

9.3. LIMITS AND MEASUREMENT RESULT

15.209(a) Limit in the below table has to be followed

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
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

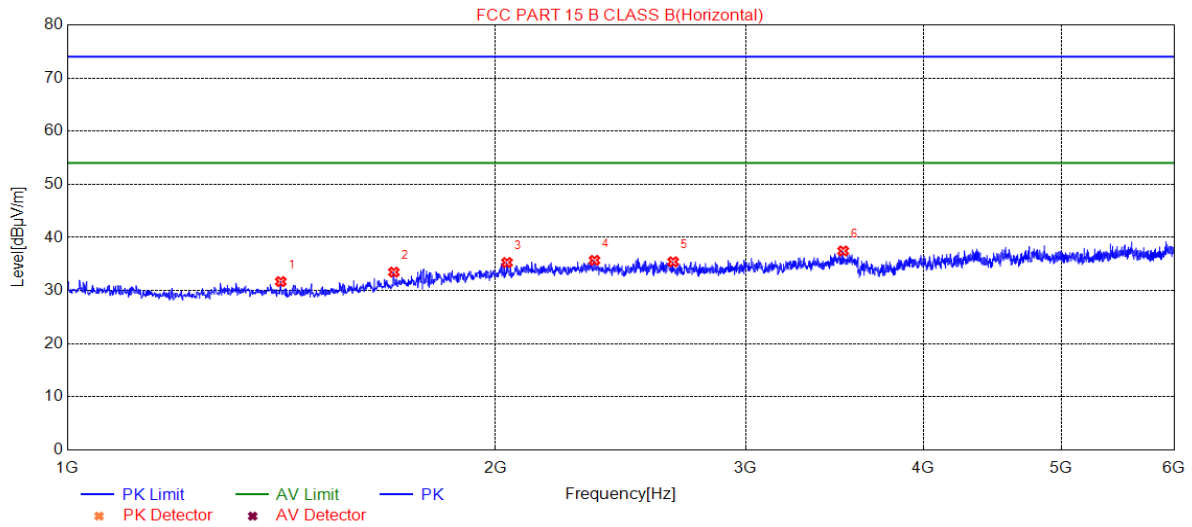
9.4. TEST RESULT

RADIATED EMISSION BELOW 30MHZ

No emission found between lowest internal used/generated frequencies to 30MHz.

RADIATED EMISSION BELOW 1GHZ

RADIATED EMISSION TEST- (30MHZ-1GHZ) -HORIZONTAL

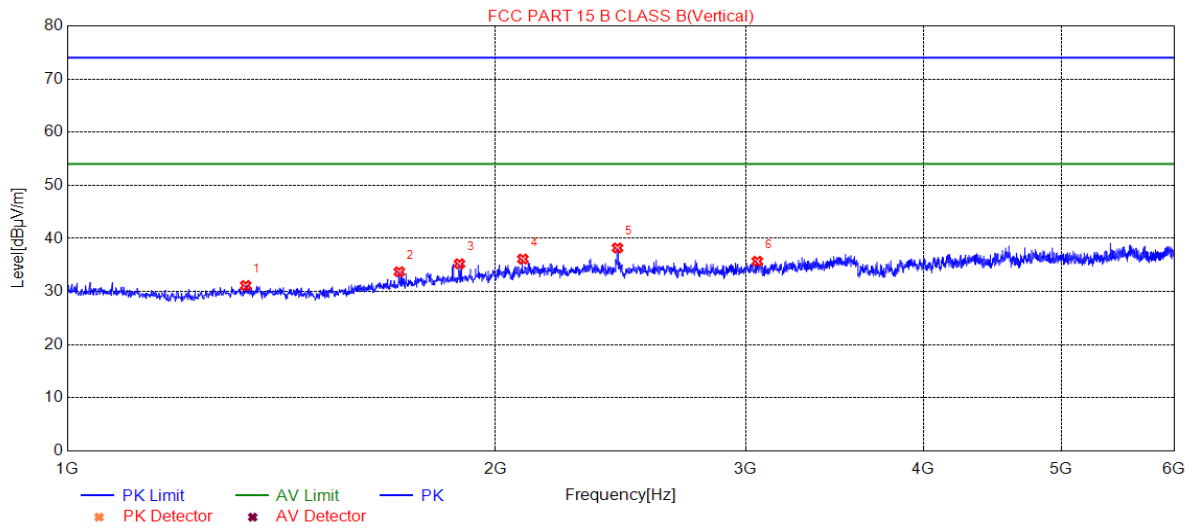


Suspected Data List

NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	1413.0826	31.69	-12.87	74.00	42.31	200	10	Horizontal
2	1697.1394	33.47	-10.53	74.00	40.53	100	90	Horizontal
3	2038.2076	35.28	-7.02	74.00	38.72	100	140	Horizontal
4	2348.2697	35.69	-5.59	74.00	38.31	150	50	Horizontal
5	2667.3335	35.42	-4.52	74.00	38.58	200	40	Horizontal
6	3512.5025	37.45	-1.14	74.00	36.55	200	110	Horizontal

RESULT: PASS

RADIATED EMISSION TEST- (30MHZ-1GHZ) -VERTICAL



Suspected Data List

NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	1335.0670	31.14	-13.03	74.00	42.86	100	300	Vertical
2	1712.1424	33.73	-10.36	74.00	40.27	100	210	Vertical
3	1887.1774	35.23	-8.44	74.00	38.77	150	220	Vertical
4	2091.2182	36.12	-6.78	74.00	37.88	100	10	Vertical
5	2437.2875	38.21	-5.18	74.00	35.79	200	260	Vertical
6	3056.4113	35.70	-3.49	74.00	38.30	150	310	Vertical

RESULT: PASS

Note: 1. Factor=Antenna Factor + Cable loss, Margin=Measurement-Limit.

2. The "Factor" value can be calculated automatically by software of measurement system.

3. All test modes for different EUT are pre-tested. The low channel for GFSK mode is the worst case and recorded in the report.

RADIATED EMISSION TEST- (ABOVE 1GHZ)

Frequency	Emission Level	Limits	Margin	Detector Type	Comment
(MHz)	(dBμV/m)	(dBμV/m)	(dB)		
Low Channel (2402 MHz)					
4804	51.25	74	-22.75	Pk	Vertical
4804	35.33	54	-18.67	AV	Vertical
4804	49.49	74	-24.51	Pk	Horizontal
4804	39.24	54	-14.76	AV	Horizontal
Mid Channel (2441 MHz)					
4882	53.22	74	-20.78	Pk	Vertical
4882	37.46	54	-16.54	AV	Vertical
4882	50.34	74	-23.66	Pk	Horizontal
4882	38.55	54	-15.45	AV	Horizontal
High Channel (2480 MHz)					
4960	50.42	74	-23.58	pk	Vertical
4960	34.33	54	-19.67	AV	Vertical
4960	51.49	74	-22.51	pk	Horizontal
4960	39.16	54	-14.84	AV	Horizontal

RESULT: PASS

Note:

1. 1GHz~25GHz:(Scan with GFSK, $\pi/4$ -DQPSK,8DPSK, the worst case is GFSK Mode, No recording in the test report at least have 20dB margin)
2. Margin = Emission Level - Limit

10. BAND EDGE EMISSION

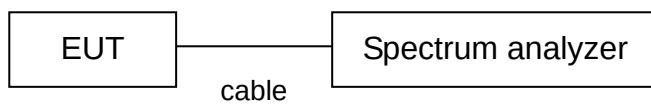
10.1. MEASUREMENT PROCEDURE

1. The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100kHz. The video bandwidth is set to 300kHz.
2. Transmitter set to the normal hopping mode at 2.4 and 2.4835 GHz.

10.2. TEST SET-UP

Radiated same as 10.2

Conducted set up



10.3. RADIATED TEST RESULT

Frequency	Emission Level	Limits	Margin	Detector	Comment
(MHz)	(dBμV/m)	(dBμV/m)	(dB)	Type	
GFSK					
2399.9	51.34	74	-22.66	peak	Vertical
2399.9	37.29	54	-16.71	AVG	Vertical
2399.9	45.46	74	-28.54	peak	Horizontal
2399.9	40.19	54	-13.81	AVG	Horizontal
2483.6	52.33	74	-21.67	peak	Vertical
2483.6	36.46	54	-17.54	AVG	Vertical
2483.6	53.75	74	-20.25	peak	Horizontal
2483.6	38.33	54	-15.67	AVG	Horizontal
π/4-DQPSK					
2399.9	49.55	74	-24.45	peak	Vertical
2399.9	39.19	54	-14.81	AVG	Vertical
2399.9	50.37	74	-23.63	peak	Horizontal
2399.9	39.46	54	-14.54	AVG	Horizontal
2483.6	51.55	74	-22.45	peak	Vertical
2483.6	39.75	54	-14.25	AVG	Vertical
2483.6	49.24	74	-24.76	peak	Horizontal
2483.6	38.53	54	-15.47	AVG	Horizontal
8DPSK					
2399.9	52.69	74	-21.31	peak	Vertical
2399.9	37.44	54	-16.56	AVG	Vertical
2399.9	49.31	74	-24.69	peak	Horizontal
2399.9	39.28	54	-14.72	AVG	Horizontal
2483.6	52.44	74	-21.56	peak	Vertical
2483.6	37.36	54	-16.64	AVG	Vertical
2483.6	52.49	74	-21.51	peak	Horizontal
2483.6	39.09	54	-14.91	AVG	Horizontal

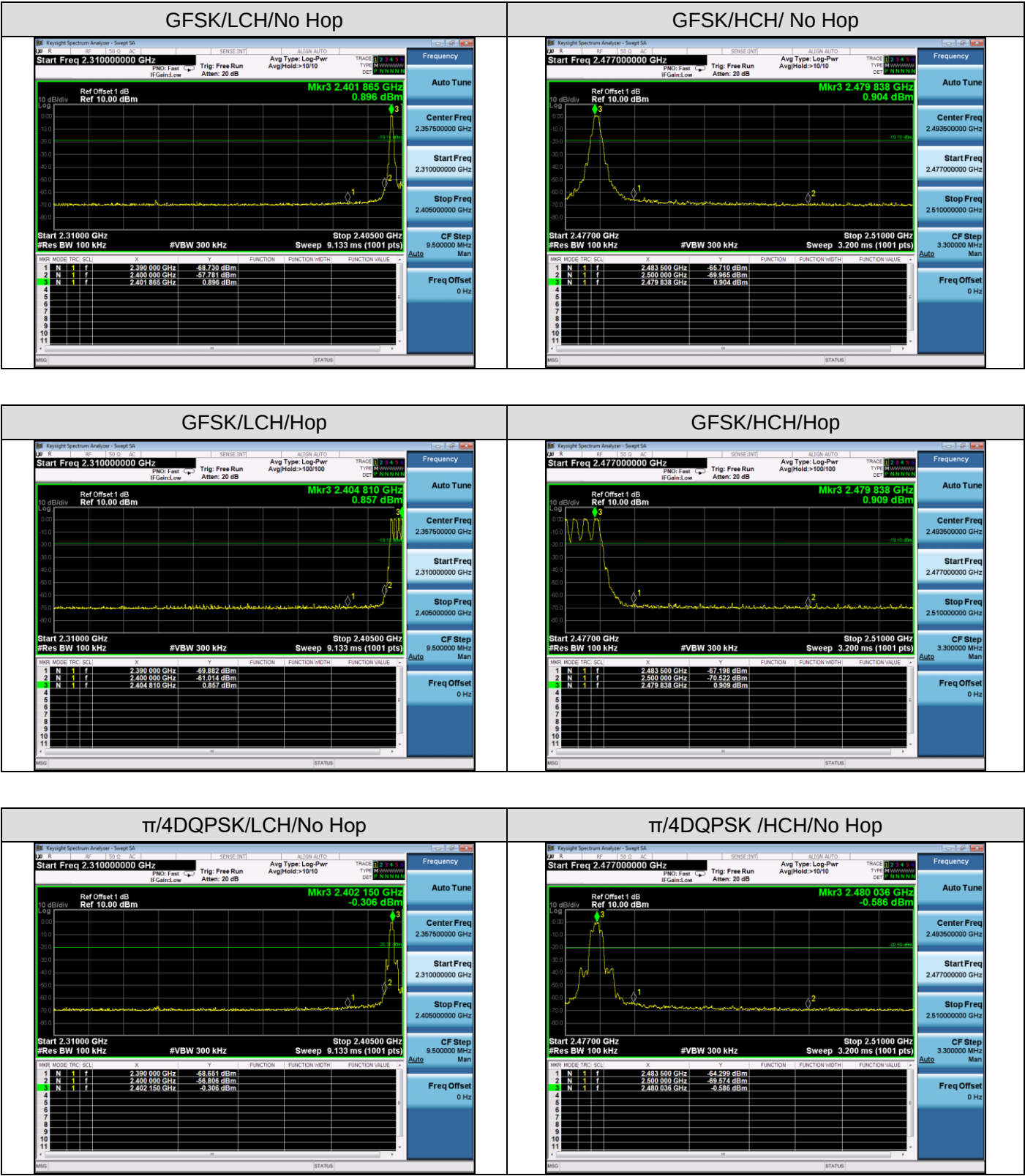
RESULT: PASS

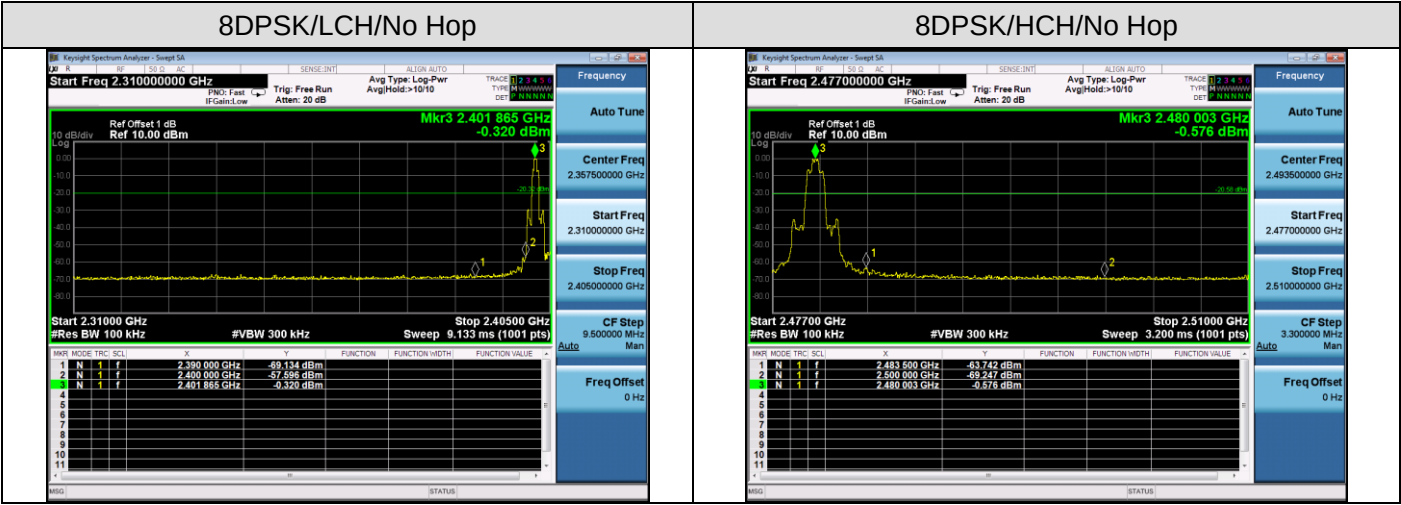
Note: The other modes radiation emission have enough 20dB margin.

Margin = Emission Level – Limit

10.4 CONDUCTED TEST RESULT

Test Graph





Note: All modes were tested, only the worst case record in the report.

11. NUMBER OF HOPPING FREQUENCY

11.1. MEASUREMENT PROCEDURE

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer Start = 2.4GHz Stop = 2.4835GHz
4. Set the Spectrum Analyzer as RBW>=1%span, VBW>=RBW.

11.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 8.2

11.3. MEASUREMENT EQUIPMENT USED

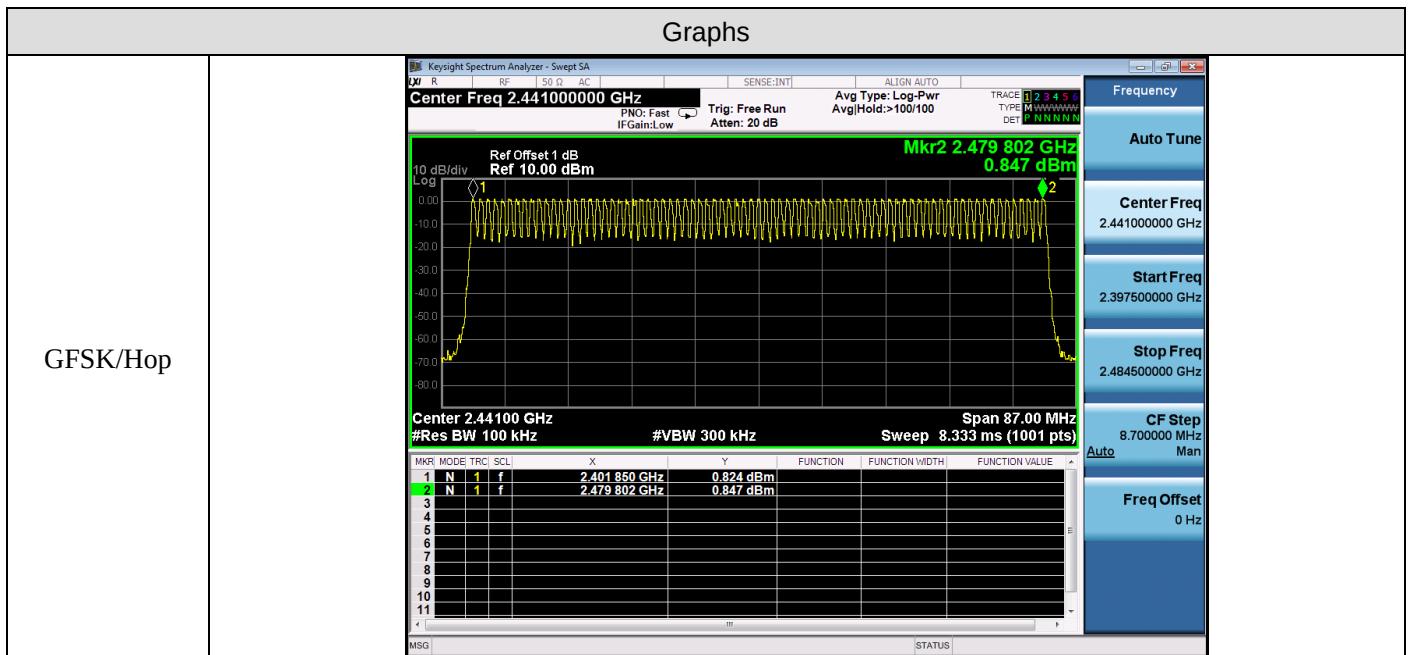
The same as described in section 6

11.4. LIMITS AND MEASUREMENT RESULT

Mode	Channel.	Number of Hopping Channel	Verdict
GFSK	Hop	79	PASS

Note: All modes were tested, only the worst case record in the report.

Test Graph



12. TIME OF OCCUPANCY (DWELL TIME)

12.1. MEASUREMENT PROCEDURE

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

1. Span: Zero span, centered on a hopping channel.
2. RBW shall be $\leq$ channel spacing and where possible RBW should be set $\gg 1/T$, where T is the expected dwell time per channel.
3. Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel.
4. Detector function: Peak. Trace: Max hold.
5. Use the marker-delta function to determine the transmit time per hop.
6. Using the following equation:

The dwell time is calculated with the following formula:

$$\text{Dwell time} = t_{\text{pulse}} \times n_{\text{hops}} / \text{number of channels} \times 31.6 \text{ s}$$

Where:

t_{pulse} is the measured pulse time (pls. refer the plots of the spectrum analyser above) [s],

n_{hops} is the number of hops per second in the actual operating mode of the transmitter [1/s].

The hopping rate of the system is 1600 hops per second and the system uses 79 channels. For this reason one time slot has a length of 625 μs .

With the used hopping mode (DH5) a packet need 5 timeslots for transmitting and the next timeslot for receiving. So the system makes in worst case 266,67 hops per second in transmit mode ($n_{\text{hops}} = 266.667$ 1/s)

12.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 8.2

12.3. MEASUREMENT EQUIPMENT USED

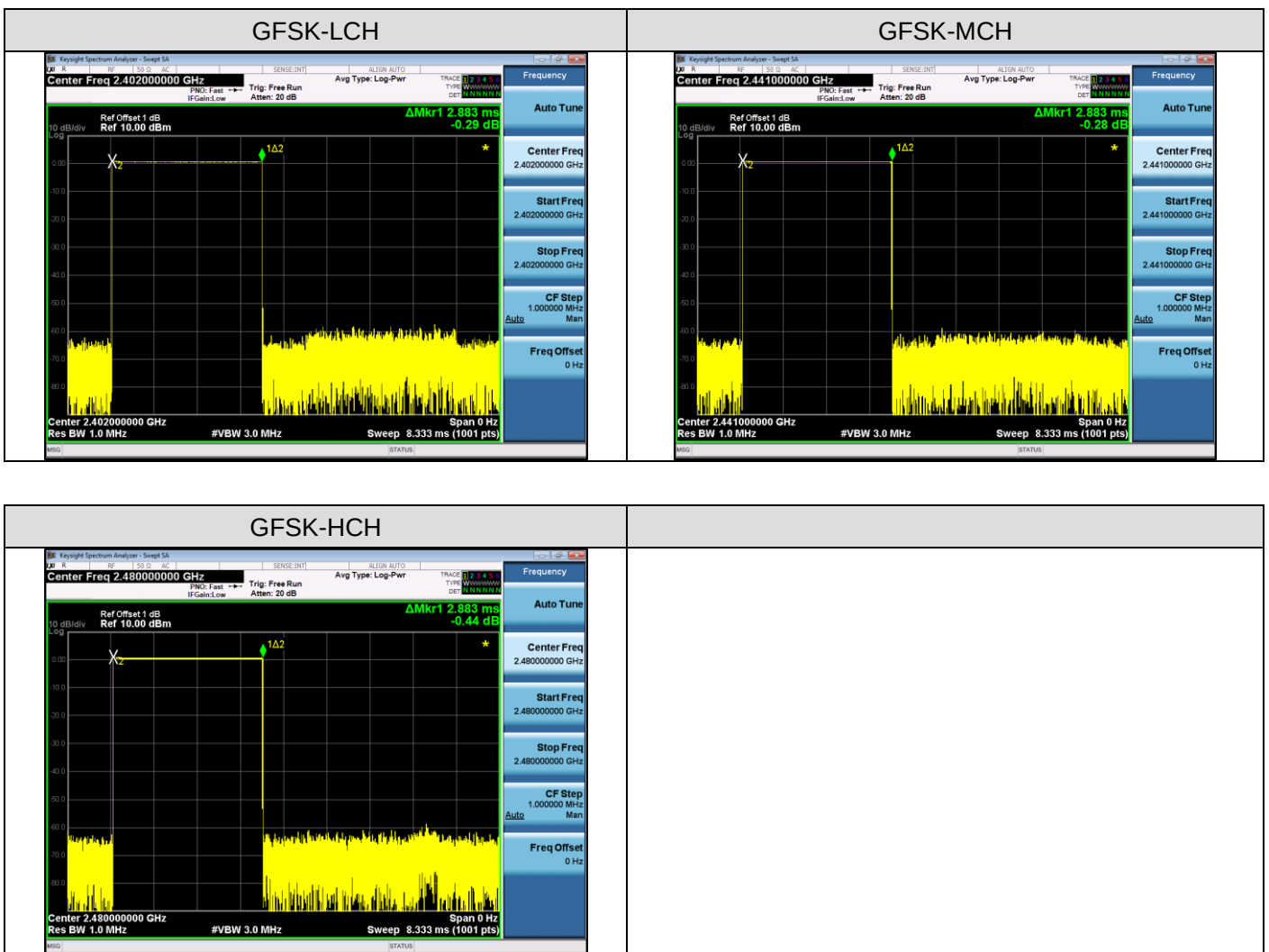
The same as described in section 6

12.4. LIMITS AND MEASUREMENT RESULT

Channel.	Burst Width [ms/hop/ch]	Dwell Time[ms]	Verdict	Limit (ms)
LCH	2.883	307.5204	PASS	400
MCH	2.883	307.5204	PASS	400
HCH	2.883	307.5204	PASS	400

Note: The DH5 for GFSK modulation is the worst case and recorded in the report.

Test Graph



13. FREQUENCY SEPARATION

13.1. MEASUREMENT PROCEDURE

1. Place the EUT on the table and set it in transmitting mode
2. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum analyzer
3. Set Span = wide enough to capture the peaks of two adjacent channels Resolution (or IF) Bandwidth (RBW) $\geq 1\%$ of the span Video (or Average) Bandwidth (VBW) $\geq$ RBW; Sweep = auto; Detector function = peak; Trace = max hold

13.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 6.2

13.3. MEASUREMENT EQUIPMENT USED

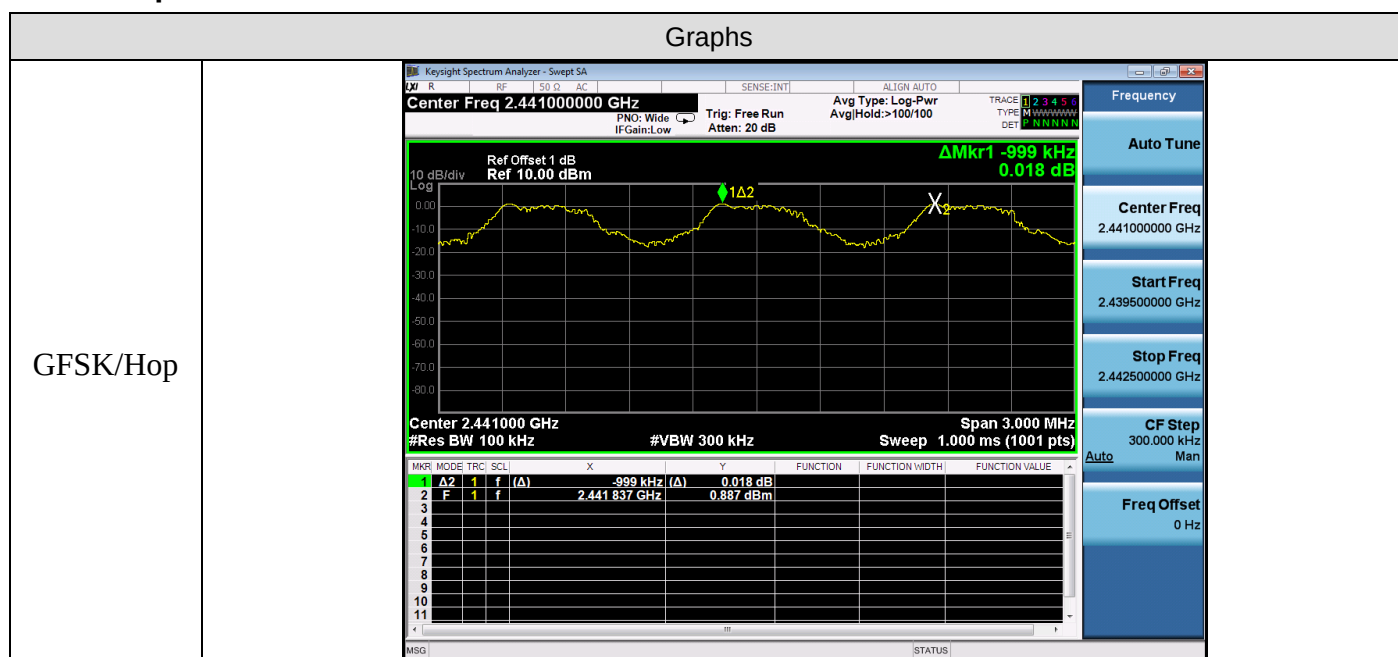
The same as described in section 6.3

13.4. LIMITS AND MEASUREMENT RESULT

Mode	Channel.	Carrier Frequency Separation [MHz]	Verdict
GFSK	Hop	-0.999	PASS

Note: All modes were tested, only the worst case record in the report.

Test Graph



14. FCC LINE CONDUCTED EMISSION TEST

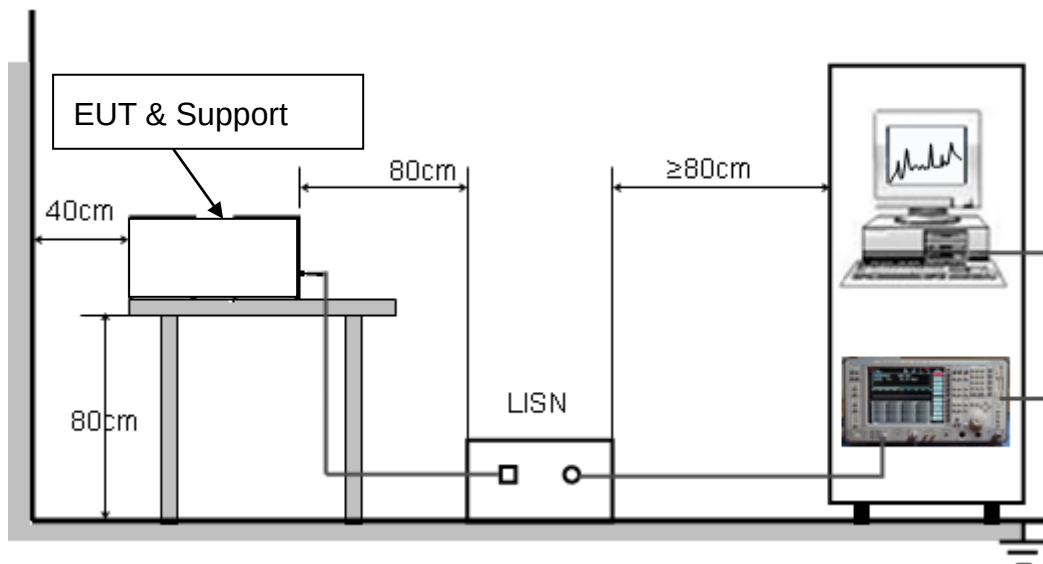
14.1. LIMITS OF LINE CONDUCTED EMISSION TEST

Frequency	Maximum RF Line Voltage	
	Q.P.(dBuV)	Average(dBuV)
150kHz~500kHz	66-56	56-46
500kHz~5MHz	56	46
5MHz~30MHz	60	50

Note:

1. The lower limit shall apply at the transition frequency.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

14.2. BLOCK DIAGRAM OF LINE CONDUCTED EMISSION TEST



14.3. PRELIMINARY PROCEDURE OF LINE CONDUCTED EMISSION TEST

1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. When the EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10 (see Test Facility for the dimensions of the ground plane used). When the EUT is a floor-standing equipment, it is placed on the ground plane which has a 3-12 mm non-conductive covering to insulate the EUT from the ground plane.
2. Support equipment, if needed, was placed as per ANSI C63.10.
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.
4. All support equipments received AC120V/60Hz power from a LISN, if any.
5. The EUT received DC charging voltage by adapter which received 120V/60Hz power by a LISN..
6. The test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 kHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.
9. The test mode(s) were scanned during the preliminary test.

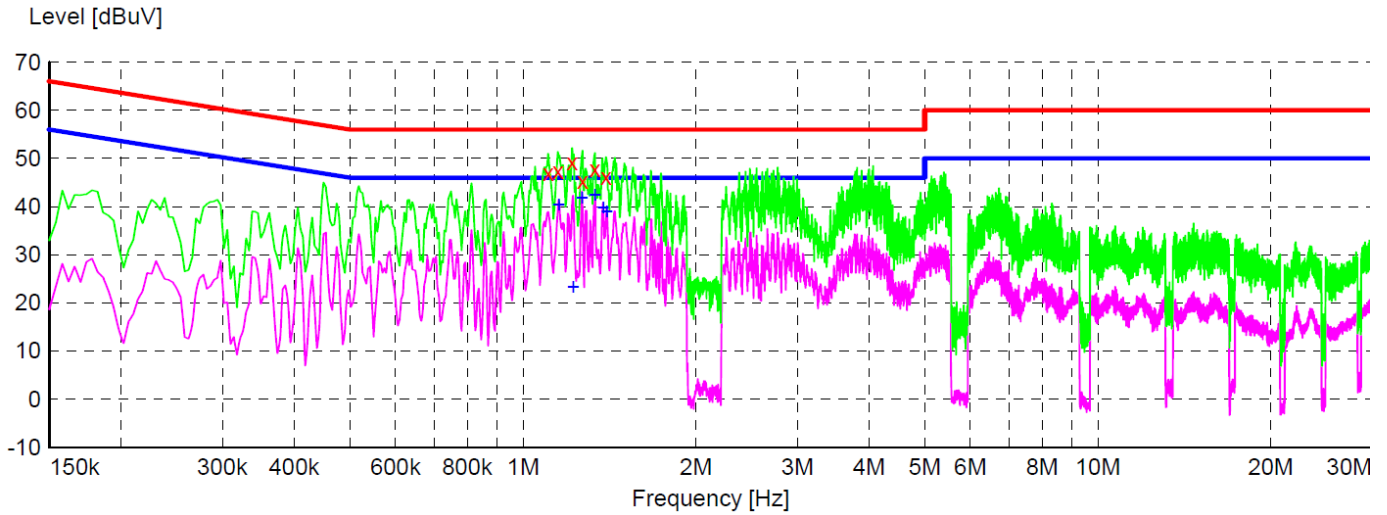
Then, the EUT configuration and cable configuration of the above highest emission level were recorded for reference of final testing.

14.4. FINAL PROCEDURE OF LINE CONDUCTED EMISSION TEST

1. EUT and support equipment was set up on the test bench as per step 2 of the preliminary test.
2. A scan was taken on both power lines, Line 1 and Line 2, recording at least the six highest emissions. Emission frequency and amplitude were recorded into a computer in which correction factors were used to calculate the emission level and compare reading to the applicable limit. If EUT emission level was less -2dB to the A.V. limit in Peak mode, then the emission signal was re-checked using Q.P and Average detector.
3. The test data of the worst case condition(s) was reported on the Summary Data page.

14.5. TEST RESULT OF LINE CONDUCTED EMISSION TEST

LINE CONDUCTED EMISSION TEST LINE 1-L



MEASUREMENT RESULT: "TEST_fin"

2019/1/15 10:40

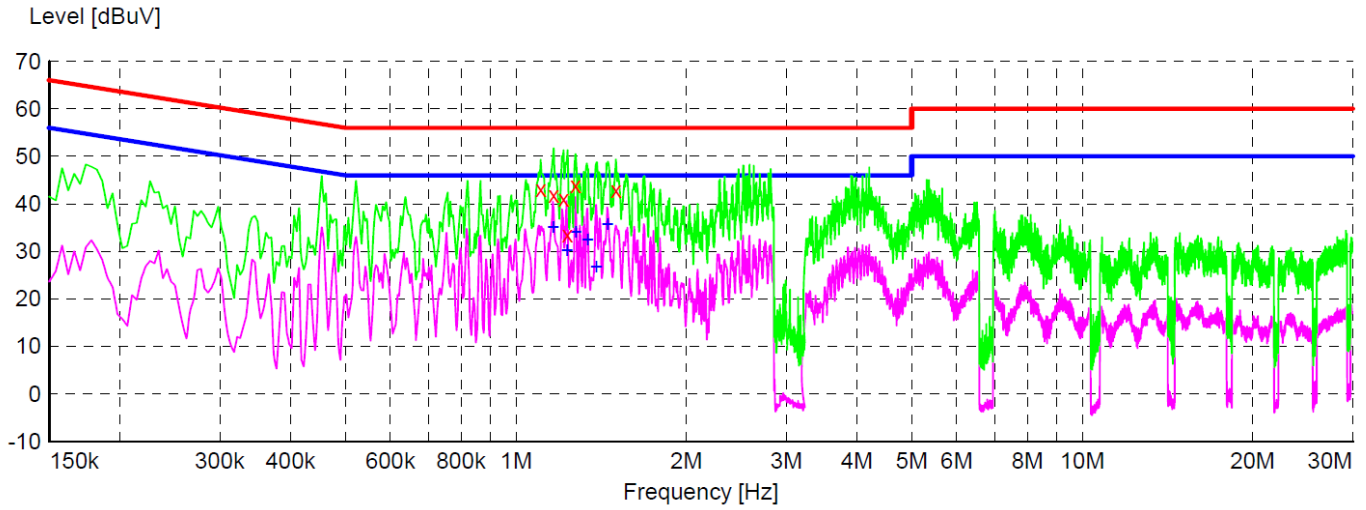
Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
1.106000	47.00	10.4	56	9.0	QP	L1	FLO
1.150000	47.30	10.4	56	8.7	QP	L1	FLO
1.218000	49.20	10.4	56	6.8	QP	L1	FLO
1.270000	45.30	10.4	56	10.7	QP	L1	FLO
1.334000	47.80	10.4	56	8.2	QP	L1	FLO
1.394000	46.00	10.4	56	10.0	QP	L1	FLO

MEASUREMENT RESULT: "TEST_fin2"

2019/1/15 10:40

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
1.154000	40.40	10.4	46	5.6	AV	L1	FLO
1.222000	23.40	10.4	46	22.6	AV	L1	FLO
1.266000	41.90	10.4	46	4.1	AV	L1	FLO
1.334000	42.40	10.4	46	3.6	AV	L1	FLO
1.378000	39.80	10.4	46	6.2	AV	L1	FLO
1.398000	39.00	10.4	46	7.0	AV	L1	FLO

LINE CONDUCTED EMISSION TEST LINE 2-N



MEASUREMENT RESULT: "TEST_fin"

2019/1/15 10:31

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
1.106000	43.10	10.4	56	12.9	QP	N	FLO
1.166000	41.80	10.4	56	14.2	QP	N	FLO
1.214000	41.00	10.4	56	15.0	QP	N	FLO
1.234000	33.50	10.4	56	22.5	QP	N	FLO
1.274000	43.90	10.4	56	12.1	QP	N	FLO
1.502000	42.80	10.4	56	13.2	QP	N	FLO

MEASUREMENT RESULT: "TEST_fin2"

2019/1/15 10:31

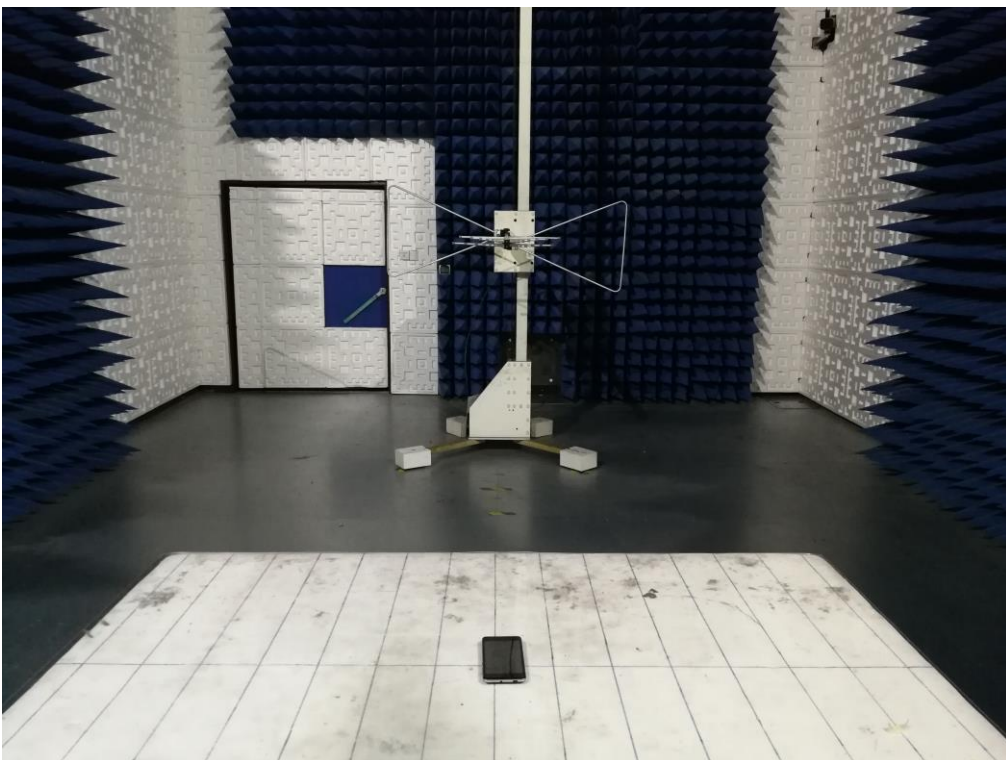
Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
1.162000	35.20	10.4	46	10.8	AV	N	FLO
1.230000	30.20	10.4	46	15.8	AV	N	FLO
1.274000	34.20	10.4	46	11.8	AV	N	FLO
1.338000	32.40	10.4	46	13.6	AV	N	FLO
1.386000	26.80	10.4	46	19.2	AV	N	FLO
1.450000	35.70	10.4	46	10.3	AV	N	FLO

APPENDIX A: PHOTOGRAPHS OF TEST SETUP

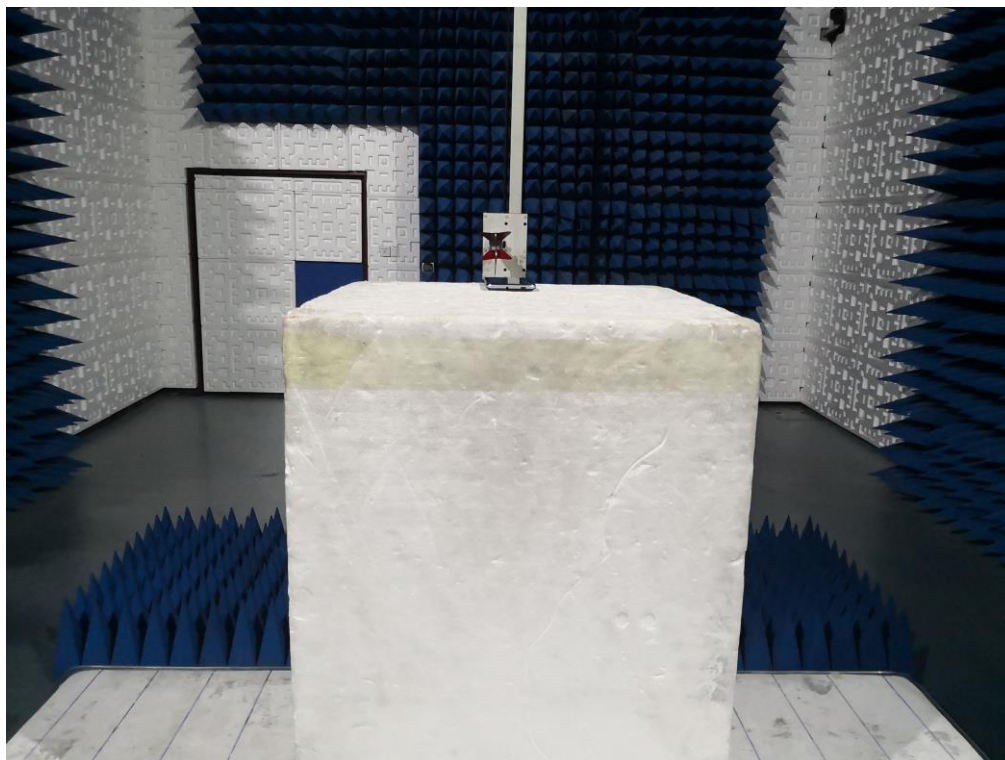
LINE CONDUCTED EMISSION TEST SETUP



RADIATED EMISSION TEST SETUP



RADIATED EMISSION ABOVE 1G TEST SETUP



----END OF REPORT----