

## ADuCRF101 Evaluation Board User Guide

### FEATURES

**4-layer PCB (33 mm × 55 mm form factor)**

**2 power supply options**

**2.2 V to 3.6 V from an external power supply**

**5 V from interface/emulator board**

**Power indicator/general-purpose LEDs**

**Reset and download push buttons**

**8-pin connector to the interface/emulator board or to**

**RS-232 interface cable (top row)**

**Access to ADuCRF101 pins on the two footprints for through-hole connectors on the edge of the board**

**32.768 kHz watch crystal footprint**

**Matching network and SMA connector for wireless communication**

### EVALUATION KIT CONTENTS

**A DVD containing evaluation software, user guides, data sheets, and example code**

**Antenna**

**Emulator board (QuickStart and QuickStart Plus kits only)**

### GENERAL DESCRIPTION

The ADuCRF101 is a fully integrated, data acquisition solution designed for low power wireless applications. It features a 12-bit ADC, a low power ARM Cortex™-M3 processor, a 431 MHz to 464 MHz and 862 MHz to 928 MHz RF transceiver, and Flash/EE memory, in a 9 mm × 9 mm LFCSP package.

### EVALUATION BOARD OVERVIEW

The ADuCRF101 mini board allows a user to program, debug, and evaluate the performance of the ADuCRF101. Its small form factor makes it the ideal hardware for evaluation of large wireless sensor networks.

Six kits are available, from a mini board only, to a combination of emulator and boards.

- EV-ADuCRF101MK3Z mini board for 433 MHz operation
- EV-ADuCRF101MK1Z mini board for 868 MHz/915 MHz operation
- EV-ADuCRF101QSP1Z QuickStart Plus for 868 MHz/915 MHz operation
- EV-ADuCRF101QSP3Z QuickStart Plus for 433 MHz operation
- EV-ADuCRF101QS1Z QuickStart for 868 MHz/915 MHz operation
- EV-ADuCRF101QS3Z QuickStart for 433 MHz operation

Figure 1 shows the content of a quick start kit, one mini board with antenna and one emulator.



Figure 1 ADuCRF101 Mini Board and Emulator Board

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**REVISION HISTORY**

**5/13—Revision 0: Initial Version**

## DEVELOPMENT SYSTEMS DESCRIPTION

Different systems are available that are optimized for the various types of evaluation requirements.

Table 1 lists the contents available for each type of system.

**Table 1. Development Systems Content**

| Content        | Mini Kit (MK) | QuickStart (QS) | QuickStart Plus (QSP) |
|----------------|---------------|-----------------|-----------------------|
| Mini Board     | 1             | 1               | 2                     |
| Antenna        | 1             | 1               | 2                     |
| Emulator Board | 0             | 1               | 1                     |
| Battery Holder | 0             | 0               | 1                     |
| DVD            | 1             | 1               | 1                     |

The mini board is optimized for 433 MHz or 868MHz/915MHz operation.

Table 2 lists the models and their optimized communication frequency.

**Table 2. Development Systems Models**

| Model             | Description     | Frequency       |
|-------------------|-----------------|-----------------|
| EV-ADuCRF101MK1Z  | Mini kit        | 868 MHz/915 MHz |
| EV-ADuCRF101MK3Z  | Mini kit        | 433 MHz         |
| EV-ADuCRF101QS1Z  | QuickStart      | 868 MHz/915 MHz |
| EV-ADuCRF101QS3Z  | QuickStart      | 433 MHz         |
| EV-ADuCRF101QSP1Z | QuickStart Plus | 868 MHz/915 MHz |
| EV-ADuCRF101QSP3Z | QuickStart Plus | 433 MHz         |

### MINI KIT

The mini kit evaluation kits contain one mini board, one antenna, and a DVD containing software and documentation. This system can be ordered, in addition to the other development systems, to increase the number of nodes in a wireless sensor network.

The mini kit does not contain an emulator.

### QUICKSTART KIT

The QuickStart kit evaluation kits contain one mini board, one antenna, one emulator board, and a DVD containing software and documentation.. This kit is ideal to evaluate the ADuCRF101 as part of an existing wireless system.

### QUICKSTART PLUS KIT

The QuickStart Plus evaluation kit contain two mini boards, two antennas, one emulator board, a battery holder, and a DVD containing software and documentation. The QuickStart Plus kit has all the components needed to quickly set up a two-node wireless communication system.

### J-LINK OB EMULATOR

The J-Link OB emulator board provides a debug path via serial wire, supply, and UART communication with the ADuCRF101 mini board. Figure 2 shows a top view of the emulator board. The J2 connector plugs into the ADuCRF101 mini board. The J2 connector pinout is shown in Figure 3.

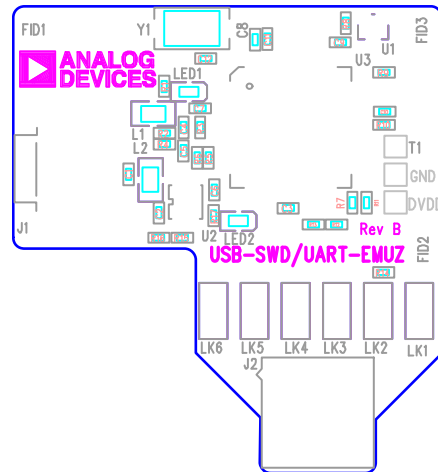
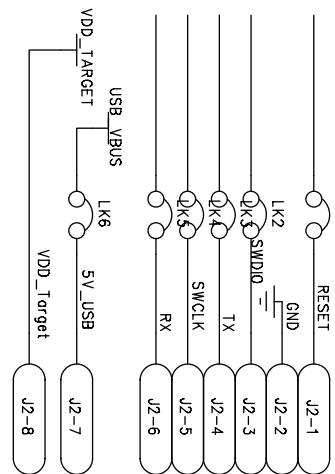


Figure 2. Emulator, Top View



MINIKIT BOARD CONNECTOR

Figure 3. J2 Connector

For downloading and debugging, LK1, LK2, LK4, and LK6 must be inserted. LK3 and LK5 are required to communicate via UART.

When measuring current consumption using an external supply on the ADuCRF101 mini board IOVDD pins, it is recommended that the emulator be disconnected.

## MINI BOARD FEATURES

### POWER SUPPLY

Two options are available for powering the board.

- Use the emulator board.  
The 5 V USB supply on J3.7 is regulated via the linear voltage regulator, U2. The 3.3 V regulator output powers the red power LED, D2. When LK1 is in place, the regulator output is connected back to the emulator board on J3.8. The regulator powers the [ADuCRF101](#) only when LK1 and LK2 are in place on the mini board.
- Apply an external power supply to IOVDD on J1.3.  
To measure the [ADuCRF101](#) current consumption only, apply the supply directly to IOVDD. Remove LK1 and LK2, and disconnect the emulator board.  
It is also possible to power the device from an external supply at 3.3 V while debugging with the emulator board. Remove LK1 and insert LK2.

Each device supply pin of the [ADuCRF101](#) is decoupled with 0.1  $\mu$ F and 100 pF capacitors. A 68  $\mu$ F capacitor is used on the supply line for the transceiver.

### POWER INDICATOR/GENERAL-PURPOSE LEDES

A power LED (D2) is used to indicate that the interface board is providing the supply to the board. Note that LK1 and LK2 must be inserted for the [ADuCRF101](#) to be powered from the emulator board. A general-purpose LED (D1) is connected to P4.2 of the [ADuCRF101](#). When P4.2 is cleared, the LED is turned on. When P4.2 is set, the LED is turned off.

### CRYSTAL CIRCUITS

Footprints for a through-hole 32.768 kHz watch crystal (Y2) and its two capacitors are included on the board. This crystal can be selected by software as the clock source of the wake-up timer.

### EMULATOR INTERFACE

Nonintrusive emulation and download are possible on the [ADuCRF101](#) via serial wire by connecting the emulator board to the J3 connector. Only two signals are required for debug purposes: SWDIO and SWCLK. The reset signal is also connected and can be used to provide a reset from the PC, if required.

Other emulators supporting serial wire debug (for example, JLINK Version 6 and higher) can be used. The connections between the mini board and the 20-pin JTAG connector are listed in Table 3.

**Table 3. Mini Board/Emulator Connections**

| Signal | J3 Connector (Mini Board) | 20-Pin JTAG Connector (Emulator)                                    |
|--------|---------------------------|---|
| GND    | J3.2                      | Pin 4, Pin 6, Pin 8, Pin 10, Pin 12, Pin 14, Pin 16, Pin 18, Pin 20 |
| VDD    | J3.8                      | Pin 1 and Pin 2   |
| SWDIO  | J3.3                      | Pin 7   |
| SWCLK  | J3.5                      | Pin 9   |
| RESET  | J3.1                      | Pin 15  |

Note that the internal pull-ups on SWDIO and SWCLK are sufficient, and no external resistors are required.

### RESET/DOWNLOAD PUSH BUTTONS

A reset push button is available to allow the user to reset the part manually. When pressed, the reset pin of the [ADuCRF101](#) is pulled to ground. Because the RESET pin on the [ADuCRF101](#) is Schmidt-triggered internally, there is no need to use an external Schmidt trigger on this pin. A second push button, BOOT, is connected to P0.6/IRQ2 and facilitates serial download mode entry.

### RS-232 INTERFACE

To interface the [ADuCRF101](#) UART pins to a PC, the USB UART interface on the emulator board is the first option to consider.

The [ADuCRF101](#) P1.0 and P1.1 lines are available on the top row of the J3 connector and can be directly connected to [EVAL-ADUC-CABLE1Z](#), as shown in Figure 4, or similar adaptor that includes an RS-232 interface device providing the required level shifting or a USB UART interface. Supply should be provided on J1.3 (IOVDD) and LK2 inserted when using an RS-232 interface.

To communicate via UART using a UART cable, [EVAL-ADUC-CABLE1Z](#), the supply should be between 3 V and 3.6 V because the cable is operational only in this supply range. The [EVAL-ADUC-CABLE1Z](#) is available for purchase on the Analog Devices, Inc. web site.

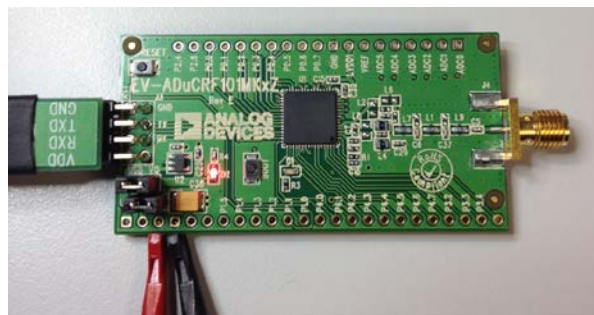


Figure 4. Mini Board Connected to [EVAL-ADUC-CABLE1Z](#)

## RF MATCHING NETWORK

An RF matching network is available to match the LNA input impedance and PA output with the 50  $\Omega$  SMA connector (J4) for [ADuCRF101](#) at different frequencies depending on the board used.

Different boards are available based on the RF transceiver frequency required. See Table 4 for the relevant model numbers.

**Table 4. ADuCRF101 Development Systems Optimized Communication Frequency**

| Frequency       | Topology                         | Models  |
|-----------------|----------------------------------|---|
| 868 MHz/915 MHz | Differential PA                  | EV-ADuCRF101MK1Z<br>EV-ADuCRF101QS1Z<br>EV-ADuCRF101QSP1Z |
| 433 MHz         | Differential and single-ended PA | EV-ADuCRF101MK3Z<br>EV-ADuCRF101QS3Z<br>EV-ADuCRF101QSP3Z |

The list of components for the different models available is available in Table 8 to Table 12.

The 868 MHz/915 MHz models come with a matching network for differential PA only. The matching network components can be modified to evaluate the single-ended PA. The list of components for single-ended PA operating at 868 MHz/915 MHz is available in Table 13.

The 433 MHz models come preloaded with a combined matching network for both differential and single ended PA operation.

## SENSITIVITY MEASUREMENTS

To perform the BER test on the RF transceiver, the internal clock and data signals of the transceiver can be brought to the [ADuCRF101](#) GPIO pins

- The CLOCK signal can be brought out to P0.6.
- The DATA signal can be brought out to P2.6.

## MINI BOARD CONNECTORS

### EDGE CONNECTORS J1 AND J2

ADuCRF101 signals, such as GPIOs and analog inputs are available on the edge of the board, on two unpopulated through-hole connectors. These two connectors can be used to plug the mini board into a prototype board.

The pinout of the two edge connectors is shown in Table 5 and in Table 6.

**Table 5. Pin Functions for Edge Connector J1**

| Pin Number | Pin Function |
|------------|--------------|
| J1-1       | 5VOUT        |
| J1-2       | VDDOUT       |
| J1-3       | IOVDD        |
| J1-4       | GND          |
| J1-5       | RESET        |
| J1-6       | NC           |
| J1-7       | P1.5         |
| J1-8       | P1.4         |
| J1-9       | P1.3         |
| J1-10      | P1.2         |
| J1-11      | P1.1         |
| J1-12      | P1.0         |
| J1-13      | P4.0         |
| J1-14      | P4.1         |
| J1-15      | P4.2         |
| J1-16      | P4.3         |
| J1-17      | P4.4         |
| J1-18      | P4.5         |
| J1-19      | P4.6         |
| J1-20      | P4.7         |
| J1-21      | P3.2         |
| J1-22      | P3.3         |
| J1-23      | P3.4         |
| J1-24      | P3.5         |

**Table 6. Pin Functions for Edge Connector J2**

| Pin No. | Pin Function |
|---------|--------------|
| J2-1    | ADC0         |
| J2-2    | ADC1         |
| J2-3    | ADC2         |
| J2-4    | ADC3         |
| J2-5    | ADC4         |
| J2-6    | ADC5         |
| J2-7    | VREF         |
| J2-8    | LVDD1        |
| J2-9    | GND          |
| J2-10   | P0.7         |
| J2-11   | P0.6         |
| J2-12   | P0.5         |
| J2-13   | P0.4         |
| J2-14   | P0.3         |
| J2-15   | P0.2         |
| J2-16   | P0.1         |
| J2-17   | P0.0         |
| J2-18   | P2.6         |
| J2-19   | P2.4         |

### EMULATION AND SERIAL INTERFACE CONNECTOR J3

Connector J3 provides a connection with the emulation board. The pinout for the J3 connector is described in Table 7.

**Table 7. Pin Functions for Edge Connector J3**

| Pin No. | Pin Function |
|---------|--------------|
| J3-1    | RESET        |
| J3-2    | GND          |
| J3-3    | SWDIO        |
| J3-4    | TX           |
| J3-5    | SWCLK        |
| J3-6    | RX           |
| J3-7    | 5VUSB        |
| J3-8    | VDDOUT       |

MINI BOARD SCHEMATIC AND ARTWORK

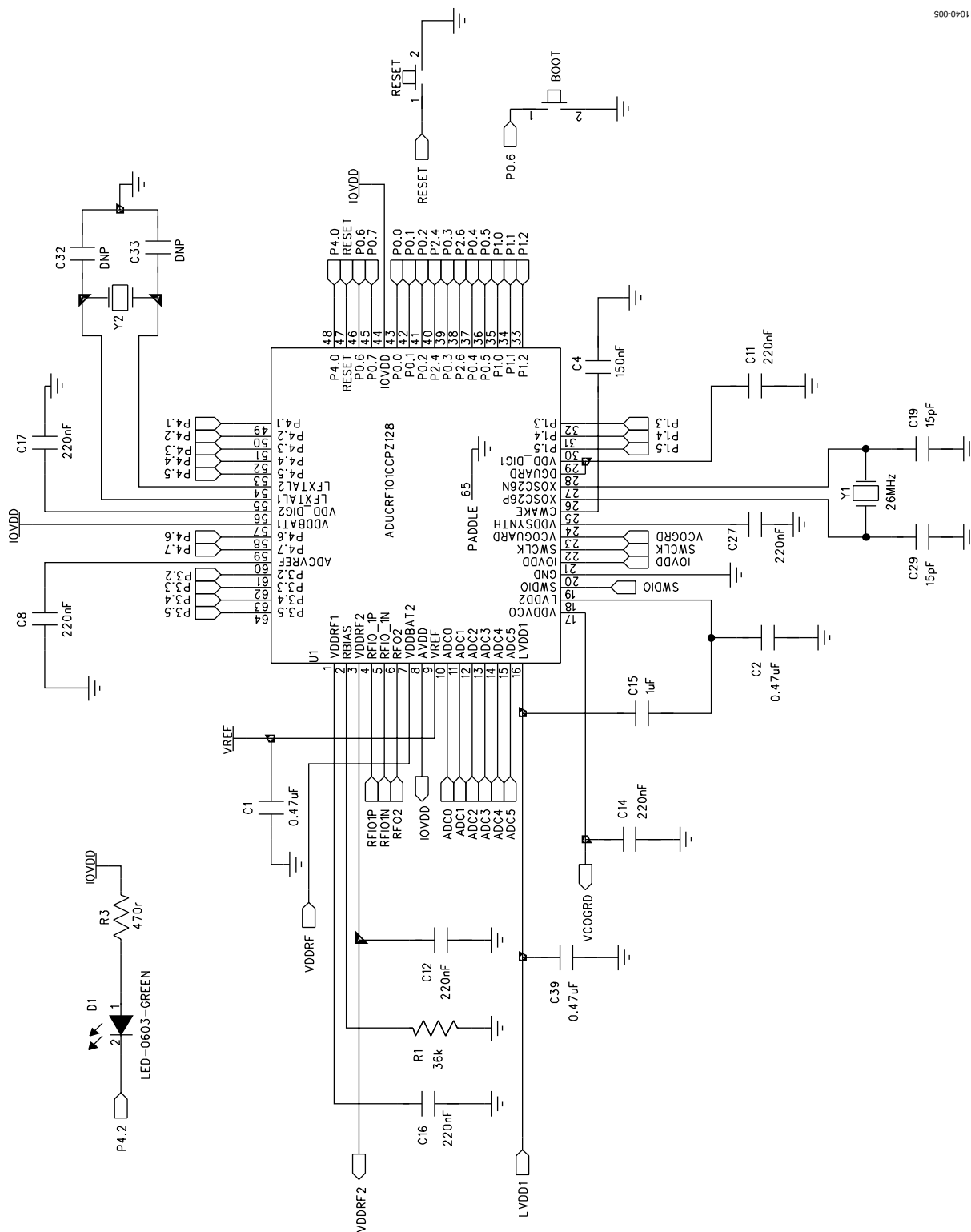
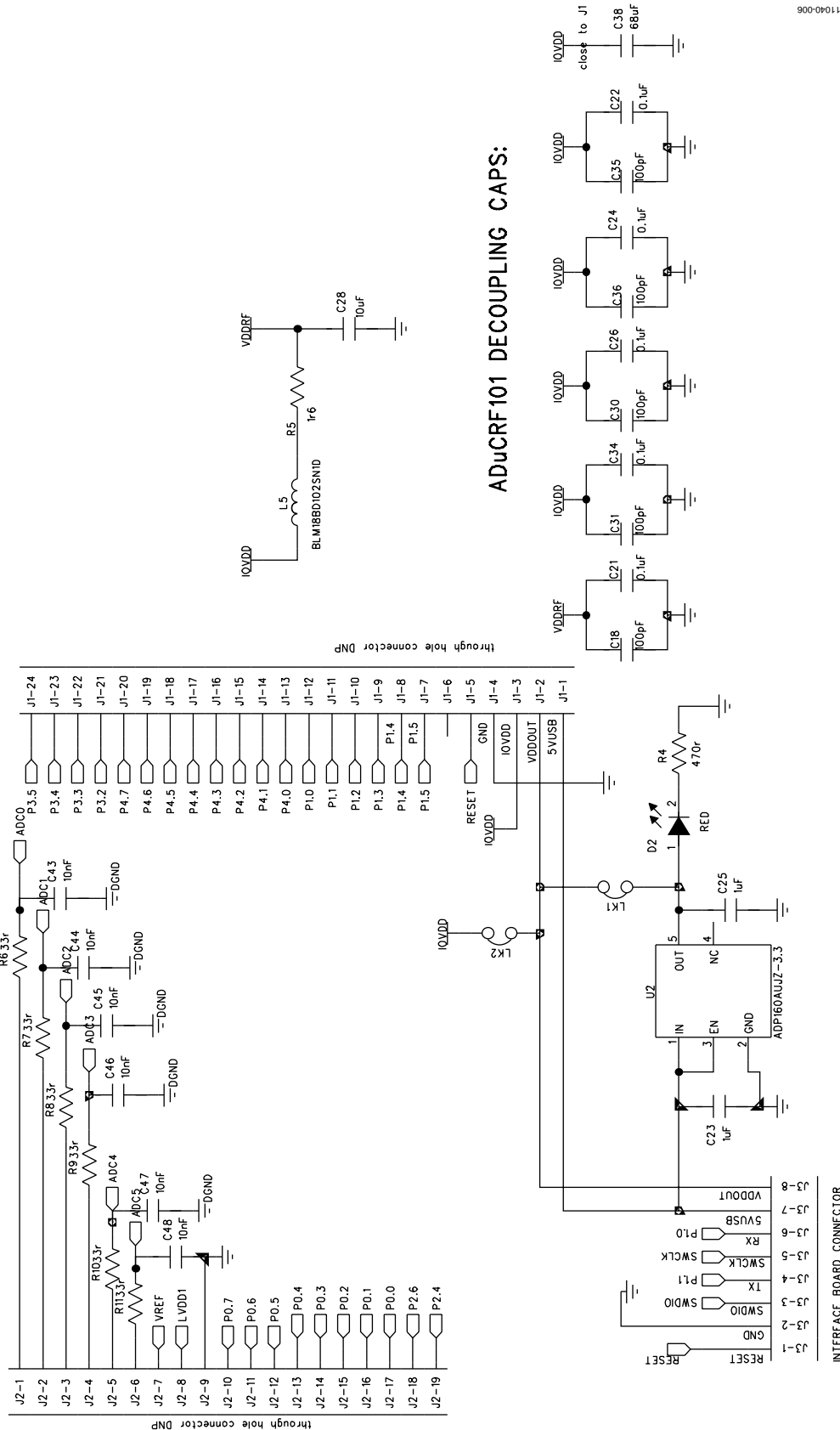
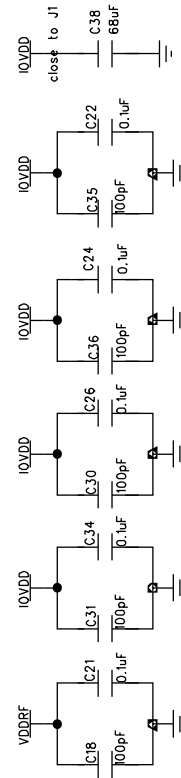


Figure 5. ADuCRF101



ADuCRF101 DECOUPLING CAPS:



through hole connector DNP

Figure 6. Connectors



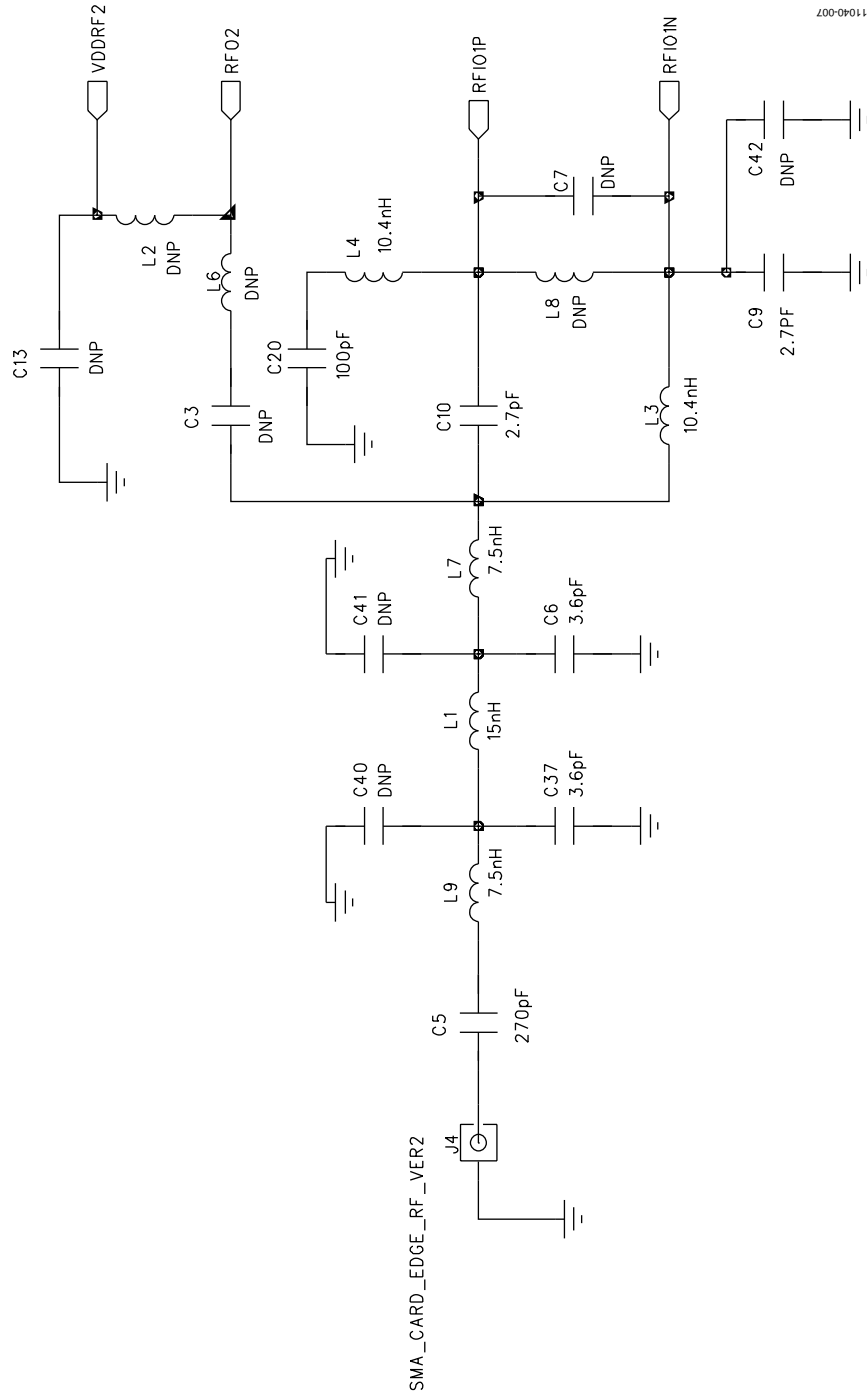


Figure 7. Matching Network Section

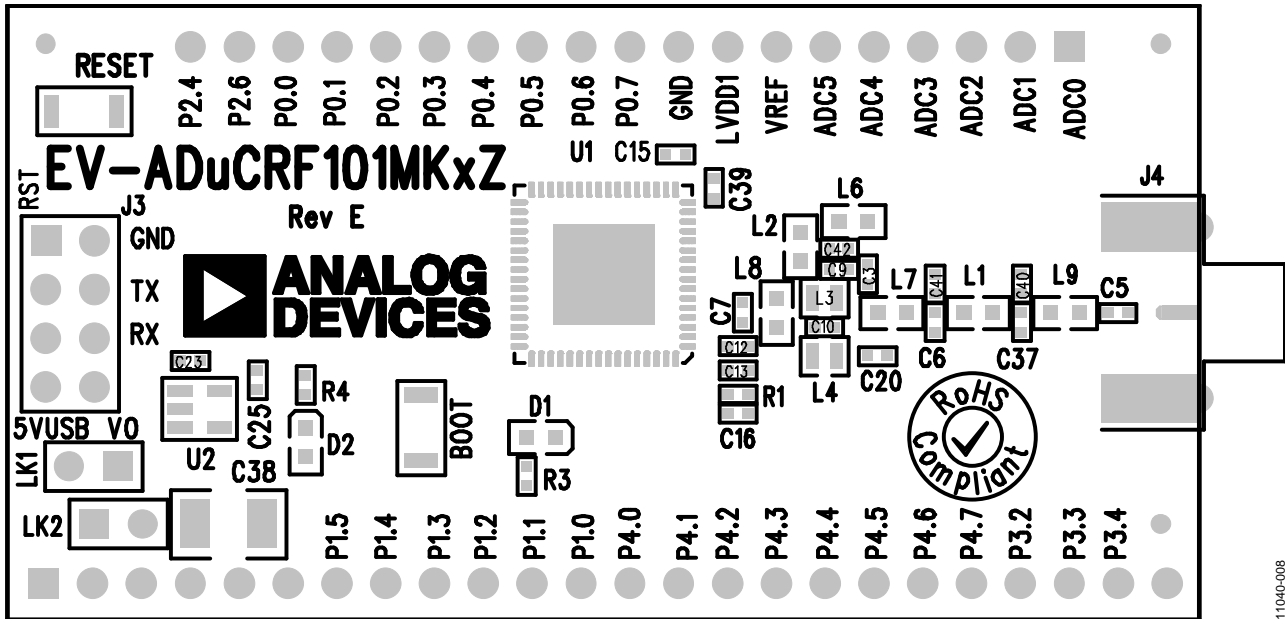


Figure 8. Top Side Silkscreen

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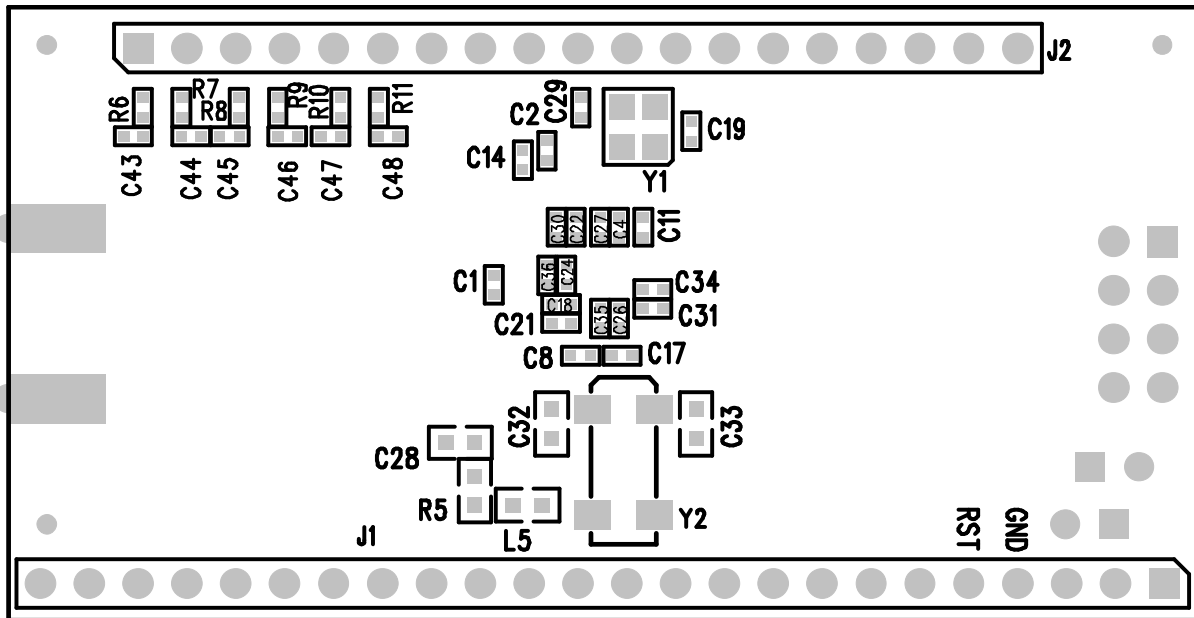


Figure 9. Bottom Side Silkscreen

11040-008

## BILL OF MATERIALS

Table 8.

| Qty | Component                        | Description  | Order No.                | Supplier       |
|-----|----------------------------------|--|--------------------------|----------------|
| 1   | EV-ADuCRF101MKxZ, Rev. E PCB     | Two-sided surface mount PSB-1                        |                          | Analog Devices |
| 1   | U1                               | Precision analog microcontroller with RF transceiver | ADuCRF101BCPZ128         | Analog Devices |
| 1   | U2                               | Low quiescent current, 3.3 V linear regulator        | ADP121-AUJZ33R7          | Analog Devices |
| 2   | Boot, Reset                      | SMD push button switch                               | B3U-1000P                | Farnell        |
| 1   | D1                               | LED, SMD, green                                      | LGQ971                   | Digi-Key       |
| 1   | D2                               | LED, 0603, red                                       | LSQ976-Z                 | Farnell        |
| 3   | C1, C2, C39                      | 0.47 $\mu$ F capacitor, 16 V, Y5V, ceramic 0402      | GRM155F51C474ZA01D       | Digi-Key       |
| 1   | C4                               | 150 nF capacitor, 10%, 10 V, 0402                    | GRM155R61A154KE19D       | Digi-Key       |
| 7   | C8, C11, C12, C14, C16, C17, C27 | 220 nF ceramic capacitor, 10 V, X5R                  | LMK105BJ224KV-F          | Digi-Key       |
| 5   | C18, C30, C31, C35, C36          | 100 pF capacitor, 5%, 50 V, 0402                     | GRM1555C1H101JD01D       | Farnell        |
| 2   | C19, C29                         | 15 pF capacitor, 50 V, 5%, C0G, 0402                 | GRM1555C1H150JZ01D       | Digi-Key       |
| 5   | C21, C22, C24, C26, C34          | 0.1 $\mu$ F ceramic capacitor, 16 V, X7R, 0402       | GRM155R71C104KA88D       | Digi-Key       |
| 3   | C15, C23, C25                    | 1 $\mu$ F capacitor, 10%, 6.3 V, X5R, 0402           | C0402C105K9PACTU         | Digi-Key       |
| 1   | C28                              | 10 $\mu$ F ceramic capacitor, 6.3 V, 20%, X5R, 0603  | GRM188R60J106ME47D       | Digi-Key       |
| 2   | C32, C33                         | Not inserted   | Not inserted             | Not inserted   |
| 1   | C38                              | 68 $\mu$ F tantalum capacitor, 6.3 V, 20%, 1210      | TCJB686M006R0070         | Digi-Key       |
| 6   | C43, C44, C45, C46, C47, C48     | 10 nF ceramic capacitor, 6.3 V, 10%, X7R, 0402       | 1758885                  | Farnell        |
| 2   | J1, J2                           | Not inserted   | Not inserted             | Not inserted   |
| 1   | J3                               | 8-pin R/A header                                     | 9-103324-0               | Farnell        |
| 1   | J4                               | Conn jack end launch PC gold SMA                     | 142-0701-851             | Digi-Key       |
| 1   | L5                               | Ferrite bead, 600 $\Omega$ at 100 MHz                | BLM18BD102SN1D           | Digi-Key       |
| 2   | LK1, LK2                         | 2-pin (0.1" pitch) header and shorting shunt         | M20-9990246              | Farnell        |
| 1   | R1                               | 36k $\Omega$ resistor, 1/16W, 1%, 0402 SMD           | RC0402FR-0736KL          | Digi-Key       |
| 2   | R3, R4                           | 470 $\Omega$ resistor, 1/16W, 1% 0402 SMD            | MCR01MZPF4700            | Digi-Key       |
| 1   | R5                               | 1.6 $\Omega$ resistor, 1/10W, 5% 0603 SMD            | RC0603JR-071R6L          | Digi-Key       |
| 6   | R6, R7, R8, R9, R10, R11         | 33 $\Omega$ resistor, 1/16W, 1% 0402 SMD             | RHM33CECT-ND             | Digi-Key       |
| 1   | Y1                               | Crystal 26 MHz, 10 pF, 3.2 X 2.5 SMD                 | NX3225SA-26.000000MHZ-G2 | Digi-Key       |
| 1   | Y2                               | 32 kHz crystal                                       | Not inserted             | Not inserted   |
| 1   | Antenna                          | 433 MHz range antenna                                | SMAMFDRA433              | VW Badland     |
|     |                                  | 868 MHz/915 MHz range antenna                        | ANT-916-CW-HWR-SMA       | Digi-Key       |

Table 9. Matching Network Bill of Material for MK1 Model (868 MHz/915 MHz Operation, Differential PA)

| Qty | Component        | Description                                | Order No.          | Supplier     |
|-----|------------------|--|--------------------|--------------|
| 4   | C3, C7, C13, C42 | Not inserted                               | Not inserted       | Not inserted |
| 2   | C9, C10          | 2.7 pF ceramic capacitor, 50 V, C0G, 0402  | GRM1555C1H2R7CZ01D | Digi-Key     |
| 1   | C20              | 100 pF capacitor, 5%, 50 V, 0402           | GRM1555C1H101JD01D | Farnell      |
| 3   | L2, L6, L8       | Not inserted                               | Not inserted       | Not inserted |
| 2   | L3, L4           | 10.4 nH RF inductor, ceramic core, 5% 0603 | 0604HQ-10NXJL      | Coilcraft    |

Table 10. Harmonic Filter Bill of Material for MK1 Model (868 MHz/915 MHz Operation, Differential PA)

| Qty | Component | Description                                 | Order No.          | Supplier     |
|-----|-----------|---|--------------------|--------------|
| 1   | C5        | 270 pF ceramic capacitor, 50 V 5% C0G, 0402 | GRM1555C1H271JA01D | Digi-Key     |
| 2   | C6, C37   | 3.6 pF ceramic capacitor, 50 V C0G, 0402    | GJM1555C1H3R6CB01D | Digi-Key     |
| 2   | C40, C41  | Not inserted                                | Not inserted       | Not inserted |
| 1   | L1        | 15 nH RF inductor, ceramic core, 5% 0603    | 0603HP-15NXJL      | Coilcraft    |
| 2   | L7, L9    | 7.5 nH RF inductor, ceramic core, 5% 0603   | 0603HP-7N5XJL      | Coilcraft    |

Table 11. Matching Network Bill of Material for MK3 Model (433 MHz Operation)

| Qty | Component | Description                               | Order No.          | Supplier     |
|-----|-----------|---|--------------------|--------------|
| 1   | C3        | 270 pF capacitor, 5%, 50 V 0402           | GRM1555C1H271JA01D | Digi-Key     |
| 2   | C9, C10   | 5.6 pF ceramic capacitor, 50 V, C0G, 0402 | GRM1555C1H5R6DZ01D | Digi-Key     |
| 2   | C13, C20  | 100 pF capacitor, 5%, 50 V, 0402          | GRM1555C1H101JD01D | Digi-Key     |
| 2   | C7, C42   | Not inserted                              | Not inserted       | Not inserted |
| 1   | L2        | 100 nH 0603 inductor                      | 0603HP-R10XJL      | Coilcraft    |
| 1   | L8        | Not inserted                              | Not inserted       | Not inserted |
| 1   | L6        | 15 nH 0603 inductor                       | 0603HP-15NXJL      | Coilcraft    |
| 2   | L3, L4    | 27 nH 0603 inductor                       | 0603HP-27NXJL      | Coilcraft    |

Table 12. Harmonic Filter Bill of Material for MK3 Model (433 MHz Operation)

| Qty | Component | Description                                  | Order No.          | Supplier     |
|-----|-----------|--|--------------------|--------------|
| 1   | C5        | 270 pF ceramic capacitor, 50 V, 5%, C0G 0402 | GRM1555C1H271JA01D | Digi-Key     |
| 2   | C6, C37   | 8.2 pF ceramic capacitor, 50 V, C0G 0402     | GJM1555C1H8R2DB01D | Digi-Key     |
| 2   | C40, C41  | Not inserted                                 | Not inserted       | Not inserted |
| 1   | L1        | 30 nH 0603 inductor                          | 0603HP-30NXJL      | Coilcraft    |
| 2   | L7, L9    | 18 nH 0603 inductor                          | 0603HP-18NXJL      | Coilcraft    |

Table 13. Matching Network Bill of Material for Single-Ended PA Topology at 868 MHz/915 MHz Operation

| Qty | Component | Description                               | Order No.          | Supplier     |
|-----|-----------|---|--------------------|--------------|
| 1   | C3        | 150 pF ceramic capacitor, 50V 5% NP0 0402 | GCM1555C1H151JA16D | Digi-Key     |
| 2   | C9, C10   | 1.5 pF ceramic capacitor, 50 V, C0G 0402  | GJM1555C1H1R5CB01  | Digi-Key     |
| 1   | C13       | 100 pF capacitor, 5%, 50 V 0402           | GRM1555C1H101JD01D | Digi-Key     |
| 2   | C7, C42   | Not inserted                              | Not inserted       | Not inserted |
| 1   | C20       | 100 pF capacitor, 5%, 50 V 0402           | GRM1555C1H101JD01D | Digi-Key     |
| 1   | L2        | 47 nH 0603 inductor                       | 0603HP-47NXJL      | Coilcraft    |
| 1   | L8        | Not inserted                              | Not inserted       | Not inserted |
| 1   | L6        | 1.8 nH 0603 inductor                      | 0603HP-1N8XJL      | Coilcraft    |
| 2   | L3, L4    | 10 nH 0603 inductor                       | 0604HQ-10NXJL      | Coilcraft    |

**ESD Caution**

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

**Legal Terms and Conditions**

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