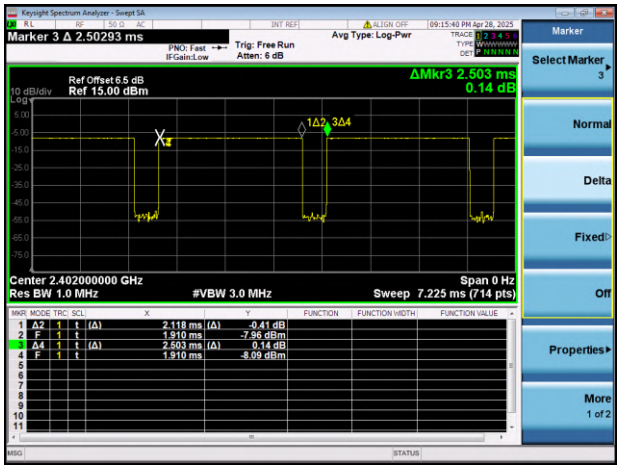
Duty Cycle Test Data

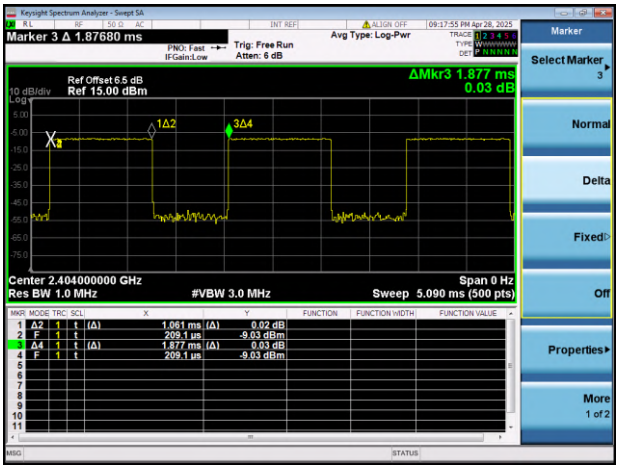
Band	On Time (ms)	On+Off Time (ms)	Duty Cycle (%)
GFSK (BLE 1Mbps)	2.118	2.503	84.62%
GFSK (BLE 2Mbps)	1.061	1.877	56.53%

Test Plots

GFSK (BLE 1Mbps)



GFSK (BLE 2Mbps)



A.2 Occupied Bandwidth

Test Data

Test Mode	GFSK (BLE 1Mbps)		
Channel	6 dB Bandwidth (kHz)	99% Bandwidth (kHz)	6 dB Bandwidth Limits (kHz)
Low	675.00	1048.20	≥500
Middle	682.40	1046.90	≥500
High	682.40	1050.30	≥500

Test Mode	GFSK (BLE 2Mbps)		
Channel	6 dB Bandwidth (kHz)	99% Bandwidth (kHz)	6 dB Bandwidth Limits (kHz)
Low	1215.00	2075.30	≥500
Middle	1200.00	2088.70	≥500
High	1215.00	2096.90	≥500

Test Plots

6 dB Bandwidth

GFSK (BLE 1Mbps) LOW CHANNEL

GFSK (BLE 1Mbps) MIDDLE CHANNEL

GFSK (BLE 1Mbps) HIGH CHANNEL

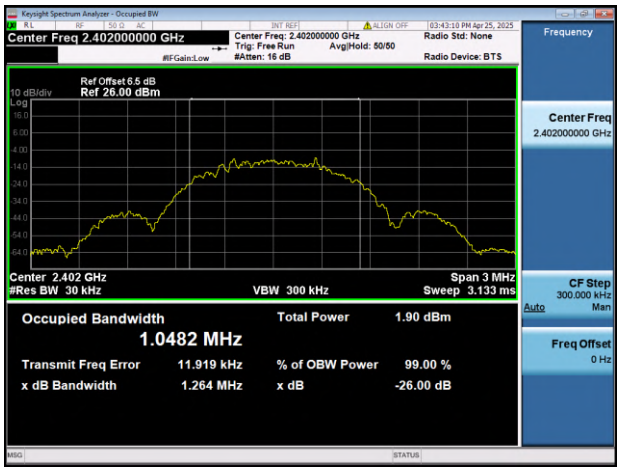
GFSK (BLE 2Mbps) LOW CHANNEL

GFSK (BLE 2Mbps) MIDDLE CHANNEL

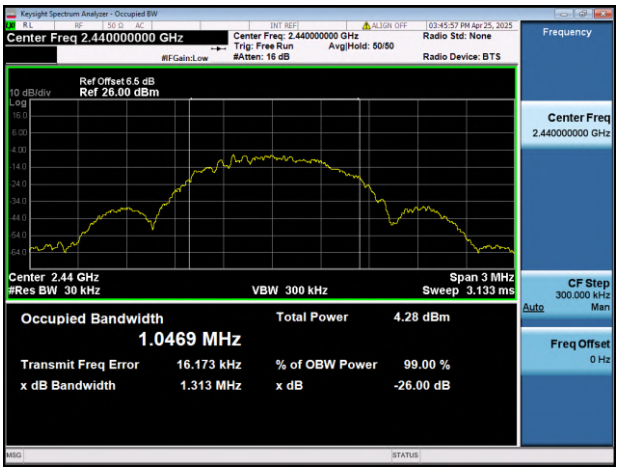
GFSK (BLE 2Mbps) HIGH CHANNEL

99% Bandwidth

GFSK (BLE 1Mbps) LOW CHANNEL

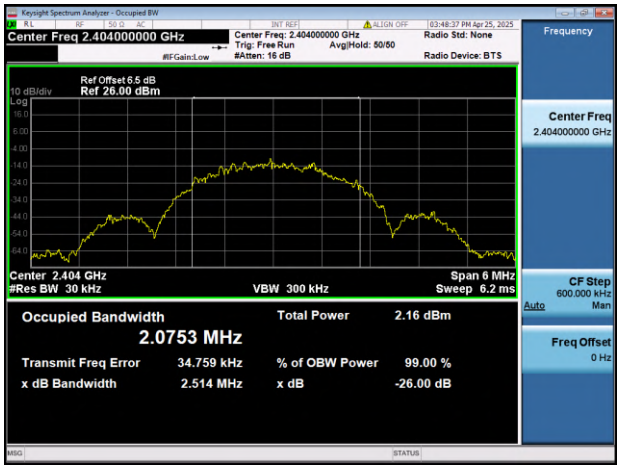


GFSK (BLE 1Mbps) MIDDLE CHANNEL

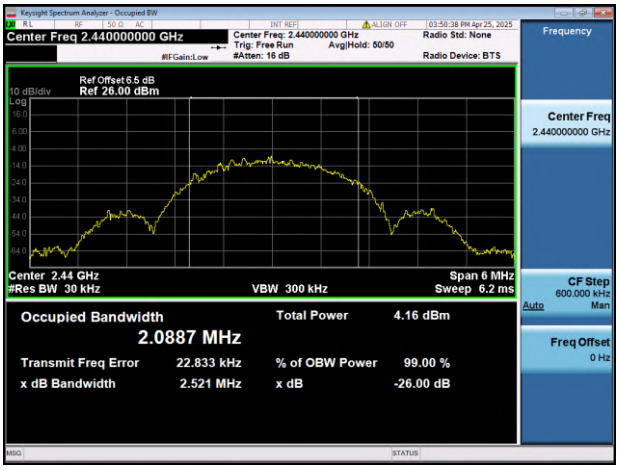


GFSK (BLE 1Mbps) HIGH CHANNEL

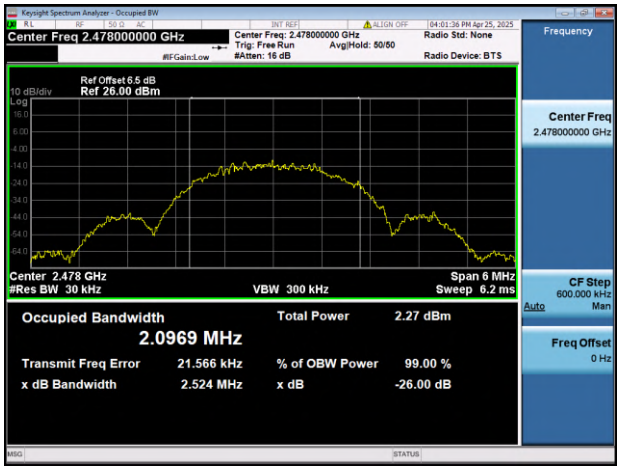
GFSK (BLE 2Mbps) LOW CHANNEL



GFSK (BLE 2Mbps) MIDDLE CHANNEL



GFSK (BLE 2Mbps) HIGH CHANNEL



A.3 Conducted Spurious Emission

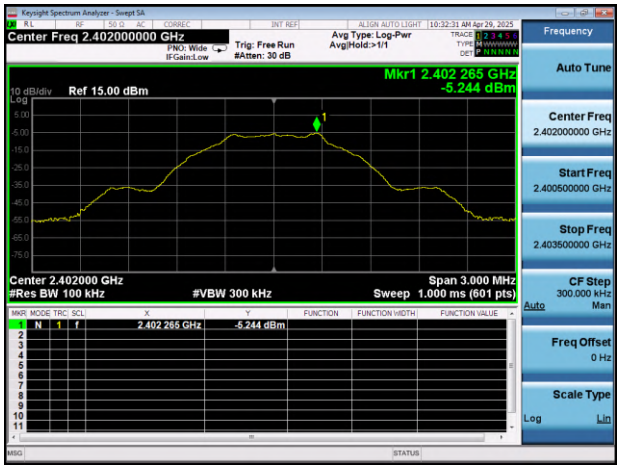
Test Data

GFSK (BLE 1Mbps)				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-44.18	-5.24	-25.24	Pass
Middle	-41.86	-2.76	-22.76	Pass
High	-42.63	-4.50	-24.50	Pass

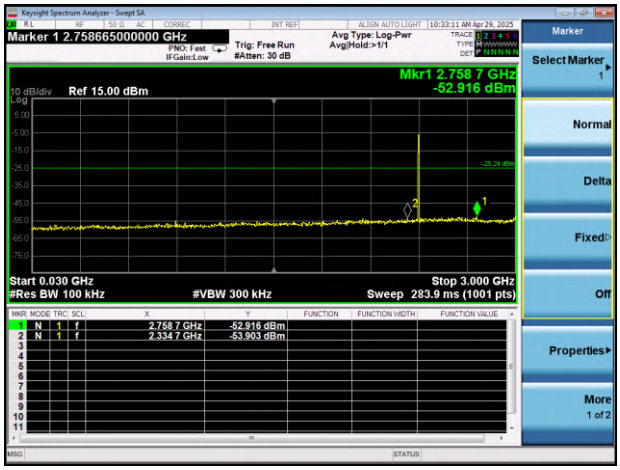
GFSK (BLE 2Mbps)				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-43.24	-5.51	-25.51	Pass
Middle	-42.42	-3.30	-23.30	Pass
High	-45.68	-4.99	-24.99	Pass

Test Plots

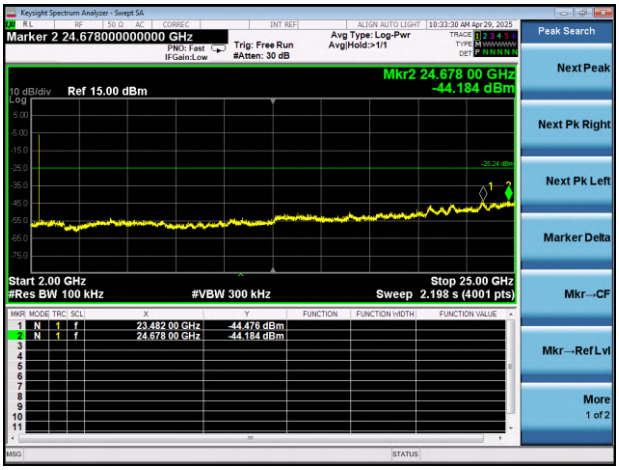
GFSK (BLE 1Mbps) LOW CHANNEL,
CARRIER LEVEL



GFSK (BLE 1Mbps) LOW CHANNEL,
SPURIOUS 30 MHz ~ 3 GHz

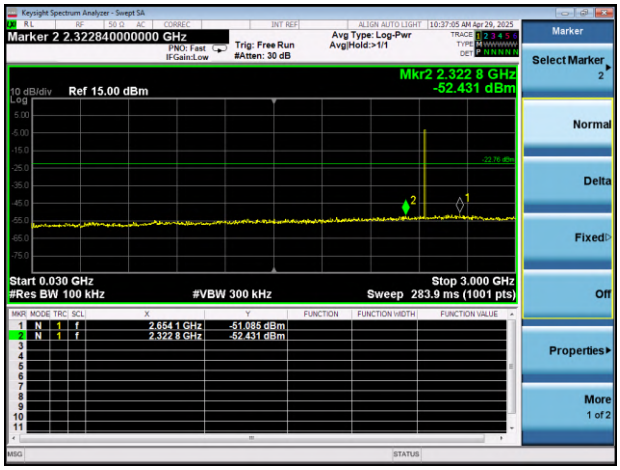


GFSK (BLE 1Mbps) LOW CHANNEL,
SPURIOUS 2 GHz ~ 25 GHz

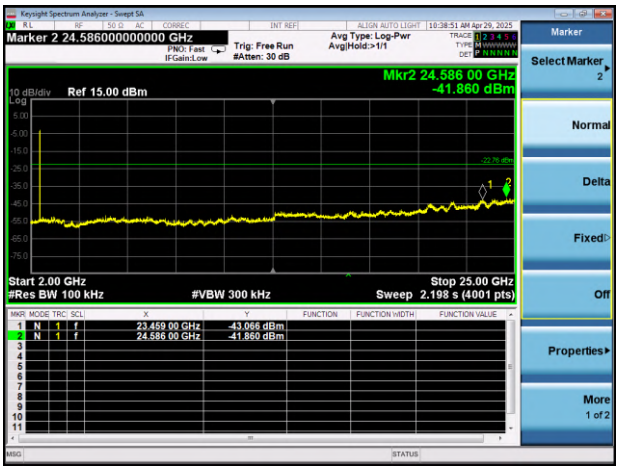


GFSK (BLE 1Mbps) MIDDLE CHANNEL,
CARRIER LEVEL

GFSK (BLE 1Mbps) MIDDLE CHANNEL,
SPURIOUS 30 MHz ~ 3 GHz

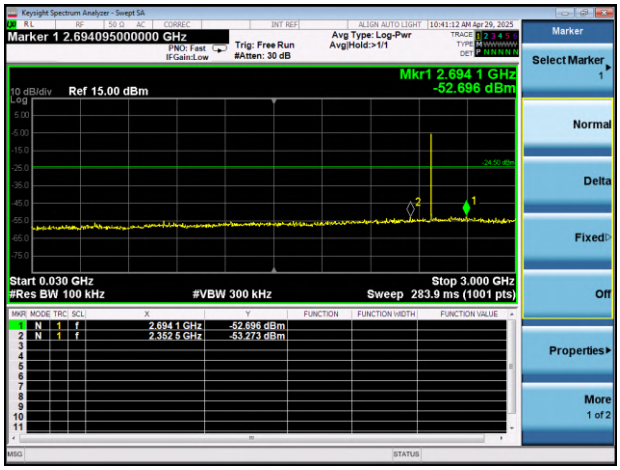


GFSK (BLE 1Mbps) MIDDLE CHANNEL,
SPURIOUS 2 GHz ~ 25 GHz

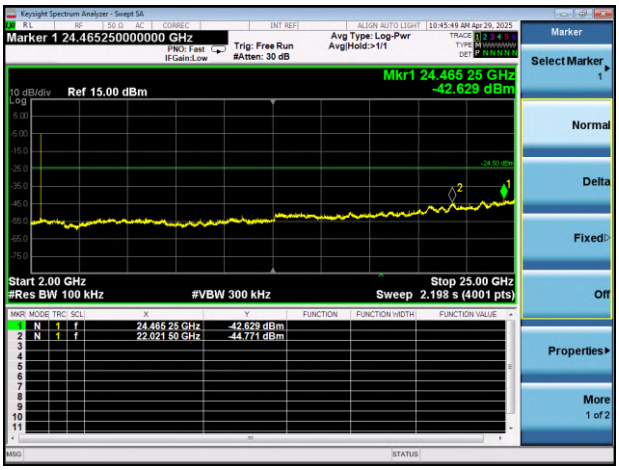


GFSK (BLE 1Mbps) HIGH CHANNEL,
CARRIER LEVEL

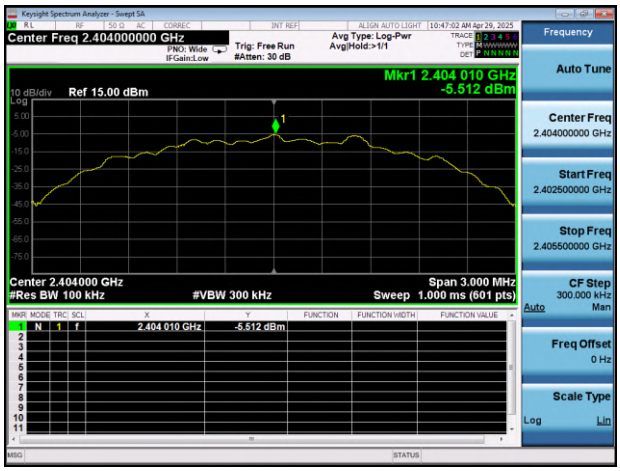
GFSK (BLE 1Mbps) HIGH CHANNEL,
SPURIOUS 30 MHz ~ 3 GHz



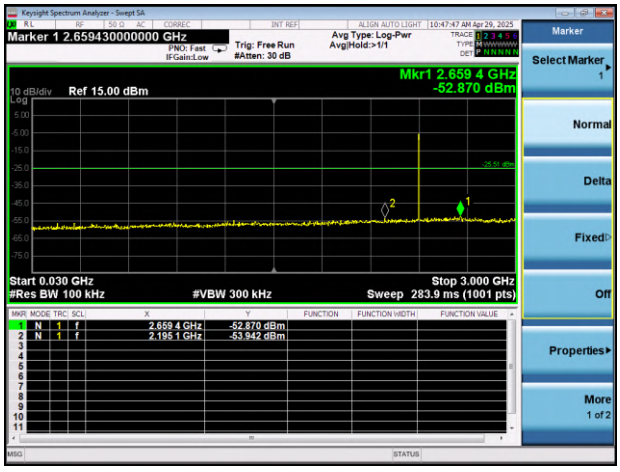
GFSK (BLE 1Mbps) HIGH CHANNEL,
SPURIOUS 2 GHz ~ 25 GHz



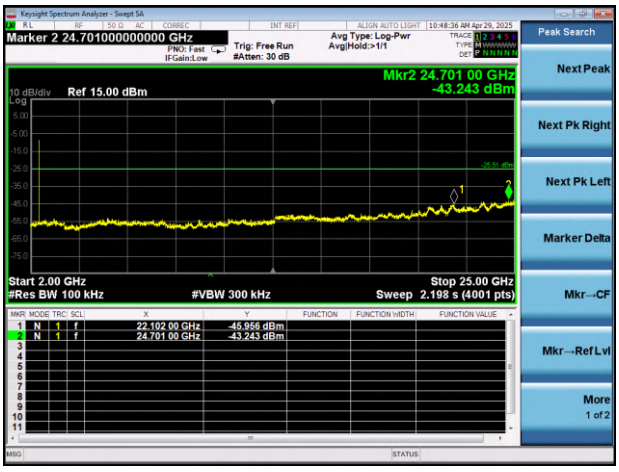
GFSK (BLE 2Mbps) LOW CHANNEL,
CARRIER LEVEL



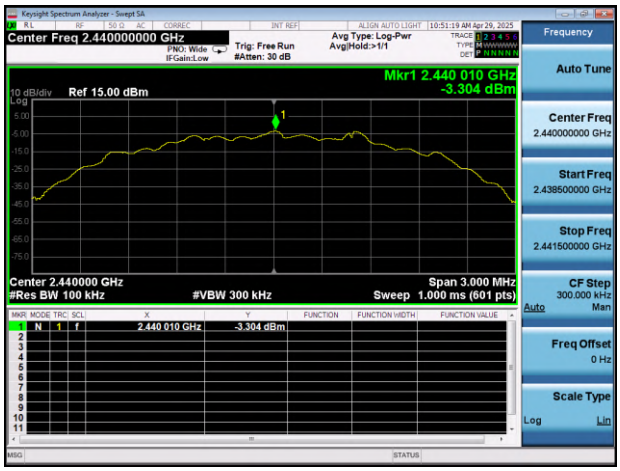
GFSK (BLE 2Mbps) LOW CHANNEL,
SPURIOUS 30 MHz ~ 3 GHz



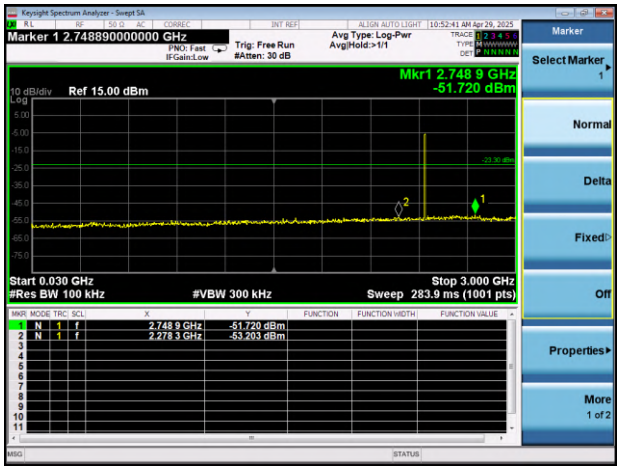
GFSK (BLE 2Mbps) LOW CHANNEL,
SPURIOUS 2 GHz ~ 25 GHz



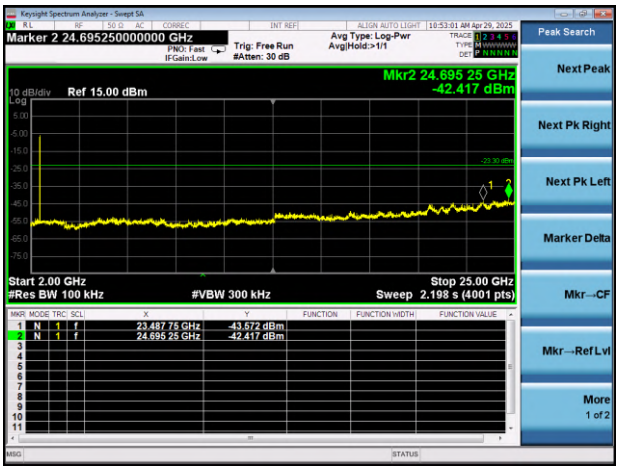
GFSK (BLE 2Mbps) MIDDLE CHANNEL,
CARRIER LEVEL



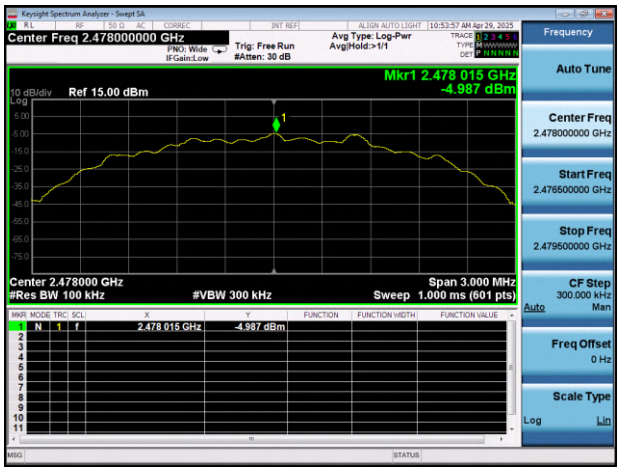
GFSK (BLE 2Mbps) MIDDLE CHANNEL,
SPURIOUS 30 MHz ~ 3 GHz



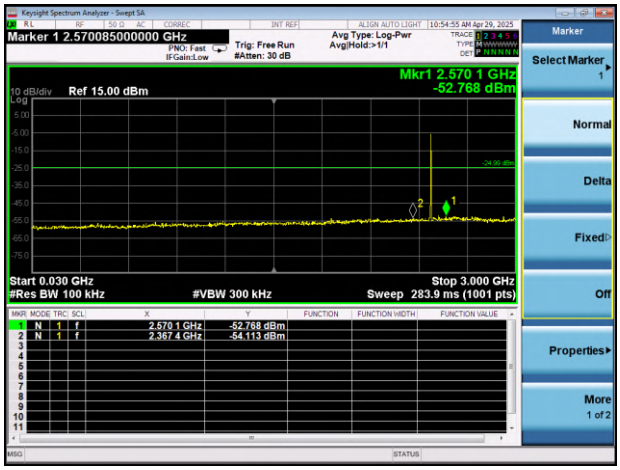
GFSK (BLE 2Mbps) MIDDLE CHANNEL,
SPURIOUS 2 GHz ~ 25 GHz



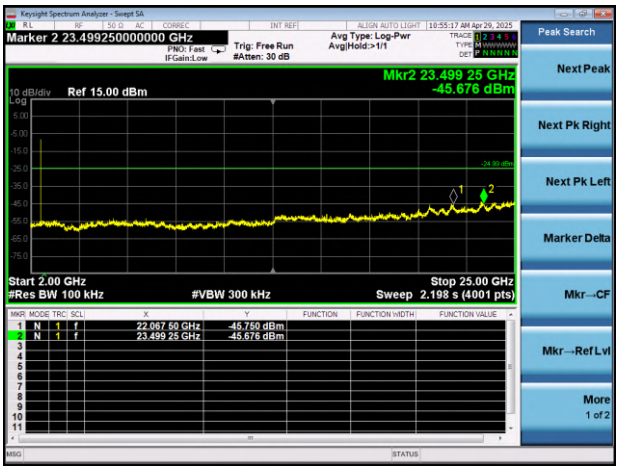
GFSK (BLE 2Mbps) HIGH CHANNEL,
CARRIER LEVEL



GFSK (BLE 2Mbps) HIGH CHANNEL,
SPURIOUS 30 MHz ~ 3 GHz



GFSK (BLE 2Mbps) HIGH CHANNEL,
SPURIOUS 2 GHz ~ 25 GHz



A.3 Band Edge (Authorized-band band-edge)

Note: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

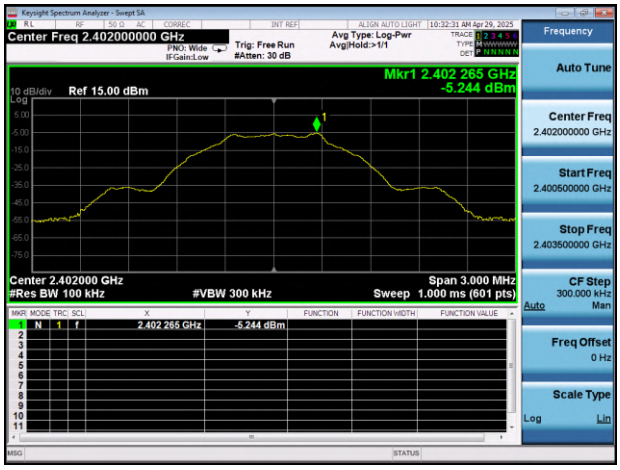
Test Data

GFSK (BLE 1Mbps)				
Channel	Measured Max. Band Edge Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-54.83	-5.24	-25.24	Pass
High	-54.93	-4.50	-24.50	Pass

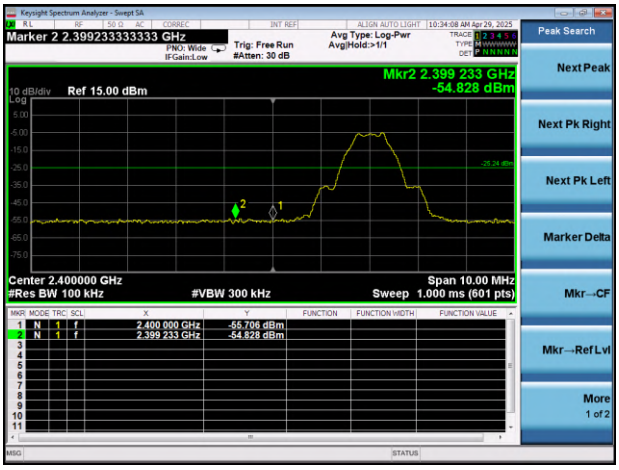
GFSK (BLE 2Mbps)				
Channel	Measured Max. Band Edge Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-54.26	-5.51	-25.51	Pass
High	-55.07	-4.99	-24.99	Pass

Test Plots

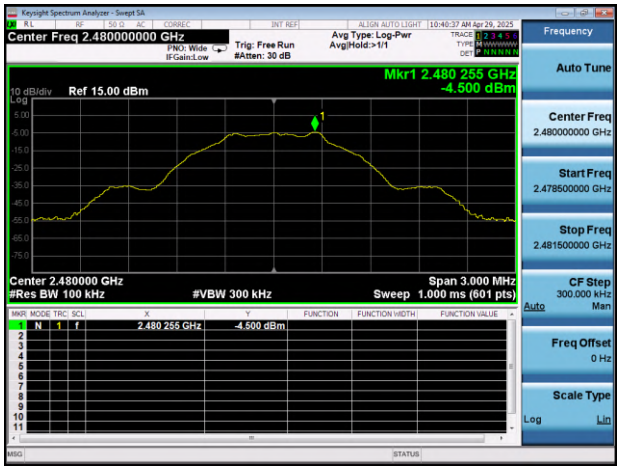
GFSK (BLE 1Mbps) LOW CHANNEL, CARRIER LEVEL



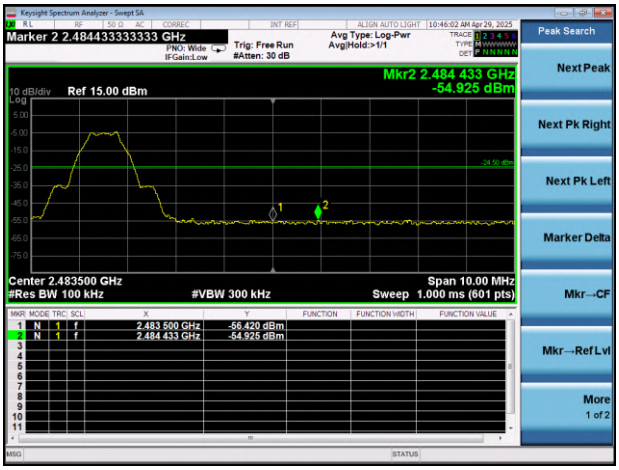
GFSK (BLE 1Mbps) LOW CHANNEL, BAND EDGE



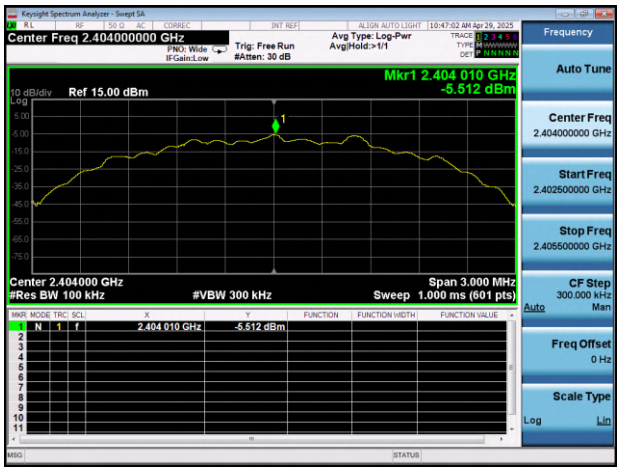
GFSK (BLE 1Mbps) HIGH CHANNEL, CARRIER LEVEL



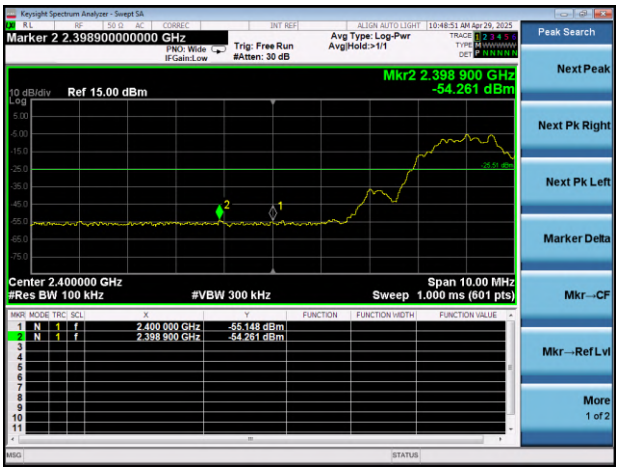
GFSK (BLE 1Mbps) HIGH CHANNEL, BAND EDGE



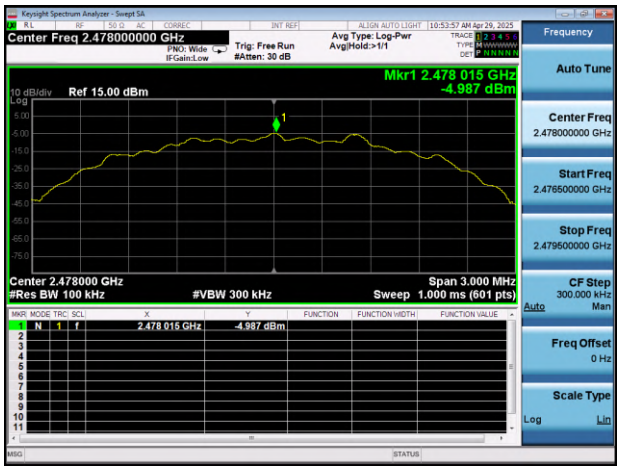
GFSK (BLE 2Mbps) LOW CHANNEL, CARRIER LEVEL



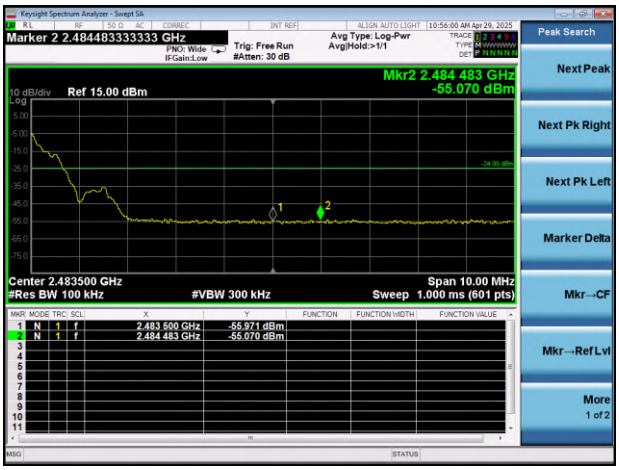
GFSK (BLE 2Mbps) LOW CHANNEL, BAND EDGE



GFSK (BLE 2Mbps) HIGH CHANNEL, CARRIER LEVEL



GFSK (BLE 2Mbps) HIGH CHANNEL, BAND EDGE



A.4 Conducted Emission

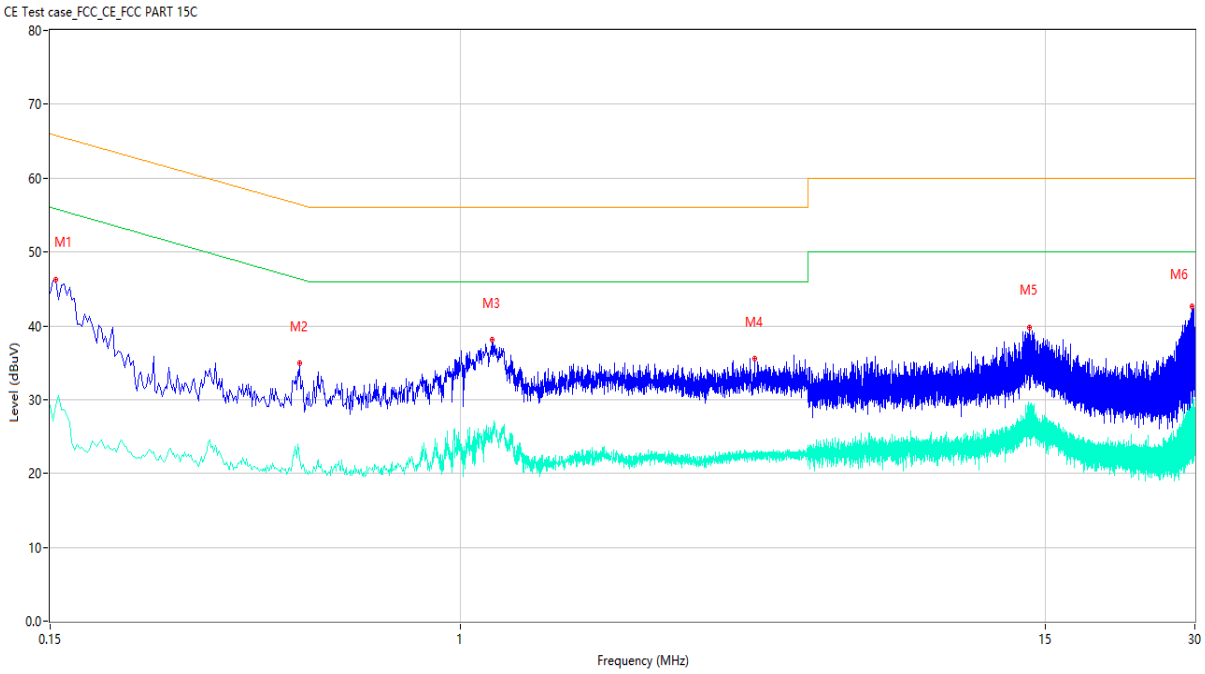
Note 1: The EUT is working in the Normal link mode. All modes have been tested and normal link mode is worst.

Note 2: Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 60 Hz and 240 VAC, 50 Hz) for which the device is capable of operation. So, The configuration 120 VAC, 60 Hz and 240 VAC, 50 Hz were tested respectively, but only the worst configuration (120 VAC, 60 Hz) shown here.

Note 3: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

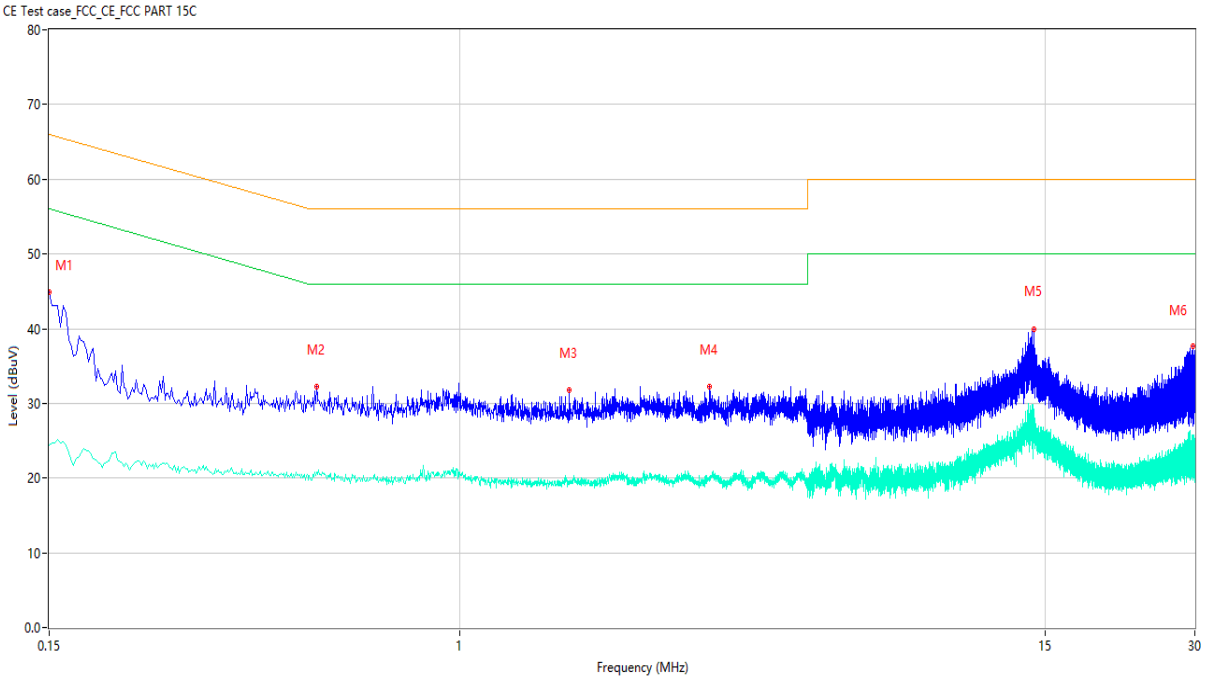
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.154	46.28	9.83	65.78	19.50	Peak	L	Pass
1**	0.154	29.26	9.83	55.78	26.52	AV	L	Pass
2	0.476	34.90	9.77	56.41	21.51	Peak	L	Pass
2**	0.476	21.91	9.77	46.41	24.50	AV	L	Pass
3	1.162	38.13	9.77	56.00	17.87	Peak	L	Pass
3**	1.162	24.32	9.77	46.00	21.68	AV	L	Pass
4	3.908	35.53	9.62	56.00	20.47	Peak	L	Pass
4**	3.908	22.42	9.62	46.00	23.58	AV	L	Pass
5	13.930	39.83	8.98	60.00	20.17	Peak	L	Pass
5**	13.930	28.48	8.98	50.00	21.52	AV	L	Pass
6	29.670	42.63	8.45	60.00	17.37	Peak	L	Pass
6**	29.670	28.32	8.45	50.00	21.68	AV	L	Pass

PHASE N



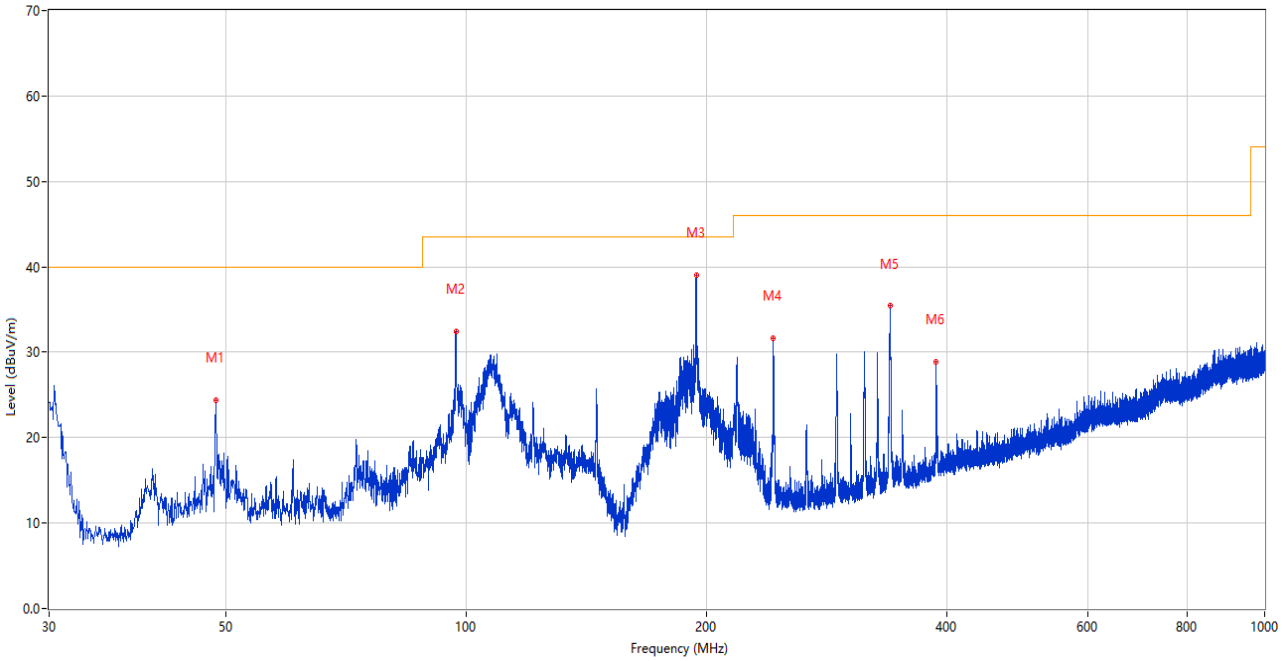
No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.150	44.97	9.73	66.00	21.03	Peak	N	Pass
1**	0.150	24.37	9.73	56.00	31.63	AV	N	Pass
2	0.516	32.28	9.75	56.00	23.72	Peak	N	Pass
2**	0.516	20.83	9.75	46.00	25.17	AV	N	Pass
3	1.662	31.80	9.75	56.00	24.20	Peak	N	Pass
3**	1.662	19.62	9.75	46.00	26.38	AV	N	Pass
4	3.180	32.25	9.70	56.00	23.75	Peak	N	Pass
4**	3.180	19.73	9.70	46.00	26.27	AV	N	Pass
5	14.264	39.99	9.01	60.00	20.01	Peak	N	Pass
5**	14.264	28.83	9.01	50.00	21.17	AV	N	Pass
6	29.796	37.70	8.50	60.00	22.30	Peak	N	Pass
6**	29.796	23.66	8.50	50.00	26.34	AV	N	Pass

A.5 Radiated Spurious Emission

Note 1: The symbol of "--" in the table which means not application.
Note 2: For the test data above 1 GHz, according the ANSI C63.4-2014, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.
Note 3: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.
Note 4: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and BLE 1M-Middle channel mode is the worst
Note 5: Results (dBuV/m) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

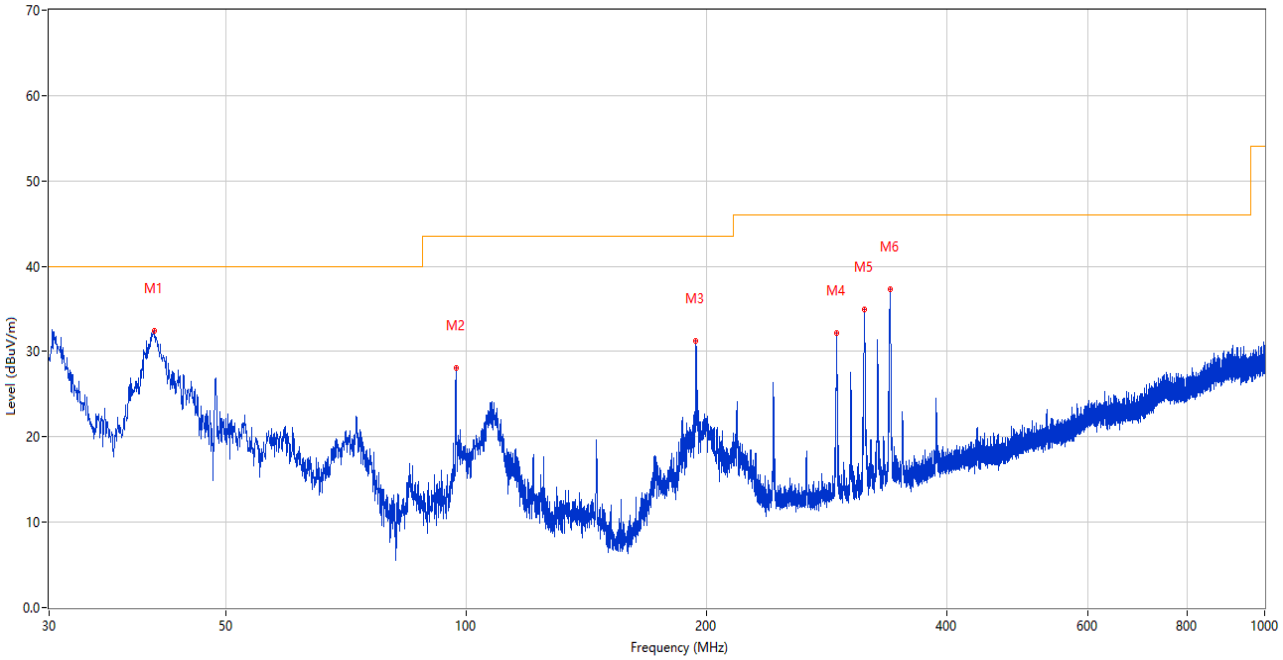
Test Data and Plots

30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	48.527	24.40	-24.50	40.0	15.60	Peak	326.00	200	Horizontal	Pass
2	96.979	32.49	-26.36	43.5	11.01	Peak	254.00	200	Horizontal	Pass
3	193.978	38.97	-25.70	43.5	4.53	Peak	80.00	100	Horizontal	Pass
4	242.382	31.62	-24.33	46.0	14.38	Peak	66.00	200	Horizontal	Pass
5	339.382	35.40	-21.97	46.0	10.60	Peak	289.00	100	Horizontal	Pass
6	387.736	28.83	-20.65	46.0	17.17	Peak	72.00	200	Horizontal	Pass

30 MHz to 1 GHz, ANT V

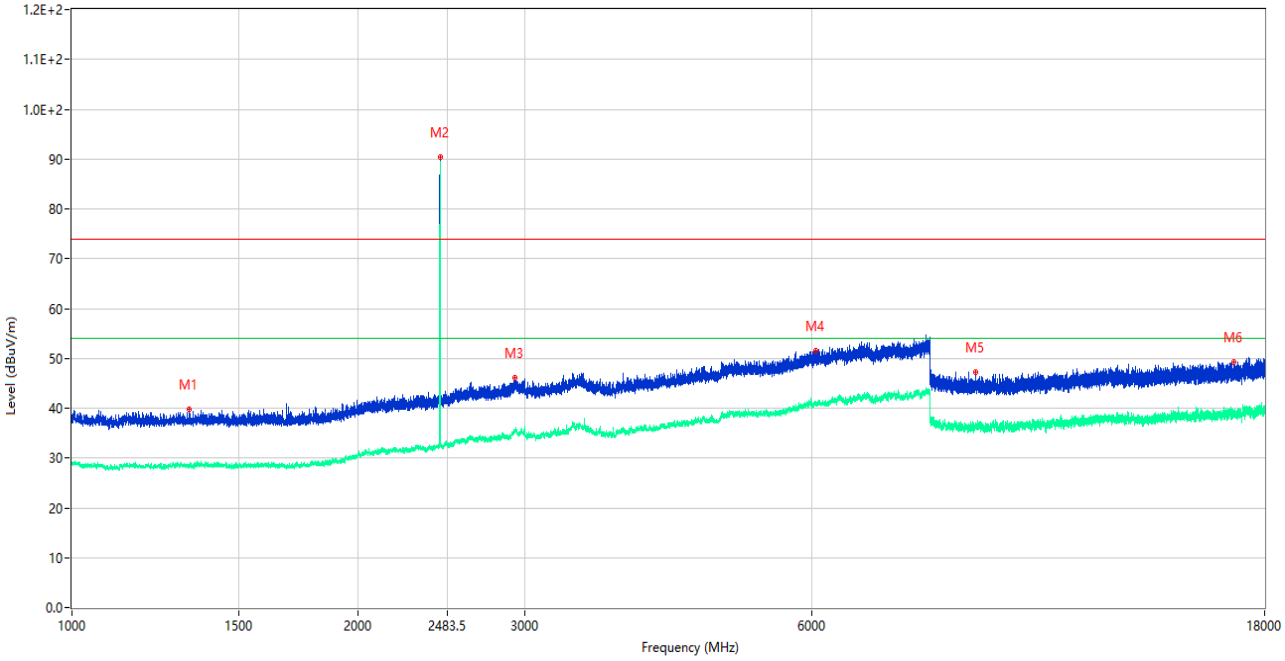


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	40.621	32.44	-25.72	40.0	7.56	Peak	213.00	100	Vertical	Pass
2	97.027	28.09	-26.36	43.5	15.41	Peak	156.00	200	Vertical	Pass
3	193.882	31.20	-25.71	43.5	12.30	Peak	359.00	200	Vertical	Pass
4	290.882	32.22	-23.17	46.0	13.78	Peak	74.00	100	Vertical	Pass
5	315.034	34.95	-22.98	46.0	11.05	Peak	81.00	100	Vertical	Pass
6	339.333	37.34	-21.98	46.0	8.66	Peak	98.00	100	Vertical	Pass

Note 1: The marked spikes near 2400 MHz with circle should be ignored because they are Fundamental signal.

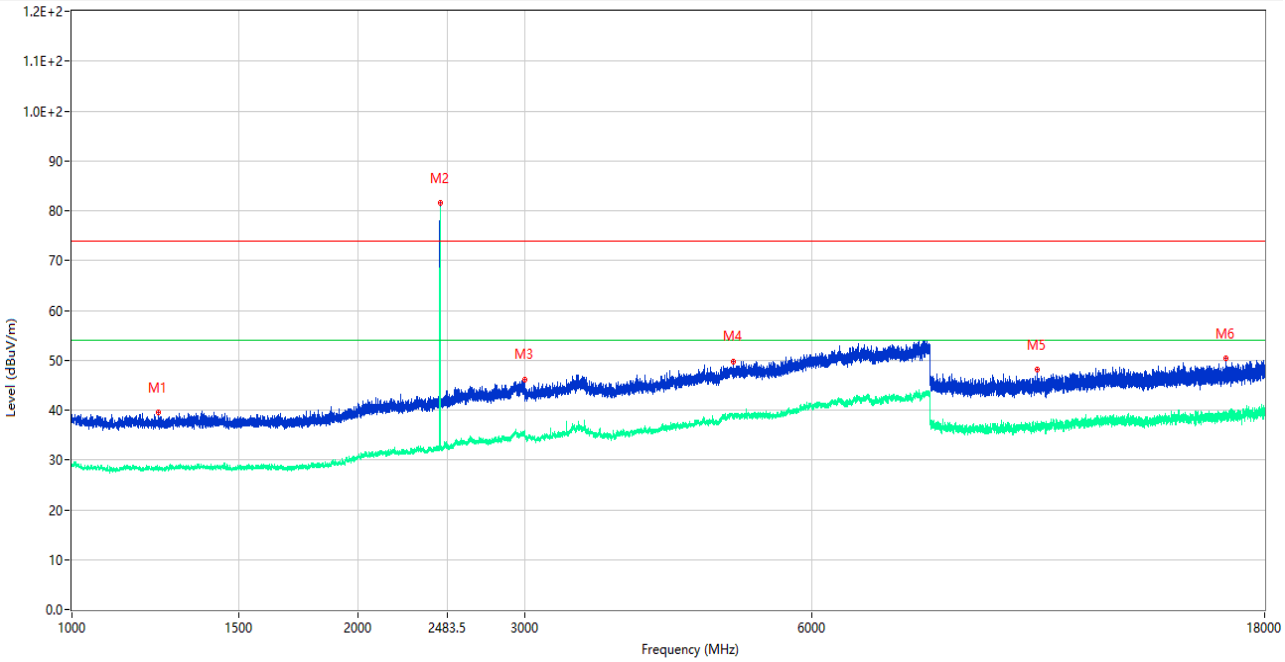
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK (BLE 1Mbps) MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



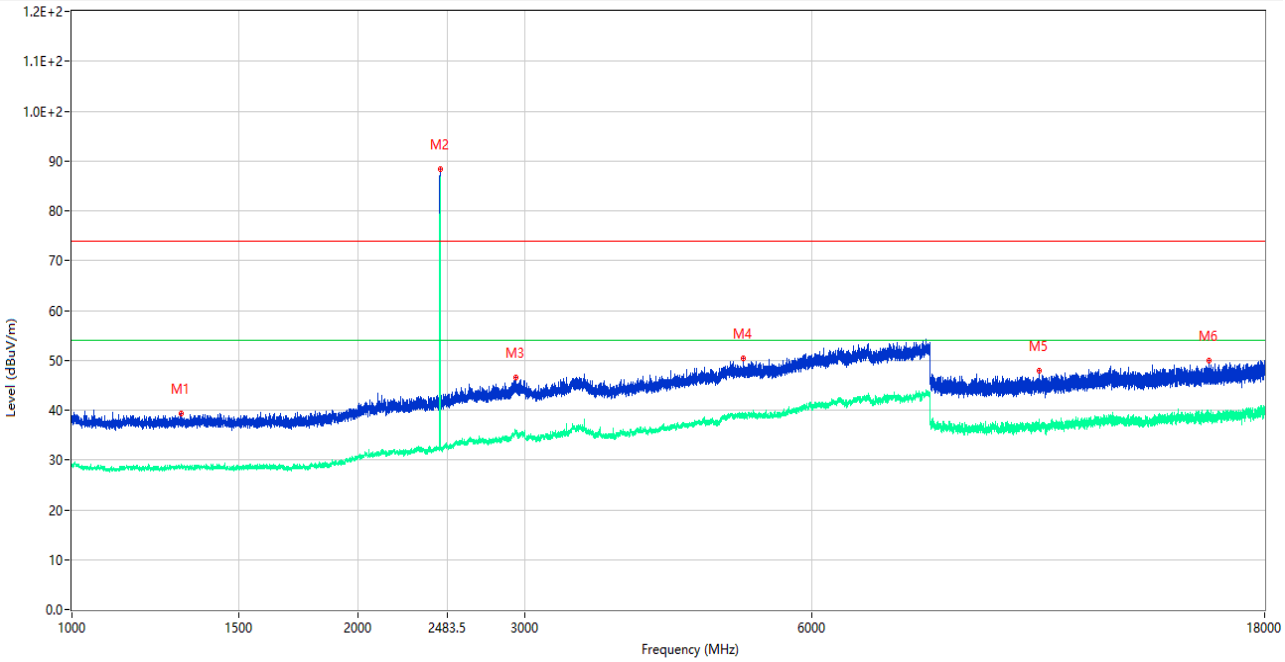
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1327.750	39.82	-15.93	74.0	34.18	Peak	323.00	150	Horizontal	Pass
1**	1327.750	28.21	-15.93	54.0	25.79	AV	323.00	150	Horizontal	Pass
2	2440.250	90.30	-12.37	74.0	-16.30	Peak	34.00	150	Horizontal	N/A
2**	2440.250	89.40	-12.37	54.0	-35.40	AV	34.00	150	Horizontal	N/A
3	2923.750	46.05	-8.30	74.0	27.95	Peak	204.00	150	Horizontal	Pass
3**	2923.750	35.30	-8.30	54.0	18.70	AV	204.00	150	Horizontal	Pass
4	6063.500	51.50	-0.34	74.0	22.50	Peak	40.00	150	Horizontal	Pass
4**	6063.500	41.01	-0.34	54.0	12.99	AV	40.00	150	Horizontal	Pass
5	8944.000	47.18	-4.50	74.0	26.82	Peak	350.00	150	Horizontal	Pass
5**	8944.000	36.54	-4.50	54.0	17.46	AV	350.00	150	Horizontal	Pass
6	16705.500	49.31	-1.62	74.0	24.69	Peak	360.00	150	Horizontal	Pass
6**	16705.500	38.73	-1.62	54.0	15.27	AV	360.00	150	Horizontal	Pass

GFSK (BLE 1Mbps) MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



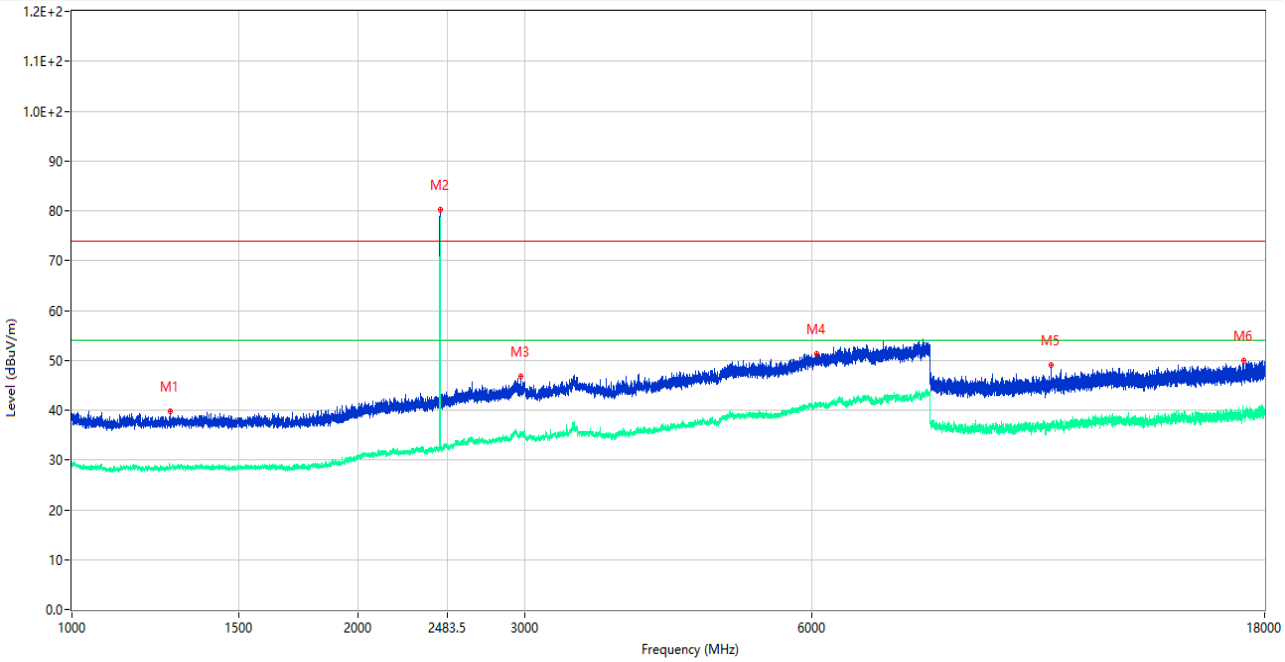
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1234.250	39.59	-16.01	74.0	34.41	Peak	202.00	150	Vertical	Pass
1**	1234.250	28.15	-16.01	54.0	25.85	AV	202.00	150	Vertical	Pass
2	2440.250	81.62	-12.37	74.0	-7.62	Peak	223.00	150	Vertical	N/A
2**	2440.250	80.66	-12.37	54.0	-26.66	AV	223.00	150	Vertical	N/A
3	2997.500	46.20	-8.80	74.0	27.80	Peak	230.00	150	Vertical	Pass
3**	2997.500	35.45	-8.80	54.0	18.55	AV	230.00	150	Vertical	Pass
4	4964.000	49.65	-2.17	74.0	24.35	Peak	132.00	150	Vertical	Pass
4**	4964.000	38.67	-2.17	54.0	15.33	AV	132.00	150	Vertical	Pass
5	10368.500	48.22	-3.31	74.0	25.78	Peak	0.00	150	Vertical	Pass
5**	10368.500	36.93	-3.31	54.0	17.07	AV	0.00	150	Vertical	Pass
6	16399.500	50.46	-1.49	74.0	23.54	Peak	10.00	150	Vertical	Pass
6**	16399.500	38.78	-1.49	54.0	15.22	AV	10.00	150	Vertical	Pass

GFSK (BLE 2Mbps) MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1303.250	39.36	-15.59	74.0	34.64	Peak	0.00	150	Horizontal	Pass
1**	1303.250	28.88	-15.59	54.0	25.12	AV	0.00	150	Horizontal	Pass
2	2440.500	88.29	-12.38	74.0	-14.29	Peak	46.00	150	Horizontal	N/A
2**	2440.500	86.50	-12.38	54.0	-32.50	AV	46.00	150	Horizontal	N/A
3	2934.000	46.57	-8.07	74.0	27.43	Peak	119.00	150	Horizontal	Pass
3**	2934.000	35.68	-8.07	54.0	18.32	AV	119.00	150	Horizontal	Pass
4	5088.500	50.34	-2.38	74.0	23.66	Peak	204.00	150	Horizontal	Pass
4**	5088.500	38.91	-2.38	54.0	15.09	AV	204.00	150	Horizontal	Pass
5	10422.000	47.84	-3.46	74.0	26.16	Peak	351.00	150	Horizontal	Pass
5**	10422.000	36.79	-3.46	54.0	17.21	AV	351.00	150	Horizontal	Pass
6	15716.500	49.96	-1.79	74.0	24.04	Peak	0.00	150	Horizontal	Pass
6**	15716.500	38.80	-1.79	54.0	15.20	AV	0.00	150	Horizontal	Pass

GFSK (BLE 2Mbps) MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



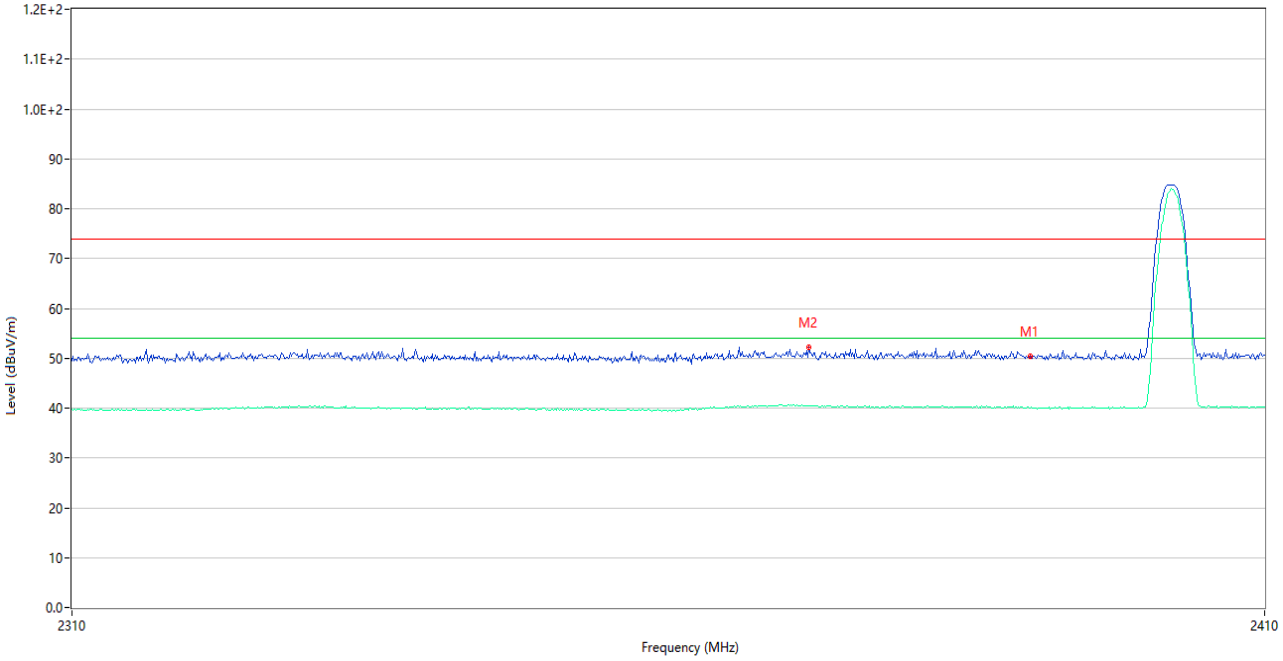
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1269.500	39.78	-15.91	74.0	34.22	Peak	297.00	150	Vertical	Pass
1**	1269.500	28.21	-15.91	54.0	25.79	AV	297.00	150	Vertical	Pass
2	2440.500	80.21	-12.38	74.0	-6.21	Peak	133.00	150	Vertical	N/A
2**	2440.500	78.23	-12.38	54.0	-24.23	AV	133.00	150	Vertical	N/A
3	2969.000	46.67	-8.40	74.0	27.33	Peak	282.00	150	Vertical	Pass
3**	2969.000	35.56	-8.40	54.0	18.44	AV	282.00	150	Vertical	Pass
4	6082.500	51.32	-0.41	74.0	22.68	Peak	0.00	150	Vertical	Pass
4**	6082.500	40.92	-0.41	54.0	13.08	AV	0.00	150	Vertical	Pass
5	10731.500	48.98	-3.80	74.0	25.02	Peak	31.00	150	Vertical	Pass
5**	10731.500	36.58	-3.80	54.0	17.42	AV	31.00	150	Vertical	Pass
6	17098.000	49.98	-0.95	74.0	24.02	Peak	360.00	150	Vertical	Pass
6**	17098.000	39.15	-0.95	54.0	14.85	AV	360.00	150	Vertical	Pass

A.7 Band Edge (Restricted-band band-edge)

Note 1: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.
Note 2: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.
Note 3: According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.
Note 4: The Level (dBuV/m) has been corrected by factor.

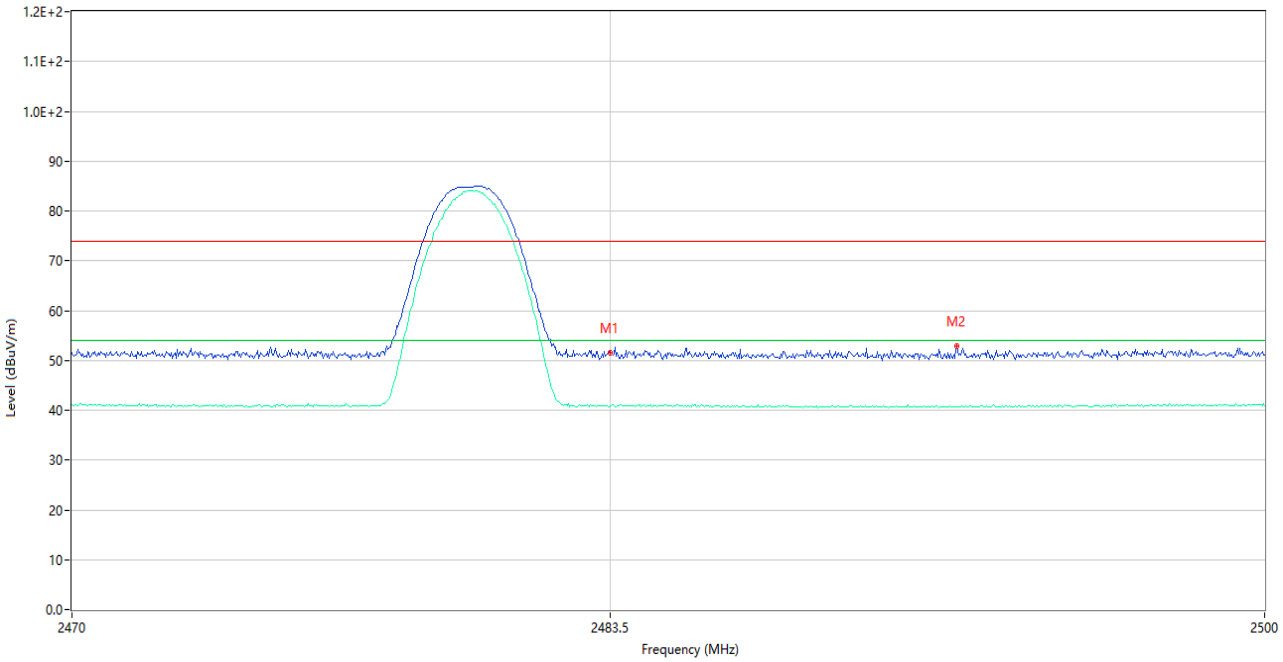
Test Data and Plots

GFSK (BLE 1Mbps) LOW CHANNEL



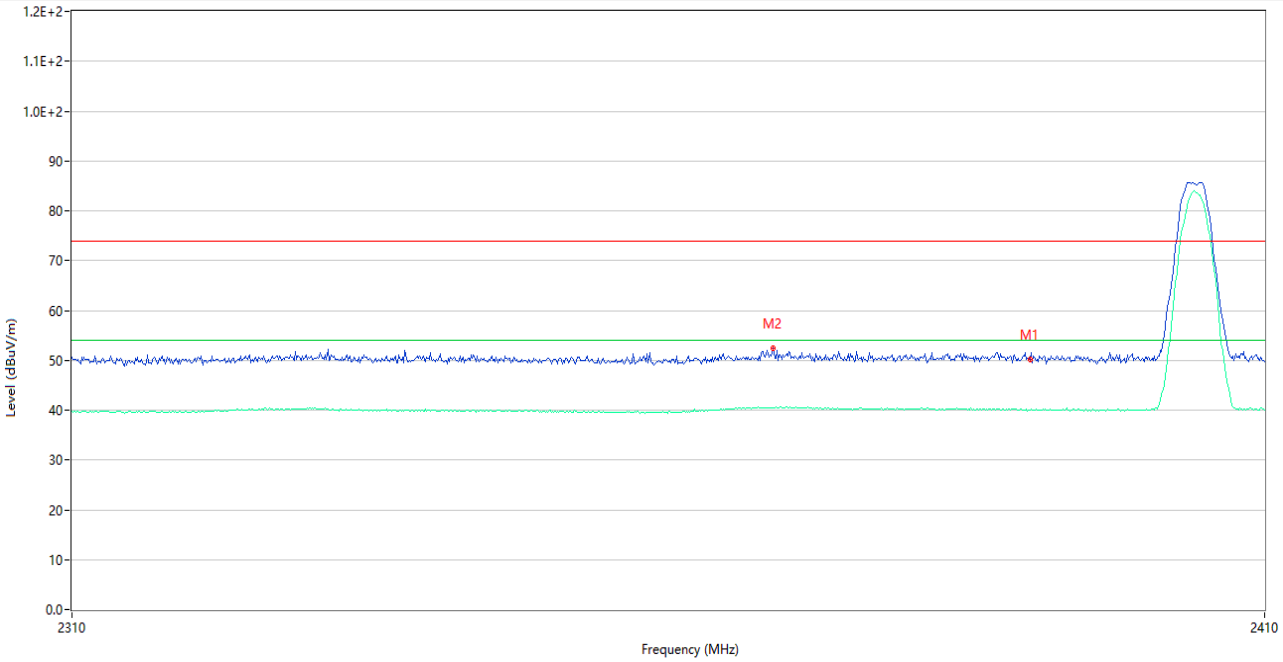
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2390.000	49.71	-4.87	74.0	24.29	Peak	212.95	150	Horizontal	Pass
1**	2390.000	39.99	-4.87	54.0	14.01	AV	212.95	150	Horizontal	Pass
2	2371.300	52.26	-4.04	74.0	21.74	Peak	26.00	150	Horizontal	Pass
2**	2371.300	40.56	-4.04	54.0	13.44	AV	26.00	150	Horizontal	Pass

GFSK (BLE 1Mbps) HIGH CHANNEL



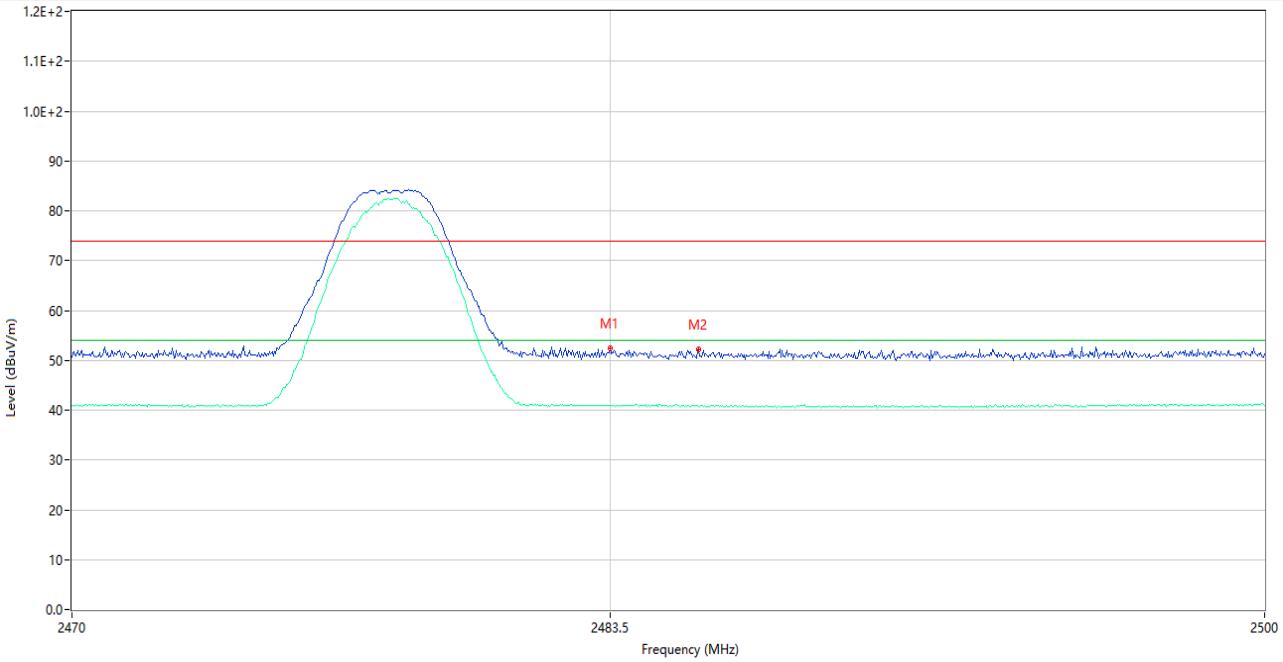
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	51.56	-3.78	74.0	22.44	Peak	158.00	150	Horizontal	Pass
1**	2483.500	40.95	-3.78	54.0	13.05	AV	158.00	150	Horizontal	Pass
2	2492.230	52.78	-3.87	74.0	21.22	Peak	308.00	150	Horizontal	Pass
2**	2492.230	40.71	-3.87	54.0	13.29	AV	308.00	150	Horizontal	Pass

GFSK (BLE 2Mbps) LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2390.000	50.18	-4.87	74.0	23.82	Peak	293.82	150	Horizontal	Pass
1**	2390.000	39.96	-4.87	54.0	14.04	AV	293.82	150	Horizontal	Pass
2	2368.300	52.34	-4.19	74.0	21.66	Peak	156.00	150	Horizontal	Pass
2**	2368.300	40.44	-4.19	54.0	13.56	AV	156.00	150	Horizontal	Pass

GFSK (BLE 2Mbps) HIGH CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	52.53	-3.78	74.0	21.47	Peak	301.00	150	Horizontal	Pass
1**	2483.500	40.92	-3.78	54.0	13.08	AV	301.00	150	Horizontal	Pass
2	2485.720	52.17	-3.78	74.0	21.83	Peak	199.00	150	Horizontal	Pass
2**	2485.720	40.76	-3.78	54.0	13.24	AV	199.00	150	Horizontal	Pass

A.8 Power Spectral Density (PSD)

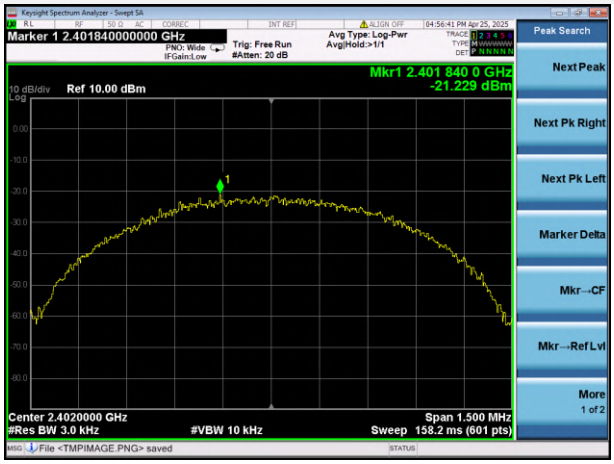
Test Data

GFSK (BLE 1Mbps)			
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low	-21.23	8	Pass
Middle	-19.14	8	Pass
High	-20.67	8	Pass

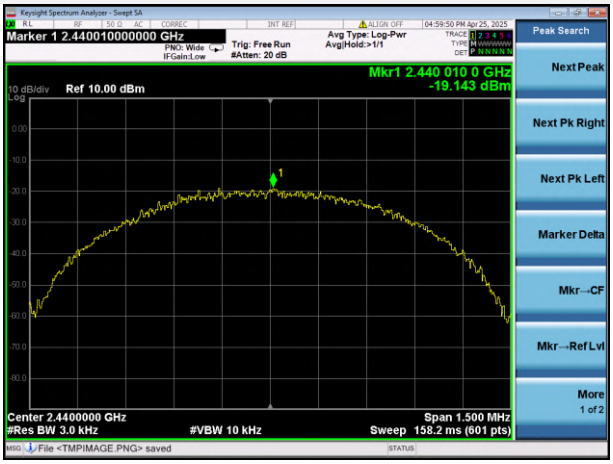
GFSK (BLE 2Mbps)			
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low	-24.04	8	Pass
Middle	-24.54	8	Pass
High	-24.64	8	Pass

Test Plots

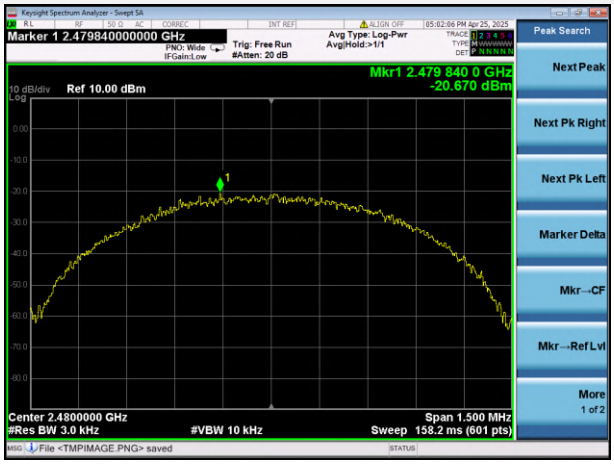
GFSK (BLE 1Mbps) LOW CHANNEL



GFSK (BLE 1Mbps) MIDDLE CHANNEL

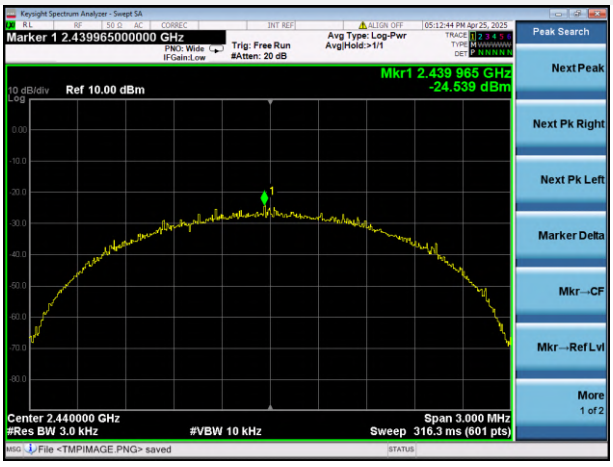


GFSK (BLE 1Mbps) HIGH CHANNEL



GFSK (BLE 2Mbps) LOW CHANNEL

GFSK (BLE 2Mbps) MIDDLE CHANNEL



GFSK (BLE 2Mbps) HIGH CHANNEL

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SH2530301-AR-1.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SH2530301-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SH2530301-AI.PDF”.

Statement

1. The Testing Center guarantees the scientificity, accuracy and impartiality of the test, and is responsible for all the information in the report, except the information provided by the customer. The customer is responsible for the impact of the information provided on the validity of the results.

2. For the report with Accreditation Symbol, the items marked with "☆" are not within the accredited scope.

3. This report is invalid if it is altered, without the signature of the testing and approval personnel, or without the test report stamp.

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6. Any objection shall be raised to the Testing Center within 30 days after receiving the report.

--END OF REPORT--