

Test Report

Report Number: F101347E3

Applicant:

connectBlue AB

Manufacturer:

connectBlue AB

Equipment under Test (EUT):

cB-0939



Laboratory (CAB) accredited by
Deutsche Gesellschaft für Akkreditierung mbH
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. DGA-PL-105/99-22,
FCC Test site registration number 90877 and
Industry Canada Test site registration IC3469A-1

REFERENCES

- [1] **ANSI C63.4-2009** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- [2] **FCC CFR 47 Part 15 (October 2009)** Radio Frequency Devices
- [3] **FCC Public Notice DA 00-705 (March 2000)**
- [4] **RSS-210 Issue 7 (June 2007)** Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment
- [5] **RSS-Gen Issue 2 (June 2007)** General Requirements and Information for the Certification of Radiocommunication Equipment
- [6] **Publication Number 913591 (March 2007)** Measurement of radiated emissions at the edge of the band for a Part 15 RF Device

TEST RESULT

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

Test engineer:	Thomas KÜHN		23 August 2010
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		23 August 2010
	Name	Signature	Date

RESERVATION

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1 IDENTIFICATION

1.1 APPLICANT

Name:	connectBlue AB
Address:	Norra Vallgatan 64 3V Malmö SE-211 19
Country:	Sweden
Name for contact purposes:	Mr. Martin Engdahl
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	martin.engdahl@connectblue.se
Applicant represented during the test by the following person:	-

1.2 MANUFACTURER

Name:	connectBlue AB
Address:	Norra Vallgatan 64 3V Malmö SE-211 19
Country:	Sweden
Name for contact purposes:	Mr. Martin Engdahl
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	martin.engdahl@connectblue.se
Applicant represented during the test by the following person:	-

1.3 TEST LABORATORY

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

accredited by DGA Deutsche Gesellschaft für Akkreditierung mbH in compliance with DIN EN ISO/IEC 17025 under Reg. No. DGA-PL-105/99-22, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (EQUIPMENT UNDER TEST)

Test object: *	Bluetooth module
Type: *	cB-0939
FCC ID: *	PVH0939
IC: *	5325A-0939
Serial number: *	None
PCB identifier: *	cB-0939-B1 / cB-0939-A1
Hardware version: *	1.0
Software version: *	3.7.0

1.5 TECHNICAL DATA OF EQUIPMENT

Channel 1	RX:	2402 MHz	TX:	2402 MHz
Channel 39	RX:	2441 MHz	TX:	2441 MHz
Channel 79	RX:	2480 MHz	TX:	2480 MHz

Fulfills Bluetooth specification: *	3.0 with EDR (class 1)				
Adaptive frequency hopping: *	Yes				
Antenna type: *	Integral and external (refer table below)				
Antenna gain: *	refer table below				
Antenna connector: *	With internal antenna, no antenna connector is mounted. For external antennas a Hirose U.FL connector is used				
Power supply: *	U _{nom} =	5.0 V DC	U _{min} =	3.3 V DC	U _{max} = 6.0 V DC
Type of modulation: *	FHSS: GFSK (1 Mbps), $\pi/4$ -DPQSK (2 Mbps) or 8DPSK (3 Mbps)				
Operating frequency range:*	2402 MHz to 2480 MHz				
Number of channels: *	79				
Temperature range: *	-40 °C to +85 °C				
Internal clock frequencies	32.768 kHz, 16 MHz and 72 MHz				

* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
DC in (carrier board)	6.3 mm jack plug	-	2 m *
-	-	-	-

*: Length during the test if no other specified.

Used antennas:

Antenna name	Manufacturer	Antenna Type	Cable length / connector	Gain [dBi] *
MICA	Antenova	Internal	-	2.7
SOA 2400/360/3/20/V	Huber+Suhner	Monopole	1.5 m cable to SMA	3
SOA 2400/360/3/20/V	Huber+Suhner	Monopole	1.5 m cable to SMA + 4 m cable to MCX	0 (incl. cable)
SOA 2400/360/3/20/V	Huber+Suhner	Monopole	1.5 m cable to MCX	3
FlatWhip-2400 (RPSMA)	ProAnt	Monopole	RPSMA connector	3
Outside-2400	ProAnt	Monopole	U.FL/10 cm cable and U.FL/25 cm cable	3
Ex-IT 2400 RP-SMA 28-001	ProAnt	Monopole	RPSMA connector	3
Ex-IT 2400 RP-SMA 70-002	ProAnt	Monopole	RPSMA connector	3
Ex-IT 2400 RP-SMA 70-001	ProAnt	Monopole	RPSMA connector	3
Ex-IT 2400 MHF 70-001	ProAnt	Monopole	10 cm cable with U.FL connector	3
WCR2400-SMRP	Laird Technologies **	Monopole	RPSMA connector	1
WCR2400-IP04 WCR2400-IP10	Laird Technologies **	Monopole	RPSMA connector and cable to U.FL with cable length 10 cm and 25 cm	2
R380.500.139	Radiall	Monopole	RPSMA connector	2
IHF-242	Joymax	Monopole	Cable to MCX and IPC (U.FL) connector	2
Ex-IT 2400 MHF 28	ProAnt	Monopole	10 cm cable with U.FL connector	2
SOA 2400/360/6/0/V	Huber+Suhner	Monopole	4 m cable to MCX	1.1 (incl. cable)
PSTG0-2400HS (RPSMA)	Mobile Mark	Monopole	RPSMA connector	0
SPA 2400/75/8/0/V	Huber+Suhner	Patch	SMA, 4 m cable to MCX	3.4 (incl. cable)
SPA 2400/70/9/0/RCP	Huber+Suhner	Patch	SMA, 4 m cable to MCX	3.4 (incl. cable)
InSide-2400	ProAnt	Patch	Cable to U.FL 10 cm	3
NanoBlue-IP04	Laird Technologies **	Patch	Cable to U.FL 10 cm	2
PlanTec m70cxr (SMA)	REEL	Patch	Cable to RPSMA connector, cable length 20 cm, 100 cm and 300 cm	1

*: declared by the applicant

**: previous Centurion

1.6 DATES

Date of receipt of test sample:	10 May 2010
Start of test:	10 May 2010
End of test:	17 August 2010

2 OPERATIONAL STATES

The EUT is intended to be used in several Bluetooth applications. Because the cB-0939 is a module, which will be implemented in a final application, it was mounted on a carrier board to connect to power supply and change the operation modes of the EUT from a Laptop with test software. As pretests have shown there was no measurable difference between the version with pin list connector or without pin list connector. Therefore all measurements were carried out with the version with pin list connector.

The tests were carried out with unmodified samples with an internal antenna (cB-0939-B1-01, sample marked with "36" for TX and RX tests and B-0939-B1-11, sample marked with "35" (low sensitivity version) for RX tests only) and unmodified samples with an antenna connector (cB-0939-B1-02, sample marked with "49" for TX and RX tests and B-0939-B1-12, sample marked with "57" (low sensitivity version) for RX tests only).

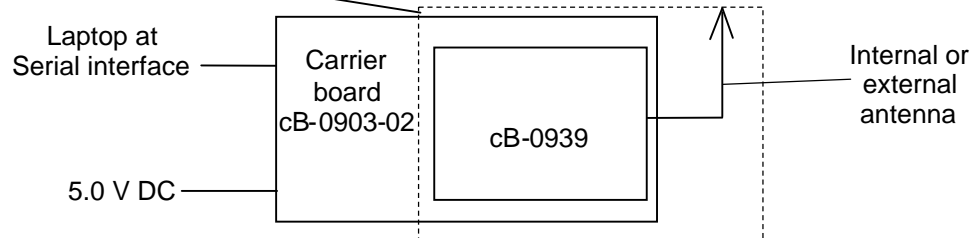
The spurious emission measurement was carried as radiated spurious emissions with internal antenna, as cabinet radiation with terminated antenna port and as conducted emissions on the antenna connector. The receiver spurious radiation was carried out in the same manner but with the both sensitivity versions. During the tests the test sample was powered with 5.0 V DC via either the carrier board cB-0903-02.

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.

The following operation modes were used during the tests:

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

Physical boundary of the EUT with cB-0903-02



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

The 3 orthogonal axes were defined as Pos.1 EUT lying flat, Pos.2 EUT standing vertical on the shorter side (of the carrier board) and Pos 3 EUT standing vertical on the longer side (of the carrier board).

The following test modes were adjusted during the tests:

Test items	Operation mode
20 dB bandwidth	1b, 2b, 3b (3 Mbps)
Carrier frequency separation	1b, 2b, 3b (3 Mbps)
Number of hopping channels	4 (1 Mbps)
Dwell time	2, 2a, 2b (1-, 2- and 3 Mbps)
Maximum peak output power	1, 1a, 1b, 2, 2a, 2b, 3, 3a and 3b (1-, 2- and 3 Mbps)
Conducted emissions (transmitter)	1, 2, 3 (1 Mbps)
Band edge compliance (radiated)	1, 3, 4 (1 Mbps)
Radiated emissions (transmitter)	1, 2, 3 (1 Mbps)
Conducted emissions on supply line	4b (3 Mbps)
Radiated emissions (receiver)	5

3 ADDITIONAL INFORMATION

As declared by the applicant the EUT is available in different Variants. For this variants the model name is extended as described below:

cB-0939-**A1**-01 (without pinlist) / cB-0939-**B1**-01 (with pinlist)
 cB-0939-A **1**-01 (HW version)
 cB-0939-A1-**01** (high sensitivity) / cB-0939-A1- **11** (low sensitivity)
 cB-0939-A1-0**1** (internal antenna) / cB-0939-A1-0**2** (external antenna)

4 OVERVIEW

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 7 [4] or RSS-Gen, Issue 2 [5]	Status	Refer page
20 dB bandwidth	General	15.247 (a) (1)	A8.1 (b) [4]	Passed	11 et seq.
Carrier frequency separation	General	15.247 (a) (1)	A8.1 (b) [4]	Passed	14 et seq.
Number of hopping channels	2400.0 - 2483.5	15.247 (a) (1) (iii)	A8.1 (d) [4]	Passed	17 et seq.
Dwell time	2400.0 - 2483.5	15.247 (a) (1) (iii)	A8.1 (d) [4]	Passed	19 et seq.
Maximum peak output power	2400.0 - 2483.5	15.247 (b) (1)	A8.4 (2) [4]	Passed	23 et seq.
Band edge compliance	2400.0 - 2483.5	15.247 (d)	A8.5 [4]	Passed	26 et seq.
Radiated emissions (transmitter)	0.009 - 25,000	15.205 (a) 15.209 (a)	A8.5 [4] 2.6 [4]	Passed	39 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.2 [5]	Passed	79 et seq.
Radiated emissions (receiver)	0.009 - 25,000	15.109 (a)	6 [5] 2.6 [4]	Passed	Annex D

5 TEST RESULTS

5.1 20 dB BANDWIDTH

5.1.1 METHOD 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 disabled, the transmitter shall work with its maximum data rate.

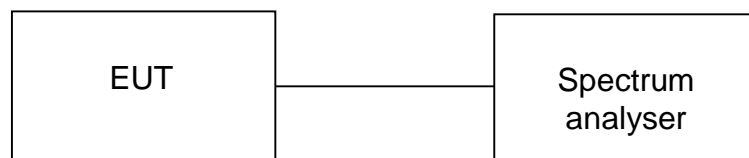
The following spectrum analyser settings shall be used:

- Span: App. 2 to 3 times the 20 dB bandwidth, centred on the actual hopping channel.
- Resolution bandwidth: $\geq 1\%$ of the 20 dB bandwidth.
- Video bandwidth: \geq 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.

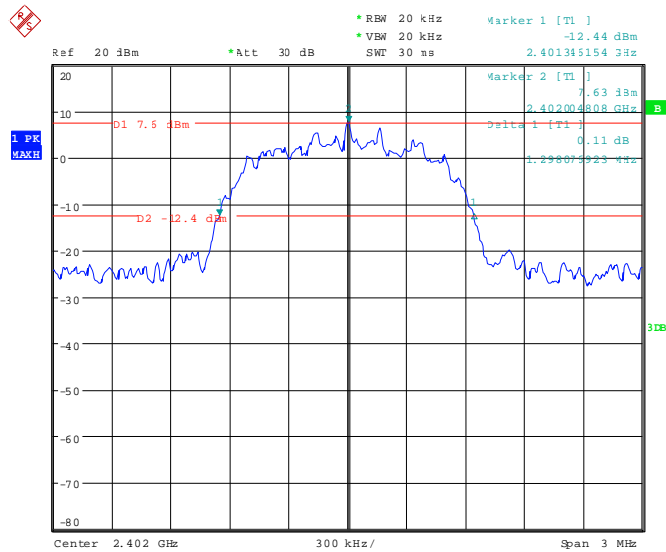
Test set-up:



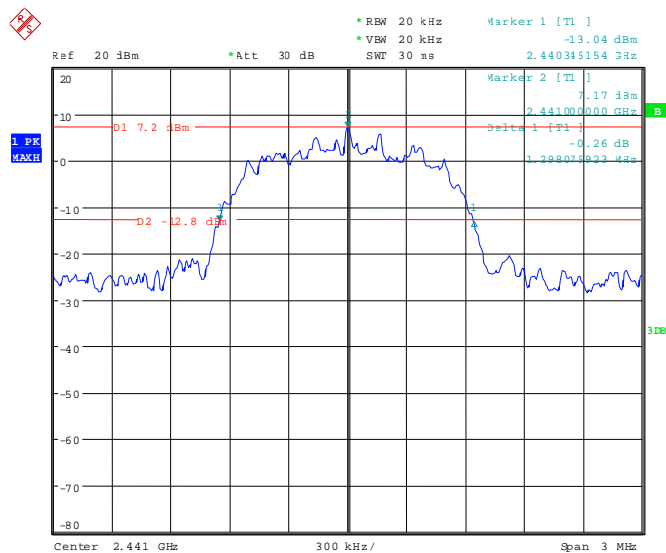
5.1.2 TEST RESULTS (20 dB BANDWIDTH)

Ambient temperature	20 °C	Relative humidity	58 %
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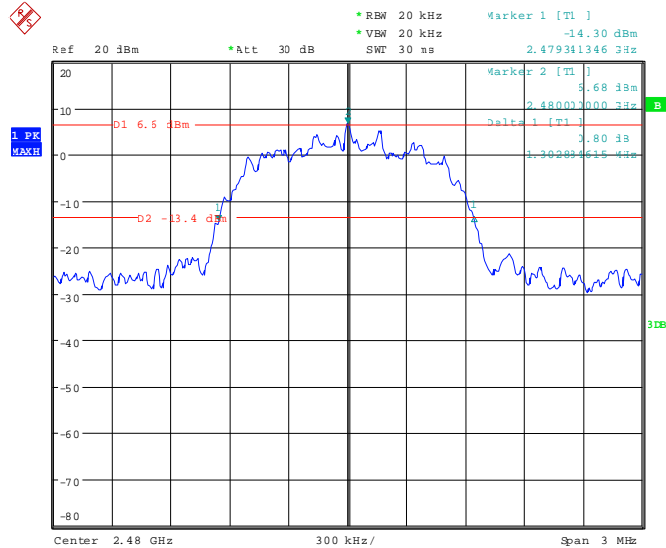
101347_164.wmf: (20 dB bandwidth at the lower end of the assigned frequency band):



101347_165.wmf: (20 dB bandwidth at the middle of the assigned frequency band):



101347_166.wmf: (20 dB bandwidth at the upper end of the assigned frequency band):



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
Operation mode 1b, 2b, 3b		
0	2402	1298.077
39	2441	1298.077
78	2480	1302.885
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 (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.

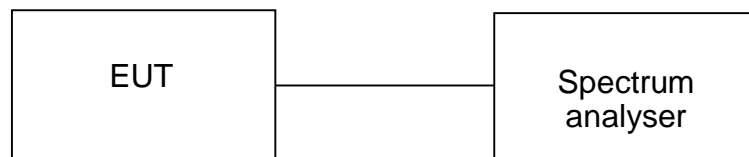
The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peaks of two adjacent channels.
- Resolution bandwidth: $\geq 1\%$ of the span.
- Video bandwidth: \geq 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.

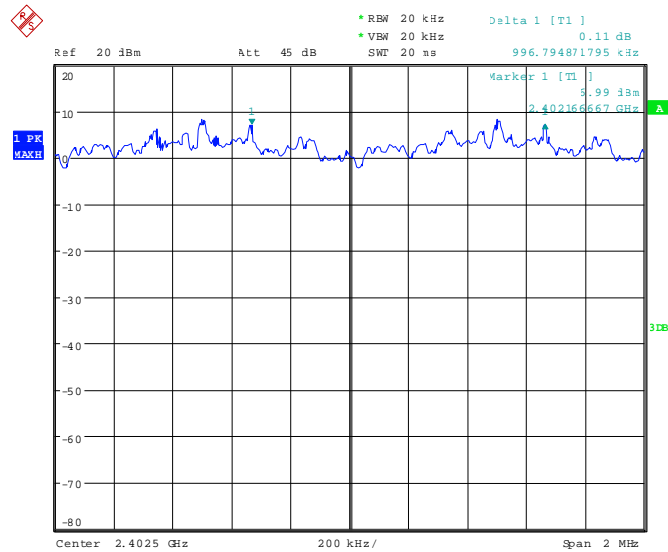
Test set-up:



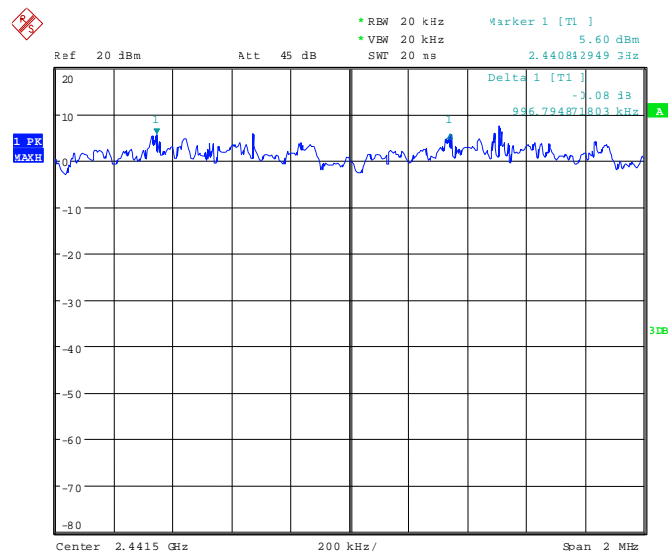
5.2.2 TEST RESULTS (CARRIER FREQUENCY SEPARATION)

Ambient temperature	20 °C	Relative humidity	58 %
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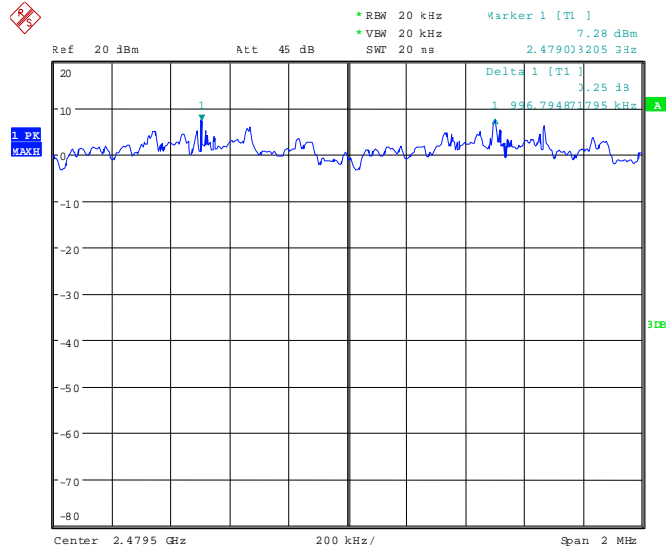
101347_167.wmf: (channel separation at the lower end of the assigned frequency band):



101347_168.wmf: (channel separation at the middle of the assigned frequency band):



101347_169.wmf: (channel separation at the upper end of the assigned frequency band):



Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
Operation mode 1b, 2b, 3b			
0	2402	996.795	865.385 ($2/3$ of the 20 dB bandwidth)
39	2441	996.795	865.385 ($2/3$ of the 20 dB bandwidth)
78	2480	996.795	868.590 ($2/3$ of the 20 dB bandwidth)
Measurement uncertainty			$<10^{-7}$

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.3 NUMBER OF HOPPING FREQUENCIES

5.3.1 METHOD OF MEASUREMENT (NUMBER OF HOPPING FREQUENCIES)

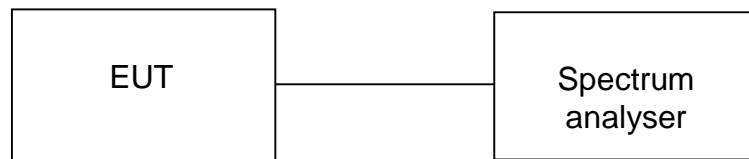
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT 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: $\geq 1\%$ of the span.
- Video bandwidth: \geq 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:

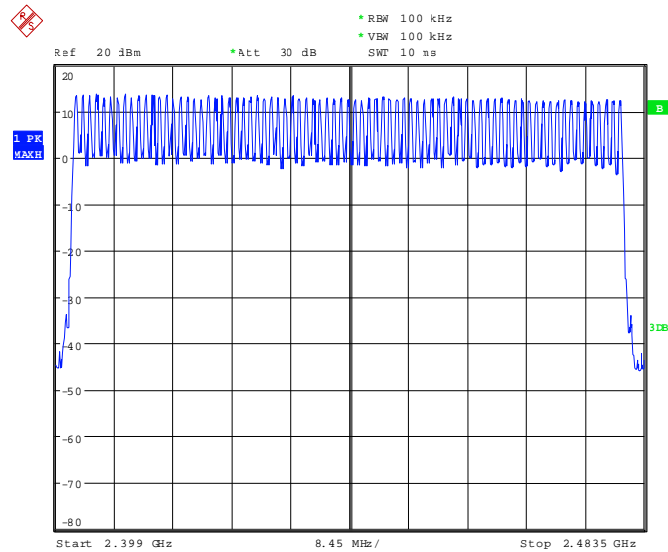


5.3.2 TEST RESULTS (NUMBER OF HOPPING FREQUENCIES)

Ambient temperature	20 °C
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Relative humidity	58 %
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101347_160.wmf (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 (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:

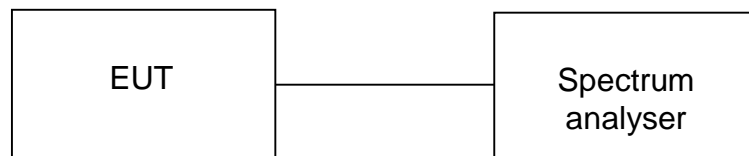
- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: \geq the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel.
- Detector function: peak.
- Trace mode: Max hold.

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:

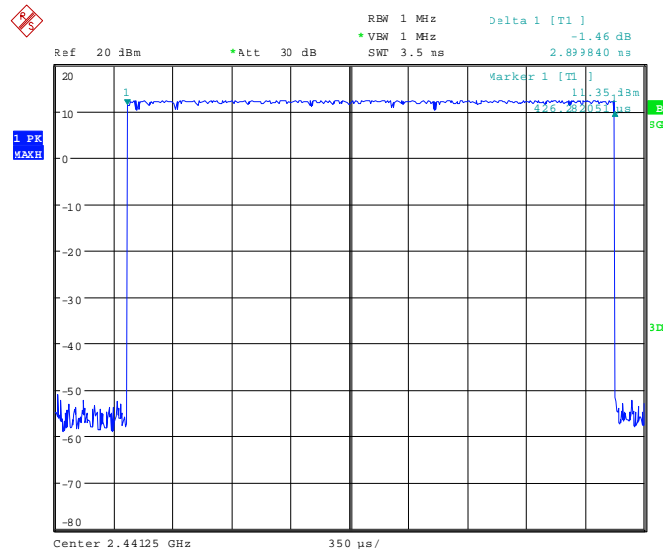


5.4.2 TEST RESULTS (DWELL TIME)

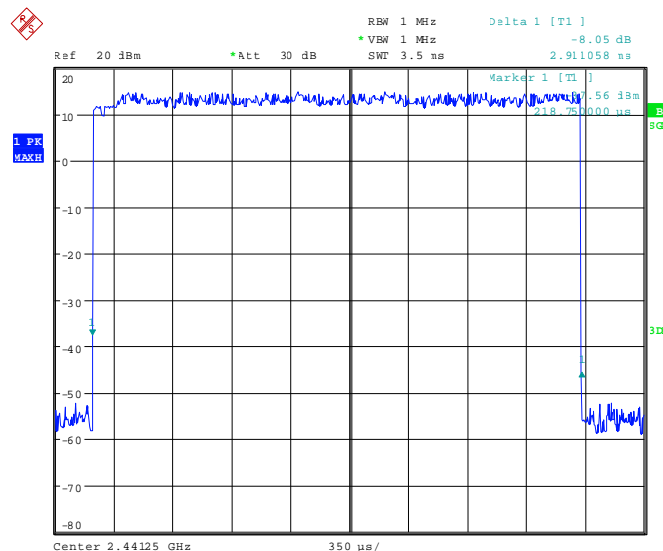
Ambient temperature	20 °C
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Relative humidity	58 %
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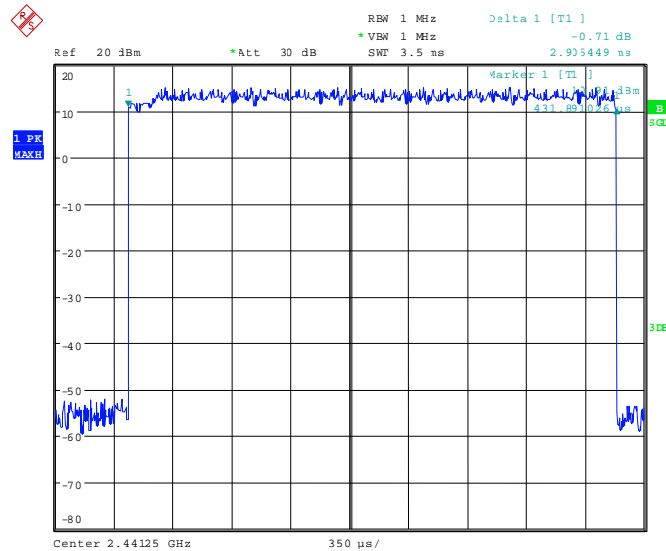
101347_161.wmf: Dwell time at the middle of the assigned frequency band), hopping mode DH5:



101347_162.wmf: Dwell time at the middle of the assigned frequency band), hopping mode 2DH5:



101347_163.wmf: Dwell time at the middle of the assigned frequency band), hopping mode 3DH5:



The dwell time is calculated with the following formula:

Dwell time = $t_{\text{pulse}} \times n_{\text{hops}} / \text{number of hopping channels} \times 31.6$ (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 modes 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 ($n_{\text{hops}} = 267$ 1/s).

Operation mode 2				
Channel number	Channel frequency [MHz]	t_{pulse} [μs]	Dwell time [ms]	Limit [ms]
39	2441	2899.840	309.317	400
Operation mode 2a				
Channel number	Channel frequency [MHz]	t_{pulse} [μs]	Dwell time [ms]	Limit [ms]
39	2441	2911.058	310.513	400
Operation mode 2b				
Channel number	Channel frequency [MHz]	t_{pulse} [μs]	Dwell time [ms]	Limit [ms]
39	2441	2905.449	309.915	400
Measurement uncertainty			$<10^{-7}$	

Test:

Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.5 MAXIMUM PEAK OUTPUT POWER

5.5.1 METHOD 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 disabled.

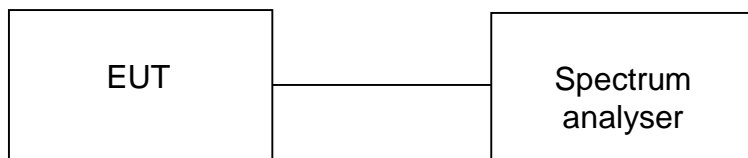
The following spectrum analyser settings shall be used:

- 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: \geq 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.

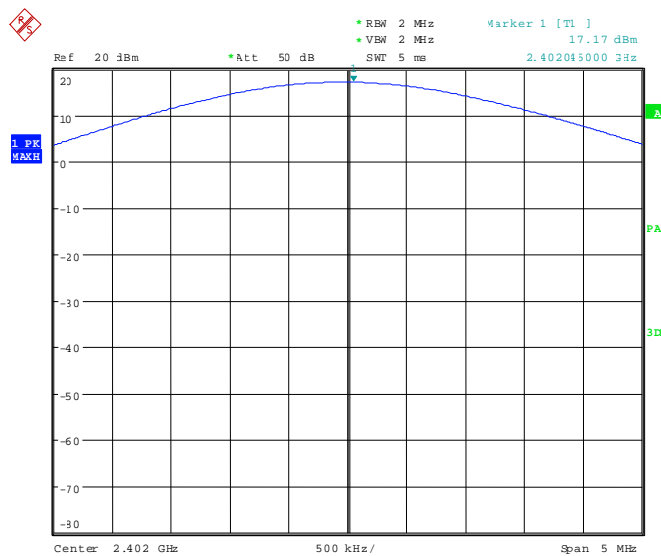
Test set-up:



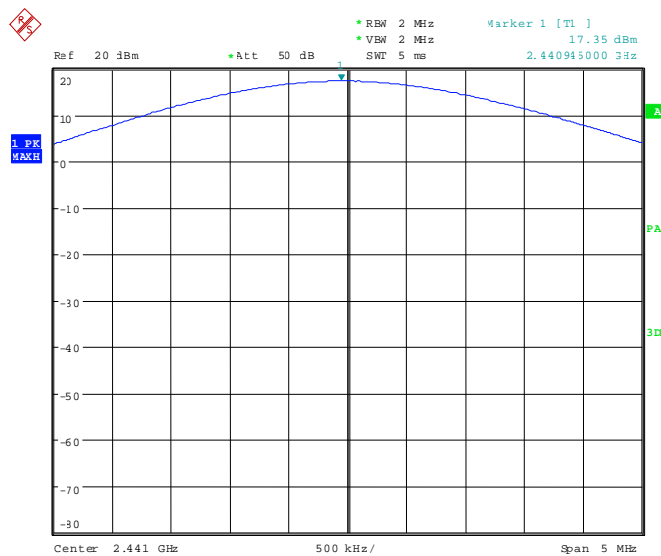
5.5.2 TEST RESULTS (MAXIMUM PEAK OUTPUT POWER)

Ambient temperature	20 °C	Relative humidity	58 %
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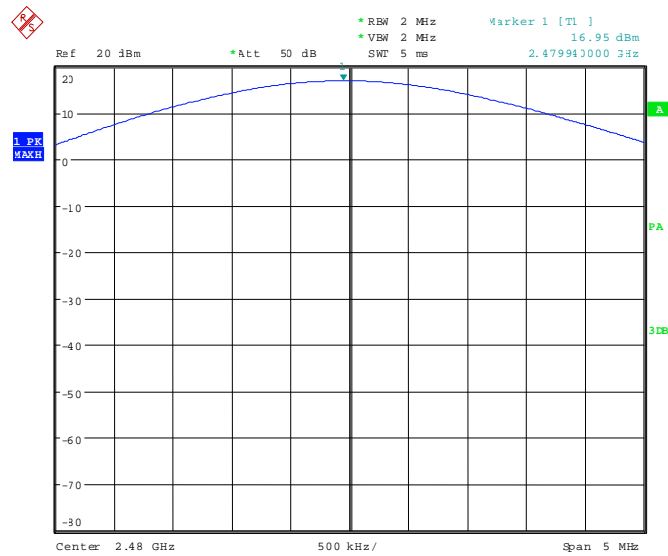
101347_194.wmf: Maximum peak output power at the lower end of the assigned frequency band (operation mode 1):



101347_195.wmf: Maximum peak output power at the middle of the assigned frequency band (operation mode 2):



101347_196.wmf: Maximum peak output power at the upper end of the assigned frequency band (operation mode 3):



Operation mode	Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1	0	2402	13.9	3.4	30.0
1a			16.3		
1b			17.2		
2	39	2441	13.7	3.4	30.0
2a			16.5		
2b			17.4		
3	78	2480	13.3	3.4	30.0
3a			16.2		
3b			17.0		
Measurement uncertainty				+0.66 dB / -0.72 dB	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.6 BAND-EDGE COMPLIANCE

5.6.1 METHOD OF MEASUREMENT (BAND-EDGE COMPLIANCE (RADIATED))

The same test set-up as used for the final radiated emission measurement shall be used (refer also subclause 5.8.1 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: \geq 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 5.8.1 of this test report, but 100 kHz resolution bandwidth shall be used.

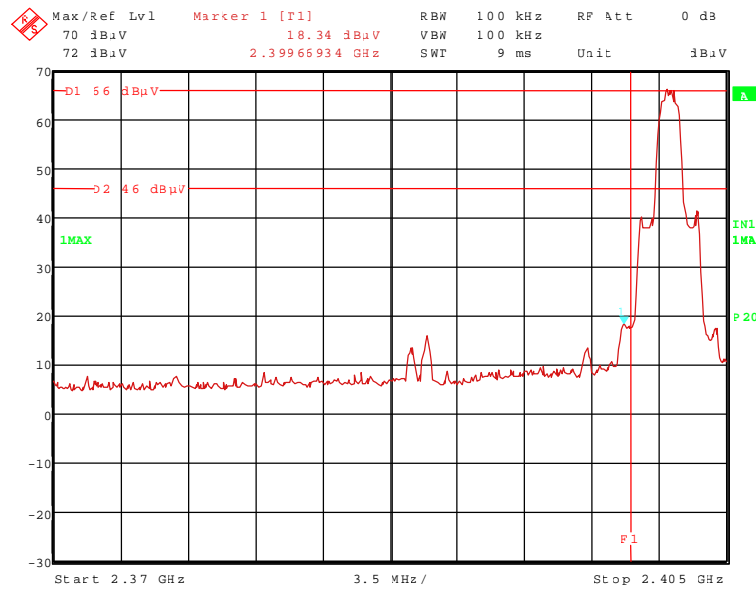
The measurement will be performed at the upper end of the assigned frequency band and with hopping on and off.

5.6.2 TEST RESULT (BAND-EDGE COMPLIANCE (RADIATED)) WITH INTERNAL ANTENNA

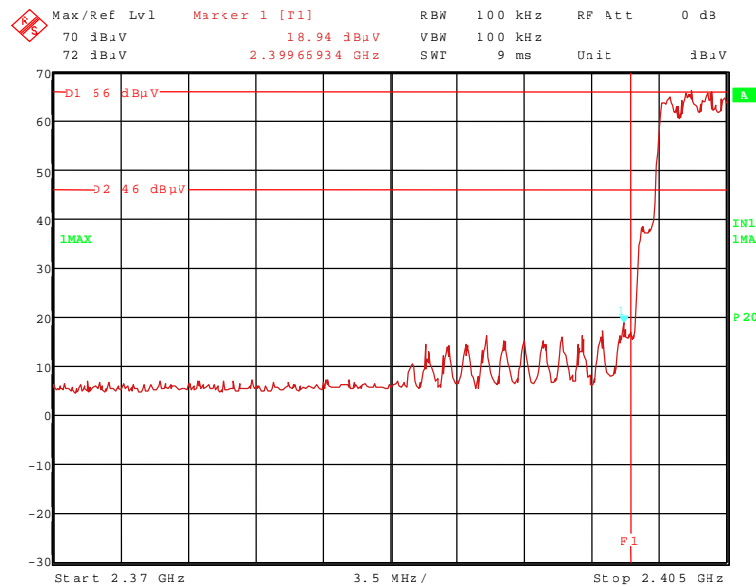
Ambient temperature	20 °C
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Relative humidity	39 %
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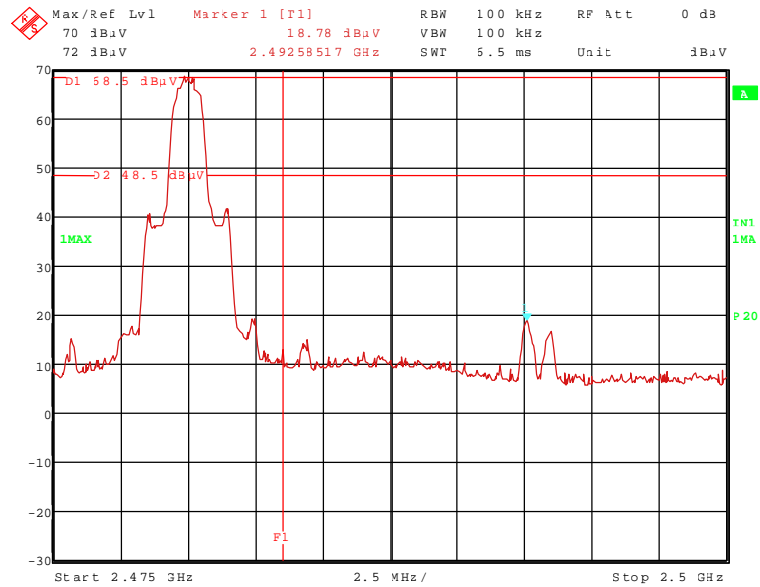
101347_7.wmf: Radiated band-edge compliance, lower band edge, hopping off (operation mode 1):



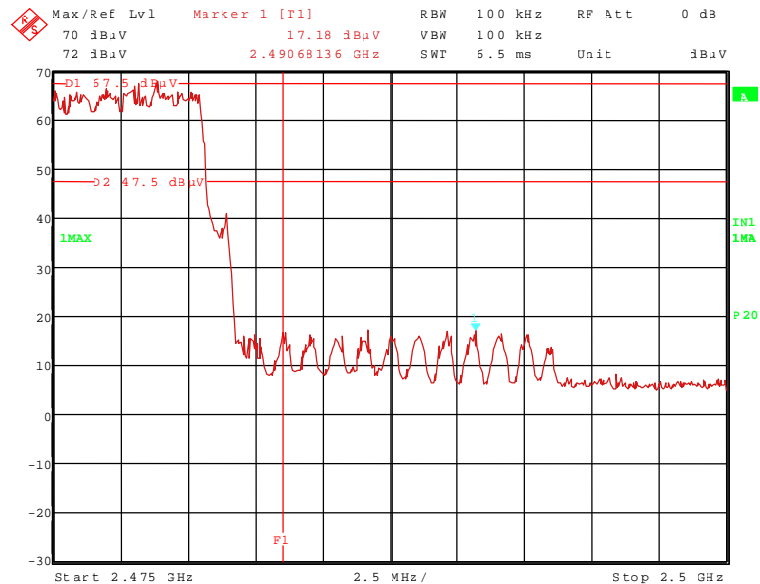
101347_8.wmf: Radiated band-edge compliance, lower band edge, hopping on (operation mode 4):



101347_10.wmf: Radiated band-edge compliance, upper band edge, hopping off (operation mode 3):



101347_9.wmf: Radiated band-edge compliance, upper band edge, hopping on (operation mode 4):



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	101.9	-	-	69.4	28.8	0.0	3.7	150	Vert.	-
2.3997	48.7	81.9	33.2	16.2	28.8	0.0	3.7	150	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	96.7	-	-	64.2	28.8	0.0	3.7	150	Vert.	-
2399.7	36.5	76.7	40.2	4.0	28.8	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	101.9	-	-	69.4	28.8	0.0	3.7	150	Vert.	-
2.3997	48.9	81.9	33.0	16.4	28.8	0.0	3.7	150	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	96.7	-	-	64.2	28.8	0.0	3.7	150	Vert.	-
2.3997	27.5	76.7	49.2	-5.0	28.8	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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	104.7	-	-	71.9	29.0	0.0	3.8	150	Vert.	-
2.4926	50.9	74.0	23.1	18.1	29.0	0.0	3.8	150	Vert.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	99.6	-	-	66.8	29.0	0.0	3.8	150	Vert.	-
2.4926	39.4	54.0	14.6	6.6	29.0	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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	104.7	-	-	71.9	29.0	0.0	3.8	150	Vert.	-
2.4907	48.4	74.0	25.6	15.6	29.0	0.0	3.8	150	Vert.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	99.6	-	-	66.8	29.0	0.0	3.8	150	Vert.	-
2.4907	27.9	54.0	26.1	-4.9	29.0	0.0	3.8	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

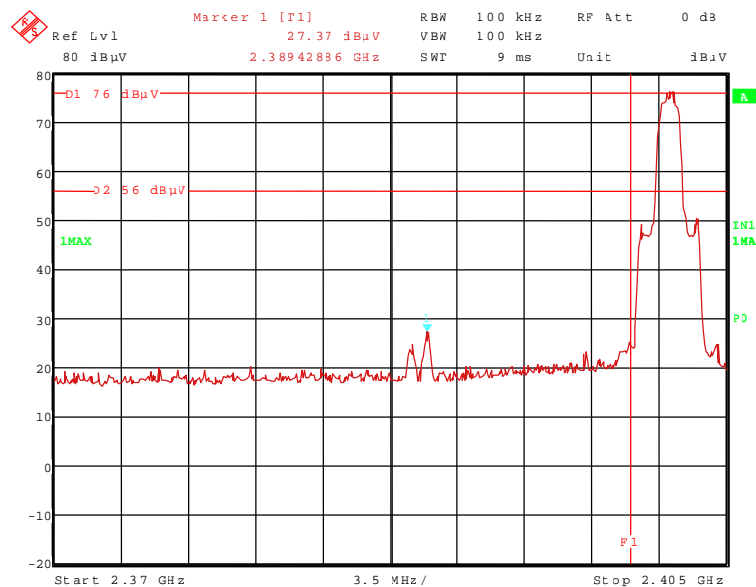
TEST EQUIPMENT USED FOR THE TEST:
29, 31 – 34, 36, 44

5.6.3 TEST RESULT (BAND-EDGE COMPLIANCE (RADIATED)) WITH EXTERNAL MONOPOLE ANTENNA

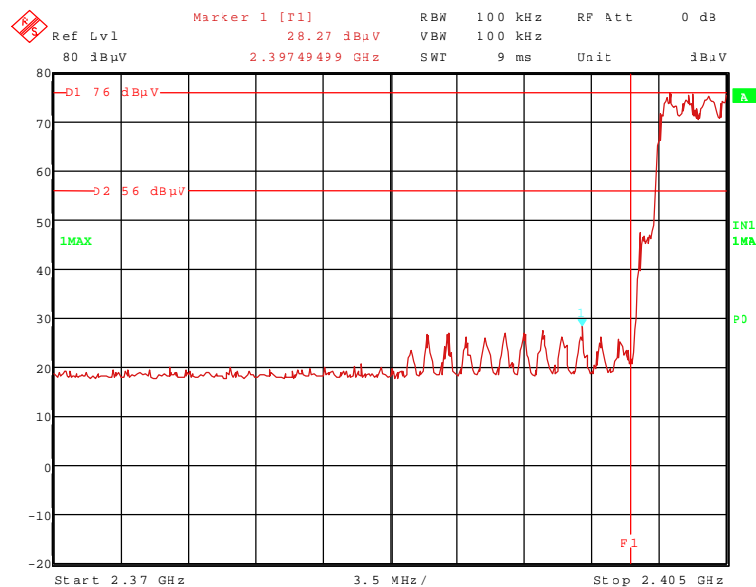
Ambient temperature	20 °C	Relative humidity	50 %
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Remark: This measurement was carried out by using the external monopole antenna type Huber+Suhner SOA 2400/360/6/0/V, because of this antenna has the highest antenna gain of all external monopole antennas in question. Additional pre-tests have shown that this antenna causes the highest emissions of all monopole antennas in question.

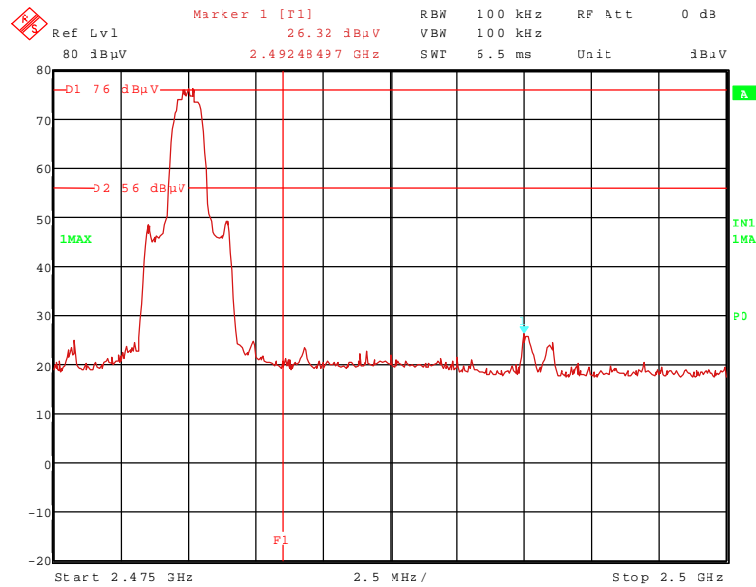
101347 17.wmf: Radiated band-edge compliance, lower band edge, hopping off (operation mode 1):



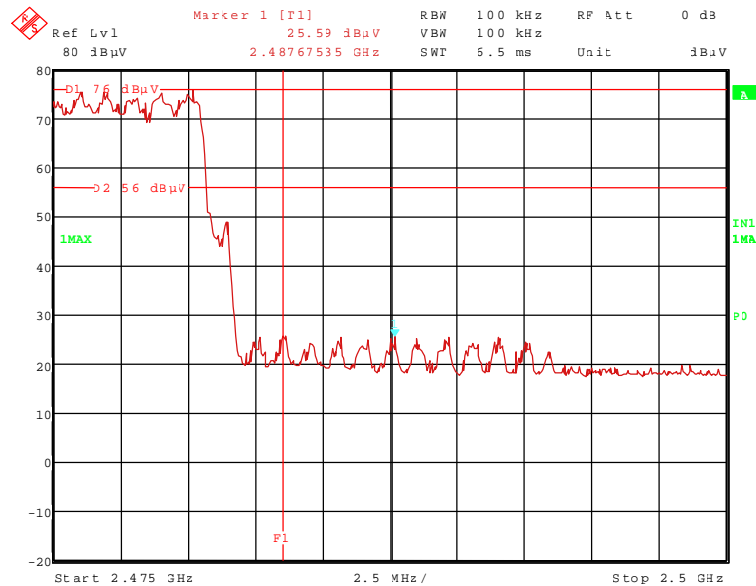
101347 18.wmf: Radiated band-edge compliance, lower band edge, hopping on (operation mode 4):



101347_20.wmf: Radiated band-edge compliance, upper band edge, hopping off (operation mode 3):



101347_19.wmf: Radiated band-edge compliance, upper band edge, hopping on (operation mode 4):



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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	113.7	-	-	81.2	28.8	0.0	3.7	150	Vert.	-
2.3895	63.1	74.0	10.9	30.7	28.7	0.0	3.7	150	Vert.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	108.2	-	-	75.7	28.8	0.0	3.7	150	Vert.	-
2.3895	52.5	54.0	1.5	20.1	28.7	0.0	3.7	150	Vert.	Yes
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	113.7	-	-	81.2	28.8	0.0	3.7	150	Vert.	-
2.3975	64.3	93.7	29.4	31.8	28.8	0.0	3.7	150	Vert.	No
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	108.2	-	-	75.7	28.8	0.0	3.7	150	Vert.	-
2.3975	39.0	88.2	49.2	6.5	28.8	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	113.5	-	-	80.7	29.0	0.0	3.8	150	Vert.	-
2.4926	62.2	74.0	11.8	29.4	29.0	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	108.2	-	-	75.4	29.0	0.0	3.8	150	Vert.	-
2.4926	52.2	54.0	1.8	19.4	29.0	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	113.5	-	-	80.7	29.0	0.0	3.8	150	Vert.	-
2.4876	61.2	74.0	12.8	28.4	29.0	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	108.2	-	-	75.4	29.0	0.0	3.8	150	Vert.	-
2.4876	38.8	54.0	15.2	6.0	29.0	0.0	3.8	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

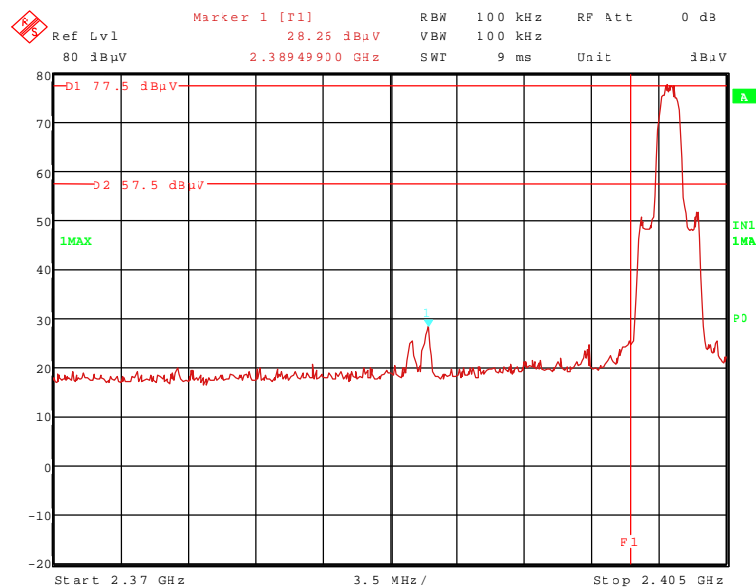
TEST EQUIPMENT USED FOR THE TEST:
29, 31 – 34, 36, 44

5.6.4 TEST RESULT (BAND-EDGE COMPLIANCE (RADIATED)) WITH EXTERNAL PATCH ANTENNA

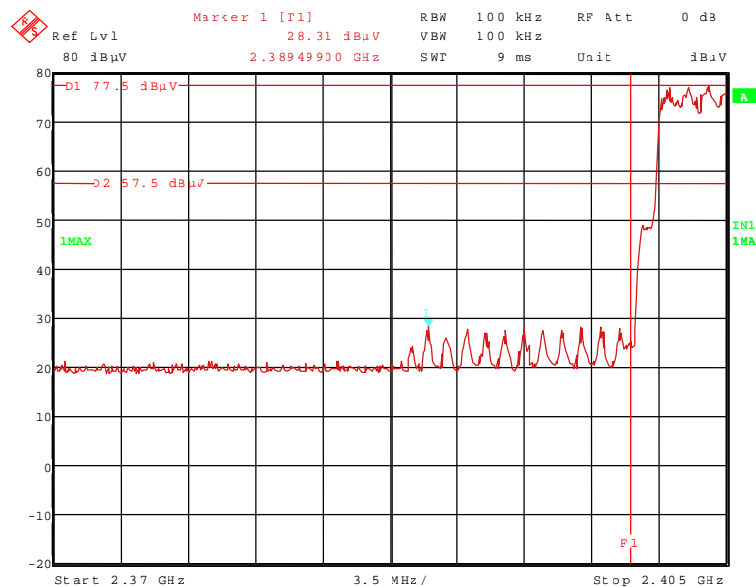
Ambient temperature	21 °C	Relative humidity	43 %
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Remark: This measurement was carried out by using the external patch antenna type Huber+Suhner SPA 2400/70/9/0/RCP, because of this antenna has the highest antenna gain of all external patch antennas in question. Additional pre-tests have shown that this antenna causes the highest emissions of all patch antennas in question.

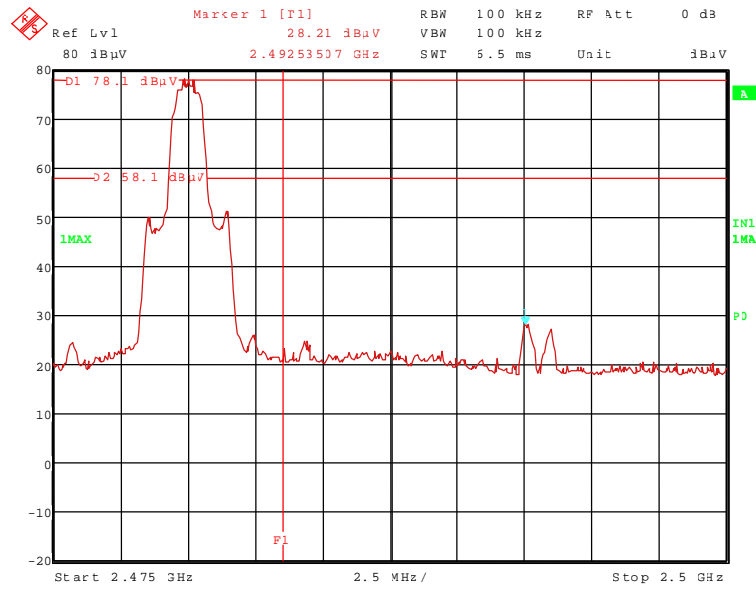
101347_42.wmf: Radiated band-edge compliance, lower band edge, hopping off (operation mode 1):



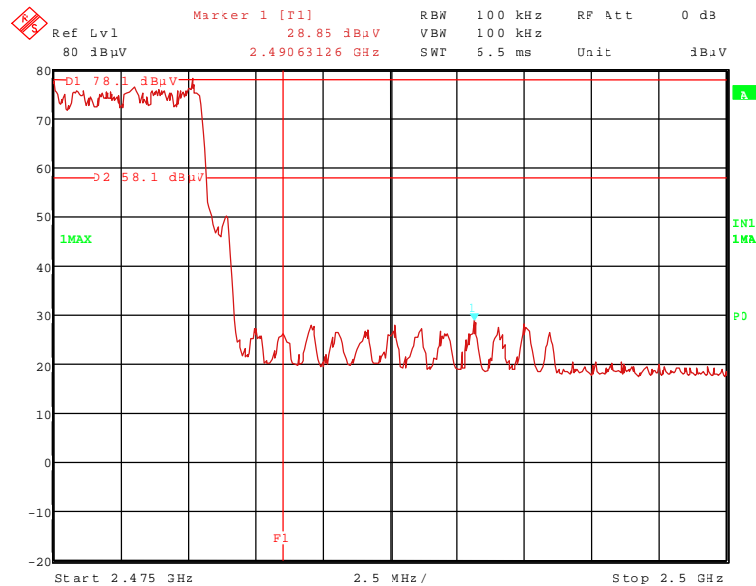
101347_45.wmf: Radiated band-edge compliance, lower band edge, hopping on (operation mode 4):



101347_43.wmf: Radiated band-edge compliance, upper band edge, hopping off (operation mode 3):



101347_44.wmf: Radiated band-edge compliance, upper band edge, hopping on (operation mode 4):



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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	113.4	-	-	80.9	28.8	0.0	3.7	150	Hor.	-
2.3895	63.8	74.0	10.2	31.4	28.7	0.0	3.7	150	Hor.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	107.9	-	-	75.4	28.8	0.0	3.7	150	Hor.	-
2.3895	52.2	54.0	1.8	19.8	28.7	0.0	3.7	150	Hor.	Yes
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	113.4	-	-	80.9	28.8	0.0	3.7	150	Hor.	-
2.3895	59.4	74.0	14.6	27.0	28.7	0.0	3.7	150	Hor.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	107.9	-	-	75.4	28.8	0.0	3.7	150	Hor.	-
2.3895	30.4	54.0	23.6	-2.0	28.7	0.0	3.7	150	Hor.	Yes
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	114.7	-	-	81.9	29.0	0.0	3.8	150	Hor.	-
2.4926	65.3	74.0	8.7	32.5	29.0	0.0	3.8	150	Hor.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	109.2	-	-	76.4	29.0	0.0	3.8	150	Hor.	-
2.4926	52.7	54.0	1.3	19.9	29.0	0.0	3.8	150	Hor.	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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	114.7	-	-	81.9	29.0	0.0	3.8	150	Hor.	-
2.4906	59.8	74.0	14.2	27.0	29.0	0.0	3.8	150	Hor.	Yes
Result measured with the average detector:										
Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	109.2	-	-	76.4	29.0	0.0	3.8	150	Hor.	-
2.4906	32.1	54.0	21.9	-0.7	29.0	0.0	3.8	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

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

5.7 RADIATED EMISSIONS

5.7.1 METHOD OF MEASUREMENT (RADIATED EMISSIONS)

The radiated emission measurement is subdivided into four stages.

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

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

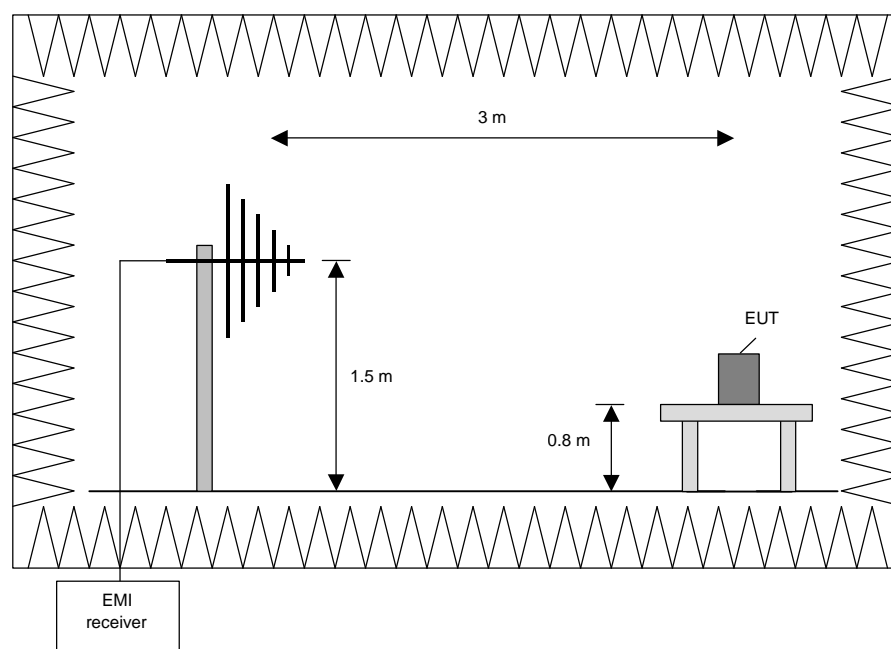
Preliminary measurement (30 MHz to 1 GHz)

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

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

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

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



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.

The following procedure will be used:

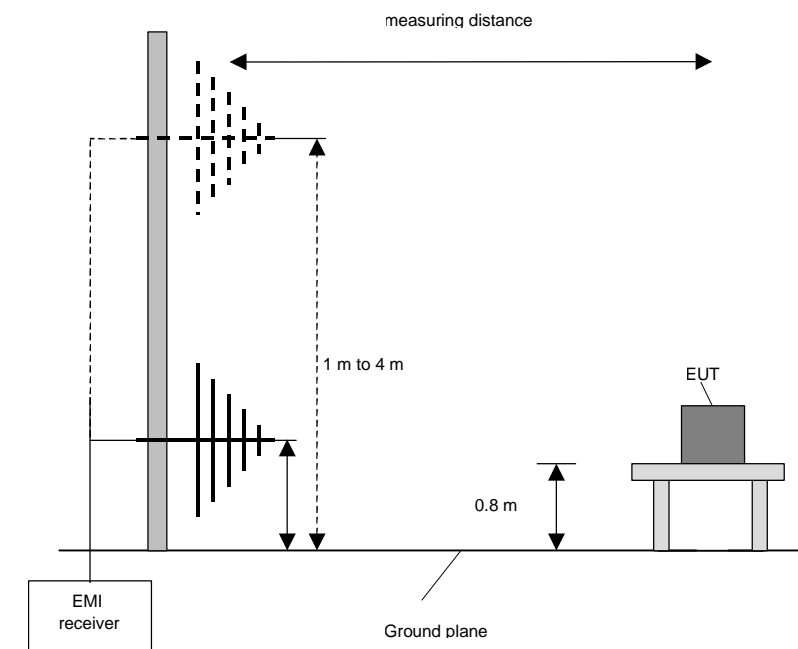
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the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

Final measurement (30 MHz to 1 GHz)

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

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

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

Preliminary and final measurement (1 GHz to 110 GHz)

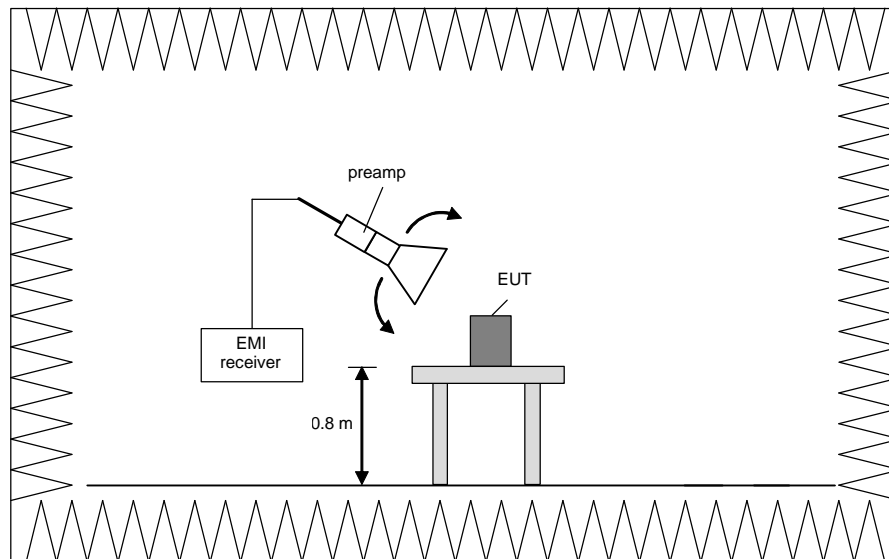
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance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

Preliminary measurement (1 GHz to 110 GHz)

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

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

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

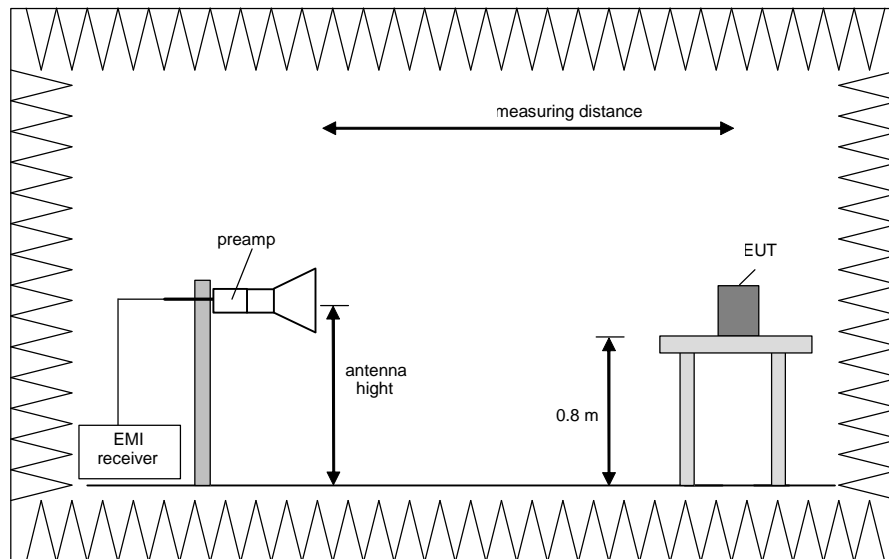


Final measurement (1 GHz to 110 GHz)

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

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

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



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 GHz.

The following procedure will be used:

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

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

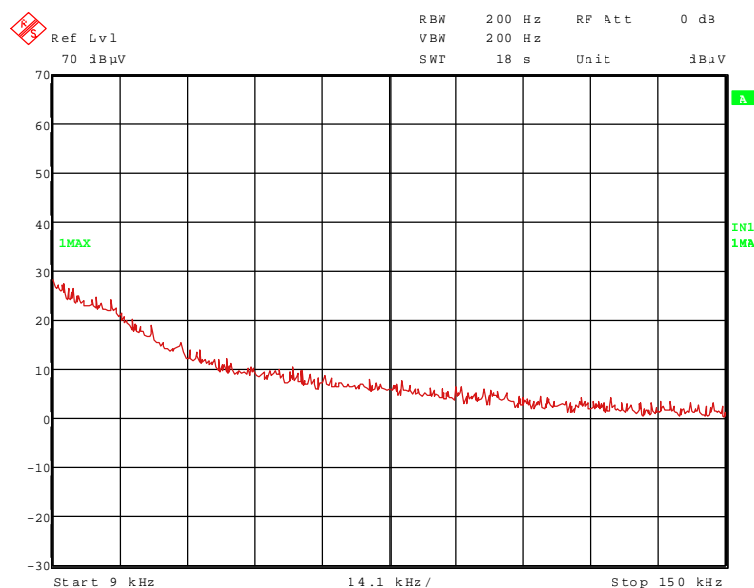
5.7.2 TEST RESULTS (RADIATED EMISSIONS)

5.7.2.1 PRELIMINARY MEASUREMENT (9 kHz to 1 GHz) WITH EXTERNAL PATCH ANTENNA

Ambient temperature	21 °C	Relative humidity	43 %
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- 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 5.0 V DC via the carrier board.
- Remark: As pre-tests have shown, the emissions in the frequency range 9 kHz to 1 GHz are not depending on the transmitter operation mode. The largest emissions in this frequency range were emitted if an external antenna is used. Therefore the emissions in this frequency range were measured only with the transmitter operates in operation mode 2 and the external patch Huber+Suhner SPA 2400/70/9/0/RCP is used, because this antenna has the highest gain from the antennas in question.

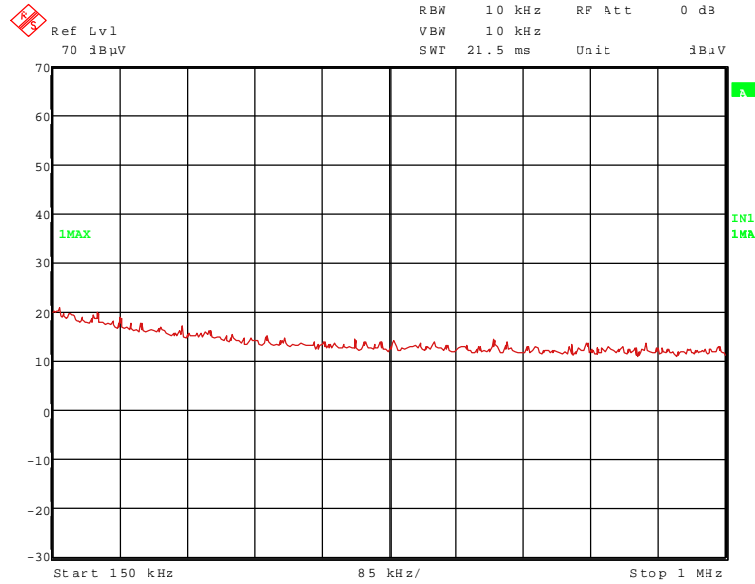
101347_85.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



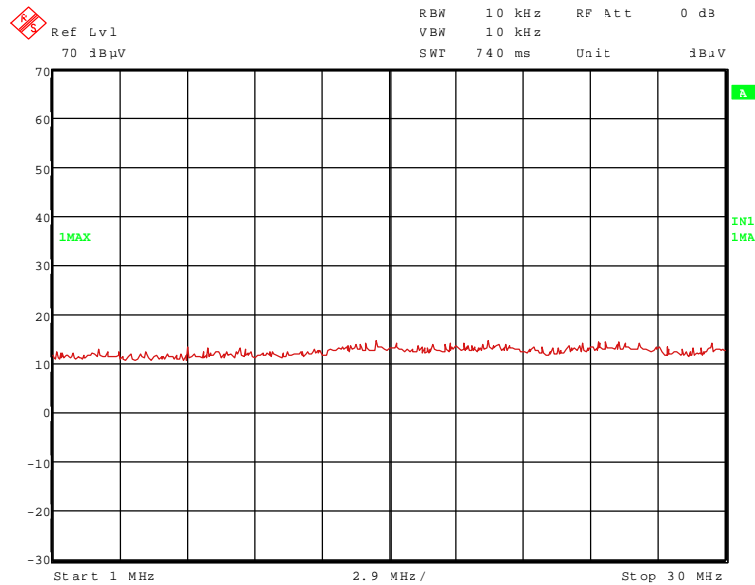
TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 35, 43, 55

101347_84.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

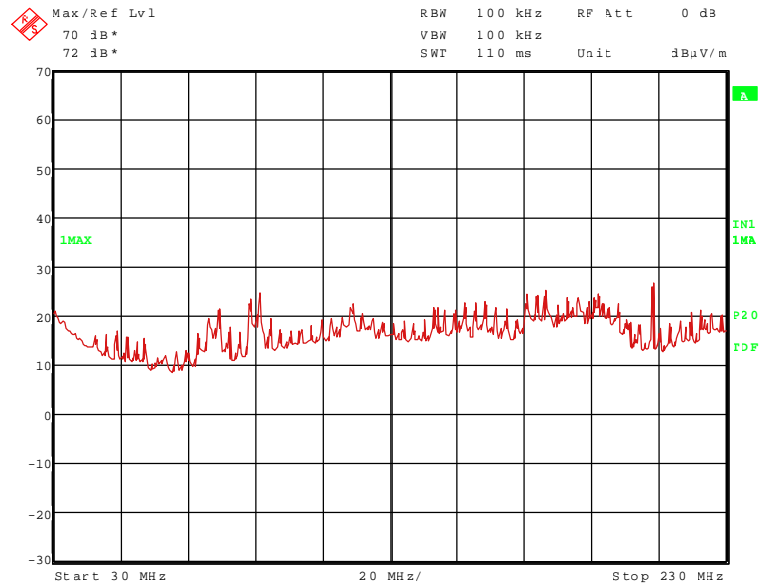


101347_83.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

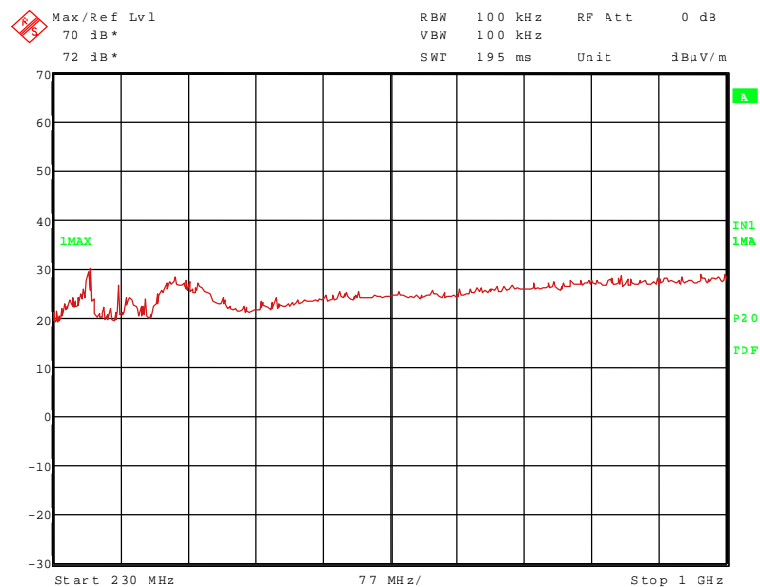


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

101347_46.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):



101347_47.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2):



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

79.186 MHz, 91.390 MHz, 176.000 MHz, 208.000 MHz, 304.000 MHz and 371.537 MHz.

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

118.850 MHz and 272.000 MHz

These frequencies have to be measured on the open area test site. The result is presented in the following.

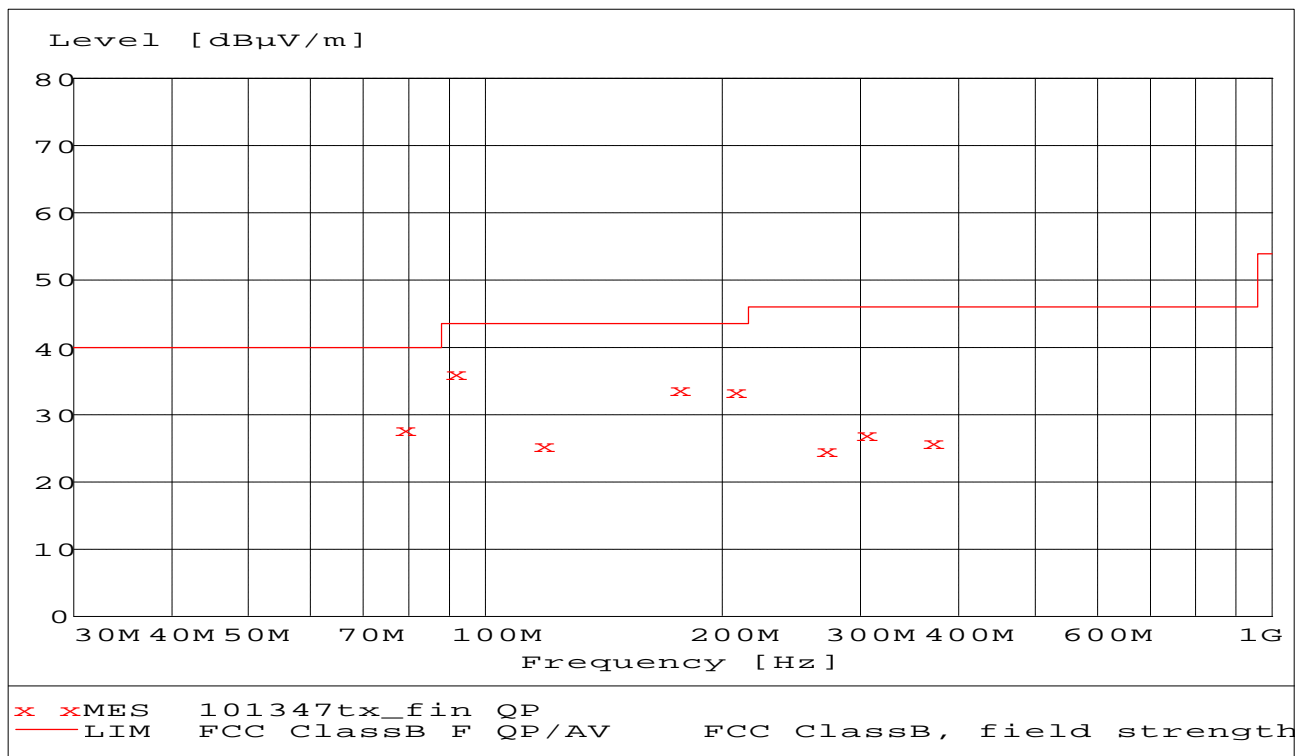
5.7.2.2 FINAL RADIATED EMISSION TEST (30 MHz to 1 GHz) WITH EXTERNAL PATCH ANTENNA

Ambient temperature	20 °C	Relative humidity	57 %
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- 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 5.0 V DC via the carrier board.
- Test results: The test results were calculated with the following formula:

$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]}$$

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.



Data record name: 101347tx

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 quasipeak detector:
(This value is 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.	Pos.
79.186	27.9	40.0	12.1	18.9	8.0	1.0	400	112	Hor.	1
91.390	36.5	43.5	7.0	25.3	10.1	1.1	400	67	Hor.	1
176.000	34.0	43.5	9.5	22.7	9.8	1.5	100	113	Vert.	1
208.000	33.4	43.5	10.1	22.6	9.3	1.5	150	112	Hor.	1
304.000	27.0	46.0	19.0	12.2	12.9	1.9	100	202	Hor.	1
371.537	25.8	46.0	20.2	8.9	14.7	2.2	100	112	Hor.	1
Spurious emissions in 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.	Pos.
118.850	25.4	43.5	18.1	11.9	12.3	1.2	100	113	Vert.	1
272.000	24.7	46.0	21.3	10.5	12.3	1.9	100	112	Hor.	1
Measurement uncertainty				+2.2 dB / -3.6 dB						

The test results were calculated with the following formula:

$$\text{Result [dBµV/m]} = \text{reading [dBµV]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]}$$

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

14 – 20

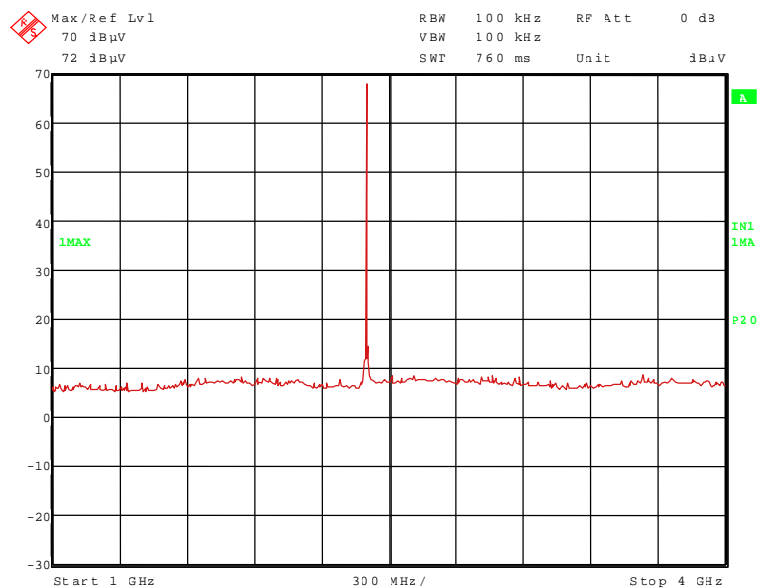
5.7.2.3 PRELIMINARY MEASUREMENT (1 GHz to 25 GHz) WITH INTERNAL ANTENNA

Ambient temperature	20 °C	Relative humidity	39 %
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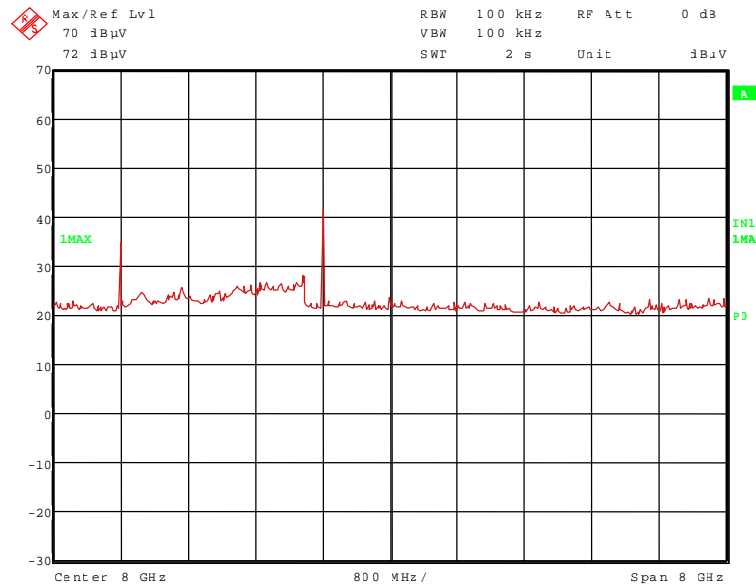
- Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.
- Cable guide: The cable of the EUT is running vertically to the false floor. For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.
- Test record: All results are shown in the following.
- Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.

Transmitter operates at the lower end of the assigned frequency band

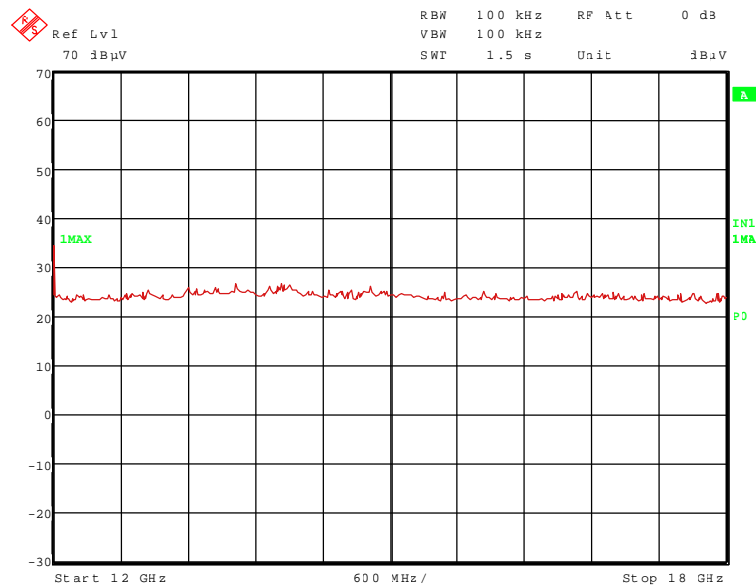
101347_2.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



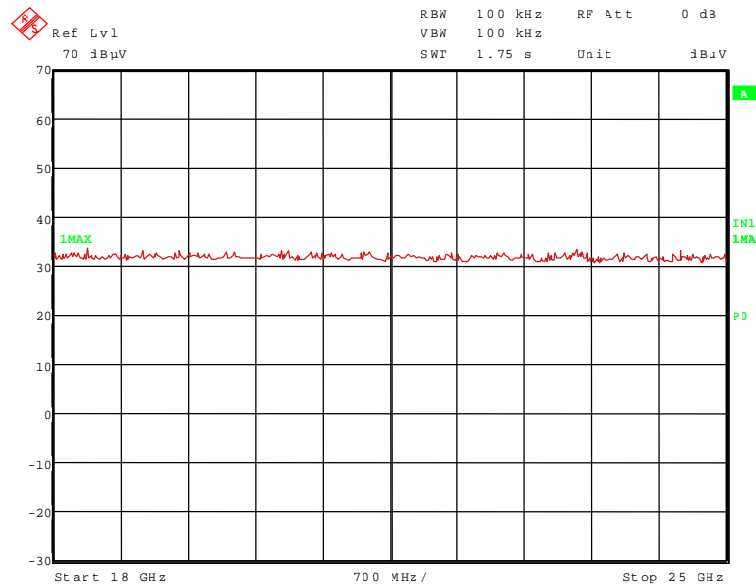
101347 5.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



101347 60.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



101347_65.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 1):



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 7.206 GHz.

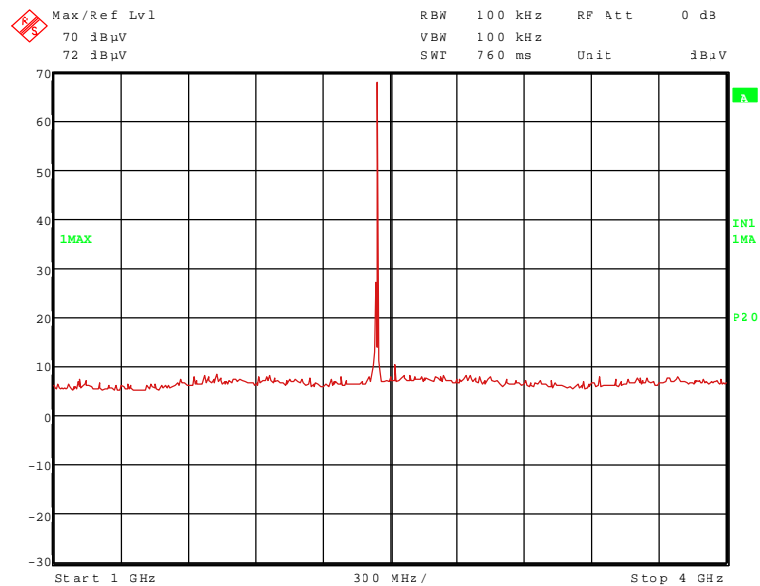
These frequencies have to be measured in a final measurement. The results were presented in the following.

TEST EQUIPMENT USED FOR THE TEST:

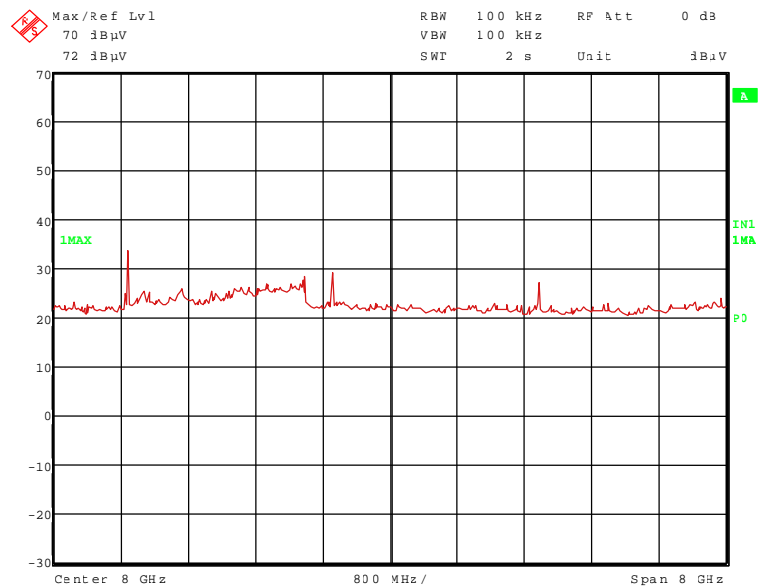
29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

Transmitter operates on the middle of the assigned frequency band

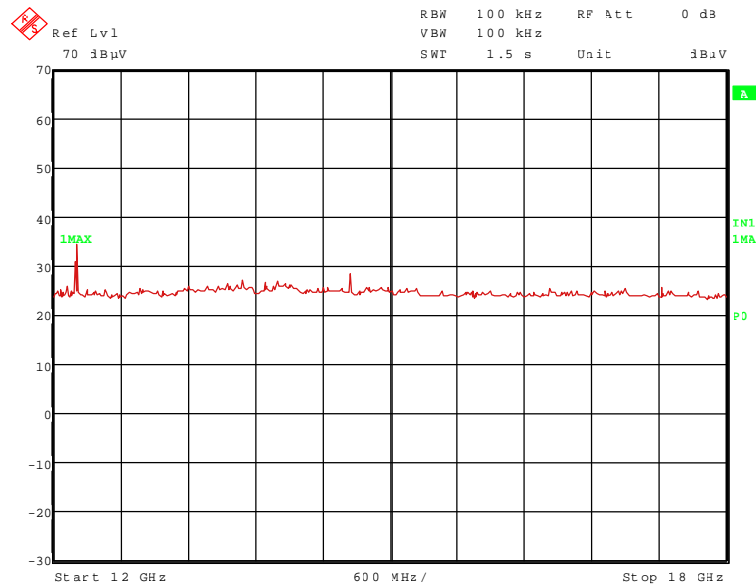
101347 1.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



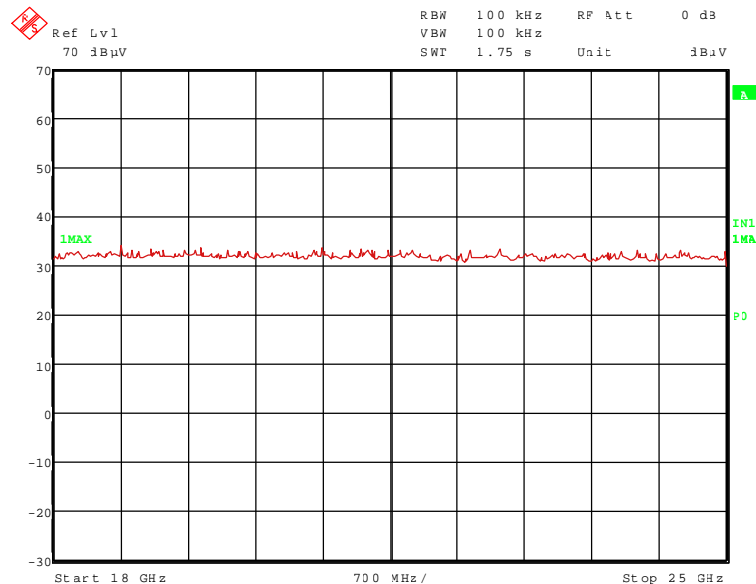
101347 4.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



101347_61.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 2):



101347_64.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 2):



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.

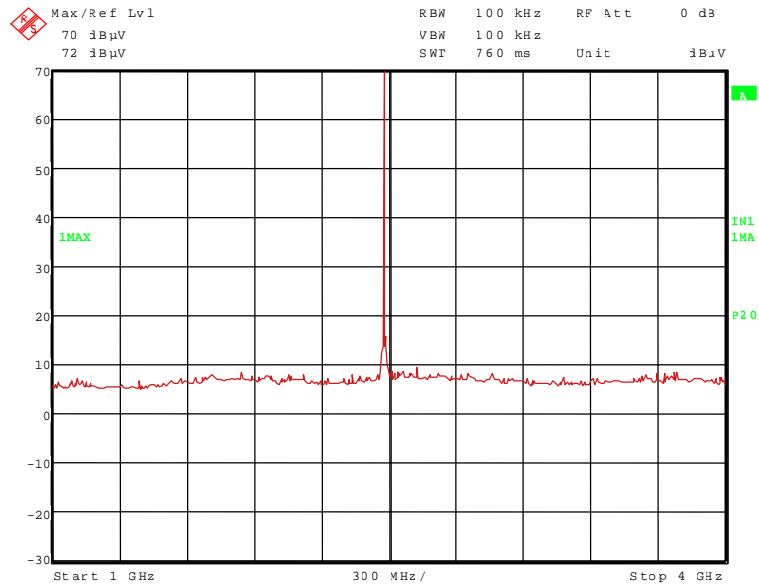
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.441 GHz, 9.764 GHz and 14.646 GHz.

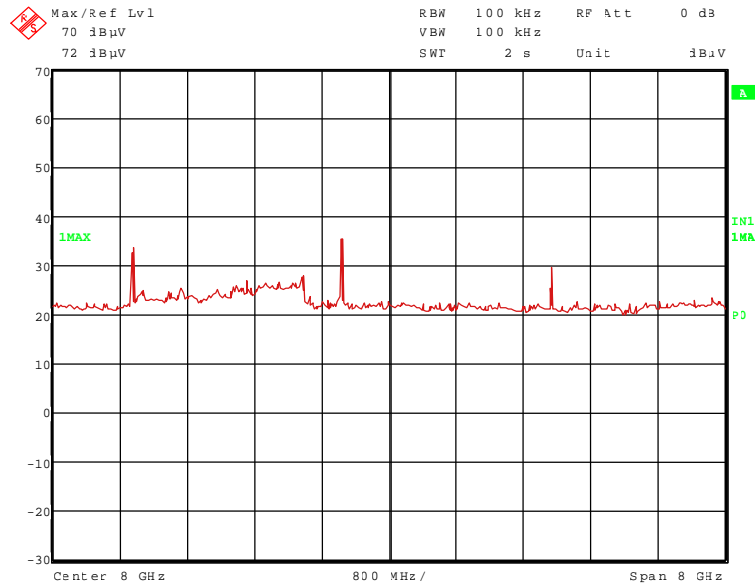
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency

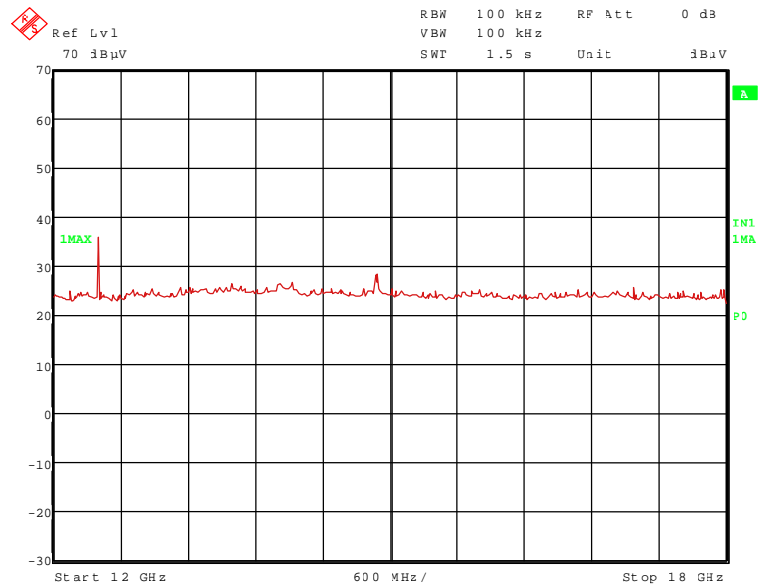
101347 3.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



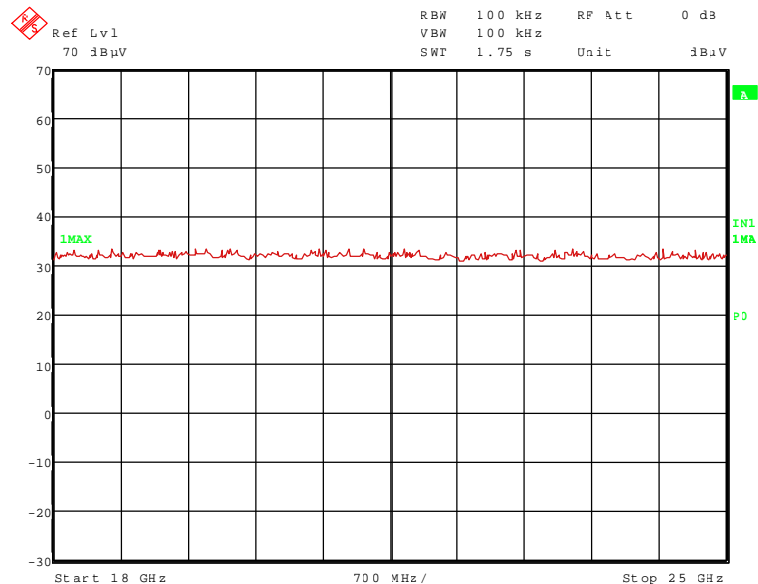
101347 6.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



101347_62.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 3):



101347_63.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 3):



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, 9.920 GHz and 14.880 GHz.

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

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

Ambient temperature	20 °C	Relative humidity	39 %
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- 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 5.0 V DC by 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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.402	101.9	-	-	69.4	28.8	0.0	3.7	150	Vert.	-	1
4.804	54.1	74.0	19.9	40.8	33.7	25.7	5.3	150	Vert.	Yes	1
7.206	64.6	81.9	17.3	45.5	36.9	24.6	6.8	150	Vert.	No	1
12.010	53.4	74.0	20.6	43.2	33.6	25.9	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.402	96.7	-	-	64.2	28.8	0.0	3.7	150	Vert.	-	1
4.804	46.5	54.0	7.5	33.2	33.7	25.7	5.3	150	Vert.	Yes	1
7.206	56.8	76.7	19.9	37.7	36.9	24.6	6.8	150	Vert.	No	1
12.010	39.8	54.0	14.2	29.6	33.6	25.9	2.5	100	Vert.	Yes	1
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamplifier dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.441	104.9	-	-	72.3	28.9	0.0	3.7	150	Vert.	-	1
4.882	54.4	74.0	19.6	41.0	33.8	25.7	5.3	150	Vert.	Yes	1
7.323	56.5	74.0	17.5	37.2	37.1	24.6	6.8	150	Vert.	Yes	1
9.764	57.6	84.9	27.3	35.2	38.4	23.9	7.9	150	Vert.	No	1
12.205	53.9	74.0	20.1	43.7	33.6	25.9	2.5	100	Vert.	Yes	1
14.646	52.3	84.9	32.6	42.7	33.7	26.6	2.5	100	Vert.	No	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamplifier dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.441	99.7	-	-	67.1	28.9	0.0	3.7	150	Vert.	-	1
4.882	46.7	54.0	7.3	33.3	33.8	25.7	5.3	150	Vert.	Yes	1
7.323	45.8	54.0	8.2	26.5	37.1	24.6	6.8	150	Vert.	Yes	1
9.764	45.9	79.7	33.8	23.5	38.4	23.9	7.9	150	Vert.	No	1
12.205	39.6	54.0	14.4	29.4	33.6	25.9	2.5	100	Vert.	Yes	1
14.646	35.3	79.7	44.4	25.7	33.7	26.6	2.5	100	Vert.	No	1
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.480	104.7	-	-	71.9	29.0	0.0	3.8	150	Vert.	-	1
4.960	54.5	74.0	19.5	40.8	34.0	25.6	5.3	150	Vert.	Yes	1
7.440	59.9	74.0	14.1	40.3	37.3	24.5	6.8	150	Vert.	Yes	1
9.920	59.5	84.7	25.2	37.0	38.5	23.9	7.9	150	Vert.	No	1
12.400	54.8	74.0	19.2	44.5	33.7	25.9	2.5	100	Vert.	Yes	1
14.880	54.3	84.7	30.4	44.8	33.7	26.7	2.5	100	Vert.	No	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.480	99.6	-	-	66.8	29.0	0.0	3.8	150	Vert.	-	1
4.960	46.9	54.0	7.1	33.2	34.0	25.6	5.3	150	Vert.	Yes	1
7.440	49.5	54.0	4.5	29.9	37.3	24.5	6.8	150	Vert.	Yes	1
9.920	49.5	79.6	30.1	27.0	38.5	23.9	7.9	150	Vert.	No	1
12.400	40.6	54.0	13.4	30.3	33.7	25.9	2.5	100	Vert.	Yes	1
14.880	37.9	79.6	41.7	28.4	33.7	26.7	2.5	100	Vert.	No	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

5.7.2.5 PRELIMINARY MEASUREMENT (1 GHz to 25 GHz) WITH EXTERNAL MONOPOLE ANTENNA

Ambient temperature	20 °C	Relative humidity	50 %
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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.

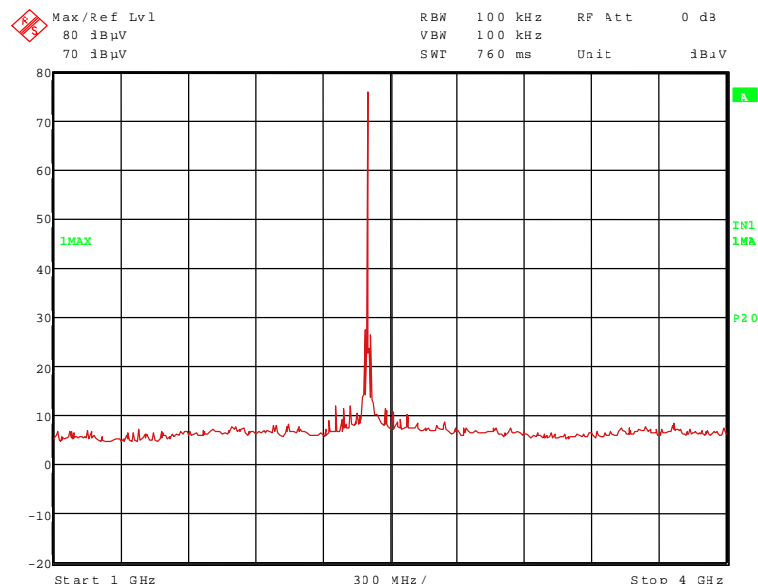
Test record: All results are shown in the following.

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

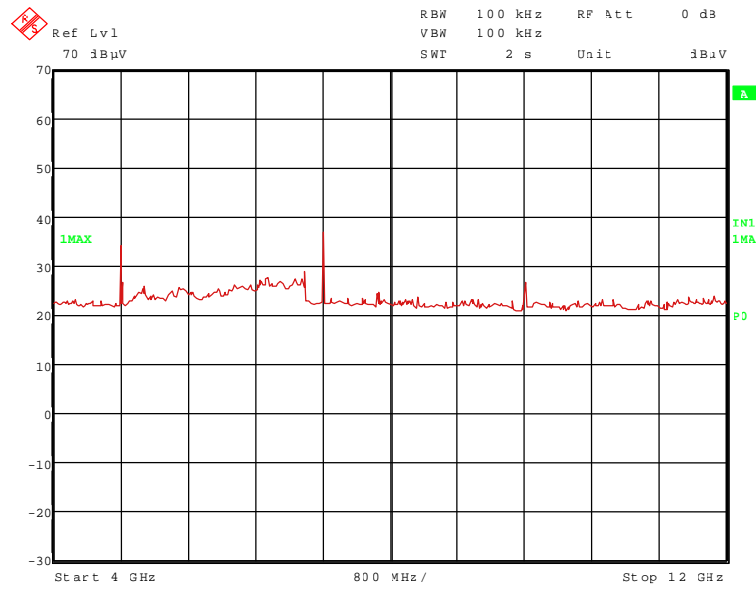
Remark: The emission measurement in this frequency range was carried out by using the external monopole antenna type Huber+Suhner SOA 2400/360/6/0/V, because of this antenna has the highest antenna gain of all external monopole antennas in question. Additional pre-tests have shown that this antenna causes the highest emissions of all monopole antennas in question.

Transmitter operates at the lower end of the assigned frequency band

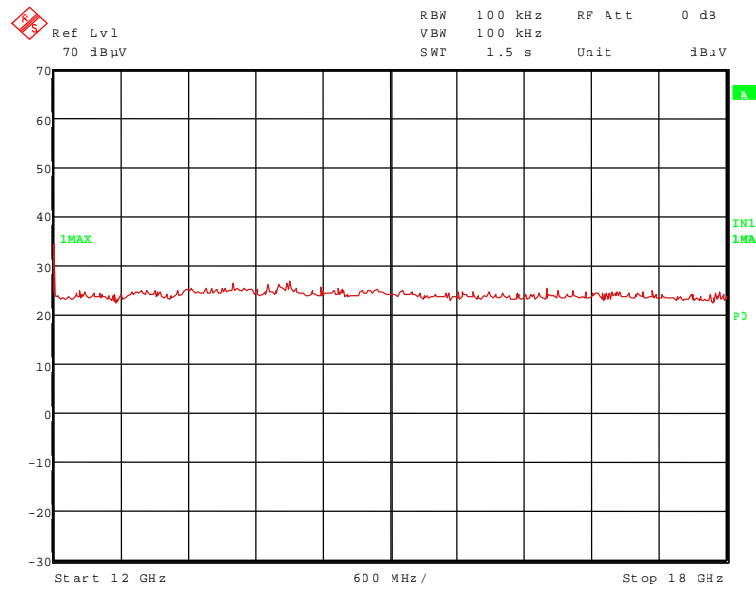
101347_41.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



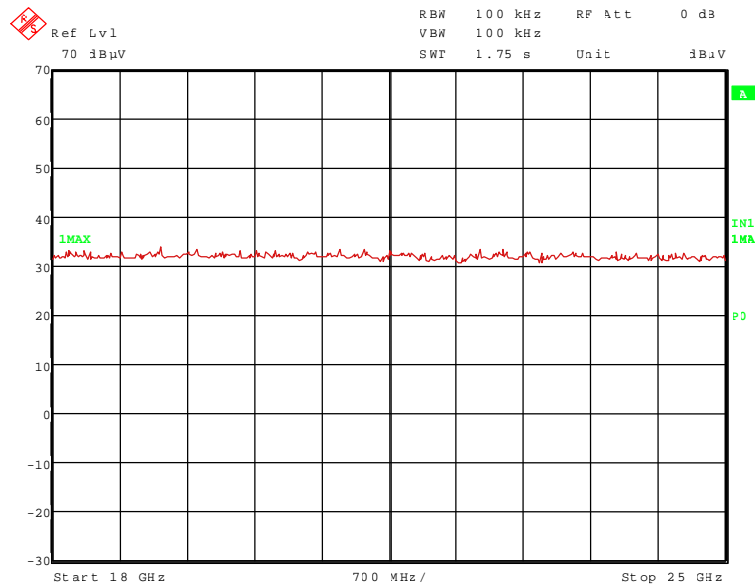
101347_36.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



101347_54.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



101347_59.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 1):



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

- 2.258 GHz, 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, 2.482 GHz, 7.206 GHz and 9.608 GHz.

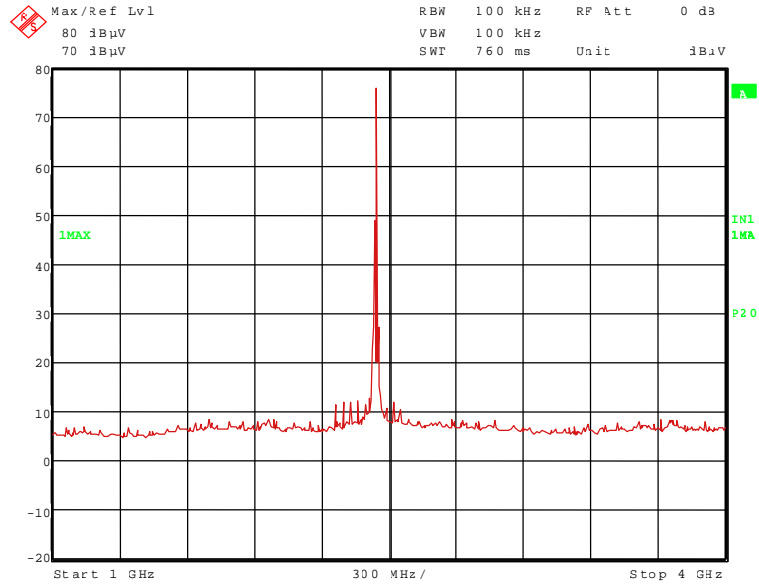
These frequencies have to be measured in a final measurement. The results were presented in the following.

TEST EQUIPMENT USED FOR THE TEST:

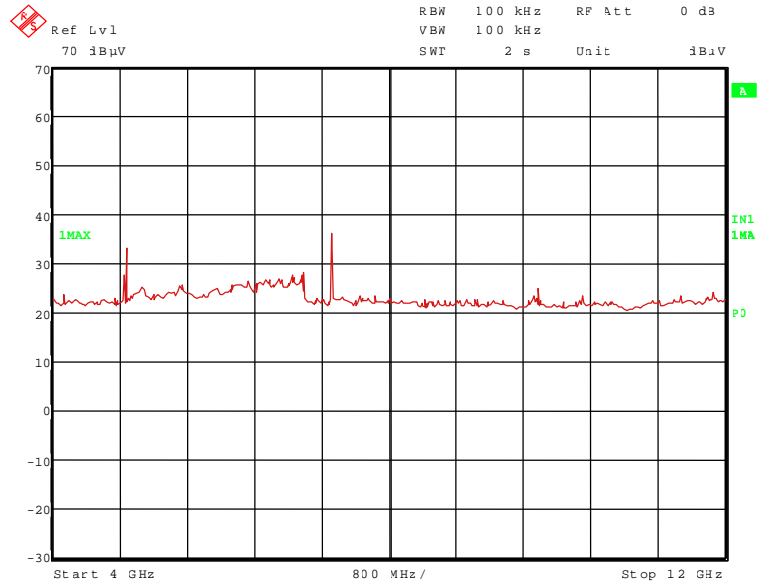
29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

Transmitter operates on the middle of the assigned frequency band

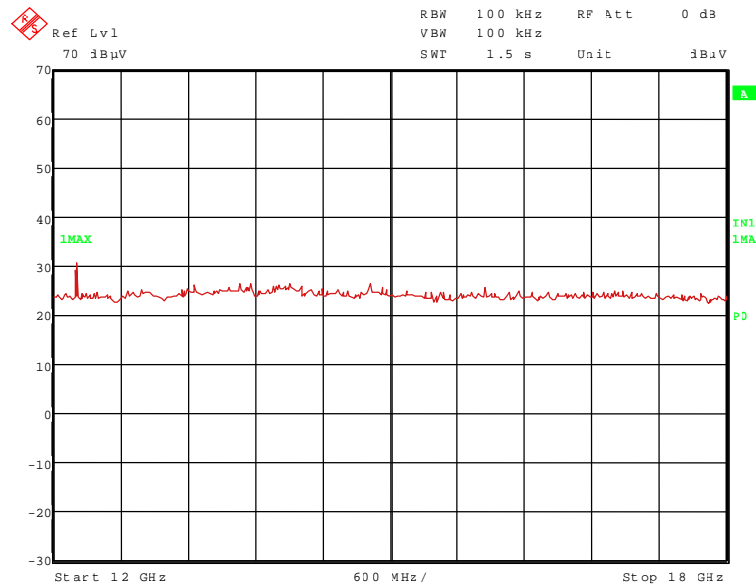
101347 40.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



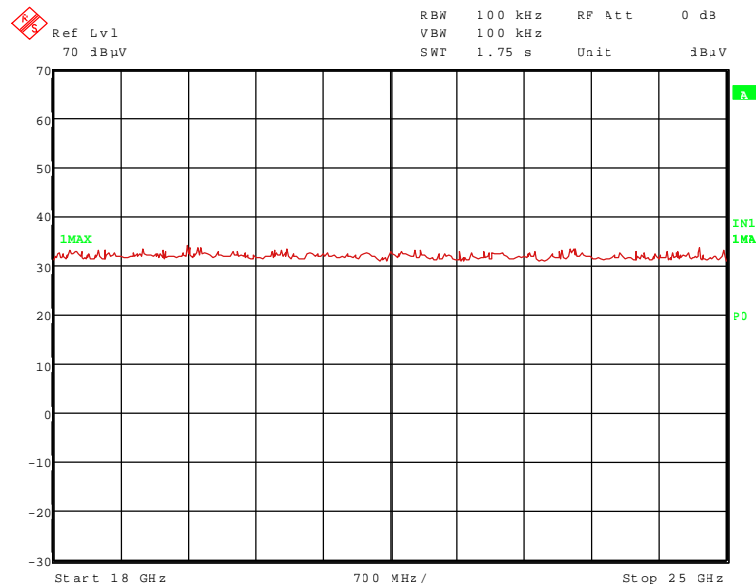
101347 37.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



101347_55.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 2):



101347_58.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 2):



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

- 2.361 GHz, 4.860 GHz, 4.882 GHz, 7.323 GHz and 12.205 GHz.

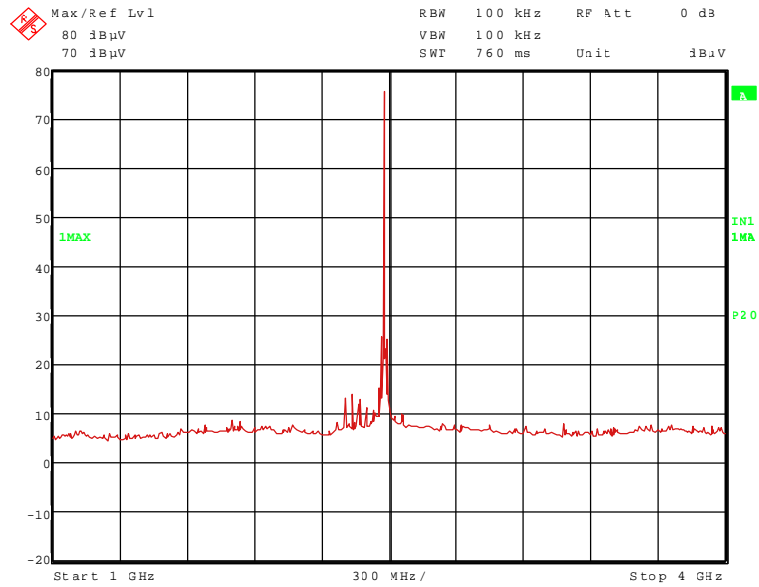
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.441 GHz and 2.521 GHz.

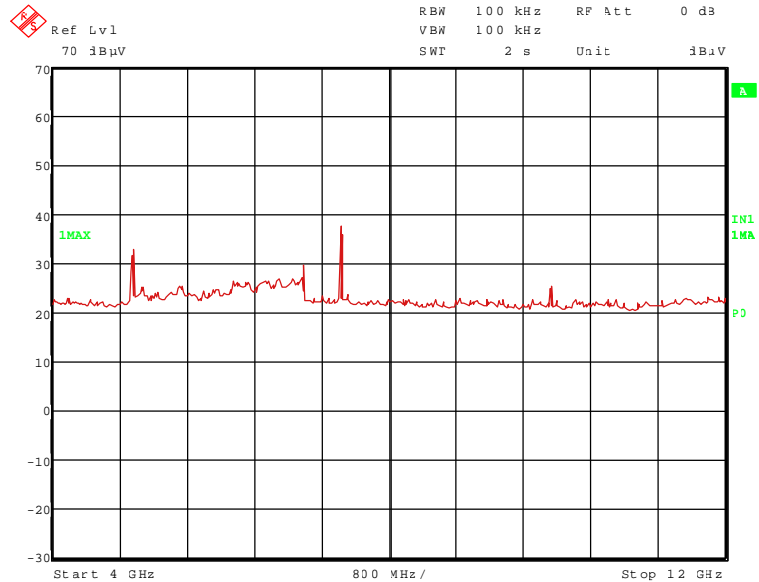
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency

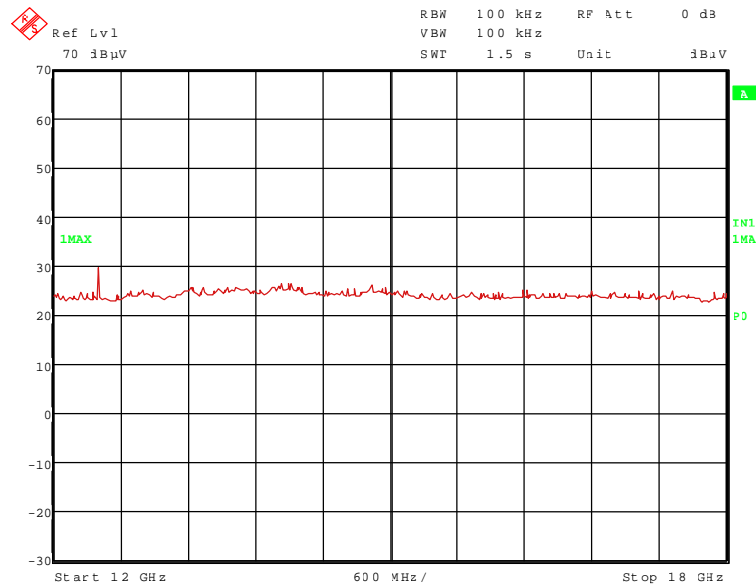
101347 39.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



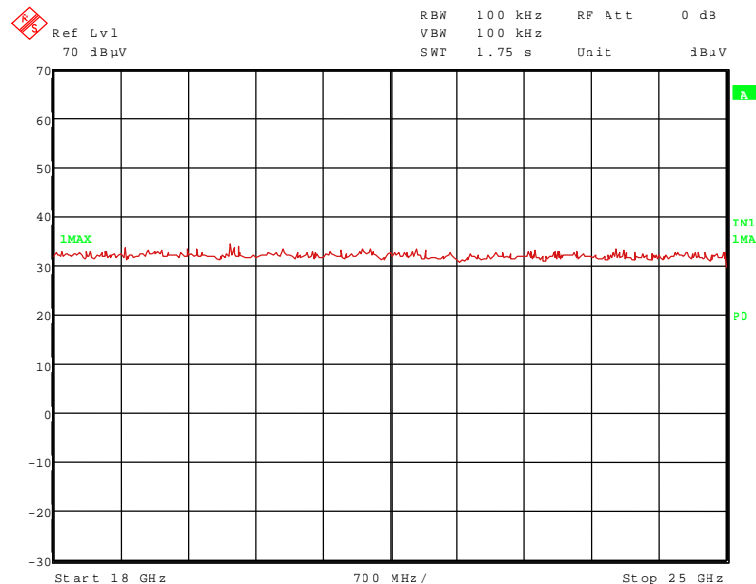
101347 38.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



101347_56.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 3):



101347_57.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 3):



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

- 2.336 GHz, 4.960 GHz, 7.440 GHz, 12.400 GHz and 19.840 GHz.

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

- 2.480 GHz, 2.560 GHz and 9.920 GHz.

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

5.7.2.6 FINAL MEASUREMENT (1 GHz to 25 GHz) WITH EXTERNAL MONOPOLE ANTENNA

Ambient temperature	20 °C
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Relative humidity	50 %
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- 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 5.0 V DC by the carrier board.
- Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.
- Remark: The emission measurement in this frequency range was carried out by using the external monopole antenna type Huber+Suhner SOA 2400/360/6/0/V, because of this antenna has the highest antenna gain of all external monopole antennas in question. Additional pre-tests have shown that this antenna causes the highest emissions of all monopole antennas in question.

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

Result measured with the peak detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.402	113.7	-	-	81.2	28.8	0.0	3.7	150	Vert.	-	1
2.258	52.2	74.0	21.8	20.3	28.4	0.0	3.5	150	Vert.	Yes	1
2.482	54.0	93.7	39.7	21.2	29.0	0.0	3.8	150	Vert.	No	1
4.804	54.5	74.0	19.5	41.2	33.7	25.7	5.3	150	Vert.	Yes	1
7.206	63.1	93.7	30.6	44.0	36.9	24.6	6.8	150	Vert.	No	1
9.608	58.3	93.7	35.4	36.1	38.3	23.9	7.8	150	Vert.	No	1
12.010	56.4	74.0	17.6	46.2	33.6	25.9	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.402	108.2	-	-	75.7	28.8	0.0	3.7	150	Vert.	-	1
2.258	41.2	54.0	12.8	9.3	28.4	0.0	3.5	150	Vert.	Yes	1
2.482	42.3	88.2	45.9	9.5	29.0	0.0	3.8	150	Vert.	No	1
4.804	44.7	54.0	9.3	31.4	33.7	25.7	5.3	150	Vert.	Yes	1
7.206	53.0	88.2	35.2	33.9	36.9	24.6	6.8	150	Vert.	No	1
9.608	44.8	88.2	43.4	22.6	38.3	23.9	7.8	150	Vert.	No	1
12.010	42.3	54.0	11.7	32.1	33.6	25.9	2.5	100	Vert.	Yes	1
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.441	114.1	-	-	81.5	28.9	0.0	3.7	150	Vert.	-	1
2.361	53.4	74.0	20.6	21.1	28.7	0.0	3.6	150	Vert.	Yes	1
2.521	54.3	94.1	39.8	21.4	29.1	0.0	3.8	150	Vert.	No	1
4.860	47.5	74.0	26.5	34.2	33.8	25.7	5.2	150	Vert.	Yes	1
4.882	54.7	74.0	19.3	41.3	33.8	25.7	5.3	150	Vert.	Yes	1
7.323	62.8	74.0	11.2	43.5	37.1	24.6	6.8	150	Vert.	Yes	1
12.205	54.7	74.0	19.3	44.5	33.6	25.9	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.441	108.6	-	-	76.0	28.9	0.0	3.7	150	Vert.	-	1
2.361	42.8	54.0	11.2	10.5	28.7	0.0	3.6	150	Vert.	Yes	1
2.521	42.4	88.6	46.2	9.5	29.1	0.0	3.8	150	Vert.	No	1
4.860	30.8	54.0	23.2	17.5	33.8	25.7	5.2	150	Vert.	Yes	1
4.882	46.6	54.0	7.4	33.2	33.8	25.7	5.3	150	Vert.	Yes	1
7.323	53.0	54.0	1.0	33.7	37.1	24.6	6.8	150	Vert.	Yes	1
12.205	40.2	54.0	13.8	30.0	33.6	25.9	2.5	100	Vert.	Yes	1
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.480	113.5	-	-	80.7	29.0	0.0	3.8	150	Vert.	-	1
2.336	53.9	74.0	20.1	21.7	28.6	0.0	3.6	150	Vert.	Yes	1
2.560	53.4	93.5	40.1	20.3	29.2	0.0	3.9	150	Vert.	No	1
4.960	52.8	74.0	21.2	39.1	34.0	25.6	5.3	150	Vert.	Yes	1
7.440	63.7	74.0	10.3	44.1	37.3	24.5	6.8	150	Vert.	Yes	1
9.920	59.5	93.5	34.0	37.0	38.5	23.9	7.9	150	Vert.	No	1
12.400	52.1	74.0	21.9	41.8	33.7	25.9	2.5	100	Vert.	Yes	1
19.840	48.6	74.0	25.4	47.4	37.0	38.3	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.480	108.2	-	-	75.4	29.0	0.0	3.8	150	Vert.	-	1
2.336	44.7	54.0	9.3	12.5	28.6	0.0	3.6	150	Vert.	Yes	1
2.560	41.2	88.2	47.0	8.1	29.2	0.0	3.9	150	Vert.	No	1
4.960	45.6	54.0	8.4	31.9	34.0	25.6	5.3	150	Vert.	Yes	1
7.440	53.9	54.0	0.1	34.3	37.3	24.5	6.8	150	Vert.	Yes	1
9.920	45.9	88.2	42.3	23.4	38.5	23.9	7.9	150	Vert.	No	1
12.400	37.5	54.0	16.5	27.2	33.7	25.9	2.5	100	Vert.	Yes	1
19.840	33.4	54.0	20.6	32.2	37.0	38.3	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

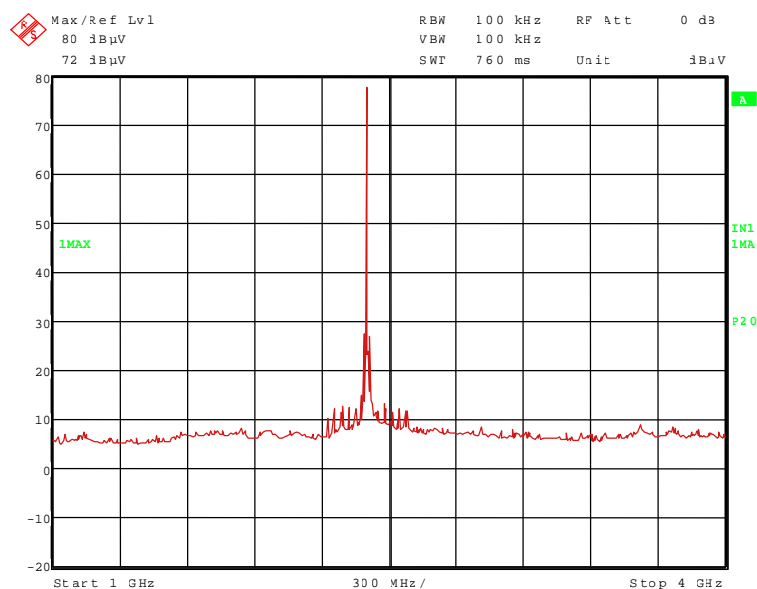
5.7.2.7 PRELIMINARY MEASUREMENT (1 GHz to 25 GHz) WITH EXTERNAL PATCH ANTENNA

Ambient temperature	21 °C	Relative humidity	43 %
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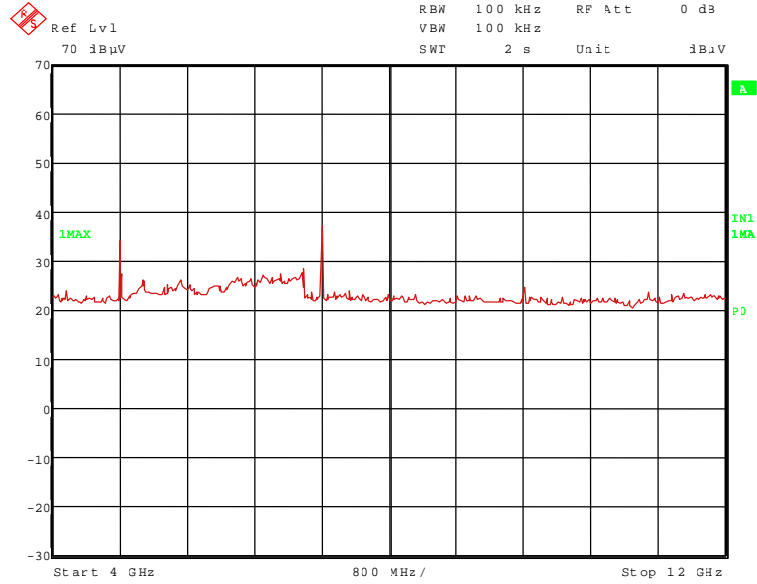
- Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.
- Cable guide: The cable of the EUT is running vertically to the false floor. For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.
- Test record: All results are shown in the following.
- Supply voltage: During all measurements the EUT was supplied with 5.0 V DC via the carrier board.
- Remark: The emission measurement in this frequency range was carried out by using the external patch antenna type Huber+Suhner SPA 2400/70/9/0/RCP, because of this antenna has the highest antenna gain of all external patch antennas in question. Additional pre-tests have shown that this antenna causes the highest emissions of all patch antennas in question.

Transmitter operates at the lower end of the assigned frequency band

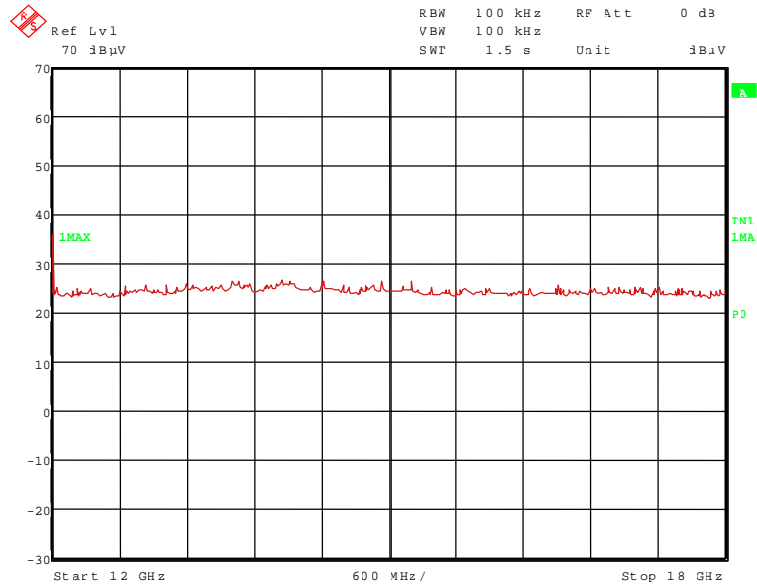
101347_34.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



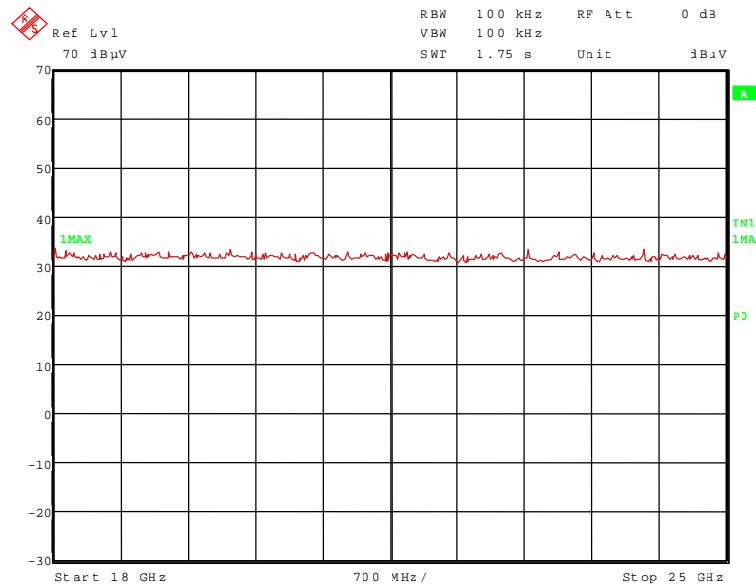
101347_35.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



101347_48.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



101347_53.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 1):



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

- 2.290 GHz, 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, 2.514 GHz, 7.206 GHz and 9.608 GHz.

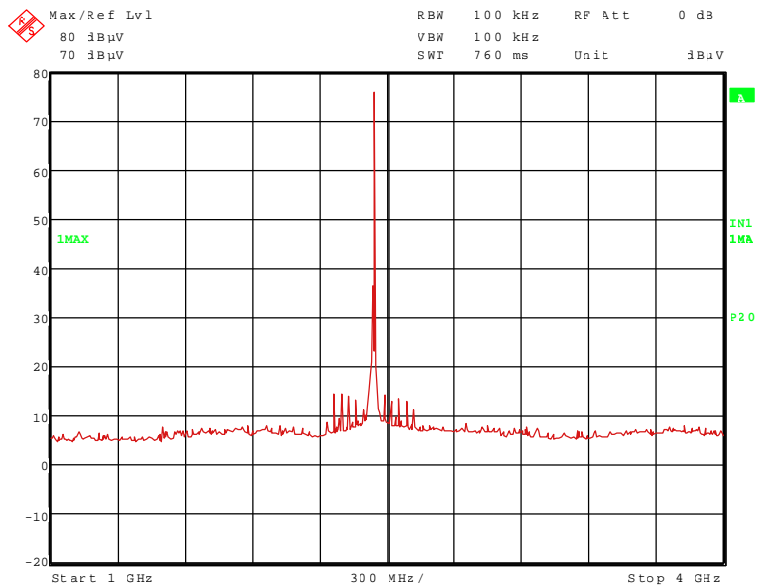
These frequencies have to be measured in a final measurement. The results were presented in the following.

TEST EQUIPMENT USED FOR THE TEST:

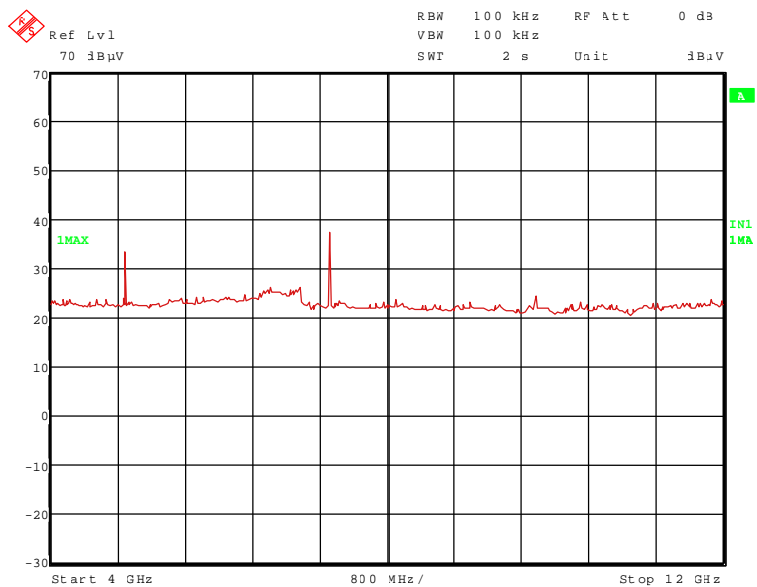
29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

Transmitter operates on the middle of the assigned frequency band

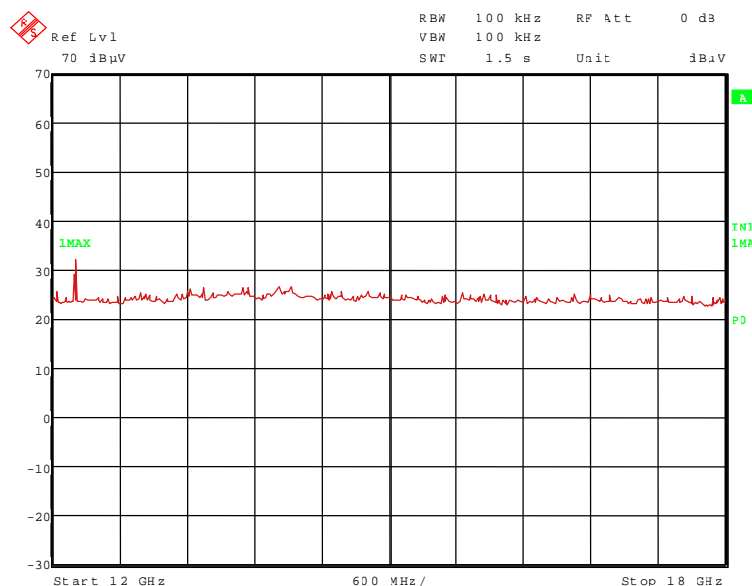
101347_31.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



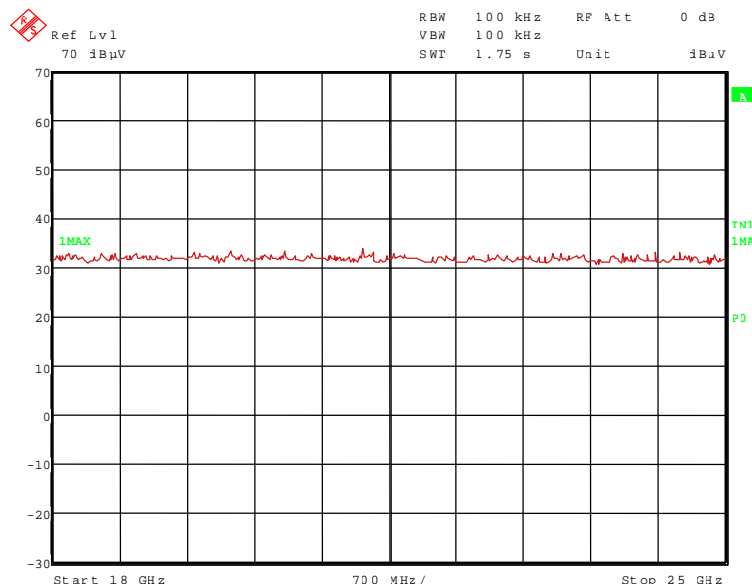
101347_30.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 2):



101347_49.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 2):



101347_52.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 2):



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

- 2.265 GHz, 4.882 GHz, 7.323 GHz and 12.205 GHz.

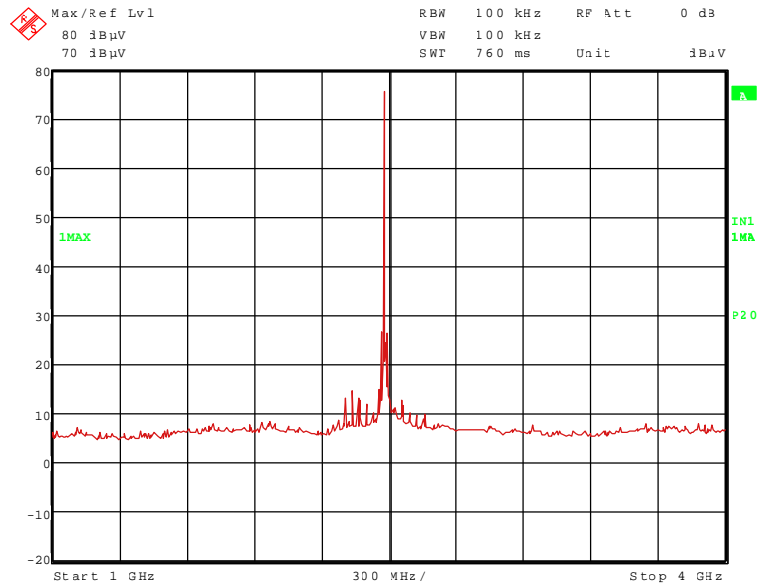
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2.441 GHz and 2.553 GHz.

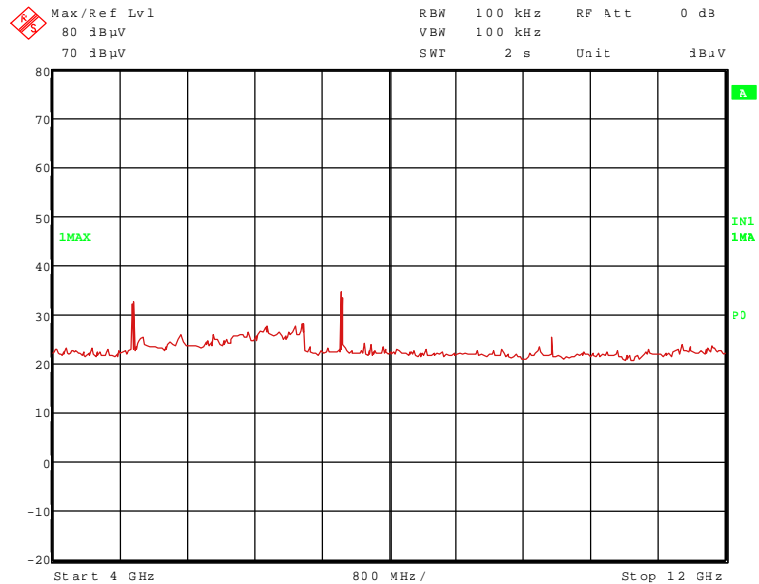
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency

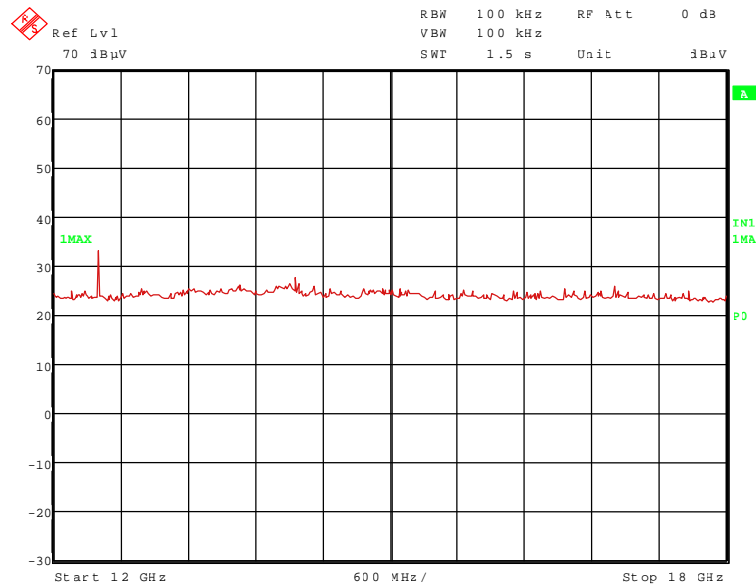
101347 32.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



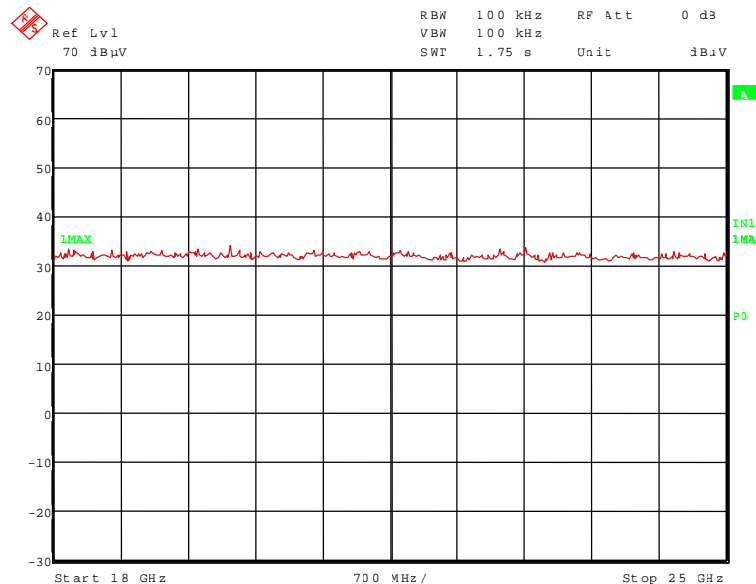
101347 33.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



101347_50.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 3):



101347_51.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 3):



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

- 2.336 GHz, 4.960 GHz, 7.440 GHz, 12.400 GHz and 19.840 GHz.

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

- 2.480 GHz and 2.560 GHz.

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

5.7.2.8 FINAL MEASUREMENT (1 GHz to 25 GHz) WITH EXTERNAL PATCH ANTENNA

Ambient temperature	21 °C	Relative humidity	43 %
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- 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 5.0 V DC by the carrier board.
- Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.
- Remark: The emission measurement in this frequency range was carried out by using the external patch antenna type Huber+Suhner SPA 2400/70/9/0/RCP, because of this antenna has the highest antenna gain of all external patch antennas in question. Additional pre-tests have shown that this antenna causes the highest emissions of all patch antennas in question.

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

Result measured with the peak detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.402	113.4	-	-	80.9	28.8	0.0	3.7	150	Hor.	-	1
2.290	52.6	74.0	21.4	20.5	28.5	0.0	3.6	150	Vert.	Yes	1
2.514	54.9	93.4	38.5	22.0	29.1	0.0	3.8	150	Hor.	No	1
4.804	54.7	74.0	19.3	41.4	33.7	25.7	5.3	150	Vert.	Yes	1
7.206	62.8	93.4	30.6	43.7	36.9	24.6	6.8	150	Vert.	No	1
9.608	57.4	93.4	36.0	35.2	38.3	23.9	7.8	150	Vert.	No	1
12.010	55.9	74.0	18.1	45.7	33.6	25.9	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.402	107.9	-	-	75.4	28.8	0.0	3.7	150	Hor.	-	1
2.290	42.1	54.0	11.9	10.0	28.5	0.0	3.6	150	Vert.	Yes	1
2.514	43.8	87.9	44.1	10.9	29.1	0.0	3.8	150	Hor.	No	1
4.804	44.8	54.0	9.2	31.5	33.7	25.7	5.3	150	Vert.	Yes	1
7.206	52.7	87.9	35.2	33.6	36.9	24.6	6.8	150	Vert.	No	1
9.608	43.9	87.9	44.0	21.7	38.3	23.9	7.8	150	Vert.	No	1
12.010	41.8	54.0	12.2	31.6	33.6	25.9	2.5	100	Vert.	Yes	1
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.441	112.1	-	-	79.5	28.9	0.0	3.7	150	Hor.	-	1
2.265	52.2	74.0	21.8	20.3	28.4	0.0	3.5	150	Vert.	Yes	1
2.553	55.1	92.1	37.0	22.0	29.2	0.0	3.9	150	Hor.	No	1
4.882	55.6	74.0	18.4	42.2	33.8	25.7	5.3	150	Vert.	Yes	1
7.323	62.5	74.0	11.5	43.2	37.1	24.6	6.8	150	Vert.	Yes	1
12.205	54.4	74.0	19.6	44.2	33.6	25.9	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.441	111.5	-	-	78.9	28.9	0.0	3.7	150	Hor.	-	1
2.265	42.9	54.0	11.1	11.0	28.4	0.0	3.5	150	Vert.	Yes	1
2.553	40.4	91.5	51.1	7.3	29.2	0.0	3.9	150	Hor.	No	1
4.882	46.9	54.0	7.1	33.5	33.8	25.7	5.3	150	Vert.	Yes	1
7.323	52.2	54.0	1.8	32.9	37.1	24.6	6.8	150	Vert.	Yes	1
12.205	40.1	54.0	13.9	29.9	33.6	25.9	2.5	100	Vert.	Yes	1
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 dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.480	114.7	-	-	81.9	29.0	0.0	3.8	150	Hor.	-	1
2.336	54.0	74.0	20.0	21.8	28.6	0.0	3.6	150	Hor.	Yes	1
2.560	55.3	94.7	39.4	22.2	29.2	0.0	3.9	150	Hor.	No	1
4.960	55.6	74.0	18.4	41.9	34.0	25.6	5.3	150	Vert.	Yes	1
7.440	63.1	74.0	11.0	43.5	37.3	24.5	6.8	150	Vert.	Yes	1
12.400	52.8	74.0	21.2	42.5	33.7	25.9	2.5	100	Vert.	Yes	1
19.840	45.3	74.0	28.7	44.1	37.0	38.3	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2.480	109.2	-	-	76.4	29.0	0.0	3.8	150	Hor.	-	1
2.336	45.1	54.0	8.9	12.9	28.6	0.0	3.6	150	Hor.	Yes	1
2.560	43.9	89.2	45.3	10.8	29.2	0.0	3.9	150	Hor.	No	1
4.960	46.9	54.0	7.1	33.2	34.0	25.6	5.3	150	Vert.	Yes	1
7.440	53.4	54.0	0.6	33.8	37.3	24.5	6.8	150	Vert.	Yes	1
12.400	38.4	54.0	15.6	28.1	33.7	25.9	2.5	100	Vert.	Yes	1
19.840	31.7	54.0	22.3	30.5	37.0	38.3	2.5	100	Vert.	Yes	1
Measurement uncertainty						+2.2 dB / -3.6 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72

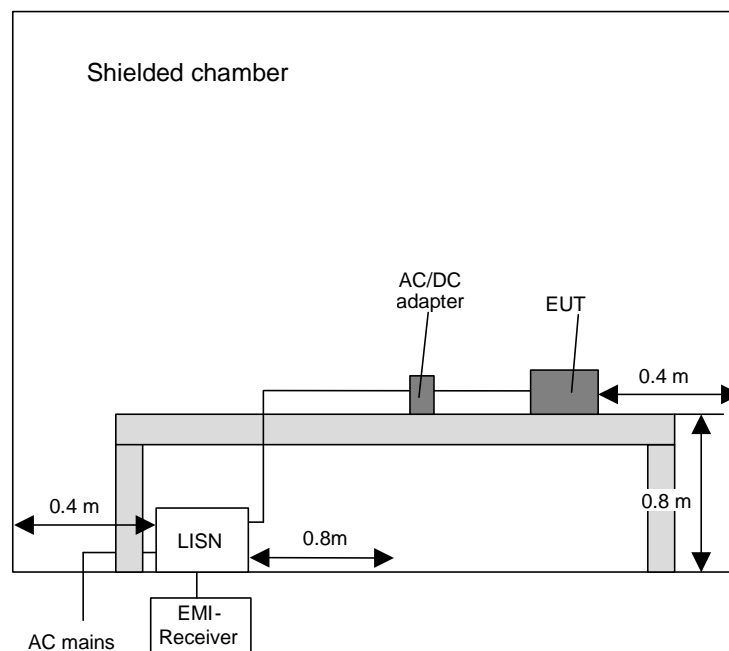
5.8 CONDUCTED EMISSIONS ON POWER SUPPLY LINES (150 kHz to 30 MHz)

5.8.1 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 C63.4-2009 [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 appropriate 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



5.8.2 TEST RESULTS (CONDUCTED EMISSIONS ON POWER SUPPLY LINES)

Ambient temperature	20 °C	Relative humidity	57 %
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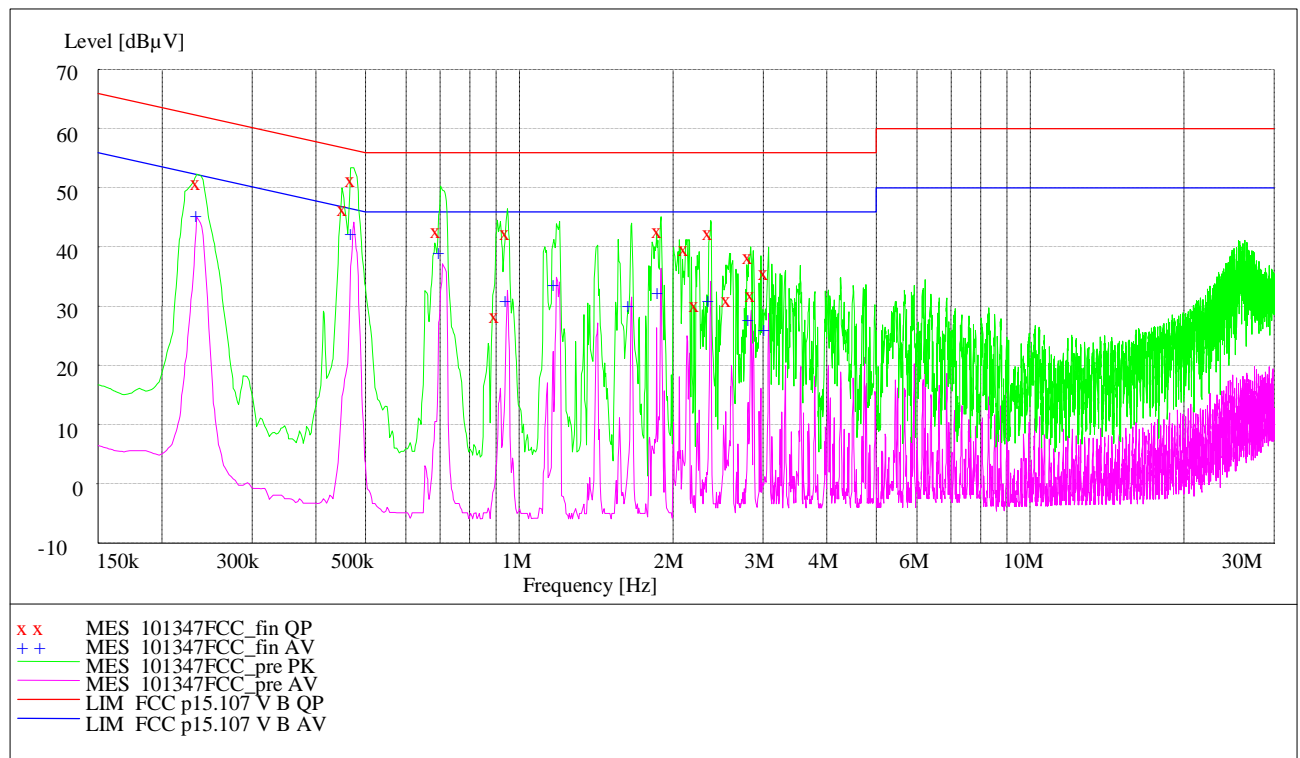
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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: The EUT operates in operation mode 4. All results are shown in the following.

Supply voltage: During the measurement the EUT was supplied 5 V DC by an AC / DC adaptor type Mascot 2121, which was supplied by 120 V AC / 60 Hz.

The curves in the diagram only represent for each frequency point the maximum measured value of all preliminary measurements which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by an x and the average measured points by a +.



Data record name: 101347FCC

Result measured with the quasipeak detector:
(These values are marked in the diagram by an x)

Frequency MHz	Level dB μ V	Transducer dB	Limit dB μ V	Margin dB	Line	PE
0.235500	51.90	1.0	62.3	10.4	L1	FLO
0.456900	47.00	0.9	56.7	9.7	L1	FLO
0.474000	52.20	0.9	56.4	4.3	L1	FLO
0.700800	43.40	0.8	56.0	12.6	N	FLO
0.911400	29.30	0.8	56.0	26.7	N	FLO
0.949200	43.30	0.8	56.0	12.7	L1	FLO
1.895100	43.70	0.7	56.0	12.3	L1	FLO
2.133600	40.30	0.8	56.0	15.7	L1	FLO
2.244300	30.80	0.7	56.0	25.2	L1	FLO
2.371200	43.30	0.7	56.0	12.7	L1	FLO
2.577300	31.90	0.7	56.0	24.1	L1	FLO
2.845500	39.20	0.9	56.0	16.8	L1	FLO
2.874300	32.70	0.9	56.0	23.3	L1	FLO
3.074100	36.40	0.7	56.0	19.6	L1	FLO
Measurement uncertainty				+3.6 dB / -4.5 dB		

Data record name: 101347FCC_fin QP

Result measured with the average detector:
(These values are marked in the diagram by an +)

Frequency MHz	Level dB μ V	Transducer dB	Limit dB μ V	Margin dB	Line	PE
0.237300	46.10	1.0	52.2	6.1	L1	FLO
0.474000	43.20	0.9	46.4	3.3	L1	FLO
0.710700	39.80	0.8	46.0	6.2	L1	FLO
0.947400	31.80	0.8	46.0	14.2	L1	FLO
1.185000	34.40	0.7	46.0	11.6	L1	FLO
1.657500	30.90	0.7	46.0	15.1	L1	FLO
1.894200	33.30	0.7	46.0	12.7	L1	FLO
2.370300	32.00	0.7	46.0	14.0	L1	FLO
2.843700	28.60	0.8	46.0	17.4	L1	FLO
3.081300	27.00	0.7	46.0	19.0	L1	FLO
Measurement uncertainty				+3.6 dB / -4.5 dB		

Data record name: 101347FCC_fin AV

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
1 – 4, 20

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	02/08/2010	02/2012
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	05/07/2010	05/2012
4	High pass filter	HR 0.13- 5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	03/15/2010	03/2012
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	08/01/2007	08/2012
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	02/04/2009	02/2010
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	03/17/2010	03/2012
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	2688	480328	10/11/2005	10/2010
36	Antenna	3115 A	EMCO	9609-4918	480183	11/04/2008	11/2013
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	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	03/10/2010	03/2012
72	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

