5.7 Radiated Spurious Emission

5.7.1 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).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. Field Strength (dBμV/m) = 20*log[Field Strength (μV/m)].
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.7.2 Test Setup

See section 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.7.3 Test Procedure

Since the emission limits are specified in terms of radiated field strength levels, measurements performed to demonstrate compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for demonstrating compliance to the specified limits; however antenna-port conducted measurements are also now acceptable to demonstrate compliance (see below for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 shall be followed.

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are

performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

General Procedure for conducted measurements in restricted bands:

a) Measure the conducted output power (in dBm) using the detector specified (see guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

E = EIRP – 20log D + 104.8

where:

E = electric field strength in dBμV/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

f) Compare the resultant electric field strength level to the applicable limit.

g) Perform radiated spurious emission test.

Quasi-Peak measurement procedure

The specifications for measurements using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

Peak power measurement procedure:

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 1.

b) VBW ≥ 3 x RBW.

c) Detector = Peak.

d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Table 1—RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction:

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent), then the following procedure shall be used:

a) The EUT shall be configured to operate at the maximum achievable duty cycle.

b) Measure the duty cycle, x, of the transmitter output signal as described in section 6.0.

c) RBW = 1 MHz (unless otherwise specified).

d) VBW ≥ 3 x RBW.

e) Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.

f) Averaging type = power (i.e., RMS).

1) As an alternative, the detector and averaging type may be set for linear voltage averaging.

2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.

g) Sweep time = auto.

h) Perform a trace average of at least 100 traces.

i) A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log(1/x), where x is the duty cycle.

2) If linear voltage averaging mode was used in step f), then the applicable correction factor is 20 log(1/x), where x is the duty cycle.

3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

NOTE: Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.

Determining the applicable transmit antenna gain:

A conducted power measurement will determine the maximum output power associated with a restricted band emission; however, in order to determine the associated EIRP level, the gain of the transmitting antenna (in dBi) must be added to the measured output power (in dBm).

Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.

See KDB 662911 for guidance on calculating the additional array gain term when determining the effective antenna gain for a EUT with multiple outputs occupying the same or overlapping frequency ranges in the same band.

Radiated spurious emission test:

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.

The measurement frequency range is from 30MHz 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 ≥ 1 GHz, 100 kHz for f < 1 GHz

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

5.7.4 Test Result

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.

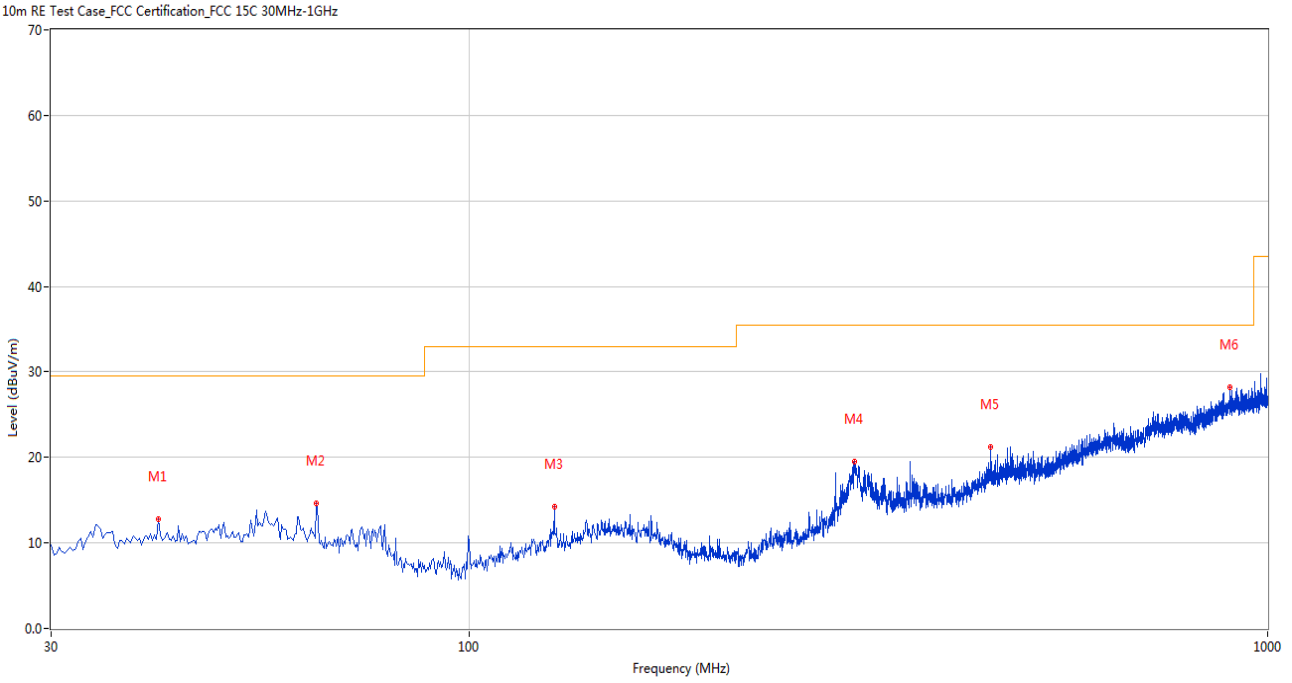
Note [3]: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

Note [4]: The EUT was tested in Link mode and the charging.

Note [5]: Results (dBuV/m) = Original reading level of Spectrum Analyzer (dBuV/m) + Factor (dB)

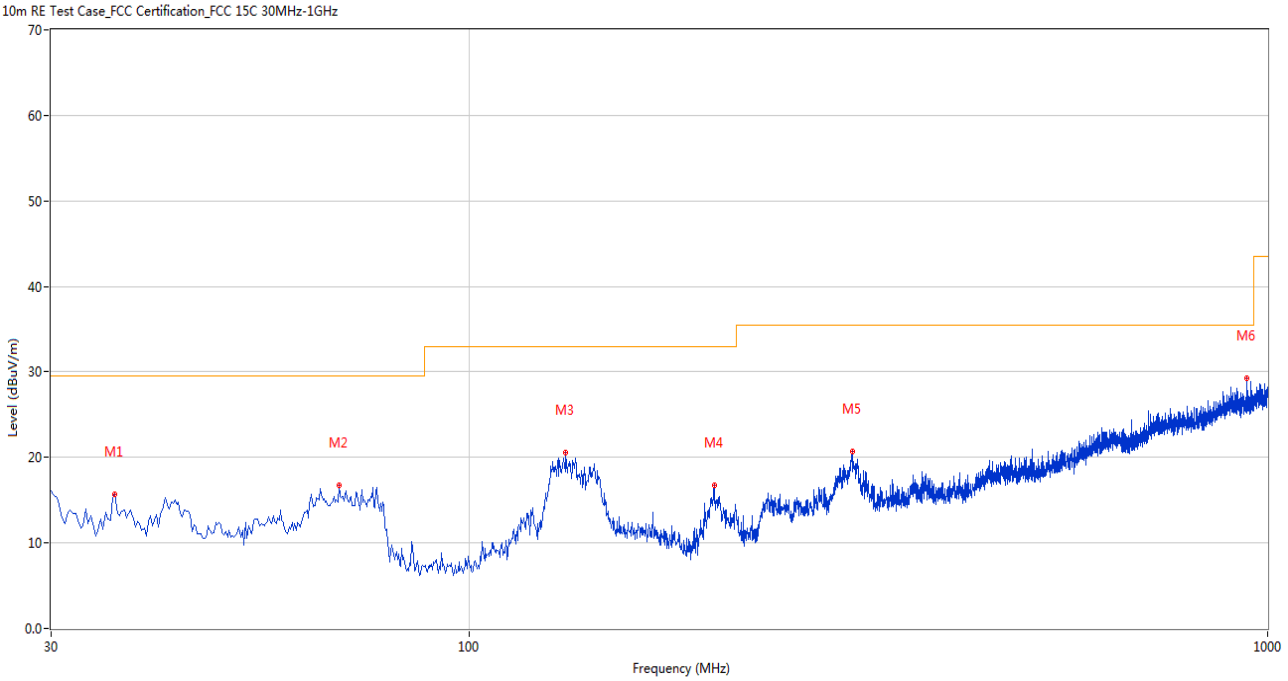
Test Data and Plots

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	40.910	12.84	-26.43	29.5	16.66	Peak	0.00	200	Horizontal	Pass
2	64.426	14.66	-27.19	29.5	14.84	Peak	167.00	100	Horizontal	Pass
3	127.946	14.26	-27.27	33.0	18.74	Peak	360.00	100	Horizontal	Pass
4	304.199	19.49	-24.88	35.5	16.01	Peak	258.00	200	Horizontal	Pass
5	449.663	21.26	-20.67	35.5	14.24	Peak	215.00	200	Horizontal	Pass
6	896.236	28.23	-10.50	35.5	7.27	Peak	252.00	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	36.061	15.66	-27.09	29.5	13.84	Peak	182.00	100	Vertical	Pass
2	68.790	16.76	-28.08	29.5	12.74	Peak	160.00	100	Vertical	Pass
3	132.309	20.60	-26.91	33.0	12.40	Peak	264.00	200	Vertical	Pass
4	202.859	16.75	-28.96	33.0	16.25	Peak	0.00	100	Vertical	Pass
5	302.017	20.67	-24.87	35.5	14.83	Peak	89.00	100	Vertical	Pass
6	941.815	29.31	-10.76	35.5	6.19	Peak	180.00	200	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) LOW CHANNEL 1 GHz to 18 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2402.600	92.94	74.0	-18.94	Peak	172.00	200	Horizontal	N/A
1**	2402.600	90.61	54.0	-36.61	AV	172.00	200	Horizontal	N/A
2	2593.900	55.58	74.0	18.42	Peak	172.00	150	Horizontal	Pass
2**	2593.900	51.77	54.0	2.23	AV	172.00	150	Horizontal	N/A
3	4801.200	49.41	74.0	24.59	Peak	332.00	150	Horizontal	Pass
3**	4801.200	45.43	54.0	8.57	AV	332.00	150	Horizontal	Pass
4	7200.675	48.25	74.0	25.75	Peak	182.00	150	Horizontal	Pass
4**	7200.675	46.20	54.0	7.80	AV	182.00	150	Horizontal	Pass
5	9601.875	52.61	74.0	21.39	Peak	252.00	150	Horizontal	Pass
5**	9601.875	45.03	54.0	8.97	AV	252.00	150	Horizontal	Pass
6	17441.137	56.33	74.0	17.67	Peak	0.00	400	Horizontal	Pass
6**	17441.137	47.53	54.0	6.47	AV	0.00	400	Horizontal	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2401.700	89.79	74.0	-15.79	Peak	23.00	200	Vertical	N/A
1**	2401.700	87.70	54.0	-33.70	AV	23.00	200	Vertical	N/A
2	2594.000	51.62	74.0	22.38	Peak	16.00	150	Vertical	Pass
2**	2594.000	48.68	54.0	5.32	AV	16.00	150	Vertical	Pass
3	4801.200	50.75	74.0	23.25	Peak	226.00	150	Vertical	Pass
3**	4801.200	46.79	54.0	7.21	AV	226.00	150	Vertical	Pass
4	4500.000	50.64	74.0	23.36	Peak	126.00	150	Vertical	Pass
4**	4500.000	47.31	54.0	6.69	AV	126.00	150	Vertical	Pass
5	7200.388	49.07	74.0	24.93	Peak	307.00	150	Vertical	Pass
5**	7200.388	44.88	54.0	9.12	AV	307.00	150	Vertical	Pass
6	9602.450	50.15	74.0	23.85	Peak	48.00	150	Vertical	Pass
6**	9602.450	46.05	54.0	7.95	AV	48.00	150	Vertical	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1399.600	42.75	74.0	31.25	Peak	184.00	400	Horizontal	Pass
1**	1399.600	32.81	54.0	21.19	AV	184.00	400	Horizontal	Pass
2	2439.700	92.76	74.0	-18.76	Peak	241.00	200	Horizontal	N/A
2**	2439.700	91.32	54.0	-37.32	AV	241.00	200	Horizontal	N/A
3	2938.000	52.02	74.0	21.98	Peak	332.00	150	Horizontal	Pass
3**	2938.000	41.81	54.0	12.19	AV	332.00	150	Horizontal	Pass
4	7314.237	46.95	74.0	27.05	Peak	327.00	150	Horizontal	Pass
4**	7314.237	43.22	54.0	10.78	AV	327.00	150	Horizontal	Pass
5	9754.537	49.61	74.0	24.39	Peak	327.00	150	Horizontal	Pass
5**	9754.537	46.25	54.0	7.75	AV	327.00	150	Horizontal	Pass
6	13351.912	55.23	74.0	18.77	Peak	17.00	150	Horizontal	Pass
6**	13351.912	47.08	54.0	6.92	AV	17.00	150	Horizontal	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2439.900	90.52	74.0	-16.52	Peak	27.00	150	Vertical	N/A
1**	2439.900	89.62	54.0	-35.62	AV	27.00	150	Vertical	N/A
2	2632.100	51.13	74.0	22.87	Peak	79.00	150	Vertical	Pass
2**	2632.100	46.86	54.0	7.14	AV	79.00	150	Vertical	Pass
3	4500.000	50.88	74.0	23.12	Peak	78.00	150	Vertical	Pass
3**	4500.000	46.16	54.0	7.84	AV	78.00	150	Vertical	Pass
4	4877.400	48.92	74.0	25.08	Peak	42.00	150	Vertical	Pass
4**	4877.400	46.69	54.0	7.31	AV	42.00	150	Vertical	Pass
5	7314.525	48.59	74.0	25.41	Peak	339.00	150	Vertical	Pass
5**	7314.525	43.88	54.0	10.12	AV	339.00	150	Vertical	Pass
6	9754.537	49.96	74.0	24.04	Peak	339.00	150	Vertical	Pass
6**	9754.537	45.84	54.0	8.16	AV	339.00	150	Vertical	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1457.100	42.24	74.0	31.76	Peak	56.00	300	Horizontal	Pass
1**	1457.100	32.95	54.0	21.05	AV	56.00	300	Horizontal	Pass
2	2479.800	94.36	74.0	-20.36	Peak	248.00	100	Horizontal	N/A
2**	2479.800	93.09	54.0	-39.09	AV	248.00	100	Horizontal	N/A
3	2671.900	51.85	74.0	22.15	Peak	254.00	150	Horizontal	Pass
3**	2671.900	47.48	54.0	6.52	AV	254.00	150	Horizontal	Pass
4	7434.700	47.14	74.0	26.86	Peak	345.00	150	Horizontal	Pass
4**	7434.700	43.80	54.0	10.20	AV	345.00	150	Horizontal	Pass
5	9914.387	49.24	74.0	24.76	Peak	33.00	150	Horizontal	Pass
5**	9914.387	46.59	54.0	7.41	AV	33.00	150	Horizontal	Pass
6	15615.974	56.38	74.0	17.62	Peak	172.00	100	Horizontal	Pass
6**	15615.974	45.99	54.0	8.01	AV	172.00	100	Horizontal	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1499.700	42.85	74.0	31.15	Peak	0.00	300	Vertical	Pass
1**	1499.700	36.48	54.0	17.52	AV	0.00	300	Vertical	Pass
2	2479.900	91.84	74.0	-17.84	Peak	30.00	150	Vertical	N/A
2**	2479.900	90.80	54.0	-36.80	AV	30.00	150	Vertical	N/A
3	4500.000	49.69	74.0	24.31	Peak	341.00	150	Vertical	Pass
3**	4500.000	46.59	54.0	7.41	AV	341.00	150	Vertical	Pass
4	4957.400	50.46	74.0	23.54	Peak	352.00	150	Vertical	Pass
4**	4957.400	45.23	54.0	8.77	AV	352.00	150	Vertical	Pass
5	7434.700	47.74	74.0	26.26	Peak	62.00	150	Vertical	Pass
5**	7434.700	42.84	54.0	11.16	AV	62.00	150	Vertical	Pass
6	9914.387	49.99	74.0	24.01	Peak	360.00	150	Vertical	Pass
6**	9914.387	47.25	54.0	6.75	AV	360.00	150	Vertical	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2403.500	95.35	74.0	-21.35	Peak	333.00	150	Horizontal	N/A
1**	2403.500	92.25	54.0	-38.25	AV	333.00	150	Horizontal	N/A
2	2595.300	54.26	74.0	19.74	Peak	33.00	200	Horizontal	Pass
2**	2595.300	49.16	54.0	4.84	AV	33.00	200	Horizontal	Pass
3	3599.800	49.57	74.0	24.43	Peak	281.00	150	Horizontal	Pass
3**	3599.800	43.81	54.0	10.19	AV	281.00	150	Horizontal	Pass
4	4805.400	49.16	74.0	24.84	Peak	213.00	150	Horizontal	Pass
4**	4805.400	45.04	54.0	8.96	AV	213.00	150	Horizontal	Pass
5	7206.425	48.56	74.0	25.44	Peak	360.00	150	Horizontal	Pass
5**	7206.425	43.64	54.0	10.36	AV	360.00	150	Horizontal	Pass
6	9610.500	51.38	74.0	22.62	Peak	310.00	150	Horizontal	Pass
6**	9610.500	48.86	54.0	5.14	AV	310.00	150	Horizontal	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2403.900	93.60	74.0	-19.60	Peak	188.00	150	Vertical	N/A
1**	2403.900	90.60	54.0	-36.60	AV	188.00	150	Vertical	N/A
2	2595.700	53.09	74.0	20.91	Peak	188.00	150	Vertical	Pass
2**	2595.700	47.93	54.0	6.07	AV	188.00	150	Vertical	Pass
3	3599.800	52.62	74.0	21.38	Peak	349.00	150	Vertical	Pass
3**	3599.800	43.97	54.0	10.03	AV	349.00	150	Vertical	Pass
4	4805.000	50.04	74.0	23.96	Peak	267.00	150	Vertical	Pass
4**	4805.000	46.26	54.0	7.74	AV	267.00	150	Vertical	Pass
5	9610.500	51.51	74.0	22.49	Peak	344.00	150	Vertical	Pass
5**	9610.500	47.74	54.0	6.26	AV	344.00	150	Vertical	Pass
6	12294.025	52.90	74.0	21.10	Peak	323.00	100	Vertical	Pass
6**	12294.025	44.00	54.0	10.00	AV	323.00	100	Vertical	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2439.900	93.65	74.0	-19.65	Peak	330.00	200	Horizontal	N/A
1**	2439.900	92.92	54.0	-38.92	AV	330.00	200	Horizontal	N/A
2	2632.100	54.08	74.0	19.92	Peak	75.00	100	Horizontal	Pass
2**	2632.100	50.90	54.0	3.10	AV	75.00	100	Horizontal	Pass
3	3599.800	49.78	74.0	24.22	Peak	57.00	150	Horizontal	Pass
3**	3599.800	43.63	54.0	10.37	AV	57.00	150	Horizontal	Pass
4	7314.525	45.91	74.0	28.09	Peak	360.00	150	Horizontal	Pass
4**	7314.525	44.26	54.0	9.74	AV	360.00	150	Horizontal	Pass
5	9754.537	49.99	74.0	24.01	Peak	189.00	150	Horizontal	Pass
5**	9754.537	47.53	54.0	6.47	AV	189.00	150	Horizontal	Pass
6	17421.713	55.64	74.0	18.36	Peak	0.00	100	Horizontal	Pass
6**	17421.713	46.57	54.0	7.43	AV	0.00	100	Horizontal	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2439.500	92.69	74.0	-18.69	Peak	212.00	100	Vertical	N/A
1**	2439.500	89.48	54.0	-35.48	AV	212.00	100	Vertical	N/A
2	2631.900	52.26	74.0	21.74	Peak	183.00	150	Vertical	Pass
2**	2631.900	47.66	54.0	6.34	AV	183.00	150	Vertical	Pass
3	3599.800	49.38	74.0	24.62	Peak	90.00	150	Vertical	Pass
3**	3599.800	43.37	54.0	10.63	AV	90.00	150	Vertical	Pass
4	6445.800	54.31	74.0	19.69	Peak	322.00	400	Vertical	Pass
4**	6445.800	44.21	54.0	9.79	AV	322.00	400	Vertical	Pass
5	12285.688	53.05	74.0	20.95	Peak	308.00	200	Vertical	Pass
5**	12285.688	43.47	54.0	10.53	AV	308.00	200	Vertical	Pass
6	17326.688	55.51	74.0	18.49	Peak	47.00	150	Vertical	Pass
6**	17326.688	45.90	54.0	8.10	AV	47.00	150	Vertical	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2285.600	51.13	74.0	22.87	Peak	278.00	150	Horizontal	Pass
1**	2285.600	48.68	54.0	5.32	AV	278.00	150	Horizontal	Pass
2	2477.500	94.85	74.0	-20.85	Peak	327.00	100	Horizontal	N/A
2**	2477.500	92.46	54.0	-38.46	AV	327.00	100	Horizontal	N/A
3	2669.700	52.39	74.0	21.61	Peak	86.00	200	Horizontal	Pass
3**	2669.700	46.68	54.0	7.32	AV	86.00	200	Horizontal	Pass
4	3599.800	50.57	74.0	23.43	Peak	284.00	150	Horizontal	Pass
4**	3599.800	43.05	54.0	10.95	AV	284.00	150	Horizontal	Pass
5	9906.050	51.24	74.0	22.76	Peak	169.00	150	Horizontal	Pass
5**	9906.050	47.60	54.0	6.40	AV	169.00	150	Horizontal	Pass
6	17465.025	55.41	74.0	18.59	Peak	230.00	100	Horizontal	Pass
6**	17465.025	46.62	54.0	7.38	AV	230.00	100	Horizontal	Pass

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

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1166.700	46.11	74.0	27.89	Peak	43.00	200	Vertical	Pass
1**	1166.700	33.24	54.0	20.76	AV	43.00	200	Vertical	Pass
2	2285.800	51.72	74.0	22.28	Peak	182.00	150	Vertical	Pass
2**	2285.800	45.45	54.0	8.55	AV	182.00	150	Vertical	Pass
3	2477.500	94.37	74.0	-20.37	Peak	220.00	100	Vertical	N/A
3**	2477.500	91.12	54.0	-37.12	AV	220.00	100	Vertical	N/A
4	2670.400	52.08	74.0	21.92	Peak	210.00	200	Vertical	Pass
4**	2670.400	46.95	54.0	7.05	AV	210.00	200	Vertical	Pass
5	3599.800	50.10	74.0	23.90	Peak	54.00	150	Vertical	Pass
5**	3599.800	42.82	54.0	11.18	AV	54.00	150	Vertical	Pass
6	9906.625	48.77	74.0	25.23	Peak	74.00	150	Vertical	Pass
6**	9906.625	47.71	54.0	6.29	AV	74.00	150	Vertical	Pass

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 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

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 ≥ 1 GHz, 100 kHz for f < 1 GHz

VBW ≥ 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.

5.8.4 Test Result

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

GFSK (BLE 1Mbps) LOW CHANNEL

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2386.200	57.80	74.0	16.20	Peak	190.00	100	Horizontal	Pass
1**	2386.200	46.41	54.0	7.59	AV	190.00	100	Horizontal	Pass
2	2389.950	55.75	74.0	18.25	Peak	241.00	200	Horizontal	Pass
2**	2389.950	46.14	54.0	7.86	AV	241.00	200	Horizontal	Pass

GFSK (BLE 1Mbps) HIGH CHANNEL

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.560	60.15	74.0	13.85	Peak	328.00	200	Horizontal	Pass
1**	2483.560	46.10	54.0	7.90	AV	328.00	200	Horizontal	Pass
2	2483.770	58.45	74.0	15.55	Peak	323.00	150	Horizontal	Pass
2**	2483.770	46.48	54.0	7.52	AV	323.00	150	Horizontal	Pass

GFSK (BLE 2Mbps) LOW CHANNEL

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2383.500	58.37	74.0	15.63	Peak	170.00	100	Horizontal	Pass
1**	2383.500	45.97	54.0	8.03	AV	170.00	100	Horizontal	Pass
2	2389.950	55.98	74.0	18.02	Peak	156.00	100	Horizontal	Pass
2**	2389.950	45.66	54.0	8.34	AV	156.00	100	Horizontal	Pass

GFSK (BLE 2Mbps) HIGH CHANNEL

No.	Frequency (MHz)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	56.19	74.0	17.81	Peak	100.00	100	Horizontal	Pass
1**	2483.500	45.81	54.0	8.19	AV	100.00	100	Horizontal	Pass
2	2495.710	57.53	74.0	16.47	Peak	36.00	100	Horizontal	Pass
2**	2495.710	45.57	54.0	8.43	AV	36.00	100	Horizontal	Pass

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 4.5.1 (Diagram 1) for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

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 kHz ≤ RBW ≤ 100 kHz.

Set the VBW ≥ 3 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

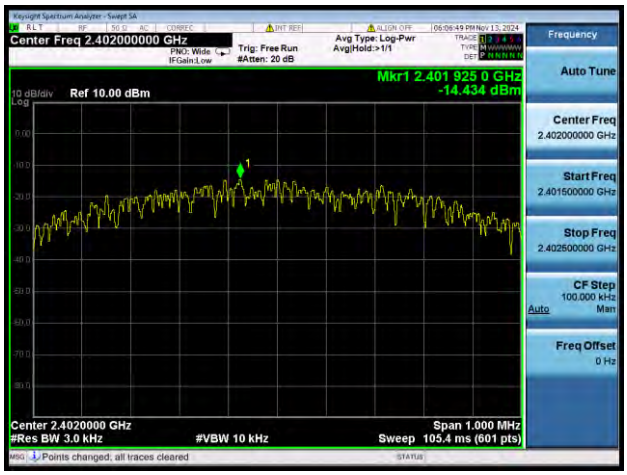
Test Data

GFSK (BLE 1Mbps)			
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low Channel	-14.43	8	Pass
Middle Channel	-14.11	8	Pass
High Channel	-14.09	8	Pass

GFSK (BLE 2Mbps)			
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low Channel	-18.96	8	Pass
Middle Channel	-18.71	8	Pass
High Channel	-19.10	8	Pass

Test Plots

GFSK (BLE 1Mbps) LOW CHANNEL



GFSK (BLE 1Mbps) MIDDLE CHANNEL

GFSK (BLE 1Mbps) HIGH CHANNEL

GFSK (BLE 2Mbps) LOW CHANNEL

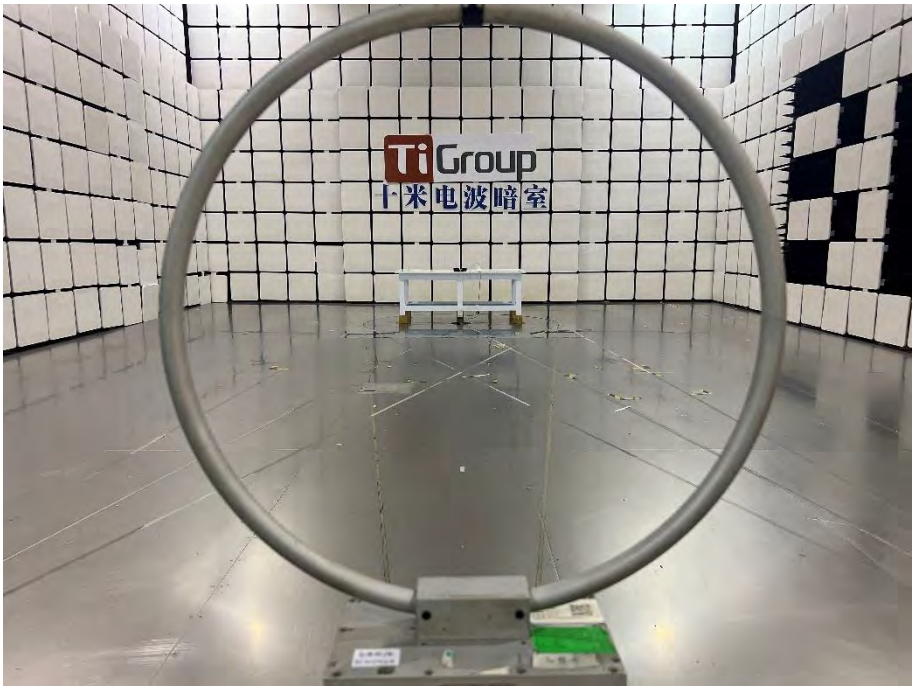
GFSK (BLE 2Mbps) MIDDLE CHANNEL

GFSK (BLE 2Mbps) HIGH CHANNEL

ANNEX A TEST SETUP PHOTOS

1 Radiated Test Photo

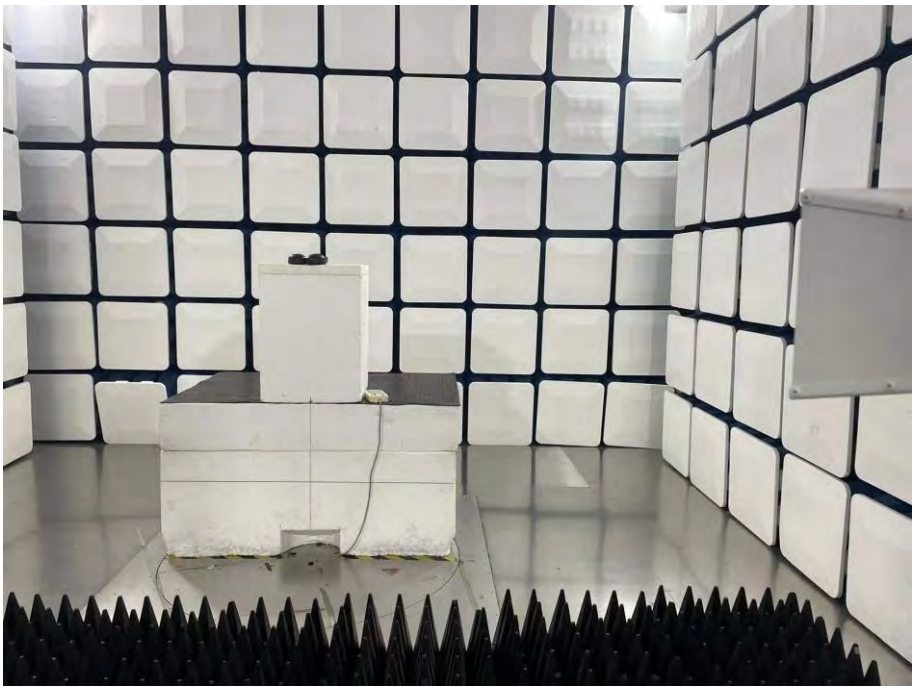
Below 30MHz



30MHz-1GHz

Close-up

Above 1GHz



Close-up

2 Conducted Test Photo

Conducted Test

3 Conducted Emission

Photo 1

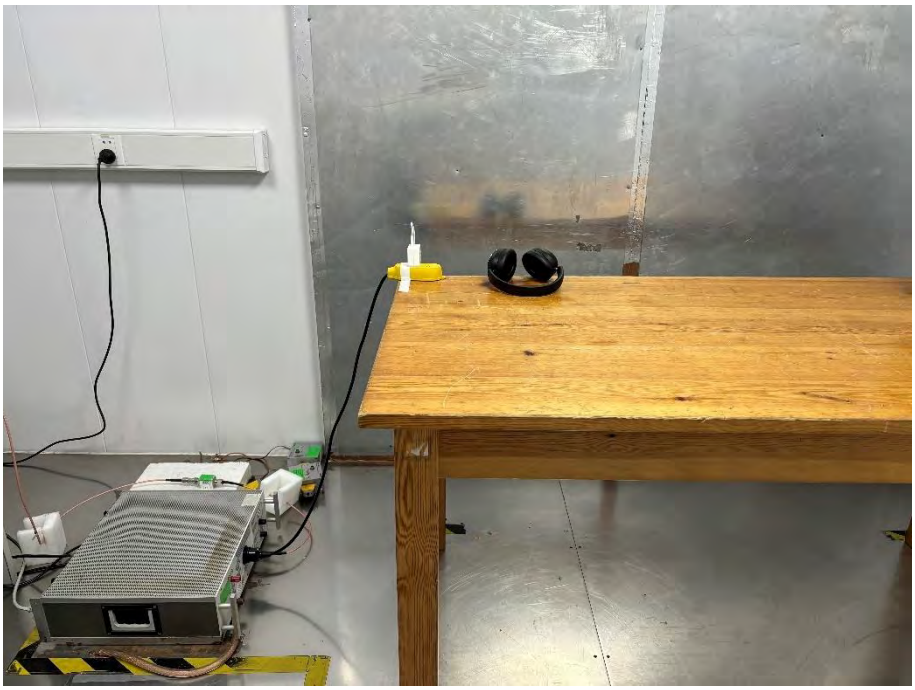
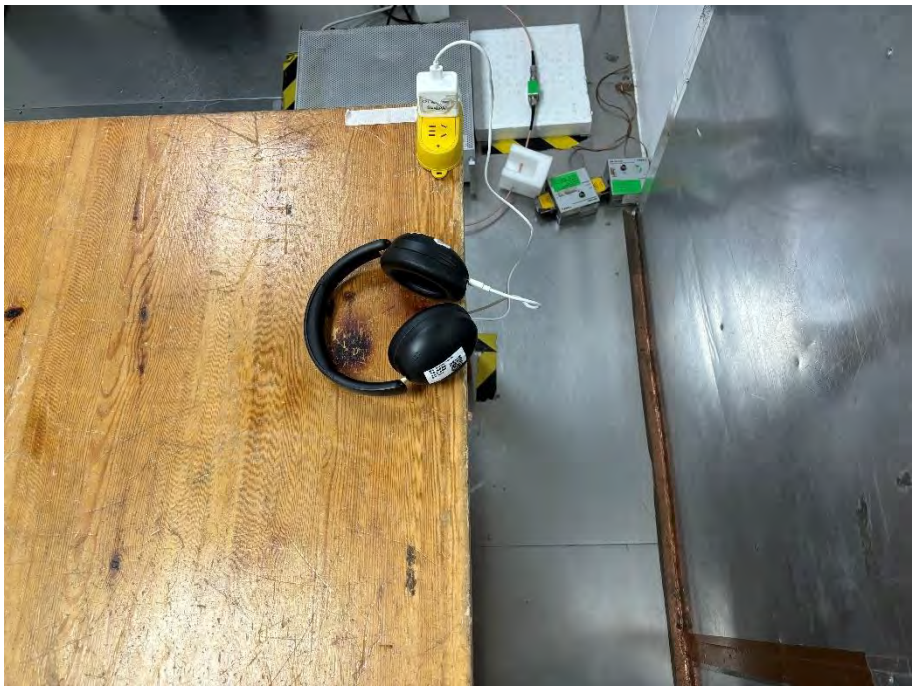


Photo 2



ANNEX B EUT EXTERNAL PHOTOS

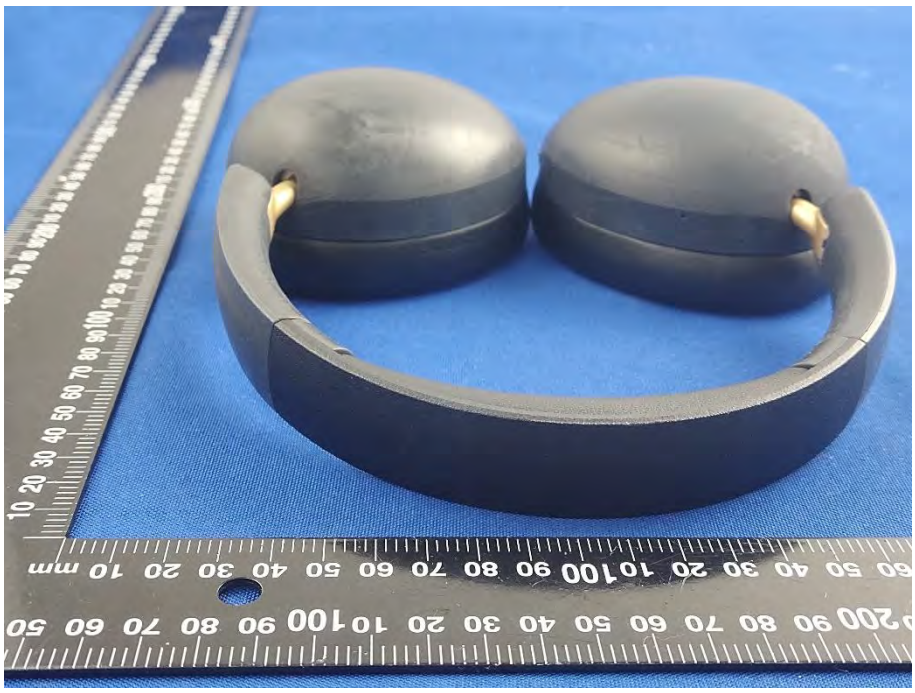
FRONT VIEW OF EUT

REAR VIEW OF EUT

LEFT VIEW OF EUT

RIGHT VIEW OF EUT

TOP VIEW OF EUT



BOTTOM VIEW OF EUT

CLOSE-UP

Headphone+Charging Cable+USB Cable

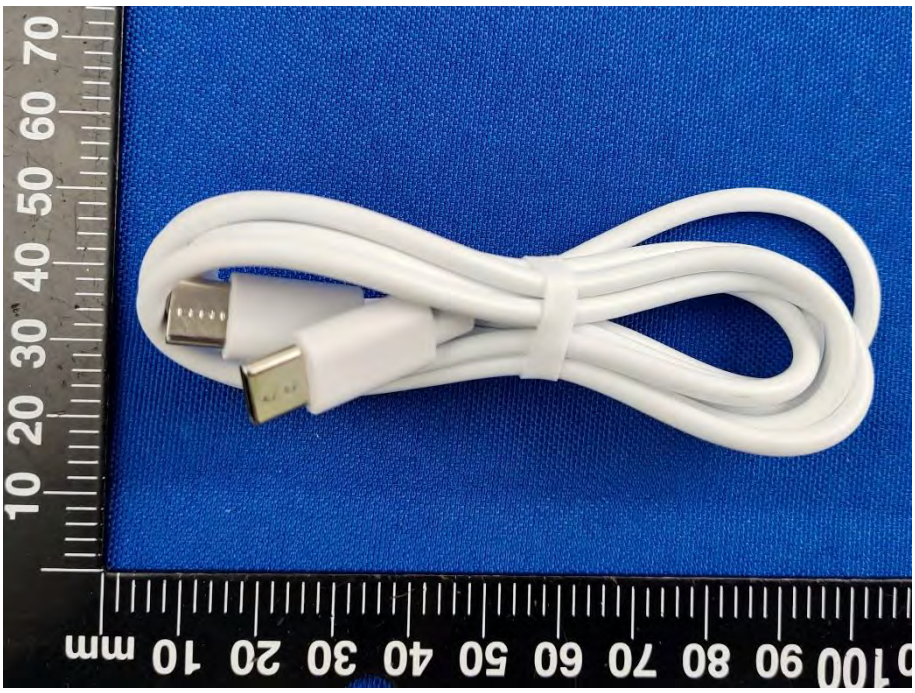
Headphone+Charging Cable

Headphone+Charging Cable+USB Cable

Headphone+Charging Cable

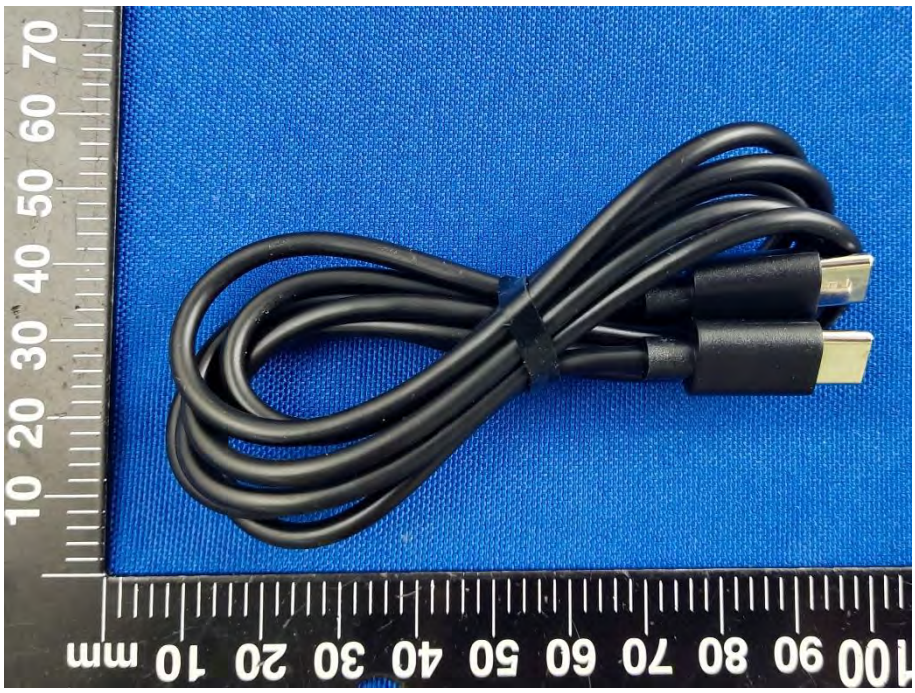
Accessory-USB-A Cable 1

Accessory-USB-C Cable 1



Accessory-USB-A Cable 2

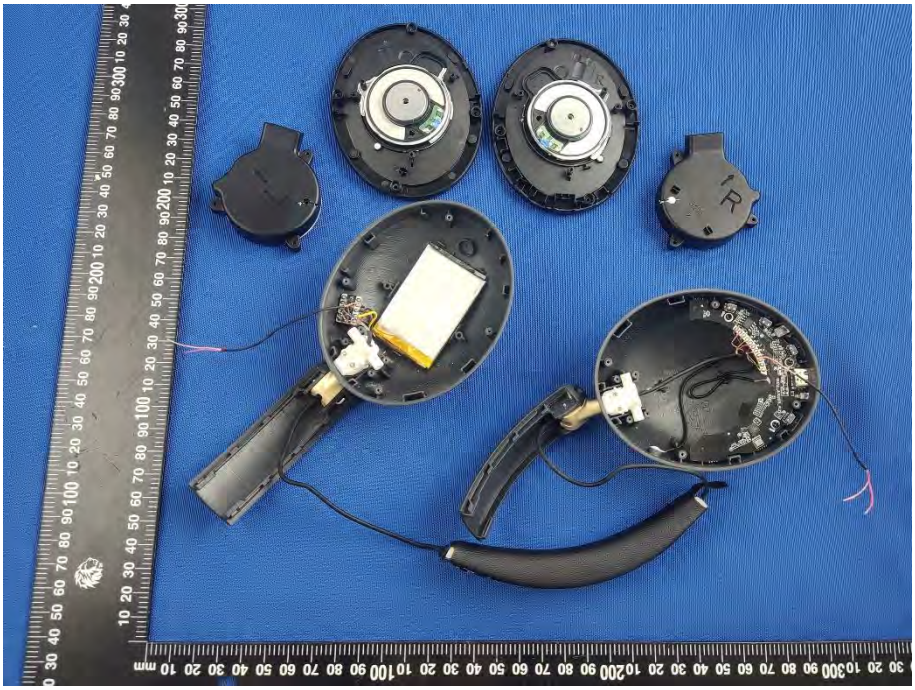
Accessory-USB-C Cable 2



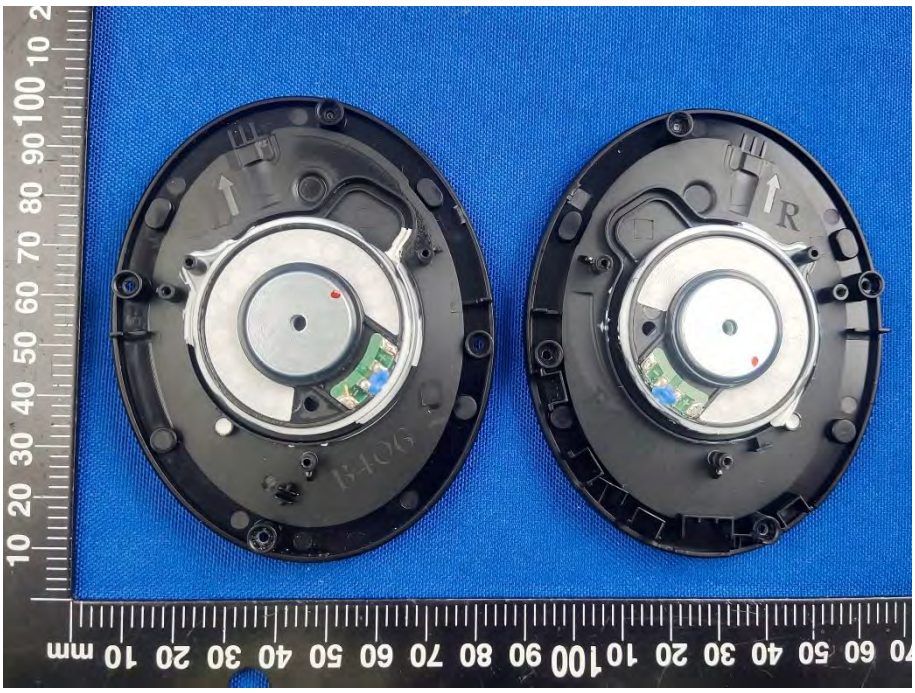
ANNEX C EUT INTERNAL PHOTOS

EUT UNCOVER VIEW 1

EUT UNCOVER VIEW 2

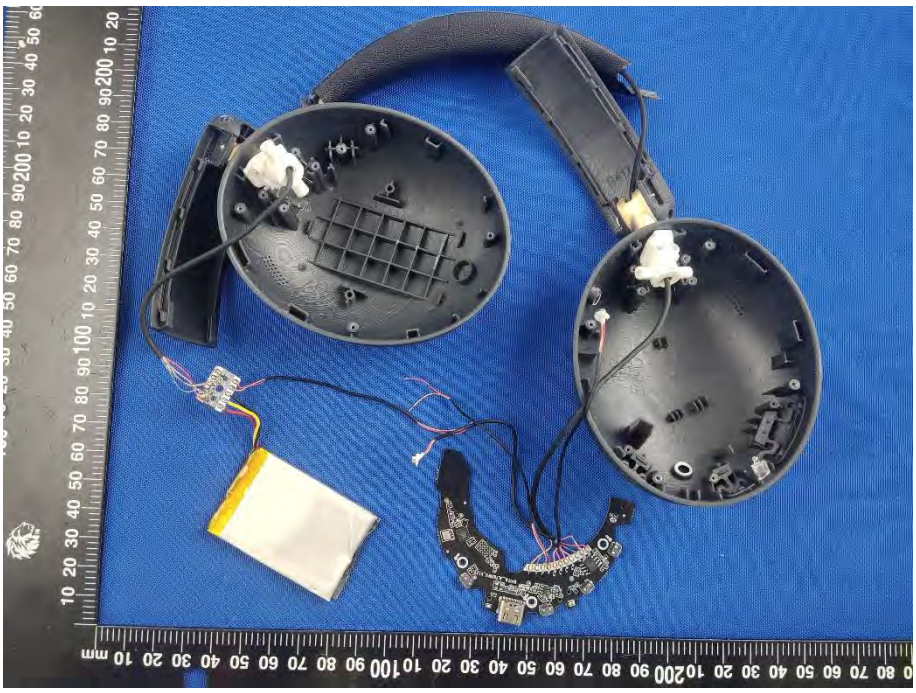


EUT UNCOVER VIEW 3

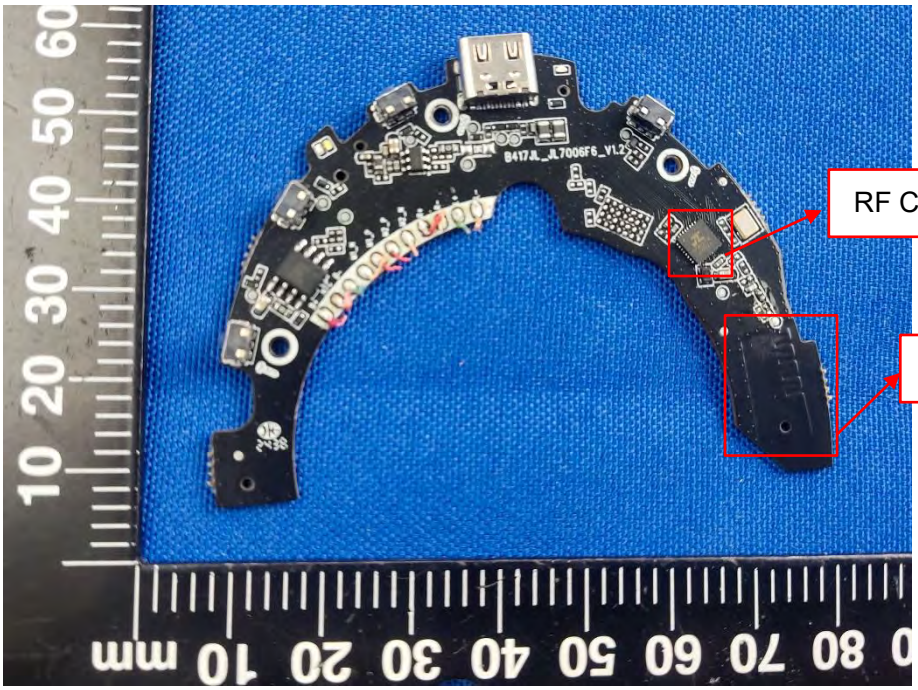


EUT UNCOVER VIEW 4

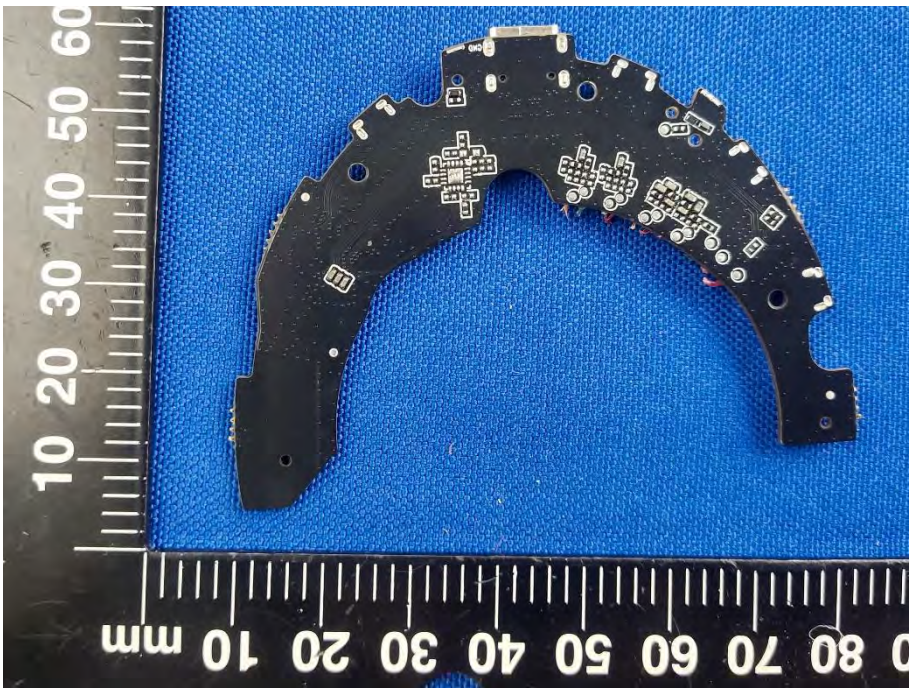
EUT UNCOVER VIEW 5



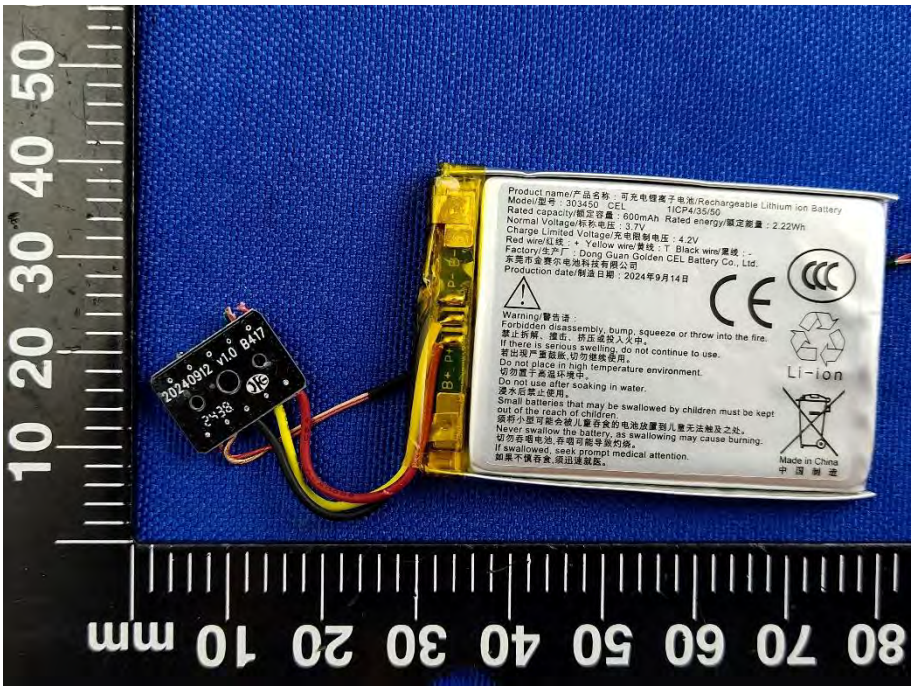
MAIN BOARD TOP VIEW



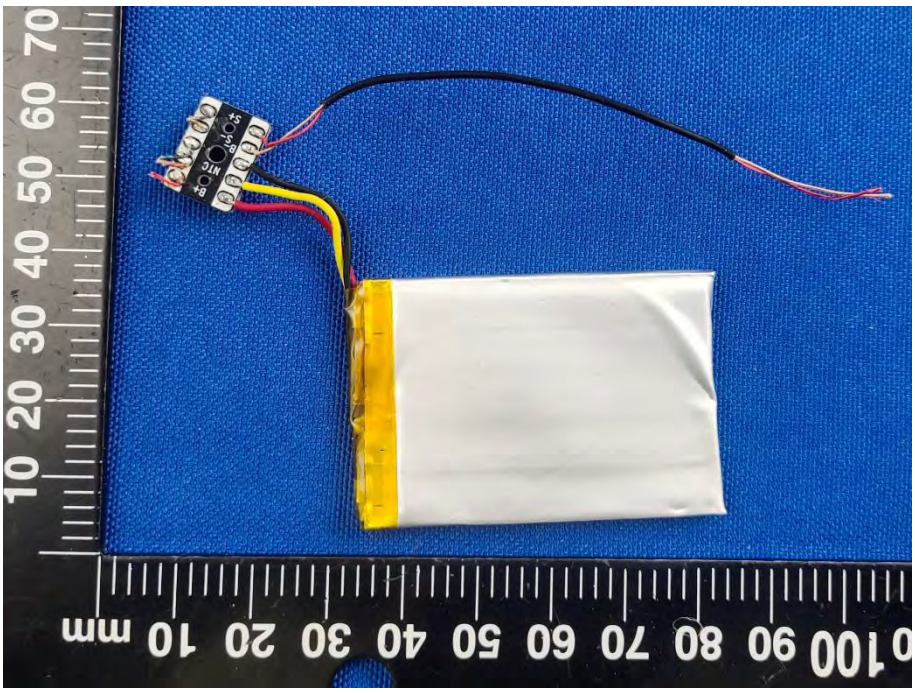
MAIN BOARD REAR VIEW



BATTERY (FRONT)



BATTERY (REAR)



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--END OF REPORT--