DC358A Quick Start Guide

Description

Simple, Small, Very accurate

The LTC2411, a differential input **No Latency ΔΣ™** 24-Bit ADC in MSOP is featured on the DC358A demonstration board. The LTC2411 features 2-ppm linearity, 4-ppm full-scale accuracy, 1-ppm offset accuracy, and 0.29-ppm RMS noise. The LTC2411 operates from 2.7 to 5.5V supplies, drawing less than 300 uA of current and 2uA sleep mode current. It provides normal mode line frequency rejection of 110 dB, and DC and line frequency common mode rejection of 140 dB. Single conversion settling time yields latency-free results, thus enables multiplexing , correlated double sampling and other interleaved sampling schemes.

The LTC2411 performs auto-zero and calibration in every output result, which are transparent to the user. The device does not require initialization.
The board includes a precision 2.5V band gap reference (LT1019-2.5), and a precision 5V buried zener reference (LT1236-5), as well as bypassing capacitors, and jumpers to select line frequency rejection and various on board /external references.

The demonstration board is designed to interface to a personal computer, as well as give an example of good placement of bypass and partitioning of an analog and digital ground.

The demo board allows the user to quickly evaluate the LTC2411 performance while demonstrating its ease of use. The board connects directly to the RS232C port of any IBM compatible PC. The demo board derives its power from the RS232 port. The on board LT1236 ordinarily powers the LTC2411, and may be used as a 5V reference. Alternatively, the 2.5V reference may be used as reference, and the 5V output from the LT1236 may be used as excitation for a bridge application, although, an external power supply is likely required in this case.
The 2.5V output from the LT1261 can also be used as a bias source for sensing single ended bipolar signals that must be able to accommodate the full +/- 2.5V input range. If, for example, an instrumentation amplifier were to be used to drive the demo board, the reference terminal of the instrumentation amplifier can be connected to the 2.5V output. Alternatively a differential amplifier scheme can be biased such that its differential outputs are centered at 2.5V.

The software included in this package presents a 7.5 digit display, as well as a histogram display, and calculated noise figure , all updated in real time.
The demonstration program also provides averaging capability, zero and full scale cal functions, and raw data output to a file, for offline evaluation.

The demo board has a group of banana jacks for 6 wire connections to a bridge or other source, as well as a group of turrets for connection to external power. See schematic.

Operation

Instructions for installation and operation of the demo program are included at the end of this document.

Hardware set-up

Step 1: Serial Port Connection

Connect the demo board DB9 socket to the serial port of the computer (Com1-4). Port selection is done in the demo program.

Step 2: Rejection frequency

The internal oscillator can be configured to reject line frequencies of 50Hz or 60Hz by tying pin 14 to Vcc or ground. Jumper JP4 has a default setting of 60 Hz (pin 2-3) This pin (Fo) can also be driven by an external clock.

Step 3: configure reference/power jumpers

Jumper JP1 Connects excitation terminal (Vex (J4) banana jack) to Vcc (may be 5V from LT1236, or external), or 2.5V reference from LT1461.
Jumper JP2 connects the output of the LT1236 precision 5V reference to the Vcc rail.
You may elect to use an external Vcc supply, for example, for testing 2.7V, 3.3V or other supply sensitivity issues. **If JP2 is installed, do not apply external power to Vcc (J3).**

Jumper JP3 allows selection of 2.5V or 5V reference. If Jumper JP2 is removed, REF+ (J6 banana jack) may be connected to an external force sense, or other external reference schemes for 6 wire ratiometric operation. REF+ must be within the range from Vrefmin above REF- to Vcc.

Jumper JP5 is analogous to JP3, for the REF- terminal. If installed, it connects REF- to ground. If removed, REF- (J7 banana plug) may be connected to an external reference within the range 0V toVcc-Vrefmin.

Step 4: Apply input signal(s)
There are a number of valid configurations for the inputs of this device
1) Single ended 0-2.5V input
Connect
Vin-(J9) to ground (J10)
REF- (J7) to ground (J10), or JP5 installed. (Experiment with this)
External 0V-2.5V signal to VIN+ (J8) (using ground at J10)
JP3 select 5V
JP2 installed
VEX(J4) & REF+(J6) and turrets not used

2) full bridge with 5V excitation
Connect
REF+ (J6) to bridge sense+
REF- (J7) to bridge sense-
VIN+(J8) to bridge out +
VIN- (J9) to bridge out -
Bridge force- to Ground (J10)
Bridge force+ to VEX (J4)
JP3 & JP5 removed
JP1 select Vcc
JP2 installed
External power (9V-12V)will be required at J1 for 350 ohm bridge.
(for silicon strain gauge bridges with 5K+ impedance, external power may not be required, depending on the RS232 line driver on the computer. Laptops, and some newer computers may require external power in any case.)

3) Half bridge (RTD or strain)
Connect
REF+ (J6) to reference arm+
REF- (J7) to reference arm-
VIN+(J8) to variable arm +
VIN- (J9) to variable arm -
Bridge force- to Ground (J10)
Bridge force+ to VEX (J4)
JP3 & JP5 removed
JP1 select Vcc
JP2 installed
Reference arm may be on top, or bottom.

2) single variable full bridge with 10V excitation

Connect
REF+ (J6) to bridge sense+
REF- (J7) to bridge sense-
VIN+(J8) to bridge out +
VIN- (J9) to bridge out -
Bridge force- to Ground (J10)
Bridge force+ to VEX (J4)
JP3 & JP5 removed
JP1 select Vcc
JP2 installed
External power (9V-12V)will be required at J1 for 350 ohm bridge.
(for silicon strain gauge bridges with 5K+ impedance, external power may not be required, depending on the RS232 line driver on the computer. Laptops, and some newer computers may require external power in any case.)

II SOFTWARE SETUP

The demonstration software may be installed on Windows 95 or Windows 98 computers using the provided diskette. The installation requires a minimum of 4 Mbytes of free hard drive space. In addition the computer must have a serial port to which the demonstration board can be connected. The diskette contains a self extracting file L2411Xtr.exe.

Simple installation

This installation expects to find the provided diskette in drive A, it requires at least 4 Mbytes of free space on drive C and the default destination directory is C:\demo2411.

Step-by-step installation

- Insert the provided diskette in a floppy drive (A)
- Go to A: directory and start the self extracting file L2411Xtr.exe. To start the self extracting process, type A:L2411Xtr in DOS or double click on the file L2411Xtr.exe in Window. The process will ask for a destination directory with a default one of C:\demo2411.
- Go to the destination directory which now should contain the executable file Demo2411.exe
- Start the demonstration by running Demo2411.exe

Running the program

At start-up the program opens a dialog window asking for the serial port to which the LTC2411 demonstration board has been connected. The user must select one of the four available options (Com1, Com2, Com3 or Com4) (WARNING: Make sure you select the right serial port number. Select the wrong serial port number may cause mouse freeze problem on some computers). Once the program is running the screen will display the image shown in Figure 1. The controls and indicators on this display are as follows:

1. **Start/Stop** switch. When this switch is flipped to the left (the switch color is green) the computer is continuously reading the LTC2411 mounted on the demonstration board connected to the selected serial port. When this switch is flipped to the right (the switch color is red) the program is stopped.

2. **Select Serial Port**. This control is active only when the Start/Stop control (#1) is in the Stop position. By activating this button the user can change the serial port number to which the demonstration board is connected. This may be necessary if the initial selection, made at start-up, is wrong or if the serial port to which the demonstration board is connected is changed after the program has been started.

3. **Interface Error**. This indicator is active only when the Start/Stop control (#1) is in the Start position. A green color signifies a normal data transfer from LTC2411 to the computer. A red color indicates the occurrence of a data transfer error.
   When this indicator remains continuously red the computer can not communicate with the demonstration board. Possible causes and solutions are as follows:

   - The serial port selection is incorrect. The user should set the Start/Stop control (#1) in the Stop position and should change the serial port selection using the Select Serial Port control (#2).
   - The demonstration board does not receive sufficient power from the computer. The user should provide external power to the demonstration board using the VEXT and GND pins.

   When this indicator is mostly green but turns red from time to time the computer can not completely synchronize its readings of the converter and is attempting to read data while the conversion cycle is not completed. All data displayed and/or stored by the computer is correct but reading attempts made in the middle of the conversion cycle may very slightly increase the conversion noise in certain circumstances. These occurrences are due to preemptive tasks that the computer must execute while acquiring data. Increasing the sample period control (#16) may reduce the number of these events at the expense of a slower data acquisition rate.

4. **7 ½ Digits Display** showing the current conversion result. The un-scaled LTC2411 output range is -0.5 Vref units to +0.5 Vref units. The displayed value may be scaled for direct reading in volts by setting the FullScale Reading control (#7) equal to the differential reference voltage applied to the LTC2411. Within the normal conversion range the indicator maintains a black background color. When an over-range or an under-range condition is detected the indicator background color oscillates between black and read. The displayed value may be offset and gain corrected if necessary using the zero cal. control (#8) and F.S. cal control (#9).
   When the Averaging control (#6) is in the OFF position the displayed value represent the last read conversion result. If the Averaging control (#6) is in the On 8x position the displayed value is the sum of the 8 most recently read conversion results divided by 8. If the Averaging control (#6) is in the On 64x position the displayed value is the sum of the 64 most recently read conversion results divided by 64.

5. **Noise Histogram.** This graph shows the histogram of the last N readings. The value of N is determined by the No. of samples control (#12). The horizontal axes shows the bin distance from the median value in parts-per-million of Vref. The vertical axes shows the height of the histogram bins in % of N. The values used in creating this display are the raw ADC readings without any averaging, scaling, calibration or decimation.

6. **Averaging**. This control determines only the values displayed by the main indicator #4. It does not modify the results shown by the Noise Histogram indicator (#5), the RMS NOISE indicator (#11) or the RAW ADC OUTPUT indicator (#13)

7. **FullScale Reading**. This control determines the units of the indicator #4 displayed values. For the default setting of 1.0000000 the display #4 shows the ADC result in Vref units. The display #4 will read directly in volts if this control is set equal with the ADC differential reference value.

8. **Zero cal**. The LTC2411 does not require a zero calibration because its offset is typically much lower than 0.5ppm of Vref over the entire temperature and voltage range. Nevertheless this button will trigger a zero calibration which is intended for tare applications. Following the activation of this control the average of the last 64 consecutive readings of the ADC is defined as the system offset and is subtracted from every value displayed by the indicator #4. While the offset calibration is in effect this control will flash red. If the noise level of the last 64 ADC readings is high the Calibration O.K. indicator (#10) will show it. The computer will postpone the zero calibration operation until it is able to acquire 64 consecutive ADC readings with a low noise level.

9. **F.S. cal**. The LTC2411 does not require gain calibration because its gain error is typically less than 2.5ppm over the entire temperature and voltage range. Nevertheless this button will trigger a gain calibration operation intended for system gain correction. A dialog window is opened following the activation of this control and the user can enter the value of the system input voltage. The average of the last 64 consecutive readings of the ADC is than assumed to be the result of this voltage and the value shown by the indicator #4 is scaled accordingly. While the gain calibration is in effect this control will flash red. If the noise level of the last 64 ADC readings is high the Calibration O.K. indicator (#10) will show it. The computer will postpone the gain calibration operation until it is able to acquire 64 consecutive ADC readings with a low noise level.
   Because the gain calibration uses the current Zero cal. (#8) and Fullscale reading (#7) settings these two controls are disabled following the activation of the F.S. cal control.

10. **Calibration O.K.** This indicator is used during the offset and gain calibration procedures When the noise level of the last 64 consecutive ADC readings is low this indicator will display the "Calibration O.K." message. When the noise level of the last 64 consecutive ADC readings is high this indicator will display the "calibration not recommended - wait for more stable readings" message.

11. **RMS NOISE** indicator. This display shows the value of the standard deviation of the last N consecutive ADC readings in parts-per-million of Vref. The value of N is set by the No. of samples control (#12). The result shown by this display is calculated using raw consecutive readings obtained directly from the LTC2411 without any averaging, scaling, calibration or decimation.

12. **No. of samples**. This control defines the number of consecutive ADC readings used in producing the NOISE HYSTOGRAM graph (#5) the RMS NOISE indicator (#11) and the RAW ADC OUTPUT graph (#13). The user is advised that a low value setting of this control (e.g. less than 64) may significantly skew the significance of the noise histogram and rms noise calculations.

13. **RAW ADC OUTPUT**. This graph presents the last N consecutive readings obtained from the LTC2411 vs. time. . The value of N is set by the No. of samples control (#12). The data is used "as read", without any averaging, scaling, calibration or decimation. The horizontal axis shows the sample number from 0 (the oldest) to N-1 (the youngest). The vertical axis is auto scaling and shows the ADC result in parts-per-million of Vref.

14. **File Comment**. This control field accepts a short string, which will be written, at the beginning of the data acquisition file when activating the control #15 creates such a file.

15. **Write to File**. When this control is activated (flipped to the left and of color green) a dialog window will open and the user can specify the location and name of a file. Subsequently this file is created and the content of the control field #14 is written at the beginning. As long as this control remains active and the program is acquiring data (the control #1 is also active) every data received from the demonstration board is written to this file. The process stops when either control #1 or control #15 is deactivated. The file is formatted as four tab-delimited columns with one row per data point. The first column contains a time value stamp in milliseconds, the second column contains the raw data as read directly from the LTC2411, the third column contains the rms noise value as shown by the indicator #11 and the fourth column contains the string "OR" to indicate an over-range condition, the string "UR" to indicate an under-range condition or nothing for a normal within-range reading.

16. **Sample period.** This control defines the data acquisition period of the demonstration program. It does not modify the LTC2413 conversion time; it just determines how often the program will initiate a new conversion. The default value of 150ms is suitable when the LTC2413 is operated using the internal oscillator in 60Hz rejection mode (Fo=GND). If the computer running the demonstration program is particularly slow or if it must handle a substantial number of simultaneous running tasks than the interface error indicator (#3) will flicker red. In this situation it is recommended to increase the sample period until the indicator #3 remains continuously green. As this value is increased the number of

ADC readings per second will decrease and the computer will be better able to keep up with all its tasks. In general a sample period value of about 250ms is a reasonable compromise.
When the LTC2413 is operated using the internal oscillator in 50Hz rejection mode the sample period should be set to a minimum value of 180ms in order to handle the increased duration of the ADC conversion cycle. When the LTC2413 is operated using an external oscillator the sample period should be maintained at least 20ms longer than the duration of ADC conversion cycle corresponding to the clock frequency used. In a similar fashion the sample period may be increased from its minimum value to accommodate a slow computer or simultaneously running tasks.

17. **Demo Board Interface Speed Selection.** This control changes the digital interface timing from fast execution-dependent timing to slower timer-based timing. Long cables or some computers may require the slower timing. If the demo were to be linked through opto-isolation, the slower timing will likely be required. Setting the speed selection to slow will set the sample period to 270 msec. Sample period can be set to periods longer than 270 msec if required, for example, to reduce the amount of data collected over long periods of time. If the speed selection is returned to fast, the sample period must be manually reset if a period less than 270 msec is desired.