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# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 1010

## 2/4 CHANNEL 24,16,16/PGA-BIT ADC WITH I2C

### LTC2493, LTC2489, LTC2487

## DESCRIPTION

Demonstration circuit 1010A-A features the LTC2493 2/4 Channel, 24-Bit ADC with I<sup>2</sup>C. 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 LTC2493 also includes an internal temperature sensor that is accurate to 2 degrees C over the operating temperature range.

The DC1010A-B features the LTC2489 16-Bit ADC that is pin out and software compatible with the LTC2493.

The DC1010A-C features the LTC2487 16-Bit ADC that also includes a PGA with a gain range from 1 to

256 and the same temperature sensor as the LTC2493.

The DC1010 is a member of Linear Technology's QuickEval™ family of Demonstration Boards. It is designed to allow easy evaluation of the LTC2493, LTC2489 or LTC2487. DC1010 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. 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. Call the LTC factory.**

LTC is a trademark of Linear Technology Corporation

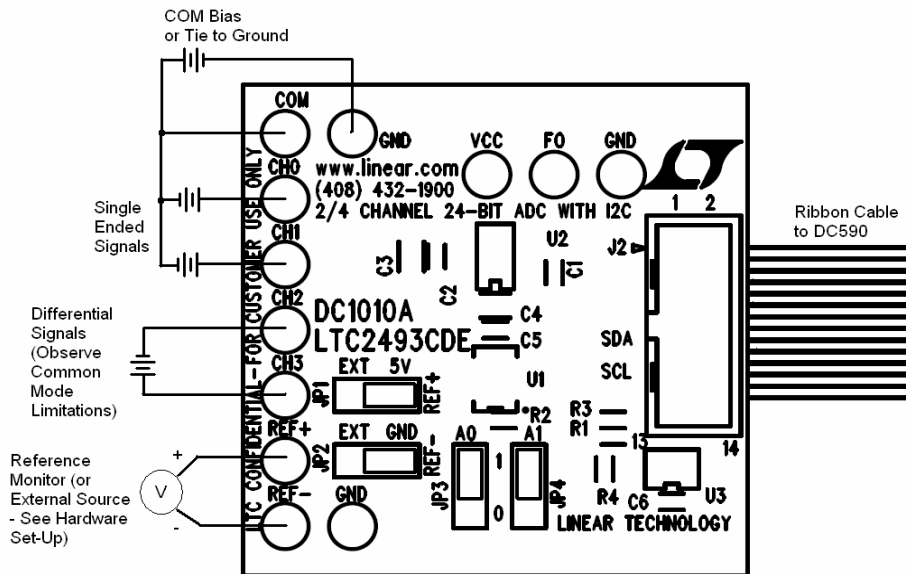


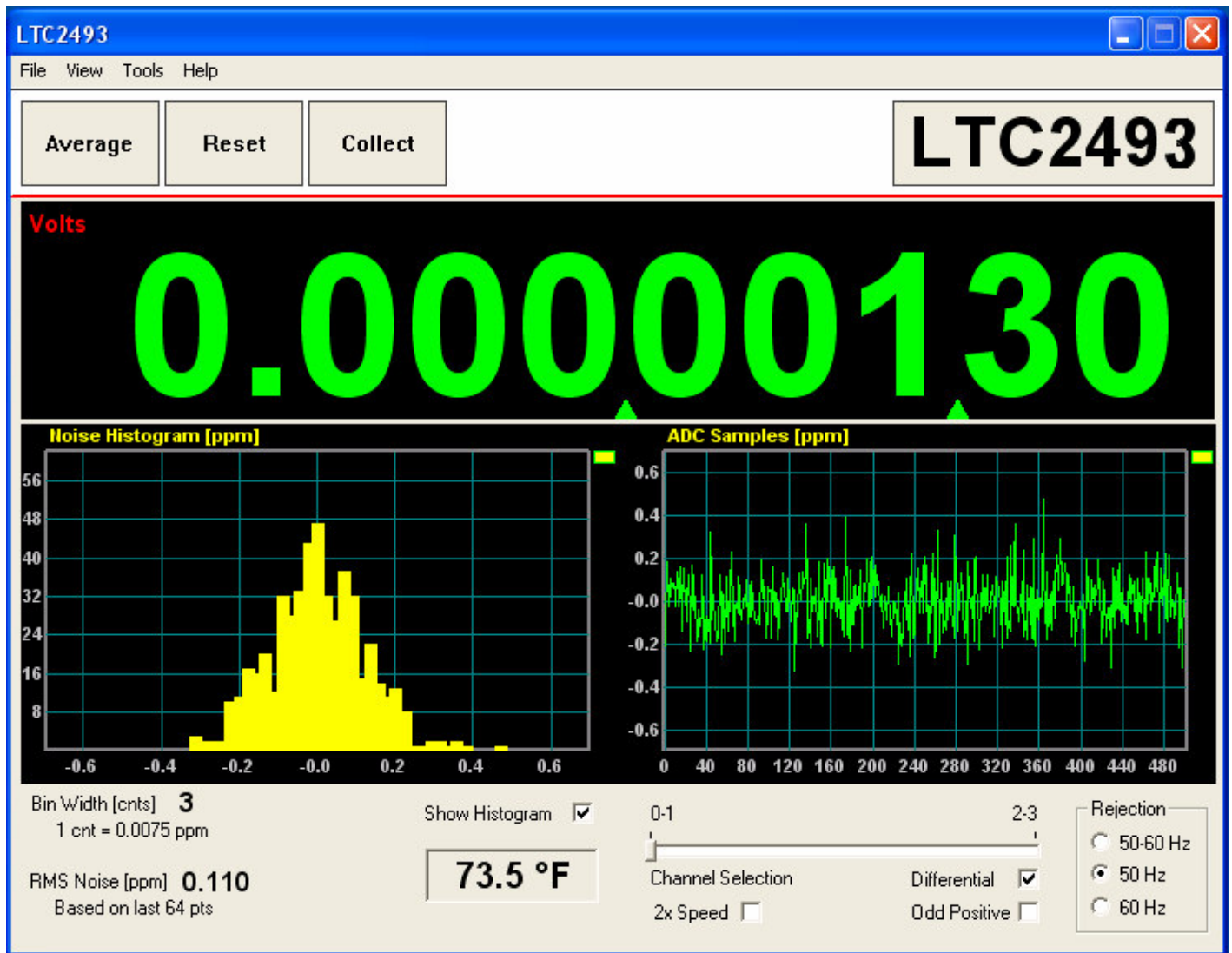
Figure 1. Proper Measurement Equipment Setup

## QUICK START PROCEDURE

Connect the DC1010 to a DC590 USB Serial Controller using the supplied 14 conductor ribbon cable. Connect DC590 to the 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. The software allows for selecting the input channel, single ended or dif-

ferential mode and 50/60 Hz 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 (LTC2493 and LTC2487 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 SET-UP

### JUMPERS

JP1, JP2 – Select the source for REF+ and REF-, respectively. REF+ can be 5.00 volts from the on-board LT1236 reference (default) or supplied externally. REF- can be Ground (0 volts, default) or supplied externally.

JP3, JP4 – Control for I<sup>2</sup>C address lines A0 and A1 respectively. These lines can be floated by removing the jumpers, grounded (Low) or tied to Vcc (High). The default mode is JP3, JP4 tied to Vcc. This is required for use with Quick Eval software. The addresses generated are shown below.

CA1	CA0	ADDRESS
LOW	LOW	0010100
LOW	HIGH	0010110
LOW	FLOAT	0010101
HIGH	LOW	0100110
HIGH	HIGH	0110100 (Default)
HIGH	FLOAT	0100111
FLOAT	LOW	0010111
FLOAT	HIGH	0100101
FLOAT	FLOAT	0100100

### 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.

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

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 Vcc supply on DC590. See the DC590 quick start guide for details.

REF+, REF- - These turrets are connected to the LTC2487/2489/2493 REF+ and REF- pins. If the on-board 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 JP2 are configured for external reference.

CH0 – CH3 – These are the differential inputs to the LTC2493/2489/2487. They may be configured as single-ended inputs with respect to the COM pin, or as differential inputs (CH0-CH1, CH2-CH3) with the polarity software selected.

### DIGITAL CONNECTION

FO – Connects to the Frequency Control Pin. When Fo is connected to GND (Default connection), the converter uses its internal oscillator running at 307.2 kHz. The conversion clock may also be overridden by driving the Fo pin with an external clock in order to change the output rate and the digital filter rejection null.

## 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. LTC2493 Noise should be approximately 0.12ppm of 5V (600nV RMS.) The electrical noise of the LTC2489 is also 600nV RMS, however this is masked by the 76.3 $\mu$ V quantization level. If the input is well between code transitions, the noise level will read zero. If the input is exactly between two codes such that the two adjacent output codes have equal probability, the noise level will be approximately 7.9ppm. The input noise of the LTC2487 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 600nVRMS 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 140 dB+ CMRR of the LTC2493. The LTC2489 will produce less than 1LSB difference.

### INPUT NORMAL MODE REJECTION

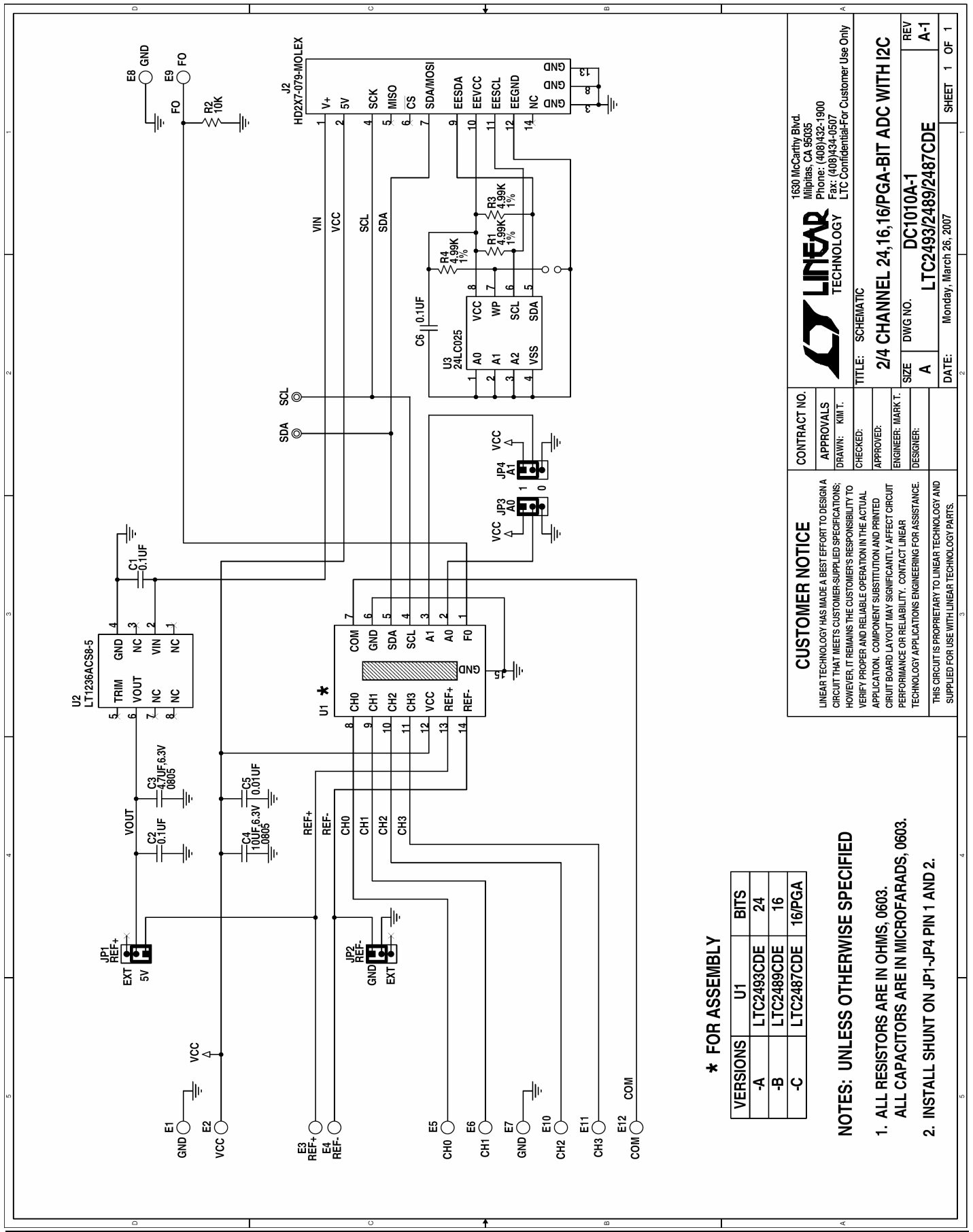
The LTC2493 and LTC2487 SINC4 digital filter can be software selected to reject 50Hz, 60Hz by 110dB, or both 50 and 60Hz by 87dB. The LTC2489's SINC4 filter is fixed at 50/60Hz. To measure input normal mode rejection, connect COM to a 2.5 volt source such as an LT1790-2.5 reference or a power supply. Connect any other input (CH0 – CH3) to the same supply through a 10k $\Omega$  resistor. Apply a 10 Hz, 2V peak-to-peak sine wave to the input through a 1 $\mu$ F capacitor.

Set the rejection frequency to 55Hz (LTC2493 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 55 Hz. The noise should be almost undetectable in the graph.

# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 1010

## 2/4 CHANNEL 24,16,16/PGA-BIT ADC WITH I2C



**\* FOR ASSEMBLY**

VERSIONS	U1	BITS
-A	LTC2493CDE	24
-B	LTC2489CDE	16
-C	LTC2487CDE	16/PGA

**NOTES: UNLESS OTHERWISE SPECIFIED**

1. ALL RESISTORS ARE IN OHMS, 0603.  
ALL CAPACITORS ARE IN MICROFARADS, 0603.
2. INSTALL SHUNT ON JP1-JP4 PIN 1 AND 2.

**CUSTOMER NOTICE**

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. THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

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TITLE: SCHEMATIC  
2/4 CHANNEL 24,16,16/PGA-BIT ADC WITH I2C  
REV: A-1  
SIZE: A  
DWG NO.: LTC2493/2489/2487CDE  
DATE: Monday, March 26, 2007  
SHEET 1 OF 1