $T_A = 25^\circ\text{C}$ .

(2) The minimum  $V_{OD}$  specification of the SN65LBC180 may not fully comply with ANSI RS-485 at operating temperatures below  $0^\circ\text{C}$ . System designers should take the possibly lower output signal into account in determining the maximum signal-transmission distance.

(3)  $\Delta|V_{OD}|$  and  $\Delta|V_{OC}|$  are the changes in the steady-state magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input is changed from a high level to a low level.

### SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{d(OD)}$	Differential output delay time	$R_L = 54 \Omega$ ,      See <a href="#">Figure 3</a>		7	12	18	ns
$t_{t(OD)}$	Differential output transition time			5	10	20	ns
$t_{PZH}$	Output enable time to high level	$R_L = 110 \Omega$ ,      See <a href="#">Figure 4</a>				35	ns
$t_{PZL}$	Output enable time to low level	$R_L = 110 \Omega$ ,      See <a href="#">Figure 5</a>				35	ns
$t_{PHZ}$	Output disable time from high level	$R_L = 110 \Omega$ ,      See <a href="#">Figure 4</a>				50	ns
$t_{PLZ}$	Output disable time from low level	$R_L = 110 \Omega$ ,      See <a href="#">Figure 5</a>				35	ns

## RECEIVER SECTION

### ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IT+}$	Positive-going input threshold voltage	$I_O = -8 \text{ mA}$			0.2	V
$V_{IT-}$	Negative-going input threshold voltage	$I_O = 8 \text{ mA}$	-0.2			V
$V_{hys}$	Hysteresis voltage ( $V_{IT+} - V_{IT-}$ )			45		mV
$V_{IK}$	Enable-input clamp voltage	$I_I = -18 \text{ mA}$			-1.5	V
$V_{OH}$	High-level output voltage	$V_{ID} = 200 \text{ mV}$ , $I_{OH} = -8 \text{ mA}$	3.5	4.5		V
$V_{OL}$	Low-level output voltage	$V_{ID} = -200 \text{ mV}$ , $I_{OL} = 8 \text{ mA}$		0.3	0.5	V
$I_{OZ}$	High-impedance-state output current	$V_O = 0 \text{ V to } V_{CC}$			$\pm 20$	$\mu\text{A}$
$I_{IH}$	High-level enable-input current	$V_{IH} = 2.4 \text{ V}$			-50	$\mu\text{A}$
$I_{IL}$	Low-level enable-input current	$V_{IL} = 0.4 \text{ V}$			-100	$\mu\text{A}$
$I_I$	Bus input current	$V_I = 12 \text{ V}$ , $V_{CC} = 5 \text{ V}$ , Other input at 0 V		0.7	1	mA
		$V_I = 12 \text{ V}$ , $V_{CC} = 0 \text{ V}$ , Other input at 0 V		0.8	1	
		$V_I = -7 \text{ V}$ , $V_{CC} = 5 \text{ V}$ , Other input at 0 V		-0.5	-0.8	
		$V_I = -7 \text{ V}$ , $V_{CC} = 0 \text{ V}$ , Other input at 0 V		-0.5	-0.8	
$I_{CC}$	Supply current	Driver disabled			5	mA
					3	

### SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PHL}$	Propagation delay time, high- to low-level output	$V_{ID} = -1.5 \text{ V to } 1.5 \text{ V}$ , See <a href="#">Figure 6</a>	11	22	33	ns
$t_{PLH}$	Propagation delay time, low- to high-level output		11	22	33	ns
$t_{sk(p)}$	Pulse skew ( $ t_{PHL} - t_{PLH} $ )			3	6	ns
$t_t$	Transition time			5	8	ns
$t_{PZH}$	Output enable time to high level	See <a href="#">Figure 7</a>			35	ns
$t_{PZL}$	Output enable time to low level				30	ns
$t_{PHZ}$	Output disable time from high level				35	ns
$t_{PLZ}$	Output disable time from low level				30	ns

## PARAMETER MEASUREMENT INFORMATION

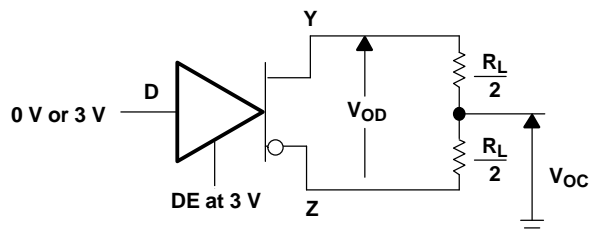


Figure 1. Differential and Common-Mode Output Voltages

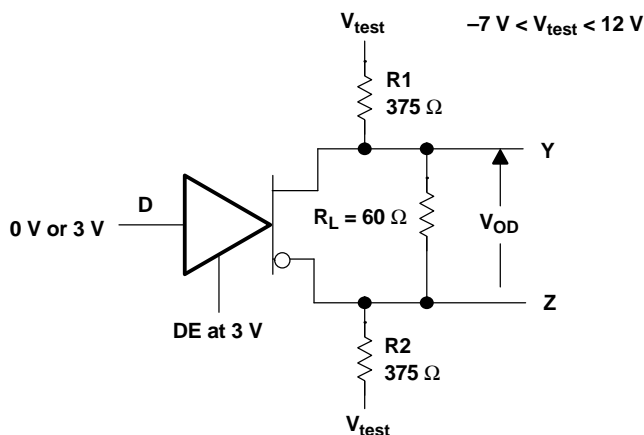
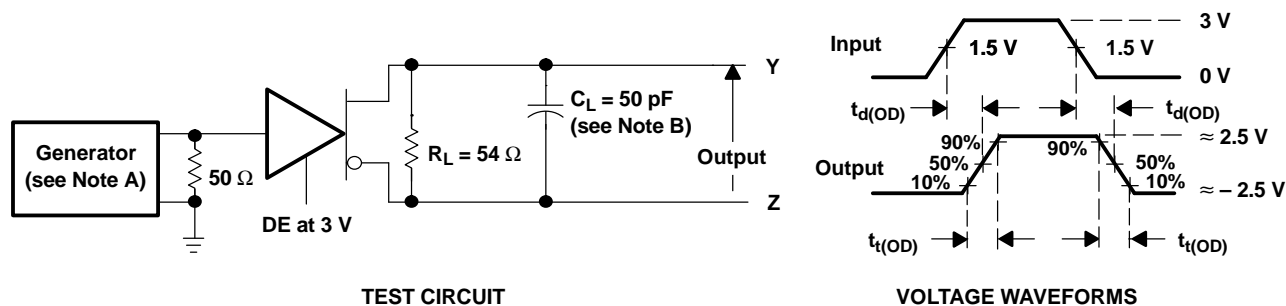


Figure 2. Driver  $V_{OD}$  Test Circuit



- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR > 1 MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_O = 50 \Omega$ .  
B.  $C_L$  includes probe and jig capacitance.

Figure 3. Driver Test Circuit and Differential Output Delay and Transition Time Voltage Waveforms

## PARAMETER MEASUREMENT INFORMATION (continued)

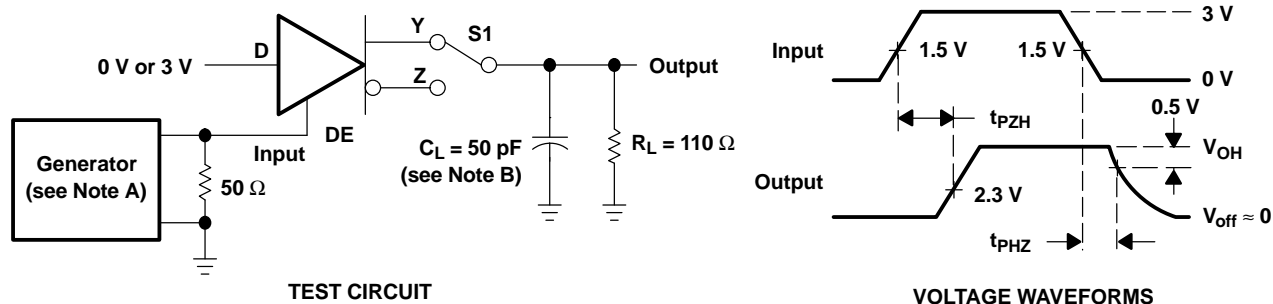


Figure 4. Driver Test Circuit and Enable and Disable Time Waveforms

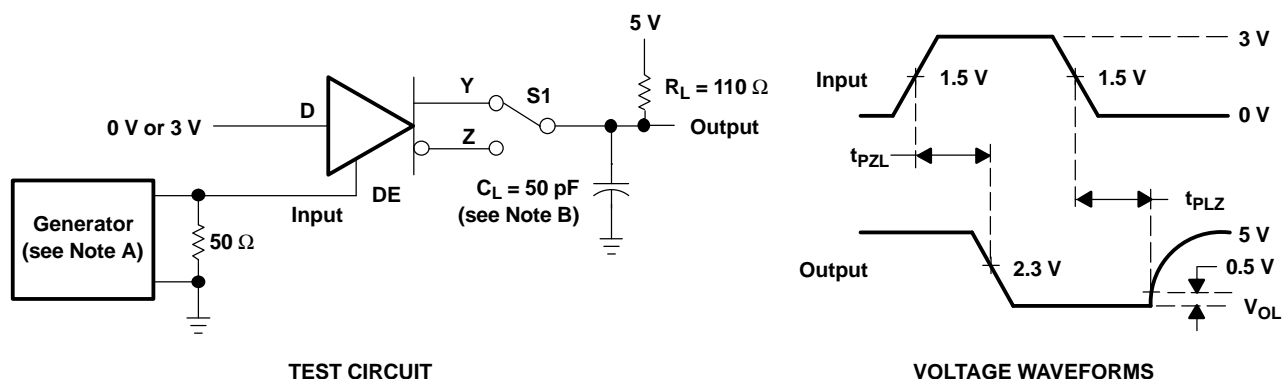
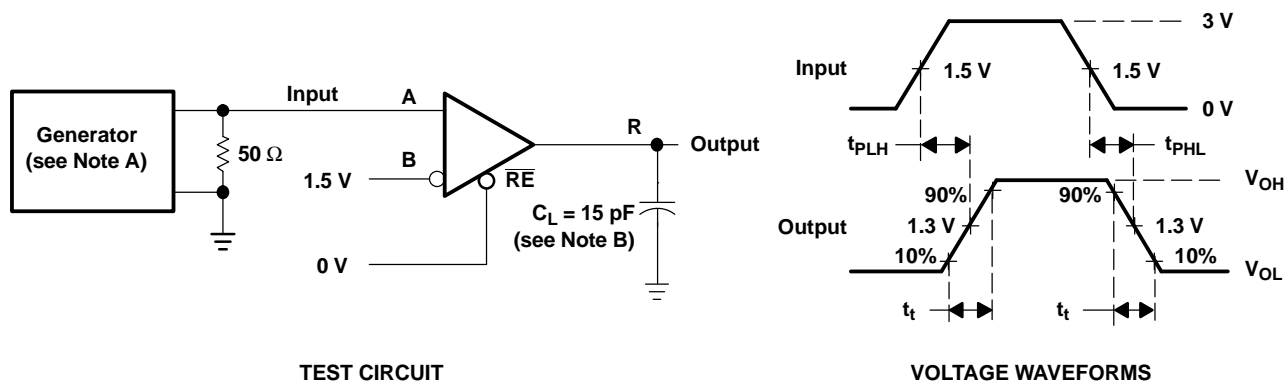


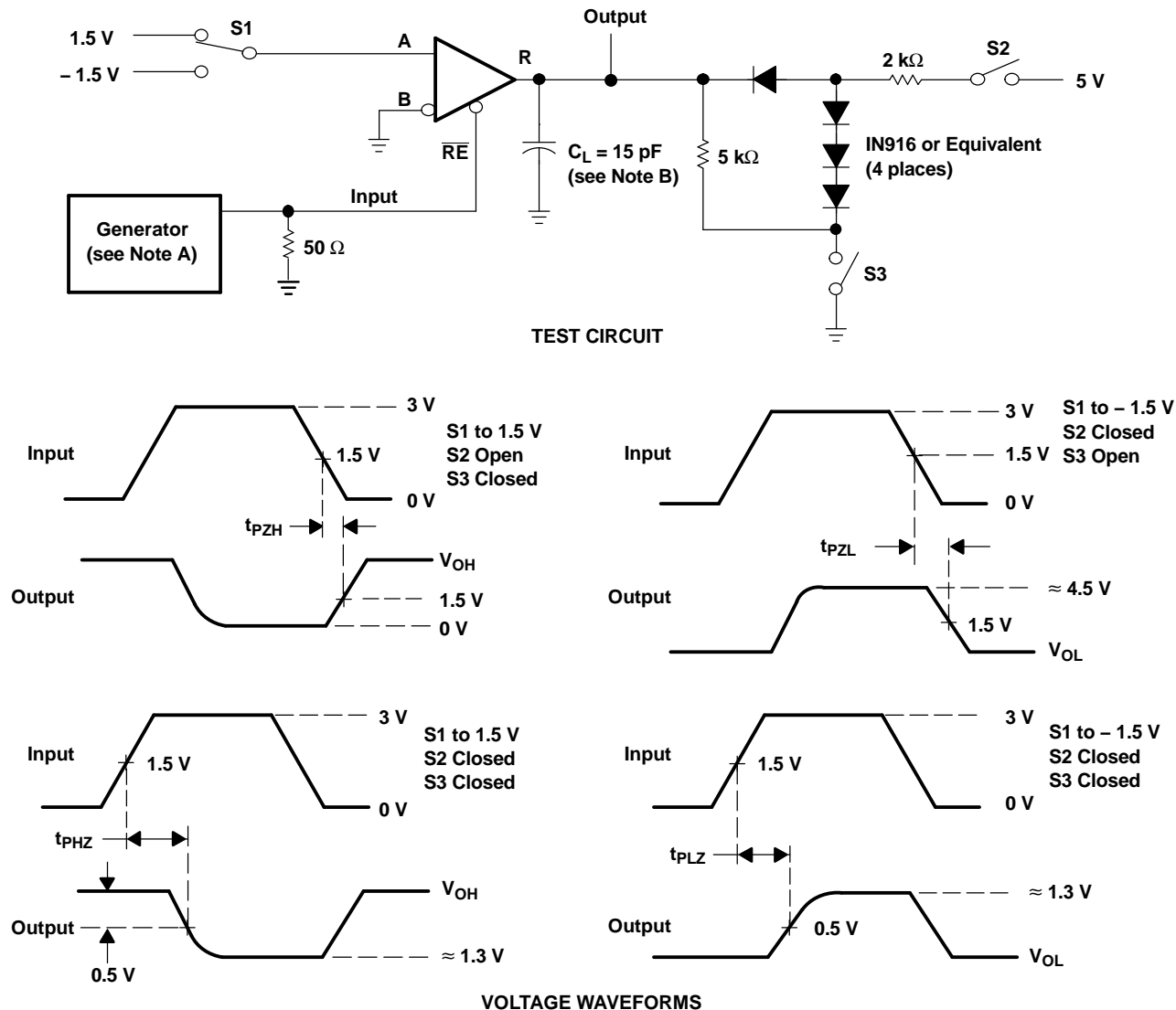
Figure 5. Driver Test Circuit and Enable and Disable Time Voltage Waveforms



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_0 = 50 \Omega$ .  
B.  $C_L$  includes probe and jig capacitance.

Figure 6. Receiver Test Circuit and Propagation Delay Time Voltage Waveforms

## PARAMETER MEASUREMENT INFORMATION (continued)



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_O = 50 \Omega$ .
- B.  $C_L$  includes probe and jig capacitance.

**Figure 7. Receiver Output Enable and Disable Times**



## TYPICAL CHARACTERISTICS

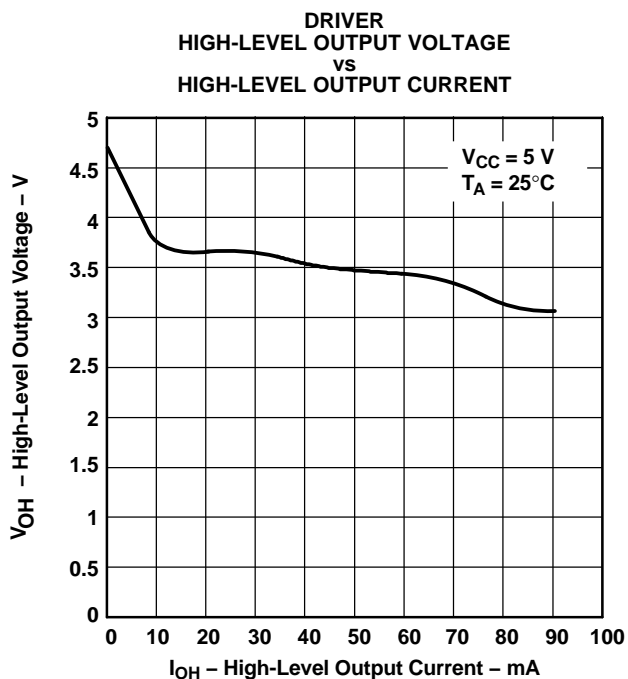


Figure 8.

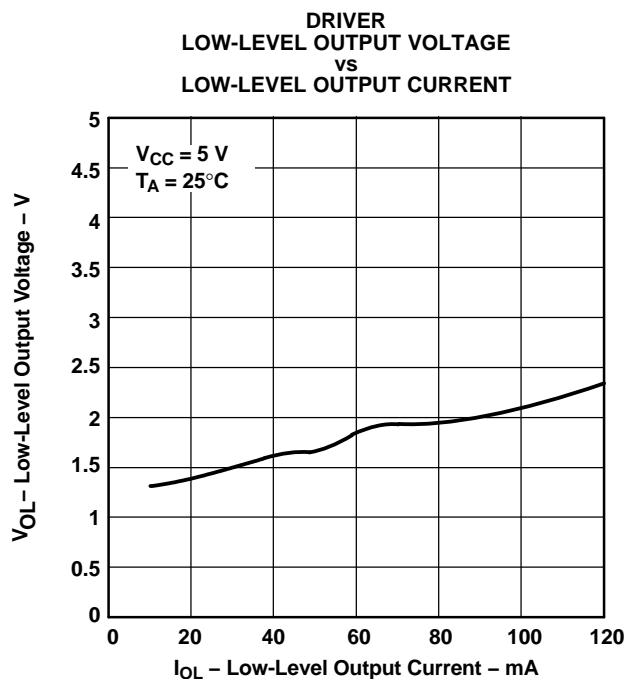


Figure 9.

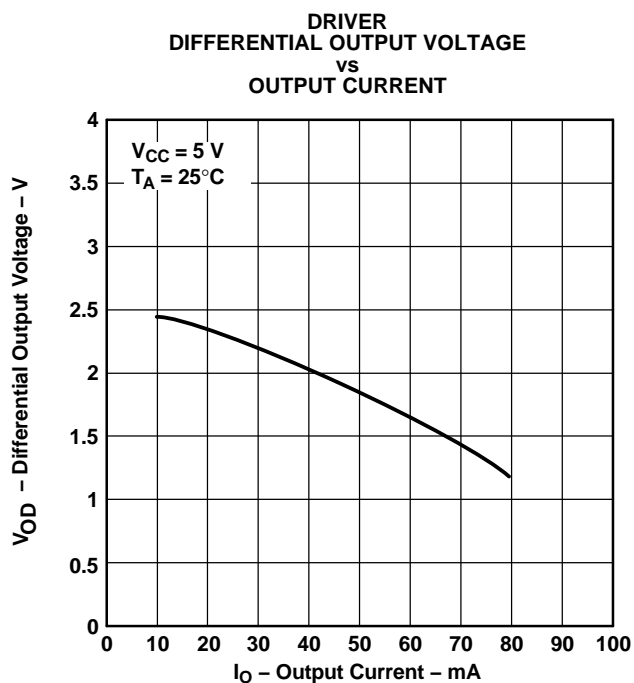


Figure 10.

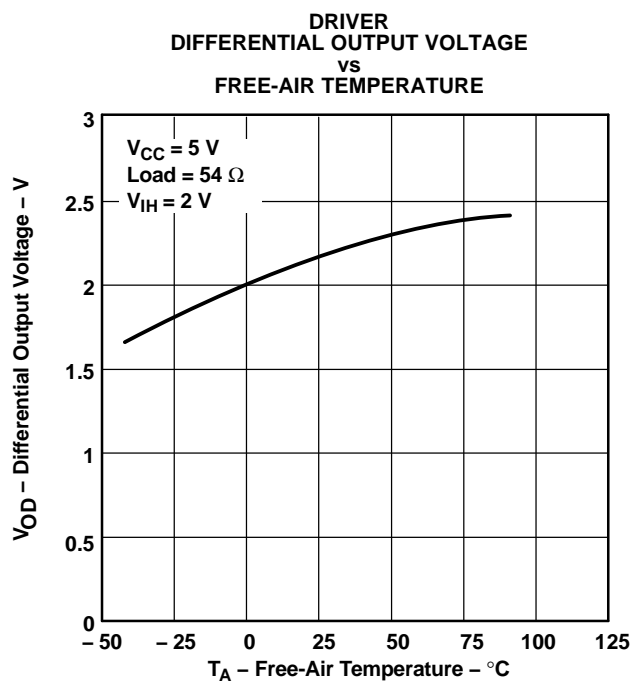


Figure 11.

## TYPICAL CHARACTERISTICS (continued)

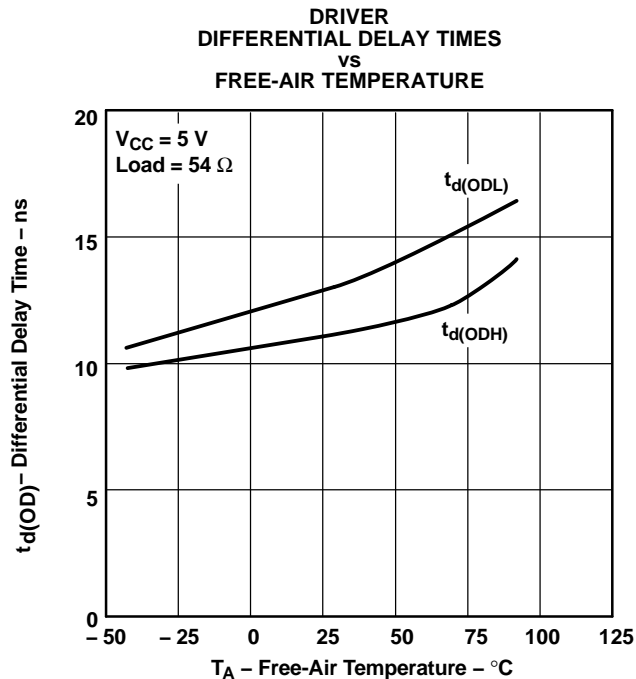


Figure 12.

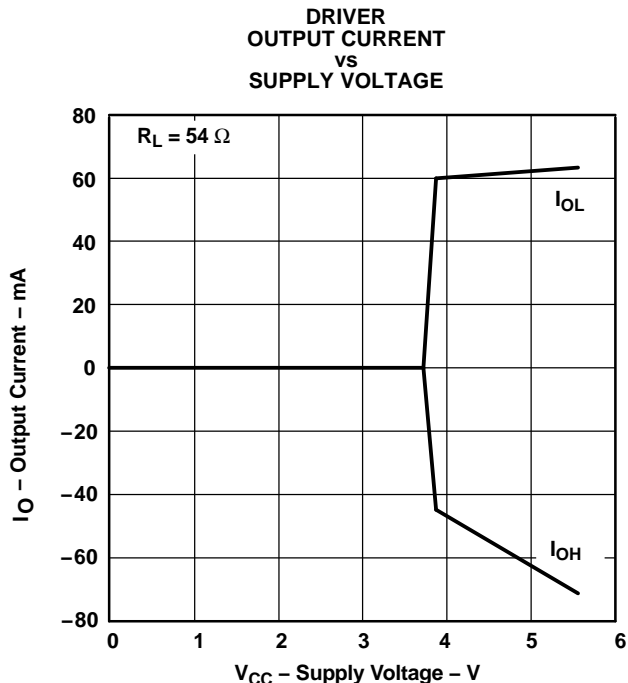


Figure 13.

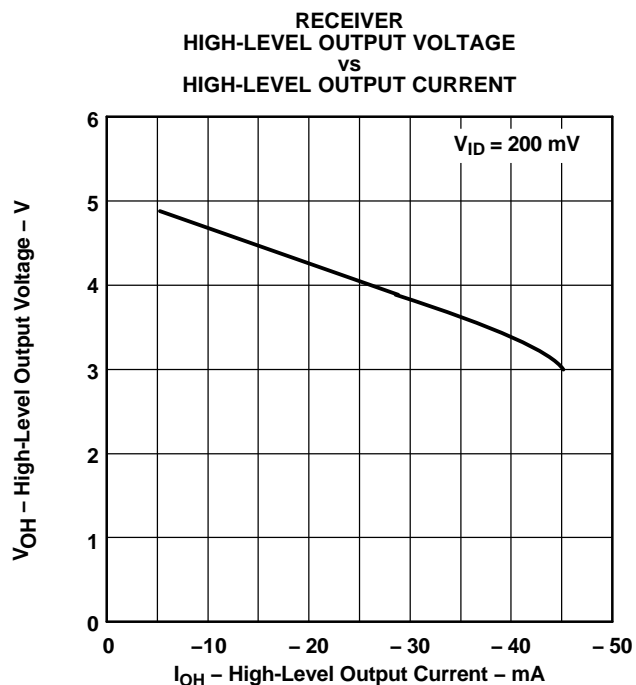


Figure 14.

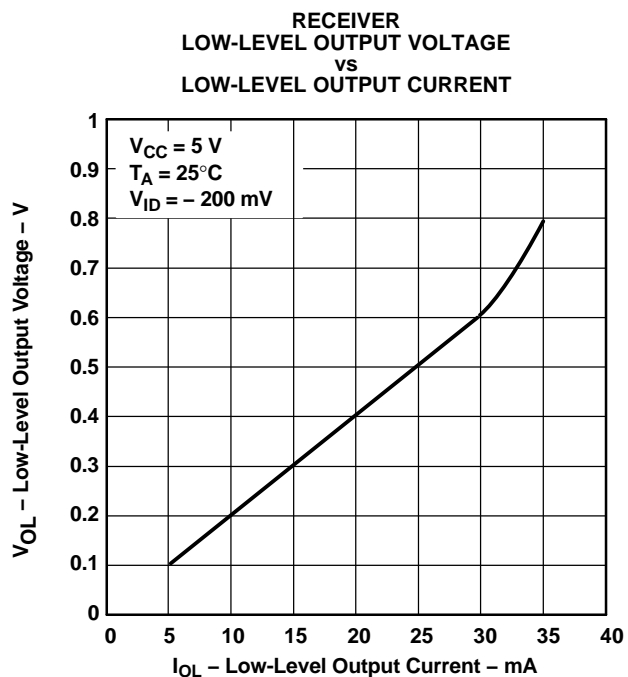


Figure 15.

## TYPICAL CHARACTERISTICS (continued)

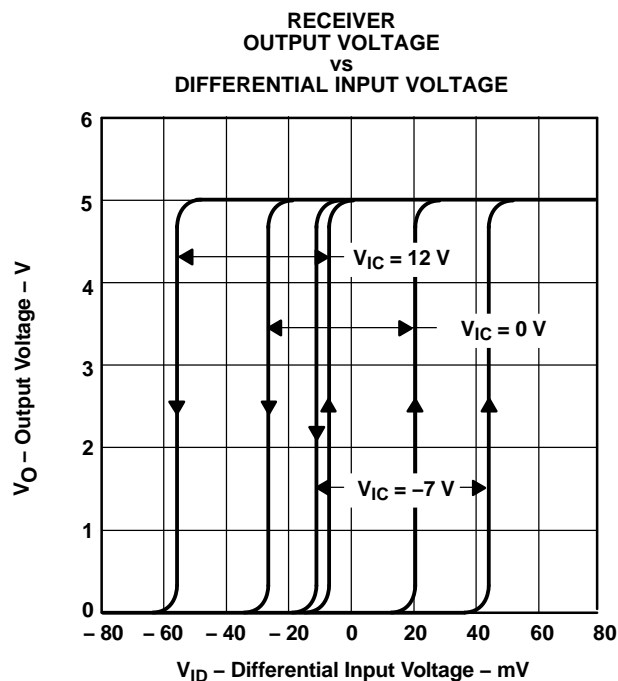


Figure 16.

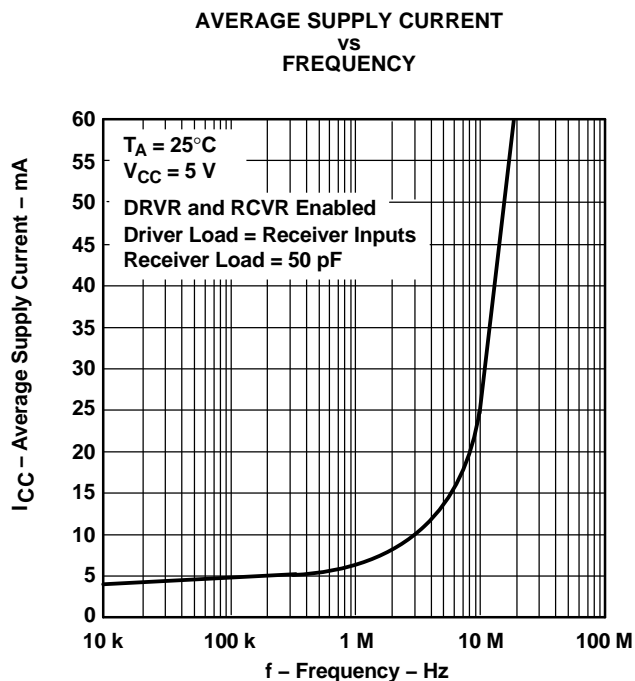


Figure 17.

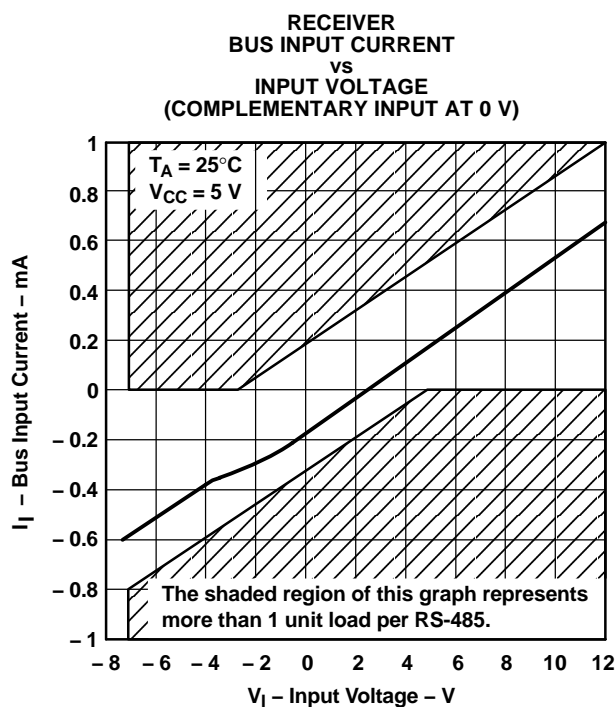


Figure 18.

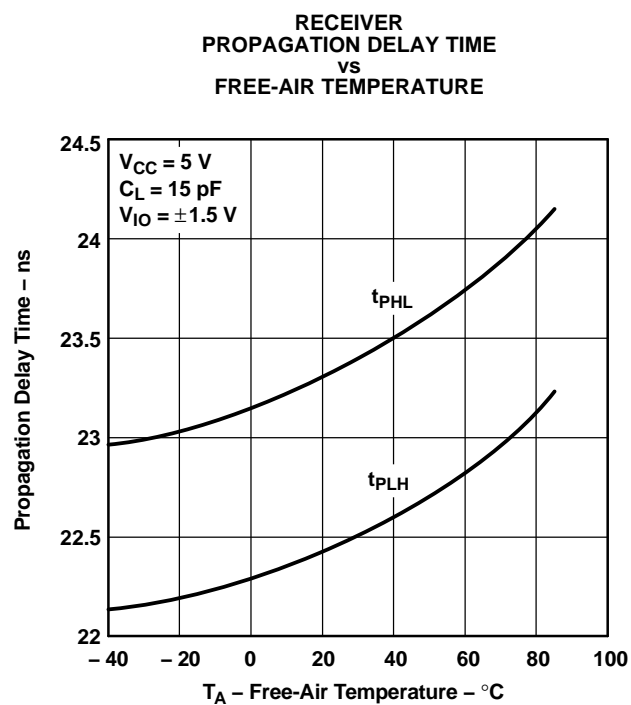
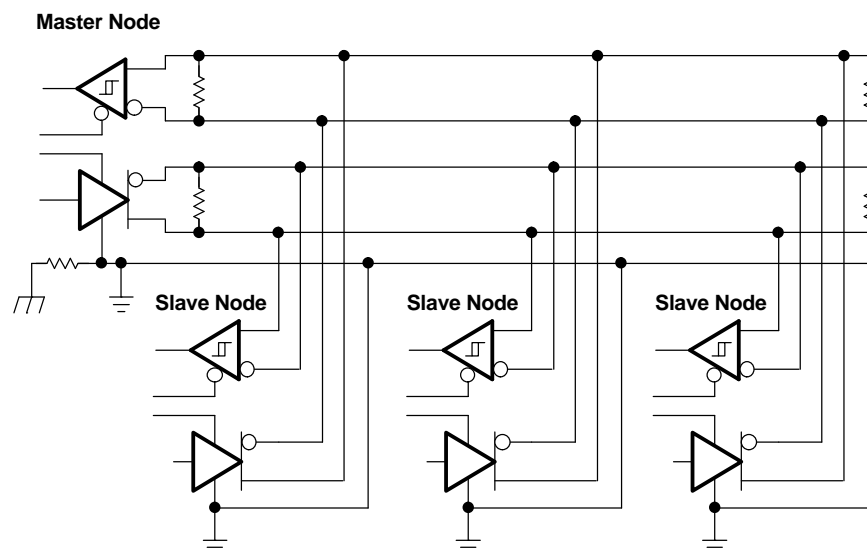


Figure 19.

## APPLICATION INFORMATION



**Figure 20. Full Duplex Application Circuit**

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
SN65LBC180D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM
SN65LBC180DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM
SN65LBC180DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM
SN65LBC180DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN65LBC180N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN65LBC180NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN65LBC180RSAR	ACTIVE	QFN	RSA	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN65LBC180RSARG4	ACTIVE	QFN	RSA	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN65LBC180RSAT	ACTIVE	QFN	RSA	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN65LBC180RSATG4	ACTIVE	QFN	RSA	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN75LBC180D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM
SN75LBC180DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM
SN75LBC180DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM
SN75LBC180DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM
SN75LBC180N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN75LBC180NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN75LBC180RSAR	ACTIVE	QFN	RSA	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN75LBC180RSARG4	ACTIVE	QFN	RSA	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN75LBC180RSAT	ACTIVE	QFN	RSA	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
SN75LBC180RSATG4	ACTIVE	QFN	RSA	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

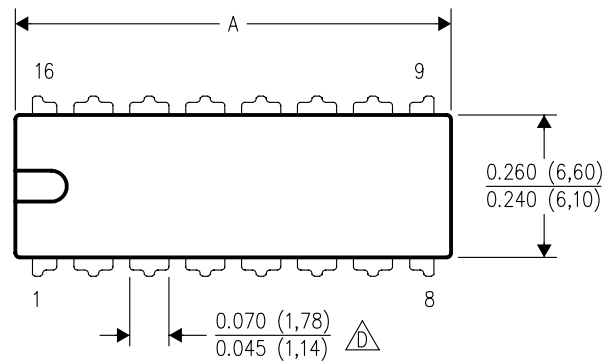
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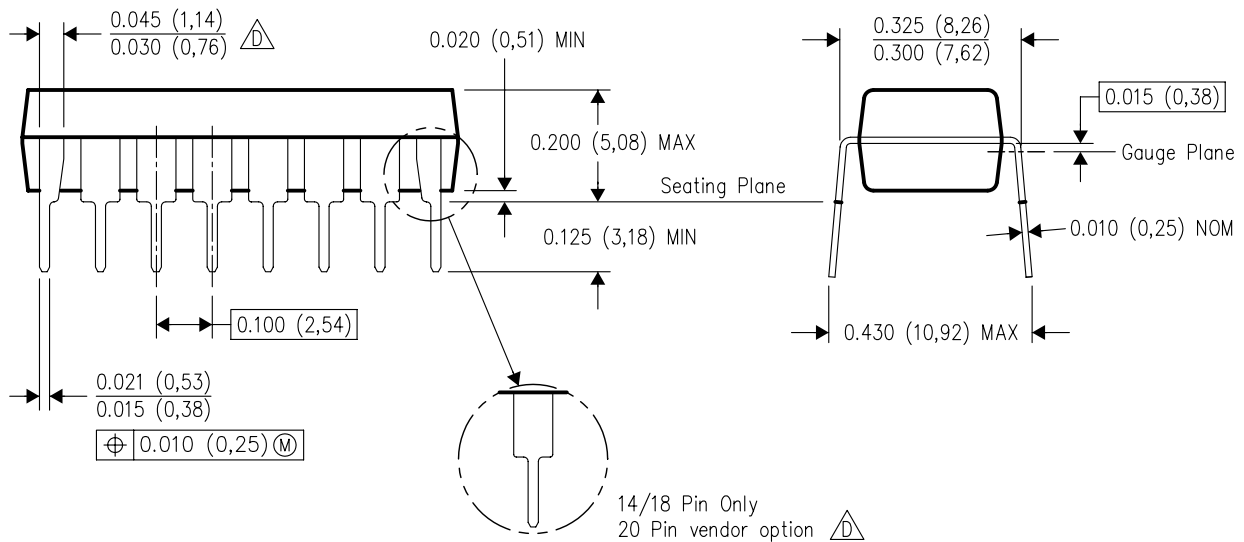
N (R-PDIP-T\*\*)

16 PINS SHOWN

# PLASTIC DUAL-IN-LINE PACKAGE



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	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.
-  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).  
 The 20 pin end lead shoulder width is a vendor option, either half or full width.

## D (R-PDSO-G14)

## PLASTIC SMALL-OUTLINE PACKAGE



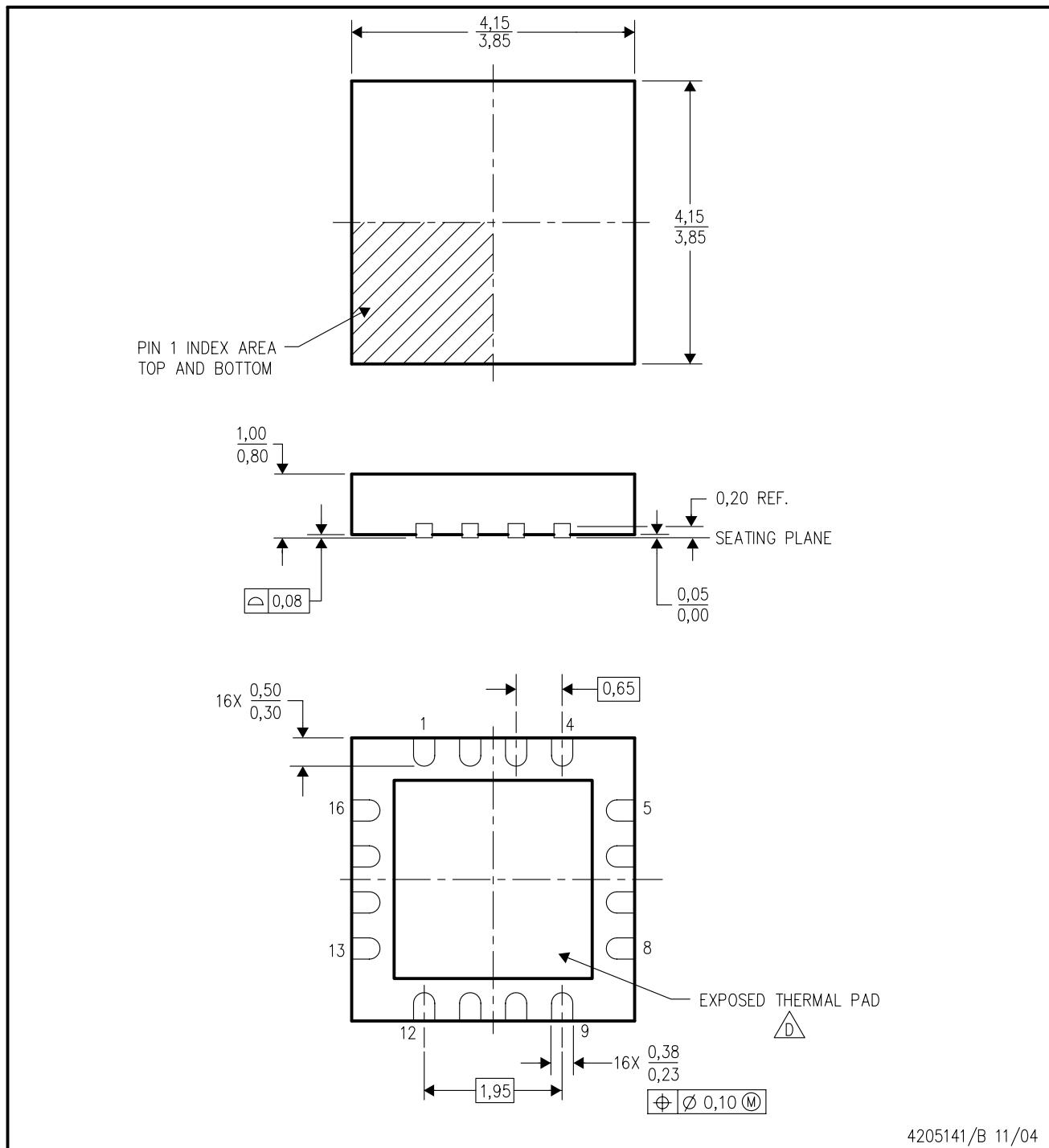
## NOTES:

- 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 .006 (0,15) per end.
- D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
- E. Reference JEDEC MS-012 variation AB.




## RSA (S-PQFP-N16)

## PLASTIC QUAD FLATPACK



4205141/B 11/04

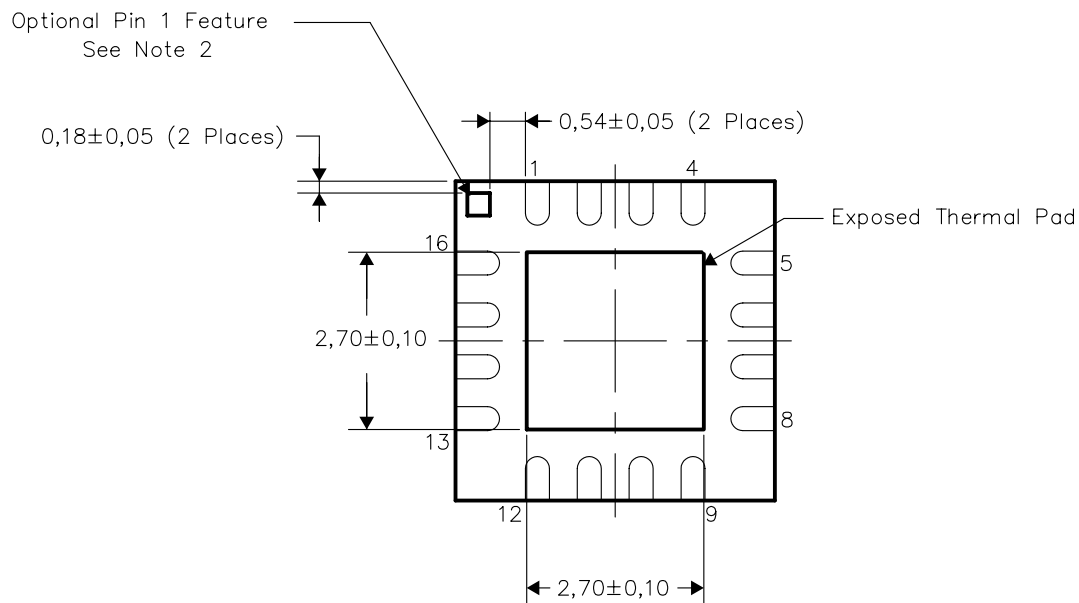
- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Quad Flatpack, No-leads (QFN) package configuration.
  -  The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
  - E. Falls within JEDEC MO-220.

## THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to a ground or power plane (whichever is applicable), or alternatively, a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, Quad Flatpack No-Lead Logic Packages, Texas Instruments Literature No. SCBA017. This document is available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.



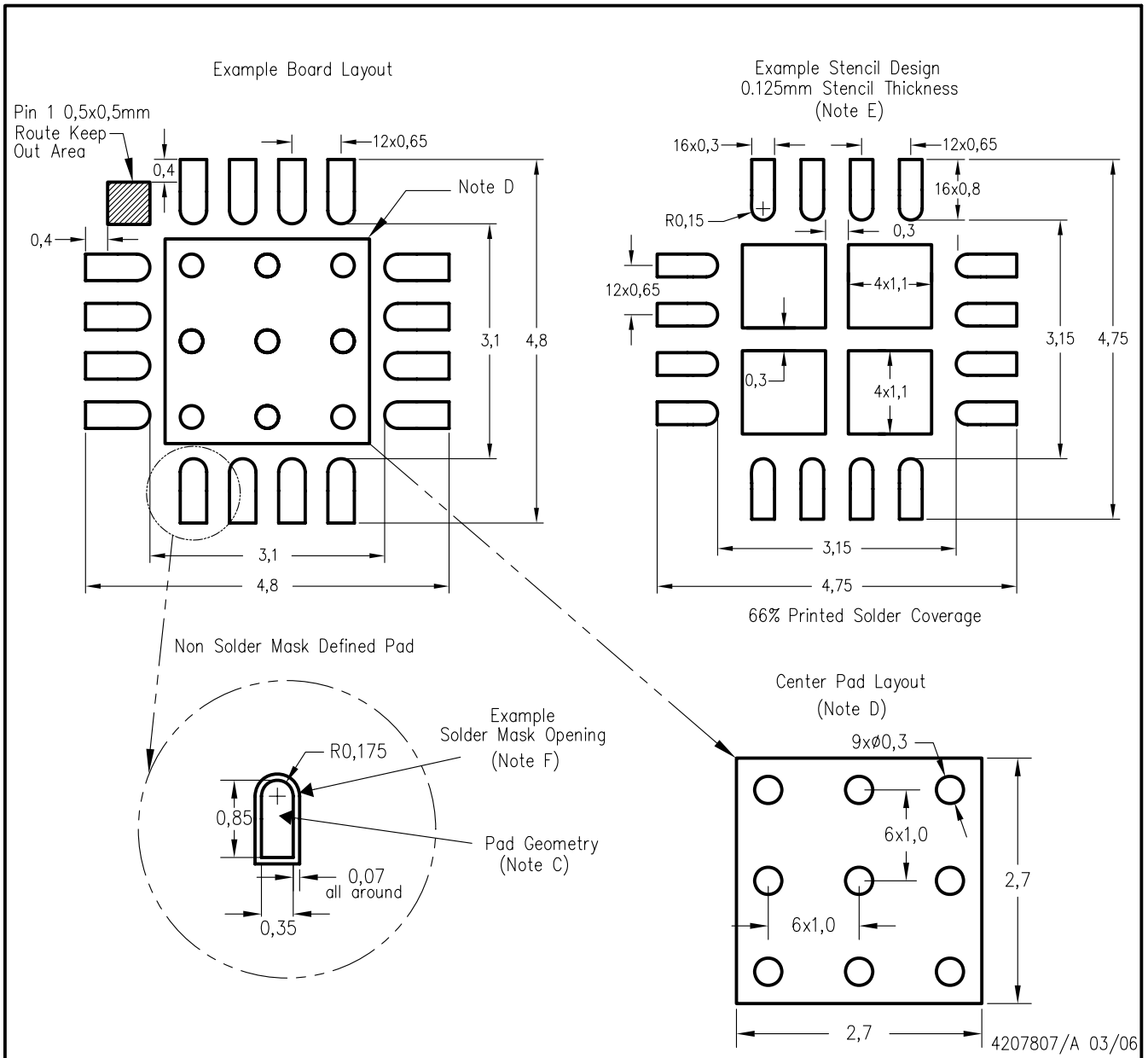
Bottom View

Exposed Thermal Pad Dimensions

NOTES:

- 1) All linear dimensions are in millimeters
- 2) The Pin 1 Identification mark is an optional feature that may be present on some devices. In addition, this Pin 1 feature if present is electrically connected to the center thermal pad and therefore should be considered when routing the board layout.

RSA (S-PQFP-N16)



- 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. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN Packages, Texas Instruments Literature No. SCBA017, SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - E. 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 stencil design considerations.
  - F. Customers should contact their board fabrication site for solder mask tolerances.

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