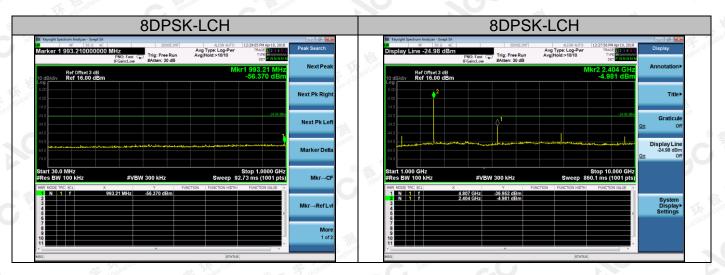
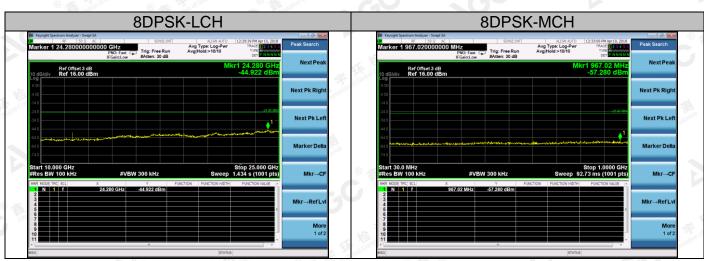
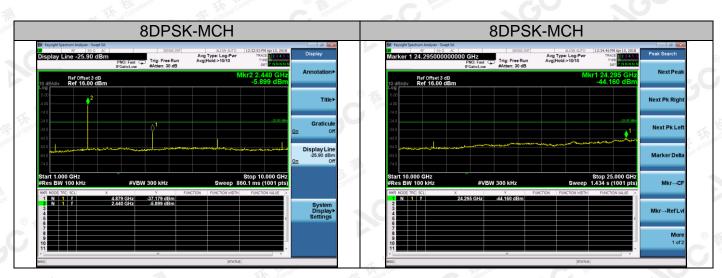


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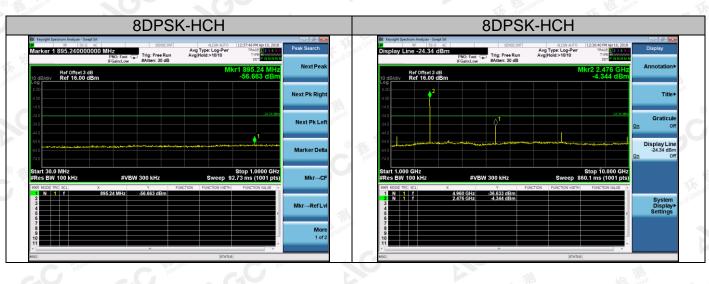


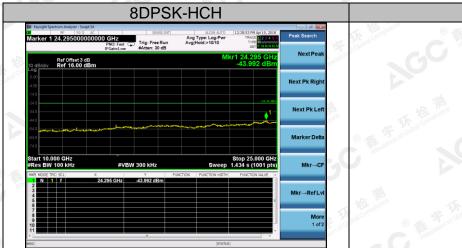
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#### **10. RADIATED EMISSION**

#### 10.1. 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 VBW and RBW for peak reading. Then 1MHz RBW and 10Hz VBW for average reading in spectrum analyzer. 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.

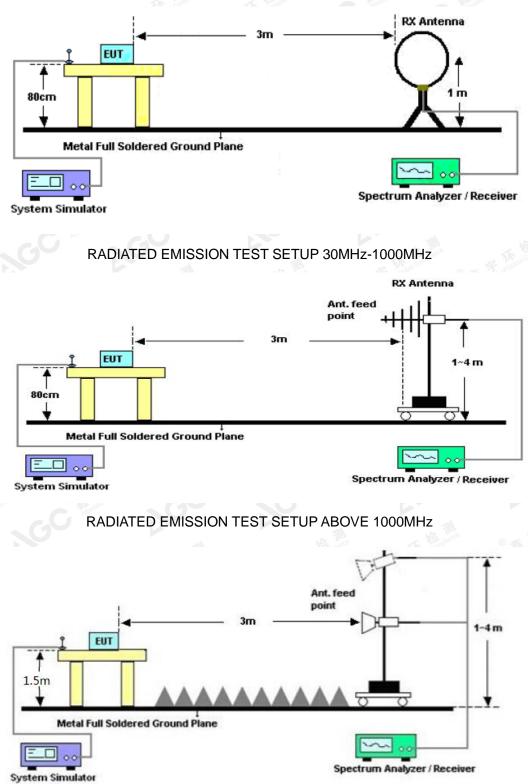
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#### 10.2. TEST SETUP

RADIATED EMISSION TEST-SETUP FREQUENCY BELOW 30MHZ



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#### **10.3. 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	The state of the s		
216~960	200	· · · · · · · · · · · · · · · · · · ·		
Above 960	500	3		

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#### 10.4. TEST RESULT

#### RADIATED EMISSION BELOW 30MHZ

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

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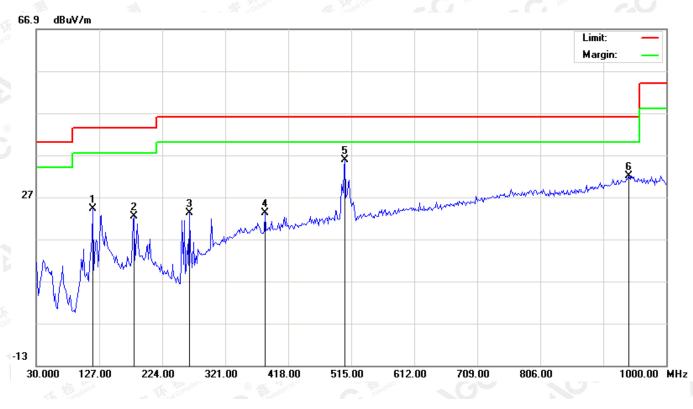




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# RADIATED EMISSION BELOW 1GHZ

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



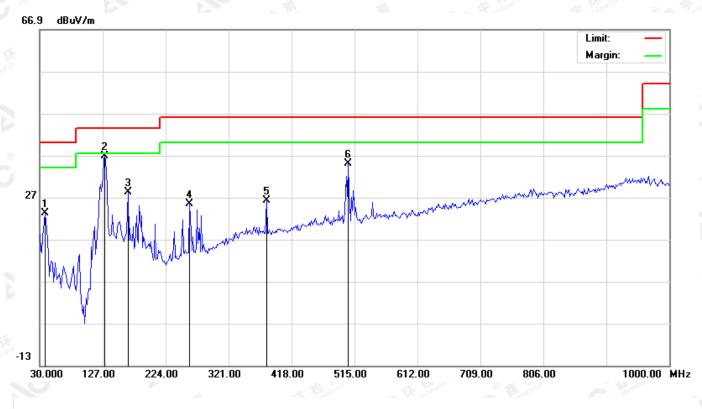
No.	Mk	Freq.	Reading	Factor	Measurement	Limit	Over	Detector	Antenna Height	Table Degree	Comment
	•	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB		cm	degree	
1		117.3000	17.63	6.48	24.11	43.50	-19.39	peak			
2		180.3500	11.39	11.09	22.48	43.50	-21.02	peak			
3		266.0333	13.61	9.63	23.24	46.00	-22.76	peak			
4		382.4333	4.32	18.95	23.27	46.00	-22.73	peak			
5	*	505.3000	14.58	21.27	35.85	46.00	-10.15	peak			
6		941.8000	2.29	29.77	32.06	46.00	-13.94	peak			

**RESULT: PASS** 

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#### RADIATED EMISSION TEST- (30MHZ-1GHZ) -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		38.0833	16.86	6.39	23.25	40.00	-16.75	peak			
2	*	130.2333	25.65	11.13	36.78	43.50	-6.72	peak			
3		165.8000	13.30	14.96	28.26	43.50	-15.24	peak			
4		261.1833	11.15	14.24	25.39	46.00	-20.61	peak			
5		379.2000	7.30	18.93	26.23	46.00	-19.77	peak			
6		505.3000	13.67	21.27	34.94	46.00	-11.06	peak			

#### **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.

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# RADIATED EMISSION TEST- (ABOVE 1GHZ)

Frequency	Emission Level	Limits	Margin	Detector	Commont	
(MHz)	(dBµV/m)	(dBµV/m)	(dB)	Туре	Comment	
al Contra	Lo	w Channel (2402	MHz)			
4804	56.23	74	-17.77	Pk	Vertical	
4804	41.22	54	-12.78	AV	Vertical	
7206	54.59	74	-19.41	Pk	Vertical	
7206	39.64	54	-14.36	AV	Vertical	
4804	58.20	74	-15.80	Pk	Horizontal	
4804	40.36	54	-13.64	AV	Horizontal	
7206	56.45	74	-17.55	Pk	Horizontal	
7206	38.09	54	-15.91	AV	Horizontal	
	Mi	d Channel (2441	MHz)	The Compliance	2 The Scongland	
4882	58.34	74	-15.66	Pk	Vertical	
4882	40.22	54	-13.78	AV	Vertical	
7323	56.11	74	-17.89	Pk 🐘	Vertical	
7323	38.49	54	-15.51	AV	Vertical	
4882	59.14	74	-14.86	Pk	Horizontal	
4882	39.35	54	-14.65	AV	Horizontal	
7323	57.69	74	-16.31	Pk	Horizontal	
7323	38.49	54	-15.51	AV	Horizontal	
	Hig	h Channel (2480	) MHz)	C.C.	GO ···	
4960	57.18	74	-16.82	pk	Vertical	
4960	41.36	54	-12.64	AV	Vertical	
7440	56.46	74	-17.54	pk	Vertical	
7440	40.19	54	-13.81	AV	Vertical	
4960	58.44	74	-15.56	pk	Horizontal	
4960	39.23	54	-14.77	AV	Horizontal	
7440	57.46	74	-16.54	pk	Horizontal	
7440	38.44	54	-15.56	AV	Horizontal	

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#### **RESULT: PASS**

#### Note:

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

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#### 11. BAND EDGE EMISSION

#### **11.1. 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.

#### 11.2. TEST SET-UP

Radiated same as 10.2

Conducted set up

EUT Spectrum analyzer

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## 11.3. RADIATED TEST RESULT

Frequency	Emission Level	Limits	Margin	Detector	0	
(MHz)	(dBµV/m)	(dBµV/m)	(dB)	Туре	Comment	
( Find Gab	ACOULT PROVIDE ALL	GFS	К			
2399.9	48.28	74	-25.72	peak	Vertical	
2399.9	41.44	54	-12.56	AVG	Vertical	
2399.9	49.36	74	-24.64	peak	Horizontal	
2399.9	41.29	54	-12.71	AVG	Horizontal	
2483.6	49.13	74	-24.87	peak	Vertical	
2483.6	42.66	54	-11.34	AVG	Vertical	
2483.6	48.19	74	-25.81	peak	Horizontal	
2483.6	40.06	54	-13.94	AVG	Horizontal	
		π/4-DQ	PSK	The Compliance	F Goba Comple	
2399.9	48.37	74	-25.63	peak	Vertical	
2399.9	42.56	54	-11.44	AVG	Vertical	
2399.9	48.19	74	-25.81	peak	Horizontal	
2399.9	41.58	54	-12.42	AVG	Horizontal	
2483.6	49.36	74	-24.64	peak	Vertical	
2483.6	41.23	54	-12.77	AVG	Vertical	
2483.6	48.14	74	-25.86	🔬 peak	Horizontal	
2483.6	41.05	54	-12.95	AVG	Horizontal	
	The the second	8DPS	SK	CC M	S GO	
2399.9	48.42	74	-25.58	peak	Vertical	
2399.9	42.87	54	-11.13	AVG	Vertical	
2399.9	49.36	74	-24.64	peak	Horizontal	
2399.9	42.69	54	-11.31	AVG	Horizontal	
2483.6	48.52	74	-25.48	peak	Vertical	
2483.6	42.26	54	-11.74	AVG	Vertical	
2483.6	48.11	74	-25.89	peak	Horizontal	
2483.6	42.47	54	-11.53	AVG	Horizontal	

#### **RESULT: PASS**

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

Margin = Emission Leve - Limit

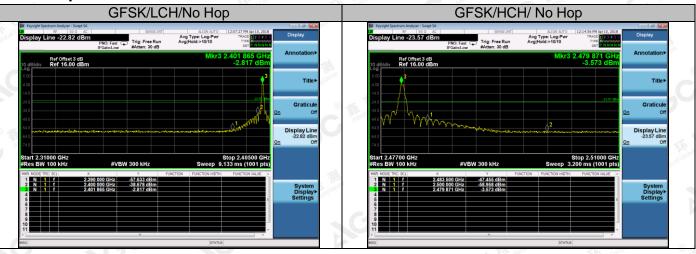
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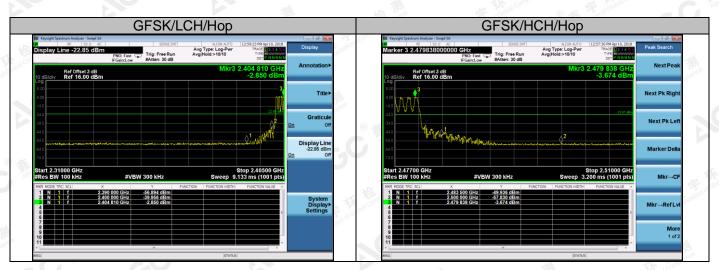


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#### **11.4 CONDUCTED TEST RESULT**

#### **Test Graph**







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8DPSK/LCH/No Hop		8DPSK/HCH/No Hop		
Krglight Steamen Andres - Samet XA. SEDAE2017 ALIGN AUTO 122:00:50 PM Art 10:2016   W 19 09 AC SEDAE2017 ALIGN AUTO 122:00:50 PM Art 10:2016   Display Line - 23:85 dBm PMO: Fast IFGainLow Arg Type: Log-Pwr Atten: 30 dB Arg Type: Log-Pwr ArgHold:>100 Bm Trace Tp 23:85: Arg Type: Log-Pwr ArgHold:>100 Bm   Ref Offset 3 dB 0 dBiolv Mkr 3:2,402:150 GHz -3.652 dBm 3.652 dBm	Display Annotation	Exception Structure Auton Auton Display		
40 50 60 60	Title►	(0) 400 43 400 43		
	Graticule On Off			
70	Display Line -23.85 dBm On Off	310 Display Line Display Line 2427 GBm 2427 GBm 2427 GBm 2747 GBm		
tarit 2.31000 GHz Stop 2.40500 GHz   Res BW 100 kHz #VBW 300 kHz Sweep 9.133 ms (1001 pts)   M K00E FRC SkL x Y Functions Instructions worthin Functions worthin	G	Start 2.47700 GHz Stop 2.51000 GHz   #Res BW 100 kHz #VBW 300 kHz Sweep 3.200 ms (1001 pts)   IMM_DOS TRUSKL x Y Function Function water and the second seco		
1 N 1 f 2390000 CHz 56524 dBm 2 N 1 f 240000 CHz 41219 dBm 3 N 1 f 240000 CHz 41219 dBm 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	System Display► Settings	N 1 7 2480 000 GHz 4573 dBm System   N 1 1 2480 000 GHz 4573 dBm Display+   N 1 1 2480 000 GHz 4272 dBm Display+   N 1 1 2480 168 GHz 4272 dBm Display+   Settings - - - - -		

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

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# **12. NUMBER OF HOPPING FREQUENCY**

#### 12.1. 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.

#### 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**

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

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

#### **Test Graph**

		Gra	phs		
The stand companies	a F A Clobal Compliance	Keysight Spectrum Analyzer - Swept SA   W T RF 50.0 AC   Marker 1 Δ 78.213000000 MHz PNO: Fast T T	SENSE:INT ALIGN AUTO Avg Type: Log-Pwr Frig: Free Run Avg Hold:>10/10	10:27:26 PM Apr09, 2018 TRACE 23456 TYPE	
Allestation of S	Allesation	PN0: Fast IFGain:Low # Ref Offset 3 dB 10 dB/div Ref 13.00 dBm	Atten: 30 dB	kr1 78.213 MHz 0.247 dB	Peak and a second se
	H. H.	3.00 -7.00 <b>X</b> \$\$0,6700,6,0,6,0,6,0,6,0,6,0,0,0,0,0,0,0,0		122 Next Pk R	ight
· · · · · · · · · · · · · · · · · · ·	C There and	27 0 -37 0 -47 0		Next Pk	Left
GFSK/Hop		67.0 		Marker D	Delta
The Barrison C.	The Ford Canal Company	Center 2.44100 GHz #VBW 30   #Res BW 100 kHz #VBW 30   MRR MODE TRC SCL X   Δ2 1 f (Δ) 78.213 MHz (Δ)	Y FUNCTION FUNCTION WIDTH	Span 87.00 MHz .333 ms (1001 pts) Mkr-	→CF
or closed C	Alexand Solution	2 F 1 f 2.401763 GHz -	4.318 dBm	Mkr→Re	fLvi Th
		8 9 9 10 11 11			Nore 1 of 2
The Comptione	8 <b>F</b>	MSG	STATUS		

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#### 13. TIME OF OCCUPANCY (DWELL TIME)

#### 13.1. 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 >> 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:

Dwell time = t<sub>pulse</sub> x n<sub>hops</sub> / number of channels x 31.6 s

Where:

t<sub>pulse</sub> is the measured pulse time (pls. refer the plots of the spectrum analyser above) [s], n<sub>hops</sub> 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  $\mu s.$ 

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 ( $n_{hops}$  = 266.667 1/s)

#### 13.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 8.2

#### 13.3. MEASUREMENT EQUIPMENT USED

The same as described in section 6

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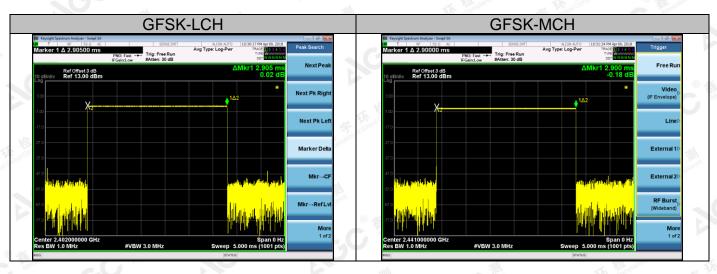


#### **13.4. LIMITS AND MEASUREMENT RESULT**

Channel.	Burst Width [ms/hop/ch]	Dwell Time[ms]	Verdict	Limit (ms)
LCH	2.905	309.8671	PASS	400
MCH	2.900	309.3337	PASS	400
НСН	2.900	309.3337	PASS	400

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

## Test Graph



		GFSK	-HCH		Alter and	
e	H Keylet Spectrum Analyzer - Sweet SA 31 T S SS S AC Marker 1 ∆ 2.90000 ms Ref Offset 3 dB 10 dB/div Ref 13.00 dBm	PNO: Fast +	Ацон вито 10:32:53 PM Apr09, 2016 Avg Type: Log-Pwr Темсе 12:33 PM Apr09, 2016 тек торово ост торово АМКr1 2:3900 ms -0.05 dB	Marker Select Marker	G	
	3.00 7.00		± 1∆2	Normal		
T	37 0 37 0 37 0			Delta Fixed⊳	C Auterational	
of Gra			and the second	Off Properties►		
0	Center 2.480000000 GHz Res BW 1.0 MHz	#VBW 3.0 MHz	Span 0 Hz Sweep 5.000 ms (1001 pts)	More 1 of 2	GC	

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#### **14. FREQUENCY SEPARATION**

#### 14.1. 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
- Set Span = wide enough to capture the peaks of two adjacent channels Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span Video (or Average) Bandwidth (VBW) ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold

#### 14.2. TEST SETUP (BLOCK DIAGRAM OF CONFIGURATION)

Same as described in section 6.2

#### 14.3. MEASUREMENT EQUIPMENT USED

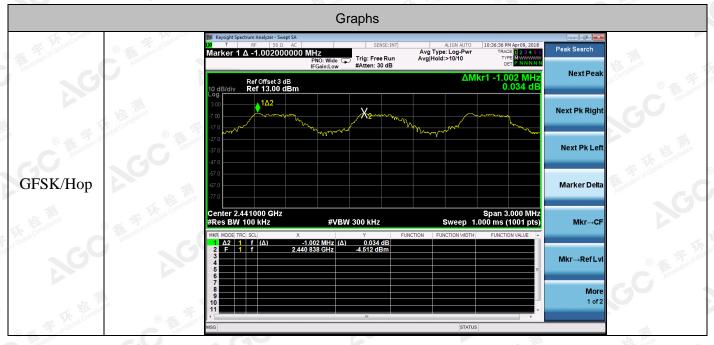
The same as described in section 6.3

#### 14.4. LIMITS AND MEASUREMENT RESULT

Mode Channel.		Carrier Frequency Separation [MHz]	Verdict	
GFSK	Нор	1002	PASS	

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

#### **Test Graph**



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# **15. FCC LINE CONDUCTED EMISSION TEST**

#### 15.1. LIMITS OF LINE CONDUCTED EMISSION TEST

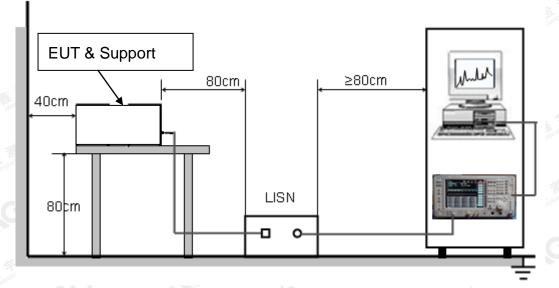
Fromuonou	Maximum RF Line Voltage					
Frequency	Q.P.( dBuV)	Average( dBuV)				
150kHz~500kHz	66-56	56-46				
500kHz~5MHz	56	46				
5MHz~30MHz	60	50				

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.

### 15.2. BLOCK DIAGRAM OF LINE CONDUCTED EMISSION TEST



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#### **15.3. PRELIMINARY PROCEDURE OF LINE CONDUCTED EMISSION TEST**

- 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/60Hzpower 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.

#### 15.4. 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.
- 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.

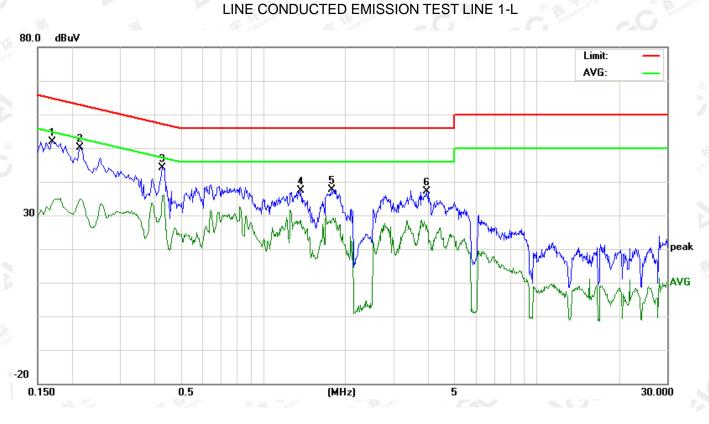
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#### 15.5. TEST RESULT OF LINE CONDUCTED EMISSION TEST



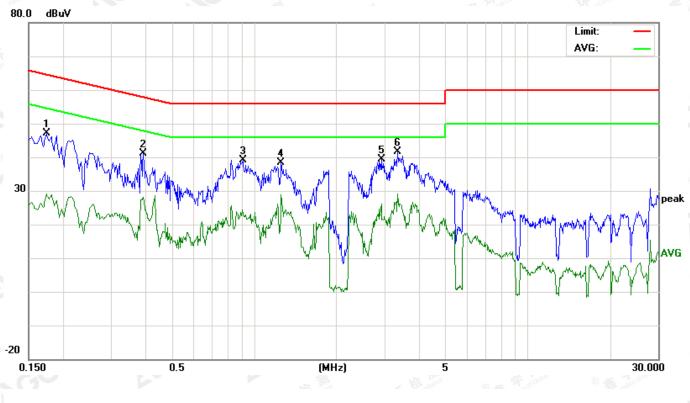
No.	Freq. (MHz)	Reading_Level (dBuV)			Correct Factor	Measurement (dBuV)			Limit (dBuV)		Margin (dB)		P/F	Comment
		Peak	QP	AVG	dB	Peak	QP	AVG	QP	AVG	QP	AVG		
1	0.1700	41.79		23.79	10.18	51.97		33.97	64.96	54.96	-12.99	-20.99	Ρ	
2	0.2140	40.01		24.77	10.23	50.24		35.00	63.04	53.04	-12.80	-18.04	Ρ	
3	0.4300	33.82		25.41	10.35	44.17		35.76	57.25	47.25	-13.08	-11.49	Р	
4	1.3740	26.89		18.27	10.38	37.27		28.65	56.00	46.00	-18.73	-17.35	Ρ	
5	1.7900	27.38		18.39	10.29	37.67		28.68	56.00	46.00	-18.33	-17.32	Ρ	
6	3.9780	26.72		16.59	10.43	37.15		27.02	56.00	46.00	-18.85	-18.98	Ρ	

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#### LINE CONDUCTED EMISSION TEST LINE 2-N

No.	Freq. (MHz)	Reading_Level (dBuV)			Correct Factor	Measurement (dBuV)			Limit (dBuV)		Margin (dB)		P/F	Comment
		Peak	QP	AVG	dB	Peak	QP	AVG	QP	AVG	QP	AVG		
1	0.1740	36.95		18.89	10.19	47.14		29.08	64.76	54.76	-17.62	-25.68	Р	
2	0.3940	30.89		17.75	10.33	41.22		28.08	57.98	47.98	-16.76	-19.90	Р	
3	0.9100	28.78		12.71	10.41	39.19		23.12	56.00	46.00	-16.81	-22.88	Р	
4	1.2620	27.96		18.43	10.38	38.34		28.81	56.00	46.00	-17.66	-17.19	Р	
5	2.9219	28.76		15.54	10.53	39.29		26.07	56.00	46.00	-16.71	-19.93	Р	
6	3.3580	31.00		18.60	10.52	41.52		29.12	56.00	46.00	-14.48	-16.88	Р	

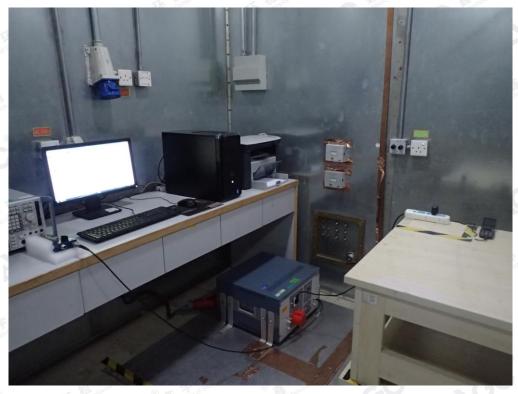
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## APPENDIX A: PHOTOGRAPHS OF TEST SETUP LINE CONDUCTED EMISSION TEST SETUP



RADIATED EMISSION TEST SETUP



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RADIATED EMISSION ABOVE 1G TEST SETUP

---END OF REPORT----

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