# AN1382: RF Performance with Bluetooth Low Energy Simultaneous Scanning

In specific Bluetooth Low Energy applications, it might be required to scan advertisements on multiple PHYs at the same time. This application note will describe how simultaneous scanning is realized between 1M and coded (500k/125k) PHYs on the supported EFR32 Series 2 devices. References to the related APIs are going to be provided. Receiver RF performance with simultaneous scanning enabled is also going to be presented.

**KEY POINTS**

- Gives an overview of simultaneous scanning
- Provides links to related APIs
- Presents receiver RF performance with simultaneous scanning enabled

  

# 1. Device Compatibility

This application note applies to 2.4 GHz Bluetooth Low Energy (BLE) standards for the following devices:

- EFR32 Gecko Series 2:
  - EFR32BG22, EFR32MG22
  - EFR32BG24, EFR32MG24

## 2. Introduction

The introduction of Bluetooth SDK v3.1 allowed scanning for advertisements on both 1M and coded PHY with time slicing:

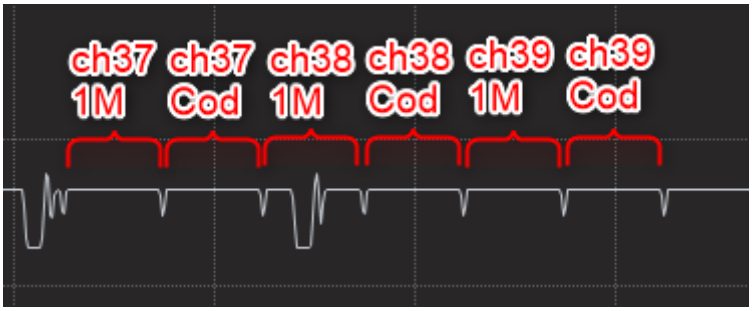


**Figure 2.1. Scanning Advertisements with Time Slicing**

However, this solution has the possibility of lost 1M advertisements while scanning on coded PHY or lost coded PHY advertisements while scanning on 1M PHY. The introduction of Bluetooth SDK v3.2 improved this feature by allowing simultaneous scanning on 1M and coded PHY in each time slice. In this case, the radio listens for both the 1M preamble + sync word AND for the coded PHY preamble + sync word **at the same time.**

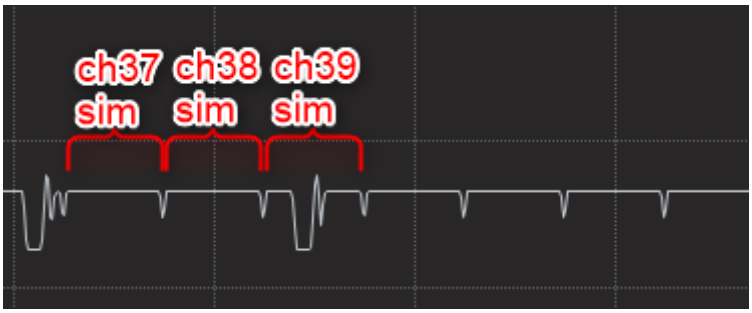


**Figure 2.2. Simultaneous Advertisement Scanning**

**Note:** Whenever an advertisement packet is received on either PHY, the data is passed to upper layers (along with the PHY information), and then scanning immediately continues on both PHYs, regardless if it is a connectable or non-connectable advertisement. The scanning procedure stops only when it is explicitly requested by the application, and connection is initiated only when it is explicitly requested by the application.

Time slicing is supported on all Bluetooth-capable EFR32 devices, while simultaneous scanning is available on devices listed in Section 1.

**Note:** The RF performance with time slicing enabled matches the RF performance shown in the device data sheets. The RF performance with simultaneous scanning enabled is presented in Section 4 and Section 5 of this document for the supported devices.

## 3. Related APIs

Starting with version 3.1, Silicon Labs' Bluetooth SDK supports listening for advertisements on both 1M PHY and Coded (125k/500k) PHY in the same scanning procedure. This can be achieved either by time slicing (continuous switching between the PHYs) or by simultaneous scanning (listening to both PHYs at the same time).

Regardless of time slicing or simultaneous scanning, scanning must start with the same API command: sl_bt_scanner_start(scanning_phy, discover_mode), where the scanning_phy parameter should be set to 0x05 (scanning on 1M and Coded PHY). See the API reference for further information.

In the case of Bluetooth SDK v3.1 (and no later) or if the selected device is not listed in Section 1, scanning on 1M and Coded PHY is always achieved with time slicing.

In the case of Bluetooth SDK v3.2 or later, and if the selected device is listed in Section 1, there is an option to choose between time slicing and simultaneous scanning. Switching between these two modes is possible using the link layer configuration API: sl_bt_system_linklayer_configure(key, data_len, data).

The key must be set to sl_bt_system_linklayer_config_key_set_simultaneous_scanning (0x0b), the data_len must be set to 1, and the data must be set to either 0 (disable simultaneous scanning, use time slicing instead) or 1 (enable simultaneous scanning). The setting will be applied on subsequent scannings, i.e., on scanning procedures started after the link layer configuration.

# 4. RF Performance with EFR32xG22 Devices

## 4.1 EFR32xG22 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 1 Mbps Data Rate

Unless otherwise indicated, typical conditions are: $T_A$ = 25 °C, VREGVDD = 3.0V, AVDD = DVDD = IOVDD = RFVDD = PAVDD = 1.8 V powered from DCDC. Crystal frequency=38.4 MHz. RF center frequency 2.45 GHz, Packet length is 255 bytes.

**Table 4.1. EFR32xG22 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 1 Mbps Data Rate**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Max usable receiver input level | SAT | Signal is reference signal, packet length is 255 bytes[1] | — | 10 | — | dBm |
| Sensitivity | SENS | Signal is reference signal, 37 byte payload[2] | — | -99.0 | — | dBm |
| | | Signal is reference signal, 255 byte payload[1] | — | -97.5 | — | dBm |
| | | With non-ideal signals, 255 byte payload[3] [1] | — | -97.2 | — | dBm |
| Signal to co-channel interferer | $C/I_{CC}$ | (see notes), 255 byte payload[1] [4] | — | 8.1 | — | dB |
| N ± 1 Adjacent channel selectivity | $C/I_1$ | Interferer is reference signal at +1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -5.2 | — | dB |
| | | Interferer is reference signal at -1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -5.0 | — | dB |
| N ± 2 Alternate channel selectivity | $C/I_2$ | Interferer is reference signal at +2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -40.8 | — | dB |
| | | Interferer is reference signal at -2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -39.6 | — | dB |
| N ± 3 Alternate channel selectivity | $C/I_3$ | Interferer is reference signal at +3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -44.5 | — | dB |
| | | Interferer is reference signal at -3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -46.2 | — | dB |
| Selectivity to image frequency | $C/I_{IM}$ | Interferer is reference signal at image frequency with 1 MHz precision, 255 byte payload[1] [6] | — | -44.5 | — | dB |
| Selectivity to image frequency ± 1 MHz | $C/I_{IM\_1}$ | Interferer is reference signal at image frequency +1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -44.5 | — | dB |
| | | Interferer is reference signal at image frequency -1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -40.8 | — | dB |

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Intermodulation performance | IM | n = 3, 255 byte payload[7] | — | -19.4 | — | dBm |

**Note:**

1. 0.017% Bit Error Rate
2. 0.1% Bit Error Rate
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 Section 4.7.1
4. Desired signal -67 dBm
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz
6. With allowed exceptions
7. As specified in Bluetooth Core specification Version 5.1, Vol 6, Part A, Section 4.4

### 4.2 EFR32xG22 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 500 kbps Data Rate

Unless otherwise indicated, typical conditions are: $T_A$ = 25 °C, VREGVDD = 3.0V, AVDD = DVDD = IOVDD = RFVDD = PAVDD = 1.8 V powered from DCDC. Crystal frequency=38.4 MHz. RF center frequency 2.45 GHz, Packet length is 255 bytes.

**Table 4.2. EFR32xG22 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 500 kbps Data Rate**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Max usable receiver input level | SAT | Signal is reference signal, packet length is 255 bytes[1] | — | 10 | — | dBm |
| Sensitivity | SENS | Signal is reference signal, 37 byte payload[2] | — | -102.4 | — | dBm |
| | | Signal is reference signal, 255 byte payload[1] | — | -101.1 | — | dBm |
| | | With non-ideal signals, 255 byte payload[3] [1] | — | -100.4 | — | dBm |
| Signal to co-channel interferer | $C/I_{CC}$ | (see notes), 255 byte payload[1] [4] | — | 2.6 | — | dB |
| N ± 1 Adjacent channel selectivity | $C/I_1$ | Interferer is reference signal at +1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -8.0 | — | dB |
| | | Interferer is reference signal at -1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -8.0 | — | dB |
| N ± 2 Alternate channel selectivity | $C/I_2$ | Interferer is reference signal at +2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -46.3 | — | dB |
| | | Interferer is reference signal at -2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -50.0 | — | dB |
| N ± 3 Alternate channel selectivity | $C/I_3$ | Interferer is reference signal at +3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -49.0 | — | dB |
| | | Interferer is reference signal at -3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -53.5 | — | dB |
| Selectivity to image frequency | $C/I_{IM}$ | Interferer is reference signal at image frequency with 1 MHz precision, 255 byte payload[1] [6] | — | -49.0 | — | dB |
| Selectivity to image frequency ± 1 MHz | $C/I_{IM\_1}$ | Interferer is reference signal at image frequency +1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -49.0 | — | dB |
| | | Interferer is reference signal at image frequency -1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -46.3 | — | dB |

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|

**Note:**

1. 0.017% Bit Error Rate
2. 0.1% Bit Error Rate
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 Section 4.7.1
4. Desired signal -67 dBm
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz
6. With allowed exceptions

### 4.3 EFR32xG22 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 125 kbps Data Rate

Unless otherwise indicated, typical conditions are: $T_A$ = 25 °C, VREGVDD = 3.0V, AVDD = DVDD = IOVDD = RFVDD = PAVDD = 1.8 V powered from DCDC. Crystal frequency=38.4 MHz. RF center frequency 2.45 GHz, Packet length is 255 bytes.

**Table 4.3. EFR32xG22 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 125 kbps Data Rate**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Max usable receiver input level | SAT | Signal is reference signal, packet length is 255 bytes[1] | — | 10 | — | dBm |
| Sensitivity | SENS | Signal is reference signal, 37 byte payload[2] | — | -106.4 | — | dBm |
| | | Signal is reference signal, 255 byte payload[1] | — | -106.1 | — | dBm |
| | | With non-ideal signals, 255 byte payload[3] [1] | — | -105.3 | — | dBm |
| Signal to co-channel interferer | $C/I_{CC}$ | (see notes), 255 byte payload[1] [4] | — | 0.8 | — | dB |
| N ± 1 Adjacent channel selectivity | $C/I_1$ | Interferer is reference signal at +1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -13.4 | — | dB |
| | | Interferer is reference signal at -1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -13.2 | — | dB |
| N ± 2 Alternate channel selectivity | $C/I_2$ | Interferer is reference signal at +2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -52.3 | — | dB |
| | | Interferer is reference signal at -2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -55.5 | — | dB |
| N ± 3 Alternate channel selectivity | $C/I_3$ | Interferer is reference signal at +3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -54.0 | — | dB |
| | | Interferer is reference signal at -3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -59.0 | — | dB |
| Selectivity to image frequency | $C/I_{IM}$ | Interferer is reference signal at image frequency with 1 MHz precision, 255 byte payload[1] [6] | — | -54.0 | — | dB |
| Selectivity to image frequency ± 1 MHz | $C/I_{IM\_1}$ | Interferer is reference signal at image frequency +1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -54.0 | — | dB |
| | | Interferer is reference signal at image frequency -1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -52.3 | — | dB |

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|

**Note:**

1. 0.017% Bit Error Rate
2. 0.1% Bit Error Rate
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 Section 4.7.1
4. Desired signal -67 dBm
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz
6. With allowed exceptions

# 5. RF Performance with EFR32xG24 Devices

## 5.1 EFR32xG24 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 1 Mbps Data Rate

Unless otherwise indicated, typical conditions are: $T_A$ = 25 °C, VREGVDD = IOVDD = AVDD = PAVDD = 3.0V, RFVDD = DVDD = 1.8 V powered from DCDC. Crystal frequency=39.0 MHz. RF center frequency 2.45 GHz, Packet length is 255 bytes.

**Table 5.1. EFR32xG24 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 1 Mbps Data Rate**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Max usable receiver input level | SAT | Signal is reference signal, packet length is 255 bytes[1] | — | 10 | — | dBm |
| Sensitivity | SENS | Signal is reference signal, 37 byte payload[2] | — | -97.8 | — | dBm |
| | | Signal is reference signal, 255 byte payload[1] | — | -96.4 | — | dBm |
| | | With non-ideal signals, 255 byte payload[3] [1] | — | -96.1 | — | dBm |
| Signal to co-channel interferer | $C/I_{CC}$ | (see notes), 255 byte payload[1] [4] | — | 8.1 | — | dB |
| N ± 1 Adjacent channel selectivity | $C/I_1$ | Interferer is reference signal at +1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -4.1 | — | dB |
| | | Interferer is reference signal at -1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -4.0 | — | dB |
| N ± 2 Alternate channel selectivity | $C/I_2$ | Interferer is reference signal at +2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -40.9 | — | dB |
| | | Interferer is reference signal at -2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -39.3 | — | dB |
| N ± 3 Alternate channel selectivity | $C/I_3$ | Interferer is reference signal at +3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -43.9 | — | dB |
| | | Interferer is reference signal at -3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -45.3 | — | dB |
| Selectivity to image frequency | $C/I_{IM}$ | Interferer is reference signal at image frequency with 1 MHz precision, 255 byte payload[1] [6] | — | -45.1 | — | dB |
| Selectivity to image frequency ± 1 MHz | $C/I_{IM\_1}$ | Interferer is reference signal at image frequency +1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -43.2 | — | dB |
| | | Interferer is reference signal at image frequency -1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -45.1 | — | dB |

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Intermodulation performance | IM | n = 3, 255 byte payload[7] | — | -19.1 | — | dBm |

**Note:**

1. 0.017% Bit Error Rate
2. 0.1% Bit Error Rate
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 Section 4.7.1
4. Desired signal -67 dBm
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz
6. With allowed exceptions
7. As specified in Bluetooth Core specification Version 5.1, Vol 6, Part A, Section 4.4

### 5.2 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 500 kbps Data Rate

Unless otherwise indicated, typical conditions are: $T_A$ = 25 °C, VREGVDD = IOVDD = AVDD = PAVDD = 3.0V, RFVDD = DVDD = 1.8 V powered from DCDC. Crystal frequency=39.0 MHz. RF center frequency 2.45 GHz, Packet length is 255 bytes.

**Table 5.2. RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 500 kbps Data Rate**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Max usable receiver input level | SAT | Signal is reference signal, packet length is 255 bytes[1] | — | 10 | — | dBm |
| Sensitivity | SENS | Signal is reference signal, 37 byte payload[2] | — | -101.4 | — | dBm |
| | | Signal is reference signal, 255 byte payload[1] | — | -100 | — | dBm |
| | | With non-ideal signals, 255 byte payload[3] [1] | — | -99.1 | — | dBm |
| Signal to co-channel interferer | $C/I_{CC}$ | (see notes), 255 byte payload[1] [4] | — | 2.7 | — | dB |
| N ± 1 Adjacent channel selectivity | $C/I_1$ | Interferer is reference signal at +1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -7.0 | — | dB |
| | | Interferer is reference signal at -1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -7.4 | — | dB |
| N ± 2 Alternate channel selectivity | $C/I_2$ | Interferer is reference signal at +2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -46.4 | — | dB |
| | | Interferer is reference signal at -2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -49.8 | — | dB |
| N ± 3 Alternate channel selectivity | $C/I_3$ | Interferer is reference signal at +3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -48.5 | — | dB |
| | | Interferer is reference signal at -3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -54.5 | — | dB |
| Selectivity to image frequency | $C/I_{IM}$ | Interferer is reference signal at image frequency with 1 MHz precision, 255 byte payload[1] [6] | — | -53.9 | — | dB |
| Selectivity to image frequency ± 1 MHz | $C/I_{IM\_1}$ | Interferer is reference signal at image frequency +1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -48.2 | — | dB |
| | | Interferer is reference signal at image frequency -1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -53.9 | — | dB |

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|

**Note:**

1. 0.017% Bit Error Rate
2. 0.1% Bit Error Rate
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 Section 4.7.1
4. Desired signal -67 dBm
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz
6. With allowed exceptions

### 5.3 RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 125 kbps Data Rate

Unless otherwise indicated, typical conditions are: $T_A$ = 25 °C, VREGVDD = IOVDD = AVDD = PAVDD = 3.0V, RFVDD = DVDD = 1.8 V powered from DCDC. Crystal frequency=39.0 MHz. RF center frequency 2.45 GHz, Packet length is 255 bytes.

**Table 5.3. RF Receiver Characteristics for Simultaneous Bluetooth Low Energy in the 2.4 GHz Band and Low Energy Coded Modulation Scan, 125 kbps Data Rate**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Max usable receiver input level | SAT | Signal is reference signal, packet length is 255 bytes[1] | — | 10 | — | dBm |
| Sensitivity | SENS | Signal is reference signal, 37 byte payload[2] | — | -105.7 | — | dBm |
| | | Signal is reference signal, 255 byte payload[1] | — | -105.4 | — | dBm |
| | | With non-ideal signals, 255 byte payload[3] [1] | — | -104.9 | — | dBm |
| Signal to co-channel interferer | $C/I_{CC}$ | (see notes), 255 byte payload[1] [4] | — | 0.8 | — | dB |
| N ± 1 Adjacent channel selectivity | $C/I_1$ | Interferer is reference signal at +1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -12.6 | — | dB |
| | | Interferer is reference signal at -1 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -13.0 | — | dB |
| N ± 2 Alternate channel selectivity | $C/I_2$ | Interferer is reference signal at +2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -52.8 | — | dB |
| | | Interferer is reference signal at -2 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -56.0 | — | dB |
| N ± 3 Alternate channel selectivity | $C/I_3$ | Interferer is reference signal at +3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -53.4 | — | dB |
| | | Interferer is reference signal at -3 MHz offset, 255 byte payload[1] [5] [4] [6] | — | -60.5 | — | dB |
| Selectivity to image frequency | $C/I_{IM}$ | Interferer is reference signal at image frequency with 1 MHz precision, 255 byte payload[1] [6] | — | -59.9 | — | dB |
| Selectivity to image frequency ± 1 MHz | $C/I_{IM\_1}$ | Interferer is reference signal at image frequency +1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -52.5 | — | dB |
| | | Interferer is reference signal at image frequency -1 MHz with 1 MHz precision, 255 byte payload[1] [6] | — | -59.9 | — | dB |

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|

**Note:**

1. 0.017% Bit Error Rate
2. 0.1% Bit Error Rate
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 Section 4.7.1
4. Desired signal -67 dBm
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz
6. With allowed exceptions

# 6. Revision History

**Rev 0.1**

April, 2022

Initial Release.