

TRF0206-SP シングル・チャネル、10MHz ~ 6.5GHz、3dB BW、ADC ドライバ・アンプ

1 特長

- QMLV (QML Class V) MIL-PRF-38535 認定済み、SMD 5962R2122001VXC
 - 吸収線量 (TID) 100krad (Si) までの放射線耐性保証 (RHA)
 - 単一イベント・ラッチアップ (SEL) 耐性: LET = 75MeV-cm²/mg
- 防衛用温度範囲: -55°C ~ +125°C、全体で認定済み
- シングルエンドから差動への変換において ADC ドライバとして優れた性能
- 差動からシングルエンド・モードで動作し、DAC バッファとして機能する
- 3dB の帯域幅: 6.5GHz
- 1dB のゲイン・フラットネス: 4.8GHz
- シングルエンドから差動への固定電力ゲイン: 12.5dB
- OIP3 性能:
 - 2GHz で 38dBm
 - 6GHz で 32dBm
- P1dB 性能:
 - 2GHz で 12dBm
 - 6GHz で 10dBm
- ノイズ指数:
 - 2GHz 時に 8dB
 - 6GHz 時に 9dB
- ゲイン不平衡および位相不平衡: ±0.4dB および ±3°
- パワーダウソ機能
- 単一電源動作: 3.3V
- 動作電流: 130mA

2 アプリケーション

- RF サンプリグまたは GSPS ADC ドライバ
- 航空宇宙および防衛
- 高速デジタイザ
- レーダー画像処理ペイロード
- コマソとデータの処理系 (C&DH 系)
- 通信ペイロード

3 概要

TRF0206-SP は、耐放射線特性を備えた非常に高性能な高周波 (RF) アンプで、RF アプリケーション用に最適化されています。このデバイスは、高性能 ADC12DJ3200QML-SP などの A/D コンバータ (ADC) を駆動する際に、シングルエンドから差動形式への変換を必要とする AC 結合アプリケーションに最適です。オンチップのマッチング部品により、プリント基板 (PCB) の実装が簡素化され、使用可能な帯域幅全体にわたって最高の性能を実現できます。このデバイスは、テキサス・インスツルメンツの先進的な相補型 BiCMOS プロセスで製造され、宇宙環境でも使用できる LCCC パッケージで供給されます。

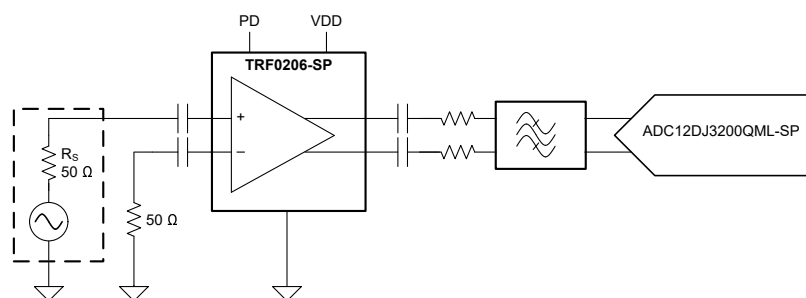
このデバイスは、3.3V の単一電源で動作します。パワーダウソ機能を利用して、消費電力を削減することが可能です。

製品情報

部品番号 ⁽¹⁾	グレード	本体サイズ ⁽²⁾
5962R2122001VXC	QMLV-RHA	FFM (LCCC、12 ピン) 6.2mm × 6.1mm
TRF0206FFM/EM	エンジニアリング・サンプル ⁽³⁾	
TRF0206EVM	セラミック評価ボード	—

- (1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。
- (2) 本体サイズ (長さ × 幅) は公称値であり、ピンは含まれていません。
- (3) これらのユニットは、技術的な評価のみを目的としています。これらのサンプルは、標準とは異なるフローに従って処理されています。これらのユニットは、認定、量産、放射線テスト、航空での使用には適していません。部品は、MIL に規定されている温度範囲全体にわたる性能も動作寿命全体にわたる性能も保証されていません。





TRF0206-SP で高速 ADC を駆動

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4 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision A (December 2022) to Revision B (August 2023)	Page
• 「製品情報」表に新しい注文用部品番号を追加	1
Changes from Revision * (November 2022) to Revision A (December 2022)	Page
• ドキュメントのステータスを「事前情報」から「量産データ」へ	1

5 Pin Configuration and Functions

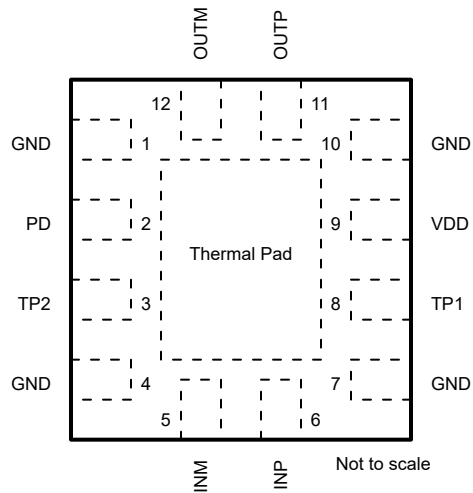


图 5-1. FFM Package, 12-Pin LCCC (Top View)

表 5-1. Pin Functions

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

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

6 Specifications

6.1 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	dBm
V _{PD}	Power-down pin voltage	−0.3	3.7	V
T _J	Junction temperature		150	°C
T _{stg}	Storage temperature	−65	150	°C
	Continuous power dissipation	See thermal information		

- (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 briefly operating outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not sustain damage, but it may not be fully functional. Operating the device in this manner may affect device reliability, functionality, performance, and shorten the device lifetime.

6.2 ESD Ratings

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

- (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

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 air temperature	−55	25		°C
T _J	Junction temperature			125	°C

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TRF0206-SP	UNIT
		FFM (LCCC)	
		12 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	69.3	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	54.5	°C/W
R _{θJB}	Junction-to-board thermal resistance	44.4	°C/W
Ψ _{JT}	Junction-to-top characterization parameter	42	°C/W
Ψ _{JB}	Junction-to-board characterization parameter	44.5	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	36.7	°C/W

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

6.5 Electrical Characteristics

Specifications correspond to the respectively identified subgroup temperature, unless otherwise noted. Test conditions at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$, single-ended input with $R_S = 50\ \Omega$, differential output with $Z_L = 100\ \Omega$, unless otherwise noted.

PARAMETER		TEST CONDITIONS	SUBGROUP ⁽¹⁾	MIN	TYP	MAX	UNIT
AC PERFORMANCE							
SSBW	Small-signal 3-dB bandwidth	$V_o = 100\text{ mV}_{PP}$			6.5		GHz
LSBW	Large-signal 3-dB bandwidth	$V_o = 1\text{ V}_{PP}$			6.5		GHz
	Bandwidth for 1.5-dB flatness				4.8		GHz
S_{21}	Power gain	$f = 2\text{ GHz}$			12.5		dB
S_{11}	Input return loss	$f = 10\text{ MHz to }4\text{ GHz}$			-10		dB
S_{12}	Reverse isolation	$f = 10\text{ MHz to }4\text{ GHz}$			-35		dB
	Gain imbalance	$f = 10\text{ MHz to }5\text{ GHz}$			± 0.4		dB
	Phase imbalance	$f = 10\text{ MHz to }5\text{ GHz}$			± 3		°
CMRR	Common-mode rejection ratio ⁽²⁾	$f = 2\text{ GHz}$			-30		dB
HD2	Second-order harmonic distortion	$f = 0.5\text{ GHz}, P_o = +2\text{ dBm}$			-65		dBc
		$f = 1\text{ GHz}, P_o = +2\text{ dBm}$			-60		
		$f = 2\text{ GHz}, P_o = +2\text{ dBm}$			-60		
		$f = 4\text{ GHz}, P_o = +2\text{ dBm}$			-60		
HD3	Third-order harmonic distortion	$f = 0.5\text{ GHz}, P_o = +2\text{ dBm}$			-65		dBc
		$f = 1\text{ GHz}, P_o = +2\text{ dBm}$			-65		
		$f = 2\text{ GHz}, P_o = +2\text{ dBm}$			-68		
		$f = 4\text{ GHz}, P_o = +2\text{ dBm}$			-58		
OP1dB	Output 1-dB compression point	$f = 0.5\text{ GHz}$			8.5		dBm
		$f = 1\text{ GHz}$			10		
		$f = 2\text{ GHz}$			12		
		$f = 4\text{ GHz}$			10.5		
		$f = 6\text{ GHz}$			10		
OIP2	Output second-order intercept point	$f = 0.5\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			65		dBm
		$f = 1\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			62		
		$f = 2\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			58		
		$f = 4\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			55		
		$f = 6\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			55		
OIP3	Output third-order intercept point	$f = 0.5\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			32		dBm
		$f = 1\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			35		
		$f = 2\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			38		
		$f = 4\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			35		
		$f = 6\text{ GHz}, P_o = -5\text{ dBm per tone, }10\text{ MHz spacing}$			32		

6.5 Electrical Characteristics (continued)

Specifications correspond to the respectively identified subgroup temperature, unless otherwise noted. Test conditions at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$, single-ended input with $R_S = 50\ \Omega$, differential output with $Z_L = 100\ \Omega$, unless otherwise noted.

PARAMETER		TEST CONDITIONS	SUBGROUP ⁽¹⁾	MIN	TYP	MAX	UNIT
NF	Noise figure	f = 0.5 GHz			7.5		dB
		f = 1 GHz			7.5		
		f = 2 GHz			8		
		f = 4 GHz			9		
		f = 6 GHz			9		
IMPEDANCE							
Z _{O-DIFF}	Differential output impedance	f = dc (internal to the device)			5		Ω
Z _{IN}	Single-ended input impedance	With INM terminated with 50 Ω			50		Ω
TRANSIENT							
V _{OMAX}	Output max operating voltage (differential)				1.7		V _{PP}
V _{OSAT}	Output saturated voltage level (differential)	f = 4 GHz			3.5		V _{PP}
T _{REC}	Over-drive recovery time	Using a 0.5-V _P input pulse of 2-ns duration			0.35		ns
POWER SUPPLY							
I _{QA}	Active current	Current on VDD pin, PD = 0	[1, 2, 3]	85	130	170	mA
I _{QPD}	Power-down quiescent current	Current on VDD pin, PD = 1	[1, 2, 3]	2	7	16	mA
ENABLE							
V _{PDHIGH}	PD pin logic high			1.55			V
V _{PDLOW}	PD pin logic low					0.7	V
I _{PDBIAS}	PD bias current (current on PD pin)	PD = high (1.8-V logic)			50	100	μA
		PD = low (3.3-V logic)			200	300	
C _{PD}	PD pin capacitance				3		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			100		ns

(1) For subgroup definitions, please see [Quality Conformance Inspection](#).

(2) CMRR is calculated using the formula $(S_{21}-S_{31}) / (S_{21}+S_{31})$. Port-1: INP, Port-2: OUTP, Port-3: OUTM.

6.6 Quality Conformance Inspection

SUBGROUP ⁽¹⁾	DESCRIPTION	TEMPERATURE (°C)
1	Static tests at	25
2	Static tests at	125
3	Static tests at	–55
4	Dynamic tests at	25
5	Dynamic tests at	125
6	Dynamic tests at	–55
7	Functional tests at	25
8A	Functional tests at	125
8B	Functional tests at	–55
9	Switching tests at	25
10	Switching tests at	125
11	Switching tests at	–55

(1) MIL-STD-883, Method 5005 – Group A

6.7 Typical Characteristics

at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$, single-ended input with $R_S = 50\ \Omega$, differential output with $Z_L = 100\ \Omega$ (unless otherwise noted)

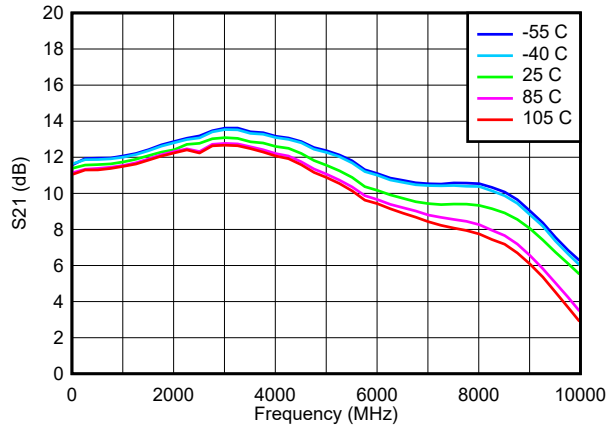


图 6-1. Power Gain Across Temperature

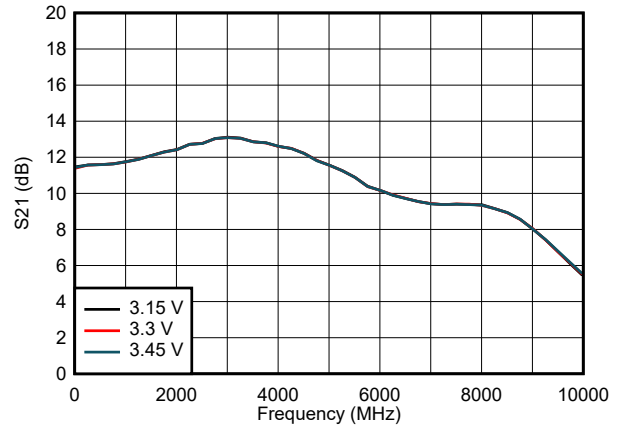


图 6-2. Power Gain Across VDD

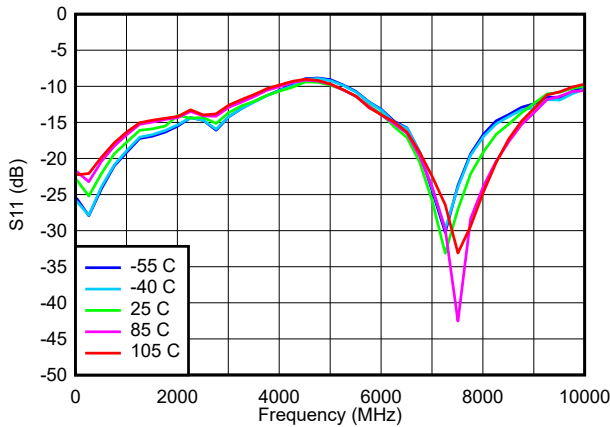


图 6-3. Return Loss Across Temperature

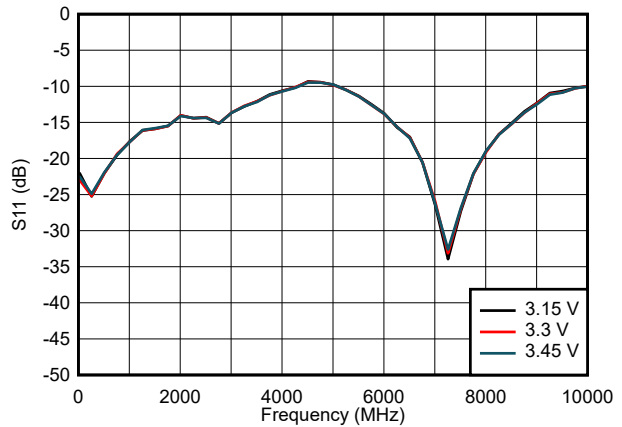


图 6-4. Return Loss Across VDD

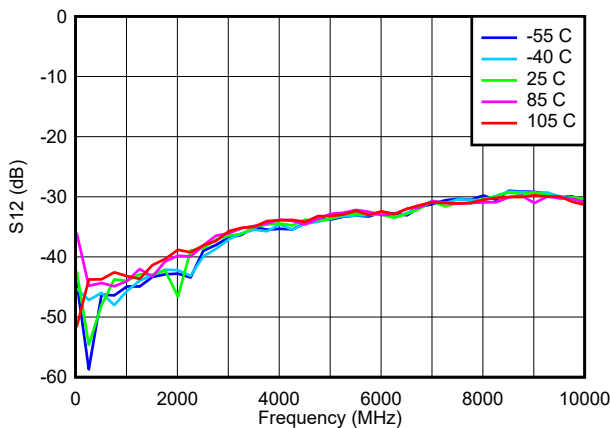


图 6-5. Reverse Isolation Across Temperature

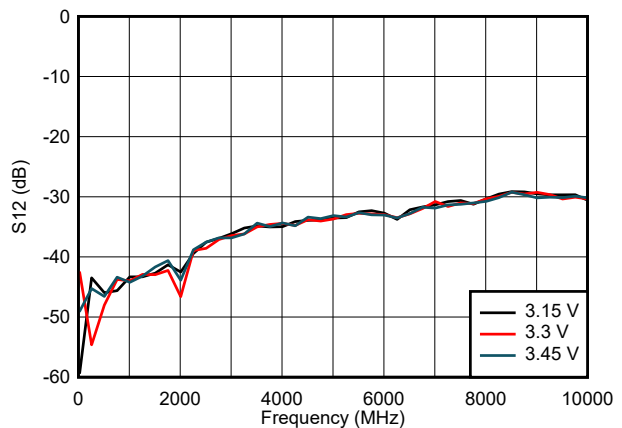
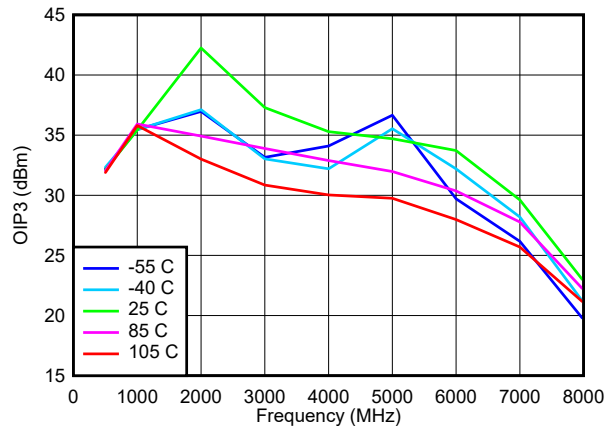


图 6-6. Reverse Isolation Across VDD

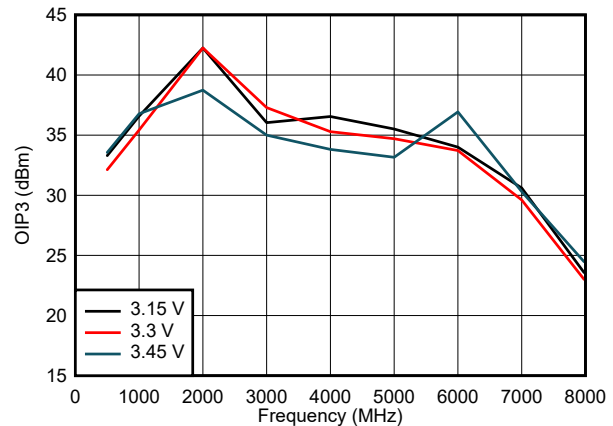
6.7 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$, single-ended input with $R_S = 50\ \Omega$, differential output with $Z_L = 100\ \Omega$ (unless otherwise noted)



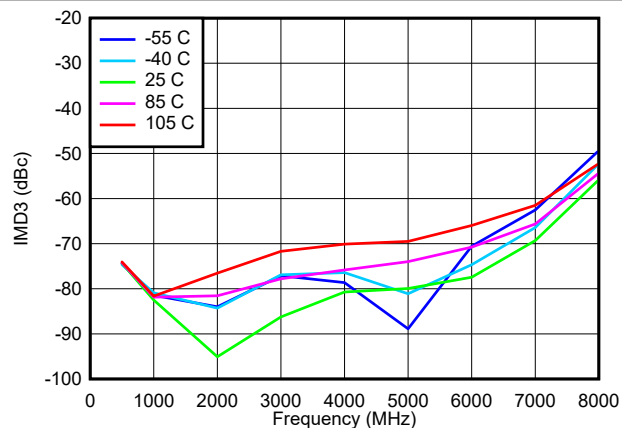
Pout / tone = -5 dBm, 10-MHz tone spacing

图 6-7. OIP3 Across Temperature



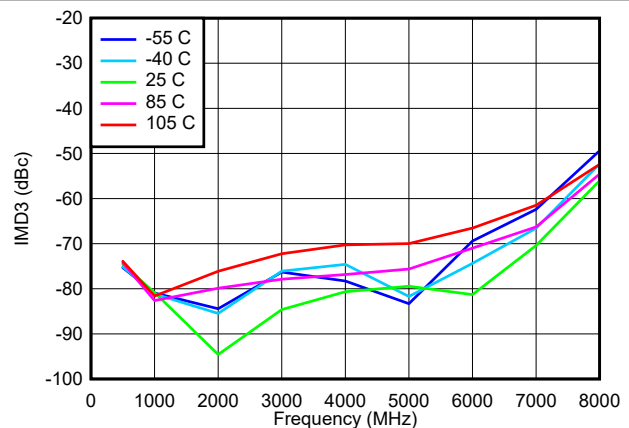
Pout / tone = -5 dBm, 10-MHz tone spacing

图 6-8. OIP3 Across VDD



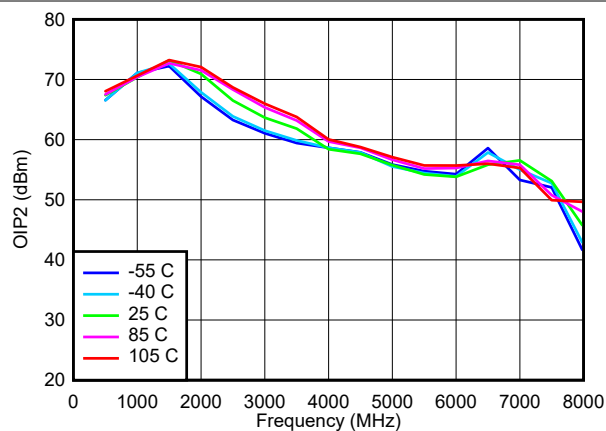
At $(2f_1 - f_2)$ frequency; $f_2 > f_1$, Pout / tone = -5 dBm,
10-MHz tone spacing

图 6-9. IMD3 Lower Frequency



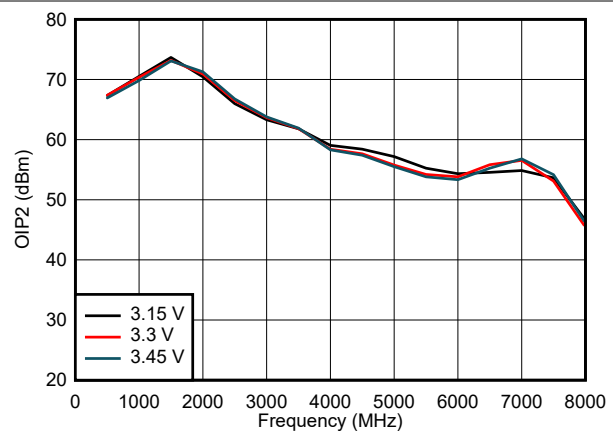
At $(2f_2 - f_1)$ frequency; $f_2 > f_1$, Pout / tone = -5 dBm,
10-MHz tone spacing

图 6-10. IMD3 Higher Frequency



At $(f_2 - f_1)$ frequency; $f_2 > f_1$, Pout / tone = -5 dBm,
10-MHz tone spacing

图 6-11. OIP2 Lower Frequency Across Temperature

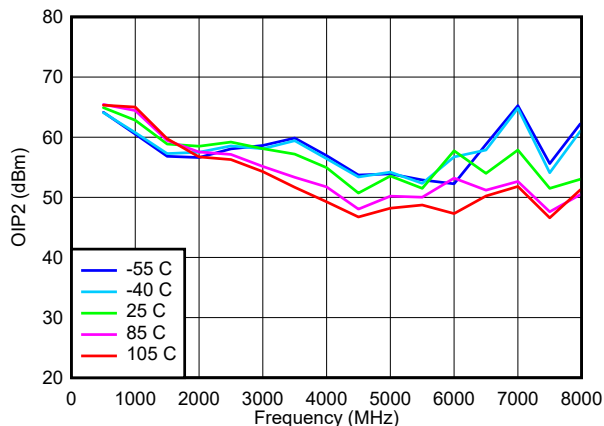


At $(f_2 - f_1)$ frequency; $f_2 > f_1$, Pout / tone = -5 dBm,
10-MHz tone spacing

图 6-12. OIP2 Lower Frequency Across VDD

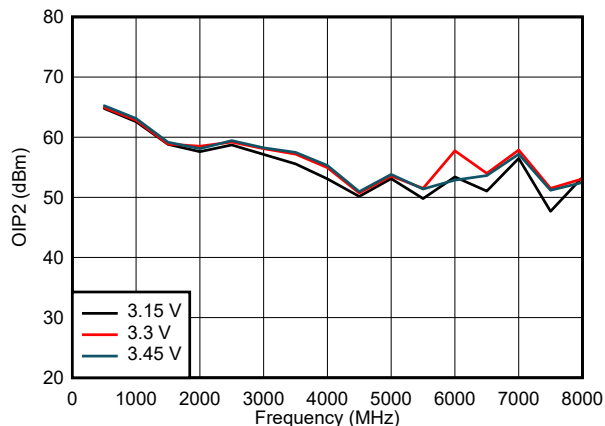
6.7 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$, single-ended input with $R_S = 50\ \Omega$, differential output with $Z_L = 100\ \Omega$ (unless otherwise noted)



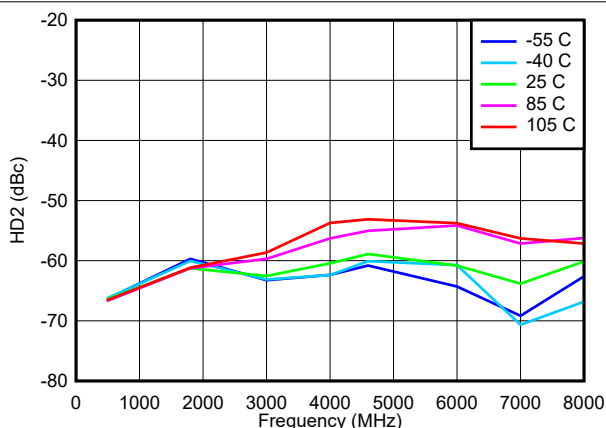
At (f_2+f_1) frequency; $f_2 > f_1$, P_{out} / tone = -5 dBm,
10-MHz tone spacing

FIG 6-13. OIP2 Higher Frequency Across Temperature



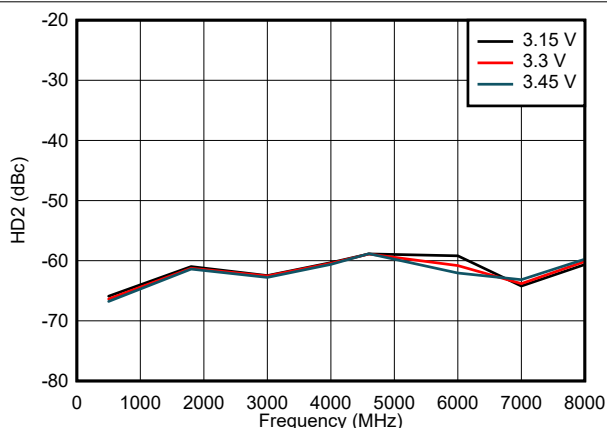
At (f_2+f_1) frequency; $f_2 > f_1$, P_{out} / tone = -5 dBm,
10-MHz tone spacing

FIG 6-14. OIP2 Higher Frequency Across VDD



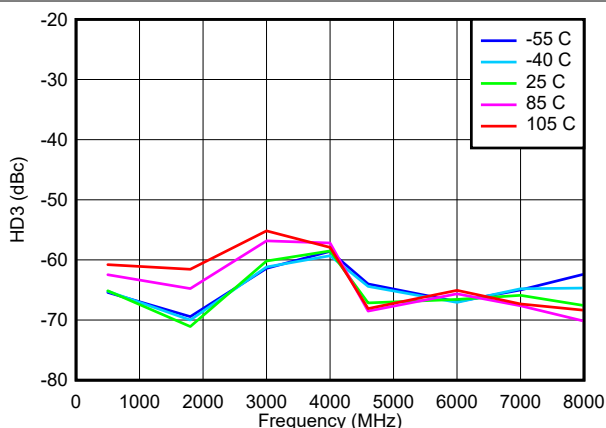
$P_{out} = +2\text{ dBm}$

FIG 6-15. HD2 Across Temperature



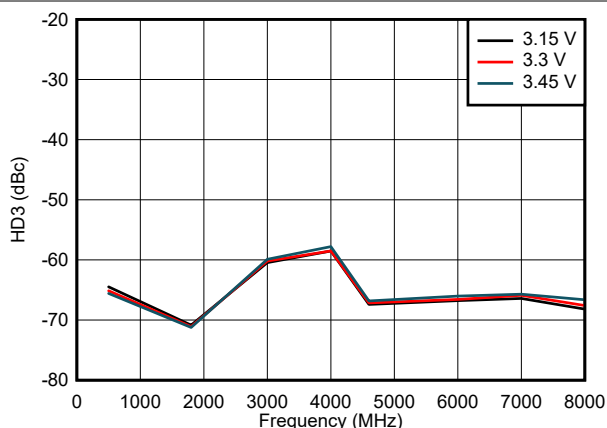
$P_{out} = +2\text{ dBm}$

FIG 6-16. HD2 Across VDD



$P_{out} = +2\text{ dBm}$

FIG 6-17. HD3 Across Temperature



$P_{out} = +2\text{ dBm}$

FIG 6-18. HD3 Across VDD

6.7 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$, single-ended input with $R_S = 50\ \Omega$, differential output with $Z_L = 100\ \Omega$ (unless otherwise noted)

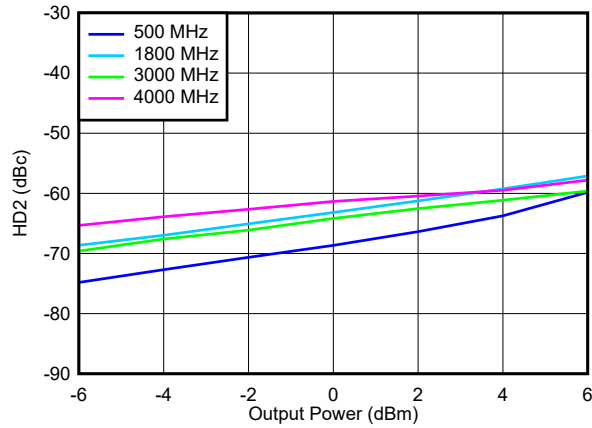


Figure 6-19. HD2 vs Output Power

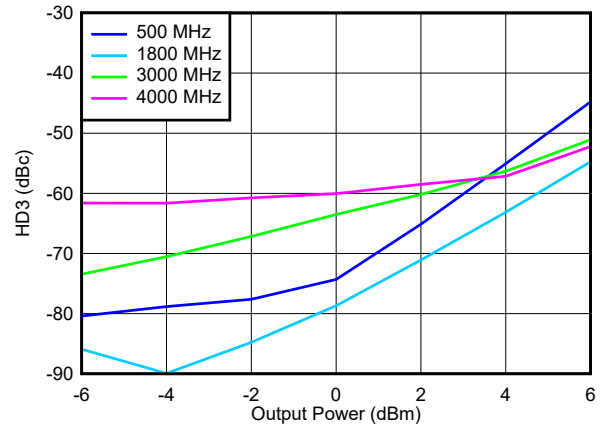


Figure 6-20. HD3 vs Output Power

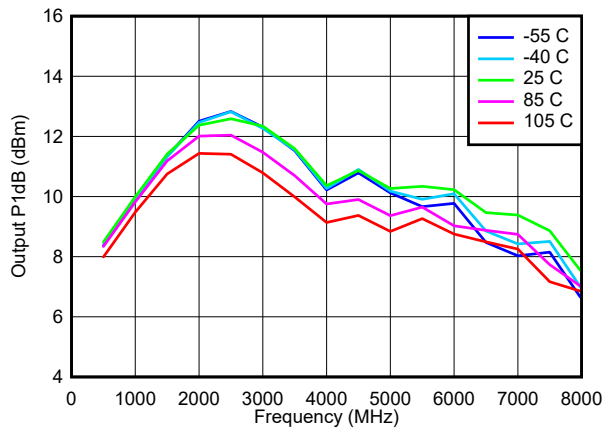


Figure 6-21. Output P1 dB Across Temperature

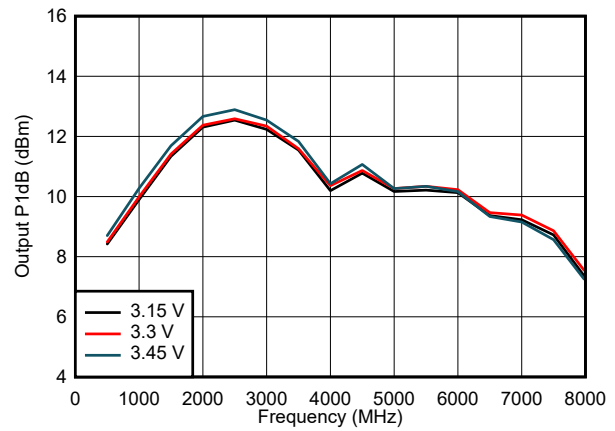


Figure 6-22. Output P1 dB Across VDD

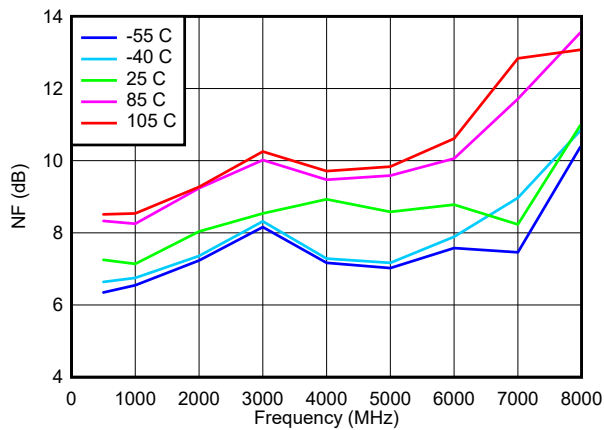


Figure 6-23. NF Across Temperature

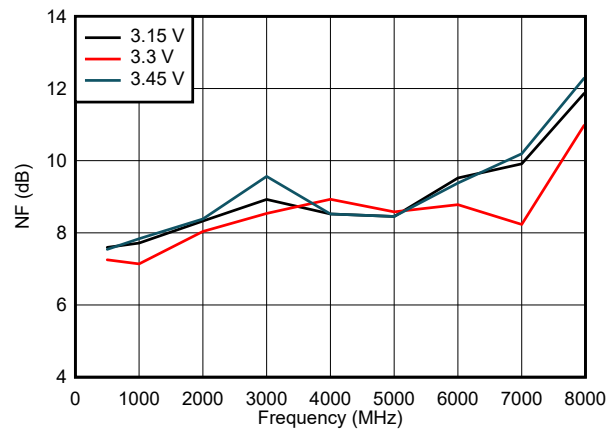


Figure 6-24. NF Across VDD

6.7 Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$, single-ended input with $R_S = 50\ \Omega$, differential output with $Z_L = 100\ \Omega$ (unless otherwise noted)

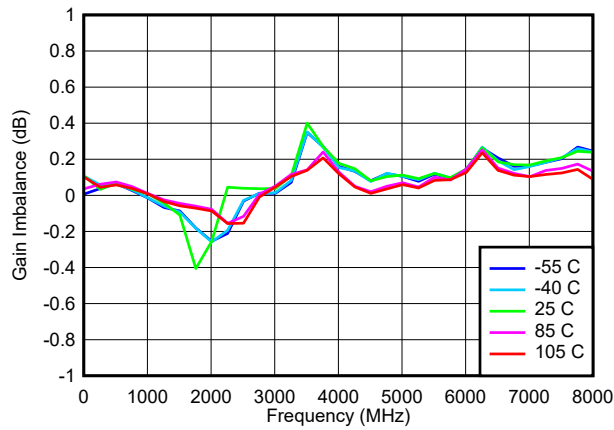


FIG 6-25. Gain Imbalance

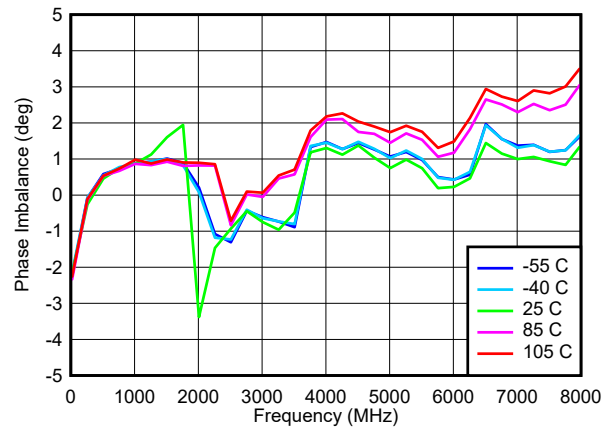


FIG 6-26. Phase Imbalance

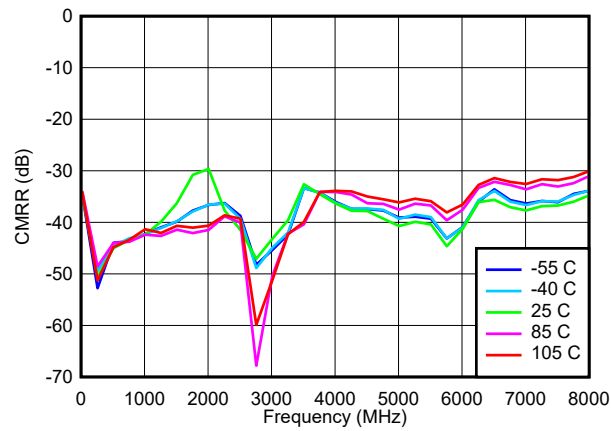


FIG 6-27. CMRR Across Temperature

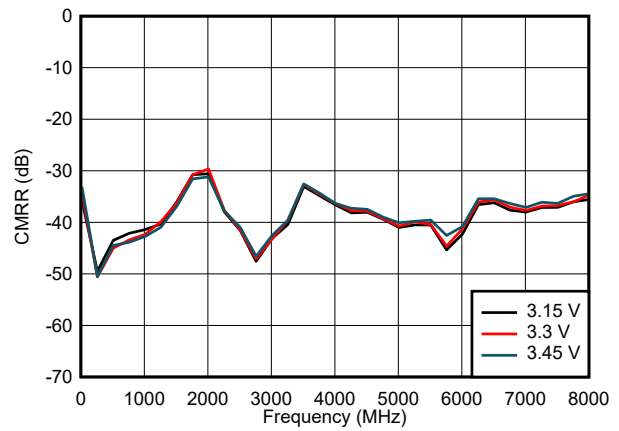


FIG 6-28. CMRR Across VDD

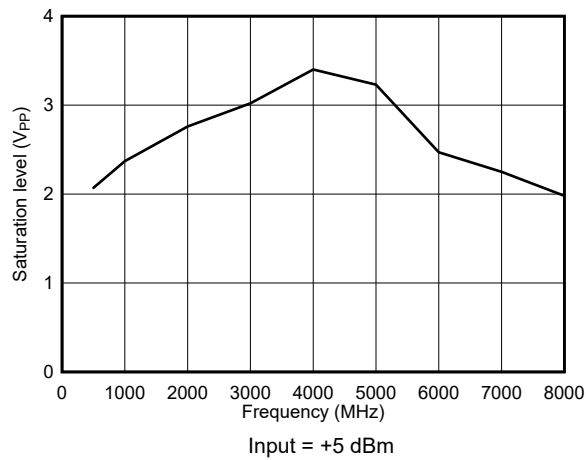


FIG 6-29. Saturation Voltage

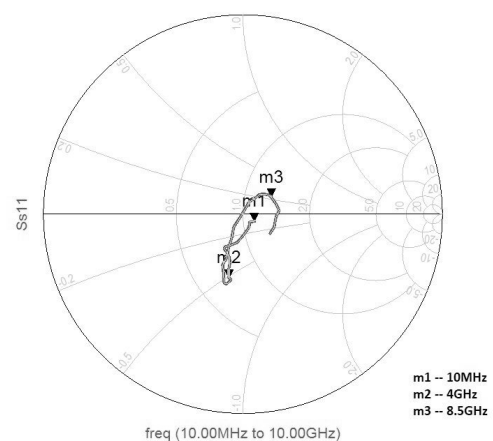


FIG 6-30. Single-Ended S11

7 Detailed Description

7.1 Overview

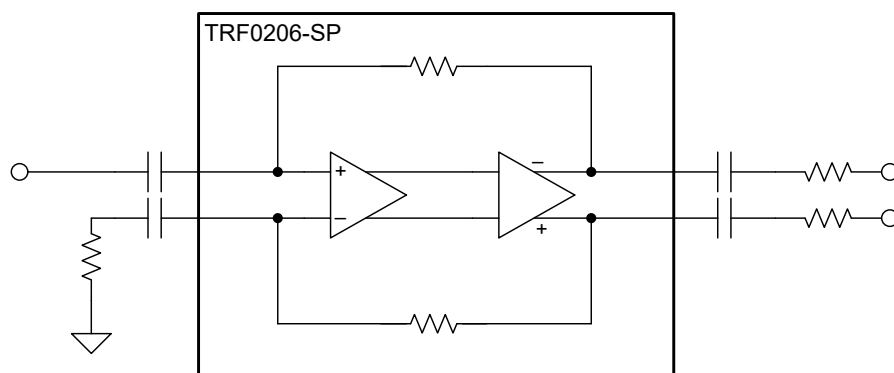
The TRF0206-SP is a very high-performance amplifier optimized for radio frequency (RF) and intermediate frequency (IF) with signal bandwidths up to 7 GHz. This device is an excellent choice for ac-coupled applications that require a single-ended to differential conversion when driving an analog-to-digital converter (ADC). The device has a two-stage architecture and provides approximately 13 dB of gain when configured for single-ended inputs driven from a 50-Ω source. This device also works as a differential-to-single-ended amplifier to act as a DAC buffer.

This TRF0206-SP does not require any pullup or pulldown components on the PCB, and thereby simplifies the layout and provides the highest performance over the whole bandwidth.

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

7.2 Functional Block Diagram

The following figure shows the functional block diagram of the TRF0206-SP. The device essentially has two stages with a voltage-feedback configuration.



7.3 Feature Description

7.3.1 Fully Differential Amplifier

The TRF0206-SP is a voltage-feedback fully differential amplifier (FDA) with a fixed gain by architecture. The TRF0206-SP operates best as a single-ended to differential amplifier by terminating the INM pin with a 50-Ω 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 appropriate series resistors or attenuator pad.

7.3.2 Single-Supply Operation

The TRF0206-SP operates on a single, 3.3-V 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.

7.4 Device Functional Modes

The TRF0206-SP has two functional modes: active and power-down. These functional modes are controlled by the PD pin as described in the previous section.

7.4.1 Power-Down Mode

The device features a power-down option. The PD pin is used to power down the amplifier. This pin supports both 1.8-V and 3.3-V 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 some lower level through this path, as is the case for any disabled feedback amplifier.

8 Application and Implementation

注

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8.1 Application Information

8.1.1 Driving a High-Speed ADC

A common application of the TRF0206-SP is to drive a high-speed ADC, such as the [ADC12DJ3200QML-SP](#) or [AFE7950](#) that have differential inputs. Conventionally, passive baluns are used to drive GSPS ADCs because of nonavailability of high-bandwidth linear amplifiers. The TRF0206-SP is an active balun that has excellent bandwidth flatness, gain, and phase imbalance comparable to or exceeding costly passive baluns.

The following figure shows a typical interface circuit for the ADC12DJ3200QML-SP. Depending on the ADC and system requirement, this circuit can be simplified or can be more complex.

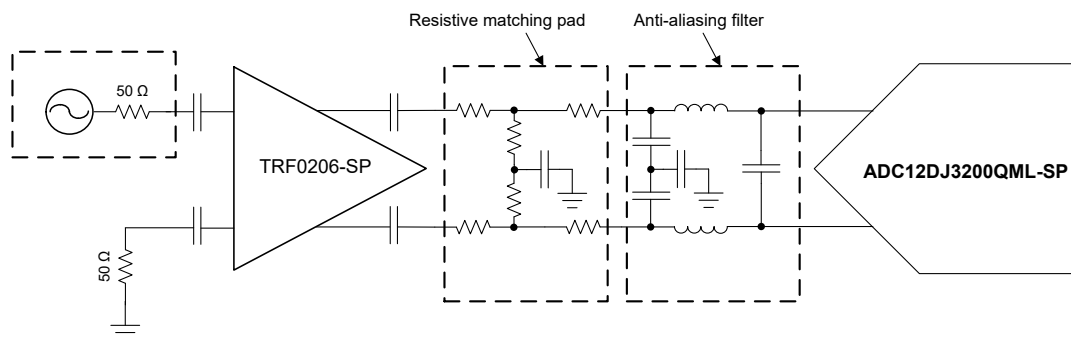
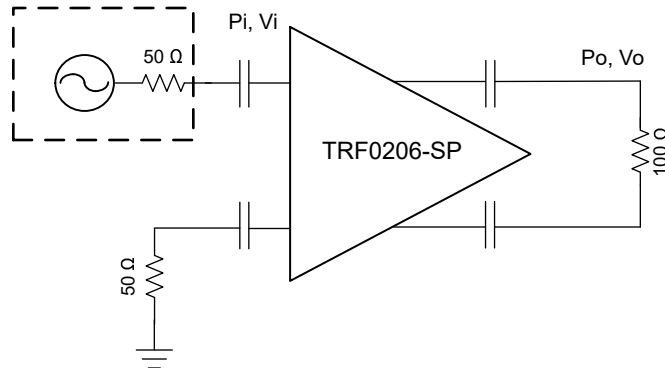


図 8-1. Interfacing with High-Speed ADC

図 8-1 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 TRF0206-SP is designed to drive these ADCs full-scale, while at the same time not overdrive the device. This functionality avoids the need for any voltage limiting device at the ADC.

8.1.2 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 100-Ω differential load and a power gain of 13 dB is assumed.



8-2. Power and Voltage Levels

$$\text{Voltage gain} = 20 \times \log(V_o / V_i) \quad (1)$$

$$\text{Power gain} = 10 \times \log(P_o / P_i) = 10 \times \log((V_o^2 / 100) / (V_i^2 / 50)) = 20 \times \log(V_o / V_i) - 3 \text{ dB} \quad (2)$$

表 8-1. Output Voltage Swings for Different Input Power Levels

INPUT		OUTPUT	
P _i (dBm)	V _i (V _{PP})	P _o (dBm)	V _o (V _{PP})
-20	0.063	-7	0.4
-15	0.112	-2	0.71
-10	0.2	3	1.263
-7	0.283	6	1.785

8.1.3 Thermal Considerations

The TRF0206-SP is packaged in a 6.10 mm × 6.20 mm LCCC-FC package that has excellent thermal properties. Connect the device thermal pad to a ground plane. Short the ground plane to the other ground pins of the device at four corners, if possible, to allow heat propagation to the top layer of the 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.

Limit the total power dissipation to keep the device junction temperature less than 150°C for instantaneous power and less than 125°C for continuous power.

8.2 Typical Application

8.2.1 TRF0206-SP Driving an AFE7950-SP Receiver

This section describes an RF receiver chain in which the TRF0206-SP is working as a single-ended to differential (S2D) amplifier and driving a receive channel of the AFE7950-SP.

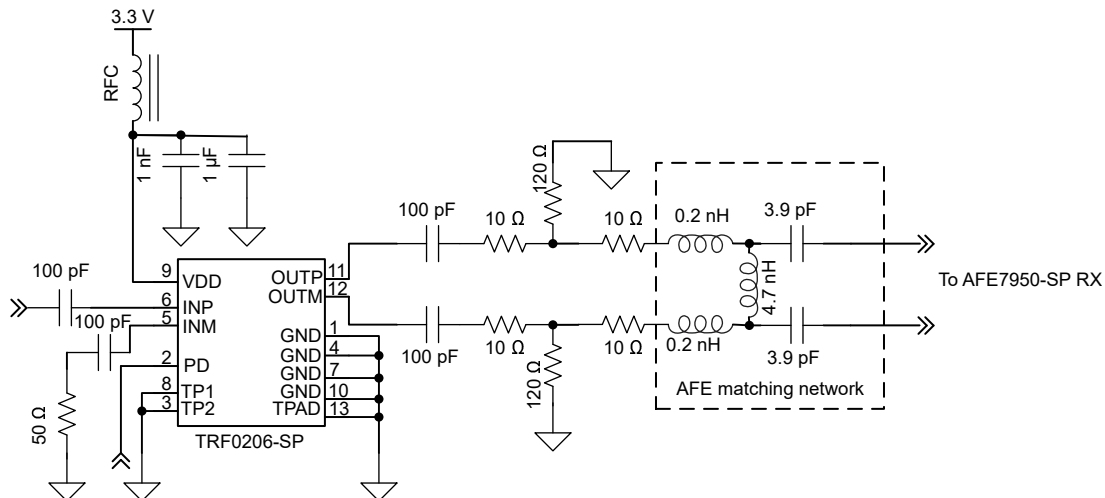


FIG 8-3. The TRF0206-SP in a Receive Chain Driving the AFE7950-SP ADC

FIG 8-3 is a generic schematics of a design in which the TRF0206-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.

8.2.1.1 Design Requirements

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

8.2.1.2 Detailed Design Procedure

The TRF0206-SP is configured as an S2D amplifier. The section close to the TRF0206-SP output is an attenuator pad that is meant for robust matching. The section close to AFE7950-SP is the matching network for the AFE that is channel and channel-frequency dependent. The matching components are chosen based on the AFE return-loss data and some trial and error because the manufactured board parameters can influence the exact component values.

8.3 Power Supply Recommendations

The TRF0206-SP requires a single 3.3-V supply. Supply decoupling is critical to high-frequency performance. Typically two or three capacitors are used for supply decoupling. Place the lowest-value capacitor, a small form-factor component, closest to the VDD pin of the device. Place a bulk decoupling capacitor that has a larger value and size next to the small capacitor. Additional layout recommendations are given in the *Layout* section.

8.4 Layout

8.4.1 Layout Guidelines

TRF0206-SP is a wide-band feedback amplifier with approximately 13 dB of gain. When designing with a wideband RF amplifier with relatively high gain, take certain board layout precautions to maintain stability and optimal performance. Use a multilayered board to maintain signal and power integrity and thermal performance. The following figure shows an example of a good layout. In this figure, only the top layer is shown.

Route the RF input and output lines as grounded coplanar waveguide (GCPW) lines. Make sure the second layer is 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. Route the INP with a 50-Ω line. Make sure that the NM pin termination has low parasitics by placing the ac-coupling capacitor and the 50-Ω resistor very close to the device. Use an RF quality 50-Ω resistor for termination. Make sure that ground planes on the top and internal layers are well stitched with vias.

As [Figure 8-4](#) shows, place thermal vias under the device that connect the top thermal pad with ground planes in the inner layers of the PCB. Also connect the thermal pad to the top layer ground plane through the ground pins.

8.4.2 Layout Example

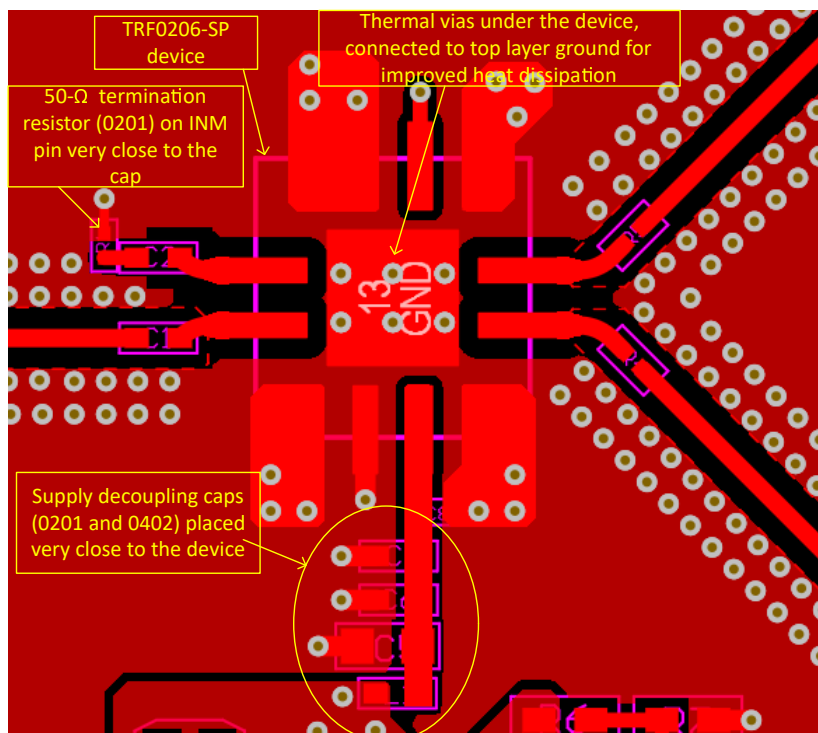


Figure 8-4. Layout Example: Placement and Top Layer Layout

The TRF0206-SP can be evaluated using the TRF0206-SP EVM board, which can be ordered from the [TRF0206-SP product folder](#). Additional information about the evaluation board construction and test setup is given in the [TRF0206-SP EVM User's Guide](#).

9 Device and Documentation Support

9.1 Device Support

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9.2 Documentation Support

9.2.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [TRF0206-SP EVM User's Guide](#)

9.3 ドキュメントの更新通知を受け取る方法

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9.7 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

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.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962R2122001VXC	ACTIVE	LCCC	FFM	12	50	Non-RoHS & Non-Green	Call TI	Call TI	-55 to 125	5962R 2122001VXC TRF0206FFM	Samples
TRF0206FFM/EM	ACTIVE	LCCC	FFM	12	50	Non-RoHS & Non-Green	Call TI	N / A for Pkg Type	-55 to 125	TRF0206FFM/EM	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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 finish/Ball material - Orderable Devices 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.

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LCCC - 1.78 mm max height

LEADLESS CERAMIC CHIP CARRIER



1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

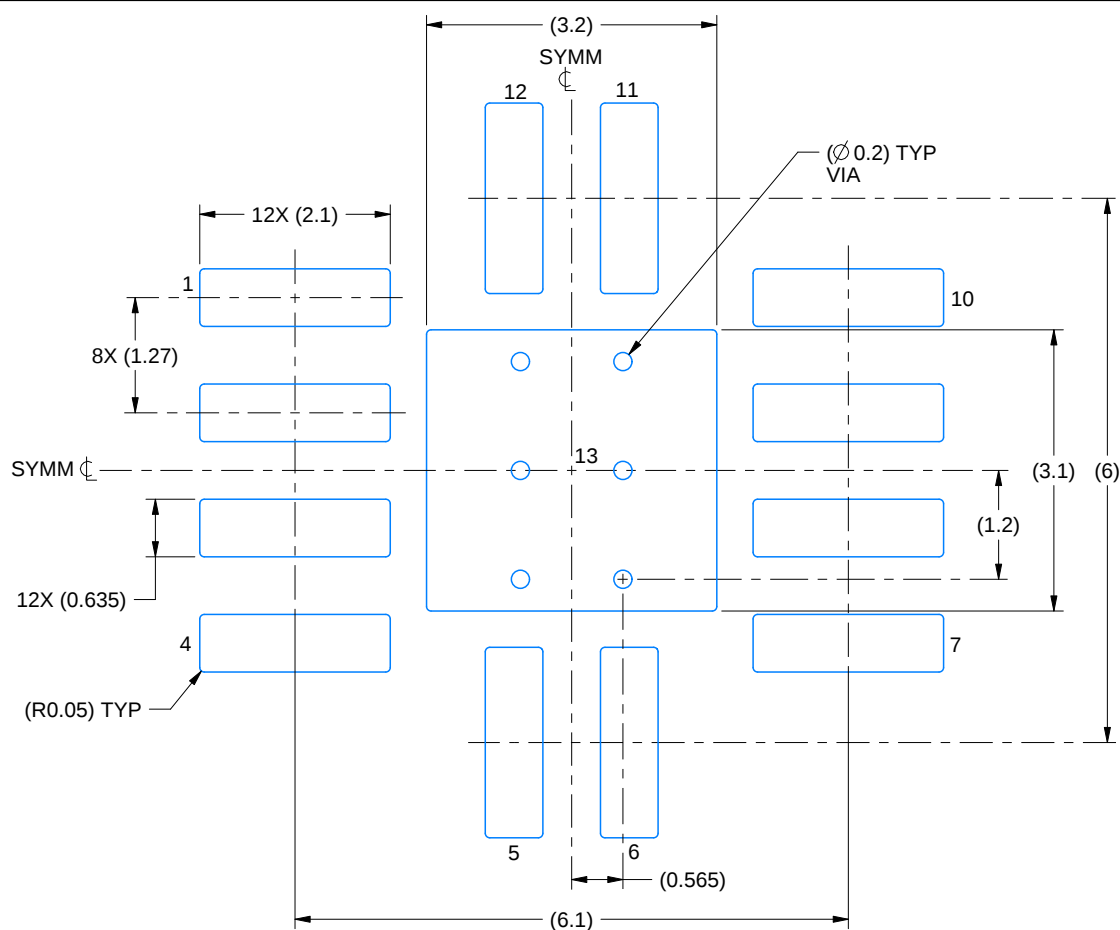
2. This drawing is subject to change without notice.

3. The terminals are gold-plated.

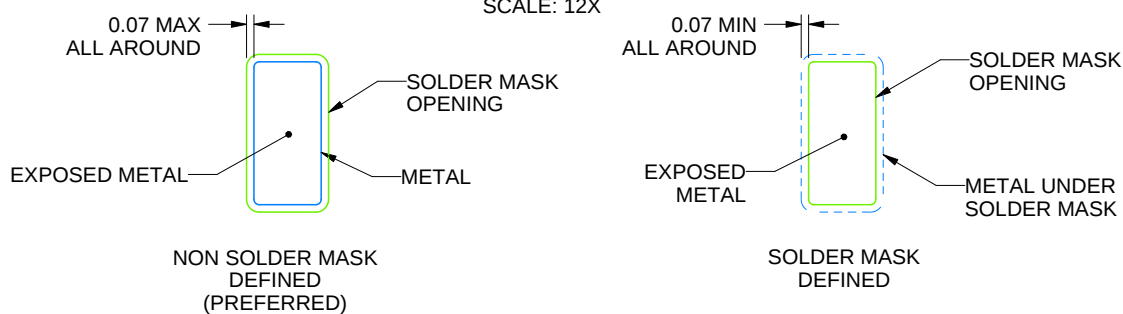
FFM0012A

LCCC - 1.78 mm max height

LEADLESS CERAMIC CHIP CARRIER



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 12X



SOLDER MASK DETAILS
NOT TO SCALE

4226328/D 01/2021

NOTES: (continued)

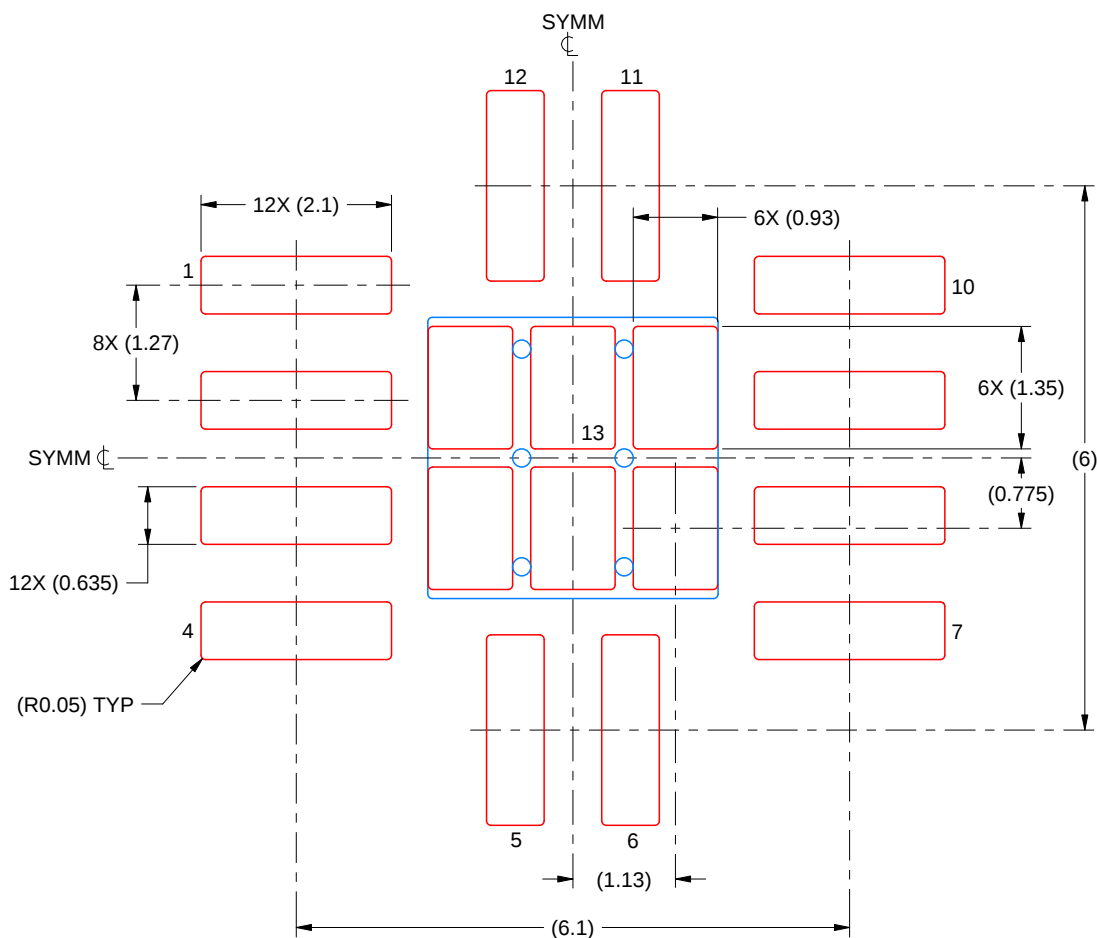
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown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

EXAMPLE STENCIL DESIGN

FFM0012A

LCCC - 1.78 mm max height

LEADLESS CERAMIC CHIP CARRIER



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 13:
76% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE: 12X

4226328/D 01/2021

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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