LDC131x and LDC161x EVM User’s Guide

User's Guide

Literature Number: SNOU133
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LDC131x and LDC161x EVM User's Guide

1 Overview

The LDC131x/161x EVM demonstrates the use of inductive sensing technology to sense and measure the presence or position of conductive target objects. The EVM contains two example LC tank sensors that are connected to the LDC131x/161x input channels. The latter is controlled by an MSP430, which interfaces to a host computer.

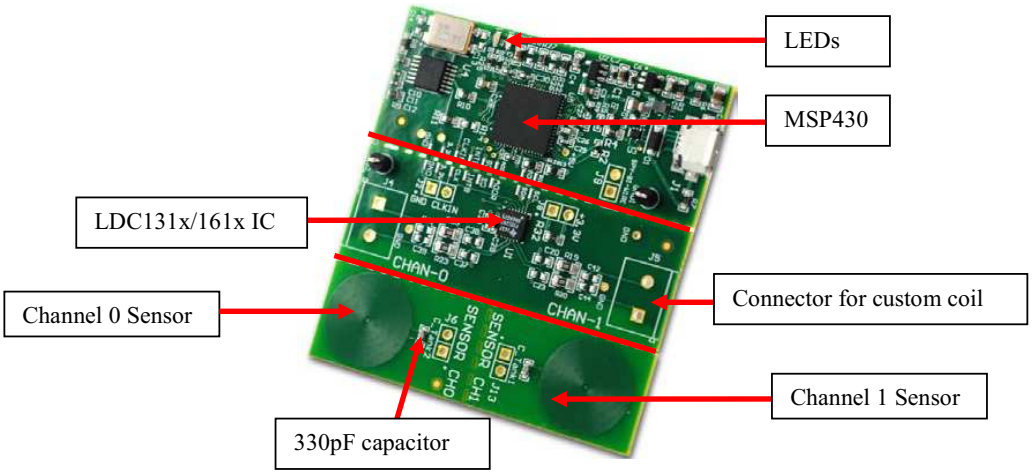


Figure 1. LDC1312/1612 Evaluation Module

The LDC1312/1612 EVM includes two example PCB sensors which are PCB inductors with 330 pF 1% COG/NP0 capacitors connected in parallel to form an LC tank. LDC1314/1614 includes two additional spaces to which two sensors can be connected.

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 turns on, which indicates the connection of the EVM to the host computer.

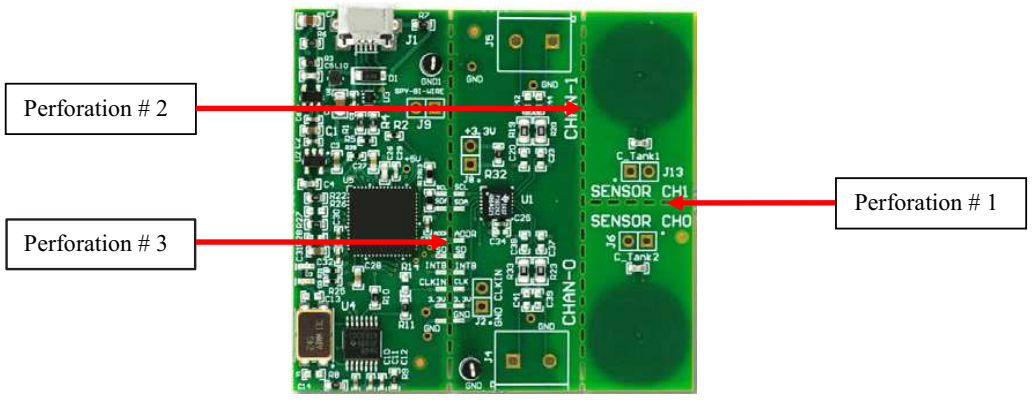


Figure 2. Perforations of the Evaluation Module

2 Quick Start Guide LDC131x/161x Evaluation Module

This section describes how to properly connect, set up and use the LDC131x/161x EVM.

2.1 LDC131x/161x Evaluation Module Overview

The LDC131x/161x Evaluation Module enables the user to test out the capabilities of the LDC131x/161x, Inductance-to-Digital Converter. The EVM is a micro USB device used with a host computer and configured using the Inductive Sensing Graphical User Interface (GUI) software.

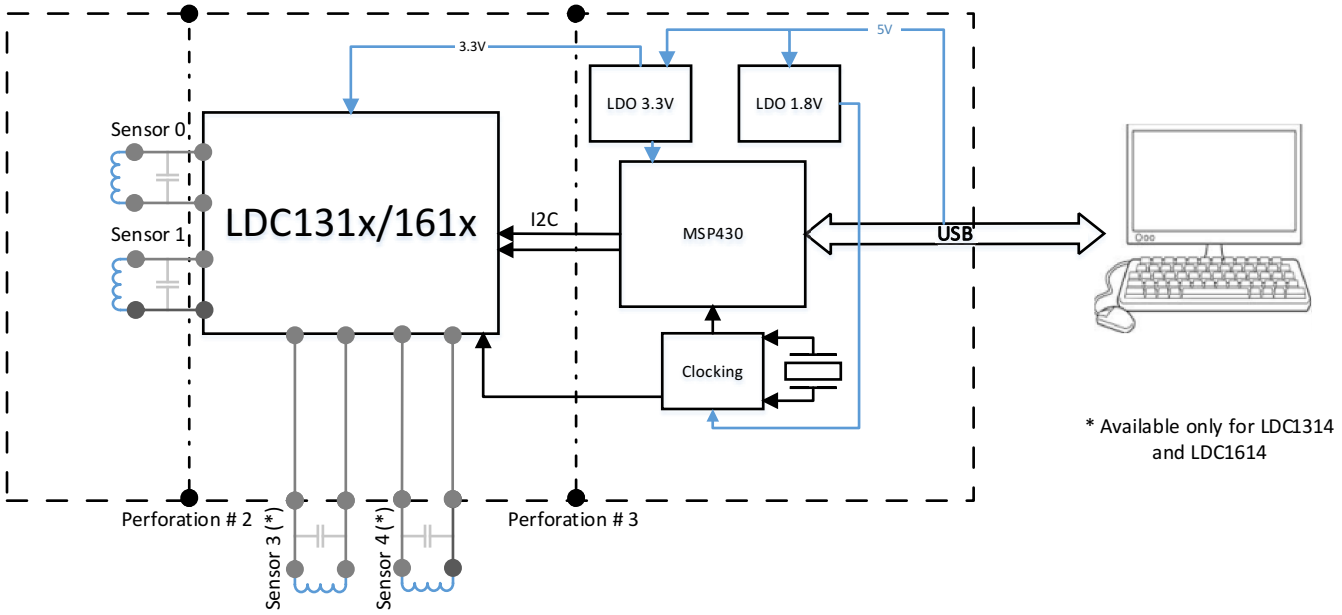


Figure 3. System Level Diagram of EVM

2.1.1 Set Up Requirements

The LDC131x/161x GUI and drivers must be installed on the host. Driver installation will launch automatically once the device is plugged in. See Section 3.3 for more information on software installation.

2.1.2 Loading and Running

1. Plug the EVM into the host computer. The host computer should automatically detect the device as a LDC131x/161xEVM.
2. Launch the GUI. It should automatically detect the presence of the EVM.
3. By default, GUI is configured to stream in single channel mode. To stream the data from both channels, change Channel Config in the Configuration tab. First, select Configuration on the icon toolbar.

Figure 4. Configuration and Streaming Icons

4. By default, the EVM will be performing conversions only on Channel 0 and Channel 1. If other channel conversion is desired, select the appropriate channel in the Channel Config toolbar: Go back to the Streaming tab.

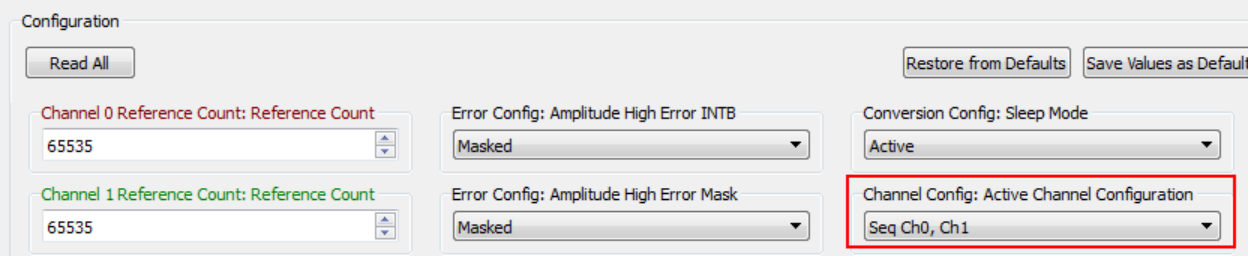


Figure 5. Configuration Registers

5. Select Start in order to begin streaming the data.

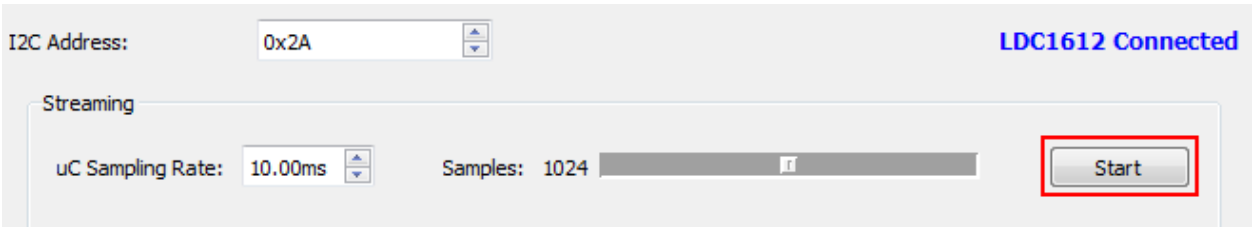


Figure 6. Start Streaming

6. The data will update in the graph shown in Figure 7: Zoom into each tab if needed by right clicking on it and selecting "Zoom to".

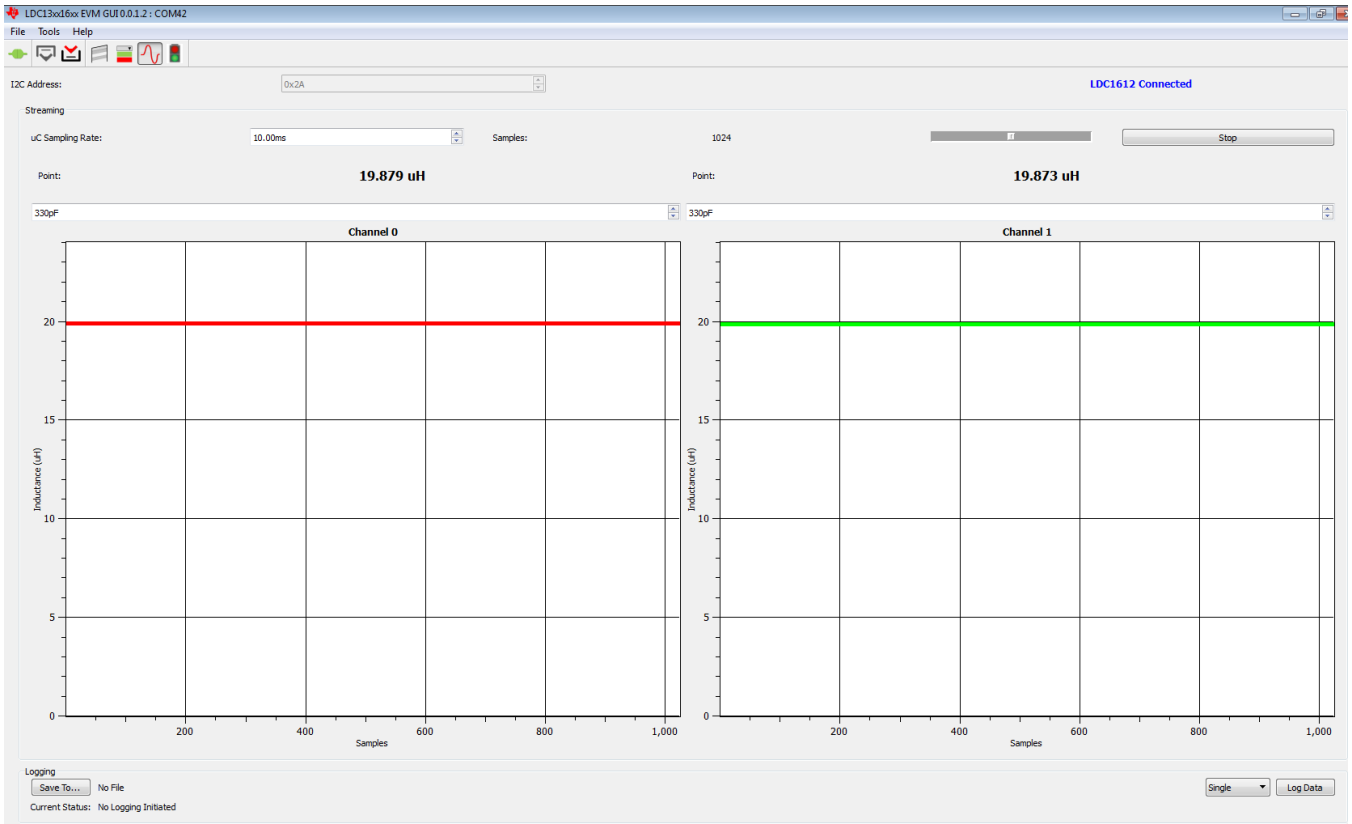


Figure 7. Streaming Data from Two Channels

3 Inductive Sensing GUI User's Guide

3.1 Inductive Sensing GUI Overview

The inductive sensing GUI provides graphical configuration and streaming support for the LDC131x/161x. The GUI package includes drivers for use with the EVM. The EVM provides a device abstraction layer for the GUI to communicate with the LDC131x/161x through I2C, 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. The following steps 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 Installation Process

The EVM GUI can be downloaded from the TI website. Select LDC131x/161x-SW for software installation.

3.4 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. Connecting an EVM of a different device (LDC1312, LDC1612, LDC1314, or LDC1614) requires GUI restart.

3.5 EVM Information

EVM Information

- Configure register data through I2C (SCL, SDA)
- Stream registers data through I2C
- Detect interrupts through I2C

3.6 Icon Toolbar

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

Figure 8. Icon Toolbar

Table 1. Icon's Description

ICON	FUNCTION	DESCRIPTION
• EVM is connected  • EVM is disconnected 	Connection State	Indicates whether an EVM is connected to the PC, and if so, provides details of the connected EVM
	Open	Opens saved register settings and defaults
	Save	Saves all current register settings and defaults
	Register Settings	Show LDC131x/161x Register Settings
	Configuration	Show EVM Configuration
	Streaming	Show Streaming Section
	Error Window	Show Error Section

3.7 Configuration Tab

In the configuration section, the device functionality can be viewed and modified. Stop streaming before making any changes on the tab.

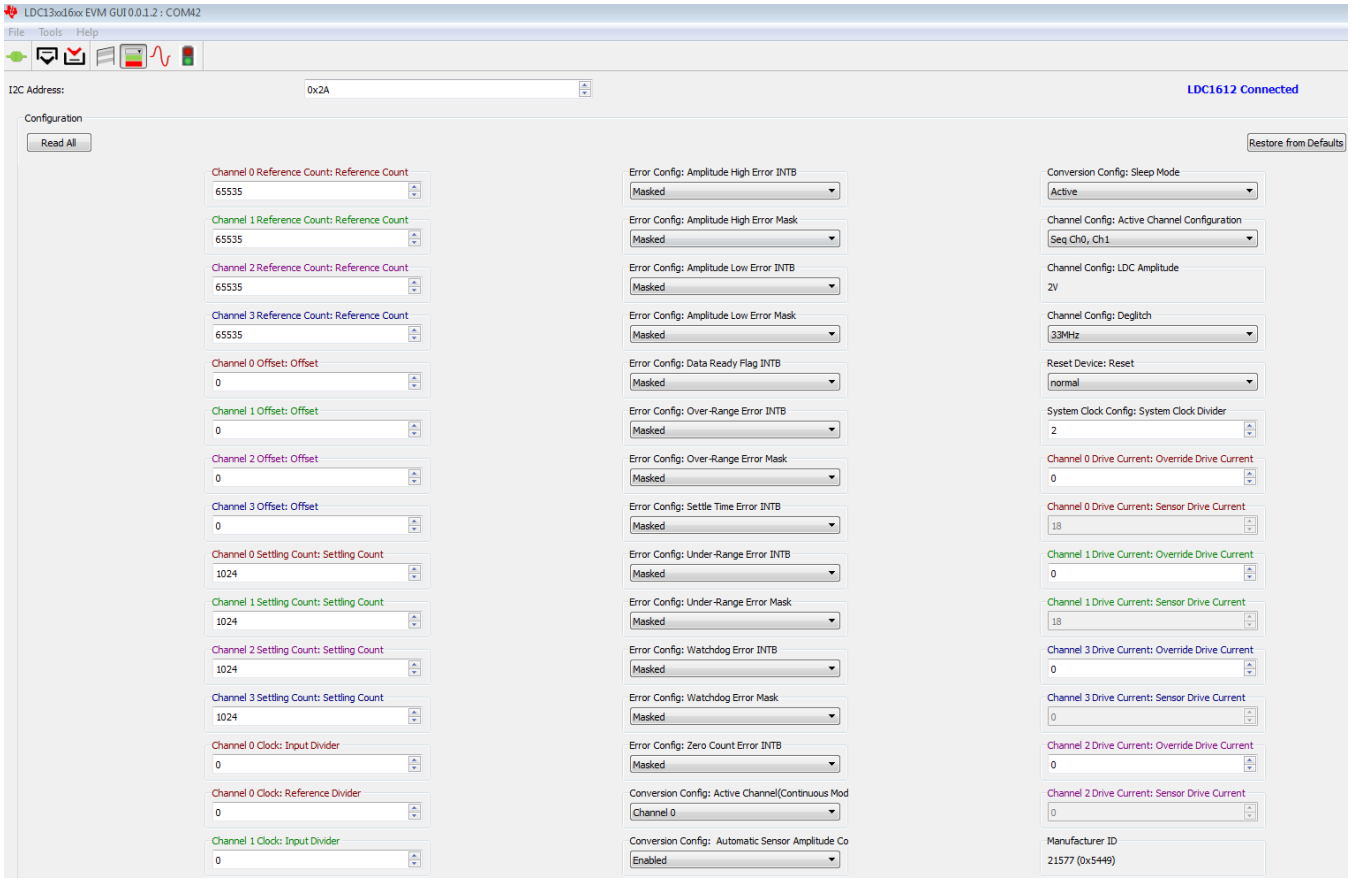


Figure 9. Configuration Section

In the Configuration tab, select the parameter to 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 restore the current configuration to the default settings.

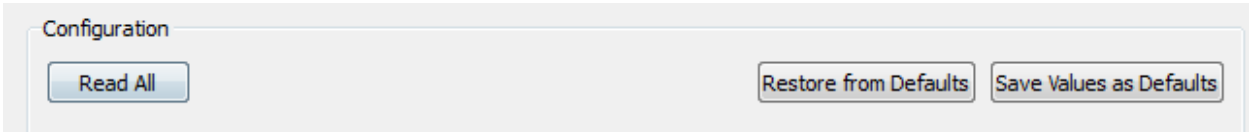
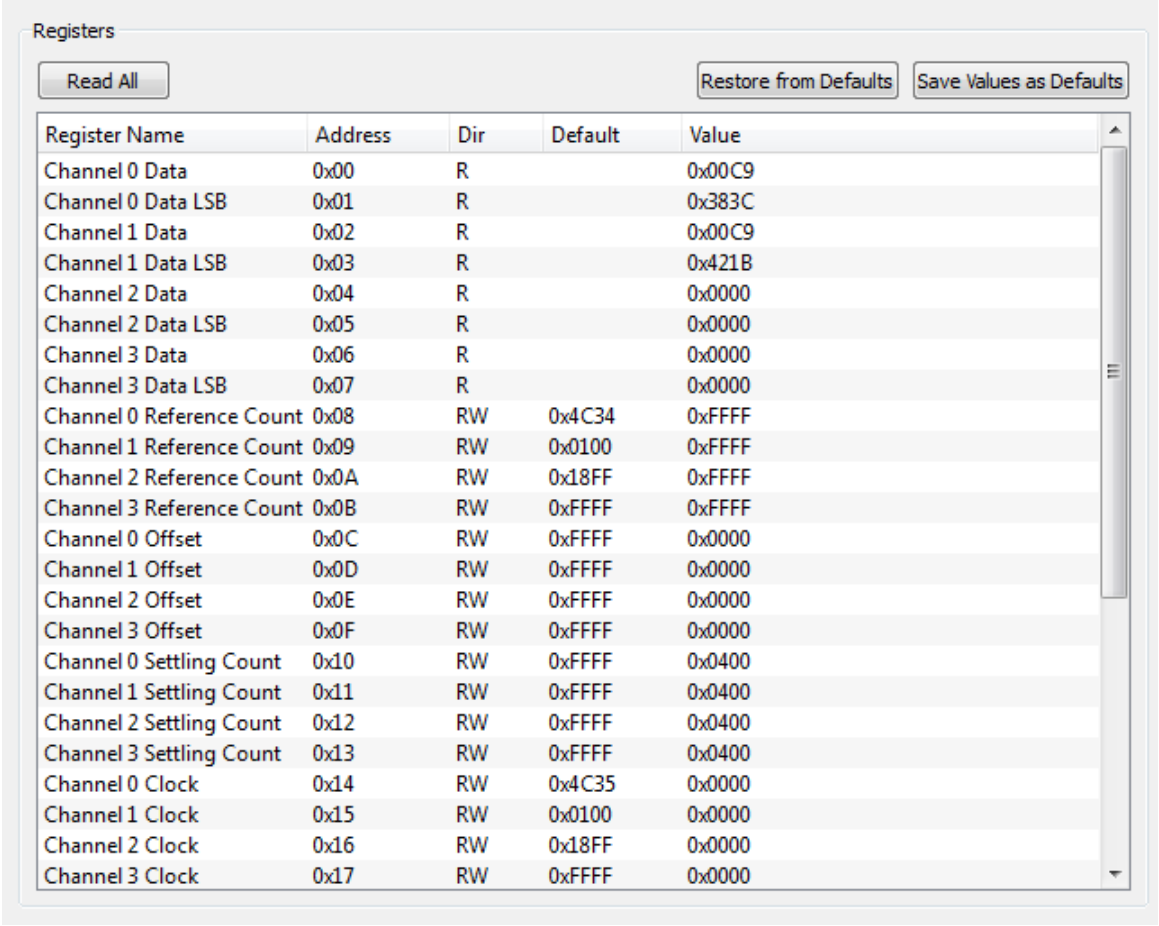


Figure 10. Reading and Setting Values

3.8 Registers Tab

In the register settings section, all registers of the device can be accessed. Register settings can be modified in either configuration or register tabs. Note that registers tab takes hexadecimal values, whereas the configurations tab works with decimal values. Alike the configurations tab, access to the settings is available after the streaming is stopped.



Register Name	Address	Dir	Default	Value
Channel 0 Data	0x00	R		0x00C9
Channel 0 Data LSB	0x01	R		0x383C
Channel 1 Data	0x02	R		0x00C9
Channel 1 Data LSB	0x03	R		0x421B
Channel 2 Data	0x04	R		0x0000
Channel 2 Data LSB	0x05	R		0x0000
Channel 3 Data	0x06	R		0x0000
Channel 3 Data LSB	0x07	R		0x0000
Channel 0 Reference Count	0x08	RW	0x4C34	0xFFFF
Channel 1 Reference Count	0x09	RW	0x0100	0xFFFF
Channel 2 Reference Count	0x0A	RW	0x18FF	0xFFFF
Channel 3 Reference Count	0x0B	RW	0xFFFF	0xFFFF
Channel 0 Offset	0x0C	RW	0xFFFF	0x0000
Channel 1 Offset	0x0D	RW	0xFFFF	0x0000
Channel 2 Offset	0x0E	RW	0xFFFF	0x0000
Channel 3 Offset	0x0F	RW	0xFFFF	0x0000
Channel 0 Settling Count	0x10	RW	0xFFFF	0x0400
Channel 1 Settling Count	0x11	RW	0xFFFF	0x0400
Channel 2 Settling Count	0x12	RW	0xFFFF	0x0400
Channel 3 Settling Count	0x13	RW	0xFFFF	0x0400
Channel 0 Clock	0x14	RW	0x4C35	0x0000
Channel 1 Clock	0x15	RW	0x0100	0x0000
Channel 2 Clock	0x16	RW	0x18FF	0x0000
Channel 3 Clock	0x17	RW	0xFFFF	0x0000

Figure 11. 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.

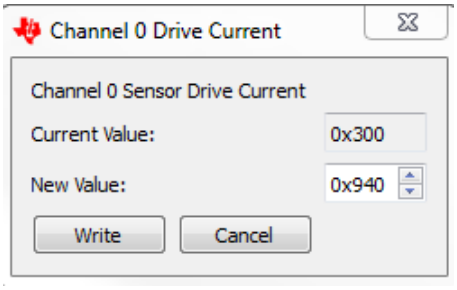


Figure 12. Read/Write Register Dialog

- Press: "Save Values as Default" to save all configuration, status, and data.
- Press: "Restore from Defaults" to write values from the default column (if they exist) to the current register value.

3.9 Error Tab

In the error window sections, all device errors can be monitored. Error conditions are highlighted in red. Green area indicates no errors were detected.

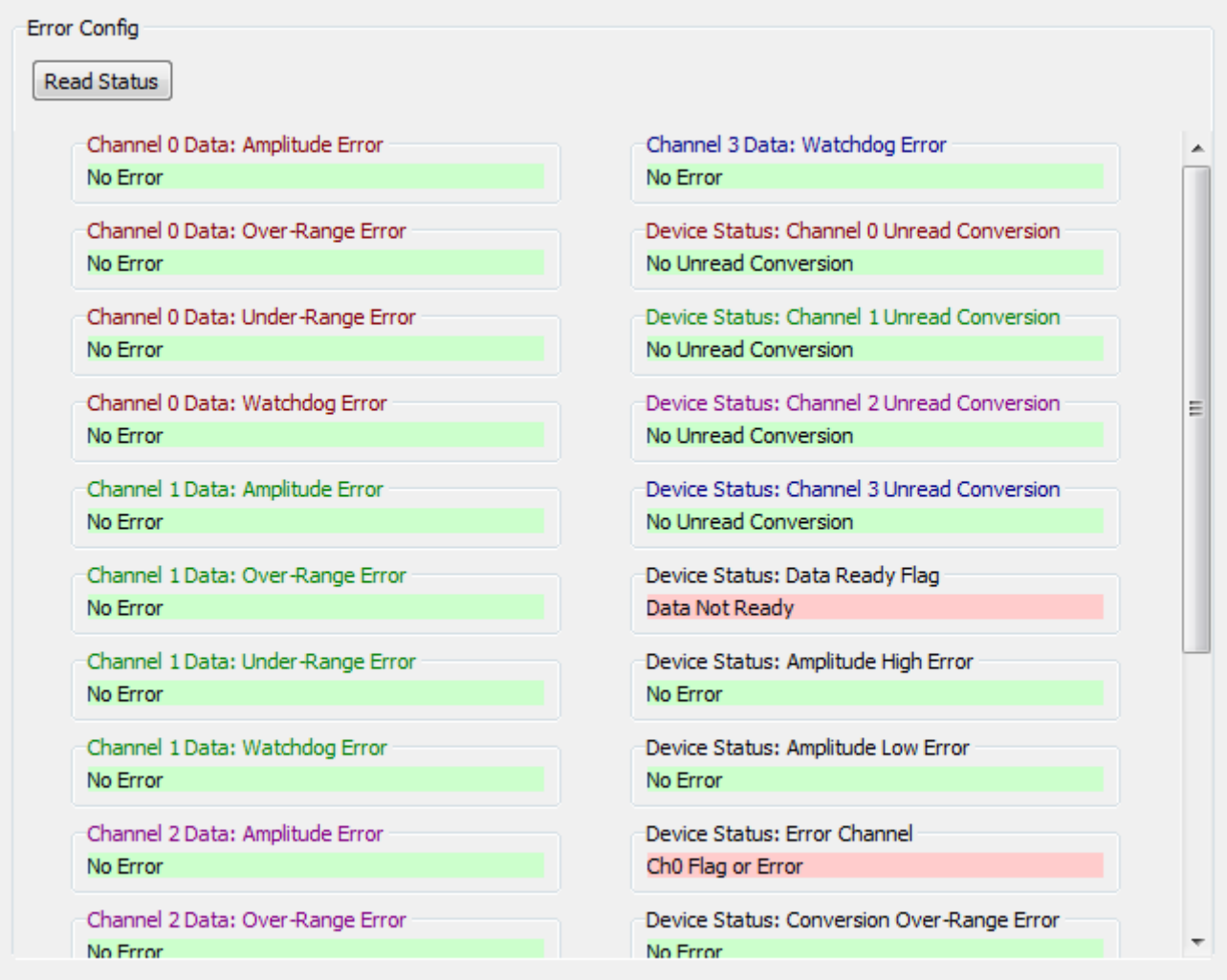


Figure 13. Error Tab

Ensure that errors are reported by selecting 'Unmask' the error in the configuration tab:

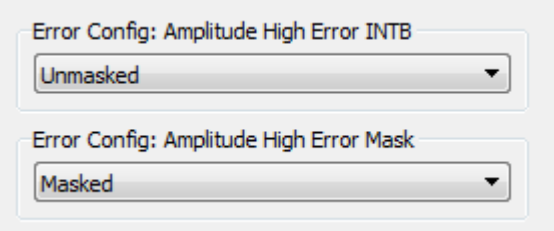


Figure 14. Error Configuration

3.10 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 microcontroller on the EVM retrieves a measurement from the LDC131x/161x.

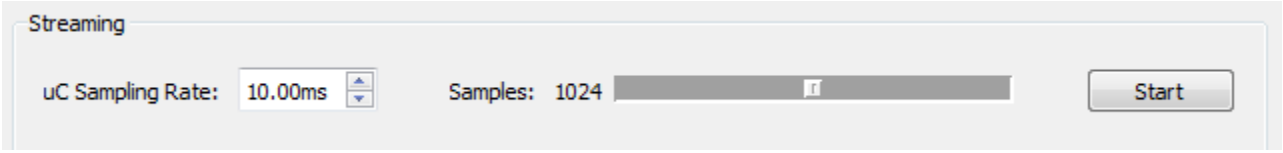


Figure 15. Streaming Configuration

The sampling rate can only be set when streaming is stopped. The limit on the sampling rate is 1000 times per second (1ms). For data logging, it is 100 times per second (10ms).

3.10.1 Average, Point, Min, Max Values

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

Table 2. Modes Description

NAME of the MODE	FUNCTION of the MODE
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
Standard Dev	The standard deviation of the data currently in the plot

A larger number of samples results in a larger averaging window.

3.10.2 Zooming and Scaling

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

Table 3. Zooming and Scaling Options

NAME of the TYPE	FUNCTION of the TYPE
Toggle Data Type	Displays inductance thresholds
Zoom to...	Zooms to window
Autoscale	Autoscales the data in the plot
Save Plot Data…	Allows to save the streaming data to a file
Reset	Resets the Zoom window to its default setting
Clear Data	Clears the data and resets streaming
Help	Clears the data and resets streaming

3.10.3 Frequency Count

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

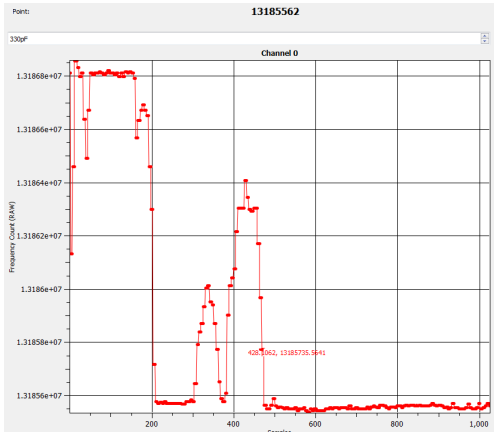


Figure 16. Switching Display Units between Inductance and Frequency Count

3.11 Saving and Loading

3.11.1 Configurations

Configurations can be saved and loaded. To save a configuration, click on the: "Save" icon in the toolbar. Type a name for the file.

Figure 17. Save 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.

To load a configuration, click on the "Open" icon in the toolbar and select the configuration file:

Figure 18. Open Icon

3.11.2 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.

3.11.3 Data Logging

Measured data from the LDC131x/161x EVM can be saved to a text file by using the logging features, which are located on the bottom of the main GUI window.

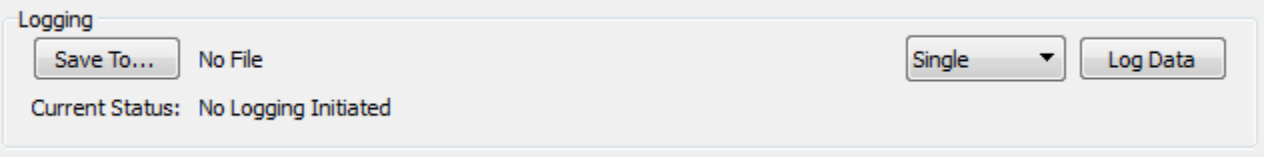


Figure 19. Data Logging

The data is saved in a comma separated text file which contains the time of data capture, 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 LDC131x/161x EVM. To stop the data saving, press the "Log Data" button a second time.

3.12 Input Clock Options

By default, the input clock for LDC131x/161x is generated externally by PLL clock synchronizer and has a value of 40 MHz. It is possible to remove R11 and connect an external clock by populating J2.

3.13 Using Multiple EVMs Simultaneously

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. 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 have 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.

3.14 EVM Sensors

The sensor portion of the LDC131x/161x Evaluation Module is perforated so that it can be snapped off and replaced with custom LC tanks. The EVM includes two 2 layer, 32 turn, 14mm diameter inductors with 330pF 1% COG/NP0 capacitors. The Inductance and series resistance of the LC tank is plotted versus frequency below.

Figure 20. EVM LC Tanks

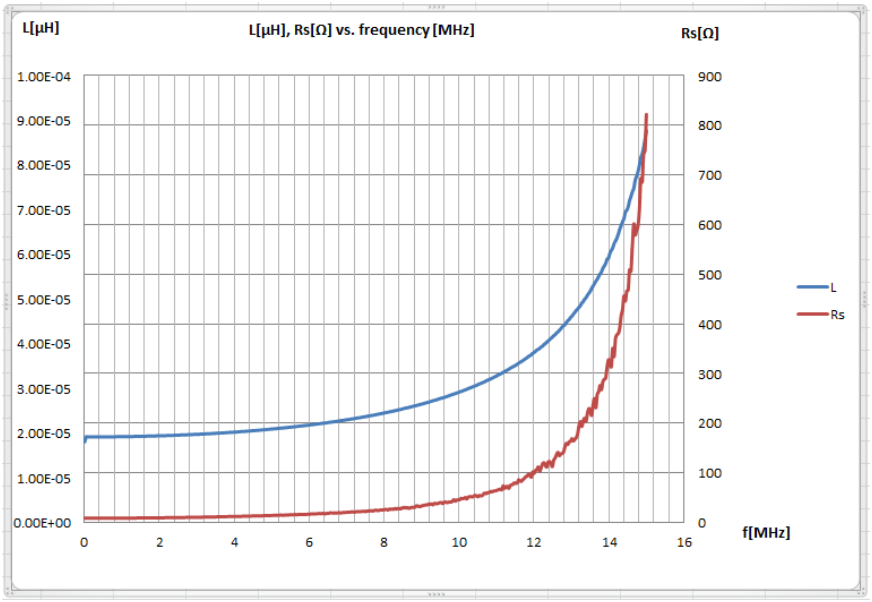


Figure 21. Plots of L and R vs. Frequency

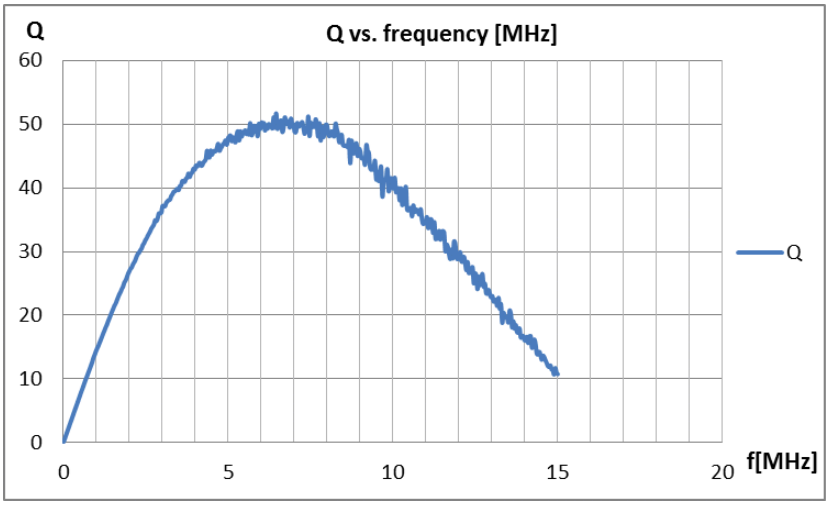


Figure 22. Plots of Q vs. Frequency

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.

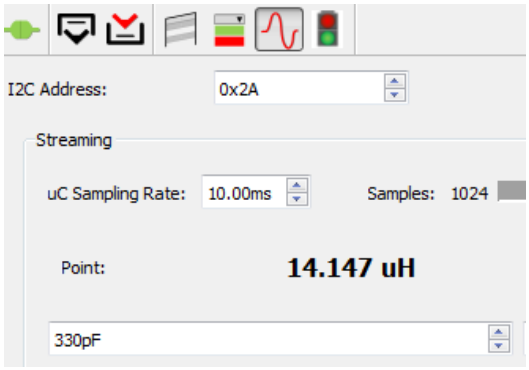


Figure 23. Sensor Capacitor Setting

4 LDC1312/1612 EVM Schematics and Layout

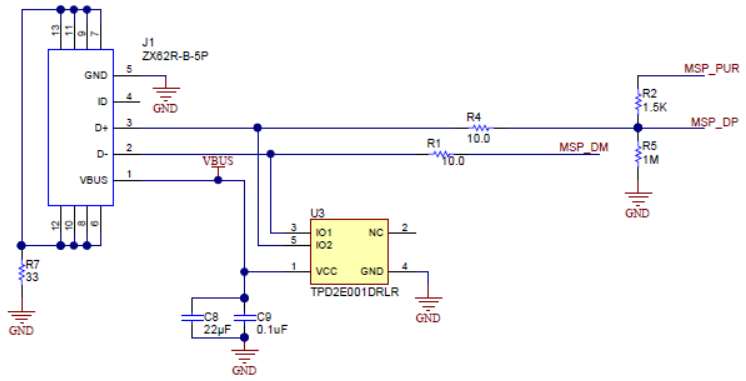


Figure 24. LDC1312/1612 USB Connection

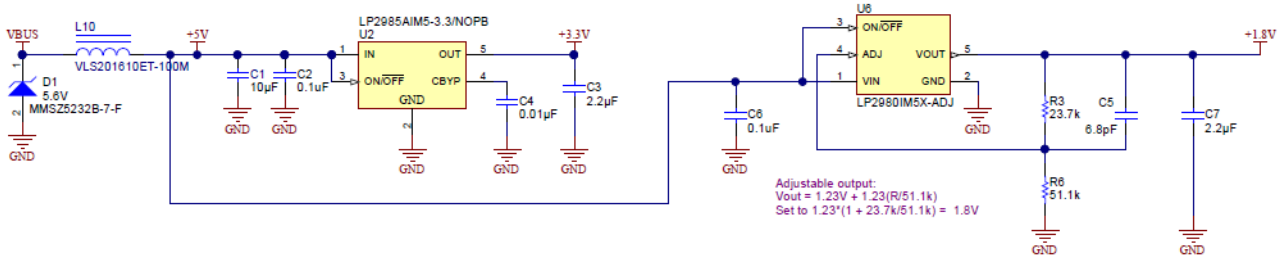


Figure 25. LDC1312/1612 Power Circuit

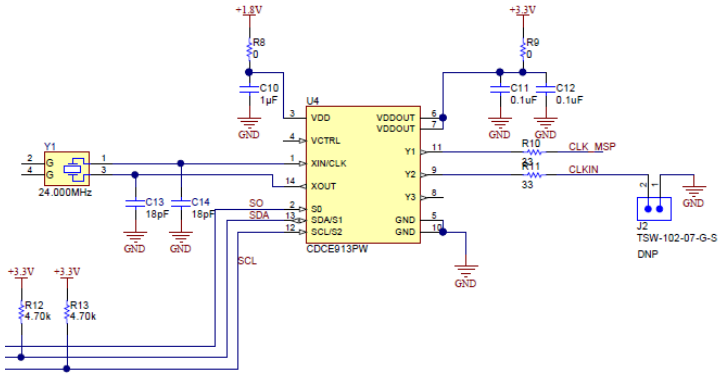


Figure 26. LDC1312/1612 Clocking

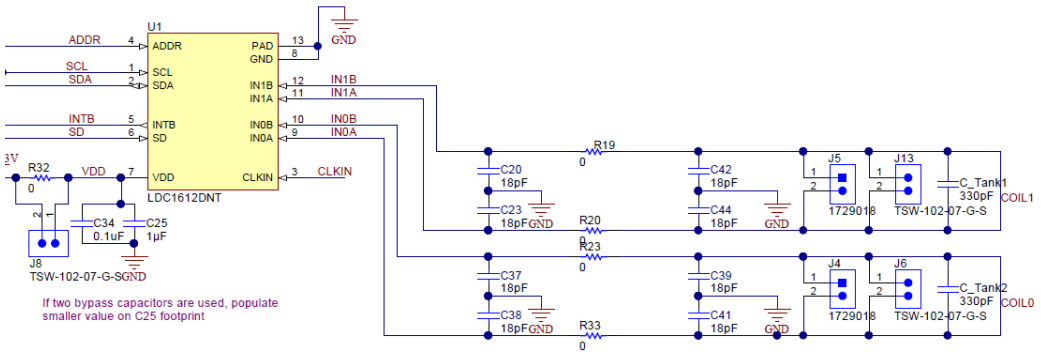


Figure 27. LDC1312/1612

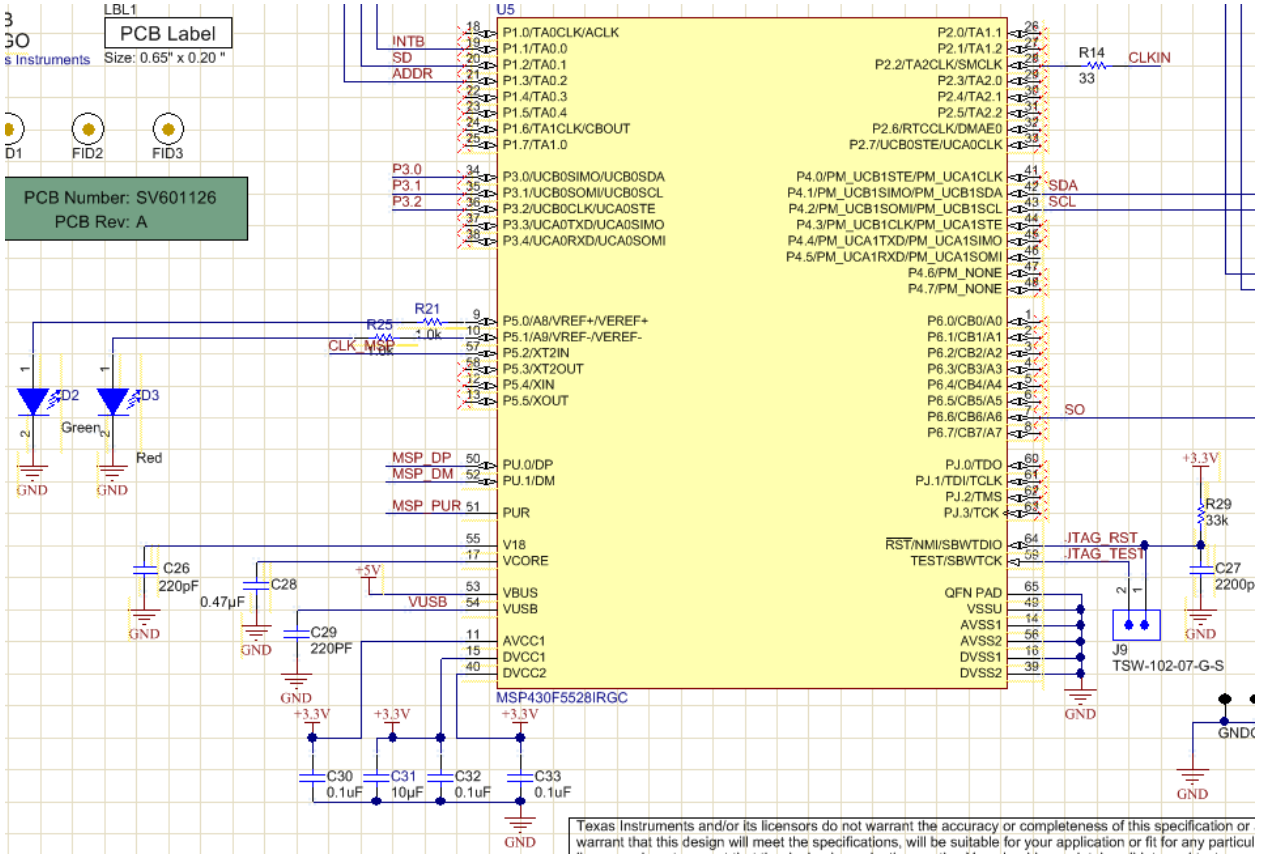


Figure 28. LDC1312/1612 MSP430 Connections

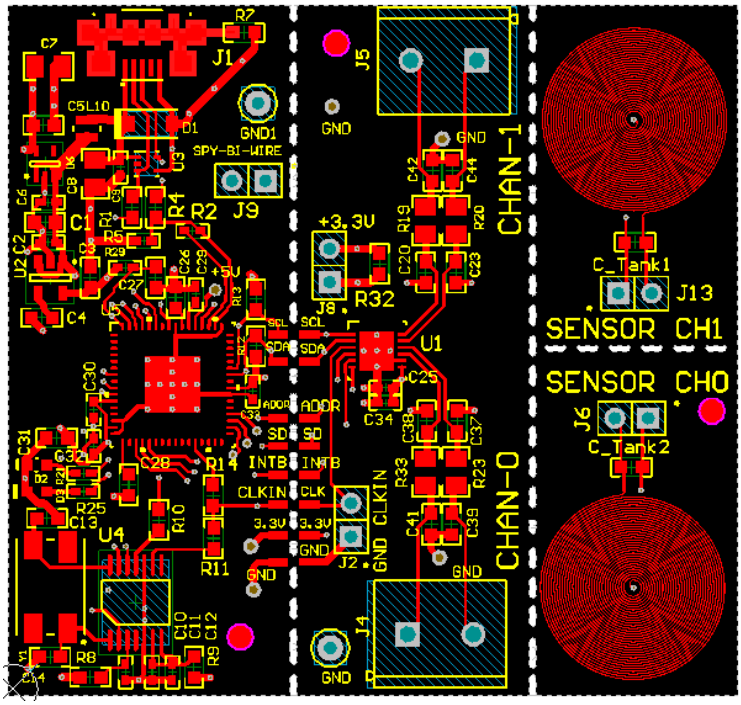


Figure 29. LDC1312/1612 Layout Top Layer – Signals and Components

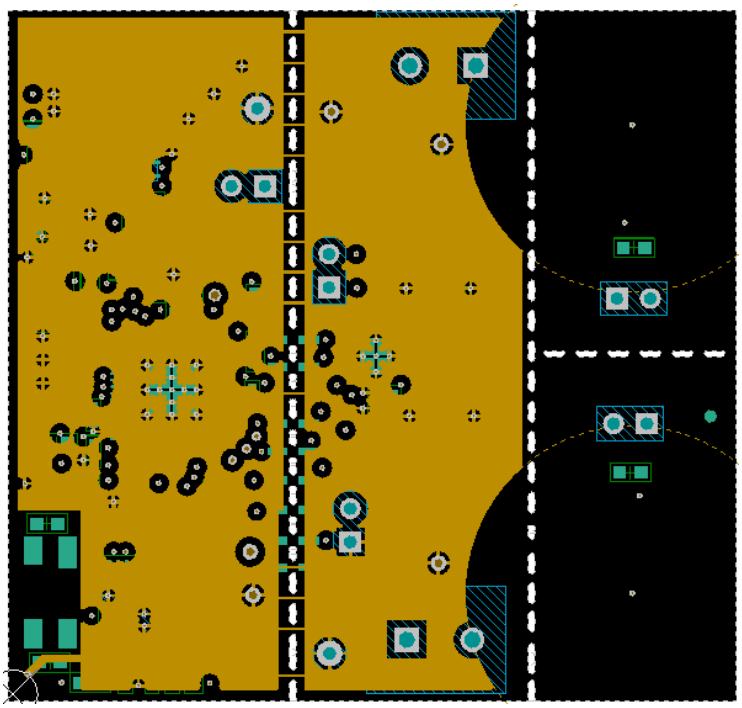


Figure 30. LDC1312/1612 Layout MidLayer 1 – Ground Plane

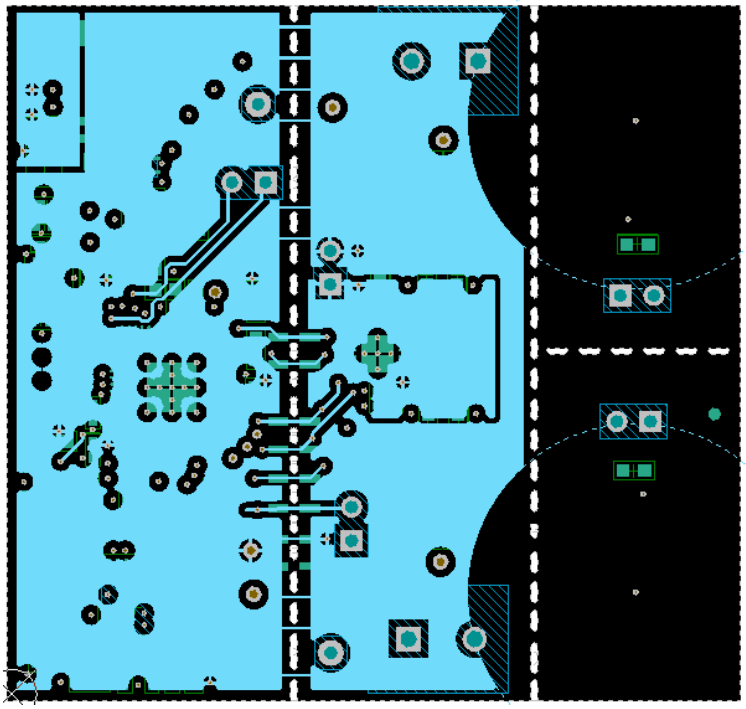


Figure 31. LDC1312/1612 Layout MidLayer 2 – Signals and Power Plane

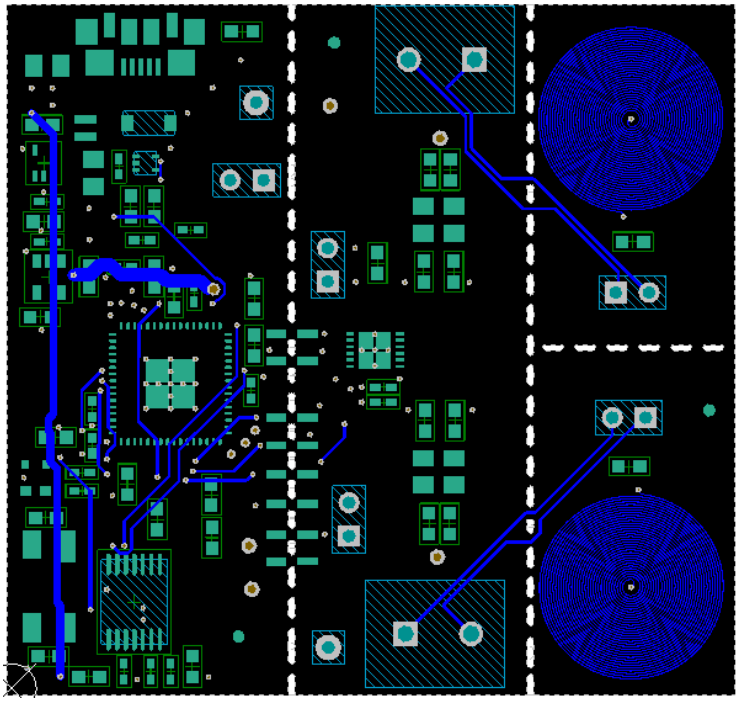


Figure 32. LDC1312/1612 Layout Bottom Layer – Signals Plane

5 LDC1314/1614 EVM Schematics and Layout

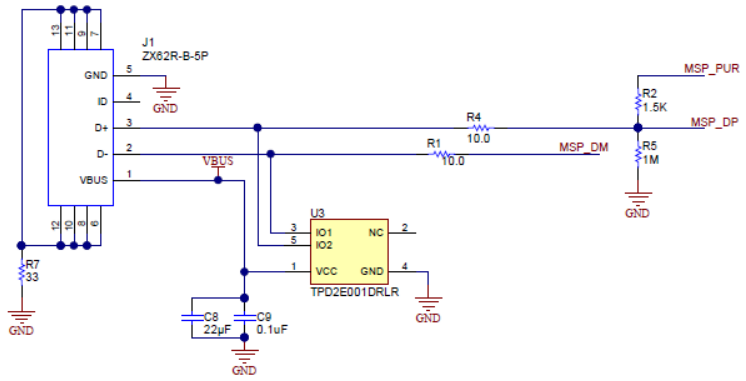


Figure 33. LDC1314/1614 USB Connection

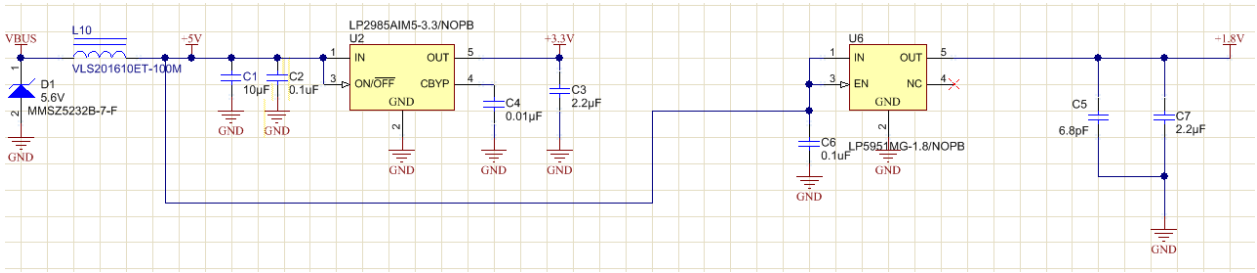


Figure 34. LDC1314/1614 Power Circuit

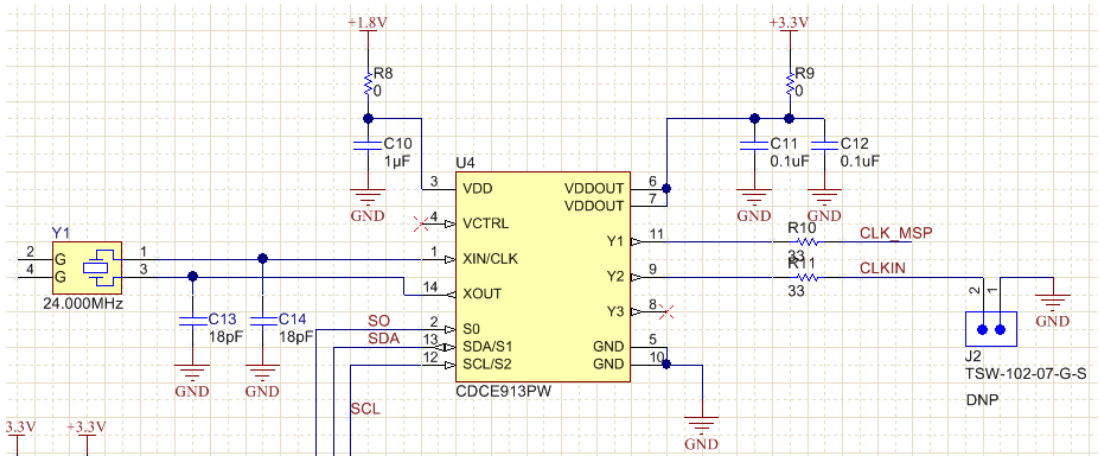


Figure 35. LDC1314/1614 Clocking

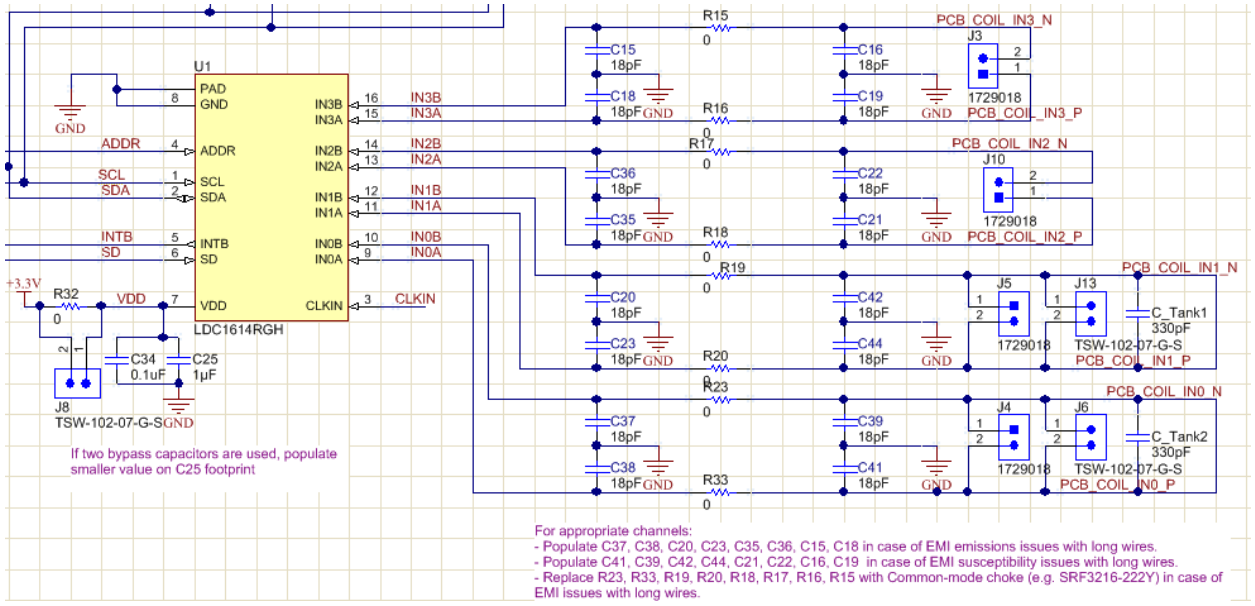


Figure 36. LDC1314/1614

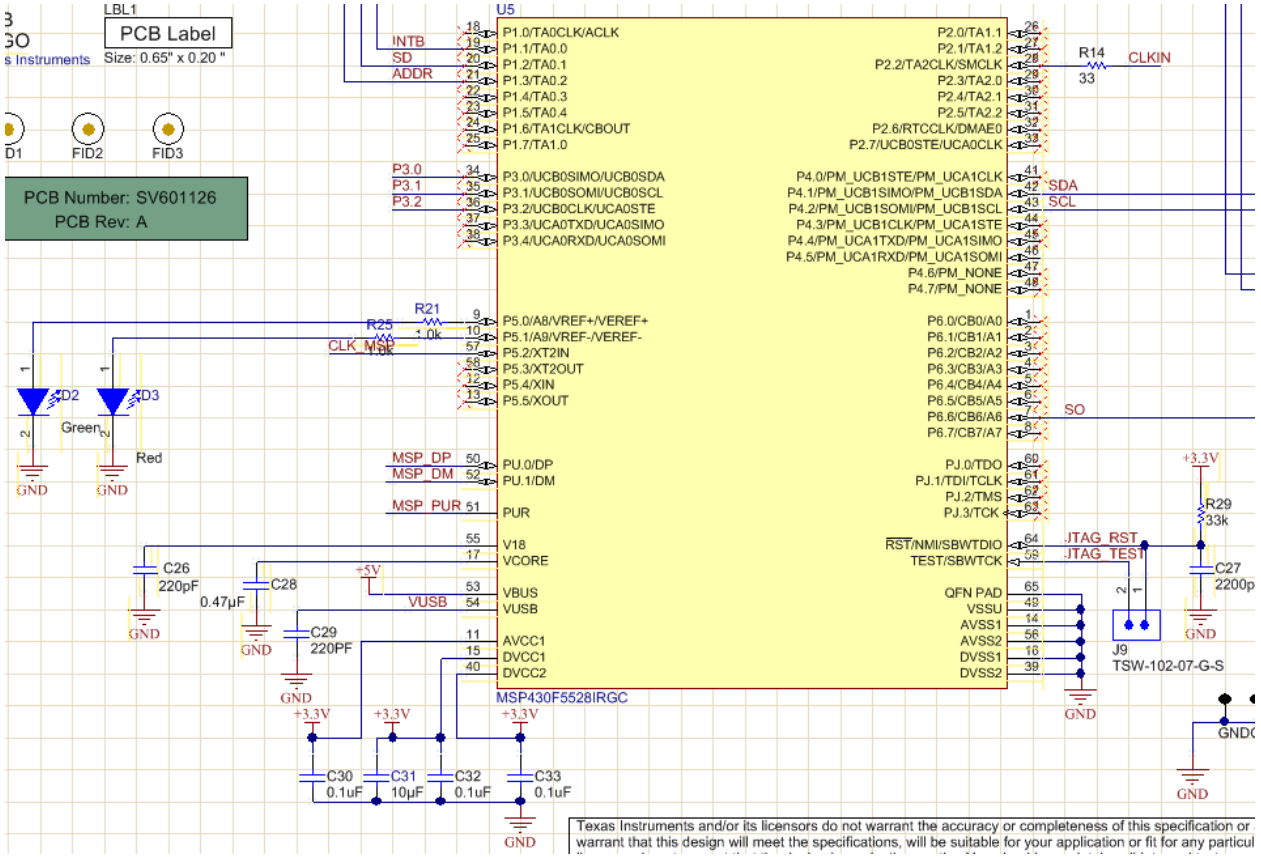


Figure 37. LDC1314/1614 MSP430 Connections

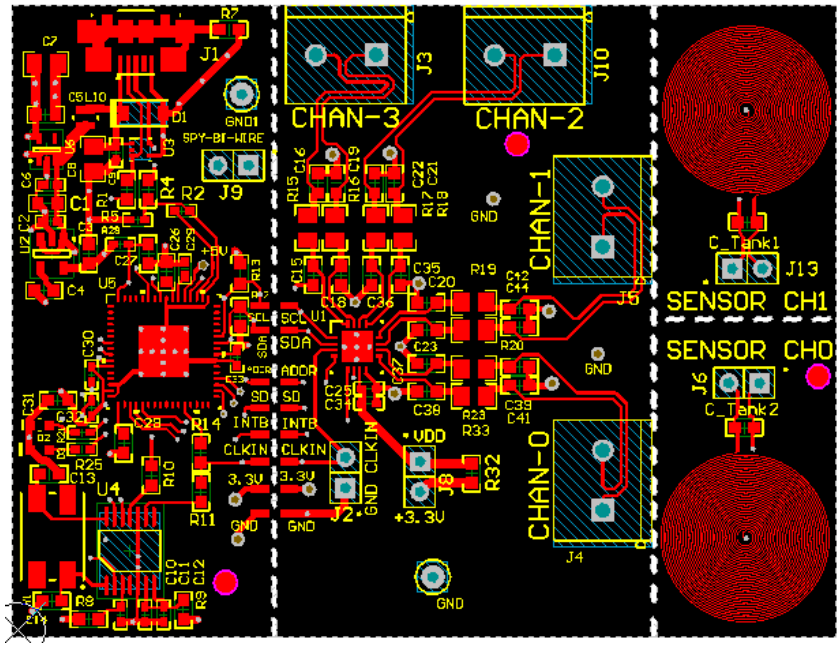


Figure 38. LDC1314/1614 Layout Top Layer – Signals and Components

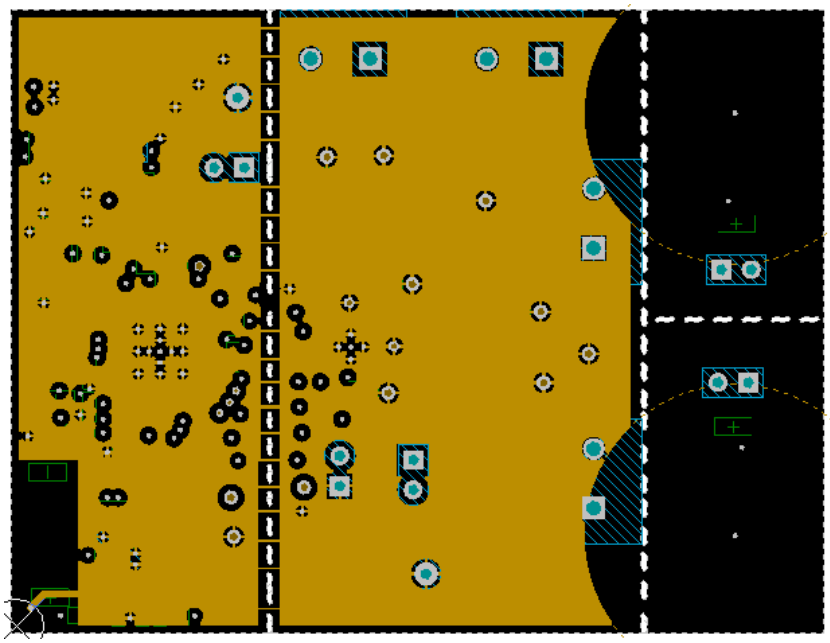


Figure 39. LDC1314/1614 Layout MidLayer 1 – Ground Plane

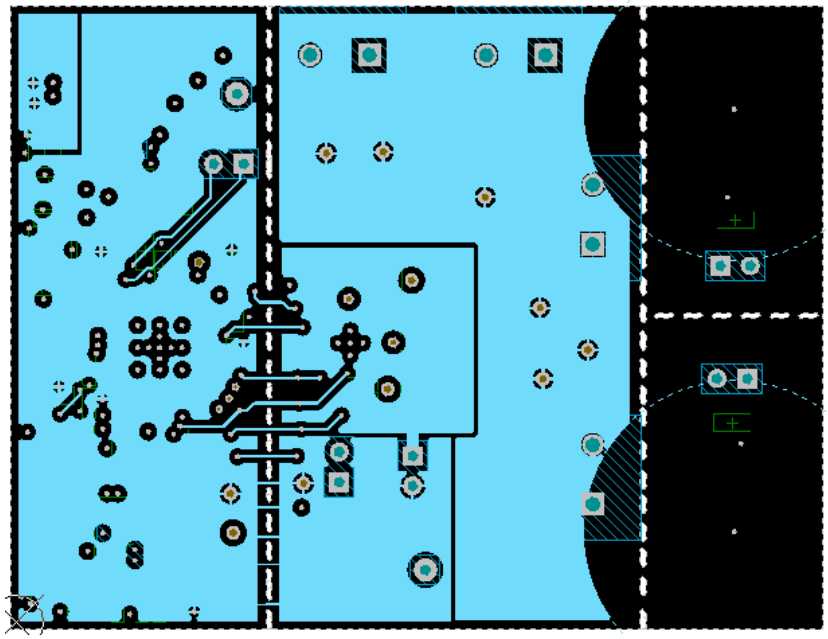


Figure 40. LDC1314/1614 Layout MidLayer 2 – Signals and Power Plane

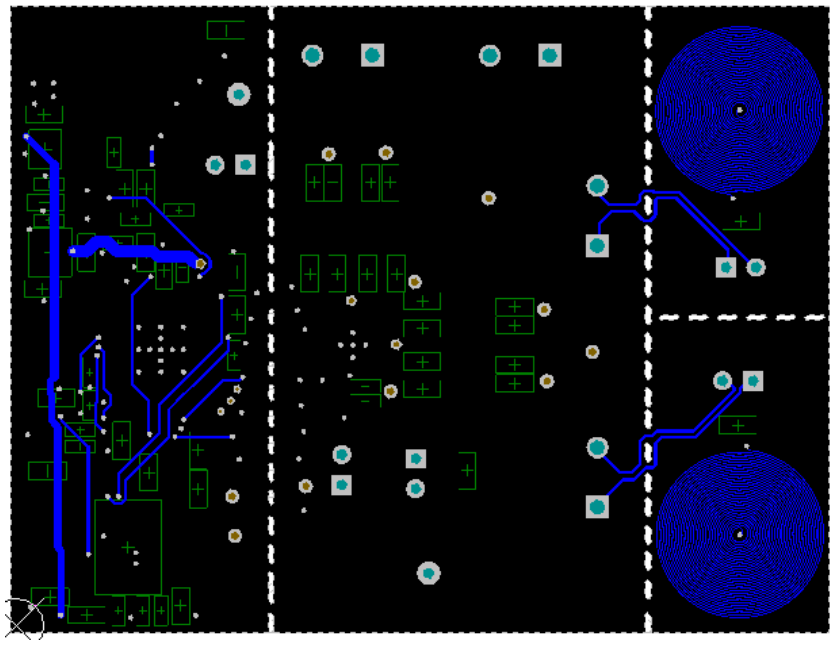


Figure 41. LDC1314/1614 Layout Bottom Layer – Signals Plane

6 Bill of Materials

Table 4. BOM for LDC1312 EVM

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
!PCB1	1		Printed Circuit Board	SV601147	Any
C1, C31	2	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	C1608X5R1A106M	TDK
C2, C6, C9, C11, C12, C30, C32, C33	8	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
C3	1	2.2uF	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0603	C0603C225K8PACTU	Kemet
C4	1	0.01uF	CAP, CERM, 0.01uF, 25V, +/-5%, C0G/NP0, 0603	C1608C0G1E103J	TDK
C5	1	6.8pF	CAP, CERM, 6.8pF, 50V, +/-4%, C0G/NP0, 0603	06035A6R8CAT2A	AVX
C7	1	2.2uF	CAP, CERM, 2.2uF, 16V, +/-10%, X7R, 0805	C0805C225K4RACTU	Kemet
C8	1	22uF	CAP, CERM, 22uF, 16V, +/-10%, X5R, 0805	C2012X5R1C226K125AC	TDK
C10, C25	2	1uF	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0402	GRM155R61A105KE15D	MuRata
C26	1	220pF	CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603	06035A221FAT2A	AVX
C27	1	2200pF	CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603	C0603X222K5RACTU	Kemet
C28	1	0.47uF	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603	C0603C474K8RACTU	Kemet
C29	1	220PF	CAP CER 220PF 50V 1% NP0 0402	C1005C0G1H221F050BA	TDK Corporation
C_Tank 1, C_Tank 2	2	330pF	CAP, CERM, 330pF, 50V, +/-1%, C0G/NP0, 0603	C1608C0G1H331F080AA	TDK
D1	1	5.6V	Diode, Zener, 5.6V, 500mW, SOD-123	MMSZ5232B-7-F	Diodes Inc.
D2	1	Green	LED, Green, SMD	LG L29K-G2J1-24-Z	OSRAM
D3	1	Red	LED, Super Red, SMD	SML-LX0603SRW-TR	Lumex
GND, GND1	2	Black	Test Point, Miniature, Black, TH	5001	Keystone
J1	1		Connector, Receptacle, Micro-USB Type B, SMT	ZX62R-B-5P	Hirose Electric Co. Ltd.
L10	1	10uH	Inductor, Shielded, Ferrite, 10uH, 0.4A, 1.38 Ω, SMD	VLS201610ET-100M	TDK
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R1, R4	2	10.0	RES, 10.0 Ω, 1%, 0.1W, 0603	CRCW060310R0FKEA	Vishay-Dale
R2	1	1.5K	RES 1.5K Ω 1/16W 5% 0402 SMD	CRCW04021K50JNED	Vishay Dale
R5	1	1M	RES,1M Ω, 5%, 0.063W, 0402	RC0402JR-071ML	Yageo
R7, R10, R11	3	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale
R8, R9, R32	3	0	RES, 0 Ω, 5%, 0.1W, 0603	CRCW06030000Z0EA	Vishay-Dale
R12, R13	2	4.70k	RES, 4.70k Ω, 1%, 0.1W, 0603	RC0603FR-074K7L	Yageo America
R19, R20, R23, R33	4	0	RES, 0 Ω, 5%, 0.125W, 0805	CRCW08050000Z0EA	Vishay-Dale
R21, R25	2	1.0k	RES, 1.0k Ω, 5%, 0.063W, 0402	CRCW04021K00JNED	Vishay-Dale

Table 4. BOM for LDC1312 EVM (continued)

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
R29	1	33k	RES, 33k Ω, 5%, 0.063W, 0402	CRCW040233K0JNED	Vishay-Dale
U1	1		Multi-Channel 12-Bit Inductance to Digital Converter with I2C, DNT0012B	LDC1312DNT	Texas Instruments
U2	1		Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator, 5-pin SOT-23, Pb-Free	LP2985AIM5-3.3/NOPB	Texas Instruments
U3	1		Low-Capacitance + / - 15 kV ESD-Protection Array for High-Speed Data Interfaces, 2 Channels, -40 to +85 degC, 5-pin SOT (DRL), Green (RoHS & no Sb/Br)	TPD2E001DRLR	Texas Instruments
U4	1		Programmable 1-PLL VCXO Clock Synthesizer With 1.8-V, 2.5-V, and 3.3-V Outputs, PW0014A	CDCE913PW	Texas Instruments
U5	1		Mixed Signal MicroController, RGC0064B	MSP430F5528IRGC	Texas Instruments
U6	1		Micropower, 150mA Low-Dropout CMOS Voltage Regulator, 5-pin SC-70, Pb-Free	LP5951MG-1.8/NOPB	Texas Instruments
Y1	1		Crystal, 24.000MHz, 18pF, SMD	ABMM-24.000MHZ-B2-T	Abracon Corportation
C13, C14, C20, C23, C37, C38, C39, C41, C42, C44	0	18pF	CAP, CERM, 18pF, 100V, +/-5%, C0G/NP0, 0603	GRM1885C2A180JA01D	MuRata
C34	0	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J2, J6, J8, J9, J13	0		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	Samtec, Inc.
J4, J5	0		TERM BLOCK 2POS 5mm, TH	1729018	Phoenix Contact
R14	0	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale

Table 5. BOM for LDC1612 EVM

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
!PCB1	1		Printed Circuit Board	SV601147	Any
C1, C31	2	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	C1608X5R1A106M	TDK
C2, C6, C9, C11, C12, C30, C32, C33	8	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
C3	1	2.2uF	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0603	C0603C225K8PACTU	Kemet
C4	1	0.01uF	CAP, CERM, 0.01uF, 25V, +/-5%, C0G/NP0, 0603	C1608C0G1E103J	TDK
C5	1	6.8pF	CAP, CERM, 6.8pF, 50V, +/-4%, C0G/NP0, 0603	06035A6R8CAT2A	AVX
C7	1	2.2uF	CAP, CERM, 2.2uF, 16V, +/-10%, X7R, 0805	C0805C225K4RACTU	Kemet
C8	1	22uF	CAP, CERM, 22uF, 16V, +/-10%, X5R, 0805	C2012X5R1C226K125AC	TDK
C10, C25	2	1uF	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0402	GRM155R61A105KE15D	MuRata
C26	1	220pF	CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603	06035A221FAT2A	AVX
C27	1	2200pF	CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603	C0603X222K5RACTU	Kemet
C28	1	0.47uF	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603	C0603C474K8RACTU	Kemet
C29	1	220PF	CAP CER 220PF 50V 1% NP0 0402	C1005C0G1H221F050BA	TDK Corporation
C_Tank 1, C_Tank 2	2	330pF	CAP, CERM, 330pF, 50V, +/-1%, C0G/NP0, 0603	C1608C0G1H331F080AA	TDK
D1	1	5.6V	Diode, Zener, 5.6V, 500mW, SOD-123	MMSZ5232B-7-F	Diodes Inc.
D2	1	Green	LED, Green, SMD	LG L29K-G2J1-24-Z	OSRAM
D3	1	Red	LED, Super Red, SMD	SML-LX0603SRW-TR	Lumex
GND, GND1	2	Black	Test Point, Miniature, Black, TH	5001	Keystone
J1	1		Connector, Receptacle, Micro-USB Type B, SMT	ZX62R-B-5P	Hirose Electric Co. Ltd.
L10	1	10uH	Inductor, Shielded, Ferrite, 10uH, 0.4A, 1.38 Ω, SMD	VLS201610ET-100M	TDK
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R1, R4	2	10.0	RES, 10.0 Ω, 1%, 0.1W, 0603	CRCW060310R0FKEA	Vishay-Dale
R2	1	1.5K	RES 1.5K Ω 1/16W 5% 0402 SMD	CRCW04021K50JNED	Vishay Dale
R5	1	1M	RES,1M Ω, 5%, 0.063W, 0402	RC0402JR-071ML	Yageo
R7, R10, R11	3	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale
R8, R9, R32	3	0	RES, 0 Ω, 5%, 0.1W, 0603	CRCW06030000Z0EA	Vishay-Dale
R12, R13	2	4.70k	RES, 4.70k Ω, 1%, 0.1W, 0603	RC0603FR-074K7L	Yageo America
R19, R20, R23, R33	4	0	RES, 0 Ω, 5%, 0.125W, 0805	CRCW08050000Z0EA	Vishay-Dale
R21, R25	2	1.0k	RES, 1.0k Ω, 5%, 0.063W, 0402	CRCW04021K00JNED	Vishay-Dale
R29	1	33k	RES, 33k Ω, 5%, 0.063W, 0402	CRCW040233K0JNED	Vishay-Dale
U1	1		Multi-Channel 28-Bit Inductance to Digital Converter with I2C, DNT0012B	LDC1612DNT	Texas Instruments

Table 5. BOM for LDC1612 EVM (continued)

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
U2	1		Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator, 5-pin SOT-23, Pb-Free	LP2985AIM5-3.3/NOPB	Texas Instruments
U3	1		Low-Capacitance + / - 15 kV ESD-Protection Array for High-Speed Data Interfaces, 2 Channels, -40 to +85 degC, 5-pin SOT (DRL), Green (RoHS & no Sb/Br)	TPD2E001DRLR	Texas Instruments
U4	1		Programmable 1-PLL VCXO Clock Synthesizer With 1.8-V, 2.5-V, and 3.3-V Outputs, PW0014A	CDCE913PW	Texas Instruments
U5	1		Mixed Signal MicroController, RGC0064B	MSP430F5528IRGC	Texas Instruments
U6	1		Micropower, 150mA Low-Dropout CMOS Voltage Regulator, 5-pin SC-70, Pb-Free	LP5951MG-1.8/NOPB	Texas Instruments
Y1	1		Crystal, 24.000MHz, 18pF, SMD	ABMM-24.000MHZ-B2-T	Abracon Corportation
C13, C14, C20, C23, C37, C38, C39, C41, C42, C44	0	18pF	CAP, CERM, 18pF, 100V, +/-5%, C0G/NP0, 0603	GRM1885C2A180JA01D	MuRata
C34	0	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J2, J6, J8, J9, J13	0		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	Samtec, Inc.
J4, J5	0		TERM BLOCK 2POS 5mm, TH	1729018	Phoenix Contact
R14	0	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale

Table 6. BOM for LDC1314 EVM

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
!PCB1	1		Printed Circuit Board	SV601126	Any
C1, C31	2	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	C1608X5R1A106M	TDK
C2, C6, C9, C11, C12, C30, C32, C33	8	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
C3	1	2.2uF	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0603	C0603C225K8PACTU	Kemet
C4	1	0.01uF	CAP, CERM, 0.01uF, 25V, +/-5%, C0G/NP0, 0603	C1608C0G1E103J	TDK
C5	1	6.8pF	CAP, CERM, 6.8pF, 50V, +/-4%, C0G/NP0, 0603	06035A6R8CAT2A	AVX
C7	1	2.2uF	CAP, CERM, 2.2uF, 16V, +/-10%, X7R, 0805	C0805C225K4RACTU	Kemet
C8	1	22uF	CAP, CERM, 22uF, 16V, +/-10%, X5R, 0805	C2012X5R1C226K125AC	TDK
C10, C25	2	1uF	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0402	GRM155R61A105KE15D	MuRata
C26	1	220pF	CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603	06035A221FAT2A	AVX
C27	1	2200pF	CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603	C0603X222K5RACTU	Kemet
C28	1	0.47uF	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603	C0603C474K8RACTU	Kemet
C29	1	220PF	CAP CER 220PF 50V 1% NP0 0402	C1005C0G1H221F050BA	TDK Corporation
C_Tank 1, C_Tank 2	2	330pF	CAP, CERM, 330pF, 50V, +/-1%, C0G/NP0, 0603	C1608C0G1H331F080AA	TDK
D1	1	5.6V	Diode, Zener, 5.6V, 500mW, SOD-123	MMSZ5232B-7-F	Diodes Inc.
D2	1	Green	LED, Green, SMD	LG L29K-G2J1-24-Z	OSRAM
D3	1	Red	LED, Super Red, SMD	SML-LX0603SRW-TR	Lumex
GND, GND1	2	Black	Test Point, Miniature, Black, TH	5001	Keystone
J1	1		Connector, Receptacle, Micro-USB Type B, SMT	ZX62R-B-5P	Hirose Electric Co. Ltd.
L10	1	10uH	Inductor, Shielded, Ferrite, 10uH, 0.4A, 1.38 Ω, SMD	VLS201610ET-100M	TDK
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R1, R4	2	10.0	RES, 10.0 Ω, 1%, 0.1W, 0603	CRCW060310R0FKEA	Vishay-Dale
R2	1	1.5K	RES 1.5K Ω 1/16W 5% 0402 SMD	CRCW04021K50JNED	Vishay Dale
R5	1	1M	RES,1M Ω, 5%, 0.063W, 0402	RC0402JR-071ML	Yageo
R7, R10, R11	3	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale
R8, R9, R32	3	0	RES, 0 Ω, 5%, 0.1W, 0603	CRCW06030000Z0EA	Vishay-Dale
R12, R13	2	4.70k	RES, 4.70k Ω, 1%, 0.1W, 0603	RC0603FR-074K7L	Yageo America
R15, R16, R17, R18, R19, R20, R23, R33	8	0	RES, 0 Ω, 5%, 0.125W, 0805	CRCW08050000Z0EA	Vishay-Dale

Table 6. BOM for LDC1314 EVM (continued)

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
R21, R25	2	1.0k	RES, 1.0k Ω, 5%, 0.063W, 0402	CRCW04021K00JNED	Vishay-Dale
R29	1	33k	RES, 33k Ω, 5%, 0.063W, 0402	CRCW040233K0JNED	Vishay-Dale
U1	1		Multi-Channel 12-Bit Inductance to Digital Converter with I2C, RGH0016A	LDC1314RGH	Texas Instruments
U2	1		Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator, 5-pin SOT-23, Pb-Free	LP2985AIM5-3.3/NOPB	Texas Instruments
U3	1		Low-Capacitance + / - 15 kV ESD-Protection Array for High-Speed Data Interfaces, 2 Channels, -40 to +85 degC, 5-pin SOT (DRL), Green (RoHS & no Sb/Br)	TPD2E001DRLR	Texas Instruments
U4	1		Programmable 1-PLL VCXO Clock Synthesizer With 1.8-V, 2.5-V, and 3.3-V Outputs, PW0014A	CDCE913PW	Texas Instruments
U5	1		Mixed Signal MicroController, RGC0064B	MSP430F5528IRGC	Texas Instruments
U6	1		Micropower, 150mA Low-Dropout CMOS Voltage Regulator, 5-pin SC-70, Pb-Free	LP5951MG-1.8/NOPB	Texas Instruments
Y1	1		Crystal, 24.000MHz, 18pF, SMD	ABMM-24.000MHZ-B2-T	Abracon Corportation
C13, C14, C15, C16, C18, C19, C20, C21, C22, C23, C35, C36, C37, C38, C39, C41, C42, C44	0	18pF	CAP, CERM, 18pF, 100V, +/-5%, C0G/NP0, 0603	GRM1885C2A180JA01D	MuRata
C34	0	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J2, J6, J8, J9, J13	0		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	Samtec, Inc.
J3, J4, J5, J10	0		TERM BLOCK 2POS 5mm, TH	1729018	Phoenix Contact
R14	0	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale

Table 7. BOM for LDC1614 EVM

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
!PCB1	1		Printed Circuit Board	SV601126	Any
C1, C31	2	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	C1608X5R1A106M	TDK
C2, C6, C9, C11, C12, C30, C32, C33	8	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
C3	1	2.2uF	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0603	C0603C225K8PACTU	Kemet
C4	1	0.01uF	CAP, CERM, 0.01uF, 25V, +/-5%, C0G/NP0, 0603	C1608C0G1E103J	TDK
C5	1	6.8pF	CAP, CERM, 6.8pF, 50V, +/-4%, C0G/NP0, 0603	06035A6R8CAT2A	AVX
C7	1	2.2uF	CAP, CERM, 2.2uF, 16V, +/-10%, X7R, 0805	C0805C225K4RACTU	Kemet
C8	1	22uF	CAP, CERM, 22uF, 16V, +/-10%, X5R, 0805	C2012X5R1C226K125AC	TDK
C10, C25	2	1uF	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0402	GRM155R61A105KE15D	MuRata
C26	1	220pF	CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603	06035A221FAT2A	AVX
C27	1	2200pF	CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603	C0603X222K5RACTU	Kemet
C28	1	0.47uF	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603	C0603C474K8RACTU	Kemet
C29	1	220PF	CAP CER 220PF 50V 1% NP0 0402	C1005C0G1H221F050BA	TDK Corporation
C_Tank 1, C_Tank 2	2	330pF	CAP, CERM, 330pF, 50V, +/-1%, C0G/NP0, 0603	C1608C0G1H331F080AA	TDK
D1	1	5.6V	Diode, Zener, 5.6V, 500mW, SOD-123	MMSZ5232B-7-F	Diodes Inc.
D2	1	Green	LED, Green, SMD	LG L29K-G2J1-24-Z	OSRAM
D3	1	Red	LED, Super Red, SMD	SML-LX0603SRW-TR	Lumex
GND, GND1	2	Black	Test Point, Miniature, Black, TH	5001	Keystone
J1	1		Connector, Receptacle, Micro-USB Type B, SMT	ZX62R-B-5P	Hirose Electric Co. Ltd.
L10	1	10uH	Inductor, Shielded, Ferrite, 10uH, 0.4A, 1.38 Ω, SMD	VLS201610ET-100M	TDK
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R1, R4	2	10.0	RES, 10.0 Ω, 1%, 0.1W, 0603	CRCW060310R0FKEA	Vishay-Dale
R2	1	1.5K	RES 1.5K Ω 1/16W 5% 0402 SMD	CRCW04021K50JNED	Vishay Dale
R5	1	1M	RES,1M Ω, 5%, 0.063W, 0402	RC0402JR-071ML	Yageo
R7, R10, R11	3	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale
R8, R9, R32	3	0	RES, 0 Ω, 5%, 0.1W, 0603	CRCW06030000Z0EA	Vishay-Dale
R12, R13	2	4.70k	RES, 4.70k Ω, 1%, 0.1W, 0603	RC0603FR-074K7L	Yageo America
R15, R16, R17, R18, R19, R20, R23, R33	8	0	RES, 0 Ω, 5%, 0.125W, 0805	CRCW08050000Z0EA	Vishay-Dale

Table 7. BOM for LDC1614 EVM (continued)

DESIG-NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
R21, R25	2	1.0k	RES, 1.0k Ω, 5%, 0.063W, 0402	CRCW04021K00JNED	Vishay-Dale
R29	1	33k	RES, 33k Ω, 5%, 0.063W, 0402	CRCW040233K0JNED	Vishay-Dale
U1	1		Multi-Channel 28-Bit Inductance to Digital Converter with I2C, RGH0016A	LDC1614RGH	Texas Instruments
U2	1		Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator, 5-pin SOT-23, Pb-Free	LP2985AIM5-3.3/NOPB	Texas Instruments
U3	1		Low-Capacitance + / - 15 kV ESD-Protection Array for High-Speed Data Interfaces, 2 Channels, -40 to +85 degC, 5-pin SOT (DRL), Green (RoHS & no Sb/Br)	TPD2E001DRLR	Texas Instruments
U4	1		Programmable 1-PLL VCXO Clock Synthesizer With 1.8-V, 2.5-V, and 3.3-V Outputs, PW0014A	CDCE913PW	Texas Instruments
U5	1		Mixed Signal MicroController, RGC0064B	MSP430F5528IRGC	Texas Instruments
U6	1		Micropower, 150mA Low-Dropout CMOS Voltage Regulator, 5-pin SC-70, Pb-Free	LP5951MG-1.8/NOPB	Texas Instruments
Y1	1		Crystal, 24.000MHz, 18pF, SMD	ABMM-24.000MHZ-B2-T	Abracon Corportation
C13, C14, C15, C16, C18, C19, C20, C21, C22, C23, C35, C36, C37, C38, C39, C41, C42, C44	0	18pF	CAP, CERM, 18pF, 100V, +/-5%, C0G/NP0, 0603	GRM1885C2A180JA01D	MuRata
C34	0	0.1uF	CAP CER 0.1UF 16V 5% X7R 0402	GRM155R71C104JA88D	Murata Electronics North America
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J2, J6, J8, J9, J13	0		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	Samtec, Inc.
J3, J4, J5, J10	0		TERM BLOCK 2POS 5mm, TH	1729018	Phoenix Contact
R14	0	33	RES, 33 Ω, 5%, 0.1W, 0603	CRCW060333R0JNEA	Vishay-Dale

Revision History

DATE	REVISION	NOTES
December 2014	*	Initial release.

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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