

FEATURES

Ideal for CATV and terrestrial applications

2.4 GHz, -3 dB bandwidth

1 dB flatness: 54 MHz to 865 MHz

Low noise figure: 4.6 dB

Low distortion

Composite second-order (CSO): -62 dBc

Composite triple beat (CTB): -72 dBc

Nominal 3 dB gain per output channel

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

75 Ω input and outputs

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 ADA4304-3/ADA4304-4 are 75 Ω active splitters for use in applications where a lossless signal split is required. Typical applications include multituner digital set-top boxes, cable splitter modules, multituners/digital cable ready (DCR) televisions, and home gateways where traditional solutions require discrete passive splitter modules with separate fixed gain amplifiers.

Rev. 0

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FUNCTIONAL BLOCK DIAGRAMS

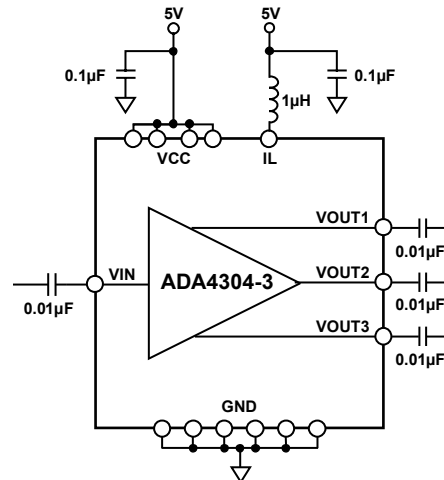


Figure 1.

07082-001

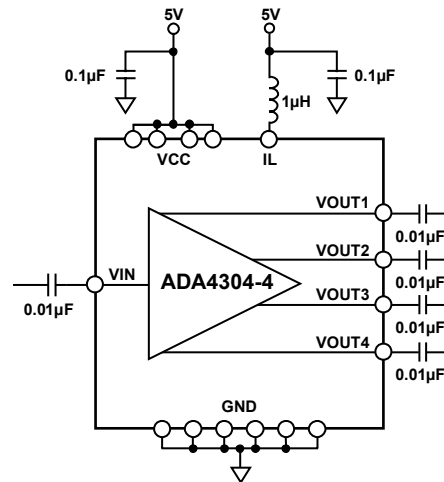


Figure 2.

07082-002

The ADA4304-3/ADA4304-4 are fabricated using the Analog Devices, Inc., proprietary silicon germanium (SiGe), complementary bipolar process, enabling them to achieve very low levels of distortion with a noise figure of 4.6 dB. The parts provide low cost alternatives that simplify designs and improve system performance by integrating a signal splitter element and a gain block into a single IC. The ADA4304-3/ADA4304-4 are available in a 16-lead LFCSP and operate in the extended industrial temperature range of -40°C to $+85^{\circ}\text{C}$.

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REVISION HISTORY

11/07—Revision 0: Initial Version

SPECIFICATIONS

V_{CC} = 5 V, 75 Ω system, T_A = 25°C, unless otherwise noted.

Table 1.

Parameter	Conditions	ADA4304-3			ADA4304-4			Unit
		Min	Typ	Max	Min	Typ	Max	
DYNAMIC PERFORMANCE								
	See Figure 19 for test circuit		2400		2400			
Bandwidth (–3 dB)								MHz
Frequency Range		54		865	54		865	MHz
Gain	f = 100 MHz		3.3			2.9		dB
Gain Flatness	54 MHz to 865 MHz		1.0			1.0		dB
NOISE/DISTORTION PERFORMANCE								
Noise Figure ¹	@ 54 MHz		4.0			4.0		dB
	@ 550 MHz		4.6			4.6		dB
	@ 865 MHz		4.8			4.8		dB
Output IP3	f ₁ = 97.25 MHz, f ₂ = 103.25 MHz		26			26		dBm
Output IP2	f ₁ = 97.25 MHz, f ₂ = 103.25 MHz		43			43		dBm
Composite Triple Beat (CTB)	135 channels, 15 dBmV/channel, f = 865 MHz		–72			–72		dBc
Composite Second Order (CSO)	135 channels, 15 dBmV/channel, f = 865 MHz		–62			–62		dBc
Cross Modulation (CXM)	135 channels, 15 dBmV/channel, 100% modulation @ 15.75 kHz, f = 865 MHz		–68			–68		dBc
INPUT CHARACTERISTICS								
Input Return Loss	See Figure 19 for test circuit							
	@ 54 MHz		–17	–13		–18	–14	dB
	@ 550 MHz		–22	–16		–21	–15	dB
	@ 865 MHz		–12	–8		–12	–8	dB
Output-to-Input Isolation	Any output, 54 MHz to 865 MHz							
	@ 54 MHz		–33	–30		–33	–31	dB
	@ 550 MHz		–33	–30		–33	–31	dB
	@ 865 MHz		–34	–31		–35	–32	dB
OUTPUT CHARACTERISTICS								
Output Return Loss	See Figure 19 and Figure 20 for test circuits							
	Any output, 54 MHz to 865 MHz							
	@ 54 MHz		–21	–17		–21	–17	dB
	@ 550 MHz		–16	–11		–17	–12	dB
	@ 865 MHz		–14	–9		–14	–9	dB
Output-to-Output Isolation	Any output, 54 MHz to 865 MHz							dB
	@ 54 MHz		–26			–26		dB
	@ 550 MHz		–25			–25		dB
	@ 865 MHz		–25			–25		dB
1 dB Compression (P1dB)	Output referred, f = 100 MHz		9.0			8.7		dBm
POWER SUPPLY								
Nominal Supply Voltage		4.75	5.0	5.25	4.75	5.0	5.25	V
Quiescent Supply Current			92	105		92	105	mA

¹ Characterized with 50 Ω 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 above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

THERMAL RESISTANCE

θ_{JA} is specified for the device (including exposed pad) soldered to a high thermal conductivity 4-layer (2s2p) circuit board, as described in EIA/JESD 51-7.

Table 3. Thermal Resistance

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

Maximum Power Dissipation

The maximum safe power dissipation in the ADA4304-3/ADA4304-4 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. 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, that is, the supply voltage (V_S) times the quiescent current (I_S). In Table 1, the maximum power dissipation of the ADA4304-3/ADA4304-4 can be calculated as

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

Airflow increases heat dissipation, effectively reducing θ_{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 θ_{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.

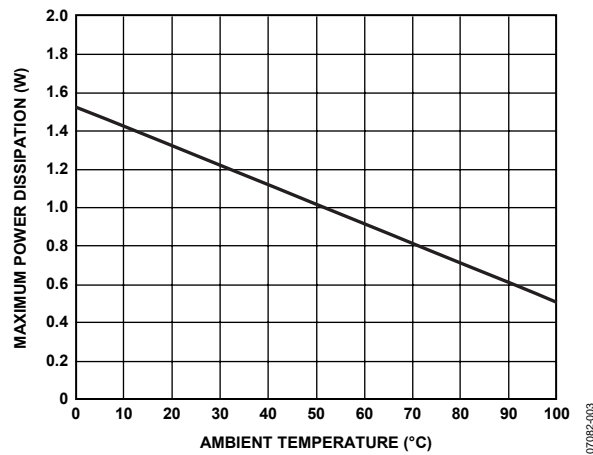


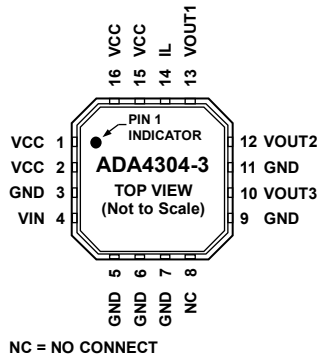
Figure 3. Maximum Power Dissipation vs. Temperature for a 4-Layer Board

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 CONFIGURATIONS AND FUNCTION DESCRIPTIONS



NC = NO CONNECT
 Figure 4. ADA4304-3 Pin Configuration

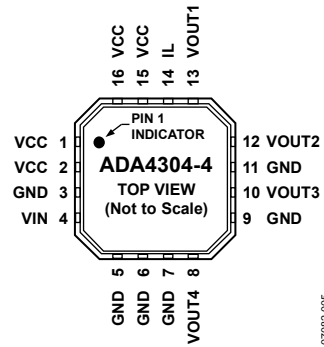


Figure 5. ADA4304-4 Pin Configuration

Table 4. ADA4304-3 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	NC	No Connection.
10	VOUT3	Output 3.
12	VOUT2	Output 2.
13	VOUT1	Output 1.
14	IL	Bias Pin.

Table 5. ADA4304-4 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	VOUT4	Output 4.
10	VOUT3	Output 3.
12	VOUT2	Output 2.
13	VOUT1	Output 1.
14	IL	Bias Pin.

TYPICAL PERFORMANCE CHARACTERISTICS

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

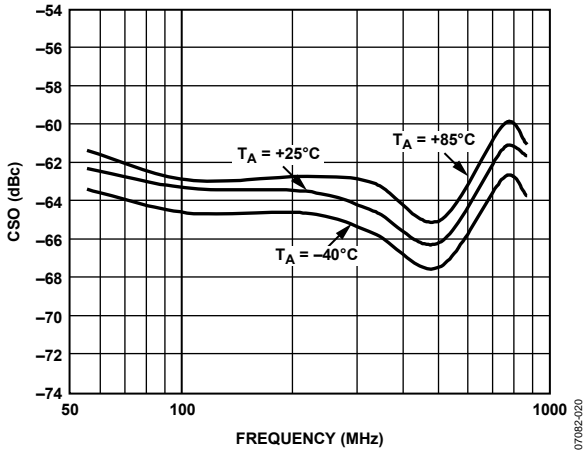


Figure 6. Composite Second Order (CSO) vs. Frequency

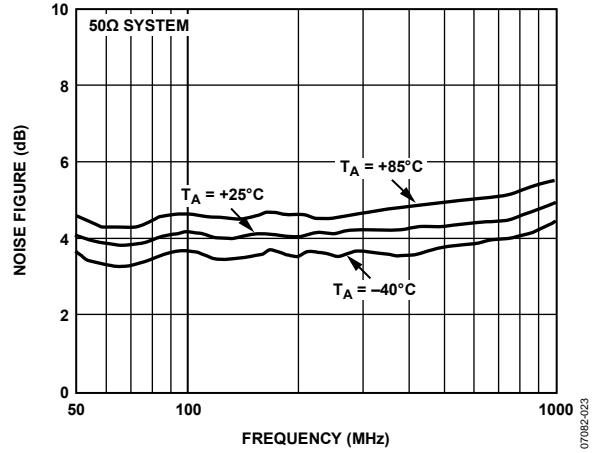


Figure 9. Noise Figure vs. Frequency

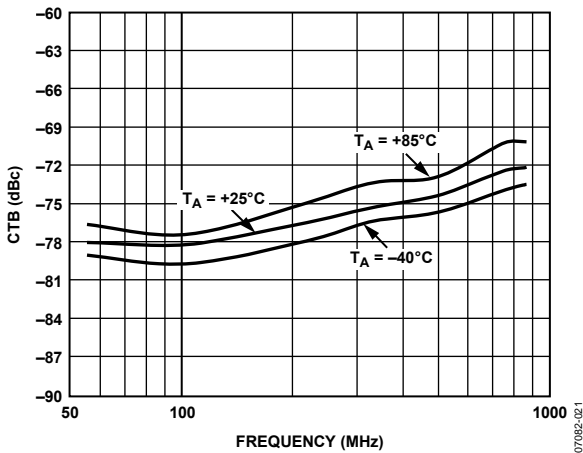


Figure 7. Composite Triple Beat (CTB) vs. Frequency

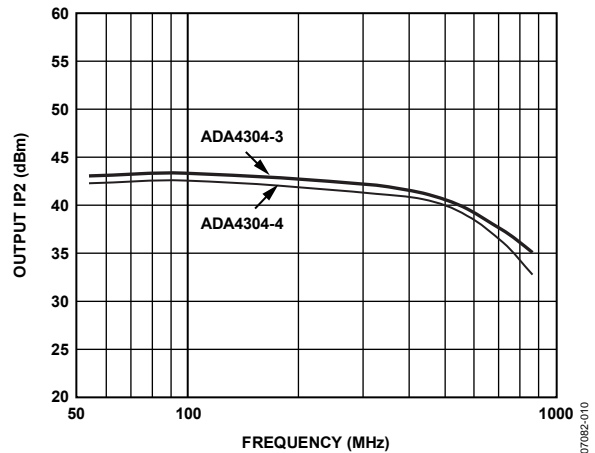


Figure 10. Output IP2 vs. Frequency

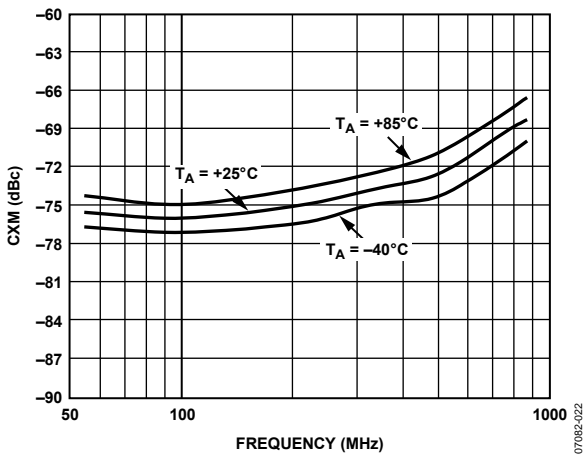


Figure 8. Cross Modulation (CXM) vs. Frequency

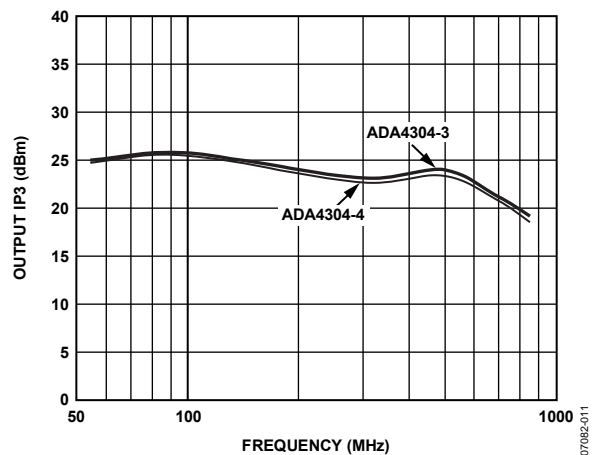


Figure 11. Output IP3 vs. Frequency

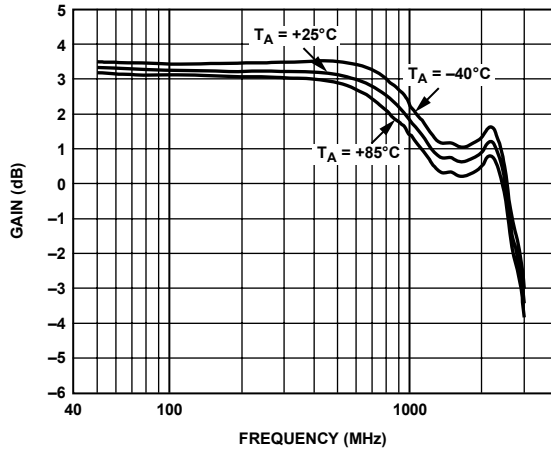


Figure 12. ADA4304-3 Gain vs. Frequency

07082-024

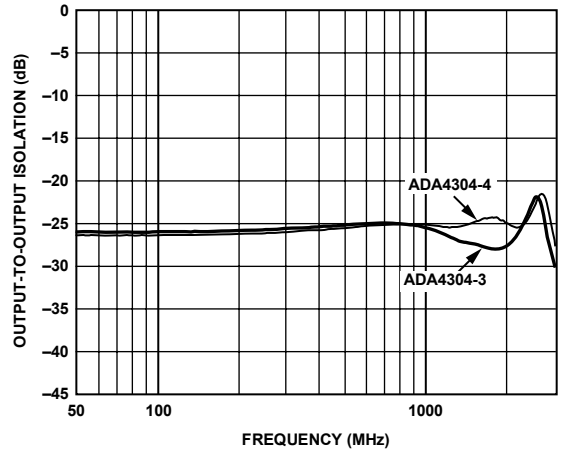


Figure 15. Output-to-Output Isolation vs. Frequency

07082-014

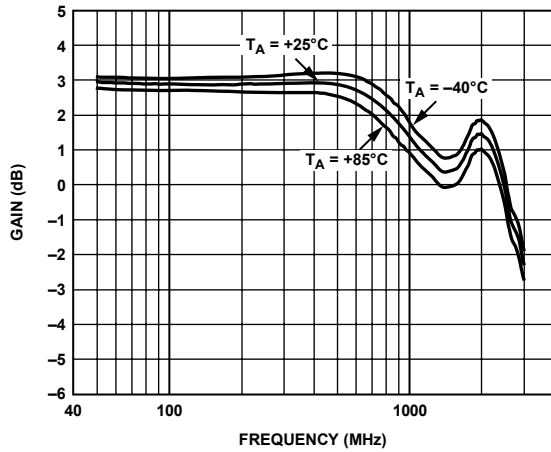


Figure 13. ADA4304-4 Gain vs. Frequency

07082-025

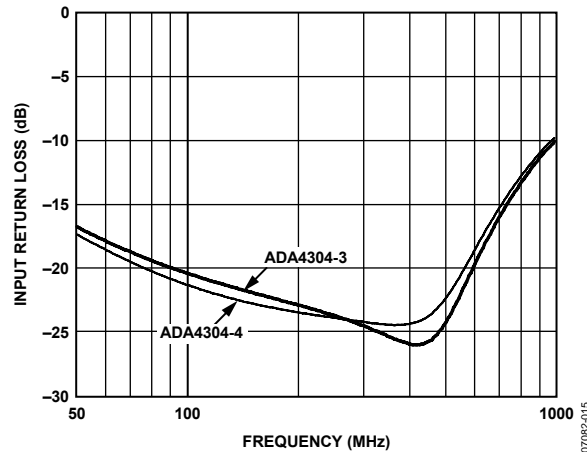


Figure 16. Input Return Loss vs. Frequency

07082-015

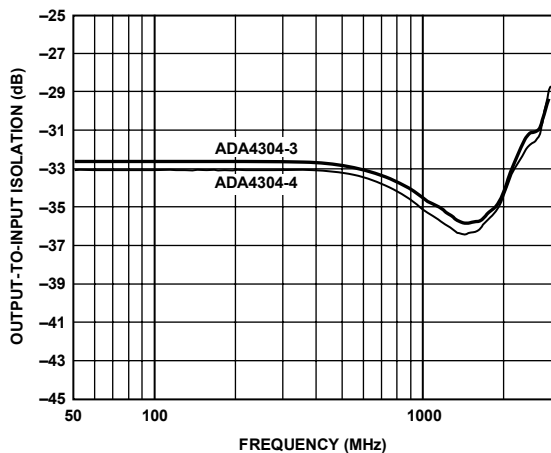


Figure 14. Output-to-Input Isolation vs. Frequency

07082-013

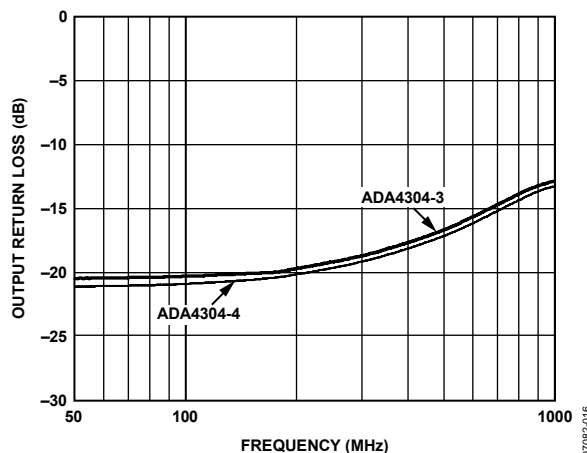


Figure 17. Output Return Loss vs. Frequency

07082-016

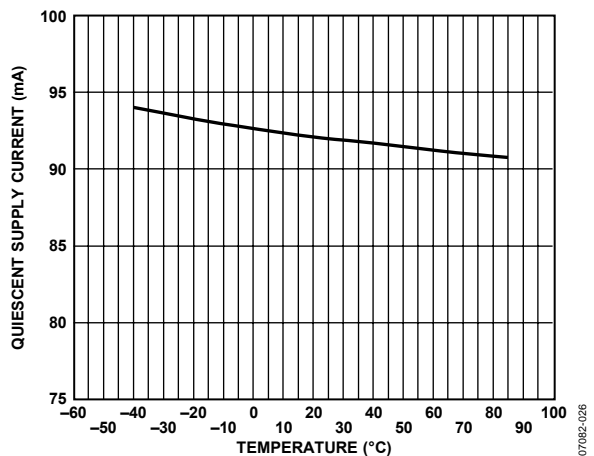
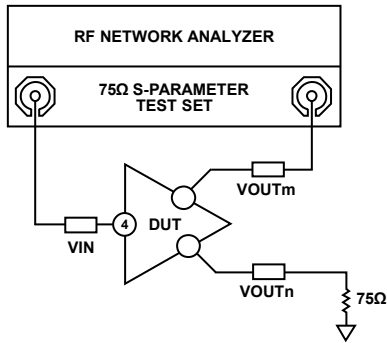


Figure 18. Quiescent Supply Current vs. Temperature

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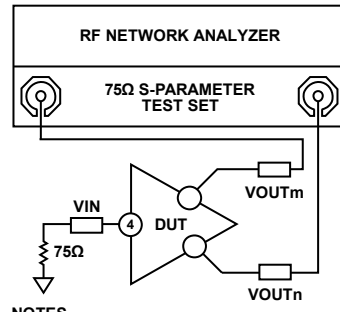
TEST CIRCUITS



NOTES
 1. TESTED FOR ALL COMBINATIONS OF VOUTm AND VOUTn.

07082-018

Figure 19. Test Circuit for Transmission, Isolation, and Reflection Measurements



NOTES
 1. TESTED FOR ALL COMBINATIONS OF VOUTm AND VOUTn.

07082-019

Figure 20. Test Circuit for Output-to-Output Isolation Measurements

APPLICATIONS

The ADA4304-3/ADA4304-4 active splitters are primarily intended for use in the downstream path of television set-top boxes (STBs) that contain multiple tuners. They are typically located directly after the diplexer in a bidirectional CATV customer premise unit. The ADA4304-3/ADA4304-4 provide a single-ended input and three or four single-ended outputs that allow the delivery of the RF signal to multiple 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 ADA4304-3/ADA4304-4 exhibit 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 ADA4304-3/ADA4304-4 to achieve a noise figure (NF) of 4.6 dB at 550 MHz.

CIRCUIT DESCRIPTION

The ADA4304-3/ADA4304-4 consist of a low noise buffer amplifier followed by a resistive power divider. This arrangement provides 3.3 dB (ADA4304-3) or 2.9 dB (ADA4304-4) 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 75Ω 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 the internal nodes of the ADA4304-3/ADA4304-4. 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 ADA4304-3/ADA4304-4 to minimize parasitic capacitance on the IL pin, which is critical for achieving the specified bandwidth and flatness.

EVALUATION BOARDS

The ADA4304-3/ADA4304-4 evaluation board allows designers to assess the performance of the parts in their particular application. The board includes 75Ω coaxial connectors and 75Ω controlled-impedance signal traces that carry the input and output signals. Power (5 V) is applied to the red VCC loop connector, and ground is connected to the black GND loop connector. Figure 21 is a schematic of the evaluation board. On the ADA4304-3 evaluation board, connector VO4 and C7 are not populated.

RF LAYOUT CONSIDERATIONS

Appropriate impedance matching techniques are mandatory when designing circuit boards for the ADA4304-3/ADA4304-4. Improper characteristic impedances on traces can cause reflections that can lead to poor linearity. The characteristic impedance of the signal trace to the input and from each output should be 75Ω . Any ground metal on the top surface near signal lines should be stitched with vias to the internal ground plane, as shown in Figure 22. The device package exposed paddle must be reflow soldered to a low inductance ground to achieve data sheet performance specifications. This is achieved by connecting the footprint ground pad with vias to a ground plane below (see Figure 22).

POWER SUPPLY

The 5 V supply should be applied to each VCC pin and RF choke via a low impedance power bus. The power bus should be decoupled to ground using a $10 \mu\text{F}$ tantalum capacitor and a $0.1 \mu\text{F}$ ceramic chip capacitor located close to the ADA4304-3/ADA4304-4. In addition, the VCC pins should be decoupled to ground with a $0.1 \mu\text{F}$ ceramic chip capacitor located as close to each pin as possible.

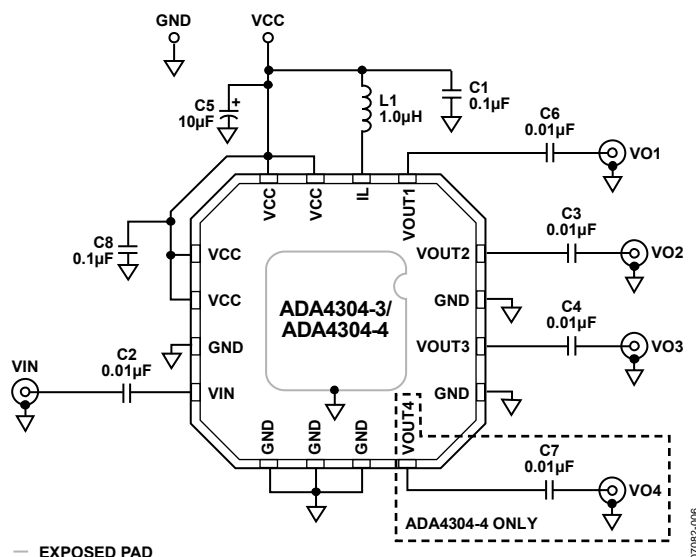


Figure 21. Evaluation Board Schematic

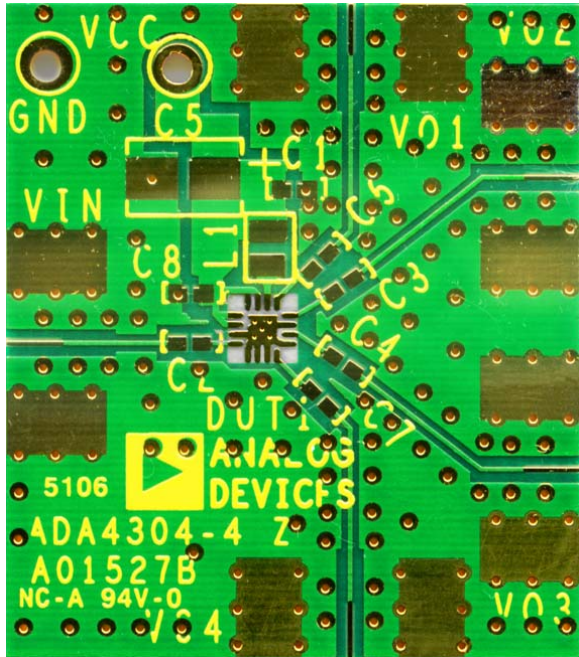


Figure 22. Evaluation Board

071082-007

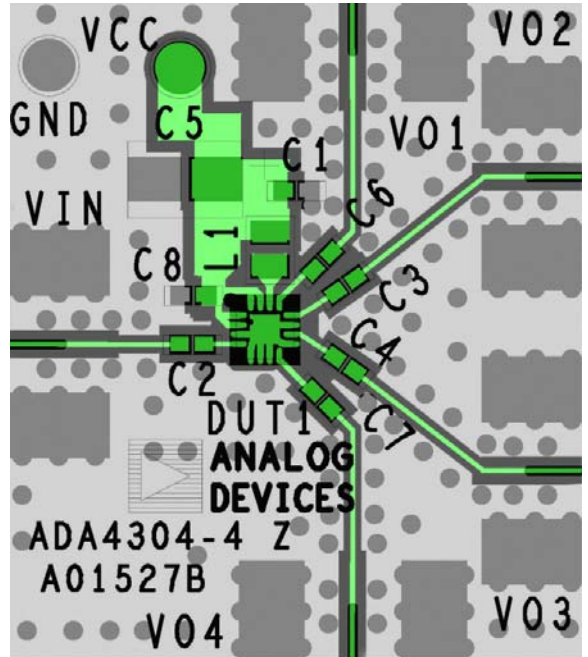
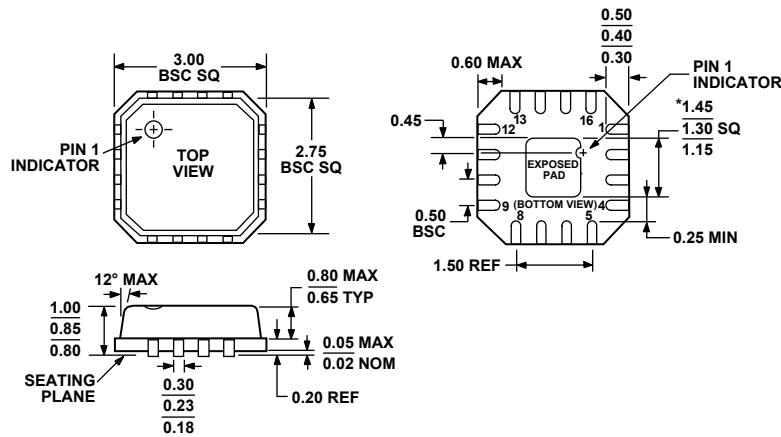


Figure 23. Evaluation Board Component Layout

071082-008

OUTLINE DIMENSIONS



*COMPLIANT TO JEDEC STANDARDS MO-220-VEED-2 EXCEPT FOR EXPOSED PAD DIMENSION.

Figure 24. 16-Lead Lead Frame Chip Scale Package [LFCSP_VQ]
 3 mm × 3 mm Body, Very Thin Quad
 (CP-16-2)
 Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Ordering Quantity	Branding
ADA4304-3ACPZ-RL ¹	-40°C to +85°C	16-Lead LFCSP_VQ	CP-16-2	5,000	H16
ADA4304-3ACPZ-R7 ¹	-40°C to +85°C	16-Lead LFCSP_VQ	CP-16-2	1,500	H16
ADA4304-3ACPZ-R2 ¹	-40°C to +85°C	16-Lead LFCSP_VQ	CP-16-2	250	H16
ADA4304-4ACPZ-RL ¹	-40°C to +85°C	16-Lead LFCSP_VQ	CP-16-2	5,000	H10
ADA4304-4ACPZ-R7 ¹	-40°C to +85°C	16-Lead LFCSP_VQ	CP-16-2	1,500	H10
ADA4304-4ACPZ-R2 ¹	-40°C to +85°C	16-Lead LFCSP_VQ	CP-16-2	250	H10

¹ Z = RoHS Compliant Part.