

Test Report

Report Number:

F181805E4

Equipment under Test (EUT):

HISCAN

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

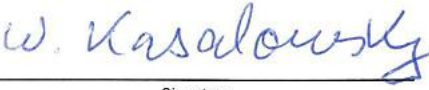

References

- [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 2 (February 2017)** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- [4] **RSS-Gen Issue 5 (April 2018)** General Requirements for Compliance 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.

Tested and written by:	Wolfgang KASALOWSKY		21.01.2019
	_____ Name	_____ Signature	_____ Date
Reviewed and approved by:	Bernd STEINER		21.01.2019
	_____ Name	_____ Signature	_____ Date

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1 Identification

1.1 Applicant

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Applicant represented during the test by the following person:	Mr. Carles Estellers, Mr. Stefan LANG

1.2 Manufacturer

Name:	Gutermann Technology GmbH
Address:	Gottlieb Daimler Straße 10 88214 Ravensburg
Country:	Germany
Name for contact purposes:	Mr. Erwin Glashauser
Phone:	+49 751 35 90 16 - 82
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eMail Address:	erwin.glashauser@gutermann-water.com
Applicant represented during the test by the following person:	Mr. Carles Estellers, Mr. Stefan LANG

1.3 Test laboratory

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

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02, FCC Test Firm Accreditation with the registration number 469623, designation number DE0004 and Industry Canada Test site registration SITE# IC3469A-1.

1.4 EUT (Equipment Under Test)

Equipment under test	
Test object: *	Correlating Hydrophone Sensor
Type / PMN: *	HISCAN
Model name / HVIN: *	HS501
FCC ID:*	ZSSHISCAN915V1
IC: *	9789A-HISCAN915V1
Serial number: *	4500001
PCB identifier: *	HS10b
Hardware version: *	01
Software version / FVIN: *	22.18
Lowest internal frequency: *	32.768 kHz

* declared by the applicant.

Note: Phoenix Testlab GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

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

Technical data of equipment					
Rated RF output power: *	16 dBm				
Antenna type: *	GT-ANT01 (dedicated antenna)				
Antenna gain: *	-0.4 dBi				
Antenna connector: *	RP-TNC				
Adaptive frequency agility: *	No				
Modulation: *	FHSS (FSK)				
Supply Voltage: *	U _{nom} =	3.6 V DC	U _{min} =	3.1 V DC	U _{max} = 3.8 V DC
Temperature range: *	-30 °C to +70 °C				
Ancillary used for test:	External battery HSB10				

* declared by the applicant.

Ancillaries tested with:
External battery HSB10
Dedicated antenna GT-ANT01
Zonescan 820 commlink, model name: CL820-1-2-A1

Ports / Connectors			
Identification	Connector		Remark
	EUT	Ancillary	
DC power	3 pole M8 plug	3 pole M8 plug	2 m
Dedicated antenna	RP-TNC male	RP-TNC female	2 m

1.6 Dates

Date of receipt of test sample:	28.11.2018
Start of test:	28.11.2018
End of test:	30.11.2018

2 Operational states

The tested sample was unmodified and could be configured via the programming interface with the help of a laptop PC with a configuration software (LapView program), which were both supplied by the applicant. After setting the operation mode, the connection between the programming interface and the Laptop PC was disconnected. The programming interface is intended to be used for testing purposes only. Therefore it was placed outside the test environment.

The EUT uses a dedicated antenna. All radiated measurements were carried out with this antenna. The conducted measurements were carried out at the antenna port.

All radiated measurements were carried out in normal operation position of the EUT (horizontal position of connectors) and with a connection to an external power box. The dedicated antenna was connected.

The following test modes were adjusted during the tests:

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

3 Additional information

None

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 247, Issue 2 [3] or RSS-Gen, Issue 5 [4]	Status	Refer page
Bandwidth	General	15.247 (a) (1) (i)	5.1 (a) [3]	Passed	9 et seq.
Carrier frequency separation	General	15.247 (a) (1) (i)	5.1 (b) [3]	Passed	12 et seq.
Number of hopping channels	902.0 – 928.0	15.247 (a) (1) (i)	5.1 (c) [3]	Passed	14 et seq.
Dwell time	902.0 – 928.0	15.247 (a) (1) (i)	5.1 (c) [3]	Passed	16 et seq.
Maximum conducted peak output power	902.0 – 928.0	15.247 (b) (2)	5.4 (a) [3]	Passed	19 et seq.
Radiated emissions (transmitter)	0.009 - 10,000	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4] 8.10 [4]	Passed	22 et seq.
Antenna requirement	-	15.203 [2]	6.8 [4]	Passed *	-

*: The EUT is fitted with a reverse TNC antenna connector. Furthermore the dedicated antenna is defined in the user manual. Therefore the requirement is regarded as fulfilled.

5 Test results

5.1 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 according to [1] shall be used:

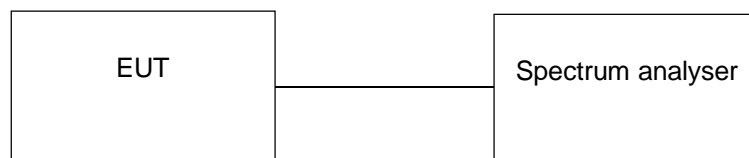
- Span: App. 2 to 5 times the OBW, centred on the actual hopping channel.
- Resolution bandwidth: 1 % to 5 % of the OBW.
- Video bandwidth: three times the resolution bandwidth.
- Set the reference level of the instrument either above the measured peak conducted output power level or as required, keeping 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.

20 dB bandwidth: 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.

99% bandwidth: Use the 99% power bandwidth function of the instrument

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

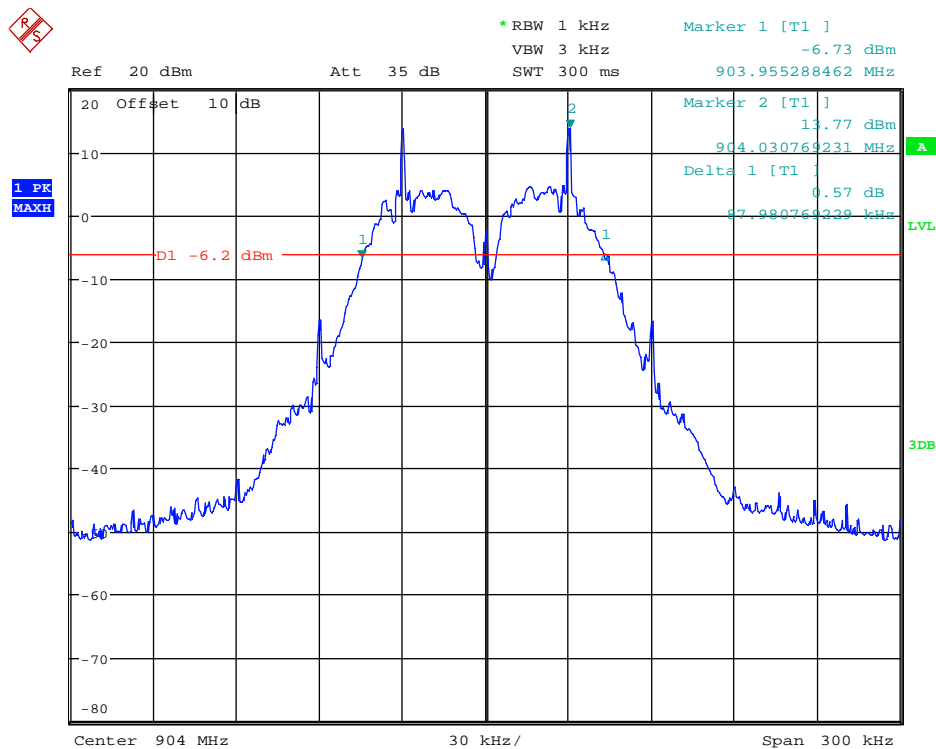
Test set-up:



5.1.2 Test results (20 dB bandwidth)

Ambient temperature	22 °C	Relative humidity	29 %
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20 dB bandwidth at the lower end of the assigned frequency band (worst case):



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
0	904.000	87.081
24	911.200	87.019
49	918.700	87.076
Measurement uncertainty		+0.66 dB / -0.72 dB

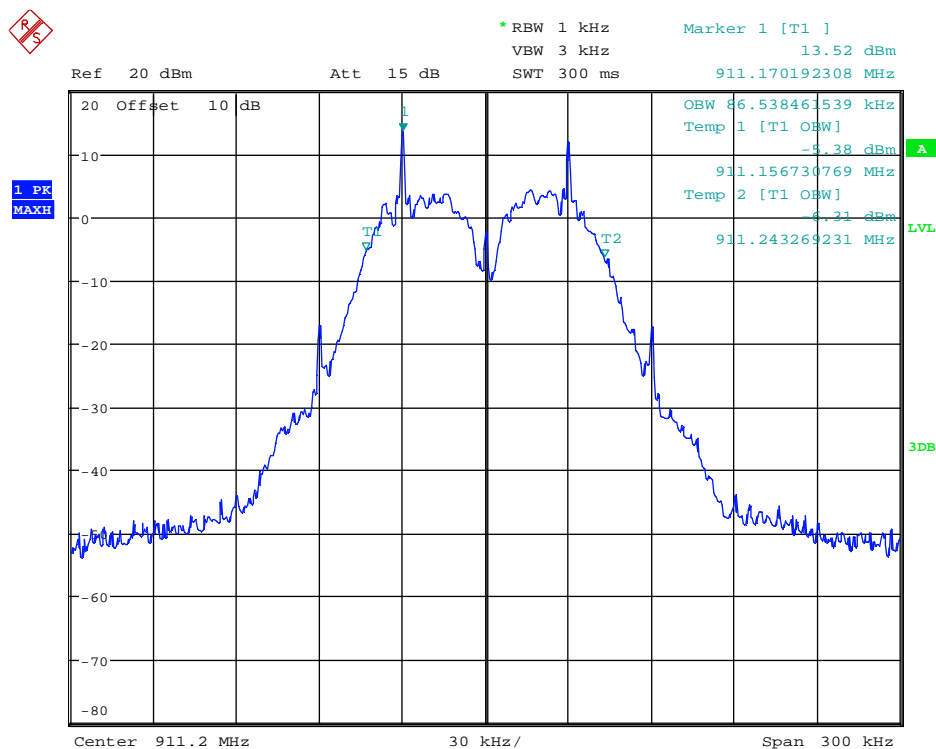
Test equipment used (see chapter 6):

10, 26

5.1.3 Test results (99 % bandwidth)

Ambient temperature	22 °C	Relative humidity	29 %
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99 % bandwidth at the middle of the assigned frequency band (worst case):



Channel number	Channel frequency [MHz]	99 % bandwidth [kHz]
0	904.000	86.538
24	911.200	86.538
49	918.700	86.538
Measurement uncertainty		+0.66 dB / -0.72 dB

Test equipment used (see chapter 6):

10, 26

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.

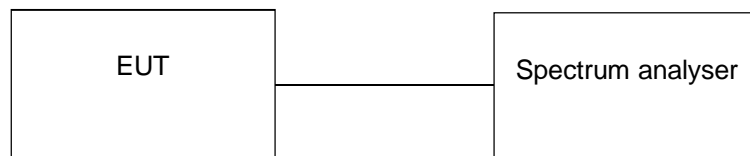
The following spectrum analyser settings according to [1] shall be used:

- 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.

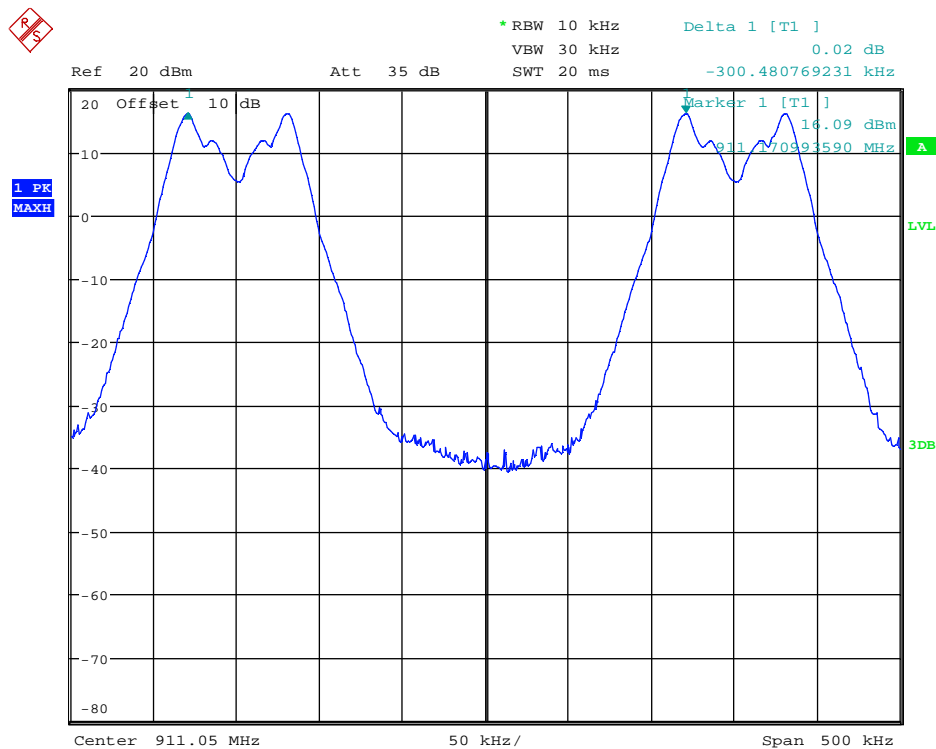
Test set-up:



5.2.2 Test results (carrier frequency separation)

Ambient temperature	22 °C	Relative humidity	29 %
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Channel separation at the middle of the assigned frequency band (worst case):



Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
0	904.000	300.481	87.081
24	911.200	300.481	87.019
49	918.700	300.481	87.076
Measurement uncertainty		<10 ⁻⁷	

Test equipment used (see chapter 6):

10, 26

5.3 Number of hopping frequencies

5.3.1 Method of measurement (number of hopping frequencies)

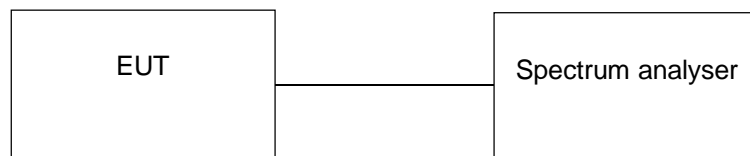
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT 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: ³ 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.

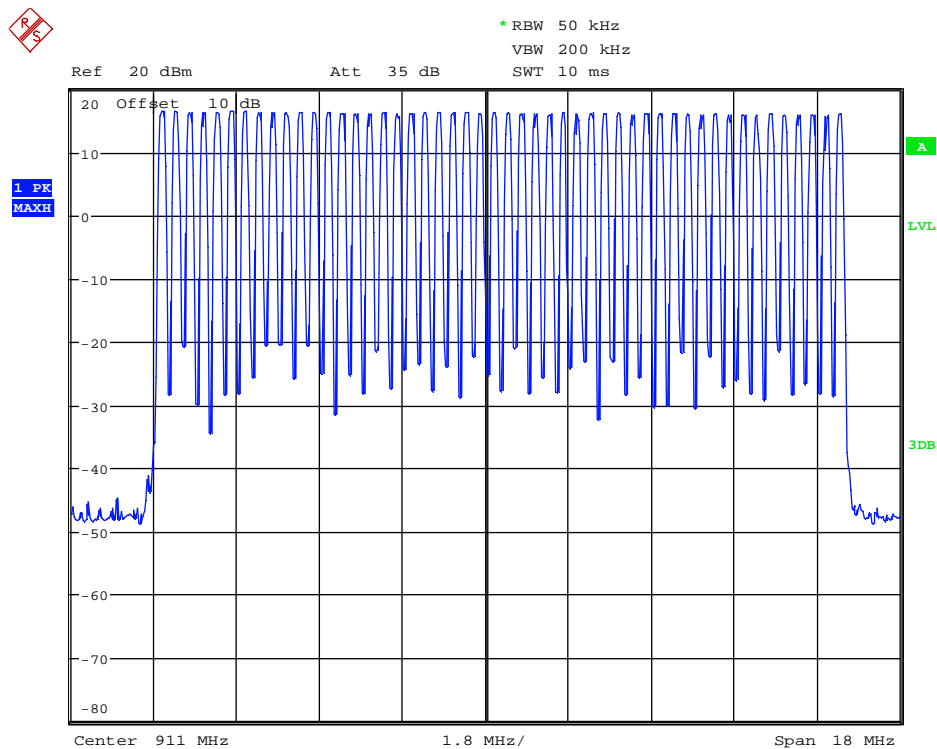
Test set-up:



5.3.2 Test results (number of hopping frequencies)

Ambient temperature	22 °C	Relative humidity	29 %
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Number of hopping channels:



Number of hopping channels	Limit
50	At least 50

Test equipment used (see chapter 6):

10, 26

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: $\frac{1}{3}$ 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.

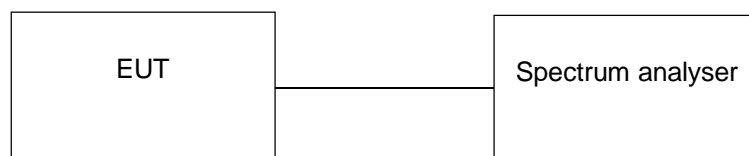
Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of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

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

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.

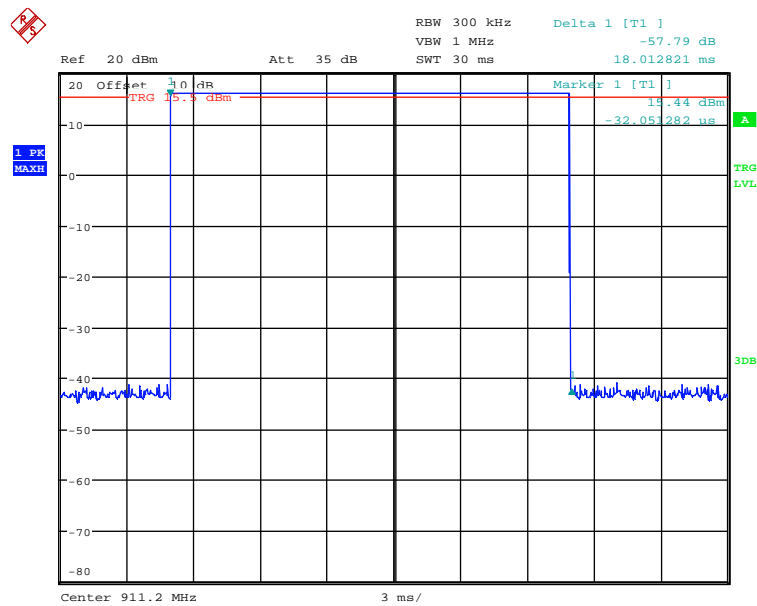
Test set-up:



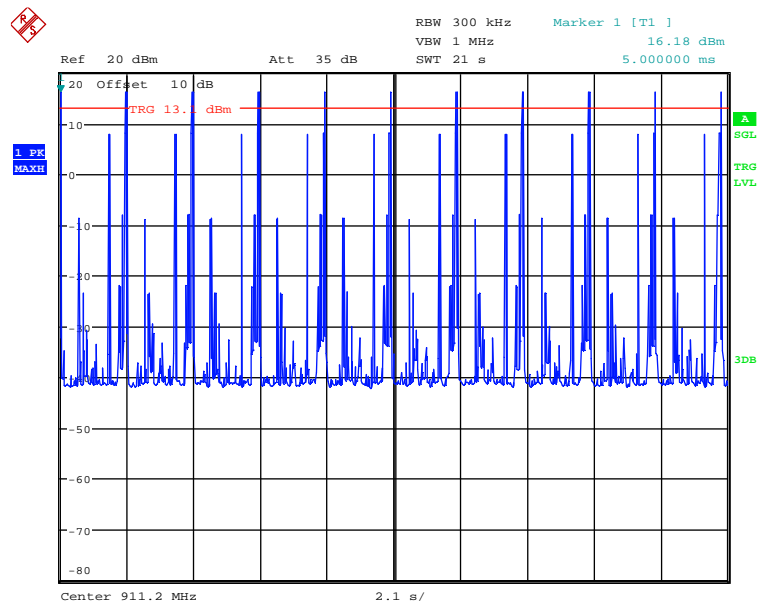
5.4.2 Test results (dwell time)

Ambient temperature	22 °C	Relative humidity	29 %
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Dwell time at the middle of the assigned frequency band (single hop):



Dwell time at the middle of the assigned frequency band (21 s sweep):



Channel number	Channel frequency [MHz]	t _{pulse} [ms]	Number of pulses	Dwell time [ms]	Limit [ms]
24	911.200	18.013	10	180.013	400.000
Measurement uncertainty				<10 ⁻⁷	

Test equipment used (see chapter 6):

10, 26

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: ³ the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

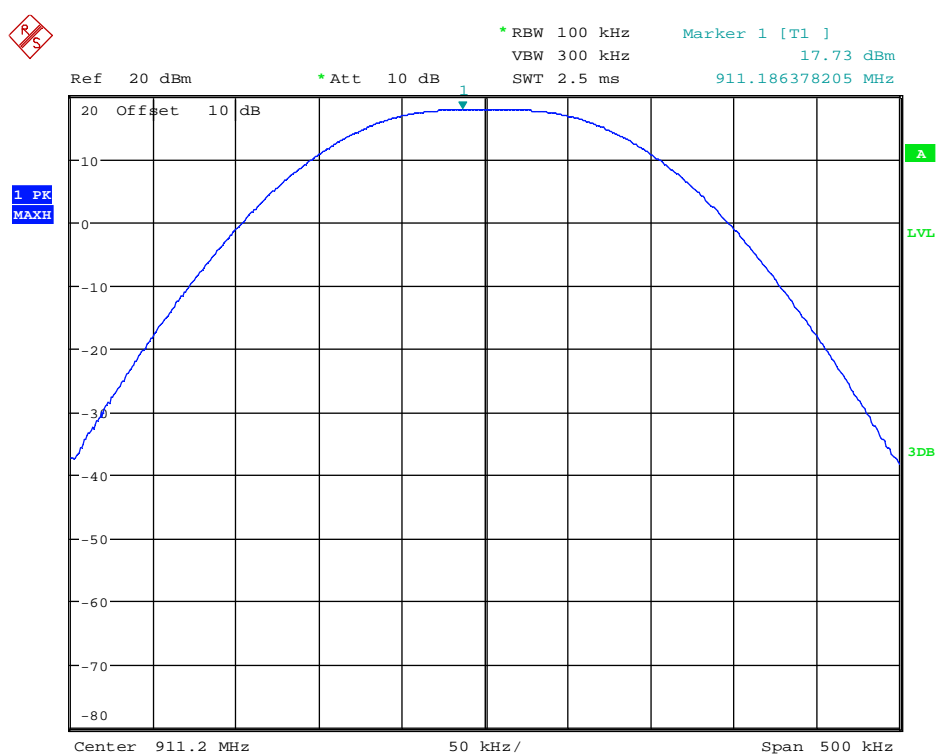
After trace stabilisation the marker shall be set on the signal peak. The indicated level is the peak output power, which has to be corrected with the value of the cable loss and an external attenuation (if necessary).

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

5.5.2 Test results (maximum peak output power)

Ambient temperature	22 °C	Relative humidity	29 %
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Maximum peak output power at the middle of the assigned frequency band (worst case):



Operation mode	Channel number	Channel frequency [MHz]	Maximum conducted peak output power [dBm]	Conducted output power limit [dBm]
1	0	904.000	17.6	30.0
2	24	911.200	17.7	30.0
3	49	918.700	17.5	30.0
Measurement uncertainty				+0.66 dB / -0.72 dB

Test equipment used (see chapter 6):

10, 26

5.6 Maximum conducted (average) output power

5.6.1 Method of measurement

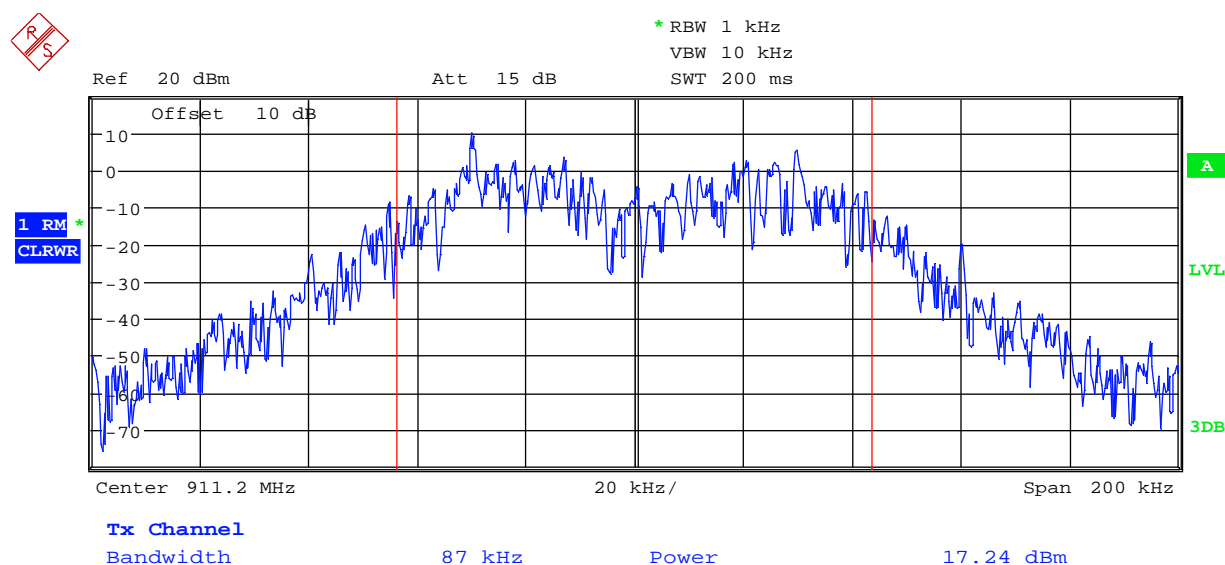
Method AVGSA-1 of [1] subclause 11.9.2.2.2 was used for the measurement.

This measurement was performed for calculation of the values for "Declaration of RF Exposure Compliance for Exemption from Routine Evaluation Limits".

5.6.2 Test results

Ambient temperature	22 °C	Relative humidity	29 %
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Maximum average output power at the middle of the assigned frequency band (worst case):



Operation mode	Channel number	Channel frequency [MHz]	Maximum conducted (average) output power [dBm]	Conducted output power limit [dBm]
1	0	904.000	17.0	30.0
2	24	911.200	17.2	30.0
3	49	918.700	17.2	30.0
Measurement uncertainty				+0.66 dB / -0.72 dB

Test equipment used (see chapter 6):

10, 26

5.7 Radiated emissions

5.7.1 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 side without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna 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.

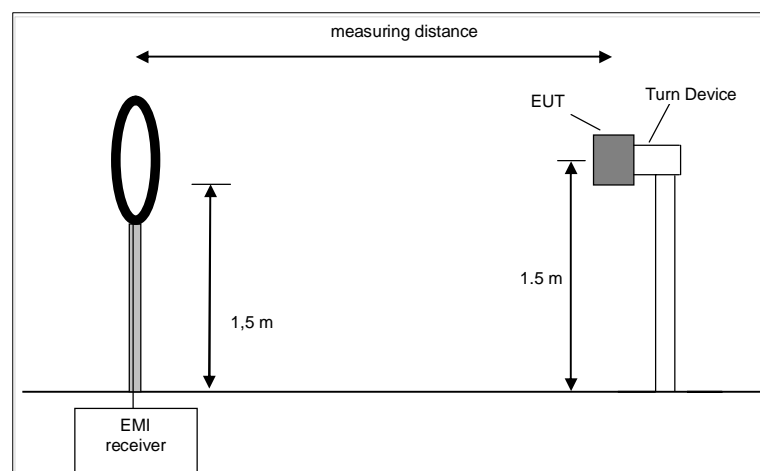
Preliminary measurement (9 kHz to 30 MHz):

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).

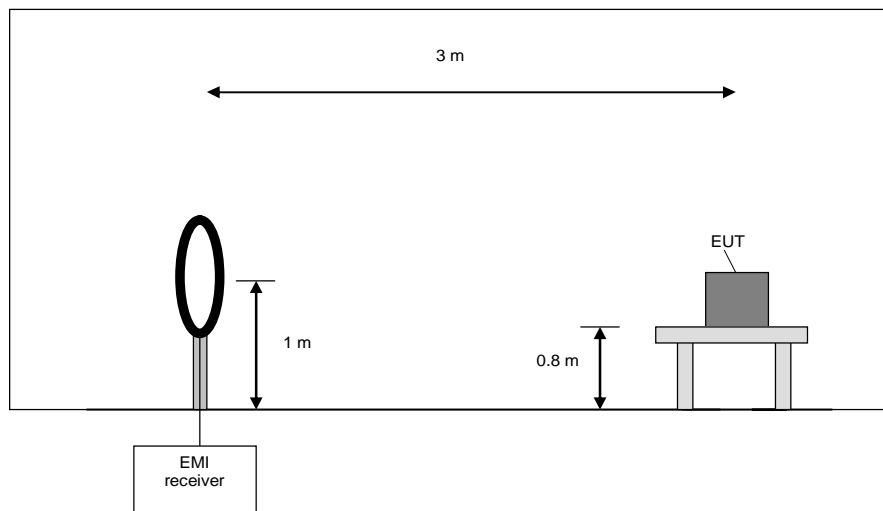
Final measurement (9 kHz to 30 MHz):

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).

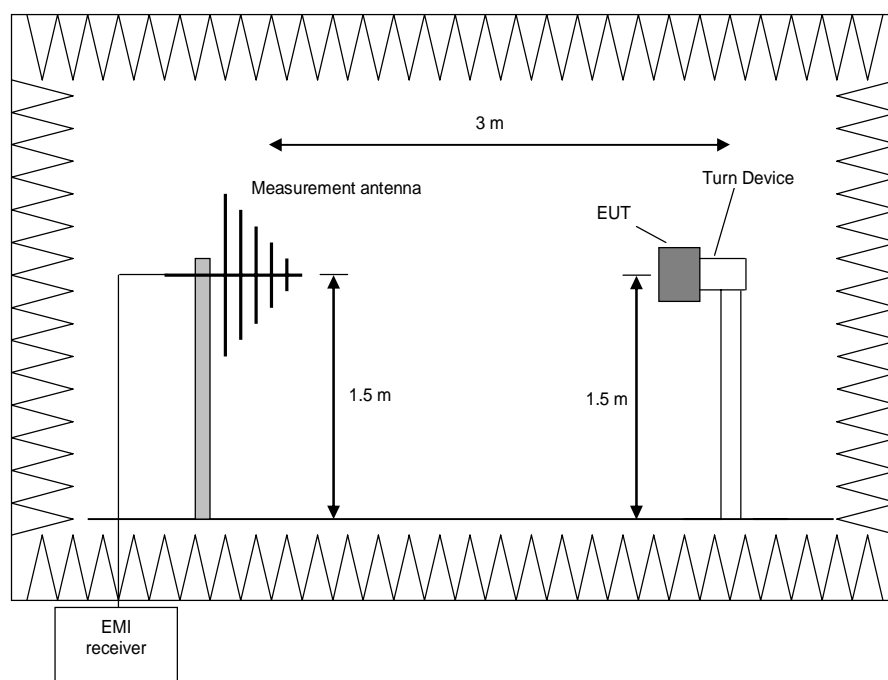
Preliminary measurement (30 MHz to 1 GHz)

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:

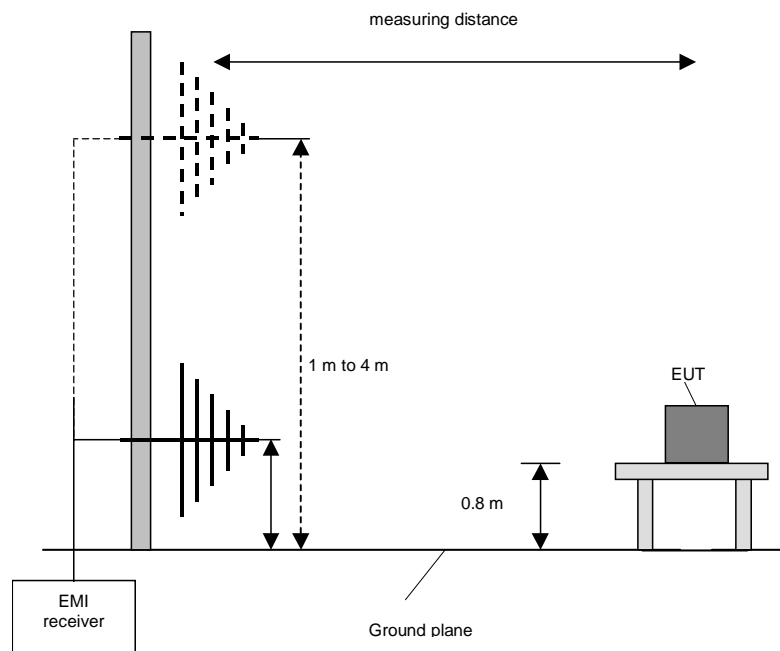
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarisation of the measuring 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)

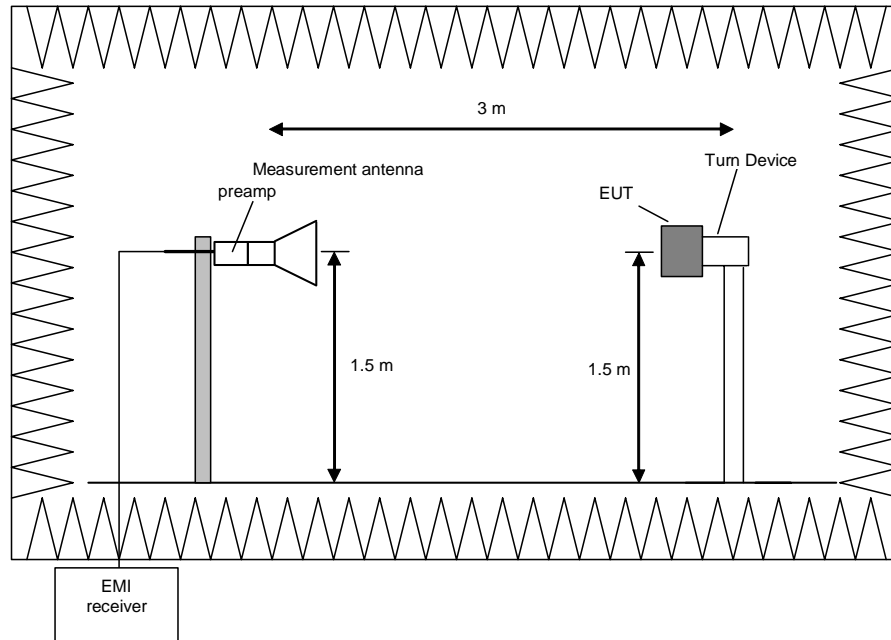
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1].

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:

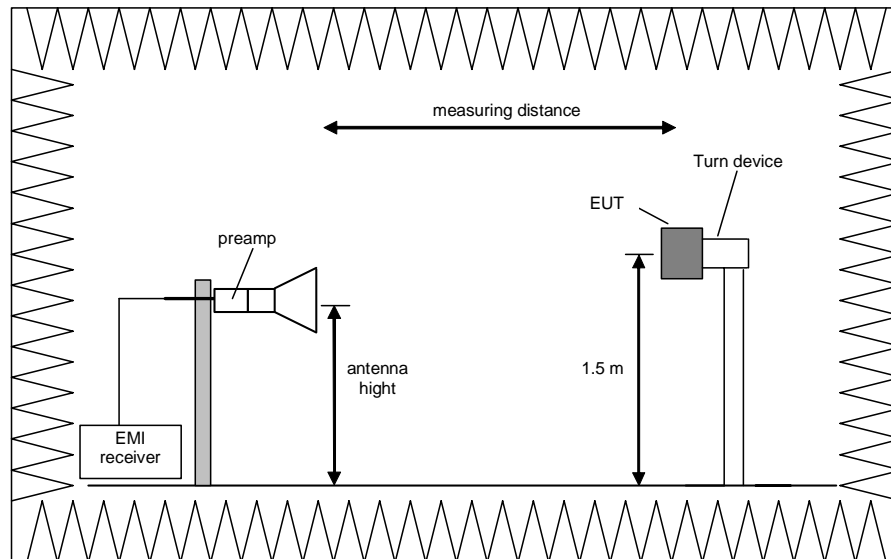
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0°.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle 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.

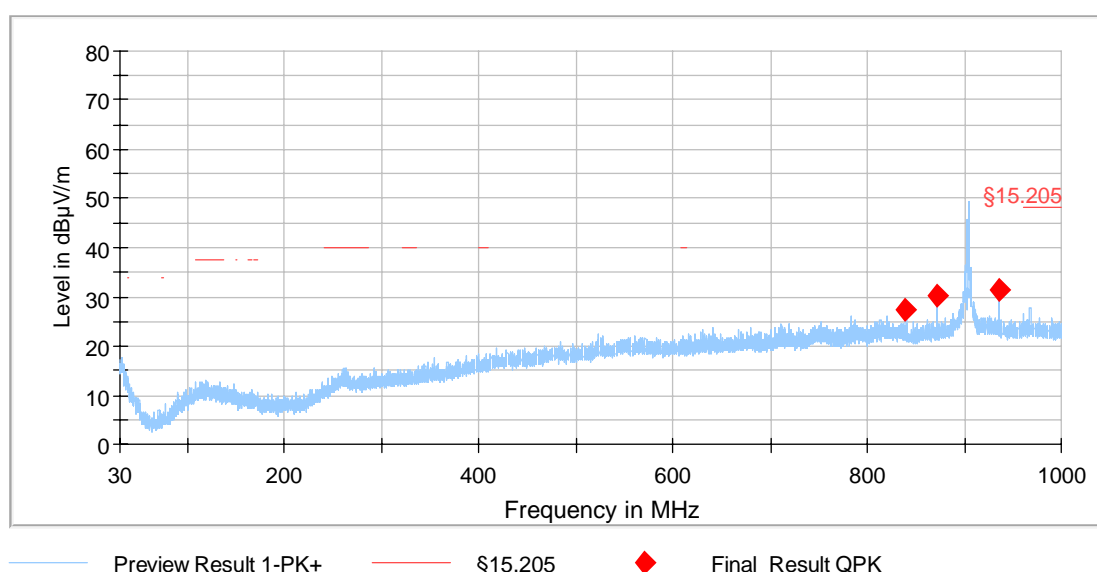
5.7.2 Test results (radiated emissions)

5.7.2.1 Preliminary radiated emission measurement

Ambient temperature	22 °C	Relative humidity	22 %
Position of EUT:	The EUT was set-up on the positioner at 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 with 3.6 V DC by the external battery HSB10.		
Frequency range:	The preliminary measurement was carried out in the frequency range 9 kHz to 10 GHz according to [2].		
Remark:	<ol style="list-style-type: none"> 1. 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 operating in operation mode 2. 2. In the frequency range 30 MHz to 1 GHz the fundamental was notched with suitable filter to avoid overloading. 3. Above 1GHz a high pass was used. 		

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

Spurious emissions from 30 MHz to 1 GHz (operation mode 1):



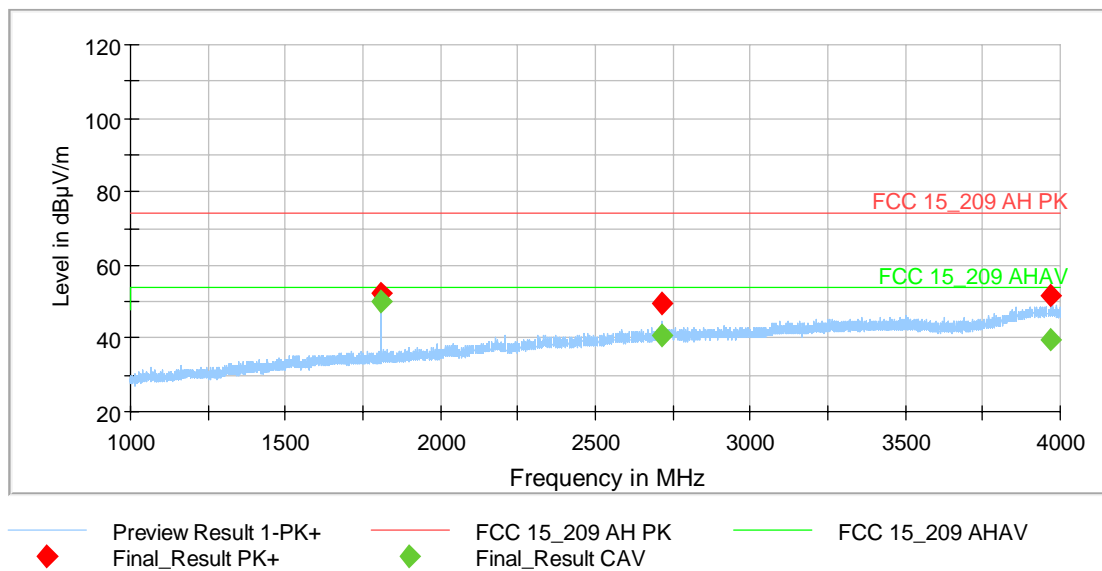
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

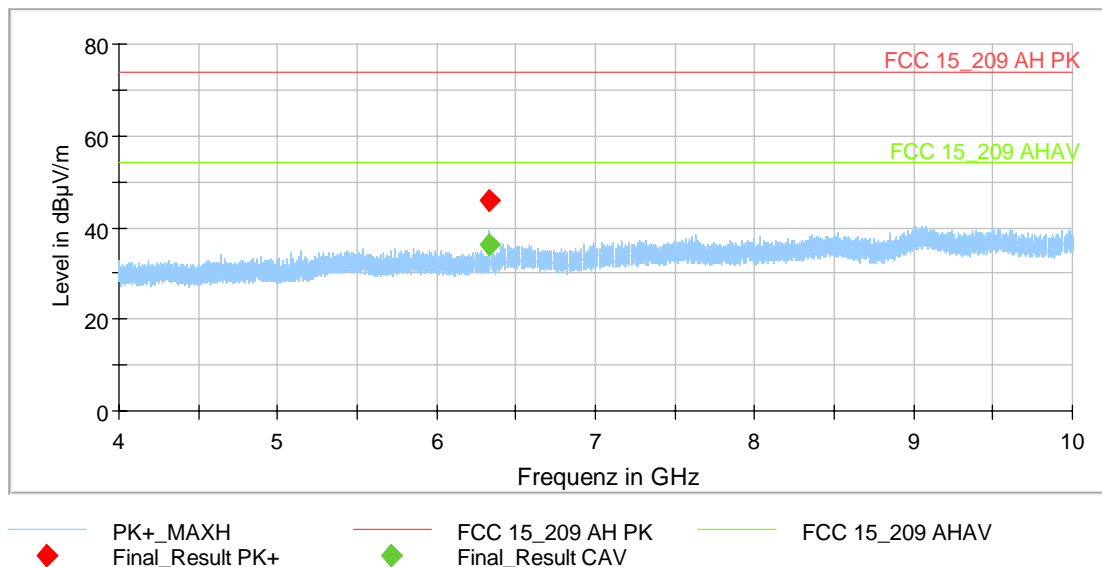
- 839.9985 MHz, 871.9600 MHz and 936.0285 MHz.

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

Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



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, 3969.700 MHz and 6327.767 MHz

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

- 2711.900 MHz

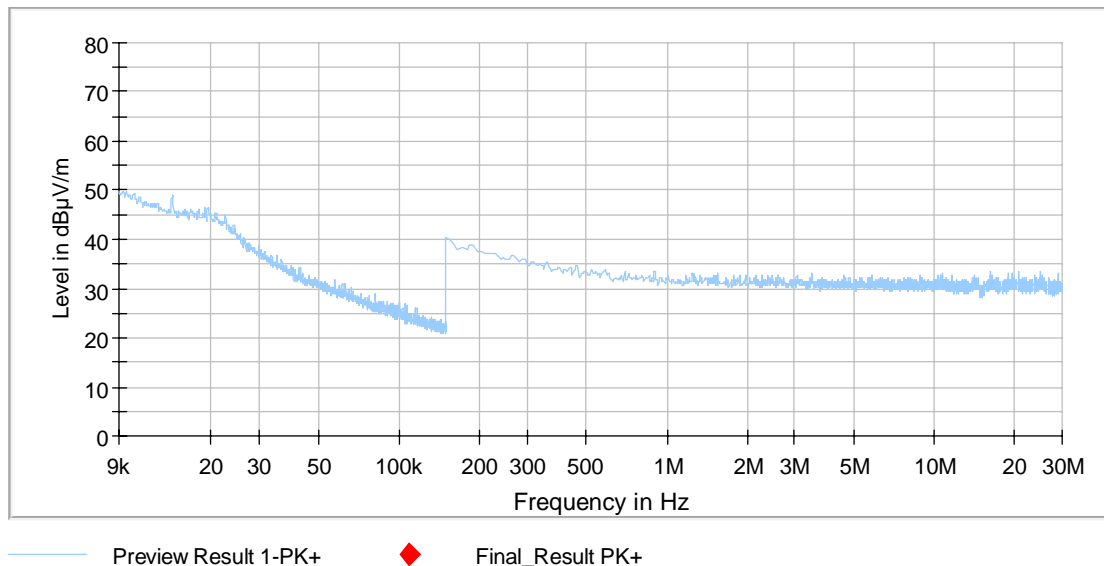
These frequencies have to be measured in a final measurement. The results were presented in the following.

Test equipment used (see chapter 6):

7, 9, 11 - 21, 22 - 25

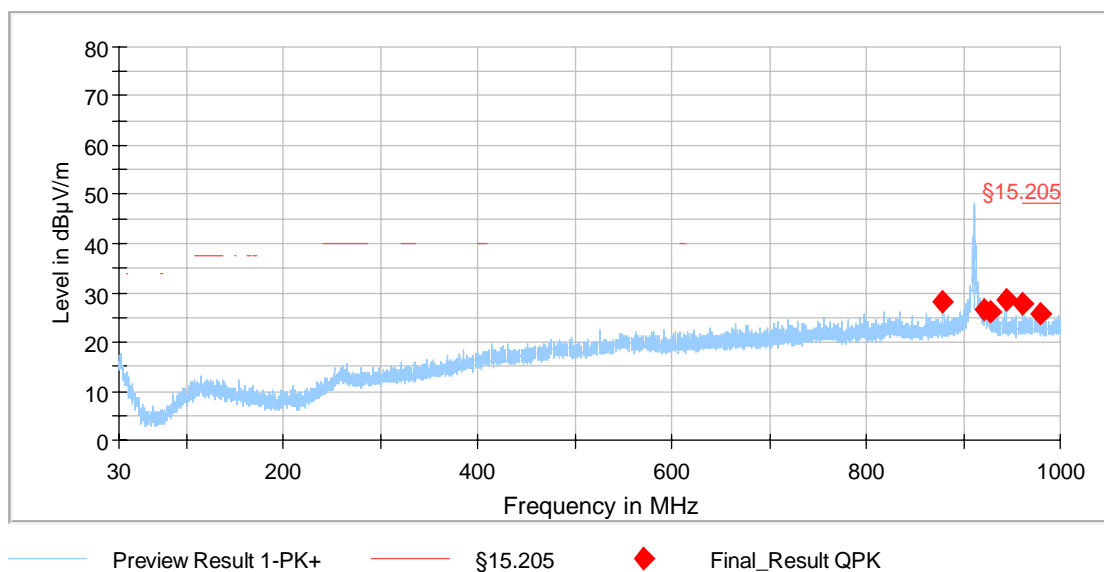
Transmitter operates on the middle of the assigned frequency band (operation mode 2)

Spurious emissions from 9 kHz to 30 MHz (operation mode 2):



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

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



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

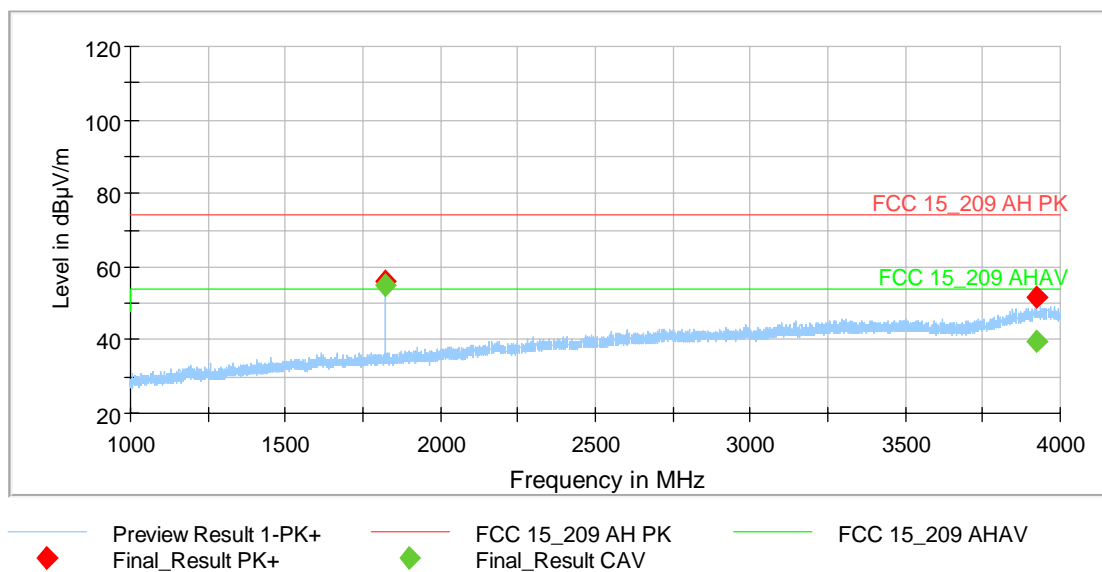
- 979.969 MHz

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

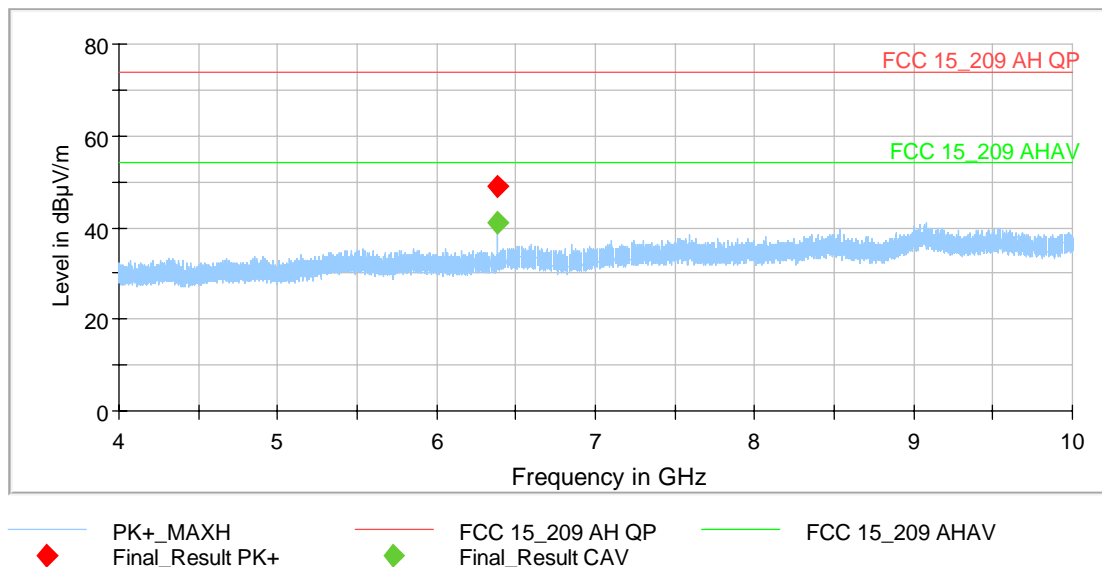
- 879.1865 MHz, 921.139 MHz, 928.0745 MHz, 943.255 MHz and 959.9875 MHz

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

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



Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



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

- 3924.550 MHz

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

- 1822.450 MHz and 6378.500 MHz

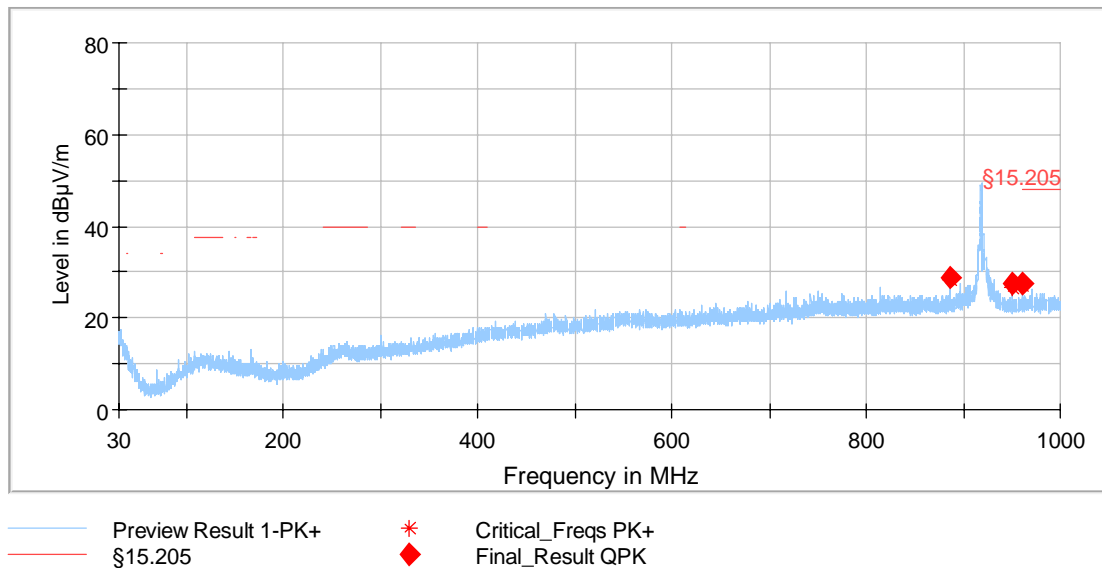
These frequencies have to be measured in a final measurement. The results were presented in the following.

Test equipment used (see chapter 6):

7, 9, 11 - 21, 22 - 25

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

Spurious emissions from 30 MHz to 1 GHz (operation mode 3):



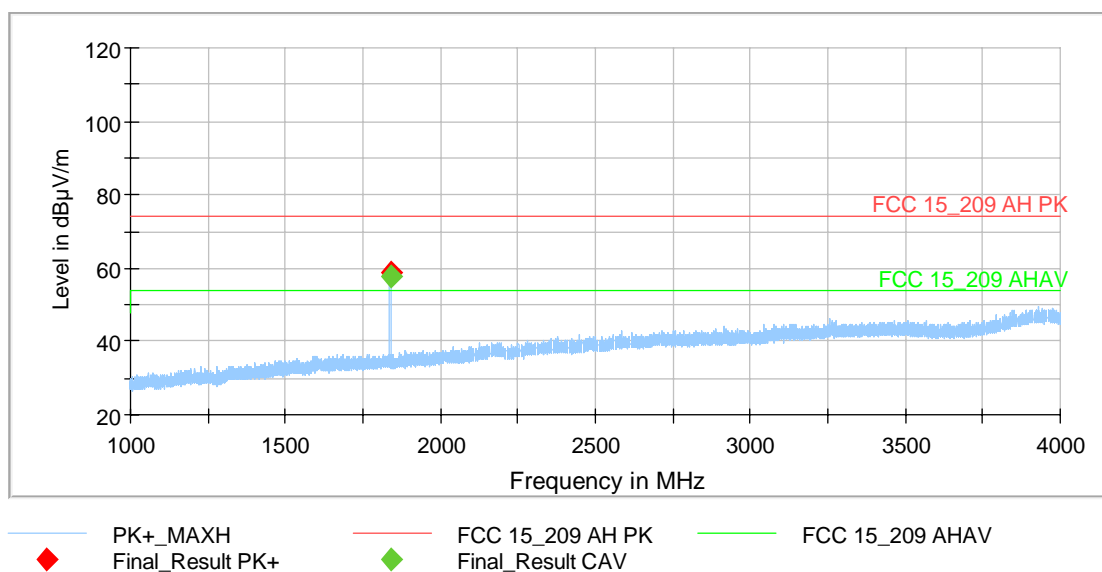
No frequency was found inside the restricted bands during the preliminary radiated emission test.

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

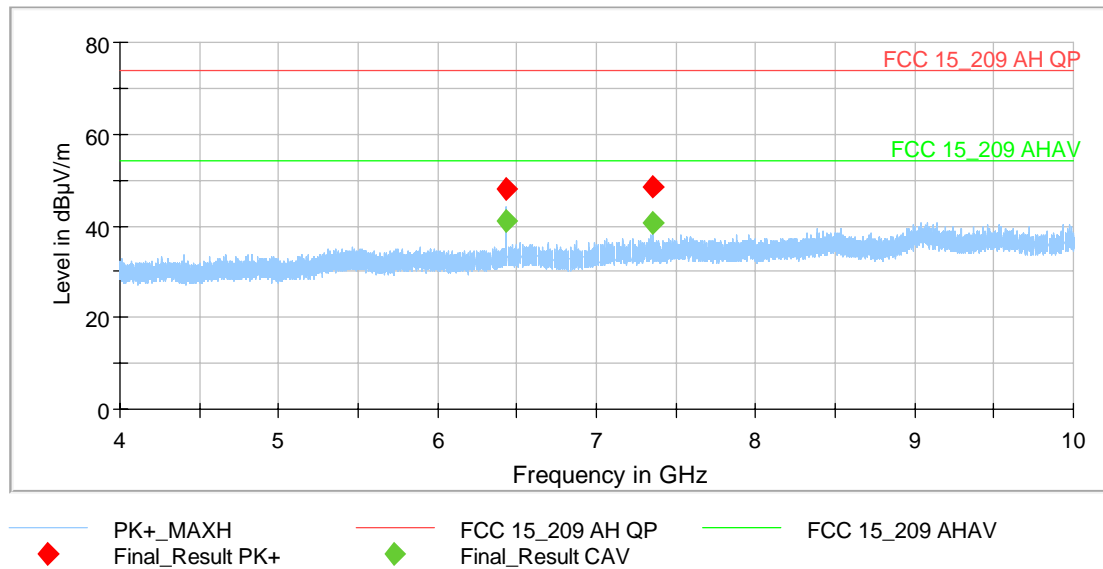
- 886.6555 MHz, 950.724 MHz and 959.9875 MHz.

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

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



Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



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

- 7349.733 MHz

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

- 1837.300 MHz and 6431.100 MHz

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

Test equipment used (see chapter 6):

7, 9, 11 - 21, 22 - 25

5.7.2.2 Final radiated emission measurement (9 kHz to 30 MHz)

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

5.7.2.3 Final radiated emission measurement (30 MHz to 1 GHz)

Ambient temperature	22 °C	Relative humidity	29 %
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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 external battery HSB10.
Test results:	The test results were calculated with the following formula:

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.

Result measured with the quasi-peak detector:

Transmitter operates on the lower end of the assigned frequency band (operation mode 1)										
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Restr. Band
839.998500	43.4	94.6	51.2	1000.0	120.000	176.0	V	284.0	33.6	N
871.960000	32.6	94.6	62.0	1000.0	120.000	107.0	V	184.0	33.2	N
904.000000	114.6	Carrier	-	1000.0	120.000	108.0	V	122.0	33.7	-
936.028500	59.1	94.6	35.5	1000.0	120.000	102.0	H	329.0	35.3	N
Transmitter operates on the middle of the assigned frequency band (operation mode 2)										
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Restr. Band
879.186500	31.1	95.7	64.6	1000.0	120.000	114.0	V	200.0	33.3	N
911.200000	115.7	Carrier	-	1000.0	120.000	110.0	V	118.0	34.0	-
921.139000	30.2	95.7	65.5	1000.0	120.000	113.0	V	120.0	34.4	N
928.074500	47.1	95.7	49.6	1000.0	120.000	400.0	H	270.0	34.8	N
943.255000	30.4	95.7	65.3	1000.0	120.000	121.0	V	195.0	35.6	N
959.987500	30.4	95.7	65.3	1000.0	120.000	104.0	V	120.0	35.6	N
979.966950	22.6	54.0	31.4	1000.0	120.000	102.0	V	73.0	35.5	Y
Transmitter operates on the upper end of the assigned frequency band (operation mode 3)										
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Restr. Band
886.655500	31.7	95.9	64.2	1000.0	120.000	115.0	V	118.0	33.4	N
918.700000	115.9	Carrier	-	1000.0	120.000	104.0	V	352.0	35.1	-
950.724000	32.9	95.9	63.0	1000.0	120.000	101.0	V	70.0	35.8	N
959.987500	30.4	95.9	65.5	1000.0	120.000	111.0	V	198.0	35.6	N
Measurement uncertainty				+2.2 dB / -3.6 dB						

Test equipment used (see chapter 6):

1 - 8

5.7.2.4 Final radiated emission measurement (1 GHz to 10 GHz)

Ambient temperature	22 °C	Relative humidity	29 %
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Position of EUT: The EUT was set-up on the positioner at 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 external battery HSB10.

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

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

Frequency [MHz]	MaxPeak [dBμV/m]	CAverage [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Pol	Azimuth [deg]	Elevation [deg]	Corr. [dB/m]	Restr. Band
1808.000	52.2	---	94.6	47.4	V	221.0	150.0	30.0	No
2711.900	---	40.6	54.0	13.4	H	327.0	120.0	36.0	Yes
2711.900	49.3	---	74.0	24.7	H	327.0	120.0	36.0	Yes
3969.700	---	39.70	54.0	14.3	V	42.0	30.0	39.0	Yes
3969.700	51.7	---	74.0	22.3	V	42.0	30.0	39.0	Yes
6327.767	45.8	---	94.6	48.8	H	201.0	60.0	2.0	No
Measurement uncertainty							+2.2 dB / -3.6 dB		

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

Frequency [MHz]	MaxPeak [dBμV/m]	CAverage [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Pol	Azimuth [deg]	Elevation [deg]	Corr. [dB/m]	Restr. Band
1822.450	56.1	---	95.7	39.6	V	223.0	150.0	30.0	No
3924.550	---	39.7	54.0	14.3	H	211.0	120.0	40.0	Yes
3924.550	51.9	---	74.0	22.1	H	211.0	120.0	40.0	Yes
6378.600	48.9	---	95.7	46.8	H	202.0	60.0	2.0	No
Measurement uncertainty							+2.2 dB / -3.6 dB		

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

Frequency [MHz[]	MaxPeak [dBμV/m[]	CAverage [dBμV/m[]	Limit [dBμV/m[]	Margin [dB[]	Pol	Azimuth [deg[]	Elevation [deg[]	Corr. [dB/m[]	Restr. Band
1837.300	58.6	---	95.9	15.4	V	206.0	0.0	30.0	No
6431.100	48.2	---	74.0	25.8	V	197.0	0.0	2.0	No
7349.733	48.4	---	74.0	25.6	V	163.0	150.0	5.0	Yes
7349.733	---	40.4	54.0	13.6	V	163.0	150.0	5.0	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB		

Test equipment used (see chapter 6):

9, 11 – 14, 16, 18 – 21, 23, 24

6 Test equipment used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Open area test site	-	Phoenix Test-Lab	-	480085	Calibration not necessary	
2	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	26.02.2018	02.2020
3	Controller	HD100	Deisel	100/670	480139	Calibration not necessary	
4	Turntable	DS420HE	Deisel	420/620/80	480087	Calibration not necessary	
5	Antenna support	AS615P	Deisel	615/310	480086	Calibration not necessary	
6	Antenna	CBL6111 D	Chase	25761	480894	19.10.2017	10.2020
7	EMI Software	EMC 32	Rohde & Schwarz	100061	481022	Calibration not necessary	
8	6 dB attenuator	R412706000	Radiall	9833	410082	Calibration not necessary	
9	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Calibration not necessary	
10	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	31.10.2018	10.2019
11	Spectrum analyzer	ESW	Rohde & Schwarz	101635	482467	29.03.2018	03.2019
12	Controller	MCU	Maturo	MCU/043/971107	480832	Calibration not necessary	
13	Turntable	DS420HE	Deisel	420/620/80	480315	Calibration not necessary	
14	Antenna support	AS615P	Deisel	615/310	480187	Calibration not necessary	
15	Antenna	CBL6112 B	Chase	2688	480328	19.06.2017	06.2020
16	Antenna	HL50	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
17	RF-cable No. 36	Sucoflex 106B	Suhner	0587/6B	480865	Calibration not necessary	
18	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Calibration not necessary	
19	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Calibration not necessary	
20	Preamplifier 100 MHz to 16 GHz	AFS6	Narda MITEQ	-	482333	10.07.2018	07.2020
21	Turn device	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
22	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	19.12.2017	12.2018
23	High Pass Filter	WHJS1000C11 /60EF	Wainwright Instruments GmbH	1	480413	Calibration not necessary	
24	High Pass Filter	WHKX4.0/18G- 8SS	Wainwright Instruments GmbH	1	480587	Calibration not necessary	
25	Tuneable Notch Filter	WRCA800/900- 0.2/40-6EEK	Wainwright Instruments GmbH	15	480414	Calibration not necessary	
26	20 dB attenuator	WA8 / 18-20-34	Weinschel	-	481450	Calibration not necessary	
27	Spectrum analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	15.03.2018	03.2020

7 Report history

Report Number	Date	Comment
F181805E4	21.01.2019	Initial document
-	-	-
-	-	-
-	-	-

8 List of annexes

Annex A	Test setup photos	5 pages
Annex B	External photos	8 pages
Annex C	Internal photos	6 pages