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Test Report

Report Number:

F172629E3

Equipment under Test (EUT):

Dual Band Radio Modem
SATEL-TR49

Applicant:

SATEL OY

Manufacturer:

SATEL OY

ilac-MRA
DAkkS Deutsche Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

[1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

[2] **FCC CFR 47 Part 15**, Radio Frequency Devices

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

[4] **RSS-Gen Issue 5 (April 2018)**, General Requirements for Compliance of Radio Apparatus

Test Result

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

Tested and written by:	Wolfgang KASALOWSKY	W. Kasalowsky	06.12.2018
	Name	Signature	Date
Reviewed and approved by:	Bernd STEINER	B. Steiner	06.12.2018
	Name	Signature	Date

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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

Contents **Page**

1 Identification

1.1 Applicant

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Country:	Finland
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eMail Address:	pekka.suominen@satel.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	SATEL OY
Address:	Meriniitynkatu 17, 24100 Salo
Country:	Finland
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: *	Dual band radio modem
HVIN: *	SATEL-TR49
Type / PMN: *	SATEL-TA37
FCC ID: *	MRBSATEL-TA37
IC: *	2422A-SATELTA37
HW version: *: *	SPL0060a 1.01
FW version: *	07.45.2.3.2.0_rc16
Serial number: *	1801000002

* declared by the applicant.

1.5 Technical Data of Equipment

900 MHz mode

Fulfills specifications: *	Freewave mode, Topcon mode		
Antenna type: *	Loaded quarter wave whip	Directional yagi	
Antenna name: *	CA915H	CA930Y	
Antenna gain: *	0 dBi	6 dBi	
Antenna connector: *	TNC-male		
Supply Voltage: *	Evaluation board:	V_{min} = 9 V_{DC}	V_{max} = 16 V_{DC}
	EUT:	V_{min} = 3.7 V_{DC}	V_{max} = 5.5 V_{DC}
Type of modulation: *	Freewave: 2-GFSK Topcon: 2-FSK		
Operating frequency range:*	902.2464 MHz to 927.8208 MHz (Freewave mode) 902.2 MHz to 927.8 MHz (Topcon mode)		
Number of channels: *	Freewave mode: variable 50 to 110 channels Topcon 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

Freewave mode			
RX:	902.2464 MHz	TX:	902.2464 MHz
RX:	915.1488 MHz	TX:	915.1488 MHz
RX:	927.8208 MHz	TX:	927.8208 MHz

Topcon mode			
RX:	902.2 MHz	TX:	902.2 MHz
RX:	915.0 MHz	TX:	915.0 MHz
RX:	927.8 MHz	TX:	927.8 MHz

Ancillary devices:	
Test Laptop	Fujitsu LIFEBOOK E780 (provided by the laboratory)
AC adapter	Enercell CAT. No. 273-316

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
RS232	“RS-232” connection @ eval board	RS232 interface @ test laptop	2 m *
DC in	“9 – 16 V DC” conection @ eval board	DC Power supply	2 m *
Antenna	TNC connector	Antenna, Attenuator, Spectrum Analyser / Dummy Load	0.5 m *

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	15.01.2018
Start of test:	05.02.2018
End of test:	05.06.2018

2 Operational States

The EUT is a radio modem transceiver operating in the frequency range 902MHz to 928 MHz.

The module is intended for implementation into various final applications.

Two modes called “Freewave mode” and “Topcon” are supported by the EUT.
In Freewave mode 50 to 110 hopping channels are supported, which can be set by the end user.
In Topcon 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 RF port, 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 evaluation board via a RS-232 connection. A test-software provided by the applicant called “TypeApproval_TR49_UI_V018_03012018.exe” was used to set the test modes.

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

All tests were carried out with an unmodified sample.

During the tests the evaluation board with the test sample was powered with 12 V DC if not otherwise stated.

The following operation modes were used during the tests:

Operation mode	Description of the operation mode	Mode	Modulation	Data rate / Mbps
1	Continuous transmitting on 902.2464 MHz	Freewave	2-GFSK	115.2 kBit/s
2	Continuous transmitting on 915.1488 MHz	Freewave	2-GFSK	115.2 kBit/s
3	Continuous transmitting on 927.8208 MHz	Freewave	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	Topcon	2-FSK	64 kBit/s
7	Continuous transmitting on 915.0 MHz	Topcon	2-FSK	64 kBit/s
8	Continuous transmitting on 927.8 MHz	Topcon	2-FSK	64 kBit/s
9	Hopping on 128 channels	Topcon	2-FSK	64 kBit/s

3 Additional Information

This test report only gives attention to the 900 MHz part of the EUT
The EUT is also able to operate in the frequency range 410 MHz to 475 MHz.
The results of this operation mode are subject of a separate test report.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 5 [4]	Status	Refer page
Carrier frequency separation	902 – 928	15.247 (a)(1)	5.1 (b) [3]	Passed	12 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	18 et seq.
Maximum Peak Output Power	902 – 928	15.247 (a)(1)(i)	5.4 (a) [3]	Passed	21 et seq.
Band edge compliance	902 – 928	15.247 (d)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	24 et seq.
Occupied Bandwidth	902 – 928	15.247 (a)(1)(i)	5.1 (c) [3]	Passed	27 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	32 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Passed	62 et seq.

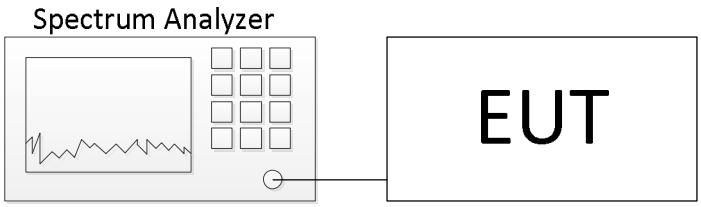
5 Results

5.1 Duty cycle

5.1.1 Method of measurement

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 Topcon 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.)

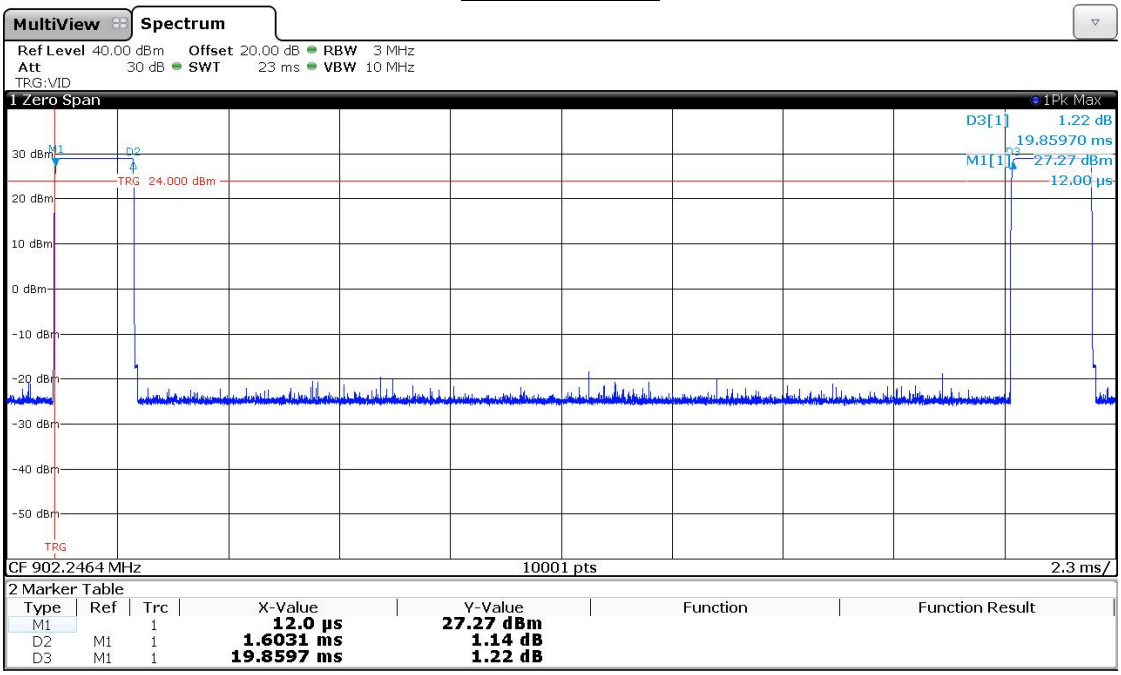
5.1.2 Test results

Ambient temperature	22 °C

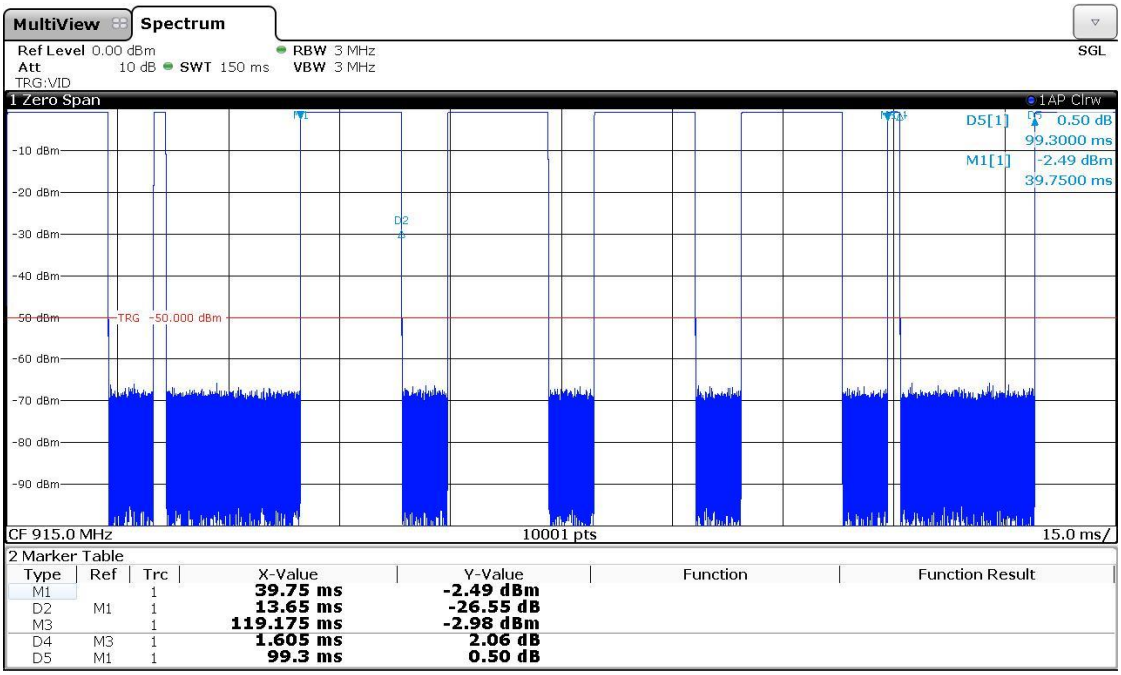
Relative humidity	38 %

Duty cycle measurement:

Freewave mode:



Freewave mode (special test mode for spurious emission measurement):



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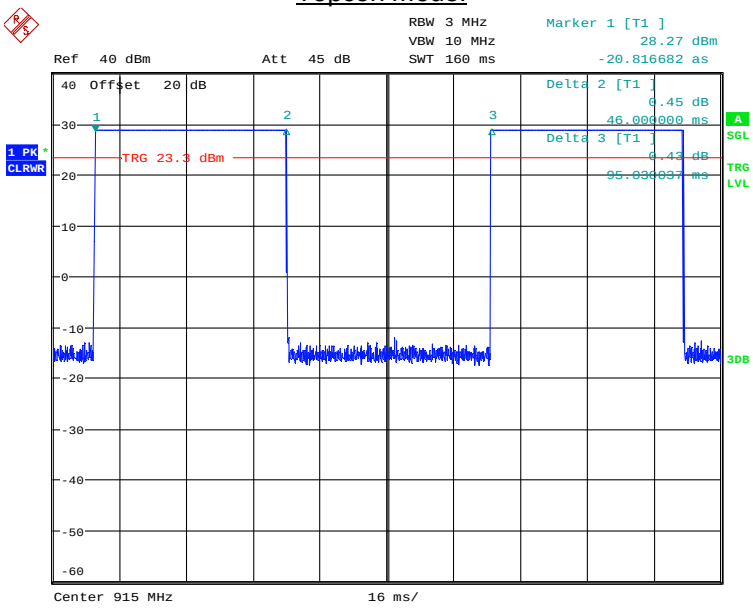
Topcon mode:



Operation mode	TX_on [µs]	TX_ges [µs]	RBW [MHz]	50/T [kHz]	50/T < RBW?
Freewave	1603	19860	3	31	Yes
Freewave (test mode for radiated spurious emission measurement > 1 GHz)	56205	99300	3	1	Yes
Topcon	46000	95030	3	1	Yes

Operation mode	Sweep points	Sweep time [µs]	Meas points	Meas points >100?	Duty cycle %	DCCF [dB]
Freewave	10001	23000	10001	Yes	8.1	10.9
Freewave (test mode for radiated spurious emission measurement > 1 GHz)	10001	15000	10001	Yes	56.6	2.5
Topcon	10001	16000	10001	Yes	48.4	3.2

The DCCF (duty cycle correction factor) is calculated by:

$$DCCF = 10 * log_{10}\left(\frac{1}{Duty\ cycle}\right)$$

Therefore, for average measurements a correction factor of 10.9 dB is used for tests in Freewave mode.
Therefore, for average measurements a correction factor of 2.5 dB is used for radiated spurious emission tests in Freewave mode.
Therefore, for average measurements a correction factor of 3.2 dB is used for tests in Topcon mode.

Test equipment used for the test:

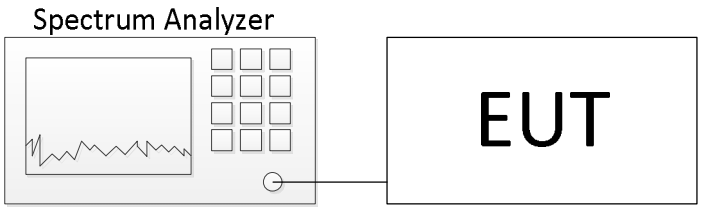
20, 23, 24, 29, 30, 31

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

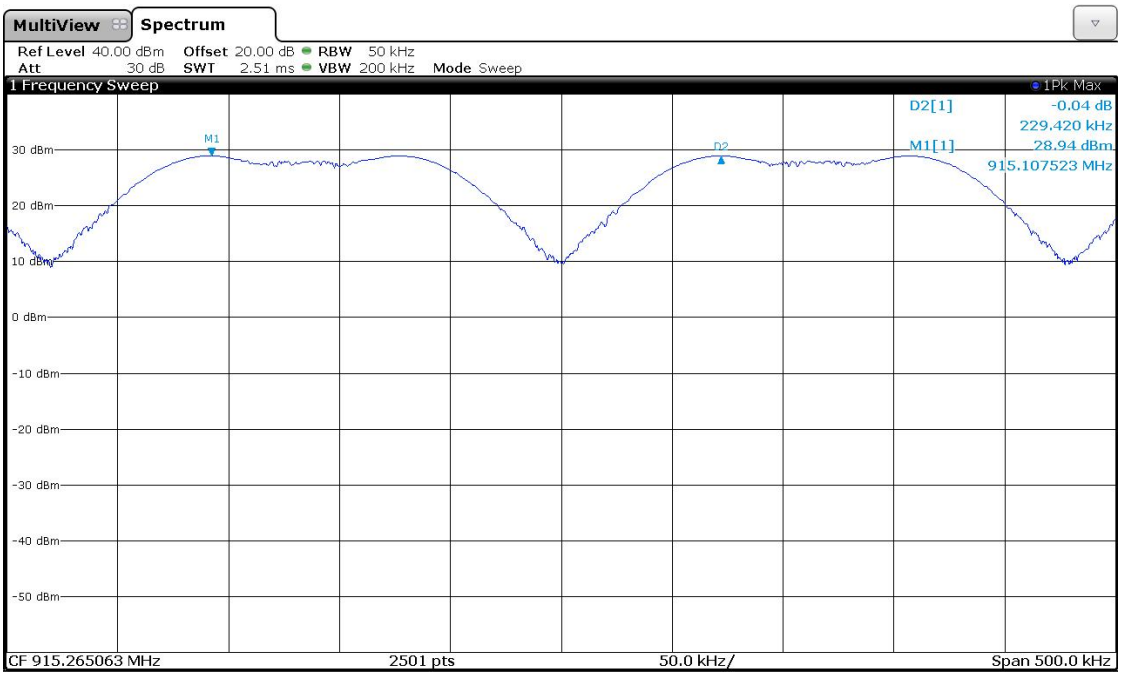
Ambient temperature	22 °C

Relative humidity	34 %

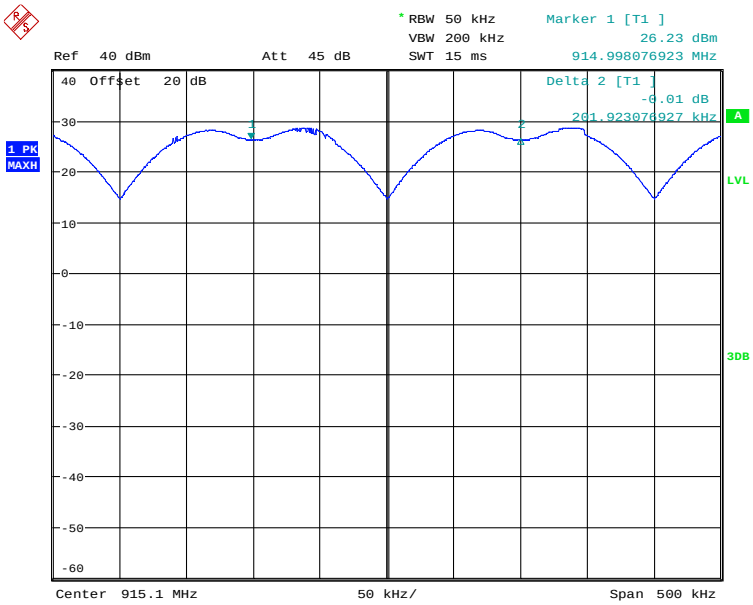
The test was performed with the EUT hopping on the highest possible number of channels, since these modes were the worst case for this test case.

CarrierFrequencySeparation

Freewave mode



Topcon mode



Operation Mode	Measurement Frequency	Frequency separation [kHz]	Margin [kHz]	Limit [kHz] (20 dB Bandwidth)	Result
5	902.2464	229.420	96.417	133.003	Passed
5	915.1488	229.420	96.407	133.013	Passed
5	927.8208	230.110	97.097	133.013	Passed
9	902.2000	201.603	60.978	140.625	Passed
9	915.0000	201.923	60.897	141.026	Passed
9	927.8000	201.603	60.000	141.603	Passed
Measurement uncertainty:		$\pm 9.5 \times 10^{-8}$			

Test: Passed

Test equipment used for the test:

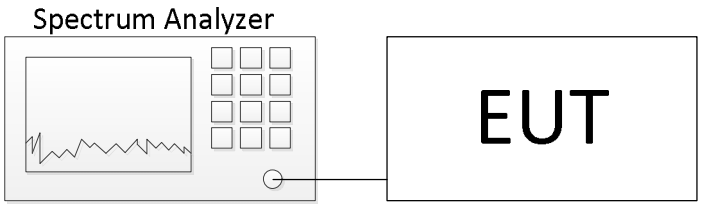
20, 23, 24, 29, 30, 31

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.

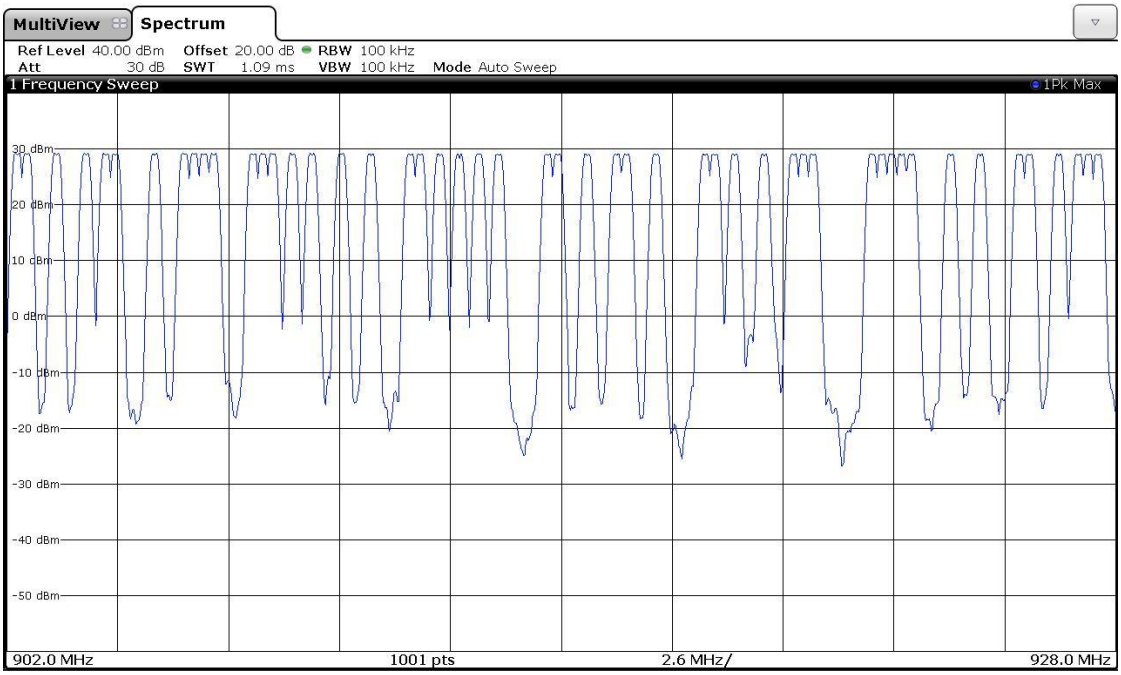
The test was performed in hopping mode.

5.3.2 Test result

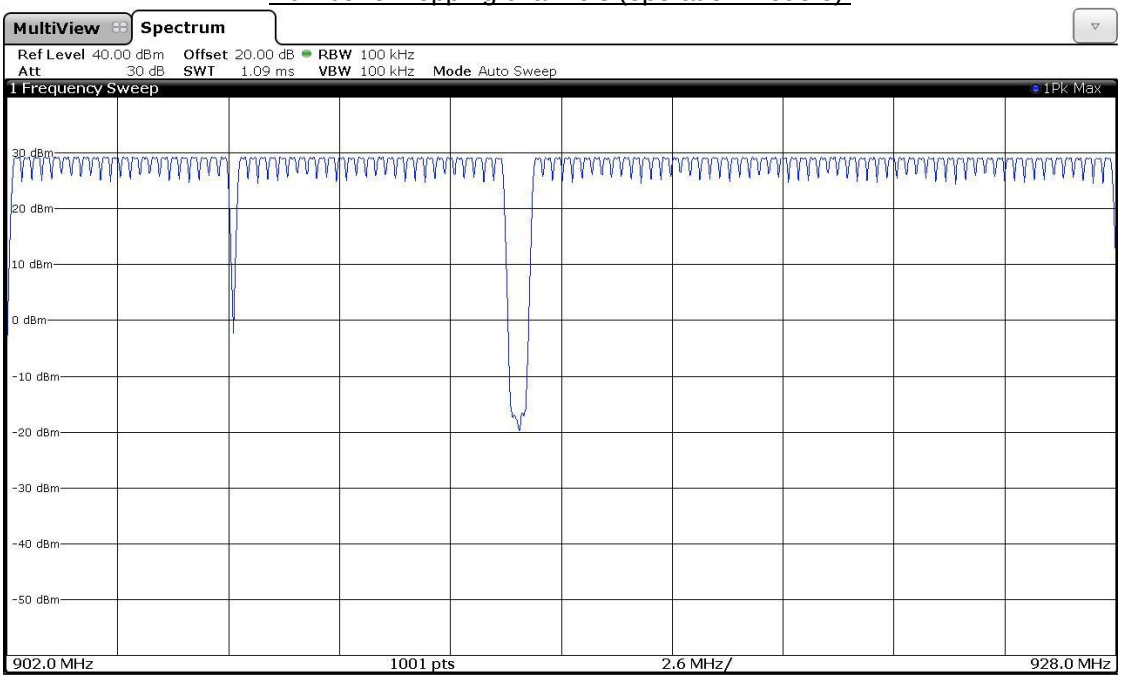
Ambient temperature	22 °C	Relative humidity	34 %

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.

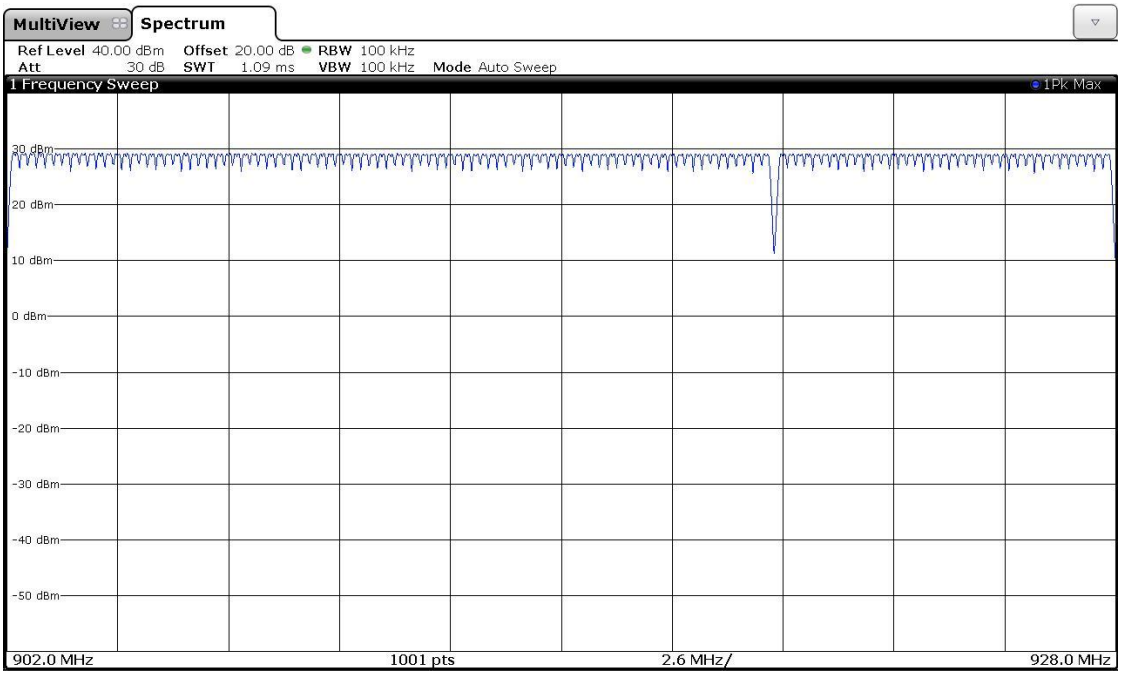
Number of hopping channels (operation mode 4):



Number of hopping channels (operation mode 5):



Number of hopping channels (operation mode 9):



Operation Mode	Number of channels	Minimum number of channels	Result
4	50	50	Passed
5	110	50	Passed
9	128	50	Passed

Test: Passed

Test equipment used for the test:

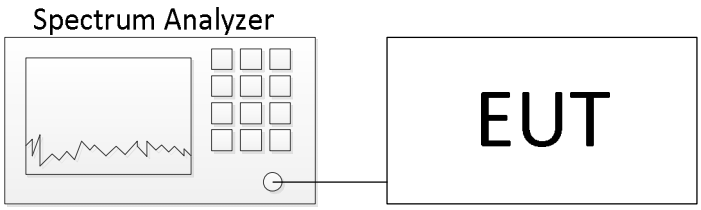
20, 23, 24, 29, 30, 31

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.

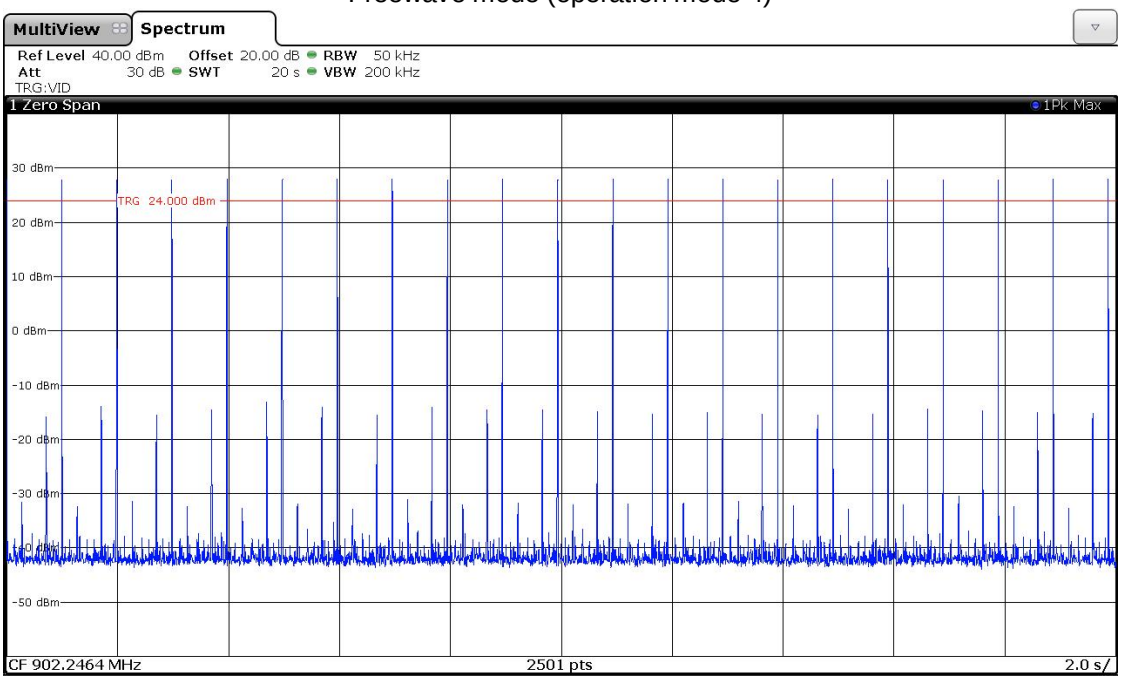
The measurement was performed at the upper and lower end and the middle of the assigned frequency band.

5.4.2 Test result

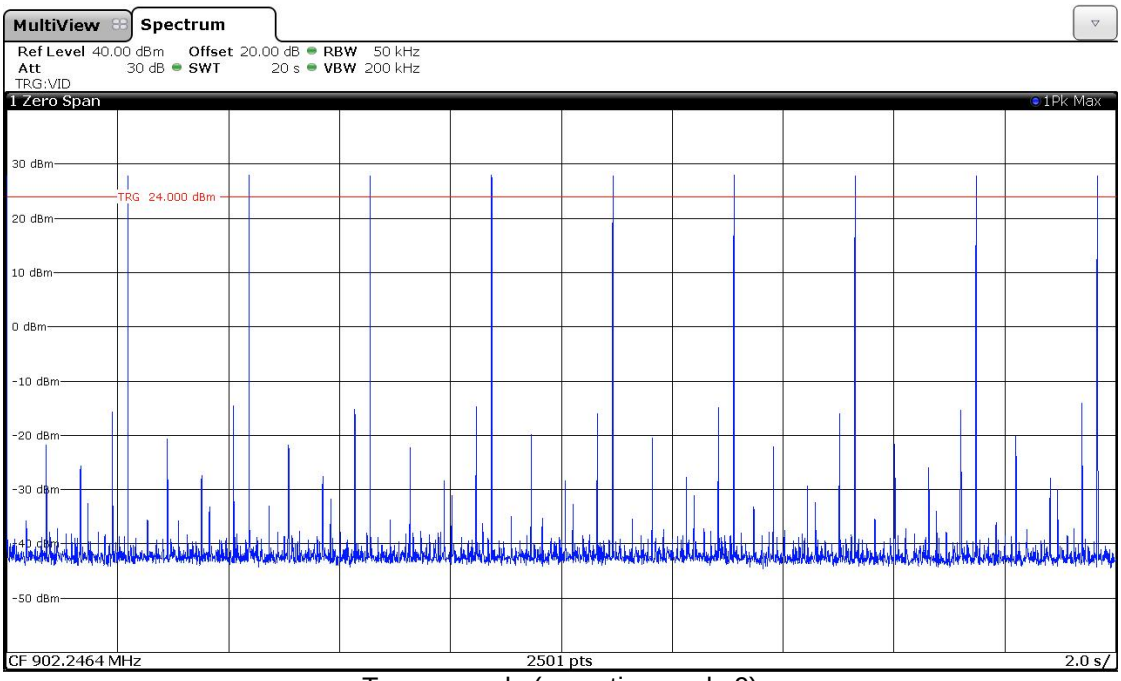
Ambient temperature	22 °C

Relative humidity	34 %

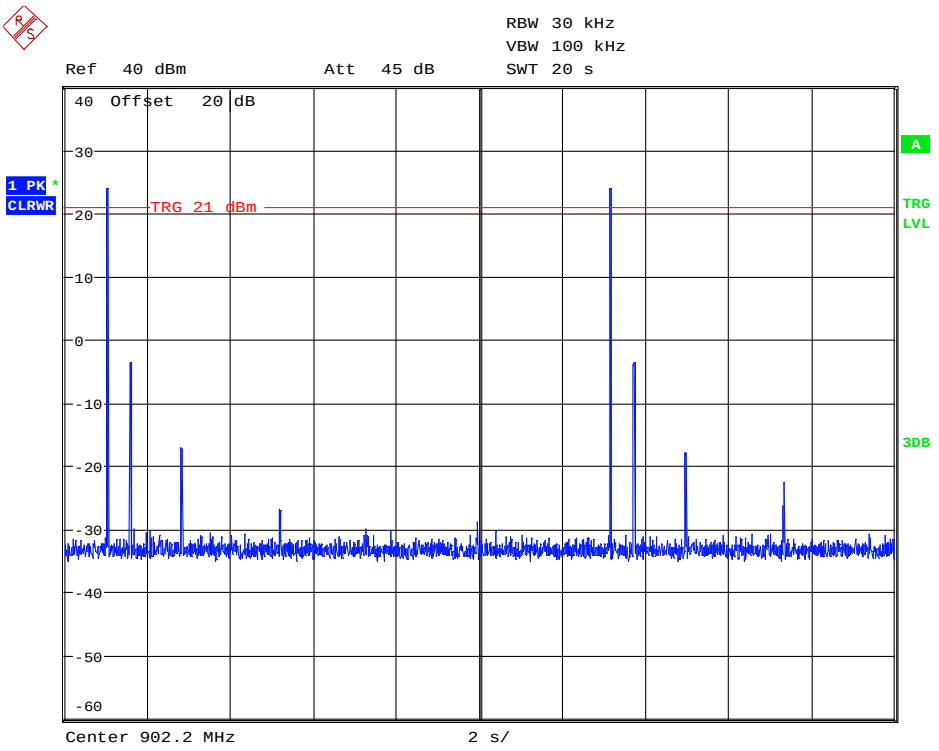
Freewave mode (operation mode 4)



Freewave mode (operation mode 5)



Topcon mode (operation mode 9)



The channel occupancy time for the multiplication of the occurred signals was derived from the measurements documented in chapter 5.1.2.

Operation Mode	Measurement Frequency	Measured Peaks in 20 s	On time for each burst [ms]	On-time in 20 s [ms]	Limit	Result
4	902.2464	21	1.603	33.663	0.4 s in 20 s	Passed
4	915.1488	21	1.603	33.663	0.4 s in 20 s	Passed
4	927.8208	21	1.603	33.663	0.4 s in 20 s	Passed
6	902.2464	9	1.603	14.427	0.4 s in 20 s	Passed
6	915.1488	9	1.603	14.427	0.4 s in 20 s	Passed
6	927.8208	9	1.603	14.427	0.4 s in 20 s	Passed
9	915.0000	2	46.000	92.000	0.4 s in 20 s	Passed
9	902.2000	2	46.000	92.000	0.4 s in 20 s	Passed
9	927.8000	2	46.000	92.000	0.4 s in 20 s	Passed
Measurement uncertainty:		± 9,5 x 10^{-8}				

Test: Passed

Test equipment used for the test:

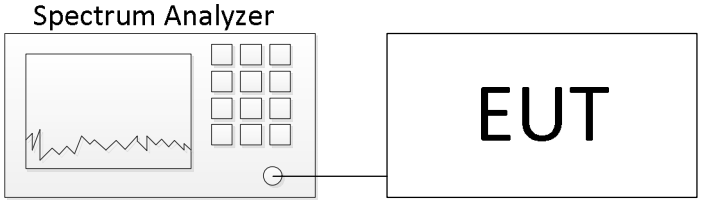
20, 23, 24, 29, 30, 31

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.

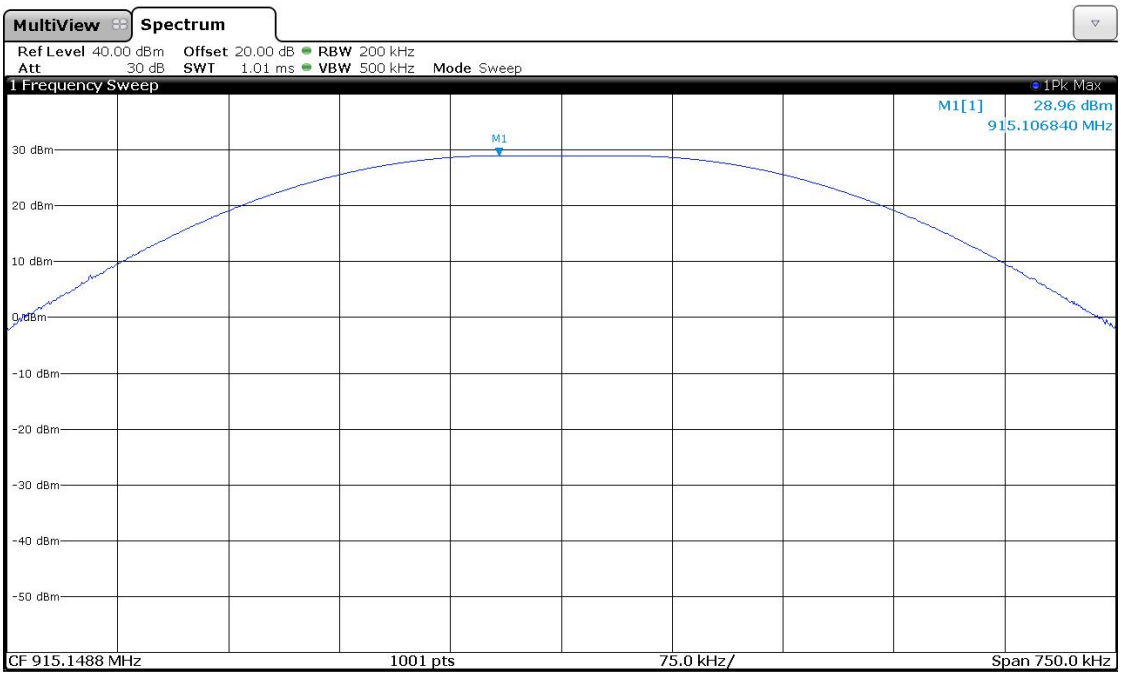
The measurement was performed at the upper and lower end and the middle of the assigned frequency band.

5.5.2 Test result

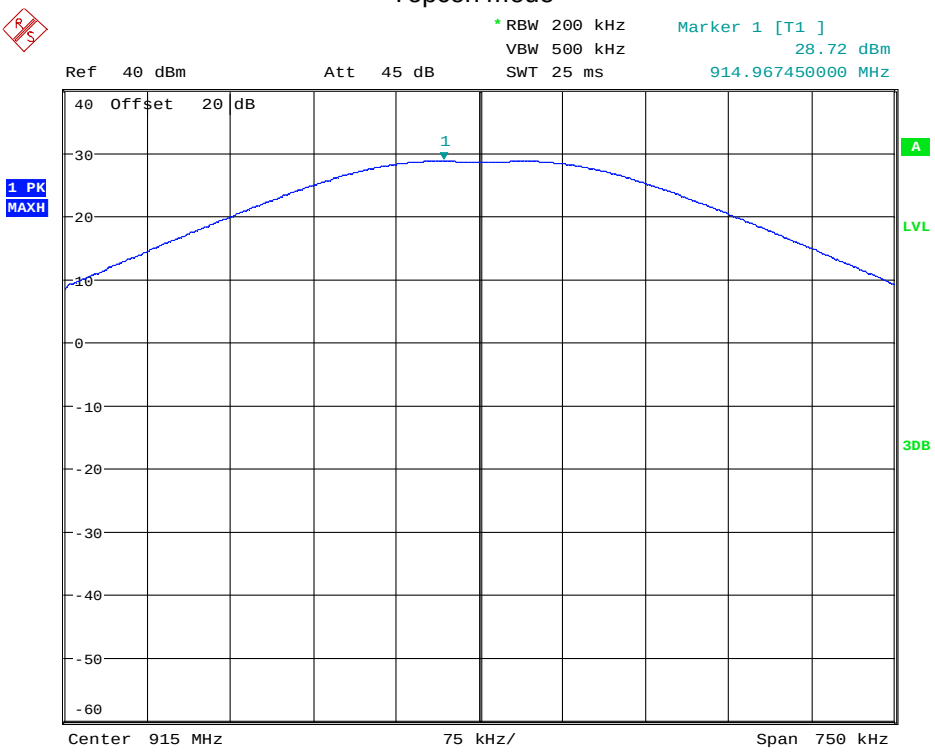
Ambient temperature	22 °C	Relative humidity	34 %

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

Freewave mode



Topcon mode



Operation Mode	Measurement Frequency[MHz]	Conducted output power [dBm]	Limit [dBm]	Margin [dB]	Result
1	902.2464	29.03	30.00	0.97	Passed
2	915.1488	28.96	30.00	1.04	Passed
3	927.8208	28.93	30.00	1.07	Passed
6	902.2000	28.77	30.00	1.23	Passed
7	915.0000	28.72	30.00	1.28	Passed
8	927.8000	28.69	30.00	1.31	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB			

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

20, 23, 24, 29, 30, 31

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).

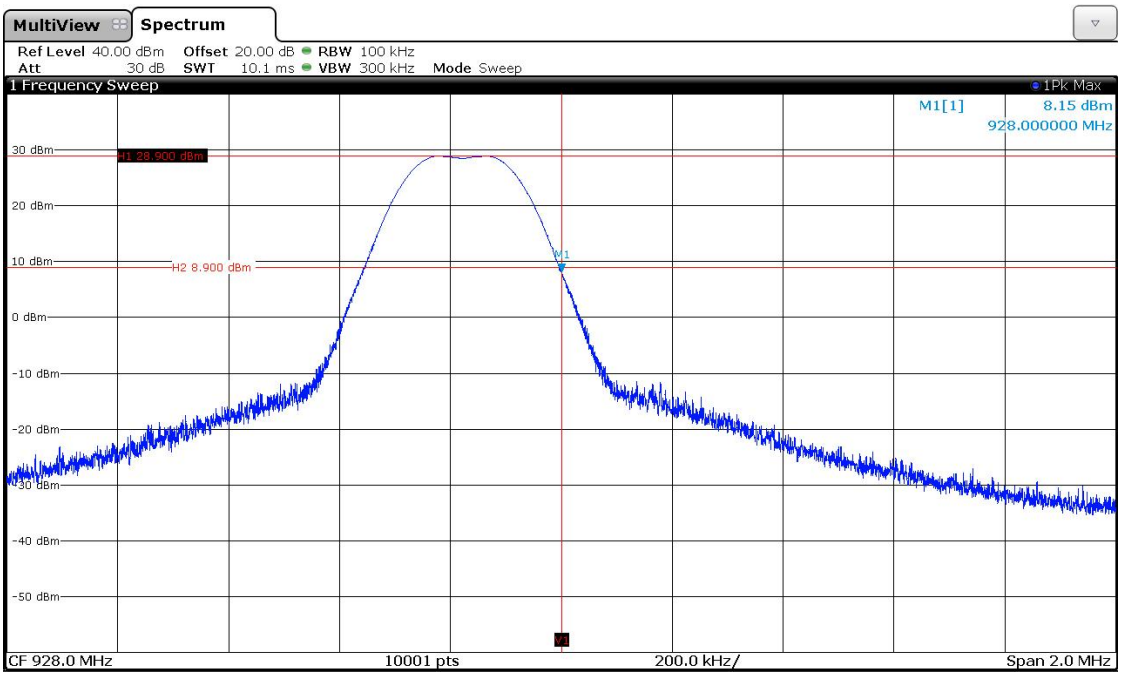
The measurements were performed at the lower and upper end of the 915 MHz band.

5.6.2 Test result

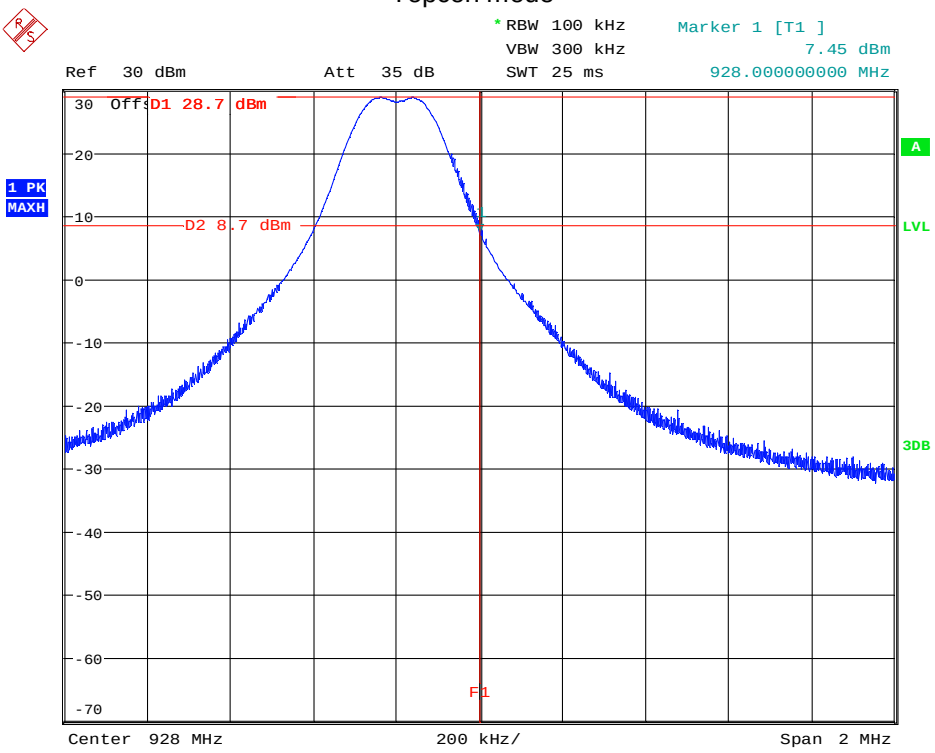
Ambient temperature	22 °C	Relative humidity	34 %

The following results were measured at the antenna port of the EUT. The plots show exemplary measurement results for the worst documented cases. The other results are listed in the following table.

Freewave mode



Topcon mode



Operation Mode	Tx Frequency [MHz]	Emission Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emisson Level [dBm]	Margin [dB]	Result
1	902.2464	902.0000	28.9	8.9	-8.3	17.2	Passed
3	927.8208	928.0000	28.9	8.9	8.2	0.7	Passed
5	902.2464	902.0000	28.9	8.9	-8.2	17.1	Passed
5	927.8208	928.0000	28.9	8.9	7.7	1.2	Passed
6	902.2000	902.0000	28.7	8.7	7.5	1.2	Passed
7	927.8000	928.0000	28.7	8.7	7.8	0.9	Passed
9	902.2000	902.0000	28.7	8.7	7.5	1.2	Passed
9	927.8000	928.0000	28.7	8.7	7.1	1.6	Passed
Measurement uncertainty:			+0.66 dB / -0.72 dB				

Test: Passed

Test equipment used for the test:

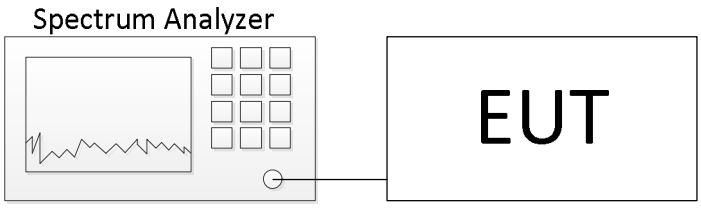
20, 23, 24, 29, 30, 31

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.

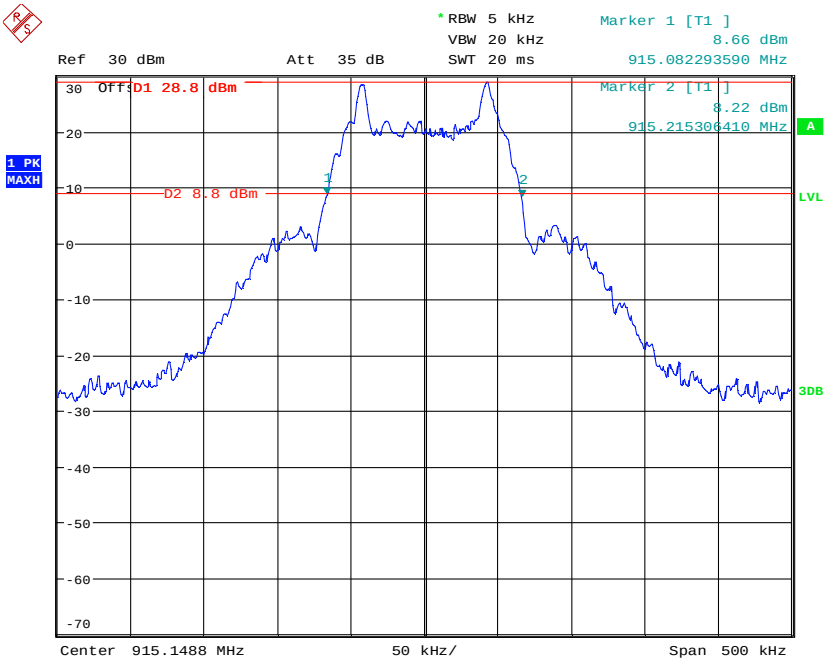
k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

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

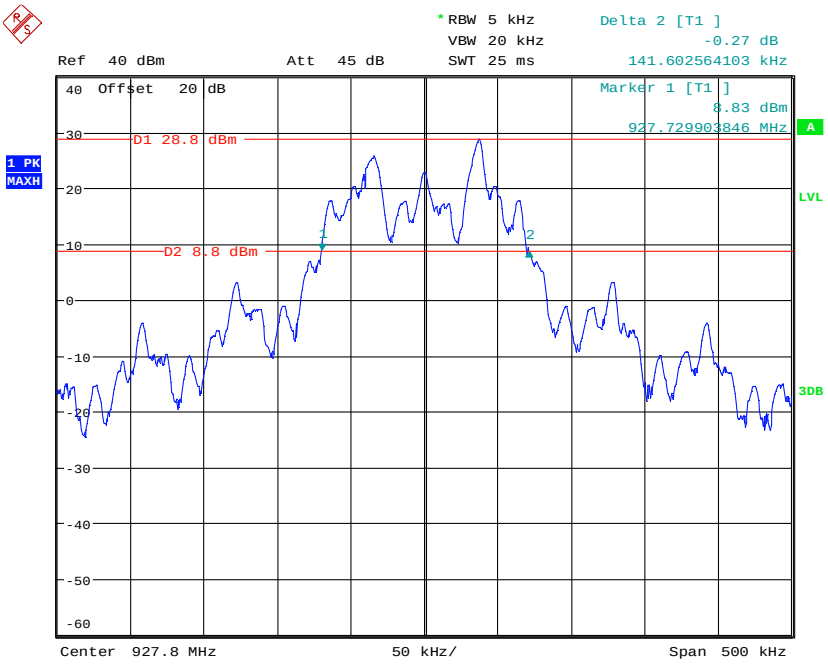
5.7.2 Test result

Ambient temperature	22 °C	Relative humidity	34 %

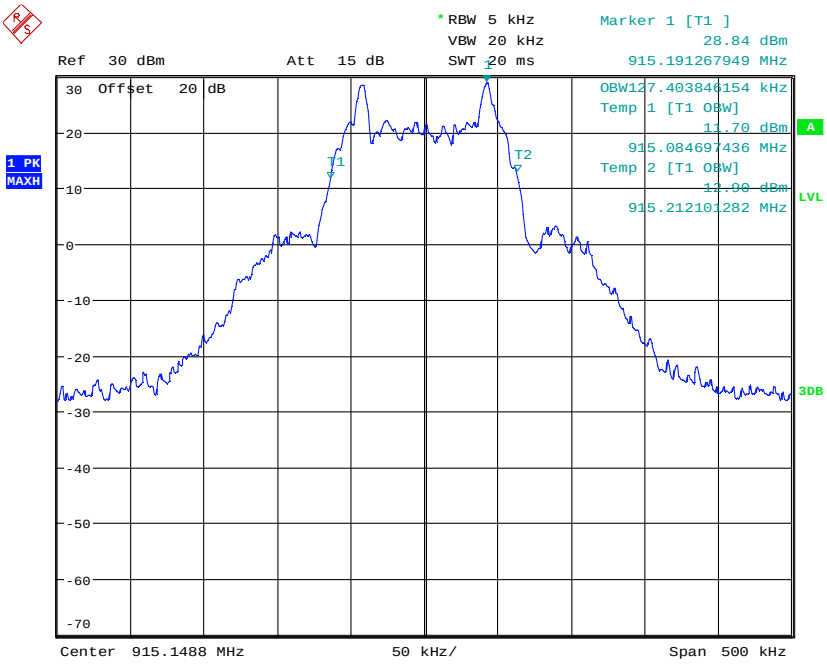
20 dB Bandwidth - Freewave mode (operation mode 2):



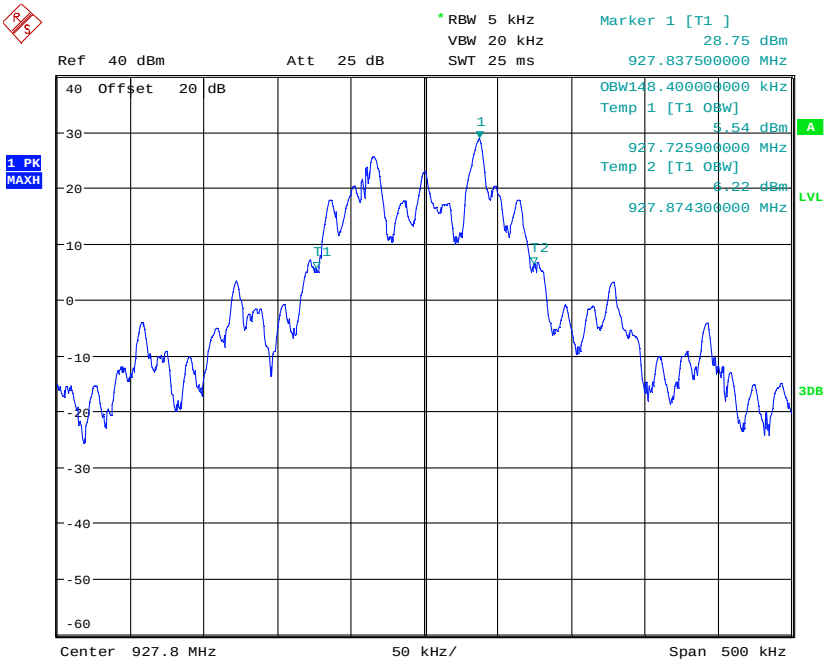
20 dB Bandwidth - Topcon mode (operation mode 8):



99% Bandwidth - Freewave mode (operation mode 2):



99% Bandwidth - Topcon mode (operation mode 8):



Operation Mode	Centre Frequency [MHz]	Measured 20 dB bandwidth [kHz]	Limit [kHz]	Margin [kHz]	Result
1	902.2464	133.003	500	366.997	Passed
2	915.1488	133.013	500	366.987	Passed
3	927.8208	133.013	500	366.987	Passed
6	902.2000	140.625	500	359.375	Passed
7	915.0000	141.026	500	358.974	Passed
8	927.8000	141.603	500	358.397	Passed
Measurement uncertainty		± 9,5 x 10^{-8}			

Operation Mode	Centre Frequency [MHz]	Measured 99% bandwidth [kHz]	Limit [kHz]	Margin [kHz]	Result
1	902.2464	127.404	500	372.596	Passed
2	915.1488	127.404	500	372.596	Passed
3	927.8208	126.603	500	373.397	Passed
6	902.2000	146.400	500	353.600	Passed
7	915.0000	144.700	500	355.300	Passed
8	927.8000	148.400	500	351.600	Passed
Measurement uncertainty		± 9,5 x 10^{-8}			

Test: Passed

Test equipment used for the test:

20, 23, 24, 29, 30, 31

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 1.
- 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 1 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.

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)

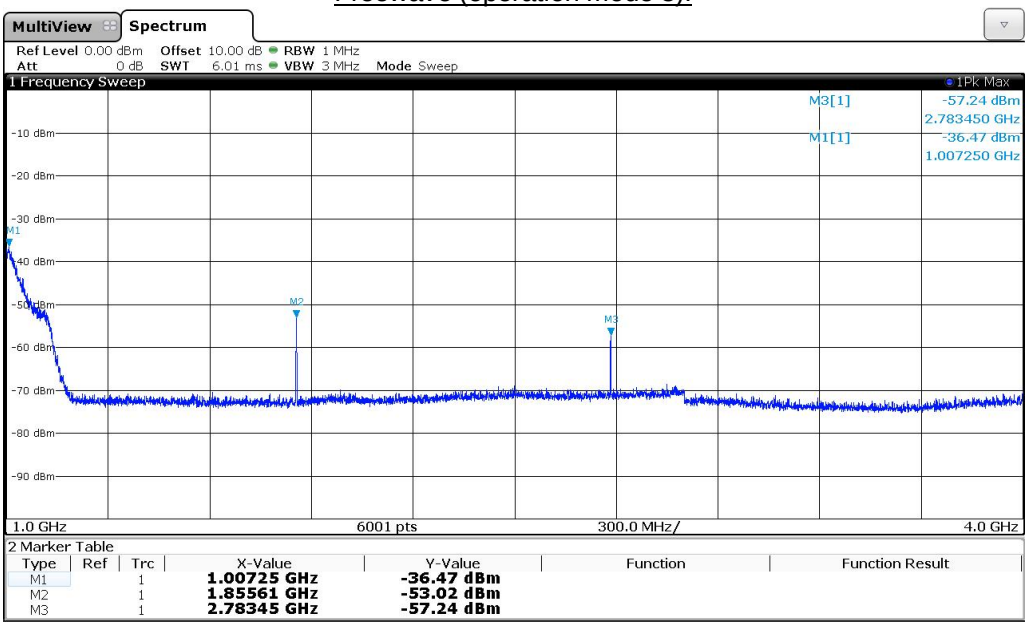
5.8.3.1 Emissions below 1 GHz

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.

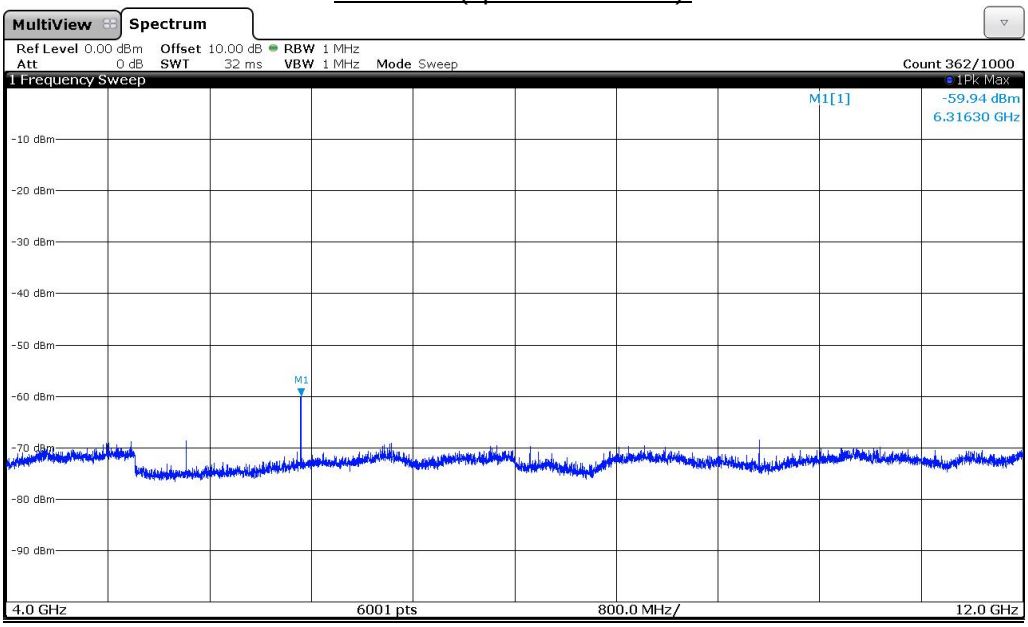
5.8.3.2 Emissions above 1 GHz

Ambient temperature	22 °C		Relative humidity	34 %

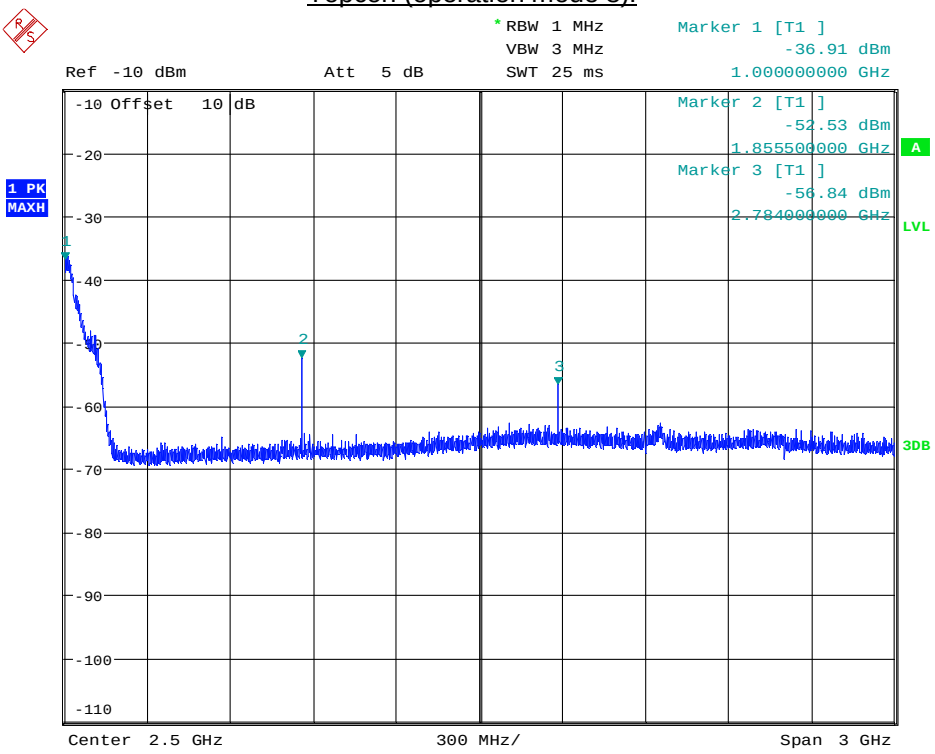
Freewave (operation mode 3):



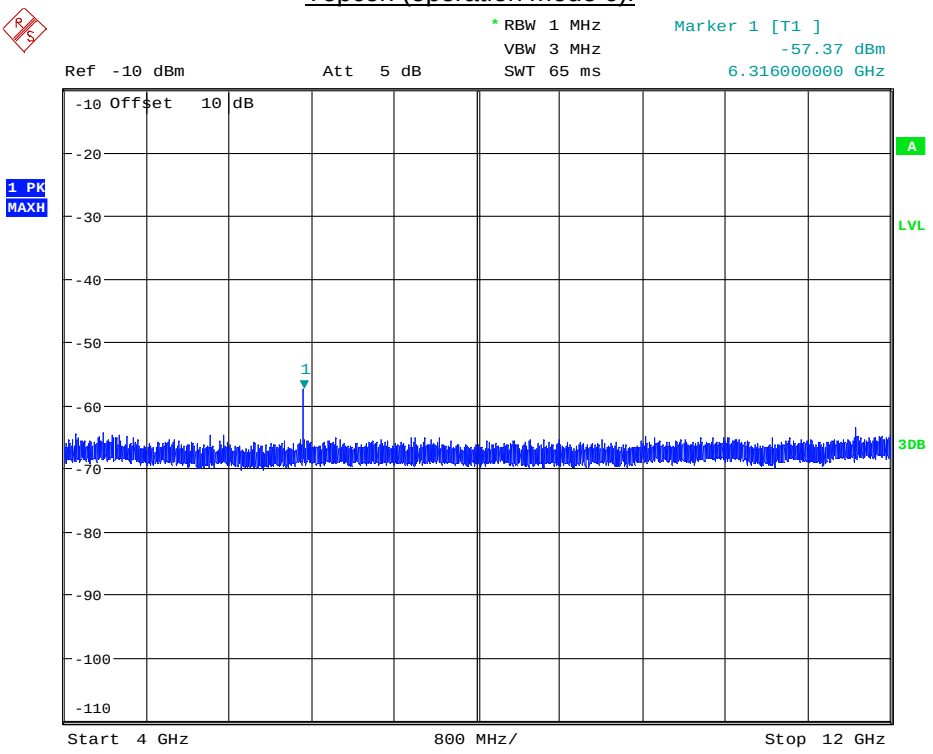
Freewave (operation mode 1):



Topcon (operation mode 8):



Topcon (operation mode 6):



Spurious Emissions (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	1002.250	56.75	74	17.25	-44.51	6	Passed	yes
Freewave	01	1804.350	43.51	74	30.49	-57.75	6	Passed	no
Freewave	01	2706.90	44.27	74	29.73	-56.99	6	Passed	yes
Freewave	01	3609.450	30.37	74	43.63	-70.89	6	Passed	yes
Freewave	01	6316.300	41.32	74	32.68	-59.94	6	Passed	no
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	1001.991	31.61	54	22.39	-80.58	6	Passed	yes
Freewave	01	1804.615	30.44	54	23.56	-81.75	6	Passed	no
Freewave	01	2706.760	31.75	54	22.25	-80.44	6	Passed	yes
Freewave	01	6315.744	29.36	54	24.64	-82.83	6	Passed	no
Measurement uncertainty:			+0.66 dB / -0.72 dB						

Spurious Emissions (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	1000.250	62.73	74	11.27	-38.53	6	Passed	yes
Freewave	25/55	1830.110	45.94	74	28.06	-55.32	6	Passed	no
Freewave	25/55	2745.460	43.55	74	30.45	-57.71	6	Passed	yes
Freewave	25/55	6406.900	38.31	74	35.69	-62.95	6	Passed	no
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	1003.387	32.19	54	21.81	-80.00	6	Passed	yes
Freewave	25/55	1830.293	30.59	54	23.41	-81.60	6	Passed	no
Freewave	25/55	2745.494	31.74	54	22.26	-80.45	6	Passed	yes
Freewave	25/55	6406.062	29.49	54	24.51	-82.70	6	Passed	no
Measurement uncertainty:			+0.66 dB / -0.72 dB						

Spurious Emissions (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	1007.250	64.79	74	9.21	-36.47	6	Passed	yes
Freewave	50/110	1855.610	48.24	74	25.76	-53.02	6	Passed	no
Freewave	50/110	2783.450	43.86	74	30.14	-57.40	6	Passed	yes
Freewave	50/110	6494.900	36.10	74	37.90	-65.16	6	Passed	no
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	1000.774	32.24	54	21.76	-79.95	6	Passed	yes
Freewave	50/110	1855.638	30.86	54	23.14	-81.33	6	Passed	no
Freewave	50/110	2783.405	31.84	54	22.16	-80.35	6	Passed	yes
Freewave	50/110	6495.063	29.11	54	24.89	-83.08	6	Passed	no
Measurement uncertainty:			+0.66 dB / -0.72 dB						

Spurious Emissions (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?
Topcon	01	1001.500	59.11	74	14.89	-42.15	6	Passed	yes
Topcon	01	1804.500	45.94	74	28.06	-55.32	6	Passed	no
Topcon	01	2707.000	46.38	74	27.62	-54.88	6	Passed	yes
Topcon	01	6316.000	43.89	74	30.11	-57.37	6	Passed	no
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?
Topcon	01	1000.940	38.70	54	15.30	-65.71	6	Passed	yes
Topcon	01	1804.383	36.83	54	17.17	-67.58	6	Passed	no
Topcon	01	2706.513	38.30	54	15.70	-66.11	6	Passed	yes
Topcon	01	6315.545	35.08	54	18.92	-69.33	6	Passed	no
Measurement uncertainty:			+0.66 dB / -0.72 dB						

Spurious Emissions (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?
Topcon	64	1001.000	63.33	74	10.67	-37.93	6	Passed	yes
Topcon	64	1830.000	47.08	74	26.92	-54.18	6	Passed	no
Topcon	64	2745.000	45.40	74	28.60	-55.86	6	Passed	yes
Topcon	64	6405.000	43.14	74	30.86	-58.12	6	Passed	no
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?
Topcon	64	1000.076	41.00	54	13.00	-63.41	6	Passed	yes
Topcon	64	1830.049	37.16	54	16.84	-67.25	6	Passed	no
Topcon	64	2745.080	37.24	54	16.76	-67.17	6	Passed	yes
Topcon	64	6405.013	34.24	54	19.76	-70.17	6	Passed	no
Measurement uncertainty:			+0.66 dB / -0.72 dB						

Spurious Emissions (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?
Topcon	128	1000.000	64.35	74	9.65	-36.91	6	Passed	yes
Topcon	128	1855.500	48.73	74	25.27	-52.53	6	Passed	no
Topcon	128	2784.000	44.42	74	29.58	-56.84	6	Passed	yes
Topcon	128	6495.000	39.00	74	35.00	-62.26	6	Passed	no
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?
Topcon	128	1000.101	41.89	54	12.11	-62.52	6	Passed	yes
Topcon	128	1855.564	39.10	54	14.90	-65.31	6	Passed	no
Topcon	128	2783.280	36.59	54	17.41	-67.82	6	Passed	yes
Topcon	128	6494.545	32.23	54	21.77	-72.18	6	Passed	no
Measurement uncertainty:			+0.66 dB / -0.72 dB						

Test equipment used for the test:

15, 20, 23, 29, 30, 31, 35

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.

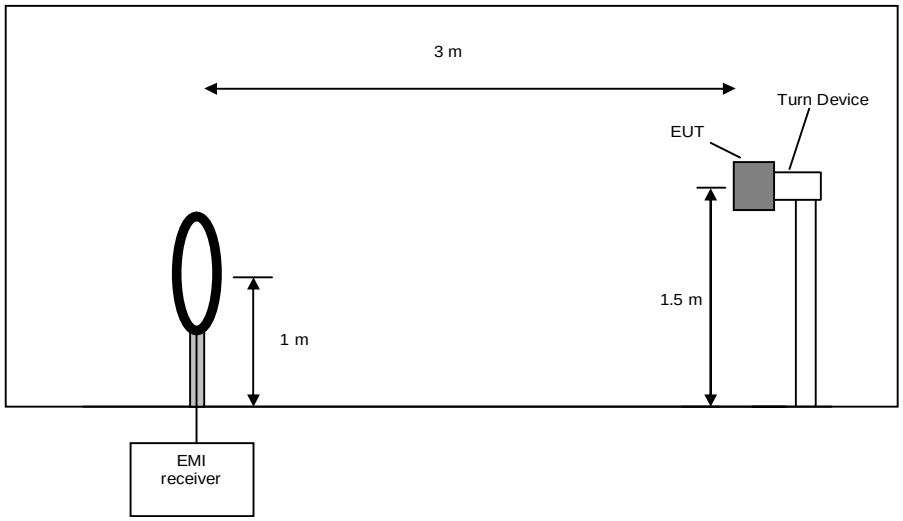
Preliminary measurement (9 kHz to 30 MHz):

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.

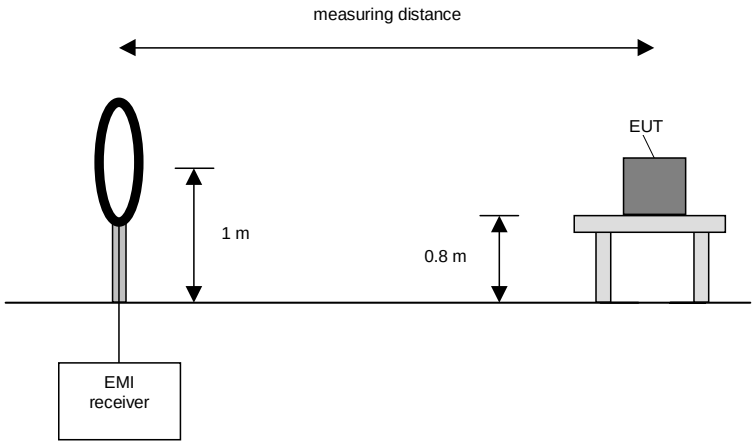
Final measurement (9 kHz to 30 MHz):

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).

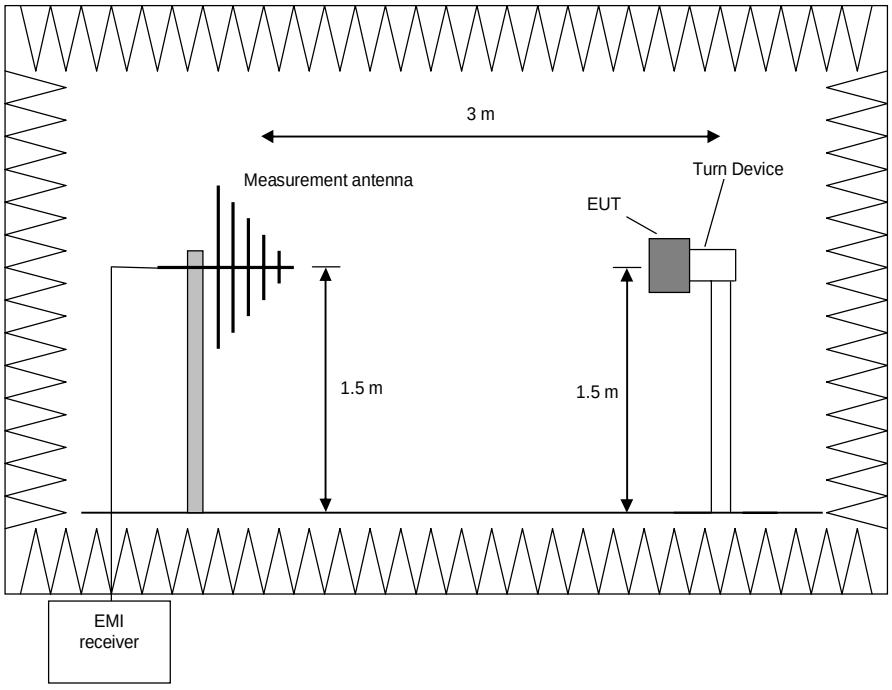
Preliminary measurement (30 MHz to 1 GHz)

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:

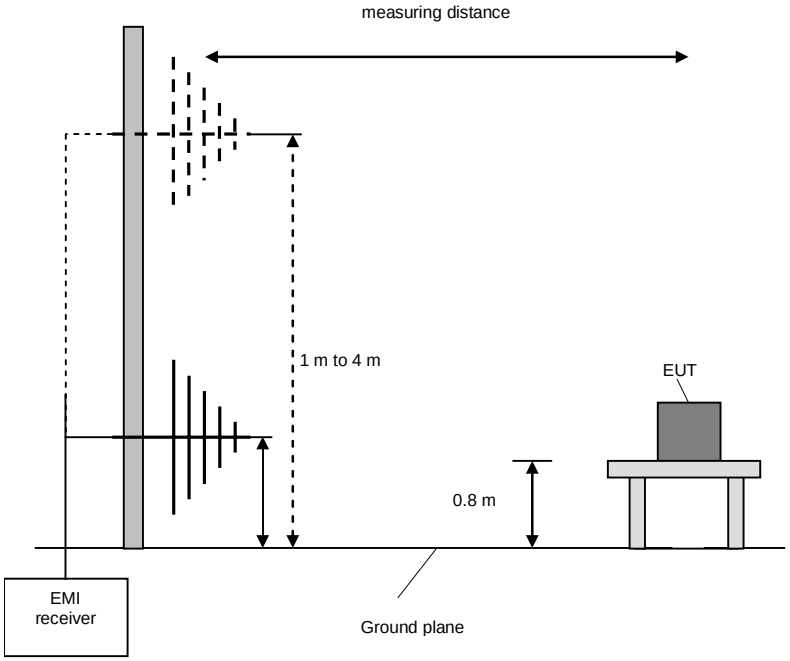
8. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
9. Manipulate the system cables within the range to produce the maximum level of emission.
10. Rotate the EUT by 360 ° to maximize the detected signals.
11. Repeat 1) to 3) with the vertical polarisation of the measuring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

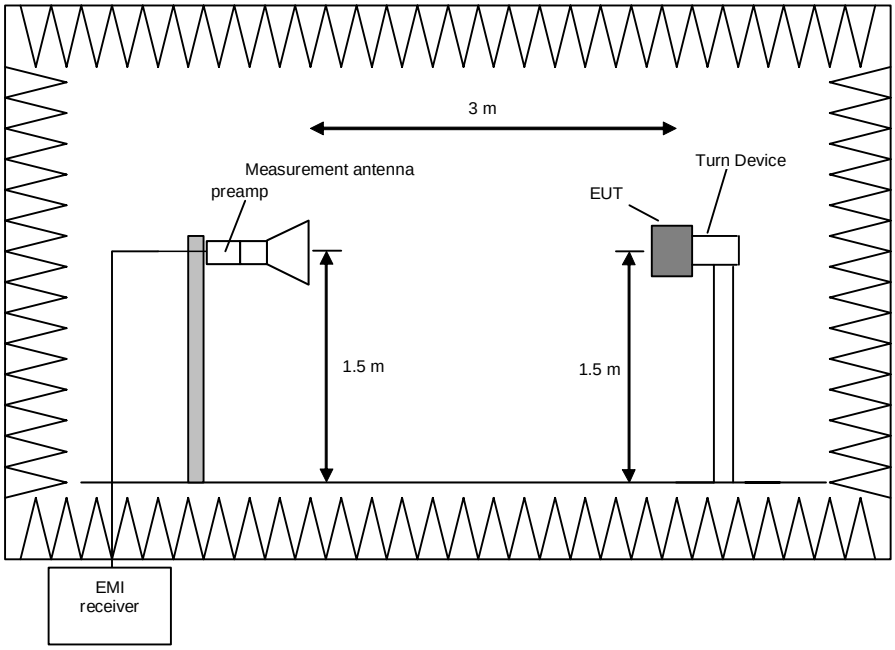
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

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:

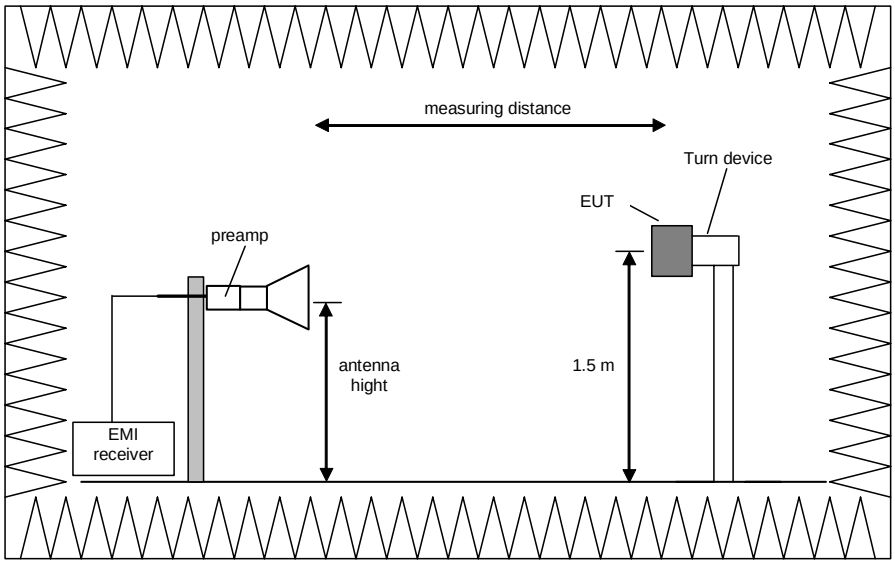
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an 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	63 %

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.

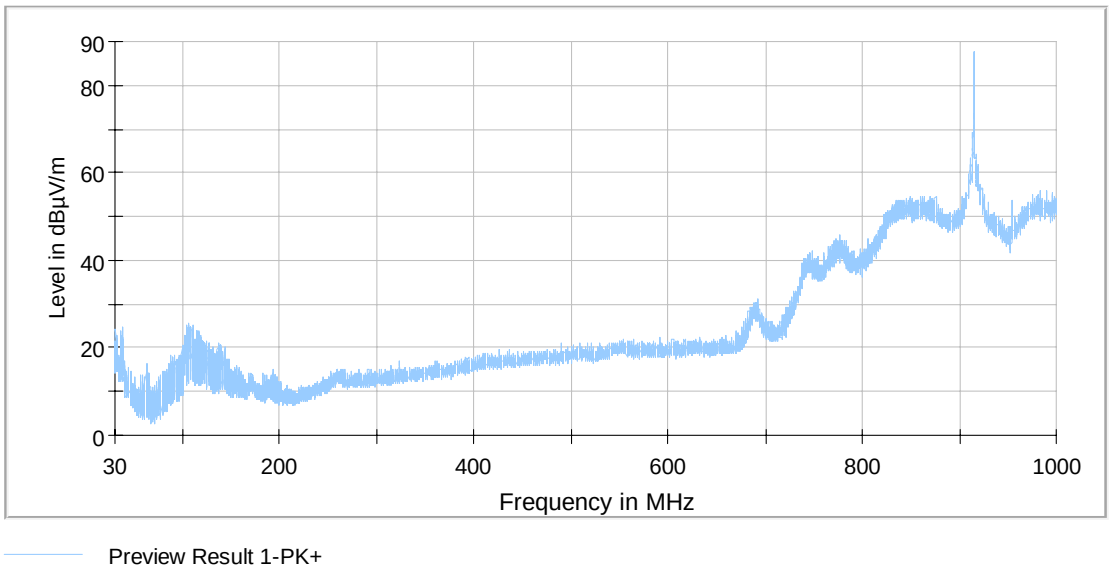
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

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

Supply voltage: During all measurements the evaluation board with 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 middle of the assigned frequency band (operation mode 8) CAY antenna



Test equipment used for the test:

8, 10 – 14, 16, 22, 29, 30

5.8.5.1 Final radiated measurements 30 MHz – 1 GHz

Ambient temperature	22 °C

Relative humidity	53 %

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)
CA915H 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
960.666500	43.93	54.00	10.07	1000.0	120.000	167.0	V	264.0	30.9	Y
963.382500	44.66	54.00	9.34	1000.0	120.000	180.0	V	265.0	31.0	Y
965.419500	44.86	54.00	9.14	1000.0	120.000	190.0	V	302.0	31.0	Y
966.098500	44.49	54.00	9.51	1000.0	120.000	194.0	V	300.0	31.0	Y
970.609000	43.88	54.00	10.12	1000.0	120.000	195.0	V	282.0	31.0	Y
971.724500	43.88	54.00	10.12	1000.0	120.000	195.0	V	288.0	31.1	Y
975.313500	44.13	54.00	9.87	1000.0	120.000	172.0	V	251.0	31.1	Y
975.653000	43.94	54.00	10.06	1000.0	120.000	183.0	V	298.0	31.1	Y
979.096500	43.13	54.00	10.87	1000.0	120.000	184.0	V	243.0	31.1	Y
979.969500	43.17	54.00	10.83	1000.0	120.000	175.0	V	242.0	31.1	Y
981.812500	41.47	54.00	12.53	1000.0	120.000	170.0	V	271.0	31.1	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)
CA930Y 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
38.633000	23.05	40.00	16.95	1000.0	120.000	265.0	V	316.0	23.3	Y
116.039000	18.07	43.50	25.43	1000.0	120.000	102.0	V	72.0	18.5	Y
961.248500	45.95	54.00	8.05	1000.0	120.000	182.0	V	253.0	30.9	Y
962.800500	46.37	54.00	7.63	1000.0	120.000	177.0	V	253.0	30.9	Y
964.643500	46.49	54.00	7.51	1000.0	120.000	188.0	V	304.0	31.0	Y
967.505000	46.22	54.00	7.78	1000.0	120.000	178.0	V	245.0	31.0	Y
973.907000	46.05	54.00	7.95	1000.0	120.000	186.0	V	27.0	35.6	Y
975.750000	45.49	54.00	8.51	1000.0	120.000	180.0	V	242.0	31.1	Y
978.126500	45.01	54.00	8.99	1000.0	120.000	182.0	V	244.0	31.1	Y
979.387500	44.66	54.00	9.34	1000.0	120.000	177.0	V	244.0	31.1	Y
982.152000	48.45	54.00	5.55	1000.0	120.000	178.0	V	245.0	31.1	Y
Measurement uncertainty:						±4.78 dB				

Transmitter operates at the middle of the assigned frequency band (operation mode 2)
CA915H 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
976.283500	42.95	54.00	11.05	1000.0	120.000	198.0	V	242.0	36.2	Y
980.357500	42.70	54.00	11.30	1000.0	120.000	198.0	V	244.0	36.1	Y
981.667000	42.95	54.00	11.05	1000.0	120.000	202.0	V	312.0	36.1	Y
984.189000	42.23	54.00	11.77	1000.0	120.000	230.0	V	291.0	36.0	Y
985.353000	42.35	54.00	11.65	1000.0	120.000	192.0	V	240.0	36.0	Y
986.177500	42.03	54.00	11.97	1000.0	120.000	216.0	V	306.0	36.0	Y
986.468500	41.96	54.00	12.04	1000.0	120.000	219.0	V	309.0	36.0	Y
987.002000	42.29	54.00	11.71	1000.0	120.000	182.0	V	237.0	36.0	Y
987.487000	42.74	54.00	11.26	1000.0	120.000	190.0	V	238.0	36.0	Y
989.039000	42.87	54.00	11.13	1000.0	120.000	185.0	V	233.0	35.9	Y
990.736500	43.11	54.00	10.89	1000.0	120.000	200.0	V	231.0	35.9	Y
991.900500	42.19	54.00	11.81	1000.0	120.000	192.0	V	263.0	35.9	Y
992.822000	42.04	54.00	11.96	1000.0	120.000	184.0	V	248.0	35.9	Y
995.101500	48.85	54.00	5.15	1000.0	120.000	202.0	V	316.0	35.9	Y
998.011500	41.79	54.00	12.21	1000.0	120.000	196.0	V	310.0	35.8	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the middle of the assigned frequency band (operation mode 2)
CA930Y 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
975.750000	43.60	54.00	10.40	1000.0	120.000	203.0	V	14.0	35.6	Y
989.233000	44.00	54.00	10.00	1000.0	120.000	187.0	V	335.0	35.3	Y
992.191500	43.84	54.00	10.16	1000.0	120.000	182.0	V	8.0	35.3	Y
998.739000	44.74	54.00	9.26	1000.0	120.000	170.0	V	353.0	35.2	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the higher end of the assigned frequency band (operation mode 3)
CA915H 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
967.893000	49.93	54.00	4.07	1000.0	120.000	197.0	V	239.0	36.3	Y
990.397000	41.91	54.00	12.09	1000.0	120.000	195.0	V	230.0	35.9	Y
992.434000	41.91	54.00	12.09	1000.0	120.000	187.0	V	249.0	35.9	Y
995.489500	42.29	54.00	11.71	1000.0	120.000	187.0	V	312.0	35.9	Y
996.653500	42.08	54.00	11.92	1000.0	120.000	191.0	V	316.0	35.9	Y
997.478000	42.18	54.00	11.82	1000.0	120.000	191.0	V	304.0	35.9	Y
998.351000	41.16	54.00	12.84	1000.0	120.000	195.0	V	280.0	35.8	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the higher end of the assigned frequency band (operation mode 3)
CA930Y 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
967.893000	49.50	54.00	4.50	1000.0	120.000	150.0	V	44.0	35.7	Y
978.272000	43.96	54.00	10.04	1000.0	120.000	187.0	V	30.0	35.5	Y
981.230500	43.59	54.00	10.41	1000.0	120.000	188.0	V	42.0	35.5	Y
982.637000	42.83	54.00	11.17	1000.0	120.000	243.0	V	7.0	35.5	Y
986.711000	44.15	54.00	9.85	1000.0	120.000	198.0	V	336.0	35.4	Y
988.990500	44.11	54.00	9.89	1000.0	120.000	183.0	V	346.0	35.3	Y
992.288500	43.13	54.00	10.87	1000.0	120.000	188.0	V	0.0	35.3	Y
994.713500	42.17	54.00	11.83	1000.0	120.000	188.0	V	22.0	35.3	Y
996.120000	42.23	54.00	11.77	1000.0	120.000	184.0	V	10.0	35.3	Y
998.448000	42.72	54.00	11.28	1000.0	120.000	184.0	V	358.0	35.2	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 6)
CA915H 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
960.181500	45.96	54.00	8.04	1000.0	120.000	182.0	V	250.0	30.9	Y
961.248500	45.95	54.00	8.05	1000.0	120.000	182.0	V	253.0	30.9	Y
962.800500	46.37	54.00	7.63	1000.0	120.000	177.0	V	253.0	30.9	Y
964.643500	46.49	54.00	7.51	1000.0	120.000	188.0	V	304.0	31.0	Y
967.505000	46.22	54.00	7.78	1000.0	120.000	178.0	V	245.0	31.0	Y
971.482000	45.57	54.00	8.43	1000.0	120.000	183.0	V	301.0	31.0	Y
974.537500	45.56	54.00	8.44	1000.0	120.000	178.0	V	247.0	31.1	Y
975.750000	45.49	54.00	8.51	1000.0	120.000	180.0	V	242.0	31.1	Y
978.126500	45.01	54.00	8.99	1000.0	120.000	182.0	V	244.0	31.1	Y
979.387500	44.66	54.00	9.34	1000.0	120.000	177.0	V	244.0	31.1	Y
982.152000	48.45	54.00	5.55	1000.0	120.000	178.0	V	245.0	31.1	Y
983.316000	43.16	54.00	10.84	1000.0	120.000	177.0	V	248.0	31.1	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the lower end of the assigned frequency band (operation mode 6)
CA930Y 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
960.084500	46.77	54.00	7.23	1000.0	120.000	237.0	V	13.0	35.6	Y
963.625000	46.51	54.00	7.49	1000.0	120.000	188.0	V	11.0	35.7	Y
966.098500	47.15	54.00	6.85	1000.0	120.000	189.0	V	1.0	35.7	Y
971.094000	47.10	54.00	6.90	1000.0	120.000	236.0	V	359.0	35.6	Y
977.108000	46.58	54.00	7.42	1000.0	120.000	185.0	V	324.0	35.6	Y
979.339000	46.76	54.00	7.24	1000.0	120.000	190.0	V	36.0	35.5	Y
983.704000	46.42	54.00	7.58	1000.0	120.000	186.0	V	348.0	35.4	Y
986.226000	46.30	54.00	7.70	1000.0	120.000	190.0	V	343.0	35.4	Y
990.057500	45.62	54.00	8.38	1000.0	120.000	186.0	V	342.0	35.3	Y
996.944500	44.26	54.00	9.74	1000.0	120.000	183.0	V	0.0	35.3	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the middle of the assigned frequency band (operation mode 7)
CA915H 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
982.103500	44.30	54.00	9.70	1000.0	120.000	197.0	V	240.0	35.5	Y
984.819500	44.60	54.00	9.40	1000.0	120.000	207.0	V	308.0	35.4	Y
988.263000	44.99	54.00	9.01	1000.0	120.000	189.0	V	225.0	35.3	Y
989.184500	45.11	54.00	8.89	1000.0	120.000	188.0	V	228.0	35.3	Y
994.034500	44.74	54.00	9.26	1000.0	120.000	197.0	V	232.0	35.3	Y
994.956000	51.67	54.00	2.33	1000.0	120.000	197.0	V	309.0	35.3	Y
997.235500	44.67	54.00	9.33	1000.0	120.000	198.0	V	306.0	35.3	Y
997.769000	43.33	54.00	10.67	1000.0	120.000	194.0	V	259.0	35.2	Y
998.933000	44.23	54.00	9.77	1000.0	120.000	197.0	V	310.0	35.2	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the middle of the assigned frequency band (operation mode 7)
CA930Y 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
960.084500	49.87	54.00	4.13	1000.0	120.000	234.0	V	16.0	35.6	Y
961.685000	48.46	54.00	5.54	1000.0	120.000	236.0	V	18.0	35.7	Y
969.736000	47.21	54.00	6.79	1000.0	120.000	193.0	V	17.0	35.6	Y
973.664500	46.48	54.00	7.52	1000.0	120.000	192.0	V	25.0	35.6	Y
976.041000	46.11	54.00	7.89	1000.0	120.000	188.0	V	26.0	35.6	Y
983.655500	45.54	54.00	8.46	1000.0	120.000	182.0	V	348.0	35.4	Y
986.565500	45.72	54.00	8.28	1000.0	120.000	181.0	V	346.0	35.4	Y
990.591000	45.55	54.00	8.45	1000.0	120.000	185.0	V	355.0	35.3	Y
992.385500	45.38	54.00	8.62	1000.0	120.000	187.0	V	8.0	35.3	Y
993.064500	45.26	54.00	8.74	1000.0	120.000	186.0	V	18.0	35.3	Y
994.956000	53.16	54.00	0.84	1000.0	120.000	187.0	V	35.0	35.3	
Measurement uncertainty						±4.78 dB				

Transmitter operates at the higher end of the assigned frequency band (operation mode 8)
CA915H 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
965.807500	46.86	54.00	7.14	1000.0	120.000	190.0	V	254.0	36.3	Y
967.747500	52.14	54.00	1.86	1000.0	120.000	199.0	V	253.0	36.3	Y
987.729500	43.50	54.00	10.50	1000.0	120.000	191.0	V	238.0	36.0	Y
991.997500	43.97	54.00	10.03	1000.0	120.000	191.0	V	245.0	35.9	Y
Measurement uncertainty						±4.78 dB				

Transmitter operates at the higher end of the assigned frequency band (operation mode 8)
CA930Y 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
967.844500	53.09	54.00	0.91	1000.0	120.000	182.0	V	1.0	35.7	Y
979.921000	45.70	54.00	8.30	1000.0	120.000	193.0	V	34.0	35.5	Y
983.558500	46.18	54.00	7.82	1000.0	120.000	185.0	V	345.0	35.4	Y
988.845000	45.98	54.00	8.02	1000.0	120.000	182.0	V	344.0	35.3	Y
990.591000	45.69	54.00	8.31	1000.0	120.000	182.0	V	342.0	35.3	Y
992.773500	45.27	54.00	8.73	1000.0	120.000	175.0	V	345.0	35.3	Y
995.004500	44.45	54.00	9.55	1000.0	120.000	185.0	V	32.0	35.3	Y
997.769000	45.00	54.00	9.00	1000.0	120.000	180.0	V	2.0	35.2	Y
Measurement uncertainty						±4.78 dB				

Test: Passed

Test equipment used for the test:

1 – 7, 22, 29, 30

5.8.1 Test results (radiated emissions) – cabinet emissions

5.8.1.1 Preliminary radiated emission measurement

Ambient temperature	22 °C	Relative humidity	52 %

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.

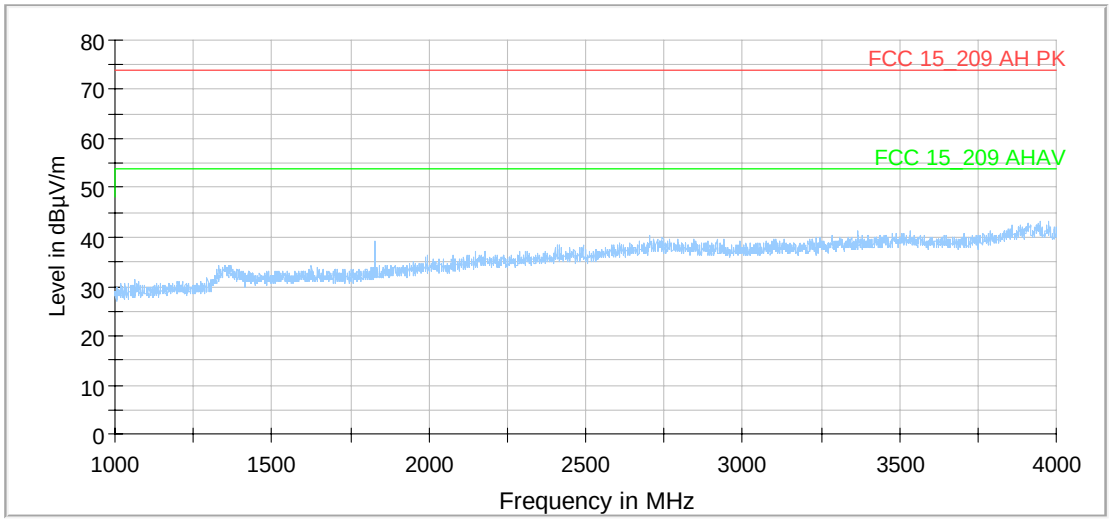
Supply voltage: During all measurements the evaluation board with the EUT was powered with 12 V via an AC/DC Adapter.

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.

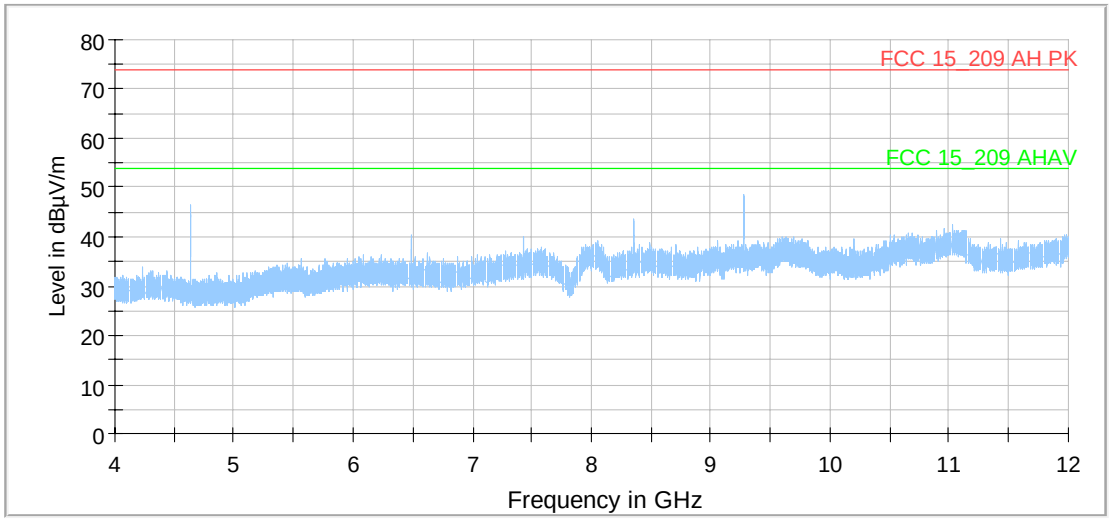
No significant emissions were found in the frequency range below 30 MHz, therefore not plots or results are shown in the following chapter.

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.

Spurious emissions from 1 GHz to 4 GHz (operation mode 7):



Spurious emissions from 4 GHz to 12 GHz (operation mode 3):



TEST EQUIPMENT USED FOR THE TEST:
8, 10 – 14, 15, 17, 18, 22, 29, 30, 32, 33, 34, 35

5.8.1.2 Final radiated measurements

The correction factor was calculated as follows:

- for peak measurements: Corr. = Antenna gain + cable attenuation – amplifier gain
- for average measurements: Corr. = Antenna gain + cable attenuation – amplifier gain + DCCF (refer to 5.1.2)

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)
1683.500000	---	21.7	54	32.3	V	34	30	-10.8
1683.500000	31.9	---	74	42.1	V	34	30	-13.3
1804.500000	---	29.5	54	24.5	H	323	90	-10.5
1804.500000	36.8	---	74	37.2	H	323	90	-13.0
4511.422222	---	41.7	54	12.3	H	289	90	-0.5
4511.422222	48.4	---	74	25.6	H	289	90	-3.0
5413.688889	---	37.5	54	16.5	H	243	120	2.2
5413.688889	45.6	---	74	28.4	H	243	120	-0.3
6315.377778	---	42.0	54	12.0	H	281	120	4.5
6315.377778	50.2	---	74	23.8	H	281	120	2.0
9022.888889	---	42.1	54	11.9	H	292	59	11.6
9022.888889	51.6	---	74	22.4	H	292	59	9.1
9924.266667	---	40.5	54	13.5	H	254	120	9.4
9924.266667	50.3	---	74	23.7	H	254	120	6.9
10827.466667	---	42.4	54	11.6	H	227	120	9.6
10827.466667	52.6	---	74	21.4	H	227	120	7.1
Measurement uncertainty				+2.2 dB / -3.6 dB				

* Duty cycle correction factor of 2.5 dB was applied for the average reading.

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)
1830.000000	---	34.2	54	19.8	H	251	90	-10.3
1830.000000	40.2	---	74	33.8	H	251	90	-12.8
2055.000000	---	23.9	54	30.1	V	159	150	-9.2
2055.000000	34.3	---	74	39.7	V	159	150	-11.7
4575.911111	---	43.4	54	10.6	H	285	90	-0.2
4575.911111	49.1	---	74	24.9	H	285	90	-2.7
5491.111111	---	34.8	54	19.2	H	289	120	2.5
5491.111111	44.1	---	74	29.9	H	289	120	0.0
6405.733333	---	41.8	54	12.2	H	283	120	5.0
6405.733333	49.9	---	74	24.1	H	283	120	2.5
7321.511111	---	38.7	54	15.3	H	301	89	7.5
7321.511111	48.0	---	74	26.0	H	301	89	5.0
8236.711111	---	39.7	54	14.3	H	258	120	8.4
8236.711111	49.1	---	74	24.9	H	258	120	5.9
9151.911111	---	41.1	54	12.9	H	276	120	10.5
9151.911111	51.1	---	74	22.9	H	276	120	8.0
10066.133333	---	39.3	54	14.7	H	303	120	10.2
10066.133333	49.1	---	74	24.9	H	303	120	7.7
Measurement uncertainty				+2.2 dB / -3.6 dB				

* Duty cycle correction factor of 2.5 dB was applied for the average reading.

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)
1735.000000	---	21.7	54	32.3	V	169	120	-10.8
1735.000000	31.3	---	74	42.7	V	169	120	-13.3
1855.500000	---	25.6	54	28.4	H	263	90	-10.4
1855.500000	40.0	---	74	34.0	H	263	90	-12.9
4639.288889	---	43.5	54	10.5	H	276	90	-0.1
4639.288889	49.5	---	74	24.5	H	276	90	-2.6
5566.622222	---	35.5	54	18.5	H	244	120	2.8
5566.622222	44.9	---	74	29.1	H	244	120	0.3
6494.444444	---	36.8	54	17.2	H	244	120	5.2
6494.444444	46.5	---	74	27.5	H	244	120	2.7
7422.888889	---	39.5	54	14.5	H	308	89	7.5
7422.888889	48.6	---	74	25.4	H	308	89	5.0
8349.955556	---	40.2	54	13.8	H	244	89	9.0
8349.955556	50.2	---	74	23.8	H	244	89	6.5
9277.777778	---	42.7	54	11.3	H	276	89	9.3
9277.777778	52.1	---	74	21.9	H	276	89	6.8
10206.488889	---	39.1	54	14.9	H	256	120	9.6
10206.488889	48.5	---	74	25.5	H	256	120	7.1
Measurement uncertainty				+2.2 dB / -3.6 dB				

* Duty cycle correction factor of 2.5 dB was applied for the average reading.

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)
1804.000000	---	32.2	54	21.8	H	227	60	-9.8
1804.000000	39.3	---	74	34.7	H	227	60	-13.0
2706.500000	---	34.8	54	19.2	H	291	60	-4.6
2706.500000	43.4	---	74	30.6	H	291	60	-7.8
4511.155556	---	42.3	54	11.7	H	281	90	0.2
4511.155556	48.7	---	74	25.3	H	281	90	-3.0
5412.933333	---	36.1	54	17.9	H	222	59	2.9
5412.933333	44.9	---	74	29.1	H	222	59	-0.3
6315.644444	---	43.4	54	10.6	H	283	120	5.2
6315.644444	50.7	---	74	23.3	H	283	120	2.0
7217.866667	---	37.0	54	17.0	H	319	90	7.7
7217.866667	46.2	---	74	27.8	H	319	90	4.5
9021.600000	---	40.8	54	13.2	H	228	120	12.3
9021.600000	51.1	---	74	22.9	H	228	120	9.1
9923.777778	---	41.3	54	12.7	H	264	120	10.1
9923.777778	51.1	---	74	22.9	H	264	120	6.9
10825.955556	---	41.6	54	12.4	H	318	120	10.3
10825.955556	50.8	---	74	23.2	H	318	120	7.1
Measurement uncertainty				+2.2 dB / -3.6 dB				

* Duty cycle correction factor of 3.2 dB was applied for the average reading.

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)
1829.500000	---	30.4	54	23.6	H	252	60	-9.6
1829.500000	38.2	---	74	35.8	H	252	60	-12.8
1939.000000	---	24.2	54	29.8	H	3	90	-8.8
1939.000000	33.8	---	74	40.2	H	3	90	-12.0
4575.155556	---	41.9	54	12.1	H	270	90	0.5
4575.155556	48.3	---	74	25.7	H	270	90	-2.7
5490.222222	---	37.0	54	17.0	H	303	120	3.2
5490.222222	45.3	---	74	28.7	H	303	120	0.0
6404.711111	---	42.8	54	11.2	H	289	120	5.7
6404.711111	50.7	---	74	23.3	H	289	120	2.5
7320.266667	---	38.7	54	15.3	H	254	90	8.2
7320.266667	48.0	---	74	26.0	H	254	90	5.0
8234.666667	---	38.4	54	15.6	H	3	120	9.2
8234.666667	47.9	---	74	26.1	H	3	120	6.0
9150.400000	---	41.5	54	12.5	H	233	59	11.2
9150.400000	51.0	---	74	23.0	H	233	59	8.0
10065.377778	---	40.7	54	13.3	H	227	59	10.8
10065.377778	50.0	---	74	24.0	H	227	59	7.6
10980.444444	---	42.2	54	11.8	H	270	120	11.2
10980.444444	51.3	---	74	22.7	H	270	120	8.0
Measurement uncertainty				+2.2 dB / -3.6 dB				

* Duty cycle correction factor of 3.2 dB was applied for the average reading.

Transmitter operates at the upper end 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)
1855.000000	---	28.2	54	25.8	H	272	90	-9.7
1855.000000	37.5	---	74	36.5	H	272	90	-12.9
2055.000000	---	24.6	54	29.4	V	159	150	-8.5
2055.000000	34.3	---	74	39.7	V	159	150	-11.7
4639.155556	---	43.0	54	11.0	H	276	90	0.6
4639.155556	48.8	---	74	25.2	H	276	90	-2.6
5566.533333	---	36.3	54	17.7	H	319	120	3.5
5566.533333	45.0	---	74	29.0	H	319	120	0.3
6494.800000	---	39.6	54	14.4	H	271	120	5.9
6494.800000	48.0	---	74	26.0	H	271	120	2.7
7422.666667	---	39.5	54	14.5	H	252	90	8.2
7422.666667	48.4	---	74	25.6	H	252	90	5.0
8350.533333	---	41.7	54	12.3	H	255	120	9.7
8350.533333	51.2	---	74	22.8	H	255	120	6.5
9277.600000	---	40.8	54	13.2	H	283	90	10.0
9277.600000	50.5	---	74	23.5	H	283	90	6.8
10206.222222	---	39.7	54	14.3	V	312	29	10.3
10206.222222	49.0	---	74	25.0	V	312	29	7.1
Measurement uncertainty				+2.2 dB / -3.6 dB				

* Duty cycle correction factor of 3.1 dB was applied for the average reading.

Test: Passed

Test equipment used for the test:

8, 10 – 14, 15, 17, 18, 22, 29, 30, 32, 33, 34, 35

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

Ambient temperature	22 °C	Relative humidity	48 %

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

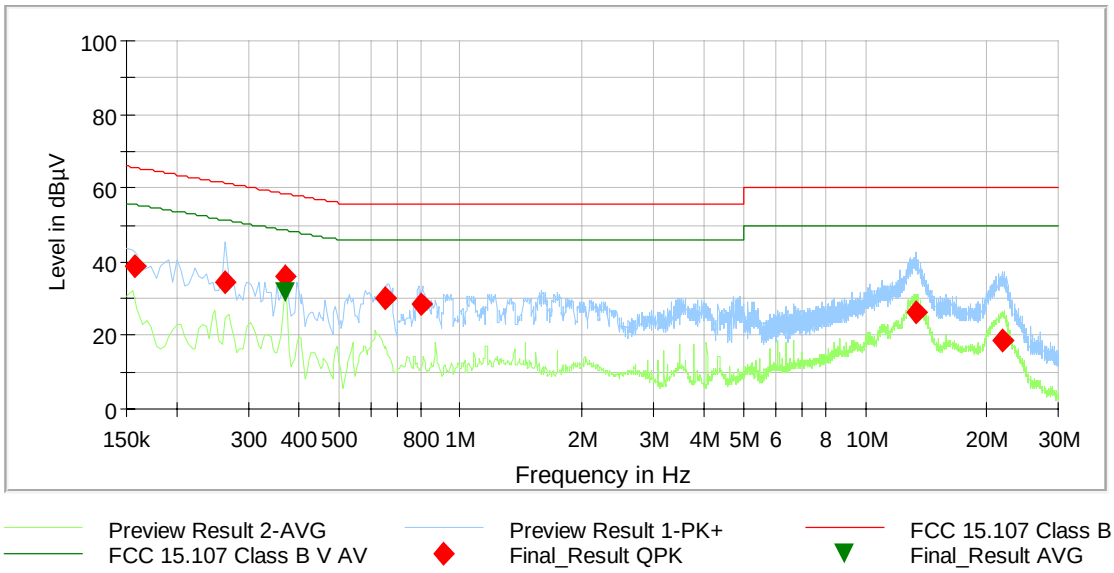
Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: Measurement performed with US 120V/60Hz. For the test a power supply type “Enercell CAT. No. 273-316” was used. The power supply provided 12 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 “+”.

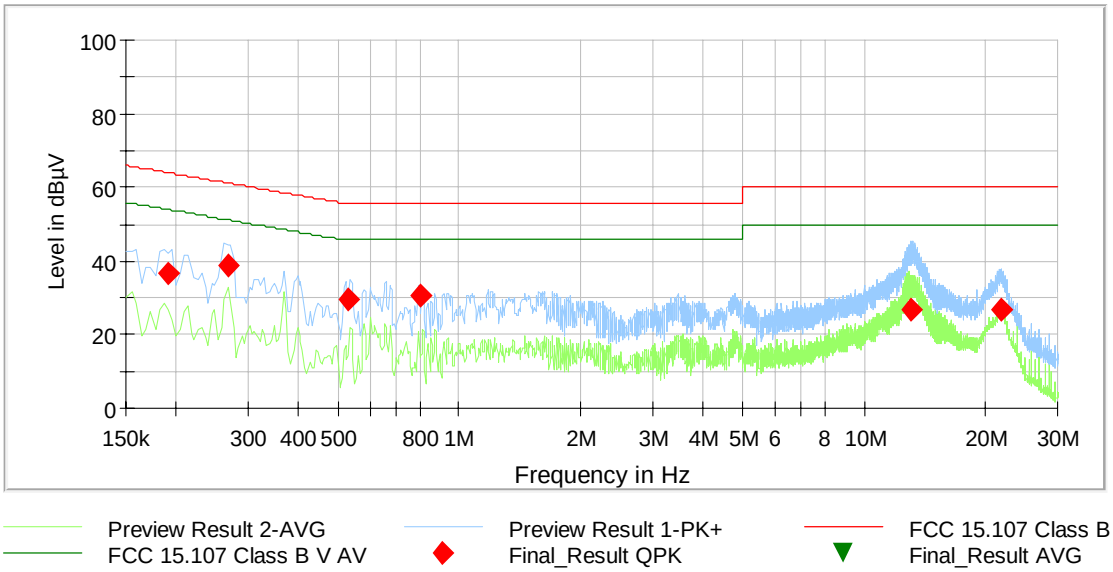
Freewave mode:



Final_Result Freewave

Frequency [MHz]	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.157200	38.97	---	65.61	26.65	5000.0	9.000	L1	FLO	9.8
0.261600	34.56	---	61.38	26.82	5000.0	9.000	N	GND	9.9
0.369600	36.02	---	58.51	22.49	5000.0	9.000	L1	FLO	9.9
0.370500	---	31.92	48.49	16.57	5000.0	9.000	L1	GND	9.9
0.653100	30.13	---	56.00	25.87	5000.0	9.000	N	FLO	9.9
0.798000	28.15	---	56.00	27.85	5000.0	9.000	L1	GND	9.9
13.299000	26.40	---	60.00	33.60	5000.0	9.000	N	GND	10.8
21.762600	18.34	---	60.00	41.66	5000.0	9.000	N	FLO	11.0

Topcon mode:



Final_Result Topcon

Frequency [MHz]	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.189600	36.83	---	64.05	27.22	5000.0	9.000	N	FLO	9.8
0.268800	38.76	---	61.15	22.40	5000.0	9.000	L1	FLO	9.9
0.530700	29.31	---	56.00	26.69	5000.0	9.000	L1	FLO	9.9
0.801600	30.61	---	56.00	25.39	5000.0	9.000	L1	FLO	9.9
13.121700	26.62	---	60.00	33.38	5000.0	9.000	N	FLO	10.8
21.887700	26.97	---	60.00	33.03	5000.0	9.000	N	FLO	11.0

Test: Passed

Test equipment used for the test:

36 - 38

6 Test equipment used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Open area test site M6	OATS M6	Phoenix Contact	-	480085	Calibration not necessary	
2	EMI Receiver	ESIB 7	Rohde & Schwarz	100304	480521	26.02.2018	02.2020
3	Controller	HD100	Deisel	100/349	480139	Calibration not necessary	
4	Turntable	DS412	Deisel	412/316	480087	Calibration not necessary	
5	Antenna mast	MA240-0	Inn-Co GmbH	MA240-0/030/6600603	480086	Calibration not necessary	
6	Antenna (Bilog)	CBL6111D	Schaffner Elektrotest GmbH / Teseq GmbH	25761	480894	19.10.2017	10.2020
7	Software	EMC32	Rohde & Schwarz	100061	481022	Calibration not necessary	
8	Fully anechoic chamber M20	B83117-E2439-T232	Albatross Projects	103	480303	Calibration not necessary	
9	EMI Receiver / Spectrum Analyser	ESI 40	Rohde & Schwarz	100064/040	480355	27.02.2018	02.2019
10	Multiple Control Unit	MCU	Maturo GmbH	MCU/043/971107	480832	Calibration not necessary	
11	Turntable	DS420 HE	Deisel	420/620/00	480315	Calibration not necessary	
12	Antenna mast	AS615P	Deisel	615/310	480187	Calibration not necessary	
13	Positioner	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
14	Antenna (Bilog)	CBL6112B	Schaffner EMV GmbH (-Chase)	2688	480328	19.06.2017	06.2020
15	Highpass Filter	WHJS1000C11/60EF	Wainwright Instruments GmbH	1	480413	Calibration not necessary	
16	RF-cable No.36	Sucoflex 106B	Suhner	0587/6B / Kabel 36	480865	Calibration not necessary	
17	RF-cable No.3	Sucoflex 106B	Suhner	0563/6B / Kabel 3	480670	Calibration not necessary	
18	RF-Cable No. 40	Sucoflex 106B	Suhner	0708/6B / Kabel 40	481330	Calibration not necessary	
19	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	23.02.2018	02.2020
20	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	15.03.2018	03.2020
21	Lowpass Filter	TP-250	Dirk Fischer Elektronik	-	480582	Calibration not necessary	
22	Tunable Band Reject Filter	WRCT880/960-5/40-8EEK	Wainwright Instruments GmbH	3	481597	Calibration not necessary	
23	Coaxial-Attenuator	WA47-20-34	Weinschel	#A1169	481452	Calibration not necessary	
24	Coaxial-Attenuator	WA8 / 18-10-34	Weinschel	-	481449	Calibration not necessary	
25	Precision Dipole	HZ-12	Rohde & Schwarz	831781/02	480061	Calibration not necessary	
26	Precision Dipole	HZ-13	Rohde & Schwarz	831782/02	480062	Calibration not necessary	
27	Antenna (Horn)	3115	EMCO Elektronik GmbH	9609-4922	480184	06.09.2016	09.2019

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
28	CW Generator Microwave	83650L	Agilent	3844A00554	480333	01.03.2018	03.2019
29	Multimeter	971A	Hewlett Packard	JP40010640	480724	31.01.2018	01.2020
30	DC power supply	TOE8951	Toellner	81995	481252	Calibration not necessary	
31	Spectrum Analyser	FSU46	Rohde & Schwarz	200125	480956	01.03.2018	03.2019
32	EMI Receiver / Spectrum Analyser	ESW	Rohde & Schwarz	101635	482467	22.06.2017	06.2019
33	Antenna (Log.Per.)	HL050	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
34	Preamplifier 100 MHz – 16 GHZ	AFS6	Narda MITEQ	2011215	482333	23.11.2016	11.2018
35	4 GHz High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments	1	480587	Calibration not necessary	
36	Shielded chamber M4	-	Siemens	B83117S1-X158	480088	Calibration not necessary	
37	Measuring receiver	ESIB 26	Rohde & Schwarz	100292	481182	28.02.2018	02.2020
38	LISN	NSLK8128	Schwarzbeck	8128155	480058	14.03.2018	03.2020

7 Report History

Report Number	Date	Comment
F172629E3	06.12.2018	Initial Test Report

8 List of Annexes

Annex A Test Setup Photos 9 Pages

172629_01.JPG: Test setup - Radiated emission (fully anechoic chamber)
172629_02.JPG: Test setup - Radiated emission (fully anechoic chamber)
172629_19.JPG: Test setup antenna port terminated- Radiated emission (fully anechoic chamber)
172629_20.JPG: Test setup CA915H antenna - Radiated emission (fully anechoic chamber)
172629_21.JPG: Test setup CA930Y antenna - Radiated emission (fully anechoic chamber)
172629_03.JPG: Test setup antenna port terminated - Radiated emission (OATS)
172629_22.JPG: Test setup CA915H antenna - Radiated emission (OATS)
172629_23.JPG: Test setup CA930Y antenna - Radiated emission (OATS)
172629_16.jpg: Test setup - Conducted emissions on power supply lines

Annex B External Photos 13 Pages

172629_06.jpg: EUT – top view
172629_07.jpg: EUT – bottom view
172629_05.jpg: EUT at eval board
172629_09.jpg: EUT, evaluation board, interface board, housing
172629_12.jpg: Evaluation board – top view
172629_13.jpg: Evaluation board – bottom view
172629_14.jpg: Interface board – top view
172629_15.jpg: Interface board – bottom view
172629_24.jpg: CA915H antenna
172629_25.jpg: CA930Y antenna
172629_26.jpg: CA930Y antenna - label
172629_17.jpg: AC adapter
172629_18.jpg: AC adapter – label

Annex C Internal Photos 2 Pages

172629_10.jpg: EUT – top view, shielding removed
172629_11.jpg: EUT – bottom view, shielding removed