

## FEATURES

- 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
  - $\pm 15$ -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 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
- Glitch-Free Power-Up/Power-Down Protection
- Receiver 3-State Outputs Active-Low Enable (SN65C1167E Only)

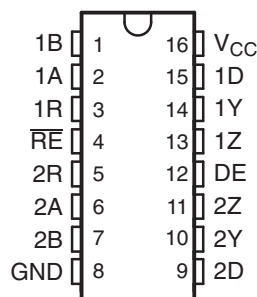
## DESCRIPTION/ORDERING INFORMATION

The SN65C1167E and SN65C1168E consist of dual drivers and dual receivers with  $\pm 15$ -kV ESD (Human Body Model [HBM]) and  $\pm 8$ -kV ESD (IEC61000-4-2 Air-Gap Discharge and Contact Discharge) for RS-422 bus pins. The devices meet the requirements of TIA/EIA-422-B and ITU recommendation V.11.

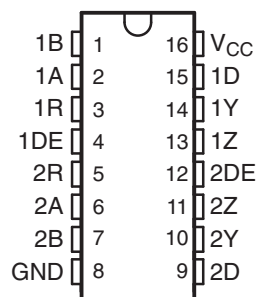
The SN65C1167E combines dual 3-state differential line drivers and 3-state differential line receivers, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can be connected together externally to function as direction control.

SN65C1168E drivers have individual active-high enables.

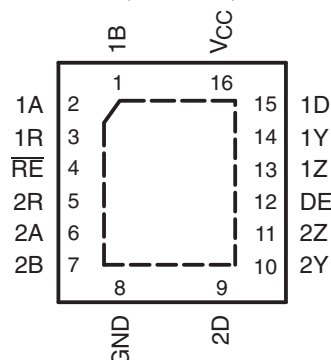
SN65C1167E . . . NS OR PW PACKAGE  
(TOP VIEW)



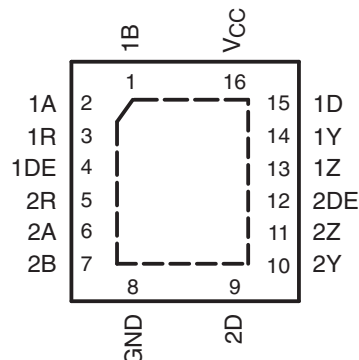
SN65C1168E . . . NS OR PW PACKAGE  
(TOP VIEW)



SN65C1167E . . . RGY PACKAGE  
(TOP VIEW)



SN65C1168E . . . RGY PACKAGE  
(TOP VIEW)



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.

# SN65C1167E, SN65C1168E DUAL DIFFERENTIAL DRIVERS AND RECEIVERS WITH $\pm 15$ -kV ESD PROTECTION

SLLS740A–MARCH 2007–REVISED APRIL 2007

## ORDERING INFORMATION

T <sub>A</sub>	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SOP – NS	Tube of 50	SN65C1167ENS	65C1167E
			SN65C1168ENS	65C1168E
		Reel of 2000	SN65C1167ENSR	65C1167E
			SN65C1168ENSR	65C1168E
	TSSOP – PW	Tube of 90	SN65C1167EPW	CB1167E
			SN65C1168EPW	CB1168E
		Reel of 2000	SN65C1167EPWR	CB1167E
			SN65C1168EPWR	CB1168E
	QFN – RGY	Reel of 1000	SN65C1167ERGYR	CB1167
			SN65C1168ERGYR	CB1168

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

## FUNCTION TABLES Each Driver

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

## SN65C1167E, Each Receiver<sup>(1)</sup>

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

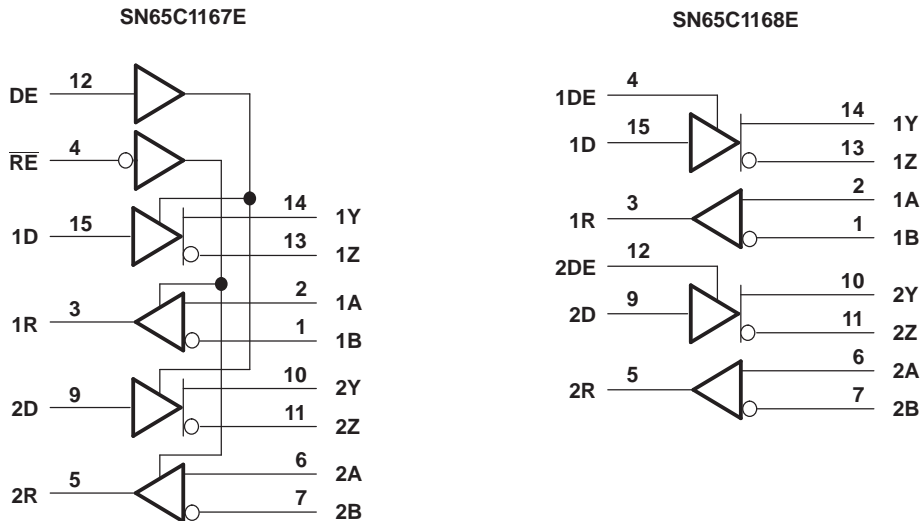
(1) H = High level, L = Low level, ? = Indeterminate, X = Irrelevant,  
Z = High impedance (off)

## SN65C1168E, Each Receiver<sup>(1)</sup>

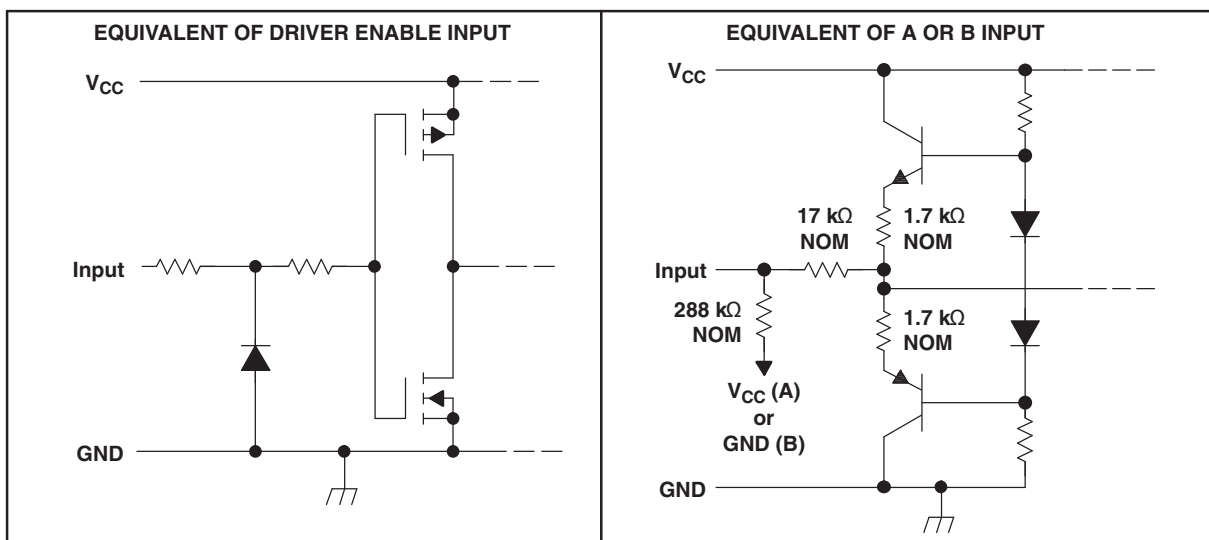
DIFFERENTIAL INPUTS A–B	OUTPUT R
$V_{ID} \geq 0.2$ V	H
$-0.2$ V $< V_{ID} < 0.2$ V	?
$V_{ID} \leq -0.2$ V	L
Open	H

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

## LOGIC DIAGRAMS (POSITIVE LOGIC)



## SCHEMATIC OF INPUTS



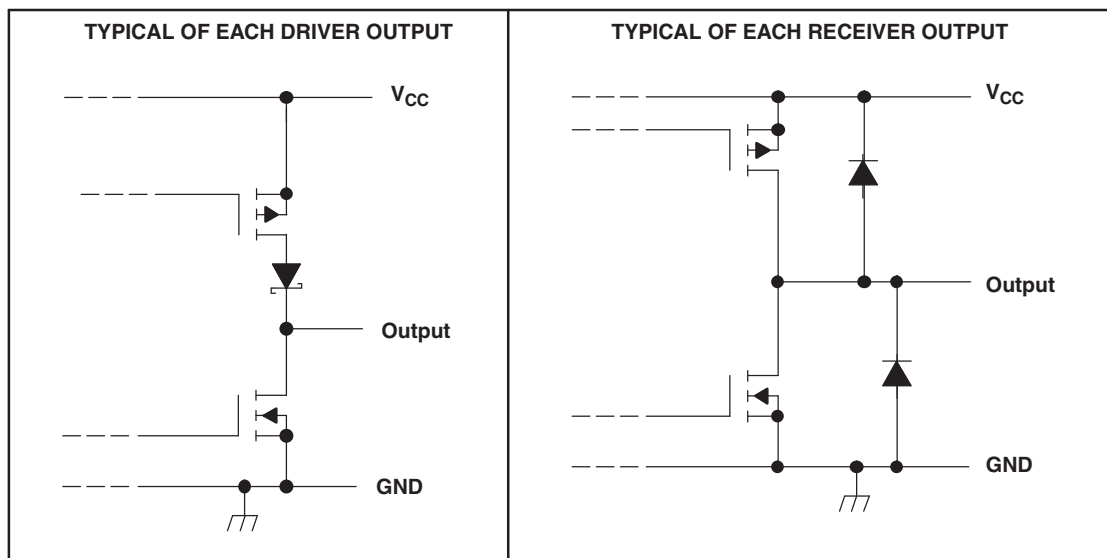
# SN65C1167E, SN65C1168E

## DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

### WITH $\pm 15$ -kV ESD PROTECTION

SLLS740A – MARCH 2007 – REVISED APRIL 2007

#### SCHEMATIC OF OUTPUTS



#### Absolute Maximum Ratings<sup>(1)</sup>

over recommended operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage range <sup>(2)</sup>	-0.5	7	V
$V_I$	Input voltage range	Driver, DE, RE	-0.5	7
		A or B, Receiver	-14	14
$V_{ID}$	Differential input voltage range <sup>(3)</sup>	Receiver	-14	14
$V_O$	Output voltage range	Driver	-0.5	7
		Receiver	-0.5	$V_{CC} + 0.5$
$I_{IK}$	Input clamp current range	Driver, $V_I < 0$	-20	mA
$I_{OK}$	Output clamp current range	Driver, $V_O < 0$	-20	mA
		Receiver	$\pm 20$	
$I_O$	Output current range	Driver	$\pm 150$	mA
		Receiver	$\pm 25$	
$I_{CC}$	Supply current range		200	mA
	GND current		-200	mA
$T_J$	Operating virtual junction temperature		150	$^{\circ}\text{C}$
$\theta_{JA}$	Package thermal impedance <sup>(4)(5)</sup>	NS package	64	$^{\circ}\text{C/W}$
		PW package	108	
		RGY package	39	
$T_A$	Operating free-air temperature range	-40	85	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature range	-65	150	$^{\circ}\text{C}$

- (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 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.
- (4) 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 $^{\circ}\text{C}$  can affect reliability.
- (5) 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 <sup>(1)</sup>	Receiver			$\pm 7$	V
$V_{ID}$	Differential input voltage	Receiver			$\pm 7$	V
$V_I$	Input voltage	Except A, B	0		5.5	V
$V_O$	Output voltage	Receiver	0		$V_{CC}$	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		–40		85	°C

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

# SN65C1167E, SN65C1168E

## DUAL DIFFERENTIAL DRIVERS AND RECEIVERS

### WITH $\pm 15$ -kV ESD PROTECTION

SLLS740A—MARCH 2007—REVISED APRIL 2007

## 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
$V_{IK}$ Input clamp voltage	$I_I = -18$ mA			-1.5	V
$V_{OH}$ High-level output voltage	$V_{IH} = 2$ V, $V_{IL} = 0.8$ V, $I_{OH} = -20$ mA	2.4	3.5		V
$V_{OL}$ Low-level output voltage	$V_{IH} = 2$ V, $V_{IL} = 0.8$ V, $I_{OL} = 20$ mA		0.2	0.4	V
$ V_{OD1} $ Differential output voltage 1	$I_O = 0$ mA	2		6	V
$ V_{OD2} $ Differential output voltage 2	$R_L = 100\ \Omega$ , See Figure 1 <sup>(2)</sup>	2	3.7		V
$\Delta V_{OB} $ Change in magnitude of differential output voltage	$R_L = 100\ \Omega$ , See Figure 1 <sup>(2)</sup>			$\pm 0.4$	V
$V_{OC}$ Common-mode output voltage	$R_L = 100\ \Omega$ , See Figure 1 <sup>(2)</sup>			$\pm 3$	V
$\Delta V_{OC} $ Change in magnitude of common-mode output voltage	$R_L = 100\ \Omega$ , See Figure 1 <sup>(2)</sup>			$\pm 0.4$	V
$I_{O(OFF)}$ Output current with power off	$V_{CC} = 0$ V	$V_O = 6$ V		100	$\mu$ A
		$V_O = -0.25$ V		100	
$I_{OZ}$ High-impedance-state output current	$V_O = 2.5$ V			20	$\mu$ A
	$V_O = 5$ V			-20	
$I_{IH}$ High-level input current	$V_I = V_{CC}$ or $V_{IH}$			1	$\mu$ A
$I_{IL}$ Low-level input current	$V_I = GND$ or $V_{IL}$			-1	$\mu$ A
$I_{OS}$ Short-circuit output current	$V_O = V_{CC}$ or $GND$ <sup>(3)</sup>	-30		-150	mA
$I_{CC}$ Supply current (total package)	No load, Enabled	$V_I = V_{CC}$ or $GND$		4	mA
		$V_I = 2.4$ or $0.5$ V <sup>(4)</sup>		5	
$C_i$ Input capacitance			6		pF

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

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

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

(4) This parameter is measured per input, while the other inputs are at  $V_{CC}$  or  $GND$ .

### 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
$t_{PHL}$ Propagation delay time, high- to low-level output	$R_1 = R_2 = 50\ \Omega$ , $R_3 = 500\ \Omega$ , $C_1 = C_2 = C_3 = 40$ pF, $S_1$ is open, See Figure 2		8	16	ns
$t_{PLH}$ Propagation delay time, low- to high-level output			8	16	ns
$t_{sk(p)}$ Pulse skew			1.5	4	ns
$t_r$ Rise time	$R_1 = R_2 = 50\ \Omega$ , $R_3 = 500\ \Omega$ , $C_1 = C_2 = C_3 = 40$ pF, $S_1$ is open, See Figure 3		5	10	ns
$t_f$ Fall time			5	10	ns
$t_{PZH}$ Output-enable time to high level	$R_1 = R_2 = 50\ \Omega$ , $R_3 = 500\ \Omega$ , $C_1 = C_2 = C_3 = 40$ pF, $S_1$ is closed, See Figure 4		10	19	ns
$t_{PZL}$ Output-enable time to low level			10	19	ns
$t_{PHZ}$ Output-disable time from high level	$R_1 = R_2 = 50\ \Omega$ , $R_3 = 500\ \Omega$ , $C_1 = C_2 = C_3 = 40$ pF, $S_1$ is closed, See Figure 4		7	16	ns
$t_{PLZ}$ Output-disable time from low level			7	16	ns

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

### ESD Protection

PARAMETER	TEST CONDITIONS	TYP	UNIT
Driver output	HBM	$\pm 15$	kV
	IEC 61000-4-2, Air-Gap Discharge	$\pm 8$	
	IEC 61000-4-2, Contact Discharge	$\pm 8$	

## 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
$V_{IT+}$	Positive-going input threshold voltage, differential input				0.2	V
$V_{IT-}$	Negative-going input threshold voltage, differential input		-0.2 <sup>(2)</sup>			V
$V_{hys}$	Input hysteresis ( $V_{IT+} - V_{IT-}$ )			60		mV
$V_{IK}$	Input clamp voltage, $\overline{RE}$	SN65C1167E $I_I = -18$ 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	SN65C1167E $V_O = V_{CC}$ 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, $\overline{RE}$	SN65C1167E $V_I = V_{CC}$ 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	mA
		$V_{IH} = 2.4$ V or 0.5 V <sup>(3)</sup>		5	9	

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

(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.

### Switching Characteristics<sup>(1)</sup>

over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
$t_{PLH}$	Propagation delay time, low- to high-level output	See Figure 5	9	15	27	ns
$t_{PHL}$	Propagation delay time, high- to low-level output	See Figure 5	9	15	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	SN65C1167E $R_L = 1$ k $\Omega$ , $C_L = 50$ pF See Figure 6		7	22	ns
$t_{PZL}$	Output-enable time to low level			7	22	ns
$t_{PHZ}$	Output-disable time from high level			12	22	ns
$t_{PLZ}$	Output-disable time from low level			12	22	ns

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

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

### ESD Protection

PARAMETER	TEST CONDITIONS	TYP	UNIT
Receiver input	HBM	$\pm 15$	kV
	IEC 61000-4-2, Air-Gap Discharge	$\pm 8$	
	IEC 61000-4-2, Contact Discharge	$\pm 8$	

## PARAMETER MEASUREMENT INFORMATION

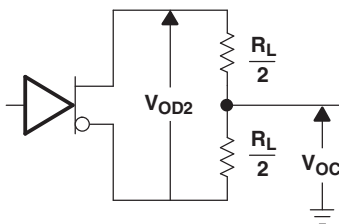
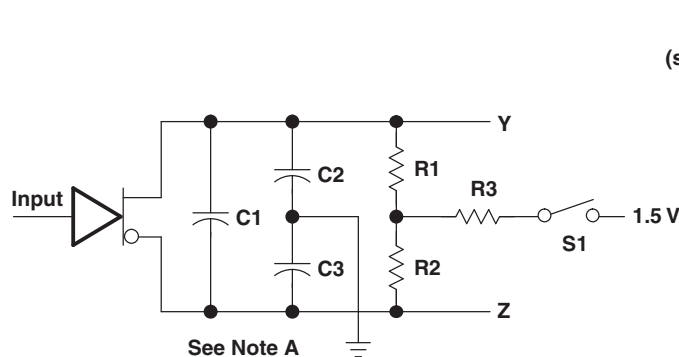
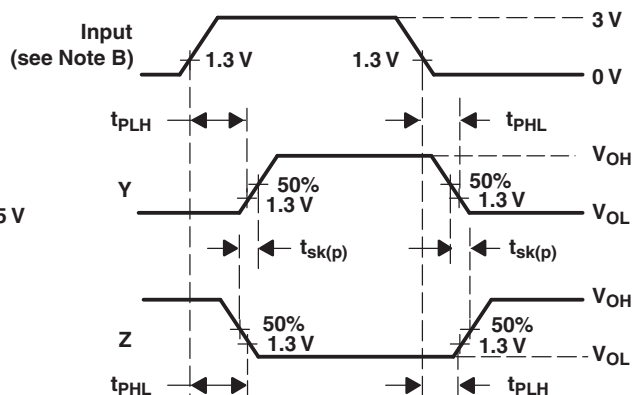


Figure 1. Driver Test Circuit,  $V_{OD}$  and  $V_{OC}$



TEST CIRCUIT

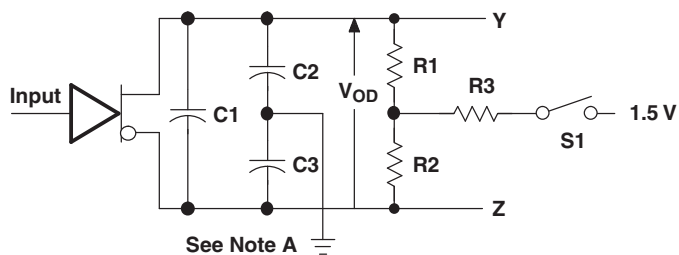


VOLTAGE WAVEFORMS

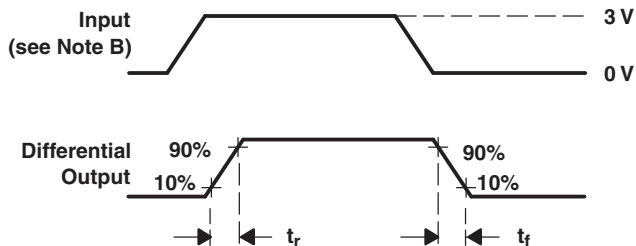
NOTES: A. C1, C2, and C3 include probe and jig capacitance.

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 2. Driver Test Circuit and Voltage Waveforms



TEST CIRCUIT



VOLTAGE WAVEFORMS

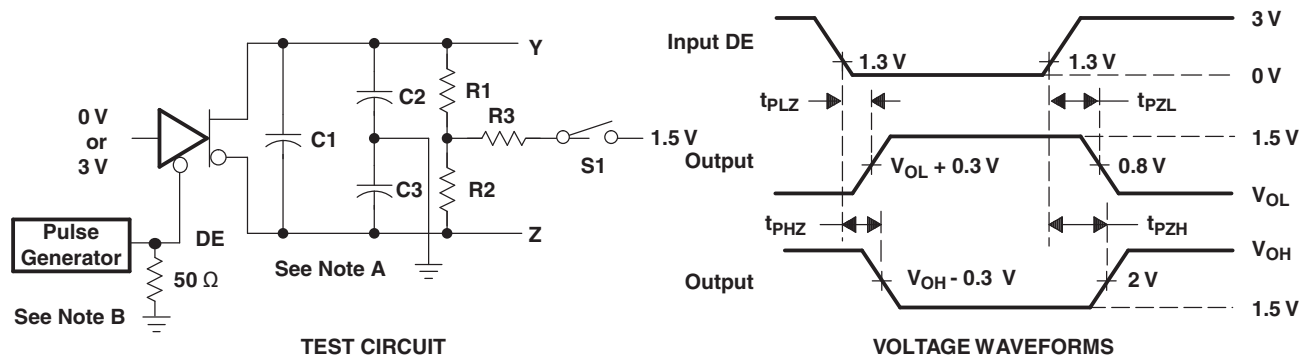
NOTES: A. C1, C2, and C3 include probe and jig capacitance.

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

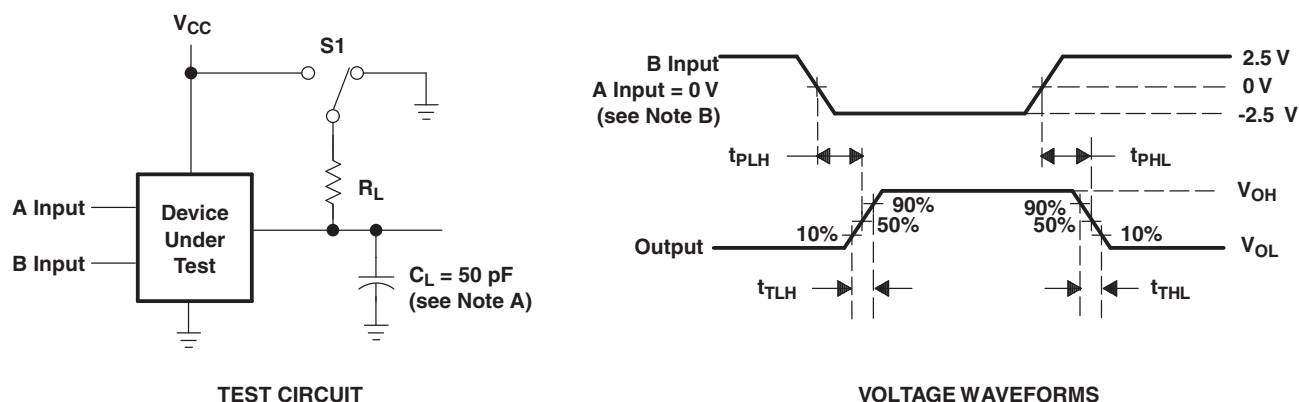


## PARAMETER MEASUREMENT INFORMATION (continued)



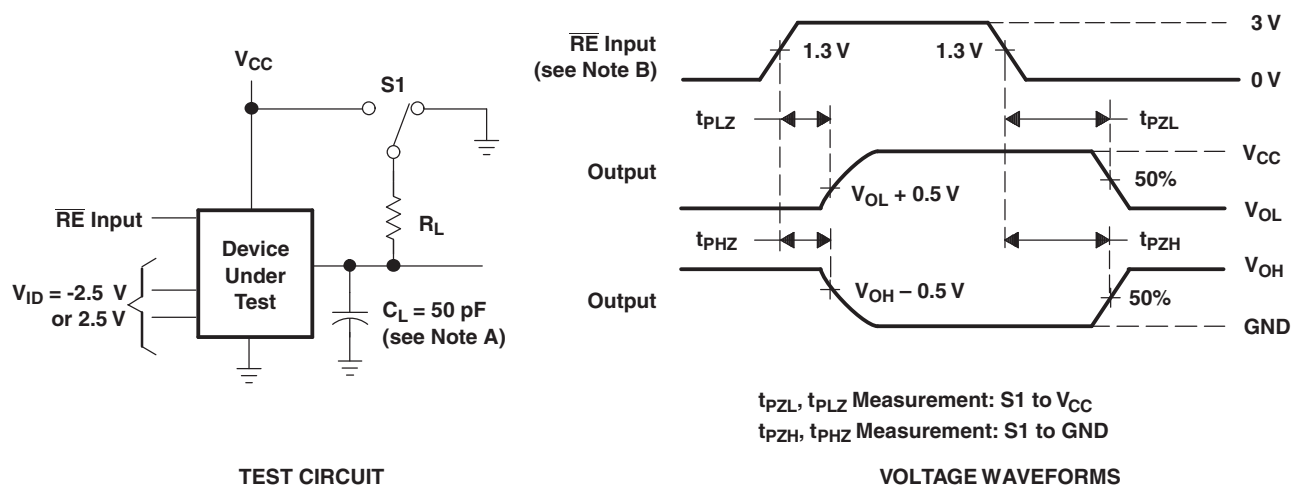
- NOTES: A. C1, C2, and C3 include probe and jig capacitance.  
B. The input pulse is supplied by a generator having the following characteristics: PRR = 1 MHz, duty cycle = 50%,  $t_r = t_f \leq 6$  ns.

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



- 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 6. Receiver Test Circuit and Voltage Waveforms

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN65C1167ENS	ACTIVE	SO	NS	16	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	65C1167E	<a href="#">Samples</a>
SN65C1167ENSG4	ACTIVE	SO	NS	16		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
SN65C1167ENSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	65C1167E	<a href="#">Samples</a>
SN65C1167ENSRG4	ACTIVE	SO	NS	16		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
SN65C1167EPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	CB1167E	<a href="#">Samples</a>
SN65C1167EPWG4	ACTIVE	TSSOP	PW	16		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
SN65C1167EPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	CB1167E	<a href="#">Samples</a>
SN65C1167EPWRG4	ACTIVE	TSSOP	PW	16		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
SN65C1167ERGYR	ACTIVE	VQFN	RGY	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	CB1167	<a href="#">Samples</a>
SN65C1167ERGYRG4	ACTIVE	VQFN	RGY	16		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
SN65C1168ENS	ACTIVE	SO	NS	16	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	65C1168E	<a href="#">Samples</a>
SN65C1168ENSG4	ACTIVE	SO	NS	16	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	65C1168E	<a href="#">Samples</a>
SN65C1168ENSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	65C1168E	<a href="#">Samples</a>
SN65C1168ENSRG4	ACTIVE	SO	NS	16		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
SN65C1168EPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	CB1168E	<a href="#">Samples</a>
SN65C1168EPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	CB1168E	<a href="#">Samples</a>
SN65C1168EPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	CB1168E	<a href="#">Samples</a>
SN65C1168EPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	CB1168E	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN65C1168ERGYR	ACTIVE	VQFN	RGY	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	CB1168	<a href="#">Samples</a>
SN65C1168ERGYRG4	ACTIVE	VQFN	RGY	16		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>

(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) 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)

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

**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**


\*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
SN65C1167ENSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
SN65C1167EPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
SN65C1167ERGYR	VQFN	RGY	16	3000	330.0	12.4	3.8	4.3	1.5	8.0	12.0	Q1
SN65C1168EPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
SN65C1168ERGYR	VQFN	RGY	16	3000	330.0	12.4	3.8	4.3	1.5	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)
SN65C1167ENSR	SO	NS	16	2000	367.0	367.0	38.0
SN65C1167EPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
SN65C1167ERGYR	VQFN	RGY	16	3000	367.0	367.0	35.0
SN65C1168EPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
SN65C1168ERGYR	VQFN	RGY	16	3000	367.0	367.0	35.0

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4040064-4/G 02/11

- 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. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4211284-3/F 12/12

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - 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 other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



RGY (R-PVQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD



4203539-3/I 06/2011

- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - This drawing is subject to change without notice.
  - QFN (Quad Flatpack No-Lead) package configuration.
  - The package thermal pad must be soldered to the board for thermal and mechanical performance.
  - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
- F** Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.
- Package complies to JEDEC MO-241 variation BA.

RGY (R-PVQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD

## 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 the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to 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, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. 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

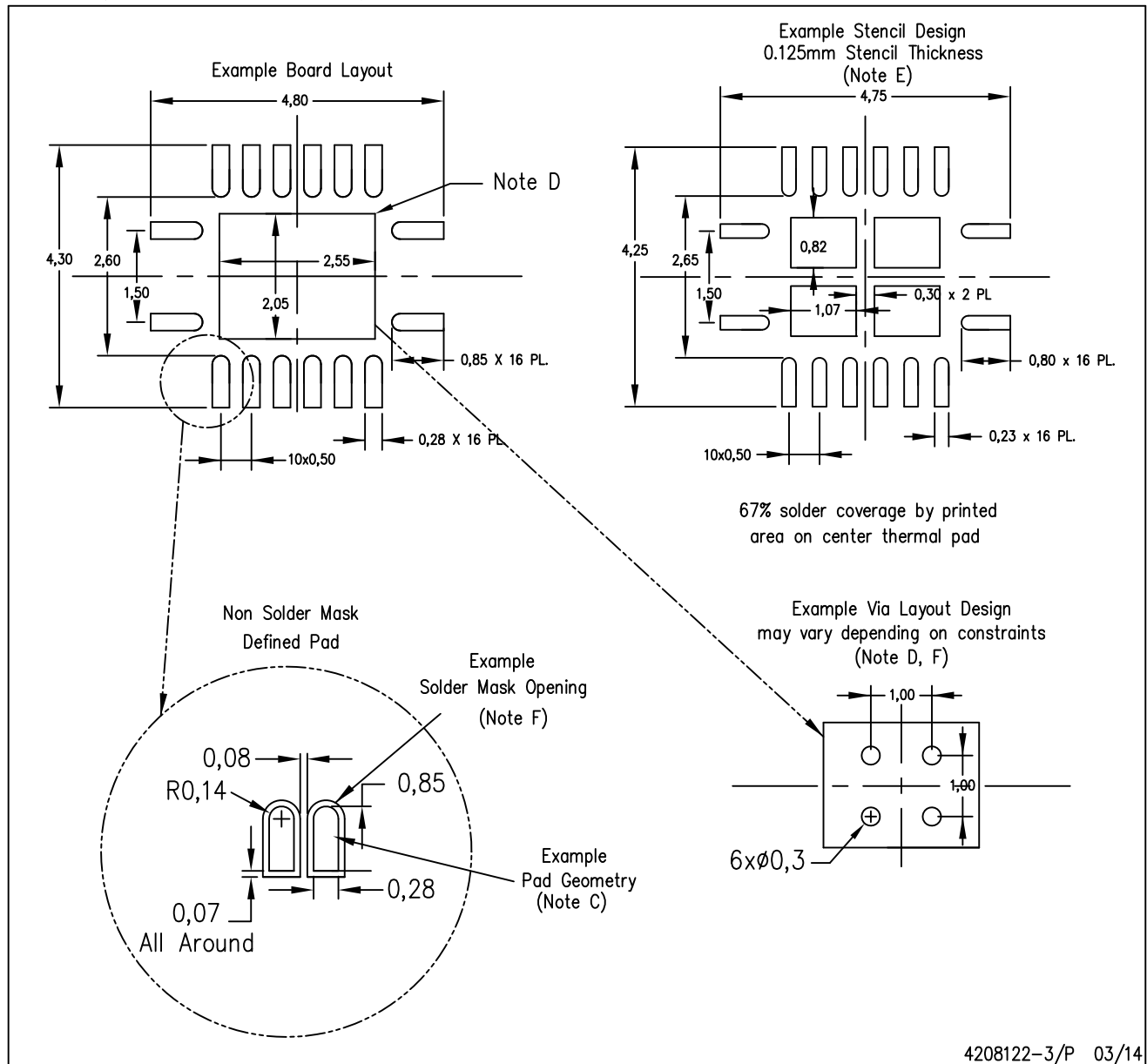
Exposed Thermal Pad Dimensions

4206353-3/P 03/14

NOTE: All linear dimensions are in millimeters

RGY (R-PVQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack QFN/SON PCB Attachment, Texas Instruments Literature No. 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>>.
  - 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.
  - Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.

# 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.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)