AN1410: Getting Started with Concurrent Mode on EFR32FG25 using RAILtest

This document is a quick start guide for Wi-SUN concurrent mode using RAILtest. It describes:

- The Wi-SUN concurrent detection mode provided with EFR32FG25
- How to configure a concurrent PHY with Simplicity Studio
- How to configure and use the concurrent mode through RAILtest
- Known issues

Proprietary is supported on all EFR32FG devices, although OFDM modulation and concurrent mode are available only on EFR32FG25 devices. In this document, only the RAILtest example application is used.

KEY POINTS

- EFR32FG25 devices support Wi-SUN FAN 1.1 with OFDM and FSK modulations and a feature allowing concurrent detection of FSK and OFDM frames.

1 Concurrent Detection Mode Description

Concurrent mode is a dual detection of Wi-SUN FSK and Wi-SUN OFDM frames at the receiver side.

This feature can be considered as an advanced mode switch case without signaling, which improves network performance. This feature requires that the receiver listens to both FSK and OFDM frames simultaneously. The first detected preamble selects the demodulator used for frame reception, FSK or OFDM. As such, only one frame can be received (no concurrent reception).

Given concurrent detection is an extension of mode switch, it is based on Wi-SUN PHY Technical Profile Specification 2V00 and uses all its definitions, in particular:

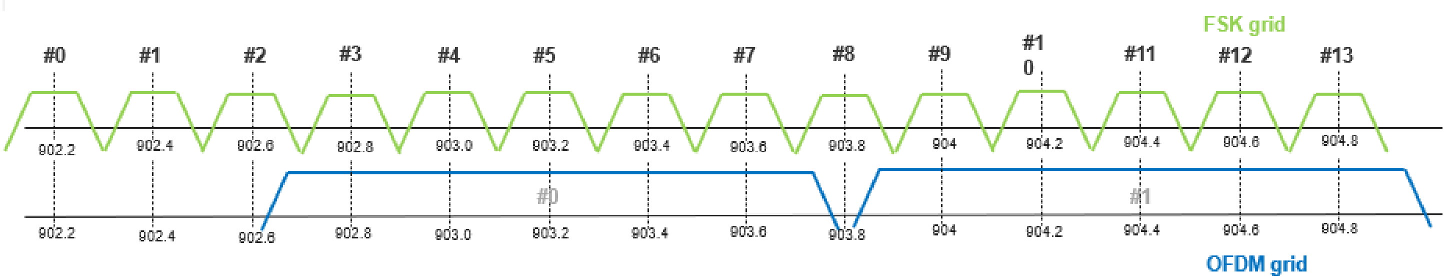
- The base PHY is the FSK PHY
- The alternate PHY is the OFDM PHY

Concurrent mode could be used by the stack as the Wi-SUN FAN 1.1 mode switch. The channel numbering re-uses the same rules as for Wi-SUN FAN 1.1 as listed below:

- The channel of the new operating mode must be a valid channel as specified by the ChanPlanID and the respective ChanMask in Wi-SUN PHY Technical Profile Specification 2V00.
- The channel of the new mode must be the one with a center frequency closest to that of the original channel used in base mode. If two channels are equally distant from the original channel, the higher channel must be used.

Note that Wi-SUN mode switch and thus the channel selection scheme differ from the one defined in IEEE802.15.4-2020.

The same RF signal is used to do the dual detection. The base (FSK PHY) channel number automatically selects the alternate (OFDM PHY) channel number as shown below for FSK mode XX and OFDM option XX.



- Base channel number 0 up to 7 selects alternate channel number 0.
- Base channel number 8 up to 13 selects alternate channel number 1.

Depending on the selected base channel number the Intermediate Frequency (IF) in the receiver is dynamically computed for the base and the alternate PHY. Therefore, the user cannot modify the IF in concurrent mode.

2 Concurrent Mode Radio Configuration

2.1 Set Up Wi-SUN Concurrent Mode

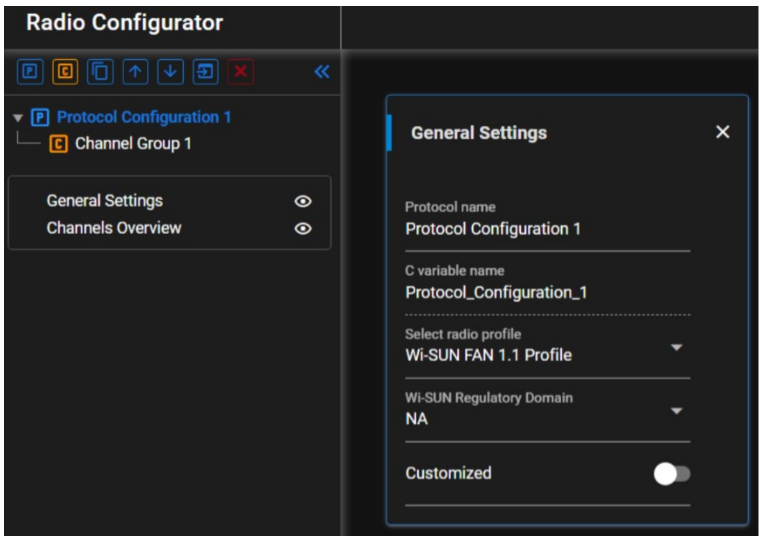
The concurrent mode configurations available are as shown below:

Regulatory Domain	Concurrent Base PHY	Concurrent Alternate PHY
NA	FSK_50kbps_1b FAN1.1 Profile	OFDM option 1 FAN1.1 Profile
JP	FSK_100kbps_2b ECHONET Profile	OFDM option 3 FAN1.1 Profile
EU	FSK_50kbps_1a FAN1.1 Profile	OFDM option 4 FAN1.1 Profile

Note: Depending on customer requests, other concurrent modes could be added in the future.

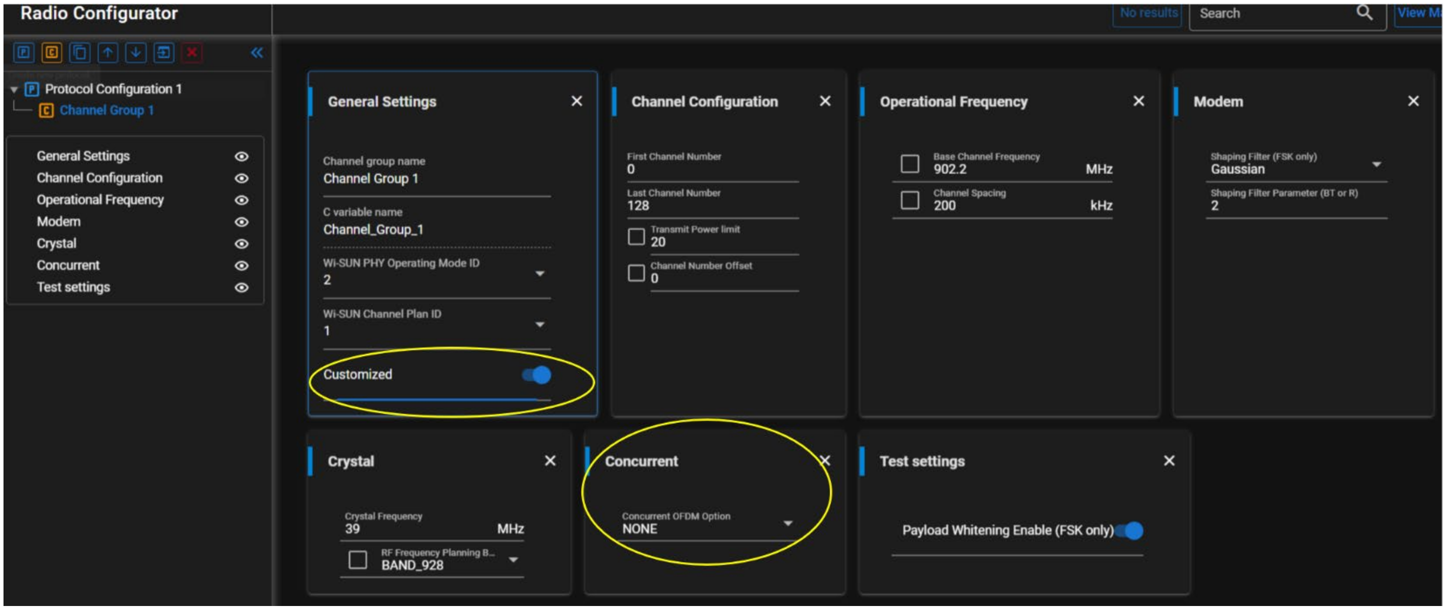
2.2 Concurrent Mode Configuration using the Simplicity Studio Radio Configurator

With the last GSDK, the Radio Configurator GUI allows you to select a concurrent PHY based on the previous table when selecting a radio profile **Wi-SUN FAN 1.1 Profile** in **Protocol Configuration** as shown below for the NA regulatory domain:

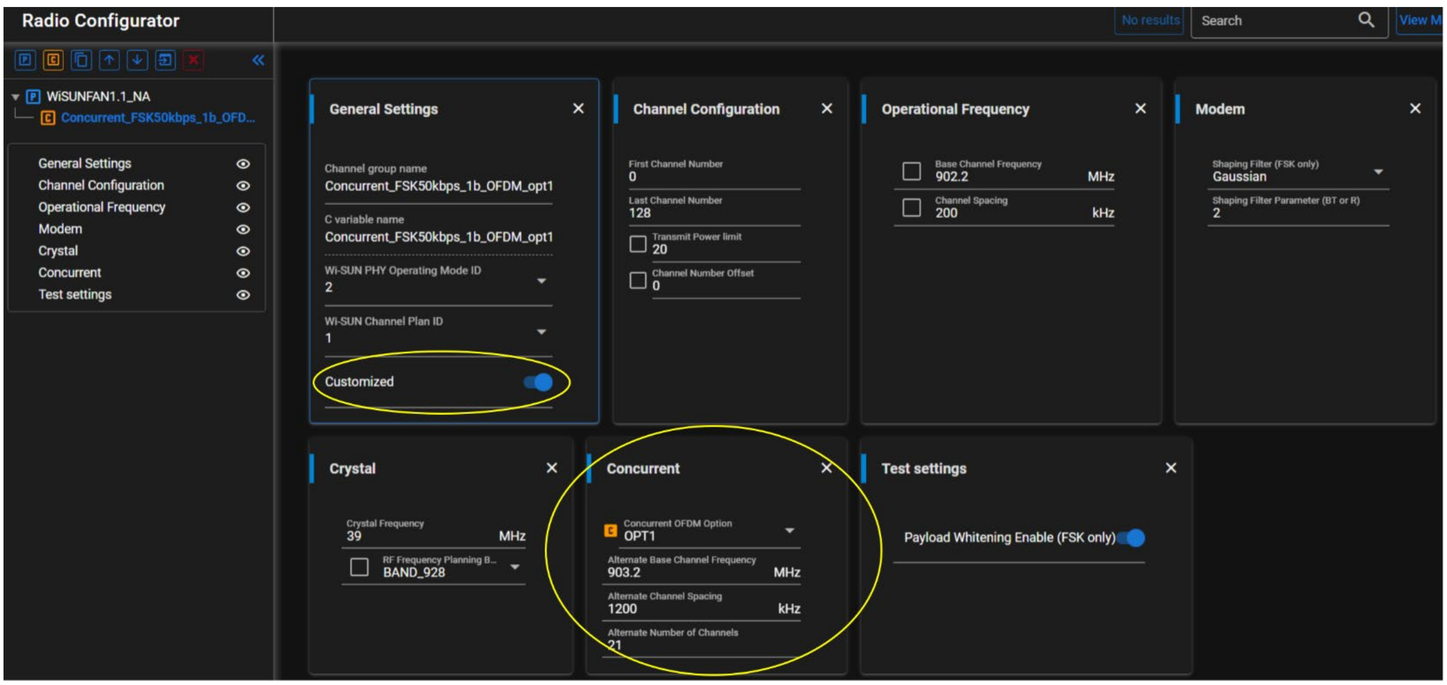


In the **Channel Group**, the base FSK PHY through the Wi-SUN PHY Operating Mode ID could be selected. Then selecting the **Customized** option, it could be possible depending on the FSK base PHY to select an alternate OFDM PHY for concurrent mode detection.

For example, the Wi-SUN FAN 1.1 with NA regulatory domain, the FSK 1b with 50kbps could be a base PHY providing **Concurrent OFDM Option** selection set by default to **NONE** as shown below:



In the previous snapshot with **Concurrent OFDM Option** set to **NONE**, it is an FSK mode 1b providing 50kbps with PHY Operating Mode ID=2. In the **Concurrent OFDM Option** list, the OFDM option can be selected to get a concurrent PHY with FSK plus OFDM as shown below:



The **Alternate Base Channel Frequency**, the **Alternate Channel Spacing**, and the **Alternate Number of Channels** are provided by default. These fields values are compliant as specified by the ChanPlanID in Wi-SUN PHY Technical Profile Specification 2V00. It is possible to modify these values nevertheless note the FSK channel plan should be compatible with the OFDM channel plan as described in section 1.

Notes:

- For Regulatory domain JP, the PHY FSK_100kbps _2b uses the ECHONET Profile in place of FAN1.1 Profile with a preamble length of 15 bytes and an FCS length with 2 bytes CRC.
- For Regulatory domain EU, a channel mask applies and forbids the use of some available channels in the middle and at the end of the RF band. The channel masking in the middle of the RF band is taken into account thanks to a RAIL callback provided by the stack (see section 4 in AN1403: Wi-SUN Mode Switch on EFR32FG25 with RAILtest).

3 Concurrent Mode with RAILtest

This section assumes the EFR32FG25 is flashed with a RAILtest application image with a Wi-SUN concurrent PHY as described in the previous section.

3.1 Concurrent Mode Usage at the Rx Side

With a concurrent PHY, the following steps are required at the receiver side:

- All PA selected in the channel-based multi-PHY must be initialized (only required once at initialization, FSK PA first then OFDM PA).
  - Set up the PA configuration.
  - Set the recommended PA level (check the max level depending on the radio board, 16 dBm for EFR32FG25).
- For IR calibration for OFDM PHY, call `setchannel` followed by "`rx 1`" for IR calibration.

The following is an example for NA concurrent mode using `configindex 0` and `setchannel 0` with the rail_config.c described in previous section:

```
rx 0
setconfigindex 0
setchannel 0
rx 1
# FSK and OFDM PA configuration + Calibration
rx 0
setpowerconfig RAIL_TX_POWER_MODE_SUBGIG_POWERSETTING_TABLE 3600 10
setpower 100
setchannel 0
rx 1
rx 0
setchannel 0
rx 1
rx 0
setpowerconfig RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE 3600 10
setpower 100
setchannel 0
rx 1
```

3.2 Concurrent Mode Usage at the Tx Side

With a concurrent PHY, use the same initialization at the transmitter side as at the receiver side, with some additional configurations for Tx.

The following additional steps are required:

- `setTxdelay 10`: Set 10 ms between data frames.
- `setTxLength 63`: Set the data frame length. This could be another frame length value. Remember to call `set802154Phr` after a new `setTxLength`. Note that FSK frame length corresponds to `setTxLength` value -2 and that OFDM frame length corresponds to `setTxLength` value -4.
- `configTxOptions`**:** Provides a way to select the base PHY or the alternate PHY in Tx through the `concurrentPhyId` field. Set to 0 to select the base PHY or 512 to select the alternate PHY.
- `Set802154phr`: Uses different parameters between FSK and OFDM frame, as described in Getting Started with Wi-SUN PHY. For OFDM PHY, `Set802154phr` should be set with the selected MCS and the new PhyModeID.

The following is an example for NA using `configindex 0`:

```
rx 0
setconfigindex 0
setchannel 0
rx 1
rx 0
setpowerconfig RAIL_TX_POWER_MODE_SUBGIG_POWERSETTING_TABLE 3600 10
setpower 160
setchannel 0
```

```
rx 1
rx 0
setchannel 0
rx 1
rx 0
setpowerconfig RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE 3600 10
setpower 160
setchannel 0
rx 1
setTxDelay 10
setTxLength 63
# CCA : enable CSMA-CA
setLbtMode csma
setLbtParams 0 0 1 -80 0 160 0

#to Tx FSK frames
rx 0
configTxOptions 0
rx 1
set802154Phr 1 0 1
tx 1

#to Tx OFDM frames using MCS4
rx 0
configTxOptions 512
rx 1
set802154Phr 2 4 0
tx 1
```

Notes:

- this previous script also allows receiving either FSK or OFDM frames.
- For FSK 2b ECHONET Profile, the set802154Phr parameters are as shown below:

  ```
  set802154Phr 1 1 1
  ```

3.3 A Complete Example

This section provides a complete Tx and Rx example, along with illustrations of diagnostic signals.

3.3.1 A Complete Tx and Rx Example

This complete example shows how to transmit FSK and OFDM modulated packets with the EFR32FG25 radio using the RAILtest application on the concurrent PHY.

```
> rx 0
{{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:79293671}}
> setconfigindex 0
{{(setconfigindex)}{configIndex:0}{firstAvailableChannel:0}}
> setchannel 0
{{(setchannel)}{channel:0}}
> rx 1
{{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:79693550}}
> rx 0
{{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:79824401}}
> setpowerconfig RAIL_TX_POWER_MODE_SUBGIG_POWERSETTING_TABLE 3600 10
{{(setpowerconfig)}{success:true}{mode:RAIL_TX_POWER_MODE_SUBGIG_POWERSETTING_TABLE    }{modeIndex:0}{voltage:3600}{rampTime:7}}
> setpower 160
{{(setpower)}{powerLevel:255}{power:160}}
> setchannel 0
{{(setchannel)}{channel:0}}
> rx 1
```

```
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:80369403}}
    > rx 0
    {{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:80503536}}
    > setchannel 0
    {{(setchannel)}{channel:0}}
    > rx 1
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:80764283}}
    > rx 0
    {{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:80901650}}
    > setpowerconfig RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE 3600 10
    {{(setpowerconfig)}{success:true}{mode:RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE   }{modeIn-
dex:2}{voltage:3600}{rampTime:7}}
    > setpower 160
    {{(setpower)}{powerLevel:255}{power:160}}
    > setchannel 0
    {{(setchannel)}{channel:0}}
    > rx 1
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:81440368}}
    > rx 0
    {{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:81440855}}
    > setchannel 0
    {{(setchannel)}{channel:0}}
    > rx 1
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:81442897}}
    > status
    {{(status)}{UserTxCount:0}{AckTxCount:0}{UserTxAborted:0}{AckTxAborted:0}{Us-
erTxBlocked:0}{AckTxBlocked:0}{UserTxUnderflow:0}{AckTxUnderflow:0}{RxCount:0}{RxCrcErr-
Drop:0}{SyncDetect:0}{NoRxBuffer:0}{TxRemainErrs:0}{RfSensed:0}{ackTimeout:0}{ackTxFp-
Set:0}{ackTxFpFail:0}{ackTxFpAd-
drFail:0}{RfState:Rx}{RAIL_state_active:0}{RAIL_state_rx:1}{RAIL_state_tx:0}{Channel:0}{AppMode:Non
e}{TimingLost:0}{TimingDetect:0}{FrameErrors:0}{RxFifoFull:0}{RxOverflow:0}{Ad-
drFilt:0}{Aborted:0}{RxBeams:0}{DataRequests:0}{Calibrations:1}{TxChannel-
Busy:0}{TxClear:0}{TxCca:0}{TxRetry:0}{UserTxStarted:1}{PaProtect:0}{SubPhy0:0}{SubPhy1:0}{Sub-
Phy2:0}{SubPhy3:0}{rxRawSourceBytes:0x000000000}}
    > setTxDelay 10
    {{(setTxDelay)}{txDelay:10}}
    > setTxLength 63
    {{(setTxLength)}{TxLength:63}{TxLength Written:63}}

    # CCA : enable CSMA-CA
    > setLbtMode csma
    {{(setLbtMode)}{LbtMode:CSMA}}
    > setLbtParams 0 0 1 -80 0 160 0
    {{(setLbtParams)}{MinBo:0}{MaxBo:0}{Tries:1}{Threshold:-80}{Backoff:0}{Dura-
tion:160}{Timeout:0}}

    # Tx FSK frame
    > rx 0
    {{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:82890344}}
    > configTxOptions 0
    {{(configTxOptions)}{waitForAck:False}{removeCrc:False}{syncWordId:0}{txAntenna:Any}{altPream-
bleLen:False}{ccaPeakRssi:False}{ccaOnly:False}{resend:False}{concurrentPhyId:0}}
    > rx 1
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:83181435}}
    > set802154Phr 1 0 1
    {{(set802154Phr)}{PhrSize:2}{PHR:0x8210}}
    {{(set802154Phr)}{len:63}{payload: 0x10 0x82 0x11 0x22 0x33 0x44 0x55 0x0f 0x77 0x88 0x99 0xaa
0xbb 0xcc 0xdd 0xee 0x10 0x11 0x12 0x13 0x14 0x15 0x16 0x17 0x18 0x19 0x1a 0x1b 0x1c 0x1d 0x1e 0x1f
0x20 0x21 0x22 0x23 0x24 0x25 0x26 0x27 0x28 0x29 0x2a 0x2b 0x2c 0x2d 0x2e 0x2f 0x30 0x31 0x32 0x33
0x34 0x35 0x36 0x37 0x38 0x39 0x3a 0x3b 0x3c 0x3d 0x3e}}
    > tx 1
    {{(tx)}{PacketTx:Enabled}{None:Disabled}{Time:83480564}}
    {{(appMode)}{None:Enabled}{PacketTx:Disabled}{Time:83507884}}
    {{(txEnd)}{txStatus:Complete}{transmitted:1}{lastTxTime:83507848}{timePos:6}{lastTx-
Start:83484458}{ccaSuccess:1}{failed:0}{lastTxStatus:0x000000000}{txRemain:0}{isAck:False}}
    > status
```

```
{{(status)}{UserTxCount:1}{AckTxCount:0}{UserTxAborted:0}{AckTxAborted:0}{Us-
erTxBlocked:0}{AckTxBlocked:0}{UserTxUnderflow:0}{AckTxUnderflow:0}{RxCount:0}{RxCrcErr-
Drop:0}{SyncDetect:0}{NoRxBuffer:0}{TxRemainErrs:0}{RfSensed:0}{ackTimeout:0}{ackTxFp-
Set:0}{ackTxFpFail:0}{ackTxFpAd-
drFail:0}{RfState:Rx}{RAIL_state_active:0}{RAIL_state_rx:1}{RAIL_state_tx:0}{Channel:0}{AppMode:Non
e}{TimingLost:0}{TimingDetect:0}{FrameErrors:0}{RxFifoFull:0}{RxOverflow:0}{Ad-
drFilt:0}{Aborted:0}{RxBeams:0}{DataRequests:0}{Calibrations:1}{TxChannel-
Busy:0}{TxClear:1}{TxCca:1}{TxRetry:0}{UserTxStarted:2}{PaProtect:0}{SubPhy0:0}{SubPhy1:0}{Sub-
Phy2:0}{SubPhy3:0}{rxRawSourceBytes:0x000000000}}

    # Tx OFDM frame using MCS4
    > rx 0
    {{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:83933827}}
    > configTxOptions 512
{{(configTxOptions)}{waitForAck:False}{removeCrc:False}{syncWordId:0}{txAntenna:Any}{altPream-
bleLen:False}{ccaPeakRssi:False}{ccaOnly:False}{resend:False}{concurrentPhyId:1}}
    > rx 1
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:84214833}}
    > set802154Phr 2 4 0
    {{(set802154Phr)}{PhrSize:4}{PHR:0x1b80400}}
    {{(set802154Phr)}{len:63}{payload: 0x00 0x04 0xb8 0x01 0x33 0x44 0x55 0x0f 0x77 0x88 0x99 0xaa
0xbb 0xcc 0xdd 0xee 0x10 0x11 0x12 0x13 0x14 0x15 0x16 0x17 0x18 0x19 0x1a 0x1b 0x1c 0x1d 0x1e 0x1f
0x20 0x21 0x22 0x23 0x24 0x25 0x26 0x27 0x28 0x29 0x2a 0x2b 0x2c 0x2d 0x2e 0x2f 0x30 0x31 0x32 0x33
0x34 0x35 0x36 0x37 0x38 0x39 0x3a 0x3b 0x3c 0x3d 0x3e}}
    > tx 1
    {{(tx)}{PacketTx:Enabled}{None:Disabled}{Time:84518189}}
    {{(appMode)}{None:Enabled}{PacketTx:Disabled}{Time:84523714}}
    {{(txEnd)}{txStatus:Complete}{transmitted:1}{lastTxTime:84523676}{timePos:6}{lastTx-
Start:84522105}{ccaSuccess:1}{failed:0}{lastTxStatus:0x000000000}{txRemain:0}{isAck:False}}
    > status
    {{(status)}{UserTxCount:2}{AckTxCount:0}{UserTxAborted:0}{AckTxAborted:0}{Us-
erTxBlocked:0}{AckTxBlocked:0}{UserTxUnderflow:0}{AckTxUnderflow:0}{RxCount:0}{RxCrcErr-
Drop:0}{SyncDetect:0}{NoRxBuffer:0}{TxRemainErrs:0}{RfSensed:0}{ackTimeout:0}{ackTxFp-
Set:0}{ackTxFpFail:0}{ackTxFpAd-
drFail:0}{RfState:Rx}{RAIL_state_active:0}{RAIL_state_rx:1}{RAIL_state_tx:0}{Channel:0}{AppMode:Non
e}{TimingLost:0}{TimingDetect:0}{FrameErrors:0}{RxFifoFull:0}{RxOverflow:0}{Ad-
drFilt:0}{Aborted:0}{RxBeams:0}{DataRequests:0}{Calibrations:1}{TxChannel-
Busy:0}{TxClear:2}{TxCca:2}{TxRetry:0}{UserTxStarted:4}{PaProtect:0}{SubPhy0:0}{SubPhy1:0}{Sub-
Phy2:0}{SubPhy3:0}{rxRawSourceBytes:0x000000000}}
```

The following example displays the reception of previous Tx FSK and OFDM modulated packets with the EFR32FG25 radio using the RAILtest application on the concurrent PHY:

```
    > rx 0
    {{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:82699471}}
    > setconfigindex 0
    {{(setconfigindex)}{configIndex:0}{firstAvailableChannel:0}}
    > setchannel 0
    {{(setchannel)}{channel:0}}
    > rx 1
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:83088638}}

    # FSK and OFDM PA configuration + Calibration
    > rx 0
    {{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:83346793}}
    > setpowerconfig RAIL_TX_POWER_MODE_SUBGIG_POWERSETTING_TABLE 3600 10
    {{(setpowerconfig)}{sucess:true}{mode:RAIL_TX_POWER_MODE_SUBGIG_POWERSETTING_TABLE}{modeIndex:0}
{voltage:3600} {rampTime:7}}
    > setpower 160
    {{(setpower)}{powerLevel:255}{power:160}}
    > setchannel 0
    {{(setchannel)}{channel:0}}
    > rx 1
    {{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:83892640}}
```

```
> rx 0
{{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:84020488}}
> setchannel 0
{{(setchannel)}{channel:0}}
> rx 1
{{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:84278019}}
> rx 0
{{(rx)}{Rx:Disabled}{Idle:Enabled}{Time:84408265}}
> setpowerconfig RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE 3600 10
{{(setpowerconfig)}{success:true}{mode:RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE}   {modeIn-
dex:2}{voltage:3600}{rampTime:7}}
> setpower 160
{{(setpower)}{powerLevel:255}{power:160}}
> setchannel 0
{{(setchannel)}{channel:0}}
> rx 1
{{(rx)}{Rx:Enabled}{Idle:Disabled}{Time:84929530}}


> status
{{(status)}{UserTxCount:0}{AckTxCount:0}{UserTxAborted:0}{AckTxAborted:0}{Us-
erTxBlocked:0}{AckTxBlocked:0}{UserTxUnderflow:0}{AckTxUnderflow:0}{RxCount:0}{RxCrcErr-
Drop:0}{SyncDetect:0}{NoRxBuffer:0}{TxRemainErrs:0}{RfSensed:0}{ackTimeout:0}{ackTxFp-
Set:0}{ackTxFpFail:0}{ackTxFpAd-
drFail:0}{RfState:Rx}{RAIL_state_active:0}{RAIL_state_rx:1}{RAIL_state_tx:0}{Channel:0}{AppMode:Non
e}{TimingLost:0}{TimingDetect:0}{FrameErrors:0}{RxFifoFull:0}{RxOverflow:0}{Ad-
drFilt:0}{Aborted:0}{RxBeams:0}{DataRequests:0}{Calibrations:1}{TxChannel-
Busy:0}{TxClear:0}{TxCca:0}{TxRetry:0}{UserTxStarted:1}{PaProtect:0}{SubPhy0:0}{SubPhy1:0}{Sub-
Phy2:0}{SubPhy3:0}{rxRawSourceBytes:0x000000000}}


# Rx event of one FSK frame (with incorrect RSSI level see known issues)
{{(rxPacket)}{len:63}{timeUs:110705035}{timePos:5}{crc:Pass}{filterMask:0x0}{rssi:-
86}{lqi:255}{phy:0}{isAck:False}{syncWordId:0}{antenna:0}{channelHopIdx:254}{channel:0}{payload:
0x10 0x82 0x11 0x22 0x33 0x44 0x55 0x0f 0x77 0x88 0x99 0xaa 0xbb 0xcc 0xdd 0xee 0x10 0x11 0x12 0x13
0x14 0x15 0x16 0x17 0x18 0x19 0x1a 0x1b 0x1c 0x1d 0x1e 0x1f 0x20 0x21 0x22 0x23 0x24 0x25 0x26 0x27
0x28 0x29 0x2a 0x2b 0x2c 0x2d 0x2e 0x2f 0x30 0x31 0x32 0x33 0x34 0x35 0x36 0x37 0x38 0x39 0x3a 0x3b
0x3c 0x3d 0x3e}}
# Rx event of one OFDM frame
{{(rxPacket)}{len:59}{timeUs:111720745}{timePos:5}{crc:Pass}{filterMask:0x0}{rssi:-
47}{lqi:235}{phy:4}{isAck:False}{syncWordId:0}{antenna:0}{channelHopIdx:254}{channel:0}{payload:
0x03 0x04 0xb8 0x01 0x33 0x44 0x55 0x0f 0x77 0x88 0x99 0xaa 0xbb 0xcc 0xdd 0xee 0x10 0x11 0x12 0x13
0x14 0x15 0x16 0x17 0x18 0x19 0x1a 0x1b 0x1c 0x1d 0x1e 0x1f 0x20 0x21 0x22 0x23 0x24 0x25 0x26 0x27
0x28 0x29 0x2a 0x2b 0x2c 0x2d 0x2e 0x2f 0x30 0x31 0x32 0x33 0x34 0x35 0x36 0x37 0x38 0x39 0x3a }}
> status
{{(status)}{UserTxCount:0}{AckTxCount:0}{UserTxAborted:0}{AckTxAborted:0}{Us-
erTxBlocked:0}{AckTxBlocked:0}{UserTxUnderflow:0}{AckTxUnderflow:0}{RxCount:2}{RxCrcErr-
Drop:0}{SyncDetect:2}{NoRxBuffer:0}{TxRemainErrs:0}{RfSensed:0}{ackTimeout:0}{ackTxFp-
Set:0}{ackTxFpFail:0}{ackTxFpAd-
drFail:0}{RfState:Rx}{RAIL_state_active:0}{RAIL_state_rx:1}{RAIL_state_tx:0}{Channel:0}{AppMode:Non
e}{TimingLost:0}{TimingDetect:0}{FrameErrors:0}{RxFifoFull:0}{RxOverflow:0}{Ad-
drFilt:0}{Aborted:0}{RxBeams:0}{DataRequests:0}{Calibrations:1}{TxChannel-
Busy:0}{TxClear:0}{TxCca:0}{TxRetry:0}{UserTxStarted:1}{PaProtect:0}{SubPhy0:1}{SubPhy1:0}{Sub-
Phy2:0}{SubPhy3:0}{rxRawSourceBytes:0x000000000}}
```

3.4 Diagnostic Signals

With concurrent PHY, both stream mode (PN9) and CW signal generation are supported. The selection between FSK or OFDM Tx path is done using `configTxOptions` with value 0 for FSK and 512 for OFDM.

As an example, the following CLI commands configure and enable the PN9 stream transmission mode on the radio using the Base FSK PHY using `configindex 0`.

```
> setconfigindex 0
> rx 0
> setpowerconfig RAIL_TX_POWER_MODE_SUBGIG_PA_POWERSETTING_TABLE 3600 10
> setpower 140
> rx 1
> configTxOptions 0
> set802154Phr 1 0 1
> setTxStream 1
```

Note with the FSK, the `setTxStream` is not running correctly so it is recommended to use the FSK PHY without the concurrent mode using OFDM (see the known issues in section 4).

For OFDM path, PN9 stream mode also requires setting up PHR (with the `set802154PHR` command) to select MCS Level. Before this it is also mandatory to configure the frame length field to 4 before the transmission, to set up the infinite stream needed for PN9.

As an example, the following CLI commands configure and enable the PN9 stream transmission mode on the radio in OFDM option 1 MCS4 at `configindex 1`.

```
> setconfigindex 1
> rx 0
> setpowerconfig RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE 3600 10
> setpower 140
> rx 1
> configTxOptions 512
> setTxLength 4
> set802154Phr 2 4 0
> setTxStream 1
```

Example:

```
> setconfigindex 1
  {{(setconfigindex)}{configIndex:1}{firstAvailableChannel:0}}
> setpowerconfig RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE 3600 10
  {{(setpowerconfig)}{success:true}{mode:RAIL_TX_POWER_MODE_OFDM_PA_POWERSETTING_TABLE }{modeIn-
dex:2}{voltage:3600}{rampTime:7}}
> setpower 140
  {{(setpower)}{powerLevel:255}{power:140}}
> configTxOptions 512
  {{(configTxOptions)}{waitForAck:False}{removeCrc:False}{syncWordId:0}{txAntenna:Any}
  {altPreambleLen:False}{ccaPeakRssi:False}{ccaOnly:False}{resend:False}{concurrentPhyId:1}}
> setTxLength 4
  {{(setTxLength)}{TxLength:4}{TxLength Written:4}}
> set802154Phr 2 4 0
  {{(set802154Phr)}{PhrSize:4}{PHR:0x400}}
  {{(set802154Phr)}{len:4}{payload: 0x00 0x04 0x00 0x00}}
> setTxStream 1
  {{(setTxStream)}{Stream:Enabled}{None:Disabled}{StreamMode:PN9}{Time:1737513509}}
```

To send a tone at the carrier frequency, the following CLI command can be used:

```
> setTxTone 1
```

Examples:

```
# To Start the tone
> setTxTone 1
  {{(setTxTone)}{Stream:Enabled}{None:Disabled}{StreamMode:Tone}{Time:1293513244}}
# To Stop the tone
> setTxTone 0
  {{(setTxTone)}{None:Enabled}{Stream:Disabled}{Time:1298384979}}
```

It is equivalent to:

```
> setTxStream 1 0
```

4 Known Issues

In this section, only the known issues related to concurrent mode are listed. Other known issues can be found in Getting Started with Wi-SUN PHY and for Wi-SUN Mode Switch in *AN1403: Wi-SUN Mode Switch on EFR32FG25 with RAILtest*.

4.1 Known Issues

- Diagnostic signals for concurrent PHY selecting FSK are not running correctly. So, it is recommended to use the FSK PHY in place of the concurrent PHY.
- The RSSI provided with FSK Rx frame could be with an offset in comparison with the RSSI provided with OFDM Rx frame.

5 Revision History

Revision 0.3

July, 2023

- Add the concurrent mode configuration in the Simplicity Studio Radio Configurator.
- Update the known issue list.

Revision 0.2

March, 2023

- Update the Wi-SUN PHY reference for Wi-SUN PHY Technical Profile Specification 2V00
- Add a known issue in FSK 2b ECHONET Profile with OFDM option 3

Revision 0.1

February, 2023

- Initial release