PHOENIX TESTLAB

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Test Report

Report Number:

F201003E1

Equipment under Test (EUT):

77V13CRN

Applicant:

Veoneer US, Inc.

Manufacturer:

Veoneer US, Inc.

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] **ANSI C63.26-2015**, American National Standard for Compliance Testing of Transmitters Used in Licesed Radio Services

[3] **FCC CFR 47 Part 95 M,** The 76-81 GHz Band Radar Service

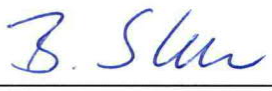
[4] **RSS-251 Issue 2 July 2018,** Vehicular Radar and Airport Fixed or Mobile Radar in the 76-81 GHz Frequency Band

[5] **RSS-Gen Issue 5 March 2019 Amendment 1,** General Requirements for Compliance of Radio Apparatus

[6] **FCC CFR 47 Part 2,** Frequency allocations and radio treaty matters; general rules and regulations

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
Tested and written by:	Thomas KÜHN		29.07.2020
Reviewed and approved by:	Bernd STEINER		29.07.2020

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.

Contents: Page

1 Identification

1.1 Applicant

Name:	Veoneer US, Inc.
Address:	26360 American Drive, Southfield, MI 48034
Country:	USA
Name for contact purposes:	Claire O'Neill
Phone:	+1 248 223 0600
Fax:	--
eMail Address:	claire.oneill@veoneer.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Veoneer US, Inc.
Address:	26360 American Drive, Southfield, MI 48034
Country:	USA
Name for contact purposes:	Claire O'Neill
Phone:	+1 248 223 0600
Fax:	--
eMail Address:	claire.oneill@veoneer.com
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-17186-01-05 and D-PL-17186-01-06, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623.

1.4 EUT (Equipment Under Test)

Test object: *	77 GHz CRN Radar Sensor
Model name / PMN: *	681083100B, 681284500B, 681284400B and 680907900A
HVIN: *	77V13CRN
FCC ID: *	WU877V13CRN
IC: *	8436B-77V13CRN
Serial number: *	00027 (681083100B), 00065 (681284500B), 00193 (681284400B) and 90057 (680907900A)
PCB identifier: *	681019700A (681083100B, 681284500B and 681284400B), 681019500A (680907900A)
Software version / FVIN: *	R255_31_13D43_0
Lowest internal frequency: *	25 MHz

*: 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

Operating frequency	76 GHz to 77 GHz					
Occupied bandwidth: *	925 MHz					
Rated rf-output power: *	29.7 dBm (e.i.r.p.)					
Antenna type: *	Internal only					
Antenna connector: *	None					
Type of modulation: *	FMCW with 32 chirps per period, chirp time 84.78 µs **					
Temperature range: *	-40 °C to 85 °C					
Supply voltage: *	U_{nom}=	12.0 V_{DC}	U_{min}=	8.0 V_{DC}	U_{max}=	16.0 V_{DC}
Ancillary used for test:	CAN interface type Vector VN1610, Laptop PC type HP Elite Book 840 with software DanView V3.27.3.2, cable harness, all supplied by the applicant					

* declared by the applicant.
** refer applicants' operational description

Identification	Connector		Length
	EUT	Ancillary	
DC / CAN	Yazaki 2x4 (681083100B, 681284500B, 681284400B) and USCAR 1x8 (680907900A)	Banana plug (DC), 9 pole D-Sub (CAN)	1.0 m

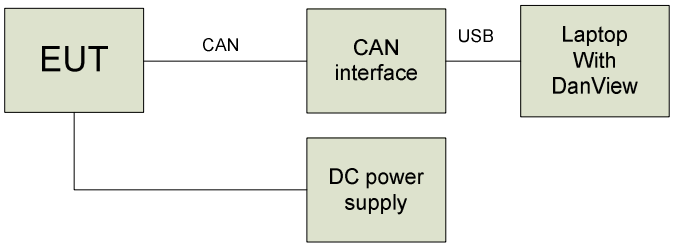
1.6 Dates

Date of receipt of test sample:	10.07.2020
Start of test:	20.07.2020
End of test:	27.07.2020

2 Operational states

The EUT is intended to be used as radar transceiver for vehicular use.
All tests were carried out with an unmodified test samples powered with 8 to 16 V_{DC} via an external power supply. The operation mode of the EUT could be chosen via the CAN connection to the laptop PC with the help the Vector CAN interface type VN1610 and the software DanView V3.27.3.2.

The system setup as follows:



3 Additional information

As declared by the applicant, the EUT is available in four different variants. Variant 1 to 3 are using the same PCB. Variant 1 is the fully stocked, at variant 2 and 3 some components at the digital part of the EUT were left. Variant 4 has a different connector and some layout changings in the digital part, the rf part is identical in all variants. So, it was agreed between the applicant and the laboratory, that the variant 1 is the fully equipped version, which could be regarded as worst case variant which was full tested. Additionally, the fundamental emission of all four variants and the emissions from the digital part of variant 4 in the frequency range 20 MHz to 1 GHz were tested.

The tested sample was not labeled as required by the FCC / ISED.

The EUT is sealed and glued, in order to keep the tested sample operational, the internal photographs in annex D of this test report were provided by the applicant.

4 Overview

Application	Frequency range [MHz]	FCC CFR 47 Part 95 M [3]	RSS-251 [4] RSS-Gen [5]	Status	Refer page
Power density	Above 40000, excluding 76000 – 81000	95.3379 (a)	8 + 9 [4]	Passed	15 et seq.
99 % bandwidth	76000 - 77000	-	6.7 [5]	Passed	13 et seq.
Occupied bandwidth	76000 - 77000	95.3379 (b)	7 [4]	Passed	17 et seq.
Maximum effective radiated power	76000 - 81000	95.3367 (b)	9 [4]	Passed	15 et seq.
Average effective radiated power	76000 - 81000	95.3367 (a)	8 [4]	Passed	15 et seq.
Modulation characteristics	76000 - 81000	FCC CFR 47 Part 2.1047 (d) [6]	6 b. [4]	Not tested *	-
Radiated emissions	0.009 – 231000 (FCC)	95.3379 (a) (2)	-	Passed	19 et seq.
	0.009 – 162000 (ISED)	-	10 [4], 6.13 [5]		
Frequency stability	76000 - 77000	95.3379 (b)	11 [4]	Passed	30 et seq.

*: The modulation characteristics was not tested; it was declared by the applicant with the operational description.

5 Test results

5.1 Minimum sweep time for RMS measurements

5.1.1 Method of measurement (minimum sweep time for RMS measurements)

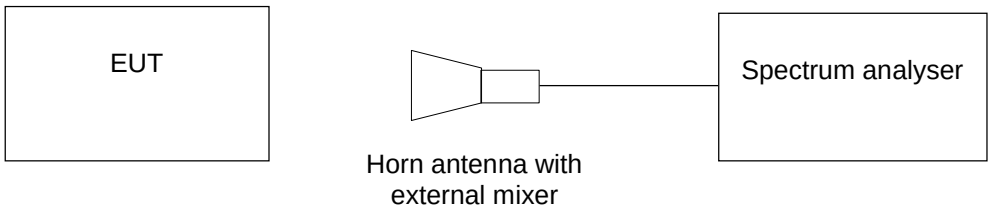
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator.

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

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Span: Zero at the maximum of the transmitted signal
- Resolution bandwidth: 1 MHz.
- Video bandwidth: 3 MHz.
- Sweep time: Large enough to capture one transmission period.
- Detector function: Peak.
- Trace mode: Max hold.
- Sweep mode: Single sweep.

The first marker shall be set on start of the transmission period, the second one to the start of the next transmission period. For all RMS measurements this pulse period shall be multiplied with the number of used sweep points to calculate the minimum sweep time for the measurement. This method of calculation of the minimum sweep time was coordinated with the FCC.

Test set-up:

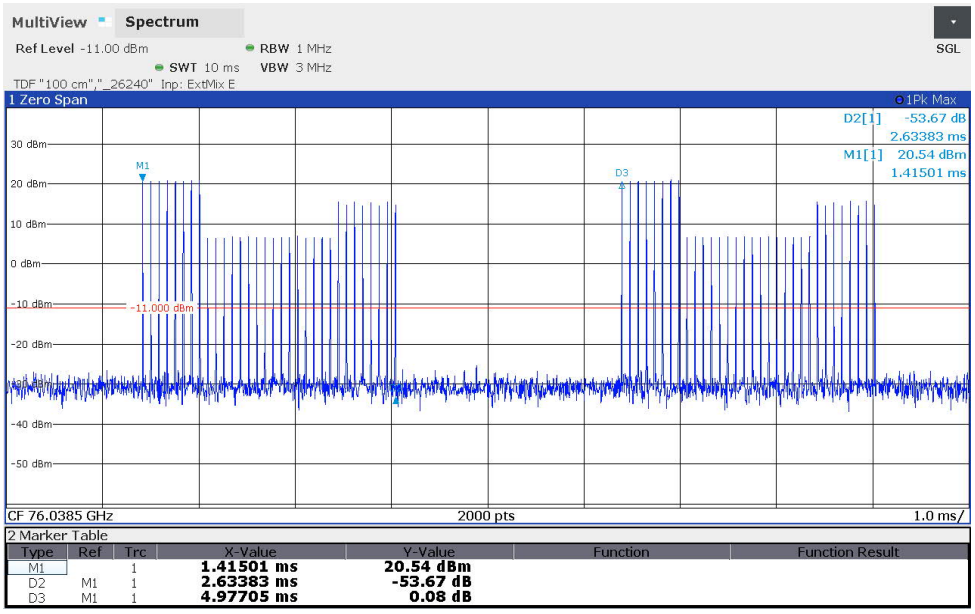


5.1.2 Test results (minimum sweep time for RMS measurements)

Ambient temperature	22 °C	Relative humidity	38 %

Measured with variant 1, measurement distance 1 m.

201003_4.png: Transmitter TX_{on} and TX_{off} time:



Pulse period = 5 ms so the minimum RMS measurement time shall be calculated with 5 ms multiplied by the number of sweep points.

For all measurements documented in this report, the minimum sweep time was doubled.

Remark: The -11 dBm line in the plot above is the reference level of the spectrum analyser.

Test equipment used (refer clause 6):

29, 30, 45 - 47

5.2 Peak correction factor for FMCW radar

5.2.1 Method of measurement (peak correction factor for FMCW radar)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator.

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

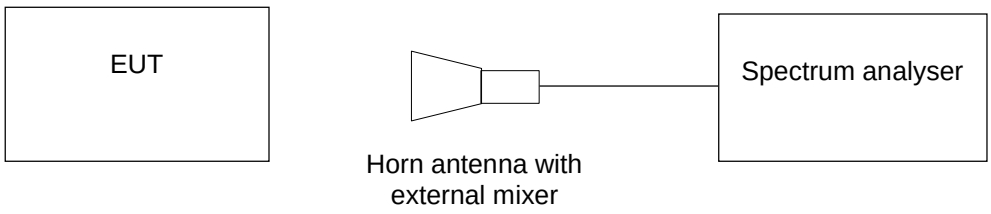
- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Span: zero at the maximum of the transmitted signal
- Resolution bandwidth: 50 MHz.
- Video bandwidth: ≥ the RBW.
- Sweep time: Twice the minimum sweep time / sweep point.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilization the marker shall be set on the signal peak this level shall be noted. Than the RBW of the spectrum analyser shall be reduced until the level difference to the noted level is more than 1 dB. The next highest RBW shall be used to calculate the peak correction factor with the following formula:

Peak correction factor = 10 x log (Used RBW/1 MHz)

Reduction below the nominal RBW of 1 MHz is not necessary (fi the level don't change between RBW of 50 MHz and 1 MHz, not correction factor has to be used. Plots hall be taken from the signal with the maximum, nominal and used RBW in order to check the calculation of the correction factor.

Test set-up:

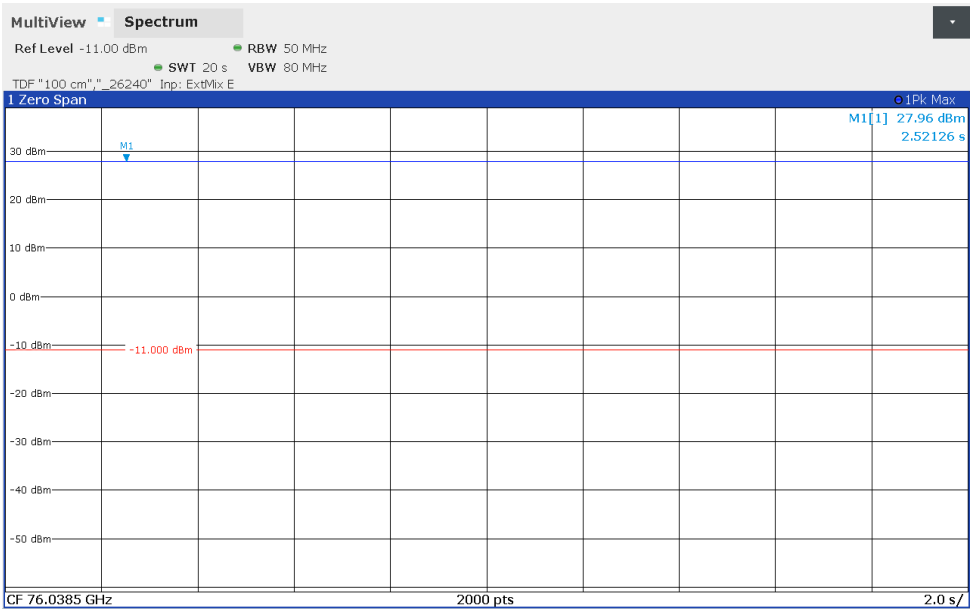


5.2.2 Test results (peak correction factor for FMCW radar)

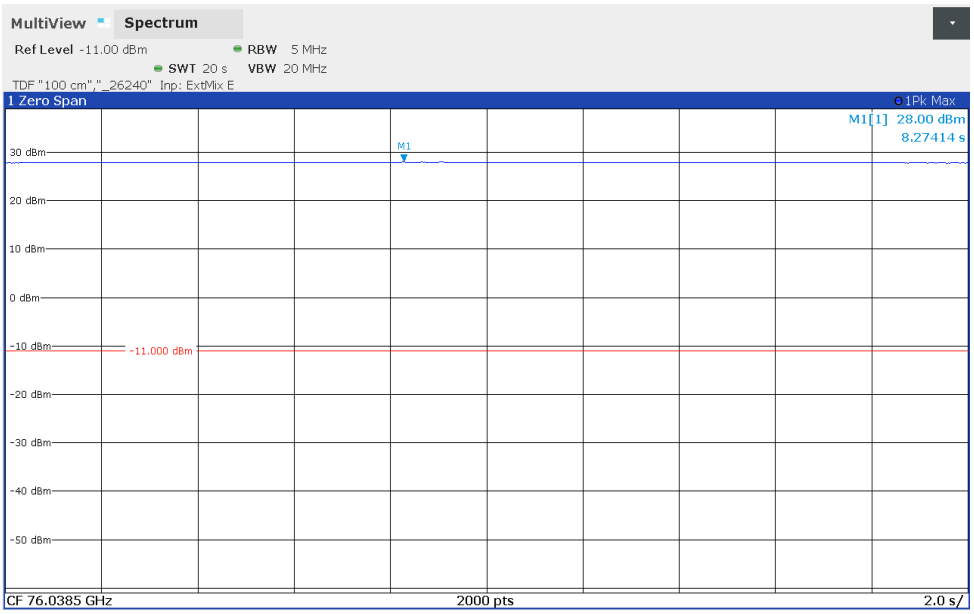
Ambient temperature	22 °C	Relative humidity	38 %

Measured at variant 1, measurement distance 1 m.

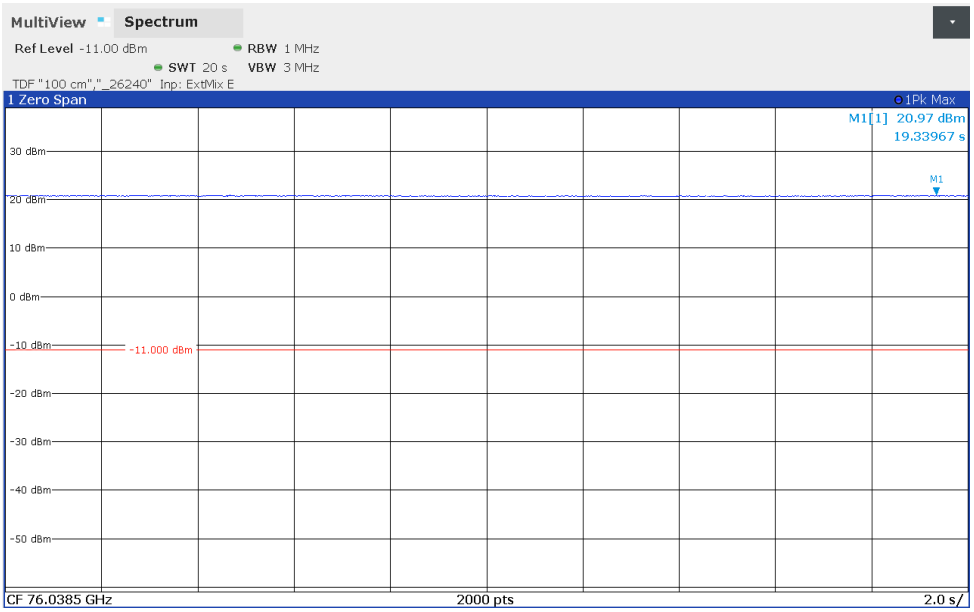
201003_1.png: Peak value with 50 MHz RBW:



201003_2.png: Peak value with 5 MHz RBW:



201003_3.png: Peak value with 1 MHz RBW:



With Used RBW = 5 MHz (lowest RBW, which shows the same peak level than measured with a RBW of 50 MHz) the peak correction factor was calculated as follows:

Peak correction factor = 10 x log (5MHz / 1 MHz) = 7.0 dB

Remark: The -11 dBm line in the plots above is the reference level of the spectrum analyser.

Test equipment used (refer clause 6):

29, 30, 45 - 47

5.3 99 % bandwidth

5.3.1 Method of measurement (99 % bandwidth)

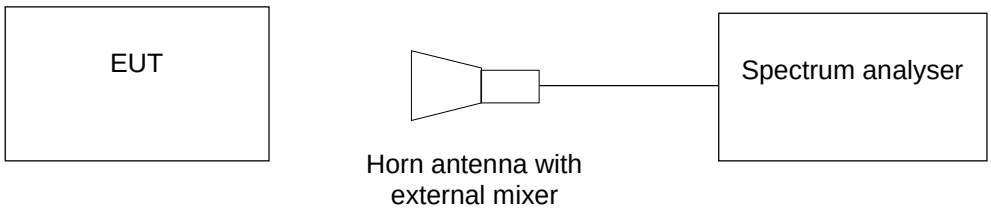
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable.

According to [5] the following spectrum analyser settings shall be used:

- Span: wide enough to capture all emission skirts.
- Resolution bandwidth: 1 to 5 % of the OBW.
- Video bandwidth: App. three times the RBW.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

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

Test set-up:

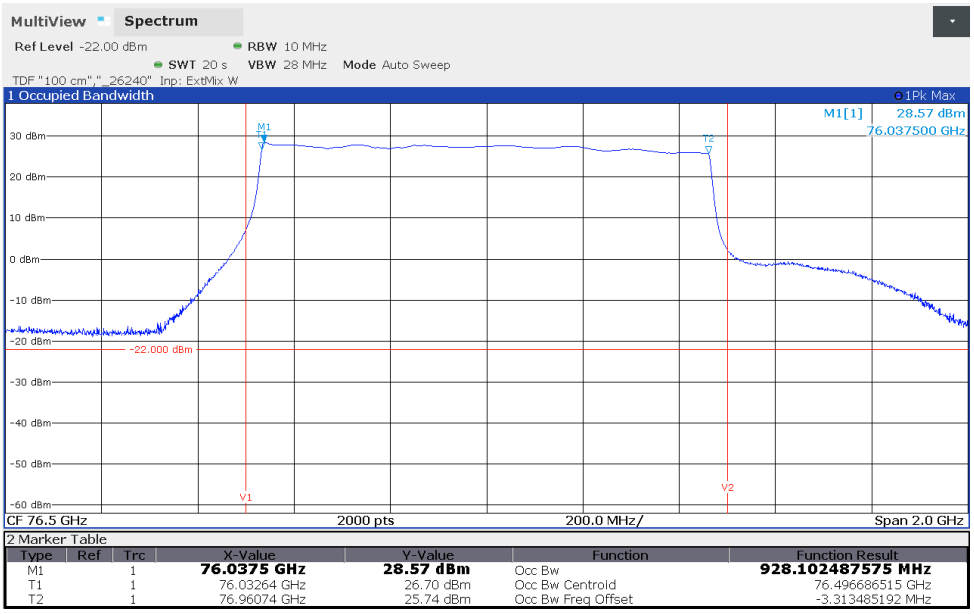


5.3.2 Test results (99 % bandwidth)

Ambient temperature	22 °C	Relative humidity	38 %

Measured at variant 1, measurement distance 1 m.

201003_7.png: 99 % bandwidth:



F_L	F_U	99 % Bandwidth	Result
76.03264 GHz	76.96074 GHz	928.102 MHz	Passed
Measurement uncertainty		$<1*10^{-7}$	

Remark: The -22 dBm line in the plot above is the reference level of the spectrum analyser.

Test equipment used (refer clause 6):

29, 30, 45 - 47

5.4 Power measurements

5.4.1 Method of measurement (power measurements)

The maximum effective radiated isotropically peak 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.

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

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Span: Twice the nominal channel frequency, centered at 76.5 GHz.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: 3 MHz.
- Sweep points: At least span / 1 MHz
- Sweep time: Twice the minimum sweep time / sweep point.
- Detector function: Peak.
- Trace mode: Max hold.
- Vertical lines: Line 1 set to 76 GHz, line 2 set to 77 GHz

After trace stabilization the marker shall be set on the signal peak.

The maximum average effective radiated isotropically power:

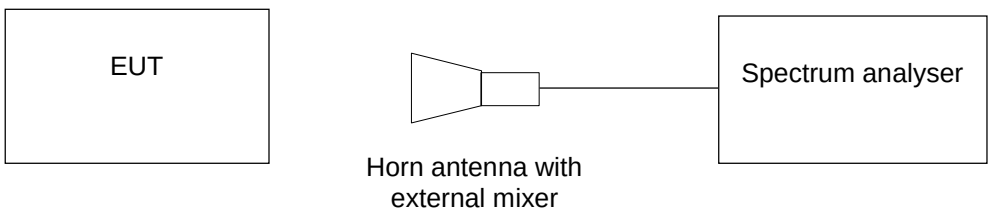
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable.

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

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Span: Twice the nominal channel frequency, centered at 76.5 GHz.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: 3 MHz.
- Sweep points: At least span / 1 MHz
- Sweep time: Twice the minimum sweep time / sweep point.
- Detector function: Peak.
- Trace mode: Max hold.
- Vertical lines: Line 1 set to 76 GHz, line 2 set to 77 GHz

After trace stabilization the marker shall be set on the signal peak. Use the channel power measurement functionality of the spectrum analyser with a 1 GHz channel width to integrate the power of the channel.

Test set-up:



5.4.2 Test results (power measurements)

Ambient temperature	23 °C		Relative humidity	46 %

Used measurement distance: 1 m

Maximum effective radiated isotropically peak power								
Test conditions		Used Variant	Peak frequency [GHz]	Measured peak level [dBm]	Peak correction factor [dB]	Peak level [dBm]	Limit [dBm]	Result
Temp.	Voltage							
T_{nom} (20 °C)	U_{nom} (12.0 V_{DC})	1	76.5230	23.0	7.0	30.0	55.0	Passed
		2	76.5225	22.6	7.0	29.6	55.0	Passed
		3	76.6443	23.2	7.0	30.2	55.0	Passed
		4	76.5215	22.1	7.0	29.1	55.0	Passed
	U_{min} (8.0 V_{DC})	1	76.5270	22.7	7.0	29.7	55.0	Passed
		2	76.5255	22.9	7.0	29.9	55.0	Passed
		3	76.5915	22.4	7.0	29.4	55.0	Passed
		4	76.6315	22.3	7.0	29.3	55.0	Passed
	U_{max} (16.0 V_{DC})	1	76.5230	23.0	7.0	30.0	55.0	Passed
		2	76.5255	22.8	7.0	29.8	55.0	Passed
		3	76.5225	23.2	7.0	30.2	55.0	Passed
		4	76.5225	22.7	7.0	29.7	55.0	Passed
T_{min} (-40 °C)	U_{nom} (12.0 V_{DC})	1	76.6495	20.9	7.0	27.9	55.0	Passed
T_{max} (+85 °C)	U_{nom} (12.0 V_{DC})	1	76.5865	24.5	7.0	31.5	55.0	Passed
Measurement uncertainty		±4.3 dB						

The plots are shown in annex A, clause 1 of this test report. The -11 dBm line in the plots in annex A is the reference level of the spectrum analyser.

Average effective radiated isotropically power						
Test conditions		Used sample	Channel width [MHz]	Channel power level [dBm]	Limit [dBm]	Result
Temp.	Voltage					
T_{nom} (20 °C)	U_{nom} (12.0 V_{DC})	1	1000	19.8	50.0	Passed
		2	1000	19.0	50.0	Passed
		3	1000	19.5	50.0	Passed
		4	1000	18.4	50.0	Passed
	U_{min} (8.0 V_{DC})	1	1000	19.3	50.0	Passed
		2	1000	19.4	50.0	Passed
		3	1000	19.4	50.0	Passed
		4	1000	18.2	50.0	Passed
	U_{max} (16.0 V_{DC})	1	1000	19.5	50.0	Passed
		2	1000	19.4	50.0	Passed
		3	1000	19.4	50.0	Passed
		4	1000	18.2	50.0	Passed
T_{min} (-40 °C)	U_{nom} (12.0 V_{DC})	1	1000	20.5	50.0	Passed
T_{max} (+85 °C)	U_{nom} (12.0 V_{DC})	1	1000	17.9	50.0	Passed
Measurement uncertainty		±4.3 dB				

The plots are shown in annex A, clause 2 of this test report. The -11 dBm line in the plots in annex A is the reference level of the spectrum analyser.

Test equipment used (refer clause 6):

29, 30, 44 - 47

5.5 Occupied bandwidth

5.5.1 Method of measurement (occupied bandwidth)

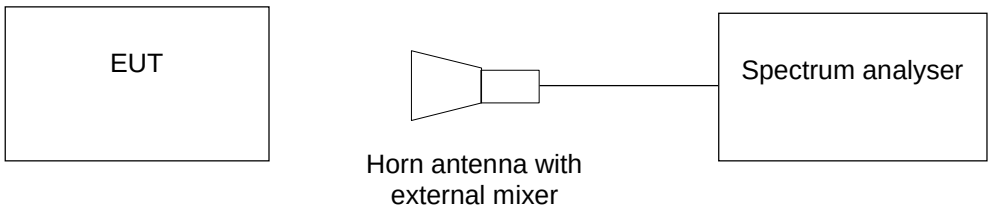
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable.

The following spectrum analyser settings shall be used:

- Span: wide enough to capture all emission skirts.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: 3 MHz.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

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

Test set-up:



5.5.2 Test results (occupied bandwidth)

Ambient temperature	23 °C	Relative humidity	46 %

Measurement distance 1 m.

Occupied bandwidth								
Test conditions		Used Variant	Peak frequency [GHz]	Lowest frequency [GHz]	Highest frequency [GHz]	Occupied bandwidth [MHz]	Limit [GHz]	Result
Temp.	Voltage							
T_{nom} (20 °C)	U_{nom} (12.0 V_{DC})	1	76.52300	76.03986	76.95795	918.093	76 – 77	Passed
		2	76.52250	76.03827	76.95604	917.770	76 – 77	Passed
		3	76.64430	76.03905	76.95759	918.534	76 – 77	Passed
		4	76.52150	76.03859	76.95682	918.230	76 – 77	Passed
	U_{min} (8.0 V_{DC})	1	76.52700	76.03970	76.95769	917.990	76 – 77	Passed
		2	76.52550	76.03865	76.95606	917.406	76 – 77	Passed
		3	76.59150	76.03924	76.95763	918.382	76 – 77	Passed
		4	76.63150	76.03840	76.95635	917.952	76 – 77	Passed
	U_{max} (16.0 V_{DC})	1	76.52300	76.03962	76.95766	918.032	76 – 77	Passed
		2	76.52550	76.03834	76.95640	918.057	76 – 77	Passed
		3	76.52250	76.03909	76.95785	918.760	76 – 77	Passed
		4	76.52250	76.03862	76.95607	917.450	76 – 77	Passed
T_{min} (-40 °C)	U_{nom} (12.0 V_{DC})	1	76.64950	76.04006	76.95680	916.738	76 – 77	Passed
T_{max} (+85 °C)	U_{nom} (12.0 V_{DC})	1	76.58650	76.04277	76.96040	917.634	76 – 77	Passed
Measurement uncertainty		$<1*10^{-7}$						

The plots are shown in annex A, clause 1 of this test report. The -11 dBm line in the plots in annex A is the reference level of the spectrum analyser.

Test equipment used (refer clause 6):

29, 30, 44 - 47

5.6 Radiated emissions

5.6.1 Method of measurement (radiated emissions)

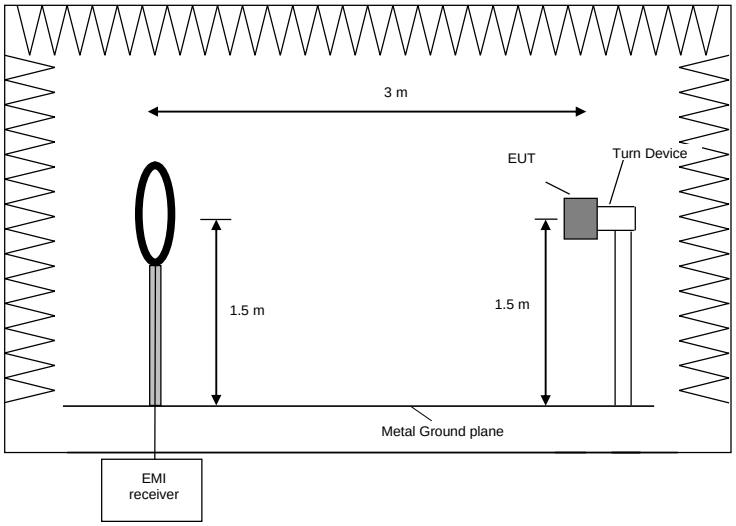
The radiated emission measurement is subdivided into different stages.

- A preliminary measurement carried out inside a semi anechoic chamber with various antenna heights in the frequency range 20 MHz to 1 GHz.
- A final measurement carried out on an outdoor test site without reflecting ground plane and fixed antenna height in the frequency range 20 MHz to 30 MHz.
- A final measurement carried out inside a semi anechoic chamber with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with fixed antenna distance and height in the frequency range up to 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range up to 40 GHz.
- A preliminary measurement carried out with variable antenna distance and height in the frequency range up to 231 GHz.
- A final measurement carried out with variable antenna distance and height in the frequency range up to 231 GHz.

The frequency range 20 MHz 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 find 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 10 MHz 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.
7) Rotate the measuring antenna and repeat steps 1) to 5).

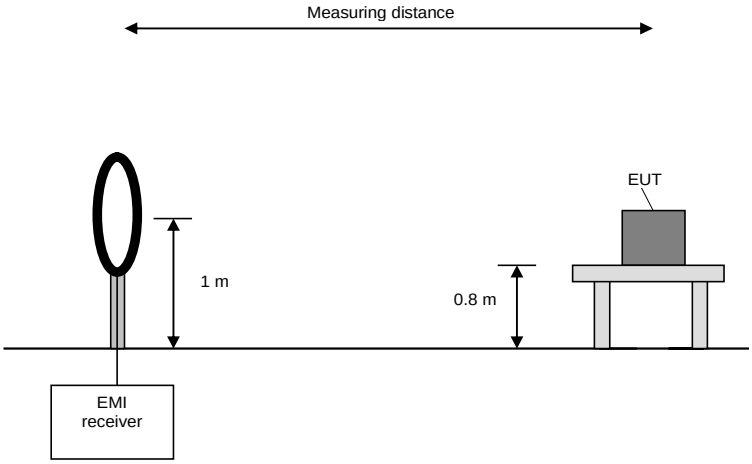
Final measurement (10 MHz to 30 MHz):

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 whichever is appropriate. In the case where larger measuring distances were required the results will be extrapolated based on the values measured on the closer distances according to [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak.

On the during the preliminary measurement detected frequencies 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
10 MHz 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 (only if the EUT is a module or is used in a handheld application).

Preliminary and final measurement (30 MHz to 1 GHz)

The EUT is measured in the frequency range from 30 MHz to 1 GHz inside a semi anechoic chamber with a metal ground plane, which has been validated to the requirements of [1]. It is placed on a 3D-positioner to allow different positions at a distance of 3 meters from the receiving antenna. Both polarizations (vertical and horizontal) have been evaluated and the turn table has been turned to 360° to maximize the emissions. The receiving antenna is raised from 1 to 4 m.

Procedure preliminary measurement:

The following procedure is used:

1) Set the measurement antenna to 1 m height.
2) Monitor the frequency range at vertical polarization and a EUT azimuth of 0 °.
3) Rotate the EUT by 360° to maximize the detected signals in two axes.
4) Repeat 1) to 2) with the horizontal polarization of the measuring antenna.
5) Increase the height of the antenna for 0.5 m and repeat steps 2) – 4) until the final height of 4 m is reached (30 MHz to 1 GHz only).
6) The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for that value.

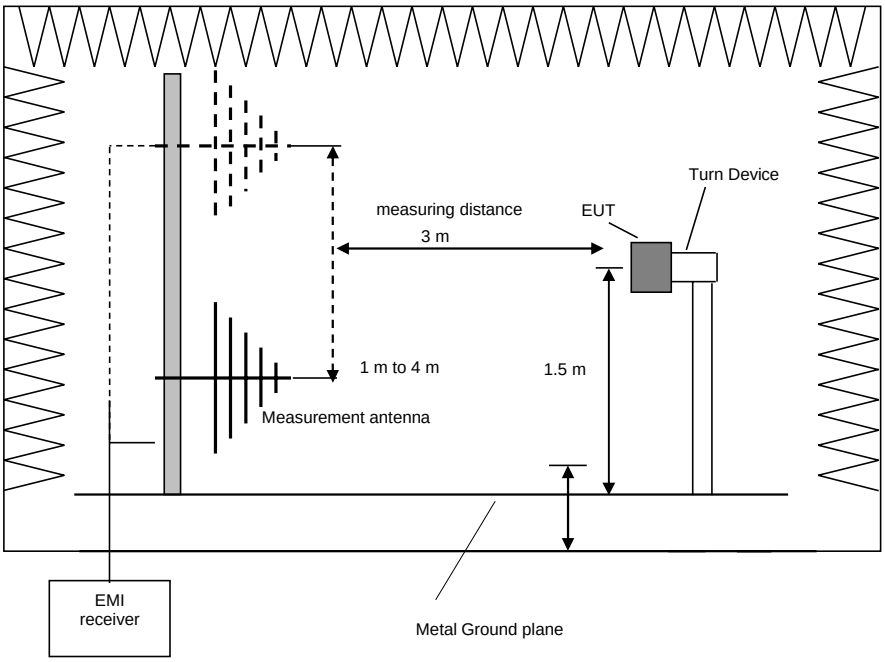
Procedure final measurement:

The following procedure is used:

1) Select the highest frequency peaks to the limit for the final measurement.
2) The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW of the pre-scan of the selected peaks.
3) If the EUT is portable or ceiling mounted, find the worst case EUT position (x, y, z) for the final test.
4) The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the value obtained in the preliminary measurement, and to monitor the emission level.
5) The worst azimuth turntable position is found by varying the turntable azimuth by +/- 25° from the value obtained in the preliminary measurement, and to monitor the emission level.
6) The final measurement is performed at the worst-case antenna height and the worst case turntable azimuth
7) Steps 2) – 6) will be repeated for each frequency peak selected in step 1).
8) For frequencies above 960 MHz the measured field strength is converted to an EIRP value

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	100 kHz



Test setup for measurements below 1 GHz

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 at a height of 1.5 m. The set-up of the Equipment under test will be in accordance with [1].

Procedure preliminary measurement:

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. 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 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz

The following minimum measuring distances must be considered in order to meet the near/far field boundaries:

Antenna frequency [GHz]	Antenna	Lowest wavelength λ [m]	Max. dimension of the antenna [m]	Min. measuring distance = $D^2/2\lambda$ [m]
1 - 12	HL050	0.3000	0.1500	0.003
12 - 18	Flann 18240	0.0250	0.0750	0.238
18 - 26	Flann 20240	0.0167	0.0520	0.081
26 - 40	Flann 22240	0.0115	0.0350	0.053

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

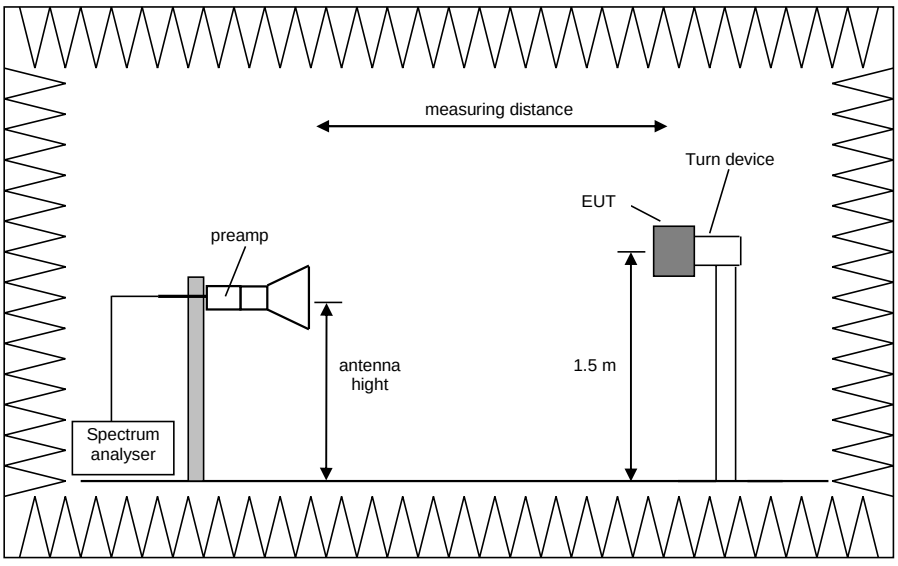
The following procedure will be used:

1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 ° with peak or RMS detector of the spectrum analyser (depending of the noise floor and the applicable limit).
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.

Procedure final measurement:

The measurements were performed in the frequency range 1 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 RMS 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.
7) Replace the EUT by a substitution antenna, which is fed by a signal generator.
8) Carry out a substitution for each frequency detected during the steps 5) to 6).
9) Calculate the EIRP values with the help of the final measurement and the substitution results.



Test setup for measurements from 1 GHz to 40 GHz

Preliminary and final measurement (40 GHz to 325 GHz)

The EUT will set up on a non-conducting turn device at a height of 1.2 m. The set-up of the Equipment under test will be in accordance with [1].

Procedure preliminary measurement:

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. In case the EUTs dimension is larger than the dimension of the used horn antenna, the height of the EUT will be variated. Measurement is carried out in all three orthogonal directions of the EUT.

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

Frequency range	Resolution bandwidth
40 GHz to 60 GHz	1 MHz
60 GHz to 90 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz
90 GHz to 140 GHz	1 MHz
110 GHz to 170 GHz	1 MHz
140 GHz to 220 GHz	1 MHz
220 GHz to 325 GHz	1 MHz

The following minimum measuring distances must be considered in order to meet the near/far field boundaries:

Antenna frequency [GHz]	Antenna	Lowest wavelength λ [m]	Max. dimension of the antenna D [m]	Min. measuring distance = $D^2/2\lambda$ [m]
40 - 60	Flann 24240	0.0075	0.0230	0.082
50 - 75	Flann 25240	0.0060	0.0190	0.030
60 - 90	Flann 26240	0.0050	0.0150	0.023
75 - 110	Flann 27240	0.0040	0.0124	0.019
90 - 140	Flann 28240	0.0033	0.0100	0.015
110 - 170	Flann 29240	0.0027	0.0085	0.013
140 - 220	Flann 30240	0.0021	0.0070	0.011
220 - 325	Flann 32240	0.0014	0.0065	0.015

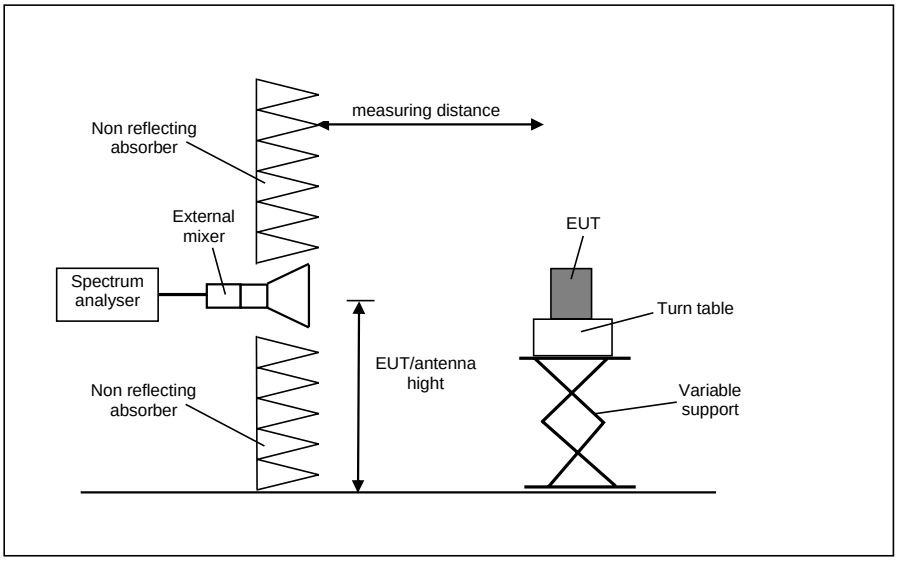
The following procedure will be used:

1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 ° with peak detector of the spectrum analyser (depending of the noise floor and the applicable limit).
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) If necessary, change EUTs height.
5) Change orthogonal direction of the EUT and repeat 1) to 4).
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 (direction, turntable and height) which produces the highest emission for each frequency will be used for the final measurement.
8) Set the direction, turntable and height to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
9) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
10) Set the spectrum analyser to EMI mode with peak and RMS detector activated.
11) Note the highest displayed RMS values
12) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

The measurements in these frequency ranges are carried out with the help of external mixers, connected to the spectrum analyser. The plots may show image signals and other mixer products additionally to the real signal. In order to reduce the displayed spectrum to the real signal, the Auto ID functionality of the spectrum analyser is used. With this function two sweeps with different local oscillator frequencies were done (SigID USB and SigID LSB). The only signals on frequencies, which were measured during both sweeps were displayed with this function. Because the EUT is a FMCW radar, were the carrier frequency is variated, it might be possible, that both sweeps (SigID USB and SigID LSB) are overlapping and a result for the AutoID is displayed. In this case a plot is provided, that shows the SigID USB and SigID LSB traces for identification.

I all plots, were an external mixer is used, a reference level line is displayed. This line shall not be confused with a limit line. The limits are shown as horizontal display line and will be marked with the extension H1 or H2.

The steps 1) to 5) are defined as preliminary, steps 6) to 12) as final measurement.



Test setup for measurements from 40 GHz to 325 GHz

5.6.2 Test results (radiated emissions)

5.6.2.1 Preliminary radiated emission measurement (10 MHz to 231 GHz)

Ambient temperature	22 °C	Relative humidity	40 %

Position of EUT: The EUT was set-up on a turn device of a height of 1.5 m (20 MHz to 40 GHz) or a non-conducting support on a turntable (40 GHz to 231 GHz). The distance between EUT and antenna was 3 m (10 MHz to 26.5 GHz), 1 m (26.5 GHz to 81 GHz), 30 cm (81 GHz to 110 GHz, 162 GHz to 231 GHz), and 10 cm (110 to 162 GHz).

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

Test record: The plots of this measurement are documented in annex A, clause 3 of this test report.

Supply voltage: During this test the EUT was powered with 12 V_{DC} by an external power supply.

Frequency range: The preliminary measurement was carried out in the frequency range 10 MHz to 162 GHz / 231 GHz according to [4] / [3].

Remark: The horizontal line on -22.000 dBm / -11.000 dBm on the plots above 40 GHz is the reference level of the spectrum analyser.

Where a limit is given as power density it was converted according to [1] to an equivalent isotropically radiated power with the following equation:

$EIRP_{Linear} = PD \times 4 \times \pi \times d^2$

Where:
PD is the power density at the distance specified by the limit, in W/m^2,
$EIPR_{Linear}$ is the equivalent isotropically radiated power, in watts,
d is the distance at which the power density limit is specified, in m.

So, the FCC CFR 47 Part 95.3379 limits were converted as follows:

Frequency range	Power density @ distance	EIRP value
40 GHz to 200 GHz	600 pW/cm^2	-1.7 dBm
200 GHz to 231 GHz	1000 pW/cm^2	0.5 dBm

Test equipment used (refer clause 6):

1 - 43, 45 - 47

5.6.2.2 Final radiated emission measurement (20 MHz to 30 MHz)

No emissions above the noise floor of the measuring system (32.6 dBµV/m or -18.9 dBµA/m), measured with peak detector at 3 m measuring distance) were found. Therefore, no final measurement was carried out on an outdoor test site.

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

Ambient temperature	22 °C	Relative humidity	56 %

Position of EUT: The EUT was set-up on a turn device 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 B of this test report.

Test record: All results are shown in the following.

Supply voltage: During this test the EUT was powered with 12 V_{DC} by an external power supply.

Test results: The test results were calculated with the following formula:
Result [dBµV/m] = reading [dBµV] + correction [dB] (cable loss antenna factor + 6 dB (used attenuator)).

The measurement time with the final detector is 1 second.

Result measured with the quasi-peak detector (variant 1):

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Evaluation [deg]	Pol.
60.465	6.4	40.0	33.6	-6.1	12.5	133	69	0	Vert.
64.030	14.2	40.0	25.8	1.7	12.5	100	201	90	Vert.
73.170	3.4	40.0	36.6	-10.4	13.8	181	279	90	Vert.
108.070	11.7	43.5	31.8	-5.8	17.5	106	161	90	Vert.
109.700	13.1	43.5	30.5	-4.6	17.6	110	142	90	Vert.
555.690	19.0	46.0	27.1	-9.6	28.6	102	325	0	Hor.
Measurement uncertainty					±5.5 dB				

Result measured with the quasi-peak detector (variant 4):

Frequency [MHz]	Result [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Readings [dBµV]	Correction [dB]	Height [cm]	Azimuth [deg]	Evaluation [deg]	Pol.
35.685	20.7	40.0	19.3	-4.1	24.8	108	194	90	Vert.
38.090	15.8	40.0	24.2	-7.7	23.5	107	209	0	Vert.
59.720	3.0	40.0	37.1	-9.7	12.6	122	325	0	Vert.
89.400	6.2	43.5	37.3	-10.0	16.2	166	216	0	Hor.
125.155	8.3	43.5	35.3	-10.4	18.6	133	228	0	Vert.
213.045	6.2	43.5	37.3	-10.0	16.2	187	233	0	Hor.
562.490	19.6	46.0	26.4	-8.9	28.5	110	188	0	Vert.
Measurement uncertainty					±5.5 dB				

Test: Passed

Test equipment used (refer clause 6):

1 - 11, 45, 46

5.6.2.4 Final radiated emission measurement (1 GHz to 231 GHz)

Ambient temperature	22 °C	Relative humidity	40 %

Position of EUT: The EUT was set-up on a turn device of a height of 1.5 m (1 GHz to 40 GHz) or a non-conducting support on a turntable (40 GHz to 231 GHz). The distance between EUT and antenna was 3 m (1 GHz to 26.5 GHz), 1 m (26.5 GHz to 81 GHz), 30 cm (81 GHz to 110 GHz and 162 GHz to 231 GHz), and 10 cm (110 to 162 GHz).

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

Supply voltage: During this test the EUT was powered with 12 V_{DC} by an external power supply.

Remark: Where a limit is given as power density it was converted according to [1] to an equivalent isotropically radiated power with the following equation:

$EIRP_{Linear} = PD \times 4 \times \pi \times d^2$

Where:
PD is the power density at the distance specified by the limit, in W/m^2,
$EIPR_{Linear}$ is the equivalent isotropically radiated power, in watts,
d is the distance at which the power density limit is specified, in m.

So, the FCC CFR 47 Part 95.3379 limits were converted as follows:

Frequency range	Power density @ distance	EIRP value
40 GHz to 200 GHz	600 pW/cm^2	-1.7 dBm
200 GHz to 231 GHz	1000 pW/cm^2	0.5 dBm

Result measured with the Average detector (variant 1):

Results according to [3]						
Results according to [3] and [4] in the frequency range 1 GHz to 40 GHz						
Frequency range [GHz]	Used antenna	Measuring distance [m]	Max. signal level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result
1 - 12	HL050	3	36.5	54.0	17.5	Passed
12 - 18	Flann 18240	3	29.1	54.0	24.9	Passed
18 - 26.5	Flann 20240	3	34.5	54.0	19.5	Passed
26.5 - 40	Flann 22240	1	33.7	54.0	20.3	Passed
Results according to [3] in the frequency range 40 GHz to 231 GHz						
Frequency range [GHz]	Used antenna	Measuring distance [m]	Max. signal level [dBm]	Limit [dBm]	Margin [dB]	Result
40 - 55	Flann 24240	1	-45.0	-1.7	43.3	Passed
55 - 73.5	Flann 25240	1	-39.6	-1.7	37.9	Passed
73.5 - 76	Flann 26240	1	-38.4	-1.7	36.7	Passed
77 - 81	Flann 26240	1	-39.4	-1.7	37.7	Passed
81 - 110	Flann 27240	0.3	-39.7	-1.7	38.0	Passed
110 - 140	Flann 28240	0.1	-39.4	-1.7	37.7	Passed
140 - 162	Flann 29240	0.1	-43.7	-1.7	42.0	Passed
162 - 170	Flann 29240	0.3	-34.0	-1.7	32.3	Passed
170 - 200	Flann 30240	0.3	-28.7	-1.7	27.0	Passed
200 - 220	Flann 30240	0.3	-28.1	0.5	28.6	Passed
220 - 231	Flann 32240	0.3	-14.9	0.5	15.4	Passed
Results according to [4] in the frequency range 40 GHz to 162 GHz						
Frequency range [GHz]	Used antenna	Measuring distance [m]	Max. signal level [dBm]	Limit [dBm]	Margin [dB]	Result
40 - 55	Flann 24240	1	-45.0	-30.0	15.0	Passed
55 - 73.5	Flann 25240	1	-39.6	-30.0	9.6	Passed
73.5 - 76	Flann 26240	1	-38.4	0.0	38.4	Passed
77 - 81	Flann 26240	1	-39.4	-30.0	9.4	Passed
81 - 110	Flann 27240	0.3	-39.7	-30.0	9.7	Passed
110 - 140	Flann 28240	0.1	-39.4	-30.0	9.4	Passed
140 - 162	Flann 29240	0.1	-43.7	-30.0	13.7	Passed
Measurement uncertainty			±4.7 dB			

Test equipment used (refer clause 6):

12 - 13, 45 - 47

5.7 Frequency stability

5.7.1 Method of measurement (frequency stability)

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.

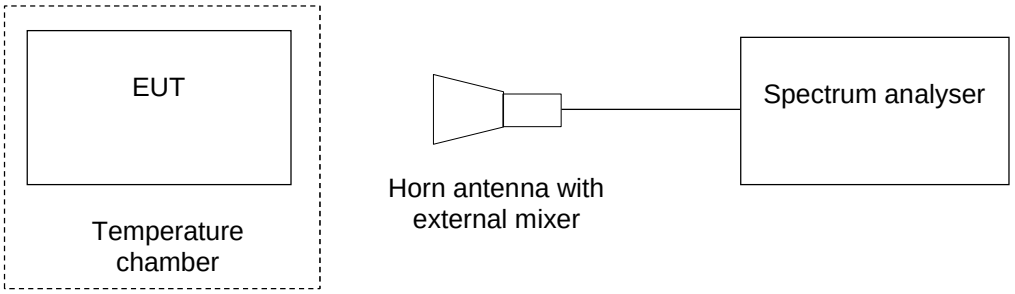
The following spectrum analyser settings according to [1] shall be used:

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Span: Twice the nominal channel frequency, centered at 76.5 GHz.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: 3 MHz.
- Sweep points: At least span / 1 MHz
- Sweep time: Twice the minimum sweep time / sweep point.
- Detector function: Peak.
- Trace mode: Max hold.
- Vertical lines: Line 1 set to 76 GHz, line 2 set to 77 GHz

The following procedure shall be used:

1) The EUT has to be placed inside the temperature chamber.
2) Start temperature is the highest operating temperature, which is declared by the applicant or 50 °C, whatever is higher.
3) After the temperature is stabilized, the EUT has to be switched on. After trace stabilization the one marker shall be set on the signal peak. A second marker shall be set to the highest peak near the lower band edge, a third marker shall be set to the highest peak near the upper band edge. These two markers have to be inside the assigned frequency band (between the vertical lines 1 and 2. The transmitting signal shall be documented and the EUT has to be switched off.
4) The temperature than shall be changed in 10 deg steps in the temperature range 50 °C to -20 °C and step 3) must be repeated.
5) In case the lowest operating temperature declared by the applicant is lower than -20 °C, repeat step 3) for this temperature.

Test set-up:



5.7.2 Test results (frequency stability)

Ambient temperature	23 °C	Relative humidity	46 %

Position of EUT: The EUT was set-up on a non-conducting support inside the temperature chamber. The measurement distance was 1 m.

Cable guide: For further information of the cable guide refer to the pictures in annex B of this test report.

Test record: The plots of this measurement are documented in annex A, clause 4 of this test report.

Supply voltage: During this test the EUT was powered with 8 to 16 V_{DC} by an external power supply.

Frequency stability						
Test conditions		f_{low}	Lower limit	f_{high}	Upper limit	Result
Temp.	Voltage	[GHz]	[GHz]	[GHz]	[GHz]	
T_{max} (+85 °C	U_{nom} (12.0 V_{DC})	76.0365	76.0	76.9585	77.0	Passed
+50 °C	U_{nom} (12.0 V_{DC})	76.0374	76.0	76.9585	77.0	Passed
+40 °C	U_{nom} (12.0 V_{DC})	76.0385	76.0	76.9595	77.0	Passed
+30 °C	U_{nom} (12.0 V_{DC})	76.0385	76.0	76.9595	77.0	Passed
T_{nom} (20 °C)	U_{nom} (12.0 V_{DC})	76.0385	76.0	76.9585	77.0	Passed
	U_{min} (8.0 V_{DC})	76.0375	76.0	76.9585	77.0	Passed
	U_{max} (16.0 V_{DC})	76.0385	76.0	76.9585	77.0	Passed
+10 °C	U_{nom} (12.0 V_{DC})	76.0385	76.0	76.9605	77.0	Passed
0 °C	U_{nom} (12.0 V_{DC})	76.0395	76.0	76.9615	77.0	Passed
-10 °C	U_{nom} (12.0 V_{DC})	76.0395	76.0	76.9615	77.0	Passed
-20 °C	U_{nom} (12.0 V_{DC})	76.0395	76.0	76.9615	77.0	Passed
T_{min} (-40 °C)	U_{nom} (12.0 V_{DC})	76.0395	76.0	76.9615	77.0	Passed
Measurement uncertainty		$<1*10^{-7}$				

Test equipment used (refer clause 6):

29, 30, 44 - 47

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Semi anechoic chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
2	RF Switch Matrix	OSP220	Rohde & Schwarz		482976	Calibration not necessary	
3	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
4	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
5	Positioner	TG1.5-10kg	Maturo	110/2648.01	483042	Calibration not necessary	
6	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
7	System software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
8	Antenna (Bilog)	CBL6111D	Schaffner	25761	480894	19.10.2017	10.2020
9	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	14.02.2020	02.2022
10	EMI Test receiver ESW	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
11	Cable C417	Sucoflex 118	Huber+Suhner	500654/118	-	Calibration not necessary	
12	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Calibration not necessary	
13	EMI Receiver / Spectrum Analyser	ESW44	Rohde & Schwarz	101635	482467	18.02.2020	02.2022
14	Log.Per. antenna	HL050	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
15	Preamplifier 100 MHz – 16 GHz	AFS6-00101600-23-10P-6-R	MITEQ	2011215	482333	13.02.2020	02.2022
16	RF-cable No.3	Sucoflex 106B	Suhner	0563/6B	480670	Calibration not necessary	
17	RF-cable 40	Sucoflex 106B	Suhner	0708/6B	481330	Calibration not necessary	
18	Standard Gain Horn 12 GHz – 18 GHz	18240-20	Flann	483	480294	Calibration not necessary	
19	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ	571667	480343	13.02.2020	02.2022
20	Standard Gain Horn 18 GHz – 26.5 GHz	20240-20	Flann	411	480297	Calibration not necessary	
21	Preamplifier 18 GHz - 26 GHz	JS4-18002600-20-5A	MITEQ	658697	480342	13.02.2020	02.2022
22	Standard Gain Horn 26.5 GHz – 40 GHz	22240-20	Flann	468	480298	Calibration not necessary	
23	Preamplifier 26 GHz - 40 GHz	JDM2-26004000-25-10P	MITEQ	128746	482806	17.02.2020	02.2022
24	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire	-	480302	Calibration not necessary	
25	Standard Gain Horn 40 GHz - 60 GHz	24240-20	Flann	263442	482858	Calibration not necessary	
26	Harmonic mixer 40 GHz - 60 GHz	FS-Z60	Radiometer Physics	100980	482708	11.03.2020	03.2021
27	Standard Gain Horn 50 GHz - 75 GHz	25240-20	Flann	263443	482859	Calibration not necessary	
28	Harmonic mixer 50 GHz - 75 GHz	FS-Z75	Radiometer Physics	101067	482705	11.03.2020	03.2021

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
29	Standard Gain Horn 60 GHz - 90 GHz	26240-20	Flann	262498	482860	Calibration not necessary	
30	Harmonic mixer 60 GHz - 90 GHz	FS-Z90	Radiometer Physics	101795	482706	11.03.2020	03.2021
31	Standard Gain Horn 75 GHz - 110 GHz	27240-20	Flann	263447	482861	Calibration not necessary	
32	Harmonic mixer 75 GHz - 110 GHz	FS-Z110	Radiometer Physics	101528	482707	11.03.2020	03.2021
33	Standard Gain Horn 90 GHz – 140 GHz	28240-20	Flann	263449	482862	Calibration not necessary	
35	Harmonic mixer 90 GHz – 140 GHz	FS-Z140	Radiometer Physics	101132	482837	12.03.2020	03.2022
36	Standard Gain Horn 140 GHz – 220 GHz	30240-20	Flann	263476	482864	Calibration not necessary	
37	Harmonic mixer 140 GHz – 220 GHz	FS-Z220	Radiometer Physics	101022	482839	12.03.2020	03.2022
38	Standard Gain Horn 110 GHz – 170 GHz	29240-20	Flann	263464	482863	Calibration not necessary	
39	Harmonic mixer 110 GHz – 170 GHz	FS-Z170	Radiometer Physics	100978	482838	12.03.2020	03.2022
40	Standard Gain Horn 220 GHz – 330 GHz	32240-20	Flann	263475	482865	Calibration not necessary	
41	Harmonic mixer 220 GHz – 325 GHz	FS-Z325	Radiometer Physics	101008	482840	12.03.2020	03.2022
42	RF-cable 0.5 m	Sucoflex 102	Huber+Suhner	510210/2	483030	Calibration not necessary	
43	RF-cable 0.5 m	Sucoflex 102	Huber+Suhner	510213/2	483031	Calibration not necessary	
44	Temperature chamber	MK 240	Binder	05-79022	480462	09.07.2020	07.2021
45	Power supply	TOE8951	Toellner	81996	481253	Calibration not necessary	
46	Multimeter	971A	Hewlett Packard	JP39009358	480721	16.01.2020	01.2021480462
47	Spectrum Analyser	FSW43	Rohde & Schwarz	100586 & 100926	481720	04.03.2020	03.2022

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA	ANSI C63.4-2014	19.09.2019	18.09.2021
Fully anechoic chamber M20	480303	1 -18 GHz	SVSWR	CISPR 16-1-4 Amd. 1	13.07.2018	12.07.2020

8 Report history

Report Number	Date	Comment
F201003E1	29.07.2020	Document created

9 List of annexes

Annex A	Measurement results	31 pages
Annex B	Test setup photographs	13 pages
Annex C	External EUT photographs	16 pages
Annex D	Internal EUT photographs	12 pages

The photographs in this annex are provided by the applicant (refer also clause 3 of this report)