



EMI - T E S T R E P O R T

- FCC Part 15.247, RSS-247 -

Type / Model Name : CSM 4

Product Description : Car Sharing Module with Bluetooth Low Energy

Applicant : Fuba Automotive Electronics GmbH

Address : TecCenter 1

31162 Bad Salzdetfurth, GERMANY

Manufacturer : Fuba Automotive Electronics GmbH

Address : TecCenter 1

31162 Bad Salzdetfurth, GERMANY

Test Result according to the standards listed in clause 1 test standards:

POSITIVE

Test Report No. :

T45165-00-01KS

20. May 2019

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

Contents

1 TEST STANDARDS	3
2 EQUIPMENT UNDER TEST	4
2.1 Photo documentation of the EUT – Detailed photos see ATTACHMENT A	4
2.2 Equipment type	4
2.3 Short description of the equipment under test (EUT)	4
2.4 Variants of the EUT	4
2.5 Operation frequency and channel plan	5
2.6 Transmit operating modes	5
2.7 Antennas	5
2.8 Power supply system utilised	5
2.9 Peripheral devices and interface cables	6
2.10 Determination of worst case conditions for final measurement	6
3 TEST RESULT SUMMARY	7
3.1 Final assessment	7
4 TEST ENVIRONMENT	8
4.1 Address of the test laboratory	8
4.2 Environmental conditions	8
4.3 Statement of the measurement uncertainty	8
4.4 Measurement protocol for FCC and ISED	9
5 TEST CONDITIONS AND RESULTS	11
5.1 AC power line conducted emissions	11
5.2 EBW and OBW	11
5.3 Maximum peak radiated output power	16
5.4 Power spectral density	18
5.5 Radiated emissions in restricted bands	22
5.6 Band edge compliance	29
5.7 Radiated emissions in non-restricted bands	32
5.8 Antenna application	35
5.9 Correction for pulse operation (duty cycle)	36
6 USED TEST EQUIPMENT AND ACCESSORIES	39

Attachment A as separate supplement

FCC ID: WNS-CSM4

IC: 3432F-CSM4

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (March, 2019)

Part 15, Subpart A, Section 15.31 Measurement standards

Part 15, Subpart A, Section 15.33 Frequency range of radiated measurements

Part 15, Subpart A, Section 15.35 Measurement detector functions and bandwidths

ECC Rules and Regulations Part 15, Subpart C - Intentional Radiators (March, 2019)

Part 15, Subpart C, Section 15.203 Antenna requirement

Part 15. Subpart C. Section 15.204 External radio frequency power amplifiers and antenna modifications

Part 15, Subpart C, Section 15.209 Radiated emission limits, general requirements

Part 15, Subpart C, Section 15.247 Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

ANSI C63.10: 2013 Testing Unlicensed Wireless Devices

ETSI TR 100 028 V1.3.1: 2001-03, Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2

KDB 558074 D01 v04 Guidance for performing compliance measurements on DTS operating under §15.247, April 5, 2017.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – Detailed photos see **ATTACHMENT A**

2.2 Equipment type

BLE device

2.3 Short description of the equipment under test (EUT)

The CSM4 (EUT) is a car sharing module using BLE wireless technology. The EUT is compatible with IEEE Standard 802.15.1. It supports the 2.4 GHz frequency band and supports no beam forming. The EUT has only one integrated antenna, no temporary connector and no external antenna can be connected. The modulation used by the EUT is GFSK with a data rate of 1 Mbit/s.

Number of tested samples:	1 conducted sample	1 radiated sample
Serial number:	1190170002	FUBA SN 003
HW version:	30005171	D1 – Muster
SW version:	000.028.017	TI Standard Software

2.4 Variants of the EUT

None.

FCC ID: WNS-CSM4
IC: 3432F-CSM4

2.5 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel	Frequency	Channel	Frequency
37	2402	18	2442
0	2404	19	2444
1	2406	20	2446
2	2408	21	2448
3	2410	22	2450
4	2412	23	2452
5	2414	24	2454
6	2416	25	2456
7	2418	26	2458
8	2420	27	2460
9	2422	28	2462
10	2424	29	2464
38	2426	30	2466
11	2428	31	2468
12	2430	32	2470
13	2432	33	2472
14	2434	34	2474
15	2436	35	2476
16	2438	36	2478
17	2440	39	2480

Note: the marked frequencies are determined for final testing.

2.6 Transmit operating modes

The EUT uses GFSK modulation and may provide following data rates:

- 1000 kbps (kbps = kilobits per second)

2.7 Antennas

The following antenna shall be used with the EUT:

Number	Characteristic	Type	Plug	f-range (GHz)	Gain (dBi)
1	Omni	PCB antenna	none	2.4 - 2.4835	5.0

2.8 Power supply system utilised

Power supply voltage, V_{nom} : 12 VDC

FCC ID: WNS-CSM4

IC: 3432F-CSM4

2.9 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- _____ Model : _____
- _____ Model : _____
- _____ Model : _____

2.10 Determination of worst case conditions for final measurement

Measurements are made in all three orthogonal axes of the EUT to locate at which position the EUT produces the maximum of the emissions.

The tests are carried out in the following frequency band:

2400 MHz – 2483.5 MHz

For the final test the following channels and test modes are selected:

IEEE Standard	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
802.15.1	00 to 39	37, 17, 39	5 dBm	DSSS	GFSK	1000 kbps

- TX continuous mode

2.10.1 Test jig

No special test jig was used.

2.10.2 Test software

The test software for the EUT provides free power setting. The EUT has a special firmware that allows enabling TX continuous mode modulated.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

3 TEST RESULT SUMMARY

BLE device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	not applicable
15.247(a)(2)	RSS-247, 6.2.4(1)	-6 dB EBW	passed
15.247(b)(3)	RSS-247, 6.2.4(1)	Maximum peak conducted output power	passed
15.247(b)(4)	-	Defacto limit	passed
15.247(d)	RSS-247, 6.2.4(2)	Out-of-band emission, radiated	passed
15.247(d)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.247(e)	RSS-247, 6.2.4(1)	PSD	passed
15.35(c)	RSS-Gen, 6.10	Pulsed operation	passed
15.203	RSS-Gen, 6.6	Antenna requirement	passed
-	RSS-Gen, 6.11	Transmitter frequency stability	not applicable
-	RSS-Gen, 6.6	99 % Bandwidth	passed

The mentioned new RSS Rule Parts in the above table are related to:

RSS-Gen, Issue 5, April 2018

RSS-247, Issue 2, February 2017

3.1 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 01 March 2019

Testing concluded on : 11 March 2019

Checked by: Tested by:

Klaus Gegenfurtner
Teamleader Radio

Hermann Smetana
Radio Team

FCC ID: WNS-CSM4

IC: 3432F-CSM4

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 °C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	± 2.71 dB
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	± 2.71 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	± 2.15 dB
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	± 3.47 dB
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	± 3.53 dB
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	± 4.44 dB
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	± 2.34 dB
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	± 5.13 dB

FCC ID: WNS-CSM4

IC: 3432F-CSM4

4.4 Measurement protocol for FCC and ISED

4.4.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011
ISED: DE0009

4.4.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

4.4.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.2.2 Radiated emission (electrical field 30 MHz - 1 GHz)

Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.10. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees.

The final level in dB μ V/m is calculated by taking the reading from the EMI receiver (Level dB μ V) and adding the correction factors and cable loss factor (dB). The FCC or CISPR limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency Delta (MHz)	Level (dB μ V)	+	Factor (dB)	=	Level (dB μ V/m)	-	CISPR Limit (dB)	=
719.0	75.0	+	32.6	=	107.6	-	110.0	= -2.4

FCC ID: WNS-CSM4

IC: 3432F-CSM4

4.4.2.3 Radiated emission (electrical field 1 GHz - 40 GHz)

Radiated emissions from the EUT are measured in the frequency range 1 GHz up to the maximum frequency as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table, 1.5 metre above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is following set out in ANSI C63.10. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyzer set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty and are calculated at the specified test distance.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

Remarks: Not applicable as the EUT is battery powered and has no AC mains connections.

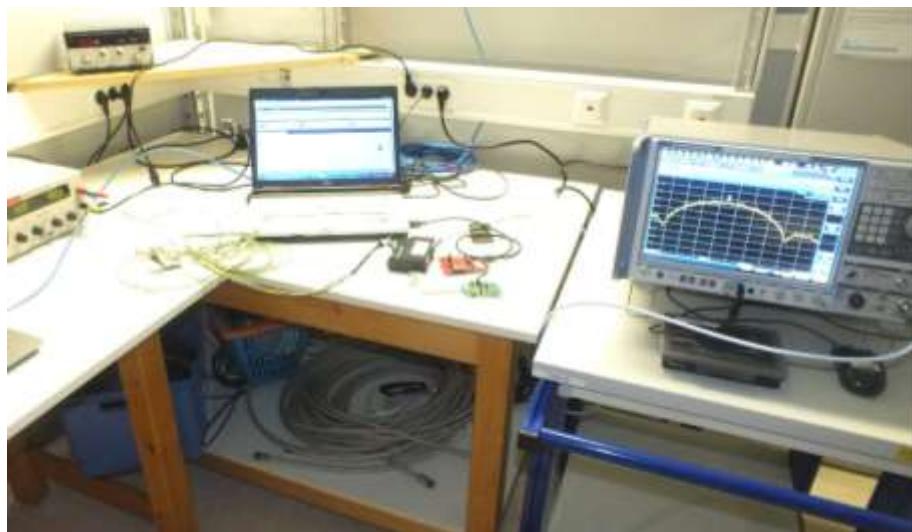
5.2 EBW and OBW

For test instruments and accessories used see section 6 Part **MB**.

5.2.1 Description of the test location

Test location: AREA4

5.2.2 Photo documentation of the test set-up



5.2.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(2):

Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.2.4 Description of Measurement

The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -6 dB. The reference level is the level of the highest signal amplitude observed at the transmitter at either the fundamental frequency or the first order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. An alternative is to use the bandwidth measurement of the analyser.

Spectrum analyser settings for EBW:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Span: 2 EBW;

Spectrum analyser settings for OBW:

RBW: 1-5% OBW, VBW: 3 RBW, Detector: Max peak, Span: 2 OBW;

5.2.5 Test result

Channel	Centre frequency (MHz)	6 dB bandwidth (kHz)	99 % bandwidth (MHz)	Minimum limit (kHz)
37	2402	715.60	1.08	500
17	2440	715.60	1.07	500
39	2480	723.60	1.07	500

The requirements are **FULFILLED**.

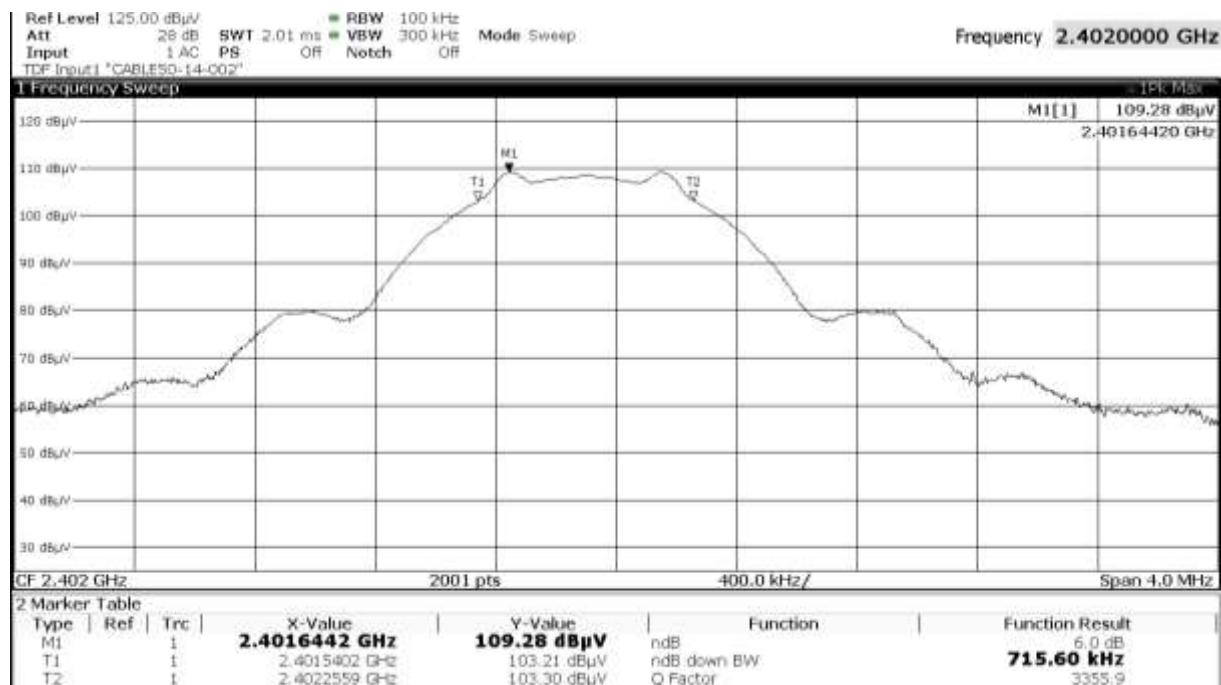
Remarks: For detailed test result please see the following test protocols

FCC ID: WNS-CSM4

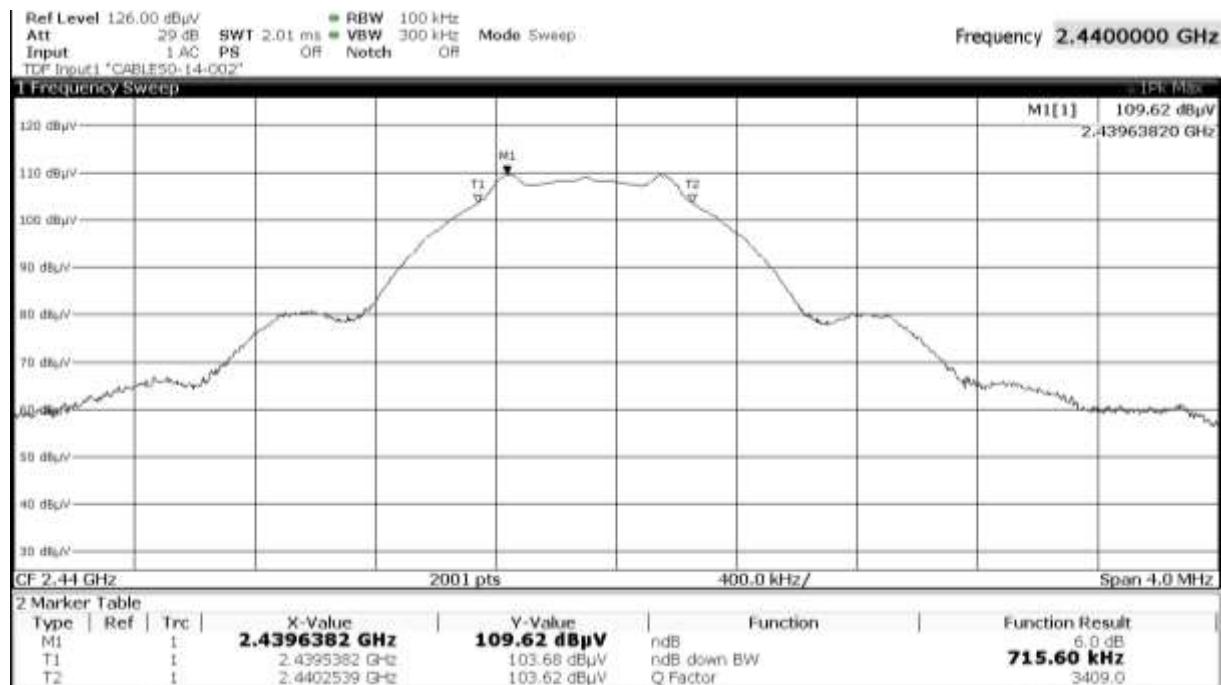
IC: 3432F-CSM4

5.2.6 Test protocols EBW

2402 MHz



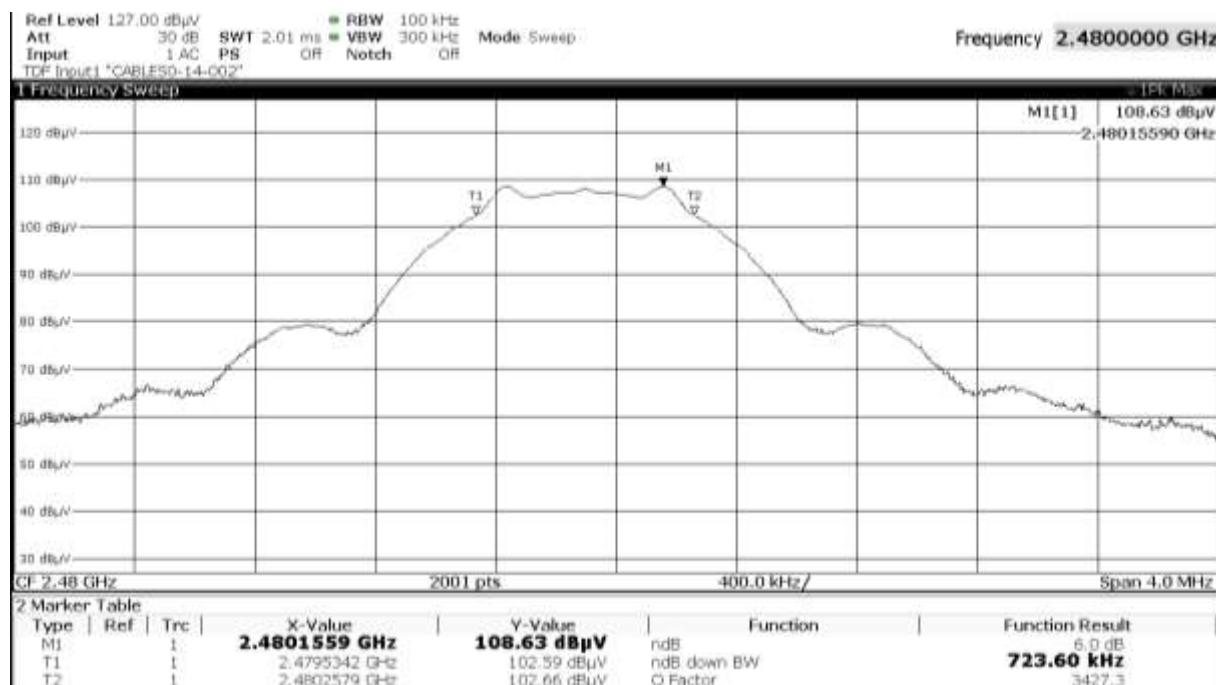
2440 MHz



FCC ID: WNS-CSM4

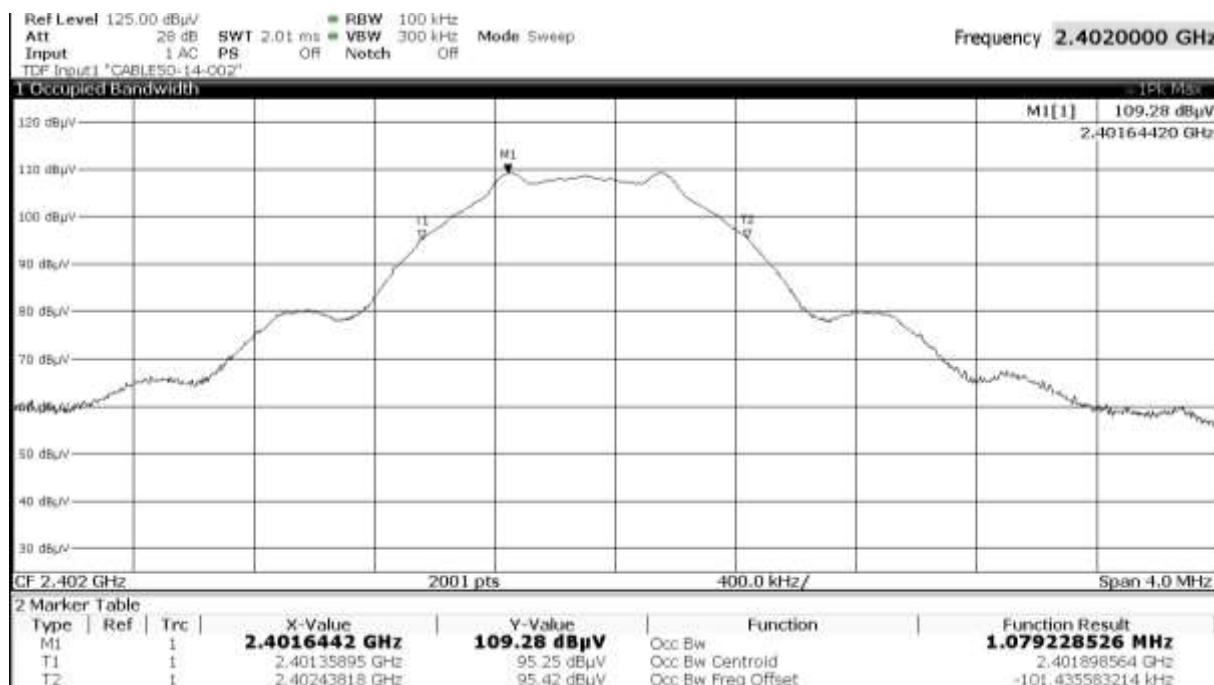
IC: 3432F-CSM4

2480 MHz



5.2.7 Test protocols OBW

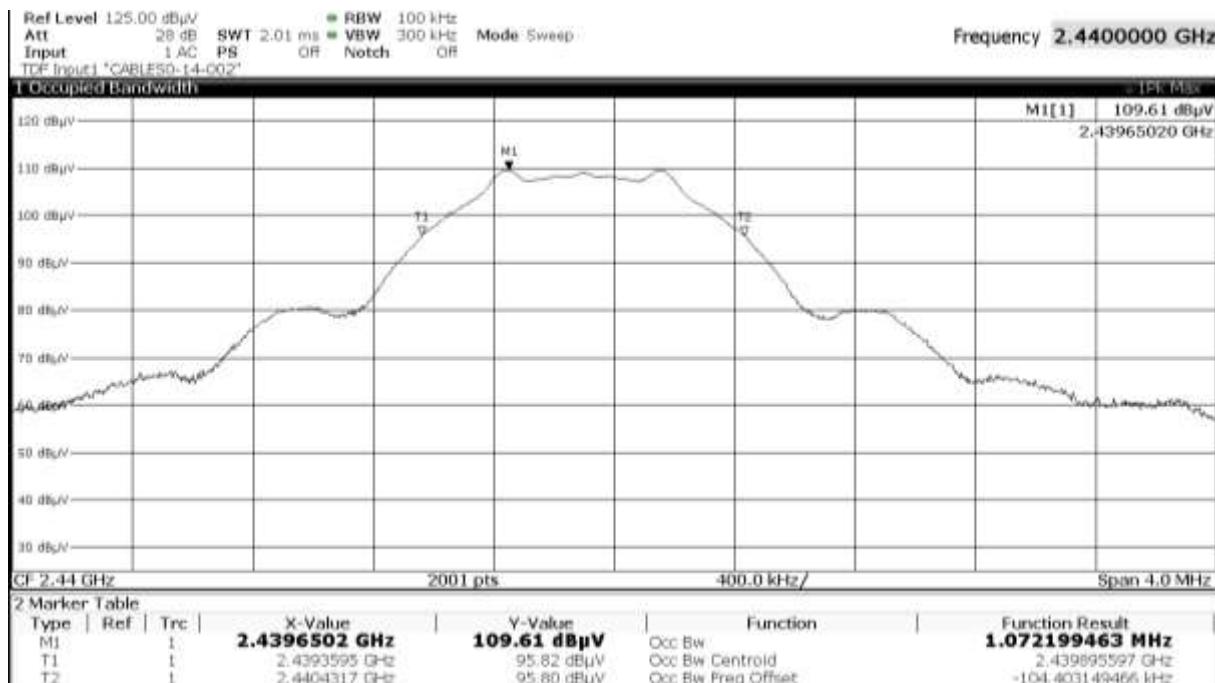
2402 MHz



FCC ID: WNS-CSM4

IC: 3432F-CSM4

2440 MHz



2480 MHz



FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.3 Maximum peak radiated output power

For test instruments and accessories used see section 6 Part **CPR 3**.

5.3.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15, Section 15.247(b)(3):

For systems using digital modulation in the 2400-2483.5 MHz band, the maximum peak output power of the transmitter shall not exceed 1 Watt. The limit is based on transmitting antennas of directional gain that do not exceed 6 dBi.

5.3.4 Description of Measurement

The maximum peak radiated output power is measured using a spectrum analyser following the procedure set out in ANSI 63.10. The EUT is set in TX continuous mode while measuring. The radiated measurement was performed in a fieldstrength measurement.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.3.5 Test result

802.15.1, 1000 kbps		Test results radiated			
		Fieldstrength E (dB μ V/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH37					
T_{nom}	V_{nom}	103.7	8.5	36.0	-27.5
Middle frequency: CH17					
T_{nom}	V_{nom}	103.1	7.8	36.0	-28.2
Highest frequency: CH39					
T_{nom}	V_{nom}	103.5	8.2	36.0	-27.8

Peak Power Limit according to FCC Part 15, Section 15.247(b)(3):

Frequency (MHz)	Peak Power Limit	
	(dBm)	(W)
902-928	36	4.0
2400-2483.5	36	4.0
5725-5850	36	4.0

Calculated maximum conducted peak output power:

802.15.1, 1000 kbps	Test results conducted			EIRP Limit (dBm)	Margin (dB)
	EIRP (dBm)	Antenna Gain (dBi)	P (dBm)		
Lowest frequency: CH37					
T_{nom}	V_{nom}	8.5	5.0	3.5	30.0
Middle frequency: CH17					
T_{nom}	V_{nom}	7.8	5.0	2.8	30.0
Highest frequency: CH39					
T_{nom}	V_{nom}	8.2	5.0	3.2	30.0

Peak Power Limit according to FCC Part 15, Section 15.247(b)(3):

Frequency (MHz)	Peak Power Limit	
	(dBm)	(W)
902-928	30	1.0
2400-2483.5	30	1.0
5725-5850	30	1.0

The requirements are **FULFILLED**.

Remarks: _____

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.4 Power spectral density

For test instruments and accessories used see section 6 Part **MB**.

5.4.1 Description of the test location

Test location: AREA4

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to FCC Part 15, Section 15.247(e):

For digitally modulated systems, the power spectral density radiated from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the radiated output power shall be used to determine the power spectral density.

5.4.4 Description of Measurement

The measurement is performed using the procedure set out in ANSI 63.10. Therefore, the PKPSD is measured conducted. The max peak was located and measured with the spectrum analyser and the marker set to peak. The maximum antenna gain is used to calculate the maximum peak power spectral density.

Spectrum analyser settings:

RBW: 3 kHz, VBW: 10 kHz, Detector: Peak, Sweep time: Auto

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.4.5 Test result

802.15.1, 1000 kbps		Test results conducted				
		PD [Pmax] (dBm/3kHz)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm/3kHz)	Margin (dB)
Lowest frequency: 2402 MHz						
T_{nom}	V_{nom}	-6.6	5.0	-1.6	14.0	-15.6
Middle frequency: 2440 MHz						
T_{nom}	V_{nom}	-6.1	5.0	-1.1	14.0	-15.1
Highest frequency: 2480 MHz						
T_{nom}	V_{nom}	-6.7	5.0	-1.7	14.0	-15.7

Power spectral density limit according to FCC Part 15, Section 15.247(e):

Frequency (MHz)	Power spectral density limit (EIRP)	
	(dBm/3 kHz)	
2400 - 2483.5	14	

The requirements are **FULFILLED**.

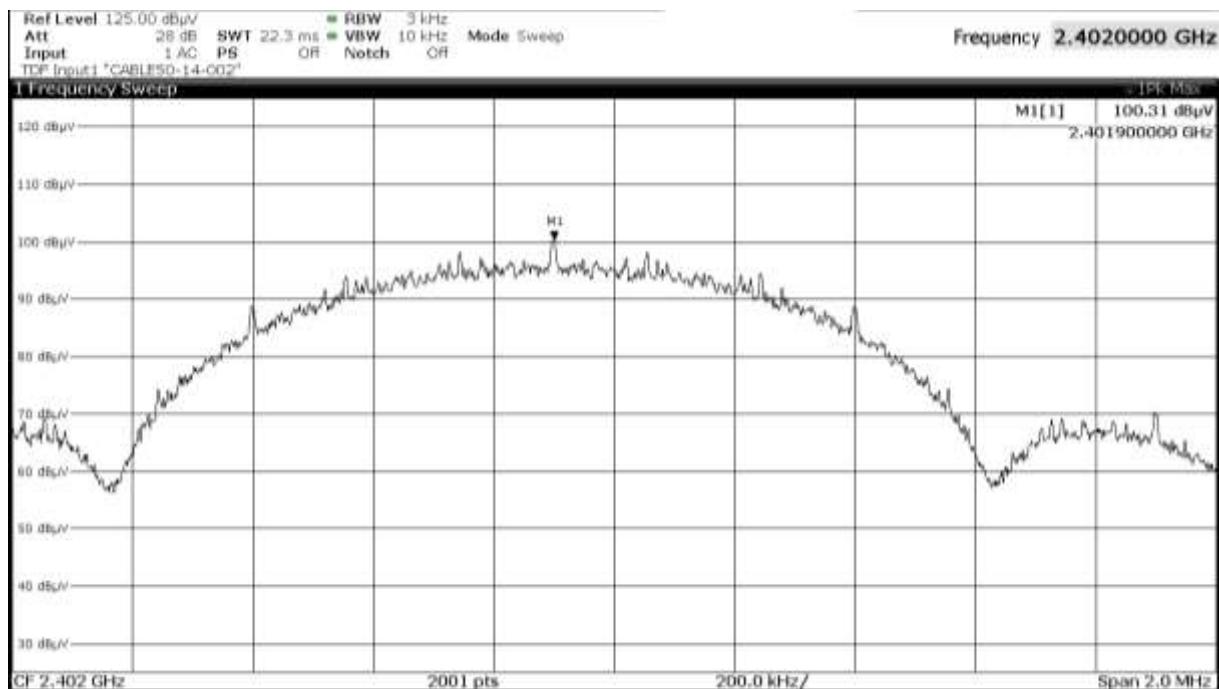
Remarks: For detailed test result please see the following test protocols

FCC ID: WNS-CSM4

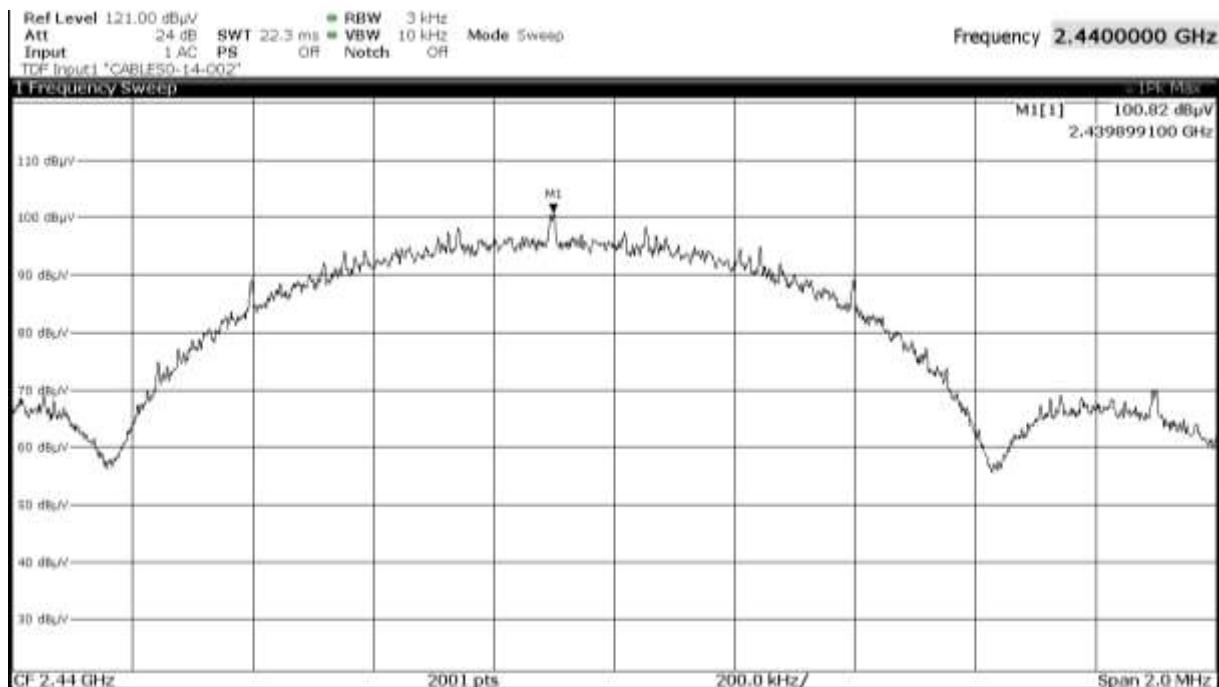
IC: 3432F-CSM4

5.4.6 Test protocols

2402 MHz



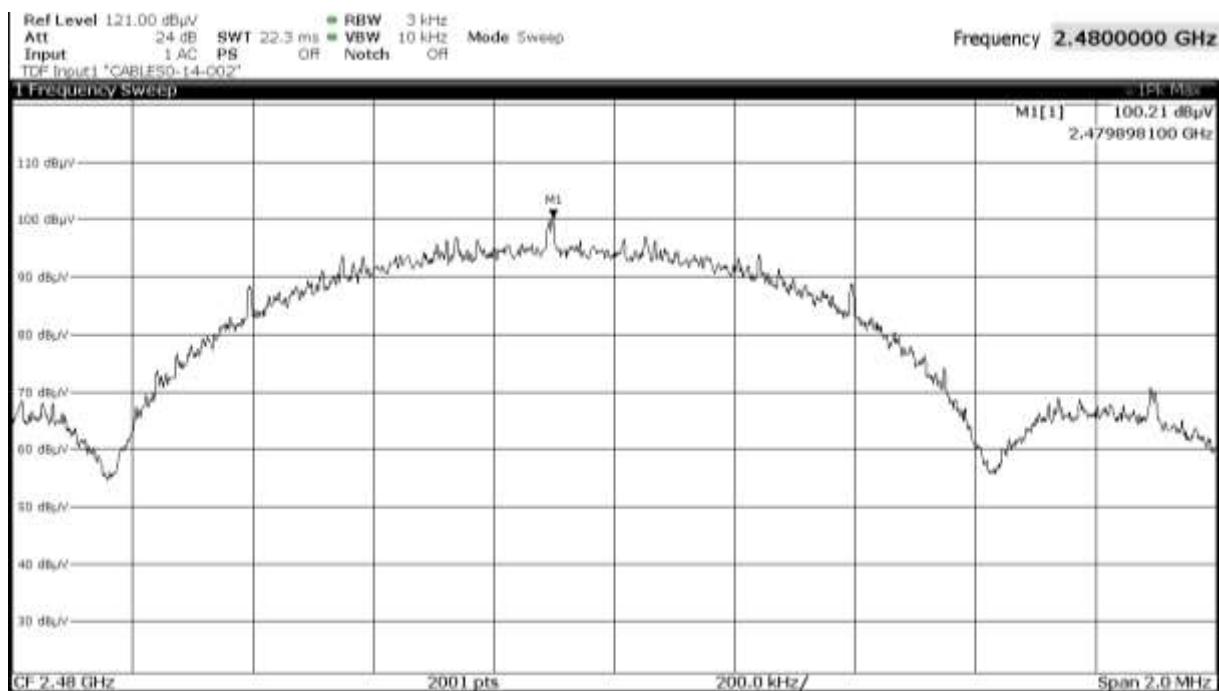
2440 MHz



FCC ID: WNS-CSM4

IC: 3432F-CSM4

2480 MHz



FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.5 Radiated emissions in restricted bands

For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

5.5.1 Description of the test location

Test location: OATS 1
Test location: Anechoic Chamber 1
Test distance: 3 m

5.5.2 Photo documentation of the test set-up

Open area test site

Test setup 30 MHz – 1 GHz



FCC ID: WNS-CSM4

IC: 3432F-CSM4

Anechoic chamber

Test setup 1 GHz – 18 GHz



Test setup 18 GHz – 26 GHz



FCC ID: WNS-CSM4**IC: 3432F-CSM4**

According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

5.5.3 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

Spectrum analyser settings:

30 MHz – 1000 MHz: RBW: 120 kHz
 1000 MHz – 26 GHz: RBW: 1 MHz, VBW: 3 MHz, Sweep: Auto, Detector function: Peak

5.5.4 Test result

5.5.1 Test result $f < 1000$ MHz

Frequency (MHz)	Reading Vert. (dB μ V)	Reading Hor. (dB μ V)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dB μ V/m)	Level Hor. (dB μ V/m)	Limit (dB μ V/m)	Dlimit (dB)
31.80	7.0	5.3	12.9	11.5	19.9	16.8	40.0	-20.1
37.60	6.1	5.4	13.3	12.1	19.4	17.5	40.0	-20.6
44.24	17.4	5.5	14.1	12.9	31.5	18.4	40.0	-8.5
73.74	17.1	7.2	12.1	11.6	29.2	18.8	40.0	-10.8

Note: no difference could be detected between the different operating frequencies.

5.5.2 Test result $f > 1$ GHz

2402 MHz

Frequency (MHz)	Level PK dB(μ V/m)	Level AV dB(μ V/m)	Limit PK dB(μ V/m)	Margin PK (dB)	Limit AV dB(μ V/m)	Margin AV (dB)
1717.13	46.8	-	74.0	-27.3	54.0	-
4803.22	50.0	-	74.0	-24.1	54.0	-
7206.64	64.5	34.8	74.0	-9.5	54.0	-19.2

Note: only when the peak value exceeds the average limit, an AV measurement is necessary. The AV value is calculated with the duty cycle correction factor of -29.7 dB.

FCC ID: WNS-CSM4**IC: 3432F-CSM4****2440 MHz**

Frequency (MHz)	Level PK dB(µV/m)	Level AV dB(µV/m)	Limit PK dB(µV/m)	Margin PK (dB)	Limit AV dB(µV/m)	Margin AV (dB)
1552.16	45.2	-	74.0	-28.8	54.0	-
4880.22	49.11	-	74.0	-24.9	54.0	-
7320.13	56.6	26.9	74.0	-17.4	54.0	-27.1

Note: only when the peak value exceeds the average limit, an AV measurement ist necessary. The AV value is calculated with the duty cycle correction factor of -29.7 dB.

2480 MHz

Frequency (MHz)	Level PK dB(µV/m)	Level AV dB(µV/m)	Limit PK dB(µV/m)	Margin PK (dB)	Limit AV dB(µV/m)	Margin AV (dB)
1733.13	45.0	-	74.0	-29.0	54.0	-
4959.22	44.3	-	74.0	-29.7	54.0	-
7439.13	59.6	29.9	74.0	-14.4	54.0	-24.1

Note: only when the peak value exceeds the average limit, an AV measurement ist necessary. The AV value is calculated with the duty cycle correction factor of -29.7 dB.

Radiated limits according to FCC Part 15 Section 15.209(a) for spurious emissions which fall in restricted bands:

Frequency (MHz)	Field strength of spurious emissions		Measurement distance (metres)
	(µV/m)	dB(µV/m)	
0.009-0.490	2400/F (kHz)		300 30 30 3 3 3 3
0.490-1.705	24000/F (kHz)		
1.705-30	30	29.5	
30-88	100	40	
88-216	150	43.5	
216-960	200	46	
Above 960	500	54	

FCC ID: WNS-CSM4**IC: 3432F-CSM4****Restricted bands of operation:**

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

RSS-Gen, Table 6 – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	12.57675 - 12.57725	399.9 - 410	7.250 - 7.750
0.495 - 0.505	13.36 - 13.41	608 - 614	8.025 - 8.500
2.1735 - 2.1905	16.42 - 16.423	960 - 1427	9.0 - 9.2
3.020 - 3.026	16.69475 - 16.69525	1435 - 1626.5	9.3 - 9.5
4.125 - 4.128	16.80425 - 16.80475	1645.5 - 1646.5	10.6 - 12.7
4.17725 - 4.17775	25.5 - 25.67	1660 - 1710	13.25 - 13.4
4.20725 - 4.20775	37.5 - 38.25	1718.8 - 1722.2	14.47 - 14.5
5.677 - 5.683	73 - 74.6	2200 - 2300	15.35 - 16.2
6.215 - 6.218	74.8 - 75.2	2310 - 2390	17.7 - 21.4
6.26775 - 6.26825	108 - 138	2483.5 - 2500	22.01 - 23.12
6.31175 - 6.31225	149.9 - 150.05	2655 - 2900	23.6 - 24.0
8.291 - 8.294	156.52475 - 156.52525	3260 - 3267	31.2 - 31.8
8.362 - 8.366	156.7 - 156.9	3332 - 3339	36.43 - 36.5
8.37625 - 8.38675	162.0125 - 167.17	3345.8 - 3358	Above 38.6
8.41425 - 8.41475	167.72 - 173.2	3500 - 4400	
12.29 - 12.293	240 - 285	4500 - 5150	
12.51975 - 12.52025	322 - 335.4	5350 - 5460	

The requirements are **FULFILLED**.

Remarks: The measurement was performed up to the 10th harmonic. For detailed test results please see the following test protocols.

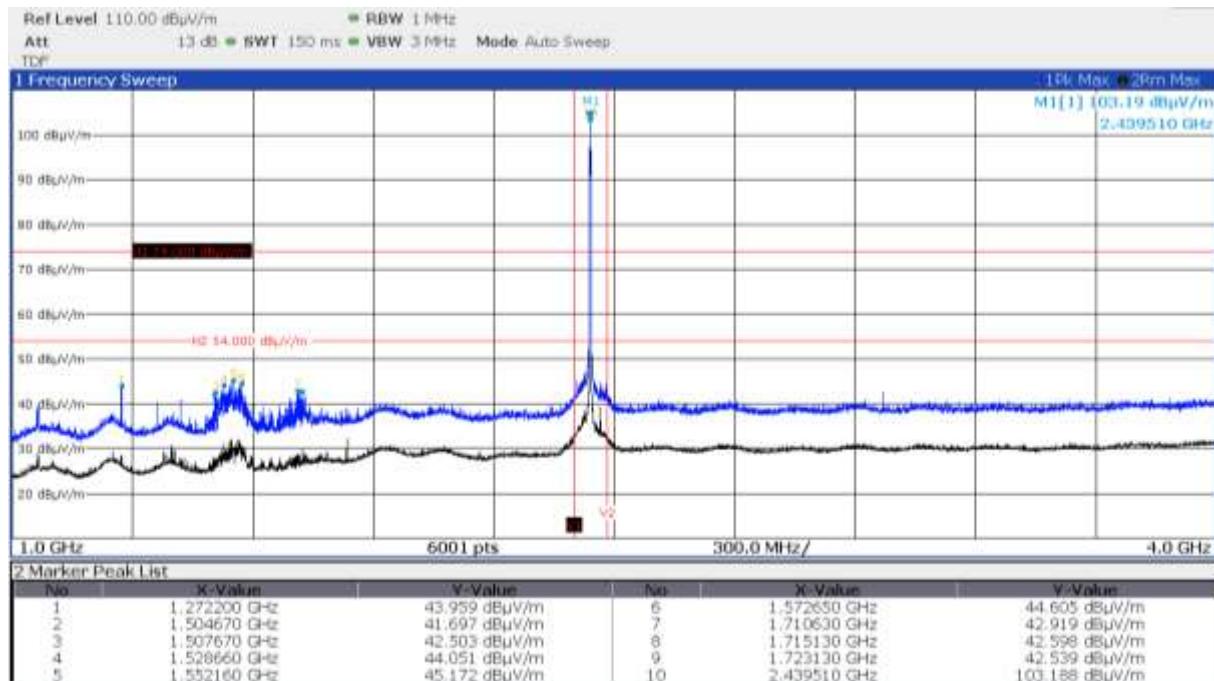
FCC ID: WNS-CSM4

IC: 3432F-CSM4

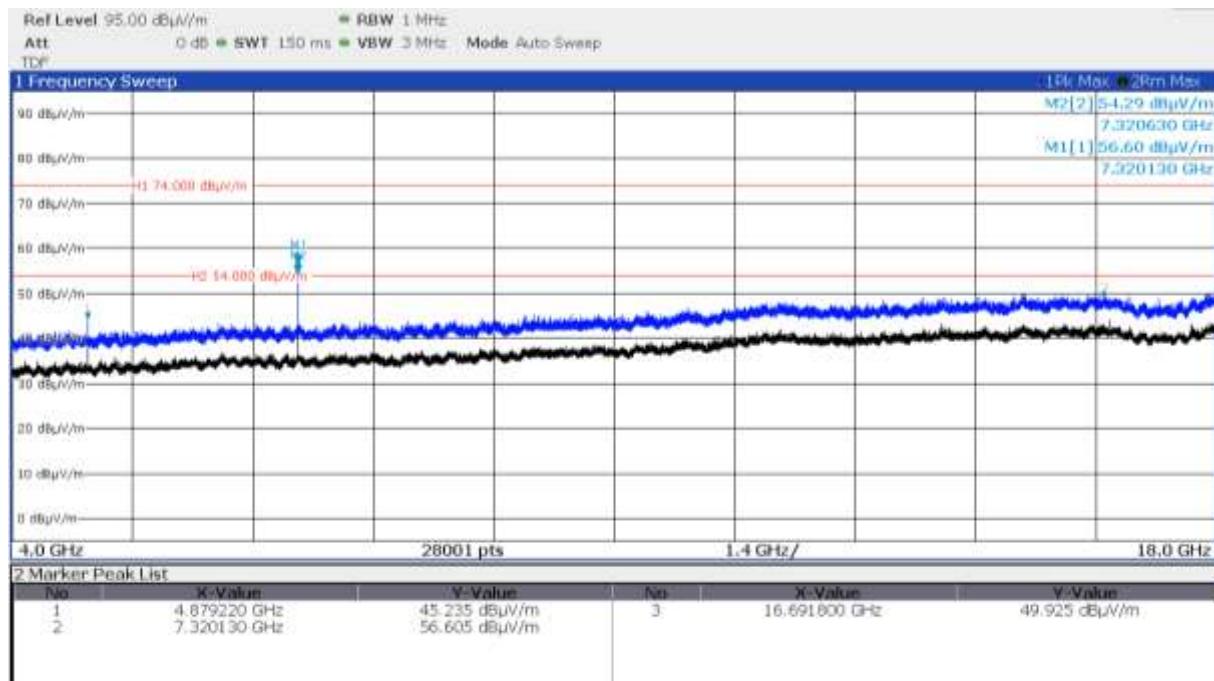
5.5.3 Test protocol

Measurement 1 GHz to 25 GHz for 2440 MHz only for reference:

1 GHz to 4 GHz



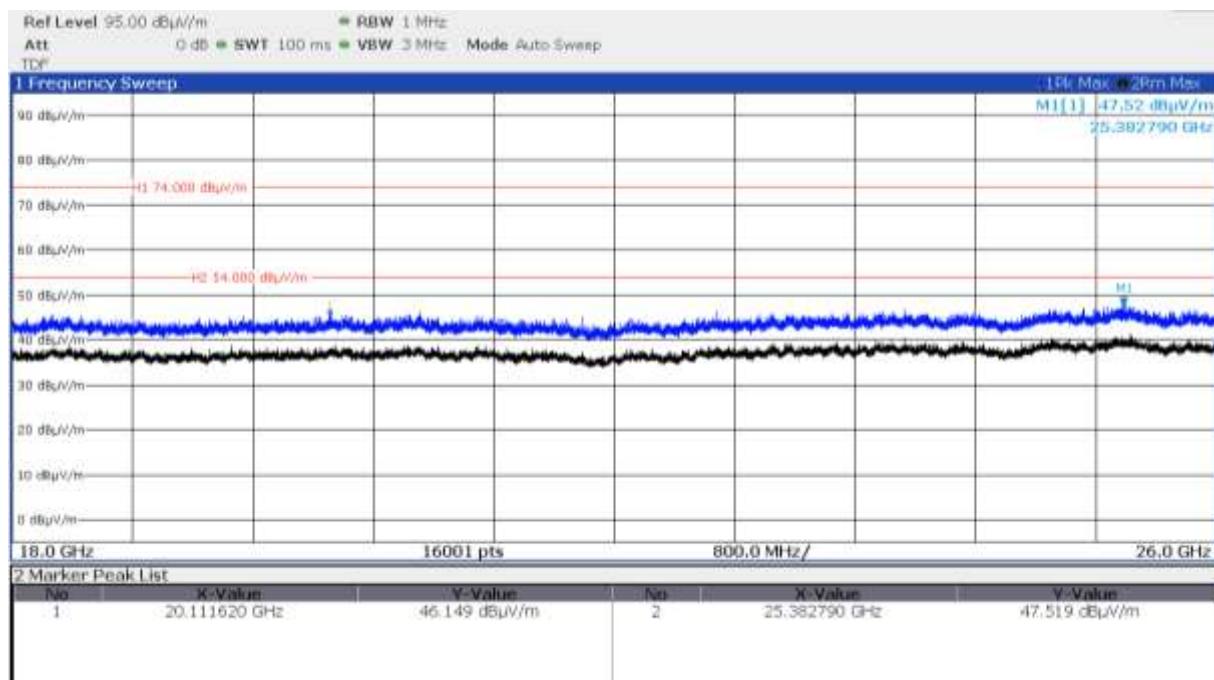
4 GHz to 18 GHz



FCC ID: WNS-CSM4

IC: 3432F-CSM4

18 GHz to 26 GHz



FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.6 Band edge compliance

For test instruments and accessories used see section 6 Part **SER3**.

5.6.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.6.2 Photo documentation of the test set-up



5.6.3 Applicable standard

According to FCC Part 15C, Section 15.247(d):

In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

5.6.4 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode at the assigned frequency according to ANSI C63.10.

Spectrum analyser settings non-restricted band:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Trace: Max hold, Sweep: auto

Spectrum analyser settings restricted band:

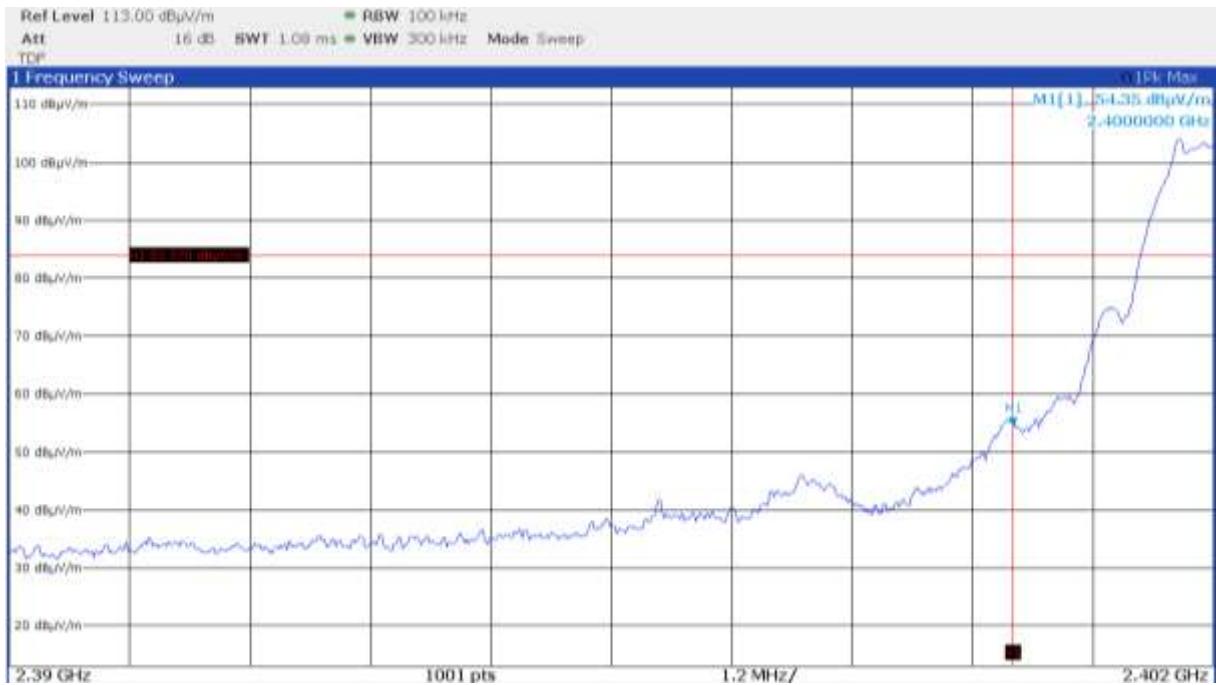
RBW: 1 MHz, VBW: 3 MHz, Detector: Max peak, Trace: Max hold, Sweep: auto

FCC ID: WNS-CSM4

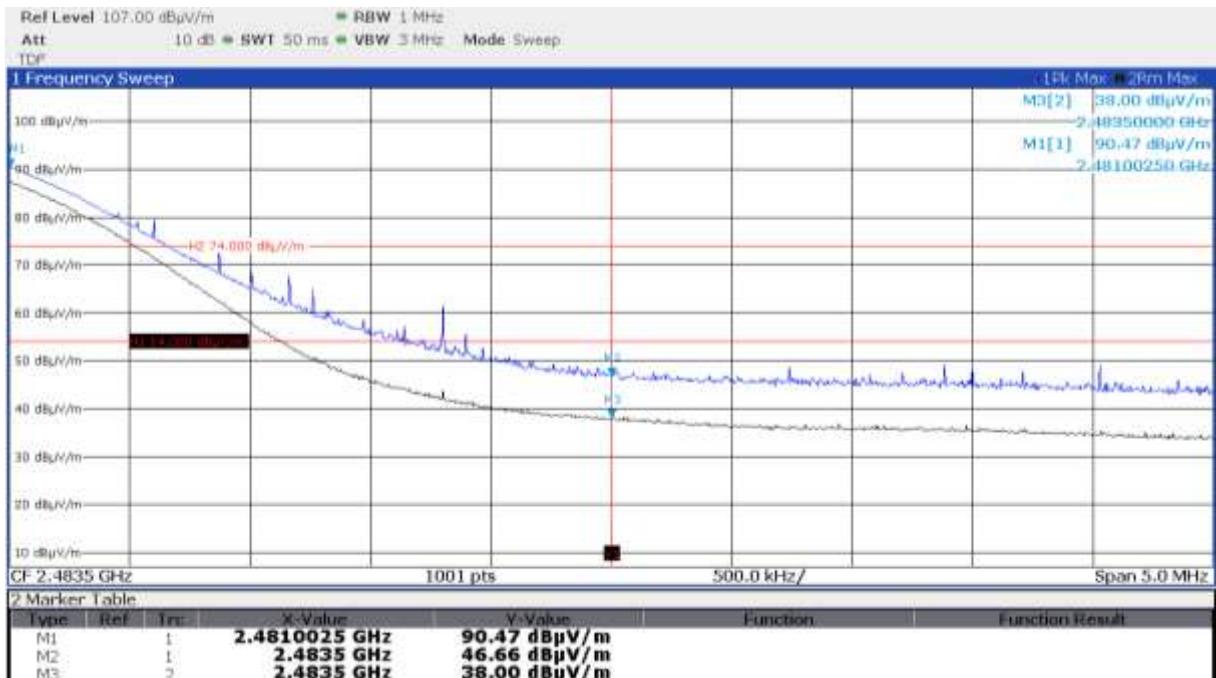
IC: 3432F-CSM4

5.6.5 Test result

Lower bandedge measurement channel 37



Upper bandedge measurement channel 39



FCC ID: WNS-CSM4**IC: 3432F-CSM4**

Limit according to FCC Subpart 15.247(d):

In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limit specified in §15.209(a) (see §15.205(c)).

The requirements are **FULFILLED**.

Remarks:

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.7 Radiated emissions in non-restricted bands

For test instruments and accessories used see section 6 Part **SER 3**.

5.7.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.7.2 Photo documentation of the test set-up



5.7.3 Applicable standard

According to FCC Part 15, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency band 2400 – 2483.50 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a) (see Section 15.205(c)).

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.7.4 Description of Measurement

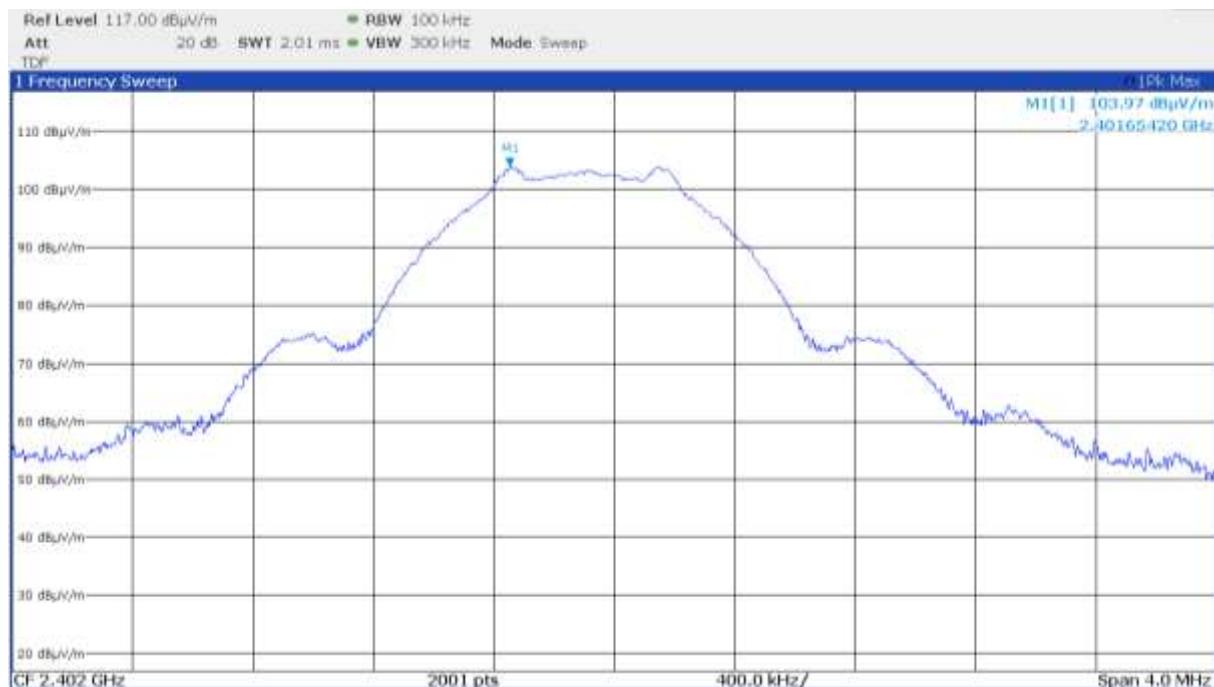
The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.10. The frequency spectrum outside from the operating frequency range (2400 - 2483.5 MHz) is scanned for emissions that exceed the limit. The measurement is performed at normal test conditions in modulated TX continuous mode.

Spectrum analyser search setting:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Trace Mode: Max hold

5.7.5 Test result

Determination of the limit level:



The 20 dB down limit: 83.97 dB μ V/m

FCC ID: WNS-CSM4

IC: 3432F-CSM4

Peak-Limit according to FCC Part 15, Section 15.247(d) for emissions falling not in restricted bands: In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.50 MHz and 5725 – 5850 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

Frequency (MHz)	Spurious emission limit
Below 1000	20 dB below the highest level of the desired power
Above 1000	20 dB below the highest level of the desired power

The requirements are **FULFILLED**.

Remarks: For detailed test results please see the following test protocols.
The unwanted emissions radiated are measured with a 1 MHz resolution bandwidth and are
compared with the general limits according to Section 15.209(a) for restricted band emissions.
Only when the general limit is exceeded within non-restricted bands, the emissions are compared
with the 20 dB down limit for non-restricted band emissions.
For further information, please refer to chapter 5.5.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.8 Antenna application

5.8.1 Applicable standard

According to FCC Part 15C, Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

The EUT has an integrated antenna. No other antenna can be used with the device.

The antenna of the EUT meets the requirement of FCC Part 15C, Section 15.203 and 15.204.

5.8.2 Antenna requirements

According to FCC Part 15C, Section 15.247(b)(4):

The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Remarks: No power reduction results from the defacto limit.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

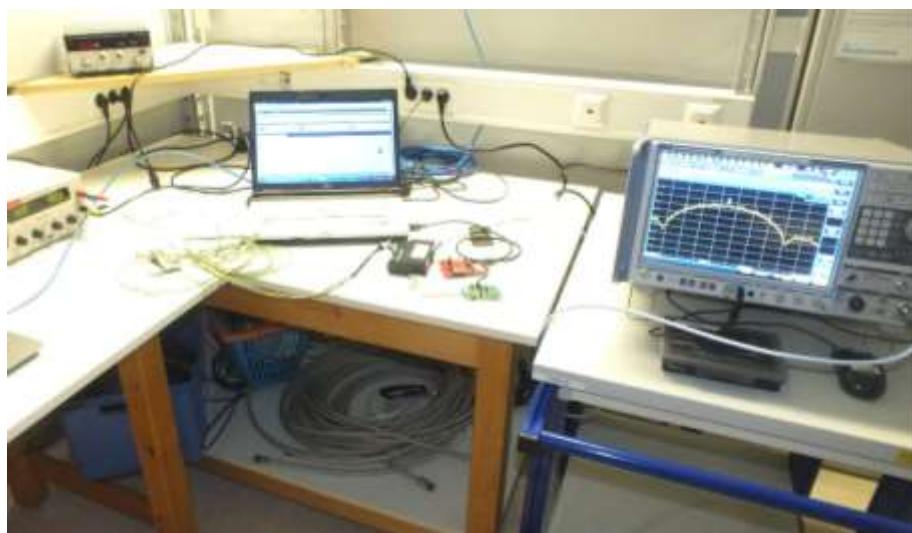
5.9 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part **DC**.

5.9.1 Description of the test location

Test location: AREA4

5.9.2 Photo documentation of the test set-up



5.9.3 Applicable standard

According to FCC Part 15A, Section 15.35(c):

When the radiated emission limits are expressed in terms of average value and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete puls train, including blanking intervals, as long as the pulse train does not exceed 0.1s. In cases where the puls train exceeds 0.1s, the measured field strength shall be determined from the average absolute voltage during a 0.1s interval during which the field strength is at its maximum. The exact method of calculating the average field strength shall be submitted.

FCC ID: WNS-CSM4

IC: 3432F-CSM4

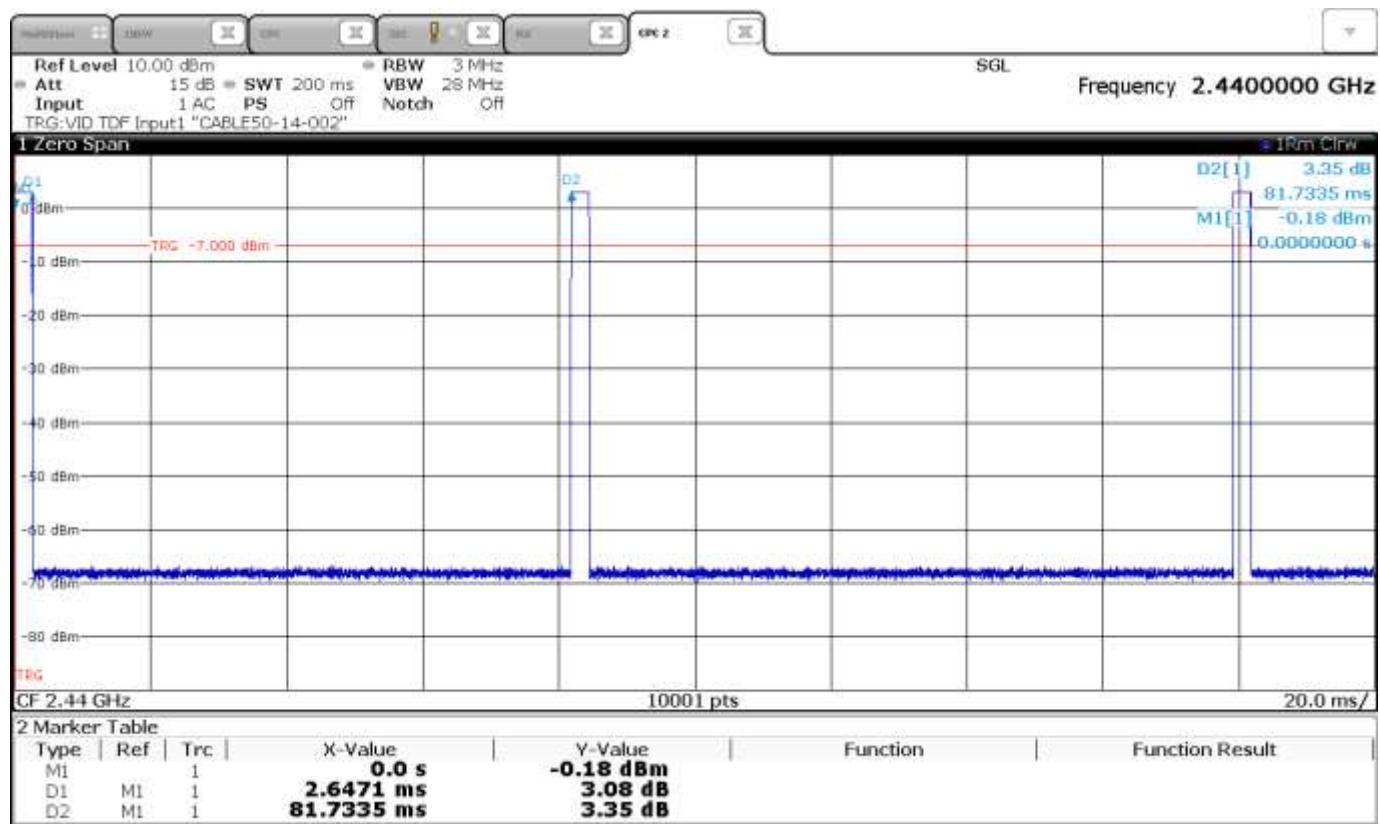
5.9.4 Description of Measurement

The duty cycle factor (dB) is calculated applying the following formula:

$$KE = 20 \log (t_w / 0.1s)$$

KE : pulse operation correction factor

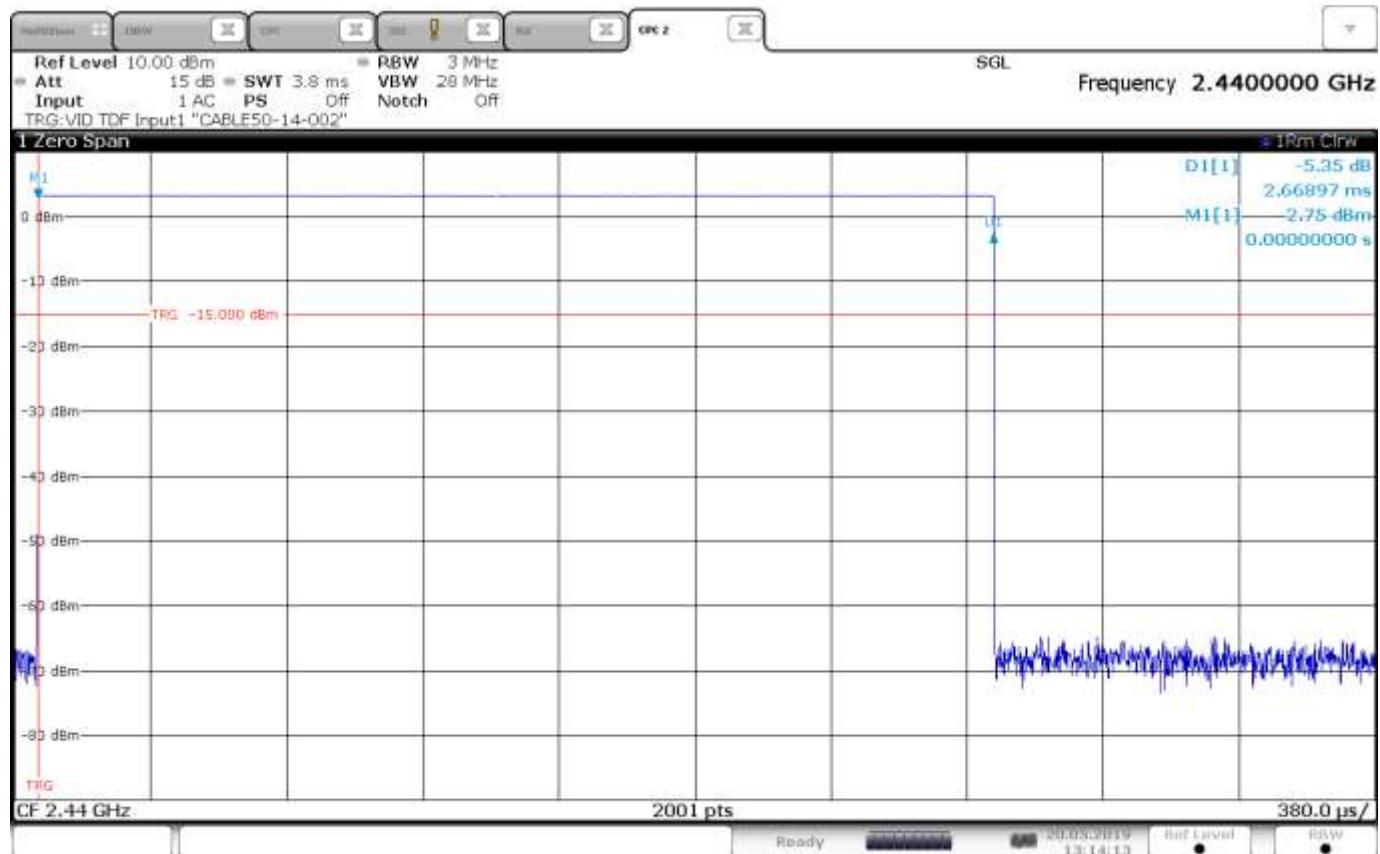
t_w : pulse duration for one complete pulse track



FCC ID: WNS-CSM4

IC: 3432F-CSM4

5.9.5 Test result



13:14:14 20.05.2019

Total length of period	81.73 ms
Max. On time	2.668 ms
DC	0.033
Correction factor	-29.7 dB

Remarks: -

FCC ID: WNS-CSM4

IC: 3432F-CSM4

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPR 3	FSW43	02-02/11-15-001	19/03/2019	19/03/2018		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	08/05/2019	08/05/2018		
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS1102-02/50-17-012					
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
DC	KK-SF106-2X11N-6,5M	02-02/50-18-016				
	EA-PS 3032-10B	01-05/50-11-011				
	ESW26	02-02/03-17-002	13/12/2019	13/12/2018		
MB	KK-SF104-11SMA-11N-2M	02-02/50-14-002				
	EA-PS 3032-10B	01-05/50-11-011				
	ESW26	02-02/03-17-002	13/12/2019	13/12/2018		
SER 2	KK-SF104-11SMA-11N-2M	02-02/50-14-002				
	ESVS 30	02-02/03-05-006	06/06/2019	06/06/2018		
	VULB 9168	02-02/24-05-005	18/04/2019	18/04/2018		
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
SER 3	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
	FSW43	02-02/11-15-001	19/03/2019	19/03/2018		
	JS4-18004000-30-5A	02-02/17-05-017				
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	08/05/2019	08/05/2018		
	BBHA 9170	02-02/24-05-014	12/06/2021	12/06/2018	12/12/2019	12/12/2018
	KMS102-0.2 m	02-02/50-11-020				
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS1102-02/50-17-012					
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				