

# SN65C1167, SN75C1167, SN65C1168, SN75C1168 DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

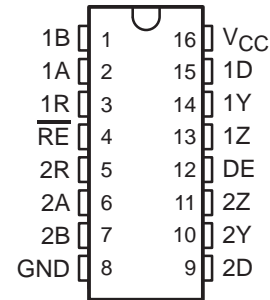
SLLS159E – MARCH 1993 – REVISED NOVEMBER 2003

- Meet or Exceed Standards TIA/EIA-422-B and ITU Recommendation V.11
- BiCMOS Process Technology
- Low Supply-Current Requirements:  
9 mA Max
- Low Pulse Skew
- Receiver Input Impedance . . . 17 k $\Omega$  Typ
- Receiver Input Sensitivity . . .  $\pm 200$  mV
- Receiver Common-Mode Input Voltage Range of -7 V to 7 V
- Operate From Single 5-V Power Supply
- Glitch-Free Power-Up/Power-Down Protection
- Receiver 3-State Outputs Active-Low Enable for SN65C1167 and SN75C1167 Only
- Improved Replacements for the MC34050 and MC34051

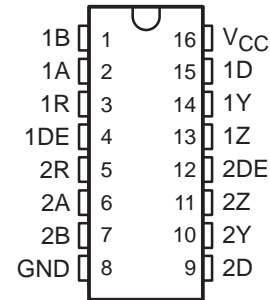
## description/ordering information

The SN65C1167, SN75C1167, SN65C1168, and SN75C1168 dual drivers and receivers are integrated circuits designed for balanced transmission lines. The devices meet TIA/EIA-422-B and ITU recommendation V.11.

SN65C1167 . . . DB OR NS PACKAGE  
SN75C1167 . . . DB, N, OR NS PACKAGE  
(TOP VIEW)



SN65C1168 . . . N, NS, OR PW PACKAGE  
SN75C1168 . . . DB, N, NS, OR PW PACKAGE  
(TOP VIEW)



## ORDERING INFORMATION

T <sub>A</sub>	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (N)	Tube	SN75C1167N	SN75C1167N
	SOP (NS)	Tape and reel	SN75C1167NSR	75C1167
	SSOP (DB)	Tape and reel	SN75C1167DBR	CA1167
	PDIP (N)	Tube	SN75C1168N	SN75C1168N
	SOP (NS)	Tape and reel	SN75C1168NSR	75C1168
	SSOP (DB)	Tape and reel	SN75C1168DBR	CA1168
	TSSOP (PW)	Tube	SN75C1168PW	CA1168
		Tape and reel	SN75C1168PWR	
-40°C to 85°C	SOP (NS)	Tape and reel	SN65C1167NSR	65C1167
	SSOP (DB)	Tape and reel	SN65C1167DBR	CB1167
	PDIP (N)	Tube	SN65C1168N	SN65C1168N
	SOP (NS)	Tape and reel	SN65C1168NSR	65C1168
	TSSOP (PW)	Tube	SN65C1168PW	CB1168
		Tape and reel	SN65C1168PWR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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# SN65C1167, SN75C1167, SN65C1168, SN75C1168

## DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

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### description/ordering information (continued)

The SN65C1167 and SN75C1167 combine dual 3-state differential line drivers and 3-state differential line receivers, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can be connected together externally to function as direction control. The SN65C1168 and SN75C1168 drivers have individual active-high enables.

### Function Tables

EACH DRIVER

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

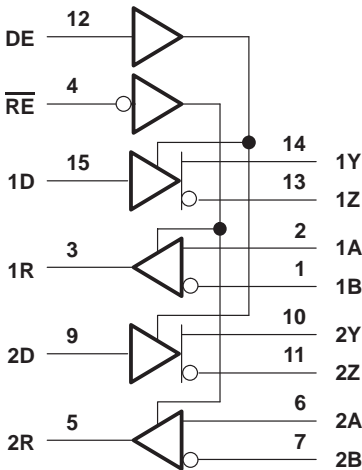
SN75C1167, EACH RECEIVER

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	L	H

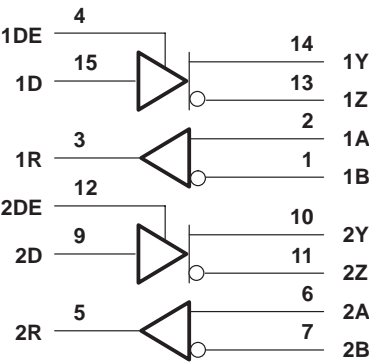
H = high level, L = low level, ? = indeterminate,  
X = irrelevant, Z = high impedance (off)

### logic diagram (positive logic)

SN65C1167/SN75C1167



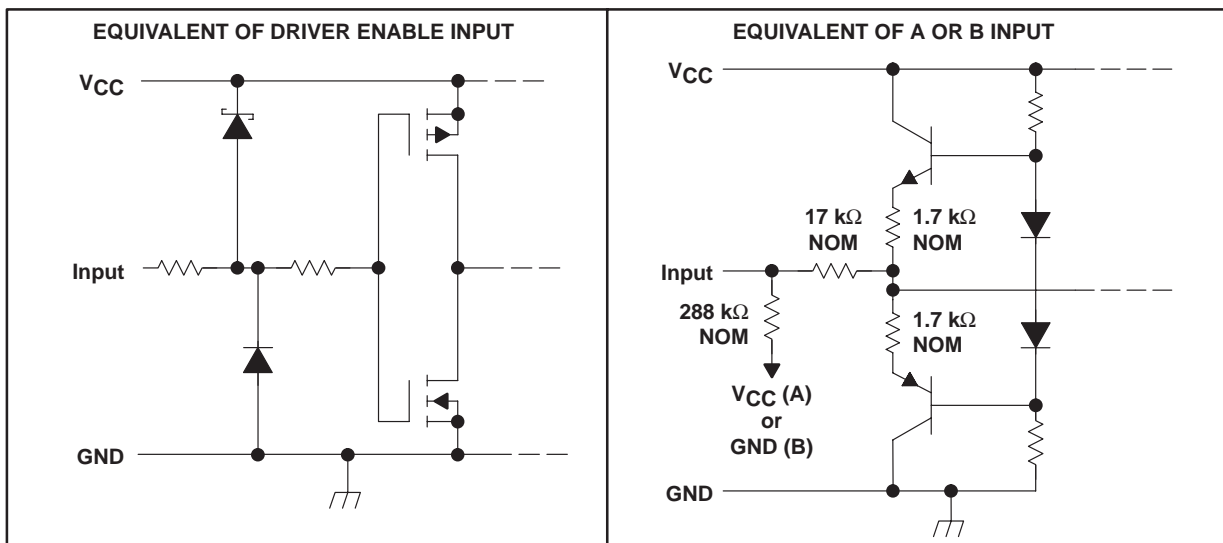
SN65C1168, SN75C1168



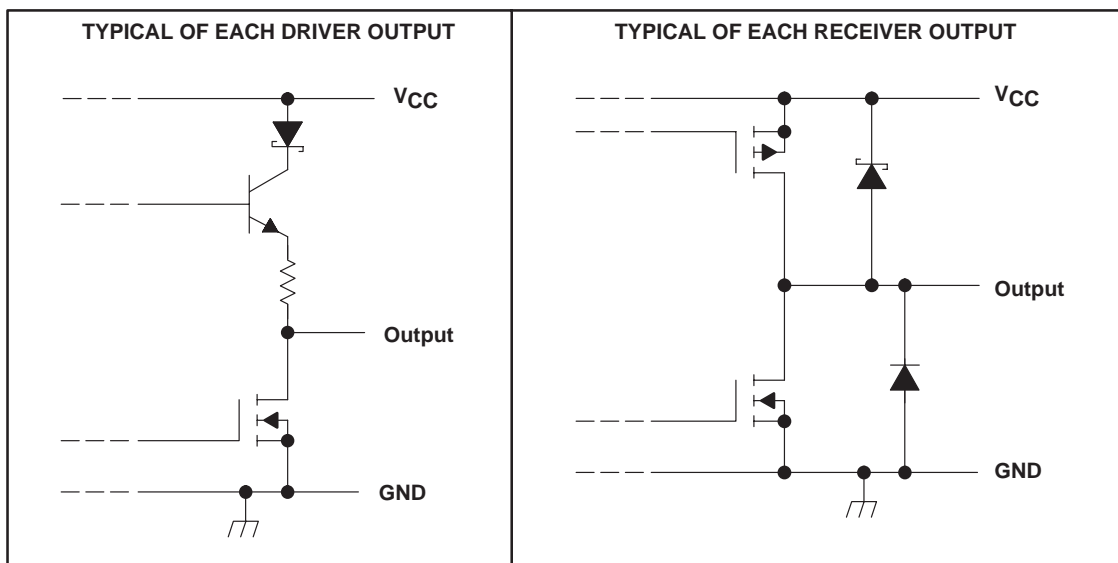
# SN65C1167, SN75C1167, SN65C1168, SN75C1168 DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

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## schematics of inputs



## schematics of outputs



# SN65C1167, SN75C1167, SN65C1168, SN75C1168

## DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

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### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage range, $V_{CC}$ (see Note 1)	–0.5 V to 7 V
Input voltage range, $V_I$	–0.5 V to $V_{CC} + 0.5$ V
Input voltage range, $V_I$ (A or B, Receiver)	–11 V to 14 V
Differential input voltage range, $V_{ID}$ , Receiver (see Note 2)	–14 V to 14 V
Output voltage range, $V_O$ , Driver	–5 V to 7 V
Clamp current range, $I_{IK}$ or $I_{OK}$ , Driver	±20 mA
Output current range, $I_O$ , Driver	±150 mA
Supply current, $I_{CC}$	200 mA
GND current	–200 mA
Output current range, $I_O$ , Receiver	±25 mA
Operating virtual junction temperature	150°C
Package thermal impedance, $\theta_{JA}$ (see Notes 3 and 4): DB package	82°C/W
N package	67°C/W
NS package	64°C/W
PW package	108°C/W
Storage temperature range, $T_{stg}$	–65°C to 150°C

<sup>†</sup> 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 voltage values except differential input voltage are with respect to the network GND.
  2. Differential input voltage is measured at the noninverting terminal with respect to the inverting terminal.
  3. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Selecting the maximum 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
$V_{IC}$	Common-mode input voltage (see Note 5)	Receiver			±7	V
$V_{ID}$	Differential input voltage	Receiver			±7	V
$V_{IH}$	High-level input voltage	Except A, B	2			V
$V_{IL}$	Low-level input voltage	Except A, B			0.8	V
$I_{OH}$	High-level output current	Receiver			–6	mA
		Driver			–20	
$I_{OL}$	Low-level output current	Receiver			6	mA
		Driver			20	
$T_A$	Operating free-air temperature	SN75C1167, SN75C1168	0		70	°C
		SN65C1167, SN65C1168	–40		85	

NOTE 5: Refer to TIA/EIA-422-B for exact conditions.



# SN65C1167, SN75C1167, SN65C1168, SN75C1168 DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

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## DRIVER SECTION

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{IK}$ Input clamp voltage	$I_I = -18 \text{ mA}$			-1.5	V
$V_{OH}$ High-level output voltage	$V_{IH} = 2 \text{ V}$ , $V_{IL} = 0.8 \text{ V}$ , $I_{OH} = -20 \text{ mA}$	2.4	3.4		V
$V_{OL}$ Low-level output voltage	$V_{IH} = 2 \text{ V}$ , $V_{IL} = 0.8 \text{ V}$ , $I_{OL} = 20 \text{ mA}$		0.2	0.4	V
$ V_{OD1} $ Differential output voltage	$I_O = 0 \text{ mA}$	2		6	V
$ V_{OD2} $ Differential output voltage	$R_L = 100 \Omega$ , See Figure 1 and Note 5	2	3.1		V
$\Delta V_{OD} $ Change in magnitude of differential output voltage				$\pm 0.4$	V
$V_{OC}$ Common-mode output voltage				$\pm 3$	V
$\Delta V_{OC} $ Change in magnitude of common-mode output voltage				$\pm 0.4$	V
$I_{O(OFF)}$ Output current with power off (see Note 3)	$V_{CC} = 0 \text{ V}$	$V_O = 6 \text{ V}$		100	$\mu\text{A}$
		$V_O = -0.25 \text{ V}$		-100	$\mu\text{A}$
$I_{OZ}$ High-impedance-state output current	$V_O = 2.5 \text{ V}$			20	$\mu\text{A}$
	$V_O = 5 \text{ V}$			-20	
$I_{IH}$ High-level input current	$V_I = V_{CC}$ or $V_{IH}$			1	$\mu\text{A}$
$I_{IL}$ Low-level input current	$V_I = \text{GND}$ or $V_{IL}$			-1	$\mu\text{A}$
$I_{OS}$ Short-circuit output current	$V_O = V_{CC}$ or $\text{GND}$ , See Note 6		-30	-150	$\text{mA}$
$I_{CC}$ Supply current (total package)	No load, Enabled	$V_I = V_{CC}$ or $\text{GND}$		4	$\text{mA}$
		$V_I = 2.4$ or $0.5 \text{ V}$ , See Note 7		5	
$C_i$ Input capacitance			6		$\text{pF}$

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

NOTES: 5. Refer to TIA/EIA-422-B for exact conditions.

6. Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.

7. This parameter is measured per input, while the other inputs are at  $V_{CC}$  or  $\text{GND}$ .

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$t_{PHL}$ Propagation delay time, high- to low-level output	$R_1 = R_2 = 50 \Omega$ , $R_3 = 500 \Omega$ , $C_1 = C_2 = C_3 = 40 \text{ pF}$ , S1 is open, See Figure 2		7	12	$\text{ns}$
$t_{PLH}$ Propagation delay time, low- to high-level output			7	12	$\text{ns}$
$t_{sk(p)}$ Pulse skew			0.5	4	$\text{ns}$
$t_r$ Rise time	$R_1 = R_2 = 50 \Omega$ , $R_3 = 500 \Omega$ , $C_1 = C_2 = C_3 = 40 \text{ pF}$ , S1 is open, See Figure 3		5	10	$\text{ns}$
$t_f$ Fall time			5	10	$\text{ns}$
$t_{PZH}$ Output enable time to high level	$R_1 = R_2 = 50 \Omega$ , $R_3 = 500 \Omega$ , $C_1 = C_2 = C_3 = 40 \text{ pF}$ , S1 is closed, See Figure 4		10	19	$\text{ns}$
$t_{PZL}$ Output enable time to low level			10	19	$\text{ns}$
$t_{PHZ}$ Output disable time from low level	$R_1 = R_2 = 50 \Omega$ , $R_3 = 500 \Omega$ , $C_1 = C_2 = C_3 = 40 \text{ pF}$ , S1 is closed, See Figure 4		7	16	$\text{ns}$
$t_{PLZ}$ Output disable time from high level			7	16	$\text{ns}$

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



# SN65C1167, SN75C1167, SN65C1168, SN75C1168

## DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

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### RECEIVER SECTION

**electrical characteristics over recommended ranges of common-mode input voltage, supply voltage, and operating free-air temperature (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{IT+}$	Positive-going input threshold voltage, differential input				0.2	V
$V_{IT-}$	Negative-going input threshold voltage, differential input		-0.2‡			V
$V_{hys}$	Input hysteresis ( $V_{IT+} - V_{IT-}$ )			60		mV
$V_{IK}$	Input clamp voltage, $\overline{RE}$	SN75C1167 $I_I = -18$ mA			-1.5	V
$V_{OH}$	High-level output voltage	$V_{ID} = 200$ mV, $I_{OH} = -6$ mA	3.8	4.2		V
$V_{OL}$	Low-level output voltage	$V_{ID} = -200$ mV, $I_{OL} = 6$ mA		0.1	0.3	V
$I_{OZ}$	High-impedance-state output current	SN75C1167 $V_O = V_{CC}$ or GND		$\pm 0.5$	$\pm 5$	$\mu$ A
$I_I$	Line input current	Other input at 0 V	$V_I = 10$ V		1.5	mA
			$V_I = -10$ V		-2.5	
$I_I$	Enable input current, $\overline{RE}$	SN75C1167 $V_I = V_{CC}$ or GND			$\pm 1$	$\mu$ A
$r_i$	Input resistance	$V_{IC} = -7$ V to 7 V, Other input at 0 V	4	17		k $\Omega$
$I_{CC}$	Supply current (total package)	No load, Enabled	$V_I = V_{CC}$ or GND		4	6
			$V_{IH} = 2.4$ V or 0.5 V, See Note 5		5	9

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

‡ The algebraic convention, where the less positive (more negative) limit is designated as minimum, is used in this data sheet for common-mode input voltage and threshold voltage levels only.

NOTE 5: Refer to TIA/EIA-422-B for exact conditions.

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 8)**

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$t_{PLH}$	Propagation delay time, low- to high-level output	See Figure 5	9	17	27	ns
$t_{PHL}$	Propagation delay time, high- to low-level output		9	17	27	ns
$t_{TLH}$	Transition time, low- to high-level output	$V_{IC} = 0$ V, See Figure 5		4	9	ns
$t_{THL}$	Transition time, high- to low-level output			4	9	ns
$t_{PZH}$	Output enable time to high level	$R_L = 1$ kW, See Figure 6		13	22	ns
$t_{PZL}$	Output enable time to low level			13	22	ns
$t_{PHZ}$	Output disable time from high level			13	22	ns
$t_{PLZ}$	Output disable time from low level			13	22	ns

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

NOTE 8: Measured per input while the other inputs are at  $V_{CC}$  or GND



## PARAMETER MEASUREMENT INFORMATION

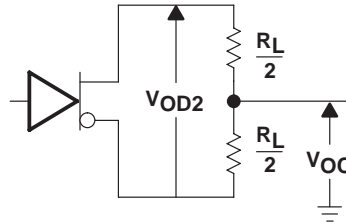
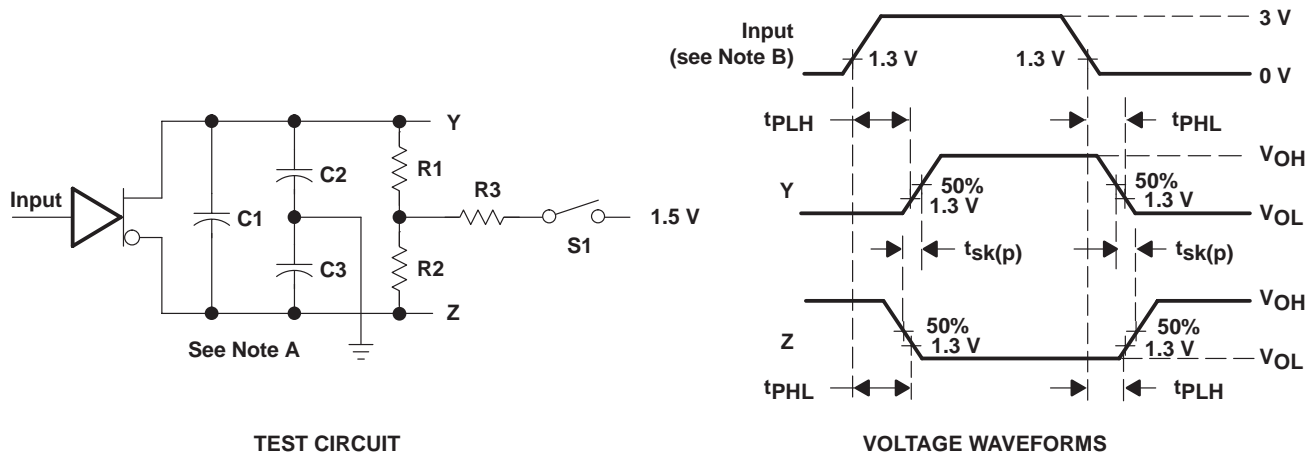
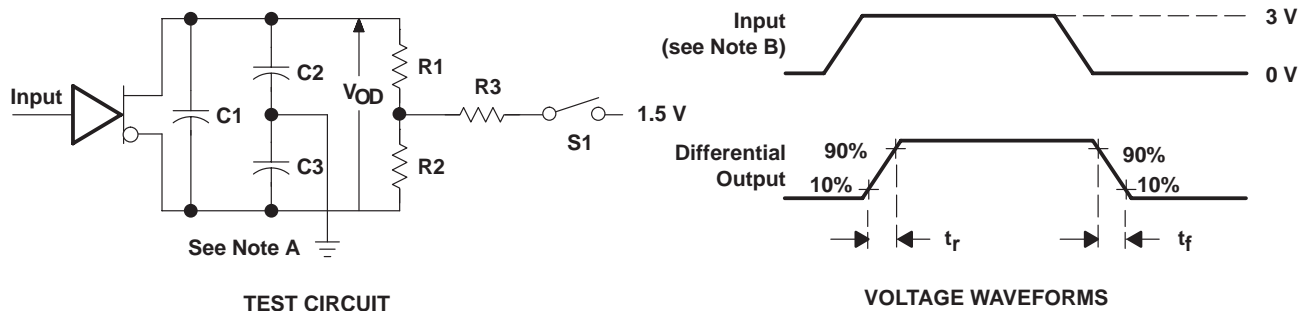


Figure 1. Driver Test Circuit,  $V_{OD}$  and  $V_{OC}$



- NOTES: A. C1, C2, and C3 include probe and jig capacitance.  
B. The input pulse is supplied by a generator having the following characteristics: PRR = 1 MHz, duty cycle = 50%,  $t_r = t_f \leq 6$  ns.

Figure 2. Driver Test Circuit and Voltage Waveforms



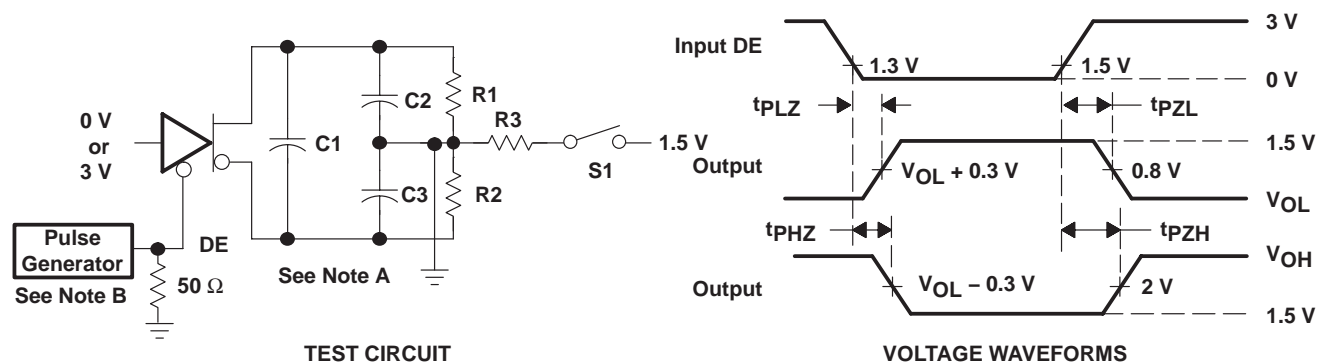
- NOTES: A. C1, C2, and C3 include probe and jig capacitance.  
B. The input pulse is supplied by a generator having the following characteristics: PRR = 1 MHz, duty cycle = 50%,  $t_r = t_f \leq 6$  ns.

Figure 3. Driver Test Circuit and Voltage Waveforms

# SN65C1167, SN75C1167, SN65C1168, SN75C1168 DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

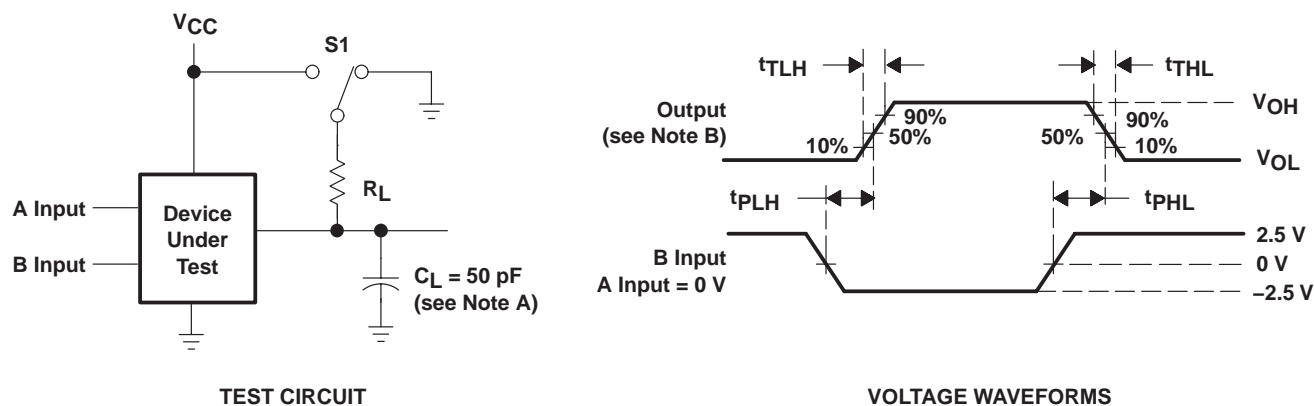
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## PARAMETER MEASUREMENT INFORMATION



NOTES: A. C1, C2, and C3 include probe and jig capacitance.  
B. The input pulse is supplied by a generator having the following characteristics: PRR = 1 MHz, duty cycle = 50%,  $t_r = t_f \leq 6$  ns.

Figure 4. Driver Test Circuit and Voltage Waveforms

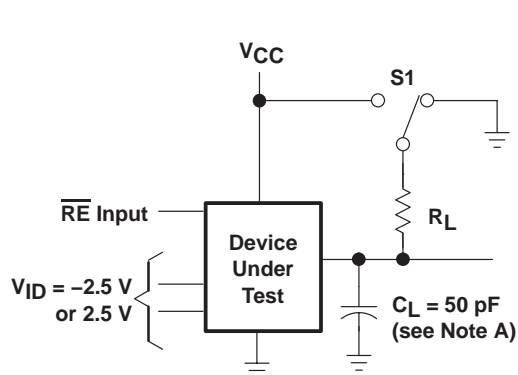


NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The pulse generator has the following characteristics: PRR  $\leq$  1 MHz, duty cycle = 50%,  $t_r = t_f \leq 6$  ns.

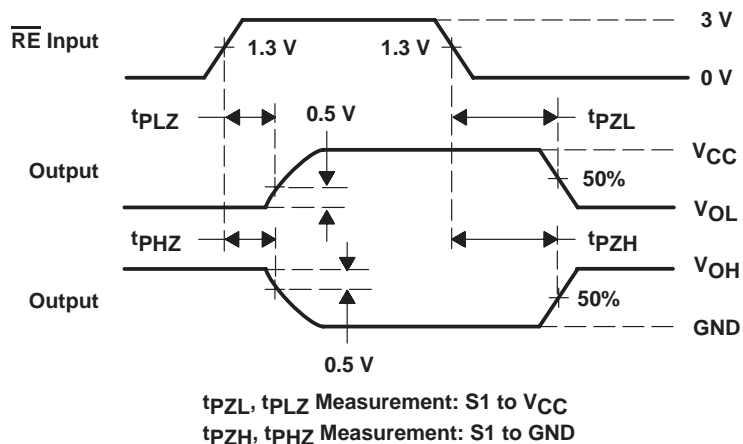
Figure 5. Receiver Test Circuit and Voltage Waveforms



## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



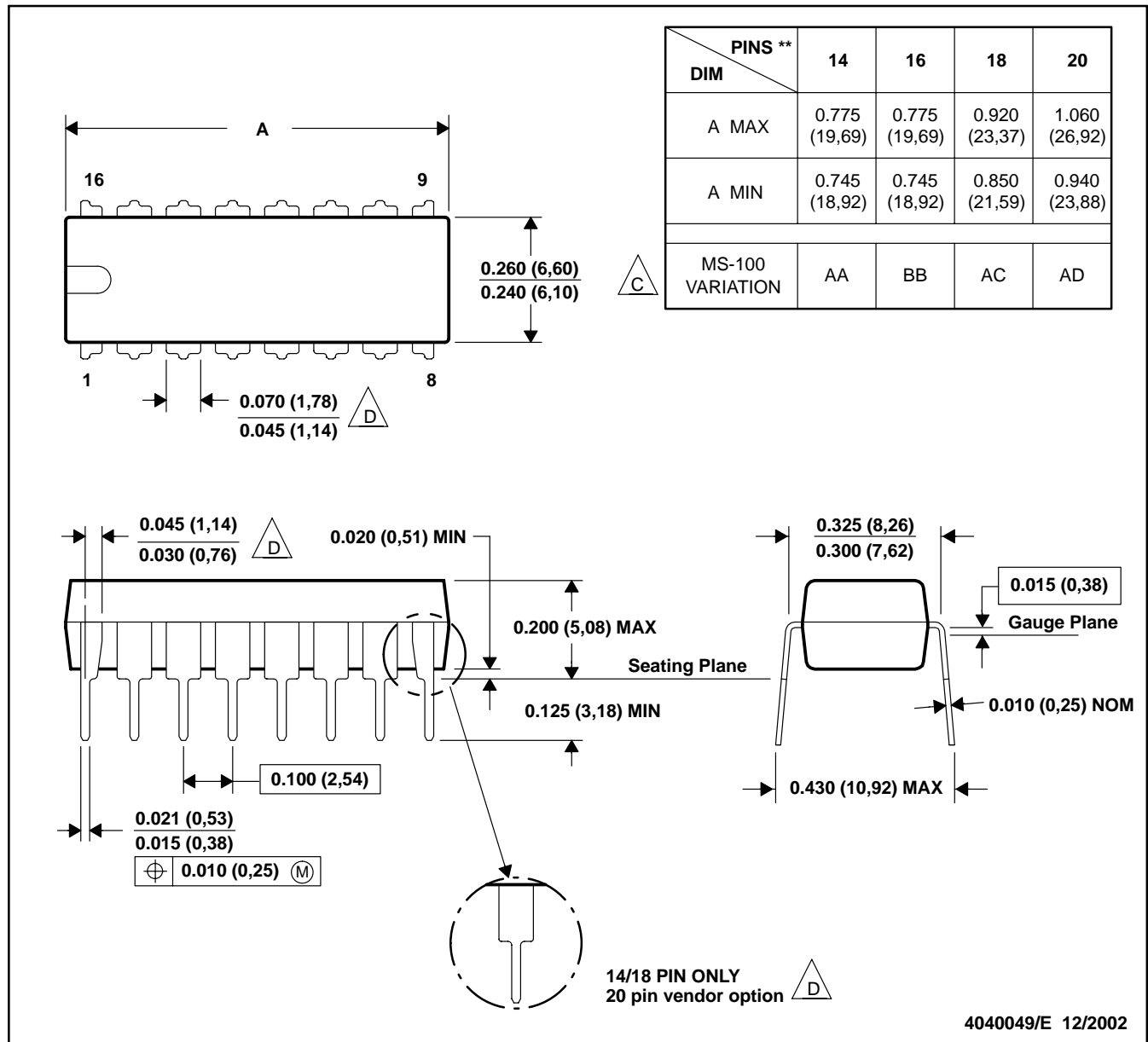
VOLTAGE WAVEFORMS

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics:  $PRR \leq 1 \text{ MHz}$ , duty cycle = 50%,  $t_r = t_f \leq 6 \text{ ns}$ .

Figure 6. Receiver Test Circuit and Voltage Waveforms

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

16 PINS SHOWN

**PLASTIC DUAL-IN-LINE PACKAGE**

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.

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

## DB (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

## PW (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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