LDC1000/LDC1001/LDC1041/LDC1051 Evaluation Module

User's Guide

Literature Number: SNAU150B
September 2013–Revised November 2019

LDC1000/LDC1001/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.

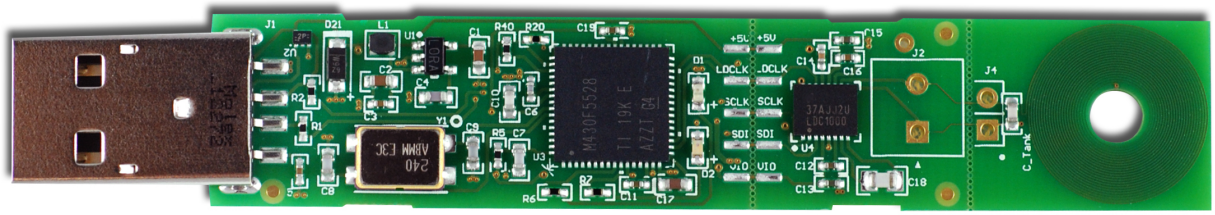


Figure 1-1. Evaluation Module

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.

1.2 Sensing Solutions EVM GUI

The Sensing Solutions EVM GUI provides direct device register access, user-friendly configuration, and data streaming.

1.2.1 System Requirements

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

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

The Sensing Solutions EVM GUI supports the following operating systems (both 32-bit and 64-bit):

- Windows XP
- Windows 7
- Windows 8 and 8.1
- Windows 10

1.2.2 Installation Instructions

The Sensing Solutions GUI and EVM driver installer is packaged in a zip file. Follow these steps to install the software:

1. Download the software ZIP file from the EVM tool page
2. Extract the downloaded ZIP file
3. Run the included executable
4. If prompted by the User Account Control about making changes to the computer, click "Yes"

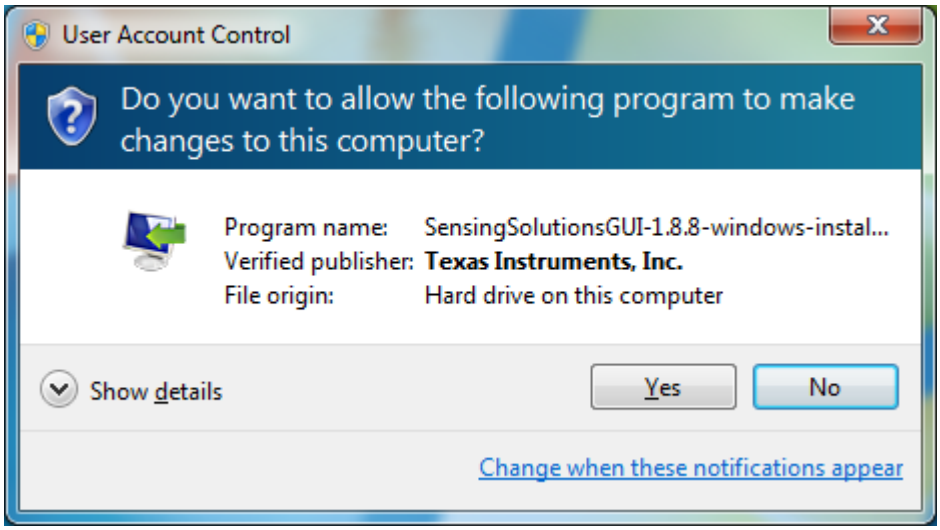


Figure 1-3. User Account Control Prompt

5. After the setup wizard starts, click "Next"

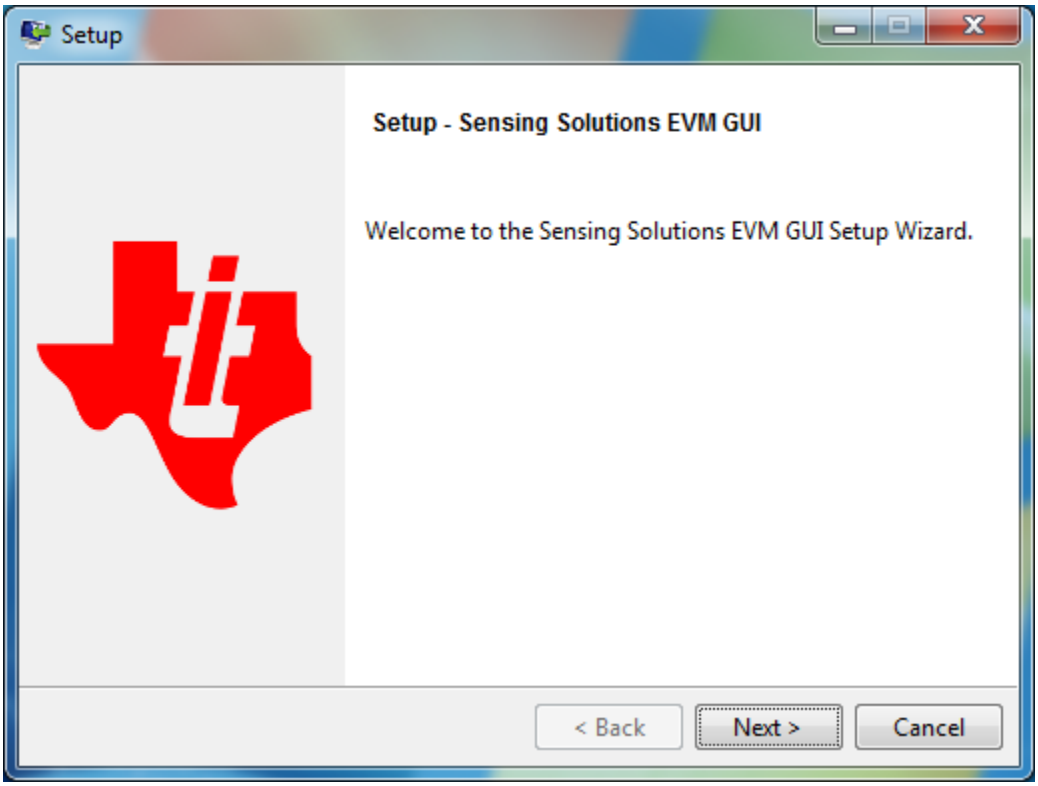


Figure 1-4. Software Installer Wizard

6. Read the license agreement, select "I accept the agreement", and click "Next"

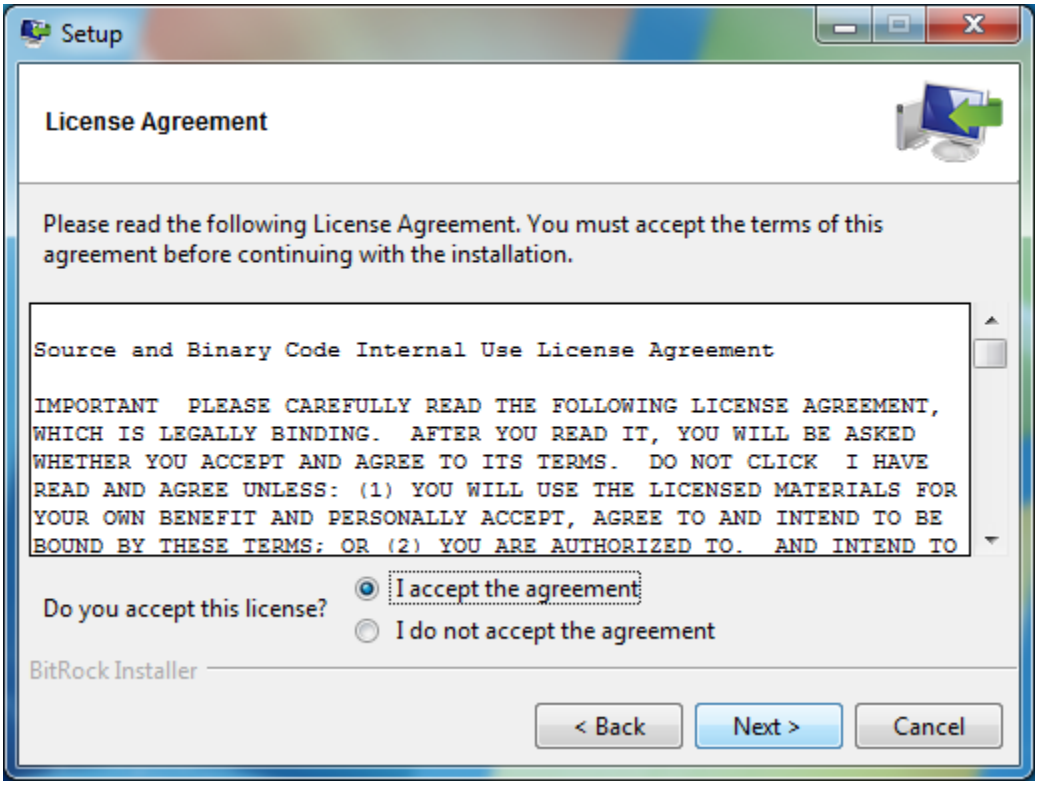


Figure 1-5. Software Installer License Agreement

7. Use the preselected installation directory and click "Next"

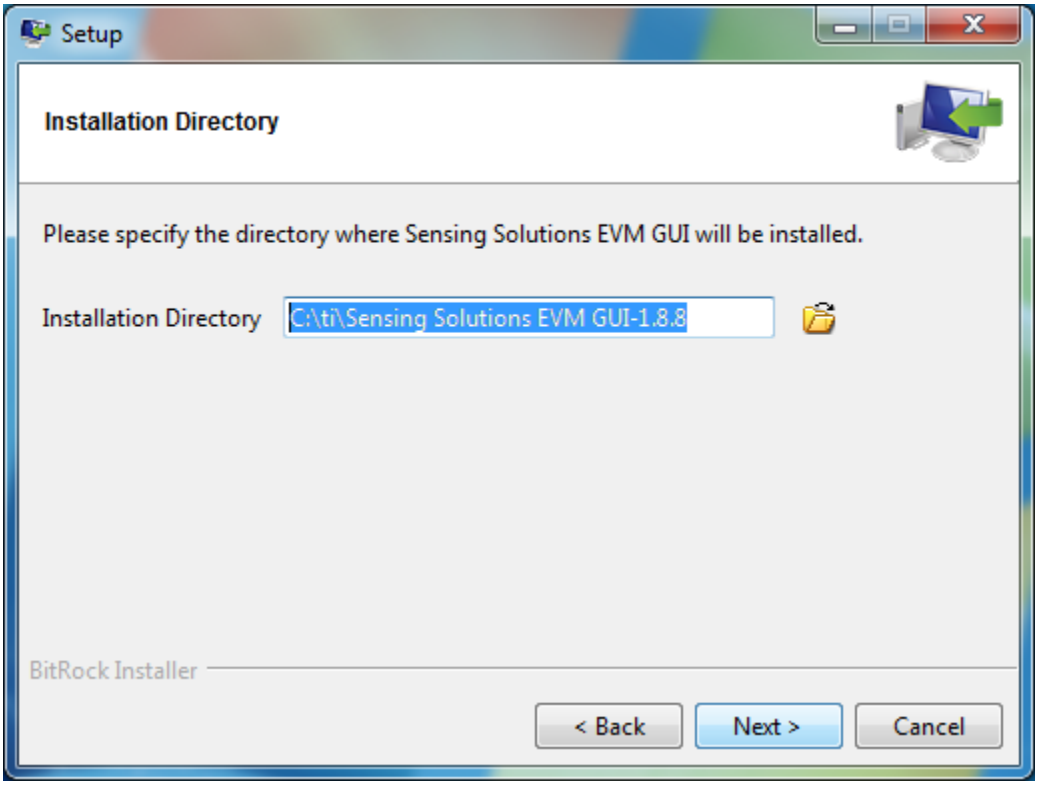


Figure 1-6. Software Installation Directory

8. Start the installation by clicking "Next"

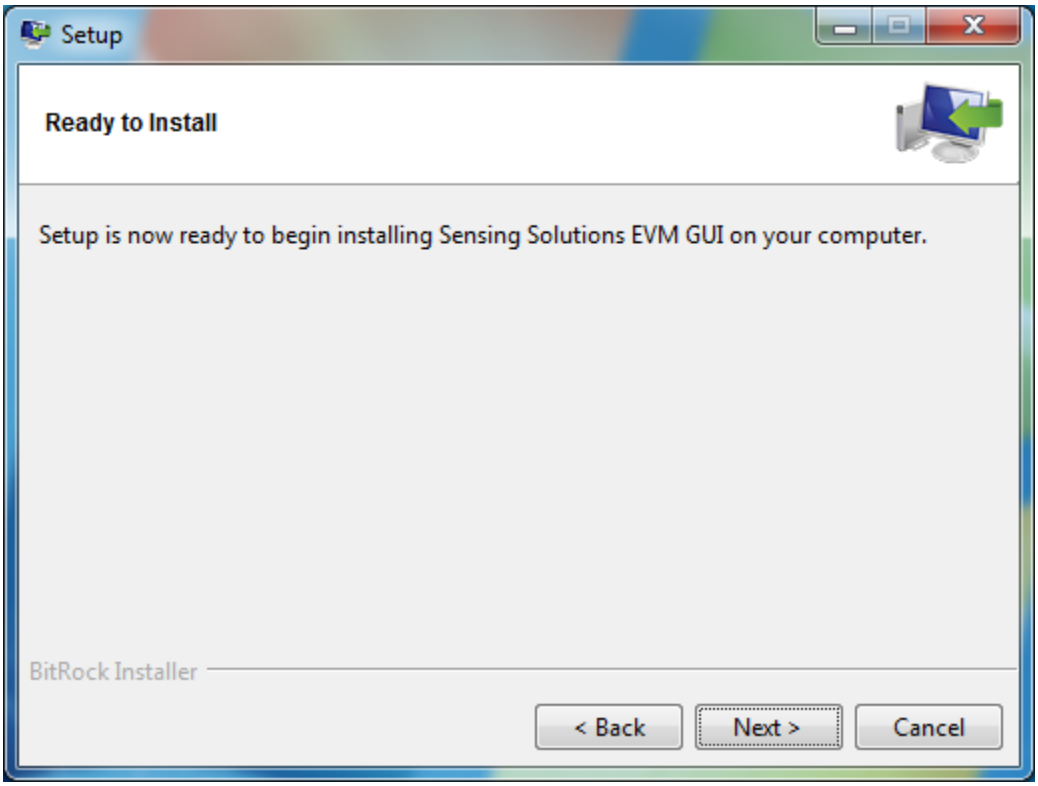


Figure 1-7. Software Installer Ready

9. Wait for the installation to complete

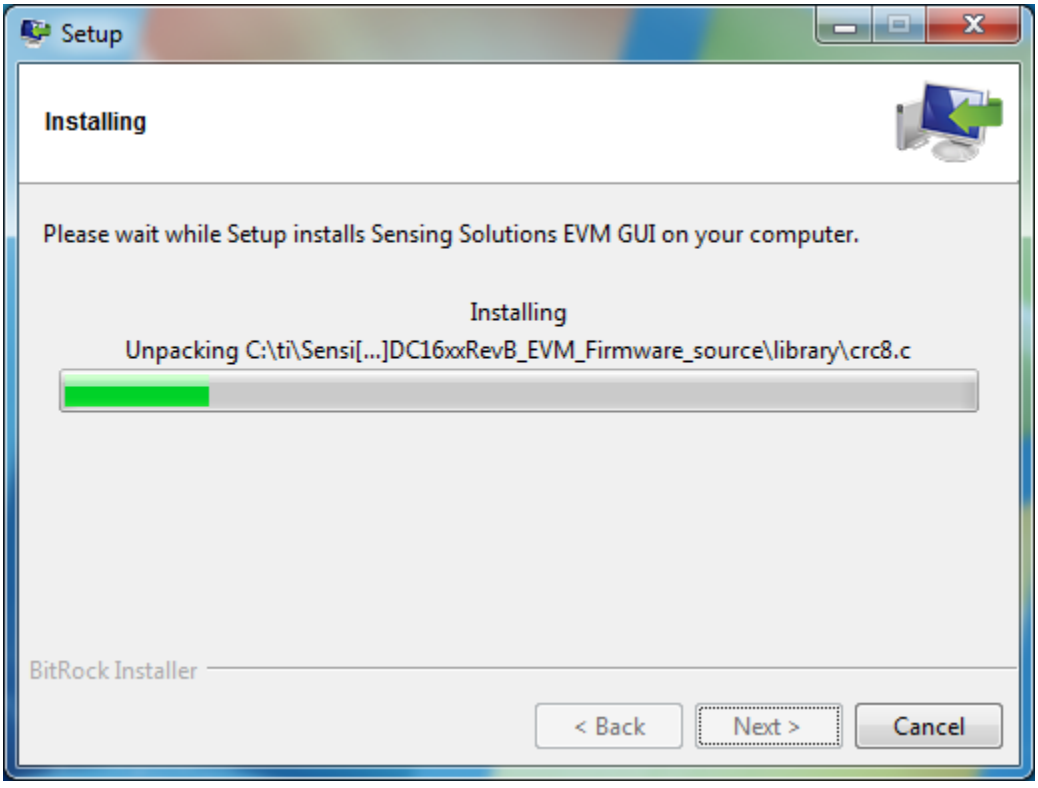


Figure 1-8. Software Installer In Progress

10. When the "Device Driver Installation Wizard" appears, click "Next" to install the EVM driver

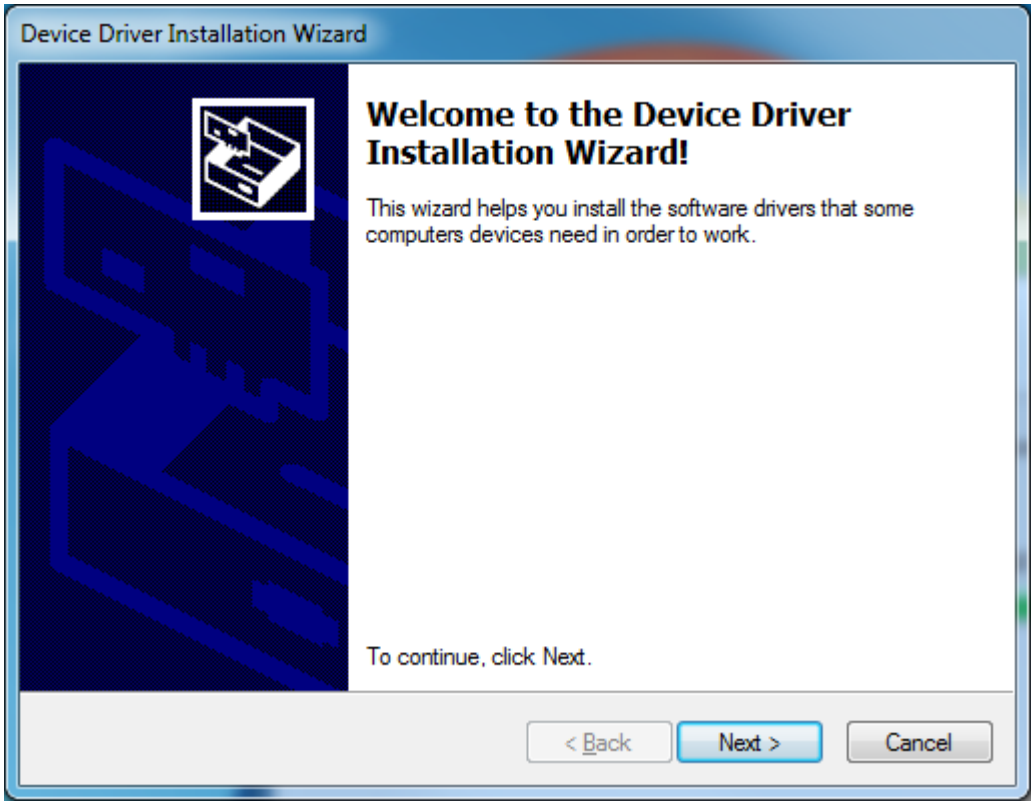


Figure 1-9. Device Driver Installer Wizard

11. Wait for the driver installation to complete

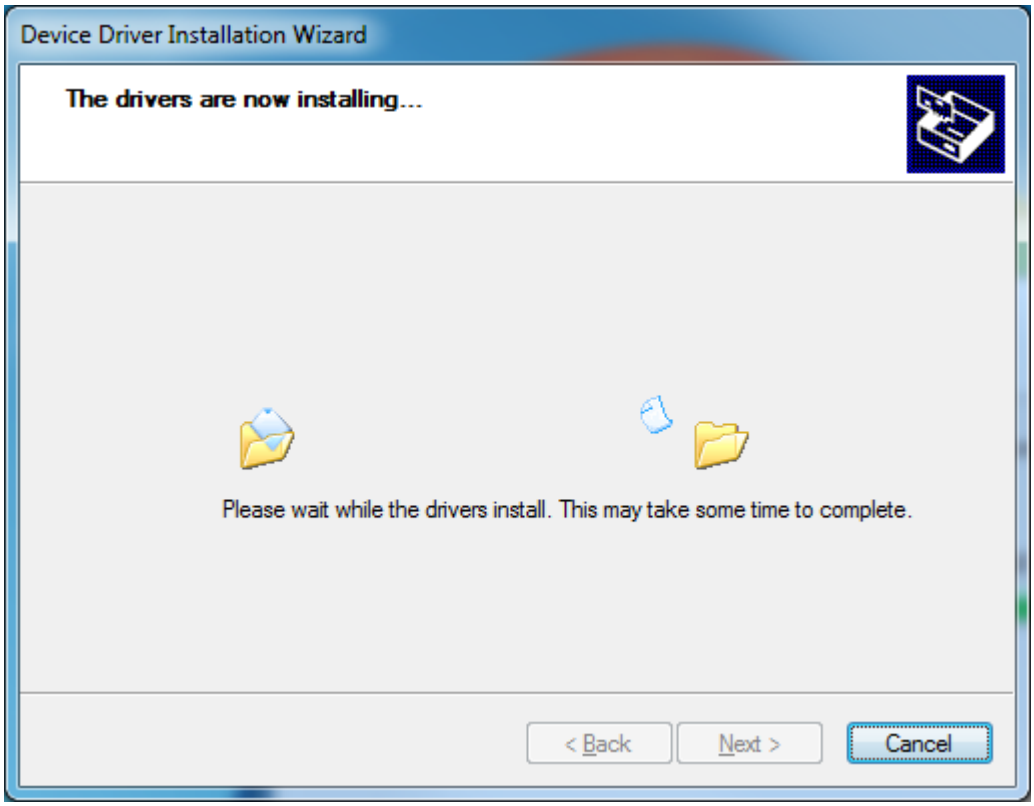


Figure 1-10. Device Driver Installer In Progress

12. After the driver installation is completed, click "Finish"

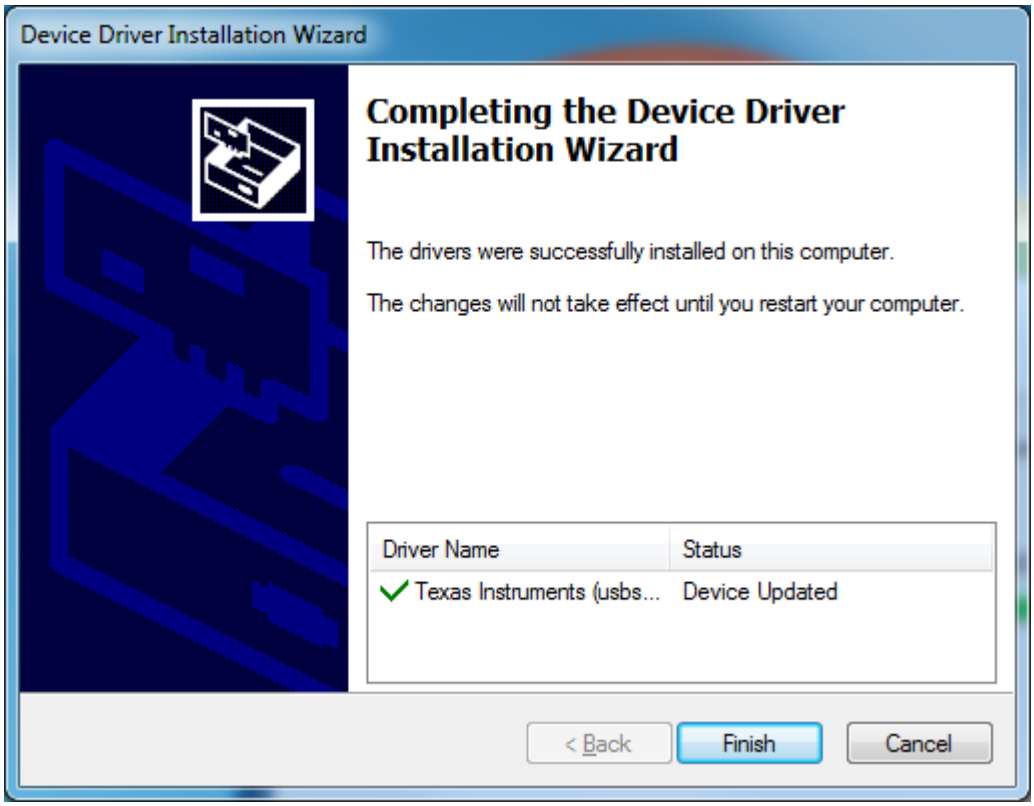


Figure 1-11. Device Driver Installer Completed

13. Click "Finish" to complete the installation

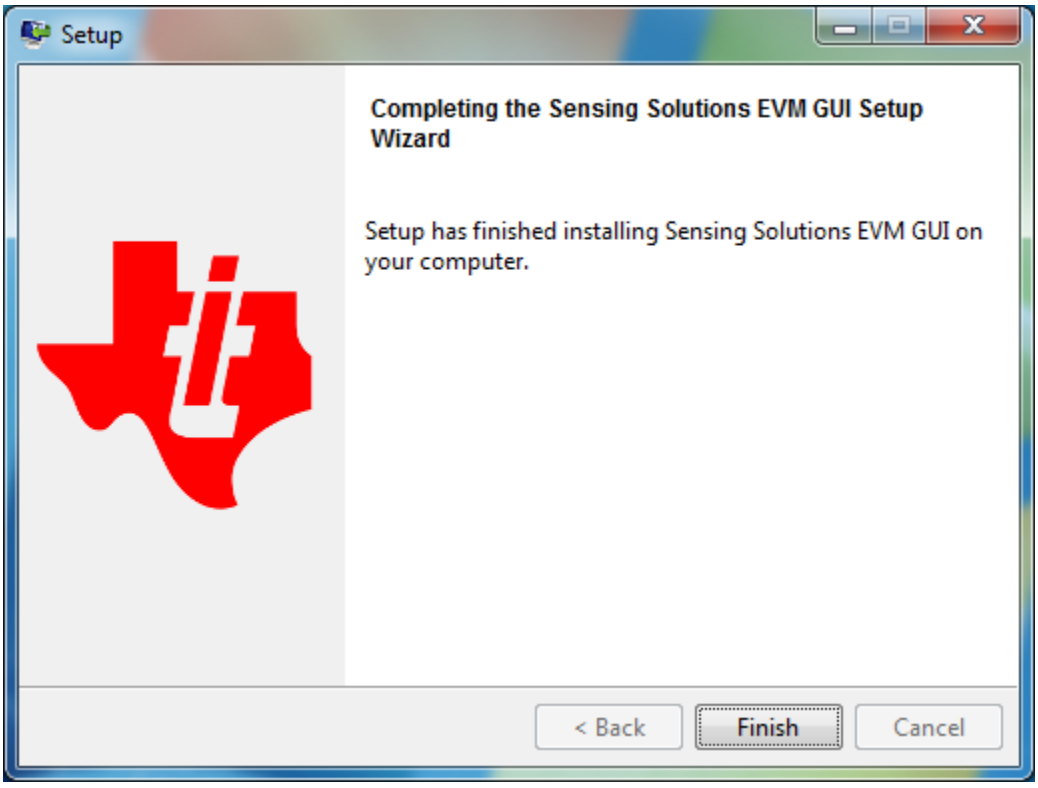


Figure 1-12. Software Installer Completed

1.2.3 Starting the GUI

Follow these steps to start the GUI:

1. Select the Windows start menu
2. Select "All programs"
3. Select "Texas Instruments"
4. Select "Sensing Solutions EVM GUI"
5. Click "Sensing Solutions EVM GUI"
6. Splash screen will appear for at least two seconds

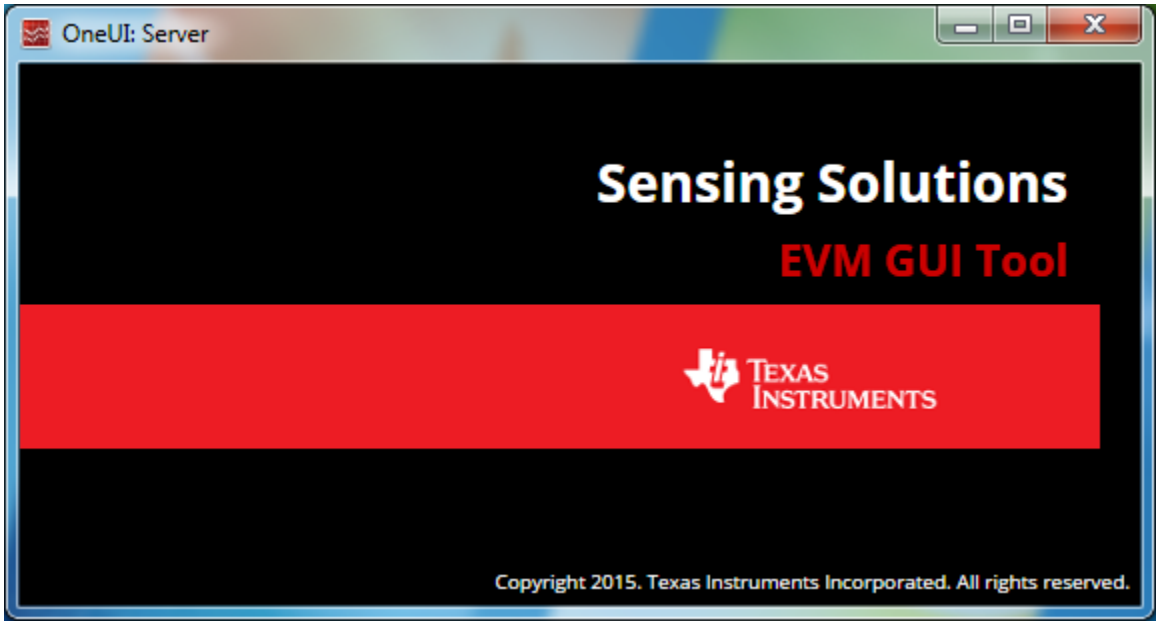


Figure 1-13. Splash Screen

7. After the splash screen is displayed the main window will open

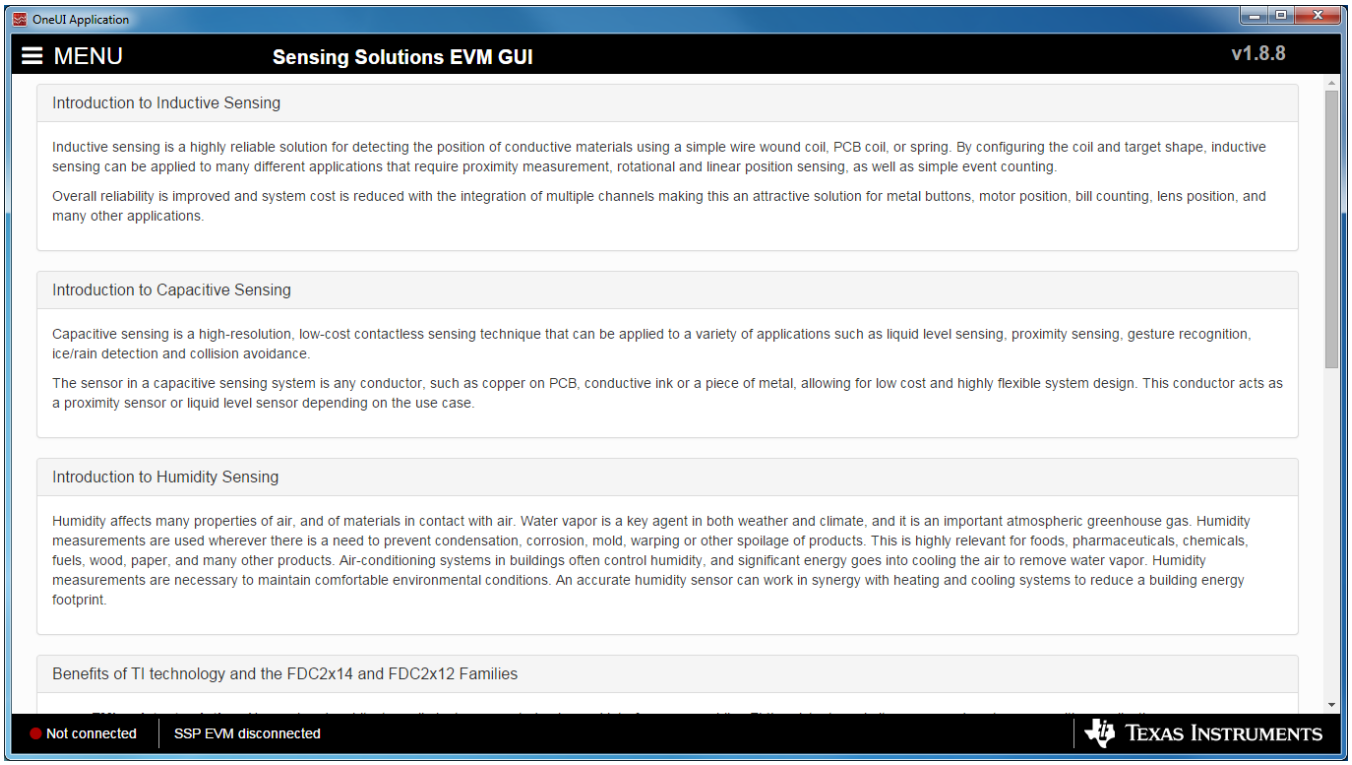


Figure 1-14. Introduction Page

1.2.4 Navigating the GUI

To navigate to different pages of the GUI follow these steps:

1. Click “Menu” in the upper left corner

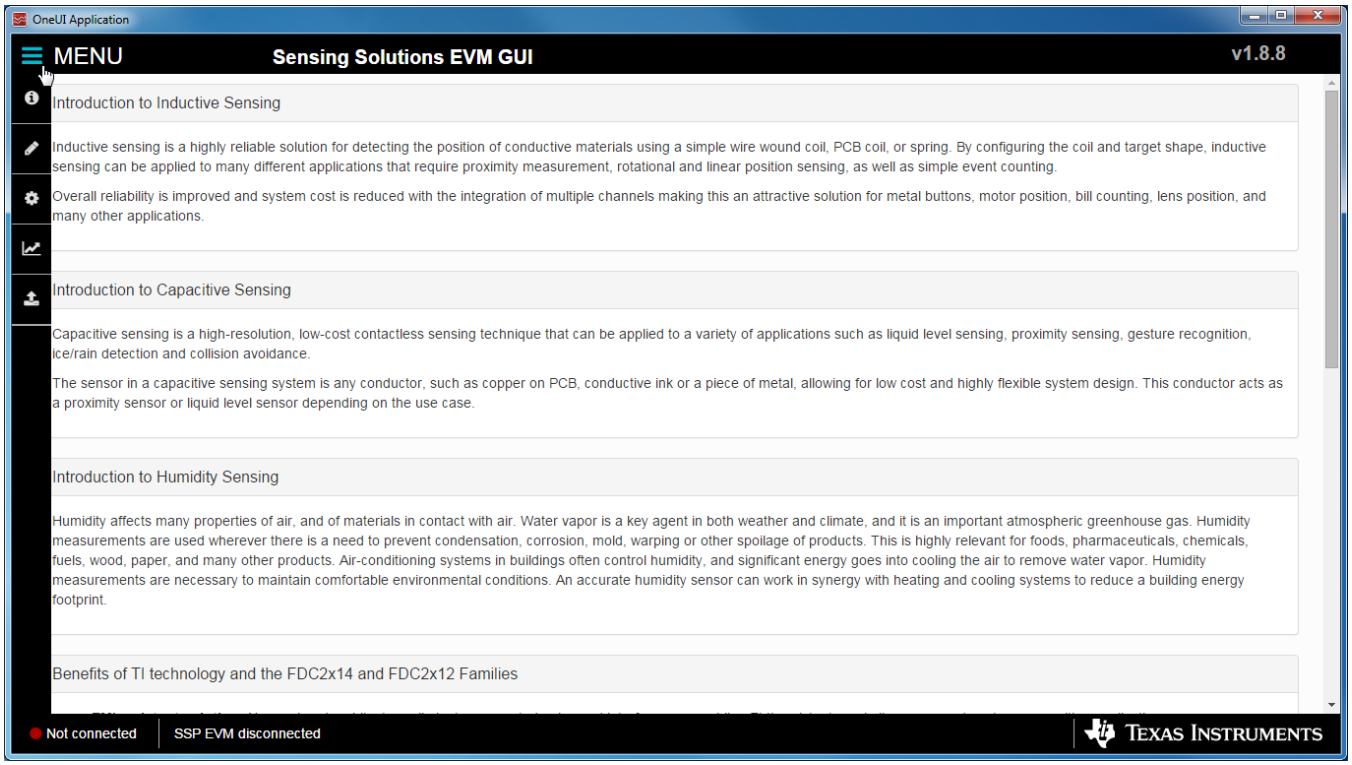


Figure 1-15. Mouse Hovered Over Menu Button

2. Select the desired page from the menu shown on the left

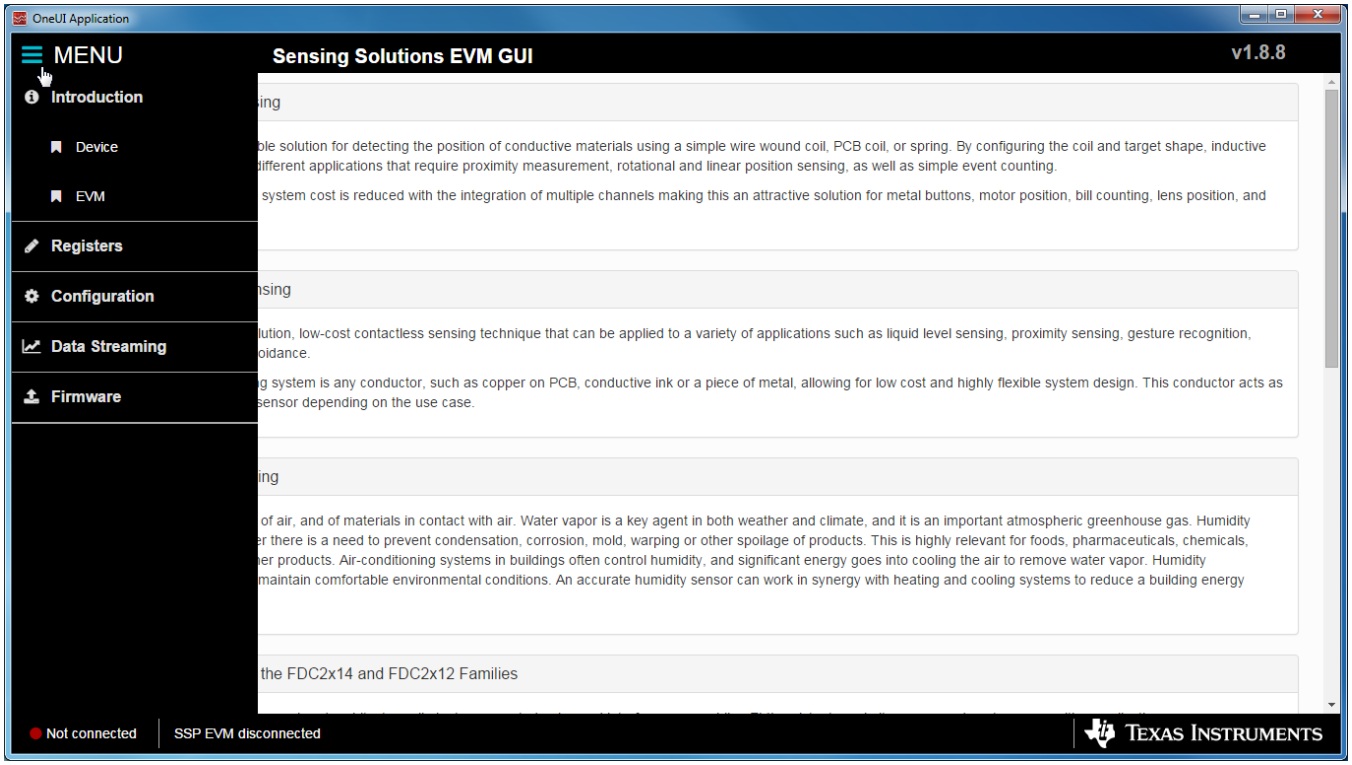


Figure 1-16. Menu Display After Clicking Button

1.2.5 Connecting the EVM

Follow these steps to connect the EVM to the GUI:

1. Attach the EVM to the computer via USB
2. The GUI always shows the connection status on the bottom left corner of the GUI

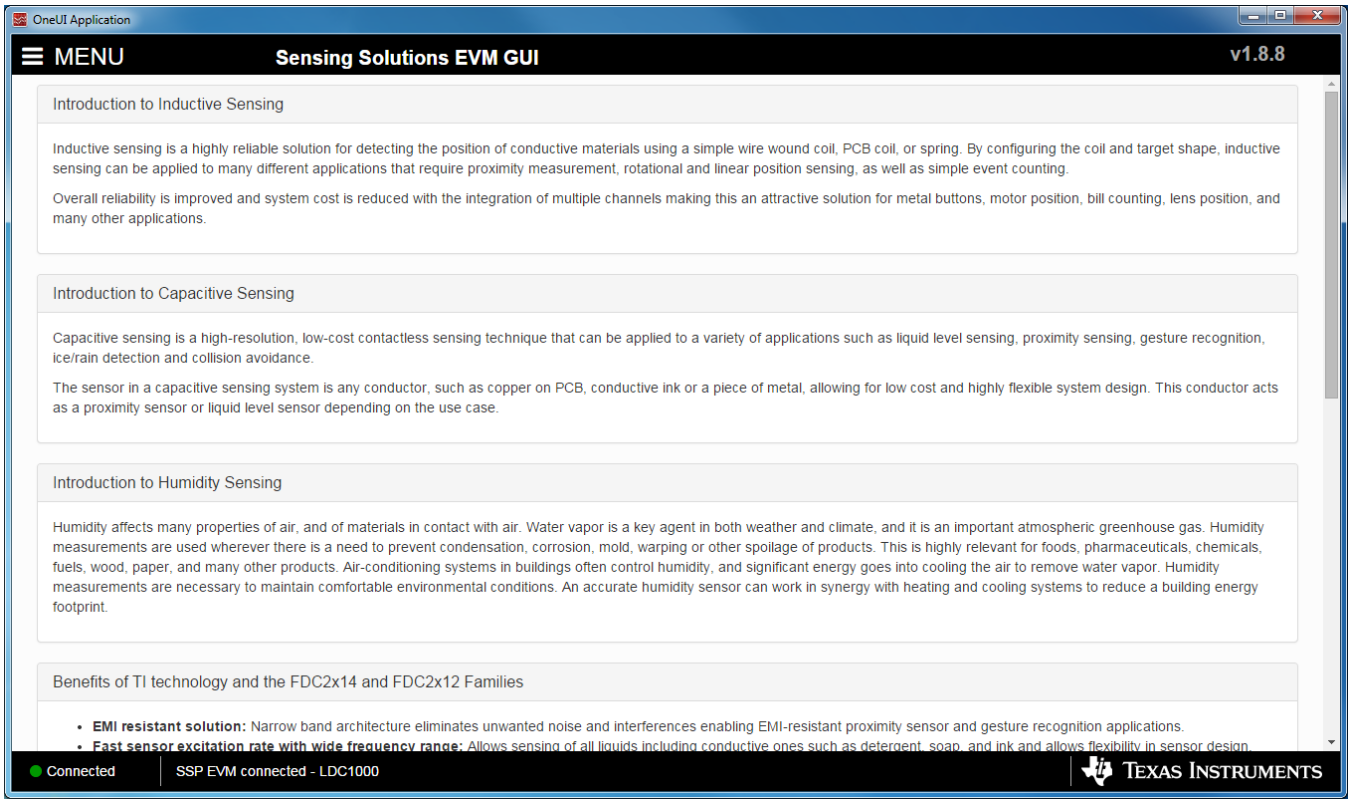


Figure 1-17. EVM Connected to GUI

1.2.6 Configuring the EVM Using the Register Page

The register page allows users to control the device directly with the register values. The user may also use this page to read the currect register values on the device.

1.2.6.1 Automatically Update GUI Register Values Using Auto-Read

Autoread will periodically request the register values on the device. Click the dropdown box next to “Auto Read” to select the update interval.

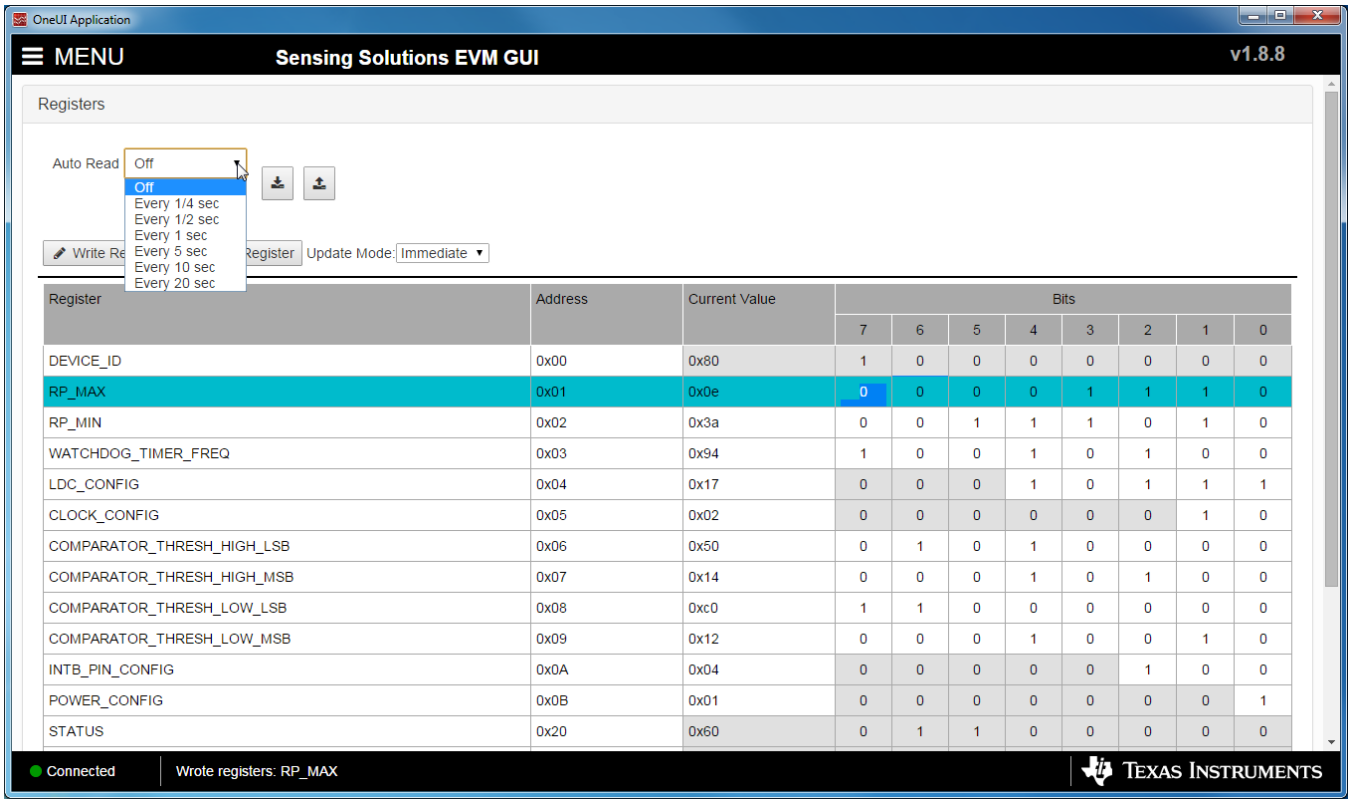
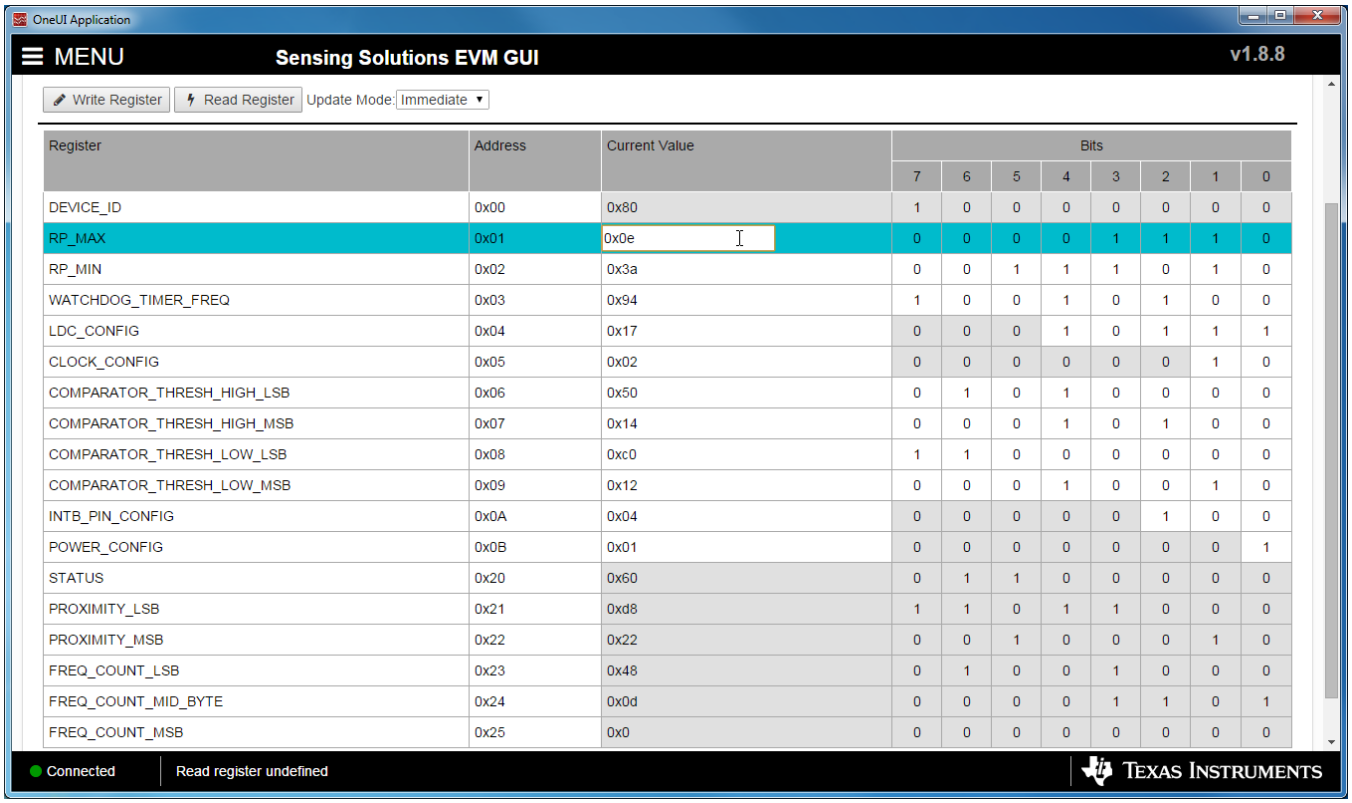


Figure 1-18. Selecting Auto-Read Interval on Register Page

1.2.6.2 Manually Update Device Register Values

There are two methods to change register values: update the entire register value or change a single bit within the register. The recommended update mode is always “Immediate” and not “Deferred”. To update register values, follow these steps.

1. Double-click the current value of the register that needs to be changed. The text will turn into an editable text box



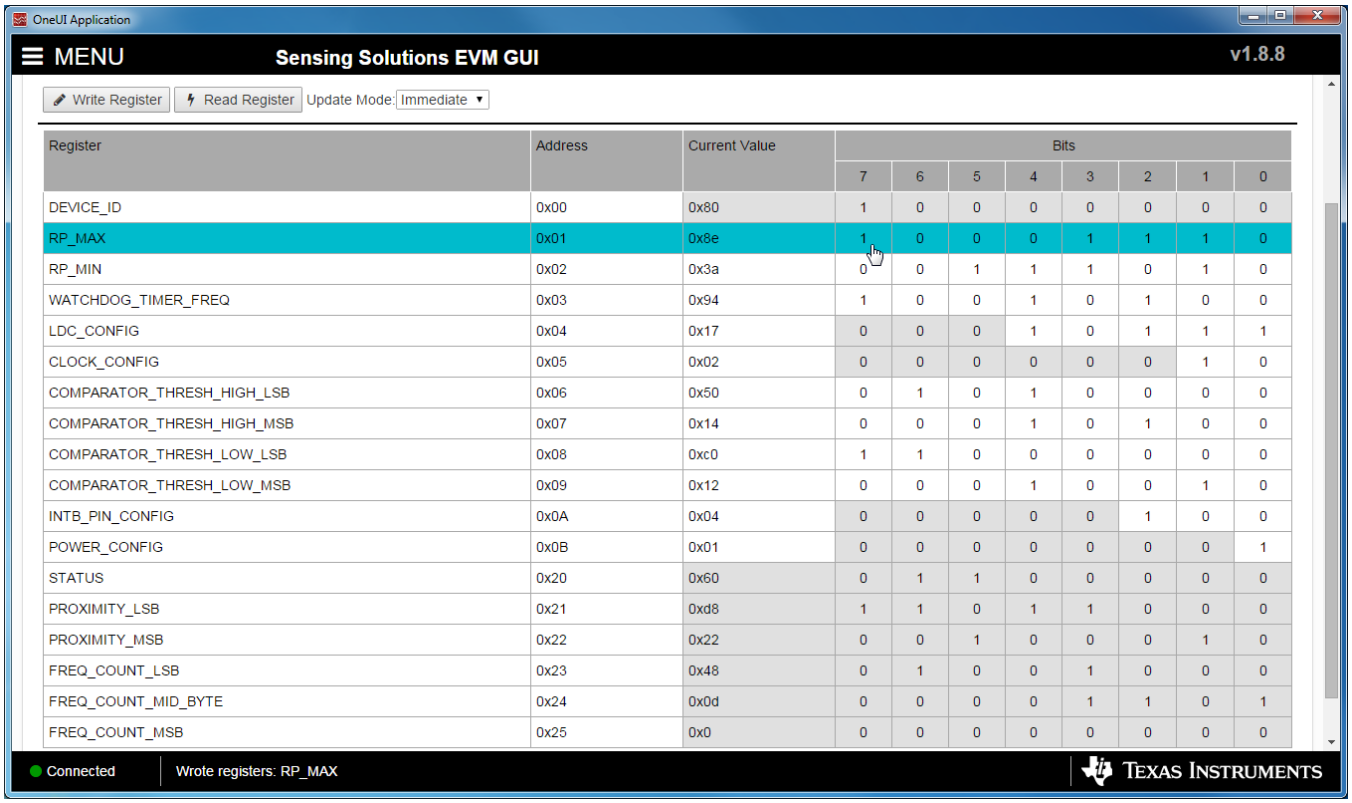
Register	Address	Current Value	Bits							
			7	6	5	4	3	2	1	0
DEVICE_ID	0x00	0x80	1	0	0	0	0	0	0	0
RP_MAX	0x01	0x0e	0	0	0	0	1	1	1	0
RP_MIN	0x02	0x3a	0	0	1	1	1	0	1	0
WATCHDOG_TIMER_FREQ	0x03	0x94	1	0	0	1	0	1	0	0
LDC_CONFIG	0x04	0x17	0	0	0	1	0	1	1	1
CLOCK_CONFIG	0x05	0x02	0	0	0	0	0	0	1	0
COMPARATOR_THRESH_HIGH_LSB	0x06	0x50	0	1	0	1	0	0	0	0
COMPARATOR_THRESH_HIGH_MSB	0x07	0x14	0	0	0	1	0	1	0	0
COMPARATOR_THRESH_LOW_LSB	0x08	0xc0	1	1	0	0	0	0	0	0
COMPARATOR_THRESH_LOW_MSB	0x09	0x12	0	0	0	1	0	0	1	0
INTB_PIN_CONFIG	0x0A	0x04	0	0	0	0	0	1	0	0
POWER_CONFIG	0x0B	0x01	0	0	0	0	0	0	0	1
STATUS	0x20	0x60	0	1	1	0	0	0	0	0
PROXIMITY_LSB	0x21	0xd8	1	1	0	1	1	0	0	0
PROXIMITY_MSB	0x22	0x22	0	0	1	0	0	0	1	0
FREQ_COUNT_LSB	0x23	0x48	0	1	0	0	1	0	0	0
FREQ_COUNT_MID_BYTE	0x24	0x0d	0	0	0	0	1	1	0	1
FREQ_COUNT_MSB	0x25	0x0	0	0	0	0	0	0	0	0

Figure 1-19. Selecting a Register's Current Value for Editting on Register Page

2. Type the new hexadecimal value into the box and click enter. The text box changes to normal text and the GUI will send a command to the EVM to update the device register

To change individual bit values rather that entire register values follow these steps.

1. Hover the mouse over the desired bit to change



Register	Address	Current Value	Bits							
			7	6	5	4	3	2	1	0
DEVICE_ID	0x00	0x80	1	0	0	0	0	0	0	0
RP_MAX	0x01	0x8e	1	0	0	0	1	1	1	0
RP_MIN	0x02	0x3a	0	0	1	1	1	0	1	0
WATCHDOG_TIMER_FREQ	0x03	0x94	1	0	0	1	0	1	0	0
LDC_CONFIG	0x04	0x17	0	0	0	1	0	1	1	1
CLOCK_CONFIG	0x05	0x02	0	0	0	0	0	0	1	0
COMPARATOR_THRESH_HIGH_LSB	0x06	0x50	0	1	0	1	0	0	0	0
COMPARATOR_THRESH_HIGH_MSB	0x07	0x14	0	0	0	1	0	1	0	0
COMPARATOR_THRESH_LOW_LSB	0x08	0xc0	1	1	0	0	0	0	0	0
COMPARATOR_THRESH_LOW_MSB	0x09	0x12	0	0	0	1	0	0	1	0
INTB_PIN_CONFIG	0x0A	0x04	0	0	0	0	0	1	0	0
POWER_CONFIG	0x0B	0x01	0	0	0	0	0	0	0	1
STATUS	0x20	0x60	0	1	1	0	0	0	0	0
PROXIMITY_LSB	0x21	0xd8	1	1	0	1	1	0	0	0
PROXIMITY_MSB	0x22	0x22	0	0	1	0	0	0	1	0
FREQ_COUNT_LSB	0x23	0x48	0	1	0	0	1	0	0	0
FREQ_COUNT_MID_BYTE	0x24	0x0d	0	0	0	0	1	1	0	1
FREQ_COUNT_MSB	0x25	0x0	0	0	0	0	0	0	0	0

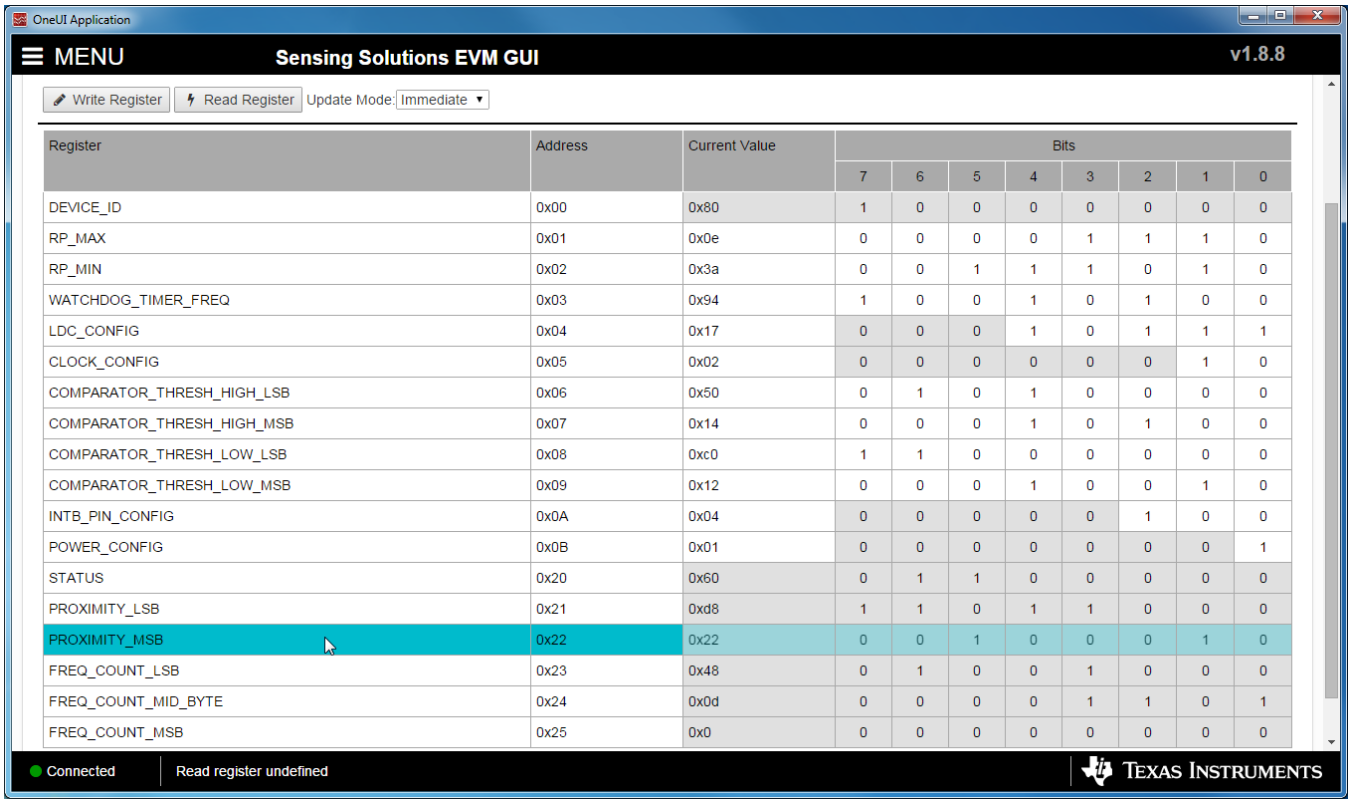
Figure 1-20. Hovering Mouse Over Register Bit Value on Register Page

2. Double-click the bit to toggle its value and the register's current value will update automatically

1.2.6.3 Reading Register Values without Auto-Read

To read register values follow these steps.

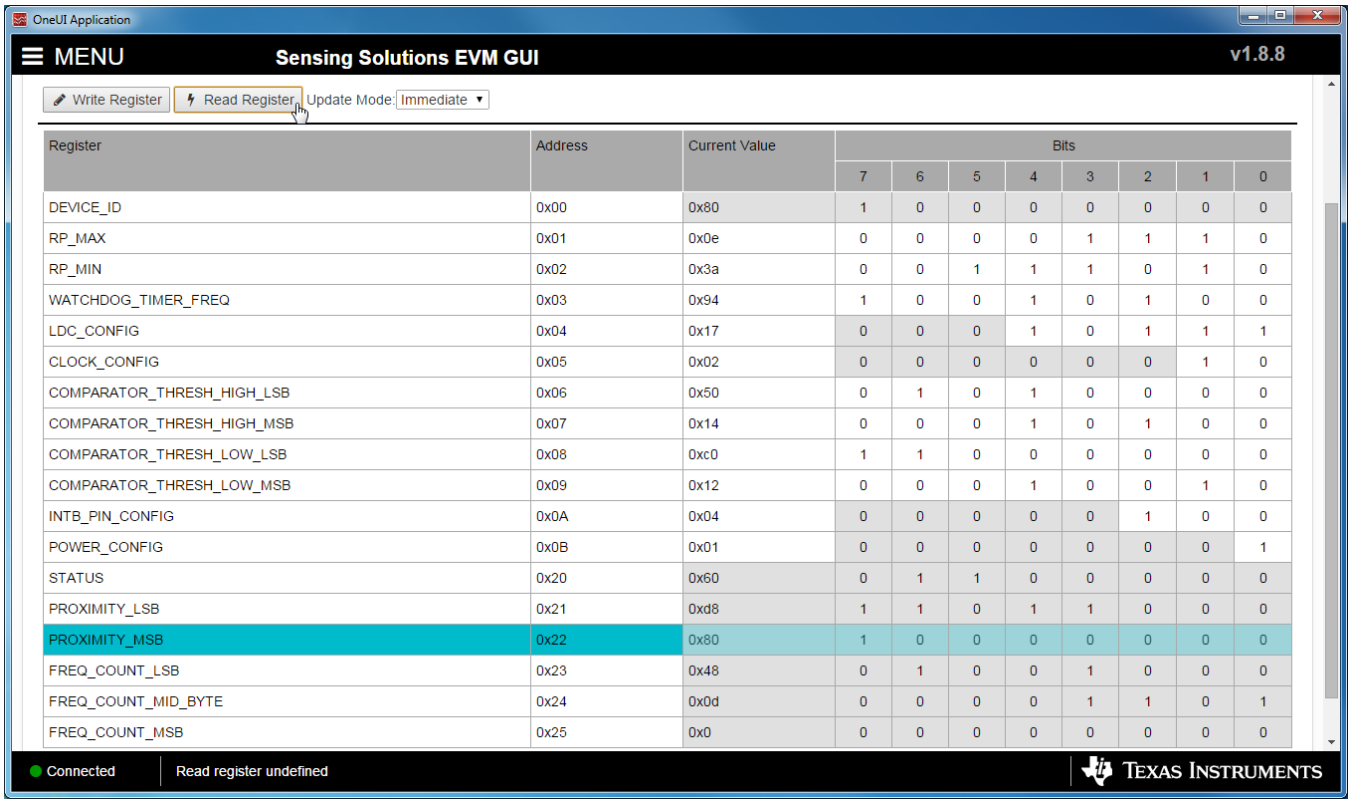
1. Select the register to update by clicking any column of the register row in the table



Register	Address	Current Value	Bits							
			7	6	5	4	3	2	1	0
DEVICE_ID	0x00	0x80	1	0	0	0	0	0	0	0
RP_MAX	0x01	0x0e	0	0	0	0	1	1	1	0
RP_MIN	0x02	0x3a	0	0	1	1	1	0	1	0
WATCHDOG_TIMER_FREQ	0x03	0x94	1	0	0	1	0	1	0	0
LDC_CONFIG	0x04	0x17	0	0	0	1	0	1	1	1
CLOCK_CONFIG	0x05	0x02	0	0	0	0	0	0	1	0
COMPARATOR_THRESH_HIGH_LSB	0x06	0x50	0	1	0	1	0	0	0	0
COMPARATOR_THRESH_HIGH_MSB	0x07	0x14	0	0	0	1	0	1	0	0
COMPARATOR_THRESH_LOW_LSB	0x08	0xc0	1	1	0	0	0	0	0	0
COMPARATOR_THRESH_LOW_MSB	0x09	0x12	0	0	0	1	0	0	1	0
INTB_PIN_CONFIG	0x0A	0x04	0	0	0	0	0	1	0	0
POWER_CONFIG	0x0B	0x01	0	0	0	0	0	0	0	1
STATUS	0x20	0x60	0	1	1	0	0	0	0	0
PROXIMITY_LSB	0x21	0xd8	1	1	0	1	1	0	0	0
PROXIMITY_MSB	0x22	0x22	0	0	1	0	0	0	1	0
FREQ_COUNT_LSB	0x23	0x48	0	1	0	0	1	0	0	0
FREQ_COUNT_MID_BYTE	0x24	0x0d	0	0	0	0	1	1	0	1
FREQ_COUNT_MSB	0x25	0x0	0	0	0	0	0	0	0	0

Figure 1-21. Selecting a Register on Register Page

2. Click the “Read Register” button to update the selected register’s current value and bit values in the table



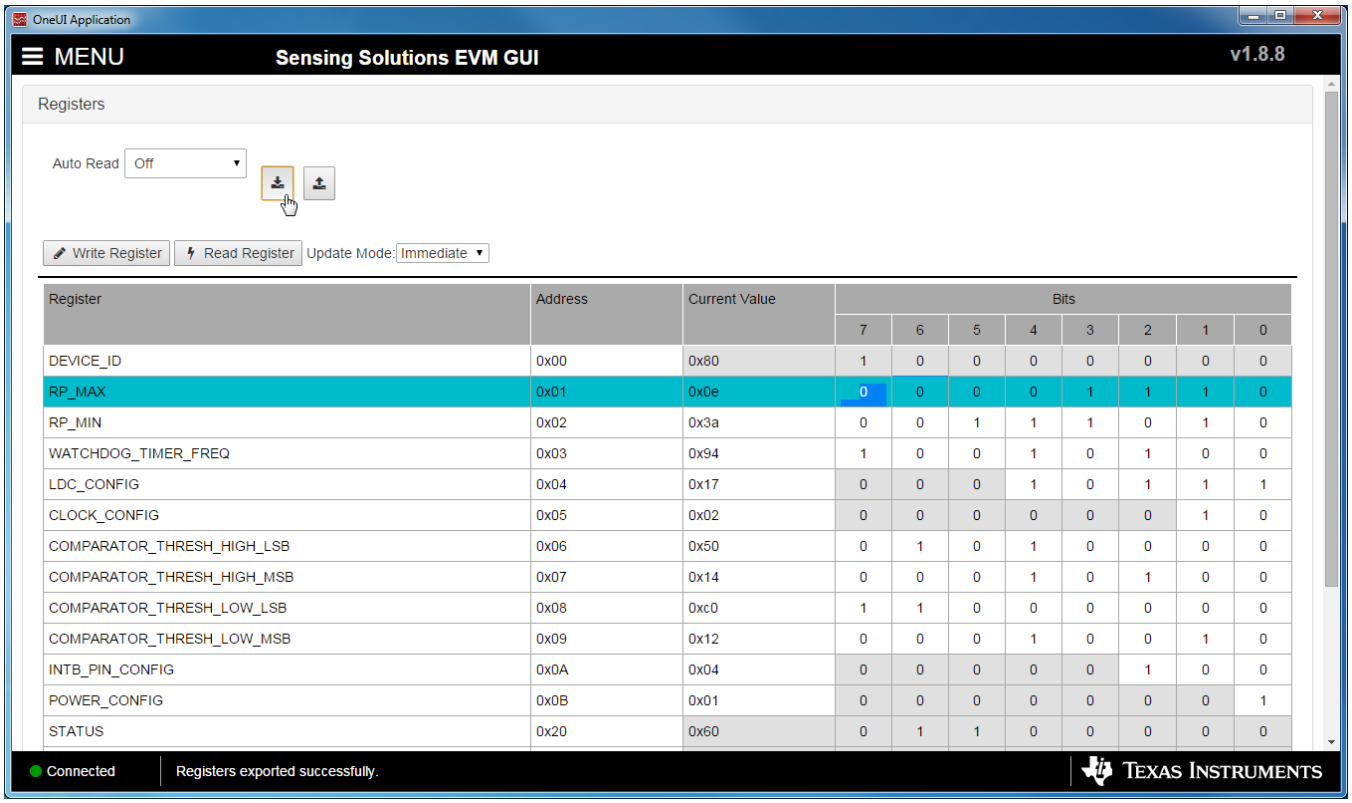
Register	Address	Current Value	Bits							
			7	6	5	4	3	2	1	0
DEVICE_ID	0x00	0x80	1	0	0	0	0	0	0	0
RP_MAX	0x01	0x0e	0	0	0	0	1	1	1	0
RP_MIN	0x02	0x3a	0	0	1	1	1	0	1	0
WATCHDOG_TIMER_FREQ	0x03	0x94	1	0	0	1	0	1	0	0
LDC_CONFIG	0x04	0x17	0	0	0	1	0	1	1	1
CLOCK_CONFIG	0x05	0x02	0	0	0	0	0	0	1	0
COMPARATOR_THRESH_HIGH_LSB	0x06	0x50	0	1	0	1	0	0	0	0
COMPARATOR_THRESH_HIGH_MSB	0x07	0x14	0	0	0	1	0	1	0	0
COMPARATOR_THRESH_LOW_LSB	0x08	0xc0	1	1	0	0	0	0	0	0
COMPARATOR_THRESH_LOW_MSB	0x09	0x12	0	0	0	1	0	0	1	0
INTB_PIN_CONFIG	0x0A	0x04	0	0	0	0	0	1	0	0
POWER_CONFIG	0x0B	0x01	0	0	0	0	0	0	0	1
STATUS	0x20	0x60	0	1	1	0	0	0	0	0
PROXIMITY_LSB	0x21	0xd8	1	1	0	1	1	0	0	0
PROXIMITY_MSB	0x22	0x80	1	0	0	0	0	0	0	0
FREQ_COUNT_LSB	0x23	0x48	0	1	0	0	1	0	0	0
FREQ_COUNT_MID_BYTE	0x24	0x0d	0	0	0	0	1	1	0	1
FREQ_COUNT_MSB	0x25	0x0	0	0	0	0	0	0	0	0

Figure 1-22. Reading the Current Device Register Value on Register Page

1.2.6.4 Saving Device Configurations

To save the current register settings of the device follow these steps.

1. Click the button immediately right to the “Auto-Read” selection dropdown



Register	Address	Current Value	Bits							
			7	6	5	4	3	2	1	0
DEVICE_ID	0x00	0x80	1	0	0	0	0	0	0	0
RP_MAX	0x01	0x0e	0	0	0	0	1	1	1	0
RP_MIN	0x02	0x3a	0	0	1	1	1	0	1	0
WATCHDOG_TIMER_FREQ	0x03	0x94	1	0	0	1	0	1	0	0
LDC_CONFIG	0x04	0x17	0	0	0	1	0	1	1	1
CLOCK_CONFIG	0x05	0x02	0	0	0	0	0	0	1	0
COMPARATOR_THRESH_HIGH_LSB	0x06	0x50	0	1	0	1	0	0	0	0
COMPARATOR_THRESH_HIGH_MSB	0x07	0x14	0	0	0	1	0	1	0	0
COMPARATOR_THRESH_LOW_LSB	0x08	0xc0	1	1	0	0	0	0	0	0
COMPARATOR_THRESH_LOW_MSB	0x09	0x12	0	0	0	1	0	0	1	0
INTB_PIN_CONFIG	0x0A	0x04	0	0	0	0	0	1	0	0
POWER_CONFIG	0x0B	0x01	0	0	0	0	0	0	0	1
STATUS	0x20	0x60	0	1	1	0	0	0	0	0

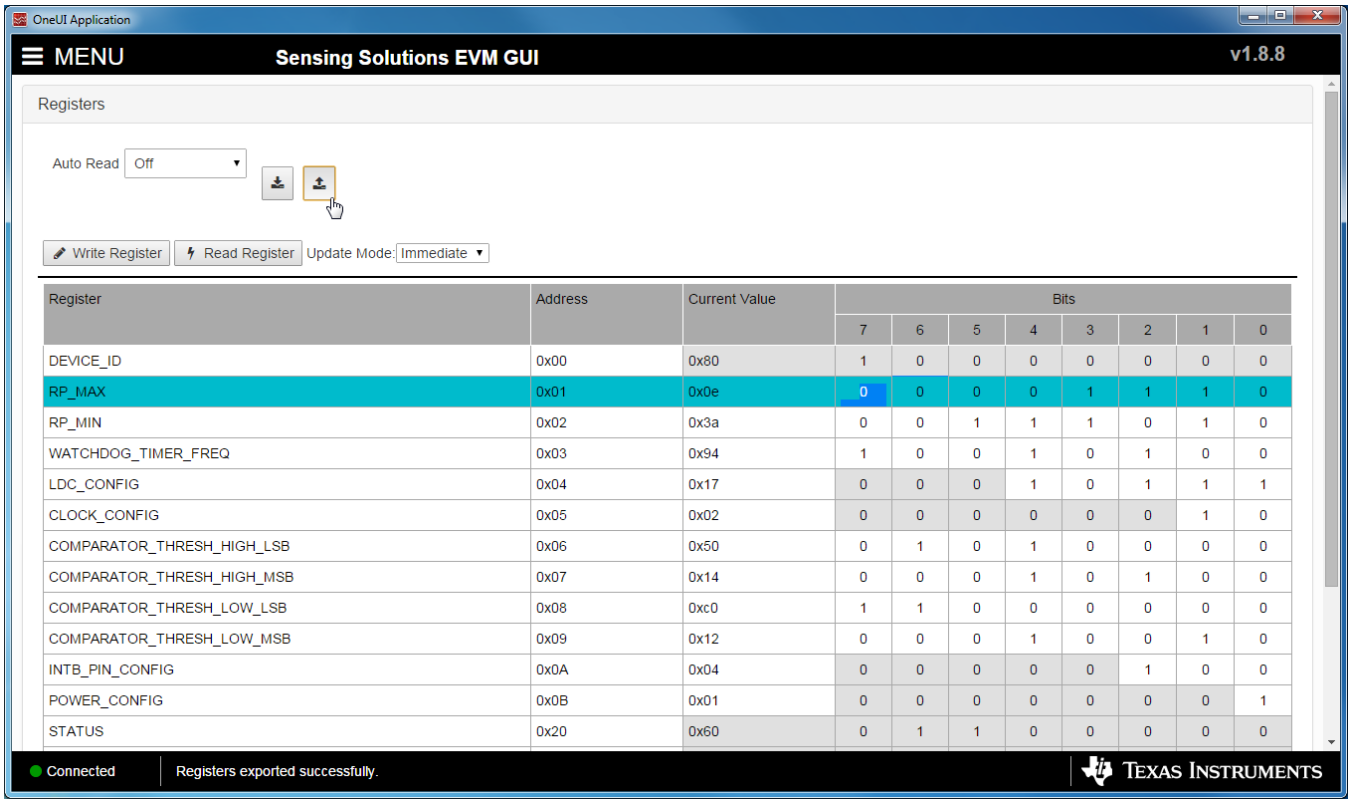
Figure 1-23. Save Register Values to File on Register Page

2. Choose a name for the JSON file and the directory to save it within. Then click “Save”

1.2.6.5 Loading Previously Saved Configurations

To load previously saved register settings from a JSON file follow these steps.

1. Click the button furthest right from the “Auto-Read” selection dropdown



Register	Address	Current Value	Bits							
			7	6	5	4	3	2	1	0
DEVICE_ID	0x00	0x80	1	0	0	0	0	0	0	0
RP_MAX	0x01	0x0e	0	0	0	0	1	1	1	0
RP_MIN	0x02	0x3a	0	0	1	1	1	0	1	0
WATCHDOG_TIMER_FREQ	0x03	0x94	1	0	0	1	0	1	0	0
LDC_CONFIG	0x04	0x17	0	0	0	1	0	1	1	1
CLOCK_CONFIG	0x05	0x02	0	0	0	0	0	0	1	0
COMPARATOR_THRESH_HIGH_LSB	0x06	0x50	0	1	0	1	0	0	0	0
COMPARATOR_THRESH_HIGH_MSB	0x07	0x14	0	0	0	1	0	1	0	0
COMPARATOR_THRESH_LOW_LSB	0x08	0xc0	1	1	0	0	0	0	0	0
COMPARATOR_THRESH_LOW_MSB	0x09	0x12	0	0	0	1	0	0	1	0
INTB_PIN_CONFIG	0x0A	0x04	0	0	0	0	0	1	0	0
POWER_CONFIG	0x0B	0x01	0	0	0	0	0	0	0	1
STATUS	0x20	0x60	0	1	1	0	0	0	0	0

Figure 1-24. Loading Previously Saved Register Values from File on Register Page

2. Select the JSON file with the desired settings and click “Open”

1.2.7 Configuring the EVM Using the Configuration Page

The Sensing Solutions GUI is capable on configuring the device more intuitively than the direct register values. The "Configuration" page provides an easy-to-use tool for updating the device configuration and provides additional information about how the device will perform.

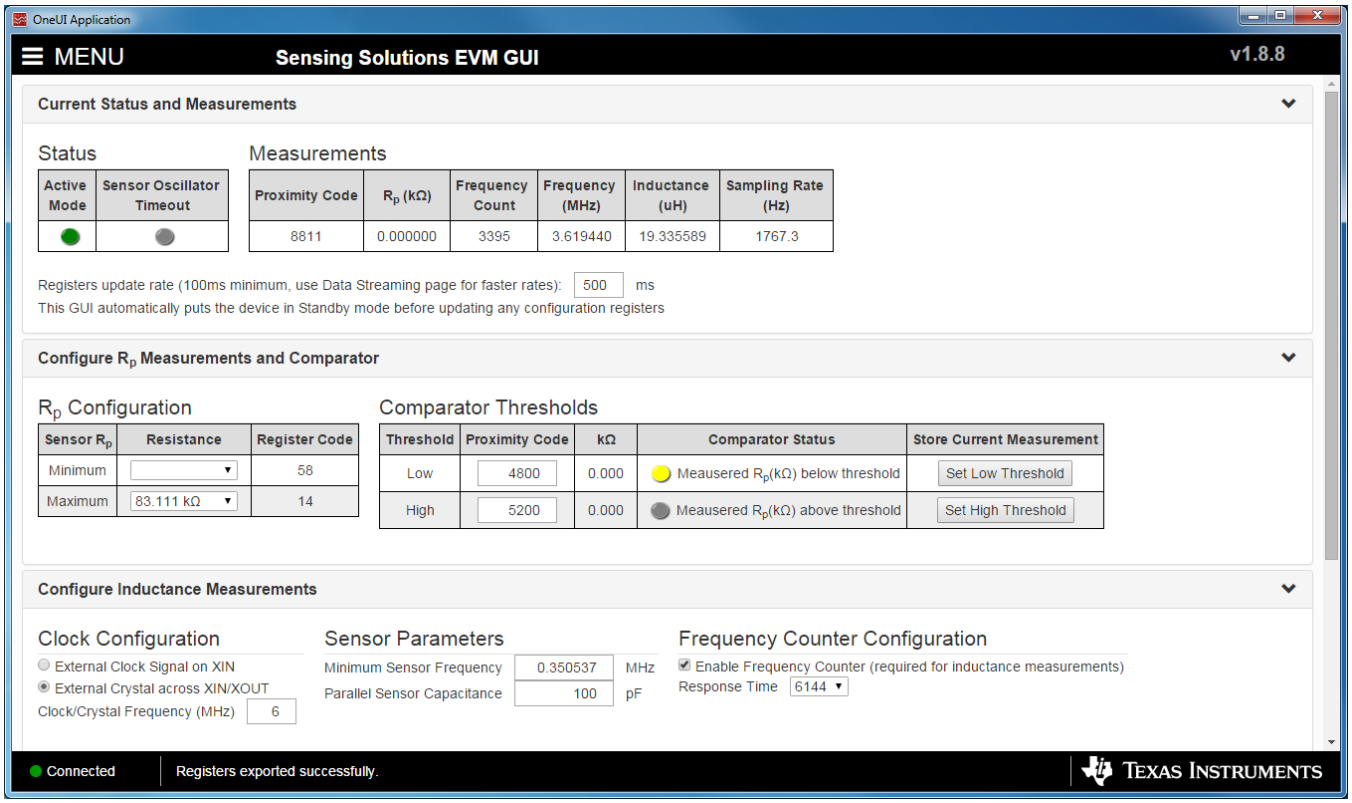


Figure 1-25. Sensor Properties and Input Adjustments on Configuration Page

1.2.8 Streaming Measurement Data

The Sensing Solutions GUI and EVM provide a tool to capture, display, and log measurement data. The section describes how to use the data measurement tools from the "Data Streaming" page accessible from the GUI menu.

1.2.8.1 Choosing the Graph and Visible Channels

Select the drop down menu on top of the y-axis to choose the graph to display.

Figure 1-26. Select the Data Graph on Data Streaming Page

To select which channel measurements are displayed in the graph, check or uncheck the available channels shown next to the graph units. Selecting or not selecting the channels only affects the graph and not the data logged to a file. If a channel is not enabled in the Configuration page it will not appear on the Data Streaming page.

1.2.8.2 Logging Data to a File

Follow these steps to log measurement data to a file.

1. Click the button in the upper right under next to "Click to Select Log File"

Figure 1-27. Select Log File Button on Data Streaming Page

2. Select a file name and directory to save the data to and then click the “Save” button
3. Whenever data streaming is running the data for all channels will be logged to this file. The selected file is shown next to the button.

1.2.8.3 Starting and Stopping Data Streaming

To start data streaming click the “Start” button.

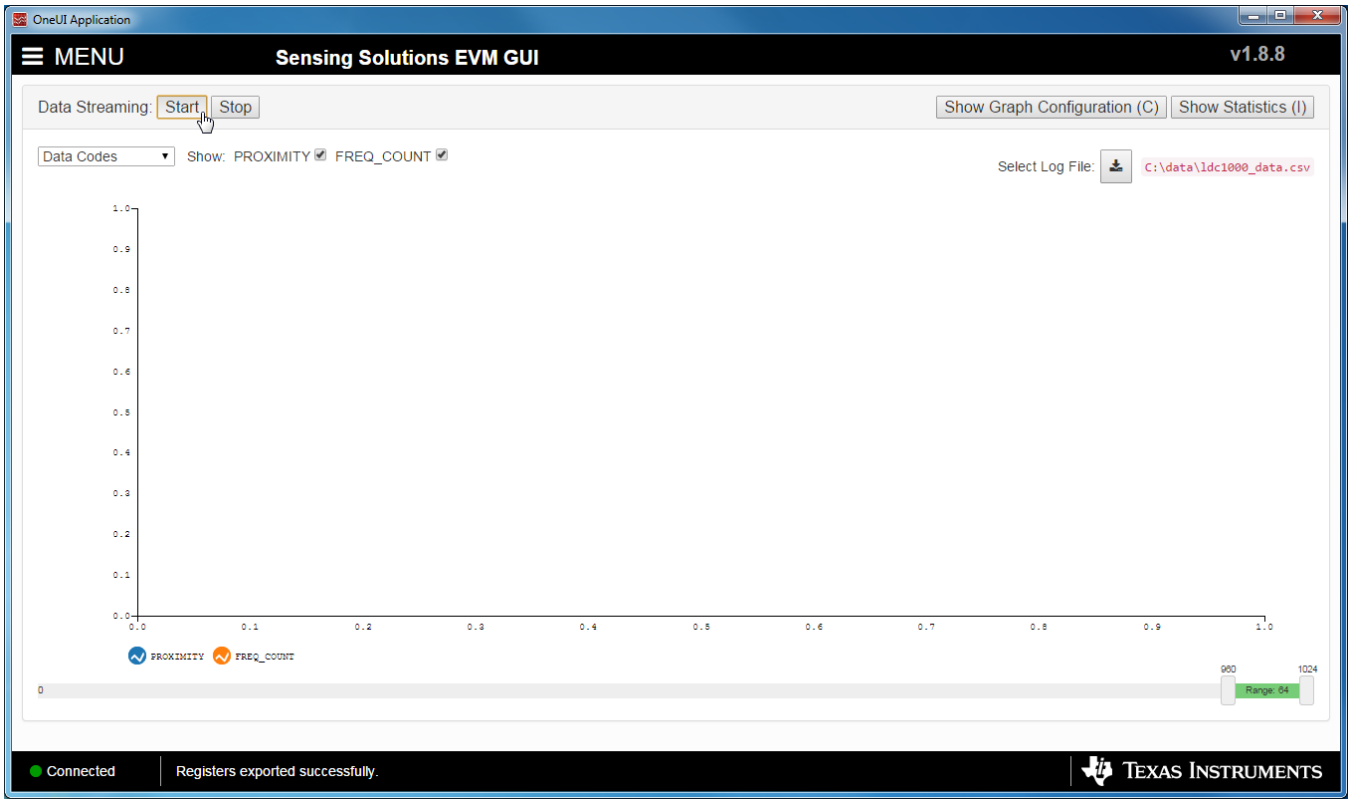


Figure 1-28. Start Button on Data Streaming Page

To stop data streaming click the “Stop” button.

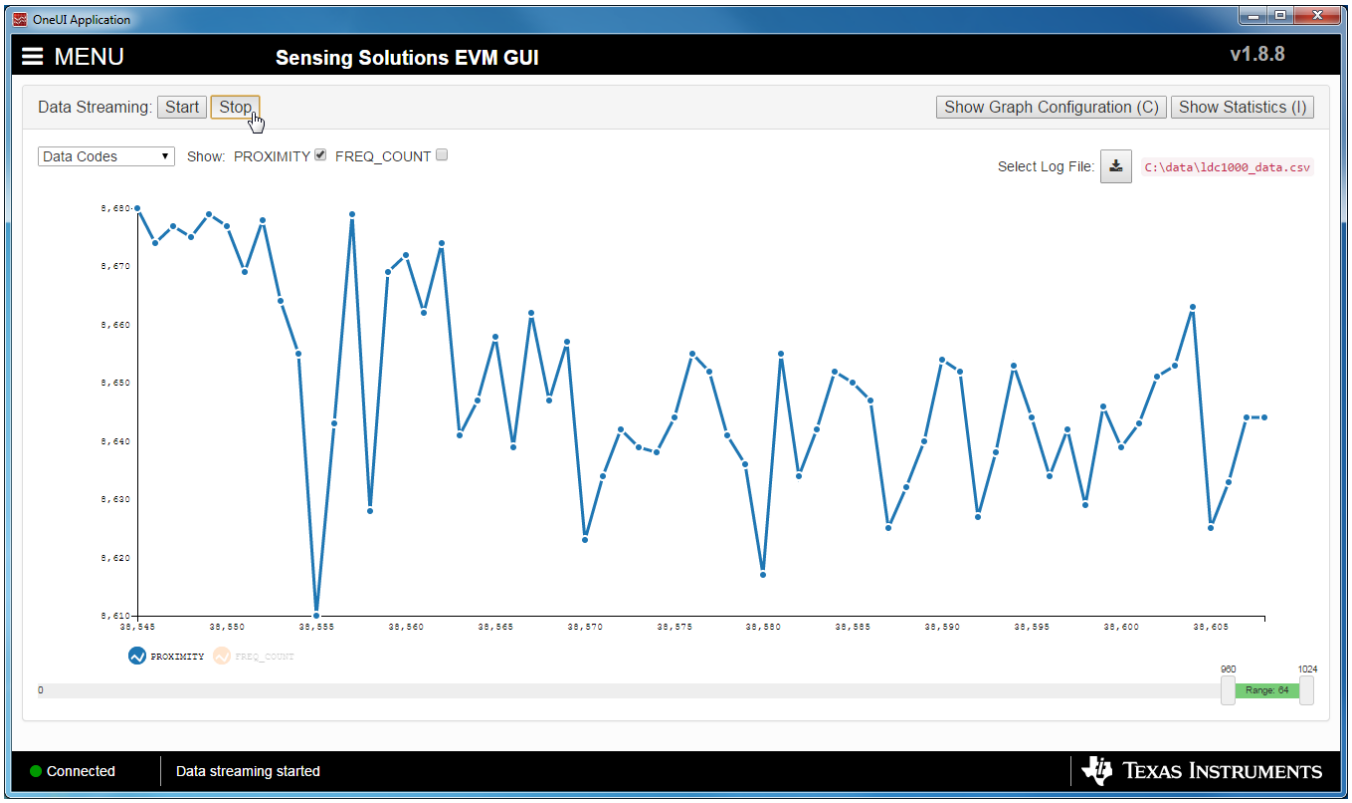


Figure 1-29. Stop Button on Data Streaming Page

1.2.8.4 Data Statistics

Click the “Show Statistics” button to view the measurement statistics.

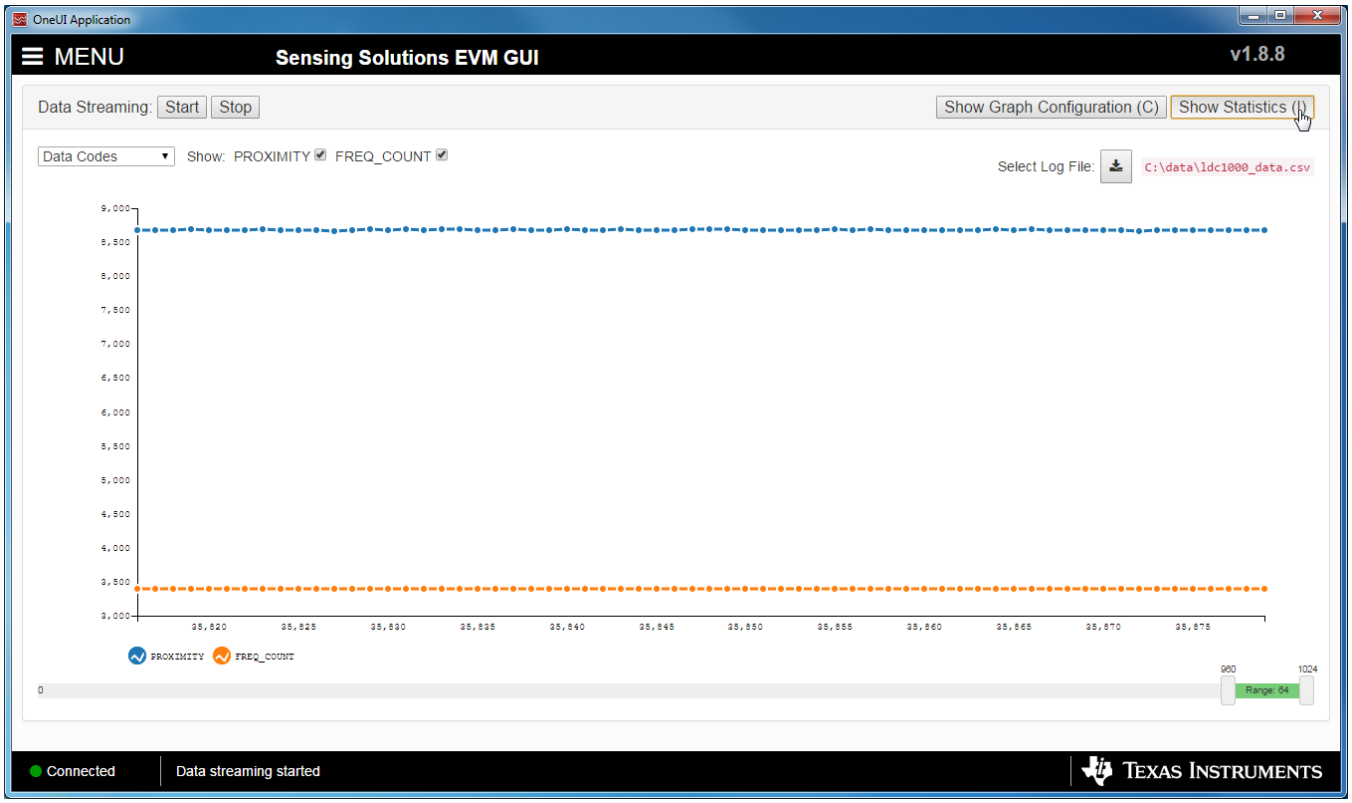


Figure 1-30. Show Statistics Button on Data Streaming Page

Click the “Hide Statistics” button to hide the measurement statistics.

Figure 1-31. Hide Statistics Button on Data Streaming Page

1.2.8.5 Configuring the Graph

To configure the graph, click the "Show Graph Configuration" button.

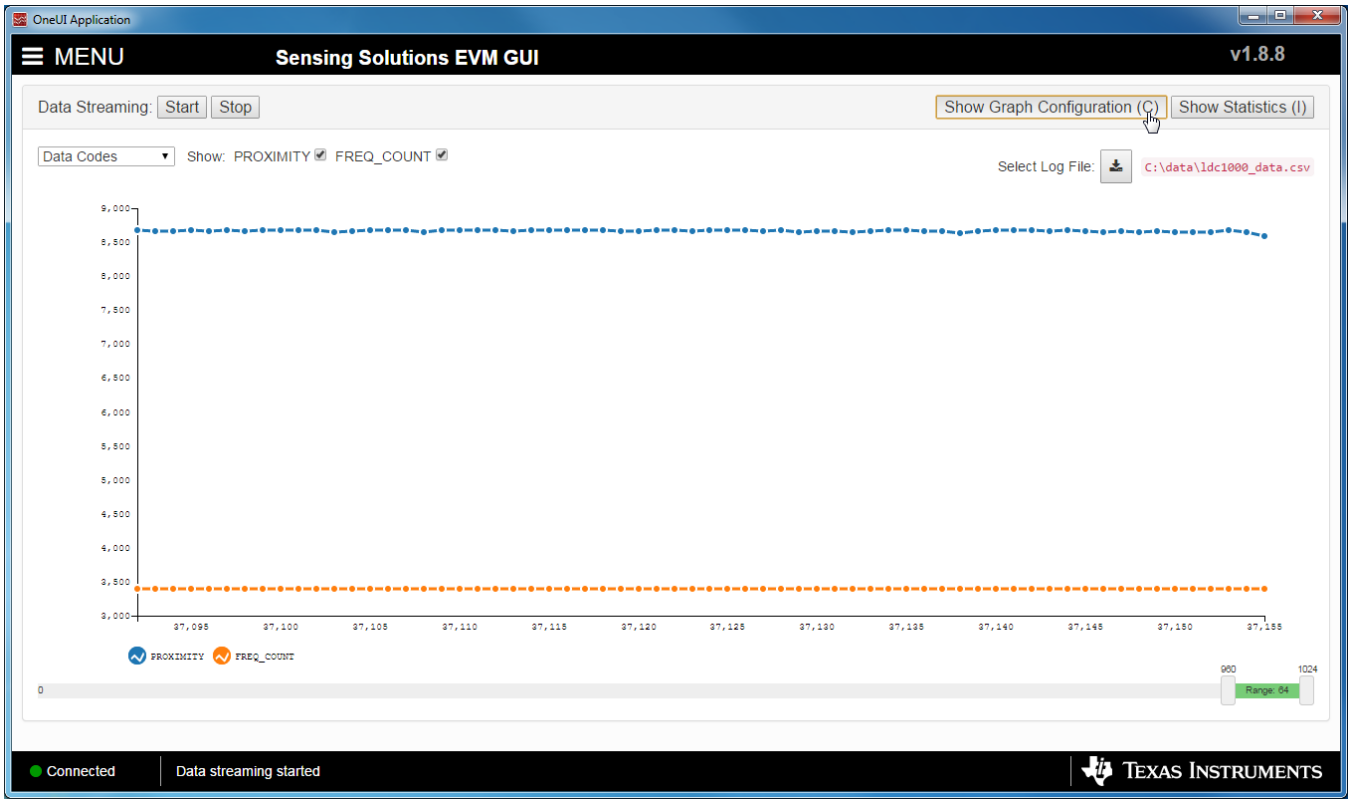


Figure 1-32. Show Graph Configuration Button on Data Streaming Page

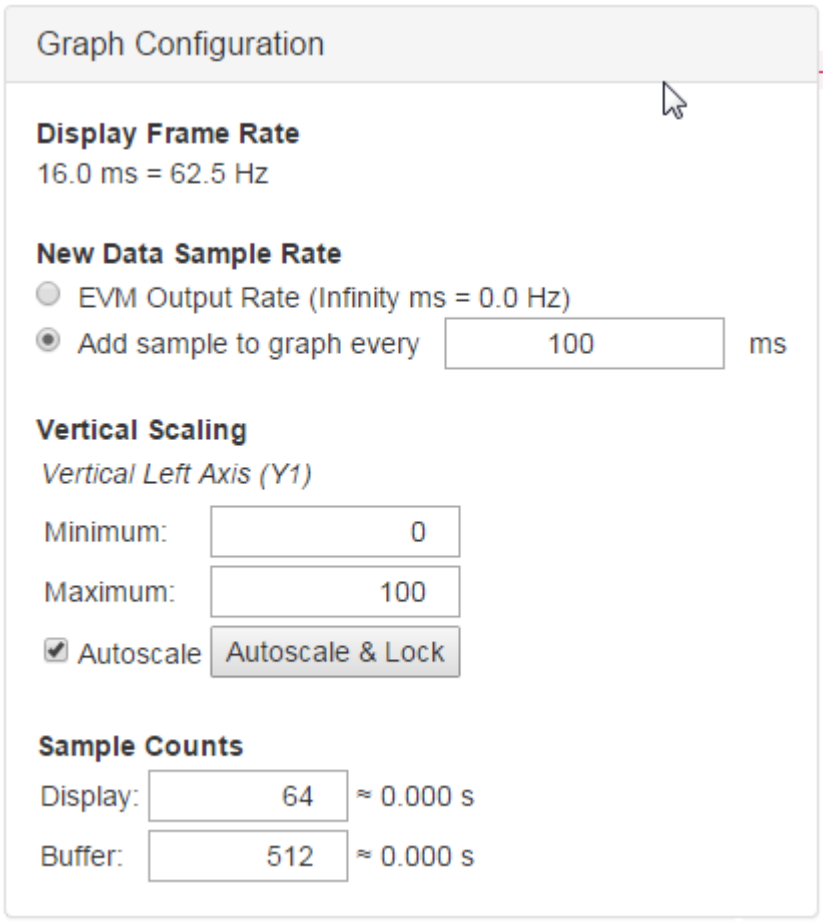


Figure 1-33. Graph Configuration Button on Data Streaming Page

The configuration window displays the actual frame rate of the graph, the rate at which data is added to the graph, the vertical scaling, and the sample buffer size. The display rate is the rate at which the graph updates on the computer display and is not configurable. It is automatically optimized by the GUI.

The "New Data Sample Rate" allows the user to choose when new data is added to the graph. Selecting "EVM Output Rate" will display data on the graph as fast as is available from the EVM. This should not be confused with the actual sampling rate of the device on the EVM which could be different. The "Add sample to graph every ... ms" will add a new sample to the graph at the specified rate.

The "Verical Scaling" allows the user to either manually set the minimum and maximum values of the y-axis on the graph or use auto-scaling. The "Autoscale & Lock" button scales the graph based on the data of the current display and then locks those vertical scaling settings.

The "Sample Counts" allows the user to specify the number of samples displayed on the graph and the total number of samples stored in the buffer. Please note the buffer size does not affect data logging to a file.

To hide the configuration window, click the "Hide Graph Configuration" button.

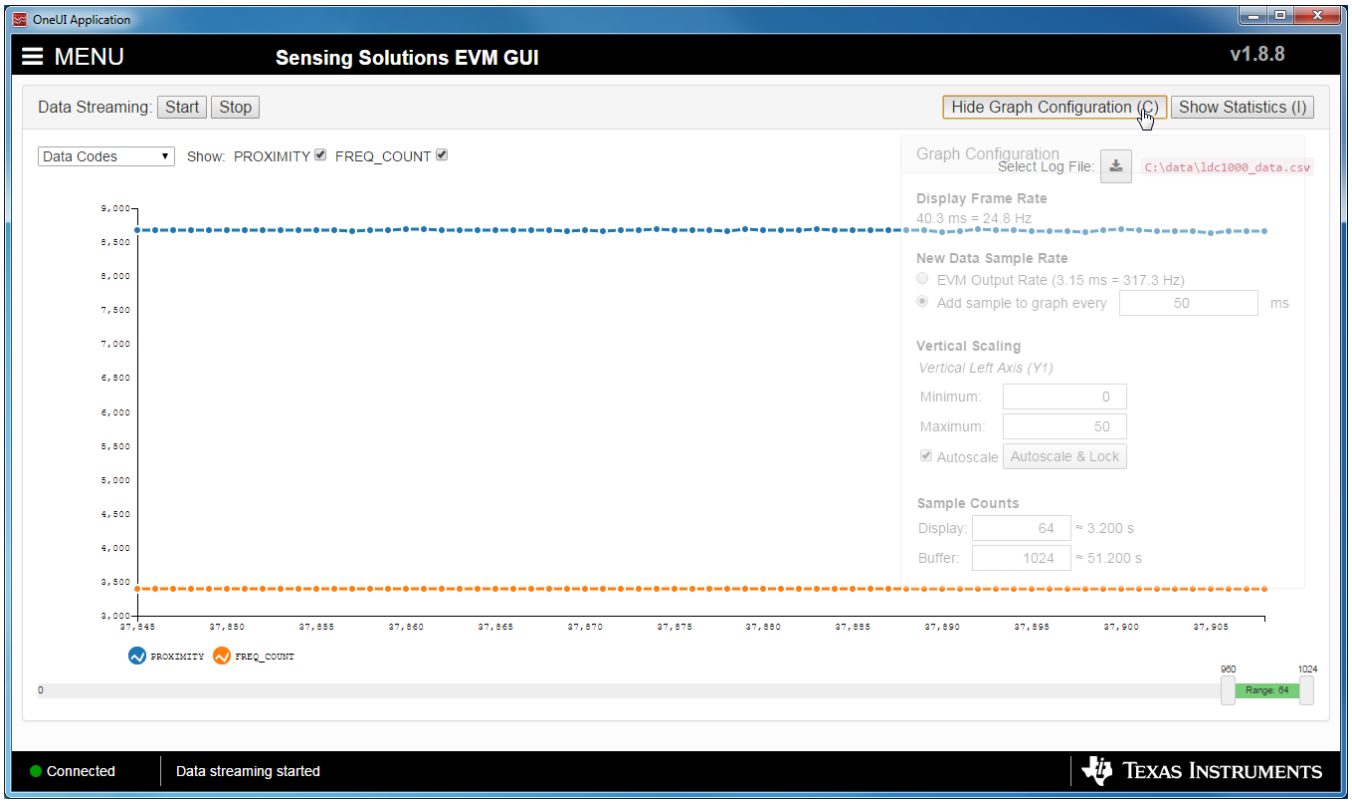


Figure 1-34. Hide Graph Configuration Button on Data Streaming Page

1.2.8.6 Navigating the Data Streaming Buffer

The Sensing Solutions EVM GUI stores a buffer of data samples and then displays a subset of those samples in the graph. The data buffer can be navigated using the horizontal slider below the graph. To adjust the samples displayed in the graph, click either the slider on the left or right side of the green bar and drag it closer or further from the other slider. The number of samples displayed is shown between the left and right sliders in the green bar.

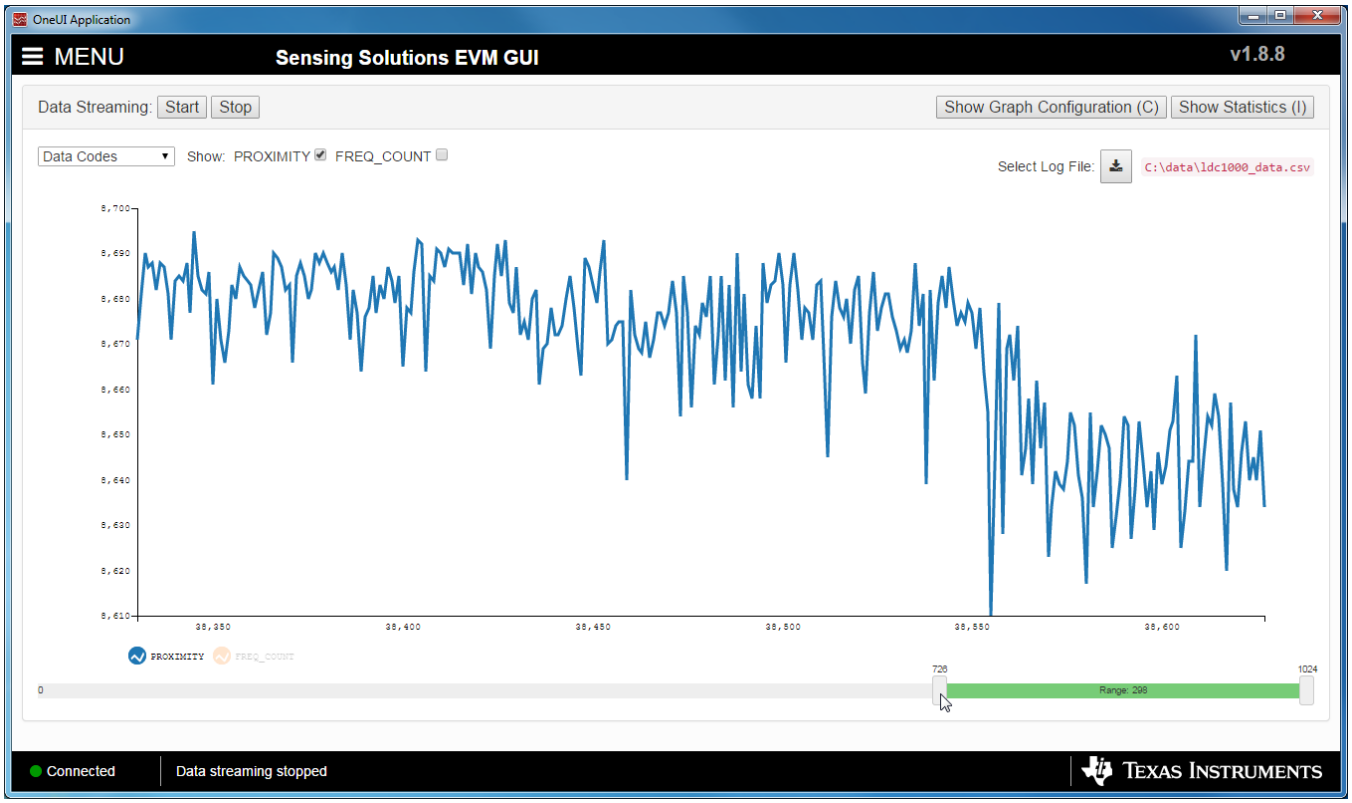


Figure 1-35. Changing Number of Samples Displayed in Data Graph

By clicking on the green bar sliders and dragging the mouse left or right, the displayed region of buffered LDC data can be adjusted.

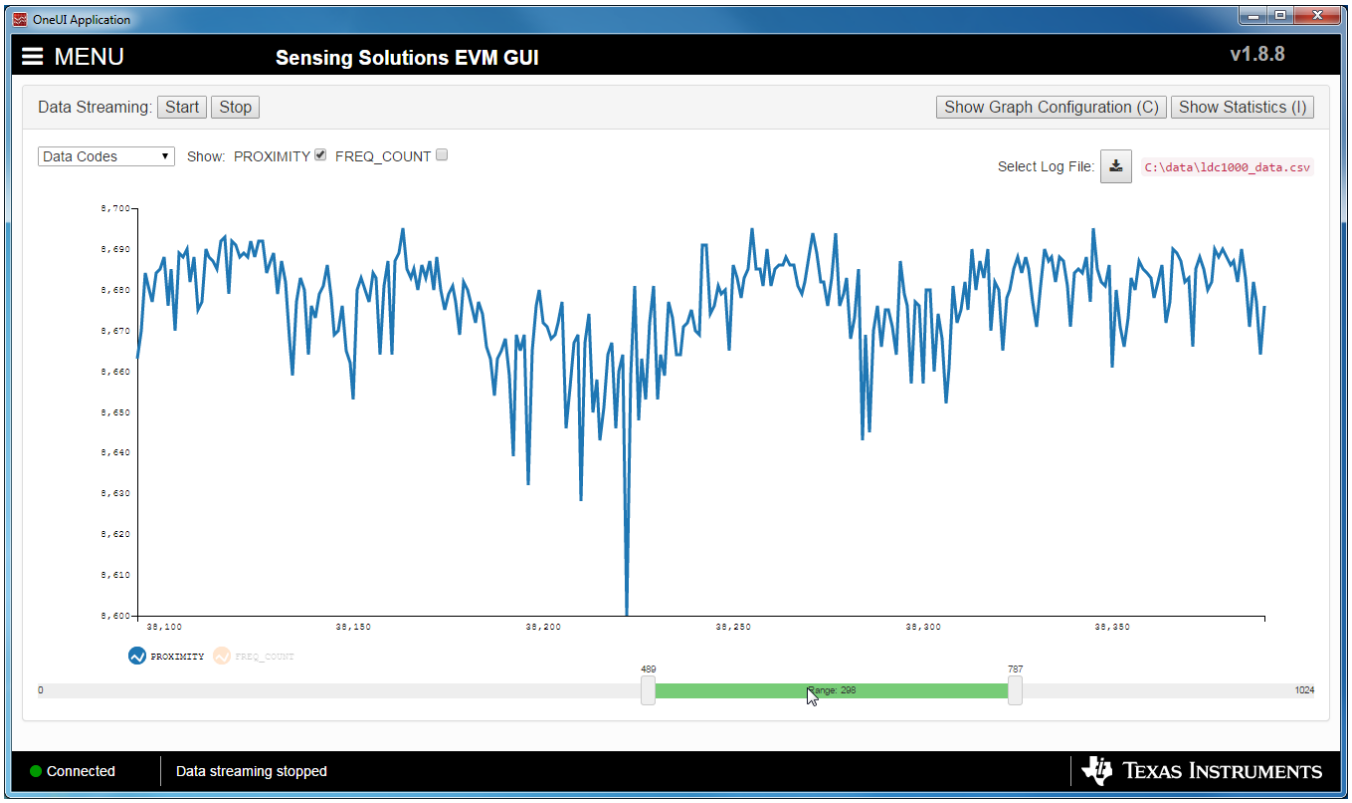


Figure 1-36. Displaying Previous Data Samples on the Data Streaming Page

1.2.9 Updating the EVM Firmware

To upload new firmware to the EVM, navigate to the "Firmware" page from the GUI menu and follow these steps. The images below show uploading the FDC2214 EVM firmware, but the steps are identical for any LDC, FDC, or HDC EVM when using their respective firmware files.

1. Click the button to select a TI-TXT firmware file

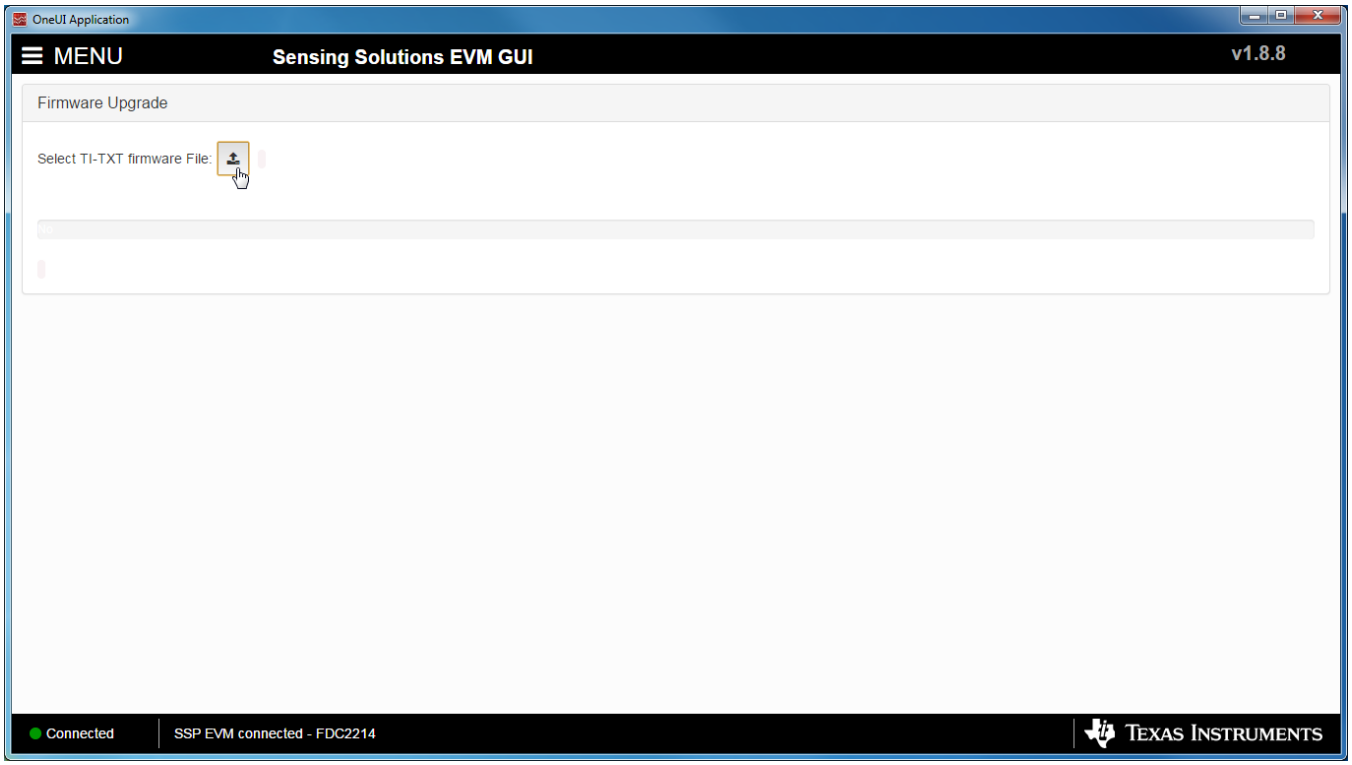


Figure 1-37. Select TI-TXT File Button on Firmware Upload Page

2. Select the firmware file and click “Open”

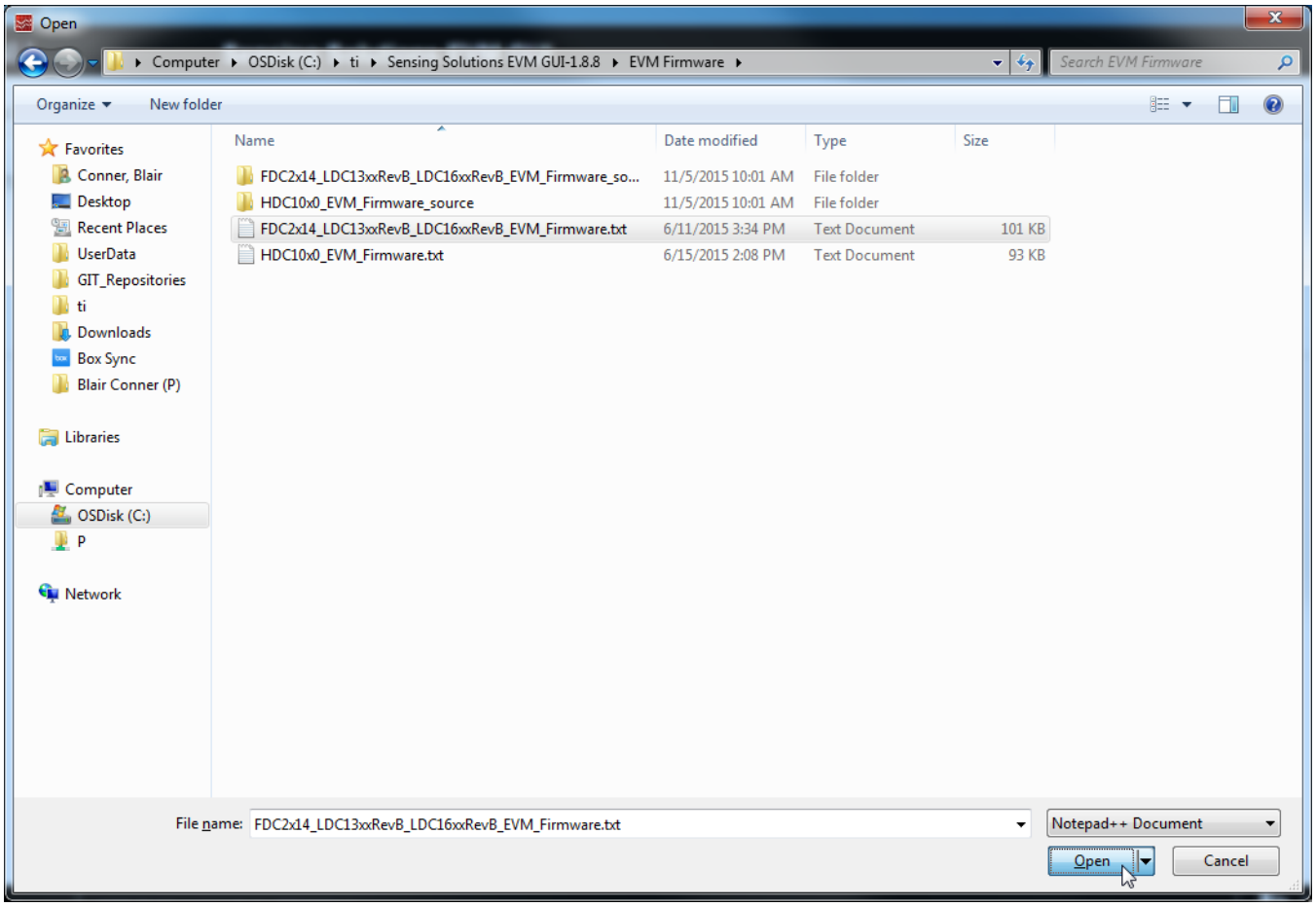


Figure 1-38. Selecting TI-TXT Firmware File for Upload to EVM

3. Click the “Upload Firmware” button

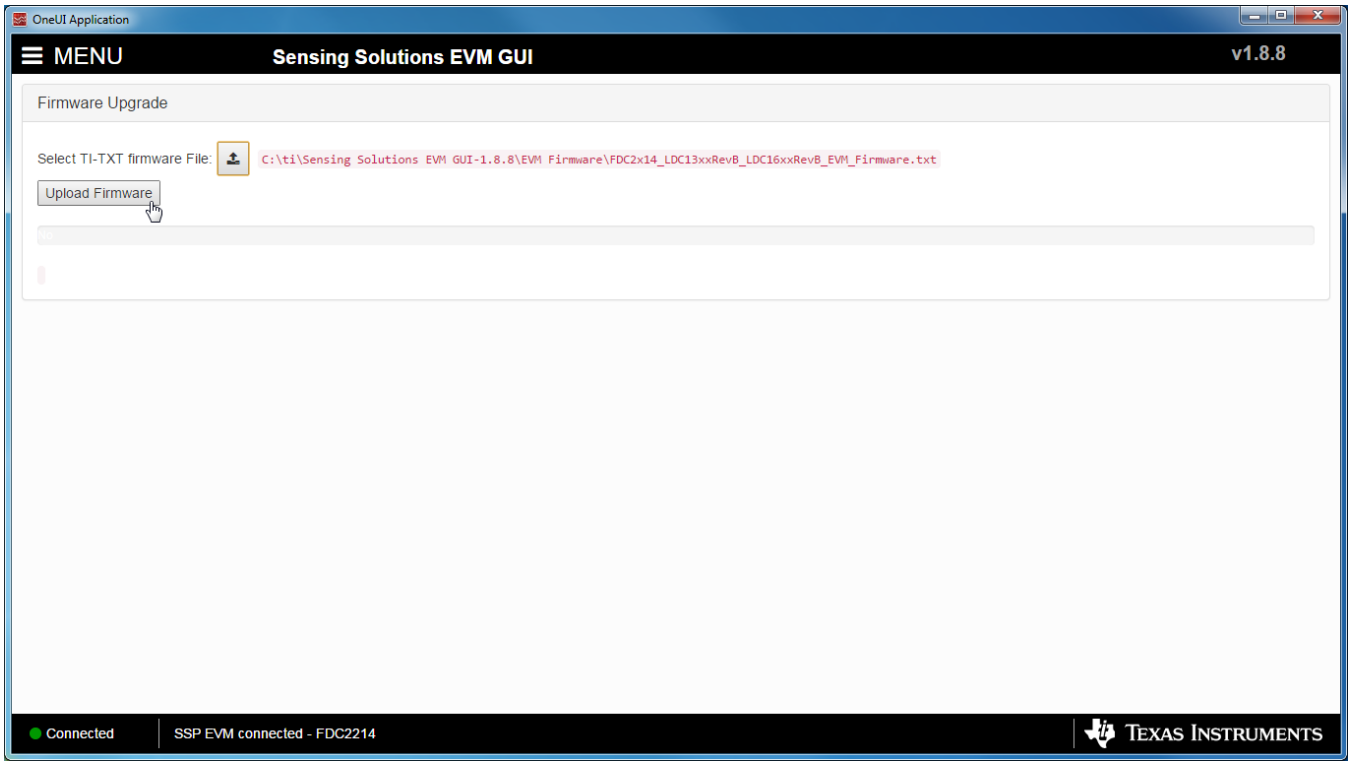


Figure 1-39. Upload Firmware Button on Firmware Upload Page

4. Wait for the firmware to upload. Do NOT disconnect the EVM from the PC at this time! Also note that the GUI will disconnect from the EVM. The upload process should not take more than one minute. If the upload fails or lasts longer than one minute, unplug the EVM and restart the GUI.

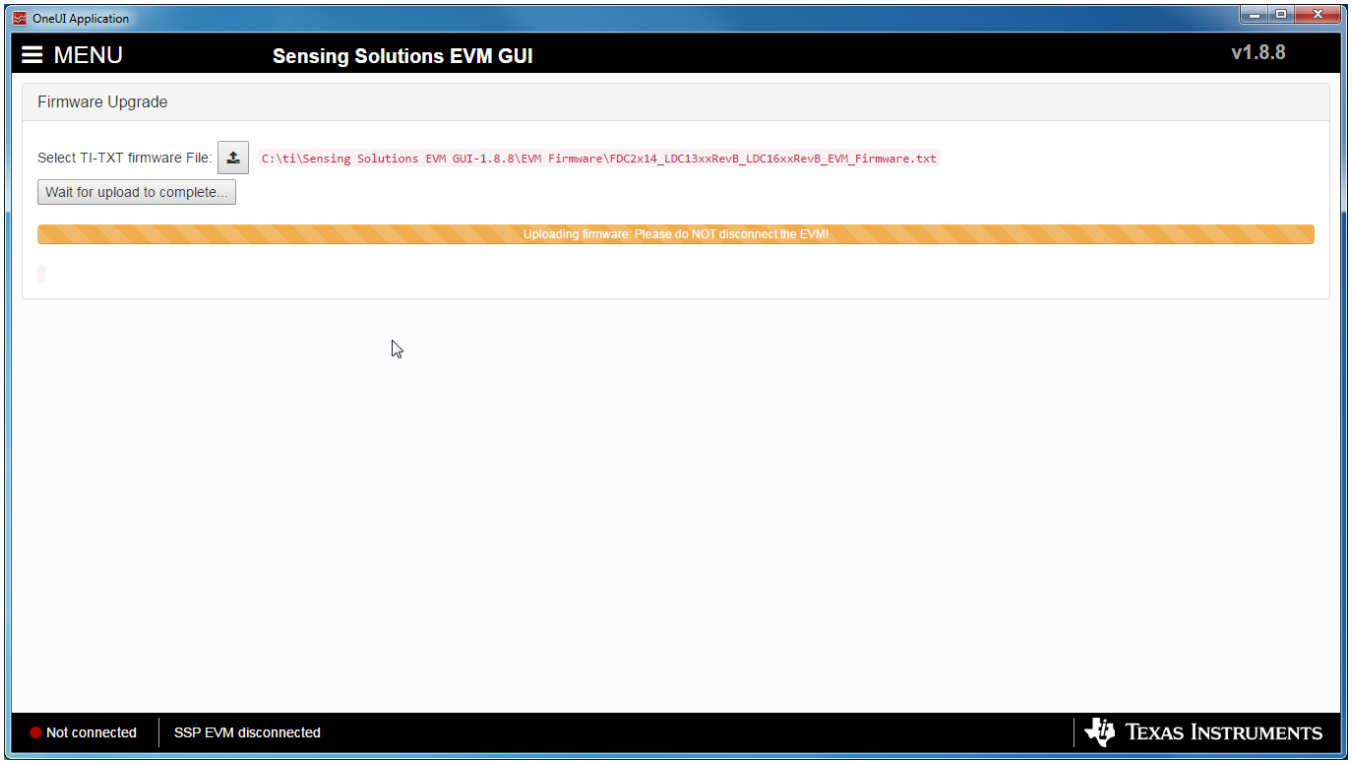


Figure 1-40. Firmware Upload in Progress

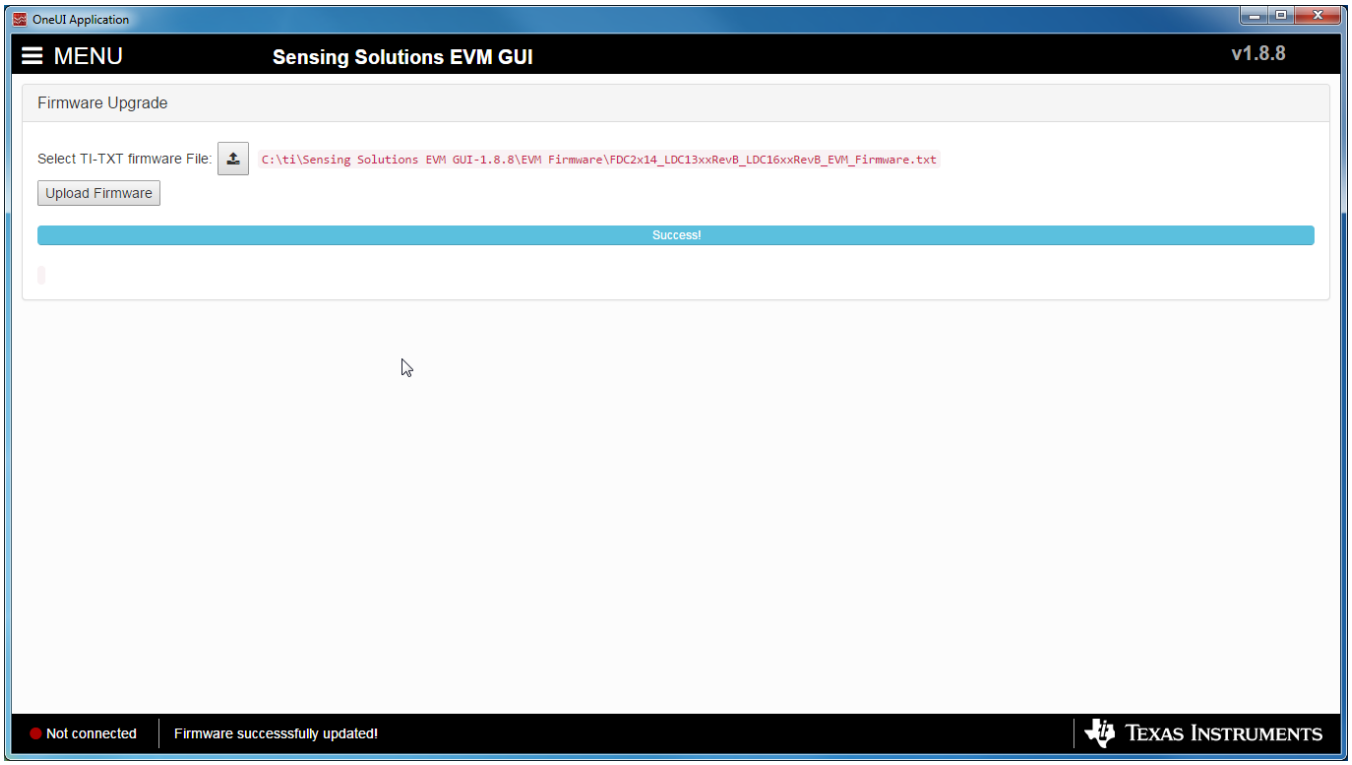


Figure 1-41. Firmware Upload Success

2.1 LDC10xx EVM Schematics

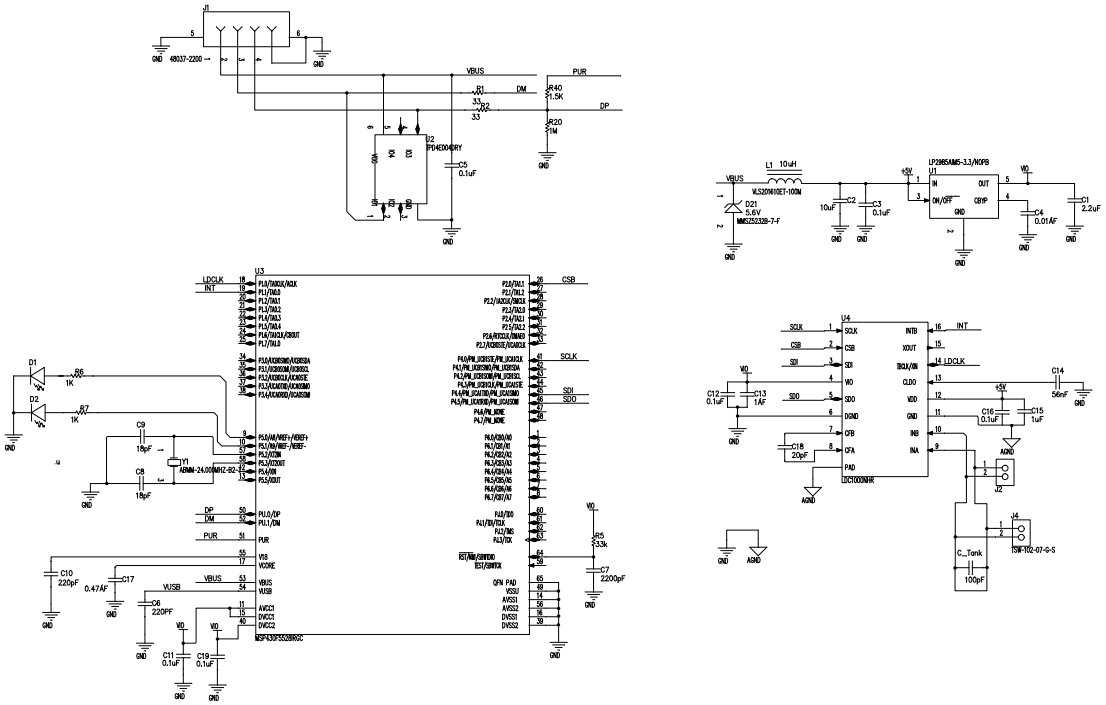


Figure 2-1. EVM Layout

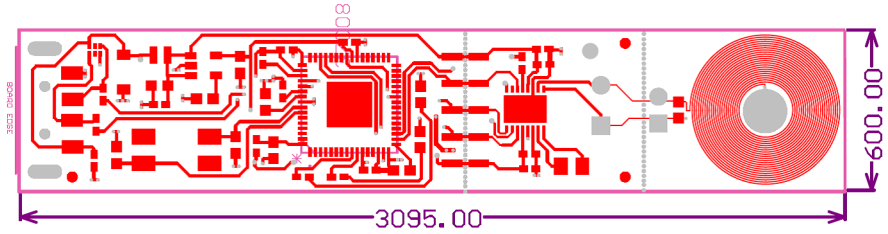


Figure 2-2. Top Layer

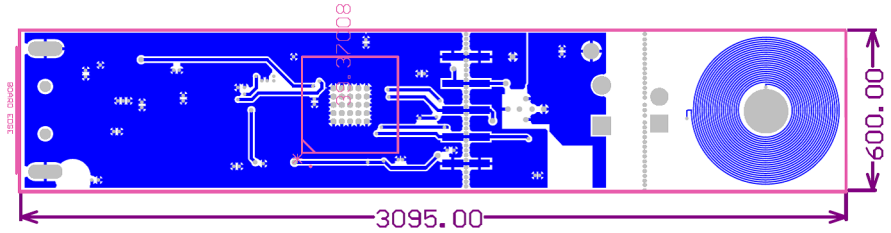


Figure 2-3. Bottom Layer

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

Designator	Quantity	Description	Manufacturer	Part Number
R40	1	RES 1.5K OHM 1/16W 5% 0402 SMD	Vishay Dale	CRCW04021K50JNED
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

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from A Revision (March 2014) to B Revision **Page**

- Added new part number LDC1001 2
- Updated GUI instructions to v1.8.8 3
- Updated *Choosing the Graph and Visible Channels* section 21

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

- Added new part numbers LDC1041/LDC1051 2
- Changed Changed Schematic to Vector graphic for better display. 37

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265