

Compliance test report ID **215392-1TRFWL**

Date of issue
January 2, 2013

FCC 47 CFR Part 15 Subpart C, §15.247

Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
and

RSS-210, Issue 8 Annex 8

Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–
2483.5 MHz, and 5725–5850 MHz Bands

Applicant **Tait Limited**
Product **Bluetooth Module (within Portable Transceiver)**
Model **TPDB1A**
FCC ID **CASTPDB1A**
IC Reg # **737A-TPDB1A**

Nemko Canada Inc., a testing
laboratory, is accredited by the
Standards Council of Canada. The
tests included in this report are
within the scope of this accreditation



Test location

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Tested by Kevin Rose, Wireless/EMC Specialist

Reviewed by Andrey Adelberg, Senior Wireless/EMC Specialist **Date** January 2, 2013

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Applicant and manufacturer

Tait Limited,
558 Wairakei Road,
Christchurch, 8140 New Zealand

1.2 Test specifications

| Standard | Description |
|---|---|
| FCC 47 CFR Part 15, Subpart C, Chapter 15.247 | Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz |
| RSS-210, Issue 8 Annex 8 | Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands |

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.4 Exclusions

None

1.5 Test report revision history

| Revision # | Details of changes made to test report |
|------------|--|
| TRF | Original report issued |

Section 2 Summary of test results

2.1 FCC Part 15 Subpart C – general requirements, test results

| Part | Test description | Verdict |
|------------|---------------------------|-------------------|
| §15.207(a) | Conducted limits | Pass |
| §15.31(e) | Variation of power source | Pass ¹ |
| §15.203 | Antenna requirement | Pass |

Notes:

¹ Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

¹ For battery-operated mode, the equipment tests shall be performed using a new/fully charged battery.

2.2 FCC Part 15 Subpart C – Intentional Radiators, test results

| Part | Test description | Verdict |
|--------------------|---|----------------|
| §15.247(a)(1) | Frequency hopping systems | |
| §15.247(a)(1)(i) | Frequency hopping systems operating in the 902–928 MHz band | Not applicable |
| §15.247(a)(1)(ii) | Frequency hopping systems operating in the 5725–5850 MHz band | Not applicable |
| §15.247(a)(1)(iii) | Frequency hopping systems operating in the 2400–2483.5 MHz band | Pass |
| §15.247(a)(2) | Minimum 6 dB bandwidth for systems using digital modulation techniques | Not applicable |
| §15.247(b) | Maximum conducted peak output power and EIRP | |
| §15.247(b)(1) | Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band | Pass |
| §15.247(b)(2) | Maximum peak output power of frequency hopping systems operating in the 902–928 MHz band | Not applicable |
| §15.247(b)(3) | Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands | Not applicable |
| §15.247(b)(4) | Conducted peak output power limitations | |
| §15.247(b)(4)(i) | Maximum peak output power for systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations. | Pass |
| §15.247(b)(4)(ii) | Maximum peak output power for systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations. | Not applicable |
| §15.247(c)(1) | Fixed point-to-point operation with directional antenna gains greater than 6 dBi | Not applicable |
| §15.247(c)(2) | Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams | Not applicable |
| §15.247(d) | Spurious emissions | Pass |
| §15.247(e) | Power spectral density for digitally modulated devices | Not applicable |
| §15.247(f) | Time of occupancy and power spectral density for hybrid systems | Not applicable |

2.3 IC RSS-GEN, Issue 3, test results

| Part | Test description | Verdict |
|-------|--|----------------|
| 4.6.1 | Occupied bandwidth | Pass |
| 6.1 | Receiver spurious emissions limits (radiated) | Not applicable |
| 6.2 | Receiver spurious emissions limits (antenna conducted) | Not applicable |
| 7.2.4 | AC power lines conducted emission limits | Pass |

Notes: ¹ According to Notice 2012-DRS0126 (from January 2012) section 2.2 of RSS-Gen, Issue 3 has been revised. The EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 IC RSS-210, Issue 8, test results

| Part | Test description | Verdict |
|-------------|--|----------------|
| A8.1 | Frequency hopping systems | |
| A8.1 (a) | Bandwidth of a frequency hopping channel | Pass |
| A8.1 (b) | Minimum channel spacing for frequency hopping systems | Pass |
| A8.1 (c) | Frequency hopping systems operating in the 902–928 MHz band | Not applicable |
| A8.1 (d) | Frequency hopping systems operating in the 2400–2483.5 MHz band | Pass |
| A8.1 (e) | Frequency hopping systems operating in the 5725–5850 MHz band | Not applicable |
| A8.2 | Digital modulation systems | |
| A8.2 (a) | Minimum 6 dB bandwidth | Not applicable |
| A8.2 (b) | Maximum power spectral density | Not applicable |
| A8.3 | Hybrid systems | |
| A8.3 (1) | Digital modulation turned off | Not applicable |
| A8.3 (2) | Frequency hopping turned off | Not applicable |
| A8.4 | Transmitter output power and e.i.r.p. requirements | |
| A8.4 (1) | Frequency hopping systems operating in the 902–928 MHz band | Not applicable |
| A8.4 (2) | Frequency hopping systems operating in the 2400–2483.5 MHz band | Pass |
| A8.4 (3) | Frequency hopping systems operating in the 5725–5850 MHz | Not applicable |
| A8.4 (4) | Systems employing digital modulation techniques | Not applicable |
| A8.4 (5) | Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band | Not applicable |
| A8.4 (6) | Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams | Not applicable |
| A8.5 | Out-of-band emissions | Pass |
| Notes: None | | |

Section 3 Equipment under test (EUT) details

3.1 Sample information

| | |
|-------------------------------|---------------|
| Receipt date | July 20, 2012 |
| Nemko sample ID number | 1 |

3.2 EUT information

| | |
|----------------------|--|
| Product name | Bluetooth Module (within Portable Transceiver) |
| Model | TPDB1A |
| Serial number | 25365412 |

3.3 Technical information

| | |
|----------------------------------|---|
| Operating band | 2.400–2.4835 GHz |
| Operating frequency | 2.402–2.480 GHz |
| Modulation type | GFSK |
| Occupied bandwidth (99 %) | 1.04 MHz |
| Emission designator | 1M04F1E |
| Power requirements | (All tests were performed with fully charged battery.) the charger uses 115 Vac 60 Hz. |
| Antenna information | Type: Surface Mount Ceramic Isolated Magnetic Dipole, Gain: 1.39 dBi The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. |

3.4 Product description and theory of operation

Internal Bluetooth is provided in the TP9300 (DMR) and TP9400 (P25) hand-portable terminals. The internal Bluetooth capability of the portable shall be limited to using the Bluetooth Headset and Handsfree profiles for connection to a single monophonic Bluetooth audio headset. In this way, Bluetooth technology is being used to provision for a wireless audio connection between the TPD radio and Bluetooth headset. No data will be passed across the Bluetooth link between the TPD radio and Bluetooth headset. The Bluetooth audio link, once enabled, will maintain a continuous Bluetooth audio link between the TPD radio and headset, and audio transmitted will be controlled either by the TPD radio or a wired-PTT tethered to the TPD radio. Operation of a wireless PTT hosted on the Bluetooth headset or elsewhere shall not be compatible with the TPD radio at first release.

3.5 EUT exercise details

As provided by the Tait TPD Bluetooth CCTM Control Ed 02 document - previously supplied.

3.6 EUT setup diagram

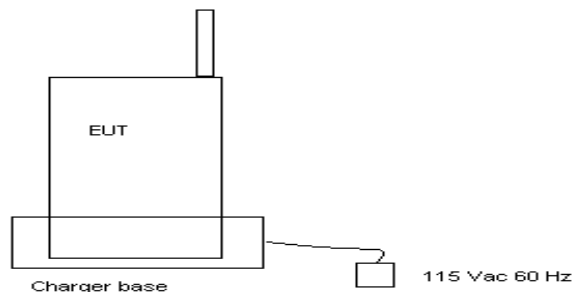


Diagram 3.6-1: Setup diagram

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature: 15–30 °C
Relative humidity: 20–75 %
Air pressure: 86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of $K=2$ with 95% certainty.

Section 7 Test equipment

7.1 Test equipment list

| Equipment | Manufacturer | Model no. | Asset no. | Cal cycle | Next cal. |
|----------------------------|-----------------|--------------|-----------|-----------|------------|
| 3 m EMI test chamber | TDK | SAC-3 | FA002047 | 1 year | Mar. 09/13 |
| Flush mount turntable | Sunol | FM2022 | FA002082 | — | NCR |
| Controller | Sunol | SC104V | FA002060 | — | NCR |
| Antenna mast | Sunol | TLT2 | FA002061 | — | NCR |
| Receiver/spectrum analyzer | Rohde & Schwarz | ESU 26 | FA002043 | 1 year | May 16/13 |
| Bilog antenna | Sunol | JB3 | FA002108 | 1 year | Feb. 07/13 |
| Horn antenna #2 | EMCO | 3115 | FA000825 | 1 year | Feb. 24/13 |
| 50 coax cable | Huber + Suhner | NONE | FA002013 | 1 year | Aug. 15/12 |
| 50 coax cable | Huber + Suhner | NONE | FA002074 | 1 year | Aug. 15/12 |
| 1–18 GHz pre-amplifier | JCA | JCA118-503 | FA002091 | 1 year | July 03/13 |
| 18–26 GHz pre-amplifier | Narda | BBS-1826N612 | FA001550 | — | VOU |
| Horn antenna 18–26.5 GHz | Electro-metrics | SH-50/60-1 | FA000479 | — | VOU |

Note: NCR - no calibration required and VOU - verify on use

Section 8 Testing data

8.1 AC power line conducted emissions

8.1.1 Definitions and limits

FCC Clause 15.207(a): Conducted limits
RSS-Gen Clause 7.2.4: AC power line conducted emissions limits

FCC:

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:

The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

Except when the requirements applicable to a given device state otherwise, for any licence-exempt radiocommunication device equipped to operate from the public utility AC power supply, either directly or indirectly, the radio frequency voltage that is conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in Table 2. The tighter limit applies at the frequency range boundaries.

The conducted emissions shall be measured with a 50 Ω/50 μH line impedance stabilization network (LISN).

Table 8.1-1: Conducted emissions limit

| Frequency of emission (MHz) | Conducted limit (dBμV) | |
|-----------------------------|------------------------|-----------|
| | Quasi-peak | Average |
| 0.15–0.5 | 66 to 56* | 56 to 46* |
| 0.5–5 | 56 | 46 |
| 5–30 | 60 | 50 |

* - Decreases with the logarithm of the frequency.

8.1.2 Test summary

| | | | | | |
|--------------------|---------------|----------------------|------------|--------------------------|------|
| Test date | July 23, 2012 | Test engineer | Kevin Rose | Verdict | Pass |
| Temperature | 24 °C | Air pressure | 1001 mbar | Relative humidity | 36 % |

8.1.3 Observations/special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

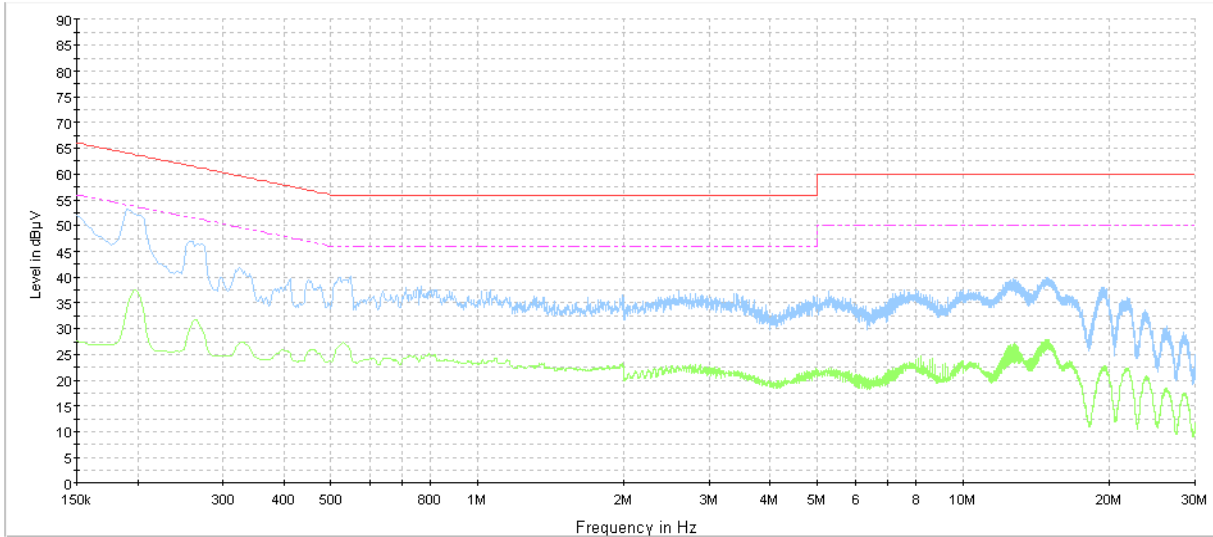
Receiver/spectrum analyzer settings

Preview measurements – Receiver:
 Peak and Average detector (Max hold), RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms
 Final measurements – Receiver:
 Q-Peak and Average detector, RBW = 9 kHz, VBW = 30 kHz, Measurement time = 100 ms

Measurement details

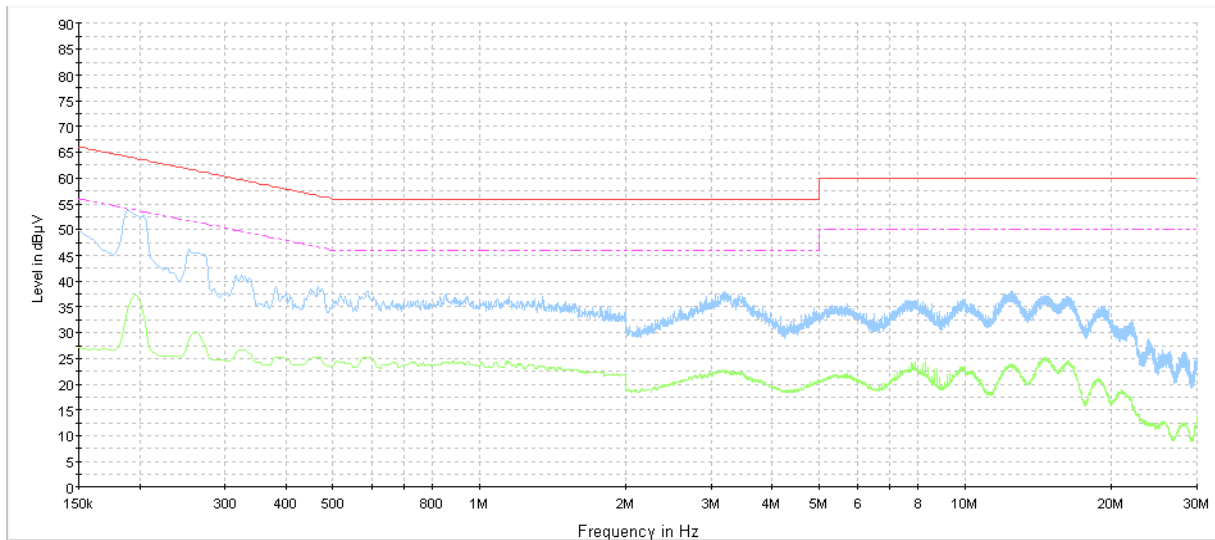
A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement. The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

8.1.4 Test data



CE Scan Phase 115 VAC 60 Hz NEX-215392 Tait Radio
— CISPR 22 Mains QP Class B.LimitLine
- - - CISPR 22 Mains AV Class B.LimitLine
— Preview Result 1-PK+
— Preview Result 2-AVG

Plot 8.1-1: Conducted emissions on phase line



CE Scan Neutral 115 VAC 60 Hz NEX-215392 Tait Radio
— CISPR 22 Mains QP Class B.LimitLine
- - - CISPR 22 Mains AV Class B.LimitLine
— Preview Result 1-PK+
— Preview Result 2-AVG

Plot 8.1-2: Conducted emissions on neutral line

8.2 Frequency hopping requirements

8.2.1 Definitions and limits

FCC Clause 15.247(a)(1) and RSS-210 Clause A8.1: Frequency hopping requirements

FCC:

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
- (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
 - (iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

IC:

A8.1 (a) Bandwidth of a frequency hopping channel

The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system RF bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset while the long term distribution appears evenly distributed.

A8.1 (b) Minimum channel spacing for frequency hopping systems

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125 W. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

A8.1 (d) Frequency hopping systems operating in the 2400–2483.5 MHz band

Frequency hopping systems operating in the 2400–2483.5 MHz band shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

8.2.2 Test summary

| | | | | | |
|--------------------|---------------|----------------------|------------|--------------------------|------|
| Test date | July 24, 2012 | Test engineer | Kevin Rose | Verdict | Pass |
| Temperature | 24 °C | Air pressure | 1002 mbar | Relative humidity | 40 % |

8.2.3 Observations/special notes and procedures

Carrier Frequency Separation

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) \geq 1% of the span

Video (or Average) Bandwidth (VBW) \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section.

Number of Hopping Frequencies

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW \geq 1% of the span

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.

Time of Occupancy (Dwell Time)

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = zero span, centered on a hopping channel

RBW = 1 MHz

VBW \geq RBW

Sweep = as necessary to capture the entire dwell time per hopping channel

Detector function = peak

Trace = max hold

If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. An oscilloscope may be used instead of a spectrum analyzer.

20 dB Bandwidth

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW \geq 1% of the 20 dB bandwidth

VBW \geq RBW

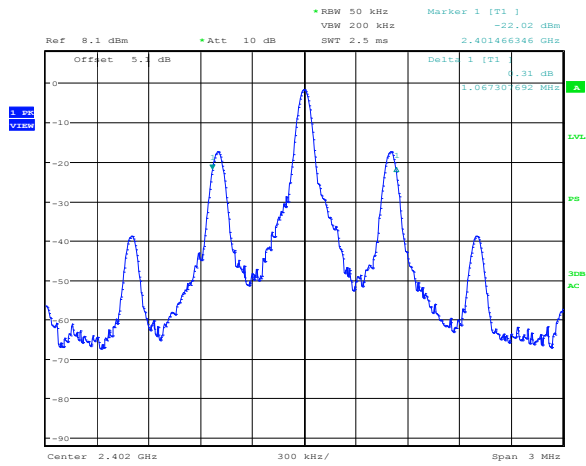
Sweep = auto

Detector function = peak

Trace = max hold

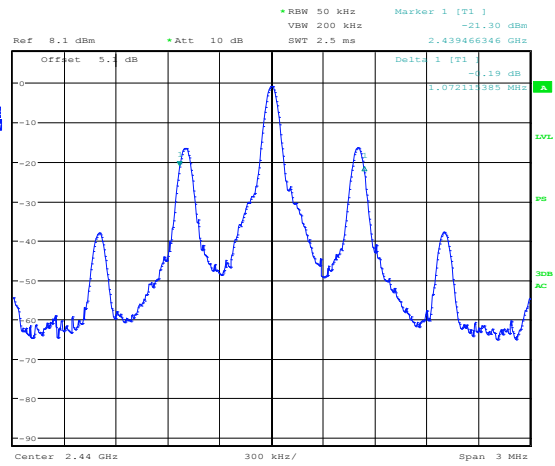
The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section.

8.2.4 Test data



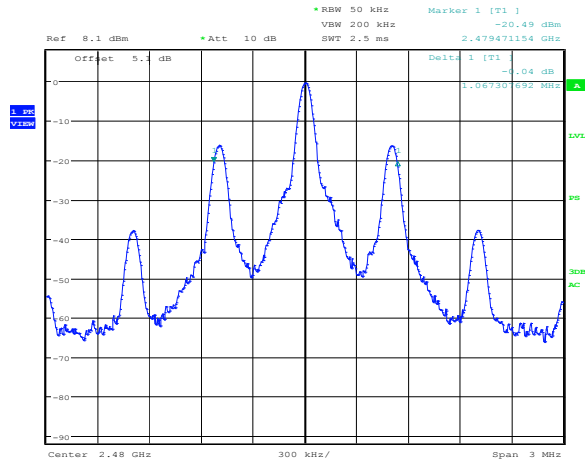
Date: 24.JUL.2012 18:39:10

Plot 8.2-1: 20 dB bandwidth on low channel



Date: 24.JUL.2012 18:40:44

Plot 8.2-2: 20 dB bandwidth on mid channel



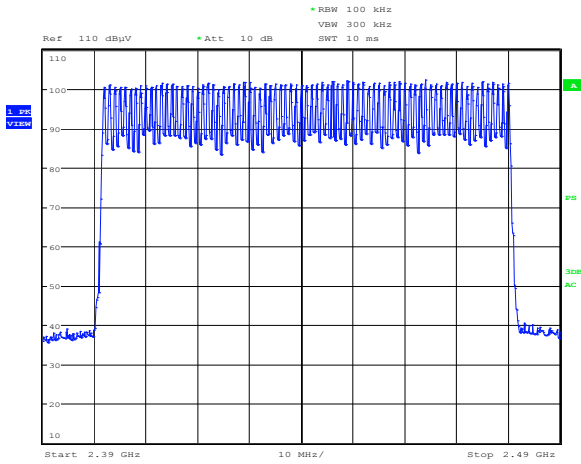
Date: 24.JUL.2012 18:47:35

Plot 8.2-3: 20 dB bandwidth on high channel

Table 8.2-1: 20 dB bandwidth results

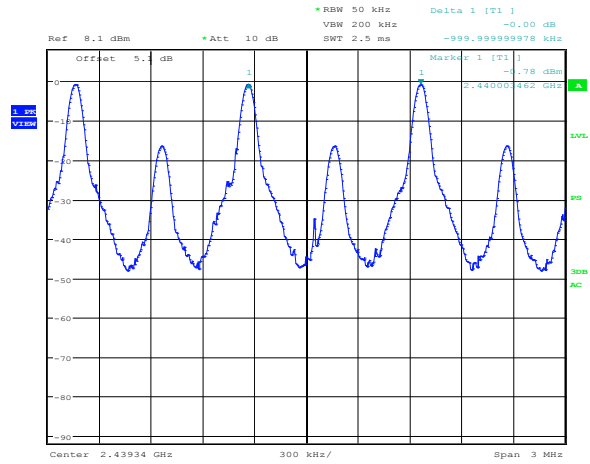
| Frequency (MHz) | 20 dB bandwidth (MHz) |
|-----------------|-----------------------|
| 2402 | 1.067 |
| 2440 | 1.072 |
| 2480 | 1.067 |

8.2.4 Test data, continued



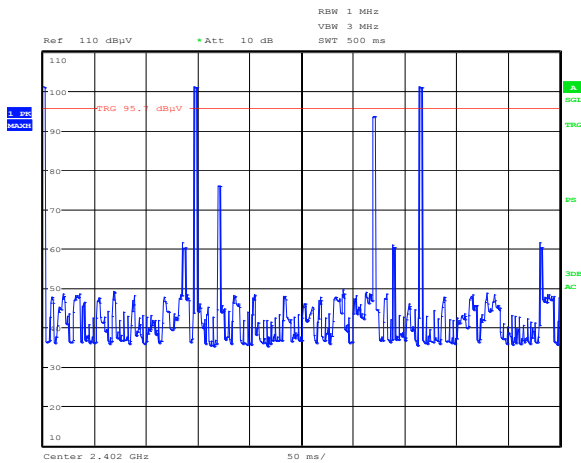
Date: 23.JUL.2012 17:54:16

Plot 8.2-4: Number of hopping channels = 79



Date: 24.JUL.2012 18:57:23

Plot 8.2-5: Channel Separation = 1 MHz

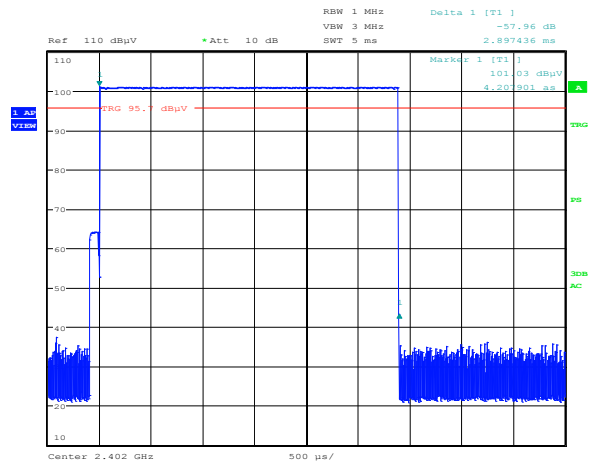


Date: 23.JUL.2012 18:20:58

Plot 8.2-6: Number of hops in 500 ms (2 times)

Note: The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Time of occupancy=
 400 ms times 79 (channels) = 31.6 sec
 2 pulses within 500 ms
 31.6 sec / 500 ms = 63.2 times 2 pulses = 126.4 pulses 2.89 ms each
 = 365.30 ms on time



Date: 23.JUL.2012 18:18:36

Plot 8.2-7: Pulse width = 2.89 ms

Average time of occupancy= 365.30 ms limit 400 ms Margin 34.7 ms

8.3 RSS-Gen Clause 4.6.1 Occupied bandwidth

8.3.1 Definitions and limits

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 percent emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1 percent of the selected span as is possible without being below 1 percent. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 percent of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded.

The span between the two recorded frequencies is the occupied bandwidth.

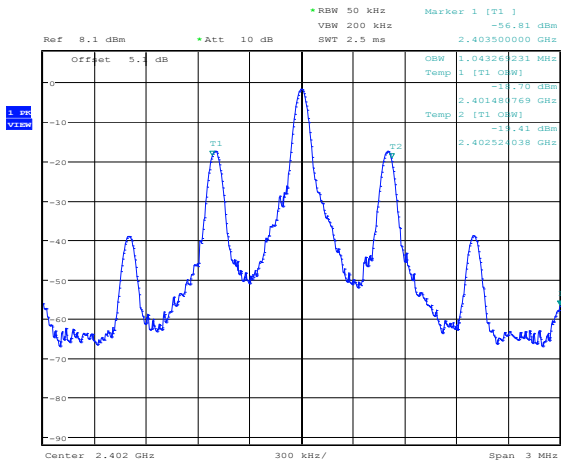
8.3.2 Test summary

| | | | | | |
|--------------------|---------------|----------------------|------------|--------------------------|------|
| Test date | July 24, 2012 | Test engineer | Kevin Rose | Verdict | Pass |
| Temperature | 24 °C | Air pressure | 1002 mbar | Relative humidity | 40 % |

8.3.3 Observations/special notes

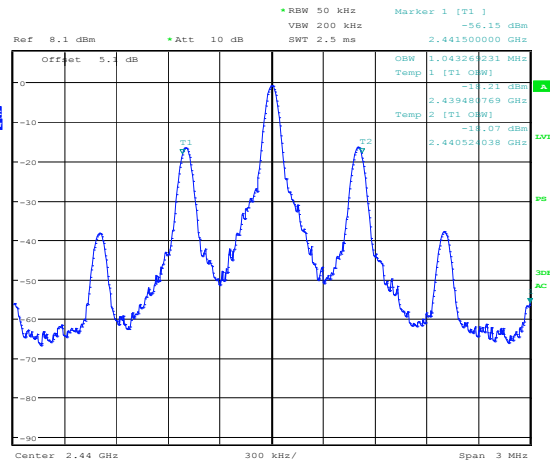
Measurements were performed with peak detector using RBW = 1–5 % of EBW. VBW was set wider than RBW.

8.3.4 Test data



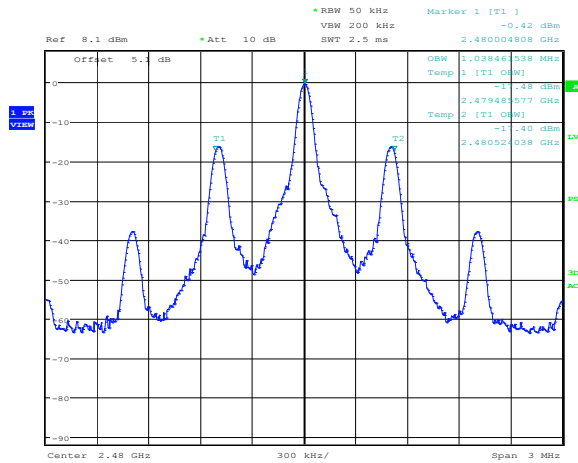
Date: 24.JUL.2012 18:34:25

Plot 8.3-1: 99 % bandwidth – Low channel



Date: 24.JUL.2012 18:29:38

Plot 8.3-2: 99 % bandwidth – Mid channel



Date: 24.JUL.2012 18:25:49

Plot 8.3-3: 99 % bandwidth – High channel

Table 8.3-1: 99 % bandwidth results

| Frequency (MHz) | 99 % bandwidth (MHz) |
|-----------------|----------------------|
| 2402 | 1.042 |
| 2440 | 1.043 |
| 2480 | 1.038 |

8.4 Transmitter output power and EIRP requirements for frequency hopping systems

8.4.1 Definitions and limits

FCC Clause 15.247(b) and RSS-210 Clause A8.4 (1, 2, 3) Transmitter output power and e.i.r.p. requirements for frequency hopping systems

FCC:

- (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
- (1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 W (30 dBm). For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 W (21 dBm).
 - (2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 W (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
 - (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
 - (i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation, as used in paragraph (b)(4)(i) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

IC:

With the digital modulation operation of the hybrid system turned off, the frequency hopping operation shall have an average time of occupancy on any frequency not exceeding 0.4 seconds within a duration in seconds equal to the number of hopping frequencies multiplied by 0.4.

A8.4 (2) Transmitter Output Power and e.i.r.p. Requirements for Frequency hopping systems operating in the 2400–2483.5 MHz band

For frequency hopping systems operating in the band 2400–2483.5 MHz employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W (21 dBm). Except as provided in Section A8.4(5), the e.i.r.p. shall not exceed 4 W (36 dBm).

A8.4 (5) Point-to-point systems in the bands 2400–2483.5 MHz and 5725–5850 MHz.

Point-to-point systems in the bands 2400–2483.5 MHz and 5725–5850 MHz are permitted to have an e.i.r.p. higher than 4 W (36 dBm) provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding 4 W (36 dBm) e.i.r.p. However, remote stations of point-to-multipoint systems shall be allowed to operate at greater than 4 W (36 dBm) e.i.r.p. under the same conditions as for point-to-point systems.

8.4.2 Test summary

| | | | | | |
|--------------------|---------------|----------------------|------------|--------------------------|------|
| Test date | July 24, 2012 | Test engineer | Kevin Rose | Verdict | Pass |
| Temperature | 24 °C | Air pressure | 1002 mbar | Relative humidity | 40 % |

8.4.3 Observations/special notes and procedures

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
 RBW > the 20 dB bandwidth of the emission being measured
 VBW ≥ RBW
 Sweep = auto
 Detector function = peak
 Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the NOTE above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.

Describe how the EUT complies with the de facto EIRP limit for every antenna proposed for use with the EUT. This includes those devices that will be used in point-to-point applications. If the peak output power, as measured above, must be reduced so that the de facto EIRP limit may be met for a particular antenna, describe exactly how much it will be reduced for that antenna. If the peak output power level is raised above the limit in order to compensate for cable loss between the EUT and the antenna, specify the minimum length of cable which will always be used, the type of cable, and its loss, in dB per unit length, for the frequency of the emission. The limit is specified in one of the subparagraphs of this Section. Also, specify who will be responsible for ensuring that compliant operation is maintained for every antenna that will be used with the EUT.

Point-to-Point Operation

If the EIRP relaxation for point-to-point operation is proposed for any particular antenna, describe who will be responsible for ensuring that the EUT is only used in such an application.

8.4.4 Test data,

Table 8.4-1: Conducted output power results

| Frequency (MHz) | Conducted output power (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|------------------------------|-------------|-------------|
| 2402 | -4.81 | 30.00 | 34.81 |
| 2440 | -4.01 | 30.00 | 34.01 |
| 2480 | -3.72 | 30.00 | 33.72 |

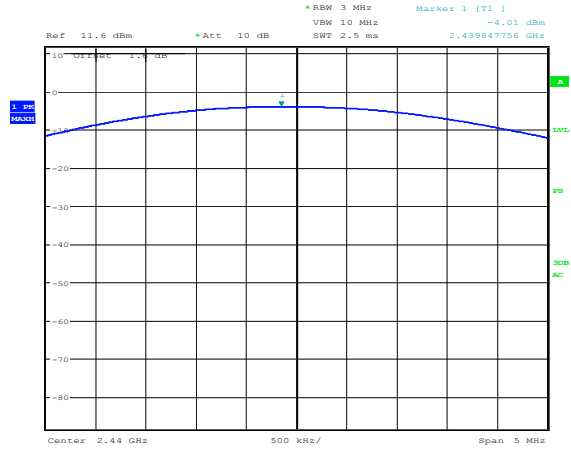
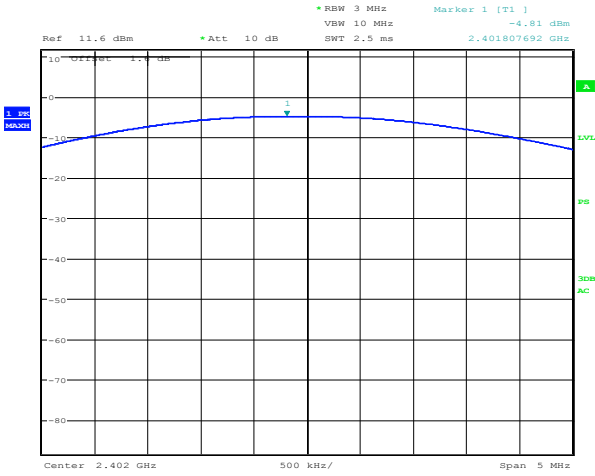
Table 8.4-2: EIRP calculation results

| Frequency (MHz) | EIRP (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|------------|-------------|-------------|
| 2402 | -3.42 | 36.00 | 39.42 |
| 2440 | -2.62 | 36.00 | 38.62 |
| 2480 | -2.33 | 36.00 | 38.33 |

EIRP = Conducted output power [dBm] + antenna gain [dBi]
 Antenna gain = 1.39 dBi

Maximum output power = -3.72 dBm = 0.00042 W Limit = 30 dBm
 Maximum EIRP = -2.33 dBm = 0.00058 W Limit = 36 dBm

8.4.4 Test data, continued

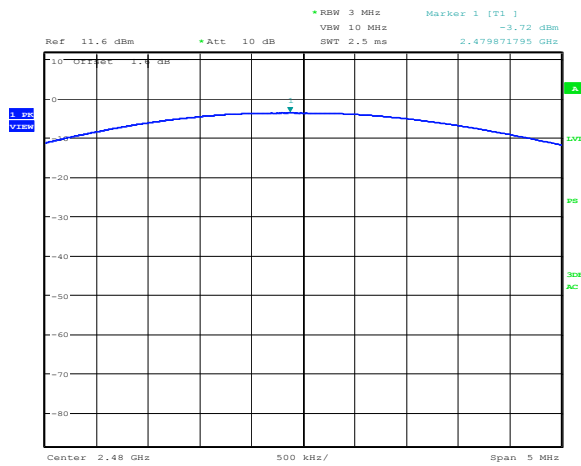


Date: 24.JUL.2012 20:03:07

Date: 24.JUL.2012 20:05:35

Plot 8.4-1: Peak output power on low channel

Plot 8.4-2: Peak output power on mid channel



Date: 24.JUL.2012 20:02:19

Plot 8.4-3: Peak output power on high channel

8.5 Spurious (out-of-band) emissions

8.5.1 Definitions and limits

FCC Clause 15.247(d): Spurious emissions
RSS-210 Clause A8.5 Out-of-band emissions

FCC:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

IC:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Table 8.5-1 is not required.

Table 8.5-1: FCC §15.209 and RSS-Gen – Radiated emission limits

| Frequency (MHz) | Field strength | | Measurement distance (m) |
|-----------------|----------------------------|-------------------------------------|--------------------------|
| | ($\mu\text{V}/\text{m}$) | ($\text{dB}\mu\text{V}/\text{m}$) | |
| 0.009–0.490* | 2400/F | $67.6-20 \times \log_{10}(F)$ | 300 |
| 0.490–1.705* | 24000/F | $87.6-20 \times \log_{10}(F)$ | 30 |
| 1.705–30.0* | 30 | 29.5 | 30 |
| 30–88 | 100 | 40.0 | 3 |
| 88–216 | 150 | 43.5 | 3 |
| 216–960 | 200 | 46.0 | 3 |
| above 960 | 500 | 54.0 | 3 |

*– applicable only to FCC requirements

Table 8.5-2: FCC Restricted bands of operation

| MHz | MHz | MHz | GHz |
|-------------------|---------------------|---------------|-------------|
| 0.090–0.110 | 16.42–16.423 | 399.9–410 | 4.5–5.15 |
| 0.495–0.505 | 16.69475–16.69525 | 608–614 | 5.35–5.46 |
| 2.1735–2.1905 | 16.80425–16.80475 | 960–1240 | 7.25–7.75 |
| 4.125–4.128 | 25.5–25.67 | 1300–1427 | 8.025–8.5 |
| 4.17725–4.17775 | 37.5–38.25 | 1435–1626.5 | 9.0–9.2 |
| 4.20725–4.20775 | 73–74.6 | 1645.5–1646.5 | 9.3–9.5 |
| 6.215–6.218 | 74.8–75.2 | 1660–1710 | 10.6–12.7 |
| 6.26775–6.26825 | 108–121.94 | 1718.8–1722.2 | 13.25–13.4 |
| 6.31175–6.31225 | 123–138 | 2200–2300 | 14.47–14.5 |
| 8.291–8.294 | 149.9–150.05 | 2310–2390 | 15.35–16.2 |
| 8.362–8.366 | 156.52475–156.52525 | 2483.5–2500 | 17.7–21.4 |
| 8.37625–8.38675 | 156.7–156.9 | 2690–2900 | 22.01–23.12 |
| 8.41425–8.41475 | 162.0125–167.17 | 3260–3267 | 23.6–24.0 |
| 12.29–12.293 | 167.72–173.2 | 3332–3339 | 31.2–31.8 |
| 12.51975–12.52025 | 240–285 | 3345.8–3358 | 36.43–36.5 |
| 12.57675–12.57725 | 322–335.4 | 3600–4400 | Above 38.6 |
| 13.36–13.41 | | | |

8.5.1 Definitions and limits, continued

Table 8.5-3: IC Restricted bands of operation

| MHz | MHz | MHz | GHz |
|-----------------|---------------------|---------------|-------------|
| 0.090–0.110 | 12.51975–12.52025 | 399.9–410 | 5.35–5.46 |
| 2.1735–2.1905 | 12.57675–12.57725 | 608–614 | 7.25–7.75 |
| 3.020–3.026 | 13.36–13.41 | 960–1427 | 8.025–8.5 |
| 4.125–4.128 | 16.42–16.423 | 1435–1626.5 | 9.0–9.2 |
| 4.17725–4.17775 | 16.69475–16.69525 | 1645.5–1646.5 | 9.3–9.5 |
| 4.20725–4.20775 | 16.80425–16.80475 | 1660–1710 | 10.6–12.7 |
| 5.677–5.683 | 25.5–25.67 | 1718.8–1722.2 | 13.25–13.4 |
| 6.215–6.218 | 37.5–38.25 | 2200–2300 | 14.47–14.5 |
| 6.26775–6.26825 | 73–74.6 | 2310–2390 | 15.35–16.2 |
| 6.31175–6.31225 | 74.8–75.2 | 2655–2900 | 17.7–21.4 |
| 8.291–8.294 | 108–138 | 3260–3267 | 22.01–23.12 |
| 8.362–8.366 | 156.52475–156.52525 | 3332–3339 | 23.6–24.0 |
| 8.37625–8.38675 | 156.7–156.9 | 3345.8–3358 | 31.2–31.8 |
| 8.41425–8.41475 | 240–285 | 3500–4400 | 36.43–36.5 |
| 12.29–12.293 | 322–335.4 | 4500–5150 | Above 38.6 |

Note: Certain frequency bands listed in Table 8.5-3 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

8.5.2 Test summary

| | | | | | |
|--------------------|---------------|----------------------|------------|--------------------------|------|
| Test date | July 24, 2012 | Test engineer | Kevin Rose | Verdict | Pass |
| Temperature | 24 °C | Air pressure | 1002 mbar | Relative humidity | 40 % |

8.5.3 Observations/special notes and procedures

Unwanted Emissions into Non-Restricted Frequency Bands

If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level.

If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured inband average PSD level.

In either case, attenuation to levels below the general emission limits specified in §15.209(a) is not required.

The following procedures can be utilized to demonstrate compliance to these limits:

First, establish a reference level by using the following procedure for measuring the peak power level in any 100 kHz bandwidth within the fundamental emission:

8.5.3 Observations/special notes and procedures, continued

Measurement Procedure – Reference Level

- a. Set the RBW = 100 kHz.
 - b. Set the VBW \geq 300 kHz.
 - c. Set the span to 5–30 % greater than the EBW.
 - d. Detector = peak.
 - e. Sweep time = auto couple.
 - f. Trace mode = max hold.
 - g. Allow trace to fully stabilize.
 - h. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
- Next, determine the power in 100 kHz band segments outside of the authorized frequency band using the following measurement:

Measurement Procedure - Unwanted Emissions

1. Set RBW = 100 kHz.
2. Set VBW \geq 300 kHz.
3. Set span to encompass the spectrum to be examined.
4. Detector = peak.
5. Trace Mode = max hold.
6. Sweep = auto couple.
7. Allow the trace to stabilize (this may take some time, depending on the extent of the span).

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified above.

Band-edge Compliance of RF Conducted Emissions (frequency hopping)

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation

RBW \geq 1% of the span

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

Spurious RF Conducted Emissions (frequency hopping)

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW \geq RBW

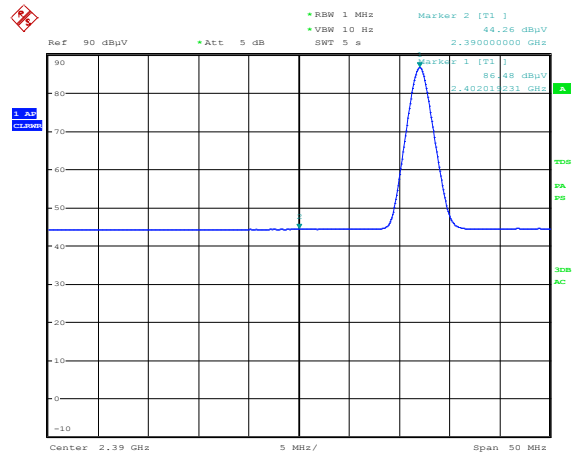
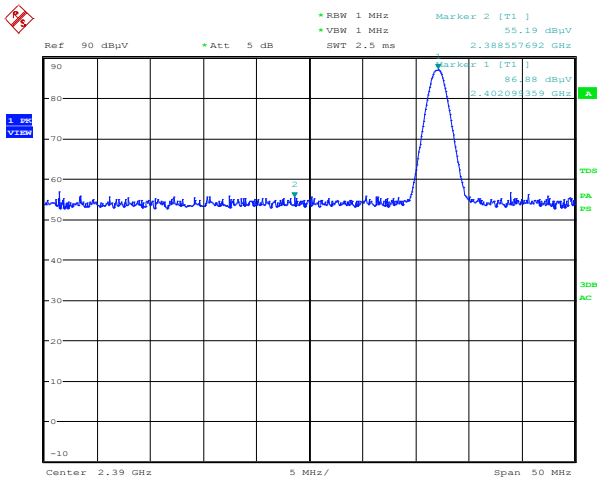
Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section.

8.5.4 Test data,

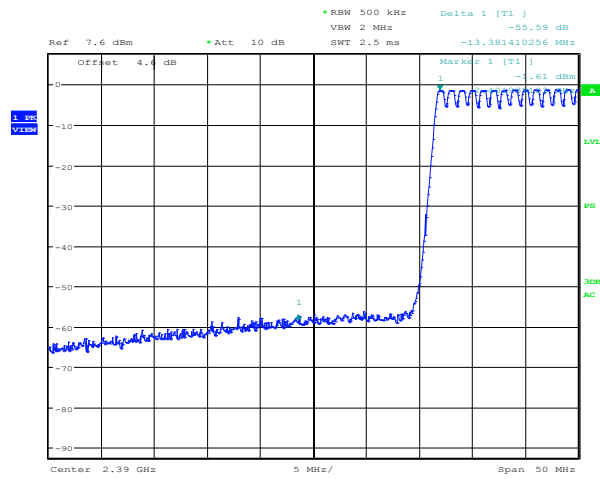


Date: 26.JUL.2012 00:46:45

Date: 26.JUL.2012 00:45:51

Plot 8.5-1: Lower band edge 1 MHz RBW 1 MHz VBW

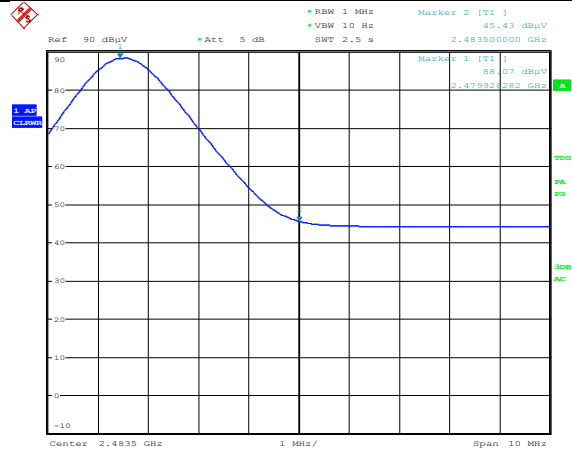
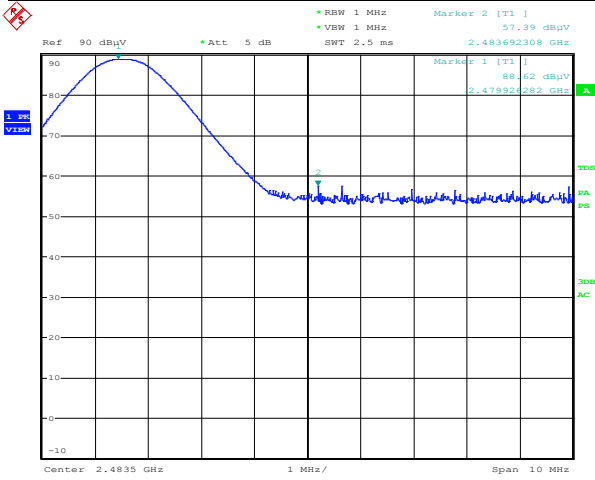
Plot 8.5-2: Lower band edge 1 MHz RBW 10 Hz VBW



Date: 23.JUL.2012 19:06:52

Plot 8.5-3: Lower band edge hopping

8.5.4 Test data, continued

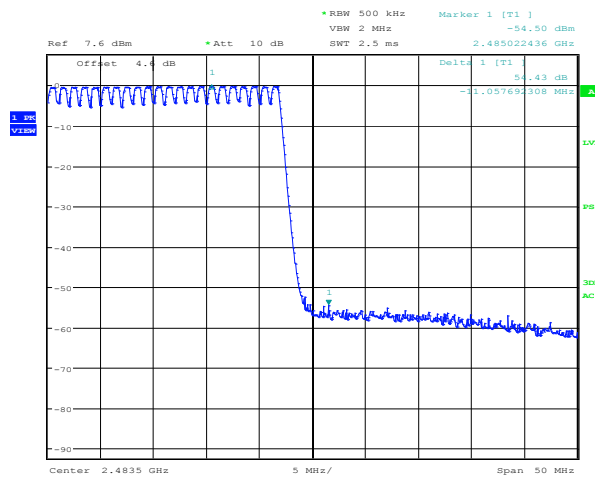


Date: 26.JUL.2012 00:43:15

Date: 26.JUL.2012 00:43:44

Plot 8.5-4: Upper band edge 1 MHz RBW 1 MHz VBW

Plot 8.5-5: Upper band edge 1 MHz RBW 10 Hz VBW

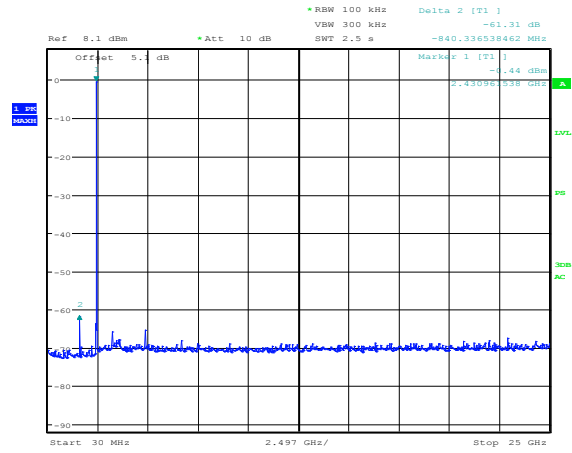
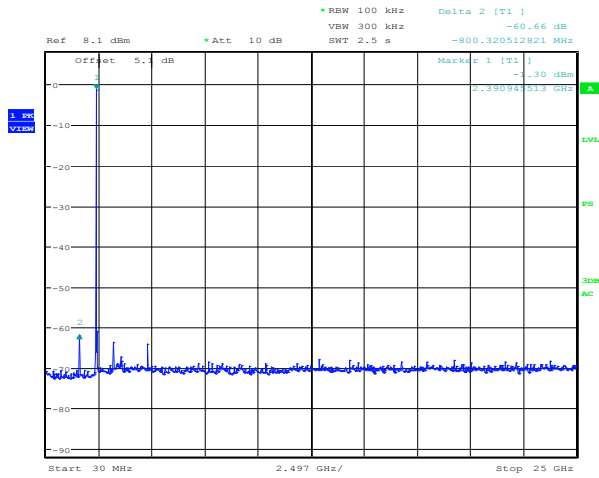


Date: 23.JUL.2012 19:05:35

Plot 8.5-6: Upper band edge hopping

8.5.4 Test data, continued

Conducted measurement

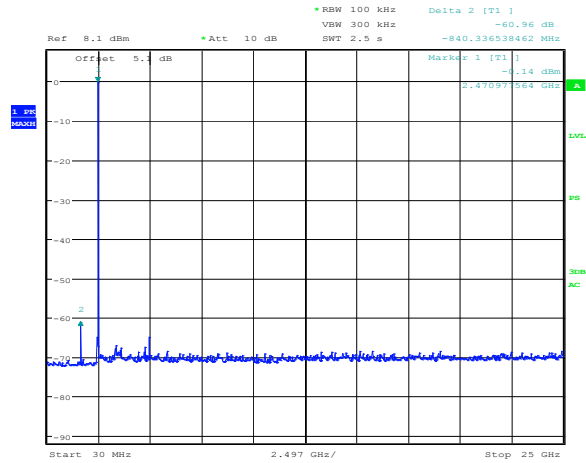


Date: 24.JUL.2012 19:05:22

Date: 24.JUL.2012 19:04:26

Plot 8.5-7: Conducted spurious emissions on low channel

Plot 8.5-8: Conducted spurious emissions on mid channel

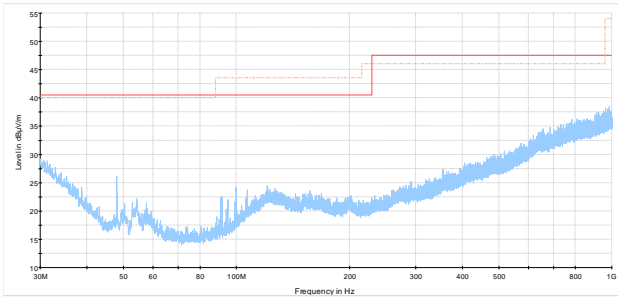


Date: 24.JUL.2012 19:06:06

Plot 8.5-9: Conducted spurious emissions on high channel

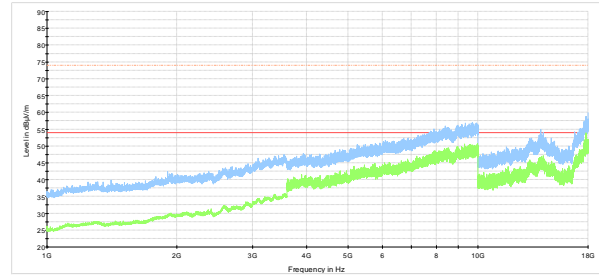
8.5.4 Test data, continued

Radiated measurement



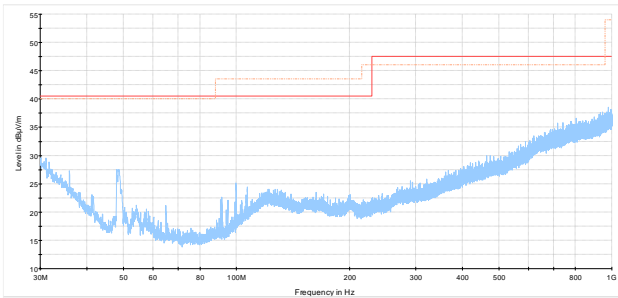
15.247 Radiated Emissions Low channel 30-1000 MHz
 CISPR22 Class B, QP 3m, Limit Line
 FCC Part 15, Class B 3m QPA-V, Limit Line
 Pretest Result 1-Pkx

Plot 8.5-10: Radiated spurious emissions on low channel



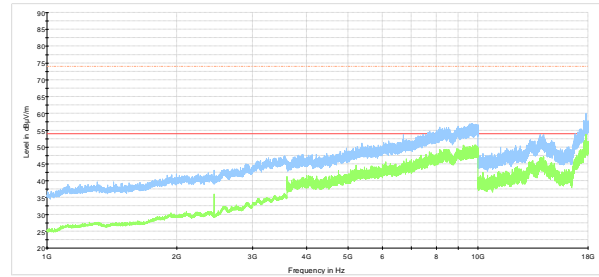
15.247 Radiated Emissions Low channel 1-18 GHz
 FCC Part 15, Class B 3m QPA-V, Limit Line
 FCC Part 15, Class B 3m Peak above 1GHz Limit Line
 Pretest Result 1-Pkx
 Pretest Result 2-Avg

Plot 8.5-11: Radiated spurious emissions on low channel



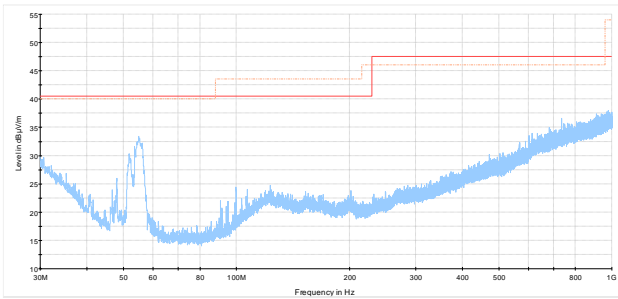
15.247 Radiated Emissions Mid channel 30-1000 MHz
 CISPR22 Class B, QP 3m, Limit Line
 FCC Part 15, Class B 3m QPA-V, Limit Line
 Pretest Result 1-Pkx

Plot 8.5-12: Radiated spurious emissions on mid channel



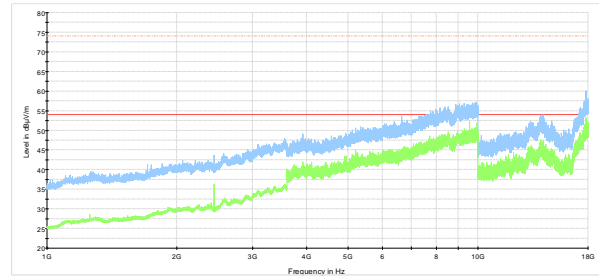
15.247 Radiated Emissions Mid channel 1-18 GHz
 FCC Part 15, Class B 3m QPA-V, Limit Line
 FCC Part 15, Class B 3m Peak above 1GHz Limit Line
 Pretest Result 1-Pkx
 Pretest Result 2-Avg

Plot 8.5-13: Radiated spurious emissions on mid channel



15.247 Radiated Emissions High channel 30-1000 MHz
 CISPR22 Class B, QP 3m, Limit Line
 FCC Part 15, Class B 3m QPA-V, Limit Line
 Pretest Result 1-Pkx

Plot 8.5-14: Radiated spurious emissions on high channel



15.247 Radiated Emissions High channel 1-18 GHz
 FCC Part 15, Class B 3m QPA-V, Limit Line
 FCC Part 15, Class B 3m Peak above 1GHz Limit Line
 Pretest Result 1-Pkx
 Pretest Result 2-Avg

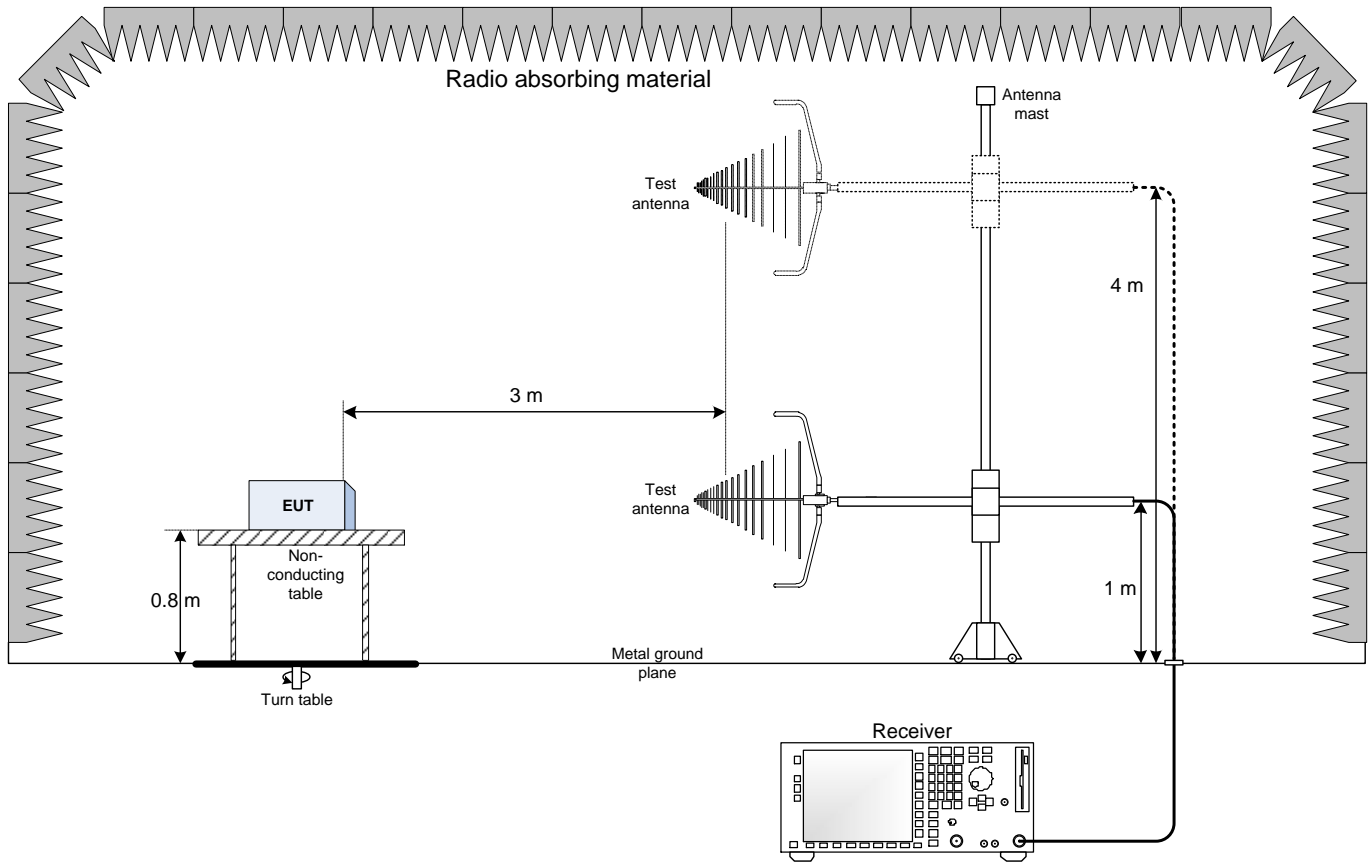
Plot 8.5-15: Radiated spurious emissions on high channel

No emissions were detected within 10 dB of limit inside the 15.205 Restricted bands.

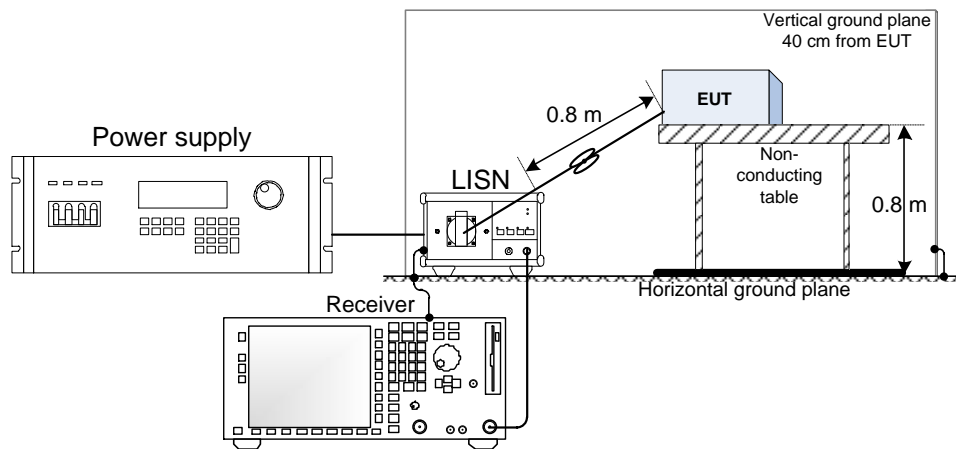
- All measurements were performed at a distance of 3 m.
- All measurements performed:
 - within 30-1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
 - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
 - and using average detector with 1 MHz/3 MHz RBW/VBW for average results

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up



Section 10 EUT photos

10.1 External photos

10.1.1 EUT front view



10.1.2 EUT rear view



www.nemko.com

10.1.3 EUT top view

Insert



www.nemko.com

10.1.4 EUT bottom view



www.nemko.com