DC346 Quick Start Guide

Description

Simple, Small, Very Accurate

Demo board DC346 features THE LTC2413, a differential input No Latency ΔΣ™ 24-Bit ADC with simultaneous 50Hz and 60Hz rejection. The LTC2413 features 2ppm linearity, 2.5ppm full-scale accuracy, exceptional 0.1ppm offset accuracy and 0.16ppm RMS noise. The LTC2413 operates on supplies from 2.7V to 5.5V, drawing less than 300μA of current. It provides 87dB minimum rejection at 50Hz and 60Hz and DC and line frequency common mode rejection of 140dB. Single-conversion settling time yields latency-free results, enabling multiplexing, correlated double sampling and other interleaved sampling schemes. The LTC2413 performs user-transparent autozero and calibration on every output. It does not require initialization.

DC346 includes a precision 2.5V bandgap reference (LT1019-2.5) and a precision 5V buried Zener reference (LT1236-5) plus bypass capacitors and jumpers to select line frequency rejection and the various onboard/external references.

DC346 is designed to interface to a personal computer and to demonstrate good placement of bypass capacitors and partitioning analog and digital grounds.

The demo board allows the user to quickly evaluate the LTC2413 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 onboard LT1236 ordinarily powers the LTC2413, 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 will probably be 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 is 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 so that its differential outputs are centered at 2.5V.

The software included in this package presents a 7.5 digit display, a histogram display, and calculated noise figure, all of which are updated in real time. It also provides averaging capability, zero-scale and full-scale calibration functions and raw data output to a file for offline evaluation.

The demo board has a group of banana jacks for six-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's DB9 socket to the serial port of the computer (Com1–Com4). Port selection is done in the demo program.

Step 2: Rejection Frequency

The internal oscillator is configured to reject line frequencies of 50Hz and 60Hz simultaneously by connecting jumper JP4. This pin (F_O) can also be driven by an external clock.

Step 3: configure reference/power jumpers

Jumper JP1 connects excitation terminal (V_{EX} (J4) banana jack) to V_{CC} (may be 5V from the LT1236, or external), or a 2.5V reference from the LT1461.

Jumper JP2 connects the output of the LT1236 precision 5V reference to the V_{CC} rail.

You may elect to use an external V_{CC} supply, for example, for testing 2.7V, 3.3V or other supply sensitivity issues. **If JP2 is installed, do not apply external power to V_{CC} (J3).**

Jumper JP3 allows selection of the 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 for 6-wire ratiometric operation. REF^+ must be within the range from V_{REFMIN} above REF^- to V_{CC}.

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 to $V_{CC} - V_{REFMIN}$.

Step 4: Apply Input Signal(s)

There are a number of valid configurations for the inputs of this device:

1) Single-Ended 0V to 2.5V input

Connect

V_{IN}^- (J9) to ground (J10)

REF^- (J7) to ground (J10), or JP5 installed. (Experiment with this)

External 0V-2.5V signal to V_{IN}^+ (J8) (using ground at J10)

JP3 select 5V

JP2 installed

V_{EX} (J4) and REF^+(J6) and turrets not used

2) Full Bridge with 5V Excitation

Connect

REF^+ (J6) to bridge sense+

REF^- (J7) to bridge sense–

V_{IN}^+(J8) to bridge out+

V_{IN}^- (J9) to bridge out–

Bridge force– to Ground (J10)

Bridge force+ to V_{EX} (J4)

JP3 and JP5 removed

JP1 select V_{CC}

JP2 installed

External power (9V to 12V)will be required at J1 for a 350Ω 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–

V_{IN}^+ (J8) to variable arm+

V_{IN}^- (J9) to variable arm–

Bridge force– to Ground (J10)

Bridge force+ to V_{EX} (J4)

JP3 and JP5 removed

JP1 select V_{CC}

JP2 installed

The 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–

V_{IN}^+ (J8) to bridge out+

V_{IN}^- (J9) to bridge out–

Bridge force- to Ground (J10)

Bridge force+ to V_{EX} (J4)

JP3 and JP5 removed

JP1 select V_{CC}

JP2 installed

External power (9V to 12V)will be required at J1 for a 350Ω 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 4MB 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 named L2413Xtr.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:\demo2413.

Step-by-Step Installation

- Insert the provided diskette in a floppy drive (A)

- Go to A: directory and start the self extracting file L2413Xtr.exe. To start the self extracting process, type A:L2413Xtr in DOS or double click on the file L2413Xtr.exe in Windows. The process will ask for a destination directory—the default is C:\demo2413.

- Go to the destination directory which now should contain the executable file

  Demo2413.exe

- Start the demonstration by running Demo2413.exe

Running the Program

At start-up, the program opens a dialog box asking for the serial port to which the LTC2413 demonstration board has been connected. The user must select one of the four available options (Com1, Com2, Com3 or Com4). 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 LTC2413 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 the LTC2413 to the computer. A red color indicates a data-transfer error. When this indicator remains continuously red, the computer cannot 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 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 $V_{EX}T$ and GND pins.

     When this indicator is mostly green but turns red from time to time, the computer cannot 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. **7.5 Digit Display** shows the current conversion result. The unscaled LTC2413 output range is –0.5 V_{REF} units to +0.5 V_{REF} units. The displayed value may be scaled for direct reading in volts by setting the FullScale Reading control (#7) to the differential reference voltage applied to the LTC2413. Within the normal conversion range the indicator maintains a black background color. When an overrange or an underrange condition is detected the indicator background color oscillates between black and red. 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 represents the last conversion result read. If the Averaging control (#6) is in the On 8x position, the displayed value is the sum of the eight 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 axis shows the bin distance from the median value in parts-per-million of V_{REF}. The vertical axis 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 V_{REF} units. The display #4 will read directly in volts if this control is set to the ADC differential reference value.

8. **Zero cal**. The LTC2413 does not require a zero calibration because its offset is typically much lower than 0.5ppm of V_{REF} 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 LTC2413 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 then 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 V_{REF}. 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 LTC2413 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 (for example, 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 LTC2413 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 newest).

The vertical axis is autoscaling and shows the ADC result in parts-per-million of V_{REF}.

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

15. **Write to File**. When this control is activated (flipped to the left and colored 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) all 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 LTC2413, the third column contains the RMS noise value as shown by indicator #11 and the fourth column contains the string "OR" to indicate an overrange condition, the string "UR" to indicate an underrange 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 165ms is suitable when the LTC2413 is operated using the internal oscillator. If the computer running the demonstration program is particularly slow or if it must handle a substantial number of simultaneous running tasks, 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 an external oscillator, the sample period should be maintained for at least 20ms over 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.