PHOENIX TESTLAB
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TEST REPORT

Test Report Reference: R51145_A Edition 1

Equipment under Test: cB-0901-0301

Serial Number: none

FCC ID: PVH090103S

Applicant: connectBlue AB

Manufacturer: connectBlue AB

Test Laboratory
(CAB)
accredited by
DATech e.V.
in compliance with DIN EN ISO/IEC 17025
under the
Reg. No. DAT-P-105/99-21,
FCC Test site registration number 90877
and
Industry Canada Test site registration IC3469

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1 IDENTIFICATION

1.1 APPLICANT

Name:	connectBlue AB
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	Malmö SE-211 19
Country:	Sweden
Name for contact purposes:	Mr. Martin Engdahl
Tel:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
e-mail address:	martin.engdahl@connectblue.se

1.2 MANUFACTURER

Name:	connectBlue AB
Address:	Norra Vallgatan 64 3V
	Malmö SE-211 19
Country:	Sweden
Name for contact purposes:	Mr. Martin Engdahl
Tel:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
e-mail address:	martin.engdahl@connectblue.se

1.3 DATES

Date of receipt of test sample:	19 July 2005
Start of test:	27 July 2005
End of test:	30 August 2005

1.4 TEST LABORATORY

The tests were carried out at: **PHOENIX TEST-LAB GmbH**
Königswinkel 10
D-32825 Blomberg **Phone:** **+49 (0) 52 35 / 95 00-0**
Germany **Fax:** **+49 (0) 52 35 / 95 00-10**

accredited by DATech e.V. in compliance with DIN EN ISO/IEC 17025 under Reg. No. DAT-P-105/99-21,
FCC Test site registration number 90877 and Industry Canada Test site registration IC3469

Test engineer:	Thomas KÜHN		27 September 2005
	Name	Signature	Date
Test report checked:	Bernd STEINER		27 September 2005
	Name	Signature	Date

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Tel. 0 52 35 / 95 00-0
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Stamp

1.5 RESERVATION

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The test results herein refer only to the tested sample. PHOENIX TEST-LAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TEST-LAB Logo and the TEST REPORT REFERENCE.

1.6 NORMATIVE REFERENCES

[1] **ANSI C63.4-2003** 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 (September 2005)** Radio Frequency Devices

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

[4] **RSS-210 Issue 6 September 2005** Low power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment

[5] **RSS-Gen Issue 1 September 2005** General Requirements and Information for the Certification of Radiocommunication Equipment

1.7 TEST RESULTS

The requirements of this test document are fulfilled by the equipment under test. The complete test results are presented in the following.

2 TECHNICAL DATA OF EQUIPMENT

2.1 DEVICE UNDER TEST

Type of equipment: *	Bluetooth module
Type designation: *	cB-0901-0301
FCC ID: *	PVH090103S
Antenna type: *	Internal or external
Antenna gain: *	Refer table below
Antenna connector: *	With internal antenna, no antenna connector is mounted. Using an external antenna, a UFL connector is used.
Power supply: *	3.0 V DC to 6.0 V DC
Type of modulation: *	FHSS (GFSK)
Operating frequency range:*	2.402 to 2.480 GHz
Number of channels: *	79
Temperature range: *	-30 °C to +85 °C

*: declared by the applicant

Bluetooth operates in the unlicensed ISM band at 2.4 GHz. In North America (USA and Canada) a band with a width of 83.5 MHz is available. In this band 79 RF channels spaced 1 MHz apart are defined. The channel is represented by a pseudo random hopping sequence through the 79 channels. The normally occupancy time of one frequency will be 625 µs. The ordinary hopping rate will be 1600 hops/s. All frequencies will be used equally.

Used antennas:

model name*	Antenna type	Rated Antenna gain*
RAD-ISM-2400-ANT-OMNI-2-0	external	+2.0 dBi
PSTG0-2400HS	external	0.0 dBi
PlanTEC WLAN (m70crx 0300 03 xxxx)	external	+1.0 dBi
WCR-2400-SMA	external	+2.5 dBi
R380500127 A	external	+2.0 dBi
Rufa 2.4 GHz	internal	+0.5 dBi

*: declared by the applicant

The following external I/O cables were used:

Cable	Length	Shielding	Connector
DC in	2 m *	No	6.3 mm jack plug
-	-	-	-

*: Length during the test if no other specified.

2.2 PERIPHERY DEVICES

The following equipment was used as control unit and ancillary equipment:

- The Bluetooth module was connected to a carrier board (cB-0903-02), which was delivered by the applicant. The carrier board was supplied via an external power supply with 5.0 V DC.
- A personal computer with a terminal-software was used, connected temporary to the carrier board, for setting the equipment into the necessary operation mode. During the measurement procedures the personal computer was disconnected.

3 OPERATIONAL STATES AND PHYSICAL BOUNDARIES

The EUT is intended to be used in several bluetooth applications. Because the cB-0901-0301 is a module, which will be implemented in a final application, it was mounted on a carrier board to change the operation modes of the EUT from a Laptop with test software. The tests were carried out with one unmodified sample with integral antenna (sample marked with “4”) and another unmodified sample with an antenna connector (sample marked with “14”) and external antennas.

During the tests the test sample was powered by an external power supply via the carrier board with 5.0 V DC.

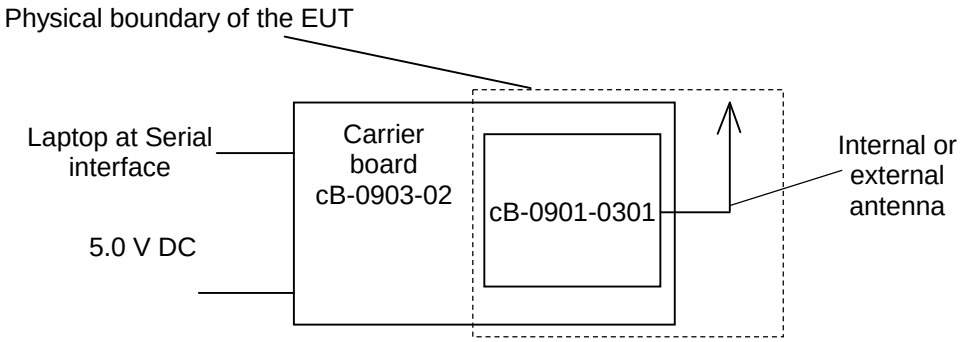
If not otherwise stated, for modulating the transmitter, a pseudo random bit sequence with a length of 27 byte and with a pattern type DH5 was used.

For selecting an operation mode, a personal computer with a software delivered by the applicant was connected to the carrier board. After adjusting the operating mode, the personal computer was removed. To do this the test-engineer was instructed by the applicant.

During the tests, the EUT was not labelled with a FCC-label.

The following operation modes were used during the tests:

Operation mode	Description of the operation mode
1	Continuous transmitting on 2402 MHz
2	Continuous transmitting on 2441 MHz
3	Continuous transmitting on 2480 MHz
4	Inquiry
5	Paging
6	Transmitter hopping on all channels
7	Continuous receiving on 2441 MHz



4 LIST OF MEASUREMENTS

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section	RSS 210, Issue 6 [4] or RSS-Gen, Issue 1 [5]	Status	Refer page
20 dB bandwitdh	General	15.247 (a) (1)	A8.1 (2) [4]	Passed	9 et seq.
Carrier frequency separation	General	15.247 (a) (1)	A8.1 (2) [4]	Passed	13 et seq.
Number of hopping channels	2400.0 - 2483.5	15.247 (a) (1) (iii)	A8.1 (4) [4]	Passed	16 et seq.
Dwell time	2400.0 - 2483.5	15.247 (a) (1) (iii)	A8.1 (4) [4]	Passed	18 et seq.
Maximum peak output power	2400.0 - 2483.5	15.247 (b) (1)	A8.4 (2) [4]	Passed	21 et seq.
Power spectral density	2441	15.247 (e)	A8.2 (2) [4]	Passed	25 et seq.
Band edge compliance	2400.0 - 2483.5	15.247 (d)	A8.5 [4]	Passed	28 et seq.
Conducted emissions (transmitter)	0.009 - 25,000	15.247 (d)	A8.5 [4]	Passed	32 et seq.
Radiated emissions (transmitter)	0.009 - 25,000	15.205 (a) 15.209 (a)	A8.5 [4] 2.6 [4]	Passed	37 et seq.
Conducted emissions on supply line	0.15 - 80	15.207 (a)	7.2.2 [5]	Passed	67 et seq.
Radiated emissions (receiver)	0.009 - 25,000	15.109 (a)	7.3 [5] 2.6 [4]	Passed	69 et seq.

5 TEST RESULTS

5.1 20 dB BANDWIDTH

5.1.1 METHODE OF MEASUREMENT (20 dB BANDWIDTH)

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 disenabled, the transmitter shall work with its maximum data rate.

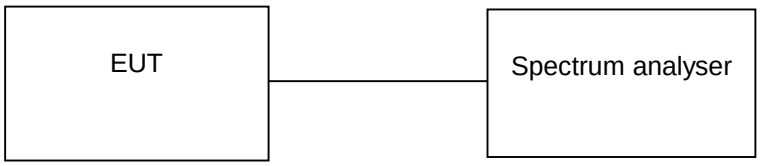
The following spectrum analyser settings shall be used:

- 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.

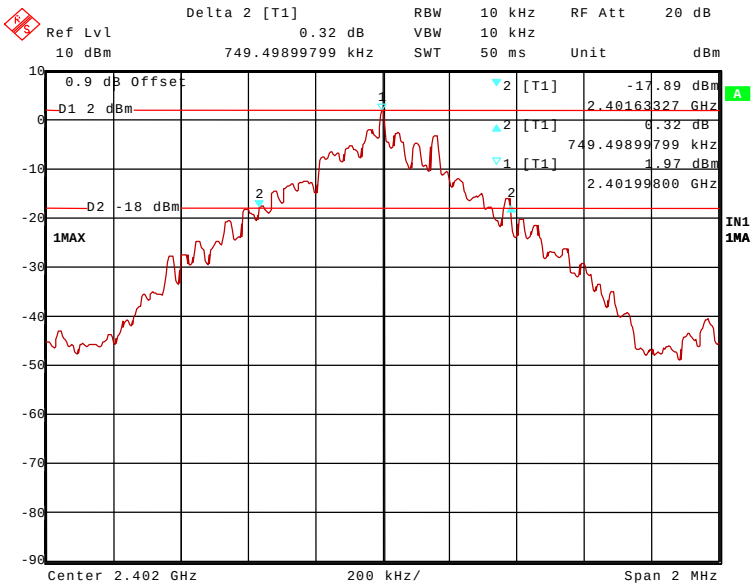
Test set-up:



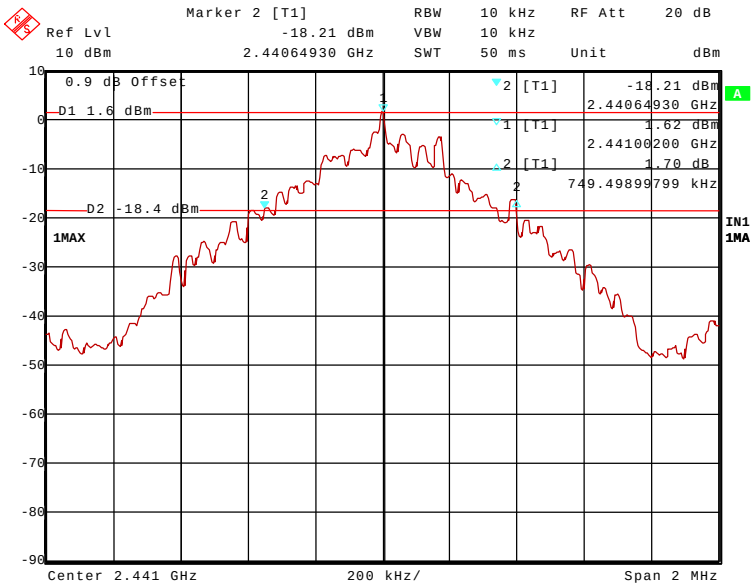
5.1.2 TEST RESULTS (20 dB BANDWIDTH)

Ambient temperature	21 °C	Relative humidity	50 %

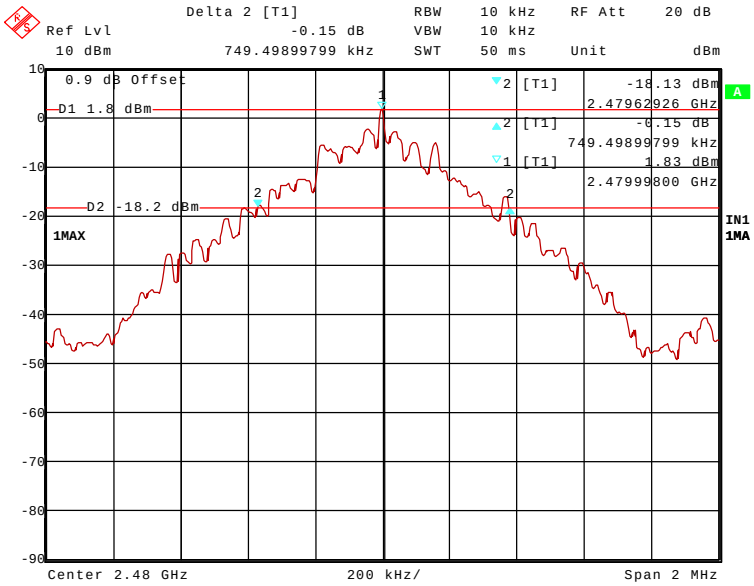
51145152.wmf: (20 dB bandwidth at the lower end of the assigned frequency band):



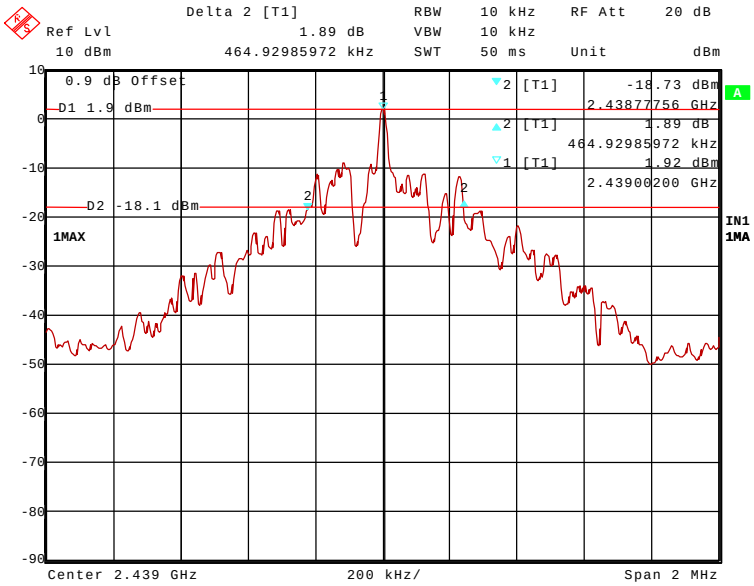
51145151.wmf: (20 dB bandwidth at the middle of the assigned frequency band):



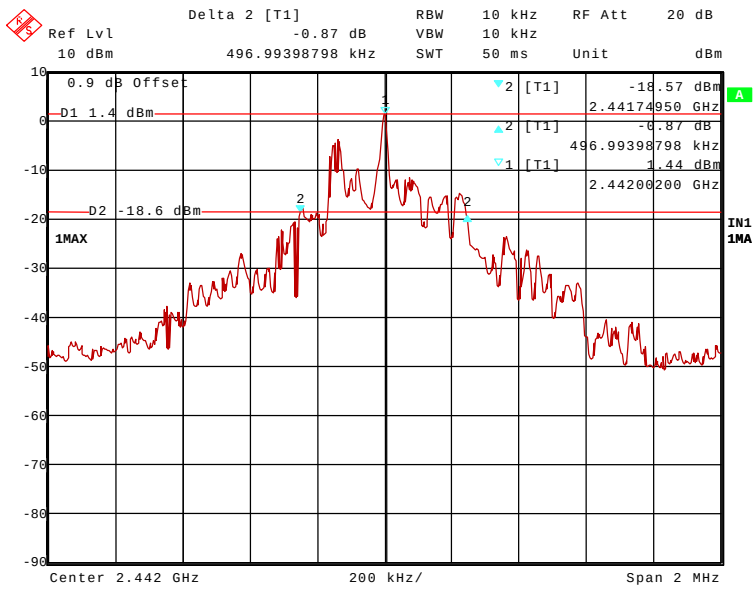
51145150.wmf: (20 dB bandwidth at the upper end of the assigned frequency band):



51145153.wmf: (20 dB bandwidth with inquiry mode):



5114535.wmf: (20 dB bandwidth with paging mode):



Channel number	Channel frequency [MHZ]	20 dB bandwidth [kHz]
0	2402	749.499
39	2441	749.499
78	2480	749.499
38 (inquiry mode)	2439	464.930
40 (paging mode)	2442	496.994

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.2 CARRIER FREQUENCY SEPARATION

5.2.1 METHODE OF MEASUREMENT (CARRIER FREQUENCY SEPARATION)

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.

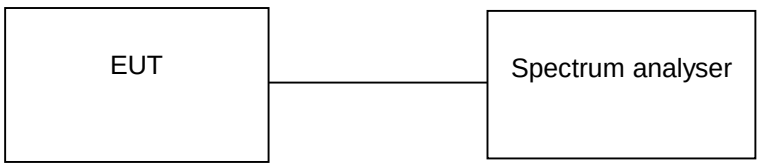
The following spectrum analyser settings shall be used:

- 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.

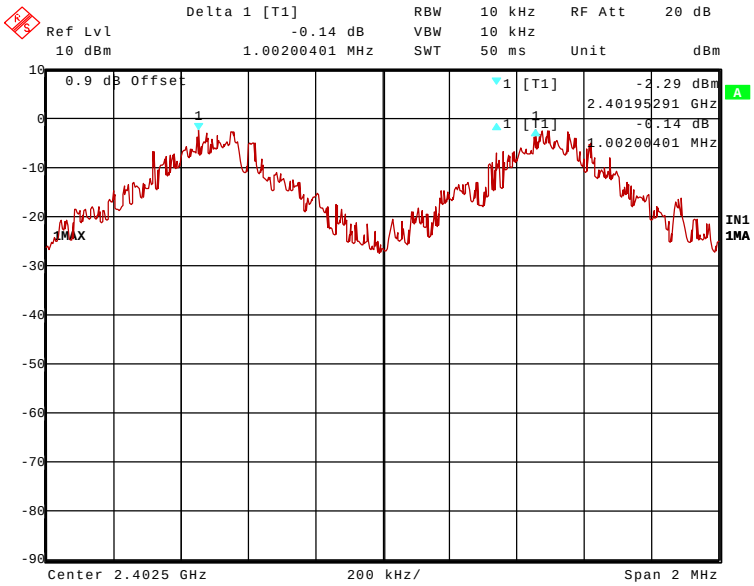
Test set-up:



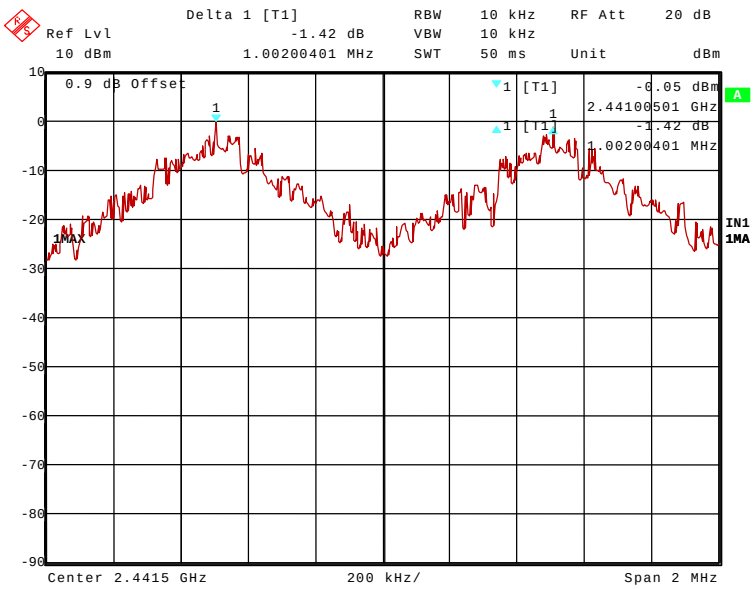
5.2.2 TEST RESULTS (CARRIER FREQUENCY SEPARATION)

Ambient temperature	21 °C	Relative humidity	50 %

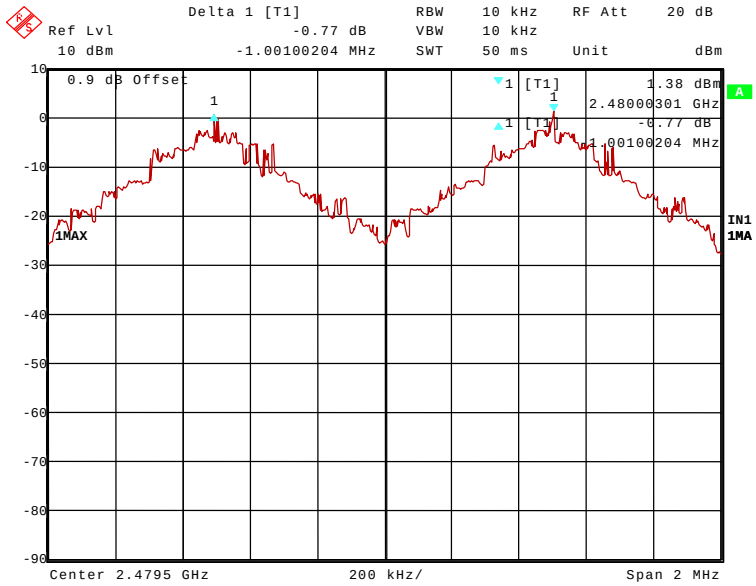
51145155.wmf: (channel separation at the lower end of the assigned frequency band):



51145156.wmf: (channel separation at the middle of the assigned frequency band):



51145157.wmf: (channel separation at the upper end of the assigned frequency band):



Channel number	Channel frequency [MHZ]	Channel separation [kHz]	Minimum limit [kHz]
0	2402	1002.004	749.499 (20 dB bandwidth)
39	2441	1002.004	749.499 (20 dB bandwidth)
78	2480	1001.002	749.499 (20 dB bandwidth)

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.3 NUMBER OF HOPPING FREQUENCIES

5.3.1 METHODE OF MEASUREMENT (NUMBER OF HOPPING FREQUENCIES)

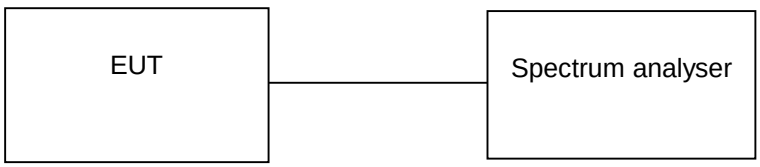
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT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

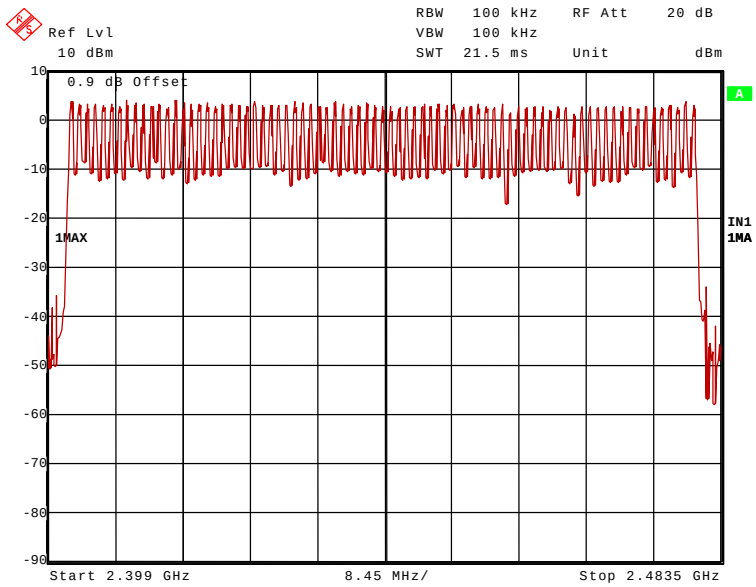
Test set-up:



5.3.2 TEST RESULTS (NUMBER OF HOPPING FREQUENCIES)

Ambient temperature	21 °C	Relative humidity	50 %

51145158.wmf (number of hopping channels):



Number of hopping channels	Limit
79	At least 15

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.4 DWELL TIME

5.4.1 METHODE OF MEASUREMENT (DWELL TIME)

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:

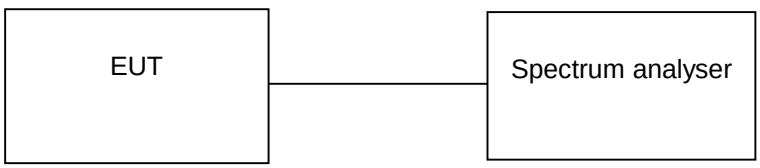
- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel.
- Detector function: peak.
- Trace mode: Max hold.

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.

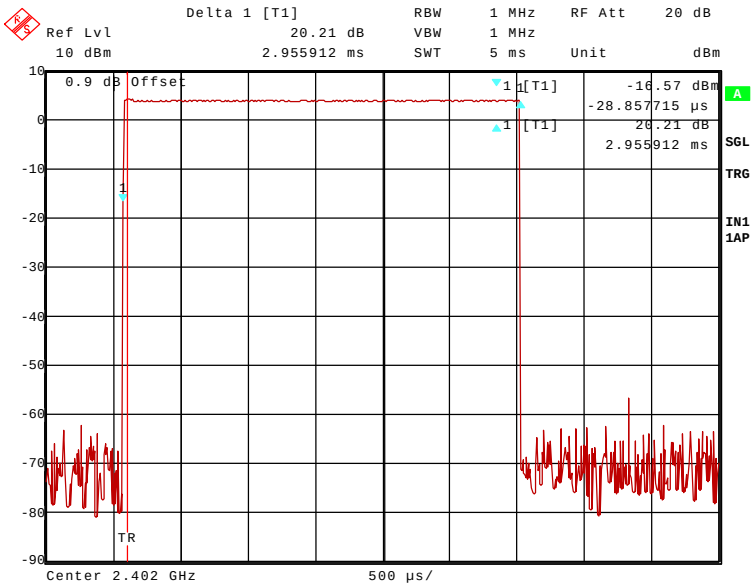
Test set-up:



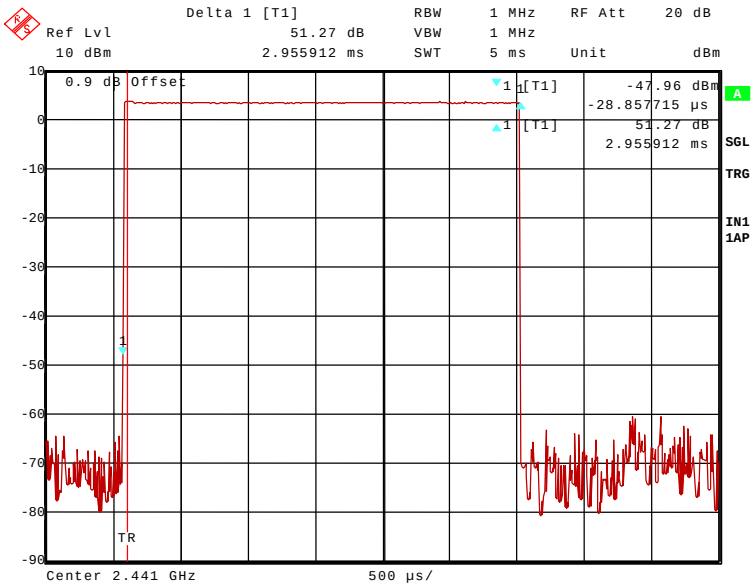
5.4.2 TEST RESULTS (DWELL TIME)

Ambient temperature	21 °C	Relative humidity	50 %

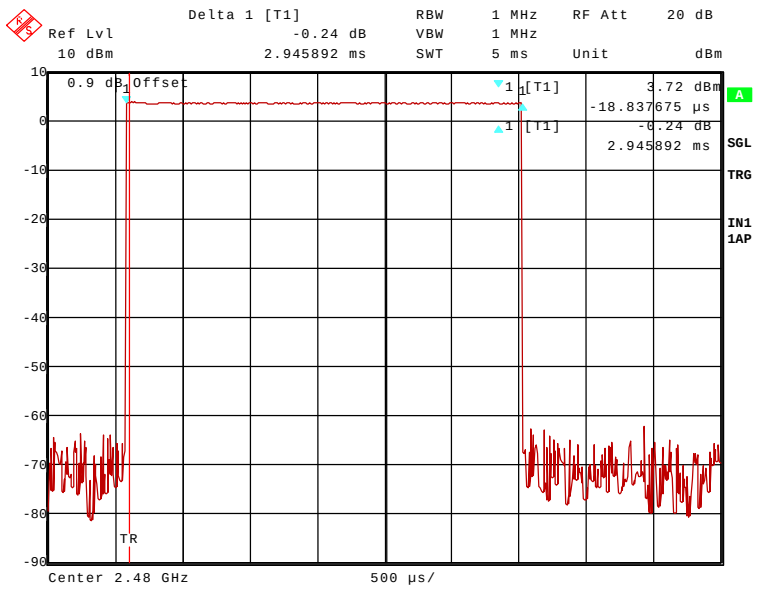
51145159.wmf: (dwell time at the lower end of the assigned frequency band), hopping mode DH5:



51145160.wmf: Dwell time at the middle of the assigned frequency band), hopping mode DH5:



51145161.wmf: (dwell time at the upper end of the assigned frequency band), hopping mode DH5:



The dwell time is calculated with the following formula:

Dwell time = t_{pulse} x n_{hops} / number of channels x 31.6 s

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 (DH5) a packet need 5 timeslots for transmitting and the next timeslot for receiving. So the system makes in worst case 266,67 hops per second in transmit mode (n_{hops} = 266.667 1/s)

Channel number	Channel frequency [MHZ]	t_{pulse}	Dwell time [ms]
0	2402	2.956 ms	315.307
39	2441	2.956 ms	315.307
78	2480	2.946 ms	314.240

Limit: The dwell time of the channel shall be less than 0.4 s in a 31.6 s period

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.5 MAXIMUM PEAK OUTPUT POWER

5.5.1 METHODE OF MEASUREMENT (MAXIMUM PEAK OUTPUT POWER)

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 disenabled.

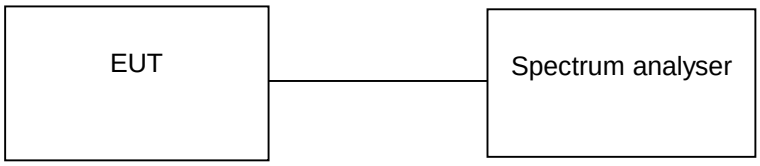
The following spectrum analyser settings shall be used:

- 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.

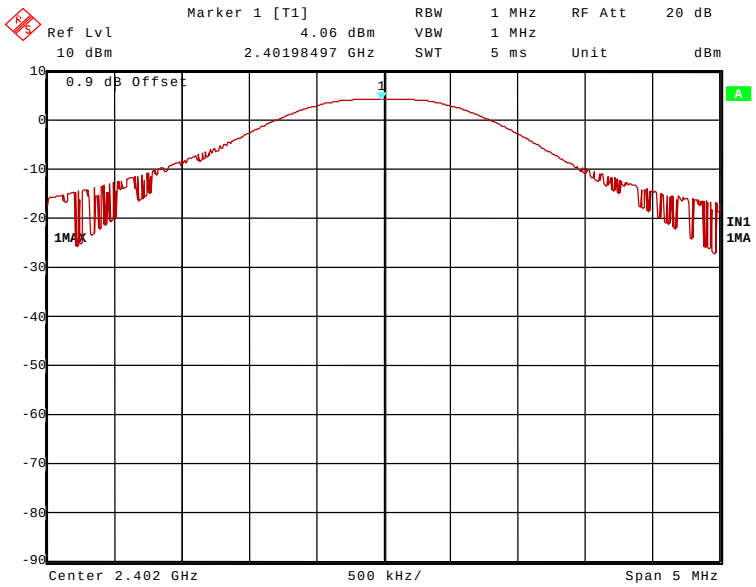
Test set-up:



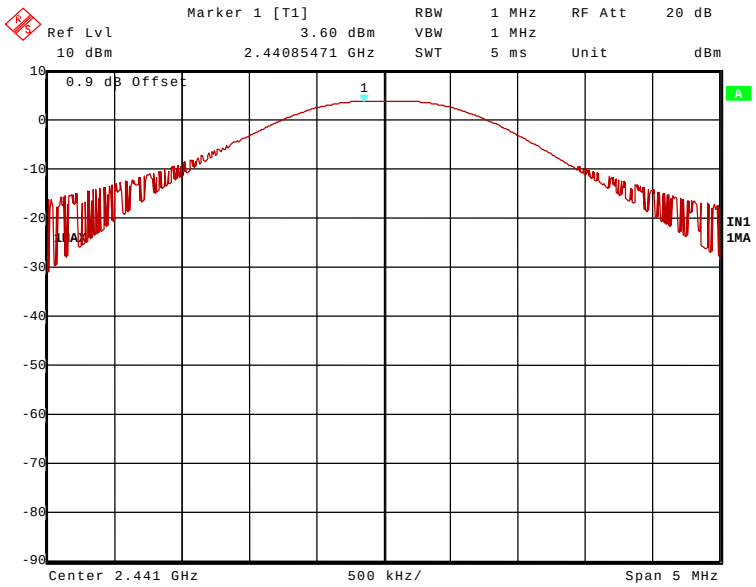
5.5.2 TEST RESULTS (MAXIMUM PEAK OUTPUT POWER)

Ambient temperature	21 °C	Relative humidity	50 %

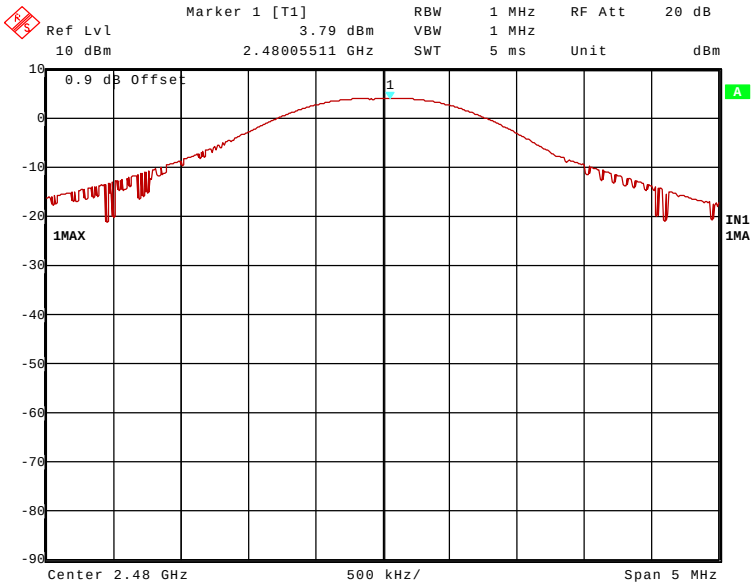
51145162.wmf (maximum peak output power at the lower end of the assigned frequency band):



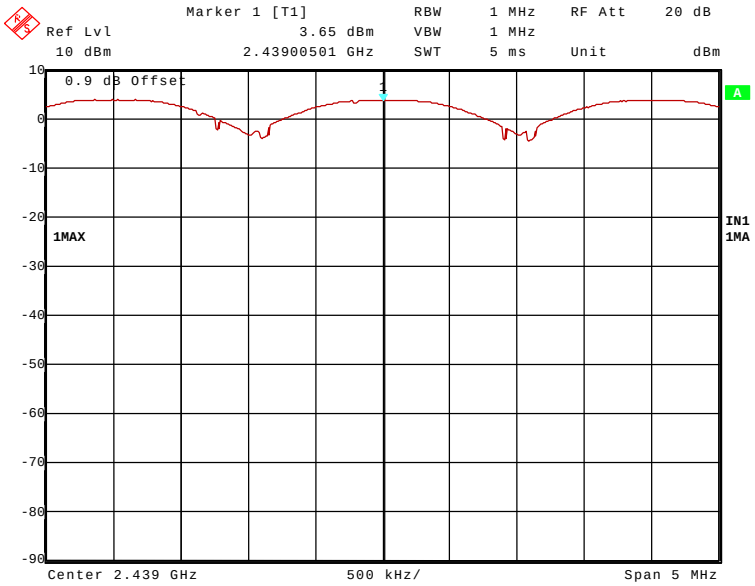
51145163.wmf (maximum peak output power at the middle of the assigned frequency band):



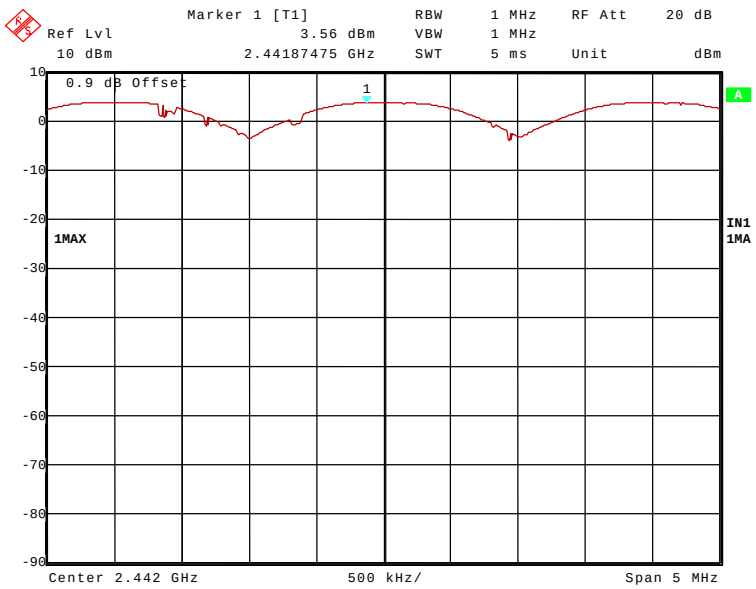
51145164.wmf (maximum peak output power at the upper end of the assigned frequency band):



51145165.wmf (maximum peak inquiry mode):



51145166.wmf (maximum peak paging mode):



Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Calculated EIRP [dBm]	Peak power limit [dBm]
0	2402	4.1	2.5	6.6	30.0
39	2441	3.6	2.5	6.1	30.0
78	2480	3.8	2.5	6.3	30.0
38 (inquiry)	2439	3.7	2.5	6.2	30.0
40 (paging)	2442	3.6	2.5	5.1	30.0

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.6 POWER SPECTRAL DENSITY

5.6.1 METHODE OF MEASUREMENT (POWER SPECTRAL DENSITY)

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 in page/inquiry mode.

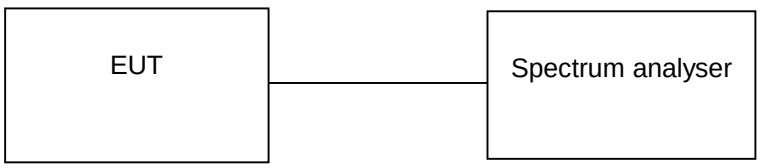
The following spectrum analyser settings shall be used:

- Span: 1.5 MHz, centred in the middle of the assigned frequency range.
- Resolution bandwidth: 3 kHz.
- Video bandwidth: 3 kHz.
- 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 power spectral density.

The measurement will be performed with the EUT in page mode and inquiry mode.

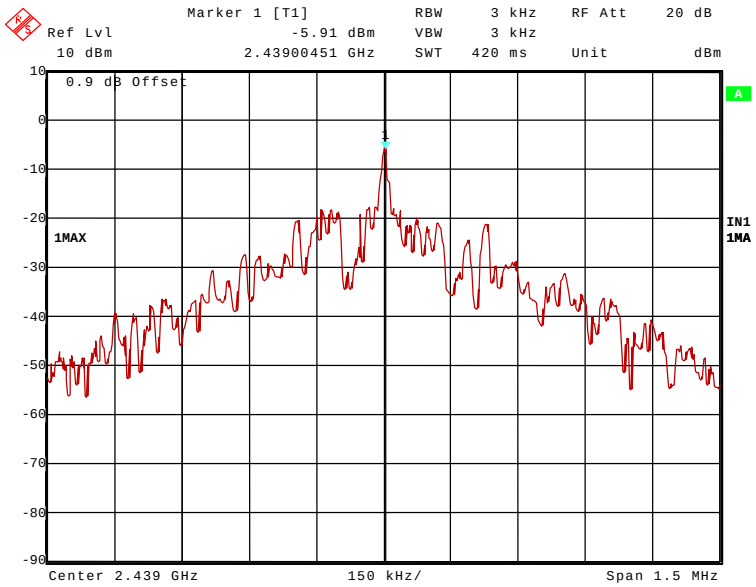
Test set-up:



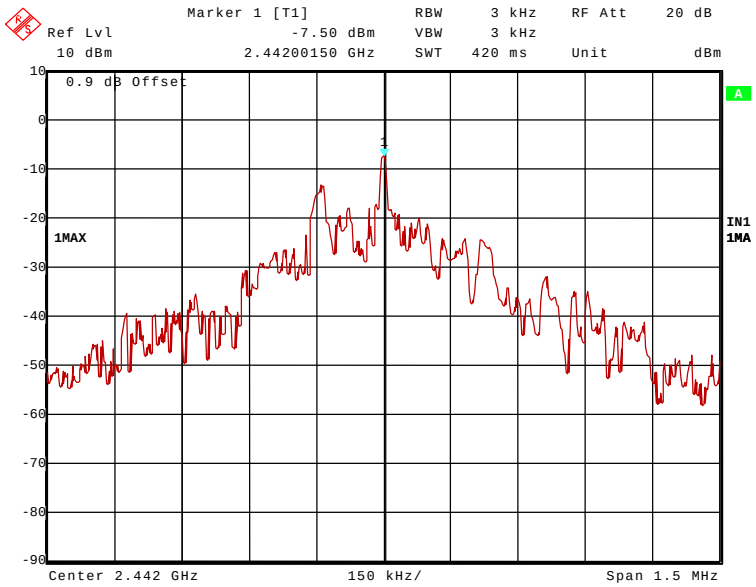
5.6.2 TEST RESULTS (POWER SPECTRAL DENSITY)

Ambient temperature	21 °C	Relative humidity	50 %

51145168.wmf (power spectral density (inquiry mode):



51145167.wmf (power spectral density (page mode):



Operation mode	Power spectral density [dBm / 3 kHz] *	Power spectral density limit [dBm / 3 kHz]
Inquiry mode	-5.9	8
Page mode	-7.5	8

* cable loss of 0.9dB respected

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.7 BAND-EDGE COMPLIANCE

5.7.1 METHODE OF MEASUREMENT (BAND-EDGE COMPLIANCE)

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 disenabled.

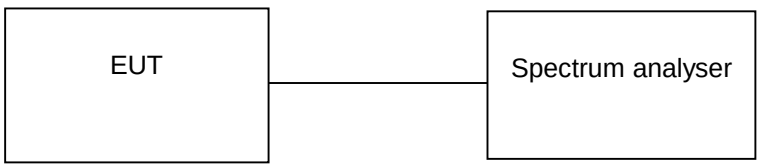
The following spectrum analyser settings shall be used:

- 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: ≥ 1 % of the span, but not below 30 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. After this the difference between this emission level and the signal peak will be calculated. With the value of measured field strength of the signal peak and the calculated difference to the emission level, the level of the field strength of the emission will be calculated.

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

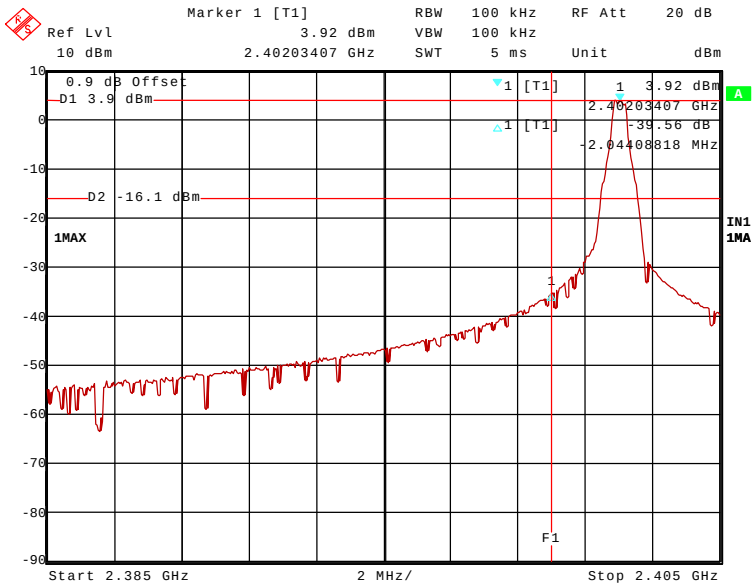
Test set-up:



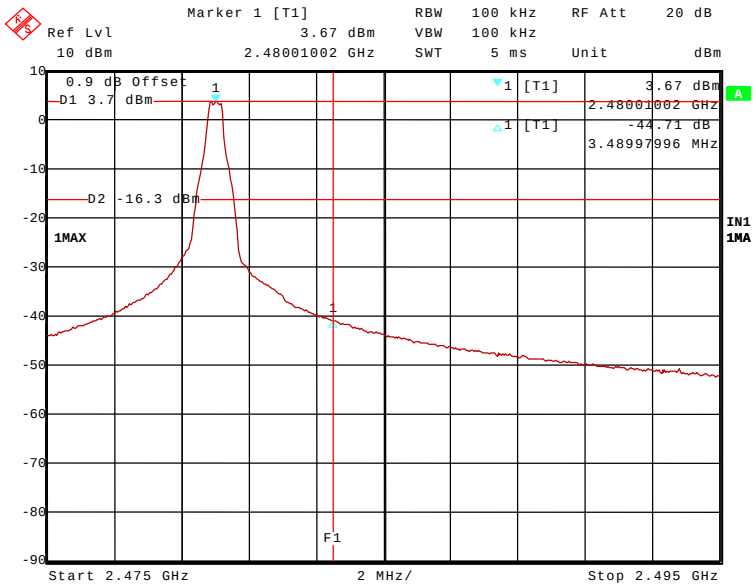
5.7.2 TEST RESULT (BAND-EDGE COMPLIANCE)

Ambient temperature	21 °C	Relative humidity	50 %

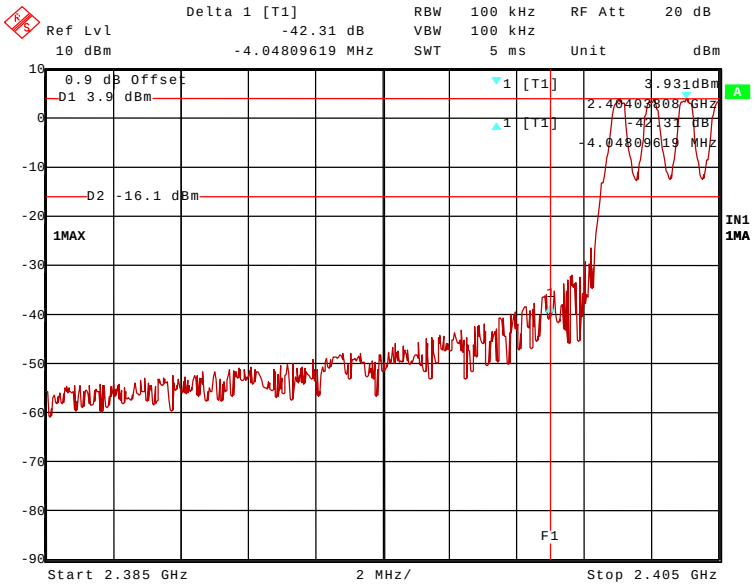
51145148.wmf (band-edge compliance, lower band edge, hopping off):



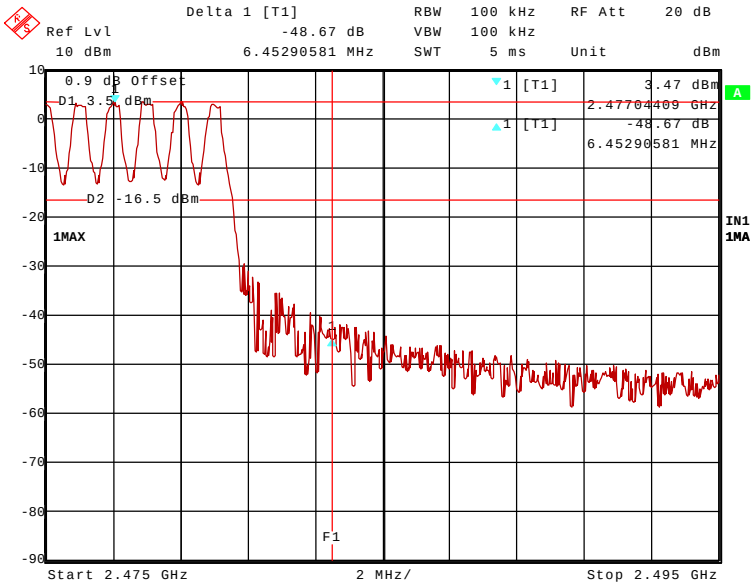
51145146.wmf (band-edge compliance, upper band edge, hopping off):



51145147.wmf (band-edge compliance, lower band edge, hopping on):



51145146.wmf (band-edge compliance, upper band edge, hopping on):



The plots on the two pages before are showing the band-edge compliance for the upper and lower 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 (c). The frequency line 1 (F1) shows the edge of the assigned frequency.

Band-edge compliance (hopping disenabled)				
Band-edge	Difference to the signal peak [dB]	Field strength of this signal peak [dBµV/m]	Field strength at the band edge [dBµV/m]	Limit [dBµV/m]
Upper	44.7	95.4	50.7	54.0
Lower	39.6	92.6	53.0	72.6

Band-edge compliance (hopping enabled)				
Band-edge	Difference to the signal peak [dB]	Field strength of this signal peak [dBµV/m]	Field strength at the band edge [dBµV/m]	Limit [dBµV/m]
Upper	48.7	95.4	46.7	54.0
Lower	42.3	92.6	50.3	72.6

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.8 CONDUCTED EMISSIONS (TRANSMITTER)

5.8.1 METHODE OF MEASUREMENT (CONDUCTED EMISSIONS)

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 disenabled.

The following spectrum analyser settings shall be used:
In the frequency range from 9 kHz to 1 MHz:

- Start frequency: 9 kHz.
- Stop frequency: 1 MHz.
- Resolution bandwidth: 200 Hz.
- Video bandwidth: 200 Hz.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

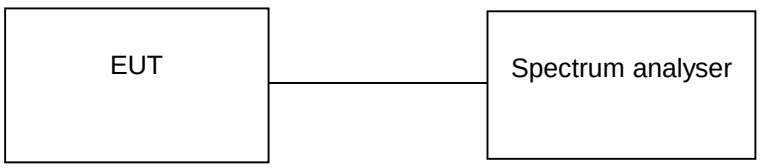
In the frequency range from 1 MHz to 25 GHz:

- Start frequency: 1 MHz.
- Stop frequency: 25 GHz.
- Resolution bandwidth: 100 kHz.
- Video bandwidth: 100 kHz.
- 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 20 dB below the peak marker. Every emission has to be below the display line.

The measurement will be performed with the EUT operates at the middle, the upper and lower end of the assigned frequency band and with hopping off.

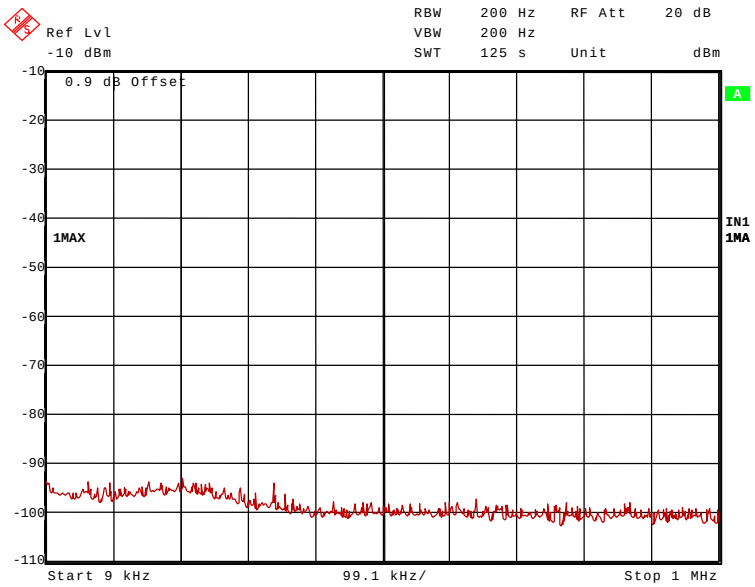
Test set-up:



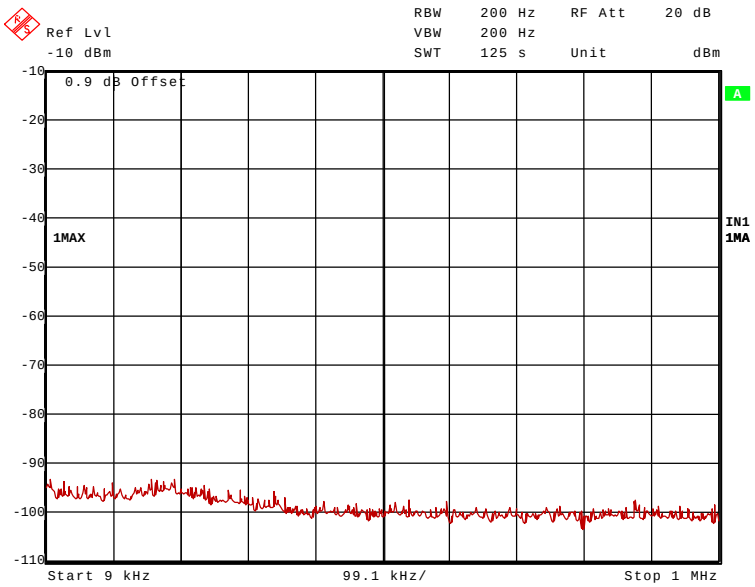
5.8.2 TEST RESULTS (CONDUCTED EMISSIONS)

Ambient temperature	21 °C	Relative humidity	50 %

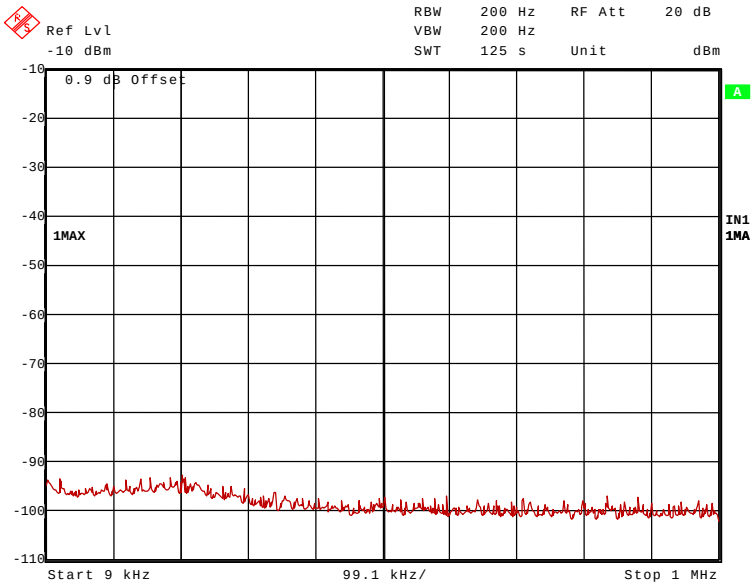
51145169.wmf (conducted emissions form 9 kHz to 1 MHz, transmitter at 2402 MHz):



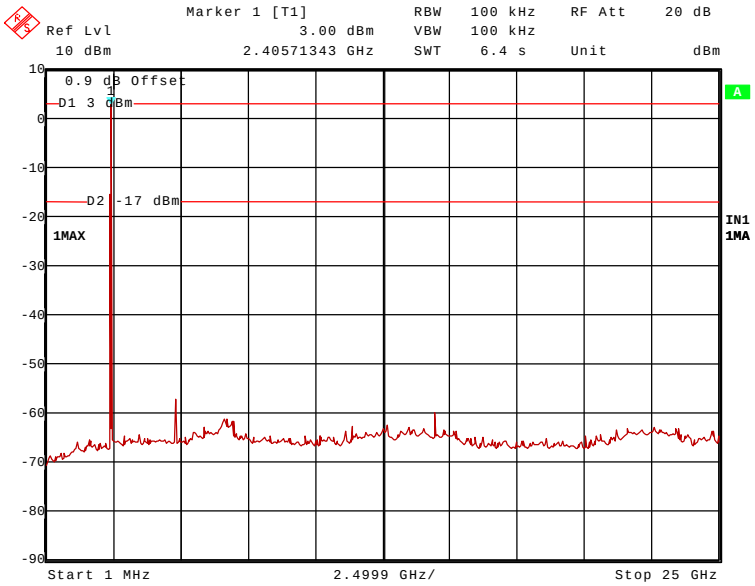
51145170.wmf (conducted emissions 9 kHz to 1 MHz, transmitter at 2441 MHz):



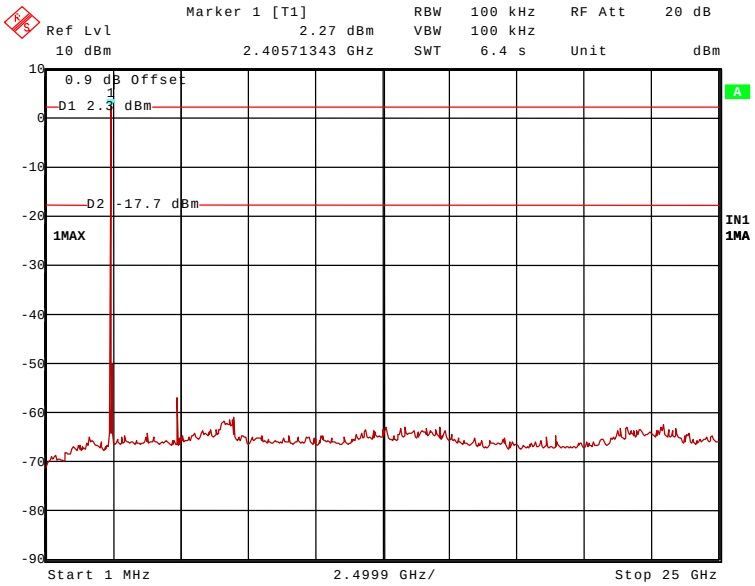
51145171.wmf (conducted emissions 9 kHz to 1 MHz, transmitter at 2480 MHz):



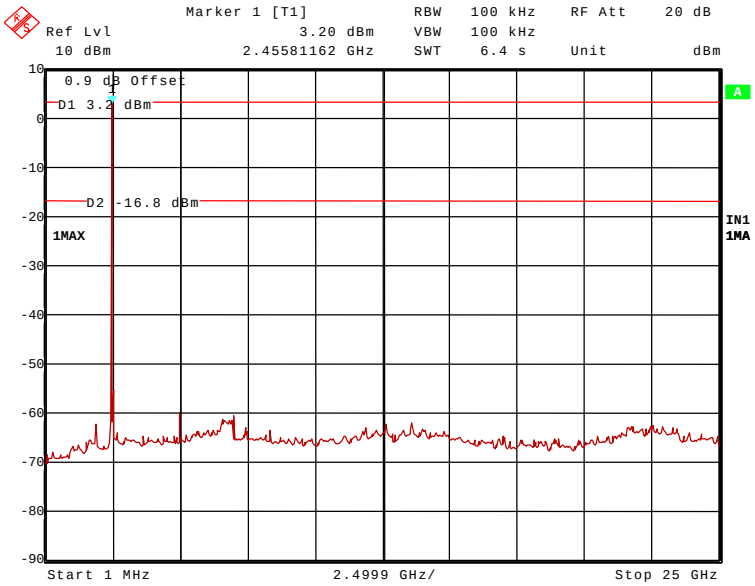
51145174.wmf (conducted emissions form 1 MHz to 25 GHz, transmitter at 2402 MHz):



51145173.wmf (conducted emissions 1 MHz to 25 GHz, transmitter at 2441 MHz):



51145172.wmf (conducted emissions 1 MHz to 25 GHz, transmitter at 2480 MHz):



Conducted emissions with transmitter operates at 2402 MHz						
Frequency	Result dBm	Limit dBm	Margin dB	Reading dBm	Cable loss dB *	Reference level [dBm]
4.804 GHz	-52.5	-17.0	35.5	-53.6	0.2	3.0
9.608 GHz	-61.5	-17.0	44.5	-63.0	0.6	3.0
Conducted emissions with transmitter operates at 2441 MHz						
Frequency	Result dBm	Limit dBm	Margin dB	Reading dBm	Cable loss dB *	Reference level [dBm]
4.882 GHz	-53.5	-17.7	35.8	-54.6	0.2	2.3
Conducted emissions with transmitter operates at 2480 MHz						
Frequency	Result dBm	Limit dBm	Margin dB	Reading dBm	Cable loss dB *	Reference level [dBm]
1.892 GHz	-56.1	-16.8	39.3	-56.7	-0.3	3.2
4.960 GHz	-57.2	-16.8	40.4	-58.3	0.2	3.2

*: Cable loss including the display offset (0.9 dB)

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54

5.9 RADIATED EMISSIONS (TRANSMITTER)

5.9.1 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 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test side without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- 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 final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 25 GHz.

All measurements will be carried out with the EUT working on the middle and upper and lower edge of the assigned frequency band. For this reason the hopping function of the EUT has to be disenabled.

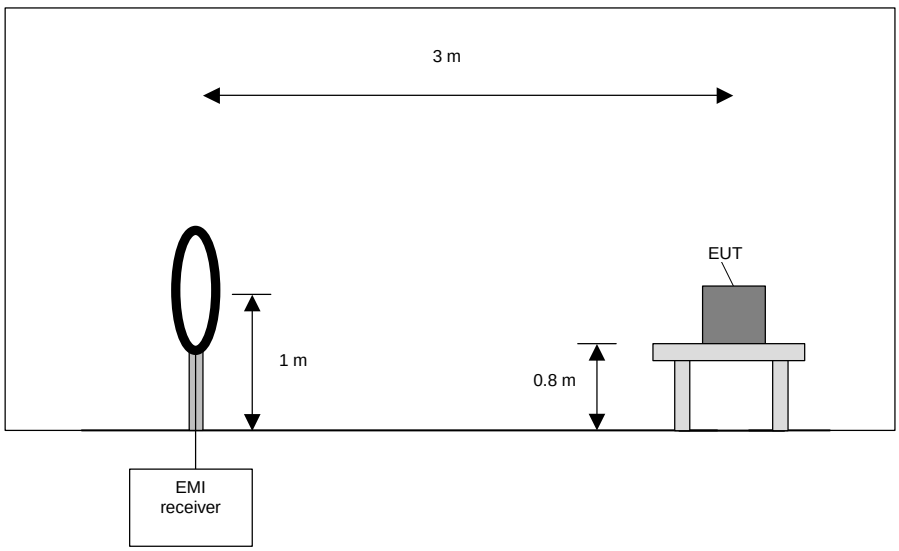
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. 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 C63.4-2003 [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

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 frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6) Repeat steps 1) to 4) with the other orthogonal axes of the EUT.
7) Rotate the measuring antenna and repeat steps 1) to 5).

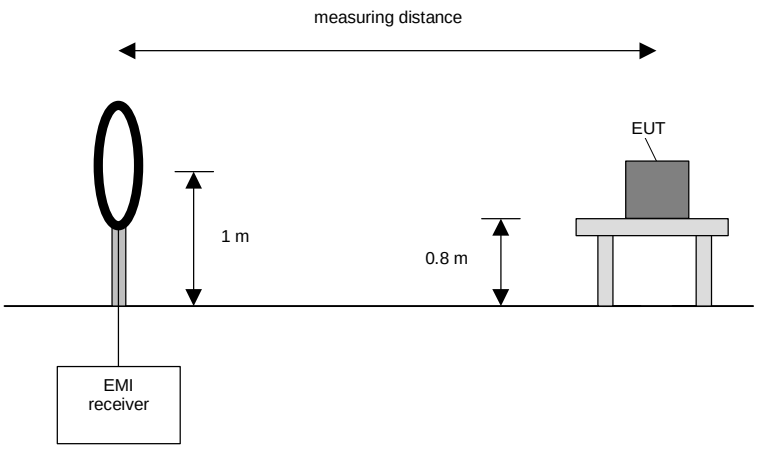
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the during the preliminary measurement detected frequencies the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

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

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Final measurement procedure:

The following procedure will be used:

1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
3) Rotate the measuring antenna to find the maximum and note the value.
4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT if applicable (handheld equipment).

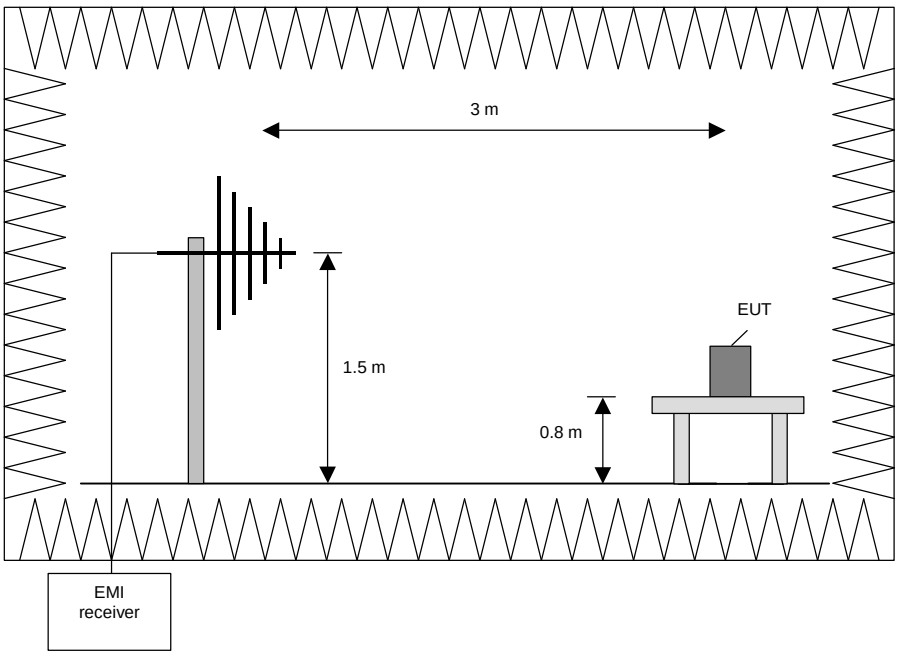
Preliminary measurement (30 MHz to 1 GHz)

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 C63.4-2003 [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:

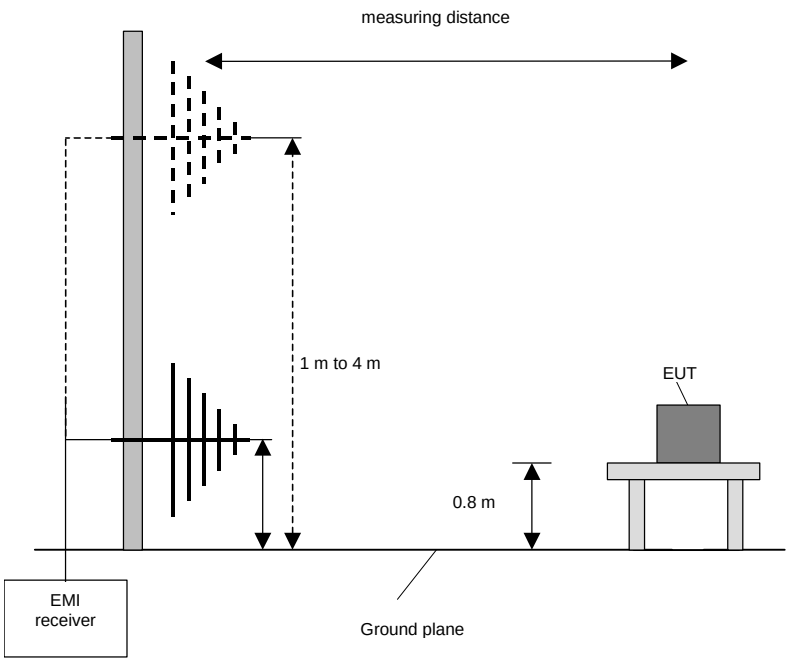
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the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

Final measurement (1 GHz to 25 GHz)

This 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 C63.4-2003 [1].

Preliminary measurement (1 GHz to 25 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 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 °. If the EUT is larger than the antenna beamwidth, the antenna will be moved to various positions, to cover the whole surface of the EUT. It might be possible to shorter the measuring distance to higher the measurement sensitivity.

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

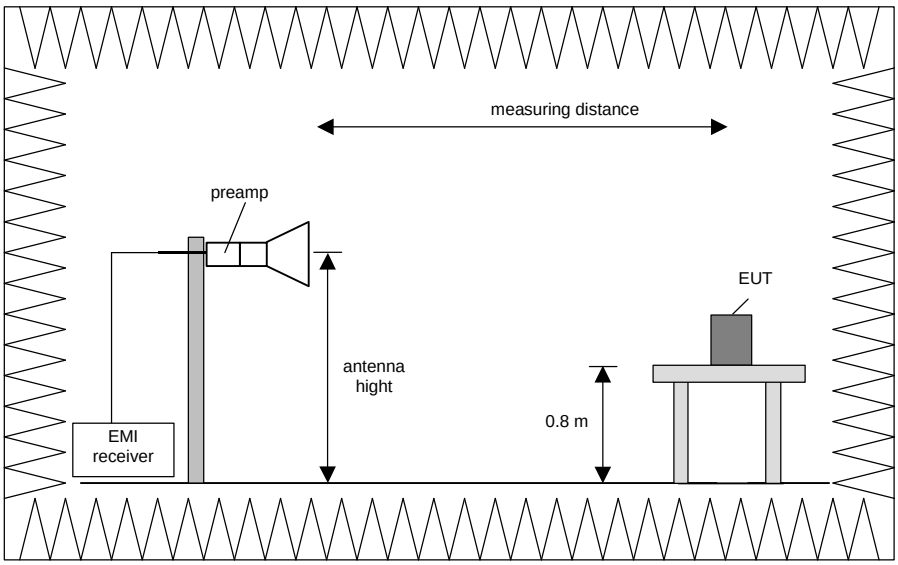
Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 25 GHz	100 kHz

Final measurement (1 GHz to 25 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 MAX Hold 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 °. If the EUT is larger than the antenna beamwidth, the antenna will be moved to various positions, to cover the whole surface of the EUT. It might be possible to shorter the measuring distance to higher the measurement sensitivity.

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 25 GHz	1 MHz



Procedure of measurement:

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 and 18 GHz to 25 GHz.
The following procedure will be used:

1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2) Rotate the EUT by 360 ° to maximize the detected signals.
3) Change the antenna polarisation.
4) Rotate the EUT by 360 ° to maximize the detected signals.
5) Make a hardcopy of the spectrum.
6) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
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) with the other orthogonal axes of the EUT if handheld equipment.
9) Repeat steps 1) to 8) for the next antenna spot if the EUT is lager than the antenna beamwidth.

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

5.9.2 TEST RESULTS (RADIATED EMISSIONS)

5.9.2.1 PRELIMINARY MEASUREMENT WITH EXTERNAL ANTENNA (9 kHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	53 %

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.

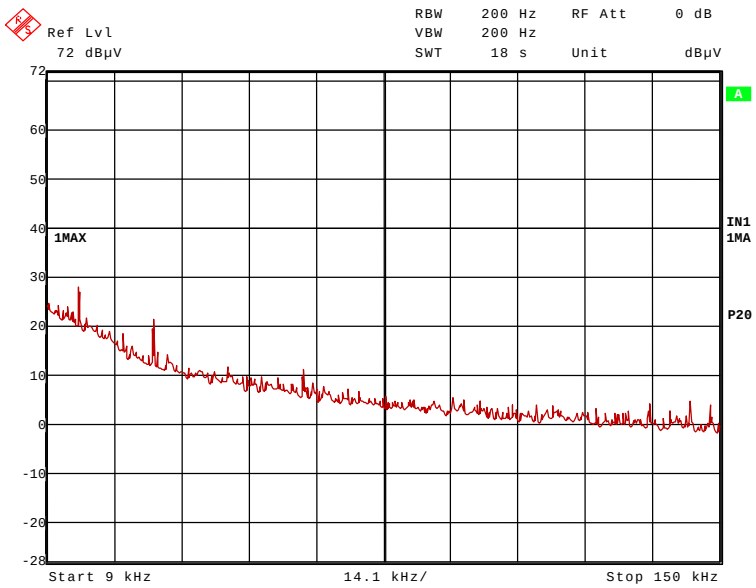
Cable guide: The cable of the EUT was fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: Where not otherwise stated the test was carried out in test mode 2 of the EUT, because there was no difference to the other test modes. All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

Remark: The emissions found around 16 kHz, 32 kHz, 48 and 62 kHz caused by the measuring system and not from the EUT.
As external antenna the WCR-2400-SMA was used, because of the highest antenna gain. Additionally pre-tests have shown, that this antenna caused the highest spurious emissions.

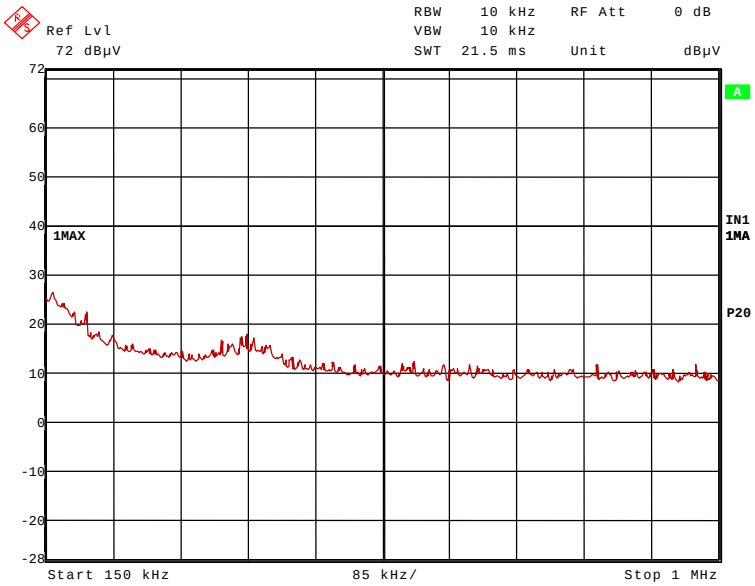
51145144.wmf: (9 kHz to 150 kHz):



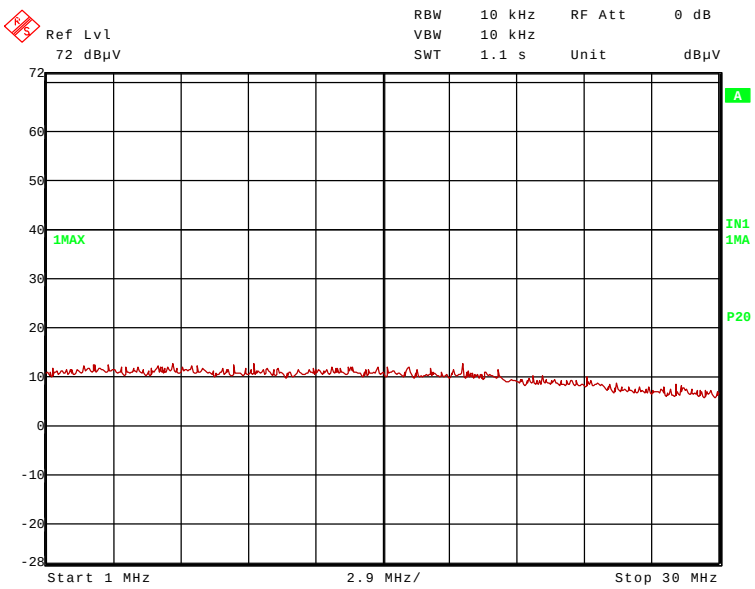
TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

51145145.wmf: (150 kHz to 1 MHz):

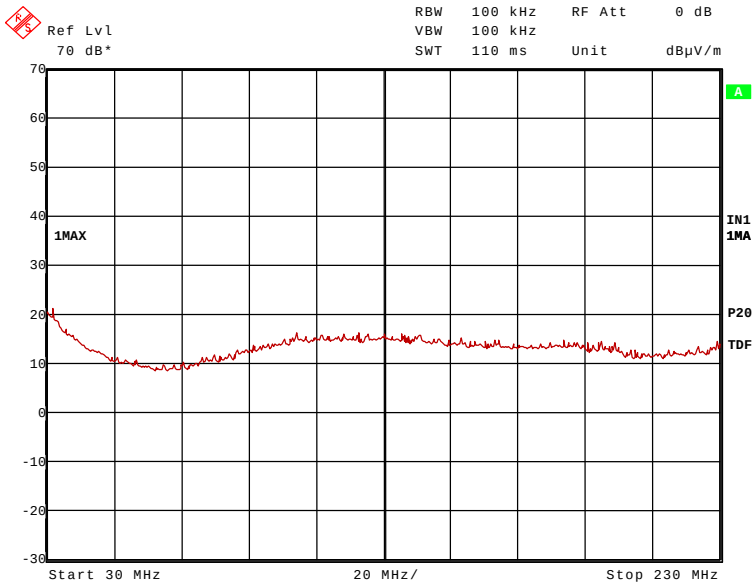


51145146.wmf: (1 MHz to 30 MHz)

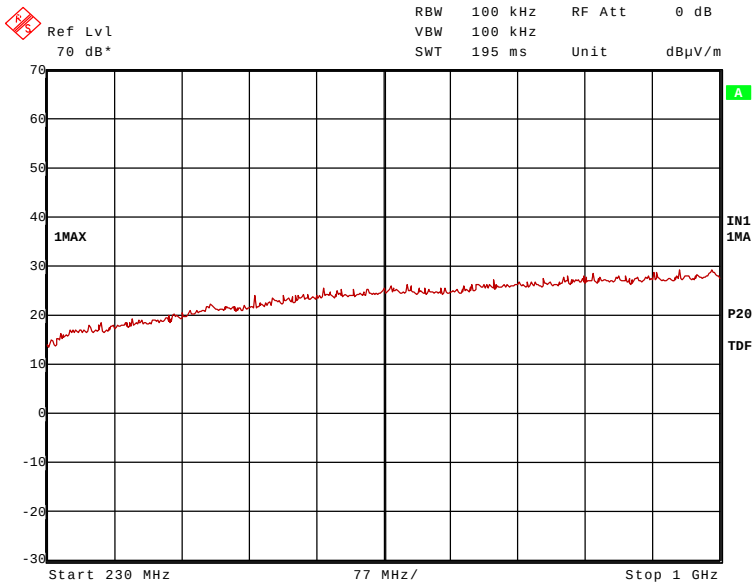


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

51145130.wmf (30 MHz to 230 MHz):



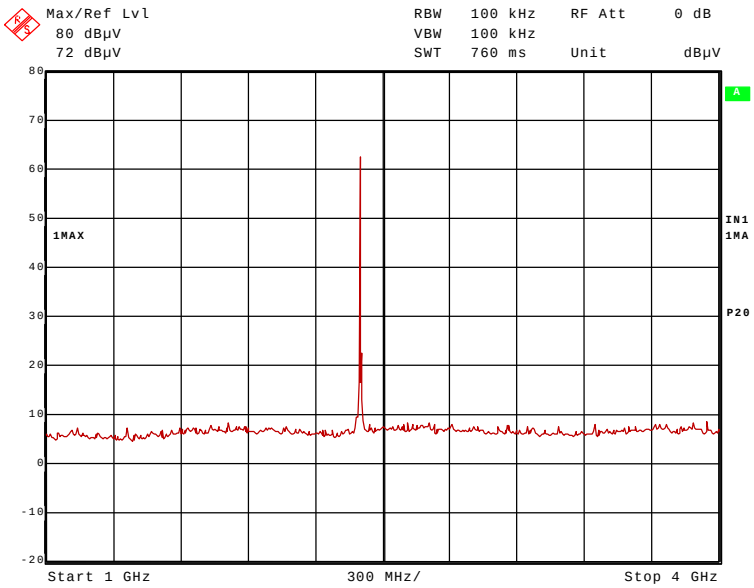
51145131.wmf (230 MHz to 1 GHz):



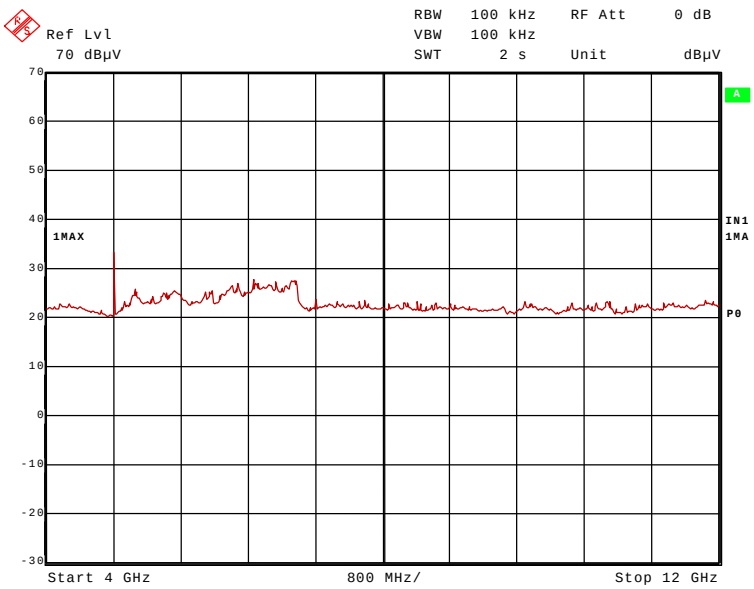
No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

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

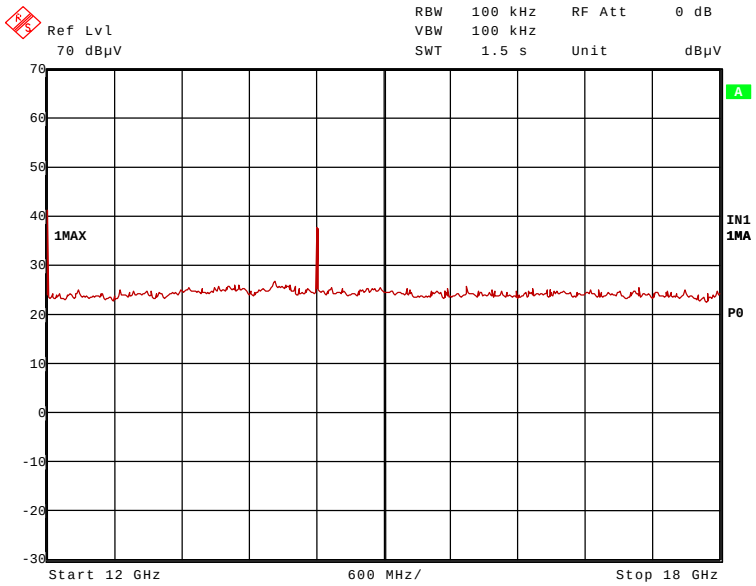
51145101.wmf (1 GHz to 4 GHz):



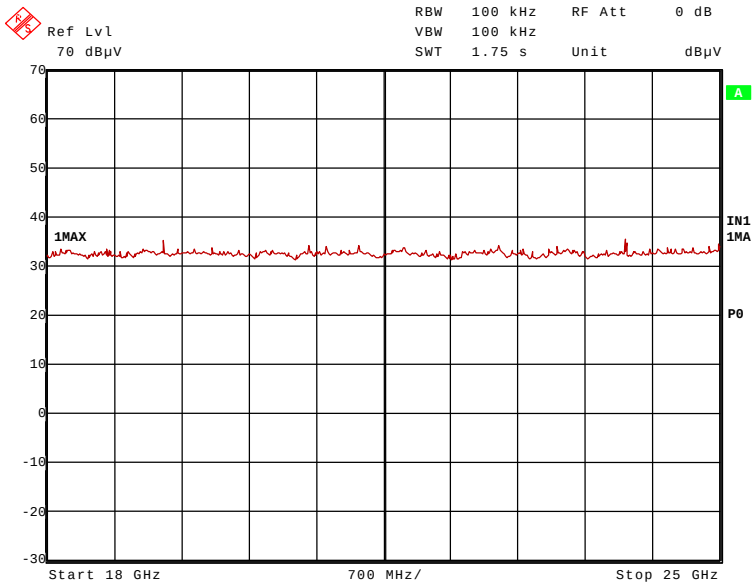
51145110.wmf (4 GHz to 12 GHz):



51145123.wmf (12 GHz to 18 GHz):



51145128.wmf (18 GHz to 25 GHz):



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

- 4.804 GHz and 12.010 GHz.

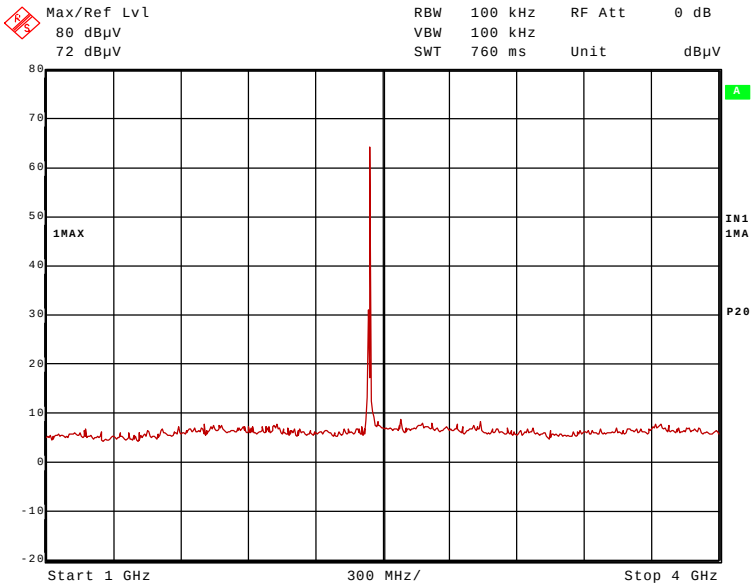
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.402 GHz and 14.412 GHz.

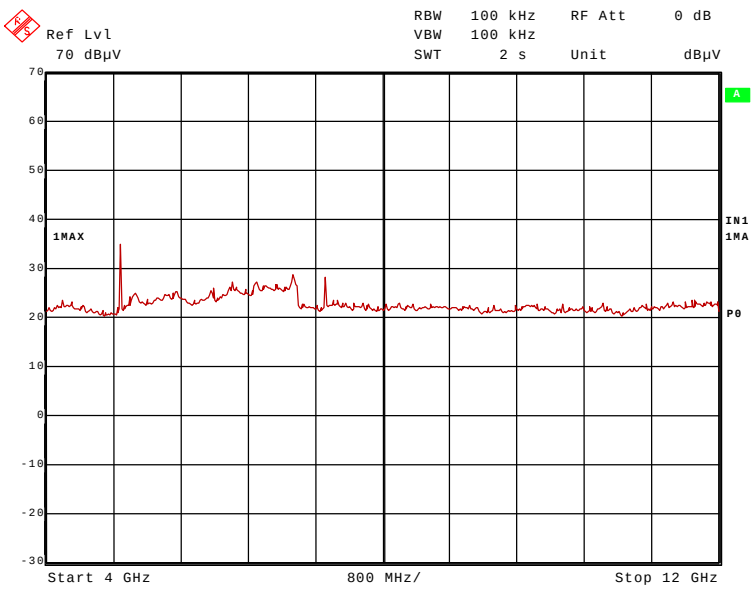
These frequencies have to be measured in a final measurement. The results were presented in the following.

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

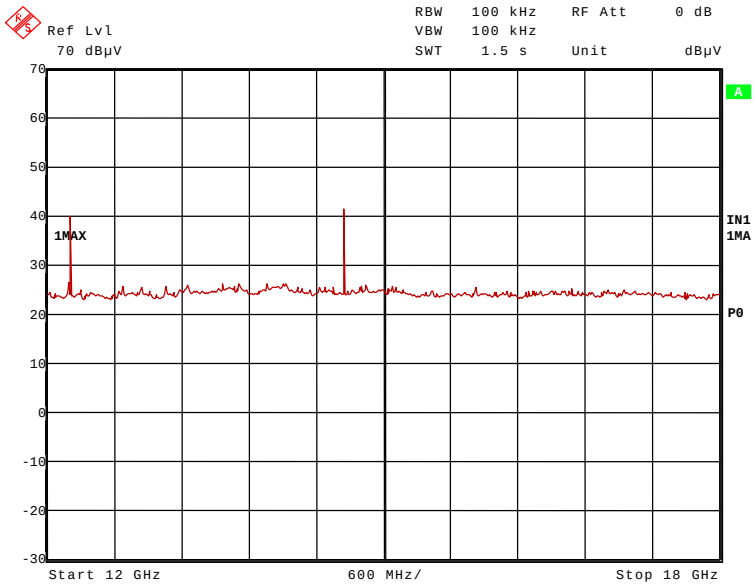
51145102.wmf (1 GHz to 4 GHz):



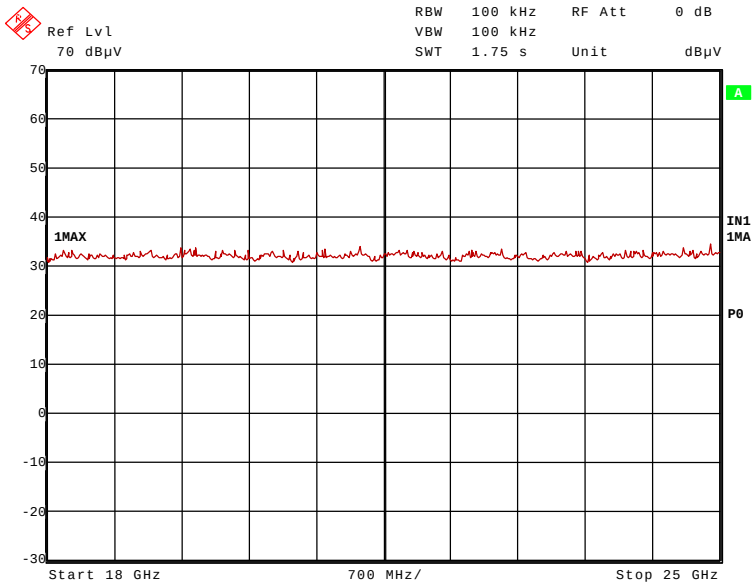
51145111.wmf (4 GHz to 12 GHz):



51145124.wmf (12 GHz to 18 GHz):



51145129.wmf (18 GHz to 25 GHz):



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

- 4.882 GHz, 7.323 GHz and 12.205 GHz.

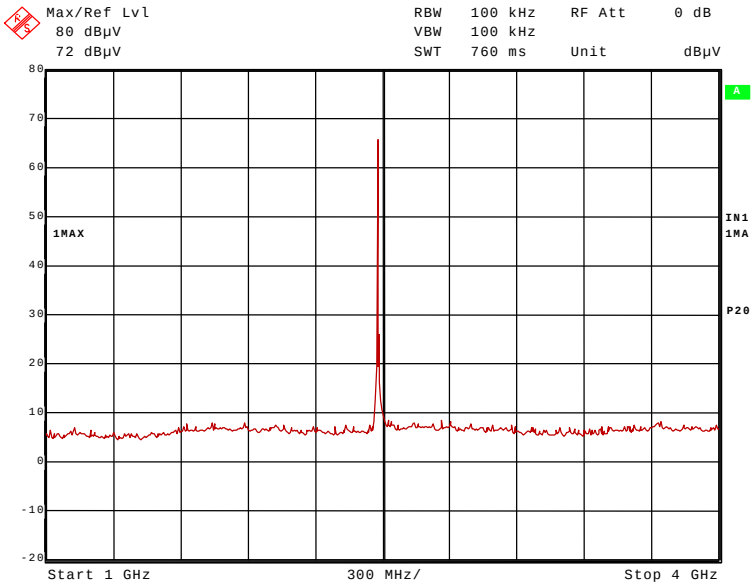
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.441 GHz and 14.646 GHz.

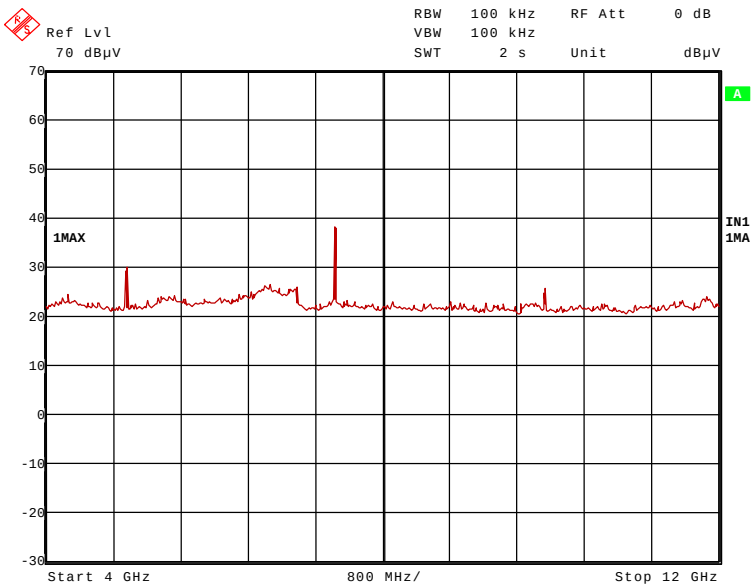
These frequencies have to be measured in a final measurement. The results were presented in the following.

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

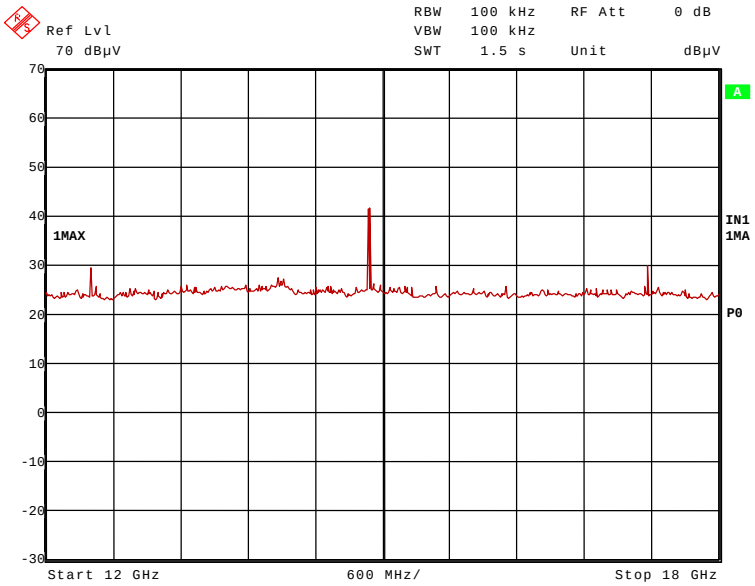
51145103.wmf (1 GHz to 4 GHz):



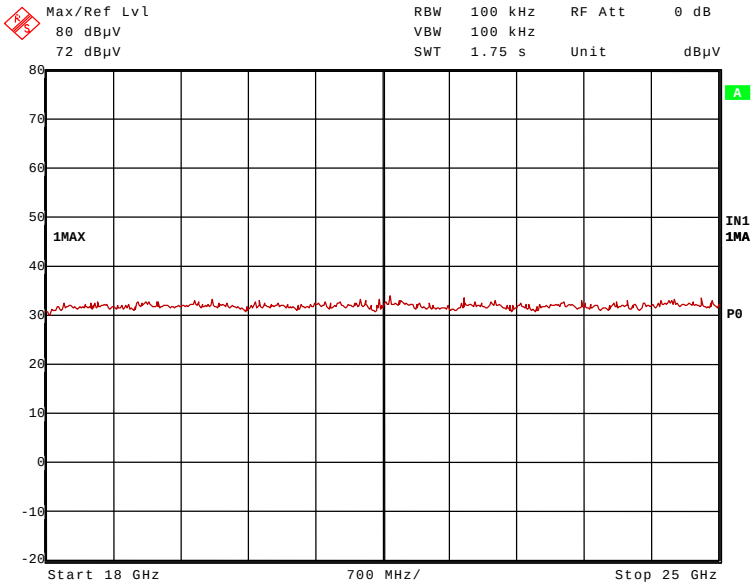
51145112.wmf (4 GHz to 12 GHz):



51145125.wmf (12 GHz to 18 GHz):



5114526.wmf (18 GHz to 25 GHz):



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

- 4.960 GHz, 7.440 GHz and 12.400.

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

- 2.480 GHz, 9.920 GHz, 14.880 GHz and 17.360 GHz.

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

5.9.2.2 FINAL MEASUREMENT WITH EXTERNAL ANTENNA (1 GHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	53 %

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 was fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

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

Remark: As external antenna the WCR-2400-SMA was used, because of the highest antenna gain. Additionally pre-tests have shown, that this antenna caused the highest spurious emissions.

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	95.3	-	-	64.0	28.5	0.0	2.8	150	Vert.	-
4.804	52.6	74.0	21.4	41.4	33.1	25.7	3.8	150	Vert.	Yes
12.010	52.4	74.0	21.6	43.7	33.6	25.9	1.0	100	Vert.	Yes
14.412	52.2	75.3	23.1	43.7	33.6	26.3	1.2	100	Vert.	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	92.6	-	-	61.3	28.5	0.0	2.8	150	Vert.	-
4.804	43.8	54.0	10.2	32.6	33.1	25.7	3.8	150	Vert.	Yes
12.010	41.1	54.0	12.9	32.4	33.6	25.9	1.0	100	Vert.	Yes
14.412	39.3	72.6	33.3	30.8	33.6	26.3	1.2	100	Vert.	No

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	95.9	-	-	64.4	28.7	0.0	2.8	150	Vert.	-
4.882	53.8	74.0	20.2	42.3	33.4	25.7	3.8	150	Vert.	Yes
7.323	58.0	74.0	16.0	41.4	36.3	24.6	4.9	150	Vert.	Yes
12.205	51.8	74.0	22.2	43.0	33.6	25.8	1.0	100	Vert.	Yes
14.646	53.2	75.9	22.7	45.0	33.6	26.6	1.2	100	Vert.	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
2.441	93.3	-	-	61.8	28.7	0.0	2.8	150	Vert.	-
4.882	44.9	54.0	9.1	33.4	33.4	25.7	3.8	150	Vert.	Yes
7.323	45.2	54.0	8.8	28.6	36.3	24.6	4.9	150	Vert.	Yes
12.205	39.9	54.0	14.1	31.1	33.6	25.8	1.0	100	Vert.	Yes
14.646	40.0	73.3	33.3	31.8	33.6	26.6	1.2	100	Vert.	No

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	98.1	-	-	66.6	28.7	0.0	2.8	150	Vert.	-
4.960	47.7	74.0	26.3	36.0	33.5	25.6	3.8	150	Vert.	Yes
7.440	58.2	74.0	15.8	42.4	36.3	24.5	5.0	150	Vert.	Yes
9.920	55.6	78.1	22.5	34.2	38.5	24.0	6.9	150	Hor.	No
12.400	46.0	74.0	28.0	37.1	33.7	25.8	1.0	100	Hor.	Yes
14.880	53.3	78.1	24.8	44.7	33.7	26.3	1.2	100	Vert.	No
17.360	45.9	78.1	32.2	37.4	33.8	26.7	1.4	100	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
2.480	95.4	-	-	63.9	28.7	0.0	2.8	150	Vert.	-
4.960	40.6	54.0	13.4	28.9	33.5	25.6	3.8	150	Vert.	Yes
7.440	50.7	54.0	3.3	34.9	36.3	24.5	5.0	150	Vert.	Yes
9.920	43.3	75.4	32.1	21.9	38.5	24.0	6.9	150	Hor.	No
12.400	32.5	54.0	21.5	23.6	33.7	25.8	1.0	100	Hor.	Yes
14.880	40.4	75.4	35.0	31.8	33.7	26.3	1.2	100	Vert.	No
17.360	31.5	75.4	43.9	23.0	33.8	26.7	1.4	100	Hor	No

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

5.9.2.3 PRELIMINARY MEASUREMENT WITH INTERNAL ANTENNA (9 kHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	53 %

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.

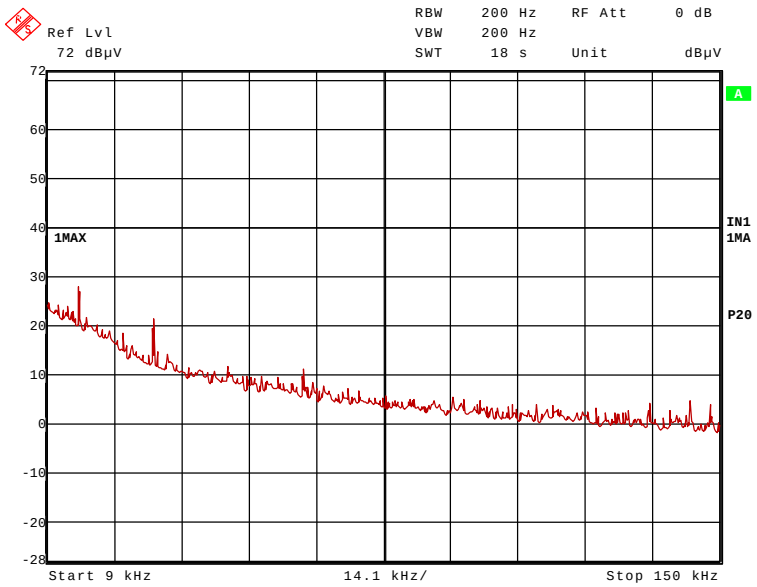
Cable guide: The cable of the EUT was fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: Where not otherwise stated the test was carried out in test mode 2 of the EUT, because there was no difference to the other test modes. All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

Remark: The emissions found around 16 kHz, 32 kHz, 48 and 62 kHz caused by the measuring system and not from the EUT.

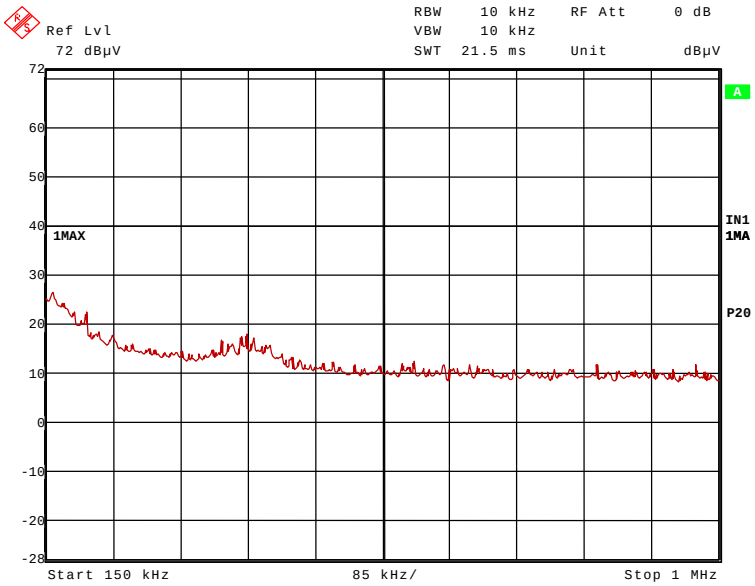
51145147.wmf: (9 kHz to 150 kHz):



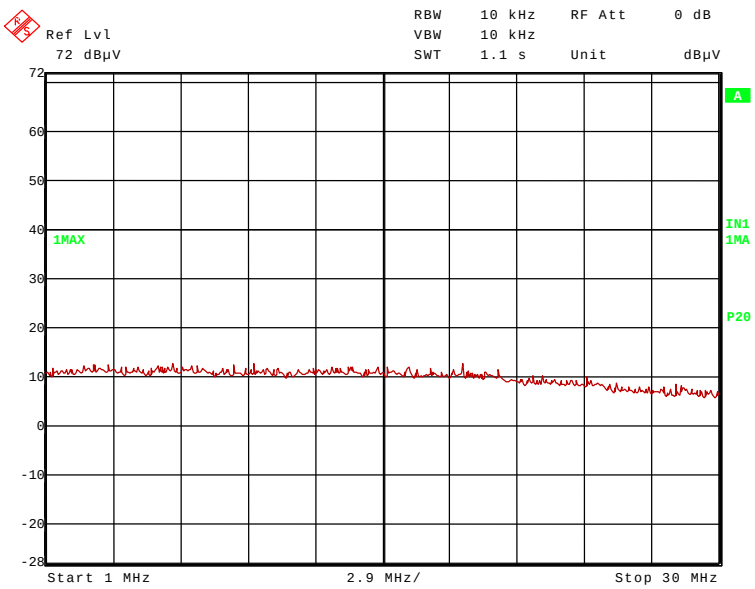
TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

51145148.wmf: (150 kHz to 1 MHz):

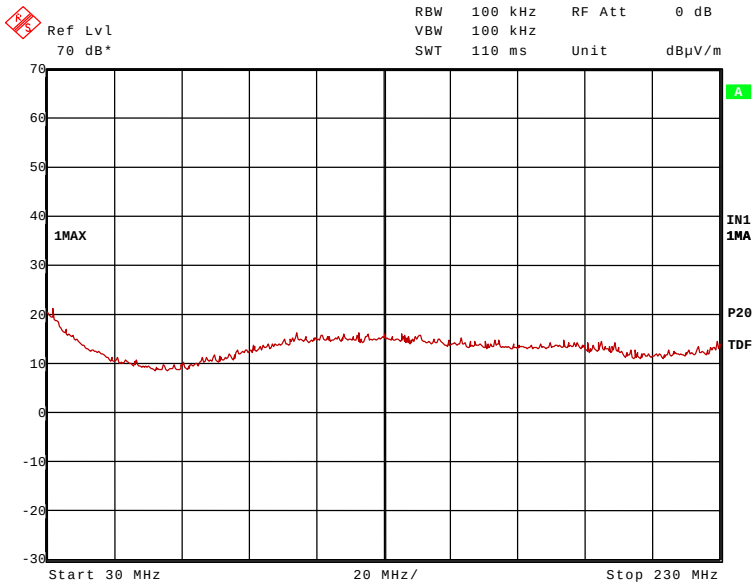


51145149.wmf: (1 MHz to 30 MHz)

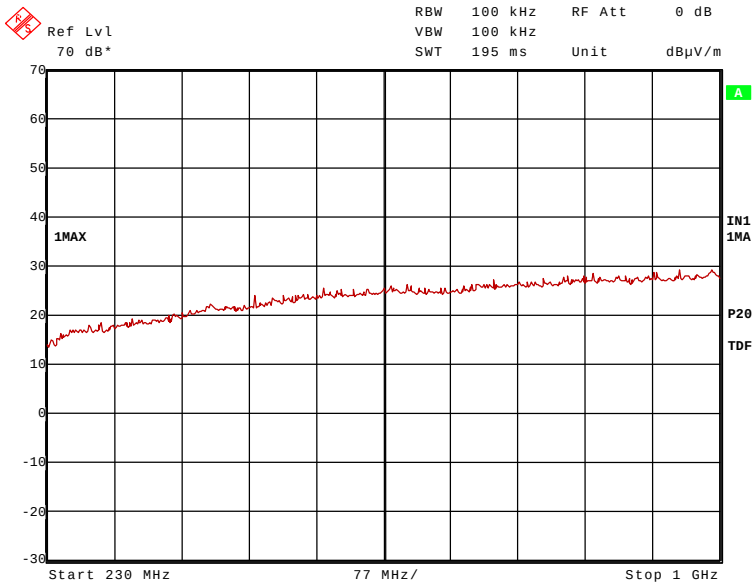


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

51145132.wmf (30 MHz to 230 MHz):



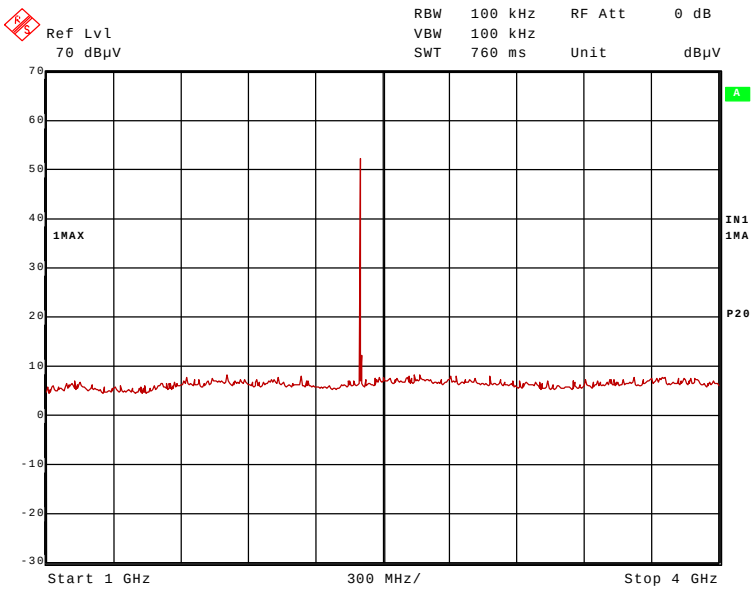
51145133.wmf (230 MHz to 1 GHz):



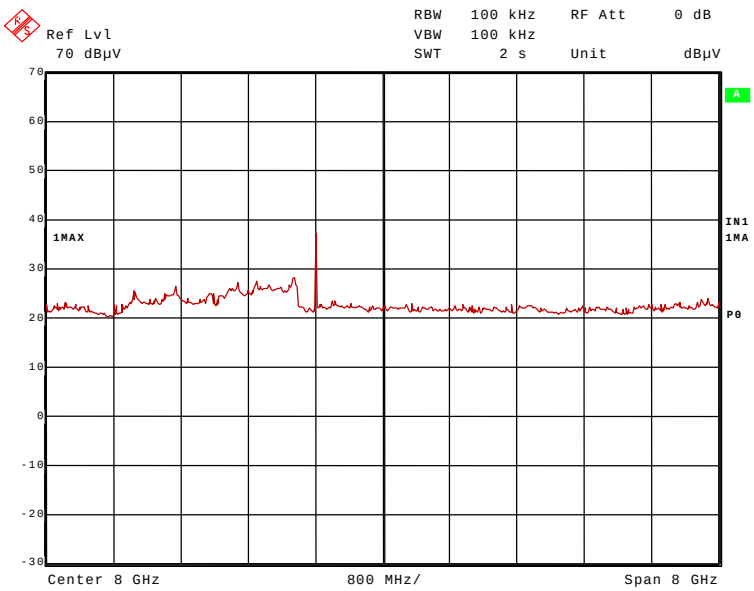
No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

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

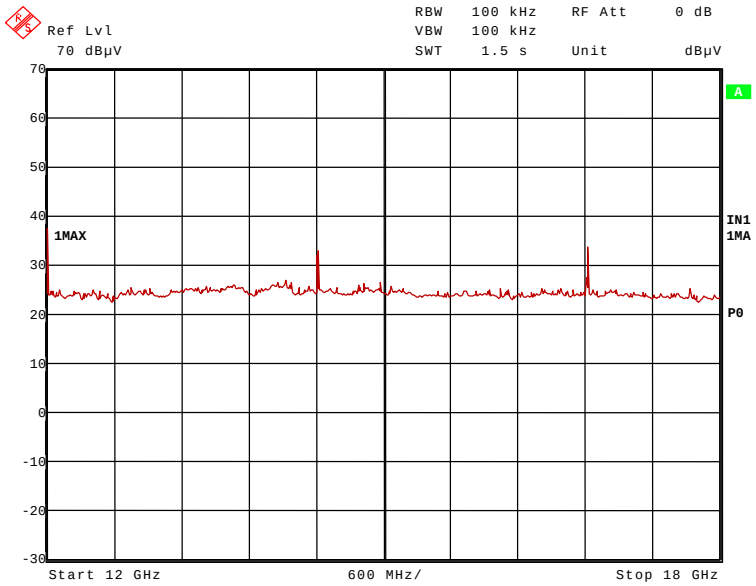
51145104.wmf (1 GHz to 4 GHz):



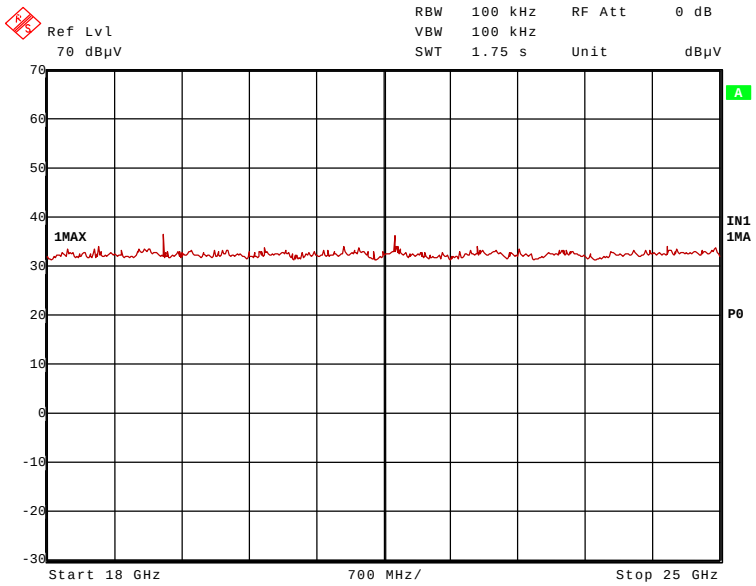
51145109.wmf (4 GHz to 12 GHz):



51145115.wmf (12 GHz to 18 GHz):



51145120.wmf (18 GHz to 25 GHz):



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

- 12.010 GHz and 19.216 GHz.

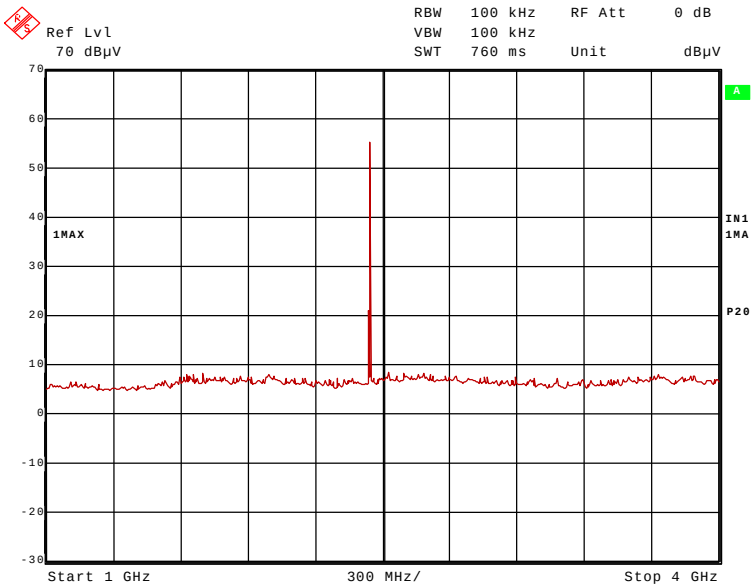
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.402 GHz, 7.206 GHz, 14.412 GHz, 16.814 GHz and 21.618 GHz.

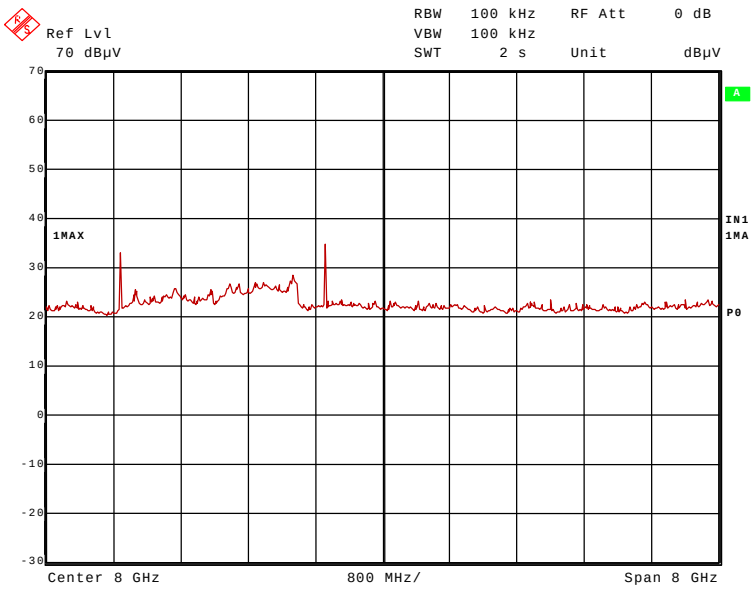
These frequencies have to be measured in a final measurement. The results were presented in the following.

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

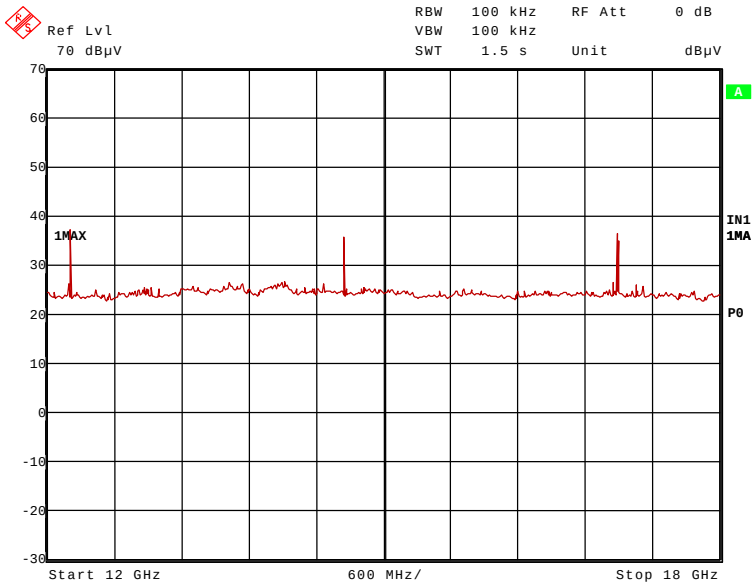
51145105.wmf (1 GHz to 4 GHz):



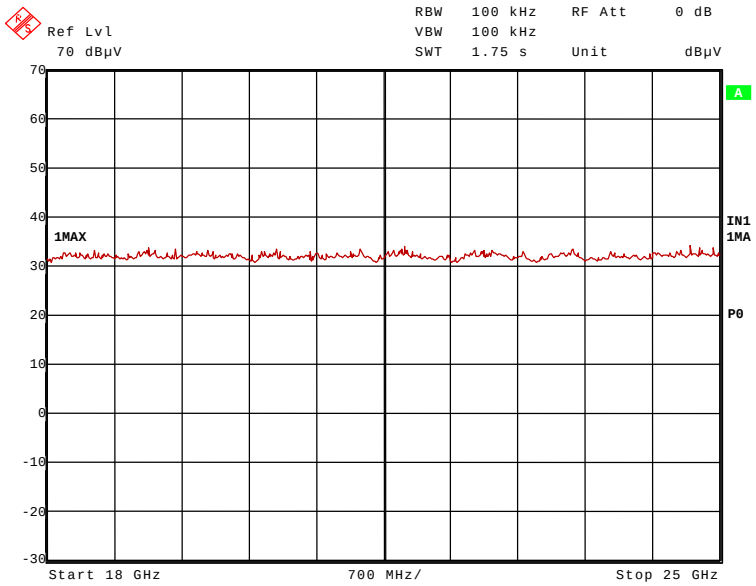
51145108.wmf (4 GHz to 12 GHz):



51145116.wmf (12 GHz to 18 GHz):



51145121.wmf (18 GHz to 25 GHz):



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

- 4.882 GHz, 7.323 GHz and 12.205 GHz.

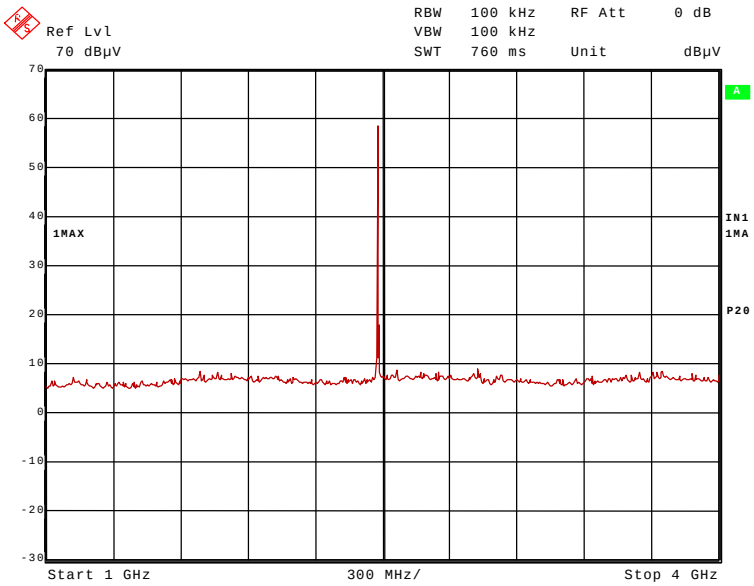
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.441 GHz and 14.646 GHz and 17.087 GHz.

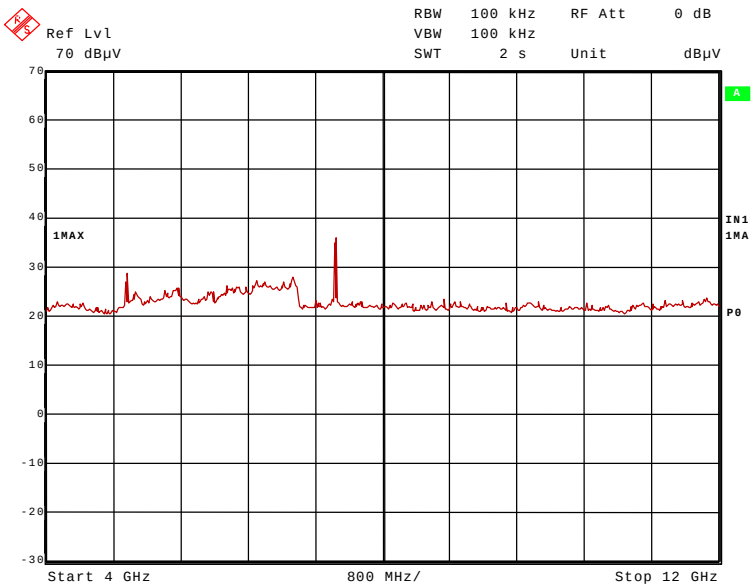
These frequencies have to be measured in a final measurement. The results were presented in the following.

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

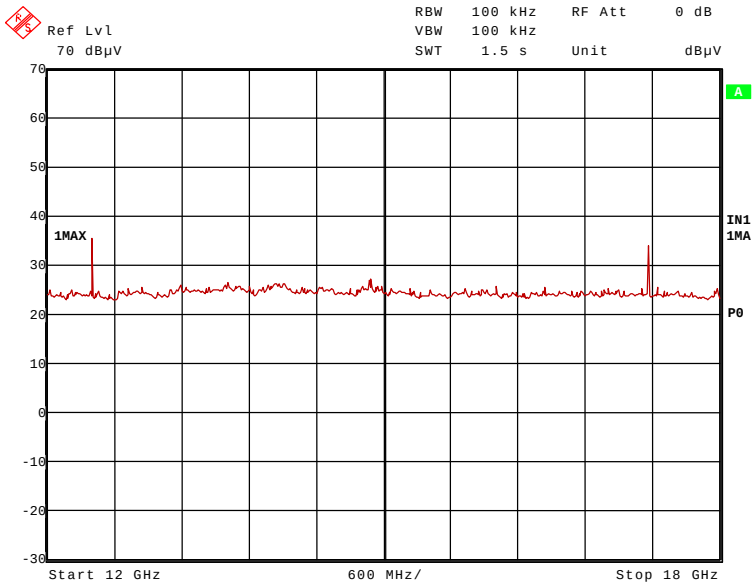
51145106.wmf (1 GHz to 4 GHz):



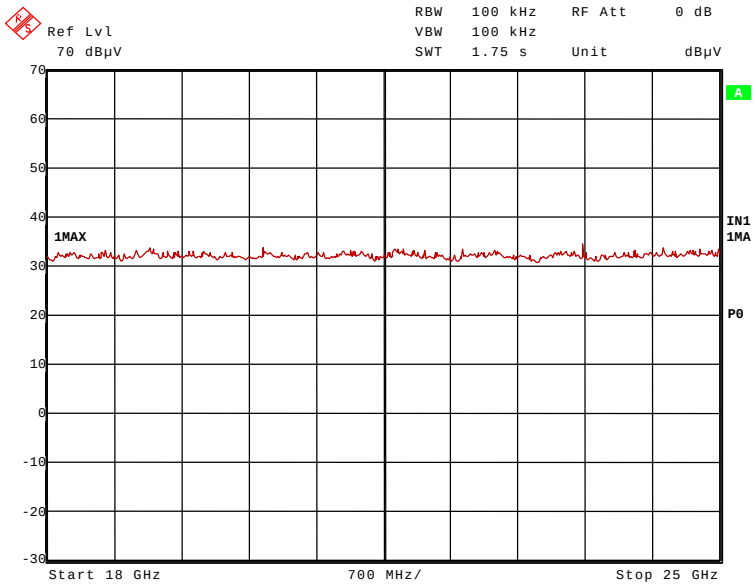
51145107.wmf (4 GHz to 12 GHz):



51145117.wmf (12 GHz to 18 GHz):



51145122.wmf (18 GHz to 25 GHz):



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

- 4.960 GHz, 7.440 GHz and 12.400 GHz.

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

- 2.480 GHz and 17.360 GHz

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

5.9.2.4 FINAL MEASUREMENT WITH INTERNAL ANTENNA (1 GHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	53 %

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 was fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

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	83.5	-	-	52.2	28.5	0.0	2.8	150	Hor.	-
7.206	62.1	74.0	11.9	45.5	36.3	24.6	4.9	150	Hor.	No
12.010	51.3	74.0	22.7	42.6	33.6	25.9	1.0	100	Hor.	Yes
14.412	48.0	74.0	26.0	39.5	33.6	26.3	1.2	100	Vert.	No
16.814	53.5	74.0	20.5	45.7	33.8	27.4	1.4	100	Vert.	No
19.216	43.9	74.0	30.1	43.3	37.1	38.0	1.5	100	Hor.	Yes
21.618	45.9	74.0	28.1	45.4	37.2	38.3	1.6	100	Vert.	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	80.6	-	-	49.3	28.5	0.0	2.8	150	Hor.	-
7.206	51.4	60.6	9.2	34.8	36.3	24.6	4.9	150	Hor.	No
12.010	39.3	54.0	14.7	30.6	33.6	25.9	1.0	100	Hor.	Yes
14.412	34.3	60.6	26.3	25.8	33.6	26.3	1.2	100	Vert.	No
16.814	33.1	60.6	27.5	25.3	33.8	27.4	1.4	100	Vert.	No
19.216	29.8	54.0	24.2	29.2	37.1	38.0	1.5	100	Hor.	Yes
21.618	30.9	60.6	29.7	30.4	37.2	38.3	1.6	100	Vert.	No

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	87.8	-	-	56.3	28.7	0.0	2.8	150	Hor.	-
4.882	52.4	74.0	21.6	40.9	33.4	25.7	3.8	150	Hor.	Yes
7.323	61.2	74.0	12.8	44.6	36.3	24.6	4.9	150	Hor.	Yes
12.205	50.6	74.0	23.4	41.3	33.6	25.8	1.0	100	Hor.	Yes
14.646	48.1	74.0	25.9	39.9	33.6	26.6	1.2	100	Vert.	No
17.087	49.2	74.0	24.8	41.3	33.8	27.3	1.4	100	Vert.	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
2.441	85.0	-	-	53.5	28.7	0.0	2.8	150	Hor.	-
4.882	42.5	54.0	11.5	31.0	33.4	25.7	3.8	150	Hor.	Yes
7.323	48.9	54.0	5.1	32.3	36.3	24.6	4.9	150	Hor.	Yes
12.205	37.9	54.0	16.1	29.1	33.6	25.8	1.0	100	Hor.	Yes
14.646	34.2	65.0	30.8	26.0	33.6	26.6	1.2	100	Vert.	No
17.087	33.4	65.0	31.6	25.5	33.8	27.3	1.4	100	Vert.	No

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	89.8	-	-	58.3	28.7	0.0	2.8	150	Hor.	-
4.960	52.5	74.0	21.5	40.8	33.5	25.6	3.8	150	Hor.	Yes
7.440	61.1	74.0	12.9	44.3	36.3	24.5	5.0	150	Hor.	Yes
12.400	48.8	74.0	25.2	39.9	33.7	25.8	1.0	100	Hor.	Yes
17.360	48.1	74.0	25.9	39.6	33.8	26.7	1.4	100	Vert.	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
2.480	87.0	-	-	55.5	28.7	0.0	2.8	150	Hor.	-
4.960	40.5	54.0	13.5	28.8	33.5	25.6	3.8	150	Hor.	Yes
7.440	50.1	54.0	3.9	33.3	36.3	24.5	5.0	150	Hor.	Yes
12.400	36.7	54.0	17.3	27.8	33.7	25.8	1.0	100	Hor.	Yes
17.360	33.3	67.0	33.7	24.8	33.8	26.7	1.4	100	Vert.	No

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

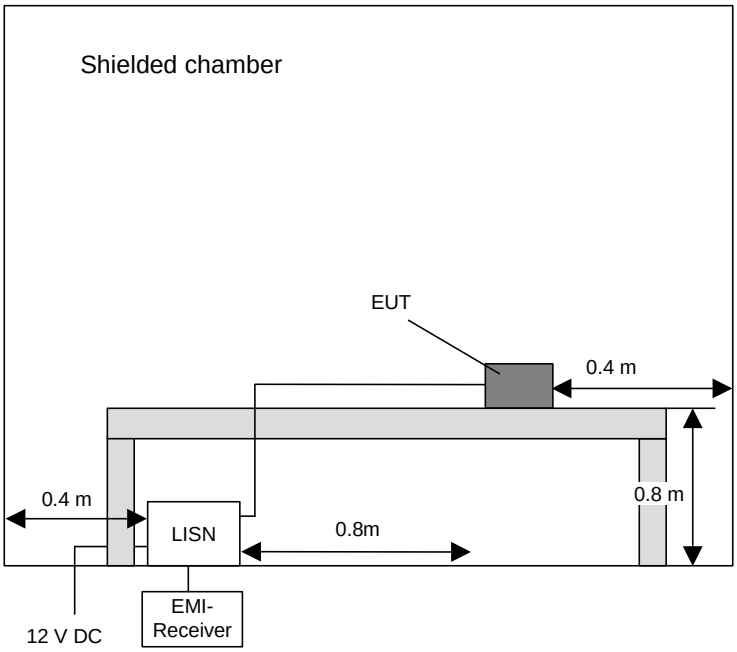
5.10 CONDUCTED EMISSIONS ON POWER SUPPLY LINES (150 kHz to 30 MHz)

5.10.1 METHOD OF MEASUREMENT

This test will be carried out in a shielded 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 above the ground plane. Floor-standing devices will be placed directly on the ground plane. The set up of the Equipment under test will be in accordance to
ANSI C63.4-2003 [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.10.2 TEST RESULTS (CONDUCTED EMISSIONS ON POWER SUPPLY LINES)

Ambient temperature	20 °C	Relative humidity	42 %

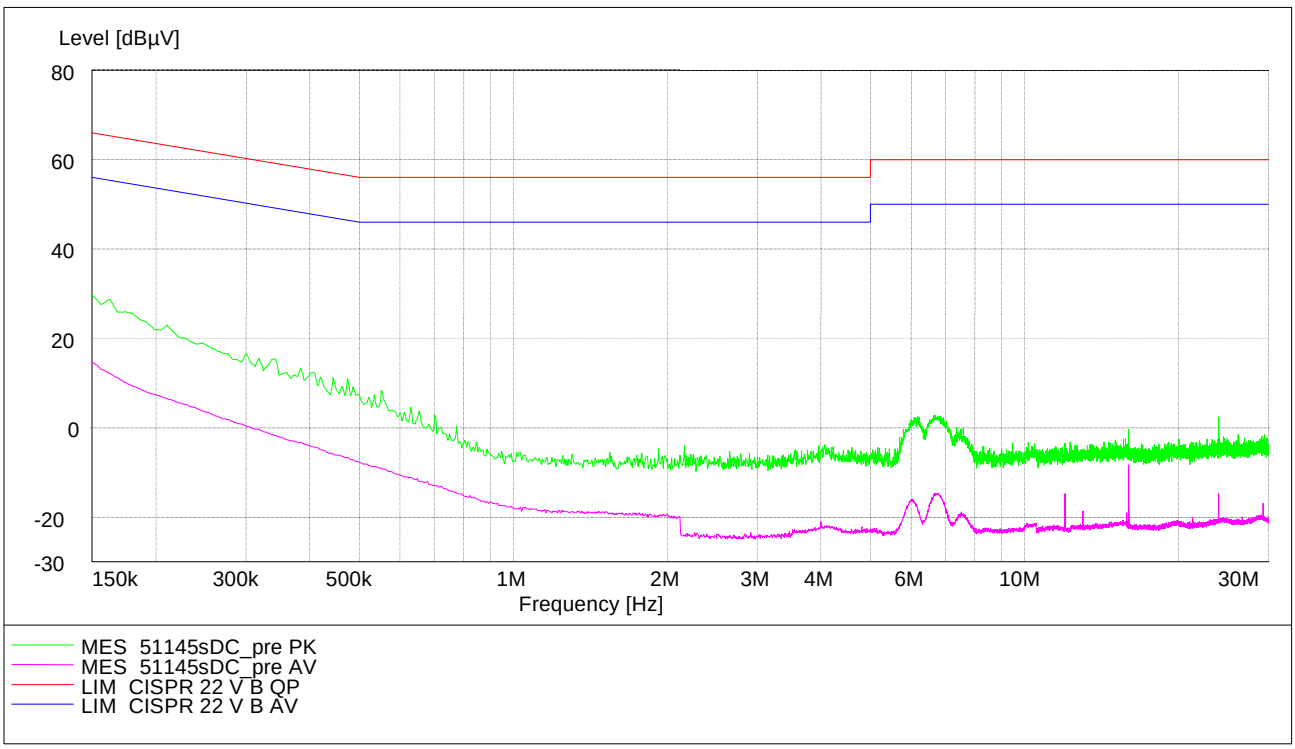
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: The cable of the EUT was fixed on the non-conducting table. For further information of 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 5.0 V DC via the carrier board.

Title: DC Powerline Conducted Emission Test with protective ground conductor simulating network
EUT: cB-0901-0301
Manufacturer: connectBlue AB
Operating Condition: Transmit on channel 39
Test site: PHOENIX TEST-LAB Blomberg M4
Operator: Th. KÜHN
Test Specification:
Comment:



Data record name: 51145sDC

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

1 – 3, 5, 6

5.11 RADIATED EMISSIONS (RECEIVER)

5.11.1 PRELIMINARY MEASUREMENT WITH EXTERNAL ANTENNA (9 kHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	57 %

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.

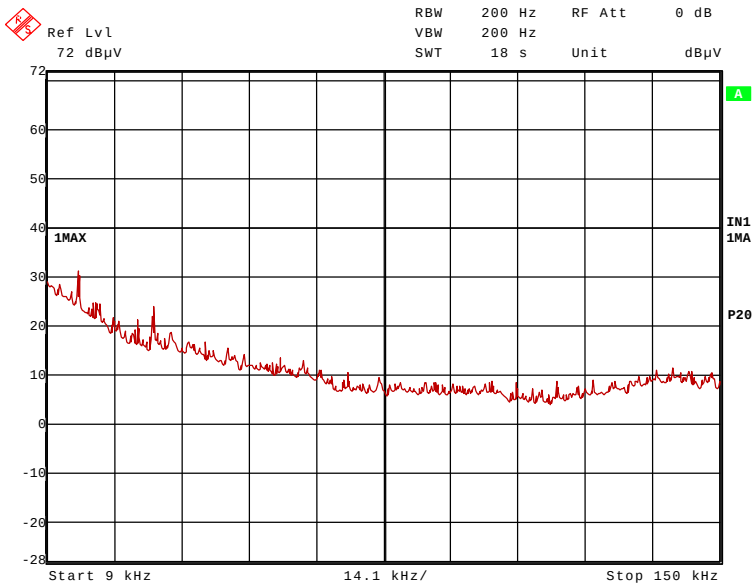
Cable guide: The cable of the EUT was fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following. Where not otherwise stated the test was carried out in test mode 7 of the EUT, because there was no difference to the other test modes.

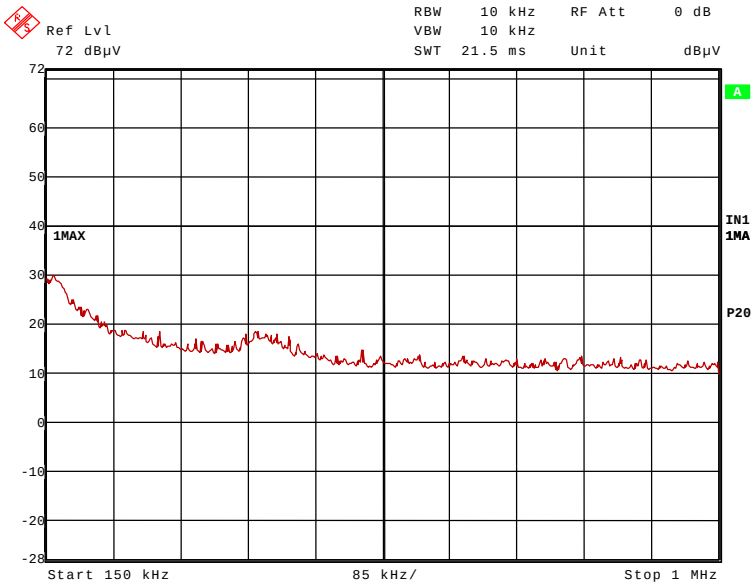
Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

Remark: The emissions found around 16 kHz, 32 kHz, 48 and 62 kHz caused by the measuring system and not from the EUT.
As external antenna the WCR-2400-SMA was used, because of the highest antenna gain. Additionally pre-tests have shown, that this antenna caused the highest spurious emissions.

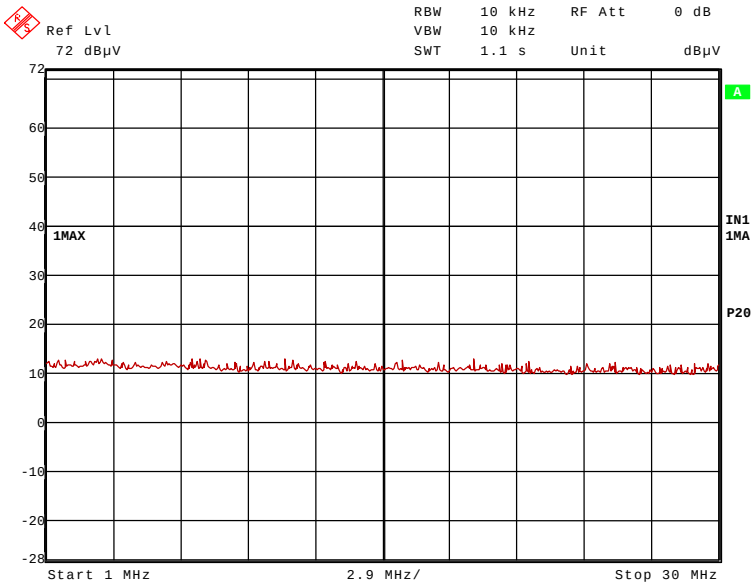
51145138.wmf: (9 kHz to 150 kHz):



51145139.wmf: (150 kHz to 1 MHz):

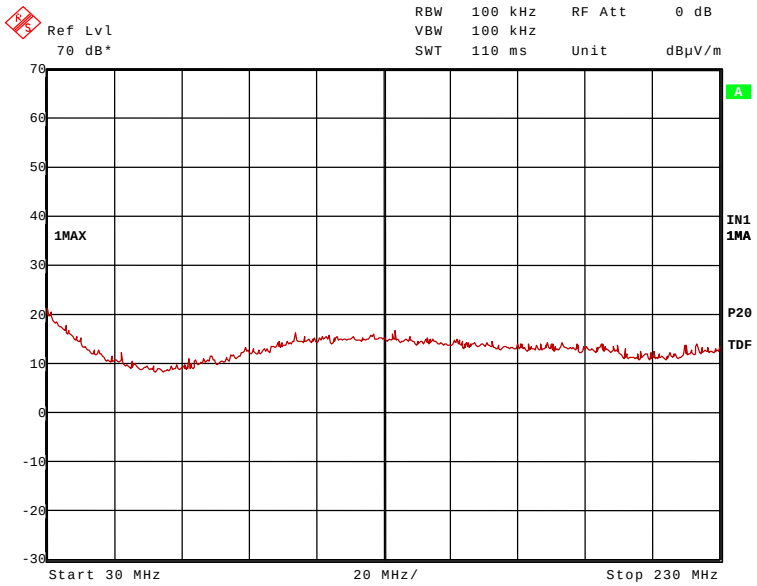


51145140.wmf: (1 MHz to 30 MHz):

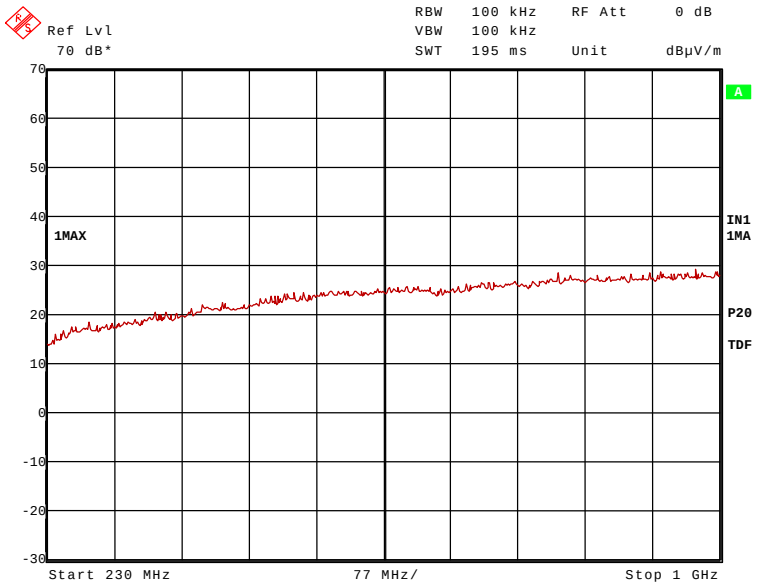


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

51145136.wmf (30 MHz to 230 MHz):

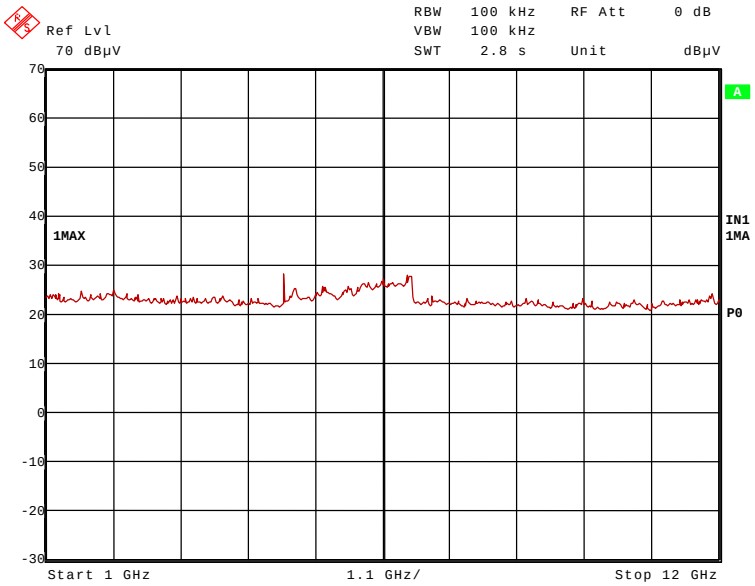


51145137.wmf (30 MHz to 230 MHz):

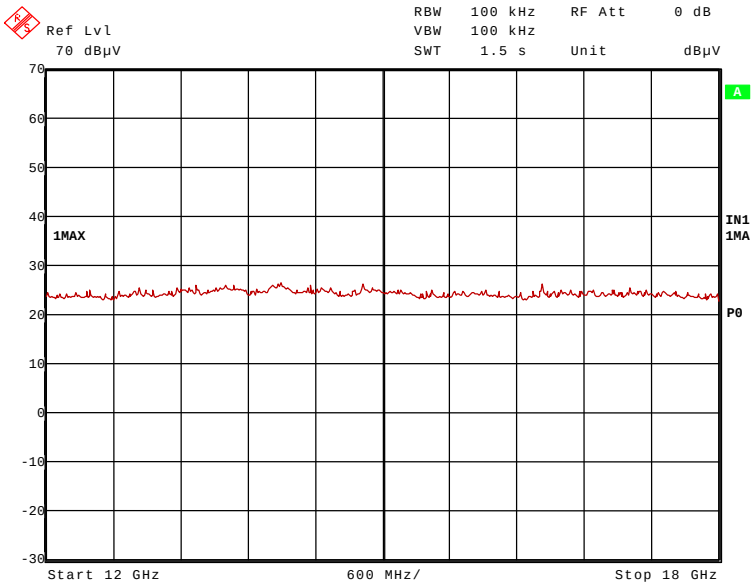


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out the open area test site.

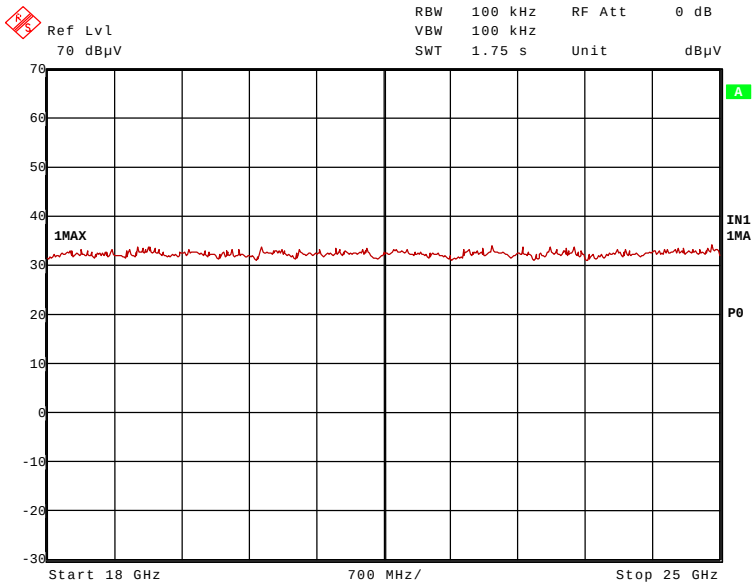
51145113.wmf (1 GHz to 12 GHz):



51145126.wmf (12 GHz to 18 GHz):



51145127.wmf (18 GHz to 25 GHz):



The following frequencies were found during the preliminary radiated emission measurement:

- 4.884 GHz.

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

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

5.11.2 FINAL MEASUREMENT WITH EXTERNAL ANTANNA (1 GHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	57 %

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 cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following. Where not otherwise stated the test was carried out in test mode 7 of the EUT, because there was no difference to the other test modes.

Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

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

Remark: As external antenna the WCR-2400-SMA was used, because of the highest antenna gain. Additionally pre-tests have shown, that this antenna caused the highest spurious emissions.

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.
4.884	44.6	74.0	29.4	32.9	33.5	25.6	3.8	150	Hor.

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.
4.884	33.2	54.0	20.8	21.5	33.5	25.6	3.8	150	Hor.

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

5.11.3 PRELIMINARY MEASUREMENT WITH INTERNAL ANTENNA (9 kHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	57 %

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.

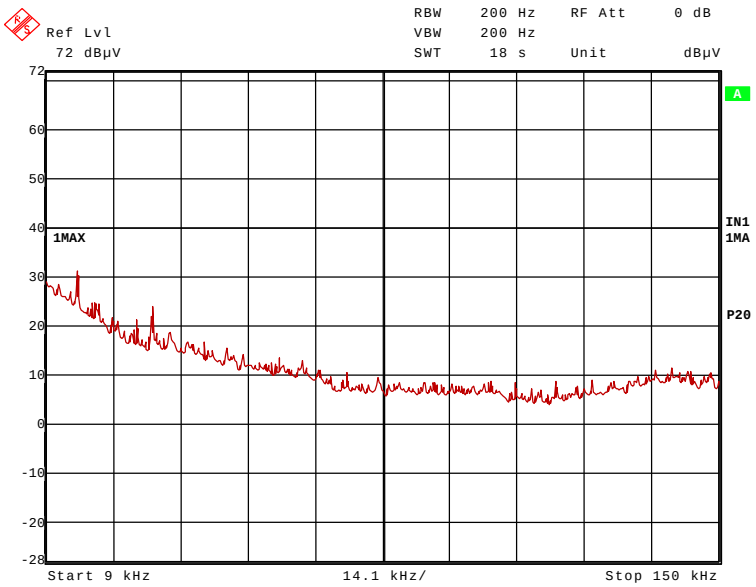
Cable guide: The cable of the EUT was fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following. Where not otherwise stated the test was carried out in test mode 7 of the EUT, because there was no difference to the other test modes.

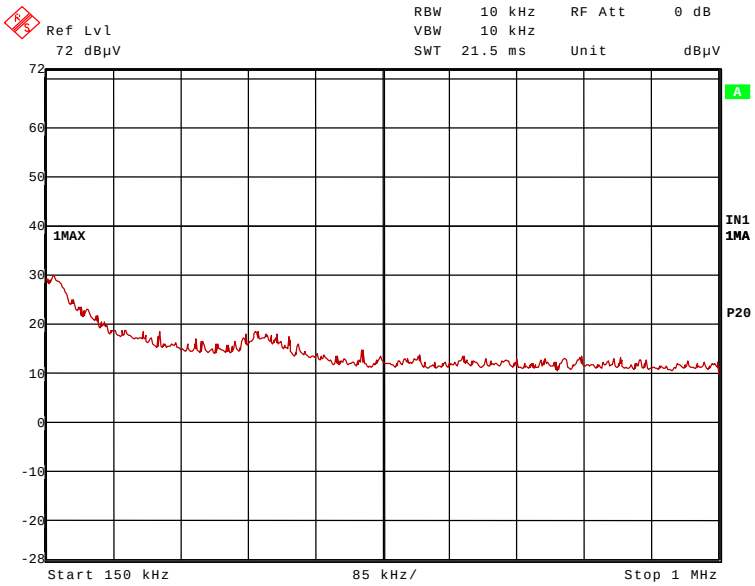
Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

Remark: The emissions found around 16 kHz, 32 kHz, 48 and 62 kHz caused by the measuring system and not from the EUT.

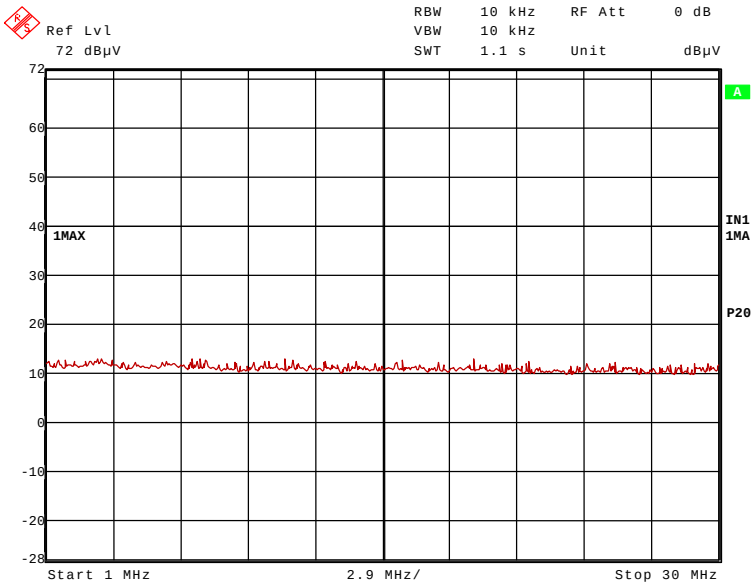
51145141.wmf: (9 kHz to 150 kHz):



51145142.wmf: (150 kHz to 1 MHz):

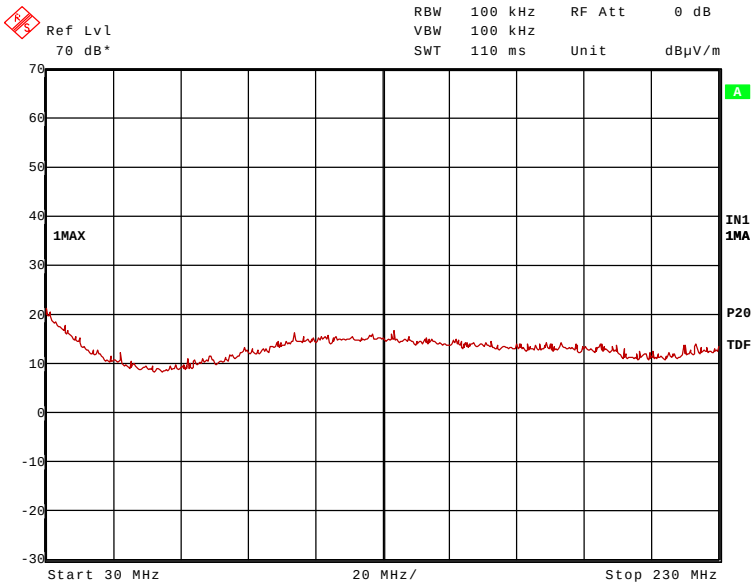


51145143.wmf: (1 MHz to 30 MHz):

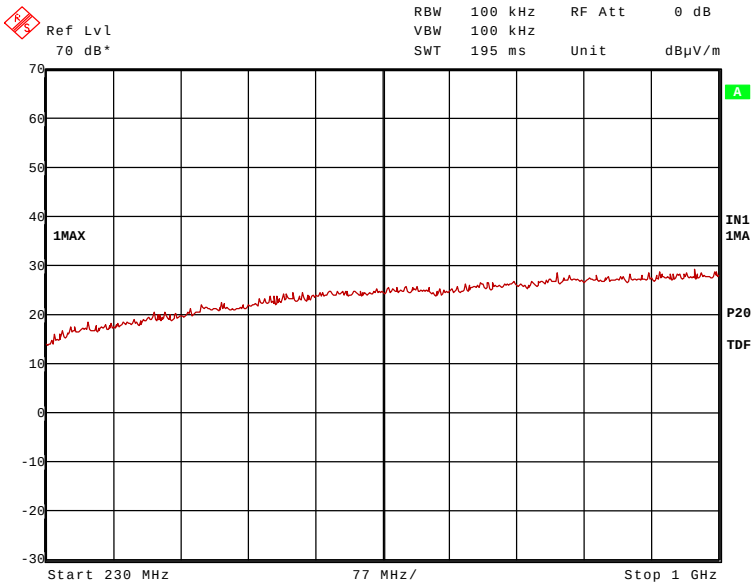


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

51145134.wmf (30 MHz to 230 MHz):

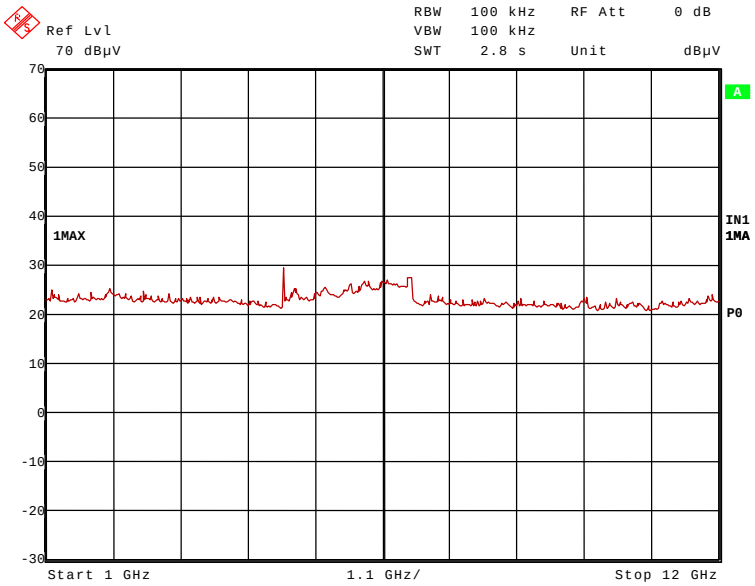


51145135.wmf (230 MHz to 1 GHz):

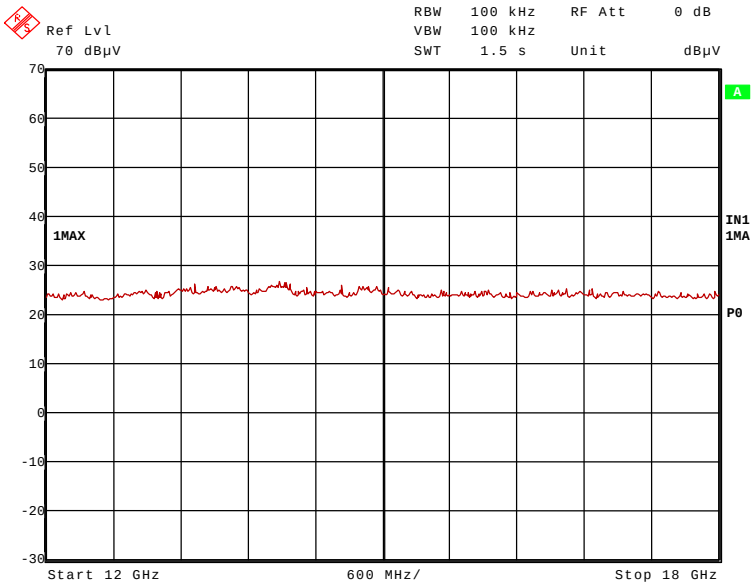


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out the open area test site.

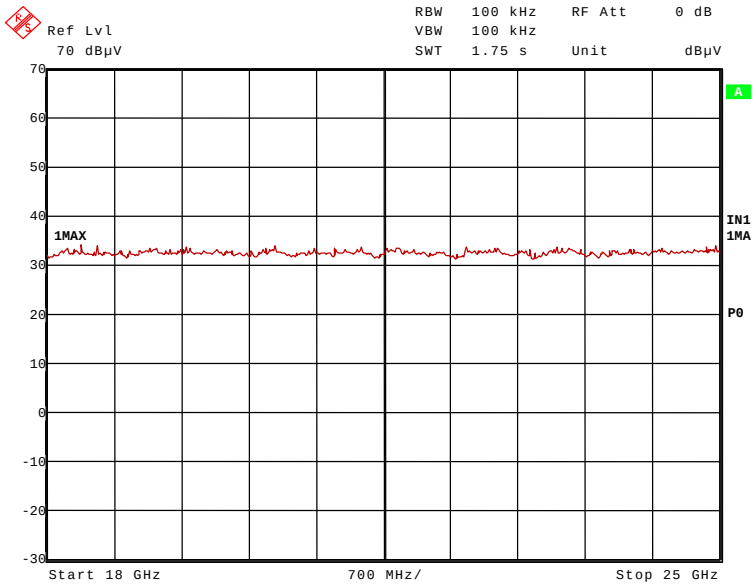
51145114.wmf (1 GHz to 12 GHz):



51145118.wmf (12 GHz to 18 GHz):



51145119.wmf (18 GHz to 25 GHz):



The following frequencies were found during the preliminary radiated emission measurement:

- 4.884 GHz.

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

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

5.11.4 FINAL MEASUREMENT WITH INTERNAL ANTANNA (1 GHz to 25 GHz)

Ambient temperature	21 °C	Relative humidity	57 %

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 cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following. Where not otherwise stated the test was carried out in test mode 7 of the EUT, because there was no difference to the other test modes.

Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

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

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.
4.884	47.2	74.0	26.8	35.5	33.5	25.6	3.8	150	Vert.

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.
4.884	40.6	54.0	13.4	28.9	33.5	25.6	3.8	150	Vert.

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39, 43, 46, 49 – 51, 54

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

Emission measurement at AC mains and DC in / out ports at M4					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
1	Shielded chamber M4	-	Siemens	B83117S1-X158	480088
2	Measuring receiver	ESAI	Rohde & Schwarz	831953/001 833181/018	480025 480026
3	LISN	NSLK8128	Schwarzbeck	8128155	480058
4	DC-filter	B84266-A21-E13	Siemens	940164525	480099
5	AC-filter	B84299-D87-E3	Siemens	930262292	480097
6	EMI-Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M5					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
7	Fully anechoic chamber M5	-	Siemens	B83177-S1-X156	480073
8	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
9	Controller	HD100	Deisel	100/324	480067
10	Antenna support	MA240	Deisel	228/314	480069
11	Turntable	DS412	Deisel	412/317	480070
12	Antenna	CBL6112C	Chase	2689	480327
13	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M6					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
14	Open area test site	-	Phoenix Test-Lab	-	480085
15	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
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 A	Chase	1643	480147
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M8					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
21	Fully anechoic chamber M8	-	Siemens	B83117-E7019-T231	480190
22	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
23	Measuring receiver	ESCS 30	Rohde & Schwarz	828985/014	480270
24	Controller	HD100	Deisel	100/427	480181
25	Turntable	DS420	Deisel	420/435/97	480186
26	Antenna support	AS615P	Deisel	615/310	480187
27	Antenna	CBL6112 A	Chase	2034	480185
28	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M20					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303
30	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355
32	Controller	HD100	Deisel	100/670	480326
33	Turntable	DS420HE	Deisel	420/620/80	480315
34	Antenna support	AS615P	Deisel	615/310	480187
35	Antenna	CBL6112 B	Chase	2688	480328
36	Antenna	3115 A	EMCO	9609-4918	480183
37	Standard Gain Horn 11.9GHz – 18GHZ	18240-20	Flann Microwave	483	480294
38	Standard Gain Horn 11.9GHz – 18GHZ	18240-20	Flann Microwave	482	480295
39	Standard Gain Horn 17.9GHz – 26.7GHZ	20240-20	Flann Microwave	411	480297
40	Standard Gain Horn 17.9GHz – 26.7GHZ	20240-20	Flann Microwave	410	480296
41	Standard Gain Horn 26.4GHz – 40.1GHZ	22240-20	Flann Microwave	469	480299

No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
42	Standard Gain Horn 26.4GHz – 40.1GHZ	22240-20	Flann Microwave	468	480298
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142
45	RF-cable 1m	KPS-1533-400-KPS	Insulated Wire	-	480300
46	RF-cable 1m	KPS-1533-400-KPS	Insulated Wire	-	480301
47	RF-cable 2m	KPS-1533-400-KPS	Insulated Wire	-	480302
48	RF-cable No. 5	RTK 081	Rosenberger		410097
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337
50	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343
51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342
52	Preamplifier	JS3-26004000-25-5A	Miteq	563593	480344
53	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Ancillary equipment used for testing					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
54	Power supply	TOE 8852	Toellner	51712	480233
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

All used measurement equipment was calibrated (if necessary). The calibration intervals and the calibration history will be given out on request.

7 LIST OF ANNEXES

Annex A	**Photographs of the test set-ups:**	**5 pages**
	cB-0901-0301 with external antenna, test set-up fully anechoic chamber	51145_c.jpg
	cB-0901-0301 with internal antenna, test set-up fully anechoic chamber	51145_q.jpg
	cB-0901-0301 with internal antenna, test set-up fully anechoic chamber	51145_n.jpg
	cB-0901-0301 with external antenna, test set-up fully anechoic chamber	51145_f.jpg
	cB-0901-0301 test set-up conducted emission measurement	51145_x.jpg
ANNEX B	**INTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**5 pages**
	cB-0901-0301 Sample “14”, top view	51145_5.jpg
	cB-0901-0301 Sample “4”, top view	51145_4.jpg
	cB-0901-0301 bottom view	51145_8.jpg
	cB-0901-02 carrier board, top view	51145_1.jpg
	cB-0901-02 carrier board, bottom view	51145_3.jpg
ANNEX C	**EXTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**- pages**
	Because the EUT is a module, which is intended to be implemented inside a final application, no external photographs were available	