

### FEATURES

Ideal for CATV and terrestrial applications

Excellent frequency response

1.6 GHz, -3 dB bandwidth

1 dB flatness to 1.0 GHz

Low noise figure: 4.0 dB

Low distortion

Composite second order (CSO): -62 dBc

Composite triple beat (CTB): -72 dBc

1 dB compression point of 8.25 dBm

2.8 dB of gain per output channel

25 dB output-to-output isolation, 50 MHz to 1000 MHz

75  $\Omega$  input and outputs

Integrated output resistors

Small package size: 16-lead, 3 mm  $\times$  3 mm LFCSP

### APPLICATIONS

Set-top boxes

Residential gateways

CATV distribution systems

Splitter modules

Digital cable ready (DCR) TVs

### GENERAL DESCRIPTION

The ADA4304-2 is a 75  $\Omega$  active splitter for use in applications where a lossless signal split is required. Typical applications include multituner digital set-top boxes, cable splitter modules, multituner/digital cable ready (DCR) televisions, and home gateways where traditional solutions require discrete passive splitter modules with separate fixed gain amplifiers.

The ADA4304-2 is fabricated using Analog Devices, Inc. proprietary silicon-germanium (SiGe), complementary bipolar process, enabling it to achieve very low levels of distortion with a noise figure of 4 dB. The part provides a low cost alternative that simplifies designs and improves system performance by integrating a signal splitter element and a gain block into a single IC. The ADA4304-2 is available in a 16-lead LFCSP and operates in the extended industrial temperature range of -40°C to +85°C.

### FUNCTIONAL BLOCK DIAGRAM

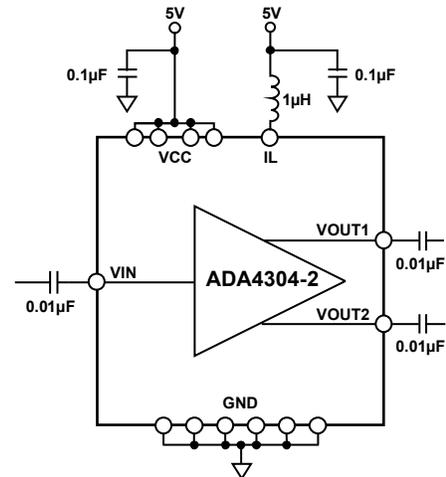


Figure 1.

06539-011

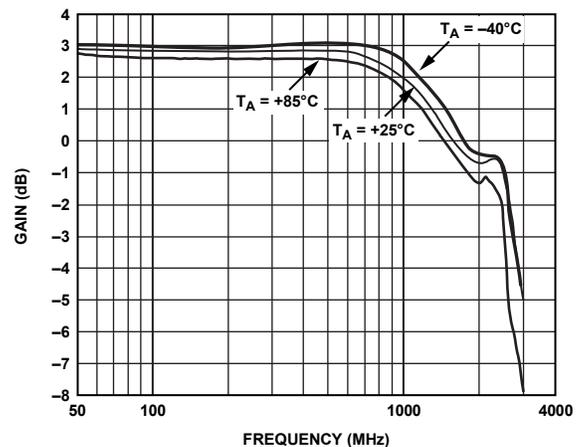


Figure 2. Gain ( $S_{21}$ ,  $S_{31}$ ) vs. Frequency

06539-011

Rev. A

[Document Feedback](#)

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**REVISION HISTORY**

**6/2016—Rev. 0 to Rev. A**

Changed CP-16-1 to CP-16-21 .....	Throughout
Changes to Figure 4 and Table 4.....	5
Deleted Evaluation Boards Section, RF Layout Considerations Section, Power Supply Section, and Figure 20; Renumbered Sequentially .....	9
Deleted Figure 21 and Figure 22.....	10
Updated Outline Dimensions .....	11
Changes to Ordering Guide .....	11

**5/2007—Revision 0: Initial Version**

## SPECIFICATIONS

$V_{CC} = 5\text{ V}$ ,  $75\ \Omega$  system,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
<b>DYNAMIC PERFORMANCE</b>					
Bandwidth (–3 dB)			1600		MHz
Specified Frequency Range		54		865	MHz
Gain ( $S_{21}$ , $S_{31}$ )	$f = 100\text{ MHz}$ ; see Figure 17 and Figure 18		2.8		dB
1 dB Gain Flatness			1000		MHz
<b>NOISE/DISTORTION PERFORMANCE</b>					
Noise Figure <sup>1</sup>	@ 54 MHz		4.0		dB
	@ 550 MHz		4.5		dB
	@ 865 MHz		4.6		dB
Output IP3	$f_1 = 97.25\text{ MHz}$ , $f_2 = 103.25\text{ MHz}$		26		dBm
Output IP2	$f_1 = 97.25\text{ MHz}$ , $f_2 = 103.25\text{ MHz}$		44.5		dBm
Composite Triple Beat (CTB)	135 channels, 15 dBmV/channel, $f = 865\text{ MHz}$		–72		dBc
Composite Second Order (CSO)	135 channels, 15 dBmV/channel, $f = 865\text{ MHz}$		–62		dBc
Cross Modulation (CXM)	135 channels, 15 dBmV/channel, 100% modulation @ 15.75 kHz, $f = 865\text{ MHz}$		–69		dBc
<b>INPUT CHARACTERISTICS</b>					
Input Return Loss ( $S_{11}$ )	See Figure 17, Figure 18, and Figure 19				
	@ 54 MHz		–15	–11	dB
	@ 550 MHz		–35.5	–22	dB
	@ 865 MHz		–13.3	–8	dB
Output-to-Input Isolation ( $S_{12}$ , $S_{13}$ )	Either output, 54 MHz to 865 MHz				
	@ 54 MHz		–32	–30	dB
	@ 550 MHz		–32	–29	dB
	@ 865 MHz		–33	–31	dB
<b>OUTPUT CHARACTERISTICS</b>					
Output Return Loss ( $S_{22}$ , $S_{33}$ )	See Figure 17, Figure 18, and Figure 19				
	Either output, 54 MHz to 865 MHz				
	@ 54 MHz		–26.7	–21	dB
	@ 550 MHz		–22	–15	dB
	@ 865 MHz		–20	–12	dB
Output-to-Output Isolation ( $S_{23}$ , $S_{32}$ )	Either output, 54 MHz to 865 MHz				dB
	@ 54 MHz		–26.7		dB
	@ 550 MHz		–25.1		dB
	@ 865 MHz		–25		dB
1 dB Compression ( $P_{1dB}$ )	Output referred, $f = 100\text{ MHz}$		8.25		dBm
<b>POWER SUPPLY</b>					
Nominal Supply Voltage		4.75	5.0	5.25	V
Quiescent Supply Current			88	105	mA

<sup>1</sup> Characterized with 50  $\Omega$  noise figure analyzer.

## ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	5.5 V
Power Dissipation	See Figure 3
Storage Temperature Range	-65°C to +125°C
Operating Temperature Range	-40°C to +85°C
Lead Temperature (Soldering, 10 sec)	300°C
Junction Temperature	150°C

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

### THERMAL RESISTANCE

$\theta_{JA}$  is specified for the device (including exposed pad) soldered to a high thermal conductivity 2s2p circuit board, as described in EIA/JESD 51-7.

Table 3. Thermal Resistance

Package Type	$\theta_{JA}$	Unit
16-Lead LFCSP (Exposed Pad)	98	°C/W

### Maximum Power Dissipation

The maximum safe power dissipation in the ADA4304-2 package is limited by the associated rise in junction temperature ( $T_J$ ) on the die. At approximately 150°C, which is the glass transition temperature, the plastic changes its properties. Even temporarily exceeding this temperature limit can change the stresses that the package exerts on the die, permanently shifting the parametric performance of the ADA4304-2. Exceeding a junction temperature of 150°C for an extended period can result in changes in the silicon devices, potentially causing failure.

The power dissipated in the package ( $P_D$ ) is essentially equal to the quiescent power dissipation; the supply voltage ( $V_S$ ) times the quiescent current ( $I_S$ ). In Table 1, the maximum power dissipation of the ADA4304-2 can be calculated as

$$P_{D(MAX)} = 5.25 \text{ V} \times 105 \text{ mA} = 551 \text{ mW}$$

Airflow increases heat dissipation, effectively reducing  $\theta_{JA}$ . In addition, more metal directly in contact with the package leads/exposed pad from metal traces, through-holes, ground, and power planes reduces the  $\theta_{JA}$ .

Figure 3 shows the maximum safe power dissipation in the package vs. the ambient temperature for the 16-lead LFCSP (98°C/W) on a JEDEC standard 4-layer board.

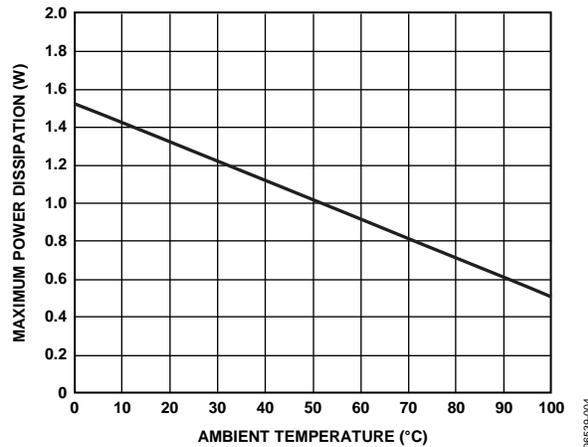


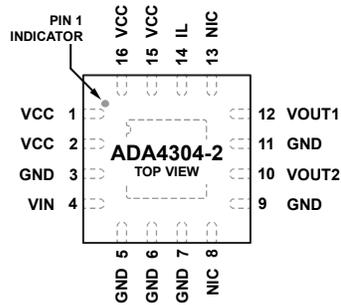
Figure 3. Maximum Power Dissipation vs. Temperature for a 4-Layer Board

### ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



- NOTES**
1. NIC = NO INTERNAL CONNECTION.
  2. THE EXPOSED PAD MUST BE CONNECTED TO GND.

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Figure 4. Pin Configuration

Table 4. Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 2, 15, 16	VCC	Supply Pin.
3, 5 to 7, 9, 11	GND	Ground.
4	VIN	Input.
8, 13	NIC	No Internal Connection.
10	VOUT2	Output 2.
12	VOUT1	Output 1.
14	IL	Bias Pin.
	EPAD	Exposed Pad. The exposed pad must be connected to GND.

# TYPICAL PERFORMANCE CHARACTERISTICS

$V_{CC} = 5\text{ V}$ ,  $75\ \Omega$  system,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

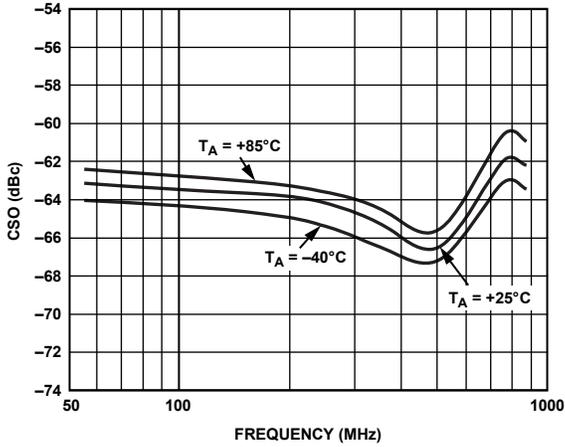


Figure 5. Composite Second Order (CSO) vs. Frequency

06539-005

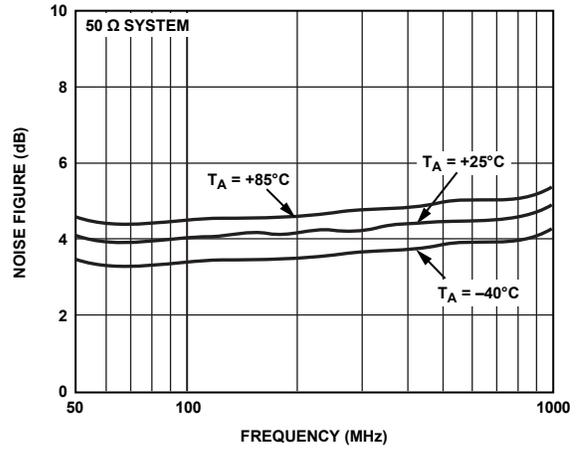


Figure 8. Noise Figure vs. Frequency

06539-008

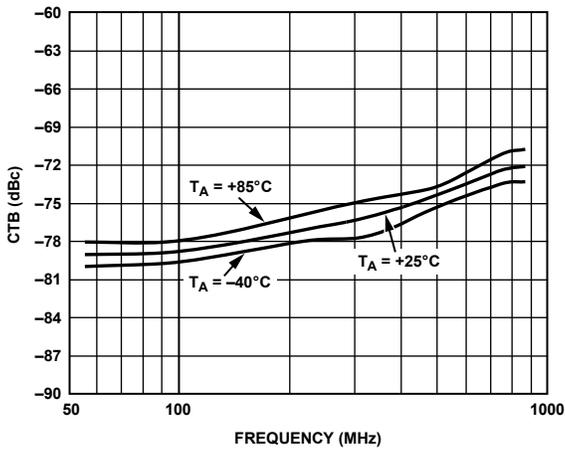


Figure 6. Composite Triple Beat (CTB) vs. Frequency

06539-007

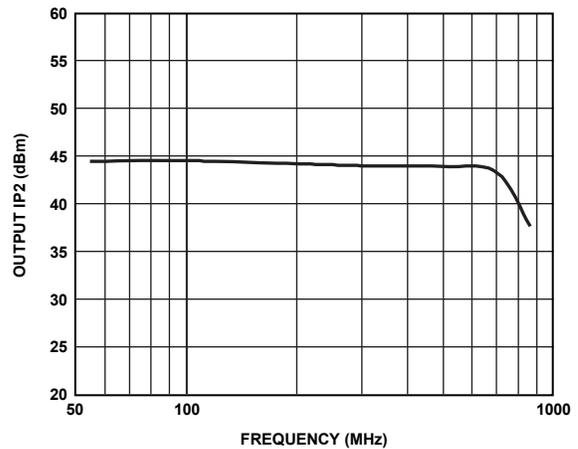


Figure 9. Output IP2 vs. Frequency

06539-009

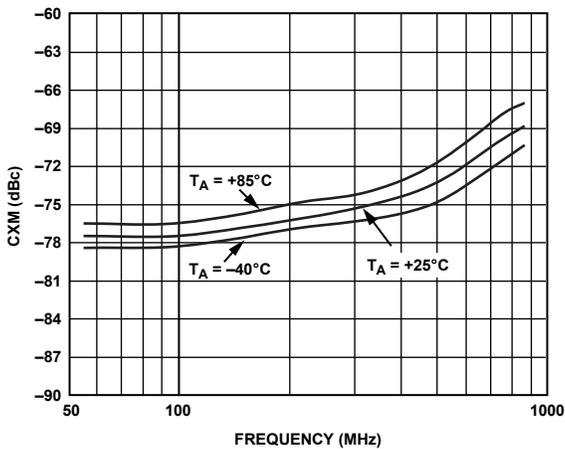


Figure 7. Cross Modulation (CXM) vs. Frequency

06539-006

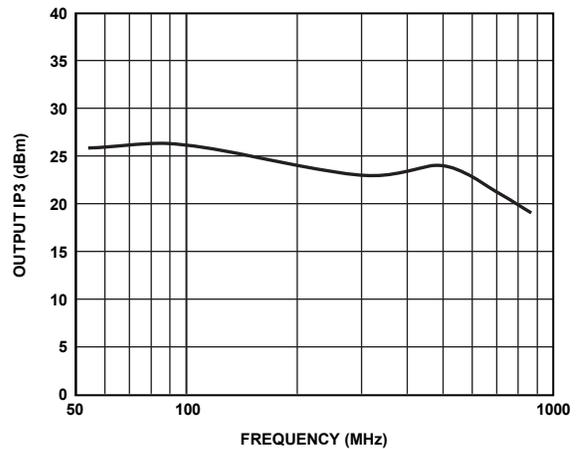


Figure 10. Output IP3 vs. Frequency

06539-010

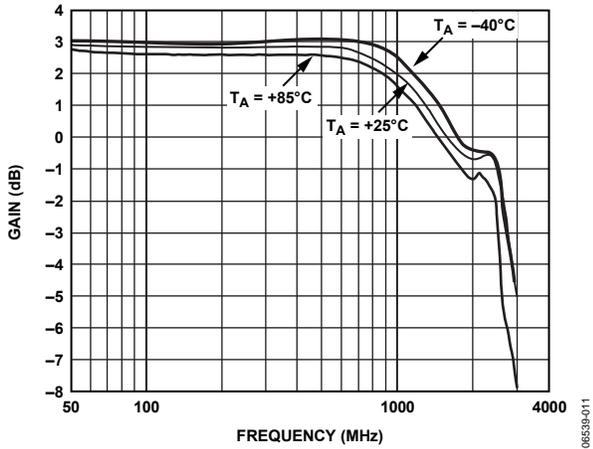


Figure 11. Gain ( $S_{21}$ ,  $S_{31}$ ) vs. Frequency

06639-011

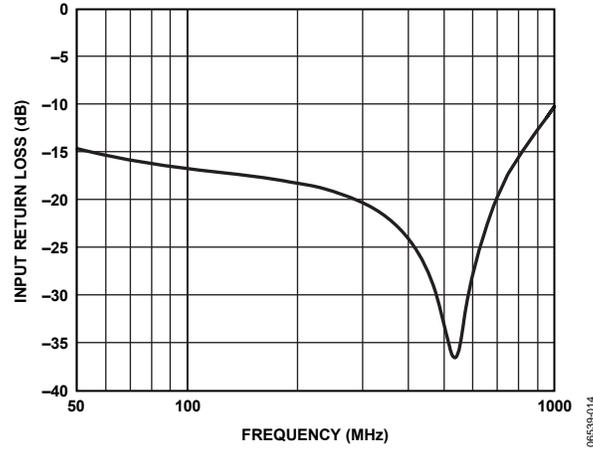


Figure 14. Input Return Loss ( $S_{11}$ ) vs. Frequency

06639-014

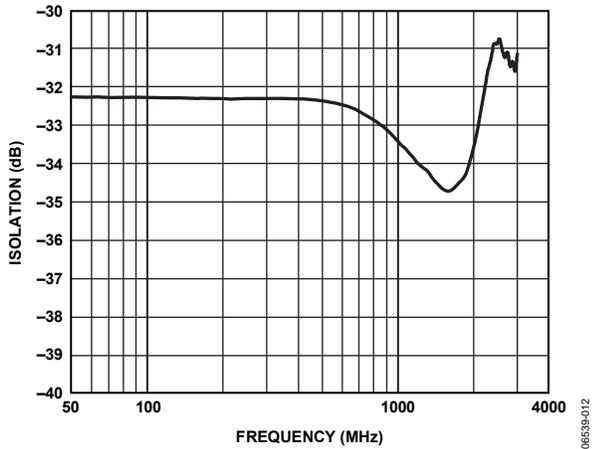


Figure 12. Output-to-Input Isolation ( $S_{12}$ ,  $S_{13}$ ) vs. Frequency

06639-012

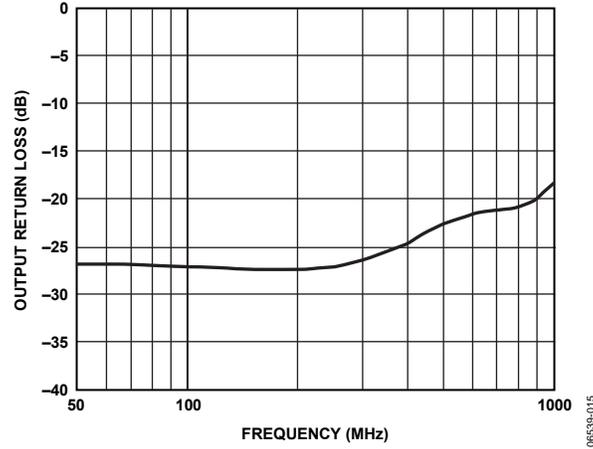


Figure 15. Output Return Loss ( $S_{22}$ ,  $S_{33}$ ) vs. Frequency

06639-015

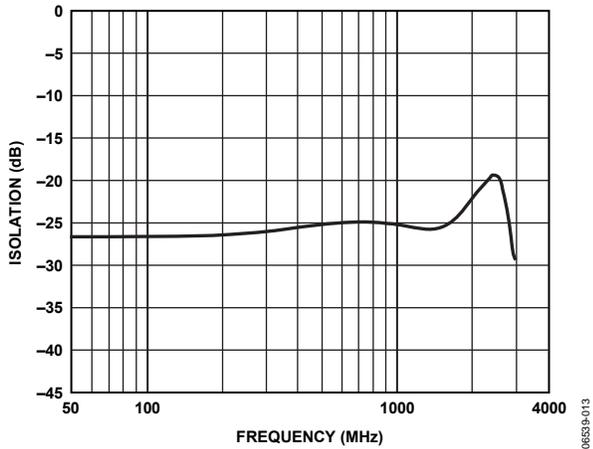


Figure 13. Output-to-Output Isolation ( $S_{23}$ ,  $S_{32}$ ) vs. Frequency

06639-013

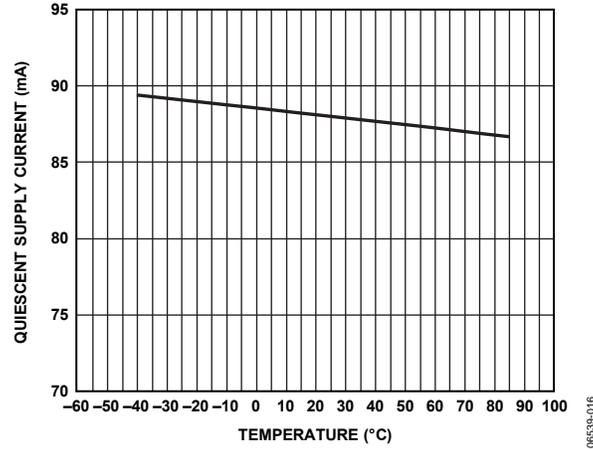


Figure 16. Quiescent Supply Current vs. Temperature

06639-016

TEST CIRCUITS

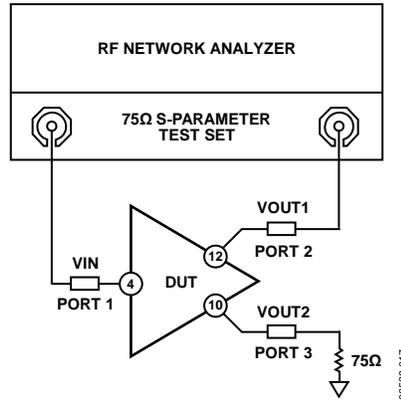


Figure 17. Test Circuit for  $S_{11}$ ,  $S_{12}$ ,  $S_{21}$ ,  $S_{22}$  Measurements

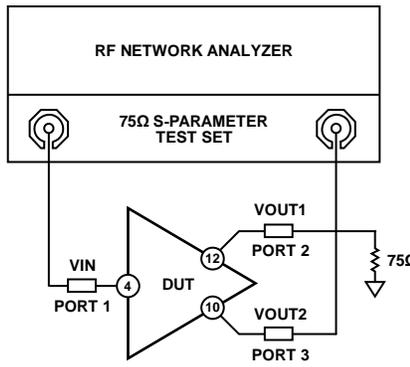


Figure 18. Test Circuit for  $S_{13}$ ,  $S_{31}$ ,  $S_{33}$  Measurements

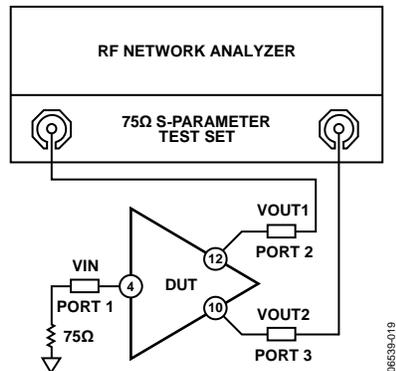


Figure 19. Test Circuit for  $S_{23}$ ,  $S_{32}$  Measurements

## APPLICATIONS INFORMATION

The [ADA4304-2](#) active splitter is primarily intended for use in the downstream path of television set-top boxes (STBs) that contain multiple tuners. It is typically located directly after the diplexer in a bidirectional CATV customer premise unit. The [ADA4304-2](#) provides a single-ended input and two single-ended outputs that allow the delivery of the RF signal to two different signal paths. These paths can include, but are not limited to, a main picture tuner, the picture-in-picture (PIP) tuner, an out-of-band (OOB) tuner, a digital video recorder (DVR), and a cable modem (CM).

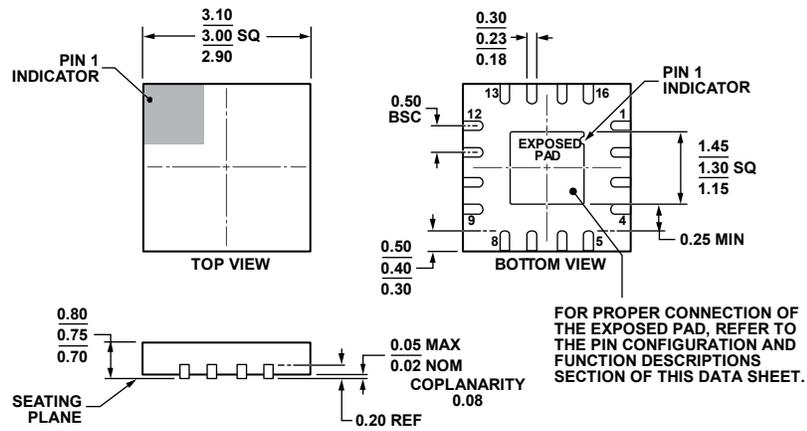
The [ADA4304-2](#) exhibits composite second order (CSO) and composite triple beat (CTB) products that are  $-62$  dBc and  $-72$  dBc, respectively. The use of the SiGe bipolar process also allows the [ADA4304-2](#) to achieve a noise figure (NF) of 4 dB.

## CIRCUIT DESCRIPTION

The [ADA4304-2](#) consists of a low noise buffer amplifier followed by a resistive power divider. This arrangement provides 2.8 dB of gain relative to the RF signal present at the input of the device. The input and each output must be properly matched to a  $75\ \Omega$  environment for distortion and noise performance to match the data sheet specifications. AC coupling capacitors of  $0.01\ \mu\text{F}$  are recommended for the input and outputs.

A  $1\ \mu\text{H}$  RF choke (Coilcraft chip inductor 0805LS-102X) is required to correctly bias internal nodes of the [ADA4304-2](#). It should be connected between the 5 V supply and the IL pin (Pin 14). The choke should be placed as close as possible to the [ADA4304-2](#) to minimize parasitic capacitance on the IL pin, which is critical for achieving the specified bandwidth and flatness.

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-220-WEED.

Figure 20. 16-Lead Lead Frame Chip Scale Package [LFCS]  
 3 mm × 3 mm Body and 0.75 mm Package Height  
 (CP-16-21)  
 Dimensions shown in millimeters

ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option	Ordering Quantity	Branding
ADA4304-2ACPZ-RL	-40°C to +85°C	16-Lead LFCS	CP-16-21	5,000	H0Z
ADA4304-2ACPZ-R7	-40°C to +85°C	16-Lead LFCS	CP-16-21	1,500	H0Z
ADA4304-2ACPZ-R2	-40°C to +85°C	16-Lead LFCS	CP-16-21	250	H0Z

<sup>1</sup> Z = RoHS Compliant Part.

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[ADA4304-4ACPZ-R2](#) [ADA4304-4ACPZ-R7](#) [ADA4304-3ACPZ-R7](#) [HMC760LC4B](#) [HMC577LC4B](#) [HMC370LP4E](#) [HMC444LP4E](#)  
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