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# LTC2449

## 8-/16-channel, High Speed 24-Bit Delta Sigma ADC

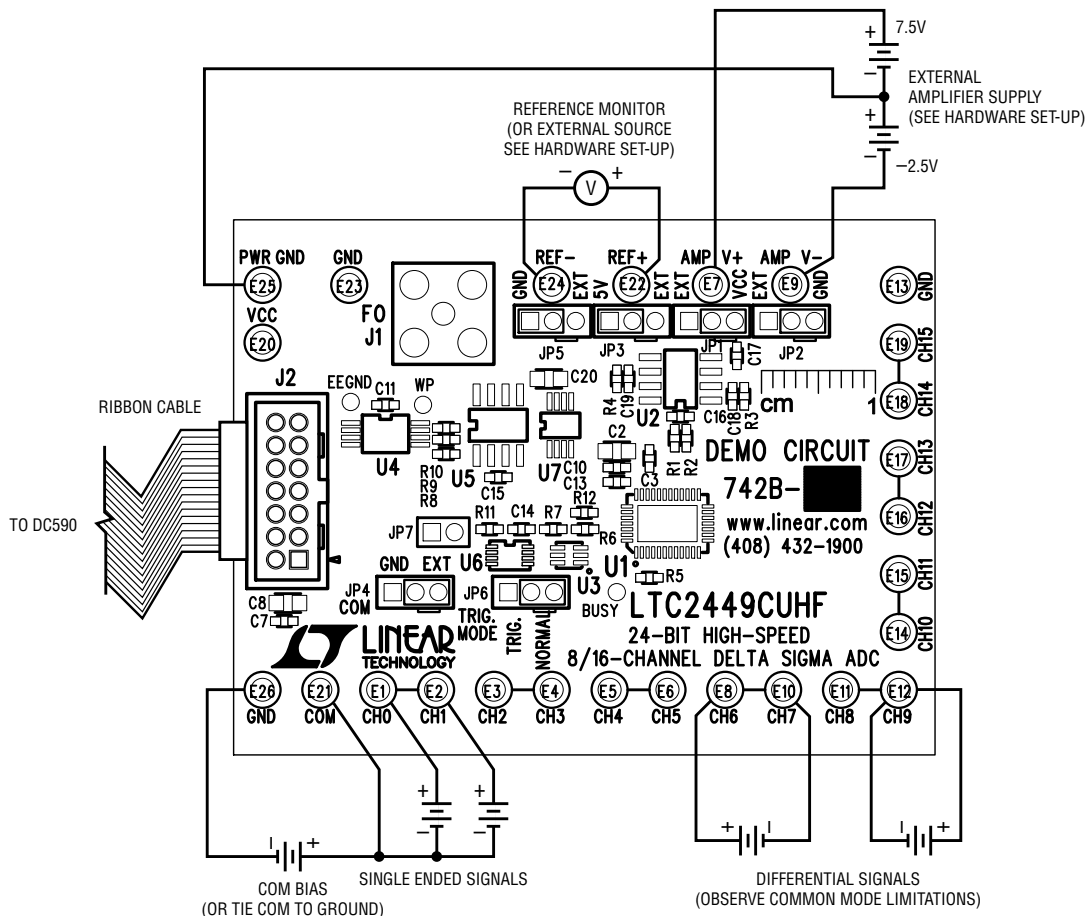
### DESCRIPTION

Demonstration circuit 742B features the **LTC<sup>®</sup>2449**, an 8-/16-channel, high speed, 24-bit  $\Delta\Sigma$  ADC with ten selectable speed/resolution modes from 6.9Hz/200nV<sub>RMS</sub> to 3.5kHz/23 $\mu$ V<sub>RMS</sub> (4kHz with external oscillator). Key DC specifications include 5ppm INL, 5 $\mu$ V offset, 10ppm full-scale error and 20nV/°C offset drift. In the 6.9Hz/200nV<sub>RMS</sub> mode, input normal mode rejection of 50Hz and 60Hz noise is better than 87dB. The accuracy (offset, full-scale, linearity, drift) and power dissipation are independent of the speed selected. The LTC2449 performs auto-zeroing of the ADC by reversing the inputs through the multiplexer output/ADC input connections. This allows an external dual buffer amplifier to isolate the signal inputs from the sampling current of the ADC.

DC742B is a member of Linear Technology's QuikEval™ family of demonstration boards. It is designed to allow easy evaluation of the LTC2449 and may be connected directly to the target application's analog signals while using the DC590 USB Serial Controller board and supplied 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/DC742B>**

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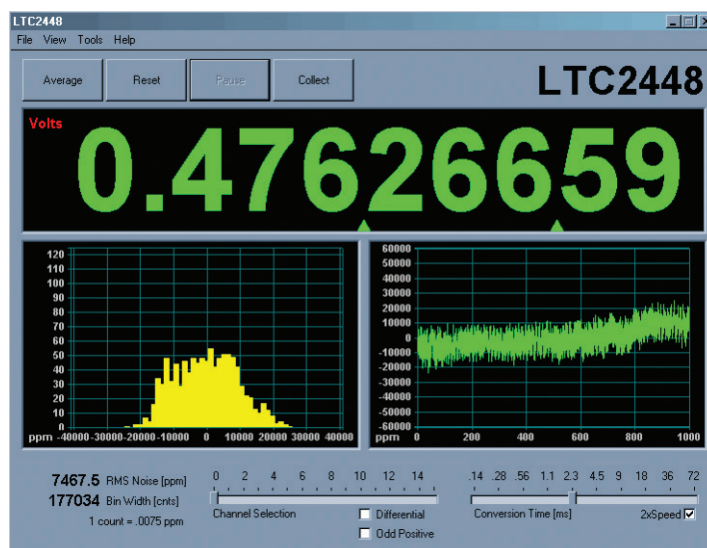


## QUICK START PROCEDURE

Connect DC742B to a DC590 USB Serial Controller using the supplied 14-conductor ribbon cable. Connect DC590 to host PC with a standard USB A/B cable. Run the evaluation software supplied with DC590 or downloaded from [www.linear.com](http://www.linear.com). The correct program will be loaded automatically. Click the COLLECT button to start reading the input voltage. Click the slider at the bottom of the strip

chart display to change the oversample ratio (OSR) which will in turn change the data output rate.

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, JP2:** Select the positive and negative supply voltages for the onboard amplifier. Supplies can be ground and  $V_{CC}$  or supplied externally.

**JP3, JP5:** Select the source for REF+ and REF-, respectively. REF+ can be 5V from the onboard LT1236 reference (default) or supplied externally. REF- can be ground (0V, default) or supplied externally.

**JP4:** Select source for analog COM input, either tied to ground or supplied externally to the COM turret post.

**JP6:** Trigger mode, either normal (default) or externally triggered.

**JP7:** Trigger input signal. Pin 1 is a 5V logic input, pin 2 is ground. When triggered mode is selected on JP6, a rising edge starts a new conversion. Note that since a conversion

cannot be terminated once started, this signal can only be used to slow down the conversion rate.

### CONNECTION TO DC590 SERIAL CONTROLLER

J2 is the power and digital interface connector. Connect to DC590 serial controller with supplied 14-conductor ribbon cable.

### 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.

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

## HARDWARE SETUP

**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 switching supply on DC590. If the DC590 serial controller is being used, the voltage must be regulated 5V only, as the isolation circuitry will also be powered from this supply. See the DC590 quick start guide for details.

**REF+, REF-:** These turrets are connected to the LTC2449 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 JP3 and JP5 are configured for external reference.

Note: The REF+ and REF- terminals are decoupled to ground with 0.1 $\mu$ F and 10 $\mu$ 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 LT1219 and LT1368.

**CHO: CH15:** These are the differential inputs to the LTC2449. They may be configured either as single-ended inputs with respect to the COM pin, or adjacent pairs may be configured as differential inputs (CHO-1, CH2-3, etc.).

## EXPERIMENTS

### INPUT NOISE

Solder a short wire from CHO to CH1. Ensure that the buffer amplifiers are in their active region of operation by either biasing the inputs to mid-supply with a 10k $\Omega$  to 10k $\Omega$  divider when the buffer amplifier is powered from V<sub>CC</sub> and ground, or tie the inputs to ground and connect an external +7.5V/-2.5V supply to the AMP V+ and V- turrets (JP1 and JP2 must be set to EXT).

Set the demo software to OSR32768 (6.8 samples per second) and check the 2X box. Noise should be approximately 0.04ppm of V<sub>REF</sub> (200nV). Next, select different oversample ratios. Measured noise for each oversample ratio should be close to values given in the LTC2449 data sheet.

### 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 5 $\mu$ V due to the 120dB CMRR of the LTC2449.

This experiment requires an external power supply to the buffer amplifier.

If the common mode voltage is limited to GND + 0.25V to V<sub>CC</sub> - 0.25V, this test may be performed with the amplifier supplies set to ground and V<sub>CC</sub>.

### INPUT NORMAL MODE REJECTION

The LTC2449's SINC4 digital filter is trimmed to strongly reject both 50Hz and 60Hz line noise when operated with the internal conversion clock and oversample ratio 32768 (6.8 samples per second). 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 (CHO to 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.

Select OSR32768 (6.8 samples per second) and 2 $\times$  mode in the demo software 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. Note that the indicated noise in ppm may still be above that of the data sheet specification because the inputs are not connected to a DC source.

Change the OSR to 16384 (13.75 samples per second;) the noise will increase substantially, as the first notch at this OSR is at 110Hz. Increase the signal generator frequency to 110Hz, the noise will drop again.

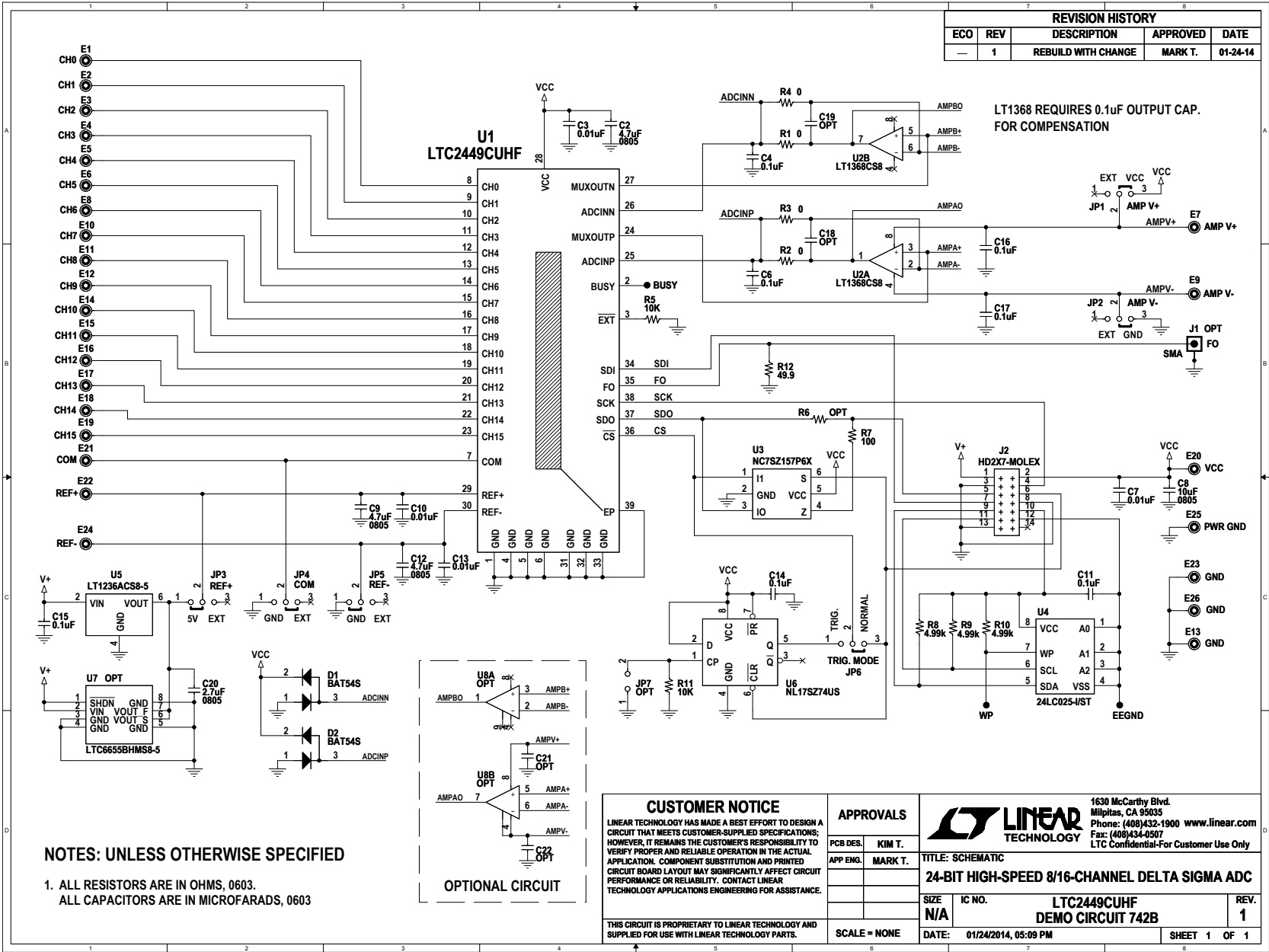
# DEMO MANUAL DC742B

## PARTS LIST

| ITEM                               | QTY | REFERENCE                             | PART DESCRIPTION   | MANUFACTURER/PART NUMBER  |
|------------------------------------|-----|---------------------------------------|--|---|
| <b>Required Circuit Components</b> |     |                                       |  |   |
| 1                                  | 3   | C2, C9, C12                           | CAP., 4.7 $\mu$ F, X5R, 6.3V, 20%, 0805                        | TAIYO YUDEN, JMK212BJ475MG-T<br>AVX, 08056D475MAT2A                         |
| 2                                  | 4   | C3, C7, C10, C13                      | CAP., 0.01 $\mu$ F, X7R, 16V, 10%, 0603                        | AVX, 0603YC103KAT2A<br>MURATA, GRM188R71C103KA01D                           |
| 3                                  | 9   | C4, C6, C11, C14,<br>C15, C16, C17    | CAP., 0.1 $\mu$ F, X7R, 16V, 20%, 0603                         | AVX, 0603YC104MAT2A<br>MURATA, GRM188R71C104MA01D                           |
| 4                                  | 1   | C8                                    | CAP., 10 $\mu$ F, X5R, 6.3V, 20%, 0805                         | TDK, C2012X5R0J106M125AB<br>AVX, 08056D106MAT2A<br>SAMSUNG, CL21A106MQFNNE  |
| 5                                  | 0   | C18, C19, C21, C22                    | CAP., OPTION, 0603   | OPT   |
| 6                                  | 1   | C20                                   | CAP., 2.7 $\mu$ F, X5R, 10V, 10%, 0805                         | KEMET, C0805C275K8PACTU   |
| 7                                  | 2   | D1, D2                                | DIODE, SCHOTTKY, 30V, 200mA, SOT23                             | DIODES INC., BAT54S-7-F   |
| 8                                  | 26  | E1-E26                                | TEST POINT, TURRET, 0.064 THT                                  | MILL-MAX, 2308-2-00-80-00-00-07-0   |
| 9                                  | 6   | JP1-JP6                               | CONN., HEADER, 1 $\times$ 3, 2mm, THT                          | SULLINS, NRPN031PAEN-RC   |
| 10                                 | 0   | JP7                                   | CONN., HEADER, 1 $\times$ 2, 2mm, THT                          | SULLINS, NRPN021PAEN-RC   |
| 11                                 | 0   | J1                                    | CONN., OPTION, JACK, SMA COAXIAL STRT.                         | OPT   |
| 12                                 | 1   | J2                                    | CONN., HEADER, SHROUDED, 2 $\times$ 7, 2mm, THT                | MOLEX, 87831-1420   |
| 13                                 | 4   | R1, R2, R3, R4                        | RES., 0 $\Omega$ , 1/10W, 0603                                 | VISHAY, CRCW06030000Z0EA  |
| 14                                 | 2   | R5, R11                               | RES., 10k $\Omega$ , 5%, 1/10W, 0603                           | VISHAY, CRCW060310K0JNEA<br>PANASONIC, ERJ3GEYJ103V                         |
| 15                                 | 0   | R6                                    | RES., OPTION, 0603   | OPT   |
| 16                                 | 1   | R7                                    | RES., 100 $\Omega$ , 1%, 1/10W, 0603                           | VISHAY, CRCW0603100RFKEA  |
| 17                                 | 3   | R8, R9, R10                           | RES., 4.99k $\Omega$ , 1%, 1/10W, 0603                         | VISHAY, CRCW06034K99FKEA  |
| 18                                 | 1   | R12                                   | RES., 49.9 $\Omega$ , 1%, 1/10W, 0603                          | VISHAY, CRCW060349R9FKEA<br>PANASONIC, ERJ3EKF49R9V<br>ROHM, MCR03EZPFX49R9 |
| 19                                 | 1   | U1                                    | I.C., 8-/16-CHANNEL DELTA SIGMA ADCs,<br>QFN38UHF-5 $\times$ 7 | LINEAR TECH., LTC2449CUHF#PBF   |
| 20                                 | 1   | U2                                    | I.C., DUAL & QUAD PRECISION OP AMP, SO8                        | LINEAR TECH., LT1368CS8#PBF   |
| 21                                 | 1   | U3                                    | I.C., NON-INVERTING MULTIPLEXER, SC70-6                        | FAIRCHILD, NC7SZ157P6X  |
| 22                                 | 1   | U4                                    | IC, MEMORY, I <sup>2</sup> C Serial EEPROM, 2K-bit, TSSOP8     | MICROCHIP, 24LC025-I/ST   |
| 23                                 | 1   | U5                                    | I.C., PRECISION REFERENCE, SO8                                 | LINEAR TECH., LT1236ACS8-5#PBF  |
| 24                                 | 1   | U6                                    | I.C., SINGLE D FLIP-FLOP, US8                                  | ON SEMI., NL17SZ74USG   |
| 25                                 | 0   | U7                                    | I.C., PRECISION REFERENCE, MSOP8                               | LINEAR TECH., LTC6655BHMS8-5#PBF  |
| 26                                 | 0   | U8                                    | I.C., OPTION, DFN8DD-3 $\times$ 3                              | OPT   |
| 27                                 | 6   | SHUNTS FOR JP1-<br>JP6 (SEE ASSY DWG) | SHUNT, 2 POS, 2mm  | SAMTEC, 2SN-BK-G  |

## REVISION NOTES

| BOARD REVISION | DESCRIPTION                                      | DATE   |
|----------------|--|--------|
| B              | Add Locations for Other Amplifier Configurations | 1/2014 |

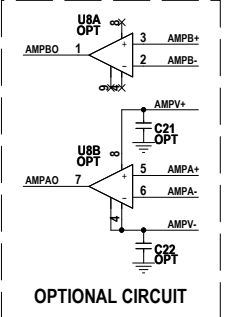


| REVISION HISTORY |     |                     |          |          |
|------------------|-----|---------------------|----------|----------|
| ECO              | REV | DESCRIPTION         | APPROVED | DATE     |
| -                | 1   | REBUILD WITH CHANGE | MARK T.  | 01-24-14 |

LT1368 REQUIRES 0.1uF OUTPUT CAP. FOR COMPENSATION

**NOTES: UNLESS OTHERWISE SPECIFIED**

- 1. ALL RESISTORS ARE IN OHMS, 0603.
- ALL CAPACITORS ARE IN MICROFARADS, 0603



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|--|--|-----------|-------------------|--|----------------------|
| LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE. |  | PCB DES.  | KIM T.            | 1630 McCarthy Blvd.<br>Milpitas, CA 95035<br>Phone: (408)432-1900 www.linear.com<br>Fax: (408)434-0507<br>LTC Confidential-For Customer Use Only |                      |
| THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.  |  | APP ENG.  | MARK T.           | TITLE: SCHEMATIC<br><b>24-BIT HIGH-SPEED 8/16-CHANNEL DELTA SIGMA ADC</b>  |                      |
|  |  | SCALE     | NONE              | SIZE   | N/A                  |
|  |  | IC NO.    | LTC2449CUHF       | DATE:  | 01/24/2014, 05:09 PM |
|  |  |           | DEMO CIRCUIT 742B | REV.   | 1                    |
|  |  |           |                   | SHEET  | 1 OF 1               |

# DEMO MANUAL DC742B

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