

Test Report

Report Number:

F161791E3

Equipment under Test (EUT):

**125 kHz Burette Reader Module
THVAC001
inside representative host "Dosing Unit"**

Applicant:

Mettler-Toledo GmbH

Manufacturer:

Mettler-Toledo GmbH



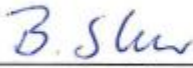
Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

- [1] **ANSI C63.10: 2013** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15 (October 2015)** Radio Frequency Devices
- [3] **RSS-210 Issue 9 (August 2016)** Licence-Exempt Radio Apparatus: Category I Equipment
- [4] **RSS-Gen Issue 4 (November 2014)** General Requirements for Compliance of Radio Apparatus

Test result

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

Test engineer:	Thomas KÜHN		10/05/2017
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		10/05/2017
	Name	Signature	Date

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1 Identification

1.1 Applicant

Name:	Mettler-Toledo GmbH
Address:	Sonnenbergstrasse 74 CH-8603 Schwerzenbach
Country:	Switzerland
Name for contact purposes:	Mr. René RISSI
Phone:	+41 44 806 73 82
eMail Address:	rene.rissi@mt.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	Mettler-Toledo GmbH
Address:	Sonnenbergstrasse 74 CH-8603 Schwerzenbach
Country:	Switzerland
Name for contact purposes:	Mr. René RISSI
Phone:	+41 44 806 73 82
eMail Address:	rene.rissi@mt.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-17186-01-02, 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)

Type object: *	125 kHz Burette Reader Module inside representative host „Dosing Unit“
Model name / HVIN: *	THVAC001
PMN: *	THVAC001
Serial No.:	51109030
FCC ID: *	THVAC001
IC: *	22032-THVAC001
PCB identifier:	51109830
Hardware version: *	N. a.
Software version / FVIN: *	V 1.2
Lowest internal frequency: *	Not provided by the applicant
Highest internal frequency: *	125 kHz

*: declared by the applicant.

1.5 Technical data of equipment

Channel 1	RX:	125 kHz	TX:	125 kHz
Rated RF output power: *	<1 μ W			
Antenna type: *	Wired coil antenna with 0.008 m ²			
Number of channels: *	1			
Antenna connector: *	None			
Modulation: *	ASK			
Data rate: *	5.2 kbit/s			
Supply voltage: *	U _{Nom} =	230 V _{AC}	U _{Min} =	90 V _{AC}
			U _{Max} =	264 V _{AC}
Power supply: *	External by FSP120-AAAN2 (dedicated AC/DC adaptor)			
Temperature range: *	0 °C to 40 °C			
Ancillary used for test:	FSP120-AAAN2 (dedicated AC/DC adaptor) for Excellence Titrator T9 with Terminal (support devices) and Dosing Unit (host)			

*: declared by the applicant.

Ports / Connectors (support device)			
Identification	Connector		Length during test
	EUT	Ancillary	
Power supply input	C14 Connector	Fixed	2.0 m
Terminal	HDMI	HDMI	1.0.m
CAN OUT	RJ-11	RJ-11	3.0.m
All other Ports were left open during the tests			

Ports / Connectors (EUT inside Host)			
Identification	Connector		Length during test
	EUT	Ancillary	
CAN IN / power in	RJ-11	RJ-11	3.0.m
All other Ports were left open during the tests			



1.6 Dates

Date of received of test sample:	10/26/2016
Start of test:	10/26/2016
End of test:	02/13/2016

2 Operational states and test setup

The EUT is 125 kHz RFID reader module, which could not be tested on a standalone basis. Therefore it was tested mounted inside a representative host device (Dosing Unit).

As declared by the applicant, the support device (Excellence Titrator T9) will always be used with a dedicated AC/DC adaptor type FSP120-AAAN2, and the host (Dosing Unit with 125 kHz RFID module) will always be supplied by the support device with 24 V_{DC}. Therefore the support device is fully covered by separate test report.

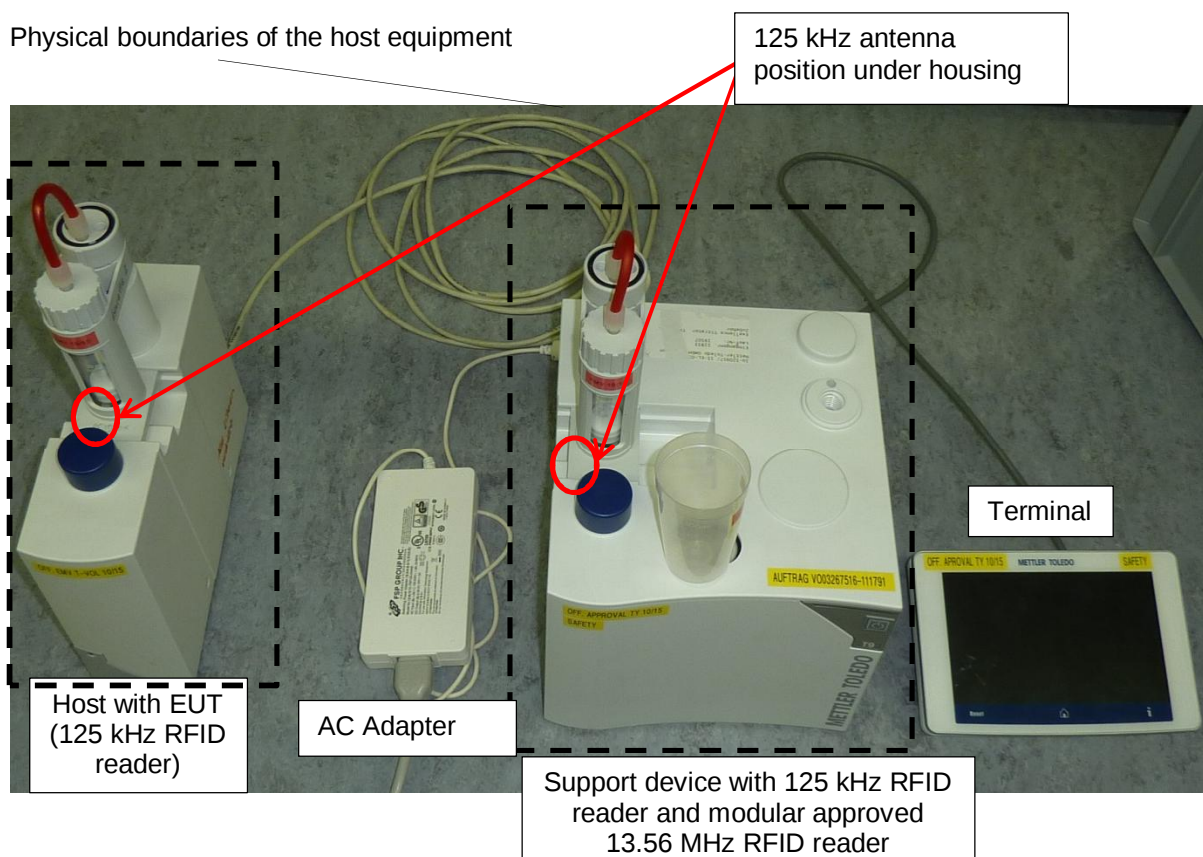
The host and support device are both classified as class A digital devices. Because the emissions of the devices are much higher than the emissions caused by the RFID reader, the devices were measured with and without transmitter antennas connected in order to identify the source of the emissions found.

The 125 kHz RFID chip is: HTRC101 (NXP Semiconductors)

During all measurements a burette with integrated TAG was mounted on the host devices.

All measurements were carried out with an unmodified sample operating in a test mode. The test mode was entered by the control panel. With this test mode the TAG data were cyclic read and the TAG was written.

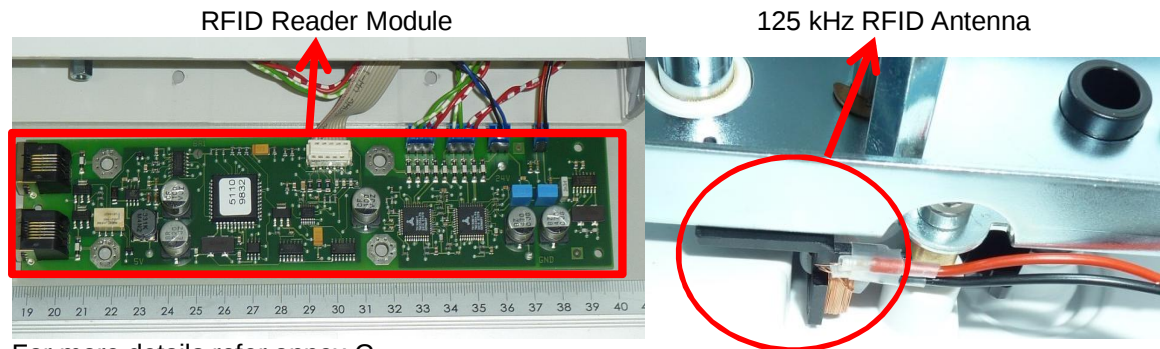
Physical boundaries of the host equipment



3 Additional information

The EUT was not labelled as required by FCC / IC.

Host: 125 kHz RFID Module mounted inside Dosing Unit



For more details refer annex C.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-Gen, Issue 4 [4] and RSS-210, Issue 9 [3]	Status	Refer page
Conducted emissions on supply line	0.15 – 30	15.207 (a)	8.8 [4]	Passed	9 et seq.
Radiated emissions	0.009 – 1.000	15.205 (a) 15.209 (a)	8.9, 8.10 [4] 4.4 [3]	Passed	13 et seq.
99 % bandwidth	0.125	-	6.6 [4]	-	29 et seq.
Antenna requirement	-	15.203 [2]	-	Passed *	-

*: Integrated antenna only, requirement fulfilled.

5 Results

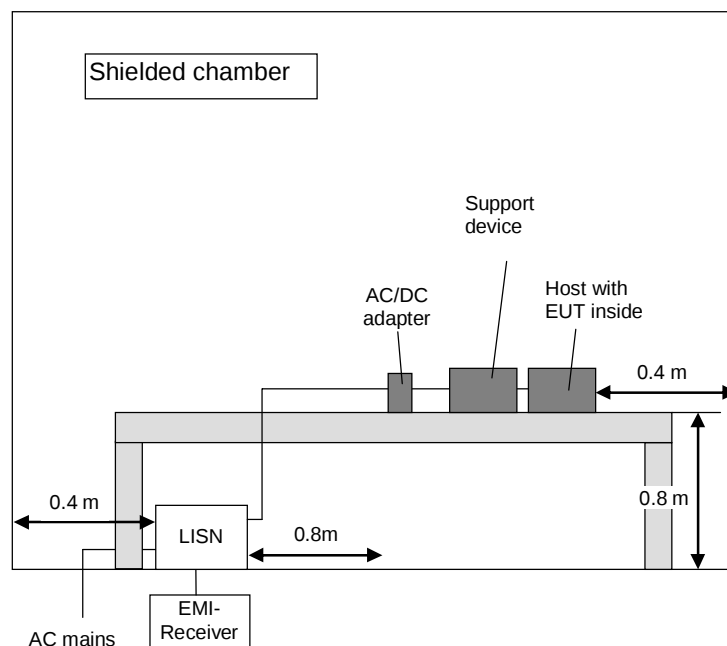
5.1 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.1.1 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



5.1.2 Test results (conducted emissions on power supply lines)

Ambient temperature	21 °C	Relative humidity	59 %
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Position of EUT: The Host and the support unit was set-up on a non-conducting table of a height of 0.8 m.

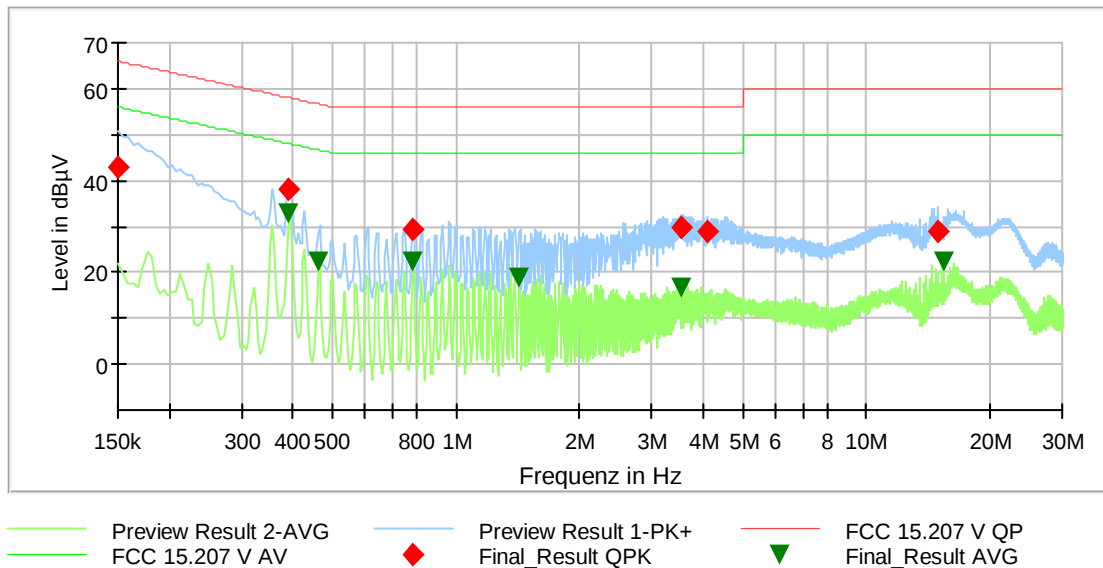
Cable guide: The cables of the host and the support device were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: The test was carried out in TAG reading and writing mode of the EUT (refer also clause 2 of this test report). All results are shown in the following.

Supply voltage: During this test the host was powered with 24 V_{DC} from the support unit, which was powered by the FSP120-AAAN2, which was itself supplied 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 ◆ and the average measured points by ▼.

Host + support device RFIDs in TAG reading and writing mode

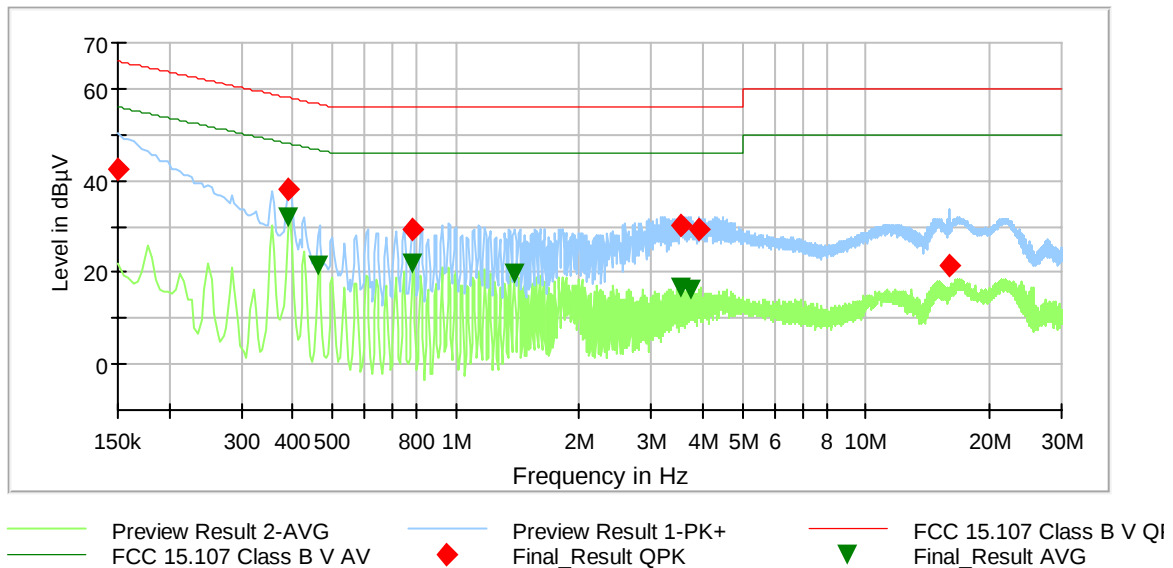


Data record name: 161791_AC_MainUnitActiveRFID+DosingUnitActiveRFID

Remark: The limits of FCC 15.207 are identical to [3]

Frequency (MHz)	QuasiPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Transducer (dB)
0.150000	43.1	---	66.0	22.9	5000.0	9.000	N	GND	9.8
0.392100	---	32.7	48.0	15.3	5000.0	9.000	N	FLO	9.9
0.392100	38.3	---	58.0	19.7	5000.0	9.000	N	FLO	9.9
0.463200	---	22.2	46.6	24.4	5000.0	9.000	L1	FLO	9.9
0.784500	---	22.4	46.0	23.6	5000.0	9.000	L1	FLO	9.9
0.788100	29.3	---	56.0	26.7	5000.0	9.000	L1	FLO	9.9
1.425300	---	19.0	46.0	27.0	5000.0	9.000	L1	FLO	9.9
3.534000	---	16.6	46.0	29.4	5000.0	9.000	L1	GND	10.3
3.538500	29.9	---	56.0	26.1	5000.0	9.000	L1	GND	10.3
4.101900	29.0	---	56.0	27.0	5000.0	9.000	L1	GND	10.3
14.997300	29.1	---	60.0	30.9	5000.0	9.000	N	FLO	10.8
15.500400	---	22.3	50.0	27.7	5000.0	9.000	L1	FLO	10.8
Measurement uncertainty				+2.78 dB / -2.78 dB					

Host + support device without RFID antennas (antennas plugged out)



Data record name: 161791_AC_MainUnit+DosingUnit_digPart

Remark: The limits of FCC 15.207 are identical to [3]

Frequency (MHz)	QuasiPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Transducer (dB)
0.150000	42.5	---	66.0	23.5	5000.0	9.000	N	GND	9.8
0.392100	---	31.9	48.0	16.1	5000.0	9.000	L1	FLO	9.9
0.392100	37.9	---	58.0	20.1	5000.0	9.000	L1	GND	9.9
0.463200	---	21.5	46.6	25.1	5000.0	9.000	L1	GND	9.9
0.784500	---	21.8	46.0	24.2	5000.0	9.000	L1	GND	9.9
0.788100	29.3	---	56.0	26.7	5000.0	9.000	L1	FLO	9.9
1.391100	---	19.6	46.0	26.4	5000.0	9.000	L1	FLO	9.9
3.534000	---	16.5	46.0	29.5	5000.0	9.000	L1	GND	10.3
3.538500	30.1	---	56.0	25.9	5000.0	9.000	L1	GND	10.3
3.748200	---	16.1	46.0	29.9	5000.0	9.000	L1	GND	10.3
3.924600	29.4	---	56.0	26.6	5000.0	9.000	L1	GND	10.3
15.998100	21.6	---	60.0	38.4	5000.0	9.000	N	FLO	10.9
Measurement uncertainty					+2.78 dB / -2.78 dB				

Test: Passed

Test equipment used (see chapter 6):

1 - 4, 6

5.2 Radiated emissions

5.2.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into six stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test site without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out on an open area test site with reflecting ground plane and various antenna heights in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 5 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 5 GHz.

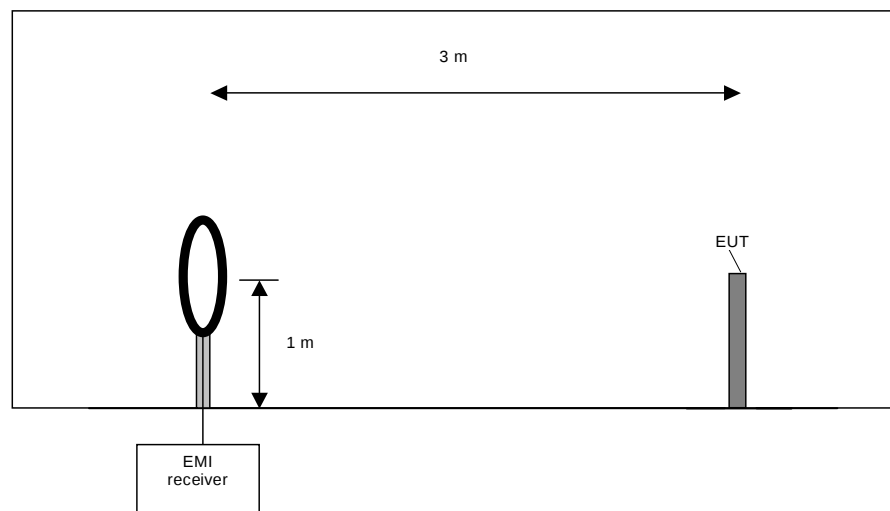
Preliminary measurement (9 kHz to 30 MHz):

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).

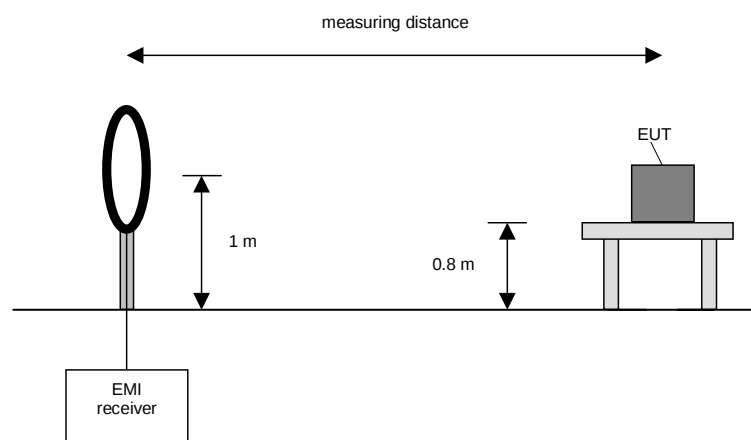
Final measurement (9 kHz to 30 MHz):

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).

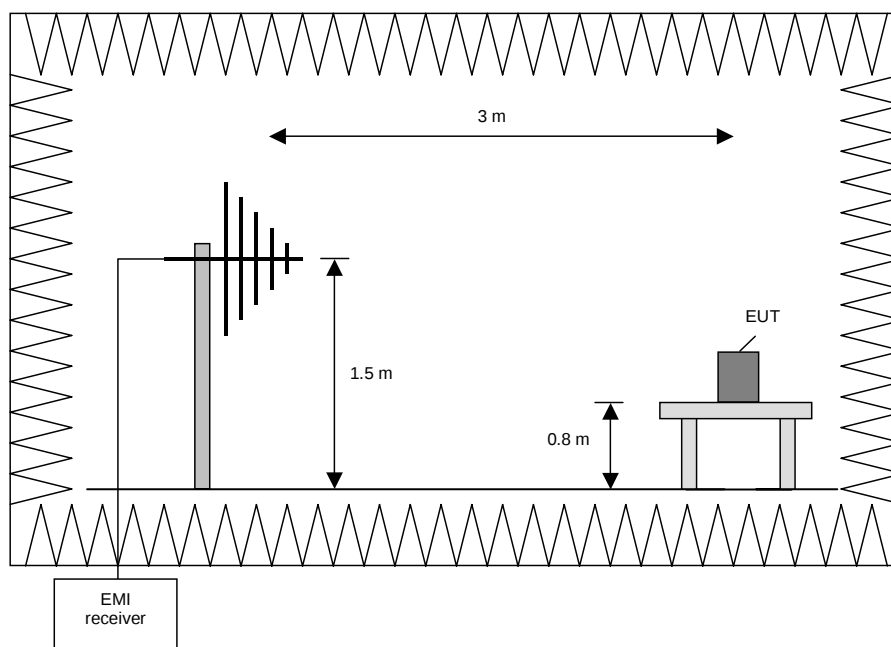
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to [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 120 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °.

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure preliminary measurement:

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

The following procedure will be used:

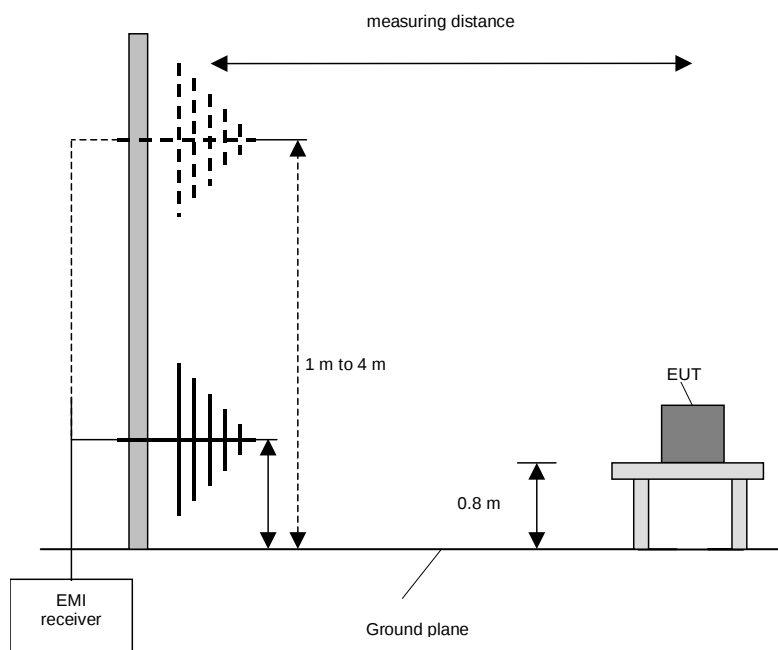
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the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

Final measurement (30 MHz to 1 GHz)

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

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

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

Preliminary and final measurement (1 GHz to 110 GHz)

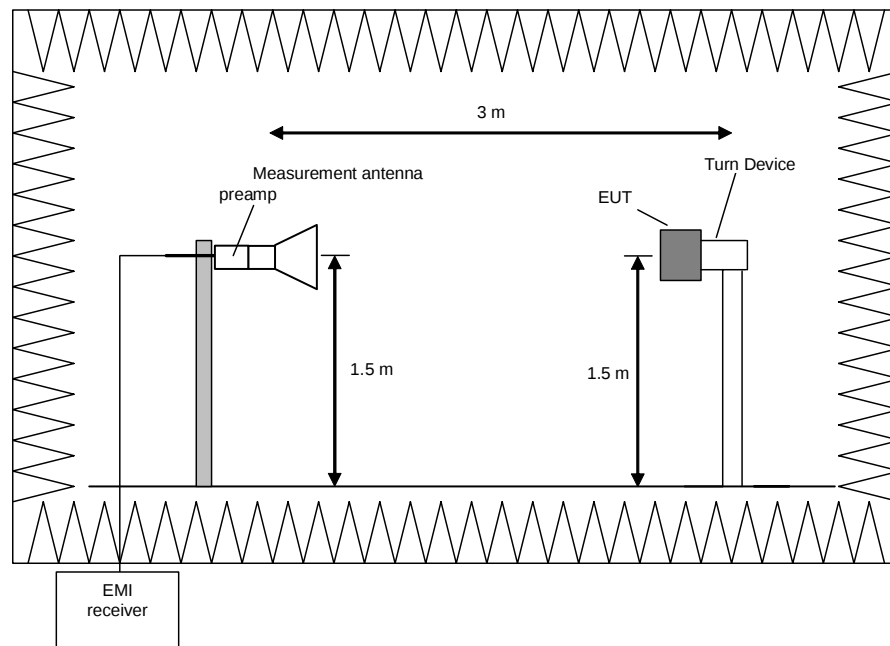
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 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	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure preliminary measurement:

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

The following procedure will be used:

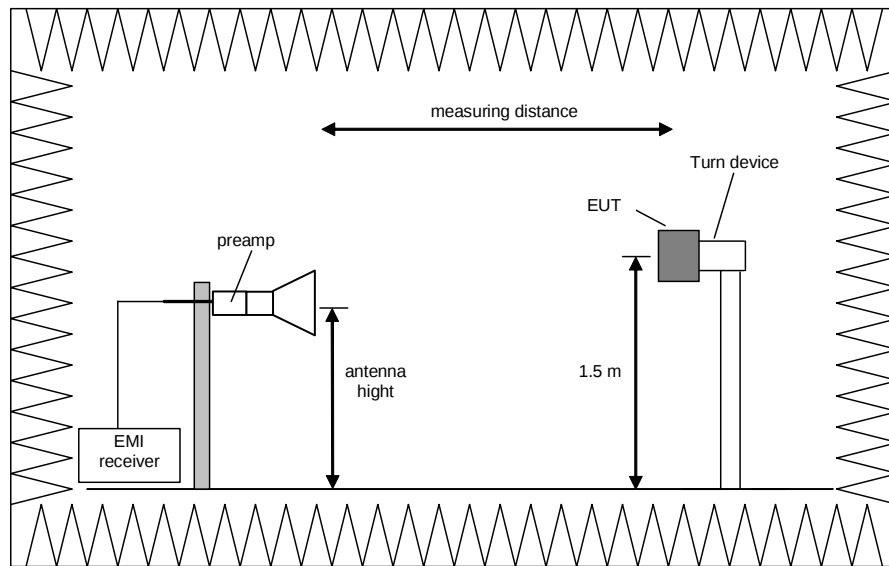
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0°.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle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

The frequency range will be divided into different sub ranges depending of the frequency range of the used 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 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 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.

5.2.2 Results preliminary measurement 9 kHz to 1 GHz

Ambient temperature	22 °C	Relative humidity	62 %
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Position of EUT: The host was set-up on a non-conducting table, the support device was placed in the false floor.

Cable guide: The cable of the host 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.

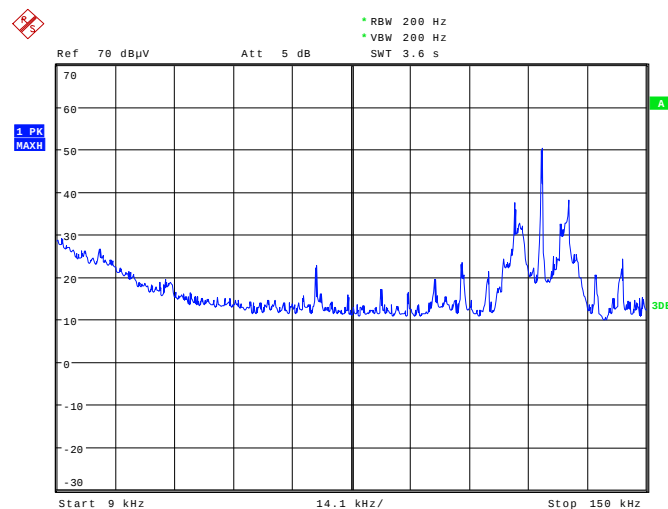
Test record: The test was carried out in TAG reading and writing mode of the EUT (refer also clause 2 of this test report). The tests were carried out in two positions; Position 1 host is standing and Position 2 host is lying. The results of the worst case positions are shown in the following. Additionally tests without RFID antennas were carried out to show that the emissions above the limit are from the digital part of the host and not from the tested radio module.

Power supply: During this test the host was powered with 24 V_{DC} via the support device (Excellence Titrator T9) by the FSP120-AAAN2, which was itself supplied with 120 V_{AC} / 60 Hz.

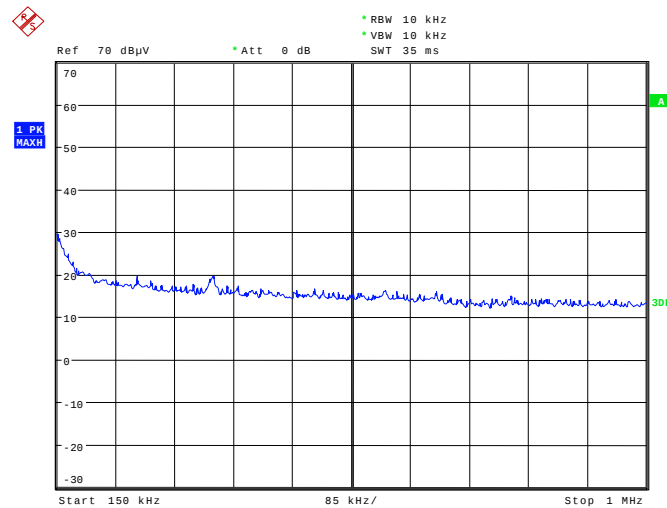
Frequency range: According to [2] from 9 kHz to 1 GHz.

Host RFID in TAG reading and writing mode, support device in false floor

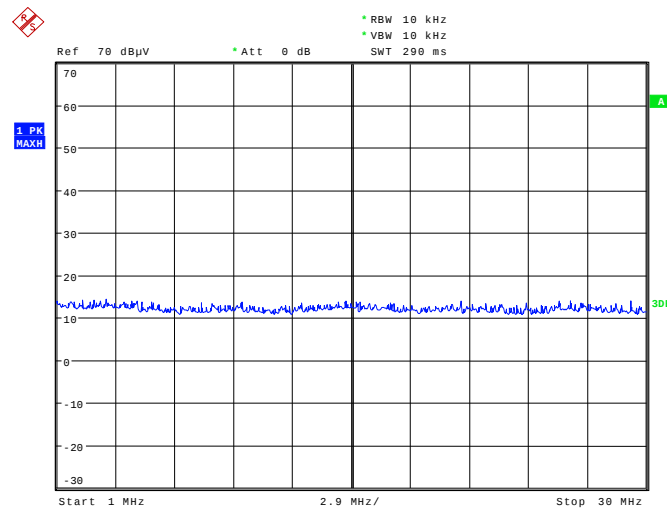
161791_209.wmf: Spurious emissions from 9 kHz to 150 kHz:



161791_210.wmf: Spurious emissions from 150 kHz to 1 MHz:



161791_211.wmf: Spurious emissions from 1 MHz to 30 MHz:

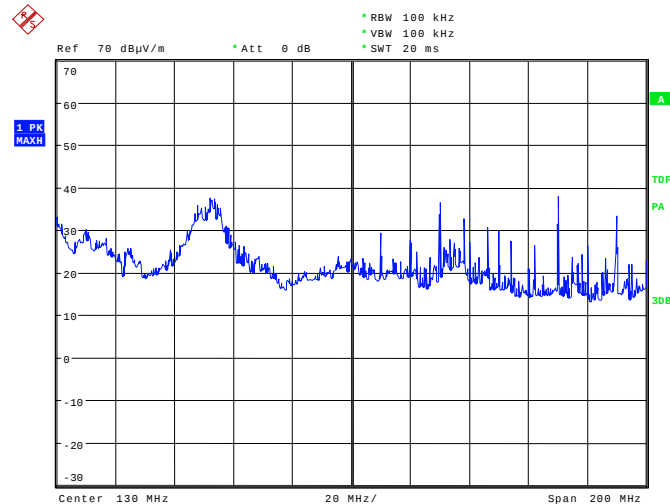


The following emissions were found according to [2] and [3].

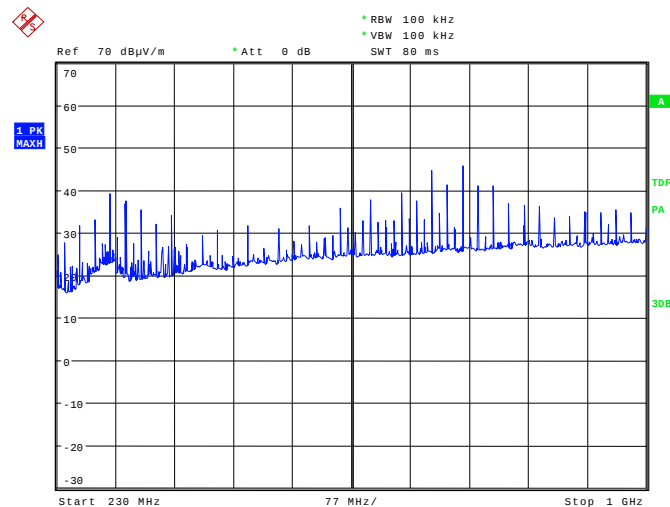
- 71.060 kHz , 105.850 kHz, 118.560 kHz, 125.005 kHz, 131.441 kHz, 144.169 kHz and, 375.015 kHz

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

161791_207.wmf: Spurious emissions from 30 MHz to 230 MHz:



161791_208.wmf: Spurious emissions from 230 MHz to 1 GHz:



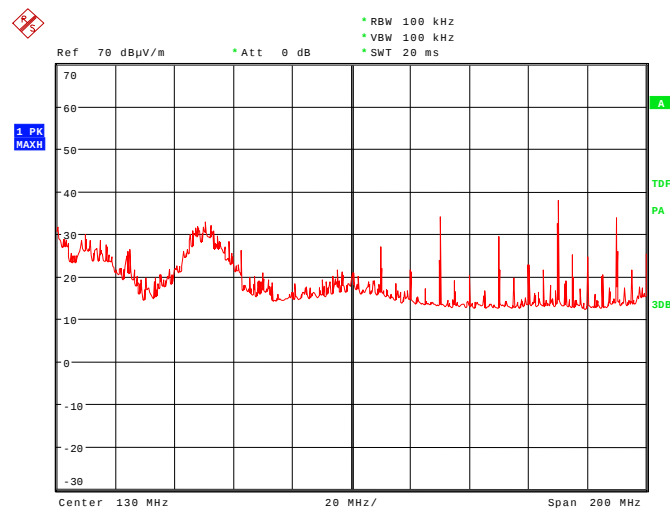
The following frequencies were found emission test outside and inside restricted bands during the preliminary radiated:

- 82.000 MHz, 139.986 MHz, 159.983 MHz, 168.006 MHz, 199.979 MHz, 219.977 MHz, 299.969 MHz, 639.934 MHz, 679.929 MHz, 719.926 MHz, 759.921 MHz

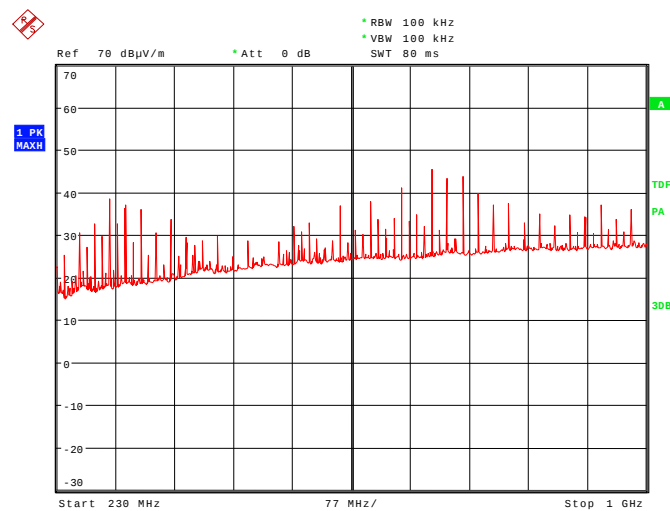
These frequencies have to be measured on the open area test site. The results were presented in the following.

Host without RFID antenna (antenna plugged out):

161791_212.wmf: Spurious emissions from 30 MHz to 230 MHz:



161791_213.wmf: Spurious emissions from 230 MHz to 1 GHz:



Test equipment used (see chapter 6)

30 – 35. 44. 51

5.2.3 Result final measurement from 9 kHz to 30 MHz

Ambient temperature	10 °C	Relative humidity	72 %
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- Position of EUT:** The host was set-up on a non-conducting table of a height of 0.8 m. The distance between host and antenna was 3 m and 10 m.
- Cable guide:** The cable of the host was fixed on the non-conducting support. For further information of the cable guide refer to the pictures in annex A of this test report.
- Test record:** The test was carried out in TAG reading and writing mode of the EUT (refer also clause 2 of this test report). The tests were carried out in two positions, Position 1 EUT is standing and Position 2 EUT is lying. The results of the worst case positions are shown in the following. Additionally tests without RFID antennas were carried out to show that the emissions above the limit are from the digital part of the EUT and not from the tested radio module.
- Power supply:** During this test the host was powered with 24 V_{DC} via the support device (Excellence Titrator T9) by the FSP120-AAAN2, which was itself supplied with 120 V_{AC} / 60 Hz.
- Test results:** The test results were calculated with the following formula:
Result [dBμV/m] = reading [dBμV] + antenna factor [dB/m]

Host RFID in TAG reading and writing mode

Results with measuring distance of 3 m						
Frequency (kHz)	Result (dBμV/m)	Limit ²⁾ (dBμV/m)	Margin (dB)	Detector	Readings (dBμV)	Antenna factor ¹⁾ (dB/m)
71.06	40.5	110.6	70.1	AV	20.5	20.0
105.85	32.6	107.1	74.5	QP	12.6	20.0
118.56	25	106.1	81.1	AV	5	20.0
131.441	30.7	105.2	74.5	AV	10.7	20.0
144.169	28.3	104.4	76.1	AV	8.3	20.0
375.015	27.2	96.1	68.9	AV	7.2	20.0
Results with measuring distance of 10 m						
Frequency (kHz)	Result (dBμV/m)	Limit ²⁾ (dBμV/m)	Margin (dB)	Detector	Readings (dBμV)	Antenna factor ¹⁾ (dB/m)
125.005 ³⁾	44.3	85.7	41.4	AV	24.3	20.0
-	All signals were below the noise floor of the measuring system at 10 m distance					
Measurement uncertainty: +4.69 dB / -4.69 dB						

- ¹⁾: Cable loss included
²⁾: Limits according to [2] and [3] extrapolated with a factor of 40 dB/decade according to [2]
³⁾: Wanted signal RFID system

Test: Passed

Test equipment used for the test:

31. 51. 53

5.2.4 Result final measurement from 30 MHz to 1 GHz

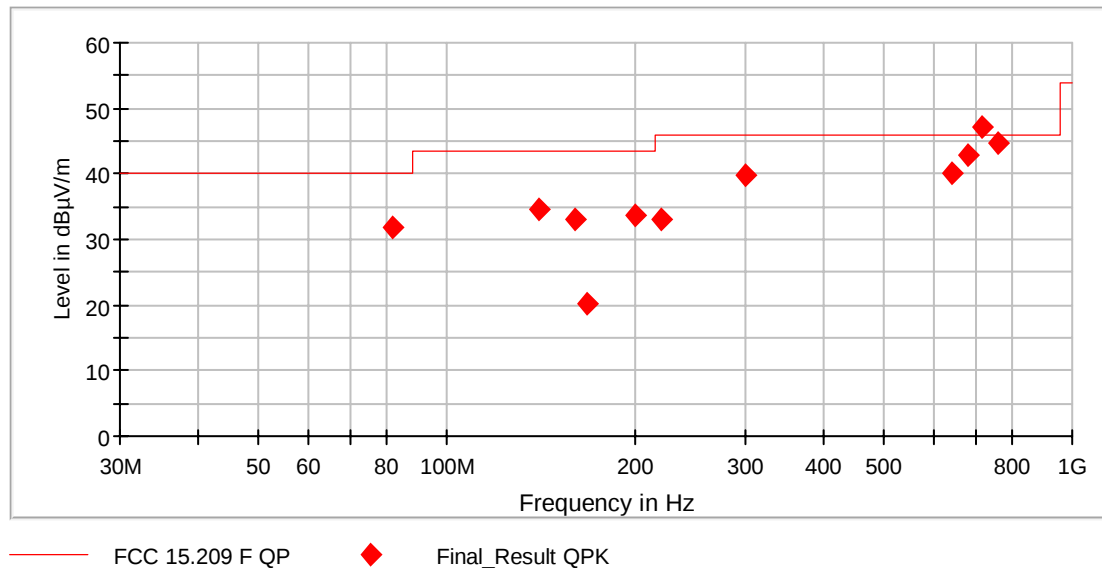
Ambient temperature	22 °C	Relative humidity	60 %
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- Position of EUT:** The EUT was setup on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.
- Test record:** The test was carried out in TAG reading and writing mode of the EUT (refer also clause 2 of this test report). The tests were carried out in two positions, Position 1 host is standing and Position 2 host is lying. The results of the worst case positions are shown in the following. Additionally tests without RFID antennas were carried out to show that the emissions above the limit are from the digital part of the EUT and not from the tested radio module.
- Power supply:** During this test the host was powered with 24 VDC via the support device (Excellence Titrator T9) by the FSP120-AAAN2, which was itself supplied with 120 VAC / 60 Hz.
- Test results:** The test results were calculated with the following formula:
- $$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]} + 6 \text{ dB}$$

The measured points and the limit line in the following diagrams refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with an ◆ 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 seconds.

Host RFID in TAG reading and writing mode position 1

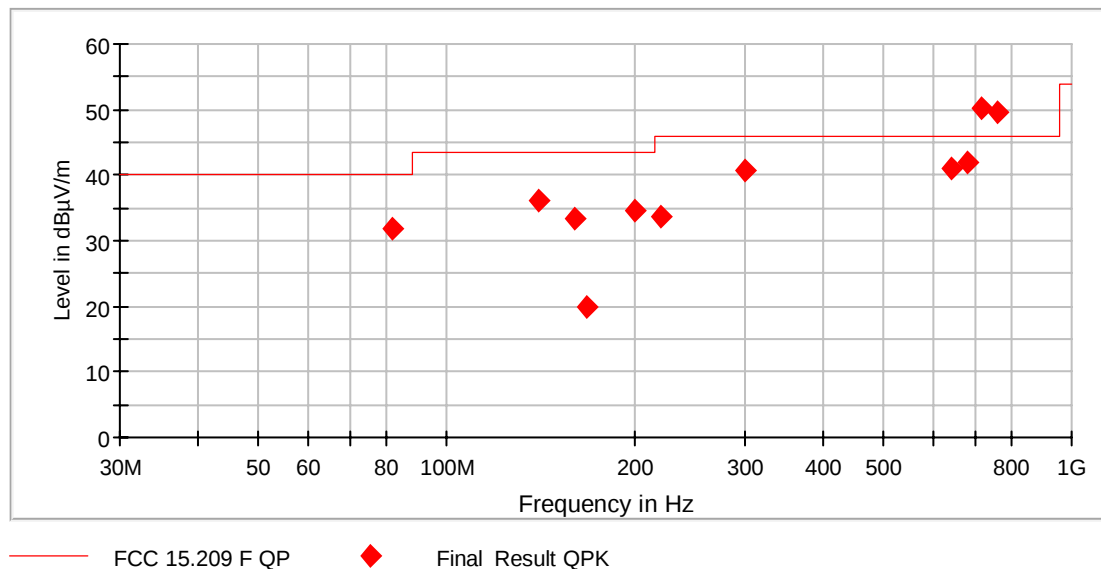


Data record name: 161791_Pos1_ff

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Rest. Band
82.000000	31.9	40.0	8.1	1000.0	120.000	400.0	H	143.0	16.5	No
139.986000	34.7	43.5	8.8	1000.0	120.000	212.0	H	270.0	20.7	No
159.983000	32.9	43.5	10.6	1000.0	120.000	101.0	V	2.0	19.7	No
168.006000	20.1	43.5	23.4	1000.0	120.000	400.0	V	204.0	19.1	Yes
199.979000	33.6	43.5	9.9	1000.0	120.000	105.0	V	13.0	18.3	No
219.977000	33.1	46.0	12.9	1000.0	120.000	136.0	H	256.0	19.2	No
299.969000	39.9	46.0	6.1	1000.0	120.000	105.0	H	90.0	22.3	No
639.934000	40.0	46.0	6.0	1000.0	120.000	104.0	V	296.0	30.5	No
679.929000	42.7	46.0	3.3	1000.0	120.000	101.0	V	283.0	30.9	No
719.926000	47.2	46.0	-1.2	1000.0	120.000	103.0	H	56.0	32.4	No
759.921000	44.6	46.0	1.4	1000.0	120.000	272.0	V	303.0	33.1	No
Measurement uncertainty: +4.78 dB / -4.78 dB										

Remark: The radiated emissions above the FCC 15.209 limit line 719.926 MHz were caused host device which was classified as class A digital devices. Therefore the test can be seen as passed.

Host RFID in TAG reading and writing mode position 2



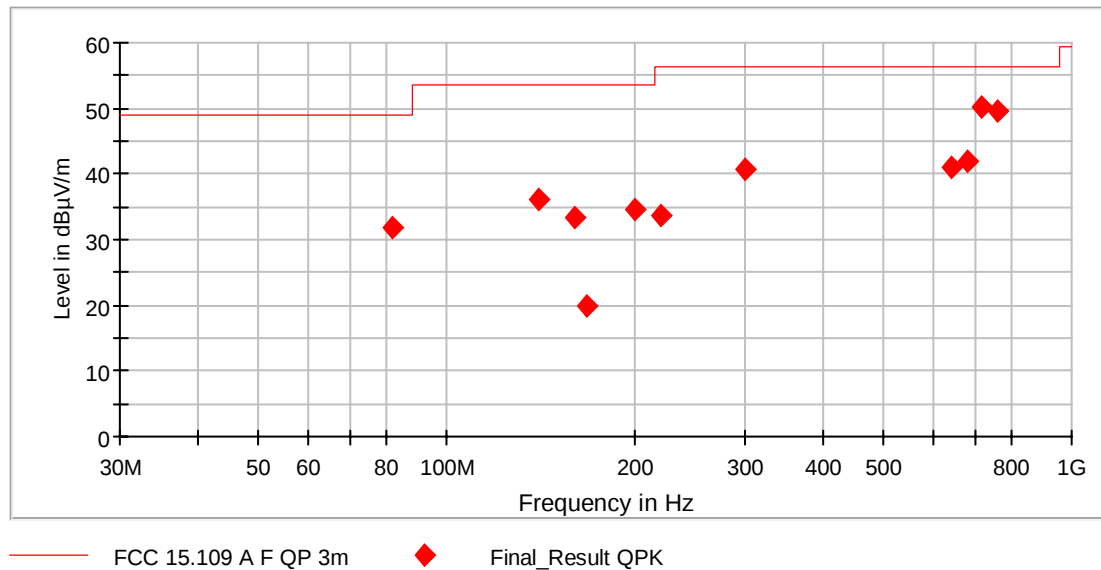
Data record name: 161971fccff2

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Rest. Band
82.000000	31.9	40.0	8.1	1000.0	120.000	400.0	H	163.0	16.5	No
139.986000	36.2	43.5	7.3	1000.0	120.000	207.0	H	79.0	20.7	No
159.983000	33.3	43.5	10.2	1000.0	120.000	165.0	H	237.0	19.7	No
168.006000	19.9	43.5	23.6	1000.0	120.000	382.0	V	142.0	19.1	Yes
199.979000	34.7	43.5	8.8	1000.0	120.000	105.0	V	343.0	18.3	No
219.977000	33.8	46.0	12.2	1000.0	120.000	145.0	H	239.0	19.2	No
299.969000	40.7	46.0	5.3	1000.0	120.000	109.0	H	254.0	22.3	No
639.934000	41.1	46.0	4.9	1000.0	120.000	121.0	V	310.0	30.5	No
679.929000	42.1	46.0	3.9	1000.0	120.000	105.0	V	24.0	30.9	No
719.926000	50.2	46.0	-4.2	1000.0	120.000	110.0	H	126.0	32.4	No
759.921000	49.6	46.0	-3.6	1000.0	120.000	103.0	H	133.0	33.1	No
Measurement uncertainty: +4.78 dB / -4.78 dB										

Remark: The radiated emissions above the FCC 15.209 limit line 719.926 and 759.921 MHz were caused host device which was classified as class A digital devices. Therefore the test can be seen as passed.

Host without RFID antenna (position 2 only was measured as worst case).

Remark: The host devices are classified as class A digital devices. Because the emissions of the hosts are much higher than the emissions caused by the RFID reader, the hosts were measured with and without RFID module in order to identify the source of the emissions found.



Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
82.000000	31.9	49.0	17.1	1000.0	120.000	400.0	H	163.0	16.5
139.986000	36.2	53.5	17.3	1000.0	120.000	207.0	H	79.0	20.7
159.983000	33.3	53.5	20.2	1000.0	120.000	165.0	H	237.0	19.7
168.006000	19.9	53.5	33.6	1000.0	120.000	382.0	V	142.0	19.1
199.979000	34.7	53.5	18.8	1000.0	120.000	105.0	V	343.0	18.3
219.977000	33.8	56.4	22.6	1000.0	120.000	145.0	H	239.0	19.2
299.969000	40.7	56.4	15.7	1000.0	120.000	109.0	H	254.0	22.3
639.934000	41.1	56.4	15.3	1000.0	120.000	121.0	V	310.0	30.5
679.929000	42.1	56.4	14.3	1000.0	120.000	105.0	V	24.0	30.9
719.926000	50.2	56.4	6.2	1000.0	120.000	110.0	H	126.0	32.4
759.921000	49.6	56.4	6.8	1000.0	120.000	103.0	H	133.0	33.1
Measurement uncertainty: +4.78 dB / -4.78 dB									

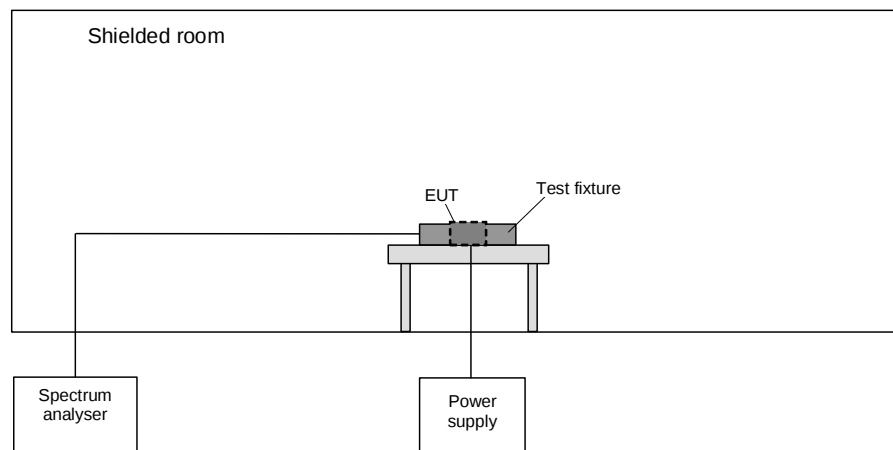
Test: Passed

Test equipment used (see chapter 6):

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5.3 99 % bandwidth

5.3.1 Method of measurement



The following procedure will be used for the occupied bandwidth measurement according to [1]:

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded.

The span between the two recorded frequencies is the occupied bandwidth.

5.3.2 Test results

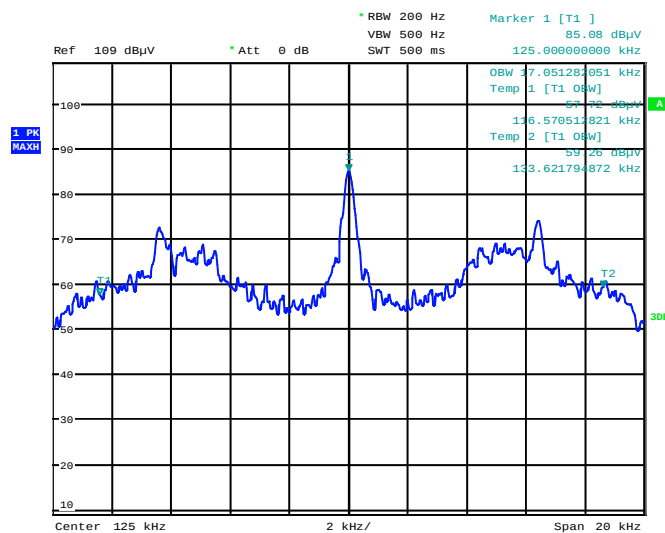
Ambient temperature:	21 °C	Relative humidity:	45 %
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Test record: The test was carried out in TAG reading and writing mode of the EUT (refer also clause 2 of this test report). All results are shown in the following.

Power supply: During this test the EUT was powered with 24 V_{DC} by the FSP120-AAAN2, which was itself supplied with 120 V_{AC} / 60 Hz.

Host RFID in TAG reading and writing mode

MT99C_003.wmf: 99 % bandwidth:



F _L	F _U	BW (F _U - F _L)
116.571 kHz	133.622 kHz	17.051 kHz
Measurement uncertainty		< 1*10 ⁻⁷

Test equipment used (see chapter 6)

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6 Test equipment

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.)	
6	EMI Software	EMC 32	Rohde & Schwarz	100061	481022	-	-
7	Outdoor test site	-	Phoenix Test-Lab	-	480293	Weekly verification (system cal.)	
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	02/18/2016	02/2018
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	AS615P	Deisel	615/310	480086	-	-
19	Antenna	CBL6111 D	Chase	25761	480894	09/18/2014	09/2017
20	EMI-Software	EMC 32	Rohde & Schwarz	-	481022	-	-
21	6 dB attenuator	R412706000	Radiall	9833	410082	Annual verification	
30	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/16/2016	02/2017
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS615P	Deisel	615/310	480187	-	-
35	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
43	Spectrum analyser	FSU46	Rohde & Schwarz	200125	480956	02/17/2016	02/2017
44	RF-cable No. 36	Sucoflex 106B	Suhner	0522/6B	480571	Weekly verification (system cal.)	
51	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/29/2016	02/2018
52	Loop Antenna Λ = 110 mm	-	Phoenix Testlab	-	410084	-	-
53	Outdoor test site	-	Phoenix Testlab	-	480293	-	-

7 Report history

Report Number	Date	Comment
F161791E3	10/05/2017	Document created
-	-	-

8 List of annexes

Annex A Test setup photos

7 pages

161791emiC1.jpg: Host (Dosing Unit), test setup fully anechoic chamber
161791emiC2.jpg: Host (Dosing Unit), test setup fully anechoic chamber
161791emiC3.jpg: Host (Dosing Unit), test setup fully anechoic chamber
161791emiC4.jpg: Host (Dosing Unit), test setup open area test site position 1
161791emiC5.jpg: Host (Dosing Unit), test setup open area test site position 2
161791emiC6.jpg: Host (Dosing Unit), test setup outdoor test site
161791emicC1.jpg: Host and support device, test setup shielded chamber

Annex B External photos

9 pages

161791eut24.jpg: Host (Dosing Unit), top view
161791eut25.jpg: Host (Dosing Unit), top view, burette removed
161791eut26.jpg: Host (Dosing Unit), left hand side view
161791eut27.jpg: Host (Dosing Unit), right hand side view
161791eut23.jpg: Host (Dosing Unit), front view
161791eut14.jpg: Host (Dosing Unit), rear view
161791eut28.jpg: Host (Dosing Unit), bottom view
161791eut20.jpg: Burette (with TAG), 3D-view 1
161791eut21.jpg: Burette (with TAG), 3D-view 2

Annex C Internal photos

4 pages

161791pcbH1.jpg: EUT (125 kHz RFID Module), PCB, bottom view
161791pcbH2.jpg: EUT (125 kHz RFID Module), PCB, top view
161791eut29.jpg: EUT (125 kHz RFID Module), antenna installation
161791eut30.jpg: EUT (125 kHz RFID Module), antenna