

RADIO TEST REPORT

No. 2103038STO-111

RF performance

EQUIPMENT UNDER TEST

Equipment: Radio to RS485 ATB Protocol Converter
Type/Model: RDB9-2.4G
Manufacturer: WESTLINE sarl
Tested by request of: C-RAD Positioning AB

SUMMARY

Referring to the emission limits, and the operating mode during the tests specified in this report, the equipment complies with the selected requirements according to the following standards:

EN 300 328 V2.2.2 (2019-07)
AS/NZS 4268:2017

Note: AS/NZS 4268:2017 is not within the scope of accreditation.

Date of issue: May 2, 2022

Tested by:


Ala El-Haery

Approved by:


Björn Utermöhl

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Revision History

Test report number	Date	Description	Changes
2103038STO-103	April 1, 2022	First release	--
2103038STO-107	April 26, 2022	Second release	Unifying of radio technique names with USBRF-2.4G and correction of receiver category
2103038STO-111	May 2, 2022	Third release	Correction of transmitting frequency range declaration

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1. CLIENT INFORMATION

The EUT has been tested by request of

Company	C-RAD Positioning AB Sjukhusvägen 12 K 753 09 Uppsala Sweden
Name of contact	Johan Bostedt Phone: +46 70 6576470
Manufacturer	WESTLINE sarl 20 rue du Buisson Richard 78600 Le Mesnil le Roi FRANCE

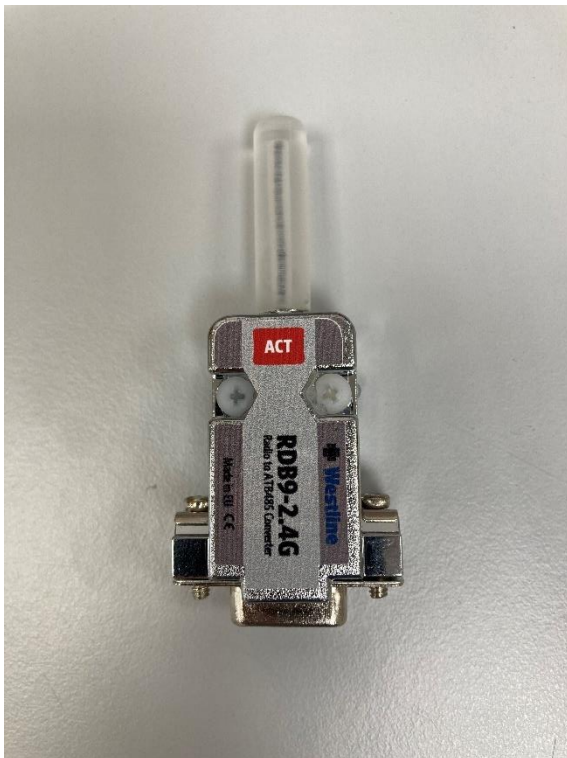
2. EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment:	Radio to RS485 ATB Protocol Converter	
Type/Model:	RDB9-2.4G	
Brand name:	WESTLINE	
Serial number:	No visible serial number	
Manufacturer:	WESTLINE sarl	
Transmitter frequency range:	2400 – 2483,5 MHz	
Receiver frequency range:	2400 – 2483,5 MHz	
Modulation technique:	☐ FHSS	☒ Other forms of modulation
Adaptive equipment:	☐ Yes	☒ No
Load based equipment:	☒ Yes	☐ No
Frame based equipment:	☐ Yes	☒ No
Channel occupancy time:	Not applicable	
Antenna:	☒ Integral antenna	☐ Dedicated antenna
Antenna connector:	☒ None, internal antenna	☐ Yes
Single antenna system:	☒ Yes	☐ No
Antenna gain ¹ :	0,0 dBi	
Beam forming gain:	Not applicable	
Declared RF output power EIRP ¹ :	0,0 dBm (EIRP)	

Radio technique:	BLE proprietary software	
Receiver category:	3	
Type of modulation(s):	GFSK	
Nominal channel bandwidth(s):	1 MHz	
Temperature range:	+15 °C to +35 °C	
Type of equipment:	Combined equipment	
Geo-location capability:	☐ Yes	☒ No

¹Declared by C-RAD Positioning AB



Photos of EUT

2.2 Additional information about the EUT

The EUT is a radio-to-RS485 ATB protocol converter which is used as computer interface in the medical patient-positioning equipments HIT, HITM and HIT950 as well as calibration products SmartPhantom RTH and SmartPhantom CT.

The EUT employs Nordic semiconductors radio module nRF24 and runs according to manufacturer in the 2.4GHz ISM band.

The RDB9-2.4G radio module is a cable replacement device used in ATB communication networks. It will transparently convert ATB frames between the radio side and the RS485 port of master and slave ATB devices. The RDB9-2.4G module can be combined with the USBRF-2.4G variant which replaces the RS485 port with a USB interface. The module is typically connected to the RS485 port of a slave device. The converter uses a fixed radio channel which is user configurable and must be used by all modules in the same network.

The EUT consists of the following units:

Unit	Type	Serial number	Comment
Unit 1	RDB9-2.4G	No visible serial number	Fitted with SMA connector for conducted emission
Unit 2	RDB9-2.4G	No visible serial number	For radiated emission

During the tests the EUT supported following software:

Software	Version	Comment
Cyrpa radio	1.6	Used by peripheral equipment to program the EUT.

2.3 Peripheral equipment

Peripheral equipment is equipment needed for correct operation of the EUT, but not included as part of the testing and evaluation of the EUT.

Equipment	Type/Model	Manufacturer	Serial number
Laptop computer	Presario CQ61	HP	CNF9366WSQ

2.4 Companion Device

Unit	Type	Serial number	Comments
Unit 1	RDB9-2.4G	No visible serial number	For Receiver Blocking Test
Unit 2	Laptop computer	CNF9366WSQ	To program and monitor the EUT

3. TEST SPECIFICATIONS

3.1 Standards

ETSI EN 300 328 V2.2.2 (2019-07): Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz band; Harmonised Standard for access to radio spectrum

AS/NZS 4268:2017: Radio equipment and systems – Short range devices – Limits and methods of measurement

3.2 Additions, deviations and exclusions from standards and accreditation

AS/NZS 4268:2017 is not within Intertek's scope of accreditation.

No other additions, deviations or exclusions have been made from standards and accreditation.

3.3 Decision rule

The statements of conformity are reported as:

Passed – When the measured values are within the specified limits.

Failed – When one or more measures values are outside the specified limits.

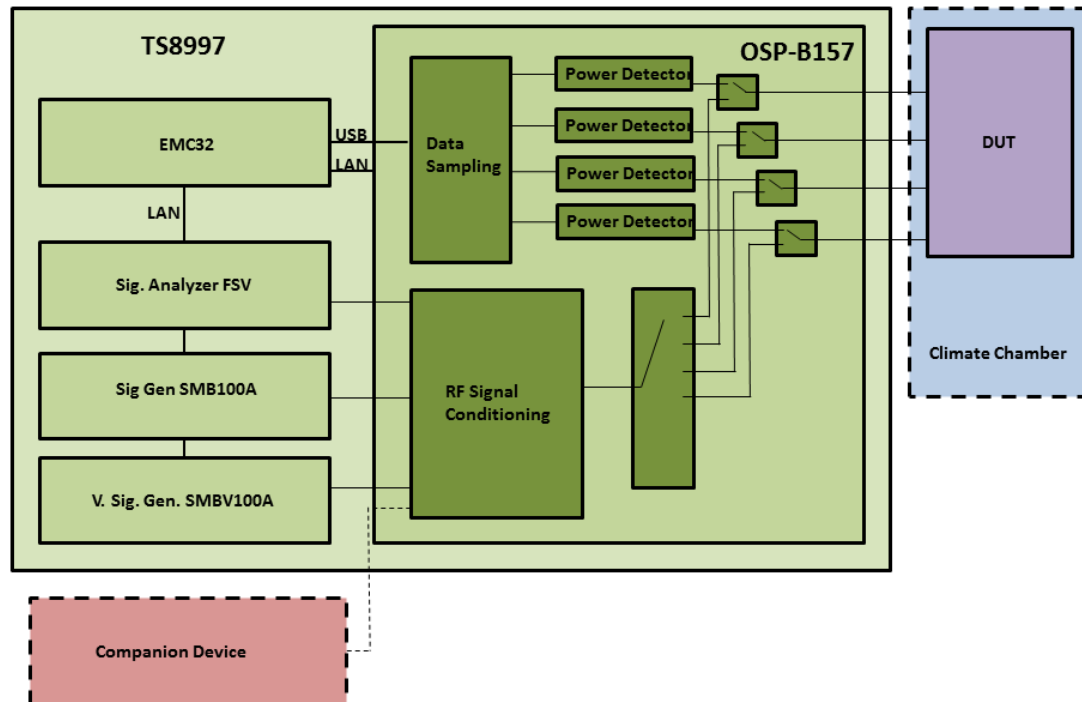
3.4 Test set-up

3.4.1 General description of R&S@TS8997

R&S@TS8997 was developed by Rohde and Schwartz as an all-in-one solution for testing according to the standard EN 300 328 and EN 301 893. It comprises of an FSV signal analyzer, a SMB100A signal generator, a SMBV100A vector signal generator and an OSP-B157 open switch and control unit (an additionally equipped version of the OSP-120). Using a modified version of R&S@EMC32, R&S@TS8997 can measure all required characteristics of EN 300 328 in an automated sequence.

3.4.2 Conducted measurements

All conducted measurements were performed using the TS8997 system and the test setup shown below.



Schematic of conducted measurements

To ensure a normal operating mode, a companion device was paired to the equipment and the connection was monitored for the duration of the tests.

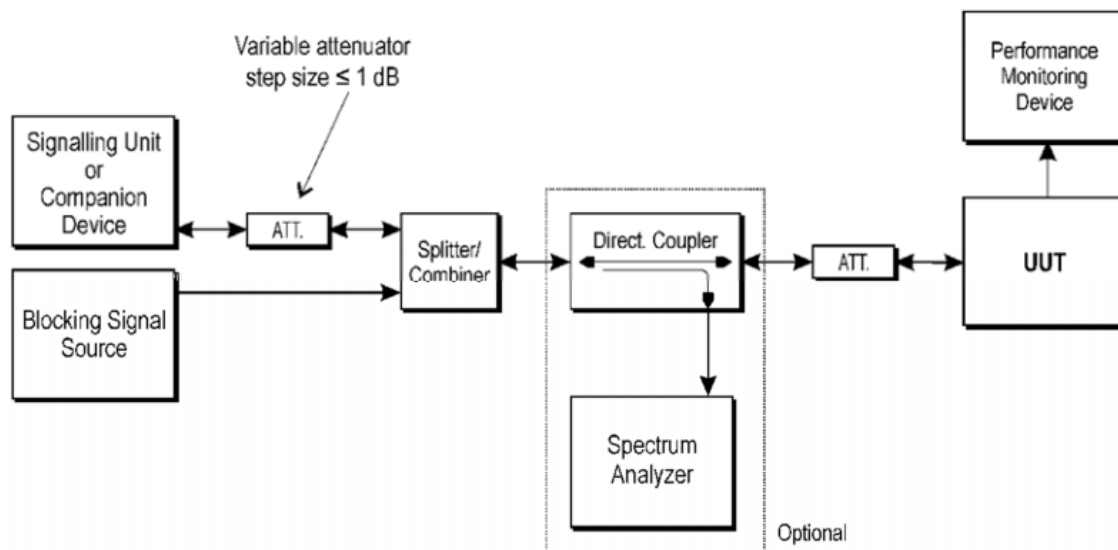
For extreme temperature tests, the DUT was placed in a climate chamber.

3.4.3 Radiated measurements

See corresponding section.

3.4.4 Receiver blocking

Conducted measurements are performed using the TS8997 system as described in 3.4.2 and the test setup shown below.



Schematic for receiver blocking

3.5 Mode of operation during the tests

All tests are made with EUT in normal operating mode.

The tests were performed on the following channels:

Low channel = 2402 MHz
 Middle channel = 2440 MHz
 High channel = 2480 MHz

3.6 Test conditions

If not additionally specified, the tests were performed under the following environmental conditions:

Parameter	Normal	Extreme
Supplying voltage, VDC	+5	--
Air temperature, °C	+22	+15 to +35

4. TEST SUMMARY

The test has been carried out at the Intertek Semko AB premises in Kista, Sweden.
The results in this report apply only to sample tested:

Reference in ETSI EN 300 328 V2.2.2	Description	Result	Section in report
Transmission requirements			
4.3.2.2	RF Output Power	PASS	5
4.3.2.3	Power Spectral Density	PASS	6
4.3.2.4	Duty cycle, Tx-Sequence, Tx-gap	NA ¹	--
4.3.1.4	Accumulated Transmit Time, Frequency Occupation and Hopping Sequence	NA ²	--
4.3.1.5	Hopping Frequency Separation	NA ²	--
4.3.2.5	Medium Utilisation	NA ¹	--
4.3.2.6	Adaptivity	NA ¹	--
4.3.2.7	Occupied Channel Bandwidth	PASS	7
4.3.2.8	Transmitter unwanted emissions in the OOB domain	PASS	8
4.3.2.9	Transmitter unwanted emissions in the spurious domain	PASS	9
Receiver requirements			
4.3.2.10	Receiver spurious emissions	PASS	9
4.3.2.11	Receiver Blocking	PASS	10
Other requirements			
4.3.2.12	Geo-location capability	NA ³	--

NT = Not Tested

NA = Not Applicable

¹ Does not apply for equipment with a declared RF output power of less than 10 dBm e.i.r.p. or for equipment when operating in a mode where the RF output power is less than 10 dBm e.i.r.p.

² Only applicable for FHSS equipment

³ Only applicable for equipment with geo-location capability

5. RF OUTPUT POWER

Date of test:	March 4, 2022	Test location:	Radiolabbet
EUT Serial:	No visible serial number	Ambient temp.	21 °C
Tested by:	Ala El-Haery	Relative humidity	17 %
Test result:	Pass	Margin:	1,0 dB

5.1 Test set-up and test procedure

The test method is in accordance with EN 300 328 V2.2.2 clause 5.4.2.2.

The TS8997 system and conducted measurement setup described in section 3.4.2 is used.

The test was repeated in extreme operating temperatures.

5.2 Test results

DUT frequency [MHz]	Max Burst RMS Power [dBm]	Max EIRP [dBm]	Limit [dBm]	Temp. [°C]	Result	Comment
2402,0	-2,8	-2,8	≤ 0,0	+22	PASS	--
2402,0	-1,5	-1,5	≤ 0,0	+15	PASS	--
2402,0	-1,5	-1,5	≤ 0,0	+35	PASS	--
2440,0	-2,0	-2,0	≤ 0,0	+22	PASS	--
2440,0	-1,1	-1,1	≤ 0,0	+15	PASS	--
2440,0	-1,0	-1,0	≤ 0,0	+35	PASS	--
2480,0	-1,8	-1,8	≤ 0,0	+22	PASS	--
2480,0	-1,1	-1,1	≤ 0,0	+15	PASS	--
2480,0	-1,0	-1,0	≤ 0,0	+35	PASS	--

Note: The Max EIRP result includes the antenna gain and beamforming gain (if applicable).

5.3 Limits

Reference: 4.3.2.2.3 in EN 300 328 V2.2.2

The maximum RF output power for non-adaptive equipment shall be declared by the manufacturer. The maximum RF output power for this equipment shall be equal to or less than the value declared by the manufacturer. This declared value shall be equal to or less than 20 dBm.

This limit shall apply for any combination of power level and intended antenna assembly.

6. POWER SPECTRAL DENSITY

Date of test:	March 4, 2022	Test location:	Radiolabbet
EUT Serial:	No visible serial number	Ambient temp.	21 °C
Tested by:	Ala El-Haery	Relative humidity	17 %
Test result:	Pass	Margin:	11,7 dB

6.1 Test set-up and test procedure

The test method is in accordance with EN 300 328 V2.2.2 clause 5.4.3.2.

The TS8997 system and conducted measurement setup described in section 3.4.2 is used.

During the tests the EUT was in normal operating mode.

6.2 Test results

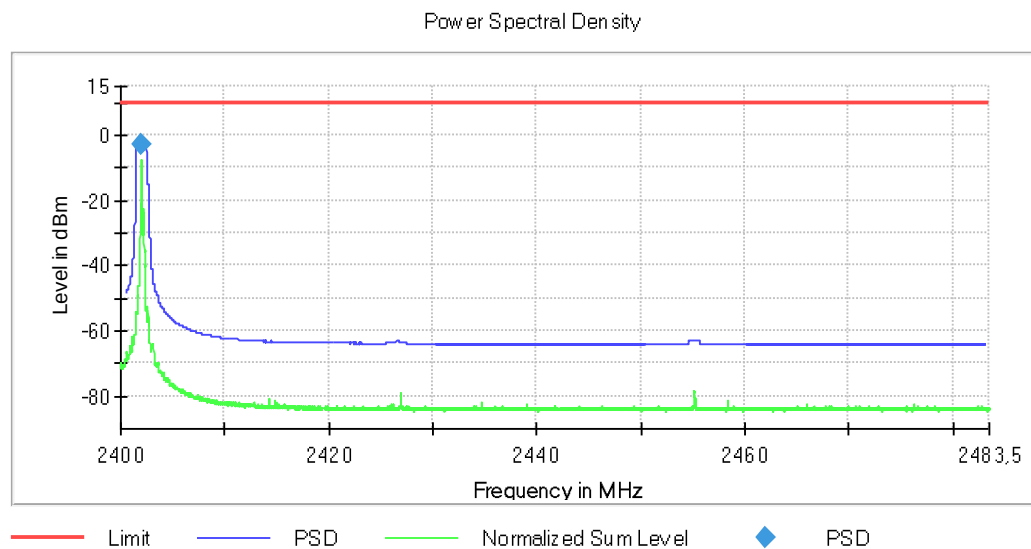


Diagram. Power Spectral Density, low channel

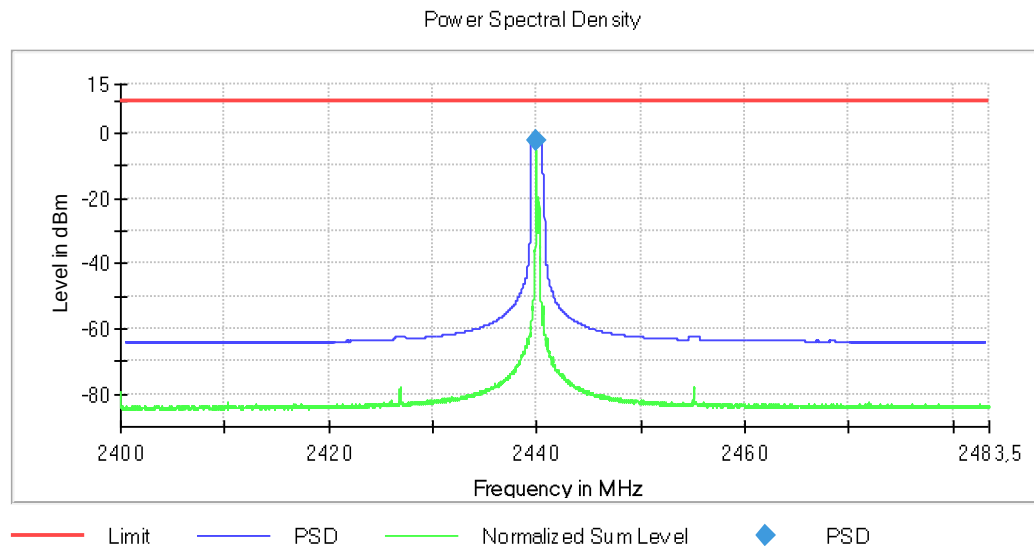


Diagram. Power Spectral Density, middle channel

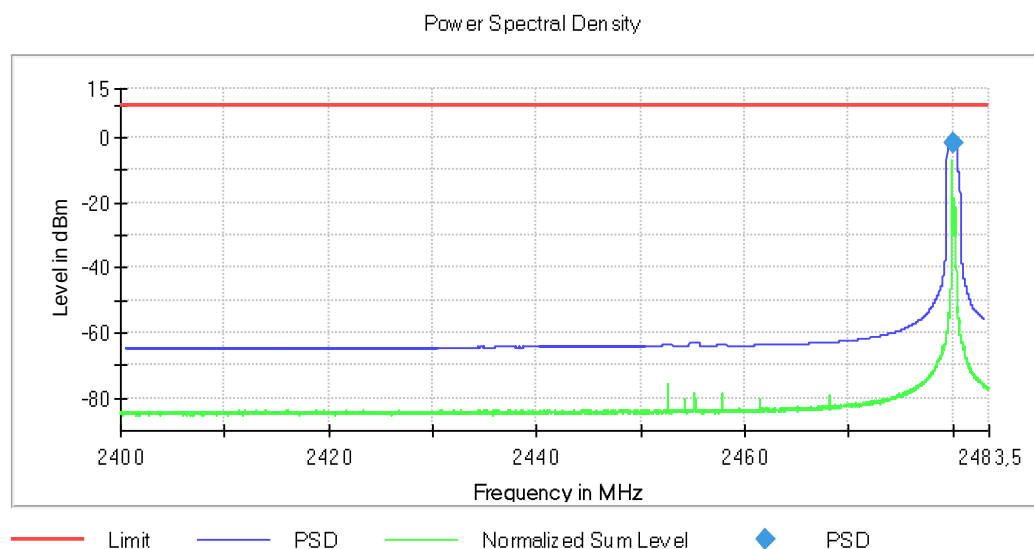


Diagram. Power Spectral Density, high channel

DUT frequency [MHz]	Center Frequency of Segment [MHz]	Level [dBm / MHz]	Limit [dBm / MHz]	Result	Comment
2402,0	2402,0	-2,8	$\leq 10,0$	PASS	--
2440,0	2440,0	-2,0	$\leq 10,0$	PASS	--
2480,0	2480,0	-1,7	$\leq 10,0$	PASS	--

Note: The level result includes the antenna gain and beamforming gain (if applicable).

6.3 Limits

Reference: 4.3.2.3.3 in EN 300 328 V2.2.2.

The maximum Power Spectral Density for non-FHSS equipment is 10 dBm per MHz.

7. OCCUPIED CHANNEL BANDWIDTH

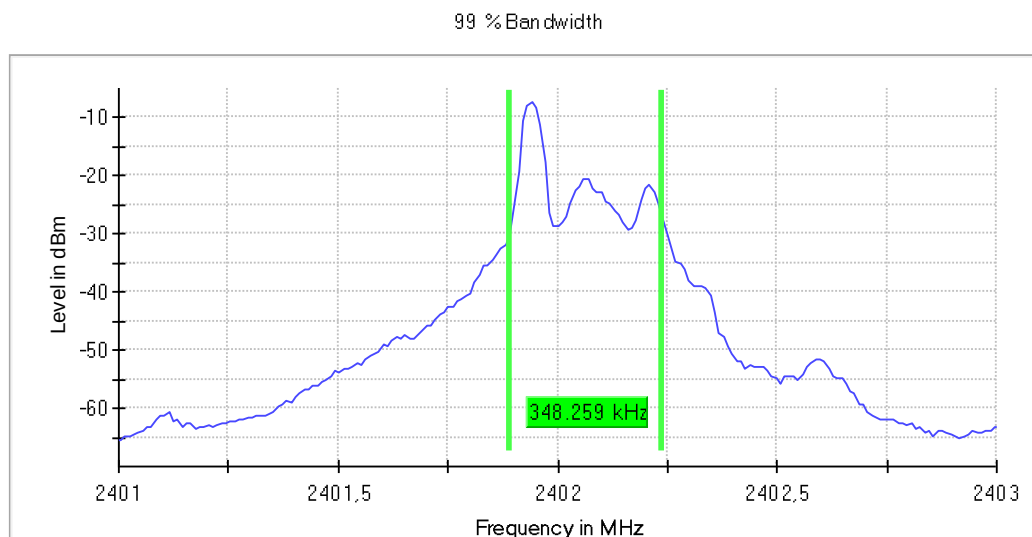
Date of test:	March 4, 2022	Test location:	Radiolabbet
EUT Serial:	No visible serial number	Ambient temp.	21 °C
Tested by:	Ala El-Haery	Relative humidity	17 %
Test result:	Pass	Margin:	1,9 MHz

7.1 Test set-up and test procedure

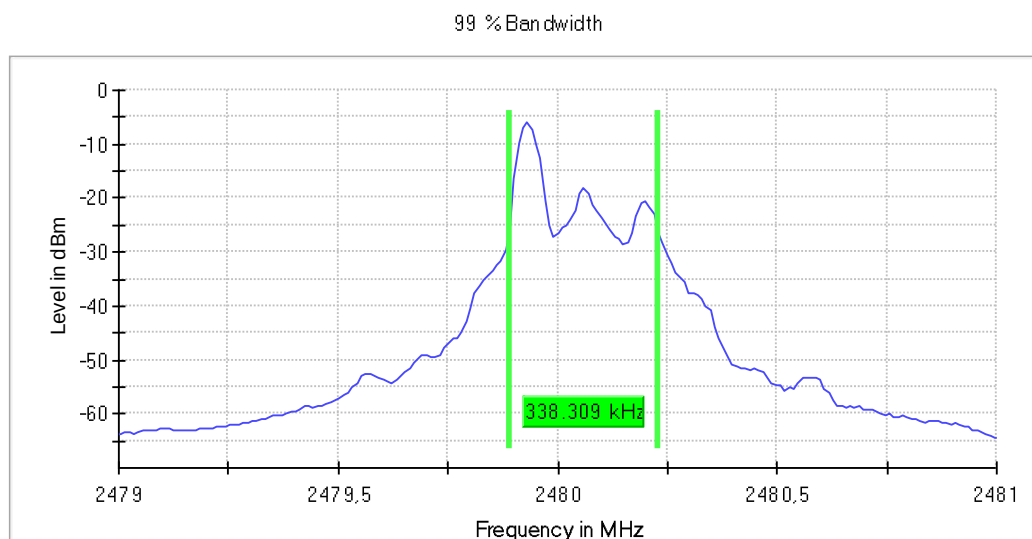
The test method is in accordance with EN 300 328 V2.2.2 clause 5.4.7.2.

The TS8997 system and conducted measurement setup described in section 3.4.2 is used.

7.2 Test results



Diagram, occupied channel bandwidth, low channel



Diagram, occupied channel bandwidth, high channel

DUT Frequency [MHz]	Channel Center Frequency [MHz]	Occupied Channel Bandwidth [MHz]	Limit Bandwidth [MHz]	Margin to edge [MHz]	Result	Comment
2402,0	2402,0	0,35	--	1,9	Pass	--
2480,0	2480,0	0,34	--	3,3	Pass	--

7.3 Limits

Reference: 4.3.2.7.3 in EN 300 328 V2.2.2.

The Occupied Channel Bandwidth shall fall completely within the band 2,4 GHz to 2,4835 GHz.

8. TRANSMITTER UNWANTED EMISSIONS IN THE OOB DOMAIN

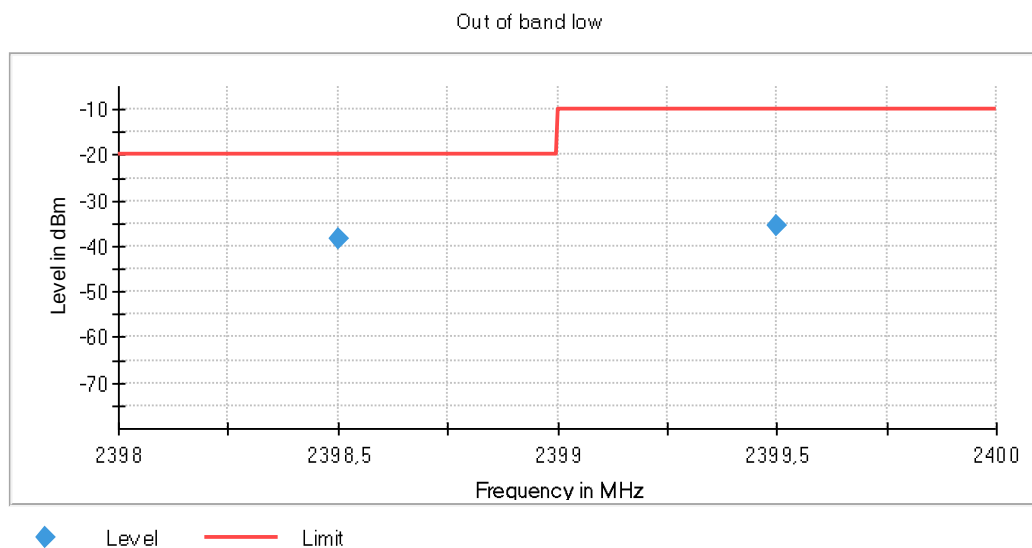
Date of test:	March 4, 2022	Test location:	Radiolabbet
EUT Serial:	No visible serial number	Ambient temp.	21 °C
Tested by:	Ala El-Haery	Relative humidity	17 %
Test result:	Pass	Margin:	> 10 dB

8.1 Test set-up and test procedure

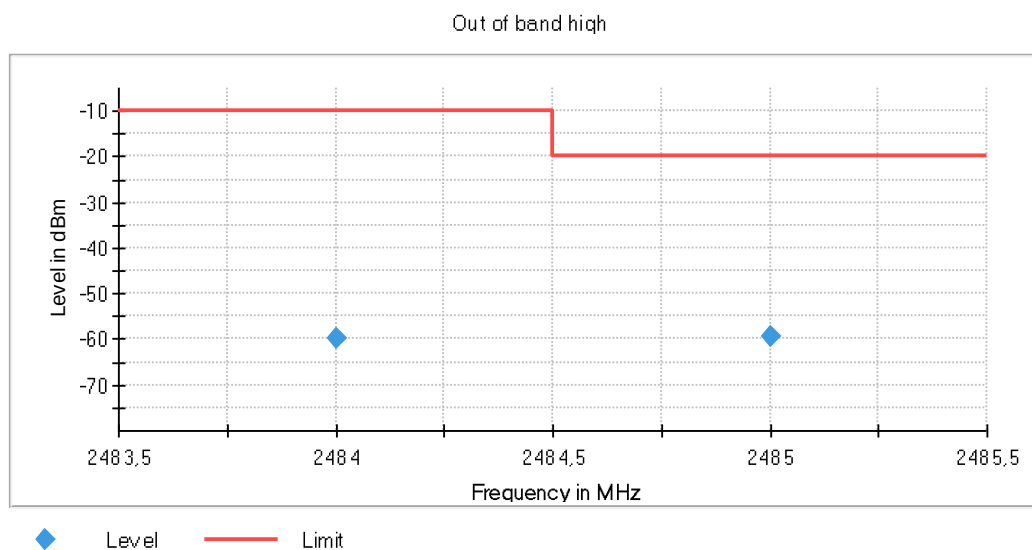
The test method is in accordance with EN 300 328 V2.2.2 clause 5.4.8.2.

The TS8997 system and conducted measurement setup described in section 3.4.2 is used.

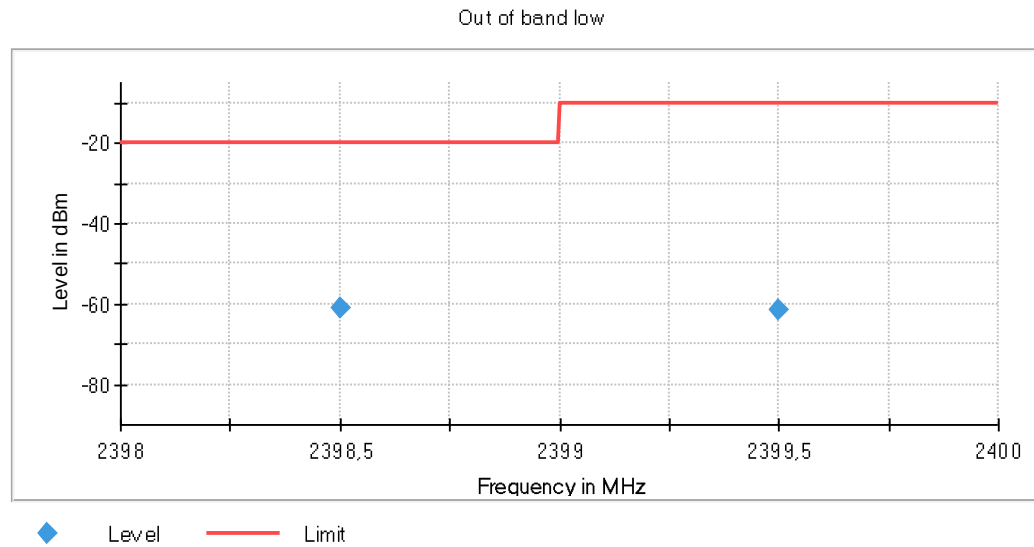
8.2 Test results



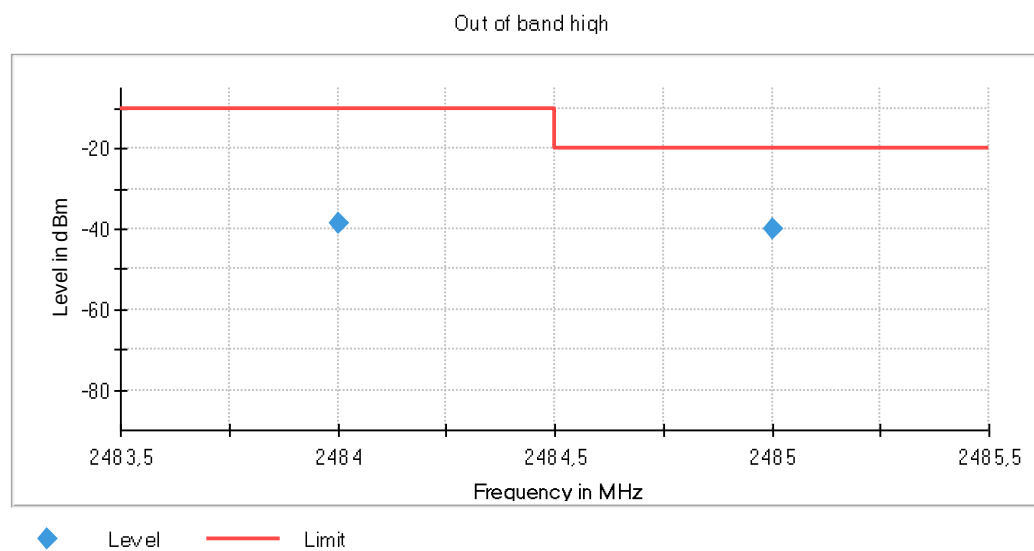
Diagram, low channel, lower band



Diagram, low channel, upper band



Diagram, high channel, lower band



Diagram, high channel, upper band

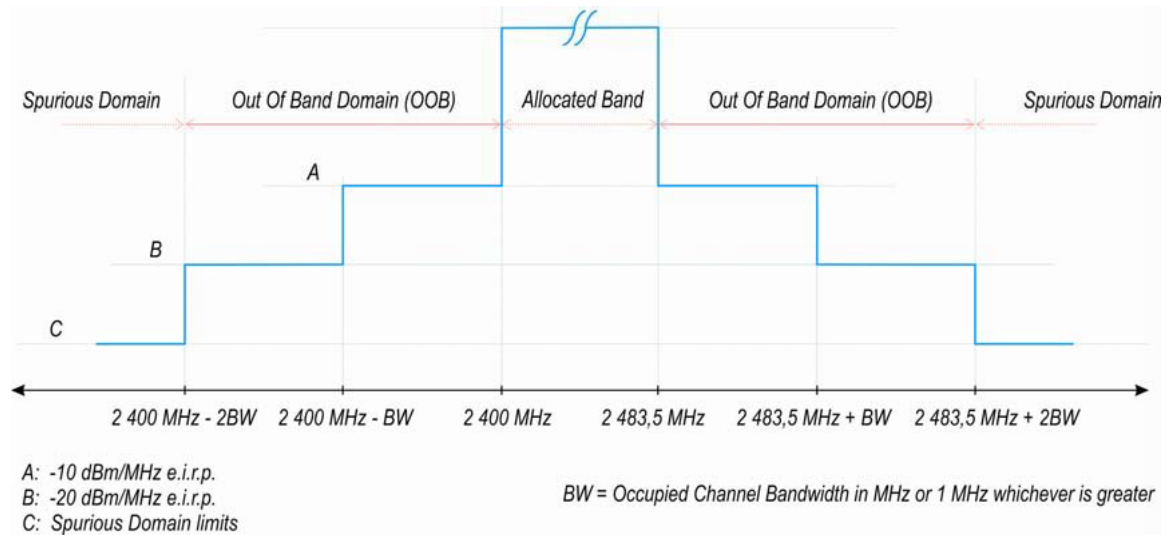
Measurement results

No emissions found within 10 dB from limit.

8.3 Limits

Reference: 4.3.2.8.3 in EN 300 328 V2.2.2.

The transmitter unwanted emissions in the out-of-band domain but outside the allocated band shall not exceed the values provided by the mask seen below.



9. SPURIOUS EMISSIONS (RADIATED)

Date of test:	February 22 / 23, 2022	Test location:	Radiohallen
EUT Serial:	No visible serial number	Ambient temp:	17 / 20 °C
Tested by:	Ala El-Haery	Relative humidity:	20 / 37 %
Test result:	Pass	Margin:	2,6 dB

9.1 Test set-up and test procedure

The test method is in accordance with EN 300 328 V2.2.2 clauses 5.4.9.2.2 and 5.4.10.2.2.

The EUT was placed in an anechoic chamber on a non-conductive support 1,5 m above the floor. Radiated power was measured at a distance of 3 m with the antenna placed 1,5 m above the floor. Overview sweeps with peak detection were performed with the measurement receiver in max-hold mode. The measurements were repeated with the EUT rotated in 45-degree steps and with the antenna in horizontal and vertical polarisation.

At the frequencies where high disturbance levels were found a search for max disturbance level was performed. With the EUT and antenna in the worst-case configuration new measurements were carried out.

Test receiver set-up 30 – 1000 MHz:

Preview test:	Peak.	RBW 100 kHz	VBW 300 kHz
Final test:	RMS.	RBW 100 kHz	VBW 300 kHz

Test receiver set-up 1 – 13 GHz:

Preview test:	Peak.	RBW 1 MHz	VBW 3 MHz
Final test:	RMS.	RBW 1 MHz	VBW 3 MHz

The EUT was evaluated in three positions: laying down flat (x-position) and standing upright short side (y-position) and standing upright long side (z-position). X- position was determined to be the worst-case position, results presented in this report are for the laying down flat position.

During the TX tests the EUT was transmitting continuous modulated carrier.

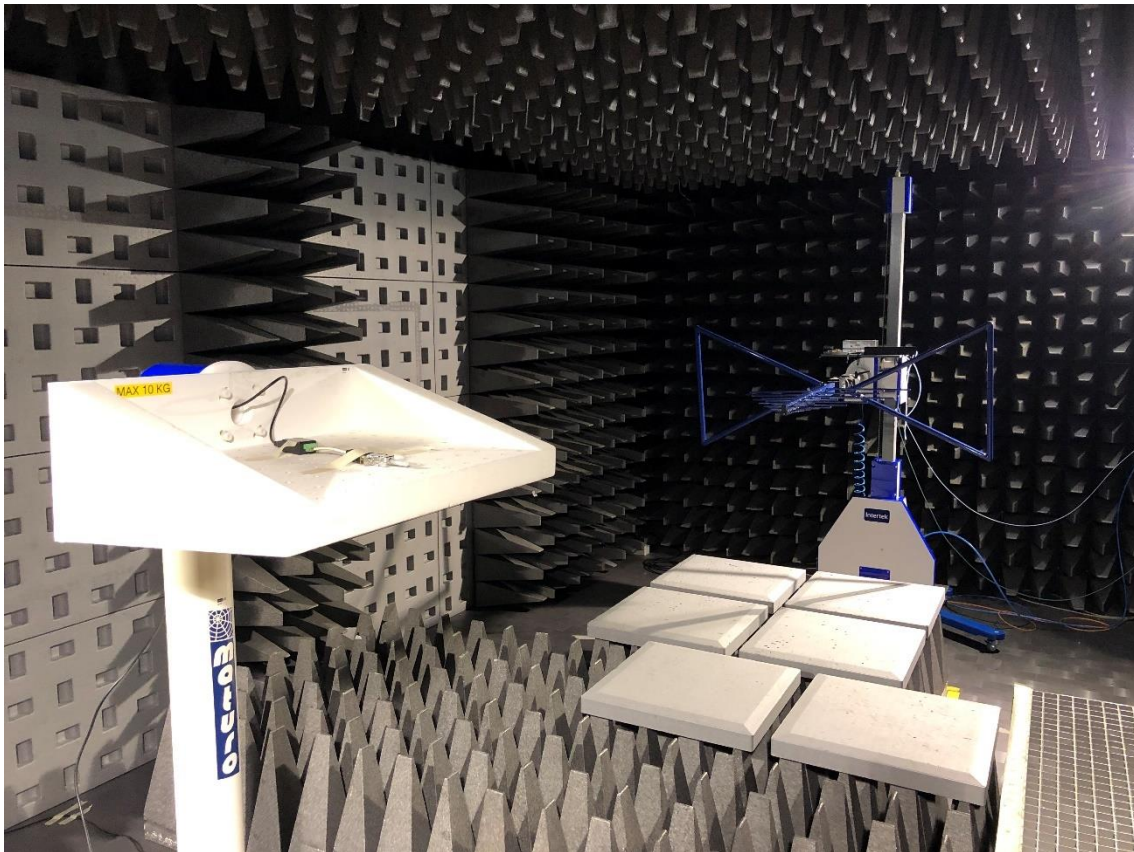


Photo of the test set-up for radiated emission 30 – 1000 MHz

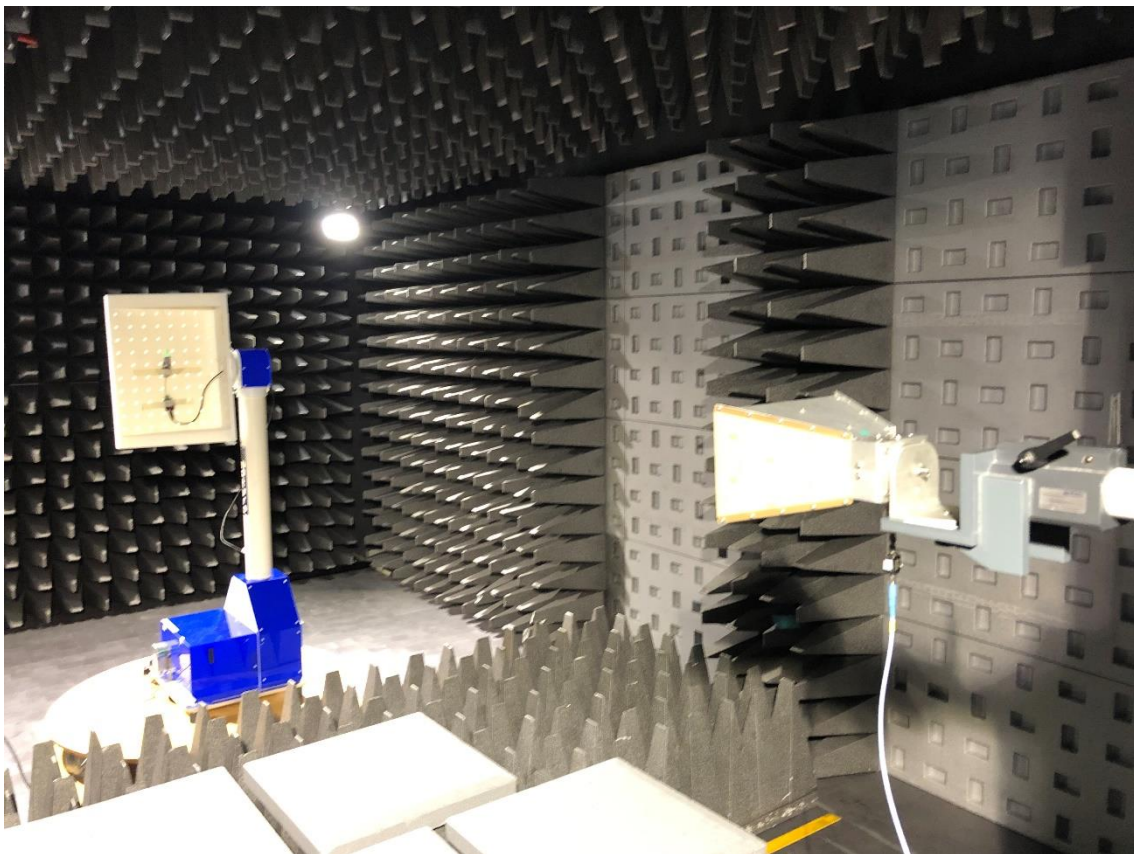
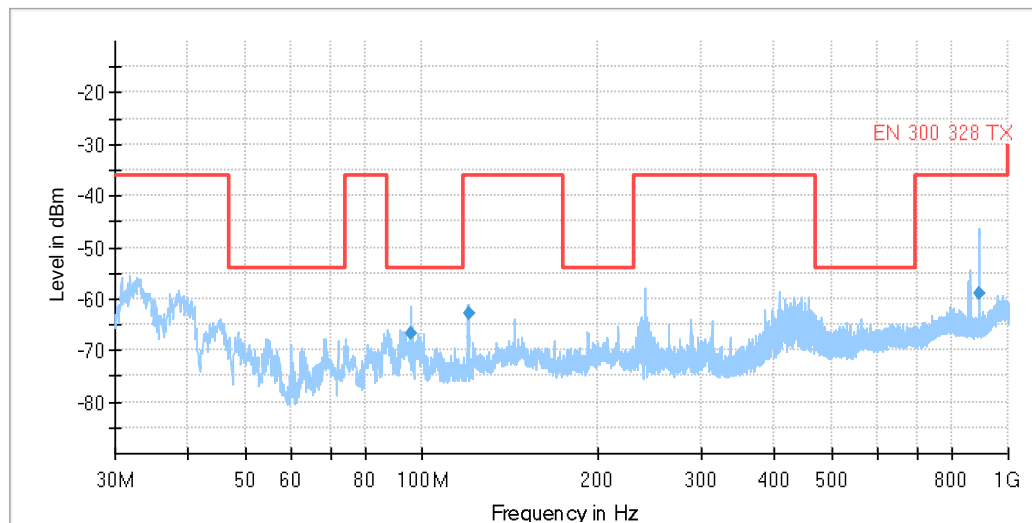
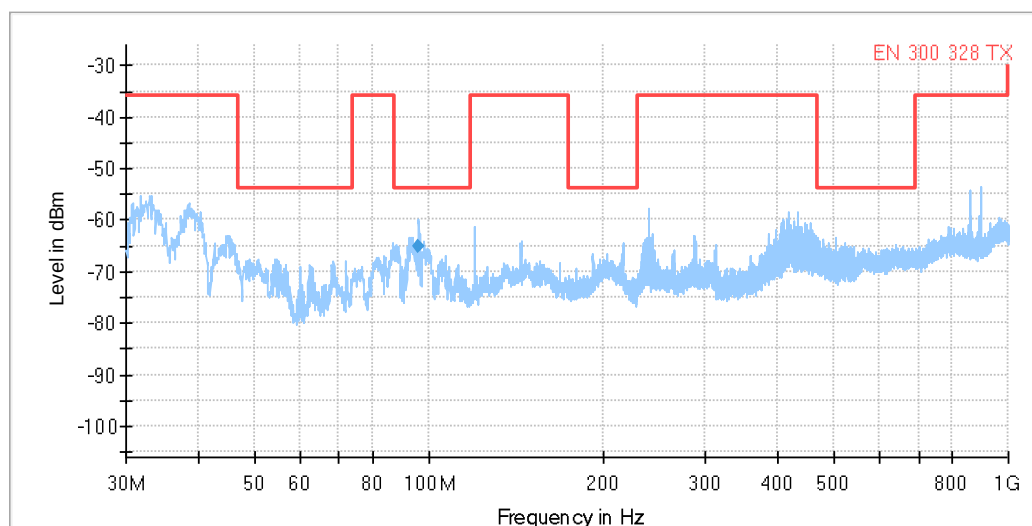


Photo of the test set-up for radiated emission 1 – 13 GHz

9.2 Test results 30 – 1000 MHz. TX mode



Diagram, Peak overview sweep, 30 MHz – 1000 MHz, TX low channel



Diagram, Peak overview sweep, 30 MHz – 1000 MHz, TX high channel

Measurement results, RMS

TX Low channel

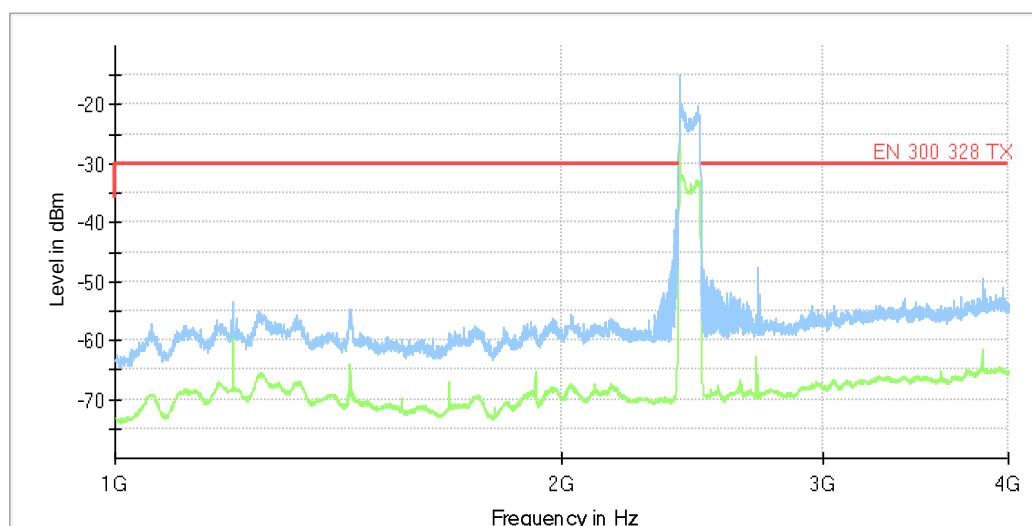
Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
96,1	-66,6	-54,0	H	12,6	PASS	--
120,0	-62,9	-36,0	V	> 20	PASS	--
892,4	-58,9	-36,0	V	> 20	PASS	--

TX High channel

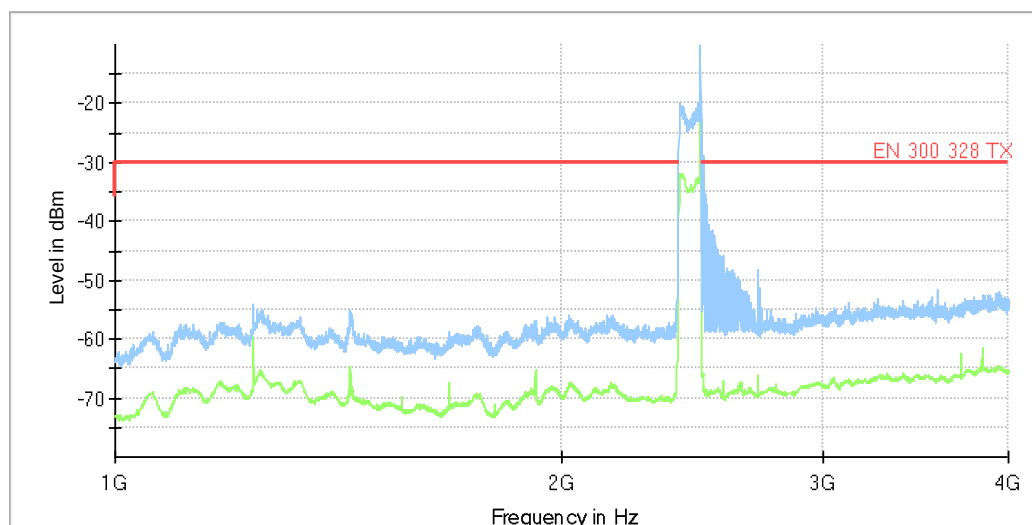
Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
96,1	-65,1	-54,0	H	11,1	PASS	--

No emissions are found within 6 dB range below the limit.

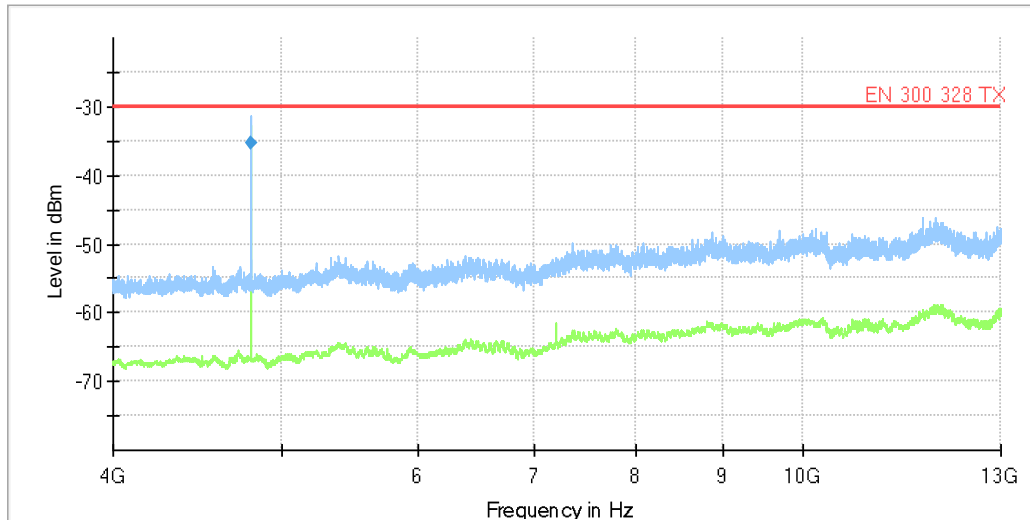
9.3 Test results 1 – 13 GHz, TX mode



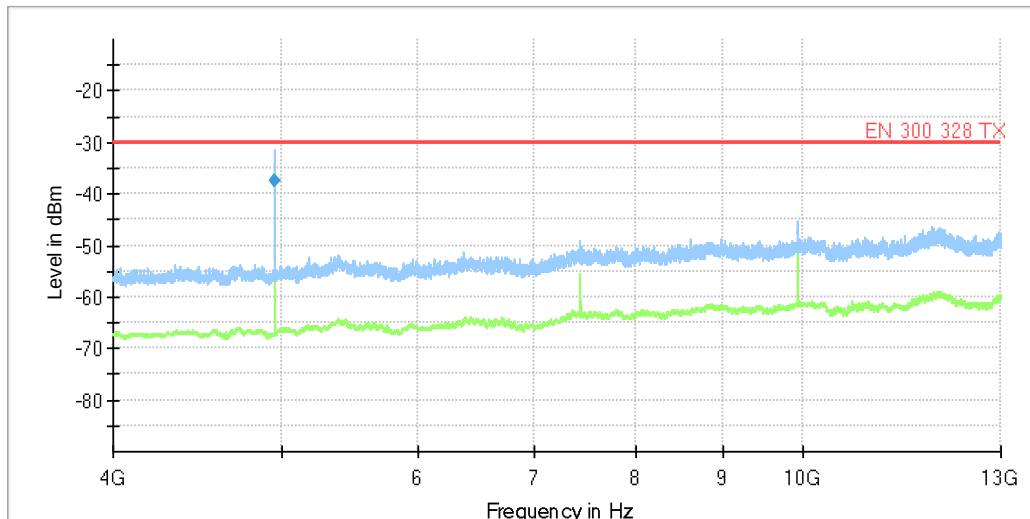
Diagram, Peak overview sweep, 1 GHz – 4 GHz, TX low channel. Carrier is attenuated by a band rejection filter.



Diagram, Peak overview sweep, 1 GHz – 4 GHz, TX high channel. Carrier is attenuated by a band rejection filter.



Diagram, Peak overview sweep, 4 GHz – 13 GHz, TX low channel. Emissions below 4000 MHz are attenuated by a high-pass filter.



Diagram, Peak overview sweep, 4 GHz – 13 GHz, TX high channel. Emissions below 4000 MHz are attenuated by a high-pass filter.

Measurement results, RMS

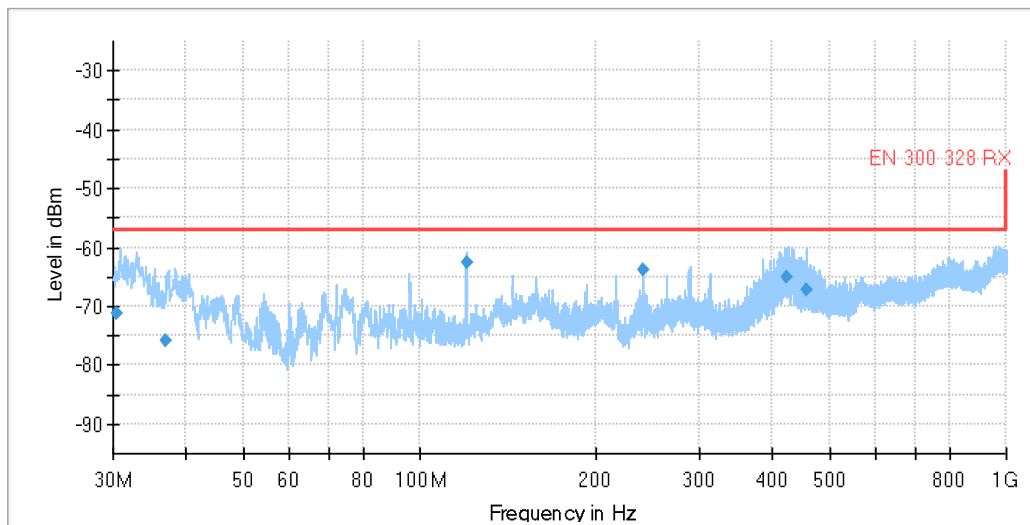
TX Low channel

Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
4803,9	-35,2	-30,0	H	5,2	PASS	--

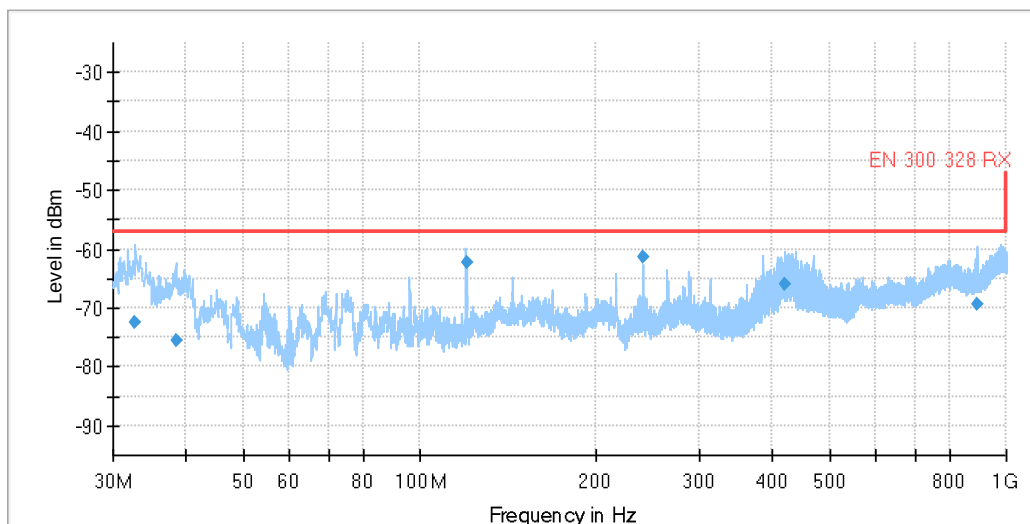
TX High channel

Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
4960,4	-37,6	-30,0	V	7,6	PASS	--

9.4 Test results 30 – 1000 MHz. RX mode



Diagram, Peak overview sweep, 30 MHz – 1000 MHz, RX low channel



Diagram, Peak overview sweep, 30 MHz – 1000 MHz, RX high channel

Measurement results, RMS

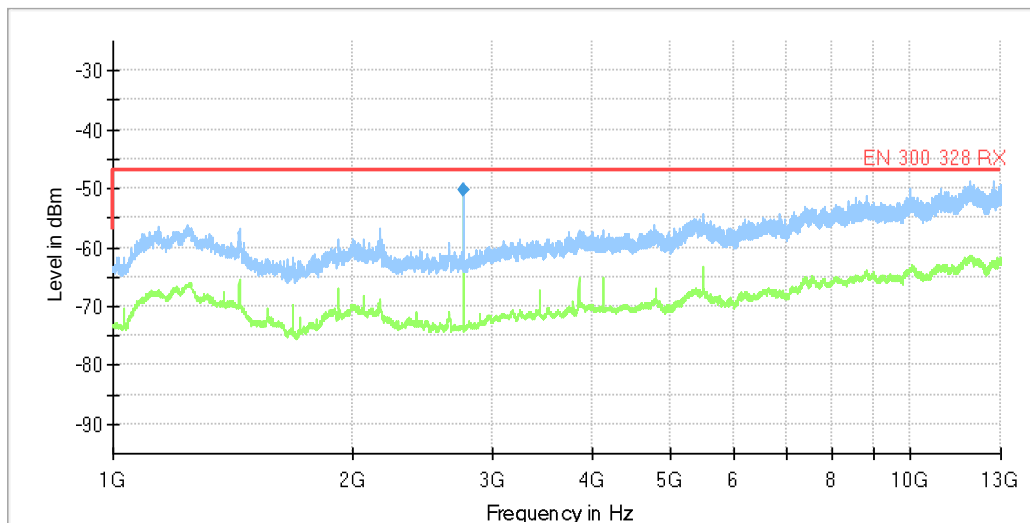
RX Low channel

Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
30,40	-71,2	-57,0	H	14,2	Pass	--
36,81	-75,8	-57,0	H	18,8	Pass	--
120,01	-62,7	-57,0	V	5,7	Pass	--
240,00	-63,7	-57,0	H	6,7	Pass	--
423,27	-65,0	-57,0	H	8,0	Pass	--
455,86	-67,3	-57,0	H	10,3	Pass	--

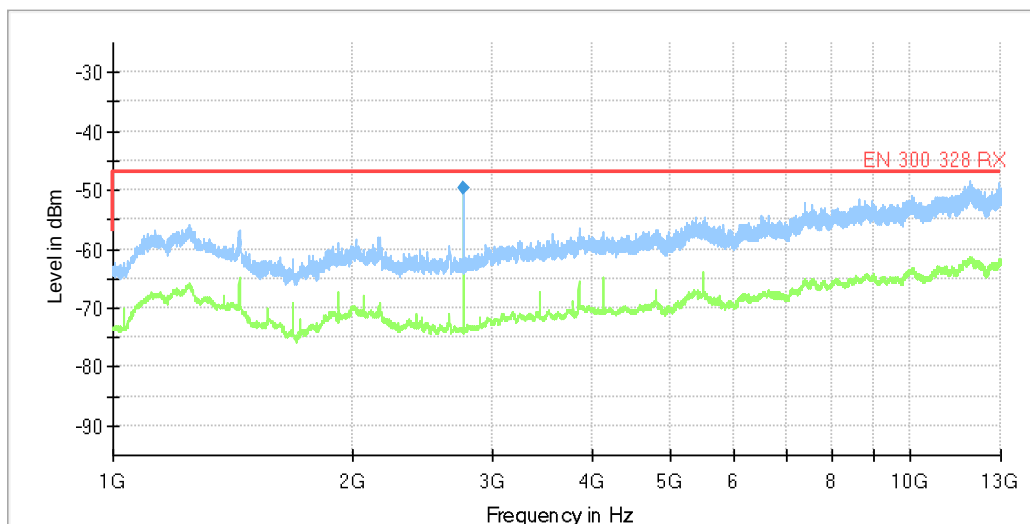
RX High channel

Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
32,77	-72,6	-57,0	H	15,6	Pass	--
38,41	-75,7	-57,0	H	18,7	Pass	--
120,00	-62,4	-57,0	V	5,4	Pass	--
240,01	-61,3	-57,0	H	4,3	Pass	--
420,08	-66,0	-57,0	H	9,0	Pass	--
892,19	-69,4	-57,0	V	12,4	Pass	--

9.5 Test results 1 – 13 GHz, RX mode



Diagram, Peak overview sweep, 1 GHz – 13 GHz, RX low channel



Diagram, Peak overview sweep, 1 GHz – 13 GHz, RX high channel

Measurement results, RMS

RX Low channel

Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
2748,7	-50,2	-47,0	H	3,2	PASS	--

RX High channel

Frequency [MHz]	Level [dBm]	Limit [dBm]	Polarization H/V	Margin [dB]	Result	Comment
2748,6	-49,6	-47,0	H	2,6	PASS	--

9.6 Limits

Reference: 4.3.2.9.3 and 4.3.2.10.3 in EN 300 328 V2.2.2.

State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 694 MHz (e.r.p)	Other frequencies ≤ 1000 MHz (e.r.p.)	Frequencies 1 GHz to 12,75 GHz (e.i.r.p.)
Operating	-54 dBm	-36 dBm	-30 dBm
RX	-57 dBm	-57 dBm	-47 dBm

10. RECEIVER BLOCKING

Date of test:	March 4, 2022	Test location:	Radiolabbet
EUT Serial:	No visible serial number	Ambient temp:	22 °C
Tested by:	Ala El-Haery	Relative humidity:	23 %
Test result:	Pass	Margin:	--

10.1 Test set-up and test procedure

The test method is in accordance with EN 300 328 V2.2.2 clause 5.4.11.2.1.

The measurement setup described in section 3.4.4 is used.

10.2 Test results

DUT frequency [MHz]	Blocking signal frequency [MHz]	Result	Comment
2402	2380	PASS	--
2402	2300	PASS	--
2480	2504	PASS	--
2480	2584	PASS	--

10.3 Performance criteria

Packet Error Rate (PER) less than or equal to 10 %.

10.4 Limits

Reference: 4.3.2.11.4 in EN 300 328 V2.2.2.

The equipment shall comply with the defined performance criteria in the presence of a blocking signal with characteristics as provided in the table below.

Receiver category 3

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 x log ₁₀ (OCBW) + 20 dB) or (-74 dBm + 20 dB) whichever is less (see note 2)	2380 2504 2300 2584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{min} + 30$ dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in EN 300 328 V2.2.2 clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in EN 300 328 V2.2.2 clause 5.4.3.2.2.			

11. MEASUREMENT UNCERTAINTY

The measurement uncertainty describes the overall uncertainty of the given measured value during operation of the EUT. Measurement uncertainty is calculated in accordance with TR 100 028-1 and TS 103 051. The measurement uncertainty is given with a confidence of 95% (k=2).

Parameter	Uncertainty
Occupied channel bandwidth	± 0,1 %
RF output power, conducted	± 0,7 dB
Power spectral density, conducted	± 1,3 dB
Unwanted emissions, conducted	± 1,3 dB
All emissions, radiated (25 MHz – 1 GHz)	± 2,9 dB
All emissions, radiated (1 GHz – 40 GHz)	± 2,8 dB
Temperature	± 0,4 °C
Humidity	± 1,5 %
Time	± 2,8 %
Duty cycle	± 2,0 %