# LDC2114 Evaluation Module for Inductive Touch Applications

# **User's Guide**



Literature Number: SNOU144 December 2016



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5



# LDC2114 Evaluation Module for Inductive Touch Inductance to Digital Converter

### 1 Overview

The LDC2114 EVM demonstrates the use of inductive sensing technology to sense and measure the presence or position of conductive target objects, and to detect the press of an inductive touch button. The LDC is controlled by an MSP430, which interfaces to a host computer.

The LDC2112 is the two-channel version of the LDC2114. The LDC2112 does not have a dedicated EVM. Instead, the four-channel LDC2114 EVM should be used to evaluate the technology and performance.

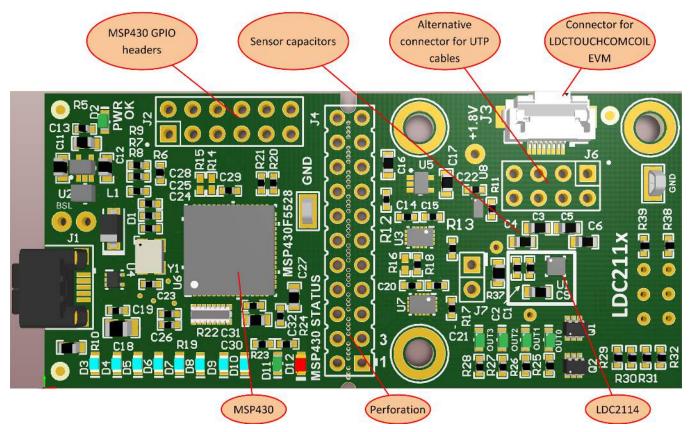


Figure 1. LDC2114 Evaluation Module

PCB perforations allow removal of the microcontroller, so that a different microcontroller can be connected.

This user guide covers the following EVMs:

### Table 1. List of Evaluation modules

EVM name	EVM revision	Device under test
LDC2114EVM	A	LDC2114 WCSP

6 LDC2114 Evaluation Module for Inductive Touch Inductance to Digital Converter

SNOU144–December 2016 Submit Documentation Feedback



#### 2 **Compatible Sensor EVM**

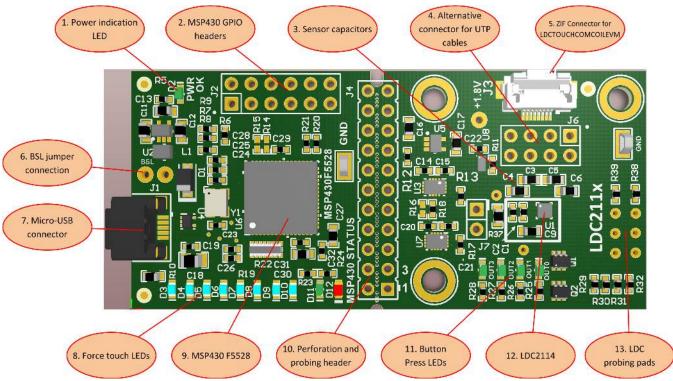
The EVM does not include any example sensors, but can easily be connected to sensors by using either the ZIF connector or soldering wires to the header pins on the PCB. The LDC2114 EVM is compatible with the LDCCOILEVM, which is available on the TI estore and contains 19 different sensor designs. Connect sensors from the LDCCOILEVM with unshielded twisted pair wires to J6 of the LDC2114 EVM.

Table 2 shows the connection options for each coil type.

### **Table 2. Connection options**

LDCTOUCHCOMCOILEVM coil type	Connect to
A	J3 ZIF connector using flat ribbon cable
В	J3 ZIF connector using flat ribbon cable
C	J3 ZIF connector using flat ribbon cable
D	J3 ZIF connector using flat ribbon cable
E	J6 2.54mm header using unshielded twisted pair wires

NOTE: When connecting the coil board to the EVM, it is recommended to attach the assembly to a static object using tape or screws. This will prevent the cables from moving and potentially changing the output code reading or reporting false triggers.



Main EVM elements

3

Figure 2. Main EVM elements

NOTE: Schematics, Layout, and Coil characteristics of the LDCCOILEVM are described in the LDCCOILEVM user guide.

The EVM has the following features, as shown in Figure 2:

- 1. Power indication LED: this LED shows that the PCB is powered through the USB cable
- 2. MSP430 GPIO headers: This is a multi-purpose GPIO header which facilitates connection with a second I2C interface, JTAG, UART, and three additional GPIOs. It also contains 5V, 3.3V, and GND rails. These pins could be used for example to connect a haptics driver or an audio amplifier. Note that functionality pof these pins is not implemented in the default EVM firmware.
- 3. Sensor capacitors: These are the sensor capacitors of the LDC2114. Replace them with suitable values if appropriate.
- 4. Alternative connection for UTP cables: Custom sensors can be connected to these header connections. Unshielded twisted pair (UTP) wires are the preferred wire choice for the sensor.
- 5. ZIF connector for LDCTOUCHCOMCOILEVM: Sensors of this PCB can be connected easily by connecting the supplied flat ribbon cable.
- 6. BSL jumper connection: If firmware upgrade is unsuccessful, put the MSP430 into bootstrap loader mode by shorting these two pins while powering up the EVM.
- 7. Micro-USB connector: connect to the PC using a micro-USB cable
- 8. Force touch LEDs: these eight LEDs show the intensity of the button press. They default firmware chooses the channel with the strongest button push to indicate intensity.
- 9. MSP430 F5528: This microcontroller is used to configure the LDC2114, facilitate data streaming to the GUI, and to show the intensity of the button press.
- Perforation and probing header: These pads can be used for probing any signals between the MSP430 and the LDC2114. It can be populated with a standard 2x11 pin 2.54mm header for ease of access. It is also possible to break the LDC along the perforation and attach a different microcontroller to these pins. The signals of the header are: [1-2]: OUT3, [3-4]: OUT2, [5-6]: OUT1, [7-8]: OUT0, [9-10]: INTB, [11-12]: LPWRB, [13-14]: SDA, [15-16]: SCL, [17-18]: GND, [19-20]: +3.3V, [21-22]: GND. Note that the signals on this header are referenced to the Microcontroller VIO voltage (3.3V).
- 11. Button Press LEDs: These LEDs indicate which button has been pressed. Note that the MAXWIN function is not enabled by default, so multiple buttons can be pressed simultaneously, and therefore multiple LEDs may light up.
- 12. LDC2114: The LDC2114 Inductive Touch Inductance-to-Digital Converter for Consumer and Low-Power Applications
- 13. LDC probing pads: These probing points use the level-shifted (1.8V referenced) signals of SDA, SCL, OUT0, OUT1, OUT2, and OUT3

### 4 Sensing Solutions EVM GUI

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

### 4.1 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



### 4.2 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 latest version of the Sensing Solutions EVM GUI from EVM tool page.

**NOTE:** The minimum Sensing Solutions GUI revision for this EVM is 1.9.1. The latest GUI can be downloaded here.

- 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.

😗 User	Account	Control	X
2		u want to allow es to this comp	the following program to make uter?
		Program name: Verified publisher: File origin:	SensingSolutionsGUI-1.8.8-windows-instal Texas Instruments, Inc. Hard drive on this computer
🕑 Sł	now <u>d</u> etai	ls	Yes No
			Change when these notifications appear

Figure 3. User Account Control Prompt

5. After the setup wizard starts, click Next.

9



Setup	
	Setup - Sensing Solutions EVM GUI
	Welcome to the Sensing Solutions EVM GUI Setup Wizard.
	< Back Next > Cancel

Figure 4. Software Installer Wizard

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

🚱 Setup		
License Agreement		
Please read the following L agreement before continui	icense Agreement. You must accept the terms of this ng with the installation.	
Source and Binary Cod	e Internal Use License Agreement	
WHICH IS LEGALLY BIND WHETHER YOU ACCEPT AN READ AND AGREE UNLESS	이는 사람이 나는 것이야지 않는 것을 많이 있는 것이 없는 것이 같이 많이 있는 것이 많이 많이 많이 많이 많이 없다. 것이 많이	
Do you accept this license?	<ul> <li>I accept the agreement</li> <li>I do not accept the agreement</li> </ul>	
BitRock Installer		
	< Back Next > Cancel	

Figure 5. Software Installer License Agreement



7. Use the preselected installation directory and click Next.

[ Setup			X
Installation Directory		=	
Please specify the directo	ory where Sensing Solutions EVM GUI will I	be installed.	
Installation Directory	:\ti\Sensing Solutions EVM GUI-1.9.1	<b>**</b>	
stallBuilder			
	< Back	Vext > Canc	el

Figure 6. Software Installation Directory

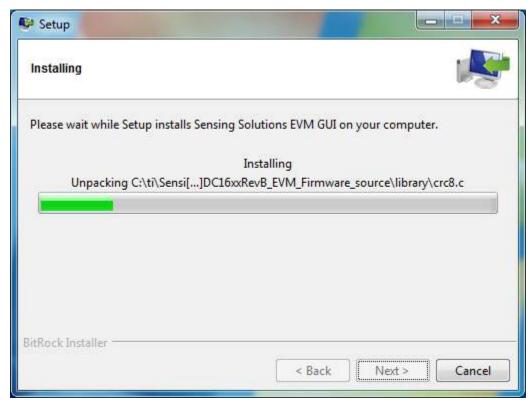
8. Start the installation by clicking Next.



# Setup		
Ready to Install		
Setup is now ready to begin	installing Sensing Solutions EV	/M GUI on your computer.
tRock Installer		
	< Back	Next > Cancel

Figure 7. Software Installer Ready

9. Wait for the installation to complete.



### Figure 8. Software Installer in Progress

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



Figure 9. Device Driver Installer Wizard

11. Wait for the driver installation to complete.



The drivers are now installing	
Please wait while the dri	ivers install. This may take some time to complete.

Figure 10. Device Driver Installer in Progress

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





Figure 11. Device Driver Installer Completed

13. Click *Finish* to complete the installation.

Setup	
	Completing the Sensing Solutions EVM GUI Setup Wizard
	Setup has finished installing Sensing Solutions EVM GUI on your computer.
	< Back Finish Cancel

### Figure 12. Software Installer Completed



### Sensing Solutions EVM GUI

### 4.3 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 GU.
- 5. Click Sensing Solutions EVM GU.
- 6. The splash screen will appear for at least two seconds.

Server OneUI: Server	
	Sensing Solutions
	EVM GUI Tool
	TEXAS INSTRUMENTS
	Copyright 2015. Texas Instruments Incorporated. All rights reserved.

### Figure 13. Splash Screen

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



<b>5</b> 0	neUI Application	x
	MENU Sensing Solutions EVM GUI v1.9.1	
	Introduction to Inductive Sensing	1
	Inductive sensing is a highly reliable solution for detecting the position of conductive materials using a simple wire wound coil, PCB coil, or spring. By configuring the coil and target shape, inductive sensing can be applied to many different applications that require proximity measurement, rotational and linear position sensing, as well as simple event counting.	
	Overall reliability is improved and system cost is reduced with the integration of multiple channels making this an attractive solution for metal buttons, motor position, bill counting, lens position, and many other applications.	
	Introduction to Capacitive Sensing	
	Capacitive sensing is a high-resolution, low-cost contactless sensing technique that can be applied to a variety of applications such as liquid level sensing, proximity sensing, gesture recognition, ice/rain detection and collision avoidance.	
	The sensor in a capacitive sensing system is any conductor, such as copper on PCB, conductive ink or a piece of metal, allowing for low cost and highly flexible system design. This conductor acts as a proximity sensor or liquid level sensor depending on the use case.	
	Introduction to Humidity Sensing	
	Humidity affects many properties of air, and of materials in contact with air. Water vapor is a key agent in both weather and climate, and it is an important atmospheric greenhouse gas. Humidity measurements are used wherever there is a need to prevent condensation, corrosion, mold, warping or other spoilage of products. This is highly relevant for foods, pharmaceuticals, chemicals, fuels, wood, paper, and many other products. Air-conditioning systems in buildings often control humidity, and significant energy goes into cooling the air to remove water vapor. Humidity measurements are necessary to maintain comfortable environmental conditions. An accurate humidity sensor can work in synergy with heating and cooling systems to reduce a building energy footprint.	
	Benefits of TI technology and the FDC2x14 and FDC2x12 Families	÷
0	Connected SSP EVM connected - LDC2114	TS

Figure 14. Introduction Page

### 4.4 Navigating the GUI

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

1. Click Menu in the upper left corner.



### Sensing Solutions EVM GUI

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See OneUI Application	×
MENU Sensing Solutions EVM GUI v1.8.8	
Introduction to Inductive Sensing	Â
Inductive sensing is a highly reliable solution for detecting the position of conductive materials using a simple wire wound coil, PCB coil, or spring. By configuring the coil and target shape, inductive sensing can be applied to many different applications that require proximity measurement, rotational and linear position sensing, as well as simple event counting.	
Overall reliability is improved and system cost is reduced with the integration of multiple channels making this an attractive solution for metal buttons, motor position, bill counting, lens position, and many other applications.	
Introduction to Capacitive Sensing	
Capacitive sensing is a high-resolution, low-cost contactless sensing technique that can be applied to a variety of applications such as liquid level sensing, proximity sensing, gesture recognition, lee/rain detection and collision avoidance.	
The sensor in a capacitive sensing system is any conductor, such as copper on PCB, conductive ink or a piece of metal, allowing for low cost and highly flexible system design. This conductor acts as a proximity sensor or liquid level sensor depending on the use case.	
Introduction to Humidity Sensing	
Humidity affects many properties of air, and of materials in contact with air. Water vapor is a key agent in both weather and climate, and it is an important atmospheric greenhouse gas. Humidity measurements are used wherever there is a need to prevent condensation, corrosion, mold, warping or other spoilage of products. This is highly relevant for foods, pharmaceuticals, chemicals, fuels, wood, paper, and many other products. Air-conditioning systems in buildings often control humidity, and significant energy goes into cooling the air to remove water vapor. Humidity measurements are necessary to maintain comfortable environmental conditions. An accurate humidity sensor can work in synergy with heating and cooling systems to reduce a building energy forbrint.	
Benefits of TI technology and the FDC2x14 and FDC2x12 Families	
Not connected SSP EVM disconnected	s

### Figure 15. Mouse Hovered Over Menu Button

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

CneUI Application	
	Sensing Solutions EVM GUI v1.8.8
Introduction	ing
Device	ble solution for detecting the position of conductive materials using a simple wire wound coil, PCB coil, or spring. By configuring the coil and target shape, inductive different applications that require proximity measurement, rotational and linear position sensing, as well as simple event counting.
EVM	system cost is reduced with the integration of multiple channels making this an attractive solution for metal buttons, motor position, bill counting, lens position, and
Configuration	nsing
🗠 Data Streaming	lution, low-cost contactless sensing technique that can be applied to a variety of applications such as liquid level sensing, proximity sensing, gesture recognition, oidance.
<b>1</b> Firmware	ig system is any conductor, such as copper on PCB, conductive ink or a piece of metal, allowing for low cost and highly flexible system design. This conductor acts as sensor depending on the use case.
	ing
	of air, and of materials in contact with air. Water vapor is a key agent in both weather and climate, and it is an important atmospheric greenhouse gas. Humidity er there is a need to prevent condensation, corrosion, mold, warping or other spoilage of products. This is highly relevant for foods, pharmaceuticals, chemicals, her products. Air-conditioning systems in buildings often control humidity, and significant energy goes into cooling the air to remove water vapor. Humidity maintain comfortable environmental conditions. An accurate humidity sensor can work in synergy with heating and cooling systems to reduce a building energy
	the FDC2x14 and FDC2x12 Families
Not connected SSP EVM	disconnected V TEXAS INSTRUMENTS

### Figure 16. Menu Display After Clicking Button

### 4.5 Connecting the EVM

Follow these steps to connect the EVM to the GUI:

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

UI Application		00
MENU	Sensing Solutions EVM GUI	v1.9.1
Introduction to Inductive S	iensing	
	reliable solution for detecting the position of conductive materials using a simple wire wound coil, PCB coil, or spring. By configuring the coil and target shap iny different applications that require proximity measurement, rotational and linear position sensing, as well as simple event counting.	e, inductive
Overall reliability is improved many other applications.	and system cost is reduced with the integration of multiple channels making this an attractive solution for metal buttons, motor position, bill counting, lens p	osition, and
Introduction to Capacitive	Sensing	
Capacitive sensing is a high- ce/rain detection and collisio	resolution, low-cost contactless sensing technique that can be applied to a variety of applications such as liquid level sensing, proximity sensing, gesture rec n avoidance.	ognition,
	nsing system is any conductor, such as copper on PCB, conductive ink or a piece of metal, allowing for low cost and highly flexible system design. This con vel sensor depending on the use case.	ductor acts as
introduction to Humidity S	ensing	
measurements are used whe fuels, wood, paper, and man	ties of air, and of materials in contact with air. Water vapor is a key agent in both weather and climate, and it is an important atmospheric greenhouse gas. rever there is a need to prevent condensation, corrosion, mold, warping or other spoilage of products. This is highly relevant for foods, pharmaceuticals, ch y other products. Air-conditioning systems in buildings often control humidity, and significant energy goes into cooling the air to remove water vapor. Humidi y to maintain comfortable environmental conditions. An accurate humidity sensor can work in synergy with heating and cooling systems to reduce a building	nemicals, ity
3enefits of TI technology	and the FDC2x14 and FDC2x12 Families	
onnected SSP EVM	connected - LDC2114	NSTRUMEN

Figure 17. EVM Connected to GUI

### 4.6 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 current register values on the device.

### 4.6.1 Automatically Update GUI Register Values Using Auto Read

Auto read will periodically request the register values on the device. Click the drop down box next to *Auto Read* to select the update interval.



MENU Sensin	ng Solutions EVM GUI									v1.9.1
egisters										
Auto Read Every 1/4 sec  Off Every 1/4 sec										
	ate Mode: Immediate 🔻									
Register Every 5 sec	Address	Current Value				E	Bits			
Every 10 sec			7	6	5	4	3	2	1	0
STATUS Every 20 sec	0x00	0x40	0	1	0	0	0	0	0	0
тис	0x01	0x0	0	0	0	0	0	0	0	0
DATA0_LSB	0x02	0xff	1	1	1	1	1	1	1	1
DATA0_MSB	0x03	0x0f	0	0	0	0	1	1	1	1
DATA1_LSB	0x04	Oxff	1	1	1	1	1	1	1	1
DATA1_MSB	0x05	0x0f	0	0	0	0	1	1	1	1
DATA2_LSB	0x06	0xff	1	1	1	1	1	1	1	1
DATA2_MSB	0x07	0x0f	0	0	0	0	1	1	1	1
DATA3_LSB	0x08	0xfe	1	1	1	1	1	1	1	0
DATA3_MSB	0x09	0x0f	0	0	0	0	1	1	1	1
RESET	0x0A	0x00	0	0	0	0	0	0	0	0
	0x0C	0x0f	0	0	0	0	1	1	1	1

Figure 18. Selecting Auto Read Interval on Register Page

#### 4.6.2 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.

### Sensing Solutions EVM GUI

MENU	Sensing Solutions EVM								1	/1.9.1
DATA1_LSB	0x04	0x00	0	0	0	0	0	0	0	0
DATA1_MSB	0x05	0x00	0	0	0	0	0	0	0	0
DATA2_LSB	0x06	Oxff	1	1	1	1	1	1	1	1
DATA2_MSB	0x07	0x0f	0	0	0	0	1	1	1	1
DATA3_LSB	0x08	Oxff	1	1	1	1	1	1	1	1
DATA3_MSB	0x09	0x0f	0	0	0	0	1	1	1	1
RESET	0x0A	0x00	0	0	0	0	0	0	0	0
EN	0x0C	0x0f	0	0	0	0	1	1	1	1
NP_SCAN_RATE	0x0D	0x01	0	0	0	0	0	0	0	1
GAIND	0x0E	0x1e	0	0	0	1	1	1	1	0
LP_SCAN_RATE	0x0F	0x02	0	0	0	0	0	0	1	0
GAIN1	0x10	0x1e	0	0	0	1	1	1	1	0
INTPOL	0x11	0x01	0	0	0	0	0	0	0	1
GAIN2	0x12	0x1e	0	0	0	1	1	1	1	0
LP_BASE_INC	0x13	0x04	0	0	0	0	0	1	0	0
GAIN3	0x14	0x1e	0	0	0	1	1	1	1	0
NP_BASE_INC	0x15	0x04	0	0	0	0	0	1	0	0
MAXWIN	0x16	0x01	0	0	0	0	0	0	0	0
LC_DIVIDER	0x17	0x01	0	0	0	0	0	0	0	1
HYST	0x18	0x0d	0	0	0	0	1	1	0	1
TM/IST	0x19	0×00	0	0	0	0	0	0	0	RUMEN

### Figure 19. Selecting a Register's Current Value for Editing 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.



### Sensing Solutions EVM GUI

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										v1.9.1
MENU Sensing Solut	tions EVM GUI	0,00	0		-		9	9		V1.9.1
DATA1_LSB	0x04	0x00	0	0	0	0	0	0	0	0
DATA1_MSB	0x05	0x00	0	0	0	0	0	0	0	0
DATA2_LSB	0x06	0x00	0	0	0	0	0	0	0	0
DATA2_MSB	0x07	0x00	0	0	0	0	0	0	0	0
DATA3_LSB	0x08	0x00	0	0	0	0	0	0	0	0
DATA3_MSB	0x09	0x00	0	0	0	0	0	0	0	0
RESET	0x0A	0x00	0	0	0	0	0	0	0	0
EN	0x0C	0x0f	0	0	0	0	1	1	1	1
NP_SCAN_RATE	0x0D	0x01	0	0	0	0	0	0	0	1
GAIN0	0x0E	0x1e	0	0	0	1	1	1	1	0
LP_SCAN_RATE	0x0F	0x02	0	0	0	0	0	0	1	0
GAIN1	0x10	0x1e	0	0	0	1	1	1	1	0
INTPOL	0x11	0x01	0	0	0	0	0	0	0	1
GAIN2	0x12	0x1e	0	0	0	1	1	1	1	0
LP_BASE_INC	0x13	0x04	0	0	0	0	0	1	0	0
GAIN3	0x14	0x1e	0	0	0	1	1	1	1	0
NP_BASE_INC	0x15	0x04	0	0	0	0	0	1	0	0
MAXWIN	0x16	0x00	0	0	0	0	0	0	0	0
LC_DIVIDER	0x17	0x01	0	0	0	0	0	0	0	1
HYST	0x18	0x0d	0	0	0	0	1	1	0	1
TWIST	0v19	0×00	٥	0	0	0	0	0	0	TRUMEN

### Figure 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.

#### 4.6.3 **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.



MENU Sen	sing Solutions EVM GUI									v1.9.1
egisters										
Auto Read Off	<u>*</u>									
	Ipdate Mode: Immediate	Current Value					liits		_	_
cyloter	Address	Gunenit value	7	6	5	4	3	2	1	0
STATUS	0x00	0x40	0	1	0	0	0	0	0	0
OUT	0x01	0x00	0	0	0	0	0	0	0	0
DATA0_LSB	0x02	0x00	0	0	0	0	0	0	0	0
DATA0_MSB	0x03	0x00	0	0	0	0	0	0	0	0
DATA1_LSB	0x04	0x00	0	0	0	0	0	0	0	0
DATA1_MSB	0x05	0x00	0	0	0	0	0	0	0	0
DATA2_LSB	0x06	0x00	0	0	0	0	0	0	0	0
DATA2_MSB	0x07	0x00	0	0	0	0	0	0	0	0
DATA3_LSB	0x08	0x00	0	0	0	0	0	0	0	0
DATA3_MSB	0x09	0x00	0	0	0	0	0	0	0	0
RESET	0x0A	0x00	0	0	0	0	0	0	0	0
		0x0f	0	0	0	0	1			

Figure 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.

MENU Sen	ising Solutions EVM GUI									v1.9.1			
egisters													
	± Update Mode: Immediate ▼												
Register	Address	Current Value	Bits										
			7	6	5	4	3	2	1	0			
STATUS	0x00	0x40	0	1	0	0	0	0	0	0			
OUT	0x01	0x00	0	0	0	0	0	0	0	0			
DATA0_LSB	0x02	Oxac	1	0	1	0	1	1	0	0			
DATA0_MSB	0x03	0x00	0	0	0	0	0	0	0	0			
DATA1_LSB	0x04	0x00	0	0	0	0	0	0	0	0			
DATA1_MSB	0x05	0x00	0	0	0	0	0	0	0	0			
DATA2_LSB	0x06	0x00	0	0	0	0	0	0	0	0			
DATA2_MSB	0x07	0x00	0	0	0	0	0	0	0	0			
DATA3_LSB	0x08	0x00	0	0	0	0	0	0	0	0			
DATA3_MSB	0x09	0x00	0	0	0	0	0	0	0	0			
RESET	0x0A	0x00	0	0	0	0	0	0	0	0			
	0x0C	0x0f	0	0	0	0	1	1	1	1			

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

Converter

### 4.6.4 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 drop down.

MENU Sen	sing Solutions EVM GUI									v1.9.1			
egisters													
	2 Jpdate Mode: Immediate V												
Register	Address	Current Value	Bits										
			7	6	5	4	3	2	1	0			
STATUS	0x00	0x40	0	1	0	0	0	0	0	0			
OUT	0x01	0x00	0	0	0	0	0	0	0	0			
DATA0_LSB	0x02	Oxac	1	0	1	0	1	1	0	0			
DATA0_MSB	0x03	0x00	0	0	0	0	0	0	0	0			
DATA1_LSB	0x04	0x00	0	0	0	0	0	0	0	0			
DATA1_MSB	0x05	0x00	0	0	0	0	0	0	0	0			
DATA2_LSB	0x06	0×00	0	0	0	0	0	0	0	0			
DATA2_MSB	0x07	0x00	0	0	0	0	0	0	0	0			
DATA3_LSB	0x08	0x00	0	0	0	0	0	0	0	0			
DATA3_MSB	0x09	0x00	0	0	0	0	0	0	0	0			
	0x0A	0x00	0	0	0	0	0	0	0	0			
RESET					0								

### Figure 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.

### 4.6.5 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 drop down.



MENU Sens	sing Solutions EVM GUI									v1.9.1
egisters										
Auto Read Off •	2									
Write Register     Kead Register U Register	pdate Mode: Immediate  Address	Current Value				E	lits			
			7	6	5	4	3	2	1	0
STATUS	0x00	0x40	0	1	0	0	0	0	0	0
OUT	0x01	0x00	0	0	0	0	0	0	0	0
DATA0_LSB	0x02	Oxac	1	0	1	0	1	1	0	0
DATA0_MSB	0x03	0x00	0	0	0	0	0	0	0	0
DATA1_LSB	0x04	0x00	0	0	0	0	0	0	0	0
DATA1_MSB	0x05	0x00	0	0	0	0	0	0	0	0
DATA2_LSB	0x06	0x00	0	0	0	0	0	0	0	0
DATA2_MSB	0x07	0x00	0	0	0	0	0	0	0	0
DATA3_LSB	0x08	0x00	0	0	0	0	0	0	0	0
DATA3_MSB	0x09	0x00	0	0	0	0	0	0	0	0
RESET	0x0A	0x00	0	0	0	0	0	0	0	0
NEOE 1			0	0	0	0	1	1		1

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

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

### 4.7 Configuring the EVM Using the Configuration Page

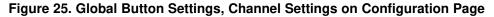
The Sensing Solutions GUI is capable to configure the device in a more intuitive way than through the direct register values. The *Configuration* page provides an easy-to-use tool for updating the device configuration and provides additional information about how the device will perform.

### 4.7.1 Changing registers through the Configuration Pane

The device configuration must only be changed while STATE\_RESET=b1. This mode can be entered while selecting the appropriate option in the *Reset Mode* section of the *Global Buttons Settings*. After changing the configuration, the *Reset Mode* must be changed back to *Active processing*, as shown in Figure 25.



Reset Mo	ode	Normal	Power Mode	Scan Rate	low P	ower Mode Scan Ra	e Inte	errupt Po	larity Bas	Base-tracking Increment		
Active proc	cessing	<ul> <li>80 sps</li> <li>40 sps</li> <li>20 sps</li> <li>10 sps</li> </ul>		Countato	<ul> <li>5 sps</li> <li>2.5 sps</li> <li>1.25 sps</li> <li>0.625 sps</li> </ul>			Active LOW     Low F		w Power Mode: 4 mal Power Mode: 4		
							LCDI			cy Divider (F		
Channel Se	ettings											~
Channel Se		.ow Power	Output Polarity	Frequenc	cy	Rp	Gain	Counter Scale	Sensor Cycle Count	Fast Tracking Factor		~
		-ow Power		Frequenc		<b>Rp</b> 350 ≤ Rp ≤ 4k Ohms ▼	Gain 30	100000000000000000000000000000000000000		A REAL PROPERTY OF A REA		~
Channel Er	inable L		Polarity		MHz •			Scale	Count	Factor		~
Channel Er	inable L	0	Polarity	3.3 MHz to 10 M	MHz •	350 ≤ Rp ≤ 4k Ohms ▼	30	Scale 0	Count 31	Factor 0		~



### 4.7.2 Selecting the Mode of Operation and Scan Rate

Each channel on the LDC2114 can be configured to operate either in *Normal power mode* or in *Low power mode*. The *Global Button Settings* menu contains *Normal Power Mode Scan Rate* and *Low Power Mode Scan Rate* selections, in which the desired scan rate chan be chosen for each mode of operation.

Channels can be assigned to either the *Normal Power Mode* or the *Low Power Mode* by toggling the *Low Power* button in the Channel Settings table for each channel individually.

### 4.7.3 Interrupt polarity

The LDC interrupt pin polarity can be chosen in the 'Interrupt Polarity' option of the 'Global Buttons Settings' section.

### 4.7.4 Base-tracking Increment

The LDC incorporates a baseline tracking algorithm to automatically compensate for any slow change in the sensor output caused by environmental variations, such as temperature drift. The baseline tracking is configured independently for Normal Power Mode and Low Power Mode. The increment for this feature is configured in the *Base-tracking Increment* option.

### 4.7.5 LC Resonant Frequency Divider (Pre-scaler)

The LCDIV field sets the oscillation frequency divider. This field should be set as described in section *Programmable button sampling window* of the LDC2114 datasheet.



### 4.7.6 Channel Settings

In the *Channel Settings* section, each channel can be configured independently. Each channel has its own enable bit and its own output pin with configurable polarity. The remaining parameters (*Frequency*,  $R_P$ , *Gain, Counter Scale, Sensor Cycle Count*, and *Fast Tracking Factor*) should be configured according to the characteristics of the attached sensor.

### 4.7.7 Algorithm Settings

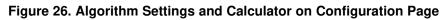
The LDC has four additional algorithms, which can be enabled in the *Algorithms Settings* section, as shown in Figure 26.

- 1. The *Max-Win* algorithm enables the system to select the button pressed with maximum force when multiple buttons are pressed at the same time. This feature must be enabled for each applicable channel individually.
- 2. The *Anti-Common Mode* algorithm eliminates false detection when a user presses the panel in certain positions, which could cause a common-mode change to two or more buttons. This feature must be enabled for each applicable channel individually.
- 3. The *Anti-Deform* algorithm filters changes due to metal deformation in the vicinity of one or more buttons. Such metal deformation can be accidentally caused by pressing a neighboring button that does not have sufficient mechanical isolation. This feature must be enabled for each applicable channel individually.
- 4. The *Anti-twist* algorithm reduces the likelihood of false detection when the case is twisted, which could cause unintended mechanical activation of the buttons, or an opposite reaction in two adjacent buttons. The anti-twist function can be enabled by configuring the *ANTITWST* setting to a value larger than 0.

### 4.7.8 Calculator

The *Calculator* does not write any registers and is used for information purposes only. It calculates the time of the sampling window for each channel based on its configured register settings.

lgorithm	Settings				~
Channel	Max-Win Group	Anti-Common Mode Group	Anti-Deform Group	Anti-twist Threshold Parameter	
0	Excluded •	Excluded •	Excluded •		
1	Excluded •	Excluded •	Excluded •	]	
2	Excluded •	Excluded •	Excluded •		
		1			
	Excluded V r Frequency (MH	Excluded	Excluded •		•
alculato	r		ndow (ms)		~
alculator Channel	r Frequency (MH	iz) Sampling Wir	ndow (ms)		~
calculator Channel	r Frequency (MH	iz) Sampling Wir 0.81	ndow (ms) 9		v
alculator Channel 0 1	r Frequency (MH	iz) Sampling Wir 0.81 0.81	<b>1dow (ms)</b> 9 9		~





### 4.7.9 Status

The Status section, as shown in Figure 27, reports the flags in the STATUS register of the LDC2114.

eUI Applic	ation			
MEN	U	Sensing Solut	ions EVM GUI	
1	Excluded •	Excluded • Excluded	T	
2	Excluded •	Excluded • Excluded		
3	Excluded •	Excluded • Excluded		
lculat	or			
Channel	Frequency (MHz)	Sampling Window (ms)		
0	7.2	1.138		
1	10	0.819		
2	10	0.819		
3	10	0.819		
HIP_READY_TO_ AXOUT: SM_WD: C_WD:	TUS: 0 ADY: 1 WRITE: 0 0 0			
IMEOUT		loading complete	- Lia	Texas In

Figure 27. Device Status

### 4.8 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.

### 4.8.1 Choosing Visible Channels

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. Figure 28 shows a streaming window in which channel 0 and channel 1 are enabled, and channel 1 shows a button press.



Sensing Solutions EVM GUI

OneUI Application     Sensing Solutions EVM GUI	v1.9.1
Data Streaming: Start Stop	Show Graph Configuration (C) Show Statistics (I)
Data Codes 🔹 Show: DATAD 🖉 DATA1 🖉 DATA2 🛄 DATA3 🗐 STATUS 🗐	Select Log File: 🛓 not logging data
<sup>80</sup> -	
28	Λ
80	
25	
20	
15	
10	$[ \Lambda]$
5	/ \
، ••••••••••••••••••••••••••••••••••••	
-5-	1,160 1,165 1,170 1,175
🚫 DATAO 🚫 DATAI 💿 DATAS 💿 STRTUS	960 1024
0	Range: 64
Connected     Data streaming started	Texas Instruments

Figure 28. Select the Data Graph on Data Streaming Page

### 4.8.2 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*.



### Sensing Solutions EVM GUI

MENU	Sen	ising Solutio	ons EVM GUI							v1.8.8
ata Streaming: Start	Stop						Show	w Graph Configur	ration (C) Sho	now Statistics (
ductance (uH)	▼ SI	how: DATA0_uH	🖉 DATA1_uH 🗹					Select Log File:	C:\data\1	\fdc2x14_data.c
1.07									<u> </u>	
0.9										
0.8										
0.7										
0.6										
0.5										
0.4										
0.3										
0.2										
0.1										
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
😞 DATAO_UH	OATA1_UH									950
										Range: 64

### Figure 29. 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.

### 4.8.3 Starting and Stopping Data Streaming

To start data streaming click the *Start* button.



OneUI Application										
E MENU	Sensing So	lutions EVM GUI							v1.8.8	
Data Streaming: Start, Sta	op					Sho	w Graph Configura	ation (C) Sh	ow Statistics (I)	
Inductance (uH)	Show: DATAC	uh 🗹 DATA1_uH 🗹					Select Log File:	🕹 C:\data\	ldc1312_data.csv	
1.0										
0.9										
0.8										
0.7										
0.6										
0.5										
0.4										
0.3										
0.2										
0.1										
0.0	0.1 0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
😞 ратко_ин 😞 ра	ATA1_uH								980 1024	
0									Range: 64	
Connected SSP EVM	connected - LDC1312						4	Texas I	NSTRUMENTS	

Figure 30. Start Button on Data Streaming Page

To stop data streaming click the Stop button.

### 4.8.4 Data Statistics

Click the *Show Statistics* button to view the measurement statistics. Click the *Hide Statistics* button to hide the measurement statistics.



### Sensing Solutions EVM GUI

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						0	HOW GI	apri Cu	niigura	tion (C)	Hide Statistics
ata Codes 🔻 Show: DATA0 🗹	DATA1 🗹 DATA2 🖗	🛿 DATA3 🗹 STATUS 🛛			Statistics						
2,500-					Data Serie	Current	Min	Max	Delta	Average	Std. Deviation
2,000					DATA0	-992	- <mark>11</mark> 47	-436	711	-979.2	123.1
					DATA1	-2048	-2048	-2048	0	-2048.0	0.0
1,500					DATA2	-2048	-2048	2047	4095	-1728.1	1099.0
1,000					DATA3	-2048	-20 <mark>48</mark>	-2048	0	-2048.0	0.0
800					Decimals	0	0	0	0	1	1
0					-		15 D				
-500											
				in .							
-1,000	••••••••••••••••									0-0-0-0	
-1,500											
-2,000											
-0.500							100121112			1010010010	
-2,500-31,275 31,280	31,285	31,290 31,295	31,300	31,305	31,310 31,315	31,3	20	31,325		31,330	31,335
	DATA2 🚫 DATAS 🔛										960
😞 DATAO 😞 DATA1 🤜											980

Figure 31. Show Statistics Button on Data Streaming Page

### Figure 32. Hide Statistics Button on Data Streaming Page

### 4.8.5 Configuring the Graph

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



Sensing Solutions EVM GUI

ta Streaming: Start Stop	Sensing Solutions EVM GUI			Hide Grap	h Configuration	(C) Show	Statistics (
ta Codes 🔻 Show: DATAO 🗹 D.	ATA1 🗹 DATA2 🗹 DATA3 🖉 STATUS 🗌			Graph Configur	ation		
1,400- 1,400 1,200	$\wedge$			Display Frame R 16.0 ms = 62.5 H New Data Sampl EVM Output F	z <b>e Rate</b> Rate (6.00 ms = 16		
1,000				<ul> <li>Add sample to</li> <li>Vertical Scaling</li> <li>Vertical Left Axis</li> </ul>	(Y1)	50	ms
600				Minimum: Maximum: Autoscale Au	-2048 2047 Itoscale & Lock		
200		•-•-•-•		Sample Counts Display: Buffer:	64 ≈ 3.200 s 1024 ≈ 51.200		
-200 - 200 2	05 910 918 920 ATA2 🐼 DATAS 🔊 STATUS	325 330	335 34	0 348	380	355	3 60 960 Range: 64

Figure 33. Show Graph Configuration Button on Data Streaming Page



Sensing Solutions EVM GUI

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Graph Confi	guration			
Display Fram	e Rate		ĺ	b
16.0 ms = 62.				
New Data Sa	mple Rate	e		
EVM Outp	ut Rate (II	nfinity ms = 0	.0 Hz)	
Add sample	le to grapi	n every	100	ms
Minimum:		0		
Vertical Left A	ixis (Y1)	0		
Maximum:	6	100		
Autoscale	Autoscal	le & Lock		
Sample Cour	nts			
		≈ 0.000 s		
Display:	64	~ 0.000 S		

Figure 34. 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 *Vertical 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.

### 4.8.6 Navigating the Data Streaming Buffer

The Sensing Solutions EVM GUI stores a buffer of data samples and then displays a subset of those samples. The data buffer can be navigated using the horizontal slider below the graph. To show more samples on 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 35. Changing Number of Samples Displayed in Data Graph

By clicking on the green bar and dragging the mouse left or right, previous samples in the buffer can be displayed.



### Sensing Solutions EVM GUI

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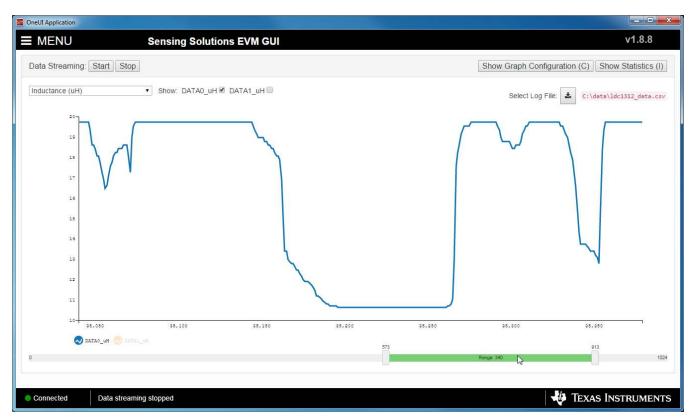


Figure 36. Displaying Previous Data Samples on the Data Streaming Page

### 4.9 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.



See OneUI Application	
MENU Sensing Solutions EVM GUI	v1.8.8
Firmware Upgrade	
Select TI-TXT firmware File:	
Connected SSP EVM connected - FDC2214	Texas Instruments

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

2. Select the firmware file and click Open.



## Sensing Solutions EVM GUI

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	der				8	≡ •	
🔆 Favorites	Name	Date modified	Туре	Size			
Conner, Blair	FDC2x14_LDC13xxRevB_LDC16xxRevB_EVM_Firmware_so	11/5/2015 10:01 AM	File folder				
E Desktop	HDC10x0_EVM_Firmware_source	11/5/2015 10:01 AM	File folder				
📃 Recent Places	FDC2x14_LDC13xxRevB_LDC16xxRevB_EVM_Firmware.txt	6/11/2015 3:34 PM	Text Document	101 KB			
길 UserData	HDC10x0_EVM_Firmware.txt	6/15/2015 2:08 PM	Text Document	93 KB			
GIT_Repositories							
鷆 ti							
🚺 Downloads							
🔄 Box Sync							
🔒 Blair Conner (P)							
📜 Libraries 📜 Computer 🌋 OSDisk (C:)							
P							
🙀 Network							

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

3. Click the Upload Firmware button.



	OneUI Application	- • ×
	MENU Sensing Solutions EVM GUI	v1.8.8
-	Firmware Upgrade	
	Select TI-TXT firmware File: 2:\ti\Sensing Solutions EVM GUI-1.8.8\EVM Firmware\FDC2x14_LDC13xxRevB_LDC16xxRevB_EVM_Firmware.txt	
	Upload Firmware	
	Connected SSP EVM connected - FDC2214     TEXAS IN:	STRUMENTS

Figure 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.

Sea OneUI Application		- 0 ×
E MENU	Sensing Solutions EVM GUI	v1.8.8
Firmware Upgrade		
Select TI-TXT firmware File:	C:\ti\Sensing Solutions EVM GUI-1.8.8\EVM Firmware\FDC2x14_LDC13xxRevB_LDC16xxRevB_EVM_Firmware.txt	
Wait for upload to complete		
	Uploading firmware: Please do NOT disconnect the EVMI	
1		
	nû.	
Not connected SSP EVM di	sconnected	Texas Instruments
	Figure 40. Firmware Upload in Progress	



## Sensing Solutions EVM GUI

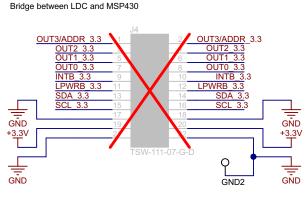
www.ti.com

S OneUI Application	
MENU     Sensing Solutions EVM GUI	v1.8.8
Firmware Upgrade	
Select TI-TXT firmware File: 🔹 C:\ti\Sensing Solutions EVM GUI-1.8.8\EVM Firmware\FDC2x14_LDC13xxRevB_LDC16xxRevB_EVM_Firmware.txt	
Upload Firmware	
Success	
E. C.	
La .	
Not connected Firmware successsfully updated!	🗤 Texas Instruments
Norconnected Finnware successionly updated:	TEXAS INSTRUMENTS

Figure 41. Firmware Upload Success



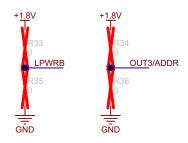
# 5 LDC2114 EVM REV A Schematics and Layout



Layout note: Perforate PCB along this header Layout note: Route traces between L & R header columns on inner layers Copyright © 2016, Texas Instruments Incorporated

# Figure 42. Bridge between LDC and MSP430

PU/PD for LDC inputs



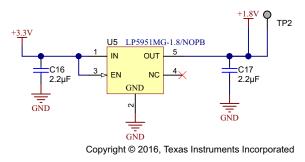
Design note: Do not populate R34 or R36 for LDC2114 Layout note: move to bottom side

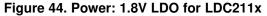
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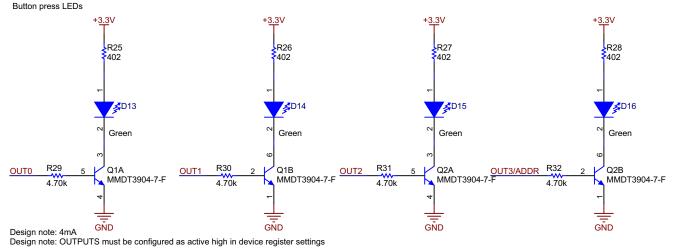
## Figure 43. PU/PD for LDC inputs

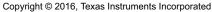


Power: 1.8V LDO for LDC211x



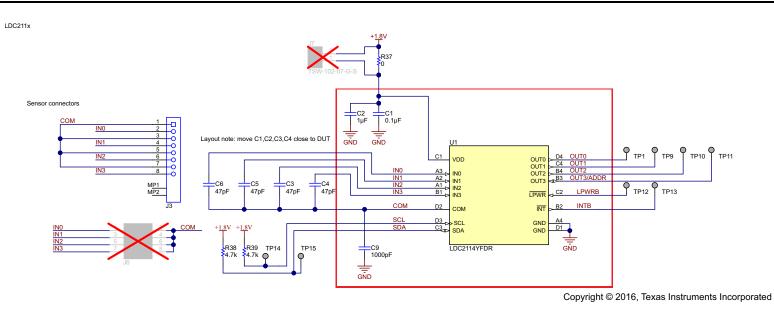


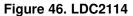








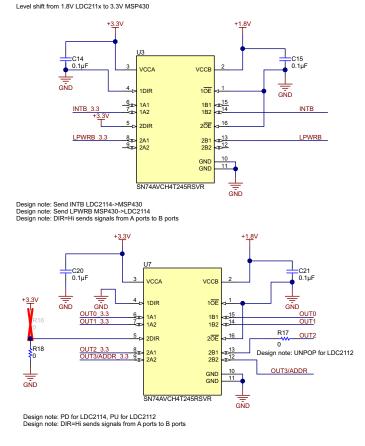






### LDC2114 EVM REV A Schematics and Layout

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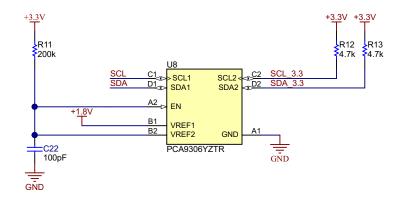


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# Figure 47. Level shift from 1.8V LDC211x to 3.3V MSP430



Level shift for I2C



Design note: MSP430: 3.3V, LDC211x: 1.8V Design note: VREF2 must be 1.8V, 3.3V, or 5V if VREF1 = 1.8V

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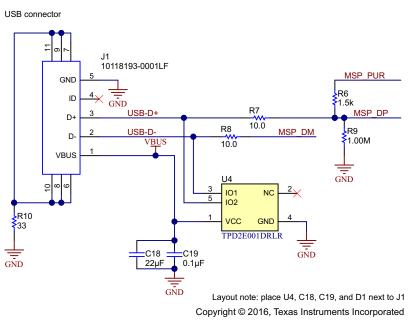
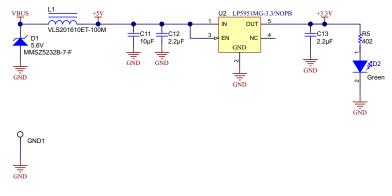
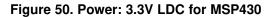


Figure 49. USB connector

Power: 3.3V LDO for MSP430



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MSP430 U6 OUT3/ADDR\_3.3 18 P2.0 P1.0/TA0CLK/ACLK P2.0/TA1.1 P2.1 OUT2 3.3 19 P1.1/TA0.0 P2.1/TA1.2 OUT1\_3.3 P1.2/TA0.1 P2.2/TA2CLK/SMCLK +3.3V +3.3V OUT0 3.3 P1.3/TA0.2 P2.3/TA2.0 +3.3V +3.3V P1.4/TA0.3 P2.4/TA2.1 P1.5/TA0.4 P2.5/TA2.2 R20 7<u>32</u> 33 √33 P1 6 P1.6/TA1CLK/CBOUT P2.6/RTCCLK/DMAE0 INTB 3.3 4.7k 25 P1.7/TA1.0 P2.7/UCB0STE/UCA0CLK R21 **4**.7k SDA2 34 P3.0/UCB0SIMO/UCB0SDA P4.0/PM\_UCB1STE/PM\_UCA1CLK 35 36 37 SCL2 SDA 3.3 P3.1/UCB0SOMI/UCB0SCL P4.1/PM UCB1SIMO/PM UCB1SDA LPWRB\_3.3 SCL 3.3 P3.2/UCB0CLK/UCA0STE P4.2/PM\_UCB1SOMI/PM\_UCB1SCL TP3 TP4 44 Tx P3.3/UCA0TXD/UCA0SIMO P4.3/PM UCB1CLK/PM UCA1STE 38  $\bigcirc$  $\bigcirc$ Rx P3.4/UCA0RXD/UCA0SOMI P4.4/PM UCA1TXD/PM UCA1SIMO VUSB MSP PUR P4.5/PM\_UCA1RXD/PM\_UCA1SOMI P4.6/PM NONE P4.7/PM\_NONE Silk: BSL Layout note: place 100mil apart S1\_LED S2\_LED 9 10 57 P5.0/A8/VREF+/VEREF+ P6.0/CB0/A0 D4 P5.1/A9/VREF-/VEREF-P6.1/CB1/A1 Xtalin D5 P5.2/XT2IN P6.2/CB2/A2 D6 58 P5.3/XT2OUT P6.3/CB3/A3 Xtalo 12 13 D7 P6.4/CB4/A4 P5.4/XIN D8 P5.5/XOUT P6.5/CB5/A5 ABM8-24.000MHZ-B2-T D9 P6.6/CB6/A6 24MHz C23 C24 D10 P6.7/CB7/A7 18pF 18pF  $\square$  $\bigcirc$  $\bigcirc$ MSP\_DP\_50 MSP\_DM\_52 JTAG TDO TP5 TTP6 TP7 ĪΤP8 60 PU.0/DP PJ.0/TDO 61 -÷. JTAG\_(DI +3.3V PU.1/DM PJ.1/TDI/TCLK GND GND JTAG (MS 62 PJ.2/TMS JTAG TCK MSP PUR51 R19 63 PJ.3/TCK Layout note: Cu cut-out under Y1, C23, C24 PUR 33k JTAG\_RST 55 64 59 V18 RST/NMI/SBWTDIO VCORE 17 JTAG TEST VCORE TEST/SBWTCK C25 0.22µF C27 53 65 QFN PAD VBUS 0.47µF VUSB 54 49 VUSB VSSU GND C26 14 AVSS1 C28 2200pF GND 56 11 AVCC1 AVSS2 0.22µF 15 16 DVCC1 DVSS1 40 39 DVCC2 DVSS2 = GND MSP430F5528IRGCT S2 LED S1 LED +<u>3.3</u>V +<u>3.3</u>V +3.3V R23 R24 402 C29 C30 C31 C32 10µF 0.1µF 1.0k 0.1µF 0.1µF GND **Z**D12 **D**11 Super Red Green GND GND

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Figure 51. MSP430



MSP430 GPIO Breakout connector and General purpose LEDs

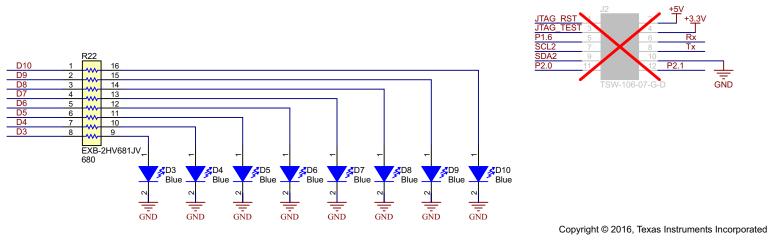


Figure 52. MSP430 GPIO Breakout connector and General purpose LEDs



LDC2114 EVM REV A Schematics and Layout

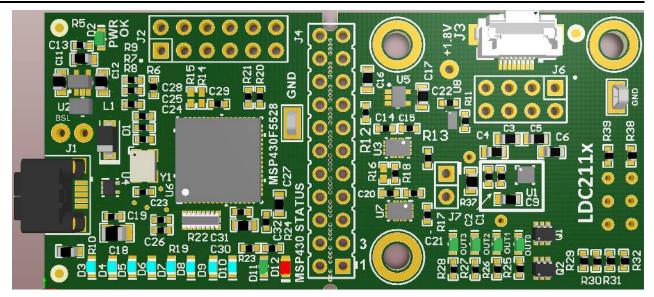


Figure 53. LDC2114 Layout Top Layer - Overview

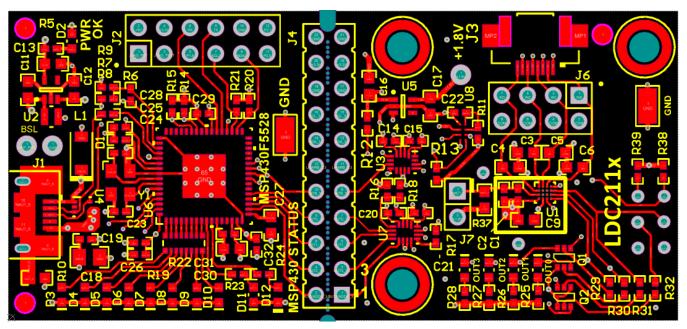


Figure 54. LDC2114 Layout Top Layer – Signals and Components



LDC2114 EVM REV A Schematics and Layout

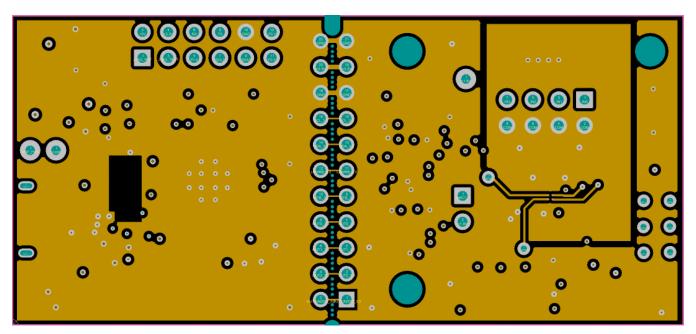


Figure 55. LDC2114 Layout MidLayer 1 – Ground Plane

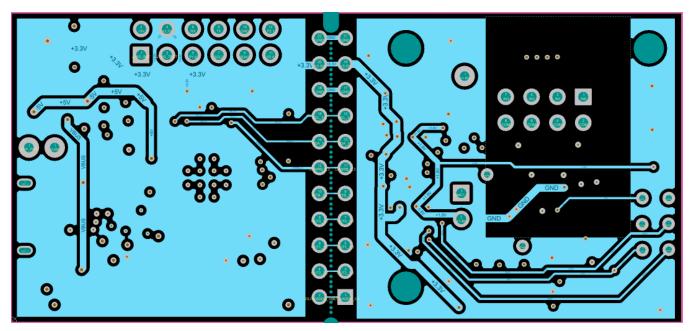


Figure 56. LDC2114 Layout MidLayer 2 – Signals and Power Plane



## LDC2114 EVM REV A Schematics and Layout

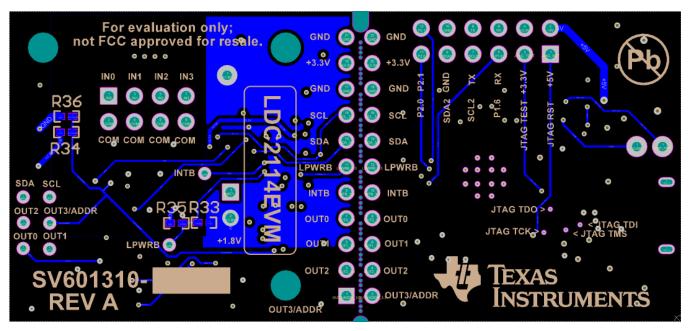


Figure 57. LDC2114 Layout Bottom Layer – Signals Plane

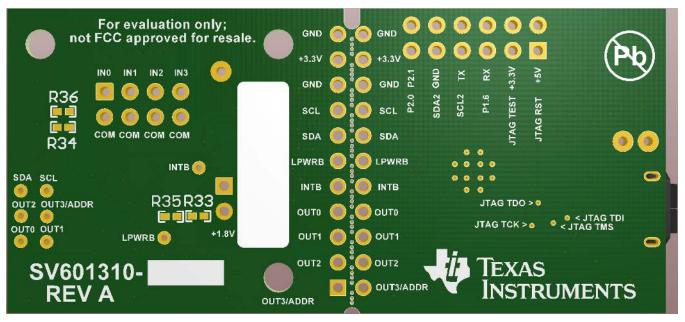


Figure 58. LDC2114 Bottom Layer - Overview



LDC2114EVM REV A Bill of Materials

## 6 LDC2114EVM REV A Bill of Materials

DESIG-	QTY.	VALUE	DESCRIPTION		MANUEACTURED
NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
C1, C14, C15, C19, C20, C21, C29, C31, C32	9	0.1uF	CAP, CERM, 0.1 μF, 50 V, +/- 10%, X7R, 0402	C1005X7R1H104K050BB	TDK
C2	1	1uF	CAP, CERM, 1 µF, 6.3 V, +/- 20%, X7R, 0402	GRM155R70J105MA12D	MuRata
C3, C4, C5, C6	4	47pF	CAP, CERM, 47 pF, 50 V, +/- 1%, C0G/NP0, 0603	GRM1885C1H470FA01J	MuRata
C9	1	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 1%, C0G/NP0, 0603	GRM1885C1H102FA01J	MuRata
C11, C30	2	10uF	CAP, CERM, 10 μF, 10 V, +/- 20%, X5R, 0603	C1608X5R1A106M080AC	TDK
C12, C13, C16, C17	4	2.2uF	CAP, CERM, 2.2 μF, 10 V, +/- 10%, X5R, 0603	C0603C225K8PACTU	Kemet
C18	1	22uF	CAP, CERM, 22 µF, 10 V, +/- 20%, X5R, 0805	CL21A226MPCLRNC	Samsung Electro- Mechanics
C22	1	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402	CC0402JRNPO9BN101	Yageo America
C23, C24	2	18pF	CAP, CERM, 18 pF, 50 V, +/- 5%, C0G/NP0, 0402	GRM1555C1H180JA01D	MuRata
C25, C28	2	0.22uF	CAP, CERM, 0.22 μF, 16 V, +/- 10%, X7R, 0402	C1005X7R1C224K050BC	TDK
C26	1	2200pF	CAP, CERM, 2200 pF, 16 V, +/- 10%, X7R, 0402	885012205027	Wurth Elektronik
C27	1	0.47uF	CAP, CERM, 0.47 μF, 10 V, +/- 10%, X7R, 0603	C0603C474K8RACTU	Kemet
D1	1	5.6V	Diode, Zener, 5.6 V, 500 mW, SOD-123	MMSZ5232B-7-F	Diodes Inc.
D2, D11, D13, D14, D15, D16	6	Green	LED, Green, SMD	LG L29K-G2J1-24-Z	OSRAM
D3, D4, D5, D6, D7, D8, D9, D10	8	Blue	LED, Blue, SMD	LB Q39G-L2N2-35-1	OSRAM
D12	1	Super Red	LED, Super Red, SMD	SML-LX0603SRW-TR	Lumex
GND1, GND2	2		Test Point, Miniature, SMT	5015	Keystone
H4	1		FFC 0.50 TYPE A 8 CKTS LGT 51	0151660075	Molex
J1	1		Connector, Receptacle, USB Micro B, R/A, SMT	10118193-0001LF	FCI
J3	1		Connector, FFC, Bottom, 0.5mm, 8 Pos, SMT	52892-0833	Molex
L1	1	10uH	Inductor, Shielded, Ferrite, 10 $\mu H,$ 0.4 A, 1.38 ohm, 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
Q1, Q2	2	40 V	Transistor, Dual NPN, 40 V, 0.2 A, SOT-363	MMDT3904-7-F	Diodes Inc.

## Table 3. BOM for LDC2114EVM rev A

DESIG- NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER	
R5, R23, R25, R26, R27, R28	6	402	RES, 402, 1%, 0.063 W, 0402	CRCW0402402RFKED	Vishay-Dale	
R6	1	1.5k	RES, 1.5 k, 5%, 0.063 W, 0402	CRCW04021K50JNED	Vishay-Dale	
R7, R8	2	10.0	RES, 10.0, 1%, 0.063 W, 0402	CRCW040210R0FKED	Vishay-Dale	
R9	1	1.00Meg	RES, 1.00 M, 1%, 0.063 W, 0402	RC0402FR-071ML	Yageo America	
R10	1	33	RES, 33, 5%, 0.1 W, 0603	CRCW060333R0JNEA	Vishay-Dale	
R11	1	200k	RES, 200 k, 5%, 0.063 W, 0402	CRCW0402200KJNED	Vishay-Dale	
R12, R13, R20, R21, R38, R39	6	4.7k	RES, 4.7 k, 5%, 0.063 W, 0402	CRCW04024K70JNED	Vishay-Dale	
R17, R18	2	0	RES, 0, 5%, 0.063 W, 0402	RC0402JR-070RL	Yageo America	
R19	1	33k	RES, 33 k, 5%, 0.063 W, 0402	CRCW040233K0JNED	Vishay-Dale	
R22	1	680	RES, 680, 5%, 0.0625 W, Resistor Array - 8x1	EXB-2HV681JV	Panasonic	
R24	1	1.0k	RES, 1.0 k, 5%, 0.063 W, 0402	CRCW04021K00JNED	Vishay-Dale	
R29, R30, R31, R32	4	4.70k	RES, 4.70 k, 1%, 0.1 W, 0402	ERJ-2RKF4701X	Panasonic	
R37	1	0	RES, 0, 5%, 0.1 W, 0603	CRCW06030000Z0EA	Vishay-Dale	
U1	1		Four-channel Inductive Sensor for Touch-on- Metal Application, YFD0016ALAL	LDC2114YFDR	Texas Instruments	
U2	1		Micropower, 150mA Low-Dropout CMOS Voltage Regulator, 5-pin SC-70, Pb-Free	LP5951MG-3.3/NOPB	Texas Instruments	
U3, U7	2		4-Bit Dual-Supply Bus Transceiver with Configurable Voltage Translation and 3-State Outputs, RSV0016A	SN74AVCH4T245RSVR	Texas Instruments	
U4	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	
U5	1		Micropower, 150mA Low-Dropout CMOS Voltage Regulator, 5-pin SC-70, Pb-Free	LP5951MG-1.8/NOPB	Texas Instruments	
U6	1		25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 47 GPIOs, -40 to 85 degC, 64-pin QFN (RGC), Green (RoHS & no Sb/Br)	MSP430F5528IRGCT	T Texas Instruments	
U8	1		DUAL BIDIRECTIONAL I2C BUS AND SMBus VOLTAGE-LEVEL TRANSLATOR, YZT0008AABW	PCA9306YZTR	Texas Instruments	
Y1	1		Crystal, 24.000MHz, 18pF, SMD	ABM8-24.000MHZ-B2-T	Abracon Corporation	
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	
H1, H2, H3	0		ROUND STANDOFF M2 STEEL 5MM	9774050243R	Wurth Elektronik	
J2	0		Header, 100mil, 6x2, Gold, TH	TSW-106-07-G-D	Samtec	
J4	0		Header, 2.54 mm, 11x2, Gold, TH	TSW-111-07-G-D	Samtec	
J6	0		Header, 100mil, 4x2, Gold, TH	TSW-104-07-G-D	Samtec	
J7	0		Header, 100mil, 2x1, Gold, TH	TSW-102-07-G-S	Samtec	

LDC2114 Evaluation Module for Inductive Touch Inductance to Digital Converter 53



DESIG- NATOR	QTY.	VALUE	DESCRIPTION	PART NUMBER	MANUFACTURER
R14, R15	0	4.7k	RES, 4.7 k, 5%, 0.063 W, 0402	CRCW04024K70JNED	Vishay-Dale
R16, R33, R34, R35, R36	0	0	RES, 0, 5%, 0.063 W, 0402	RC0402JR-070RL	Yageo America

# Table 3. BOM for LDC2114EVM rev A (continued)

## STANDARD TERMS FOR EVALUATION MODULES

- 1. Delivery: TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
  - 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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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:

**FCC NOTICE:** 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 may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

- 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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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用 いただく。

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