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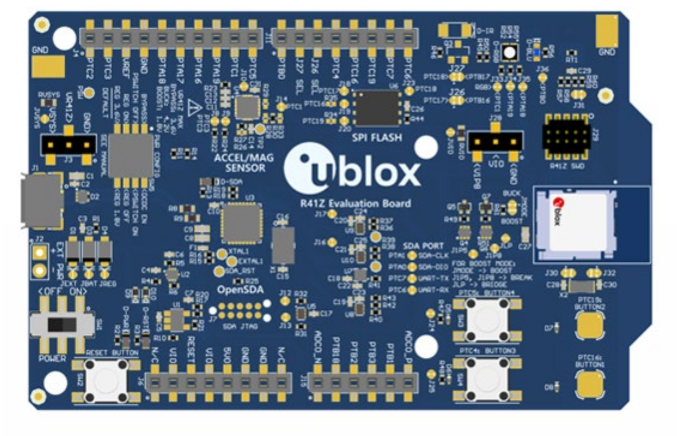
EVK-R41Z

Evaluation kit for R41Z modules

User guide



Abstract

This document describes how to set up the EVK-R41Z evaluation kit to evaluate R41Z series modules. It also describes the different options for debugging and the development capabilities included in the evaluation board.

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Document information

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This document applies to the following products:

Product name	Type number
R41Z-Eval	R41Z-Eval-00

Contents

1 Product description

The R41Z evaluation kit allows for stand-alone use of the R41Z module featuring the NXP MKW41Z RF System on Chip (SoC).

This guide provides setup instructions for starting development and describes the hardware functionality of the R41Z evaluation kit that can facilitate development of your project.

The R41Z evaluation kit provides a great starting point for almost any Bluetooth low energy, Thread, or Zigbee project. All the features of the R41Z module are easily accessed from the evaluation board. A simple USB connection provides power and OpenSDA V2.1 based debugging. Four user buttons (two conventional and two capacitive) are available, as well as an RGB LED, reset button, combination acceleration/magnetometer sensor, and an external 4 Mbit flash module. Arduino form factor headers provide access to 16 GPIO and 6 analog inputs. This allows for easy use of the many existing Arduino shields. Current sense resistors allow for measuring current into the R41Z module and into the shield.

1.1 Key features

- R41Z Bluetooth low energy and IEEE 802.15.4 module
- On-board programming and debug (OpenSDA v2.1)
- Virtual COM port over USB
- Pin-for-pin compatible with projects created for the NXP FRDM-KW41Z board
- Buttons and LEDs for user interaction
- 3-axis combination accelerometer and magnetometer, I2C interface
- 4 Mbit Flash, SPI interface
- Provision for IR LED
- 32.768 kHz crystal
- CR2032 battery holder
- Supports all DC-DC modes of the R41Z module
- Adjustable output regulator simplifies development

Figure 1: EVK-R41Z evaluation board (Top view)

1.2 Kit includes

R41Z evaluation kit includes:

- R41Z evaluation board
- Micro-USB cable
- Quick start guide

1.3 Development tools

The tools listed below will aid in development with the R41Z modules. Not all tools will be required depending on which software suite is used.

Tool	Description
MCUXpresso IDE	An easy-to-use integrated development environment (IDE) for creating, building, debugging, and optimizing your application.
MCUXpresso SDK	An open source software development kit (SDK) built specifically for your processor and evaluation board selections.
MCUXpresso Config Tools	A comprehensive suite of system configuration tools, including pins, clocks, Peripherals, and more.
NXP IoT Toolbox	IoT Toolbox is an all-in-one application capable of demonstrating NXP's Bluetooth® LE, Zigbee and Thread capabilities through the implementation of Bluetooth® LE and custom proprietary profiles, allowing the interaction with different smartphones.

Table 1: Useful tools

2 Hardware description

Design files for the R41Z evaluation kit can be obtained from your u-blox sales representative.

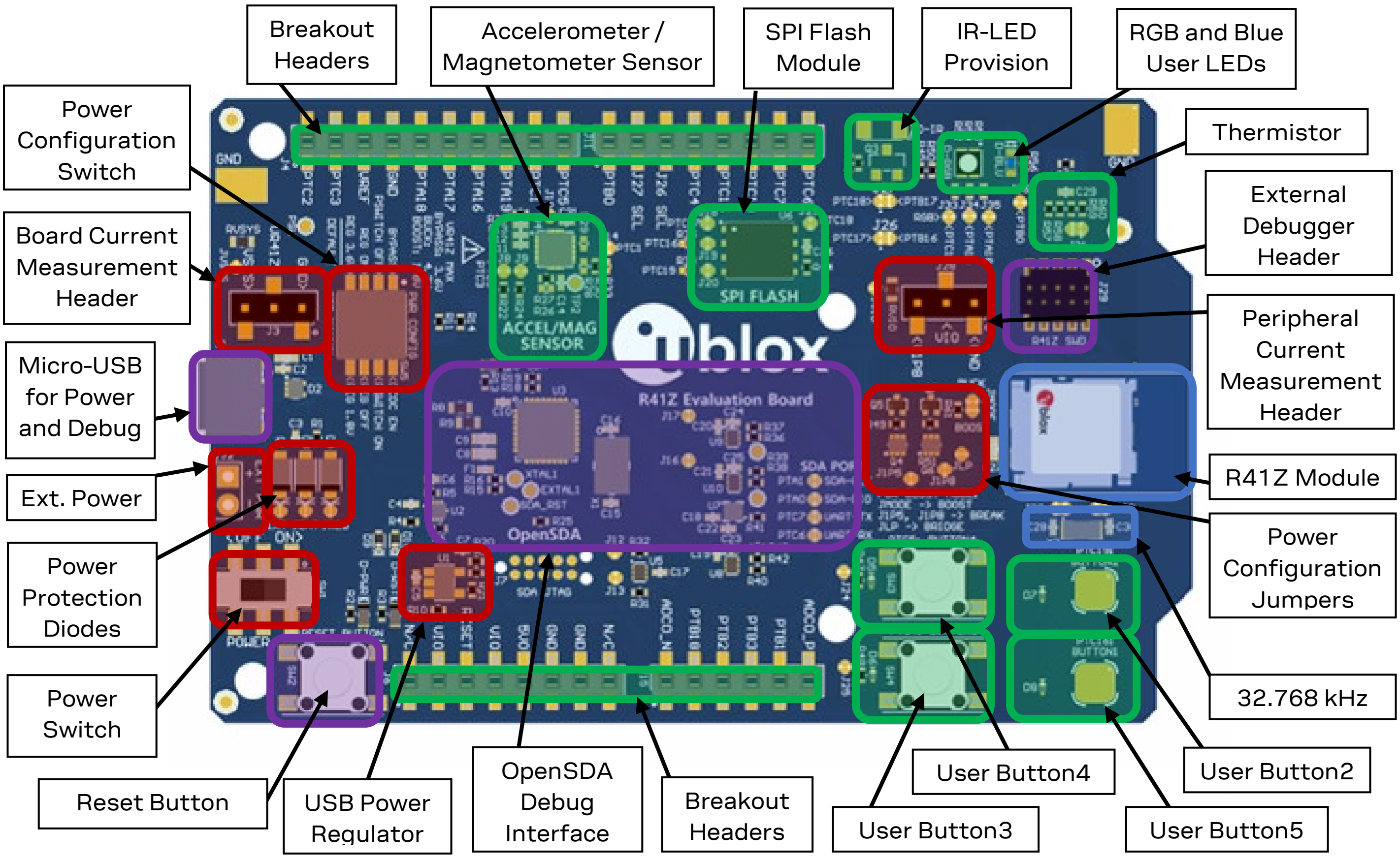

Figure 2: Evaluation board layout

2.1 Power

The R41Z evaluation board has three possible power sources: USB, a CR2032 coin cell, and a 2.54 mm through-hole connector. These sources are connected through protection diodes to prevent reverse voltage to any supply. These allows for more than one source to be connected at a time. For example, a coil cell battery may remain connected to the board while the board is being debugged with the USB source connected. However, since the diodes do cause approximately a 0.3 V drop in source voltage, there is the option to bypass the diodes via solder jumpers.

☞ Care should be taken to not damage the supplies or evaluation board when the protection is by-passed.

If necessary, the LDO regulator can be disabled in order to allow for USB based debugging while powering the R41Z from either an external source or a coil cell. Since the R41Z can accept a wide range of power options, the LDO regulator can be adjusted to simulate some sources. For details on these options, see the power configuration switch, section 2.2.1.

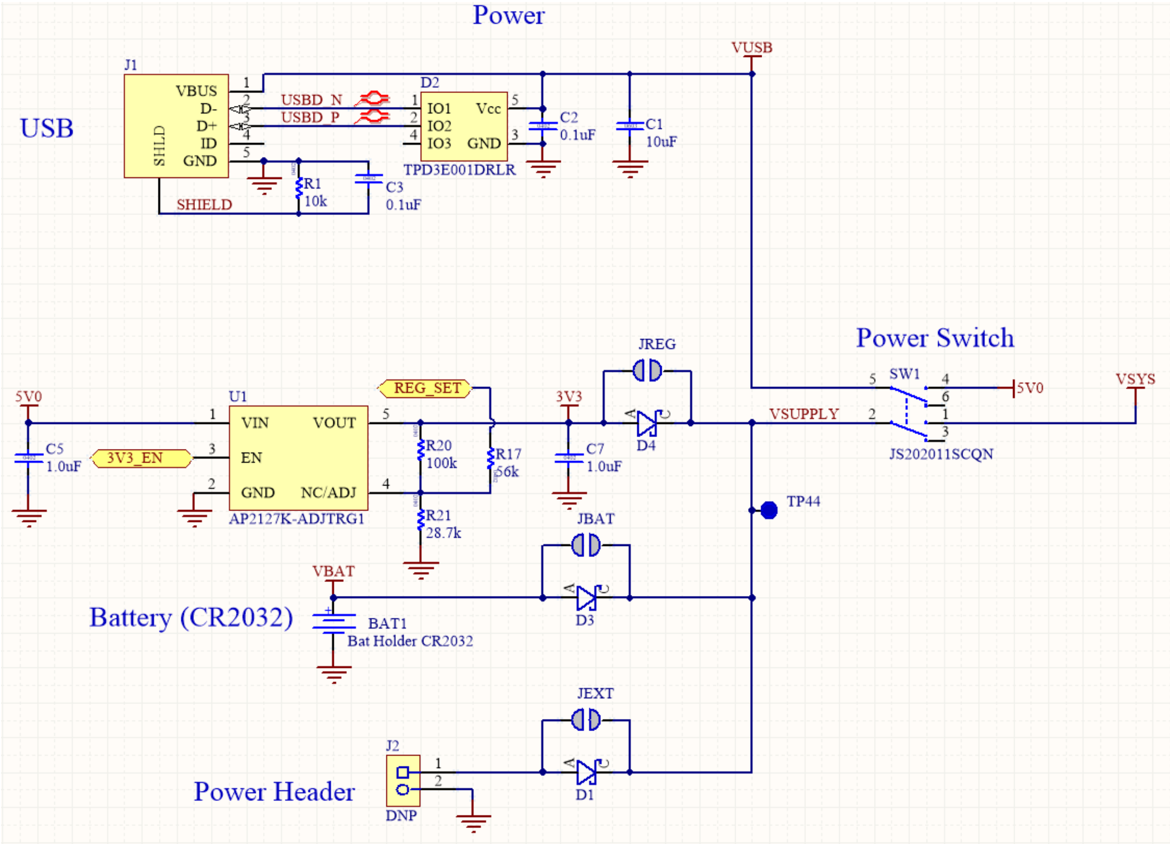

Figure 3: Schematic: Power supply

2.2 R41Z power modes

The R41Z module contains a DC-DC converter that allows it to operate in a variety of power environments. The R41Z evaluation board supports all these operating modes, which are summarized in Table 2:

Mode	Input voltage	Output voltage	Usage notes
Bypass	1.71 V – 3.6 V	N/A	DC-DC Converter is bypassed: Input voltage directly supplies all internal module power rails. Suitable for larger or non-battery powered applications that have steady, regulated 3.3 V or 1.8 V power rails that power multiple devices. Since the DC-DC converter is bypassed in this mode, the R41Z cannot provide regulated power to other devices.
Buck	1.8 V – 4.2 V	1.8 V – 3.0 V [1]	DC-DC Converter operates in buck mode. Internal power rails are sourced and regulated by the R41Z module. An externally available power rail (V1P8) allows the R41Z to supply regulated power to other peripheral devices. Suitable for small applications powered directly from a lithium ion battery [2]. If total power consumption is low, the R41Z module can provide a regulated power rail to supply other devices.
Boost	0.9 V – 1.8 V	1.8 V – 3.0 V [1]	DC-DC Converter operates if boost mode. Internal power rails are sourced and regulated by the R41Z module. An externally available power rail (V1P8) allows the R41Z to supply regulated power to other peripheral devices. Suitable for small applications powered directly from a low voltage battery [2] (For example, alkaline or NiMH). If total power consumption is low, the R41Z module can provide a regulated power rail to supply other devices.
Note 1: Output voltage is user adjustable in Buck and Boost mode. Defaults to 1.8 V at Power On Reset. In Buck mode, output voltage cannot be greater than input voltage.			
Note 2: The R41Z does not include automatic battery management. Applications powered from batteries must include battery management and protection features implemented with additional hardware and/or software.			

Table 2: R41Z DC-DC converter power modes

2.2.1 Power configuration switch

The power configuration switch allows easy and quick adjustment of most power settings on the R41Z evaluation board.

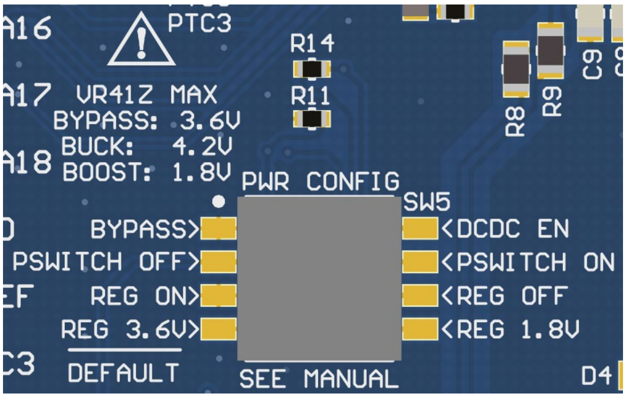

Figure 4: Power configuration switch

SW position	Default (SW position off)	Option (SW position on)
1	Bypass Power Mode	DC-DC Power Mode. Buck Mode by default; Boost mode selectable with Power Configuration Jumpers. See DC-DC Mode Selection.
2	PSWITCH OFF. When in Buck Mode, the DC-DC converter will not start when power is applied. Use this option when using Bypass Mode.	PSWITCH ON. When in Buck mode, the DC-DC converter will automatically start when power is applied. Use this option when using Boost Mode.
3	Regulator On. When USB is connected, the LDO regulator will supply power to the evaluation board.	Regulator Off. When USB is connected, the LDO regulator will not supply power.
4	Regulator 3.6 V. When USB is connected, the LDO regulator will output 3.6 V. With the reverse protection diode, 3.3 V is applied to the R41Z.	Regulator 1.8 V. When USB is connected, the LDO regulator will output 1.8 V. With the reverse protection diode, 1.5 V is applied to the R41Z. Useful for using Boost mode.

Table 3: Power configuration switch options

2.2.2 DC-DC mode selection

For details regarding the electrical connections required to implement each power mode, please reference the R41Z evaluation board Schematic and R41Z Module Data Sheet. These documents are available online at the u-blox website.

Switching between Bypass Mode and Buck mode can be accomplished using the Power Configuration Switch. To use Boost Mode there are other changes that must be made through the power configuration jumpers, summarized below.

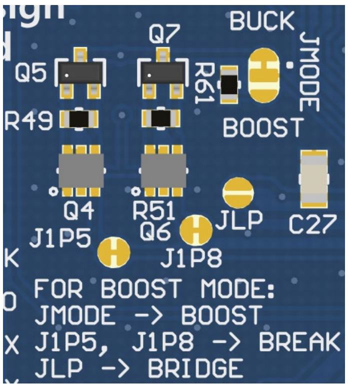

Figure 5: Power configuration jumpers (Default)

The 4 jumpers used to switch between Buck and Boost DC-DC modes are labeled JMODE, JLP, J1P5, and J1P8. See the figures below for how to set these jumpers along with the correct Power Configuration Switch positions.

Mode	PWR Config SW	JMODE	JLP	J1P5	J1P8
Bypass	Pos. 1: Bypass (off) Pos. 2: PSWITCH (off) Pos. 4: REG 3.6 V (off)	Buck (Default)	Open (Default)	Closed (Default)	Closed (Default)
Buck	Pos. 1: DC-DC EN (on) Pos. 2: PSWITCH (off or on*) Pos. 4: REG 3.6 V (off)	Buck (Default)	Open (Default)	Closed (Default)	Closed (Default)
Boost	Pos. 1: DC-DC EN (on) Pos. 2: PSWITCH (on) Pos. 4: REG 1.8 V (on)	Boost	Closed	Open	Open
*Note: See Table 3 for information about using PSWITCH in Buck mode					

Table 4 – DC-DC Mode selection

Figure 6 shows the power configuration jumpers in Boost mode with solder jumpers across JMODE and JLP. JMODE features a white dot, highlighted by a red circle below, to indicate the default bridged connection. Do not bridge all three pads of jumper JMODE.

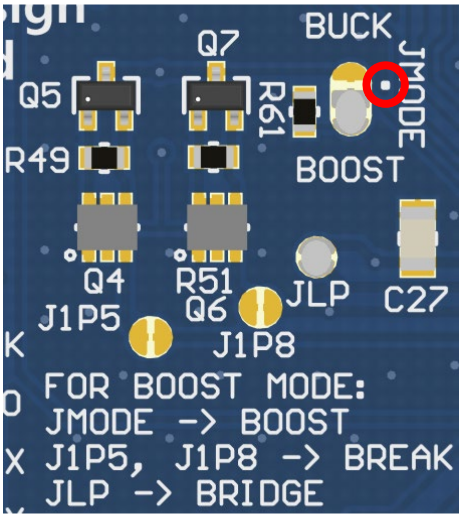

Figure 6: Power configuration jumpers (Boost mode)

2.2.3 Measuring power consumption

When operating the R41Z evaluation board in Bypass power mode, the board power source (LDO regulator, coin cell, or external power) directly powers the R41Z module as well as all onboard peripheral devices and any connected expansion shield.

When operating in either Buck or Boost DC-DC power mode, the R41Z module supplies regulated power to the peripheral devices and shield.

The evaluation board features two current measurement headers that allow direct measurement of total system current and peripheral current. The current consumption of only the R41Z Module can be indirectly measured by subtracting the peripheral current from the system current reading.

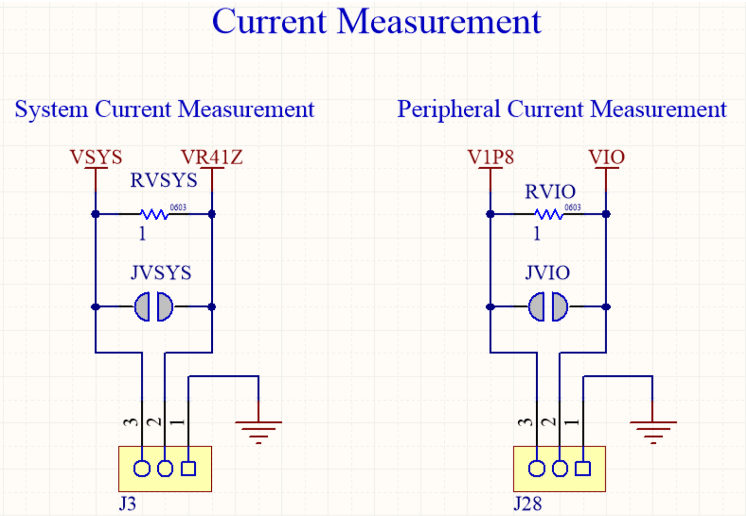

Figure 7: Schematic: Current measurement headers

2.3 Debug interface

The R41Z evaluation board features an OpenSDA 2.1 interface which includes a SWD connection and virtual COM port for easy programming and debugging of the R41Z module.

2.3.1 OpenSDA interface

The OpenSDA hardware is separated from the R41Z target by a set of level shifters to ensure that debugging can be done regardless of the DC-DC mode used. The interface will operate in a similar manner to other evaluation boards that use OpenSDA. When connected to a host computer, the evaluation board will appear as a mass storage device named "FRDM-KW41Z". Binary files can be directly copied to this drive to load them to the R41Z target.

The R41Z evaluation board ships with a SEGGER debug application loaded though other OpenSDA 2.1 applications may be used. To load a new OpenSDA application, apply power to the board while holding the reset button. The evaluation board will appear as mass storage device named "Maintenance" onto which the OpenSDA application binary can be copied.

2.3.2 Reset button

The primary function of the reset button is to reset the R41Z module. It is also used to put the OpenSDA interface into "Maintenance" mode to allow for different debug applications to be loaded. The reset pin on the R41Z module and the OpenSDA I/O are both connected to the reset button and isolated from each other by diodes. Unlike the standard OpenSDA implementation, a header is not needed to select which device the reset button is connected to.

When power is initially applied, the OpenSDA interface momentarily ignores any reset signal asserted by the R41Z in order to sample the state of the reset button. This is done by setting the reset line level shifter between the OpenSDA interface and the R41Z to a high impedance state.

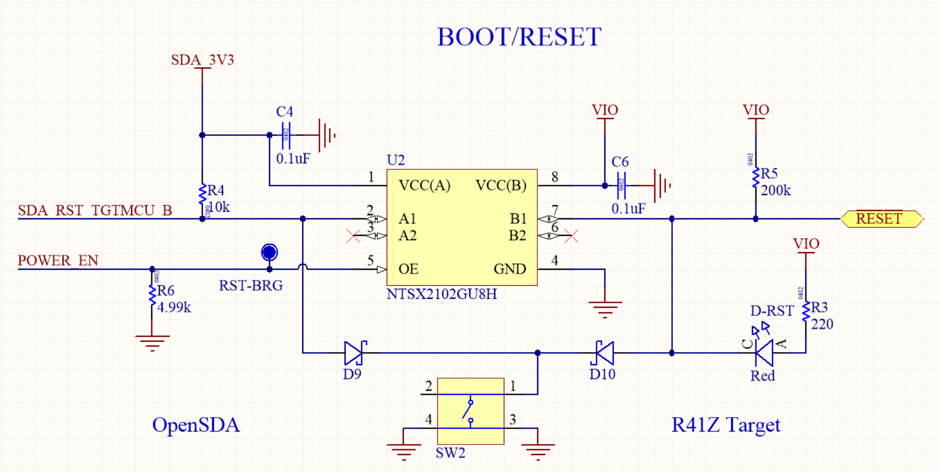

Figure 8: Schematic: Reset button

2.3.3 External debug header

In addition to the onboard OpenSDA interface, the R41Z evaluation board supports the use of external debuggers. A standard 10-pin SWD/JTAG header is provided with the following pinout to the target R41Z module:

Pin	Usage
1	V1P8 (R41Z I/O voltage)
2	SWDIO
3	GND
4	SWCLK
5	GND
6	N/C
7	N/C
8	N/C
9	GND
10	RESET_N

Table 5: External debugger header pinout

2.4 Peripherals

The R41Z evaluation board includes a set of onboard peripherals and a set of Arduino style headers that allow for additional peripherals of the user's choice to be added in the form of expansion shields. These headers share I/O connections to the R41Z module with the existing onboard peripherals. If an on-board peripheral will interfere with the operation of a shield, jumpers can be used to disconnect the on-board device.

2.4.1 Expansion headers

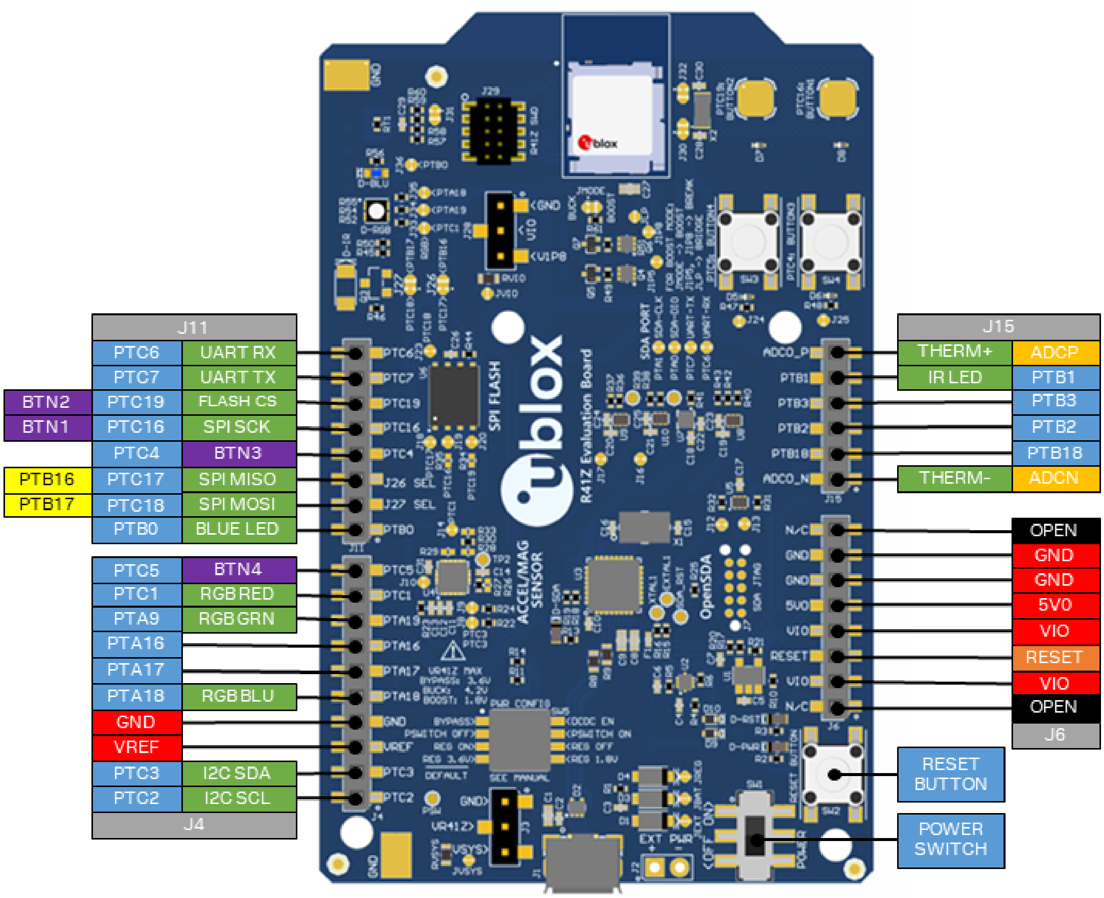

Figure 9: Expansion header pinout

2.4.2 IR LED provision

An unpopulated position for an IR LED and driver transistor are provided on the evaluation board. If IR is part the application under development, these parts can be populated by the end user. The IR LED footprint is intended for a right angle, SMT 3317 package. The drive transistor footprint is intended for an SOT-23 NPN BJT. Resistor R45 is not provided on the board to avoid pulling down PTB1.

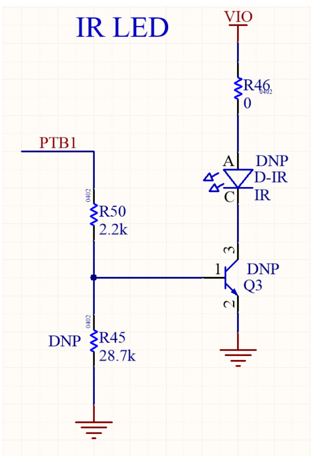

Figure 10: Schematic: IR LED

2.4.3 User LEDs

The R41Z evaluation board features an RGB LED and a separate blue LED. Since the GPIO used are shared with the expansion header, solder jumpers are provided to disconnect the LEDs if required. Since the LEDs are powered from the peripheral power bus VIO, they will be powered directly by the R41Z module when it is operating in either Buck or Boost DC-DC mode. This may affect LED visibility at low output voltages.

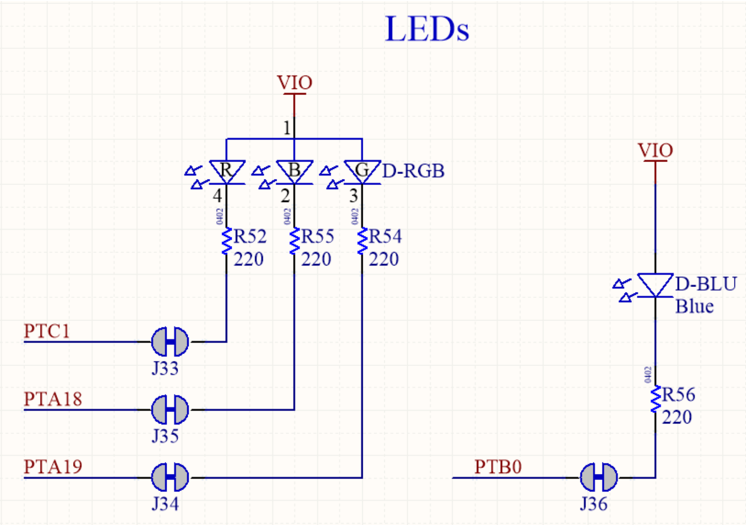

Figure 11: Schematic: User LEDs

2.4.4 Thermistor

A thermistor circuit is provided to demonstrate the analog capabilities of the R41Z module and to aid development of applications requiring temperature measurement.

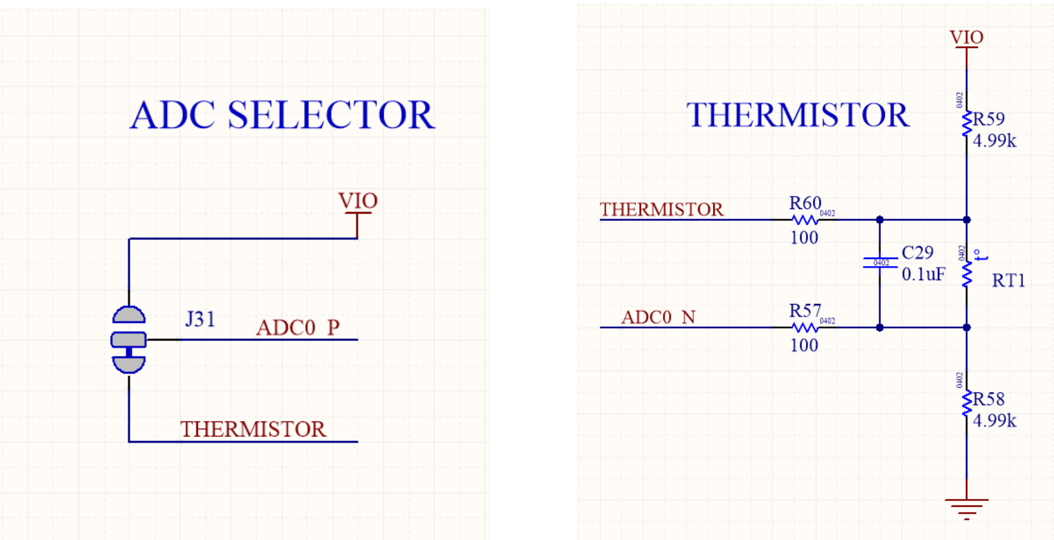

Figure 12: Schematic: Thermistor and ADC mode selection

2.4.5 User buttons

Two mechanical buttons (SW3, SW4) and two capacitive touch buttons (SW2, SW5) are provided on the evaluation board. The Capacitive touch buttons enable easy development of applications that make use of the R41Z's Touch Sense Input (TSI) module.

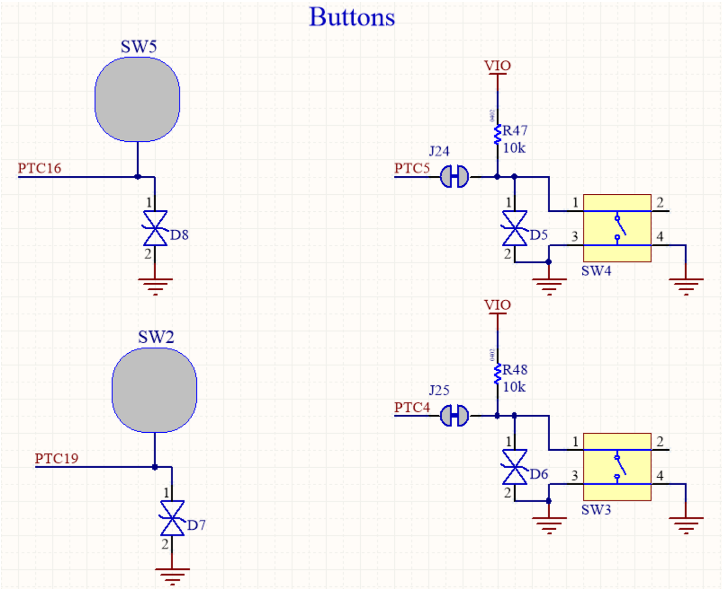

Figure 13: Schematic: User buttons

2.4.6 SPI flash

To assist development of applications requiring external storage, a 4 Mbit flash module is provided (Adesto Tech. AT45DB041E-MHN2B-T). The flash uses an SPI interface with signals shared with the expansion headers. When using multiple Chip Select (CS) signals, this allows the same SPI bus to be used with both the Flash module and one or more SPI devices on an expansion shield. However, some signals are also shared with the TSI user buttons.

Signal	R41Z I/O
SPI CLK	PTC16 (SW5)
SPI MOSI	PTC17
SPI MISO	PTC18
Flash CS_n	PTC19 (SW2)

Table 6: SPI flash port signals

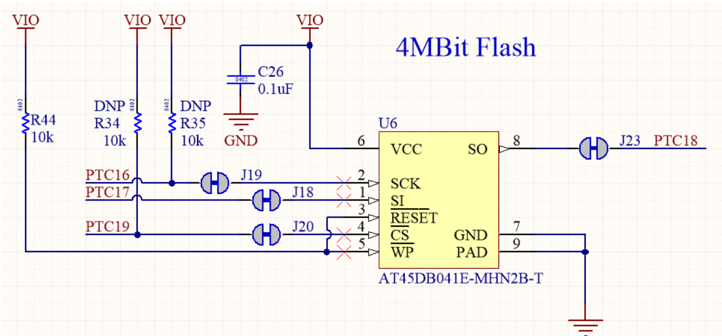

Figure 14: Schematic: SPI flash

2.4.7 I2C acceleration/magnetometer sensor

For development of applications that require orientation and movement tracking, a combined accelerometer and magnetometer is provided (NXP FXOS8700CQR1). The sensor can support either SPI or I2C interfaces but is used exclusively with the I2C interface on the R41Z evaluation board. When in I2C mode, the address of the sensor can be set using external pull-up and pull-down resistors. The signals used for the I2C bus are shared with the expansion headers. Because of the addressed nature of I2C it is possible to use this same bus to connect to additional devices on a shield.

Address	SA1	SA0
0x1C	1	0
0x1D	0	1
0x1E	0	0
0x1F (Default)	1	1

Table 7: Combo sensor addresses

Signal	R41Z I/O
Interrupt	PTC1
SCLK	PTC2
SDA	PTC3

Table 8: I2C sensor signals

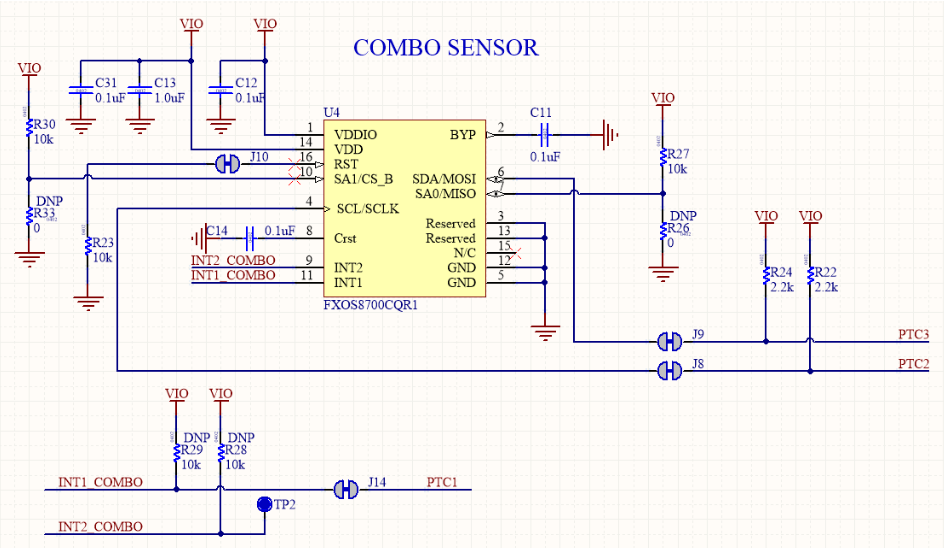

Figure 15: Schematic: I2C combo sensor

2.5 R41Z module

For details on the R41Z module, see the R41Z data sheet. The R41Z module is an industry leading Bluetooth low energy and IEEE 802.15.4 pre-certified module with a wide range of potential applications.

2.5.1 32.768 kHz oscillator

For RTC and to maintain high accuracy Bluetooth low energy time keeping in low power modes, an external 32.768 kHz crystal oscillator is provided. Some applications may not require this external oscillator in which case a set of jumpers can be used to connect these I/O to the expansion headers. The R41Z module features programmable capacitors which can be used in place of external capacitors. However, external capacitors are provided on the R41Z evaluation board to simplify firmware development.

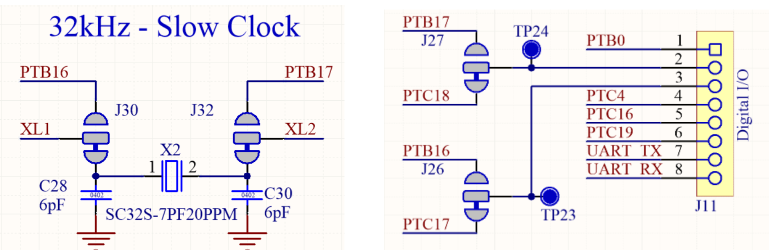

Figure 16: Schematic: 32 kHz oscillator

3 Setting up the evaluation board

This section provides information on how to set up and program the R41Z evaluation kit with an example application.

☞ This process will erase any preloaded firmware provided by u-blox including bootloader and demonstration firmware, if provided. To access any firmware or demo applications that may be preloaded on the R41Z evaluation kit, please contact your u-blox sales rep.

3.1 Set up the tool chain

The MCUXpresso tools are used for application development for the R41Z. All examples within the SDK for the NXP FRDM-KW41Z will function, unchanged, on the R41Z-EVAL.

1. Establish an account and login to the NXP website:
    a. https://www.nxp.com/webapp-signup/register for a new account
    b. https://www.nxp.com/security/login to login to an existing account
2. Download and install the NXP Semiconductors "IoT Toolbox" app on an available iOS or Android device. The app is available from the respective app stores. This app will be used to connect to the R41Z-EVAL board loaded with the SDK examples.
3. Download and install the MCUXpresso IDE on a PC. Windows, macOS and Linux are supported.
4. Download and install the MCUXpresso Config Tools on a PC. Windows, macOS and Linux are supported.
5. Download the MCUXpresso SDK. Select the FRDM-KW41Z Development Board. This download will be a zip file.
    a. The SDK documentation is available in the "docs" directory within the zip file.
6. Open the MCUXpresso IDE.
7. Install the MCUXpresso SDK into the IDE by dragging the downloaded zip file to the lower right pane:

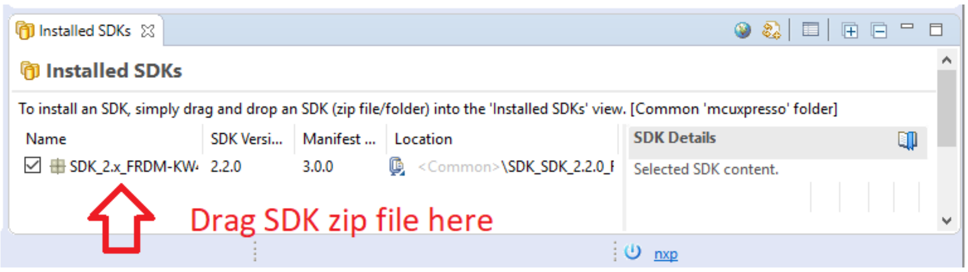

Figure 17: SDK installation

8. Connect the R41Z evaluation board to your host computer using the supplied USB cable. The board will show up as a mass storage device and a new virtual COM port will also appear.

3.2 Try an example

Import and run an example from the SDK.

1. In the lower left pane, click "Import SDK example(s)…".

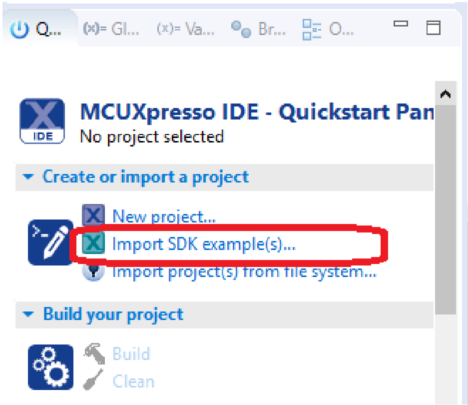

Figure 18: Import example

2. Click the "frdmkw41z" under "Available boards", then click "Next".

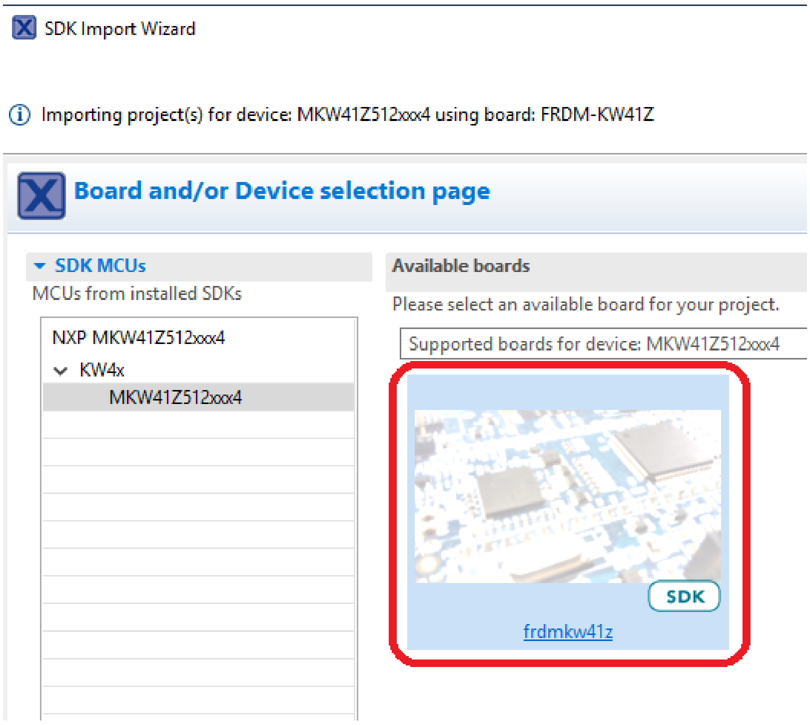

Figure 19: Select board

3. On the next screen, select the example, then click Finish. In this case, we will use the "Bluetooth beacon".

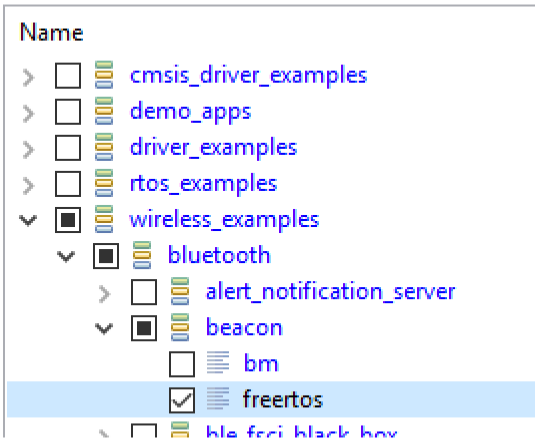

Figure 20: Select Bluetooth beacon example

4. Application source code is in the project tree under the "source" directory:

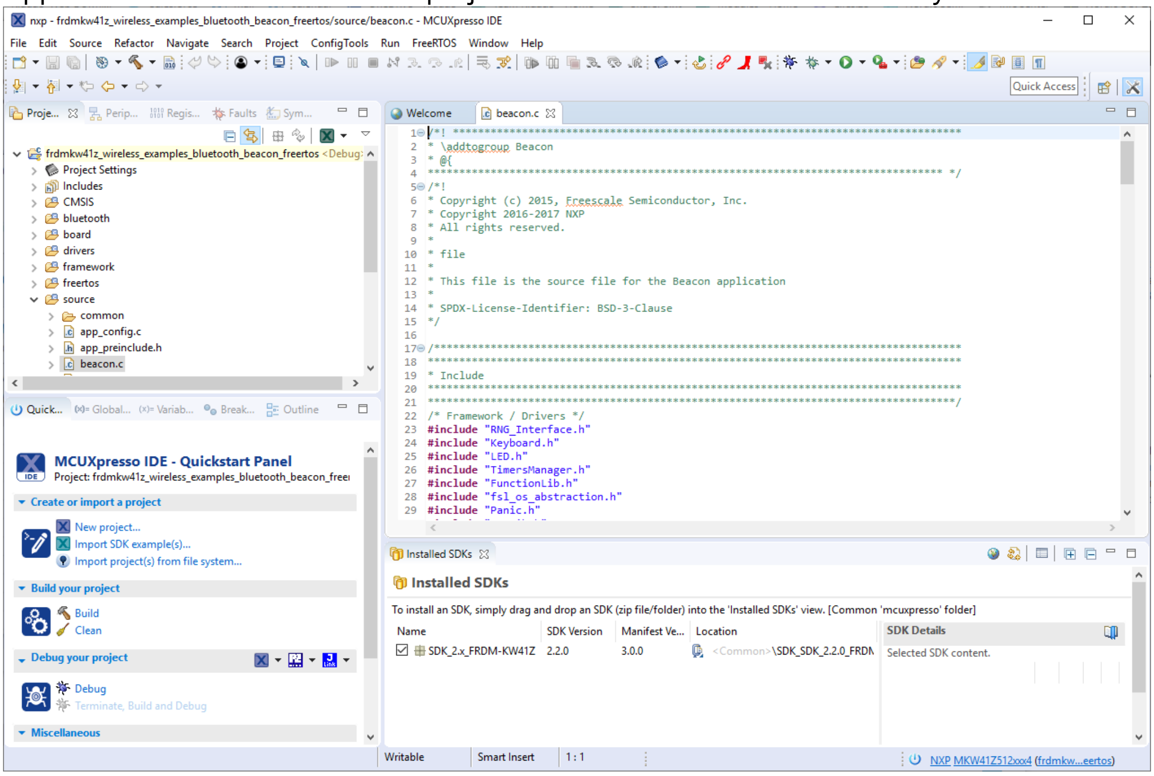

Figure 21: Example source code

5. Click the "hammer" icon to build the project:

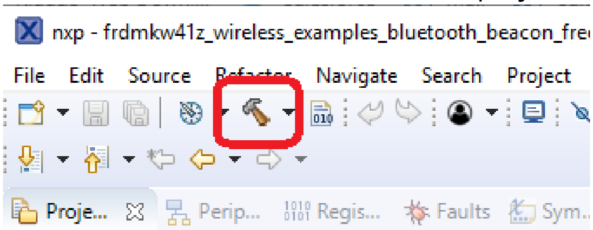

Figure 22: Build the example

6. Click the blue “bug” icon to start debugging:

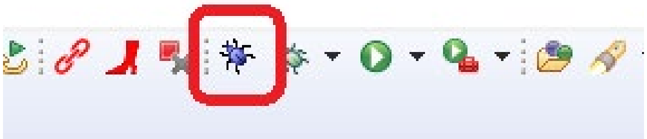

Figure 23: Start debugging

7. Select the “J-Link OpenSDA” debug probe and click OK:

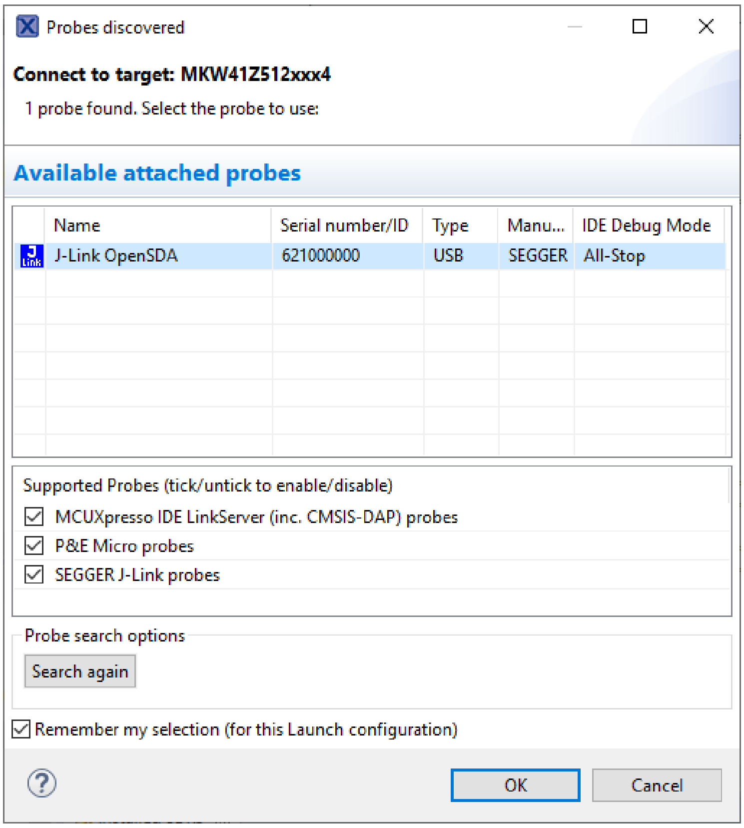

Figure 24: Debug probe selection

8. Accept the OpenSDA terms of use:

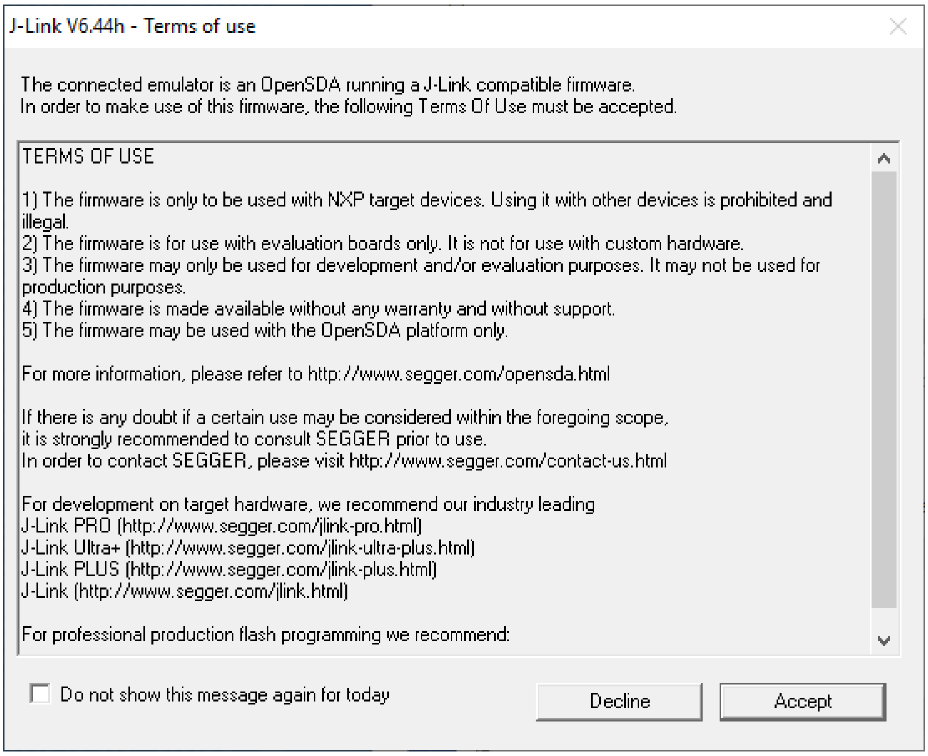

Figure 25: OpenSDA terms of use

9. Click the "Play" icon to run the application:

Figure 26: Run the example

10. Observe the blue LED flashing on the R41Z-EVAL board:

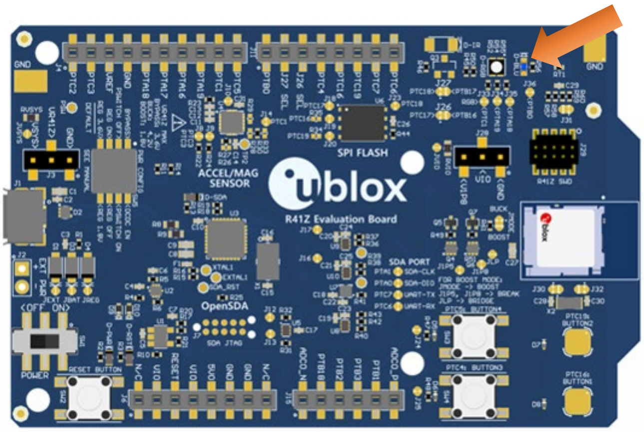

Figure 27: Flashing LED

11. Open the NXP IoT Toolbox mobile app on your mobile device, and tap the “Beacons” icon:

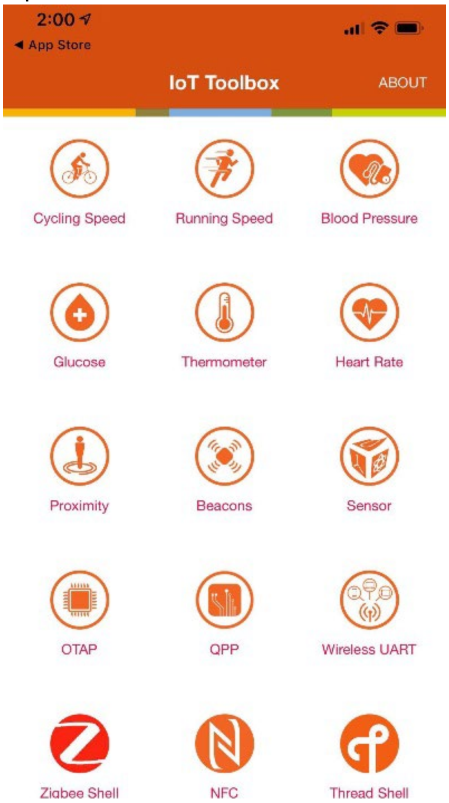

Figure 28: NXP IoT toolbox mobile app

12. See the beacon RSSI increase as you move the mobile device closer to the R41Z-EVAL.

Figure 29: Advertising beacon

13. The advertising data for A, B, and C values may be changed in the file “app_config.c”:
/* Advertising Data */

```
static const uint8_t adData0[1] =  {
(gapAdTypeFlags_t)(gLeGeneralDiscoverableMode_c | gBrEdrNotSupported_c) };
static uint8_t adData1[26] = {
                /* Company Identifier*/
                mAdvCompanyId,
                /* Beacon Identifier */
                mBeaconId,
                /* UUID */
                mUuid,
                /* A */
                0x00, 0x00,
                /* B */
                0x00, 0x00,
                /* C */
                0x00, 0x00,
                /* RSSI at 1m */
                0x1E};
```

Related documents

[1] R41Z module product summary, UBX-19033358
[2] R41Z module data sheet, UBX-19033355
[3] u-blox package information guide, UBX-14001652
[4] NXP KW41Z Fact sheet
[5] NXP BLE Mobile toolbox
[6] NXP KW41Z Data sheet
[7] NXP KW41Z Reference manual
[8] NXP KW41Z Errata

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Revision history

Revision	Date	Comments
0.9	09-Sep-2016	Initial release.
2.0	09-May-2019	Updated to new document format.
R03	05-Nov-2019	Document converted from Rigado R41Z evaluation kit user guide to u-blox R41Z evaluation kit user guide.
R04	26-Aug-2020	Updated images of EVK.

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