



UG350: Silicon Labs Coexistence Development Kit (SLWSTK-COEXBP)

The Coexistence Development Kit (SLWSTK-COEXBP) is a development kit designed by Silicon Labs to demonstrate coexistence between different radios transmitting in the 2.4 GHz ISM band. This document revision pertains to revision 3.0 of the SLWSTK-COEXBP kit. SLWSTK-COEXBP additionally requires the EFR32™ Mighty Gecko Wireless Starter Kit (SLWSTK6000B), which contains the following devices:

- 3 x Wireless starter kit (WSTK) mainboard (BRD4001A)
- 3 x EFR32MG12 2.4 GHz 19 dBm radio board (BRD4161A)
- 3 x EFR32MG12 2.4 GHz 10 dBm radio board (BRD4162A)

A Logic Analyzer, to view the logic signals, is optional but recommended.

The software requirements for running the coexistence features are as follows:

- Silicon labs EmberZNet PRO (Zigbee) stack
- Silicon Labs Flex SDK (includes RAIL)
- Software required to run and view logic analyzer waveforms

The software images required to create a Zigbee network with coexistence features enabled must be built through sample applications in the EmberZNet PRO stack, with added modifications.

The software required to exercise the coexistence features is available as a custom application built on top of the Flex stack.

This User's Guide refers to Silicon labs EmberZNet PRO release version 6.2.3 and up, and Silicon Labs Flex SDK release version 2.2.2.1.

The following documents are useful resources for understanding Zigbee networks and coexistence, and will also be referred to in this user's guide:

- *AN1017: Zigbee® and Thread Coexistence with Wi-Fi*
- *QSG106: Getting Started with EmberZNet PRO*

KEY POINTS

- Describes coexistence hardware and related software requirements.
- Provides step-by-step instructions for the installation and configuration of coexistence features in software.
- Details hardware included in the kit and how to use it.
- Explains additional software plugins and packages used for advanced testing.

1. Introduction

SLWSTK-COEXBP: Silicon Labs Coexistence Development Kit is designed to demonstrate multiple radio coexistence features available as part of the SDK. These features enable radios in a single product (that is, Gateway, Hub, and so on) running on different protocols to arbitrate network traffic to avoid interference. This User Guide details coexistence features in the EmberZNet stack.

A Coexistence test configuration requires the following components:

- Three WSTK boards with either 19 or 10 dBm radio boards mounted, and loaded with the following software images:
 - PTA (Packet Traffic Arbitration) Master: Acts as a Wi-Fi emulator and responds to activity on the co-located Z3Light running the coexistence features.
 - Z3Light: Zigbee router/coordinator with coexistence features enabled and connected to the PTA Master.
 - Z3Switch: Used to create a network with the Z3Light to generate Zigbee traffic.
- Coexistence Backplane Board

A logic analyzer is optional but highly recommended to enable signal analysis and debugging. In our setup, we use a Saleae logic analyzer.

To set up the recommended coexistence test configuration, the PTA Master and Z3Light both are plugged into headers on the Coexistence Backplane Board. The Coexistence Backplane Board has routes between those headers that enable connections between the two boards. The Coexistence Backplane Board also has routes from the headers to external test points. This allows probing of the signals for debugging and evaluation purposes. The Z3Switch is not plugged into the Coexistence Backplane Board. The recommended configuration for using the Silicon Labs Coexistence Development Kit is shown in the following figure.

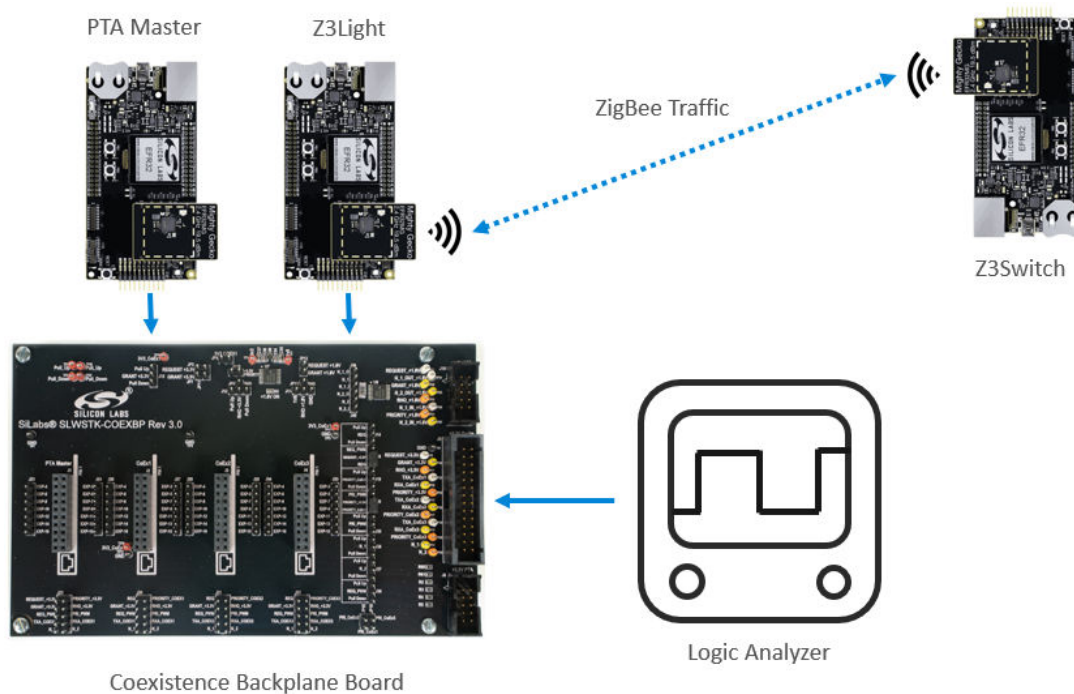


Figure 1.1. Typical Zigbee Coexistence Test Configuration

This configuration is shown in the following figures.

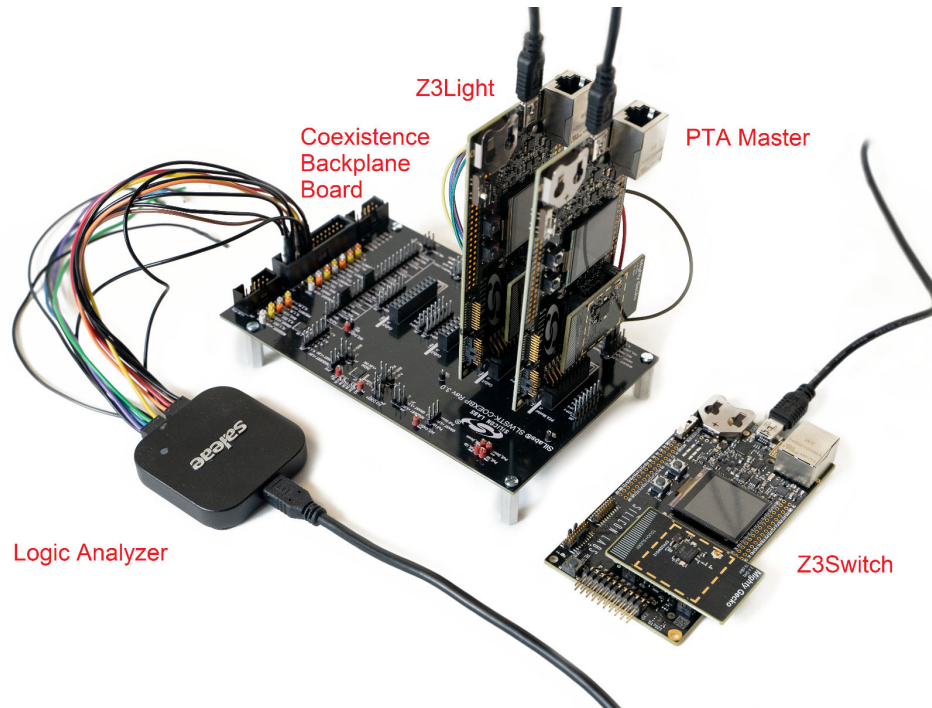


Figure 1.2. Zigbee Coexistence Test Setup (1)

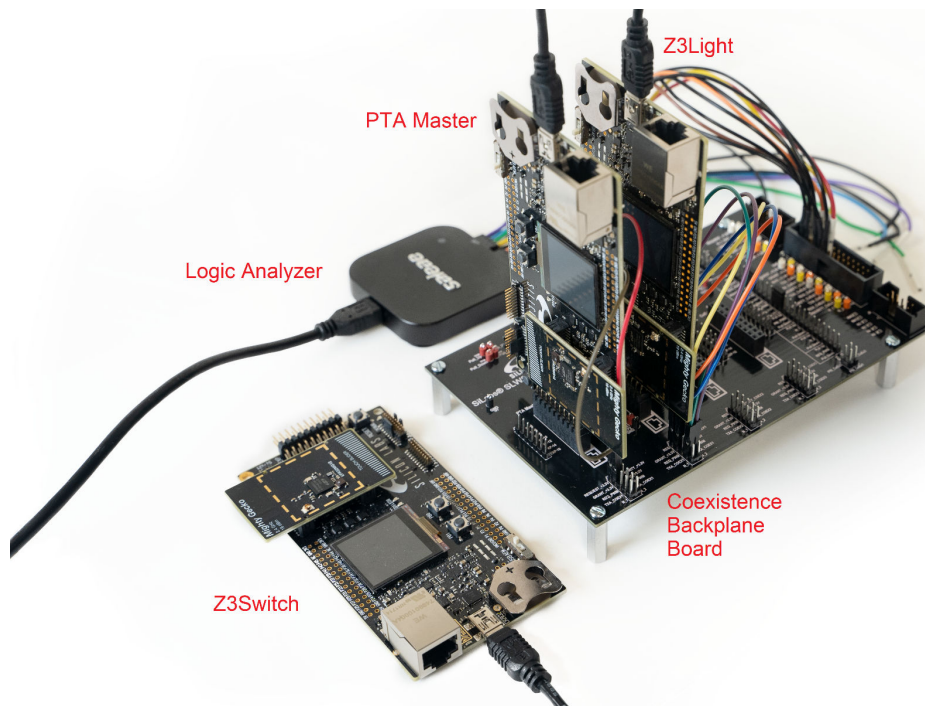


Figure 1.3. Zigbee Coexistence Test Setup (2)

2. Theory of Operation

This section describes the steps required to bring up a Zigbee network with coexistence features enabled. The section is divided into multiple subsections detailing each step required. The subsections are:

- **2.1 Bringing Up a Standalone Zigbee Network.** Introduces building and flashing the Z3Light and Z3Switch applications, and sending commands over the network between them.
- **2.2 Adding the Throughput Library to Zigbee Devices.** The applications are rebuilt with the throughput library, flashed, and network traffic created between them.
- **2.3 Adding the Coexistence Feature to Zigbee Devices.** Coexistence features are added and the coexistence backplane board is introduced. Network traffic is created using the throughput library added in the previous step.
- **2.4 Using PTA Master within the Test Setup.** The PTA Master application is built and flashed to a device, which then is introduced to the test setup as a coexistence master device.
- **2.5 Replacing PTA Master with an External Wi-Fi Device.** The PTA Master device is replaced with an external Wi-Fi chipset.

Note: This section guides through the steps required to set up coexistence on EFR32MG12-based devices. Refer to section [3.1 Jumper Wire Configurations for Different Boards/Devices](#) regarding connection and wiring information for other compatible devices.

2.1 Bringing Up a Standalone Zigbee Network

The first step in setting up for coexistence testing is understanding how to set up a Zigbee network between two devices. For this purpose, we recommend following the steps in *QSG106: Getting Started with EmberZNet PRO* (QSG106) to build, flash, and verify network commands between the Z3Light and Z3Switch example applications. These applications will be modified and used in subsequent steps. This allows you to become familiar with application development using the Zigbee stack. It is also important to be familiar with the steps in QSG106 as the document will be referred to extensively in the following steps. QSG106 can be found through the list of documents on the Simplicity Studio Launcher perspective, and on the Silicon Labs website under Zigbee documentation. A direct link to the document is below:

<https://www.silabs.com/documents/public/quick-start-guides/qsg106-efr32-zigbee-pro.pdf>

2.2 Adding the Throughput Library to Zigbee Devices

This step explains how to modify the example applications to add the throughput library. The throughput library is an additional plugin available in the EmberZNet PRO stack that allows transmitting data between devices at controllable speeds. It is useful for the evaluation of network quality and connection stability. More information regarding the throughput library can be found in section [4. Throughput Library](#).

2.2.1 Rebuilding and Flashing the Images

1. If you have not already done so in the previous section, follow the steps in QSG106 to start the Z3Light and Z3Switch example applications. Otherwise return to the Simplicity IDE perspective for one of the examples. If the .isc file is not open, double-click the .isc file in the Project Explorer to open it.
2. Do not generate the application yet. Additional plugins need to be added.
3. Go to the Plugins tab and enter the keyword “throughput” to search for the throughput library plugin.
4. Check the checkbox next to the plugin name to enable the plugin.

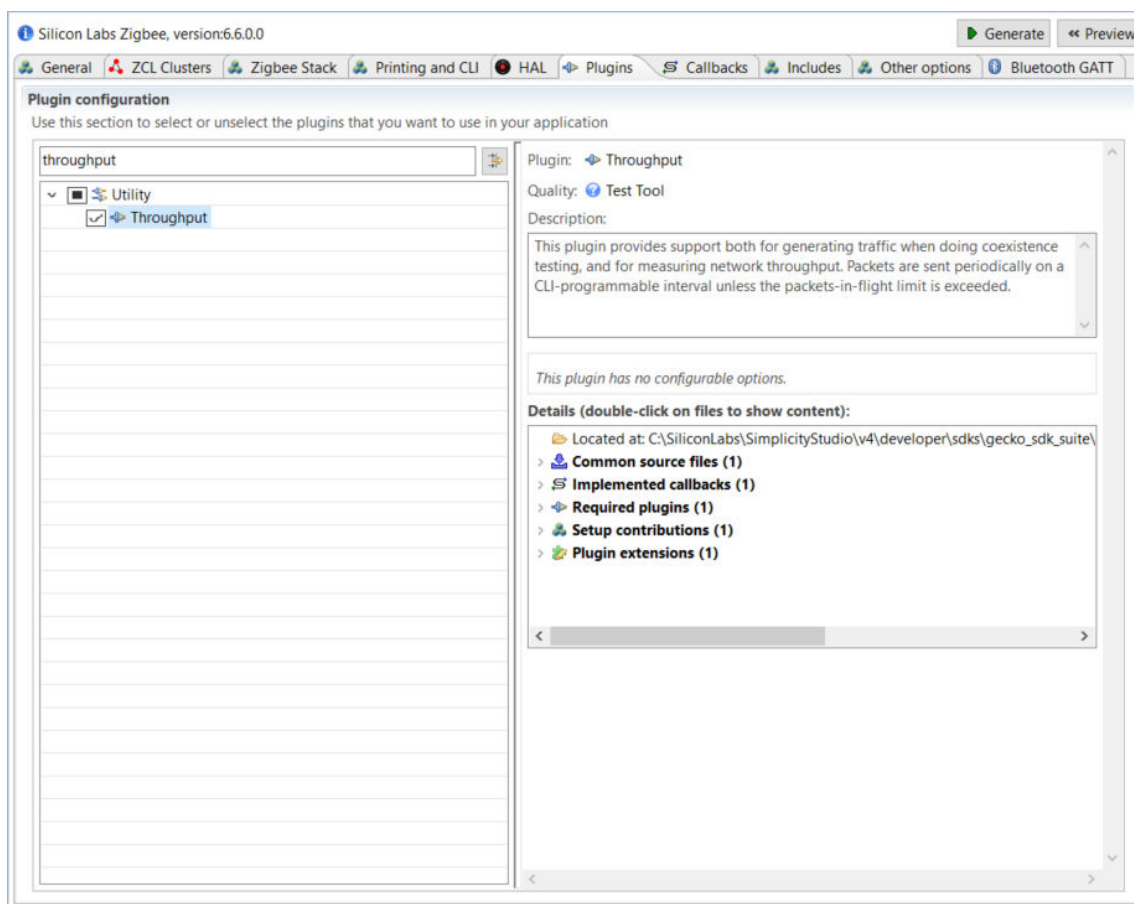


Figure 2.1. Enabling the Throughput Plugin

5. Repeat for the other example application.
6. Follow the rest of the steps in QSG106 to generate, build, and flash both the Z3Light and Z3Switch application images.

2.2.2 Using the Throughput Library to Send Zigbee Traffic

1. From Simplicity studio, access the CLI consoles of the Z3Light and Z3Switch WSTKs. Refer to QSG106 for instructions on opening CLI consoles.
2. In the console of the Z3Switch example, send the command `info` to display network information regarding the device. Note the Node ID in the command's response.
3. In the console of the Z3Light, send the following command

```
plugin throughput set-all <0xNodeID> 10 10 127 1 0 100000
```

where NodeID is the node ID of the Z3Switch noted in step 2 above, typed as a hex number. This configures the throughput settings.

4. Still in the console of the Z3Light, send the following command:

```
plugin throughput start
```

A series of 10 packets is then sent from the Z3Light to the Z3Switch, generating Zigbee traffic. The Z3Switch console also indicates packets being received.

More information on the commands used in step 3 and 4 as well as other features of the throughput library can be found in section [4. Throughput Library](#).

2.3 Adding the Coexistence Feature to Zigbee Devices

This step describes the procedure to enable and configure coexistence features in the example applications. This section uses the Z3Light application as the example, however the same procedure can be used to enable coexistence on any application. The coexistence features are contained in an additional plugin available in the EmberZNet PRO stack. More information regarding the coexistence plugin can be found in section 4 of document *AN1017: Zigbee® and Thread Coexistence with Wi-Fi*.

It is also recommended to enable the FEM driver plugin. This plugin provides visibility into the state of the radio for debugging purposes and monitoring radio activity.

Note: This procedure assumes you have created, built, flashed, and verified example applications with the Throughput library as described in section [2.2 Adding the Throughput Library to Zigbee Devices](#).

2.3.1 Rebuilding and Flashing the Images

1. Return to the Simplicity IDE perspective for the Z3Light sample application .isc file.
2. Go to the Plugins tab and search for the keyword “coexistence” to find the coexistence configuration plugin.
3. Check the checkbox next to the plugin name to enable the plugin.

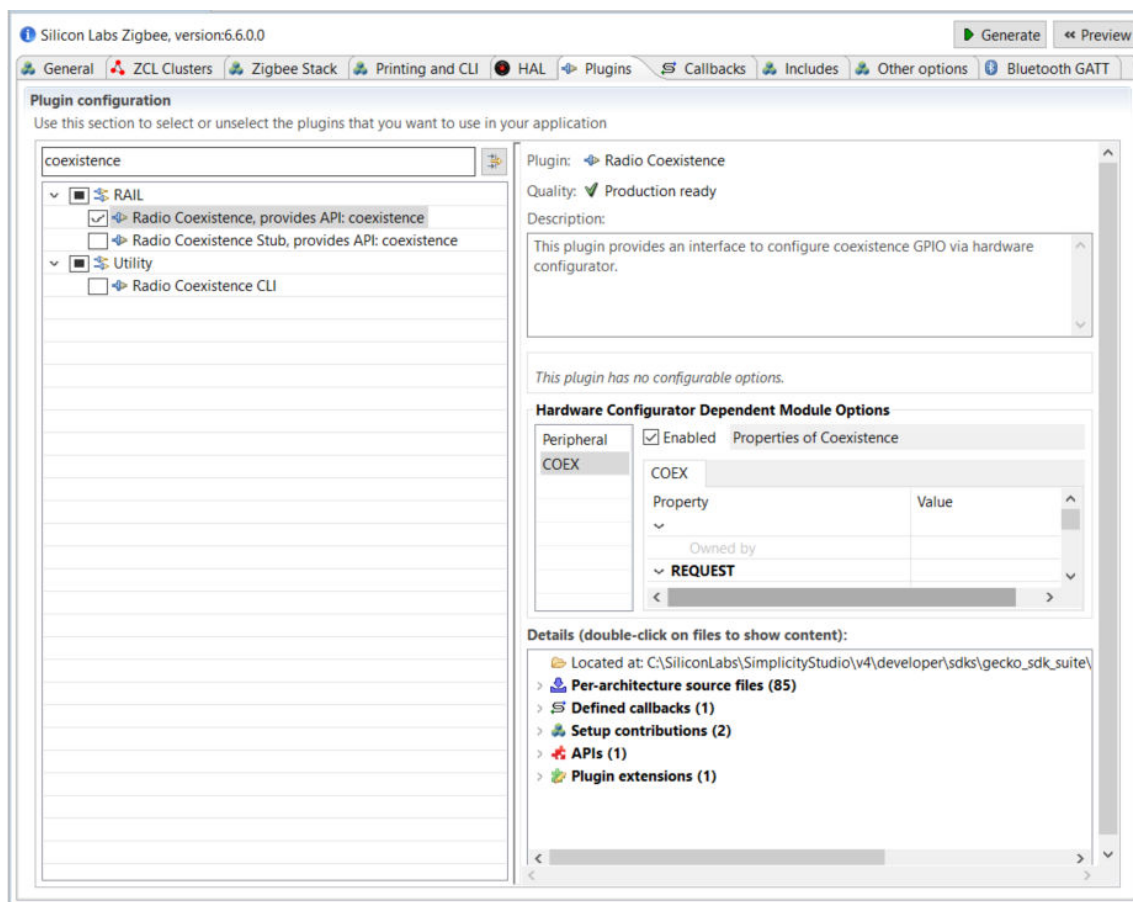


Figure 2.2. Enabling the Coexistence Configuration Plugin

4. Uncheck the checkbox next to the Stub plugin to disable Stub functions.
5. In the menu on the right, make sure the Enabled box next to **Properties of Coexistence** is checked.
6. Modify the fields in the menu on the right as follows:
 - REQUEST Signal: PC10
 - GRANT Signal: PC9
 - PRIORITY Signal: PD12
 - RHO Signal: Disabled

Leave all other settings with their default values.

7. Still in the Plugins tab, search for keyword “fem” to bring the FEM driver plugin.

8. Check the checkbox next to the plugin name to enable the plugin.

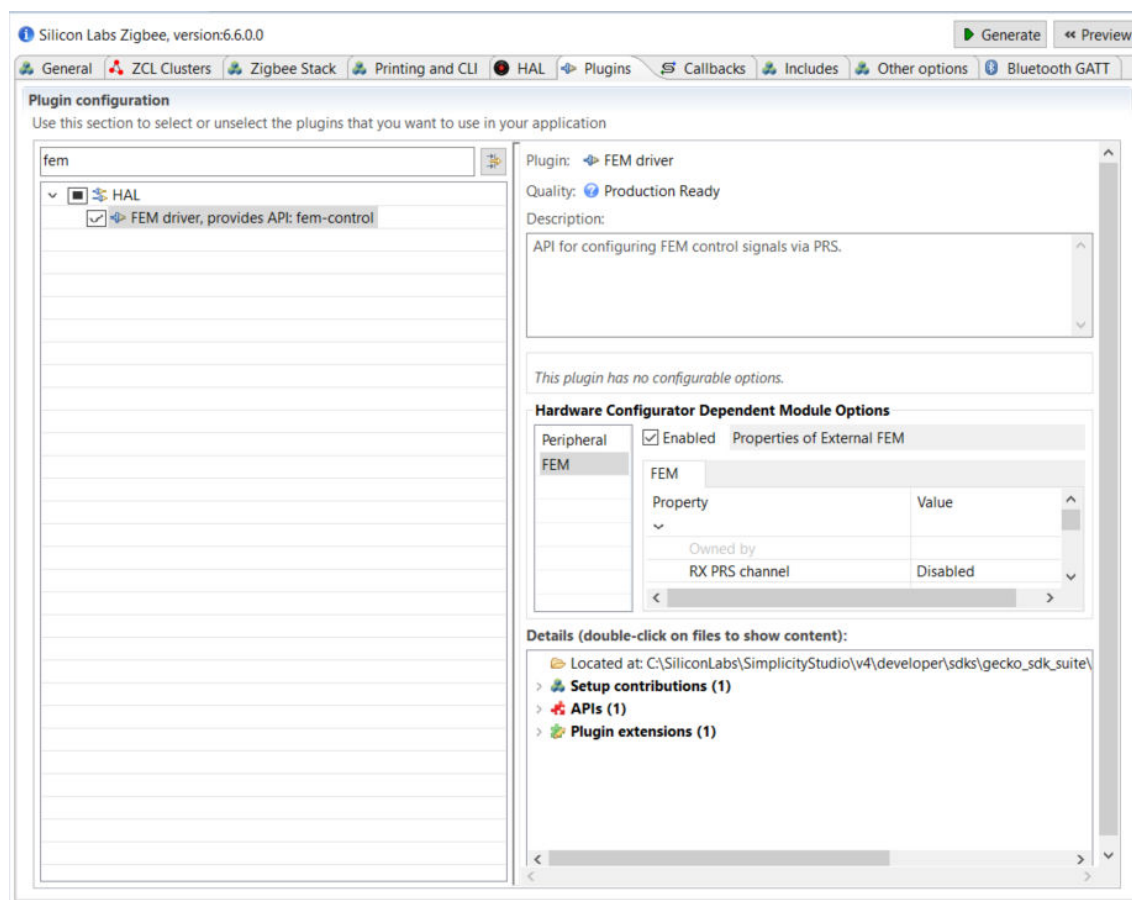


Figure 2.3. Enabling the FEM Driver Plugin

9. In the menu on the right, make sure the Enabled box next to **Properties of External FEM** is checked.

10. Modify the fields in the menu on the right as follows:

- RX PRS channel: CH6
- PRS channel 6 output pin: PD11
- TX PRS channel: CH5
- PRS channel 5 output pin: PD10
- Enable RX mode: True
- Enable TX mode: True

Leave all other settings with their default values.

11. Repeat for the other example application.

12. Follow the rest of the steps in QSG106 to generate, build, and flash the Z3Light application image.

2.3.2 Setting up the Coexistence Backplane Board

1. Add the appropriate jumper wires and jumpers as shown in the following figure. This sets the GRANT line to always asserted, and allows the Z3Light to exercise the coexistence signals.

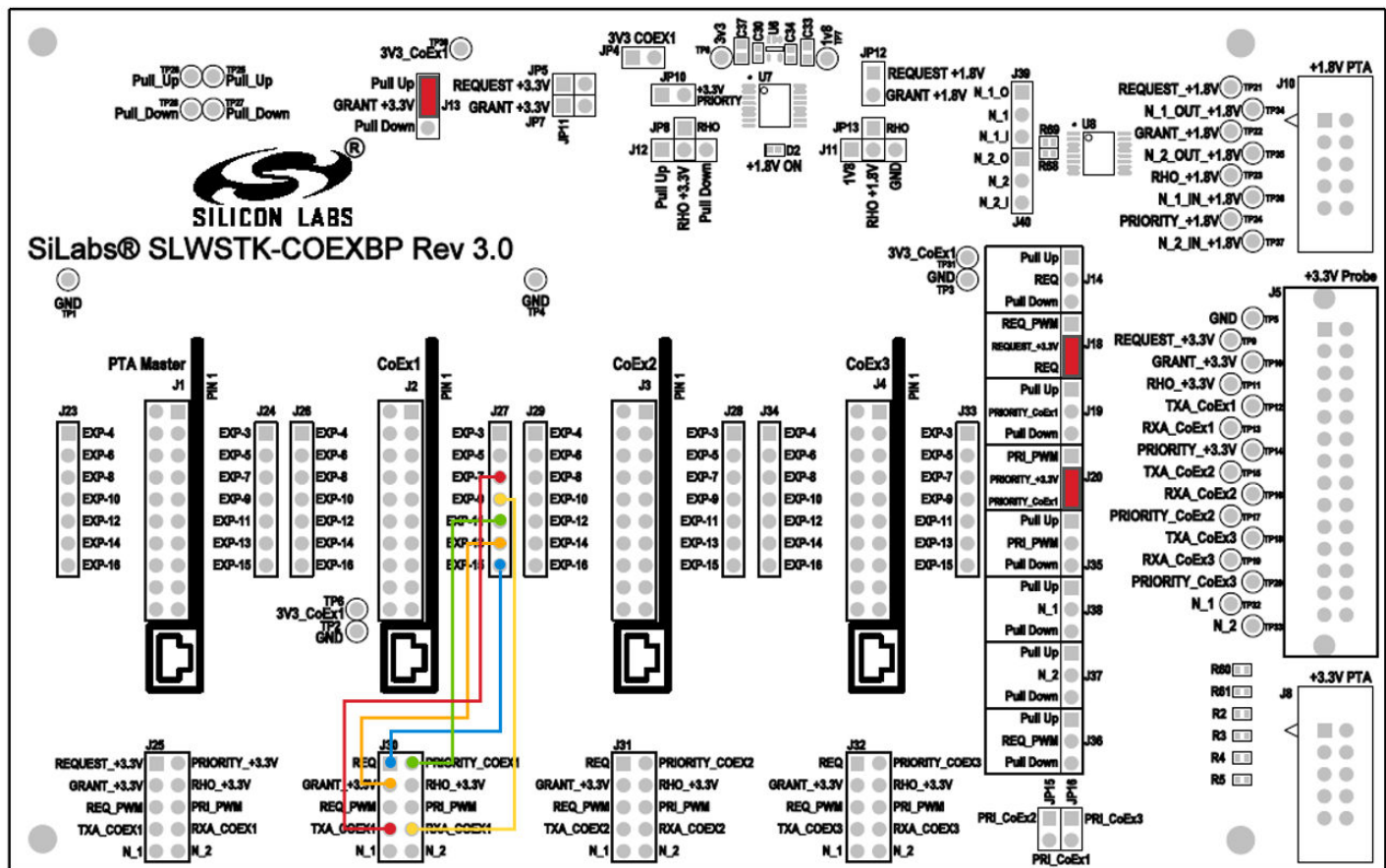


Figure 2.4. Jumper Configurations for Coexistence Testing

2. Plug the Z3Light board into the CoEx1 position (J2) in the Coexistence Backplane board. Follow the silk label for proper orientation.
3. If using a logic analyzer, probe the test points or pins in header J5 (+3.3V probe header) on the right side to access the following signals:
 - REQUEST_+3.3V – TP9 or J5 pin 2
 - GRANT_+3.3V – TP10 or J5 pin 4
 - PRIORITY_+3.3V – TP14 or J5 pin 12
 - TXA_CoEx1 – TP12 or J5 pin 8
 - RXA_CoEx1 – TP13 or J5 pin 10

2.3.3 Using the Throughput Library to Send Zigbee Traffic

1. From Simplicity studio, access the CLI consoles of the Z3Light and Z3Switch WSTKs.
2. In the console of the Z3Switch example, send the command `info` to display network information regarding the device. Note the Node ID in the command's response.
3. In the console of the Z3Light, send the following command

```
plugin throughput set-all <0xNodeID> 10 10 127 1 0 100000
```

where NodeID is the node ID of the Z3Switch noted in step 2 above, typed as a hex number. This configures the throughput settings.

4. Still in the console of the Z3Light, send the following command:

```
plugin throughput start
```

A series of 10 packets is then sent from the Z3Light to the Z3Switch, generating Zigbee traffic. The Z3Switch console also indicates packets being received.

More information on the commands used in step 3 and 4 as well as other features of the throughput library can be found in section [4. Throughput Library](#).

5. Activity corresponding to sending 10 packets can also be observed on the logic analyzer. It will look similar to the following capture.

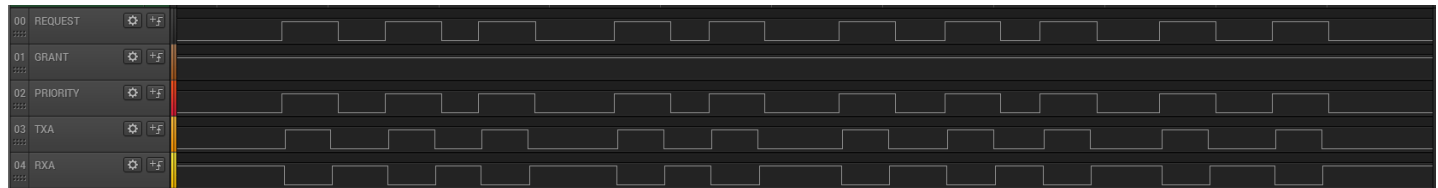


Figure 2.5. Logic Analyzer Result for Coexistence Testing

REQUEST and PRIORITY signals are asserted 10 times during the throughput run, indicating 10 attempts to send the messages. In addition, TXA is also asserted within these REQUEST cycles, indicating the radio was transmitting. GRANT signal is always asserted due to the configuration of the board. The RXA signal is de-asserted when the radio is transmitting, otherwise it remains asserted representing the radio is in receive mode.

2.4 Using PTA Master within the Test Setup

The PTA master application is a custom application built in the Flex SDK. It is designed to assist in evaluating the coexistence features available in the stack by acting as a Wi-Fi master device emulator. The PTA master only emulates the GPIO behaviors and cannot generate actual Wi-Fi traffic. More information regarding the features of the PTA Master can be found in section [5. PTA Master Application](#).

Note: This procedure uses the Z3Light and Z3Switch devices created and installed with the Coexistence Backplane board in the previous procedure.

2.4.1 Obtaining the PTA Master Application

To obtain the PTA Master application project, you must have the correct version of the Flex SDK (v2.2.2.1) installed. You must also add the correct board (BRD4161A) to the **My Products** list in Studio.

To add the correct board, go to Simplicity Studio's Launcher Perspective, and in the My Products section search for "BRD4161A" and click it to add it to the list.

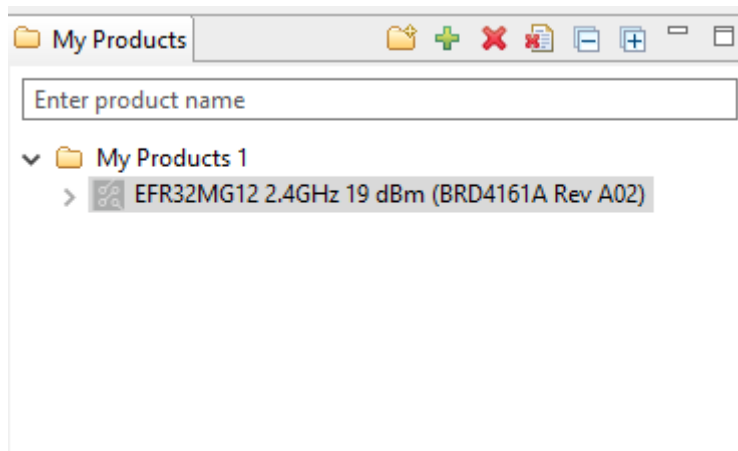


Figure 2.6. Selected Board Added to My Products

Next, make sure the Preferred SDK is set to Flex SDK 2.2.2.1.

EFR32MG12 2.4GHz 19 dBm (BRD4161A Rev A02)

Preferred SDK: Gecko SDK Suite v2.2.2: Flex 2.2.2.1
Click [here](#) to change the preferred SDK.

Figure 2.7. Preferred SDK Selected

If this is not the case, click the **here** link to change the preferred SDK and select Flex SDK 2.2.2.1. Click **[OK]**.

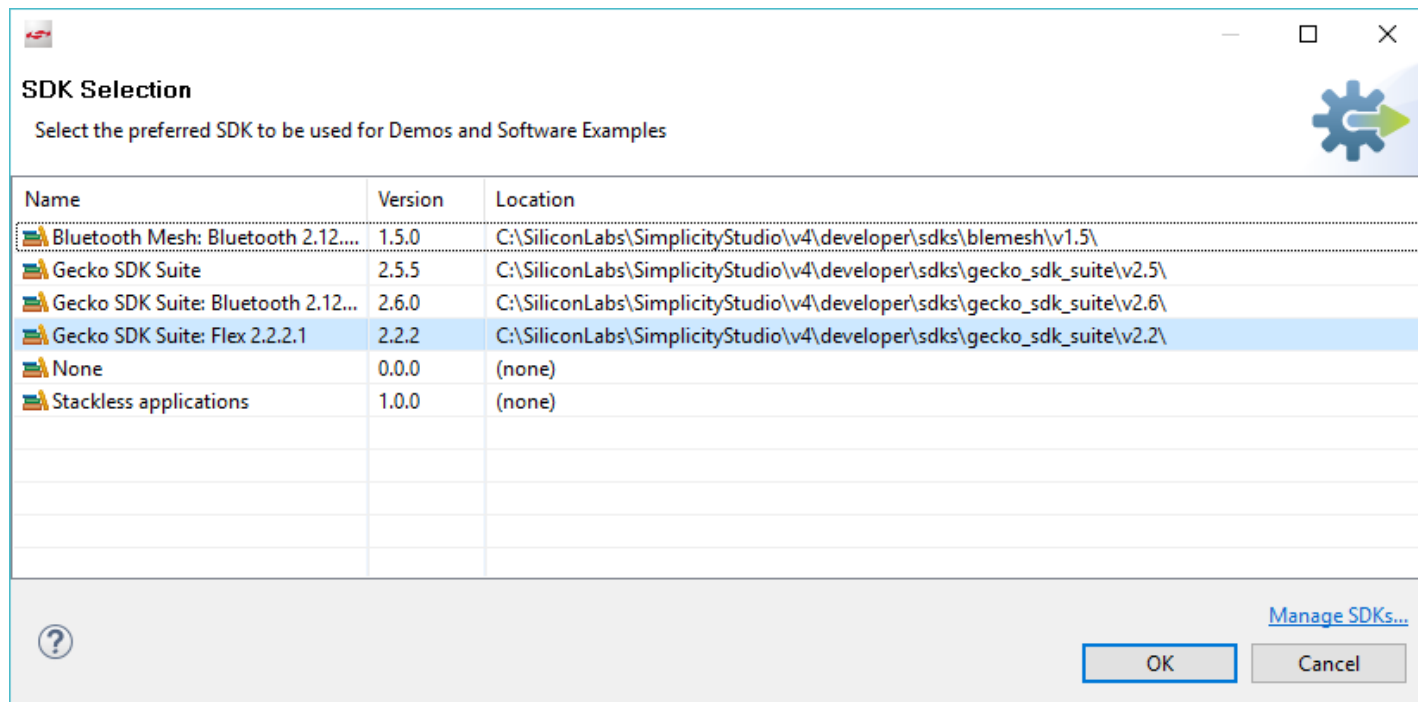


Figure 2.8. Preferred SDK List

If you do not see Flex 2.2.2.1 on the list, either it is not set as a Preferred SDK, or it is not installed. Click the **Manage SDKs** link in the lower right. A list of installed SDKs opens. If you see Flex 2.2.2.1 on the list, make sure the checkbox next to it is checked and click **[OK]**. If you do not see it, follow these steps to install it.

1. Click the **Need more SDKs?** link in the lower right.

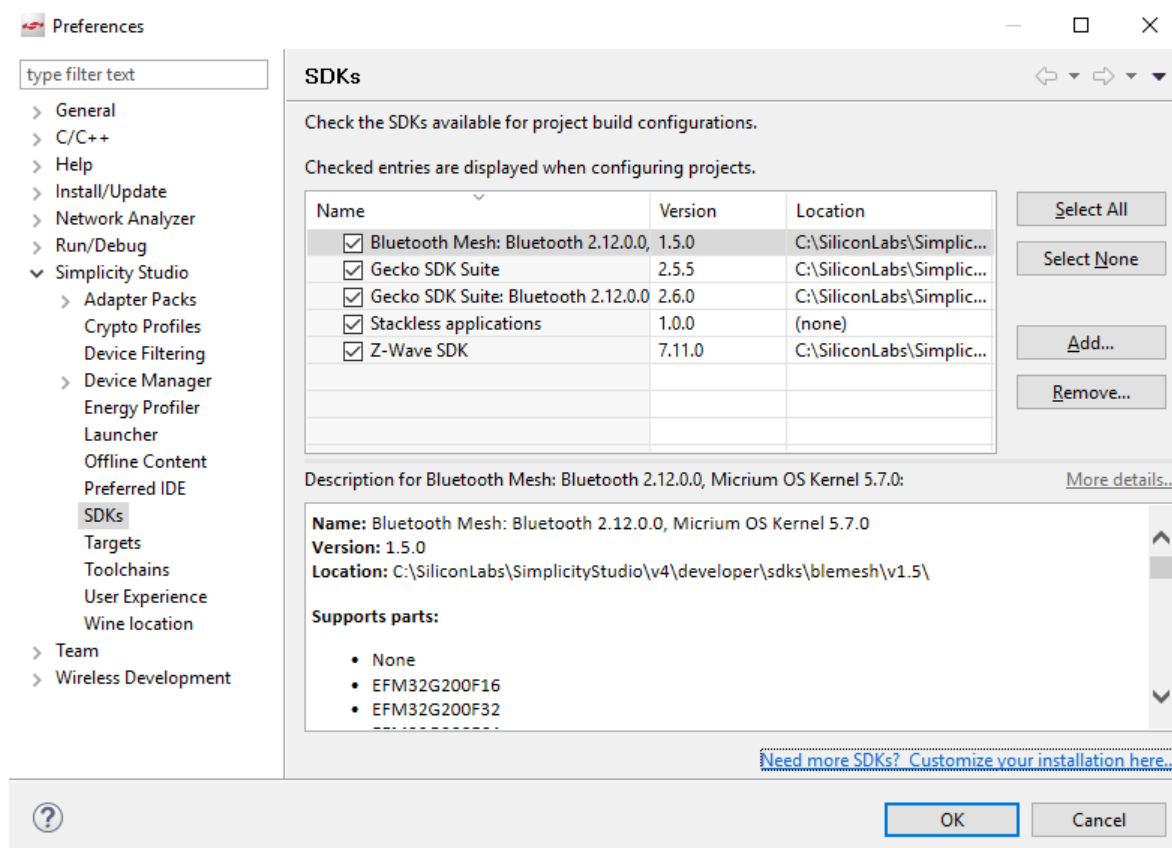


Figure 2.9. Installed SDKs

2. Click **Package Manager**.

3. Click the **SDKs** tab. In the **Categories** drop down, select 'Flex'. In the **Version** drop down, select 'All'. Scroll down until you see **Flex SDK - 2.2.2.1**. Click **[Install]**.

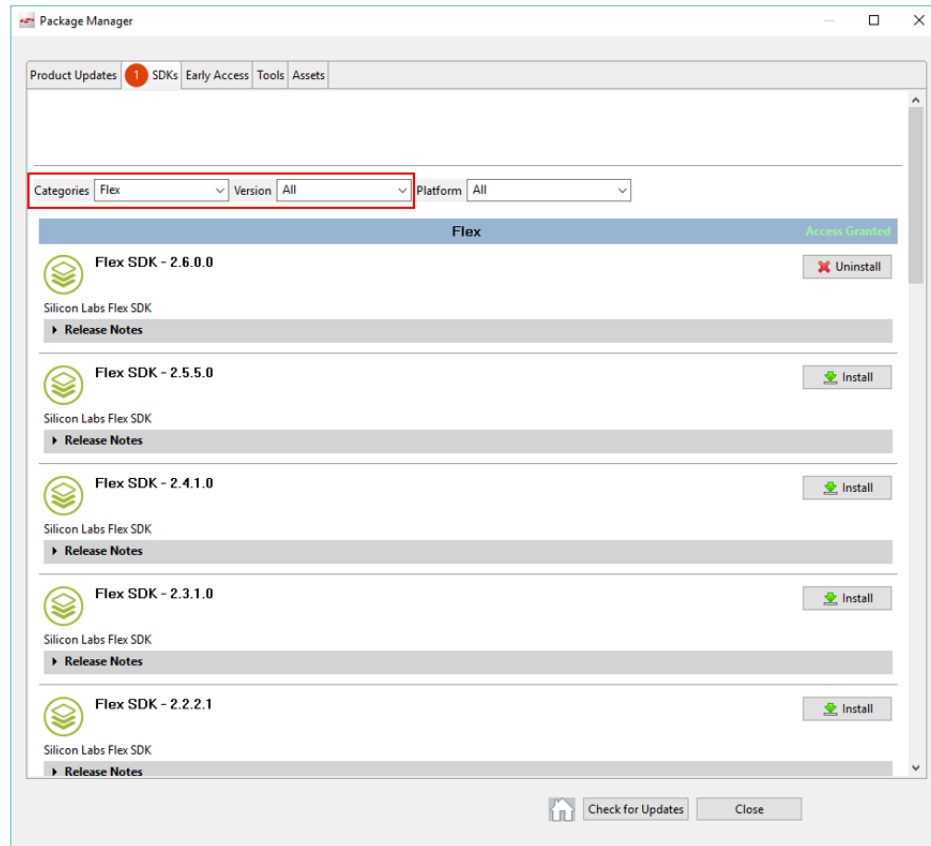


Figure 2.10. SDK Package Manager

4. When installation is complete, click **[Close]**.

5. You should now see Flex SDK 2.2.2.1 on the list of installed SDKs. It should be checked as available. Click [OK].

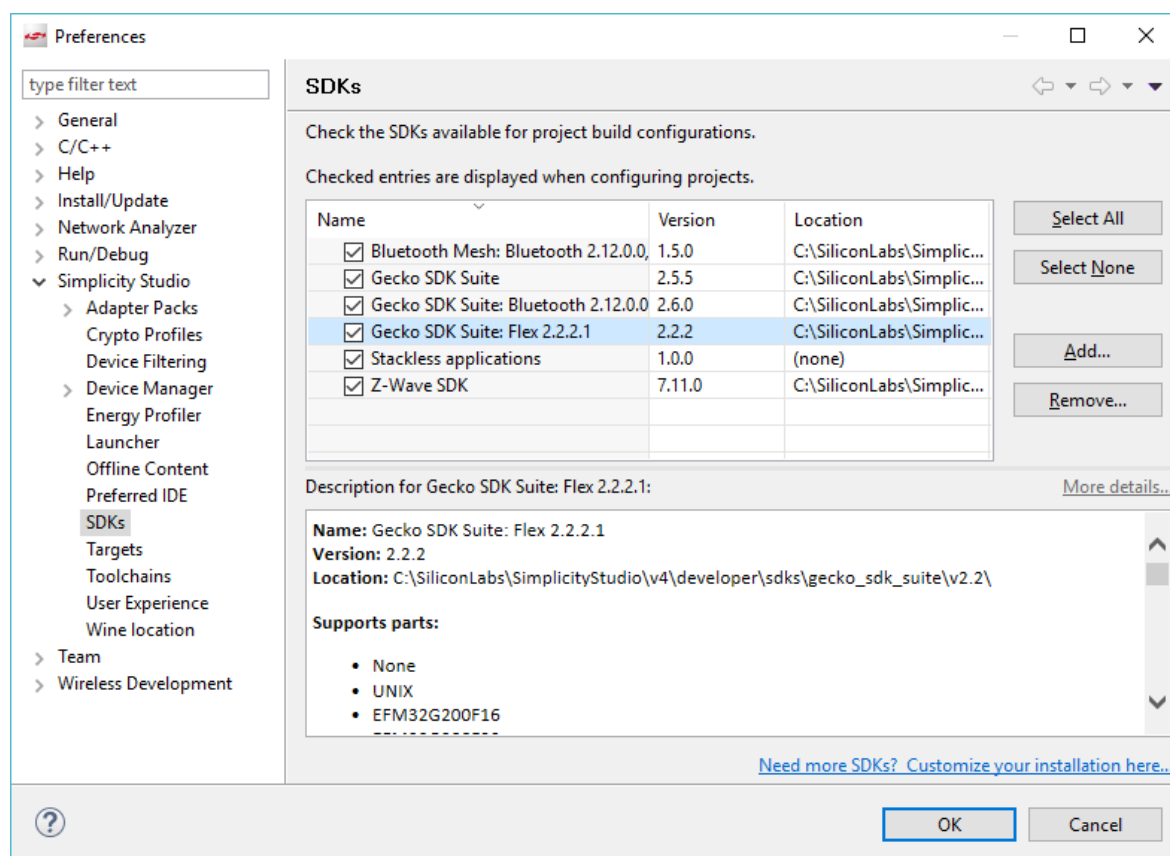


Figure 2.11. Installed SDKs with Flex 2.2.2.1

6. Click the **here** link to change the preferred SDK, select **Gecko SDK Suite: Flex 2.2.2.1**, and click [OK]. If everything is set correctly, you should see the **IoT PTA Master** application in the list of Examples.

Software Examples



- ▼ Flex SDK 2.2.2.1
 - ▶ **Silicon Labs Flex SDK Examples**
- ▼ Gecko Bootloader 1.5.0
 - ▶ **Gecko Bootloader Examples**
- ▼ IoT Systems Sample Applications
 - ▼ **Coexistence Examples**



Figure 2.12. PTA Master Application in the Examples List

2.4.2 Building and Flashing the PTA Master Application

Click the PTA Master application shown in the Examples section. You are prompted whether you would like to create the application. Click [Yes].

Simplicity Studio creates a project with the application, and switches to the Simplicity IDE perspective.

An .isc file also opens. From this point on, the process is similar to that used for previous applications.

Follow the steps in QSG106 to generate, build, and flash the PTA Master application onto one of the boards.

2.4.3 Setting up the PTA Master Device with the Coexistence Backplane Board

1. Remove the jumper from J13 (added to assert GRANT line in Section 2.3.2 Setting up the Coexistence Backplane Board) and add additional jumper wires required to communicate with the PTA Master, as shown in the following diagram:

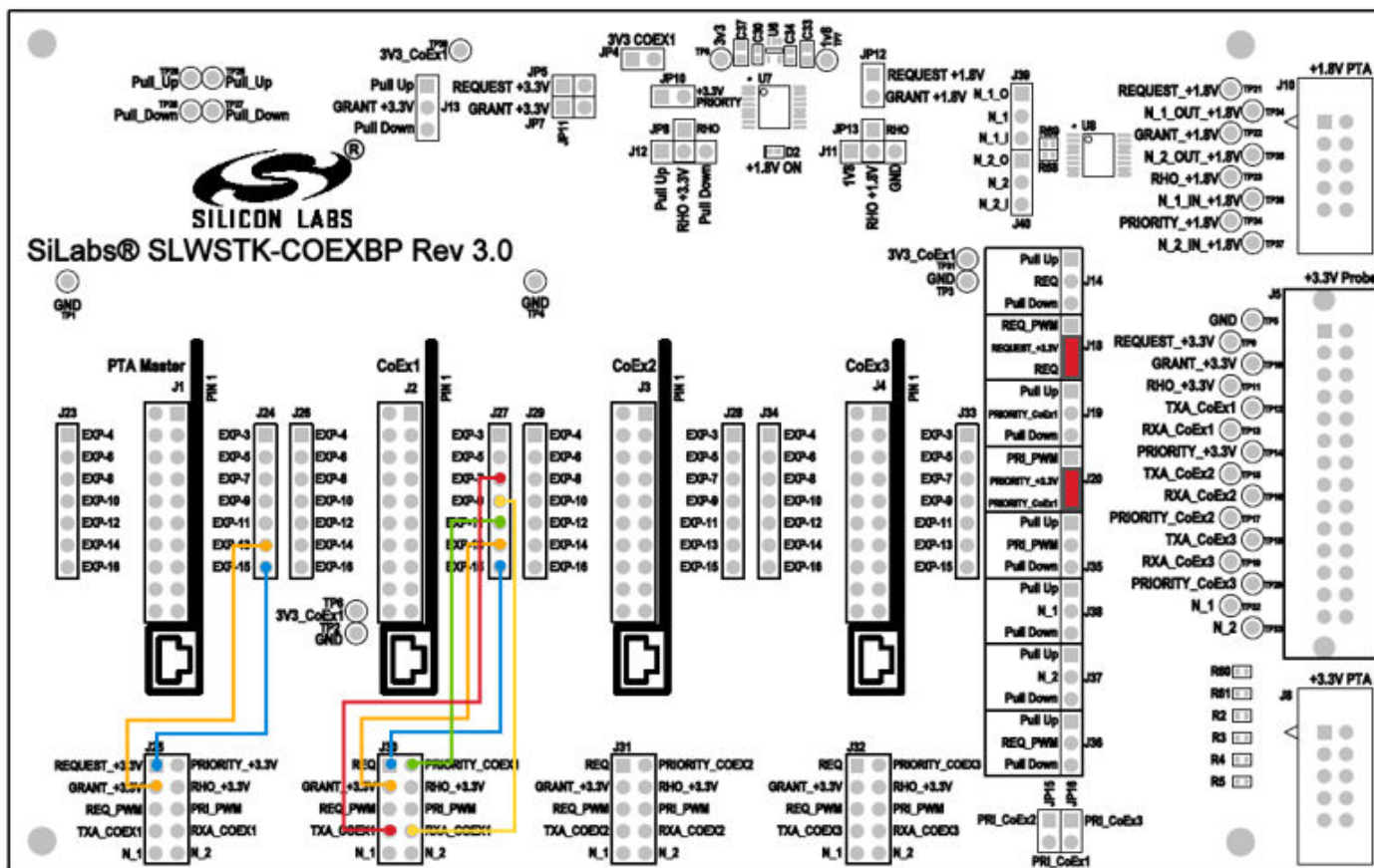


Figure 2.13. Jumper Configuration for Coexistence Testing with PTA Master Device

2. Plug PTA Master device into dedicated header J1, on the left side of the board. Make sure the board is oriented according to the silk near the header.

2.4.4 Configuring the PTA Master Application to Work With Z3Light

The PTA Master application features run-time configurable options to configure the behavior. By default, all additional features are turned off, and all signals are assumed active High.

Therefore, the PTA Master will work with the Z3Light device as is, without needing additional configurations. Details regarding additional configurations can be found in section 5. PTA Master Application.

2.4.5 Using the Throughput Library to Send Zigbee Traffic

1. From Simplicity studio, access the CLI consoles of the Z3Light and Z3Switch WSTKs.
2. In the console of the Z3Switch example, send the command `info` to display network information regarding the device. Note the Node ID in the command's response.
3. In the console of the Z3Light, send the following command:

```
plugin throughput set-all <0xNodeID> 10 10 127 1 0 100000
```

where NodeID is the node ID of the Z3Switch noted in step 2 above, typed as a hex number. This configures the throughput settings.

4. Still in the console of the Z3Light, send the following command:

```
plugin throughput start
```

A series of 10 packets is then sent from the Z3Light to the Z3Switch, generating Zigbee traffic. The Z3Switch console also indicates packets being received.

More information on the commands used in step 3 and 4 as well as other features of the throughput library can be found in section [4. Throughput Library](#).

5. Activity corresponding to sending 10 packets can also be observed on the logic analyzer. It will look similar to the following capture.

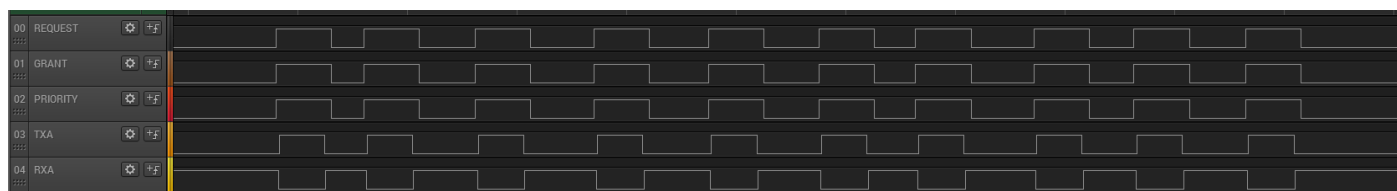


Figure 2.14. Logic Capture for Coexistence Testing with PTA Master Device

REQUEST and PRIORITY signals are asserted 10 times during the throughput run, indicating 10 attempts to send the messages. Note here that the GRANT signal controlled by PTA Master is also asserted and de-asserted with REQUEST. In default settings, the PTA Master is configured to always GRANT when the slave REQUESTs. In addition, TXA is also asserted within these REQUEST cycles, indicating the radio was transmitting. The RXA signal is de-asserted when the radio is transmitting, otherwise it remains asserted representing the radio is in receive mode.

2.5 Replacing PTA Master with an External Wi-Fi Device

Once evaluation has been completed using the PTA Master application, the next step is to use an actual external Wi-Fi chipset to interface with the coexistence features in the Z3Light device. The following steps detail how this can be achieved.

1. Remove the PTA Master device.
2. Connect the external Wi-Fi device coexistence signals to the appropriate header.
 - If using a +3.3V signals Wi-Fi device, use header J8.
 - If using a +1.8V signals Wi-Fi device, use header J10.

Refer to section [3. Coexistence Backplane Board](#) for more detail.

3. The PTA signals are routed from the CoEx plugin headers to the probe headers J8 and J10 when configured to be used, so the Wi-Fi device should be able to receive and respond to the signal states.

3. Coexistence Backplane Board

This section gives a detailed explanation of the Coexistence Backplane Board. The board is compatible with all EFR32MG1x series devices. [Table 3.1 Jumper Wire Recommendations for PTA on Different Devices on page 17](#) shows recommended PTA pin selections for different supported boards.

Note: Due to GPIO limitations on some boards, GPIOs routed to peripherals on the WSTK may need to be used for PTA functions. This requires that the peripheral configurations be disabled in the hardware configuration. Instructions on how to achieve this are in section [3.1.1 Disabling Peripheral Functionality](#).

For BRD4169: Button and LED peripherals need to be disabled.

For BRD4180: Button, LED, and UART RTS/CTS need to be disabled.

Other radio boards do not require any peripherals to be disabled.

3.1 Jumper Wire Configurations for Different Boards/Devices

Table 3.1. Jumper Wire Recommendations for PTA on Different Devices

Board/Device	REQUEST (EXP/GPIO)	GRANT (EXP/GPIO)	PRIORITY (EXP/GPIO)	RHO (EXP/GPIO)
BRD4151/EFR32MG1P	EXP15/PC10	EXP13/PF3	EXP11/PD12	EXP16/PC11
BRD4161/EFR32MG12P	EXP15/PC10	EXP13/PC9	EXP11/PD12	EXP16/PC11
BRD4168/EFR32MG13P	EXP15/PC10	EXP13/PF3	EXP11/PD12	EXP16/PC11
BRD4169/EFR32MG14P	EXP15/PC10	EXP13/PF3	EXP10/PC9	EXP16/PC11
BRD4180/EFRMG21	EXP11/PB00	EXP6/PC01	EXP13/PB01	Not supported

It is also helpful to observe the FEM control signals, and the recommended pins for different boards are shown in the following table.

Table 3.2. Jumper Wire Recommendations for Radio State on Different Devices

Board/Device	TX PRS Channel	TX (EXP/GPIO)	RX PRS Channel	RX (EXP/GPIO)
BRD4151/EFR32MG1P	CH5	EXP7/PD10	CH6	EXP9/PD11
BRD4161/EFR32MG12P	CH5	EXP7/PD10	CH6	EXP9/PD11
BRD4168/EFR32MG13P	CH5	EXP7/PD10	CH6	EXP9/PD11
BRD4169/EFR32MG14P	CH2	EXP7/PF6	CH3	EXP9/PF7
BRD4180/EFRMG21	CH8	EXP7/PD02	CH9	EXP9/PD03

For jumper positions for different coexistence configurations, refer to section [3.2 Configuring for Different PTA Scenarios](#).

3.1.1 Disabling Peripheral Functionality

1. In the project .isc file, select the HAL configuration tab and click **[Open Hardware Configurator]**.

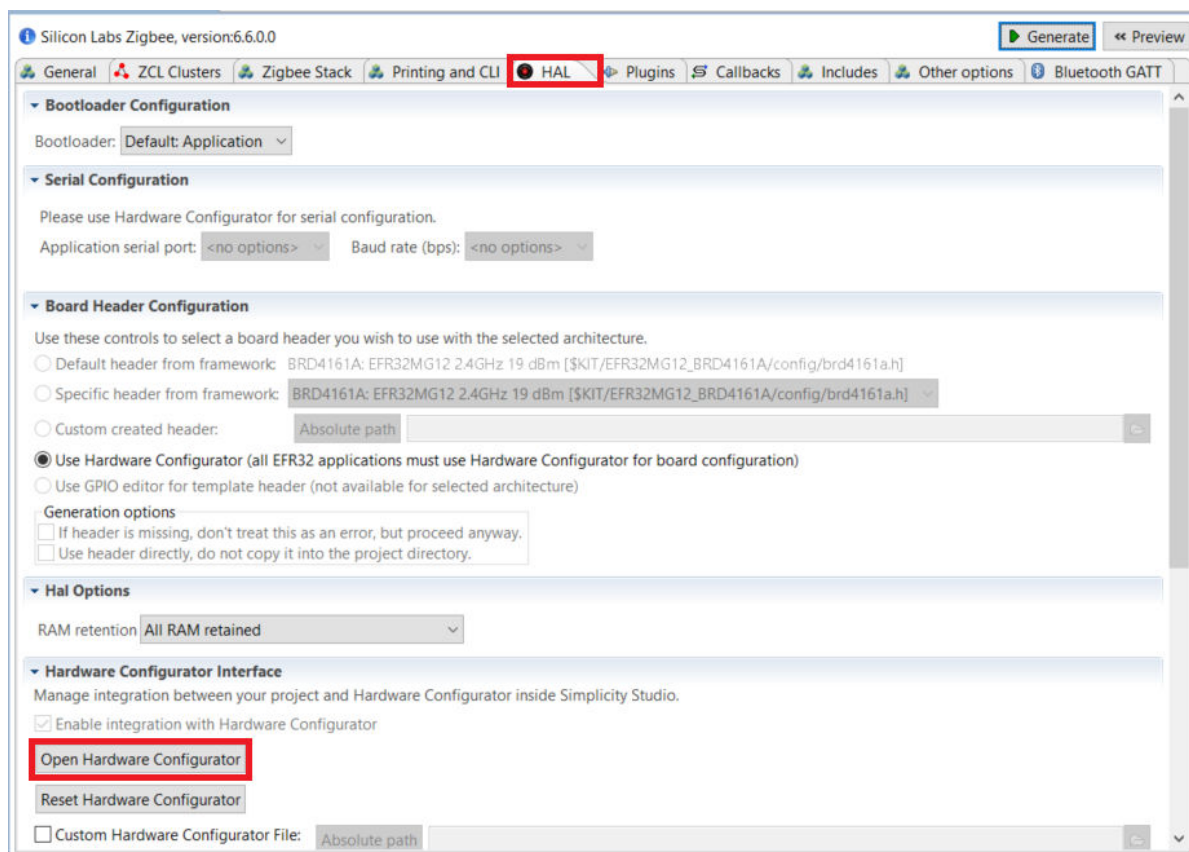


Figure 3.1. Open Hardware Configurator

This opens a new tab with the Configurator perspective active.

2. Click the DefaultMode Peripherals tab to open a list of enabled configurators.

3. To disable LED and Button peripherals, uncheck the checkboxes next to **LED** and/or **Button**, and click [Save] (or press Ctrl+S). The hal-config.h file will be automatically updated with the latest changes.

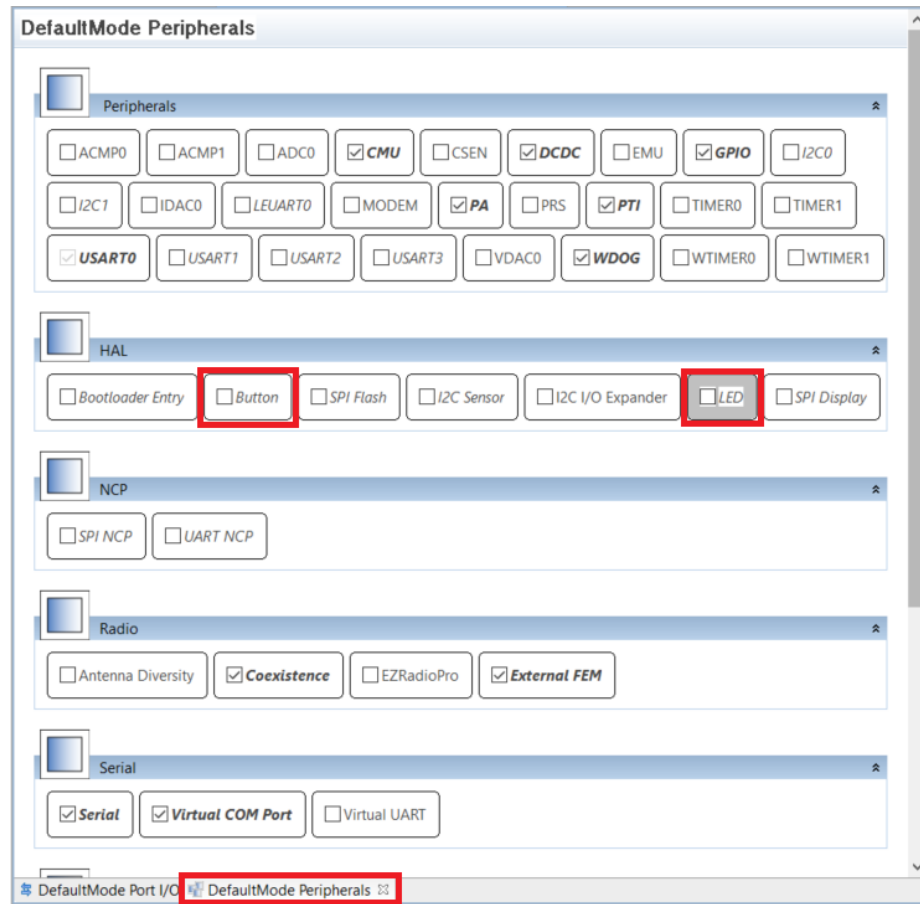


Figure 3.2. Disable Button and LED Configurations

4. To disable the USART CTS/RTS support, select the USART0 box under Peripherals, and modify the properties as follows:

Flow Control Mode: No flow control

USART CTS pin: Disabled

USART RTS pin: Disabled

Click **[Save]** (or press Ctrl+S). The hal-config.h file will be automatically updated with the latest changes.

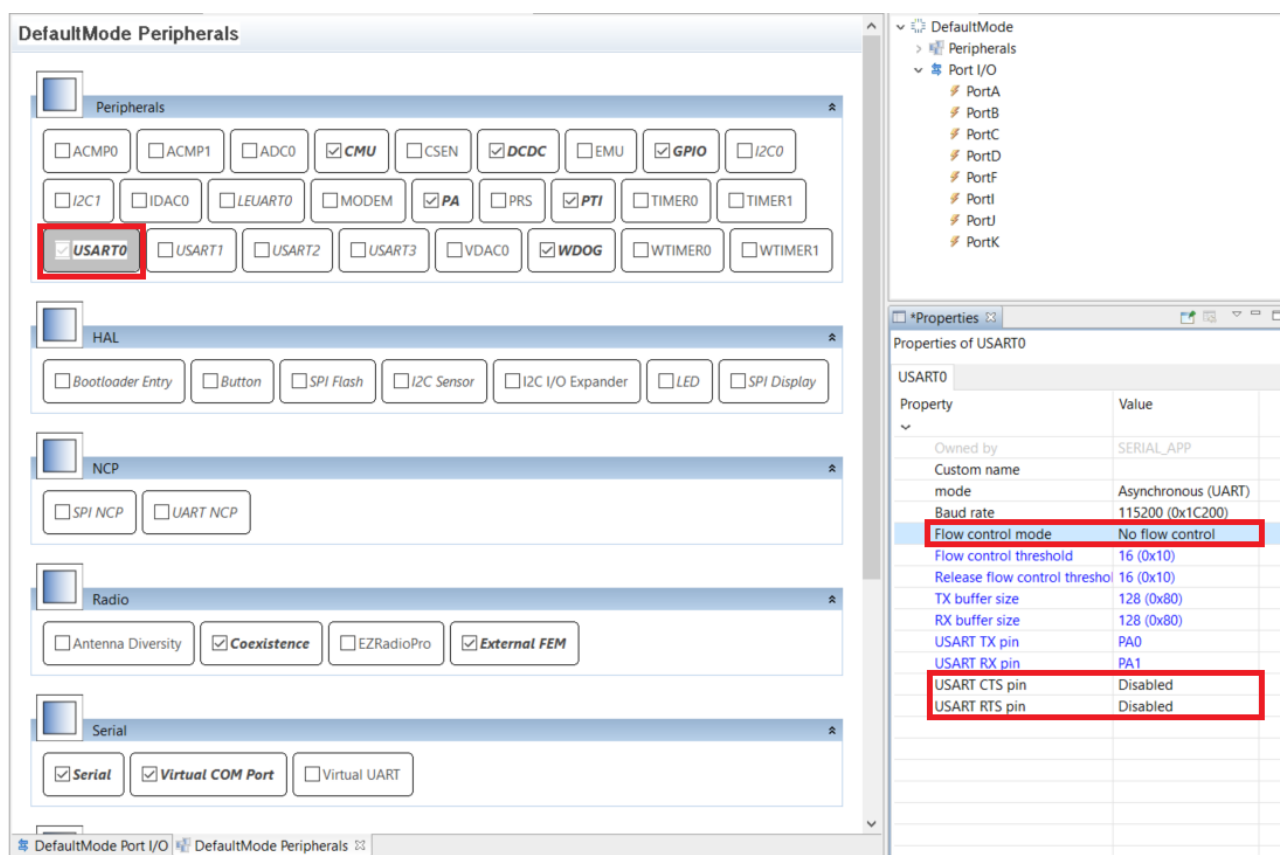


Figure 3.3. Disable USART CTS/RTS Support

5. Once all changes have been saved, rebuild project using instructions in *QSG106: Getting Started with EmberZNet PRO*.

3.2 Configuring for Different PTA Scenarios

3.2.1 Single-EFR32 Radio

For a single EFR32 radio, be sure to:

1. Configure Board jumpers and jumper wires as follows. Make sure the jumper wire selections are based off the board and device being used. Refer to [Table 3.1 Jumper Wire Recommendations for PTA on Different Devices](#) on page 17 and [Table 3.2 Jumper Wire Recommendations for Radio State on Different Devices](#) on page 17 for details.

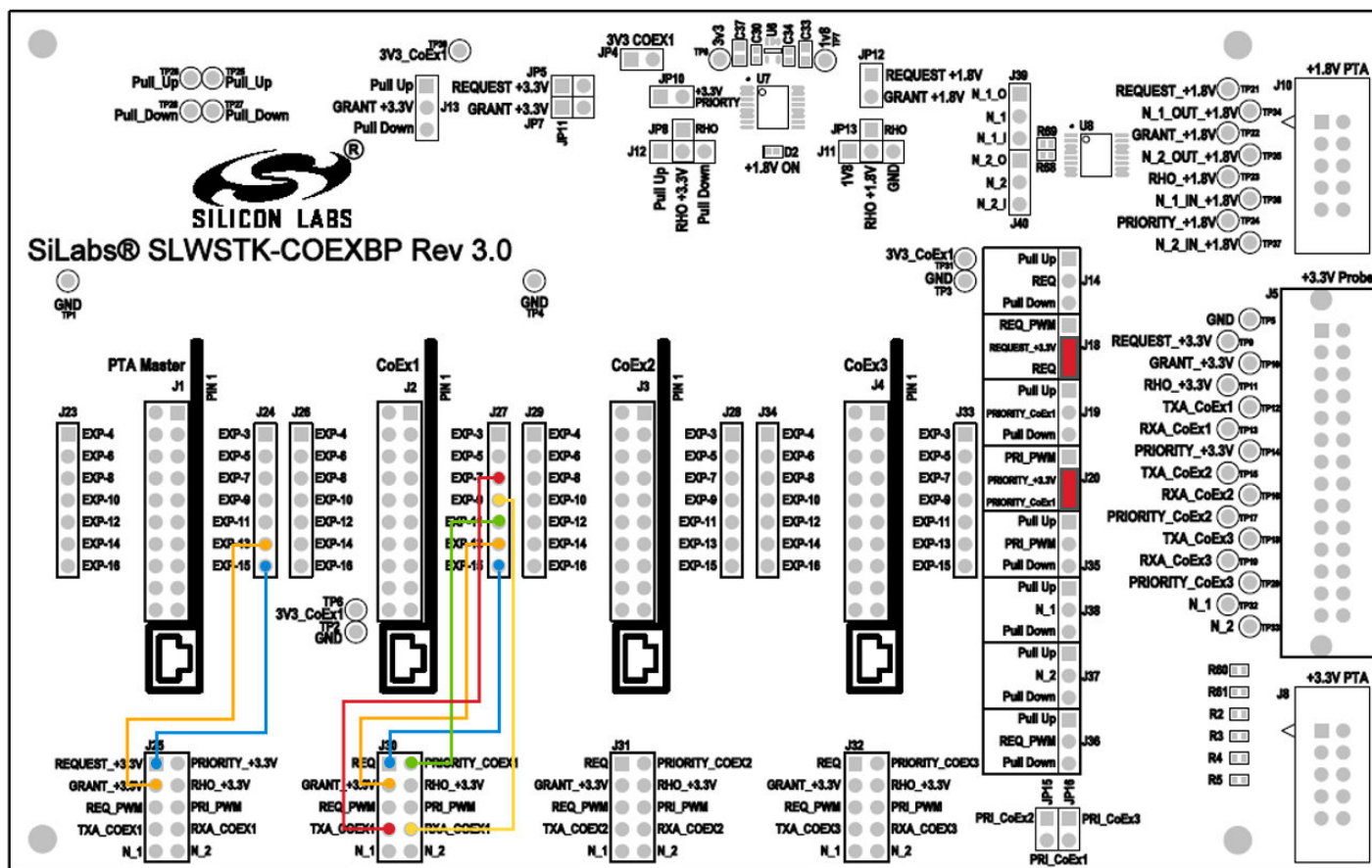


Figure 3.4. Coexistence Backplane Board Jumpers for Single-EFR32 Radio

2. Develop the desired PTA test application using AppBuilder.
3. Add the coexistence-configuration plugin and configure for target Wi-Fi/PTA device as per single-radio description (see the section “PTA Support Software Setup” in *AN1017: Zigbee® and Thread Coexistence with Wi-Fi*).
4. Add FEM driver plugin (configured as described above) to enable TXA and RXA observation.
5. Build the EFR32 application and program the WSTK.
6. Plug the EXP header on the EFR32/WSTK Board into Coexistence Backplane Board CoEx1 header (J2) (ensure pin 1 to pin 1).
7. Enable PTA on the Wi-Fi/PTA device.
8. Execute Wi-Fi stream and 802.15.4 stream.
9. Observe Wi-Fi error rate and 802.15.4 message success.
10. Observe PTA signals to debug, and adjust as necessary.
11. With the PTA solution confirmed, the coexistence-plugin only needs to be modified for the PTA GPIOs assigned on target hardware.

3.2.2 Multi-EFR32 Radios with Unshared PRIORITY

For multi- EFR32 radios with unshared PRIORITY, be sure to do the following:

1. Configure Board jumpers and jumper wires as follows. If using two radios, do not configure jumper wires for Coex 3. Make sure the jumper wire selections are based off the board and device being used. Refer to [Table 3.1 Jumper Wire Recommendations for PTA on Different Devices on page 17](#) and [Table 3.2 Jumper Wire Recommendations for Radio State on Different Devices on page 17](#) for details.

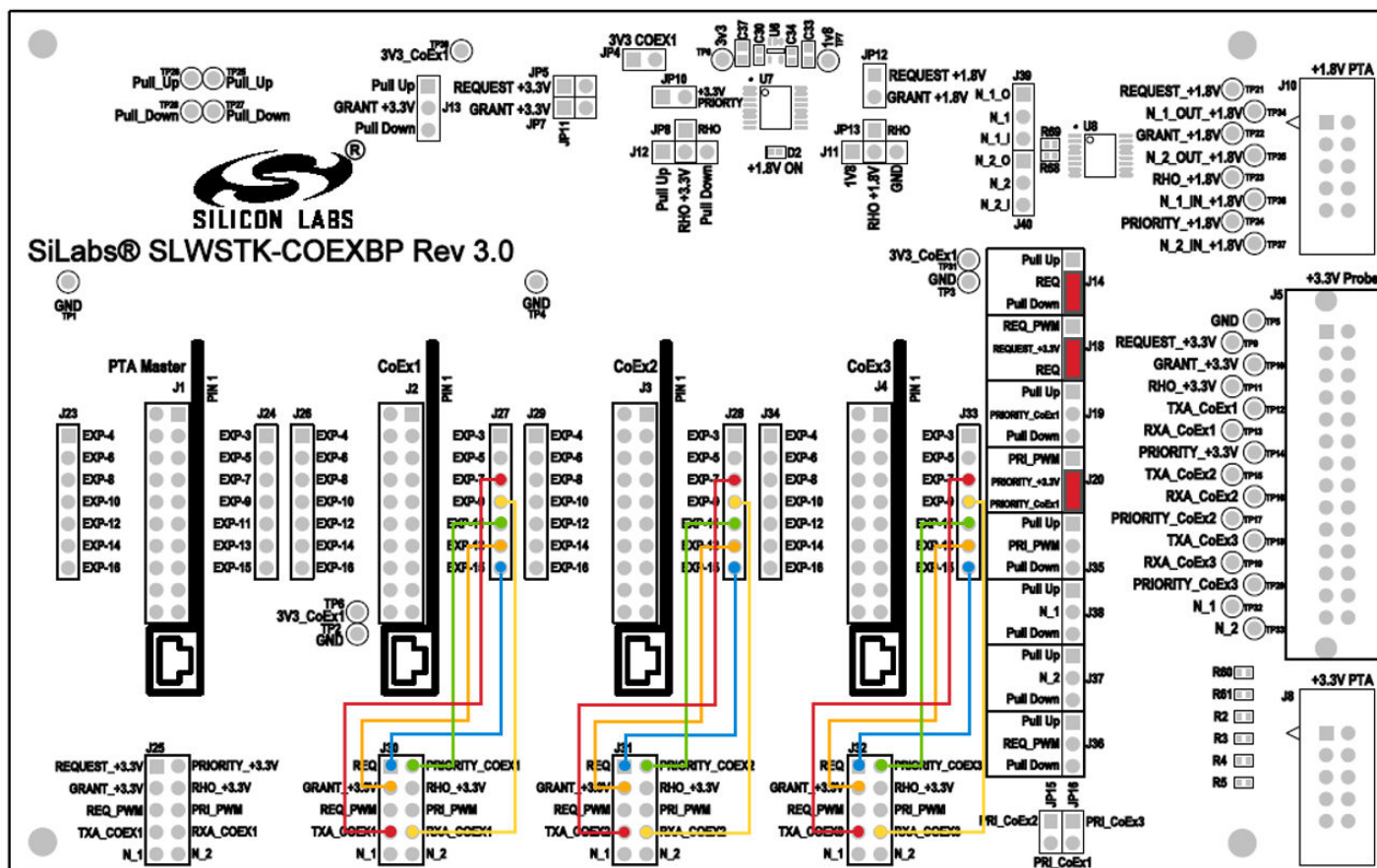


Figure 3.5. Coexistence Backplane Board Jumpers for Multi-EFR32 Radios with Unshared PRIORITY

2. Develop desired PTA test applications using AppBuilder.
3. Add coexistence-configuration plugins and configure for target Wi-Fi/PTA device as per multi-radio description (see the section "PTA Support Software Setup" in *AN1017: Zigbee® and Thread Coexistence with Wi-Fi*).
4. Add the FEM driver plugin (configured as described above) to enable TXA and RXA observation.
5. Build the EFR32 applications and program the WSTKs.
6. Plug the EXP header on one EFR32/WSTK Board into Coexistence Backplane Board CoEx1 header (J2) and the second and third EFR32/WSTK Boards, if used, into CoEx2 and CoEx3 headers (J3 and/or J4) (ensure pin 1 to pin 1).
7. Enable PTA on the Wi-Fi/PTA device.
8. Execute Wi-Fi stream and 802.15.4 streams.
9. Observe Wi-Fi error rate and 802.15.4 message success.
10. Observe PTA signals to debug and adjust as necessary.
11. With the PTA solution confirmed, the coexistence-plugin only needs to be modified for the PTA GPIOs assigned on target hardware.

3.2.3 Multi-EFR32 Radios with Shared PRIORITY

For multi-EFR32 radios with shared PRIORITY, be sure to do the following.

1. Configure Board jumpers and jumper wires as follows. If using 2 radios, do not configure jumper wires for Coex 3. Make sure the jumper wire selections are based off the board and device being used. Refer to [Table 3.1 Jumper Wire Recommendations for PTA on Different Devices on page 17](#) and [Table 3.2 Jumper Wire Recommendations for Radio State on Different Devices on page 17](#) for details.

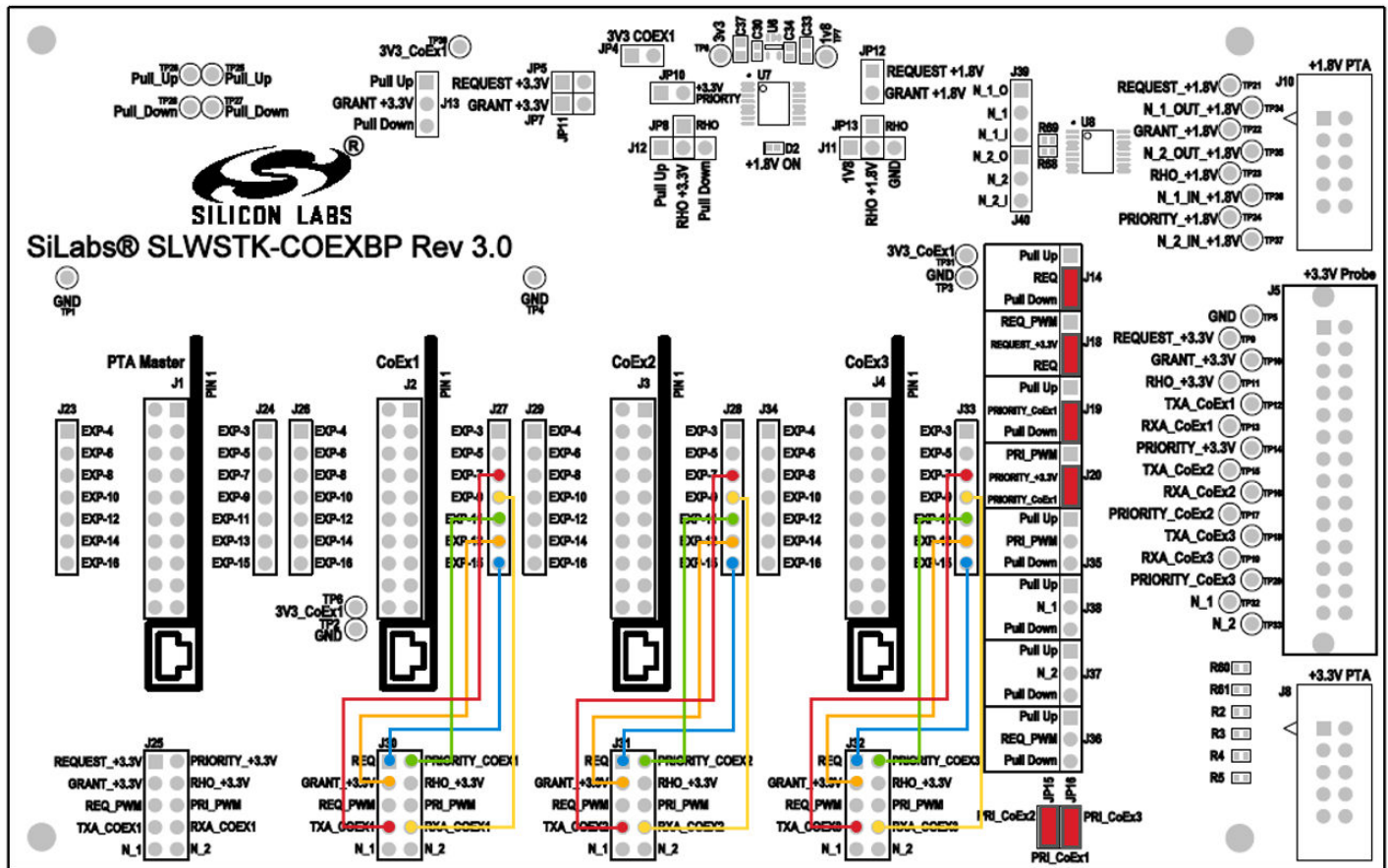


Figure 3.6. Coexistence Backplane Board Jumpers for Multi-EFR32 Radios with Shared PRIORITY

2. Develop desired PTA test applications using AppBuilder.
3. Add coexistence-configuration plugins and configure for target Wi-Fi/PTA device as per multi-radio description (see the section "PTA Support Software Setup" in *AN1017: Zigbee® and Thread Coexistence with Wi-Fi*).
4. Add the FEM driver plugin (configured as described above) to enable TXA and RXA observation.
5. Build the EFR32 applications and program the WSTKs.
6. Plug the EXP header on one EFR32/WSTK Board into Coexistence Backplane Board CoEx1 header (J2) and the second and third EFR32/WSTK Boards, if used, into CoEx2 and CoEx3 headers (J3 and/or J4) (ensure pin 1 to pin 1).
7. Enable PTA on the Wi-Fi/PTA device.
8. Execute Wi-Fi stream and 802.15.4 streams.
9. Observe Wi-Fi error rate and 802.15.4 message success.
10. Observe PTA signals to debug and adjust as necessary.
11. With the PTA solution confirmed, the coexistence-plugin only needs to be modified for the PTA GPIOs assigned on target hardware.

3.2.4 PWM Feature

Refer to *AN1017: Zigbee® and Thread Coexistence with Wi-Fi* on how to set up the board to use the PWM feature.

3.3 I/O to Wi-Fi/PTA Devices for +3.3V or +1.8V

The Coexistence Backplane Board provides the capability of interfacing to Wi-Fi/PTA devices via +3.3 V or +1.8 V I/O as needed.

3.3.1 I/O for +3.3V

For +3.3 V I/O to Wi-Fi/PTA device, PTA signal connections to Wi-Fi/PTA should be made to J8 as shown in the following table. Add appropriate jumpers and jumper wires based on device configuration explained in section [3.2 Configuring for Different PTA Scenarios](#).

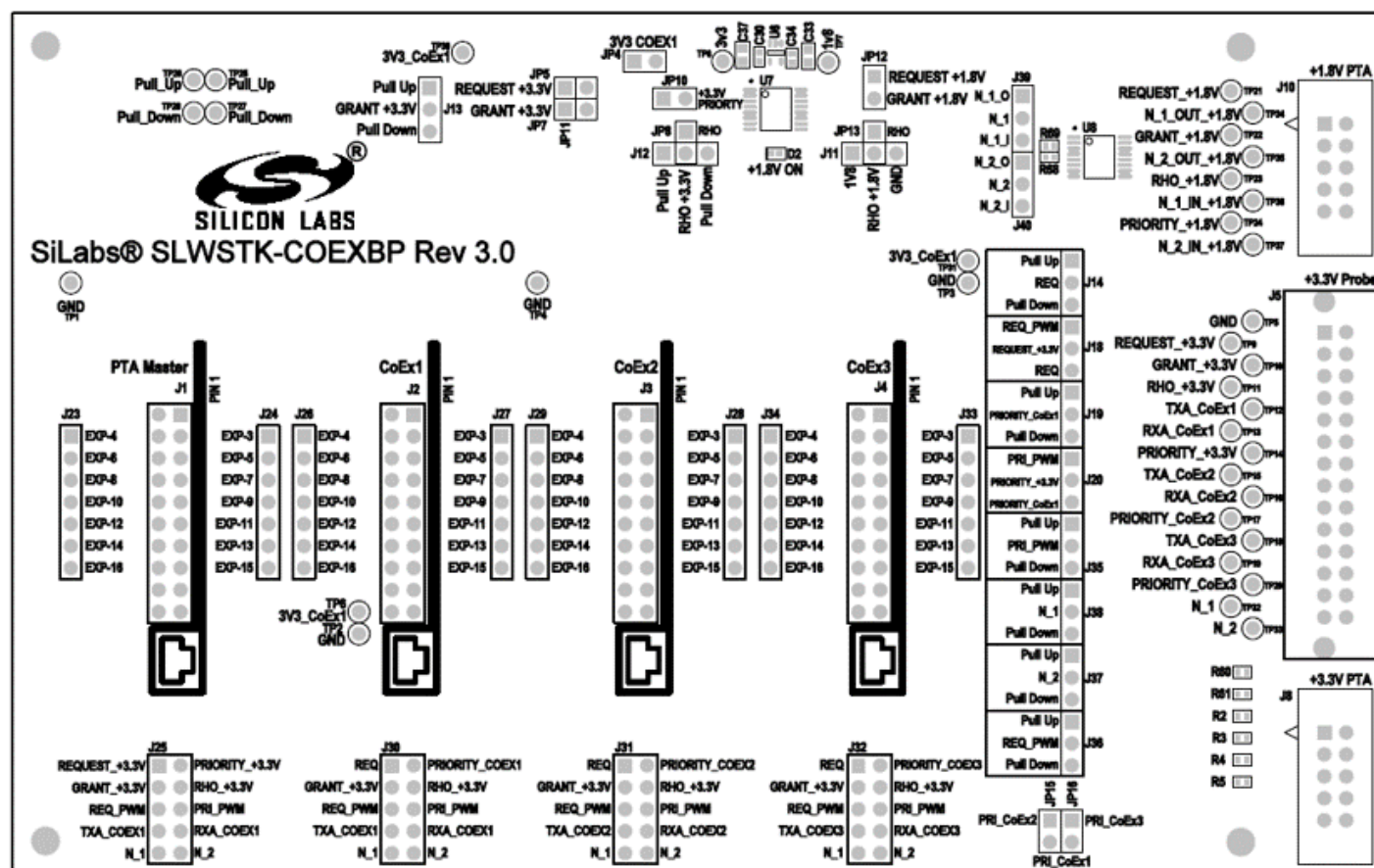


Figure 3.7. Coexistence Backplane Board Jumpers for +3.3V I/O Operation

The +3.3V /IO connections to Wi-Fi/PTA device can be made via +3.3V PTA HDR (J8) as follows:

Table 3.3. Header (J8) Pins for +3.3V I/O Connections

EFR32 PTA Signal	J8 Pin
REQUEST_+3.3V	1
GRANT_+3.3V	3
RHO_+3.3V	5
PRIORITY_+3.3V	7
GND	9 and 10

Note: Additional jumpers are required to configure the REQUEST and PRIORITY signals. Jumper configuration varies with single-EFR32 radio and multi-EFR32 radio configurations and active-high/active-low polarities. See section [3.2 Configuring for Different PTA Scenarios](#) for these jumper options.

3.4 Probe Header

The EFR32 PTA signals (+3.3V I/O) are observable via a logic analyzer connected to J5 as shown below:

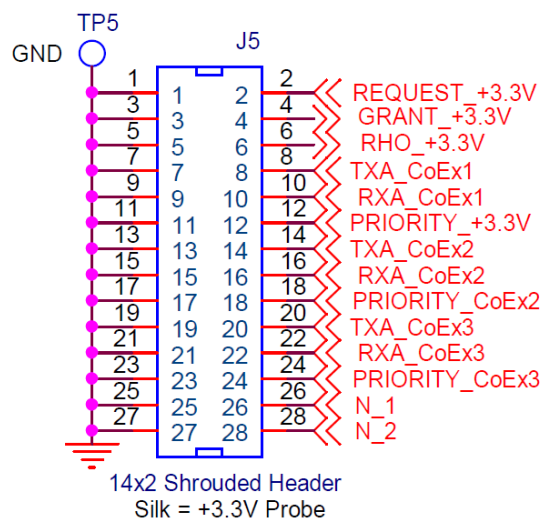


Figure 3.9. Coexistence Backplane Board Header for PTA Signal Logic Analyzer Connection

Where:

- CoEx1 refers to EFR32/WSTK connected into CoEx1 header (J2)
- CoEx2 refers to EFR32/WSTK connected into CoEx2 header (J3)
- CoEx3 refers to EFR32/WSTK connected into CoEx3 header (J4)

Note: Depending on jumper configurations, PRIORITY_+3.3 V can be PRIORITY_CoEx1 or wired-OR/-AND of multiple PRIORITY signals. See section [3.2 Configuring for Different PTA Scenarios](#) for these PRIORITY_+3.3 V jumper options.

3.5 Board Schematics

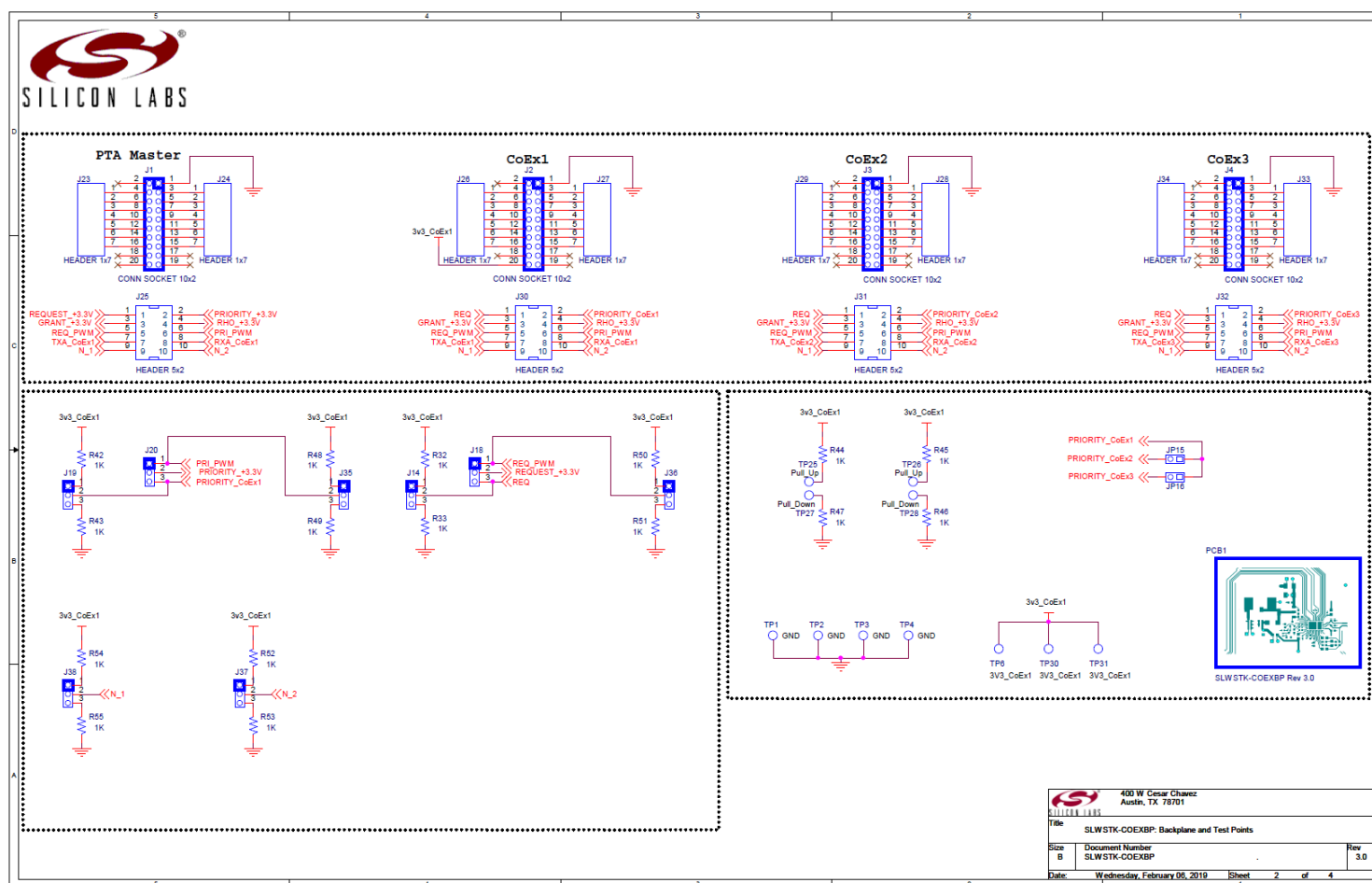


Figure 3.10. SLWSTK-COEXBP Schematic (1/3)

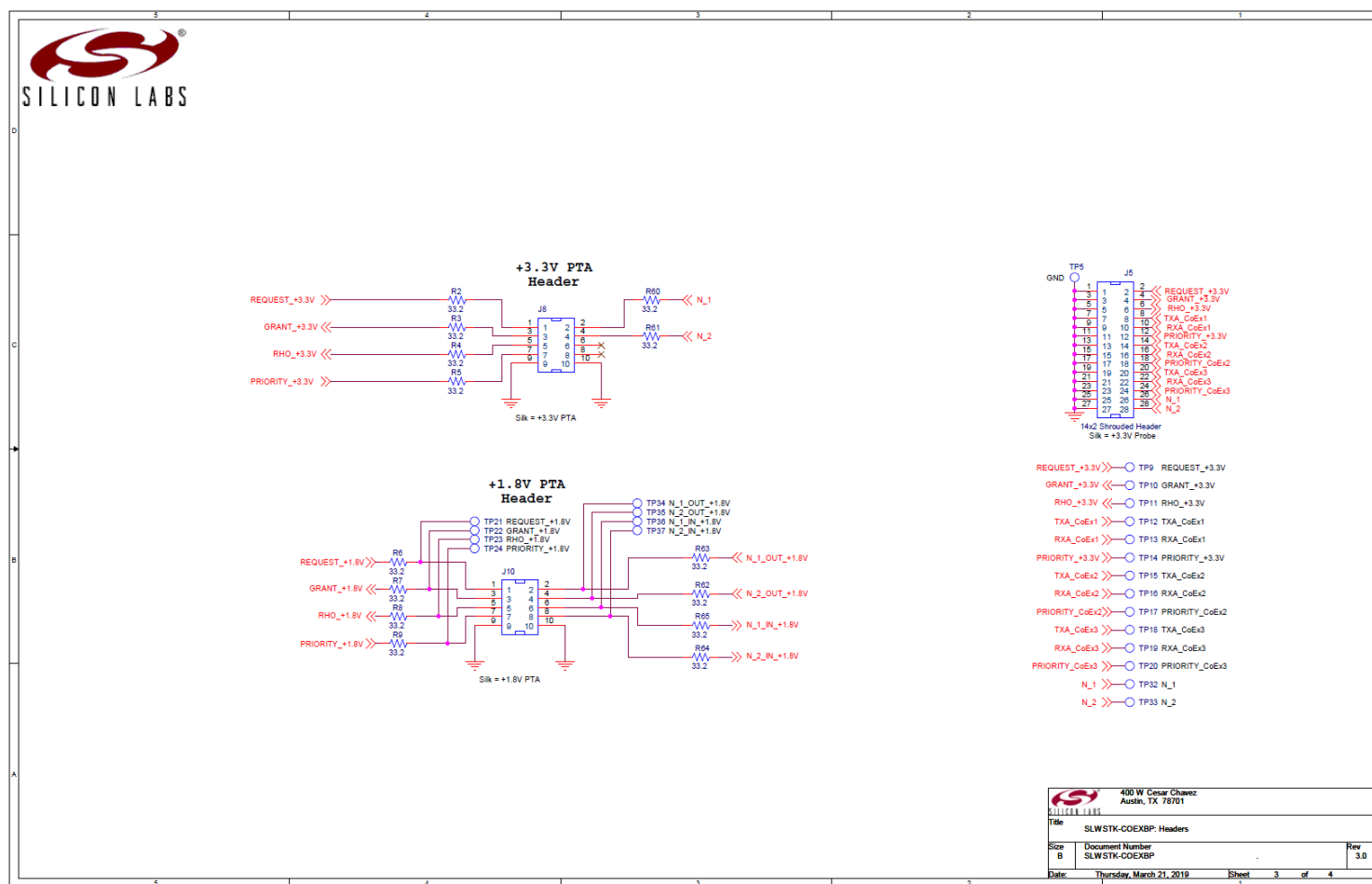


Figure 3.11. SLWSTK-COEXBP Schematic (2/3)

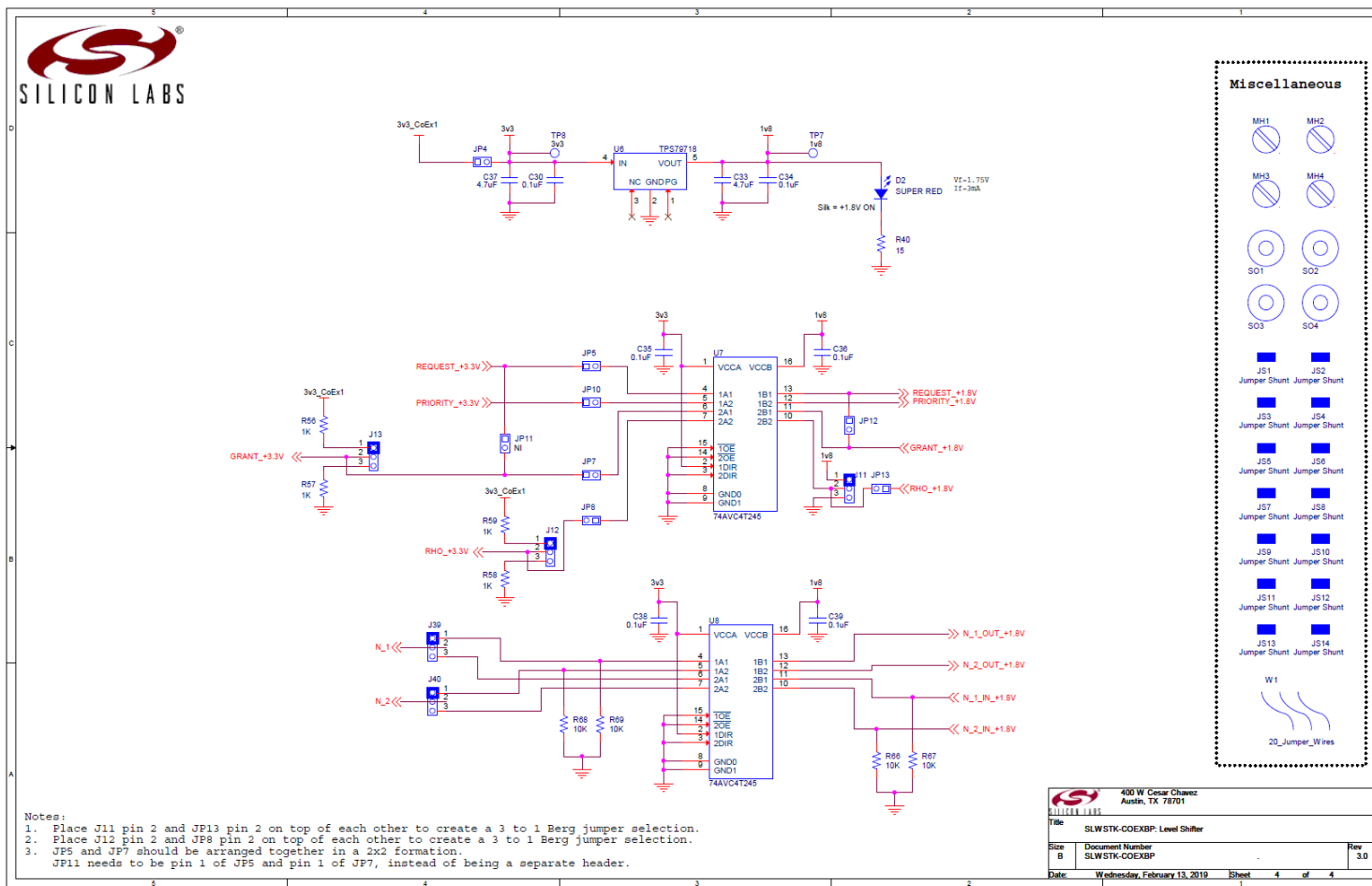


Figure 3.12. SLWSTK-COEXBP Schematic (3/3)

3.6 Packet Trace

For the purposes of debugging, it can be useful to monitor the packet trace (PTI) signals generated by the radio device. These signals, when viewed with TXA and RXA to indicate radio state, can help determine when a packet was received or transmitted, and whether the radio transaction was successful. To access the PTI signals, some modifications need to be made to the coexistence device's WSTK board.

1. Solder a header into the pin locations currently marked as NC. These pins are not connected to any functions on the WSTK board. It is also recommended to add header pins to the adjacent GND pin locations to provide proper ground reference to the logic analyzer.

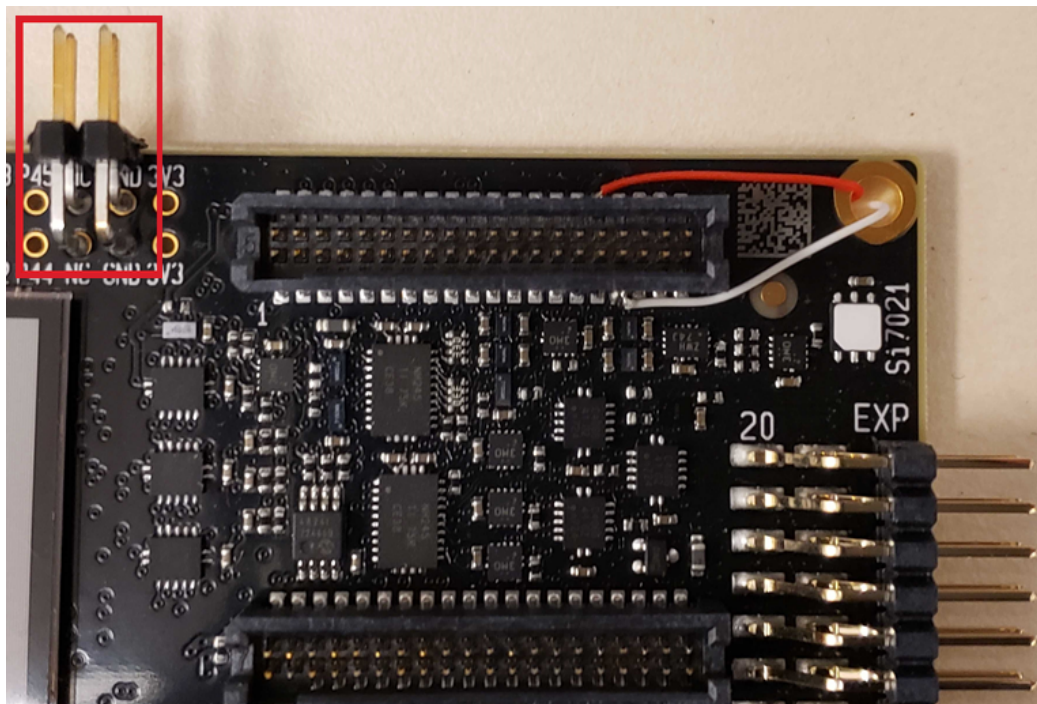


Figure 3.13. PTI Header Location

2. Solder wires to pin 32 and pin 33 of the 40-pin connector. Pin 32 corresponds to the PTI_Frame/PTI_Sync signal, and Pin 33 corresponds to the PTI_DATA signal.

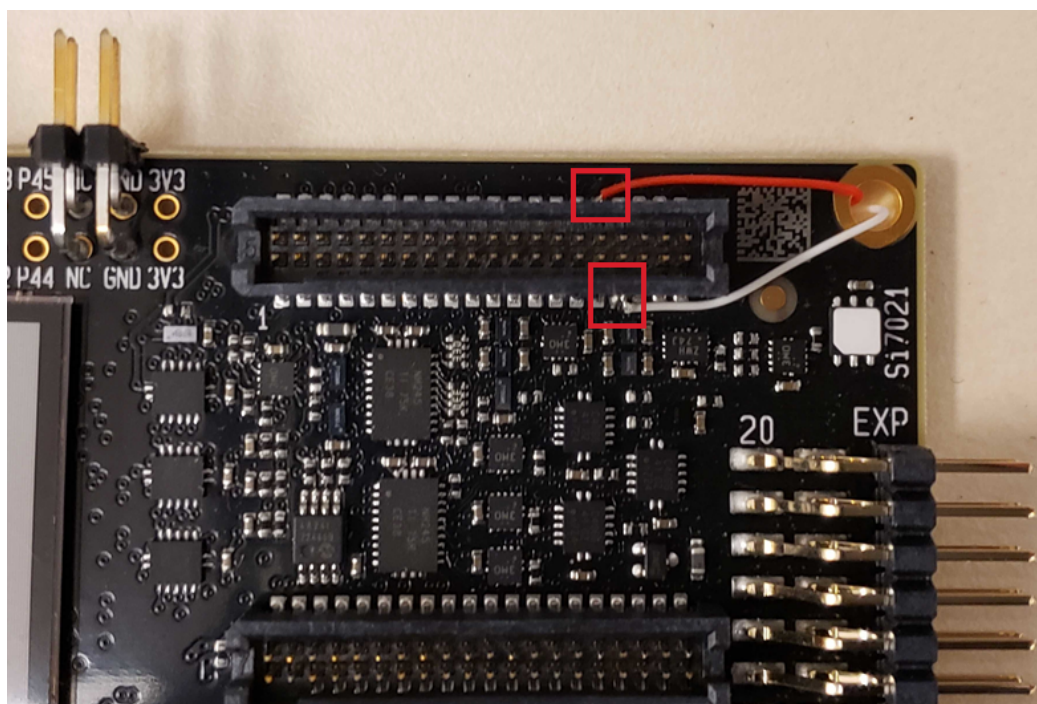


Figure 3.14. PTI Pin Locations

3. Route these wires to the back of the board and solder onto the header pins that are in the NC pin locations.

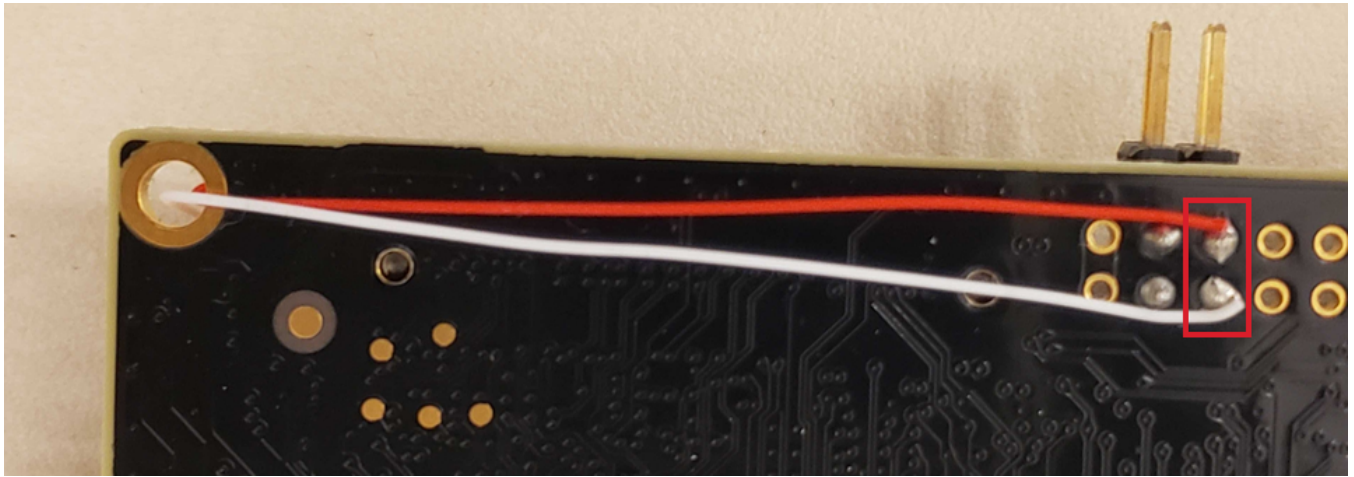


Figure 3.15. PTI Header Soldering

4. Connect a logic analyzer to the two PTI signals.

The logic analyzer will now be able to capture Packet Trace information alongside coexistence activity from the radio.

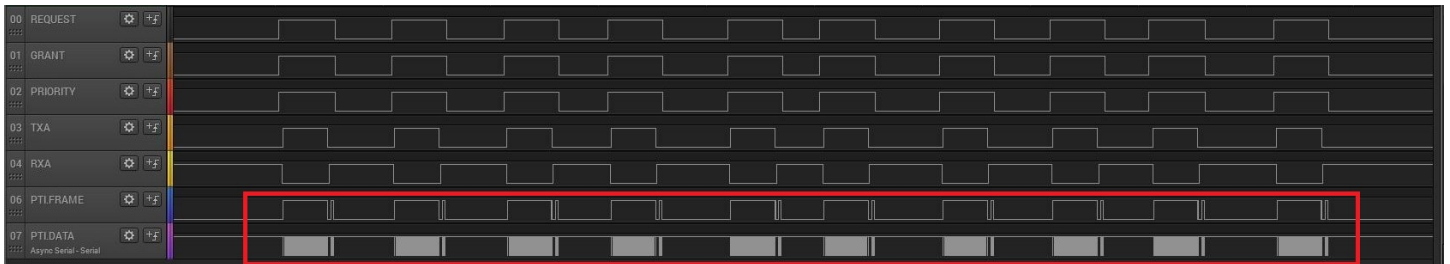


Figure 3.16. PTI Logic Capture

For information on how to analyze the PTI data captured, refer to *AN1017: Zigbee® and Thread Coexistence with Wi-Fi* or contact the Silicon Labs support team.

4. Throughput Library

4.1 Throughput Library Commands

Table 4.1. List of Commands Available in the Throughput Library

Command	Command Description	Arguments		
		Name	Type	Description
plugin throughput start	Start the throughput test			
plugin throughput stop	Abort the test while running			
plugin throughput print-result	Show the results of the last test			
plugin throughput set-destination	Set the destination nodeId	nodeId	INT16U	Destination nodeId
plugin throughput set-interval	Set the interval	interval	INT16U	Interval in ms
plugin throughput set-timeout	Set the test timeout	timeout	INT32U	Timeout in ms
plugin throughput set-count	Set the number of packets to send	count	INT16U	Packets to send
plugin throughput set-inflight	Set the number of packets in flight during the test	inflight_count	INT8U	Packets in flight
plugin throughput set-packet-size	Set the packet length	packet	INT8U	Packet length in bytes
plugin throughput set-all	Set all parameters: <ul style="list-style-type: none"> • NodeID • Count • Interval • Packet Length • Max In-Flight • APS Options • Test Timeout 	nodeId	INT16U	Destination nodeId
		count	INT16U	Packets to send
		interval	INT16U	Interval in ms
		packet	INT8U	Packet length in bytes
		inflight_count	INT8U	Packets in flight
		apsOptions	INT16U	APS Options
		timeout	INT32U	Timeout in ms

Command	Command Description	Arguments		
		Name	Type	Description
plugin throughput set-aps-ack-off	Turn off APS acks			
plugin throughput set-aps-ack-on	Turn on APS acks			
plugin throughput print-parameters	Print all the test parameters			
plugin throughput print-counters	Print the stack counters			
plugin throughput clear-counters	Clear all the stack counters			

4.2 Using the Throughput Library

To begin using the throughput library, the required parameters need to be defined. The simplest way to achieve this is by using command “plugin throughput set-all <parameters>”. Details regarding the command and order of parameters can be found in [Table 4.1 List of Commands Available in the Throughput Library on page 32](#).

A sample command is `plugin throughput set-all <0xNodeID> 10 0 127 1 0 100000`, where NodeID needs to be defined as the nodeID of the receiving node, typed as a hex number. Note: to achieve maximum throughput, the interval field should be set to 0.

To print the parameters currently set, use the command `plugin throughput print-parameters`. This returns the parameters currently defined, in the following format:

```
TEST PARAMETERS
Destination nodeID: 0x1234
Packets to send: 10
Transmit interval: 0 ms
Payload size: 77B
Packet size: 127B
Packets in flight: 1
APS Options = 0x0000
Timeout: 100000 ms
```

To start the throughput process, use the command `plugin throughput start`. This starts sending packets to the other device. To stop the test during the run, use command `plugin throughput stop`. Once the test is complete, you can print the results using `plugin throughput print-result`. This produces the results of the most recent run, in the following format:

```
THROUGHPUT RESULTS
Total time 96 ms
Success messages: 10 out of 10
Payload Throughput: 64166 bits/s
Phy Throughput: 105833 bits/s
Min packet send time: 6 ms
Max packet send time: 8 ms
Avg packet send time: 6 ms
STD packet send time: 2 ms
```

The throughput is calculated by dividing the total number of bits sent by the total time.

For Phy Throughput:

$$\text{Phy Throughput (bits/s)} = \frac{\text{Packet size (Bytes)} * 8 \frac{\text{bits}}{\text{Byte}} * \text{No. of packets}}{\text{Total Time (s)}}$$

For Payload Throughput:

$$\text{Payload Throughput (bits/s)} = \frac{\text{Payload size (Bytes)} * 8 \frac{\text{bits}}{\text{Byte}} * \text{No. of packets}}{\text{Total Time (s)}}$$

The throughput plugin also tracks some counters to provide visibility and help with debugging purposes. Use `plugin throughput print-counters`. The results are produced in the following format:

```
COUNTERS
CCA Failures: 0
Mac Tx Ucast: 10
Mac Tx Ucast Retry: 0
Mac Tx Ucast Fail: 0
APS Tx Ucast Success: 10
APS Tx Ucast Retry: 0
APS Tx Ucast Fail: 0
```

Details regarding the MAC and APS stack counters can be found in *AN1017: Zigbee® and Thread Coexistence with Wi-Fi* and are also documented in the stack API documentation.

5. PTA Master Application

The PTA Master application is custom application built on the Flex stack, designed to help customers evaluate coexistence features on the silicon labs devices. The Zigbee radios act as slave devices, and require a master device to react and respond to coexistence requests. The PTA Master application implements this and allows users control to the behavior of the PTA Master to evaluate the corresponding behavior of the slave device.

5.1 Commands in the PTA Master Application

Table 5.1. List of Commands Available in the PTA Master Application

Command	Command Description	Argument and Description
configuration	Print out the current configuration of features	
request	Set REQUEST signal polarity	activehigh: sets the signal polarity active HIGH activelow: sets the signal polarity active LOW
grant	Set GRANT signal polarity	activehigh: sets the signal polarity active HIGH activelow: sets the signal polarity active LOW
priority	Set PRIORITY signal polarity	activehigh: sets the signal polarity active HIGH activelow: sets the signal polarity active LOW
rho	Set RHO signal polarity	activehigh: sets the signal polarity active HIGH activelow: sets the signal polarity active LOW
grantabort	Enable/Disable GRANT Abort feature, and set abort percentage	0: disables GRANT Abort 1-100: enables GRANT Abort and sets percentage of GRANTS that are aborted
grantdelay	Enable/Disable GRANT Delay feature, and set delay percentage	0: disables GRANT Delay 1-100: enables GRANT Delay and sets percentage of GRANTS that are delayed
grantdeny	Enable/Disable GRANT Deny feature, and set deny percentage	0: disables GRANT Deny 1-100: enables GRANT Deny and sets percentage of GRANTS that are denied
rhofeature	Enable/Disable Radio Hold Off (RHO) feature, and set rho percentage	0: disables RHO feature, and sets pin to High Z mode. 1-100: enables RHO and sets percentage of Radio Hold Off requests
txStreamToggling	Output a toggling stream for a specified time, up to 60 seconds. Note: This feature sets GRANT to always asserted	1-60: time for which to output stream
setTxStream	Output a stream	1: Enable stream 0: Disable stream
setPower	Set the current transmit power in deci dBm, or raw units if 'raw' is specified	Output power to set (range depends on capabilities of radio device. Refer to datasheet of device for more info)
getPower	Get the current transmit power in deci dBm	
setchannel	Set the current radio channel	0-15: Value 0 corresponds to Zigbee channel 11
getchannel	Get the current radio channel	

5.2 Using the PTA Master Application

The PTA Master application is ready to use after compilation with the following default features:

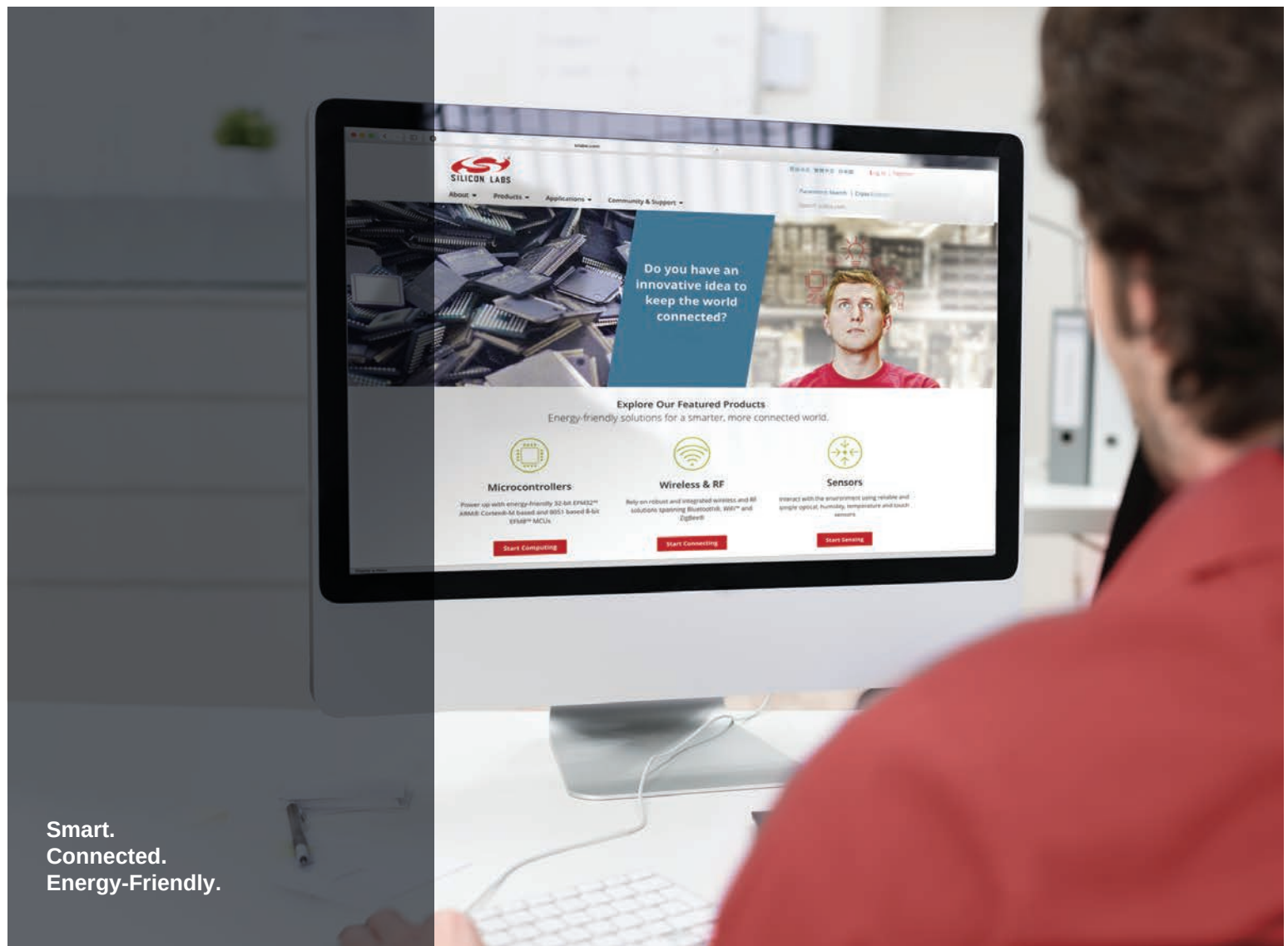
- REQUEST is set to Active HIGH
- GRANT is set to Active HIGH
- PRIORITY is set to Active HIGH
- RHO is set to Active HIGH, but the feature is disabled and the pin is set to High Z mode
- GRANT Abort, GRANT Delay, and GRANT Deny are disabled
- No stream is active

To change any of the default configurations, use the commands previously listed.

Use the configuration command to print out current configuration. An example output returned through the CLI is:

```
Request:      Active High
Grant:        Active High
Priority:      Active High
Radio Hold Off: Active High
Grant Abort:   Disabled
Grant Delay:   Disabled
Grant Deny:    Disabled
RHO Feature:   Disabled
```

The PTA Master application can also hinder network traffic to test behavior of the slave device in such conditions. The `txStreamToggling` command outputs a periodic stream for a specified time, causing packets or sections of packets on the network to get corrupted.

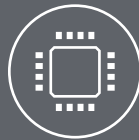


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