*User's Guide*

# *BOOST-LDC3114 Evaluation Module User's Guide*


**ABSTRACT**

This user's guide describes the characteristics, operation, and use of the BOOST-LDC3114 Evaluation Module (EVM). Complete schematic diagrams, printed circuit board layouts, and bill of materials are included in this document.


## Table of Contents



## Trademarks

# 1 Overview

The BOOST-LDC3114EVM demonstrates the use of inductive sensing technology to sense and measure the presence or position of a conductive target object and to detect the press of an inductive touch button. The LDC3114 in the EVM is controlled by a MSP432 on the mother board, which connects to a host computer.

The EVM is comprised of two boards, the BOOST-LDC3114 board and the PAMB (Precision Amps Mother Board). This is set up as a boosterpack and allows the LDC board to easily be used with a different microcontroller.

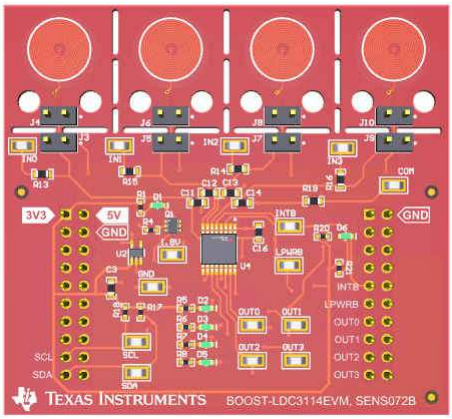


**Figure 1-1. BOOST-LDC3114EVM**

## 1.1 EVM Kit Contents

Table 1-1 details the contents of the EVM kit. Contact the nearest Texas Instruments Product Information Center if any components are missing.

**Table 1-1. EVM Kit Contents**

| Item | Quantity |
|---|---|
| BOOST-LDC3114EVM | 1 |
| PAMB Controller Board | 1 |
| Micro-USB Cable | 1 |
| 3D Printed Button Attachment | 1 |
| 3D Printed Proximity Attachment | 1 |

## 1.2 Compatible Sensors

The BOOST-LDC3114EVM includes four identical example sensors that are perforated so they can be removed and replaced with different sensors by soldering onto the provided header pin locations. The LDCCOILEVM and LDCTOUCHCOMCOILEVM both have compatible sensors that can be used with the BOOST-LDC3114EVM and can be obtained if testing with various sensor designs is necessary. Other sensors can be connected to the input headers with an unshielded twisted pair of wires. The included sensors are designed to allow the 3D printed attachments that come with the EVM to attach to the board.

## 1.3 Main EVM Elements

Figure 1-2 shows the layout of the BOOST-LDC3114EVM and points out various features. The sensor coils are located on a perforated section of the board so they can be placed remotely from the sensor or replaced with other, compatible sensors by using the sensor connection headers.

The BOOST-LDC3114EVM has multiple test points designated for the power, ground, $I^2C$, and output pins. Additionally, the button detection LEDs on the output pins are located in the center of the board. The test

points connected to the sensors have a resistor pad that can be populated with a 1-kΩ resistor to decouple the oscilloscope probe capacitance.

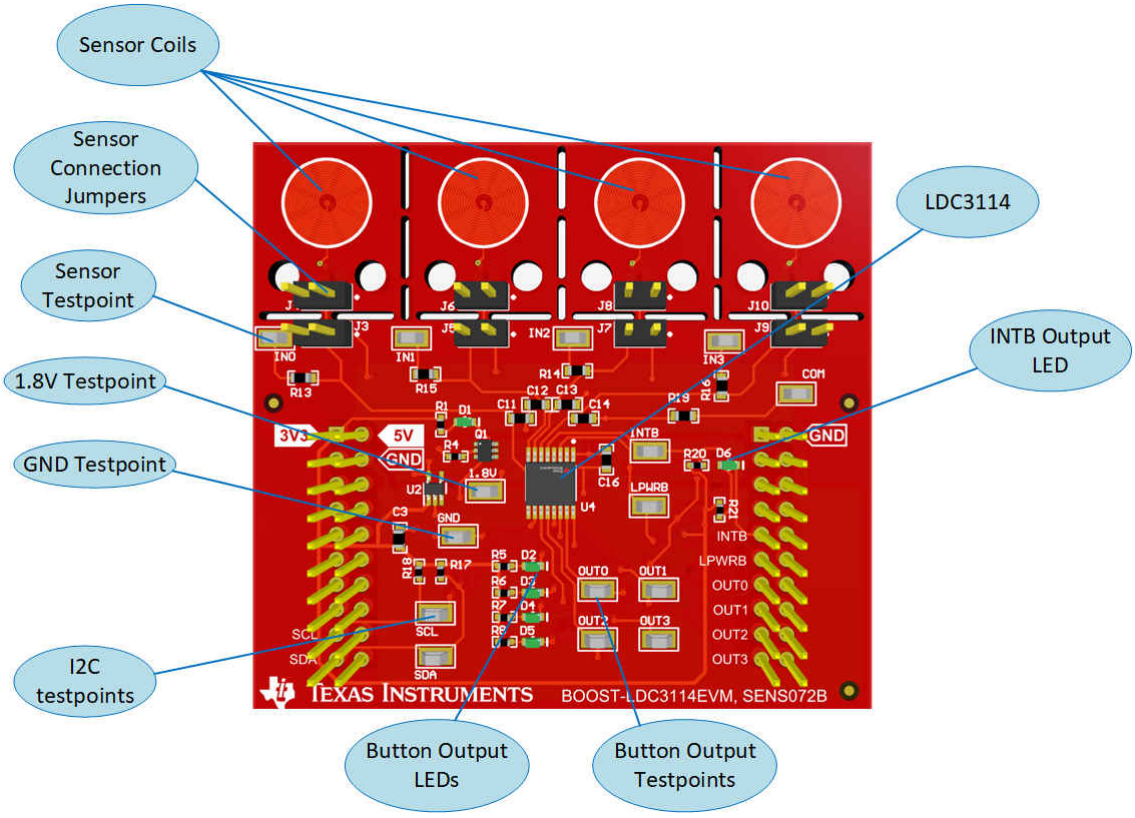


**Figure 1-2. EVM Features**

# 2 EVM GUI

The BOOST-LDC3114EVM GUI provides direct device register access and data streaming.

## 2.1 System Requirements

The BOOST-LDC3114EVM software is compatible with Windows, Mac, and Linux operating systems. The online software works with Chrome, Firefox, and Safari browsers.

## 2.2 Installation

The GUI software for the BOOST-LDC3114EVM runs on TI's GUI Composer framework. The software is available as a live version that runs in a browser and as a download for offline use.

Download and install the PAMB Controller drivers from https://www.ti.com/lit/zip/sbac253. This is a one-time only setup.

Go to https://dev.ti.com/gallery/search/LDC3114EVM_GUI to access the online GUI version. To access the offline GUI, mouse over the *Download* icon, select your operating system from the list, then follow the installation instructions.

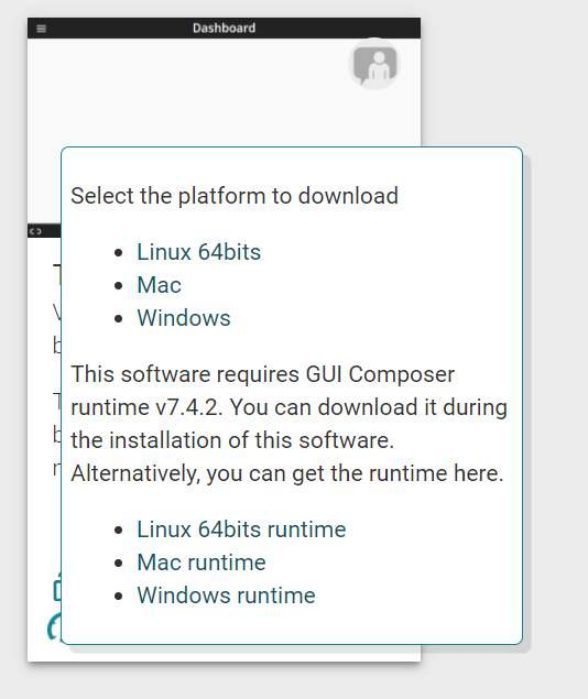


**Figure 2-1. Download Pop-Up Window**

## 2.3 Navigation

For first-time use, follow the prompts for TI Cloud Agent Installation:

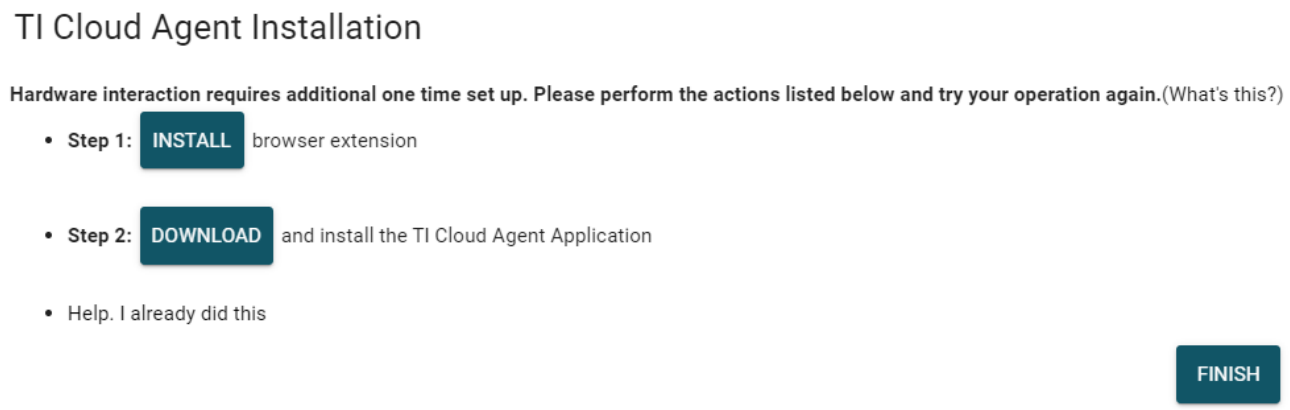


**Figure 2-2. Initial GUI Setup**

After the successful completion of the previous steps, make sure the text *Hardware Connected* appears in the bottom-left corner of the screen.

If the hardware is not recognized, go to *Options→Serial Port...* and select the correct port, then click *Ok*.

The main page has the device name and links to other pages in the GUI.

### 2.3.1 Registers

The Registers page allows the user to read and write to the device registers. Additionally, the Auto Read function will default to Off, but can be set to the following speeds:

- Every 1 sec
- Every 5 sec
- Every 10 sec
- Every 20 sec
- Every 30 sec
- Every 60 sec
- As fast as possible

The data registers have been combined onto a single line in the GUI for ease of use, but they are still separate 8-bit registers in the device. The firmware on the EVM reads the needed registers for a given channel and combines them in the proper order before reporting the data to the GUI.

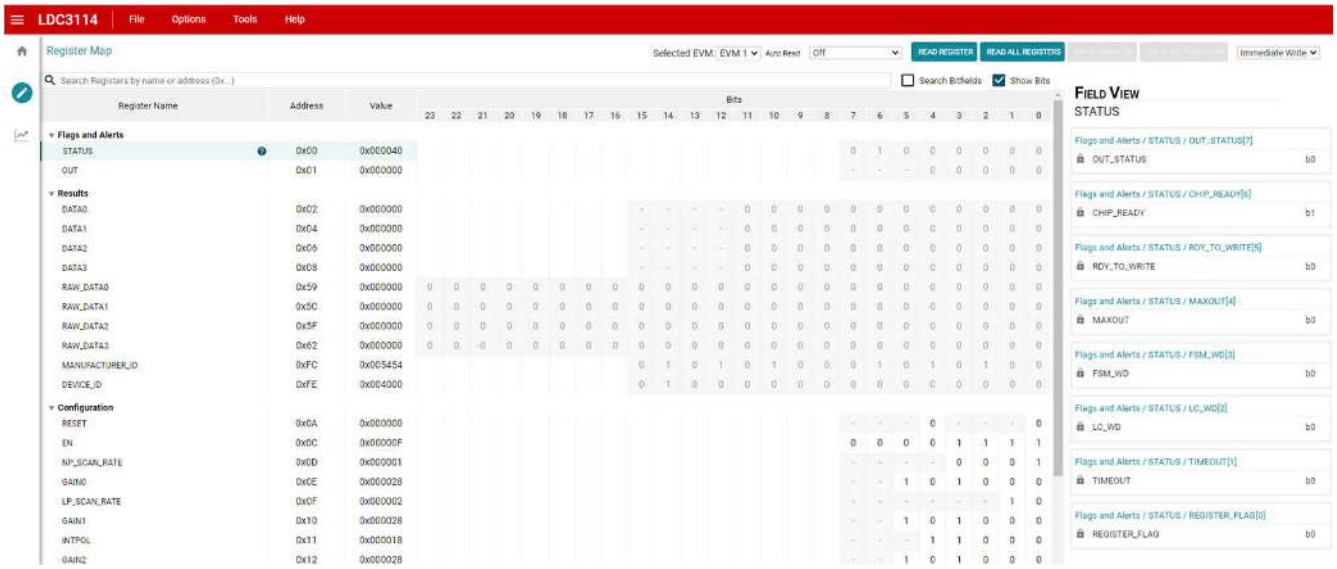


**Figure 2-3. Registers Page**

#### *2.3.1.1 Basic Register Configuration*

- The device must be in Config mode before you are able to set register configurations
  - Set the *CONFIG_MODE* bit of *RESET (Address 0x0A)* to 1 to put the device into Config mode
- Choose the sampling rate based on the power consumption requirement of the system by configuring the *NP_SCAN_RATE (Address 0x0D)* or *LP_SCAN_RATE (Address 0x0F)* registers
- Ensure that the correct sensor parameters are selected by configuring the *SENSORn_CONFIG* registers
  - These registers are used to set the sensor Rp range, frequency range, and cycle count
- To operate in Raw Data Mode, set the *BALG_EN* bit of *INTPOL (Address 0x011)* to 0 to disable the Button Algorithm
- Set the *CONFIG_MODE* bit of *RESET (Address 0x0A)* to 0 to put the device back into Normal mode

### 2.3.2 Data Plot

In the Data Plot tab the data can be viewed in a graph and saved to a file. The graph will be configured for either raw data or button algorithm data depending on the register settings of the device. Additionally, desired channels can be enabled or disabled to be included in the graph. Note that the Data Plot tab does not change the register configuration of the device so the proper register configuration will need to be made on the register tab.

Click *Save Plot* to save the data plot as a .csv file or click *Clear Plot* to clear the data plot. Additionally, the number of samples collected and saved can be changed using the provided text box. The delay box has an auto delay checkbox that will automatically calculate the minimum delay between samples based on the register settings. In the case where continuous sample rate is chosen, a quick calculation section will appear and auto delay will no longer determine the best timing. This is due to the need for the sensor frequency in the delay function.

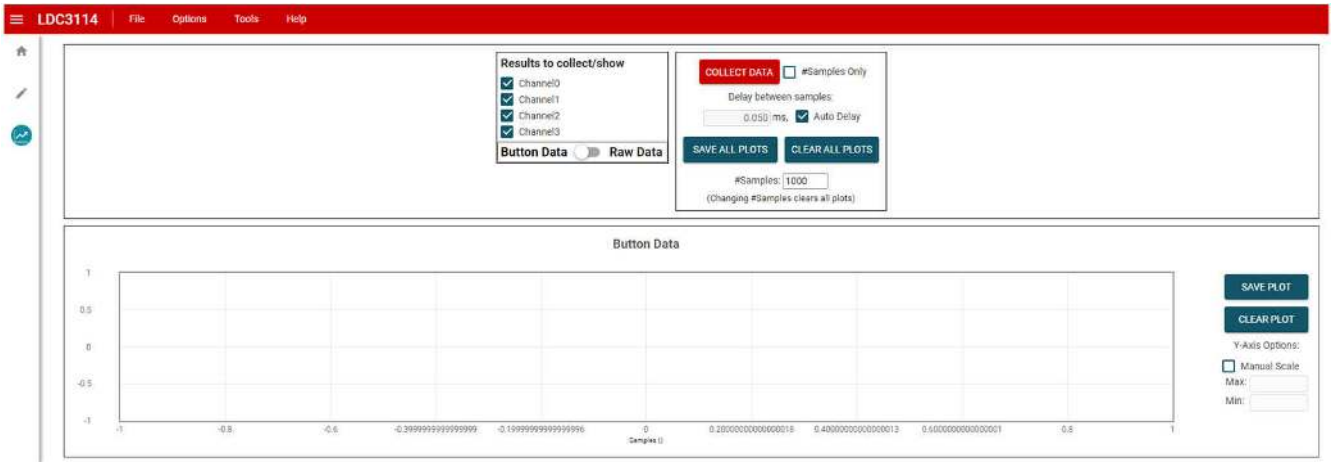


**Figure 2-4. Data Plot**

### 2.3.3 Collateral

The Collateral page is where the user can find links to various resources, including data sheets, application notes, firmware, and any applicable reports.


**Figure 2-5. Collateral Page**

## 2.4 Firmware Updates

If there are issues with the PAMB controller such that it is unable to connect to the GUI or the LEDs do not light, the firmware may need to be re-flashed through a batch file.

Before this can be done, the PAMB controller must be put back into Device Firmware Upgrade (DFU) mode. The steps to put the controller into DFU mode are as follows:

1. Ensure the USB cable is unplugged, then remove the LDC3114 daughter card from the PAMB.
2. Locate the two test points near the PK1 and PK2 header pins.
3. Reconnect the USB cable to power the USB board.
4. Use a pair of metal tweezers or wire to short and hold the connection between the PK1 and PK2 test points.
5. With the test points still shorted, press and release the RESET button (SW1) on the PAMB board.
6. If successful, none of the LEDS on the PAMB board will be on.
7. Launch the LDC3114EVM GUI.
8. Navigate to *File* > *Program Device* to launch the firmware update. Wait for the firmware to update and **do not disconnect the USB cable or press the RESET button during the update.**
9. When the update is complete, the EVM firmware should reboot and connect to the GUI. If the firmware does not reconnect momentarily, press the RESET button OR unplug and plug in the USB cable to reconnect.

## 2.5 Direct EVM Communication

A computer can also communicate directly with the EVM over USB. The EVM is programmed to accept a few commands so that register access can be achieved. The main two commands are to read a register using "rreg" or to write a register using "wreg". The register read takes the desired register address as an argument and returns a confirmation with the register address number, value of the register in decimal, and the state of the EVM. A register write takes the address and value of the register as two separate inputs in hexadecimal format. The write command then returns and acknowledgment along with the EVM state following the command. Even though the arguments are required to be in hexadecimal format, there are a few different options for them. They can either include a prefix of "0x" or not as long as the "x" is always lower case. Here is an example of the different ways to read register address 0x04:

- rreg 4
- rreg 04
- rreg 0x04

An example of a register read for the STATUS register (address 0x00) would be to send the command "rreg 00". The confirmation received from this command will show as follows:

{"acknowledge":"rreg 00"}

{"register":{"address":0,"value":64}}

{"evm_state":"idle"}

An example of a register write command would be to send "wreg 0A 01". This writes the value 0x01 to the RESET register of the device. The confirmation received for this command can be seen below:

{"acknowledge":"wreg 0A 01"}

{"console":"Writing 0x0001 to RESET register"}

{"evm_state":"idle"}

This same syntax can be used for complete register access to the device. An important thing to note is that the data registers (addresses 0x02 through 0x08 for button algorithm and 0x59 through 0x64 for raw data) have been combined in the command so that only the first of each channels data needs to be used to get the data. For example, to get the raw data from channel 0, the command "rreg 59" will grab all three data registers and combine them properly before returning the value in decimal format.

# 3 Schematic

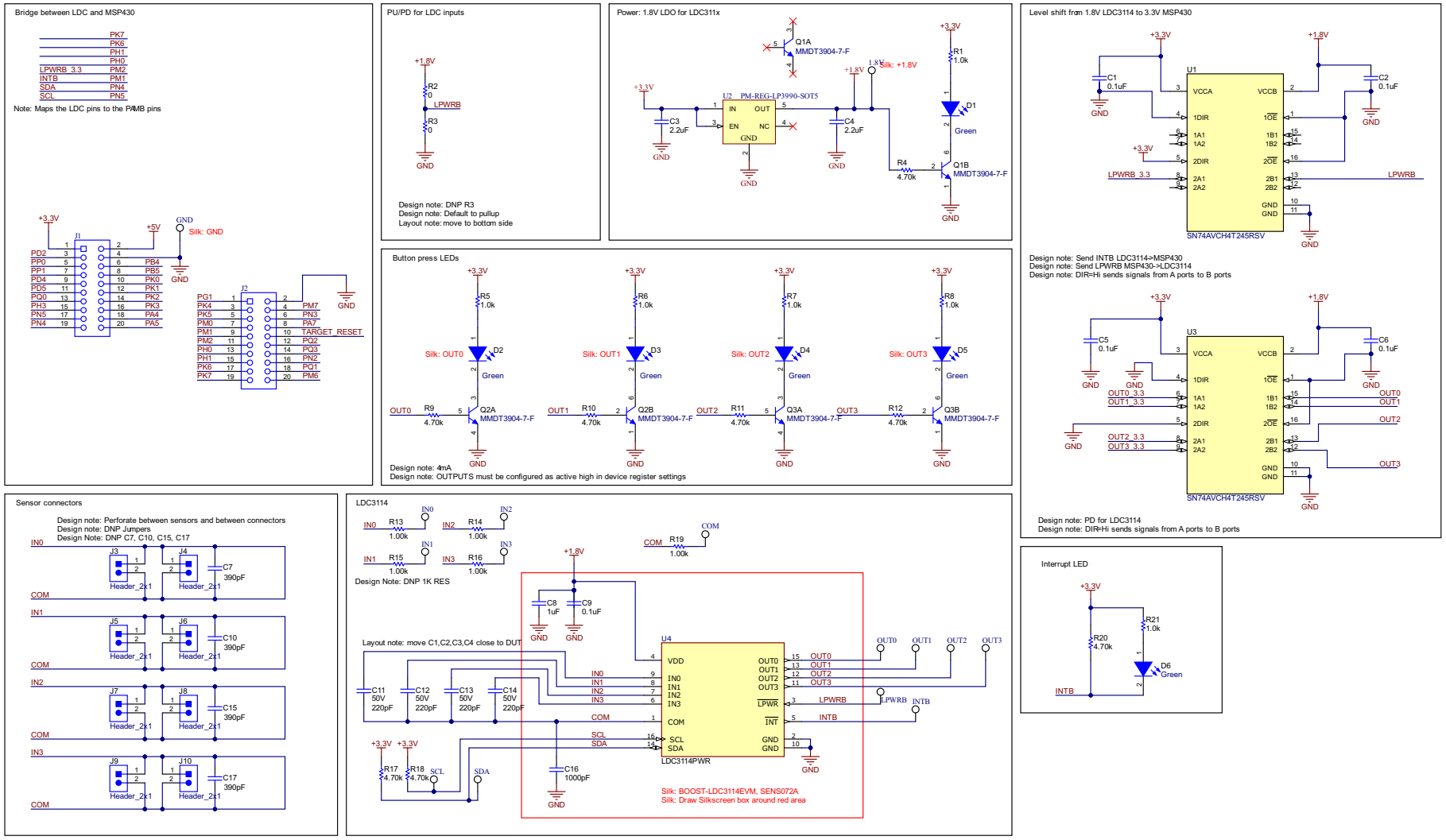


**Figure 3-1. Schematic**

# 4 Layout

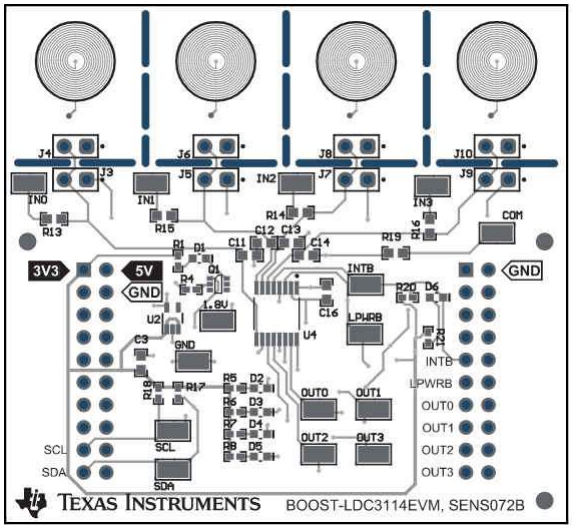


**Figure 4-1. Top View Layout**

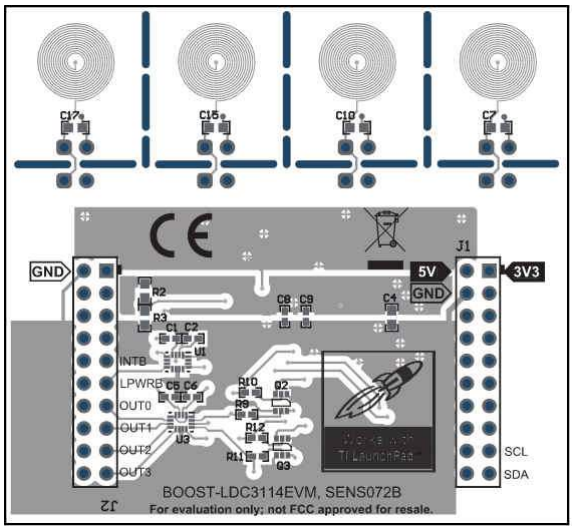


**Figure 4-2. Bottom View Layout**

# 5 Bill of Materials

**Table 5-1. BOOST-LDC3114EVM BOM**

| Designator | QTY | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| !PCB1 | 1 | | Printed Circuit Board | | SENS072 | Any |
| 1.8V, COM, GND, IN0, IN1, IN2, IN3, INTB, LPWRB, OUT0, OUT1, OUT2, OUT3, SCL, SDA | 15 | | Test Point, Miniature, SMT | Testpoint_Keystone_Miniature | 5015 | Keystone |
| C1, C2, C5, C6, C9 | 5 | 0.1uF | CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0402 | 0402 | C1005X7R1H104K050BB | TDK |
| C3, C4 | 2 | 2.2uF | CAP, CERM, 2.2 uF, 10 V, +/- 10%, X5R, 0603 | 0603 | C0603C225K8PACTU | Kemet |
| C7, C10, C15, C17 | 4 | 390pF | CAP, CERM, 390 pF, 50 V, +/- 1%, C0G/NP0, 0603 | 0603 | CC0603FRNPO9BN391 | Yageo America |
| C8 | 1 | 1uF | CAP, CERM, 1 uF, 6.3 V, +/- 20%, X7R, 0402 | 0402 | GRM155R70J105MA12D | MuRata |
| C11, C12, C13, C14 | 4 | 220pF | CAP, CERM, 47 pF, 50 V, +/- 1%, C0G/NP0, 0603 | 0603 | GRM1885C1H470FA01J | MuRata |
| C16 | 1 | 1000pF | CAP, CERM, 1000 pF, 50 V, +/- 1%, C0G/NP0, 0603 | 0603 | GRM1885C1H102FA01J | MuRata |
| D1, D2, D3, D4, D5, D6 | 6 | Green | LED, Green, SMD | 1.7x0.65x0.8mm | LG L29K-G2J1-24-Z | OSRAM |
| H1 | 1 | | Kitting Item: PAMB Controller | | DC081 | Texas Instruments |
| H2 | 1 | | Kitting Item: 3025010-03; Cable, USB A MALE to Micro B MALE 3'; CDDS 6612041 | | 6612041 | Qualtek |
| H3 | 1 | | Kitting Item: 3D printed attachments - button and proximity slider | | | |
| J1, J2 | 2 | | Receptacle, 2.54mm, 10x2, Tin, TH | Receptacle, 2.54mm, 10x2, TH | SSQ-110-03-T-D | Samtec |
| Q1, Q2, Q3 | 3 | 40 V | Transistor, Dual NPN, 40 V, 0.2 A, SOT-363 | SOT-363 | MMDT3904-7-F | Diodes Inc. |
| R1, R5, R6, R7, R8, R21 | 6 | 1.0k | RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402 | 0402 | ERJ-2GEJ102X | Panasonic |
| R2, R3 | 2 | 0 | RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 0603 | ERJ-3GEY0R00V | Panasonic |
| R4, R9, R10, R11, R12, R17, R18, R20 | 8 | 4.70k | RES, 4.70 k, 1%, 0.1 W, 0402 | 0402 | ERJ-2RKF4701X | Panasonic |
| R19 | 1 | 1.00k | RES, 1.00 k, 1%, 0.1 W, 0603 | 0603 | ERJ-3EKF1001V | Panasonic |
| U1, U3 | 2 | | 4-Bit Dual-Supply Bus Transceiver with Configurable Voltage Translation and 3-State Outputs, RSV0016A (UQFN-16) | RSV0016A | SN74AVCH4T245RSVR | Texas Instruments |
| U2 | 1 | | Micropower, 150mA Low-Dropout CMOS Voltage Regulator, 5-pin SC-70, Pb-Free | DCK0005A | LP5951MG-1.8/NOPB | Texas Instruments |

**Table 5-1. BOOST-LDC3114EVM BOM (continued)**

| Designator | QTY | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| U4 | 1 | | 4-channel hybrid inductive touch and inductance to digital converter | TSSOP16 | LDC3114PWR | Texas Instruments |
| FID1, FID2, FID3 | 0 | | Fiducial mark. There is nothing to buy or mount. | N/A | N/A | N/A |
| J3, J4, J5, J6, J7, J8, J9, J10 | 0 | | Header, 100mil, 2x1, Gold, TH | 2x1 Header | TSW-102-07-G-S | Samtec |
| R13, R14, R15, R16 | 0 | 1.00k | RES, 1.00 k, 1%, 0.1 W, 0603 | 0603 | ERJ-3EKF1001V | Panasonic |

# 6 Revision History

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

| Changes from Revision A (September 2021) to Revision B (April 2022) | Page |
|---|---|
| • Added 3D printed attachments to the kit contents | 2 |
| • Updated GUI section to reflect changes in GUI version 1.1.0 | 4 |
| • Changed Figure 2-3 | 5 |
| • Changed Figure 2-5 | 7 |
| • Added direct EVM communication section | 8 |

| Changes from Revision * (February 2021) to Revision A (September 2021) | Page |
|---|---|
| • Changed the *Overview* section | 2 |
| • Changed the *Main EVM Elements* section | 2 |
| • Changed the *Basic Register Configuration* section | 6 |
| • Changed the *Schematic* section | 9 |
| • Changed the *Layout* section | 10 |
| • Changed the *Bill of Materials* section | 11 |

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