AN14889

FRDM-MCXW72 Radio Frequency System Evaluation Report for Bluetooth Low Energy and for IEEE 802.15.4

Rev. 1.0 — 5 February 2026 Application note

Document information

Information	Content
Keywords	AN14889, FRDM-MCXW72 board, Radio Frequency (RF) evaluation, test setup, test description, test results
Abstract	This document provides the RF evaluation test results of the FRDM-MCXW72 board for Bluetooth Low Energy (Bluetooth LE) 2FSK modulation and IEEE 802.15.4 OQPSK modulation applications. It also includes the test setup and description.

1 Introduction

This document provides the radio frequency (RF) evaluation test results of the FRDM-MCXW72 board for Bluetooth Low Energy (2FSK modulation) and IEEE 802.15.4 (OQPSK modulation) applications. It includes the test setup description and the tools used to perform the tests on your own. For more information about the Bluetooth LE and IEEE 802.15.4 radio parameters, see the *FRDM-MCXW72 Data Sheets*.

For more information about the FRDM-MCXW72 board, refer to the Board User Manual (document UM12222). The schematic and design files are available on the below URL on NXP webpage:

FRDM-MCXW72 Design Resources.

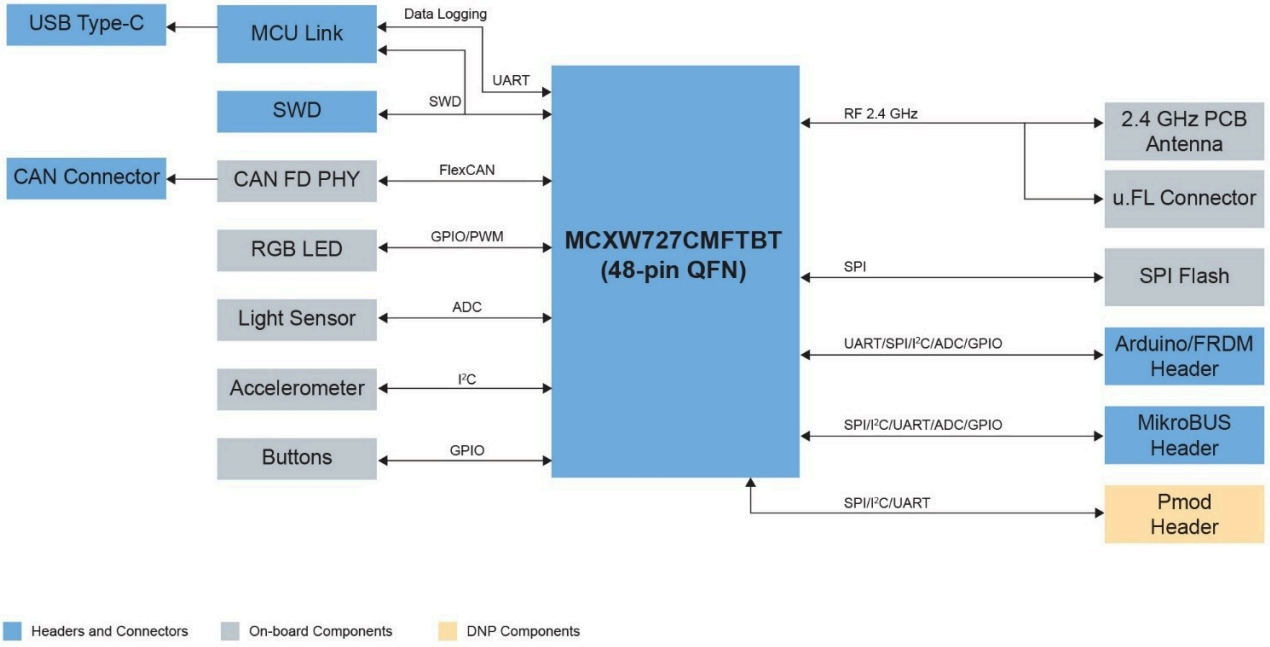

Figure 1. Block diagram of the FRDM-MCXW72 board

Figure 2 shows the FRDM-MCXW72 board.

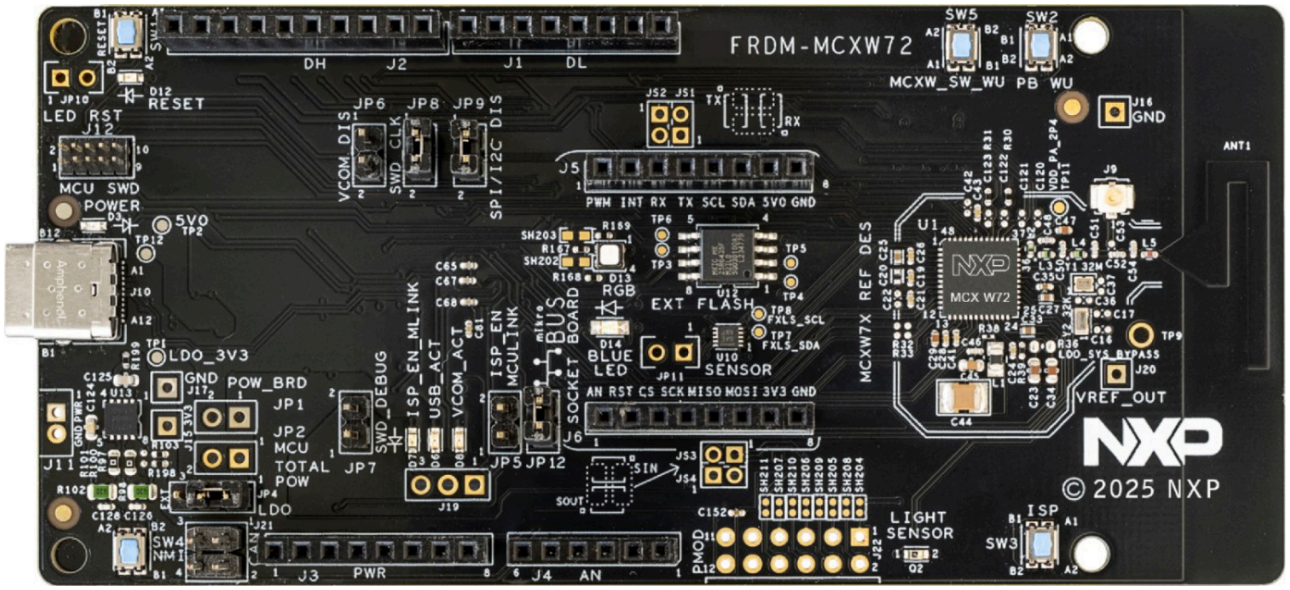

Figure 2. FRDM-MCXW72 board

1.1 Software and list of equipment

Before you measure the test performances, you must load a binary code (connectivity software) into the flash memory of the board.

The FRDM-MCXW72 webpage describes how to use the FRDM-MCXW72 board to load the code for the Bluetooth Low Energy or IEEE 802.15.4. The binary code that is used for the following tests are:

- The Connectivity Software package supports both the Bluetooth LE and the IEEE 802.15.4 protocols. Refer to the below documentation for details of the setting: Connectivity Test Tool User Guide.
- The `HCI_blackbox` demo example must be used for Bluetooth LE tests only.

A serial terminal emulator is used to communicate with the MCX W72 MCU.

1.1.1 List of equipment used for Bluetooth Low Energy (Bluetooth LE) tests

The below equipment is used for performing receiver (RX) and transmitter (TX) measurements for Bluetooth LE tests:

1. Spectrum analyzer - 25 GHz for harmonic measurements up to H10
2. Rhode & Schwarz SFU - used as an interference source
3. Rhode & Schwarz SMBV100B
4. Rhode & Schwarz CMW270 (`HCI_bb` software)
5. Agilent 33250A
6. Rhode & Schwarz ZND vector network analyzer (for S11 measurements)
7. RF shielded box *(to avoid interferers)*
8. Power supply
9. PC equipped with a general-purpose interface bus (GPIB) card

Note: *All Bluetooth RF test measurements were performed using the FRDM-MCXW72 board LI25362095.*

1.1.2 List of equipment used for IEEE 802.15.4 tests

The below equipment is used for performing receiver (RX) and transmitter (TX) measurements for IEEE 802.15.4 tests:

1. Rhode & Schwarz FSV – spectrum analyzer with IEEE 802.15.4 PHY EVM test option
2. Keysight N5182B
3. Keysight E8267D – *used as an interferer source for IEEE 802.15.4*
4. Spectrum analyzer – *25 GHz for harmonic measurements up to H10*
5. Rhode & Schwarz ZND Vector Network analyzer – *for S11 measurements*
6. Shielded room

Note: *All IEEE 802.15.4 RF test measurements were performed using the FRDM-MCXW72 board LI24180019.*

2 Bluetooth LE application

This section provides the list of tests for TX and RX measurements for Bluetooth LE.

2.1 List of tests

Following is the list of tests conducted for Bluetooth LE:

- TX tests include:
  - Frequency accuracy
  - Phase noise
  - Transmitter power: Bluetooth LE 1 Mbit/s, 2 Mbit/s, 500 kbit/s (LR S=2), 125 kbit/s (LR S=8)
  - Transmitter power In Band
  - Transmitter spurious: H2 to H10, ETSI, and FCC
  - Lower Band edge (MIIT-China)
  - Upper band edge
    - Upper Band Edge – MIIT China
    - Upper Band Edge (FCC ANSI C63.10, 58074 D01 DTS)
  - Out Of Band
    - Out Of Band (ETSI 300 328 chapter 5.4.8.2.1)
    - Out Of Band (ARIB STD T-66)
  - Maximum Transmitter output power: 1 Mbit/s, 2 Mbit/s, 500 kbit/s (LR S=2), and 125 kbit/s (LR S=8)
  - Bluetooth LE Transmitter output spectrum: 1 Mbit/s and 2 Mbit/s
  - Modulation characteristics: 1 Mbit/s, 2 Mbit/s, 125 kbit/s LR (S=8)
  - Carrier frequency offset and drift: 1 Mbit/s, 2 Mbit/s, 125 kbit/s LR (S=8)
- Receiver (RX) tests include:
  - Sensitivity: 1 Mbit/s, 2 Mbit/s, LR (S=2 and S=8)
  - Bathtub: 1 Mbit/s, 2 Mbit/s, LR (S=2 and S=8)
  - Receiver maximum input level: 1 Mbit/s, 2 Mbit/s, LR (S=2 and S=8)
  - Receiver spurious: from 30 MHz to 12.5 GHz)
  - Receiver interference rejection performances include:
    - Adjacent, alternate, and co-channel rejection:
      - 1 Mbit/s, 2 Mbit/s, 500 kbit/s (LR S=2), 125 kbit/s (LR S=8)
    - Receiver blocking: 1 Mbit/s – category 1 and category 2
    - Blocking interferers
  - Intermodulation

2.2 Summary of transmission and reception tests

RF PHY Bluetooth Test Specification: ***RFPHY.TS.p23ed2 (2025-06-25)***

To view the list of measurements for transmission and reception tests provided to Europe and the United States (US), use the following links:

- Transmission tests for Europe
- Reception tests for Europe
- Miscellaneous tests for US
- Transmission tests for US

Table 1 shows the transmission tests for Europe.

Table 1. Transmission tests for Europe

Transmission	Reference	Limits	Status
TX Maximum Output Power	Bluetooth LE 6.0, BV-01-C	-20 dBm ≤ PAVG ≤ +10 dBm EIRP	Pass
TX Power In band (1 Mbit/s)	Bluetooth LE 6.0, BV-03-C	PTX <= -20 dBm for (fTX +/- 2 MHz)	Pass
		PTX <= -30 dBm for (fTX +/- [3+n] MHz)	
TX Power In band (2 Mbit/s)	Bluetooth LE 6.0, BV-08-C	P_{TX} <= -20 dBm for (f_{TX} +/- 4 MHz) and (fTX +/- 5 MHz)	Pass
		P_{TX} <= -30 dBm for (f_{TX} +/- [3+n] MHz)	
Modulation characteristics 1 Mbit/s, LE coded (S=8)	Bluetooth LE 6.0, BV-05-C	225 kHz <= delta f1avg <= 275 kHz	Pass
	Bluetooth LE 6.0, BV-13-C		
Modulation characteristics 2 Mbit/s	Bluetooth LE 6.0, BV-10-C	450 kHz <= delta f1avg <= 550 kHz	Pass
Carrier frequency offset and drift	Bluetooth LE 6.0, BV-06-C	f_{TX} – 150 kHz <= f_n <= f_{TX} + 150 kHz where f_{TX} is the nominal transmit frequency and n=0,1,2,3…k	Pass
1 Mbit/s		|f0 – fn| <= 50 kHz where n=2,3,4…k	
2 Mbit/s	Bluetooth LE 6.0, BV-12-C	• |f0 – f3| <= 19.2 kHz • |f0 – f(n-3)| <= 19.2 kHz where n=7,8,9,…k	
Carrier frequency offset and drift LE coded (S=8)	Bluetooth LE 6.0, BV-14-C	• fTX – 150 kHz <= fn <= fTX + 150 kHz where fTX is the nominal transmit frequency and n=0,1,2,3…k • |f0 – fn| <= 50 kHz, where n=2,3,4…k	Pass
Spurious 30 MHz – 1 GHz	ETSI EN 300 328 v2.2.2 (2019-07)	-36 dBm or -54 dBm (depends on frequency) (100 kHz BW)	Pass
Spurious 1 GHz – 12.75 GHz	ETSI EN 300 328	-30 dBm (1 MHz BW)	Pass
	v2.2.2 (2019-07)		
EIRP TX spectral density	ETSI EN 300 328	10 dBm/MHz	Pass
	v2.2.2 (2019-07)		
Phase noise (unspread)	NA	NA	For information

Table 2 shows the reception tests for Europe.

Table 2. Reception tests for Europe

Reception Tests	Reference	Limits	Result
RX Sensitivity - 1 Msps	Bluetooth LE 6.0, BV-01-C	Packet error rate (PER) 30.8 % with a minimum of 1500 packets	Pass
RX Sensitivity - 2 Msps	Bluetooth LE 6.0, BV-08-C	PER 30.8 % with a minimum of 1500 packets	Pass
RX Sensitivity - LE coded (S=2)	Bluetooth LE 6.0, BV-26-C	PER 30.8 % with a minimum of 1500 packets	Pass
RX Sensitivity - LE coded (S=8)	Bluetooth LE 6.0, BV-27-C	PER 30.8 % with a minimum of 1500 packets	Pass
Co-channel - 1 Msps	Bluetooth LE 6.0, BV-03-C	> 21 dB	Pass
Adjacent channel interference rejection (N+/-1, 2, 3+ MHz) 1 Msps	Bluetooth LE 6.0, BV-03-C	> 15 dB, -17 dB, -27 dB	Pass
Co-channel - 2 Msps	Bluetooth LE 6.0, BV-09-C	> 21 dB	Pass
Adjacent channel interference rejection (N+/-2, 4, 6+ MHz) - 2 Msps	Bluetooth LE 6.0, BV-09-C	> 15 dB, -17 dB, -27 dB	Pass
Co-channel - LE coded (S=2)	Bluetooth LE 6.0, BV-28-C	> 17 dB	Pass
Adjacent channel interference rejection (N+/-2, 4, 6+ MHz) LE coded (S=2)	Bluetooth LE 6.0, BV-09-C	> 11 dB, -21 dB, -31 dB	Pass
Co-channel - LE coded (S=8)	Bluetooth LE 6.0, BV-28-C	> 12 dB	Pass
Adjacent channel interference rejection (N+/-2, 4, 6+ MHz) LE coded (S=8)	Bluetooth LE 6.0, BV-09-C	> 6 dB, -26 dB, -36 dB	Pass
Blocking Interferers 1 Mbit/s	Bluetooth LE 6.0, BV-04-C	-30 dBm (30 MHz to 2 GHz and 3 GHz to 12.5 GHz)	Pass
Blocking Interferers 2 Mbit/s	ETSI v2.2.2	-35 dBm (2003 MHz to 2399 MHz and 2484 MHz to 2997 MHz)	
Intermodulation 1 Mbit/s 2 Mbit/s	Bluetooth LE 6.0, BV-05-C Bluetooth LE 6.0, BV-11-C	PER 30.8% with a minimum of 1500 packets	
RX Maximum input level 1 Mbit/s	Bluetooth LE 6.0, BV-06-C	PER 30.8 % with a minimum of 1500 packets	Pass
2 Msps	Bluetooth LE 6.0, BV-12-C		
RX emissions 30 MHz – 1 GHz	ETSI EN 300 328 v2.2.2 (2019-07)	-57 dBm (100 kHz)	Pass

Table 2. Reception tests for Europe*...continued*

Reception Tests	Reference	Limits	Result
RX emissions 1 GHz – 12.5 GHz	ETSI EN 300 328 v2.2.2 (2019-07)	-47 dBm (1 MHz)	Pass

Table 3. Miscellaneous tests for US

Return loss	Return loss mode	Status
Return loss (S11)	Return loss in TX mode	For information
	Return loss in RX mode	

Table 4. Transmission tests for US

Transmission test type	Reference	Limit	Status
TX maximum power	FCC part15.247	PAVG ≤ 100 mW +20 dBm EIRP	Pass
Spurious 1 GHz – 25 GHz	FCC part15.249	Field strength < 500 µ/m @3m -41.25 dBm (1 MHz BW)	Pass

2.3 Conducted tests

This section describes the tests conducted for Bluetooth Low Energy transmission and reception.

2.3.1 TX tests

This section describes the test setup, method, and results for Bluetooth LE applications transmission tests.

2.3.1.1 Test setup N1

Figure 3 shows the test setup to conduct generic TX Bluetooth LE tests.

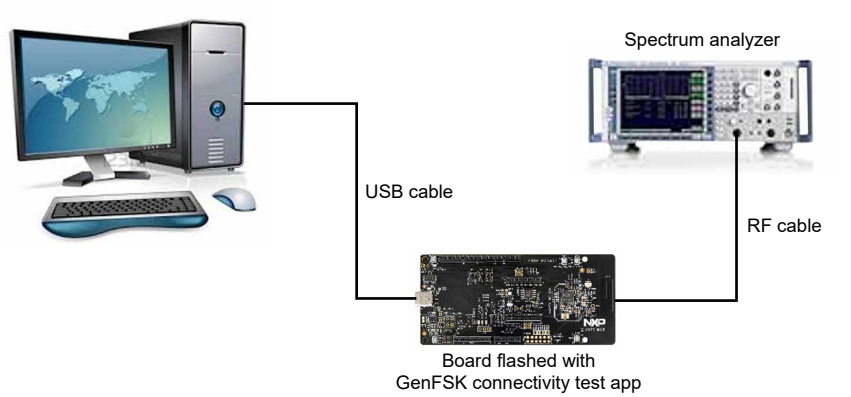

Figure 3. Test setup N1

2.3.1.2 Test setup N2

Figure 4 shows the test setup to conduct specific TX Bluetooth LE tests.

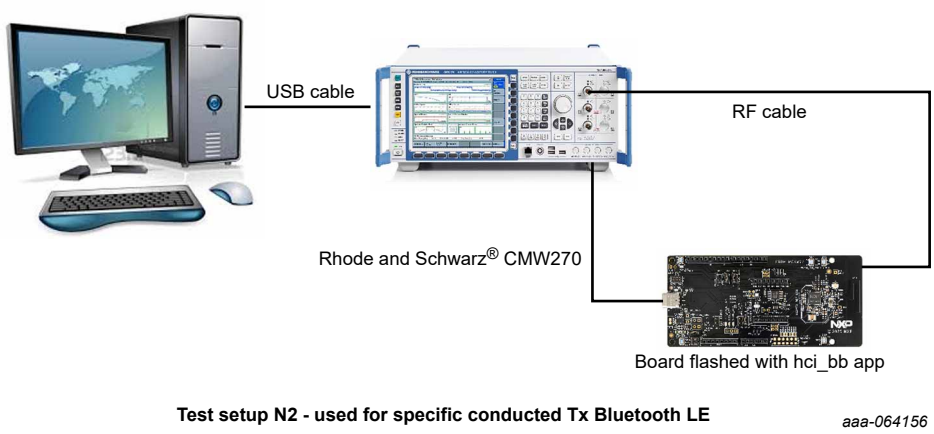

Figure 4. TX Bluetooth LE test setup (Test setup N2)

2.3.1.3 Frequency accuracy

This section describes the test method and result of frequency accuracy measurements done using the FRDM-MCXW72 board.

2.3.1.3.1 Test method

Follow the test method described below:

- N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, continuous waveform (CW), continuous emitting mode, frequency: Bluetooth LE Channel 17 (2.440 GHz)
- Set the analyzer to:
  - Center frequency = 2.44 GHz, span = 1 MHz
  - Reference amplitude = 20 dBm
  - RBW (resolution bandwidth) = 10 kHz
  - VBW (video bandwidth) = 100 kHz
- Measure the continuous waveform (CW) frequency with the marker of the spectrum analyzer.

2.3.1.3.2 Result

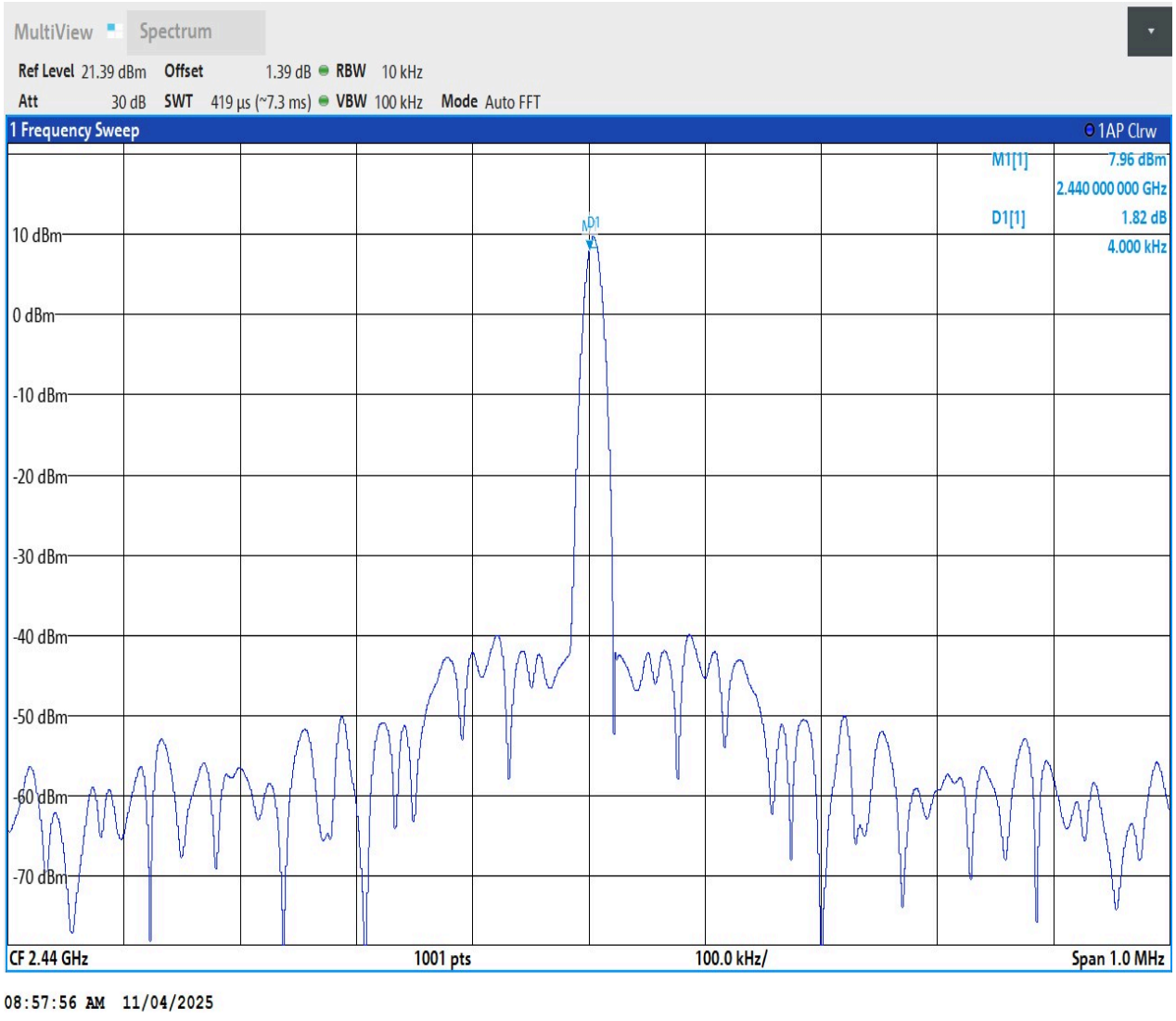

Figure 5. Frequency accuracy

- Measured frequency: 2.440004 GHz
- ppm value = (2.440004 - 2.44) / 2.44 = 1.6 ppm

Table 5. Frequency accuracy

Frequency accuracy	
Result	**Target**
1.6 ppm	+/-25 ppm

The frequency accuracy depends on the XTAL model. The model used on the board is NX1612SA 32 MHZ EXS00A CS14160.

Conclusion:

- The frequency accuracy complies with the data sheet.

2.3.1.4 Phase noise

This section explains the test method used to measure the phase noise and provides the corresponding results.

2.3.1.4.1 Test method

- N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, continuous waveform (CW), continuous emitting mode, frequency: Bluetooth LE Channel 17 (2.440 GHz)

  Set the analyzer to:
  - Center frequency = 2.440 GHz, span = 1 MHz, Reference amplitude = 20 dBm, RBW = 10 kHz, VBW = 100 kHz
- Measure the phase noise at the 100-kHz offset frequency:
  - RBW (spectrum analyzer) = 10 kHz (20log(10 kHz) = 40 dBc)

2.3.1.4.2 Result

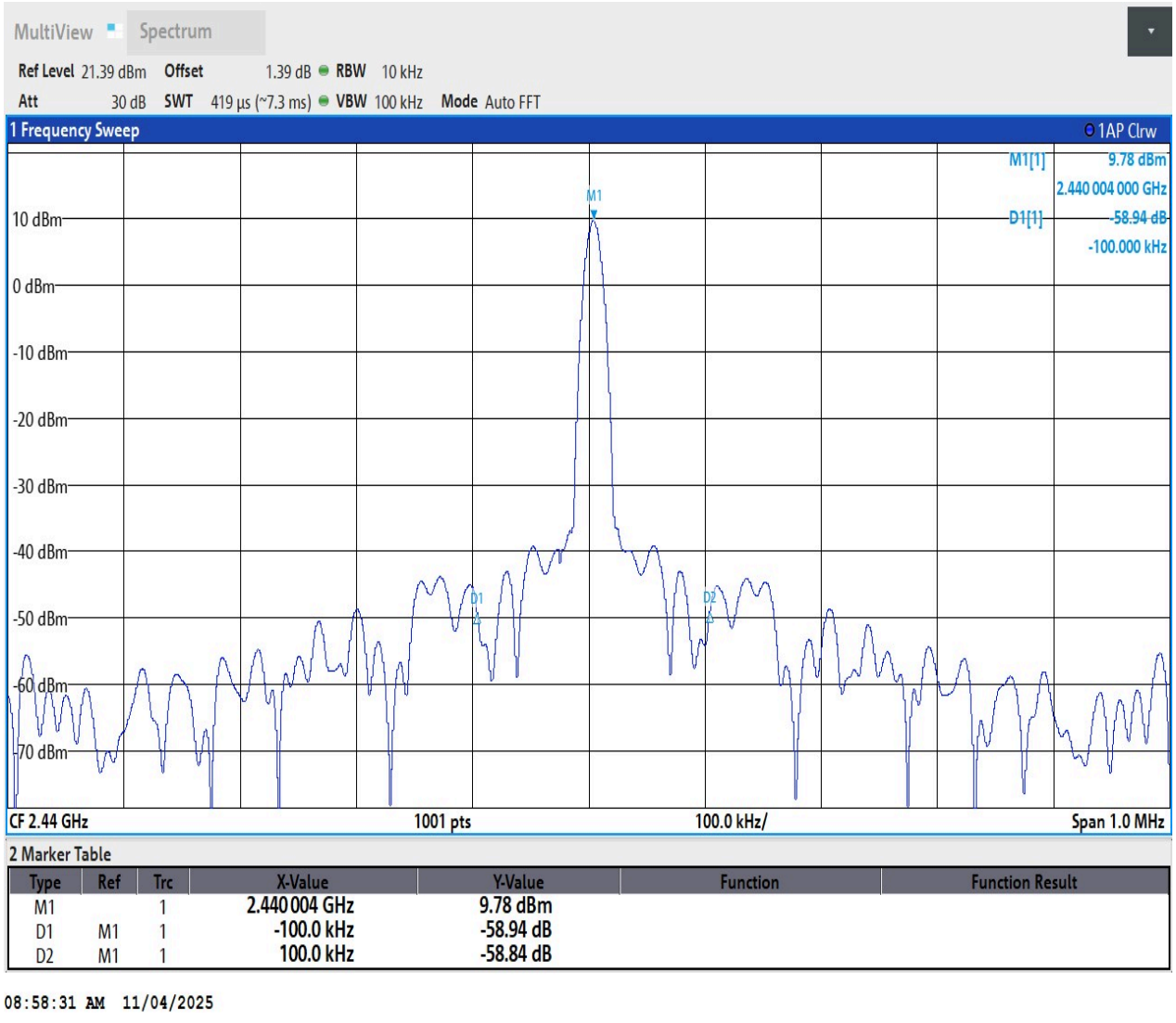

Figure 6. Conducted phase noise

- Marker value (delta) = -56.68 dBm / 100 kHz = -106.68 dBc/Hz

The phase noise is just for informational purposes. No specific issue on this parameter.

2.3.1.5 TX power (fundamental)

This section explains the test method used to measure the TX power (fundamental) and provides the corresponding results.

2.3.1.5.1 Test method

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode, data rate (1 Mbit/s, 2 Mbit/s, 500 kbit/s, and 125 kbit/s for Bluetooth LE)
- Set the analyzer to:
  - Start frequency= 2.392 GHz
  - Stop frequency= 2.49 GHz
  - Reference amplitude = 10 dBm
  - Sweep time = 100 ms
  - RBW = 3 MHz
  - VBW = 3 MHz
  - Max Hold mode
  - Detector = RMS
- Sweep all the channels from Bluetooth LE channel 37(2.402 GHz) to Bluetooth LE channel 39 (2.480 GHz).
  Note: *The software tool allows sweep from GenFSK Channel 0 (2.360 GHz) to GenFSK Channel 127 (2.488 GHz).*

2.3.1.5.2 Result

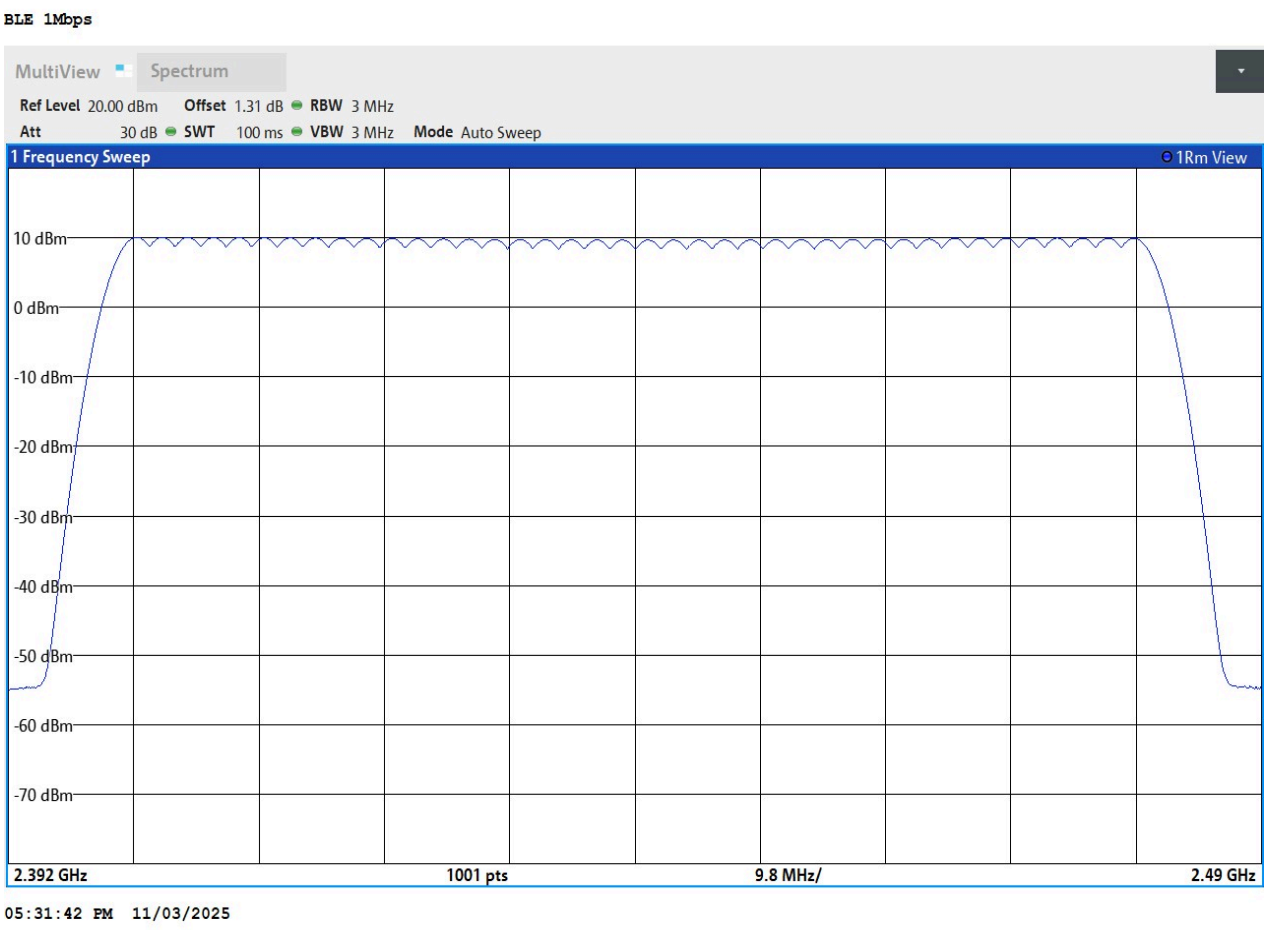

Figure 7. TX power (Bluetooth LE)

- Maximum power is on channel 17.0: 9.68 dBm
- Minimum power is on channel 37.0: 10.07 dBm
- Tilt over frequencies is: 0.39 dB

2.3.1.5.3 Conclusion

- The default TX power is too high in line with the expected results.
- The TX power is flat over frequencies.

2.3.1.6 TX power In Band

This section explains the test method used to measure the TX Power In Band and provides the corresponding results.

2.3.1.6.1 Test method

Test method:

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode, data rate (1 Mbit/s, 2 Mbit/s, 500 kbit/s, and 125 kbit/s)
- Set the analyzer to:
  - Start frequency= 2.35 GHz
  - Stop frequency= 2.5 GHz
  - Reference amplitude = 10 dBm
  - sweep time = 100 ms
  - RBW = 100 kHz, VBW = 300 kHz
  - Max Hold mode
  - Detector = RMS
  - Number of Sweeps = 10
- Sweep on Bluetooth LE channels
  - Channel 37 (2.402 GHz)
  - Channel 17 (2.440 GHz)
  - Channel 39 (2.480 GHz)

2.3.1.6.2 Result

2.3.1.6.2.1 Channel 37

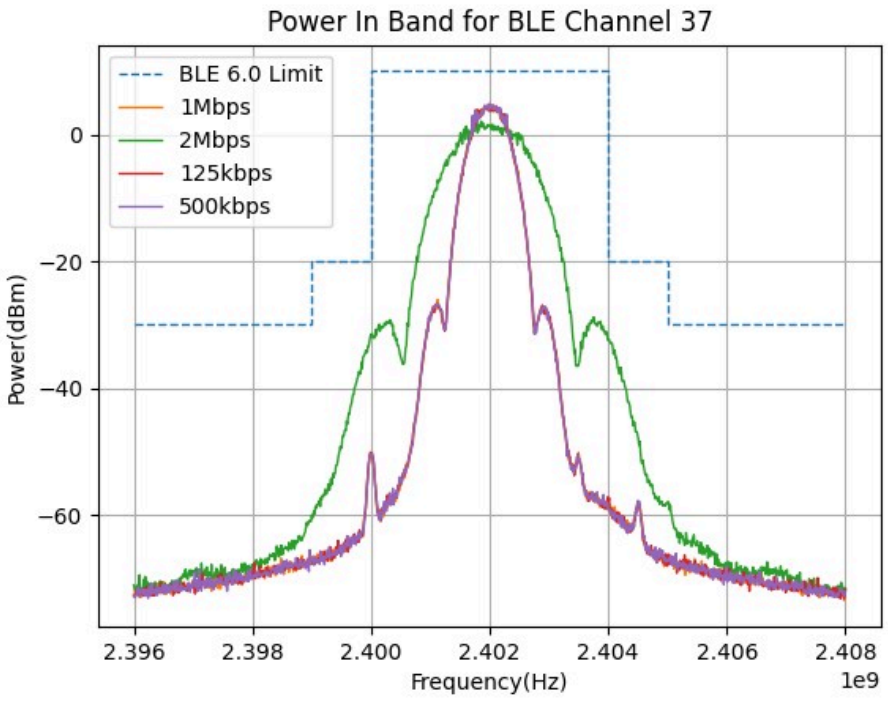

Figure 8. TX power In Band – Channel 37

Table 6. Bluetooth LE 1 Mbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-50.41	dBm	2.400 GHz
Max peak level >=+2 MHz	-59.09	dBm	2.404 GHz
Max peak level <=-3 MHz	-66.54	dBm	2.399 GHz
Max peak level >=+3 MHz	-66.54	dBm	2.405 GHz

Table 7. Bluetooth LE 2 Mbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-31.65	dBm	2.404 GHz
Max peak level >=+2 MHz	-32.46	dBm	2.408 GHz
Max peak level <=-3 MHz	-60.06	dBm	2.403 GHz
Max peak level >=+3 MHz	-60.06	dBm	2.411 GHz

Table 8. Bluetooth LE 500 kbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-51.0	dBm	2.404 GHz
Max peak level >=+2 MHz	-59.2	dBm	2.408 GHz
Max peak level <=-3 MHz	-67.63	dBm	2.403 GHz
Max peak level >=+3 MHz	-67.63	dBm	2.411 GHz

Table 9. Bluetooth LE 125 kbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-50.59	dBm	2.404 GHz
Max peak level >=+2 MHz	-59.29	dBm	2.408 GHz
Max peak level <=-3 MHz	-68.11	dBm	2.403 GHz
Max peak level >=+3 MHz	-68.11	dBm	2.411 GHz

2.3.1.6.2.2 Channel 17

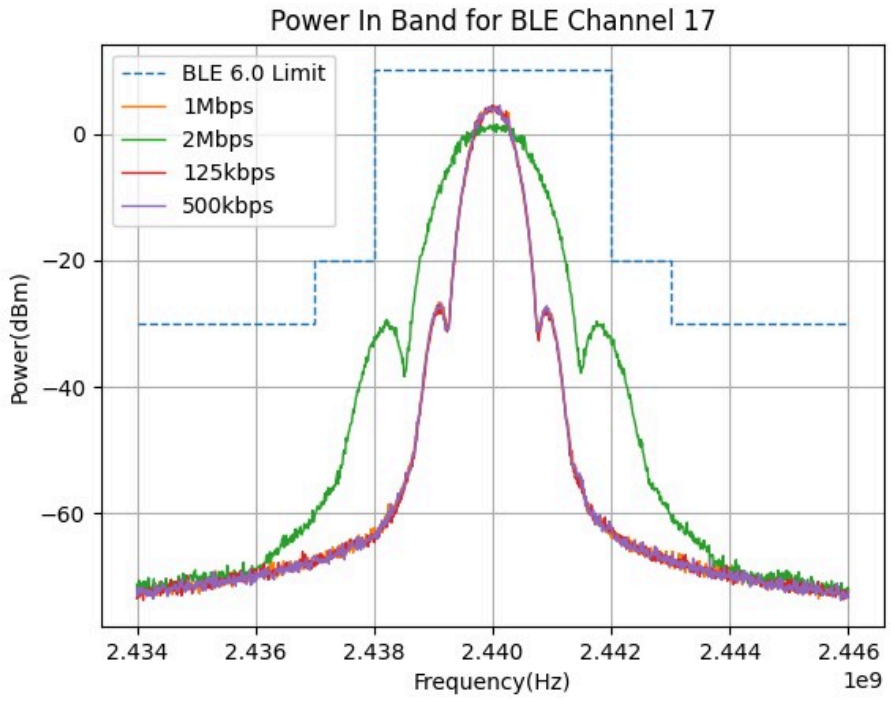

Figure 9. TX power In Band – Channel 17

Table 10. Channel 17, Bluetooth LE 1 Mbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-62.95	dBm	2.438 GHz
Max peak level >=+2 MHz	-63.9	dBm	2.442 GHz
Max peak level <=-3 MHz	-68.33	dBm	2.437 GHz
Max peak level >=+3 MHz	-68.18	dBm	2.443 GHz

Table 11. Channel 17, Bluetooth LE 2 Mbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-33.47	dBm	2.438 GHz
Max peak level >=+2 MHz	-33.75	dBm	2.442 GHz
Max peak level <=-3 MHz	-60.32	dBm	2.437 GHz
Max peak level >=+3 MHz	-60.16	dBm	2.443 GHz

Table 12. Channel 17, Bluetooth LE 500 kbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-63.82	dBm	2.438 GHz
Max peak level >=+2 MHz	-63.06	dBm	2.442 GHz
Max peak level <=-3 MHz	-66.77	dBm	2.437 GHz

Table 12. Channel 17, Bluetooth LE 500 kbit/s*...continued*

Max peak level frequency	Value	Unit	Condition
Max peak level >=+3 MHz	-67.36	dBm	2.443 GHz

Table 13. Channel 17, Bluetooth LE 125 kbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-63.91	dBm	2.438 GHz
Max peak level >=+2 MHz	-63.11	dBm	2.442 GHz
Max peak level <=-3 MHz	-68.34	dBm	2.437 GHz
Max peak level >=+3 MHz	-66.96	dBm	2.443 GHz

2.3.1.6.2.3 Channel 39

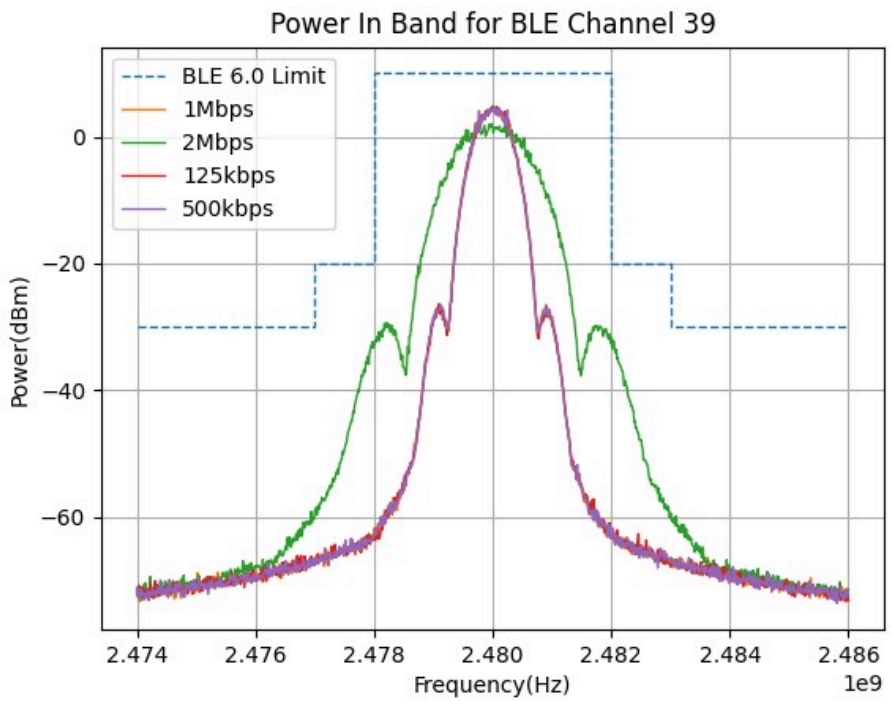

Figure 10. TX power In Band – Channel 39

Table 14. Channel 39, Bluetooth LE 1 Mbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-62.54	dBm	2.478 GHz
Max peak level >=+2 MHz	-62.51	dBm	2.482 GHz
Max peak level <=-3 MHz	-68.56	dBm	2.477 GHz
Max peak level >=+3 MHz	-66.53	dBm	2.483 GHz

Table 15. Channel 39, Bluetooth LE 2 Mbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-33.43	dBm	2.478 GHz
Max peak level >=+2 MHz	-31.71	dBm	2.482 GHz
Max peak level <=-3 MHz	-61.18	dBm	2.477 GHz
Max peak level >=+3 MHz	-59.36	dBm	2.483 GHz

Table 16. Channel 39, Bluetooth LE 500 kbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-62.91	dBm	2.478 GHz
Max peak level >=+2 MHz	-63.58	dBm	2.482 GHz
Max peak level <=-3 MHz	-68.02	dBm	2.477 GHz
Max peak level >=+3 MHz	-67.17	dBm	2.483 GHz

Table 17. Channel 39, Bluetooth LE 125 kbit/s

Max peak level frequency	Value	Unit	Condition
Max peak level <=-2 MHz	-64.02	dBm	2.478 GHz
Max peak level >=+2 MHz	-63.22	dBm	2.482 GHz
Max peak level <=-3 MHz	-66.55	dBm	2.477 GHz
Max peak level >=+3 MHz	-67.84	dBm	2.483 GHz

Conclusion:

- The FRDM-MCXW72 board is within the expected limits and passes the Bluetooth LE 6.0 certification in the Power In Band test.

2.3.1.7 TX spurious

This section describes the TX spurious tests (including harmonics ETSI and FCC).

2.3.1.7.1 Test results (Conducted TX spurious)

This section provides the spurious overview of the full band when the device is in the transmission mode for:

- 1 GHz to 25 GHz
- 30 MHz to 25 GHz

1 GHz to 25 GHz

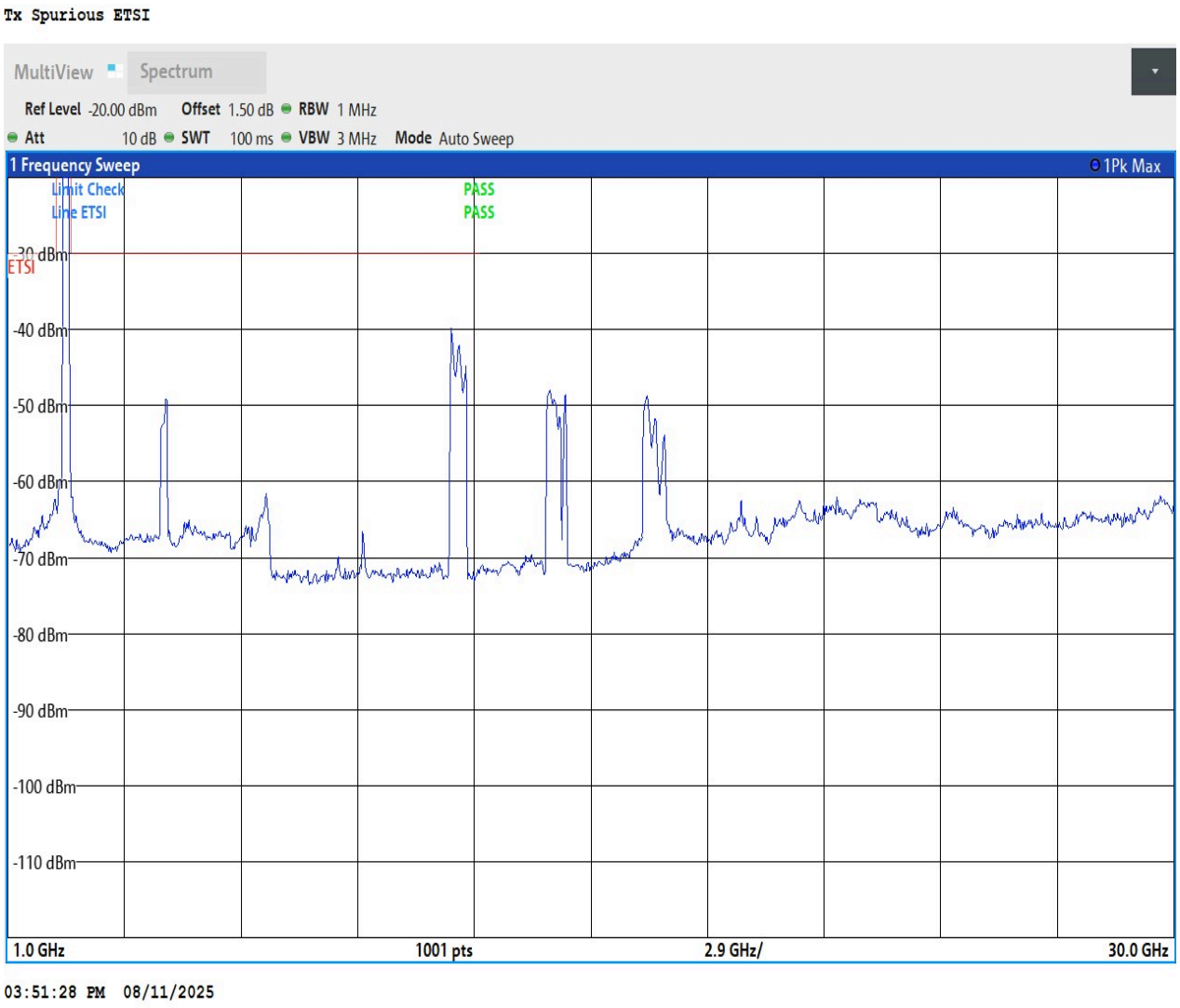

Figure 11. Bluetooth LE - Conducted TX spurious (1 GHz to 25 GHz)

Note: *These results are for illustration only as they used a uFL connector calibrated up to 6 GHz only.*

30 MHz to 1 GHz

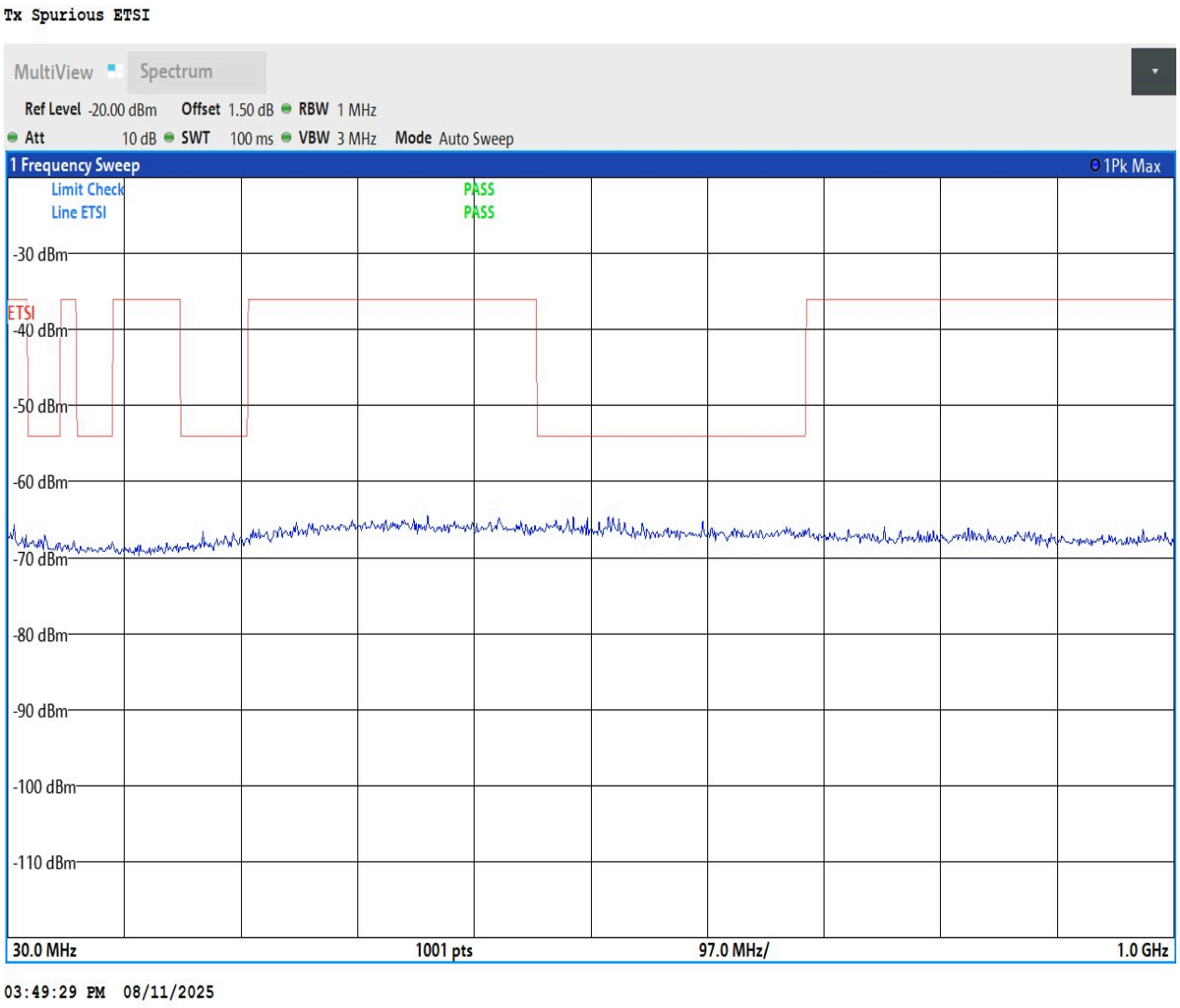

Figure 12. BLE - Zoom In - Conducted TX spurious (30 MHz to 1 GHz)

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

2.3.1.7.2 Conclusion

- The FRDM-MCXW72 passes the ETSI TX Spurious Certification with a margin of 8.88 dB.
- Harmonics are specifically measured in the following sections.

2.3.1.7.2.1 H2 (ETSI test conditions, peak measurement)

Test method:

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  - Start frequency= 4.7 GHz
  - Stop frequency= 5 GHz
  - Reference amplitude = -20 dBm
  - Sweep time = 100 ms
  - RBW = 1 MHz
  - VBW = 3 MHz
  - Max Hold mode
  - Detector: Peak
- Sweep all the channels from
  - Bluetooth Low Energy: channel 0 to channel 39

H2 Results

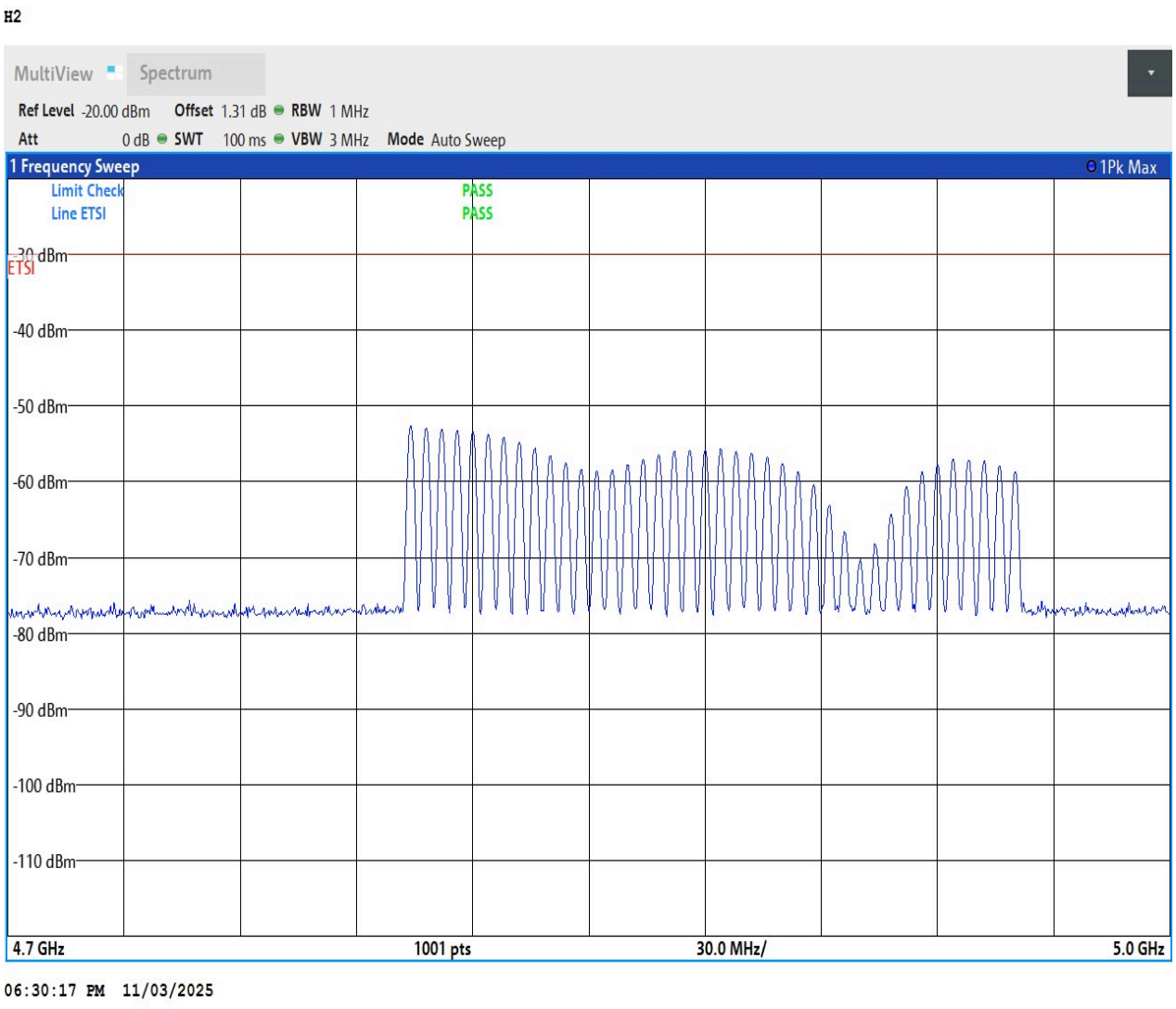

Figure 13. BLE - Conducted H2 spurious

- The maximum power is at frequency 4.95 GHz: -52.75dBm

Conclusion

- There is more than 22.8 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.2 H3 (ETSI test conditions, peak measurement)

This test uses the same method as the H2, except that the spectrum analyzer frequency start/stop is set to 7.0 and 7.5 GHz.

H3 Results

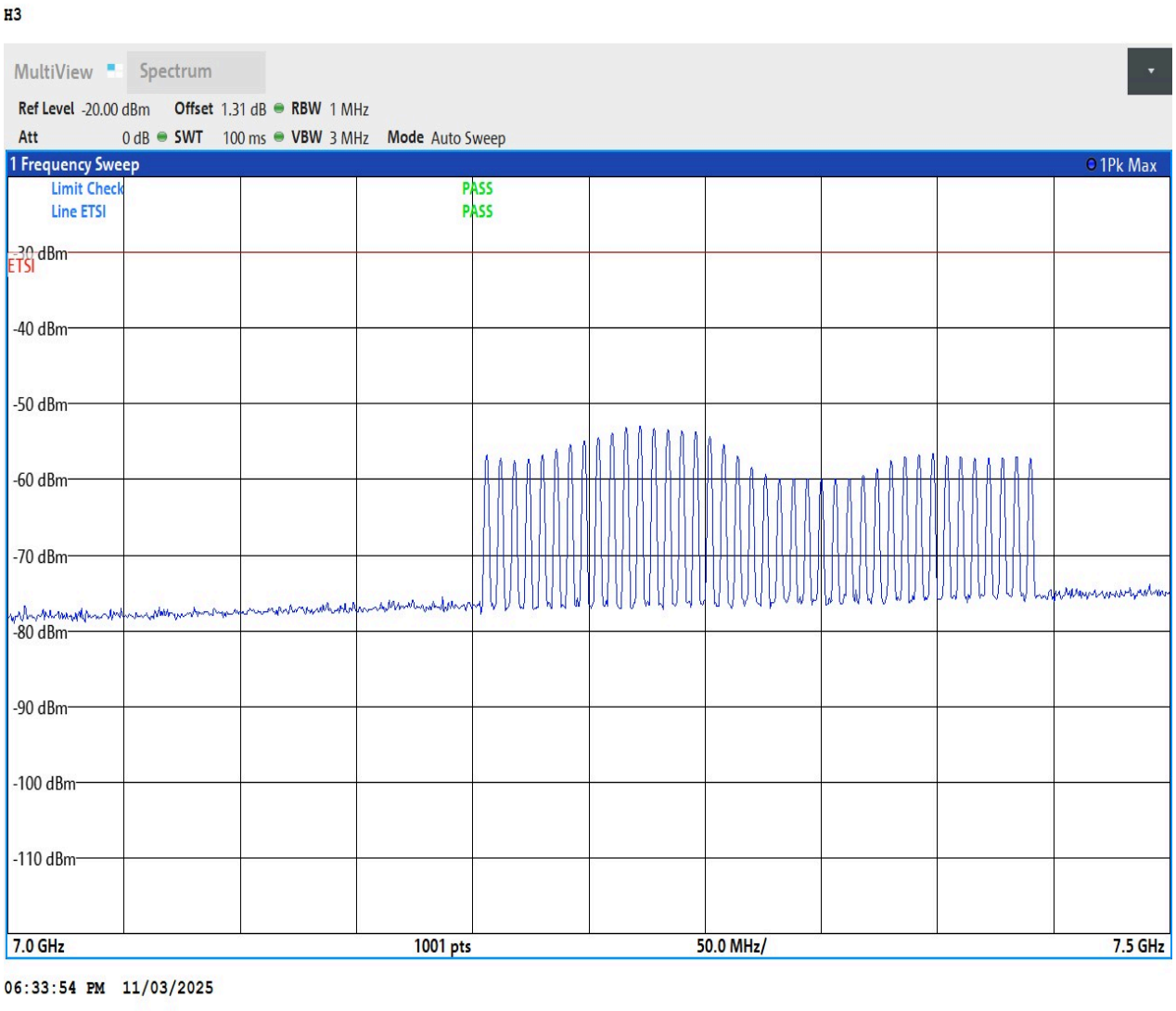

Figure 14. Bluetooth LE - Conducted H3 spurious

The maximum power is at frequency 7.27 GHz: -53.08 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion There is more than 23.1 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.3 H4 (ETSI test conditions, peak measurement)

This test follows the same method as for H2, except that the spectrum analyzer frequency span is set from 9.4 GHz to 10.0 GHz.

H4 Results

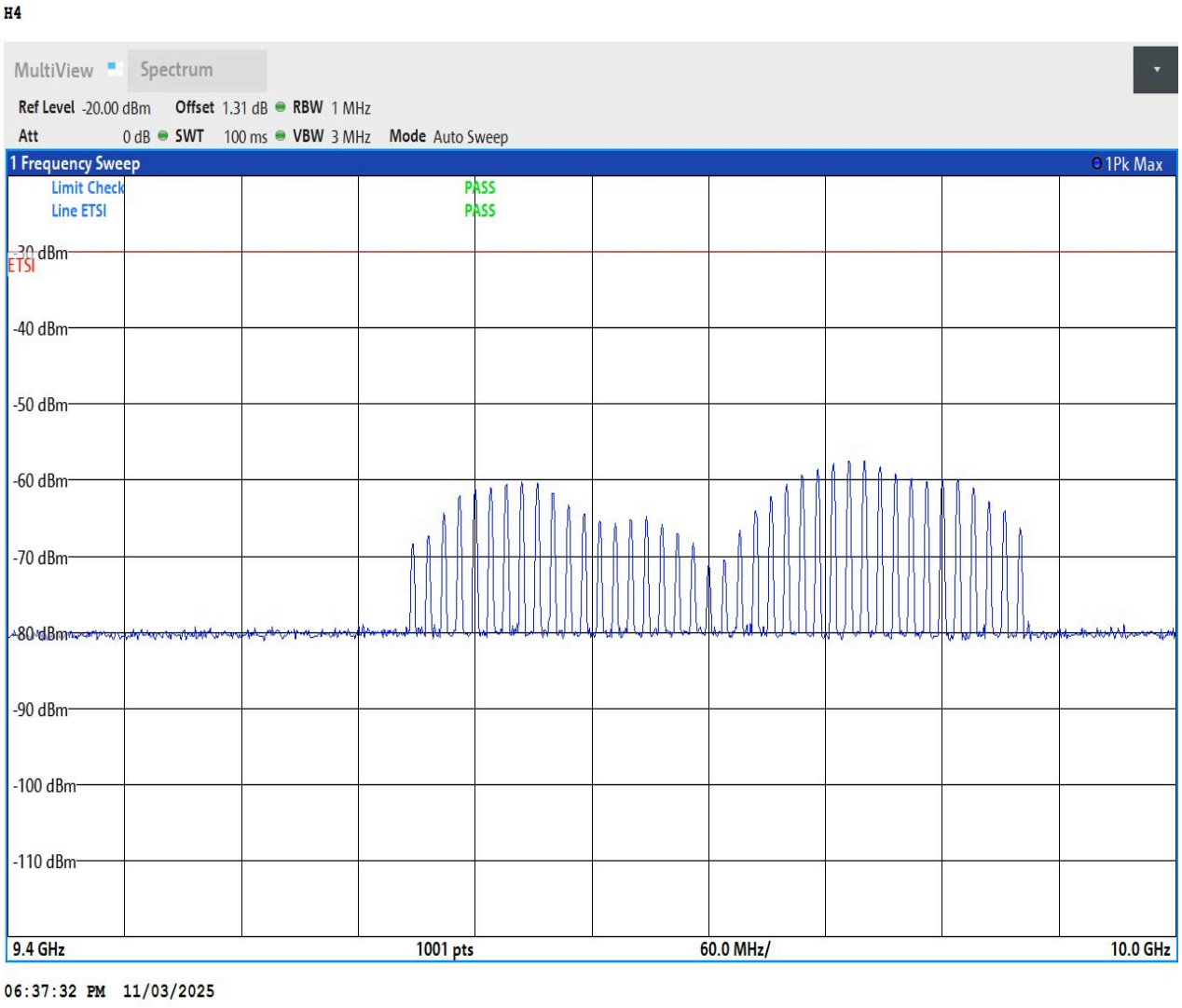

Figure 15. Bluetooth LE - Conducted H4 spurious

Maximum power is at frequency 9.82 GHz: -57.54 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion There is more than 27.5 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.4 H5 (ETSI test conditions, peak measurement)

This test uses the same method as the H2, except that the spectrum analyzer frequency span is set from 11.7 GHz to 12.5 GHz.

H5 Results

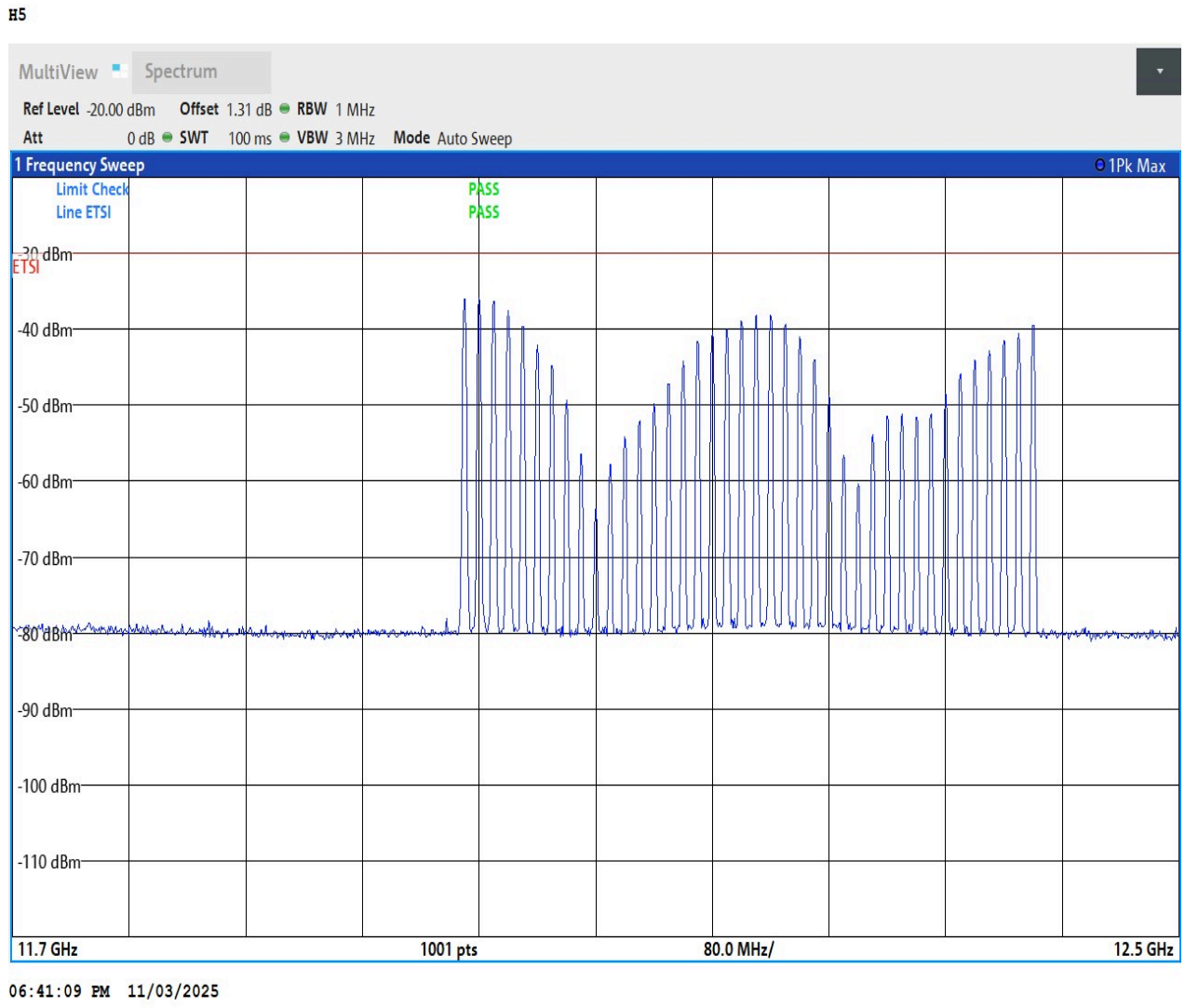

Figure 16. Bluetooth LE - Conducted H5 spurious

- The maximum power is at the frequency 12.01 GHz: -35.78 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

There is more than 5.8 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.5 H6 (ETSI test conditions, peak measurement)

This test uses the same method as the H2, except that the spectrum analyzer frequency span is set from 14.1 GHz to 15 GHz. Result:

H6 Results

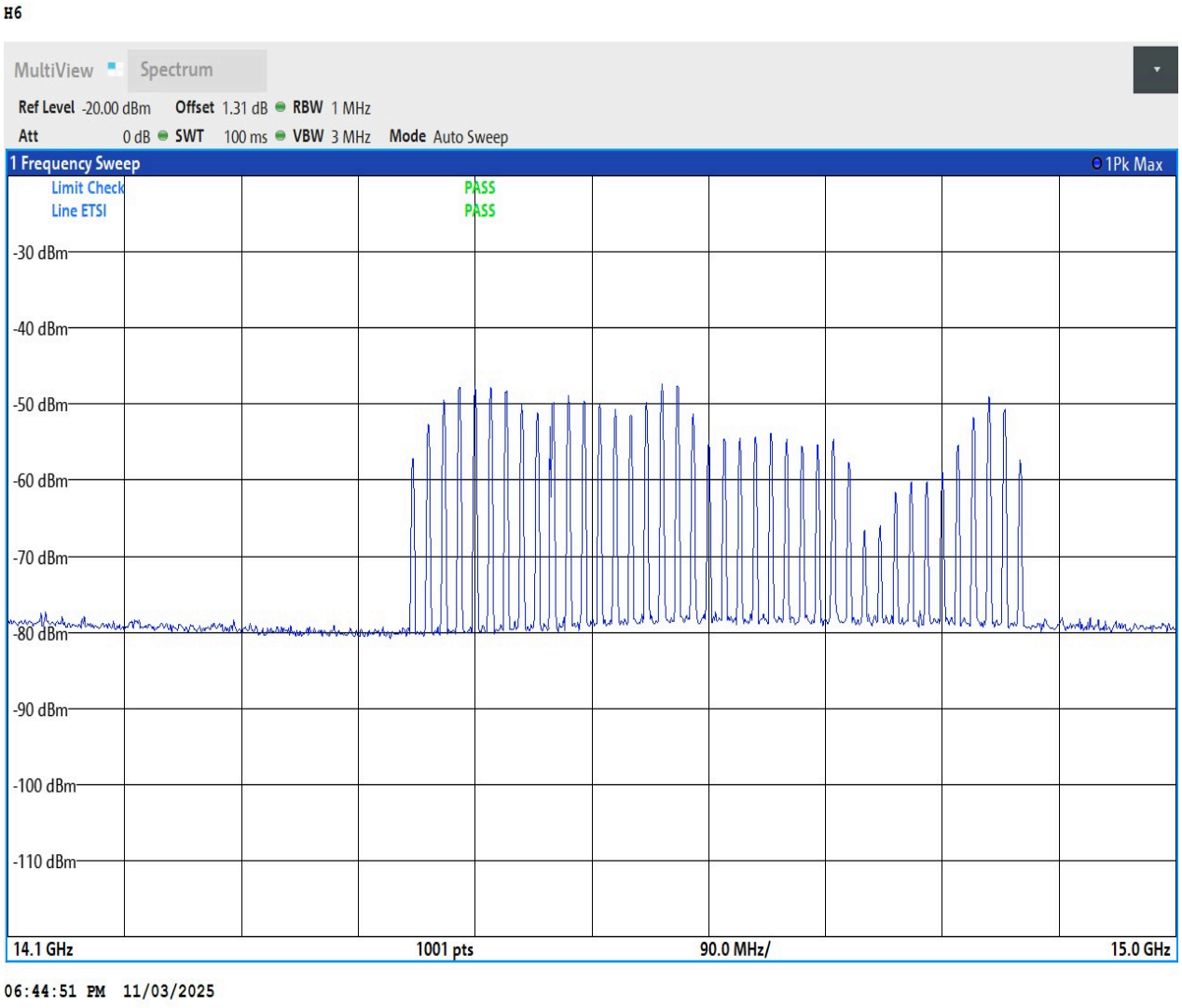

Figure 17. Bluetooth LE - Conducted H6 spurious

- Maximum power is at frequency 14.58 GHz - 47.38 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 17.4 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.6 H7 (ETSI test conditions, peak measurement)

This test uses the same method as the H2, except that the spectrum analyzer frequency span is set from 16.45 GHz to 17.5 GHz. Result:

H7 Results

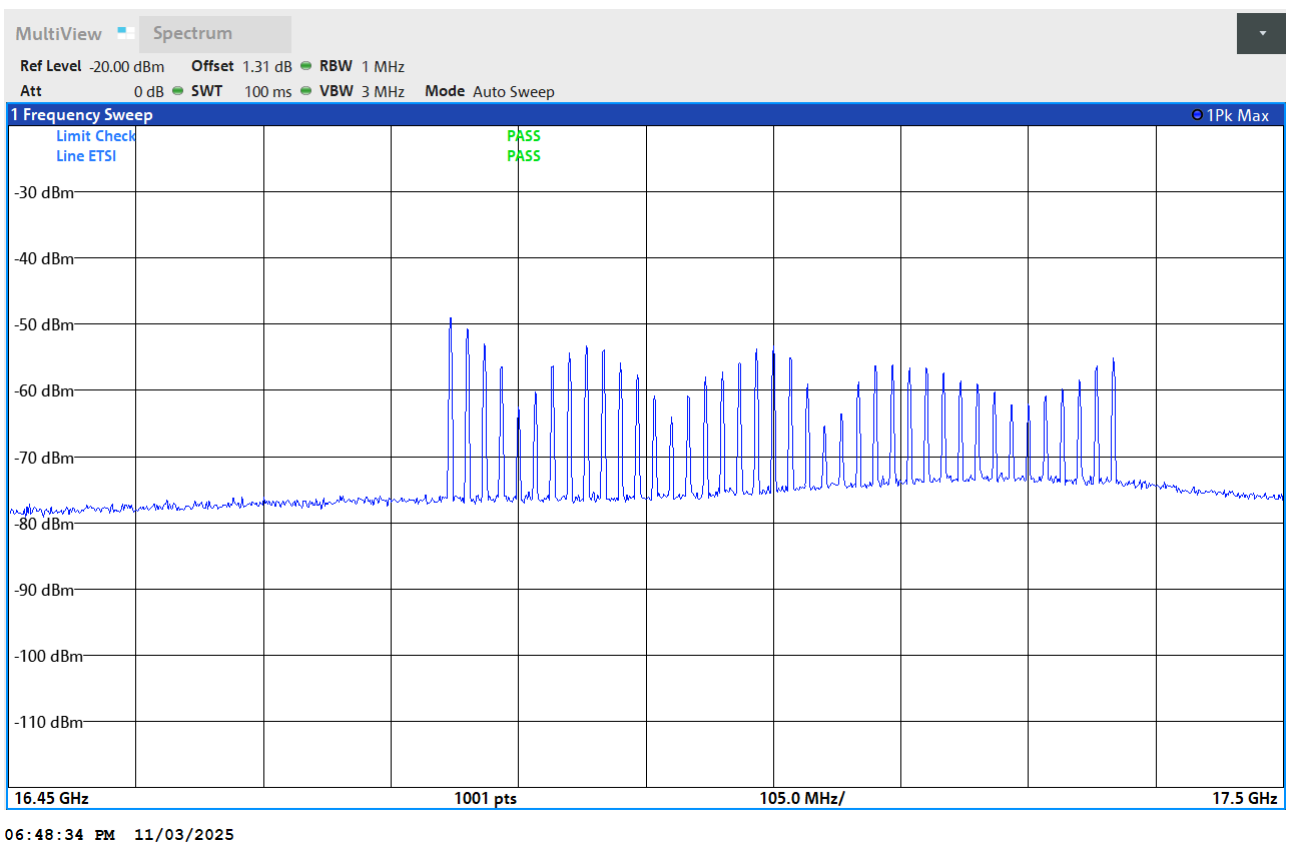

Figure 18. Bluetooth LE - Conducted H7 spurious

- Maximum power is at frequency 17.33 GHz: -49.07 dBm

Conclusion:

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

- There is more than 19.1 dB margin for Bluetooth LE to the ETSI limit

2.3.1.7.2.7 H8 (ETSI test conditions, peak measurement)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 18.8 GHz to 20 GHz.

H8 results

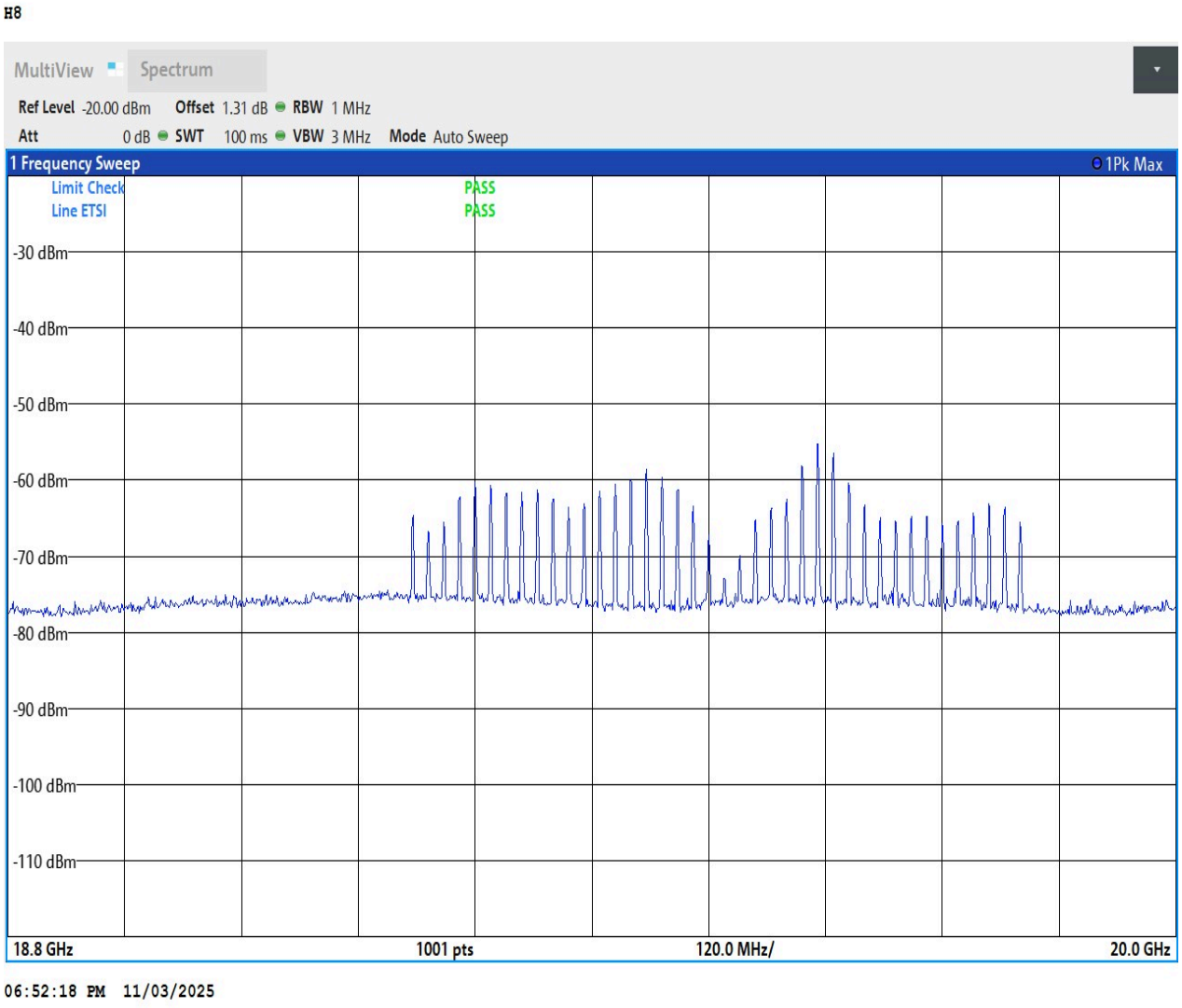

Figure 19. Bluetooth LE - Conducted H8 spurious

- Maximum power is at frequency 19.6 GHz -55.42 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 25.4 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.8 H9 (ETSI test conditions, peak measurement)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 21.15 GHz to 22.5 GHz.

H9 Results

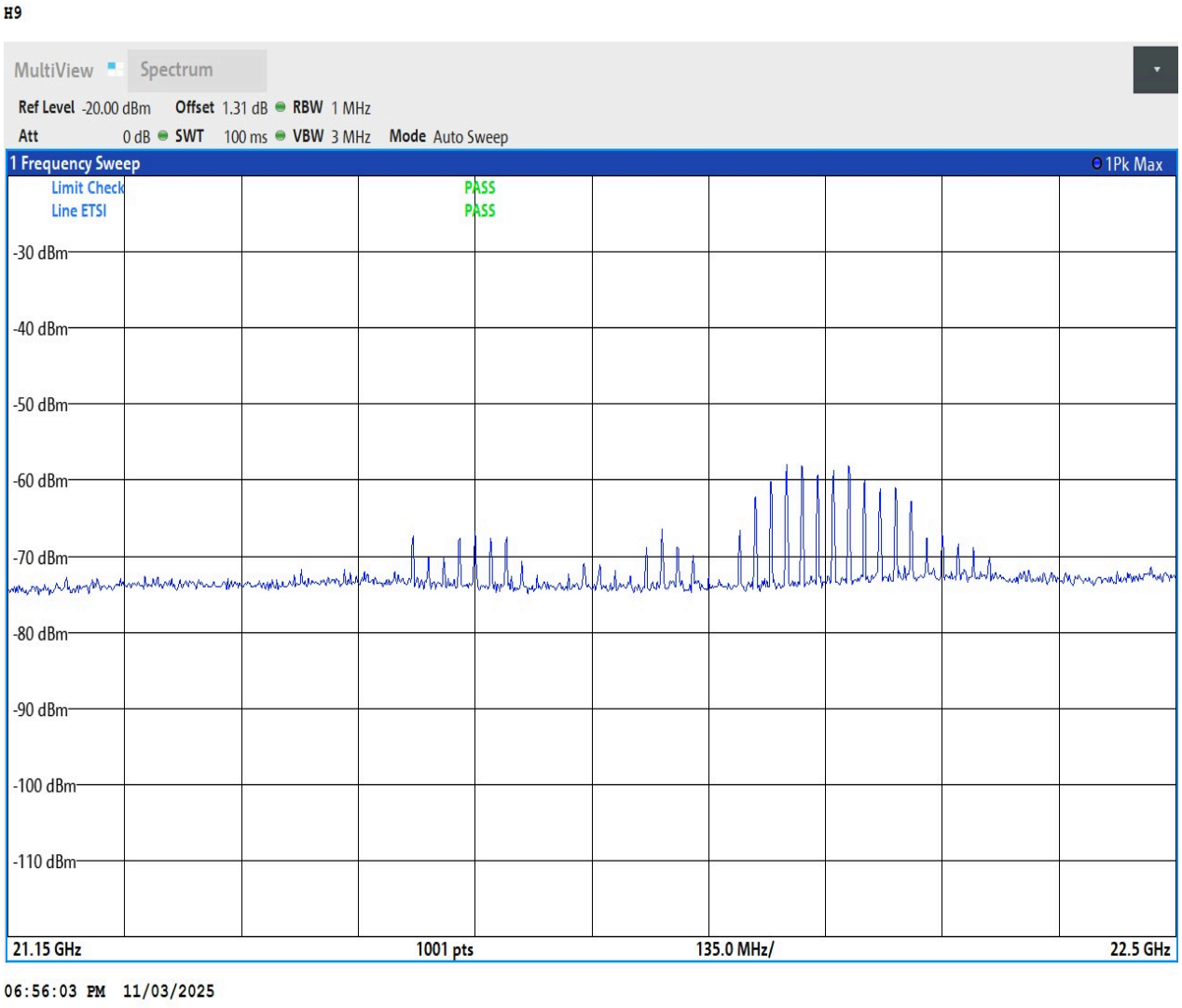

Figure 20. Bluetooth LE - Conducted H9 spurious

- Maximum power is at frequency 22.03 GHz: -58.09 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

There is more than 28.1 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.9 H10 (ETSI test conditions, peak measurement)

This test uses the same method as the H2, except that the spectrum analyzer frequency span is set from 23.35 GHz to 25 GHz. Result:

H10 Results

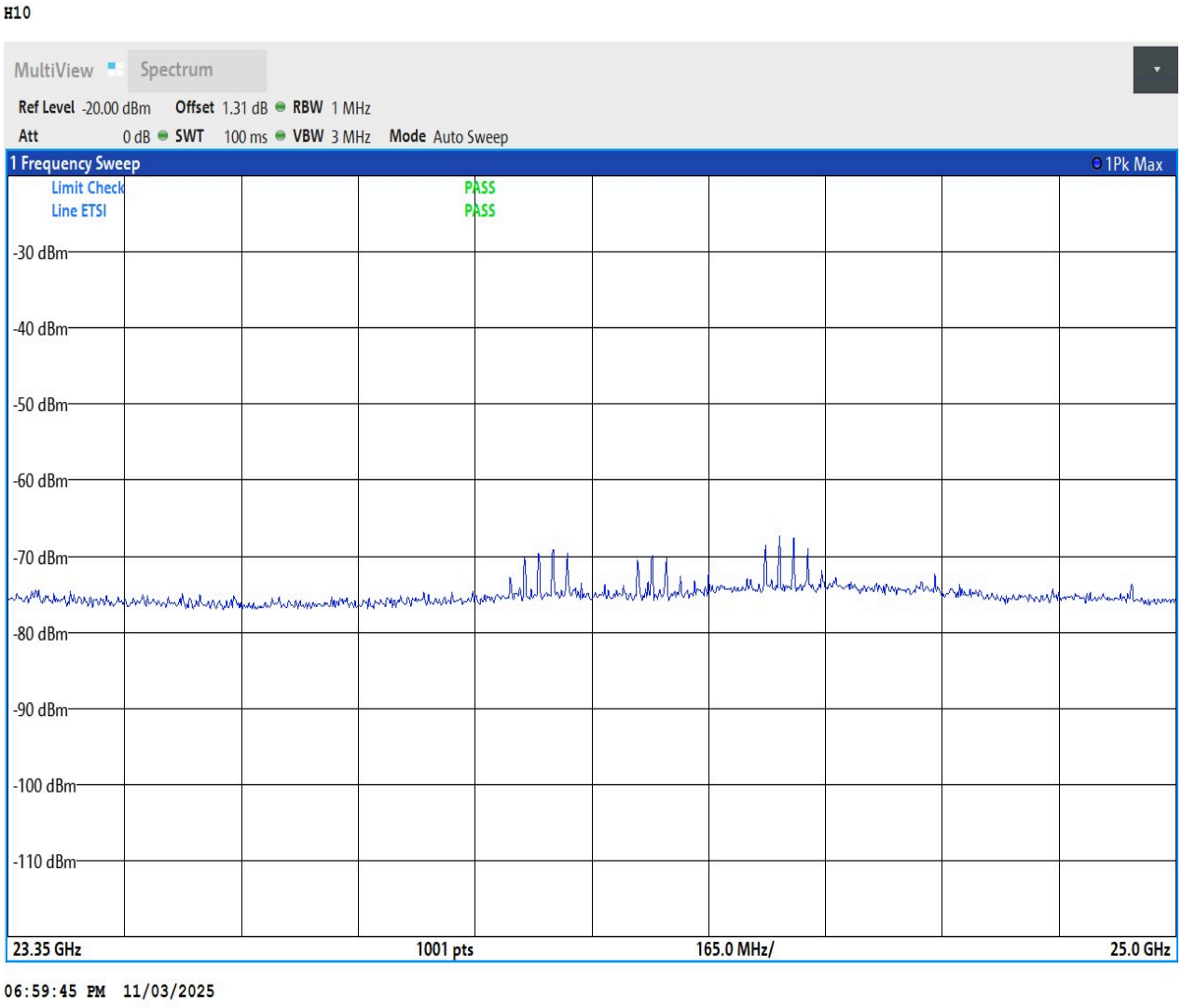

Figure 21. Bluetooth LE - Conducted H10 spurious

- Maximum power is at frequency 24.43 GHz: -67.3 dBm.

Conclusion:

- There is more than 37.3 dB margin for Bluetooth LE to the ETSI limit.

2.3.1.7.2.10 H2 (FCC test conditions, average measurement)

Test method:

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  - Start frequency= 4.7 GHz
  - Stop frequency= 5 GHz
  - Reference amplitude = -20 dBm
  - sweep time = 100 ms
  - RBW = 1 MHz
  - VBW = 3 MHz
  - Trace: Max Hold mode
  - Detector: RMS
- Sweep all the Bluetooth LE channels from:
  - Channel 0 to Channel 39

Results

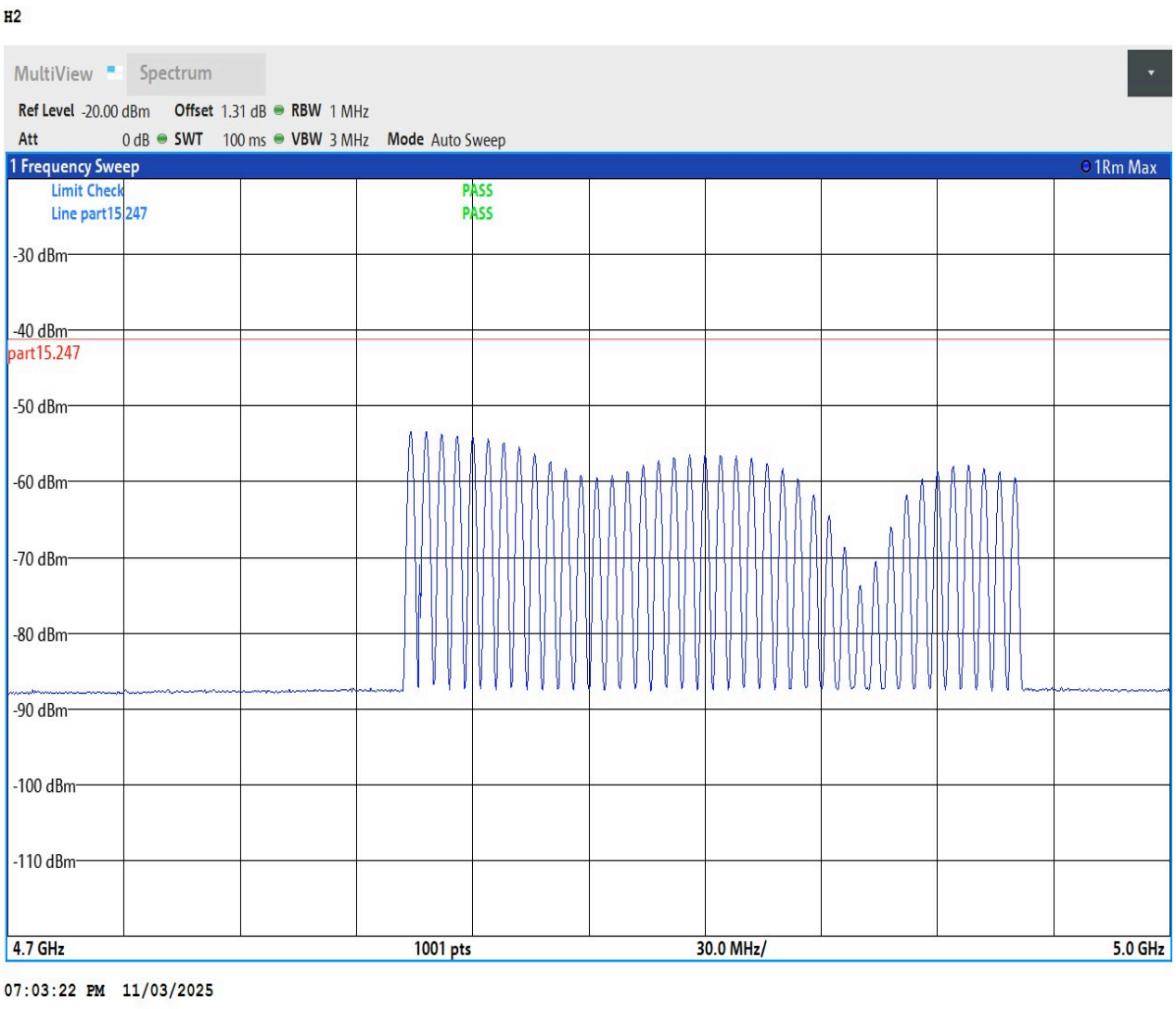

Figure 22. Bluetooth LE - Conducted H2 FCC spurious

- Maximum power is at frequency 4.95 GHz -53.37 dBm

Conclusion:

- There is more than 12.2 dB margin for Bluetooth LE to the FCC limit.

2.3.1.7.2.11 H3 (FCC test conditions, average measurement)

This test uses the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 7.0 GHz to 7.5 GHz.

Results

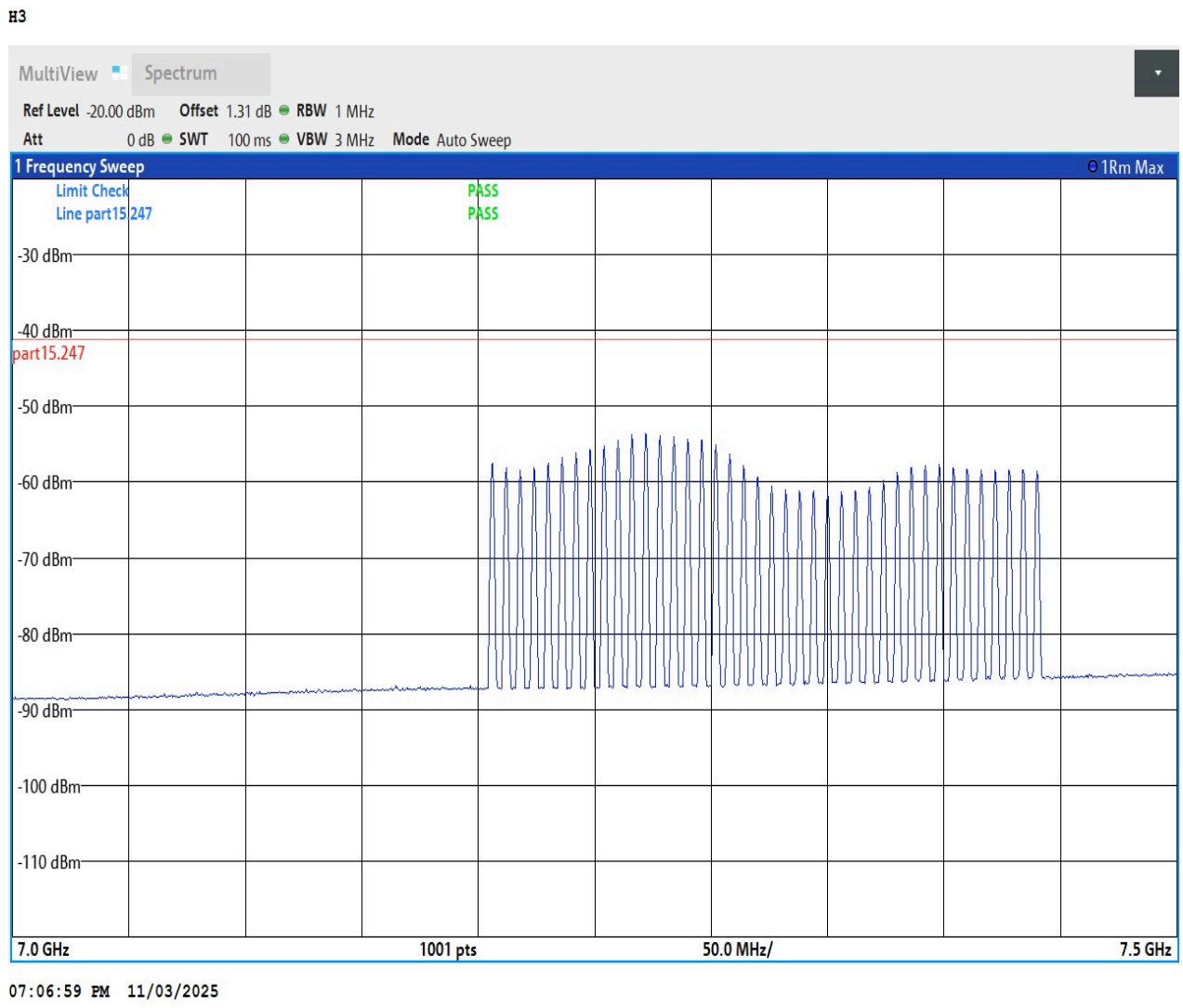

Figure 23. Bluetooth LE - Conducted H3 FCC spurious

- Maximum power is at frequency 7.27 GHz: -53.56 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 12.4 dB margin for Bluetooth LE to the FCC limit.

2.3.1.7.2.12 H4 (FCC test conditions, average measurement)

This test uses the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 9.4 GHz to 10 GHz.

Results

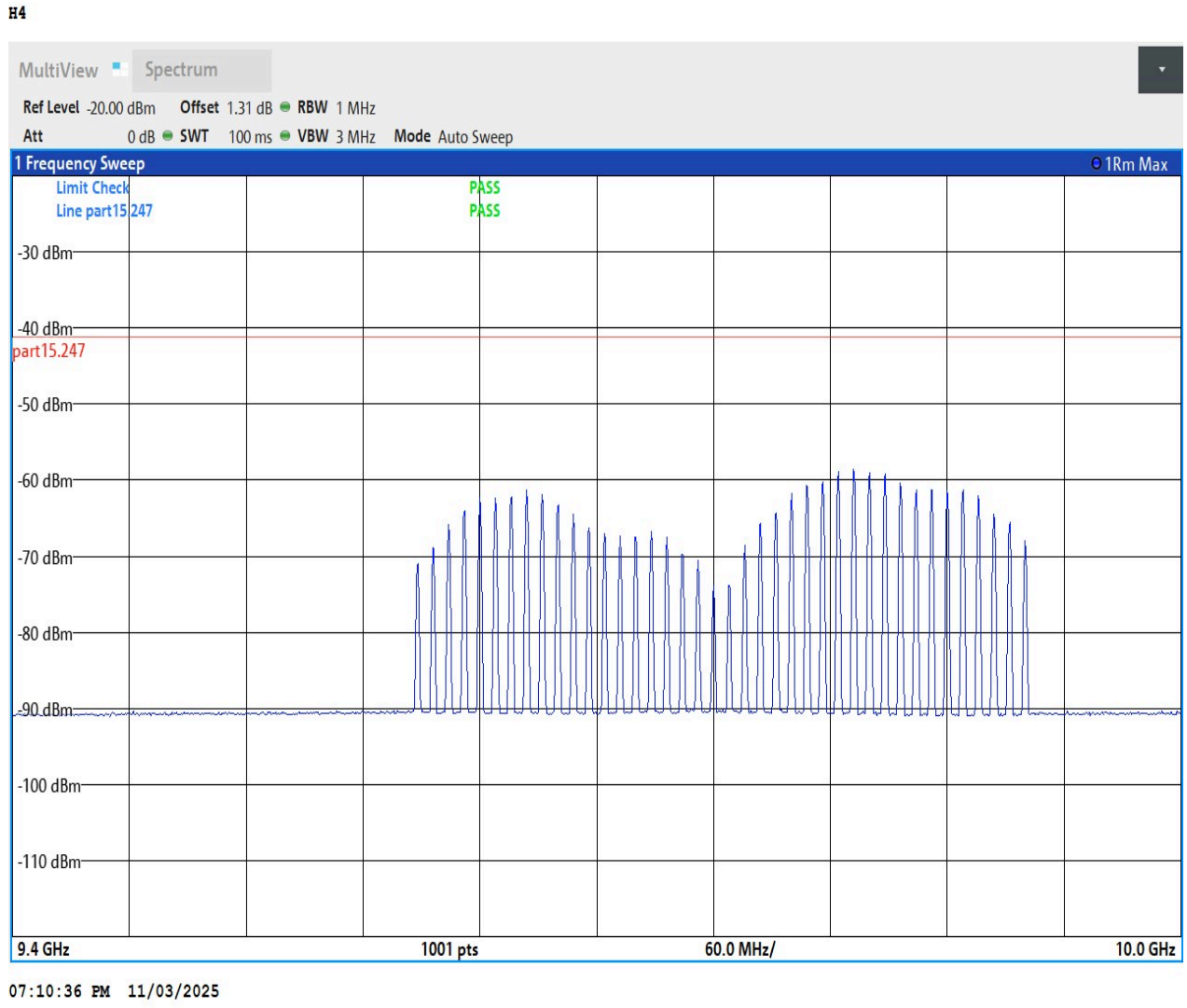

Figure 24. Bluetooth LE - Conducted H4 FCC spurious

- Maximum power is at frequency 9.82 GHz: -58.53 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion

- There is more than 17.4 dB margin for Bluetooth LE to the FCC limit.

2.3.1.7.2.13 H5 (FCC test conditions, average measurement)

This test uses the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 11.7 GHz to 12.5 GHz.

Results

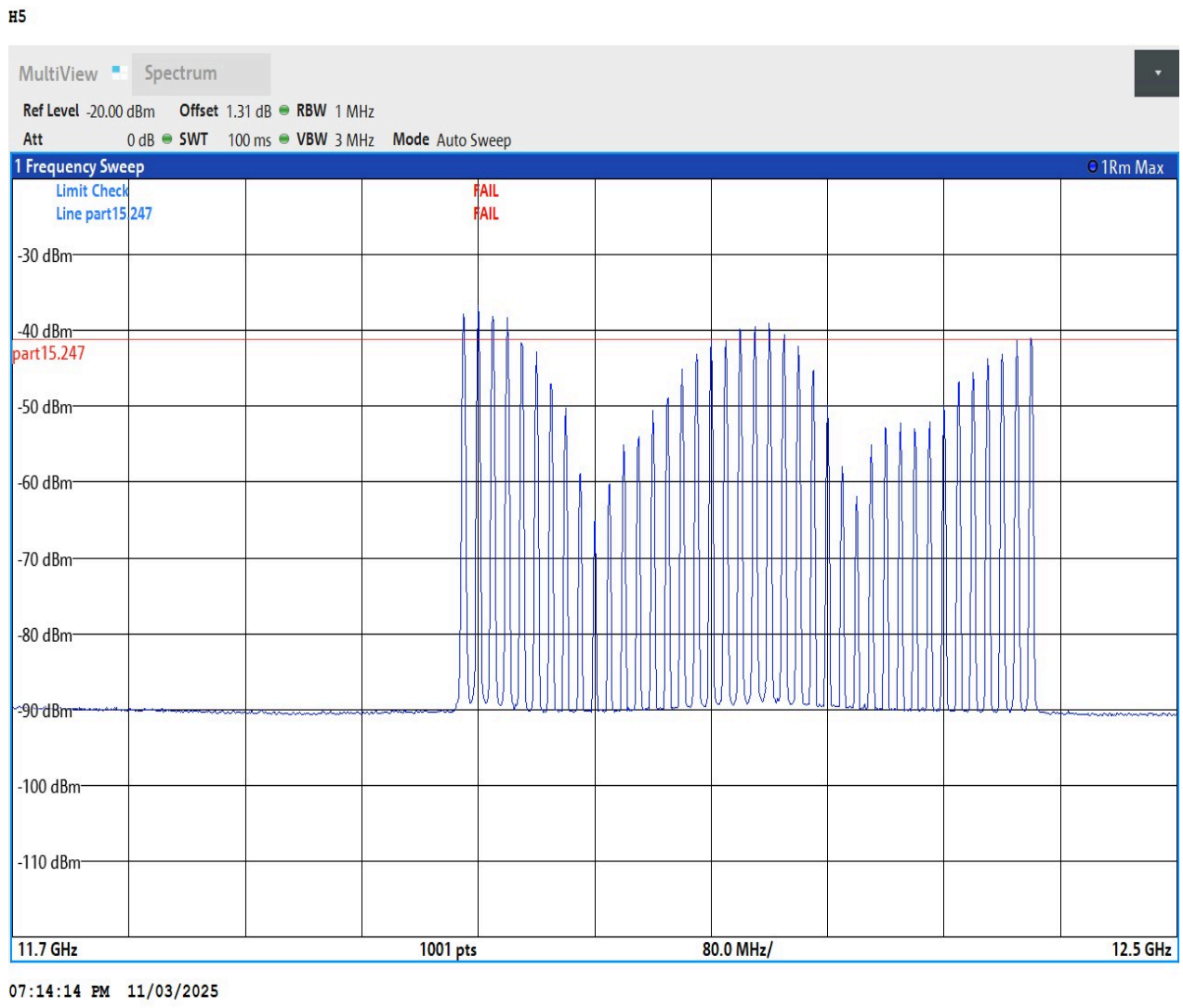

Figure 25. Bluetooth LE - Conducted H5 FCC spurious

- Maximum power is at frequency 12.01 GHz: -36.53 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion

- The output power level may be lowered to pass the H5 test, depending on the board used.

2.3.1.7.2.14 H6 (FCC test conditions, average measurement)

This test uses the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 14.1 GHz to 15 GHz.

Results

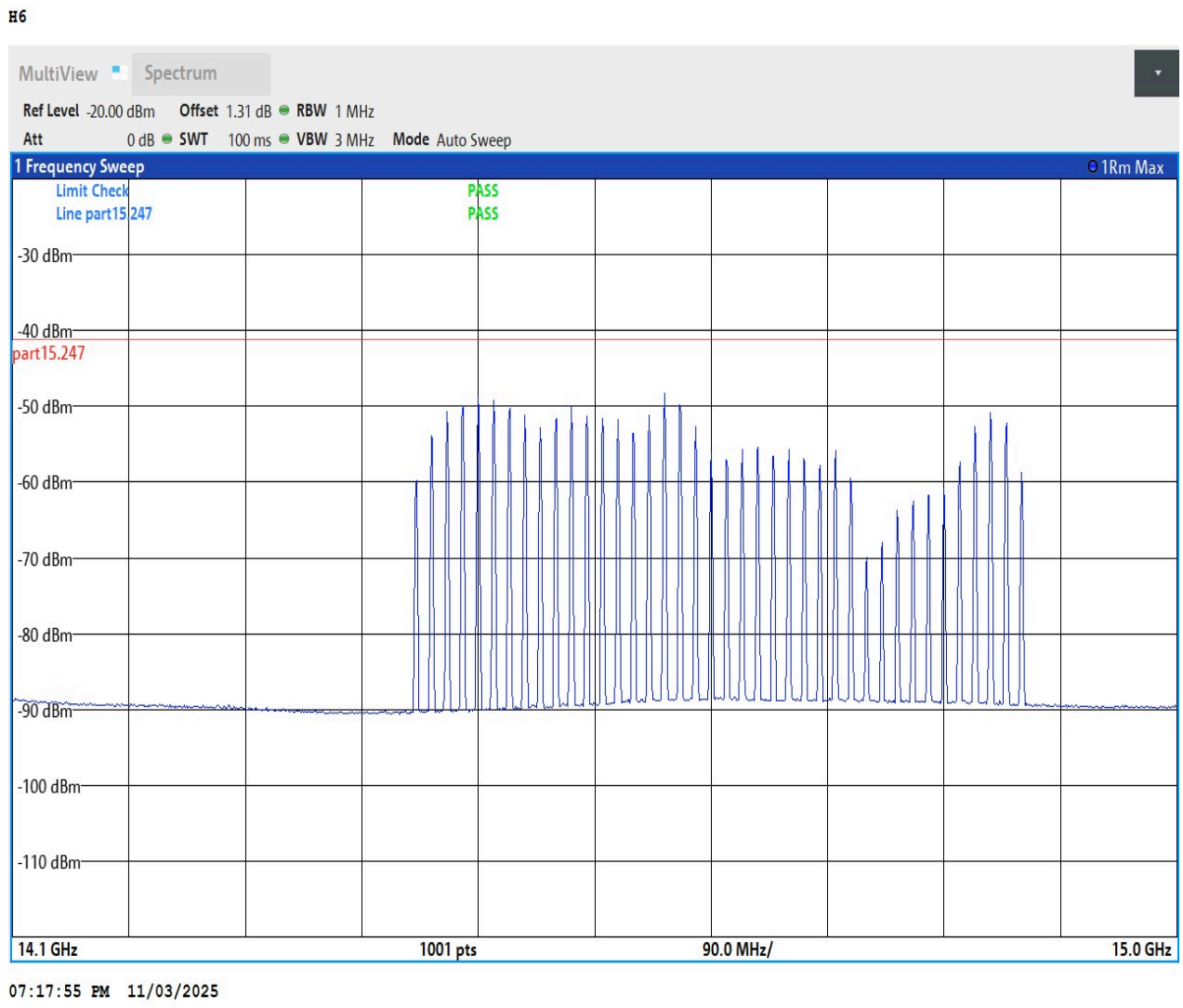

Figure 26. Bluetooth LE - Conducted H6 FCC spurious

- Maximum power is at frequency 14.58 GHz: -48.26 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion

- There is more than 7.1 dB margin for Bluetooth LE to the FCC limit.

2.3.1.7.2.15 H7 (FCC test conditions, average measurement)

This test uses the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 16.45 GHz to 17.5 GHz.

Results

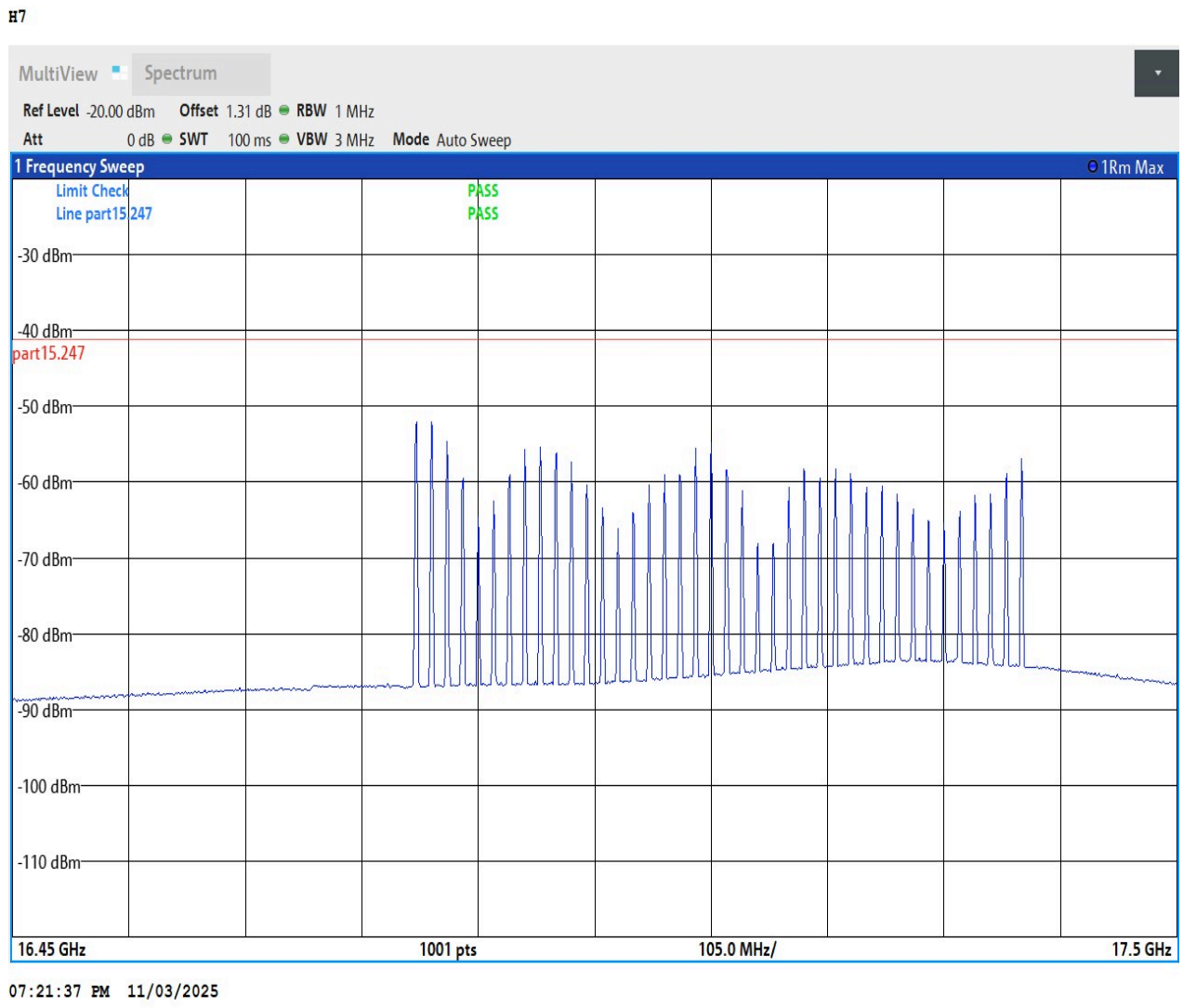

Figure 27. Bluetooth LE - Conducted H7 spurious

- Maximum power is at frequency 17.33 GHz: -51.99 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 10.9 dB margin for Bluetooth LE to the FCC limit.

2.3.1.7.2.16 H8 (FCC test conditions, average measurement)

This test uses the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 18.8 GHz to 20 GHz. Result:

Results

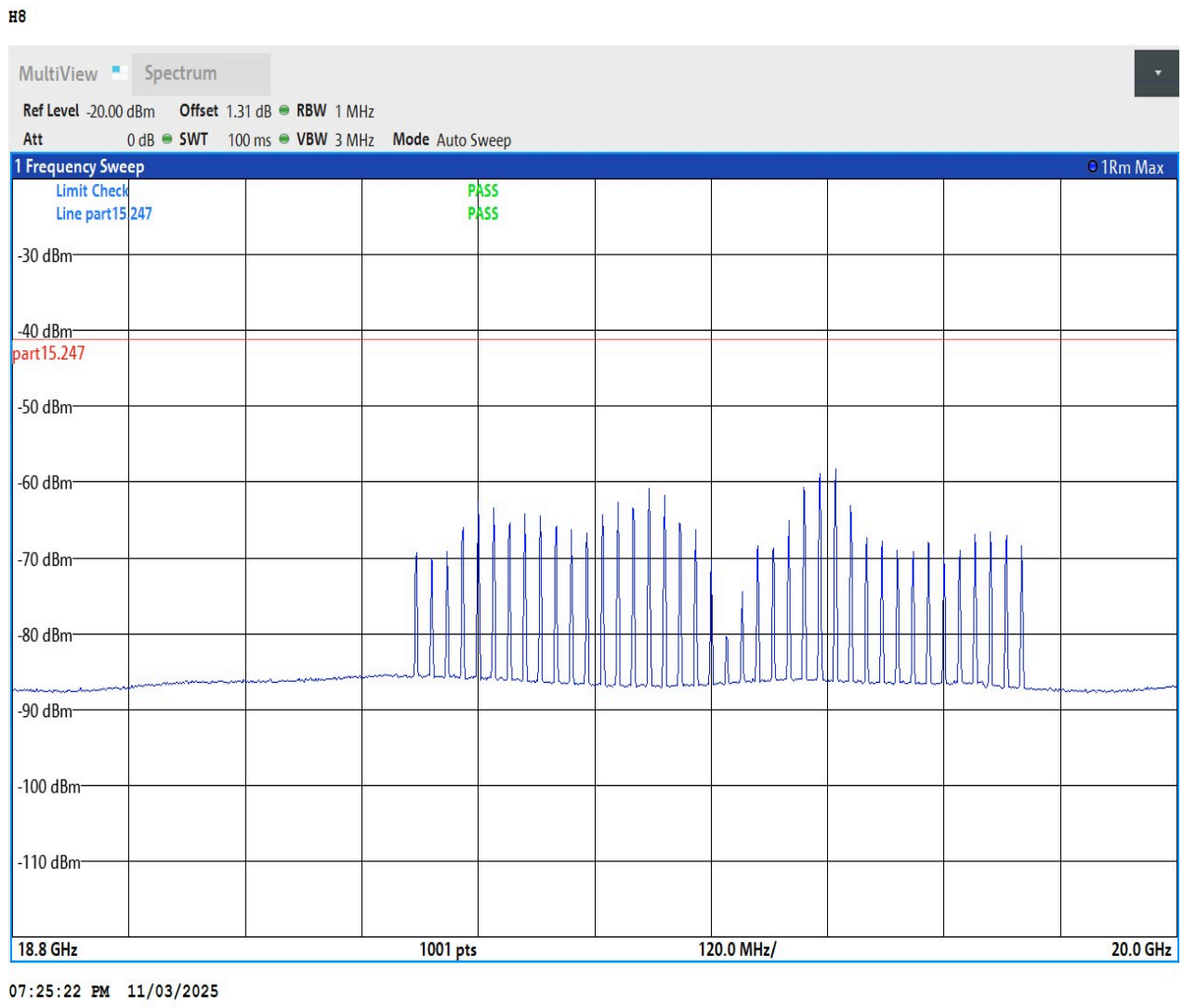

Figure 28. Bluetooth LE - Conducted H8 FCC spurious

- Maximum power is at frequency 19.62 GHz: -58.23 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 17.1 dB margin for Bluetooth LE to the FCC limit.

2.3.1.7.2.17 H9 (FCC test conditions, average measurement)

This test uses the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 21.15 GHz to 22.5 GHz. Result:

Results

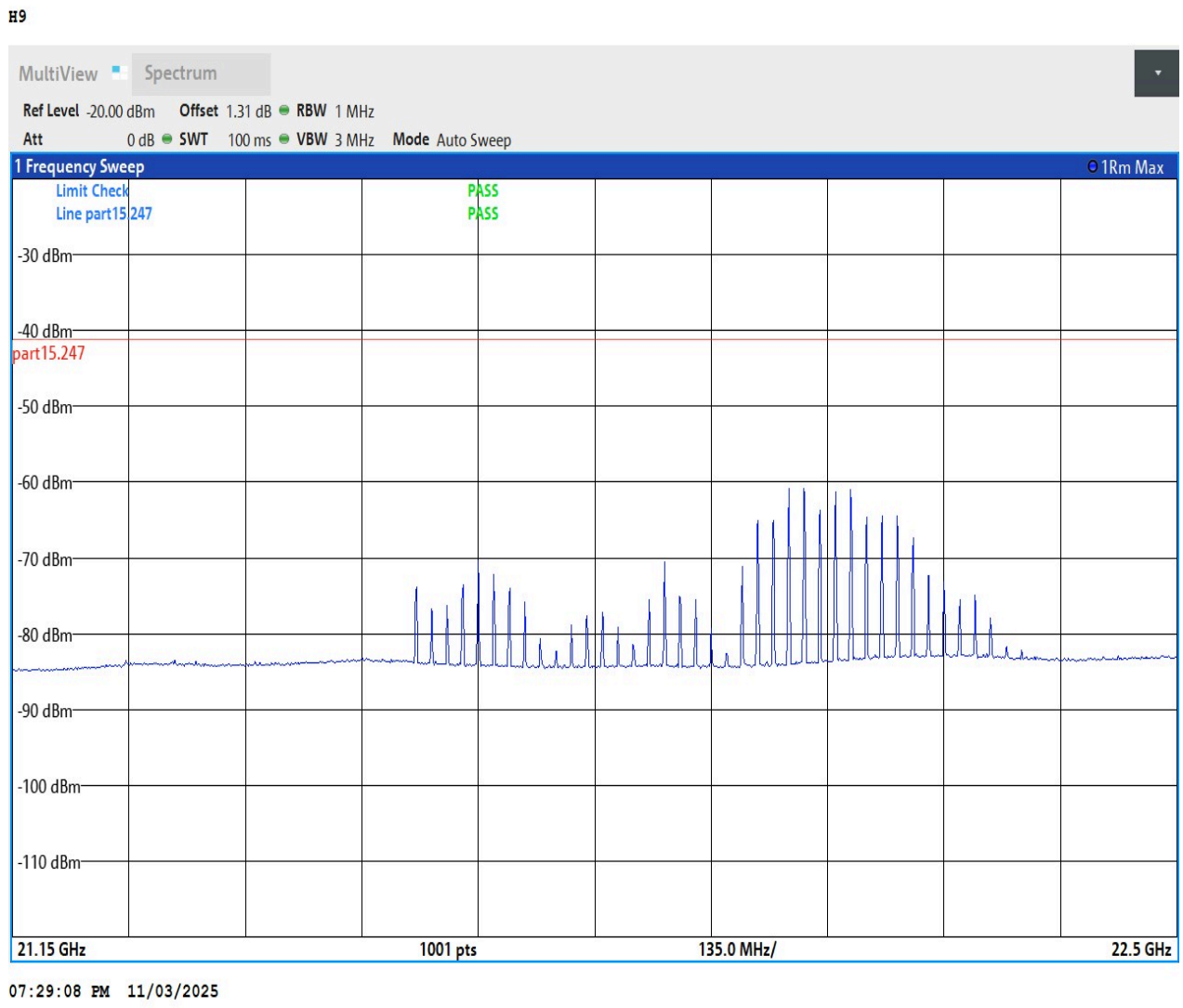

Figure 29. Bluetooth LE - Conducted H9 FCC spurious

- Maximum power is at frequency 22.01 GHz: -60.82 dBm,

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 19.7 dB margin for Bluetooth LE to the FCC limit.

2.3.1.7.2.18 H10 (FCC test conditions, average measurement)

This test follows the same method as the H2 FCC, except that the spectrum analyzer frequency span is set from 23.35 GHz to 25 GHz.

Results

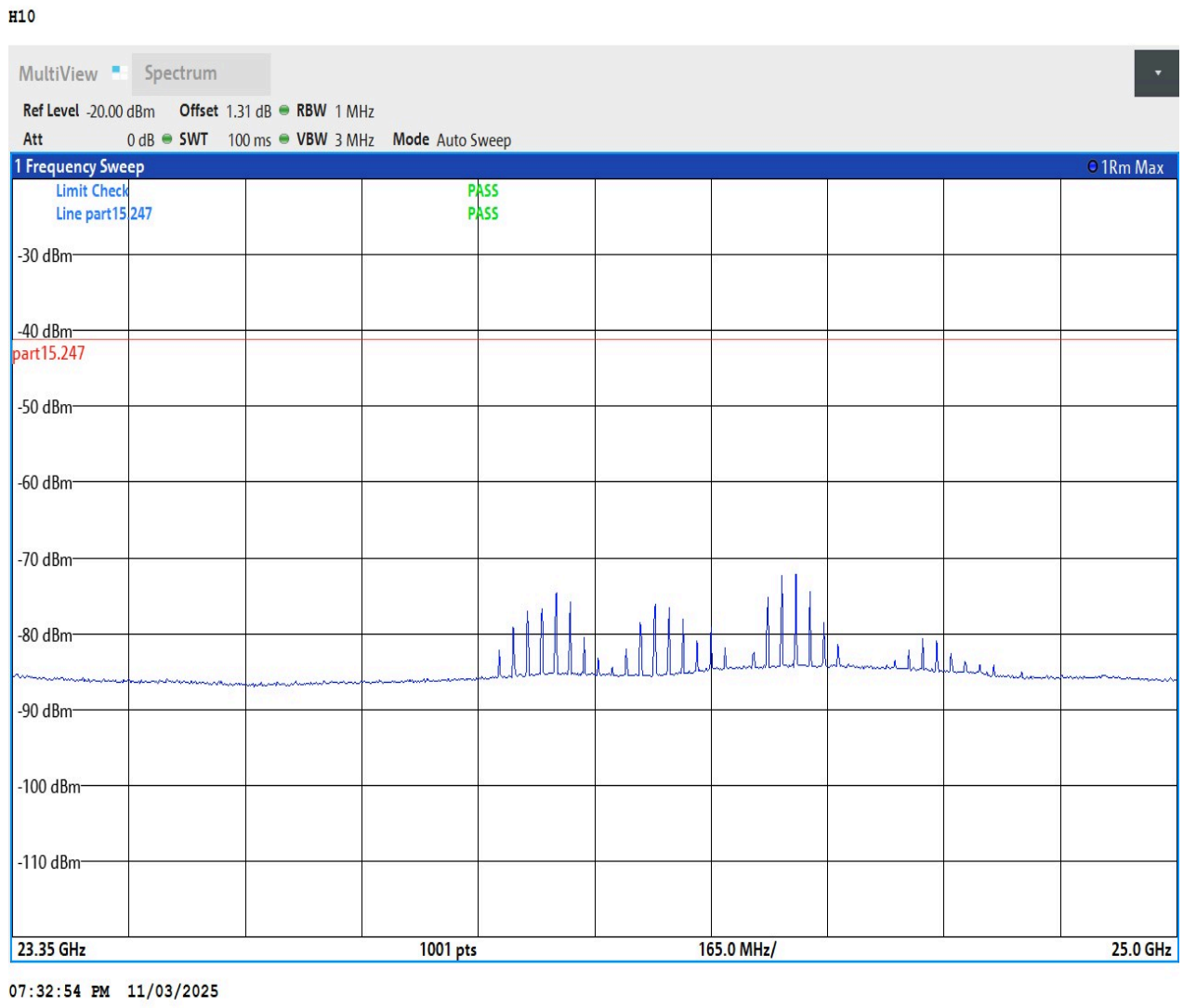

Figure 30. Bluetooth LE - Conducted H10 FCC spurious

- Maximum power is at frequency 24.42 GHz: -72.28 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion

There is more than 31.2 dB margin for Bluetooth LE to the FCC limit.

2.3.1.8 Lower Band Edge – MIIT China

Test method

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, burst mode
- Set the Bluetooth LE Channel 37 (2.402 GHz)
- Set the analyzer to:
  - Start frequency= 2.375 GHz
  - Stop frequency=2.405 GHz
  - Reference amplitude=-20 dBm
  - Sweep time=100 ms
  - Sweep point: 8001 pts
- RBW = 1 MHz, VBW = 3 MHz
- Detector = RMS MaxHold

2.3.1.8.1 Lower Band Edge – MIIT China Bluetooth LE results

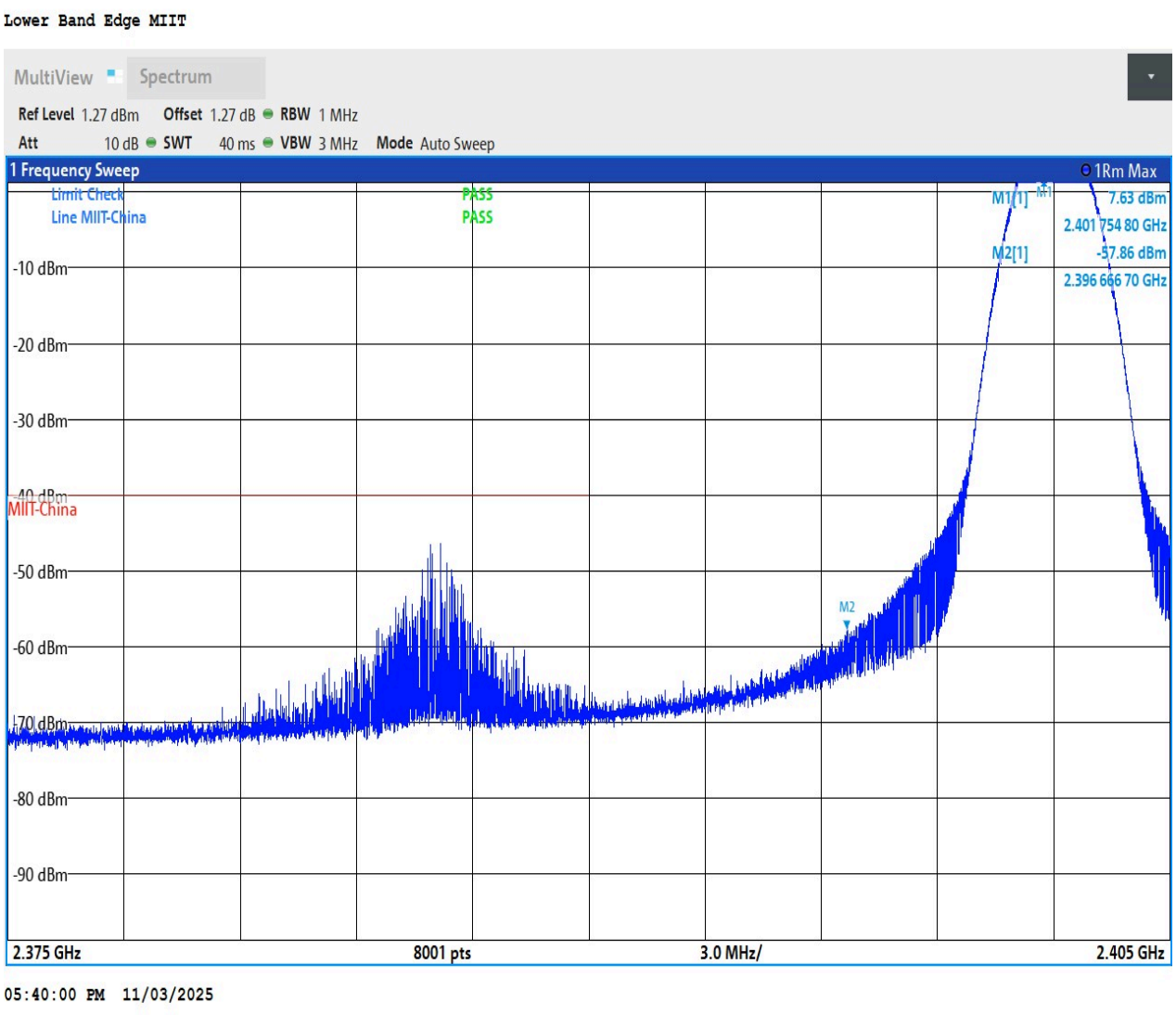

Figure 31. Lower Band Edge – Channel 37

Conclusion:

- The Lower Band Edge test passes the Bluetooth SIG (MIIT-China) certification.
- There is a good margin of 26.53 dB.

2.3.1.9 Upper Band Edge – MIIT China

Test method

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, burst mode
- Set the channel 39 (2.48 GHz)
- Set the analyzer to:
  - Start frequency= 2.477 GHz

- Stop frequency=2.507 GHz
- Reference amplitude=-20 dBm
- Sweep time=40 ms
- Sweep point: 8001 pts

- RBW = 1 MHz, Video BW = 3 MHz
- Detector Mode = RMS
- Trace Mode: Max Hold

2.3.1.9.1 Upper Band Edge (Bluetooth LE) results

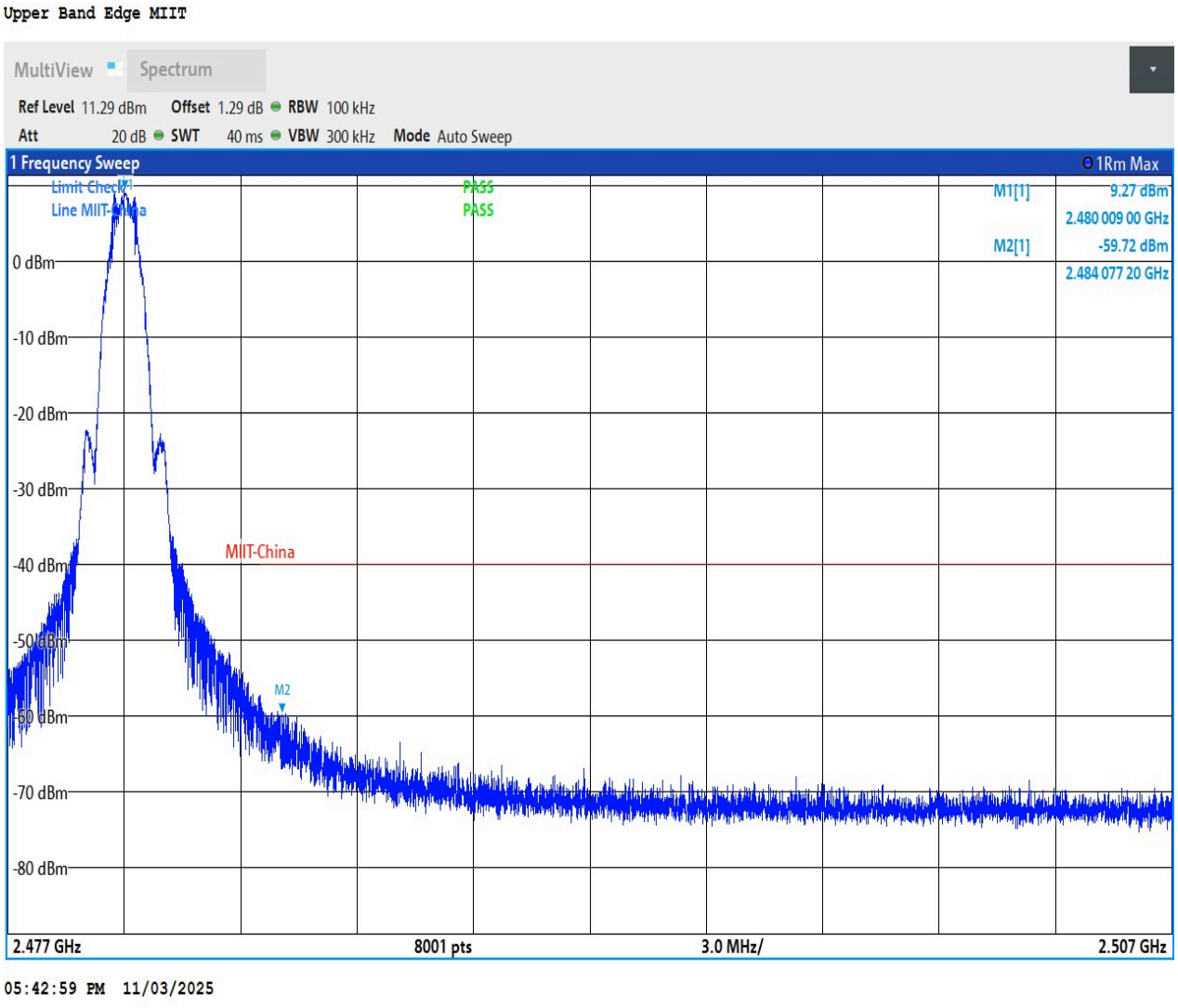

Figure 32. Upper Band Edge – Channel 39

Conclusion:

- The board passes the Upper Band Edge MIIT certification.
- There is a good margin of 17.67 dB.

2.3.1.10 Upper Band Edge (FCC ANSI C63.10, 558074 D01 DTS)

Test method

- Test setup N1 is used. See Figure 3
- Set the radio parameters of the board to:
  - TX mode, modulated (1 Mbit/s, 2 Mbit/s, 500 kbit/s, 125 kbit/s)
  - Continuous emitting mode
  - Maximum RF output power +10 dBm
- Set the analyzer to:
  - Start frequency = 2.475 GHz
  - Stop frequency = 2.485 GHz
  - Reference amplitude=-20 dBm
  - Sweep time=Auto
  - RBW = 100 kHz
  - Video BW = 300 kHz
  - Detector = Average
  - Average mode: power
  - Number of Sweeps = 100
  - Set the channel 39 (2.48 GHz)
  - Trace mode: Max hold

2.3.1.10.1 Upper Band Edge – Channel 39 (Bluetooth LE) results

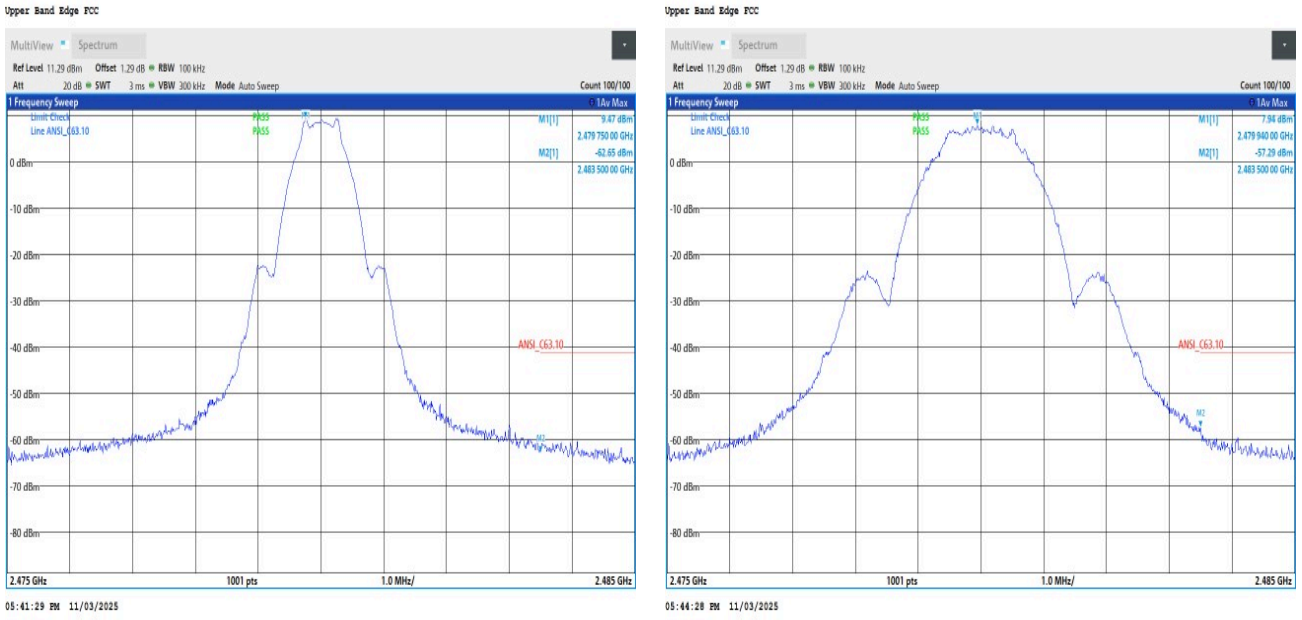

Figure 33. Upper Band Edge – Channel 39 (Bluetooth LE) results

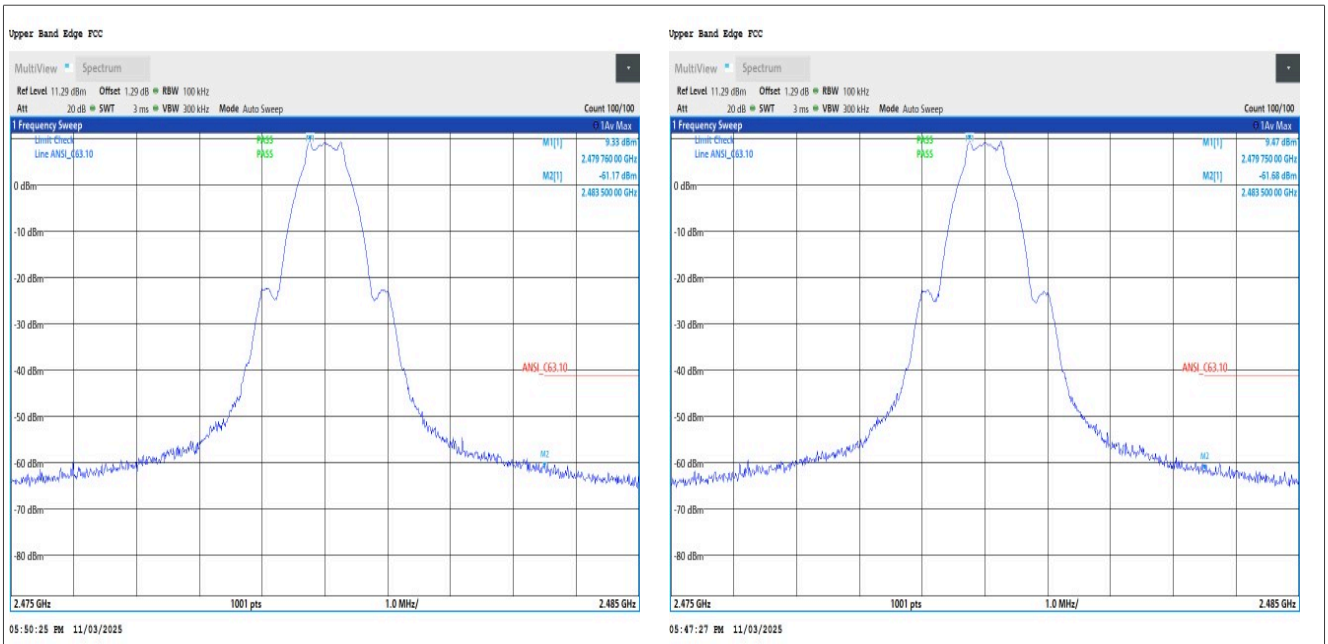

Figure 34. Upper Band Edge – Channel 39 (Bluetooth LE) results

Table 18. Upper Band Edge (FCC ANSI)

Modulation	1 Mbit/s	2 Mbit/s	500 kbit/s	125 kbit/s
Level @2.4835 GHz	-61.21 dBm	-58.95 dBm	-59.3 dBm	-61.2 dBm

FCC upper limit: -41.25 dBm

Conclusion:

- The board passes the Upper Band Edge FCC Certification.
- There is a minimum of 17.8 dB margin.

2.3.1.11 Out Of Band (ETSI 300 328 chapter 5.4.8.2.1)

Test method:

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  - Start frequency = 2.475 GHz, Stop frequency = 2.485 GHz
  - Reference amplitude = -20 dBm
  - Sweep time=100 ms,
  - RBW = 1 MHz, Video BW = 3 MHz
  - Detector = RMS
  - Average mode: power
  - Number of Sweeps = 100
- Set the channel to Channel 37 (2.402 GHz) and Channel 39 (2.48 GHz)
- Trace mode: Max hold

Result

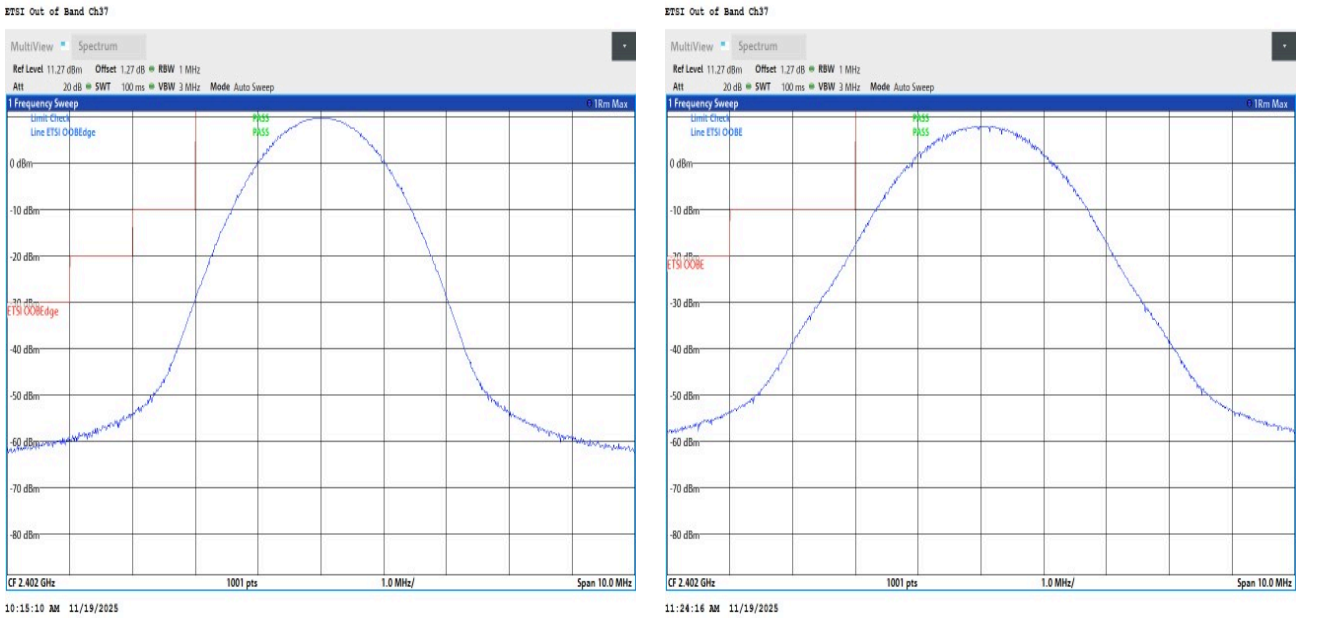

Figure 35. Out of Band ETSI – Channel 37 (Bluetooth LE) results

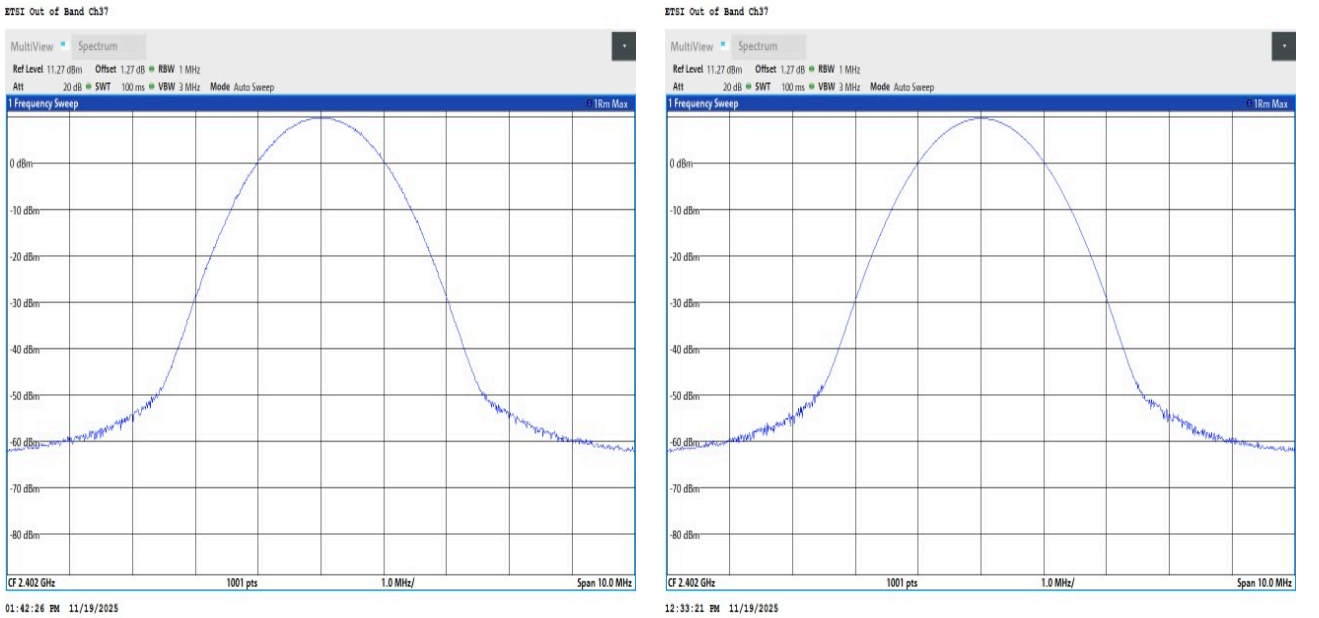

Figure 36. Out of Band ETSI – Channel 39 (Bluetooth LE) results

Conclusion:

- The FRDM-MCXW72 passes the ETSI limit.
- There is a 1000 dB margin below the limit.

2.3.1.12 Out Of Band (ARIB STD T-66)

Test method:

- Test setup N1 is used. See Figure 3.
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  - Start frequency = 2.475 GHz
  - Stop frequency = 2.485 GHz
  - Reference amplitude = -20 dBm
  - Sweep time = 100 ms
  - RBW = 1 MHz, Video BW = 1 MHz
  - Detector = Peak
  - Average mode: power
  - Number of sweeps = 100
- Set the channel 37 (2.402 GHz) and channel 39 (2.48 GHz)
- Trace mode: Max hold

2.3.1.12.1 Out of Band 1 Mbit/s Channel 37 ARIB

Figure 37 illustrates the detailed results of Out of Band 1 Mbit/s Channel 37 (ARIB).

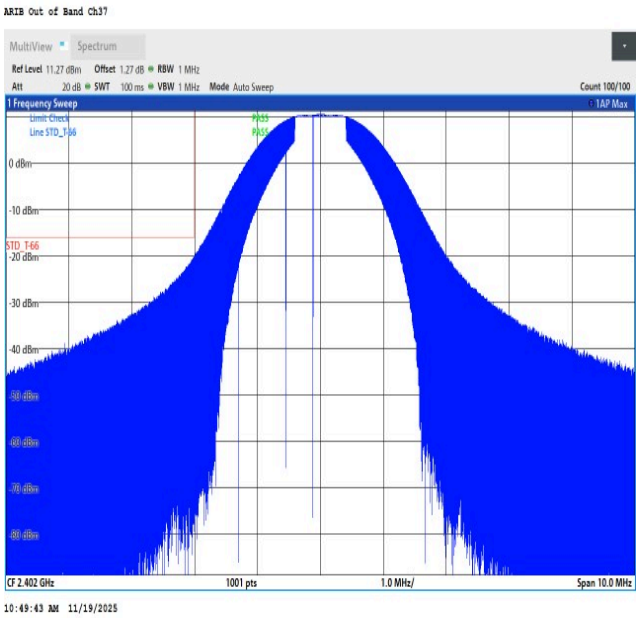

Figure 37. Out of Band 1 Mbit/s Channel 37 ARIB

2.3.1.12.2 Out of Band 2 Mbit/s Channel 37 ARIB

Figure 38 illustrates the detailed results of Out of Band 2 Mbit/s Channel 37 (ARIB).

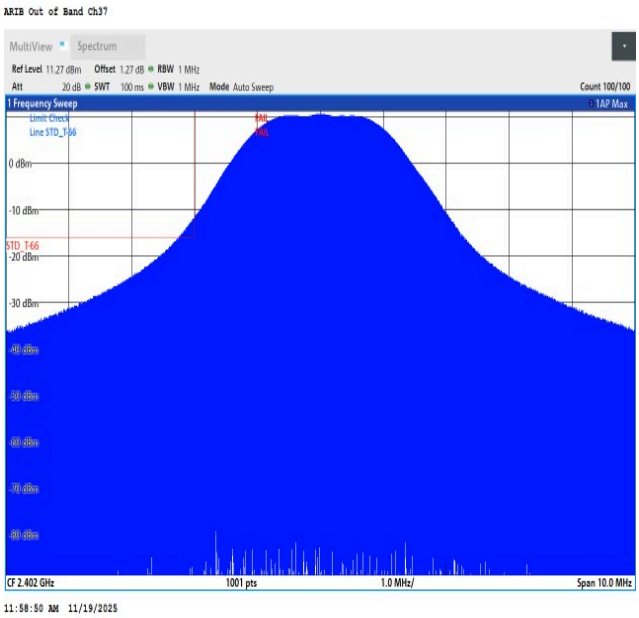

Figure 38. Out of Band 2 Mbit/s Channel 37 ARIB

2.3.1.12.3 Out of Band 500 kbit/s Channel 37 ARIB

Figure 39 illustrates the detailed results of Out of Band 500 kbit/s Channel 37 (ARIB).

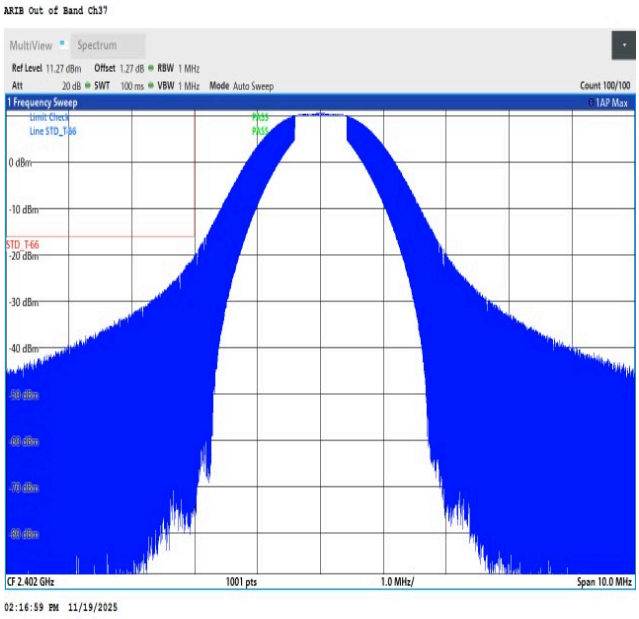

Figure 39. Out of Band 500 Kbit/s Channel 37 ARIB

2.3.1.12.4 Out of Band 125 kbit/s Channel 37 ARIB

Figure 40 illustrates the detailed results of Out of Band 125 kbit/s Channel 37 (ARIB).

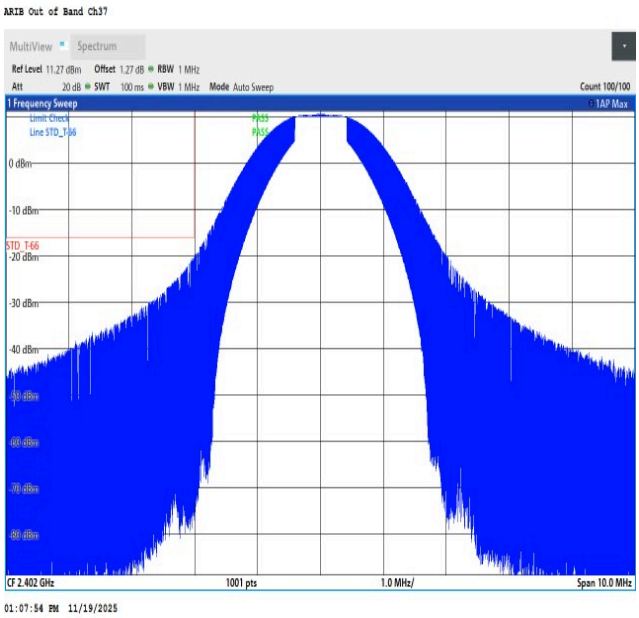

Figure 40. Out of Band 125 Kbit/s Channel 37 ARIB

2.3.1.12.5 Out of Band 1 Mbit/s Channel 39 ARIB

Figure 41 illustrates the detailed results of Out of Band 1 Mbit/s Channel 39 (ARIB).

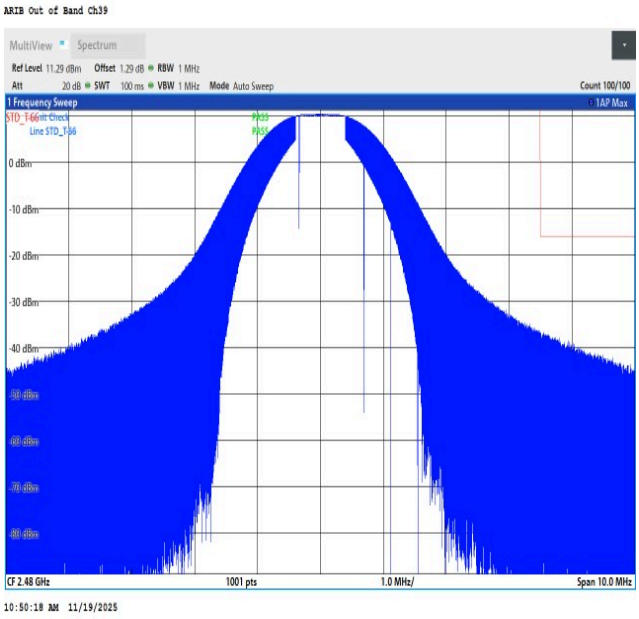

Figure 41. Out of Band 1 Mbit/s Channel 39 ARIB

2.3.1.12.6 Out of Band 2 Mbit/s Channel 39 ARIB

Figure 42 illustrates the detailed results of Out of Band 2 Mbit/s Channel 39 (ARIB).

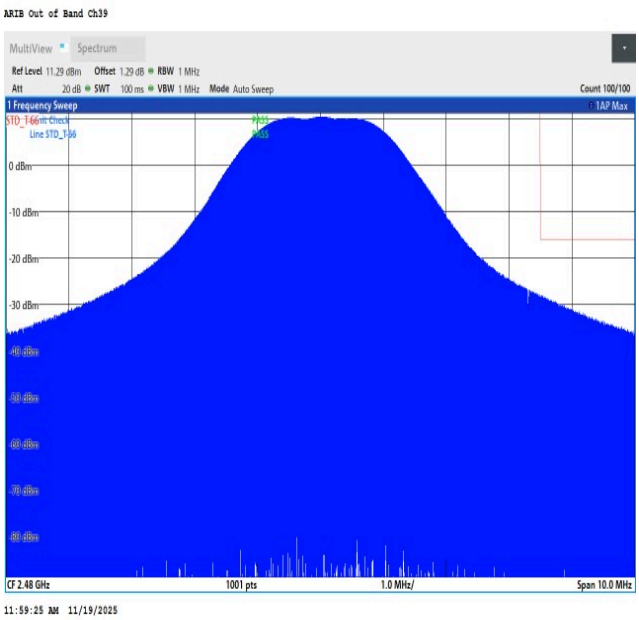

Figure 42. Out of Band 2 Mbit/s Channel 39 ARIB

2.3.1.12.7 Out of Band 500 kbit/s Channel 39 ARIB

Figure 43 illustrates the detailed results of Out of Band 500 kbit/s Channel 39 (ARIB).

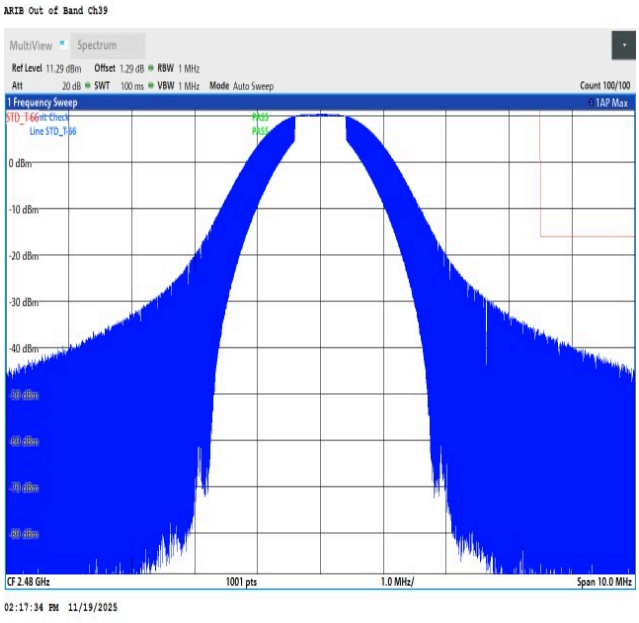

Figure 43. Out of Band 500 Kbit/s Channel 39 ARIB

2.3.1.12.8 Out of Band 125 kbit/s Channel 39 ARIB

Figure 44 illustrates the detailed results of Out of Band 125 kbit/s Channel 39 (ARIB).

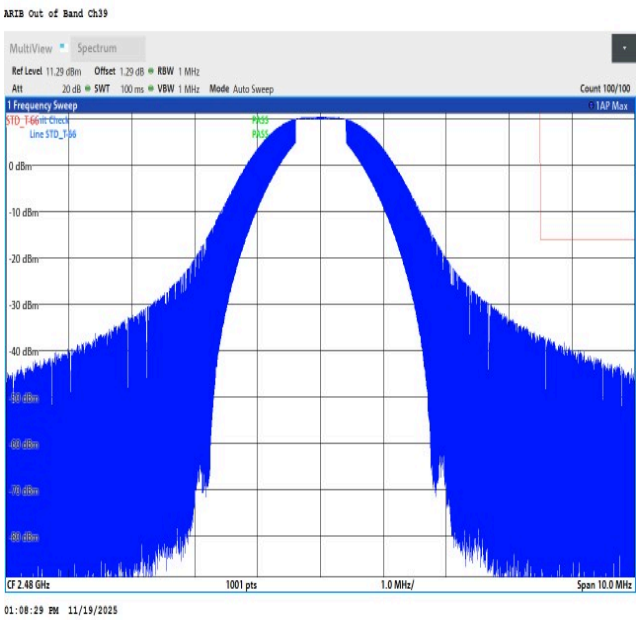

Figure 44. Out of Band 125 kbit/s Channel 39 ARIB

Conclusion:

- The FRDM-MCXW72 mostly passes the ARIB limit. The output power level may be lowered to pass the 2 Mbit/s standard, depending on the board used.
- There is a 20.75 dB margin below the limit.

2.3.1.12.9 Conclusion

- The FRDM-MCXW72 mostly passes the ARIB limit. The output power level may be lowered to pass the 2 Mbit/s standard, depending on the board used.
- There is a 20.75 dB margin below the limit.

2.3.1.13 Maximum TX output power

A CMW equipment is used to measure the PER at the maximum TX output power.

The application flashed on the board is HCI Black Box (`hci_bb`).

Test method:

- Test setup N2 is used. See Figure 4.
- Criterion: PER < 30.8 % with 1500 packets
- Bluetooth LE Channels under test: 37 (2.402 GHz), 17 (2.440 GHz), and 39 (2.480 GHz)

Table 19. Bluetooth LE 1 Mbit/s (maximum TX output power)

Bluetooth LE Channel	Power Type	Measured (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Status
37	Average	10.25	-20.0	20.0	Pass
	Peak	10.67	None	13.72	Pass
17	Average	10.25	-20.0	20.0	Pass
	Peak	10.7	None	13.58	Pass

Table 19. Bluetooth LE 1 Mbit/s (maximum TX output power)*...continued*

Bluetooth LE Channel	Power Type	Measured (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Status
39	Average	10.06	-20.0	20.0	Pass
	Peak	10.5	None	13.35	Pass

Result

Conclusion: The FRDM-MCXW72 passes the BLE BV-01-C test.

2.3.1.14 Bluetooth LE TX output spectrum

A CMW equipment is used to measure the adjacent channel power.

The application flashed on the board is HCI Black Box (`hci_bb`).

Test method:

- Test setup N2 is used.
- Bluetooth LE Channels under test:
  - Channel 2 (2408 MHz),
  - Channel 17 (2.440 GHz), and
  - Channel 35 (2476 MHz).

2.3.1.14.1 Tx output spectrum (1 Mbit/s)

This section describes the results of TX ouput spectrum at 1 Mbit/s for channels 2, 17, and 35.

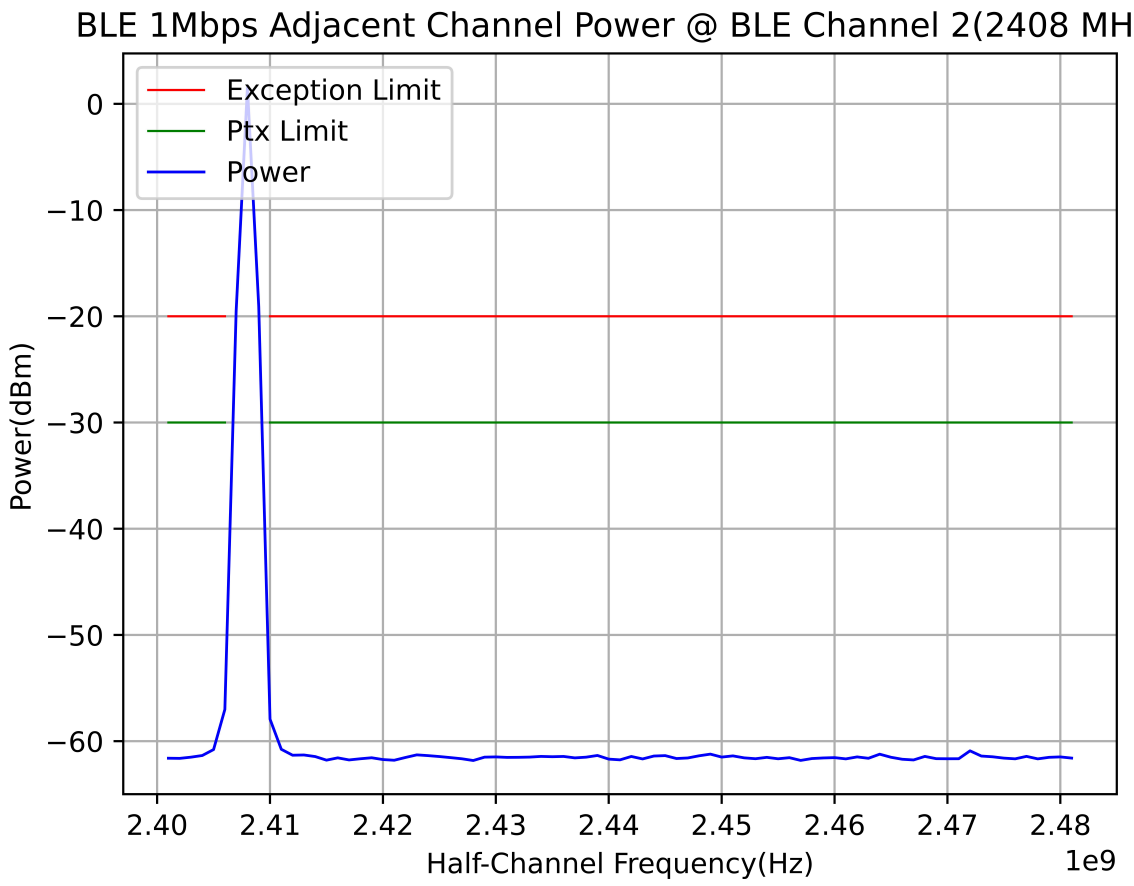

Figure 45. Bluetooth LE TX Output Spectrum Channel 2, 1 Mbit/s

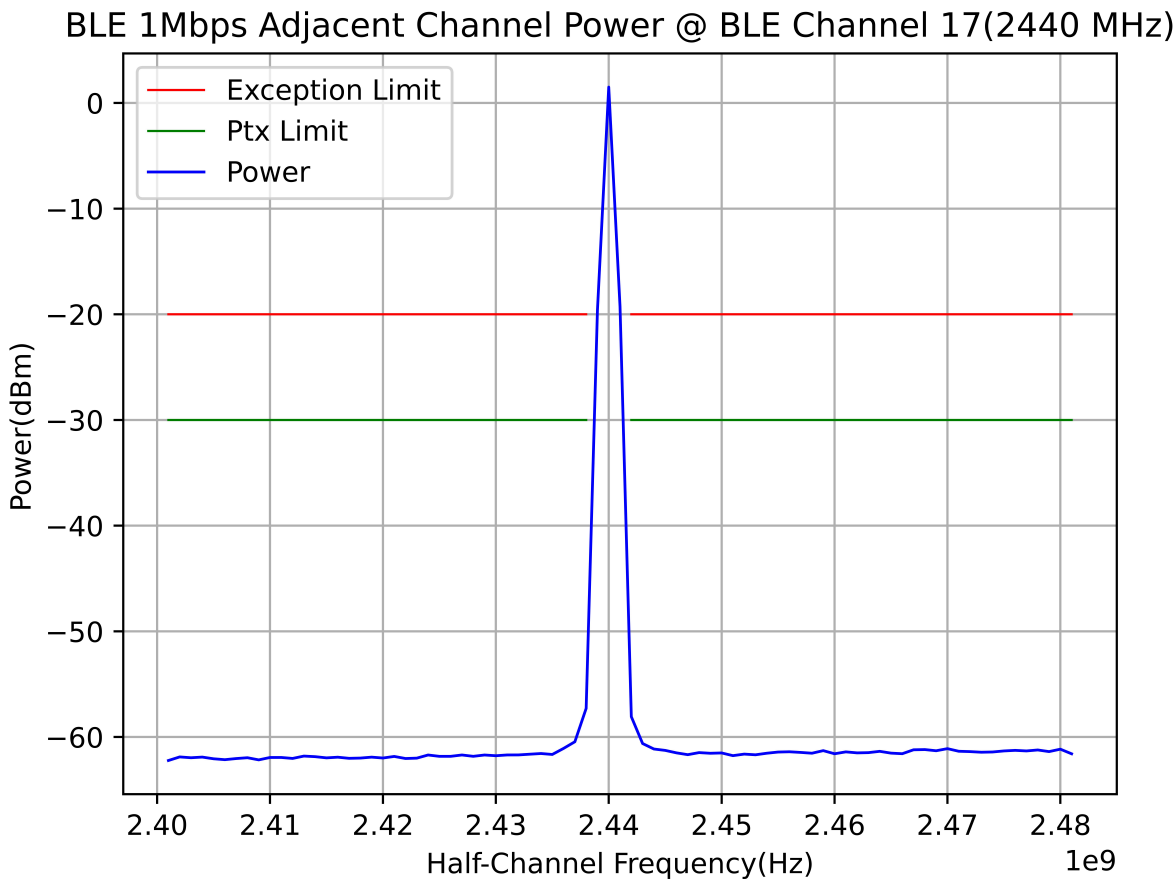

Figure 46. Bluetooth LE TX Output Spectrum Channel 17, 1 Mbit/s

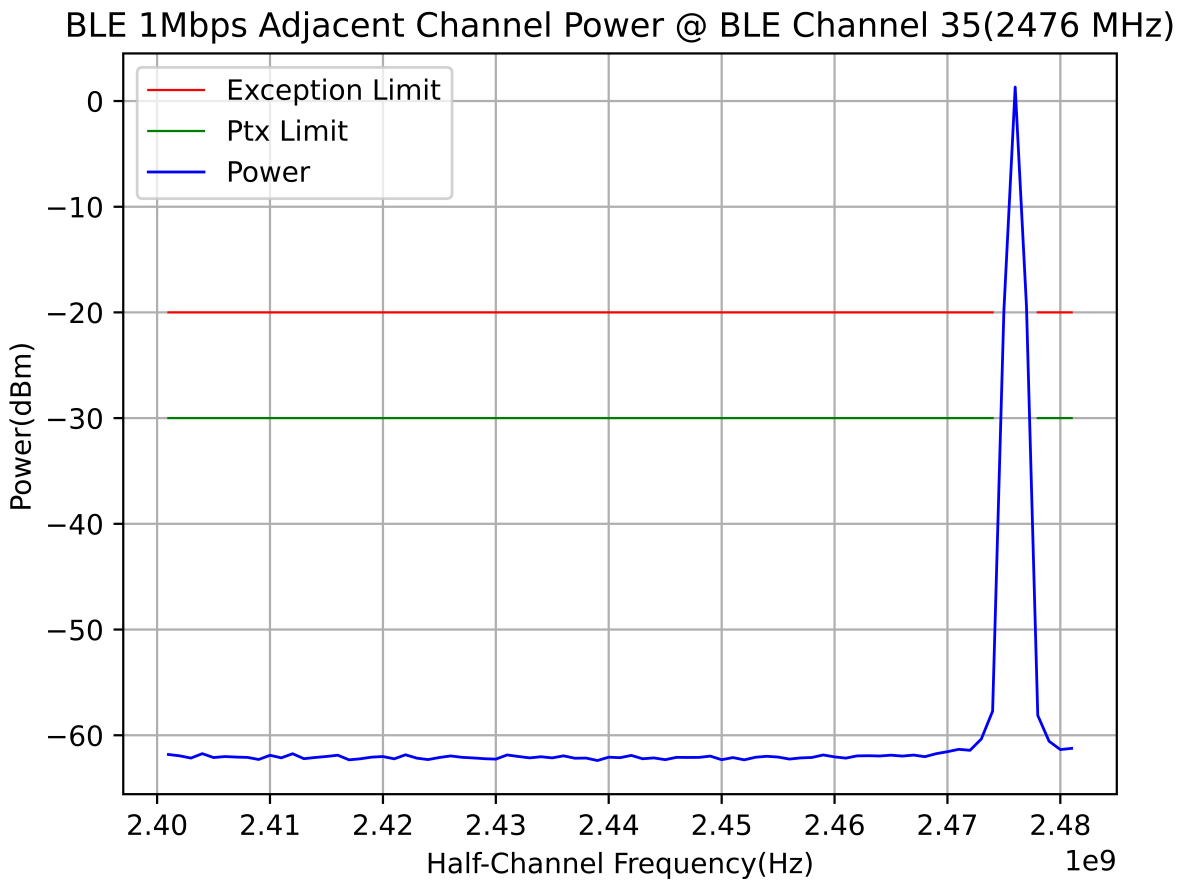

Figure 47. Bluetooth LE TX Output Spectrum Channel 35, 1 Mbit/s

2.3.1.14.2 Tx ouput spectrum (2 Mbit/s)

This section describes the results of TX ouput spectrum at 2 Mbit/s for channels 2, 17, and 35.

Result:

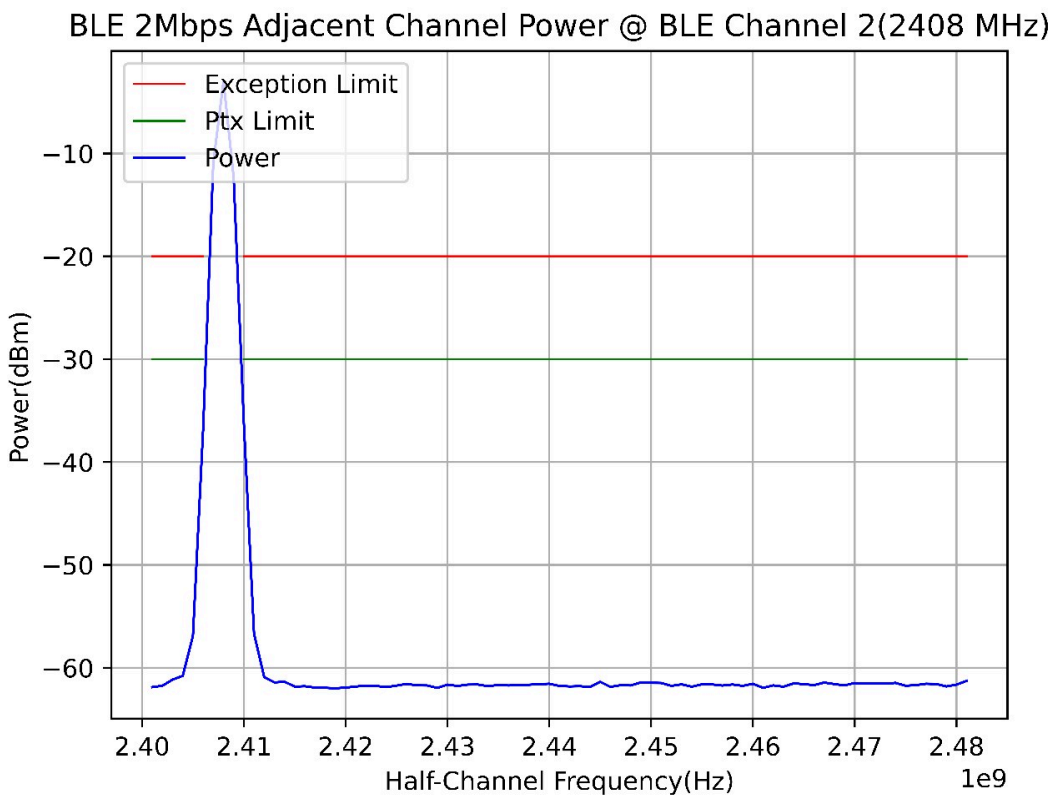

Figure 48. Channel 2, 2 Mbit/s

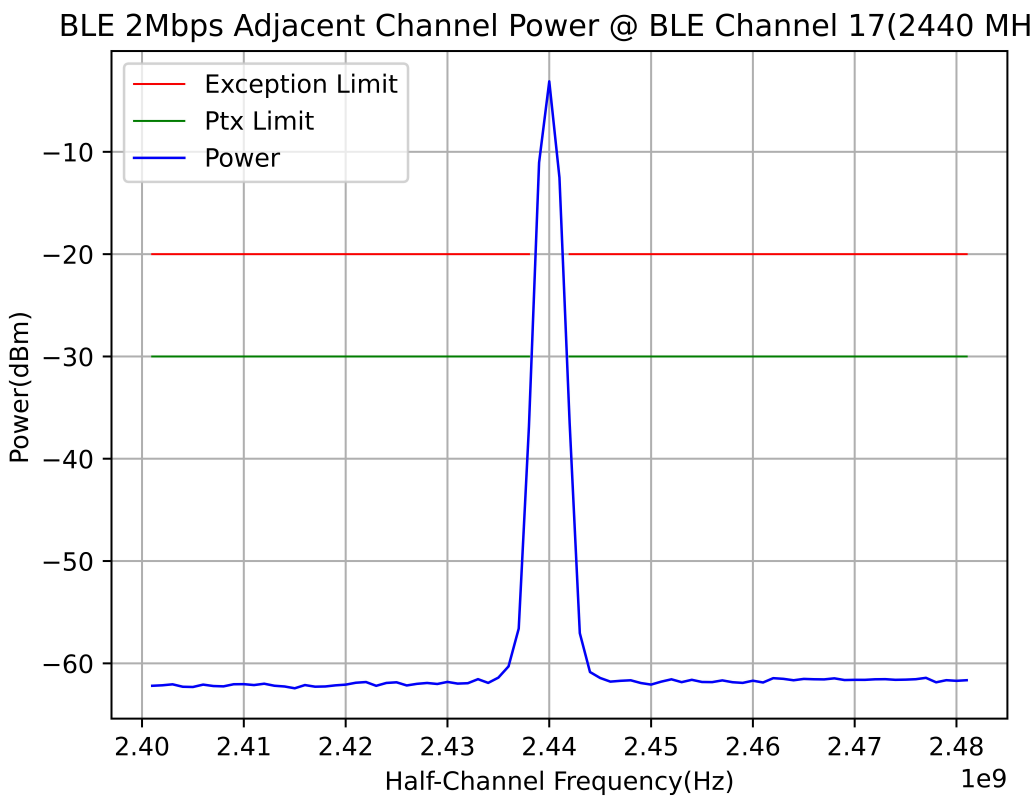

Figure 49. Channel 17, 2 Mbit/s

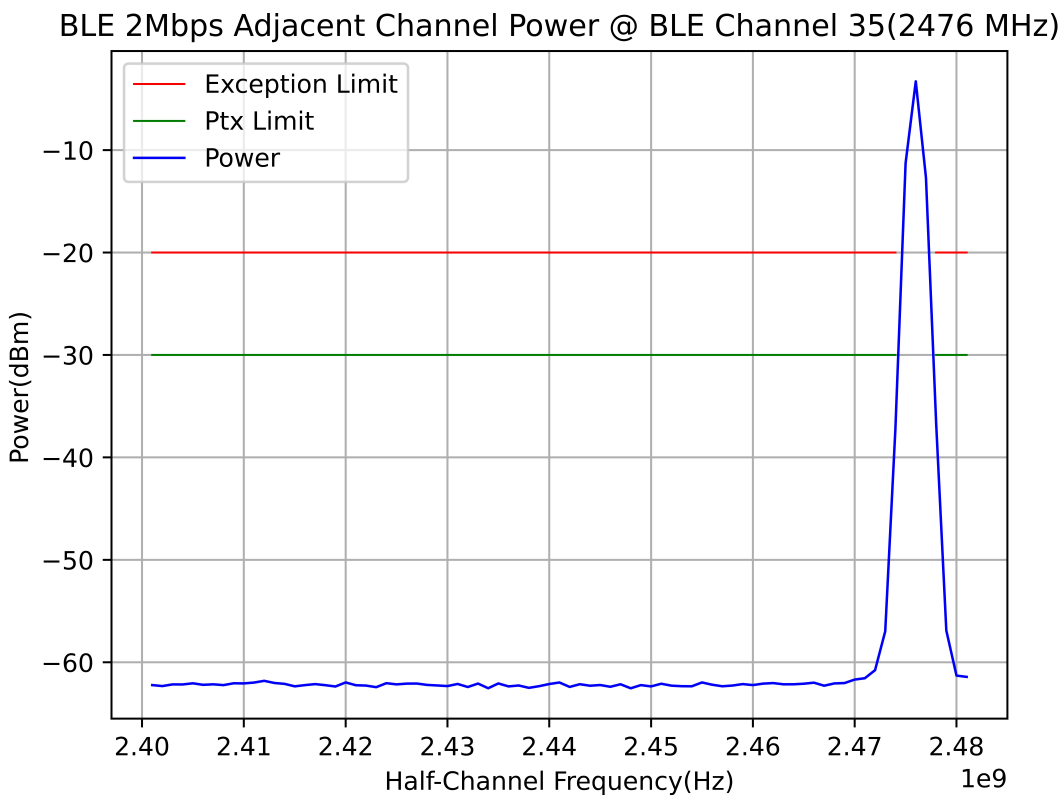

Figure 50. Channel 35, 2 Mbit/s

2.3.1.15 Modulation characteristics

A CMW equipment is used to measure the frequency deviation df1 and df2.

The application flashed on the board is: HCI Black Box (`hci_bb`).

Test method:

- Test setup N2 is used.
- Bluetooth LE Channels under test: Channel 37 (2.402 GHz), Channel 17 (2.402 GHz), and Channel 39 (2.480 GHz)

Result:

Table 20. Modulation characteristics at 1 Mbit/s

Bluetooth LE Channel	Frequency Deviation Type	Measured	Lower Limit	Upper Limit	Status
37	df1 Average (kHz)	**253.16**	*225.0*	*275.0*	Pass
	df2 99.9% (kHz)	**212.6**	*185.0*	*None*	Pass
	df2 Average / df1 Average	**0.84**	*0.8*	*None*	Pass
17	df1 Average (kHz)	**246.92**	*225.0*	*275.0*	Pass
	df2 99.9% (kHz)	**210.4**	*185.0*	*None*	Pass

Table 20. Modulation characteristics at 1 Mbit/s*...continued*

Bluetooth LE Channel	Frequency Deviation Type	Measured	Lower Limit	Upper Limit	Status
	df2 Average / df1 Average	**0.85**	*0.8*	*None*	Pass
39	df1 Average (kHz)	**252.75**	*225.0*	*275.0*	Pass
	df2 99.9% (kHz)	**210.9**	*185.0*	*None*	Pass
	df2 Average / df1 Average	**0.83**	*0.8*	*None*	Pass

Table 21. Modulation characteristics at 2 Mbit/s

Bluetooth LE Channel	Frequency Deviation Type	Measured	Lower Limit	Upper Limit	Status
37	df1 Average (kHz)	**508.54**	*450.0*	*550.0*	Pass
	df2 99.9% (kHz)	**418.8**	*370.0*	*None*	Pass
	df2 Average / df1 Average	**0.82**	*0.8*	*None*	Pass
17	df1 Average (kHz)	**508.91**	*450.0*	*550.0*	Pass
	df2 99.9% (kHz)	**420.6**	*370.0*	*None*	Pass
	df2 Average / df1 Average	**0.83**	*0.8*	*None*	Pass
39	df1 Average (kHz)	**510.65**	*450.0*	*550.0*	Pass
	df2 99.9% (kHz)	**423.6**	*370.0*	*None*	Pass
	df2 Average / df1 Average	**0.83**	*0.8*	*None*	Pass

Table 22. Modulation characteristics at LE coded (S8)

Bluetooth LE Channel	Frequency Deviation Type	Measured	Lower Limit	Upper Limit	Status
37	df1 Average (kHz)	**253.16**	*225.0*	*275.0*	Pass
	df1 99.9% (kHz)	**237.02**	*185.0*	*None*	Pass
17	df1 Average (kHz)	**253.4**	*225.0*	*275.0*	Pass
	df1 99.9% (kHz)	**236.66**	*185.0*	*None*	Pass
39	df1 Average (kHz)	**252.96**	*225.0*	*275.0*	Pass
	df1 99.9% (kHz)	**240.26**	*185.0*	*None*	Pass

Conclusion: The FRDM-MCXW72 passes the Modulation Characteristics test.

2.3.1.16 Carrier frequency offset and drift

A CMW equipment is used to measure the frequency deviation df1 and df2. The application flashed on the board is HCI Black Box (`hci_bb`).

Test method:

- Test setup N2 is used.
- Bluetooth LE Channels under test: 37 (2.402 GHz), Channel 17 (2.402 GHz), and Channel 39 (2.480 GHz)

Result:

Table 23. Carrier frequency offset and drift at 1 Mbit/s

1 Mbit/s Bluetooth LE Channel	Measure Type	Measured	Lower Limit	Upper Limit	Status
37	Frequency Accuracy (kHz)	**-2800.37**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**1495.98**	*-50000*	*50000*	Pass
	Max Drift Rate (k Hz/50µs)	**1088.74**	*-20000*	*20000*	Pass
	Frequency Offset (kHz)	**-2800.37**	*-150000*	*150000*	Pass
	Initial Frequency Drift (kHz)	**1057.13**	*-23000*	*23000*	Pass
17	Frequency Accuracy (kHz)	**-2921.74**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**1500.33**	*-50000*	*50000*	Pass
	Max Drift Rate (k Hz/50µs)	**-1077.86**	*-20000*	*20000*	Pass
	Frequency Offset (kHz)	**-2921.74**	*-150000*	*150000*	Pass
	Initial Frequency Drift (kHz)	**-684.97**	*-23000*	*23000*	Pass
39	Frequency Accuracy (kHz)	**-2982.84**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**1584.04**	*-50000*	*50000*	Pass
	Max Drift Rate (kHz/50 µs)	**-1302.68**	*-20000*	*20000*	Pass
	Frequency Offset (kHz)	**-2982.84**	*-150000*	*150000*	Pass
	Initial Frequency Drift (kHz)	**623.72**	*-23000*	*23000*	Pass

Table 24. Carrier frequency offset and drift at 2 Mbit/s

2 Mbit/s Bluetooth LE Channel	Measure Type	Measured	Lower Limit	Upper Limit	Status
37	Frequency Accuracy (kHz)	**-3174.7**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**2077.59**	*-50000*	*50000*	Pass

Table 24. Carrier frequency offset and drift at 2 Mbit/s*...continued*

2 Mbit/s Bluetooth LE Channel	Measure Type	Measured	Lower Limit	Upper Limit	Status
	Max Drift Rate (kHz/ 50 µs)	**-1062.4**	*-20000*	*20000*	Pass
	Frequency Offset (kHz)	**-3174.7**	*-150000*	*150000*	Pass
	Initial Frequency Drift (kHz)	**978.33**	*-13300*	*13300*	Pass
17	Frequency Accuracy (kHz)	**-3109.45**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**1759.33**	*-50000*	*50000*	Pass
	Max Drift Rate (k Hz/50µs)	**1176.6**	*-20000*	*20000*	Pass
	Frequency Offset (kHz)	**-3109.45**	*-150000*	*150000*	Pass
	Initial Frequency Drift (kHz)	**1018.21**	*-13300*	*13300*	Pass
39	Frequency Accuracy (kHz)	**-2489.63**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**1292.63**	*-50000*	*50000*	Pass
	Max Drift Rate (k Hz/50µs)	**1519.39**	*-20000*	*20000*	Pass
	Frequency Offset (kHz)	**-3120.96**	*-150000*	*150000*	Pass
	Initial Frequency Drift (kHz)	**-1249.8**	*-13300*	*13300*	Pass

Table 25. 500 kbit/s Bluetooth LE Channel, Carrier frequency offset and drift at LR (S=2)

500 kbit/s Bluetooth LE Channel	Measure Type	Measured	Lower Limit	Upper Limit	Status
37	Frequency Accuracy (kHz)	**-1858.59**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**-684.12**	*-50000*	*50000*	Pass
	Max Drift Rate (kHz/50 µs)	**-684.12**	*-19200*	*19200*	Pass
	Frequency Offset (kHz)	**-2157.18**	*-150000*	*150000*	Pass
17	Frequency Accuracy (kHz)	**-1936.05**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**-641.89**	*-50000*	*50000*	Pass
	Max Drift Rate (kHz/50 µs)	**-492.77**	*-19200*	*19200*	Pass
	Frequency Offset (kHz)	**-2161.47**	*-150000*	*150000*	Pass

Table 25. 500 kbit/s Bluetooth LE Channel, Carrier frequency offset and drift at LR (S=2)*...continued*

500 kbit/s Bluetooth LE Channel	Measure Type	Measured	Lower Limit	Upper Limit	Status
39	Frequency Accuracy (kHz)	**-1938.59**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**-826.35**	*-50000*	*50000*	Pass
	Max Drift Rate (k Hz/50µs)	**-409.86**	*-19200*	*19200*	Pass
	Frequency Offset (kHz)	**-2317.61**	*-150000*	*150000*	Pass

Table 26. 125 kbps Bluetooth LE Channel, Carrier frequency offset and drift at LR (S=8)

125 kbps Bluetooth LE Channel	Measure Type	Measured	Lower Limit	Upper Limit	Status
37	Frequency Accuracy (kHz)	**-1929.82**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**-1067.78**	*-50000*	*50000*	Pass
	Max Drift Rate (kHz/50 µs)	**1190.99**	*-19200*	*19200*	Pass
	Frequency Offset (kHz)	**-2711.16**	*-150000*	*150000*	Pass
17	Frequency Accuracy (kHz)	**-1853.29**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**-1171.79**	*-50000*	*50000*	Pass
	Max Drift Rate (k Hz/50µs)	**-1020.2**	*-19200*	*19200*	Pass
	Frequency Offset (kHz)	**-2516.3**	*-150000*	*150000*	Pass
39	Frequency Accuracy (kHz)	**-1901.81**	*-150000*	*150000*	Pass
	Frequency Drift (kHz)	**-896.04**	*-50000*	*50000*	Pass
	Max Drift Rate (k Hz/50µs)	**993.97**	*-19200*	*19200*	Pass
	Frequency Offset (kHz)	**-2556.55**	*-150000*	*150000*	Pass

Conclusion:

The FRDM-MCXW72 passes the Carrier Frequency Offset and Drift test.

2.3.2 RX tests

This section describes the test setup, method, and results for Bluetooth LE applications reception tests.

2.3.2.1 Test setups for Rx Bluetooth LE tests

This section explains various test setup methods to conduct Rx Bluetooth LE tests such as, sensitivity, interference rejection, spurious, and intermodulation.

Note: *In addition to Test setups N3, N4, and N5, N1 is also used for conducted Rx BLE Spurious tests. See See Figure 3.*

2.3.2.1.1 Test setup N3

Figure 51 shows the test setup to conduct Rx Bluetooth LE sensitivity tests.

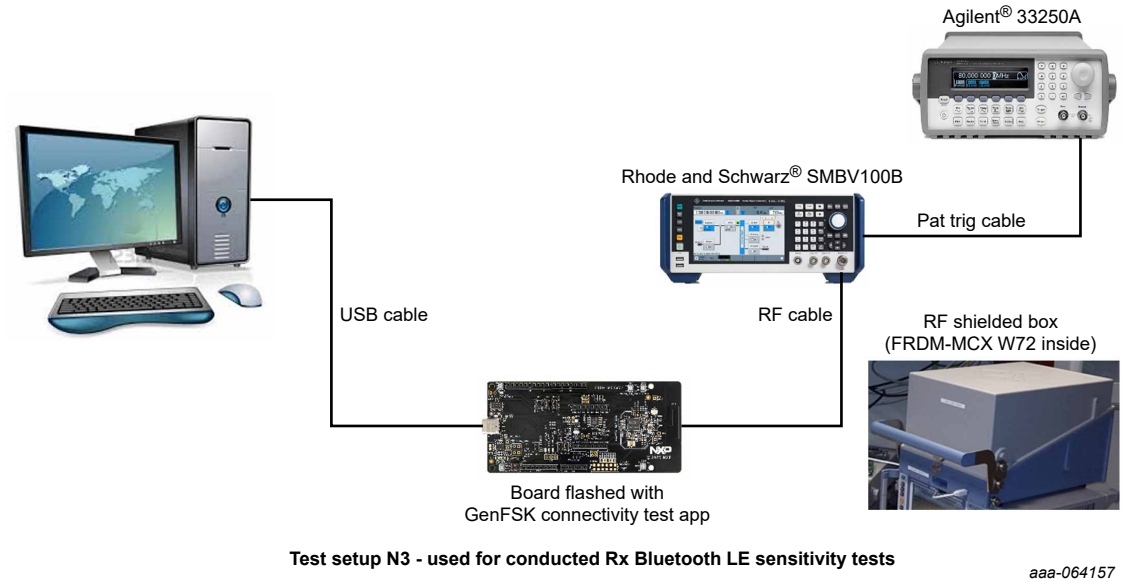

Figure 51. Test setup N3

2.3.2.1.2 Test setup N4

Figure 52 shows the test setup to conduct Rx Bluetooth LE sensitivity tests.

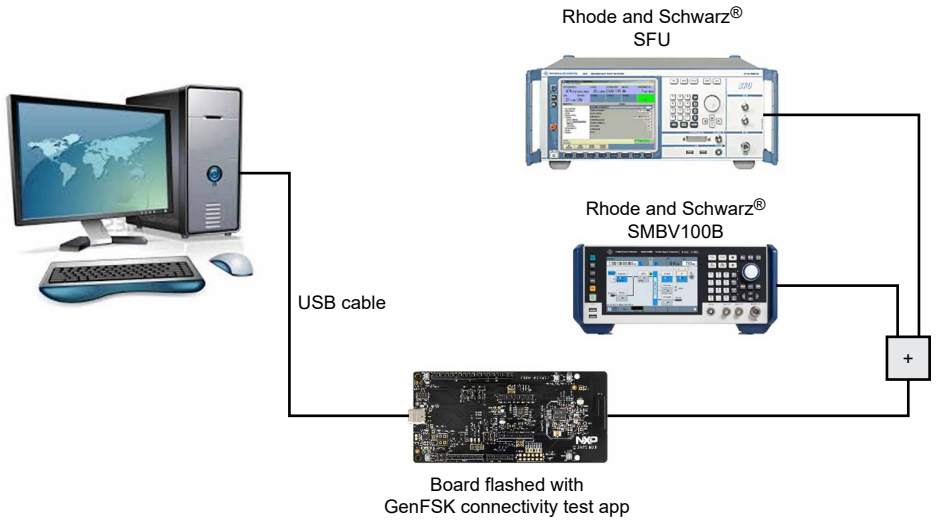

Figure 52. Test setup N4

2.3.2.1.3 Test setup N5

Figure 53 shows the test setup to conduct Rx Bluetooth LE intermodulation tests.

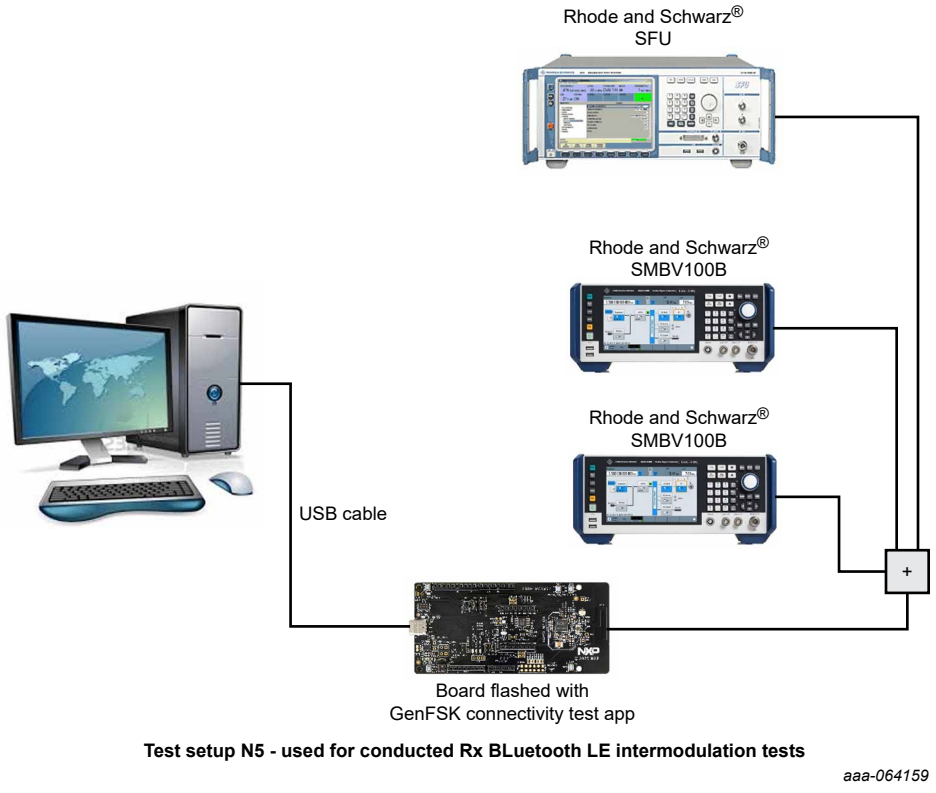

Figure 53. Test setup N5

2.3.2.2 Sensitivity

This section describes the test results for the Bluetooth LE receiver sensitivity tests for 1 Mbit/s, 2 Mbit/s, LR (S=2) and LR (S=8).

2.3.2.2.1 Test method

To remain immune to the external parasitic signals, FRDM-MCXW72 is put into an RF shielded box.

- Test setup N3 is used. See Figure 51.

Note: A desense is observed on XTAL (32 MHz) Harmonics.

The ARB generator is used to generate 1500 Bluetooth LE packets. The Serial terminal window is used to control the module.

- Four modes are checked: 1 Mbit/s, 2 Mbit/s, LR (S=2) and LR (S=8)
- Set it to the Bluetooth LE Channel 37 (2.402 GHz).
- The connection is automatically established and the PER (Packet Error Rate) is measured.
- Decrease the level of the SFU at the RF input of the module until PER = 30.8 %.
- Repeat it up to Channel 39.

2.3.2.2.2 Results

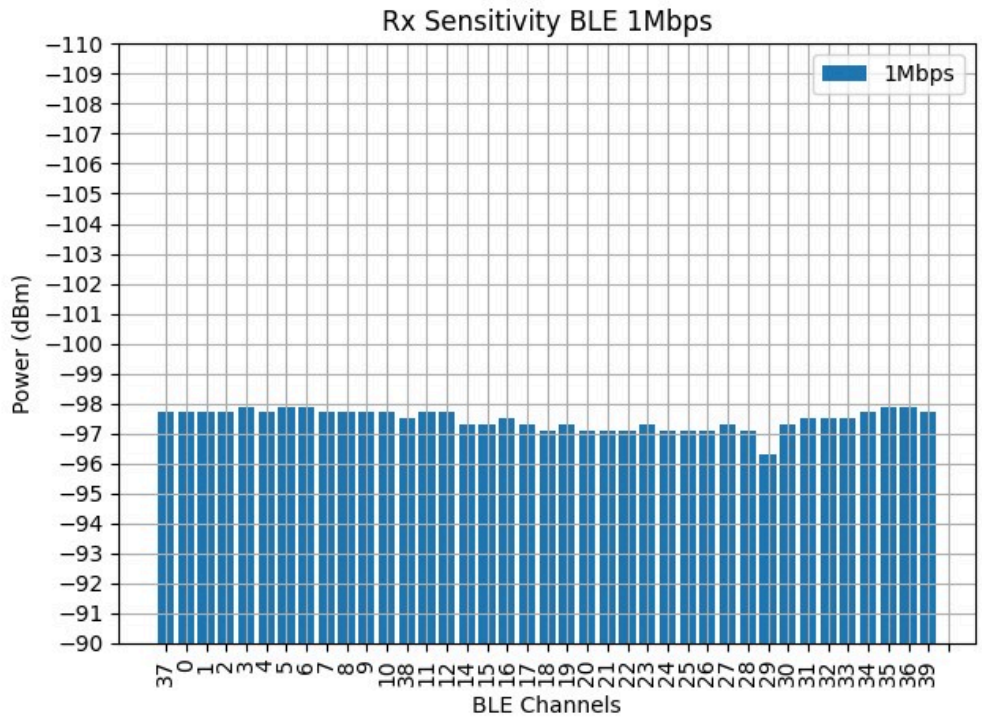

Figure 54. Sensitivity result – 1 Mbit/s

- The best sensitivity is on channel 3: -97.9 dBm
- The lowest sensitivity is on channel 29: -96.3 dBm
- Delta over channels: 1.6 dB

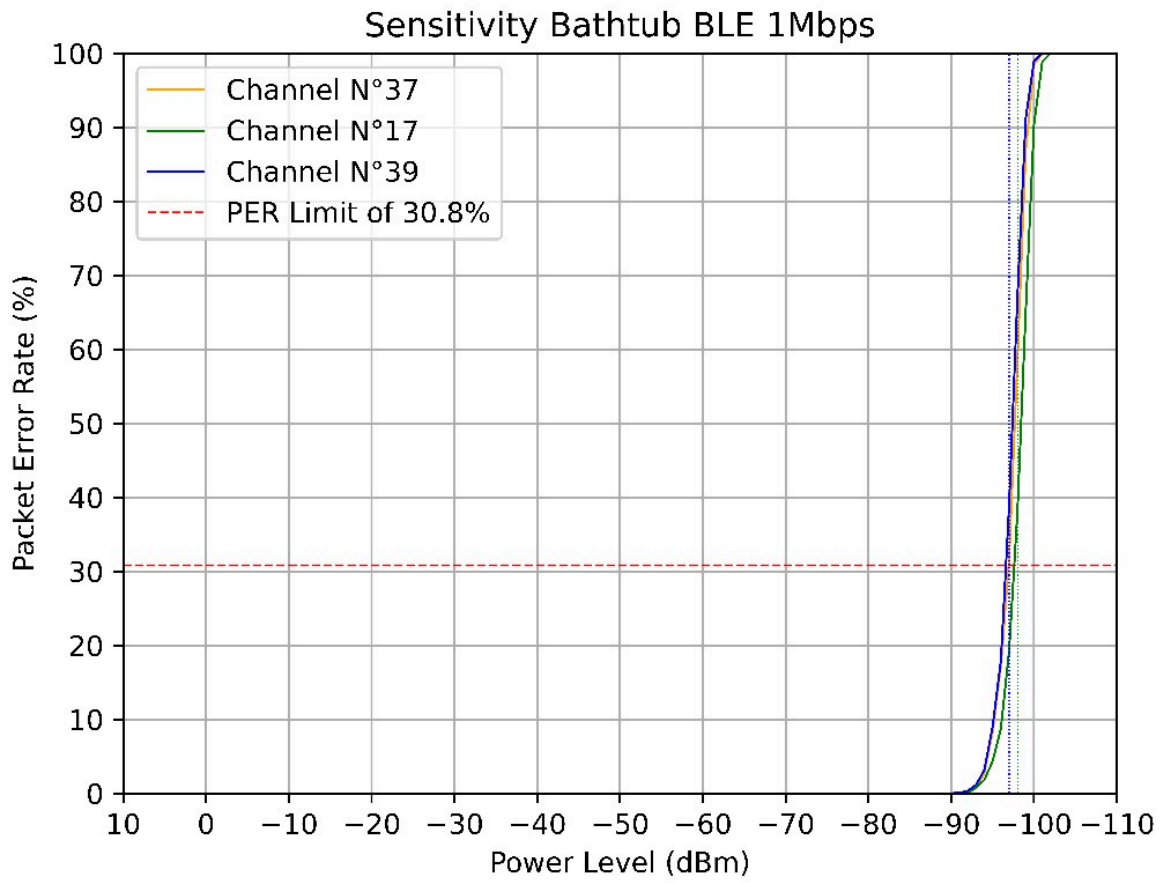

Figure 55. Sensitivity bathtub result – 1 Mbit/s

Note: *A desense can be commonly observed on the frequencies of the board XTAL harmonics. FRDM-MCX W72 shows an average value of -97.47 dBm (1 Mbit/s) at SMA connector.*

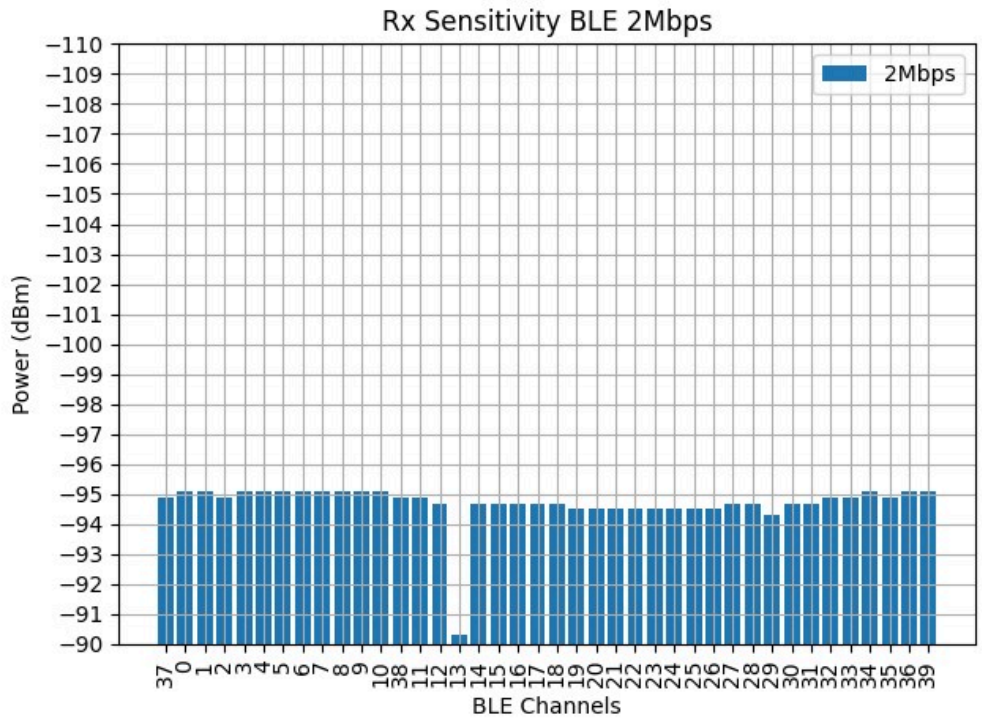

Figure 56. Sensitivity result – 2 Mbit/s

Sensitivity result – 2 Mbit/s

- The best sensitivity is on channel 0: -95.1 dBm
- The lowest sensitivity is on channel 13: -90.3 dBm
- Delta over channels: 4.8 dB

Note: A desense is commonly observed on the frequencies of the board XTAL harmonics. FRDM-MCX W72 shows an average value of -94.705 dBm (2 Mbit/s) at the SMA connector.

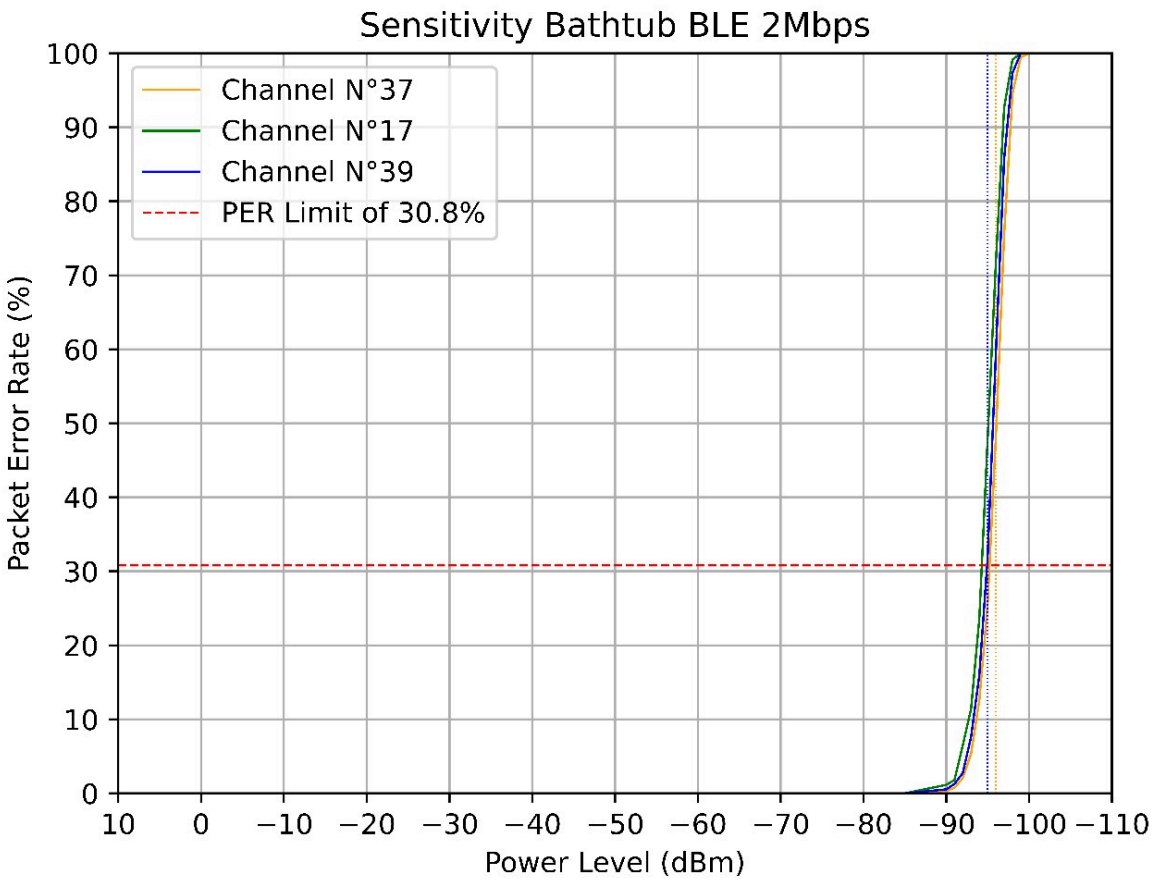

Figure 57. Sensitivity Bathtub result – 2 Mbit/s

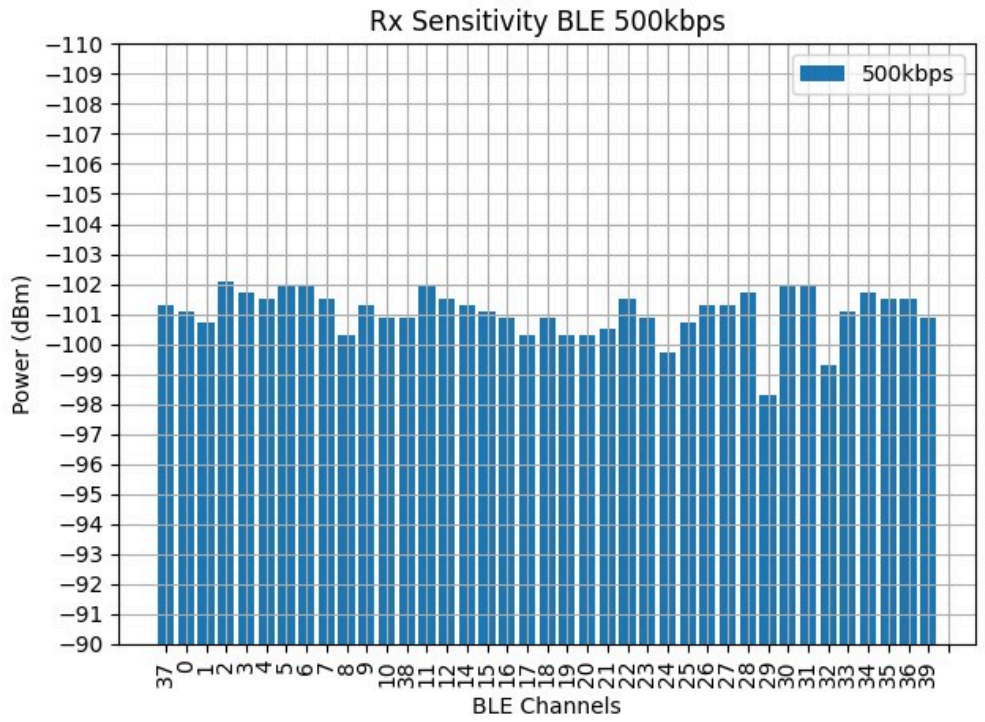

Figure 58. Sensitivity result – LR (S=2)– 500 kbit/s

Sensitivity result – LR (S=2)

- The best sensitivity is on channel 2: -102.1 dBm
- The lowest sensitivity is on channel 29: -98.3 dBm
- Delta over channels: 3.8 dB

Note: *A desense is commonly observed on the frequencies of the board XTAL harmonics. FRDM-MCX W72 shows an average value of -101.05897435897435 dBm (500 kbit/s) at the SMA connector.*

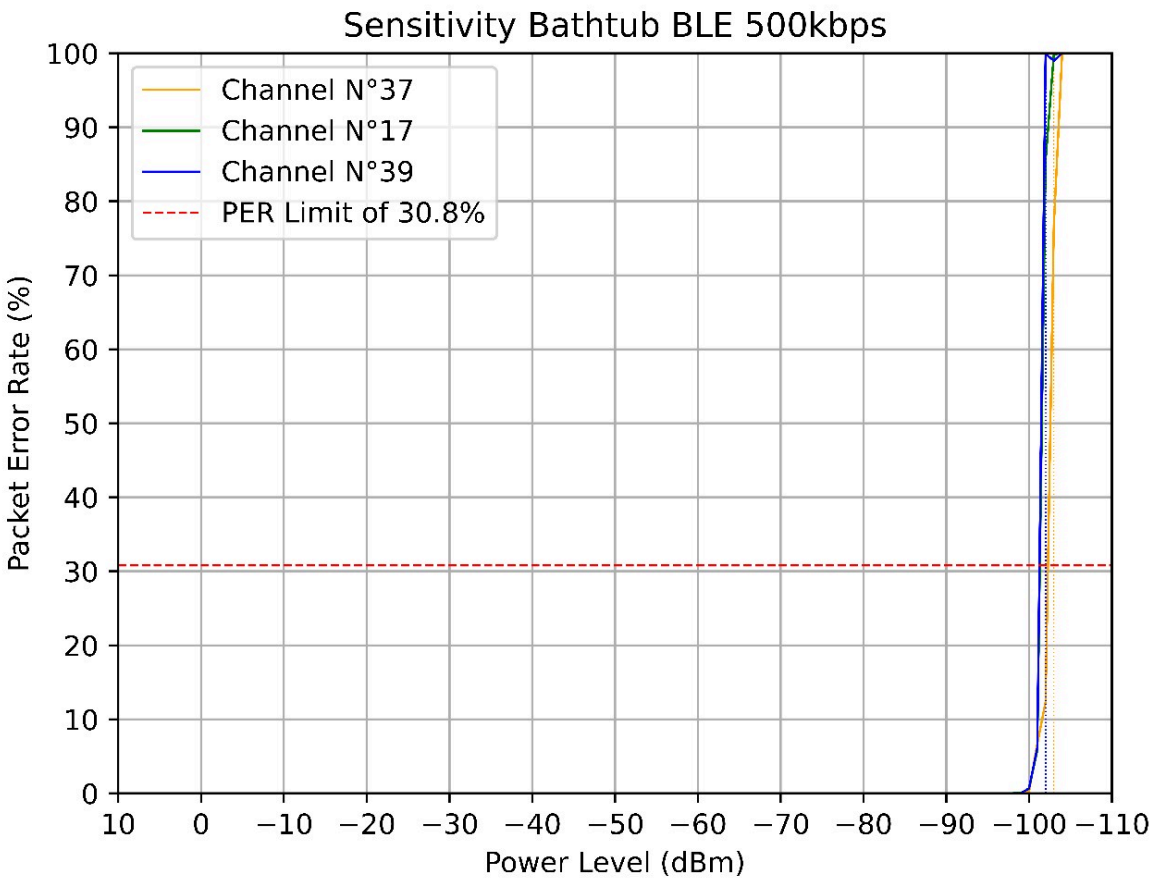

Figure 59. Sensitivity bathtub result – LR (S=2) (Bluetooth LE 500 kbit/s)

Sensitivity result – LR (S=8), 125 kbit/s

- The best sensitivity is on channel 0: -106.4 dBm.
- The lowest sensitivity is on channel 29: -102.2 dBm.
- Delta over channels: 4.2 dB

Note: A desense is commonly observed on the frequencies of the board XTAL harmonicsFRDM-MCX W72 shows an average value of -105.6 dBm (125 Kbit/s) at SMA connector.

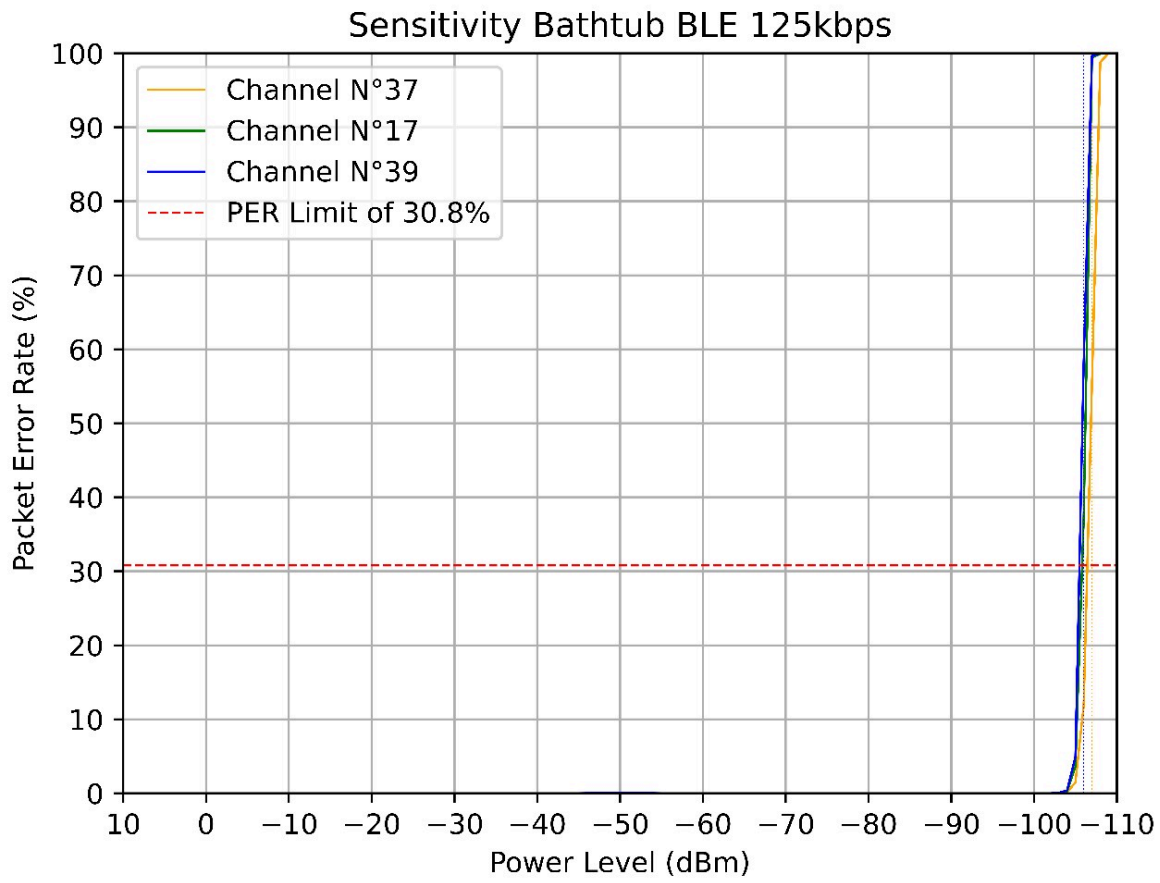

Figure 60. Sensitivity bathtub Bluetooth LE (125 kbit/s) result – LR (S=8)

2.3.2.2.3 Conclusion

FRDM-MCXW72 withstands an average sensitivity level of:

- -97.46923076923076 dBm @1 Mbit/s
- -94.705 dBm@2 Mbit/s
- -101.05897435897435 dBm@LRS2
- -105.8 dBm@LRS8

2.3.2.3 Receiver maximum input level

This section describes the test results for the Bluetooth LE receiver maximum input level test.

The application flashed on the board: HCI Black Box (`hci_bb`).

Test method:

- The same test setup as with the sensitivity test is used but with a CMW270 instrument replacing the combination of RF generator and ARB generator.
- The signal level is increased up to the PER = 30.8 % with 1500 packets

Results:

Table 27. Maximum input power – 1 Mbit/s

Bluetooth LE Channel	RF Level (dBm):	Packet Error Rate (%):	Lower Limit (%)	Upper Limit(%)	Status
37	**0**	10.0	*None*	*0.0*	30.8
17	**0**	10.0	*None*	*0.0*	30.8
39	**0**	10.0	*None*	*0.0*	30.8

Table 28. Maximum input power – 2 Mbit/s

Bluetooth LE Channel	RF Level (dBm):	Packet Error Rate (%):	Lower Limit (%)	Upper Limit (%)	Status
37	**0**	10.0	*None*	*0.0*	30.8
17	**0**	10.0	*None*	*0.0*	30.8
39	**0**	10.0	*None*	*0.0*	30.8

Conclusion:

- The maximum input level is superior to 0.0 dBm. The results are limited by the maximum output power of the equipment.

2.3.2.4 RX spurious

The application flashed on the board is the GenFSK Connectivity test app.

Test method

- Use the Test Method N1. See Figure 3.
- Set the radio parameters of the board to:
- Receiver mode, frequency: channel 18
- Set the analyzer to:
  - Reference amplitude = - 20 dBm
  - Trace = max hold
  - Detector = max peak
  - Start/stop frequency: 30 MHz / 1 GHz
    - RBW = 100 kHz, VBW = 300 kHz

  Then, set the start/stop frequency: 1 GHz / 12.5 GHz
    - RBW = 1 MHz, VBW = 3 MHz

2.3.2.4.1 RX spurious Bluetooth LE results

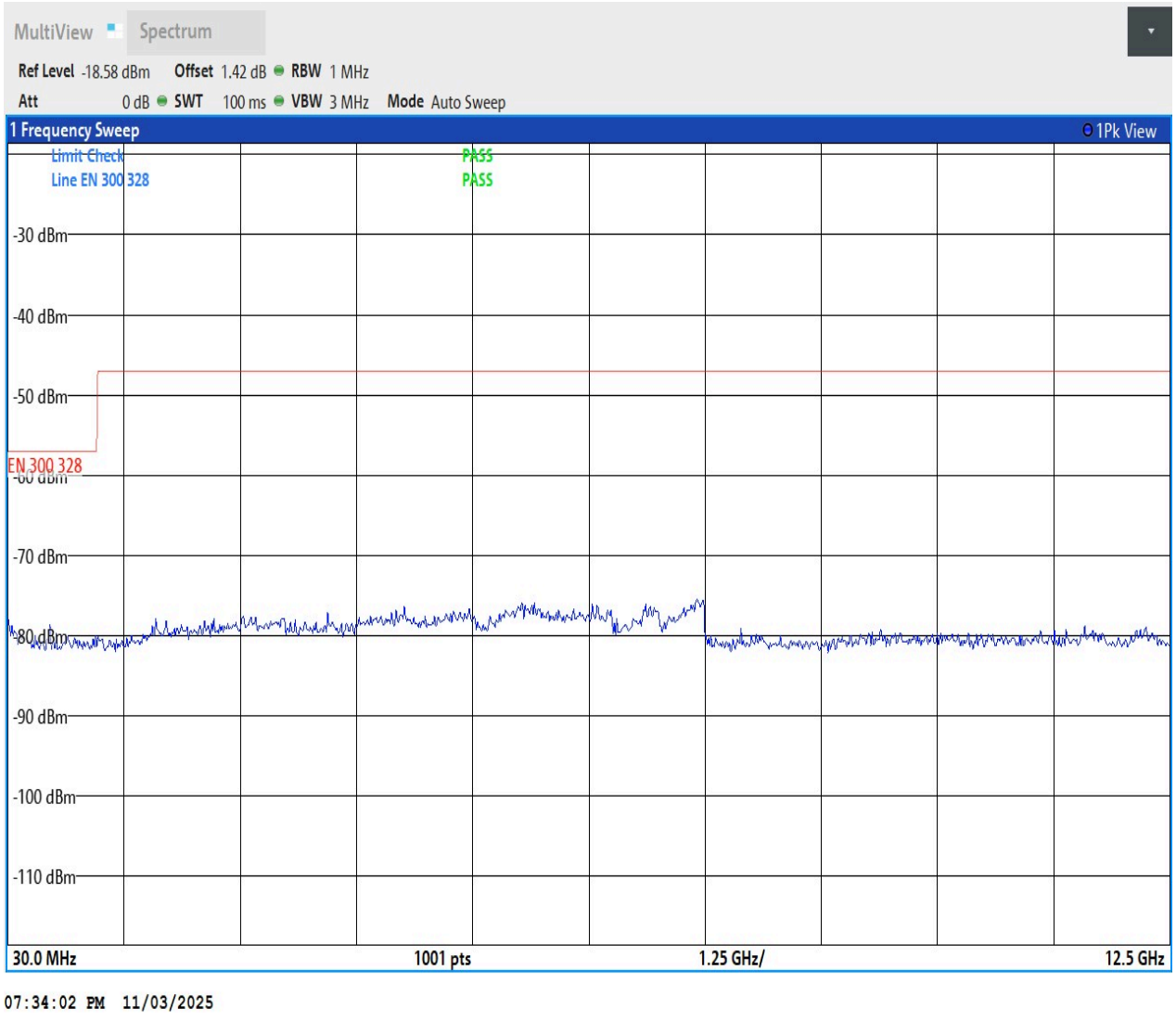

Figure 61. Bluetooth LE - Conducted RX spurious 30 MHz – 12.5 GHz

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion

- The FRDM-MCXW72 passes the ETSI limit.
- There is 21.02 dB margin to the limit.

2.3.2.5 Interferer results in Bluetooth

2.3.2.5.1 Receiver interference rejection performances

Adjacent, alternate, and co-channel (AAC) rejection

This section describes the adjacent, alternate, and co-channel rejection at Bluetooth LE 1 Mbit/s, 2 Mbit/s, 500 kbit/s (LR S=2), and 125 kbit/s (LR S=8).

The interferers are at the adjacent and alternate channels (+/-1 MHz, +/-2 MHz, +/-3 MHz) or co-channel.

The test is performed with only one interfering unmodulated signal at a time.

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 30.8 % with 1500 packets.
- The wanted signal is set to -67 dBm; the interferer is increased until the PER threshold is reached.
- Bluetooth LE Channels under test: Channel 1 (2.406 GHz), Channel 17 (2.440 GHz), and Channel 35 (2.476 GHz)

2.3.2.5.1.1 AAC Bluetooth LE @1 Mbit/s

This section describes the Adjacent, alternate, and co-channel rejection (AAC) results for 1 Mbit/s.

Results

Table 29. Channel 1, 2405 MHz results

Parameter	Channel 1, Wanted frequency: 2405 MHz						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz)	*2403*	*2404*	*2405*	*2406*	*2407*	*2408*	*2409*
Maximum Interferer level (dBm)	-10.0	-20.0	-23.0	-64.5	-72.0	-64.5	-19.0
Maximum Interferer level (C/I dB)	-57.0	-47.0	-44.0	-2.5	5.0	-2.5	-48.0
Bluetooth Low Energy 5.x limit (C/I limit)	15	-17	-27	-27	-27	-27	-17
Margin (dB):	30.0	20.0	27.0	17.5	16.0	17.5	31.0

Table 30. Channel 17, 2440 MHz

Parameter	Channel 17, Wanted frequency: 2440 MHz						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**

Table 30. Channel 17, 2440 MHz*...continued*

Parameter	Channel 17, Wanted frequency: 2440 MHz						
Interferer frequency (MHz)	*2437*	*2438*	*2439*	*2440*	*2441*	*2442*	*2443*
Maximum Interferer level (dBm)	-11.0	-9.0	-9.0	-19.0	-23.0	-64.5	-72.0
Maximum Interferer level (C/I dB)	-56.0	-58.0	-58.0	-48.0	-44.0	-2.5	5.0
Bluetooth Low Energy 5.x limit (C/I limit)	15	-17	-27	-27	-27	-27	-17
Margin (dB)	29.0	31.0	31.0	21.0	27.0	17.5	16.0

Table 31. Channel 35, 2476 MHz

Wanted	Channel 35, Wanted frequency: 2476 MHz						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz)	*2473*	*2474*	*2475*	*2476*	*2477*	*2478*	*2479*
Maximum Interferer level (dBm)	-64.5	-18.0	-10.0	-8.0	-9.0	-18.0	-23.0
Maximum Interferer level (C/I dB)	-2.5	-49.0	-57.0	-59.0	-58.0	-49.0	-44.0
Bluetooth Low Energy 5.x limit (C/I limit)	15	-17	-27	-27	-27	-27	-17
Margin (dB)	17.5	32.0	30.0	32.0	31.0	22.0	27.0

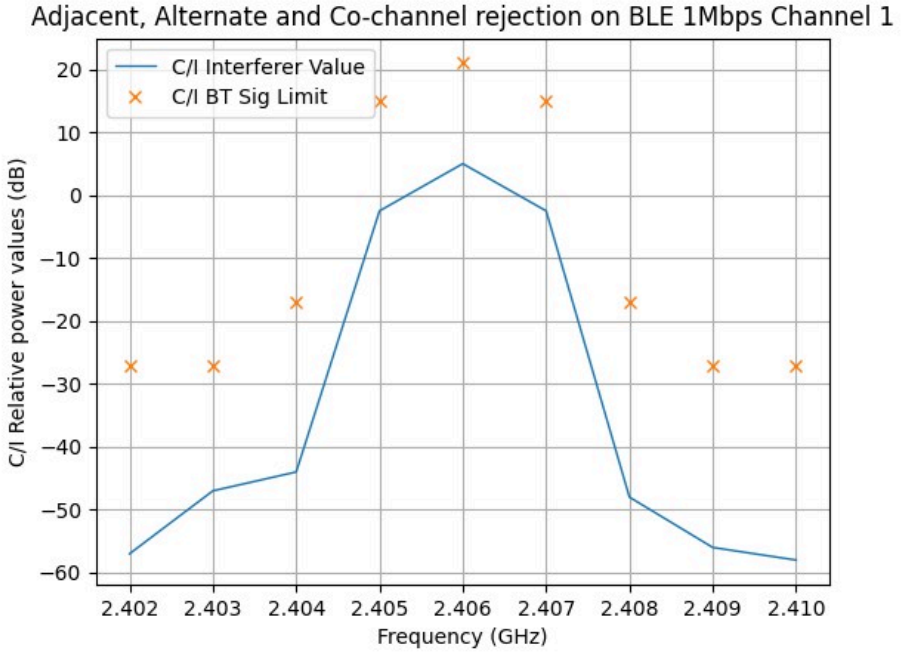

Figure 62. Adjacent, alternate, and co-channel rejection Bluetooth LE @1 Mbit/s, Channel 1

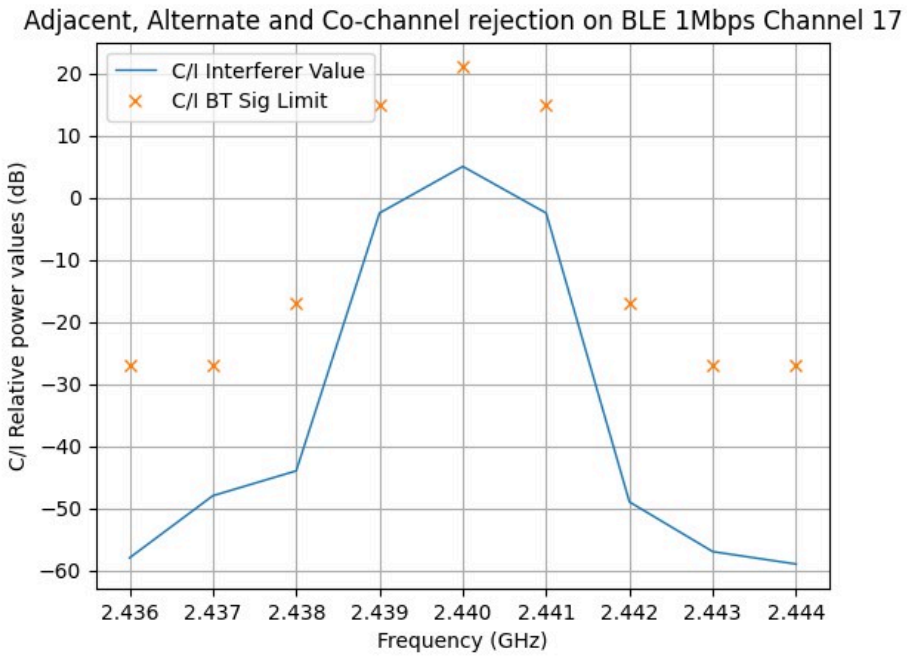

Figure 63. Adjacent, alternate, and co-channel rejection Bluetooth LE @1 Mbit/s, Channel 17

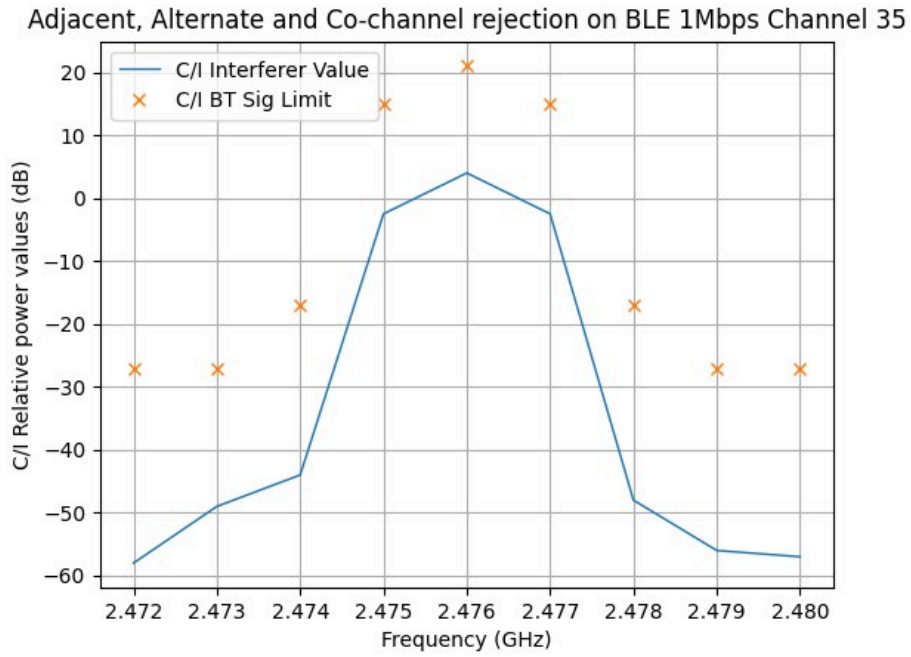

Figure 64. Adjacent, alternate, and co-channel rejection Bluetooth LE @1 Mbit/s, Channel 35

Conclusion: The FRDM-MCXW72 board passes the Bluetooth LE certification for this test with a worst margin of 16.0.

2.3.2.5.1.2 AAC Bluetooth LE @ 2 Mbit/s

This section describes the results for AAC Bluetooth LE @2 Mbit/s (LR S=2).

Table 32. AAC Bluetooth LE @2 Mbit/s (LR S=2) Channel 1

Wanted	**Channel 1**						
Wanted frequency (MHz)	***2406***						
Interferer	**N-6 MHz (Adjacent)**	**N-4 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N (Co-channel)**	**N+2 MHz (Adjacent)**	**N+4 MHz (Adjacent)**	**N+6 MHz (Adjacent)**
Interferer frequency (MHz)	*2400*	*2402*	*2404*	*2406*	*2408*	*2410*	*2412*
Maximum Interferer level (dBm)	-9.0	-11.0	-29.0	-58.0	-73.0	-59.0	-18.0
Maximum Interferer level (C/I dB)	-58.0	-56.0	-38.0	-9.0	6.0	-8.0	-49.0
Bluetooth LE 5.x limit (C/I limit)	15	-17	-27	-27	-27	-27	-17
Margin (dB)	31.0	29.0	21.0	24.0	15.0	23.0	32.0

Table 33. AAC Bluetooth LE @2 Mbit/s (LR S=2) Channel 17

Wanted	**Channel 17**						
Wanted frequency (MHz)	*2440*						
Interferer	**N-6 MHz (Adjacent)**	**N-4 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N (Co-channel)**	**N+2 MHz (Adjacent)**	**N+4 MHz (Adjacent)**	**N+6 MHz (Adjacent)**
Interferer frequency (MHz)	*2434*	*2436*	*2438*	*2440*	*2442*	*2444*	*2446*
Maximum Interferer level (dBm):	-11.0	-9.0	-9.0	-10.0	-28.0	-58.0	-73.0
Maximum Interferer level (C/I dB)	-56.0	-58.0	-58.0	-57.0	-39.0	-9.0	6.0
Bluetooth LE 5.x limit (C/I limit):	15	-17	-27	-27	-27	-27	-17
Margin (dB)	29.0	31.0	31.0	30.0	22.0	24.0	15.0

Table 34. AAC Bluetooth LE @2 Mbit/s (LR S=2), Channel 35

Wanted	**Channel 35**						
Wanted frequency (MHz)	*2476*						
Interferer:	**N-6 MHz (Adjacent)**	**N-4 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N (Co-channel)**	**N+2 MHz (Adjacent)**	**N+4 MHz (Adjacent)**	**N+6 MHz (Adjacent)**
Interferer frequency (MHz):	*2470*	*2472*	*2474*	*2476*	*2478*	*2480*	*2482*
Maximum Interferer level (dBm):	-59.0	-16.0	-9.0	-7.0	-7.0	-10.0	-28.0
Maximum Interferer level (C/I dB):	-8.0	-51.0	-58.0	-60.0	-60.0	-57.0	-39.0
Bluetooth LE 5.x limit (C/I limit):	15	-17	-27	-27	-27	-27	-17
Margin (dB):	23.0	34.0	31.0	33.0	33.0	30.0	22.0

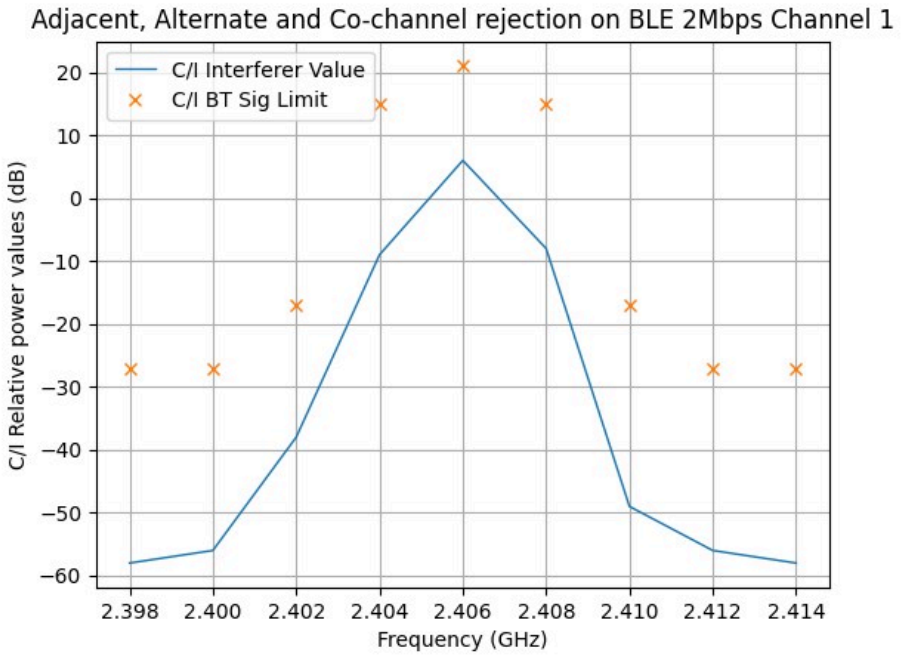

Figure 65. AAC on Bluetooth LE 2 Mbit/s Channel 1

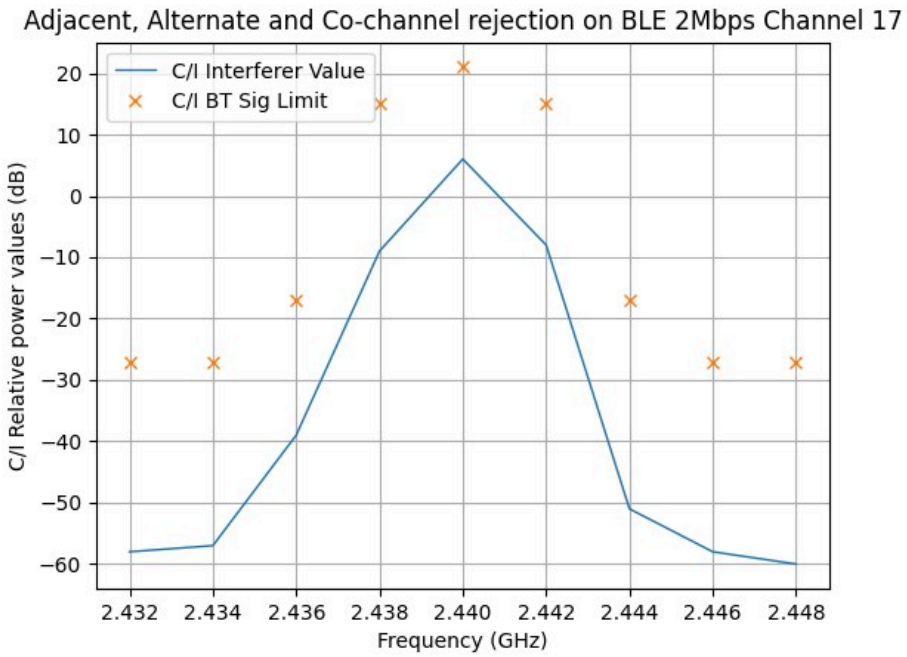

Figure 66. AAC on Bluetooth LE 2 Mbit/s Channel 17

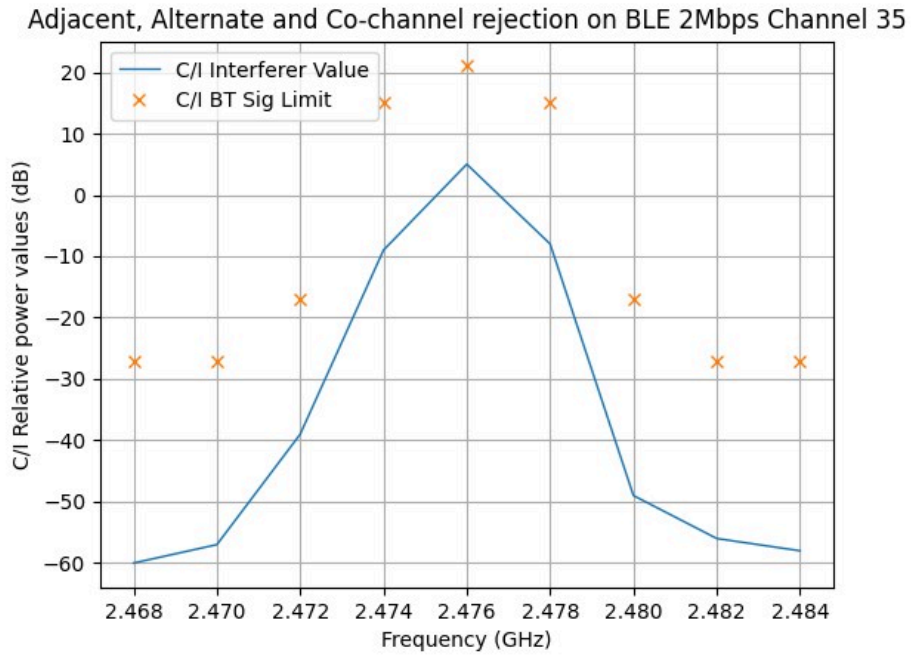

Figure 67. AAC on Bluetooth LE 2 Mbit/s Channel 35

Conclusion: The FRDM-MCXW72 board passes the Bluetooth LE certification for this test with a worst margin of 16.0.

2.3.2.5.1.3 AAC Bluetooth LE @ 500 kbit/s (LR S=2)

This section describes the results for AAC Bluetooth LE @500 kbit/s (LR S=2).

Table 35. AAC, Bluetooth LE @500 kbit/s (LR S=2), Channel 1

Wanted	**Channel 1**						
Wanted frequency (MHz)	*2406*						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz)	*2403*	*2404*	*2405*	*2406*	*2407*	*2408*	*2409*
Maximum Interferer level (dBm)	-10.0	-16.0	-24.0	-61.0	-74.0	-61.0	-17.0
Maximum Interferer level (C/I dB)	-62.0	-56.0	-48.0	-11.0	2.0	-11.0	-55.0
Bluetooth LE 5.x limit (C/I limit)	11	-17	-27	-27	-27	-27	-17
Margin (dB)	35.0	29.0	31.0	22.0	15.0	22.0	38.0

Table 36. AAC, Bluetooth LE @500 kbit/s (LR S=2), Channel 17

Wanted	**Channel 17**						
Wanted frequency (MHz)	*2440*						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz)	*2437*	*2438*	*2439*	*2440*	*2441*	*2442*	*2443*
Maximum Interferer level (dBm)	-11.0	-11.0	-9.0	-15.0	-23.0	-61.0	-74.0
Maximum Interferer level (C/I dB)	-61.0	-61.0	-63.0	-57.0	-49.0	-11.0	2.0
Bluetooth LE 5.x limit (C/I limit)	11	-17	-27	-27	-27	-27	-17
Margin (dB)	34.0	34.0	36.0	30.0	32.0	22.0	15.0

Table 37. AAC, Bluetooth LE @500 kbit/s (LR S=2), Channel 35

Wanted	**Channel 35**						
Wanted frequency (MHz)	*2476*						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz)	*2473*	*2474*	*2475*	*2476*	*2477*	*2478*	*2479*
Maximum Interferer level (dBm)	-61.0	-17.0	-10.0	-8.0	-10.0	-15.0	-24.0
Maximum Interferer level (C/I dB)	-11.0	-55.0	-62.0	-64.0	-62.0	-57.0	-48.0
Bluetooth LE 5.x limit (C/I limit)	11	-17	-27	-27	-27	-27	-17
Margin (dB)	22.0	38.0	35.0	37.0	35.0	30.0	31.0

Adjacent, alternate and co-channel rejection Bluetooth LE @500 Kbit/s (LR S=2)

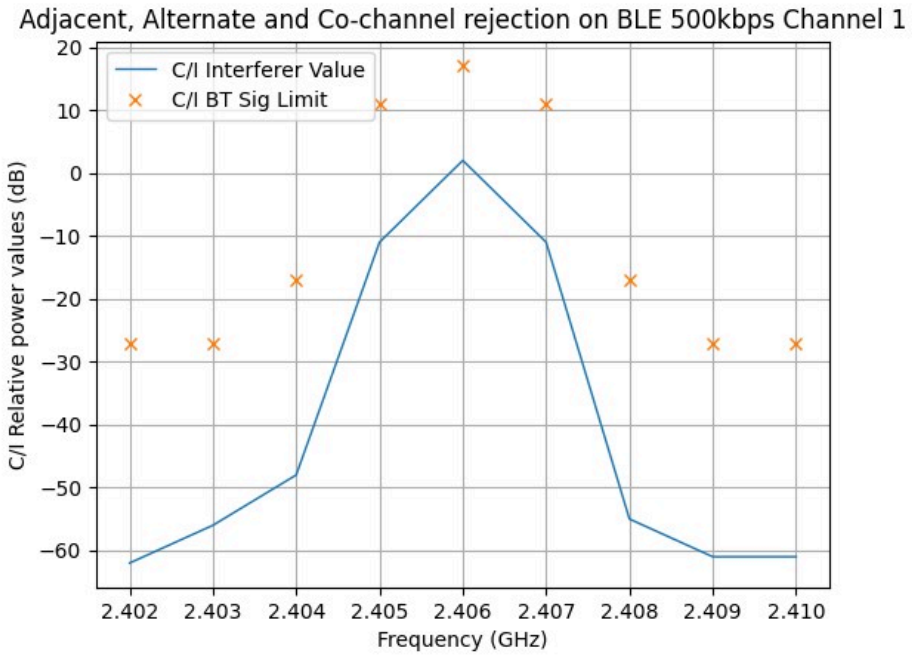

Figure 68. AAC on Bluetooth LE 500 kbit/s Channel 1

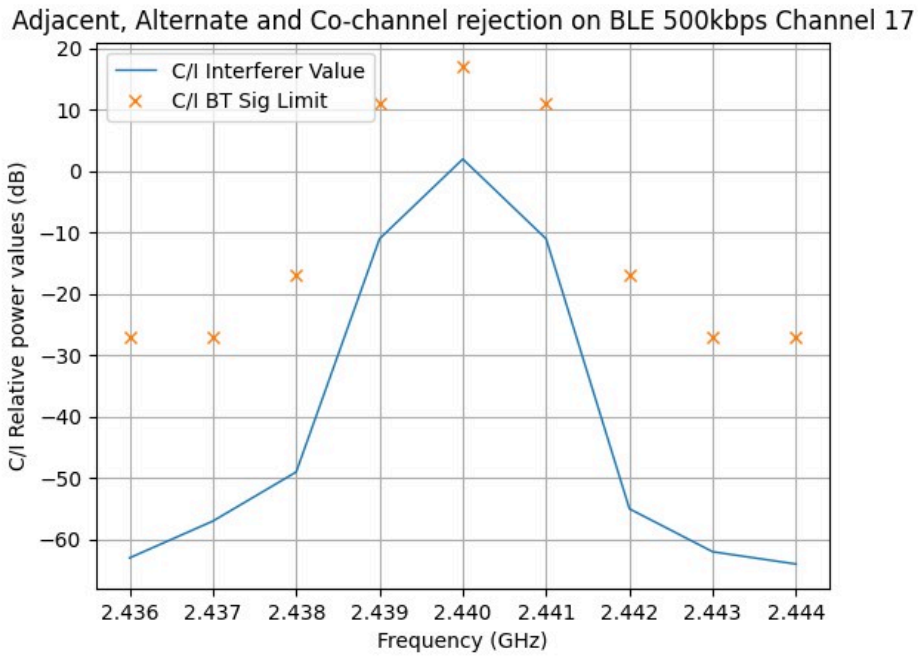

Figure 69. AAC on Bluetooth LE 500 kbit/s Channel 17

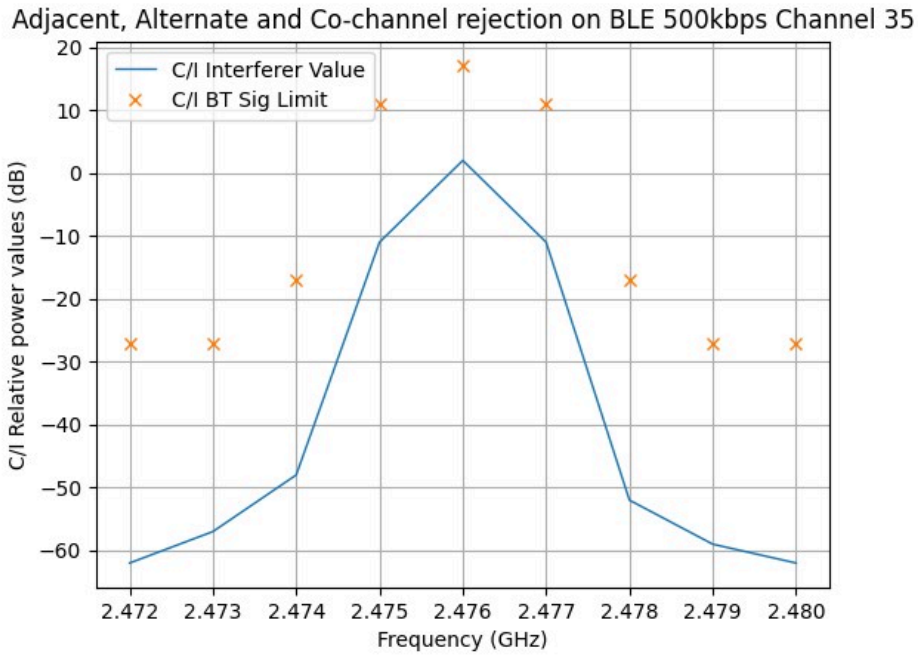

Figure 70. AAC on Bluetooth LE 500 kbit/s Channel 35

Conclusion: The FRDM-MCXW72 board passes the Bluetooth LE certification for this test with a worst margin of 16.0.

2.3.2.5.1.4 AAC Bluetooth LE @ 125 kbit/s (LR S=8)

This section describes the results for AAC Bluetooth LE @125 kbit/s (LR S=8).

Table 38. AAC Bluetooth LE @ 125 kbit/s (LR S=8), Channel 1

Wanted	**Channel 1**						
Wanted frequency (MHz)	*2406*						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz):	*2403*	*2404*	*2405*	*2406*	*2407*	*2408*	*2409*
Maximum Interferer level (dBm):	-12.0	-23.0	-28.0	-68.0	-79.0	-69.0	-24.0
Maximum Interferer level (C/I dB):	-67.0	-56.0	-51.0	-11.0	0.0	-10.0	-55.0
Bluetooth LE 5.x	-36	-36	15	-36	12	6	-26

Table 38. AAC Bluetooth LE @ 125 kbit/s (LR S=8), Channel 1*...continued*

Wanted	Channel 1						
limit (C/I limit):							
Margin (dB):	31.0	20.0	25.0	17.0	12.0	16.0	29.0

Table 39. AAC Bluetooth LE @ 125 kbit/s (LR S=8), Channel 17

Wanted	Channel 17						
Wanted frequency (MHz)	*2440*						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz):	*2437*	*2438*	*2439*	*2440*	*2441*	*2442*	*2443*
Maximum Interferer level (dBm):	-14.0	-12.0	-12.0	-23.0	-28.0	-68.0	-81.0
Maximum Interferer level (C/I dB):	-65.0	-67.0	-67.0	-56.0	-51.0	-11.0	2.0
Bluetooth LE 5.x limit (C/I limit):	-36	-36	15	-36	12	6	-26
Margin (dB):	29.0	31.0	31.0	20.0	25.0	17.0	10.0

Table 40. AAC Bluetooth LE @ 125 kbit/s (LR S=8), Channel 35

Wanted	Channel 35						
Wanted frequency (MHz)	***2476***						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz):	*2473*	*2474*	*2475*	*2476*	*2477*	*2478*	*2479*
Maximum Interferer level (dBm):	-69.0	-23.0	-13.0	-12.0	-11.0	-22.0	-28.0
Maximum Interferer	-10.0	-56.0	-66.0	-67.0	-68.0	-57.0	-51.0

Table 40. AAC Bluetooth LE @ 125 kbit/s (LR S=8), Channel 35*...continued*

Wanted	Channel 35						
level (C/I dB):							
Bluetooth LE 5.x limit (C/I limit):	-36	-36	15	-36	12	6	-26
Margin (dB):	16.0	30.0	30.0	31.0	32.0	21.0	25.0

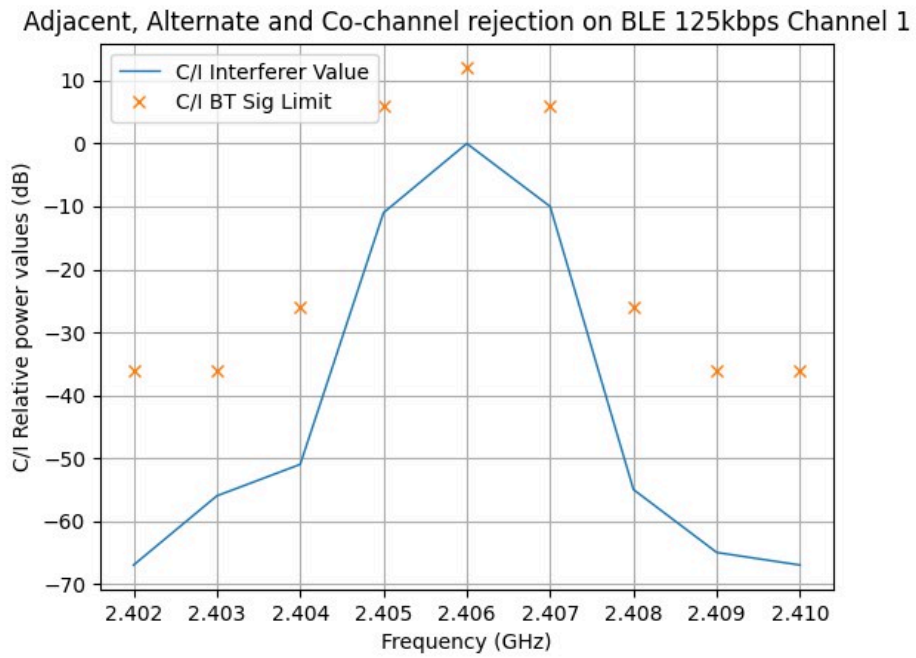

Figure 71. AAC on Bluetooth LE 125 kbit/s Channel 1

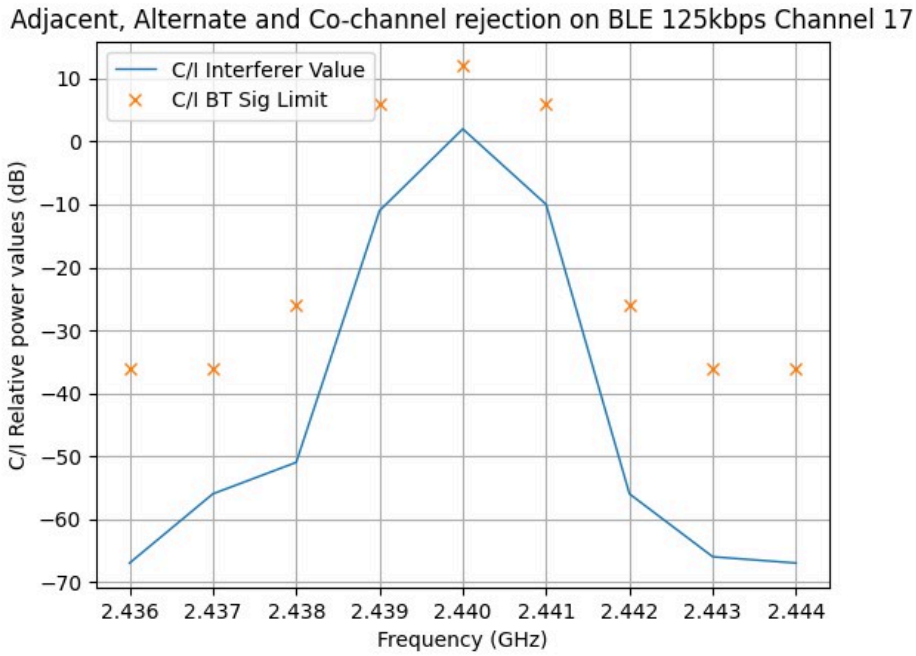

Figure 72. AAC on Bluetooth LE 125 kbit/s Channel 17

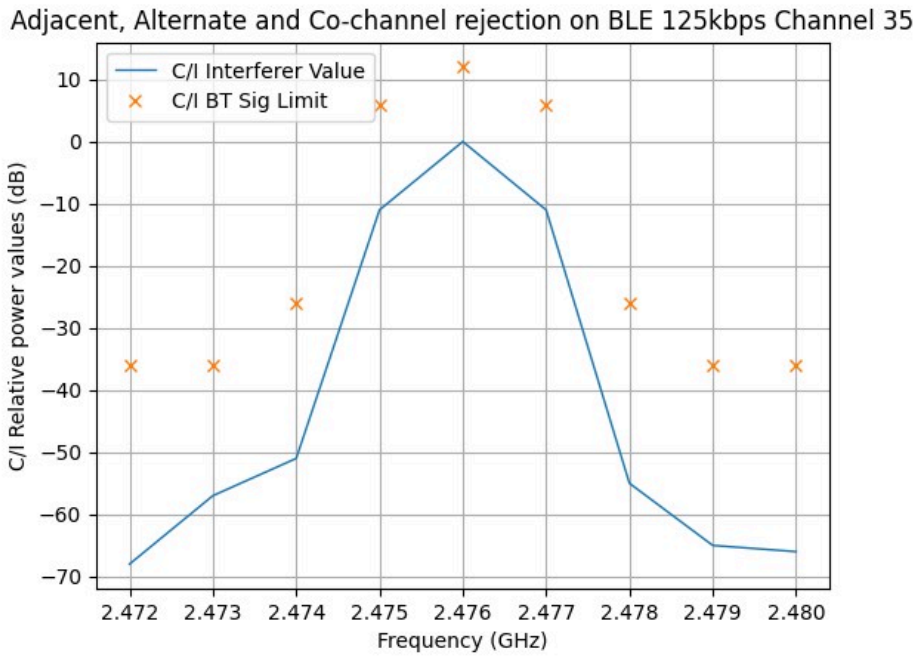

Figure 73. AAC on Bluetooth LE 125 kbit/s Channel 35

Conclusion

The FRDM-MCXW72 board passes the Bluetooth LE certification for this test with a worst margin of 16.0.

2.3.2.5.2 Receiver Blocking

The blocking interferers are located at the out of band channels depending on the receiver category.

2.3.2.5.2.1 Receiver category 1 - Bluetooth LE 1 Mbit/s

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.2.)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- For an interferer set at 2.380 GHz and 2.504 GHz, the wanted signal is set to the lowest value between 10log(OCBW) -133 dBm and -68 dBm.

For an interferer set at 2.300 GHz, 2.330 GHz, 2.360 GHz, 2.524 GHz, 2.584 GHz, and 2.674 GHz, the wanted signal is set to the lowest value between 10log(OCBW) -139 dBm and -74 dBm.

In both cases, the interferer power level is increased until the PER threshold is reached.

- Bluetooth LE Channels under test: 37 (2.402 GHz) and 39 (2.480 GHz).

Result

Table 41. Receiver Blocking (Out of Band) rejection - Bluetooth LE 1 Mbit/s, Channel 37

Channel	**37**							
Frequency (MHz)	2402							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**4.2**	**6.5**	**4.6**	**2.8**	**5.1**	**6.3**	**6.2**	**5.6**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	38.2	40.5	38.6	36.8	39.1	40.3	40.2	39.6

Table 42. Receiver Blocking (Out of Band) rejection - Bluetooth LE 1 Mbit/s, Channel 39

Channel	**39**							
Frequency (MHz)	2480							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674

Table 42. Receiver Blocking (Out of Band) rejection - Bluetooth LE 1 Mbit/s, Channel 39*...continued*

Channel	39							
Maximum Interferer Level (dBm)	**4.3**	**6.7**	**5.7**	**4.7**	**-9.8**	**5.9**	**5.9**	**5.7**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	38.3	40.7	39.7	38.7	24.2	39.9	39.9	39.7

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 1 test, there is a margin of 24.2 dB until the limit.

2.3.2.5.2.2 Receiver category 2 - Bluetooth LE 1 Mbit/s

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.3.)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- The wanted signal is set to the lowest value between -64 dBm and 10log(OCBW) -129 dBm. The continuous waveform (CW) interferer is increased until the PER threshold is reached.
- Channels under test: Bluetooth LE Channel 37 (2.402 GHz) and Bluetooth LE Channel 39 (2.480 GHz).

Result:

Table 43. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 1 Mbit/s, Channel 37

Channel	37			
Frequency (MHz)	2402			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**8.0**	**>10**	**8.6**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	42.0	44.0	42.6	44.0

Table 44. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 1 Mbit/s, Channel 39

Channel	39			
Frequency (MHz)	2480			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz):	2300	2380	2504	2584

Table 44. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 1 Mbit/s, Channel 39*...continued*

Channel	39			
Maximum Interferer Level (dBm)	**8.6**	**>10**	**-8.9**	**9.8**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	42.6	44.0	25.1	43.8

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 2 test, there is a margin of 44.0 dB until the limit.

2.3.2.5.2.3 Receiver category 1 - Bluetooth LE 2 Mbit/s

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.2)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- For an interferer set at 2.380 GHz and 2.504 GHz, the wanted signal is set to the lowest value between 10log(OCBW)-133 dBm and -68 dBm.
- For an interferer set at 2.300 GHz, 2.330 GHz, 2.360 GHz, 2.524 GHz, 2.584 GHz and 2.674 GHz, the wanted signal is set to the lowest value between 10log(OCBW) -139 dBm and -74 dBm.
  In both cases, the interferer power level is increased until the PER threshold is reached.
- Bluetooth LE Channels under test: 37 (2.402 GHz), and 39 (2.480 GHz)

Result:

Table 45. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 2 Mbit/s, Channel 37

Channel	37							
Frequency (MHz)	**2402**							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**4.2**	**6.5**	**4.6**	**2.8**	**5.1**	**6.3**	**6.2**	**5.6**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin (dB)	38.2	40.5	38.6	36.8	39.1	40.3	40.2	39.6

Table 46. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 2 Mbit/s, Channel 39

Channel	39							
Frequency (MHz)	2480							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**4.3**	**6.7**	**5.7**	**4.7**	**-9.8**	**5.9**	**5.9**	**5.7**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	38.3	40.7	39.7	38.7	24.2	39.9	39.9	39.7

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 1 test, there is a margin of 24.2 dB until the limit.

2.3.2.5.2.4 Receiver category 2 - Bluetooth LE 2 Mbit/s

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.3)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- The wanted signal is set to the lowest value between -64 dBm and 10log(OCBW) -129 dBm. The continuous waveform (CW) interferer is increased until the PER threshold is reached.
- Bluetooth LE Channels under test: 37 (2.402 GHz), and 39 (2.480 GHz).

Result:

Table 47. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 2 Mbit/s, Channel 37

Channel	37			
Frequency (MHz)	2402			
Interferer Type:	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**5.2**	**7.7**	**6.3**	**7.5**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin (dB)	39.2	41.7	40.3	41.5

Table 48. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 2 Mbit/s, Channel 39

Channel	Channel 39			
Frequency (MHz)	2480			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**5.5**	**8.1**	**-8.8**	**7.2**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	39.5	42.1	25.2	41.2

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 2 test, there is a margin of 42.1 dB until the limit.

2.3.2.5.2.5 Receiver category 1 - Bluetooth LE 500 kbit/s (LR S=2)

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.2.)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- For an interferer set at 2.380 GHz and 2.504 GHz, the wanted signal is set to the lowest value between 10log(OCBW) - 133 dBm and -68 dBm.
- For an interferer set at 2.300 GHz, 2.330 GHz, 2.360 GHz, 2.524 GH, 2.584 GHz, and 2.674. GHz, the wanted signal is set to the lowest value between 10log(OCBW) -139 dBm and -74 dBm. In both cases, the interferer power level is increased until the PER threshold is reached.
- Bluetooth LE Channels under test: 37 (2.402 GHz), and 39 (2.480 GHz)

Result:

Table 49. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 500 kbit/s (LR S=2), Channel 37

Channel	37							
Frequency (MHz)	2402							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**4.2**	**6.5**	**4.6**	**2.8**	**5.1**	**6.3**	**6.2**	**5.6**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	38.2	40.5	38.6	36.8	39.1	40.3	40.2	39.6

Table 50. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 500 kbit/s (LR S=2), Channel 39

Channel	39							
Frequency (MHz)	2480							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**4.3**	**6.7**	**5.7**	**4.7**	**-9.8**	**5.9**	**5.9**	**5.7**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	38.3	40.7	39.7	38.7	24.2	39.9	39.9	39.7

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 2 test, there is a margin of 44.0 dB until the limit.

2.3.2.5.2.6 Receiver category 2 - Bluetooth LE 500 kbit/s (LR S=2)

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.3)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- The wanted signal is set to the lowest value between-64 dBm and 10log(OCBW)-129 dBm; the continuous waveform (CW) interferer is increased until the PER threshold is reached.
- Bluetooth LE Channels under test: 37 (2.402 GHz), and 39 (2.480 GHz).

Result: Receiver Blocking (Out of Band) rejection

Table 51. Receiver category 2 - Bluetooth LE 500 Kbit/s (LR S=2), Channel 37

Channel	37			
Frequency (MHz)	2402			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	44.0	44.0	44.0	44.0

Table 52. Receiver category 2 - Bluetooth LE 500 Kbit/s (LR S=2), Channel 39

Channel	39			
Frequency (MHz)	2480			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	44.0	44.0	44.0	44.0

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 2 test, there is a margin of 44.0 dB until the limit.

2.3.2.5.2.7 Receiver category 1 - Bluetooth LE 125 kbit/s (LR S=8)

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.2)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- For an interferer set at 2.380 GHz and 2.504 GHz, the wanted signal is set to the lowest value between 10log(OCBW)-133 dBm and -68 dBm.
- For an interferer set at 2.300 GHz, 2.330 GHz, 2.360 GHz, 2.524 GH, 2.584 GHz and 2.674 GHz, the wanted signal is set to the lowest value between 10log(OCBW) -139 dBm and -74 dBm. In both cases, the interferer power level is increased until the PER threshold is reached.
- Bluetooth LE Channels under test: 37 (2.402 GHz) and 39 (2.480 GHz).

Result: Receiver Blocking (Out Of Band) rejection

Table 53. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 125 Kbit/s (LR S=8), Channel 37

Channel	37							
Frequency (MHz)	2402							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**4.2**	**6.5**	**4.6**	**2.8**	**5.1**	**6.3**	**6.2**	**5.6**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	38.2	40.5	38.6	36.8	39.1	40.3	40.2	39.6

Table 54. Receiver Blocking (Out Of Band) rejection - BLE-125 Kbit/s (LR S=8), Channel 39

Channel	39							
Frequency (MHz)	2480							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**4.3**	**6.7**	**5.7**	**4.7**	**-9.8**	**5.9**	**5.9**	**5.7**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin (dB)	38.3	40.7	39.7	38.7	24.2	39.9	39.9	39.7

Conclusion: The FRDM-MCX W72 passes the Receiver Blocking Category 1 test, there is a margin of 24.2 dB until the limit.

2.3.2.5.2.8 Receiver category 2 - Bluetooth LE 125 kbit/s (LR S=8)

The test is performed with only one interfering signal at a time. (Refer to ETSI 300.328 2.2.2 chapter 4.3.1.12.4.3.)

Test method:

- Test setup N4 is used. See Figure 52.
- Criterion: PER < 10 %.
- The wanted signal is set to the lowest value between -64 dBm and 10log(OCBW) -129 dBm; the continuous waveform (CW) interferer is increased until the PER threshold is reached.
- Bluetooth LE Channels under test: 37 (2.402 GHz) and 39 (2.480 GHz).

Result

Table 55. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 125 kbit/s (LR S=8)

Channel	37			
Frequency (MHz)	2402			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	44.0	44.0	44.0	44.0

Table 56. Receiver Blocking (Out Of Band) rejection - Bluetooth LE 125 kbit/s (LR S=8)

Channel	39			
Frequency (MHz)	2480			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin (dB)	44.0	44.0	44.0	44.0

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 2 test, there is a margin of 44.0 dB until the limit.

2.3.2.5.3 Blocking Interferers

This section describes the test method and results for blocking interferers test for Bluetooth LE measurements at 1 Mbit/s 2 Mbit/s, 500 kbit/s, and 125 kbit/s.

2.3.2.5.3.1 Bluetooth LE 1 Mbit/s

A continuous waveform (CW) is used as the interferer source to verify that the receiver performs satisfactorily in the frequency range outside the 2400 MHz to 2483.5 MHz band.

Test method:

- 4 is used. See Figure 52.
- Criterion: PER < 30.8 % with 1500 packets
- The wanted signal is set to -67 dBm; the interferer level is increased until the PER threshold is reached.
- Channel under test: 12 (2426 MHz)

Table 57. Blocking interferers Bluetooth LE 1 Mbit/s

Wanted signal 2426 MHz@-67 dBm	Channel 12 (2426 MHz)	Channel 12 (2426 MHz)	Channel 12 (2426 MHz)	Channel 12 (2426 MHz)	Criteria
Interferer (MHz)	30 - 2000 (step 10 MHz)	2003 – 2399 (step 3 MHz)	2484 – 2997 (step 3 MHz)	3 GHz - 12.75 GHz (step 25 MHz)	-
Unwanted level (dBm)	-30	-35	-35	-30	-
Status (unwanted level)	Pass	Pass	Pass	Pass	-
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 10
Status (Unwanted level -50 dBm)	Pass	Pass	Pass	Pass	-
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 3

Conclusion:

- The FRDM-MCXW72 passes the 1 Mbit/s Blocking Interferers test.

2.3.2.5.3.2 Bluetooth LE 2 Mbit/s

A continuous waveform (CW) is used as the interferer source to verify that the receiver performs satisfactorily with frequency outside the 2400 MHz to 2483.5 MHz range.

Test method:

- 4 is used. See Figure 52.
- Criterion: PER < 30.8 % with 1500 packets.
- The wanted signal is set to -67 dBm; the interferer level is increased until the PER threshold is reached.
- Channel under test: Channel 12 (2426 MHz).

Table 58. Blocking interferers Bluetooth LE 2 Mbit/s

Wanted signal 2426 MHz@-67 dBm	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Criteria
Interferer (MHz)	30 - 2000 (step 10 MHz)	2003 – 2399 (step 3 MHz)	2484 – 2997 (step 3 MHz)	3 GHz - 12.75 GHz (step 25 MHz)	
Unwanted level (dBm)	-30	-35	-35	-30	
Status (unwanted level)	Pass	Pass	Pass	Pass	
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 10
Status (Unwanted level -50 dBm)	Pass	Pass	Pass	Pass	
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 3

Conclusion:

- The FRDM-MCXW72 passes the 2 Mbit/s Blocking Interferers test.

2.3.2.5.3.3 Bluetooth LE 500 kbit/s (LR S=2)

A continuous waveform (CW) is used as the interferer source to verify that the receiver performs satisfactorily with frequency outside the 2400 MHz to 2483.5 MHz band.

Test method:

- Test setup 4 is used. See Figure 52.
- Criterion: PER < 30.8 % with 1500 packets.
- The wanted signal is set to -67 dBm; the interferer level is increased until the PER threshold is reached.
- Channel under test: 12 (2426 MHz).

Table 59. Blocking interferers 500 kbit/s

Wanted signal 2426 MHz @-67 dBm	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Criteria
Interferer (MHz)	30 - 2000 (step 10 MHz)	2003 – 2399 (step 3 MHz)	2484 – 2997 (step 3 MHz)	3 GHz - 12.75 GHz (step 25 MHz)	
Unwanted level (dBm)	-30	-35	-35	-30	
Status (unwanted level)	Pass	Pass	Pass	Pass	
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 10
Status (Unwanted level -50 dBm)	Pass	Pass	Pass	Pass	
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 3

Conclusion:

- The FRDM-MCXW72 passes the 500 kbit/s Blocking Interferers test.

2.3.2.5.3.4 Bluetooth LE 125 kbit/s (LR S=8)

A continuous waveform (CW) is used as the interferer source to verify that the receiver performs satisfactorily with frequency outside the 2400 MHz to 2483.5 MHz band.

Test method:

- Test setup 4 is used. See Figure 52.
- Criterion: PER < 30.8 % with 1500 packets.
- The wanted signal is set to -67 dBm; the interferer level is increased until the PER threshold is reached.
- Channel under test: 12 (2426 MHz).

Table 60. Blocking Interferers – 125 kbit/s

Wanted signal 2426 MHz @-67 dBm	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Criteria
Interferer (MHz)	30 – 2000 (step 10 MHz)	2003 – 2399 (step 3 MHz)	2484 – 2997 (step 3 MHz)	3 GHz – 12.75 GHz (step 25 MHz)	
Unwanted level (dBm)	-30	-35	-35	-30	
Status (unwanted level)	Pass	Pass	Pass	Pass	
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 10
Status (Unwanted level -50 dBm)	Pass	Pass	Pass	Pass	

Table 60. Blocking Interferers – 125 kbit/s *...continued*

Wanted signal 2426 MHz @-67 dBm	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Channel 12 2426 MHz	Criteria
Number of blocking fail	0	0	0	0	Fail blockers must not exceed 3

Conclusion:

- The FRDM-MCXW72 passes the 125 kbit/s Blocking Interferers test.

2.3.2.5.4 Intermodulation

This test verifies that the receiver intermodulation performance is satisfactory.

Test method:

- Test setup N5 is used. See Section 2.3.2.1.3.
- Two interferers are used in combination with the wanted signal. One interferer is a sinusoid non-modulated signal and the second interferer is a Bluetooth LE modulated signal with PRSB15 data. The two interferers are set at the same power level.
- Criterion: PER < 30.8 % with 1500 packets.
- Bluetooth LE channels under test: Channel 37 (2.402 GHz), Channel 17 (2.440 GHz), and Channel 39 (2.480 GHz).
- The wanted signal is set to -64 dBm; the interferer levels are first set below the limit values and then increased until PER criterion is reached.

2.3.2.5.4.1 Bluetooth LE 1 Mbit/s

This section describes the Bluetooth LE RX Intermodulation at 1 Mbit/s.

Table 61. Bluetooth LE RX Intermodulation 1 Mbit/s Channel 37

Bluetooth LE Wanted Channel	Channel 37					
Wanted Frequency (MHz)	**2402**					
Interferer Type	Low	Low	Low	High	High	High
CW Interferer Frequency (MHz)	2397	2398	2399	2405	2406	2407
Bluetooth LE Interferer Frequency (MHz):	2392	2394	2396	2408	2410	2412
Combined Interferers Level (dBm)	**-35**	**-35**	**-35**	**-35**	**-35**	**-35**
Bluetooth LE 6.0 limit (dBm)	-50	-50	-50	-50	-50	-50
Margin (dB)	1050	1050	1050	1050	1050	1050

Table 62. Bluetooth LE RX Intermodulation 1 Mbit/s Channel 17

Bluetooth LEWanted Channel	**Channel 17**					
Wanted Frequency (MHz)	**2440**					
Interferer Type	Low	Low	Low	High	High	High
CW Interferer Frequency (MHz)	2435	2436	2437	2443	2444	2445
Bluetooth LE Interferer Frequency (MHz):	2430	2432	2434	2446	2448	2450
Combined Interferers Level (dBm)	**-35**	**-35**	**-35**	**-35**	**-35**	**-35**
Bluetooth LE 6.0 limit (dBm)	-50	-50	-50	-50	-50	-50
Margin (dB)	1050	1050	1050	1050	1050	1050

Table 63. Bluetooth LE RX Intermodulation 1 Mbit/s Channel 39

Bluetooth LE Wanted Channel:	**Channel 39**					
Wanted Frequency (MHz):	2480					
Interferer Type:	Low	Low	Low	High	High	High
CW Interferer Frequency (MHz):	2475	2476	2477	2483	2484	2485
Bluetooth LE Interferer Frequency (MHz):	2470	2472	2474	2486	2488	2490
Combined Interferers Level (dBm)	**-24**	**-24**	**-24**	**-25**	**-25**	**-25**
Bluetooth LE 6.0 limit (dBm)	-50	-50	-50	-50	-50	-50
Margin (dB)	25	25	25	24	24	24

Conclusion: The FRDM-MCXW72 board passes the 1 Mbit/s Intermodulation test with a margin of 24.0 dB.

2.3.2.5.4.2 Bluetooth LE 2 Mbit/s

This section describes the Bluetooth LE RX Intermodulation at 2 Mbit/s

Table 64. Bluetooth LE RX Intermodulation 2 Mbit/s Channel 37

Bluetooth LE Wanted Channel	**Channel 37**					
Wanted Frequency (MHz)	**2402**					
Interferer Type	Low	Low	Low	High	High	High
CW Interferer Frequency (MHz)	2392	2394	2396	2408	2410	2412
Bluetooth LE Interferer Frequency (MHz)	2382	2386	2390	2414	2428	2432
Combined Interferers Level (dBm)	**-40**	**-40**	**-40**	**-40**	**-40**	**-40**
Bluetooth LE 6.0 limit (dBm)	-50	-50	-50	-50	-50	-50
Margin (dB)	1050	1050	1050	1050	1050	1050

Table 65. Bluetooth LE RX Intermodulation 2 Mbit/s Channel 17

Bluetooth LE Wanted Channel	**Channel 17**					
Wanted Frequency (MHz)	**2440**					
Interferer Type	Low	Low	Low	High	High	High
CW Interferer Frequency (MHz)	2430	2432	2434	2446	2448	2450
BLE Interferer Frequency (MHz)	2420	2424	2428	2452	2456	2460
Combined Interferers Level (dBm)	**-40**	**-40**	**-40**	**-40**	**-40**	**-40**
BLE 6.0 limit (dBm)	-50	-50	-50	-50	-50	-50
Margin (dB)	1050	1050	1050	1050	1050	1050

Table 66. Bluetooth LE RX Intermodulation 2 Mbit/s Channel 39

Bluetooth LE Wanted Channel:	**Channel 39**					
Wanted Frequency (MHz):	**2480**					
Interferer Type:	Low	Low	Low	High	High	High
CW Interferer Frequency (MHz):	2470	2472	2474	2486	2488	2490
Bluetooth LE Interferer Frequency (MHz):	2460	2464	2468	2492	2496	2500
Combined Interferers Level (dBm)	**-26**	**-24**	**-24**	**-26**	**-27**	**-29**
Bluetooth LE 6.0 limit (dBm)	-50	-50	-50	-50	-50	-50
Margin (dB)	23	25	25	23	22	20

Intermodulation – 2 Mbit/s

Conclusion: The board passes the 2 Mbit/s Intermodulation test with a margin of 20.0 dB.

3 IEEE 802.15.4 application

This section describes the test procedure and results for IEEE 802.15.4 measurements.

3.1 Test presentation

This section provides the list of tests and a test summary and describes the conducted tests.

3.1.1 List of tests

1. TX tests
   a. Frequency accuracy
   b. Phase noise
   c. TX power
   d. TX power in band
   e. TX spurious
   f. EVM and offset EVM
   g. Lower band edge
   h. Upper band edge
   i. Out of band
2. RX tests
   a. Sensitivity
   b. Sensitivity bathtub
   c. RX spurious
   d. Adjacent, alternate, co-channel interferences
   e. Receiver blocking

3.2 Test summary

This section synthetizes in Table 67 and Table 68 the main tests performed on the FRDM-MCXW72 modules. Most of the test results details and setup are described in this document. For further information, contact your local NXP contact.

Table 67. List of Transmission tests (Europe)

Parameter	Reference	Limit	Status
TX maximum power	ETSI EN 300 328	20 dBm, 100 mW (radiated)	Pass
Eirp TX spectral density	ETSI EN 300 328	10 dBm/MHz	Pass
TX spectral density	IEEE 802.15.4_2011	-20 dBc or -30 dBm (100 kHz, f-fc > 3.5 MHz)	Pass
Spurious 30 MHz – 1 GHz	ETSI EN 300 328	-36 dBm or -54 dBm (depends on frequency) (100 kHz BW)	Pass
Spurious 1 GHz - 12.5 GHz	ETSI EN 300 328	-30 dBm (1 MHz BW)	Pass
EVM	IEEE 802.15.4_2011	35%	Pass
Offset EVM	IEEE 802.15.4_2011	4.5%	Pass
TX frequency accuracy	IEEE 802.15.4_2011	+/- 40 ppm	Pass
Phase noise (unspread)	IEEE 802.15.4_2003	NA	For information

Table 68. List of reception tests (Europe)

Test parameter	Reference	Limit	Status
RX emissions 30 MHz – 1 GHz	ETSI EN 300 328	-57 dBm (100 kHz)	Pass
RX emissions 1 GHz - 12.5 GHz	ETSI EN 300 328	-47 dBm (1 MHz)	Pass
RX sensitivity	IEEE 802.15.4	-85 dBm	Pass
Adjacent channel interference rejection N +/-1	IEEE 802.15.4_2011	0 dB	Pass
Alternate channel interference rejection N +/-2	IEEE 802.15.4_2011	30 dB	Pass
Receiver blocking	ETSI EN 300 328	-57 dBm / -47 dBm	Pass
Receiver maximum input level	IEEE 802.15.4_2011	-20 dBm	Pass

Table 69. List of Miscellaneous tests

Parameter	Description	Status
Return loss (S11)	Return loss in TX mode	For information
	Return loss in RX mode	For information

Table 70. List of Transmission tests (US)

	Frequency range	Reference	Limit	Status
Transmission	Spurious 1 GHz - 12.5 GHz	FCC part15	-41 dBm (1 MHz BW)	Pass

3.3 Conducted tests

This section describes the tests methods and results for conducted for IEEE TX and RX 802.15.4 measurements.

3.3.1 TX tests

This section explains various IEEE 802.15.4 transmission tests, their test methods, and test results.

3.3.1.1 Test setup N6

6 shows the setup used for IEEE TX tests.

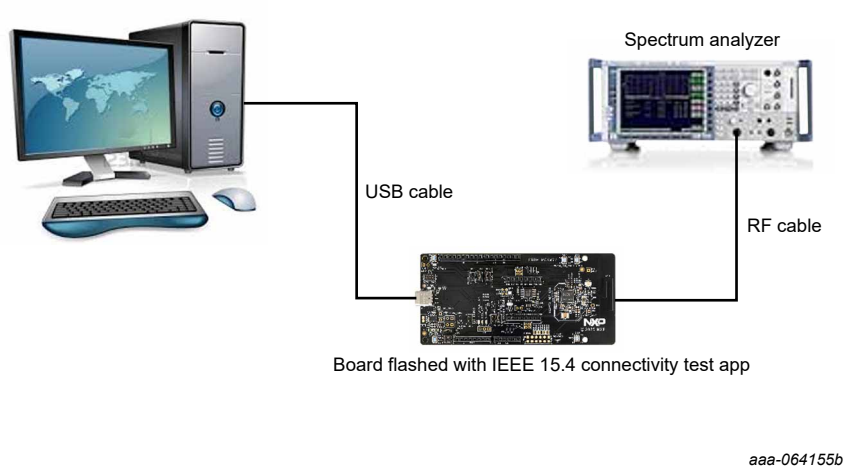

Figure 74. Test setup N6

Note: *The setup is identical to the Test setup 1 that is used for conducting generic TX Bluetooth LE tests except that it uses the IEEE 15.4 test application.*

3.3.1.2 Frequency accuracy

Test method:

- Use the Test setup 6. See Figure 74.
- Set the radio in:
  - TX mode, continuous waveform (CW), continuous unmodulated emitting mode, frequency: 2.405 GHz, IEEE.802.15.4 Channel 11
- Set the analyzer to:
  - Center frequency = 2.405 GHz, span = 1 MHz, Reference amplitude = 20 dBm, RBW = 10 kHz
- Measure the continuous waveform (CW) frequency with the marker of the spectrum analyzer.

Result

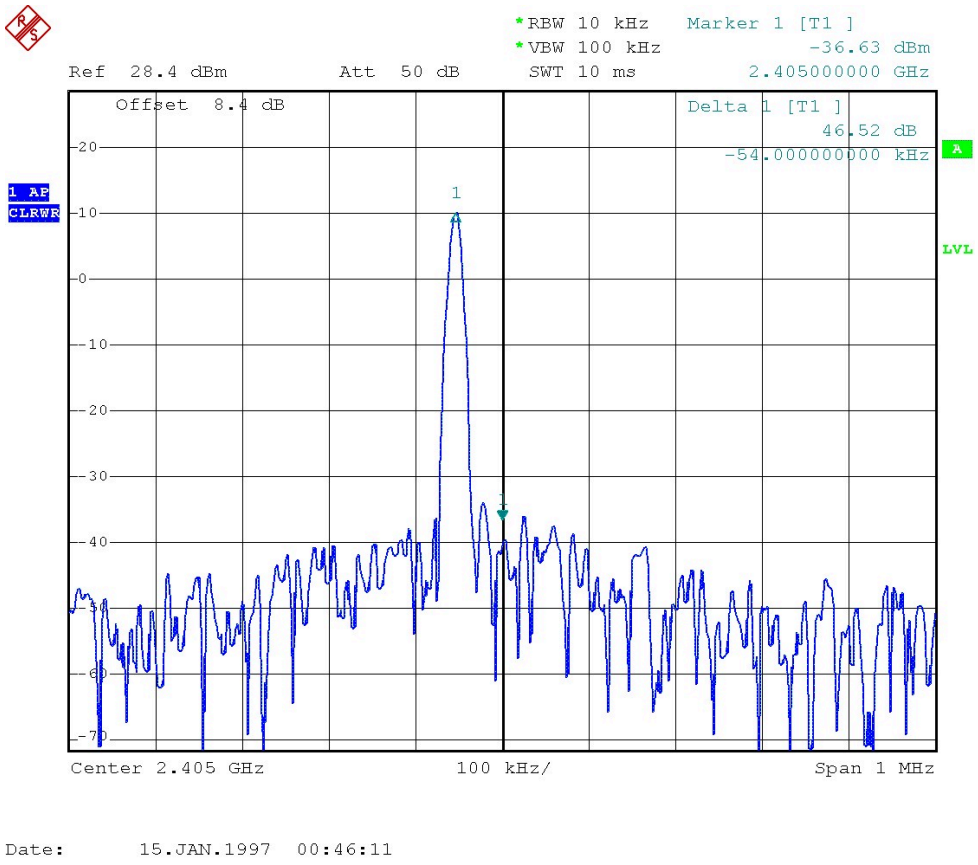

Figure 75. Frequency accuracy results for IEEE 802.15.4

- Measured frequency: 2.405 GHz
- ppm value = (2.404946-2.405) / 2.405 = -22.5 ppm

Table 71. Frequency accuracy (IEEE 802.15.4)

Result	Target	IEEE 802.15.4 limit
-22.5 ppm	+/- 25 ppm	+/- 40 ppm

Note: *The frequency accuracy depends on the XTAL model, which is NX1612SA 32MHZ EXS00A CS14160 on this board. XTAL Trim software parameter could use change this accuracy.*

Conclusion: The board passes the Frequency Accuracy Test.

3.3.1.3 Phase noise @ 100 kHz offset

Test method:

- Use the Test setup N6. See Figure 74.
- Set the radio in:
  - TX mode, continuous waveform (CW) continuous emitting mode, frequency: 2.405 GHz, IEEE.802.15.4 Channel 11
- Set the analyzer to:
  - Center frequency = 2.405 GHz, span = 1 MHz, Reference amplitude = 20 dBm
- Measure the phase noise at 100 kHz offset frequency.
  - RBW = 10 kHz (40 dBc)

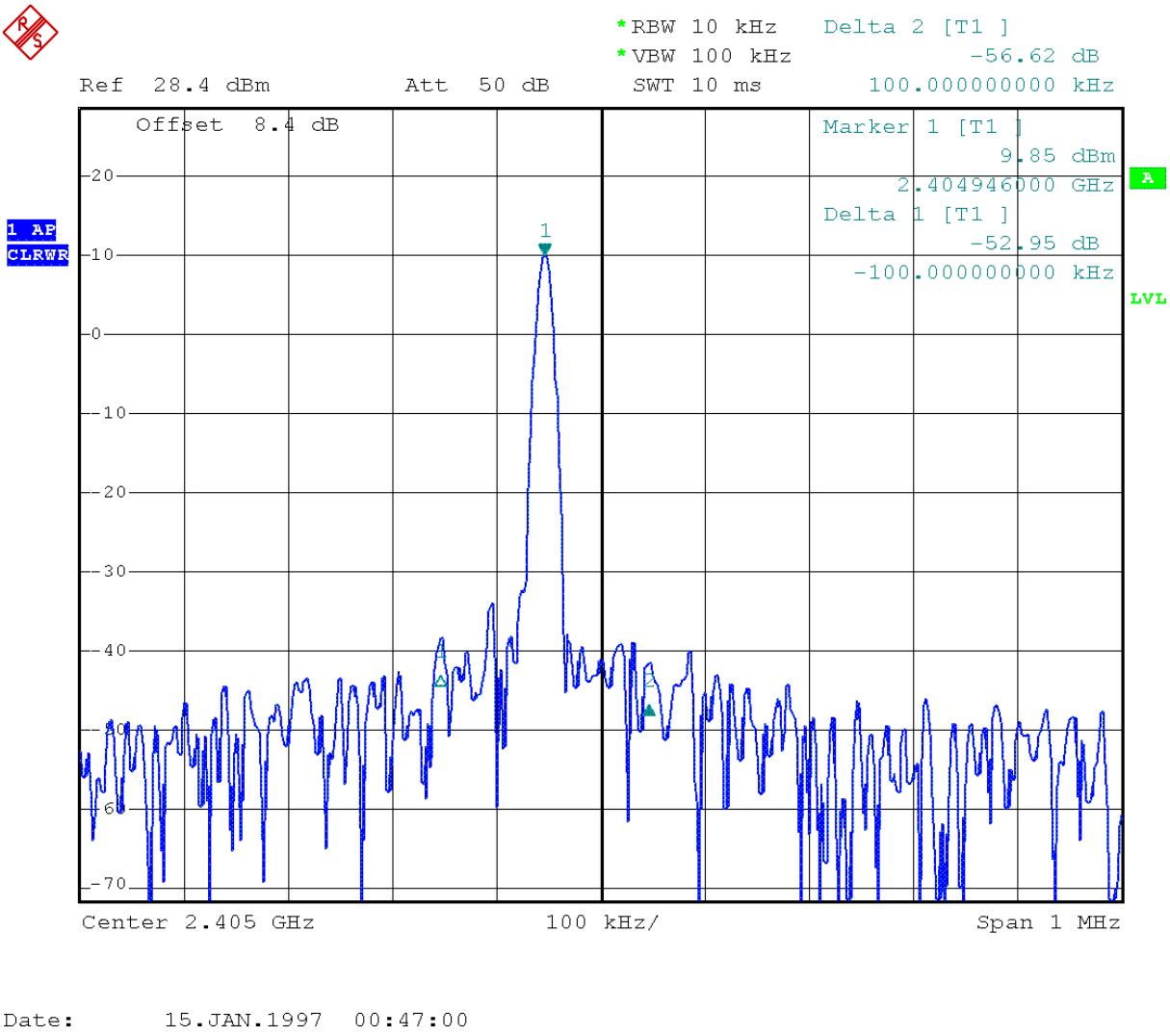

Figure 76. Phase noise TX (IEEE 802.15.4)

Phase noise Results:

- Marker value = -50.63 dBm within 10 kHz RBW:
  - Marker delta = 10.0 – (-50.63)
  - Phase noise at 100 kHz offset = Marker delta -10 Log (10 kHz) = **-100.63 dBc/Hz**

Note: *Phase noise is for information only.*

3.3.1.4 TX Power (fundamental)

Test method

- Use the Test setup N6. See Figure 74.
- Set the radio in:
  - TX mode, modulated, continuous emitting mode
- Set analyzer to:
  - Start frequency = 2.4 GHz, Stop frequency = 2.5 GHz
  - Reference amplitude = 20 dBm

– Sweep time = 100 ms
– RBW = 3 MHz

- Max Hold mode
- Detector: Peak
- Sweep all the channels from IEEE 802.15.4 Channel 11 to IEEE 802.15.4 Channel 26

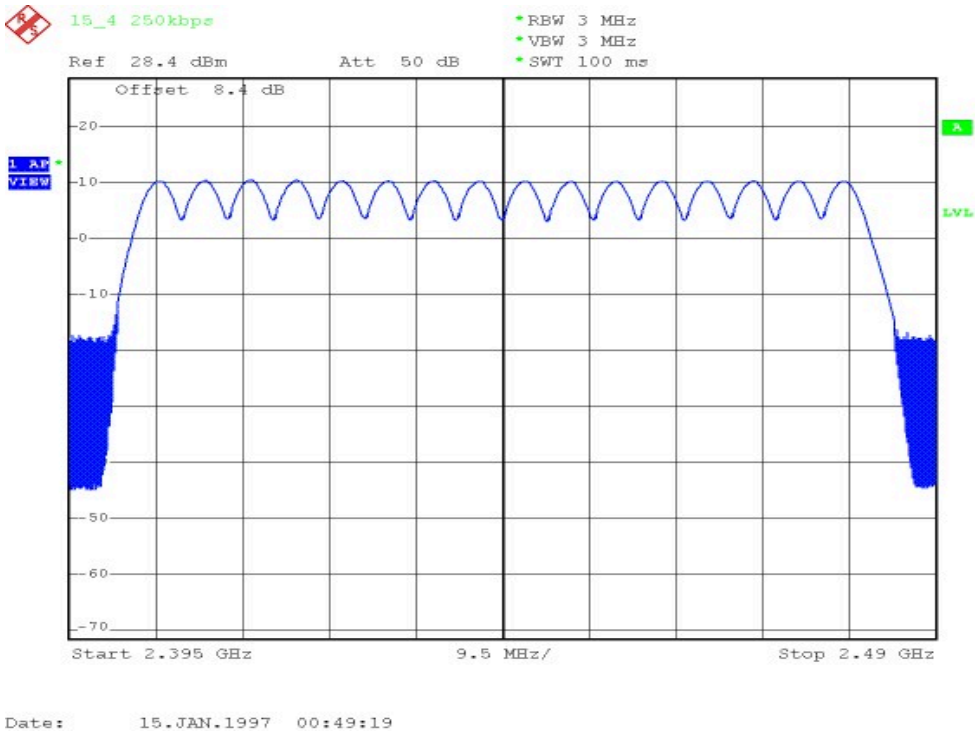

Figure 77. IEEE 802.15.4 TX Power (fundamental)

Result:

- Maximum power is on channel 22: 9.92 dBm
- Minimum power is on channel 13: 10.15 dBm
- Tilt over frequencies is: 0.23 dB

Conclusion:

- The default TX power is in line with the expected results.
- TX power is flat over frequencies.

3.3.1.5 TX power In Band

Test method:

- Use the Test setup 6. See Figure 74.
- Set the radio parameters of the board to:
  – TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  – Start frequency= 2.35 GHz, Stop frequency= 2.5 GHz
  – Reference amplitude = 10 dBm, sweep time = 100 ms,
  – RBW = 100 KHz, Video BW = 300 KHz

- Max Hold mode
- Detector = RMS
- Number of Sweeps = 10

• Sweep on Channel 11, Channel 18, and channel 26

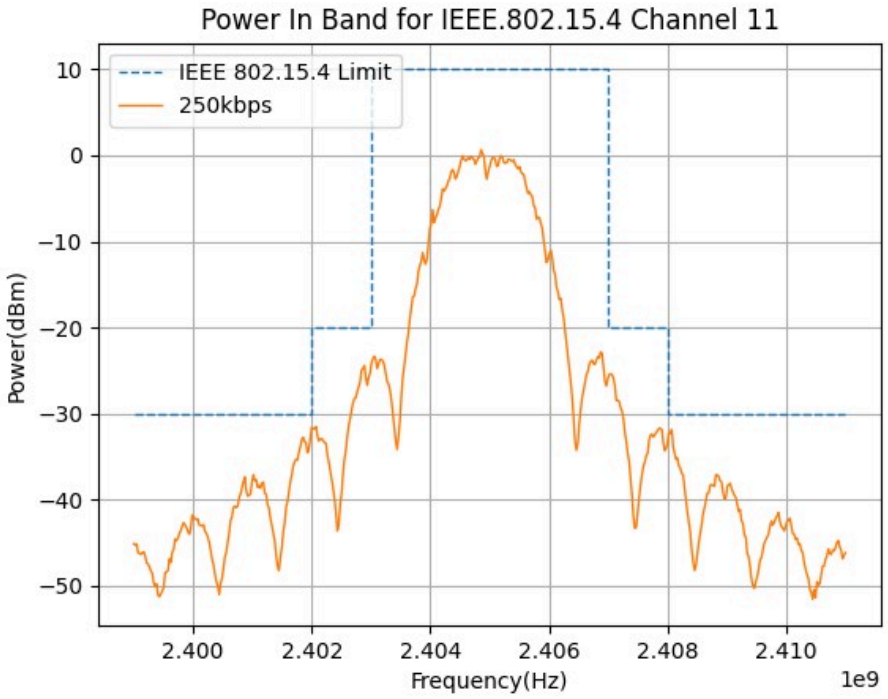

Figure 78. IEEE 802.15.4 Tx power In Band – Channel 11

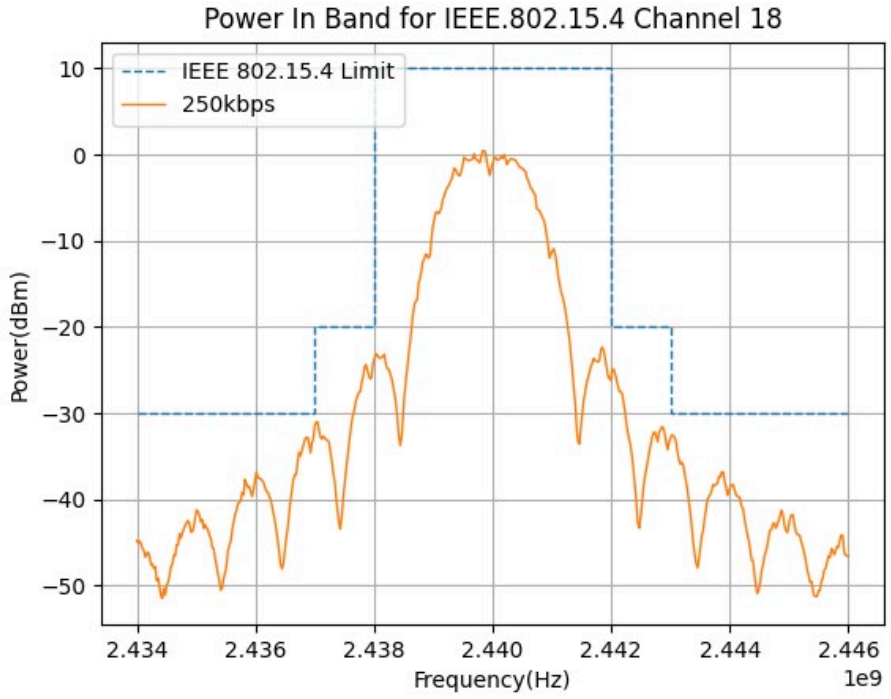

Figure 79. IEEE 802.15.4 Tx power In Band – Channel 18

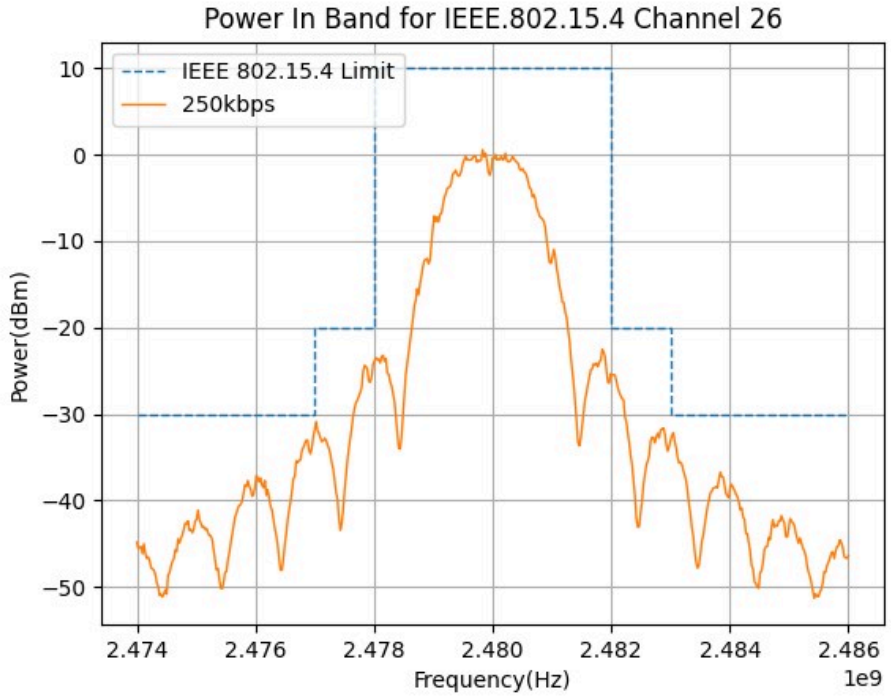

Figure 80. IEEE 802.15.4 Tx power In Band – Channel 26

Conclusion:

- The FRDM-MCXW72 board is within the expected limits and passes the 15.4 certification concerning the Power In Band test.

3.3.1.6 TX spurious

Global view from 0.03 GHz to 25 GHz

Use the Test setup N6. See Figure 74.

Spurious overview of the full band from 30 MHz to 25 GHz when the device is in the transmission mode.

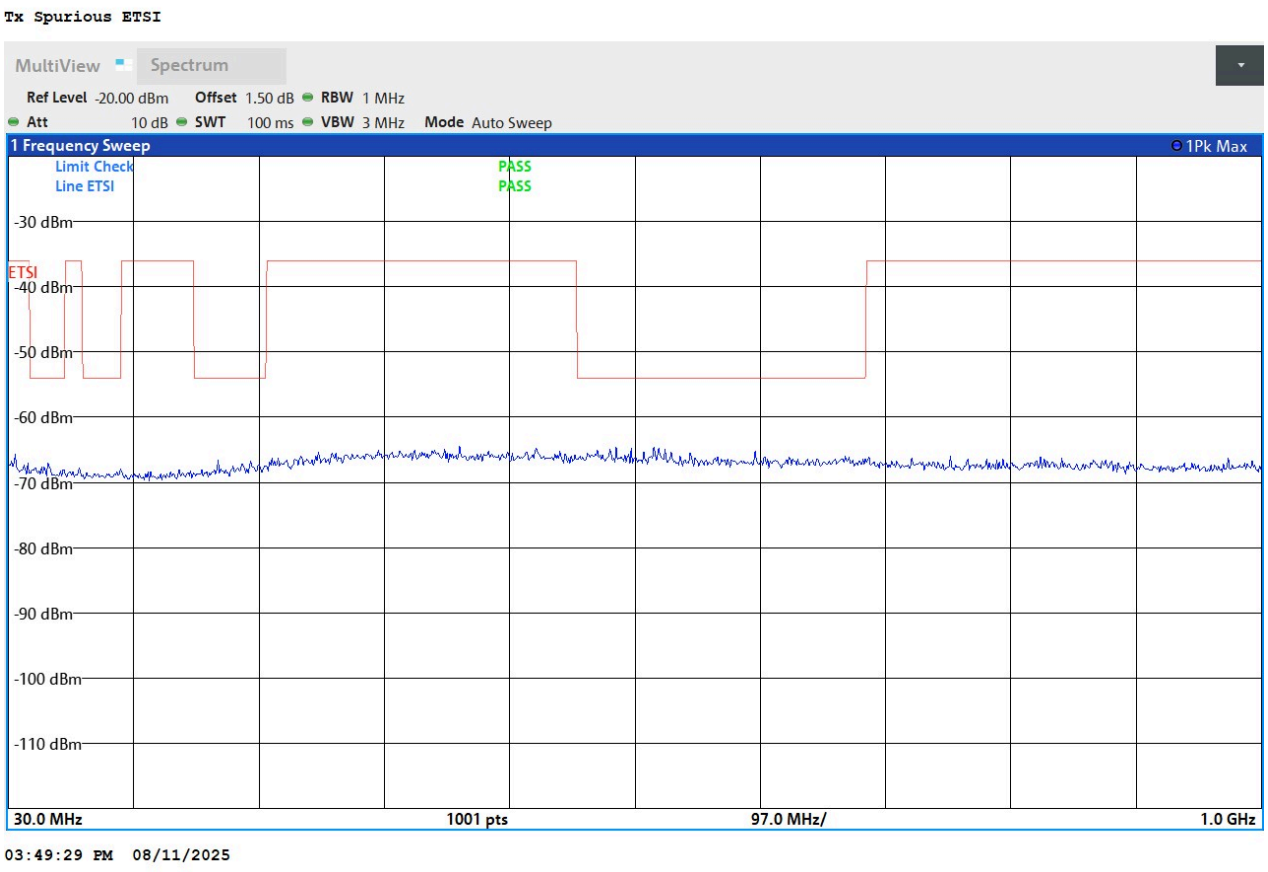

Figure 81. IEEE.802.15.4 - Conducted TX spurious (1 GHz to 25 GHz)

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

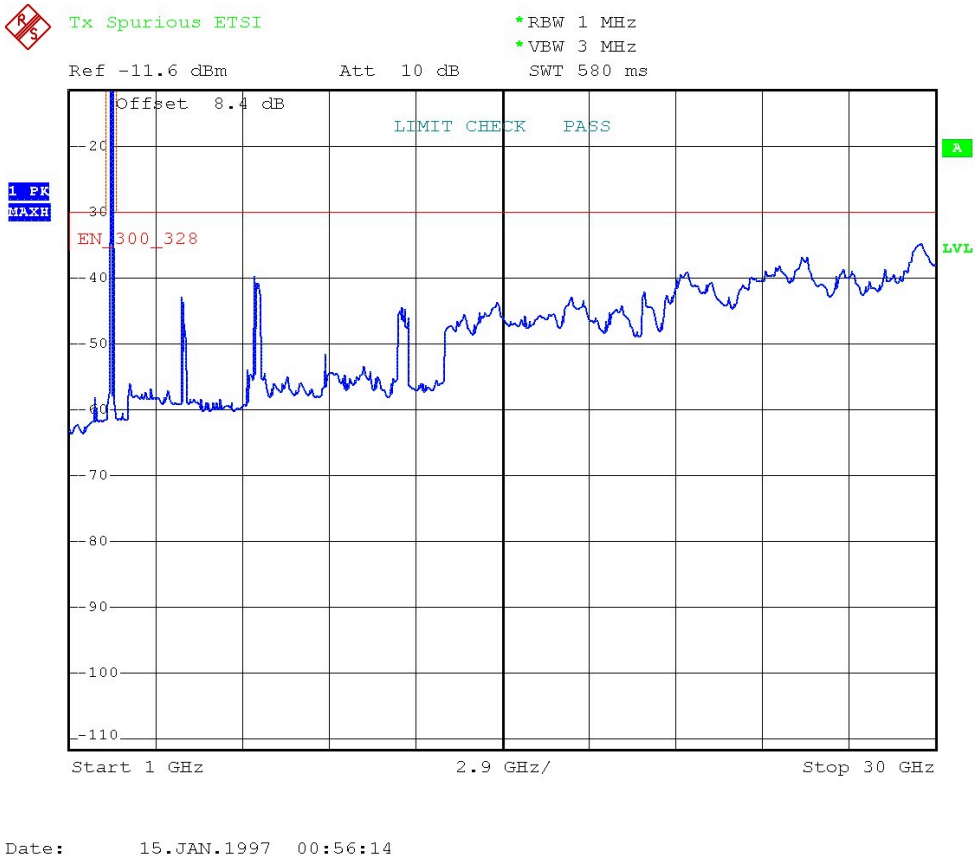

Figure 82. IEEE.802.15.4 - Conducted TX spurious (30 MHz to 1 GHz)

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- The FRDM-MCXW72 passes the ETSI Tx Spurious Certification with a margin of 4.71 dB.
- Harmonics are specifically measured in the following paragraphs.

3.3.1.6.1 H2 (ETSI test conditions)

Test method:

- **Test setup N1** is used. See Figure 3.
- Set the radio in:
  - TX mode, modulated, continuous emitting mode.
- Set the analyzer to:
  - Start frequency = 4.8 GHz, Stop frequency = 5 GHz,
  - Reference amplitude = -20 dBm, sweep time = 100 ms, RBW = 1 MHz
- Max Hold mode

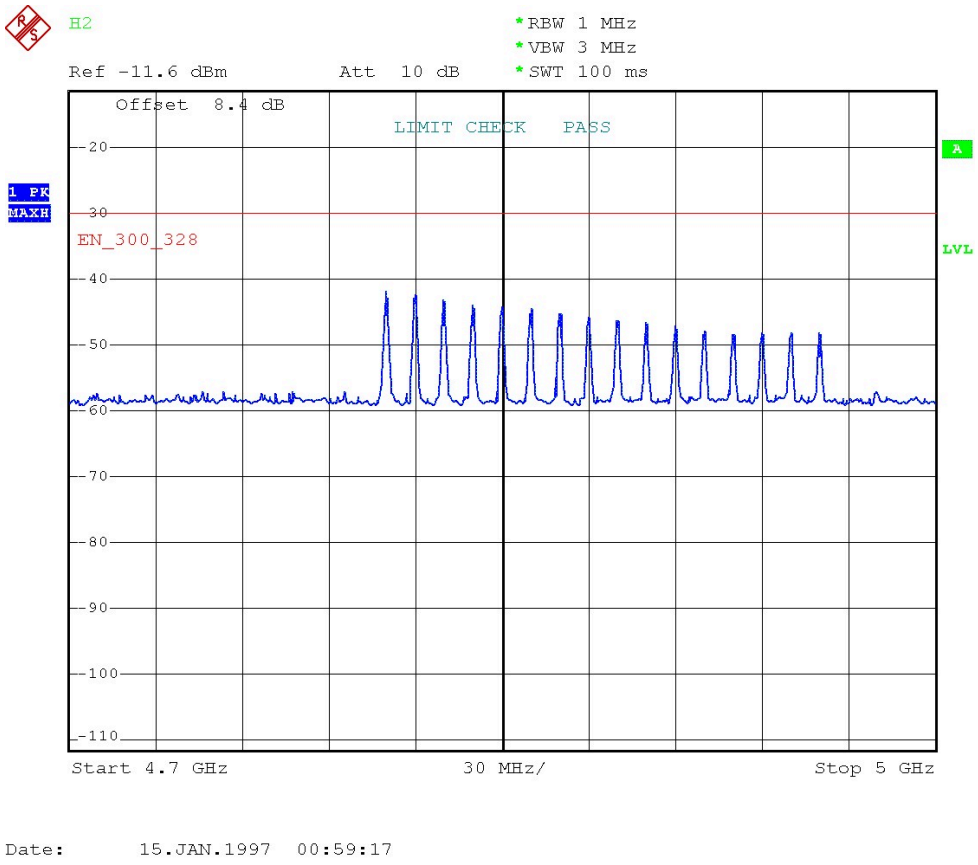

Figure 83. IEEE 802.15.4 - Conducted H2 spurious

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Result:

- Maximum power is at frequency 4.81 GHz: -42.21 dBm

Conclusion:

- There is more than 12.2 dB margin for Bluetooth LE to the ETSI limit

3.3.1.6.2 H3 (ETSI test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 7.0 GHz to 7.5 GHz.

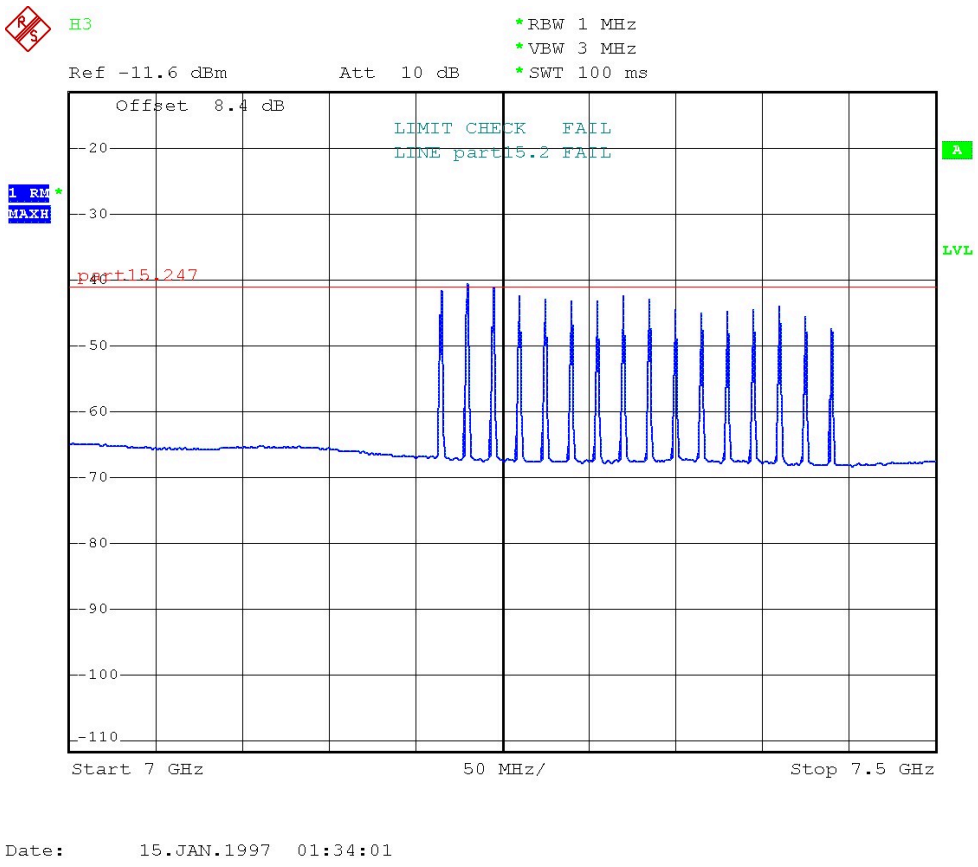

Figure 84. IEEE 802.15.4 - Conducted H3 spurious

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

- Maximum power is at frequency 7.23 GHz: -40.52 dBm.

Conclusion: The power is 0.6 dB, which is too high than Bluetooth LE to the FCC limit. Maximum output power can be lowered to pass the limit.

3.3.1.6.3 H4 (ETSI test conditions)

Use the same method as for H2, except that the spectrum analyzer frequency span is set from 9.4 GHz to 10.0 GHz.

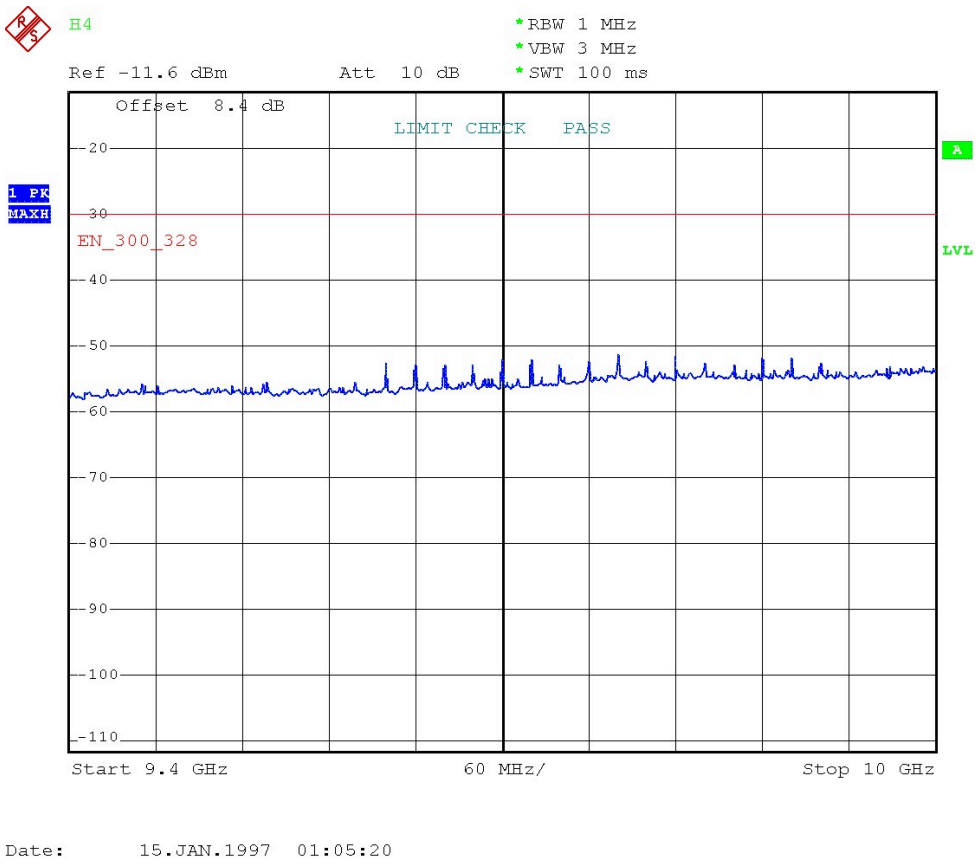

Figure 85. IEEE 802.15.4 - Conducted H4 spurious

Result

- The maximum power is at the frequency 9.88 GHz: -52.05 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 22.0 dB margin for Bluetooth LE to the ETSI limit.

3.3.1.6.4 H5 (ETSI test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 11.7 GHz to 12.5 GHz.

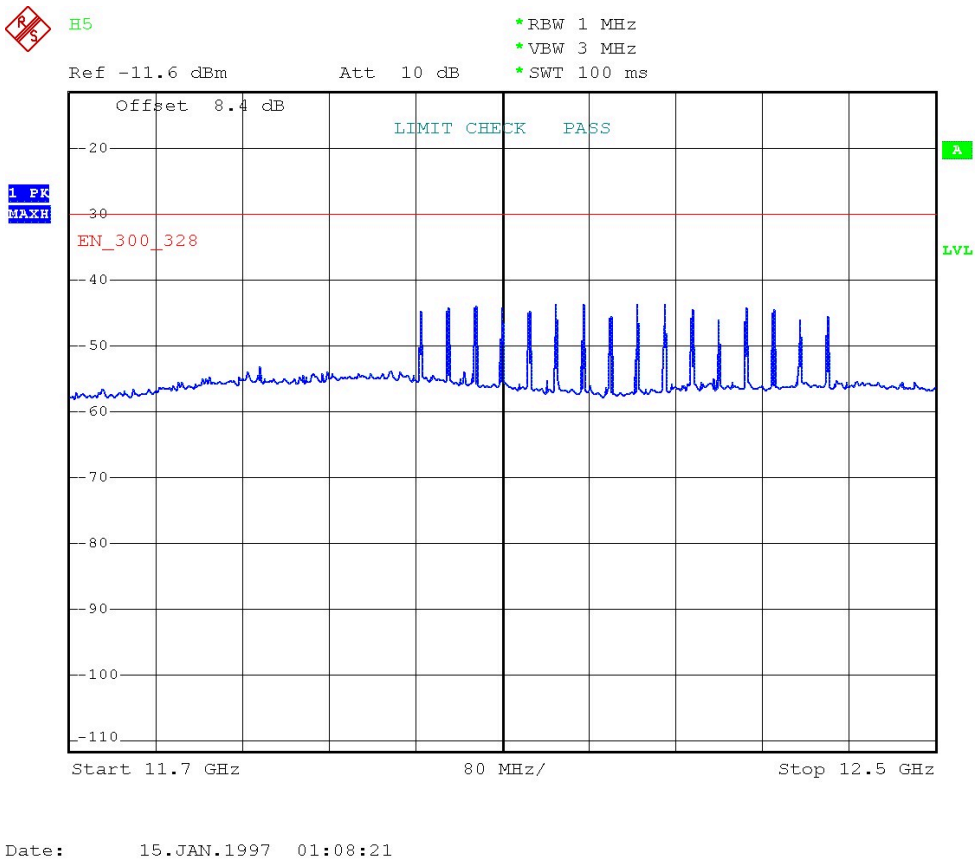

Figure 86. IEEE 802.15.4 - Conducted H5 spurious

Result

- Maximum power is at frequency 12.18 GHz: -43.77 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 13.8 dB margin for Bluetooth LE to the ETSI limit.

3.3.1.6.5 H6 (ETSI test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 14.1 GHz to 15 GHz.

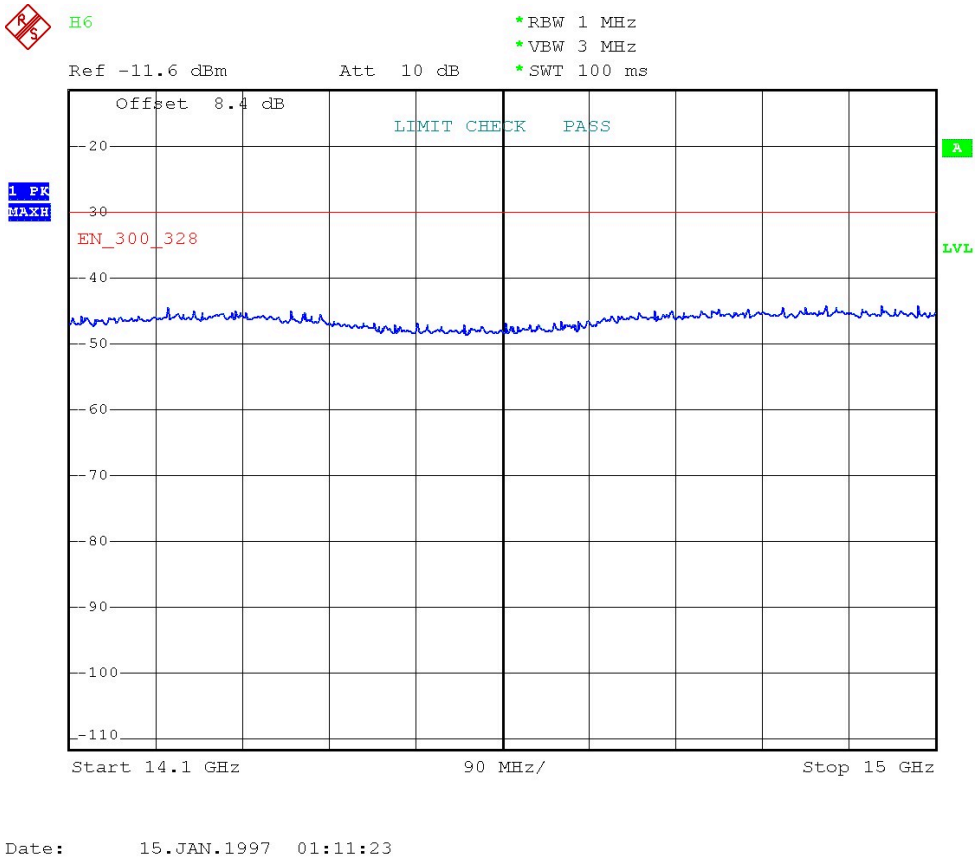

Figure 87. IEEE 802.15.4 - Conducted H6 spurious

- Maximum power is at frequency 14.89 GHz: -44.15 dBm

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 14.1 dB margin for Bluetooth LE to the ETSI limit.

3.3.1.6.6 H7 (ETSI test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 16.45 GHz to 17.5 GHz.

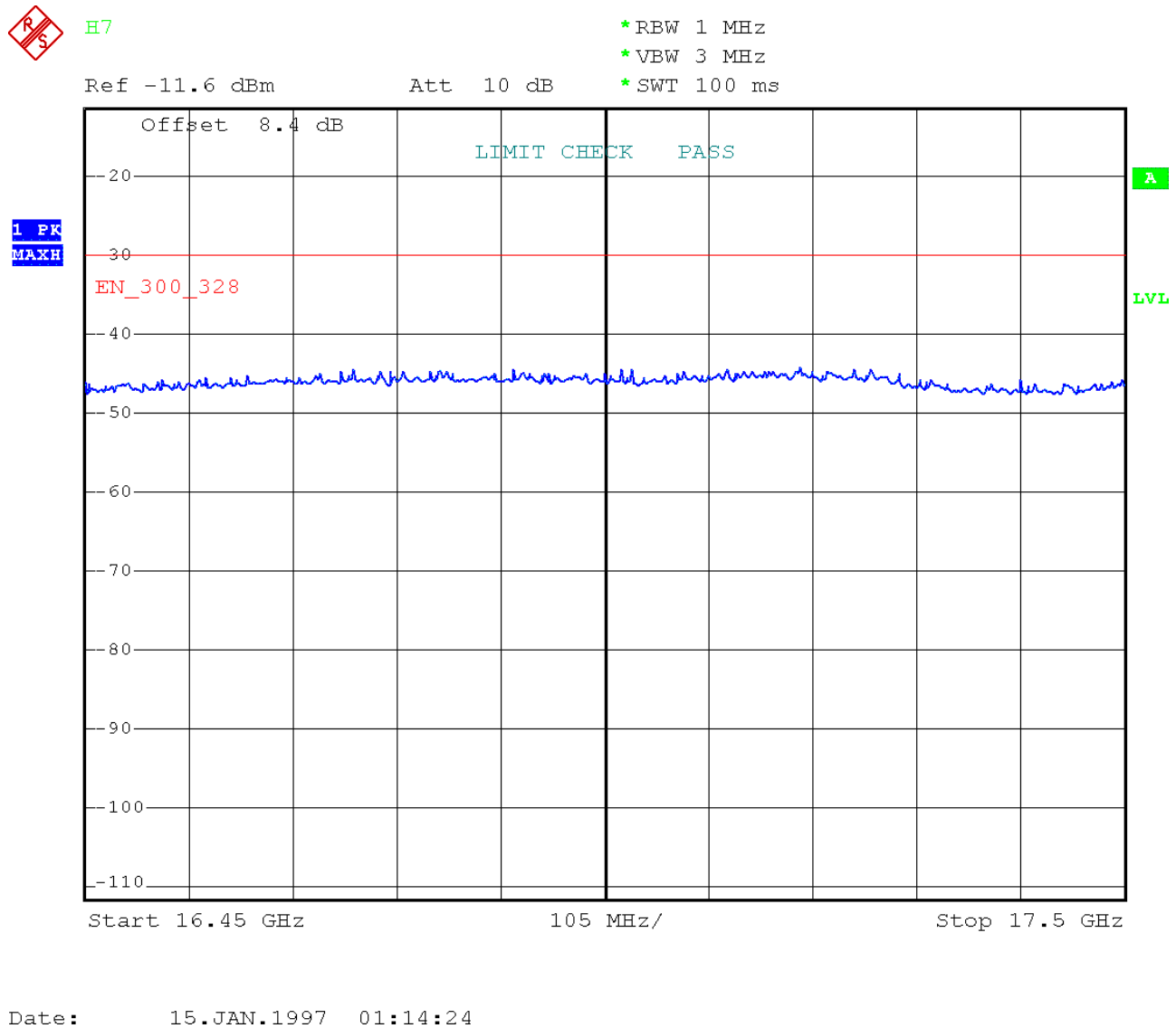

Figure 88. IEEE 802.15.4 - Conducted H7 spurious

Result:

- Maximum power is at frequency 17.24 GHz: -44.41 dBm.
  Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 14.4 dB margin for Bluetooth LE to the ETSI limit.

3.3.1.6.7 H8 (ETSI test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 18.8 GHz to 20 GHz.

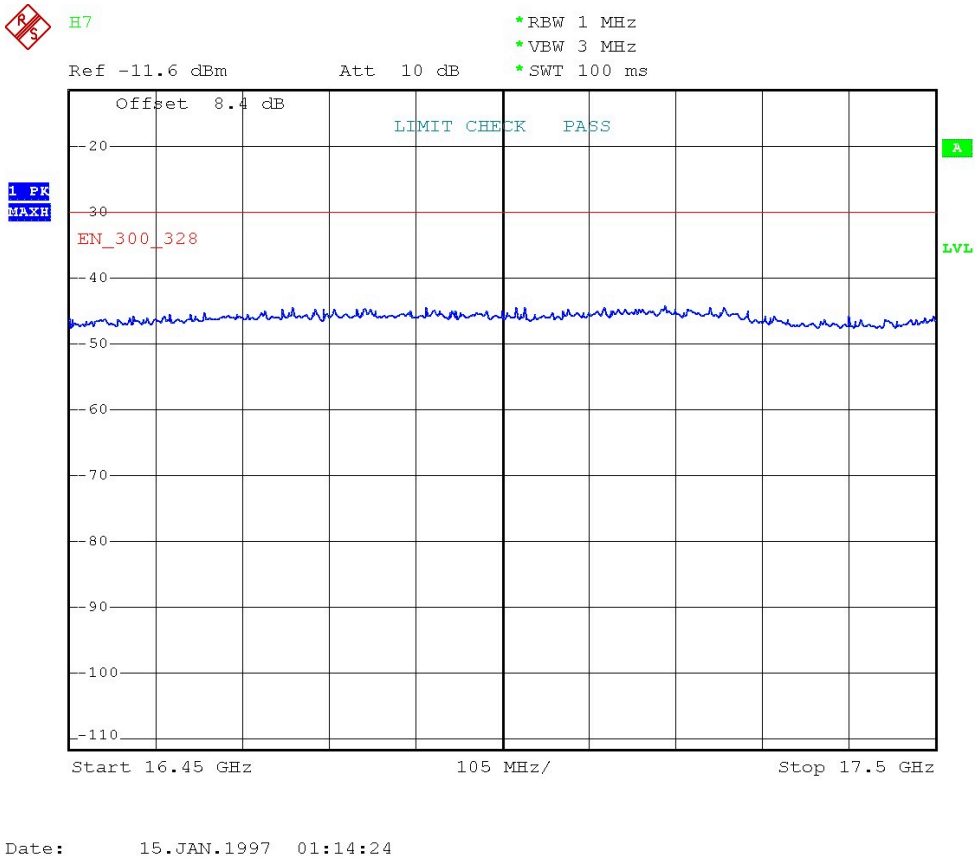

Figure 89. IEEE 802.15.4 - Conducted H8 spurious

Result

- Maximum power is at frequency 19.5 GHz -42.69 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

There is more than 12.7 dB margin for Bluetooth LE to the ETSI limit.

3.3.1.6.8 H9 (ETSI test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 21.15 GHz to 22.5 GHz.

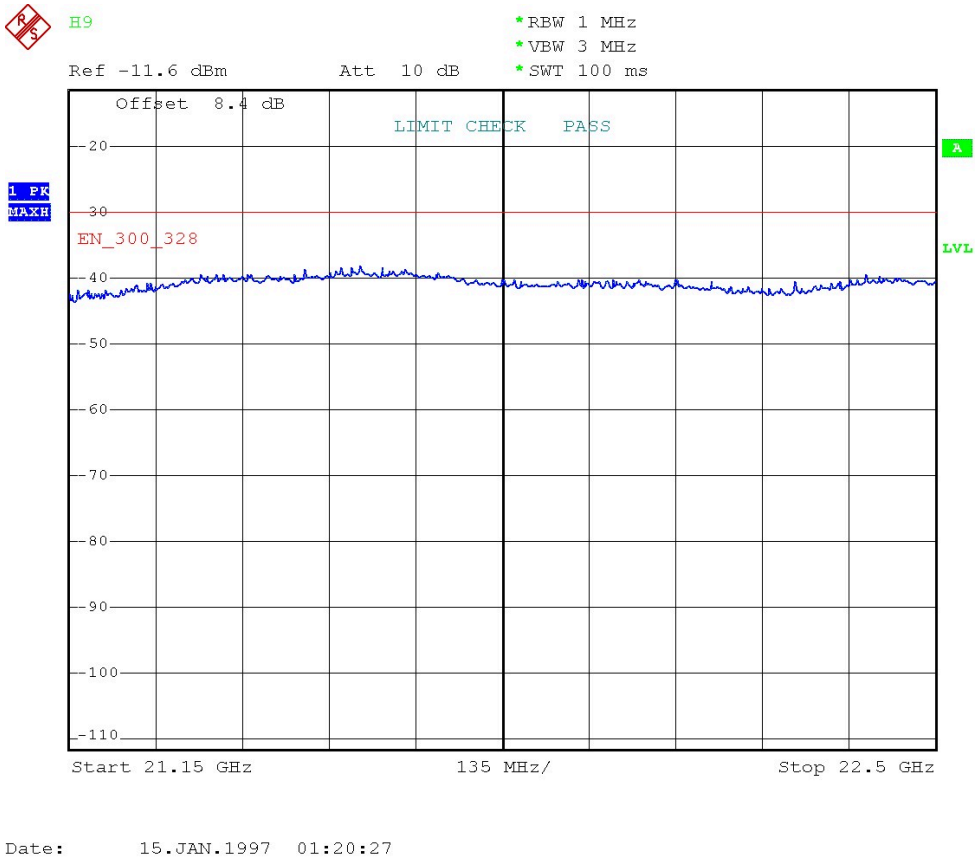

Figure 90. IEEE 802.15.4 - Conducted H9 spurious

Result

- Maximum power is at frequency 21.68 GHz: -39.09 dBm.

Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 9.1 dB margin for Bluetooth LE to the ETSI limit.

3.3.1.6.9 H10 (ETSI test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 23.35 GHz to 25 GHz.

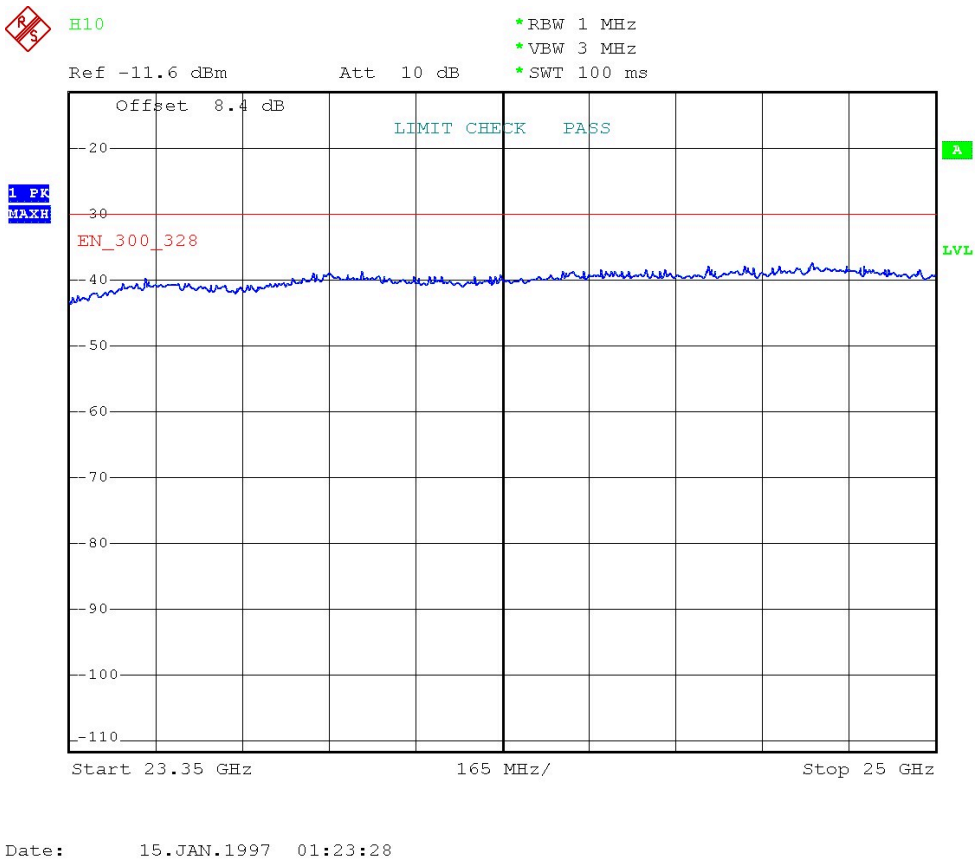

Figure 91. IEEE 802.15.4 - Conducted H10 spurious

Result

- Maximum power is at frequency 24.77 GHz: -37.42 dBm.
  Note: *These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.*

Conclusion:

- There is more than 7.4 dB margin for Bluetooth LE to the ETSI limit.

3.3.1.6.10 H2 (FCC test conditions)

Test method

- Set the radio in:
  - TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  - Start frequency= 4.8 GHz, Stop frequency = 5 GHz,

Reference amplitude = -20 dBm, RF attenuation = sweep time = 100 ms, RBW = 1 MHz.

- Trace mode: Average
- Detector RMS
- Sweep all the channels from
  - IEEE 802.15.4: channel 0 to channel 39.

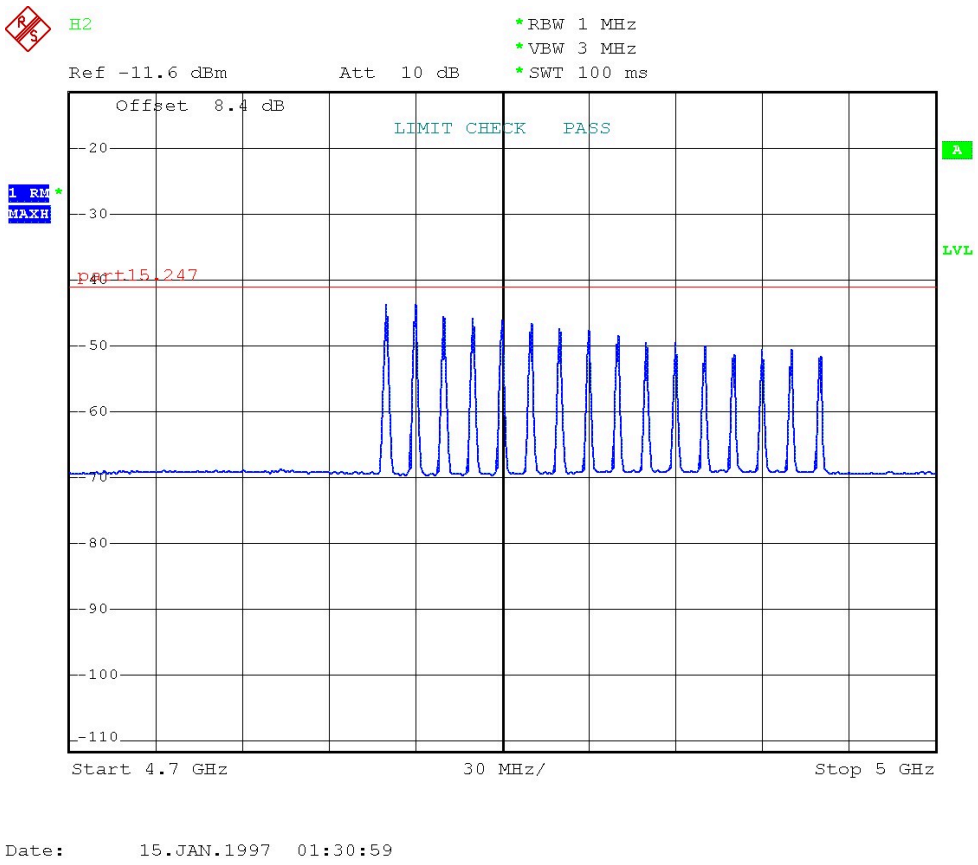

Figure 92. IEEE 802.15.4 - Conducted H2 FCC spurious

IEEE 802.15.4 results

- Maximum power is at frequency 4.81 GHz -43.72 dBm.
  Conclusion:
- There is more than 2.6 dB margin for Bluetooth LE to the FCC limit.

3.3.1.6.11 H3 (FCC test conditions)

The test method is similar as for the H2, except the spectrum analyzer frequency start/stop are set to 7.2 GHz and 7.5 GHz.

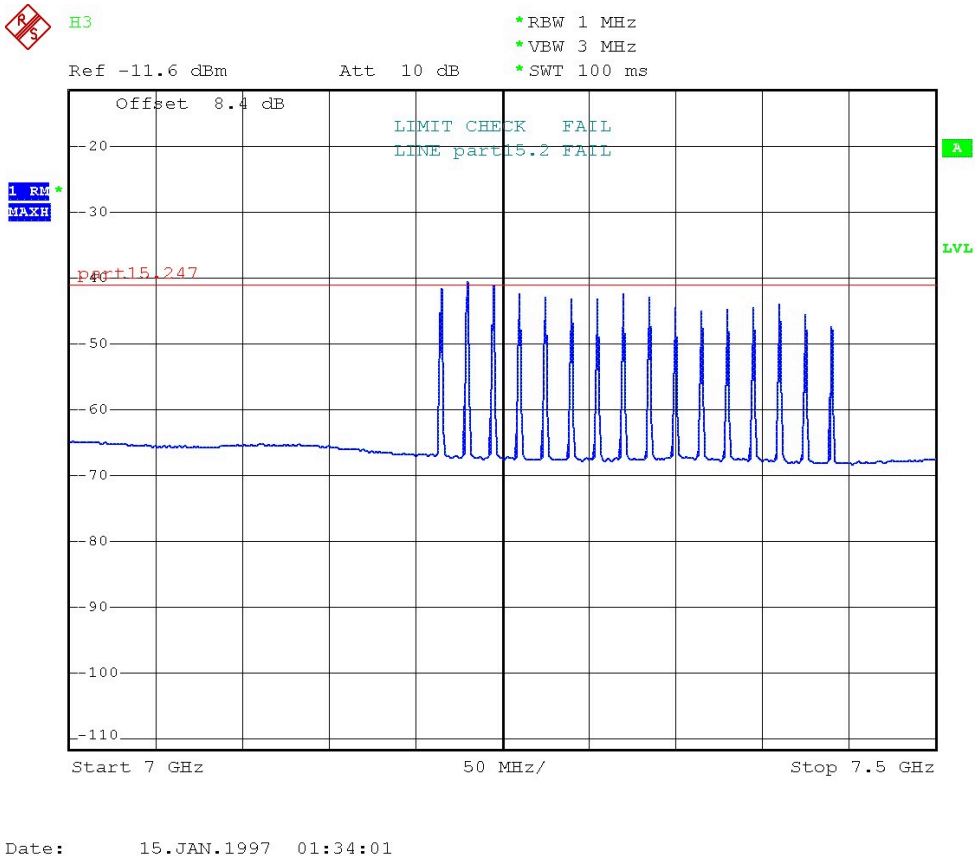

Figure 93. IEEE 802.15.4 - Conducted H3 FCC spurious

Result:

- Maximum power is at frequency 7.23 GHz: -40.52 dBm.
  Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion:

- The power is 0.6 dB too high than Bluetooth LE to the FCC limit. Max Output power may be lowered to pass the limit.

3.3.1.6.12 H4 (FCC test conditions)

The test method is similar as for the H2, except the spectrum analyzer frequency span is set from 9.6 GHz to 10.0 GHz.

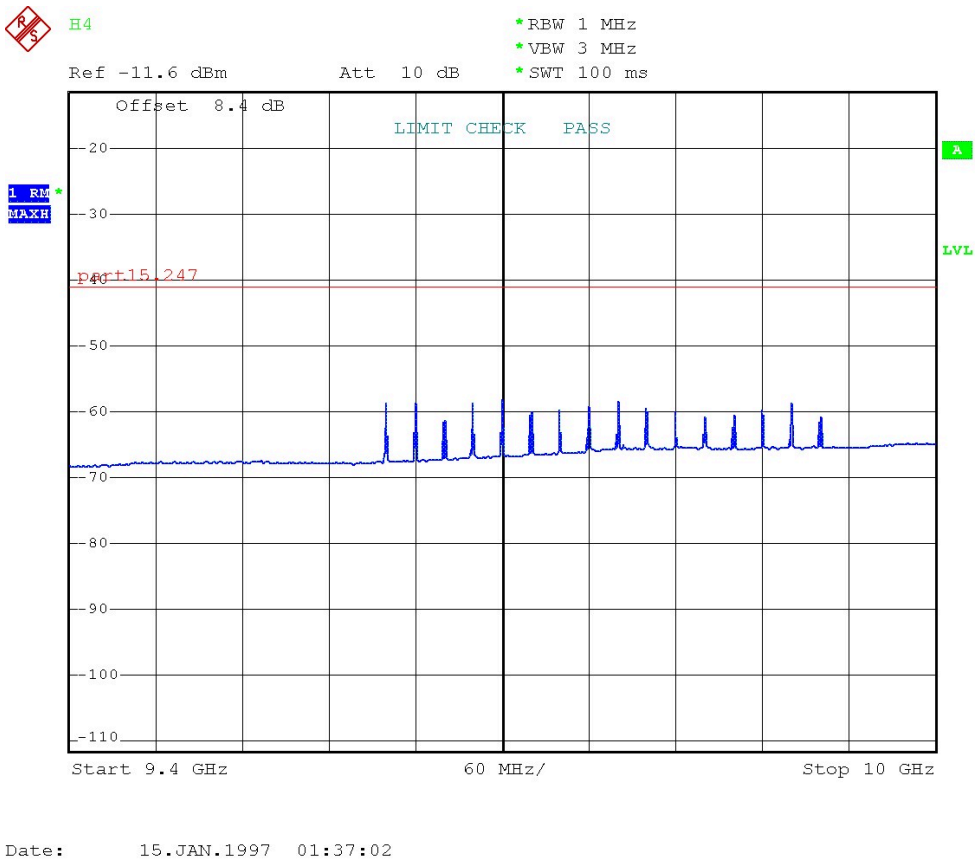

Figure 94. IEEE 802.15.4 - Conducted H4 FCC spurious

Result

- Maximum power is at frequency 9.7 GHz: -58.14 dBm.
  Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion:

- There is more than 17.0 dB margin for Bluetooth LE to the FCC limit

3.3.1.6.13 H5 (FCC test conditions)

The test method is similar as for the H2, except the spectrum analyzer frequency span is set from 12 GHz to 12.5 GHz.

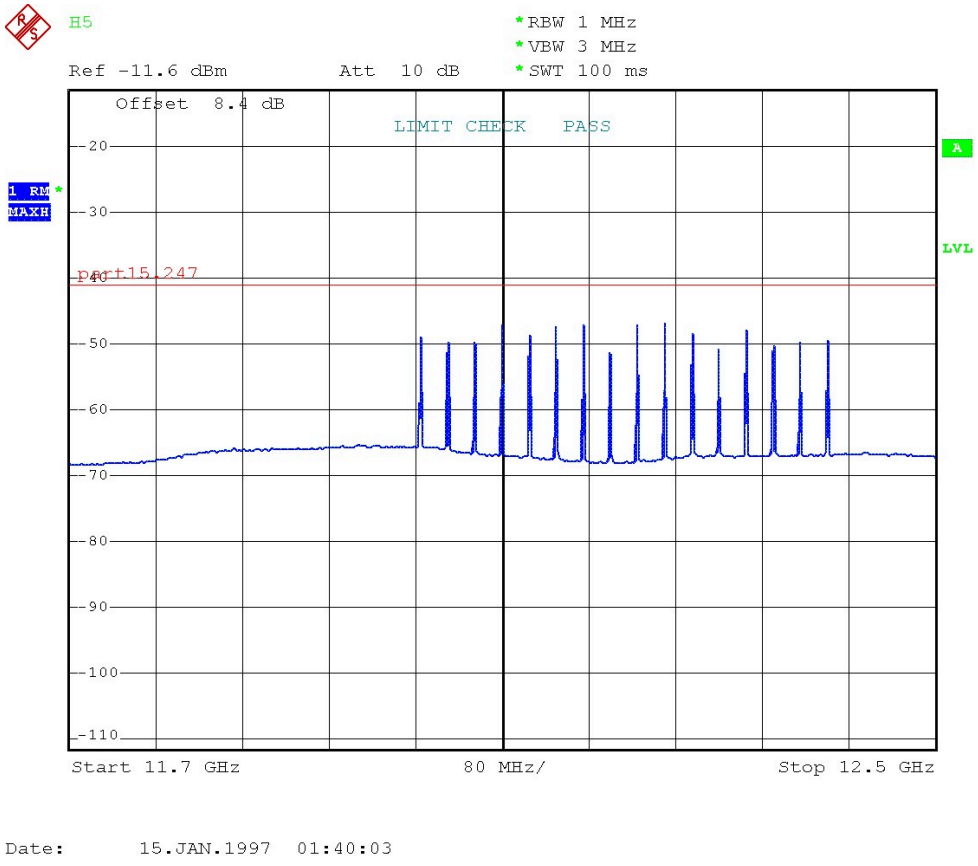

Figure 95. IEEE 802.15.4 - Conducted H5 FCC spurious

Result:

- Maximum power is at frequency 12.25 GHz: -46.96 dBm.
  Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion:

- There is more than 5.8 dB margin for Bluetooth LE to the FCC limit

3.3.1.6.14 H6 (FCC test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 14.1 GHz to 15 GHz.

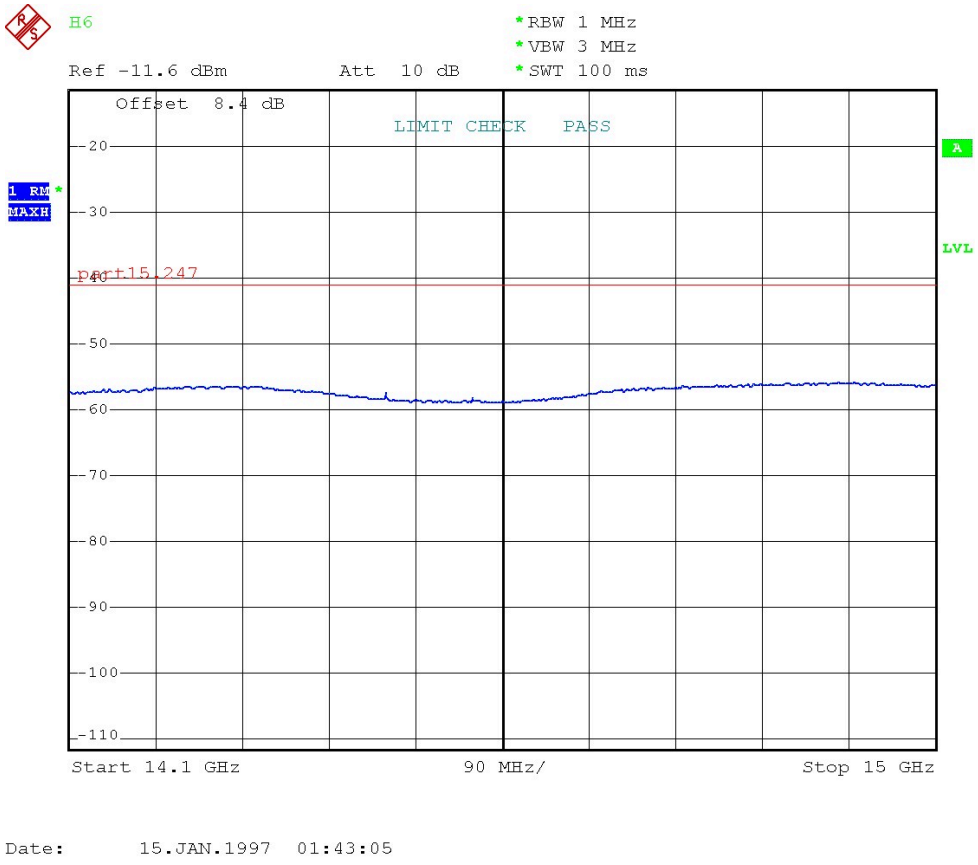

Figure 96. IEEE 802.15.4 - Conducted H6 FCC spurious

Result:

- Maximum power is at frequency 14.92 GHz: -55.88 dBm

Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion:

- There is more than 14.8 dB margin for Bluetooth LE to the FCC limit.

3.3.1.6.15 H7 (FCC test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 16.45 GHz to 17.5 GHz.

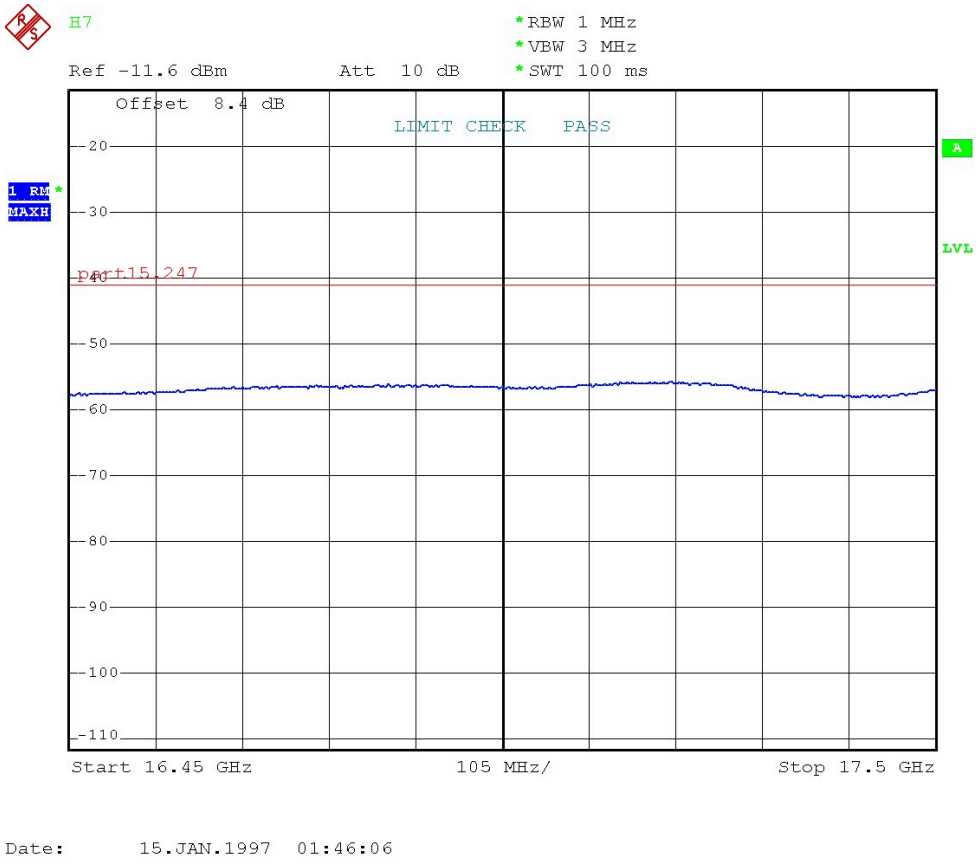

Figure 97. IEEE 802.15.4 - Conducted H7 FCC spurious

Result:

- Maximum power is at frequency 17.18 GHz: -55.75 dBm
  Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion:

- There is more than 14.6 dB margin for Bluetooth LE to the FCC limit.

3.3.1.6.16 H8 (FCC test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 18.8 GHz to 20 GHz.

Result:

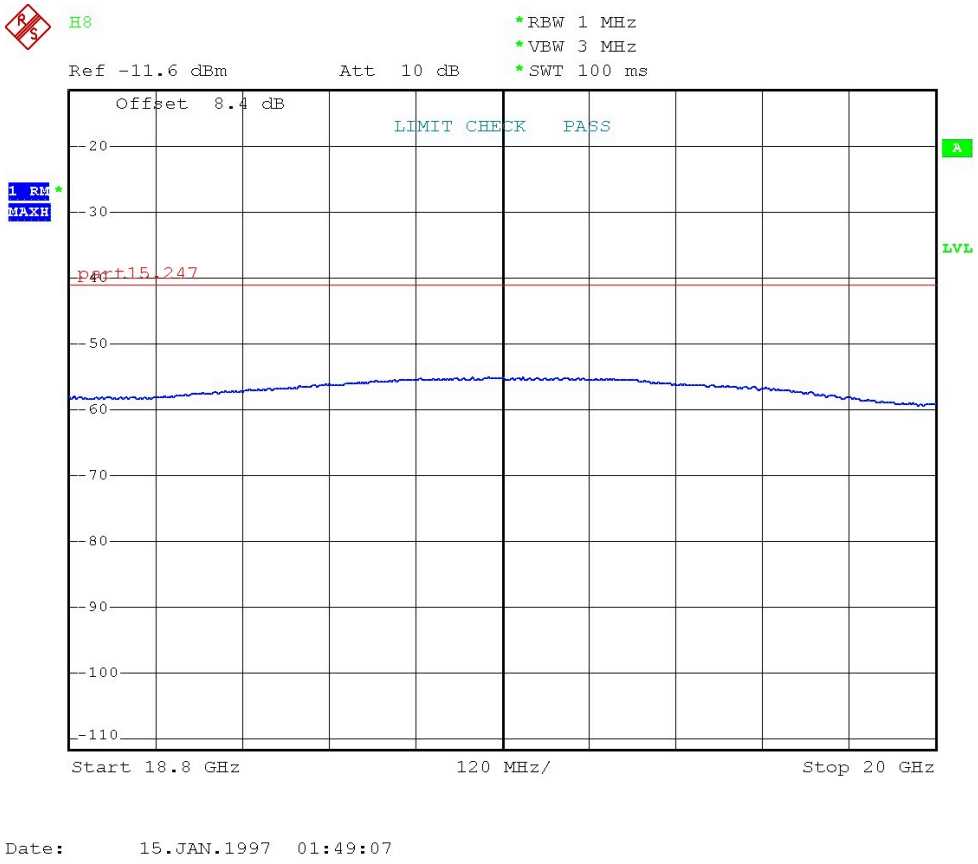

Figure 98. IEEE 802.15.4 - Conducted H8 FCC spurious

- Maximum power is at frequency 19.38 GHz: -55.16 dBm

Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion

- There is more than 14.0 dB margin for Bluetooth LE to the FCC limit.

3.3.1.6.17 H9 (FCC test conditions)

Test method

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 21.15 GHz to 22.5 GHz. Result:

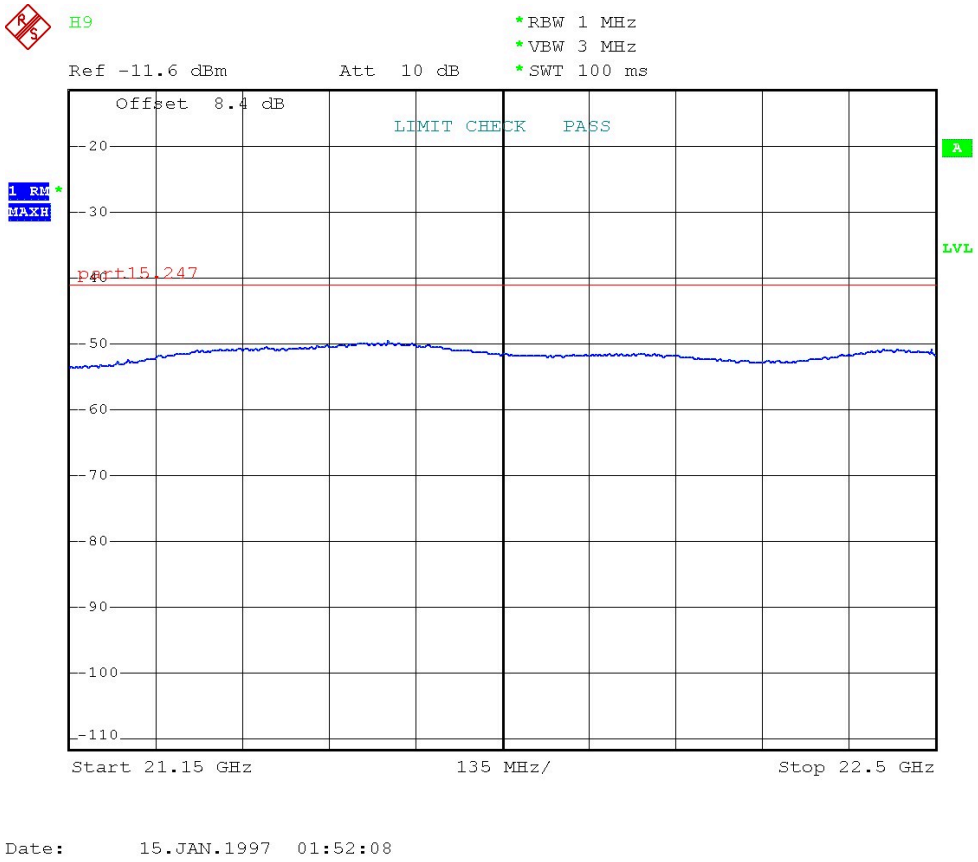

Figure 99. IEEE 802.15.4 - Conducted H9 FCC spurious

- The maximum power is at frequency 21.65 GHz: -50.03 dBm.

Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion

There is more than 8.9 dB margin for Bluetooth LE to the FCC limit.

3.3.1.6.18 H10 (FCC test conditions)

Use the same method as the test for H2, except that the spectrum analyzer frequency span is set from 23.35 GHz to 25 GHz.

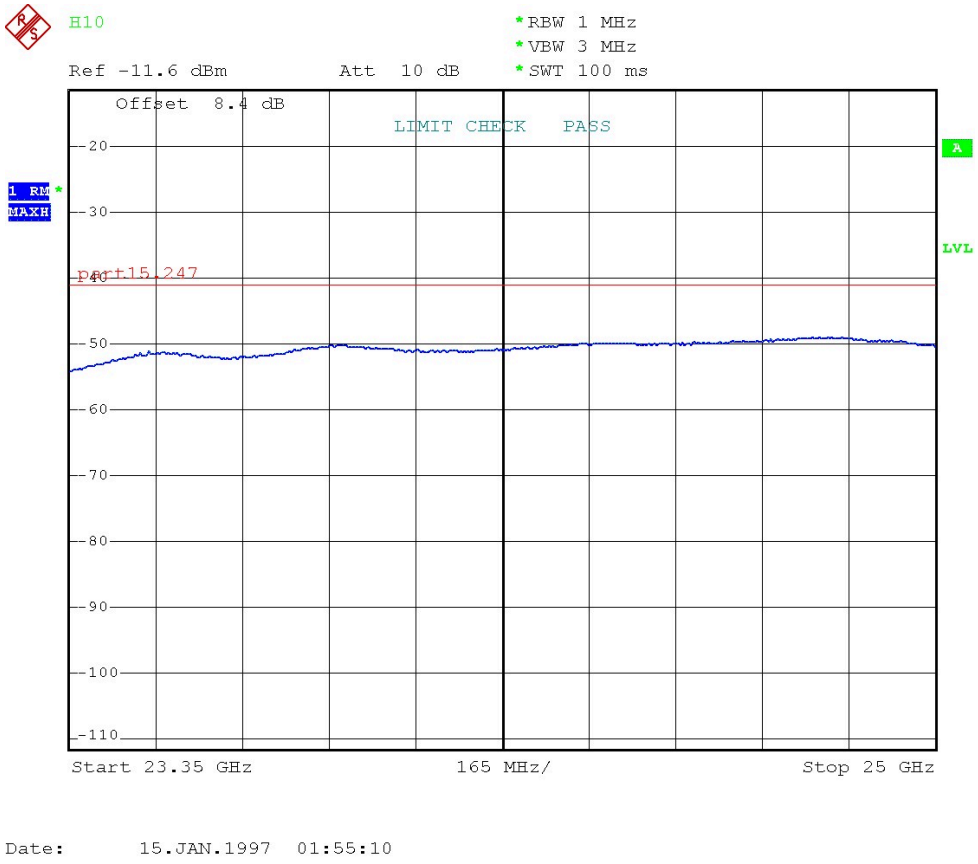

Figure 100. IEEE 802.15.4 - Conducted H10 FCC spurious

Result:

- Maximum power is at the frequency 24.8 GHz: -49.03 dBm.

Note: These results are for illustration only as they were obtained using a uFL connector calibrated up to 6 GHz only.

Conclusion:

- There is more than 7.9 dB margin for Bluetooth LE to the FCC limit.

3.3.1.7 TX modulation

Test method:

- Use the Test setup N6. See Figure 74.
- To do the EVM measurement, use the specific menu of the Spectrum analyzer.
- Set the MCX W72 in continuous modulated mode.
- First set the TX frequency to IEEE 802.15.4 Channel 11.
- Measure the offset EVM value.
- Repeat the test for each channel from IEEE 802.15.4 Channel 11 to IEEE 802.15.4 Channel 26.

3.3.1.7.1 EVM

The following graph shows the EVM test result.

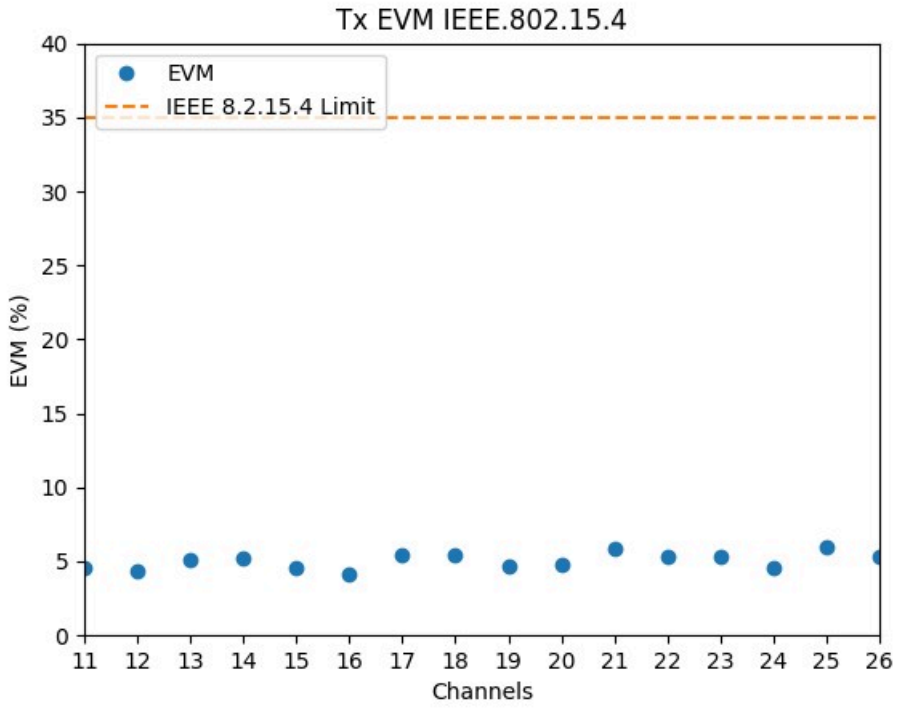

Figure 101. EVM in regular mode

The maximum value is on channel 25 with **5.95 %**.

Conclusion:

- The board passes the IEEE 802.15.4 EVM certification test.

3.3.1.7.2 Offset EVM

Test method:

- Use a similar method as for the EVM measurement.

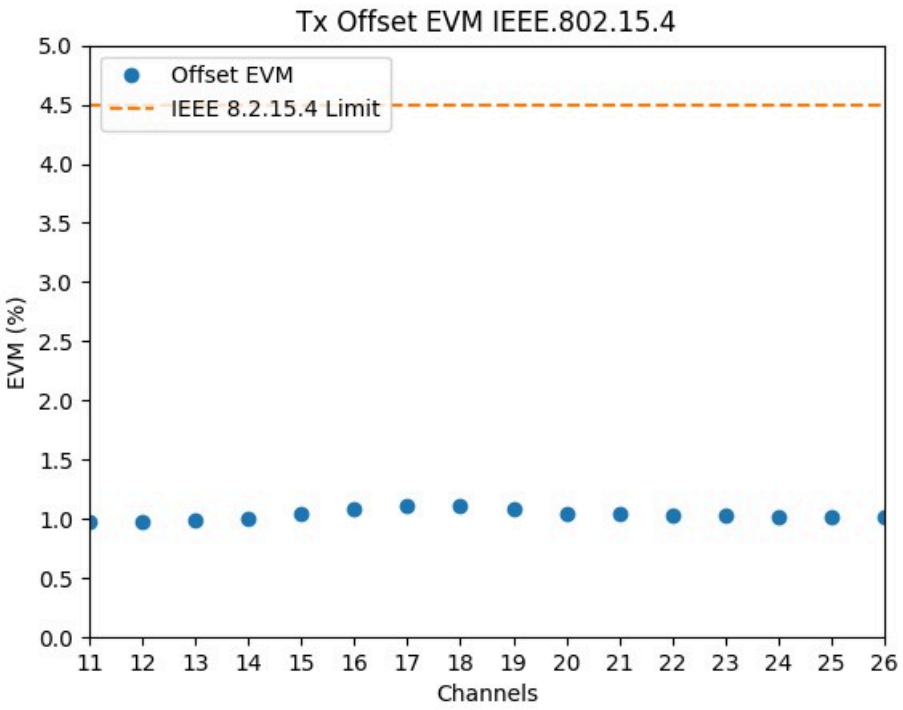

Figure 102. Offset EVM in regular mode

Result

The maximum value is on channel 17 with 1.11 %.

Conclusion

- The board passes the IEEE.802.15.4 Offset EVM certification test.

3.3.1.8 Lower Band Edge – China MIIT

- Use the Test setup N6. See Figure 74
- Set the radio parameters of the board to:
  - TX mode, modulated, burst mode
- Set the IEEE 802.15.4 Channel 11 (2.405 GHz)
- Set the analyzer to:
  - Start frequency= 2.385 GHz
  - Stop frequency = 2.415 GHz
  - Reference amplitude = -20 dBm
  - Sweep time = 100 ms
  - Sweep point: 8001 pts
  - RBW = 1 MHz
  - Video BW = 3 MHz
  - Detector Mode = RMS
  - Trace Mode = Max Hold

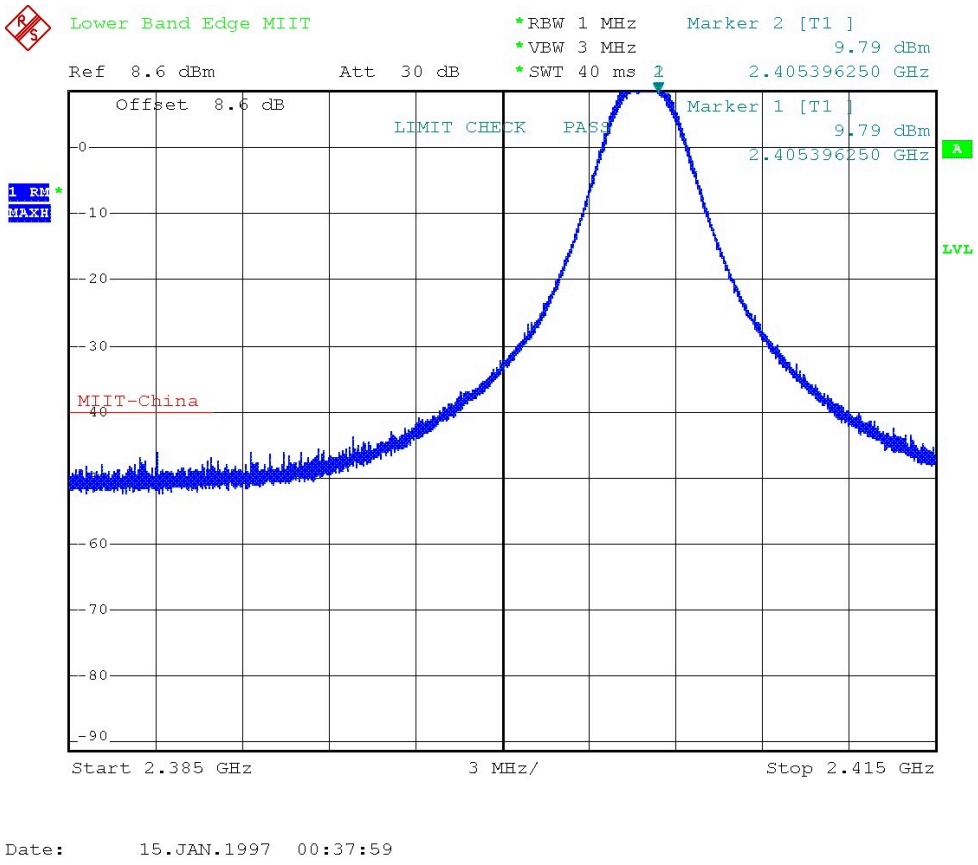

Figure 103. Lower Band Edge – Channel 11 (MIIT-China)

Conclusion

- The Lower Band Edge test passes the MIIT-China certification.

3.3.1.9 Upper Band Edge – MIIT China

- Use the Test setup N6. See Figure 74
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode
- Set the channel 26 (2.48 GHz)
- Set the TX output power to -5 dBm
- Set the analyzer to:
  - Start frequency = 2.477 GHz
  - Stop frequency = 2.507 GHz
  - Reference amplitude = -20 dBm
  - Sweep time = 40 ms
  - Sweep point: 8001 pts
  - RBW = 1 MHz
  - Video BW = 3 MHz
  - Detector Mode = RMS
  - Trace Mode = Max Hold

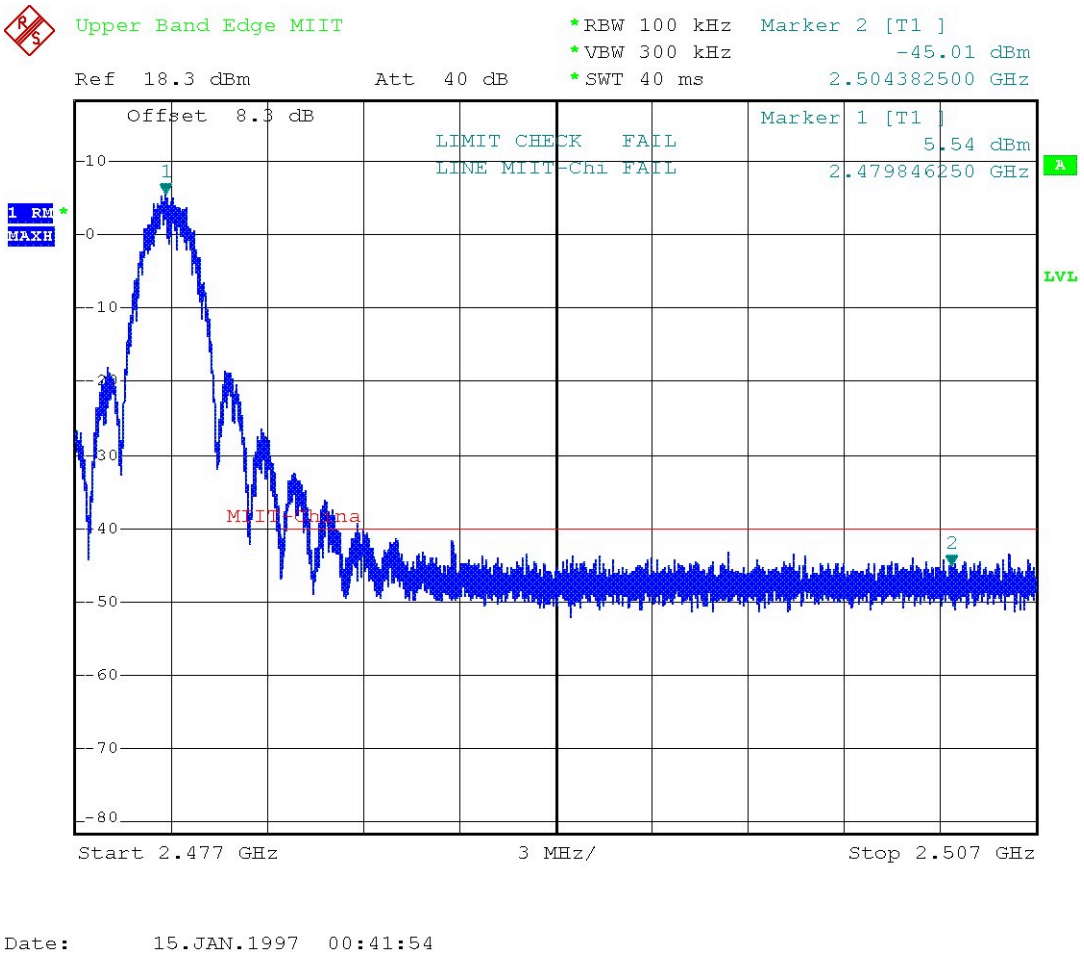

Figure 104. Upper Band Edge – MIIT China

Conclusion:

- The MCX W72-FRDM passes the Upper Band Edge MIIT test by lowering the max Output Power level.

3.3.1.10 Upper Band Edge (FCC ANSI C63.10, 558074 D01 DTS)

- Use the Test setup N6. See Figure 74
- Set the radio parameters of the board to:
  - TX mode, modulated, and continuous emitting mode.
- Set the analyzer to:
  - Start frequency = 2.475 GHz
  - Stop frequency =2.485 GHz
  - Reference amplitude = -20 dBm
  - Sweep time = 100 ms
  - RBW = 100 kHz
  - Video BW = 300 kHz
  - Detector = Average
  - Average mode: power
  - Number of sweeps = 100
- Set the channel 26 (2.48 GHz)

- Trace mode: Max hold

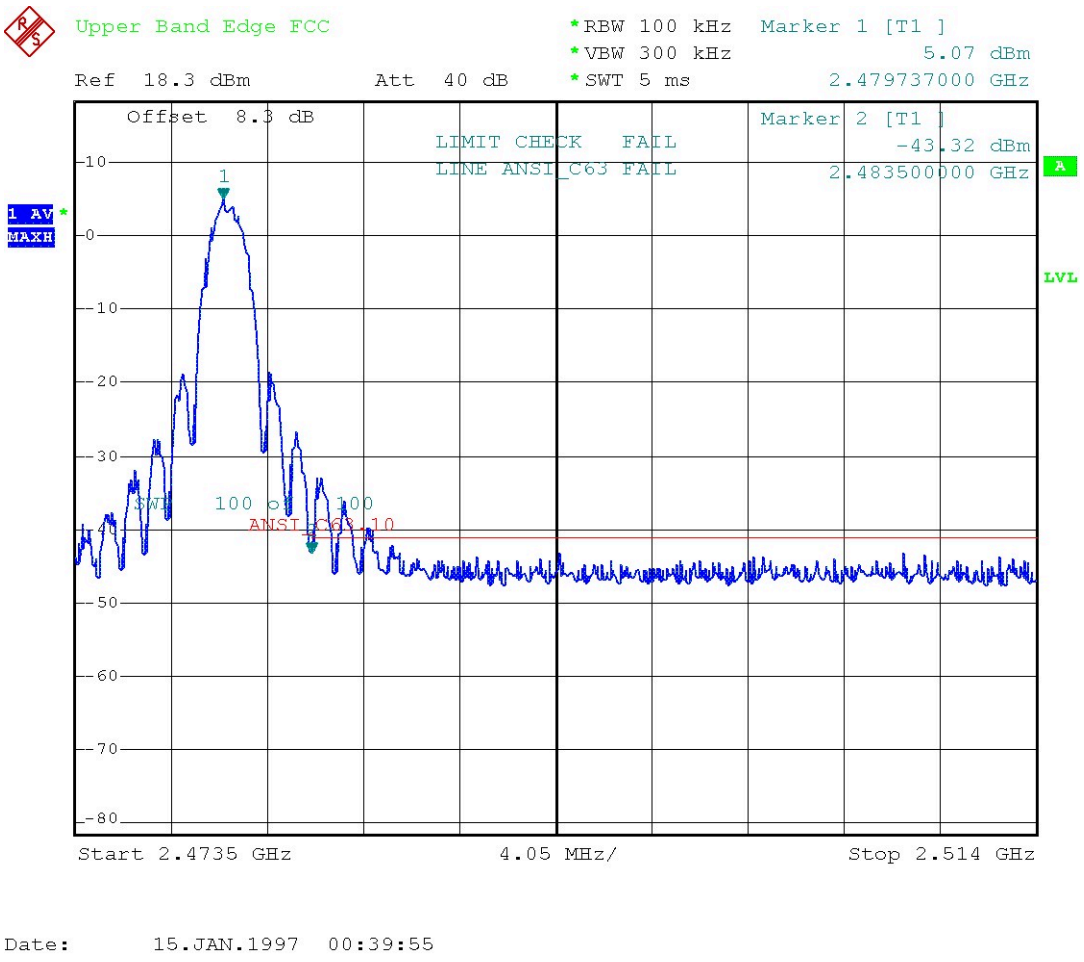

Figure 105. Upper Band Edge (FCC ANSI C63.10, 558074 D01 DTS)

Results:

Table 72. Upper Band Edge (FCC ANSI)

Modulation	TX power
Level @2.4835 GHz	-44.62 dBm

FCC limit: <-41.15 dBm

Conclusion:

- The board passes the Upper Band Edge FCC Certification.
- There is a minimum of 3.47 dB margin.

3.3.1.11 Out Of Band (ETSI 300 328 chapter 5.4.8.2.1)

Test method:

- Use the Test setup N6. See Figure 74
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  - Start frequency = 2.375 GHz
  - Stop frequency = 2.510 GHz
  - Reference amplitude = -20 dBm
  - Sweep time = 100 ms
  - RBW = 1 MHz
  - Video BW = 3 MHz
  - Detector mode = RMS
  - Average mode: power
  - Number of sweeps = 100
- Set the channel 11 (2.405 GHz) and 26 (2.48 GHz)
- Trace mode: Max hold

Results

Figure 106. Out Of Band – Channel 11

Figure 107. Out Of Band – Channel 26

Conclusion:

- The FRDM-MCX W72 board passes the Out Of Band ETSI test for IEEE.802.15.4 Applications.

3.3.1.12 Out Of Band (ARIB STD T-66)

Test method:

- Use the Test setup N6. See Figure 74
- Set the radio parameters of the board to:
  - TX mode, modulated, continuous emitting mode
- Set the analyzer to:
  - Start frequency = 2.475 GHz
  - Stop frequency = 2.485 GHz
  - Reference amplitude = -20 dBm
  - Sweep time = 100 ms
  - RBW = 1 MHz, Video BW = 1 MHz
  - Detector mode = Peak
  - Average mode: power
  - Number of sweeps = 100
- Set the channel to Channel 11 (2.405 GHz) and Channel 26 (2.48 GHz)
- Trace mode: Max hold

Results:

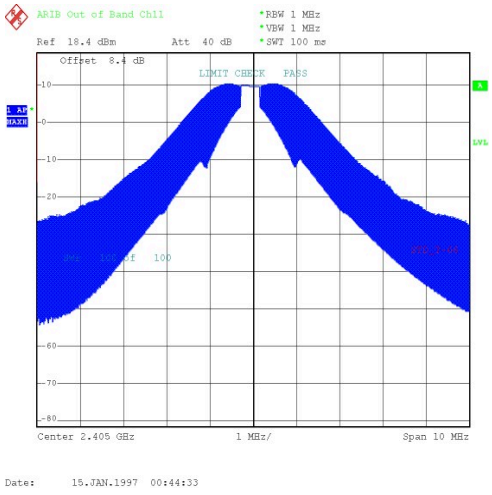

Figure 108. Out of Band – Channel 11 - ARIB

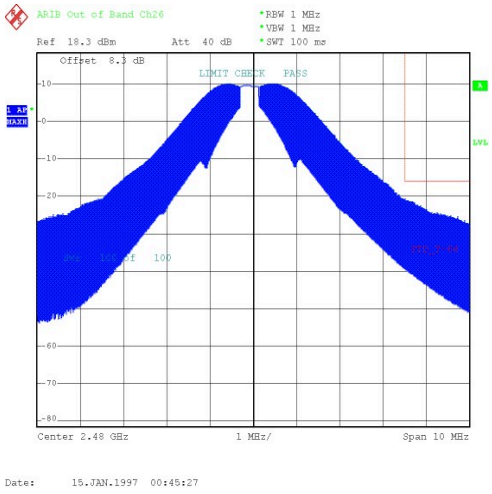

Figure 109. Out of Band – Channel 26 - ARIB

Conclusion

The FRDM-MCX W72 board passes the Out Of Band ARIB test for IEEE.802.15.4 Applications.

3.3.2 RX tests

This section explains various IEEE 802.15.4 reception tests, their test methods, and test results.

3.3.2.1 IEEE RX test setup

This section explains various test setup methods to conduct IEEE receiver tests such as sensitivity, interference rejection, spurious, and intermodulation.

3.3.2.1.1 Test setup N7

Figure 110 shows the test setup to conduct IEEE RX sensitivity tests.

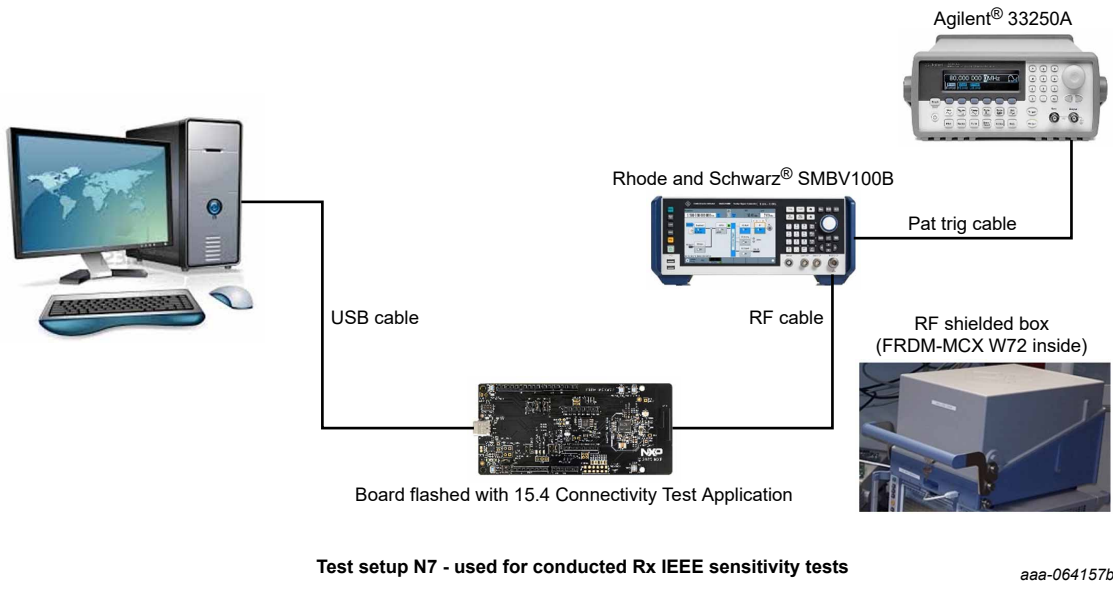

Figure 110. Test setup N7

Note: *This test setup is identical to test setup N3 except for the application used.*

3.3.2.1.2 Test setup N8

Figure 93 shows the test setup to conduct Rx Bluetooth LE interference rejection tests.

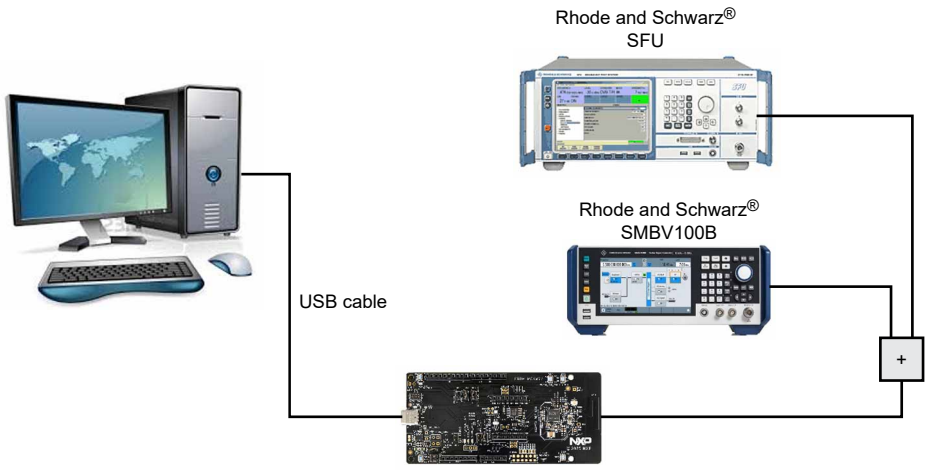

Figure 111. Test setup N8

Note: *This test setup is totally identical to test setup N4 except for the application used.*

3.3.2.1.3 Test setup N9

Figure 112 shows the test setup to conduct RX IEEE 15.4 spurious tests.

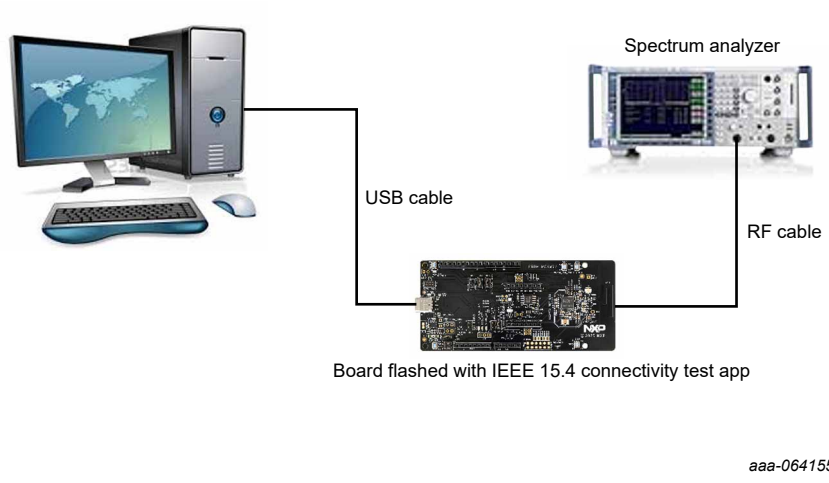

Figure 112. Test setup N9

Note: *This test setup is identical to Test setup N6.*

3.3.2.2 RX sensitivity

Test method

- Use the Test setup N7. See Figure 110.
- The FRDM-MCXW72 is placed in an RF shield box to limit external interferences.
- The generator is used in ARB mode to send 1000 packets of 20 octets each.
- A serial terminal window is used to control the module.
- Set the receive frequency to Channel 11.
- The connection is automatically established, and the Packet Error Rate (PER) is measured.
- Decrease the level of the generator at the RF input of the module until PER = 1%.
- Perform the same for other channels.

Result:

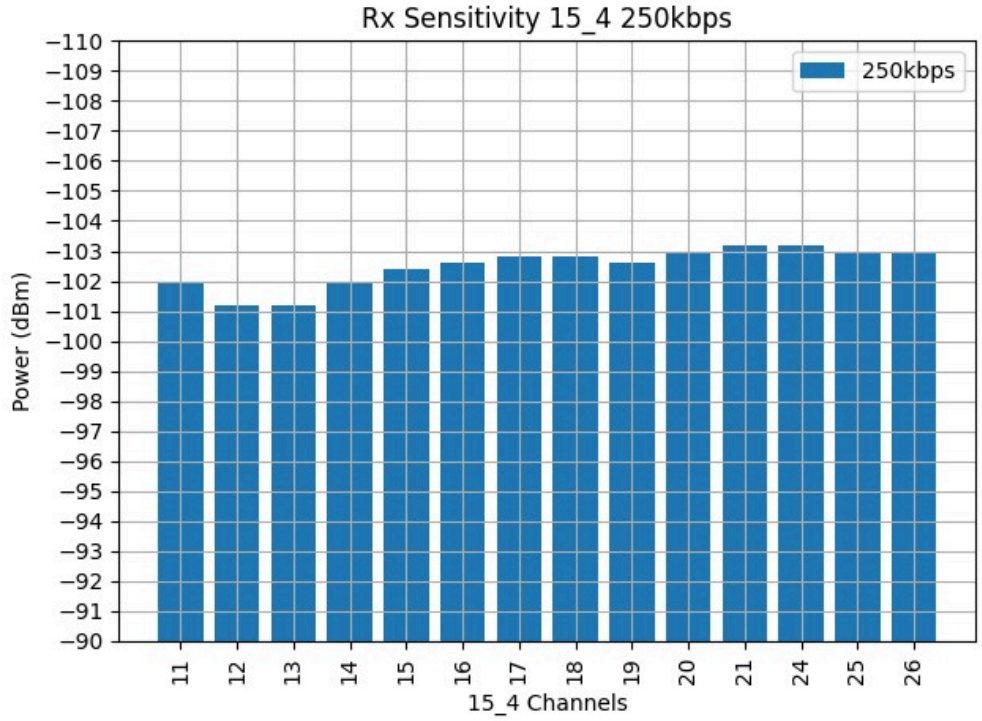

Figure 113. Rx Sensitivity

Conclusion:

- The best sensitivity is on channel 21: -103.2 dBm
- The lowest sensitivity is on channel 12: -101.2 dBm
- Delta over channels: 2.0 dB

FRDM-MCXW72 shows an average value of -102.5 dBm at SMA connector.

Attention: *In the Rx test, FRDM-MCX W72 is not able to receives all packages when set interval time <1.6 ms between two packets. However, the calculation below shows that 832 µs is ok:*

- All frames are 20 bytes = 40 bytes + 12 symbols for PHY header = 52 symbols
- Time delta between two 20 bytes frames is 832µs = 52 symbols.
- Time delta = SFD2 - SFD1 = [4 bytes preamble, 1 byte SFD] of frame2 + [IFS] + [length + PHY payload] of frame 1 = 10 symbols +IFS + 42 symbols = = 52 symbols + IFS => IFS = 0

3.3.2.3 RX sensitivity bathtub

Test method:

- Use the Test setup N7. See Figure 110.
- Place the FRDM-MCXW72 board in an RF shield box to limit external interferences.
- To send 1000 packets of 20 octets each, use the generator in ARB mode.
- Use a serial terminal window to control the module.
- Set the receive frequency to Channel 11.
- The connection is automatically established, and the Packet Error Rate (PER) is measured.
- Decrease the level of the generator at the RF input of the module until PER = 1 %.
- Note the value.

Result:

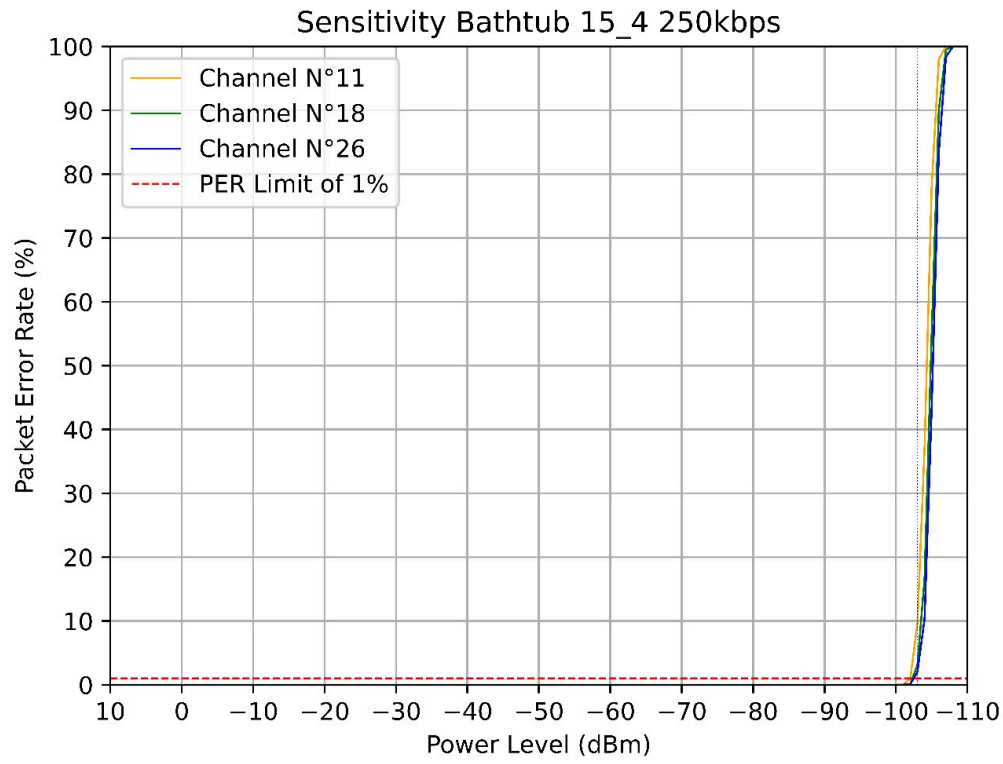

Figure 114. Sensitivity bathtub

3.3.2.4 RX spurious

Test method:

- Use the Test setup N9. See Figure 112.
- Set the radio in: Receiver mode, frequency: channel 18
- Set the analyzer to:
  - Reference amplitude = - 20 dBm, Trace = max hold, detector = max peak
  - Start/stop frequency: 30 MHz/1 GHz, RBW = 100 kHz,
  - Then the start/stop frequency: 1 GHz/12.75 GHz, RBW = 1 MHz

Results:

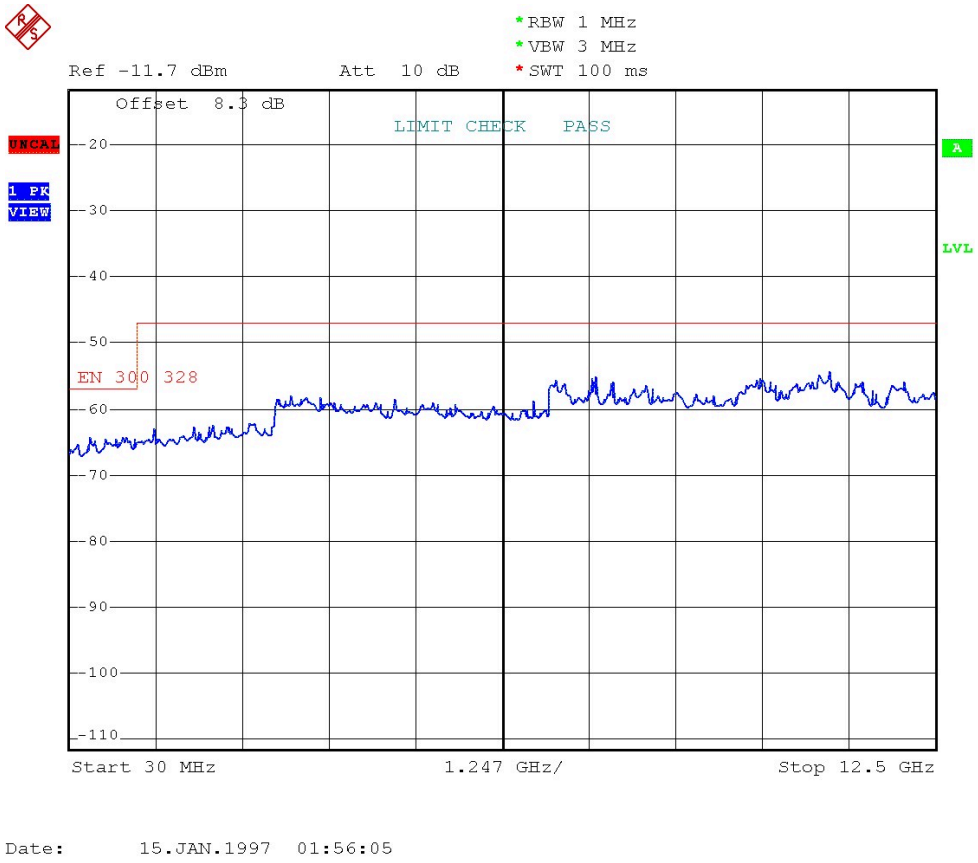

Figure 115. IEEE.802.15.4 - Conducted Rx spurious 30 MHz – 12.5 GHz

Conclusion:

- The FRDM-MCXW72 passes the ETSI limit.
- There is 7.28 dB margin to the limit.

3.3.2.5 Receiver interference rejection

This section describes the IEEE 802.15.4 receiver interference rejection for adjacent and alternate channels with standard interferers.

3.3.2.5.1 Adjacent and alternate channels with standard interferers

The interferers are at the adjacent and alternate channels (+/-1 MHz, +/-2 MHz, +/-3 MHz) or co-channel. The test is performed with only one interfering unmodulated signal at a time.

Test method:

- Test setup N8 is used. See Figure 111.
- Criterion: PER < 1.0 % with 1000 packets.
- The wanted signal is set to -82 dBm; the interferer is increased until the PER threshold is reached.
- Channels under test: Channel 11 (2.405 GHz), Channel 18 (2.440 GHz), and Channel 26 (2.480 GHz)
  Note:
  – n-1, n-2 are not system relevant for channel 11.

– *n+1, n+2 are not system relevant for channel 26.*

Table 73. IEEE RX Interference rejection results for Channel 11

Wanted channel:	**Channel 11**						
Wanted frequency (MHz):	*2405*						
Interferer:	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz):	*2390*	*2395*	*2400*	*2405*	*2410*	*2415*	*2420*
Maximum Interferer level (dBm):	12.0	8.0	4.0	-61.0	4.0	8.0	12.0
Maximum Interferer level (C/I dB):	-94.0	-90.0	-86.0	-21.0	-86.0	-90.0	-94.0
Bluetooth LE 5.x limit (C/I limit):	-27	-17	15	21	15	-17	-27
Margin (dB):	67.0	73.0	101.0	42.0	101.0	73.0	67.0

Table 74. IEEE RX Interference rejection results for Channel 18

Wanted:	**Channel 18**						
Wanted frequency (MHz)	*2440*						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz):	*2425*	*2430*	*2435*	*2440*	*2445*	*2450*	*2455*
Maximum Interferer level (dBm)	12.0	7.0	3.0	-62.0	3.0	6.0	10.0
Maximum Interferer level (C/I dB)	-94.0	-89.0	-85.0	-20.0	-85.0	-88.0	-92.0
Bluetooth LE 5.x limit (C/I limit)	-27	-17	15	21	15	-17	-27
Margin (dB)	67.0	72.0	100.0	41.0	100.0	71.0	65.0

Table 75. IEEE RX Interference rejection results for Channel 26

Wanted	**Channel 26**						
Wanted frequency (MHz)	*2480*						
Interferer	**N-3 MHz (Adjacent)**	**N-2 MHz (Adjacent)**	**N-1 MHz (Adjacent)**	**N (Co-channel)**	**N+1 MHz (Adjacent)**	**N+2 MHz (Adjacent)**	**N+3 MHz (Adjacent)**
Interferer frequency (MHz):	*2465*	*2470*	*2475*	*2480*	*2485*	*2490*	*2495*
Maximum Interferer level (dBm):	11.0	7.0	4.0	-61.0	4.0	7.0	12.0
Maximum Interferer level (C/I dB):	-93.0	-89.0	-86.0	-21.0	-86.0	-89.0	-94.0
Bluetooth LE 5.x limit (C/I limit):	-27	-17	15	21	15	-17	-27

Table 75. IEEE RX Interference rejection results for Channel 26*...continued*

Wanted	Channel 26						
Margin (dB):	66.0	72.0	101.0	42.0	101.0	72.0	67.0

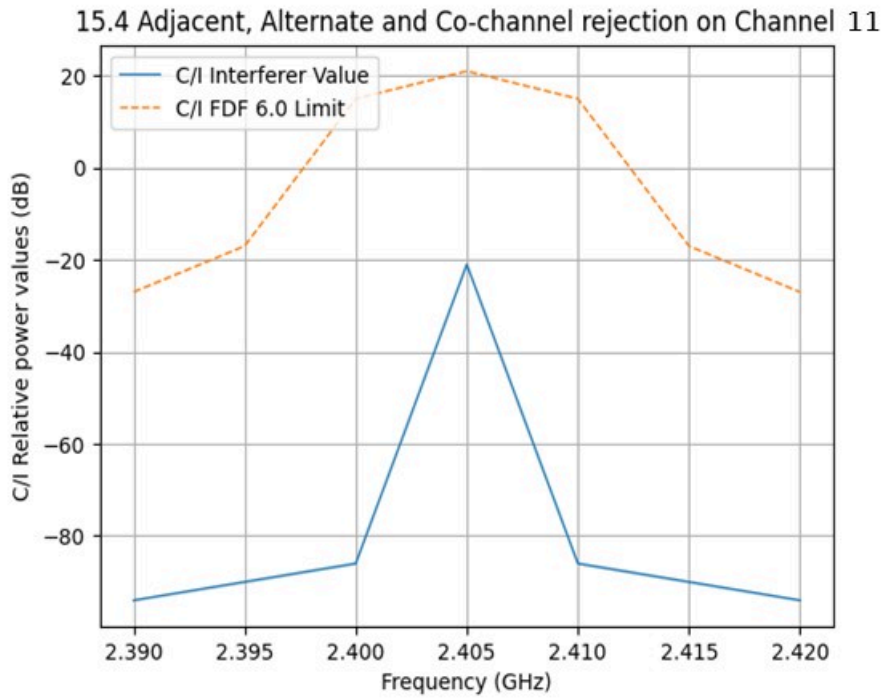

Figure 116. Adjacent, alternate, and co-channel rejection @ channel 11

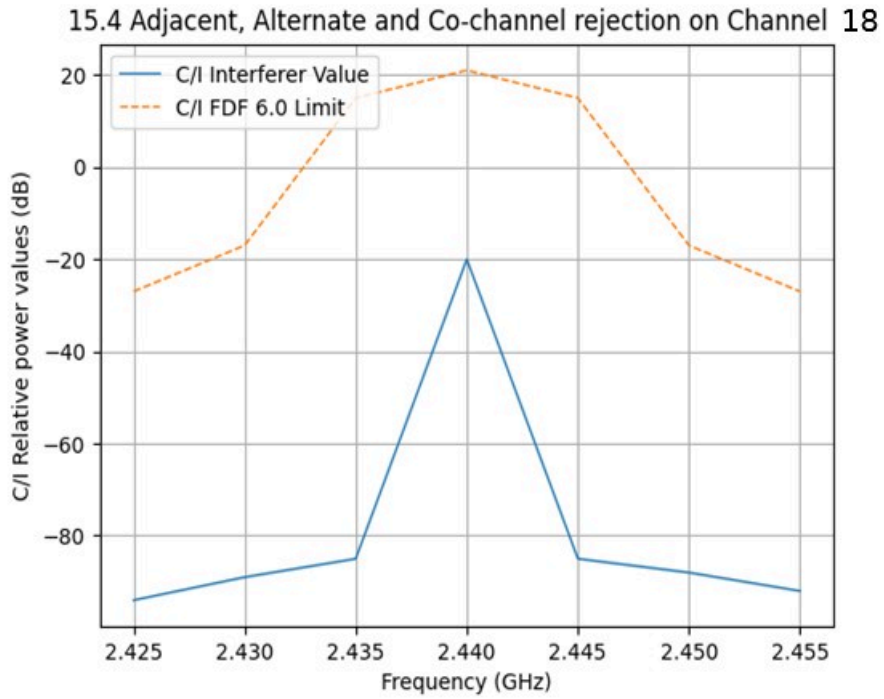

Figure 117. Adjacent, alternate, and co-channel rejection @ channel 18

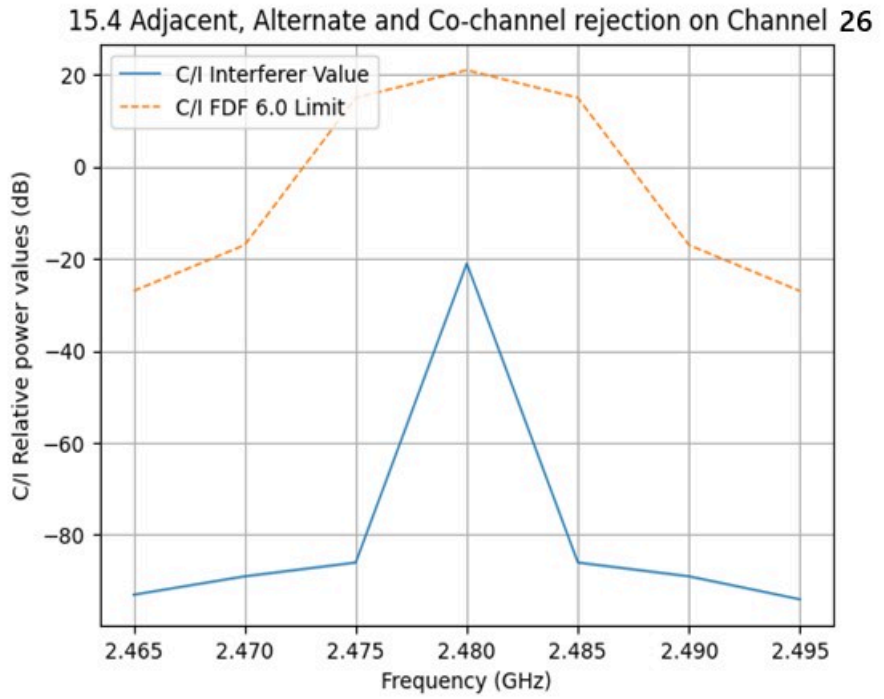

Figure 118. Adjacent, alternate, and co-channel rejection @ channel 26

Conclusion: The FRDM-MCXW72 board passes the IEEE 802.15.4 certification for this test with a worst margin of 41.0.

3.3.2.6 Receiver blocking

Refer to ETSI 300.328 2.2.2 Chapter 4.3.1.12.4.2 for the details of receiver blocking tests.

3.3.2.6.1 Receiver category 1

The test is performed with only one interfering signal at a time.

The Application flashed on the board is the 15.4 Connectivity Test App.

Test method:

- Test setup N8 is used. See Figure 111.
- The interferer is a continuous waveform (CW) signal.
- Criterion: PER < 10 %
- For an interferer set at 2.380 GHz and 2.504 GHz, set the wanted signal to the lowest value between 10log(OCBW)-133 dBm and -68 dBm.
- For interferers set at 2.300 GHz, 2.330 GHz, 2.360 GHz, 2.524 GH, 2.584 GHz, and 2.674 GHz, set the wanted signal to the lowest value between 10log(OCBW) -139 dBm and -74 dBm.
- In both cases, the interferer power level is increased until the PER threshold is reached.
- IEEE.802.15.4 channels under test: 11 (2.405 GHz) and 26 (2.480 GHz)

Result

Table 76. Receiver Blocking (Out of Band) rejection Category 1 (Channel 11)

Channel	**11**							
Frequency (MHz)	**2405**							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0

Table 77. Receiver Blocking (Out of Band) rejection Category 1 (Channel 26)

Channel	**26**
Frequency (MHz)	**2480**

Table 77. Receiver Blocking (Out of Band) rejection Category 1 (Channel 26)*...continued*

Channel	26							
Interferer Type	**Low**	**Low**	**Low**	**Low**	**High**	**High**	**High**	**High**
Interferer Frequency (MHz)	2300	2330	2360	2380	2504	2524	2584	2674
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34	-34	-34	-34	-34
Margin(dB)	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 1 test, there is a margin of 44.0 dB until the limit.

3.3.2.6.2 Receiver category 2

The test is performed with only one interfering signal at a time.

The application flashed on the board: 15.4 Connectivity Test App

Test method:

- Test setup N8 is used. See Figure 111.
- Interferer is a continuous waveform (CW) signal.
- Criterion: PER < 10 %
- The wanted signal is set to the lowest value between -64 dBm and 10log(OCBW) -129 dBm.The continuous waveform (CW) interferer is increased until the PER threshold is reached.
- Channels under test: IEEE.802.15.4 Channel 11 (2.405 GHz) and Channel 26 (2.480 GHz).

Result

Table 78. Results for Receiver category 2 (Channel 11)

Channel	Channel 11			
Frequency (MHz)	2405			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	44.0	44.0	44.0	44.0

Table 79. Results for Receiver category 2 (Channel 26)

Channel	Channel 26			
Frequency (MHz)	2480			
Interferer Type	**Low**	**Low**	**High**	**High**
Interferer Frequency (MHz)	2300	2380	2504	2584
Maximum Interferer Level (dBm)	**>10**	**>10**	**>10**	**>10**
300.328 Lower limit (dBm)	-34	-34	-34	-34
Margin(dB)	44.0	44.0	44.0	44.0

Receiver Blocking (Out Of Band) rejection

Conclusion: The FRDM-MCXW72 passes the Receiver Blocking Category 2 test, there is a margin of 44.0 dB until the limit.

4 Return loss

This section describes the return loss in receiver and transmitter modes.

4.1 RX mode

In the RX mode, the return loss measurement is performed by setting the LNA gain of MCX W72 to the maximum.

Hardware: FRDM-MCXW72

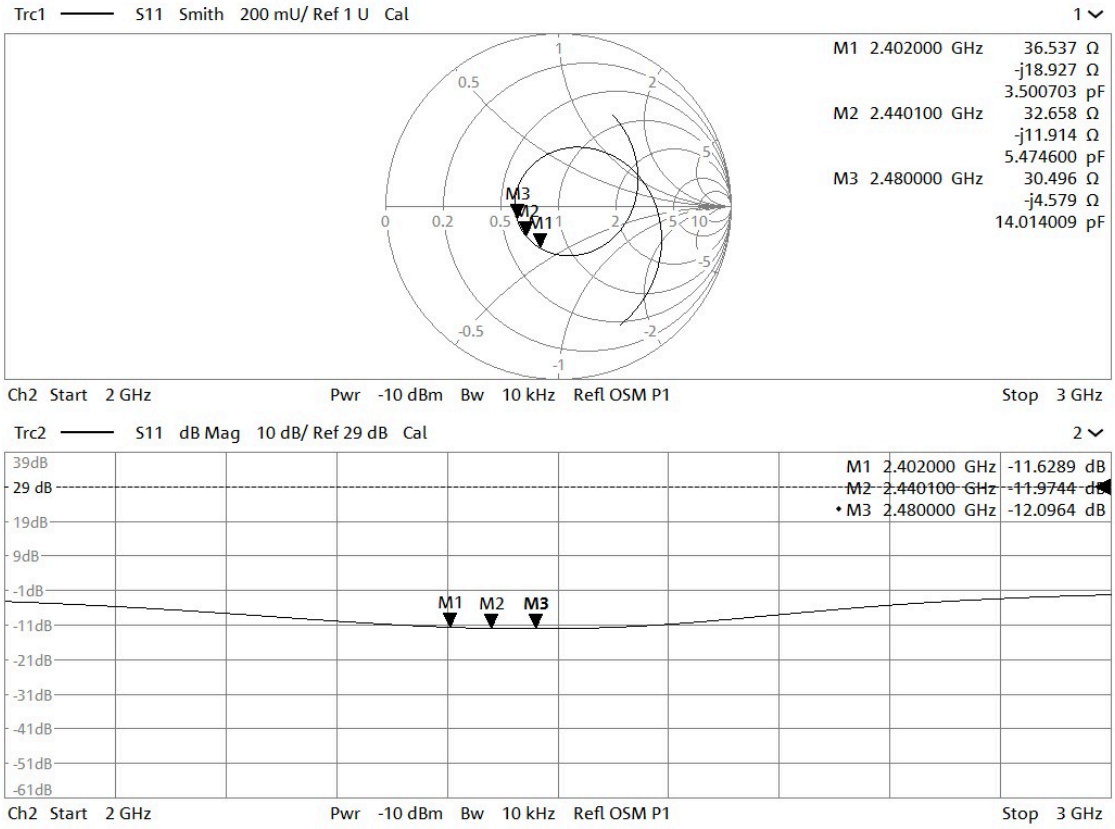

Figure 119. S11 diagram (RX mode)

There is no specification for the return loss.

4.2 TX mode

In the TX mode, the return loss measurement is performed by setting the MCX W72 RF output power to the maximum.

Hardware: FRDM-MCXW72

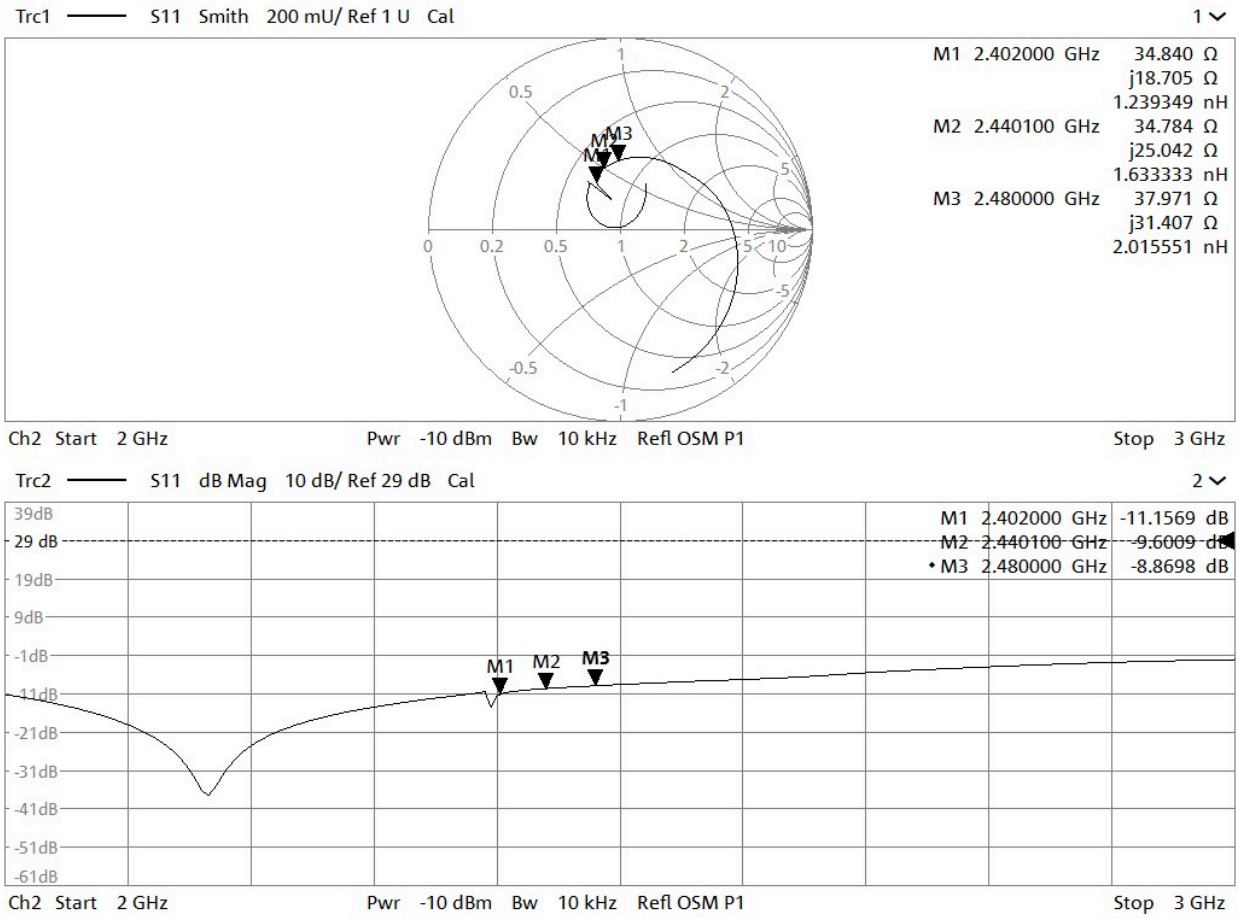

Figure 120. S11 diagram (TX mode)

There is no specification for the return loss.

5 Conclusion

Beyond the RED, FCC, Bluetooth LE 6.0 and IEEE 802.15.4 compliances, these radio tests prove a good performance of the MCX W72 wireless MCU.

6 References

- **FCC**: 47 CFR Part 15C
- **RED**: European Radio Equipment Directive applied from June 2016
- **R&TTE**: Radio & Telecommunications Terminal Equipment Directive (R&TTED) (1999/5/EC) was stopped on June 2016
- **ETSI EN 300 328 v2.2.2**: European Telecommunication Standard - Radio Equipment and Systems (RES) Wideband data transmission systems, technical characteristics and test conditions for data transmission equipment operating in the 2.4 GHz ISM band and using spread spectrum modulation techniques
- **RF-PHY TS 6.0**: Bluetooth Test Specification. This document defines test structures and procedures for qualification testing of Bluetooth implementations of the Bluetooth Low Energy RF PHY.
- **IEEE 802.15.4:** IEEE standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 15.4: Wireless

Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low Rate Wireless Personnel Area Networks (LR-WPANs)

Table 80. Related documentation

Document Title	Description	Link / how to obtain
MCX W72 Reference Manual	Provides a detailed description about the MCX W72 MCU and its features, including memory maps, power supplies, and clocks.	https://www.nxp.com/products/MCX-W72#documentation
MCX W72 Product Family Data Sheet	Provides information about the MCX W72 electrical characteristics, hardware design considerations, and ordering information.	
FRDM-MCXW72 board schematics	Provides a circuit representation showing the functionality and connectivity of the FRDM-MCXW72 board components.	https://www.nxp.com/FRDM-MCXW72#design-resources

7 Acronyms

Table 81 lists the acronyms used in this document.

Table 81. Acronyms

Acronym	Description
ARB	Arbitrary waveform generator
CCC	Car connectivity consortium
CDE	Complex-domain distance estimation
CS	Channel sounding
CW	Continuous wave
FRDM	Freedom development platform
GenFSK	Generic frequency shift keying
GPIB	General-purpose interface bus
HADM	High accuracy distance measurement
MCIQ	Multichannel IQ: Method to capture IQ samples of data exchanged between two devices on multiple channels.
MUSIC	Multiple signal classification
PCT	Phase correction term
OQPSK	Offset quadrature phase-shift keying
RADE	Rapid accelerate distance estimation
RSSI	Received signal strength indicator (in dBm)
RTP	Round-trip phase
RTT	Round-trip time
RX	Receiver
SRDE	Super resolution distance estimation
ToF	Time of flight
TX	Transmitter

8 Revision history

Table 82 lists the updates to this document.

Table 82. Revision history

Document ID	Release date	Description
AN14889 v.1.0	5 February 2026	Initial public release

9 Appendix A

This section describes the IEEE.802.15.4 Connectivity Test Tool settings that must be used for performing the IEEE tests described in this application note.

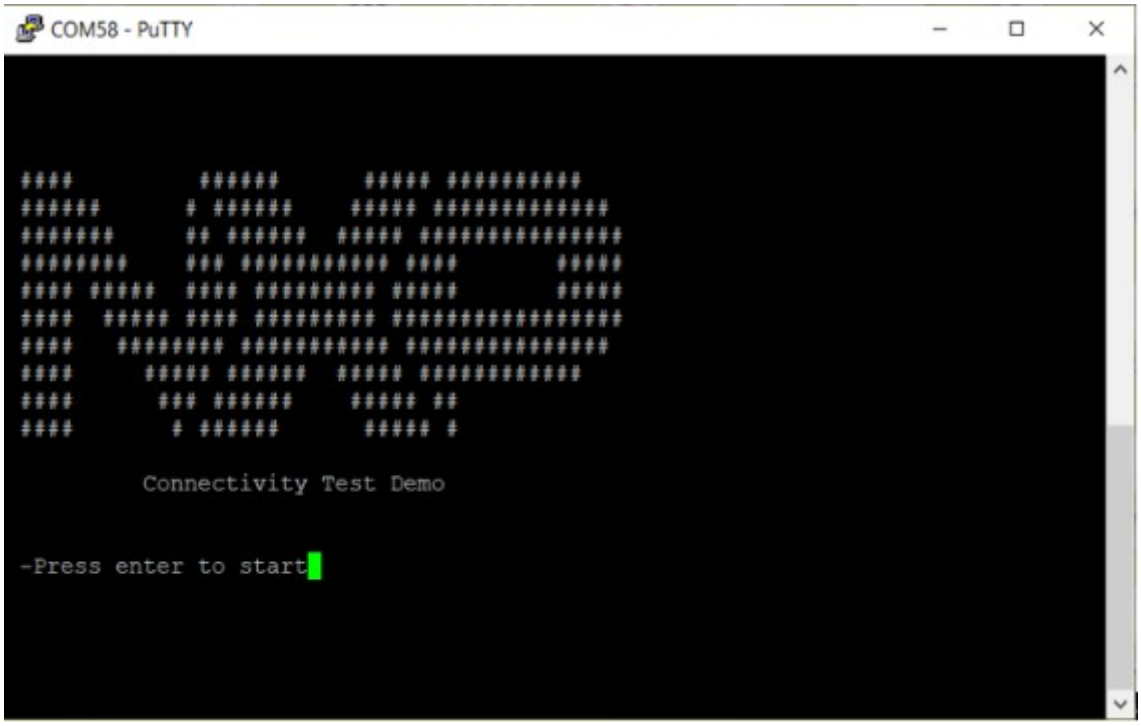

Figure 121. Connectivity Test App

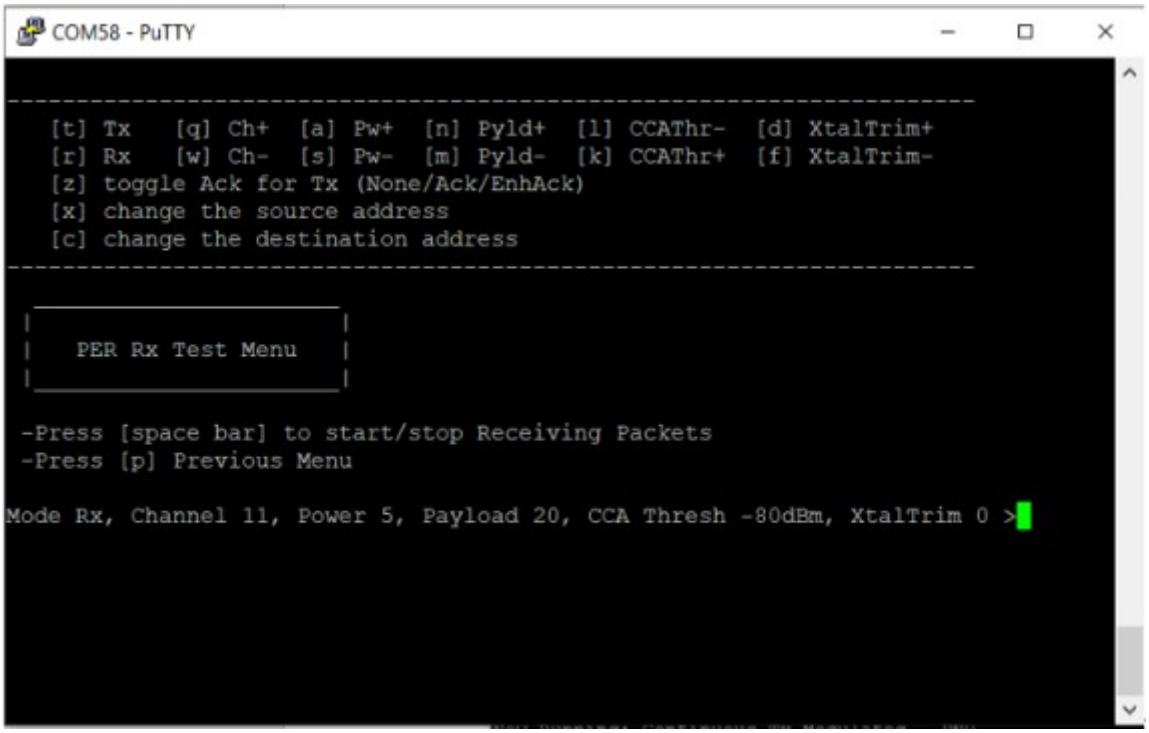

Figure 122. PER RX Test Menu

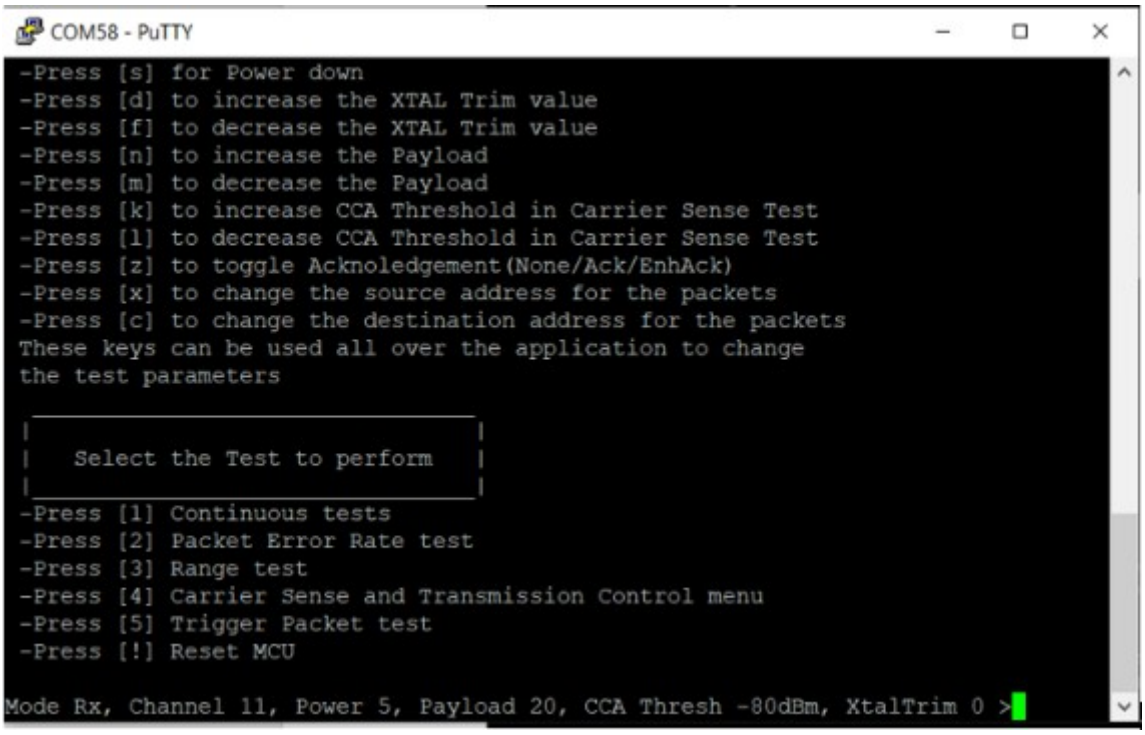

Figure 123. Test selection menu

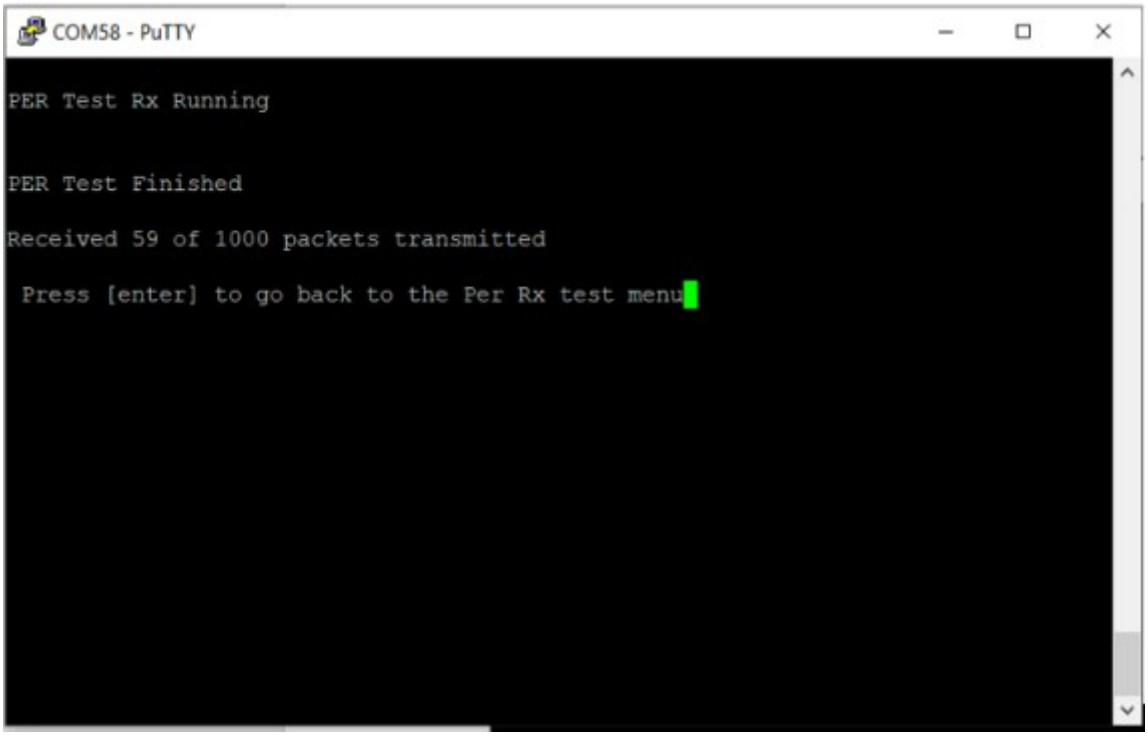

Figure 124. PER Test RX running

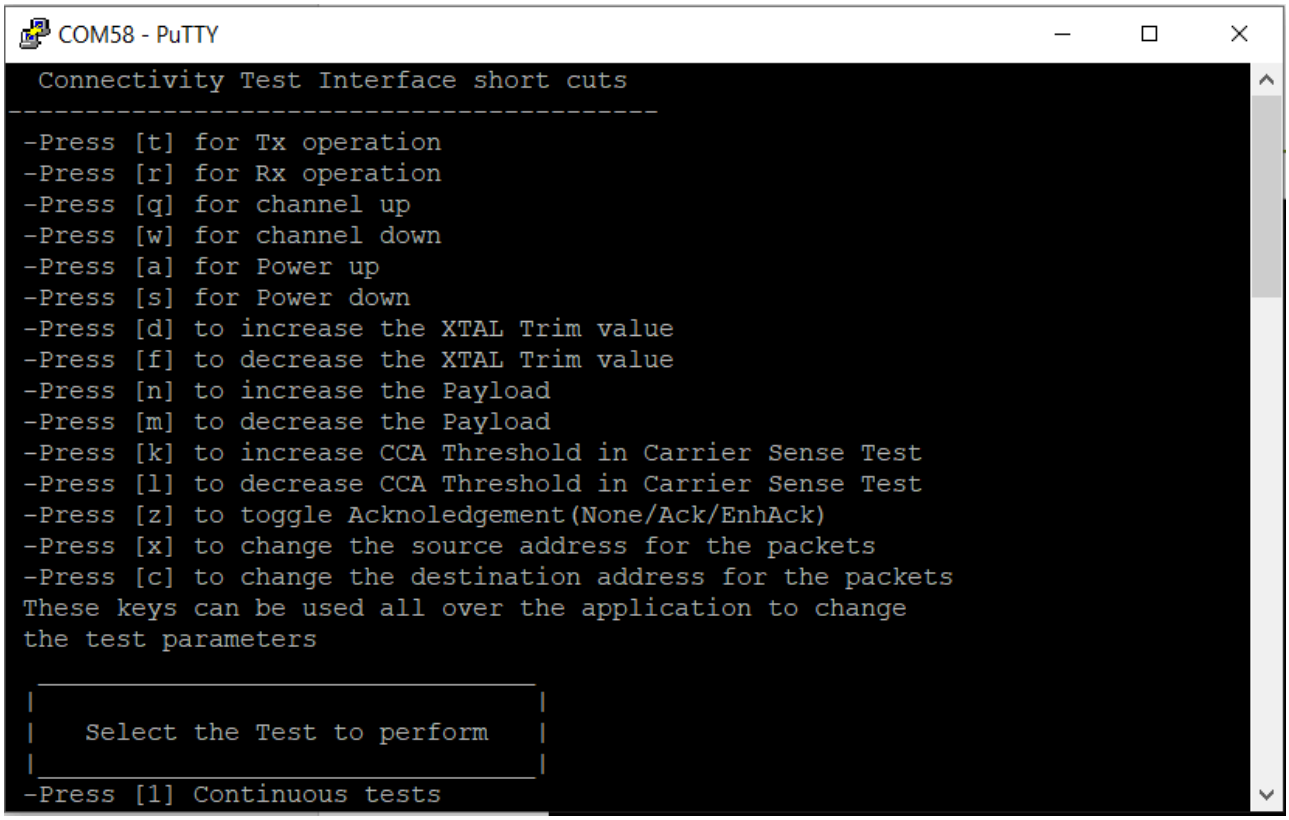

Figure 125. Connectivity test interface shortcuts

Table 12 lists the key selection for the menus available in the Connectivity Test Tool application GUI. These key sequences can be used for performing the tests described in the left column.

Table 83. CMET selection key for tests in Transmit modes

Link to the Section §	CMET selection key in Connectivity Tool Application
Frequency Accuracy	1)4)
Phase Noise @ 100 kHz offset	1)4)
TX Power (fundamental)	1)3)2)+/-
TX spurious	1)3)2)
TX Modulation	1)3)2)
EVM	1)3)2
Offset EVM	1)4)
Upper band edge	1)3)ch26
TX return loss	1)3)2）

A signal generator sends packets to the FRDM-MCXW72 device. Then, the packets received by the FRDM-MCXW72 board are counted for about 6 seconds and tests are performed.

Tests done

The ratio of the “packets received” and the “sent packets” is calculated and displayed.

Table 84. CMET selection key for PER test

Chapter ¤§	CMET key selection
IEEE RX Sensitivity	5)Space bar)+/-
Sensitivity PER bathtub	5)Space bar)
Receiver Maximum Input Level	5)Space bar)+/-
Rx Spurious	5)Space bar)
Receiver interference rejection	5)Space bar)+/-
Receiver Blocking	5)Space bar)+/-
Rx return loss	

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Tables

Figures

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