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Test Report

Report Number:

F170913E2

Equipment under Test (EUT):

Radar transceiver for movement detection
RMS320-343300

Applicant:

SICK AG

Manufacturer:

SICK AG

ilac-MRA

DAkkS
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-310 Issue 4 (July 2015)** Licence-Exempt Radio Apparatus: Category II 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 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

	Name	Signature	Date
Test engineer:	Thomas KÜHN		05/12/2017
Authorized reviewer:	Bernd STEINER		05/12/2017

This test report is only valid in its original form.

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.

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1 Identification

1.1 Applicant

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Country:	Germany
Name for contact purposes:	Mr. Lutz HOFFMANN
Phone:	+49 40 61 16 80 - 239
Fax:	+49 40 61 13 60 3 - 31
eMail Address:	lutz.hoffmann@sick.de
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	SICK AG
Address:	Merkurring 20 22143 Hamburg
Country:	Germany
Name for contact purposes:	Mr. Lutz HOFFMANN
Phone:	+49 40 61 16 80 - 239
Fax:	+49 40 61 13 60 3 - 31
eMail Address:	lutz.hoffmann@sick.de
Manufacturer represented during the test by the following person:	-

1.3 Test laboratory

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

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02.

1.4 EUT (Equipment Under Test)

Test object: *	Radar transceiver for movement detection
Type / PMN: *	RMS320-343300
Modelname / HVIN:*	RMS320
Order number: *	1083661
Serial number: *	17168001
PCB identifier: *	EK-Digital 2078094, EK-IO 2092886 (LPL 4093891 A, LPL 4093891 B)
Hardware version: *	Prototype
Software version: *	0.2.0.9B , Frontend FW. T0.00.19,
Type designation of the used RF-module: *	Smartmicro UMRR-0A4903-1F0902-03062
PCB identifier RF-module: *	Antenna-1Fxx02, UMR-0Axx03
Hardware version RF-module: *	DSP#0x00027FDF, RF#0x00028A58
FCC ID:*	WRMRMS320
Lowest / highest internal frequency:*	10 MHz / 24.25 GHz

*: Declared by the applicant.

1.5 Technical data of equipment

Receiver class: *	2					
Rated RF output power: *	+12.7 dBm EIRP					
Number of channels: *	One					
Channel spacing: *	None					
Antenna gain: *	13.7 dBi					
Antenna type: *	Internal patch antenna (part of the RF-module)					
Frequency range: *	24.050 GHz to 24.250 GHz					
Modulation: *	FMCW					
Bit rate of transmitter: *	None					
Supply Voltage: *	U_{Nom} =	24.0 V DC	U_{Min}=	9.0 V DC	U_{Max}=	36.0 V DC
Power Supply: *	External by switch mode auxiliary supply					
Temperature range: *	-40 °C to +65 °C					
Ancillaries to be tested with:	AC/DC adaptor type PHOENIX CONTACT MINI-PS-100-240AC/24DC/1.3 for AC power line conducted test					

*: Declared by the applicant.

Ports/Connectors

Identification	Connector		Length
	EUT	Ancillary	
Power	5 pole M12 connector	-	2.5 m
Ethernet	4 pole M12 connector	-	Not used
I/O	8 pole M12 connector	-	Not used
-	-	-	-

*: Length during the test

1.6 Dates

Date of receipt of test sample:	04/28/2017
Start of test:	05/03/2017
End of test:	05/09/2017

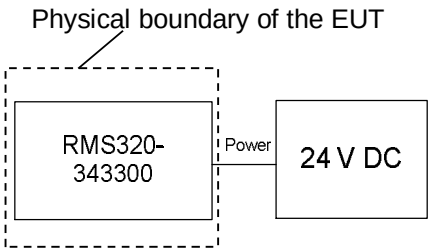
2 Operational states

The EUT is a radar transceiver sensor module for movement detection intended to be used in several applications. It is equipped with an Ethernet port and several I/O ports and a CAN interface.All tests were carried out with an unmodified sample with integral antenna.

During all tests the EUT was supplied with 24 V DC by an external power supply.

The EUT could be mounted in several positions. The worst case position for the radiated spurious emissions was with the antenna patch shows to the measuring antenna. For details refer also the annex A of this test report.

The physical boundaries of the Equipment Under Test are shown below.



3 Additional information

The tested sample was not labeled with the final label version.

4 Test overview

Application	Frequency range	FCC 47 CFR Part 15 section [2]	RSS 310, Issue 4 [3] and RSS-Gen, Issue 4 [4]	Status	Refer page
Bandwidth	24.000 GHz to 24.250 GHz	15.215 (c)	6.6 [4]	Passed	8 et seq.
Band edge compliance	24.000 GHz to 24.250 GHz	15.215 (c)	-	Passed	10 et seq.
Field strength of fundamental	24.000 GHz to 24.250 GHz	15.249 (a)	3.10 [3]	Passed	15 et seq.
Field strength of harmonics	25 GHz to 110 GHz	15.249 (a)	3.10 [3]	Passed	15 et seq.
Emissions outside the specified bands	1 MHz to 110 GHz	15.205 (a), 15.209 (a), 15.249 (d) 15.249 (e)	8.10 [4] 3.10 [3]	Passed	15 et seq.
Conducted emissions	150 kHz to 30 MHz	15.207	8.8 [4]	Passed	30 et seq.
Antenna requirement	-	15.203 [2]	-	Passed *	-

*: Integrated antenna only, requirement fulfilled.

5 Test results

5.1 Bandwidth

5.1.1 Method of measurement (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 or a test fixture shall be used. The EUT has to be switched on, the transmitter shall work with its maximum data rate.

The following spectrum analyser settings shall be used:

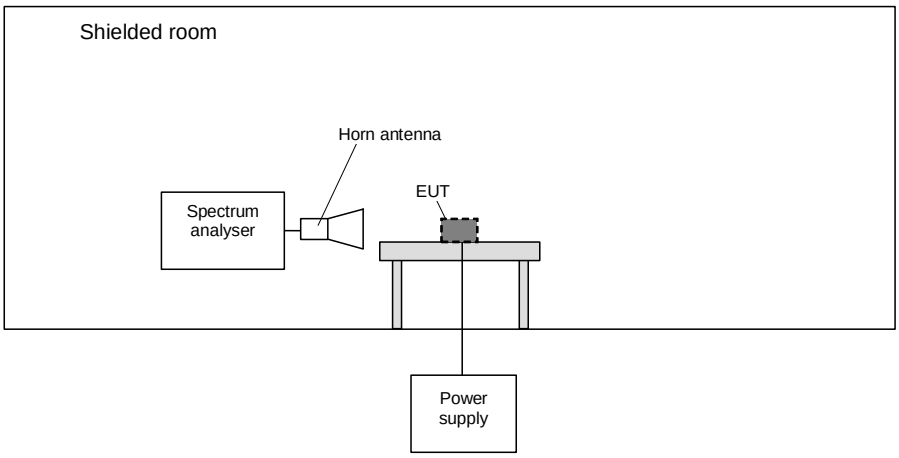
- Span: App. 2 to 3 times the 20 dB bandwidth, centred on the actual channel.
- Resolution bandwidth: App. 1 % of the emission bandwidth.
- Video bandwidth: equal or greater than the RBW.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

<u>20 dB bandwidth:</u>

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.

<u>99 % bandwidth:</u>

After trace stabilisation the marker shall be set on the signal peak. Use the 99 % bandwidth functionality of the spectrum analyser to integrate the requested bandwidth.



5.1.2 Test results (20 dB bandwidth)

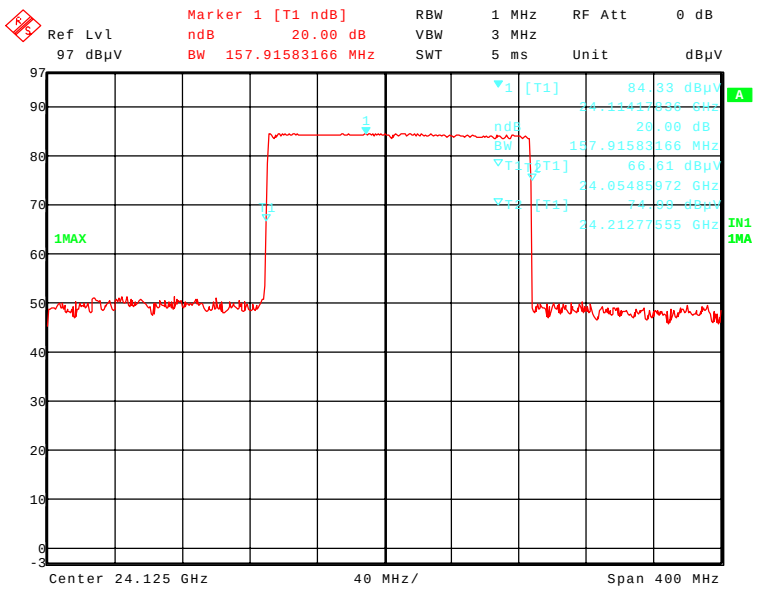
Ambient temperature	22 °C

Relative humidity	32 %

Position of EUT: The EUT was set-up 30 cm in front of the measuring antenna

Supply voltage: During all measurements the EUT was directly supplied with 24.0 V_{DC} by an external power supply.

170913_107.wmf: 20 dB bandwidth:



F_L	F_U	BW (F_U - F_L)
24.05485972 GHz	24.21277555 GHz	157.91583 MHz
Measurement uncertainty		$< \pm 1*10^{-7}$

Test: Passed

Test equipment used (refer clause 6):

6, 7, 17, 25

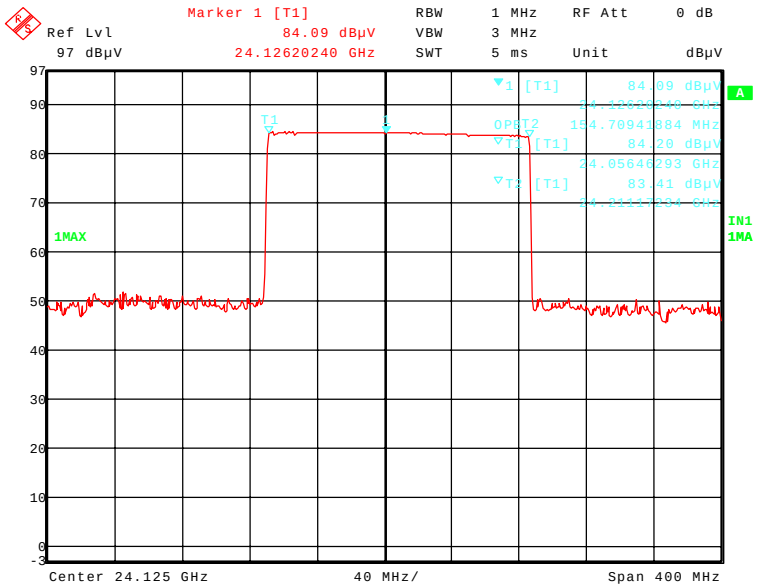
5.1.3 Test results (99 % bandwidth)

Ambient temperature	22 °C	Relative humidity	32 %

Position of EUT: The EUT was set-up 30 cm in front of the measuring antenna

Supply voltage: During all measurements the EUT was directly supplied with 24.0 V_{DC} by an external power supply.

170913_108.wmf: 99 % bandwidth:



F_L	F_U	BW (F_U - F_L)
24.05646293 GHz	24.21117234 GHz	154.70942 MHz
Measurement uncertainty		$< \pm 1*10^{-7}$

Test: Passed

Test equipment used (refer clause 6):

6, 7, 17, 25

5.2 Band-edge compliance

5.2.1 Method of measurement (band-edge compliance)

The same test set-up as used for the final radiated emission measurement shall be used.
The measurements shall be carried out with using a resolution bandwidth of 100 kHz.

The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peak level of the emission on the channel closest to the band-edge, as well as any modulation products, which fall outside the assigned frequency band.
- Resolution bandwidth: 100 kHz.
- Video bandwidth: ³ the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

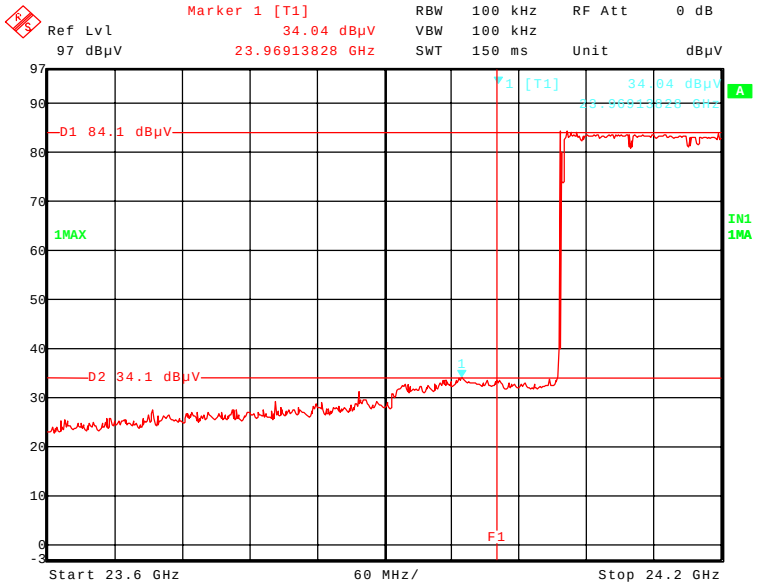
After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 50 dB below the first line (or the peak marker). The frequency line shall be set on the edge of the assigned frequency band. Set the second marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge. This frequency shall be measured with the EMI receiver as described in subclause 5.3.1 of this test report, but 100 kHz resolution bandwidth shall be used.

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

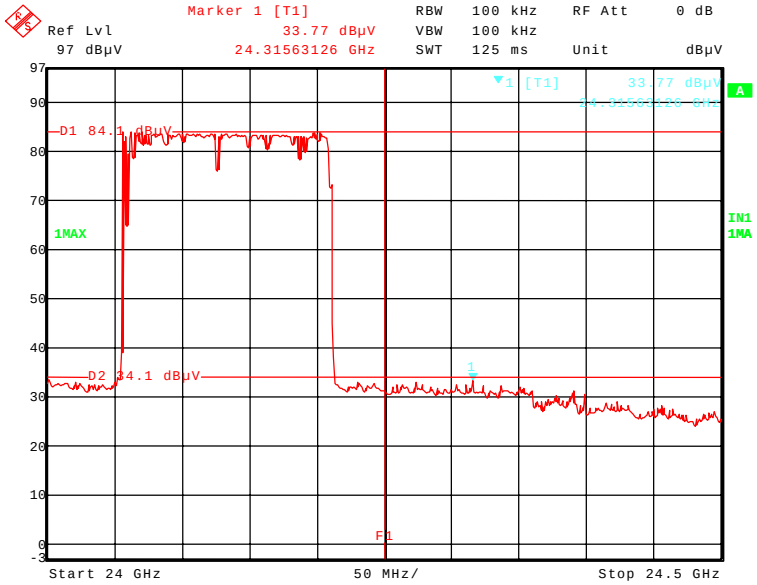
5.2.2 Test results (band-edge compliance)

Ambient temperature	22 °C	Relative humidity	32 %

170913_109.wmf: Band-edge compliance, lower band edge:



170913_110.wmf: Band-edge compliance, upper band edge:



The plots on the page before are showing the band-edge compliance for the lower and upper band-edge.
The display line 1 (D1) in these plots represents the highest level within the assigned frequency band.
The display line 2 (D2) represents the -50 dB offset to this highest level and shows the compliance with FCC 47 CFR Part 15.249 (d). The frequency line 1 (F1) shows the edge of the assigned frequency.

15.215 (c)

Band-edge compliance (lower band edge)										
Result measured with the peak detector:										
Frequency GHz	Result dBµV/m	Limit (3 m) dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Corr. [dB] / measuring distance [cm]	Restr. Band	Pos.
23.969138	54.5	74.0	19.5	32.4	37.3	0.0	4.8	-20.0 / 30 cm	Yes	1
Result measured with the average detector:										
Frequency GHz	Result dBµV/m	Limit (3 m) dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Corr. [dB] / measuring distance [cm]	Restr. Band	Pos.
23.969138	31.3	54.0	22.7	9.2	37.3	0.0	4.8	-20.0 / 30 cm	Yes	1
Measurement uncertainty							-3.6 dB / +2.2 dB			

Band-edge compliance (upper band edge)										
Result measured with the peak detector:										
Frequency GHz	Result dBµV/m	Limit (3 m) dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Corr. [dB] / measuring distance [cm]	Restr. Band	Pos.
24.315631	52.8	74.0	21.2	30.7	37.3	0.0	4.8	-20.0 / 30 cm	No	1
Result measured with the average detector:										
Frequency GHz	Result dBµV/m	Limit (3 m) dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Corr. [dB] / measuring distance [cm]	Restr. Band	Pos.
24.315631	33.9	54.0	19.5	11.8	37.2	0.0	4.8	-20.0 / 30 cm	No	1
Measurement uncertainty							-3.6 dB / +2.2 dB			

Test: Passed

Test equipment used (refer clause 6):

6, 7, 17, 25

5.3 Radiated emissions

5.3.1 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 110 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.

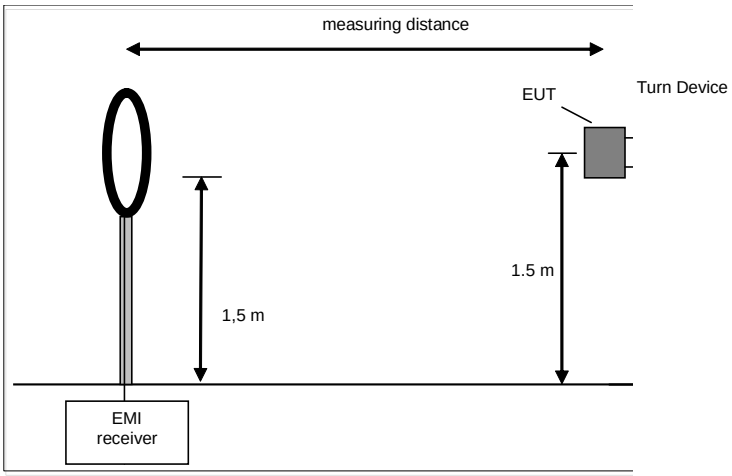
Preliminary measurement (9 kHz to 30 MHz):

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).

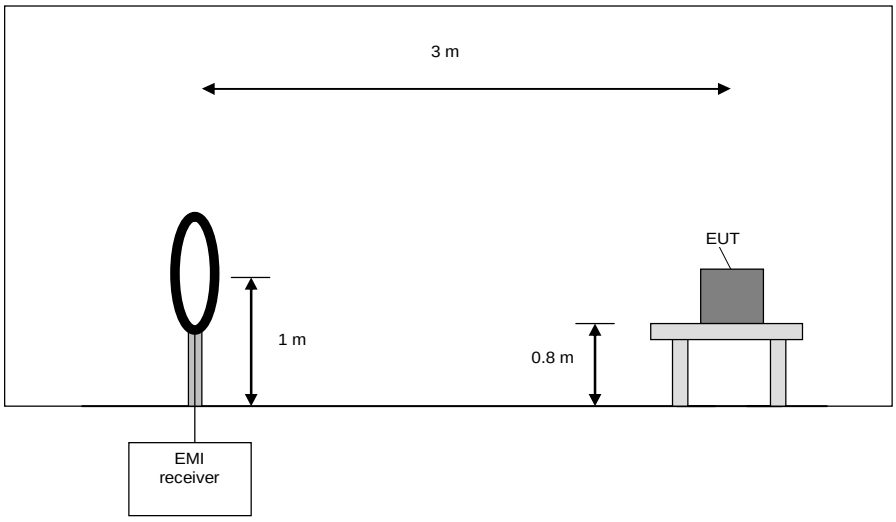
Final measurement (9 kHz to 30 MHz):

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).

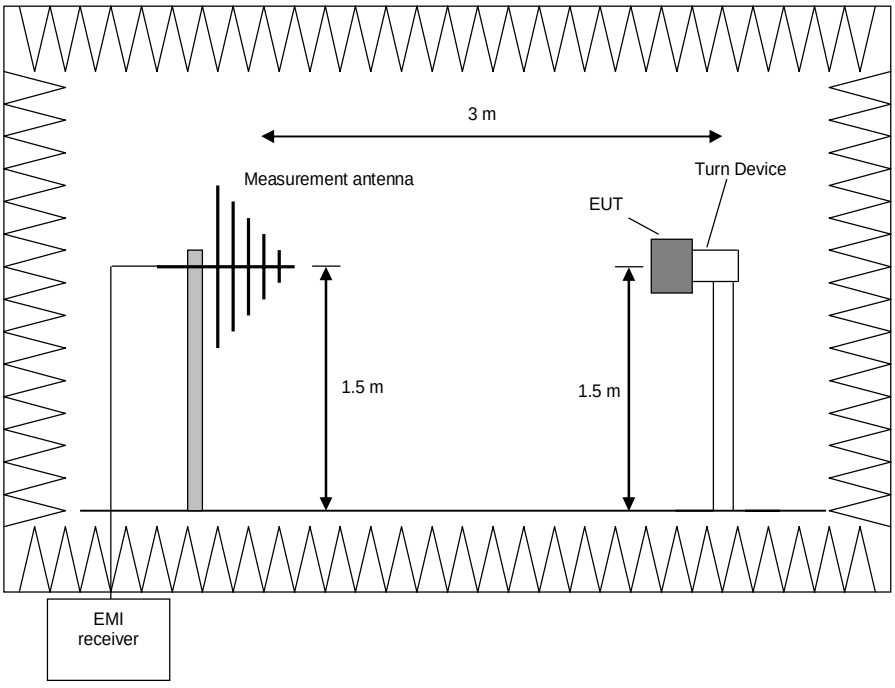
Preliminary measurement (30 MHz to 1 GHz)

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:

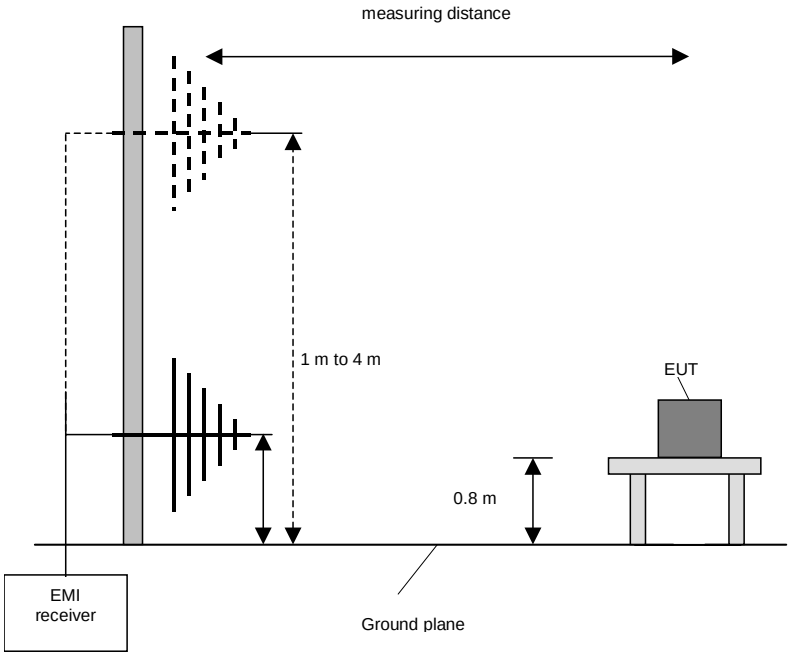
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarisation of the measuring 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 110 GHz)

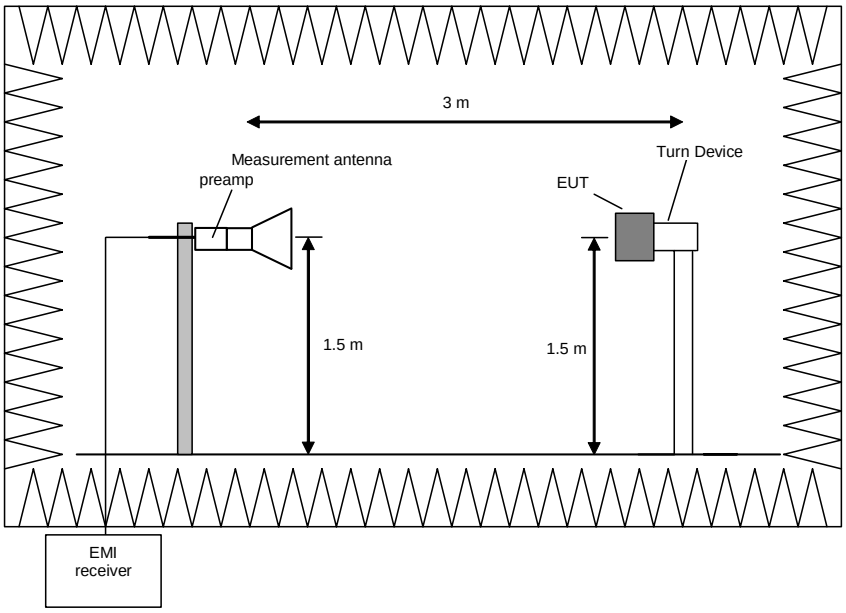
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna 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	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
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 110 GHz.
The following procedure will be used:

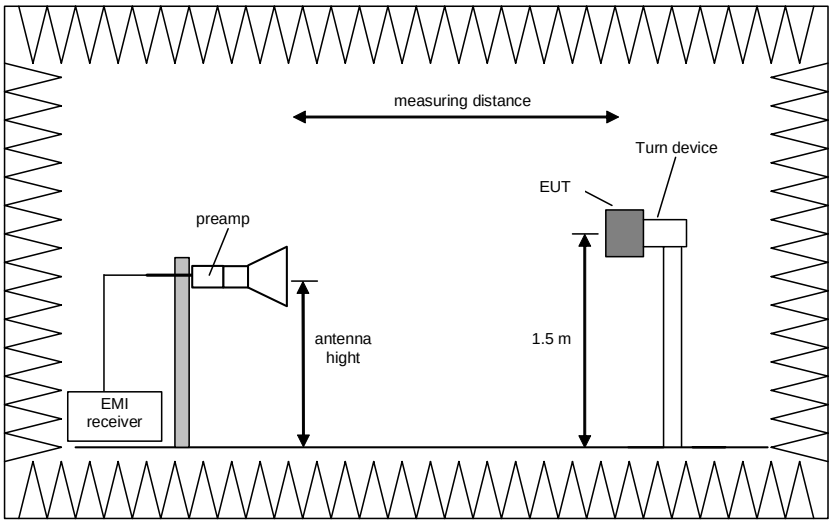
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an 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 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed 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
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 GHz.
The following procedure will be used:

1) 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.

5.3.2 Test results (radiated emissions)

5.3.2.1 Preliminary radiated emission measurement

Ambient temperature	22 °C	Relative humidity	32 %

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 (1 MHz to 18 GHz). In all other frequency ranges the EUT was set up on a non-conducting table at a height of 80 cm; in these frequency ranges the EUT was setup in three orthogonal directions and the antenna was moved 360 ° around the EUT with an distance of 30 cm and vertical / horizontal polarisation.

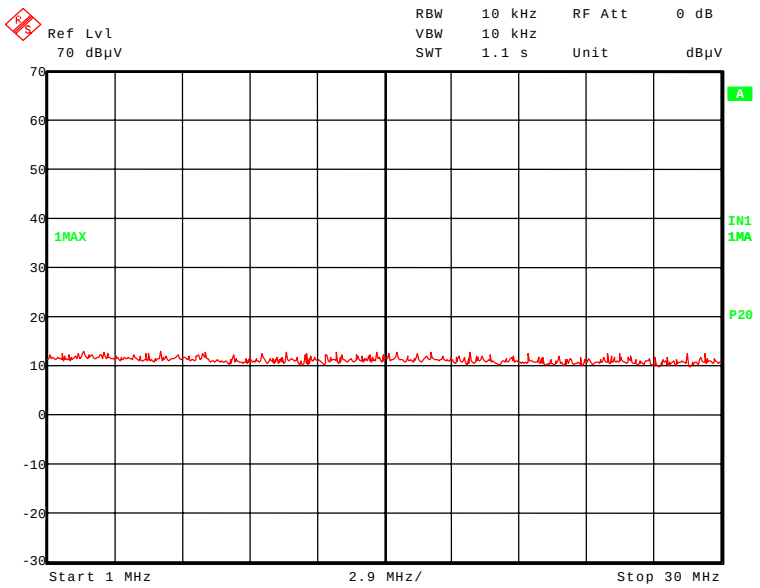
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied 24.0 V DC by an external power supply.

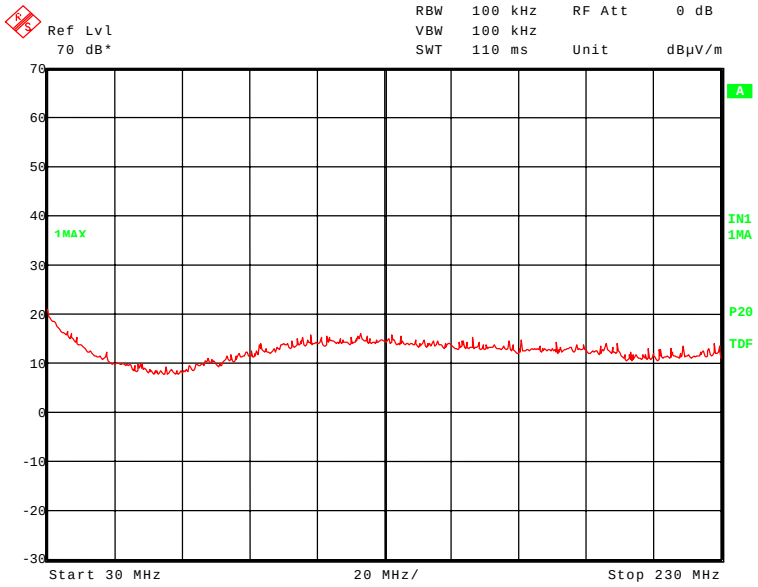
Frequency range: The preliminary measurement was carried out in the frequency range 1 MHz to 110 GHz according to [2].

170913_114.wmf: Radiated emissions from 1 MHz to 30 MHz:

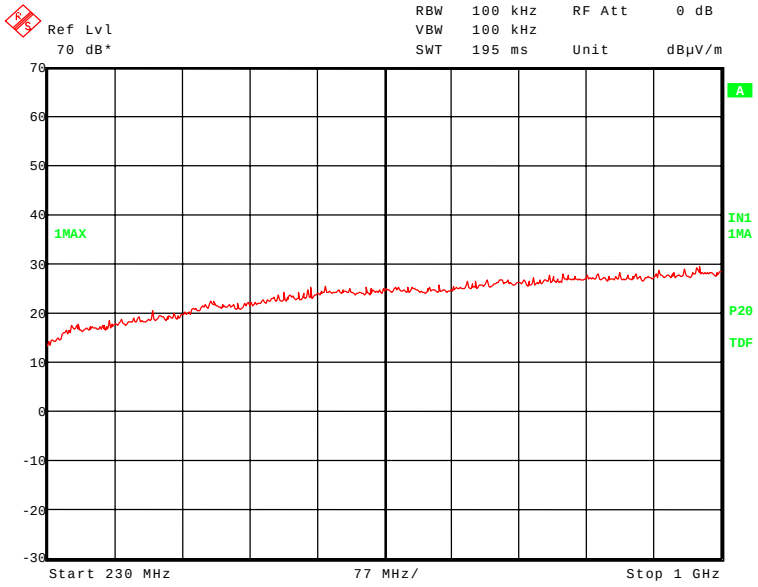


No emissions above the noise floor of the measurement system (max. 33 dBµV/m (measured with peak detector)) found during the preliminary measurement. So no final measurements on the outdoor test site were carried out.

170913_112_.wmf: Radiated emissions from 30 MHz to 230 MHz:

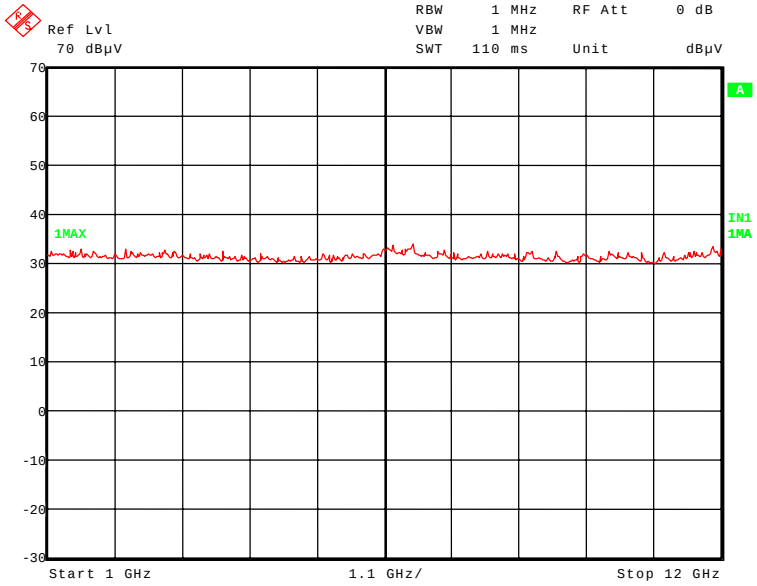


170913_113.wmf: Radiated emissions from 230 MHz to 1 GHz:

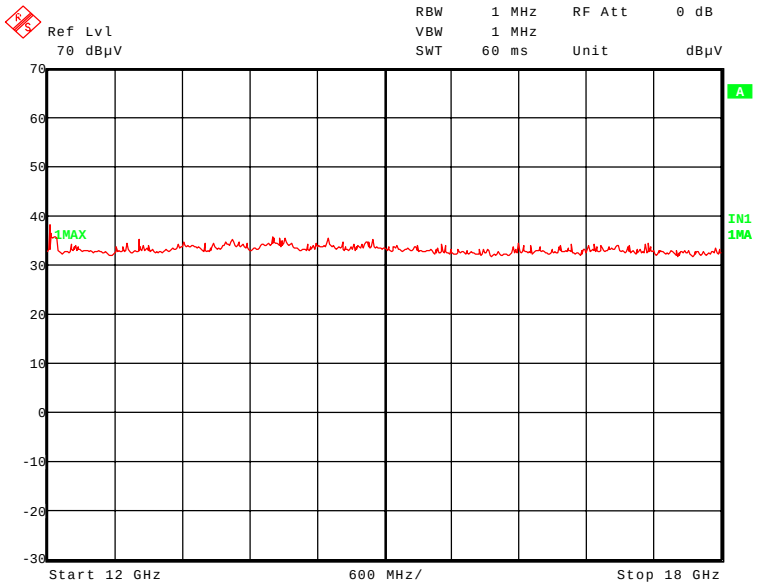


No emissions above the noise floor of the measurement system (max. 30 dBµV/m (measured with peak detector)) found during the preliminary measurement. So no final measurements on the open area test site were carried out.

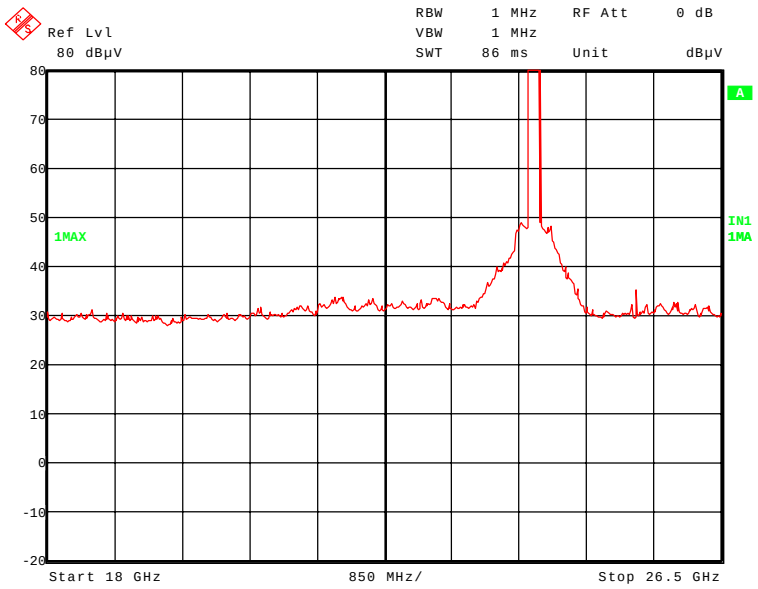
170913_115.wmf: Radiated emissions from 1 GHz to 12 GHz:



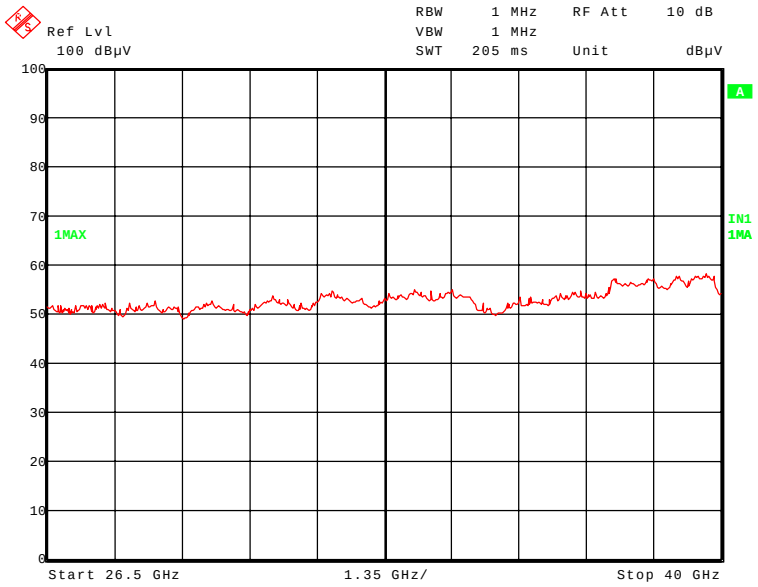
170913_111.wmf: Radiated emissions from 12 GHz to 18 GHz:



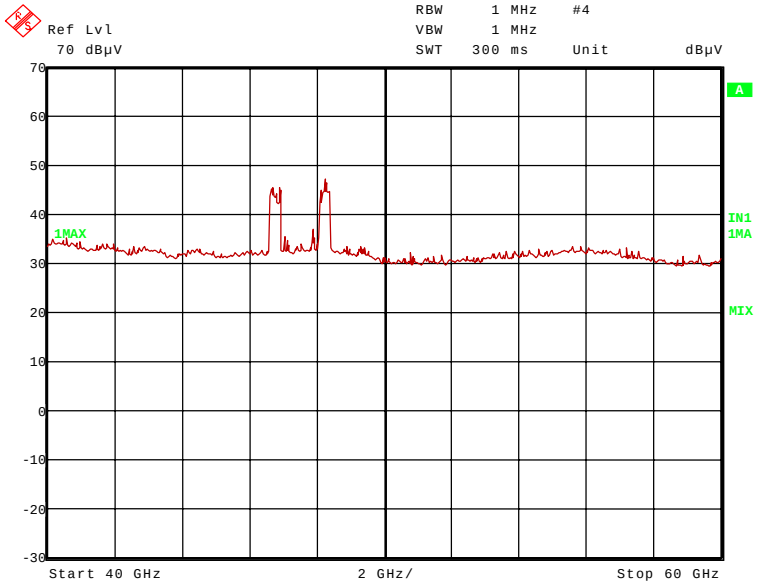
170913_102.wmf: Radiated emissions from 18 GHz to 26.5 GHz:



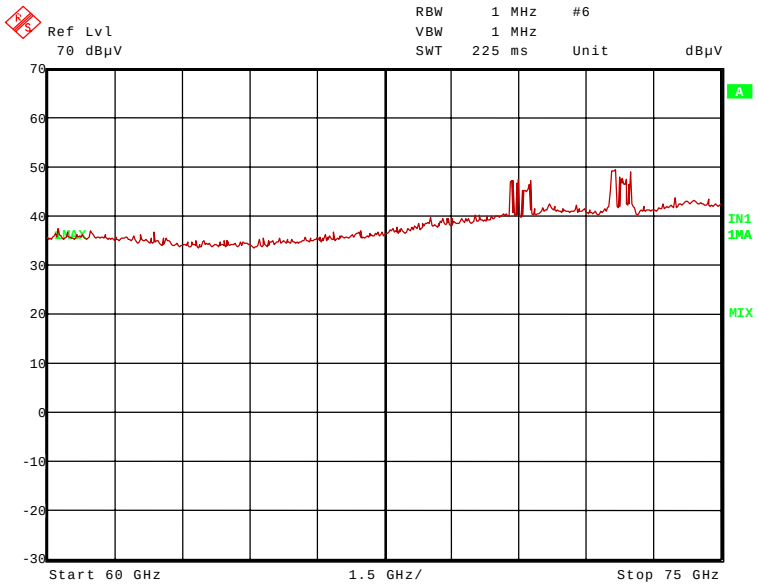
170913_103.wmf: Radiated emissions from 26.5 GHz to 40 GHz:



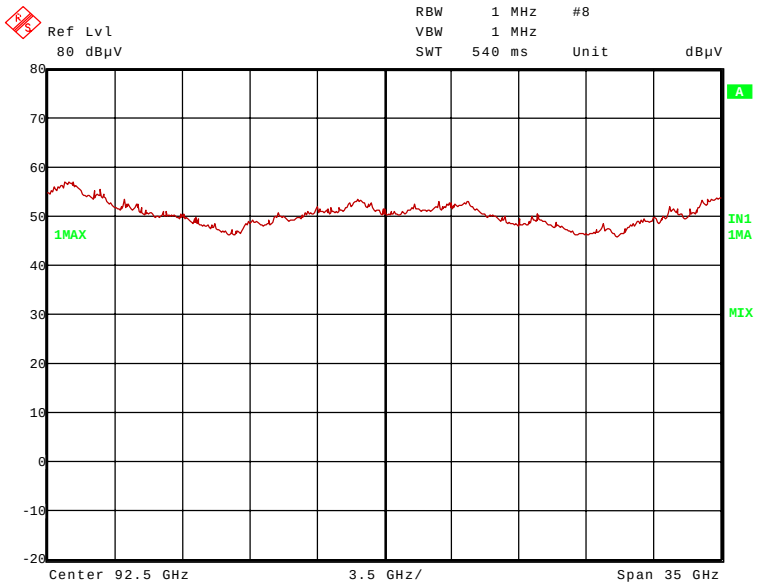
170913_104.wmf: Radiated emissions from 40 GHz to 60 GHz:



170913_105.wmf: Radiated emissions from 60 GHz to 75 GHz:



170913_106.wmf: Radiated emissions from 75 GHz to 110 GHz:



The following fundamental frequency was found during the preliminary radiated emission measurement:

- 24.126 GHz.

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

- 48.400 GHz and 72.697GHz.

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

- 12.046 GHz.

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

- 25.320 GHz.

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

The emissions around 47 GHz and 70.5 GHz are mirror frequencies caused by the harmonic mixer.

Test equipment used (refer clause 6):

6 - 25

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

No emissions above the noise floor of the measurement system (max. 33 dBµV/m (measured with peak detector)) found during the preliminary measurement. So no final measurements on the outdoor test site were carried out.

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

No emissions above the noise floor of the measurement system (max. 30 dBµV/m (measured with peak detector)) found during the preliminary measurement. So no final measurements on the open area test site were carried out.

5.3.2.4 Final radiated emission measurement (1 GHz to 110 GHz)

Ambient temperature	22 °C	Relative humidity	32 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 1.5 m (1 GHz to 18 GHz) and 80 cm (18 GHz to 110 GHz). The distance between EUT and the antenna was 3 m (1 GHz to 18 GHz) and 30 cm (18 GHz to 110 GHz).

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24.0 V_{DC} by an external power supply.

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

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

Result [dBµV/m] = reading [dBµV] + cable loss [dB] + antenna factor [dB/m] – Preamp [dB] + measuring distance correction factor [dB]

Result measured with the peak detector:

Frequency GHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Corr. Factor* dB	Height cm	Pol.
12.046	44.1	74.0	29.9	36.9	30.7	26.6	3.1	0	150	Vert.
24.126	105.2	128.0	22.8	83.1	37.3	0.0	4.8	-20.0	80	Vert.
25.320	64.4	74.0	9.6	42.3	37.3	0.0	4.8	-20.0	80	Vert.
48.400	70.3	88.0 / 74.0 **	17.7 / 3.7 **	46.1	44.2	0.0	-	-20.0	80	Vert.
72.697	73.5	88.0 / 74.0 **	14.5 / 0.5 **	47.2	46.3	0.0	-	-20.0	80	Vert.
Measurement uncertainty							+2.2 dB / -3.6 dB			

*: Measuring distance correction factor from 3 m to 30 cm
**: RSS-310 requirement

Result measured with the average detector:

Frequency GHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Corr. Factor* dB	Height cm	Pol.
12.046	27.9	54.0	26.1	20.7	30.7	26.6	3.1	0	150	Vert.
24.126	59.0	108.0	49.0	36.9	37.3	0.0	4.8	-20.0	80	Vert.
25.320	49.7	54.0	4.3	27.6	37.3	0.0	4.8	-20.0	80	Vert.
48.400	48.8	68.0 / 54.0 **	21.2/ 5.2 **	24.6	44.2	0.0	-	-20.0	80	Vert.
72.697	52.7	68.0 / 54.0**	15.3 / 1.3 **	26.4	46.3	0.0	-	-20.0	80	Vert.
Measurement uncertainty							+2.2 dB / -3.6 dB			

*: Measuring distance correction factor from 3 m to 30 cm
**: RSS-310 requirement

Test: Passed

Test equipment used (see chapter 6):

6 - 25

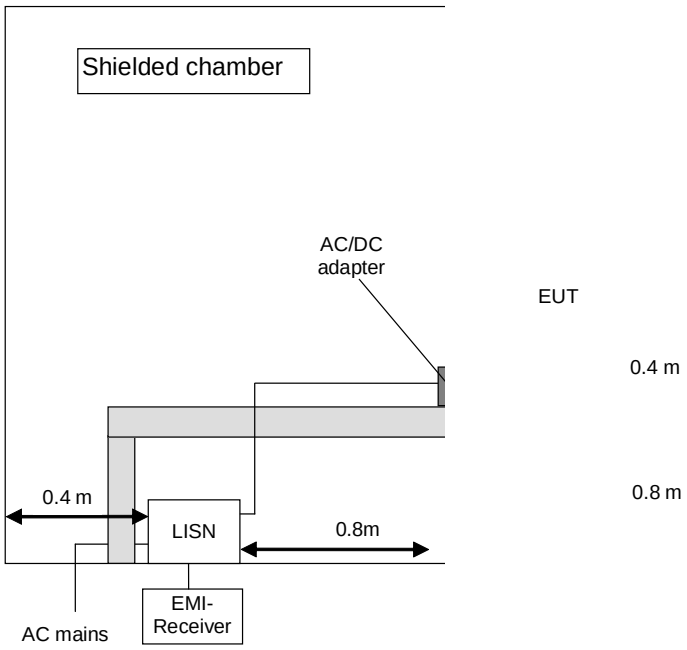
5.4 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.4.1 Method of measurement

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. The setup of the Equipment under test will be in accordance to [1].

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

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.4.2 Test results (conducted emissions on power supply lines)

Ambient temperature	22 °C	Relative humidity	36 %

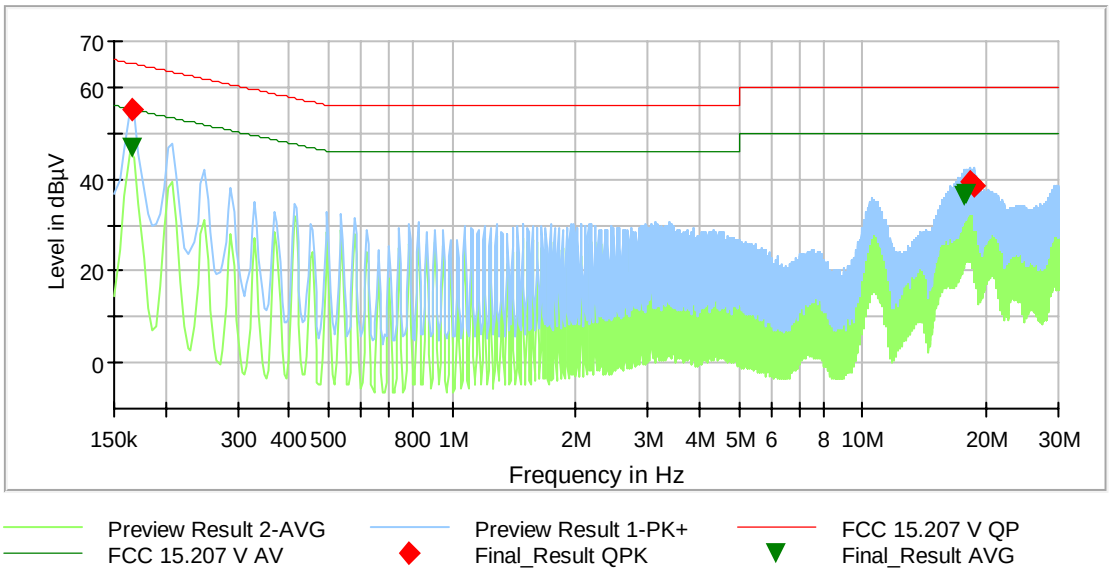
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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

Test record: All results are shown in the following.

Supply voltage: The EUT was supplied with 24.0 V_{DC} an AC/DC adaptor type PHOENIX CONTACT MINI-PS-100-240AC/24DC/1.3, which was connected to an AC mains network with 120 V_{AC} / 60 Hz.

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



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Transducer (dB)
0.165300	---	46.8	55.2	8.4	5000.0	9.000	N	FLO	9.8
0.165300	55.2	---	65.2	10.0	5000.0	9.000	N	GND	9.8
17.627100	---	36.5	50.0	13.5	5000.0	9.000	N	GND	10.9
17.872800	---	36.6	50.0	13.4	5000.0	9.000	N	FLO	10.9
18.369600	39.4	---	60.0	20.6	5000.0	9.000	N	GND	10.9
18.616200	38.6	---	60.0	21.4	5000.0	9.000	N	GND	10.9
Measurement uncertainty			±2.76 dB						

Test: Passed

Test equipment used (refer clause 6):

1 - 5

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Shielded chamber M4	-	Siemens	B83117-S1-X158-	480088	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	02/15/2016	02/2018
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	02/16/2016	02/2018
4	Transient Filter Limiter	CFL 9206A	Teseq GmbH	38268	481982	Weekly verification (system cal.)	
5	EMI Software	EMC 32	Rohde & Schwarz	100061	481022	-	-
6	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Weekly verification (system cal.)	
7	EMI Receiver / spectrum analyser	ESI 40	Rohde & Schwarz	100064/040	480355	15.02.2017	02.2018
8	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
9	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
10	Antenna support	AS615P	Deisel	615/310	480187	-	-
11	Antenna	CBL6112 B	□hase	2917	480447	11/05/2015	11/2018
12	Antenna	HL50	Rohde & Schwarz	100438	481170	08/27/2014	08/2017
13	RF-cable No.3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
14	RF-cable No.36	Sucoflex 106B	Suhner	0587/6B	480865	Weekly verification (system cal.)	
15	RF-cable 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	
16	Standard gain horn antenna	18240-20	Flann Microwave	483	480294	Calibration not necessary	
17	Standard gain horn antenna	20240-20	Flann Microwave	411	480297	Calibration not necessary	
18	Standard gain horn antenna	20240-20	Flann Microwave	410	480296	Calibration not necessary	
19	Standard gain horn antenna	22240-20	Flann Microwave	469	480299	Calibration not necessary	
20	Standard gain horn	23240-20 / 23093-TF30	Flann Microwave	122391 / 130137	480483	Calibration not necessary	
21	Standard gain horn / harmonic mixer	24240-20 / FS-Z60	Flann Microwave / Rohde & Schwarz	133313 / 1089.0799.02	480480 / 480481	Calibration not necessary	
22	Standard gain horn / harmonic Mixer	27240-20 / FS-Z75	Flann Microwave / Rohde & Schwarz	132148 / 100045	480482 / 480480	Calibration not necessary	
23	Preamplifier 100 MHz - 13 GHz	JS3-00101200-23-5A	MITEQ Hauppauge N.Y.	681851	480337	18.02.2016	02.2018
24	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	18.02.2016	02.2018
25	Preamplifier 26 GHz - 40 GHz	JS4-26004000-25-5A	MITEQ Hauppauge N.Y.	563593	480344	18.02.2016	02.2018
26	RF-cable 2m	Insulated Wire Inc.	Insulated Wire	KPS-1533-800-KPS	480302	Calibration not necessary	

7 Report history

Report Number	Date	Comment
F170913E2	05/12/2017	Document created
-	-	-
-	-	-

8 List of annexes

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170913_ug.JPG: RMS320-343300, test setup fully anechoic chamber (table, pos. 3)
170913_ua.JPG: RMS320-343300, test setup fully anechoic chamber
170913_ub.JPG: RMS320-343300, test setup fully anechoic chamber
170913_uc.JPG: RMS320-343300, test setup fully anechoic chamber
170913_uh.JPG: RMS320-343300, test setup fully anechoic chamber
170913_ui.JPG: RMS320-343300, shielded chamber

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170913_4.JPG: RMS320-343300, connector view

Annex C Internal photographs 16 pages
170913_1.JPG: RMS320-343300, 3-D-view 1
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170913_3.JPG: RMS320-343300, type plate view
170913_4.JPG: RMS320-343300, connector view
170913_5.JPG: RMS320-343300, internal view 1 (radar module removed)
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170913_15.JPG: RMS320-343300, PCB 1, top view
170913_16.JPG: RMS320-343300, PCB 1, bottom view
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170913_12.JPG: RMS320-343300, radar module, front housing removed
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170913_14.JPG: RMS320-343300, radar module, internal view 2
170913_21.JPG: RMS320-343300, radar module, RF-PCB, top view
170913_22.JPG: RMS320-343300, radar module, RF-PCB, bottom view
170913_24.JPG: RMS320-343300, radar module, PCB 2, top view
170913_23.JPG: RMS320-343300, radar module, PCB 2, bottom view