WDS User's Guide for EZRadio® Next Generation Devices

1. Introduction

Wireless Development Suite (WDS) is a set of tools, reference designs, and utilities supporting the Silicon Labs line of ISM band RFICs.

1.1. Wireless Development Suite

WDS Chip Configurator (WDS CC) is a software utility used to configure and test the transceiver. The WDS Chip Configurator tool enables users to configure the Next Generation EZRadio (and other chips) to perform a variety of controlled lab experiments. When the appropriate configuration is found for a user's requirement, the tool can generate a C-header configuration file or complete project of the selected example application with customized radio settings.

1.2. Purpose of this Document

This document describes WDS, its features, general usage, and the input and output parameters of basic applications. It also provides a brief overview of the supported hardware and setup instructions for testing and verification.

This description covers the usage of the Next Generation EZRadio (Si4355, Si4455) chip family.

2. Getting Started

2.1. Hardware and Software Requirements

- Windows XP or later
- Microsoft .NET framework 3.5 or later
- Silicon Labs CP210x VCP driver
- MCR v7.14 or later (Matlab compiler runtime for the modem calculator)
- WDS v3.1.4.0 or later

The lack of the .NET framework and VCP driver are recognized during WDS installation. The install wizard will prompt for the installation of the missing components.

2.2. Download WDS

WDS can be obtained at no cost from the Silicon Labs web site:

http://www.silabs.com/Support%20Documents/Software/WDS3-Setup.exe

As features are enhanced, device firmware updates may be needed. When WDS is installed, it automatically prompts for a FW update if it detects an older version.

2.3. Installation Steps

Note: Before installing this software, local administration rights must be obtained from your network administrator.

1. Insert the installation media or download the latest WDS release from the Silicon Labs web site.
2. Double-click the WDS setup icon.
3. Follow the step-by-step instructions on the screen.
4. Click “Next” to start the installation process, or click “Cancel” to abort the installation and close the installer package. Some screen images may differ slightly between software revisions.

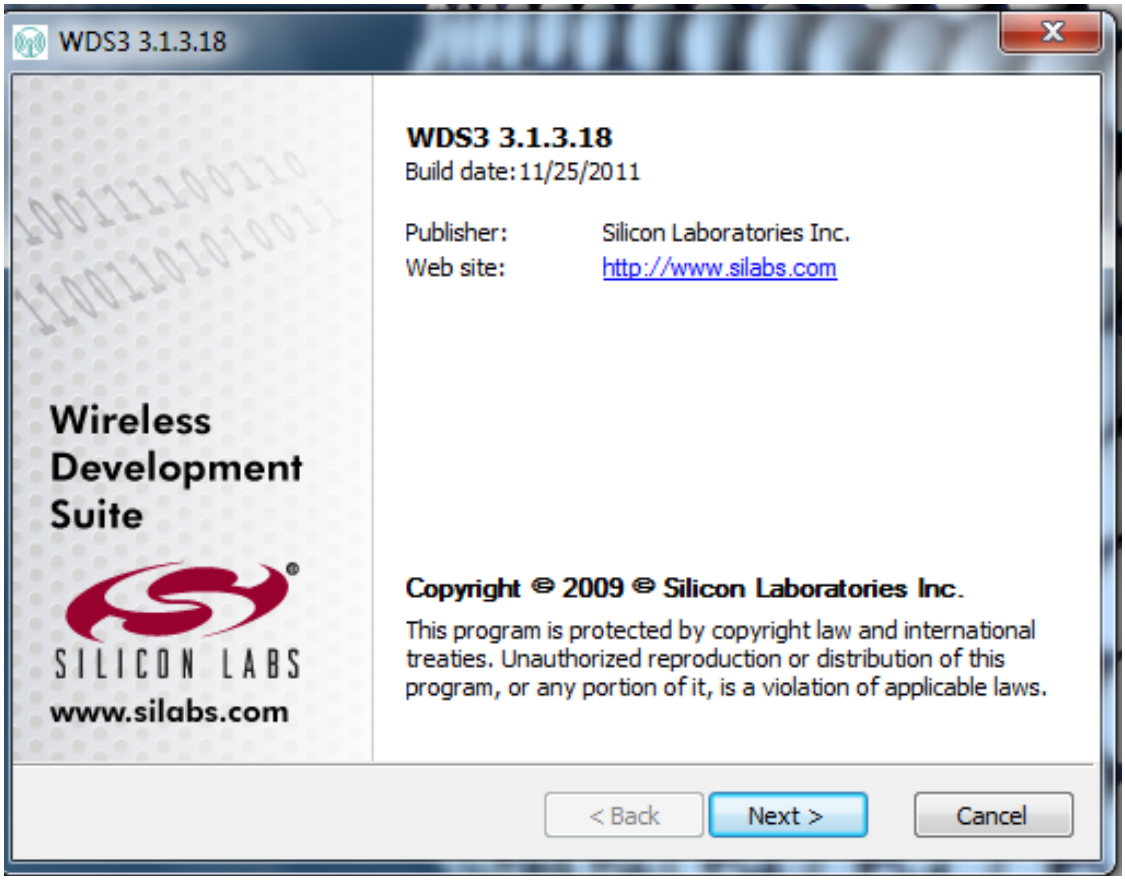

Figure 1. WDS Setup Screen

After clicking on the “Next” button, the software license agreement screen shown in Figure 2 appears. In order to install WDS, this license must be accepted by clicking the check box. Once accepted, the “Next” button is made available, and installation can continue.

Figure 2. WDS License Agreement

After accepting the license, installer options are made available. Here, the user can determine where the application should be installed on their computer. The user has the ability to select an installation folder that may better suit their requirements. However, Silicon Labs recommends using the default directory:

C:\Program Files\Silabs\WDS3

New installations of the WDS Chip Configurator may overwrite historical WDS data. Customers are advised to back up any data they may have. Project files may be found in:
C:\ProgramFiles\Silabs\WDS3\Project_Configurations.

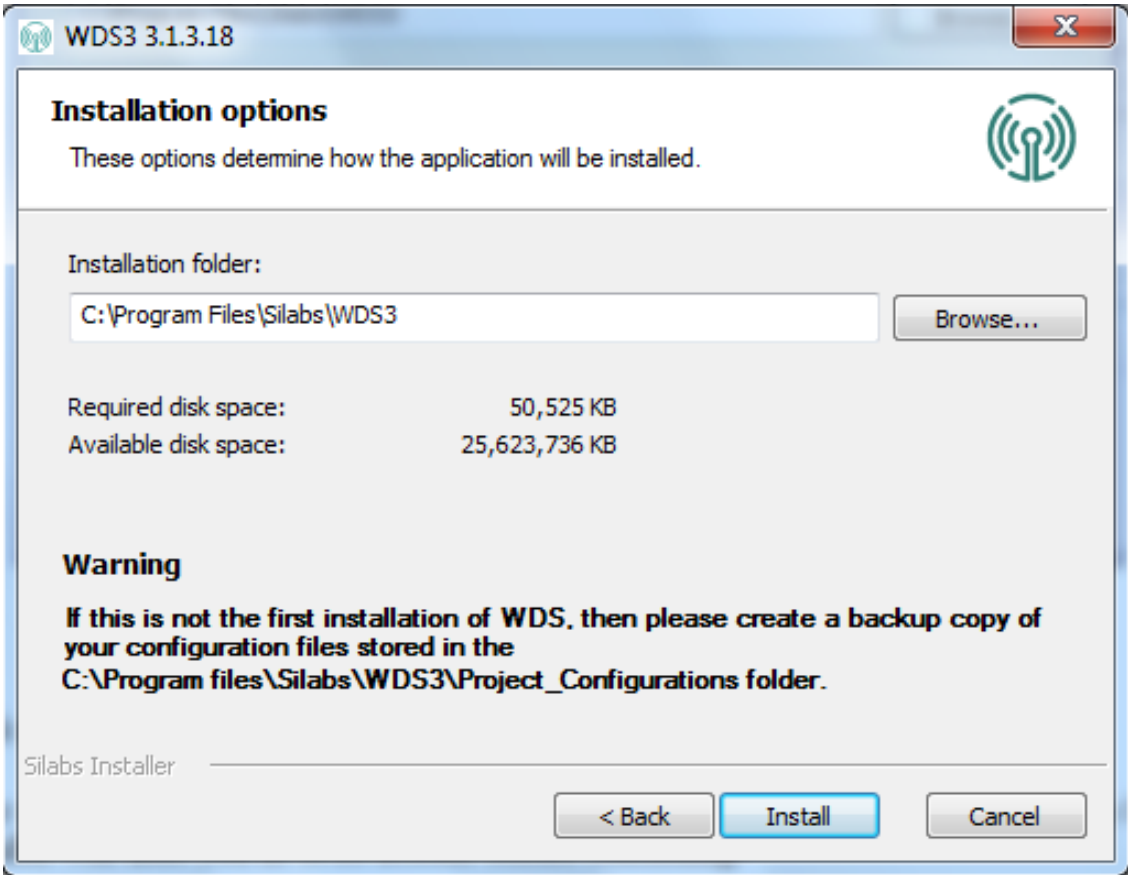

Figure 3. WDS Installation Options

Note: Disk space is highlighted for convenience.

When the settings are confirmed, click “Install” to continue. If an existing installation is found, the WDS installer will alert as to its actions before continuing.

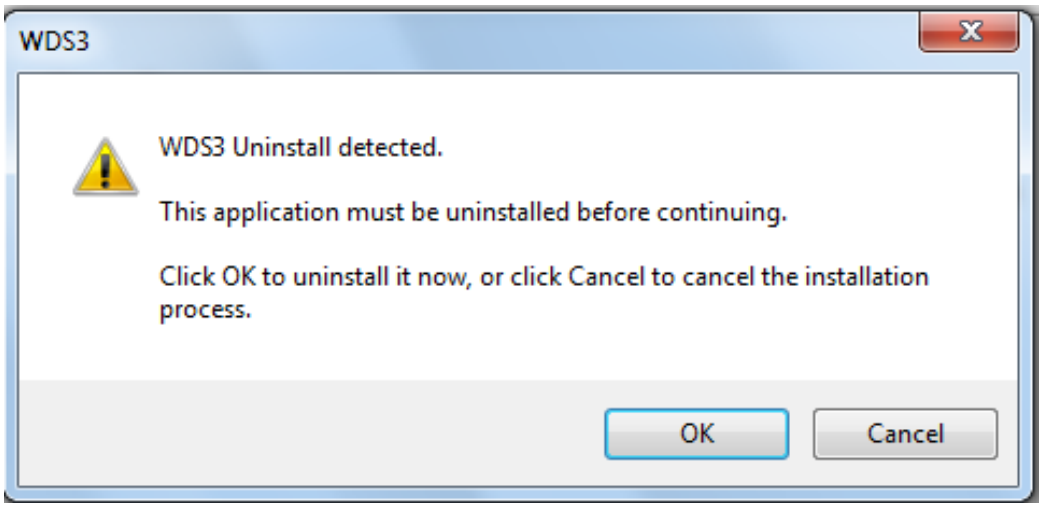

Figure 4. WDS Uninstall of Previous Versions

Installation time may vary depending on system configuration. When the installer has completed, the screen shown in Figure 5 appears.

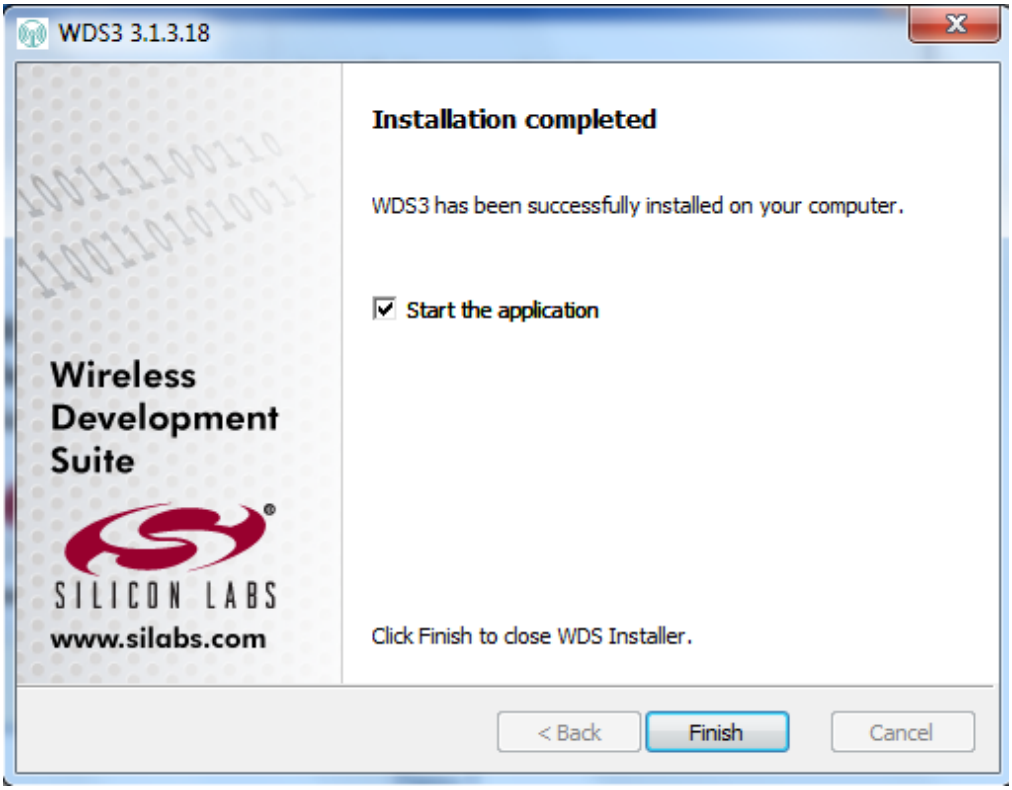

Figure 5. WDS Successful Installation

If it is desired for the installer to launch WDS upon closing, enable the "Start the application" check box before clicking "Finish".

2.4. Setup WDS

The main screen is the main control interface for all functions performed in the WDS environment. The main window control buttons are located on the tool bar at the top of the screen.

2.4.1. Preferences

Global WDS environmental controls, such as log information, language control, and automatic update settings, can be set up here.

2.4.2. Auto Update

WDS is able to update itself if a newer version is released. If the automatic update is enabled in WDS preferences, upon application startup, WDS checks the Silicon Labs web site to determine if a newer release is available. It prompts for the release notes of the new version and lets the user decide whether to install the new release.

If the automatic update is turned off, the user can manually initiate an update check in the WDS preferences software update dialog box.

2.4.3. Sending Feedback

This button opens the mailbox editor and attaches the current WDS log file. The user is then free to add dialogue to explain what they are trying to achieve with WDS. The log file is added so that Silicon Labs can try to reproduce a user's exact WDS instance to better support their needs.

2.4.4. Licensing

Some of the WDS features are license protected when they are in the development phase or if certain features and products are not yet released to the public web site. If you received a license to use WDS, please follow the easy 4-step instructions shown in Figure 6.

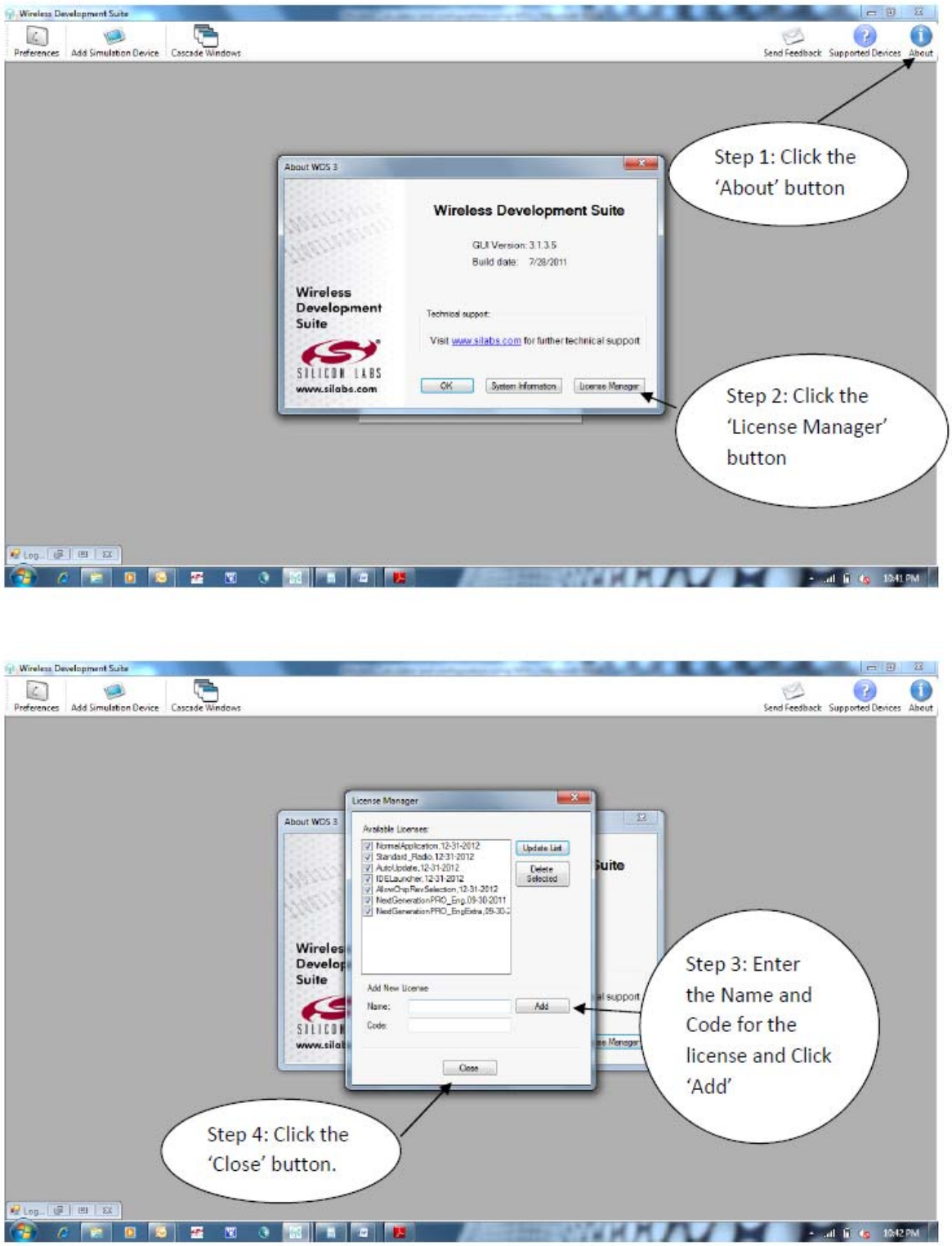

Figure 6. Adding License Information to WDS

3. Supported Devices

EZRadio Next Generation devices are supported on the following HW platforms:

- The RFStick
- The LCD Base Board + RF Pico Board

3.1. The RFStick Platform

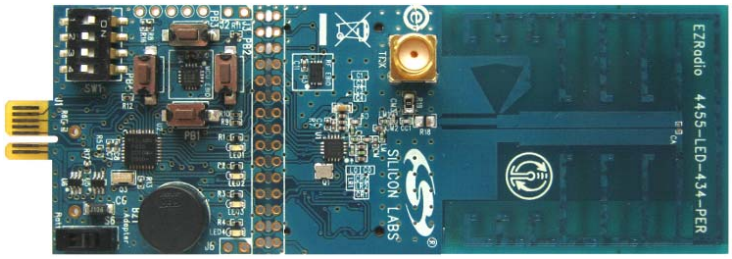

Figure 7. The RFStick

The RFStick is a basic demo system for the evaluation of EZRadio chips. The board has two main parts, the MCU part and the radio part. The MCU part of the board contains a Silabs C8051F930 MCU and basic human interface devices (four push-buttons, four LEDs, four switches, and a buzzer). The radio part contains the EZRadio chip, the matching circuit, and the antenna. The RF output is selectable via a 0 Ω resistor between a PCB antenna and a 50 Ω SMA output connector. The MCU is connected to the EZRadio chip via an SPI bus and some other GPIOs (see Table 1). The RF section of the board can be broken off along a perforation and installed in the user's own hardware as a radio module. Table 1 contains the signal connections between the EZRadio chip and the MCU.

Table 1. Connections between the EZRadio Chip and the MCU

Si4355, Si4455			RFStick		C80C51F930
Pin Number	**Pin Name**	**Pin Function**	**J3 pins**	**Signal Name**	**Pin Name**
EP, 1, 6, 9	GND	Ground	3–4	GND	GND
7, 8	VDD	Supply Voltage input	1–2	VDD	VDD
12	NIRQ	Interrupt output, active low	19–20	NIRQ	P1.4
2	SDN	Shutdown input, active high	5–6	SDN	P1.5
16	NSEL	SPI select input	11–12	NSEL	P1.3
13	SCLK	SPI clock input	17–18	SCLK	P1.0
15	SDI	SPI data input	13–14	MOSI	P1.2
14	SDO	SPI data output	15–16	MISO	P1.1
10	GPIO_0	General Purpose I/O	23 x 24	GPIO_0/PB1	P0.0
11	GPIO_1	General Purpose I/O	21 x 22	GPIO_1/PB2	P0.1
19	GPIO_2	General Purpose I/O	9 x 10	GPIO_2/PB3	P0.2
20	GPIO_3	General Purpose I/O	7 x 8	GPIO_3/PB4	P0.3

The four GPIO signals' primary function is push-button input to the MCU (PB1-PB4); so, these signals are not connected to the EZRadio chip by default (represented by x in the table above). The user can connect them by soldering jumpers across the appropriate pins of J3.

3.1.1. Setting Up and Connecting the RFStick to a PC

The power source of the board can be selected with the power supply selector switch (S6). If S6 is in the “Adapter” position, supply voltage is provided by a Toolstick Base Adapter connected to the J1 PCB edge connector. If S6 is in the “Battery” position, the supply voltage is provided by two AAA batteries in the battery holder on the bottom side of the board. Current consumption of the RF part (RFVDD) can be measured on J6. Since J6 is shorted by a PCB track on the bottom side of the board, the user must cut the track if this feature is used.

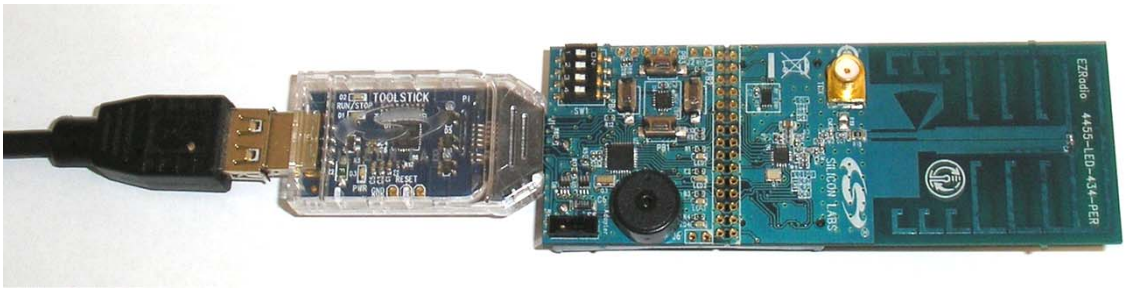

Figure 8. Connecting the RFStick to the PC

Perform the following steps to connect to a PC:

1. Select the desired power source with the S6 power selector switch.
2. Connect the J1 connector of the RFStick to the Toolstick Base Adapter.
3. Connect the Toolstick Base Adapter to the USB port of the PC.
4. Wait for Windows to install the driver of the Toolstick Base Adapter, if necessary.

The RFStick is available from Silicon Labs in three different frequency band versions as part of several EZRadio kits.

Table 2. RFStick Selection

Part Number	Board Description
4355-LED-434-SRX	Si4355 RFStick 434 MHz, factory loaded with SRX FW.
4355-LED-868-SRX	Si4355 RFStick 868 MHz, factory loaded with SRX FW.
4355-LED-915-SRX	Si4355 RFStick 915 MHz, factory loaded with SRX FW.
4455-LED-434-PER	Si4455 RFStick 434 MHz, factory loaded with PER FW.
4455-LED-868-PER	Si4455 RFStick 868 MHz, factory loaded with PER FW.
4455-LED-915-PER	Si4455 RFStick 915 MHz.

Table 3. Kits Containing RFStick

Part Number	Kit Name
EZR-LEDK1W-434	Si4010 EZRadio Remote Control Demo Kit 434 MHz
EZR-LEDK1W-868	Si4010 EZRadio Remote Control Demo Kit 868 MHz
EZR-LEDK1W-915	Si4010 EZRadio Remote Control Demo Kit 915 MHz
EZR-LEDK2W-434	Si4455 EZRadio Two Way Link Demo Kit 434 MHz
EZR-LEDK2W-868	Si4455 EZRadio Two Way Link Demo Kit 868 MHz
EZR-LEDK2W-915	Si4455 EZRadio Two Way Link Demo Kit 915 MHz
4010-KFOBDEV-434	Si4010 Development Kit 434 MHz
4010-KFOBDEV-868	Si4010 Development Kit 868 MHz
4010-KFOBDEV-915	Si4010 Development Kit 915 MHz

More information and schematics in the kit user guides are available at www.silabs.com.

3.2. The LCD Base Board Platform

The LCD Base Board platform is a demo and development platform for the EZRadio. It consists of an LCD Base Board and interchangeable RF Pico Boards.

Figure 9. The LCD Base Board Platform

Table 4. Kits Containing the LCD Base Board Platform

Part Number	Kit Name
EZR-LCDK2W-434	EZRadio Two Way Link Development Kit 434 MHz
EZR-LCDK2W-868	EZRadio Two Way Link Development Kit 868 MHz
EZR-LCDK2W-915	EZRadio Two Way Link Development Kit 915 MHz
4010-AESK1W-315	Si4010 Remote Keyless Entry Demo Kit with AES Encryption 315 MHz
4010-AESK1W-434	Si4010 Remote Keyless Entry Demo Kit with AES Encryption 434 MHz
4010-AESK1W-868	Si4010 Remote Keyless Entry Demo Kit with AES Encryption 868 MHz
4010-AESK1W-915	Si4010 Remote Keyless Entry Demo Kit with AES Encryption 915 MHz
4012-LCDK1W-434	Si4012 EZRadio One Way Link Development Kit 434 MHz
4012-LCDK1W-915	Si4012 EZRadio One Way Link Development Kit 915 MHz

3.2.1. The LCD Base Board

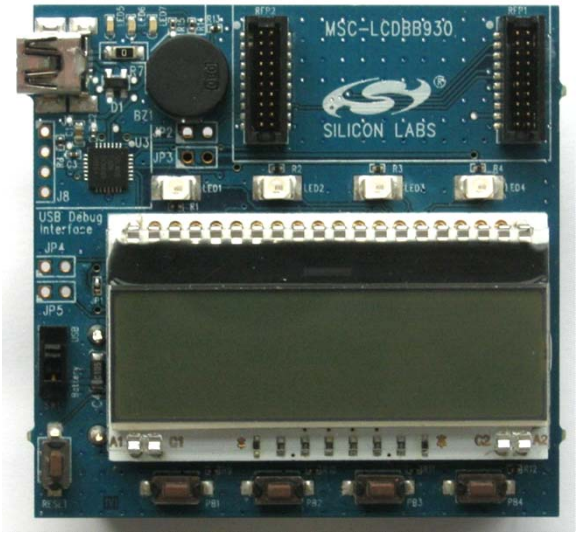

Figure 10. LCD Base Board

The board contains an LCD, four pushbuttons, four LEDs, and a buzzer connected to a Silicon Labs Si8051F930 MCU (U2, under the LCD). The MCU is also connected to an RF Pico Board connector pair (RFP1, RFP2). The connection between the MCU and the EZRadio chip on the RF Pico Board is compatible with the RFStick. See Table 2 for details. A Silicon Labs USB to C2 debug interface (U4) is also integrated on the board, so the board can be directly connected via USB to the PC for downloading and debugging code on the U2 MCU.

Table 5. LCD Base Board Selection

Part Number	Board Description
MSC-LCDBB930-PER	LCD Base board factory loaded with PER demo fw
MSC-LCDBB930-AES	LCD Base board factory loaded with AES demo fw

3.2.2. The RF Pico Board

Figure 11. RF Pico Board

The RF Pico Board is a radio module that contains an EZRadio IC, matching network, and PCB antenna. The RF output is selectable between the PCB antenna and a 50 Ω SMA output connector via a 0 Ω resistor. The boards also have a factory-loaded board identification memory (EBID) that contains data describing the board properties. Any RF Pico Board can be connected to the LCD base board via the unified RF Pico connector pair on the bottom side of the board.

Table 6. RF Pico Board Selection

Part Number	Board Description
4355-PRXB315B	RX PICO board, 315 MHz, PCB antenna, SMA
4355-PRXB434B	RX PICO board, 434 MHz, PCB antenna, SMA
4355-PRXB868B	RX PICO board, 868 MHz, PCB antenna, SMA
4355-PRXB915B	RX PICO board, 915 MHz, PCB antenna, SMA
4455-PCE10D434B	TRX PICO board, 434 MHz, PCB antenna, SMA
4455-PCE10D868B	TRX PICO board, 868 MHz, PCB antenna, SMA
4455-PCE10D915B	TRX PICO board, 915 MHz, PCB antenna, SMA

3.2.3. Setting Up and Connecting the LCD Base Board to a PC

The power source of the platform can be selected with the power-supply selector switch (SW1) on the base board. If SW1 is in the “USB” position, the supply voltage is provided by the PC connected to the J7 mini USB connector. If SW1 is in the “Battery” position, the supply voltage is provided by three AA batteries in the battery holder on the bottom side of the board. The current consumption of the RF part of the connected RF Pico Board (RFVDD) can be measured on JP3. Since JP3 is shorted by a PCB track on the bottom side of the board, the user must cut the track if this feature is used. Perform the following steps to connect the platform to a PC:

1. Connect an RF Pico Board to the LCD base board through RFP1 and RFP2.
2. Select the desired power source with the SW1 power selector switch.
3. Connect the LCD base board to a USB port of the PC.
4. Wait for Windows to install the driver of the debug interface if necessary.

4. Supported Radios

The EZRadio Next Generation devices (Si4355 and Si4455) are easy-to-use radio chips that combine plug-and-play simplicity, superb RF performance, and the flexibility needed to handle a wide variety of applications. The radios can be programmed by the host MCU through an SPI port using few API commands. There are several parameters that define the behavior and the performance of the radio. WDS provides an easy-to-use graphical interface for configuring desired radio settings, such as data rate, modulation, frequency, etc., and outputs a single configuration array that sets the radio to the desired mode. This saves the user from having to adjust hundreds of different parameters and makes the configuration process easy and straightforward. Based on user input, the WDS generates a radio_config.h header file that contains all the information needed for the application to configure the radio properly. WDS can also be used customize the example applications with the selected parameters and either open the complete project in the Silicon Labs IDE or load the example code to the connected evaluation board directly.

5. WDS Workflow

WDS functions are best utilized if one of the development boards is connected to the PC (Hardware Mode), but limited features are also available in Simulation mode. In this case, there is no physical hardware connected to the PC, but the GUI can be used to create example projects or obtain a configuration array. The general workflow is shown in Figure 12.

The radio can be configured in several different ways:

- Novice users can utilize the simplicity of the Configuration Wizard. It suggests radio configurations based on a few basic questions.
- The Radio Configuration Application is the most common way to control the radio. All configuration options are represented on the graphical user interface. Several tested and validated settings are provided in the form of an EZConfig table. Using these pre-tested settings makes the development process efficient and safe.
- If the desired radio configuration cannot be found in the EZConfig table, the user has the ability to create a custom setting and add it to the table.

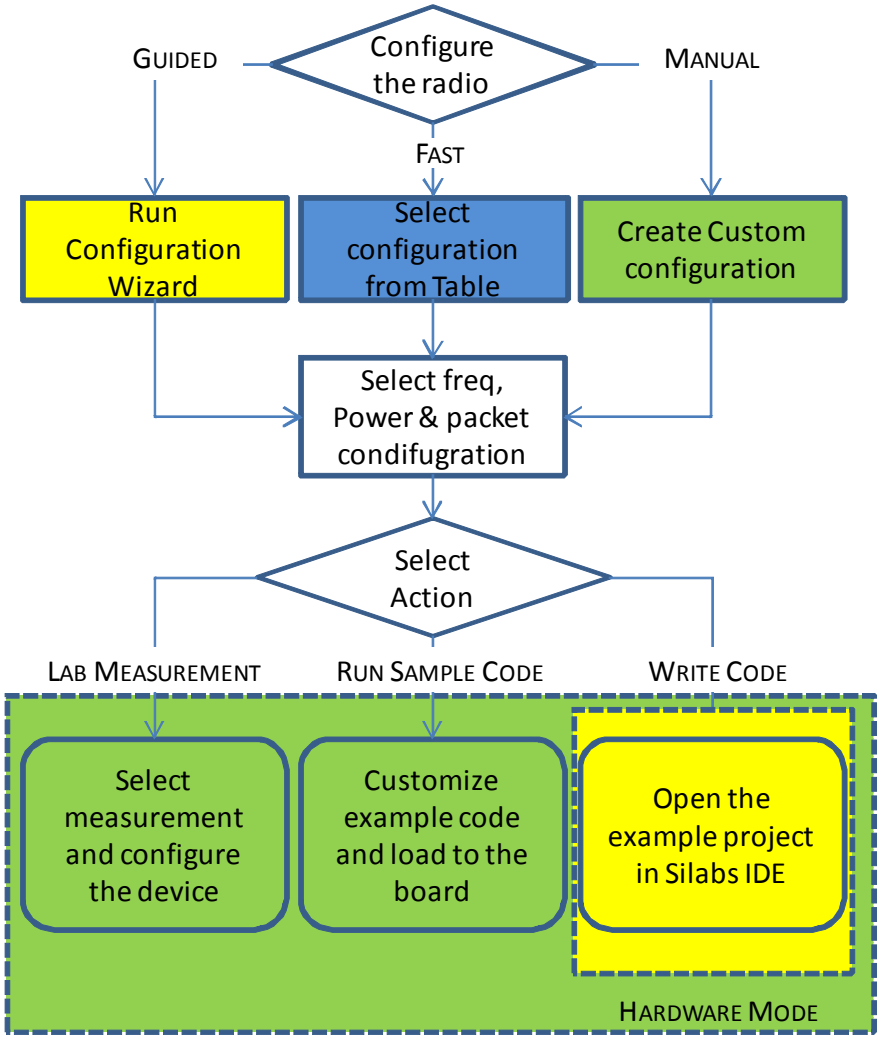

Figure 12. WDS Workflow

5.1. Simulation Mode

WDS can be used without connecting physical HW to the PC to obtain configuration parameters. After running the WDS, the user needs to select simulation mode from the “Select Mode” pop-up window shown in Figure 13.

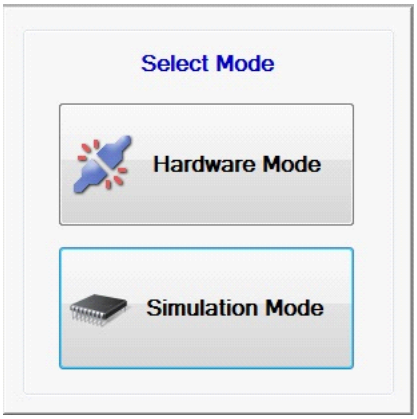

Figure 13. Select Mode

WDS offers different Applications to start (to support other Silicon Labs radios), but only the Radio Configuration Application supports the EZRadio Next Generation family.

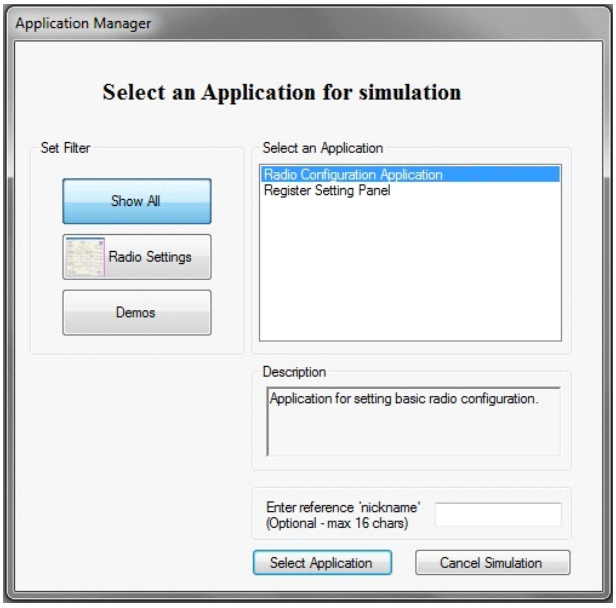

Figure 14. Select Application for Simulation Mode

The user selects which radio to use. Both the Si4355 and Si4455 can be configured from the Radio Configuration Application.

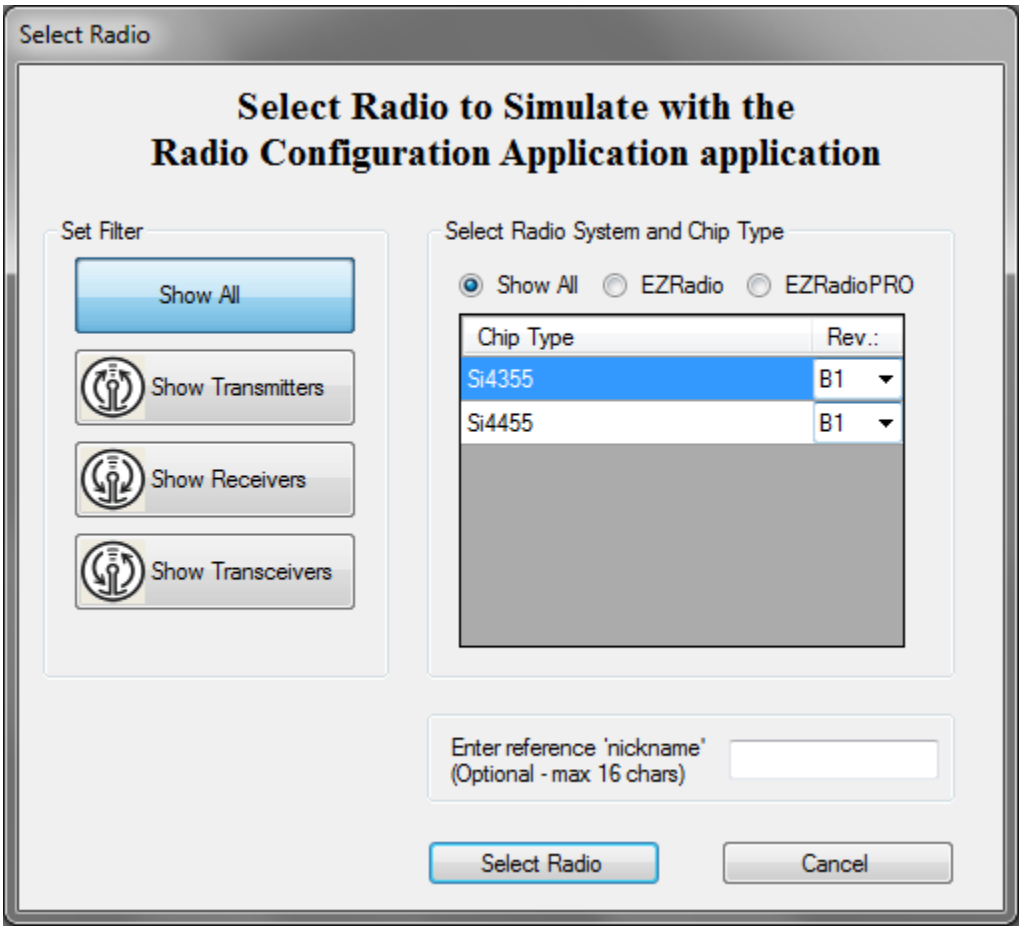

Figure 15. Select Radio for Simulation Mode

WDS launches the Radio Configuration Application. The Configuration Wizard is part of this application and is shown first to help the user set up the radio quickly and efficiently. If it is not desired to run the application with the Wizard by default, the “Run the Wizard as default” check box must be deselected. The Configuration Wizard is also accessible from the Radio Configuration Application.

In simulation mode only the “Launch IDE” option is available to generate a C project from the radio configuration. All other options are available only in Hardware mode, since those require physical HW for correct operation.

The Radio Configuration Application is discussed in more detail in "5.3. Radio Configuration Application" on page 17.

5.2. Hardware Mode

WDS continuously polls the devices connected to the PC so it can automatically recognize whether any of the connected HW can work with the GUI. Devices can be attached to the PC before running WDS or even while the GUI is running.

After connecting any of the EZRadio Next Generation development platforms (listed in the Supported Devices paragraph) the desired application can be selected from the pop-up window. Each board is equipped with an Electronic Board Identification Database (“EBID”) that is used to store information about the given board, such as product name, version number, radio type, etc. WDS can always access that information (even if the user has changed the host MCU code on the device). WDS summaries the HW and FW revision numbers and other board-related information and shows a picture of the recognized device on the “Select Application” pop-up window.

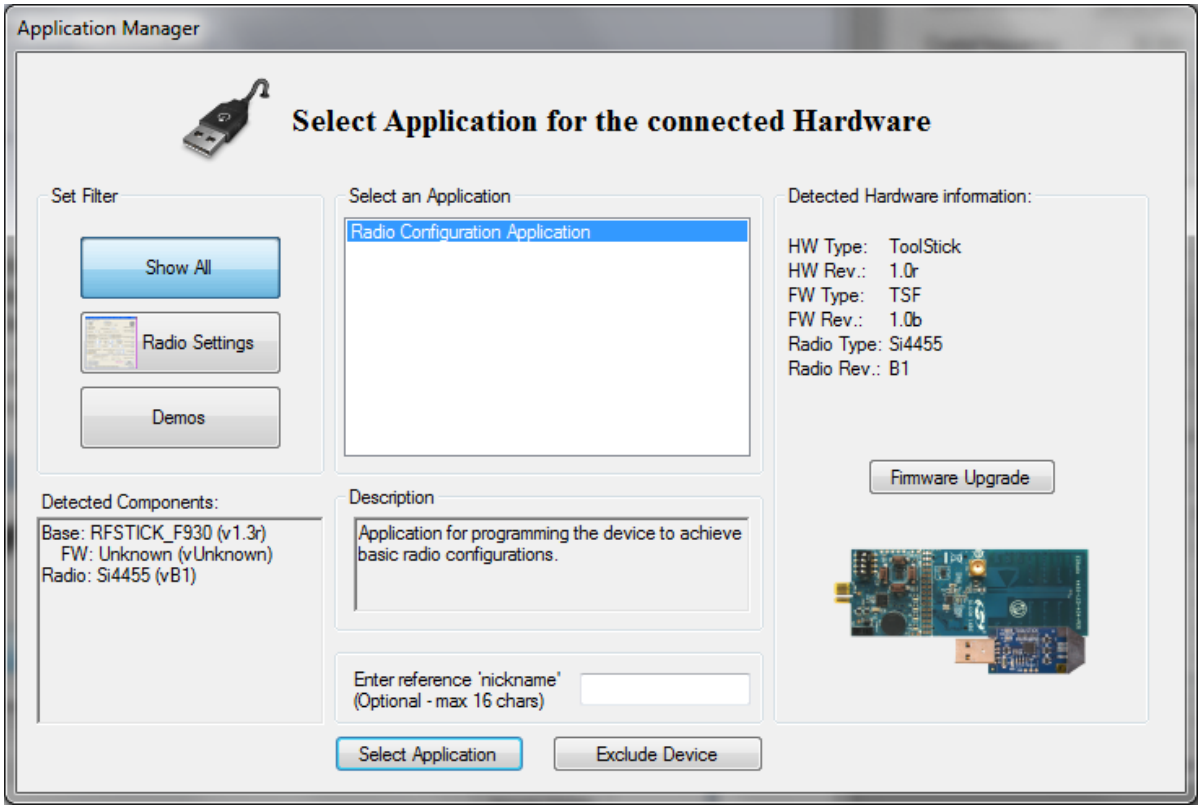

Figure 16. Select Application for Connected Hardware

WDS launches the Radio Configuration Application. The Configuration Wizard is part of this application and is shown first to help the user set up the radio quickly and efficiently. If it is not desired to run the application with the Wizard by default, the “Run the Wizard as default” check box needs to be deselected. The Configuration Wizard is also accessible from the Radio Configuration Application. In Hardware mode, all the options are available:

- “Lab evaluation” is for laboratory measurement purposes. The user can measure and verify all the parameters of the radio using lab equipment.
- The user can customize the RF parameters of one of the example applications and launch the complete C project in the Silicon Labs IDE by pressing the “Launch IDE” button.
- The customized example application can be loaded directly into the connected board without involving any other steps (“Load firmware”). This process enables RF engineers to efficiently verify radiated performance in an antenna test chamber or measure range with a desired RF configuration.

The Radio Configuration Application is discussed in more detailed in the “5.3. Radio Configuration Application”.

5.3. Radio Configuration Application

The behavior and RF configuration of the EZRadio Next Generation radios can be set by the EZConfig array after Power On Reset. The basic settings cannot be modified after configuration; only a few parameters can be changed during normal operation (center frequency, output power, interrupt properties, etc.). The main purpose of the Radio Configuration Application is to easily define the desired radio configuration, generate the EZConfig array, and select the next action the user wants to perform with the radio.

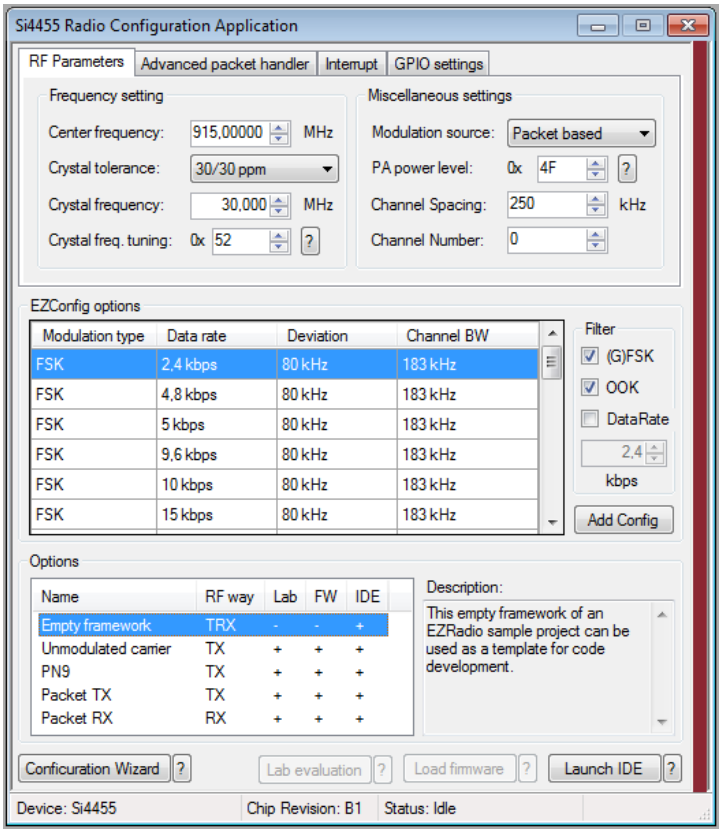

Figure 17. Radio Configuration Application

The GUI is divided into three sections, and it is recommended that the user configure the radios in this order.

The top section holds all detailed configuration options: operation mode, frequency, packet related settings, etc. The settings are separated into groups and are shown on different tabs.

The “RF Parameters” tab lists the frequency, operating mode, and output power related settings.

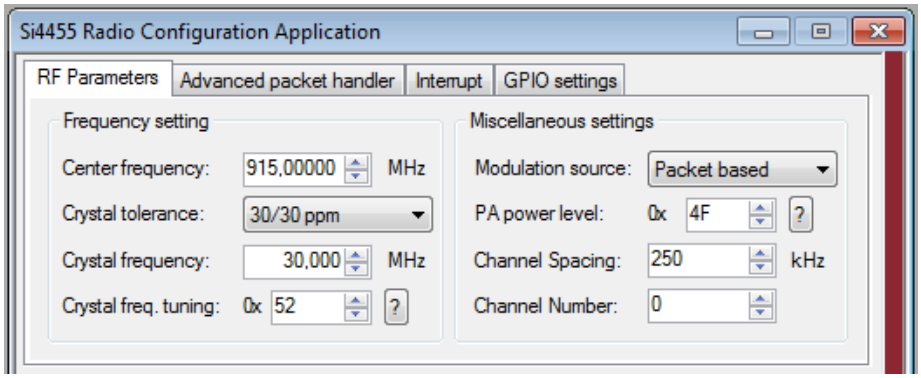

Figure 18. RF Parameters Tab

The “Advanced Packet Handler” tab holds all packet mode related configuration options, such as defining the length of the preamble, defining the synchron word, enable the CRC calculation or Manchester coding. The user can also select between fixed and variable length payload of the RF packet. The default value of these settings is defined in a way that provides excellent RF performance; It is, therefore, suggested to change it only if the user wishes to use a different packet configuration.

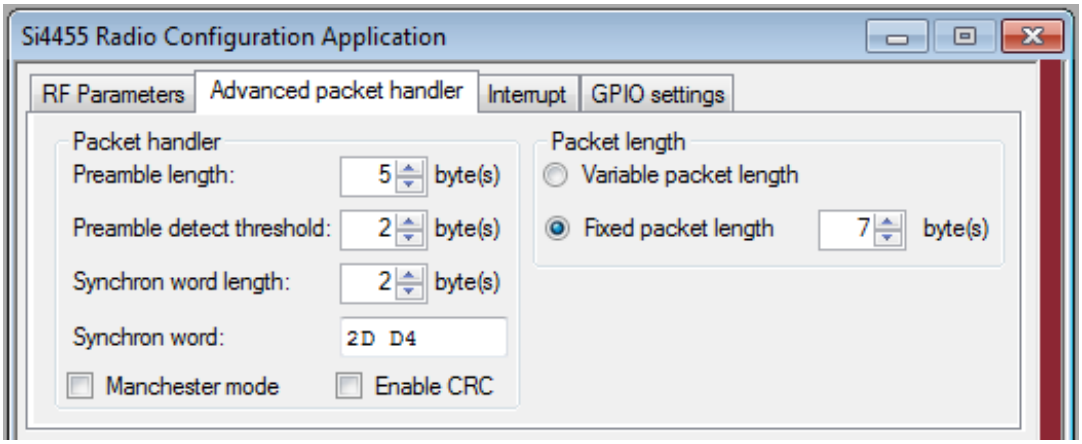

Figure 19. Advanced Packet Handler Tab

The “Interrupt” tab allows configuration of the interrupt properties. The user can customize what event should trigger a radio interrupt towards the host MCU.

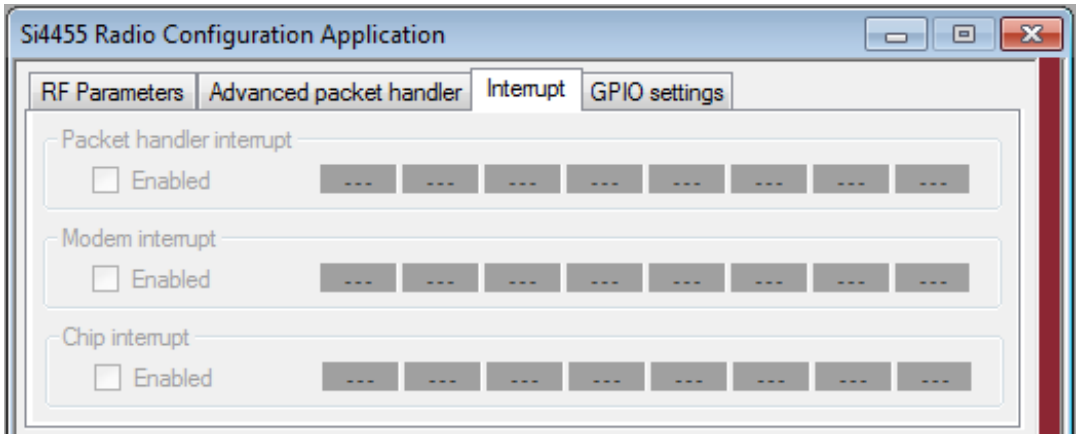

Figure 20. Interrupt Tab

The middle section holds the EZConfig options. Silicon Labs has defined and detailed several RF configurations. It is recommended that the user select one of them and use it in the final application to minimize the risk of false configuration and also to quicken the development process. The RF configurations are organized in a table that lists the major properties of the given configuration, such us modulation mode, data rate, deviation (in case of (G)FSK), and channel bandwidth (in the case of OOK). To quickly find the desired settings, the filter may be used next to the table to narrow down the selection based on the modulation mode or the desired data rate (WDS will suggest the two closest possible and available data rate options).

If the desired setting is not listed in the table, a custom setting may be generated by pressing the “Add Config” button. A small pop-up window appears allowing the user to enter the exact desired parameters. WDS will then generate a new entry in the table with those settings.

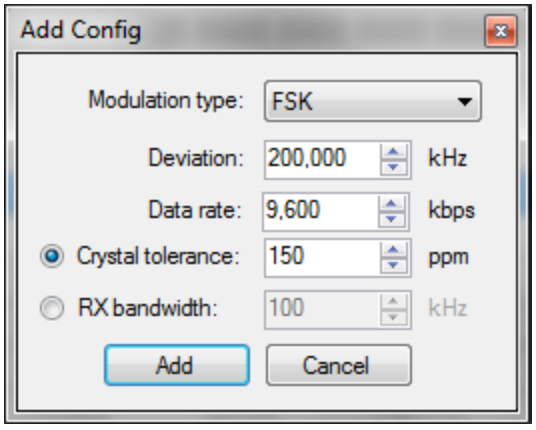

Figure 21. Add Config Window

Notes:

1. The predefined EZConfig options are generated and validated to operate with 30MHz crystal. If the user changes the crystal frequency, then WDS will generate a custom setting with the desired crystal frequency.
2. It requires running the calculator to generate a custom setting. The calculator uses Matlab runtime environment, therefore it has to be installed on the PC (part of the WDS install). The first calculation may take 30..60 second, because the runtime environment has to be loaded into the memory of the PC.

After the radio configurations are defined on the first two sections of the Radio Configuration Application, the user needs to select the desired action in the bottom section. A table summarizes the suggested steps for evaluating the radio in the lab:

- The “Power mode + AUX” option can be used to measure the current consumption of the different power modes of the radio and to evaluate the operation of the auxiliary functions (low battery detector, analog-to-digital converter, etc.)
- The “Unmodulated Carrier” option sets the radio into continuous unmodulated transmit mode. It can be used to measure the output power and the frequency accuracy of the transmit device.
- The “PN9” option sets the radio into continuous modulated transmit mode. It is typically used to evaluate the transmit parameters of the radio, such us occupied bandwidth, adjacent channel selectivity, etc.
- The “Direct Rx” option sets the radio into continuous direct receiver mode, and the radio outputs the received data and the recovered data clock on its GPIOs. This mode can be used to evaluate the radio receive performance parameters, such as sensitivity, selectivity, blocking, etc.
- The “Direct TX” option sets the radio into continuous direct transmit mode, and the radio expects the data to be transmitted on its GPIO (it also provides a data clock for synchronization on a different GPIO). Some of the legacy system still uses direct mode, where the modulation is coming from a host MCU through a pin. This mode can be used to test these requirements.

The table also suggests basic operation modes for code development or simple RF test or range test purposes:

- The “Packet TX” option allows transmitting packets with the radio upon the pressing of a button on the development board or initiating packet transmission from the GUI if it is used in Lab measurement.
- The “Packet RX” sets the radio into receive mode and waits for packets. If it is used as a standalone demo or source code, an LED is blinked upon packet reception, or the user needs to poll the receiver from the GUI and read the FIFO content if the setup is used for lab measurement purposes.

Note: The “Packet TX and Packet RX” options can be used together to build a simple, one-way range test setup. If a button is pressed on the transmitter board, the corresponding LED blinks on the receiver board.

- The “Bidirectional link” option realizes a bidirectional communication between two boards (the same code needs to be loaded into both boards). This use case is suggested for range measurement purposes.

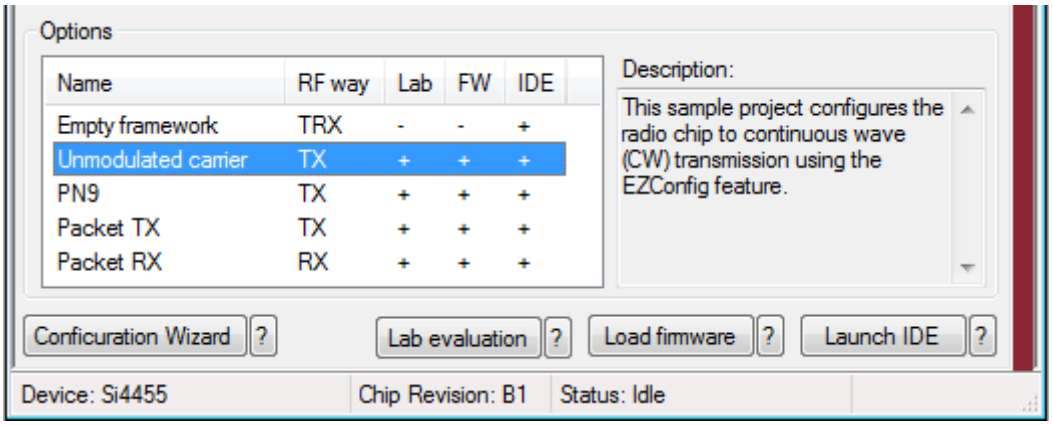

Figure 22. Suggested Use Cases

Most of the above-listed use cases are available for all purposes, but some of them have limited purposes. the table summarizes these limited purposes:

- "Lab" for laboratory measurement purposes. The user can measure and verify the parameters of the radio using lab equipment. To activate this action, the "Lab evaluation" button needs to be pressed, and the GUI will show a new window according to the selected measurement option. The different lab measurement options are covered in more detail in "5.4. Laboratory Measurements".
- "IDE" means that the user can customize the RF parameters of one of the example applications and launch the complete C project in the Silicon Labs IDE by pressing the "Launch IDE" button. The GUI will show a new window to customize the project location, the compiler, and other IDE related settings. The IDE Launch functionality is described in "5.5. Launching an Example Application in Silicon Labs IDE" on page 26.
- "FW" means that the customized example application can be loaded directly into the connected board without any other steps. After pressing the "Load firmware" button, the GUI customizes the HEX file of the selected use case with the desired RF configuration and loads the HEX file into the FLASH of the host MCU. WDS shows the status of the FW load and returns to the Radio Configuration Application if it finished the process successfully. There is also a text box next to the table that provides a detailed description of the different use cases.

5.4. Laboratory Measurements

After setting the desired radio configuration on the Radio Configuration Application, the user must select the use case for lab measurement purposes and press the “Lab evaluation” button. WDS loads Lab Measurement FW into the host MCU of the connected development board and configures the radio according to the selected use case and radio configuration. The GUI also switches off the Radio Configuration Application and launches a new window that helps control desired radio functions, such as center frequency, fine tuning of the output power, etc., and allows the reading of status information from the radio. The window always shows the appropriate settings for the given use case. Once the lab measurement is finished, the user can switch back to the Radio Configuration Application to create FW based on the evaluated parameters.

5.4.1. Unmodulated Carrier, PN9 and Direct Tx

The most common RF measurement is to verify the output power and the harmonics/spurs of the radio in transmit mode. For this purpose, the “Unmodulated Carrier” lab measurement can be used.

In addition to the unmodulated parameters, it is important to verify the occupied bandwidth and shape of the transmitted, modulated signal. The “PN9” or “Direct TX” lab measurements are suitable for this purpose. Both tests behave the same (they set the radio into continuous modulated transmit mode), but the modulation source is different. The internal PN9 random generator is used to modulate the output power in “PN9” test mode. However, sometimes, the host MCU generates the modulation data. For such purposes, the “Direct TX” lab measurement is recommended, which expects the data on one of the GPIOs of the radio.

During these tests, the GUI allows the user to change a couple basic parameters, such as center frequency, output power, and crystal frequency tuning. It also possible to read back status information, such as battery voltage, fast response register values, etc.

Note that this is a practical test to fine-tune the center frequency. Due to the crystal tolerances and possible mismatch between the internal capacitance of the crystal circuit and the load capacitance of the crystal, the radio may work on a slighlty different frequency than expected. The crystal frequency tuning property can be used to cancel the frequency error by simply fine tuning its value while monitoring the exact center frequency with a spectrum analyzer.

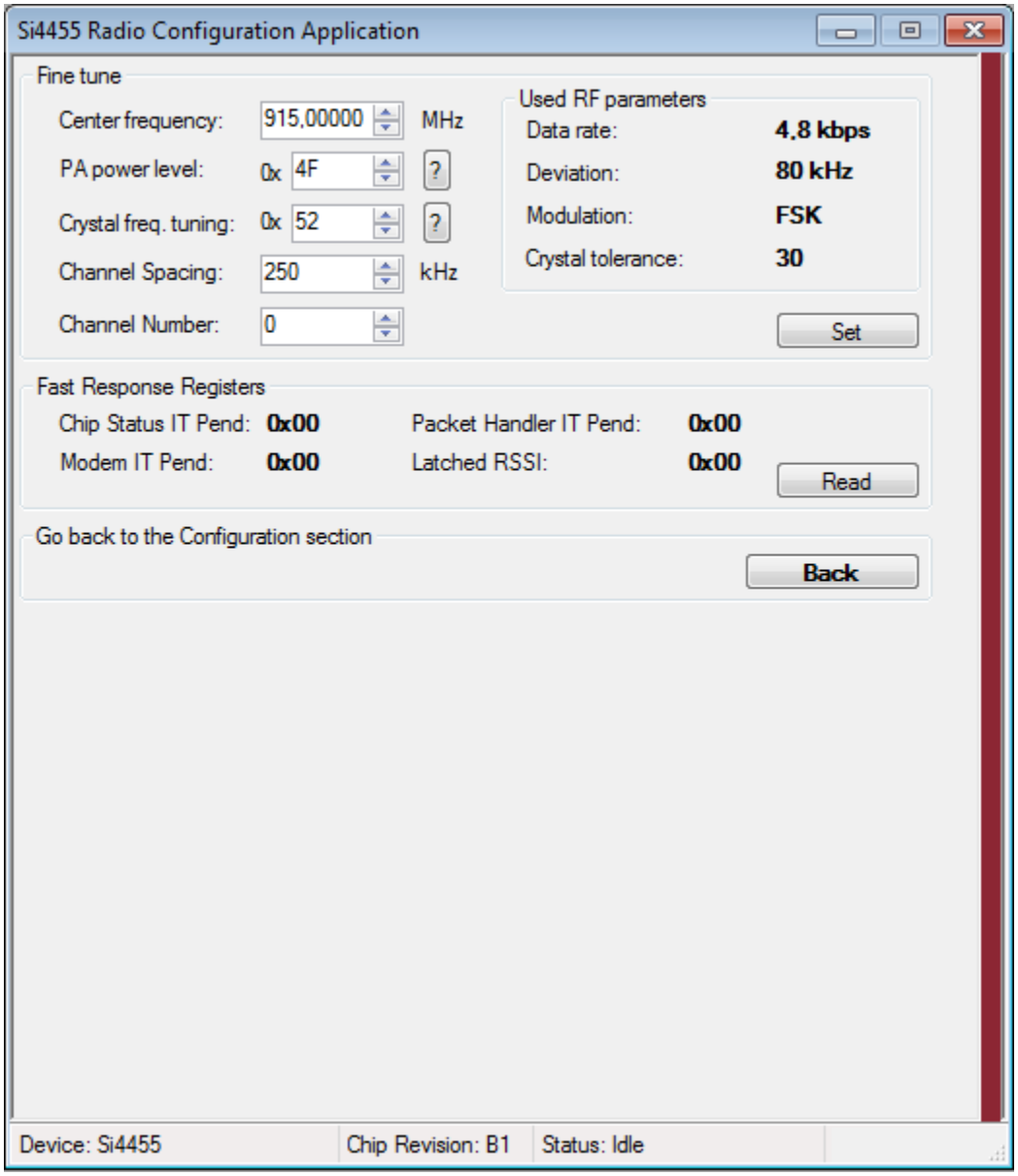

Figure 23. CW, PN9 and Direct TX Lab Measurements

5.4.2. Direct RX

Direct RX mode can be used to verify the most common receiver RF performance characteristics, such as sensitivity, blocking, selectivity, etc. The test sets the radio into continuous receive mode and outputs the received data bits on one of the GPIOs of the radio. The recovered data clock is also provided on a different GPIO for synchronization purposes. Using an RF signal generator with bit error rate measurement options, all the receiver parameters can be evaluated.

This lab measurement also allows reading of back status information and monitoring of the interrupt status registers. WDS also enables fine tuning of basic RF parameters, such as center frequency, output power, and crystal frequency.

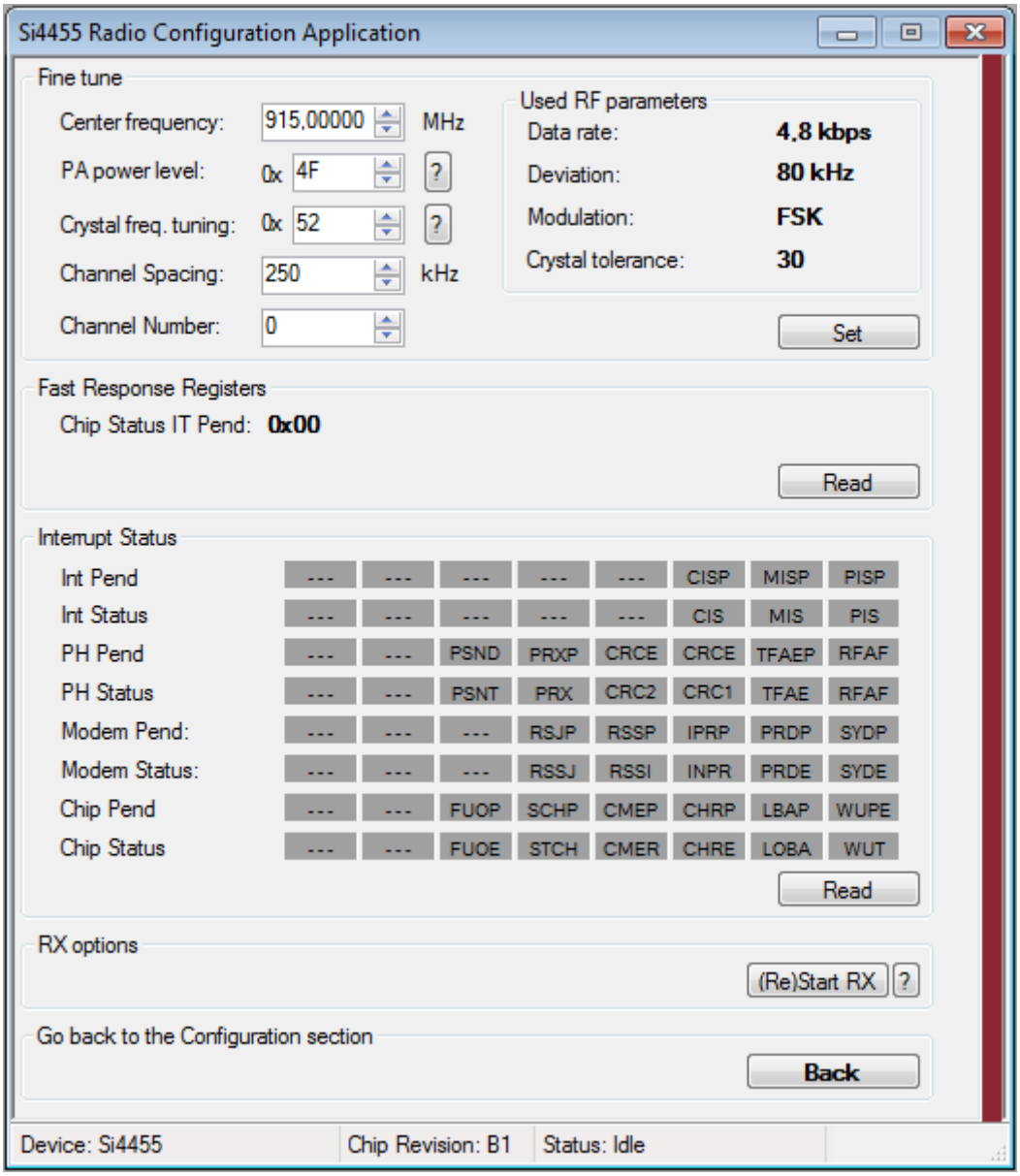

Figure 24. Direct RX Lab Measurement

5.4.3. Packet TX

If the application transmits packets, it is desired to verify the transmit side of the link. The Packet TX test can be used for this purpose. WDS allows the user to define the contents of the packet and initiate packet transmission with the Start TX button, which sends the packet once. If desired, packet content can be changed before sending the next packet.

This lab measurement allows the user to read back status information and monitor the interrupt status registers. WDS also enables fine tuning of basic RF parameters, such as center frequency, output power, and crystal frequency.

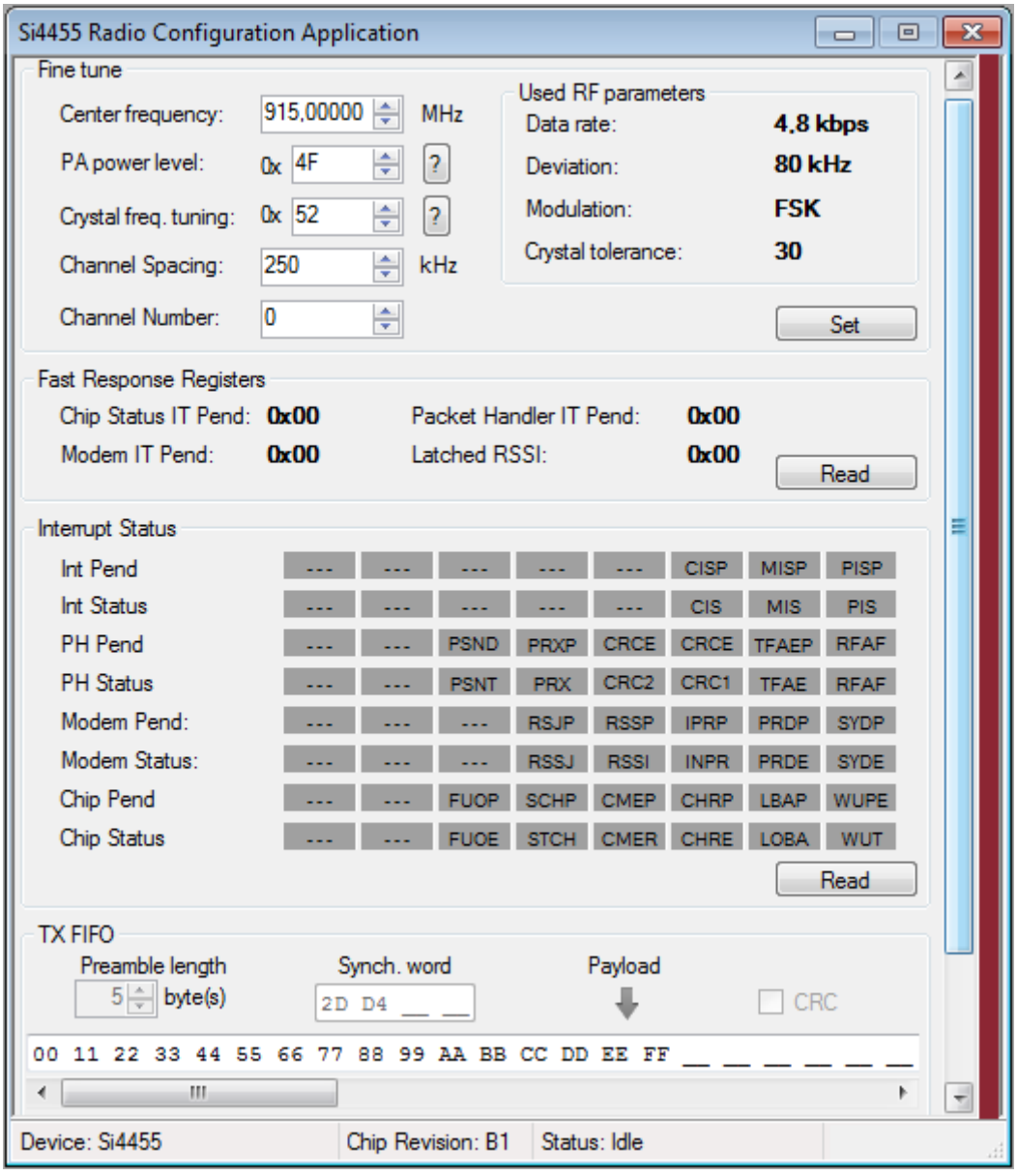

Figure 25. Packet TX Lab Measurement

5.4.4. Packet RX

When using packet-based communication, it is useful to check the sensitivity by measuring the packet error rate. The Packet RX test is suitable for this since the radio can be placed into receive mode where it waits to receive a packet. Once a valid packet is received, the user can read the FIFO content by pressing the “Read” button. The radio then needs to be placed back to receive mode with the “Restart Rx” button.

This lab measurement also allows the user to read back status information and monitor the interrupt status registers. WDS also enables fine tuning of basic RF parameters, such as center frequency, output power, and crystal frequency.

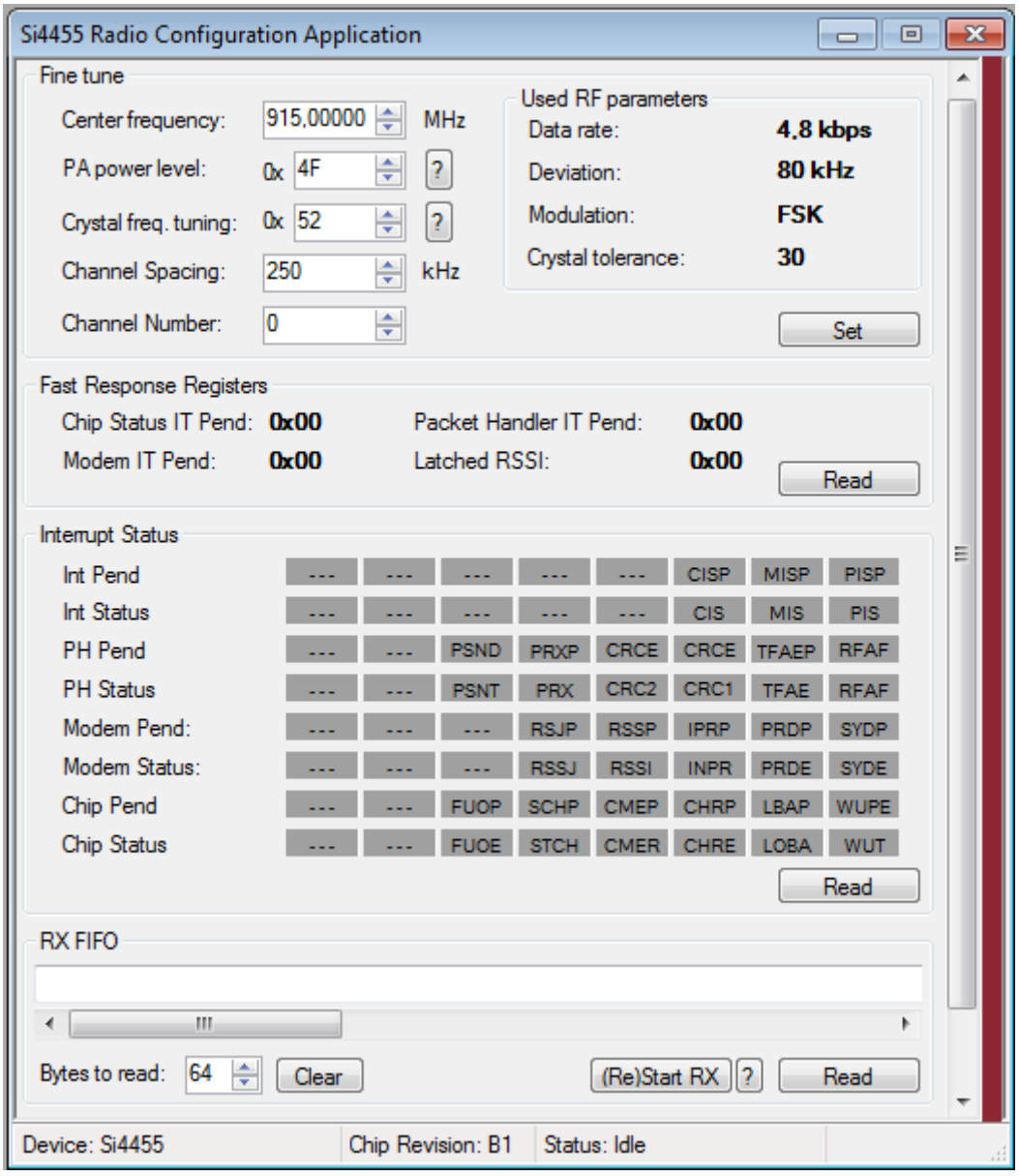

Figure 26. Packet Rx Lab Measurement

5.5. Launching an Example Application in Silicon Labs IDE

The Radio Configuration Application not only helps to configure and test the radio, but it can also create a complete C project customized with the desired radio setting. Users can select from the predefined use cases or use the blank framework, which only contains the necessary radio configuration header files and function prototypes for the interface functions that the user may fill up according to the microcontroller being used.

After configuring the radio in the Radio Configuration Application and selecting the use case, the user needs to press the “Launch IDE” button. The GUI provides a pop-up window to customize the project settings with the file locations, compilers used, etc.

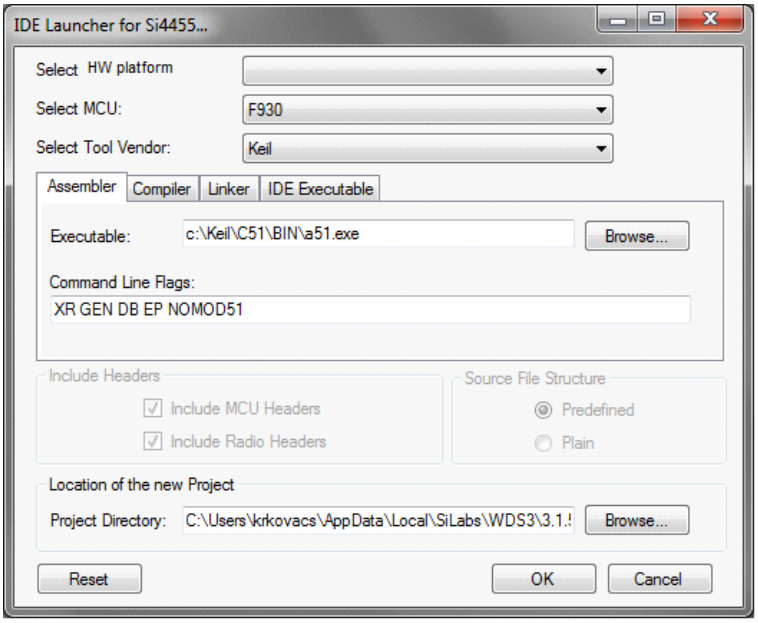

Figure 27. IDE Launcher

Finally, WDS launches the Silicon Labs IDE with the selected C project. The user can then start FW development with a ready and functional example project.

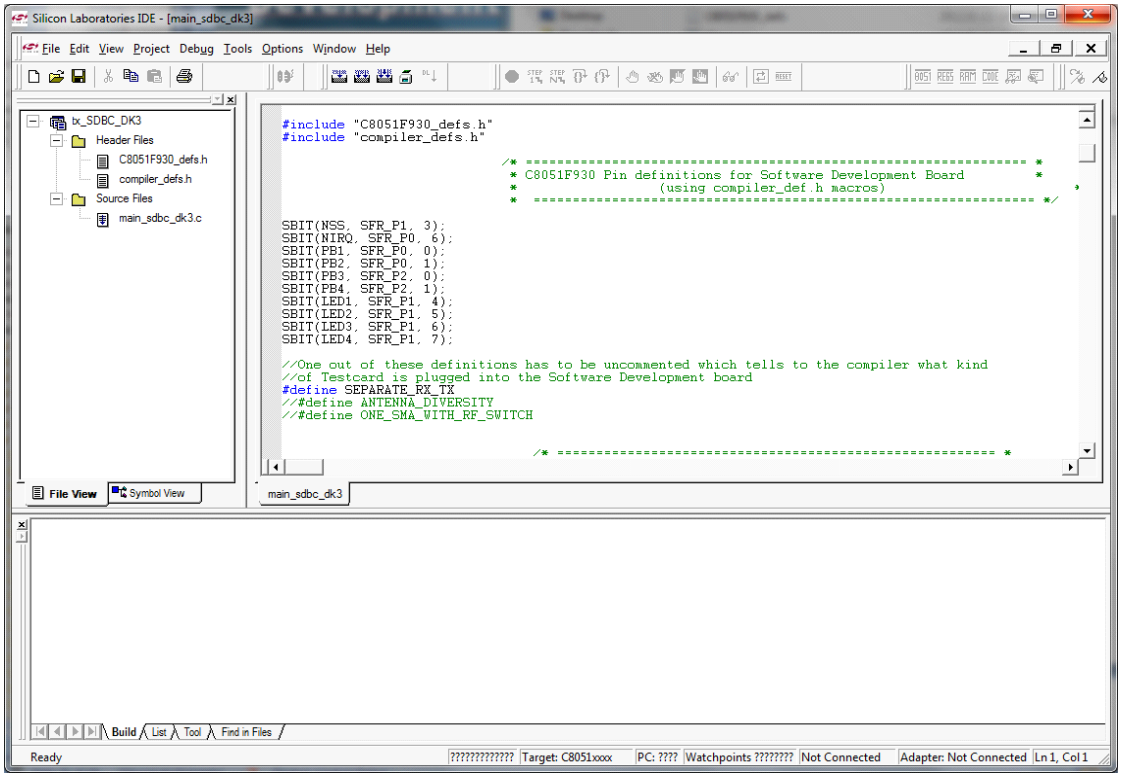

Figure 28. Radio Project in the Silicon Labs IDE

5.6. Wizard

The Wizard helps to determine the appropriate RF configurations for the regulatory compliance requirements of the selected region and the desired frequency band. The user only needs to answer a few basic questions related to the application, such as the desired operation mode of the device, the target region where the end application will be used, and the cost concerns regarding the crystal. The Wizard then calculates the maximum allowed output power of the transmitter according to the regulatory standards and the expected current consumption of the transmitter. In addition to the transmit device parameters, the Wizard also provides additional useful information about the expected link performance. If possible, the Wizard lists antenna options together with the expected indoor and outdoor range in the “Recommended Tx Options” information box. The expected range is calculated based on the assumption that both Rx and Tx devices use the same antenna structure. The gain of the antennas is determined by the maximum allowed radiated power of the regulatory standard valid for the selected region. The expected range calculation also takes into account the expected sensitivity of the receiver, which is calculated based on the data rate and the crystal oscillator accuracy.

A small information box provides a summary of the selected options, including the number of the regulatory standard, the antenna gain to fulfill the standard with the selected output power, and the maximum allowed radiated power.

The “Recommended RF settings” box contains the closest possible RF setting options of the EZConfig table determined according to the desired data rate.

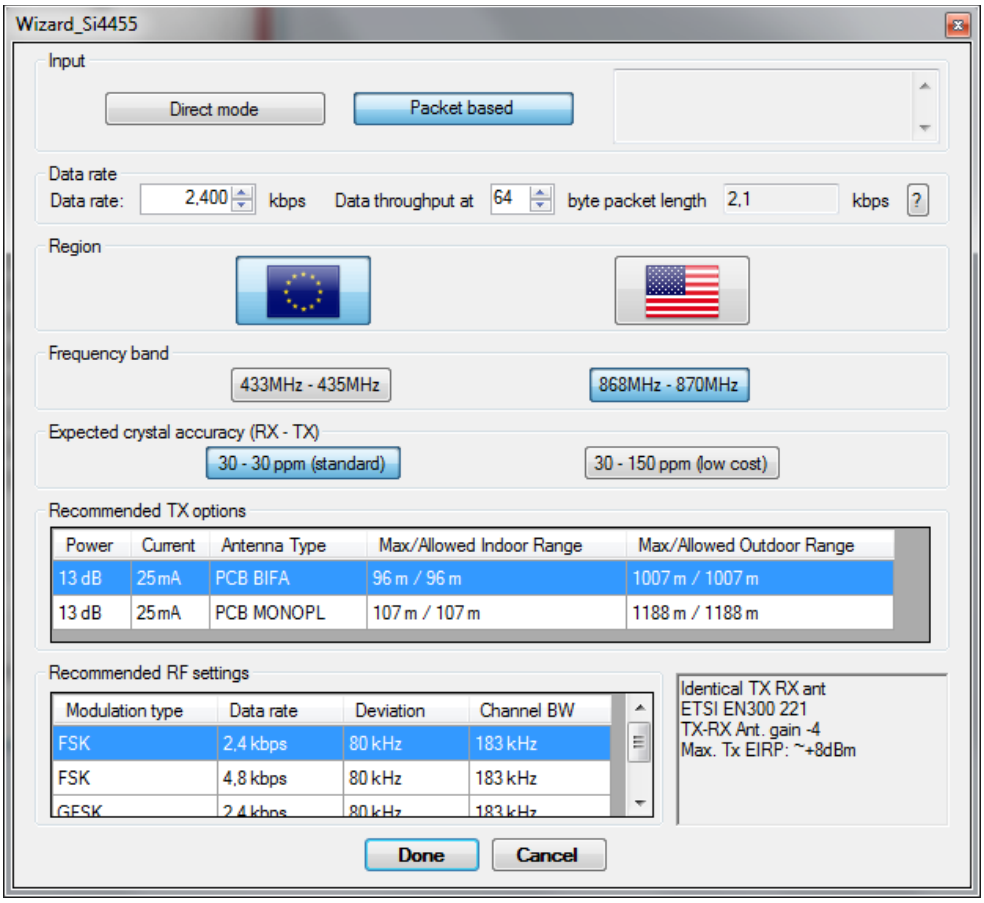

Figure 29. Wizard

After the desired configuration is selected and the “Done” button is pressed, the Wizard window is closed and WDS configures the Radio Configuration Application according to the selection made in the Wizard. The user can generate example source code or perform measurements as described in "5.3. Radio Configuration Application" on page 17.

NOTES:

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and register to submit a technical support request.