PHOENIX TESTLAB

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Test Report

Report Number: F136031E1

Applicant:

Bury GmbH & Co. KG

Manufacturer:

Bury GmbH & Co. KG

Equipment under Test (EUT):

CCBT Lumen

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

Laboratory accredited by
Deutsche Akkreditierungsstelle GmbH (DAkkS)
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. D-PL-17186-01-02

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REFERENCES

[1] **ANSI C63.4-2009** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

[2] **FCC CFR 47 Part 15 (October 2013)** Radio Frequency Devices

[3] **FCC Public Notice DA 00-705 (March 2000)**

[4] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

[5] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radio Apparatus

[6] **Publication Number 913591 (March 2007)** Measurement of radiated emissions at the edge of the band for a Part 15 RF Device

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

	Name	Signature	Date
Test engineer:	Paul NEUFELD		20 May 2014
Authorized reviewer:	Bernd STEINER		20 May 2014

RESERVATION

This test report is only valid in its original form.

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1 IDENTIFICATION

1.1 Applicant

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1.2 Manufacturer

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Country:	Mr. Christoph KOSTON
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Fax:	koston@bury.com
Mail address:	-

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
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accredited by DGA Deutsche Gesellschaft für Akkreditierung mbH in compliance with DIN EN ISO/IEC 17025 under Reg. No. DGA-PL-105/99-22, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	CCBT Lumen
Type: *	Handsfree Car Kit
FCC ID: *	QZ9-CCBTL
IC: *	n.a.
Serial number: *	9140000000043529
PCB identifier: *	BL10351
Hardware version: *	HW245101
Software version: *	SWV10b

1.5 Technical data of equipment

Fulfills Bluetooth specification: *	2.1 (with EDR)					
Antenna type: *	Integral antenna: Inverted Printed F					
Antenna gain: *	-5.6 dBi					
Rated output power: *	12 dBm					
Antenna connector: *	None (SMB connector temporary installed for conducted tests)					
Power supply: *	U_{nom}=	12.0 V DC	U_{min}=	9.0 V DC	U_{max}=	16.0 V DC
Type of modulation: *	FHSS: GFSK (1 Mbps), π/4-DQPSK (2 Mbps) and 8DPSK (3 Mbps)					
Operating frequency range:*	2402 MHz to 2480 MHz					
Number of channels: *	79					
Temperature range: *	-20 to +70 ˚C					

*: declared by the applicant

The following external I/O cables were used:

Identification	Connector		Length *
	EUT	Ancillary	
DC power cable 12 V	CAP HSG ASSY 16P	Laboratory power supply	1 m
Temporary data connection for testing purposes	Temporary cables soldered to the PCB	DB-25 connector connector on a laptop computer	0.5 m

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	11 April 2014
Start of test:	11 April 2014
End of test:	13 May 2014

2 OPERATIONAL STATES

The equipment under test (EUT) is a Bluetooth device. The Bluetooth device is equipped with an integral antenna.

The EUT provides a Bluetooth A2DP communication link for car applications. The EUT was powered by 12 V DC by a lab power supply.

All tests were carried out with an unmodified sample.

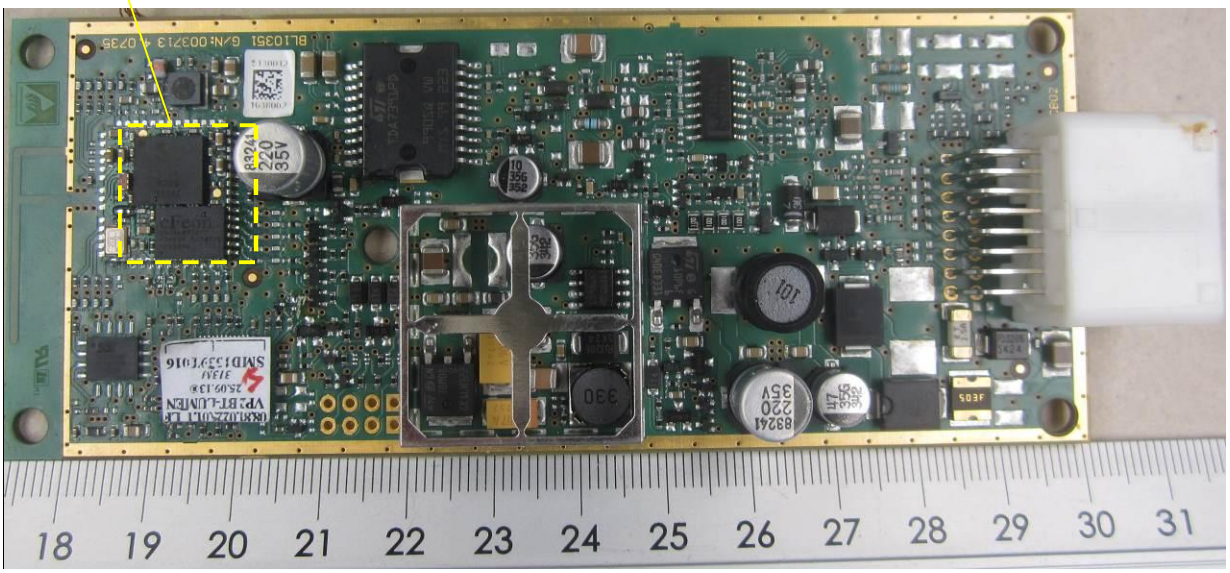
Operation mode:

With a test software which was provided by the applicant (csr blueSuite) the hopping can be enabled and disabled. Furthermore the equipment could be set to transmit only and receive only mode with a certain modulation scheme and datarate on a certain frequency. This software was installed on a laptop PC, which was connected to the Equipment under test via the carrier board.

The EUT was a Bluetooth 2.1 device which was able to operate with GFSK, π/4-DQPSK and 8DPSK. The table below shows the worst case modulation and data rate for appropriate test cases.

Operation mode	Description of the operation mode	Modulation	Hopping mode
1, 1a, 1b	Continuous transmitting on 2402 MHz	GFSK	DH1, DH3, DH5
2, 2a, 2b	Continuous transmitting on 2441 MHz	GFSK	DH1, DH3, DH5
3, 3a, 3b	Continuous transmitting on 2480 MHz	GFSK	DH1, DH3, DH5
4, 4a, 4b	Transmitter hopping on all channels	GFSK	DH1, DH3, DH5
5	Continuous transmitting on 2402 MHz	8DPSK	3DH5
6	Continuous transmitting on 2441 MHz	8DPSK	3DH5
7	Continuous transmitting on 2480 MHz	8DPSK	3DH5

Physical boundaries of the Bluetooth part:



The following test modes were adjusted during the tests:

Preliminary tests were performed in different data rates and different orthogonal directions (if applicable), to find worst-case configuration and position. The data rate shown in the table below shows the found worst-case rate with respect to specific test item. The following table shows a list of the test modes used for the results, documented in this report. The radiated emission measurement was carried out in the orthogonal direction that emits the highest spurious emission levels.

Test items	Operation mode
20 dB bandwidth	5, 6, 7 (3 Mbps)
Carrier frequency separation	1, 2, 3 (1 Mbps)
Number of hopping frequencies	4 (1 Mbps)
Dwell Time	2, 2a, 2b (1 Mbps)
Maximum peak output power	1b, 3b, 4b (1 Mbps)
Band edge compliance (radiated)	1b, 3b, 4b (1 Mbps)
Radiated emissions (transmitter)	1b, 2b, 3b (1 Mbps)

3 ADDITIONAL INFORMATION

During the tests the EUT was not labelled with a label which fulfils the FCC / IC requirements.

4 OVERVIEW

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 8 [4] or RSS-Gen, Issue 3 [5]	Status	Refer page
20 dB bandwidth	General	15.247 (a) (1)	A8.1 (a) [4]	Passed	8 et seq.
Carrier frequency separation	General	15.247 (a) (1)	A8.1 (b) [4]	Passed	12 et seq.
Number of hopping channels	2400.0 - 2483.5	15.247 (a) (1) (iii)	A8.1 (c) [4]	Passed	16 et seq.
Dwell time	2400.0 - 2483.5	15.247 (a) (1) (iii)	A8.1 (d) [4]	Passed	18 et seq.
Maximum peak output power	2400.0 - 2483.5	15.247 (b) (1)	A8.4 (2) [4]	Passed	23 et seq.
Band edge compliance	2400.0 - 2483.5	15.247 (d)	A8.5 [4]	Passed	26 et seq.
Radiated emissions (transmitter)	0.009 - 25,000	15.205 (a) 15.209 (a)	A8.5 [4] 2.5 [4]	Passed	30 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.2 [5]	Not applicable *	

*: Not applicable because of vehicular environment.

5 TEST RESULTS

5.1 20 dB bandwidth

5.1.1 Method of measurement (20 dB bandwidth)

The measurement was carried out in a radiated way. The measurement setup is the same as described in section 5.7.1 of this test report.

The EUT has to be switched on and the hopping function has to be disenabled, the transmitter shall work with its maximum data rate.

The following spectrum analyser settings shall be used:

- Span: App. 2 to 3 times the 20 dB bandwidth, centred on the actual hopping channel.
- Resolution bandwidth: ≥ 1 % of the 20 dB bandwidth.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 20 dB below the first line (or the peak marker). The frequency lines shall be set on the intersection points between the second display line and the measured curve.

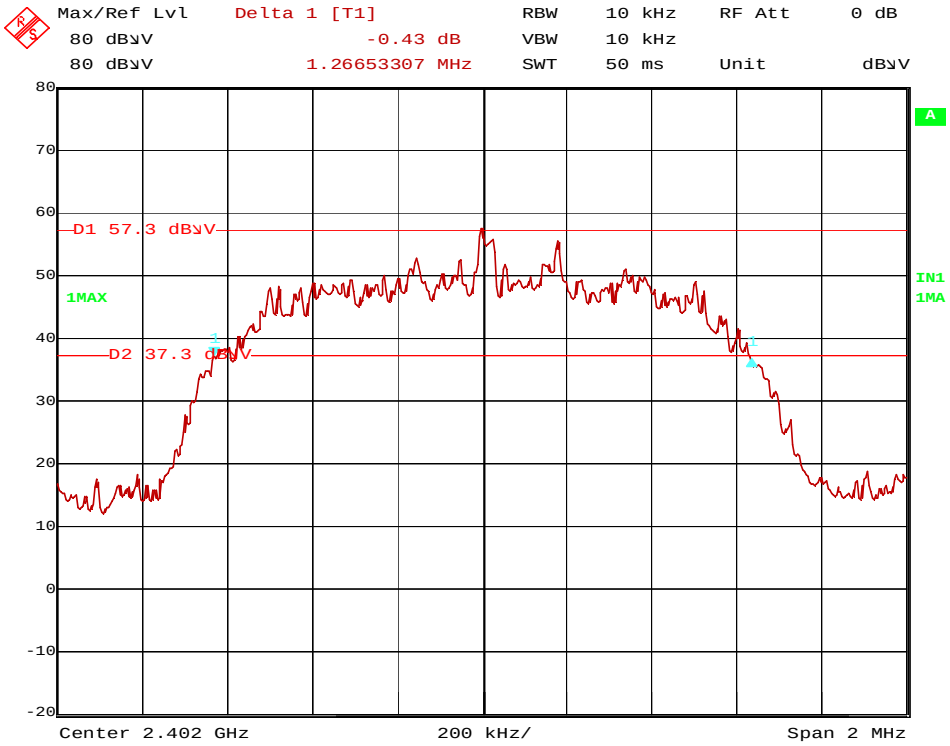
The measurement will be performed at the upper, the lower end and the middle of the assigned frequency band.

5.1.2 Test results (20 dB bandwidth)

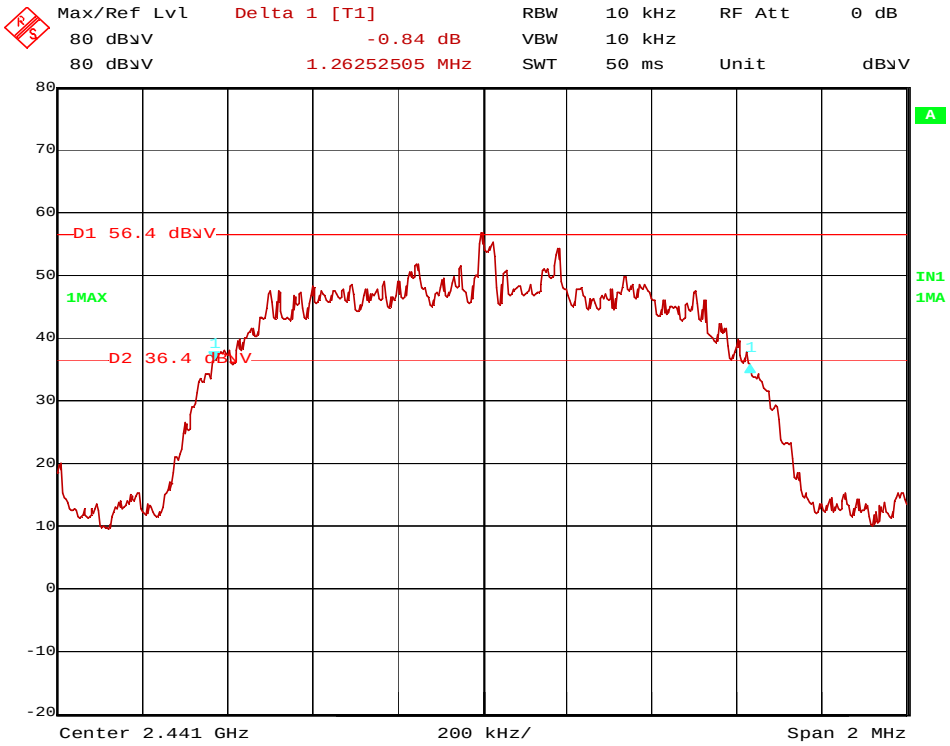
Ambient temperature	22 °C	Relative humidity	26 %

The 8DPSK was found to be the worst case modulation scheme. Therefore all tests were performed using this modulation.

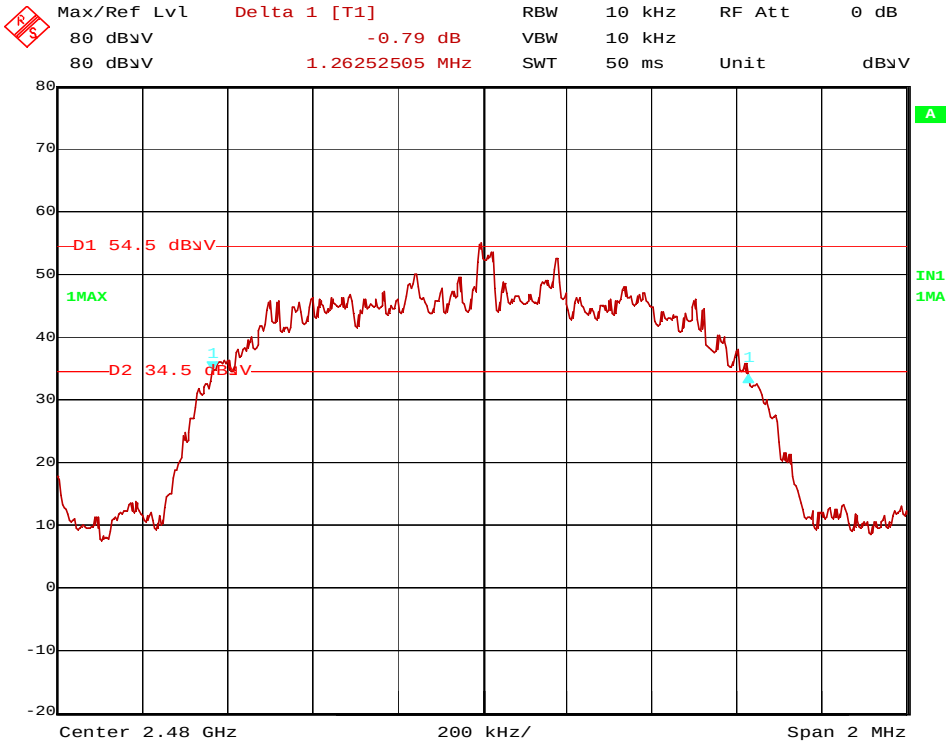
136031_17.wmf: 20 dB bandwidth at the lower end of the assigned frequency band:



136031_18.wmf: 20 dB bandwidth at the middle of the assigned frequency band:



136031_16.wmf: 20 dB bandwidth at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
Operation mode 5, 6, 7		
0	2402	1266.533
39	2441	1262.525
78	2480	1262.525
Measurement uncertainty		+0.66 dB / -0.72 dB

TEST EQUIPMENT USED FOR THE TEST:

6, 8 – 11, 13, 17, 18

5.2 Carrier frequency separation

5.2.1 Method of measurement (carrier frequency separation)

The measurement was carried out in a radiated way. The measurement setup is the same as described in section 5.7.1 of this test report.

The EUT has to be switched on and the hopping function has to be enabled.

The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peaks of two adjacent channels.
- Resolution bandwidth: ≥ 1 % of the span.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker and the delta marker function will be used to determine the separation between the peaks of two adjacent channel signals.

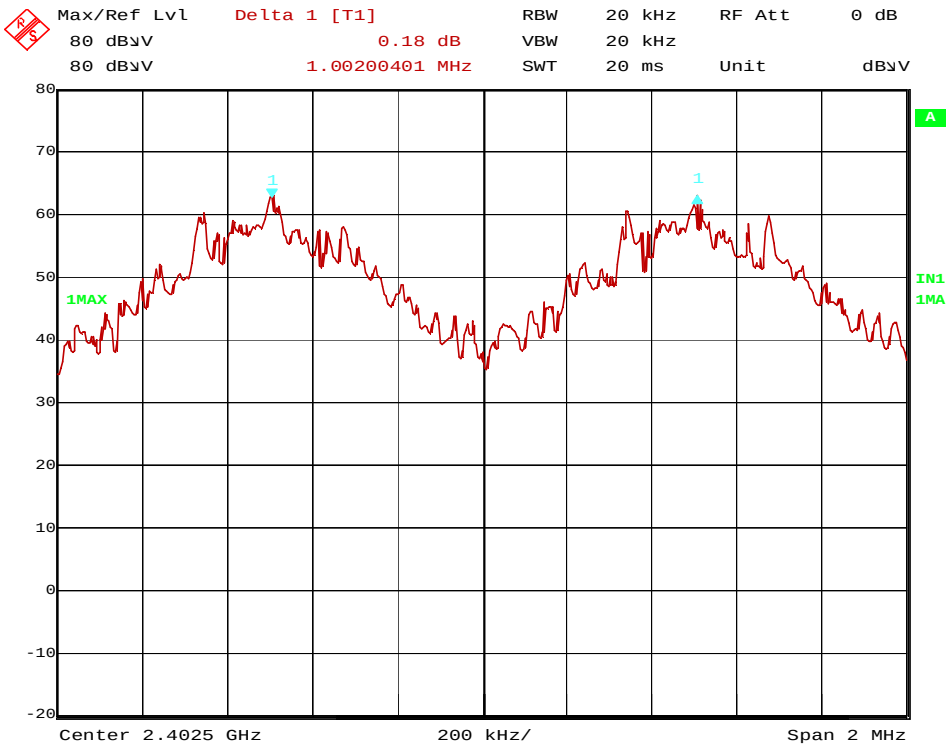
The measurement will be performed at the upper, the lower end and the middle of the assigned frequency band.

5.2.2 Test results (carrier frequency separation)

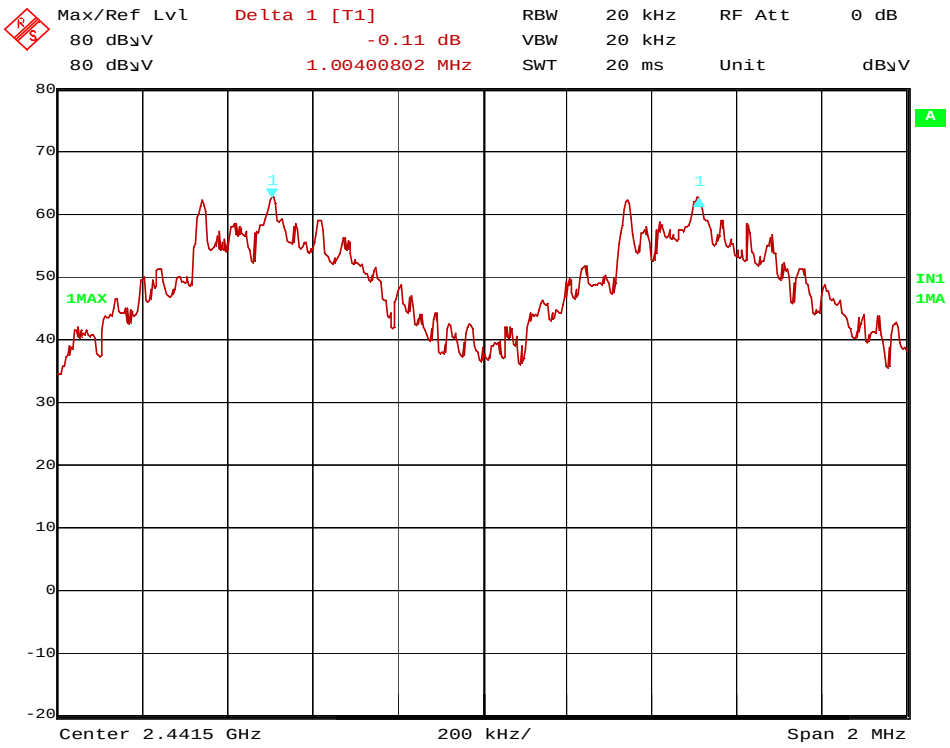
Ambient temperature	22 °C	Relative humidity	26 %

The carrier frequency separation was equal for all modulations, therefore only one exemplary modulation GFSK (DH5) is submitted below.

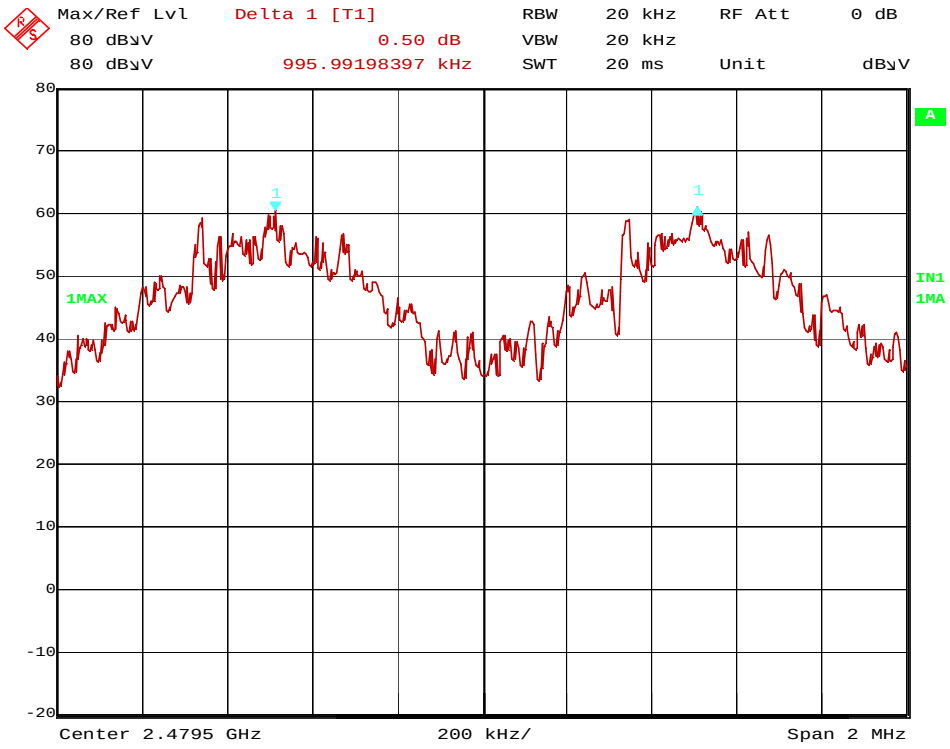
136031_6.wmf: Channel separation at the lower end of the assigned frequency band:



136031_7.wmf: Channel separation at the middle of the assigned frequency band:



136031_8.wmf: Channel separation at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
Operation mode 4			
0	2402	1002.004	844.355 ($^2/_3$ of the 20 dB bandwidth)
39	2441	1004.008	841.683 ($^2/_3$ of the 20 dB bandwidth)
78	2480	995.992	841.683 ($^2/_3$ of the 20 dB bandwidth)
Measurement uncertainty			$<10^{-7}$

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

6, 8 – 11, 13, 17, 18

5.3 Number of hopping frequencies

5.3.1 Method of measurement (number of hopping frequencies)

The measurement was carried out in a radiated way. The measurement setup is the same as described in section 5.7.1 of this test report.

The EUT has to be switched on and the hopping function has to be enabled.

The following spectrum analyser settings shall be used:

- Span: Equal to the assigned frequency band.
- Resolution bandwidth: ≥ 1 % of the span.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

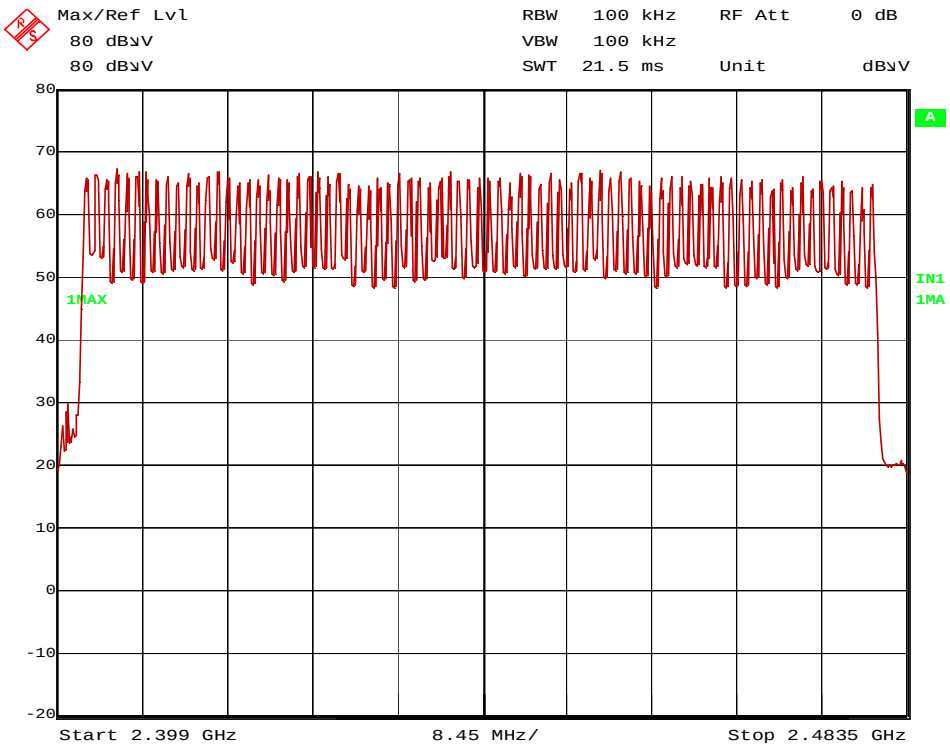
After trace stabilisation the number of hopping channels could be counted. It might be possible to divide the span into some sub ranges in order to clearly show all hopping frequencies.

5.3.2 Test results (number of hopping frequencies)

Ambient temperature	21 °C	Relative humidity	37 %

The number of hopping frequencies is equal for all modulations, therefore only the results for one modulation is submitted below.

136031_9.wmf: Number of hopping channels:



Number of hopping channels	Limit
79	At least 15

TEST EQUIPMENT USED FOR THE TEST:

6, 8 – 11, 13, 17, 18,

5.4 Dwell time

5.4.1 Method of measurement (dwell time)

The measurement was carried out in a radiated way. The measurement setup is the same as described in section 5.7.1 of this test report.

The EUT has to be switched on and the hopping function has to be enabled.

The following spectrum analyser settings shall be used:

- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel.
- Detector function: peak.
- Trace mode: Max hold.

The marker and delta marker function of the spectrum analyser will be used to determine the dwell time.

The measurement will be performed at the upper and lower end and the middle of the assigned frequency band.

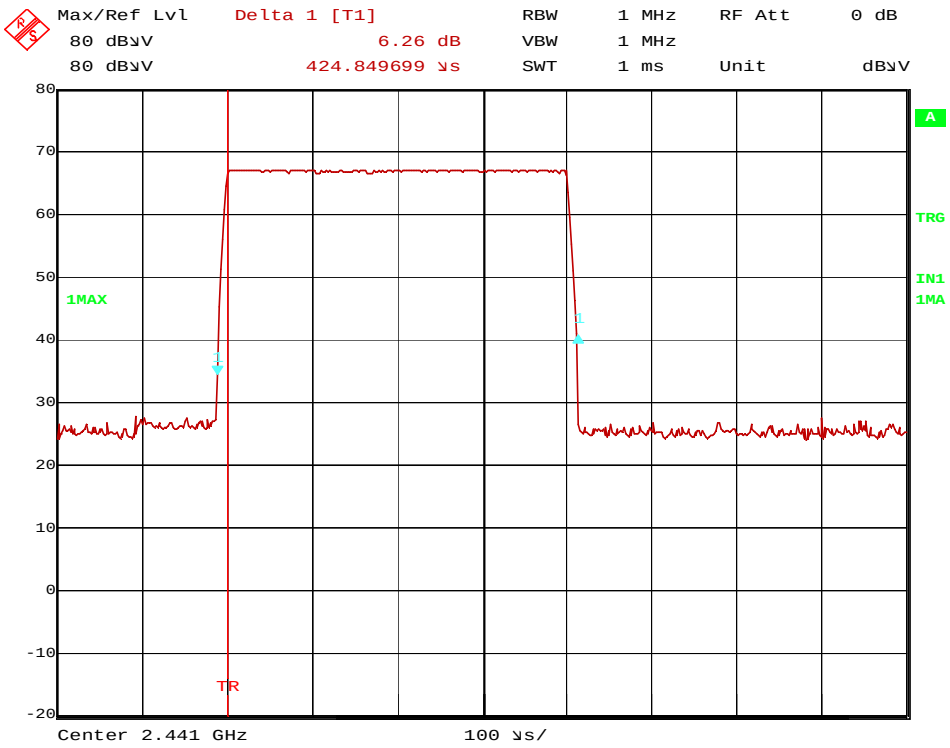
If the EUT is possible to operate with different mode of operation (data rates, modulation formats etc.) the test will be repeated with every different operation mode of the EUT.

5.4.2 Test results (dwell time)

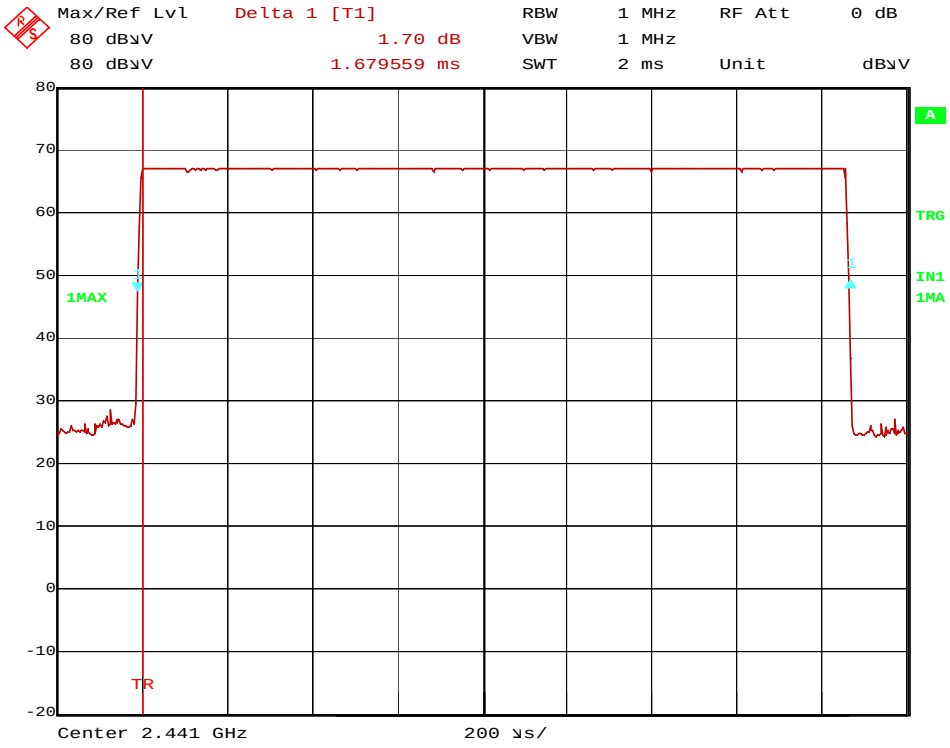
Ambient temperature	21 °C	Relative humidity	37 %

The dwell time on each channel is independent of the modulation, therefore the results for only one mode is submitted below.

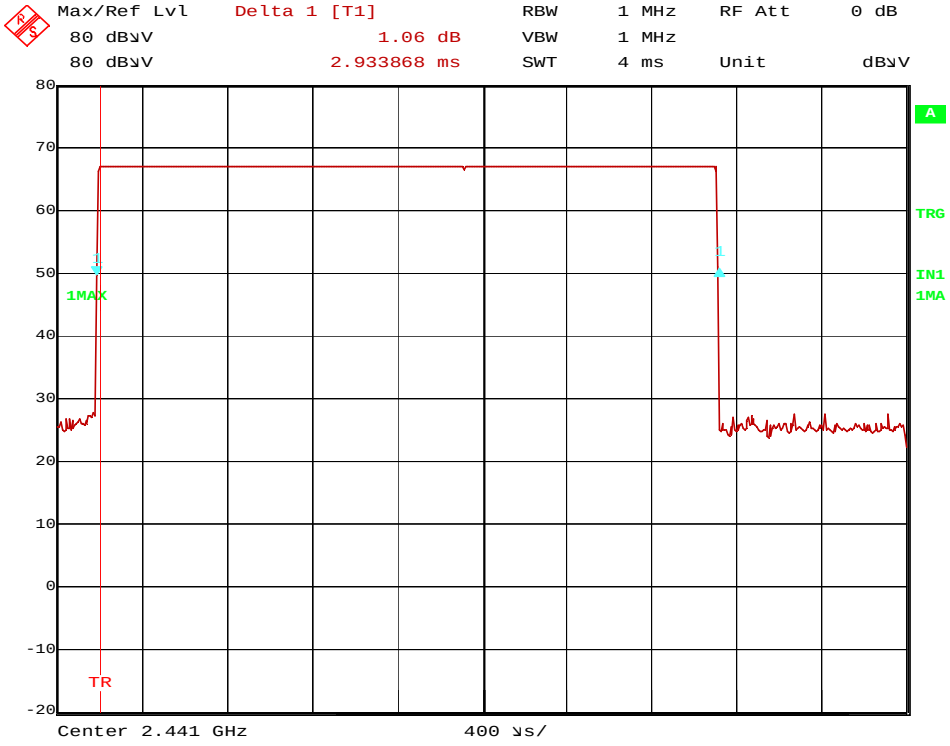
136031_10.wmf: Dwell time at the middle of the assigned frequency band (operation mode 2):



136031_12.wmf: Dwell time at the middle of the assigned frequency band (operation mode 2a):



136031_11.wmf: Dwell time at the middle of the assigned frequency band (operation mode 2b):



The dwell time is calculated with the following formula:

Dwell time = t_{pulse} x n_{hops} / number of hopping channels x 31.6 (equal to 0.4 s x number of hopping channels)

Where:

t_{pulse} is the measured pulse time (pls. refer the plots of the spectrum analyser above) [s],
n_{hops} is the number of hops per second in the actual operating mode of the transmitter [1/s].

The hopping rate of the system is 1600 hops per second and the system uses 79 channels. For this reason one time slot has a length of 625 µs.

With the used hopping mode (DH1) a packet need 1 timeslot for transmitting and the next timeslot for receiving. So the system makes in worst case 800 hops per second in transmit mode (n_{hops} = 800 1/s).

With the used hopping mode (DH3) a packet need 3 timeslots for transmitting and the next timeslot for receiving. So the system makes in worst case 400 hops per second in transmit mode (n_{hops} = 400 1/s).

With the used hopping mode (DH5) a packet need 5 timeslots for transmitting and the next timeslot for receiving. So the system makes in worst case 267 hops per second in transmit mode (n_{hops} = 267 1/s).

Operation mode 2				
Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Dwell time [ms]	Limit [ms]
39	2441	0.425	136.196	400
Operation mode 2a				
Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Dwell time [ms]	Limit [ms]
39	2441	1.680	269.188	400
Operation mode 2b				
Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Dwell time [ms]	Limit [ms]
39	2441	2.934	313.803	400
Measurement uncertainty			$<10^{-7}$	

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

6, 8 – 11, 13, 17, 18,

5.5 Maximum peak output power

5.5.1 Method of measurement (maximum peak output power)

The measurement was carried out in a radiated way. The measurement setup is the same as described in section 5.7.1 of this test report.

The EUT has to be switched on and the hopping function has to be disenabled, the transmitter shall work with its maximum data rate.

The measured output power, which is the result of the radiated measurement, is corrected by the antenna factor, cable attenuation and the preamp value.

The following spectrum analyser settings shall be used:

- Span: Approx. 5 times the 20 dB bandwidth, centred on a hopping channel.
- Resolution bandwidth: > the 20 dB bandwidth of the emission being measured.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The indicated level is the peak output power, which has to be corrected with the value of the cable loss and an external attenuation (if necessary).

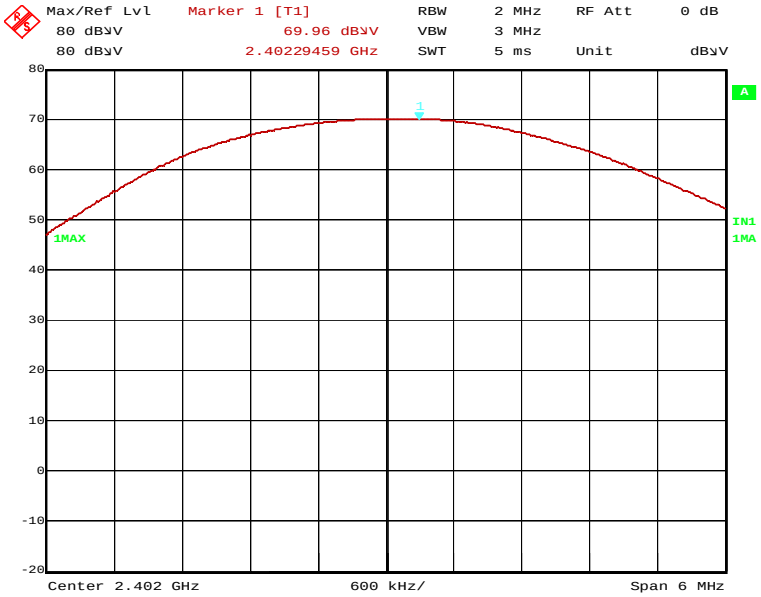
The measurement will be performed at the upper and lower end and the middle of the assigned frequency band.

5.5.2 Test results (maximum peak output power)

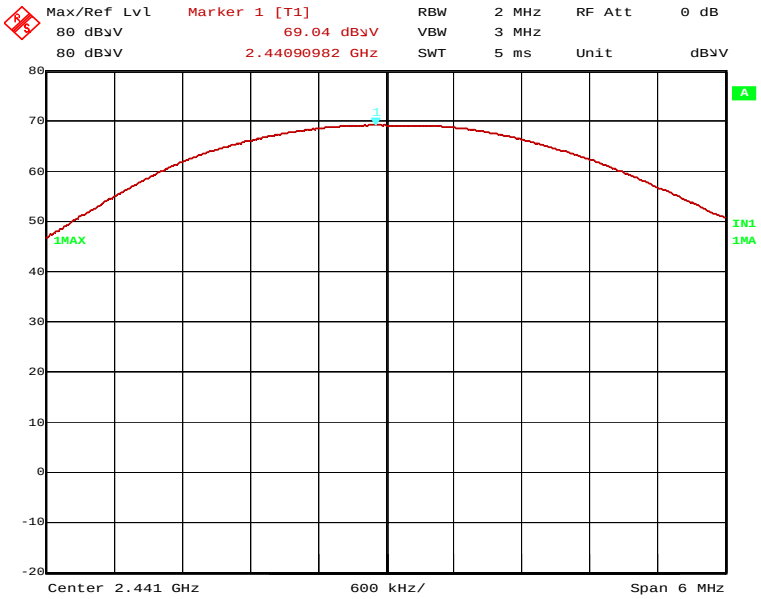
Ambient temperature	21 °C	Relative humidity	37 %

The GFSK modulation has found to be the worst case modulation for the output measurement, therefore only the measurements using this modulation are submitted below.

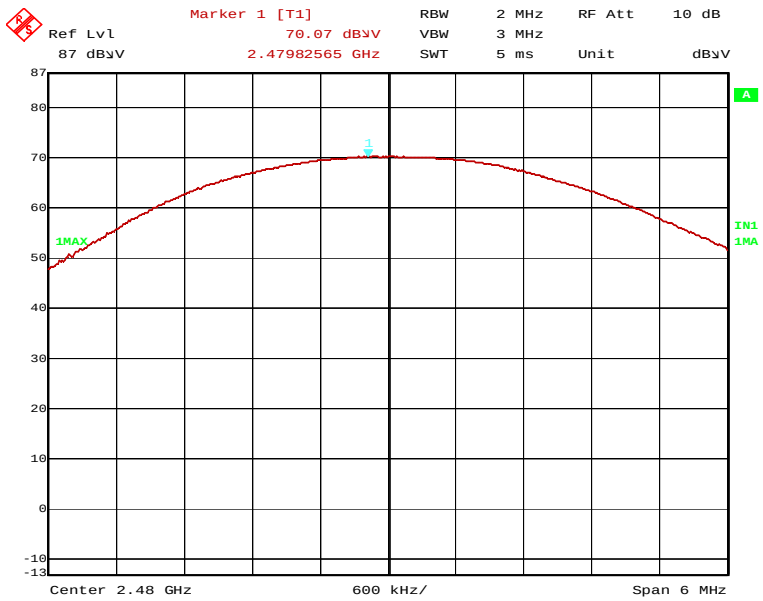
136031_Pwr_Ch2.wmf:Maximum peak output power at the lower end of the assigned frequency band (operation mode 1):



031_2.wmf: Maximum peak output power at the middle of the assigned frequency band (operation mode 2):



031_3.wmf: Maximum peak output power at the upper end of the assigned frequency band (operation mode 3):



Operation mode	Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1	0	2402	11.7	-5.6	30.0
2	39	2441	10.8	-5.6	30.0
3	78	2480	11.9	-5.6	30.0
Measurement uncertainty				+0.66 dB / -0.72 dB	

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

6, 8 – 11, 13, 17, 18,

5.6 Band-edge compliance

5.6.1 Method of measurement (band-edge compliance (radiated))

The same test set-up as used for the final radiated emission measurement shall be used (refer also subclause 5.2.1 of this test report). The measurements shall be carried out with using a resolution bandwidth of 100 kHz.

The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peak level of the emission on the channel closest to the band-edge, as well as any modulation products, which fall outside the assigned frequency band.
- Resolution bandwidth: 100 kHz.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 20 dB below the first line (or the peak marker). The frequency line shall be set on the edge of the assigned frequency band. Set the second marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge. This frequency shall be measured with the EMI receiver as described in subclause 5.2.1 of this test report, but 100 kHz resolution bandwidth shall be used.

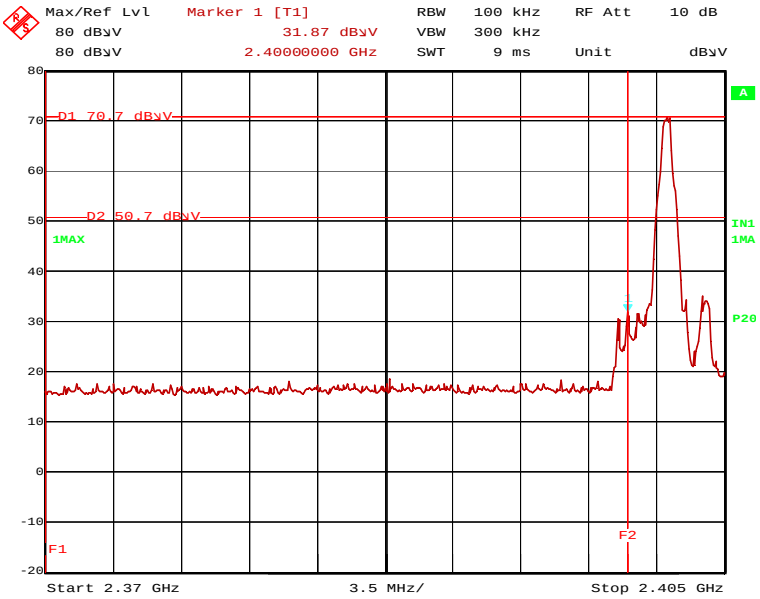
The measurement will be performed at the upper end of the assigned frequency band and with hopping on and off.

5.6.2 Test results (band-edge compliance (radiated))

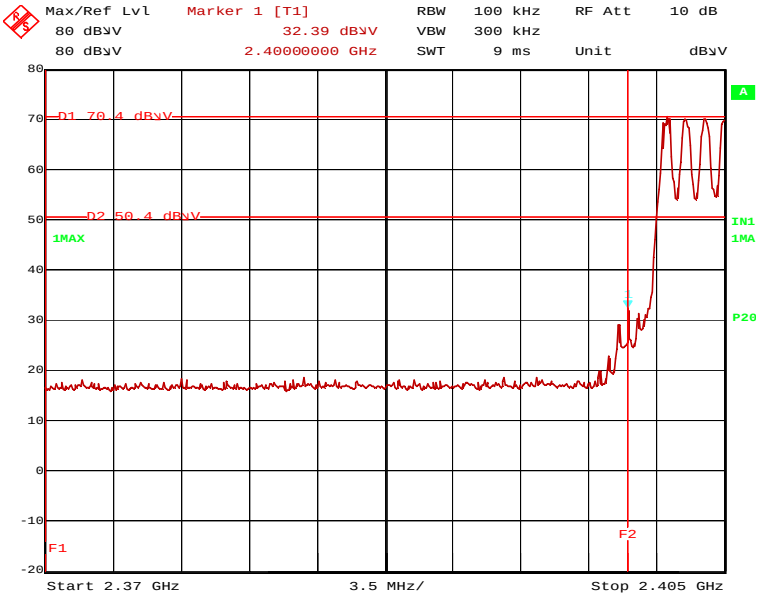
Ambient temperature	21 °C	Relative humidity	38 %

The GFSK modulation has found to be the worst case modulation for the output measurement, therefore only the measurements using this modulation are submitted below.

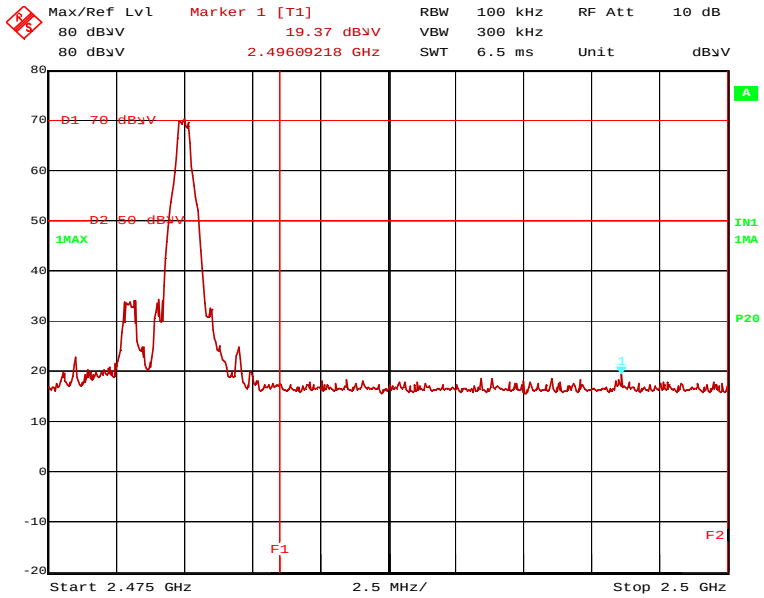
136031_BandEdge_Low_HopOff.wmf: Radiated band-edge compliance, lower band edge, hopping off:



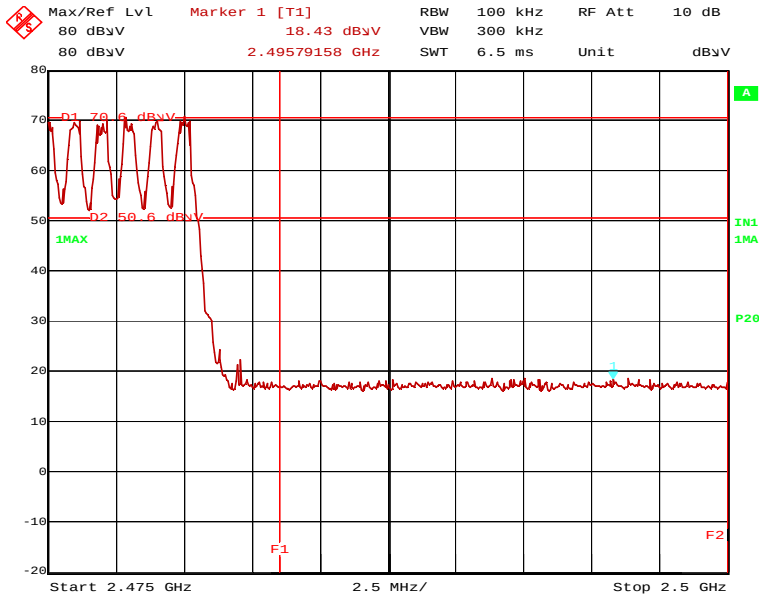
136031_BandEdge_Low_HopOn.wmf: Radiated band-edge compliance, lower band edge, hopping on:



136031_BandEdge_High_HopOff.wmf: Radiated band-edge compliance, upper band edge, hopping off:



136031_BandEdge_High_HopOn.wmf: Radiated band-edge compliance, upper band edge, hopping on:



The plots on the page before are showing the radiated band-edge compliance for the upper band-edge, with and without hopping. The display line 1 (D1) in these plots represents the highest level within the assigned frequency band. The display line 2 (D2) represents the 20 dB offset to this highest level and shows the compliance with FCC 47 CFR Part 15.247 (d). The frequency line 1 (F1) shows the edge of the assigned frequency.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

Operation Mode	Bluetooth channel	Bluetooth mode	Band-Edge	Reference Level dBm	Limit dBµV	Unwanted Emission Frequency MHz	Unwanted Emission Level dBµV	Margin dB
1	0	Hopping off	low	70.7	50.7	2400.000	31.9	18.8
4	0	Hopping on	low	70.4	50.4	2400.000	32.4	18.0
Measurement uncertainty				+0.66 dB / -0.72 dB				

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

Band Edge Compliance, GFSK modulation, continuous transmitting on channel 78 (Operation mode 3)										
Frequency MHz	Emission Level dBµV/m	Peak Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2496.1	59.95	74	14.05	27.6	28.55	0	3.8	150	Hor.	-
Frequency MHz	Emission Level dBµV/m	Average Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2496.1	45.75	54	8.25	13.4	28.55	0	3.8	150	Hor.	-
Measurement uncertainty						+2.2 dB / -3.6 dB				

Band Edge Compliance, GFSK modulation, randomly hopping on all channels (Operation mode 4)										
Frequency MHz	Emission Level dBµV/m	Peak Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2495.8	59.46	74	14.54	27.11	28.55	0	3.8	150	Hor.	-
Frequency MHz	Emission Level dBµV/m	Average Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2495.8	45.48	54	8.52	13.13	28.55	0	3.8	150	Hor.	-
Measurement uncertainty						+2.2 dB / -3.6 dB				

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:
6, 8 – 11, 13, 17, 18,

5.7 Radiated emissions

5.7.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into four stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 110 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 110 GHz.

All measurements will be carried out with the EUT working on the middle of the assigned frequency band.

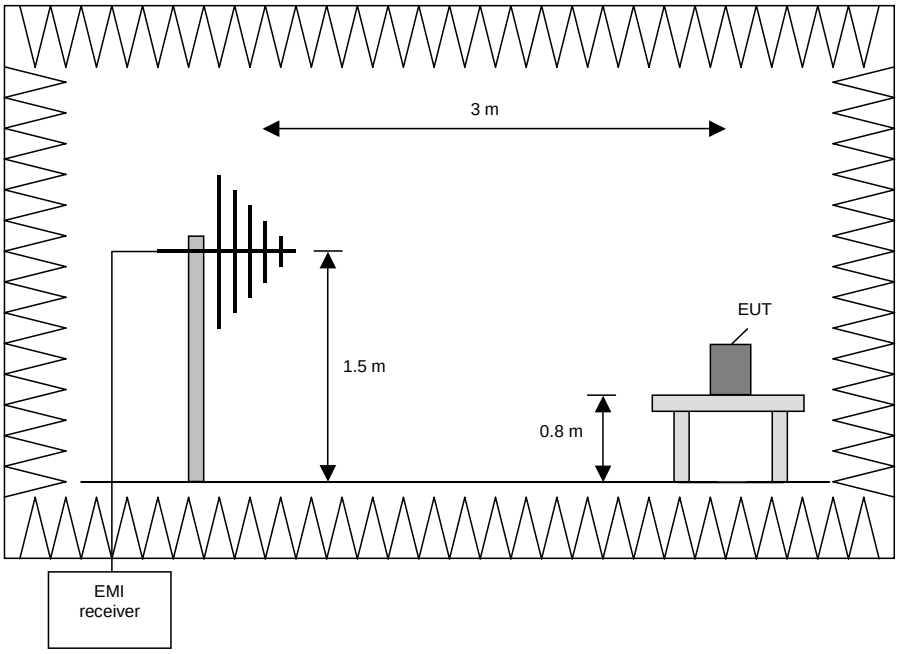
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

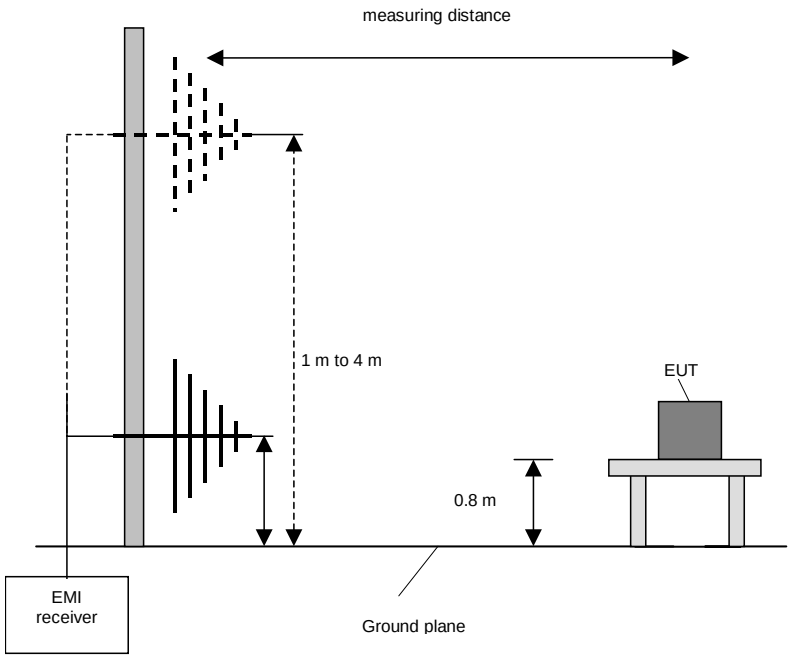
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6. Repeat 1) to 4) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
7. Repeat 1) to 5) with the vertical polarisation of the measuring antenna.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
4) Repeat 1) to 3) for the other orthogonal antenna polarization.
5) Move the antenna and the turntable to the position where the maximum value is detected.
6) Measure while moving the antenna slowly +/- 1 m.
7) Set the antenna to the position where the maximum value is found.
8) Measure while moving the turntable +/- 45 °.
9) Set the turntable to the azimuth where the maximum value is found.
10) Measure with Final detector (QP and AV) and note the value.
11) Repeat 5) to 10) for each frequency.
12) Repeat 1) to 11) for each orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 110 GHz)

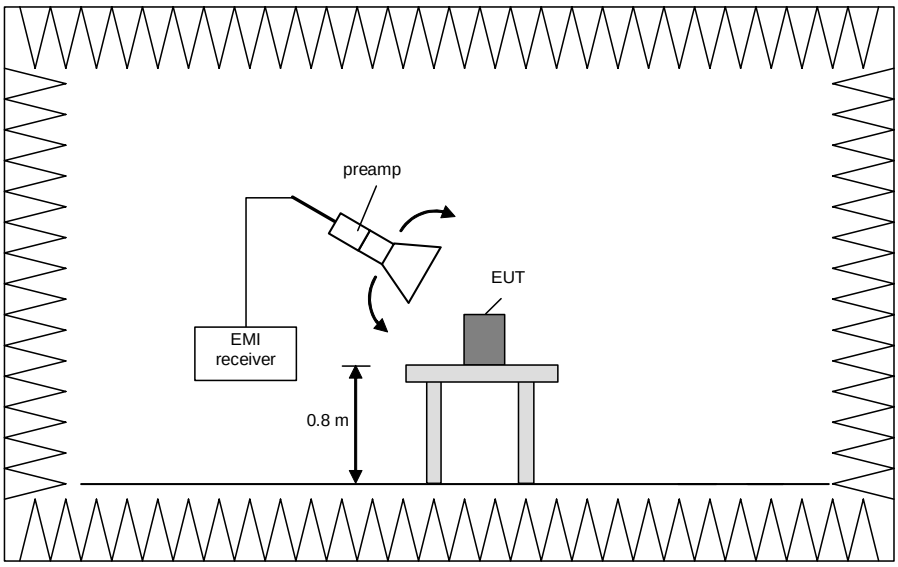
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

Preliminary measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna, the antenna close to the EUT and while moving the antenna over all sides of the EUT. With the spectrum analyser in CLEAR / WRITE mode the cone of the emission should be found and than the measuring distance will be set to 3 m with the receiving antenna moving in this cone of emission. At this position the final measurement will be carried out.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz
40 GHz to 60 GHz	100 kHz
50 GHz to 75 GHz	100 kHz
75 GHz to 110 GHz	100 kHz

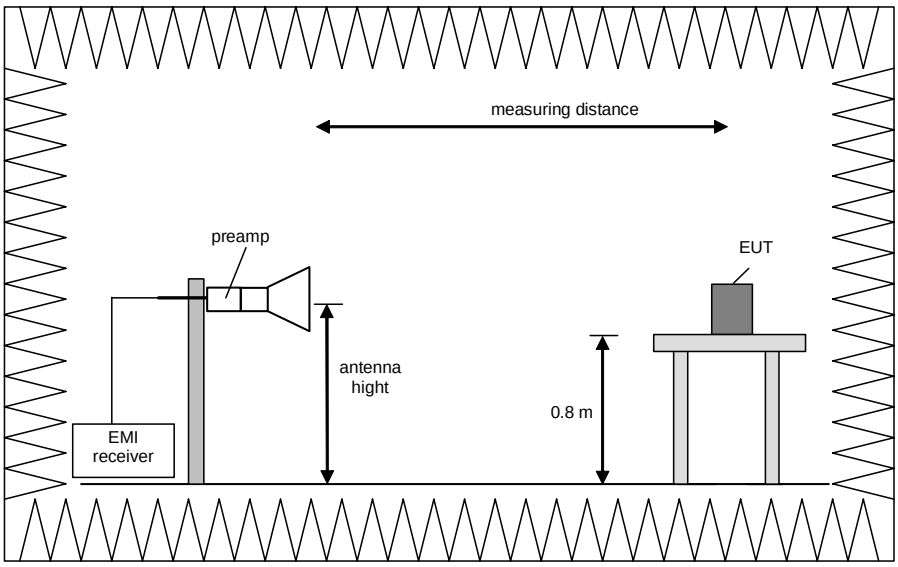


Final measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 ° in order to have the antenna inside the cone of radiation.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure of measurement:

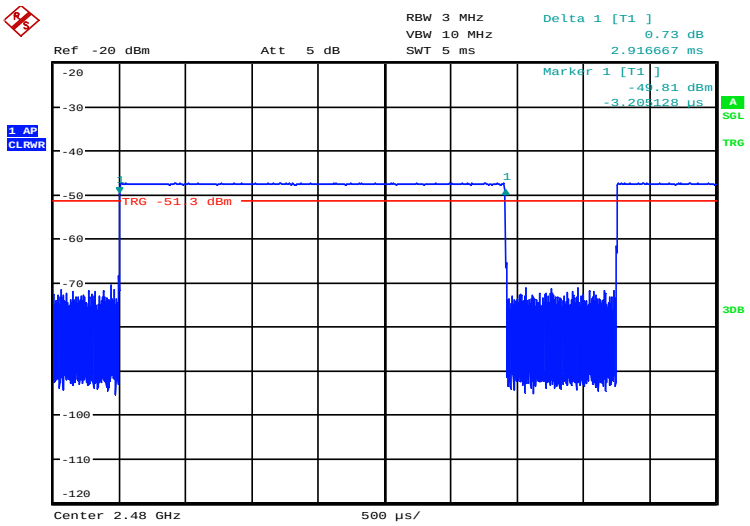
The measurements were performed in the frequency range 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 GHz.
The following procedure will be used:

1) Monitor the frequency range at horizontal polarisation and move the antenna over all sides of the EUT (if necessary move the EUT to another orthogonal axis).
2) Change the antenna polarisation and repeat 1) with vertical polarisation.
3) Make a hardcopy of the spectrum.
4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
5) Change the analyser mode to Clear / Write and found the cone of emission.
6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3 m and the antenna will be still inside the cone of emission.
7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarisation and azimuth and the peak and average detector, which causes the maximum emission.
8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

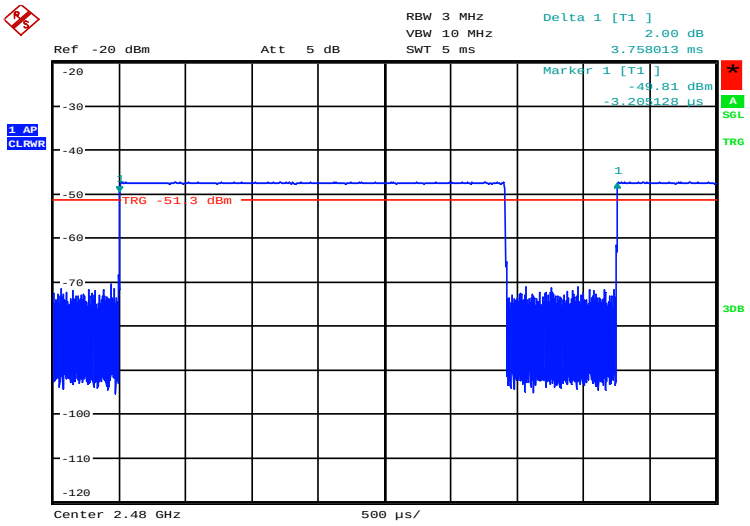
Step 1) to 6) are defined as preliminary measurement.

Duty Cycle correction

136031_ZeroSpan_TxOn__BT_DH5_BT78.wmf: (operation mode 1):



136031_ZeroSpan_TxPeriod__BT_DH5_BT78.wmf: (operation mode 1):



The duty cycle correction factor is derived by the following formula:

$$D_{Cycle} = 10 \cdot \log_{10}\left(\frac{TX_{On+Off}}{Tx_{On}}\right) = 10 \cdot \log_{10}\left(\frac{3.758ms}{2.917ms}\right) = 1.1dB$$

Therefore for all tests carried out with a CISPR average detector and this value is added on to the measured value

TEST EQUIPMENT USED FOR THE TEST:
7, 32

5.7.2 Test results (radiated emissions)

5.7.2.1 Preliminary radiated emission measurement (9 kHz to 1 GHz)

Ambient temperature	20 °C	Relative humidity	43 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

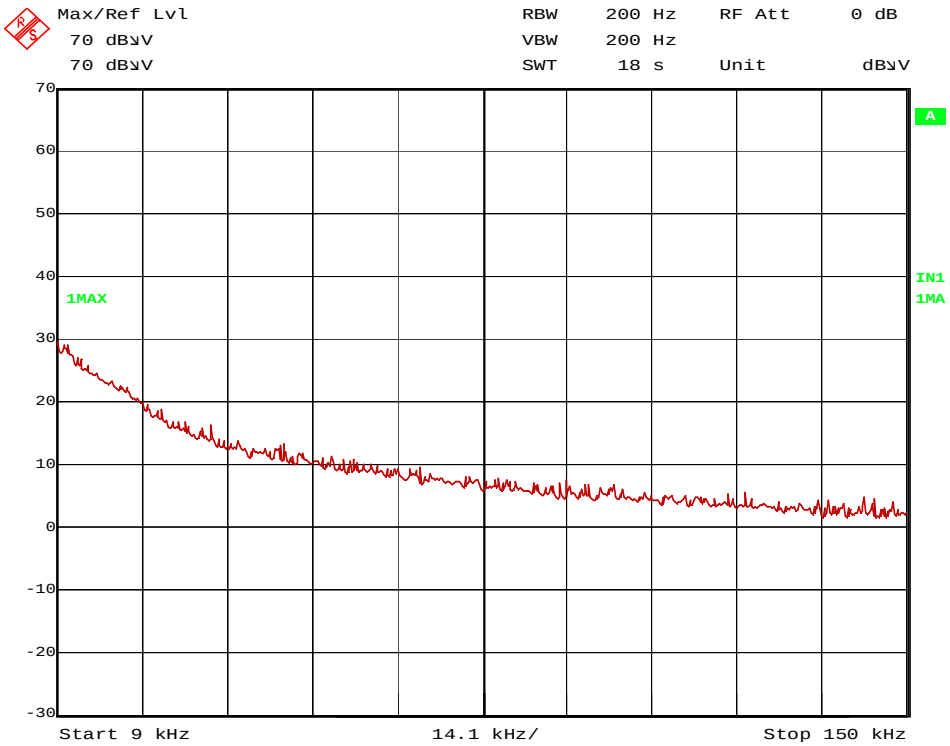
Cable guide: The cable of the EUT is running vertically to the false floor. For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

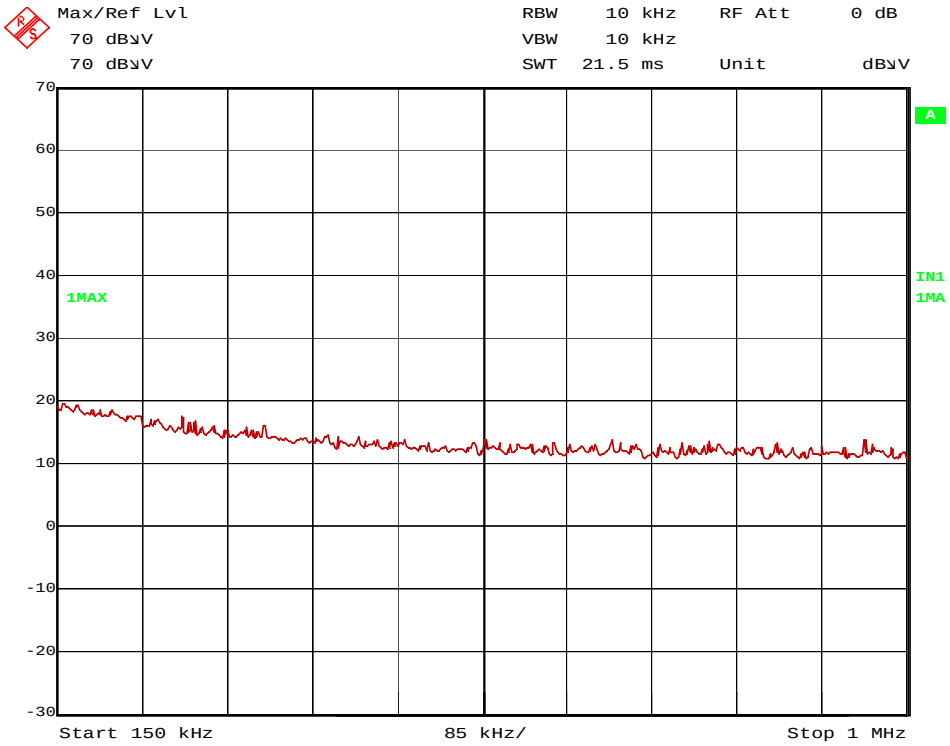
Supply voltage: During all measurements the EUT was supplied with 12.0 V DC.

Remark: No difference was found with each modulation and EUT channel, therefore only one exemplary plot for each frequency range is submitted below.

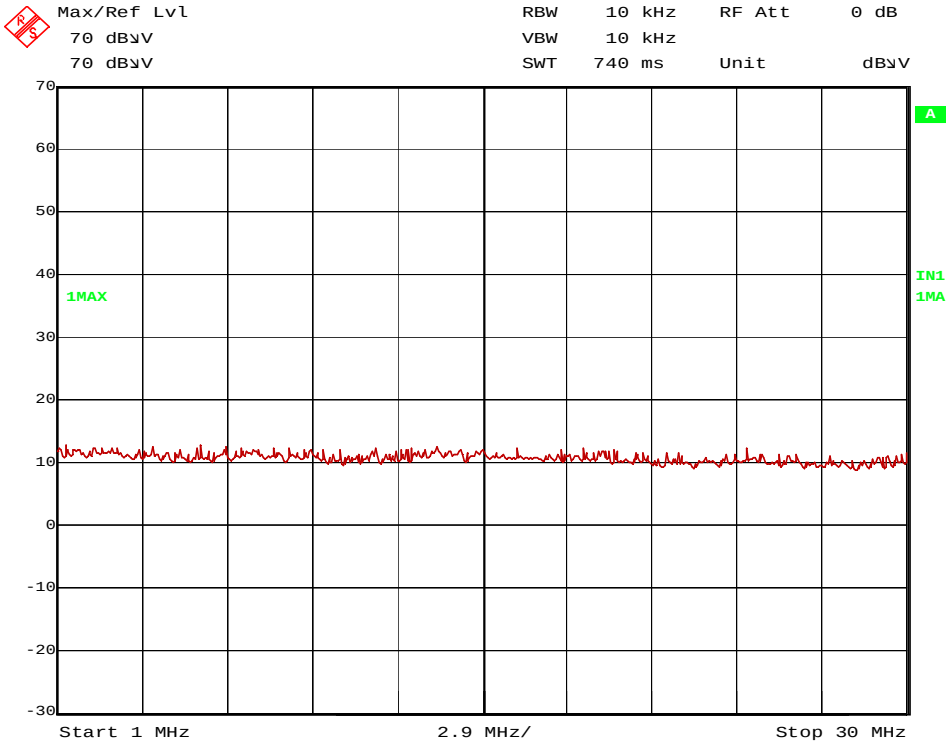
136031_BT_9-150k_mid.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



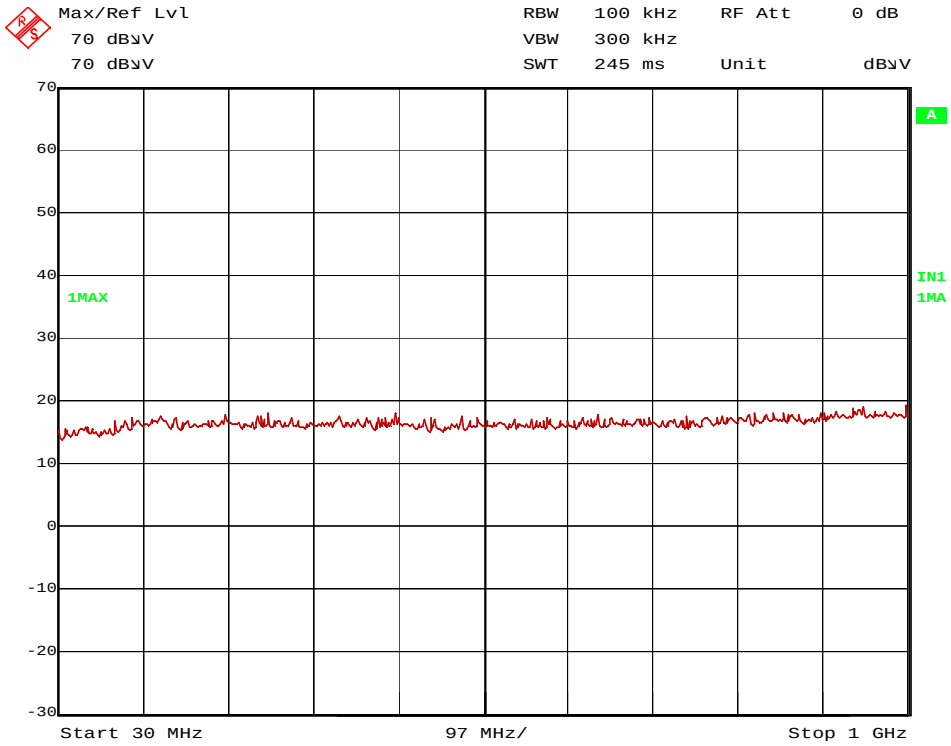
136031_BT_150k-1M_mid.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):



136031_BT_1M-30M_mid.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):



136031_BT_30M-1G_mid.wmf: Spurious emissions from 30 MHz to 1 GHz (operation mode 2):



No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test inside this frequency range, so no final measurements were carried out on the outdoor test site.

TEST EQUIPMENT USED FOR THE TEST:
6, 8 – 12, 19, 25

5.7.2.2 Preliminary radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	38 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: The cable of the EUT is running vertically to the false floor. For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

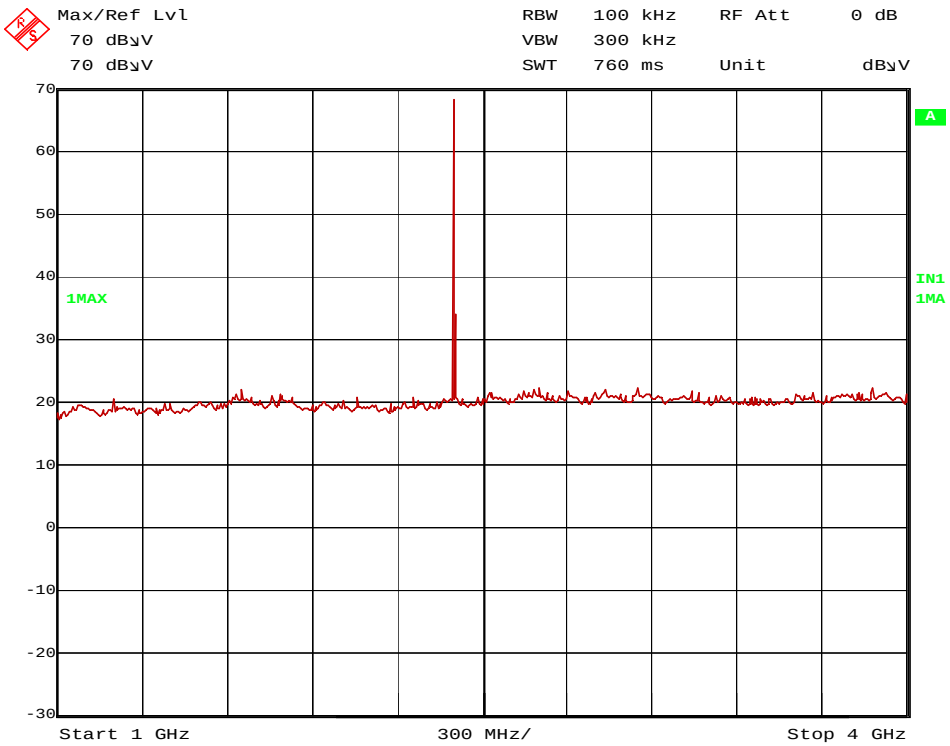
Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 12.0 V DC.

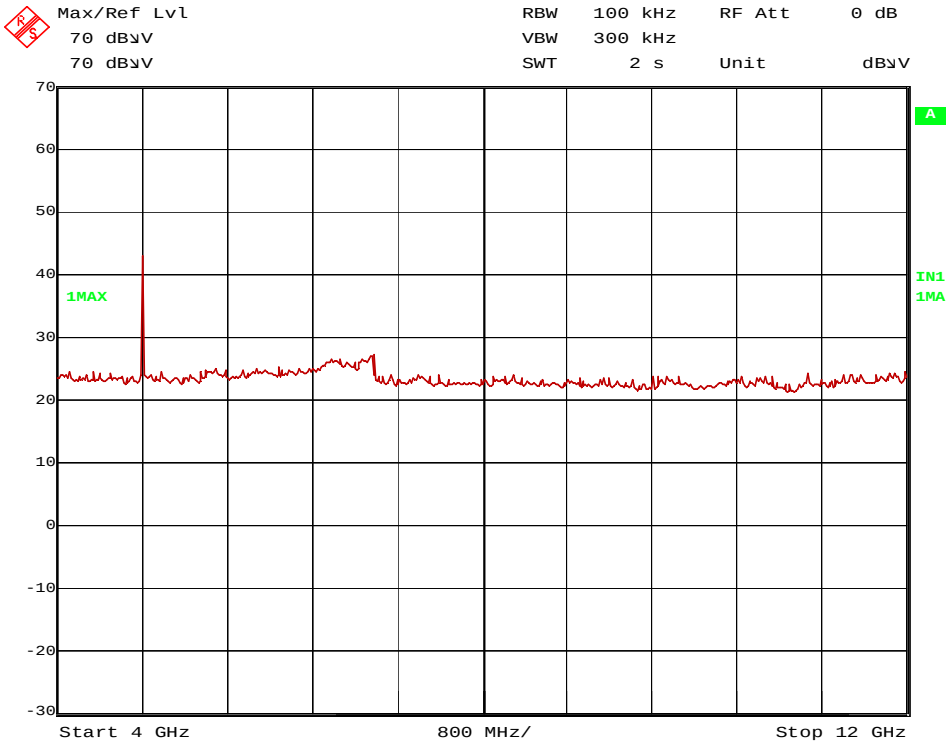
Remark: The worst case modulation for spurious emissions was found to the GFSK modulation with 1 Mbps, therefore only these measurements are submitted below.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

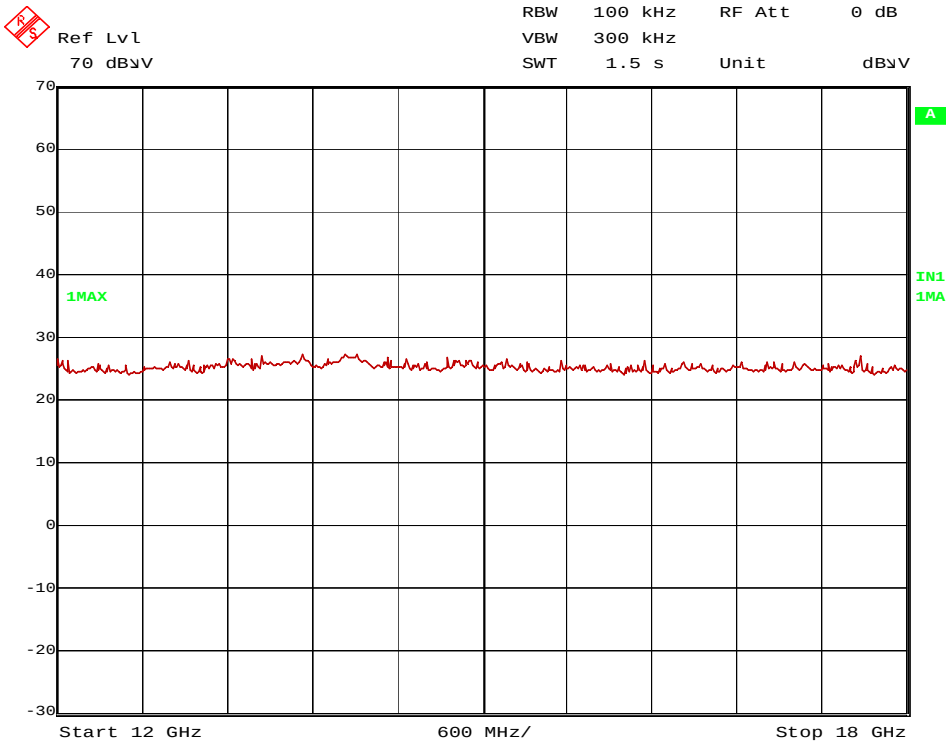
136031_BT_1-4G_Low.wmf: Spurious emissions from 1 GHz to 4 GHz:



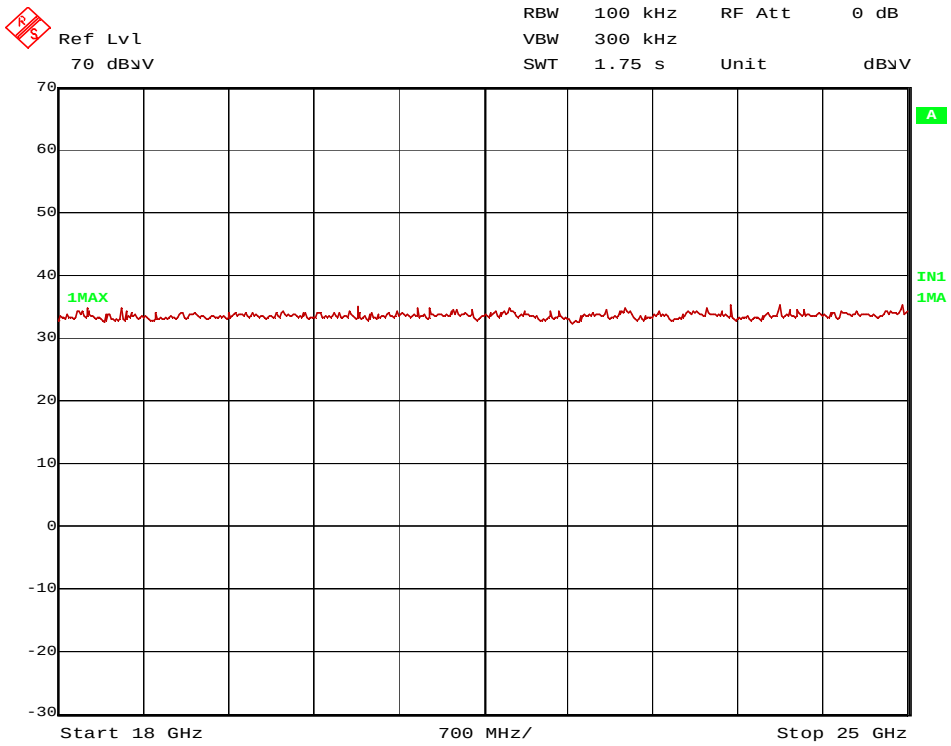
136031_BT_4-12G_Low.wmf: Spurious emissions from 4 GHz to 12 GHz:



136031_BT_12-18G_low.wmf: Spurious emissions from 12 GHz to 18 GHz:



136031_BT_18-25G_low.wmf: Spurious emissions from 18 GHz to 25 GHz:



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 4.804 GHz.

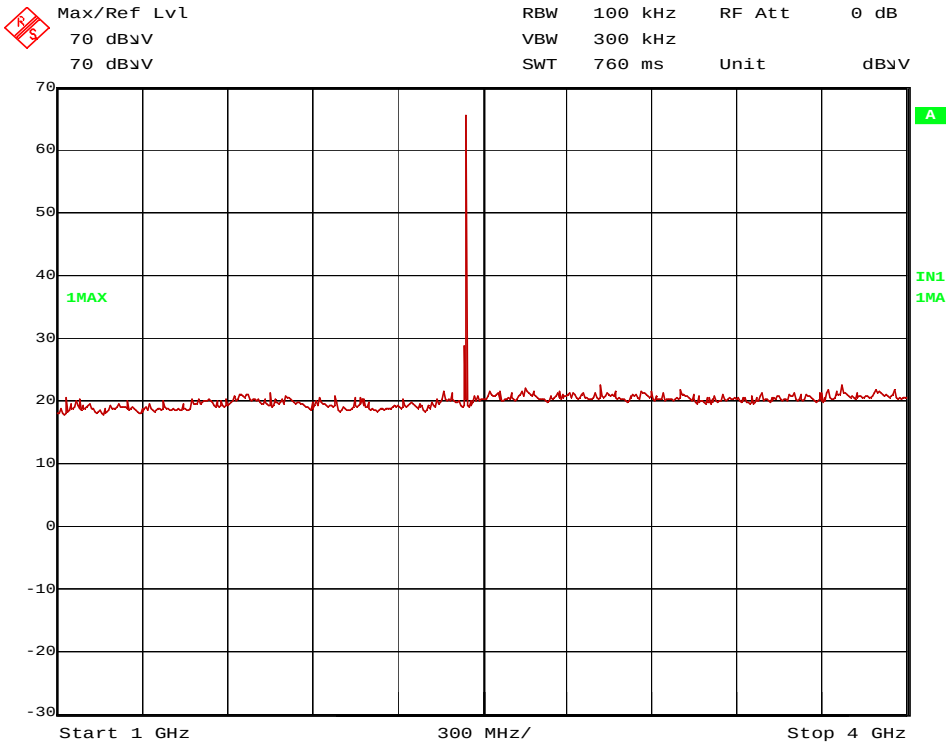
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.402 GHz

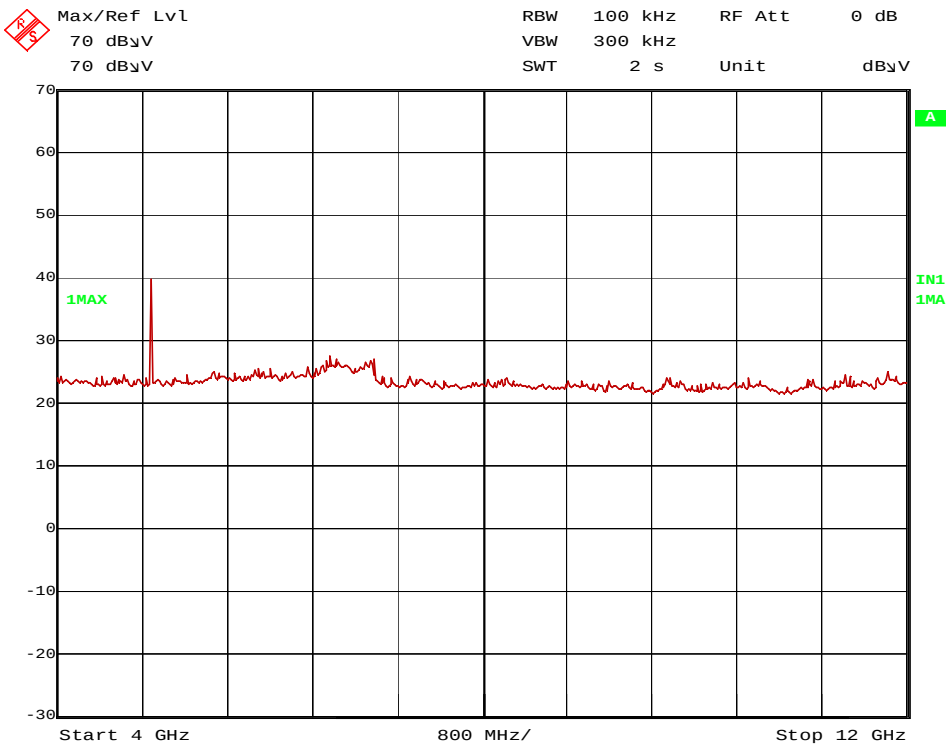
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the middle of the assigned frequency band (operation mode 2)

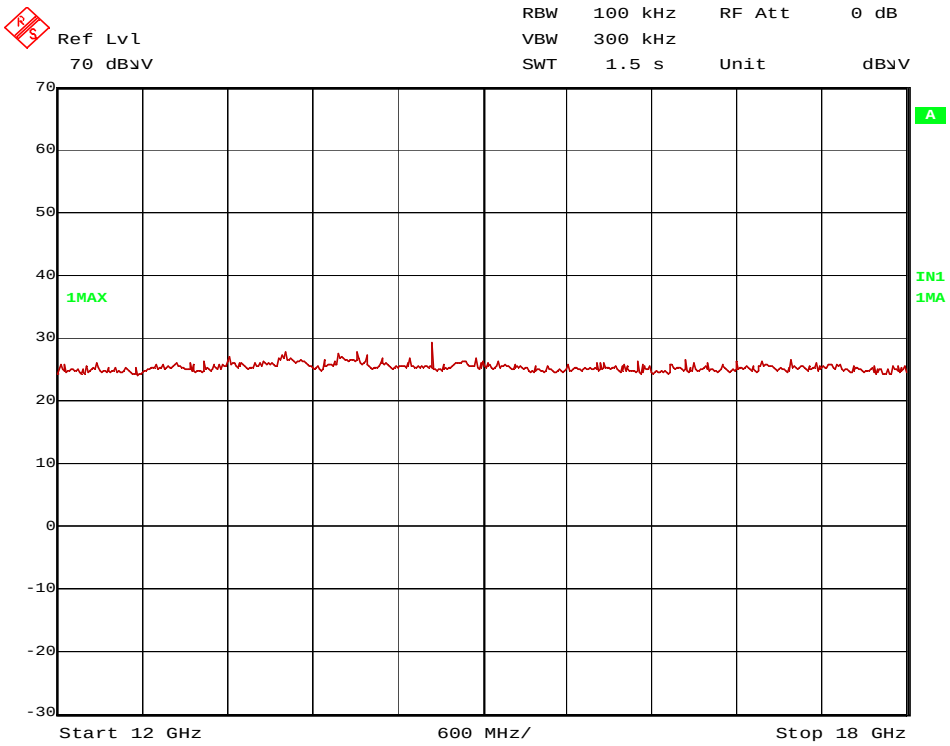
136031_BT_1-4G_Mid.wmf: Spurious emissions from 1 GHz to 4 GHz:



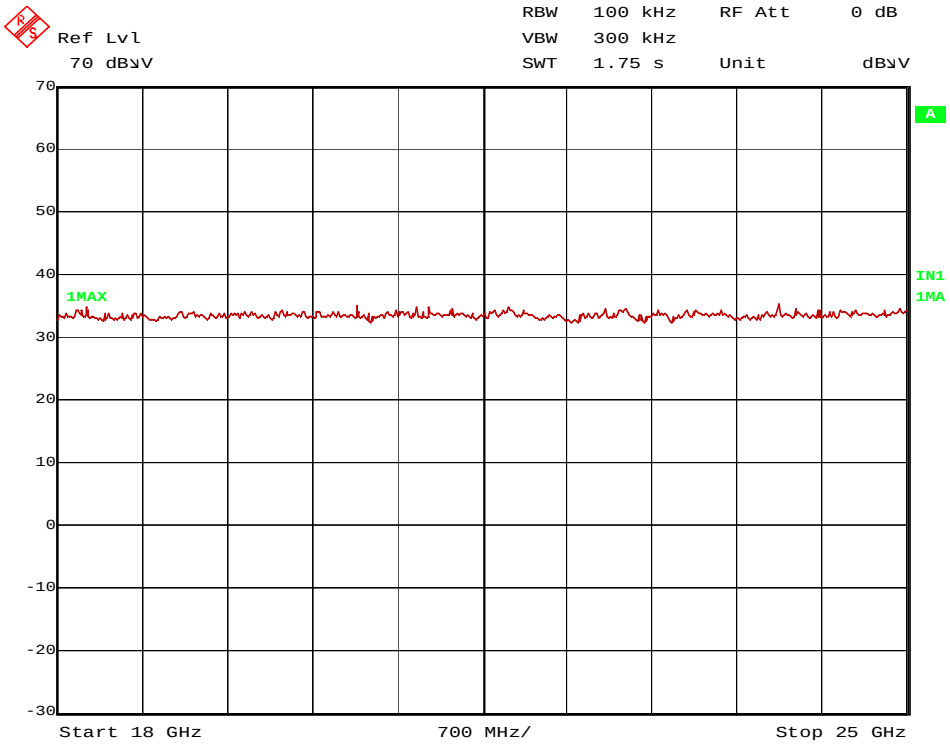
136031_BT_4-12G_Mid.wmf: Spurious emissions from 4 GHz to 12 GHz:



136031_BT_12-18G_mid.wmf: Spurious emissions from 12 GHz to 18 GHz:



136031_BT_18-25G_mid.wmf: Spurious emissions from 18 GHz to 25 GHz:



The following frequency was found inside the restricted bands during the preliminary radiated emission test:

- 4.882 GHz.

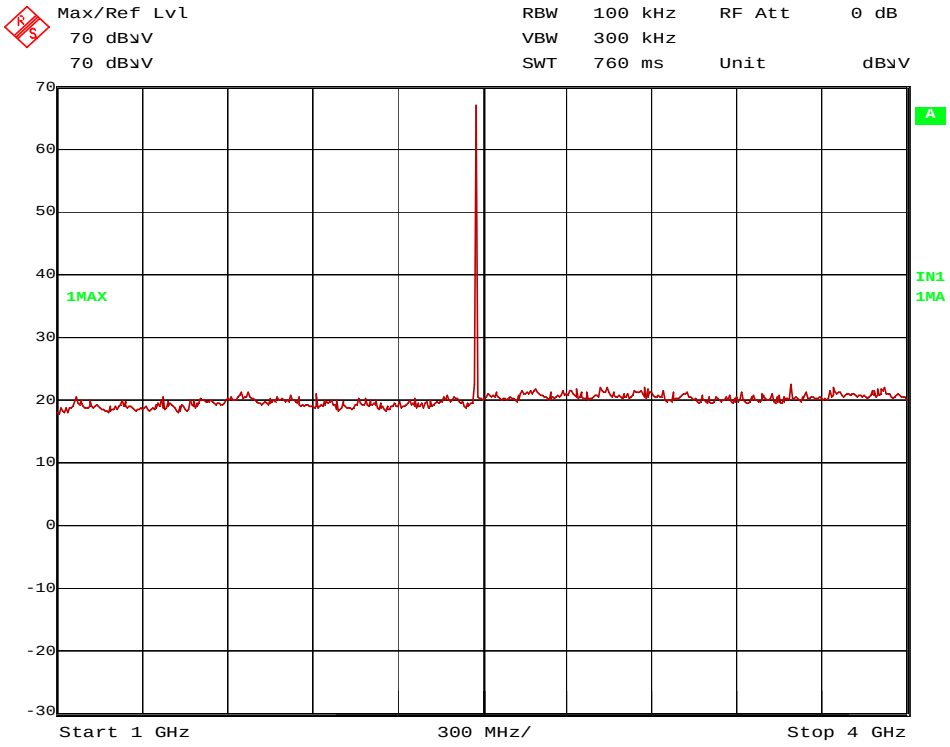
The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 2.441 GHz.

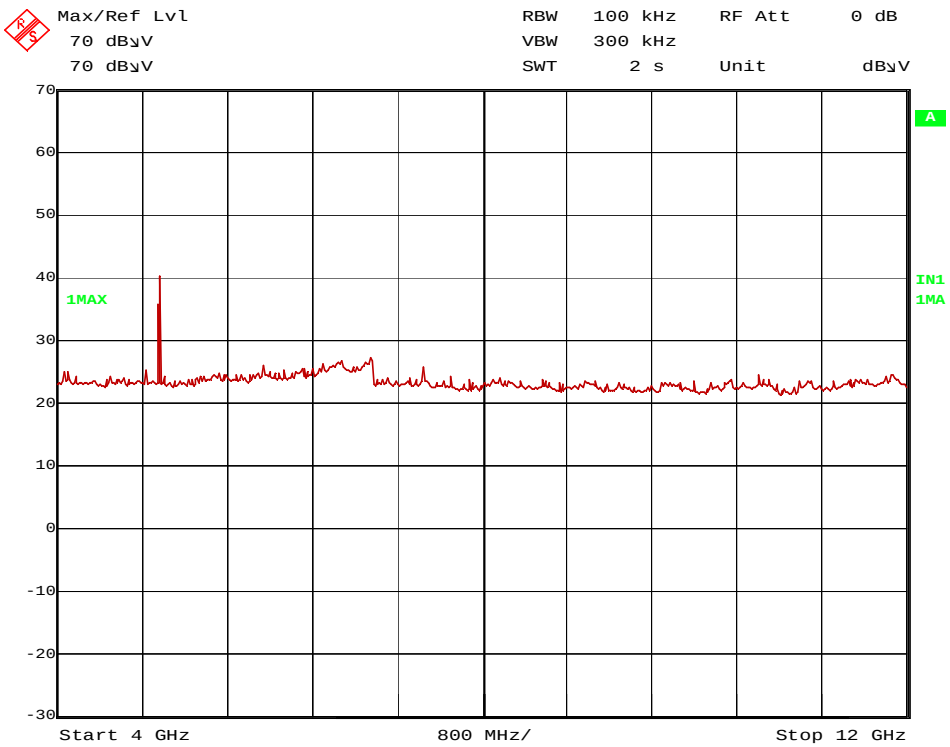
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency (operation mode 3)

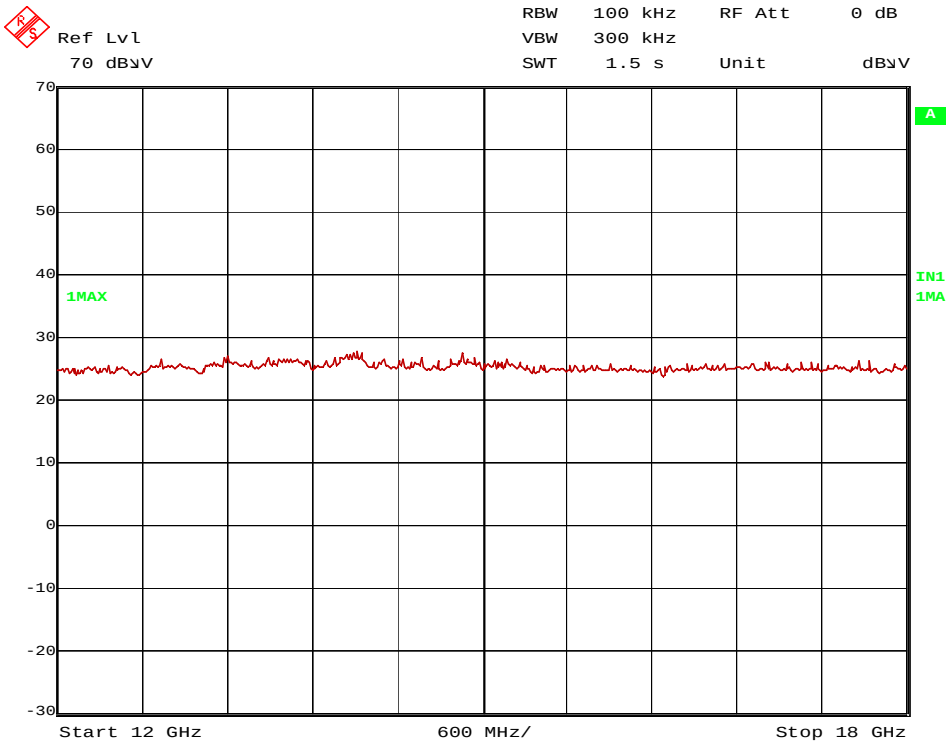
136031_BT_1-4G_High.wmf: Spurious emissions from 1 GHz to 4 GHz:



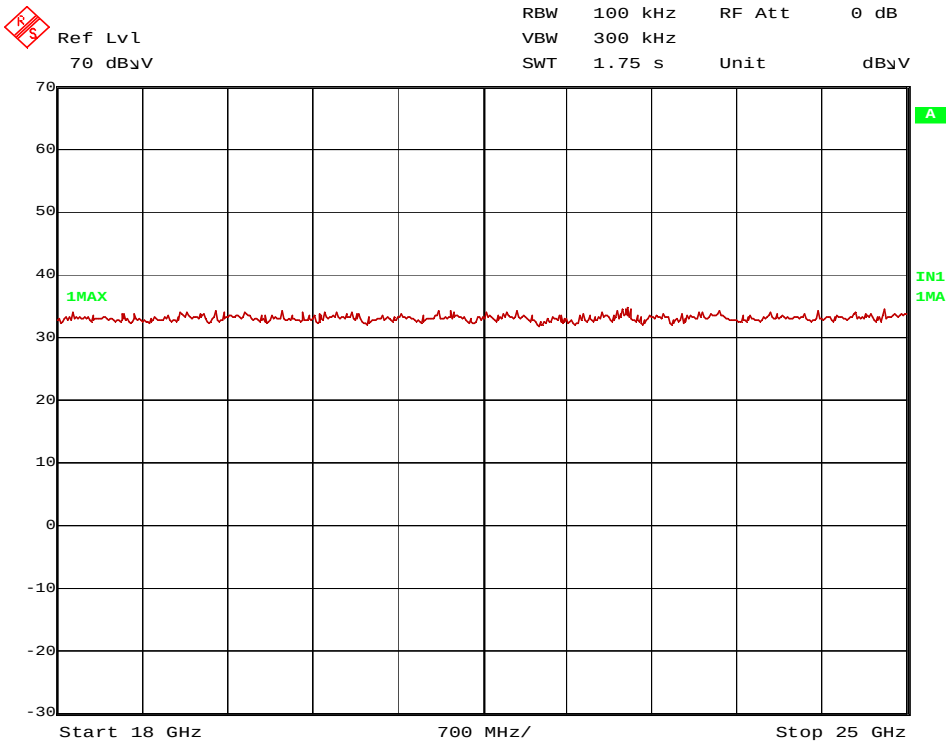
136031_BT_4-12G_High.wmf: Spurious emissions from 4 GHz to 12 GHz:



136031_BT_12-18G_high.wmf: Spurious emissions from 12 GHz to 18 GHz:



136031_BT_18-25G_high.wmf: Spurious emissions from 18 GHz to 25 GHz:



The following frequency was found inside the restricted bands during the preliminary radiated emission test:

- 4.960 GHz.

The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.480 GHz.

These frequencies have to be measured in a final measurement. The results were presented in the following.

6, 8 – 11, 13-15, 17 – 20, 22, 23, 24, 28, 29

5.7.2.3 Final radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	38 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: The cable of the EUT is running vertically to the false floor. For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 12.0 V DC.

Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

Result measured with the peak detector:

Frequency MHz	Emission Level dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2402.0	74.89	-	-	69.35	28.34	26.50	3.70	150	Hor.	-
4804.0	58.82	74.00	15.18	46.55	32.57	25.60	5.30	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency MHz	Emission Level dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2402.0	74.89	-	-	69.35	28.34	26.50	3.70	150	Vert.	-
4804.0	48.16	54.00	5.84	34.79	32.57	25.60	5.30	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the middle of the assigned frequency band (operation mode 2)

Result measured with the peak detector:

Frequency MHz	Emission Level dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height Cm	Pol.	Restr. Band
2441.0	72.58	-	-	66.95	28.43	26.50	3.70	150	Vert.	-
4882.0	56.84	74.00	17.16	44.32	32.82	25.60	5.30	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency MHz	Emission Level dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2441.0	62.26	-	-	56.63	28.43	26.50	3.70	150	Vert.	-
4882.0	45.42	54.00	8.58	31.80	32.82	25.60	5.30	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

Result measured with the peak detector:

Frequency MHz	Emission Level dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2480.0	74.24	-	-	68.39	28.55	26.50	3.80	150	Vert.	-
4960.0	57.84	74.00	16.16	45.25	32.89	25.60	5.30	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency MHz	Emission Level dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2480.0	63.83	-	-	57.98	28.55	26.50	3.80	150	Vert.	-
4960.0	41.91	54.00	12.09	28.22	32.89	25.60	5.30	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:
6, 8 – 11, 13-15, 17 – 19, 22, 23, 24,28, 29

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
3	LISN	NSLK8128	Schwarzbeck	8128155	480058	04/05/2012	05/2014
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
5	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
6	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
7	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	07/15/2013	07/2015
8	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/26/2014	02/2016
9	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
10	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
11	Antenna support	AS615P	Deisel	615/310	480187	-	-
12	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
13	Antenna	3115 A	EMCO	9609-4918	480183	11/09/2011	11/2014
14	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
15	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
16	Standard Gain Horn Antenne 26.4 – 40.1 GHz	22240-20	Flann Microwave	469	480229	Six month verification (system cal.)	
17	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
18	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
19	RF-cable No. 36	Sucoflex 106B	Huber&Suhner	500003/6B / Kabel 36-	481680	Weekly verification (system cal.)	
20	RF-cable 1 m	KPS-1533-400-KPS	Insulated Wire	-	480300	Six month verification (system cal.)	
21	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire		480302	Six month verification (system cal.)	
22	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
23	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	Six month verification (system cal.)	
24	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
25	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/2014	02/2016
26	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	07/2013	07/2015
27	Peak Power Sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	07/2013	07/2015
28	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

29	Single Control Unit	SCU	Maturo GmbH	SCU/006/971107	480831	Calibration not necessary	
30	High-pass Filter	H26G40G1	Microwave Circuits, Inc.	33471	480593	Six month verification (system cal.)	
31	Temperature Test Chamber	MK 240	Binder	05-79022	480462	02/18/2014	08/2015
32	Test fixture	-	PHOENIX TESTLAB GmbH	-	410160	Calibration not necessary	

7 REPORT HISTORY

Report Number	Date	Comment
F136031E2	20 May 2014	Document created

8 LIST OF ANNEXES

ANNEX A TEST SETUP PHOTOGRAPHS 4 pages

136031_15: Test setup - Radiated emission (fully anechoic chamber)
136031_16: Test setup - Radiated emission (fully anechoic chamber)
136031_17: Test setup - Radiated emission (fully anechoic chamber)
136031_18: Test setup - Radiated emission (fully anechoic chamber)

ANNEX B EXTERNAL PHOTOGRAPHS 3 pages

136031_1.jpg: EUT External – 3D Top View
136031_2.jpg: EUT External – 3D Bottom View
136031_3.jpg: EUT Label

ANNEX C INTERNAL PHOTOGRAPHS 4 pages

136031_4.jpg: EUT – Internal - Top View
136031_8.jpg: EUT – Internal - Top View – No Shielding
136031_6.jpg: EUT – Internal – Close-up shielded section
136031_7.jpg: EUT – Internal - Bottom View