LDC1000/LDC1041/LDC1051 Evaluation Module

User's Guide

Literature Number: SNAU150A
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LDC1000/LDC1041/LDC1051 Evaluation Module

1.1 Overview

The LDC10xx Evaluation Module is designed to provide an example LC tank and coil structure application which interfaces to a host computer. The module can be used independently of the GUI by the on-board embedded LED, which demonstrates threshold detection.

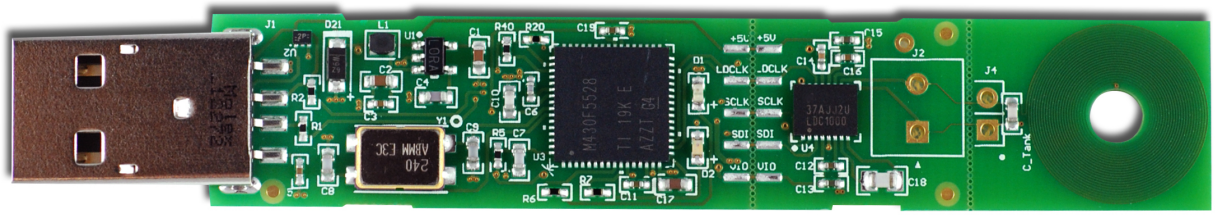

Figure 1-1. Evaluation Module

The EVM includes an example PCB sensor which is a 2 layer, 23 turn, 14mm diameter inductor with a 100pF 1% NP0 capacitor connected in parallel to form an LC tank.

The EVM is perforated at two locations to provide the option to interface to various system configurations. The first perforation, between the coil and the LDC10xx, can be used to snap off the PCB coil and connect a custom coil. The second perforation is between the LDC10xx and the MSP430, and provides the option to connect the LDC10xx and the sensor to a different system or to use multiple sensors in one system for prototyping.

Figure 1-2. LDC1000+Sensor

When the evaluation module first powers up from the USB port, it will flash a series of green and red LED lights to indicate self-test. When the self-test is finished, the green LED indicates the status of the LDC10xx INTB pin. When the INTB pin is asserted, the green LED is lit. By default, INTB is configured for threshold detection.

Quick Start Guide LDC10xx Evaluation Module

2.1 LDC10xx Evaluation Module Overview

The LDC10xx Evaluation Module (EVM) enables the user to test out analog and digital capabilities of the LDC10xx Inductance-to-Digital Converter. The EVM is a USB device used with a host computer and accessed using the Inductive Sensing Graphical User Interface (GUI) software, which is documented in Chapter 3.

To quickly get started on the LDC10xx GUI, follow the steps below to load and configure a device:

2.1.1 Evaluation Module

Set Up Requirements:

1. The LDC10xx GUI and drivers must be installed on the host.
2. Available USB port on host computer.

Loading and Running:

1. Plug the EVM into the host computer. The host computer should automatically detect the device as a LDC10xxEVM.
2. Launch the GUI. It should automatically detect the presence of the EVM, read all the configuration registers, and begin streaming data.

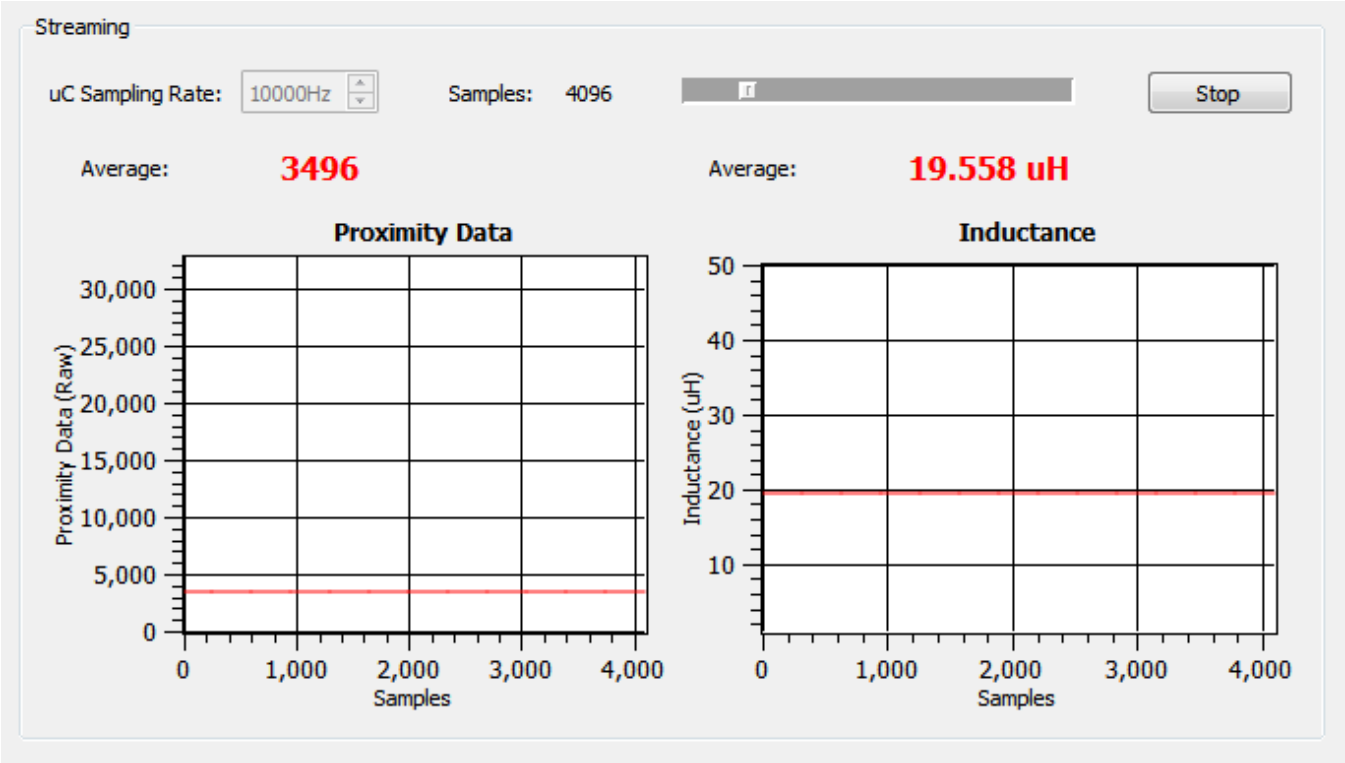

Figure 2-1. Streaming Section

Reconnecting the EVM

If the EVM is disconnected from the host at any time, simply reconnect the device and the GUI will automatically discover and re-establish the streaming abilities with the device.

Configuring the Device Manually

1. The GUI puts the device in streaming mode by default. Click on "Stop" in the streaming section to stop continuous LDC10xx conversion.

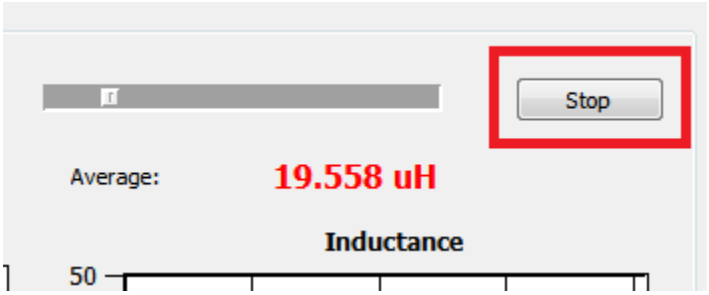

Figure 2-2. Stop Streaming

2. Click on the Configuration icon in the main window toolbar.

Figure 2-3. Configuration Icon

3. Select the parameter to change. When entering the comparator thresholds, press ENTER to confirm the change. Changes are applied immediately.

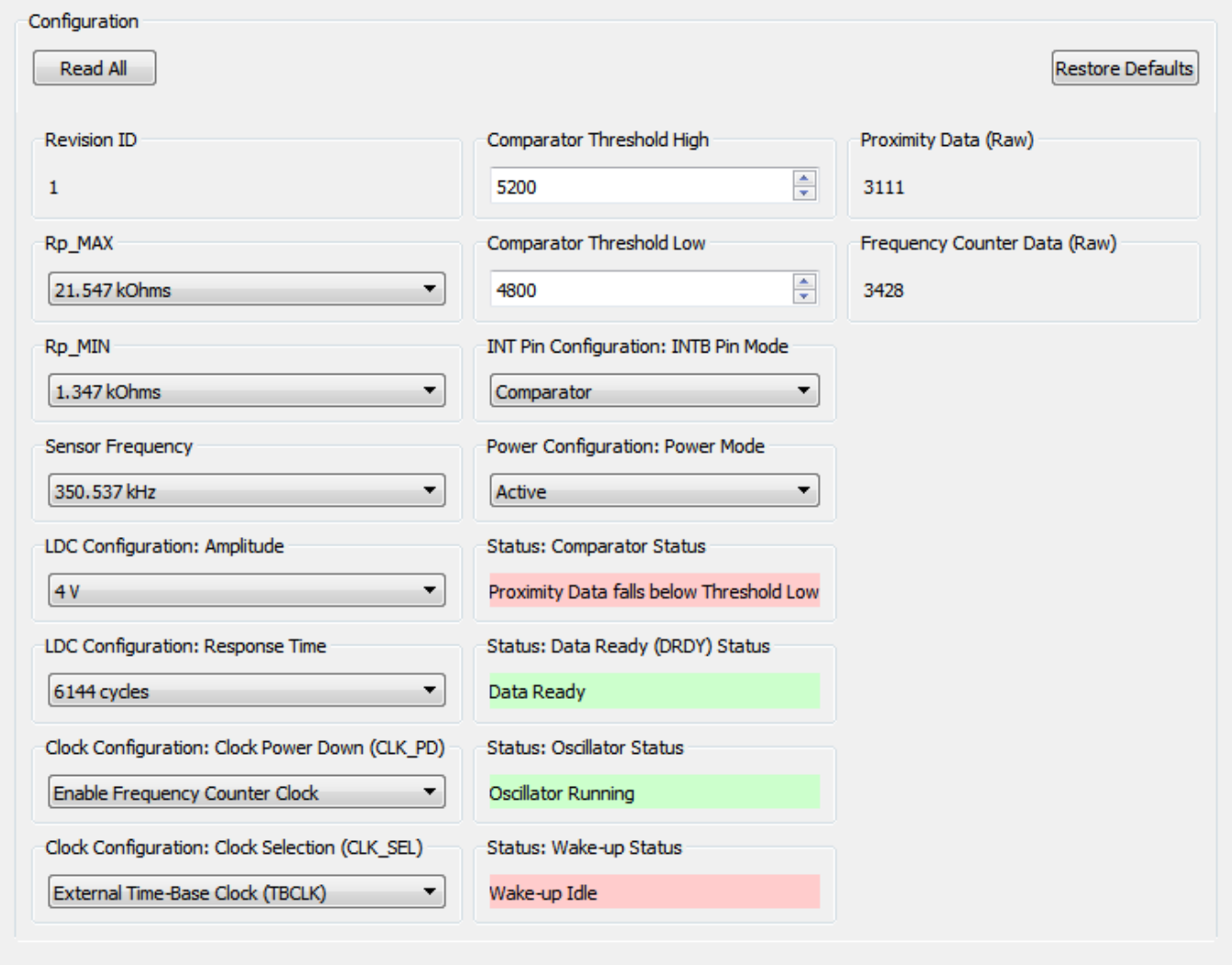

Figure 2-4. Configuration Section

Saving Device Configuration

1. Click on the "Save" icon in the toolbar.

Figure 2-5. Save Icon

2. Type a name for the file.

Configuring the Device with Configuration File Defaults

1. The GUI puts the device in streaming mode by default. Click on "Stop" in the streaming section to stop streaming.
2. Click on the "Open" icon in the toolbar.

Figure 2-6. Open Icon

3. Select the configuration file.

4. After the configuration file is loaded, current values are written once to all supported registers. To restore defaults *defined in the configuration file*, click on Restore Defaults to write all current registers with the new configuration file defaults.

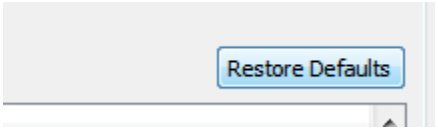

Figure 2-7. Restore Defaults

Inductive Sensing GUI User Guide

3.1 Inductive Sensing GUI Overview

The inductive sensing GUI provides graphical configuration and streaming support for the LDC10xx. **The GUI package includes drivers for use with the LDC10xx Evaluation Modules (EVM).** The EVM provides a device abstraction layer for the GUI to communicate with the LDC10xx through SPI, and includes other extended functionality.

3.2 Host Platform Requirements

The Inductive Sensing GUI supports:

- 32-bit and 64-bit Windows 7
- 32-bit and 64-bit Windows XP

The host machine is required for device configuration and data streaming. Below are the steps which are necessary to prepare the EVM for the GUI:

- The GUI must be installed on the host.
- The EVM driver must be installed on the host.
- The EVM must be connected to a full speed USB port (USB 1.0 or above).

3.3 EVM Information

For the TI LDC10xx EVM:

- The EVM allows the GUI to:
  - Configuring register data through SPI (CSB, SCLK, SDO, SDI)
  - Stream register data through **SPI**
  - Stream register data through **SPI**
  - Detect interrupts through **SPI**

3.4 Icon Toolbar

The icon toolbar contains various icons which navigate between sections and perform various functions.

Figure 3-1. Icon Toolbar

Name	Description	Icon
Connection Information	Indicates whether an EVM is connected to the PC, and if so, provides details of the connected EVM	• EVM is connected  • EVM is disconnected 

Open	Opens saved register settings and defaults	
Save	Saves all current register settings and defaults	
Register Settings	Show LDC10xx Register Settings	
Configuration	Show EVM Configuration	
Streaming	Show Streaming Section	

3.5 Multiple EVMs

To connect multiple EVMs to a single host, multiple instances of the GUI should be launched. Each EVM will interface to only one instance of the GUI; multiple instances cannot connect to the same EVM. Use the following procedure to setup multiple EVMs:

1. Connect the desired number of EVMs to the available USB ports.
2. Open one instance of the GUI, note the COM port number at the top of the GUI. This EVM is the highest priority. Remove and replace each EVM individually until the COM port number changes. Note the new COM port number.
3. This EVM is the next highest priority. Repeat this process until no EVMs are connected and the EVM with the lowest priority has been identified.
4. When all of the EVMs are to be used simultaneously, open one GUI for each EVM and plug in the EVMs from lowest priority to highest priority – each will claim their own instance of GUI.

3.6 General Configuration

In the configuration section, all registers of the device can be accessed. To access this section, streaming must be stopped.

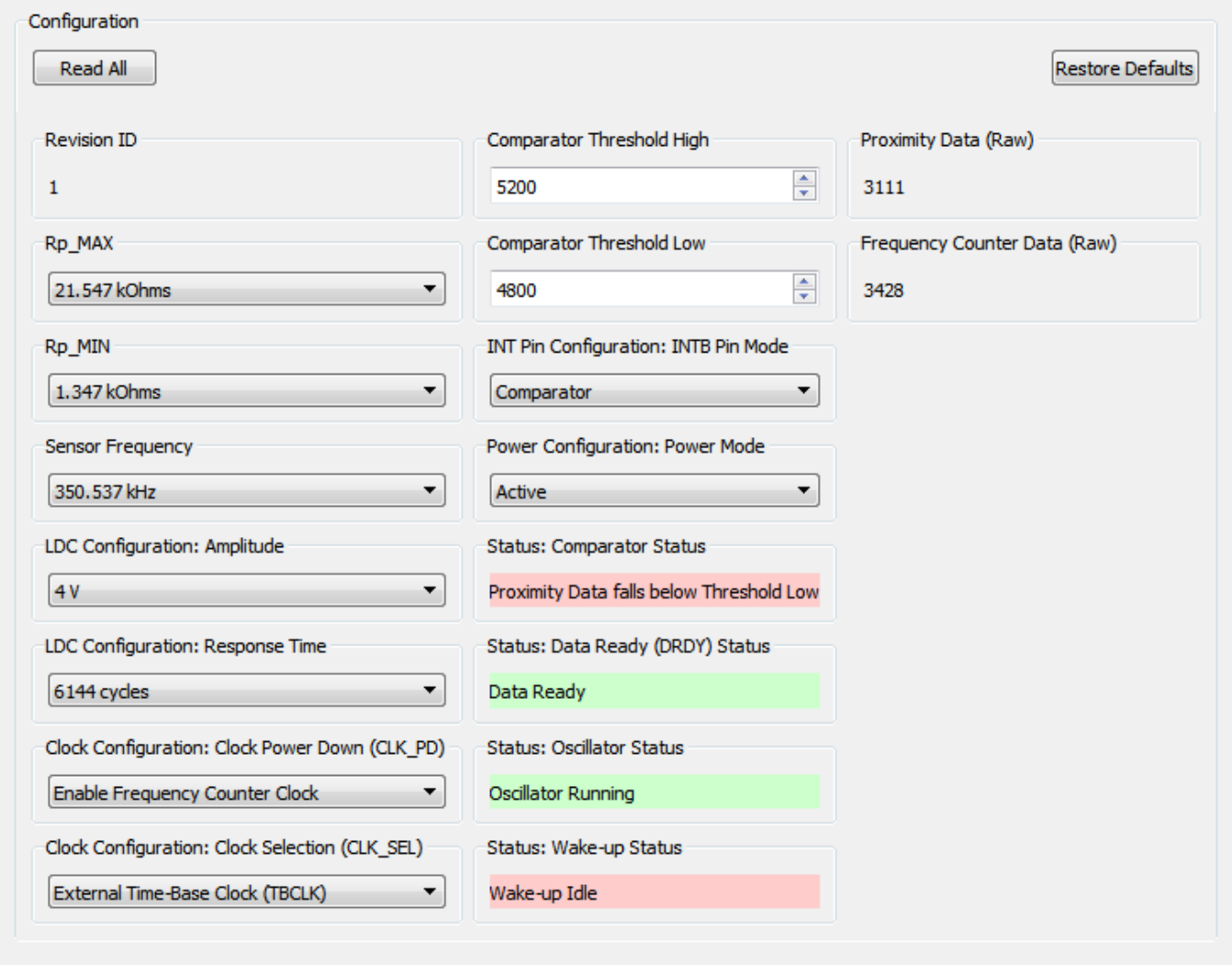

Figure 3-2. Configuration Section

In the configuration window, select the parameter to change. When entering the comparator thresholds, press ENTER to confirm the change. Changes are applied immediately.

Press “Read All” to refresh all configuration, status, and data settings.

Press “Restore from Defaults” to write values from the default column (if they exist) to the current register values.

Press "Save Values as Defaults" to set the current configuration settings as the default settings.

3.7 Register Settings

In the register settings section, all registers of the device can be accessed. To read/write registers, streaming must be stopped.

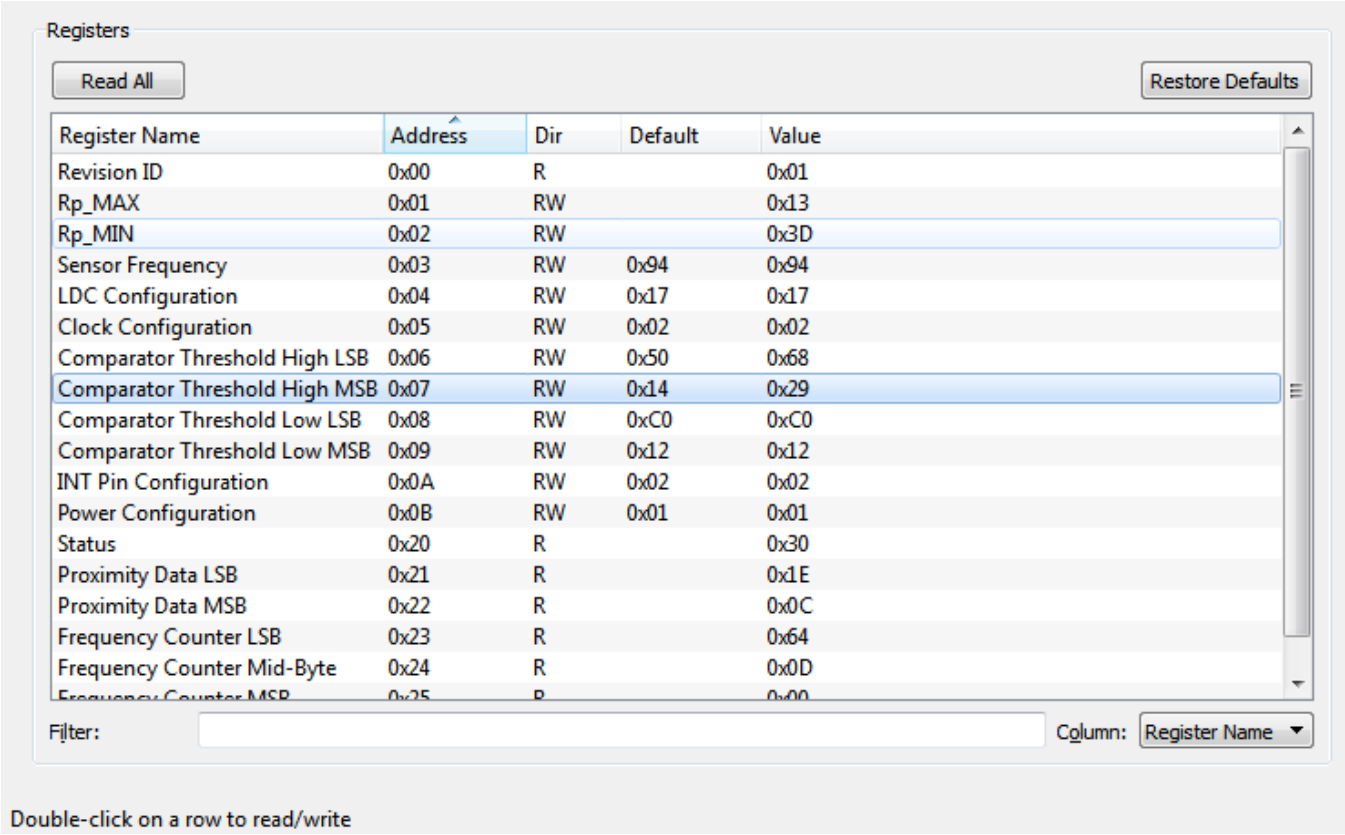

Figure 3-3. Register Settings

Double-click on a register in the table to read/write. If a register is read only, the selected register is read immediately and the table value updated. If the register is read/write, a dialog pops up and the user can set a new register value. If the value is not changed, it will default to a read.

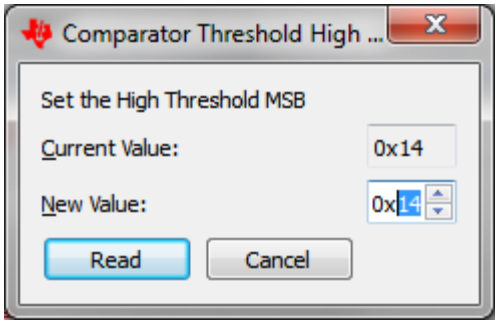

Figure 3-4. Read/Write Register Dialog

Press “Read All” to refresh all configuration, status, and data.

Press “Restore Defaults” to write values from the default column (if they exist) to the current register value.

3.8 Data Streaming

Data is streamed from the EVM to the GUI when streaming is started. The sampling rate of the EVM and the number of samples to plot can be configured. The sampling rate is the rate at which the micro-controller on the EVM retrieves a measurement from the LDC10xx.

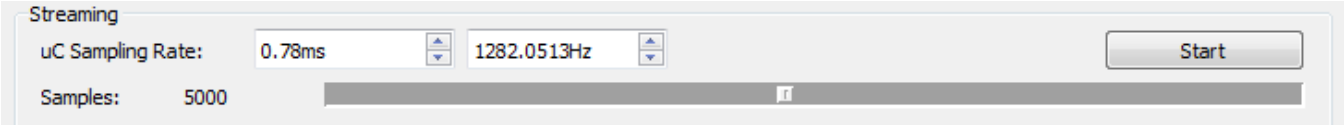

Figure 3-5. Streaming Configuration

The sampling rate can only be set when streaming is stopped.

3.8.1 Average, Point, Min, Max Values

Average is the default display type. To toggle between sample point, min, and max values, right-click on the GUI. The various display modes are:

Average Mode	The average of all the data points currently in the plot
Point Mode	The newest data point value currently in the plot
Min Mode	The minimum data point value currently in the plot
Max Mode	The maximum data point value currently in the plot

A larger number of samples would result in a larger averaging window.

3.8.2 Zooming and Scaling

Plots are interactive. Zooming options are available by right-clicking the plot and selecting an option from the context menu.

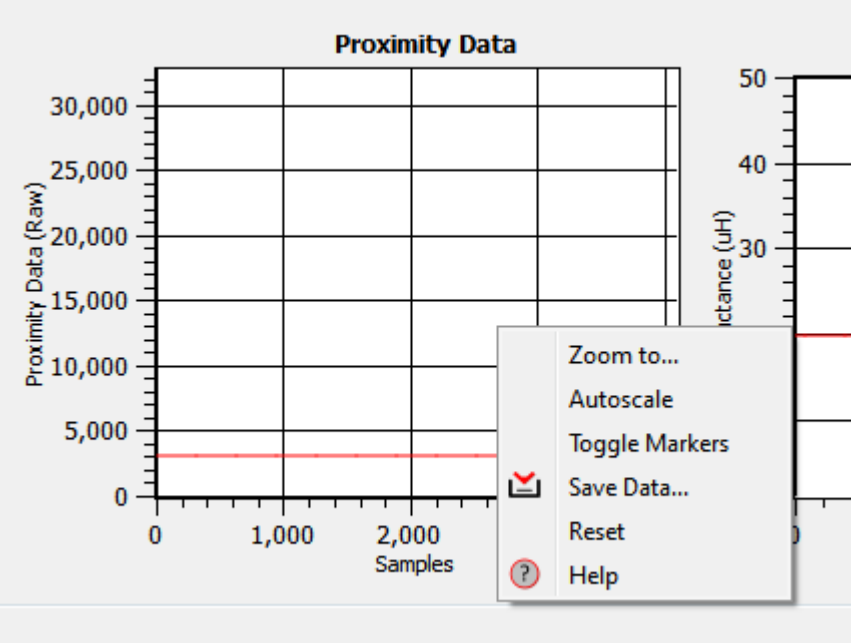

Figure 3-6. Plot Context Menu

Zoom to...	Zooms to window
Autoscale	Autoscales the data in the plot
Reset	Resets the Zoom window to its default setting
Help	Displays shortcut keys and mouse mappings for scaling and zooming

3.8.3 Threshold Display

To display R_P Thresholds, right-click the plot and select “Toggle Markers.”

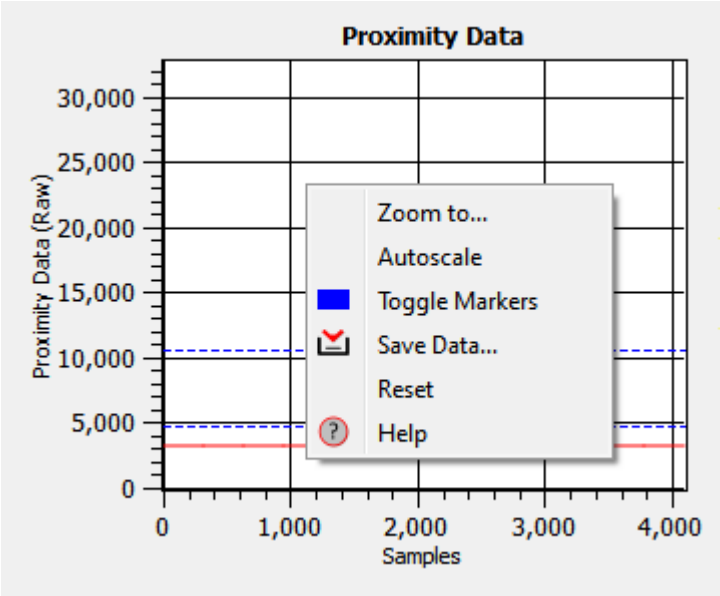

Figure 3-7. Toggling Markers

3.8.4 Inductance Raw Data

To display the raw frequency count output data instead of the inductance data, right click on the Inductance plot and select "Toggle Data Type".

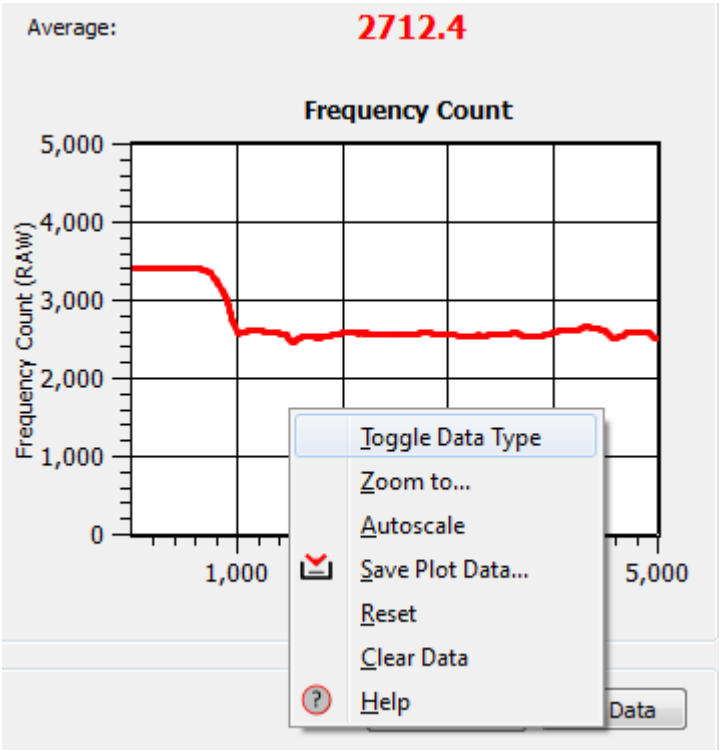

Figure 3-8. Switching Display Units Between Inductance and Frequency Count

3.8.5 LDCLK

The LDC10xx uses a reference clock generated by the MCU on the EVM to measure the inductance. The clock frequency can be changed to several settings by the LDCLK selection. The higher the frequency of the LDCLK, the more accurately the LDC10xxEVM can measure the inductance. When the LDCLK is set to OFF, then no inductance measurements are performed and the inductance measurement graph is not displayed. Note that it may take a some time for the inductance measurement result to stabilize after changing the LDCLK frequency.

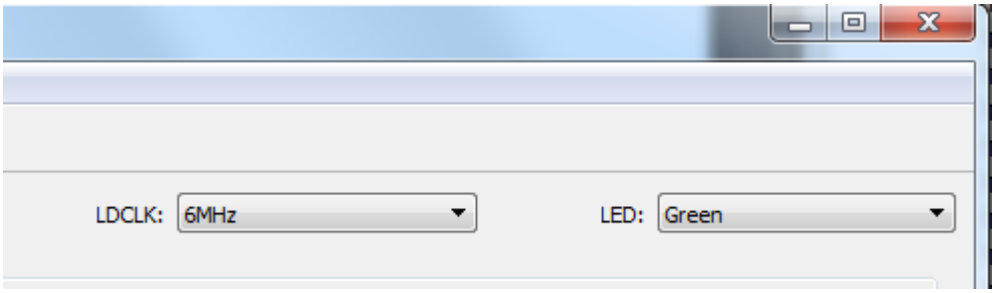

Figure 3-9. LDCLK Configuration

3.8.6 LED

The Red and Green LEDs on the LDC10xxEVM can be turned on or off using this menu.

3.9 Saving and Loading

3.9.1 Configurations

Configurations can be saved and loaded. To save a configuration, click on the **"Save"** icon. To load a configuration, click on the **"Open"** icon.

Configurations include all register names, current values, and default values. They are saved in Comma-Separated Files (*.csv) and can be modified using a text or spreadsheet editor.

3.9.2 Plot Data

Right-click a plot and select “Save Data…”

Data can be saved to a new file or an existing one. If an existing file is chosen, data will be appended.

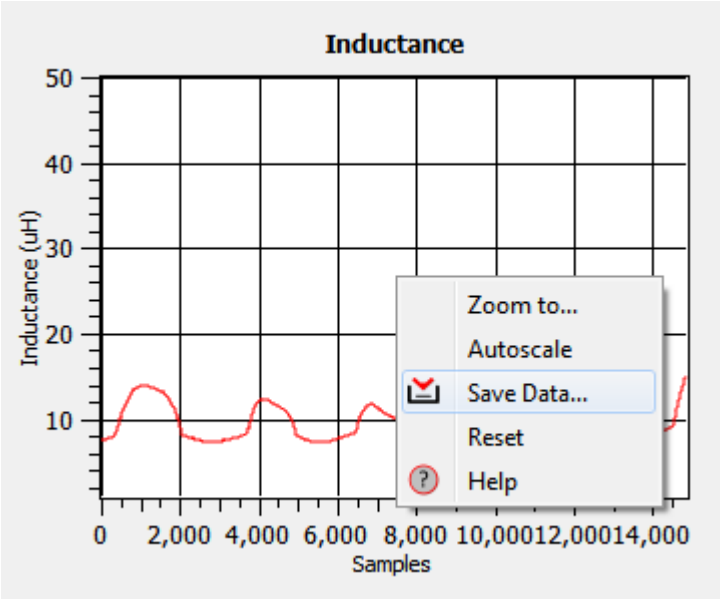

Figure 3-10. Saving Data from a Plot

3.9.3 Data Logging

Measured data from the LDC10xxEVM can be saved to a text file by using the Logging features, which are located on the bottom of the main GUI window.

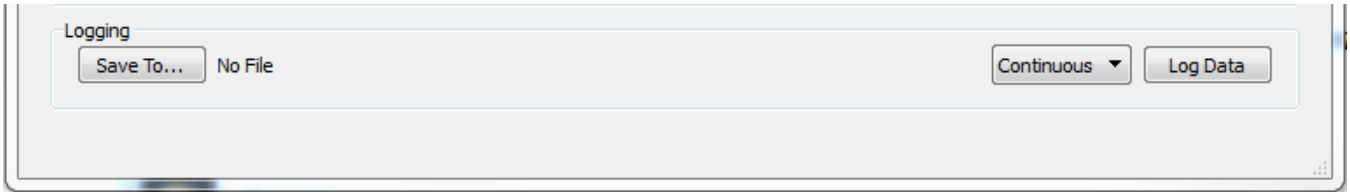

Figure 3-11. Data Logging

The data is saved in an ASCII text file which contains the time of data capture, the R_P measurement, the inductance measurement, and the raw inductance data. Data can be logged either as a single measurement or as a continuous stream of data. To save a single measurement, set the middle button to "Single"; if a continuous log is desired, change the setting to "Continuous". Once the mode is set, press the "Log Data" button to save the file. A file save dialogue will open asking for the file name. It is recommended to add ".txt" to the end of the filename if a text editor is to be used to analyze the data, or use an extension of ".csv" if a spreadsheet program is to be used. When the Logging save mode is continuous, the GUI will continuously save the data from the LDC10xxEVM; to stop the data saving, press the "Log Data" button a second time.

3.10 Using a Custom Sensor

The coil plus capacitor portion of the LDC10xx Evaluation Module is perforated so that it can be snapped off and replaced with a custom LC tank.

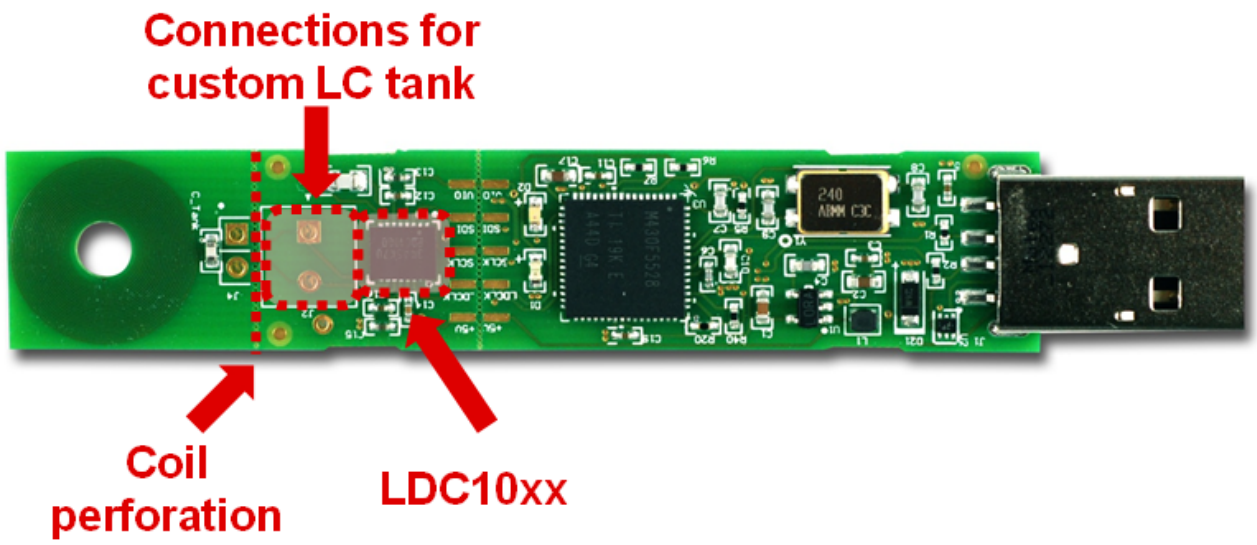

Figure 3-12. Custom Sensor Connection

By default, the Evaluation Module is fitted with a 100pF 1% NP0 sensor capacitor in parallel to the PCB coil. When the sensor capacitor value is changed as a result of replacing the default LC tank with a custom inductive sensor, it is necessary to input the new capacitor value into the Sensor Capacitor field in the GUI to ensure that the inductance data is calculated correctly.

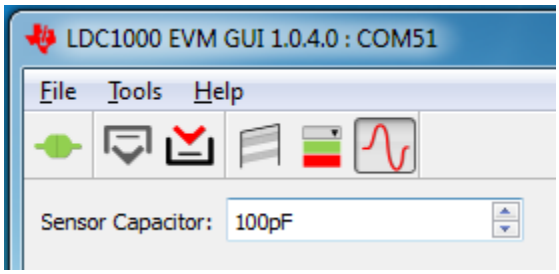

Figure 3-13. Sensor Capacitor Setting

3.11 Additional Resources

Several resources are included in the GUI installation directory (typically C:\Program Files (x86)\Texas Instruments LDC1000 EVM). These resources can be useful for development of LDC10xx projects.

3.11.1 PCB Information

In the installation directory, refer to the PCB subdirectory. In the PCB/Fabrication Drawing subdirectory the schematic, Bill of Materials, and a printout of the layout is included. The Gerbers and manufacturing files are included the PCB/Gerber subdirectory.

3.11.2 Firmware Resources

In the installation directory, refer to Firmware subdirectory. The firmware image is provided, along with the source code and Code Composer project workspace for the LDC10xx EVM firmware.

3.11.3 Matlab Interface

A Matlab interface library is included in the installation. Refer to installation directory and then navigate to Matlab\Doc\html\index.html for documentation on the provided functions.

3.11.4 Labview Resources

A Labview interface library is included in the installation. The Labview subdirectory contains VIs to read and write LDC10xx registers and to stream data from the LDC10xxEVM.

4.1 LDC10xx EVM Schematics

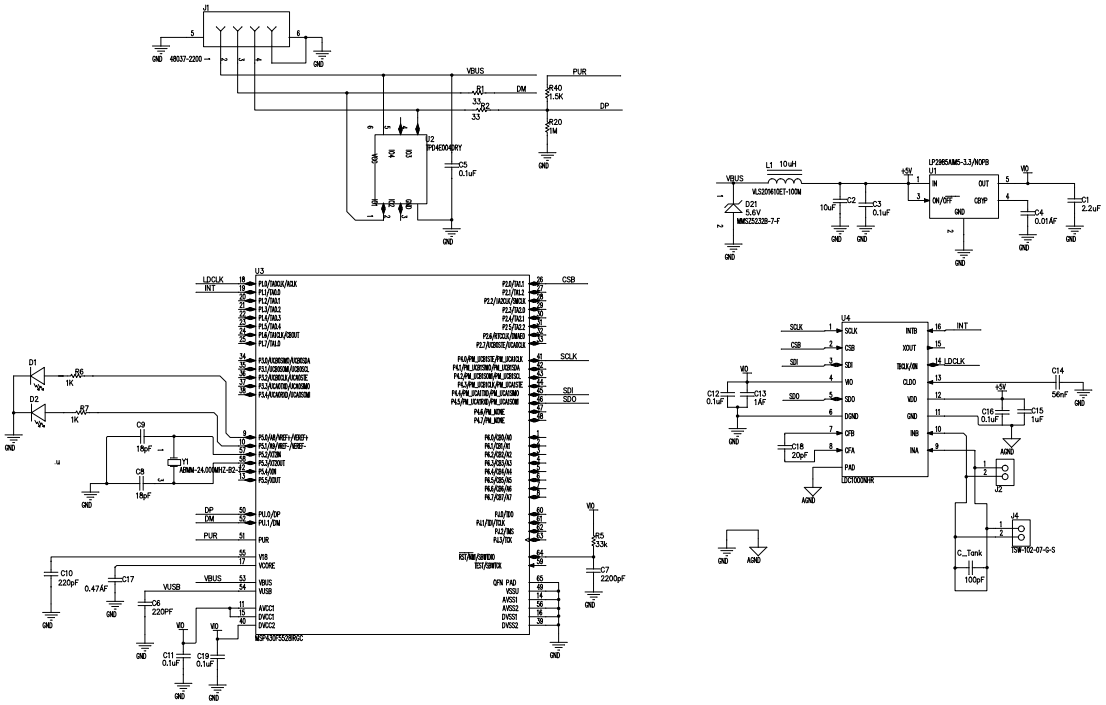

Figure 4-1. EVM Layout

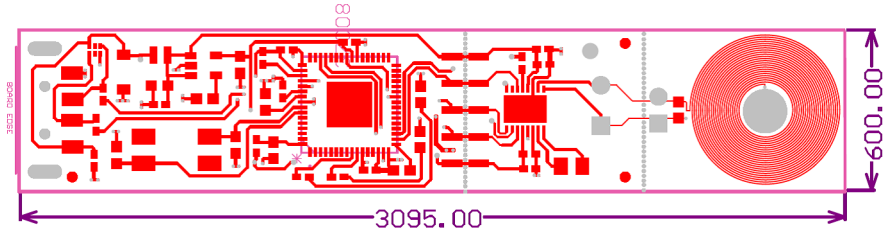

Figure 4-2. Top Layer

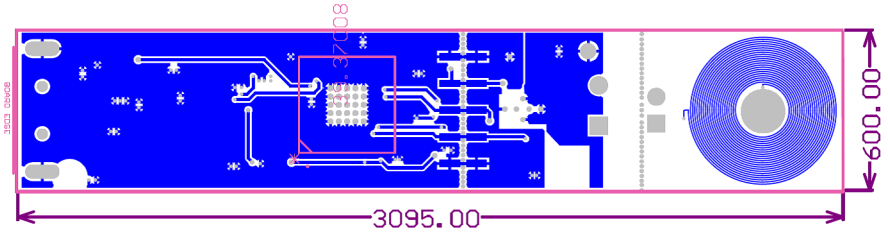

Figure 4-3. Bottom Layer

Bill of Materials

Designator	Quantity	Description	Manufacturer	Part Number
C1	1	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0603	Kemet	C0603C225K8PACTU
C2	1	CAP CER 10UF 10V 10% X5R 0603	TDK Corporation	C1608X5R1A106K080AC
C3, C5, C11, C12, C16, C19	6	CAP CER 0.1UF 16V 5% X7R 0402	Murata Electronics North America	GRM155R71C104JA88D
C4	1	CAP, CERM, 0.01uF, 25V, +/-5%, C0G/NP0, 0603	TDK	C1608C0G1E103J
C6	1	CAP CER 220PF 50V 1% NP0 0402	TDK Corporation	C1005C0G1H221F050BA
C7	1	CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603	Kemet	C0603X222K5RACTU
C8, C9	2	CAP CER 18PF 100V 5% NP0 0603	MuRata	GRM1885C2A180JA01D
C10	1	CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603	AVX	06035A221FAT2A
C13, C15	2	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0402	MuRata	GRM155R61A105KE15D
C14	1	CAP CER 0.056UF 16V 5% X7R 0402	Kemet	C0402C563J4RACTU
C17	1	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603	Kemet	C0603C474K8RACTU
C18	1	CAP CER 20PF 50V 5% NP0 0805	Kemet	C0805C200J5GACTU
C_Tank	1	CAP CER 100PF 50V 1% NP0 0603	AVX Corporation	06035A101FAT2A
D1	1	LED SMARTLED GREEN 570NM 0603	OSRAM Opto Semiconductors Inc	LG L29K-G2J1-24-Z
D2	1	LED 660NM SUPER RED DIFF 0603SMD	Lumex Opto/Components Inc	SML-LX0603SRW-TR
D21	1	Diode, Zener, 5.6V, 500mW, SOD-123	Diodes Inc.	MMSZ5232B-7-F
FID1, FID2, FID3	3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J1	1	Connector, USB Type A, 4POS R/A, SMD	Molex	48037-2200
L1	1	INDUCTOR POWER 10UH .45A SMD	TDK Corporation	VLS201610ET-100M
R1, R2	2	RES, 33 ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW040233R0JNED
R5	1	RES, 33k ohm, 5%, 0.063W, 0402	Vishay-Dale	CRCW040233K0JNED
R6, R7	2	RES 1K OHM 1/10W 5% 0402 SMD	Panasonic Electronic Components	ERJ-2GEJ102X
R20	1	RES,1M ohm, 5%, 0.063W, 0402	Yageo	RC0402JR-071ML
R40	1	RES 1.5K OHM 1/16W 5% 0402 SMD	Vishay Dale	CRCW04021K50JNED

Designator	Quantity	Description	Manufacturer	Part Number
U1	1	Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator, 5-pin SOT-23, Pb-Free	Texas Instruments	LP2985AIM5-3.3/NOPB
U2	1	4-CHANNEL ESD-PROTECTION ARRAY FOR HIGH-SPEED DATA INTERFACES, DRY006A	Texas Instruments	TPD4E004DRY
U3	1	MCU	Texas Instruments	MSP430F5528IRGCR
U4	1	Inductance to Digital Converter	Texas instruments	LDC1000
Y1	1	CRYSTAL 24.000MHZ 18PF SMD	Abracon Corporation	ABMM-24.000MHZ-B2-T
J2	0	TERM BLOCK 2POS 3.81MM PCB HORIZ	FCI	20020327-D021B01LF
J4	0	Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	Samtec, Inc.	TSW-102-07-G-S

Revision History

Changes from Original (September 2013) to A Revision **Page**

- Added new part numbers LDC1041/LDC1051 2
- Additional sections on design resources installed with GUI, how to use a custom sensor, and information on new data logging feature 3
- Added New Section 14
- Changed Changed Schematic to Vector graphic for better display. 17

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