

Test Report

Report Number: F130413E1

Applicant:

Hatox GmbH

Manufacturer:

Hatox GmbH

Equipment under Test (EUT):

**Transceiver module
H153V2**



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 (April 2013)** Radio Frequency Devices
- [3] **FCC Public Notice DA 00-705 (March 2000)**
- [4] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
- [5] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radio Apparatus

TEST RESULT

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

Test engineer:	Manuel BASTERT		10 April 2013
	Name	Signature	Date
Authorized reviewer:	Thomas KÜHN		10 April 2013
	Name	Signature	Date

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1 IDENTIFICATION

1.1 Applicant

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eMail Address:	thomas.haug@hatox.com
Applicant represented during the test by the following person:	Mr. Thomas HAUG

1.2 Manufacturer

Name:	Hatox GmbH
Address:	Kreuzstr. 70 75214 Birkenfeld
Country:	Germany
Name for contact purposes:	Mr. Thomas HAUG
Phone:	+49 7231 2980680
Fax:	+49 7231 2980688
eMail Address:	thomas.haug@hatox.com
Manufacturer represented during the test by the following person:	Mr. Thomas HAUG

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: *	Transceiver module
Model name: *	H153V2
FCC ID: *	FCC-ID: SCAH153V2
IC: *	IC: 10949A-H153V2
PCB identifier: *	H153V2
Serial number: *	1000
Hardware version: *	2.0.0
Software version: *	1.0.0
Lowest / highest internal clock frequency: *	14.7456 MHz

1.5 Technical data of equipment

Channel 1	RX:	902.500 MHz	TX:	902.500 MHz
Channel 500	RX:	914.975 MHz	TX:	914.975 MHz
Channel 1000	RX:	927.475 MHz	TX:	927.475 MHz

Rated RF output power: *	<10 dBm					
Antenna type: *	Internal (helical antenna)					
Antenna gain: *	0 dBi					
Modulation: *	FHSS (FSK)					
Supply Voltage: *	U _{nom} =	3.0 V _{DC}	U _{min} =	2.0 V _{DC}	U _{max} =	6.0 V _{DC}
Temperature range: *	-20 °C to + 75 °C					
Ancillary used for test:	Hatox programmer					

* declared by the applicant.

1.6 Dates

Date of receipt of test sample:	25 February 2013
Start of test:	25 February 2013
End of test:	27 February 2013

2 OPERATIONAL STATES

All tests were carried out with an unmodified sample with integral antenna.

During the all tests the EUT was powered by an external power supply with 3 V_{DC}.

The operation mode could be chosen with the help of a temporary connected laptop PC and a programming adaptor.

The conducted measurements were carried out at a temporary antenna connector equipped EUT.

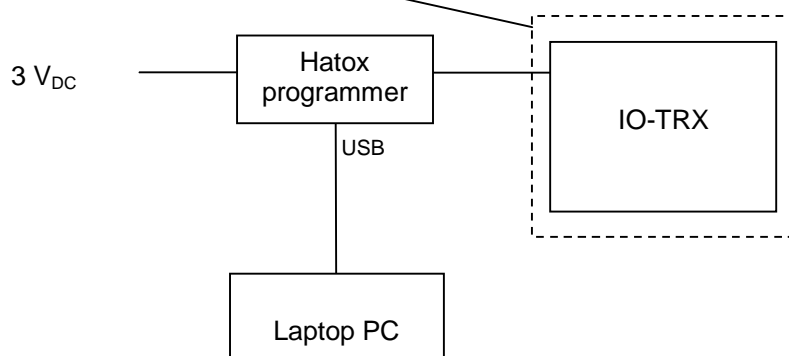
For all measurements the output power of the EUT was set to its maximum value.

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

The following operation modes were used during the tests:

Operation mode	Description of the operation mode
1	Transmit on 902.500 MHz (channel 1)
2	Transmit on 914.975 MHz (channel 500)
3	Transmit on 927.475 MHz (channel 1000)
4	Transmit on all channels (hopping enabled)

Physical boundary of the EUT



3 ADDITIONAL INFORMATION

None.

4 OVERVIEW

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 8 [4] or RSS-Gen, Issue 3 [5]	Status	Refer page
20 dB bandwidth	General	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	8 et seq.
Carrier frequency separation	General	15.247 (a) (1) (i)	-	Passed	11 et seq.
Number of hopping channels	902.0 – 928.0	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	14 et seq.
Dwell time	902.0 – 928.0	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	16 et seq.
Maximum peak output power	902.0 – 928.0	15.247 (b) (2)	A8.4 (1) [4]	Passed	18 et seq.
Radiated emissions (transmitter)	0.009 - 10,000	15.247 (d) 15.205 (a) 15.209 (a)	A8.5 [4] 2.5 [4] 7.2.2 [5]	Passed	21 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.4 [5]	Passed	38 et seq.

5 TEST RESULTS

5.1 20 dB bandwidth

5.1.1 Method of measurement

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

The following spectrum analyser settings shall be used:

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

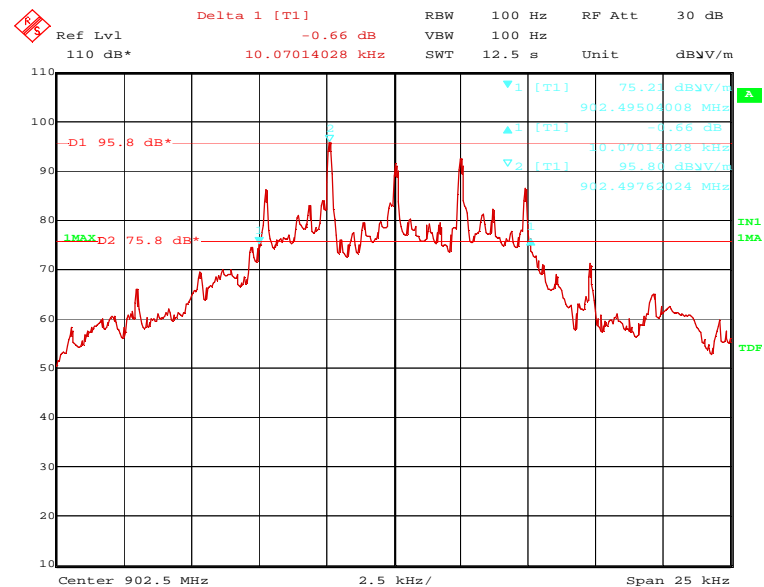
Test setup:



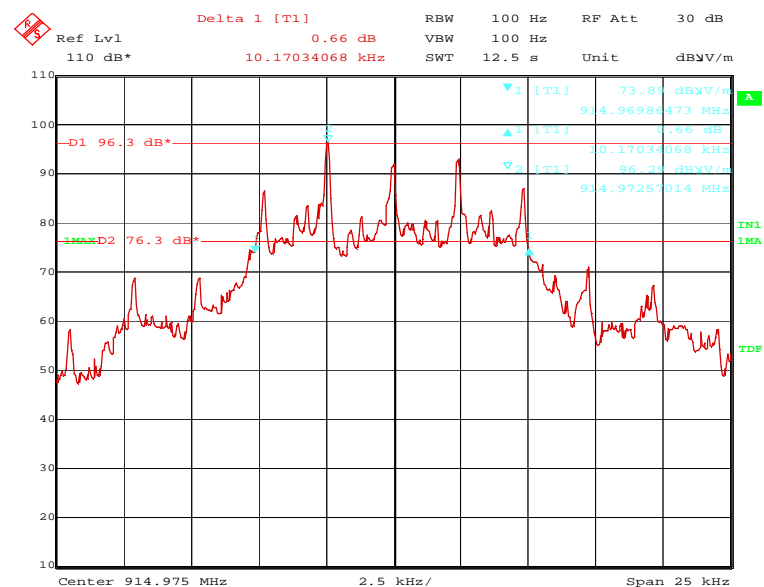
5.1.2 Test results

Ambient temperature	21 °C	Relative humidity	27 %
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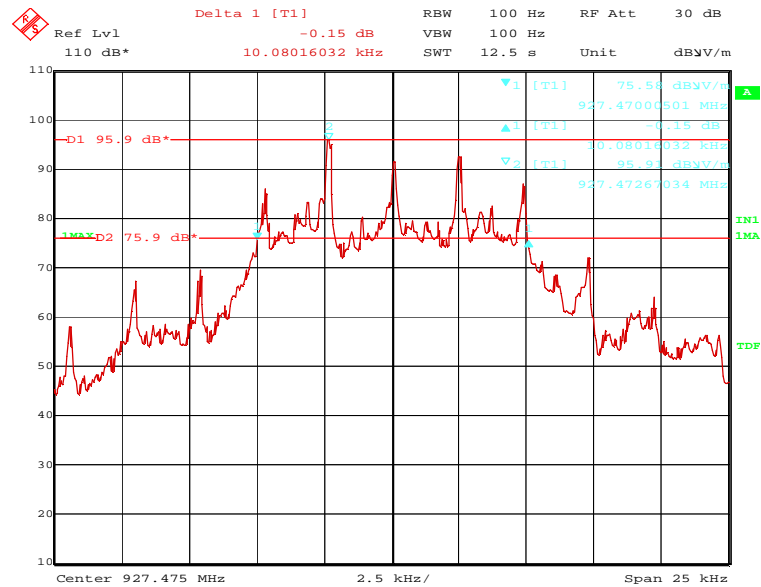
130413_3.wmf: 20 dB bandwidth at the lower end of the assigned frequency band:



130413_9.wmf: 20 dB bandwidth at the middle of the assigned frequency band:



130413_6.wmf: 20 dB bandwidth at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
1	902.500	10.070140 kHz
500	914.975	10.170341 kHz
1000	927.475	10.080160 kHz
Measurement uncertainty: +0.66 dB / -0.72 dB		

Test result: Passed.

TEST EQUIPMENT USED FOR THE TEST:
31

5.2 Carrier frequency separation

5.2.1 Method of measurement

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

The following spectrum analyser settings shall be used:

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

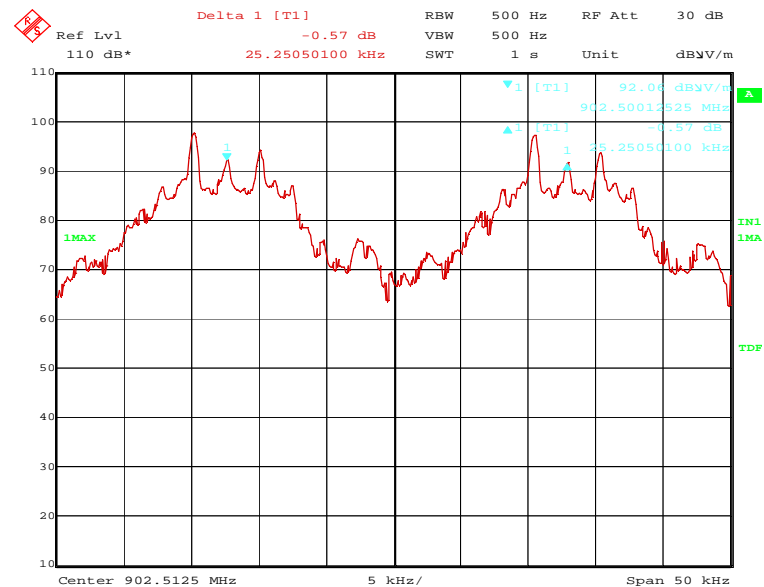
Test setup:



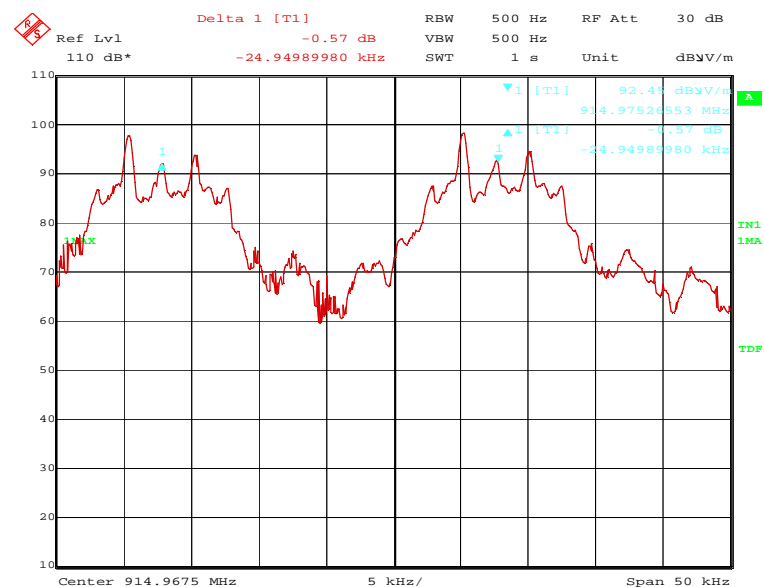
5.2.2 Test results

Ambient temperature	21 °C	Relative humidity	27 %
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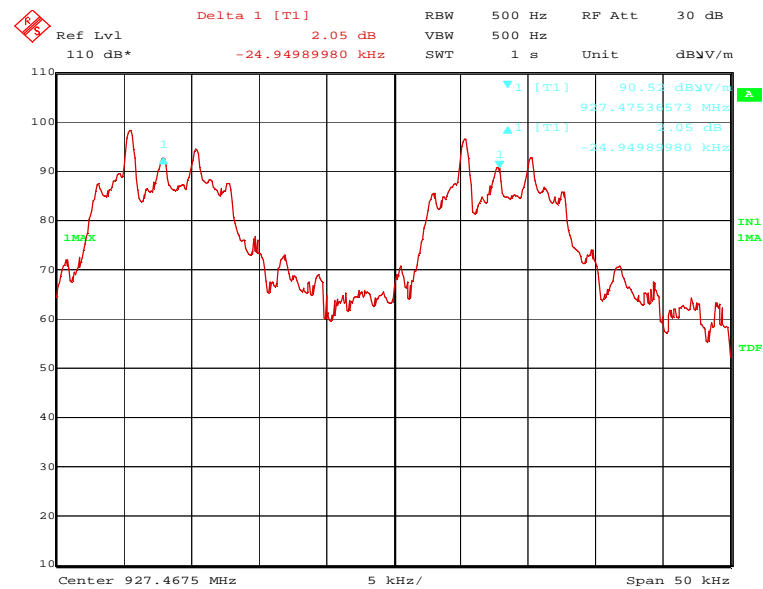
130413_4.wmf: Channel separation at the lower end of the assigned frequency band:



130413_10.wmf: Channel separation at the middle of the assigned frequency band:



130413_5.wmf: Channel separation at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
1	902.500	25.250 kHz	10.070 kHz (the 20 dB bandwidth)
500	914.975	24.949 kHz	10.170 kHz (the 20 dB bandwidth)
1000	927.475	24.950 kHz	10.080 kHz (the 20 dB bandwidth)
Measurement uncertainty: $<10^{-7}$			

Test result: Passed.

TEST EQUIPMENT USED FOR THE TEST:

31

5.3 Number of hopping frequencies

5.3.1 Method of measurement

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

The following spectrum analyser settings shall be used:

- Span: Equal to the assigned frequency band.
- Resolution bandwidth: $\geq 1\%$ 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.

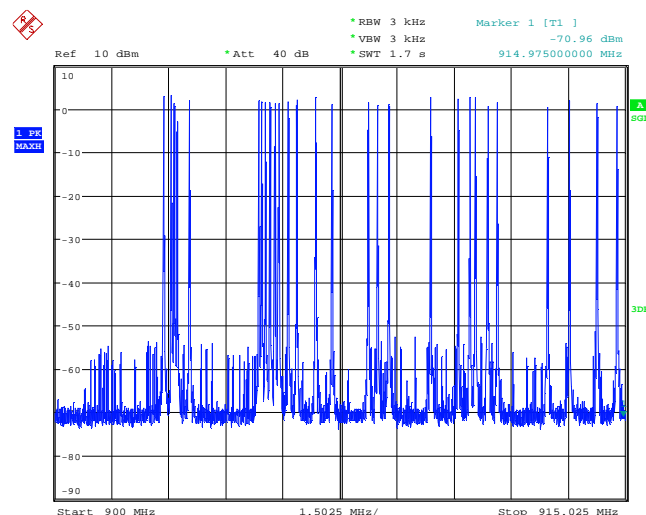
Test setup:



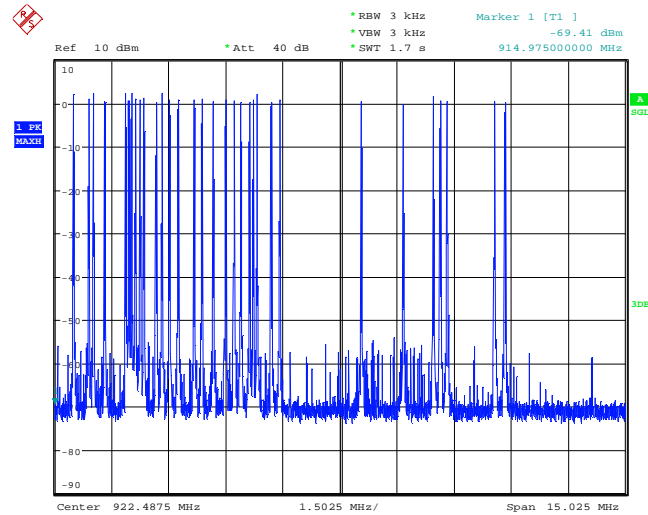
5.3.2 Test results

Ambient temperature	21 °C	Relative humidity	28 %
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130413_16.wmf: Number of hopping channels (part 1):



130413_17.wmf: Number of hopping channels (part 2):



Remark: Because of the small channel separation (25 kHz) the RBW was set to a smaller value than required in order to count the number of hopping channels.

Number of hopping channels	Limit
Operation mode 4	
60	At least 50

Test result: Passed.

TEST EQUIPMENT USED FOR THE TEST:
30

5.4 Dwell time

5.4.1 Method of measurement

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

The following spectrum analyser settings shall be used:

- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: \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 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.

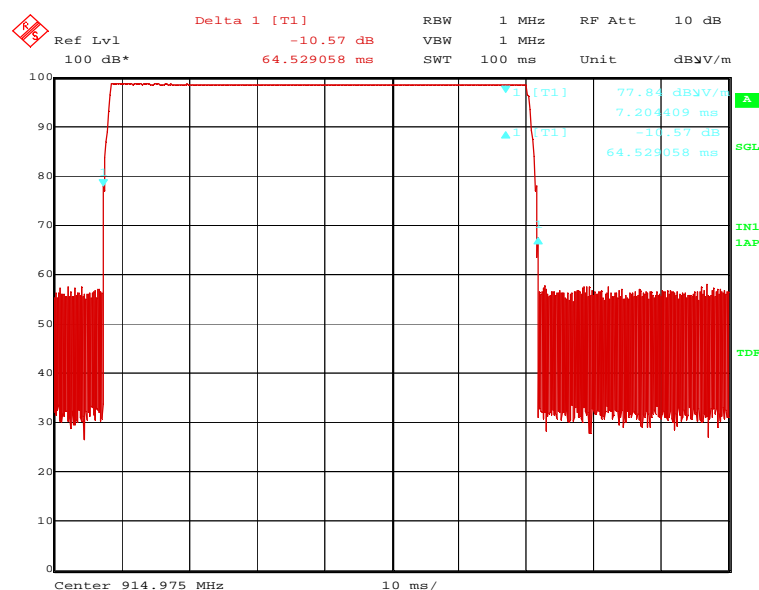
Test setup:



5.4.2 Test results

Ambient temperature	21 °C	Relative humidity	27 %
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130413_11.wmf: Dwell time at the middle of the assigned frequency band:



The dwell time is calculated with the following formula:

$$\text{Dwell time} = t_{\text{pulse}} \times n_{\text{hops}} / \text{number of hopping channels} \times 20 \text{ s}$$

Where:

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

The hopping rate of the system is 8.8 hops per second and the system uses 60 channels.

Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Dwell time [ms]	Limit [ms]
500	914.975	64.529	189.285	400
Measurement uncertainty: $<10^{-7}$				

Test result: Passed.

TEST EQUIPMENT USED FOR THE TEST:
31

5.5 Maximum peak output power

5.5.1 Method of measurement

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

The following spectrum analyser settings shall be used:

- Span: Approx. 5 times the 20 dB bandwidth, centred on a hopping channel.
- Resolution bandwidth: > the 20 dB bandwidth of the emission being measured.
- Video bandwidth: \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.

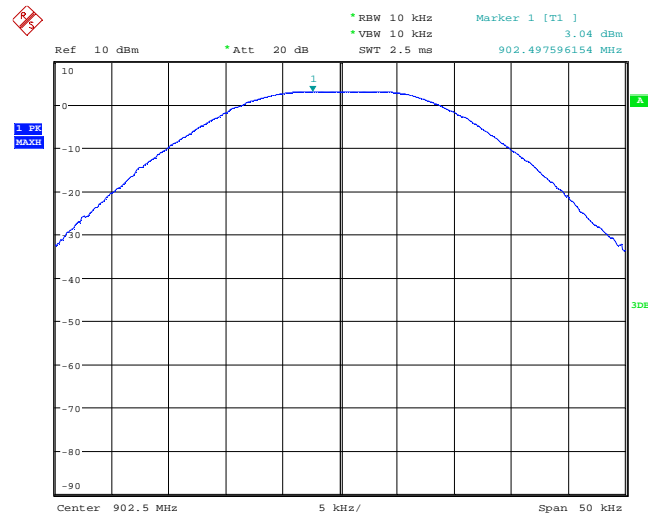
Test setup:



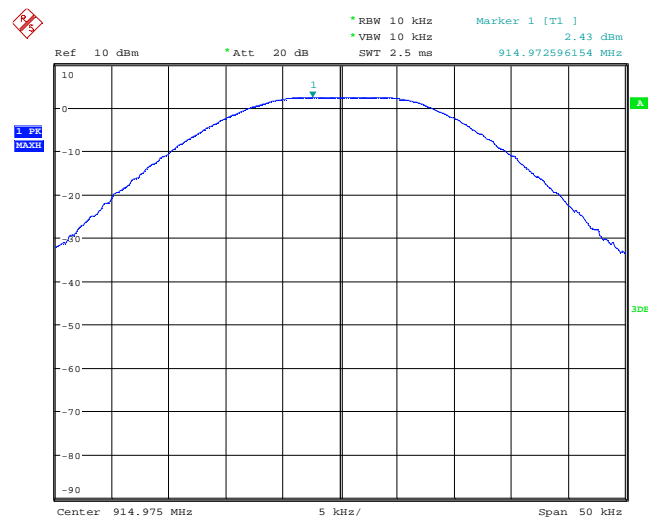
5.5.2 Test results

Ambient temperature	21 °C	Relative humidity	27 %
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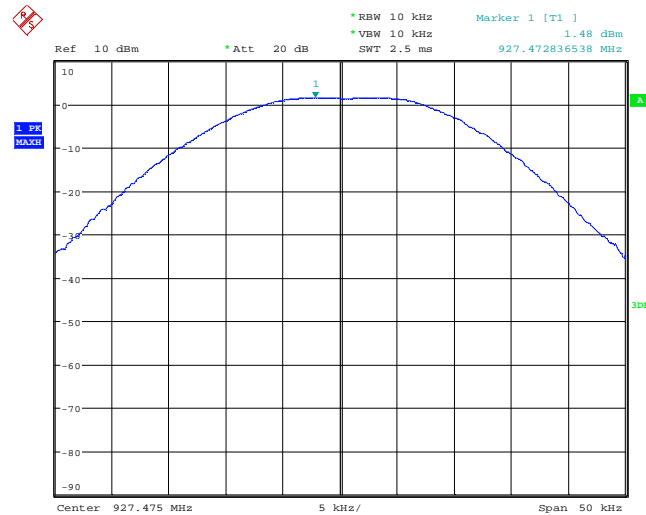
130413_23.wmf: Maximum peak output power at 902.5 MHz:



130413_24.wmf: Maximum peak output power 914.975 MHz:



130413_25.wmf: Maximum peak output power at 927.475 MHz:



Operation mode	Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1	1	902.500	3.0	0.0	30.0
2	500	914.975	2.4	0.0	30.0
3	1000	917.475	1.5	0.0	30.0
Measurement uncertainty: +0.66 dB / -0.72 dB					

Test result: Passed.

TEST EQUIPMENT USED FOR THE TEST:

30

5.6 Radiated emissions

5.6.1 Method of measurement

The radiated emission measurement is subdivided into four stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out on an open area test 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.

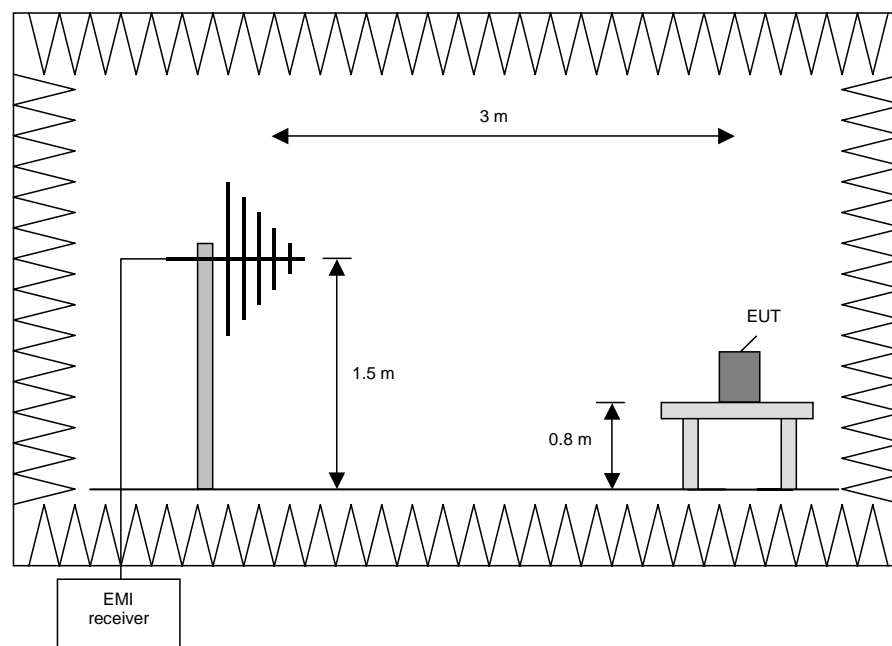
Preliminary measurement (30 MHz to 1 GHz)

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 200 MHz	100 kHz
200 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 200 MHz and 200 MHz to 1 GHz.

The following procedure will be used:

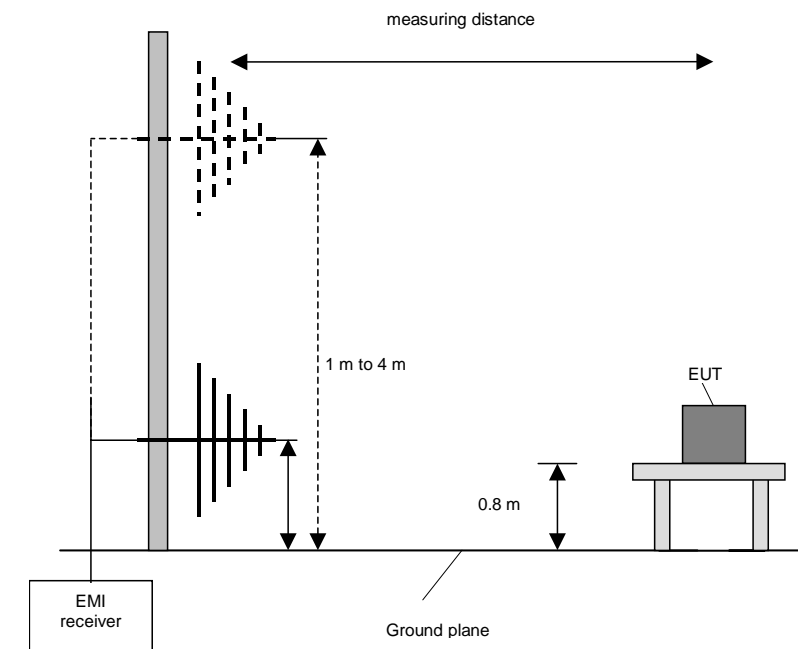
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the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

Final measurement (30 MHz to 1 GHz)

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

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

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

Preliminary and final measurement (1 GHz to 110 GHz)

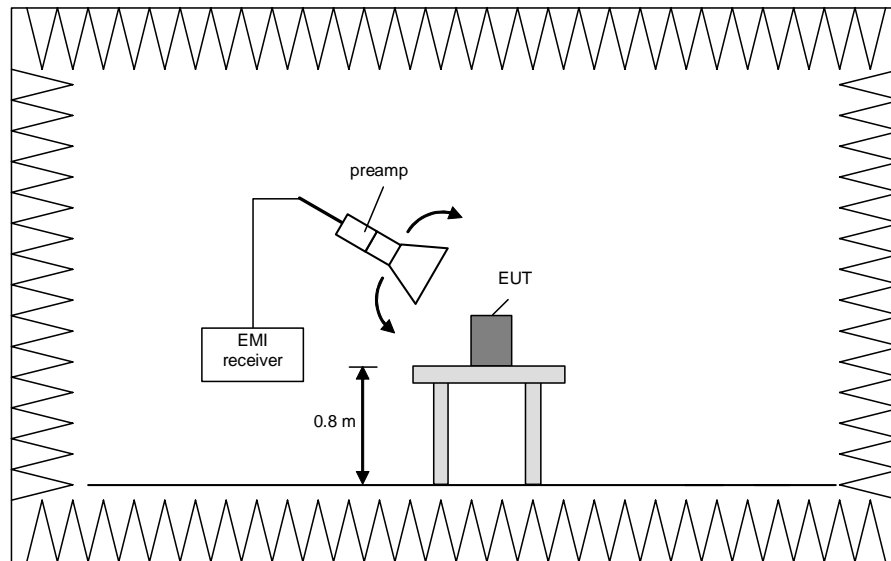
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance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

Preliminary measurement (1 GHz to 110 GHz)

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

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

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

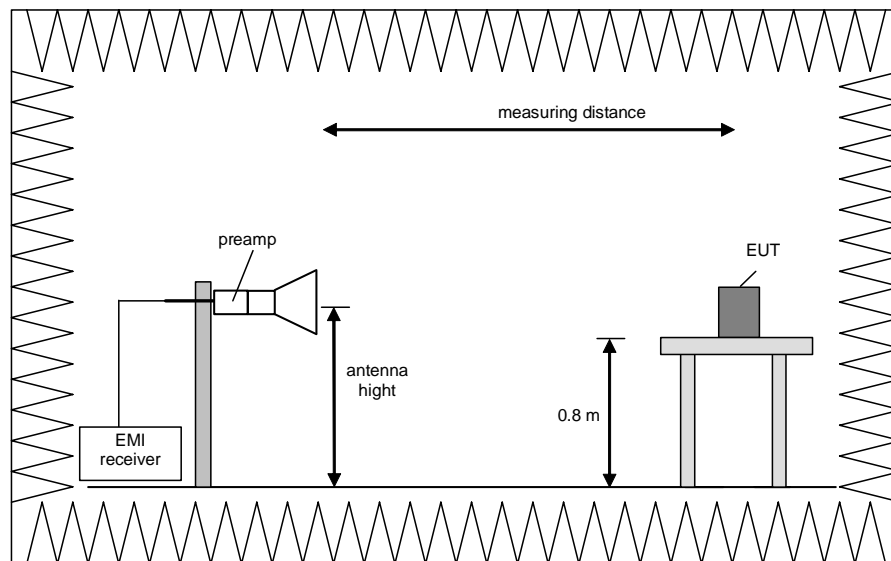


Final measurement (1 GHz to 110 GHz)

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

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

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



Procedure of measurement:

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

The following procedure will be used:

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

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

5.6.2 Test results

5.6.2.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	27 %
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Position of EUT: The EUT was setup on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

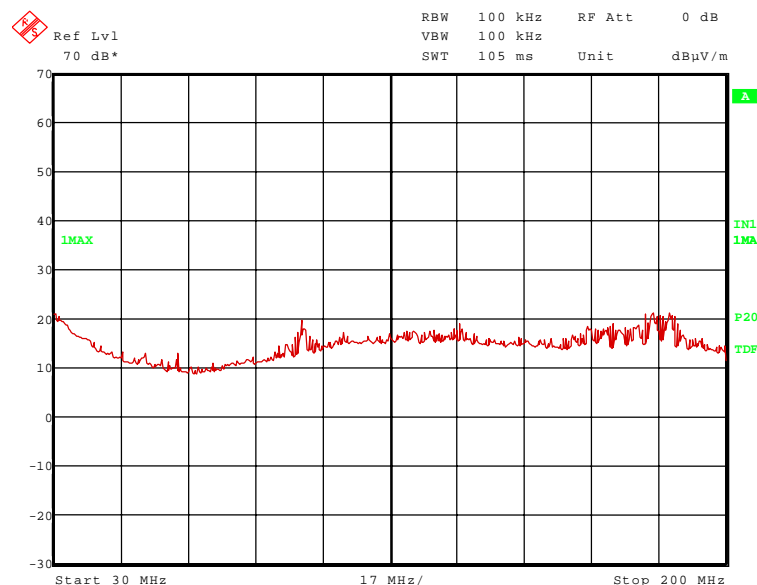
Test record: All results of the three positions are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 3.0 V DC by an external power supply.

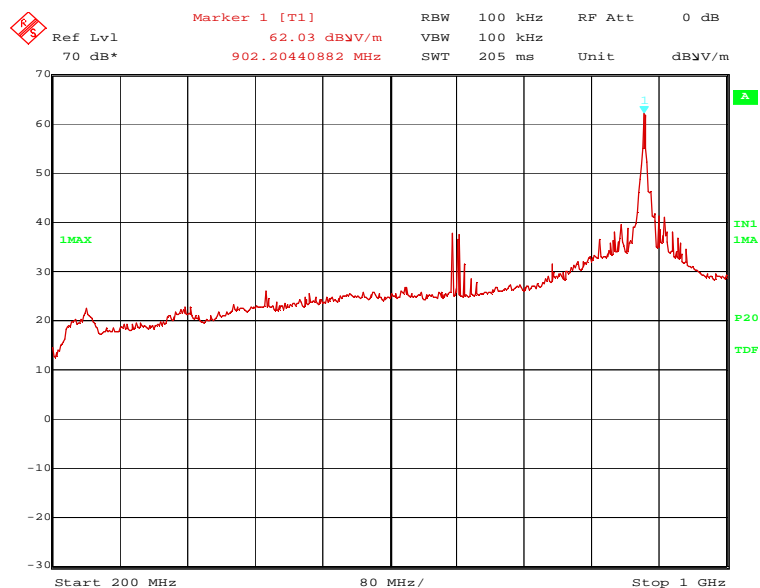
Remark: As pre-tests have shown, the emissions in the frequency range 10 MHz to 30 MHz are not depending on the transmitter operation mode. Therefore the emissions in this frequency range were measured only with the transmitter operates in operation mode 2.

Transmitter operates at 902.5 MHz (operation mode 1)

130413_2.wmf: Spurious emissions from 30 MHz to 200 MHz (operation mode 1):



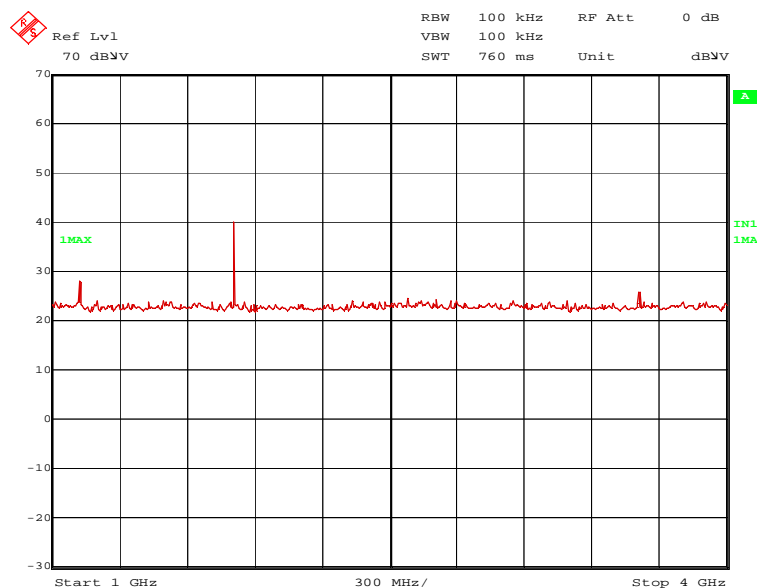
130413_1.wmf: Spurious emissions from 200 MHz to 1 GHz (operation mode 1, carrier notched):



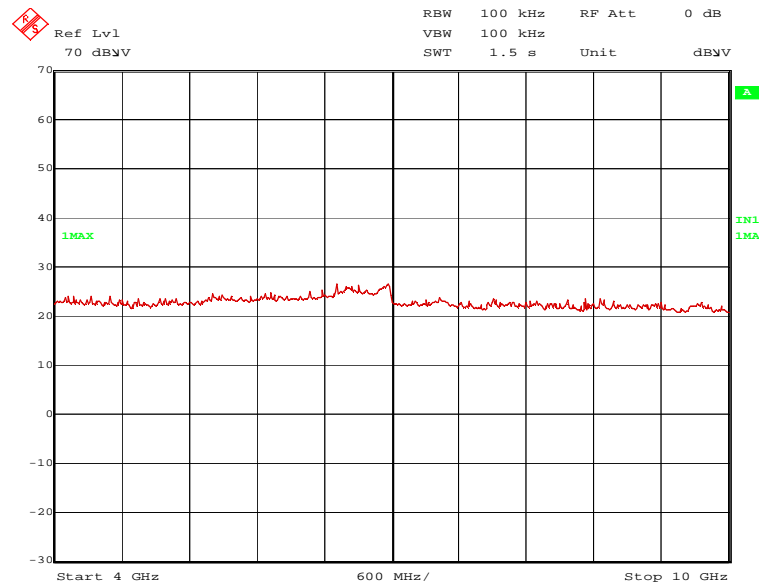
Frequencies found	Frequency in MHz
Outside restricted bands	181.892, 183.755, 457.134, 673.941, 681.319, 878.873, 902.500, 915.738
Inside restricted bands	None

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

130413_19.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



130413_20.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 1):



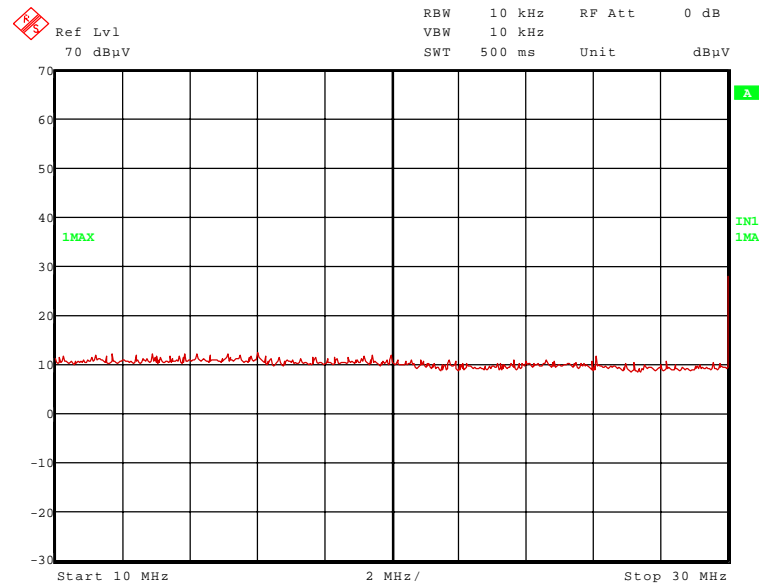
Frequencies found	Frequency in MHz
Outside restricted bands	1805.000
Inside restricted bands	1123.690, 3610.000

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 - 36, 43, 44, 45, 49, 55, 73, 75, 83

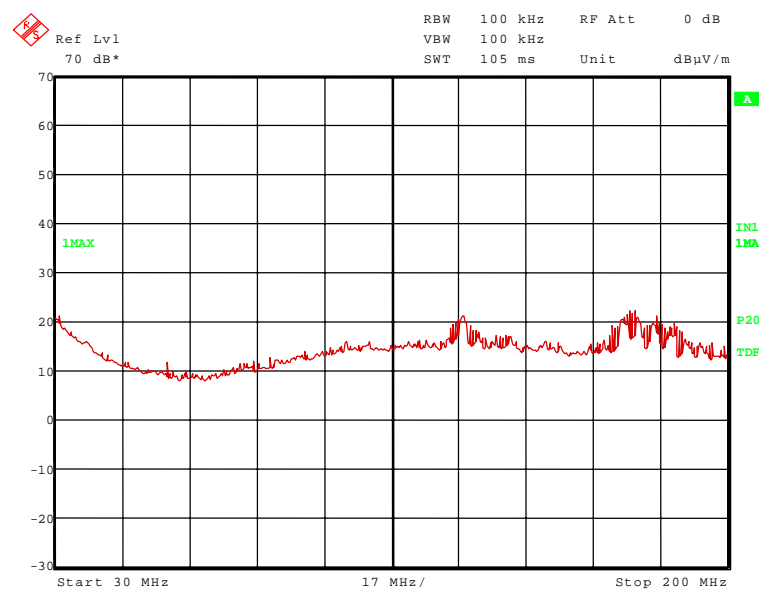
Transmitter operates at 914.975 MHz (operation mode 2)

130413_14.wmf: Spurious emissions from 10 MHz to 30 MHz (operation mode 2):

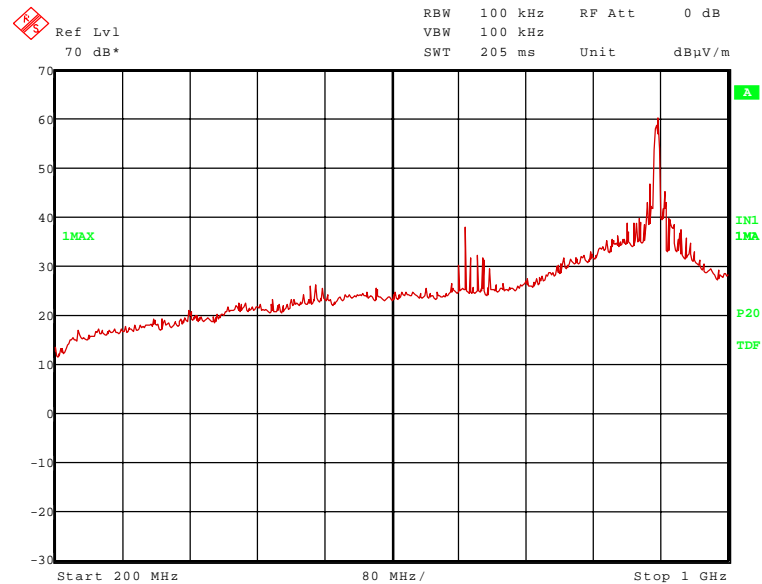


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

130413_13.wmf: Spurious emissions from 30 MHz to 200 MHz (operation mode 2):



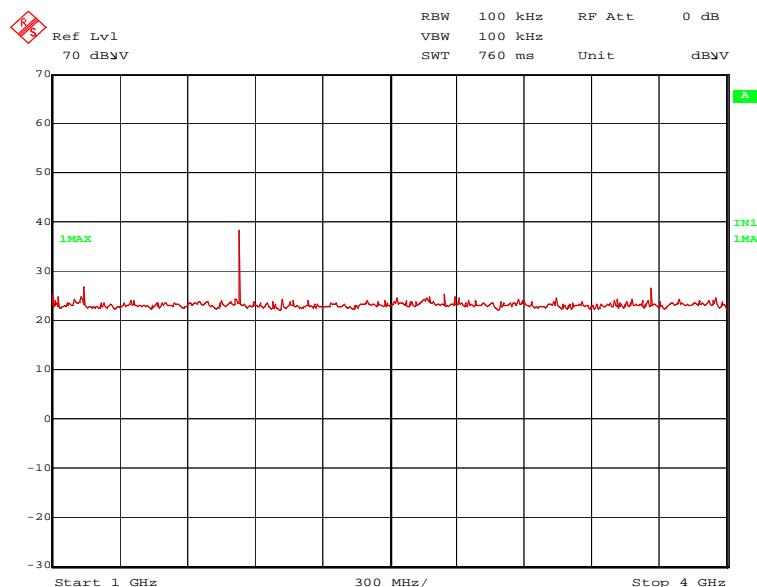
130413_12.wmf: Spurious emissions from 200 MHz to 1 GHz (operation mode 2, carrier notched):



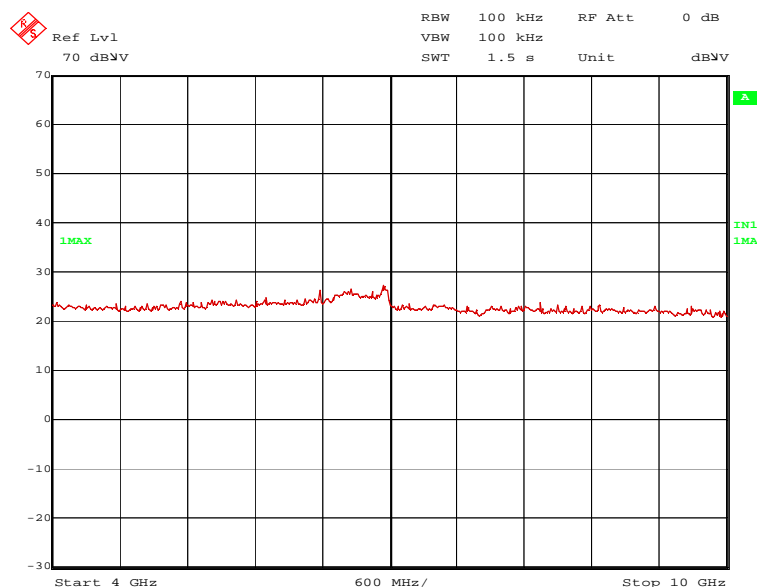
Frequencies found	Frequency in MHz
Outside restricted bands	181.360, 183.800, MHz, 686.500, 693.810, 701.230, 914.975
Inside restricted bands	132.345

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

130413 15.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



130413 18.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



Frequencies found	Frequency in MHz
Outside restricted bands	1829.950
Inside restricted bands	1137.435, 3659.900

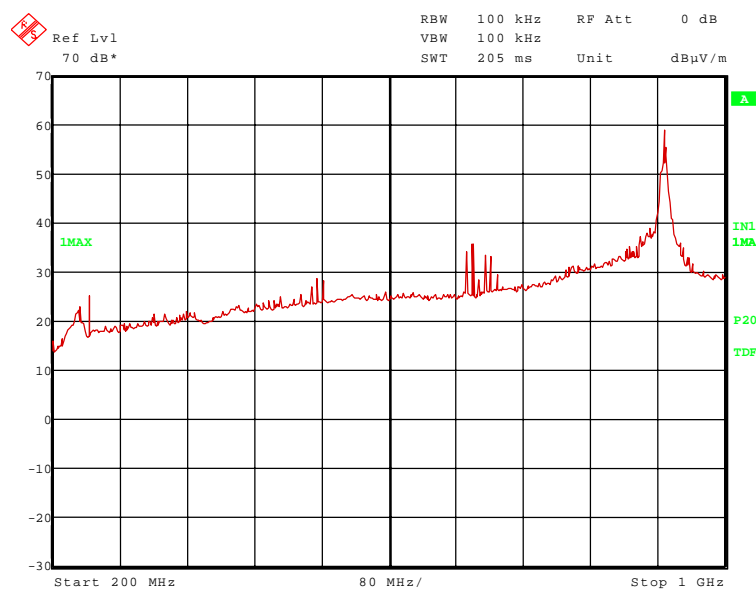
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates at 927.475 MHz (operation mode 3)

130413_8.wmf: Spurious emissions from 30 MHz to 200 MHz (operation mode 3):



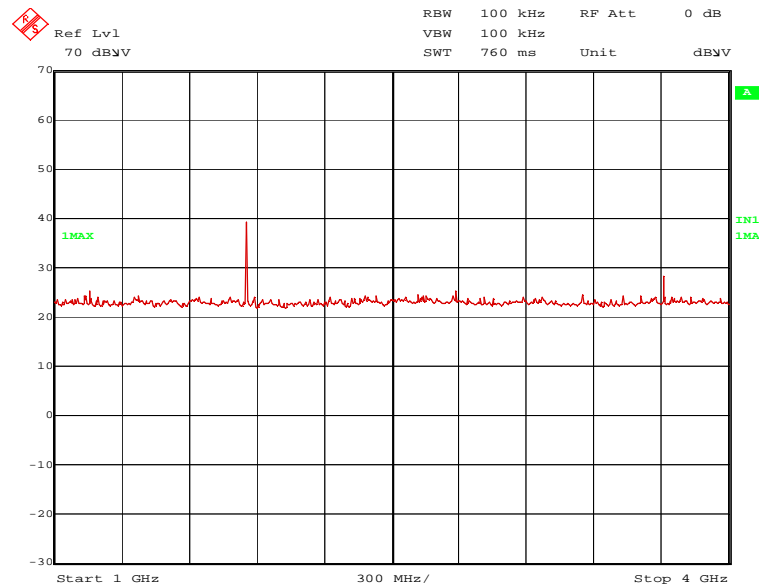
130413_7.wmf: Spurious emissions from 200 MHz to 1 GHz (operation mode 3, carrier notched):



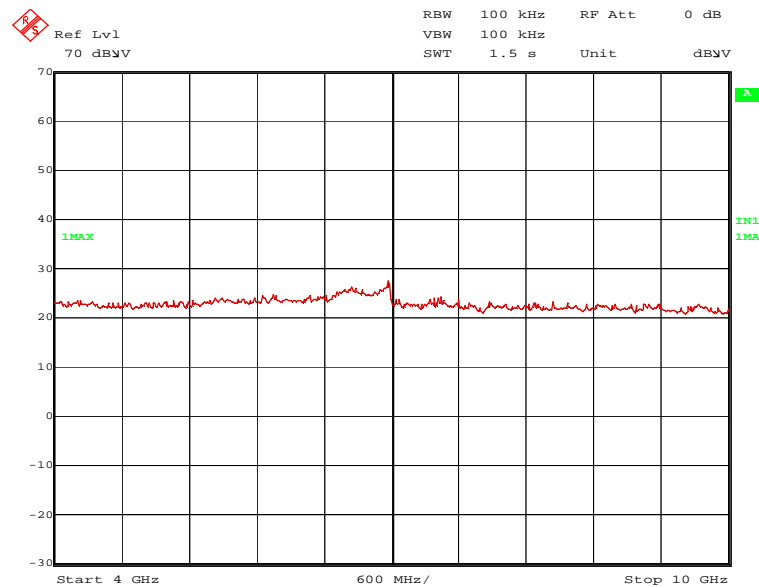
Frequencies found	Frequency in MHz
Outside restricted bands	181.244, 228.909, 514.596, 691.548, 698.918, 927.475
Inside restricted bands	132.981, 244.866

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

130413_21.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



130413_22.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



Frequencies found	Frequency in MHz
Outside restricted bands	1854.950
Inside restricted bands	3709.900

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

5.6.2.2 Final radiated emission measurement (30 MHz to 1 GHz) with internal antenna

Ambient temperature	21 °C	Relative humidity	26 %
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Position of EUT: The EUT was setup on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 3 V_{DC} by an external power supply.

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 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.

Transmitter operates at 902.5 MHz (operation mode 1)

Result measured with the quasi-peak detector:

Transmitter operates on the lower end of the assigned frequency band (operation mode 1)										
Spurious emissions outside restricted bands										
Frequency MHz	Result dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.	Pos.
902.500	107.2	-	-	81.3	22.5	3.4	100.0	85.0	Hor.	1
181.892	17.9	87.2	69.3	7.1	9.3	1.5	100.0	37.0	Vert.	2
183.755	16.7	87.2	70.5	6.0	9.2	1.5	100.0	59.0	Vert.	3
457.134	25.2	87.2	62.0	6.1	16.7	2.4	176.0	153.0	Hor.	1
673.941	42.2	87.2	45.0	19.5	19.8	2.9	122.0	166.0	Hor.	3
681.319	41.7	87.2	45.5	19.0	19.8	2.9	114.0	164.0	Hor.	3
878.873	35.5	87.2	51.7	10.1	22.0	3.4	100.0	86.0	Hor.	1
915.738	37.3	87.2	49.9	11.0	22.9	3.4	100.0	86.0	Hor.	1
Spurious emissions inside restricted bands										
Frequency MHz	Result dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.	Pos.
-	-	-	-	-	-	-	-	-	-	-
Measurement uncertainty: +2.2 dB / -3.6 dB										

Transmitter operates at 914.975 MHz (operation mode 2)

Result measured with the quasi-peak detector:

Transmitter operates on the lower end of the assigned frequency band (operation mode 1)										
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.
914.975	106.3			80.1	22.8	3.4	109.0	126.0	Vert.	2
181.360	23.1	86.3	63.2	12.3	9.3	1.5	100.0	225.0	Vert.	3
183.800	11.1	86.3	75.2	0.4	9.2	1.5	100.0	315.0	Vert.	1
686.500	35.1	86.3	51.2	12.2	19.9	3.0	114.0	164.0	Hor.	3
701.230	32.1	86.3	54.2	9.0	20.1	3.0	125.0	271.0	Hor.	1
Spurious emissions inside restricted bands										
Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.	Pos.
132.345	29.3	43.5	14.2	15.9	12.1	1.3	175.0	138.0	Vert.	3
Measurement uncertainty: +2.2 dB / -3.6 dB										

Transmitter operates at 927.475 MHz (operation mode 3)

Result measured with the quasi-peak detector:

Transmitter operates on the lower end of the assigned frequency band (operation mode 1)										
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.
927.475	105.0	-	-	78.2	23.4	3.4	100.0	245.0	Hor.	1
181.244	17.1	85.0	67.9	6.3	9.3	1.5	100.0	180.0	Vert.	1
228.909	15.8	85.0	69.2	3.9	10.3	1.6	165.0	180.0	Hor.	1
514.596	37.2	85.0	47.8	17.0	17.6	2.6	172.0	90.0	Hor.	3
691.548	41.7	85.0	43.3	18.8	19.9	3.0	124.0	115.0	Hor.	1
698.918	44.3	85.0	40.7	21.3	20.0	3.0	122.0	116.0	Hor.	1
Spurious emissions inside restricted bands										
Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.	Pos.
132.981	18.5	43.5	25.0	5.2	12.0	1.3	325.0	199.0	Vert.	3
244.866	21.4	46.0	24.6	7.9	11.8	1.7	134.0	109.0	Vert.	3
Measurement uncertainty: +2.2 dB / -3.6 dB										

Test result: Passed.

TEST EQUIPMENT USED FOR THE TEST:
14 - 20

5.6.2.3 Final radiated emission measurement (1 GHz to 40 GHz) with internal antenna

Ambient temperature	21 °C	Relative humidity	27 %
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Position of EUT: The EUT was setup on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 3 V_{DC} by an external power supply.

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

Transmitter operates at 902.5 MHz (operation mode 1)

Result measured with the peak detector:

Frequency GHz	Corr. Value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
902.500	107.2	-	-	84.1	20.6	0.0	2.5	150	Vert.	-	3
1123.690	35.4	74.0	38.6	34.8	24.6	26.5	2.5	150	Vert.	Yes	3
1805.000	46.2	87.2	41.0	43.2	26.5	26.5	3.0	150	Vert.	No	3
3610.000	43.4	74.0	30.6	33.7	31.3	26.2	4.6	150	Vert.	Yes	3
Measurement uncertainty: +2.2 dB / -3.6 dB											

Result measured with the average detector:

Frequency GHz	Corr. Value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
902.500	107.2	-	-	84.1	20.6	0.0	2.5	150	Vert.	-	3
1123.690	23.5	54.0	30.5	22.9	24.6	26.5	2.5	150	Vert.	Yes	3
1805.000	38.9	87.2	48.3	35.9	26.5	26.5	3.0	150	Vert.	No	3
3610.000	30.8	54.0	23.2	21.1	31.3	26.2	4.6	150	Vert.	Yes	3
Measurement uncertainty: +2.2 dB / -3.6 dB											

Transmitter operates at 914.975 MHz (operation mode 2)

Result measured with the peak detector:

Frequency GHz	Corr. Value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
914.975	106.3	-	-	83.2	20.7	0.0	2.6	150	Vert.	-	3
1137.435	34.4	74.0	39.6	33.8	24.6	26.5	2.5	150	Hor.	Yes	3
1829.950	45.9	86.3	40.4	42.4	26.7	26.5	3.3	150	Vert.	No	3
3659.900	43.6	74.0	30.4	33.8	31.5	26.2	4.5	150	Hor.	Yes	3
Measurement uncertainty: +2.2 dB / -3.6 dB											

Result measured with the average detector:

Frequency GHz	Corr. Value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
914.975	106.3	-	-	83.2	20.7	0.0	2.6	150	Vert.	-	3
1137.435	18.5	54.0	35.5	17.9	24.6	26.5	2.5	150	Hor.	Yes	3
1829.950	38.7	86.3	47.6	35.2	26.7	26.5	3.3	150	Vert.	No	3
3659.900	31.6	54.0	22.4	21.8	31.5	26.2	4.5	150	Hor.	Yes	3
Measurement uncertainty: +2.2 dB / -3.6 dB											

Transmitter operates at 927.475 MHz (operation mode 3)

Result measured with the peak detector:

Frequency GHz	Corr. Value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
927.475	105.0	-	-	81.4	20.9	0.0	2.7	150	Vert.	-	3
1854.950	46.5	85.0	38.5	42.4	27.0	26.5	3.6	150	Vert.	No	3
3709.900	43.9	74.0	30.1	33.7	31.8	26.2	4.6	150	Vert.	Yes	3
Measurement uncertainty: +2.2 dB / -3.6 dB											

Result measured with the average detector:

Frequency GHz	Corr. Value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
927.475	105.0	-	-	81.4	20.9	0.0	2.7	150	Vert.	-	3
1854.950	39.0	85.0	46.0	34.9	27.0	26.5	3.6	150	Vert.	No	3
3709.900	32.4	54.0	21.6	22.2	31.8	26.2	4.6	150	Vert.	Yes	3
Measurement uncertainty: +2.2 dB / -3.6 dB											

Test result: Passed.

TEST EQUIPMENT USED FOR THE TEST:
29, 31 - 34, 36, 44, 45, 49, 73

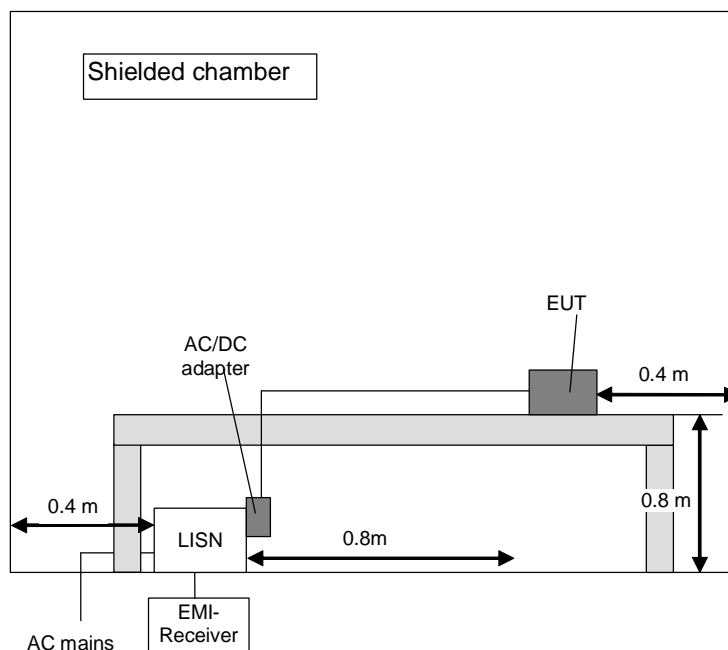
5.7 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.7.1 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 0.8 m 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 appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.7.2 Test results

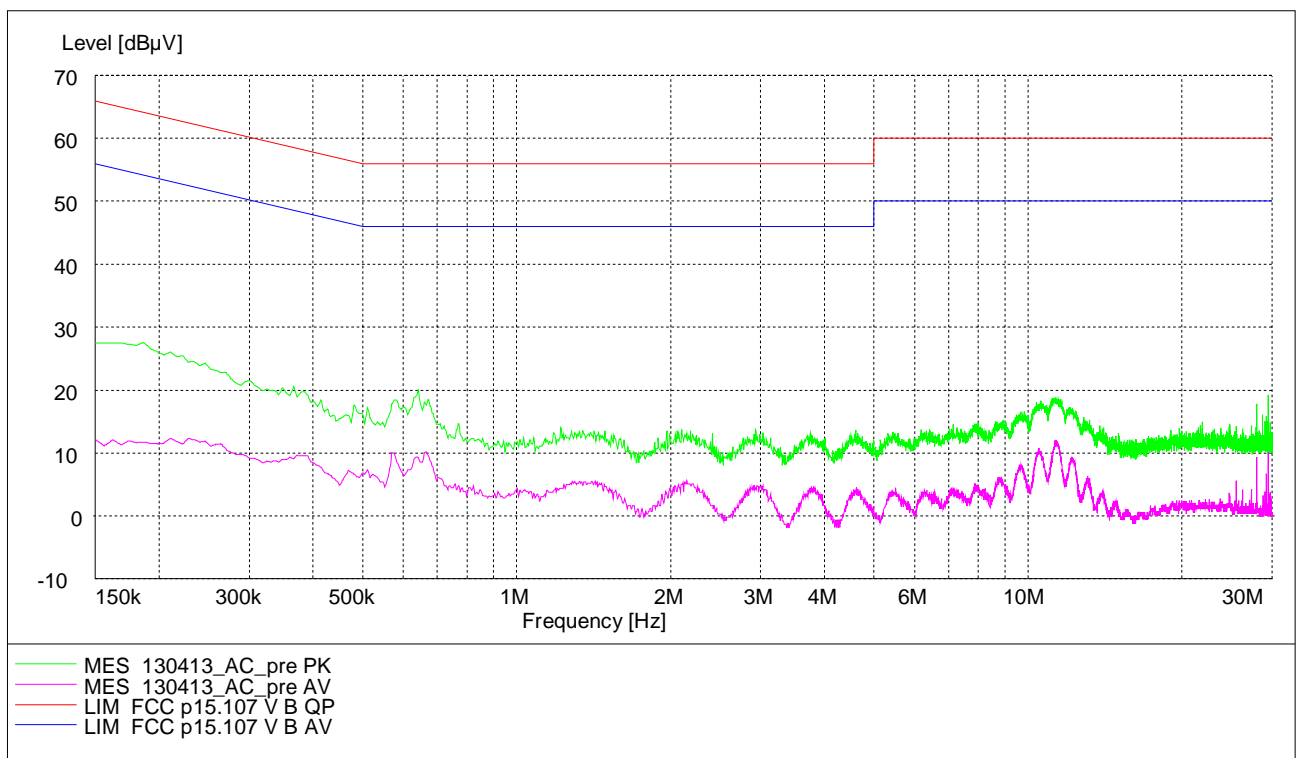
Ambient temperature	21 °C	Relative humidity	26 %
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Position of EUT: The EUT was setup on a non-conducting table of a height of 0.8 m.

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

Test record: All results are shown in the following. This test was carried out in

Supply voltage: During all measurements the EUT was supplied with 3.0 V_{DC} by an AC / DC adaptor type FW3288, which was supplied by 120 V AC / 60 Hz.



Test result: 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	03/09/2012	03/2014
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	12/20/2012	12/2013
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	02/15/2012	02/2014
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	AS615P	Deisel	615/310	480086	-	-
19	Antenna	CBL6111 D	Chase	25761	480894		
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	02/15/2012	02/2014
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/13/2012	02/2014
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS615P	Deisel	615/310	480187	-	-
35	Antenna	CBL6112 B	Chase	2688	480328	04/21/2011	04/2014
36	Antenna	3115 B	EMCO	9609-4922	480184	09/28/2011	09/2014
43	RF-cable No. 36	Sucoflex 106B	Suhner	0522/6B	480571	Weekly verification (system cal.)	
44	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
45	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
55	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/16/2012	02/2014
73	High Pass Filter	WHJS1000C 11/60EF	Wainwright Instruments GmbH	1	480413	Weekly verification (system cal.)	
75	High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments GmbH	1	480587	Weekly verification (system cal.)	
83	Tuneable Notch Filter	WRCA800/90 0-0.2/40-6EEK	Wainwright Instruments GmbH	15	480414	Weekly verification (system cal.)	

7 REPORT HISTORY

Report Number	Date	Comment
F130413E1	10 April 2013	Document created

8 LIST OF ANNEXES

ANNEX A TEST SETUP PHOTOS 10 pages

130413_1.jpg	Test setup fully anechoic chamber (Position 1)
130413_2.jpg	Test setup fully anechoic chamber (Position 2)
130413_3.jpg	Test setup fully anechoic chamber (Position 3)
130413_4.jpg	Test setup fully anechoic chamber
130413_5.jpg	Test setup fully anechoic chamber
130413_6.jpg	Test setup fully anechoic chamber
130413_7.jpg	Test setup open area test site (Position 1)
130413_8.jpg	Test setup open area test site (Position 2)
130413_9.jpg	Test setup open area test site (Position 3)
130413_15.jpg	Test setup shielded chamber

ANNEX B INTERNAL PHOTOS 6 pages

130413_10.jpg	H153V2, 3D view 1
130413_11.jpg	H153V2, 3D view 2
130413_12.jpg	H153V2, PCB bottom and type plate view
130413_13.jpg	Supply and programming PCB connected to H153V2, bottom view
130413_14.jpg	Ancillary programmer (connected to programming PCB)
130413_15.jpg	H153V2, shielding removed