

# LTC2499/LTC2497/LTC2495

## 24-/16-Bit Easy Drive

### 8-/16- Channel Delta Sigma

#### ADC with I<sup>2</sup>C Interface

## DESCRIPTION

Demonstration circuit 1012A-A features the **LTC<sup>®</sup>2499** 8-/16-channel, 24-bit delta sigma ADC with Easy Drive™ inputs. Key DC specifications include 2ppm INL, 1ppm offset, 25ppm full-scale error and 10nV/°C offset drift. In the 6.8Hz/600nV<sub>RMS</sub> mode, input normal mode rejection of 50Hz and 60Hz noise is better than 87dB. The LTC2499 also includes an internal temperature sensor that is accurate to 2°C over the operating temperature range.

DC1012A-B features the LTC2497 16-bit  $\Delta\Sigma$  ADC that is pinout and software compatible with the LTC2499.

DC1012A-C features the LTC2495 16-bit  $\Delta\Sigma$  ADC that also includes a PGA with a gain range from 1 to 256 and the same temperature sensor as the LTC2499.

DC1012A is a member of Linear Technology's QuikEval™ family of demonstration boards. It is designed to allow easy evaluation of the LTC2499, LTC2497 or LTC2495. DC1012A may be connected directly to the target application's analog signals while using the DC590 USB serial controller board and QuikEval software to measure performance. The exposed ground planes allow proper grounding to prototype circuitry. After evaluating with LTC's software, the digital signals can be connected to the application's processor/controller for development of the serial interface.

**Design files for this circuit board are available at <http://www.linear.com/demo>**

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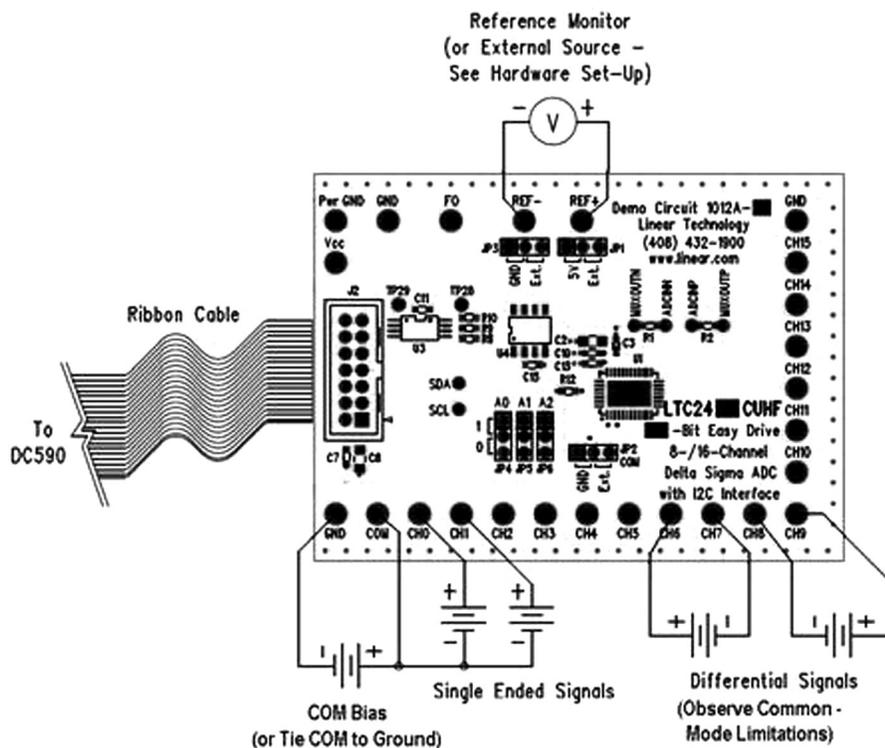


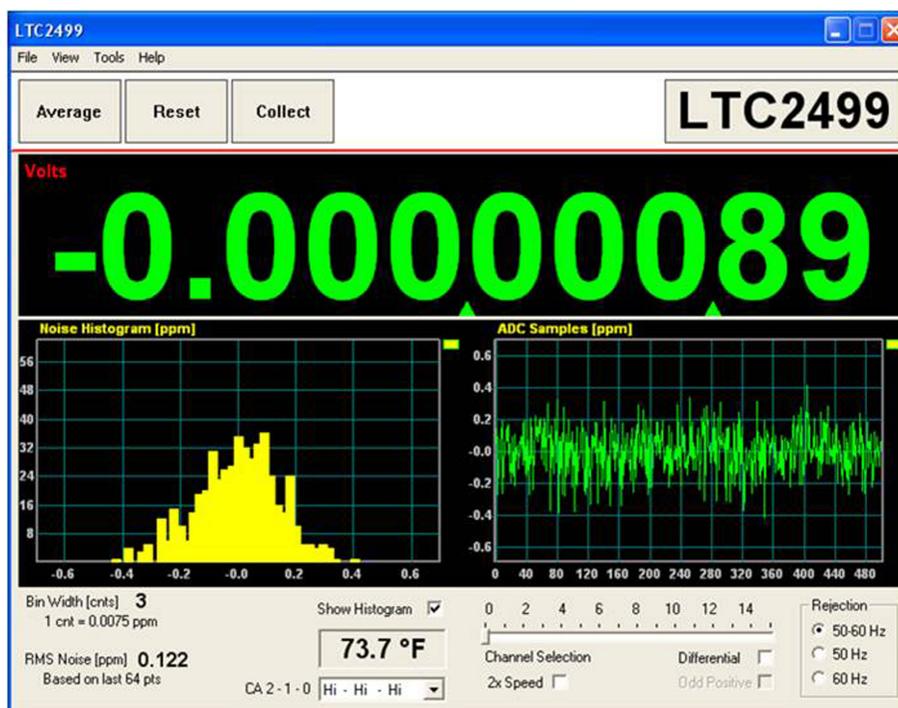
Figure 1. Proper Measurement Equipment Setup

## QUICK START PROCEDURE

Connect the DC1012A to a DC590 USB serial controller using the supplied 14-conductor ribbon cable. Connect the DC590 to host PC with a standard USB A/B cable. Run the evaluation software supplied with the DC590 or downloaded from [www.linear.com/software](http://www.linear.com/software). The correct program will be loaded automatically. Click the COLLECT button to start reading the input voltage. The software allows for selecting the input channel, single ended or dif-

ferential mode and 50Hz/60Hz rejection settings. Selecting 2x speed located at the bottom of the strip-chart display will double the data output rate at the expense of offset accuracy (LTC2499 and LTC2495 only).

Tools are available for logging data, changing reference voltage, changing the number of points in the strip chart and histogram, and changing the number of points averaged for the DVM display.



## HARDWARE SETUP

### Jumpers

**JP1, JP3** – Select the source for REF+ and REF–, respectively. REF+ can be 5.00V from the onboard LT1236 reference (default) or supplied externally. REF– can be ground (0V, default) or supplied externally.

**JP2** – Select source for analog COM input, either tied to ground or supplied externally to the COM turret post.

**JP4 – JP6** – (CA0-CA2) Address select lines. Lines may be 1, 0 or floating for a total of 27 different addresses. The default setting is all 1s.

### Connection to DC590 Serial Controller

J2 is the power and digital interface connector. Connect to a DC590 serial controller with the supplied 14-conductor ribbon cable. Digital signals are also connected to through-hole test points on the circuit board.

### Analog Connections

Analog signal connections are made via the row of turret posts along the edge of the board. Also, if you are connecting the board to an existing circuit, the exposed ground planes along the edges of the board may be used to form a solid connection between grounds.

## HARDWARE SETUP

**GND** – Ground turrets are connected directly to the internal analog ground plane.

**PWR GND** – Power ground, connected to the power return trace.

**VCC** – This is the supply for the ADC. Do not draw any power from this point. External power may be applied to this point after disabling the  $V_{CC}$  supply on DC590. See the DC590 quick start guide for details.

**REF+, REF-** – These turrets are connected to the LTC2495/LTC2497/LTC2499 REF+ and REF- pins. If the onboard reference is being used, the reference voltage may be monitored from this point. An external reference may be connected to these terminals if JP1 and JP3 are configured for external reference.

Note: The REF+ and REF- terminals are decoupled to ground with 0.01 $\mu$ F and 4.7 $\mu$ F capacitors in parallel. Thus any source connected to these terminals must be able to drive a capacitive load and have very low impedance at DC. Examples are series references that require an output capacitor and C-Load™ stable op amps such as the LT®1219 and LT1368.

**CH0 – CH15** – These are the differential inputs to the LTC2499/2497/2495. They may be configured as single-ended inputs with respect to the COM pin, or as differential inputs (CH0-1, CH2-3, etc.) with the polarity software selected.

## EXPERIMENTS

### Input Noise

Solder a short wire between the CH0 and CH1 turrets. Connect the inputs to ground through a short wire and start taking data. LTC2499 noise should be approximately 0.12ppm of 5V (600nV<sub>RMS</sub>.) The electrical noise of the LTC2497 is also 600nV<sub>RMS</sub>, however this is masked by the 76.3 $\mu$ V quantization level. If the input is midway between code transitions, the noise level will read zero. If the input is exactly on a code transition such that the two adjacent output codes have equal probability, the noise level will be approximately 7.9ppm. The input noise of the LTC2495 is apparent at very high gain settings (128 or 256.) Note that with a 5V reference and gain set to 256, 1LSB is equal to 298nV – which is lower than the 600nV<sub>RMS</sub> electrical noise of the input stage.

### Common Mode Rejection

Tie the two inputs (still connected together from previous experiment) to ground through a short wire and note the indicated voltage. Tie the inputs to REF+; the difference should be less than 0.5 $\mu$ V due to the 140dB+ CMRR of the LTC2499. The LTC2497 will produce less than 1LSB difference.

### Input Normal Mode Rejection

The LTC2499 and LTC2495 SINC4 digital filter can be software selected to reject 50Hz, 60Hz by 110dB, or both 50Hz and 60Hz by 87dB. The LTC2497's SINC4 filter is fixed at 50Hz/60Hz. To measure input normal mode rejection, connect COM to a 2.5V source such as an LT1790-2.5 reference or a power supply. Connect any other input (CH0-CH15) to the same supply through a 10k resistor. Apply a 10Hz, 2V peak-to-peak sine wave to the input through a 1 $\mu$ F capacitor.

Set the rejection frequency to 55Hz (LTC2499 only) and start taking data. The input noise will be quite large, and the graph of output vs. time should show large variations.

Next, slowly increase the frequency to 55Hz. The noise should be almost undetectable in the graph.

# DEMO MANUAL DC1012A

## PARTS LIST

| ITEM             | QTY | REFERENCE                                | PART DESCRIPTION                            | MANUFACTURER/PART NUMBER        |
|------------------|-----|--|---|---------------------------------|
| 1                | 4   | C3, C7, C10, C13                         | CAP., CHIP X7R 0.01 $\mu$ F 16V             | AVX, 0603YC103KAT1A 0603        |
| 2                | 2   | C11, C15                                 | CAP., CHIP X7R 0.1 $\mu$ F 16V              | AVX, 0603YC104MAT1A 0603        |
| 3                | 1   | C29                                      | CAP., CHIP X5R 1 $\mu$ F 10V                | TAIYO YUDEN, LMK107BJ105KA 0603 |
| 4                | 3   | C2, C9, C12                              | CAP., CHIP X5R 4.7 $\mu$ F 6.3V             | TAIYO YUDEN, JMK212BJ475MG 0805 |
| 5                | 1   | C8                                       | CAP., CHIP X5R 10 $\mu$ F 6.3V              | TDK, C2012X5R0J106M 0805        |
| 6                | 26  | TP1-TP6, TP8, TP10-TP12, TP14-TP27, TP33 | TURRET, TESTPOINT 0.064"                    | MILL-MAX, 2308-2                |
| 7                | 0   | TP7, TP9, TP13, TP28, TP29, TP30-TP32    | Opt. (SURFACE MOUNT PAD ONLY )              |                                 |
| 8                | 6   | JP1-JP6                                  | HEADER, 3-PIN 1 ROW 0.079CC                 | SAMTEC, TMM-103-02-L-S          |
| 9                | 6   | FOR (JP1-JP6)                            | SHUNT, 0.079" CENTER                        | SAMTEC, 2SN-BK-G                |
| 10               | 1   | J2                                       | HEADER, VERTICAL DUAL 2X7 0.079CC           | MOLEX, 87831-1420               |
| 11               | 2   | R1, R2                                   | RES., CHIP 0 $\Omega$                       | VISHAY, CRCW06030000Z0EA        |
| 12               | 3   | R8, R9, R10                              | RES., CHIP 4.99k 1%                         | AAC, CR16-4991FM 0603           |
| 13               | 1   | R12                                      | RES., CHIP 10k 5%                           | AAC, CR16-103JM 0603            |
| 14               | 1   | U4                                       | I.C., PRECISION REFERENCE S08               | LINEAR TECH., LT1236ACS8-5#PBF  |
| 15               | 1   | U3                                       | I.C., SERIAL EEPROM, TSSOP-8                | MICROCHIP, 24LC025-I/ST (PbF)   |
| <b>DC1012A-A</b> |     |  |   |                                 |
| 1                | 1   | U1                                       | I.C., 24-BIT 8-/16-CHANNEL DELTA SIGMA ADCs | LINEAR TECH., LTC2499CUHF 38QFN |
| <b>DC1012A-B</b> |     |  |   |                                 |
| 1                | 1   | U1                                       | I.C., 16-BIT 8-/16-CHANNEL DELTA SIGMA ADCs | LINEAR TECH., LTC2497CUHF 38QFN |
| <b>DC1012A-C</b> |     |  |   |                                 |
| 1                | 1   | U1                                       | I.C., 16-BIT 8-/16-CHANNEL DELTA SIGMA ADCs | LINEAR TECH., LTC2495CUHF 38QFN |



# DEMO MANUAL DC1012A

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This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

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