Test Report

T004 (EN ISO/IEC 17025)

INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C AND ISED CANADA REQUIREMENTS

Equipment Under Test:	Shooting Star Communicator modem
Trademark:	Intel
Model:	Intel Shooting Star
Applicant:	Intel Corporation 2200 Mission College Blvd Santa Clara, CA 95054 USA
Manufacturer:	Intel Corporation 2200 Mission College Blvd Santa Clara, CA 95054 USA
FCC Rule Part:	15.247: 2018
IC Rule Part:	RSS-247, Issue 2, 2017 RSS-GEN Issue 5 Amendment 1, 2019
KDB:	558074 D01 15.247 Meas Guidance v05r02 Guidance for Compliance Measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under §15.247 of the FCC rules (April 2, 2019)

Date:	2 July 2020	Date:	2 July 2020
Issued by:	Jani Tuomela Testing Engineer	Checked by:	Rauno Repo Testing Engineer

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GENERAL REMARKS

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

RELEASE HISTORY

Version	Changes	Issued
1.0	Initial release	10 September 2019
1.1	Corrections made based on ACB comments	30 June 2020
1.2	Section Antennas replaced with section Communicator antennas orientation during radiated emission	2 July 2020

PRODUCT DESCRIPTION

Equipment Under Test

Shooting Star Communicator modem

Trade mark:	Intel
Model:	Intel Shooting Star
Type:	EVT
Serial no:	033
Modem FW:	479
FCC ID:	2AJ2A-DLM24GM
IC:	1000B-DLM24GM

General Description

EUT is poe operated radio control system. EUT contains two 2.4GHz radio parts that supports frequency hopping (FHSS).

Classification

Fixed device	☐
Mobile Device (Human body distance > 20cm)	☒
Portable Device (Human body distance < 20cm)	☐

Modifications Incorporated in the EUT

No modifications were applied during the tests.

Ratings and declarations

Operating Frequency Range (OFR):	2402.5 – 2477.5 MHz
Channels:	76
Channel separation:	1 MHz
Transmission technique:	FHSS, OFDM
Antenna type:	dipole (Pulse W1030)
Integral Antenna gains:	2.0 dBi

Power Supply

Operating voltage:	48 Vdc, poe
Ethernet switch, AC power unit	115V, 60Hz

Mechanical Size of the EUT

Height: 95 mm	Width: 160 mm	Depth: 62 mm

Peripherals

Ethernet switch	tp-link TL-SG108PE,	s/n: 2187240001254
Power supply	tp-link T480125-2-DT	s/n: 185479
Computer	HP Elitebook 5540w	s/n: CND1177MFQ

SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.207(a) / RSS-GEN 8.8	Conducted Emissions on Power Supply Lines	PASS
§15.247(b)(3) / RSS-247 5.4(d)	Maximum Peak Conducted Output Power	PASS
§15.247(a)(1) / RSS-247 5.1	Hopping Channel Carrier Frequency Separation	PASS
§15.247(a)(1) / RSS-247 5.1	Number of Hopping Frequencies	PASS
§15.247(a)(1) / RSS-247 5.1	Average Time of Occupancy of Hopping Frequency	PASS
§15.247(a)(1) / RSS-247 5.1	20 dB Bandwidth	PASS
§15.247(e) / RSS-247 5.2(b)	Power Spectral Density	N/T[1]
RSS-GEN 6.7	99% Occupied Bandwidth	PASS
§15.247(d) / RSS-247 5.5	100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions	PASS
§15.209(a), §15.247(d) / RSS-247 5.5	Radiated Emissions Within the Restricted Bands	PASS

1) Not applicable for FHSS

The decision rule applied for the tests results stated in this test report is according to the requirements of section 1.3 of ANSI C63.10-2013.

EUT Test Conditions during Testing

Test	Operating mode
Conducted Emissions on Power Supply Lines	continuous transmit
Maximum Peak Conducted Output Power	continuous transmit
Hopping Channel Carrier Frequency Separation	hopping, continuous transmit
Number of Hopping Frequencies	hopping
Average Time of Occupancy of Hopping Frequency	hopping
20 dB Bandwidth	continuous transmit
99% Occupied Bandwidth	continuous transmit
100 kHz Bandwidth of Frequency Band Edges, Conducted Spurious Emissions	continuous transmit, hopping
Radiated Emissions Within the Restricted Bands	continuous transmit. The EUT was set to a test mode allowing simultaneous transmission to find the worst-case modes. According to the manufacturer this operation will not be possible in normal use.

Table 1: Test frequencies

Channel	Frequency (MHz)
0, low	2402.5
37, middle1	2439.5
39, middle2	2441.5
75, high	2477.5
0-75, hopping mode	2402.5-2477.5

Communicator antennas orientation during radiated emission

The EUT antennas were positioned for worst case emissions.

Test Facility

Testing Laboratory / address: FCC designation number: **FI0002** ISED CAB identifier: **T004**	SGS Fimko Ltd Takomotie 8 FI-00380, HELSINKI FINLAND
Test Site:	☐ K10LAB, ISED Canada registration number: **8708A-1** ☒ K5LAB, ISED Canada registration number: **8708A-2** ☐ T10LAB

TEST RESULTS

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz

Standard:	ANSI C63.10	(2013)
Tested by:	RRE	
Date:	10 September 2019	
Temperature:	23 ± 3°C	
Humidity:	20 - 60 % RH	
Barometric pressure:	1001 hPa	
Measurement uncertainty:	± 2.9 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.207 (a)
RSS-GEN 8.8

Conducted disturbance voltage was measured with an artificial main network from 150 kHz to 30 MHz with 4 kHz steps and a resolution bandwidth of 9 kHz. Measurements were carried out with peak and average detectors.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

115V 60Hz AC input of Ethernet switch

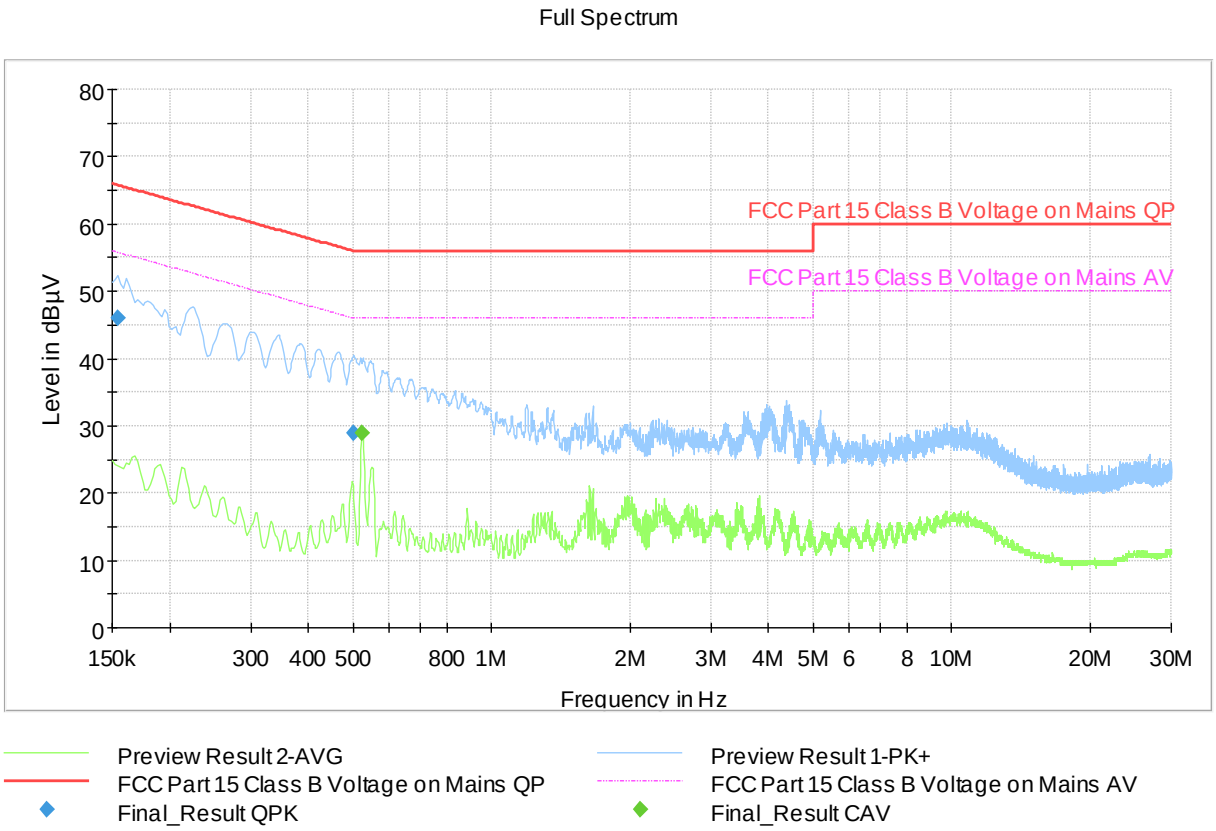


Figure 1: The measured curves with peak- and average detector

Final measurements from the worst frequencies

Table 2: Final QuasiPeak and Average measurements from the worst frequencies

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.154000	45.94	---	65.78	19.84	1000.0	9.000	N	ON	9.6
0.502250	28.86	---	56.00	27.14	1000.0	9.000	N	ON	9.7
0.524750	---	28.87	46.00	17.13	1000.0	9.000	N	ON	9.7

The correction factor in the final result table contains the sum of the transducers.
The result value is the measured value corrected with the correction factor.

Maximum Peak Conducted Output Power

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	6 August 2019	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	
Measurement uncertainty:	± 2.87dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(b)(3)
RSS-247 5.4(d)

Test according to FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 7.8.5

Measured values are peak values.

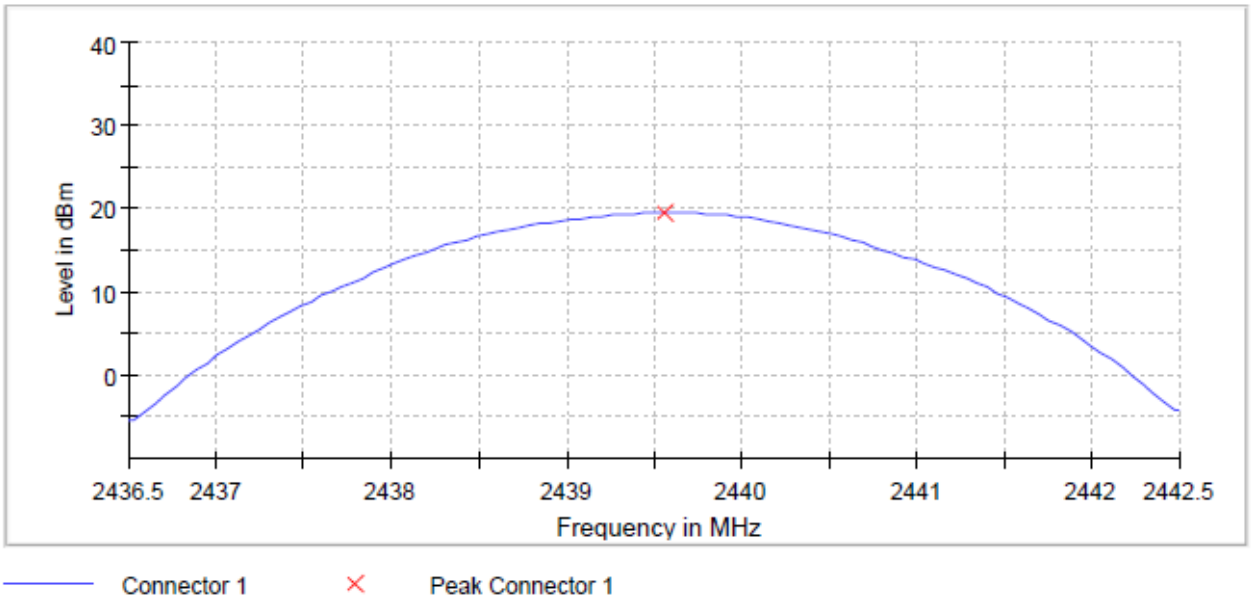
Results:

Table 3: Maximum conducted output power

Modem/Data rate	Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
1/1200	0	18.7	21	2.3	PASS
1/1200	37	19.6	21	1.4	PASS
1/1200	75	18.8	21	2.2	PASS
1/2400	0	18.5	21	2.5	PASS
1/2400	37	19.1	21	1.9	PASS
1/2400	75	18.6	21	2.4	PASS
2/1200	0	18.1	21	2.9	PASS
2/1200	37	19.0	21	2.0	PASS
2/1200	75	18.6	21	2.4	PASS
2/2400	0	18.7	21	2.3	PASS
2/2400	37	18.9	21	2.1	PASS
2/2400	75	19.2	21	1.8	PASS

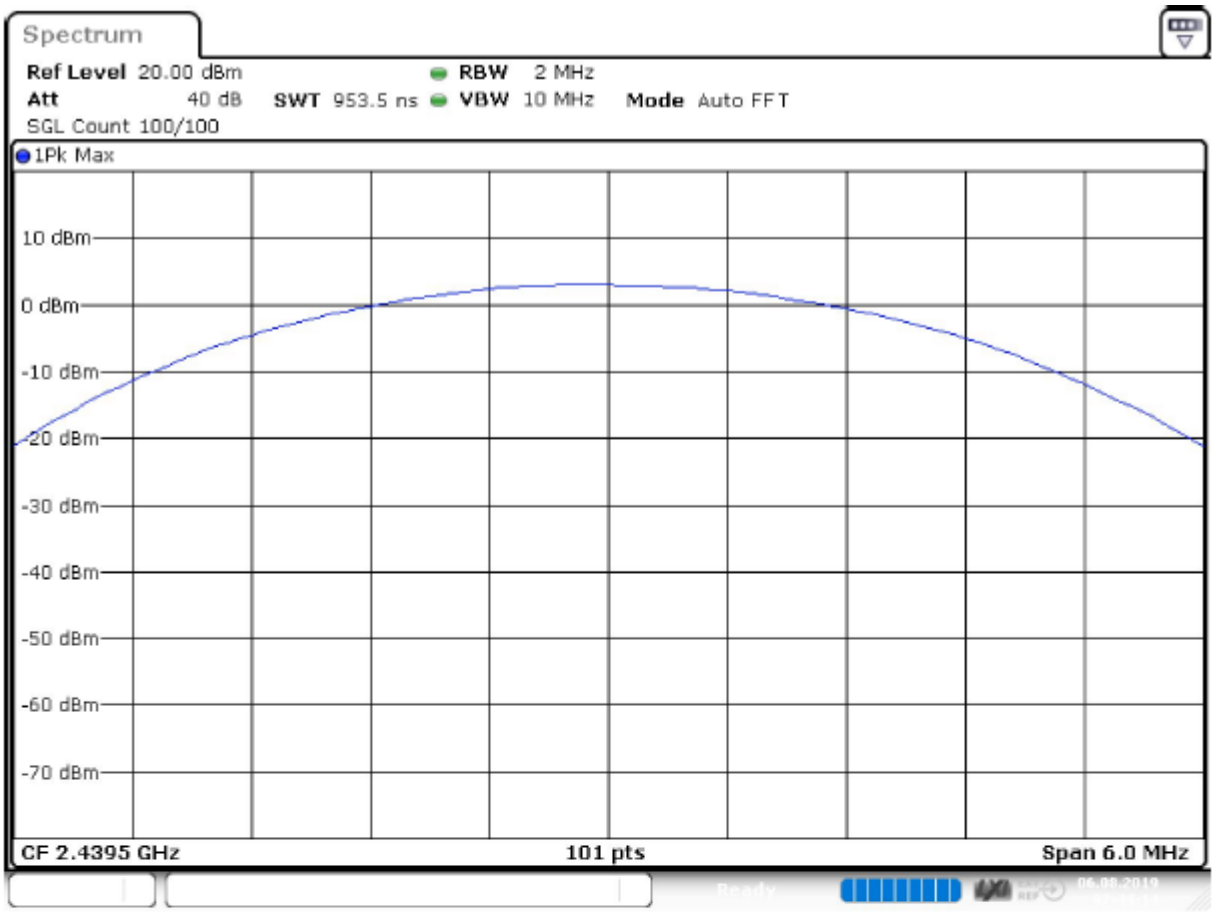
Result

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2439.500000	19.6	21.0	PASS



Peak Power 1

Figure 2: Maximum conducted power, modem1 1200kbps channel 37



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.43650 GHz	2.43650 GHz
Stop Frequency	2.44250 GHz	2.44250 GHz
Span	6.000 MHz	6.000 MHz
RBW	2.000 MHz	>= 1.145 MHz
VBW	10.000 MHz	>= 6.000 MHz
SweepPoints	101	~ 101
Sweeptime	953.450 ns	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	6 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Table 4: Measurement settings, maximum conducted output power

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	8 – 13 August 2019	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	
Measurement uncertainty:	± 4.51 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

RSS-247 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the 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. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a)**.**

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables).

Peak values of emissions below 1000 MHz measured for reference as well as transmitter fundamental.

The pre-measurements were performed with the EUT being in three orthogonal positions (X, Y, Z). The EUT was set to a test mode allowing simultaneous transmission to find the worst-case modes. According to the manufacturer this operation will not be possible in normal use.

Final measurements were done in worst position.

Frequency range [MHz]	Limit [µV/m]	Limit [dBµV/m]	Detector
30 - 80	100	40.0	Quasi-peak
88 - 216	150	43.5	Quasi-peak
216 - 960	200	46.0	Quasi-peak
960 - 1000	500	53.9	Quasi-peak
Above 1000	500	53.9	Average
Above 1000	5000	73.9	Peak

Table 5: Quasipeak results below 1GHz, both transmitters operate, data rate 1200kbps

Modem/channel	Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1/ch0 2/ch75	1.639750	-13.37	23.34	36.71	1000.0	9.000	100.0	90	200.0	-20.5
1/ch75 2/ch0	1.684000	-13.42	23.11	36.53	1000.0	9.000	100.0	0	194.0	-20.5
1/ch37 2/ch39	1.562000	-13.24	23.76	37.00	1000.0	9.000	100.0	0	180.0	-20.5
1/ch0 2/ch75	31.385000	30.05	40.00	9.95	1000.0	120.000	400.0	V	203.0	16.4
	34.625000	25.88	40.00	14.12	1000.0	120.000	105.0	V	34.0	16.6
	96.315000	22.41	43.50	21.09	1000.0	120.000	121.0	V	125.0	12.3
1/ch75 2/ch0	31.425000	30.48	40.00	9.52	1000.0	120.000	400.0	V	195.0	16.4
	98.435000	23.91	43.50	19.59	1000.0	120.000	105.0	V	45.0	12.6
	249.995000	27.07	46.00	18.93	1000.0	120.000	100.0	V	61.0	15.7
	749.995000	25.84	46.00	20.16	1000.0	120.000	105.0	H	86.0	25.8
1/ch37 2/ch39	30.615000	32.79	40.00	7.21	1000.0	120.000	400.0	V	224.0	16.4
	98.475000	22.42	43.50	21.08	1000.0	120.000	108.0	V	52.0	12.6
	249.995000	26.28	46.00	19.72	1000.0	120.000	127.0	H	106.0	15.7
	947.575000	20.87	46.00	25.13	1000.0	120.000	173.0	V	36.0	27.8

Table 6: Peak results above 1GHz, both transmitters operate, data rate 1200kbps

Modem/channel	Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1/ch0 2/ch75	1768.775000	54.20	-20dBc	43.67	1000.0	1000.000	248.0	V	30.0	18.0
	2388.800000	62.74	74.00	11.26	1000.0	1000.000	312.0	H	311.0	20.1
	2397.200000	61.25	-20dBc	36.62	1000.0	1000.000	334.0	V	0.0	20.2
	2402.600000	117.87	N/A Tx	---	1000.0	1000.000	253.0	H	315.0	20.2
	2477.500000	118.78	N/A Tx	---	1000.0	1000.000	291.0	H	47.0	20.2
	2483.700000	63.04	74.00	10.96	1000.0	1000.000	314.0	V	267.0	20.2
	2552.675000	67.11	-20dBc	30.76	1000.0	1000.000	272.0	H	39.0	20.2
	19821.025000	65.21	74.00	8.79	1000.0	1000.000	172.0	V	222.0	5.7
1/ch75 2/ch0	2327.525000	57.90	74.00	16.10	1000.0	1000.000	235.0	H	344.0	19.7
	2388.800000	56.06	74.00	17.94	1000.0	1000.000	193.0	V	191.0	20.1
	2400.000000	74.42	-20dBc	24.76	1000.0	1000.000	367.0	V	301.0	20.2
	2402.400000	119.18	N/A Tx	---	1000.0	1000.000	277.0	H	44.0	20.2
	2477.700000	116.43	N/A Tx	---	1000.0	1000.000	263.0	H	322.0	20.2
	2483.700000	66.50	74.00	7.50	1000.0	1000.000	235.0	H	324.0	20.2
	19220.425000	65.88	74.00	8.12	1000.0	1000.000	152.0	H	58.0	6.6
1/ch37 2/ch39	7324.775000	53.15	73.90	20.75	1000.0	1000.000	159.0	H	208.0	10.2
	19531.925000	67.28	73.90	6.62	1000.0	1000.000	148.0	V	211.0	6.2

Table 7: Average results above 1GHz, both transmitters operate, data rate 1200kbps

Modem/channel	Frequency (MHz)	CAverag (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1/ch0 2/ch75	2380.000000	44.68	54.00	9.32	1000.0	1000.000	309.0	H	97.0	20.0
	2487.900000	44.85	54.00	9.15	1000.0	1000.000	287.0	H	39.0	20.3
	19819.575000	38.33	54.00	15.67	1000.0	1000.000	153.0	V	218.0	5.7
1/ch75 2/ch0	2327.475000	42.20	54.00	11.80	1000.0	1000.000	235.0	H	344.0	19.7
	2389.400000	43.13	54.00	10.87	1000.0	1000.000	125.0	H	227.0	20.1
	2487.900000	43.57	54.00	10.43	1000.0	1000.000	238.0	H	321.0	20.3
	19220.175000	39.34	54.00	14.66	1000.0	1000.000	134.0	V	205.0	6.6
1/ch37 2/ch39	2287.925000	31.46	53.90	22.44	1000.0	1000.000	190.0	H	281.0	4.2
	7324.725000	31.01	53.90	22.89	1000.0	1000.000	172.0	H	210.0	10.2
	19531.675000	39.43	53.90	14.47	1000.0	1000.000	153.0	V	211.0	6.2

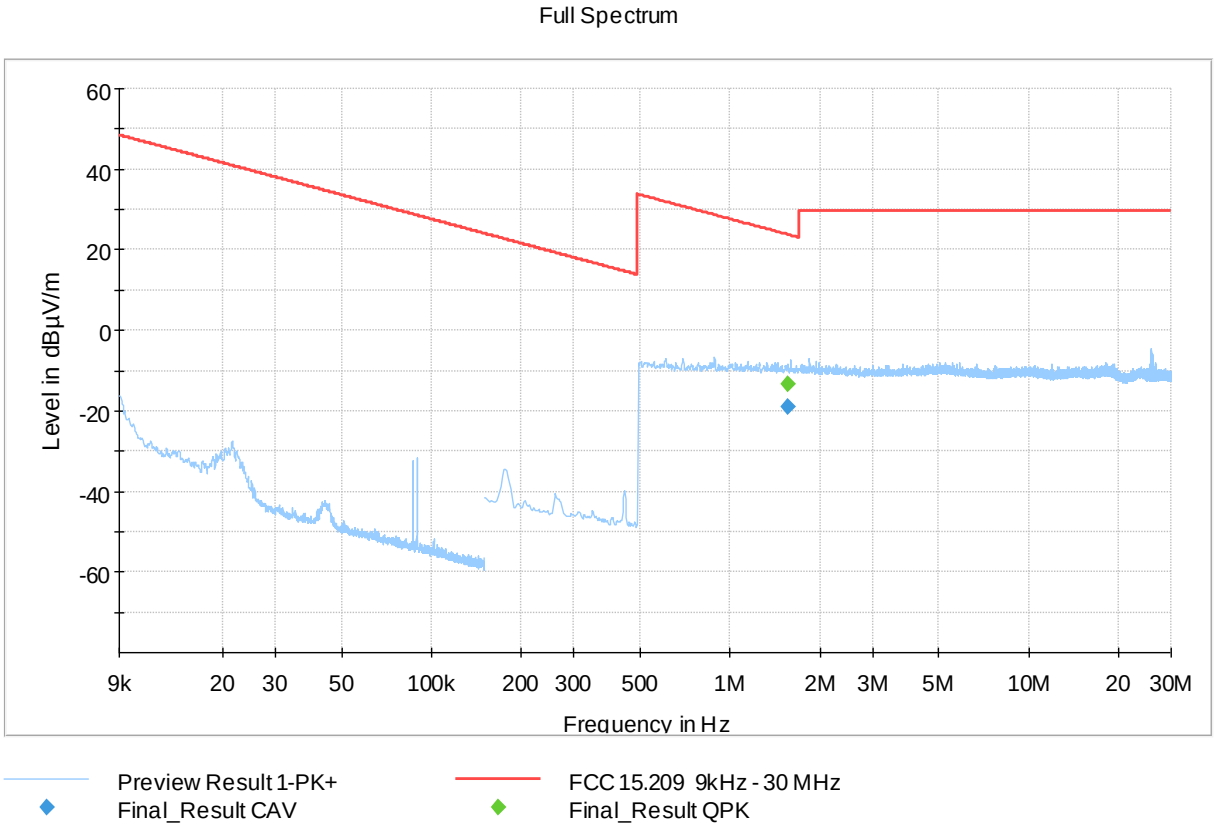


Figure 3: 9 kHz – 30 MHz, modem1/channel37, modem2/channel39

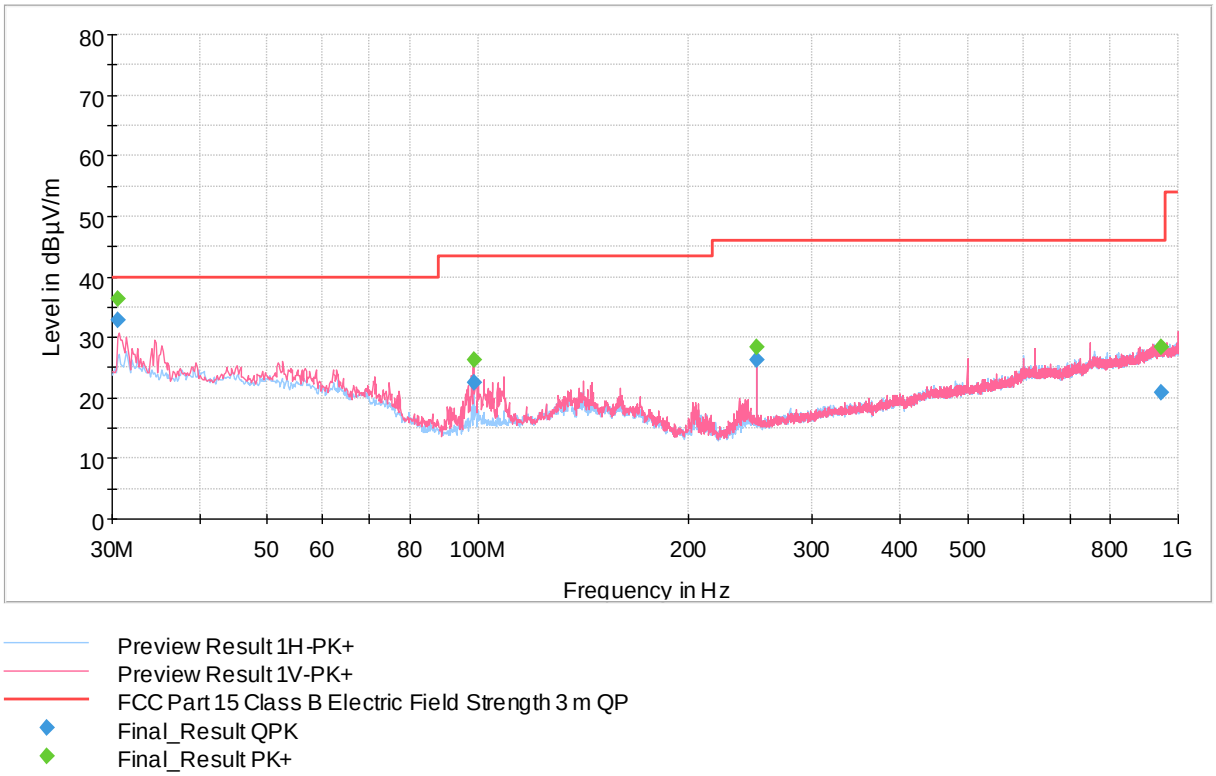


Figure 4: 30 MHz – 1000 MHz, modem1/channel37, modem2/channel39

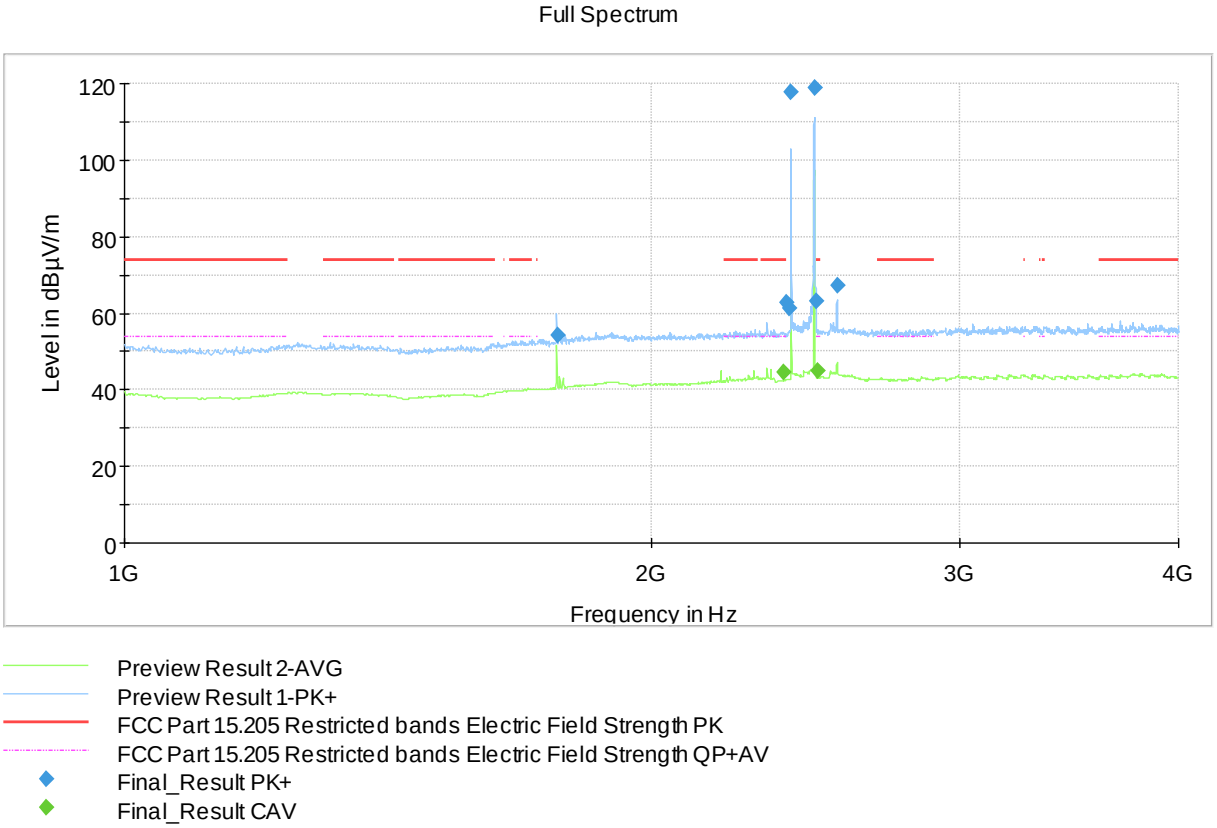


Figure 5: 1 GHz – 4 GHz, modem1/channel0, modem2/channel75

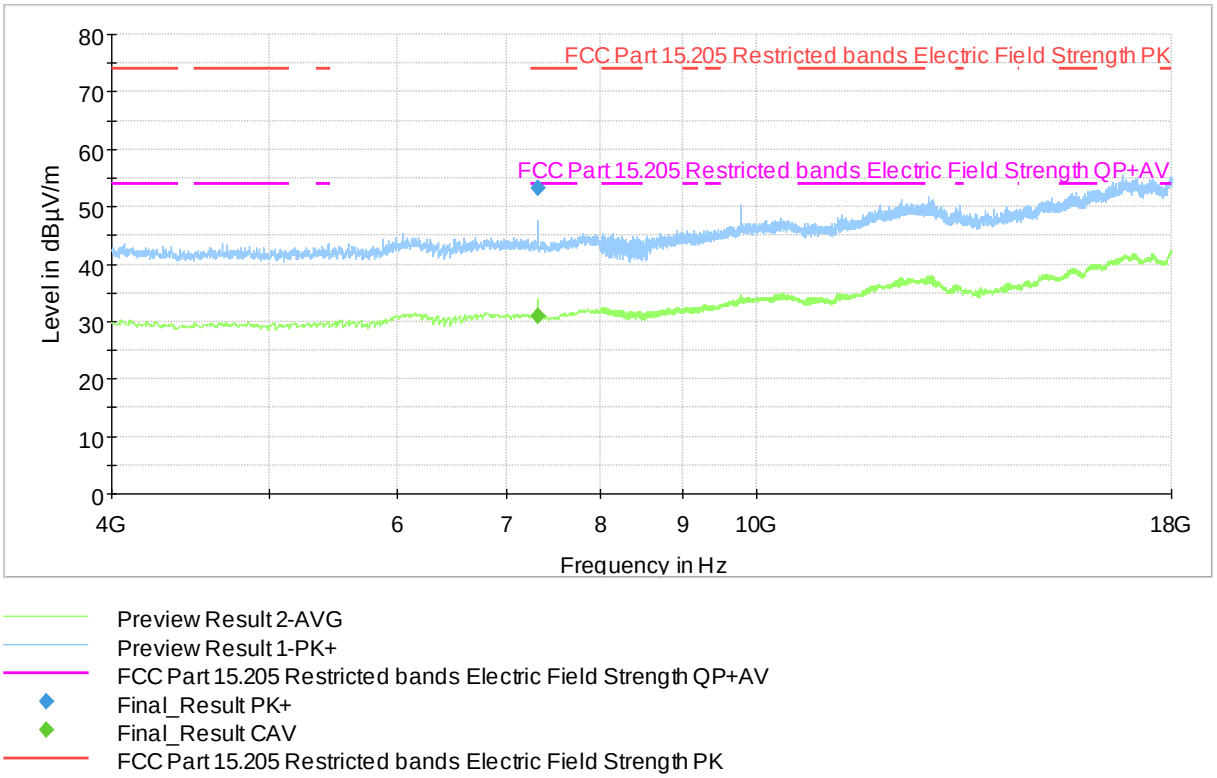


Figure 6: 4 GHz – 18 GHz, modem1/channel37, modem2/channel39

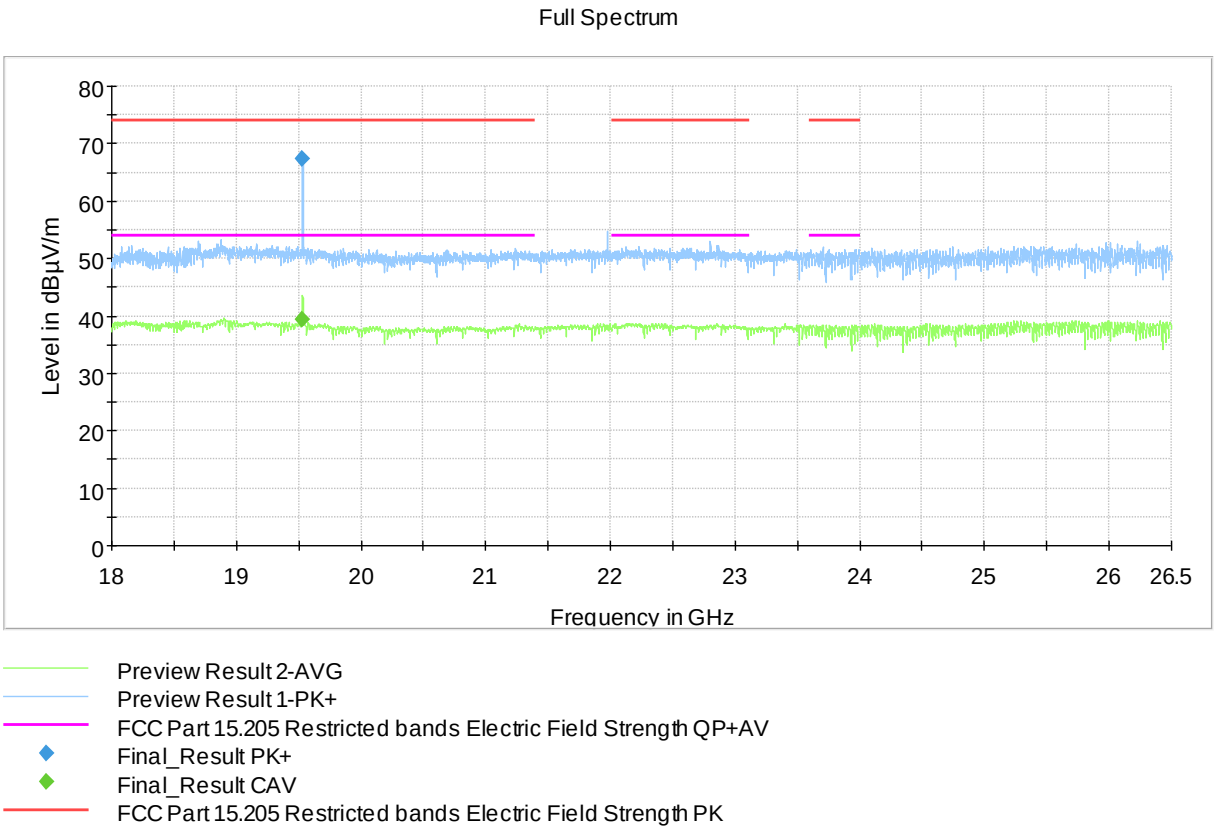


Figure 7: 18 GHz – 26.5 GHz, modem1/channel37, modem2/channel39

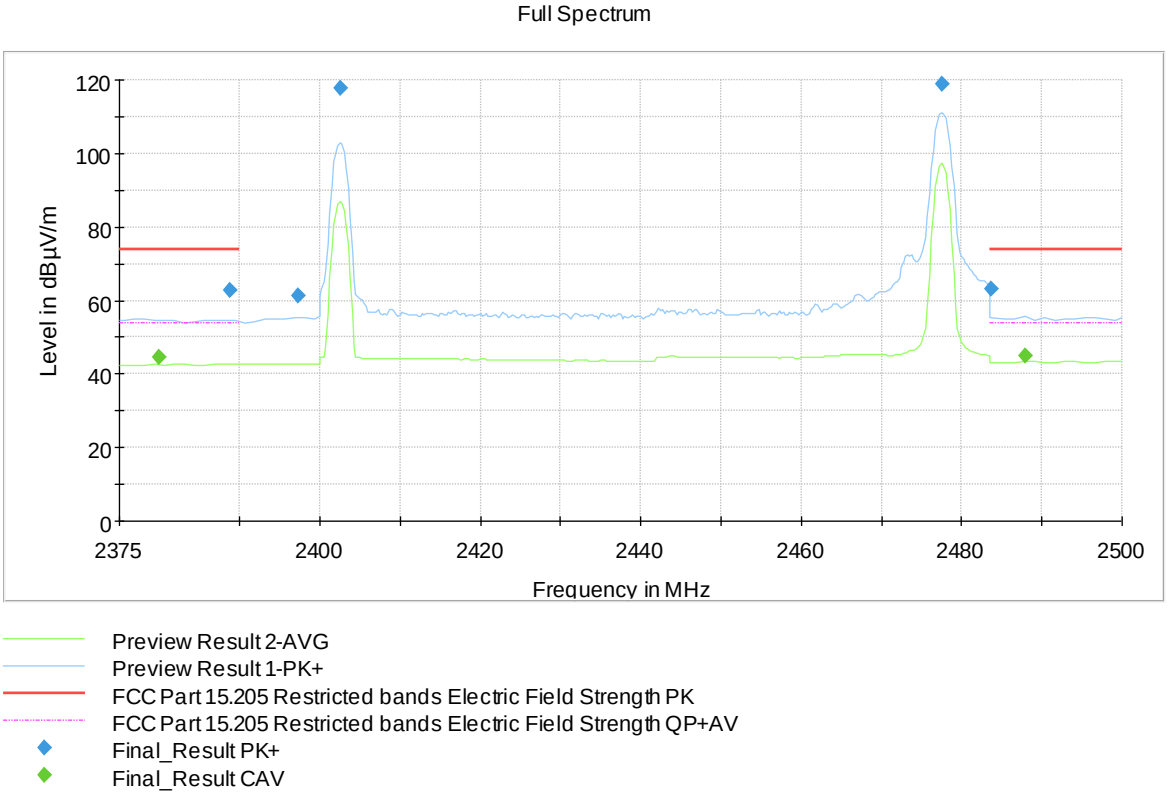


Figure 8: Radiated lower and upper band edge, modem1/ch0 modem2/ch75

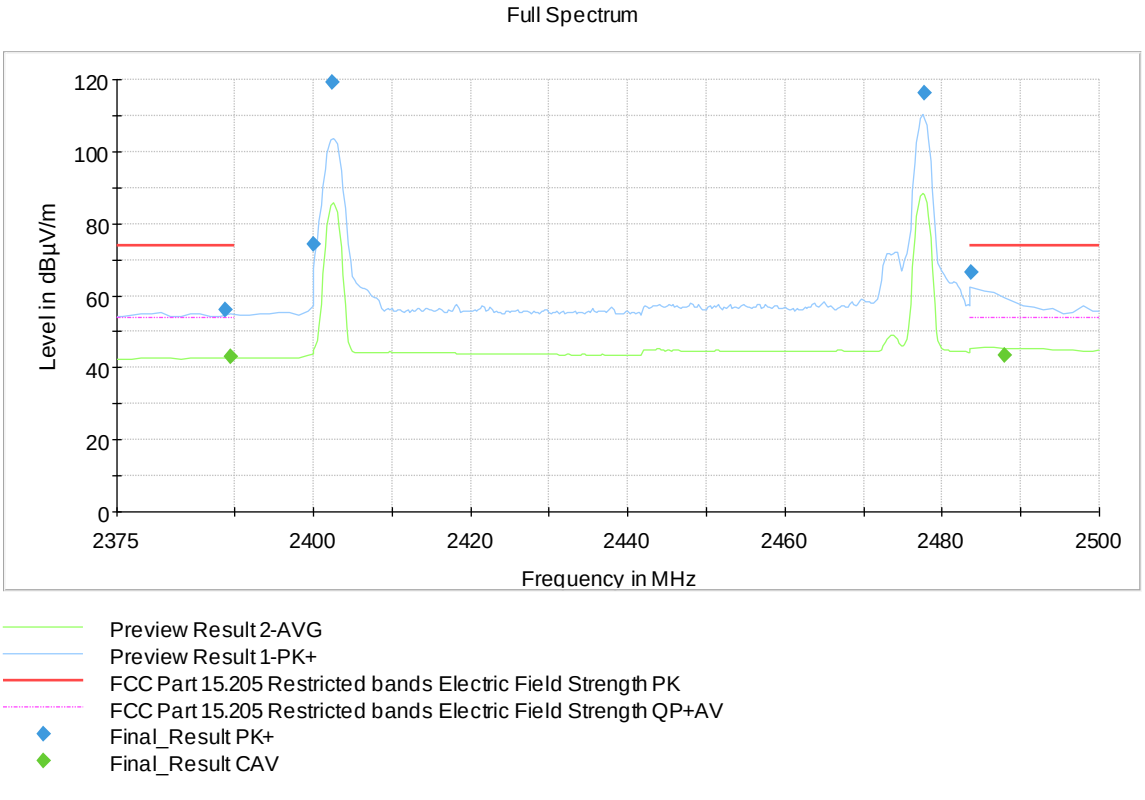


Figure 9: Radiated lower and upper band edge, modem1/ch75 modem2/ch0

Transmitter Band Edge Measurement, Conducted Spurious Emission

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	JAT
Date:	6 August 2019	25 June 2020
Temperature:	23 ± 3 °C	23 ± 3 °C
Humidity:	20 - 60 % RH	20 - 60 % RH
Measurement uncertainty:	± 2.87 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

RSS-247 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. 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 limits specified in Section 15.209(a) (see Section 15.205(c)).

Table 8: Band edge attenuation, On channel mode

Modem/Datarate	Band Edge Attenuation	
	Lower Band Edge dBc	Upper Band Edge dBc
1/1200	-54.0	-55.2
1/2400	-53.4	-54.8
2/1200	-53.6	-58.3
2/2400	-55.3	-55.2
	Limit: -20 dBc	

Table 9: Band edge attenuation, Hopping mode

Modem/Datarate	Band Edge Attenuation	
	Lower Band Edge dBc	Upper Band Edge dBc
1/1200	-55.8	-56.2
1/2400	-57.2	-56.8
2/1200	-56.2	-55.3
2/2400	-55.9	-54.8
	Limit: -20 dBc	

Result

DUT Frequency (MHz)	Result
2402.500000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2402.625000	15.7

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.675000	-37.7	33.4	-4.3	PASS
2399.725000	-37.8	33.5	-4.3	PASS
2399.575000	-38.5	34.2	-4.3	PASS
2399.875000	-38.5	34.2	-4.3	PASS
2399.525000	-38.6	34.3	-4.3	PASS
2399.925000	-38.6	34.3	-4.3	PASS
2399.975000	-38.7	34.4	-4.3	PASS
2399.625000	-39.2	34.9	-4.3	PASS
2399.275000	-39.3	35.0	-4.3	PASS
2397.125000	-39.3	35.0	-4.3	PASS
2397.175000	-39.3	35.0	-4.3	PASS
2399.225000	-39.4	35.1	-4.3	PASS
2399.825000	-39.5	35.2	-4.3	PASS
2397.375000	-39.5	35.2	-4.3	PASS
2398.575000	-39.5	35.2	-4.3	PASS

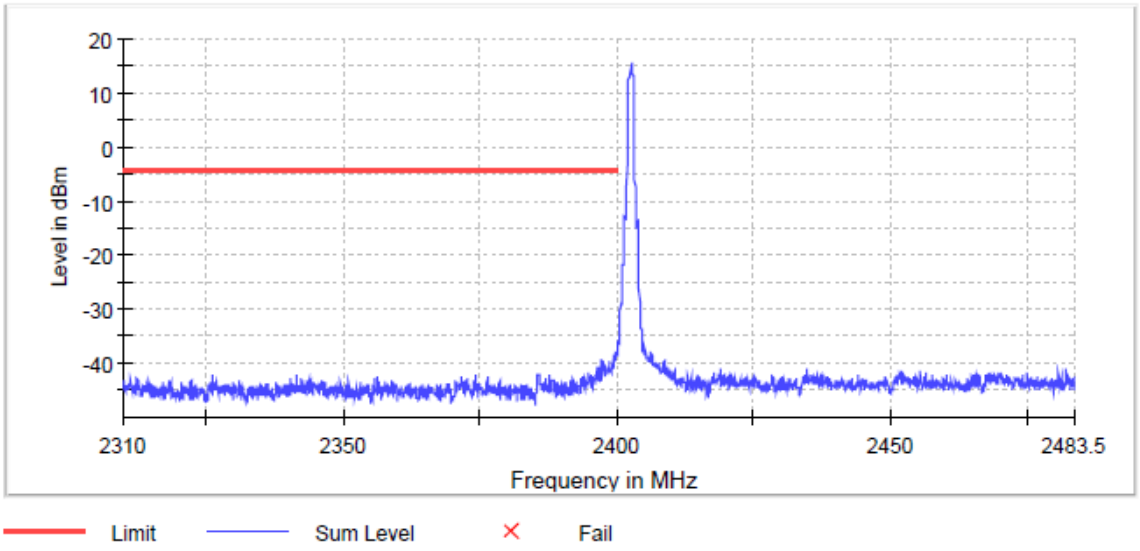


Figure 10: Lower Band Edge, modem1, 2400kbps, channel0

Reported result = Inband Peak – maximum from Measurements = 15.7 - (-37.7) = 53.4 (-dBc)

Measurement 1

Setting	Instrument Value	Target Value
Start Frequency	2.31000 GHz	2.31000 GHz
Stop Frequency	2.40000 GHz	2.40000 GHz
Span	90.000 MHz	90.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1800	~ 1800
Sweeptime	113.672 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Measurement 2

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	94.727 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	16 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Table 10: Measurement settings, lower band edge

Result

DUT Frequency (MHz)	Result
2477.500000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2477.625000	14.9

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2485.925000	-39.9	34.8	-5.1	PASS
2485.975000	-40.4	35.3	-5.1	PASS
2485.875000	-40.6	35.5	-5.1	PASS
2483.725000	-40.8	35.7	-5.1	PASS
2484.275000	-40.9	35.8	-5.1	PASS
2486.225000	-41.1	36.0	-5.1	PASS
2488.125000	-41.2	36.0	-5.1	PASS
2484.225000	-41.2	36.1	-5.1	PASS
2483.775000	-41.2	36.1	-5.1	PASS
2483.875000	-41.2	36.1	-5.1	PASS
2486.325000	-41.3	36.1	-5.1	PASS
2488.175000	-41.3	36.2	-5.1	PASS
2491.225000	-41.4	36.3	-5.1	PASS
2484.925000	-41.4	36.3	-5.1	PASS
2489.925000	-41.5	36.4	-5.1	PASS

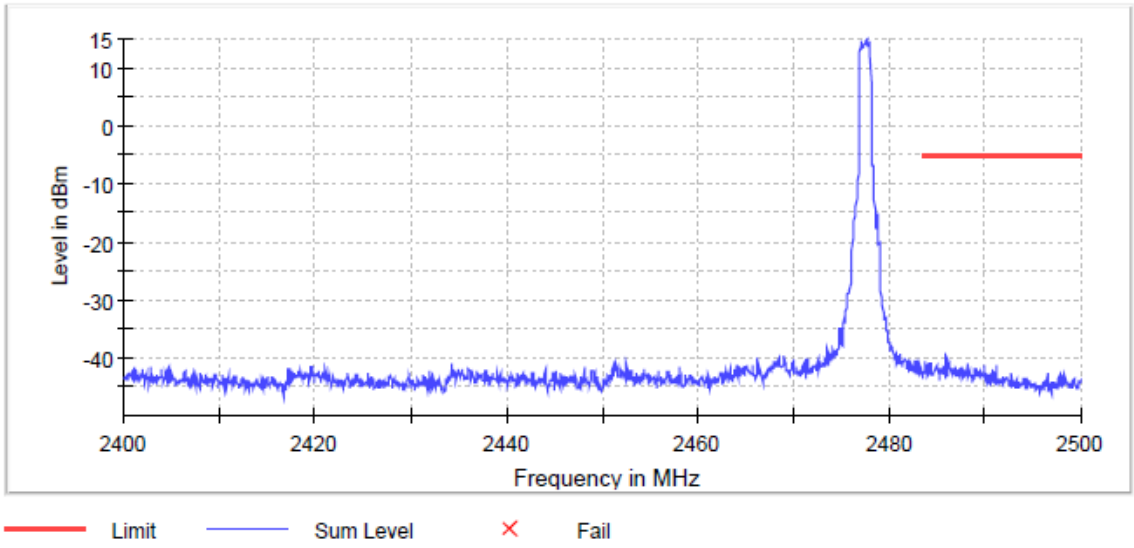


Figure 11: Upper Band Edge, modem1, 2400kbps, channel75

Measurement 1

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	94.727 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	12 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.15 dB	0.50 dB

Measurement 2

Setting	Instrument Value	Target Value
Start Frequency	2.48350 GHz	2.48350 GHz
Stop Frequency	2.50000 GHz	2.50000 GHz
Span	16.500 MHz	16.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	330	~ 330
Sweeptime	18.945 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Table 11: Measurement settings, upper band edge

Result

DUT Frequency (MHz)	Result
hopping	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2475.575000	15.0

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.625000	-40.9	35.8	-5.0	PASS
2399.675000	-40.9	35.9	-5.0	PASS
2391.975000	-41.9	36.9	-5.0	PASS
2386.425000	-42.1	37.1	-5.0	PASS
2350.725000	-42.2	37.1	-5.0	PASS
2372.925000	-42.2	37.2	-5.0	PASS
2386.475000	-42.3	37.3	-5.0	PASS
2340.975000	-42.3	37.3	-5.0	PASS
2310.325000	-42.3	37.3	-5.0	PASS
2369.275000	-42.4	37.4	-5.0	PASS
2377.225000	-42.5	37.4	-5.0	PASS
2399.425000	-42.5	37.4	-5.0	PASS
2364.825000	-42.5	37.5	-5.0	PASS
2380.625000	-42.5	37.5	-5.0	PASS
2392.025000	-42.6	37.5	-5.0	PASS

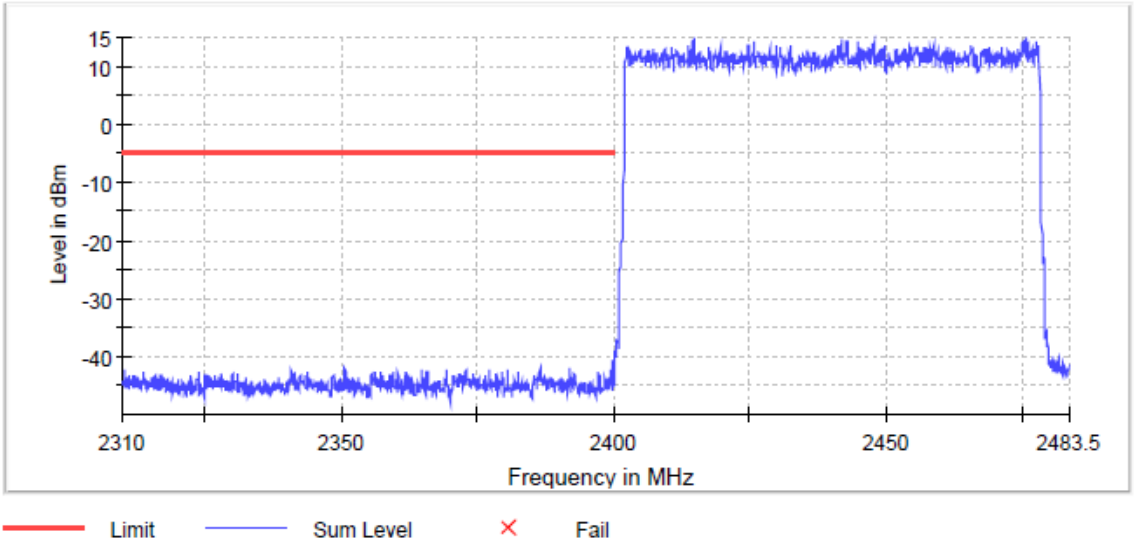


Figure 12: Lower Band Edge, modem2, 2400kbps, hopping mode

Measurement 1

Setting	Instrument Value	Target Value
Start Frequency	2.31000 GHz	2.31000 GHz
Stop Frequency	2.40000 GHz	2.40000 GHz
Span	90.000 MHz	90.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1800	~ 1800
Sweeptime	113.672 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Measurement 2

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	94.727 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	132 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Table 12: Measurement settings, lower band edge, hopping mode

Result

DUT Frequency (MHz)	Result
hopping	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2408.625000	14.9

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2484.375000	-39.9	34.9	-5.1	PASS
2484.425000	-40.2	35.1	-5.1	PASS
2485.125000	-40.4	35.3	-5.1	PASS
2485.175000	-40.4	35.3	-5.1	PASS
2484.325000	-41.3	36.2	-5.1	PASS
2483.875000	-41.4	36.3	-5.1	PASS
2484.075000	-41.5	36.4	-5.1	PASS
2483.825000	-41.5	36.4	-5.1	PASS
2488.225000	-41.6	36.5	-5.1	PASS
2485.925000	-41.6	36.5	-5.1	PASS
2485.875000	-41.7	36.6	-5.1	PASS
2489.225000	-41.8	36.7	-5.1	PASS
2488.275000	-41.8	36.7	-5.1	PASS
2484.025000	-41.9	36.8	-5.1	PASS
2486.525000	-41.9	36.8	-5.1	PASS

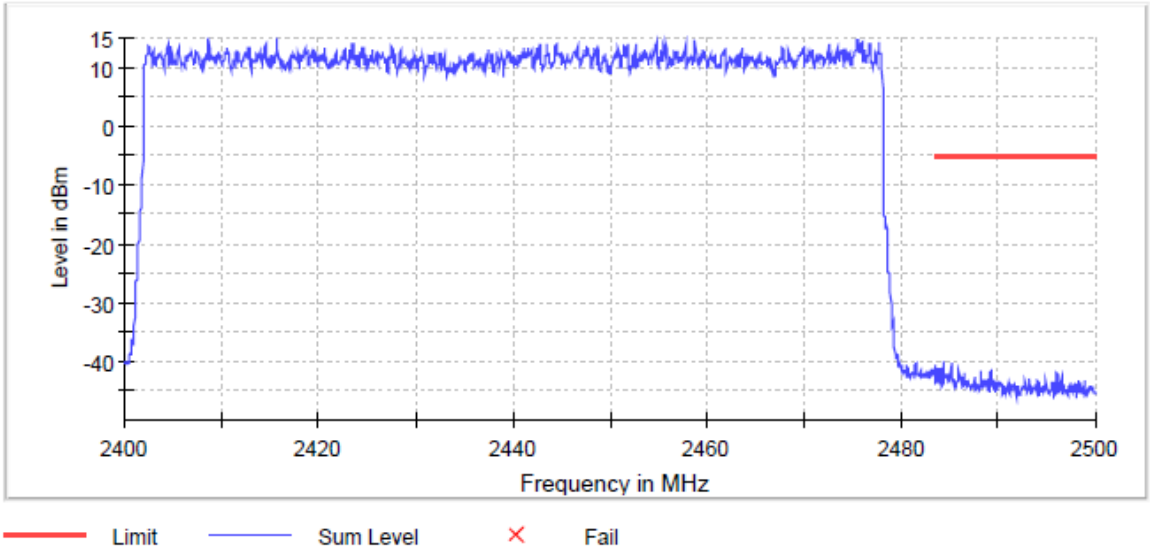


Figure 13: Upper band edge results, modem2, 2400kbps, hopping mode

Measurement 1

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	94.727 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	136 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Measurement 2

Setting	Instrument Value	Target Value
Start Frequency	2.48350 GHz	2.48350 GHz
Stop Frequency	2.50000 GHz	2.50000 GHz
Span	16.500 MHz	16.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	330	~ 330
Sweeptime	18.945 µs	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Table 13: Measurement settings, upper band edge

Conducted spurious emissions results LOW channel

Table 14: Pre measurements, conducted spurious emissions LOW channel 0, Modem 1, 1200kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2398.629887	-39.7	34.3	-5.5
2398.555826	-40.2	34.7	-5.5
2399.074248	-40.2	34.8	-5.5
2399.148308	-40.4	34.9	-5.5
2399.444549	-40.8	35.3	-5.5
2399.962970	-41.1	35.6	-5.5
2399.296428	-41.3	35.9	-5.5
2399.518609	-41.4	35.9	-5.5
2399.740789	-41.4	35.9	-5.5
2399.370488	-41.6	36.1	-5.5
2399.666729	-41.6	36.1	-5.5
2399.222368	-41.7	36.3	-5.5
2399.592669	-41.7	36.3	-5.5
2399.814850	-41.8	36.3	-5.5
2398.259586	-42.1	36.6	-5.5

Table 15: Pre measurements, conducted spurious emissions LOW channel 0, Modem 1, 2400kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25833.552475	-34.7	28.1	-6.6
25902.630035	-35.3	28.7	-6.6
20150.820857	-35.3	28.7	-6.6
25863.682049	-35.3	28.8	-6.6
17871.261375	-35.4	28.8	-6.6
25857.803108	-35.5	28.9	-6.6
25901.160300	-35.5	28.9	-6.6
25890.137285	-35.5	29.0	-6.6
25890.872152	-35.6	29.0	-6.6
25882.053741	-35.6	29.1	-6.6
25834.287343	-35.6	29.1	-6.6
25898.955697	-35.6	29.1	-6.6
18174.026851	-35.7	29.1	-6.6
18179.905792	-35.7	29.1	-6.6
25918.062256	-35.7	29.1	-6.6

Table 16: Pre measurements, conducted spurious emissions LOW channel 0, Modem 2, 1200kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25851.924166	-34.8	28.0	-6.8
25882.788608	-34.9	28.1	-6.8
25820.324857	-35.2	28.4	-6.8
25917.327388	-35.2	28.4	-6.8
25905.569506	-35.3	28.5	-6.8
19846.585646	-35.4	28.5	-6.8
25915.122785	-35.4	28.6	-6.8
25868.826123	-35.5	28.7	-6.8
25906.304373	-35.6	28.7	-6.8
25912.183315	-35.6	28.8	-6.8
25857.068240	-35.6	28.8	-6.8
25901.160300	-35.7	28.9	-6.8
25867.356387	-35.8	29.0	-6.8
25863.682049	-35.8	29.0	-6.8
25866.621520	-35.8	29.0	-6.8

Table 17: Pre measurements, conducted spurious emissions LOW channel 0, Modem 2, 2400kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25864.416917	-35.3	28.1	-7.2
25876.174799	-35.5	28.3	-7.2
25925.410932	-35.5	28.3	-7.2
25888.667549	-35.5	28.3	-7.2
25954.070771	-35.5	28.4	-7.2
25865.151784	-35.5	28.4	-7.2
25889.402417	-35.6	28.4	-7.2
25646.161222	-35.6	28.4	-7.2
25884.993211	-35.7	28.5	-7.2
25916.592521	-35.8	28.6	-7.2
25816.650519	-35.8	28.6	-7.2
18157.124895	-35.8	28.6	-7.2
25858.537975	-35.8	28.6	-7.2
20239.739844	-35.8	28.6	-7.2
25855.598505	-35.9	28.7	-7.2

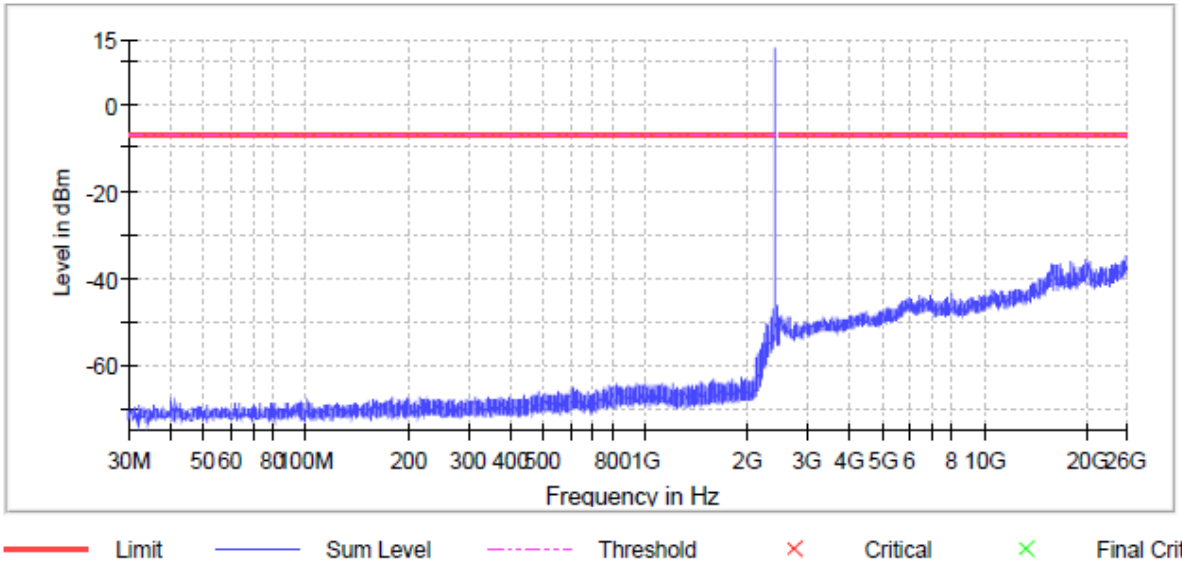


Figure 14: Conducted spurious emissions 30 - 26500 MHz LOW channel 0, Modem 2, 1200kbps

Table 18: Final measurements, conducted spurious emissions LOW channel 0, Modem 2, 1200kbps

No final measurements were made; no emissions near the limit (marginal >20dB).

Table 19: Measurement settings, conducted spurious emissions LOW channel

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	32001	~ 47400
Sweeptime	32.100 ms	AUTO
Reference Level	-10.000 dBm	-30.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	30	30
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	1.00 dB	1.00 dB
Run	8 / max. 40	max. 40
Stable	1 / 1	1
Max Stable Difference	0.44 dB	1.00 dB

Conducted spurious emissions results MID channel 37

Table 20: Pre measurements, conducted spurious emissions MID channel 37, Modem 1, 1200kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
20242.679315	-34.3	29.3	-5.1
25809.301842	-35.1	30.0	-5.1
25855.598505	-35.2	30.1	-5.1
25854.863637	-35.2	30.1	-5.1
24685.689189	-35.2	30.1	-5.1
25933.494477	-35.3	30.2	-5.1
25915.122785	-35.3	30.2	-5.1
25900.425432	-35.3	30.2	-5.1
25829.143269	-35.5	30.4	-5.1
25875.439932	-35.6	30.5	-5.1
25845.310357	-35.7	30.6	-5.1
25881.318873	-35.7	30.6	-5.1
25938.638550	-35.7	30.6	-5.1
25852.659034	-35.8	30.7	-5.1
25898.955697	-35.8	30.7	-5.1

Table 21: Pre measurements, conducted spurious emissions MID channel 37, Modem 1, 2400kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25904.834638	-34.4	28.2	-6.2
25921.736594	-34.6	28.3	-6.2
25865.886652	-35.2	28.9	-6.2
25885.728079	-35.3	29.1	-6.2
20243.414182	-35.4	29.1	-6.2
25897.485961	-35.4	29.1	-6.2
25524.908058	-35.4	29.2	-6.2
25933.494477	-35.4	29.2	-6.2
25934.229344	-35.5	29.3	-6.2
25820.324857	-35.5	29.3	-6.2
25846.045225	-35.6	29.3	-6.2
25895.281358	-35.7	29.4	-6.2
24219.048225	-35.7	29.4	-6.2
25912.918182	-35.7	29.4	-6.2
25909.243844	-35.7	29.5	-6.2

Table 22: Pre measurements, conducted spurious emissions MID channel 37, Modem 2, 1200kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25896.751094	-44.0	37.0	-6.9
25871.030726	-44.8	37.9	-6.9
25909.978712	-45.0	38.1	-6.9
25909.243844	-45.1	38.1	-6.9
20019.279546	-45.1	38.2	-6.9
25912.183315	-45.2	38.3	-6.9
25860.742578	-45.3	38.3	-6.9
25771.088724	-45.3	38.4	-6.9
25946.722095	-45.3	38.4	-6.9
25870.295858	-45.3	38.4	-6.9
19469.598536	-45.4	38.4	-6.9
25616.766515	-45.4	38.4	-6.9
25911.448447	-45.4	38.5	-6.9
25943.782624	-45.4	38.5	-6.9
25921.001727	-45.4	38.5	-6.9

Table 23: Pre measurements, conducted spurious emissions MID channel 37, Modem 2, 2400kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25896.751094	-34.8	28.4	-6.5
25970.972727	-35.1	28.7	-6.5
25895.281358	-35.2	28.7	-6.5
25876.174799	-35.2	28.7	-6.5
25861.477446	-35.2	28.8	-6.5
25823.264328	-35.3	28.9	-6.5
25854.863637	-35.4	28.9	-6.5
25884.258343	-35.4	29.0	-6.5
20139.797842	-35.4	29.0	-6.5
25931.289874	-35.5	29.0	-6.5
25338.986539	-35.5	29.1	-6.5
25907.039241	-35.6	29.1	-6.5
25862.947181	-35.6	29.1	-6.5
25916.592521	-35.6	29.1	-6.5
25883.523476	-35.7	29.2	-6.5

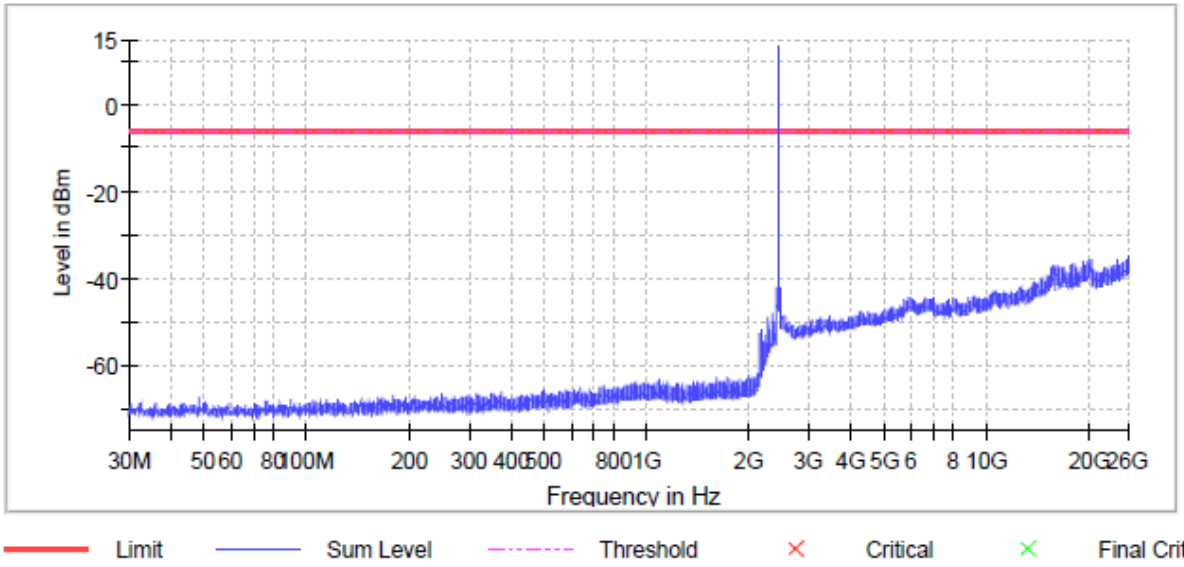


Figure 15: Conducted spurious emissions 30 - 26500 MHz MID channel 37, Modem 1, 2400kbps

Table 24: Final measurements, conducted spurious emissions MID channel 37, Modem 1, 2400kbps

No final measurements were made; no emissions near the limit (marginal >20dB).

Table 25: Measurement settings, conducted spurious emissions MID channel 37

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	32001	~ 47400
Sweeptime	32.100 ms	AUTO
Reference Level	-10.000 dBm	-30.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	30	30
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	1.00 dB	1.00 dB
Run	23 / max. 40	max. 40
Stable	1 / 1	1
Max Stable Difference	0.00 dB	1.00 dB

Conducted spurious emissions results HIGH channel

Table 26: Pre measurements, conducted spurious emissions HIGH channel 75, Modem 1, 1200kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25890.137285	-35.0	28.3	-6.8
25876.174799	-35.0	28.3	-6.8
25943.782624	-35.1	28.3	-6.8
25901.895167	-35.1	28.4	-6.8
25866.621520	-35.5	28.7	-6.8
25918.062256	-35.5	28.8	-6.8
25718.913120	-35.5	28.8	-6.8
25910.713579	-35.6	28.8	-6.8
25887.932682	-35.7	28.9	-6.8
25896.751094	-35.7	29.0	-6.8
25879.849138	-35.7	29.0	-6.8
25854.128769	-35.7	29.0	-6.8
25872.500461	-35.8	29.0	-6.8
25977.586536	-35.8	29.0	-6.8
20132.449166	-35.8	29.1	-6.8

Table 27: Pre measurements, conducted spurious emissions HIGH channel 75, Modem 1, 2400kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25916.592521	-34.1	28.1	-6.0
25919.531991	-34.9	29.0	-6.0
25846.780093	-35.5	29.6	-6.0
20126.570224	-35.6	29.7	-6.0
25884.993211	-35.6	29.7	-6.0
25890.137285	-35.7	29.7	-6.0
25860.742578	-35.7	29.7	-6.0
25885.728079	-35.8	29.8	-6.0
25873.970196	-35.8	29.8	-6.0
25915.122785	-35.8	29.8	-6.0
25964.358918	-35.8	29.8	-6.0
17826.434447	-35.8	29.8	-6.0
25990.814154	-35.8	29.8	-6.0
25902.630035	-35.8	29.9	-6.0
25838.696549	-35.8	29.9	-6.0

Table 28: Pre measurements, conducted spurious emissions HIGH channel 75, Modem 2, 1200kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25923.941197	-34.6	27.4	-7.3
25716.708517	-34.8	27.6	-7.3
25871.030726	-35.0	27.8	-7.3
25922.471462	-35.2	27.9	-7.3
25915.122785	-35.2	28.0	-7.3
25894.546491	-35.2	28.0	-7.3
25861.477446	-35.3	28.0	-7.3
25981.260875	-35.4	28.1	-7.3
25895.281358	-35.5	28.2	-7.3
25840.166284	-35.5	28.2	-7.3
25917.327388	-35.6	28.3	-7.3
25812.241313	-35.6	28.3	-7.3
25876.174799	-35.6	28.4	-7.3
25860.742578	-35.6	28.4	-7.3
25892.341888	-35.7	28.4	-7.3

Table 29: Pre measurements, conducted spurious emissions HIGH channel 75, Modem 2, 2400kbps

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25898.955697	-34.9	29.4	-5.5
25862.212314	-35.1	29.6	-5.5
25934.229344	-35.1	29.7	-5.5
25898.220829	-35.1	29.7	-5.5
25890.137285	-35.2	29.7	-5.5
25909.243844	-35.3	29.8	-5.5
25819.589989	-35.3	29.8	-5.5
25903.364903	-35.3	29.9	-5.5
25860.742578	-35.3	29.9	-5.5
25849.719563	-35.4	29.9	-5.5
25933.494477	-35.4	29.9	-5.5
25923.206329	-35.4	30.0	-5.5
25880.584005	-35.5	30.0	-5.5
25875.439932	-35.5	30.1	-5.5
25776.967665	-35.6	30.1	-5.5

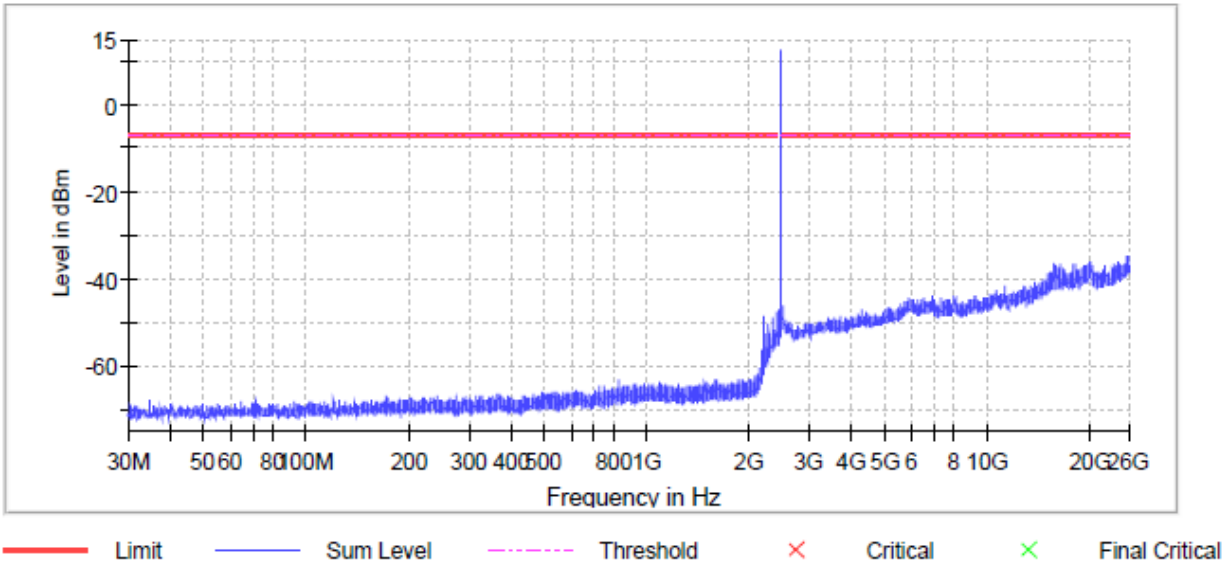


Figure 16: Conducted spurious emissions 30 - 26500 MHz HIGH channel 75, Modem 2, 1200kbps

Table 30: Final measurements, conducted spurious emissions HIGH channel 75, Modem 2, 1200kbps

No final measurements were made; no emissions near the limit (marginal >20dB).

Table 31: Measurement settings, conducted spurious emissions HIGH channel 75

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	32001	~ 47400
Sweeptime	32.100 ms	AUTO
Reference Level	-10.000 dBm	-30.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	30	30
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	1.00 dB	1.00 dB
Run	19 / max. 40	max. 40
Stable	1 / 1	1
Max Stable Difference	0.12 dB	1.00 dB

20 dB Bandwidth of the Hopping Channel

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	6 August 2019	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

FCC Rule: §15.247(a)(1)(iii)
RSS-247 5.1

Results:

Table 32: 20 dB bandwidth test results

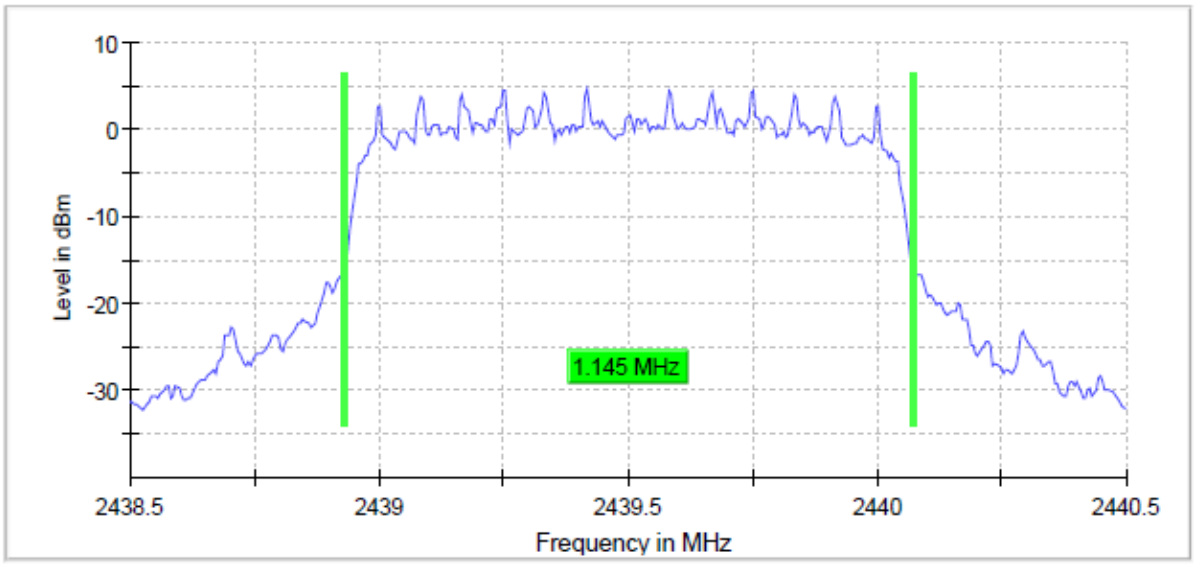
Modem/Datarate	Channel	20 dB BW [MHz]	Minimum limit [MHz]	Result
1/1200	0	1.135000	-	PASS
	37	1.145000		PASS
	75	1.145000		PASS
1/2400	0	1.130000	-	PASS
	37	1.130000		PASS
	75	1.130000		PASS
2/1200	0	1.145000	-	PASS
	37	1.145000		PASS
	75	1.145000		PASS
2/2400	0	1.130000	-	PASS
	37	1.130000		PASS
	75	1.130000		PASS

20 dB Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2439.500000	1.145000	---	---	2438.927500	2440.072500

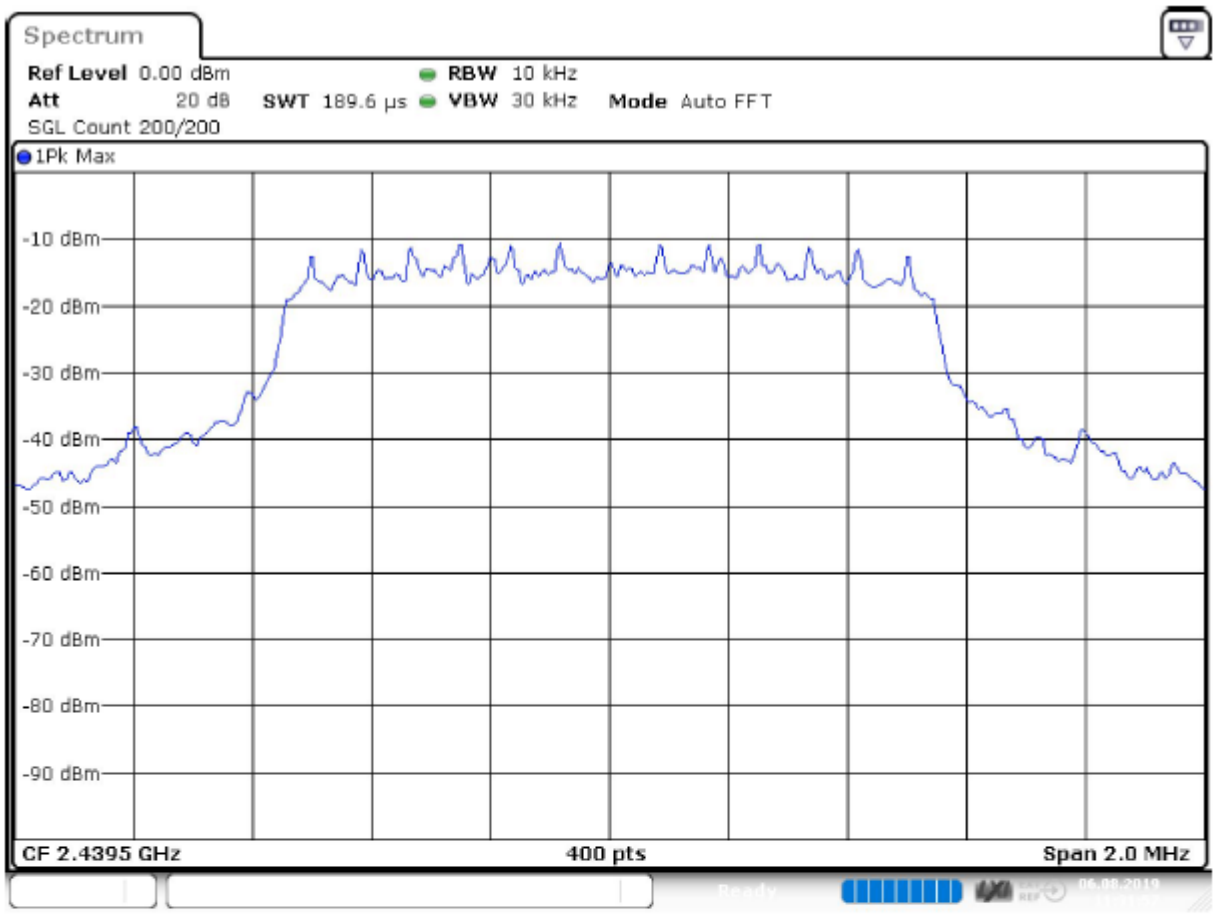
(continuation of the "20 dB Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Max Level (dBm)	Result
2439.500000	4.5	PASS



Bandwidth

Figure 17: 20 dB channel BW, modem2, 1200kbps, channel0



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.43850 GHz	2.43850 GHz
Stop Frequency	2.44050 GHz	2.44050 GHz
Span	2.000 MHz	2.000 MHz
RBW	10.000 kHz	>= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	400	~ 400
Sweeptime	189.648 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	200	200
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	25 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.03 dB	0.50 dB

Table 33: Measurement settings, 20 dB bandwidth

Hopping Channel Carrier Frequencies Separation

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	6 August 2019	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

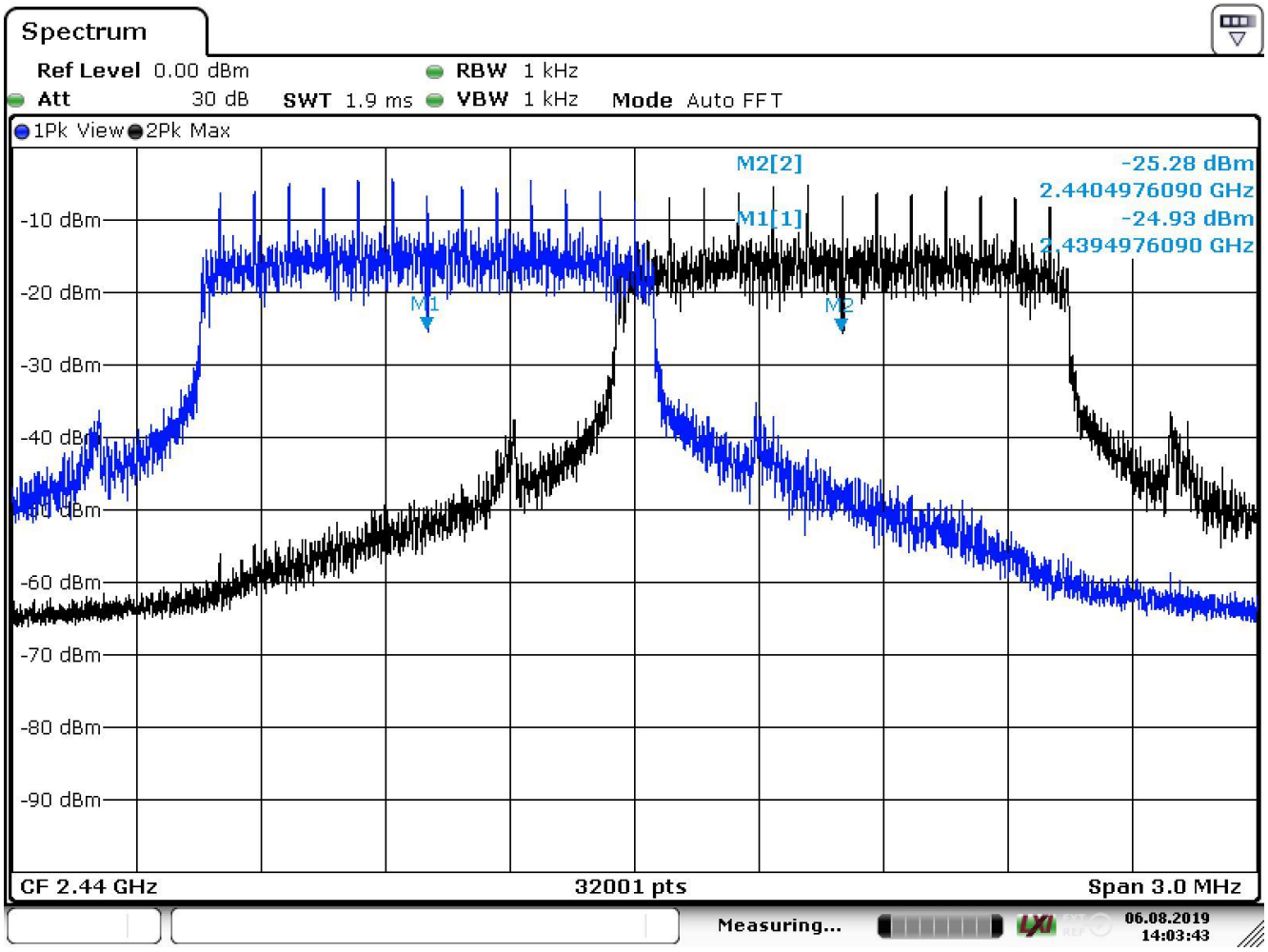
FCC Rule: 15.247(a)(1)
RSS-247 5.1

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test result

Table 34: Hopping channel carrier frequencies separation test result, modem1, 2400kbps

DUT Frequency [MHz]	Center Frequency low Channel (MHz)	Center Frequency high Channel (MHz)	Channel Separation (MHz)	Minimum limit (MHz)	Result
2439.500000	2440.4976090	2439.497090	1.0000000	0.753333	**PASS**



Date: 6.AUG.2019 14:03:43

Figure 18: Measured hopping channels carrier frequency separation, modem1 2400kbps, channel38/channel37

Measurement was made separately for channel0 and channel1 the EUT being in channel mode.

Hopping channel carrier frequencies separation = Freq_ch38 – Freq_ch37
= 2440.4976090-2439.497090=1.0000000 (MHz)

Number of Hopping Channels

Standard:	ANSI C63.10	(2013)
Tested by:	JAT	
Date:	6 August 2019	
Temperature:	23 ± 3 °C	
Humidity:	20 - 60 % RH	

FCC Rule: 15.247(a)(1)(iii)
RSS-247 5.1

For frequency hopping systems operating in the 2400-2483.5 MHz band shall use at least 15 channels.

Test result

Table 35: Number of hopping channels, modem1, CW

Operating frequency [MHz]	Number of channels	Minimum Limit	Result
2402.5 – 2477.5	76	15	PASS

Table 36: Number of hopping channels, mode2, CW

Operating frequency [MHz]	Number of channels	Minimum Limit	Result
2402.5 – 2477.5	76	15	PASS

Number of hopping channels:
(Freq_ch0 – Freq_ch75)/Hopping Channel Carrier Frequencies Separation =2477.5-2402.5=75/1 = 75

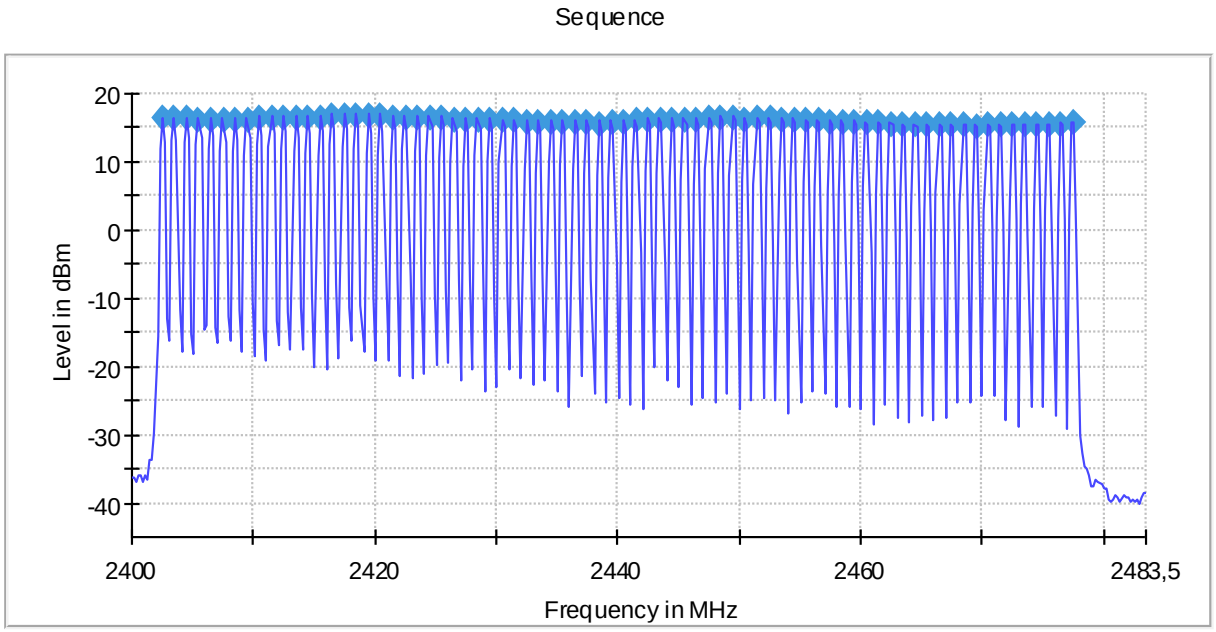


Figure 19: Number of hopping channels, modem1, CW

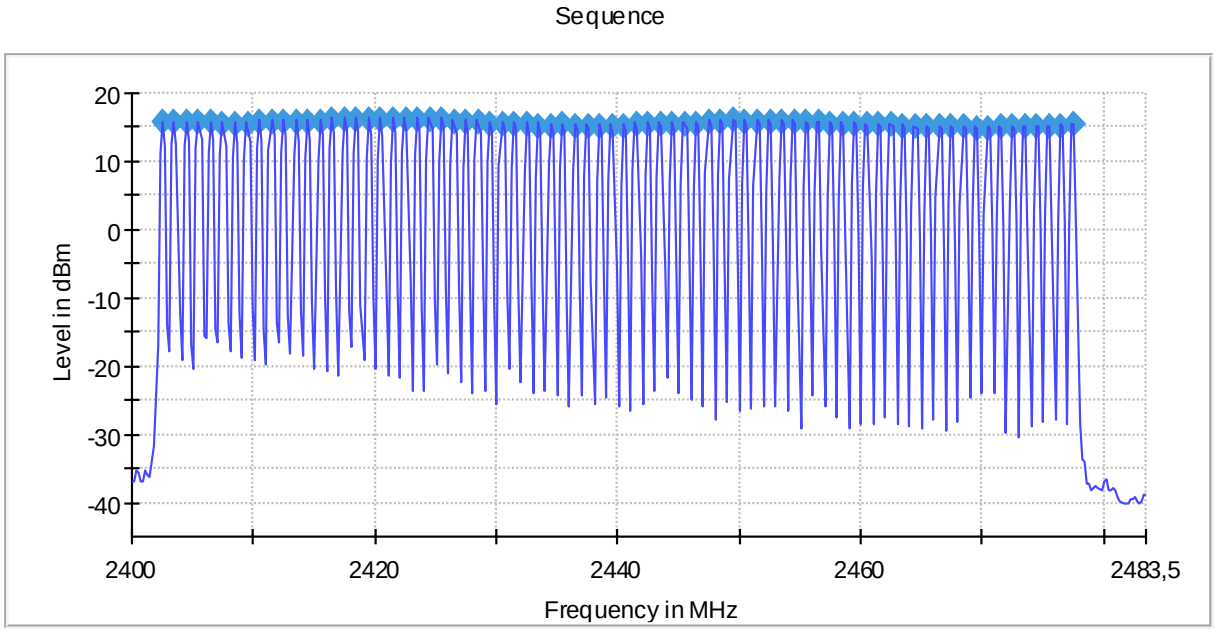


Figure 20: Number of hopping channels, modem2, CW

Table 37: Measurement settings**,** Number of hopping channels

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	200.000 kHz	<= 299.000 kHz
VBW	200.000 kHz	>= 200.000 kHz
SweepPoints	418	~ 418
Sweeptime	47.405 µs	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	95 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Average Time of Occupancy of Hopping Frequency

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	JAT
Date:	6 August 2019	25 June 2020
Temperature:	23 ± 3 °C	23 ± 3 °C
Humidity:	20 - 60 % RH	20 - 60 % RH

FCC Rule: 15.247(a)(1)(iii)
RSS-247 5.1

For frequency hopping systems operating in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test result

Table 38: Result

Modem/Datarate	Channel	Result	Number of Hops	Average time of occupancy (ms)
1/1200	0	PASS	12	226.490
	37	PASS	12	226.550
	75	PASS	12	226.520
1/2400	0	PASS	12	336.260
	37	PASS	12	336.340
	75	PASS	12	336.340
2/1200	0	PASS	12	226.360
	37	PASS	12	226.350
	75	PASS	12	226.430
2/2400	0	PASS	12	336.120
	37	PASS	12	336.360
	75	PASS	12	336.320

Table 39: Period, modem1 2400kbps, channel0

DUT Frequency (MHz)	Min (ms)	Max (ms)	Mean (ms)
2402.5	2530.800	2530.810	2530.804

Table 40: Transmit Time per Hop, modem1 2400kbps, channel0

DUT Frequency (MHz)	Min (ms)	Max (ms)	Limit Max for Max (ms)	Limit Min for Max (ms)	Mean (ms)
2402.5	28.000	28.040	400.000	0.000	28.022

Table 41: Dwell time, modem1 2400kbps, channel0

DUT Frequency (MHz)	Min (ms)	Max (ms)	Mean (ms)
2402.5	30.850	30.870	30.858

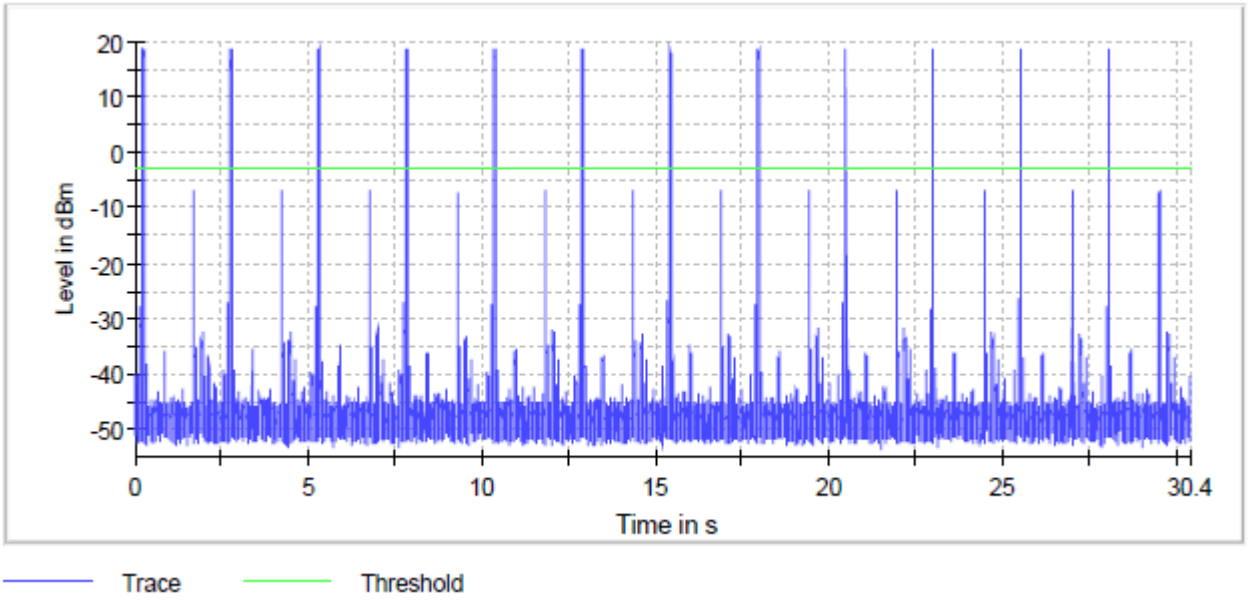


Figure 21: Time of channel occupancy, modem1 2400kbps, channel0

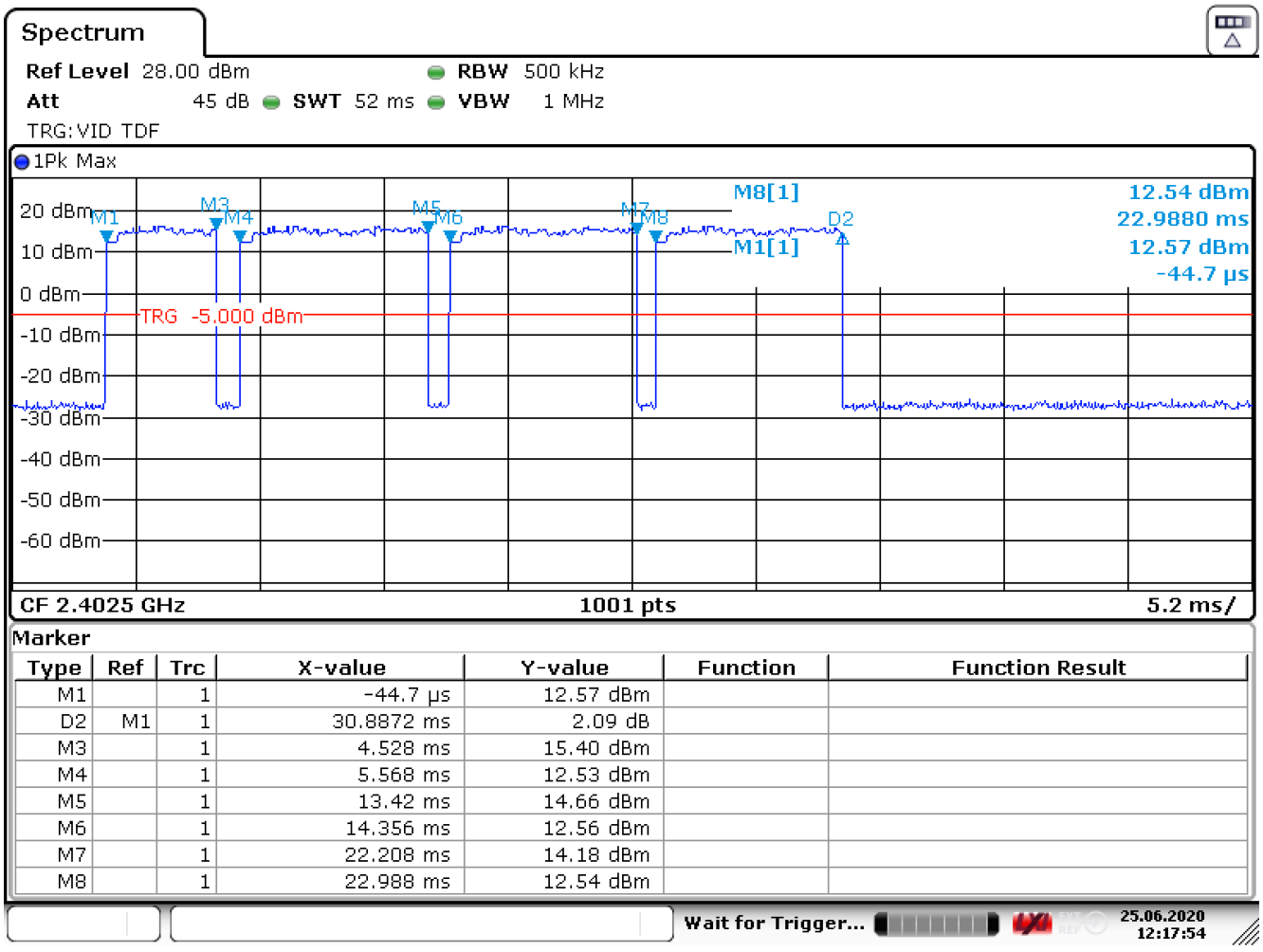


Figure 22: Zero-span trace of dwell time, modem1 2400kbps, channel0

Table 42: Measurement settings, Time of channel occupancy

Measurement

Setting	Instrument Value	Target Value
Center Frequency	2.40250 GHz	2.40250 GHz
Span	ZeroSpan	ZeroSpan
RBW	500.000 kHz	~ 500.000 kHz
VBW	1.000 MHz	~ 1.500 MHz
SweepPoints	30001	~ 30001
Sweeptime	30.400 s	30.400 s
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak
SweepCount	1	1
Filter	Channel	Channel
Trace Mode	Clear Write	Clear Write
Sweeptype	Sweep	AUTO
Preamp	off	off
Trigger	External	External
Trigger Offset	0.000 s	0.000 s

OSP

Setting	Instrument Value	Target Value
Measurement Time	30.400 s	30.400 s
Tracepoints	30399999	30399999
Time resolution	1.000 µs	1.000 µs
Detector	RMS	RMS

99% Occupied Bandwidth

Standard: RSS-GEN (2019)
Tested by: PKA
Date: 6 August 2019
Temperature: 23 ± 3 °C
Humidity: 20 - 60 % RH

RSS-GEN 6.6

Results

Table 43: 99% occupied bandwidth test results

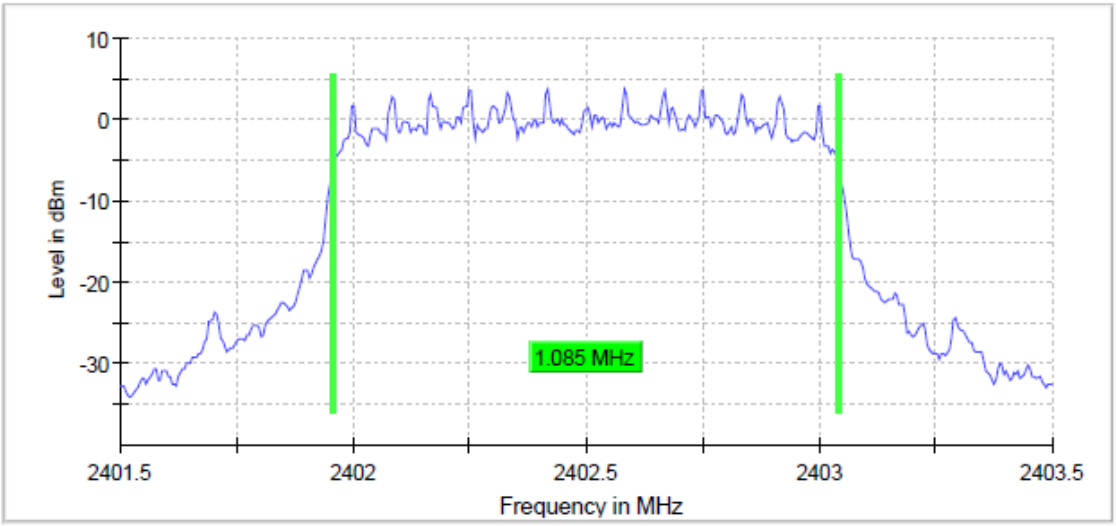
Modem/Datarate	Channel	99% BW [MHz]	Limit	Result
1/1200	0	1.085000	-	PASS
	37	1.085000		PASS
	75	1.085000		PASS
1/2400	0	1.085000	-	PASS
	37	1.085000		PASS
	75	1.080000		PASS
2/1200	0	1.085000	-	PASS
	37	1.085000		PASS
	75	1.080000		PASS
2/2400	0	1.080000	-	PASS
	37	1.080000		PASS
	75	1.080000		PASS

99 % Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)
2402.500000	1.085000	---	---	2401.957500	2403.042500

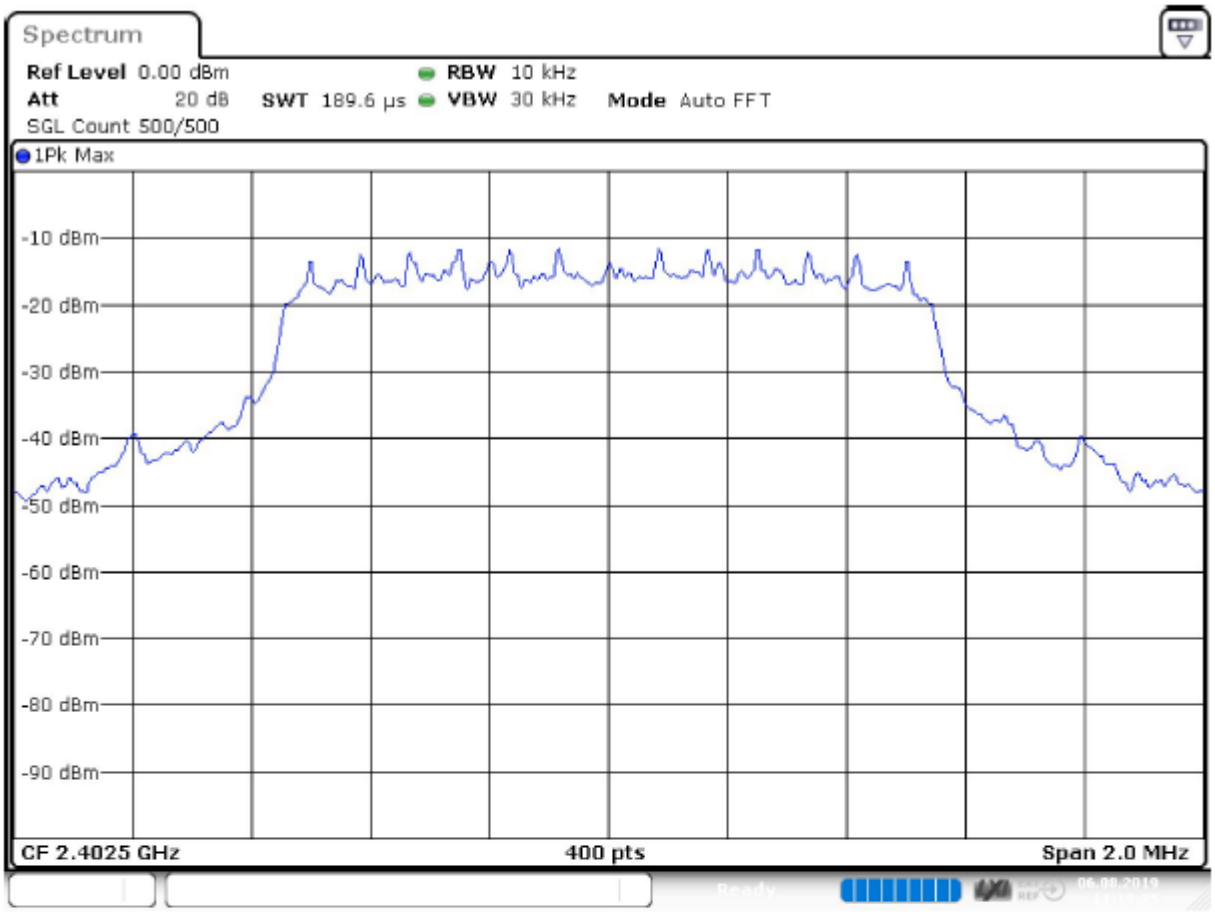
(continuation of the "99 % Bandwidth" table from column 6 ...)

DUT Frequency (MHz)	Result
2402.500000	PASS



Bandwidth

Figure 23: 99% OBW, modem2, 1200kbps, channel0



Measurement

Setting	Instrument Value	Target Value
Start Frequency	2.40150 GHz	2.40150 GHz
Stop Frequency	2.40350 GHz	2.40350 GHz
Span	2.000 MHz	2.000 MHz
RBW	10.000 kHz	>= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	400	~ 400
Sweeptime	189.648 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	500	500
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	20 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.08 dB	0.30 dB

Table 44: Measurements settings, 99% occupied bandwidth

TEST EQUIPMENT

RF-Test Equipment

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
ANTENNA	A.H. SYSTEMS	SAS-200/518	inv:7873	NCR	NCR
SPECTRUM ANALYZER	AGILENT	E7405A	inv:9746	2018-01-08	2020-01-08
RF PREAMPLIFIER	CIAO	CA118-3123	inv:10278	2018-11-26	2019-11-26
RF PREAMPLIFIER	CIAO	CA1840-5019	inv:10593	2018-09-12	2019-09-12
TEMPERATURE/ HUMIDITY METER	DAVIS	VantagePro	inv:5296	2018-09-18	2019-09-18
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH	inv:10517	2018-11-13	2019-11-13
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH	inv:10516	2018-11-13	2019-11-13
ANTENNA	EMCO	3117, 1-18GHz	inv:7293	2018-03-14	2020-03-14
ANTENNA	EMCO	3160-09, 18-26.5GHz	inv:7294	2019-03-11	2020-03-11
ATTENUATOR	PASTERNACK	PE 7004-4	inv:10126	2019-04-01	2021-04-01
ATTENUATOR	HUBER&SUHNER	6606.19.AA	inv:10395	2019-04-01	2021-04-01
ATTENUATOR	HUBER&SUHNER	6606.19.AA	inv:10395	2019-04-01	2021-04-01
TURNTABLE	MATURO	DS430 UPGRADED	inv:10182	NCR	NCR
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv:10183	NCR	NCR
ANTENNA MAST	MATURO	TAM 4.0E	inv:10181	NCR	NCR
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	NCR
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2019-06-28	2020-06-27
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSV40	inv:10881	2019-02-07	2021-02-07
ANTENNA	ROHDE & SCHWARZ	HFH2-Z2 , 335.4711.52	inv:8013	2018-10-30	2020-10-30
OSP BASE UNIT	ROHDE & SCHWARZ	OSP120	inv:10882	2019-02-28	2021-02-28
OSP-B157W 8 PORT	ROHDE & SCHWARZ	OSP-B157W8	inv:10883	2019-02-06	2021-02-06
OSP-B157WX	ROHDE & SCHWARZ	OSP-B157WX	inv:10884	2019-02-13	2021-02-13
RF SIGNAL GENERATOR	ROHDE & SCHWARZ	SMB100A	inv:9288	2017-02-10	2020-02-10
VECTOR SIGNAL GENERATOR	ROHDE & SCHWARZ	SMBV100A	inv:9290	2019-06-25	2020-06-22
ANTENNA	SCHWARZBECK	VULB 9168, 30-2000MHz	inv:8911	2018-10-25	2020-10-25
POWER SUPPLY	THANDAR	PL330TP	inv:9787	NCR	NCR
POWER SUPPLY	THANDAR	TS3021S	sn:099610	NCR	NCR
FILTER	WAINWRIGHT	HP, WHKX4.0/18G-10SS	inv:10403	2019-04-01	2021-04-01
FILTER	WAINWRIGHT	BR, WRCG2400/2483-2490/2493-35/10SS	inv:8027	2019-04-01	2021-04-01

Conducted Emissions

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
POWER SUPPLY	CALIFORNIA INSTR.	5001i-400	inv:9488	NCR	NCR
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	NCR
LISN	ROHDE & SCHWARZ	ENV216	inv:9611	2019-03-01	2020-03-01
LISN	ROHDE & SCHWARZ	ESH3-Z5	inv:8019	2019-05-28	2020-05-28
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2019-06-28	2020-06-27

NCR = No calibration required

END OF TEST REPORT