Mailing Address: PO Box 11400, Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd., Tucson, AZ 85706
Tel: (520) 746-1111 • Telex: 066-6491 • FAX (520) 889-1510 • Product Info: (800) 548-6132 • Internet: www.burr-brown.com/

COMPARING THE ADS1201 TO THE CS5321

By Robert Schreiber

INTRODUCTION

The ADS1201 is a high dynamic range, low-cost, ΔΣ modulator. Although the performance of the ADS1201 can be assessed with the DEM-ADS1201U demonstration board, there have been numerous independent evaluations of the ADS1201 in a variety of systems. The comparisons were undertaken due to the high performance and significant cost savings of the ADS1201 over alternative solutions. By direct comparison to other solutions, the exceptional value of the ADS1201 becomes apparent.

The intent of this application bulletin is to provide a simple means of comparing the operation of the ADS1201 ΔΣ modulator to Crystal's CS5321 ΔΣ modulator. It is not the intent of this document to describe the theory or the operation behind ΔΣ modulators, it is merely to provide the methodology, configuration, and results of tests that were performed using these modulators with a common digital filter. The theory of operation and device specifications can be found in the individual data sheets for these parts.

TEST OVERVIEW

The tests were performed by an independent evaluator, Martin Company, using the CS5321 evaluation board. The CS5321 evaluation board was designed to demonstrate the performance of the CS5321 ΔΣ modulator with the CS5322 digital filter. The CS5321 accepts an analog input and outputs a high-rate, low-resolution bit-stream to the CS5322 digital filter. The result from the digital filter is a low-rate, high resolution (24-bit) digital representation of the analog value. Since the basic operation of the ADS1201 and CS5321 is the same, the ADS1201 modulator can be used with the CS5322 filter to obtain the same 24-bit digital representation. The following paragraph is an overview of how the CS5321 evaluation board was setup to accommodate both the ADS1201 and the CS5321.

The CS5321 was removed from the evaluation board and replaced with socketed pins. The ADS1201 was evaluated by inserting the DEM-ADS1201UADP board into the socketed pins. It should be noted that the CS5321 evaluation board was optimized to demonstrate the performance of the CS5321. The CS5321 evaluation board does not demonstrate the optimum performance of the ADS1201, therefore, the actual in-circuit performance of the ADS1201 with the digital filter may be significantly better than the test results indicate.

Some key points about the comparison are listed below:

1. HBR = 1 mode was used with a MCLK frequency of 1.024MHz, which according to the CS5321 specification, gives the best performance of the part. In this mode, the CS5321 internally divides MCLK by 4, resulting in an MDATA rate of 256kHz (to the CS5322 digital filter).

   The ADS1201 does not internally divide MCLK by 4; the ADS1201 shifts data out at the MCLK rate. Therefore an external counter (divided by 4) was required to slow the MCLK to the ADS1201 and thus, the MDATA rate from the ADS1201 to the CS5322. Due to this limitation of the CS5322 digital filter, the ADS1201 MCLK rate was run at 256kHz, not the optimal rate of 320kHz.

2. The ADS1201 operates from a single +5VDC supply and has a differential voltage range of ±5V with respect to the A_{IN+} and A_{IN-} pins (the differential voltage range is ±10V when V_{BIAS} is used).

   The CS5321 operates from both a +5VDC and –5VDC supply and has a single-ended voltage range of ±4.5V with respect to ground.

3. The CS5321 uses an LTC1019-4.5 voltage reference. The ADS1201 requires a 2.5V reference. The DEM-ADS1201UADP demo board allows two options for the ADS1201 reference. First, the REF1004-2.5 on the DEM-ADS1201UADP board can be used. Alternately, an LTC1019-2.5 can be inserted in the socket on the CS5321 demo board in place of the LTC1019-4.5. The REF1004-2.5 offers comparable performance to the LTC1019 at a lower cost.

TEST SETUP

CS5321 SETUP AND CONFIGURATION

In order to use the DEM-ADS1201UADP with the CS5321 evaluation board, U2 (CS5321) must be replaced with the DEM-ADS1201UADP board (see Figure 1). All components needed for the modification are included with the DEM-ADS1201UADP kit. The instructions for making the modifications are listed below.

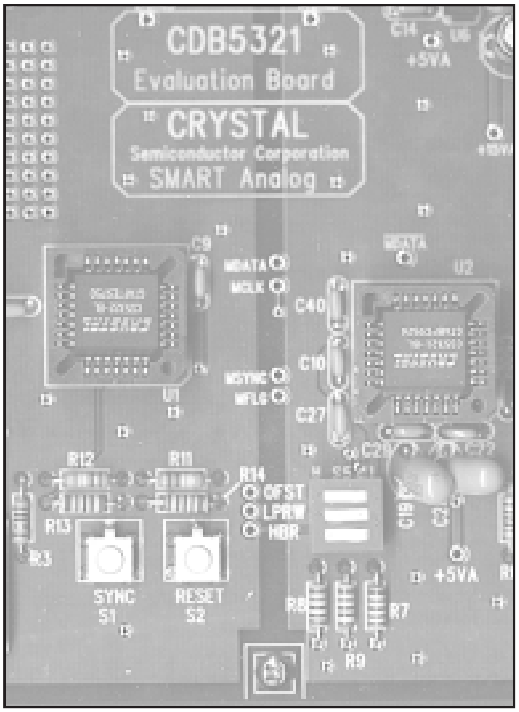

FIGURE 1. Socketed CS5321.

To insert the DEM-ADS1201UADP into the CS5321 evaluation board, the CS5321 must be first be removed from the board. It is recommended to install socketed pins in the CS5321 evaluation board to allow for ease in inserting and removing the DEM-ADS1201UADP board and the socketed CS5321. The socketed pins are provided with the DEM-ADS1201UADP, but may also be obtained from Robinson Nugent (part number SBE-100-S-TG30, and the web site is www.robinsonnugent.com). Figure 2 shows the CS5321 evaluation board after insertion of the socketed pins.

The DEM-ADS1201UADP should be inserted as shown in Figure 3. Note the orientation reference on the DEM-ADS1201UADP to the CS5322 (silkscreen arrow pointing to the CS5322).

The CS5321 uses a 4.5V reference and the ADS1201 uses a 2.5V reference. The DEM-ADS1201UADP provides two options for the voltage reference. The on-board REF1004-2.5 can be used, or optionally, the LTC1019-4.5 on the CS5321 evaluation board can be replaced with the LTC1019-2.5.

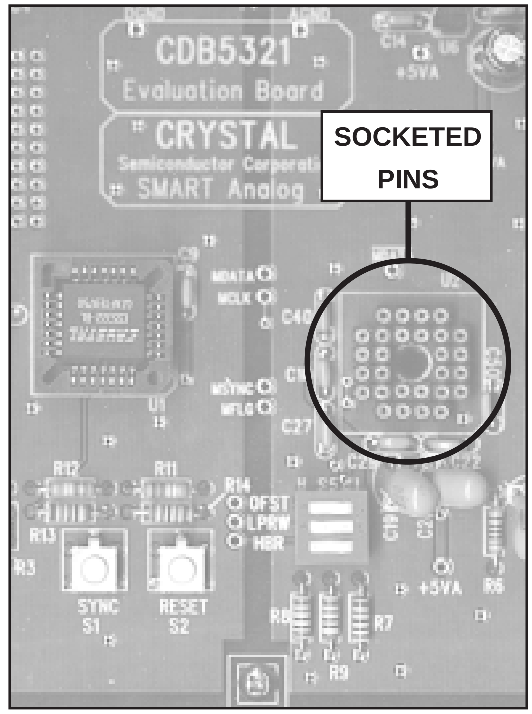

FIGURE 2. CS5321 Socketed Pins Replacement.

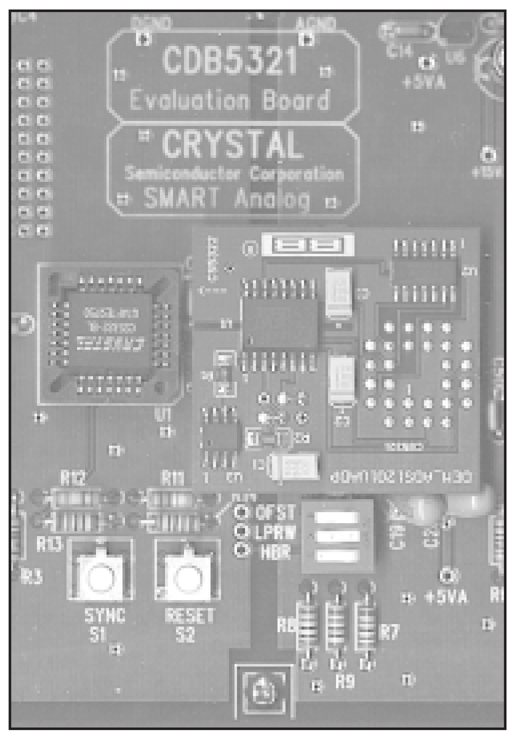

FIGURE 3. Insertion of the DEM-ADS1201UADP into the CS5321 Evaluation Board.

The switch settings on the CS5321 board should be set to their recommended default states for optimal performance with the CS5321. The default settings are listed in Table I.

S3 SETTINGS	S4 SETTINGS	S5 SETTINGS
USEOR = ON	DECA = OFF	OFST = 1
ORCAL = ON	DECB = OFF	LPRW = 0
SID = OFF	DECC = ON	HBR = 1
ERR = OFF	PWDN = ON	
RSEL = OFF	H/S = OFF	
CS = ON	CSEL = ON	
R/W = OFF	TDATA = ON	
JP13 CLOSED		
J4 = CLK/2 (1.024MHz CLKIN to the CS5321)		

TABLE I. CDB5321 Evaluation Board Settings.

DEM-ADS1201UADP SETUP AND CONFIGURATION

The operation of the DEM-ADS1201UADP is straightforward. The schematic is shown in Figure 4.

The interface of the DEM-ADS1201UADP to the CS5321 evaluation board is accomplished through the seven signals described in Table II. The pin numbers listed below reference the pin number on the CS5321 socket as shown in Figure 4.

PIN #	NAME	DESCRIPTION
2	V_{DD1}	Positive Analog Supply Voltage
5	V_{REF+}	This pin is the Reference Voltage from the LTC1019-4.5. For the CS5321, a 4.5V reference is used. For the ADS2101, a 2.5V reference is used. The LTC1019-2.5 may be used as an alternative voltage reference to the REF1004-2.5. This is accomplished by replacing U8 (LTC1019) on the CS5321 evaluation board with the appropriate voltage reference and modifying the jumper settings on the DEM-ADS1201UADP board.
9	A_{IN+}	Positive Analog Input
18	MDATA	Modulator Output Data from the ADS1201/CS5321 to the CS5322. The MDATA is shifted out of the ADS1201/CS5321 at a 256kHz rate.
22	V_{DD2}	Positive Digital Supply Voltage
20	MCLK	Modulator Input Clock from the CS5322 to the ADS1201/CS5321. The evaluation board default setting for MCLK is 1.024MHz. The CS5321 internally divides this clock by 4 to clock the modulator. Since the ADS1201 uses MCLK to directly clock the modulator, an external divide by 4 is needed to ensure synchronization with the CS5322. Therefore, a counter (74HCT393) is used.
25	MSYNC	This is used by the CS5322 to synchronize MCLK with MDATA for the ADS1201/CS5321. This is needed as the CS5321 internally divides MCLK by 4 to clock the modulator. This signal is tied to the CLR pin of the 74HCT393 to ensure synchronization when using the ADS1201.

TABLE II. Pin Descriptions.

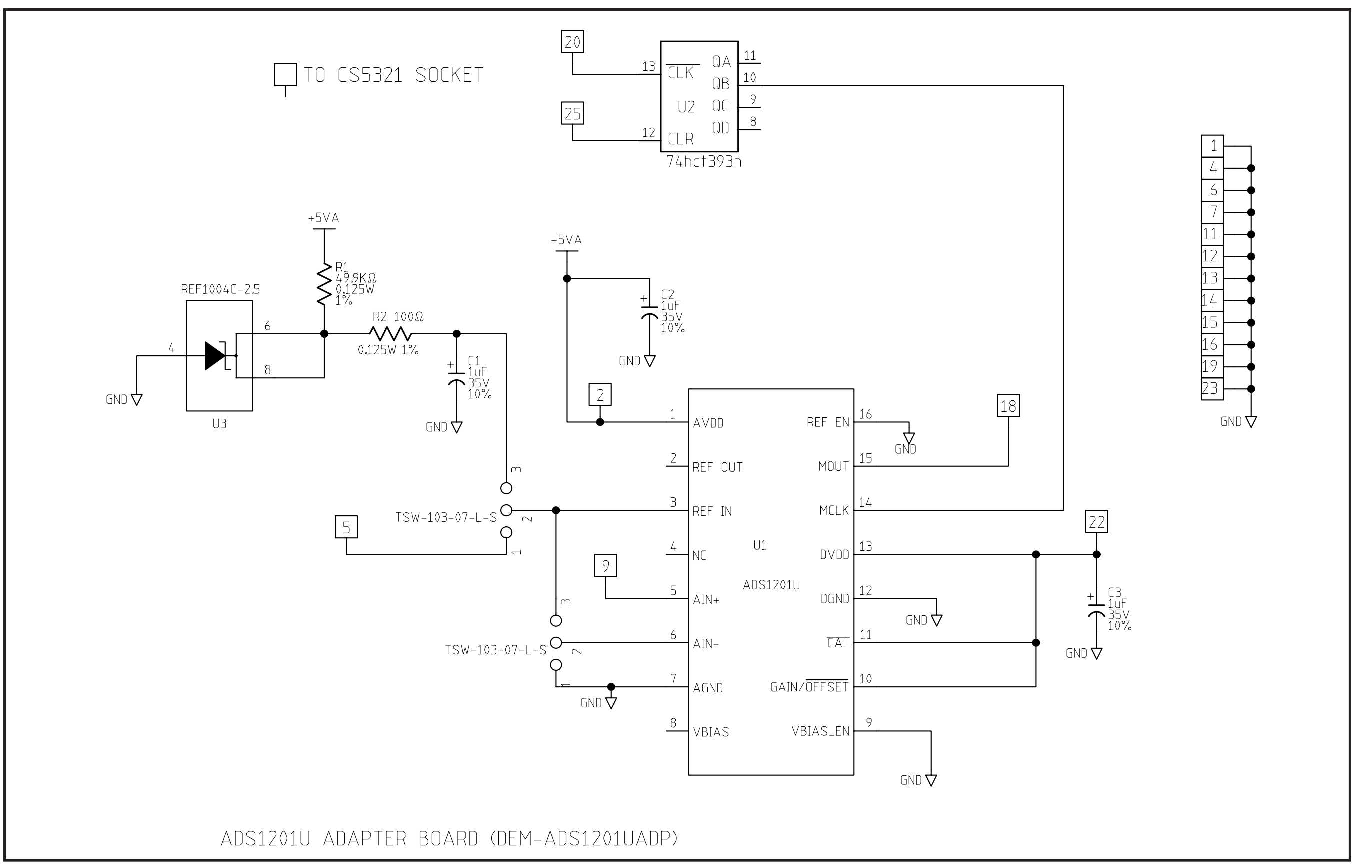

FIGURE 4. DEM-ADS1201UADP Schematic.

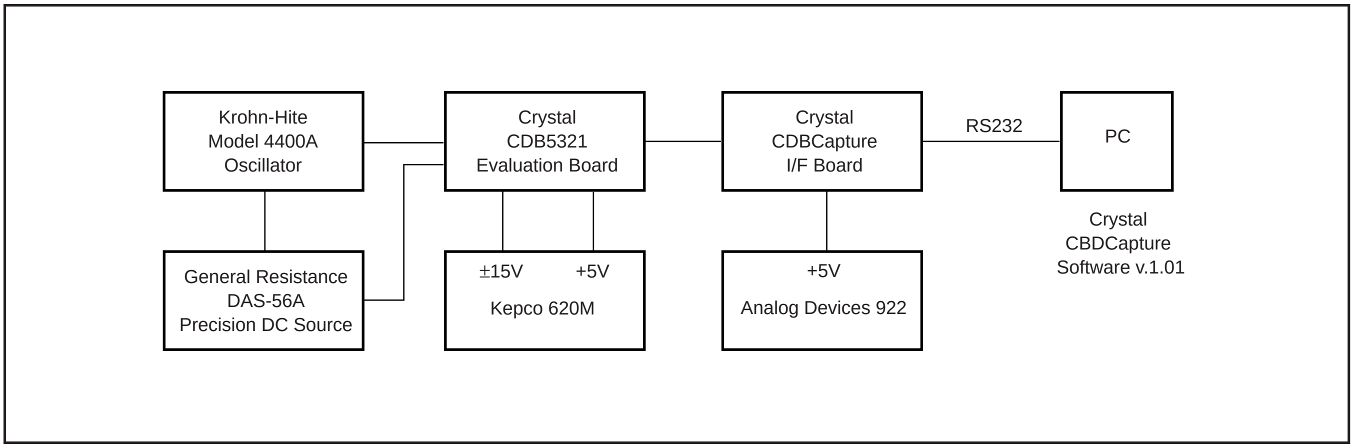

FIGURE 5. Test Equipment Setup.

The DEM-ADS1201UADP has two sets of through holes for configuring the V_{REF} and the A_{IN-} Input.

The three through holes near R2 on the DEM-ADS1201UADP control whether V_{REF} comes from the REF1004-2.5 or the LTC1019-2.5. When a wire is placed in the two through holes near U3 and R2 (the default setting), the REF1004-2.5 is the source for V_{REF} (see Figure 3). When a wire is placed in the two through holes near C2, the LTC1019-2.5 is the source for the V_{REF}. Note that when using the DEM-ADS1201UADP board with the LTC1019 V_{REF} enabled, the LTC1019-4.5 (U8 on the CS5321 evaluation board) must be replaced with the LTC1019-2.5. Refer to Table III.

WIRE SETTINGS	CONDITION
Upper (by R2)	V_{REF} tied to REF1004-2.5 (default)
Lower (by C2)	V_{REF} tied to LTC1019-2.5
Open	V_{REF} unconnected

TABLE III. V_{REF} Wire Settings.

The three through holes near U_1 (at the A_{IN-} input) control whether A_{IN-} is tied to AGND or V_{REF}. When a wire is placed in the upper two through holes near R1, the A_{IN-} pin is tied to the V_{REF} (see Figure 3). When a wire is placed in the lower two through holes near C2, the A_{IN-} pin is tied to AGND (the default setting). Refer to Table IV.

WIRE SETTINGS	CONDITION
Upper (by R1)	A_{IN-} tied to external V_{REF}
Lower (by C2)	A_{IN-} tied to AGND (default)
Open	A_{IN-} unconnected

TABLE IV. A_{IN-} Wire Settings.

TEST EQUIPMENT SETUP AND CONFIGURATION

TEST EQUIPMENT

1. Krohn-Hite 4400A Oscillator
2. General Resistance DAS-56A DC Source
3. CDB5321 Evaluation Board
4. CDBCAPTURE Interface Board
5. Kepco 620M Power Supply
6. Analog Devices 922 Power Supply
7. ADS1201 Adaptor Board

TEST CONFIGURATION

The test equipment was set up as shown in Figure 5. Data was taken with no signal input and a 32Hz sinewave input for both devices. The Krohn-Hite Oscillator was configured for a 5.0Vp-p 32Hz input. The General Resistance DAS-56A was configured for a 2.5V offset.

TEST RESULTS

The test results are shown in Figures 6 through 10. Figure 6 shows the performance of the ADS1201 in the DEM-ADS1201U Demo Board with no input signal (for reference purposes). Figure 7 shows the ADS1201 in the CS5321 evaluation board with no input signal. Figure 8 shows the CS5321 in the CS5321 evaluation board with no input signal. Figure 9 shows the ADS1201 in the CS5321 evaluation board with a 32Hz signal input. Figure 10 shows the CS5321 in the CS5321 evaluation board with a 32Hz signal.

The test results summary is shown in Table V. The test results were calculated by the CS5321 evaluation board software from data taken with a 32Hz, 5Vp-p, sinewave input.

PARAMETER	ADS1201	CS5321
S/N+D (dB)	93.949	96.294
S/D (dB)	97.896	99.684
S/N (dB)	95.836	98.602

TABLE V. Data from 32Hz, 5Vp-p Sinewave Source.

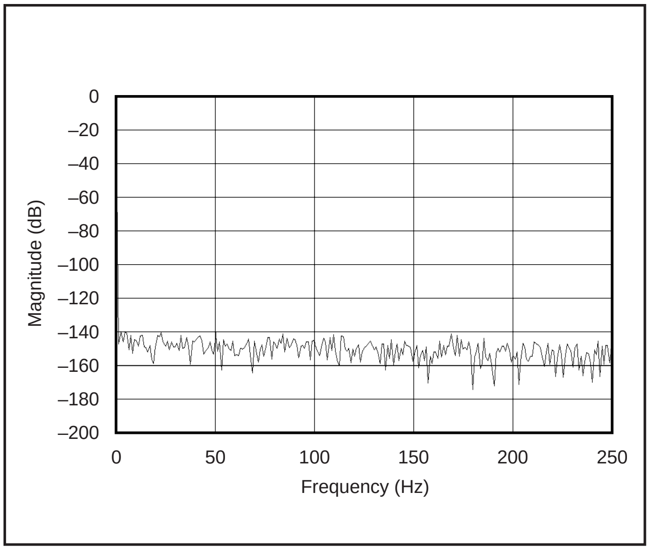

FIGURE 6. ADS1201 in the DEM-ADS1201U Demo Board with No Input Signal.

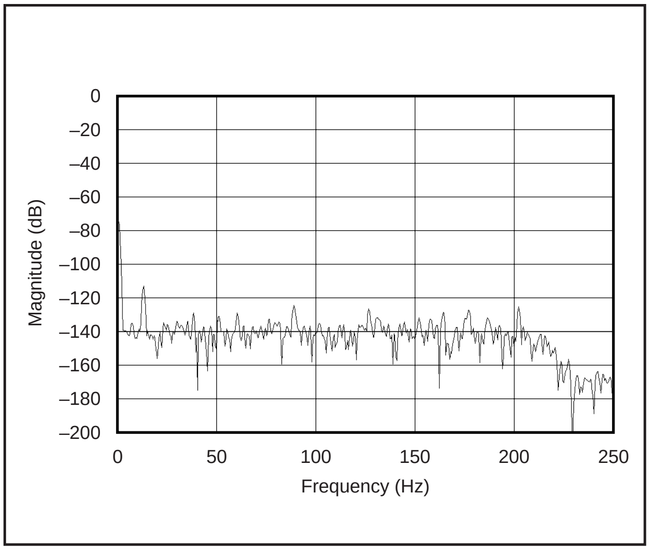

FIGURE 7. ADS1201 in the CS5321 Evaluation Board with No Input Signal.

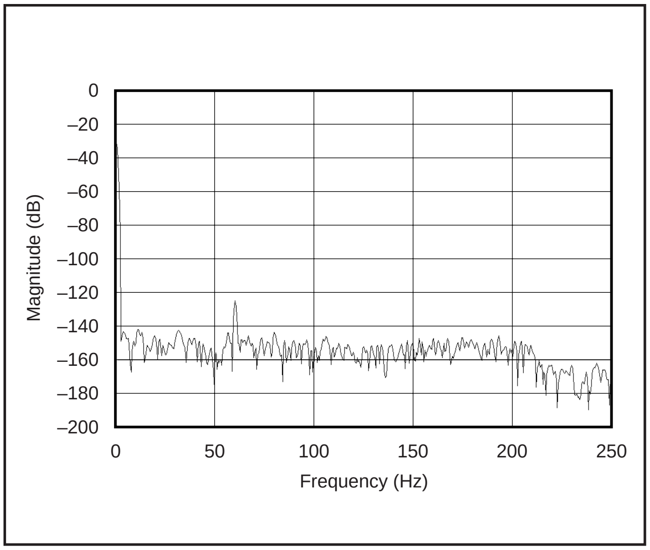

FIGURE 8. CS5321 in the CS5321 Evaluation Board with No Input Signal.

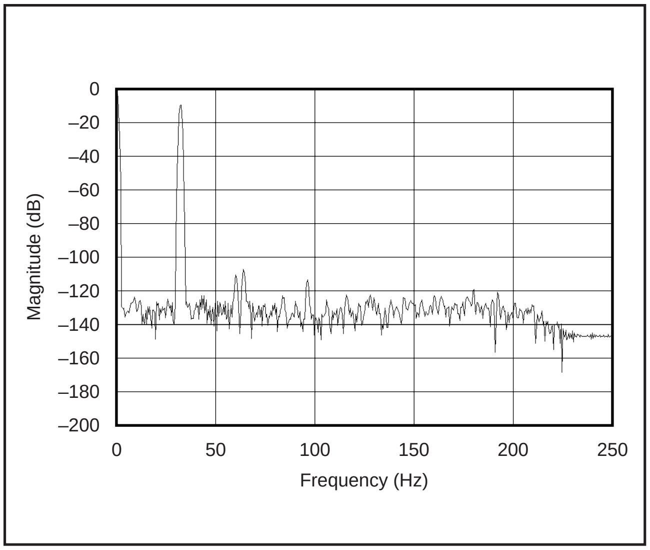

FIGURE 9. ADS1201 in the CS5321 Evaluation Board with a 32Hz, 5Vp-p Sinewave Input.

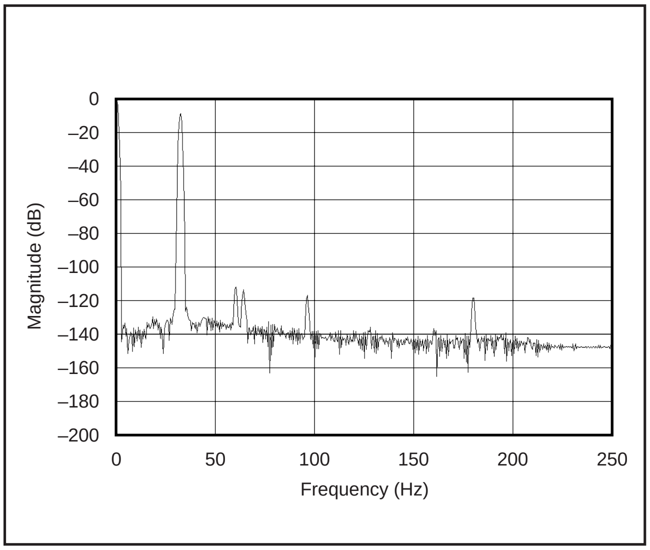

FIGURE 10. CS5321 in the CS5321 Evaluation Board with a 32Hz, 5Vp-p Sinewave Input.

Testing Performed by:
Martin Company
1117 Lawrence Street
Rosenberg, Texas 77471
TEL: 281-342-7431
FAX: 281-342-5925
www.martincomp.com

DEM-ADS1201UADP BILL OF MATERIALS

REF DESIGNATOR	QUANTITY	PART NUMBER	DESCRIPTION	VENDOR
R1	1	CRCW12064992F	50kΩ Resistor 0.125Ω, 1% Chip Thick-Film	Dale
R2	1	CRCW12061000F	100Ω Resistor 0.125Ω, 1% Chip Thick-Film	Dale
C1, C2, C3	3	T491A105K016AS	1µf, 20V, 10% Tantalum Chip-Molded Capacitor	Kemet
U1	1	ADS1201U	Delta-Sigma Modulator	Burr-Brown
U2	1	74HCT393	4-Bit Counter	
U3	1	REF1004C-2.5	2.5V Voltage Reference	Burr-Brown
Male Socket Pins	28	09-8090-2-03	PLCC-28 Socket Replacement Pins (Male)	Concord
Female Socket PIns	28	SBE-100-S-TG30	PLCC-28 Socket Replacement Pins (Female)	Robinson Nugent

DEM-ADS1201UADP LAYOUT

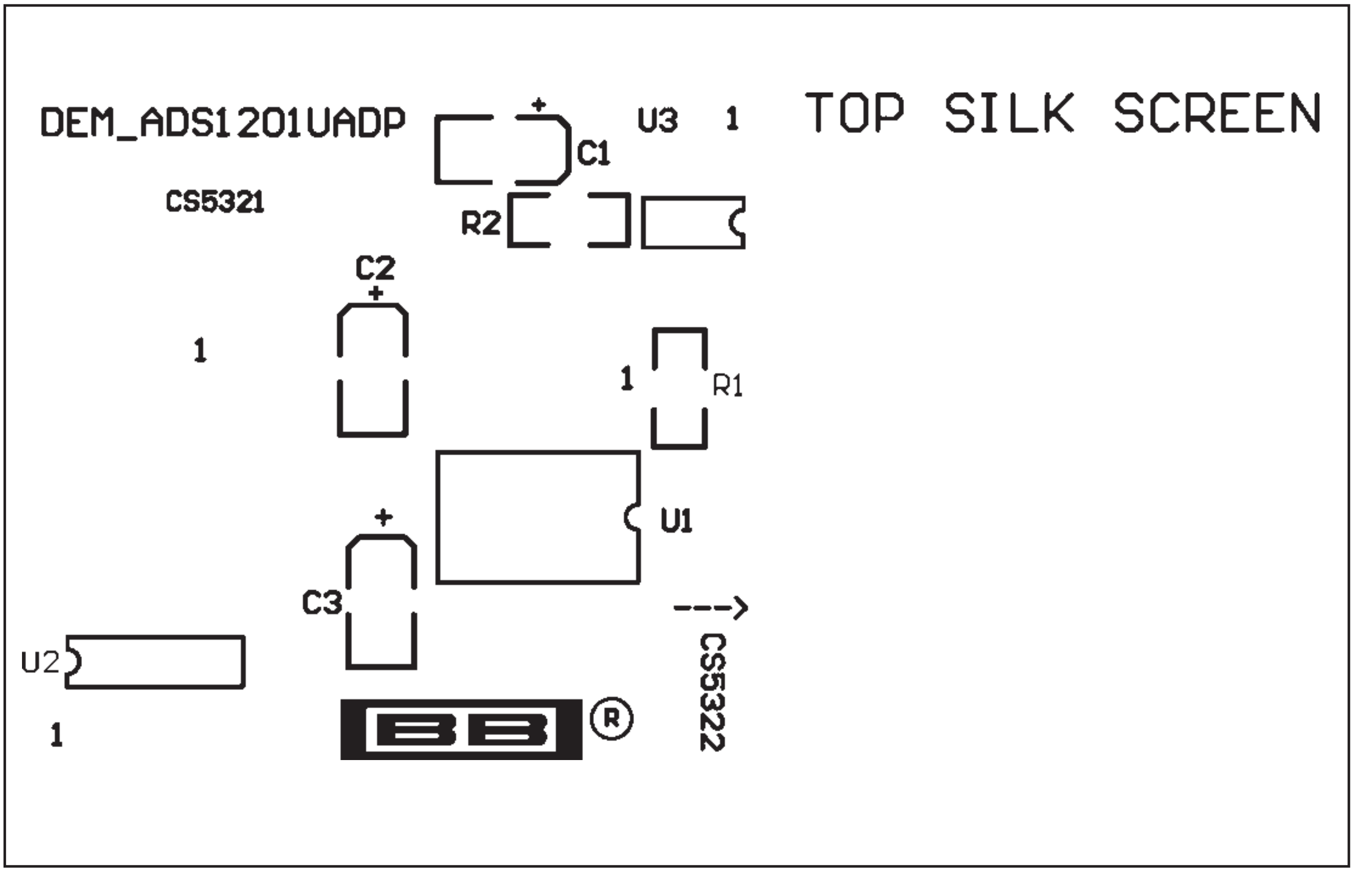

FIGURE 11. Top Silkscreen (Scale 2.5:1).

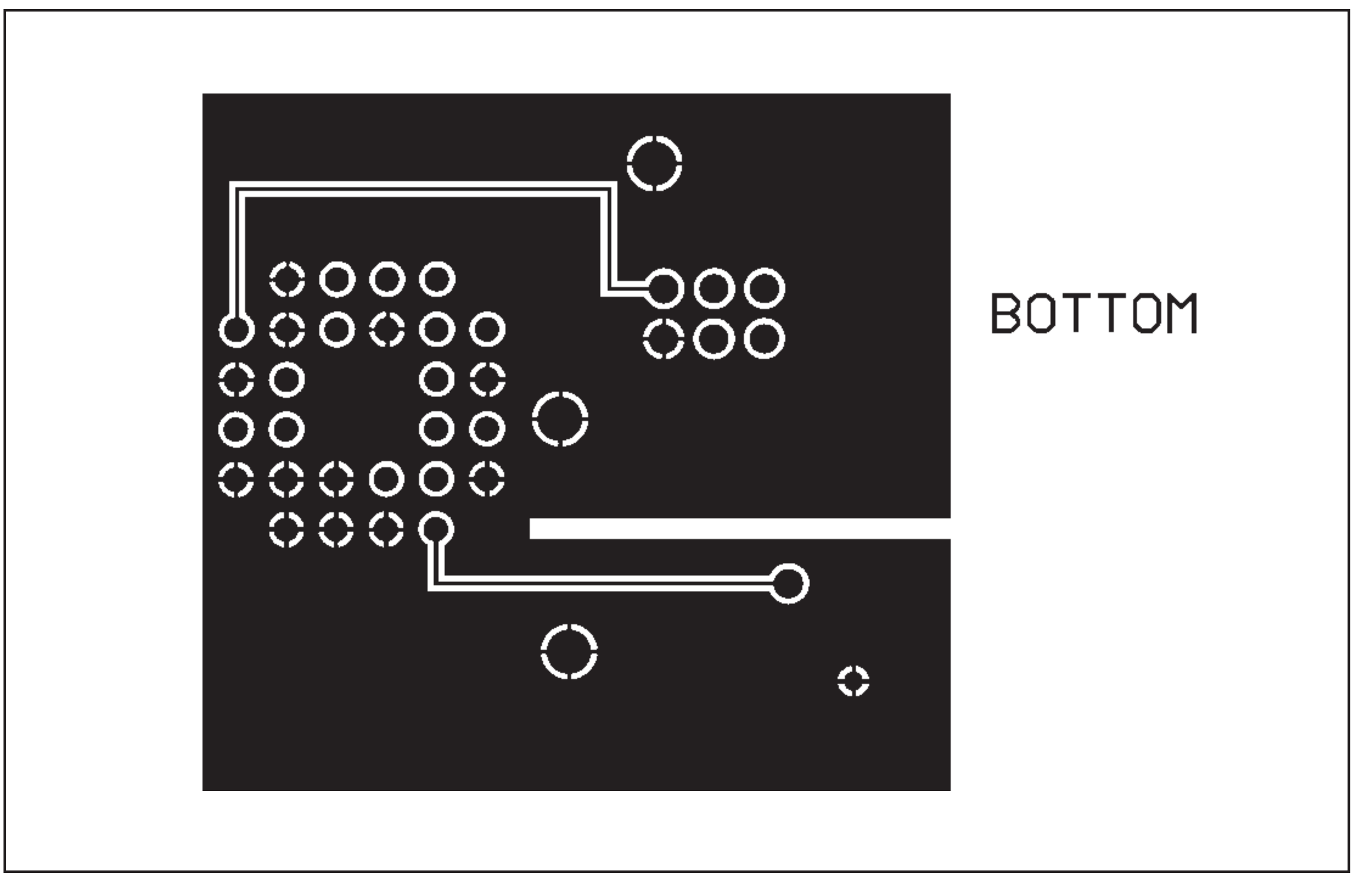

FIGURE 12. Top Layer (Scale 2.5:1).

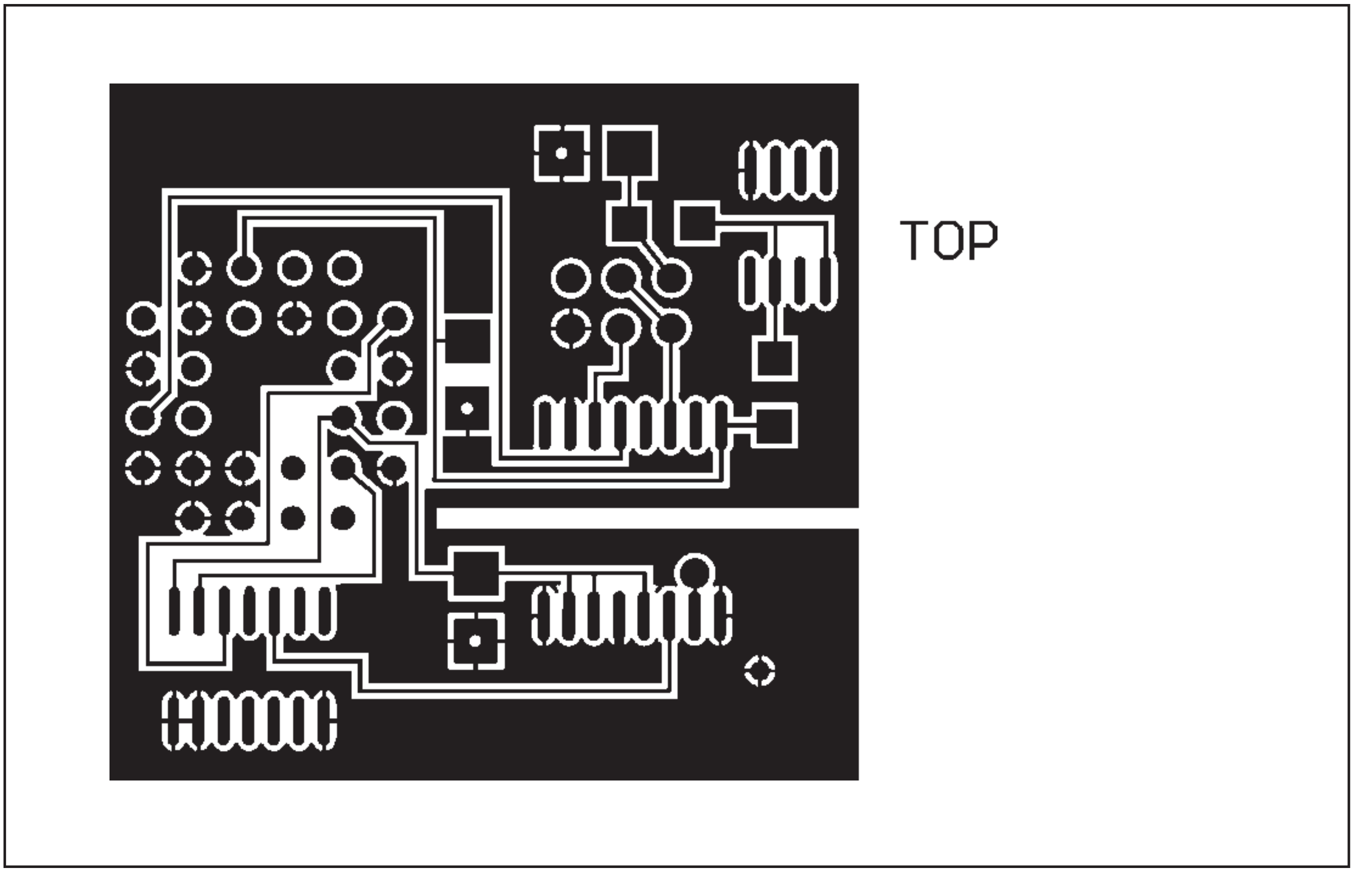

FIGURE 13. Bottom Layer (Scale 2.5:1).

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.