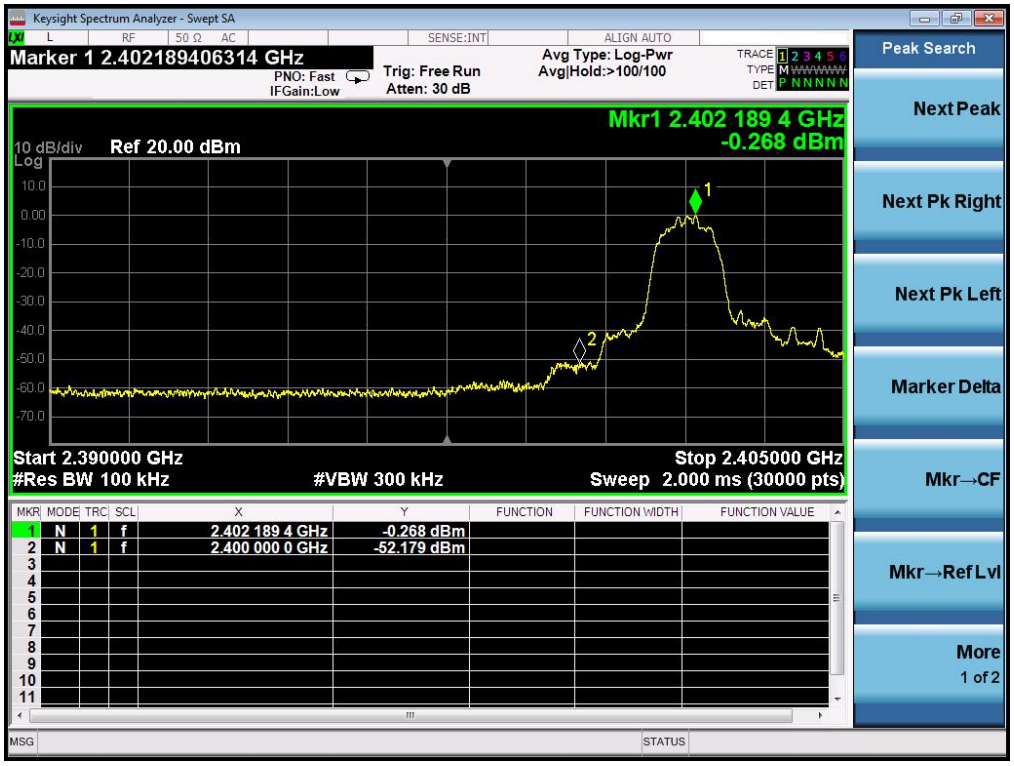
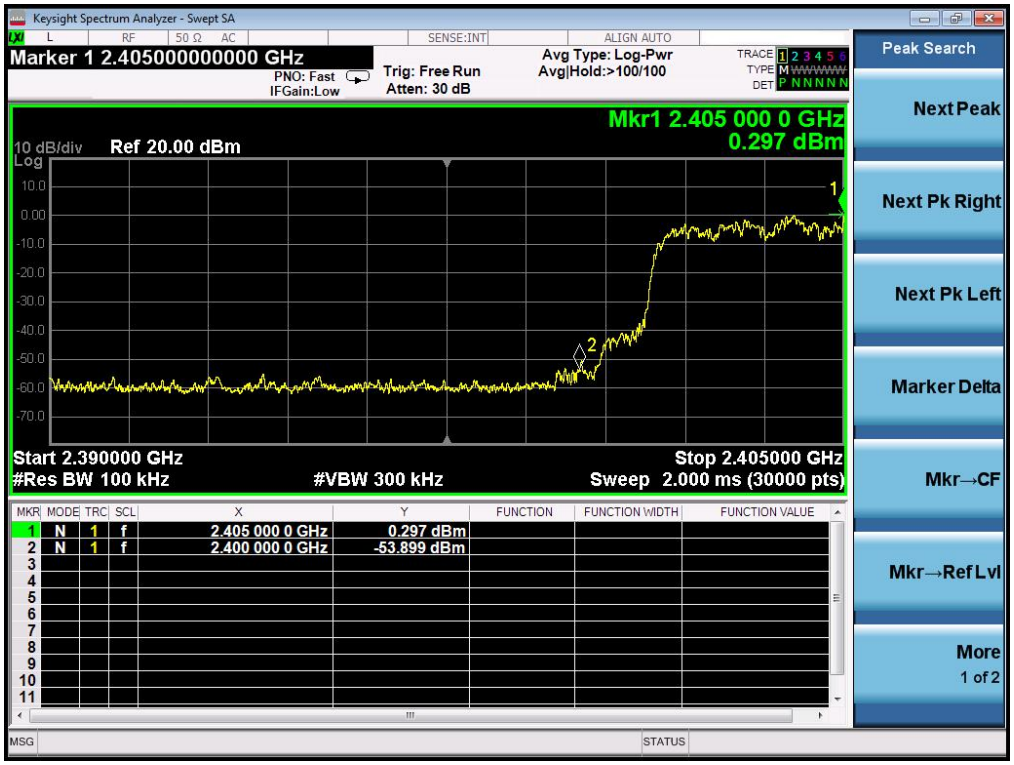
8-DPSK MODULATION IN LOW CHANNEL

Hopping off

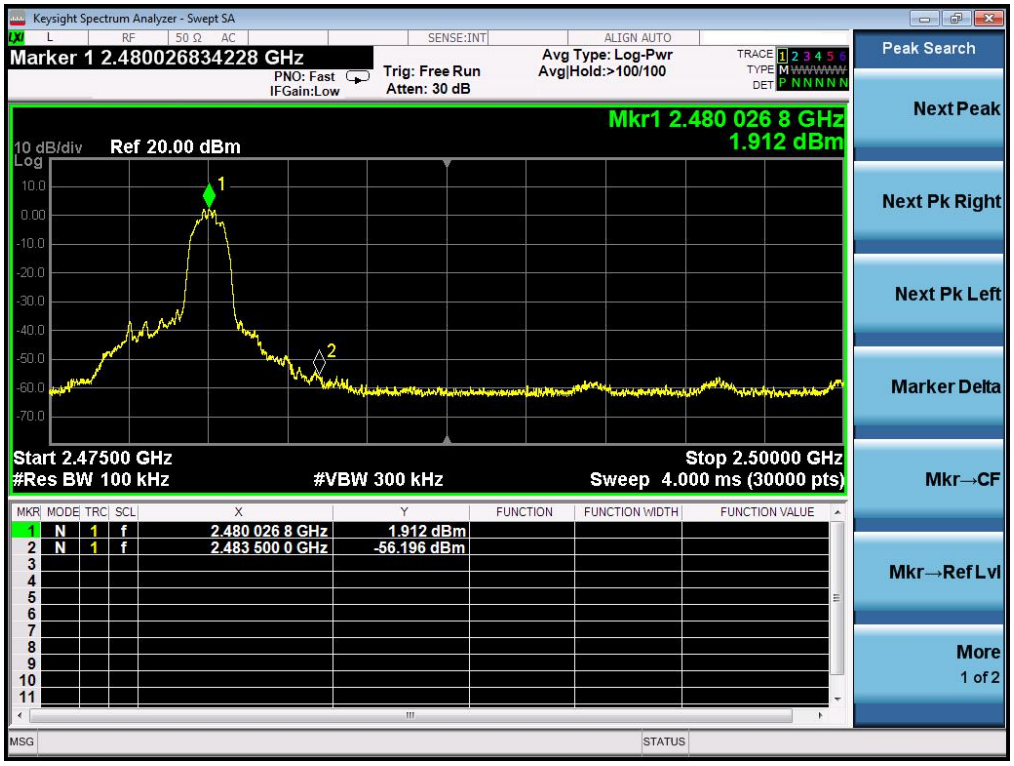


Hopping on

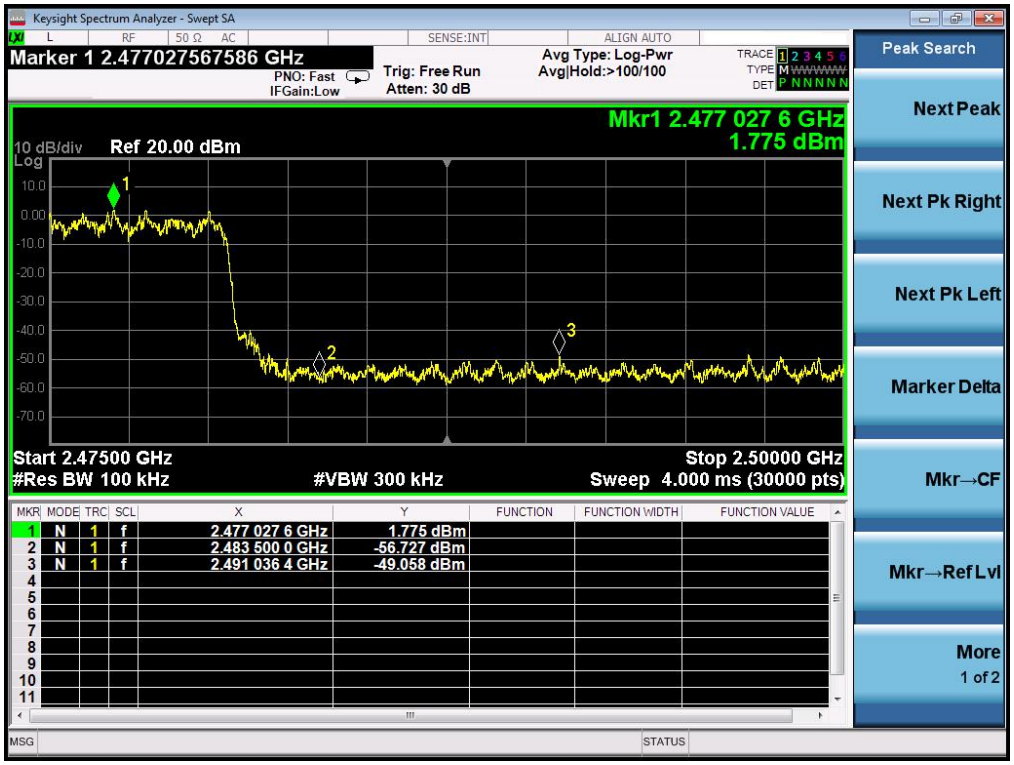


8-DPSK MODULATION IN HIGH CHANNEL

Hopping off



Hopping on



9. RADIATED EMISSION

9.1. MEASUREMENT PROCEDURE

1. The EUT was placed on the top of the turntable 0.8 or 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
6. For emissions above 1GHz, use 1MHz RBW and 3MHz VBW for peak reading. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.
7. When the radiated emissions limits are expressed in terms of the average value of the emissions, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum values.
8. If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
9. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
10. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High - Low scan is not required in this case.

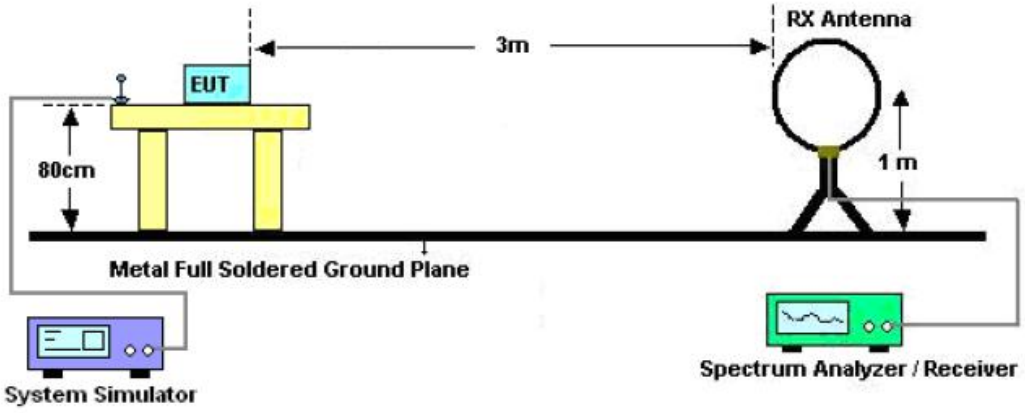
The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Start ~Stop Frequency	9KHz~150KHz/RB 200Hz for QP
Start ~Stop Frequency	150KHz~30MHz/RB 9KHz for QP
Start ~Stop Frequency	30MHz~1000MHz/RB 120KHz for QP
Start ~Stop Frequency	1GHz~26.5GHz 1MHz/3MHz for Peak, 1MHz/3MHz for Average

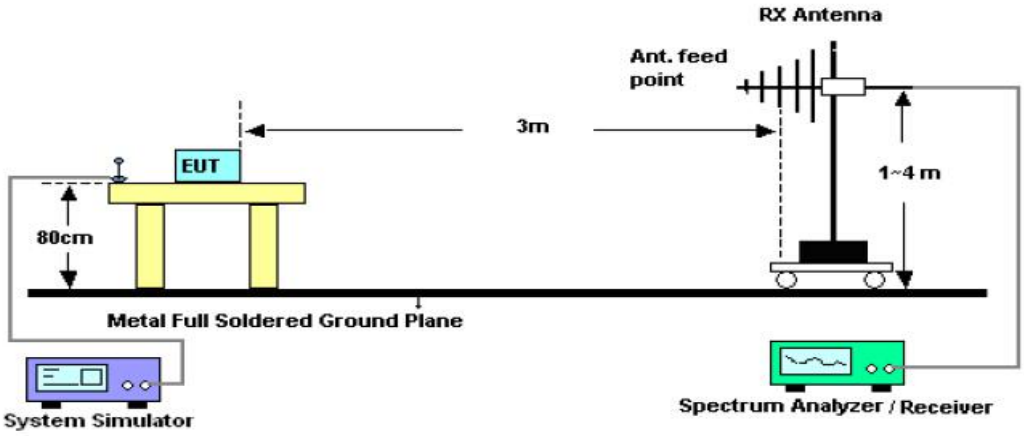
Receiver Parameter	Setting
Start ~Stop Frequency	9KHz~150KHz/RB 200Hz for QP
Start ~Stop Frequency	150KHz~30MHz/RB 9KHz for QP
Start ~Stop Frequency	30MHz~1000MHz/RB 120KHz for QP

9.2. TEST SETUP

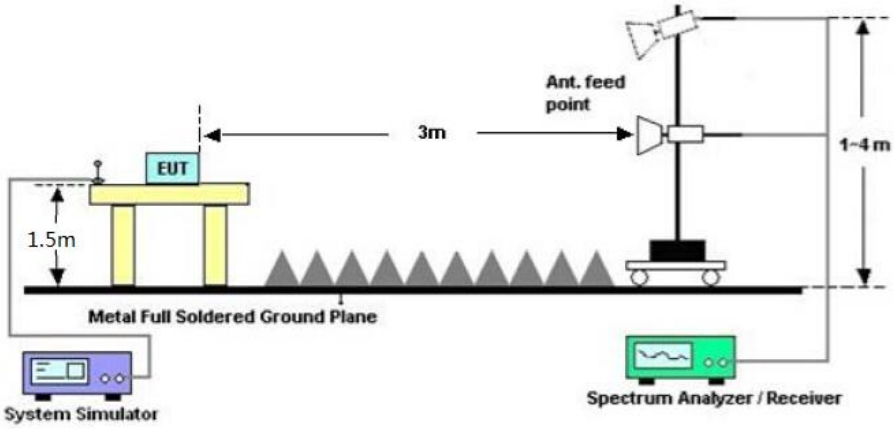
Radiated Emission Test-Setup Frequency Below 30MHz



RADIATED EMISSION TEST SETUP 30MHz-1000MHz



RADIATED EMISSION TEST SETUP ABOVE 1000MHz



9.3. LIMITS AND MEASUREMENT RESULT

15.209 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

Note: All modes were tested For restricted band radiated emission,
the test records reported below are the worst result compared to other modes.

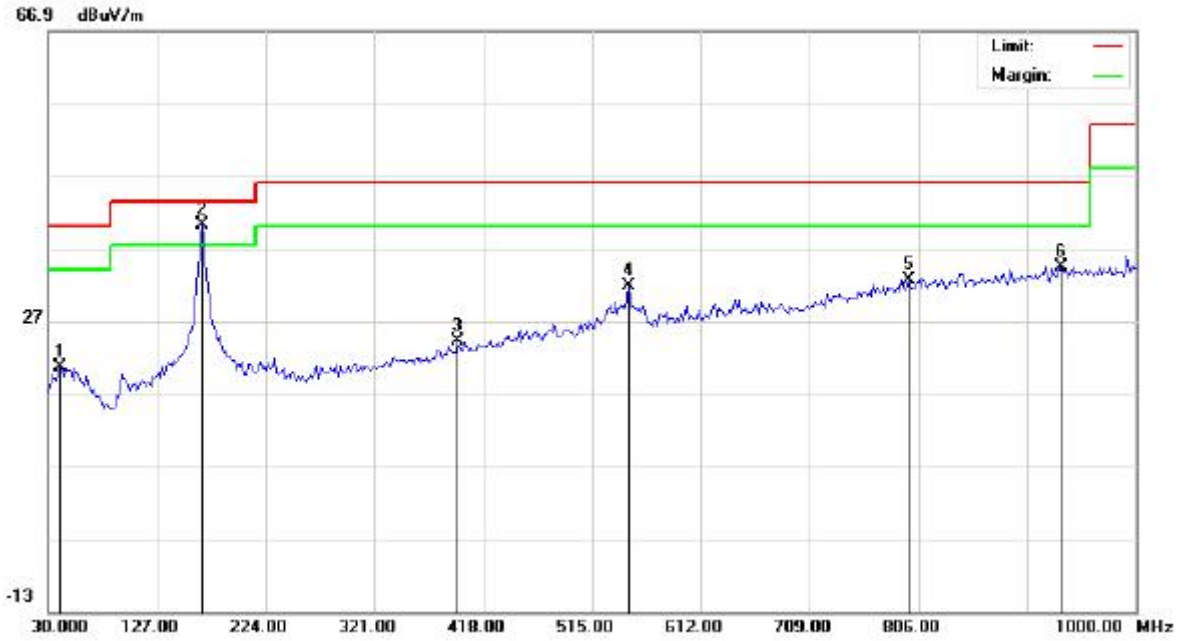
9.4. TEST RESULT

RADIATED EMISSION BELOW 30MHZ

Emission from 9kHz to 30MHz are more than 20dB below the limit.

RADIATED EMISSION BELOW 1GHZ

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 4	**Antenna**	Horizontal



No.	Mk.	Freq.	Reading	Factor	Measurement	Limit	Over	Detector	Antenna Height	Table Degree	Comment
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB		cm	degree	
1		41.3167	0.55	20.04	20.59	40.00	-19.41	peak			
2	*	167.4167	21.79	18.43	40.22	43.50	-3.28	peak			
3		395.3667	1.30	22.82	24.12	46.00	-21.88	peak			
4		547.3333	5.91	25.92	31.83	46.00	-14.17	peak			
5		797.9167	2.30	30.36	32.66	46.00	-13.34	peak			
6		933.7167	2.46	31.99	34.45	46.00	-11.55	peak			

RESULT: PASS

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 4	**Antenna**	Vertical

No.	Mk.	Freq.	Reading	Factor	Measurement	Limit	Over	Detector	Antenna Height	Table Degree	Comment
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB		cm	degree	
1		34.8500	5.47	18.32	23.79	40.00	-16.21	peak			
2	*	167.4167	14.47	18.43	32.90	43.50	-10.60	peak			
3		419.6167	0.47	23.37	23.84	46.00	-22.16	peak			
4		647.5667	1.49	27.52	29.01	46.00	-16.99	peak			
5		854.5000	2.01	31.11	33.12	46.00	-12.88	peak			
6		970.9000	2.10	32.31	34.41	54.00	-19.59	peak			

RESULT: PASS

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

2. All test modes had been pre-tested. The mode 4 is the worst case and recorded in the report.

RADIATED EMISSION ABOVE 1GHZ

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 1	**Antenna**	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Value Type
4804.000	45.85	0.08	45.93	74	-28.07	peak
4804.000	39.56	0.08	39.64	54	-14.36	AVG
7206.000	41.32	2.21	43.53	74	-30.47	peak
7206.000	36.74	2.21	38.95	54	-15.05	AVG

Remark:
Factor = Antenna Factor + Cable Loss – Pre-amplifier.

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 1	**Antenna**	Vertical

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Value Type
4804.000	43.63	0.08	43.71	74	-30.29	peak
4804.000	37.11	0.08	37.19	54	-16.81	AVG
7206.000	40.81	2.21	43.02	74	-30.98	peak
7206.000	32.49	2.21	34.7	54	-19.3	AVG

Remark:
Factor = Antenna Factor + Cable Loss – Pre-amplifier.

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 2	**Antenna**	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Value Type
4882.000	45.26	0.14	45.4	74	-28.6	peak
4882.000	39.74	0.14	39.88	54	-14.12	AVG
7323.000	41.21	2.36	43.57	74	-30.43	peak
7323.000	37.06	2.36	39.42	54	-14.58	AVG

Remark:
Factor = Antenna Factor + Cable Loss – Pre-amplifier.

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 2	**Antenna**	Vertical

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Value Type
4882.000	42.16	0.14	42.3	74	-31.7	peak
4882.000	37.82	0.14	37.96	54	-16.04	AVG
7323.000	40.26	2.36	42.62	74	-31.38	peak
7323.000	34.88	2.36	37.24	54	-16.76	AVG

Remark:
Factor = Antenna Factor + Cable Loss – Pre-amplifier.

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 3	**Antenna**	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Value Type
4960.000	45.65	0.22	45.87	74	-28.13	peak
4960.000	39.02	0.22	39.24	54	-14.76	AVG
7440.000	41.78	2.64	44.42	74	-29.58	peak
7440.000	35.15	2.64	37.79	54	-16.21	AVG
Remark:						
Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 3	**Antenna**	Vertical

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Value Type
4960.000	43.63	0.22	43.85	74	-30.15	peak
4960.000	36.42	0.22	36.64	54	-17.36	AVG
7440.000	39.16	2.64	41.8	74	-32.2	peak
7440.000	32.22	2.64	34.86	54	-19.14	AVG
Remark:						
Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

RESULT: PASS

Note:

Other emissions from 1G to 25 GHz are considered as ambient noise. No recording in the test report.

Factor = Antenna Factor + Cable loss - Amplifier gain, Over=Measure-Limit.

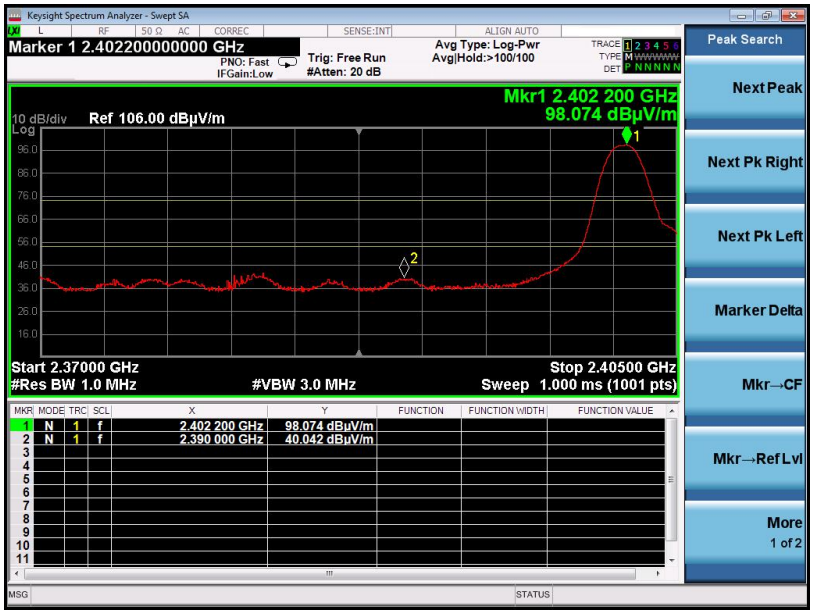
The “Factor” value can be calculated automatically by software of measurement system.

All test modes had been tested. The GFSK modulation is the worst case and recorded in the report.

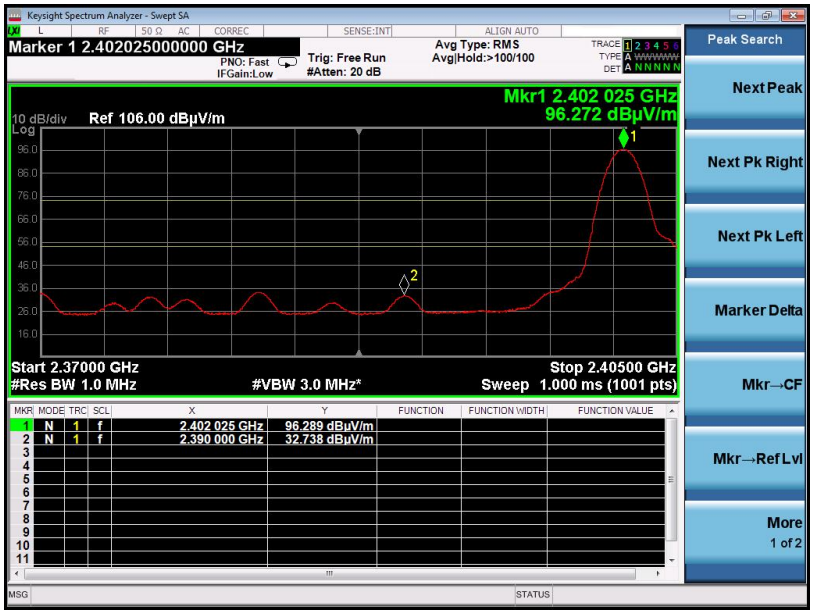
TEST RESULT FOR RESTRICTED BANDS REQUIREMENTS

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 1	**Antenna**	Horizontal

PK



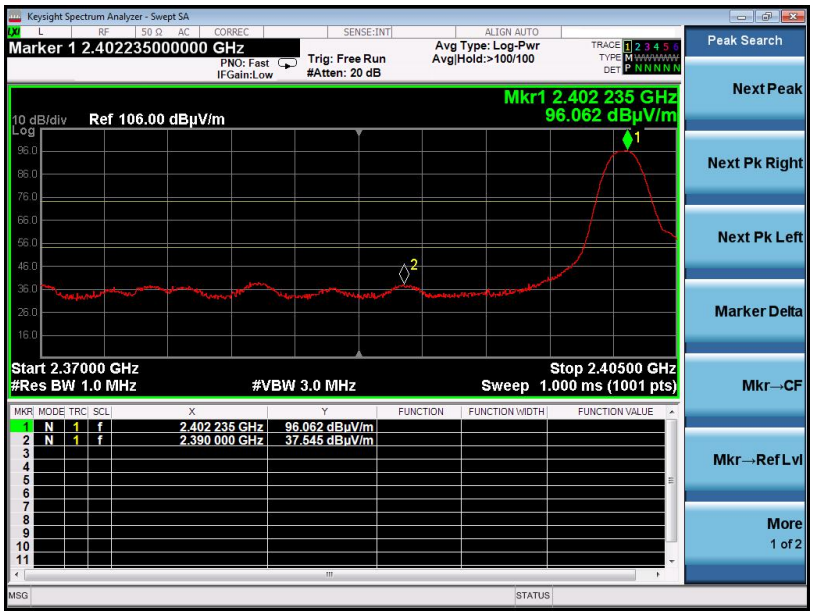
AV



RESULT: PASS

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 1	**Antenna**	Vertical

PK



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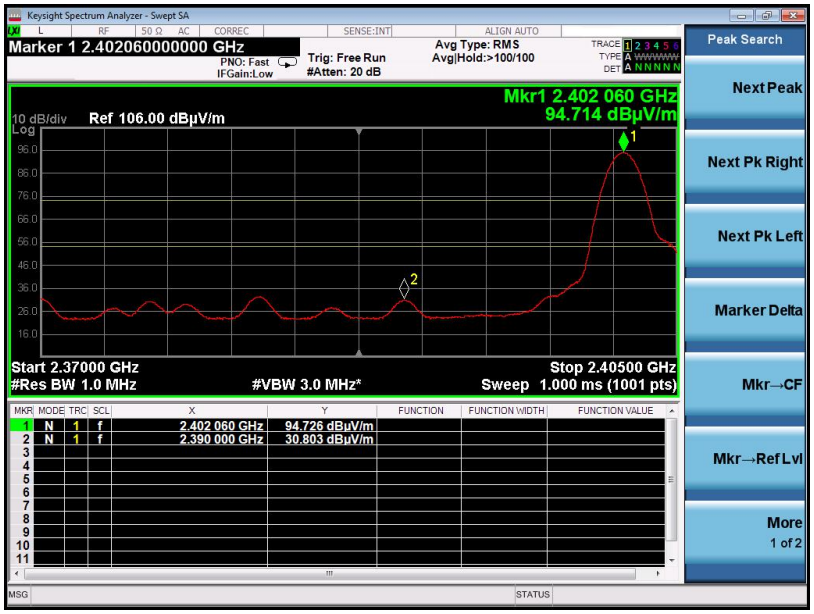
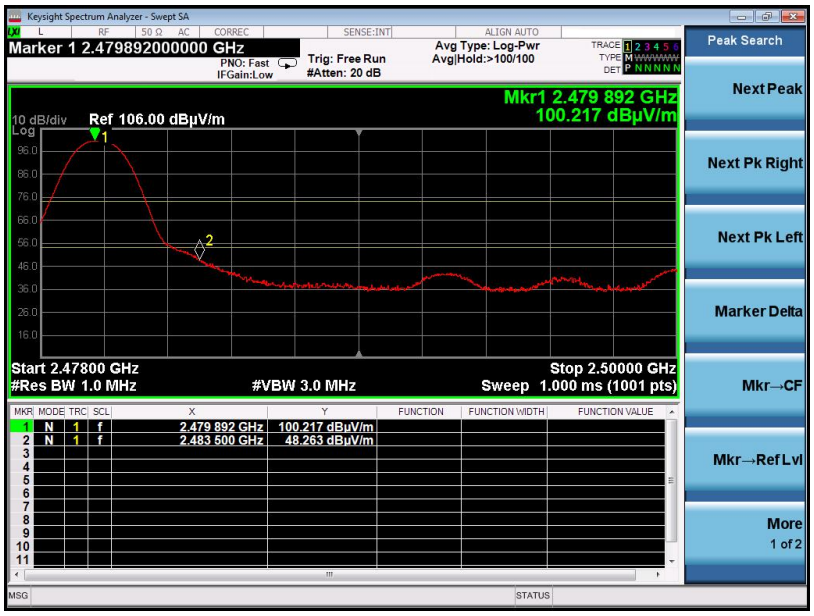


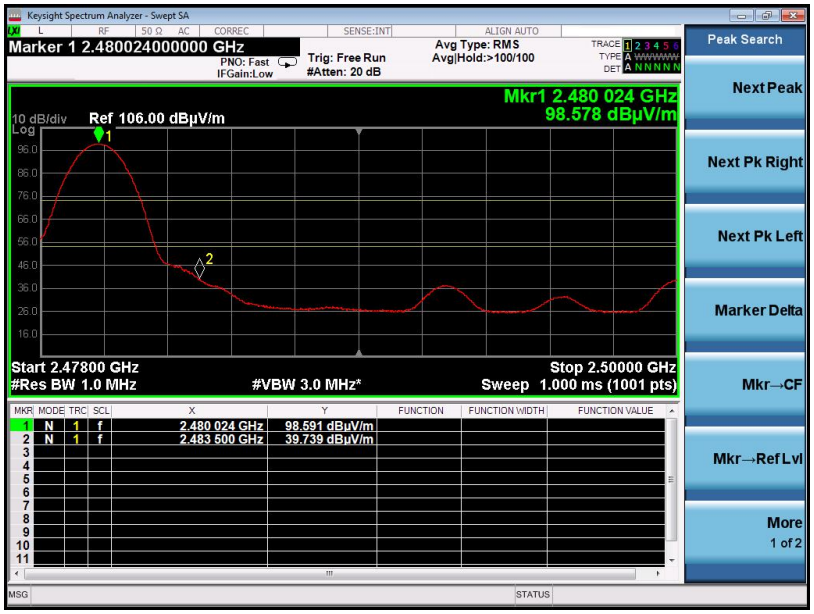
RESULT: PASS

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 3	**Antenna**	Horizontal

PK



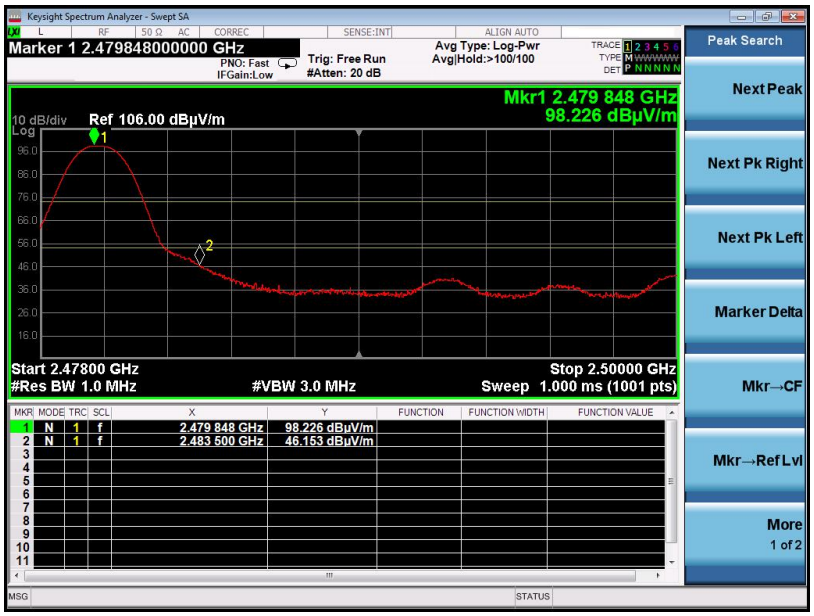
AV



RESULT: PASS

EUT	HELM Sportsband HD Triple Driver	**Model Name**	HSB-100
Temperature	25°C	**Relative Humidity**	55.4%
Pressure	960hPa	**Test Voltage**	Normal Voltage
Test Mode	Mode 3	**Antenna**	Vertical

PK



AV

RESULT: PASS

Note: The factor had been edited in the “Input Correction” of the Spectrum Analyzer. So the Amplitude of test plots is equal to Reading level plus the Factor in dB. Use the A dB(µV) to represent the Amplitude. Use the F dB(µV/m) to represent the Field Strength. So A=F. All test modes had been pre-tested. The GFSK modulation is the worst case and recorded in the report.

10. NUMBER OF HOPPING FREQUENCY

10.1. MEASUREMENT PROCEDURE

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

1. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
2. RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3. VBW ≥ RBW. Sweep: Auto. Detector function: Peak. Trace: Max hold.
4. Allow the trace to stabilize.

10.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 8.2

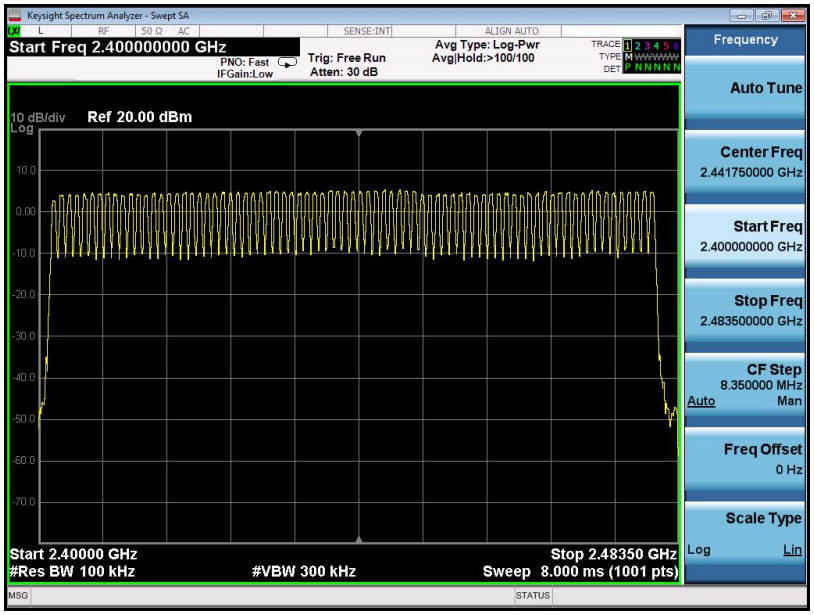
10.3. MEASUREMENT EQUIPMENT USED

The same as described in section 6

10.4. LIMITS AND MEASUREMENT RESULT

TOTAL NO. OF HOPPING CHANNEL	LIMIT (NO. OF CH)	MEASUREMENT (NO. OF CH)	RESULT
	>=15	79	PASS

TEST PLOT FOR NO. OF TOTAL CHANNELS



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

11. TIME OF OCCUPANCY (DWELL TIME)

11.1. 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≤channel spacing and where possible RBW should be set >> 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; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
4. Detector function: Peak. Trace: Max hold.
5. Use the marker-delta function to determine the transmit time per hop.
6. Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:
(Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)
7. The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

11.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 8.2

11.3. MEASUREMENT EQUIPMENT USED

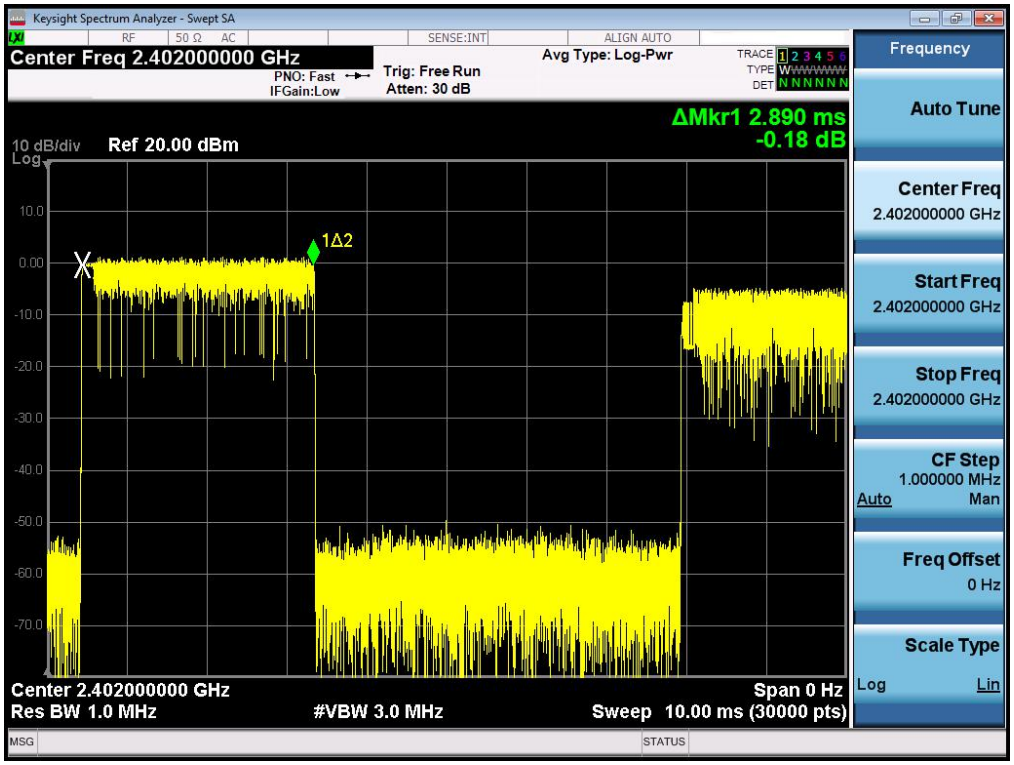
The same as described in section 6

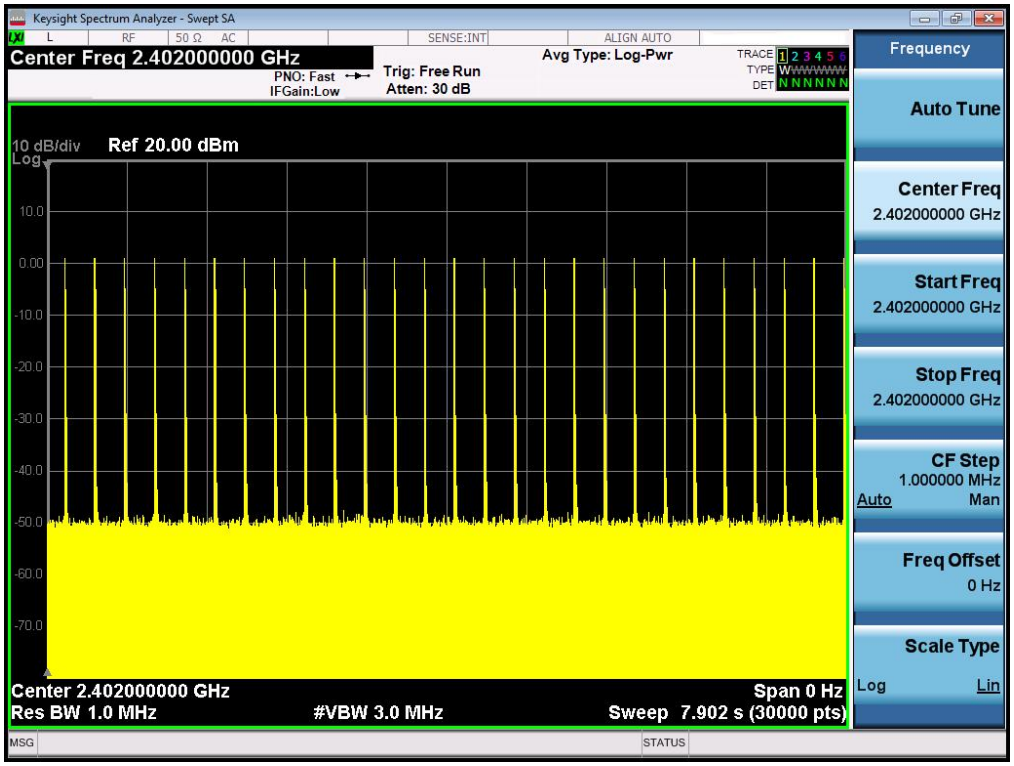
11.4. LIMITS AND MEASUREMENT RESULT

Channel	Time of Pulse for DH5 (ms)	Number of hops in the period specified in the requirements	Sweep Time (ms)	Limit (ms)
Low	2.890	27*4	312.120	400
Middle	2.877	26*4	299.208	400
High	2.876	27*4	310.608	400

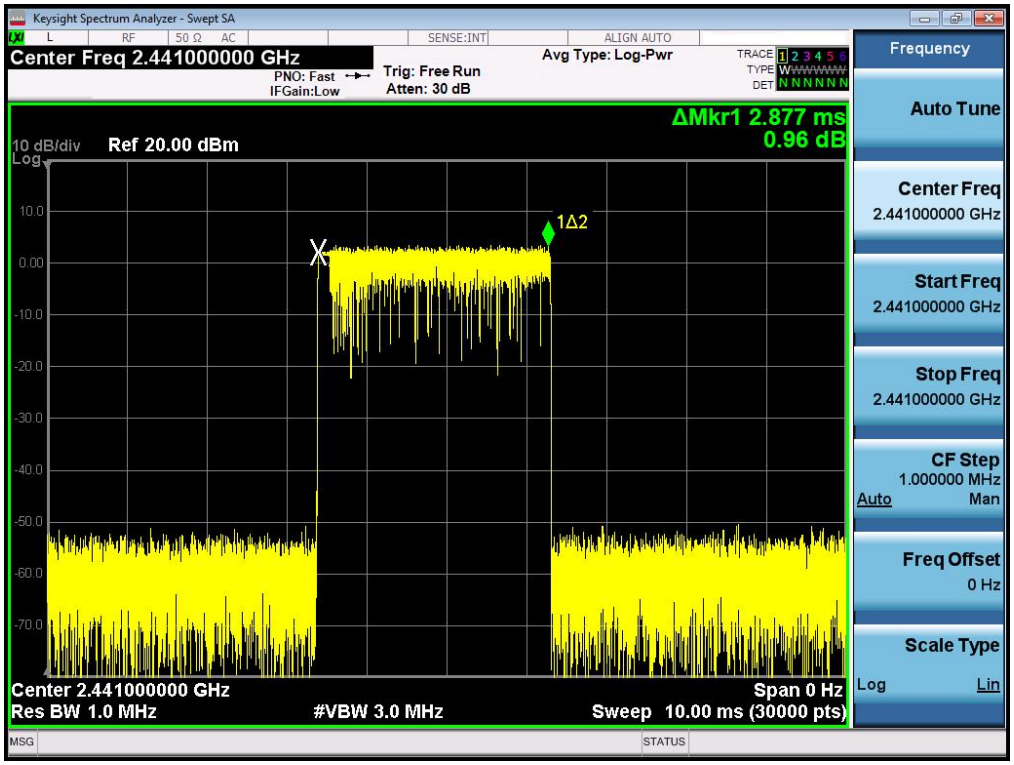
Note: The 8-DPSK modulation is the worst case and recorded in the report.

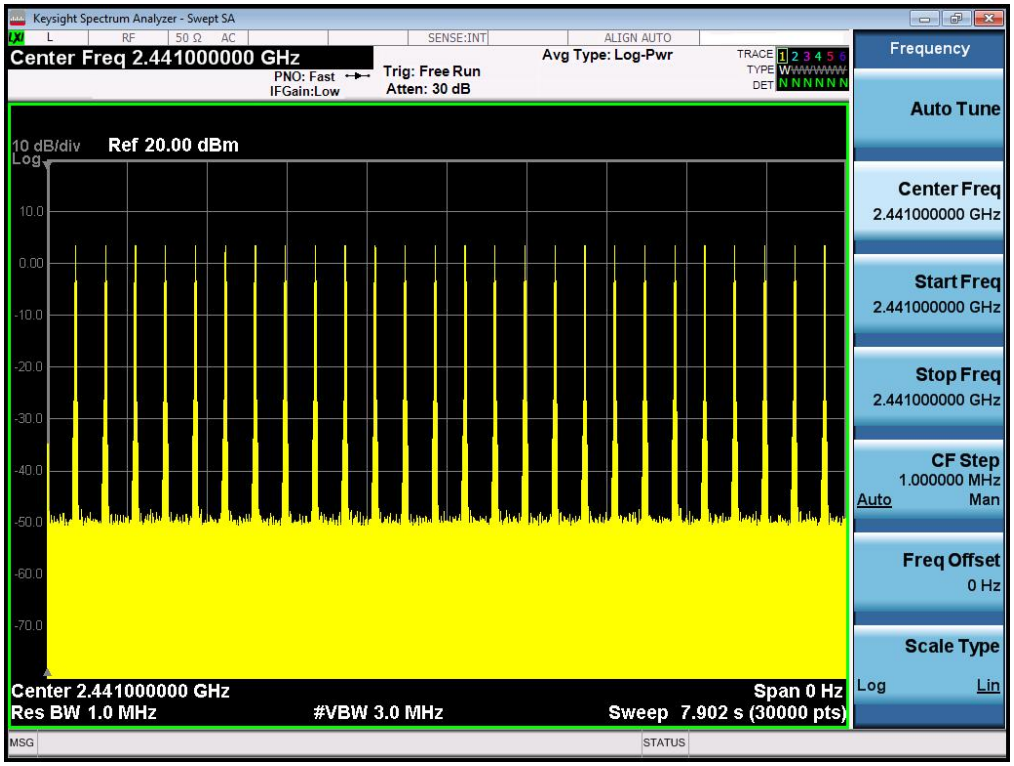
TEST PLOT OF LOW CHANNEL



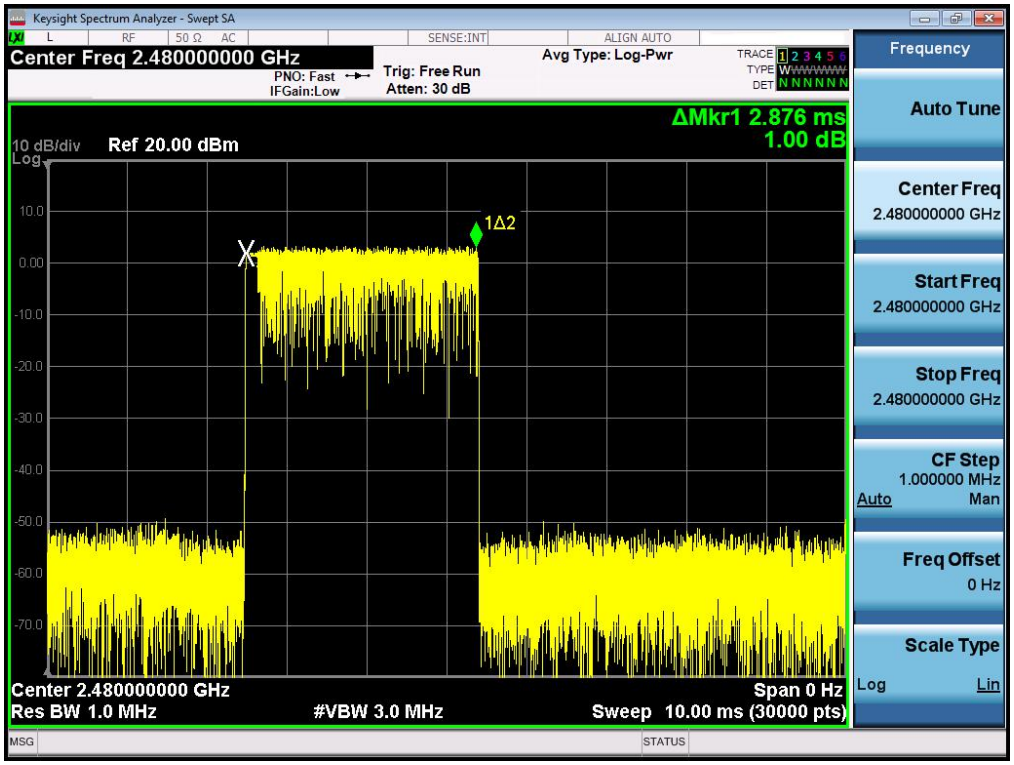


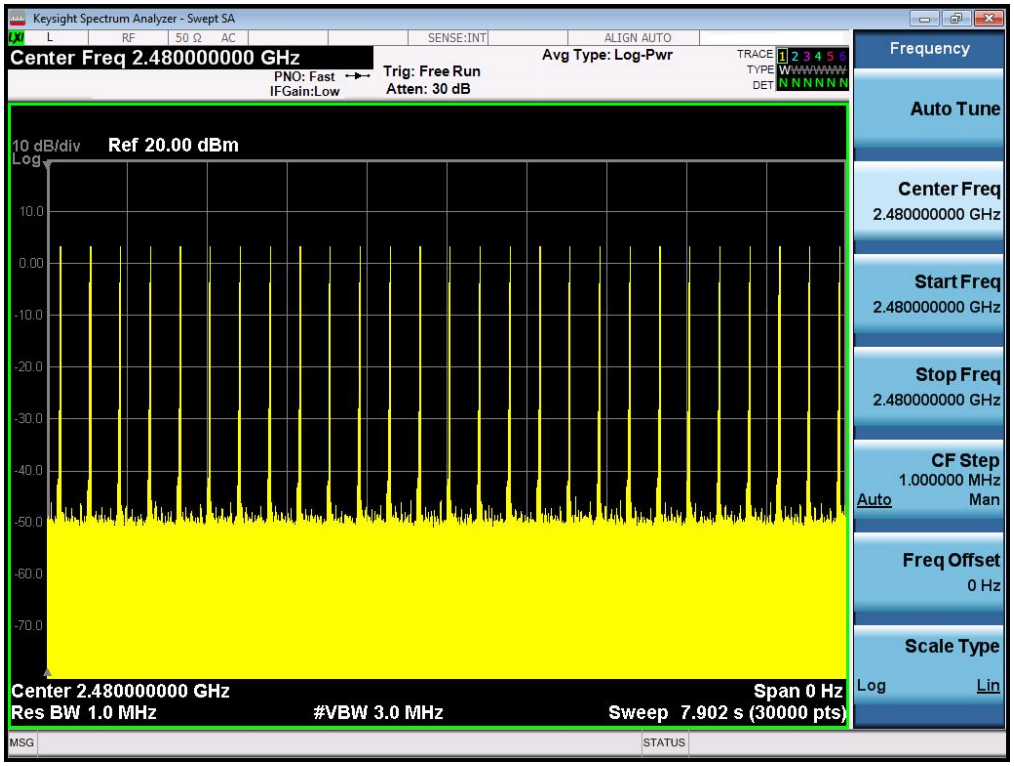
TEST PLOT OF MIDDLE CHANNEL





TEST PLOT OF HIGH CHANNEL





12. FREQUENCY SEPARATION

12.1. MEASUREMENT PROCEDURE

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
1. Span: Wide enough to capture the peaks of two adjacent channels.
2. RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
3. Video (or average) bandwidth (VBW) ≥ RBW.
4. Sweep: Auto. e) Detector function: Peak. f) Trace: Max hold. g) Allow the trace to stabilize.
Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

12.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 6.2

12.3. MEASUREMENT EQUIPMENT USED

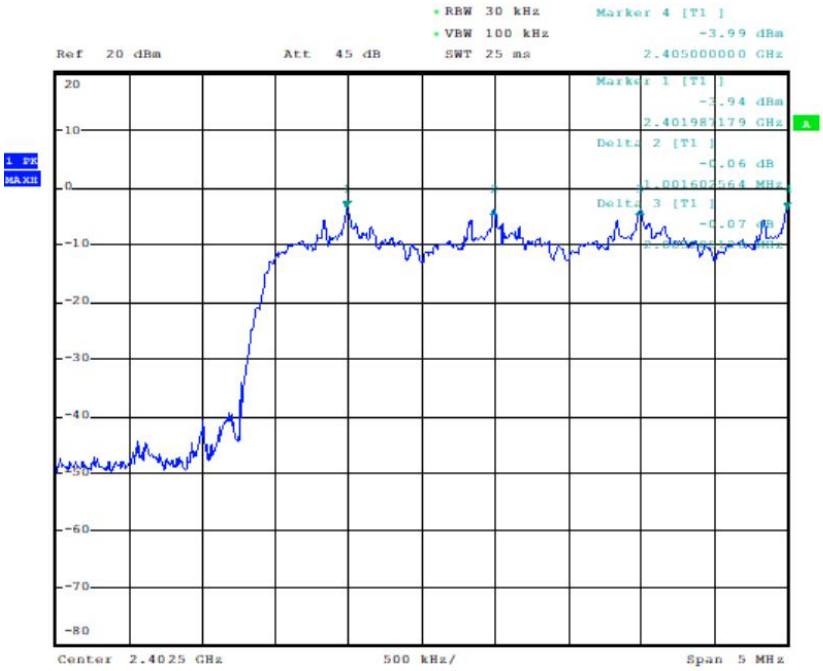
The same as described in section 6.3

12.4. LIMITS AND MEASUREMENT RESULT

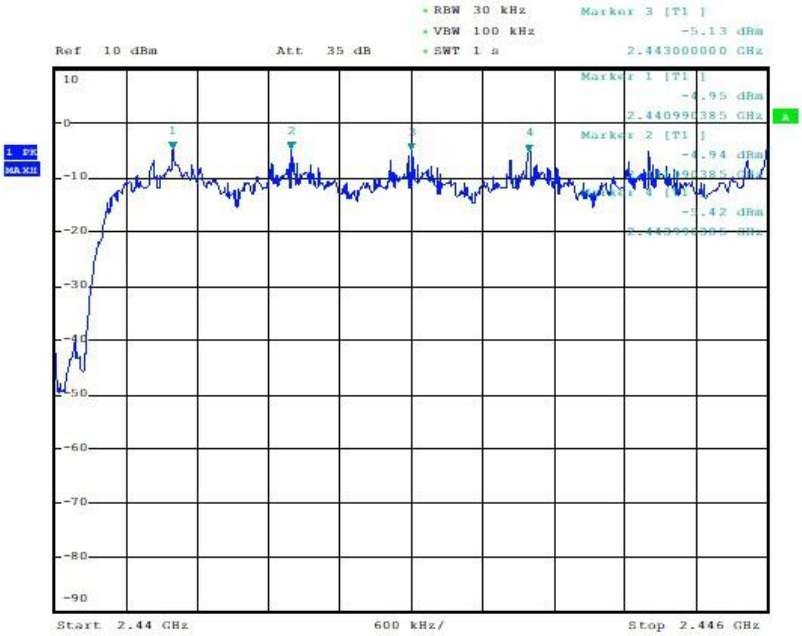
CHANNEL	CHANNEL SEPARATION	LIMIT	RESULT
	KHz	KHz	
CH00	1000	2/3 20 dB BW	Pass
CH39	1005	2/3 20 dB BW	Pass
CH78	1001	2/3 20 dB BW	Pass

TEST PLOT FOR FREQUENCY SEPARATION

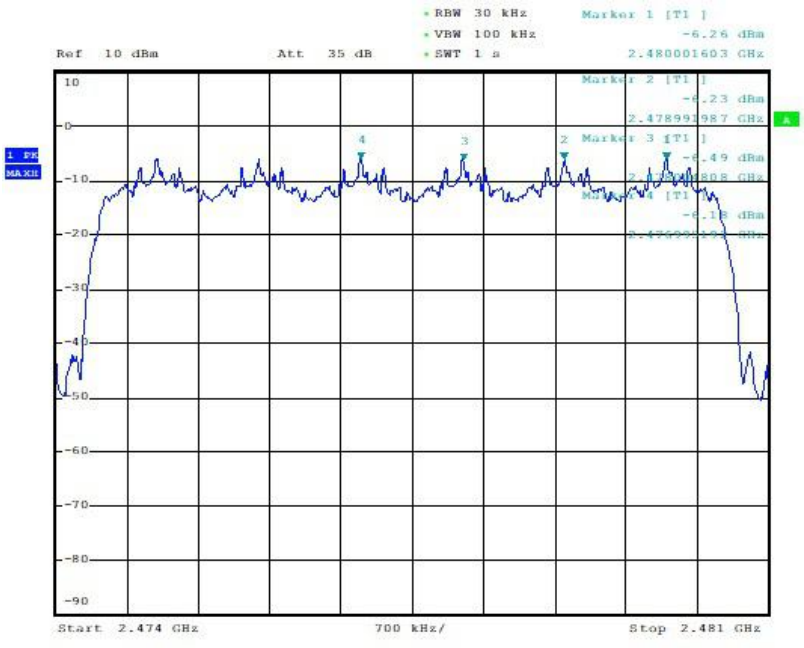
CH00



CH39



CH78



Note: The 8-DPSK modulation is the worst case and recorded in the report.

13. FCC LINE CONDUCTED EMISSION TEST

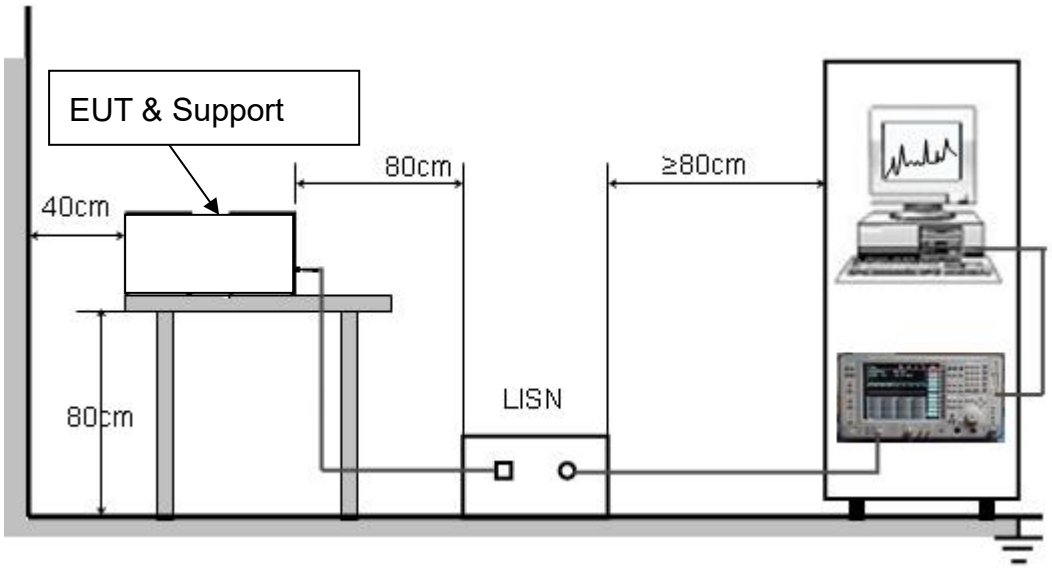
13.1. LIMITS OF LINE CONDUCTED EMISSION TEST

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.

13.2. BLOCK DIAGRAM OF LINE CONDUCTED EMISSION TEST



13.3. 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 5V power from adapter which received AC120V/60Hz power from 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.

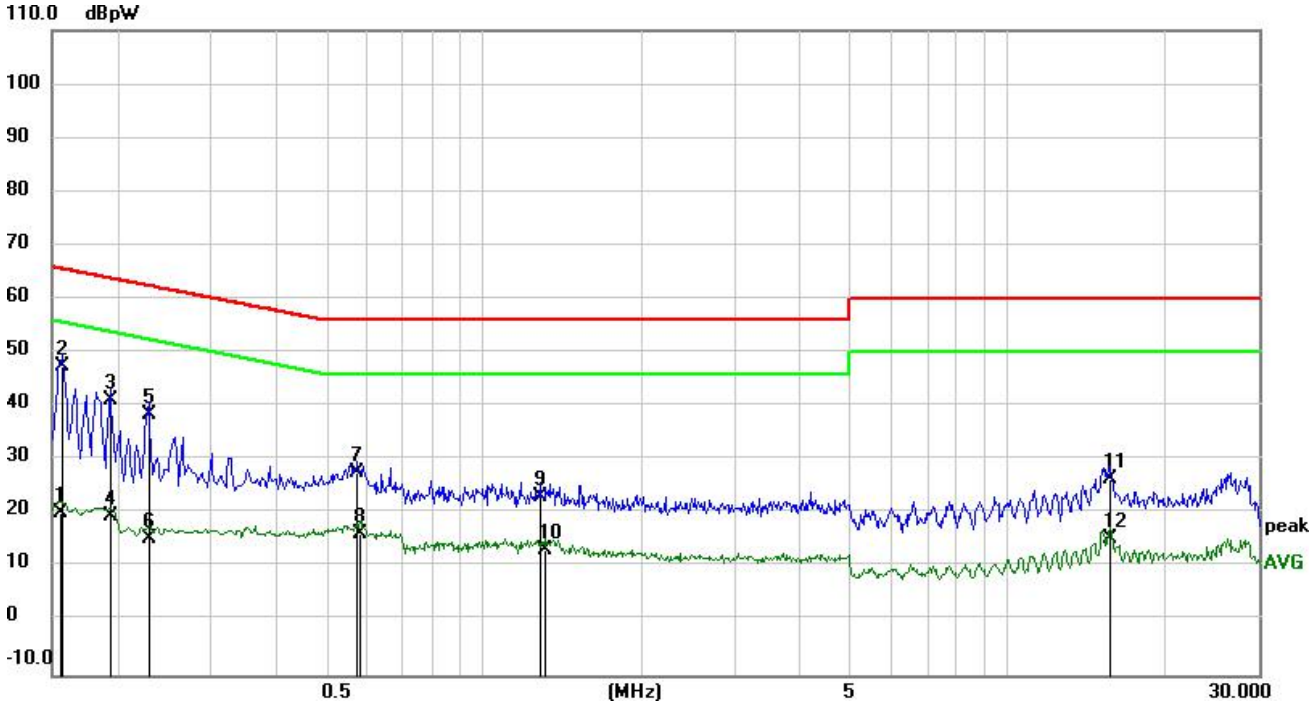
Then, the EUT configuration and cable configuration of the above highest emission level were recorded for reference of final testing.

13.4. 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.

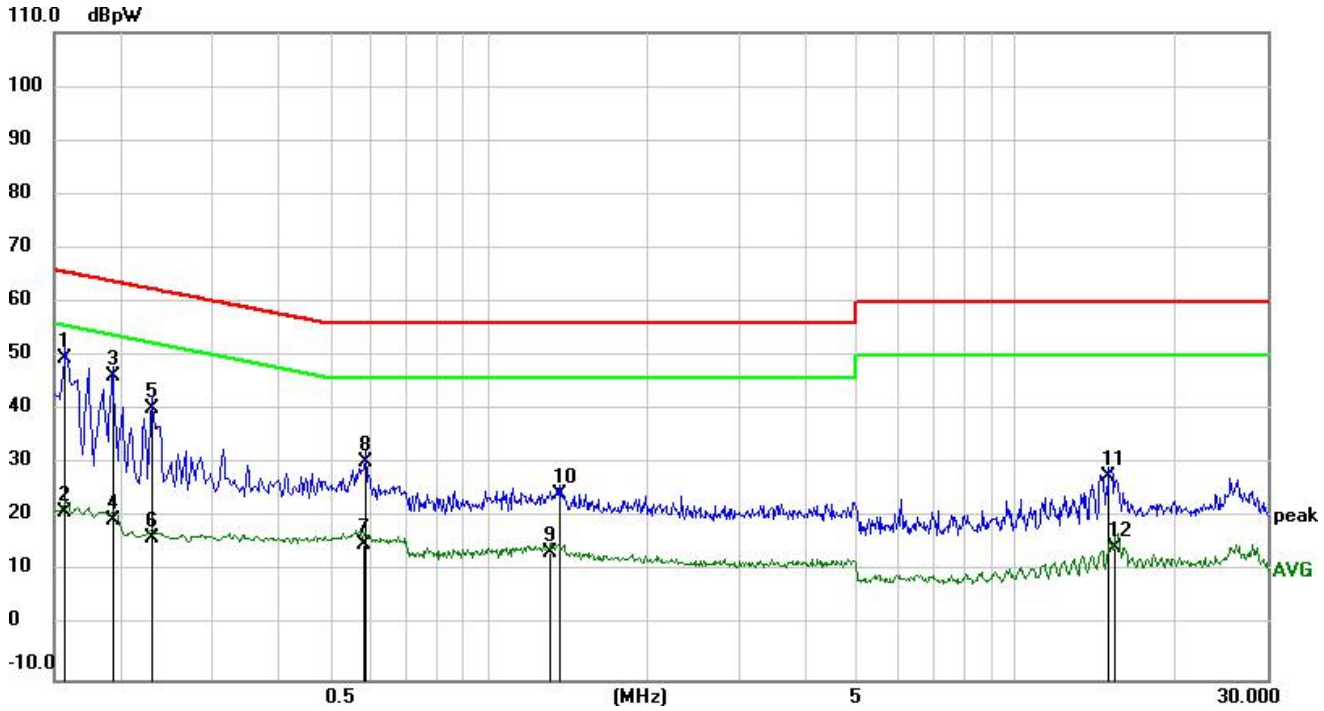
13.5. TEST RESULT OF LINE CONDUCTED EMISSION TEST

Line Conducted Emission Test Line 1-L



No. Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
	MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	0.1556	10.18	9.94	20.12	55.70	-35.58	AVG	
2 *	0.1580	37.48	9.94	47.42	65.57	-18.15	QP	
3	0.1940	31.30	9.90	41.20	63.86	-22.66	QP	
4	0.1940	9.66	9.90	19.56	53.86	-34.30	AVG	
5	0.2300	28.55	9.90	38.45	62.45	-24.00	QP	
6	0.2300	5.32	9.90	15.22	52.45	-37.23	AVG	
7	0.5740	17.63	9.93	27.56	56.00	-28.44	QP	
8	0.5820	6.39	9.93	16.32	46.00	-29.68	AVG	
9	1.2820	13.13	9.99	23.12	56.00	-32.88	QP	
10	1.3099	3.23	9.99	13.22	46.00	-32.78	AVG	
11	15.5700	14.39	12.06	26.45	60.00	-33.55	QP	
12	15.6420	3.37	12.08	15.45	50.00	-34.55	AVG	

Line Conducted Emission Test Line 2-N



No. Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
	MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1 *	0.1580	39.52	9.93	49.45	65.57	-16.12	QP	
2	0.1580	11.19	9.93	21.12	55.57	-34.45	AVG	
3	0.1940	36.42	9.90	46.32	63.86	-17.54	QP	
4	0.1940	9.55	9.90	19.45	53.86	-34.41	AVG	
5	0.2300	30.22	9.90	40.12	62.45	-22.33	QP	
6	0.2300	6.42	9.90	16.32	52.45	-36.13	AVG	
7	0.5820	5.26	9.94	15.20	46.00	-30.80	AVG	
8	0.5860	20.51	9.94	30.45	56.00	-25.55	QP	
9	1.3140	3.46	9.99	13.45	46.00	-32.55	AVG	
10	1.3700	14.33	9.99	24.32	56.00	-31.68	QP	
11	15.0540	15.83	11.82	27.65	60.00	-32.35	QP	
12	15.4500	2.38	11.94	14.32	50.00	-35.68	AVG	

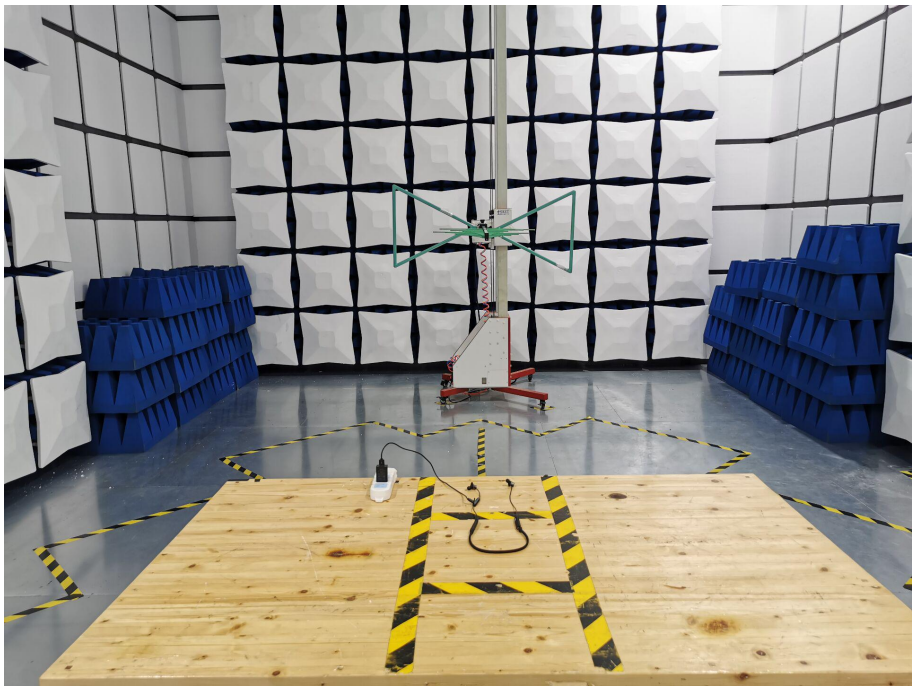
RESULT: PASS

Note: All the test modes had been tested, the mode 1 was the worst case. Only the data of the worst case would be record in this test report.

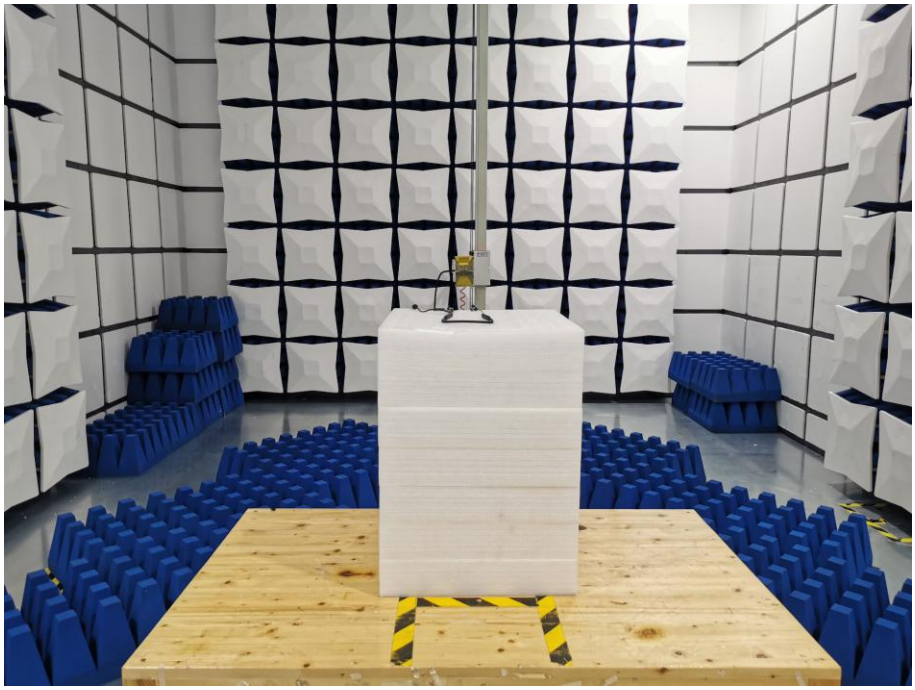
APPENDIX A: PHOTOGRAPHS OF TEST SETUP

CONDUCTED EMISSION TEST SETUP

RADIATED EMISSION TEST SETUP BELOW 1GHZ



RADIATED EMISSION TEST SETUP ABOVE 1GHZ



----END OF REPORT----