

# LTC2480 16-Bit Delta Sigma ADC with Easy Drive Input Current Cancellation

## DESCRIPTION

Demonstration circuit 798B features the LTC2480, a 16-bit high performance  $\Delta\Sigma$  analog-to-digital converter (ADC). The LTC2480 features 0.12LSB linearity, 0.16LSB full-scale accuracy, 5 $\mu$ V offset, and 1.45 $\mu$ V<sub>RMS</sub> noise. The input is fully differential, with input common mode rejection of 140dB. The LTC2480 is available in a 10-pin DFN package and has an easy to use SPI interface.

DC798B is a member of Linear Technology's QuikEval™ family of demonstration boards. It is designed to allow easy evaluation of the LTC2480 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 Linear Technology's software, the digital signals can be connected to the end 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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## BOARD PHOTO

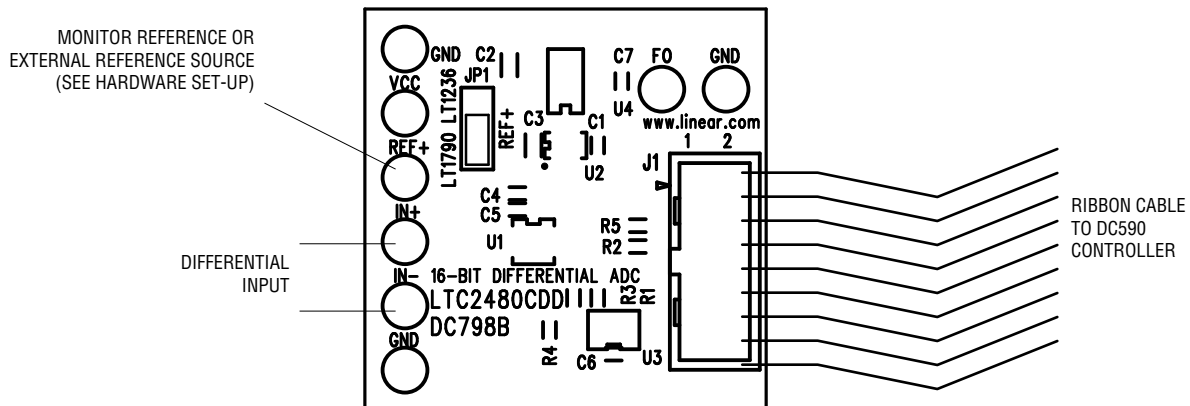


Figure 1. Connection Diagram

## QUICK START PROCEDURE

Connect DC798B 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 <http://www.linear.com/software>. The correct program will be loaded automatically. Click the COLLECT button to start

reading the input voltage. Details on software features are documented in the control panel's help menu.

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.

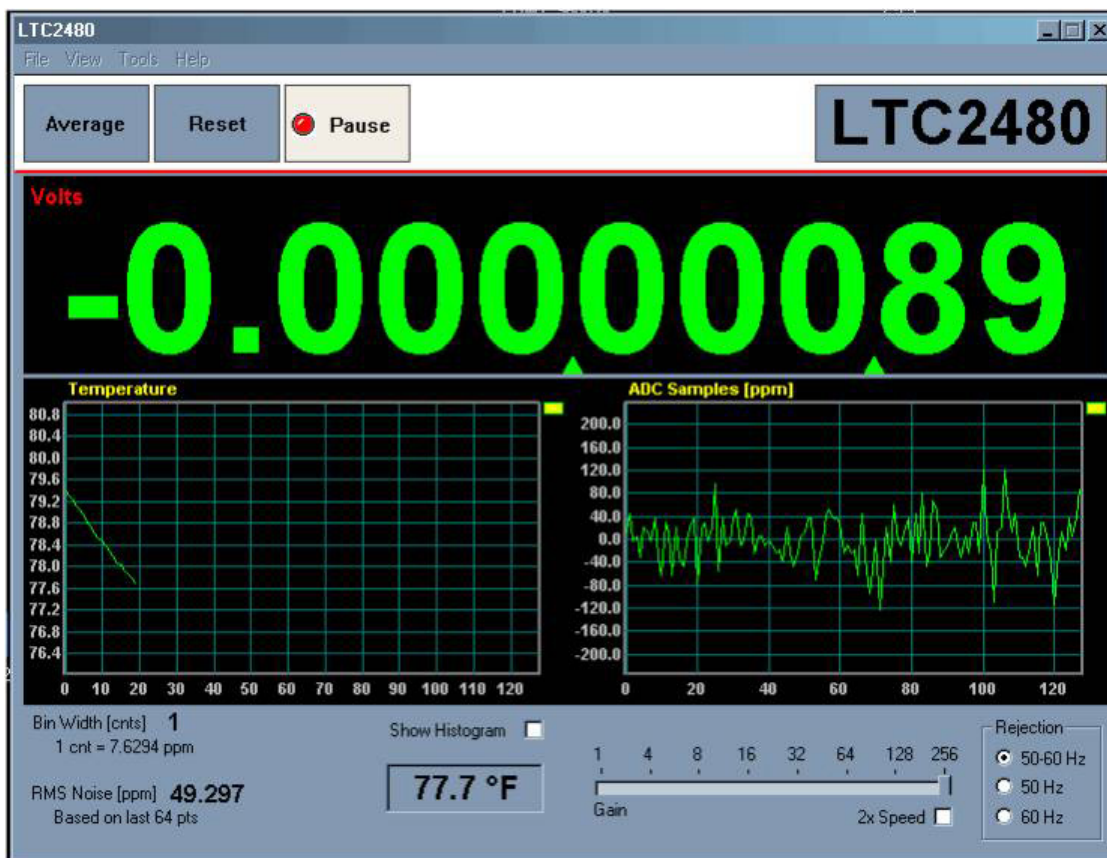


Figure 2. Software Screenshot

## HARDWARE SETUP

### Connection To DC590 Serial Controller

J1 is the power and digital interface connector. Connect to DC590 serial controller with supplied 14-conductor ribbon cable.

### Jumpers

**JP1:** Select the source for REF<sup>+</sup>. Two 5V references are available to suit different applications—an LT1790A-5 suitable for most applications using the lower gain settings and an LT1236 that allows full noise performance at the highest gain settings. An external reference can also be applied to the REF<sup>+</sup> turret post if JP1 is removed completely.

### Analog Connections

Analog signal connections are made via the row of turret posts along the edge of the board. Also, when 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:** Three ground turrets are connected directly to the internal ground planes.

**V<sub>CC</sub>:** This is the supply for the ADC. Do not draw any power from this point.

**REF<sup>+</sup>:** Connected to the LTC2480 reference pin. If one of the onboard references is being used, the reference voltage may be monitored from this point. An external reference may be connected to these terminals if JP1 is removed.

**IN<sup>+</sup>/IN<sup>-</sup>:** These are the differential inputs to the LTC2480.

**f<sub>0</sub>:** An external conversion clock may be applied to the f<sub>0</sub> turret to modify the frequency rejection characteristics or data output rate of the LTC2480. This should be a square wave with a low level equal to ground and a high level equal to V<sub>CC</sub>. While up to a 2MHz clock can be used, performance may be compromised. Refer to the LTC2480 data sheet. This terminal has a 5k pull-down resistor to keep it from floating when no signal is applied.

## EXPERIMENTS

### Input Noise

One of the characteristics of the LTC2480 is that the 600nV input noise floor is far below the quantization level of 38μV when a 5V reference is used and the PGA is set to a gain of 1. This means that the output will be stable if the input noise level is significantly below 38μV. In this sense, the LTC2480 is a true 17 effective bit part, whereas many 16-bit SAR converters have several LSBs of noise.

Solder a short wire from the IN<sup>-</sup> turret post to the IN<sup>+</sup> turret post. Noise should be below the quantization level of the LTC2480. This will result in a noise reading of zero on the control software.

Increase the gain setting to 256 (1× speed mode.) This results in a 149nV LSB size, allowing a true measurement of the input noise. Two references are included on DC798B; an LT1790-5.0 and an LT1236-5. For applications using the lower gain settings, the LT1790 is adequate. However, in the highest gain settings the LT1790 can elevate the input

noise by a factor of 2 or 3. The LT1236 is significantly quieter than the LT1790 and is a good choice for very high resolution applications. The LT1790 is a good choice for low power applications or where small size is required.

### Common Mode Rejection

Tie the two inputs (still connected together) to ground through a short wire and note the indicated voltage. Tie the inputs to REF<sup>+</sup>; the difference should be less than 0.5μV due to the 140dB minimum CMRR of the LTC2480.

### Bipolar Symmetry

To demonstrate the symmetry of the ADCs transfer function, connect a stable, low noise, floating voltage source (with a voltage less than V<sub>REF</sub>/2) from IN<sup>+</sup> to IN<sup>-</sup> and note the indicated voltage. Reverse the polarity; the indicated voltage will typically be within one LSB of the first reading multiplied by -1.

# DEMO MANUAL DC798B

## EXPERIMENTS

One convenient voltage source for this experiment is a single alkaline battery. While a battery has fairly low noise, it is sensitive to temperature drift. It is best to use a large (D-size) battery that is insulated from air currents. A better source is a battery powered series reference such as the LT1790. This part is available with output voltages of 1.25V, 2.048V, 2.5V, 3V, 3.3V, 4.096V and 5V.

### Input Normal Mode Rejection

The LTC2480's SINC4 digital filter is trimmed to reject 50Hz or 60Hz line noise when operated with the internal conversion clock. To measure input normal mode rejection, connect IN<sup>-</sup> to a 2.5V source such as an LT1790-2.5 reference or 1k – 1k divider from the onboard 5V reference

to ground. Apply a 10Hz, 2V peak-to-peak sine wave to IN<sup>+</sup> through a 1μF capacitor. No DC bias is required because the 2M to 3M input impedance of the LTC2480 tends to self-bias the input to mid-reference (see data sheet Applications Information for details.)

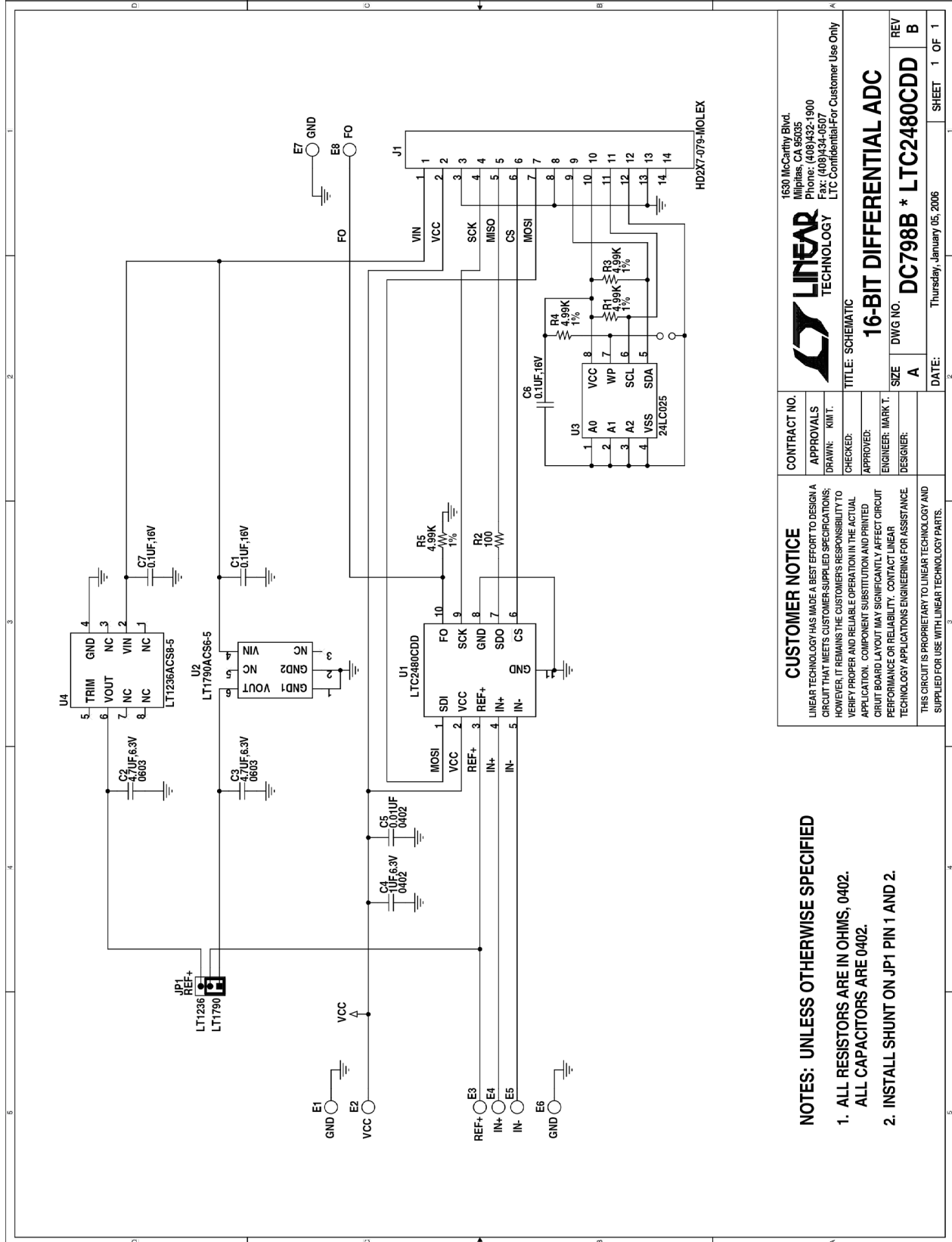
Start taking data. The input noise will be quite large, and the graph of output vs. time should show large variations.

Next, slowly increase the frequency to 60Hz (or 50Hz or 55Hz, depending on the selected rejection frequency.) The noise should be almost undetectable in the graph. Note that the indicated noise in ppm may still be above that of the datasheet specification because the inputs are not connected to a DC source.

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	3	C1, C6, C7	CAP., X7R, 0.1μF, 16V, 20%, 0402	TDK, C1005X7R1C104M
2	2	C2, C3	CAP., X5R, 4.7μF, 6.3V, 20%, 0603	TDK, C1608X5R0J475M
3	1	C4	CAP., X5R, 1μF, 6.3V, 20%, 0402	TDK, C1005X5R0J105M
4	1	C5	CAP., X7R, 0.01μF, 25V, 10%, 0402	AVX, 04023C103KAT1A
5	8	E1 to E8	TESTPOINT, TURRET, .064"	MILL-MAX, 2308-2
6	1	JP1	JMP, 3-PIN, 1 ROW, .079CC	COMM-CON, 2802S-03-G1
7	1	SHUNTS FOR JP1 PIN 1 & 2	SHUNT, .079" CENTER	COMM-CON CCIJ2MM-138G
8	1	J1	HEADER, 2 × 7 PIN, 0.079CC	MOLEX, 87331-1420
9	4	R1, R3, R4, R5	RES., CHIP 4.99k 1/16W, 1%, 0402	AAC, CR05-4991FM
10	1	R2	RES., CHIP 100, 1/16W, 5%, 0402	AAC, CR05-101JM
11	1	U1	I.C., LTC2480CDD, DFN10DD	LINEAR TECH., LTC2480CDD
12	1	U2	I.C., LT1790ACS6-5, SOT23-6	LINEAR TECH., LT1790ACS6-5
13	1	U3	I.C., 24LC025, TSSOP8	MICROCHIP, 24LC025
14	1	U4	I.C., LT1236ACS8-5, S08	LINEAR TECH., LT1236ACS8-5

**SCHEMATIC DIAGRAM**



<b>CONTRACT NO.</b>		1630 McCarthy Blvd. Milpitas, CA 95035 Phone: (408)432-1900 Fax: (408)434-0507 LTC Confidential-For Customer Use Only	
<b>APPROVALS</b>		DRAWN: KMT CHECKED: APPROVED: ENGINEER: MARK T. DESIGNER:	
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<b>NOTES: UNLESS OTHERWISE SPECIFIED</b>		1. ALL RESISTORS ARE IN OHMS, 0402. ALL CAPACITORS ARE 0402. 2. INSTALL SHUNT ON JP1 PIN 1 AND 2.	
<b>TITLE: SCHEMATIC</b>		<b>16-BIT DIFFERENTIAL ADC</b>	
<b>SIZE</b>	<b>DWG NO.</b>	<b>REV</b>	<b>REV</b>
A	DC798B * LTC2480CDD	B	B
<b>DATE:</b> Thursday, January 05, 2006		<b>SHEET</b> 1 OF 1	



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