PHOENIX TESTLAB
Königswinkel 10
32825 Blomberg, Germany
Phone: +49 (0) 52 35 / 95 00-0
Fax: +49 (0) 52 35 / 95 00-10
office@phoenix-testlab.de
www.phoenix-testlab.de

Test Report

Report Number:

F170226E1

Equipment under Test (EUT):

SATELLINE-M3-TR9

Applicant:

Satel Oy, Salo

Manufacturer:

Satel Oy, Salo

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 (June 2017)**, Radio Frequency Devices

[3] **RSS-247 Issue 2 (February 2017)**, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[4] **RSS-Gen Issue 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.

Test engineer:	Paul NEUFELD		20.06.2017
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		20.06.2017
	Name	Signature	Date

This test report is only valid in its original form.

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

Contents **Page**

1 Identification

1.1 Applicant

Name:	Satel Oy, Salo
Address:	Meriniitynkatu 17, 24100 Salo
Country:	Finnland
Name for contact purposes:	Pekka SUOMINEN
Phone:	+358 2 777 7800
Fax:	+358 2 777 7810
eMail Address:	pekka.suominen@satel.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Satel Oy, Salo
Address:	Meriniitynkatu 17, 24100 Salo
Country:	Finnland
Name for contact purposes:	Pekka SUOMINEN
Phone:	+358 2 777 7800
Fax:	+358 2 777 7810
eMail Address:	pekka.suominen@satel.com
Applicant represented during the test by the following person:	-

1.3 Test Laboratory

The tests were carried out by:

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)

Test object: *	UHF radio modem
Type / PMN: *	SATEL-TA31
FCC ID: *	MRBSATEL-TA31
IC: *	2422A-SATELTA31
Serial number: *	170400001
PCB identifier: *	SPL0041c
HVIN (Hardware Version Identification Number): *	SATELLINE-M3-TR9
FVIN (Firmware Version Identification Number): *	07.37.2.3.0.20_2
Hardware version: *	1.03
Software version: *	07.37.2.3.0.20_2

Freewave mode:

Channel 00	RX:	902.2464 MHz	TX:	902.2464 MHz
Channel 25/55	RX:	915.1488 MHz	TX:	915.1488 MHz
Channel 50/110	RX:	927.8208 MHz	TX:	927.8208 MHz

Option 9 mode:

Channel 01	RX:	902.2 MHz	TX:	902.2 MHz
Channel 64	RX:	915.0 MHz	TX:	915.0 MHz
Channel 128	RX:	927.8 MHz	TX:	927.8 MHz

1.5 Technical Data of Equipment

Fulfills specifications: *	Freewave mode, Option 9 mode					
Antenna type: *	See antenna list below.					
Antenna gain: *	See antenna list below.					
Antenna connector: *	See antenna list below.					
Power supply - EUT	U_{nom}=	12.0 V DC	U_{min}=	9.0 V DC	U_{max}=	30.0 V DC
Type of modulation: *	Freewave: 2-GFSK Option 9: 2-FSK					
Operating frequency range:*	902.2464 MHz to 927.8208 MHz (Freewave mode) 902.2 MHz to 927.8 MHz (Option 9 mode)					
Number of channels: *	Freewave mode: variable 50 to 110 channels Option 9 mode: fix 128 channels					
Temperature range: *	-40 °C to +70 °C					
Lowest / highest Internal clock frequency: *	32 MHz / 927.8208 MHz					

* Declared by the applicant

Ancillary devices:

Test Laptop	Fujitsu LIFEBOOK E751 (provided by the laboratory)

Table 1 Antenna specifications

Antenna name	Manufacturer	Antenna type	Gain [dBi]
CAH ComAnt®	Oy Completech Ltd	Half wave whip antenna with elevated feed	5
CAY ComAnt®	Oy Completech Ltd	Directional yagi antenna	6

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
RS232 cable	"RS-232" connection @ eval board	RS232 interface @ test laptop	1 m *
DC power supply cable	"9 – 30 V DC" conection @ eval board	DC Power supply	1 m *

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	06.02.2017
Start of test:	21.02.2017
End of test:	08.06.2017

2 Operational States

The SATELLINE-M3-TR9 is a wireless transceiver module in the Frequency band from 902 – 928 MHz. The module is intended for implementation into various final applications.

Two modes called “Freewave mode” and “Option 9” are supported by the EUT. In Freewave mode 50 to 110 hopping channels are supported, which can be set by the end user. In Option 9 mode 128 hopping channels are set fixed, the number of hopping channels cannot be changed by the end user.

The antenna port conducted tests were performed on the TNC interface, the radiated tests were performed with a terminated antenna port. Where the antenna port conducted tests failed, radiated tests with both antennas were performed.

The test modes were set with the aid of a Laptop PC connected to the EUT via an RS-232 connection. A test-software provided by the applicant called “TypeApproval_TR9_UI_V006.1_22022017.exe” was used to set the test modes.

The output power was set to 1 W for all tests.

The following operation modes were identified as worst case condition and used during the tests:

Operation mode	Description of the operation mode	mode	channel	Modulation	Data rate / Mbps
1	Continuous transmitting on 902.2464 MHz	Freewave	01	2-GFSK	115.2 kBit/s
2	Continuous transmitting on 915.1488 MHz	Freewave	25/55	2-GFSK	115.2 kBit/s
3	Continuous transmitting on 927.8208 MHz	Freewave	50/110	2-GFSK	115.2 kBit/s
4	Hopping on 50 channels	Freewave	-	2-GFSK	115.2 kBit/s
5	Hopping on 110 channels	Freewave	-	2-GFSK	115.2 kBit/s
6	Continuous transmitting on 902.2 MHz	Option 9	01	2-FSK	64 kBit/s
7	Continuous transmitting on 915.0 MHz	Option 9	64	2-FSK	64 kBit/s
8	Continuous transmitting on 927.8 MHz	Option 9	128	2-FSK	64 kBit/s
9	Hopping on 128 channels	Option 9		2-FSK	64 kBit/s

3 Additional Information

All tests were performed at an unmodified sample.

4 Overview

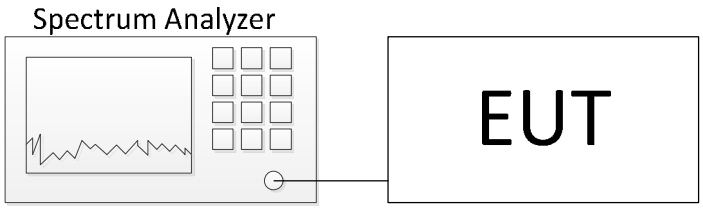
Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
Carrier frequency separation	902 – 928	15.247 (a)(1)	5.1 (b) [3]	Passed	13 et seq.
Number of hopping frequencies	902 – 928	15.247 (a)(1)(i)	5.1 (c) [3]	Passed	15 et seq.
Time of occupancy (dwell time)	902 – 928	15.247 (b)(2)	5.1 (c) [3]	Passed	17 et seq.
Maximum Peak Output Power	902 – 928	15.247 (a)(1)(i)	5.4 (a) [3]	Passed	19 et seq.
Occupied Bandwidth	902 – 928	15.247 (a)(1)(i)	5.1 (c) [3]	Passed	23 et seq.
Band edge compliance	902 – 928	15.247 (d)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	21 et seq.
Radiated emissions (transmitter)	0.009 – 26,500	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	26 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Passed	55 et seq.

5 Results

5.1 Duty cycle

The measurement was performed as an antenna port conducted measurement, as shown below.

Test Setup:



The method described in chapter 11.6.0 b) of document [1] was used to perform the following test.

The measurement was performed using Freewave and option 9 mode.

The following measurement technique was used:

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between two bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

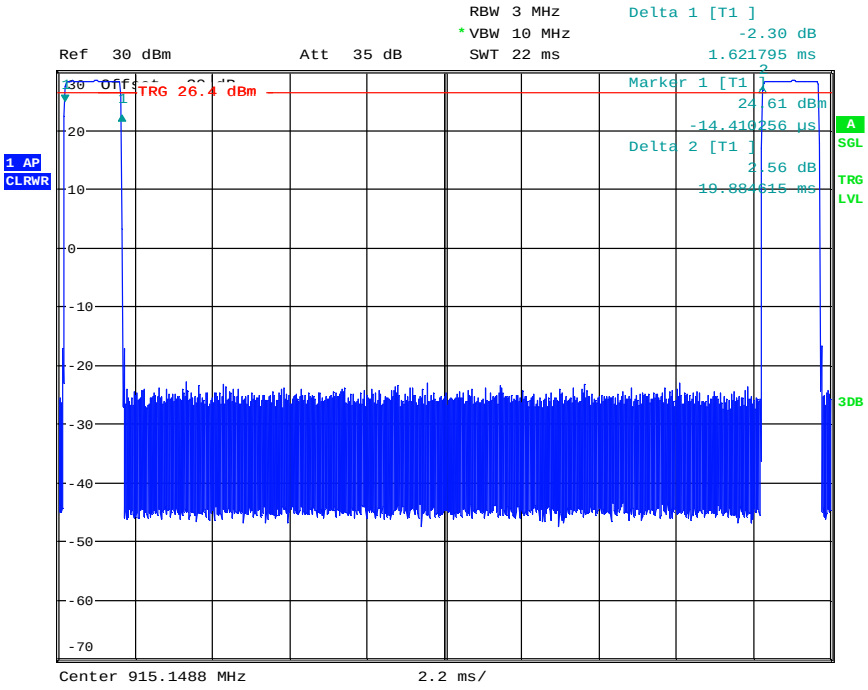
- Set the center frequency of the instrument to the center frequency of the transmission.
- Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
- Set VBW ≥ RBW.
- Set detector = peak or average.
- The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

5.1.1 Test results

Ambient temperature	22 °C	Relative humidity	40 %

The following plot only shows the worst case for the duty cycle correction, the other results are only submitted in the calculations below.

Freewave DutyCycle.wmf: Duty cycle measurement on channel 25/55:



-

$$T_{TX} = 1.622ms \quad (1)$$

$$\frac{50}{T_{TX}} = \frac{50}{1.622ms} = 30.826kHz \leq RBW \leq VBW \quad (2)$$

Measurement Points 10000 for 22 ms à 1.622 ms = 737 measurement points à Signal has 739 measurement points (and fulfils the requirement of at least 100 Points resolution for the signal)

$$T_{TX\_On} = 1.622ms \quad (3)$$

$$T_{TX\_Period} = 19.885ms \quad (4)$$

If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log(1/x), where x is the duty cycle.

$$x = \frac{1.622ms}{19.885s} = 0.0816 = 8.2\% \quad (5)$$

Correction factor: $10 \times \log\left(\frac{1}{x}\right) = 10 \times \log\left(\frac{1}{0.0816}\right) = 10.9dB$ (6)

Therefore, for average measurements a correction factor of 10.9 dB is used for all tests in Freewave mode. For tests in Option 9 mode, a T_{TX} time of 46.0449 ms with 94.8625 ms cycle time was measured. Therefore a duty cycle correction factor of 3.1 dB is used.

TEST EQUIPMENT USED FOR THE TEST:

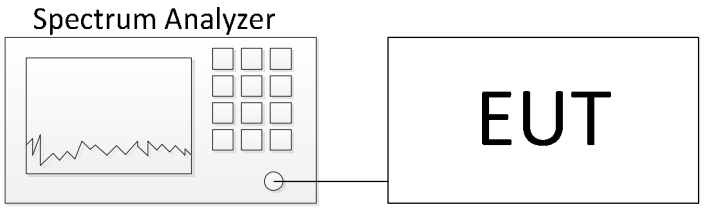
30

5.2 Carrier frequency separation

5.2.1 Method of measurement

The measurement was performed as an antenna port conducted measurement, as shown below.

Test Setup:



Acceptable measurement configurations

The procedure is described in chapter 7.8.2 of document [1].

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

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

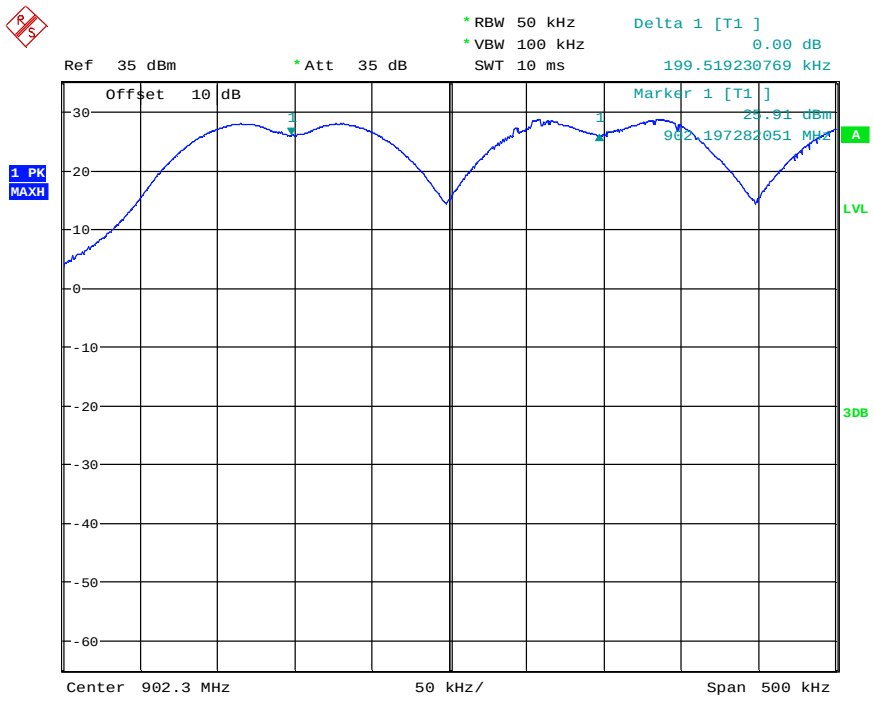
Since the peaks where not sufficient to determine the middle frequency of the channels, a characteristic dip was used to identify the frequency of the hopping channel.

5.2.2 Test results

Ambient temperature	22 °C	Relative humidity	62 %

The test was performed with the EUT hopping on the highest possible number of channels, since these modes were the worst case for this test case.

CarrierFrequencySeparation_Low.wmf: Carrier Frequency separation (operation mode 10):



Operation Mode	Measurement Frequency	Frequency separation [MHz]	Margin [MHz]	Limit [MHz]	Result
5	902.2464	250.8010	119.3907	131.4103	Passed
5	915.1488	250.0000	118.5897	131.4103	Passed
5	927.8208	250.0240	118.6137	131.4103	Passed
9	902.2000	199.5190	59.1590	140.3600	Passed
9	915.0000	200.3210	59.4610	140.8600	Passed
9	927.8000	201.1220	60.0964	141.0256	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

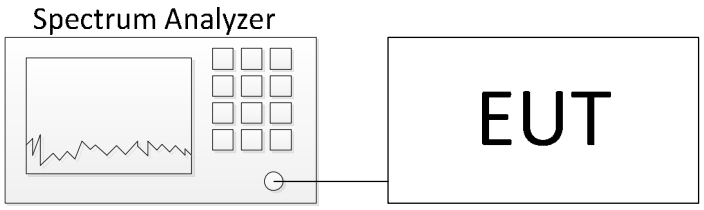
30

5.3 Number of hopping frequencies

5.3.1 Method of measurement

The measurement was performed as an antenna port conducted measurement, as shown below.

Test Setup:



Acceptable measurement configurations

The procedure is described in chapter 7.8.3 of document [1].

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c) VBW ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

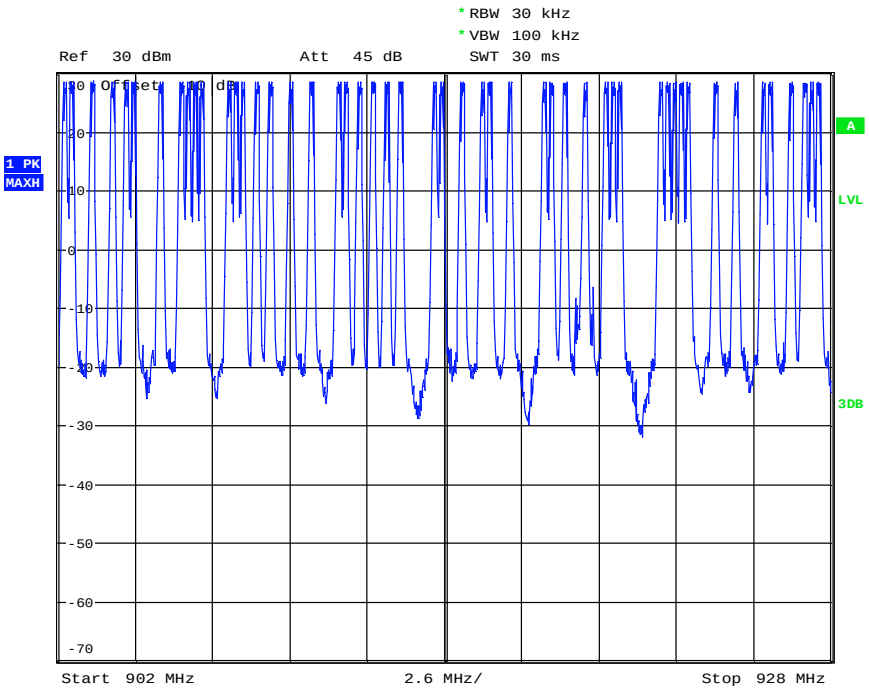
The test was performed in hopping mode.

5.3.2 Test result

Ambient temperature	22 °C	Relative humidity	59 %

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

HOPCH50.WMF: Number of hopping channels (operation mode 4):



Operation Mode	Number of channels	Minimum number of channels	Result
4	50	50	Passed
5	110	50	Passed
9	128	50	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

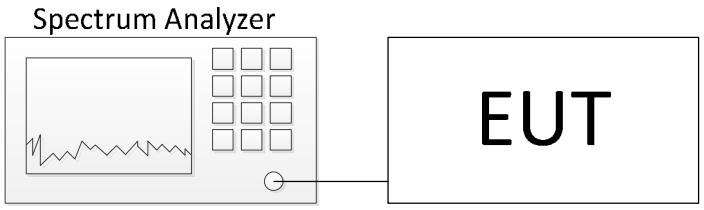
30

5.4 Time of occupancy (dwell time)

5.4.1 Method of measurement

The measurement was performed as an antenna port conducted measurement, as shown below.

Test Setup:



Acceptable measurement configurations

The procedure is described in chapter 7.8.4 of document [1].

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time. Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)

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

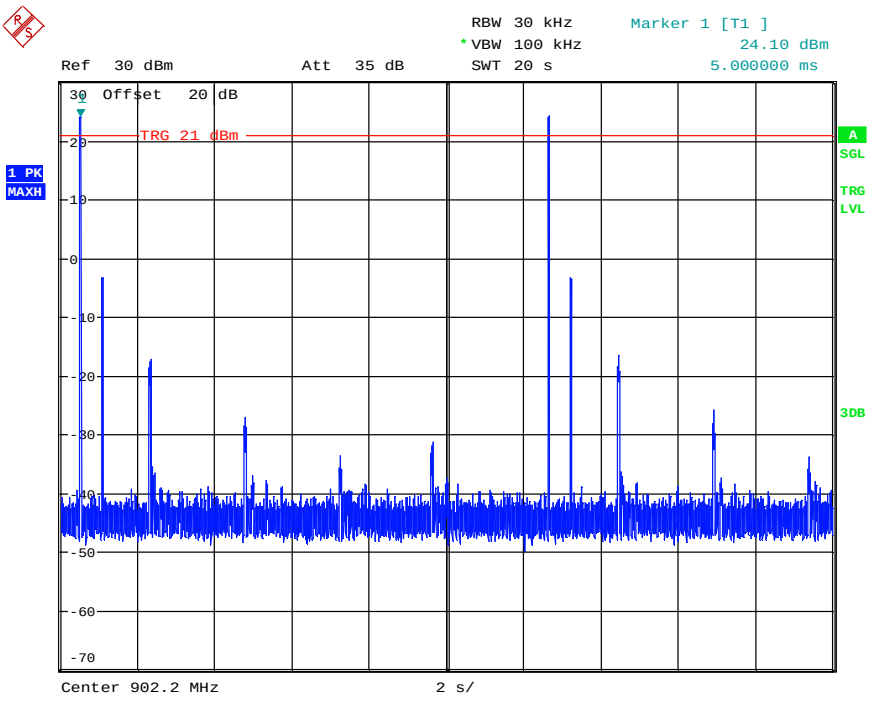
The measurement was performed at the upper and lower end and the middle of the assigned frequency band.

5.4.2 Test result

Ambient temperature	22 °C	Relative humidity	59 %

HOPSLOW.wmf: Power Spectral Density (operation mode 9):

The channel occupancy time for the multiplication of the occurred signals was derived from the measurements documented in chapter 5.1.1.



Operation Mode	Measurement Frequency	Measured Peaks in 20 s	On time for each burst [ms]	On-time [ms]	Limit	Result
4	902.2464	22	1.622	35.684	0.4 s in 20 s	Passed
4	915.1488	21	1.622	34.062	0.4 s in 20 s	Passed
4	927.8208	21	1.622	34.062	0.4 s in 20 s	Passed
6	902.2464	9	1.622	14.598	0.4 s in 20 s	Passed
6	915.1488	9	1.622	14.598	0.4 s in 20 s	Passed
6	927.8208	9	1.622	14.598	0.4 s in 20 s	Passed
9	915.0000	2	46.0449	92.100	0.4 s in 20 s	Passed
9	902.2000	2	46.0449	92.100	0.4 s in 20 s	Passed
9	927.8000	2	46.0449	92.100	0.4 s in 20 s	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

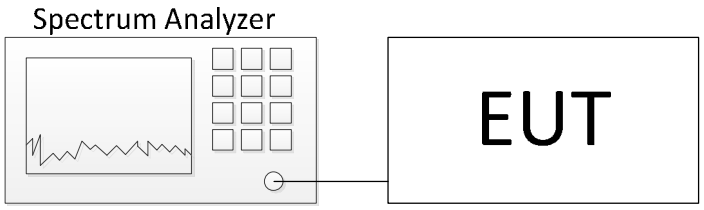
30

5.5 Maximum Peak Output Power

5.5.1 Method of measurement

The measurement was performed as an antenna port conducted measurement, as shown below.

Test Setup:



Acceptable measurement configurations

The procedure is described in chapter 7.8.5 of document [1].

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
   1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
   2) RBW > 20 dB bandwidth of the emission being measured.
   3) VBW ≥ RBW.
   4) Sweep: Auto.
   5) Detector function: Peak.
   6) Trace: Max hold.

b) Allow trace to stabilize.

c) Use the marker-to-peak function to set the marker to the peak of the emission.

d) The indicated level is the peak output power, after any corrections for external attenuators and cables.

e) A plot of the test results and setup description shall be included in the test report.

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

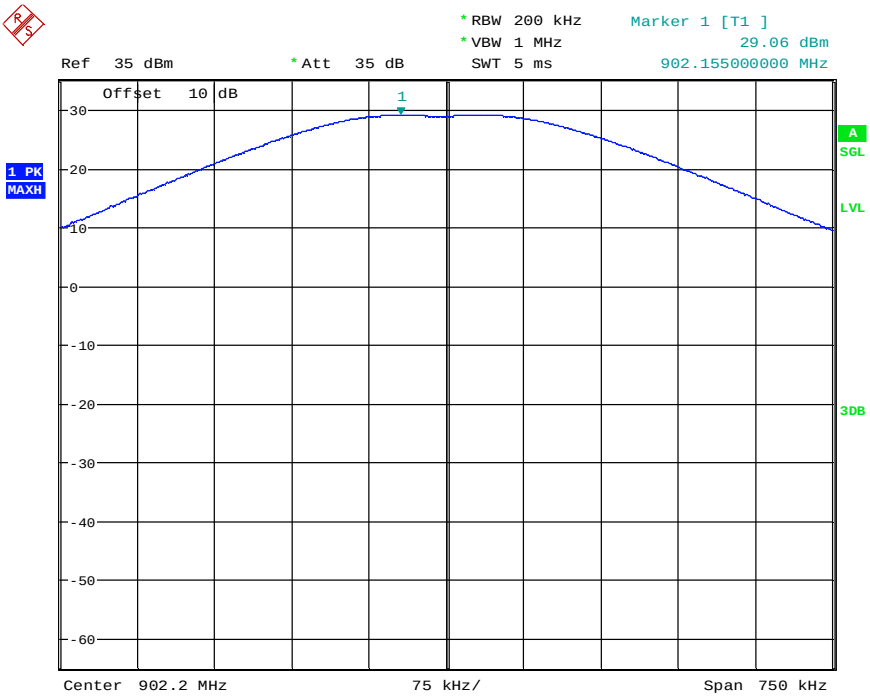
5.5.2 Test result

Ambient temperature	22 °C

Relative humidity	59 %

The antenna gain of all antennas was 6 dBi or lower, therefore the no limit correction was performed.

179226_OutputPower_Low.wmf: Maximum peak output power (operation mode 6):



Operation Mode	Measurement Frequency[MHz]	Conducted output power [dBm]	Limit [dBm]	Margin [dB]	Result
1	902.2464	28.9	30.0	1.1	Passed
2	915.1488	28.9	30.0	1.1	Passed
3	927.8208	28.8	30.0	1.2	Passed
6	902.2000	29.1	30.0	0.8	Passed
7	915.0000	29.0	30.0	0.9	Passed
8	927.8000	28.6	30.0	1.4	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.6 Band-edge compliance

5.6.1 Method of measurement (band edges next to unrestricted bands (conducted))

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 6.10.4 of document [1].

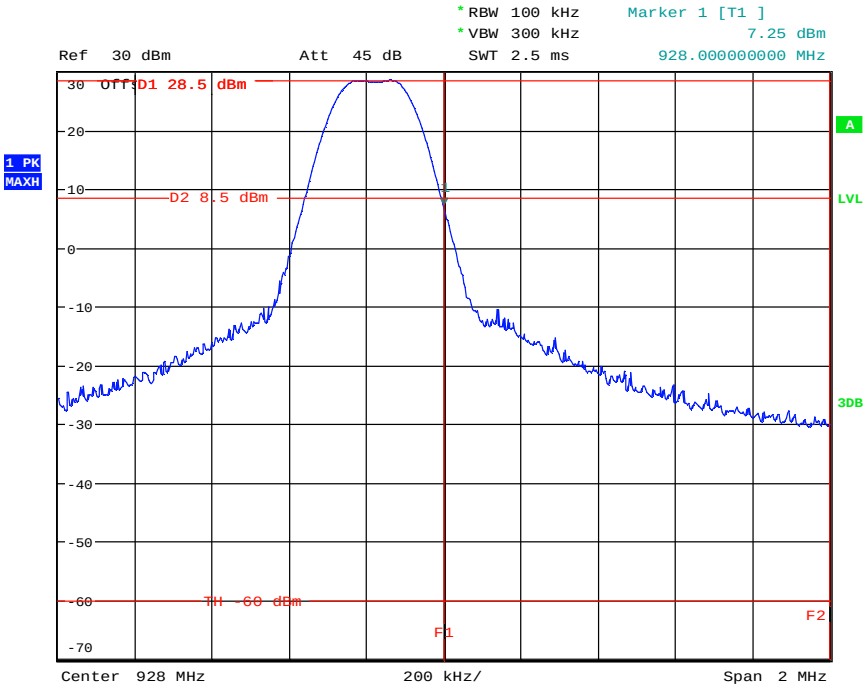
a) Connect the EMI receiver or spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).
b) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).
c) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent “normal mode of operation” as specified in 6.10.3.
d) If using the radiated method, then use the applicable procedure(s) of 6.4, 6.5, or 6.6, and orient the EUT and measurement antenna positions to produce the highest emission level.
e) Perform the test as follows:
    1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
    2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
    3) Attenuation: Auto (at least 10 dB preferred).
    4) Sweep time: Coupled.
    5) Resolution bandwidth: 100 kHz.
    6) Video bandwidth: 300 kHz.
    7) Detector: Peak.
    8) Trace: Max hold.
f) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator overshoot.
g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission. h) Repeat step c) through step e) for every applicable modulation.
i) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel) and repeat step c) through step d).
j) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

The measurements were performed at the lower and upper end of the 915 MHz band.

5.6.2 Test result

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

Freewave_BandEdge_High.wmf: conducted band-edge compliance (operation mode 3):



Operation Mode	Tx Frequency [MHz]	Emission Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emisson Level [dBm]	Margin [dB]	Result
1	902.2464	902.0000	28.5	8.5	-7.1	15.6	Passed
3	927.8208	928.0000	28.5	8.5	7.3	1.2	Passed
5	902.2464	901.9936	28.6	8.6	-9.9	18.5	Passed
5	927.8208	928.0000	28.3	8.3	6.7	1.6	Passed
6	902.2000	902.0000	29.0	9.0	7.7	1.3	Passed
7	927.8000	928.0000	28.4	8.4	6.6	1.8	Passed
9	902.2000	902.0000	28.4	8.4	7.1	1.3	Passed
9	927.8000	928.0010	29.0	9.0	6.5	2.5	Passed

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

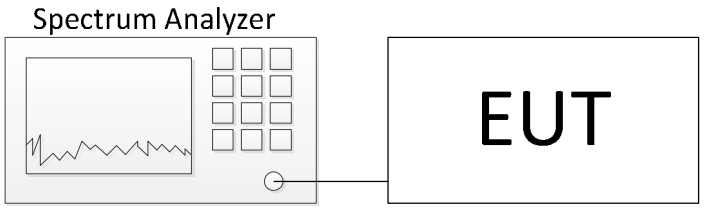
30

5.7 Occupied bandwidth

5.7.1 Method of measurement

The measurement was performed as an antenna port conducted measurement, as shown below.

Test Setup:



Acceptable measurement configurations

The procedure is described in chapter 7.8.7 of document [1], which refers to chapter 6.9.1 in the same document.

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are −6 dB, −20 dB, and −26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by "−xx dB." The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the "−xx dB" bandwidth; other requirements might specify that the "−xx dB" bandwidth be entirely contained within the authorized or designated frequency band.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2 [1].
d) Steps a) through c) might require iteration to adjust within the specified tolerances.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−xx dB down" requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
f) Set detection mode to peak and trace mode to max hold.
g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
h) Determine the "−xx dB down amplitude" using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "−xx dB down amplitude" determined in step h). If a marker is below this "−xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "−xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

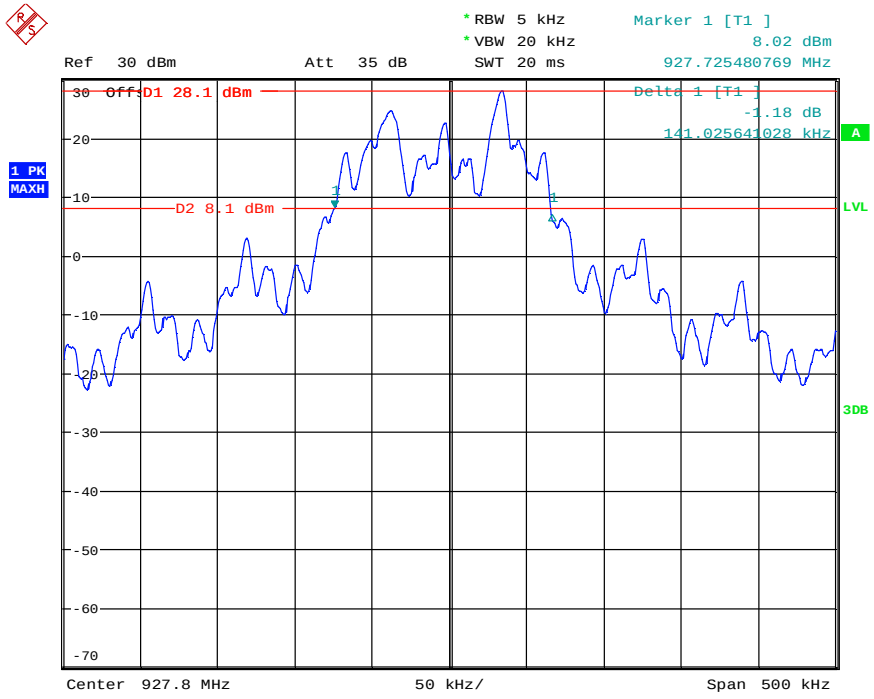
The measurement was performed at the upper and lower end and the middle of the assigned frequency band.

5.7.2 Test result

Ambient temperature	22 °C

Relative humidity	59 %

179226_High_20dB-BW_ManualFreq.wmf: Occupied Bandwidth (operation mode 8):



Operation Mode	Centre Frequency [MHz]	Measured occupied bandwidth [kHz]	Limit [kHz]	Margin [kHz]	Result
1	902.2464	131.4103	500	368.5897	Passed
2	915.1488	131.4103	500	368.5897	Passed
3	927.8208	131.4103	500	368.5897	Passed
6	902.2000	140.3600	500	359.6400	Passed
7	915.0000	140.8600	500	359.1400	Passed
8	907.8000	141.0256	500	358.9744	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.8 Maximum unwanted emissions

5.8.1 Method of measurement (conducted emissions in the restricted bands)

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly mounted to a spectrum analyser. Since the ANSI C63.10-2013 only refers to spurious emission measurements in 7.8.6 to 5.5 and 5.6, which do not offer any details concerning the measurement procedure, the measurement procedures in in part 11.12.2.2 in document [1] were used for the following tests.

If emissions were detected during the preliminary measurements, they were measured using the following measurement procedures:

Procedure for average measurement: 11.12.2.5.2 – Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction:

If continuous transmission of the EUT (D ≥ 98%) cannot be achieved and the duty cycle is constant (duty cycle variations are less than ±2%), then the following procedure shall be used:

- The EUT shall be configured to operate at the maximum achievable duty cycle.
- Measure the duty cycle D of the transmitter output signal as described in 11.6 in [1].
- Set the RBW = 1 MHz (unless otherwise specified).
- Set the VBW ≥ 3 x RBW.
- Detector = power average (RMS).
- Ensure that the number of measurement points in the sweep to ≥ 2 x (span/RBW).
- Averaging type = power
- Sweep time = auto
- Perform a trace average of at least 100 traces
- Correct the resulting measurement value by adding the duty cycle correction value (only applicable if not transmit continuously).

Peak measurement procedure: 11.12.2.4 in [1]

- Set the analyzer span to encompass the entire unwanted emission bandwidth.
- Set the RBW = specified in Table 2.
- Set the VBW ≥ RBW.
- Set sweep time = auto.
- Detector = peak.
- Trace mode = max hold.
- Allow the trace to stabilize.
- Use the peak marker function to determine the peak power over the emission bandwidth.

Table 2 RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

5.8.1.1 Limit calculations

The following general procedure is described in chapter 11.12.2.2 in [1].

a) Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 11.12.2.3 through 11.12.2.5 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP (see 11.12.2.6 for guidance on determining the applicable antenna gain).
c) Add the appropriate maximum ground reflection factor to the EIRP (6 dB for frequencies ≤ 30 MHz; 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and 0 dB for frequencies > 1000 MHz).
d) For MIMO devices, measure the power of each chain and sum the EIRP of all chains in linear terms (i.e., watts and mW).
e) Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

$$E. = EIRP - 20\log(d) + 104.8 \quad (1)$$

where

E is the electric field strength in dBµV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m

f) Compare the resultant electric field strength level with the applicable regulatory limit.
g) C Perform the radiated spurious emission test.

Chapter 14 in [1] states, that for transmitters with multiple outputs in the same band, summing of emissions and accounting for array gain have to be considered.

For this test report the procedure of summing of emissions as described in 14.3.2.2 in [1] was used.

To account for directional gain which might occur in case of N transmit antennas, the directional has to be calculated as

$$G_{Dir} = G_{Ant} + 10\log(N)dBi \ ,$$

whereby N is the number of antennas.

This EUT has only one antenna port, therefore no calculation for multiple ports have to be performed.

All

5.8.2 Method of measurement (conducted emissions in the unrestricted bands)

In any 100 kHz outside the authorized frequency band, the power shall be attenuated by 20 dB, compared to the highest in band power in any 100 kHz. This shall be demonstrated by using the peak power procedure. Since the ANSI C63.10-2013 only refers for spurious emission measurements in 7.8.6 to 5.5 and 5.6, the reference level shall be measured using the procedure described in 5.8.2.1 and the emission level according to procedure 5.8.2.2. The procedures are based on chapter 11.11.2 and 11.11.3 in [1].

5.8.2.1 Reference level measurement

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

5.8.2.2 Emission level measurement

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Ensure that the number of measurement points ≥ span/RBW
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level.

5.8.3 Test results (conducted emissions)

5.8.3.1 Emissions below 1 GHz

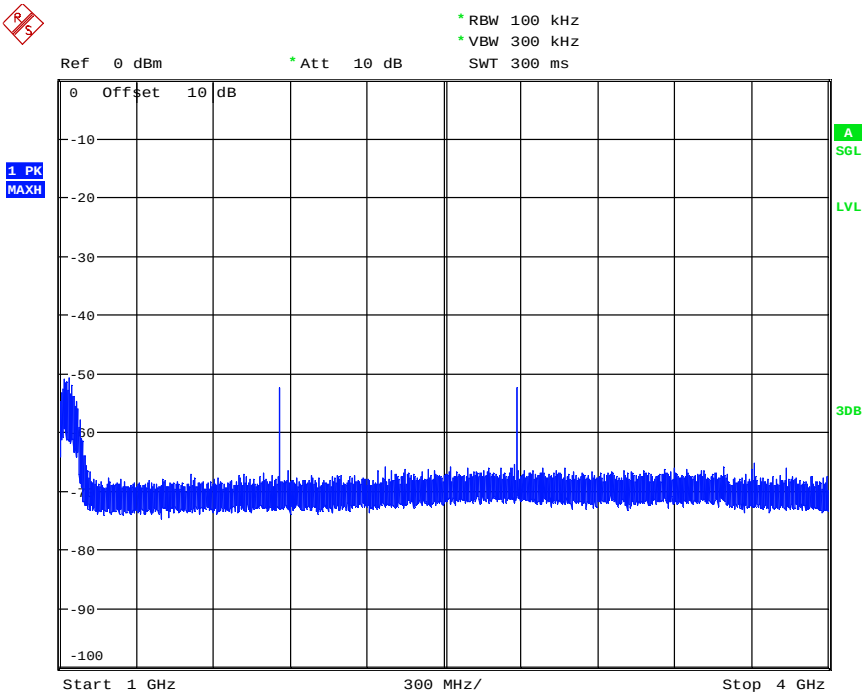
No significant emissions up to 20 dB to the limit were found in the frequency range below 30 MHz, therefore no results are submitted below. The emissions from 30 MHz to 1 GHz were failed during the conducted measurements; therefore only radiated measurements with both antennas were performed.

Since conformance to restricted band limits is sufficient, all tests were compared with restricted band limits for simplification of the reporting.

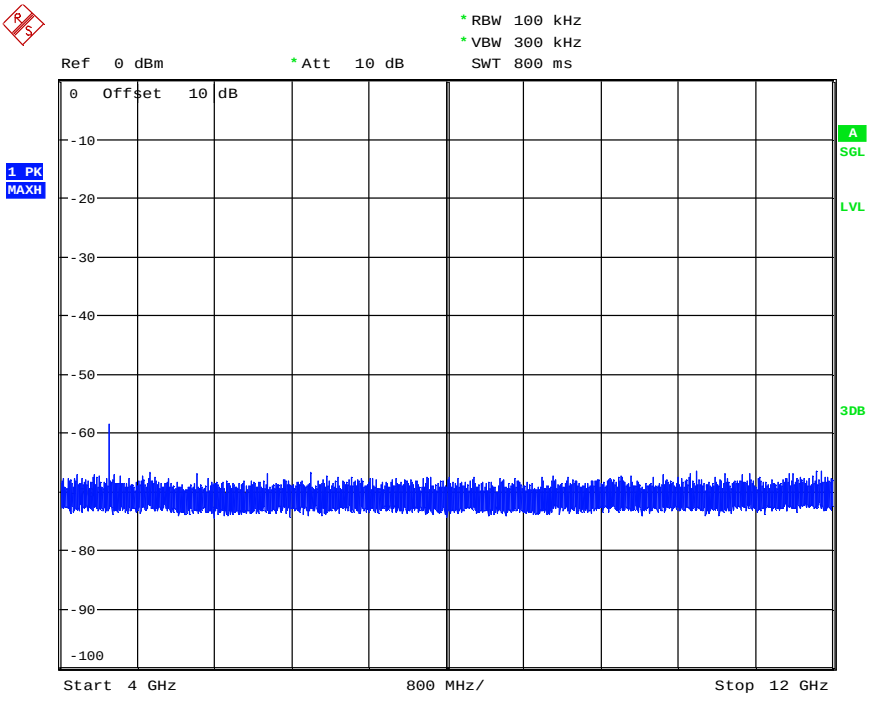
5.8.3.2 Emissions above 1 GHz

Ambient temperature	22 °C	Relative humidity	59 %

179226_SpurEmiss1-4G_ManualFreq_High.wmf: conducted spurious emissions (operation mode 3):



179226_SpurEmiss4-12G_ManualFreq_Low.wmf: conducted spurious emissions (operation mode 1):



Spurious Emissions, channel 01 (Operation mode 1)									
Peak Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Freewave	01	1014.990	61.1	74.0	12.9	-40.1	6.0	Passed	-
Freewave	01	1025.090	60.4	74.0	13.6	-40.8	6.0	Passed	-
Freewave	01	2706.700	53.3	74.0	20.7	-47.9	6.0	Passed	-
Freewave	01	2706.570	52.8	74.0	21.2	-48.4	6.0	Passed	-
Freewave	01	4510.880	48.3	74.0	25.7	-52.9	6.0	Passed	-
Average Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Freewave	01	1014.500	49.0	54.0	5.0	-63.2	6.0	Passed	-
Freewave	01	1034.290	48.6	54.0	5.4	-63.6	6.0	Passed	-
Freewave	01	2706.600	50.2	54.0	3.8	-62.0	6.0	Passed	-
Freewave	01	2706.660	50.4	54.0	3.6	-61.8	6.0	Passed	-
Freewave	01	4511.200	46.0	54.0	8.0	-66.2	6.0	Passed	-

Spurious Emissions, channel 25/55 (Operation mode 2)									
Peak Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Freewave	25/55	1035.220	59.8	74.0	14.2	-41.5	6.0	Passed	Y
Freewave	25/55	1026.440	60.2	74.0	13.8	-41.1	6.0	Passed	Y
Freewave	25/55	2745.650	53.6	74.0	20.4	-47.7	6.0	Passed	Y
Freewave	25/55	2745.200	53.1	74.0	20.9	-48.1	6.0	Passed	Y
Freewave	25/55	4576.033	47.9	74.0	26.1	-53.4	6.0	Passed	Y
Average Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Freewave	25/55	1043.860	51.0	54.0	3.0	-61.2	6.0	Passed	Y
Freewave	25/55	1021.860	50.5	54.0	3.5	-61.7	6.0	Passed	Y
Freewave	25/55	2745.550	52.0	54.0	2.0	-60.2	6.0	Passed	Y
Freewave	25/55	2745.420	50.3	54.0	3.7	-61.9	6.0	Passed	Y
Freewave	25/55	4575.963	45.8	54.0	8.2	-66.4	6.0	Passed	Y

Spurious Emissions, channel 50/110 (Operation mode 3)									
Peak Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Freewave	50/110	1034.870	62.4	74.0	11.6	-38.9	6.0	Passed	Y
Freewave	50/110	1017.950	63.5	74.0	10.5	-37.7	6.0	Passed	Y
Freewave	50/110	1028.040	63.1	74.0	10.9	-38.2	6.0	Passed	Y
Freewave	50/110	2783.550	52.4	74.0	21.6	-48.9	6.0	Passed	Y
Freewave	50/110	4638.760	47.7	74.0	26.3	-53.6	6.0	Passed	Y
Average Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Freewave	50/110	1033.160	52.6	54.0	1.4	-59.6	6.0	Passed	Y
Freewave	50/110	1012.930	53.9	54.0	0.1	-58.3	6.0	Passed	Y
Freewave	50/110	1023.180	53.2	54.0	0.8	-59.0	6.0	Passed	Y
Freewave	50/110	2783.420	49.8	54.0	4.2	-62.4	6.0	Passed	Y
Freewave	50/110	4638.930	44.8	54.0	9.2	-67.4	6.0	Passed	Y

Spurious Emissions, channel 01 (Operation mode 6)									
Peak Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Option 9	01	2706.430	52.3	74.0	21.7	-49.0	6.0	Passed	Y
Option 9	01	1029.430	59.1	74.0	14.9	-42.2	6.0	Passed	Y
Option 9	01	4510.643	45.9	74.0	28.1	-55.3	6.0	Passed	Y
Option 9	01	4511.313	45.8	74.0	28.2	-55.4	6.0	Passed	Y
Option 9	01	5412.623	41.7	74.0	32.3	-59.6	6.0	Passed	Y
Average Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Option 9	01	2706.580	48.0	54.0	6.0	-56.4	6.0	Passed	Y
Option 9	01	1039.310	44.0	54.0	10.0	-60.4	6.0	Passed	Y
Option 9	01	4510.993	40.7	54.0	13.3	-63.7	6.0	Passed	Y
Option 9	01	4510.903	40.5	54.0	13.5	-63.9	6.0	Passed	Y
Option 9	01	5413.213	35.3	54.0	18.7	-69.1	6.0	Passed	Y

Spurious Emissions, channel 64 (Operation mode 7)									
Peak Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Option 9	64	1035.220	59.8	74.0	14.2	-41.5	6.0	Passed	Y
Option 9	64	1026.440	60.2	74.0	13.8	-41.1	6.0	Passed	Y
Option 9	64	2745.650	53.6	74.0	20.4	-47.7	6.0	Passed	Y
Option 9	64	2745.200	53.1	74.0	20.9	-48.1	6.0	Passed	Y
Option 9	64	4576.033	47.9	74.0	26.1	-53.4	6.0	Passed	Y
Average Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Option 9	64	1043.860	43.2	54.0	10.8	-61.2	6.0	Passed	Y
Option 9	64	1021.860	42.7	54.0	11.3	-61.7	6.0	Passed	Y
Option 9	64	2745.550	44.2	54.0	9.8	-60.2	6.0	Passed	Y
Option 9	64	2745.420	42.5	54.0	11.5	-61.9	6.0	Passed	Y
Option 9	64	4575.963	38.0	54.0	16.0	-66.4	6.0	Passed	Y

Spurious Emissions, channel 64 (Operation mode 8)									
Peak Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Option 9	128	1022.940	63.8	74.0	10.2	-37.5	6.0	Passed	-
Option 9	128	1031.120	63.7	74.0	10.3	-37.6	6.0	Passed	-
Option 9	128	2783.230	52.6	74.0	21.4	-48.7	6.0	Passed	-
Option 9	128	4639.003	46.6	74.0	27.4	-54.6	6.0	Passed	-
Average Emission – Restricted Band									
Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restr. Band?
Option 9	128	1017.830	50.4	54.0	3.6	-54.0	6.0	Passed	-
Option 9	128	1024.800	50.3	54.0	3.7	-54.1	6.0	Passed	-
Option 9	128	2783.450	47.6	54.0	6.4	-56.8	6.0	Passed	-
Option 9	128	4638.923	39.0	54.0	15.0	-65.4	6.0	Passed	-

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
30, 10 - 13

5.8.4 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 height 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 above 1 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range above 1 GHz.

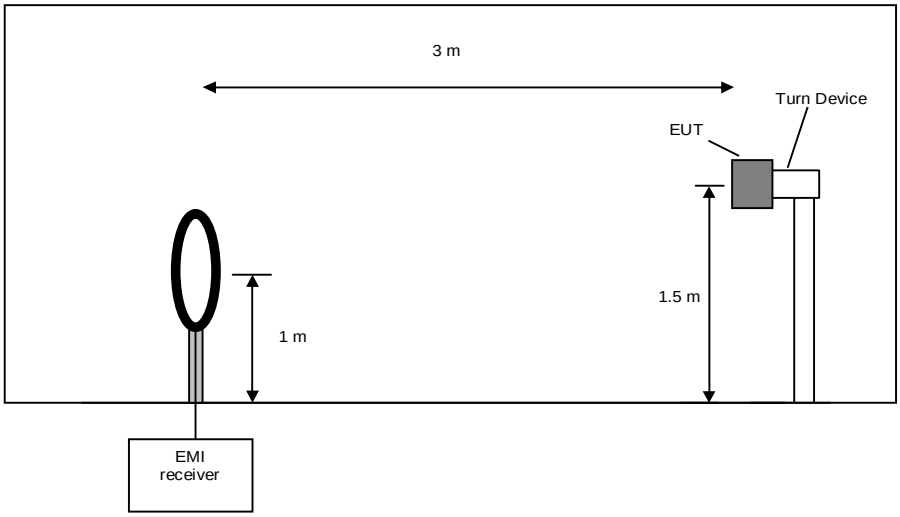
Preliminary measurement (9 kHz to 30 MHz):

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 turn device on the height of 1.5m. 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.

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 0° (45°, 90°) 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.

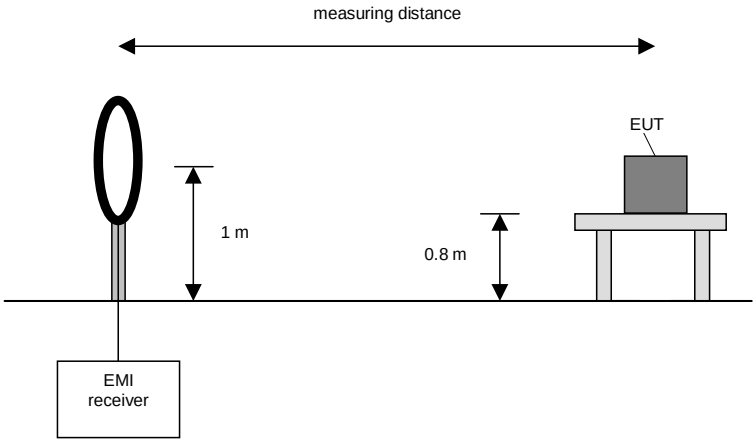
Final measurement (9 kHz to 30 MHz):

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).

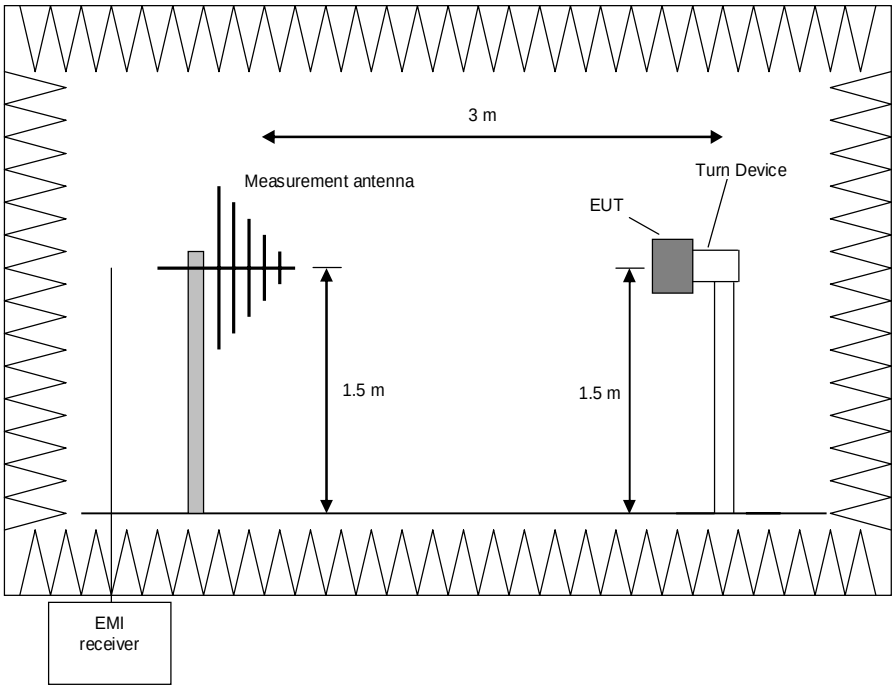
Preliminary measurement (30 MHz to 1 GHz)

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 1.5m. 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:

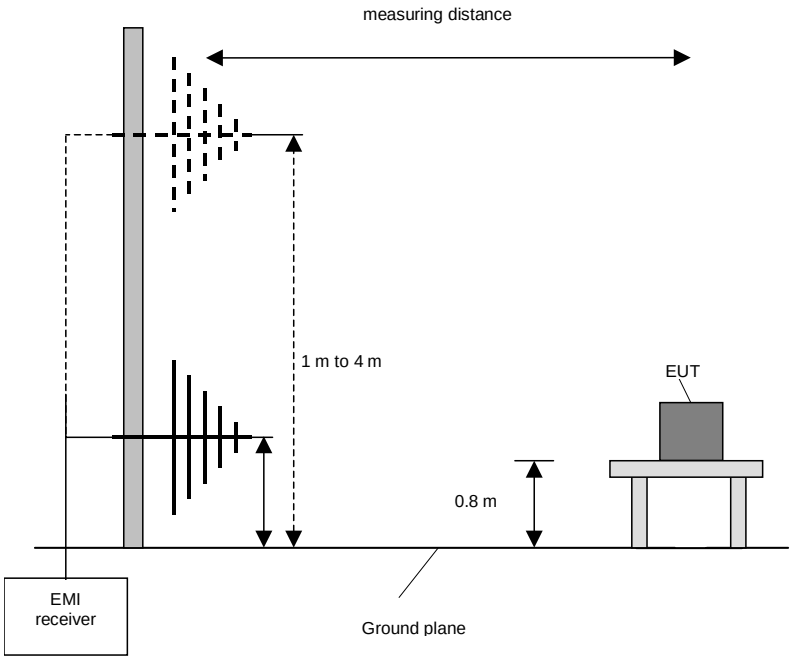
8. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
9. Manipulate the system cables within the range to produce the maximum level of emission.
10. Rotate the EUT by 360 ° to maximize the detected signals.
11. Repeat 1) to 3) with the vertical polarisation of the measuring antenna.
12. Make a hardcopy of the spectrum.
13. Repeat 1) to 5) with the EUT raised by an angle of 0° (45°, 90°) according to 6.6.5.4 in [1].
14. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

Final measurement (30 MHz to 1 GHz)

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

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

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

Preliminary and final measurement (1 GHz to 40 GHz)

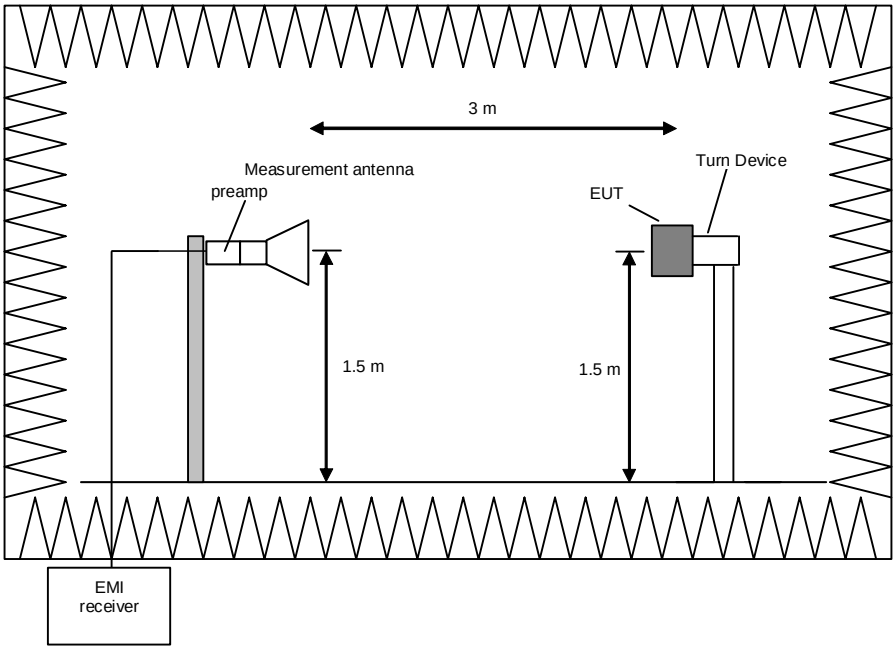
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

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

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



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.
The following procedure will be used:

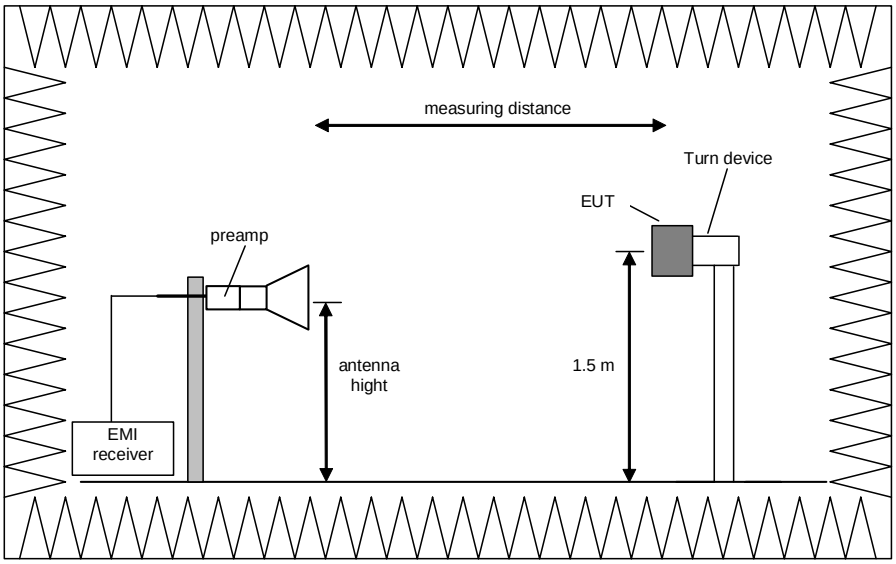
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an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

Final measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

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

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



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 /26.5 GHz and 26.5 GHz to 40 GHz.
The following procedure will be used:

1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
3) Set the spectrum analyser to EMI mode with peak and average detector activated.
4) Rotate the turntable from 0° to 360° to find the TT Pos. 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.

5.8.5 Test results (radiated emissions) – Emissions with both antennas from 30 MHz – 1 GHz

5.8.5.1 Preliminary radiated emission measurement 30 MHz – 1 GHz

Ambient temperature	22 °C	Relative humidity	59 %

Position of EUT: The EUT was set-up on an EUT turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.

For the final test on the open area test site the EUT was placed on a table with the height of 0.8 m. The distance between EUT and antenna was 3 m.

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

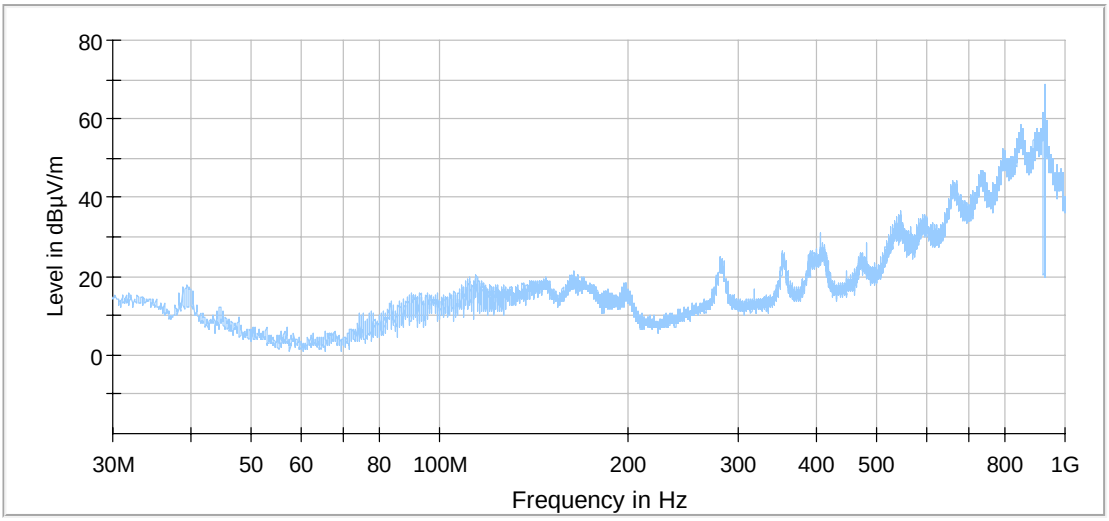
Test record: Only the plot of the worst case emission is submitted below.

Supply voltage: During all measurements the host of the EUT was powered with 12 V via an AC/DC Adapter.

Remark: Since the emissions during the conducted measurements failed, all tests are repeated with both antennas.

Transmitter operates at the upper end of the assigned frequency band (operation mode 8) CAY antenna

170226 M9 Yagi 30M-1G High: Spurious emissions from 30 MHz to 1 GHz (operation mode 8):



TEST EQUIPMENT USED FOR THE TEST:
28, 29, 32 – 34, 44

5.8.5.2 Final radiated measurements 30 MHz – 1 GHz

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

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
609.251667	27.81	46.00	18.19	1000.0	120.000	185.0	V	65.0	29.7	Y
888.450000	47.98	105.82	57.84	1000.0	120.000	154.0	V	262.0	33.5	N
896.802778	54.90	105.82	50.92	1000.0	120.000	101.0	V	11.0	33.8	N
899.012222	57.68	105.82	48.14	1000.0	120.000	101.0	V	13.0	33.9	N
902.246400	125.82	Fund.	-	1000.0	120.000	108.0	V	21.0	34.0	-
928.920556	47.83	105.82	57.99	1000.0	120.000	252.0	V	93.0	35.2	N
929.621111	74.76	105.82	31.06	1000.0	120.000	298.0	V	165.0	35.2	N
962.493333	42.29	54.00	11.71	1000.0	120.000	154.0	V	272.0	35.4	Y
963.355556	39.32	54.00	14.68	1000.0	120.000	211.0	V	331.0	35.4	Y
982.324444	41.77	54.00	12.23	1000.0	120.000	197.0	V	186.0	35.4	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

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

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
404.527778	20.82	46.00	25.18	1000.0	120.000	100.0	H	254.0	25.2	Y
409.485556	21.70	46.00	24.30	1000.0	120.000	102.0	H	246.0	25.4	Y
608.335556	29.75	46.00	16.25	1000.0	120.000	104.0	V	106.0	29.7	Y
611.083889	28.39	46.00	17.61	1000.0	120.000	117.0	V	351.0	29.8	Y
662.224444	40.90	111.37	70,47	1000.0	120.000	102.0	V	336.0	30.2	N
737.722778	46.00	111.37	65,37	1000.0	120.000	150.0	V	168.0	32.6	N
834.776667	51.82	111.37	59,55	1000.0	120.000	126.0	V	174.0	33.7	N
887.749444	51.68	111.37	59,69	1000.0	120.000	111.0	V	225.0	33.5	N
892.922778	50.84	111.37	60,53	1000.0	120.000	122.0	V	181.0	33.6	N
897.449444	60.76	111.37	50,61	1000.0	120.000	111.0	V	181.0	33.8	N
902.246400	131.37	Fund.	-	1000.0	120.000	109.0	V	168.0	34.0	-
932.423333	48.44	111.37	62,93	1000.0	120.000	104.0	V	176.0	35.3	N
982.270556	48.55	54.00	5.45	1000.0	120.000	105.0	V	174.0	35.4	Y
997.090000	42.06	54.00	11.94	1000.0	120.000	103.0	V	162.0	35.6	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

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

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
608.658889	27.73	46.00	18.27	1000.0	120.000	100.0	V	337.0	29.7	Y
849.865556	47.74	106.38	58.64	1000.0	120.000	150.0	V	294.0	33.8	N
891.306111	49.03	106.38	57.35	1000.0	120.000	142.0	V	258.0	33.6	N
901.814444	49.47	106.38	56.91	1000.0	120.000	143.0	V	252.0	34.0	N
915.148800	126.38	Fund.	-	1000.0	120.000	103.0	V	10.0	34.4	-
928.489444	51.29	106.38	55.09	1000.0	120.000	209.0	V	255.0	35.1	N
932.153889	51.12	106.38	55.26	1000.0	120.000	208.0	V	258.0	35.3	N
932.638889	50.78	106.38	55.6	1000.0	120.000	209.0	V	261.0	35.3	N
960.068333	42.63	54.00	11.37	1000.0	120.000	209.0	V	297.0	35.5	Y
969.337222	35.84	54.00	18.16	1000.0	120.000	230.0	V	205.0	35.4	Y
990.353889	42.00	54.00	12.00	1000.0	120.000	208.0	V	173.0	35.5	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

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

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
608.982222	29.64	46.00	16.36	1000.0	120.000	101.0	V	33.0	29.7	Y
843.075556	55.06	111.77	56.71	1000.0	120.000	115.0	V	171.0	33.8	N
899.120000	54.31	111.77	57.46	1000.0	120.000	107.0	V	242.0	33.9	N
901.652778	57.41	111.77	54.36	1000.0	120.000	104.0	V	176.0	34.0	N
915.148800	131.77	Fund.	-	1000.0	120.000	107.0	V	181.0	34.4	-
928.758889	57.01	111.77	54.76	1000.0	120.000	109.0	V	172.0	35.1	N
929.351667	50.64	111.77	61.13	1000.0	120.000	296.0	V	187.0	35.2	N
990.407778	45.94	54.00	8.06	1000.0	120.000	104.0	V	163.0	35.5	Y
995.150000	48.80	54.00	5.20	1000.0	120.000	102.0	V	169.0	35.6	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 3) CAH antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
407.761111	27.50	46.00	18.50	1000.0	120.000	129.0	V	232.0	25.3	Y
609.521111	26.72	46.00	19.28	1000.0	120.000	100.0	V	41.0	29.7	Y
610.598889	26.10	46.00	19.90	1000.0	120.000	104.0	V	322.0	29.8	Y
854.122778	50.87	106.23	55.36	1000.0	120.000	102.0	V	294.0	33.8	N
895.778889	50.17	106.23	56.06	1000.0	120.000	150.0	V	156.0	33.7	N
902.030000	51.05	106.23	55.18	1000.0	120.000	152.0	V	151.0	34.0	N
927.820800	126.23	Fund.	-	1000.0	120.000	207.0	V	147.0	35.1	-
935.602778	57.39	106.23	48.84	1000.0	120.000	210.0	V	157.0	35.4	N
960.014444	46.54	54.00	7.46	1000.0	120.000	215.0	V	268.0	35.5	Y
965.026111	42.33	54.00	11.67	1000.0	120.000	199.0	V	153.0	35.4	Y
967.774444	46.48	54.00	7.52	1000.0	120.000	198.0	V	153.0	35.4	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 3) CAY antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
608.281667	29.52	46.00	16.48	1000.0	120.000	103.0	V	30.0	29.7	Y
851.212778	55.82	111.22	55,4	1000.0	120.000	115.0	V	190.0	33.8	N
899.012222	55.67	111.22	55,55	1000.0	120.000	108.0	V	168.0	33.9	N
900.952222	56.08	111.22	55,14	1000.0	120.000	105.0	V	190.0	33.9	N
927.820800	131.22	Fund.	-	1000.0	120.000	103.0	V	191.0	35.1	-
931.291667	62.11	111.22	49,11	1000.0	120.000	105.0	V	171.0	35.3	N
935.764444	61.23	111.22	49,99	1000.0	120.000	103.0	V	166.0	35.4	N
963.193889	45.98	54.00	8.02	1000.0	120.000	103.0	V	195.0	35.4	Y
965.241667	45.15	54.00	8.85	1000.0	120.000	105.0	V	190.0	35.4	Y
967.882222	51.15	54.00	2.85	1000.0	120.000	105.0	V	168.0	35.4	Y
984.911111	46.38	54.00	7.62	1000.0	120.000	106.0	V	201.0	35.5	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 6) CAH antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
610.652778	29.43	46.00	16.57	1000.0	120.000	101.0	V	42.0	29.8	Y
892.168333	50.18	108.09	57.91	1000.0	120.000	150.0	V	219.0	33.6	N
898.203889	58.88	108.09	49.21	1000.0	120.000	150.0	V	219.0	33.8	N
899.227778	58.87	108.09	49.22	1000.0	120.000	150.0	V	226.0	33.9	N
902.200000	128.09	Fund.	-	1000.0	120.000	150.0	V	218.0	34.0	-
929.405556	52.70	108.09	55.39	1000.0	120.000	230.0	V	288.0	35.2	N
942.285000	86.79	108.09	21.3	1000.0	120.000	400.0	V	114.0	35.5	N
964.487222	43.78	54.00	10.22	1000.0	120.000	150.0	V	138.0	35.4	Y
974.133333	39.65	54.00	14.35	1000.0	120.000	150.0	V	136.0	35.4	Y
982.270556	44.06	54.00	9.94	1000.0	120.000	198.0	V	291.0	35.4	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 6) CAY antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
608.497222	31.26	46.00	14.74	1000.0	120.000	103.0	V	282.0	29.7	Y
894.000556	57.85	102.40	44.19	1000.0	120.000	109.0	V	21.0	33.7	N
897.934444	62.72	102.40	39.32	1000.0	120.000	105.0	V	16.0	33.8	N
902.200000	132.40	Fund.	-	1000.0	120.000	105.0	V	21.0	34.0	-
929.297778	52.86	102.40	49.18	1000.0	120.000	109.0	V	5.0	35.2	N
929.675000	66.39	102.40	35.65	1000.0	120.000	388.0	V	138.0	35.2	N
968.906111	46.02	54.00	7.98	1000.0	120.000	102.0	V	12.0	35.4	Y
982.216667	50.25	54.00	3.75	1000.0	120.000	105.0	V	5.0	35.4	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 7) CAH antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
608.012222	29.22	46.00	16.78	1000.0	120.000	102.0	V	84.0	29.7	Y
846.632222	49.95	106.72	56.77	1000.0	120.000	102.0	V	187.0	33.8	N
901.275556	49.33	106.72	57.39	1000.0	120.000	150.0	V	218.0	33.9	N
915.000000	126.72	Fund.	-	1000.0	120.000	218.0	V	241.0	34.4	-
928.058333	44.74	106.72	61.98	1000.0	120.000	163.0	V	24.0	35.1	N
932.423333	52.06	106.72	54.66	1000.0	120.000	211.0	V	159.0	35.3	N
961.038333	43.41	54.00	10.59	1000.0	120.000	211.0	V	252.0	35.5	Y
985.557778	42.65	54.00	11.35	1000.0	120.000	150.0	V	271.0	35.5	Y
995.042222	46.49	54.00	7.51	1000.0	120.000	210.0	V	14.0	35.6	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 7) CAY antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
608.497222	31.26	46.00	14.74	1000.0	120.000	103.0	V	282.0	29.7	Y
894.000556	57.85	112.40	54.55	1000.0	120.000	109.0	V	21.0	33.7	N
897.934444	62.72	112.40	49.07	1000.0	120.000	105.0	V	16.0	33.8	N
902.200000	132.40	Fund.	-	1000.0	120.000	105.0	V	21.0	34.0	-
929.297778	52.86	112.40	58.93	1000.0	120.000	109.0	V	5.0	35.2	N
929.675000	66.39	112.40	45.4	1000.0	120.000	388.0	V	138.0	35.2	N
968.906111	46.02	54.00	7.98	1000.0	120.000	102.0	V	12.0	35.4	Y
982.216667	50.25	54.00	3.75	1000.0	120.000	105.0	V	5.0	35.4	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 8) CAH antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
612.754444	29.08	46.00	16.92	1000.0	120.000	101.0	V	40.0	29.9	Y
849.165000	51.66	107.12	55.46	1000.0	120.000	101.0	V	21.0	33.8	N
855.308333	51.91	107.12	55.21	1000.0	120.000	105.0	V	294.0	33.7	N
927.800000	127.12	Fund.	-	1000.0	120.000	209.0	V	163.0	35.1	-
931.992222	56.79	107.12	50.33	1000.0	120.000	152.0	V	157.0	35.3	N
935.279444	80.70	107.12	26.42	1000.0	120.000	112.0	V	92.0	35.4	N
936.626667	53.06	107.12	54.06	1000.0	120.000	212.0	V	163.0	35.4	N
960.014444	48.06	54.00	5.94	1000.0	120.000	214.0	V	250.0	35.5	Y
960.499444	44.40	54.00	9.60	1000.0	120.000	216.0	V	247.0	35.5	Y
967.612778	43.53	54.00	10.47	1000.0	120.000	198.0	V	156.0	35.4	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 8) CAY antenna

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]	Restr. Band
407.653333	31.39	46.00	14.61	1000.0	120.000	100.0	H	256.0	25.3	Y
609.736667	30.88	46.00	15.12	1000.0	120.000	101.0	V	34.0	29.8	Y
852.991111	56.46	111.79	55.33	1000.0	120.000	120.0	V	181.0	33.8	N
895.132222	58.21	111.79	53.58	1000.0	120.000	104.0	V	181.0	33.7	N
900.413333	56.77	111.79	55.02	1000.0	120.000	103.0	V	180.0	33.9	N
927.600000	131.79	Fund.	-	1000.0	120.000	102.0	V	169.0	35.1	-
932.207778	61.05	111.79	50.74	1000.0	120.000	105.0	V	176.0	35.3	N
933.932222	58.92	111.79	52.87	1000.0	120.000	103.0	V	188.0	35.3	N
960.068333	48.58	54.00	5.42	1000.0	120.000	107.0	V	197.0	35.5	Y
967.612778	52.96	54.00	1.04	1000.0	120.000	102.0	V	196.0	35.4	Y
984.048889	48.54	54.00	5.46	1000.0	120.000	102.0	V	196.0	35.4	Y
Measurement uncertainty						+2.2 dB / -3.6 dB				

TEST EQUIPMENT USED FOR THE TEST:
14 – 17, 19

5.8.6 Test results (radiated emissions) – cabinet emissions

5.8.6.1 Preliminary radiated emission measurement

Ambient temperature	22 °C	Relative humidity	59 %

Position of EUT: The EUT was set-up on an EUT 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 the annex A in the test report.

Test record: Since the conducted measurement at the non-restricted band-edges were passed, no final measurements at the band-edges were performed.

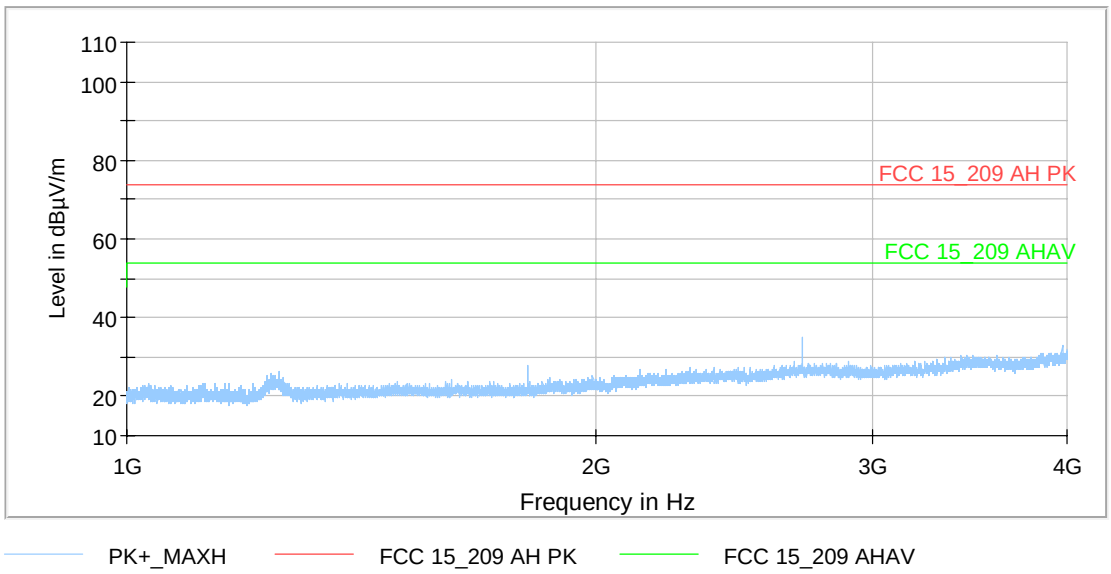
Supply voltage: During all measurements the host of the EUT was powered with 12 V via an AC/DC Adapter.

Remark: Document [3] states in 12.7.4.2, that in case of conducted measurements, additional radiated cabinet emission measurements must be performed. The radiated measurements were performed with a terminated antenna port.

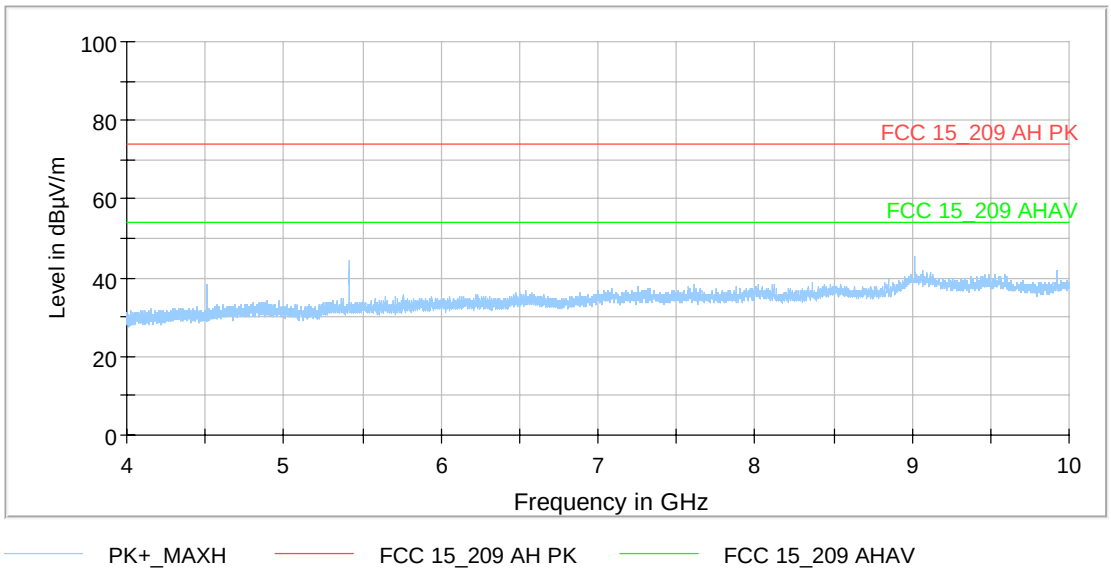
No significant emissions were found in the frequency range below 30 MHz, therefore not plots or results are shown in the following chapter.

The results for the frequency range 30 MHz to 1 GHz can be found in chapter 5.8.5, where the radiated measurements with both antennas are documented.

170226 M9 1-3GHz low(1): Spurious emissions from 1 GHz to 4 GHz (operation mode 6):



170226 M9 4-12 GHz Low(2): Spurious emissions from 4 GHz to 12 GHz (operation mode 6):



TEST EQUIPMENT USED FOR THE TEST:
11, 28, 29, 32 – 43, 49, 72

5.8.6.2 Final radiated measurements

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

Frequency [MHz]	MaxPeak [dBµV/m]	CAverage [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1804.241383	---	30.92	54.00	23.08	H	334.0	90.0	-13.0
1804.241383	32.80	---	74.00	41.20	H	334.0	90.0	-13.0
2706.816400	---	36.78	54.00	17.22	H	322.0	120.0	-7.8
2706.816400	39.37	---	74.00	34.63	H	322.0	120.0	-7.8
5413.016795	---	41.65	54.00	12.35	H	276.0	90.0	-0.4
5413.016795	46.32	---	74.00	27.68	H	276.0	90.0	-0.4
5413.658295	---	42.28	54.00	11.72	V	319.0	120.0	-0.4
5413.658295	46.38	---	74.00	27.62	V	319.0	120.0	-0.4
9022.792395	---	49.08	54.00	4.92	H	260.0	90.0	8.9
9022.792395	51.86	---	74.00	22.14	H	260.0	90.0	8.9
9924.410000	---	46.46	54.00	7.54	V	314.0	29.0	6.8
9924.410000	48.46	---	74.00	25.54	V	314.0	29.0	6.8
9925.054395	---	46.58	54.00	7.42	V	314.0	29.0	6.8
9925.054395	48.60	---	74.00	25.40	V	314.0	29.0	6.8
Measurement uncertainty				+2.2 dB / -3.6 dB				

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

Frequency [MHz]	MaxPeak [dBµV/m]	CAverage [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1830.056783	---	31.25	54.00	22.75	H	309.0	90.0	-12.8
1830.056783	33.81	---	74.00	40.19	H	309.0	90.0	-12.8
2745.307683	---	36.20	54.00	17.80	H	323.0	90.0	-7.8
2745.307683	39.81	---	74.00	34.19	H	323.0	90.0	-7.8
4575.190000	41.74	---	74.00	32.26	H	280.0	60.0	-2.8
4575.190000	---	39.51	54.00	14.49	H	280.0	60.0	-2.8
4575.849405	---	40.44	54.00	13.56	H	282.0	90.0	-2.8
4575.849405	44.17	---	74.00	29.84	H	282.0	90.0	-2.8
5490.354400	46.74	---	74.00	27.26	H	302.0	150.0	-0.1
5490.354400	---	41.62	54.00	12.38	H	302.0	150.0	-0.1
5490.837700	---	42.82	54.00	11.18	H	284.0	60.0	-0.1
5490.837700	47.50	---	74.00	26.50	H	284.0	60.0	-0.1
9150.819400	51.10	---	74.00	22.90	H	206.0	90.0	7.9
9150.819400	---	47.55	54.00	6.45	H	206.0	90.0	7.9
9152.089905	51.99	---	74.00	22.01	H	255.0	60.0	7.9
9152.089905	---	47.85	54.00	6.15	H	255.0	60.0	7.9
Measurement uncertainty				+2.2 dB / -3.6 dB				

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

Frequency [MHz]	MaxPeak [dBµV/m]	CAverage [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1855.4631	35.86	---	74	38.14	V	219	0	-12.6
1855.4631	---	32.08	54	21.92	V	219	0	-12.6
2783.5199	39.04	---	74	34.96	H	348	120	-7.9
2783.5199	---	36.26	54	17.74	H	348	120	-7.9
4638.9074	---	39.98	54	14.02	V	331	150	-2.8
4638.9074	43.07	---	74	30.93	V	331	150	-2.8
5566.4840	---	41.34	54	12.66	V	322	60	0.1
5566.4840	45.27	---	74	28.73	V	322	60	0.1
5567.2223	46.80	---	74	27.20	H	278	60	0.1
5567.2223	---	41.93	54	12.07	H	278	60	0.1
9277.7700	---	47.40	54	6.60	H	322	120	6.6
9277.7700	52.50	---	74	21.50	H	322	120	6.6
9278.8099	52.62	---	74	21.38	H	325	120	6.6
9278.8099	---	47.39	54	6.61	H	325	120	6.6
Measurement uncertainty				+2.2 dB / -3.6 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 6)

Frequency [MHz]	MaxPeak [dBµV/m]	CAverage [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1804.2205	---	25.80	54	28.20	H	321	90	-13.0
1804.2205	33.97	---	74	40.03	H	321	90	-13.0
2706.5077	---	33.72	54	20.28	H	333	90	-7.8
2706.5077	41.06	---	74	32.94	H	333	90	-7.8
3971.1499	---	30.99	54	23.01	V	89	150	-4.5
3971.1499	39.77	---	74	34.23	V	89	150	-4.5
4510.6999	44.24	---	74	29.76	H	277	120	-3.1
4510.6999	---	35.33	54	18.67	H	277	120	-3.1
5412.8518	---	38.24	54	15.76	H	251	120	-0.4
5412.8518	47.22	---	74	26.78	H	251	120	-0.4
5413.3013	48.15	---	74	25.85	H	295	120	-0.4
5413.3013	---	41.01	54	12.99	H	295	120	-0.4
9022.1773	---	44.46	54	9.54	H	228	90	8.9
9022.1773	53.21	---	74	20.79	H	228	90	8.9
10826.0166	---	43.34	54	10.66	H	328	120	7.0
10826.0166	52.47	---	74	21.53	H	328	120	7.0
10826.7665	---	43.59	54	10.41	H	328	120	7.0
10826.7665	53.33	---	74	20.67	H	328	120	7.0
Measurement uncertainty				+2.2 dB / -3.6 dB				

Transmitter operates at the middle of the assigned frequency band (operation mode 7)

Frequency [MHz]	MaxPeak [dBµV/m]	CAverage [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1830.4485	---	26.99	54	27.01	V	1	0	-12.8
1830.4485	35.34	---	74	38.66	V	1	0	-12.8
2745.2174	---	29.97	54	24.03	V	1	0	-7.8
2745.2174	38.44	---	74	35.56	V	1	0	-7.8
4574.8700	44.51	---	74	29.49	H	288	90	-2.8
4574.8700	---	36.32	54	17.68	H	288	90	-2.8
5489.8490	47.72	---	74	26.28	H	314	120	-0.1
5489.8490	---	40.79	54	13.21	H	314	120	-0.1
5489.9812	47.95	---	74	26.05	V	253	150	-0.1
5489.9812	---	41.18	54	12.82	V	253	150	-0.1
9149.6175	52.12	---	74	21.88	H	227	90	7.9
9149.6175	---	43.05	54	10.95	H	227	90	7.9
9150.3514	---	43.34	54	10.66	H	219	90	7.9
9150.3514	52.13	---	74	21.87	H	219	90	7.9
Measurement uncertainty				+2.2 dB / -3.6 dB				

Transmitter operates at the middle of the assigned frequency band (operation mode 8)

Frequency [MHz]	MaxPeak [dBµV/m]	CAverage [dBµV/m]	Limit [dBµV/m]	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1855.1956	36.91	---	74	37.09	H	321	120	-12.6
1855.1956	---	30.19	54	23.81	H	321	120	-12.6
2782.6960	38.18	---	74	35.82	V	358	0	-7.9
2782.6960	---	29.94	54	24.06	V	358	0	-7.9
3710.2574	---	31.45	54	22.55	H	261	90	-6.4
3710.2574	39.71	---	74	34.29	H	261	90	-6.4
5565.3527	---	42.08	54	11.92	H	305	120	0.1
5565.3527	49.45	---	74	24.55	H	305	120	0.1
5565.8120	48.49	---	74	25.51	H	297	120	0.1
5565.8120	---	41.32	54	12.68	H	297	120	0.1
9275.5417	---	40.82	54	13.18	H	243	90	6.6
9275.5417	50.27	---	74	23.73	H	243	90	6.6
9276.2880	51.59	---	74	22.41	H	326	90	6.6
9276.2880	---	42.48	54	11.52	H	326	90	6.6
Measurement uncertainty				+2.2 dB / -3.6 dB				

TEST EQUIPMENT USED FOR THE TEST:
11, 28, 29, 32 – 43, 49, 72

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

Ambient temperature	20 °C	Relative humidity	52 %

Position of EUT: For this test, the EUT was set to transmit in hopping mode in Freewave mode and Option 9 mode.

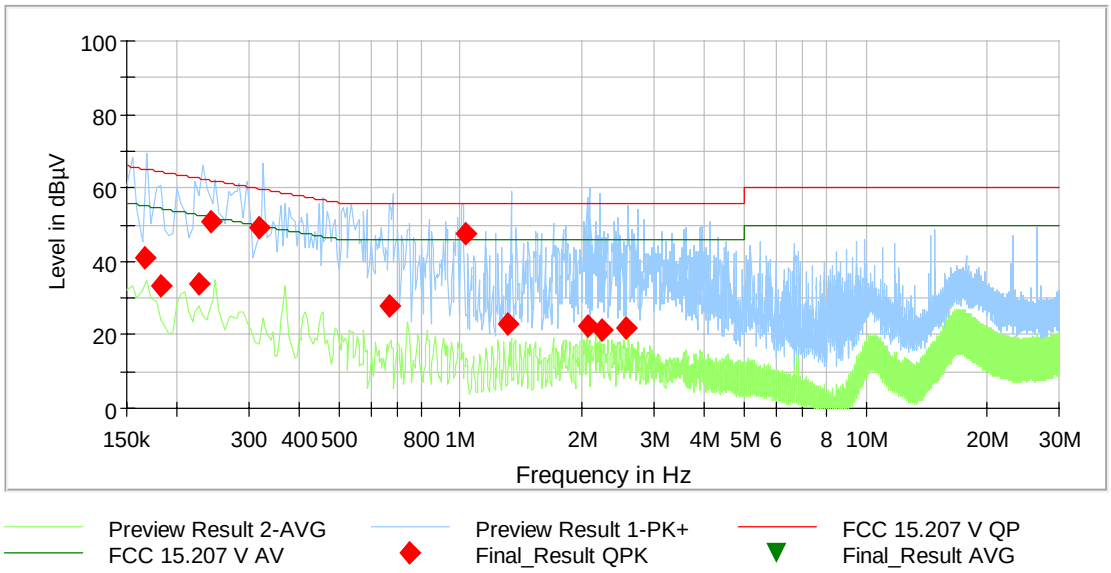
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: Measurement performed with US 120V/60Hz. For the test a power supply type “MINI-PS-100-240AC/24DC/1.3” by Phoenix Contact was used. The power supply provided 24 V DC.

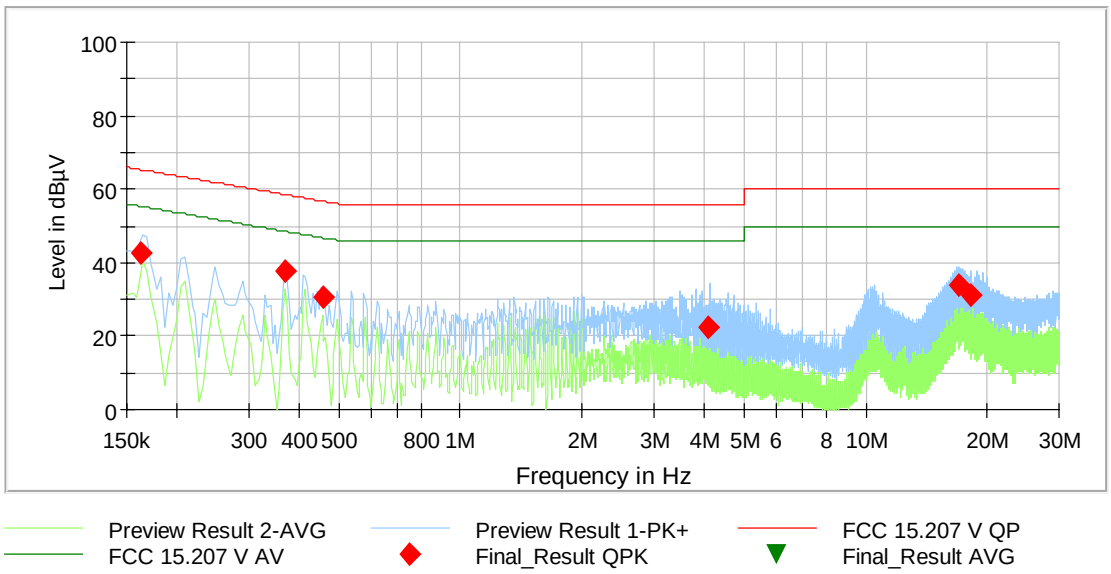
The curves in the diagram only represent for each frequency point the maximum measured value of all preliminary measurements which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by “◊” and the average measured points by “+”.

Freewave mode:



Data record name: 170226 Freewave.rtf

Option 9:



Data record name: 170226 Option 9.rtf

Final_Result Freewave

Frequency [MHz]	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.165300	41.01	---	65.19	24.18	5000.0	9.000	N	GND	9.8
0.182400	33.49	---	64.38	30.89	5000.0	9.000	L1	GND	9.8
0.226500	34.11	---	62.58	28.47	5000.0	9.000	N	GND	9.9
0.240900	50.94	---	62.07	11.12	5000.0	9.000	N	FLO	9.9
0.319200	49.18	---	59.73	10.54	5000.0	9.000	N	FLO	9.9
0.664800	27.95	---	56.00	28.05	5000.0	9.000	L1	GND	9.9
1.023900	47.45	---	56.00	8.55	5000.0	9.000	N	FLO	9.9
1.311000	22.83	---	56.00	33.17	5000.0	9.000	N	FLO	9.9
2.062500	22.16	---	56.00	33.84	5000.0	9.000	N	FLO	10.1
2.226300	21.47	---	56.00	34.53	5000.0	9.000	N	FLO	10.1
2.554800	21.89	---	56.00	34.11	5000.0	9.000	N	FLO	10.2

Final_Result Option 9

Frequency [MHz]	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.162600	42.71	---	65.33	22.62	5000.0	9.000	N	GND	9.8
0.370500	37.91	---	58.49	20.58	5000.0	9.000	L1	FLO	9.9
0.456900	30.53	---	56.75	26.22	5000.0	9.000	L1	FLO	9.9
4.092000	22.40	---	56.00	33.60	5000.0	9.000	L1	GND	10.3
16.917000	33.61	---	60.00	26.39	5000.0	9.000	L1	FLO	10.8
18.221100	31.07	---	60.00	28.93	5000.0	9.000	L1	FLO	10.9

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
1 – 6

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662		
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	15.02.2016	15.02.2018
3	LISN	NSLK8128	Schwarzbeck	8128155	480058	16.02.2016	16.02.2018
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
5	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
6	Netzteil AC	AC6803A AC Quelle 2000VA	Keysight	JPVJ002509	482350	Calibration not necessary	
10	Low pass Filter	TP-250	Dirk Fischer Elektronik	-	480582	Weekly verification (system cal.)Calibration not necessary	
11	High pass Filter	WHJS1000C 11/60EF	Wainwright Instruments GmbH	1	480413	Weekly verification (system cal.)Calibration not necessary	
12	Highpass Filter	WHK2.8/18G -10SS	Wainwright Instuments GmbH	1	480867	Weekly verification (system cal.)Calibration not necessary	
13	Tunable Band Reject Filter	WRCT880/960-5/40-8EEK	Wainwright Instruments GmbH	3	481597	Verification before measurement	
14	Open area test site M6	Freifeld M6	Phoenix Contact	-	480085	20.04.2017	20.04.2018
15	Antenna mast	MA240-0	Inn-Co GmbH	MA240-0/030/6600603	480086	Calibration not necessary	
16	Turntable	DS412	Deisel	412/316	480087	Calibration not necessary	
17	Relay Switch Unit	RSU	Rohde & Schwarz	375344/005	480077	Calibration not necessary	
18	Controller	MCU	Maturo	041/971107	482113	Calibration not necessary	
19	Controller	HD100	Deisel	100/349	480139	Calibration not necessary	
28	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586	481720	24.02.2016	01.02.2018
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	17.02.2016	17.02.2018
32	Controller	MCU	Maturo	MCU/043/971107	480832	Calibration not necessary	
33	Turntable	DS420HE	Deisel	420/620/80	480315	Calibration not necessary -	
34	Antenna support	AS615P	Deisel	615/310	480187	Calibration not necessary-	
36	Antenna	3115 A	EMCO	9609-4918	480183	10.11.2014	10.11.2017
41	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
42	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
43	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	29.02.2016	29.02.2018
44	Antenna	CBL6112 B	Chase	2688	480328	14.04.2014	14.04.2017
44	Antenna	CBL6112 B	Chase	2688	480328	19.06.2017	19.06.2019

49	Preamplifier 100 MHz - 16 GHz	AFS6-00101600-10P-6-R	Narda MITEQ		482333	23.11.2016	01.11.2018
72	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

7 Report History

Report Number	Date	Comment
F170226E1	20.06.2017	Initial Test Report

8 List of Annexes

ANNEX A TEST SETUP PHOTOS 11 pages

170226_01.jpg	Test setup - conducted tests
170226_02.jpg	Test setup CAY antenna - Radiated emission anechoic chamber
170226_03.jpg	Test setup CAH antenna - Radiated emission anechoic chamber
170226_04.jpg	Test setup antenna port terminated - Radiated emission anechoic chamber
170226_05.jpg	Test setup antenna port terminated- Radiated emission anechoic chamber
170226_06.jpg	Test setup CAH antenna - Radiated emission anechoic chamber
170226_07.jpg	Test setup CAY antenna - Radiated emission anechoic chamber
170226_08.jpg	Test setup CAY antenna - Radiated emission open area test site
170226_09.jpg	Test setup CAH antenna - Radiated emission open area test site
170226_10.jpg	Test setup antenna port terminated - Radiated emission anechoic chamber
170226_11.jpg	Test setup – conducted emissions on power supply lines

ANNEX B EXTERNAL PHOTOS 16 pages

170226_20.jpg	EUT (red) on Eval board (blue) – top view
170226_21.jpg	Evalboard housing – bottom view
170226_22.jpg	Evalboard housing – label
170226_23.jpg	Evalboard housing – side view (connectors)
170226_24.jpg	Evalboard housing without EUT – top view
170226_25.jpg	Evalboard – top view
170226_26.jpg	Evalboard – bottom view
170226_27.jpg	connector board – top view
170226_28.jpg	connector board – bottom view
170226_29.jpg	EUT – top view
170226_30.jpg	EUT – bottom view
170226_33.jpg	CAY antenna – top view
170226_34.jpg	CAY antenna – bottom view
170226_35.jpg	CAY antenna – label
170226_36.jpg	CAH antenna
170226_37.jpg	CAH antenna - label

ANNEX C INTERNAL PHOTOS 2 pages

170226_31.jpg	EUT without shielding – bottom view
170226_32.jpg	EUT without shielding – top view