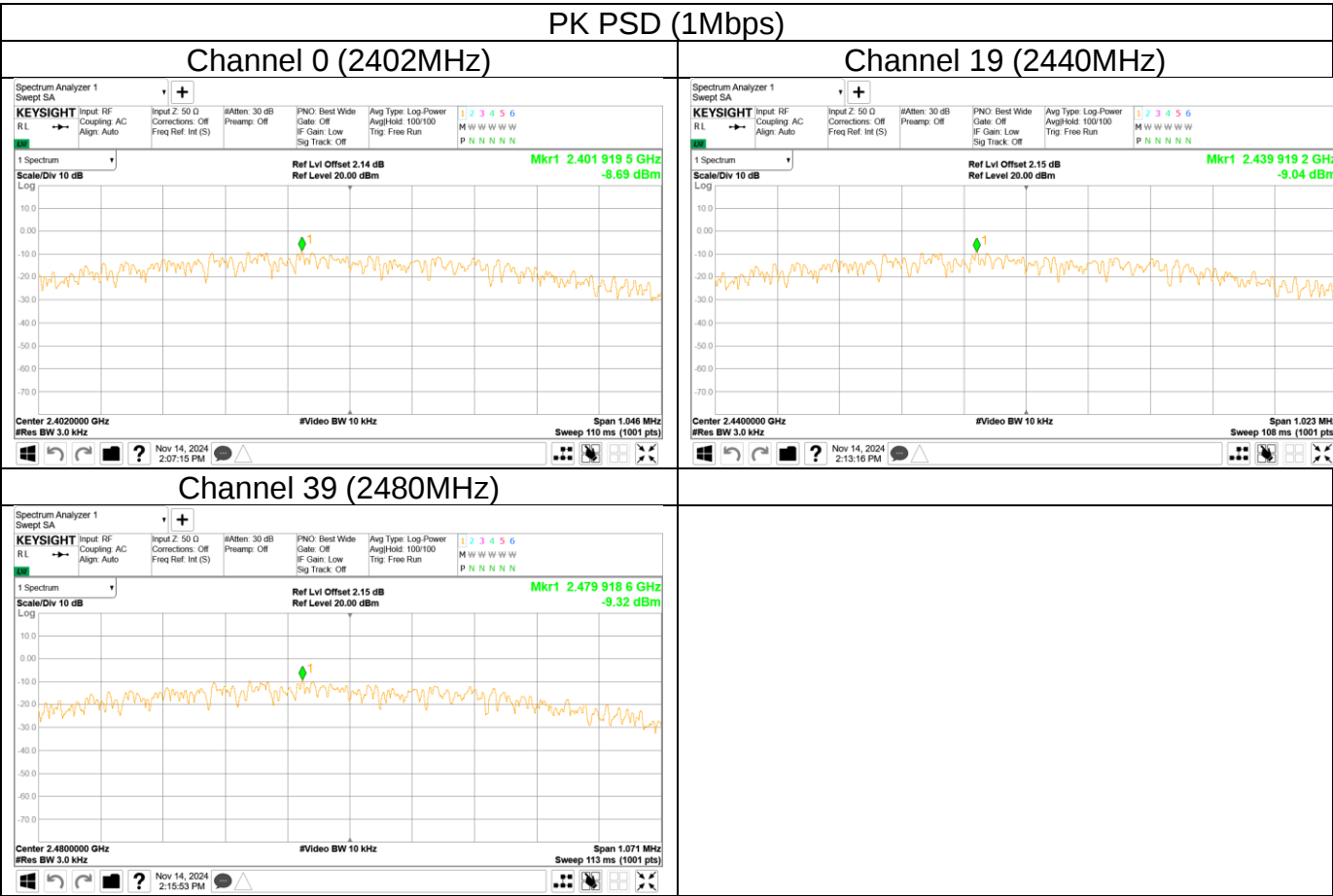
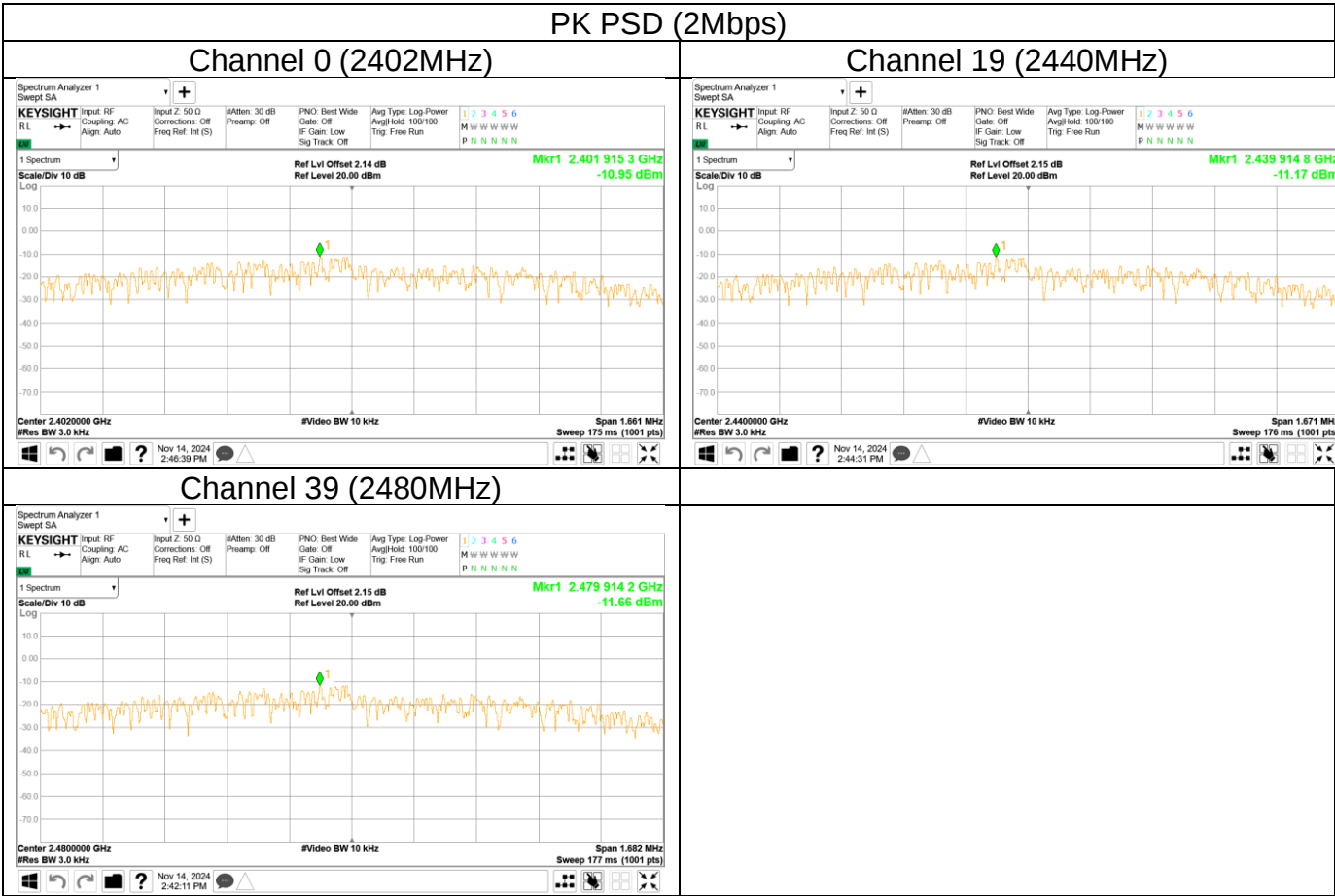








9.5 Spurious RF conducted emissions

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
5. The level displayed must comply with the limit specified in this Section. Submit these plots.
6. Repeat above procedures until all frequencies measured were complete.

Limit

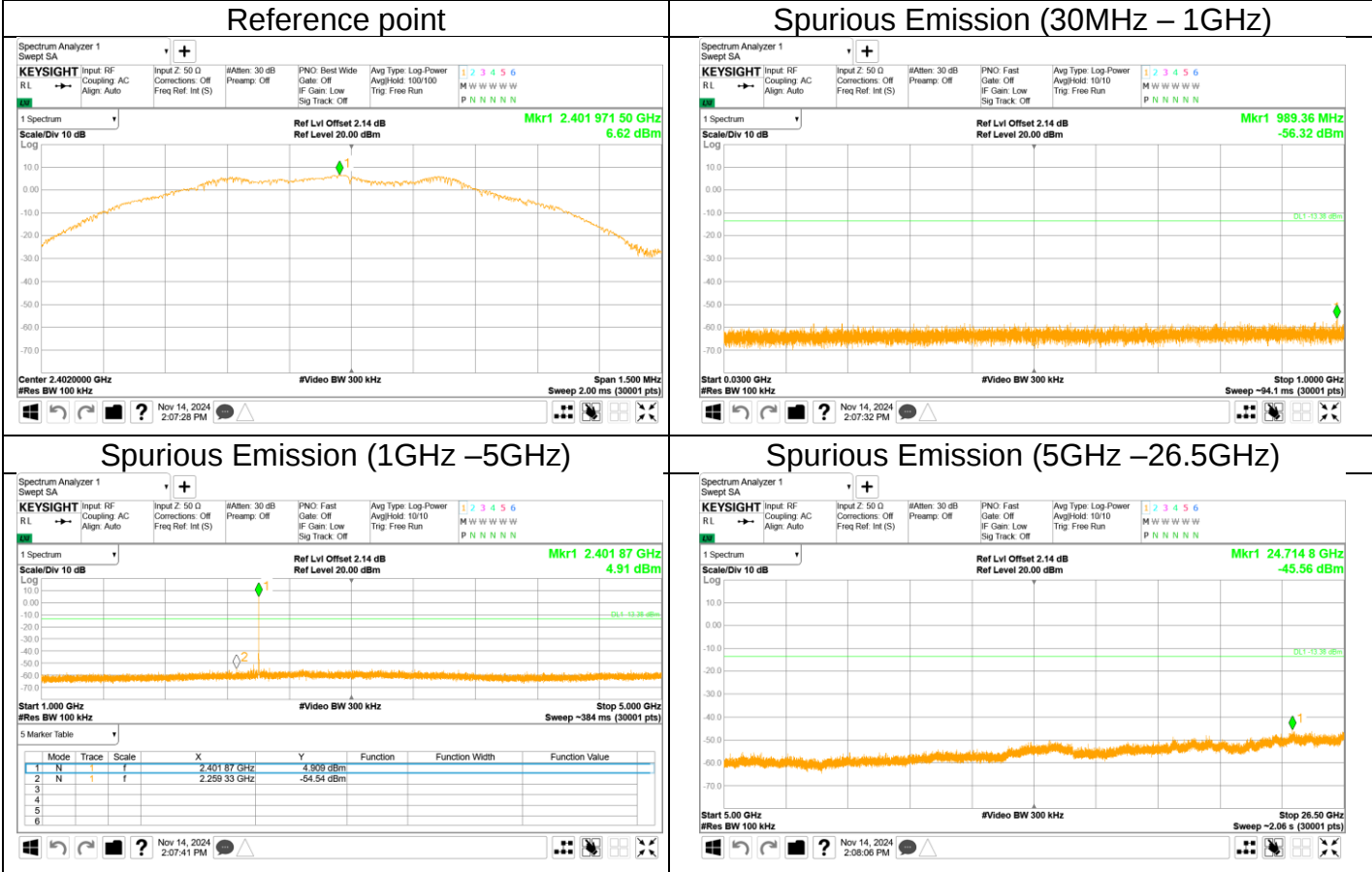
According to §15.247(d), spurious RF conducted emissions limit as below:

Frequency Range MHz	Limit (dBc)
30-25000	-20



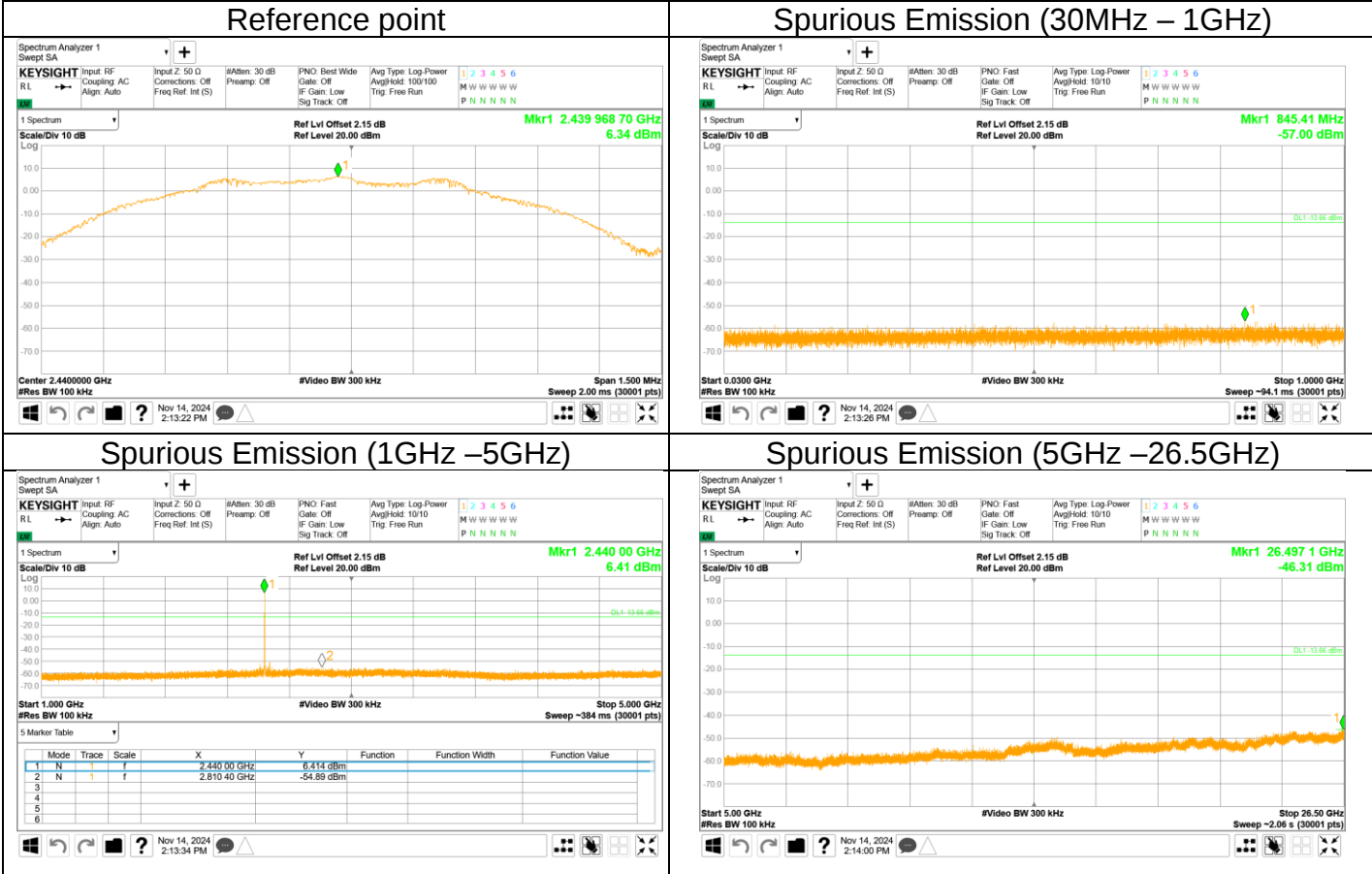
Spurious RF conducted emissions

Out-of-Band Emissions (1Mbps)
Channel 0 (2402MHz)



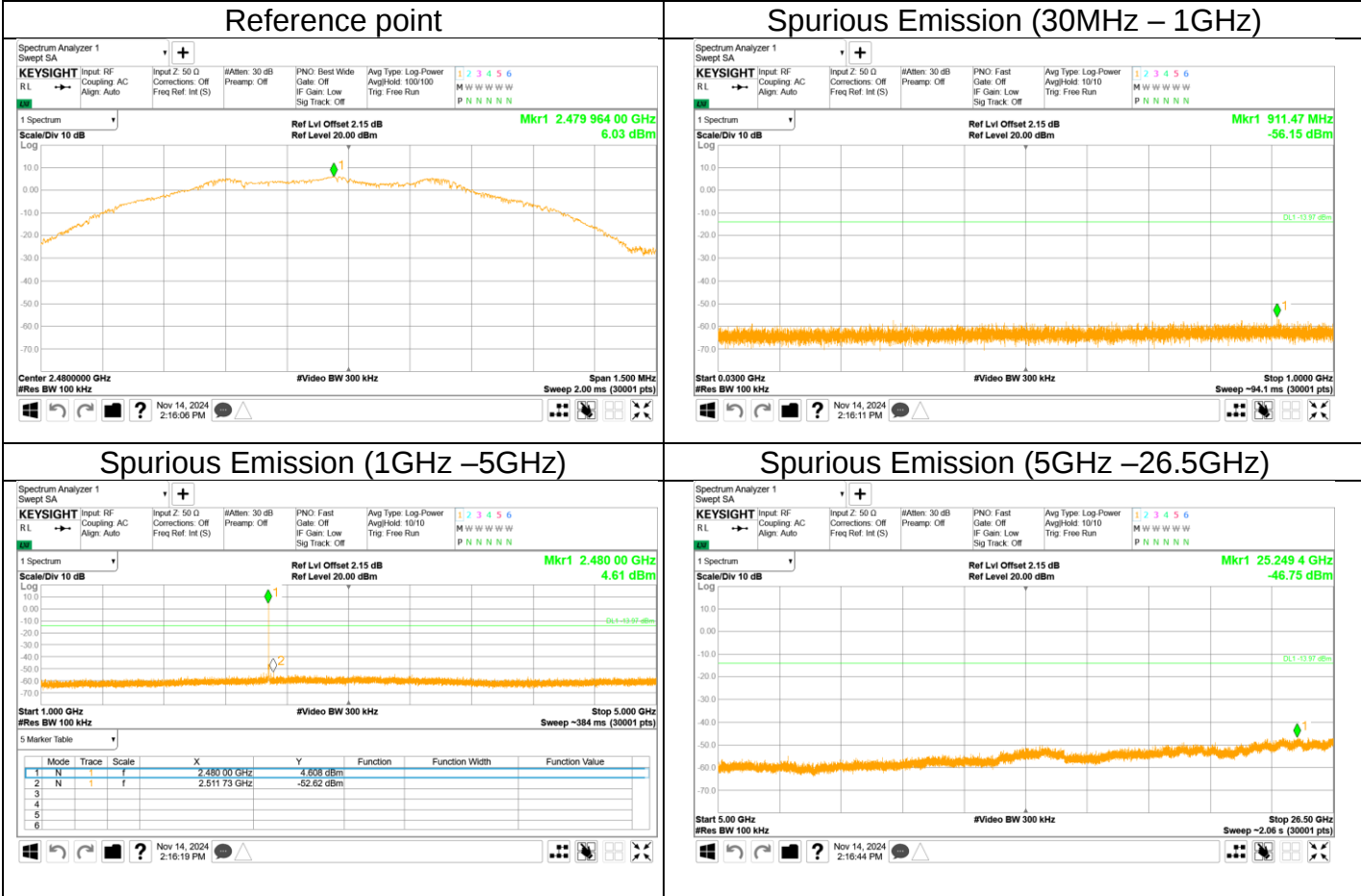


Out-of-Band Emissions (1Mbps)
Channel 19 (2440MHz)



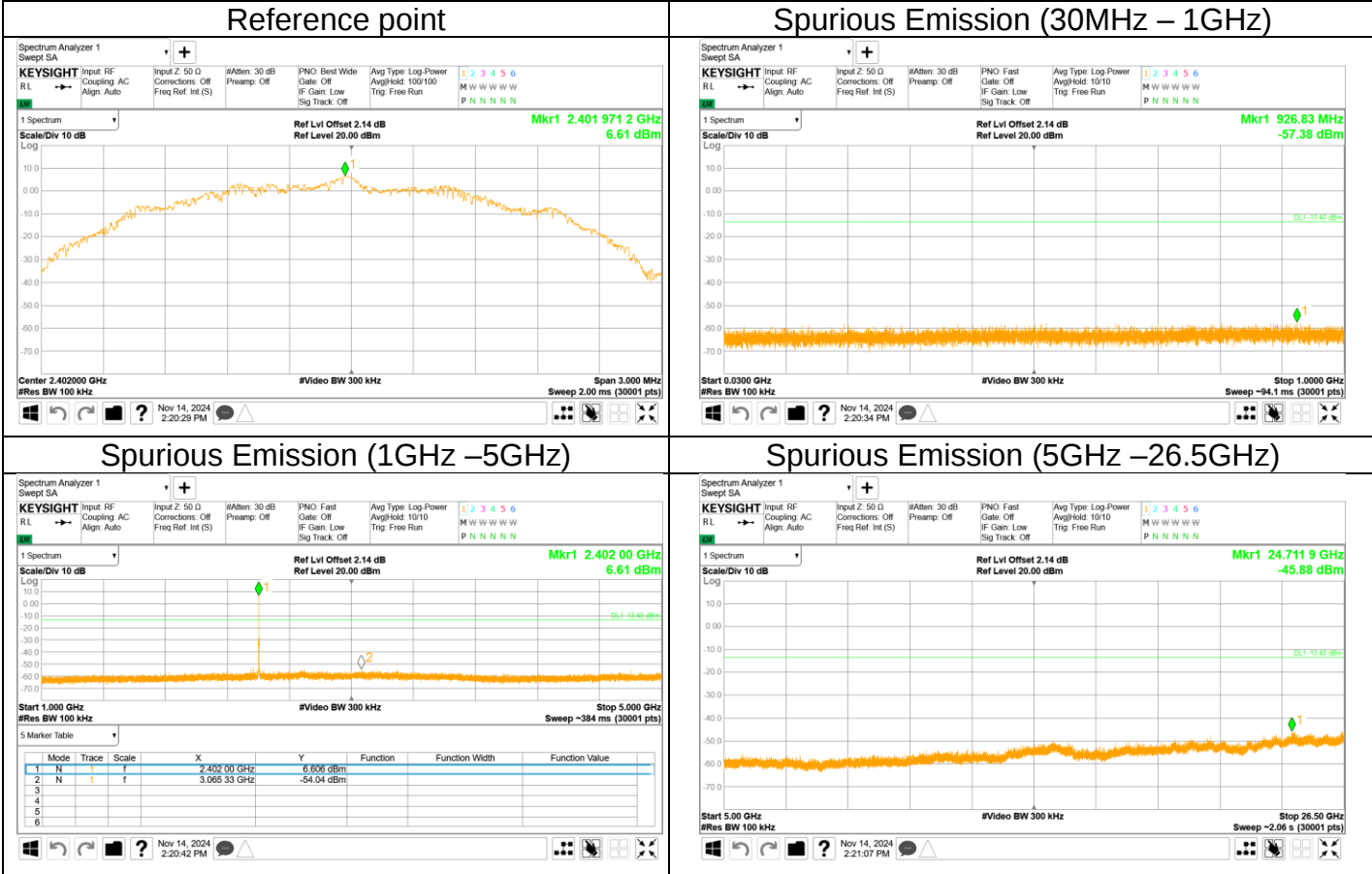


Out-of-Band Emissions (1Mbps)
Channel 39 (2480MHz)



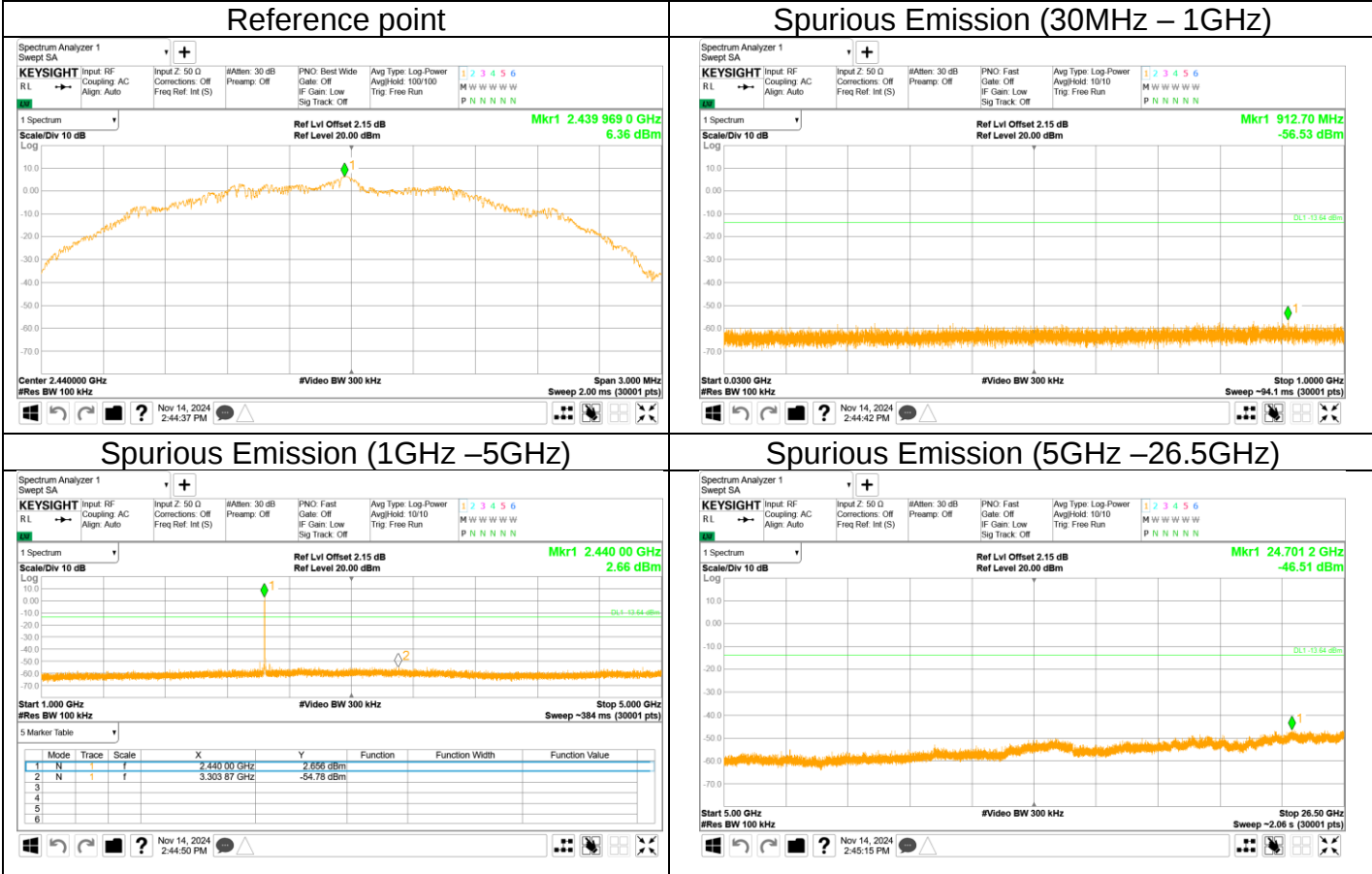


Out-of-Band Emissions (2Mbps)
Channel 0 (2402MHz)



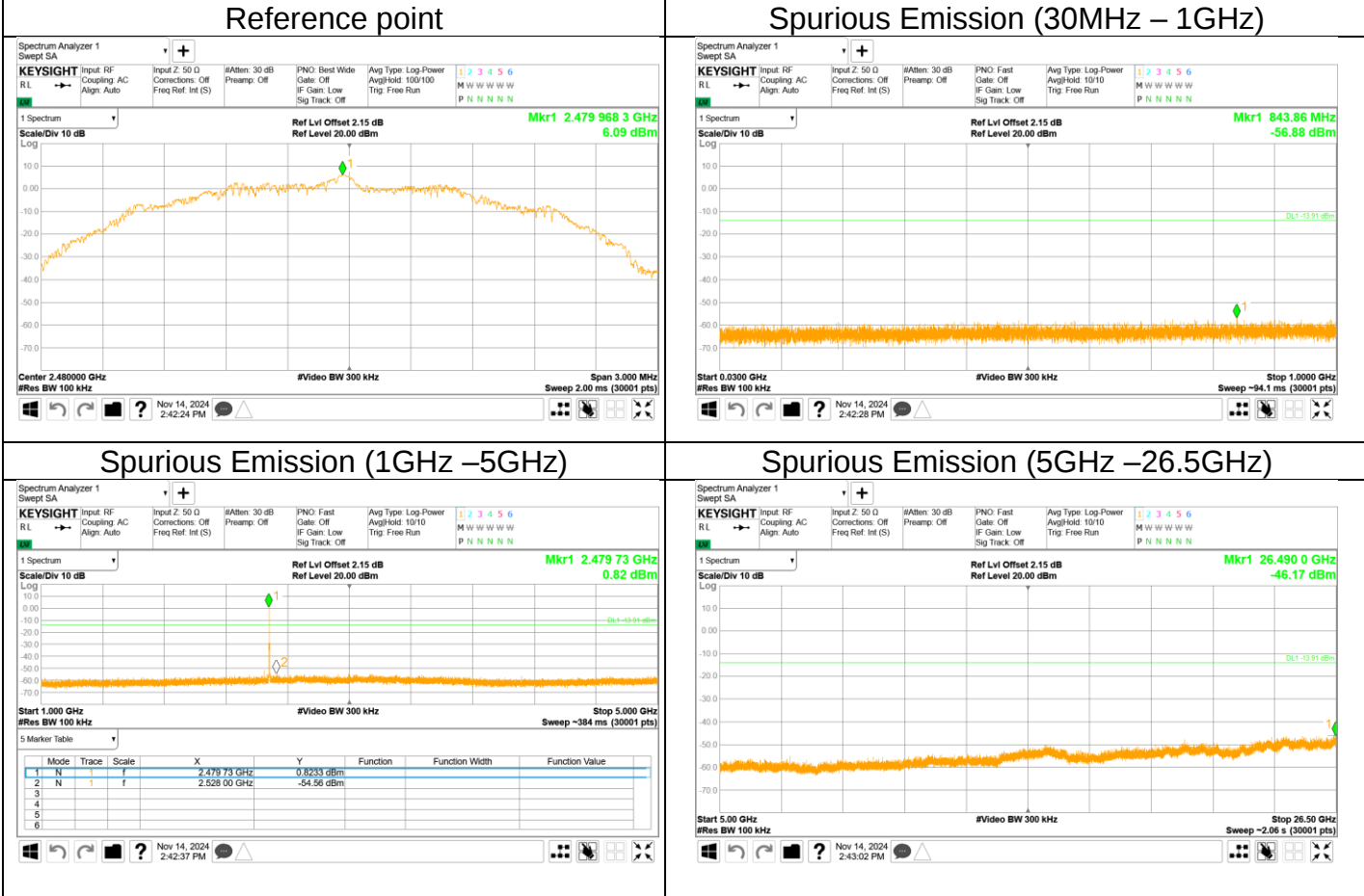


Out-of-Band Emissions (2Mbps)
Channel 19 (2440MHz)





Out-of-Band Emissions (2Mbps)
Channel 39 (2480MHz)





9.6 Band edge

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize, use the peak and delta measurement to record the result.
5. The level displayed must comply with the limit specified in this Section.
6. Repeat above procedures until all frequencies measured were complete and submit all the plots.

Limit:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that 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 § 15.247(b)(3) and RSS-247 section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB.

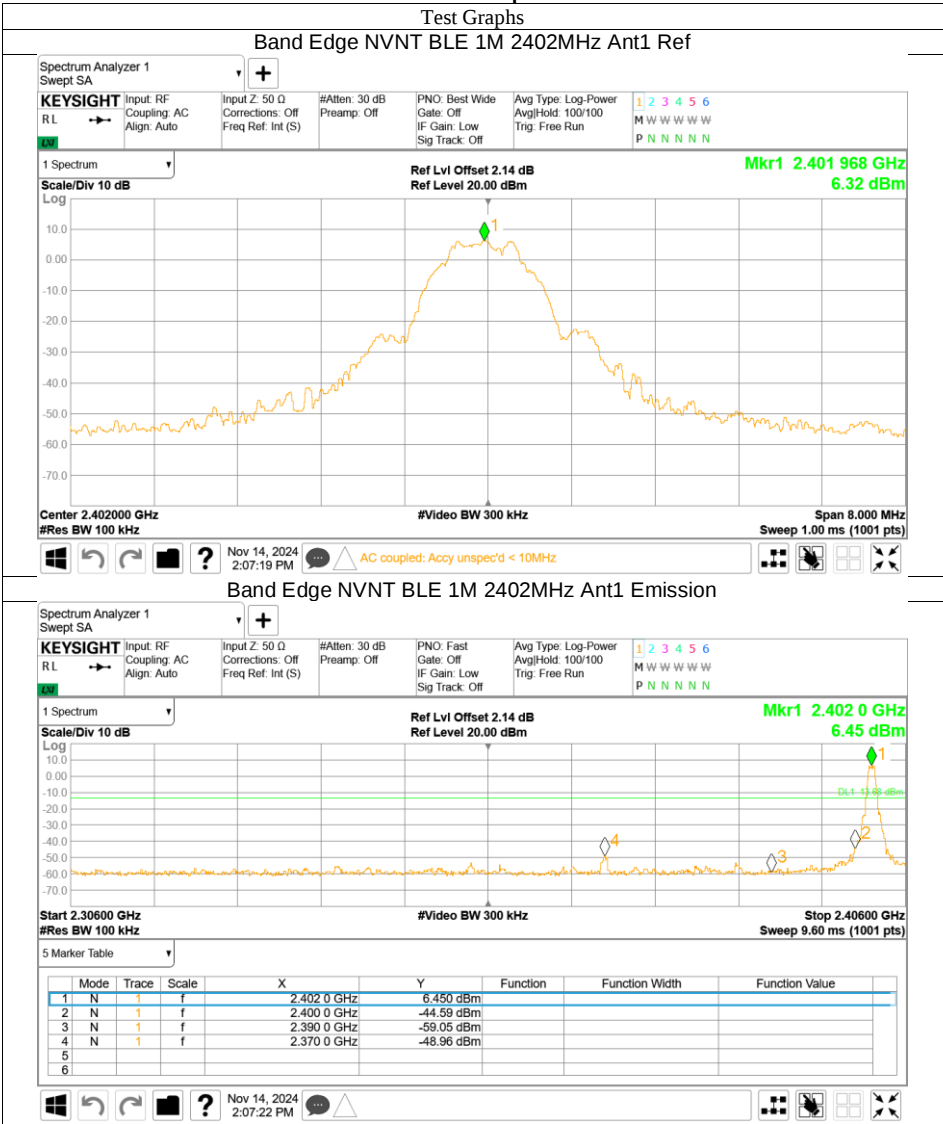
According to §15.247(d), band edge limit as below:

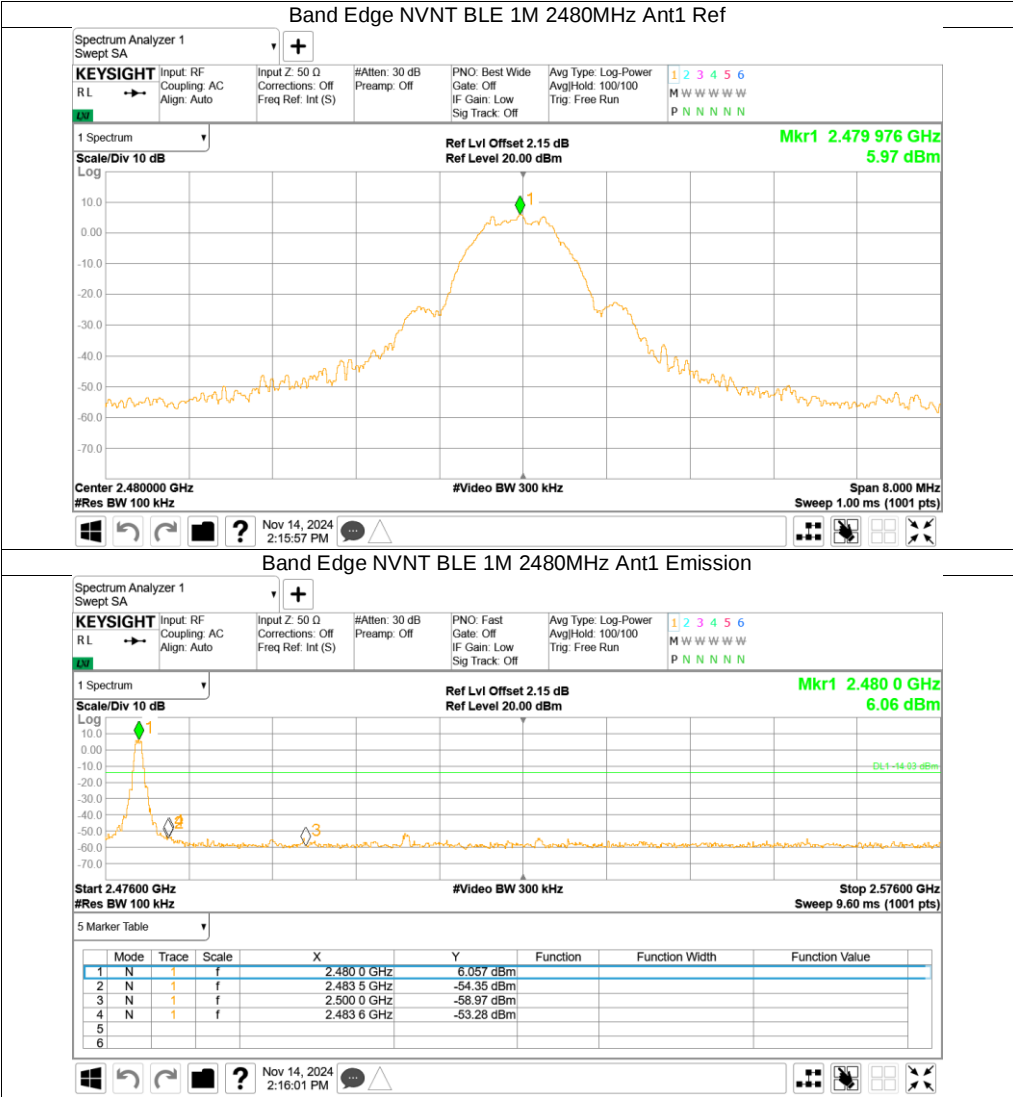
Frequency Range MHz	Limit (dBc)
30-25000	-20



Test result

1Mbps

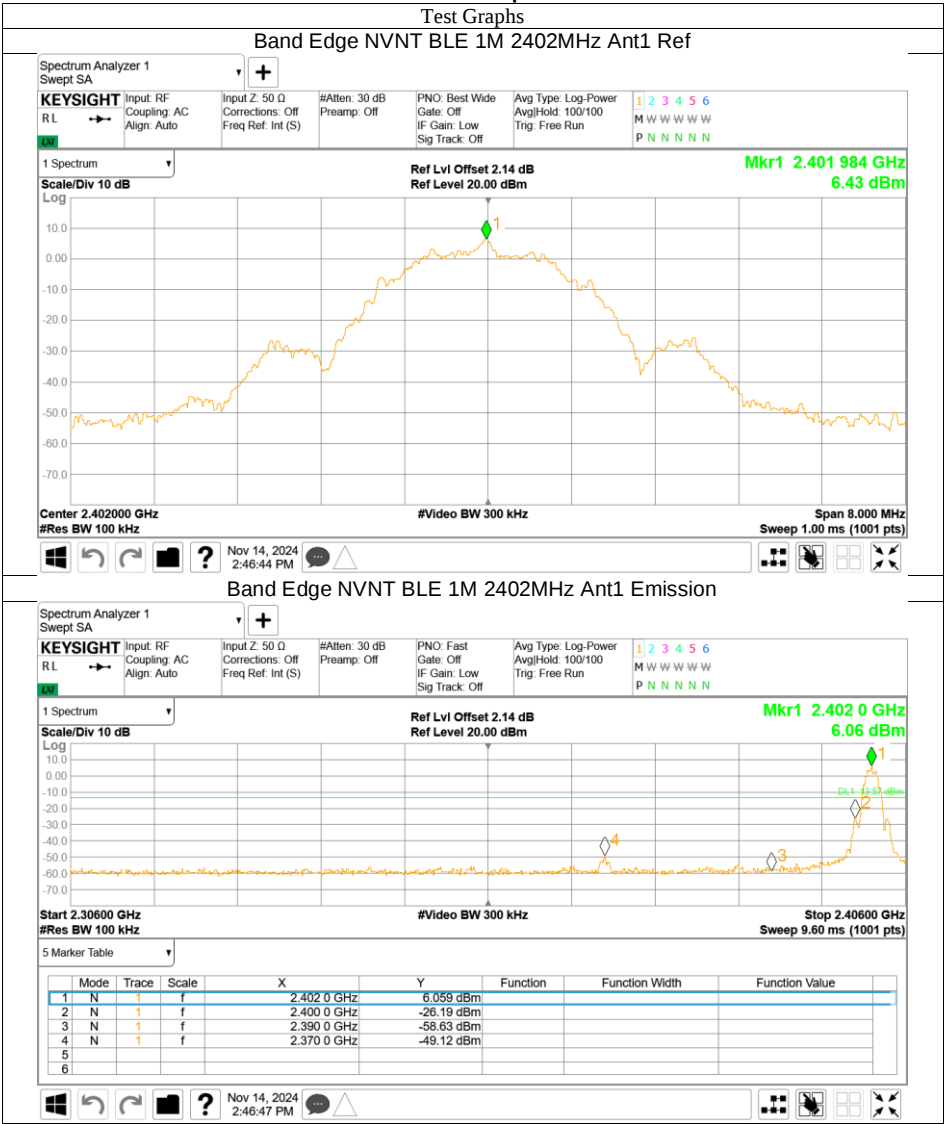


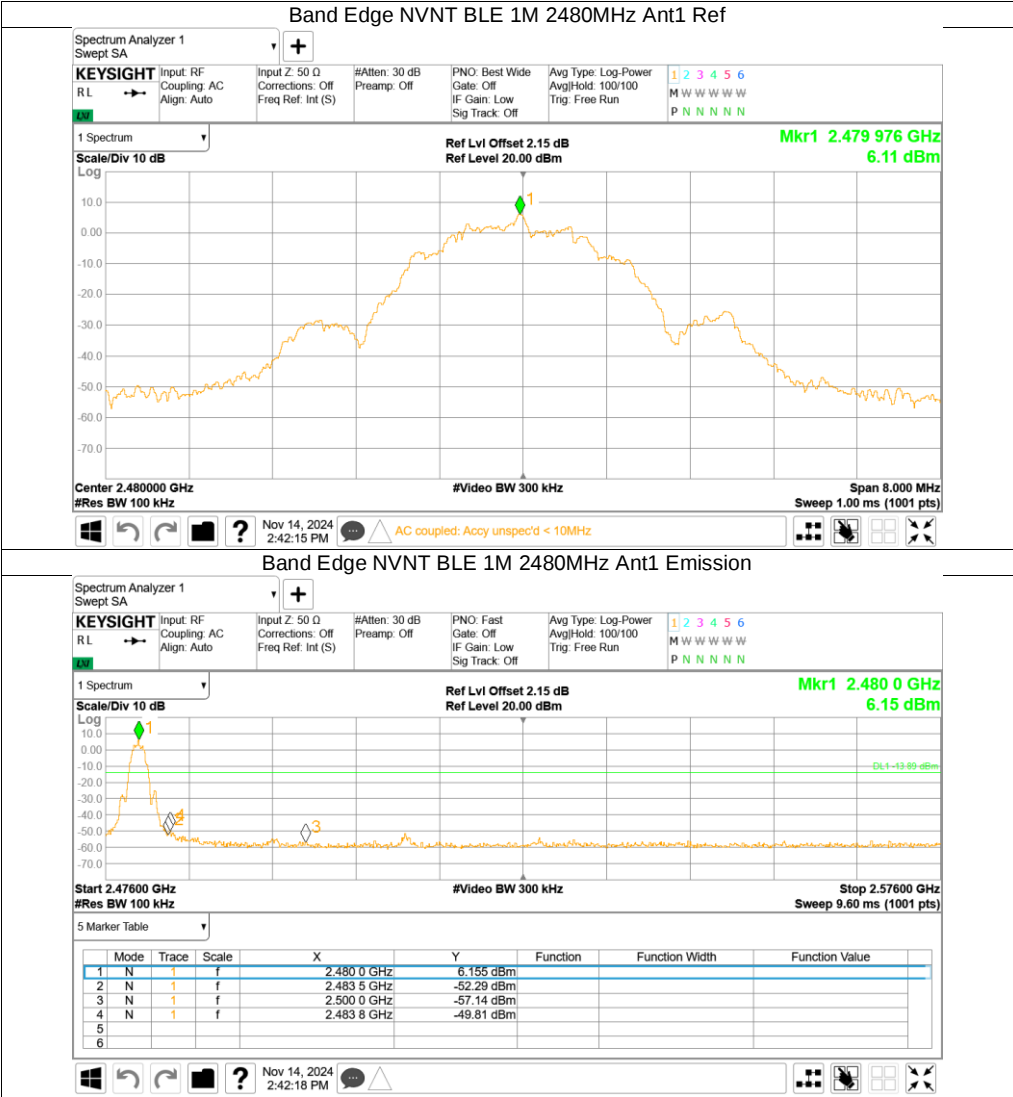




2Mbps

Test Graphs







9.7 Spurious radiated emissions for transmitter

Test Method

1. The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings According to C63.10
 - 1) Procedure for Unwanted Emissions Measurements Below 1000 MHz
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz to 120kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.
 - 2) For Peak unwanted emissions Above 1GHz:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.
Procedures for average unwanted emissions measurements above 1GHz
 - a) RBW = 1MHz.
 - b) VBW \ [3 × RBW].
 - c) Detector = RMS (power averaging), if [span / (# of points in sweep)] \ RBW / 2.
Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
 - d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
 - e) Sweep time = auto.
 - f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of 1 / D, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
 - g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
 - 1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is $[10 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.
 - 2) If linear voltage averaging mode was used in the preceding step e), then the correction



factor is $[20 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission (AV) at frequency above 1GHz.

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that 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 § 15.247(b)(3) and RSS 247 section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in § 15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a) and RSS-Gen section 8.9, must also comply with the radiated emission limits specified in § 15.209(a) and RSS-Gen section 8.10.

Frequency MHz	Field Strength $\mu\text{V/m}$	Field Strength $\text{dB}\mu\text{V/m}$	Detector	Measurement distance meters
0.009-0.490	2400/F(kHz)	48.5-13.8	AV	300
0.490-1.705	24000/F(kHz)	33.8-23.0	QP	30
1.705-30	30	29.5	QP	30
30-88	100	40	QP	3
88-216	150	43.5	QP	3
216-960	200	46	QP	3
960-1000	500	54	QP	3
Above 1000	500	54	AV	3
Above 1000	5000	74	PK	3

Note 1: Limit $3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 300\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(300\text{m}/3\text{m})$ (Below 30MHz)

Note 2: Limit $3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 30\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(30\text{m}/3\text{m})$ (Below 30MHz)

Spurious Radiated Emissions for Transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Data of measurement within frequency range 9kHz-30MHz is the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report.



Test result

The worst case of Radiated Emission below 1GHz: Only the worst case listed as below.

30-1000MHz Radiated Emission

EUT Information

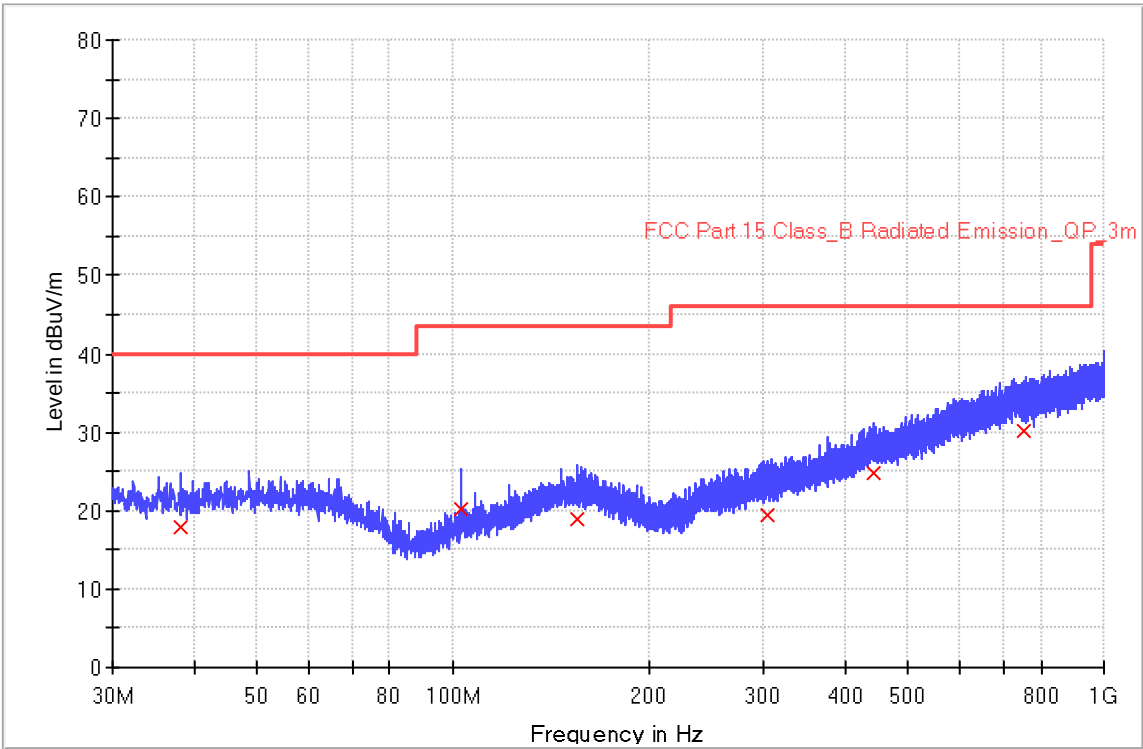
EUT Name:	Tubular motor
Model:	CM-03-E
Client:	Coulisse B.V.
Op Cond:	Power on and TX at 2402MHz, 2Mbps
Operator:	Tianji XU
Test Spec:	FCC Part 15.209(a)
Sample No:	SHA-816506-10

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup:	RE_VULB9168
Receiver:	[ESR 3]
Level Unit:	dBuV/m

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	120 kHz	0.2 s	20 dB

RE_VULB9168_pre_Cont_30-1000





Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)
38.160000	17.9	1000.0	120.000	150.0	H	246.0	19.7	22.1
102.640000	20.1	1000.0	120.000	200.0	H	205.0	16.3	23.4
155.320000	18.8	1000.0	120.000	120.0	H	292.0	21.0	24.7
305.000000	19.5	1000.0	120.000	180.0	H	118.0	21.6	26.5
443.360000	24.7	1000.0	120.000	150.0	H	135.0	25.7	21.3
755.240000	30.2	1000.0	120.000	302.0	H	26.0	31.7	15.8

(continuation of the "Limit and Margin" table from column 16 ...)

Frequency (MHz)	Limit - QPK (dBuV/m)
38.160000	40.0
102.640000	43.5
155.320000	43.5
305.000000	46.0
443.360000	46.0
755.240000	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
 Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)



30-1000MHz Radiated Emission

EUT Information

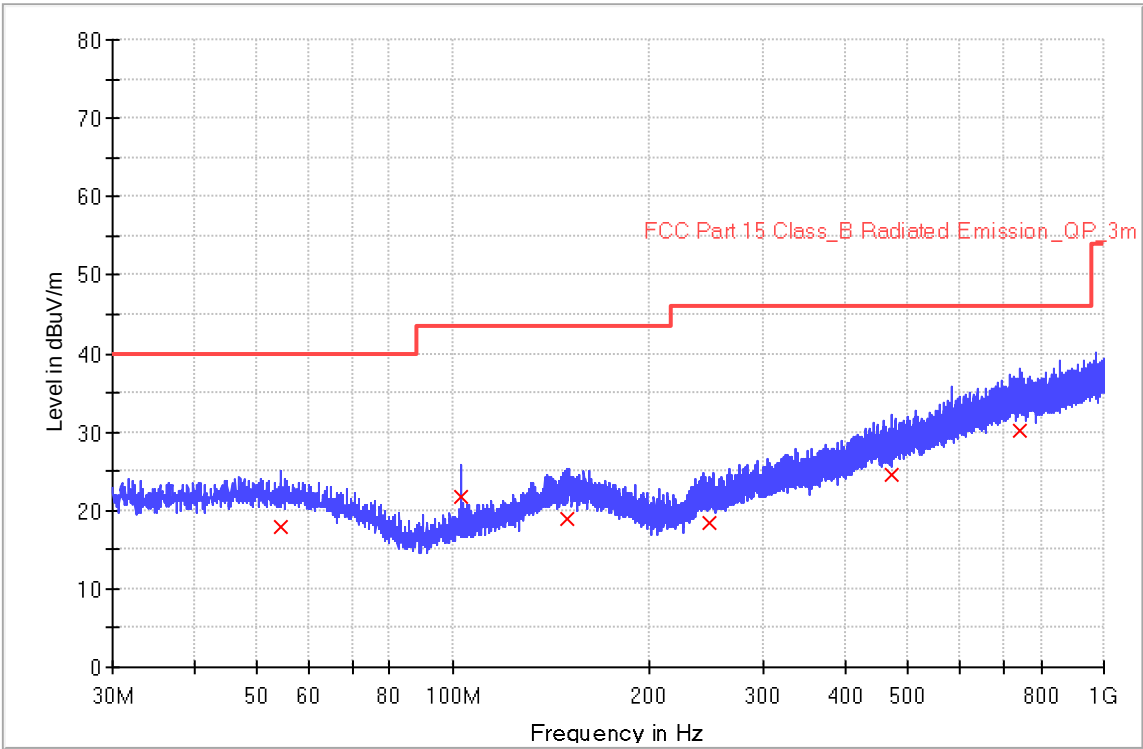
EUT Name: Tubular motor
Model: CM-03-E
Client: Coulisse B.V.
Op Cond: Power on and TX at 2402MHz, 2Mbps
Operator: Tianji XU
Test Spec: FCC Part 15.209(a)
Sample No: SHA-816506-10

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup: RE_VULB9168
Receiver: [ESR 3]
Level Unit: dBuV/m

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	120 kHz	0.2 s	20 dB

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

EMC_SHA_F_R_02.10E



Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)
54.400000	17.8	1000.0	120.000	100.0	V	321.0	20.4	22.2
102.640000	21.8	1000.0	120.000	150.0	V	137.0	16.3	21.7
149.880000	18.9	1000.0	120.000	120.0	V	98.0	20.9	24.6
247.240000	18.5	1000.0	120.000	200.0	V	113.0	19.9	27.5
471.640000	24.6	1000.0	120.000	158.0	V	287.0	25.9	21.4
743.040000	30.2	1000.0	120.000	202.0	V	40.0	31.7	15.8

(continuation of the "Limit and Margin" table from column 16 ...)

Frequency (MHz)	Limit - QPK (dBuV/m)
54.400000	40.0
102.640000	43.5
149.880000	43.5
247.240000	46.0
471.640000	46.0
743.040000	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

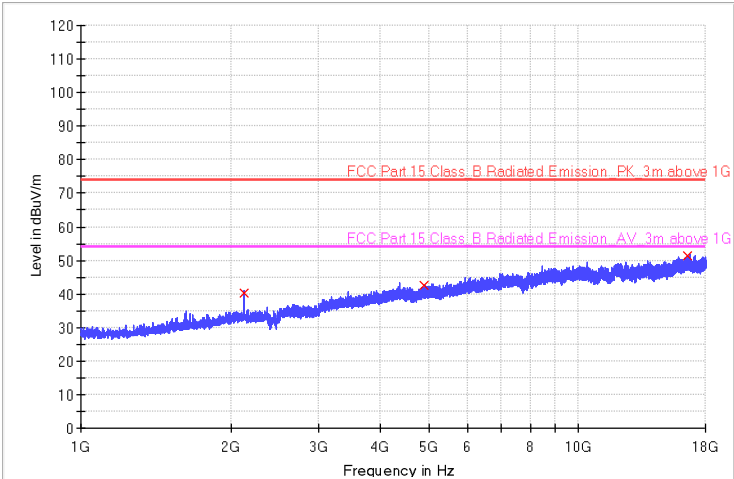
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)



Radiated Emission 1-18GHz

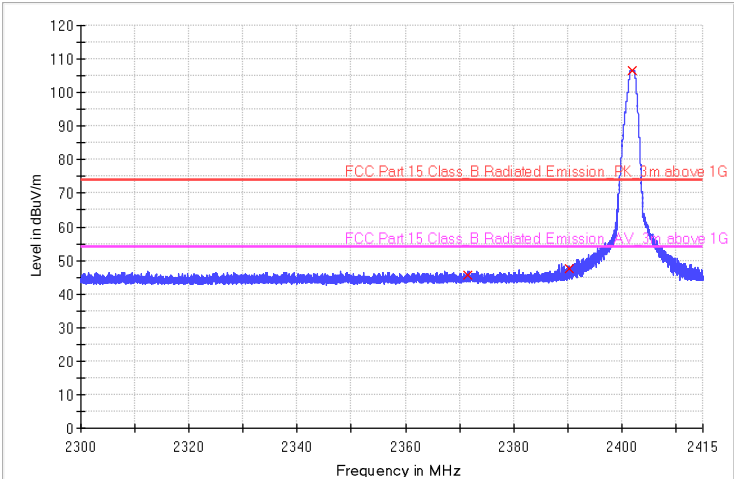
Frequency:2402MHz, 1Mbps

RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
2126.200000	40.2	153.0	H	268.0	-11.4	33.8	74.0
4883.500000	42.6	154.0	H	25.0	-2.4	31.4	74.0
16532.800000	51.3	163.0	H	135.0	6.8	22.7	74.0

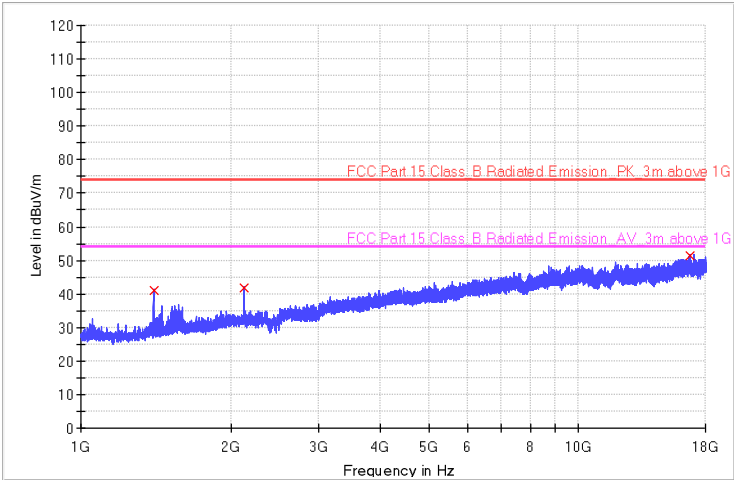
RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
2371.600000	45.6	186.0	H	228.0	-0.8	28.4	74.0
2390.200000	47.7	146.0	H	132.0	-0.8	26.3	74.0
2401.900000	106.5	199.0	H	157.0	-0.8	/	/

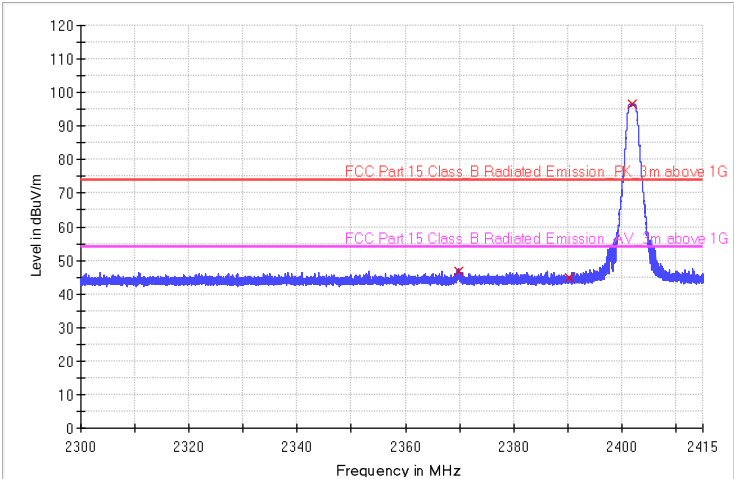


RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
1399.900000	41.1	160.0	V	330.0	-15.4	32.9	74.0
2129.500000	41.6	146.0	V	23.0	-11.4	32.4	74.0
16714.300000	51.2	209.0	V	134.0	7.2	22.8	74.0

RE_HF907_BRF_Pre

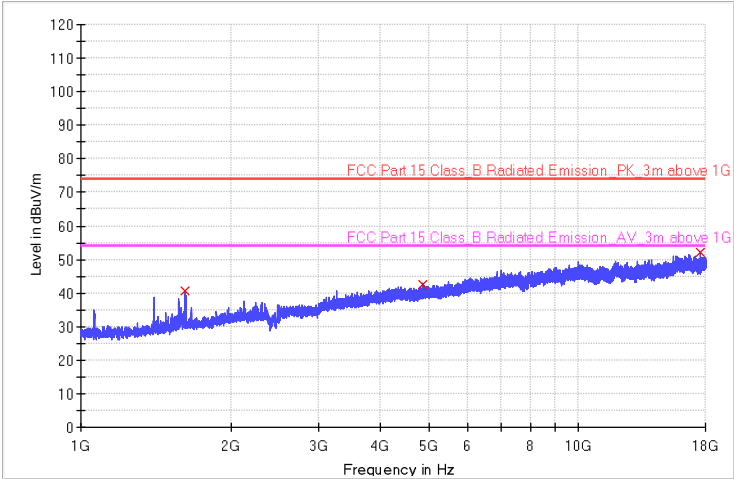


Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
2369.800000	46.7	153.0	V	31.0	-0.8	27.3	74.0
2390.200000	44.8	167.0	V	257.0	-0.8	29.2	74.0
2401.900000	96.6	138.0	V	174.0	-0.8	/	/



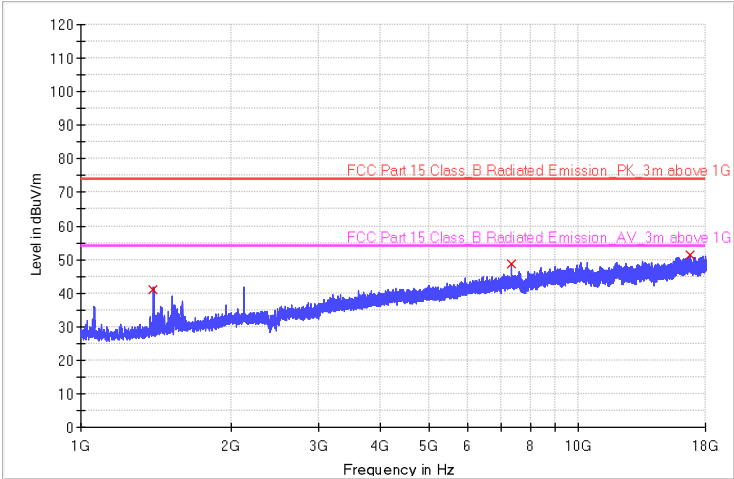
Frequency:2440MHz

RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
1617.400000	40.5	121.0	H	14.0	-13.9	33.5	74.0
4855.900000	42.5	105.0	H	13.0	-2.5	31.5	74.0
17612.200000	52.2	173.0	H	257.0	7.3	21.8	74.0

RE_HF907_BRF_Pre

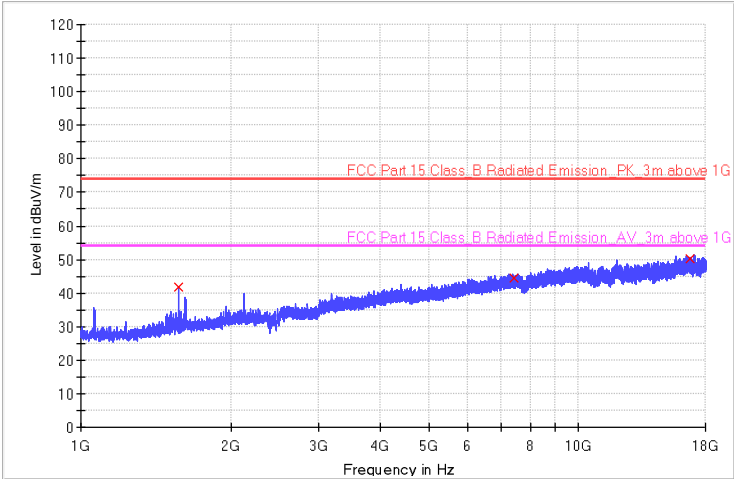


Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
1399.000000	41.2	206.0	V	65.0	-15.4	32.8	74.0
7319.200000	48.7	103.0	V	13.0	0.8	25.3	74.0
16747.900000	51.3	161.0	V	117.0	7.2	22.7	74.0



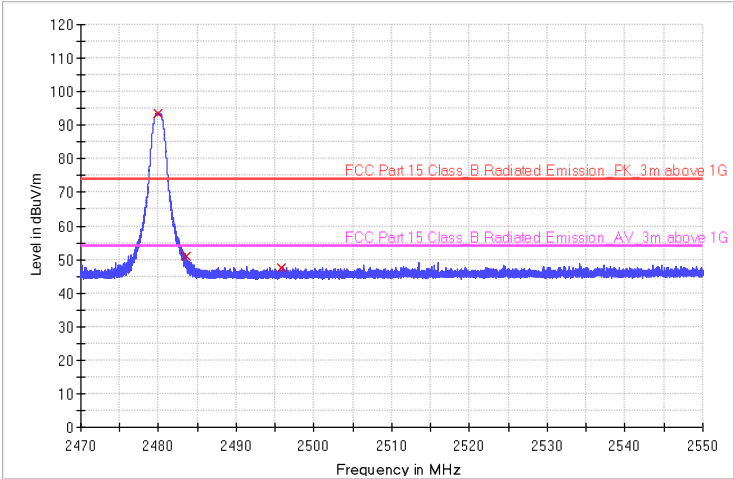
Frequency:2480MHz

RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
1570.000000	41.7	134.0	H	13.0	-14.2	32.3	74.0
7204.600000	44.5	209.0	H	287.0	0.8	29.5	74.0
16725.400000	50.4	118.0	H	341.0	7.2	23.6	74.0

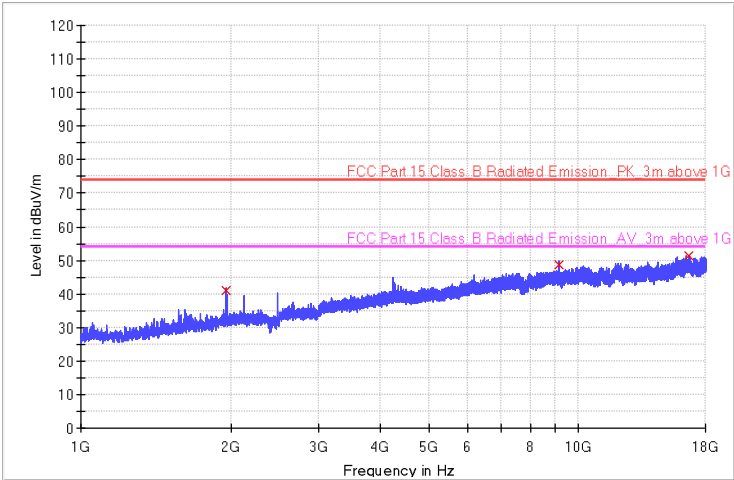
RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
2479.900000	93.6	107.0	H	228.0	-0.3	/	/
2483.500000	50.8	200.0	H	185.0	-0.3	23.2	74.0
2495.800000	47.4	174.0	H	314.0	-0.3	26.6	74.0

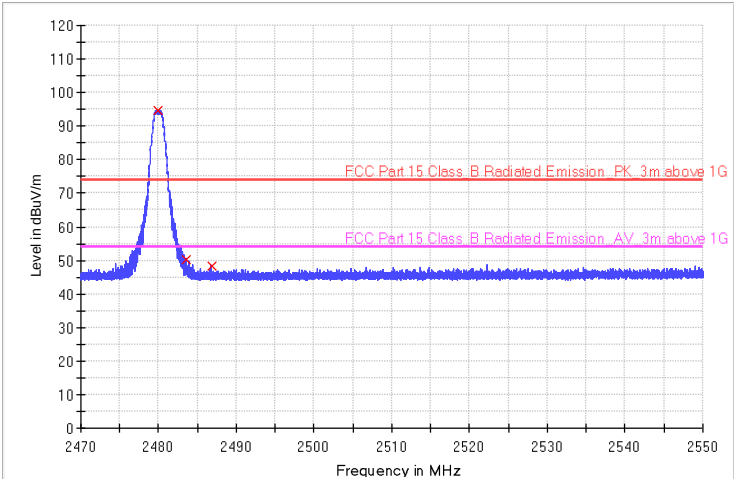


RE_HF907_BRF_Pre



Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
1958.500000	41.2	137.0	V	0.0	-12.1	32.8	74.0
9139.900000	48.7	198.0	V	0.0	2.3	25.3	74.0
16612.900000	51.3	131.0	V	0.0	7.0	22.7	74.0

RE_HF907_BRF_Pre

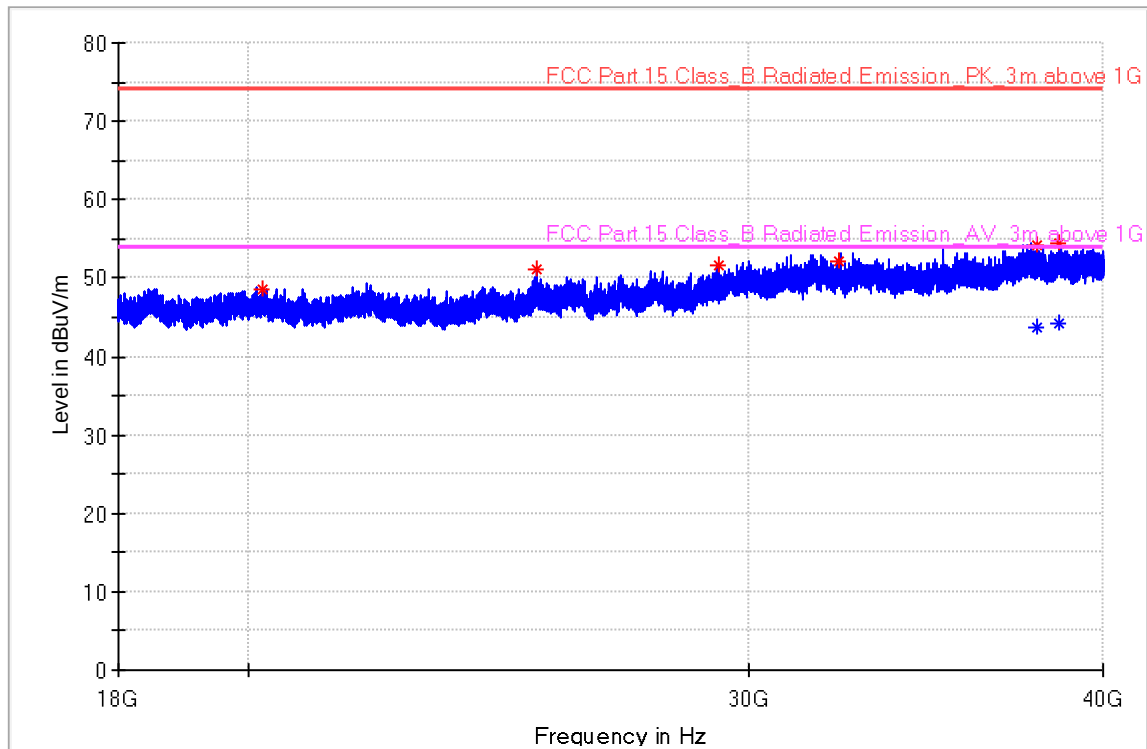


Frequency (MHz)	MaxPeak (dBuV/m)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - PK+ (dB)	Limit - PK+ (dBuV/m)
2480.000000	94.7	179.0	V	237.0	-0.3	/	/
2483.500000	50.1	185.0	V	228.0	-0.3	23.9	74.0
2486.800000	48.3	146.0	V	135.0	-0.3	25.7	74.0

The worst case of Radiated Emission Above 18GHz

Frequency: 2402MHz, 2Mbps

Full Spectrum

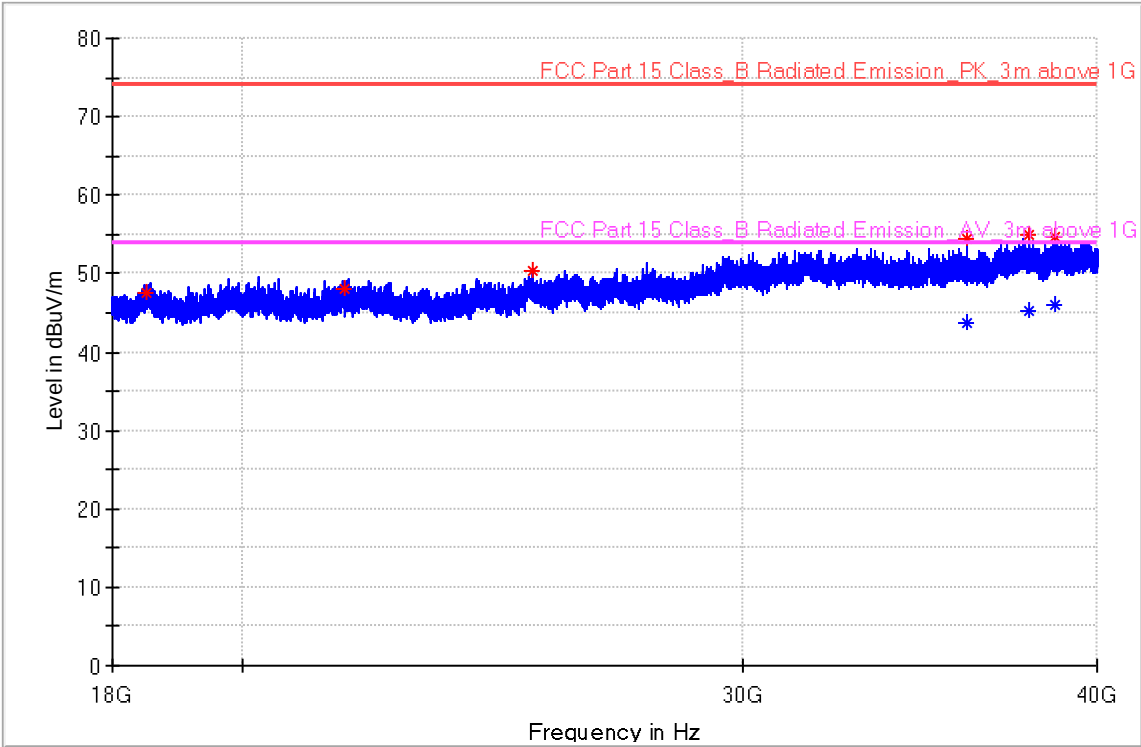


Limit and Margin

Frequency (MHz)	MaxPeak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
20231.625000	48.60	---	74.00	25.40	193	H	166.0	12.6
25266.187500	51.20	---	74.00	22.80	275	H	231.0	13.2
29292.875000	51.65	---	74.00	22.35	194	H	346.0	19.3
32298.625000	52.16	---	74.00	21.84	224	H	324.0	18.9
37915.500000	---	43.82	54.00	10.18	159	H	346.0	18.1
37915.500000	54.24	---	74.00	19.76	178	H	217.0	19.6
38585.125000	---	44.33	54.00	9.67	113	H	346.0	18.1
38585.125000	54.56	---	74.00	19.44	193	H	339.0	18.1



Full Spectrum



Limit and Margin

Frequency (MHz)	MaxPeak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18515.625000	47.47	---	74.00	26.53	184	V	126.0	9.7
21741.375000	48.14	---	74.00	25.86	230	V	81.0	15.4
25303.312500	50.33	---	74.00	23.67	240	V	300.0	13.8
36022.150000	54.55	---	74.00	19.45	196	V	227.0	17.5
36022.150000	---	43.75	54.00	10.25	177	V	307.0	17.5
37882.500000	---	45.24	54.00	8.76	129	V	220.0	19.7
37882.500000	54.91	---	74.00	19.09	287	V	198.0	19.6
38655.250000	---	46.17	54.00	7.83	184	V	88.0	15.6
38655.250000	54.65	---	74.00	19.35	230	V	103.0	17.9

Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading



10 Test Equipment List

List of Test Instruments
Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
C	Signal spectrum analyzer	Agilent	N9020B	MY59050168	2024-2-19	2025-2-18
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2024-8-1	2025-7-31
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2024-8-1	2025-7-31
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2024-8-30	2025-8-29
	Double-ridged waveguide horn antenna	Rohde & Schwarz	HF907	102393	2024-4-14	2025-4-13
	Pre-amplifier	Shenzhen HzEMC	HPA-081843	HYP A23026	2024-4-16	2025-4-15
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2024-6-26	2025-6-25
	Double Ridged Horn Antenna	ETS-Lindgren	3116C	00246076	2023-7-7	2026-7-6
	3m Semi-anechoic chamber	TDK	9X6X6	----	2024-5-8	2027-5-7
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2024-8-1	2025-7-31
	LISN	Rohde & Schwarz	ENV216	101924	2024-8-1	2025-7-31

Measurement Software Information			
Test Item	Software	Manufacturer	Version
C	MTS 8310	MWRFTtest	3.0.0.0
RE	EMC 32	Rohde & Schwarz	V10.50.40
CE	EMC 32	Rohde & Schwarz	V9.15.03

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density*
- Spurious RF conducted emissions
- Band edge



11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, 3.16dB
Radiated Disturbance	9kHz to 30MHz, 3.52dB 30MHz to 1GHz, 5.03dB (Horizontal) 5.12dB (Vertical) 1GHz to 18GHz, 5.49dB 18GHz to 40GHz, 5.63dB
RF Conducted Measurement	Power related: 1.16dB Frequency related: 6.00×10^{-8}

Measurement Uncertainty Decision Rule:

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2023, clause 4.3.3.



12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



13 Photographs of EUT

Refer to the < External Photos > & < Internal Photos >.

THE END