AN972: EFR32 RF Evaluation Guide

This evaluation guide provides an easy way to evaluate the performance of the Wireless Gecko EFR32 devices using the Silicon Labs Radio Abstraction Interface Layer (RAIL). RAILtest is a standalone test application, which is used for testing radio functionality, as well as peripherals, deep sleep states, etc. Basic transmit and receive commands allow customers to fully evaluate the receiving and transmitting performance and to test RF functionality of development kit hardware or customer hardware. Note that some of the lab testes require RF test equipment, such as a spectrum analyzer and RF signal generator. It is a useful test application to be used for basic testing of your custom EFR32 design and characterization.The test can be used in the laboratory to measure the basic RF parameters of the radio (output power, sensitivity, etc.).

The two tables below illustrate which RAILtest feature is suitable for which RF evaluation test.

KEY POINTS

- How to evaluate the performances of the Wireless Gecko EFR32 devices
- RAILtest is a standalone test application used for testing radio functionality
- RAILtest can be used in the laboratory to measure the basic RF parameters of the radio

Reception Test		
	PER	BER
Rx sensitivity	triggered and non-triggered	x
Selectivity	x	x
Blocking	x	x
Intermodulation	x	x
Maximum input Power	x	x

Transmission Test			
	CW mode	PN9 mode	Packet mode
Tx Power	x	—	—
Power Spectral Density Mask	—	x	—
Phase Noise	x	—	—
Spurious Emission	x	—	—
Transient Power	—	—	x

1. Running Simplicity Studio

For more information on Simplicity Studio, please refer to *QSG121: Getting Started with Silicon Labs RAIL On the Wireless Gecko (EFR32) Portfolio*.

Before running the RAILtest, the platform must be configured according to the following instructions:

To start, you need to set up an EFR32 development kit radio board with a mainboard for Wireless Starter Kits (WSTK). Once you have installed all the required software you can connect your EFR32 development kit hardware to your PC using a mini USB cable. Make sure the 3-way power switch in the bottom left is set to AEM.

If you want to connect to your WSTK over Ethernet, you should also plug in an Ethernet cable at this time. The IP address will be printed to the LCD screen during startup of the WSTK but may be lost when the app starts. To see this again, reboot the WSTK and press the reset button for several seconds to prevent the EFR32 from loading its application.

1.1 Select RAILtest application

1. Once Simplicity Studio is running, under the Devices tab, select the S/N (device serial number) of your device. There should be only one if you have connected only one EFR32 development kit. (After connecting the WSTK to the PC, the first screen on the LCD of the mainboard is the Start Screen, which shows the Serial Number of your device.)
2. In the Launcher (default) perspective, click on the Getting Started tile, and view all the software examples by clicking on the View All link.

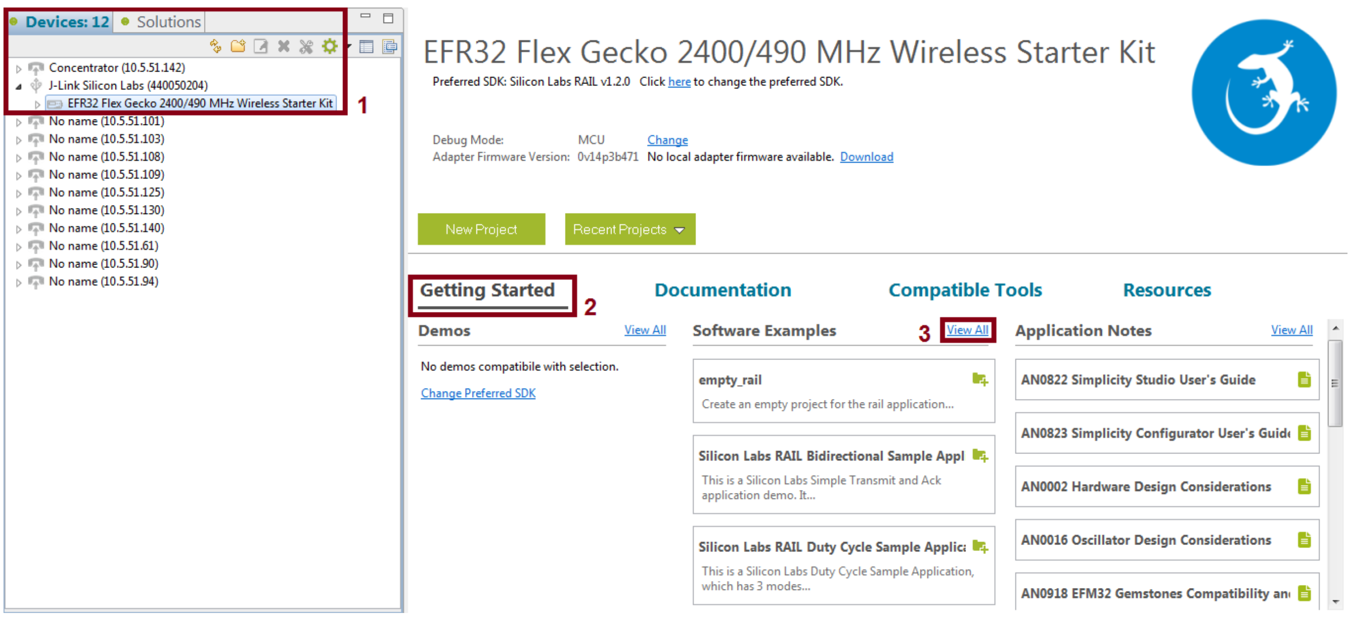


Figure 1.1. Simplicity Studio's Simplicity Perspective

3. In Project Setup dialog, on the SDK drop-down menu, select the Silicon Labs RAIL. By default, Simplicity Studio loads the Kit and Part number of your connected starter kit. If it is not correct, you must change it manually.

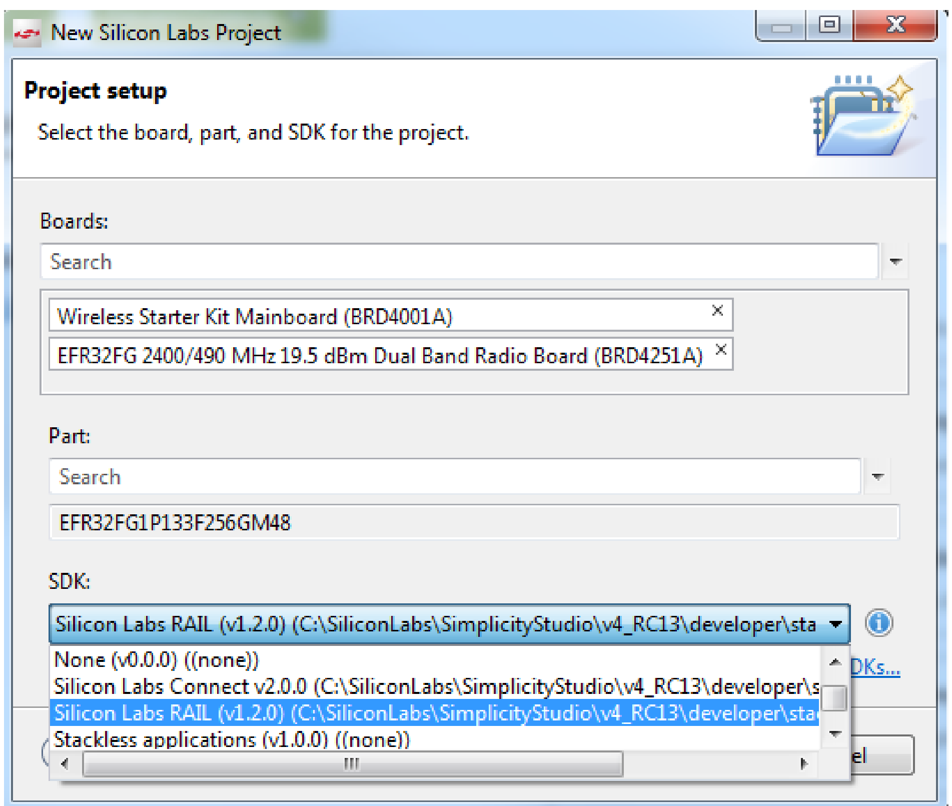


Figure 1.2. New Silicon Labs MCU Example Project Window

4. Click [**Next**] .
5. In the Select Silicon Labs RAIL Framework Sample Applications dialog, select Silicon Labs RAIL RAILTEST Sample Application for EFR32.

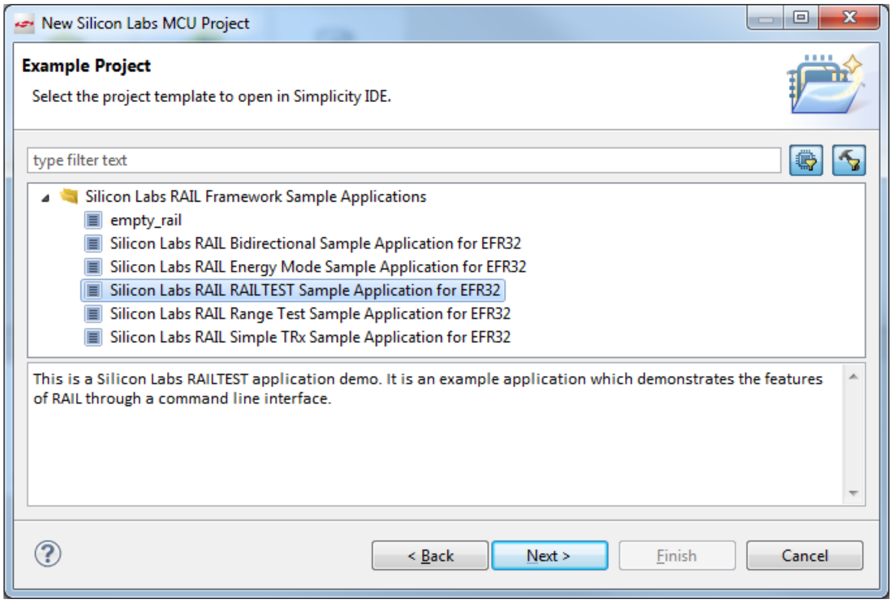
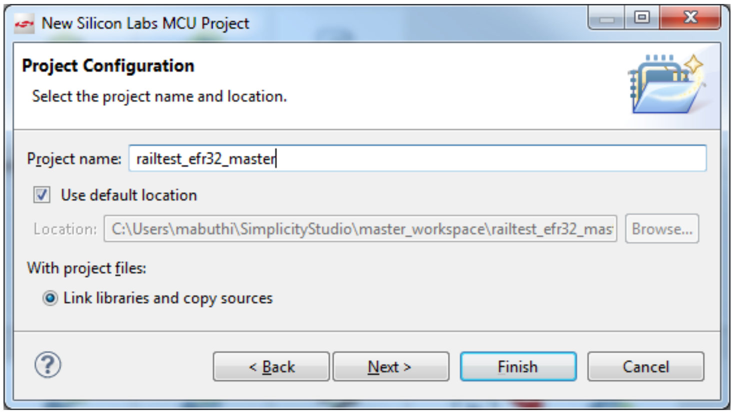


Figure 1.3. Sample Applications Dialog

6. Click [**Next**].
7. In the Project Configuration window, specify a location for your application.



Note: the location must be on the same Windows partition as the stack.

Figure 1.4. Project Configuration Window

8. Specify a name for your application.
9. Click [**Next**]. This window shows the various build configurations available.
10. Check one of the initial build configuration to include in the project. (You can edit these later through the "Manage Configurations" command.
11. Click [**Finish**].

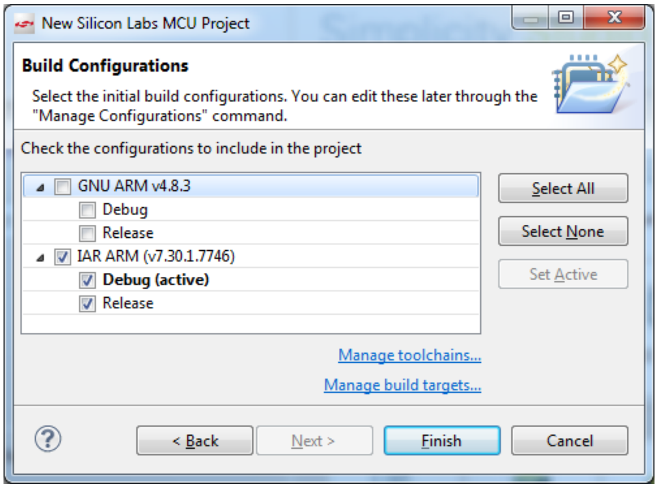


Figure 1.5. Build Configurations

Note: You must have a Toolchain and Build target selected and configured for the [**Finish**] button to enable. If you do not see the [**Finish**] button enabled, check your Toolchains and Build targets by clicking on the links at the bottom of the dialog.

1.2 Generate the Application

When you finish creating your sample application, an Application Builder General tab opens.

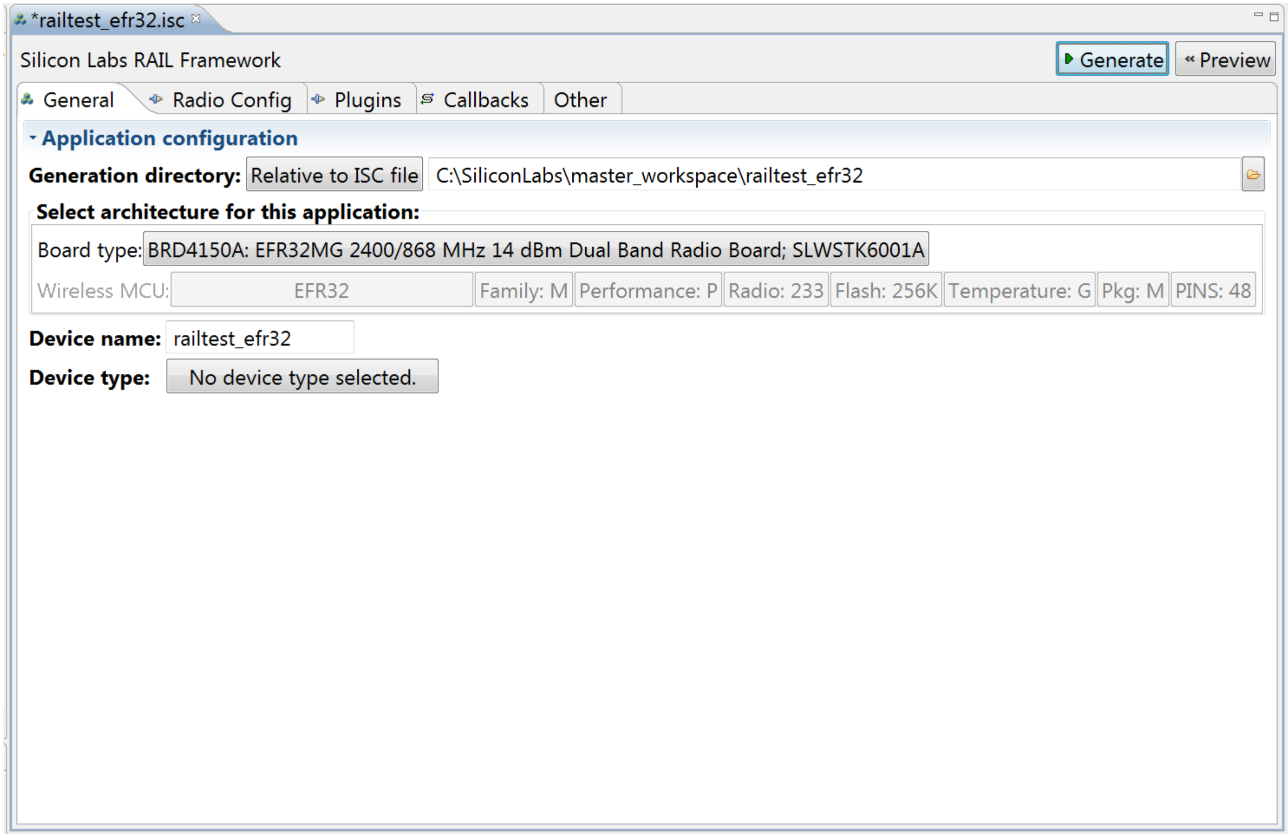


Figure 1.6. Application Builder General Tab

1. In the General Tab, if the architecture parameters shown for MCU and Radio and Board Type are not correct for your target device, change them by clicking on one of the configuration buttons and then selecting from its list. In general, the initial configuration settings for sample applications should be correct.
2. The RAIL application framework allows you to modify the PHY configuration for the application. Choose the “Radio Config” tab to modify the PHY configuration for your application. For more information on how to set the modem parameters, please refer to *AN971: EFR32 Radio Configurator User's Guide*.

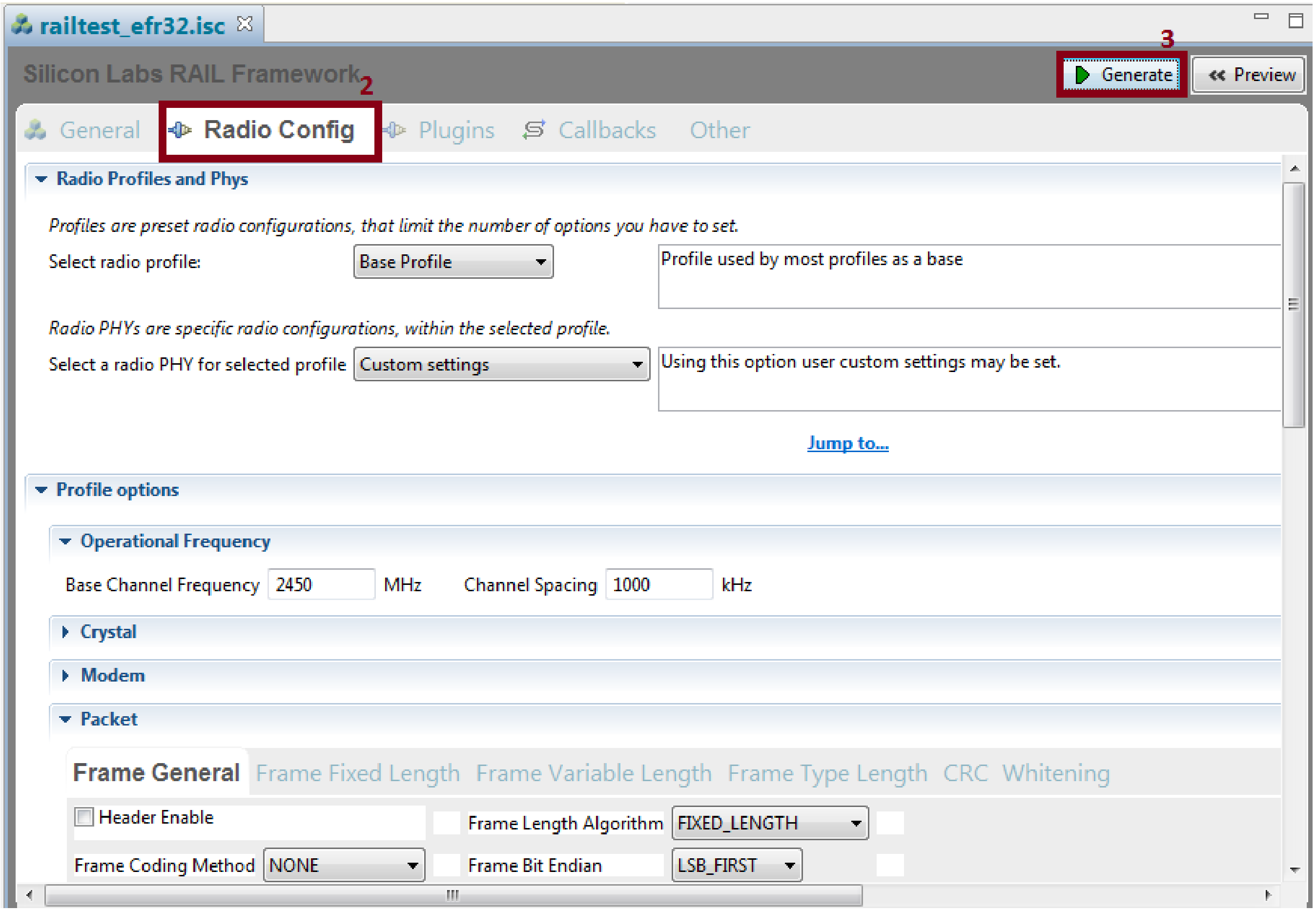


Figure 1.7. Application Builder Radio Config Tab

3. Click [**Generate**] in the upper right corner of Application Builder window. Note that whenever the Build Configuration has been changed, you have to click [**Generate**] again.
4. When generation is complete a dialog shows the generated files, one of which has the extension .eww. Click [**OK**].

1.3 Build the Application

Click [**Build**] in the top tool bar.

Your sample application will compile based on its build configuration. You can change the build configuration at any time in the Project Explorer View by right clicking on the project and going to Build Configurations > Set Active.

1.4 Load the Binary onto your Device/Flash Programming

In case a full erase is not necessary, press the Debug button in the Developer Perspective.

This will flash the project into the board if it was successfully built. This will only update the program memory.

Once the project is flashed, the board can be started with the Resume button .

An alternative way to the above described process:

1. In the Simplicity Studio Launcher window, select your target device.
2. With the device selected, select the [**Flash Programmer**] tile under the Compatible Tools menu:

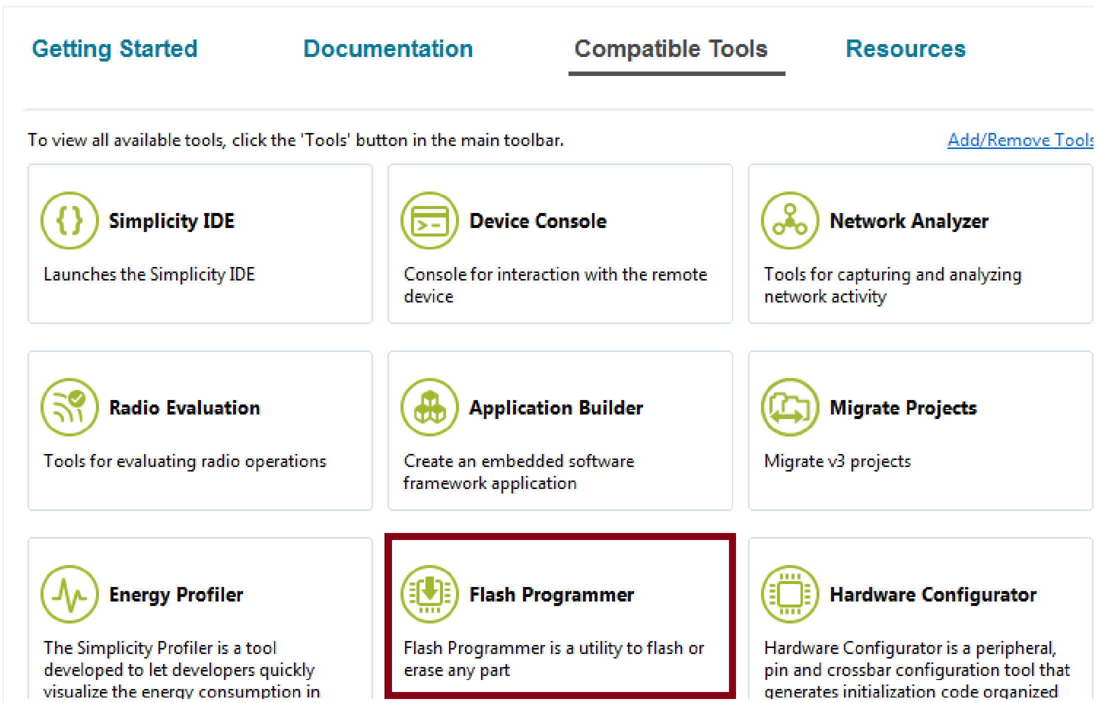


Figure 1.10. Flash Programmer Tile

3. The Flash Programmer opens. In this window, you can choose your file type and browse your file.
4. Select your file type.

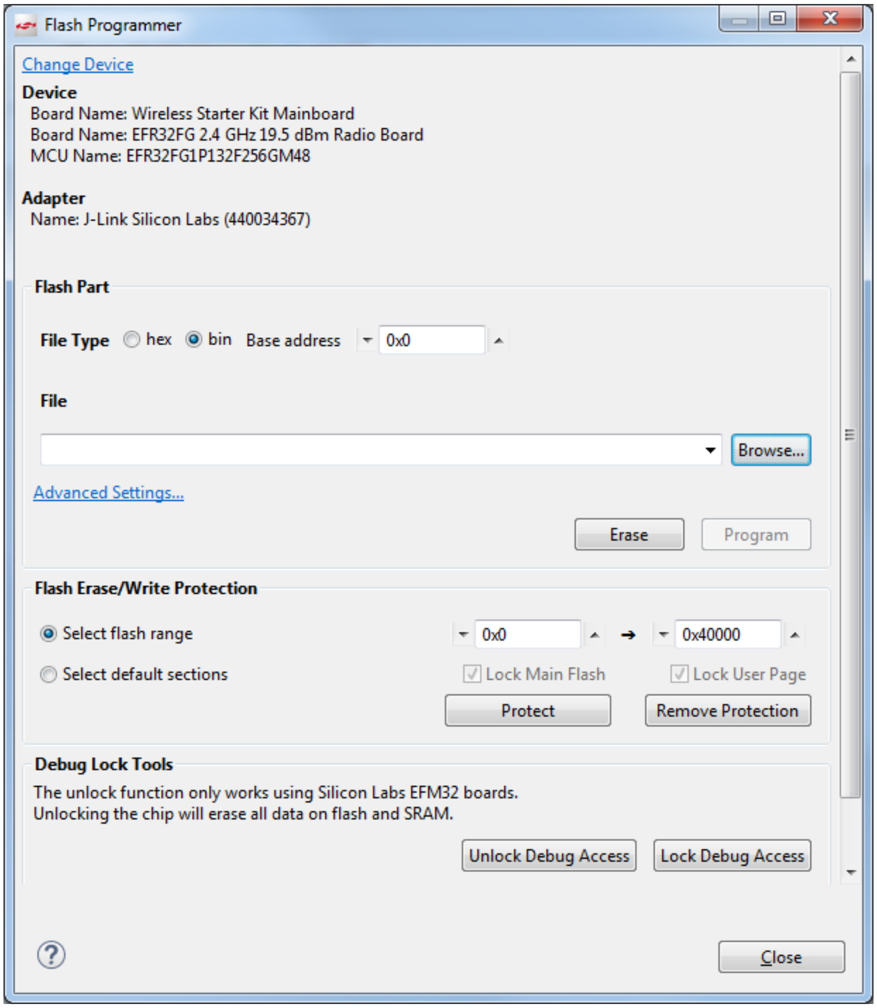


Figure 1.11. Uploading .bin or .hex Images

5. Navigate to the .bin or .hex image you wish to upload.
6. Check [**Erase**], to make sure that any previous bootloader or other non-volatile data is erased before your new image is uploaded.
7. Click [**Program**] to program the flash.
8. You will be notified once the upload is complete.

After starting the demo, the screen shows three parameters: Rx Count, Tx Count, and Channel Number.

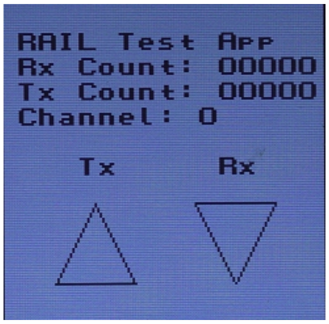


Figure 1.12. RAILtest Application Start Screen

1.5 Serial Port Communication

The RAILtest application should be accessed using a standard serial port. The default version uses the WSTK's built in serial port to provide access to this so do not attempt to connect directly to the UART GPIOs.

The serial port can be accessed using Ethernet or USB. Both provide the same level of functionality so it's completely up to you what to use.

- For USB plug the device into your computer and find the Virtual COM port that is created. It will show up as a "JLink CDC UART Port" in the Device Manager. The Virtual COM port should work with any UART settings, but the physical UART is configured for 115200 8-N-1 if you want to match that. For UART based communication, you can use any terminal emulator program that supports serial port communication like TeraTerm or PuTTY.
- For Ethernet, use a telnet client to connect to port 4901 on the WSTK. You can use a program like PuTTY for this or the standard command line telnet client.

1.6 Console View

Once the RAILtest application is loaded onto the EFR32 you can interact with the RAILtest application using the Command Line Interface. The Console View will give you a CLI interface in Simplicity Studio's Network Analyzer Perspective so that you can interact directly with the RAILtest application.

1. Right-click on your device in the Devices View. (You can reach the Devices View by going back to the Simplicity Launcher Perspective and selecting Network Analyzer.)

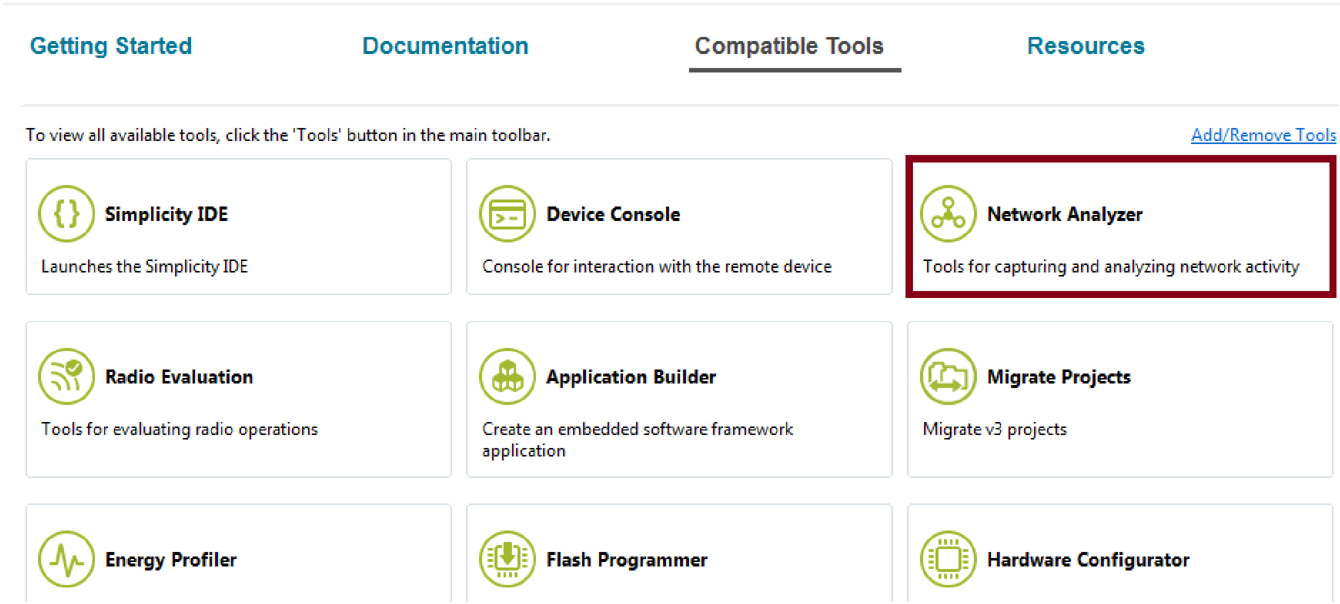


Figure 1.11. Network Analyzer Tile

2. Choose Connect (if you are not already connected) and then [**Launch Console**] . To get a prompt on the Console Serial 1 tab, press [**Enter**].

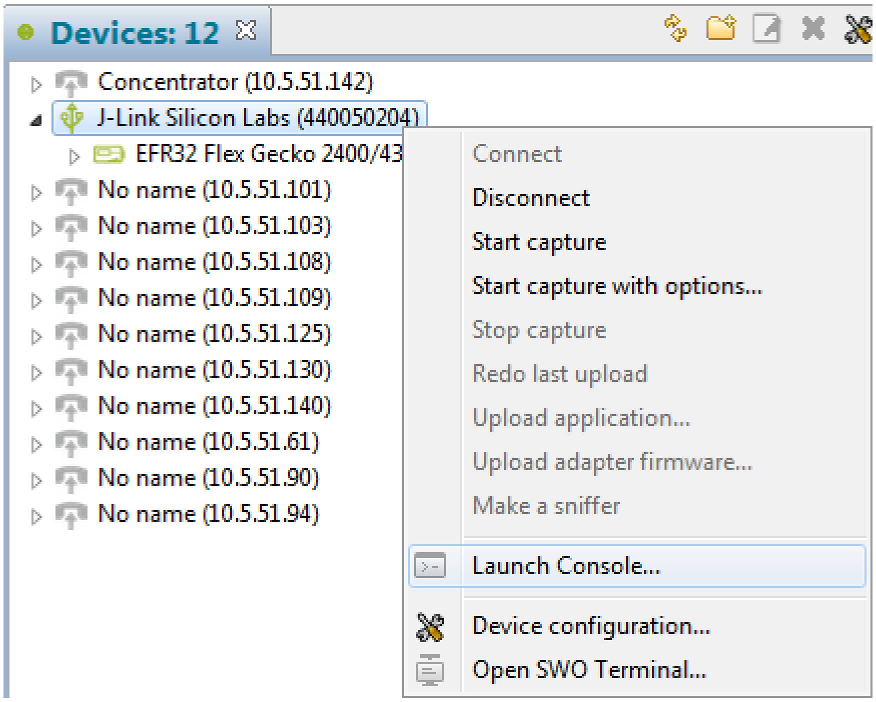


Figure 1.12. Launch Console

2. Basics of the RAILtest Application

The RAILtest application provides you with a simple tool for testing out the radio and the functionality of the RAIL library. For any advanced usage you will have to write your own software against the RAIL library and create a custom radio configuration.

Note: If you are going to use the WSTK as a mobile device to run the RAILtest application, it is recommended that you connect an external AA battery pack or a USB power bank to the WSTK board. The coin cell battery will not have enough power to do long-term testing using sample applications like RAILtest.

2.1 CLI

The most powerful way to interact with the sample application is using the provided command line interface. The setup instructions above described, how to connect to this interface.

2.2 Command Input

The syntax for this interface is the standard command [arg0, arg1, ...] syntax where the number and type of arguments depends on the specific command. Numeric values can be prefixed with 0x to indicate hexadecimal values. Note that the maximum number of arguments to any command is 9 and the maximum length of a command line is 255 characters.

For a full listing of the command options you can use the help command.

2.3 Command Output

All responses to commands are formatted in a human readable yet parsable format. There are two variations of this format: single and multi line. Both of these follow the following set of rules.

- Start and end with curly braces { }.
- List the command name, enclosed in parentheses ( ).
- Contain any number of tag/value pairs enclosed in curly braces { }.
- Carriage returns and line feeds are treated as whitespace by any parser.

2.3.1 Single Response

Used when there is only a single response to a command.

- There is a single start/end curly brace wrapper.
- Tag/value pairs are wrapped in a single set of curly braces, separated by a colon {tag:value}.

Example:

```
> getchannel
{{(getchannel)}{channel:4}}
```

2.3.2 Multi Response

Used when a command may have multiple responses. For example, when reading a block of memory, or receiving multiple packets.

- Response starts with a header, delimited by a hash # at the start of the line.
- Header includes the command name, followed by any tags individually wrapped with curly braces { }.
- Following the header, any number of responses can be provided.
- Data lines do not contain the command name or tags, only the values that correspond to the tags in the order described in the header.

Example:

```
> getmemw 0x20000000 4
#{{(getmemw)}{address}{value}}
{{0x20000000}{0x0000e530}}
{{0x20000004}{0x000051c6}}
{{0x20000008}{0x0000c939}}
{{0x2000000c}{0x0000e090}}
```

3. Transmission Test

3.1 Output a Continuous Unmodulated Tone for Testing Tx Power, Phase Noise and Spurious Emission

CW mode is used to test the output power of the test card and obverse the unmodulated carrier spectrum. In this mode, only the frequency and the output power are configurable parameters.

Enable the CW mode:

```
setTxTone          [enable] Enable(1) or Disable(0) a tone from the radio
```

The setPower command can be used to change the output power; enter the desired power in deci dBm.

Note: The radio state must be IDLE. Call "rx 0" first.

```
setPower       s    [power] Set the current transmit power in deci dBm
```

To modify your frequency to a value not defined in the channel list, you will need to set the application into the FREQUENCY_OVERRIDE debug mode via debugMode which tells the application to ignore the current channel selection. Once in the FREQUENCY_OVERRIDE debug mode, you can use the freqOverride command to switch to another center frequency.

Note: The freqOverride command requires you to be in FREQUENCY_OVERRIDE debug mode.

Note: The radio state must be IDLE in order for the channel to be changed or the frequency to be modified. Call "rx 0" first.

Example:

```
rx                0               [enable] Enable(1) or Disable(0) receive mode
setDebugMode      1               [mode] 1 = Frequency Override. 0 = Disable debug mode
freqOverride      2404000000      [freq] Change to freq specified in Hz. Requires debug mode to be enabled.
```

Another way to change the frequency is to change the channel. The specific channel configuration depends on the PHY configuration you have chosen for your test app. To switch between channels, use the setChannel [num] command. In addition, you can use button PB1 to cycle between channels. (The channel spacing value is used for relative frequency configuration where one would like to configure a frequency so many channel spacing away from the base channel frequency.)

To get the current radio channel, use this command:

```
getchannel          Get the current radio channel
```

To set another radio channel, use this command:

```
rx            0         [enable] Enable(1) or Disable(0) receive mode
setchannel    u         [channel] Set the current radio channel
```

Note: The radio state must be IDLE in order for the channel to be changed or the frequency to be modified. Call "rx 0" first.

A spectrum analyzer is used to measure the transmit performances of the radio and must be connected through a proper RF cable to the RF connector of the radio board.

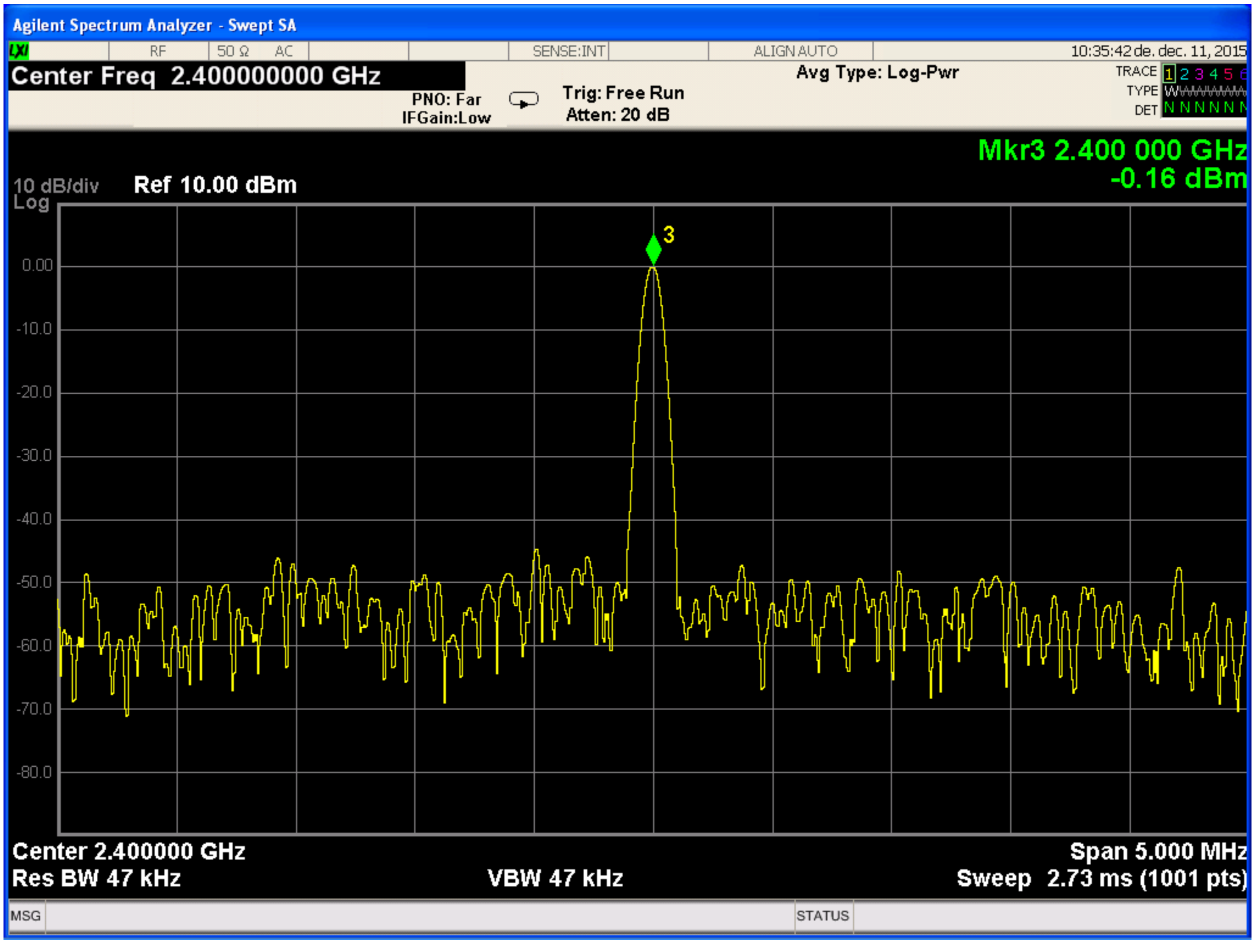


Figure 3.1. Unmodulated CW signal Measured with Spectrum Analyzer

CW mode is also capable to test Phase Noise and Spurious Emission.

3.2 Output a Continuous Modulated PN9 Stream for Testing Power Spectral Density Mask

In this mode, the modulation content is generated internally using a pseudo-random (PN9 sequence) bit generator. The primary purpose of this mode is to observe the modulated spectrum without having to provide data for the radio. This mode is used to test the power spectral density mask. A spectrum analyzer is used to measure the power spectral density mask of the radio and must be connected through a proper RF cable to the RF connector of the radio board.

In this mode, only the frequency and the output power are configurable parameters. (To change these parameters, please refer to 3.1 Output a Continuous Unmodulated Tone for Testing Tx Power, Phase Noise and Spurious Emission.)

Enable PN9 mode:

```
setTxStream          Enable/Disable a PN9 stream from the radio
```

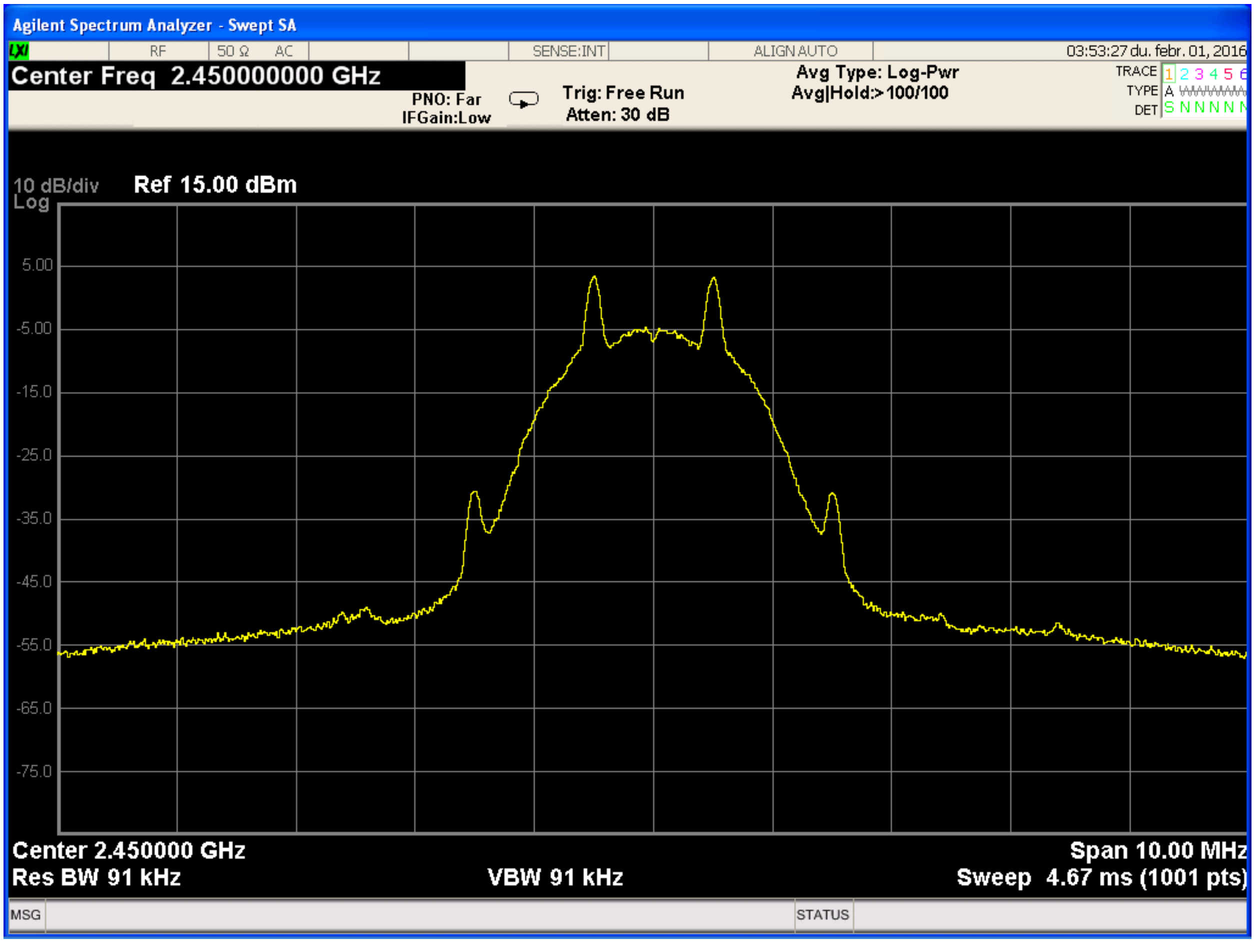


Figure 3.2. PN9 Modulated Signal (2GFSK, 1Mbps Data Rate, ± 500 kHz Deviation)

The figure above shows the demodulated signal when the radio board works in PN9 mode. The data rate is 1 Mbps; the deviation is 500 kHz, and the modulation type is 2GFSK.

3.3 Enable Direct Mode

In direct mode, the radio will still attempt to decode received packets, but the data bit streams are input to and output from the chip in real-time on a physical I/O pin. This is often useful in legacy systems that do not use a conventional packet structure, or when the host MCU must perform customized packet handling or processing. In TX Direct mode, the TX modulation data is applied to an input pin of the chip and processed in “real time” (i.e., not stored in a register for transmission at a later time).

The GPIOs for direct mode are fixed for now to the following pins.

```
DIN - EFR32_PC10 -> EXP_HEADER15/WSTK_P12
DOUT - EFR32_PC11 -> EXP_HEADER16/WSTK_P13
```

The data on these pins is asynchronous and can be connected directly to a UART. To enter direct mode issue the `directMode 1` command after starting the app. To leave direct mode use `directMode 0`. If you want to transmit you must enable the transmitter by issuing `directTx 1` and later stop it with `directTx 0`. Receive is controlled using the standard `rx 1/0` command, but is enabled by default when not transmitting.

In this mode, only the frequency and the output power are configurable parameters. (To change these parameters, please refer to 3.1 Output a Continuous Unmodulated Tone for Testing Tx Power, Phase Noise and Spurious Emission.)

3.4 Enable Packet Mode

The application starts in packet mode with the receiver enabled. In this mode we receive and transmit packets using the radio's frame controller hardware.

To transmit a specified number of packets, use this command:

```
tx        w        [n] Transmit n packets. If n is 0 transmit infinitely
```

Or press button PB0. If you hold PB0 for a couple of seconds or run the tx 0 command you can toggle the continuous transmit mode.

In this mode, the frequency, the output power, delay in between each transmitted packet, the length and the value of the bytes to send are configurable parameters. (To change the frequency and the output power parameters, please refer to 3.1 Output a Continuous Unmodulated Tone for Testing Tx Power, Phase Noise and Spurious Emission.)

When transmitting multiple packets or infinite packets there is a configurable delay in between each transmit. By default this is 250 ms, but it can be set with the following command:

```
setTxDelay       w        [delay] Set the inter-packet delay in milliseconds for repeated Tx
```

Get the inter-packet delay in milliseconds for repeated Tx, use the getTxDelay command.

In case the desired delay is lower than 15 ms, all the peripherals need to be disabled.

```
setPeripheralEnable       u        [enable] Turn LEDs and LCD on/off
```

The application by default sends a fixed packet, but it is possible to override the values via setTxPayload. The command allows you to modify the values of the payload at specific offsets. For instance to modify the first 4 bytes sent in the packet to be 0x01 0x02 0x03 0x04, this is the command:

```
setTxPayload 0 0x01 0x02 0x03 0x04
```

Note: To view the currently configured TX Packet information, use the following command:

```
printTxPacket       Print the current Tx data and length
```

A byte in the payload holds the length of the packet for variable length schemes. The length byte in IEEE 802.15.4 is the first byte; this is what you can set using the setTxPayload command. The length byte also covers the CRC length of the packet, and the length parameter covers the length byte; this is what you can set using the setTxLength command.

All in all, here is an example to set 3 byte payload to 0x01 0x02 0x03, while using IEEE 802.15.4 configuration:

```
setTxLength 4
setTxPayload 0 0x05 0x01 0x02 0x03
```

A spectrum analyzer is used to view the over the air sent packets of the radio. It must be connected through a proper RF cable to the RF connector of the radio board..

Figure 3.3. Analog FM Demodulation of the Sent Data

4. Reception Test

4.1 Running Bit Error Test from the CLI to Measure RX Sensitivity, Selectivity Testing (co, adjacent, alternate, image), Blocking, Intermodulation, Maximum Input Power

The sensitivity of the radio can be measured with a continuously-looped PN sequence (x^9 + x^5 + 1). This mode is called bit error rate (BER). The EFR32 hardware has the ability to enter BER receive mode for diagnostic purposes. The radio is set into continuous receive mode. The RF data needs to be fed to the RX SMA of the test card or radio board. By adjusting the output power of the signal generator or an EFR32, the sensitivity of the radio can be measured (it is typically measured for 10^-3 BER).

4.1.1 BER Measurement Procedure

To run the BER test successfully, a radio configuration specific to BER mode must be generated by the radio configurator. Reconfigure for BER testing needs to be checked on the Radio Config tab in Simplicity Studio.

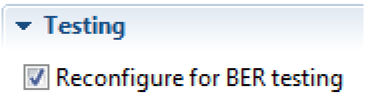


Figure 4.1. Enable BER Testing in Simplicity Studio

The `setBerConfig` command allows the user to specify how many bytes to receive in BER receive mode. The maximum number of bytes you can designate to receive is 536870911. Specifying a number of 0 or a number greater than the maximum possible value will automatically configure the BER test to receive the maximum number of bytes for testing.

The `berRx` command allows the user to enter and exit BER receive mode. If the test is allowed to run to completion, there is no need to exit BER receive mode.

The `berStatus` command allows the user to query for test statistics during or after a test. The statistics are reset when `setBerConfig` is run or when `berRx` 1 is run. The statistics include BitsToTest (total bits to be tested), BitsTested (the number of bits already received and tested), PercentDone (percentage of how many configured bytes have been received), RSSI (an instantaneous RSSI value corresponding to the last byte received), BitErrors (the number of received bits determined to be in error), and PercentBitError (percentage of bit errors to bits tested).

Example:

```
> setberconfig 100000

> berrx 1

> berstatus{{(berStatus)}{BitsToTest:800000}{BitsTested:0}{PercentDone:0.00}{RSSI:0}{BitErrors:0}{PercentBitError:0.00}}

// PN9 transmission enabled here

> berstatus
{{(berStatus)}{BitsToTest:800000}{BitsTested:121312}{PercentDone:15.16}{RSSI:-23}{BitErrors:0}{PercentBitError:0.00}}

> setberconfig 1000000

> berrx 1

> berstatus{{(berStatus)}{BitsToTest:8000000}{BitsTested:4418528}{PercentDone:55.23}{RSSI:-96}{BitErrors:960478}{PercentBitError:21.74}}

> berstatus{{(berStatus)}{BitsToTest:8000000}{BitsTested:8000000}{PercentDone:100.00}{RSSI:-97}{BitErrors:2752908}{PercentBitError:34.41}}
```

4.2 Running a Packet Error Test from the CLI

PER mode is capable to test RX sensitivity (triggered and non-triggered PER), Selectivity (co, adjacent, alternate, image), Blocking, Intermodulation and Maximum input power.

4.2.1 Basics of the Packet Error Rate

Packet error rate can be calculated with the following equation:

$$Packet\ Error\ Rate(PER)[\%] = \frac{(P_{Tx} - P_{Rx})}{P_{Tx}} * 100$$

Where PTX is the number of sent packets and PRX is the number of received packets.

4.2.2 Non-Triggered PER

By default the application starts in packet mode with the receiver enabled. In this mode we receive and transmit packets using the radio's frame controller hardware. In case a packet is received, the payload content and length, the RSSI, the CRC status and the time can be read from the receiver response.

Example:

```
{{(rx)}{len:24}{timeUs:265911670}{crc:Pass}{rssi:0xcf}{payload: 0x0f 0x16
0x11 0x22 0x33 0x44 0x55 0x66 0x77 0x88 0x99 0xaa 0xbb 0xcc 0xdd 0xee 0xff
0x00 0x11 0x22 0x33 0x44 0x55 0x66}}
```

The sensitivity of the radio can be also measured by receiving packets. This test also involves an RF signal generator, which can transmit predefined packets. In this mode, the radio is set to receive and the generator must send packets. In case the radio does not receive the packet, there won't be any RX response. Further on to view the number of received packet, CRC errors and sync detect errors, use status command.

Example:

```
status
{{(status)}{TxCount:0}{RxCount:9}{SyncDetect:9}{InvalidCrc:0}{RxOverflow:0}{AddrFilt:0}{TxAbort:0}{TxChannelBus
y:0}{Channel:0}{TxMode:Off}{RxMode:Enabled}}
```

By adjusting the output power of the generator, the sensitivity of the radio can be determined. It is usually defined for a 1% or 20% packet error rate.

To reset all the counters use:

```
resetCounters       Resets the Tx and Rx counters
```

In case a long and fast test needs to be run, it is better to disable the Rx responses, to make the communication and the test faster.

```
setRxNotification       u       [enable] Enable/Disable LED toggle and status print for every receive packet
```

PER Measurement Procedure Using Link Test

1. Load the RAILtest application on two EFR32 nodes.
2. In case, you have more channels, set the radio to the desired channel on both nodes with the `setchannel n` command where "n" is the desired channel number.

   To view the currently configured TX Packet information, use `printTxPacket`.
3. Issue the `rx 1` command on the first node.
4. Issue the `tx n`[dec value] command on the second node. This command will transmit n packets of the form required for PER analysis. (For actual PER analysis, send 1000 or more packets.)

   Another way to send packets is to press button PB0. If you hold PB0 for a couple of seconds you can toggle continuous tx mode where a packet is sent every 250 ms.
5. To view the number of received packets, CRC errors and sync detect errors, use the status command.

4.2.3 Triggered PER

RAILtest can be used to determine the packet error rate (PER) for a given setup. The Wireless Gecko is capable of triggering a connected RF signal generator to transmit a specific number of packets with configured trigger interval, counting the correctly received packets, and calculating the actual PER value.

To set up this test, a piece of test equipment needs to be configured to send a packet on the rising edge of a GPIO. That should be connected to PC7 on the EFR32, or PC3 on the WSTK. `perRx 100 10000` will configure the Packet Error Rate test to send 100 packets, waiting 10000 µs between each packet. At the end of the test, the app will give an output indicating that PER mode has finished, and the statistics on the test can be recovered with `perStatus` and `status`. Note that calling `perRx 0 0` will cancel an ongoing test, and that calling `perRx` will have the same effect as calling `resetCounters`.

By adjusting the output power of the generator, the sensitivity of the radio can be determined. It is usually defined for a 1% or 20% packet error rate.

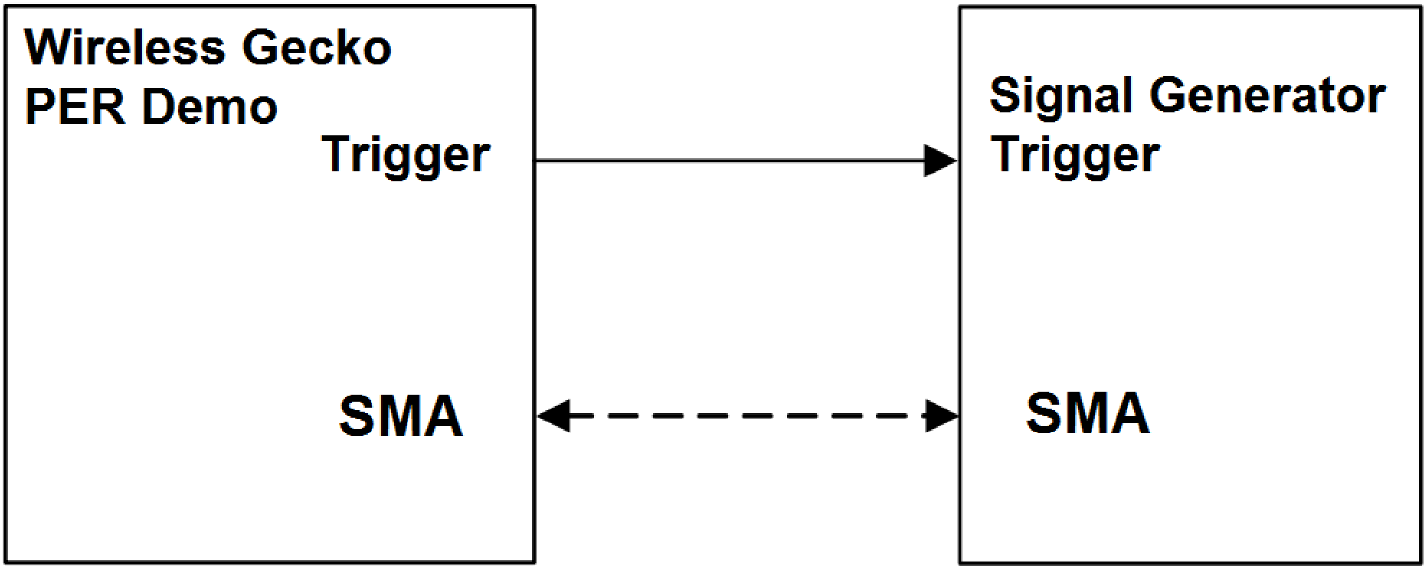


Figure 4.2. Packet Error Rate Measurement Setup

4.3 RSSI Curve

Received signal strength indicator (RSSI) is an estimate of the signal strength in the channel to which the receiver is tuned. The RSSI value can be read with 0.25 dB resolution per bit. The RSSI may be read at any time while the Radio is in Receive mode. The RSSI is not latched, but continuously updated while in Receive mode.

To read the RSSI value, use the following command:

```
getRssi       Get RSSI in dBm if the receiver is turned on.
```

Example:

```
> getRssi
getRssi
{{(getRssi)}{rssi:-94}}

> >
```

Please note that a systematic offset (see figure below) will appear in the RSSI value returned by RAIL test command due to matching network, radio configuration, etc. The users need to profile their board and account for the offset when using the returned value.

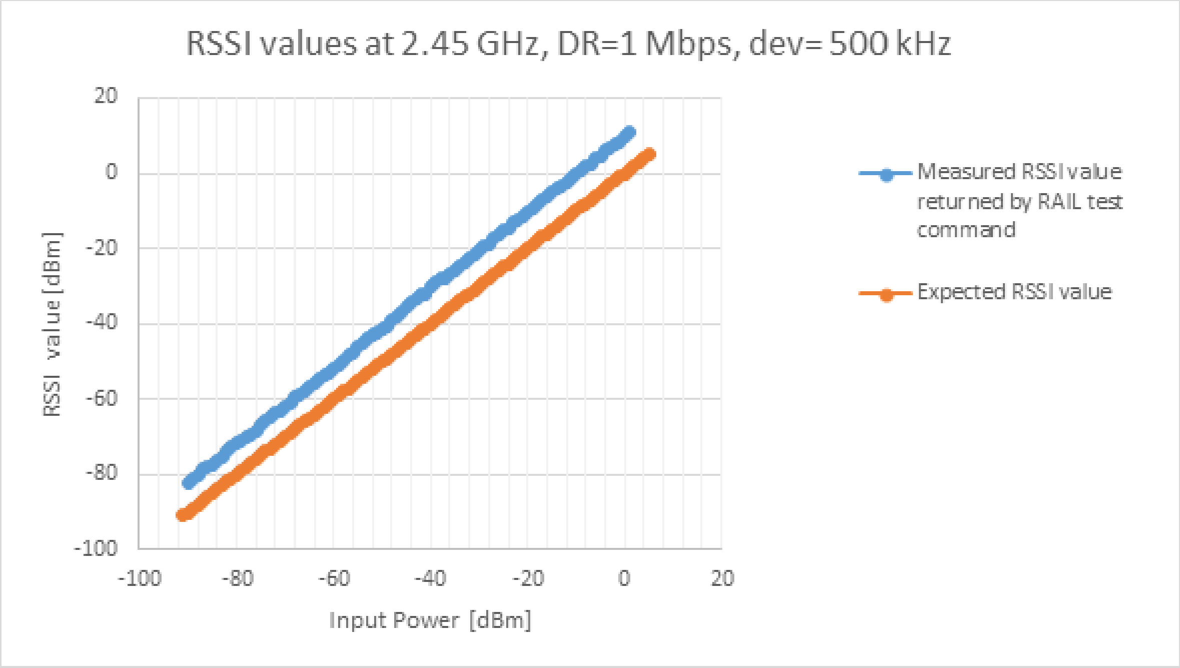


Figure 4.3. RSSI Curve

4.3.1 Customer Production Test: Transmission Power

The high resolution RSSI enables accurate channel power comparison measurement that can be useful for production tests transmission power without an instrument.

Measurement procedure:

1. Load the RAILtest application on two EFR32 nodes.
2. In case, you have more channels, set the radio to the desired channel on both nodes with the `setchannel n` command where "n" is the desired channel number.
3. Issue the `toggletone` command on the first node to set CW mode.
4. Read the RSSI level on the second node with the `getRssi` command.

5. Current Consumption Test

Current consumption measurement procedure:

1. Load the RAILtest application on an EFR32 RF radio board.
2. Issue the appropriate command/commands to set the device in the required mode (for example: Tx), which current consumption has to be measured.
3. In Simplicity Studio's Launcher Perspective, select your target device.
4. With the device selected, select the Energy Profiler tile under the Compatible Tools menu item.

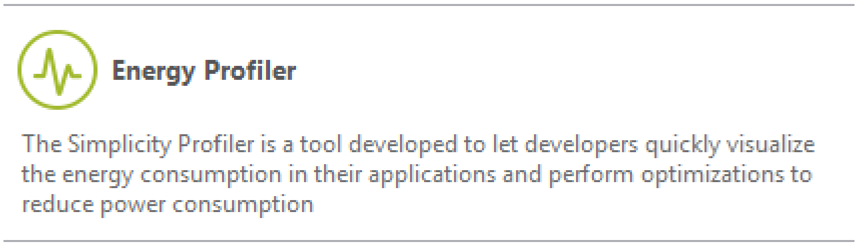


Figure 5.1. Energy Profiler Tile

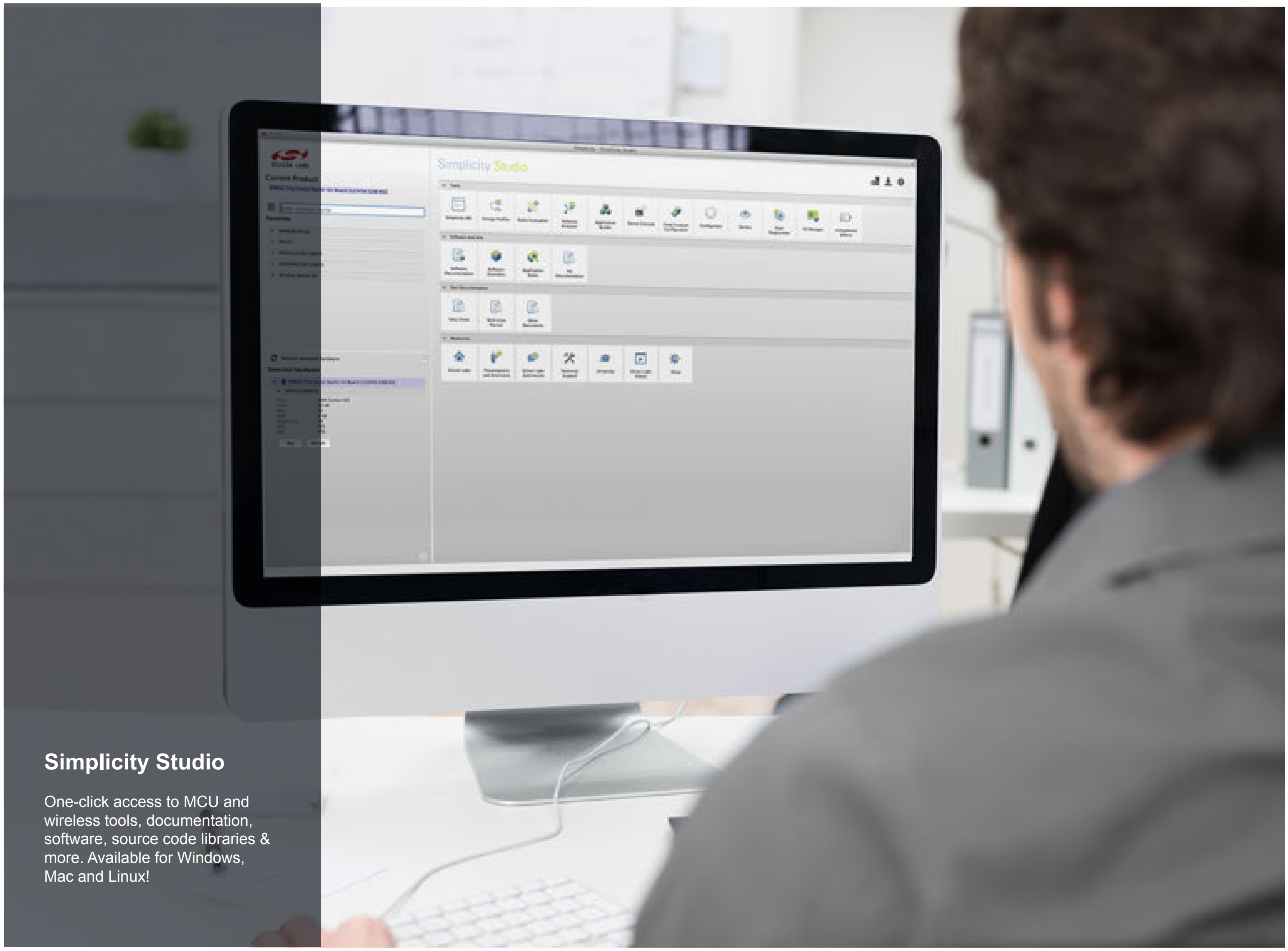
5. After the Energy Profiler Perspective opens hit the play button to start the measurement. In this perspective you will see the current and the average current consumption on the plot.

Figure 5.2. Energy Profiler

It is also possible to scan just a selected range in this perspective.

There are several energy modes available through RAIL, which can be set with the following commands.

```
--- Energy Modes and RF Sense ---
sleep       bw*       [EM# [RfSenseUs RfBand]] Sleep in EM# with RFSenseUs on
                      RfBand (0=none,1=2.4GHz,2=SubGHz,3=both) (and UART input)
rfsense     ww        [RfSenseUs RfBand] Start RfSensing with RSenseUs on RfBand
```



IoT Portfolio
www.silabs.com/IoT

SW/HW
www.silabs.com/simplicity

Quality
www.silabs.com/quality

Support and Community
community.silabs.com

SILICON LABS

Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

http://www.silabs.com