

# SN65C1168E-SEP Dual Differential Drivers and Receivers With $\pm 12$ -kV ESD Protection

## 1 Features

- VID V62/19606
- Radiation hardened
  - Single event latch-up (SEL) immune to 43 MeV-cm<sup>2</sup>/mg at 125°C
  - ELDRS-free to 30 krad(Si)
  - Total ionizing dose (TID) RLAT for every wafer lot up to 20 krad(Si)
- Space Enhanced Plastic
  - Controlled baseline
  - Gold wire
  - NiPdAu lead finish
  - One assembly and test site
  - One fabrication site
  - Available in military (–55°C to 125°C) temperature range
  - Extended product life cycle
  - Extended product-change notification
  - Product traceability
  - Enhanced mold compound for low outgassing
- Meet or exceed standards TIA/EIA-422-B and ITU recommendation V.11
- Operate from single 5-V power supply
- ESD protection for RS-422 bus pins
  - $\pm 12$ -kV human-body model (HBM)
  - $\pm 8$ -kV IEC 61000-4-2, contact discharge
  - $\pm 8$ -kV IEC 61000-4-2, air-gap discharge

- Low-pulse skew
- Receiver input impedance . . . 17 k $\Omega$  (typical)
- Receiver input sensitivity . . .  $\pm 200$  mV
- Receiver common-mode input voltage range of –7 V to 7 V
- Glitch-free power-up/power-down protection

## 2 Applications

- Support low earth orbit space applications
- Satellite communications
- AC and servo motor drives

## 3 Description

The SN65C1168E-SEP consists of dual drivers and dual receivers with  $\pm 12$ -kV ESD (HBM) and  $\pm 8$ -kV ESD (IEC61000-4-2 Air-Gap Discharge and Contact Discharge) for RS-422 bus pins. The device meets the requirements of TIA/EIA-422-B and ITU recommendation V.11. Some parameters do not meet all TIA/EIA-422-B and ITU recommendation V.11 requirements after 20-krad(Si) TID exposure.

The SN65C1168E-SEP drivers have individual active-high enables.

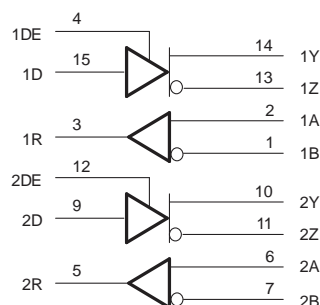
### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SN65C1168EMPWTSEP	TSSOP (16)	5.00 mm x 4.40 mm
SN65C1168EMPWSEP		

(1) For all available packages, see the orderable addendum at the end of the data sheet.

## Block Diagram

SN65C1168E-SEP



Copyright © 2017, Texas Instruments Incorporated



## Table of Contents

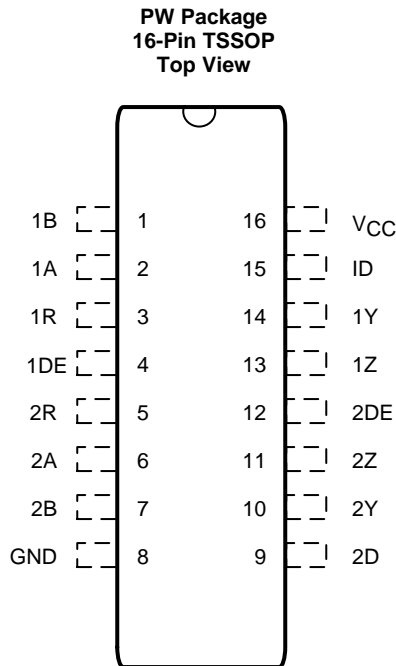
<b>1 Features</b> .....	<b>1</b>	8.1 Overview .....	<b>12</b>
<b>2 Applications</b> .....	<b>1</b>	8.2 Functional Block Diagram .....	<b>12</b>
<b>3 Description</b> .....	<b>1</b>	8.3 Feature Description .....	<b>12</b>
<b>4 Revision History</b> .....	<b>2</b>	8.4 Device Functional Modes .....	<b>13</b>
<b>5 Pin Configuration and Functions</b> .....	<b>3</b>	<b>9 Application and Implementation</b> .....	<b>14</b>
<b>6 Specifications</b> .....	<b>4</b>	9.1 Application Information .....	<b>14</b>
6.1 Absolute Maximum Ratings .....	<b>4</b>	9.2 Typical Application .....	<b>15</b>
6.2 ESD Ratings .....	<b>4</b>	<b>10 Power Supply Recommendations</b> .....	<b>15</b>
6.3 Recommended Operating Conditions .....	<b>5</b>	<b>11 Device and Documentation Support</b> .....	<b>16</b>
6.4 Thermal Information .....	<b>5</b>	11.1 Device Support .....	<b>16</b>
6.5 Driver Section Electrical Characteristics .....	<b>6</b>	11.2 Receiving Notification of Documentation Updates .....	<b>16</b>
6.6 Receiver Section Electrical Characteristics .....	<b>7</b>	11.3 Community Resources .....	<b>16</b>
6.7 Driver Section Switching Characteristics .....	<b>7</b>	11.4 Trademarks .....	<b>16</b>
6.8 Receiver Section Switching Characteristics .....	<b>8</b>	11.5 Electrostatic Discharge Caution .....	<b>16</b>
<b>7 Parameter Measurement Information</b> .....	<b>9</b>	11.6 Glossary .....	<b>16</b>
<b>8 Detailed Description</b> .....	<b>12</b>	<b>12 Mechanical, Packaging, and Orderable Information</b> .....	<b>16</b>

## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
July 2019	*	Initial release.

## 5 Pin Configuration and Functions



### Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
1A	2	I	RS422 differential input (noninverting) to receiver 1
2A	6	I	RS422 differential input (noninverting) to receiver 2
1B	1	I	RS422 differential input (inverting) to receiver 1
2B	7	I	RS422 differential input (inverting) to receiver 2
1D	15	I	Logic data input to RS422 driver 1
2D	9	I	Logic data input to RS422 driver 2
1DE	4	I	Driver 1 enable (active high)
2DE	12	I	Driver 2 enable (active high)
GND	8	—	Device ground
1R	3	O	Logic data output of RS422 receiver 1
2R	5	O	Logic data output of RS422 receiver 2
V <sub>CC</sub>	16	—	Power supply
1Y	14	O	RS-422 differential (noninverting) driver output 1
2Y	10	O	RS-422 differential (noninverting) driver output 2
1Z	13	O	RS-422 differential (noninverting) driver output 1
2Z	11	O	RS-422 differential (noninverting) driver output 2

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT	
V <sub>CC</sub>	Supply voltage <sup>(2)</sup>	−0.5	7	V	
V <sub>I</sub>	Input voltage	Driver, DE, RE	−0.5	7	V
		A or B, Receiver	−14	14	
V <sub>ID</sub>	Differential input voltage <sup>(3)</sup>	Receiver	−14	14	V
V <sub>O</sub>	Output voltage	Driver	−0.5	7	V
		Receiver	−0.5	V <sub>CC</sub> + 0.5	
I <sub>IK</sub>	Input clamp current	Driver, V <sub>I</sub> < 0		−20	mA
I <sub>OK</sub>	Output clamp current	Driver, V <sub>O</sub> < 0		−20	mA
		Receiver	−20	20	
I <sub>O</sub>	Output current	Driver	−150	150	mA
		Receiver	−25	25	
I <sub>CC</sub>	Supply current		200	mA	
	GND current		−200	mA	
T <sub>J</sub>	Operating virtual junction temperature		150	°C	
T <sub>stg</sub>	Storage temperature	−65	150	°C	

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values except differential input voltage are with respect to the network GND.
- (3) Differential input voltage is measured at the noninverting terminal, with respect to the inverting terminal.

### 6.2 ESD Ratings

		VALUE	UNIT	
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±12000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±1000	
		IEC 61000-4-2, air-gap discharge	±8000	
		IEC 61000-4-2, contact discharge	±8000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

			MIN	NOM	MAX	UNIT
V <sub>CC</sub>	Supply voltage		4.5	5	5.5	V
V <sub>IC</sub>	Common-mode input voltage <sup>(1)</sup>	Receiver			±7	V
V <sub>ID</sub>	Differential input voltage	Receiver			±7	V
V <sub>I</sub>	Input voltage	Except A, B	0		5.5	V
V <sub>O</sub>	Output voltage	Receiver	0		V <sub>CC</sub>	V
V <sub>IH</sub>	High-level input voltage	Except A, B	2			V
V <sub>IL</sub>	Low-level input voltage	Except A, B			0.8	V
I <sub>OH</sub>	High-level output current	Receiver			-6	mA
		Driver			-20	
I <sub>OL</sub>	Low-level output current	Receiver			6	mA
		Driver			20	
T <sub>A</sub>	Operating free-air temperature		-55		125	°C

(1) Refer to TIA/EIA-422-B for exact conditions.

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		SN65C1168E-SEP	UNIT
		PW (TSSOP)	
		16 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	102.5	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	32.3	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	48.8	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	1.8	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	48.2	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	N/A	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

## 6.5 Driver Section Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT	
V <sub>IK</sub>	Input clamp voltage	I <sub>I</sub> = -18 mA			-1.5	V	
V <sub>OH</sub>	High-level output voltage	V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OH</sub> = -20 mA	2.4	3.5		V	
V <sub>OL</sub>	Low-level output voltage	V <sub>IH</sub> = 2 V, V <sub>IL</sub> = 0.8 V, I <sub>OL</sub> = 20 mA		0.2	0.4	V	
V <sub>OD1</sub>	Differential output voltage 1	I <sub>O</sub> = 0 mA	2		6	V	
V <sub>OD2</sub>	Differential output voltage 2	R <sub>L</sub> = 100 Ω, see Figure 1 <sup>(2)</sup>	2	3.7		V	
Δ V <sub>OD</sub>	Change in magnitude of differential output voltage	R <sub>L</sub> = 100 Ω, see Figure 1 <sup>(2)</sup>	-0.4		0.4	V	
V <sub>OC</sub>	Common-mode output voltage	R <sub>L</sub> = 100 Ω, see Figure 1 <sup>(2)</sup>	-3		3	V	
Δ V <sub>OC</sub>	Change in magnitude of common-mode output voltage	R <sub>L</sub> = 100 Ω, see Figure 1 <sup>(2)</sup>	-0.4		0.4	V	
I <sub>O(OFF)</sub>	Output current with power off	V <sub>CC</sub> = 0 V	V <sub>O</sub> = 6 V		100	μA	
			V <sub>O</sub> = -0.25 V		100		
I <sub>O(OFF)</sub>	Output current with power off <sup>(3)</sup>	V <sub>CC</sub> = 0 V	V <sub>O</sub> = 6 V		3	mA	
			V <sub>O</sub> = -0.25 V		3		
I <sub>OZ</sub>	High-impedance-state output current	V <sub>O</sub> = 2.5 V		20		μA	
		V <sub>O</sub> = 5 V		-20			
I <sub>OZ</sub>	High-impedance-state output current <sup>(3)</sup>	V <sub>O</sub> = 2.5 V		2		mA	
		V <sub>O</sub> = 5 V		-2			
I <sub>IH</sub>	High-level input current	V <sub>I</sub> = V <sub>CC</sub> or V <sub>IH</sub>		1		μA	
I <sub>IL</sub>	Low-level input current	V <sub>I</sub> = GND or V <sub>IL</sub>		-36		μA	
I <sub>OS</sub>	Short-circuit output current	V <sub>O</sub> = V <sub>CC</sub> or GND <sup>(4)</sup>		-30	-160	mA	
I <sub>CC</sub>	Supply current (total package)	No load, Enabled	V <sub>I</sub> = V <sub>CC</sub> or GND		4	6	mA
			V <sub>I</sub> = 2.4 or 0.5 V <sup>(5)</sup>		5	9	
I <sub>CC</sub>	Supply current (total package) <sup>(3)</sup>	No load, Enabled	V <sub>I</sub> = V <sub>CC</sub> or GND		17		mA
			V <sub>I</sub> = 2.4 or 0.5 V <sup>(5)</sup>		16		
C <sub>i</sub>	Input capacitance			6		pF	

(1) All typical values are at V<sub>CC</sub> = 5 V and T<sub>A</sub> = 25°C.

(2) Refer to TIA/EIA-422-B for exact conditions.

(3) 25°C only. Post 20-krad(Si) HDR TID using worst case static biasing.

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

(5) This parameter is measured per input, while the other inputs are at V<sub>CC</sub> or GND.

## 6.6 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 <sup>(1)</sup>	MAX	UNIT
V <sub>IT+</sub>	Positive-going input threshold voltage, differential input				0.2	V
V <sub>IT-</sub>	Negative-going input threshold voltage, differential input		-0.2 <sup>(2)</sup>			V
V <sub>hys</sub>	Input hysteresis (V <sub>IT+</sub> - V <sub>IT-</sub> )			60		mV
V <sub>OH</sub>	High-level output voltage	V <sub>ID</sub> = 200 mV, I <sub>OH</sub> = -6 mA	3.8	4.2		V
V <sub>OL</sub>	Low-level output voltage	V <sub>ID</sub> = -200 mV, I <sub>OL</sub> = 6 mA		0.1	0.3	V
I <sub>I</sub>	Line input current	Other input at 0 V			1.5	mA
		V <sub>I</sub> = 10 V V <sub>I</sub> = -10 V			-2.5	
r <sub>I</sub>	Input resistance	V <sub>IC</sub> = -7 V to 7 V, other input at 0 V	4	17		kΩ
I <sub>CC</sub>	Supply current (total package)	No load, Enabled			4	mA
		V <sub>I</sub> = V <sub>CC</sub> or GND V <sub>IH</sub> = 2.4 V or 0.5 V <sup>(3)</sup>			5	
I <sub>CC</sub>	Supply current (total package) <sup>(4)</sup>	No load			17	mA
		V <sub>I</sub> = 2.4 or 0.5 V <sup>(5)</sup>			16	

(1) All typical values are at V<sub>CC</sub> = 5 V and T<sub>A</sub> = 25°C.

(2) 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.

(3) Refer to TIA/EIA-422-B for exact conditions.

(4) 25°C only. Post 20-krad(Si) HDR TID using worst case static biasing.

(5) This parameter is measured per input, while the other inputs are at V<sub>CC</sub> or GND.

## 6.7 Driver Section Switching Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
t <sub>PHL</sub>	Propagation delay time, high- to low-level output	R1 = R2 = 50 Ω, R3 = 500 Ω, C1 = C2 = C3 = 40 pF, S1 is open, see <a href="#">Figure 2</a>		8	16	ns
t <sub>PLH</sub>	Propagation delay time, low- to high-level output			8	16	ns
t <sub>sk(p)</sub>	Pulse skew			1.5	4	ns
t <sub>r</sub>	Rise time	R1 = R2 = 50 Ω, R3 = 500 Ω, C1 = C2 = C3 = 40 pF, S1 is open, see <a href="#">Figure 3</a>		5	8	ns
t <sub>f</sub>	Fall time			5	8	ns
t <sub>PZH</sub>	Output-enable time to high level	R1 = R2 = 50 Ω, R3 = 500 Ω, C1 = C2 = C3 = 40 pF, S1 is closed, see <a href="#">Figure 4</a>		10	19	ns
t <sub>PZL</sub>	Output-enable time to low level			10	19	ns
t <sub>PHZ</sub>	Output-disable time from high level	R1 = R2 = 50 Ω, R3 = 500 Ω, C1 = C2 = C3 = 40 pF, S1 is closed, see <a href="#">Figure 4</a>		7	16	ns
t <sub>PLZ</sub>	Output-disable time from low level			7	16	ns
f <sub>SW</sub>	Maximum switching frequency	R1 = R2 = 50 Ω, R3 = 500 Ω, C1 = C2 = C3 = 40 pF, S1 is open, see <a href="#">Figure 3</a>	20			MHz

(1) All typical values are at V<sub>CC</sub> = 5 V and T<sub>A</sub> = 25°C.

## 6.8 Receiver Section Switching Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
$t_{PLH}$	Propagation delay time, low- to high-level output	See <a href="#">Figure 5</a>	9	15	27	ns
$t_{PHL}$	Propagation delay time, high- to low-level output	See <a href="#">Figure 5</a>	9	15	27	ns
$t_{TLH}$	Transition time, low- to high-level output	$V_{IC} = 0\text{ V}$ , see <a href="#">Figure 5</a>		4	9	ns
$t_{PHL}$	Transition time, high- to low-level output			4	9	ns

(1) Measured per input while the other inputs are at  $V_{CC}$  or GND.

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



## 7 Parameter Measurement Information

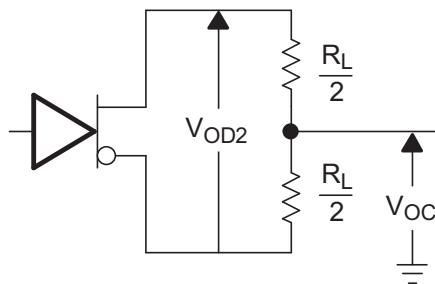
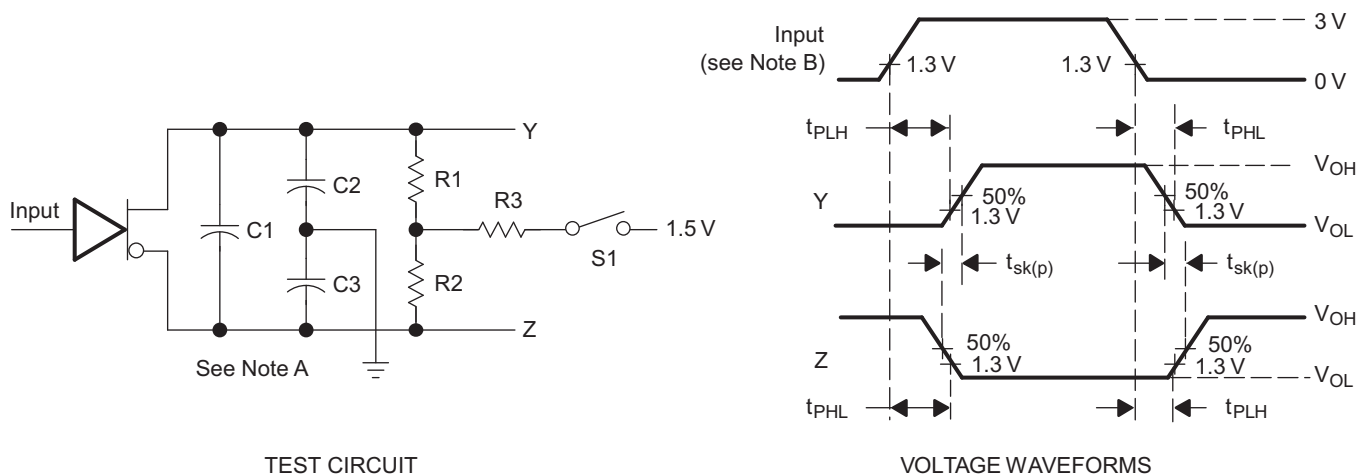
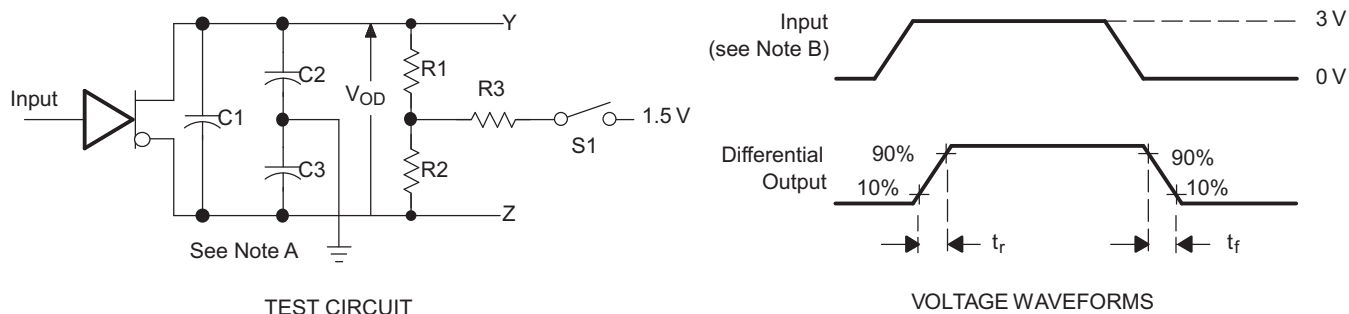


Figure 1. Driver Test Circuit,  $V_{OD}$  and  $V_{OC}$



- TEST CIRCUIT
- 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.

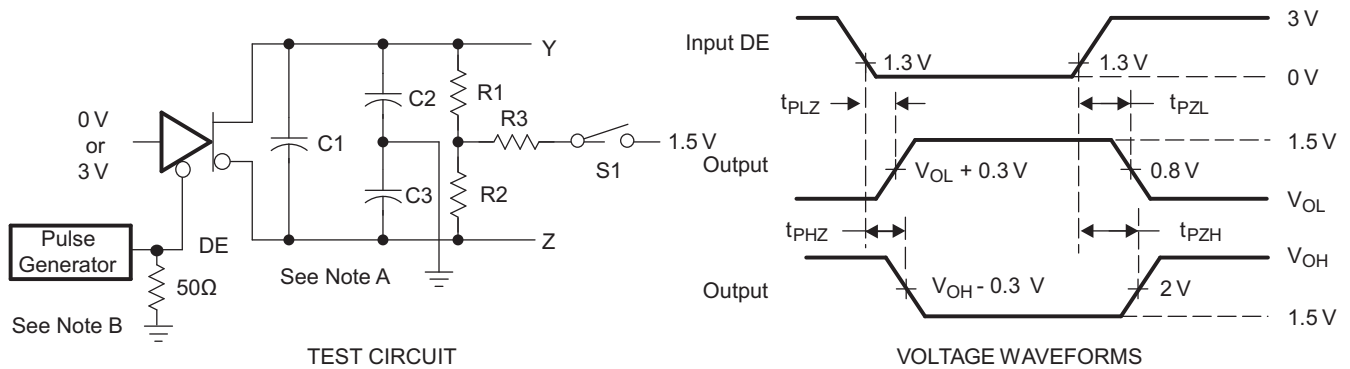
Figure 2. Driver Test Circuit and Voltage Waveforms



- TEST CIRCUIT
- 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.

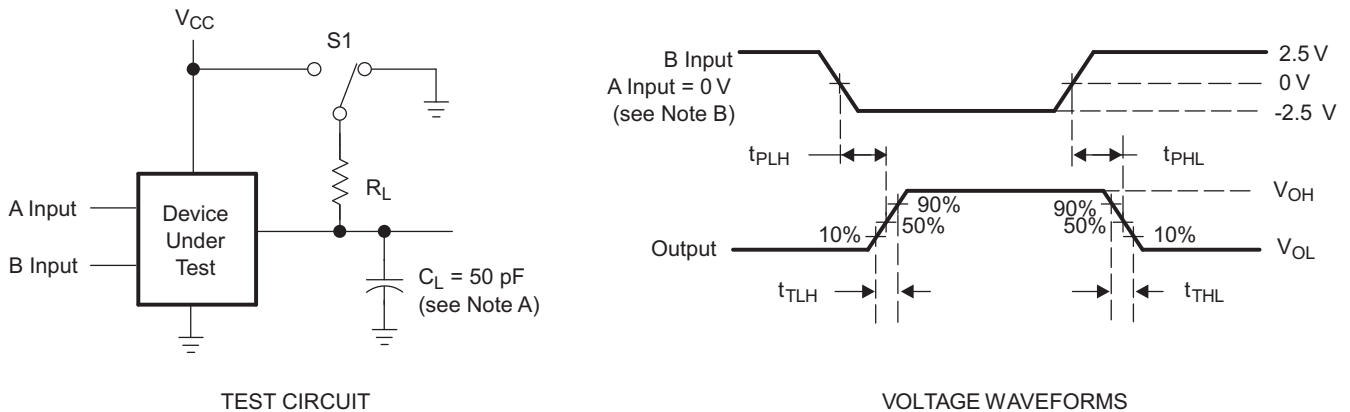
Figure 3. Driver Test Circuit and Voltage Waveforms

Parameter Measurement Information (continued)



- 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.

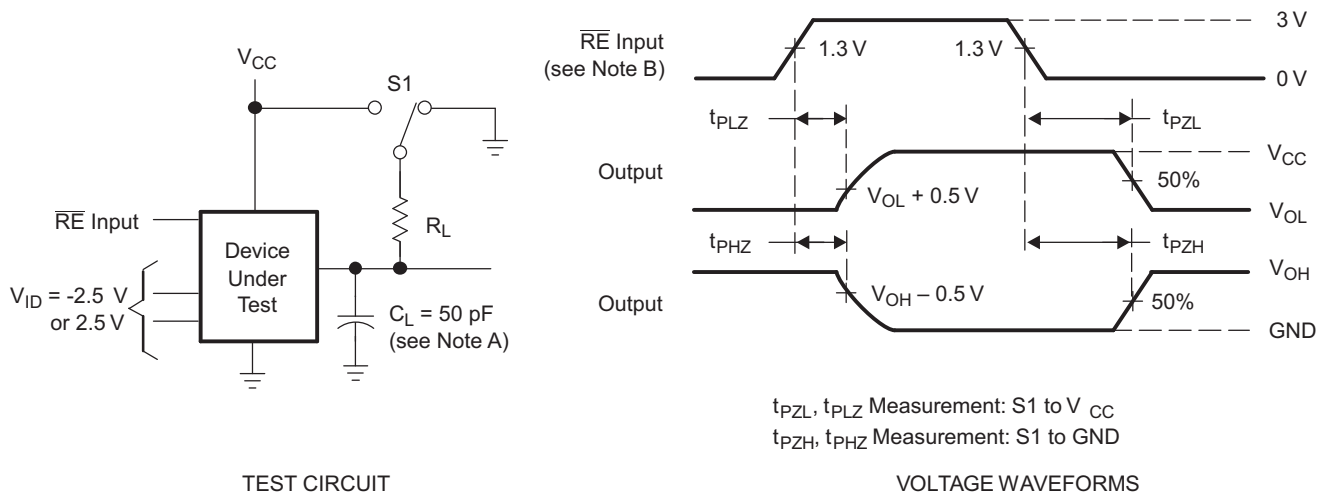
Figure 4. Driver Test Circuit and Voltage Waveforms



- 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 5. Receiver Test Circuit and Voltage Waveforms

Parameter Measurement Information (continued)



- 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<sub>r</sub> = t<sub>f</sub> ≤ 6 ns.

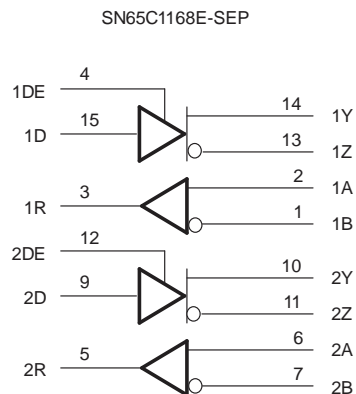
Figure 6. Receiver Test Circuit and Voltage Waveforms

## 8 Detailed Description

### 8.1 Overview

The SN65C1168E-SEP consist of dual drivers and dual receivers powered from a single 5-V supply. This device meets the requirements of TIA/EIA-422-B and ITU recommendation V.11.

### 8.2 Functional Block Diagram



Copyright © 2017, Texas Instruments Incorporated

### 8.3 Feature Description

#### 8.3.1 Active High Driver Output Enables

SN65C1168E-SEP drivers can be configured individually by 1DE and 2DE logic inputs. Both drivers are set at high-impedance when disabled.

## 8.4 Device Functional Modes

Table 1 and Table 2 lists the functional modes of SN65C1168E-SEP.

**Table 1. Each Driver<sup>(1)</sup>**

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

(1) H = High level, L = Low level, X = Irrelevant, Z = High impedance (off)

**Table 2. Each Receiver<sup>(1)</sup>**

DIFFERENTIAL INPUTS A-B	OUTPUT R
$V_{ID} \geq 0.2 \text{ V}$	H
$-0.2 \text{ V} < V_{ID} < 0.2 \text{ V}$	?
$V_{ID} \leq -0.2 \text{ V}$	L
Open	H

(1) H = High level, L = Low level, ? = Indeterminate

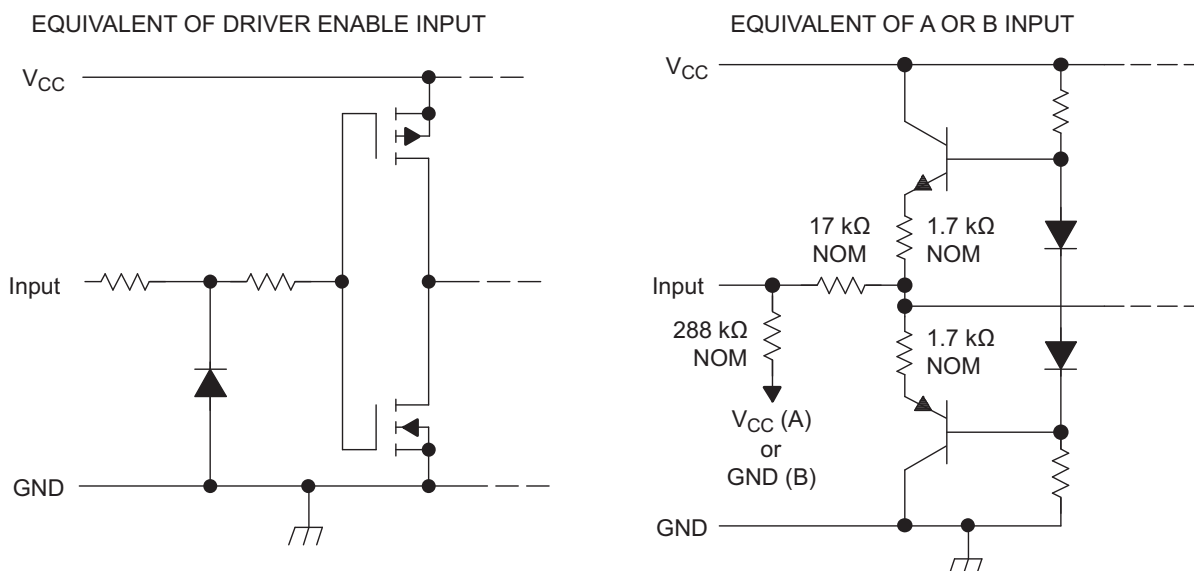
## 9 Application and Implementation

### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

Figure 7 shows a typical RS-422 application. One transmitter is able to broadcast to multiple receiving nodes connected together over a shared differential bus. Twisted-pair cabling with a controlled differential impedance is used, and a termination resistance is placed at the farthest receive end of the cable in order to match the transmission line impedance and minimize signal reflections.



**Figure 7. Schematic of Inputs**

## Application Information (continued)

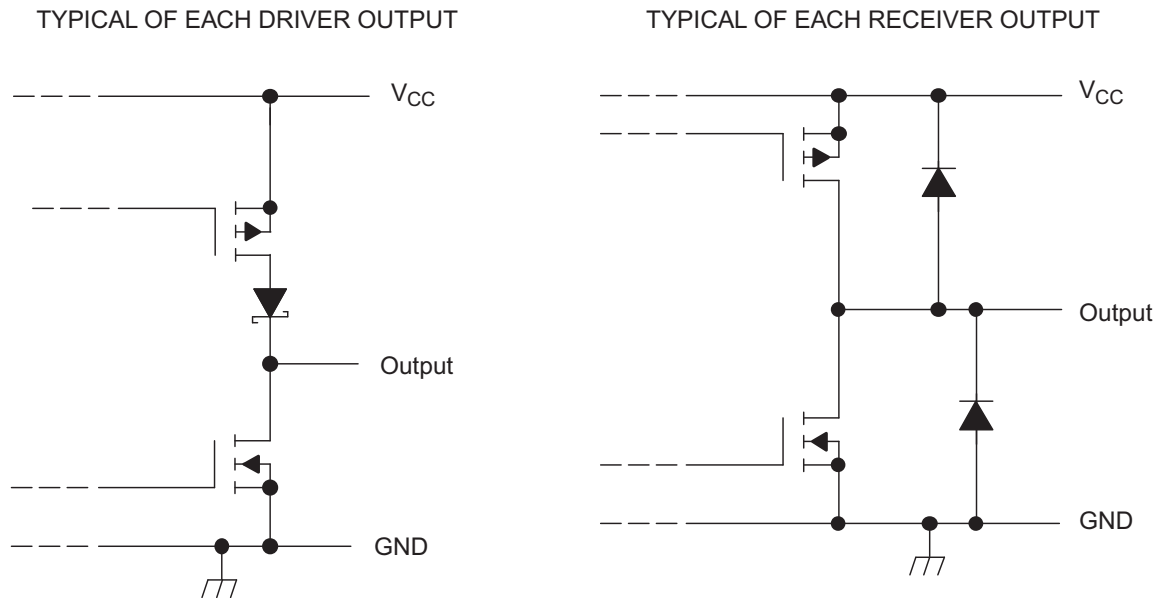


Figure 8. Schematic of Outputs

## 9.2 Typical Application

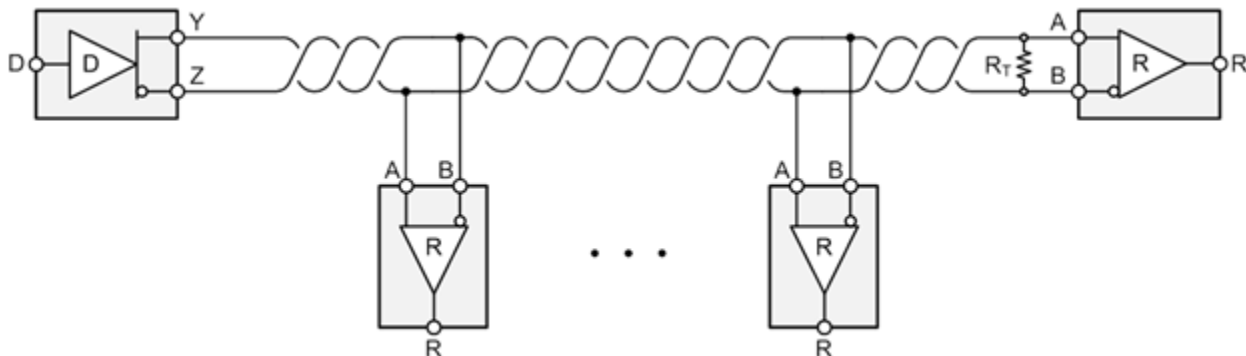


Figure 9. Typical RS-422 Application

### 9.2.1 Design Requirements

A typical RS-422 implementation using SN65C116xE requires the following:

- 5-V power source.
- Connector that ensures the correct polarity for port pins.
- Cabling that supports the desired operating rate and transmission distance.

### 9.2.2 Detailed Design Procedure

Place the device close to bus connector to keep traces (stub) short to prevent adding reflections to the bus line. If desired, add external fail-safe biasing to ensure  $\pm 200$  mV on the A-B port when the driver circuit is disabled.

## 10 Power Supply Recommendations

Use a 5-V power supply for  $V_{CC}$  place 0.1- $\mu$ F bypass capacitors close to the power supply pins to reduce errors coupling in from noisy or high impedance power supplies.

## 11 Device and Documentation Support

### 11.1 Device Support

#### 11.1.1 Third-Party Products Disclaimer

TI'S PUBLICATION OF INFORMATION REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE AN ENDORSEMENT REGARDING THE SUITABILITY OF SUCH PRODUCTS OR SERVICES OR A WARRANTY, REPRESENTATION OR ENDORSEMENT OF SUCH PRODUCTS OR SERVICES, EITHER ALONE OR IN COMBINATION WITH ANY TI PRODUCT OR SERVICE.

#### 11.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on Alert me to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

#### 11.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

#### 11.4 Trademarks

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

#### 11.5 Electrostatic Discharge Caution



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.

#### 11.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">SN65C1168EMPWSEP</a>	Active	Production	TSSOP (PW)   16	90   TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-55 to 125	1168SEP
SN65C1168EMPWSEP.A	Active	Production	TSSOP (PW)   16	90   TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-55 to 125	1168SEP
<a href="#">SN65C1168EMPWTSEP</a>	Active	Production	TSSOP (PW)   16	250   SMALL T&R	Yes	NIPDAU	Level-3-260C-168 HR	-55 to 125	1168SEP
SN65C1168EMPWTSEP.A	Active	Production	TSSOP (PW)   16	250   SMALL T&R	Yes	NIPDAU	Level-3-260C-168 HR	-55 to 125	1168SEP
V62/19606-0XE	Active	Production	TSSOP (PW)   16	90   TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-55 to 125	1168SEP
V62/19606-0XE-T	Active	Production	TSSOP (PW)   16	250   SMALL T&R	Yes	NIPDAU	Level-3-260C-168 HR	-55 to 125	1168SEP

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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**

**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
SN65C1168EMPWTSEP	TSSOP	PW	16	250	180.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

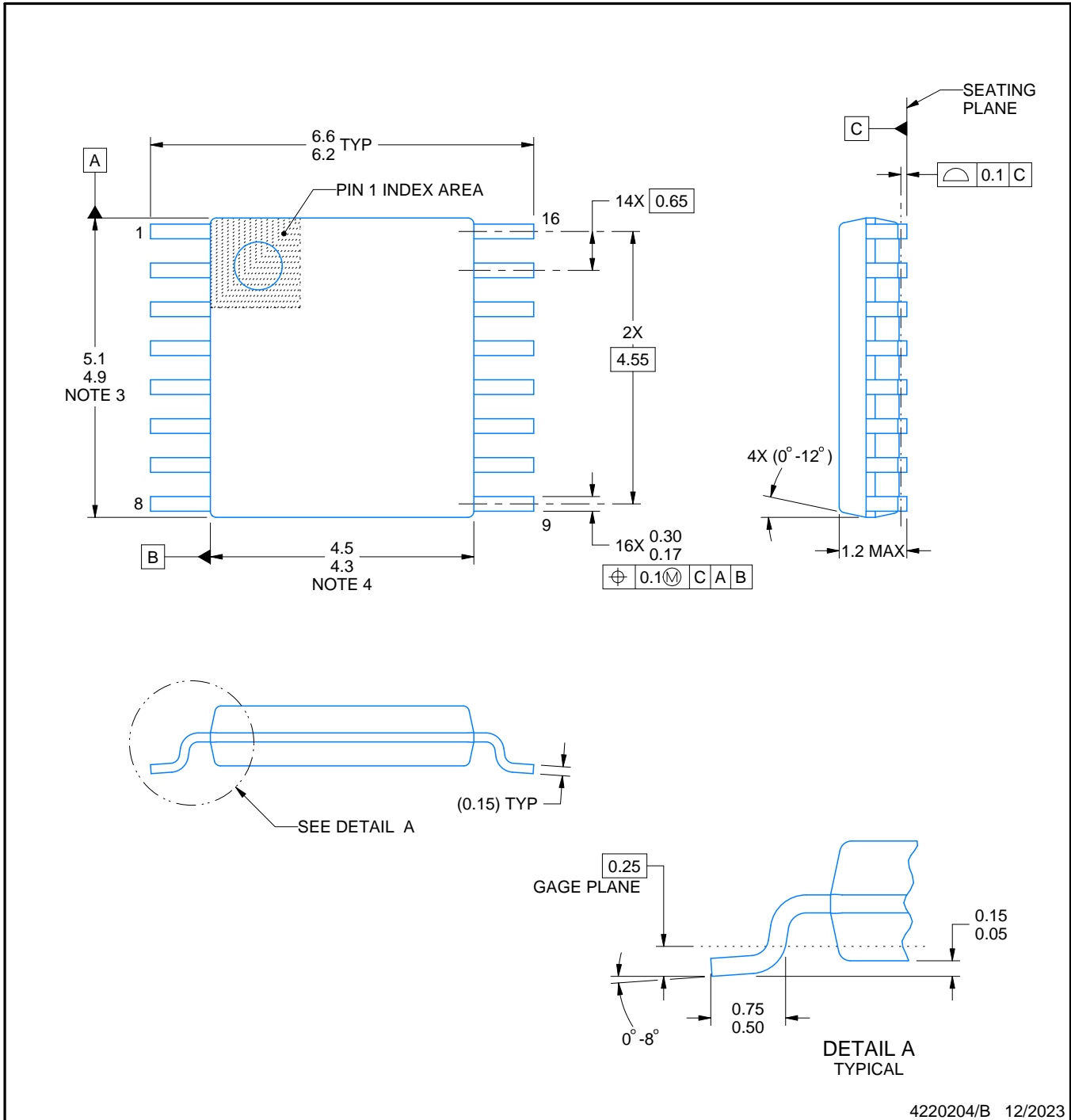
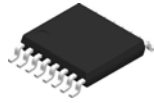

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65C1168EMPWTSEP	TSSOP	PW	16	250	213.0	191.0	35.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN65C1168EMPWSEP	PW	TSSOP	16	90	530	10.2	3600	3.5
SN65C1168EMPWSEP.A	PW	TSSOP	16	90	530	10.2	3600	3.5
V62/19606-0XE	PW	TSSOP	16	90	530	10.2	3600	3.5



4220204/B 12/2023

**NOTES:**

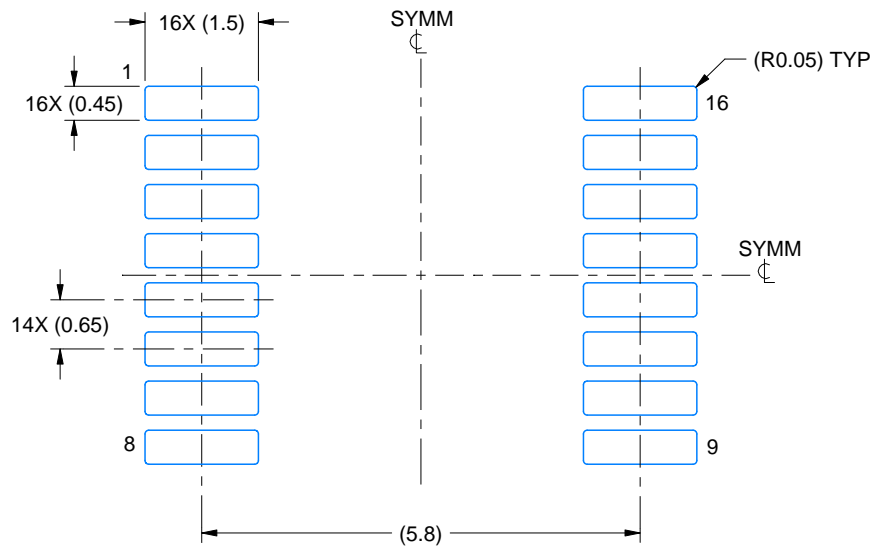
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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.

# EXAMPLE BOARD LAYOUT

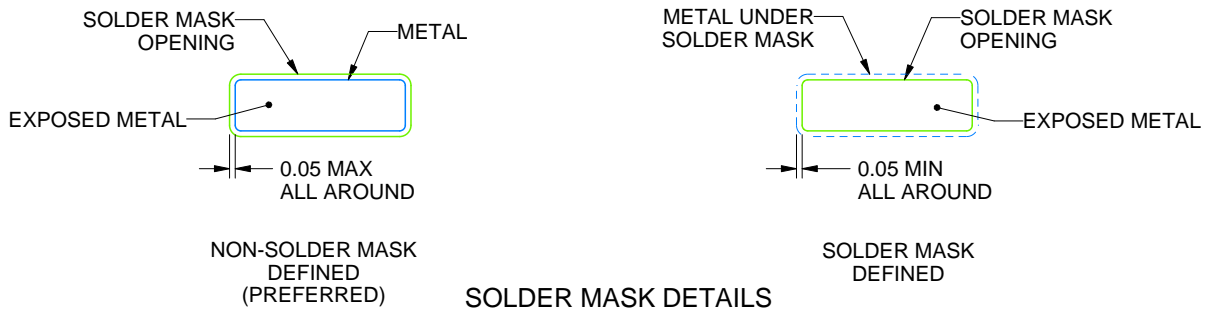
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

4220204/B 12/2023

NOTES: (continued)

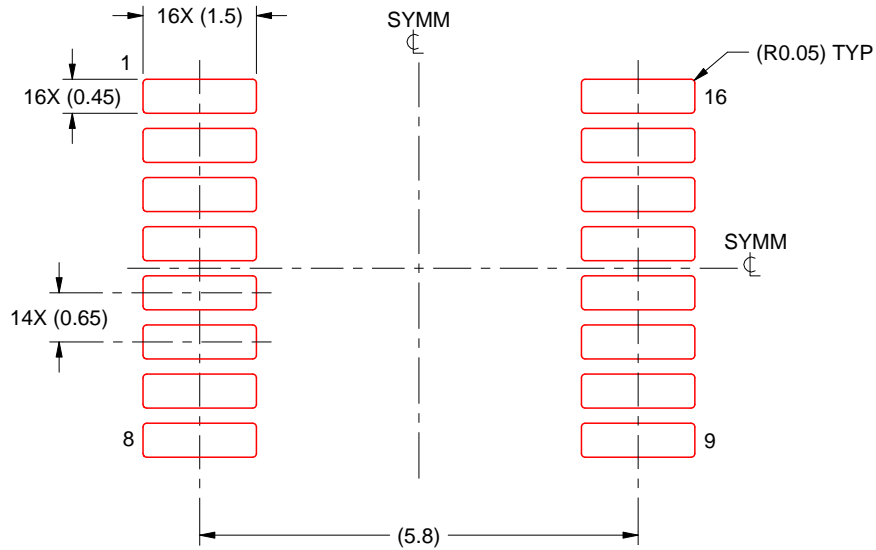
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4220204/B 12/2023

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.



## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#), [TI's General Quality Guidelines](#), or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2025, Texas Instruments Incorporated

Last updated 10/2025