

5.8 Band Edge (Restricted-band band-edge)

5.8.1 Limit

FCC §15.209&15.247(d);

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

5.8.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

For transmitters operating above 1 GHz repeat the measurement with an average detector.

1.1.1 Test Result

Please refer to ANNEX A.7.

5.9 Power Spectral density (PSD)

5.9.1 Limit

FCC §15.247(e);

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used.

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

5.9.2 Test Setup

See section 4.4.1 (Diagram 1) for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.

Set the VBW $\geq 3 \text{ RBW}$.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

5.9.4 Test Result

Please refer to ANNEX A.7.

ANNEX A TEST RESULT

A.1 Output Power, E.I.R.P, Duty Cycle

Peak Power Test Data

Channel	Measured Output Peak Power		Limit		Verdict
	GFSK(BLE)		dBm	mW	
	dBm	mW			
Low	2.188	1.66	30	1000	Pass
Middle	1.974	1.58			Pass
High	1.530	1.42			Pass

Test plots

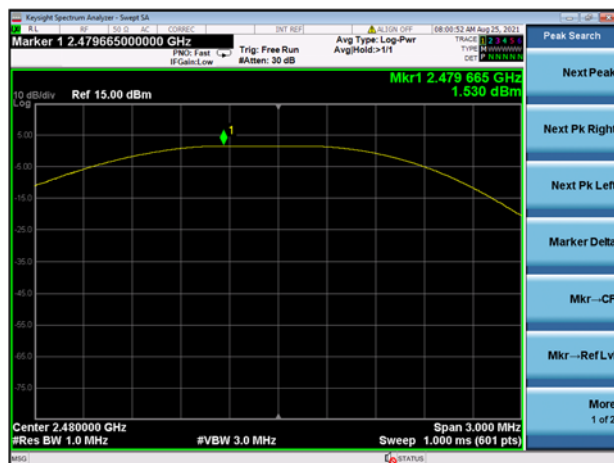
GFSK(BLE) LOW CHANNEL



GFSK(BLE) MIDDLE CHANNEL



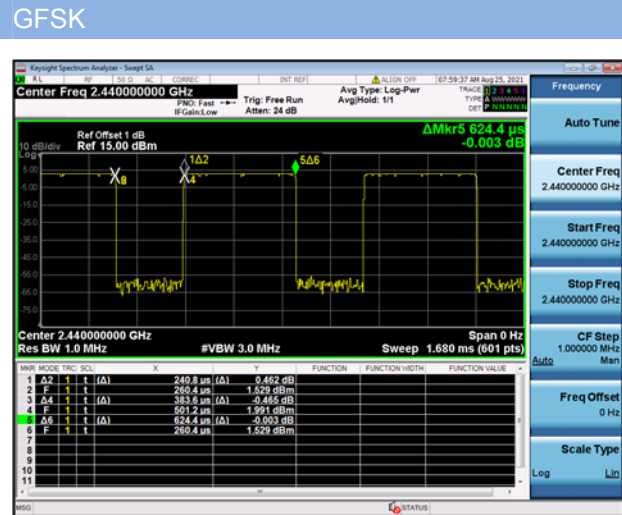
GFSK(BLE) HIGH CHANNEL



Duty Cycle Test Data

Band	On Time (ms)	On+Off Time (ms)	Duty Cycle (%)
GFSK	0.384	0.624	61

Test plots



A.2 Occupied Bandwidth

Test Data

Test Mode	GFSK (BLE)		
Channel	6 dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limits (kHz)
Low Channel	0.689941	1.037461	≥500
Middle Channel	0.684814	1.032881	≥500
High Channel	0.684814	1.043884	≥500

Test plots

6 dB Bandwidth

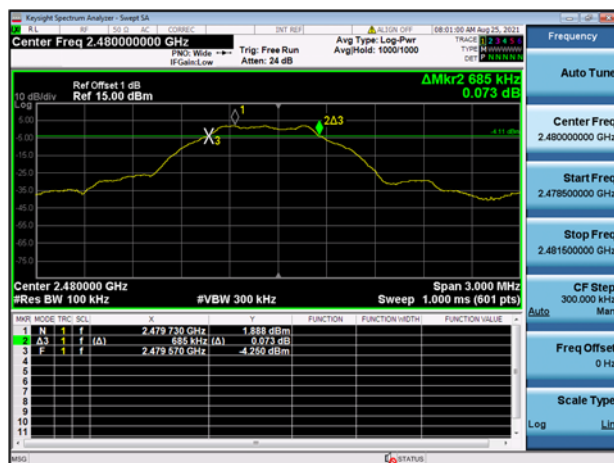
GFSK (BLE) LOW CHANNEL



GFSK (BLE) MIDDLE CHANNEL



GFSK (BLE) HIGH CHANNEL

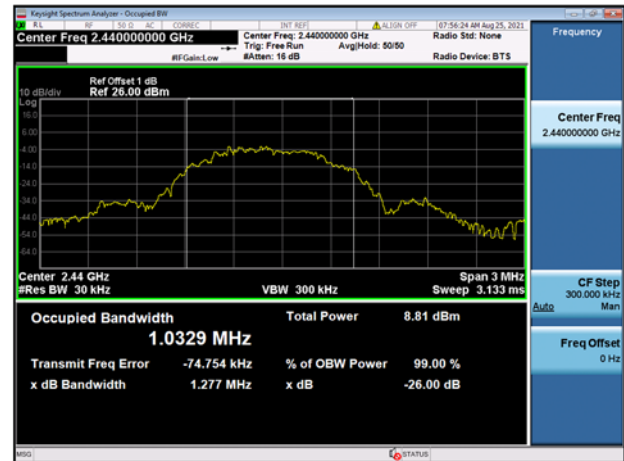


99% Bandwidth

GFSK (BLE) LOW CHANNEL



GFSK (BLE) MIDDLE CHANNEL



GFSK (BLE) HIGH CHANNEL



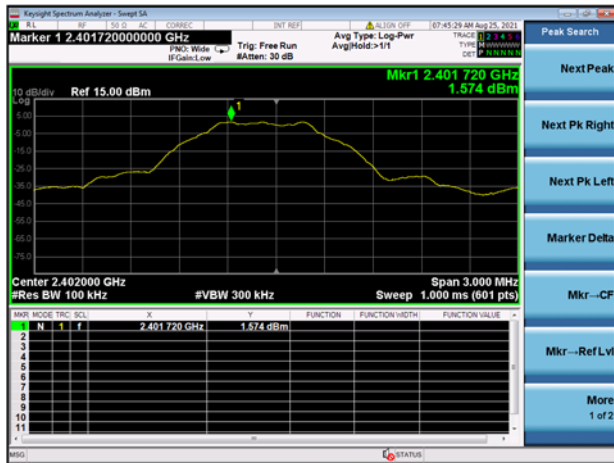
A.3 Conducted Spurious Emissions

Test Data

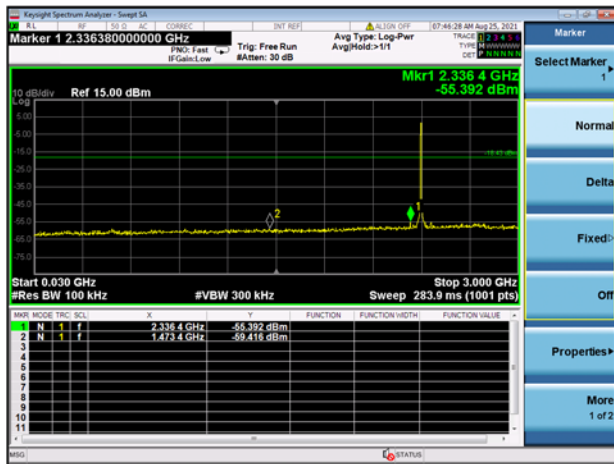
GFSK (BLE)				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-54.163	1.574	-18.426	Pass
Middle	-52.288	1.242	-18.758	Pass
High	-53.232	0.850	-19.150	Pass

Test Plots

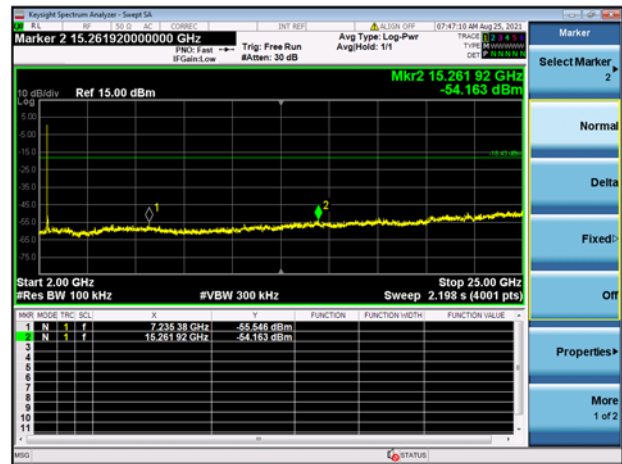
GFSK (BLE) LOW CHANNEL, CARRIER LEVEL



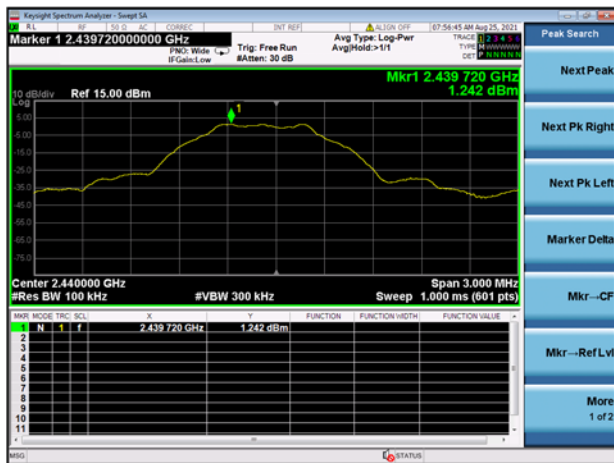
GFSK (BLE) LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



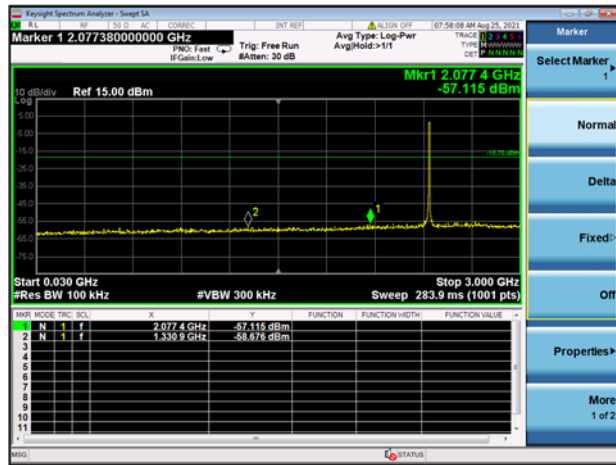
GFSK (BLE) LOW CHANNEL, SPURIOUS 2 GHz ~ 25 GHz



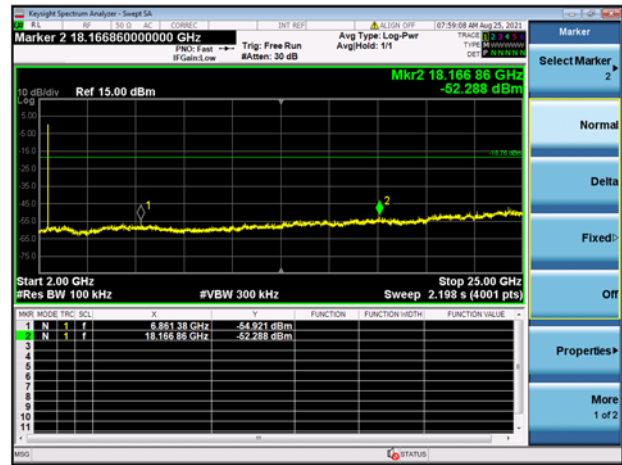
GFSK (BLE) MIDDLE CHANNEL, CARRIER LEVEL



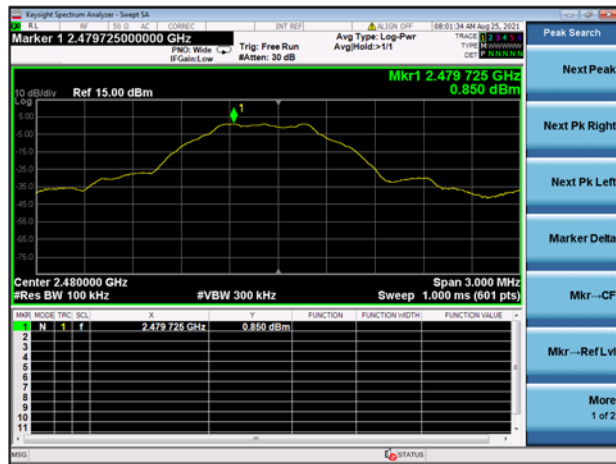
GFSK (BLE) MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



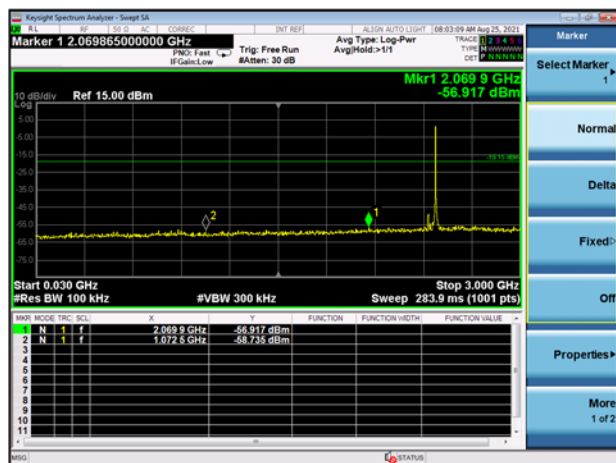
GFSK (BLE) MIDDLE CHANNEL, SPURIOUS 2 GHz ~ 25 GHz



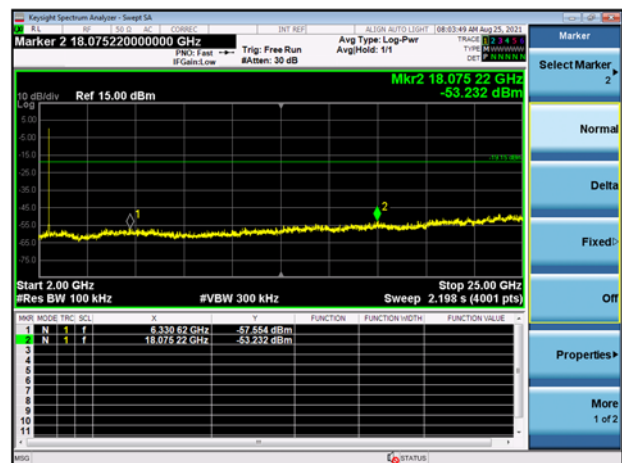
GFSK (BLE) HIGH CHANNEL, CARRIER LEVEL



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



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



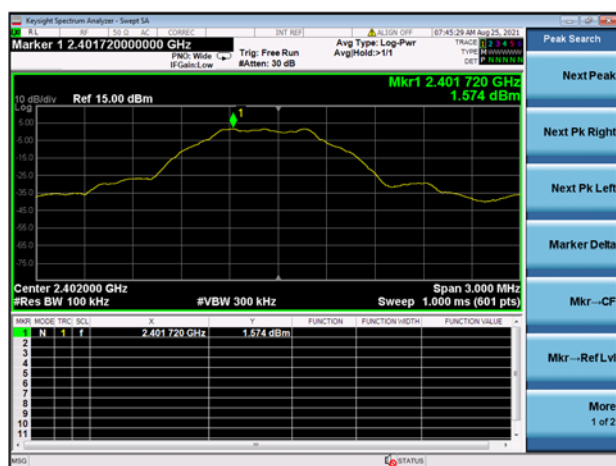
A.4 Band Edge (Authorized-band band-edge)

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

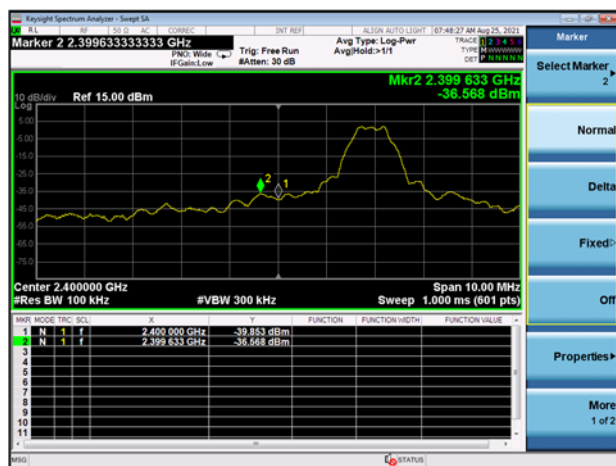
Channel	Measured Max. Band Edge Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low Channel	-28.531	1.574	-18.426	Pass
High Channel	-35.353	0.850	-19.15	Pass

Test Plots

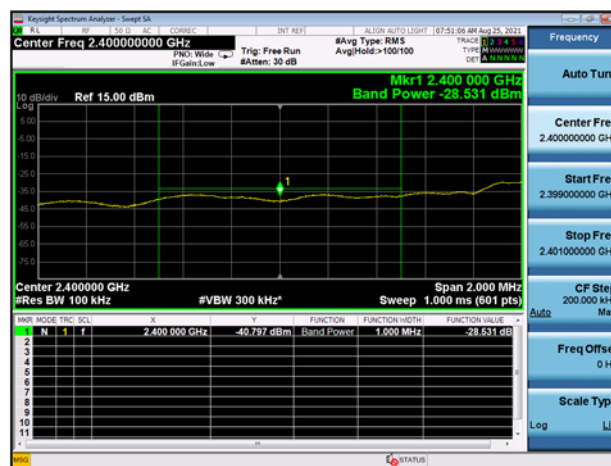
LOW CHANNEL, Carrier level



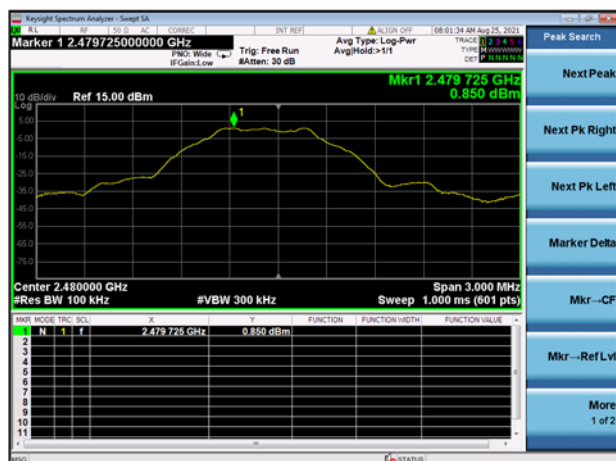
LOW CHANNEL, Reference level



LOW CHANNEL, Band Edge



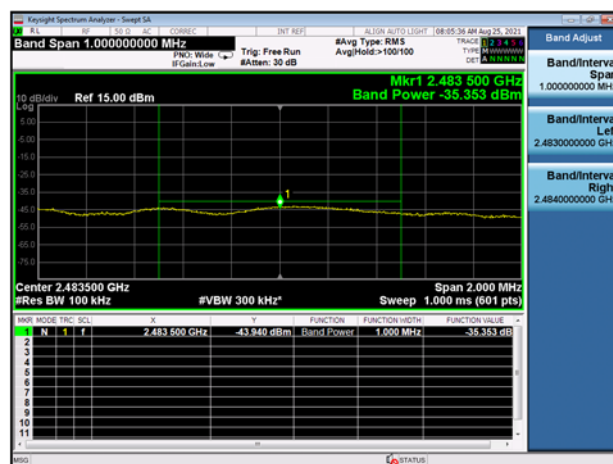
High CHANNEL, Carrier level



HIGH CHANNEL, Reference level



HIGH CHANNEL, Band Edge



A.5 Conducted Emissions

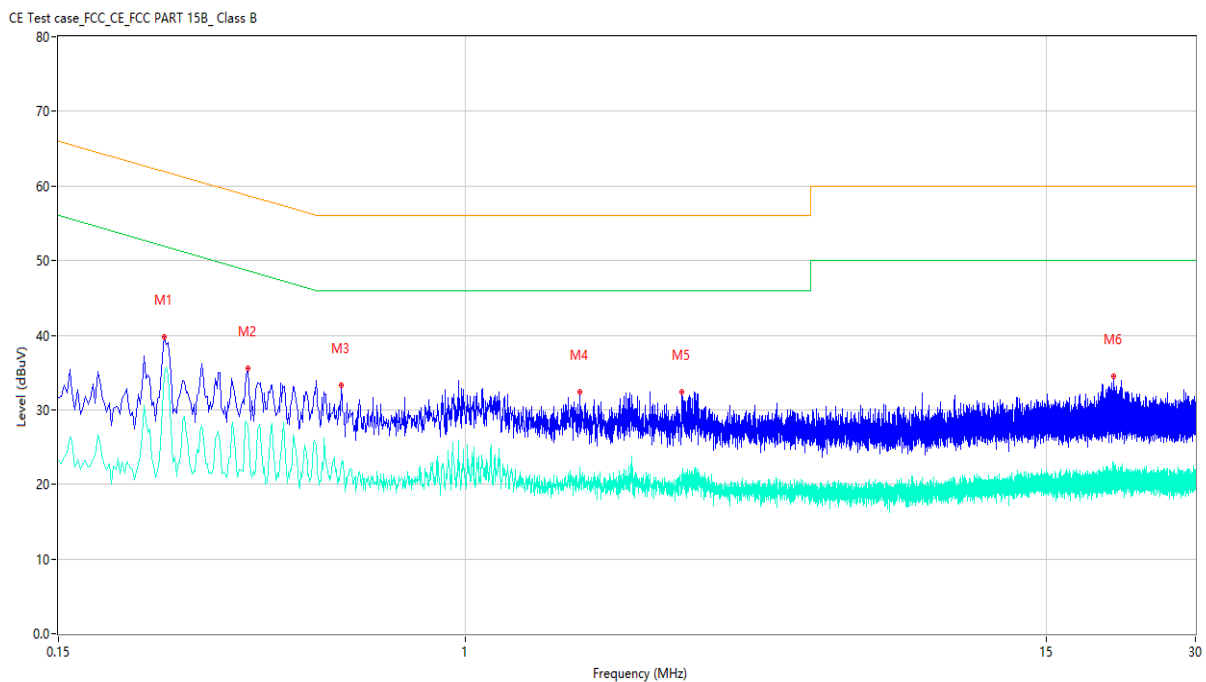
Note¹: The EUT is working in the Normal link mode. All modes have been tested and normal link mode is worst.

Note²: 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.

Note³: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

Test Data and Plots

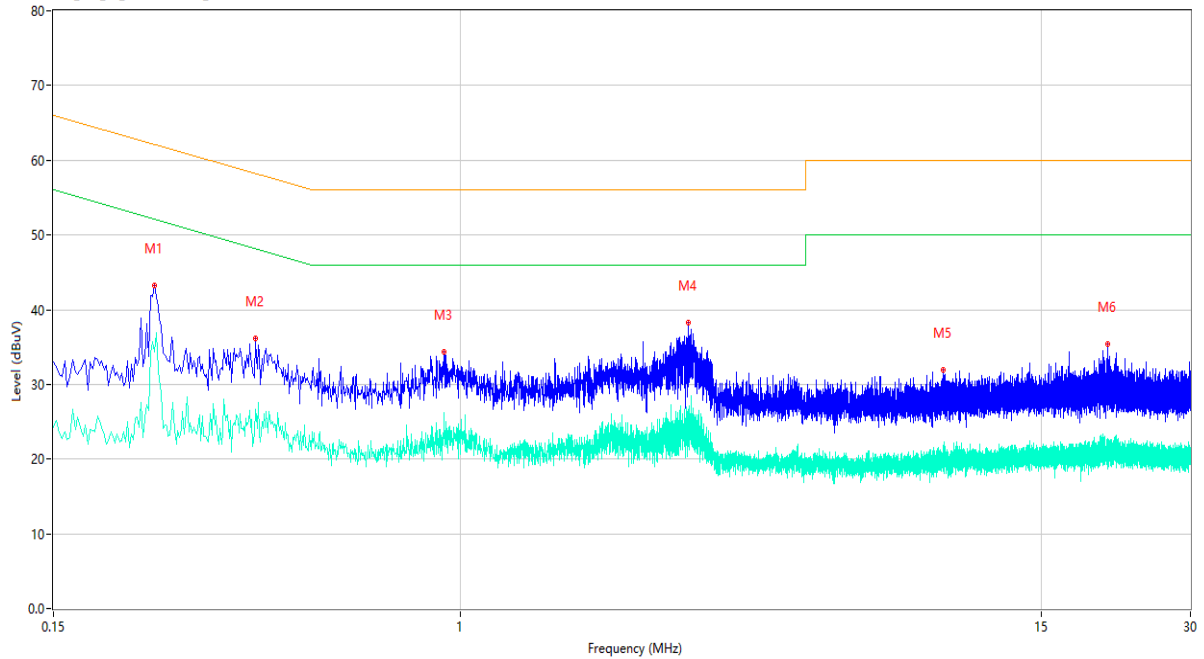
PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.246	39.74	10.35	61.89	-22.15	Peak	L	Pass
1**	0.246	34.80	10.35	51.89	-17.09	AV	L	Pass
2	0.362	35.57	10.50	58.68	-23.11	Peak	L	Pass
2**	0.362	27.79	10.50	48.68	-20.89	AV	L	Pass
3	0.560	33.30	10.10	56.00	-22.70	Peak	L	Pass
3**	0.560	22.57	10.10	46.00	-23.43	AV	L	Pass
4	1.706	32.38	10.23	56.00	-23.62	Peak	L	Pass
4**	1.706	22.34	10.23	46.00	-23.66	AV	L	Pass
5	2.742	32.36	10.29	56.00	-23.64	Peak	L	Pass
5**	2.742	21.40	10.29	46.00	-24.60	AV	L	Pass
6	20.492	34.51	10.75	60.00	-25.49	Peak	L	Pass
6**	20.492	22.03	10.75	50.00	-27.97	AV	L	Pass

PHASE N

CE Test case_FCC_CE_FCC PART 15B_Class B



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.240	43.21	10.34	62.10	-18.89	Peak	N	Pass
1**	0.240	34.30	10.34	52.10	-17.80	AV	N	Pass
2	0.384	36.20	10.50	58.19	-21.99	Peak	N	Pass
2**	0.384	26.66	10.50	48.19	-21.53	AV	N	Pass
3	0.926	34.28	10.25	56.00	-21.72	Peak	N	Pass
3**	0.926	26.24	10.25	46.00	-19.76	AV	N	Pass
4	2.888	38.22	10.32	56.00	-17.78	Peak	N	Pass
4**	2.888	25.32	10.32	46.00	-20.68	AV	N	Pass
5	9.478	32.01	10.08	60.00	-27.99	Peak	N	Pass
5**	9.478	19.82	10.08	50.00	-30.18	AV	N	Pass
6	20.426	35.38	10.79	60.00	-24.62	Peak	N	Pass
6**	20.426	22.74	10.79	50.00	-27.26	AV	N	Pass

A.6 Radiated Spurious Emission

Note¹: The symbol of “--” in the table which means not application.

Note²: 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.

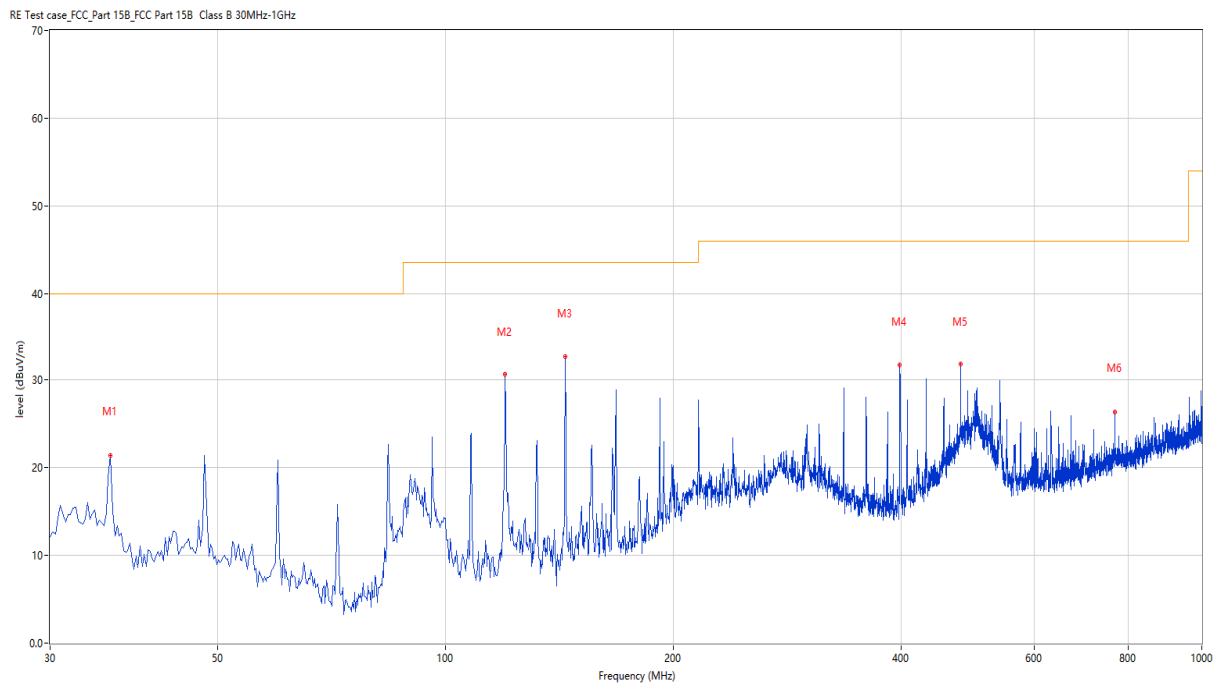
Note³: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

Note⁴: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and BLE 1M-Low channel mode is the worst.

Note⁵: Results (dBuV/m) = Original reading level of Spectrum Analyzer (dBuV/m) + Factor (dB)

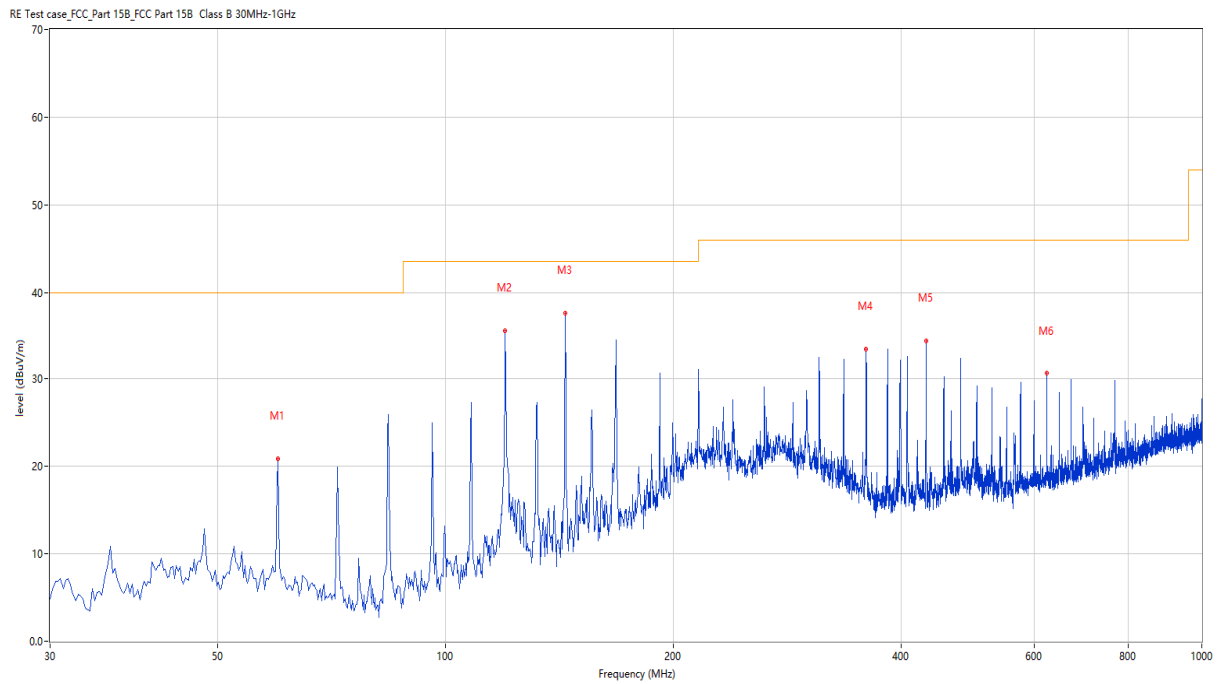
Test Data and Plots

30 MHz to 1 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	36.062	21.44	-27.78	40.0	-18.56	Peak	185.00	100	Vertical	Pass
2	119.967	30.72	-28.95	43.5	-12.78	Peak	120.00	100	Vertical	Pass
3	143.975	32.73	-31.12	43.5	-10.77	Peak	64.00	100	Vertical	Pass
4	398.842	31.78	-21.19	46.0	-14.22	Peak	106.00	100	Vertical	Pass
5	480.080	31.79	-19.39	46.0	-14.21	Peak	99.00	100	Vertical	Pass
6	768.170	26.39	-13.44	46.0	-19.61	Peak	26.00	100	Vertical	Pass

30 MHz to 1 GHz, ANT H

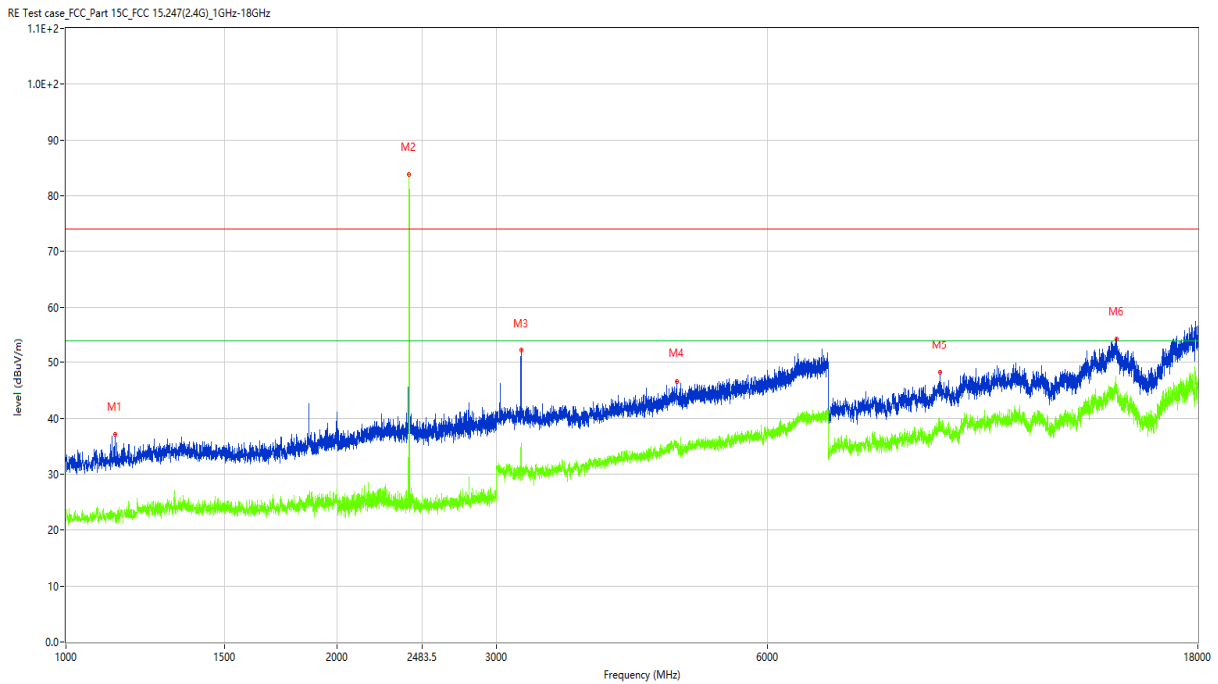


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	60.070	20.87	-26.76	40.0	-19.13	Peak	179.00	200	Horizontal	Pass
2	119.967	35.60	-28.95	43.5	-7.90	Peak	182.00	200	Horizontal	Pass
3	143.975	37.59	-31.12	43.5	-5.91	Peak	173.00	200	Horizontal	Pass
4	360.042	33.44	-22.11	46.0	-12.56	Peak	169.00	100	Horizontal	Pass
5	432.065	34.44	-20.37	46.0	-11.56	Peak	187.00	100	Horizontal	Pass
6	624.125	30.63	-16.02	46.0	-15.37	Peak	112.00	100	Horizontal	Pass

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

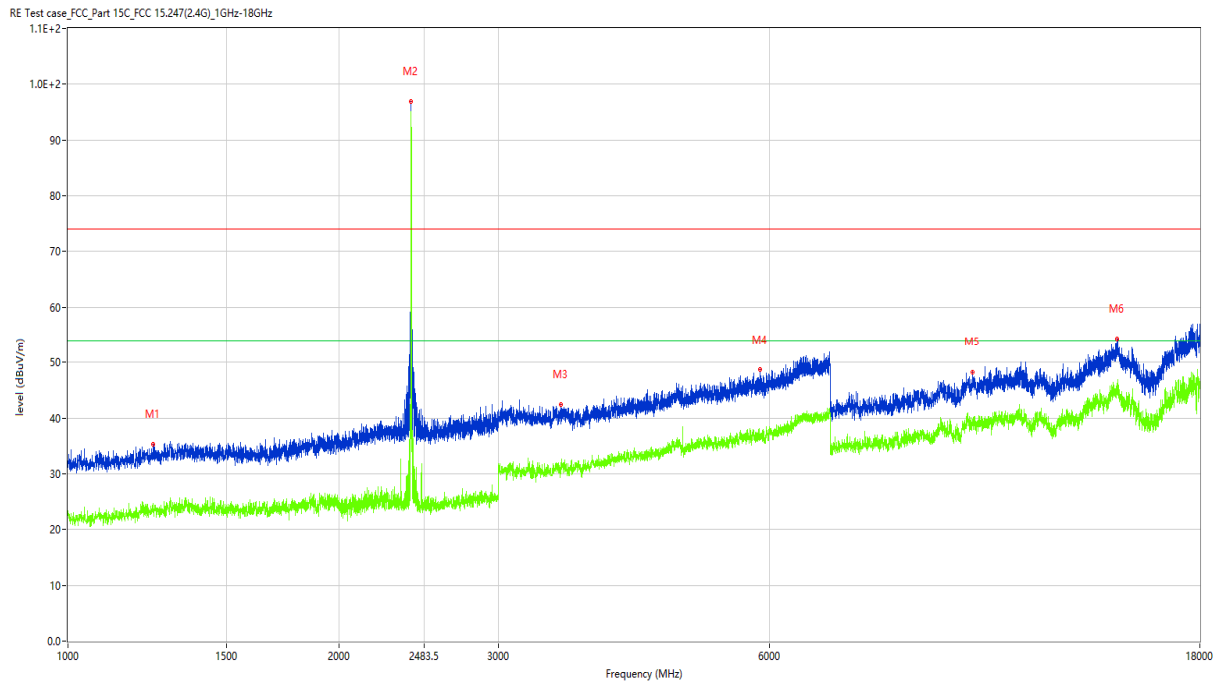
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V



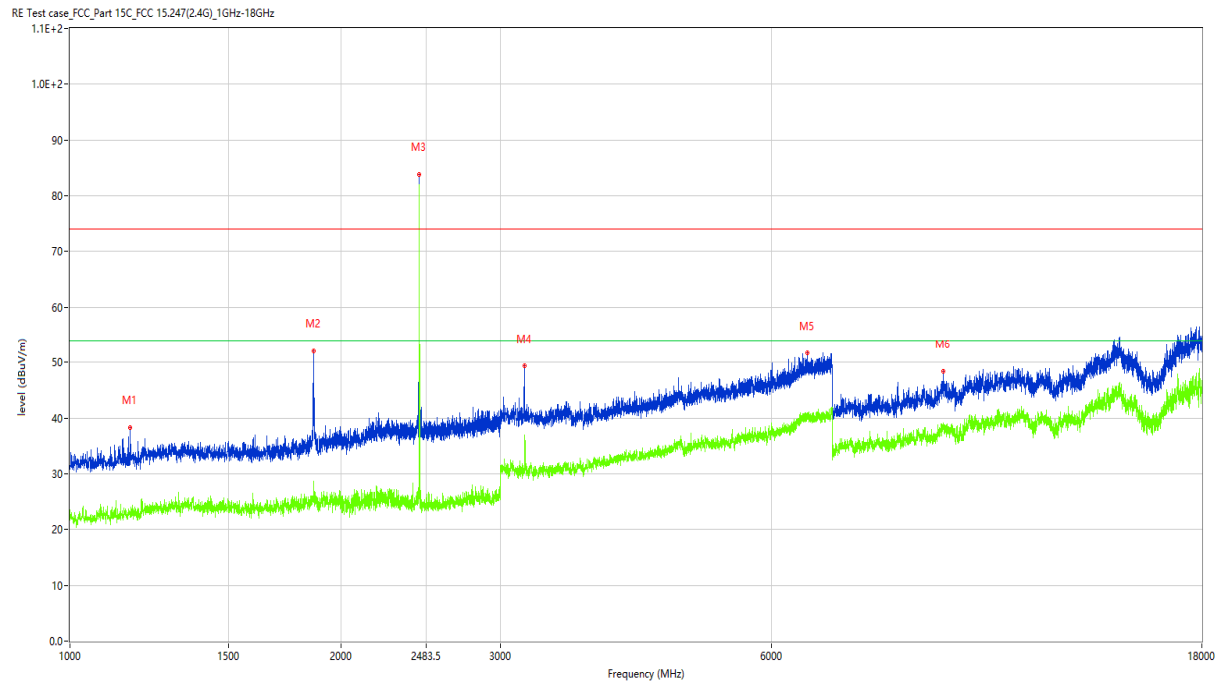
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1133.000	37.06	-17.17	74.0	-36.94	Peak	351.00	100	Vertical	Pass
1**	1133.000	23.16	-17.17	54.0	-30.84	AV	351.00	100	Vertical	Pass
2	2402.500	81.94	-12.07	74.0	7.94	Peak	207.00	100	Vertical	N/A
2**	2402.500	83.83	-12.07	54.0	29.83	AV	207.00	100	Vertical	N/A
3	3198.000	52.17	-6.78	74.0	-21.83	Peak	0.00	100	Vertical	Pass
3**	3198.000	35.60	-6.78	54.0	-18.40	AV	0.00	100	Vertical	Pass
4	4755.000	46.62	-2.88	74.0	-27.38	Peak	104.00	100	Vertical	Pass
4**	4755.000	35.58	-2.88	54.0	-18.42	AV	104.00	100	Vertical	Pass
5	9323.750	48.14	4.28	74.0	-25.86	Peak	200.00	100	Vertical	Pass
5**	9323.750	37.75	4.28	54.0	-16.25	AV	200.00	100	Vertical	Pass
6	14634.000	54.29	12.01	74.0	-19.71	Peak	232.00	100	Vertical	Pass
6**	14634.000	44.90	12.01	54.0	-9.10	AV	232.00	100	Vertical	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



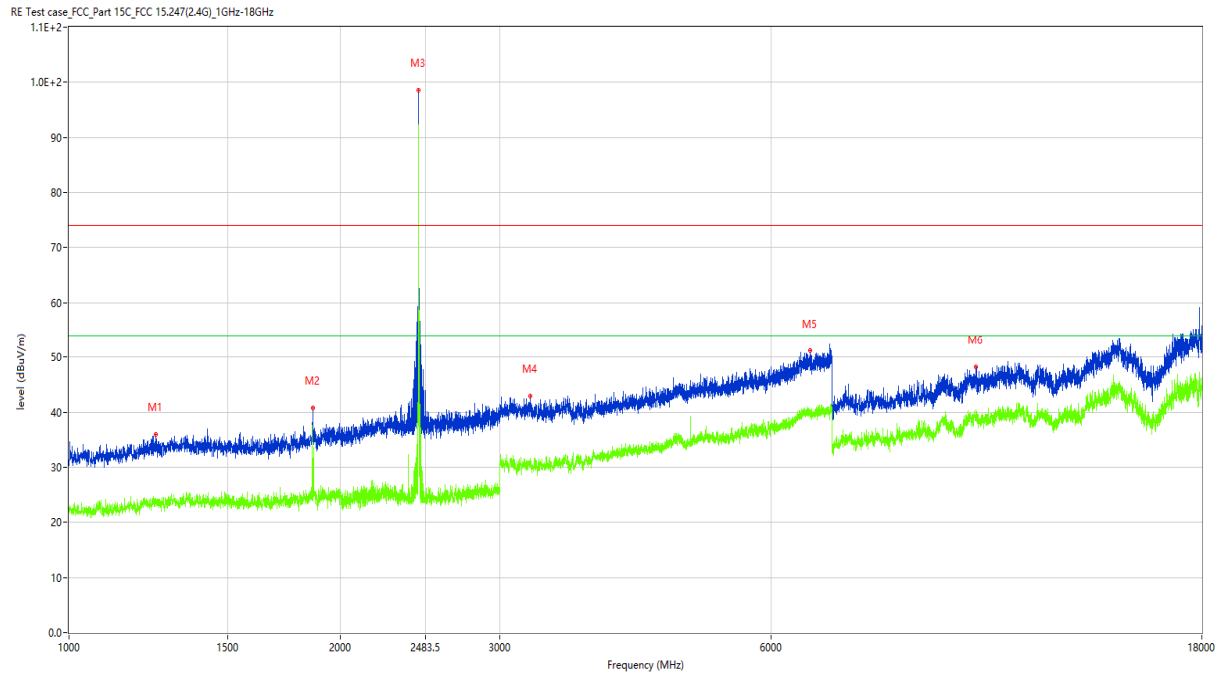
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1243.500	35.24	-16.19	74.0	-38.76	Peak	202.00	100	Horizontal	Pass
1**	1243.500	24.68	-16.19	54.0	-29.32	AV	202.00	100	Horizontal	Pass
2	2402.000	96.94	-12.10	74.0	22.94	Peak	202.00	100	Horizontal	N/A
2**	2402.000	92.85	-12.10	54.0	38.85	AV	202.00	100	Horizontal	N/A
3	3523.000	42.47	-6.47	74.0	-31.53	Peak	7.00	100	Horizontal	Pass
3**	3523.000	31.45	-6.47	54.0	-22.55	AV	7.00	100	Horizontal	Pass
4	5852.000	48.75	-1.36	74.0	-25.25	Peak	62.00	100	Horizontal	Pass
4**	5852.000	37.11	-1.36	54.0	-16.89	AV	62.00	100	Horizontal	Pass
5	10080.000	48.26	6.50	74.0	-25.74	Peak	0.00	100	Horizontal	Pass
5**	10080.000	39.48	6.50	54.0	-14.52	AV	0.00	100	Horizontal	Pass
6	14573.500	54.39	11.96	74.0	-19.61	Peak	286.00	100	Horizontal	Pass
6**	14573.500	46.13	11.96	54.0	-7.87	AV	286.00	100	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



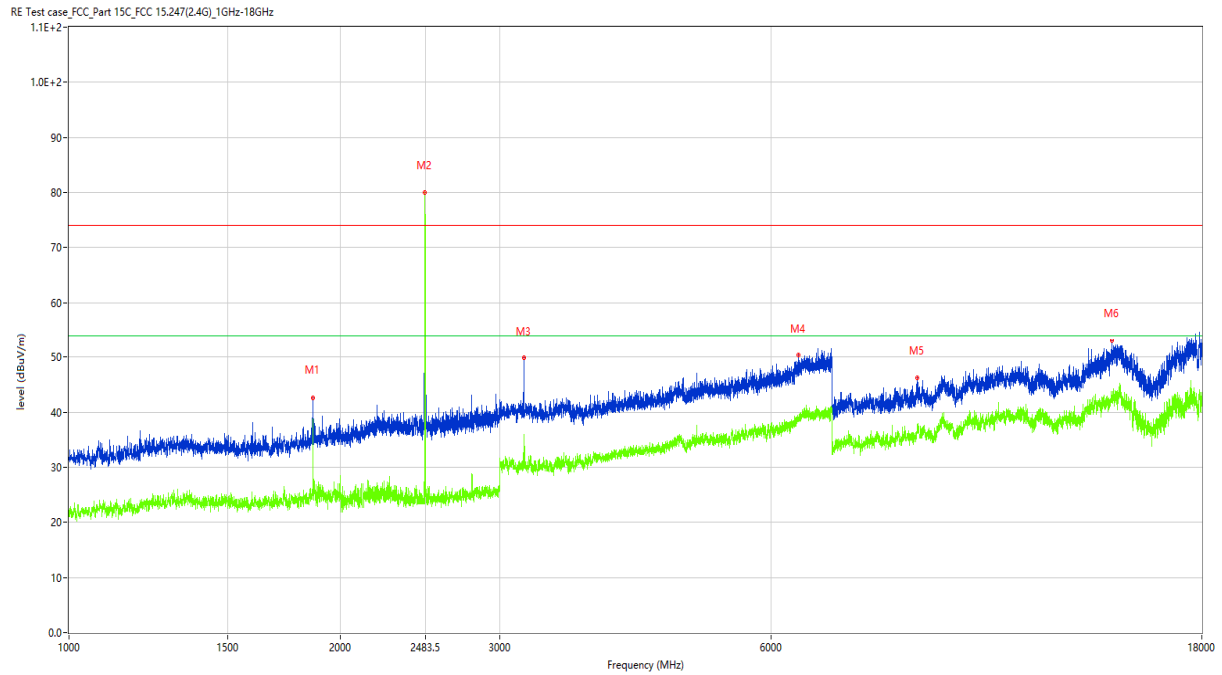
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1165.500	38.24	-16.89	74.0	-35.76	Peak	1.00	100	Vertical	Pass
1**	1165.500	22.74	-16.89	54.0	-31.26	AV	1.00	100	Vertical	Pass
2	1864.500	52.09	-14.76	74.0	-21.91	Peak	54.00	100	Vertical	Pass
2**	1864.500	28.62	-14.76	54.0	-25.38	AV	54.00	100	Vertical	Pass
3	2439.500	83.86	-12.43	74.0	9.86	Peak	247.00	100	Vertical	N/A
3**	2439.500	62.40	-12.43	54.0	8.40	AV	247.00	100	Vertical	N/A
4	3190.000	49.41	-7.42	74.0	-24.59	Peak	36.00	100	Vertical	Pass
4**	3190.000	30.80	-7.42	54.0	-23.20	AV	36.00	100	Vertical	Pass
5	6575.000	51.68	1.59	74.0	-22.32	Peak	160.00	100	Vertical	Pass
5**	6575.000	40.89	1.59	54.0	-13.11	AV	160.00	100	Vertical	Pass
6	9301.750	48.40	4.50	74.0	-25.60	Peak	64.00	100	Vertical	Pass
6**	9301.750	38.40	4.50	54.0	-15.60	AV	64.00	100	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



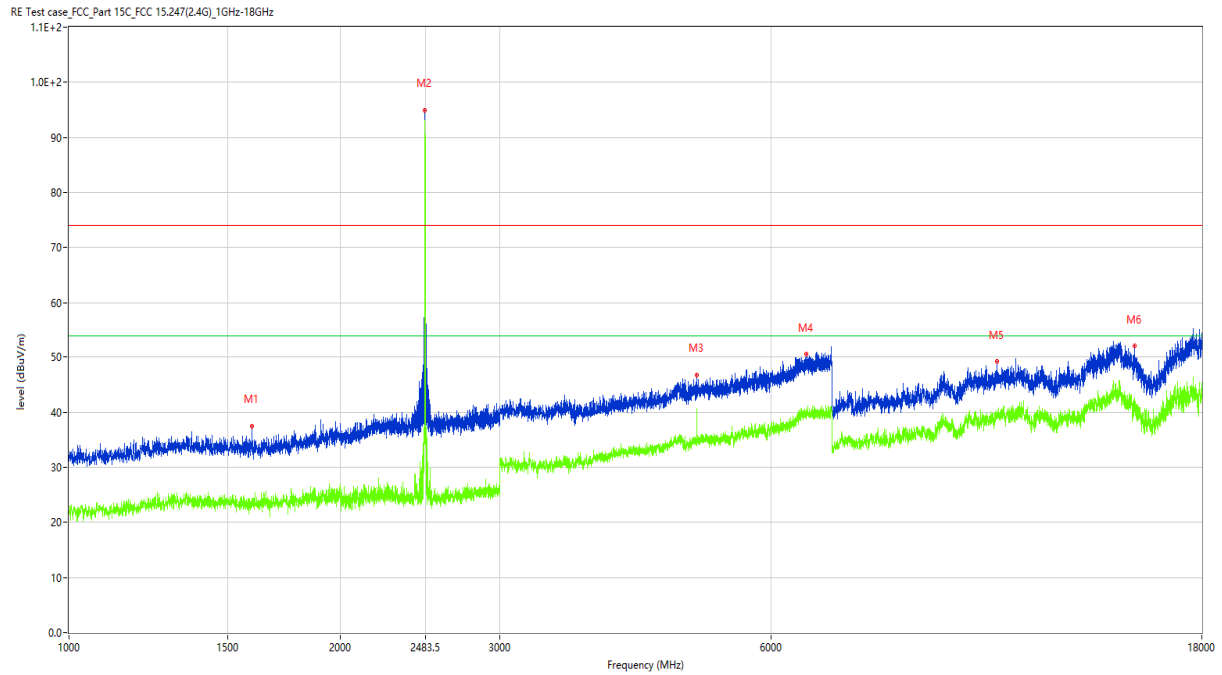
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1249.000	35.92	-16.19	74.0	-38.08	Peak	360.00	100	Horizontal	Pass
1**	1249.000	24.19	-16.19	54.0	-29.81	AV	360.00	100	Horizontal	Pass
2	1861.500	40.74	-14.69	74.0	-33.26	Peak	67.00	100	Horizontal	Pass
2**	1861.500	26.01	-14.69	54.0	-27.99	AV	67.00	100	Horizontal	Pass
3	2439.500	98.57	-12.43	74.0	24.57	Peak	211.00	100	Horizontal	N/A
3**	2439.500	82.37	-12.43	54.0	28.37	AV	211.00	100	Horizontal	N/A
4	3243.000	42.82	-7.17	74.0	-31.18	Peak	1.00	100	Horizontal	Pass
4**	3243.000	31.64	-7.17	54.0	-22.36	AV	1.00	100	Horizontal	Pass
5	6621.000	51.17	2.96	74.0	-22.83	Peak	0.00	100	Horizontal	Pass
5**	6621.000	40.27	2.96	54.0	-13.73	AV	0.00	100	Horizontal	Pass
6	10104.750	48.19	6.23	74.0	-25.81	Peak	233.00	100	Horizontal	Pass
6**	10104.750	40.49	6.23	54.0	-13.51	AV	233.00	100	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1863.000	42.65	-14.57	74.0	-31.35	Peak	113.00	100	Vertical	Pass
1**	1863.000	25.04	-14.57	54.0	-28.96	AV	113.00	100	Vertical	Pass
2	2480.500	78.05	-11.67	74.0	4.05	Peak	210.00	100	Vertical	N/A
2**	2480.500	80.01	-11.67	54.0	26.01	AV	210.00	100	Vertical	N/A
3	3194.000	49.87	-7.10	74.0	-24.13	Peak	1.00	100	Vertical	Pass
3**	3194.000	30.29	-7.10	54.0	-23.71	AV	1.00	100	Vertical	Pass
4	6433.000	50.31	1.19	74.0	-23.69	Peak	1.00	100	Vertical	Pass
4**	6433.000	38.90	1.19	54.0	-15.10	AV	1.00	100	Vertical	Pass
5	8705.000	46.14	2.78	74.0	-27.86	Peak	297.00	100	Vertical	Pass
5**	8705.000	36.20	2.78	54.0	-17.80	AV	297.00	100	Vertical	Pass
6	14306.750	53.09	10.89	74.0	-20.91	Peak	76.00	100	Vertical	Pass
6**	14306.750	42.99	10.89	54.0	-11.01	AV	76.00	100	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1595.000	37.44	-16.48	74.0	-36.56	Peak	6.00	100	Horizontal	Pass
1**	1595.000	23.88	-16.48	54.0	-30.12	AV	6.00	100	Horizontal	Pass
2	2479.500	94.89	-11.57	74.0	20.89	Peak	247.00	100	Horizontal	N/A
2**	2479.500	80.93	-11.57	54.0	26.93	AV	247.00	100	Horizontal	N/A
3	4959.000	46.68	-2.67	74.0	-27.32	Peak	36.00	100	Horizontal	Pass
3**	4959.000	34.80	-2.67	54.0	-19.20	AV	36.00	100	Horizontal	Pass
4	6559.000	50.52	1.77	74.0	-23.48	Peak	360.00	100	Horizontal	Pass
4**	6559.000	39.89	1.77	54.0	-14.11	AV	360.00	100	Horizontal	Pass
5	10682.250	49.16	6.64	74.0	-24.84	Peak	32.00	100	Horizontal	Pass
5**	10682.250	40.02	6.64	54.0	-13.98	AV	32.00	100	Horizontal	Pass
6	15175.750	52.05	9.57	74.0	-21.95	Peak	32.00	100	Horizontal	Pass
6**	15175.750	41.36	9.57	54.0	-12.64	AV	32.00	100	Horizontal	Pass

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

Note¹: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

Note²: 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.

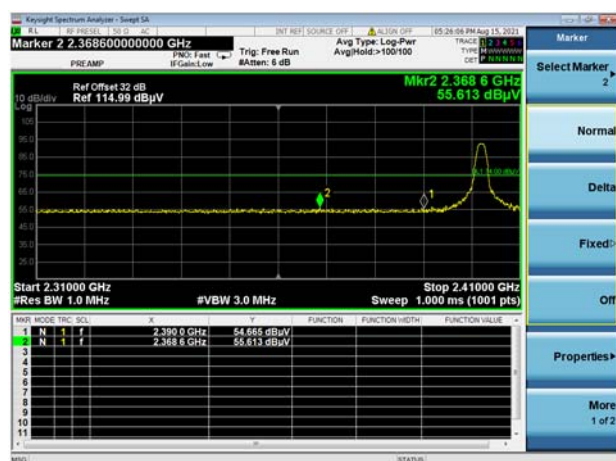
Note³: According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note⁴: The Level (dBuV/m) has been corrected by factor.

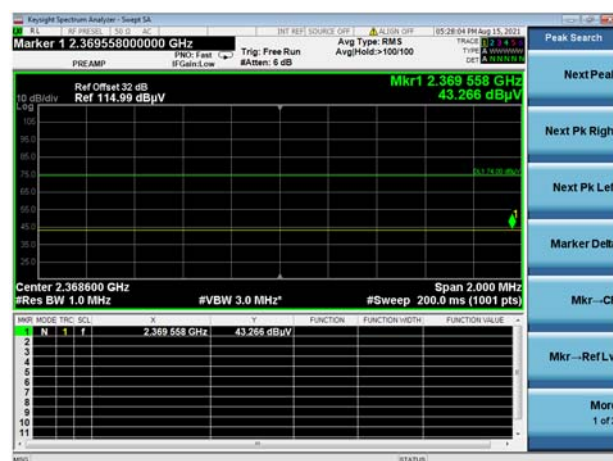
Test Mode	Test Channel	Frequency (MHz)	Level (dBuV/m)	Factor (dB)	Limit Line (dBuV/m)	Margin (dB)	Remark	Verdict
GFSK	Low	2390	55.613	32	74	18.387	PEAK	Pass
		2390	43.266	32	54	10.734	AVERAGE	Pass
GFSK	HIGH	2483.5	59.806	32	74	14.194	PEAK	Pass
		2483.5	43.106	32	54	10.894	AVERAGE	Pass

Test plots

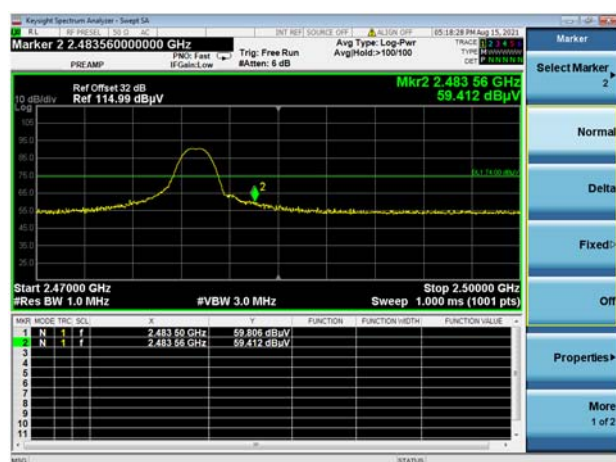
LOW CHANNEL, PEAK



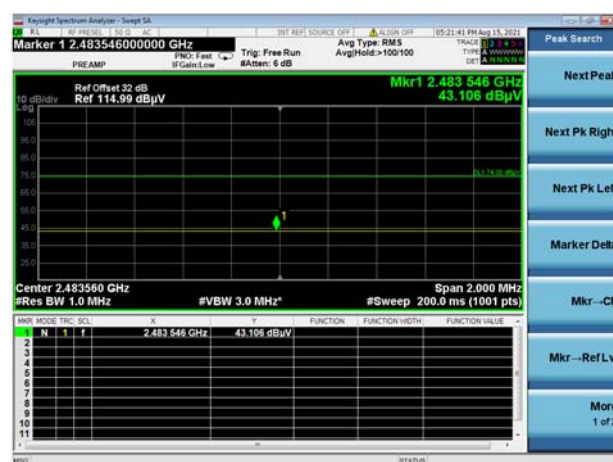
LOW CHANNEL, AV



HIGH CHANNEL, PEAK



HIGH CHANNEL, AV



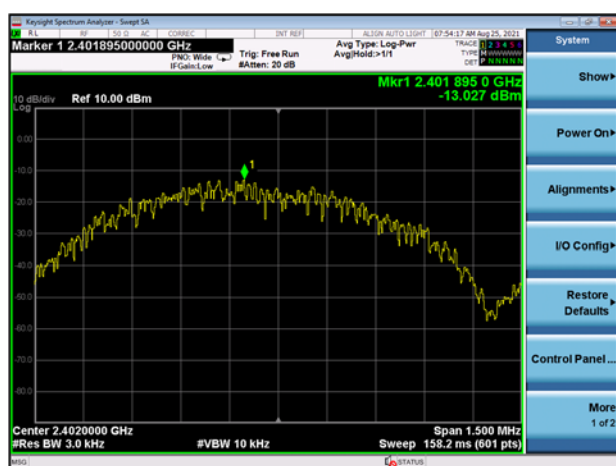
A.8 Power Spectral Density (PSD)

Test Data

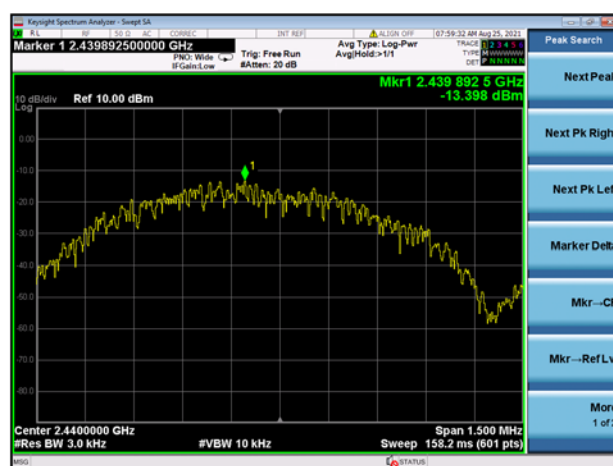
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low Channel	-13.027	8	Pass
Middle Channel	-13.398	8	Pass
High Channel	-13.797	8	Pass

Test plots

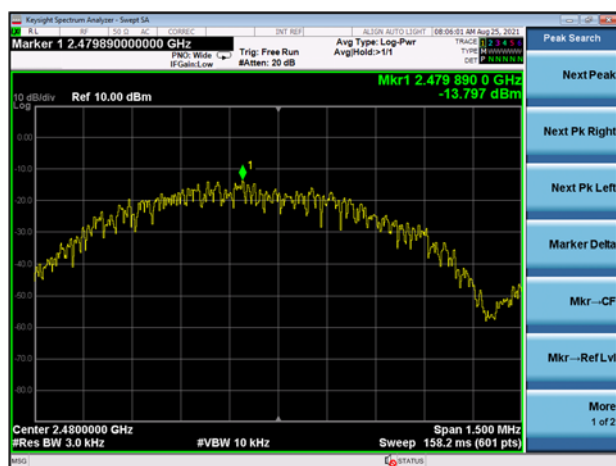
GFSK (BLE) LOW CHANNEL



GFSK (BLE) MIDDLE CHANNEL



GFSK (BLE) HIGH CHANNEL



ANNEX B TEST SETUP PHOTOS

Please refer the document "BL-EC2180109-AR.PDF".

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document "BL-EC2180109-AW.PDF".

ANNEX D EUT INTERNAL PHOTOS

Please refer the document "BL-EC2180109-AI.PDF".

--END OF REPORT--