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Test Report

Report Number:

F153494E3

Equipment under Test (EUT):

EASYSCAN SENSOR, ZONESCAN 820 Logger and ZONESCAN 820 Repeater

Applicant:

Gutermann Technology GmbH

Manufacturer:

Gutermann Technology GmbH



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

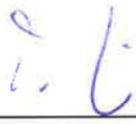
References

- [1] **ANSI C63.10: 2013** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15** Radio Frequency Devices
- [3] **RSS-247 Issue 1 (May 2015)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
- [4] **RSS-Gen Issue 4 (November 2014)** General Requirements for Compliance of Radio Apparatus

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 0) were fulfilled by the equipment under test.

The complete test results are presented in the following.

Test engineer:	Thomas KÜHN		02/15/2016
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		02/15/2016
	Name	Signature	Date

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

This test report is valid in hardcopy form as well as in electronic form.

1 Identification

1.1 Applicant

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eMail Address:	hermann.waibel@gutermann-water.com
Applicant represented during the test by the following person:	Mr. Hermann WAIBEL, Mr. Stefan LANG

1.2 Manufacturer

Name:	Gutermann Technology GmbH
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Country:	Germany
Name for contact purposes:	Mr. Hermann WAIBEL
Phone:	+49 751 35 90 16 - 83
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eMail Address:	hermann.waibel@gutermann-water.com
Manufacturer represented during the test by the following person:	Mr. Hermann WAIBEL, Mr. Stefan LANG

1.3 Test laboratory

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

accredited by DGA Deutsche Gesellschaft Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	Wireless transceiver for water leakage detection
PMN: * Modelname / HVIN): *	EASYSCAN SENSOR GESA501, GESB501.
PMN: * Modelname / HVIN: *	ZONESCAN 820 Logger Logger 5-1-C1, Logger 5-2-C1.
PMN: * Modelname / HVIN: *	ZONESCAN 820 Repeater Repeater 5-1-C1
FCC ID:*	ZSS-ZS820915LRC
IC: *	9789A-ZS820915LRC
Serial number: *	EASYSCAN SENSOR: 2500005, ZONESCAN 820 Logger with internal antenna: 507838, ZONESCAN 820 Logger with external antenna: 507841, ZONESCAN 820 Repeater: 1501451.
PCB identifier: *	ZS820-10C
Hardware version: *	01 (EASYSCAN SENSOR), C1 (ZONESCAN 820 Logger), C1 (ZONESCAN 820 Repeater).
Software version: *	5.6 (EASYSCAN SENSOR), 5.6 (ZONESCAN 820 Logger), 8.1.1 (ZONESCAN 820 Repeater).
Lowest internal frequency: *	32.768 kHz

1.5 Technical data of equipment

Channel 0	RX:	904.000 MHz	TX:	904.000 MHz
Channel 24	RX:	911.200 MHz	TX:	911.200 MHz
Channel 49	RX:	918.700 MHz	TX:	918.700 MHz

Rated RF output power: *	13 dBm				
Antenna type: *	Integral or 02+MT07-1+174U+SMA M (external)				
Antenna gain: *	0 dBi				
Antenna connector: *	Yes				
Adaptive frequency agility: *	No				
Modulation: *	FHSS (GFSK)				
Supply Voltage: *	U _{nom} =	3.6 V DC	U _{min} =	2.6 V DC	U _{max} = 3.7 V DC
Temperature range: *	-30 °C to +70 °C				
Ancillary used for test:	-				

* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length *
	EUT	Ancillary	
-	-	-	-

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	11/03/2015
Start of test:	11/06/2015
End of test:	11/13/2015

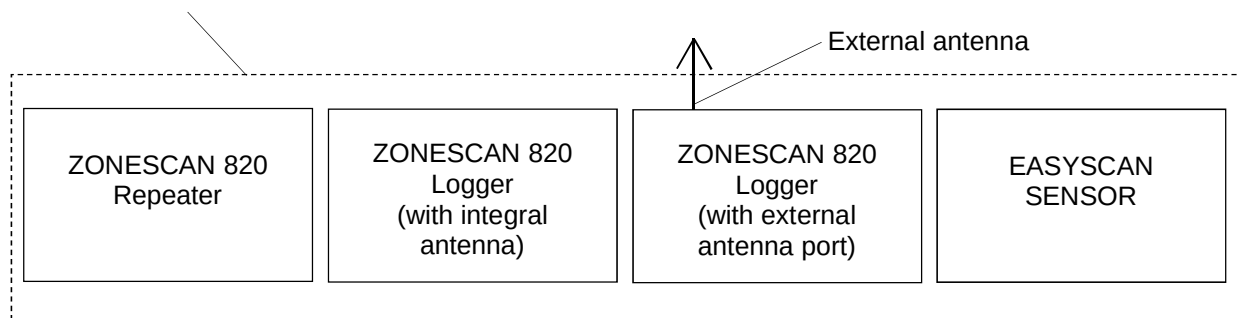
2 Operational states

The following test samples were used for the tests:

Zonescan 820 Logger with integral antenna, serial number 507838, Zonescan 820 Logger with external antenna port, serial number 507841 and EASYSCAN SENSOR, serial number 2500005 and Zonescan 820 Repeater, serial number 1501451. All samples were unmodified and could be configured to operate as requested for any test item.

The RF circuit of all samples is identically, all samples are using the same PCB; the RF output is either connected to the internal antenna or to the external reverse SMA plug. All conducted measurements were carried out with a sample with Zonescan 820 Logger with external antenna port.

Physical boundaries of the Equipment Under Test



The following test modes were adjusted during the tests:

Test items	Operation	Operation mode
20 dB bandwidth	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Carrier frequency separation	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Number of hopping channels	Transmit with normal modulation, hopping on all channels	4
Dwell time	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Maximum peak output power	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Radiated emissions (transmitter)	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Conducted emissions on supply line	Transmit with normal modulation, hopping on all channels	4

3 Additional information

During the tests the EUT was not labelled as required by FCC / IC.

Test case	Carried out with	Comment
20 dB bandwidth	Zonescan 820 Logger with external antenna port only	The RF circuit of all samples is identically, all samples are using the same PCB; the RF output is either connected to the internal antenna or to the external reverse SMA plug.
Carrier frequency separation		
Number of hopping channels		
Dwell time		
Maximum peak output power		
Radiated emissions	EASYSKAN SENSOR, Zonescan 820 Logger with internal antenna, Zonescan 820 Logger with external antenna port	As pre tests have shown, that there was no measurable difference between the ZONESCAN 820 Logger with internal antenna and the ZONESCAN 820 repeater. Therefore the results of the ZONESCAN 820 Logger with internal antenna were documented only, no photographs of the test setups for the measurement of the ZONESCAN 820 Logger with the integral antenna were provided, because the setups are identical to the setups for the measurement of the EASYSKAN SENSOR

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 247, Issue 1 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
20 dB bandwidth	General	15.247 (a) (1) (i)	5.1 (1) [3]	Passed	8 et seq.
Carrier frequency separation	General	15.247 (a) (1) (i)	5.1 (2) [3]	Passed	11 et seq.
Number of hopping channels	902.0 – 928.0	15.247 (a) (1) (i)	5.1 (3) [3]	Passed	14 et seq.
Dwell time	902.0 – 928.0	15.247 (a) (1) (i)	5.1 (3) [3]	Passed	16 et seq.
Maximum peak output power	902.0 – 928.0	15.247 (b) (2)	5.4 (1) [3]	Passed	20 et seq.
Radiated emissions (transmitter)	0.009 - 10,000	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4]	Passed	23 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Not applicable *	-
Antenna requirement	-	15.203 [2]	-	Passed **	-

*: Not applicable because the EUT is equipped with an internal non chargeable battery only.

** : The EUT has either an integrated antenna or a reverse SMA antenna connector. Furthermore the antenna specifications for the external antenna are defined in the user manual, so the requirement is regarded as fulfilled.

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.

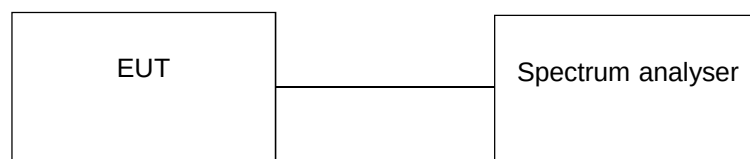
The following spectrum analyser settings according to [1] shall be used:

- Span: App. 2 to 5 times the 20 dB bandwidth, centred on the actual hopping channel.
- Resolution bandwidth: 1 % to 5 % of the 20 dB bandwidth.
- Video bandwidth: three times the resolution bandwidth.
- Set the reference level of the instrument either above the measured peak conducted output power level or as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (OBW/RBW)]$ below the reference level.
- 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. Alternatively the 20 dB down function of the spectrum analyser could be used.

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

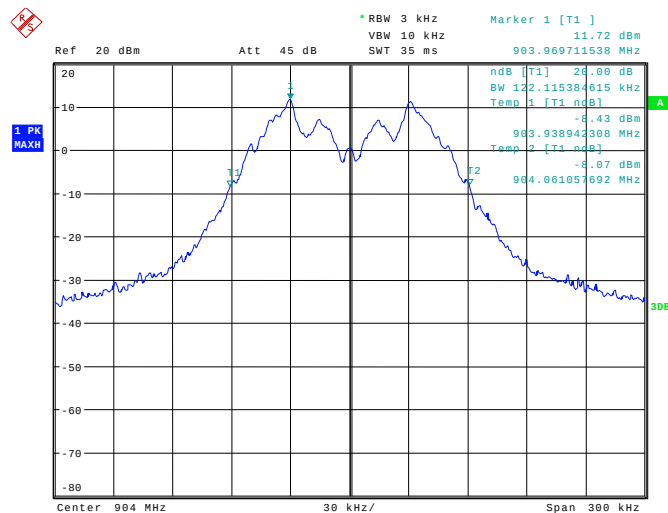
Test set-up:



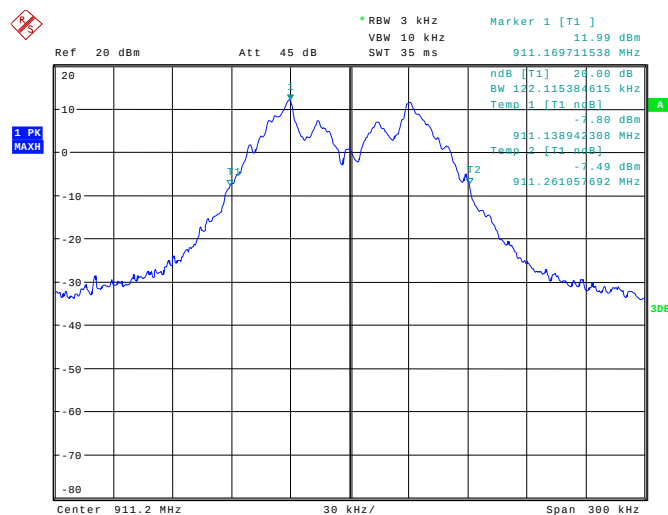
5.1.2 Test results (20 dB bandwidth)

Ambient temperature	22 °C	Relative humidity	50 %
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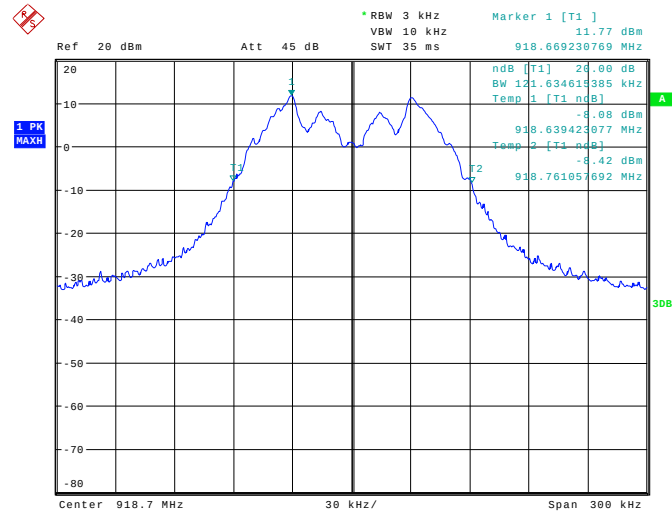
153494_186.wmf: 20 dB bandwidth at the lower end of the assigned frequency band:



153494_187.wmf: 20 dB bandwidth at the middle of the assigned frequency band:



153494_188.wmf: 20 dB bandwidth at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
20 dB bandwidth		
0	904.000	122.115
24	911.200	122.115
49	918.700	121.635
Measurement uncertainty		+0.66 dB / -0.72 dB

Test equipment used (see chapter 6):

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.

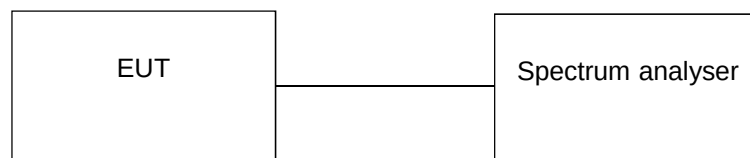
The following spectrum analyser settings according to [1] shall be used:

- Span: Wide enough to capture the peaks of two adjacent channels.
- Resolution bandwidth: Start with the Resolution bandwidth set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- Video bandwidth $\geq$ 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.

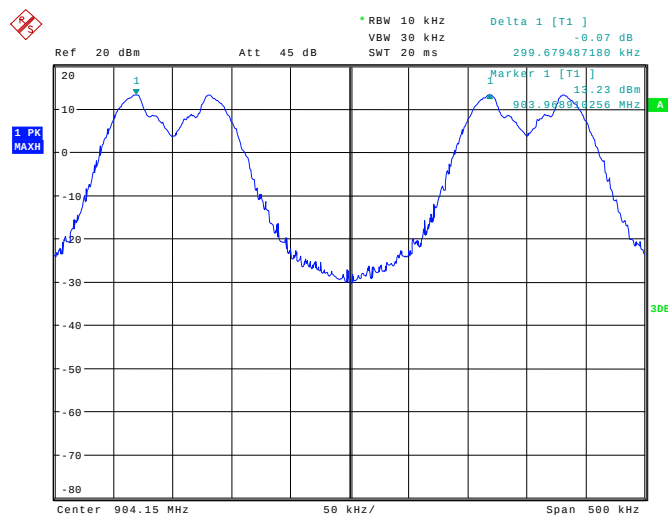
Test set-up:



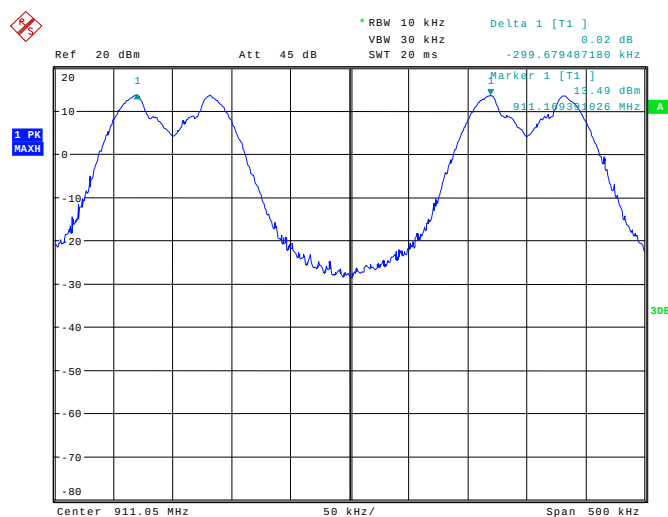
5.2.2 Test results (carrier frequency separation)

Ambient temperature	22 °C	Relative humidity	50 %
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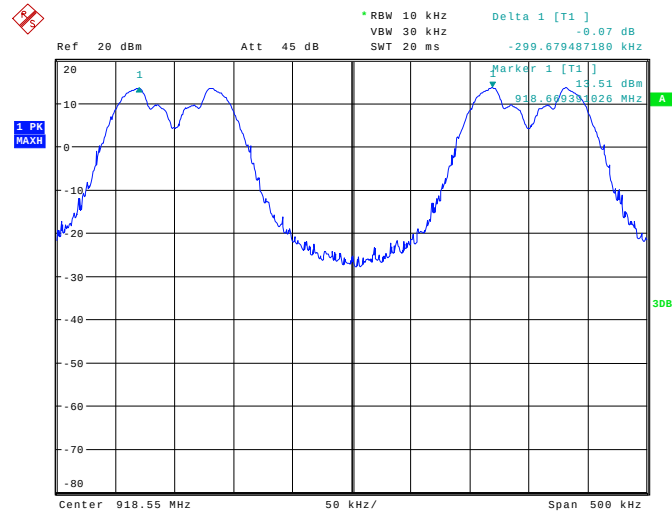
153494_191.wmf: Channel separation at the lower end of the assigned frequency band:



153494_190.wmf: Channel separation at the middle of the assigned frequency band:



153494_189.wmf: Channel separation at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
0	904.000	299.679	122.115
24	911.200	299.679	122.115
49	918.700	299.679	121.635
Measurement uncertainty			$<10^{-7}$

Test: Passed

Test equipment used (see chapter 6):

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5.3 Number of hopping frequencies

5.3.1 Method of measurement (number of hopping frequencies)

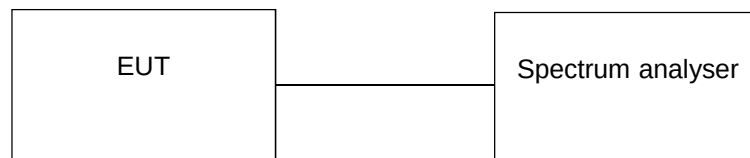
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT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

The following spectrum analyser settings according to [1] shall be used:

- Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- Resolution bandwidth: To identify clearly the individual channels, set the Resolution bandwidth to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- 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.

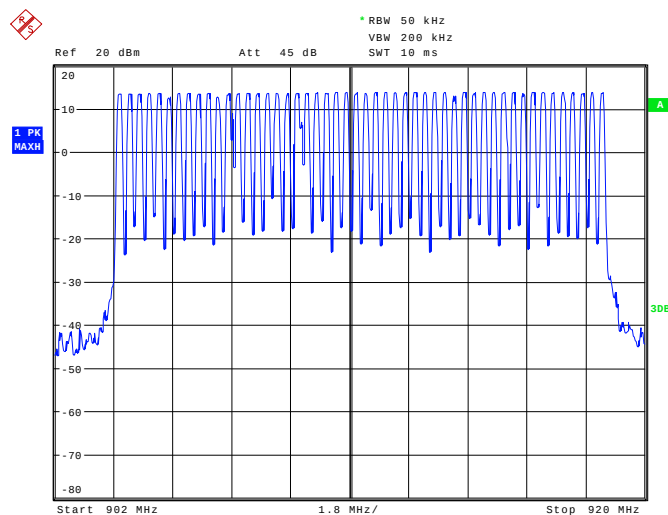
Test set-up:



5.3.2 Test results (number of hopping frequencies)

Ambient temperature	22 °C	Relative humidity	50 %
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153494_192.wmf: Number of hopping channels:



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

Test: Passed

Test equipment used (see chapter 6):

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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 according to [1] shall be used:

- Span: Zero, centred on a hopping channel.
- Resolution bandwidth shall be $\leq$ channel spacing and where possible Resolution bandwidth should be set $\gg 1 / T$, where T is the expected dwell time per channel.
- Video bandwidth: $\geq$ the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a 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.

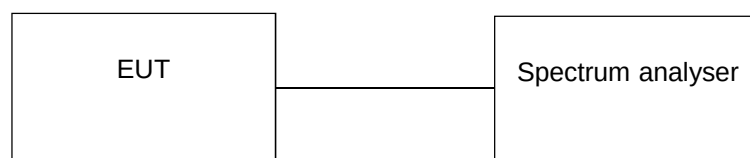
Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

$$\begin{aligned} & \text{(Number of hops in the period specified in the requirements)} = \\ & \text{(number of hops on spectrum analyzer)} \times (\text{period specified in the requirements} / \text{analyzer sweep time}) \end{aligned}$$

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

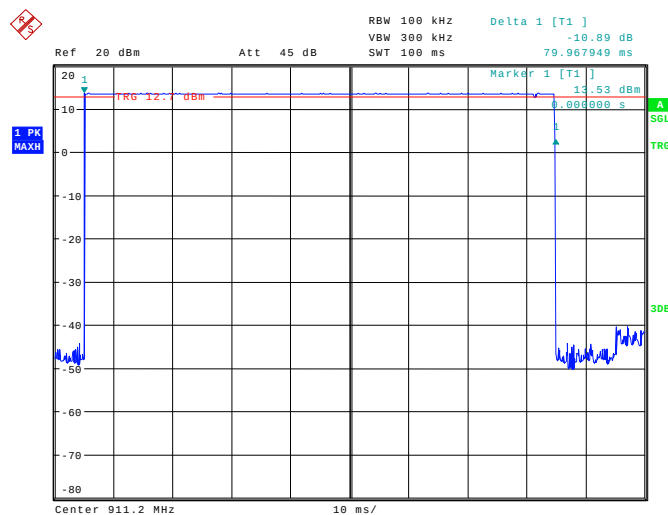
Test set-up:



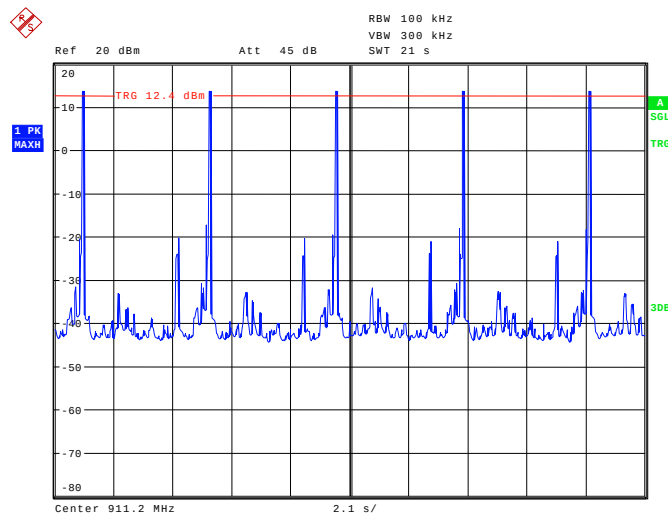
5.4.2 Test results (dwell time)

Ambient temperature	22 °C	Relative humidity	50 %
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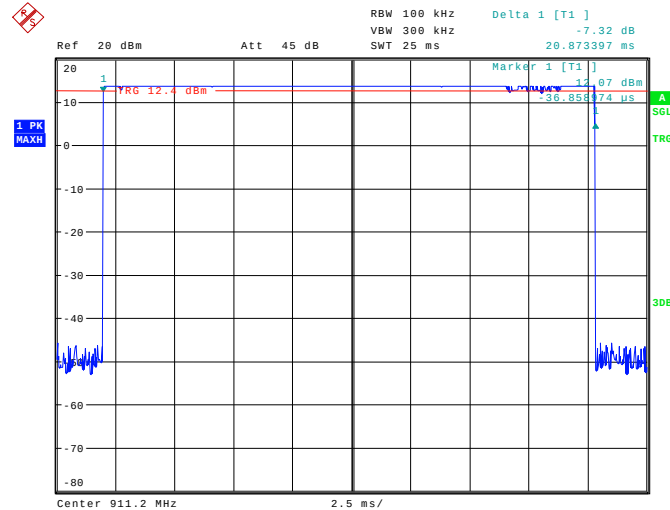
153494_196.wmf: Dwell time at the middle of the assigned frequency band (single hop, repeater mode):



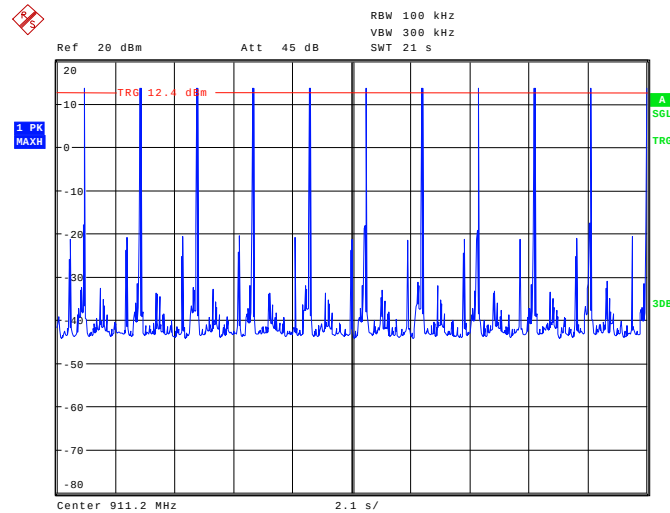
153494_197.wmf: Dwell time at the middle of the assigned frequency band (21 s sweep, repeater mode):



153494_200.wmf: Dwell time at the middle of the assigned frequency band (single hop, logger mode):



153494_199.wmf: Dwell time at the middle of the assigned frequency band (21 s sweep, logger mode):



Dwell time in repeater mode					
Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Number of pulses	Dwell time [ms]	Limit [ms]
24	911.200	79.968	5	399.84	400.000
Dwell time in logger mode					
Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Number of pulses	Dwell time [ms]	Limit [ms]
24	911.200	20.874	10	208.74	400.000
Measurement uncertainty				$<10^{-7}$	

Test: Passed

Test equipment used (see chapter 6):

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.

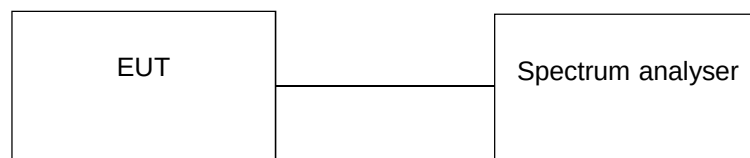
The following spectrum analyser settings according to [1] shall be used:

- 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.

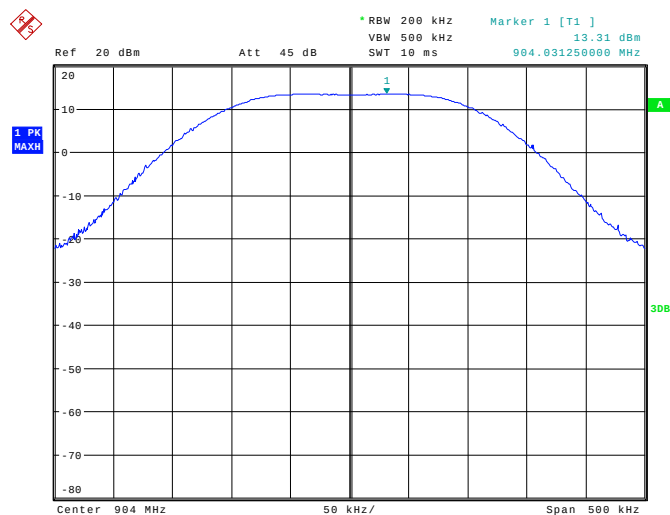
Test set-up:



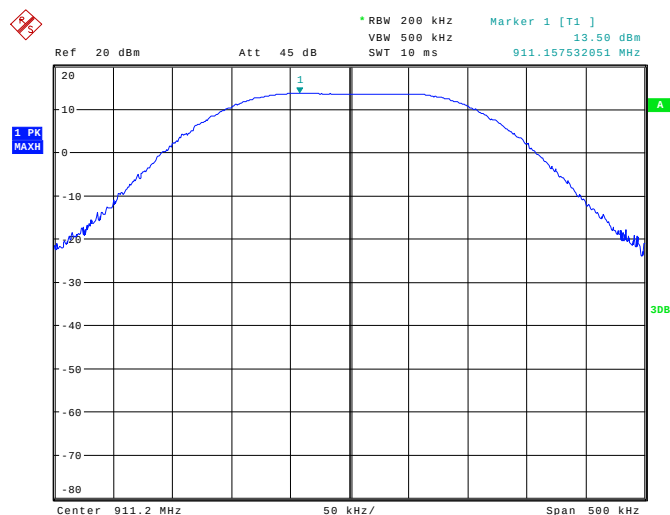
5.5.2 Test results (maximum peak output power)

Ambient temperature	22 °C	Relative humidity	50 %
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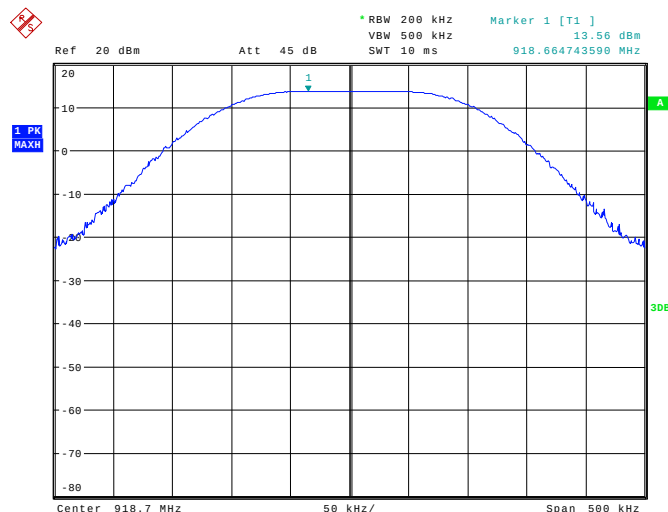
153494_193.wmf: Maximum peak output power at the lower end of the assigned frequency band:



153494_194.wmf: Maximum peak output power at the middle of the assigned frequency band:



153494_195.wmf: Maximum peak output power at the upper end of the assigned frequency band:



Operation mode	Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1	0	904.000	13.3	0 dBi	30.0
2	24	911.200	13.5	0 dBi	30.0
3	49	918.700	13.6	0 dBi	30.0
Measurement uncertainty				+0.66 dB / -0.72 dB	

Test: Passed

Test equipment used (see chapter 6):

30

5.6 Radiated emissions

5.6.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into five stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test site without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test site with reflecting ground plane and various antenna heights 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 25 / 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 40 GHz.

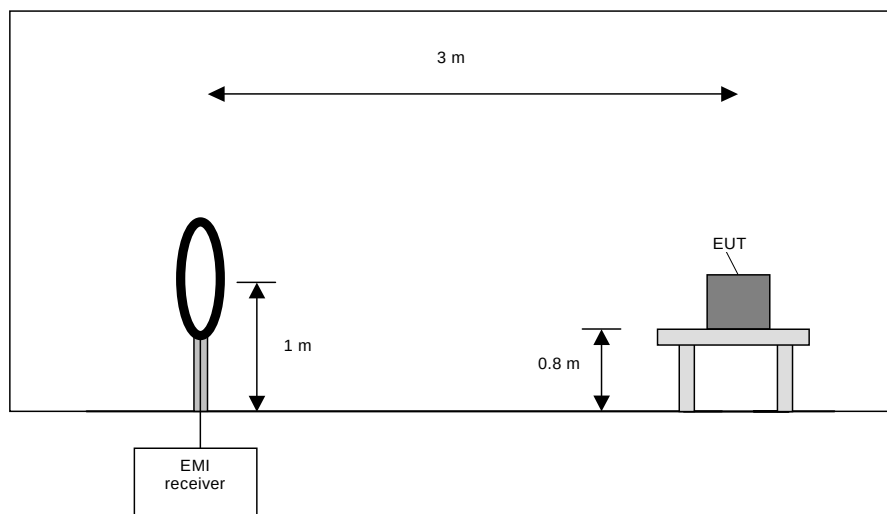
Preliminary measurement (9 kHz to 30 MHz):

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

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

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

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



Preliminary measurement procedure:

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

The following procedure will be used:

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

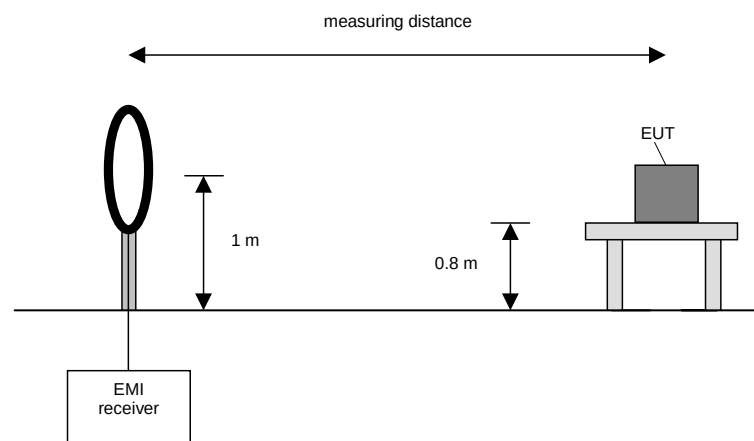
Final measurement (9 kHz to 30 MHz):

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

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

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

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



Final measurement procedure:

The following procedure will be used:

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

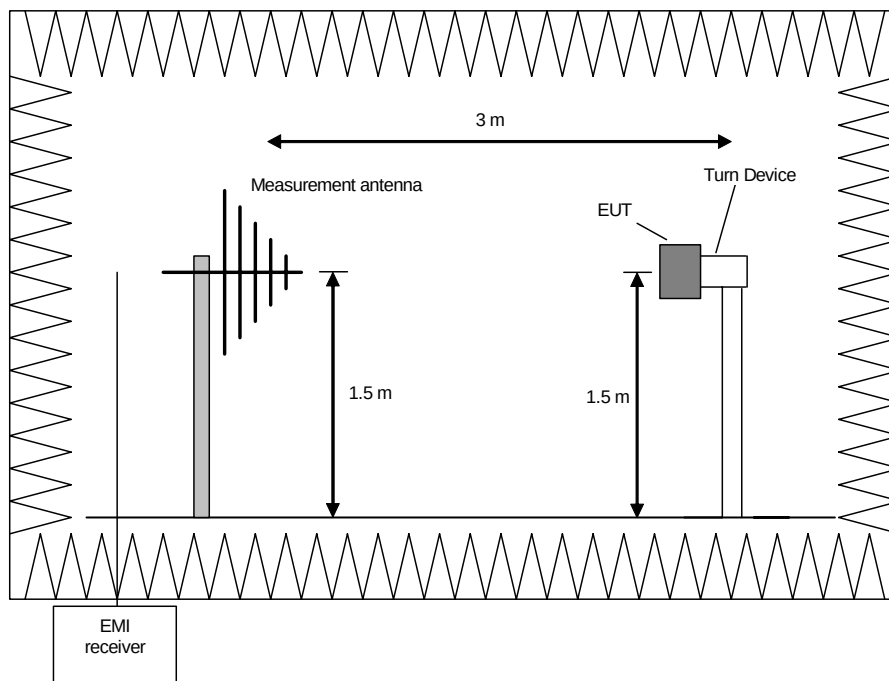
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. 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 [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 °. This measurement is repeated after raising the EUT in 30 ° steps according 6.6.5.4 in [1].

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:

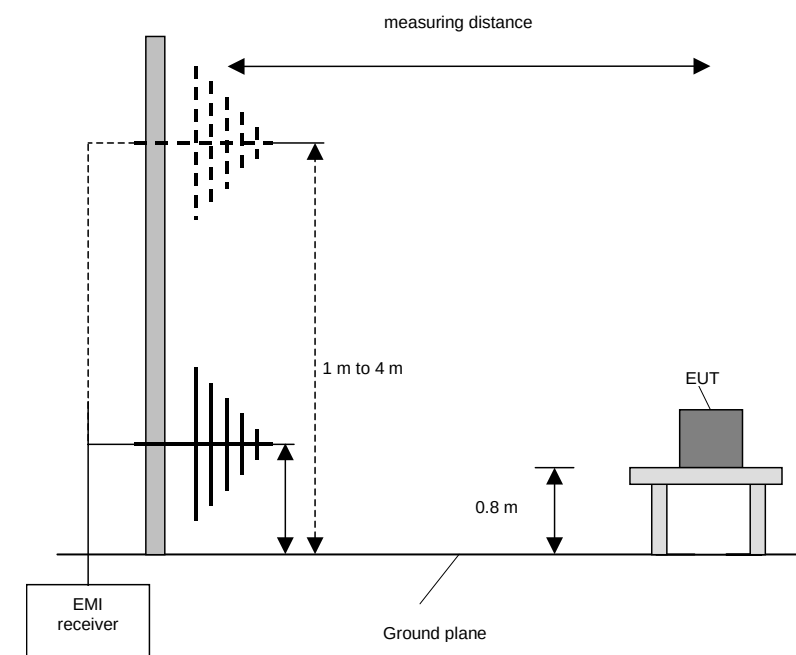
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarisation of the measuring antenna.
5. Make a hardcopy of the spectrum.
6. Repeat 1) to 5) with the EUT raised by an angle of 30 ° (60 °, 90 °, 120 ° and 150 °) according to 6.6.5.4 in [1].
7. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

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 40 GHz)

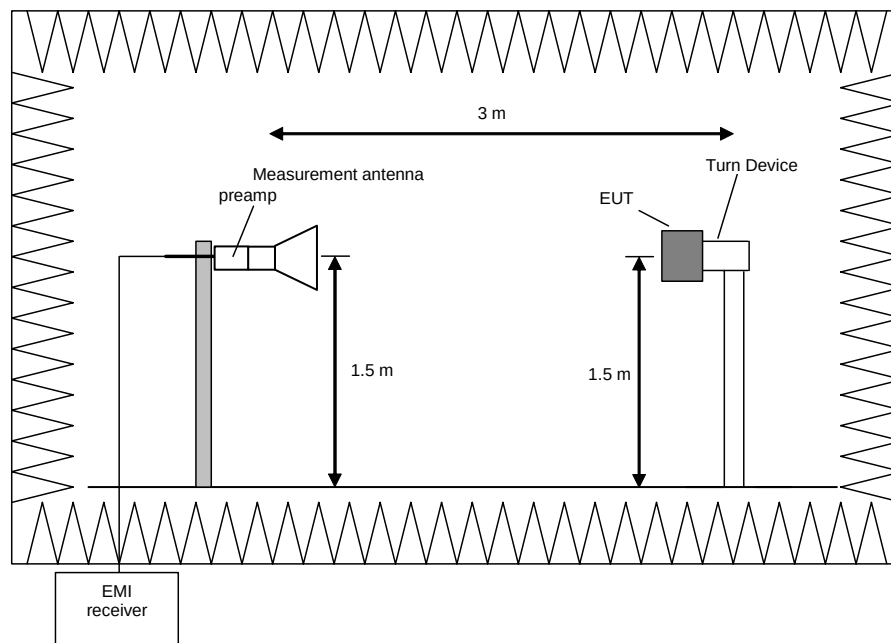
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 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 and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30 ° steps according 6.6.5.4 in [1].

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

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 25 / 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.

The following procedure will be used:

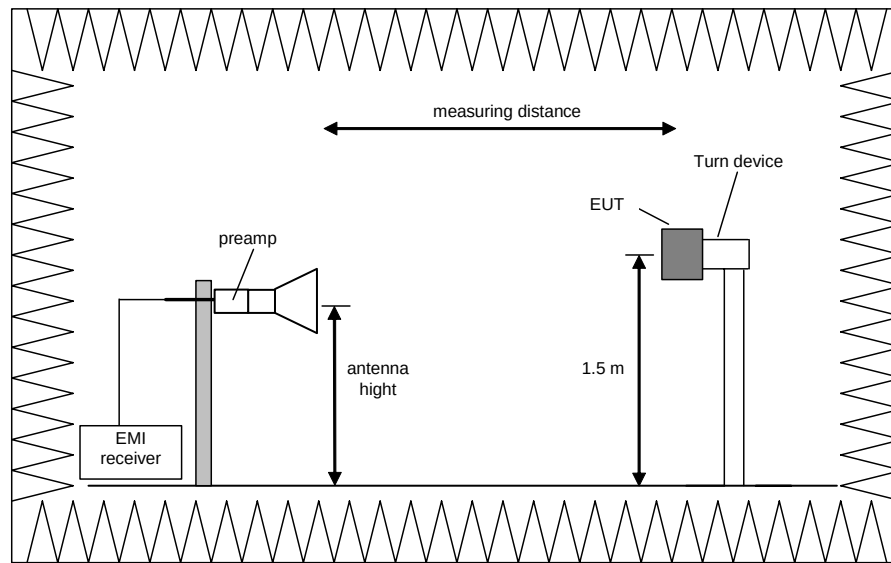
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 40 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 by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

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

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 25 / 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 /26.5 GHz and 26.5 GHz to 40 GHz.

The following procedure will be used:

- 1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
- 2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser to EMI mode with peak and average detector activated.
- 4) Rotate the turntable from 0° to 360° to find the EUT angle that produces the highest emissions.
- 5) Note the highest displayed peak and average values
- 6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.6.2 Test results (radiated emissions)

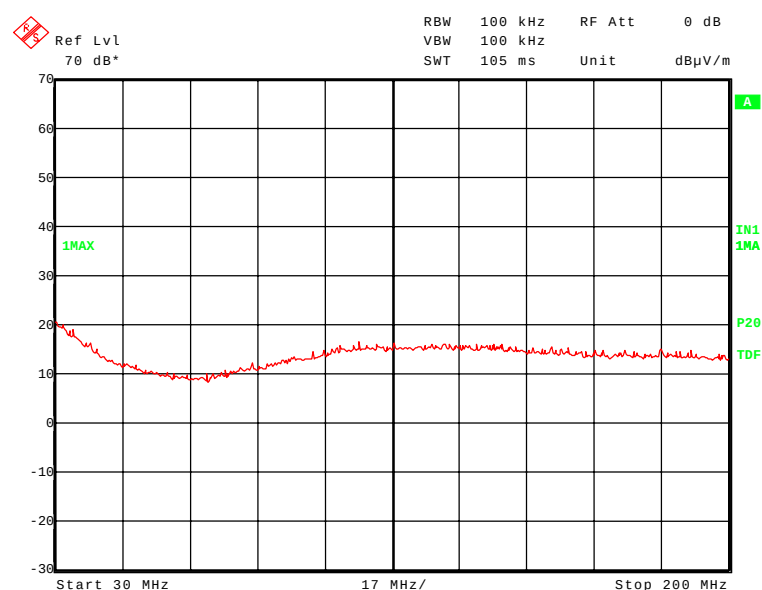
5.6.2.1 Preliminary radiated emission measurement with internal antenna (ZONESCAN 820 Logger)

Ambient temperature	22 °C	Relative humidity	50 %
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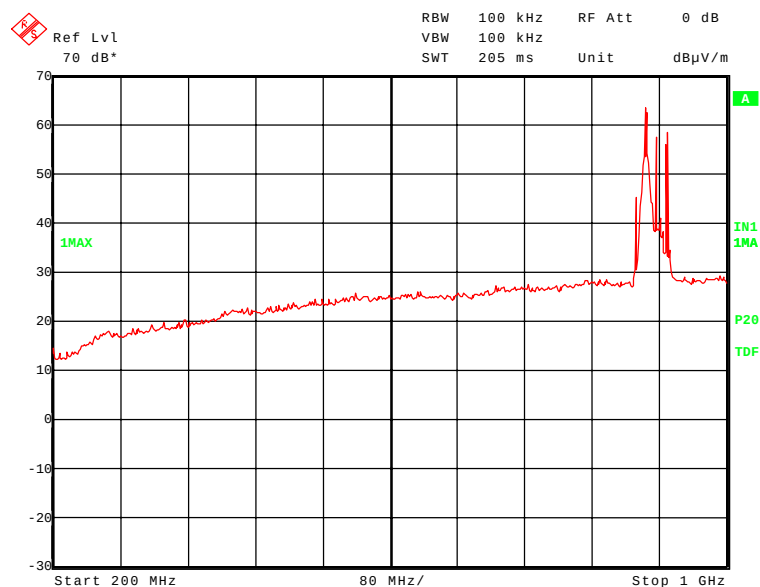
Position of EUT:	The EUT was set-up on a non-conducting table of a height of 0.8 m and 1.5 m. The distance between EUT and antenna was 3 m.
Cable guide:	For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.
Test record:	All results are shown in the following.
Supply voltage:	During all measurements the EUT was supplied 3.6 V DC by the internal battery.
Frequency range:	The preliminary measurement was carried out in the frequency range 9 kHz to 10 GHz according to [2].
Remark:	As pre-tests have shown, the emissions in the frequency range 9 kHz 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 the lower end of the assigned frequency band (operation mode 1)

153494_107.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 1):



153494_108.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 1, carrier notched):



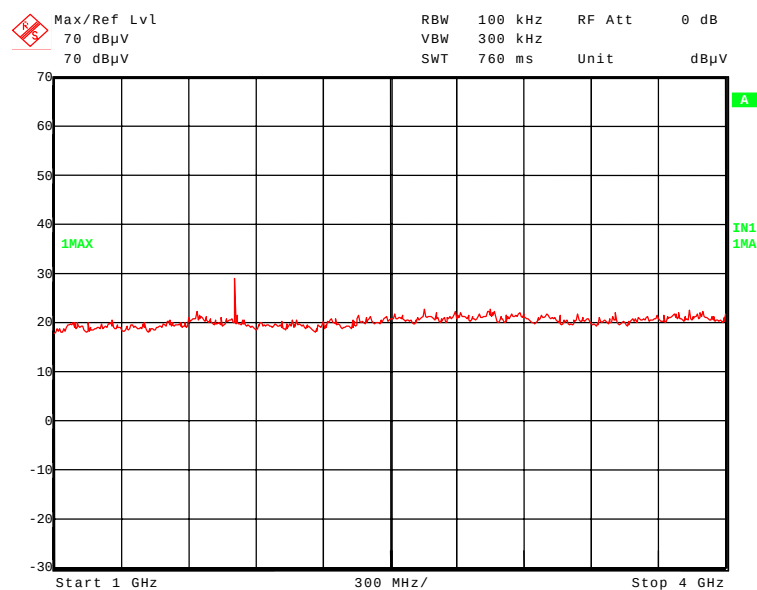
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

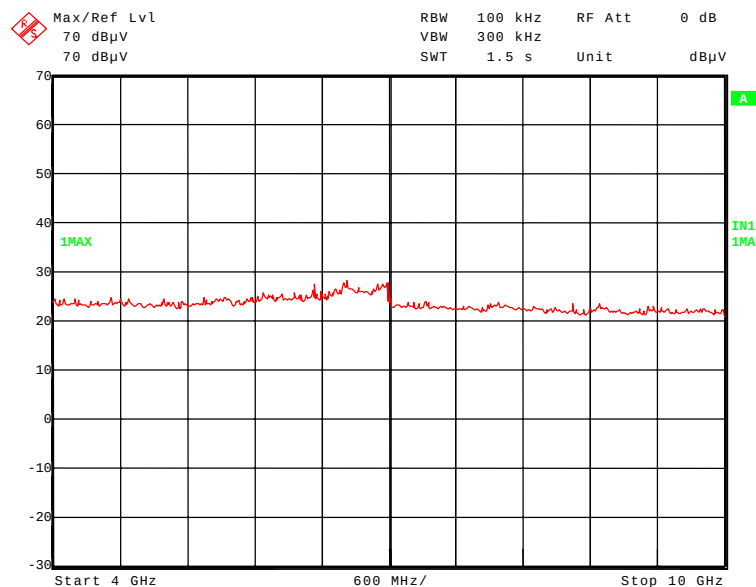
- 892.000 MHz, 904.000MHz, 908.000, MHz, 916.000 MHz, 920.000 MHz and 928.000 MHz.

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

153494_174.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



153494_175.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 1):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

- 1808.000 MHz and 6328.000 MHz

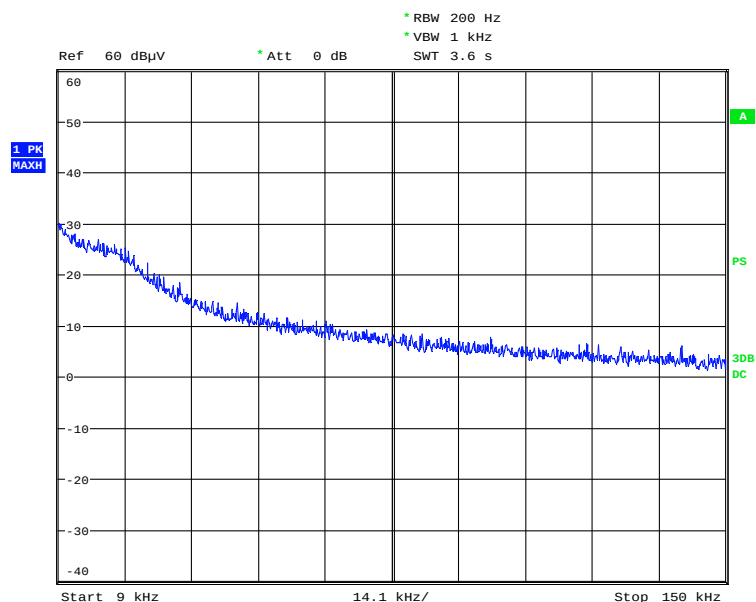
These frequencies have to be measured in a final measurement. The results were presented in the following.

Test equipment used (see chapter 6):

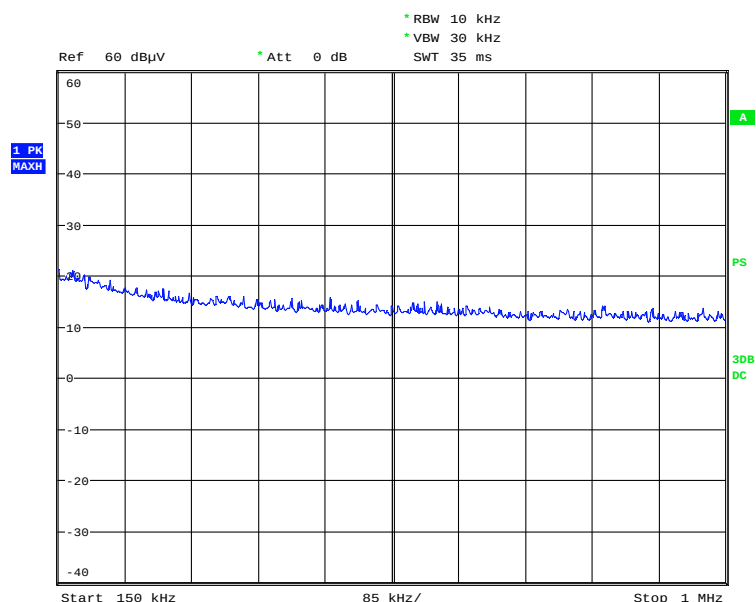
22 - 25, 29, 31 - 36, 43 - 45, 49, 50, 55, 73, 75, 83

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

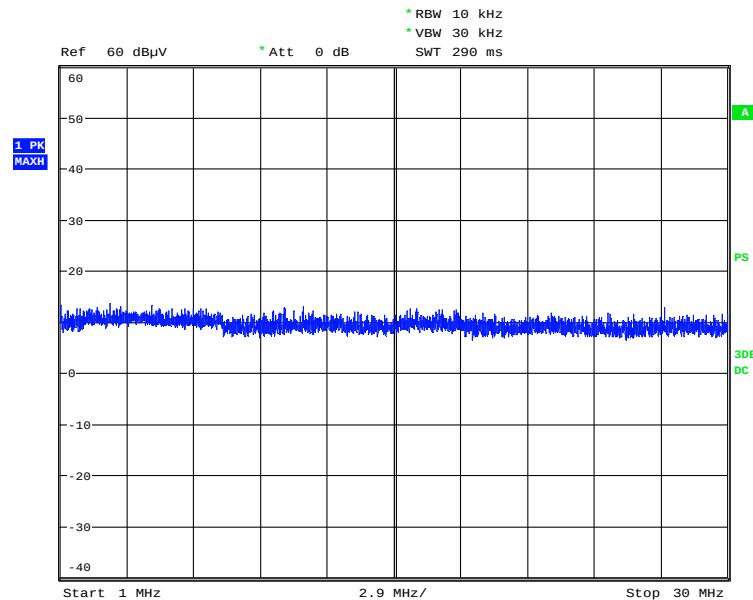
153494_156.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



153494_158.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

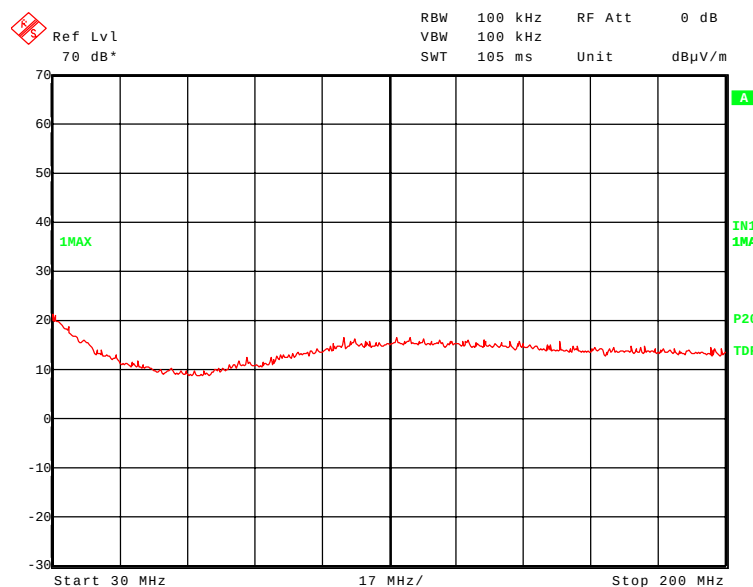


153494_160.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

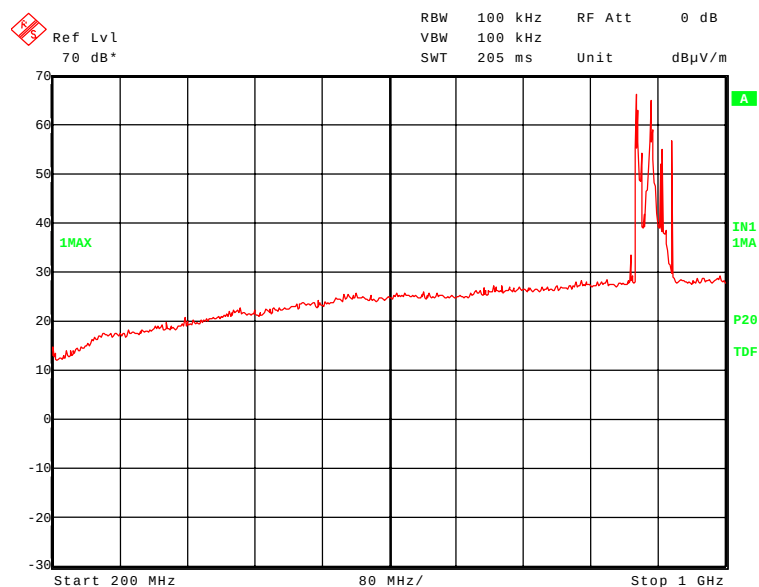


No significant frequencies above the noise floor of the system (max. 33 dBμV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

153494_102.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):



153494_101.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2, carrier notched):



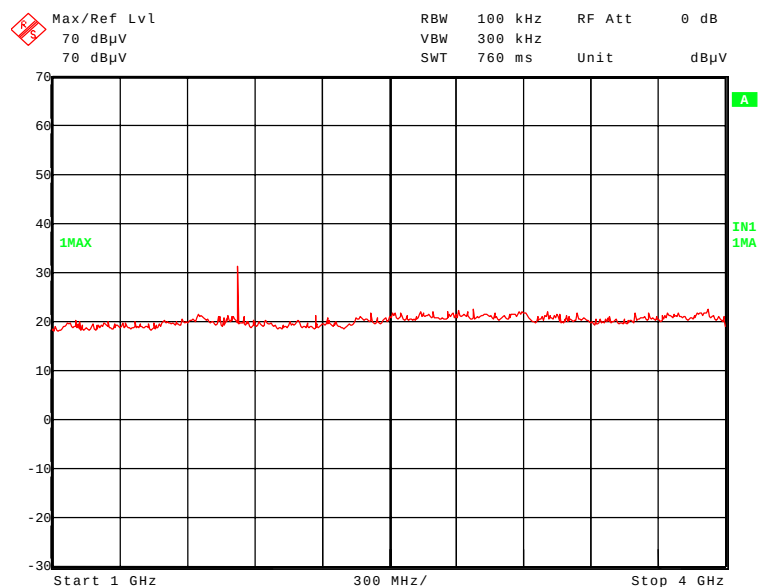
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

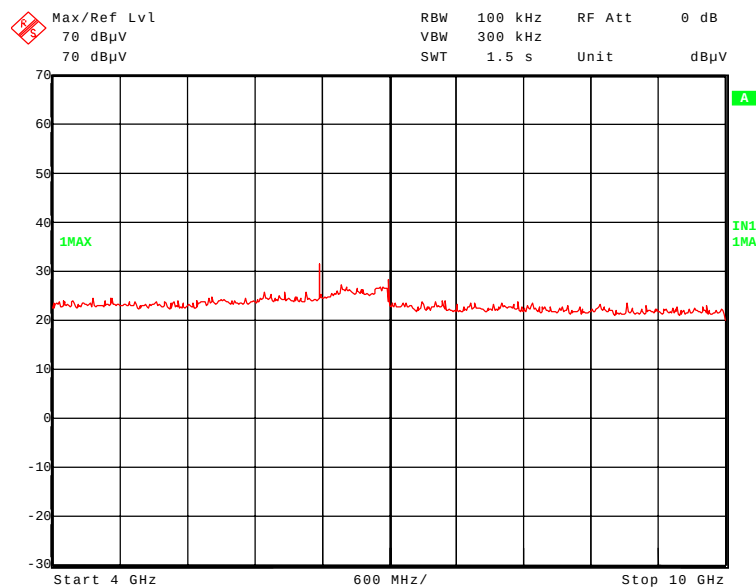
- 887.232 MHz, 899.170 MHz, 911.200 MHz, 923.170 MHz, 928.961 MHz and 935.170 MHz

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

153494_177.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



153494_176.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

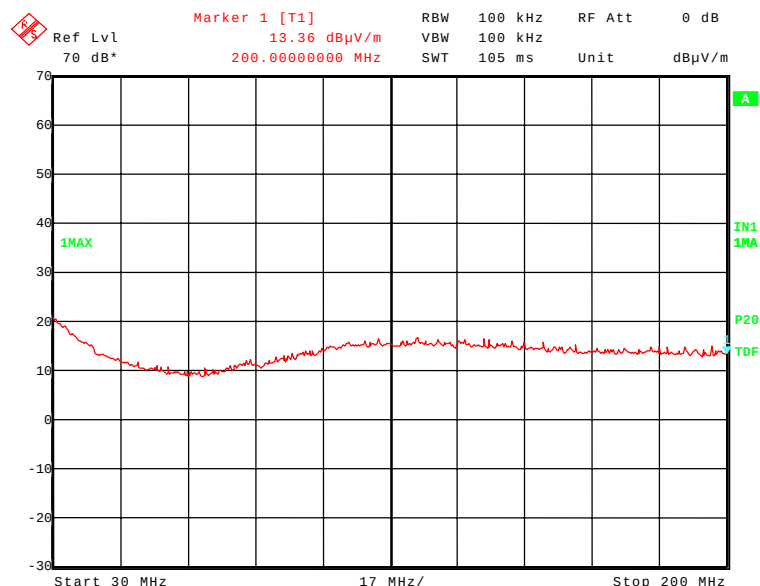
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 1822.400 MHz and 6378.400 MHz

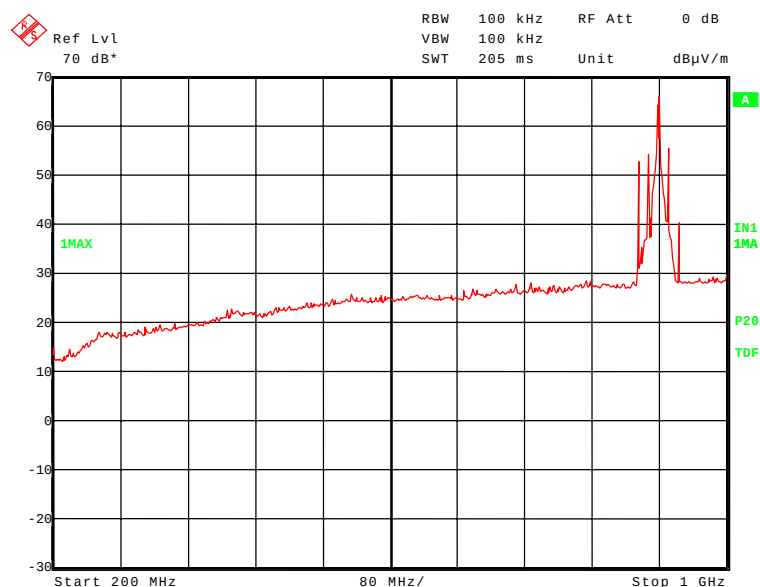
These frequencies have to be measured in a final measurement. The results were presented in the following.

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

153494_112.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 3):



153494_111.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 3, carrier notched):



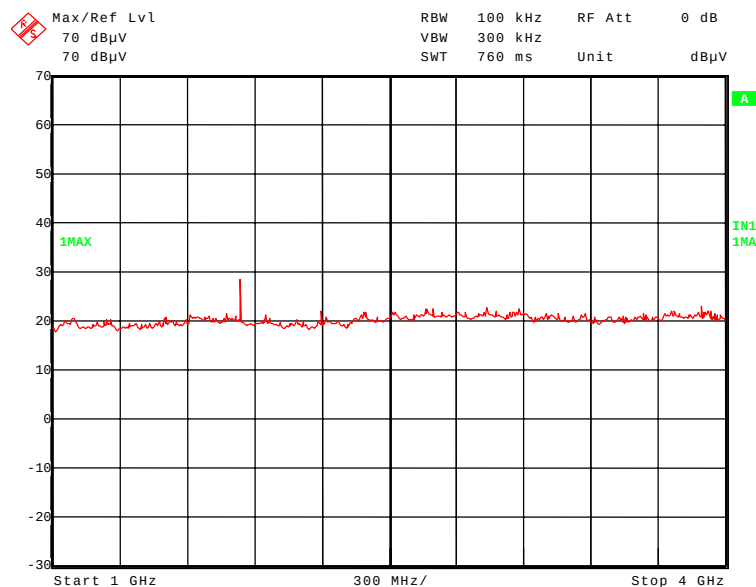
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

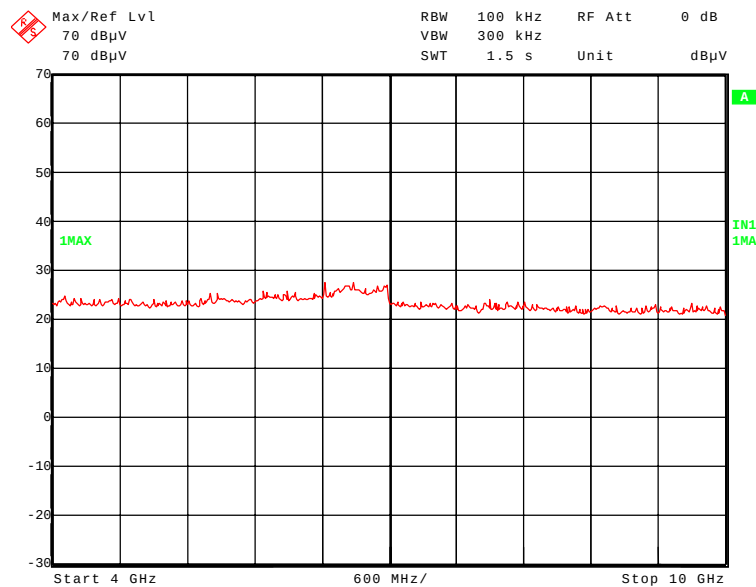
- 894.700 MHz, 906.700 MHz, 911.030 MHz, 918.700 MHz, 926.375 MHz, 930.700 MHz and 942.700 MHz.

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

153494_178.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



153494_179.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

- 1837.400 MHz and 6430.900 MHz.

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 (ZONESCAN 820 Logger)

Ambient temperature	21 °C	Relative humidity	45 %
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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: 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 3.6 V DC by the internal battery.

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

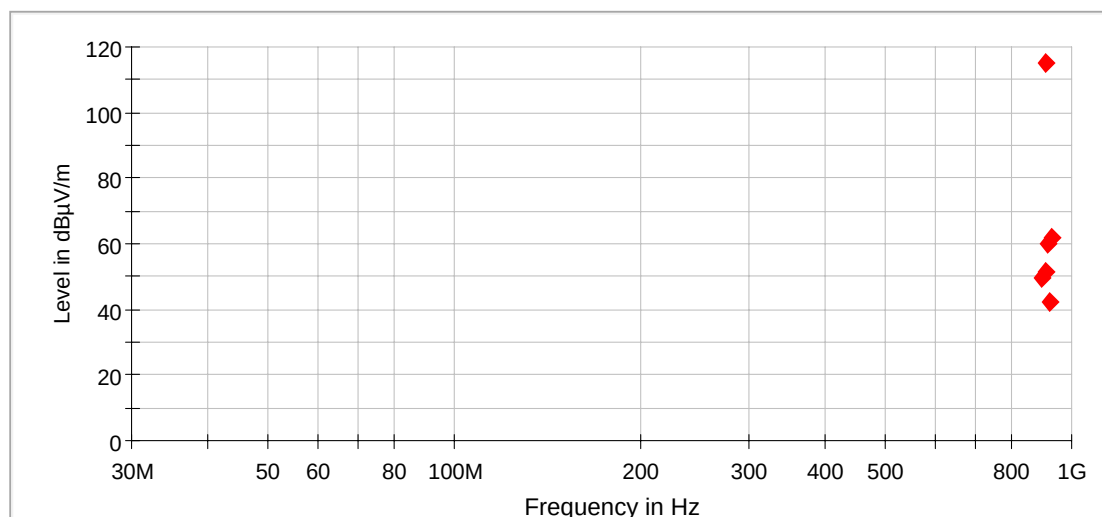
$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]} + 6 \text{ dB}$$

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

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

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

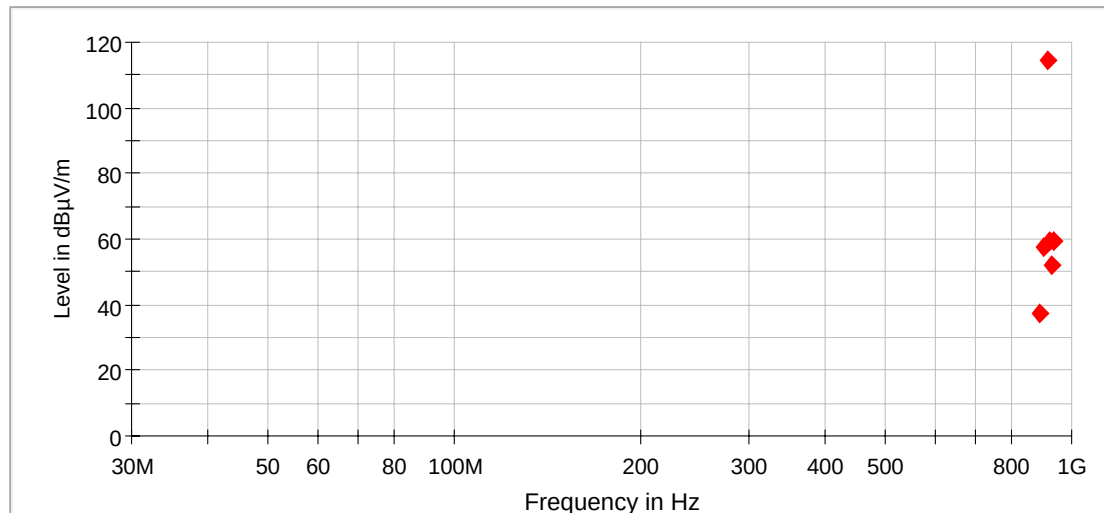
Transmitter operates on the lower end of the assigned frequency (operation mode 1)



◆ Final_Result QPK

Data record name: 153494ff820ilow

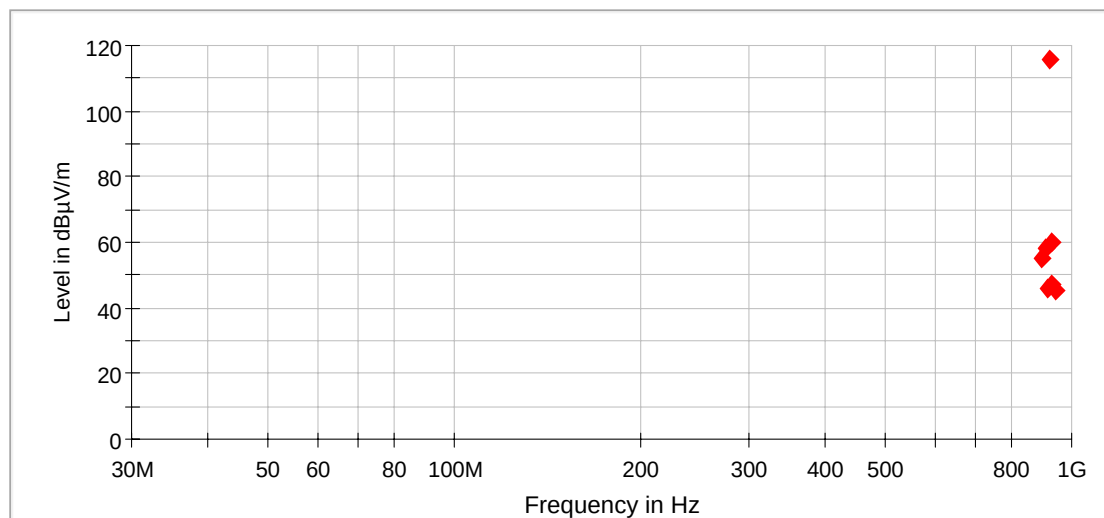
Transmitter operates on the middle of the assigned frequency (operation mode 2)



◆ Final_Result QPK

Data record name: 153494ff820imid

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



◆ Final_Result QPK

Data record name: 153494ff820ihigh

Result measured with the quasi-peak detector:
(These values were marked in the diagrams by an x)

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.
892.000	49.7	94.9	45.2	18.1	22.2	3.4	112.0	255.0	Vert.
904.000	114.9	Carrier	-	83.0	22.5	3.4	109.0	259.0	Vert.
908.000	51.6	94.9	43.3	19.6	22.6	3.4	109.0	253.0	Vert.
916.000	60.2	94.9	34.8	27.9	22.9	3.4	106.0	296.0	Vert.
920.000	42.2	94.9	52.7	9.7	23.1	3.4	108.0	293.0	Vert.
928.000	61.7	94.9	33.2	28.9	23.4	3.4	102.0	246.0	Vert.

Transmitter operates on the middle of the assigned frequency band (operation mode 2)									
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.
887.232	37.6	94.6	57.0	6.1	22.1	3.4	110.0	256.0	Vert.
899.170	57.7	94.6	36.9	26.1	22.4	3.4	107.0	248.0	Vert.
911.200	114.6	Carrier	-	82.5	22.7	3.4	108.0	248.0	Vert.
923.170	59.3	94.6	35.3	26.7	23.2	3.4	105.0	245.0	Vert.
928.961	51.8	94.6	42.9	18.9	23.5	3.4	400.0	204.0	Vert.
935.170	59.6	94.6	35.0	26.5	23.7	3.4	104.0	245.0	Vert.

Transmitter operates on the upper end of the assigned frequency band (operation mode 3)									
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.
894.700	54.9	95.5	40.6	23.3	22.2	3.4	108.0	253.0	Vert.
906.700	57.9	95.5	37.6	28.0	22.5	3.4	110.0	252.0	Vert.
911.030	46.1	95.5	49.4	14.0	22.7	3.4	108.0	248.0	Vert.
918.700	115.5	Carrier	-	83.1	23.0	3.4	108.0	294.0	Vert.
926.375	47.0	95.5	48.5	14.2	23.4	3.4	103.0	245.0	Vert.
930.700	59.9	95.5	35.7	27.0	23.5	3.4	103.0	245.0	Vert.
942.700	45.2	95.5	50.3	12.0	23.8	3.4	102.0	307.0	Vert.
Measurement uncertainty						+2.2 dB / -3.6 dB			

Test: Passed

Test equipment used (see chapter 6):

14 - 21

5.6.2.3 Final radiated emission measurement (1 GHz to 10 GHz) with internal antenna (ZONESCAN 820 Logger)

Ambient temperature	22 °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 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: 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 3.6 V DC by the internal battery.

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

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

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

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

Result measured with the peak detector:

Frequency MHz	Result 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
1808.000	62.1	94.9	32.8	33.1	26.5	0.0	2.5	150	Vert.	No
6328.000	51.7	94.9	43.2	36.8	34.3	24.5	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result 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
1808.000	56.9	94.9	38.0	27.9	26.5	0.0	2.5	150	Vert.	No
6328.000	41.5	94.9	53.4	26.6	34.3	24.5	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

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

Result measured with the peak detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1822.400	64.7	95.8	31.1	35.4	26.7	0.0	2.6	150	Vert.	No
6378.400	52.1	95.8	43.7	36.9	34.3	24.2	5.2	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1822.40	60.7	95.8	35.1	31.4	26.7	0.0	2.6	150	Vert.	No
6378.40	44.5	95.8	51.3	29.3	34.3	24.2	5.2	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

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

Result measured with the peak detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.400	62.6	96.1	33.5	33.1	26.8	0.0	2.7	150	Vert.	No
6430.900	50.7	96.1	45.4	35.8	34.2	24.4	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.400	56.5	96.1	39.6	27.0	26.8	0.0	2.7	150	Vert.	No
6430.900	39.6	96.1	56.5	24.7	34.2	24.4	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

Test equipment used (see chapter 6):

29, 31 - 34, 36, 44, 45, 49, 50, 73, 75

5.6.2.4 Preliminary radiated emission measurement with external antenna (ZONESCAN 820 Logger)

Ambient temperature	22 °C	Relative humidity	51 %
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Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m and 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: 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.

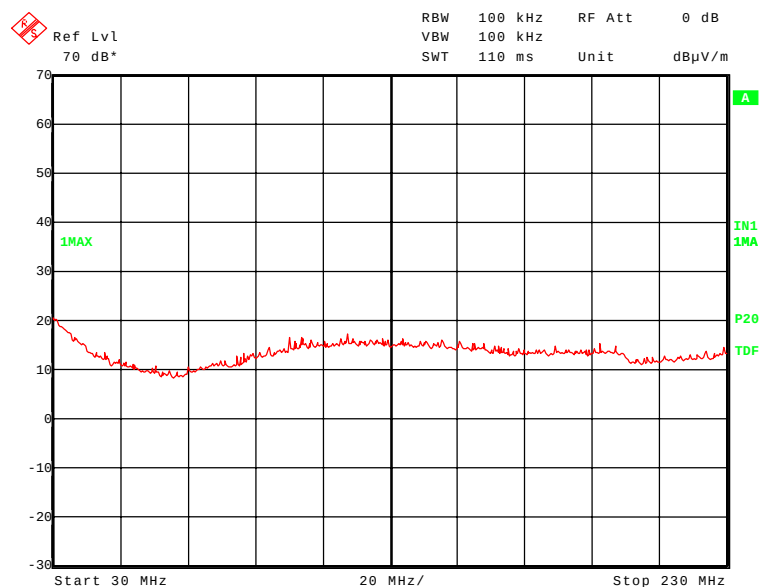
Supply voltage: During all measurements the EUT was supplied 3.6 V DC by the internal battery.

Frequency range: The preliminary measurement was carried out in the frequency range 10 MHz to 10 GHz according to [2].

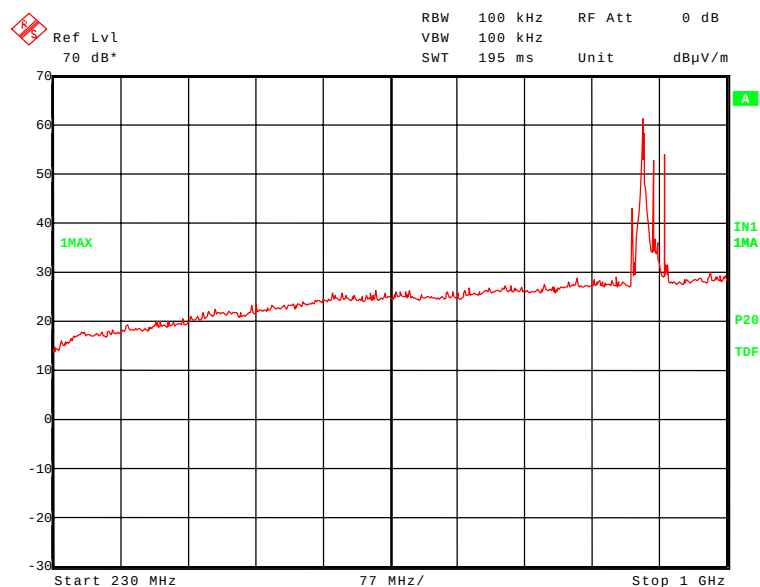
Remark: As pre-tests have shown, the emissions in the frequency range 10 MHz to 30 MHz are not depending on the transmitter operation mode. Therefore the emissions in this frequency range were measured only with the transmitter operates in operation mode 2.

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

153494_117.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 1):



153494_118.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 1, carrier notched):



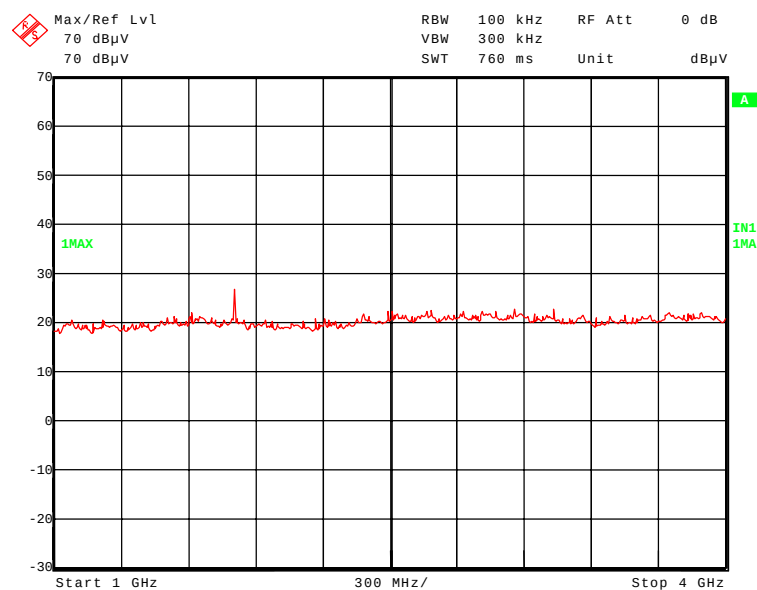
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

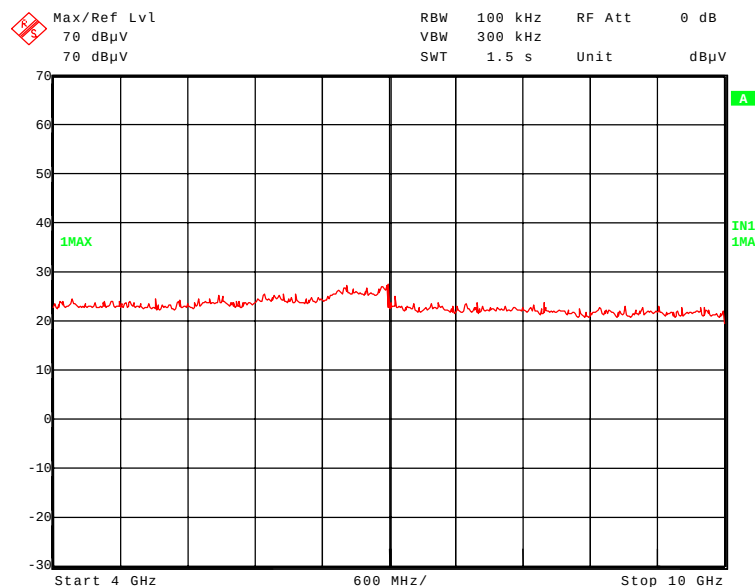
- 892.000 MHz, 904.000MHz, 908.000, MHz, 916.000 MHz, 920.000 MHz and 928.000 MHz.

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

153494_168.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



153494_169.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 1):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

- 1808.000 MHz

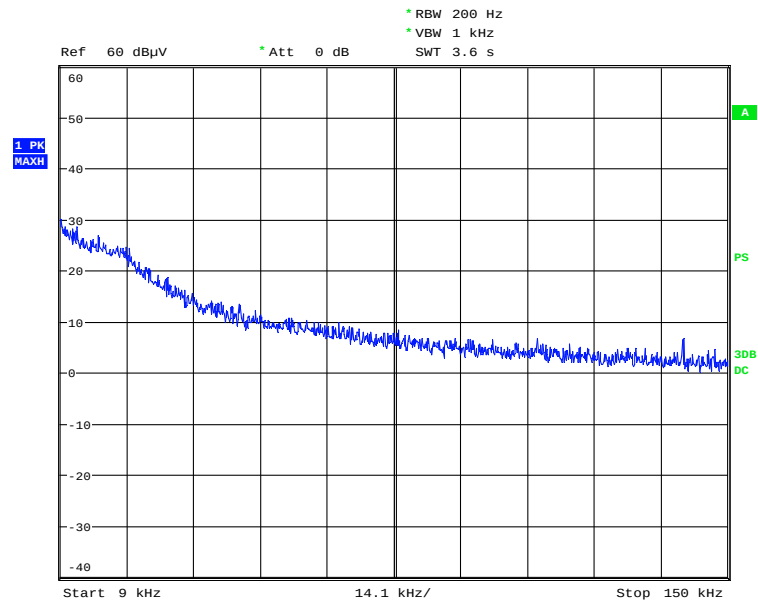
This frequency has to be measured in a final measurement. The results were presented in the following.

Test equipment used (see chapter 6):

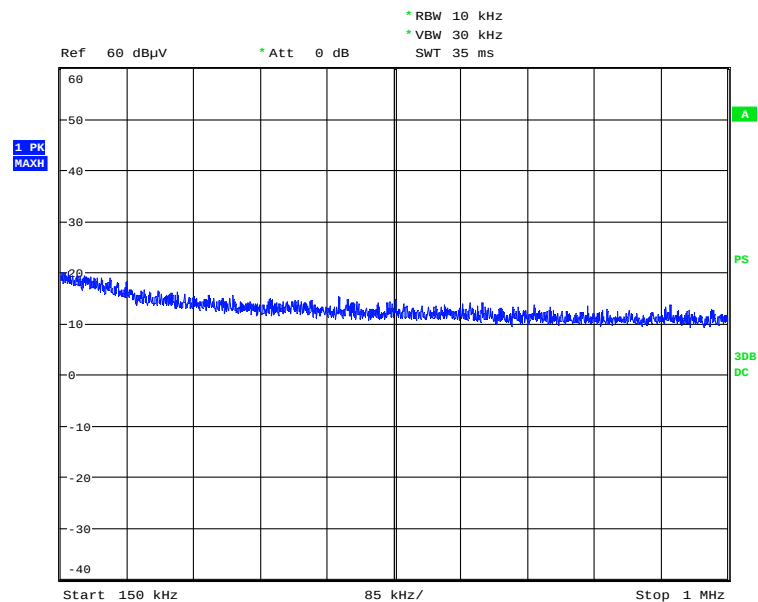
22 - 25, 29, 31 - 36, 43 - 45, 49, 50, 55, 73, 75, 83

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

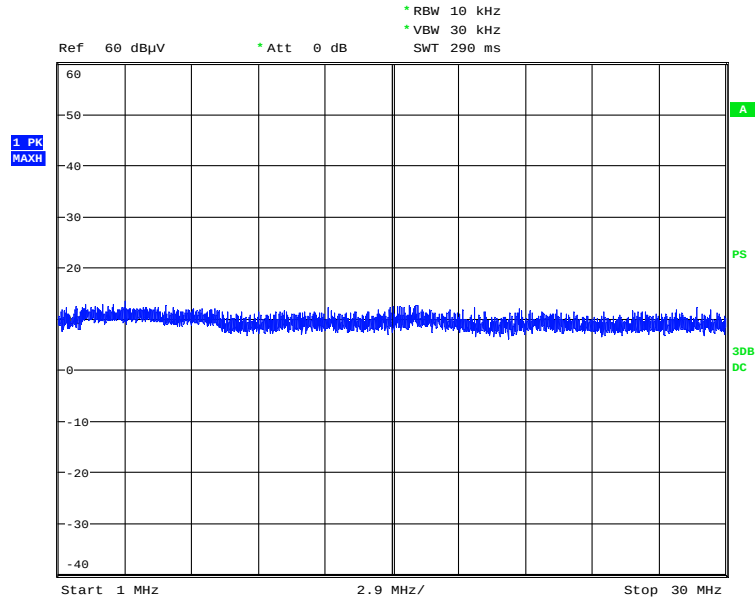
153494_155.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



153494_154.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

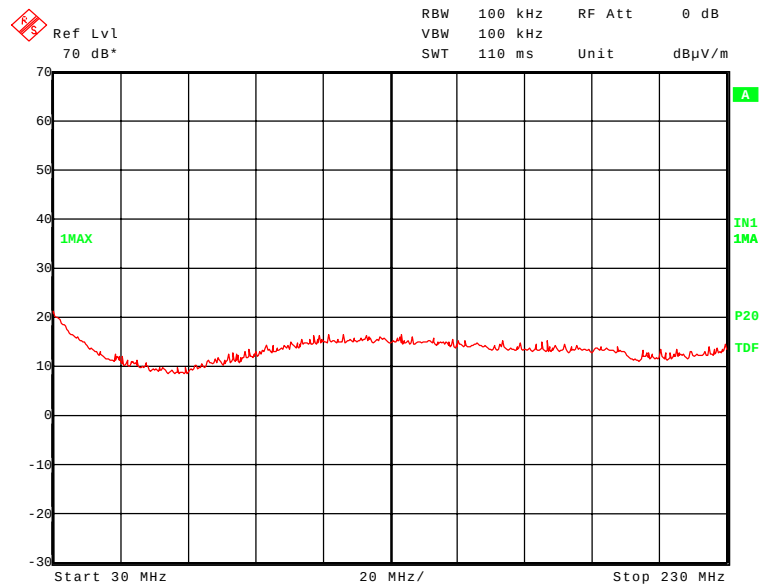


153494 153.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

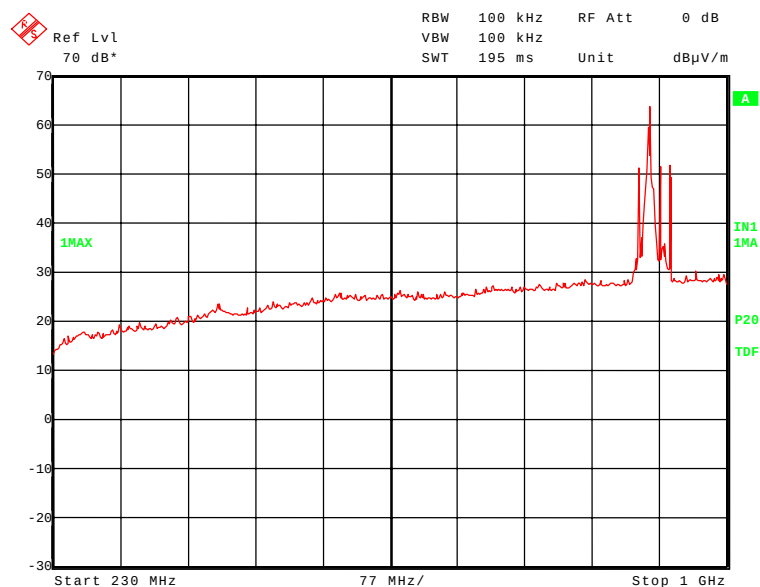


No significant frequencies above the noise floor of the system (max. 33 dBμV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

153494 116.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):



153494_115.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2, carrier notched):



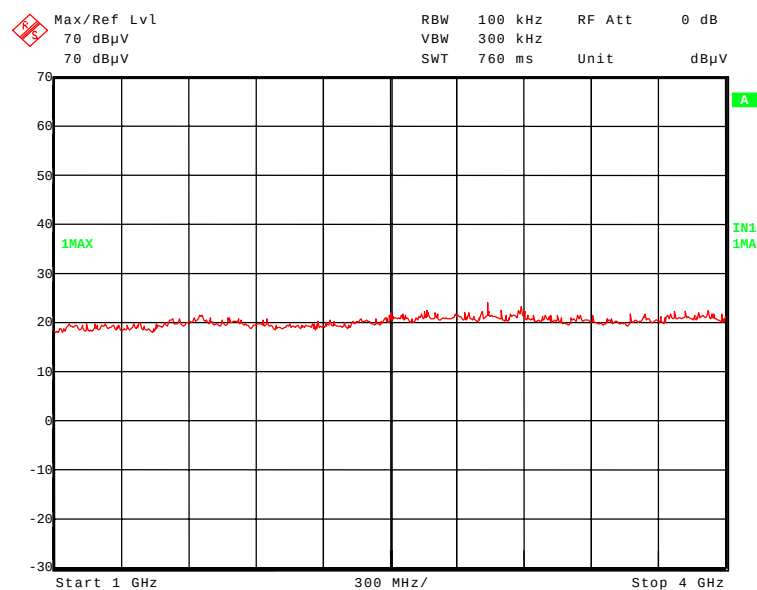
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

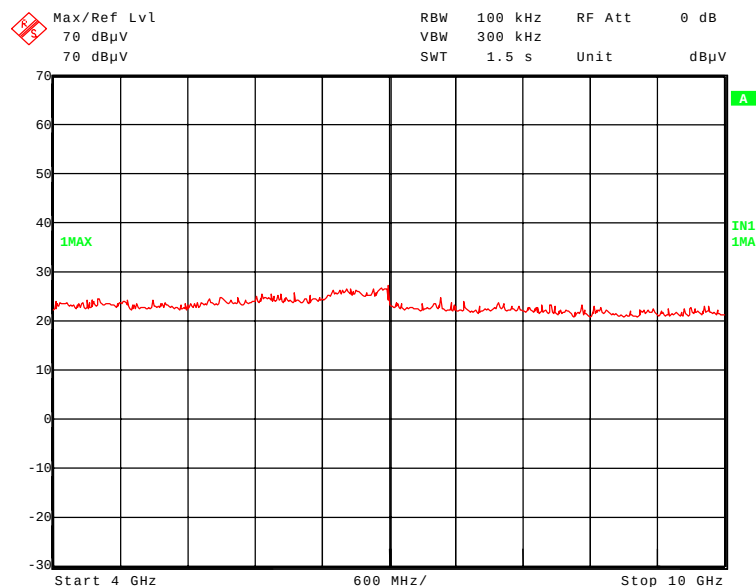
- 887.232 MHz, 899.170 MHz, 911.200 MHz, 923.170 MHz, 929.000 MHz and 935.200 MHz

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

153494_171.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



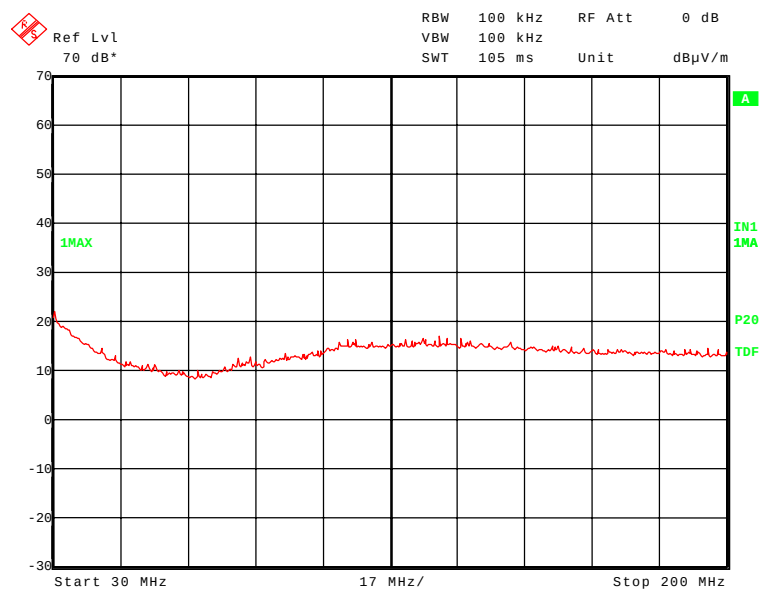
153494_170.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



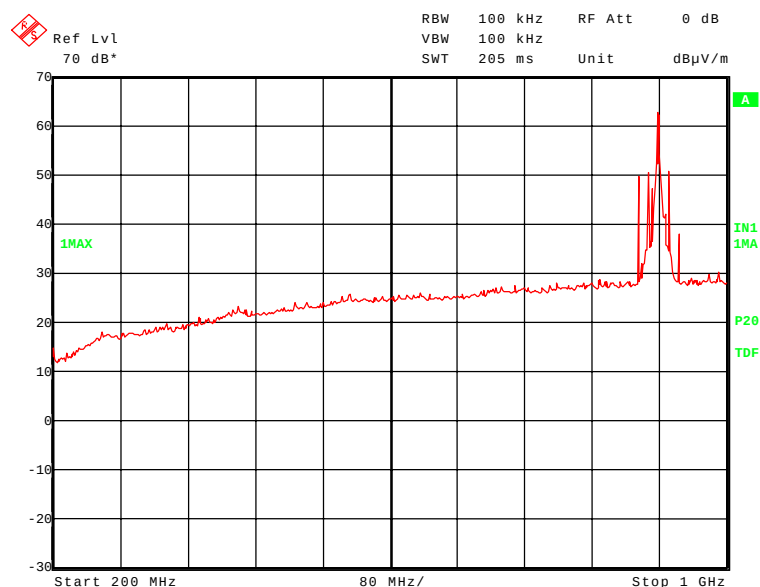
No significant frequencies above the noise floor of the system (max. 40 dBμV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no final measurements were carried in this operation mode.

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

153494_113.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 3):



153494_114.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 3, carrier notched):



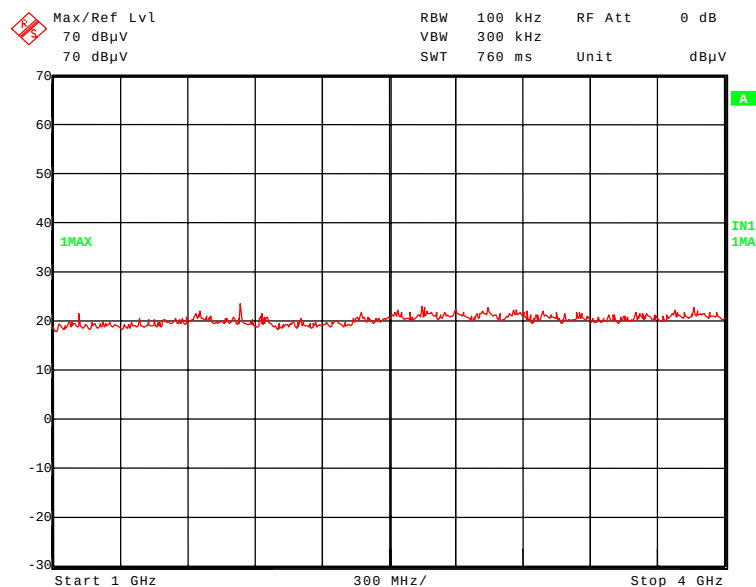
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

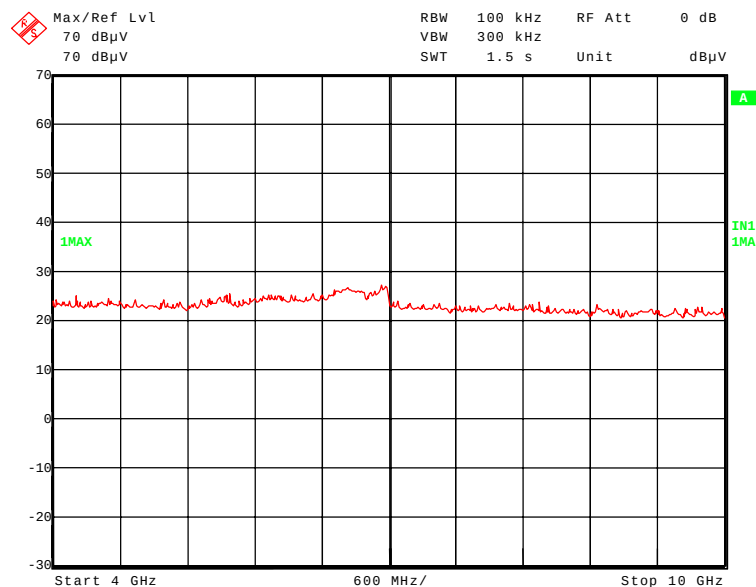
- 894.700 MHz, 906.700 MHz, 911.030 MHz, 918.700 MHz, 926.375 MHz, 930.700 MHz and 942.700 MHz.

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

153494_173.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



153494_172.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

- 1837.400 MHz

This frequency has to be measured in a final measurement. The results were presented in the following.

5.6.2.5 Final radiated emission measurement (30 MHz to 1 GHz) with external antenna (ZONESCAN 820 Logger)

Ambient temperature	21 °C	Relative humidity	45 %
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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: 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 3.6 V DC by the internal battery.

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

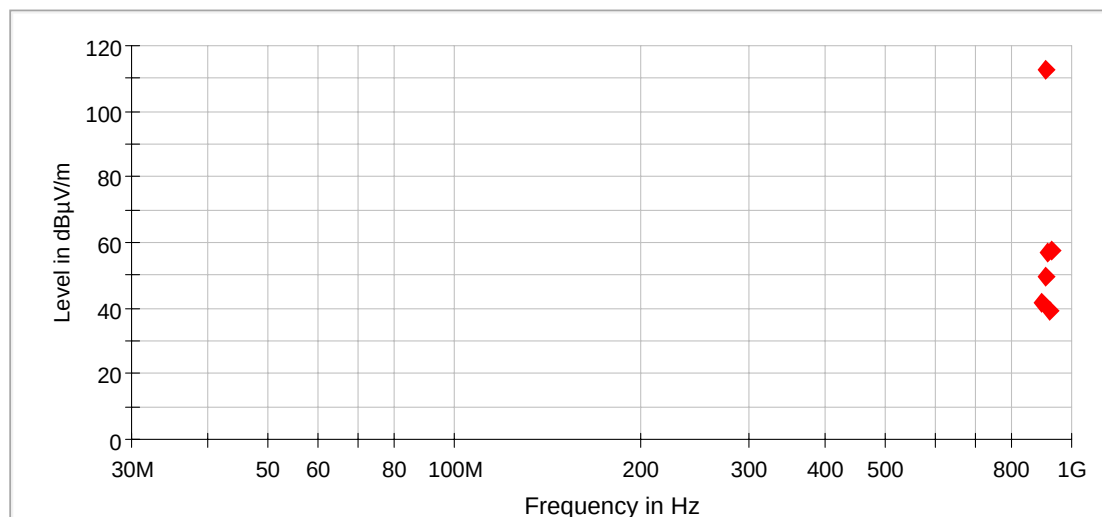
$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]} + 6 \text{ dB}$$

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

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

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

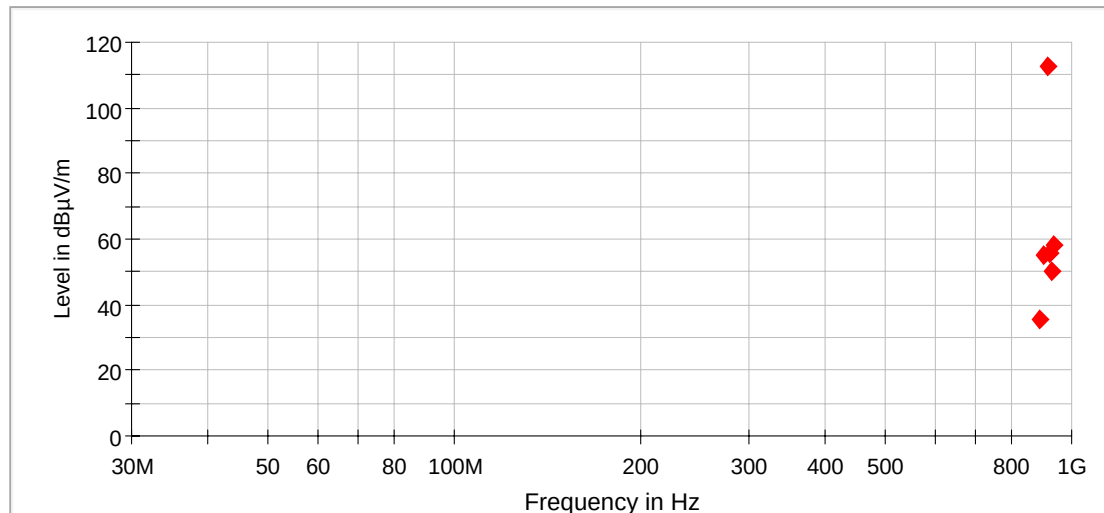
Transmitter operates on the lower end of the assigned frequency (operation mode 1)



◆ Final_Result QPK

Data record name: 153494ff820elow

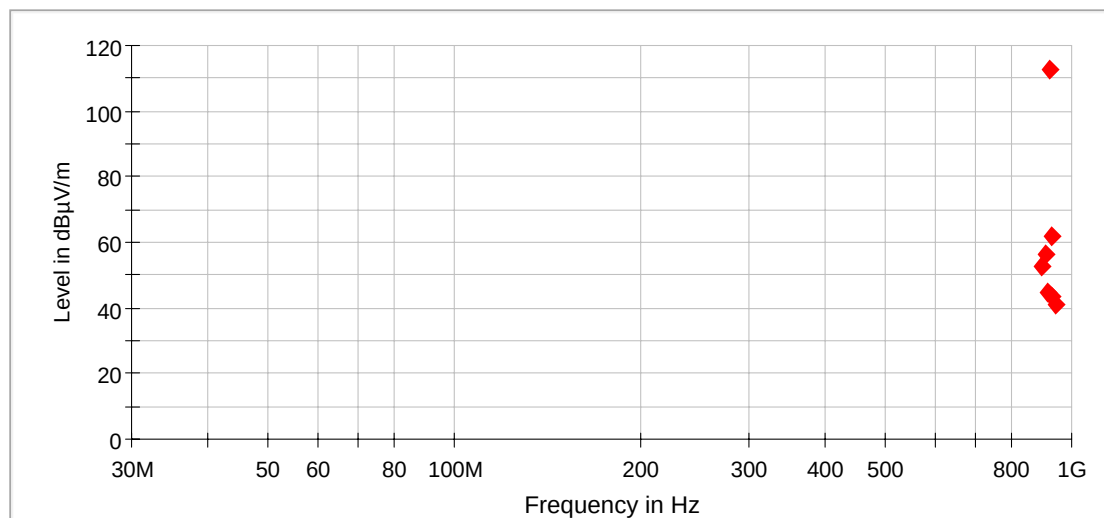
Transmitter operates on the middle of the assigned frequency (operation mode 2)



◆ Final_Result QPK

Data record name: 153494ff820emid

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



◆ Final_Result QPK

Data record name: 153494ff820ehigh

Result measured with the quasi-peak detector:
(These values were marked in the diagrams by an x)

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.
892.000	41.6	93.0	51.5	10.0	22.2	3.4	150.0	89.0	Vert.
904.000	113.0	Carrier	-	81.1	22.5	3.4	109.0	89.0	Vert.
908.000	49.4	93.0	43.6	17.4	22.6	3.4	117.0	348.0	Vert.
916.000	57.2	93.0	35.8	24.9	22.9	3.4	118.0	294.0	Vert.
920.000	39.1	93.0	53.9	6.6	23.1	3.4	120.0	294.0	Vert.
928.000	57.5	93.0	35.5	24.7	23.4	3.4	116.0	293.0	Vert.

Transmitter operates on the middle of the assigned frequency band (operation mode 2)									
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.
887.232	35.8	92.7	56.9	4.3	22.1	3.4	114.0	91.0	Vert.
899.170	54.9	92.7	37.8	23.1	22.4	3.4	119.0	296.0	Vert.
911.200	112.7	Carrier	-	83.6	22.7	3.4	120.0	346.0	Vert.
923.170	55.6	92.7	37.1	23.0	23.2	3.4	116.0	294.0	Vert.
928.961	50.1	92.7	42.6	17.2	23.5	3.4	400.0	28.0	Vert.
935.170	57.9	92.7	34.8	24.8	23.7	3.4	115.0	346.0	Vert.

Transmitter operates on the upper end of the assigned frequency band (operation mode 3)									
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.
894.700	52.7	92.5	39.8	27.1	22.2	3.4	122.0	346.0	Vert.
906.700	56.4	92.5	36.1	30.5	22.5	3.4	117.0	349.0	Vert.
911.030	44.8	92.5	47.7	18.7	22.7	3.4	117.0	345.0	Vert.
918.700	112.5	Carrier	-	86.1	23.0	3.4	120.0	292.0	Vert.
926.375	43.7	92.5	48.8	16.9	23.4	3.4	115.0	293.0	Vert.
930.700	61.9	92.5	30.6	35.0	23.5	3.4	106.0	1.0	Vert.
942.700	41.1	92.5	51.4	13.9	23.8	3.4	150.0	56.0	Vert.
Measurement uncertainty				+2.2 dB / -3.6 dB					

Test: Passed

Test equipment used (see chapter 6):

14 - 21

5.6.2.6 Final radiated emission measurement (1 GHz to 10 GHz) with external antenna (ZONSCAN 820 Logger)

Ambient temperature	22 °C	Relative humidity	51 %
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Position of EUT: The EUT was set-up on a non-conducting table of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: 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 3.6 V DC by the internal battery.

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

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

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

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

Result measured with the peak detector:

Frequency MHz	Result 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
1808.000	60.8	93.0	32.2	31.8	26.5	0.0	2.5	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result 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
1808.000	54.0	93.0	39.0	25.0	26.5	0.0	2.5	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

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

Result measured with the peak detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.400	60.2	92.5	32.3	30.7	26.8	0.0	2.7	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.4000	50.5	92.5	42.0	21.0	26.8	0.0	2.7	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

Test equipment used (see chapter 6):

29, 31 - 34, 36, 44, 45, 49, 50, 73, 75

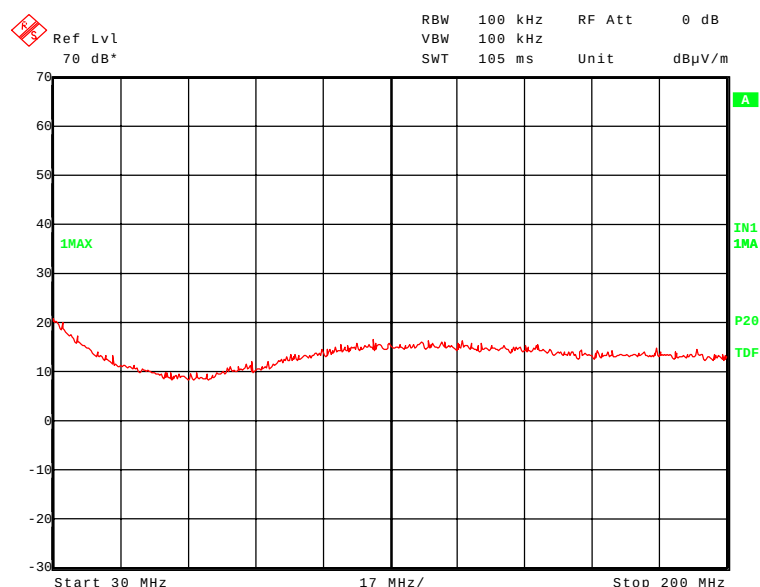
5.6.2.7 Preliminary radiated emission measurement with internal antenna (EASYSKAN SENSOR)

Ambient temperature	22 °C	Relative humidity	48 %
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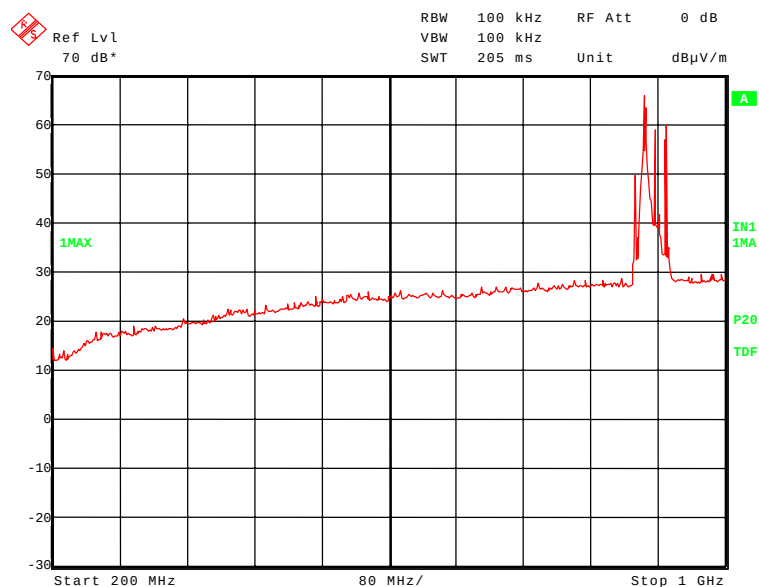
Position of EUT:	The EUT was set-up on a non-conducting table of a height of 0.8 m and 1.5 m. The distance between EUT and antenna was 3 m.
Cable guide:	For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.
Test record:	All results are shown in the following.
Supply voltage:	During all measurements the EUT was supplied with 3.6 V DC by the internal battery.
Frequency range:	The preliminary measurement was carried out in the frequency range 9 kHz to 10 GHz according to [2].
Remark:	As pre-tests have shown, the emissions in the frequency range 9 kHz 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 the lower end of the assigned frequency band (operation mode 1)

153494_106.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 1):



153494_105.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 1, carrier notched):



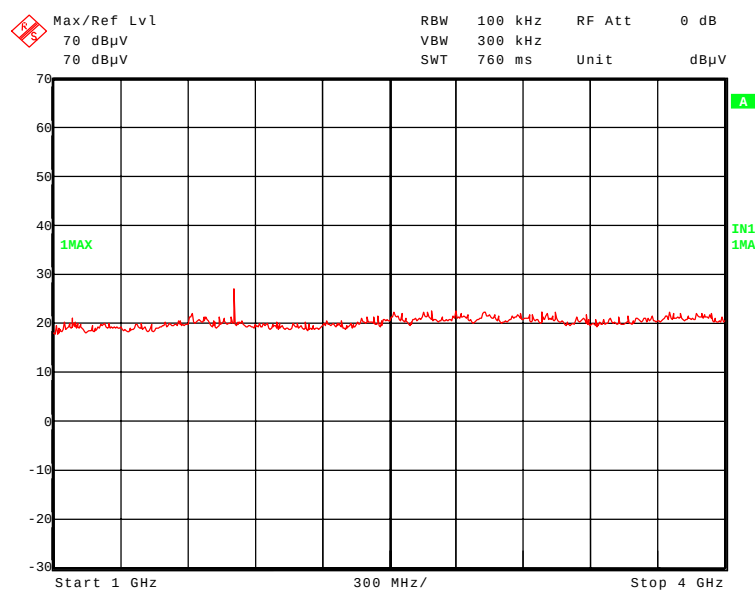
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

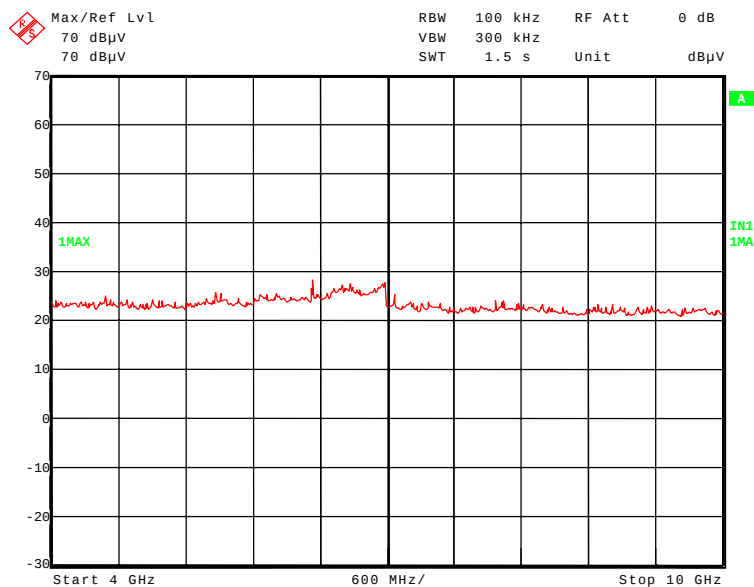
- 892.000 MHz, 904.000MHz, 908.000, MHz, 916.000 MHz, 920.000 MHz and 928.000 MHz.

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

153494_181.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



153494_180.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 1):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

- 1808.000 MHz and 6328.000 MHz

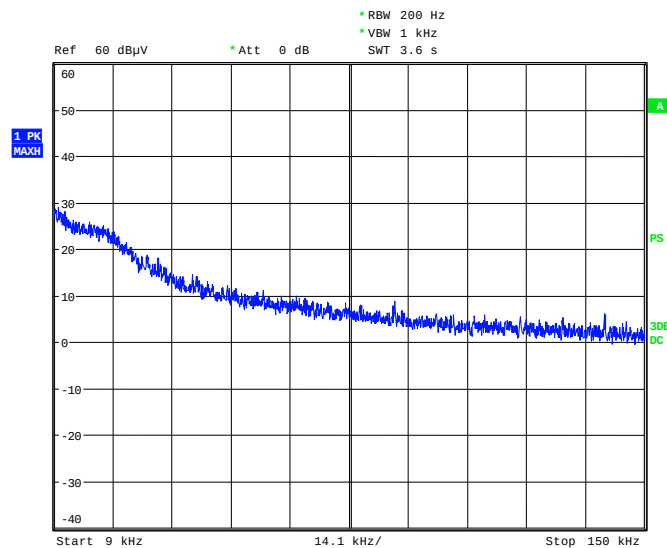
These frequencies have to be measured in a final measurement. The results were presented in the following.

Test equipment used (see chapter 6):

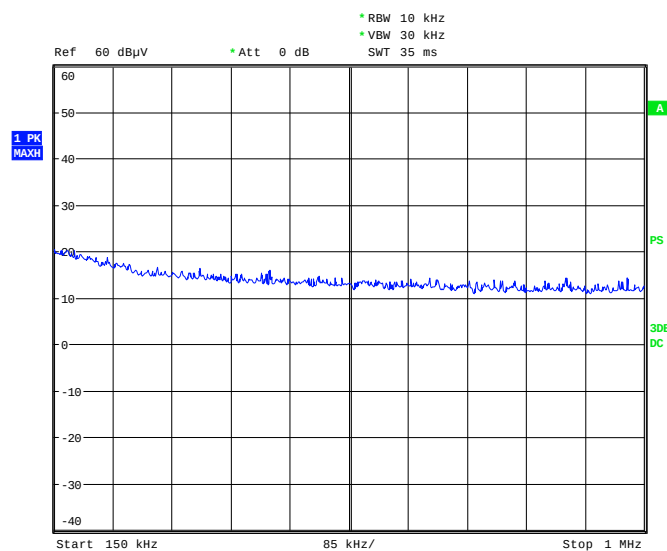
22 - 25, 29, 31 - 36, 43 - 45, 49, 50, 55, 73, 75, 83

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

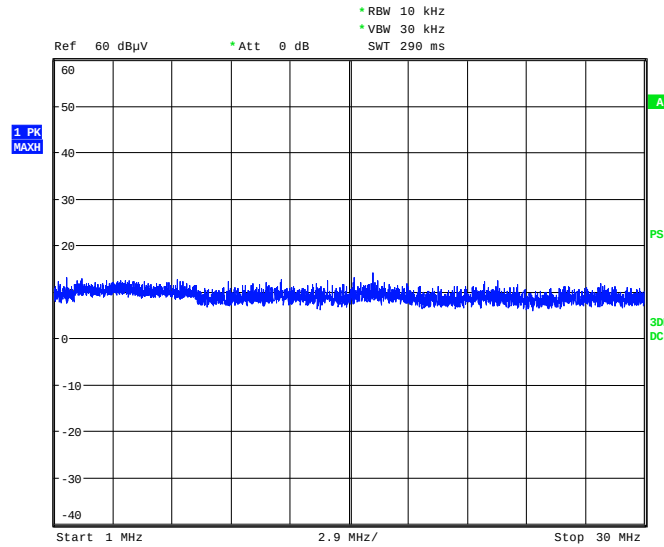
153494_162.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



153494_163.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

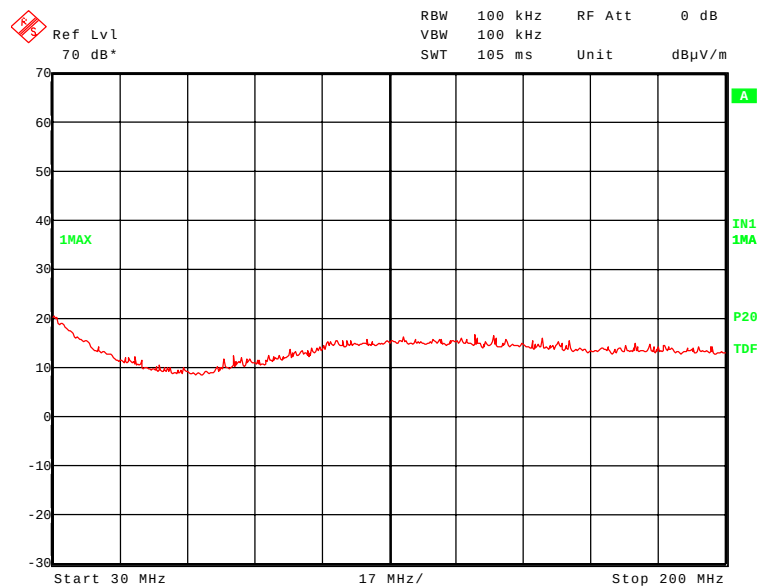


153494 .wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

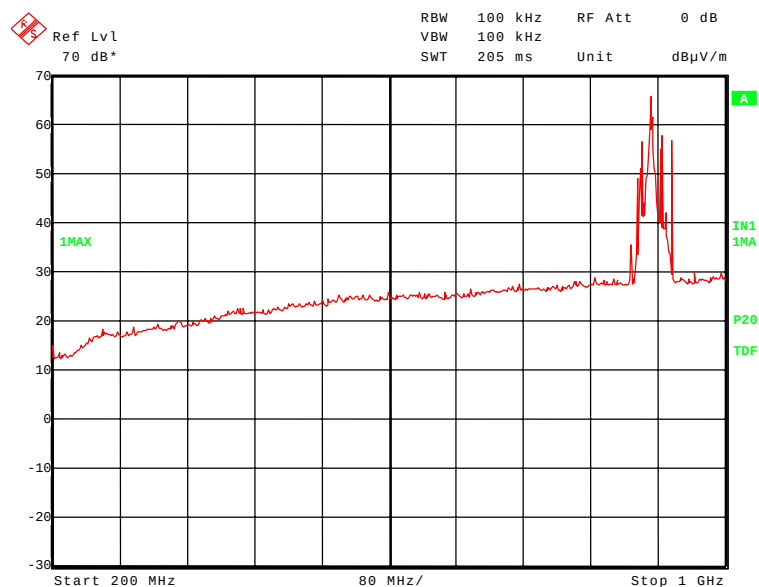


No significant frequencies above the noise floor of the system (max. 33 dB μ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

153494_103.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):



153494_104.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2, carrier notched):



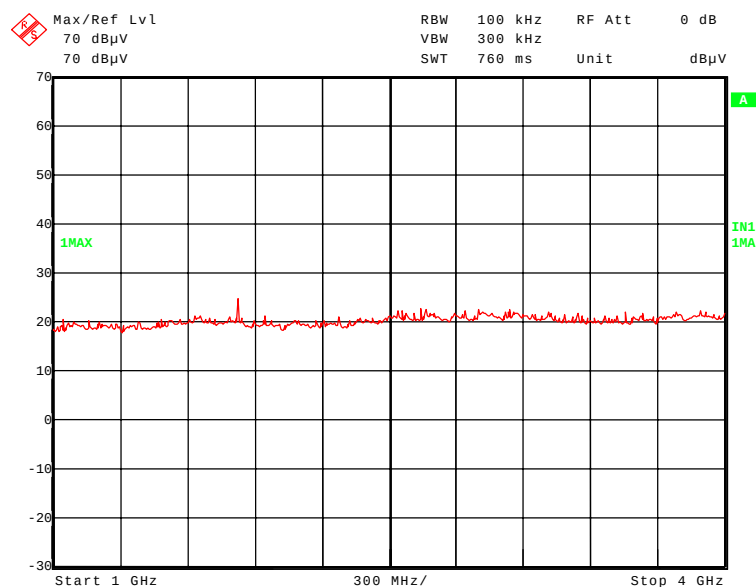
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

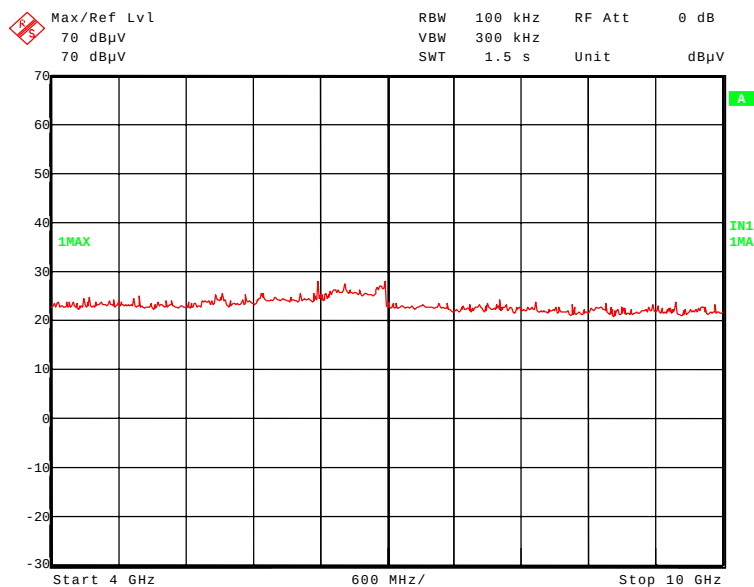
- 887.232 MHz, 899.170 MHz, 911.200 MHz, 923.170 MHz, 928.961 MHz and 935.170 MHz

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

153494_182.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



153494_183.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

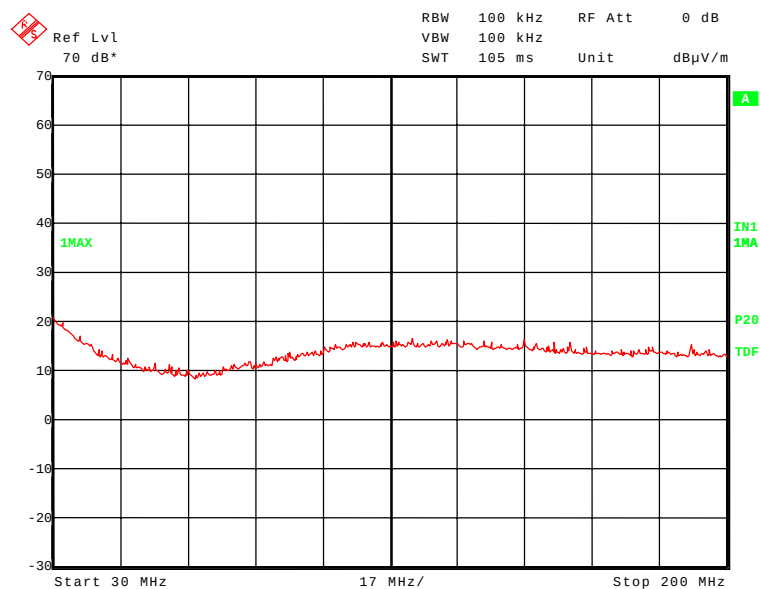
The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 1822.400 MHz and 6378.400 MHz

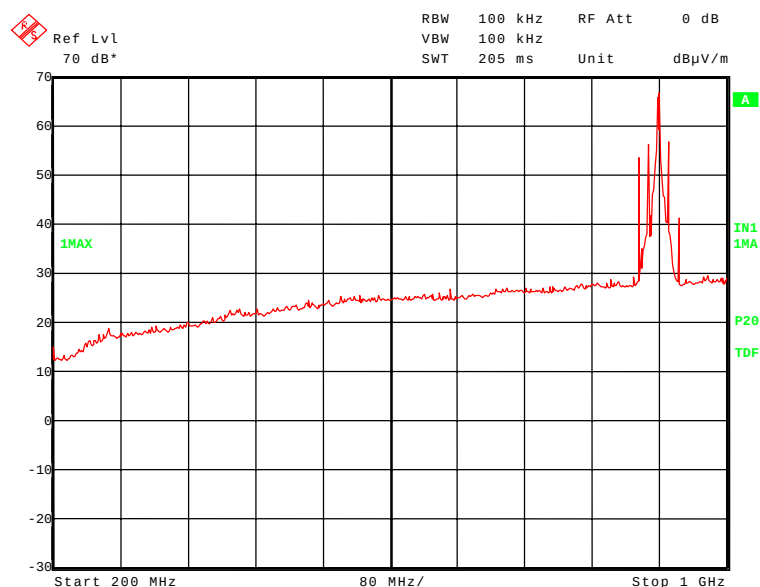
These frequencies have to be measured in a final measurement. The results were presented in the following.

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

153494_109.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 3):



153494_110.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 3, carrier notched):



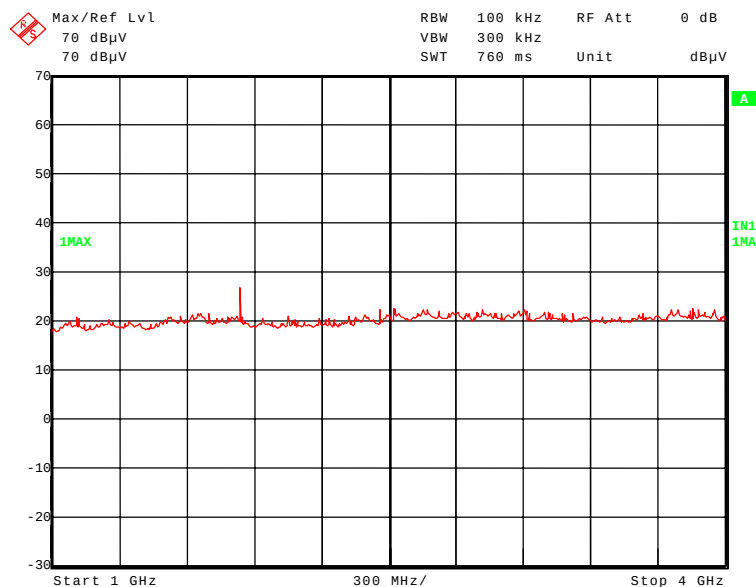
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

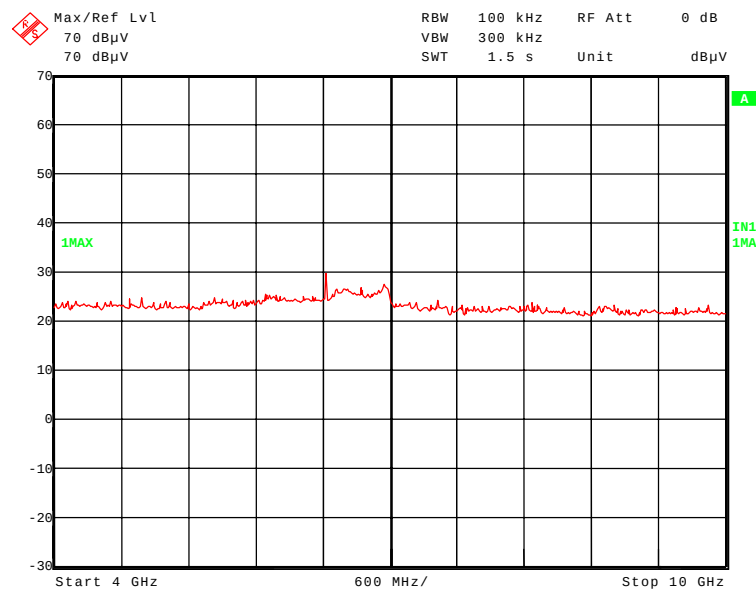
- 894.700 MHz, 906.700 MHz, 911.030 MHz, 918.700 MHz, 926.375 MHz, 930.700 MHz and 942.700 MHz.

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

153494_184.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



153494_185.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

- 1937.400 MHz and 6430.900 MHz

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

5.6.2.8 Final radiated emission measurement (30 MHz to 1 GHz) measurement with internal antenna (EASYSCAN SENSOR)

Ambient temperature	21 °C	Relative humidity	45 %
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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: 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 3.6 V DC by the internal battery.

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

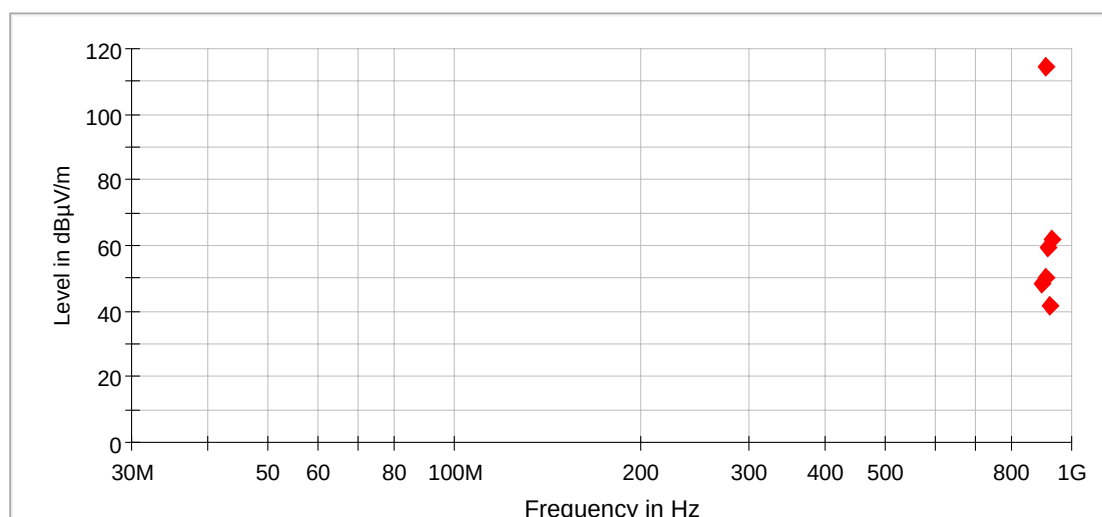
$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]} + 6 \text{ dB}$$

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

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

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

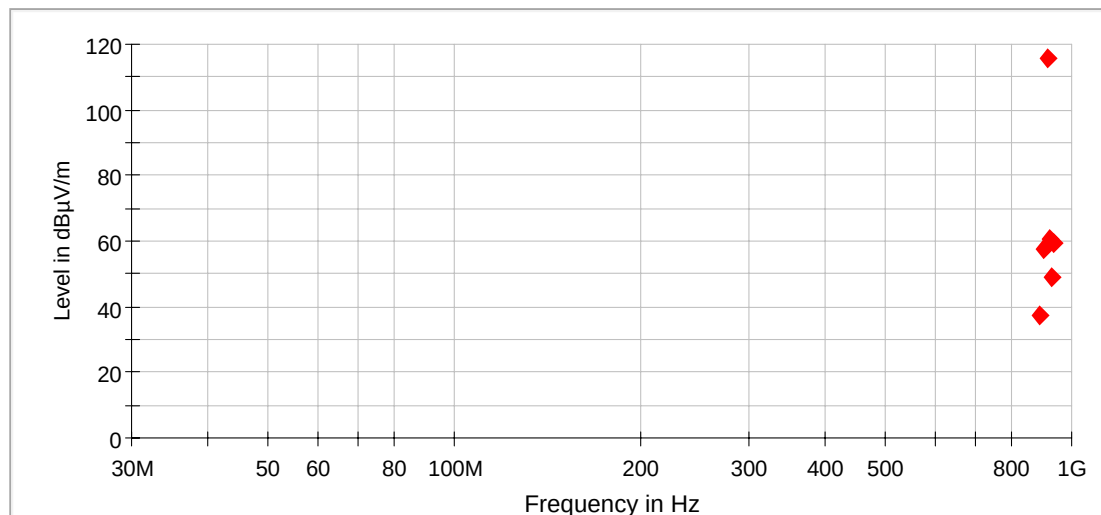
Transmitter operates on the lower end of the assigned frequency (operation mode 1)



◆ Final_Result QPK

Data record name: 153494ffeasylow

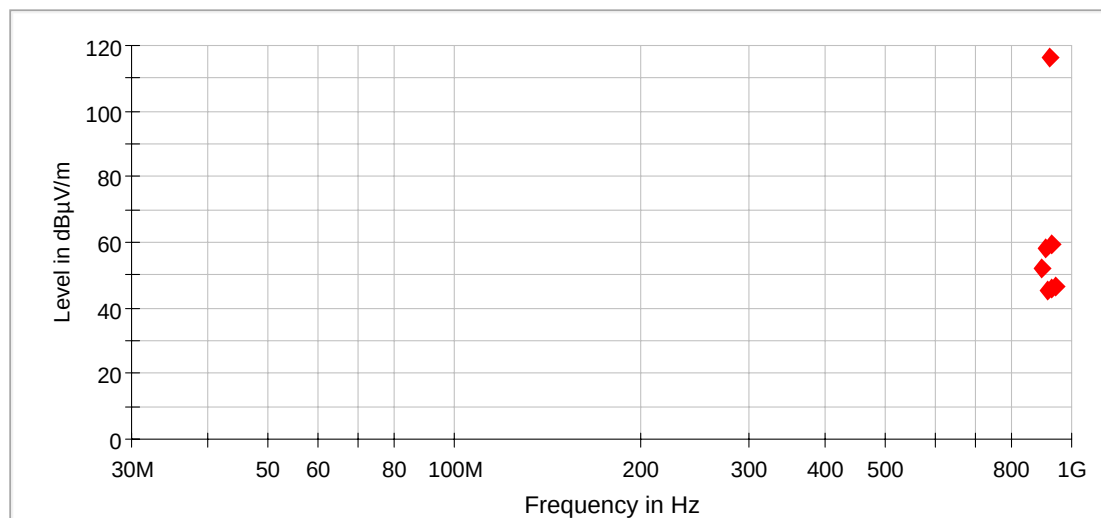
Transmitter operates on the middle of the assigned frequency (operation mode 2)



◆ Final_Result QPK

Data record name: 153494ffeasymid

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



◆ Final_Result QPK

Data record name: 153494ffeasyhigh

Result measured with the quasi-peak detector:
(These values were marked in the diagrams by an x)

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.
892.000	48.5	94.5	46.0	16.9	22.2	3.4	100.0	242.0	Vert.
904.000	114.5	Carrier	-	82.6	22.5	3.4	105.0	248.0	Vert.
908.000	50.4	94.5	44.1	18.4	22.6	3.4	110.0	252.0	Vert.
916.000	59.4	94.5	35.1	27.1	22.9	3.4	104.0	247.0	Vert.
920.000	41.7	94.5	52.8	9.2	23.1	3.4	104.0	247.0	Vert.
928.000	61.6	94.5	32.9	28.8	23.4	3.4	100.0	246.0	Vert.

Transmitter operates on the middle of the assigned frequency band (operation mode 2)									
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.
887.232	37.5	95.8	58.3	6.0	22.1	3.4	109.0	52.0	Vert.
899.170	57.8	95.8	38.0	26.0	22.4	3.4	108.0	63.0	Vert.
911.200	115.8	Carrier	-	83.7	22.7	3.4	102.0	62.0	Vert.
923.170	60.4	95.8	35.4	27.8	23.2	3.4	102.0	65.0	Vert.
928.961	49.3	95.8	46.5	16.4	23.5	3.4	307.0	54.0	Vert.
935.170	59.5	95.8	36.3	26.4	23.7	3.4	102.0	65.0	Vert.

Transmitter operates on the upper end of the assigned frequency band (operation mode 3)									
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.
894.700	51.8	96.1	44.4	20.2	22.2	3.4	100.0	244.0	Vert.
906.700	58.0	96.1	38.1	26.1	22.5	3.4	108.0	248.0	Vert.
911.030	45.3	96.1	50.8	13.2	22.7	3.4	105.0	248.0	Vert.
918.700	116.1	Carrier	-	83.7	23.0	3.4	107.0	296.0	Vert.
926.375	46.2	96.1	49.9	13.4	23.4	3.4	102.0	245.0	Vert.
930.700	59.5	96.1	36.6	26.6	23.5	3.4	102.0	242.0	Vert.
942.700	46.5	96.1	49.6	13.3	23.8	3.4	102.0	304.0	Vert.

Measurement uncertainty

+2.2 dB / -3.6 dB

Test: Passed

Test equipment used (see chapter 6):

14 - 21

5.6.2.9 Final radiated emission measurement (1 GHz to 10 GHz) measurement with internal antenna (EASYSKAN SENSOR)

Ambient temperature	22 °C	Relative humidity	48 %
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Position of EUT: The EUT was set-up on a non-conducting table of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: 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 3.6 V DC by the internal battery.

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

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

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

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

Result measured with the peak detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1808.000	62.1	94.5	32.4	33.1	26.5	0.0	2.5	150	Vert.	No
6328.000	51.2	94.5	43.3	36.3	34.3	24.5	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1808.000	55.8	94.5	38.7	26.8	26.5	0.0	2.5	150	Vert.	No
6328.000	41.2	94.5	53.3	26.3	34.3	24.5	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

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

Result measured with the peak detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1822.400	61.1	95.8	34.7	31.8	26.7	0.0	2.6	150	Vert.	No
6378.400	50.4	95.8	45.4	35.2	34.3	24.2	5.2	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1822.400	55.7	95.8	40.1	26.4	26.7	0.0	2.6	150	Vert.	No
6378.400	39.5	95.8	56.3	24.3	34.3	24.2	5.2	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

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

Result measured with the peak detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.400	61.8	96.1	34.3	32.3	26.8	0.0	2.7	150	Vert.	No
6430.900	51.7	96.1	44.4	36.8	34.2	24.4	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.400	56.5	96.1	39.6	27.0	26.8	0.0	2.7	150	Vert.	No
6430.900	43.6	96.1	52.5	28.7	34.2	24.4	5.1	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

Test equipment used (see chapter 6):

29, 31 - 34, 36, 44, 45, 49, 50, 73, 75

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	03/06/2015	03/2017
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	09/18/2014	09/2017
20	EMI Software	EMC 32	Rohde & Schwarz	100061	481022	-	-
21	6 dB attenuator	R412706000	Radiall	9833	410082	Weekly verification (system cal.)	
22	Fully anechoic chamber M8	-	Siemens	B83117-E7019-T231	480190	Weekly verification (system cal.)	
23	Turntable	DS420	Deisel	420/435/97	480186	-	-
24	Measuring receiver	ESU8	Rohde & Schwarz	100218	480998	02/24/2014	02/2016
25	Controller	MCU	Maturo	MCU/039/971107	481353	-	-
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	03/09/2015	03/2016
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	03/02/2015	03/2016
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	04/14/2014	04/2017
36	Antenna	HL50	Rohde & Schwarz	100438	481170	08/27/2014	08/2017
43	RF-cable No. 36	Sucoflex 106B	Suhner	0587/6B	480865	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.)	
50	Turn device	TDF 1.5- 10Kg	Maturo	15920215	482034	-	-
55	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	09/22/2014	09/2015
73	High Pass Filter	WHJS1000C11 /60EF	Wainwright Instruments GmbH	1	480413	Weekly verification (system cal.)	
75	High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments GmbH	1	480587	Weekly verification (system cal.)	
83	Tuneable Notch Filter	WRCA800/900-0.2/40-6EEK	Wainwright Instruments GmbH	15	480414	Weekly verification (system cal.)	

7 Report history

Report Number	Date	Comment
F153494E3	02/15/2016	Document created
-	-	-
-	-	-
-	-	-

8 List of annexes

Annex A Test set-up photographs 16 pages

153494_I_U_A.JPG: ZONESCAN 820 Logger with integrated antenna, test setup fully anechoic chamber
 153494_I_U_B.JPG: ZONESCAN 820 Logger with integrated antenna, test setup fully anechoic chamber
 153494_I_U_G.JPG: ZONESCAN 820 Logger with integrated antenna, test setup fully anechoic chamber
 153494_I_U_I.JPG: ZONESCAN 820 Logger with integrated antenna, test setup fully anechoic chamber
 153494_I_U_J.JPG: ZONESCAN 820 Logger with integrated antenna, test setup fully open area test site
 153494_X_U_A.JPG: ZONESCAN 820 Logger with integrated antenna, test setup fully anechoic chamber
 153494_X_U_G.JPG: ZONESCAN 820 Logger with integrated antenna, test setup fully anechoic chamber
 153494_X_U_L.JPG: ZONESCAN 820 Logger with external antenna, test setup fully anechoic chamber
 153494_X_U_P.JPG: ZONESCAN 820 Logger with external antenna, test setup fully anechoic chamber
 153494_X_U_H.JPG: ZONESCAN 820 Logger with external antenna, test setup fully open area test site
 153494_X_U_R.JPG: ZONESCAN 820 Logger with external antenna, test setup conducted measurements
 153494_E_U_C.JPG: EASYSCAN SENSOR, test setup fully anechoic chamber
 153494_E_U_G.JPG: EASYSCAN SENSOR, test setup fully anechoic chamber
 153494_E_U_I.JPG: EASYSCAN SENSOR, test setup fully anechoic chamber
 153494_E_U_E.JPG: EASYSCAN SENSOR, test setup fully anechoic chamber
 153494_E_U_A.JPG: EASYSCAN SENSOR, test setup fully open area test site

Annex B External photographs 12 pages

153494_I_U_1.JPG: ZONESCAN 820 Logger with integrated antenna, 3-D-view 1
 153494_I_U_2.JPG: ZONESCAN 820 Logger with integrated antenna, 3-D-view 2
 153494_I_U_3.JPG: ZONESCAN 820 Logger with integrated antenna, type plate view
 153494_X_U_1.JPG: ZONESCAN 820 Logger with external antenna port, 3-D-view 1
 153494_X_U_2.JPG: ZONESCAN 820 Logger with external antenna port, 3-D-view 2
 153494_X_U_3.JPG: ZONESCAN 820 Logger with external antenna port, type plate view
 153494_E_U_4.JPG: EASYSCAN SENSOR, 3-D-view 1
 153494_E_U_2.JPG: EASYSCAN SENSOR, 3-D-view 2
 153494_E_U_3.JPG: EASYSCAN SENSOR, type plate view
 153494_R_U_2.JPG: ZONESCAN 820 Repeater, 3-D-view 1
 153494_R_U_3.JPG: ZONESCAN 820 Repeater, 3-D-view 2
 153494_R_U_3.JPG: ZONESCAN 820 Repeater, type plate view

Annex C

Internal photographs

24 pages

153494_I_U_4.JPG: ZONESCAN 820 Logger with integrated antenna, internal view 1
153494_I_U_5.JPG: ZONESCAN 820 Logger with integrated antenna, internal view 2
153494_I_U_6.JPG: ZONESCAN 820 Logger with integrated antenna, disassembled 1
153494_I_U_7.JPG: ZONESCAN 820 Logger with integrated antenna, disassembled 2
153494_I_U_10.JPG: ZONESCAN 820 Logger with integrated antenna, PCB, top view
153494_I_U_9.JPG: ZONESCAN 820 Logger with integrated antenna, PCB, bottom view
153494_X_U_4.JPG: ZONESCAN 820 Logger with external antenna port, internal view 1
153494_X_U_5.JPG: ZONESCAN 820 Logger with external antenna port, internal view 2
153494_X_U_6.JPG: ZONESCAN 820 Logger with external antenna port, disassembled 1
153494_X_U_7.JPG: ZONESCAN 820 Logger with external antenna port, disassembled 2
153494_X_U_9.JPG: ZONESCAN 820 Logger with external antenna port, PCB, top view
153494_X_U_8.JPG: ZONESCAN 820 Logger with external antenna port, PCB, bottom view
153494_E_U_16.JPG: EASYSCAN SENSOR, internal view 1
153494_E_U_13.JPG: EASYSCAN SENSOR, internal view 2
153494_E_U_5.JPG: EASYSCAN SENSOR, internal view 3
153494_E_U_6.JPG: EASYSCAN SENSOR, disassembled 1
153494_E_U_7.JPG: EASYSCAN SENSOR, disassembled 2
153494_E_U_12.JPG: EASYSCAN SENSOR, PCB, top view
153494_E_U_11.JPG: EASYSCAN SENSOR, PCB, bottom view
153494_R_U_4.JPG: ZONESCAN 820 Repeater, internal view 1
153494_R_U_5.JPG: ZONESCAN 820 Repeater, internal view 2
153494_E_U_8.JPG: ZONESCAN 820 Repeater, disassembled
153494_R_U_9.JPG: ZONESCAN 820 Repeater, PCB, top view
153494_R_U_11.JPG: ZONESCAN 820 Repeater, PCB, bottom view