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Test Report

Report Number: F132962E1

Applicant:

Robert Bosch Car Multimedia GmbH

Manufacturer:

Robert Bosch Car Multimedia GmbH

Equipment under Test (EUT):

Rotterdam UBT40

Article number: 7 620 000 143

Laboratory (CAB) accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under the Reg. No. D-PL-17186-01-02 ,
FCC Test site registration number 90877.

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 (July 2013)** Radio Frequency Devices

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

[4] **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.

Test engineer:	Manuel BASTERT		10 July 2013
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		10 July 2013
	Name	Signature	Date

RESERVATION

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1 IDENTIFICATION

1.1 Applicant

Name:	Robert Bosch Car Multimedia GmbH
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1.2 Manufacturer

Name:	Robert Bosch Car Multimedia GmbH
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Country:	Germany
Name for contact purposes:	Mr. Tilman ALMSTEDT
Phone:	+49 (0) 5121 49 4226
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Mail address:	Eike-Tilman.Almstedt@de.bosch.com

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

Accredited by DGA Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under the Reg. No. D-PL-17186-01-02, FCC Test site registration number 90877.

1.4 EUT (Equipment Under Test)

Equipment under test: *	Car radio with Bluetooth and USB
Model name: *	Rotterdam UBT40
Brand name: *	Bosch
Article number: *	7 620 000 143
FCC ID: *	YBN-ROTT1324
Serial number: *	905CM0143D0002603
Hardware versions: *	Main PCB: 8 638 501 075 Switch PCB: 8 638 502 550 Connector PCB: 8 638 205
Software version: *	04.01

1.5 Technical data of equipment

Fulfills Bluetooth specification: *	V2.1 (with EDR)					
Antenna type: *	ISM2400 Vertical Embedded Antenna					
Antenna gain: *	3 dBi					
Rated output power: *	0.0 dBm (50 Ω)					
Antenna connector: *	None (SMB connector temporary installed for conducted tests)					
Power supply: *	U_{nom}=	24.0 V_{DC}	U_{min}=	21.6 V_{DC}	U_{max}=	31.2 V_{DC}
Type of modulation: *	FHSS (GFSK, π/4-DQPSK, 8DPSK)					
Operating frequency range:*	2402 MHz to 2480 MHz					
Number of channels: *	79					
Temperature range: *	-20 °C to +55 °C					

*: declared by the applicant

The following external I/O cables were used:

Identification	Connector		Length *
	EUT	Ancillary	
Power supply	Customer defined	-	2 m
-	-	-	-
-	-	-	-

*: Length during the test if no other specified.

Ancillary equipment:

An ALPS Bluetooth evaluation board FX417Z24-2 and an IBM ThinkPad T42 laptop were used to set up the operation modes as described in chapter 2 of this report.

1.6 Dates

Date of receipt of test sample:	03 July 2013
Start of test:	03 July 2013
End of test:	09 July 2013

2 OPERATIONAL STATES

The EUT is a car radio providing Bluetooth functionality to take a telephone call using the Hands Free Profile (HFP). For the tests two modified samples were used. One with the internal antenna and one with a temporary antenna connector installed instead of the internal antenna. At both samples the UART interface of the Bluetooth chip was wired to an external connector.

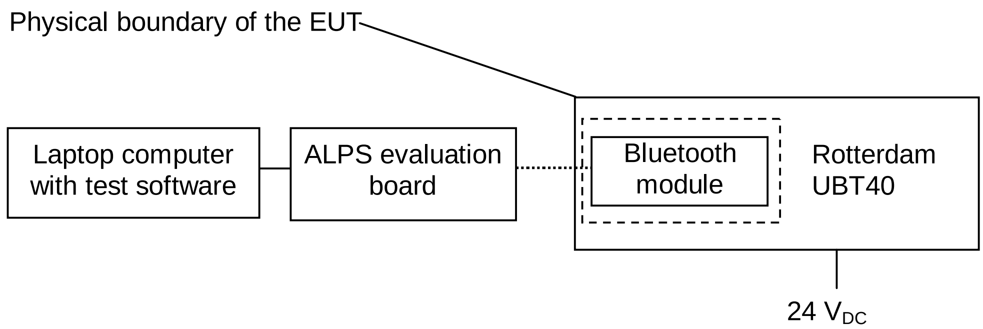
If not otherwise stated, for modulating the transmitter, a pseudo random bit sequence with a length of 339 byte and with a pattern type DH5 was used. During all tests a power setting of 50 was used.

The spurious emission measurement was carried out as radiated spurious emissions with the integrated antenna. During the tests the test sample was powered with 24 V_{DC}.

The operation mode was adjusted with the help of a configuration-software installed on a laptop computer. It was connected to the EUT via ALPS evaluation board to the UART interface of the Bluetooth part. After adjusting the operation mode the ALPS evaluation board and the PC were disconnected from the EUT.

The following operation modes were used during the tests:

Operation mode	Description of the operation mode	Modulation	Data rate / Mbps
1 1a 1b	Continuous transmitting on 2402 MHz	GFSK π/4-DQPSK 8DPSK	1 2 3
2 2a 2b	Continuous transmitting on 2441 MHz	GFSK π/4-DQPSK 8DPSK	1 2 3
3 3a 3b	Continuous transmitting on 2480 MHz	GFSK π/4-DQPSK 8DPSK	1 2 3
4 4a 4b	Transmitter hopping on all channels	GFSK π/4-DQPSK 8DPSK	1 2 3



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 mode 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	1b, 2b, 3b (3 Mbps)
Carrier frequency separation	1, 2, 3 (1 Mbps)
Number of hopping channels	4
Dwell time	2, 2a, 2b (1, 2 and 3 Mbps)
Maximum peak output power	1, 2, 3 (1 Mbps)
Band edge compliance (radiated)	1, 3, 4 (1 Mbps)
Radiated emissions (transmitter)	1, 2, 3 (1 Mbps)
Radiated emissions (receiver)	5

3 ADDITIONAL INFORMATION

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

4 OVERVIEW

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	Status	Refer page
20 dB bandwitdh	General	15.247 (a) (1)	Passed	9 et seq.
Carrier frequency separation	General	15.247 (a) (1)	Passed	12 et seq.
Number of hopping channels	2400.0 - 2483.5	15.247 (a) (1) (iii)	Passed	15 et seq.
Dwell time	2400.0 - 2483.5	15.247 (a) (1) (iii)	Passed	17 et seq.
Maximum peak output power	2400.0 - 2483.5	15.247 (b) (1)	Passed	21 et seq.
Band edge compliance	2400.0 - 2483.5	15.247 (d)	Passed	24 et seq.
Radiated emissions (transmitter)	0.009 - 25,000	15.205 (a) 15.209 (a)	Passed	29 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	Not applicable *	

*: Not applicable because of vehicular environment.

5 TEST RESULTS

5.1 20 dB bandwidth

5.1.1 Method of measurement

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be disabled, the transmitter shall work with its maximum data rate.

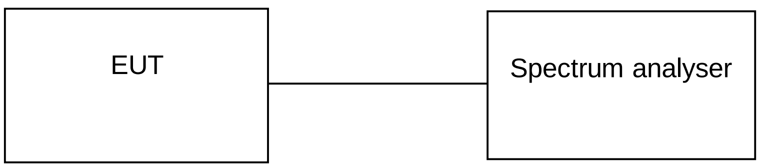
The following spectrum analyser settings shall be used:

- 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.

Test set-up:

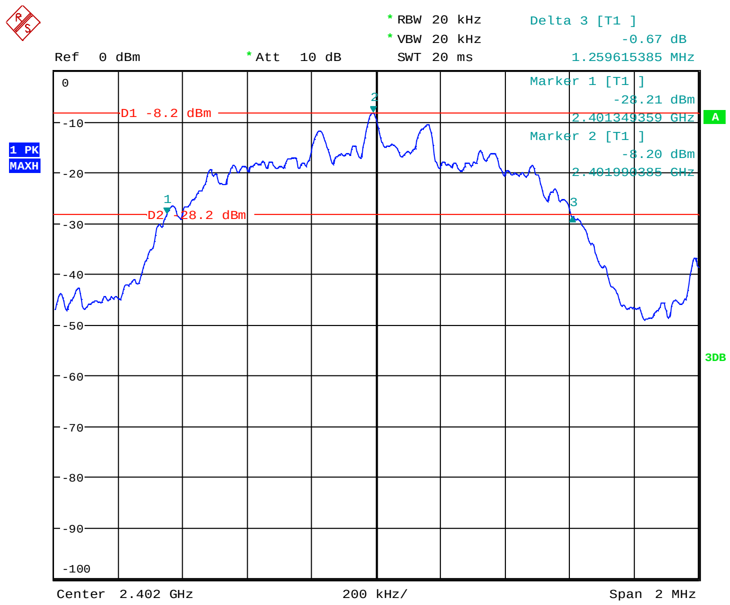


5.1.2 Test results

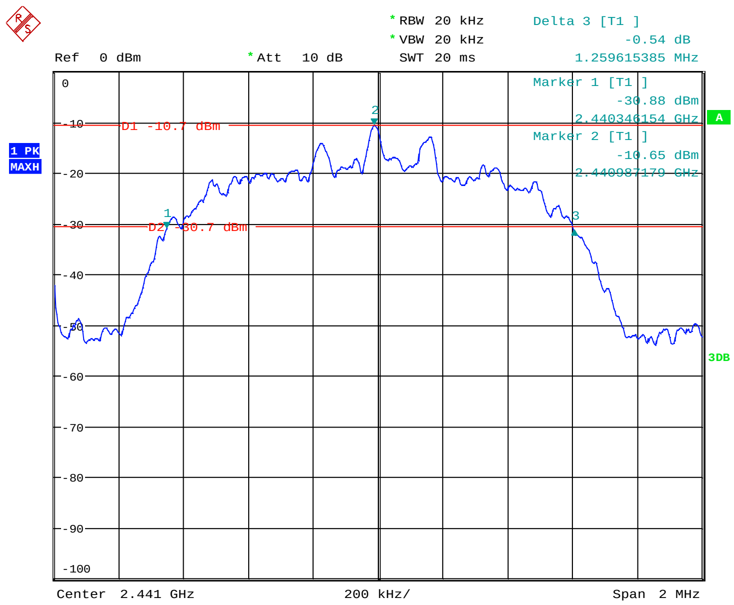
Ambient temperature	23 °C

Relative humidity	60 %

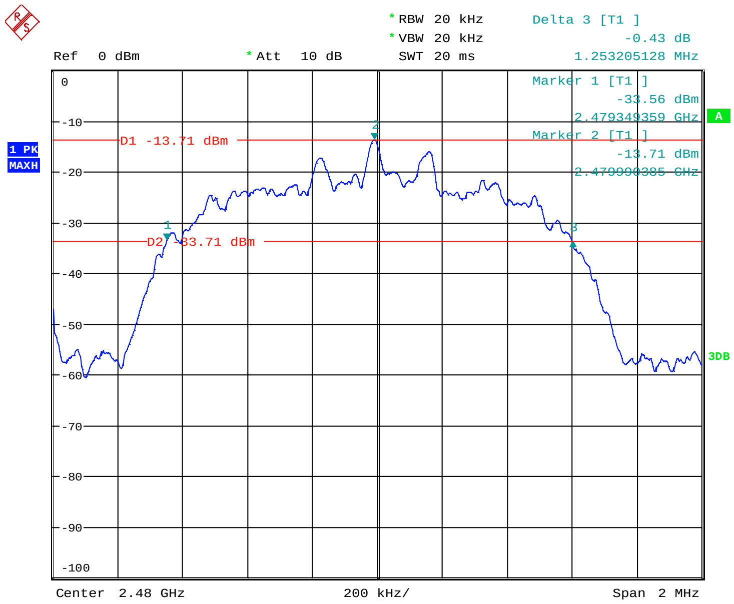
132962_32: 20 dB bandwidth at the lower end of the assigned frequency band:



132962_31: 20 dB bandwidth at the middle of the assigned frequency band:



132962_30: 20 dB bandwidth at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
Operation mode 1, 2, 3 (GFSK)		
0	2402	830.128
39	2441	791.667
78	2480	798.077
Operation mode 1b, 2b, 3b (8DPSK)		
0	2402	1259.615
39	2441	1259.615
78	2480	1253.205
Measurement uncertainty		+0.66 dB / -0.72 dB

TEST EQUIPMENT USED FOR THE TEST:

30

5.2 Carrier frequency separation

5.2.1 Method of measurement

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be enabled.

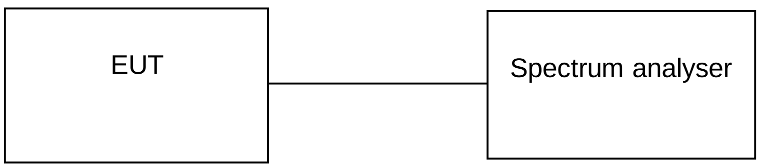
The following spectrum analyser settings shall be used:

- 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.

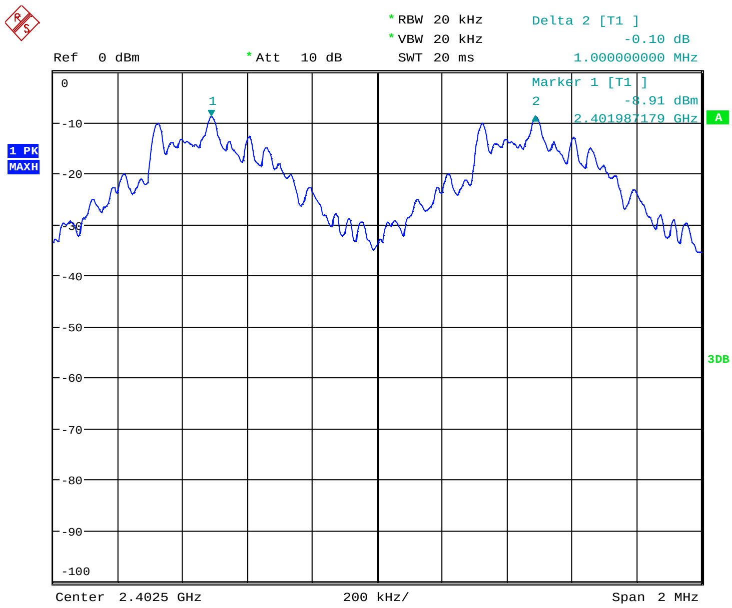
Test set-up:



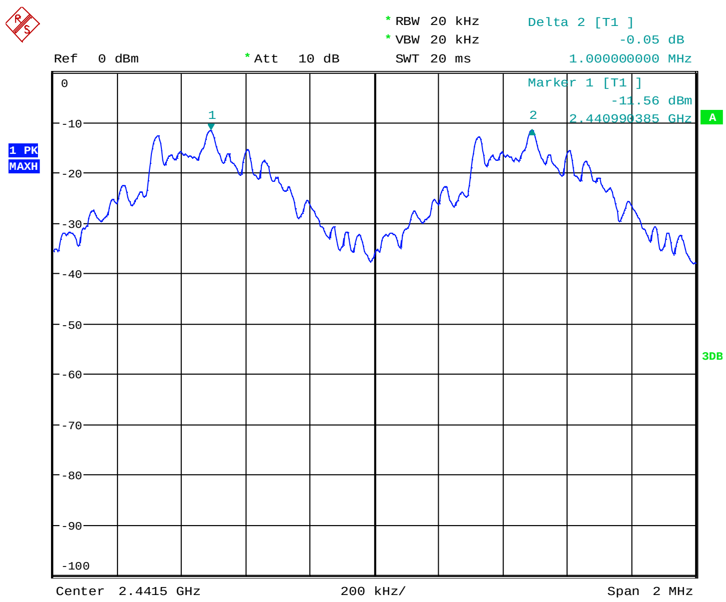
5.2.2 Test results

Ambient temperature	21 °C	Relative humidity	37 %

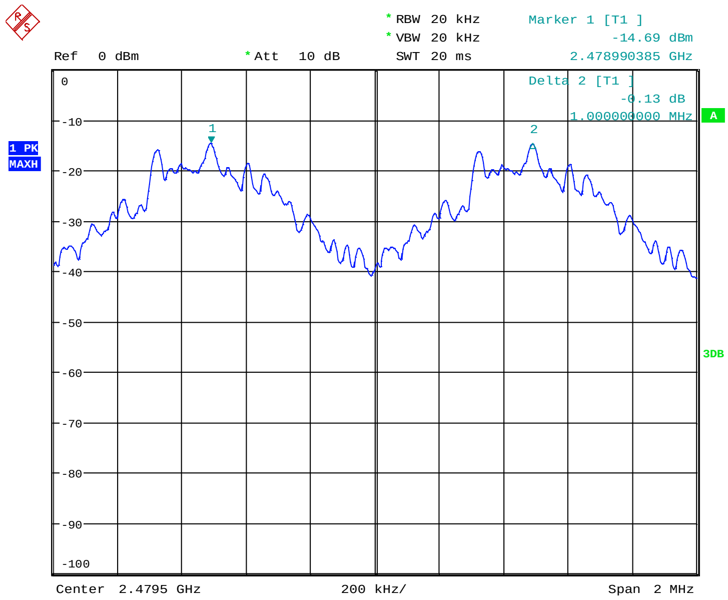
132962_27: Channel separation at the lower end of the assigned frequency band:



132962_28: Channel separation at the middle of the assigned frequency band:



132962_29: 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	1000.000	849.572 ($^2/_3$ of the 20 dB bandwidth)
39	2441	1000.000	841.881 ($^2/_3$ of the 20 dB bandwidth)
78	2480	1000.000	837.607 ($^2/_3$ of the 20 dB bandwidth)
Measurement uncertainty			$<10^{-7}$

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.3 Number of hopping frequencies

5.3.1 Method of measurement

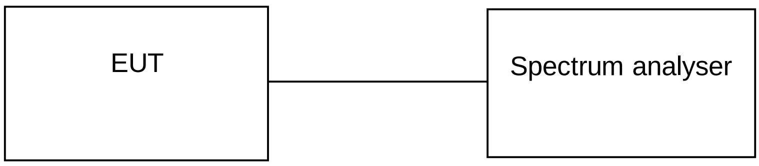
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT 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.

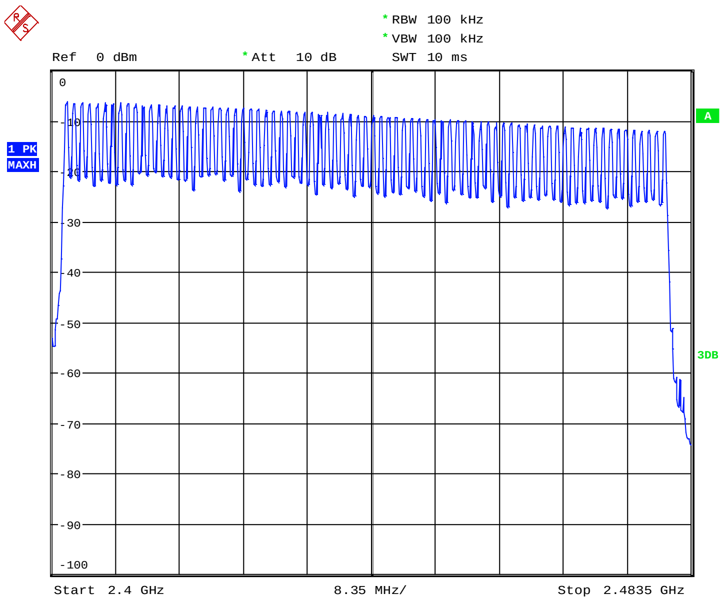
Test set-up:



5.3.2 Test results

Ambient temperature	21 °C		Relative humidity	37 %

132962_20: Number of hopping channels:



Number of hopping channels	Limit
79	At least 15

TEST EQUIPMENT USED FOR THE TEST:

30

5.4 Dwell time

5.4.1 Method of measurement

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be enabled.

The following spectrum analyser settings shall be used:

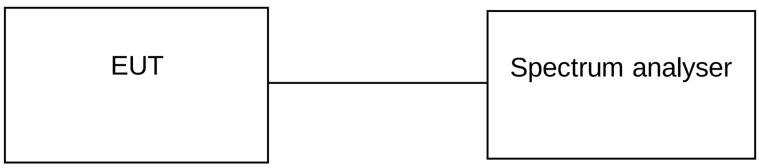
- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel.
- Detector function: peak.
- Trace mode: Max hold.

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.

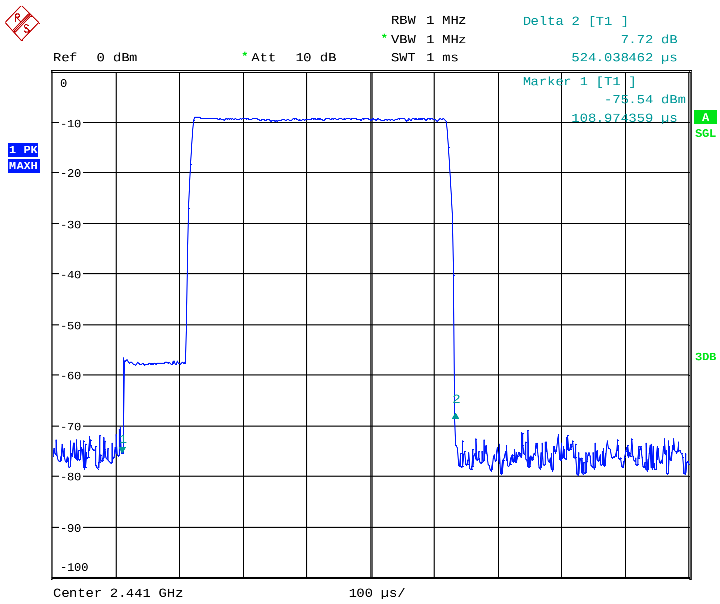
Test set-up:



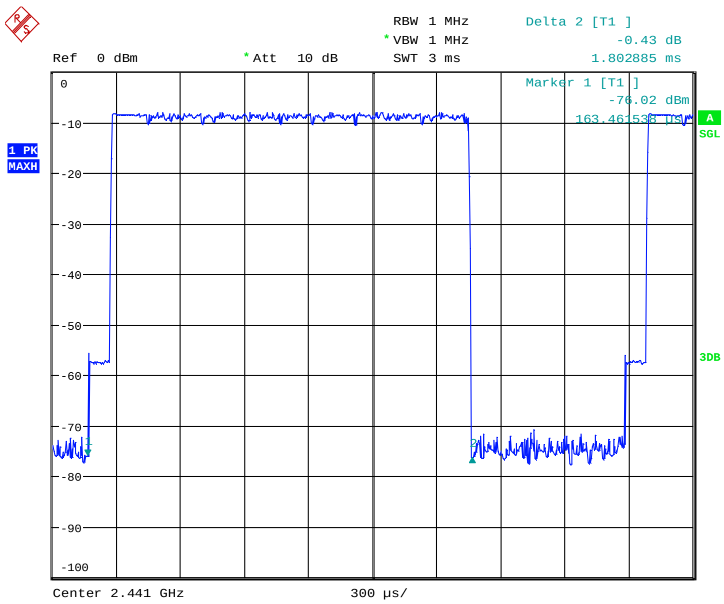
5.4.2 Test results

Ambient temperature	21 °C	Relative humidity	56 %

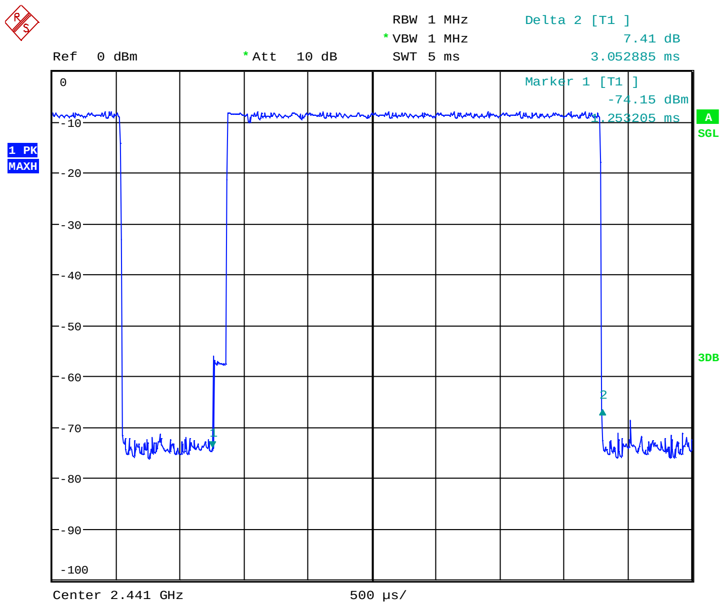
<u>132962_24: Dwell time at the middle of the assigned frequency band (hopping mode DH1):</u>



<u>132962_25: Dwell time at the middle of the assigned frequency band (hopping mode DH3):</u>



132962_26: Dwell time at the middle of the assigned frequency band (hopping mode 3-DH5):



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, 2DH5 and 3DH5) 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).

Hopping mode DH1				
Channel number	Channel frequency [MHz]	t_{pulse} [µs]	Dwell time [ms]	Limit [ms]
39	2441	524.04	167.93	400
Hopping mode DH3				
Channel number	Channel frequency [MHz]	t_{pulse} [µs]	Dwell time [ms]	Limit [ms]
39	2441	1802.89	288.88	400
Hopping mode 3-DH5				
Channel number	Channel frequency [MHz]	t_{pulse} [µs]	Dwell time [ms]	Limit [ms]
39	2441	3052.89	326.52	400
Measurement uncertainty			$<10^{-7}$	

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

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5.5 Maximum peak output power

5.5.1 Method of measurement

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be disabled.

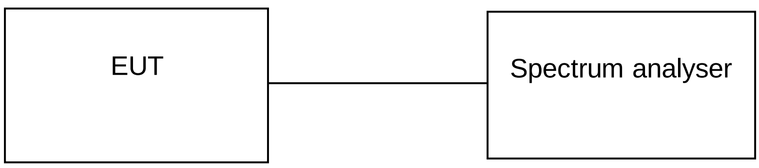
The following spectrum analyser settings shall be used:

- 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.

Test set-up:

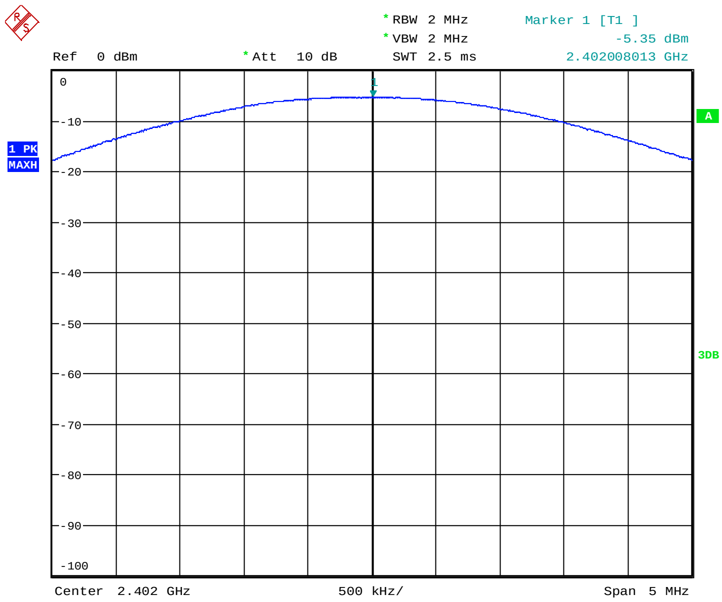


5.5.2 Test results

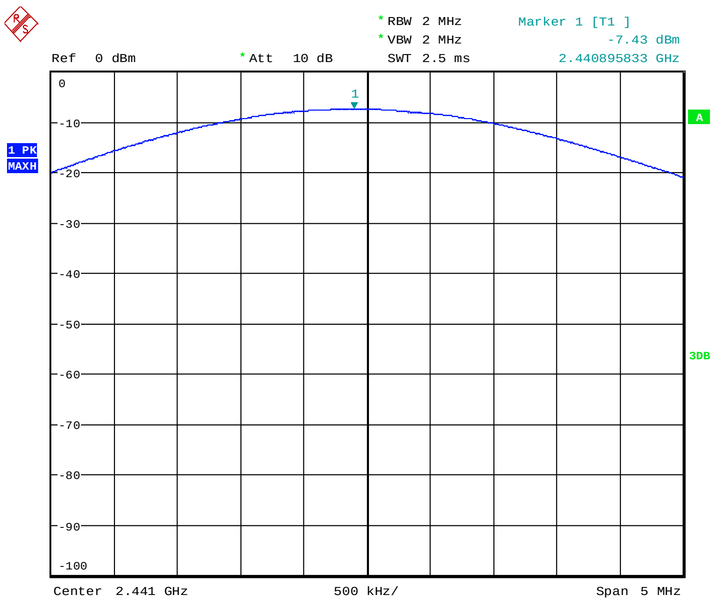
Ambient temperature	21 °C

Relative humidity	57 %

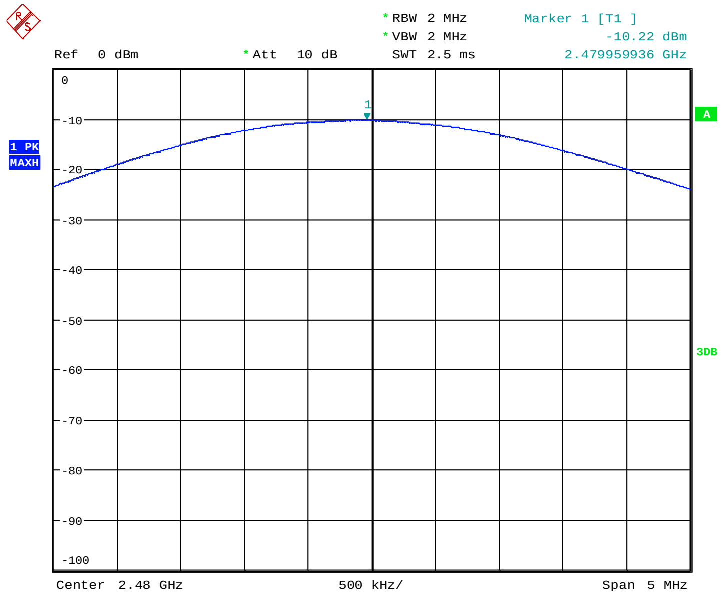
132962_21c: Maximum peak output power at the lower end of the assigned frequency band (operation mode 1b / worst case):



132962_22c: Maximum peak output power at the middle of the assigned frequency band (operation mode 2b / worst case):



132962_23c: Maximum peak output power at the upper end of the assigned frequency band (operation mode 3b / worst case):



Operation mode	Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1 1a 1b	0	2402	-6.3 -5.3 **-5.3**	3.0	30.0
2 2a 2b	39	2441	-9.3 -7.7 **-7.4**	3.0	30.0
3 3a 3b	78	2480	-12.2 -10.4 **-10.2**	3.0	30.0
Measurement uncertainty				+0.66 dB / -0.72 dB	

These values represent the worst case operation mode.

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.6 Band-edge compliance (radiated)

5.6.1 Method of measurement

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.

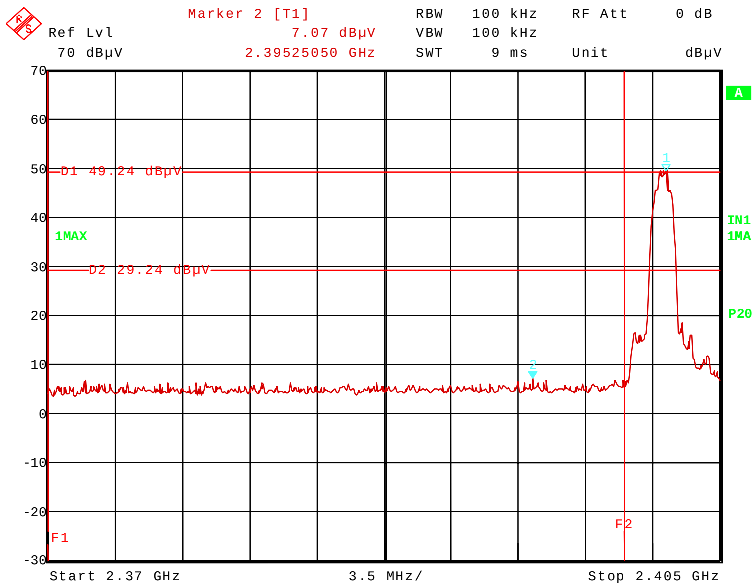
After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 20 dB below the first line (or the peak marker). The frequency line shall be set on the edge of the assigned frequency band. Set the second marker 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.

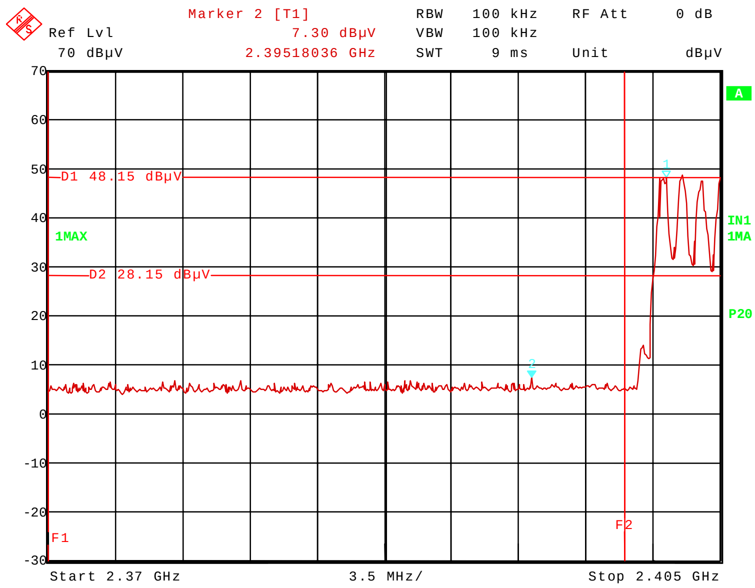
5.6.2 Test results

Ambient temperature	21 °C	Relative humidity	56 %

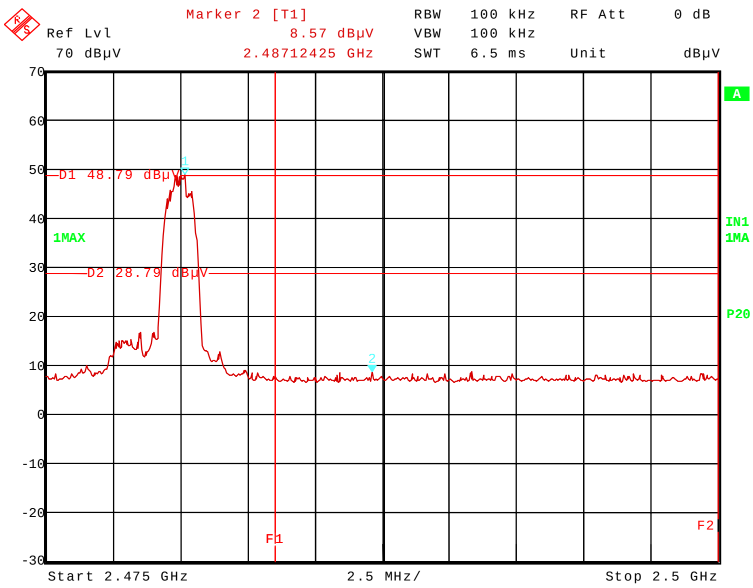
132962_10: Radiated band-edge compliance, lower band edge, hopping off:



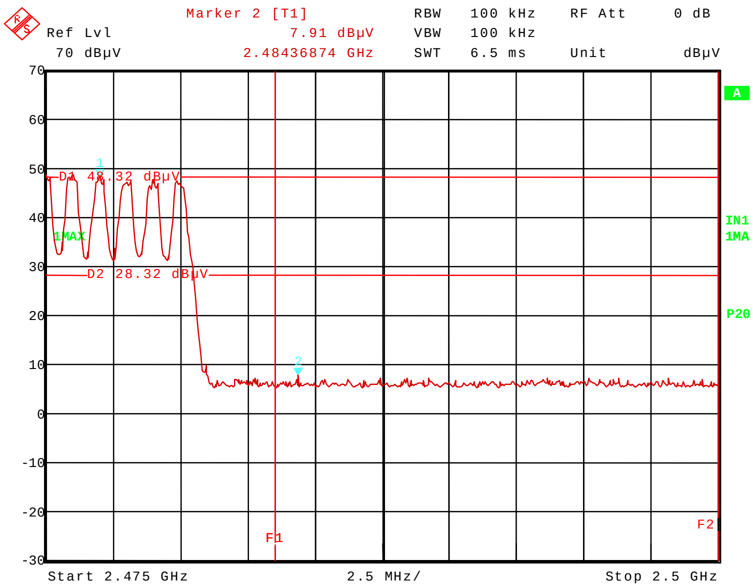
132962_9: Radiated band-edge compliance, lower band edge, hopping on:



132962_7: Radiated band-edge compliance, upper band edge, hopping off:



132962_8: 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.

Band-edge compliance (lower band edge. hopping disabled)										
Result measured with the peak detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	85.90	-	-	53.86	28.34	0.0	3.7	150	Vert.	-
2.3952	53.36	74.0	20.64	21.32	28.34	0.0	3.7	150	Hor.	No
Result measured with the average detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	70.92	-	-	38.88	28.34	0.0	3.7	150	Vert.	-
2.3952	40.02	54.0	13.98	7.98	28.34	0.0	3.7	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Band-edge compliance (lower band edge. hopping enabled)										
Result measured with the peak detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	85.90	-	-	53.86	28.34	0.0	3.7	150	Vert.	-
2.3952	53.36	74.00	20.64	21.32	28.34	0.0	3.7	150	Hor.	No
Result measured with the average detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	70.92	-	-	38.88	28.34	0.0	3.7	150	Vert.	-
2.3952	40.02	54.0	13.98	7.98	28.34	0.0	3.7	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Band-edge compliance (upper band edge. hopping disabled)										
Result measured with the peak detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	83.0	-	-	50.7	28.5	0.0	3.8	150	Vert.	-
2.4871	53.5	74.0	20.5	21.2	28.5	0.0	3.8	150	Vert.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	67.9	-	-	35.6	28.5	0.0	3.8	150	Vert.	-
2.4871	40.0	54.0	14.0	7.7	28.5	0.0	3.8	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Band-edge compliance (upper band edge. hopping enabled)										
Result measured with the peak detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	81.53	-	-	49.18	28.55	0.0	3.8	150	Vert.	-
2.4844	53.06	74.00	20.94	20.71	28.55	0.0	3.8	150	Vert.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	42.36	-	-	10.01	28.55	0.0	3.8	150	Vert.	-
2.4844	40.12	54.00	13.88	7.77	28.55	0.0	3.8	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:
29, 31 – 34, 36, 44

5.7 Radiated emissions

5.7.1 Method of measurement

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.

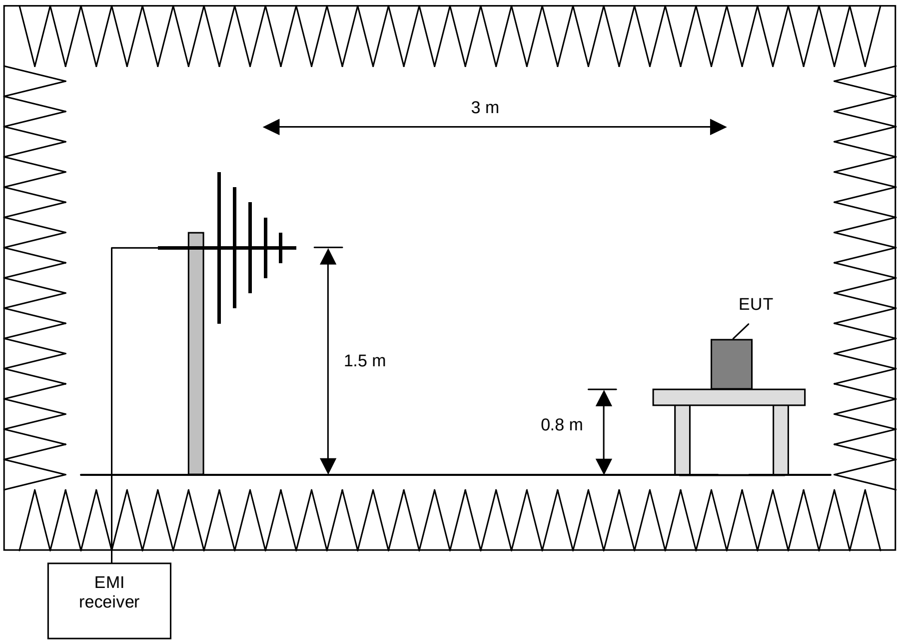
Preliminary measurement (30 MHz to 1 GHz)

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 setup 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:

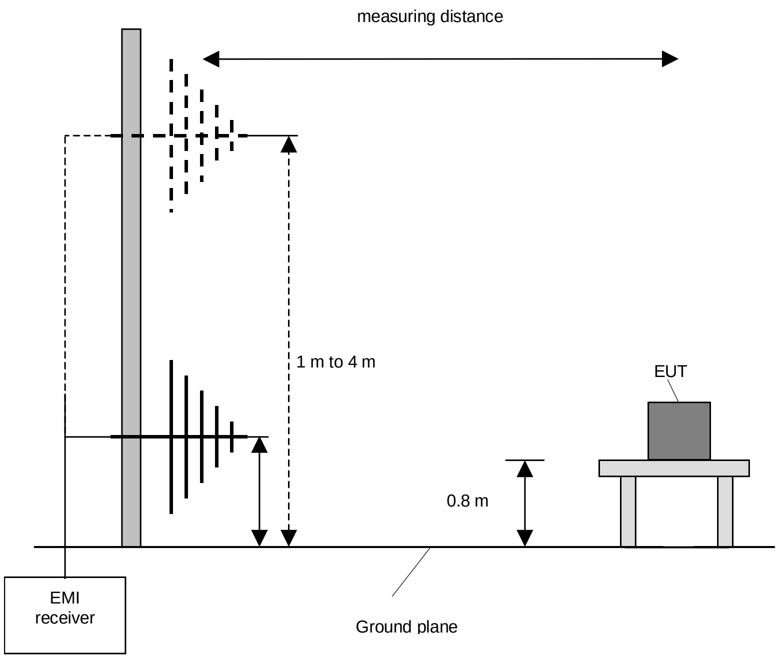
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the 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)

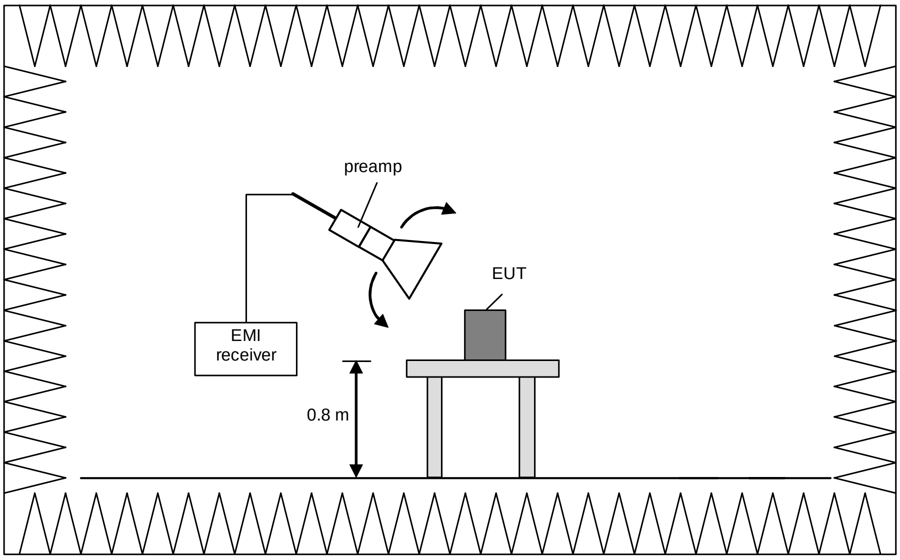
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance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

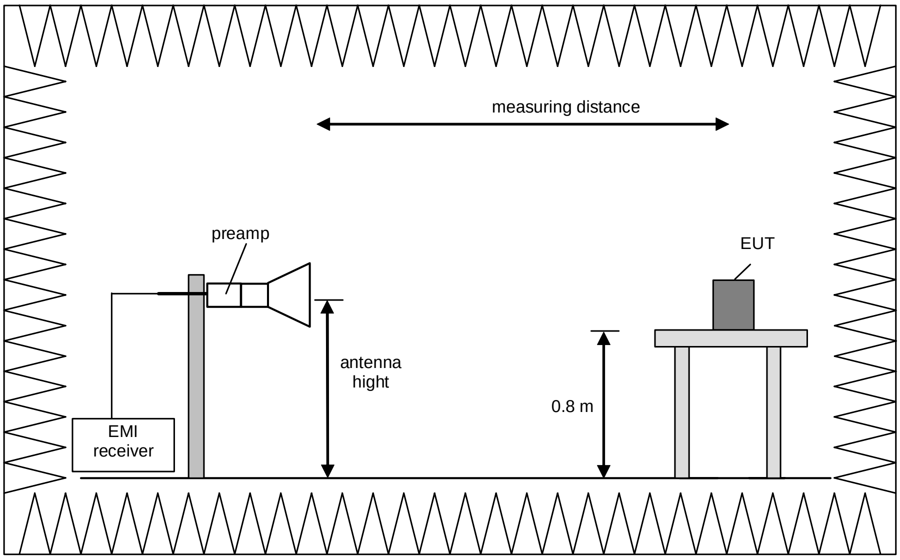


Final measurement (1 GHz to 110 GHz)

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.

5.7.2 Test results

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

Ambient temperature	21 °C	Relative humidity	59 %

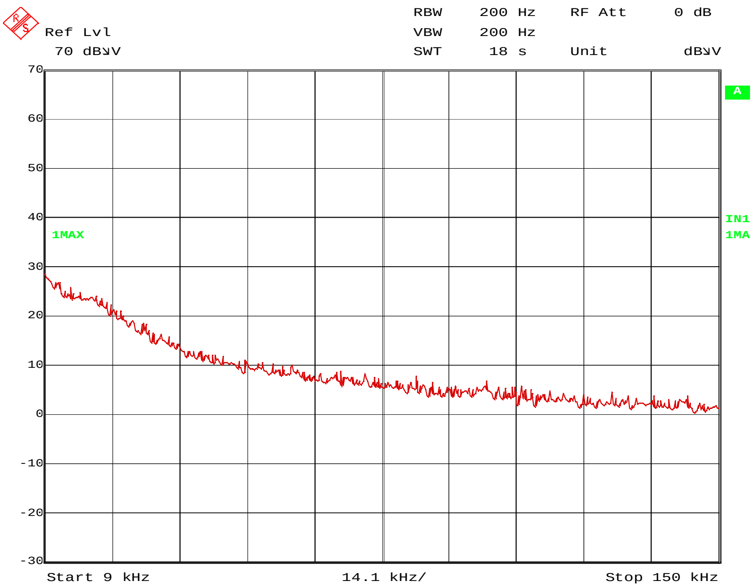
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

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.

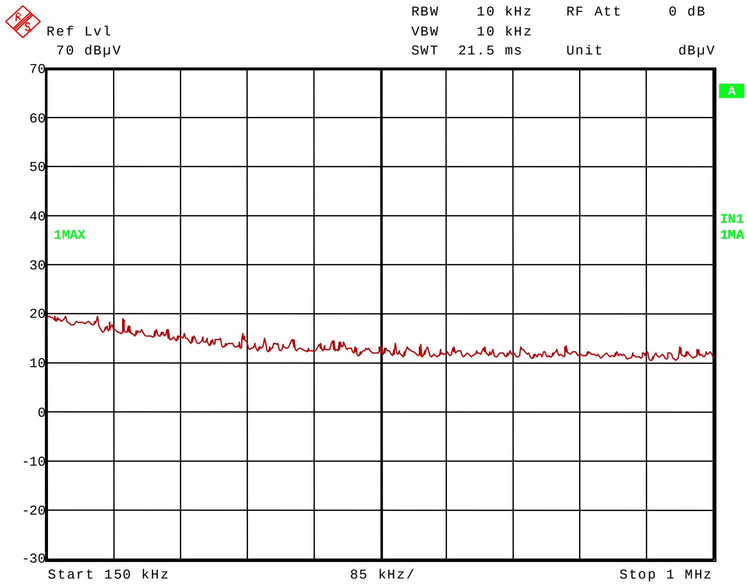
Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24.0 V_{DC}.

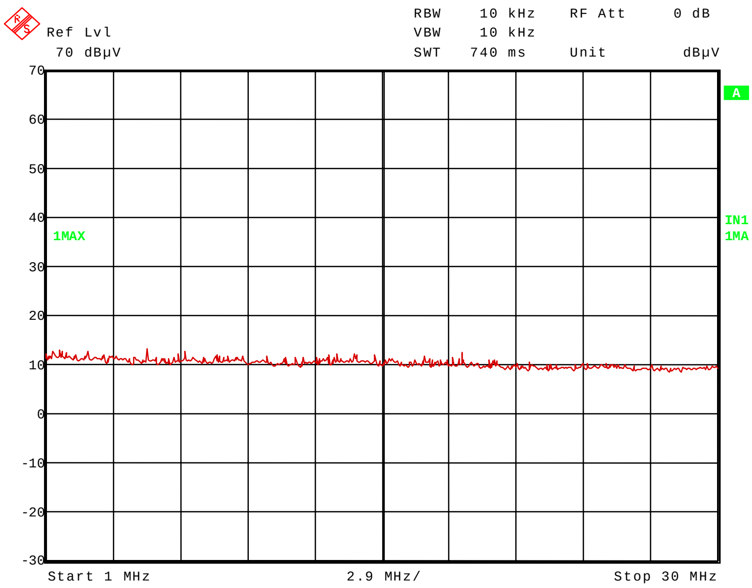
132962_17: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



132962_18: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):



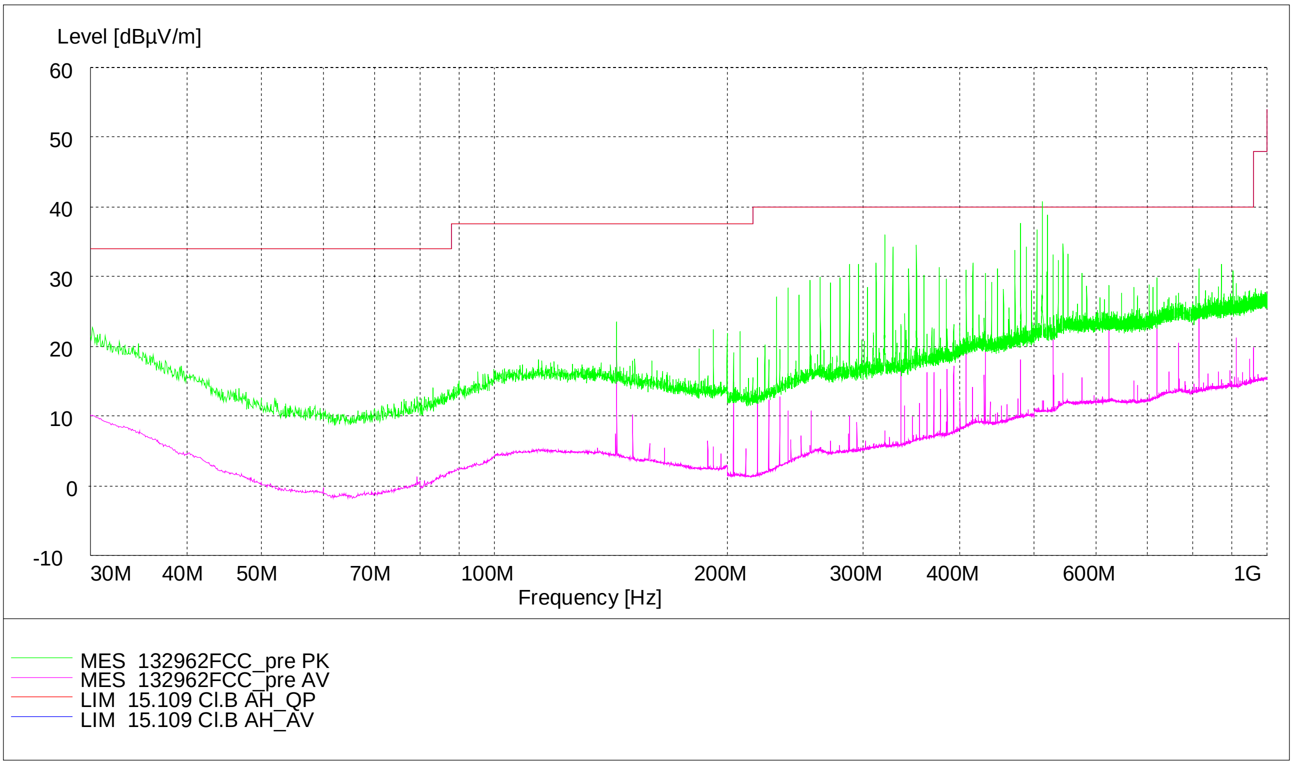
132962_19: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):



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

TEST EQUIPMENT USED FOR THE TEST:
29, 31 – 35, 43, 55

Spurious emissions from 30 MHz to 1000 MHz (operation mode 2):



The following frequencies were found during the preliminary measurement and have to be measured on the open area test site. The result is presented in the following.

144.000 MHz
320.000 MHz
432.000 MHz
479.000 MHz
511.980 MHz
528.000 MHz

5.7.2.2 Final radiated emission test (30 MHz to 1 GHz)

Ambient temperature	21 °C		Relative humidity	59 %

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.

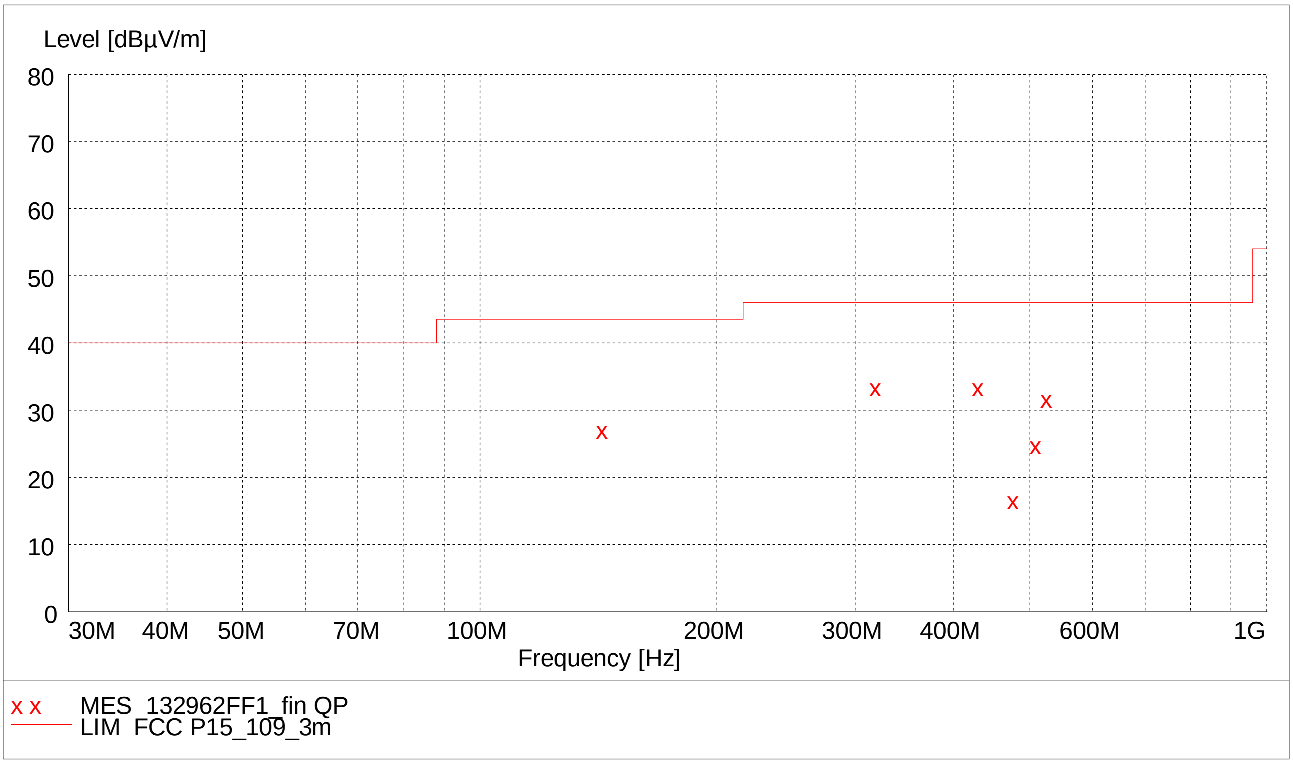
Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24.0 V_{DC}.

Test results: The test results were calculated with the following formula:

Result [dBµV/m] = reading [dBµV] + cable loss [dB] + antenna factor [dB/m]

The measured points and the limit line in the following diagram refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with an x are the measured results of the standard final measurement on the open area test site.



The results of the standard subsequent measurement on the open area test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

The measurement time with the quasi-peak measuring detector is 1 second.

Result measured with the quasi-peak detector (marked in the diagram by an x):

Spurious emissions outside restricted bands									
Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.
144.000	27.3	46.0	18.7	14.2	11.8	1.3	213	83	Vert.
320.000	33.7	46.0	12.3	18.4	13.4	1.9	101	167	Vert.
432.000	33.7	46.0	12.3	15.1	16.3	2.3	204	135	Vert.
479.000	16.9	46.0	29.1	-2.5	17.0	2.4	380	46	Hor.
511.980	25.0	46.0	21.0	4.9	17.6	2.5	353	91	Hor.
528.000	32.0	46.0	14.0	11.5	17.9	2.6	155	109	Vert.
Spurious emissions inside restricted bands									
Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.
-	-	-	-	-	-	-	-	-	-
Measurement uncertainty				+2.2 dB / -3.6 dB					

The test results were calculated with the following formula:

Result [dBµV/m] = reading [dBµV] + cable loss [dB] + antenna factor [dB/m]

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

14 – 20

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

Ambient temperature	21 °C	Relative humidity	59 %

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.

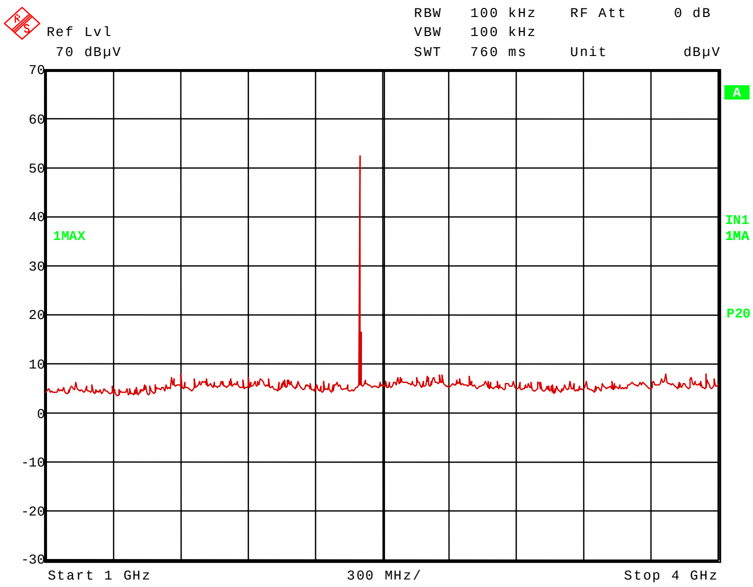
Cable guide: The cable of the EUT is running vertically to the false floor. For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

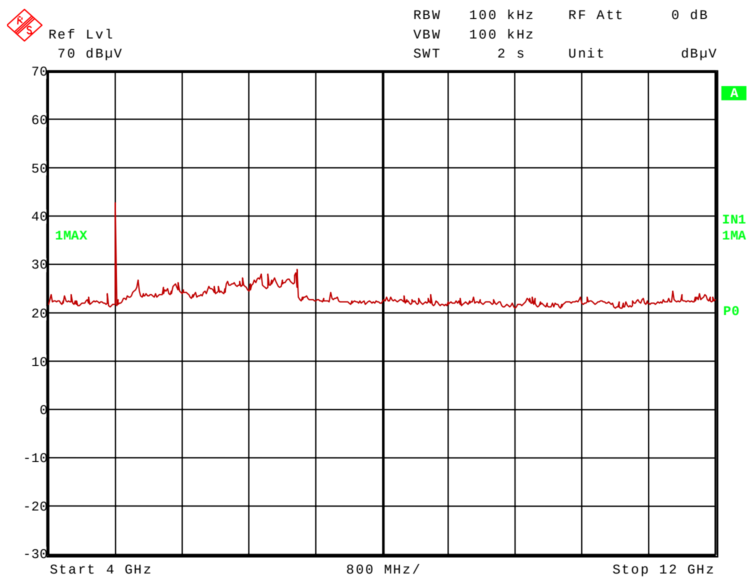
Supply voltage: During all measurements the EUT was supplied with 24.0 V_{DC}.

<u>Transmitter operates at 2.402 GHz (operation mode 1)</u>

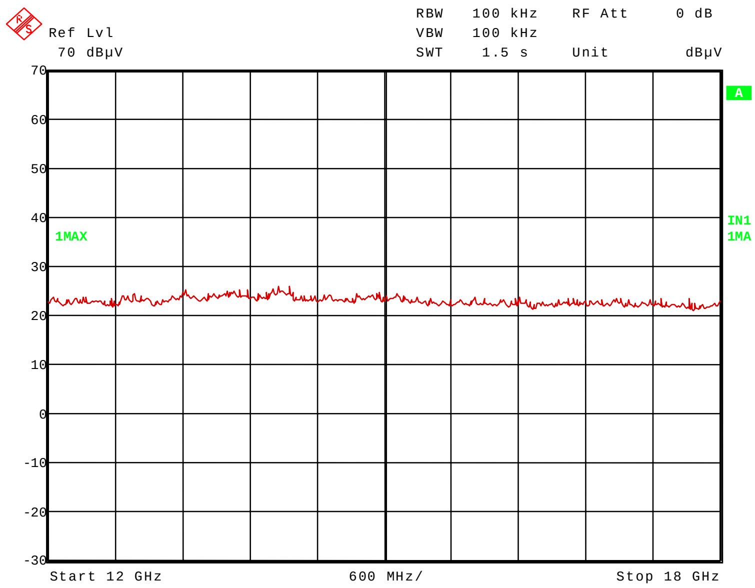
<u>132962_1: Spurious emissions from 1 GHz to 4 GHz:</u>



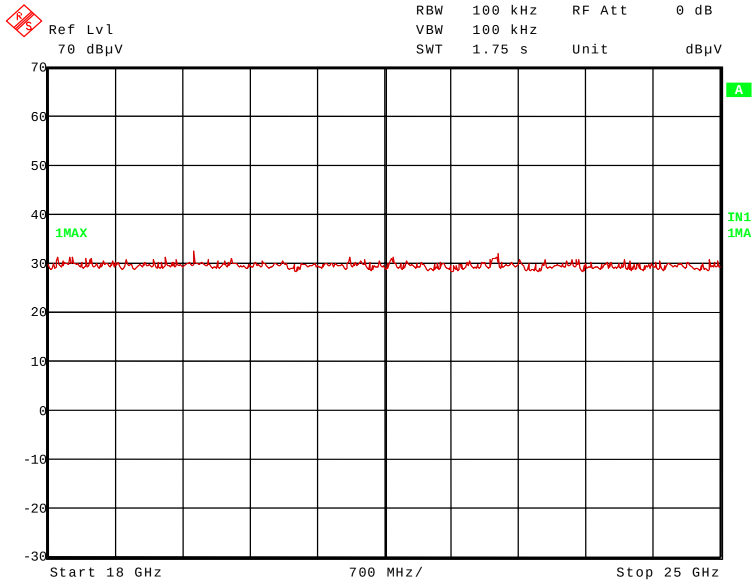
132962_2: Spurious emissions from 4 GHz to 12 GHz:



132962_11: Spurious emissions from 12 GHz to 18 GHz:



132962_12: Spurious emissions from 18 GHz to 25 GHz:



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

- 4.804 GHz.

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

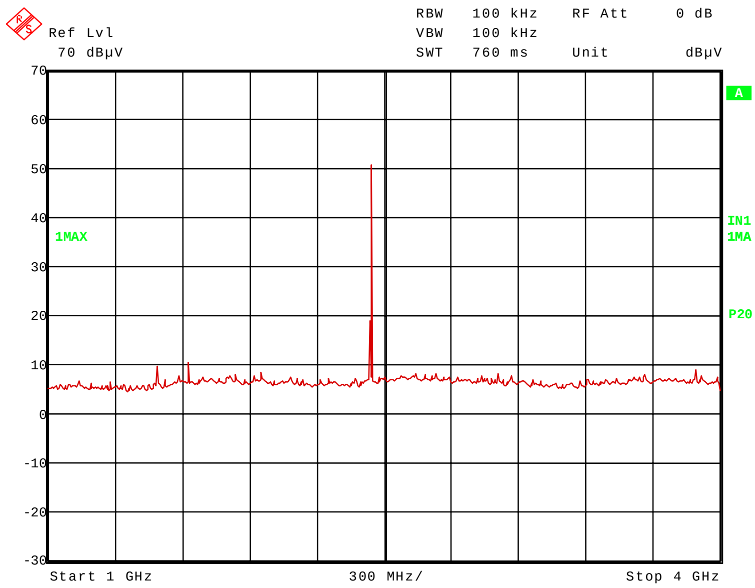
- 2.402 GHz.

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

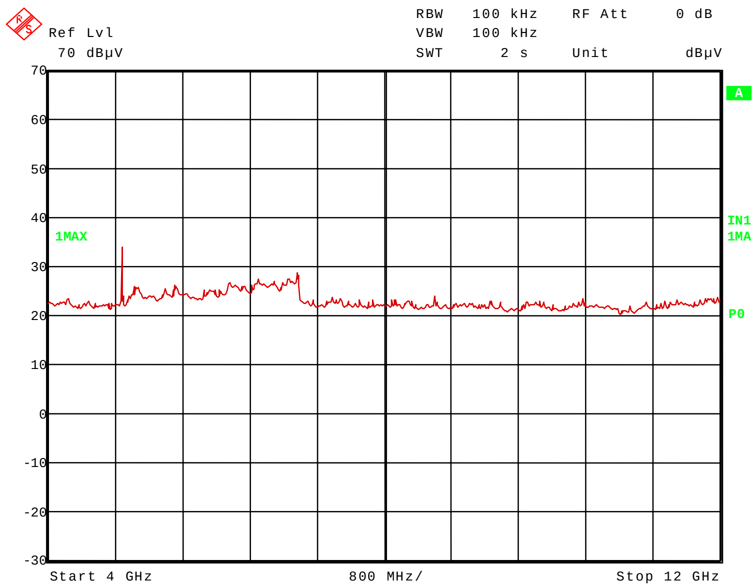
TEST EQUIPMENT USED FOR THE TEST:
29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

Transmitter operates at 2.441 GHz (operation mode 2)

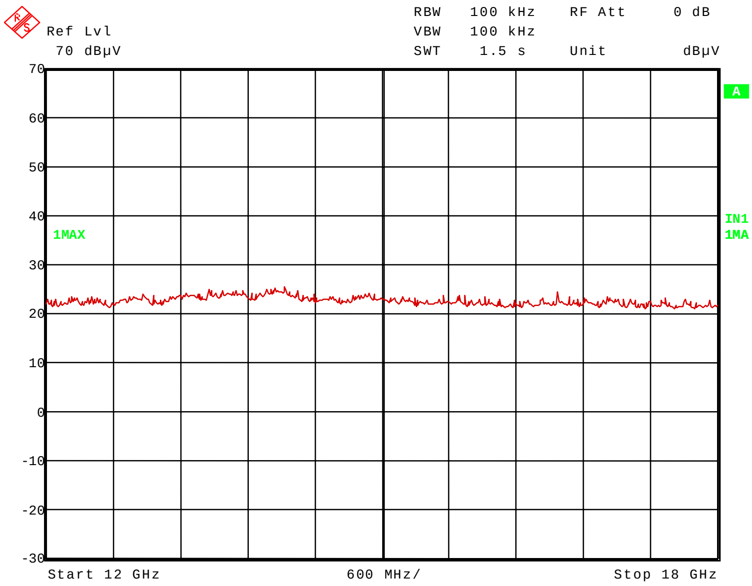
132962_4: Spurious emissions from 1 GHz to 4 GHz:



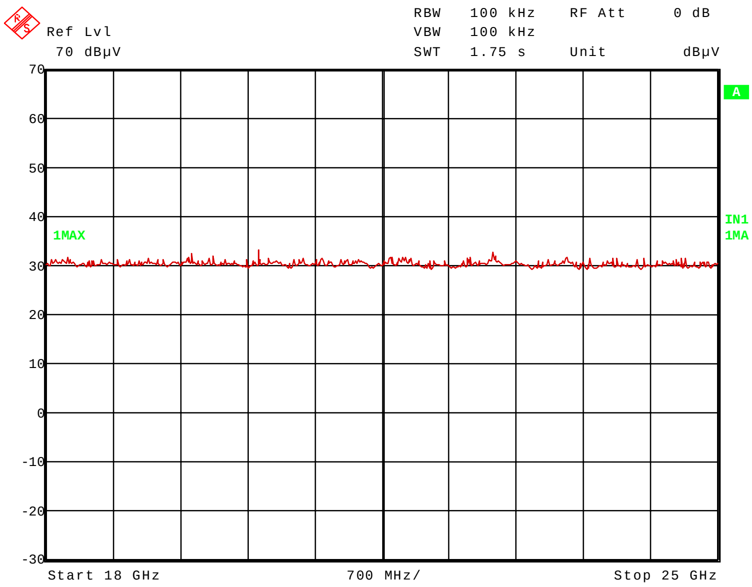
132962_3: Spurious emissions from 4 GHz to 12 GHz:



132962_14: Spurious emissions from 12 GHz to 18 GHz:



132962_13: 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.

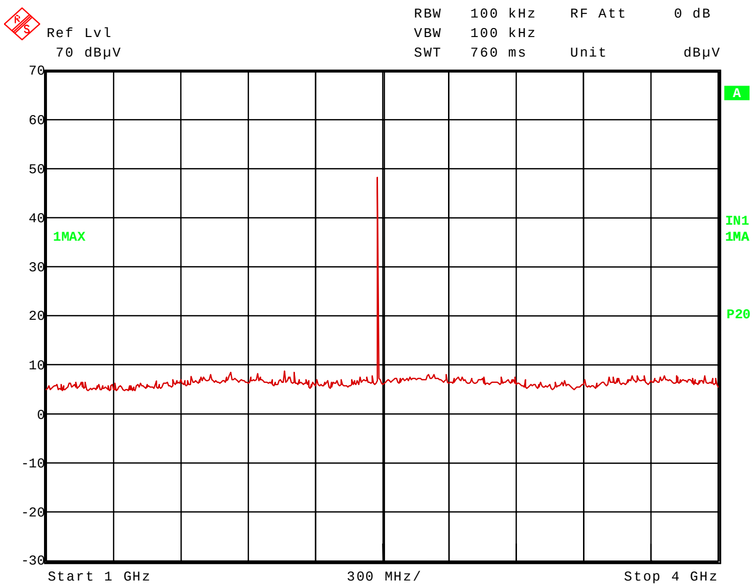
The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 2.441 GHz.

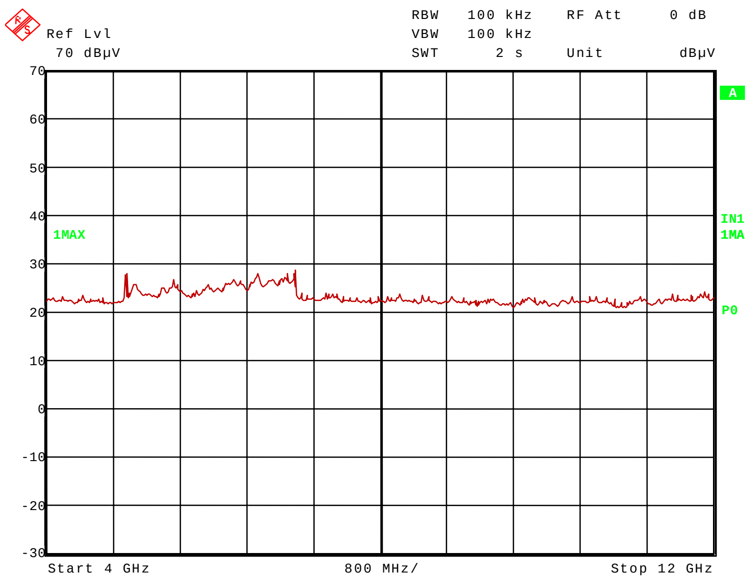
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates 2.48 GHz (operation mode 3)

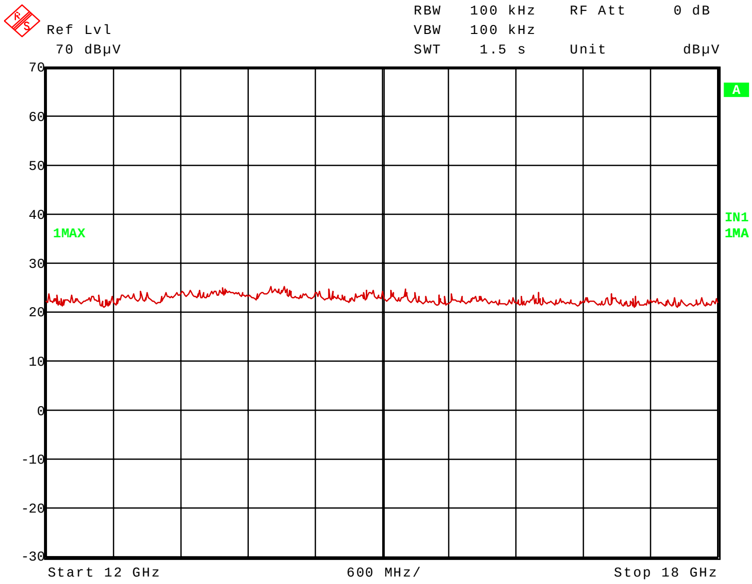
132962_5: Spurious emissions from 1 GHz to 4 GHz:



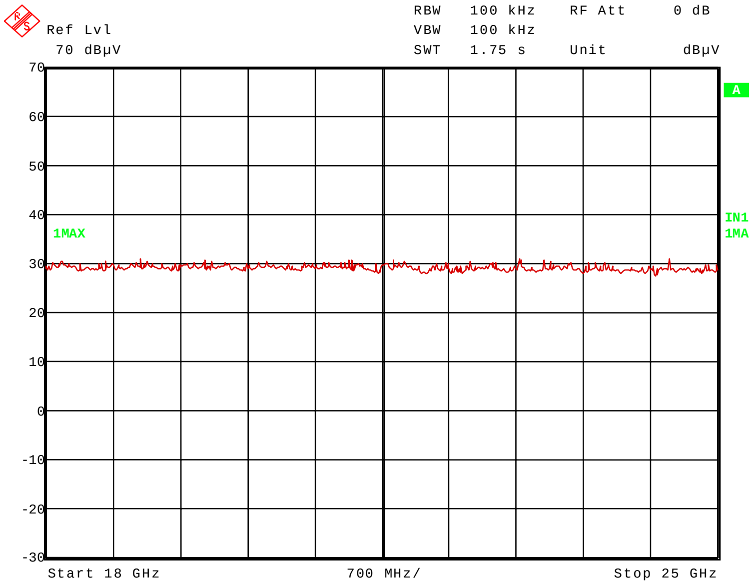
132962_6: Spurious emissions from 4 GHz to 12 GHz:



132962_15: Spurious emissions from 12 GHz to 18 GHz:



132962_16: 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 frequency was 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.

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

Ambient temperature	21 °C

Relative humidity	59 %

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 24.0 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 GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	86.3	-	-	54.3	28.3	0.0	3.7	150	Vert.	-
4.804	53.3	74.0	20.7	41.1	32.6	25.7	5.3	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	80.3	-	-	48.3	28.3	0.0	3.7	150	Vert.	-
4.804	41.7	54.0	12.3	29.5	32.6	25.7	5.3	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 GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height Cm	Pol.	Restr. Band
2.441	85.9	-	-	53.8	28.4	0.0	3.7	150	Vert.	-
4.882	52.4	74.0	21.6	40.0	32.8	25.7	5.3	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.441	79.8	-	-	47.7	28.4	0.0	3.7	150	Vert.	-
4.882	38.4	54.0	15.6	26.0	32.8	25.7	5.3	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 GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	83.5	-	-	51.2	28.5	0.0	3.8	150	Vert.	-
4.960	50.7	74.0	23.3	38.1	32.9	25.6	5.3	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	77.4	-	-	45.1	28.5	0.0	3.8	150	Vert.	-
4.960	35.3	54.0	18.7	22.7	32.9	25.6	5.3	150	Vert.	Yes
Measurement uncertainty						+2.2 dB / -3.6 dB				

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:
29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	02/06/2013	02/2015
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	AS615P	Deisel	615/310	480086	-	-
19	Antenna	CBL6111 D	Chase	1643	480894	09/28/2011	09/2014
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	02/15/2012	02/2014
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/13/2012	02/2014
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS615P	Deisel	615/310	480187	-	-
35	Antenna	CBL6112 B	Chase	2917	480328	04/21/2011	04/2014
36	Antenna	3115 A	EMCO	9609-4918	480183	11/09/2011	11/2014
37	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
39	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141	Weekly verification (system cal.)	
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142	Weekly verification (system cal.)	
46	RF-cable 1 m	KPS-1533-400-KPS	Insulated Wire	-	480301	Six month verification (system cal.)	
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
50	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	Six month verification (system cal.)	
51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
55	Antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/16/2012	02/2014
72	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

7 REPORT HISTORY

Report Number	Date	Comment
F132962E1	10 July 2013	Document created

8 LIST OF ANNEXES

ANNEX A TEST SETUP PHOTOS 6 pages

132962_01.jpg	Test set-up fully anechoic chamber
132962_02.jpg	Test set-up fully anechoic chamber
132962_03.jpg	Test set-up fully anechoic chamber
132962_04.jpg	Test set-up fully anechoic chamber
132962_05.jpg	Test set-up fully anechoic chamber
132962_06.jpg	Test set-up open area test site

ANNEX B EXTERNAL PHOTOS 4 pages

132962_07.jpg	EUT, 3D view 1
132962_08.jpg	EUT, 3D view 2
132962_09.jpg	Type plate
132962_10.jpg	Connector view

ANNEX C INTERNAL PHOTOS 8 pages

132962_11.jpg	Main PCB, top view
132962_12.jpg	Main PCB, bottom view
132962_14.jpg	Switch PCB, rear view
132962_16.jpg	Switch PCB, front view
132962_15.jpg	Switch PCB, detail view to Bluetooth unit (shielded)
132962_18.jpg	Switch PCB, detail view to Bluetooth unit (unshielded)
132962_19.jpg	Switch PCB, detail view to temporary antenna connector
132962_17.jpg	Switch PCB, detail view to internal antenna