

TRF0208-SP Radiation-Hardness-Assured (RHA), Near-DC to 11GHz, Fully Differential **RF Amplifier**

1 Features

- Standard microcircuit drawing (SMD), 5962-24202
- Radiation:
 - Total ionizing dose (TID)
 - Radiation hardness assurance (RHA) up to 100krad (Si) TID
 - Enhanced low dose rate sensitivity (ELDRS) free process
 - High dose rate radiation lot acceptance testing (HDR RLAT) up to 100krad (Si) TID
 - Single event effects (SEE)
 - Single event latch-up (SEL) immune to linear energy transfer (LET) of 75MeV-cm²/mg
 - Single event transient (SET) characterized to LET of 75MeV-cm²/mg
- Space-grade QMLP
 - Lead-free construction
 - Extended temperature range: –55°C to +125°C
- Excellent performance driving RF ADCs
- Fixed power gain of 16dB in single-ended-todifferential mode
- Bandwidth: 11GHz, 3dB Gain flatness: 8GHz, 1dB
- OIP3: 36dBm (2GHz), 32dBm (6GHz)
- P1dB: 14.5dBm (2GHz), 11dBm (6GHz)
- NF: 6.8dB (2GHz), 6.8dB (6GHz)
- Gain and phase imbalance: ±0.3dB and ±3°
- Power-down feature
- Single-supply operation: 3.3V
- Active current: 138mA

2 Applications

- RF sampling or GSPS ADC driver
- Aerospace and defense

- Phased array radar
- Communications payload
- Radar imaging payload

3 Description

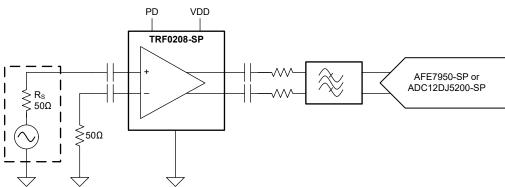
The TRF0208-SP is a very high performance fully differential amplifier (FDA) optimized for radio frequency (RF) applications. This device is excellent for ac-coupled applications that require a singleended to differential conversion when driving an analog-to-digital converter (ADC) such as the highperformance AFE7950-SP or ADC12DJ5200-SP. The on-chip matching components simplify printed circuit board (PCB) implementation and provide the highest performance over the usable bandwidth. The device is fabricated using TI's advanced complementary BiCMOS process, and available in a space-saving WQFN-FCRLF package.

The TRF0208-SP operates on a single-rail supply and consumes about 138mA of active current. A powerdown feature is available for power savings.

Device Information

PART NUMBER ⁽¹⁾	GRADE	BODY SIZE(2)
5962R2420201PXE	Flight-grade QMLP-RHA	2.00mm × 2.00mm
TRF0208RPVTSP/EM	Engineering samples ⁽³⁾	Mass = 7.558mg

- For more information, see Section 10.
- The body size (length × width) is a nominal value and does not include pins. Mass is a nominal value.
- These units are intended for engineering evaluation only. These samples are processed to a non-compliant flow. These units are not for qualification, production, radiation testing, or flight use. Parts are not warranted for performance over the full MIL specified temperature range, or operating life.



TRF0208-SP Driving a High-Speed ADC



Table of Contents

A - P. C. L. C. C.	16
2 Applications	. 10
3 Description	. 18
4 Pin Configuration and Functions 7.3 Power Supply Recommendations	.21
5 Specifications4 7.4 Layout4	. 21
5.1 Absolute Maximum Ratings	
5.2 ESD Ratings	
5.3 Recommended Operating Conditions4 8.2 Documentation Support	
5.4 Thermal Information	.22
5.5 Electrical Characteristics	
5.6 Typical Characteristics	
6 Detailed Description	
6.1 Overview	
6.2 Functional Block Diagram	
6.3 Feature Description	
6.4 Device Functional Modes	. 23

4 Pin Configuration and Functions

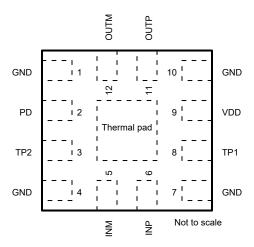


Figure 4-1. RPV Package, 12-Pin WQFN-FCRLF (Top View)

Table 4-1. Pin Functions

PIN	PIN		DESCRIPTION		
NAME	NO.	TYPE ⁽¹⁾	DESCRIPTION		
GND	1, 4, 7, 10	GND	Ground		
INM	5	I	Differential signal input, negative		
INP	6	I	differential signal input, positive		
OUTM	12	0	Differential signal output, negative		
OUTP	11	0	Differential signal output, positive		
PD	2	I	Power-down signal. Supports 1.8V and 3.3V logic. 0 = Chip enabled 1 = Power down		
TP1	8	_	Test pin. Short to ground.		
TP2	3	_	Test pin. Short to ground.		
VDD	9	Р	3.3V supply		
Thermal pad	Pad	_	Thermal pad. Connect to ground on board.		

(1) I = input, O = output, P = power, GND = ground



5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

		MIN	MAX	UNIT
V_{DD}	Supply voltage	-0.3	3.7	V
INP, INM	Input pin power		20 ⁽²⁾	dBm
V_{PD}	Power-down pin voltage	-0.3	3.7 ⁽³⁾	V
TJ	Junction temperature		150	°C
T _{stg}	Storage temperature	-65	150	°C

⁽¹⁾ Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

5.2 ESD Ratings

			VALUE	UNIT
V	Flectrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	±1000	V
V _(ESD)		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002, all pins ⁽²⁾	±250	v

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

5.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage	3.2	3.3	3.45	V
T _A	Ambient free-air temperature	– 55	25		°C
TJ	Junction temperature			125	°C

5.4 Thermal Information

		TRF0208-SP	
	THERMAL METRIC(1)	RPV (WQFN-FCRLF)	UNIT
		12 PINS	
R _{0JA}	Junction-to-ambient thermal resistance	66.9	°C/W
R _{0JC(top)}	Junction-to-case (top) thermal resistance	64.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	17.4	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	1.7	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	17.2	°C/W
R _{0JC(bot)}	Junction-to-case (bottom) thermal resistance	9.0	°C/W

For more information about traditional and new thermal metrics, see the <u>Semiconductor and IC Package Thermal Metrics</u> application report.

Product Folder Links: TRF0208-SP

⁽²⁾ When $V_{DD} = 0V$, maximum value is 0dBm.

⁽³⁾ When $V_{DD} = 0V$, maximum value is 0.3V

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



5.5 Electrical Characteristics

at T_A = 25°C, V_{DD} = 3.3V, 50Ω single-ended input, and 100Ω differential output (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT				
AC PERF	ORMANCE									
SSBW	Small-signal 3dB bandwidth	$V_O = 0.1V_{PP}$		11		GHz				
LSBW	Large-signal 3dB bandwidth	V _O = 1V _{PP}		11		GHz				
1dB BW	Bandwidth for 1dB flatness			8		GHz				
S21	Power gain	f = 2GHz		16		dB				
S11	Input return loss	f = 10MHz to 8GHz		-10		dB				
S12	Reverse isolation	f = 2GHz		-35		dB				
Imb _{GAIN}	Gain imbalance	f = 10MHz to 8GHz		± 0.3		dB				
Imb _{PHASE}	Phase imbalance	f = 10MHz to 8GHz		± 3		degrees				
CMRR	Common-mode rejection ratio ⁽¹⁾	f = 2GHz		-45		dB				
		f = 0.5GHz, P _O = 3dBm		-70						
		f = 2GHz, P _O = 3dBm		-65		dBc				
HD2	Second-order harmonic distortion	f = 6GHz, P _O = 3dBm		-52		aBc				
		f = 8GHz, P _O = 3dBm		-50						
		f = 0.5GHz, P _O = 3dBm		-68						
HD3	Third-order harmonic distortion	f = 2GHz, P _O = 3dBm		-63		dBc				
		f = 6GHz, P _O = 3dBm		-54						
		f = 8GHz, P _O = 3dBm		-60						
	Second-order intermodulation distortion	f = 0.5GHz, P _O = -4dBm per tone (10MHz spacing)		-72						
		f = 2GHz, P _O = -4dBm per tone (10MHz spacing)		-64		dBc				
IMD2		f = 6GHz, P _O = -4dBm per tone (10MHz spacing)		-54						
		f = 8GHz, P _O = -4dBm per tone (10MHz spacing)		-48		_				
		f = 0.5GHz, P _O = -4dBm per tone (10MHz spacing)		–77						
	Third-order intermodulation distortion	f = 2GHz, P _O = -4dBm per tone (10MHz spacing)		-80		dBc				
IMD3		f = 6GHz, P _O = -4dBm per tone (10MHz spacing)		-70						
		f = 8GHz, P _O = -4dBm per tone (10MHz spacing)		-48		-				
		f = 0.5GHz		11						
00440	Output 1 dDion noint	f = 2GHz		14.5		al Duna				
OP1dB	Output 1dB compression point	f = 6GHz		11		dBm				
		f = 8GHz		7.5		\dashv				
		f = 0.5GHz, P _o = –4dBm per tone (10MHz spacing)		68						
OUDG		f = 2GHz, P _o = -4dBm per tone (10MHz spacing)		60						
OIP2	Output second-order intercept point	f = 6GHz, P _o = -4dBm per tone (10MHz spacing)		50		dBm				
		f = 8GHz, P _o = –4dBm per tone (10MHz spacing)		45						

5.5 Electrical Characteristics (continued)

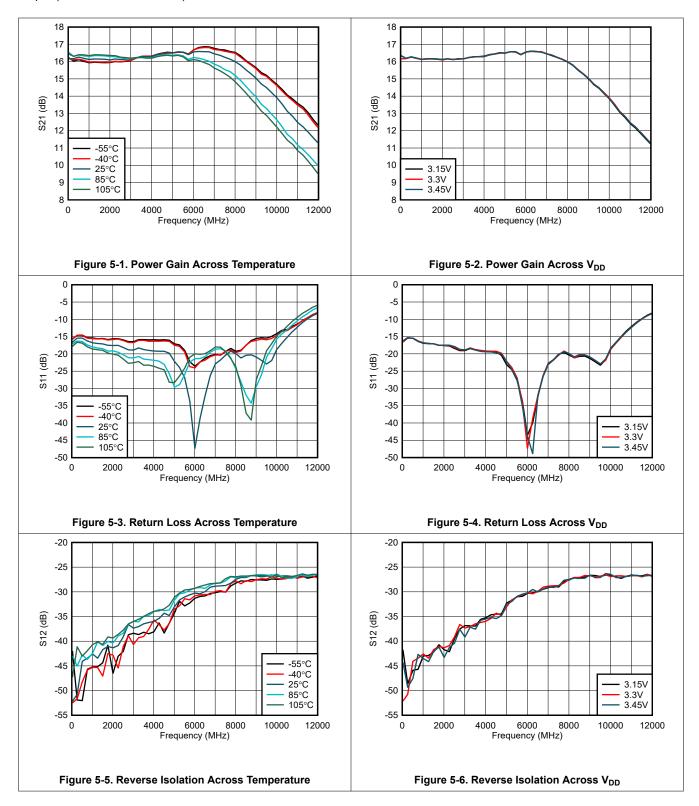
at T_A = 25°C, V_{DD} = 3.3V, 50Ω single-ended input, and 100Ω differential output (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN TYP	MAX	UNIT		
		f = 0.5GHz, P _o = -4dBm per tone (10MHz spacing)	34				
		f = 2GHz, P _o = –4dBm per tone (10MHz spacing)	36				
OIP3	Output third-order intercept point	f = 4GHz, P _o = –4dBm per tone (10MHz spacing)	35		dBm		
		$f = 6GHz$, $P_o = -4dBm$ per tone (10MHz spacing)	32				
		$f = 8GHz$, $P_0 = -4dBm$ per tone (10MHz spacing)	21	21			
		f = 0.5GHz	6.5				
NF	Noise Eigure	f = 2GHz	6.8		dВ		
INF	Noise Figure	f = 6GHz	6.8		dB		
		f = 8GHz	8.5				
IMPEDAI	NCE						
Z_{O-DIFF}	Differential output impedance	f = dc (internal to the device)	3		Ω		
Z _{IN}	Single-ended input impedance	INM pin terminated with 50Ω	50		Ω		
TRANSIE	ENT						
V_{OMAX}	Maximum output voltage (differential)		2		V_{PP}		
V _{OSAT}	Output saturated voltage level (differential)	f = 2GHz	3.9		V_{PP}		
t _{REC}	Overdrive recovery time	Using a –0.5V _P input pulse of 2ns duration	0.2		ns		
POWER	SUPPLY						
I _{QA}	Active current	Current on V _{DD} pin, PD = 0	138		mA		
I _{QPD}	Power-down quiescent current	Current on V _{DD} pin, PD = 1	7		mA		
ENABLE							
V_{PDHIGH}	PD pin logic high		1.45		V		
V_{PDLOW}	PD pin logic low		0.8		V		
1	PD bias current (current on PD pin)	PD = high (1.8V logic)	50	100	пΔ		
I _{PDBIAS}	pill)	PD = high (3.3V logic)	200	250	μA 50		
C _{PD}	PD pin capacitance		2		pF		
t _{ON}	Turn-on time	50% V _{PD} to 90% RF	200		ns		
t _{OFF}	Turn-off time	50% V _{PD} to 10% RF	50		ns		

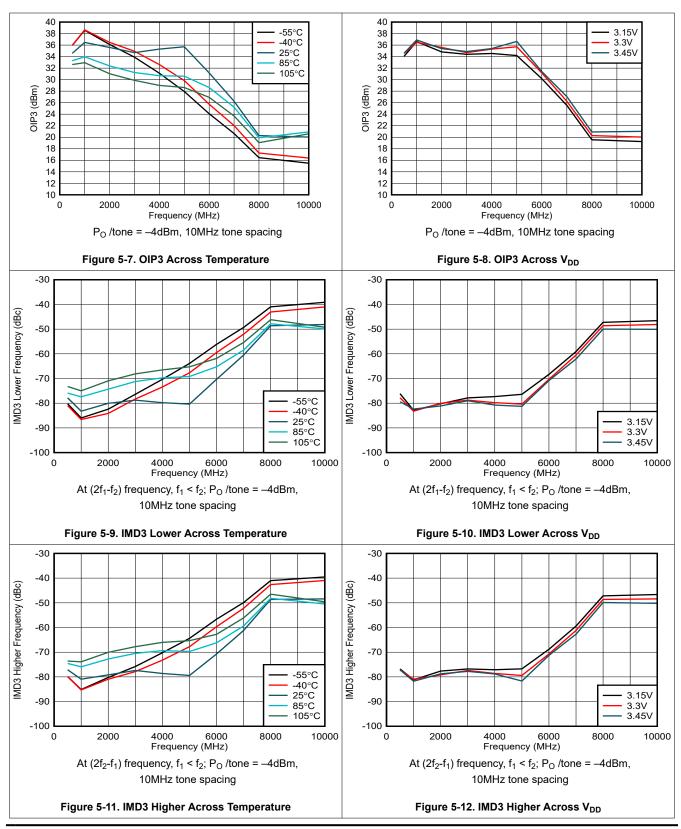
⁽¹⁾ Calculated using the formula (S21–S31)/(S21+S31). Port-1: INP, Port-2: OUTP, Port-3: OUTM.

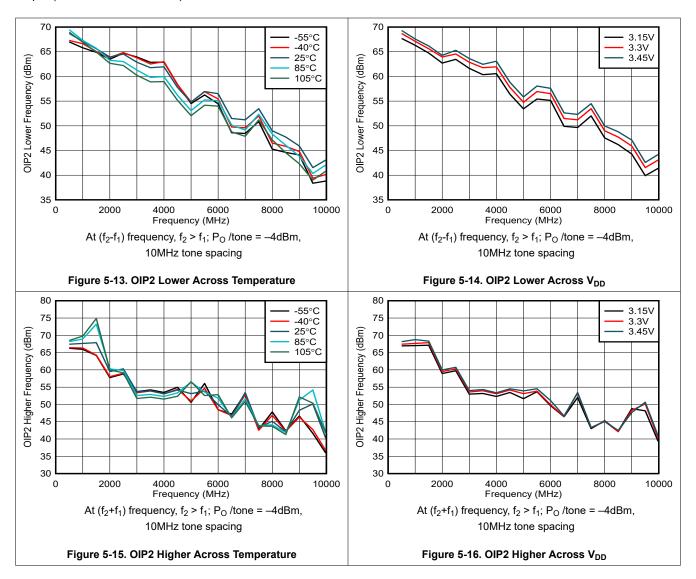
Product Folder Links: TRF0208-SP

5.6 Typical Characteristics



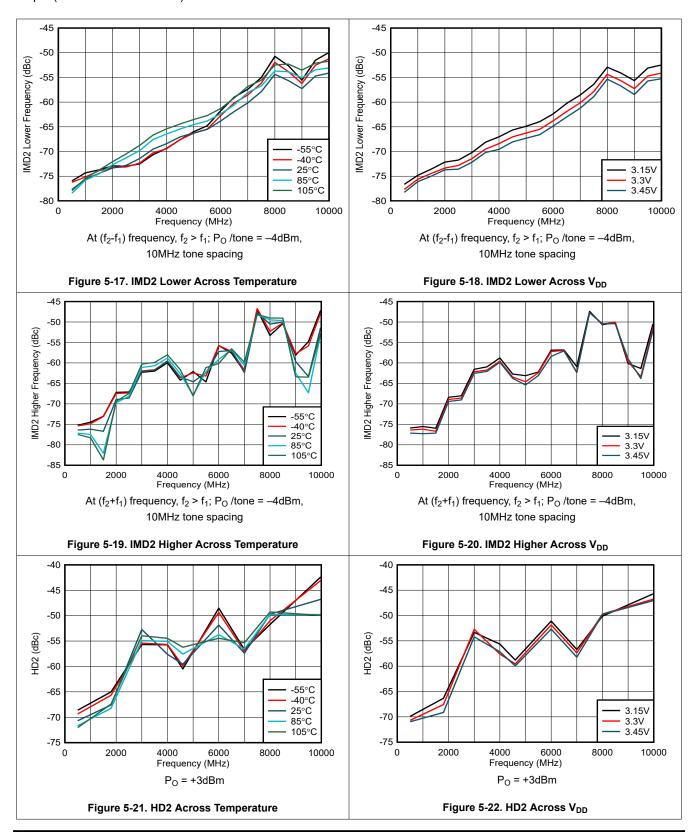






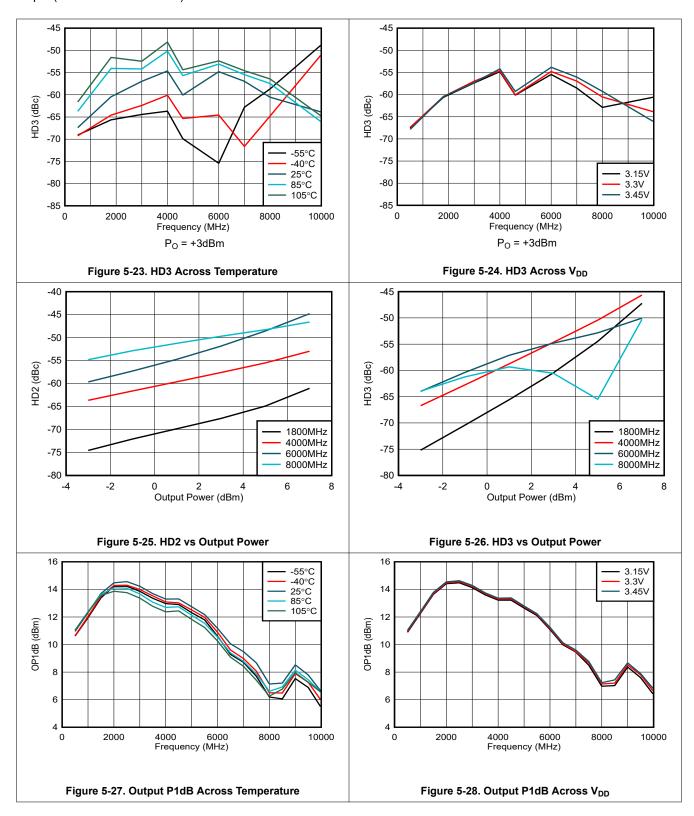


at T_A = 25°C, temperature curves specify ambient temperature, V_{DD} = 3.3V, 50Ω single-ended input, and 100Ω differential output (unless otherwise noted)



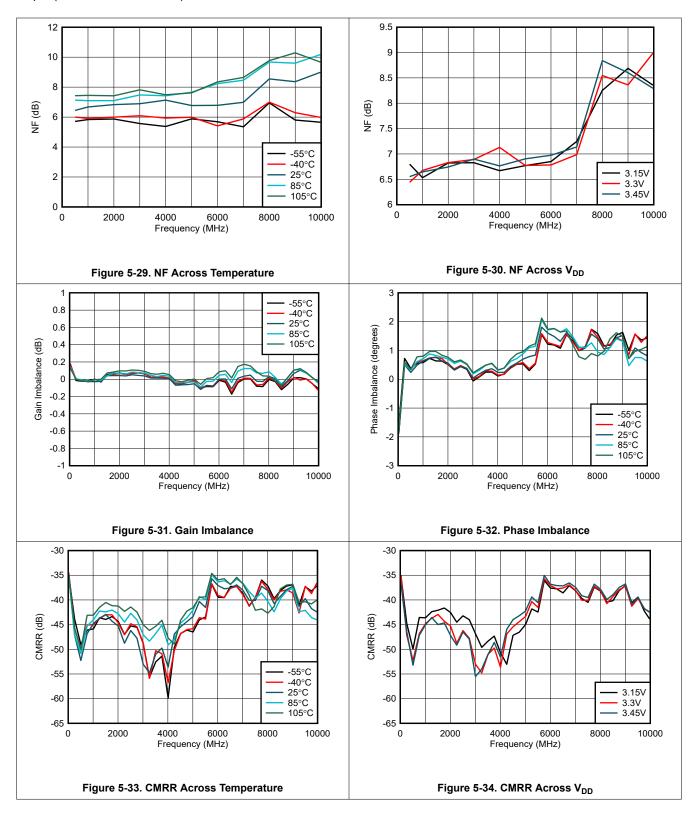
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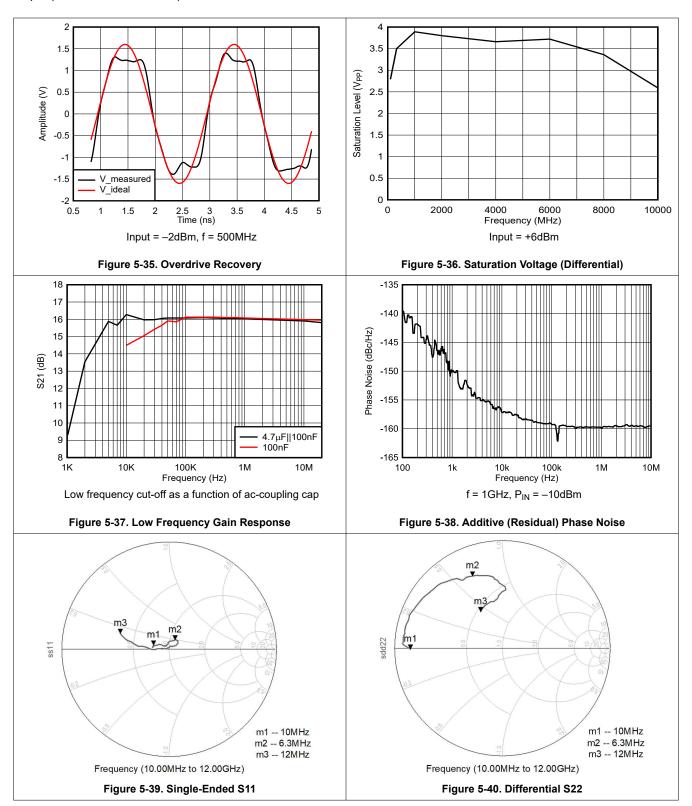


at T_A = 25°C, temperature curves specify ambient temperature, V_{DD} = 3.3V, 50Ω single-ended input, and 100Ω differential output (unless otherwise noted)



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6 Detailed Description

6.1 Overview

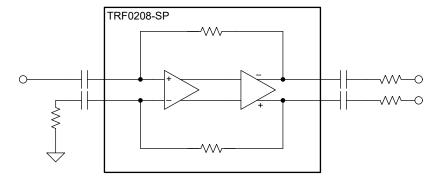
The TRF0208-SP is a very high-performance amplifier optimized for radio frequency (RF) and intermediate frequency (IF) with signal bandwidths up to 11GHz. The device is designed for ac-coupled applications that require a single-ended-to-differential conversion when driving an analog-to-digital converter (ADC). The low frequency response is limited only by the ac-coupling capacitor on the PCB. If the lowest signal frequency is >100KHz, use 100nF ac-coupling capacitors. If the lowest signal frequency is 9kHz, use a 4.7μ F capacitor in parallel with 100nF capacitor on each input-output pin. The device has a two-stage architecture and provides approximately 16dB of gain in single-ended-to-differential mode, when driving a differential 100Ω load for single-ended inputs driven from a 50Ω source. This device also works as a fully-differential amplifier.

This device does not require any pullup or pulldown components on the PCB, and thereby simplifies the layout and provides the highest performance over the entire bandwidth.

The input and output are ac coupled. The TRF0208-SP is powered with 3.3V supply. A power-down feature is also available.

6.2 Functional Block Diagram

The following figure shows the functional block diagram of TRF0208-SP. The device essentially has two stages with a voltage-feedback configuration.



Product Folder Links: TRF0208-SP

6.3 Feature Description

6.3.1 Fully-Differential Amplifier

The TRF0208-SP is a voltage-feedback fully differential amplifier (FDA) with a fixed gain by architecture. The TRF0208-SP operates as a single-ended to differential amplifier by terminating the INM pin with a 50Ω resistor and driving the INP pin directly with no external components.

This amplifier has nonlinearity cancellation circuits that provide excellent linearity performance over a wide range of frequencies.

The output of the amplifier has a low dc impedance. Therefore, if required, the output of the amplifier can be matched to a load by adding the appropriate series resistors or attenuator pad.

6.3.2 Single Supply Operation

The TRF0208-SP operates on a single 3.3V supply. The input and output bias voltages are set internally. Therefore, ac-couple the signal path on the board at all four RF input and output pins. Single-supply operation simplifies the board design.

6.4 Device Functional Modes

TRF0208-SP has two functional modes: active and power-down. The functional modes are controlled by the PD pin as described below.

6.4.1 Power Down Mode

The device features a power-down option. The PD pin is used to power down the amplifier. This pin supports both 1.8V and 3.3V digital logic, and is referenced to ground. A logic 1 turns the device off and places the device into a low-quiescent-current state.

When disabled, the signal path is still present through the internal circuits. Input signals applied to a disabled device still appear at the outputs at a lower level through this path, as is the case for any disabled feedback amplifier.

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7 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, as well as validating and testing their design implementation to confirm system functionality.

7.1 Application Information

7.1.1 Driving a High-Speed ADC

A common application for the TRF0208-SP is driving a high-speed ADC that has a differential input (such as the ADC12DJ5200-SP or AFE7950-SP). Conventionally passive baluns are used to drive giga-samples-per-second (GSPS) ADCs as a result of the low availability of high-bandwidth, linear amplifiers. The TRF0208-SP is typically configured as a single-ended to differential (S2D) RF amplifier that has excellent bandwidth flatness, gain, and phase imbalance comparable to or exceeding costly passive RF baluns.

Figure 7-1 shows a typical interface circuit for ADC12DJ5200-SP. Depending on the ADC and system requirement, this circuit can be simplified or can be more complex.

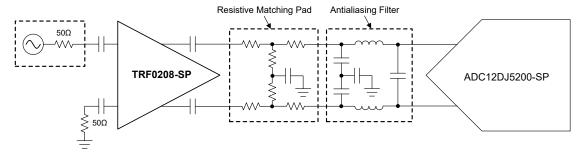
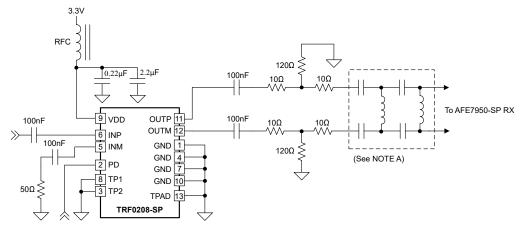


Figure 7-1. Interfacing With the ADC12DJ5200-SP

Figure 7-1 shows two sections of the circuit between the driver amp and the ADC: namely, the matching pad (or attenuator pad) and the antialiasing filter. Use small-form-factor, RF-quality, passive components for these circuits. The output swing of the TRF0208-SP is designed to drive these ADCs full-scale, while at the same time not overdrive the ADC. This functionality avoids the need for any voltage limiting device at the ADC.

Figure 7-2 shows a typical interface circuit for the AFE7950-SP, where the TRF0208-SP is the S2D amplifier.



A. AFE matching network – component type (L or C) and values depend on channel (A, B, C, D, FB1, and FB2) and frequency band.

Figure 7-2. Interfacing With the AFE7950-SP

Product Folder Links: TRF0208-SP

7.1.2 Calculating Output Voltage Swing

This section gives a quick reference of the output voltage swings for different input power levels. In this example, the output is terminated with a 100Ω differential load and a power gain of 16dB is assumed.

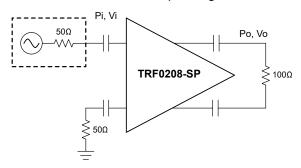


Figure 7-3. Power and Voltage Levels

$$Voltage gain = 20 \times log(V_O / V_I)$$
 (1)

Power gain =
$$10 \times \log(P_O / P_I) = 10 \times \log((V_O^2 / 100) / (V_I^2 / 50)) = 20 \times \log(V_O / V_I) - 3dB$$
 (2)

Table 7-1. Output Voltage Swings for Different Input Power Levels

INF	PUT	OUTPUT (TRF0208-SP)			
P _I (dBm ₅₀)	V _I (V _{PP})	P _O (dBm ₁₀₀)	V _O (V _{PP})		
-20	0.063	-4	0.564		
–15	0.112	1	1.004		
-10	0.2	6	1.785		
-9	0.224	7	2.002		

7.1.3 Thermal Considerations

The TRF0208-SP is available in a 2mm × 2mm, WQFN-FCRLF package that has excellent thermal properties. Connect the thermal pad underneath the chip to a ground plane. Short the ground plane to the other ground pins of the chip at four corners, if possible, to allow heat propagation to the top layer of PCB. Use a thermal via that connects the thermal pad plane on the top layer of the PCB to the inner layer ground planes to allow heat propagation to the inner layers.

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7.2 Typical Applications

An example of the TRF0208-SP acting as an S2D amplifier for the AFE7950-SP is explained in this section.

7.2.1 TRF0208-SP in Receive Chain

This section describes an RF receiver chain in which the TRF0208-SP operates as a single-ended-to-differential (S2D) amplifier and drives a receive channel of AFE7950-SP.

Figure 7-4 shows a generic schematic of a design in which TRF0208-SP drives an AFE7950-SP receive channel. The exact values of the components depend on the frequency band for which the AFE7950-SP front-end is matched.

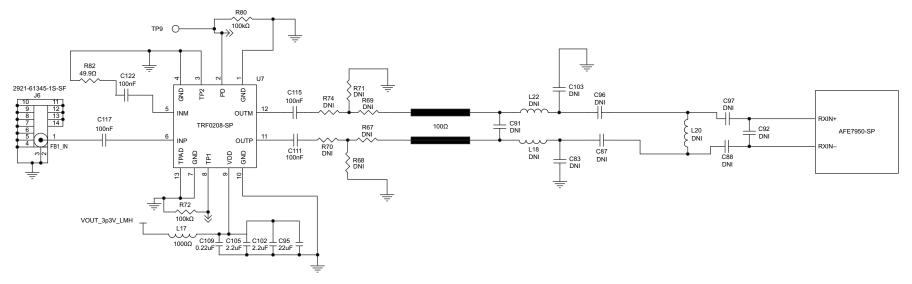


Figure 7-4. TRF0208-SP in a Receive Chain With the AFE7950-SP

7.2.1.1 Design Requirements

The AFE7950-SP channel is required to be matched to 2.3GHz.

7.2.1.2 Detailed Design Procedure

The TRF0208-SP is configured as an S2D amplifier. The section close to TRF0208-SP output is an attenuator pad that is meant for robust matching. The section close to the AFE7950-SP is the matching network for the AFE7950-SP ADC input that is channel dependent. The matching components are chosen based on the AFE7950-SP return-loss data and some final optimization because the manufactured board parameters can influence the exact component values needed.

Table 7-2 shows the bill of materials (BOM) values of the design for RXA channel that is matched to center frequency of 2.3GHz.

Table 7-2. Component Values of RX Chain With Center Frequency = 2.3GHz

SECTION	DESIGNATOR	TYPE	VALUE	INSTALL OR DO NOT INSTALL
DC block cap	C117	Capacitor	100nF	Install
DC block cap	C115	Capacitor	100nF	Install
DC block cap	C111	Capacitor	100nF	Install
DC block cap	C122	Capacitor	100nF	Install
INM term	R82	Resistor	50Ω	Install
Attenuator	R74	Resistor	10Ω	Install
Attenuator	R70	Resistor	10Ω	Install
Attenuator	R69	Resistor	10Ω	Install
Attenuator	R67	Resistor	10Ω	Install
Attenuator	R71	Resistor	120Ω	Install
Attenuator	R68	Resistor	120Ω	Install
Matching	C91	_	_	Do not install
Matching	C103	_	_	Do not install
Matching	C83	_	_	Do not install
Matching	L22	Inductor	0.1nH	Install
Matching	L18	Inductor	0.1nH	Install
Matching	C96	Inductor	0.1nH	Install
Matching	C87	Inductor	0.1nH	Install
Matching	L20	Inductor	5.6nH	Install
Matching	C97	Capacitor	3.9pF	Install
Matching	C88	Capacitor	3.9pF	Install
Matching	C92	_	_	Do not install



7.2.1.3 Application Curve

Figure 7-5 shows the in-band output response for the design in the previous section. The response is measured with an input power of –30dBm at the input of TRF0208-SP.

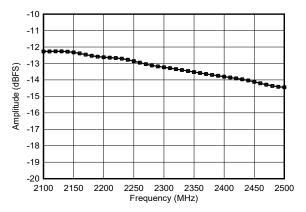


Figure 7-5. In-Band Output Response

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7.3 Power Supply Recommendations

The TRF0208-SP requires a single 3.3V supply. Supply decoupling is critical to high-frequency performance. Typically two or three capacitors are used for supply decoupling. For the lowest-value capacitor, use a small, form-factor component that is placed closest to the V_{DD} pin of the device. Use a bulk decoupling capacitor of a larger value and size that can be placed next to the small capacitor. See also Section 7.4.

7.4 Layout

7.4.1 Layout Guidelines

TRF0208-SP is a wide-band, voltage-feedback amplifier with approximately 16dB of gain. When designing with a wide-band RF amplifier with relatively high gain, take precautions with board layout to maintain stability and optimized performance. Use a multilayer board to maintain signal and power integrity and thermal performance. Figure 7-6 shows an example of a good layout. This figure shows only the top layer.

Route the RF input and output lines as grounded coplanar waveguide (GCPW) lines. For the second layer, use a continuous ground layer without any ground-cuts near the amplifier area. Match the output differential lines in length to minimize phase imbalance. Use small-footprint passive components wherever possible. Also take care of the input side layout. Use a 50Ω line for the INP routing, and maintain that the termination on INM pin has low parasitics by placing the ac-coupling capacitor and the 50Ω resistor very close to the device. Use an RF-quality, 50Ω resistor for termination. Maintain that the ground planes on the top and internal layers are well stitched with vias.

Place thermal vias under the device that connect the top thermal pad with ground planes in the inner layers of the PCB. For improved heat dissipation, connect the thermal pad to the top-layer ground plane through the ground pins (see also Section 7.4.2).

7.4.2 Layout Example

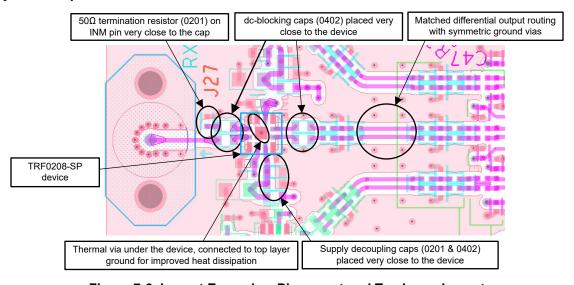


Figure 7-6. Layout Example – Placement and Top Layer Layout

The TRF0208-SP device can be evaluated using the TRF0208-SP EVM board. Additional information about the evaluation board construction and test setup is given in the *TRF0208SEP/SP EVM* user's guide.

8 Device and Documentation Support

8.1 Device Support

8.1.1 Third-Party Products Disclaimer

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8.2 Documentation Support

8.2.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, TRF0208SEP/SP EVM User's Guide
- Texas Instruments, TRF0208-SP Total Ionizing Dose (TID) Report
- Texas Instruments, TRF0208-SP Single-Event Effects Test Report

8.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* 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.

8.4 Support Resources

TI E2E[™] support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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8.5 Trademarks

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8.6 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

8.7 Glossary

TI Glossary

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

9 Revision History

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

Product Folder Links: TRF0208-SP



10 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.

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
5962R2420201PXE	Active	Production	WQFN-HR (RPV) 12	250 SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	202
TRF0208RPVTSP/EM	Active	Production	WQFN-HR (RPV) 12	250 SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	25 to 25	202

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

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.

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⁽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.

PACKAGE MATERIALS INFORMATION

www.ti.com 25-Nov-2025

TAPE AND REEL INFORMATION





	Dimension designed to accommodate the component width
В0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TRF0208RPVTSP/EM	WQFN- HR	RPV	12	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2

PACKAGE MATERIALS INFORMATION

www.ti.com 25-Nov-2025

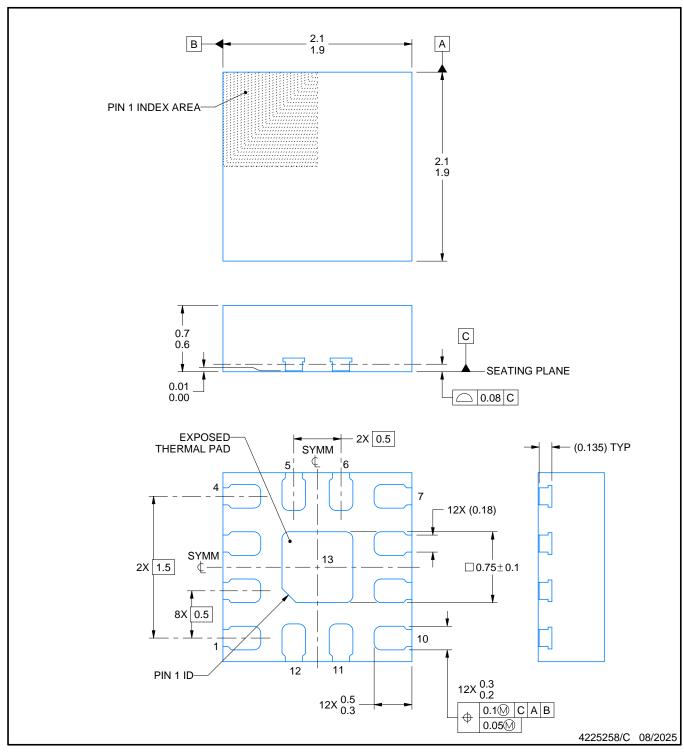


*All dimensions are nominal

Ì	Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)	
ı	TRF0208RPVTSP/EM	WQFN-HR	RPV	12	250	210.0	185.0	35.0	



PLASTIC QUAD FLATPACK - NO LEAD

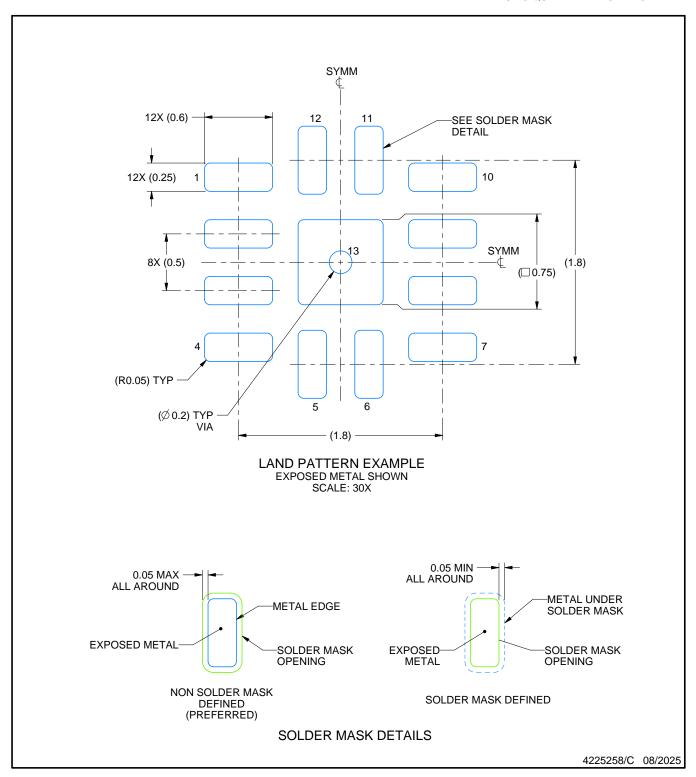


NOTES:

- 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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



PLASTIC QUAD FLATPACK - NO LEAD

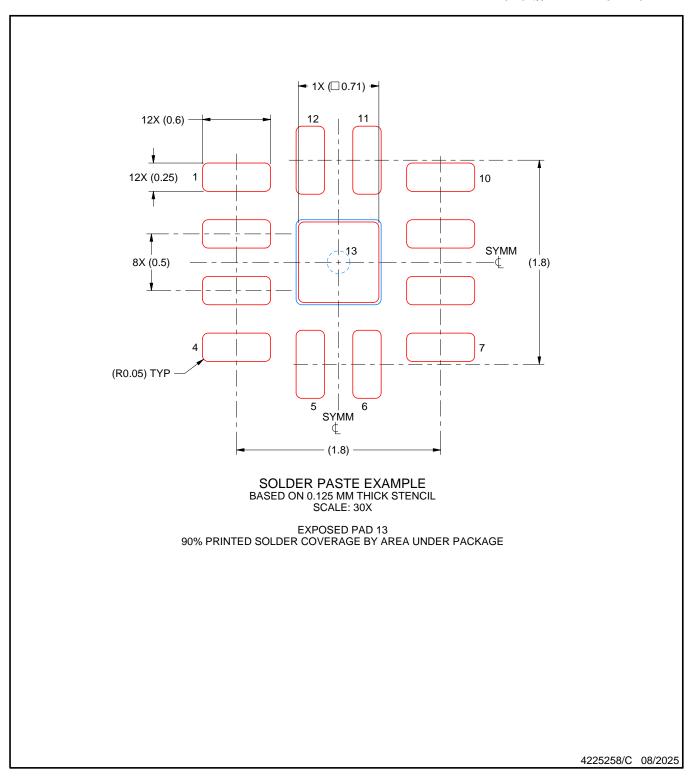


NOTES: (continued)

- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
- 5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

^{6.} Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



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