

9.6 Test Result for Radiated Spurious Emission

9.6.1 9 kHz ~ 25 GHz Data for BT1

Test Mode : BLE 1M

● Low frequency

Frequency (MHz)	Reading		Pol.	T.F (dB)	DCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
2 389.73	35.69	63.18	V	0.53	0.68	54.0	74.0	36.9	63.7	17.1	10.3
4 803.58	49.99	66.45	V	−0.50	0.68	54.0	74.0	50.2	66.0	3.8	8.1
9 607.18	27.37	40.73	V	13.34	0.68	54.0	74.0	41.4	54.1	12.6	19.9

● Middle frequency

Frequency	Reading		Pol.	T.F (dB)	DCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
4 879.74	47.55	62.59	V	−0.21	0.68	54.0	74.0	48.0	62.4	6.0	11.6
9 759.20	25.18	37.43	H	14.25	0.68	54.0	74.0	40.1	51.7	13.9	22.3

● High frequency

Frequency	Reading		Pol.	T.F (dB)	DCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
2 483.63	37.67	62.68	V	−9.50	0.68	54.0	74.0	28.8	53.2	25.2	20.8
4 960.01	43.87	57.77	V	0.43	0.68	54.0	74.0	45.0	58.2	9.0	15.8
9 919.18	24.99	37.58	V	14.63	0.68	54.0	74.0	40.3	52.2	13.7	21.8

Note 1: The radiated emissions were investigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found above listed frequencies.

Note 2: DCF(Duty Cycle Factor)

- $T_{total} = 2.5 \text{ ms} / T_{on} = 2.14 \text{ ms}$

- Duty Cycle = $T_{on} / T_{total} = 2.14 / 2.5 = 0.856$

- DCF = $10 \times \log(1/\text{Duty Cycle}) \text{ dB} = 10 \times \log(1/0.856) \text{ dB} = 0.68 \text{ dB}$

Note 3: Sample Calculation.

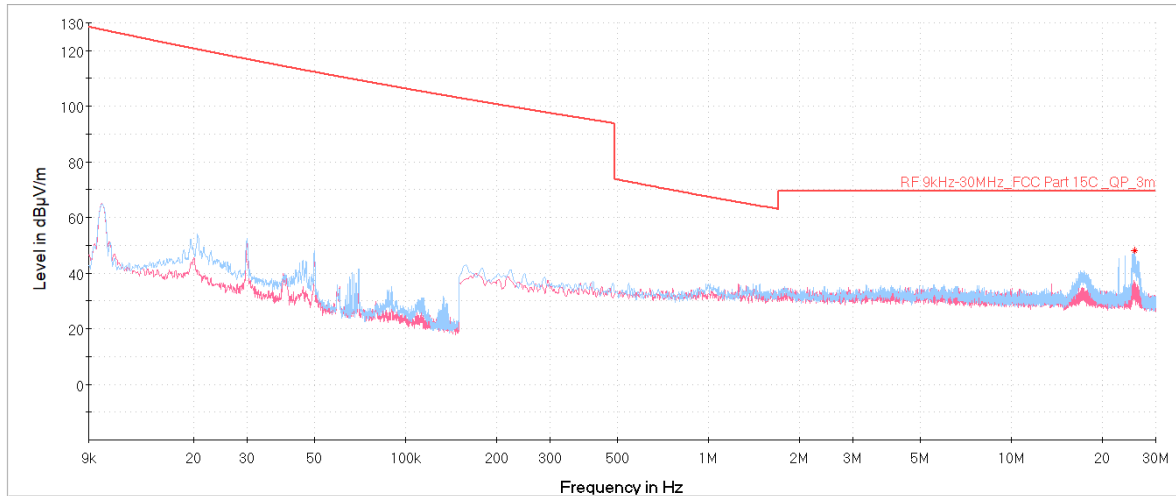
Margin = Limit - Result / Peak Result = Peak Reading + TF / Average Result = Average Reading + TF + DCF

TF = Ant factor + Cable Loss + Filter Loss - Amp Gain + Distance Factor

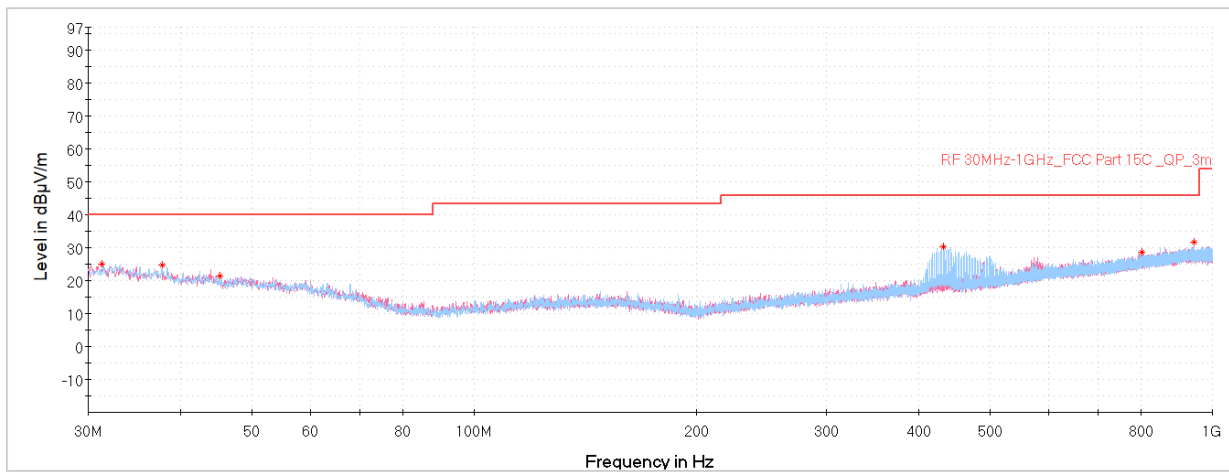
Distance Factor = $20\log(\text{applied distance}/\text{required distance}) = 20\log(3.75\text{m}/3\text{m}) = 1.94$

9.6.2 9 kHz ~ 25 GHz Plots for BT1

- BLE 1M Low Channel (Worst-Channel) – Pre-scan 9 kHz ~ 30 MHz

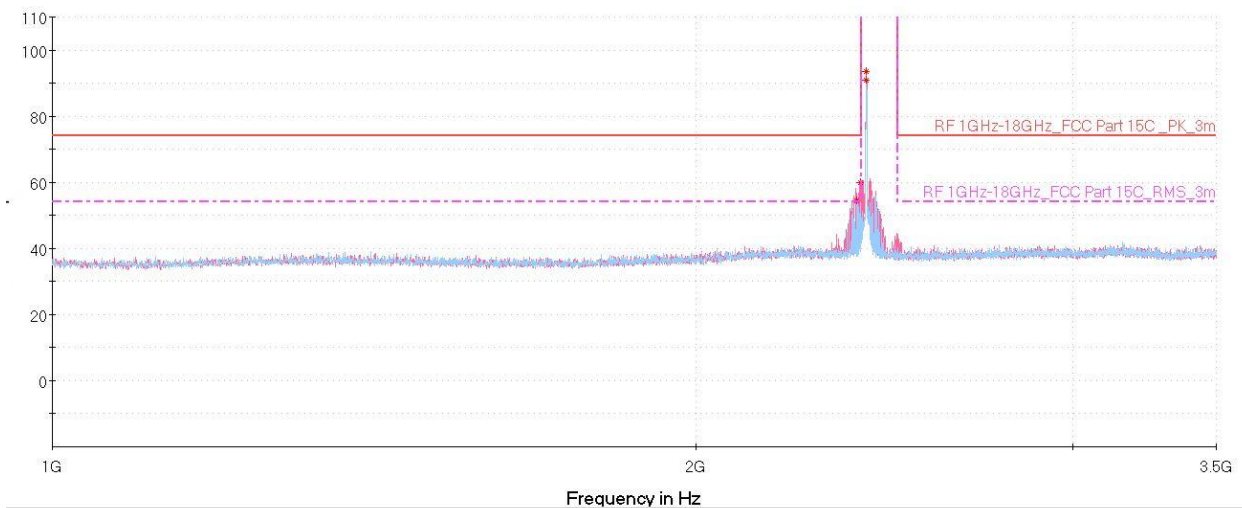


- BLE 1M Low Channel (Worst-Channel) – Pre-scan 30 MHz ~ 1 GHz

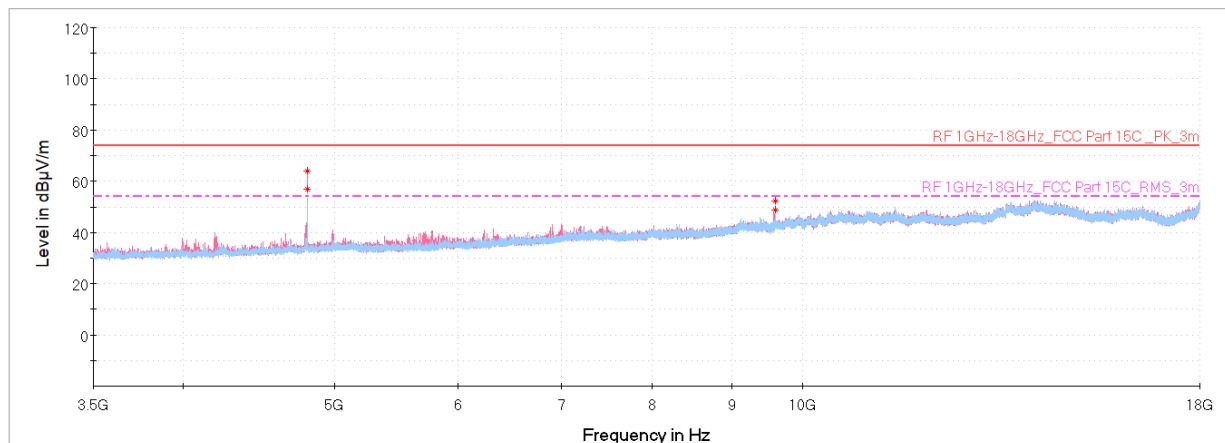


- * The correction factors have already been applied to the attached plots
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- BLE 1M Low Channel (Worst-Channel) – Pre-scan 1 GHz ~ 3.5 GHz

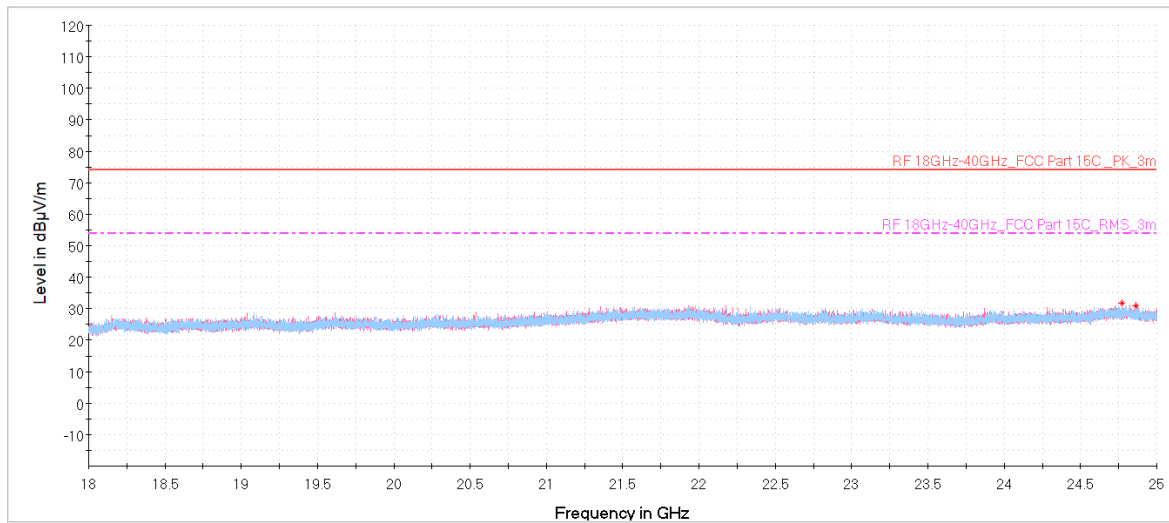


- BLE 1M Low Channel (Worst-Channel) – Pre-scan 3.5 GHz ~ 18 GHz



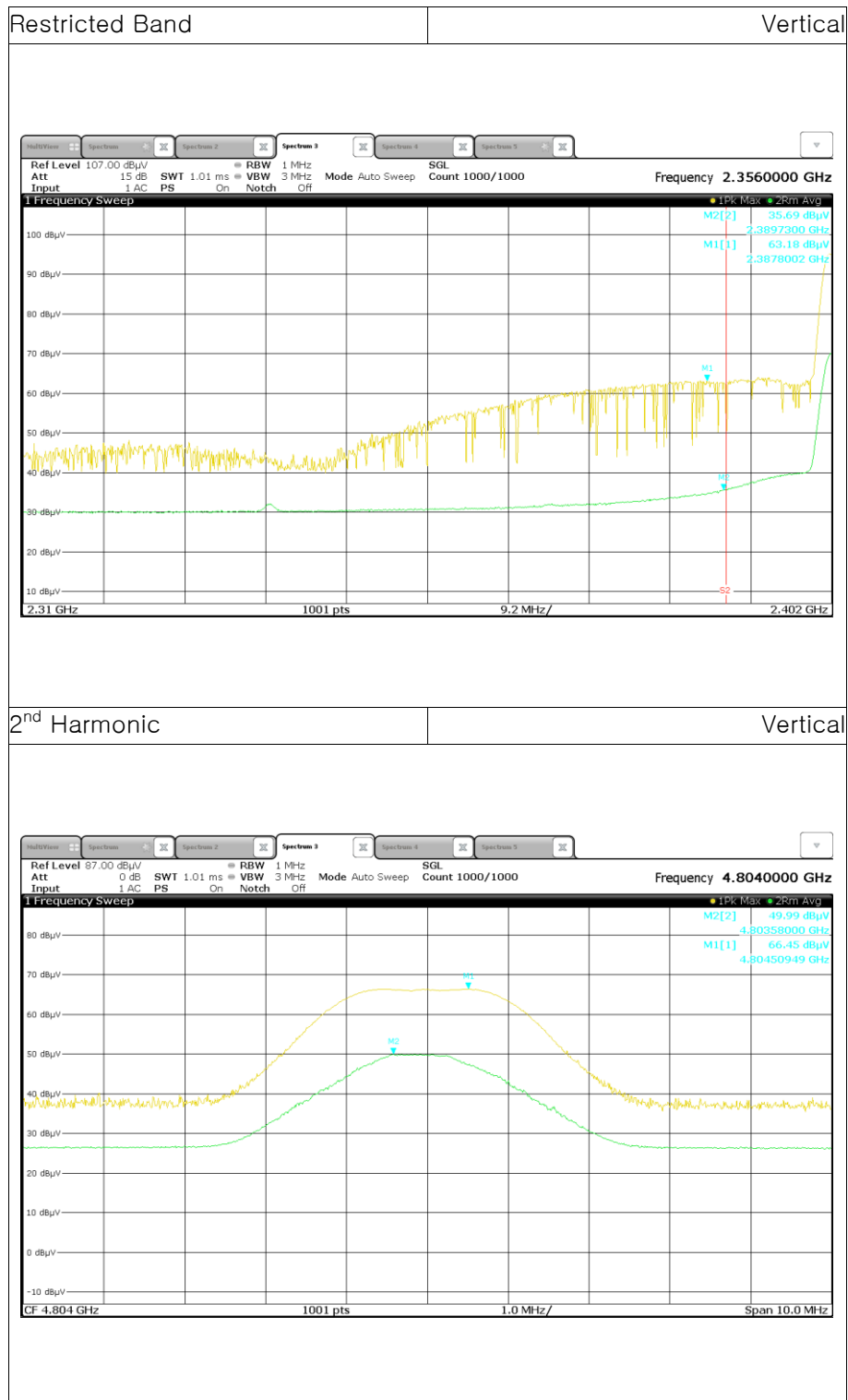
- * The correction factors have already been applied to the attached plots
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- BLE 1M Low Channel (Worst-Channel) – Pre-scan 18 GHz ~ 25 GHz

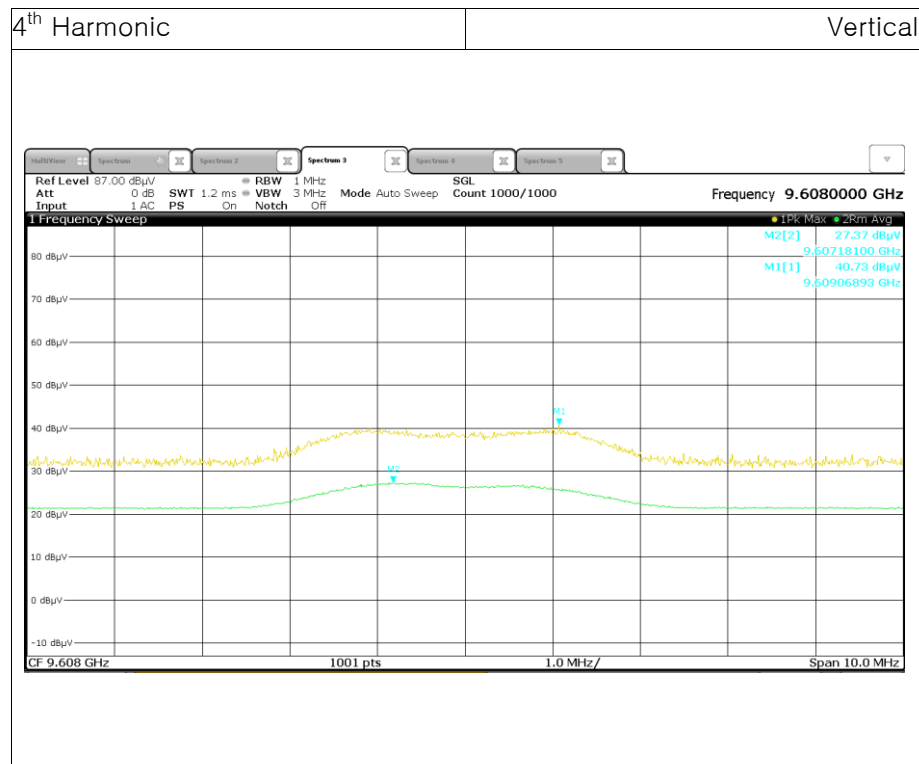


- * The correction factors have already been applied to the attached plots
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- BLE 1M _ Low frequency

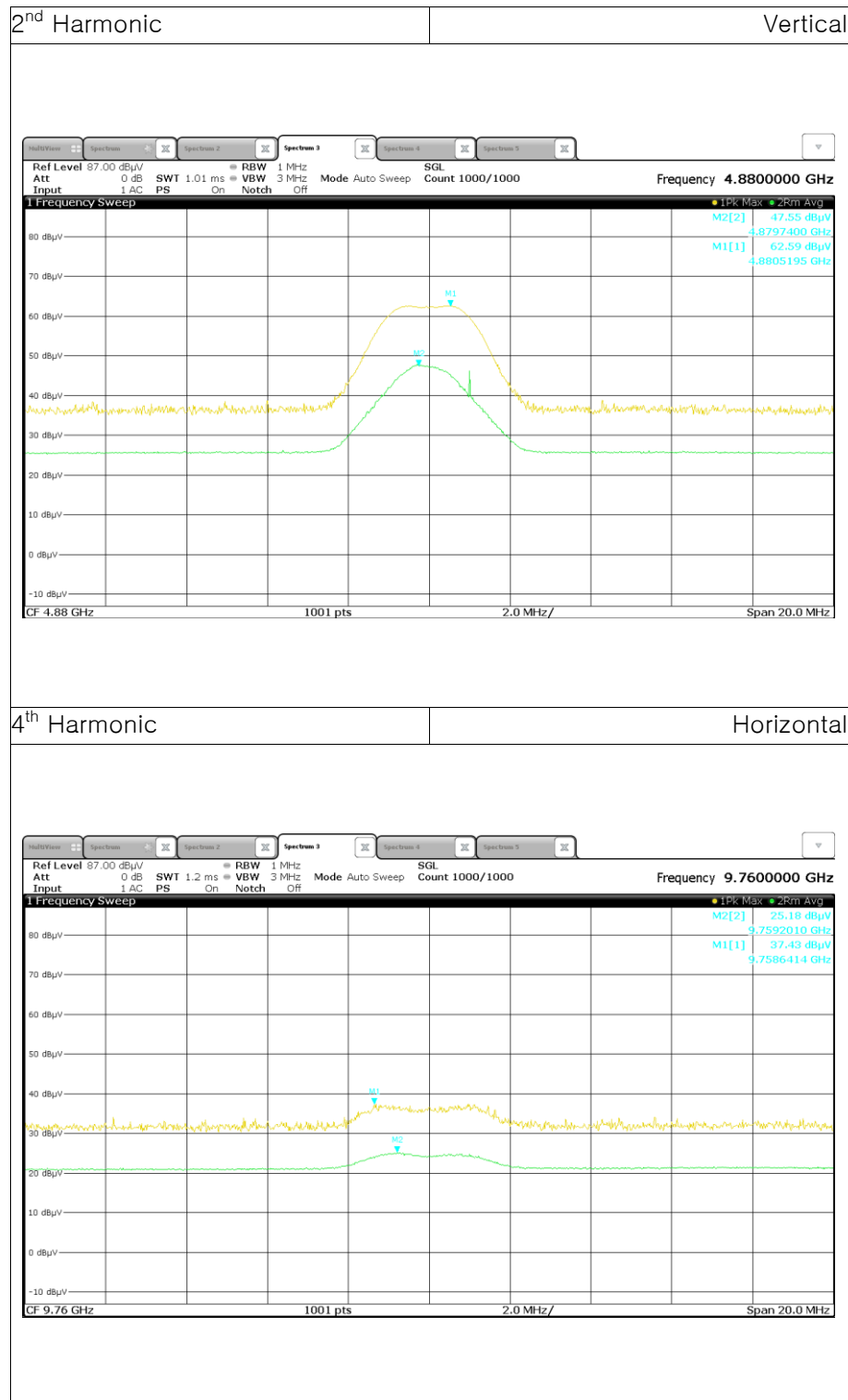


* The correction factors have not been applied to the attached plots.



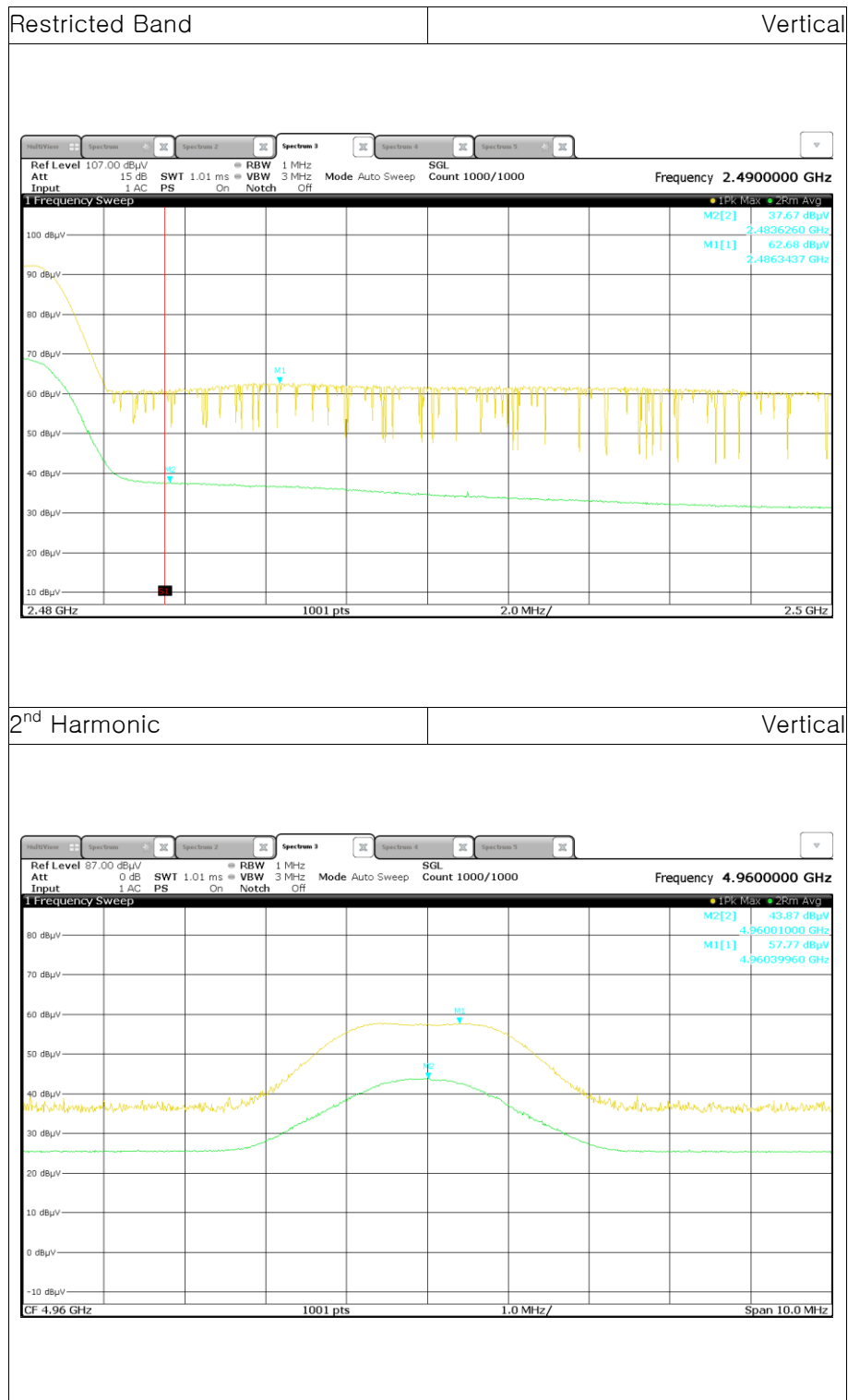
* The correction factors have not been applied to the attached plots.

- BLE 1M _ Mid frequency

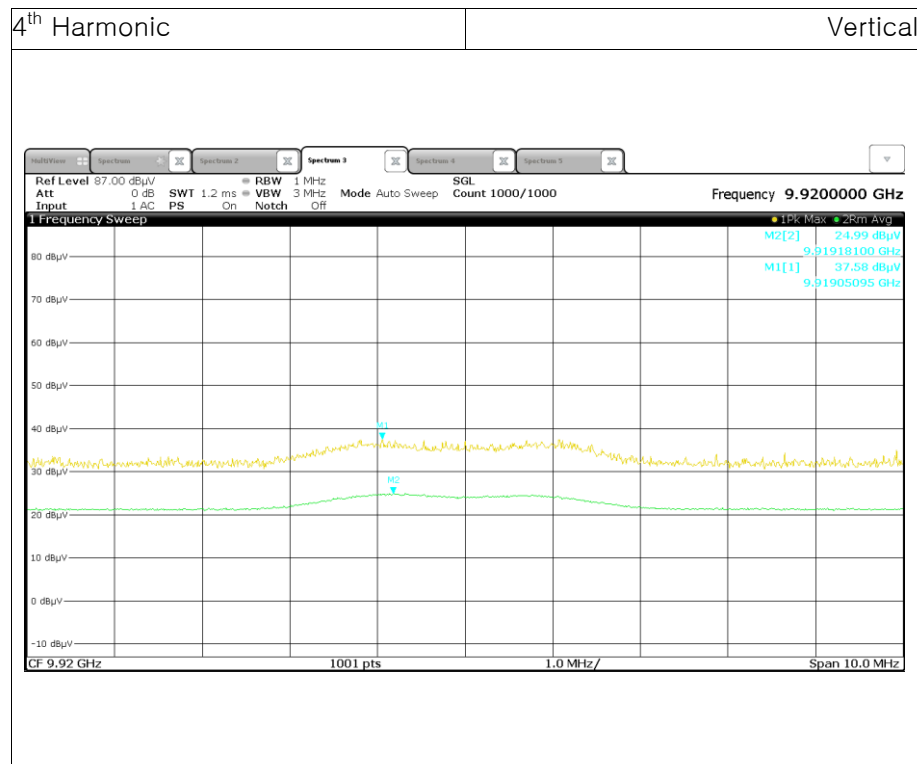


* The correction factors have not been applied to the attached plots.

- BLE 1M _ High frequency

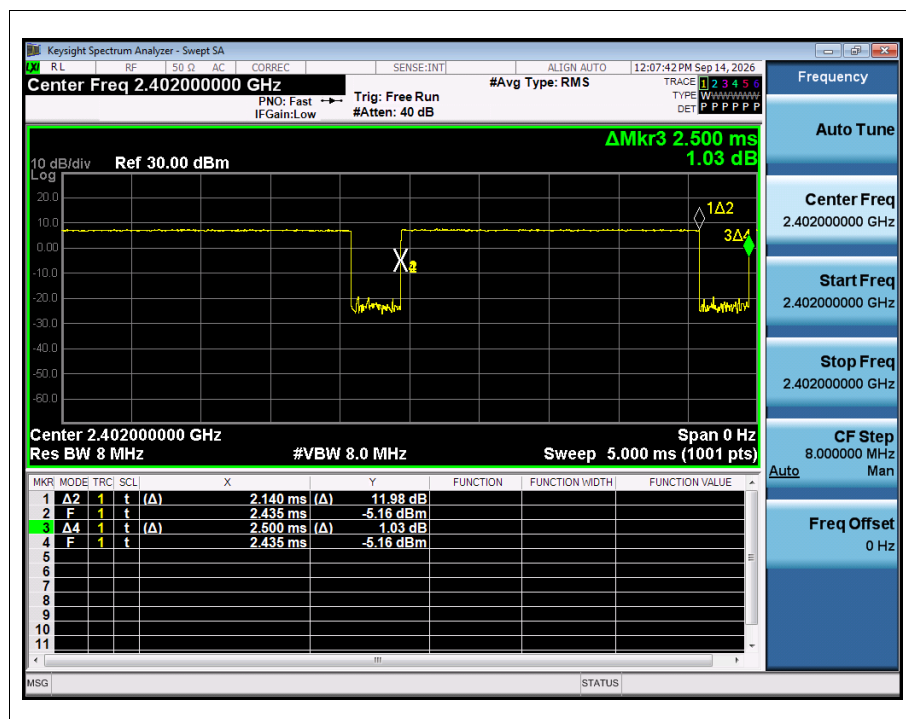


* The correction factors have not been applied to the attached plots.



* The correction factors have not been applied to the attached plots.

- BLE 1M _ Duty Cycle



9.6.3 9 kHz ~ 25 GHz Data for BT2

Test Mode : BLE 1M

● Low frequency

Frequency	Reading		Pol.	T.F (dB)	DCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
2 383.94	31.99	45.63	V	-9.50	3.73	54.0	74.0	26.2	36.1	27.8	37.9

● Middle frequency

Frequency	Reading	Pol.	T.F (dB)	DCF (dB)	Limits	Result	Margin
	(dBuV/m)				(dBuV/m)	(dBuV/m)	(dB)
(MHz)	AV / Peak				AV / Peak	AV / Peak	AV / Peak
No major peak found							

● High frequency

Frequency	Reading		Pol.	T.F (dB)	DCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
2 483.55	32.78	46.84	H	-9.50	3.73	54.0	74.0	27.0	37.3	27.0	36.7

Note 1: The radiated emissions were investigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found above listed frequencies.

Note 2: DCF(Duty Cycle Factor)

– $T_{total} = 5.0 \text{ ms} / T_{on} = 2.12 \text{ ms}$

– Duty Cycle = $T_{on} / T_{total} = 2.14 / 2.5 = 0.424$

– DCF = $10 \times \log(1/\text{Duty Cycle}) \text{ dB} = 10 \times \log(1/0.424) \text{ dB} = 3.73 \text{ dB}$

Note 3: Sample Calculation.

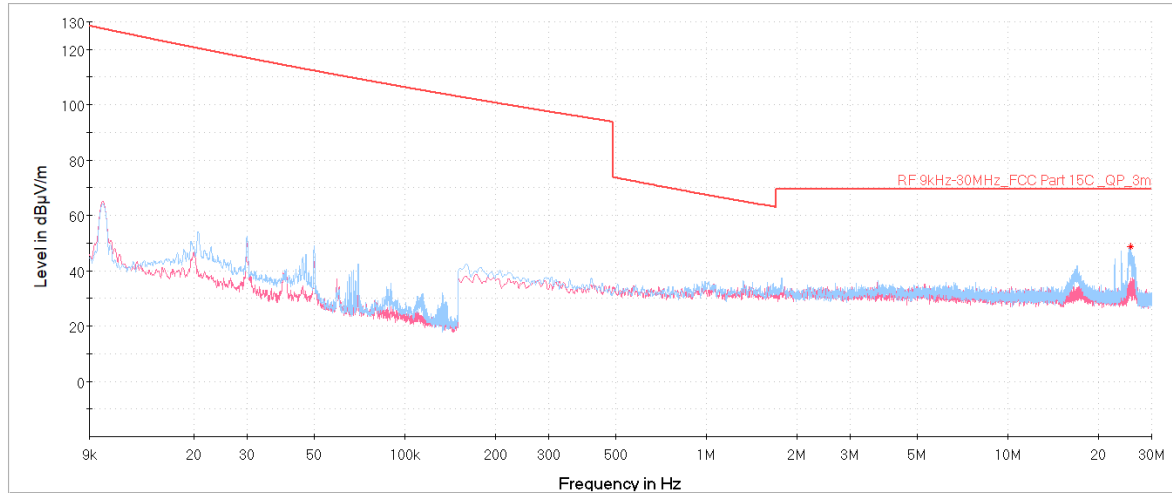
Margin = Limit – Result / Peak Result = Peak Reading + TF / Average Result = Average Reading + TF + DCF

TF = Ant factor + Cable Loss + Filter Loss – Amp Gain + Distance Factor

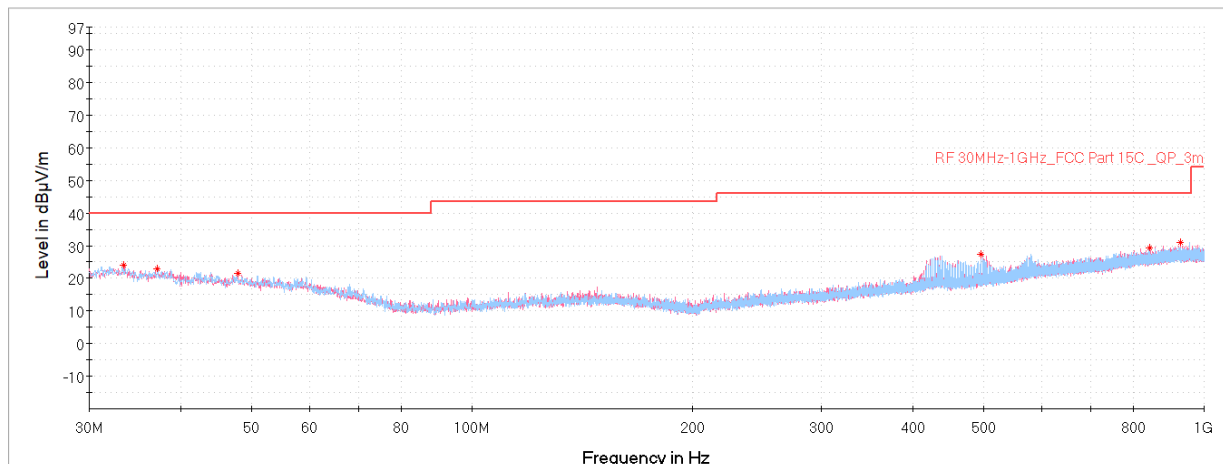
Distance Factor = $20\log(\text{applied distance}/\text{required distance}) = 20\log(3.75\text{m}/3\text{m}) = 1.94$

9.6.4 9 kHz ~ 25 GHz Plots for BT2

- BLE 1M High Channel (Worst-Channel) – Pre-scan 9 kHz ~ 30 MHz

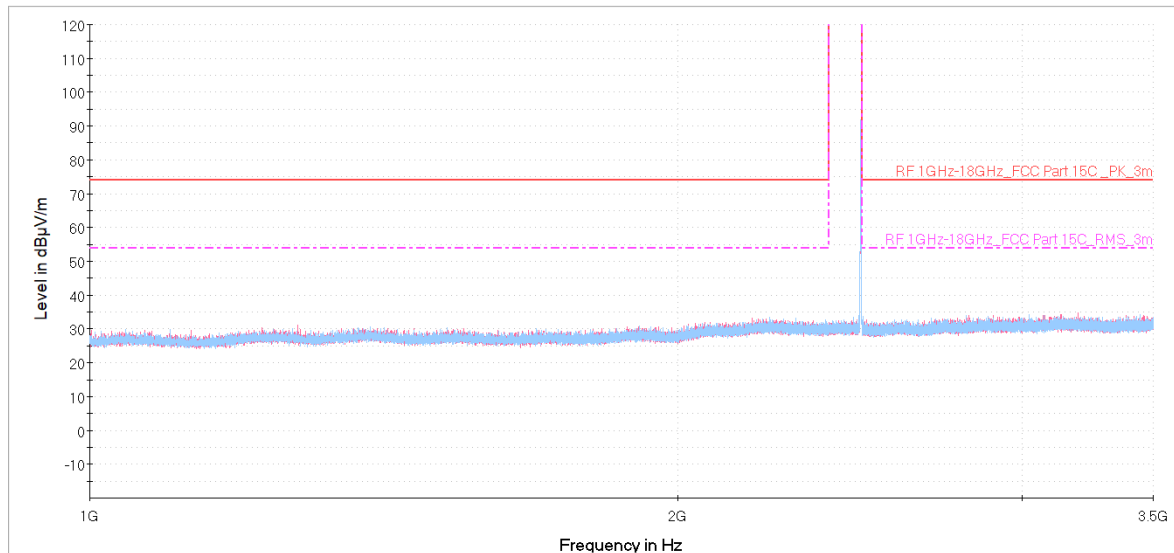


- BLE 1M High Channel (Worst-Channel) – Pre-scan 30 MHz ~ 1 GHz



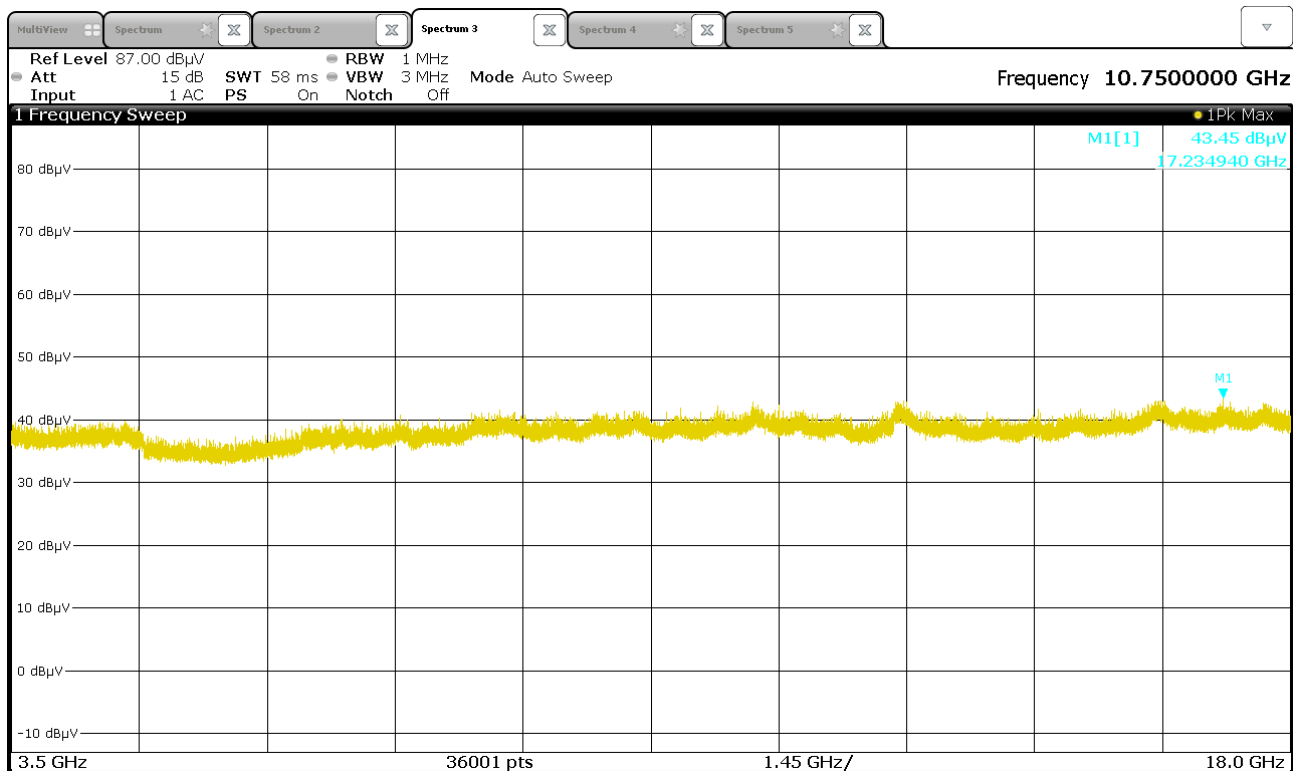
- * The correction factors have already been applied to the attached plots
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- BLE 1M High Channel (Worst-Channel) – Pre-scan 1 GHz ~ 3.5 GHz



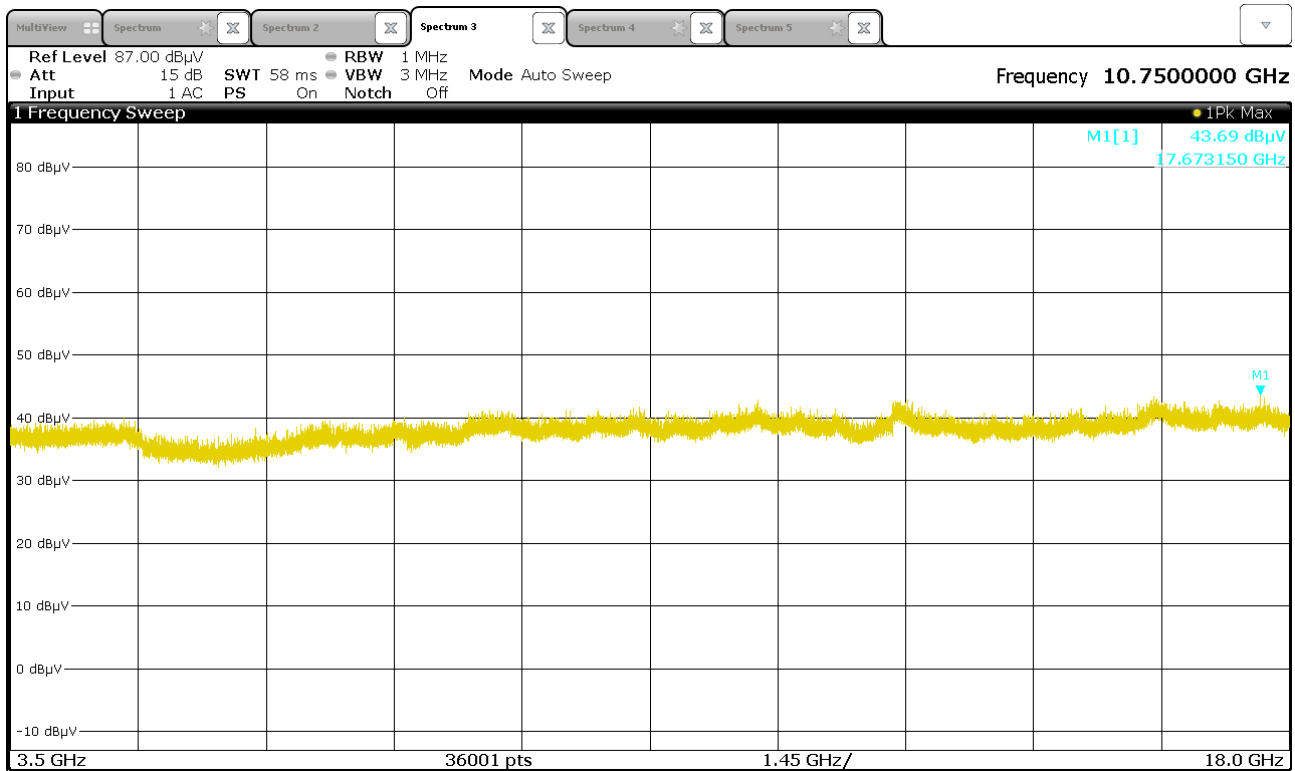
- * The correction factors have already been applied to the attached plot.
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- BLE 1M High Channel (Worst-Channel) – Pre-scan 3.5 GHz ~ 18 GHz (Horizontal)



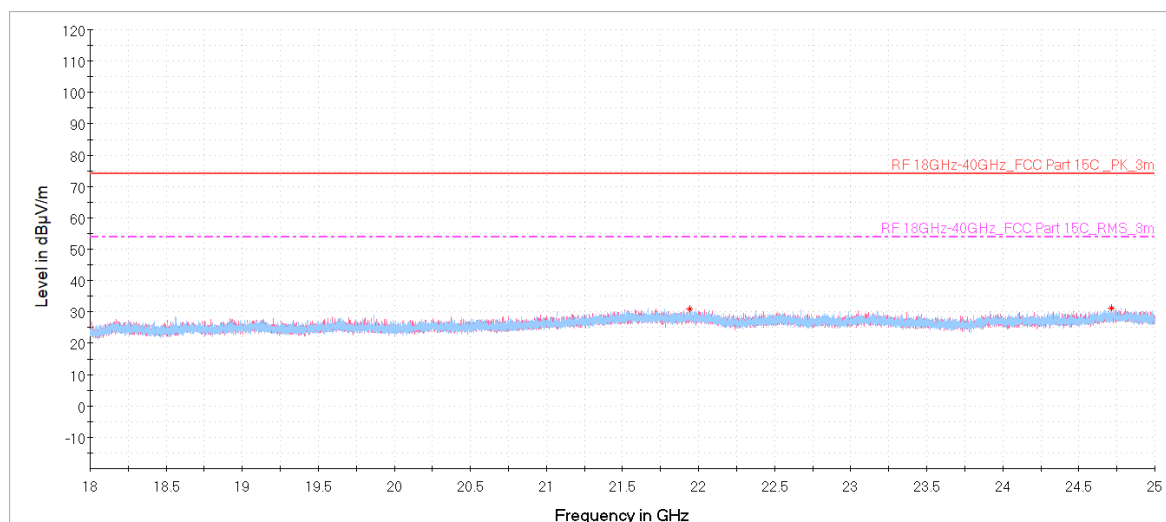
- * The correction factors have not been applied to the attached plot.

- BLE 1M High Channel (Worst-Channel) – Pre-scan 3.5 GHz ~ 18 GHz (Vertical)



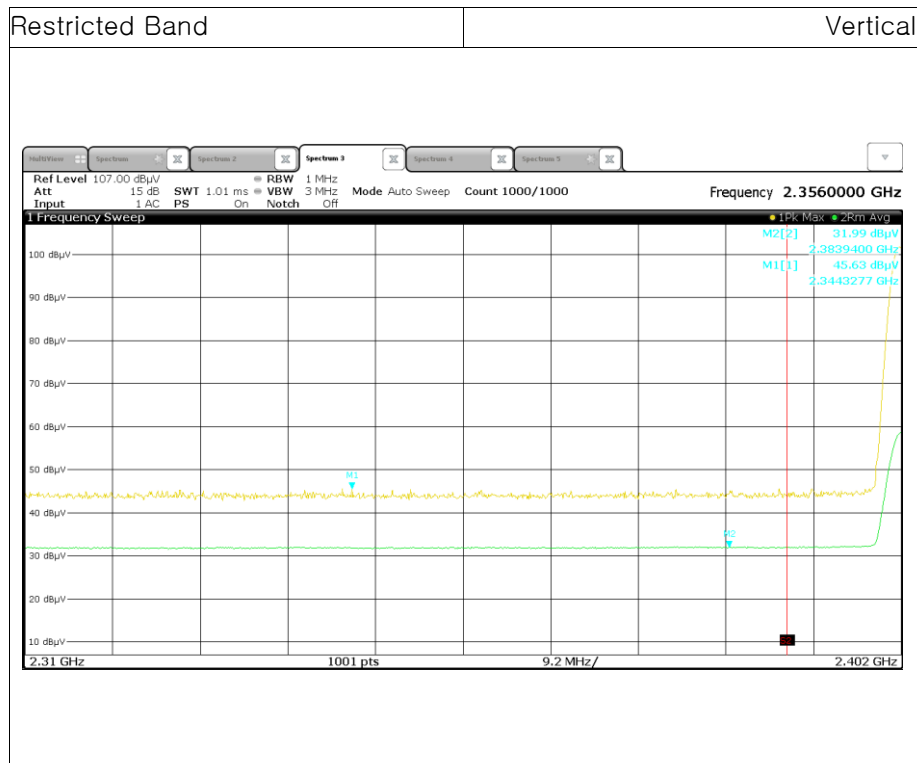
* The correction factors have not been applied to the attached plot.

- BLE 1M High Channel (Worst-Channel) – Pre-scan 18 GHz ~ 25 GHz

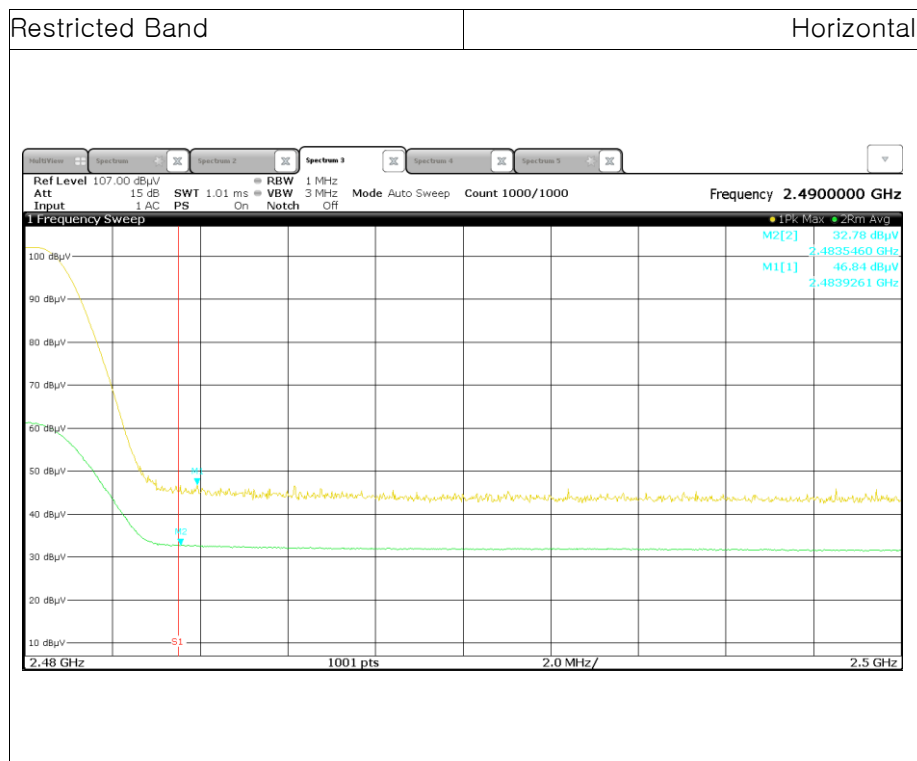


* The correction factors have already been applied to the attached plot
 * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- BLE 1M _ Low frequency

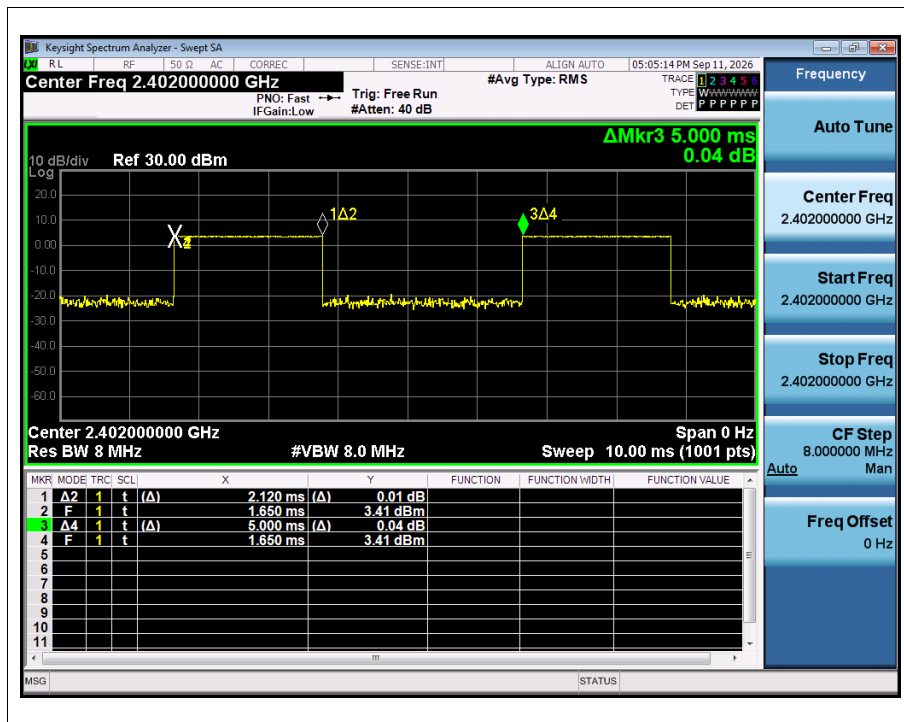


- BLE 1M _ High frequency



* The correction factors have not been applied to the attached plots.

- BLE 1M _ Duty Cycle



9.6.5 9 kHz ~ 25 GHz Data for Mesh

● Low frequency

Low frequency											
Frequency	Reading		Pol.	T.F (dB)	DCCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dBuV/m)		(dB)	
	AV / Peak					AV / Peak		AV / Peak		AV / Peak	
2 389.57	–	47.13	V	10.53	–34.21	54.0	74.0	23.5	57.7	30.6	16.3
4 819.17	–	58.48	H	–0.44	–34.21	54.0	74.0	23.8	58.0	30.2	16.0
7 231.81	–	56.24	H	9.53	–34.21	54.0	74.0	31.6	65.8	22.4	8.2

● Middle frequency

Middle frequency											
Frequency	Reading		Pol.	T.F (dB)	DCCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dB)			
	AV / Peak					AV / Peak		AV / Peak			
4 889.13	–	57.61	H	–0.17	–34.21	54.0	74.0	23.2	57.4	30.8	16.6
7 333.62	–	55.02	V	9.82	–34.21	54.0	74.0	30.6	64.8	23.4	9.2

● High frequency

Frequency (MHz)	Reading		Pol.	T.F (dB)	DCCF (dB)	Limits		Result		Margin	
	(dBuV/m)					(dBuV/m)		(dB)			
	AV / Peak					AV / Peak		AV / Peak			
2 483.70	–	58.34	V	10.50	–34.21	54.0	74.0	34.6	68.8	19.4	5.2
4 951.21	–	58.38	H	0.31	–34.21	54.0	74.0	24.5	58.7	29.5	15.3
7 426.77	–	53.45	H	10.11	–34.21	54.0	74.0	29.4	63.6	24.7	10.4

Note 1: The radiated emissions were investigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found above listed frequencies.

Note 2: DCCF(Duty Cycle Correction Factor)

– $T_{on} = 0.649 \text{ ms}$ / $T_{off} = 39.35 \text{ ms}$

– $DCCF = 20 \times \log(\text{The Worst Case Dwell Time} / 100 \text{ ms}) \text{ dB} = 20 \times \log(1.947/100) \text{ dB} = -34.21 \text{ dB}$

Note 3: Sample Calculation.

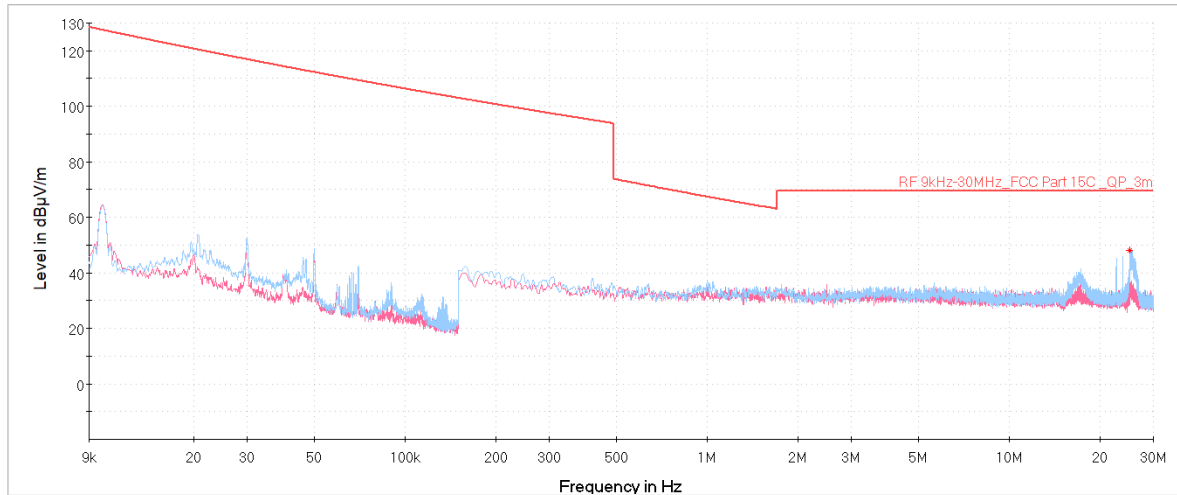
Margin = Limit – Result / Peak Result = Peak Reading + TF / Average Result = Average Reading + TF + DCCF

TF = Ant factor + Cable Loss + Filter Loss – Amp Gain + Distance Factor

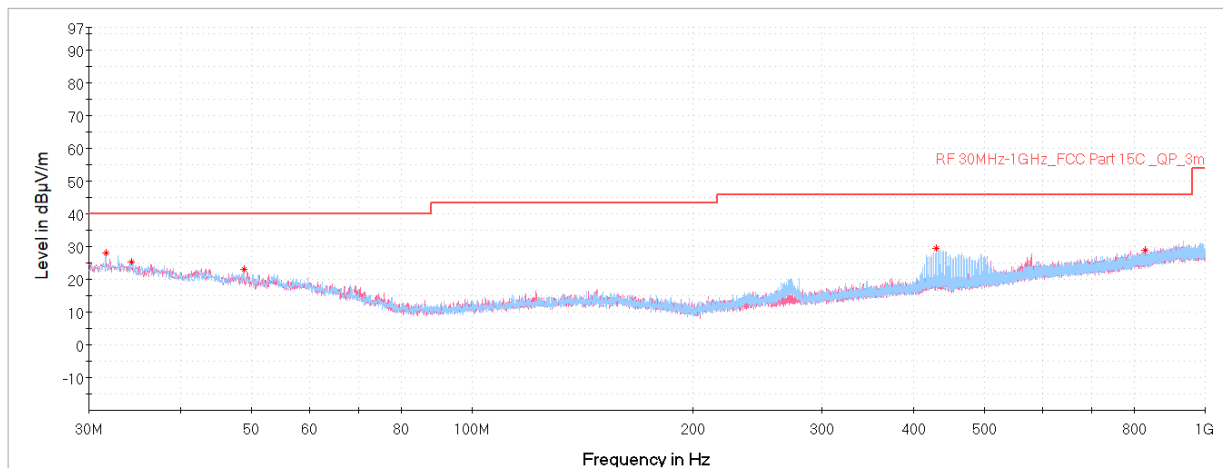
Distance Factor = $20\log(\text{applied distance}/\text{required distance}) = 20\log(3.75\text{m}/3\text{m}) = 1.94$

9.6.6 9 kHz ~ 25 GHz Plots for Mesh

- Mesh High Channel (Worst-Channel) – Pre-scan 9 kHz ~ 30 MHz

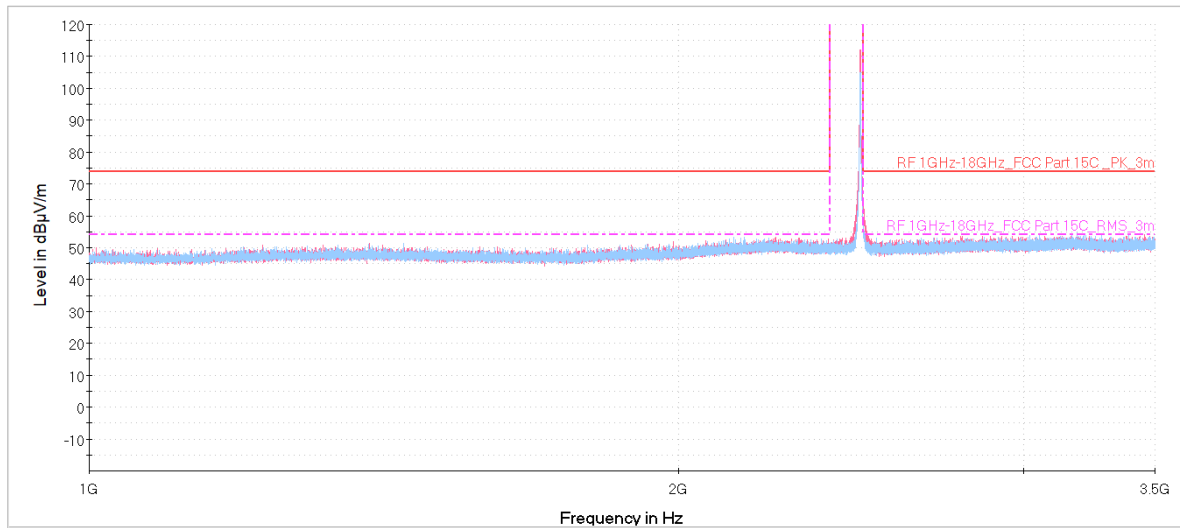


- Mesh High Channel (Worst-Channel) – Pre-scan 30 MHz ~ 1 GHz

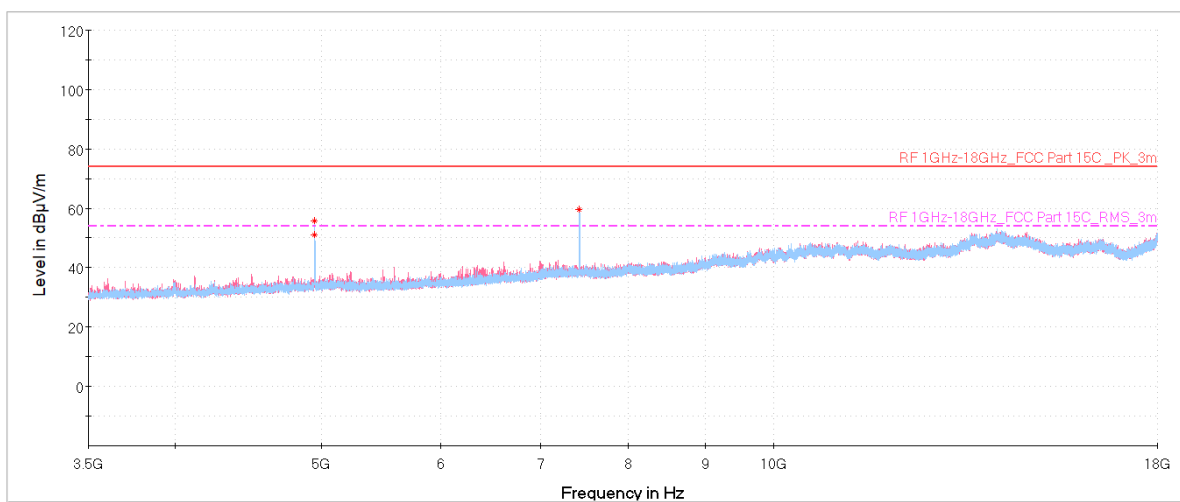


- * The correction factors have already been applied to the attached plots
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- Mesh High Channel (Worst-Channel) – Pre-scan 1 GHz ~ 3.5 GHz

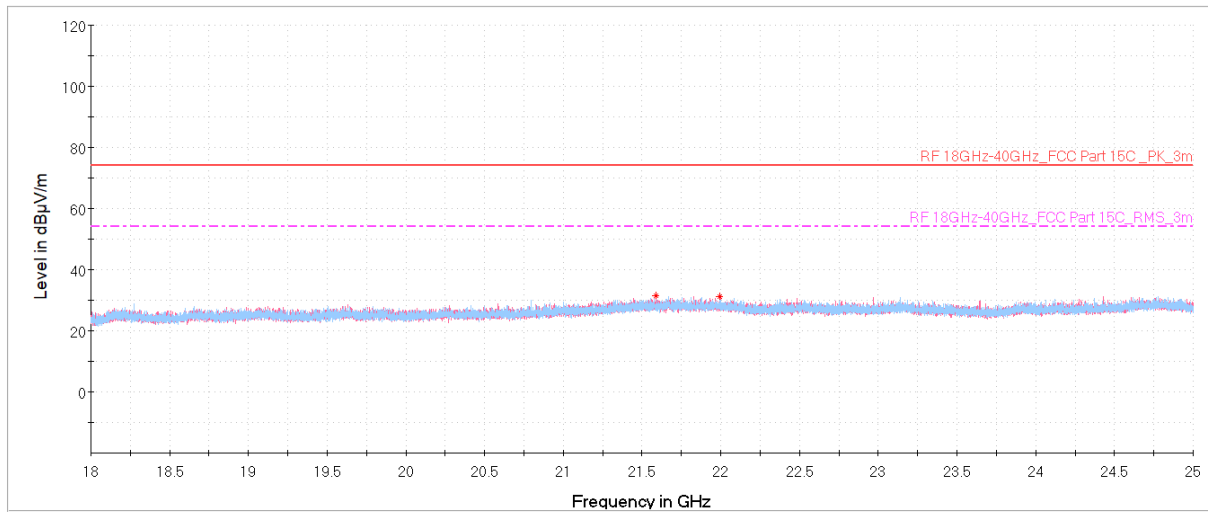


- Mesh High Channel (Worst-Channel) – Pre-scan 3.5 GHz ~ 18 GHz



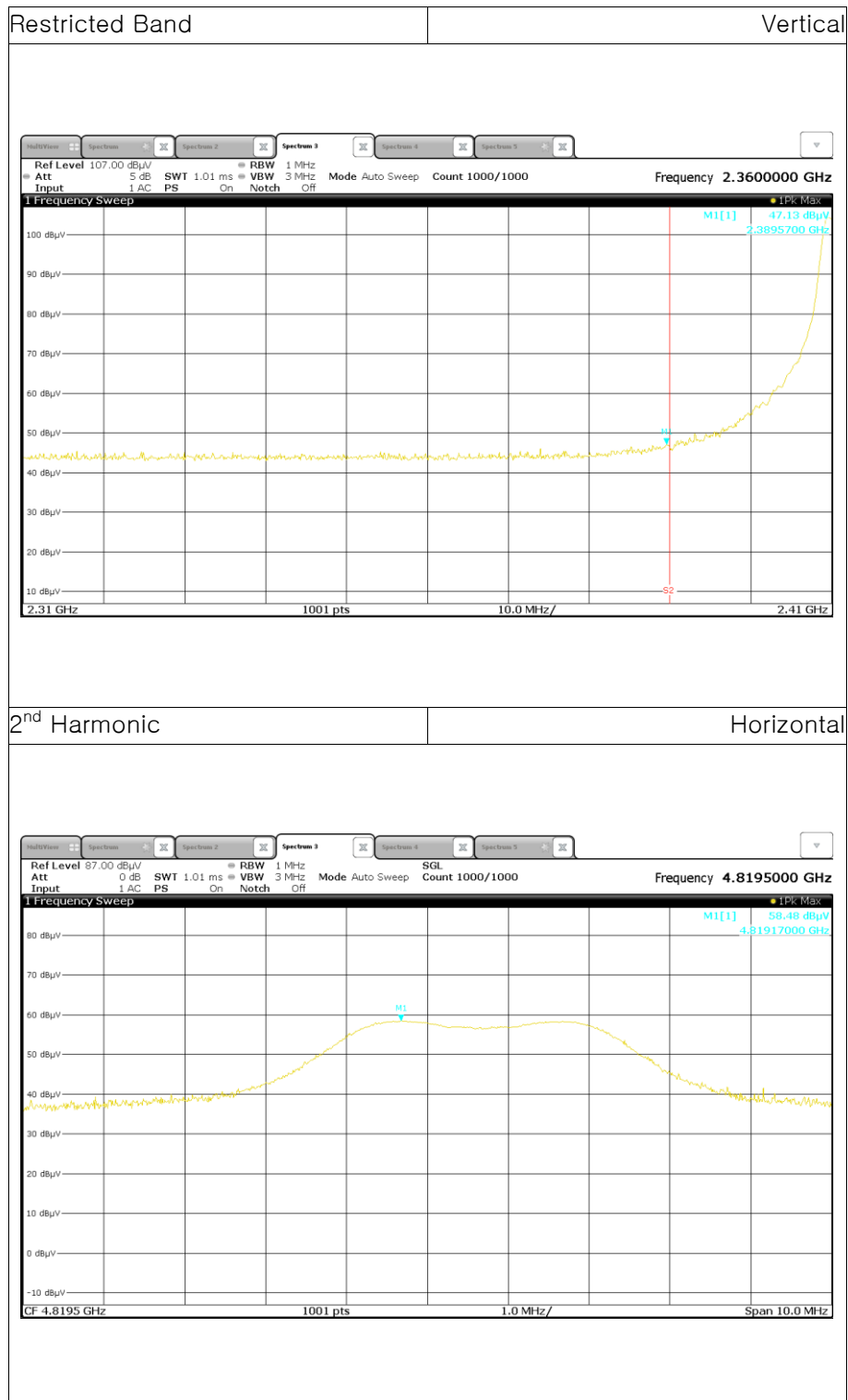
- * The correction factors have already been applied to the attached plots.
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- Mesh High Channel (Worst-Channel) – Pre-scan 18 GHz ~ 25 GHz

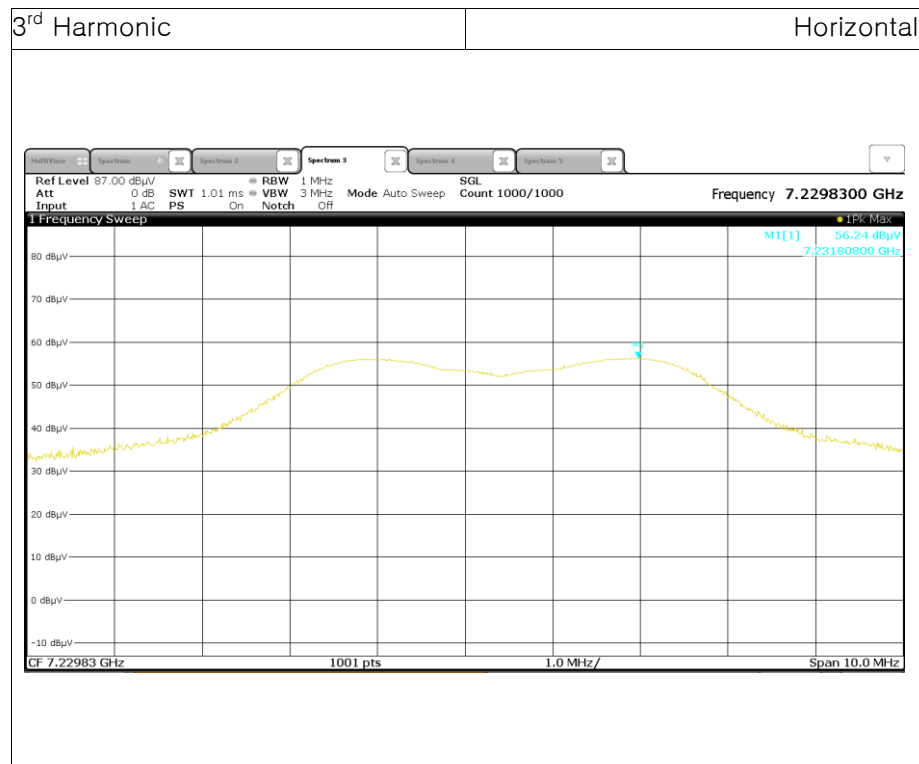


- * The correction factors have already been applied to the attached plot
- * Applied Correction Factor = Ant factor + Cable Loss + Filter Loss – Amp Gain

- Mesh _ Low frequency

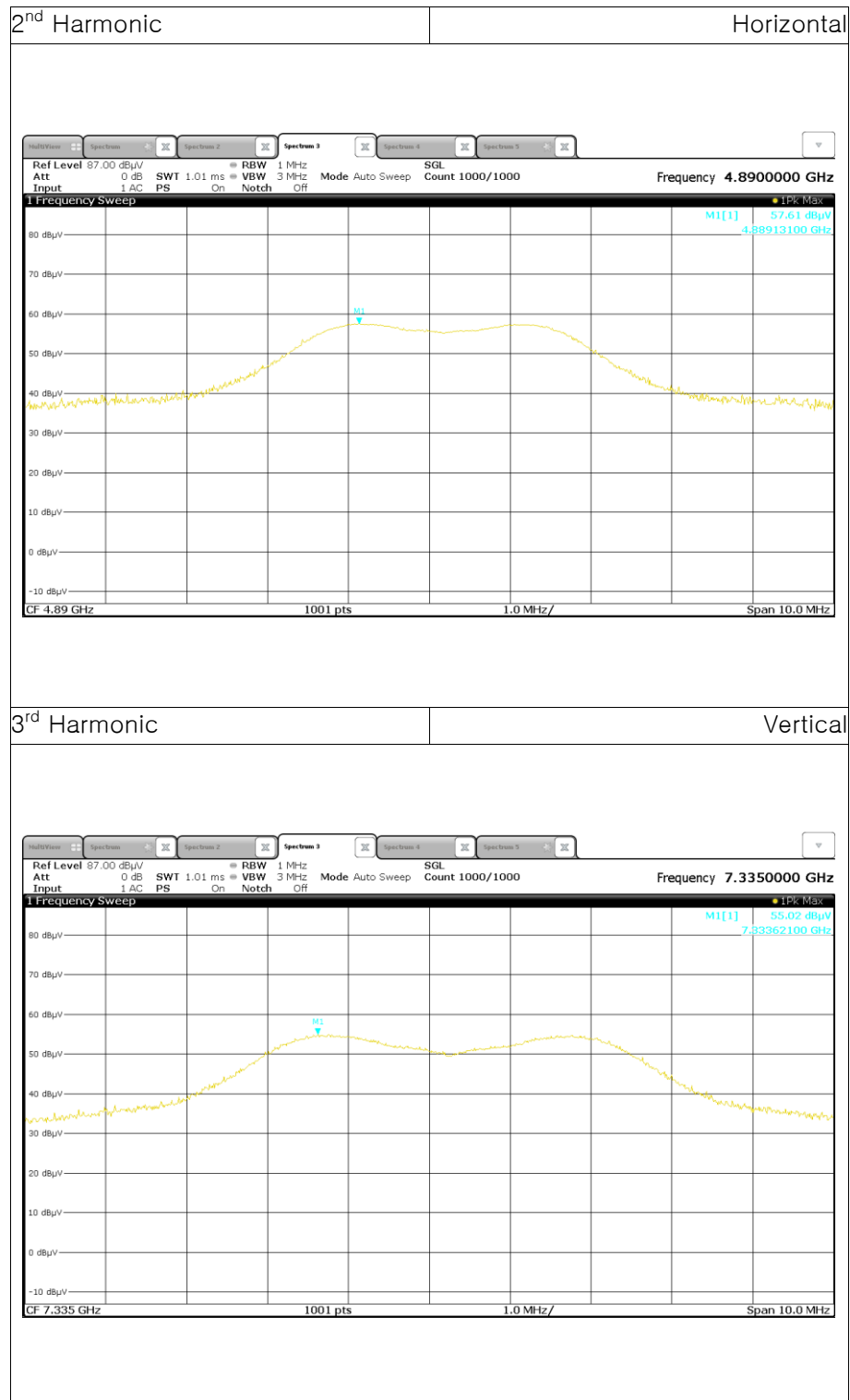


* The correction factors have not been applied to the attached plots.



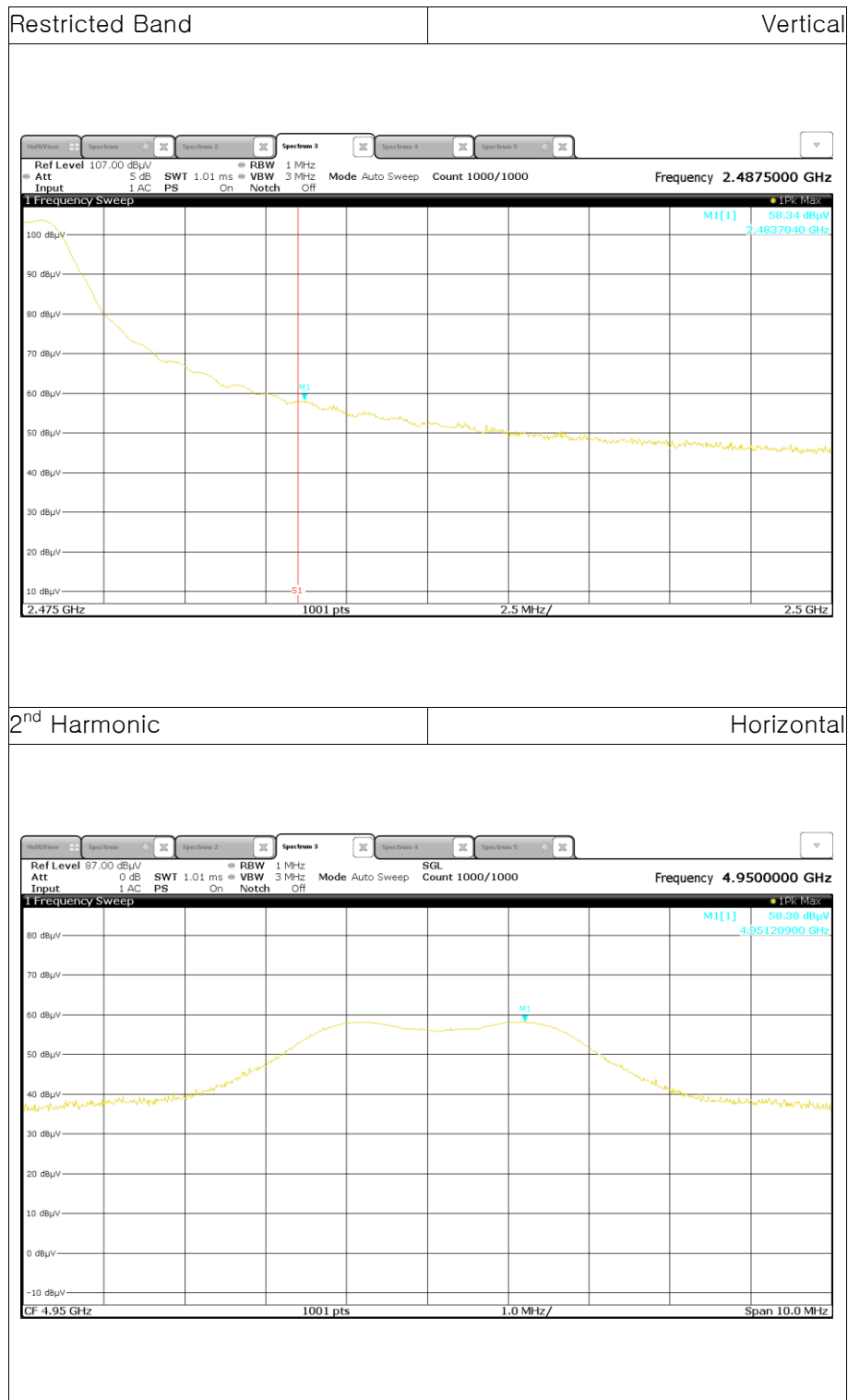
* The correction factors have not been applied to the attached plots.

- Mesh _ Mid frequency

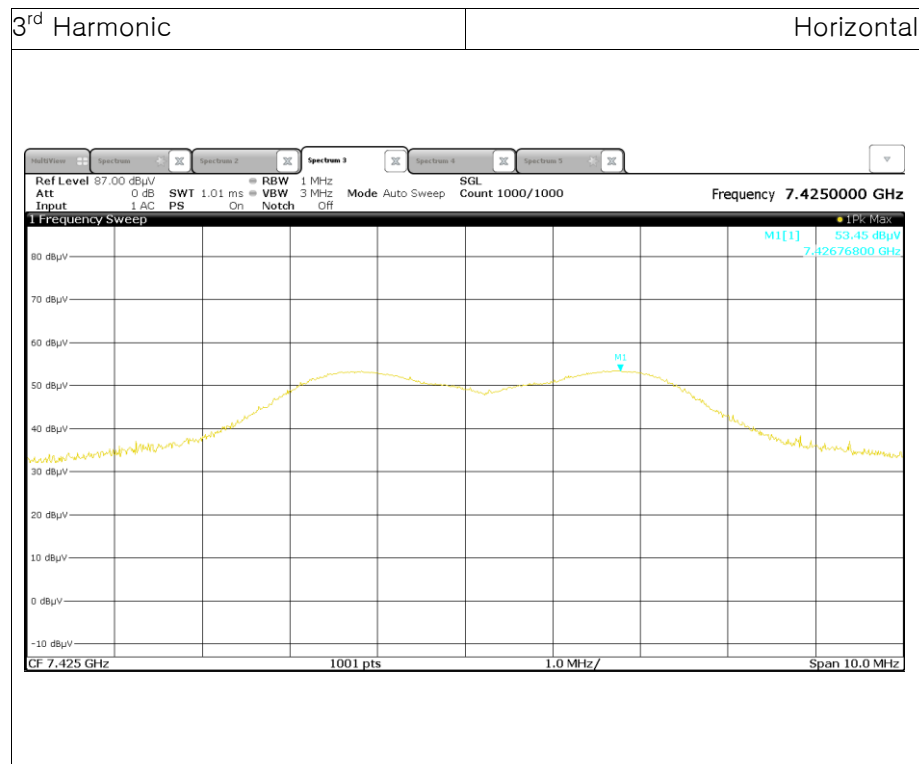


* The correction factors have not been applied to the attached plots.

- Mesh _ High frequency

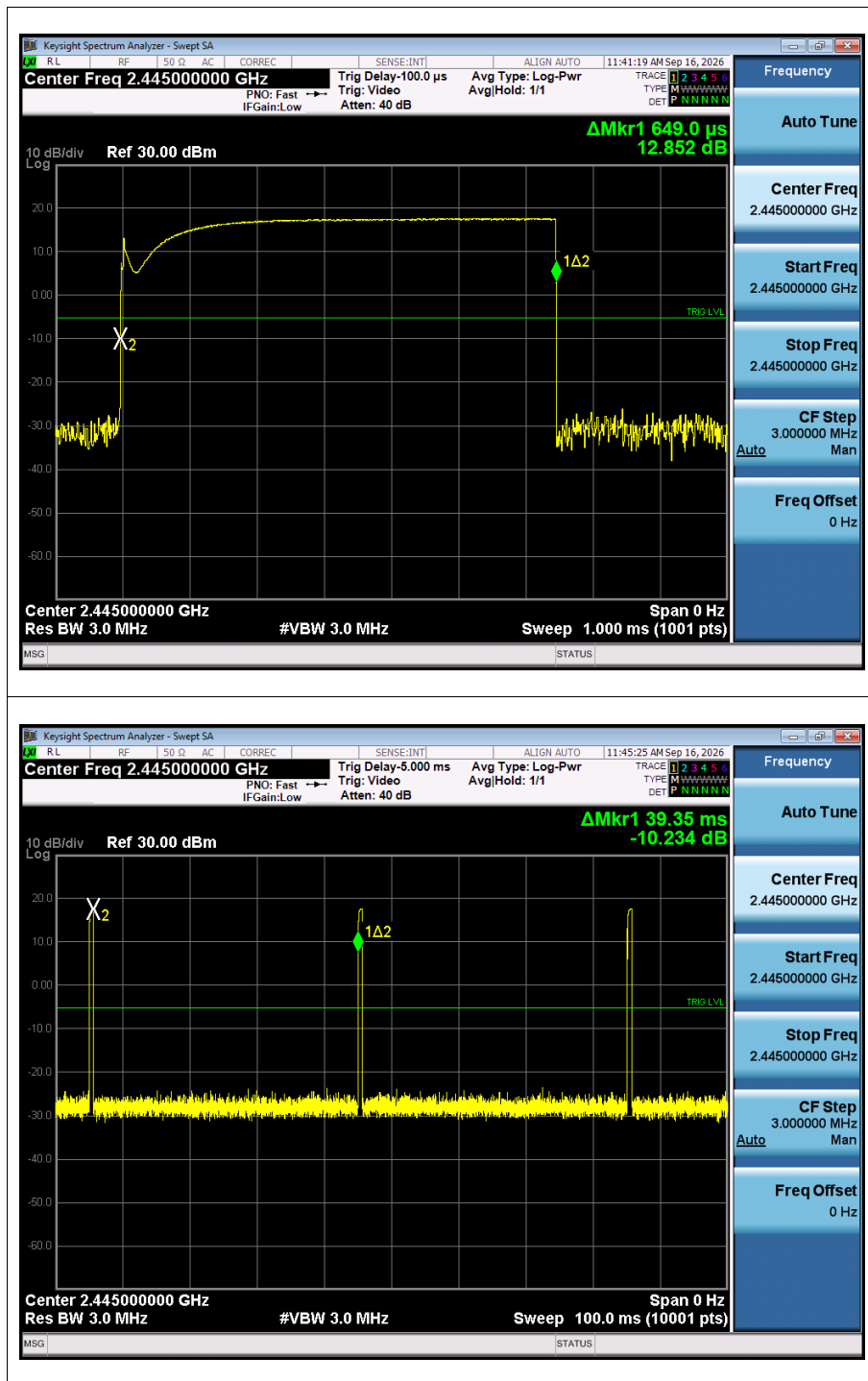


* The correction factors have not been applied to the attached plots.



* The correction factors have not been applied to the attached plots.

- Mesh _ Duty Cycle





10. Conducted Emission

10.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

10.2 Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency Range (MHz)	Conducted Limit (dBuV)	
	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

10.3 Test Procedure

Conducted emissions from the EUT were measured according to the ANSI C63.10.

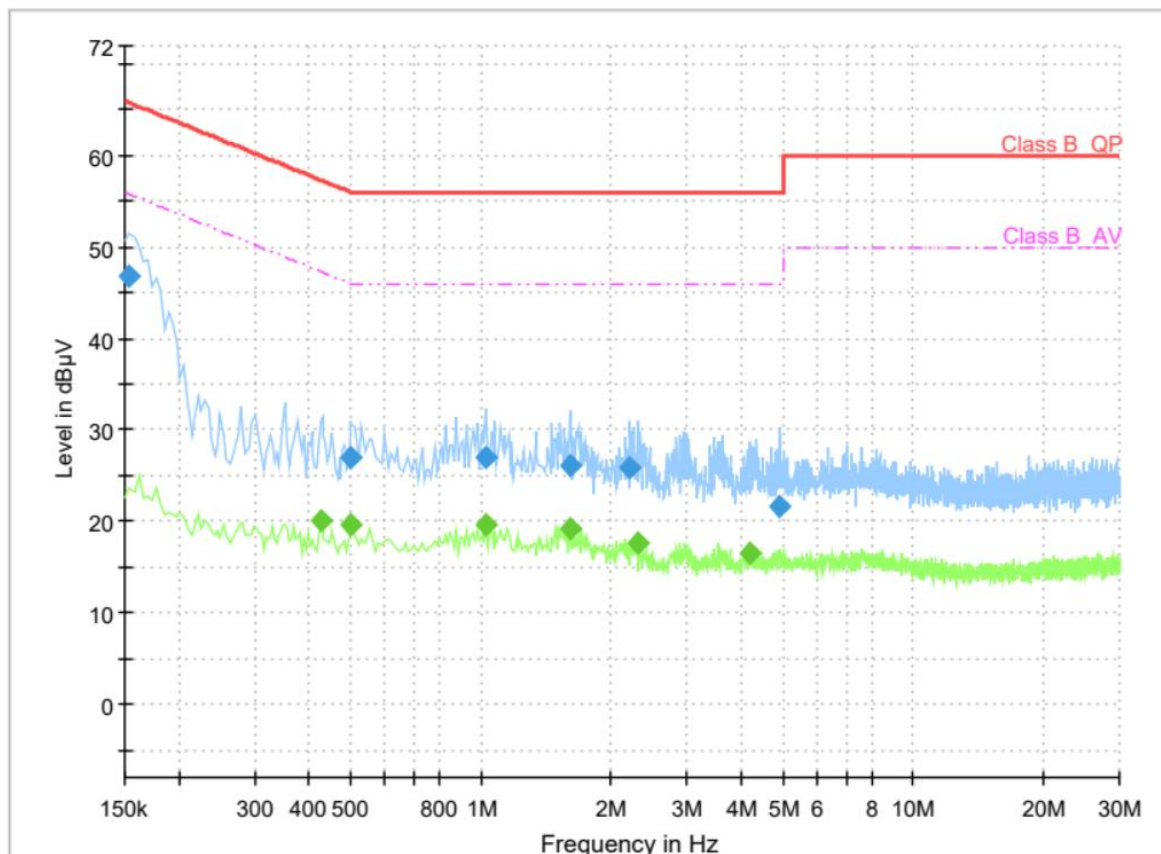
1. The test procedure is performed in a 6.5 m $\times$ 3.5 m $\times$ 3.5 m (L $\times$ W $\times$ H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) $\times$ 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.



10.4 Test Result

- AC Line Conducted Emission (Graph) for BT1

Conducted Emission

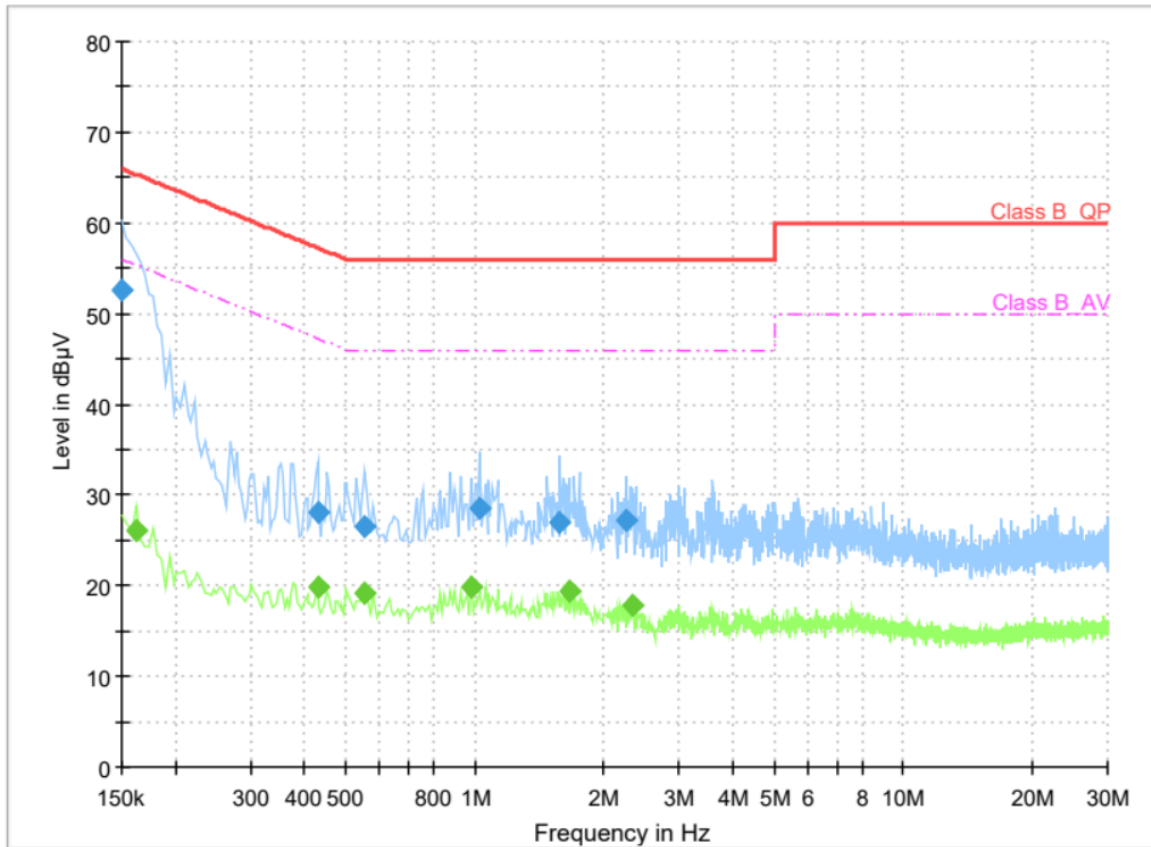


Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.154	46.72	---	65.78	19.06	9	L1	19.8
0.426	---	19.97	47.33	27.36	9	L1	19.8
0.500	26.93	---	56.00	29.07	9	L1	19.9
0.500	---	19.71	46.00	26.29	9	L1	19.8
1.030	---	19.69	46.00	26.31	9	L1	19.7
1.030	27.05	---	56.00	28.95	9	L1	19.7
1.610	26.03	---	56.00	29.97	9	L1	19.7
1.610	---	19.28	46.00	26.72	9	L1	19.7
2.210	25.86	---	56.00	30.14	9	L1	19.7
2.310	---	17.60	46.00	28.40	9	L1	19.7
4.200	---	16.60	46.00	29.40	9	L1	19.7
4.930	21.56	---	56.00	34.44	9	L1	19.7



Conducted Emission



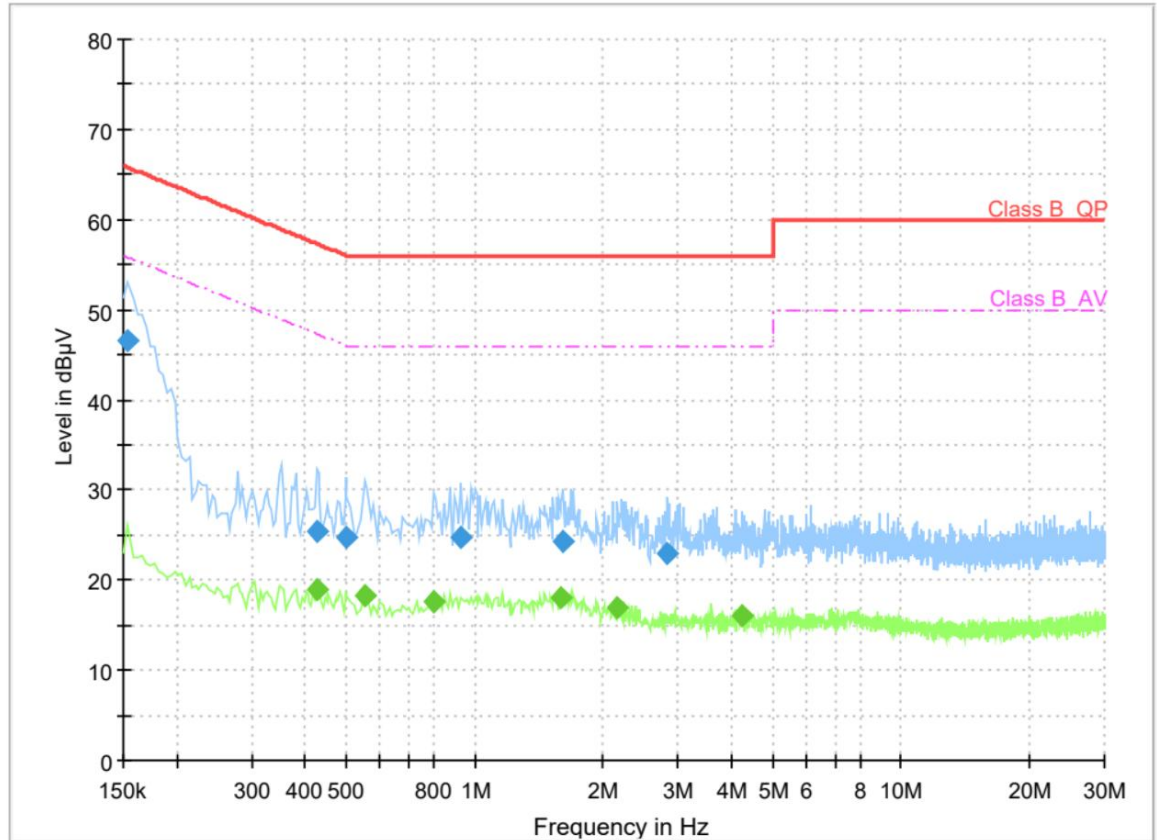
Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.150	52.54	---	66.00	13.46	9	N	19.7
0.162	---	26.02	55.36	29.34	9	N	19.9
0.430	---	19.80	47.25	27.45	9	N	19.8
0.430	28.09	---	57.25	29.16	9	N	19.8
0.550	---	19.08	46.00	26.92	9	N	19.8
0.550	26.58	---	56.00	29.42	9	N	19.8
0.980	---	19.94	46.00	26.06	9	N	19.7
1.030	28.55	---	56.00	27.45	9	N	19.7
1.580	26.87	---	56.00	29.13	9	N	19.7
1.660	---	19.36	46.00	26.64	9	N	19.7
2.260	27.17	---	56.00	28.83	9	N	19.6
2.340	---	17.74	46.00	28.26	9	N	19.6



- AC Line Conducted Emission (Graph) for BT2

Conducted Emission

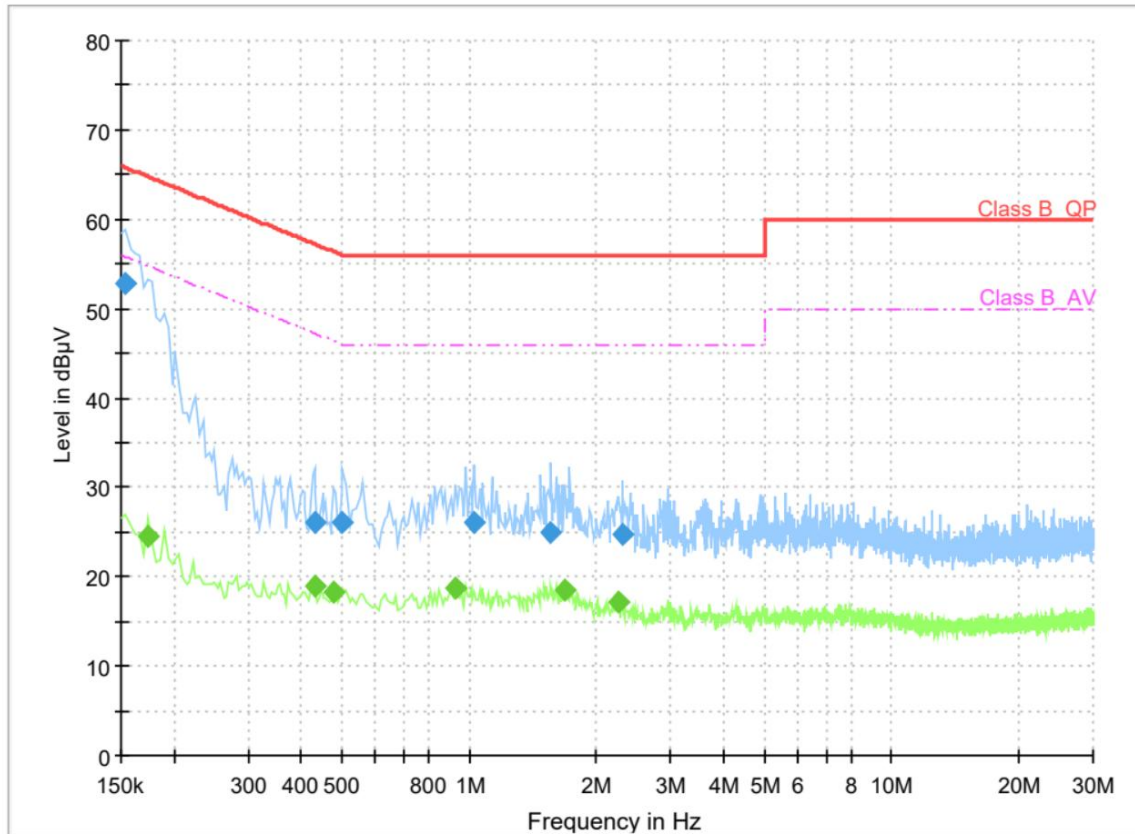


Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.154	46.50	---	65.78	19.29	9	L1	19.8
0.426	---	18.83	47.33	28.50	9	L1	19.8
0.426	25.43	---	57.33	31.90	9	L1	19.8
0.500	24.84	---	56.00	31.16	9	L1	19.9
0.550	---	18.37	46.00	27.63	9	L1	19.8
0.800	---	17.68	46.00	28.32	9	L1	19.8
0.930	24.69	---	56.00	31.31	9	L1	19.7
1.590	---	18.07	46.00	27.93	9	L1	19.7
1.610	24.28	---	56.00	31.72	9	L1	19.7
2.160	---	16.94	46.00	29.06	9	L1	19.7
2.840	22.85	---	56.00	33.15	9	L1	19.7
4.250	---	16.02	46.00	29.98	9	L1	19.7



Conducted Emission



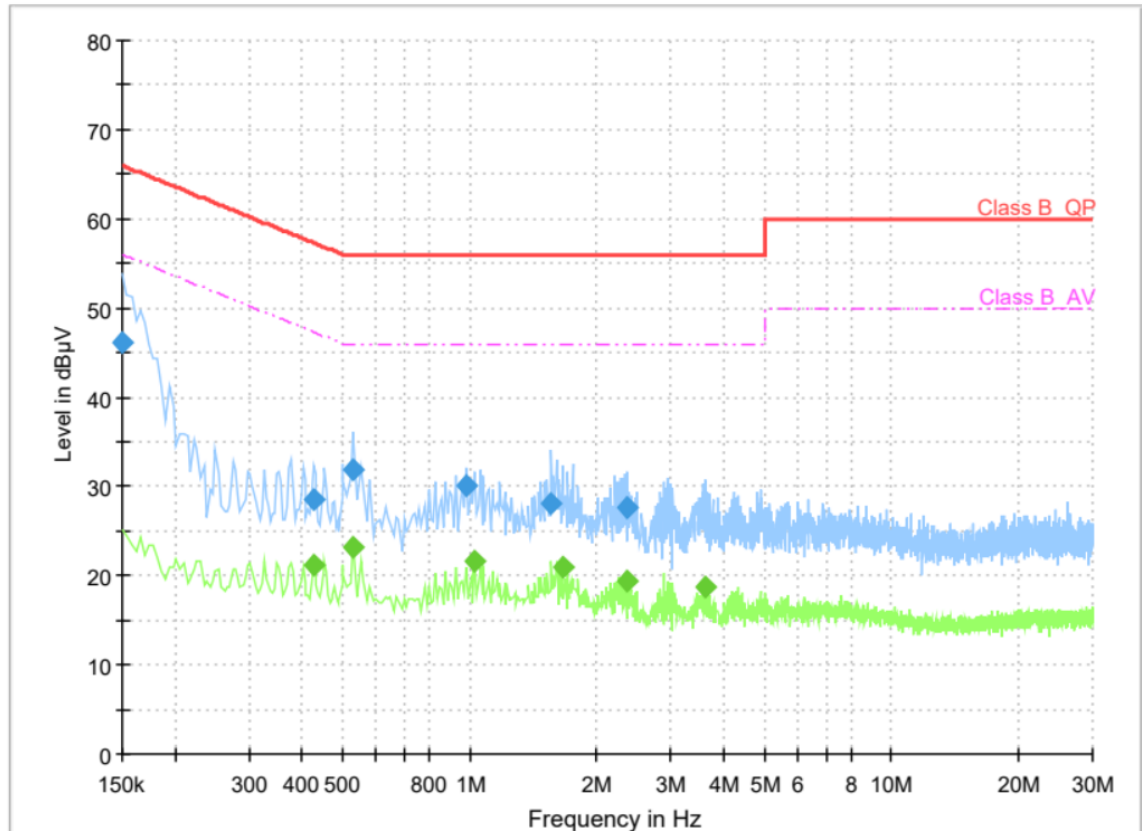
Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.154	52.89	---	65.78	12.90	9	N	19.8
0.174	---	24.55	54.77	30.22	9	N	20.0
0.430	---	18.88	47.25	28.38	9	N	19.8
0.430	26.12	---	57.25	31.13	9	N	19.8
0.478	---	18.23	46.37	28.15	9	N	19.8
0.500	26.03	---	56.00	29.97	9	N	19.8
0.930	---	18.63	46.00	27.37	9	N	19.7
1.030	26.00	---	56.00	30.00	9	N	19.7
1.560	24.86	---	56.00	31.14	9	N	19.7
1.680	---	18.45	46.00	27.55	9	N	19.7
2.260	---	17.06	46.00	28.94	9	N	19.6
2.310	24.84	---	56.00	31.16	9	N	19.6



- AC Line Conducted Emission (Graph) for Mesh

Conducted Emission

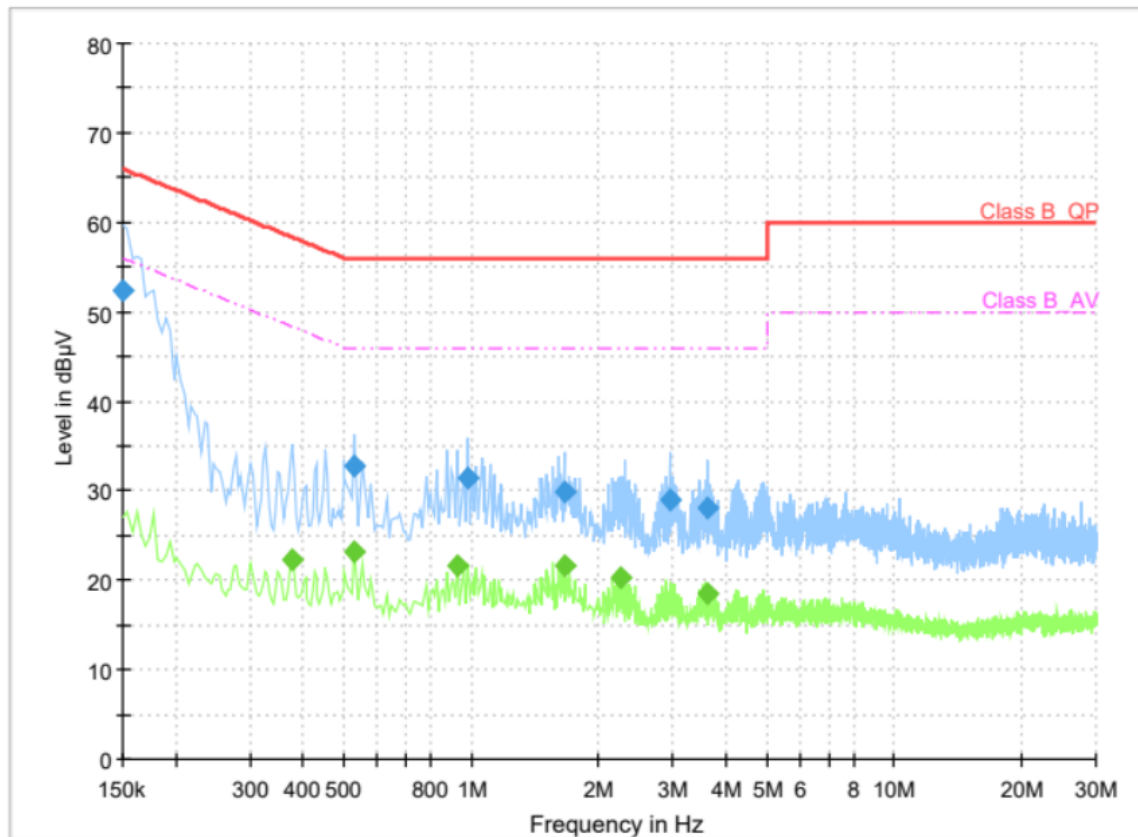


Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.150	46.17	---	66.00	19.83	9	L1	19.7
0.426	---	21.20	47.33	26.13	9	L1	19.8
0.426	28.43	---	57.33	28.90	9	L1	19.8
0.530	---	23.13	46.00	22.87	9	L1	19.8
0.530	31.85	---	56.00	24.15	9	L1	19.8
0.980	29.98	---	56.00	26.02	9	L1	19.7
1.030	---	21.57	46.00	24.43	9	L1	19.7
1.560	28.02	---	56.00	27.98	9	L1	19.7
1.660	---	21.04	46.00	24.96	9	L1	19.7
2.360	---	19.46	46.00	26.54	9	L1	19.7
2.360	27.73	---	56.00	28.27	9	L1	19.7
3.620	---	18.67	46.00	27.33	9	L1	19.7



Conducted Emission



Final Result

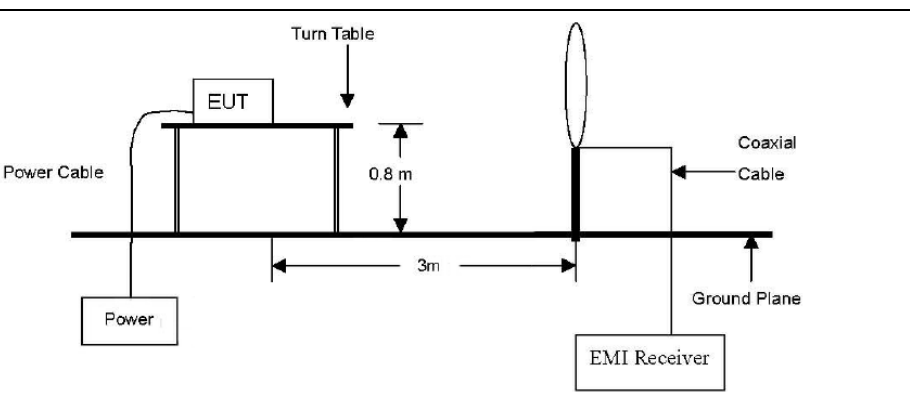
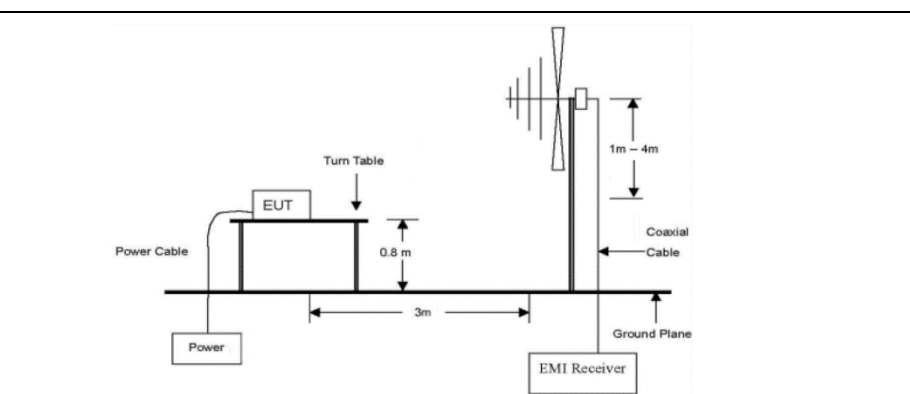
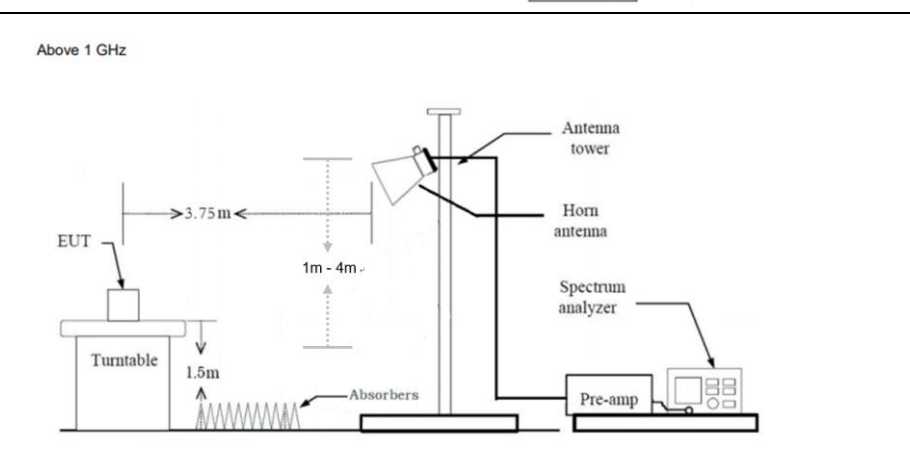
Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.150	52.33	---	66.00	13.67	9	N	19.7
0.378	---	22.19	48.32	26.14	9	N	19.8
0.530	---	23.26	46.00	22.74	9	N	19.8
0.530	32.82	---	56.00	23.18	9	N	19.8
0.930	---	21.71	46.00	24.29	9	N	19.7
0.980	31.44	---	56.00	24.56	9	N	19.7
1.660	29.96	---	56.00	26.04	9	N	19.7
1.660	---	21.52	46.00	24.48	9	N	19.7
2.260	---	20.26	46.00	25.74	9	N	19.6
2.940	28.97	---	56.00	27.03	9	N	19.6
3.620	---	18.57	46.00	27.43	9	N	19.6
3.620	28.03	---	56.00	27.97	9	N	19.6

APPENDIX I

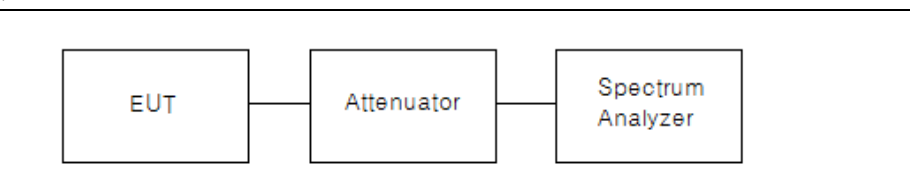
TEST SETUP



● Radiated Measurement

below 30 MHz	
below 1 GHz	
above 1 GHz	

● Conducted Measurement

Conducted	
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APPENDIX II

UNCERTAINTY



Measurement Item	Expanded Uncertainty $U = kU_c (k=2)$
Conducted RF power	0.34 dB
Conducted Spurious Emissions	0.34 dB
Radiated Spurious Emissions	5.82 dB
Conducted Emissions	2.00 dB