
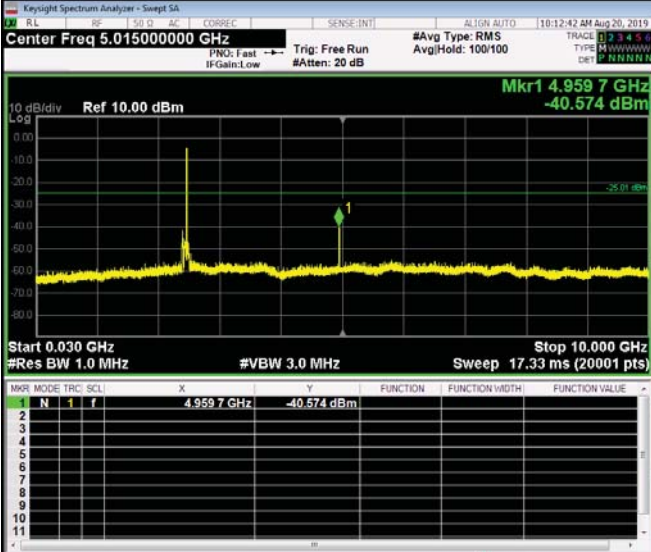
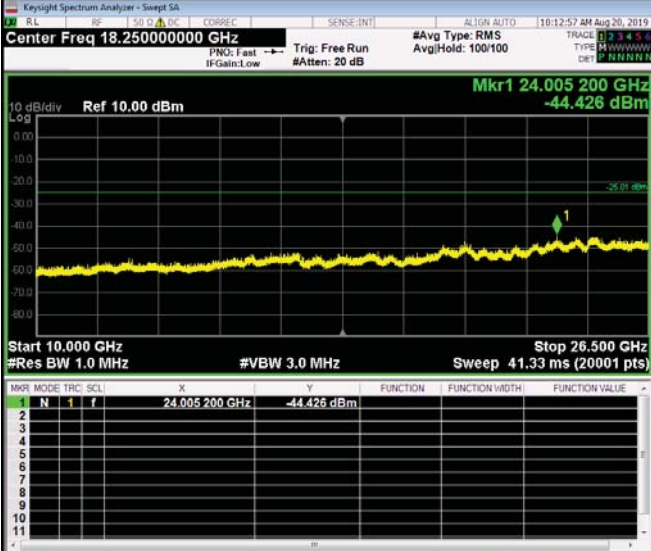
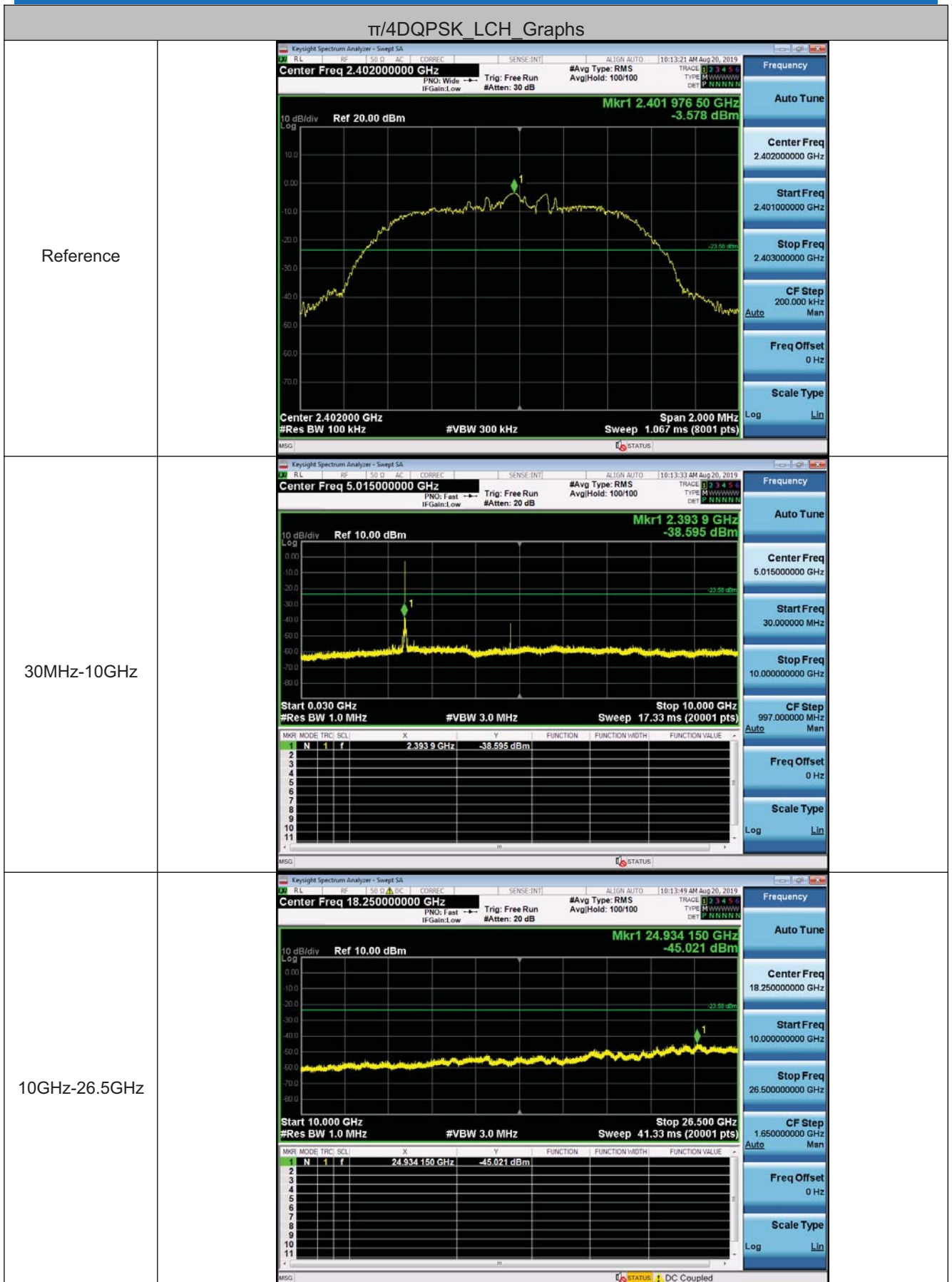
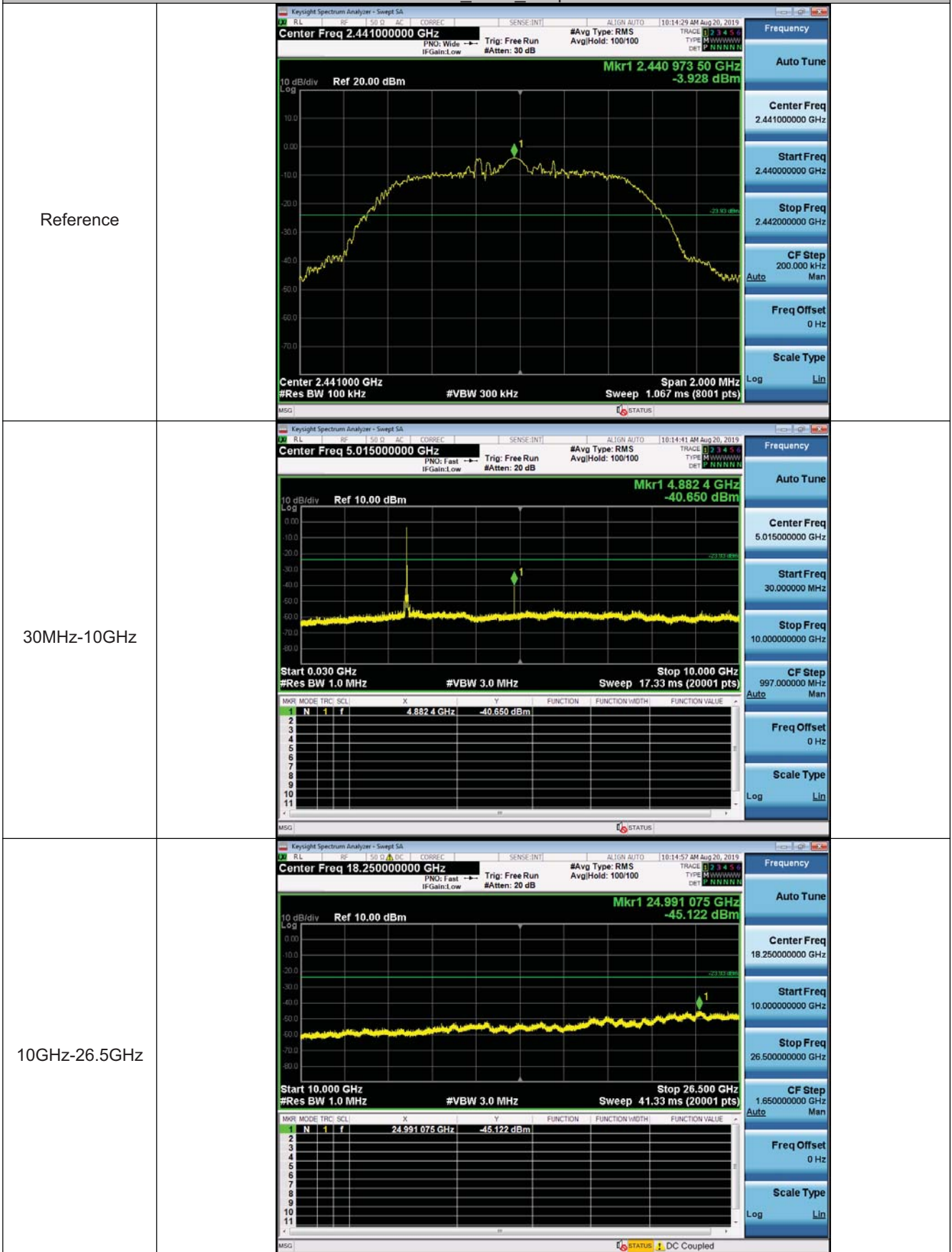


GFSK HCH Graphs

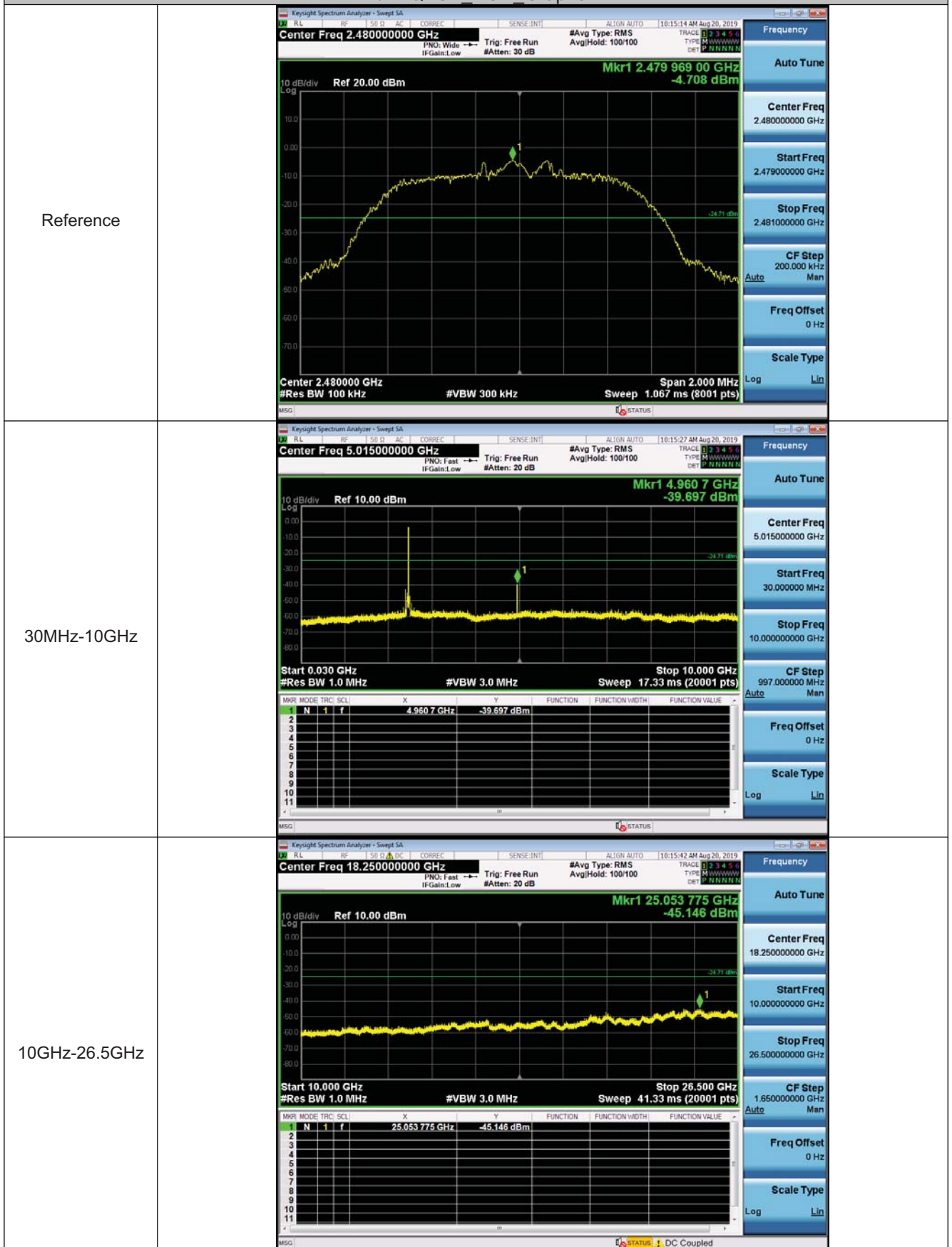
Reference	 <p>Key parameters for Reference graph:</p> <ul style="list-style-type: none"> Center Freq: 2.48000000 GHz Mkr1: 2.479 989 50 GHz, -5.006 dBm Span: 2.000 MHz #Res BW: 100 kHz #VBW: 300 kHz Sweep: 1.067 ms (8001 pts) 																																																																																																												
30MHz-10GHz	 <p>Key parameters for 30MHz-10GHz graph:</p> <ul style="list-style-type: none"> Center Freq: 5.01500000 GHz Mkr1: 4.959 7 GHz, -40.574 dBm Start: 0.030 GHz Stop: 10.000 GHz #Res BW: 1.0 MHz #VBW: 3.0 MHz Sweep: 17.33 ms (20001 pts) <table border="1" data-bbox="550 1220 1204 1402"> <thead> <tr> <th>MKR</th> <th>MODE</th> <th>TRC</th> <th>SCL</th> <th>X</th> <th>Y</th> <th>FUNCTION</th> <th>FUNCTION WIDTH</th> <th>FUNCTION VALUE</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>N</td> <td>1</td> <td>f</td> <td>4.959 7 GHz</td> <td>-40.574 dBm</td> <td></td> <td></td> <td></td> </tr> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>4</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>5</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>7</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>8</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>9</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>10</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>11</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	1	N	1	f	4.959 7 GHz	-40.574 dBm				2									3									4									5									6									7									8									9									10									11								
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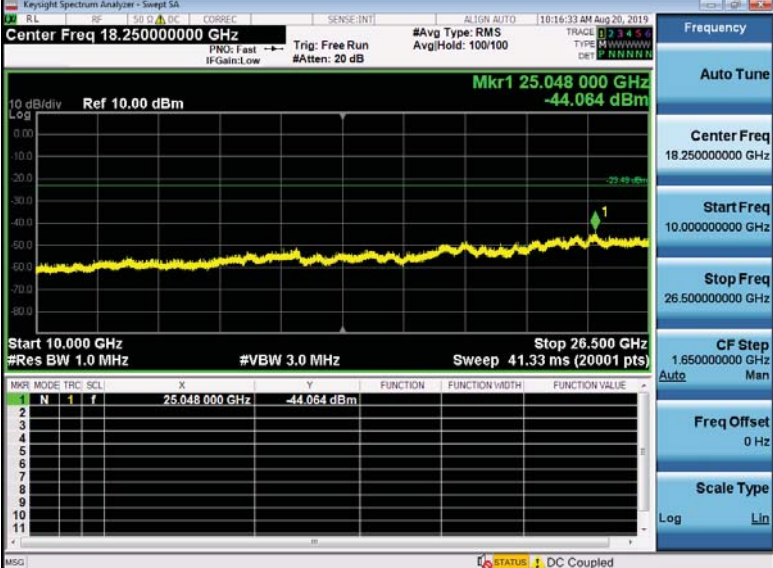
$\pi/4$ DQPSK_MCH_Graphs




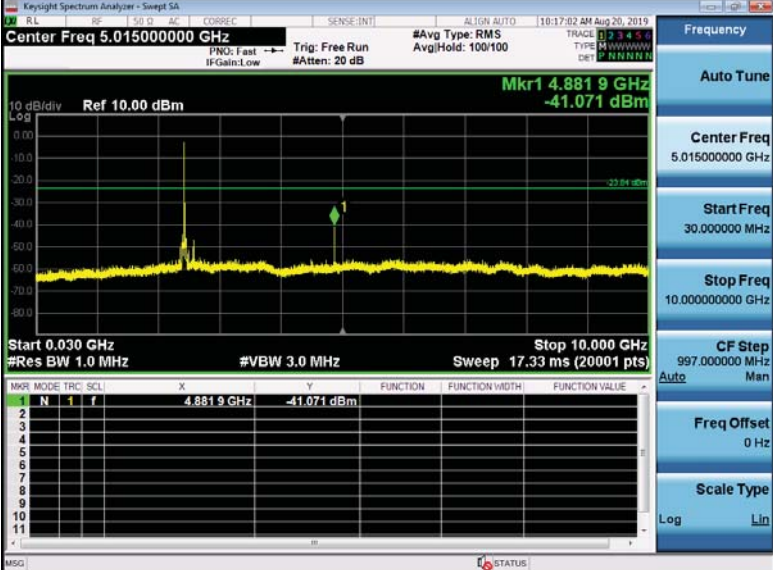
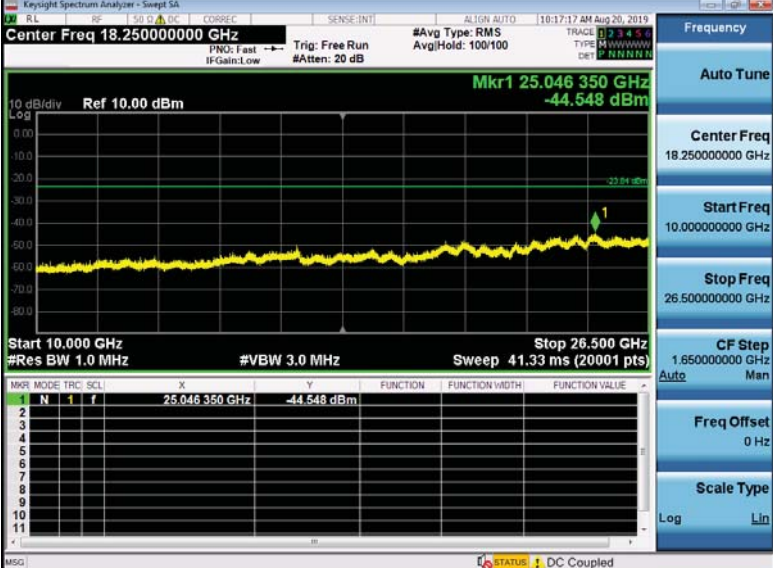
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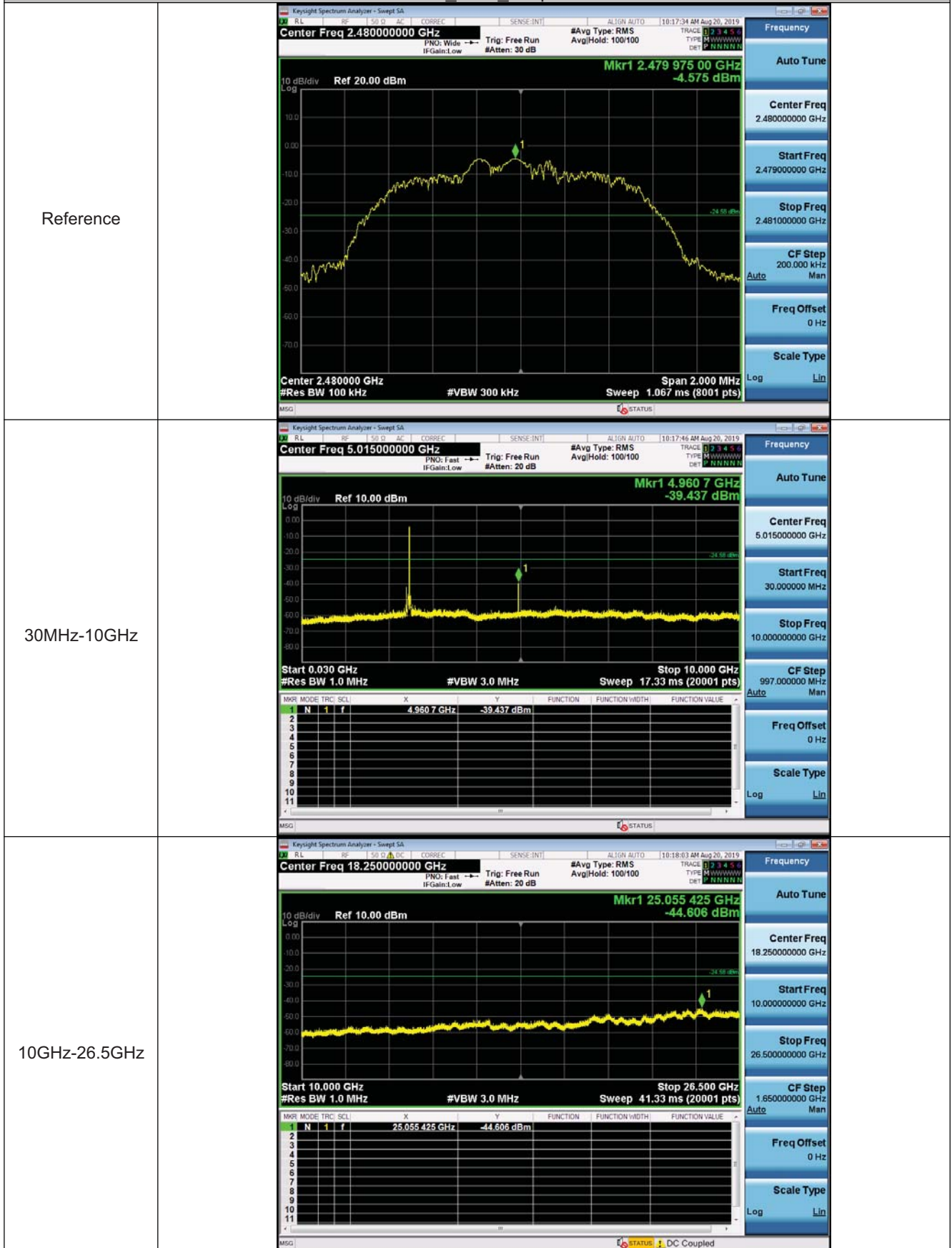
8DPSK LCH_Graphs

Reference	 <p>KeySight Spectrum Analyzer - Swept SA Center Freq 2.40200000 GHz #Avg Type: RMS Avg/Hold: 100/100 Mkr1 2.401 975 75 GHz -3.491 dBm Ref 20.00 dBm Span 2.000 MHz #Res BW 100 kHz #VBW 300 kHz Sweep 1.067 ms (8001 pts)</p>																																																																																																												
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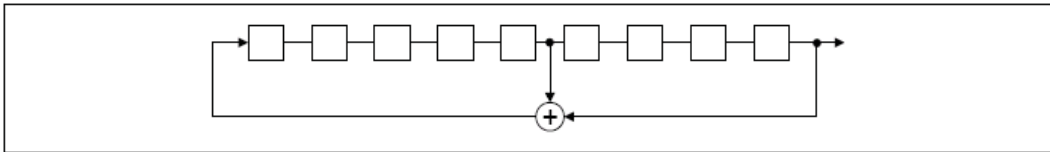
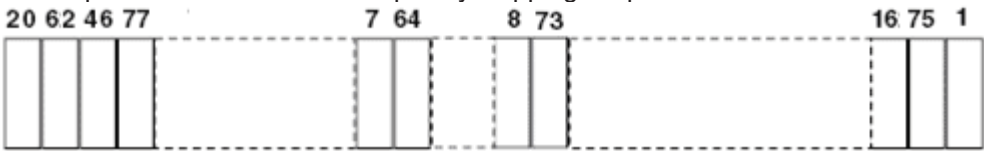
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Remark: Pre test 9kHz to 25GHz, find the highest point when testing, so only the worst data were shown in the test report. Per FCC Part 15.33 (a) and 15.31 (o) ,The amplitude of spurious emissions from intentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

5.10. Other requirements Frequency Hopping Spread Spectrum System

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1), (h) requirement:
<p>The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.</p> <p>Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.</p> <p>The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.</p>	
<p>Compliance for section 15.247(a)(1)</p>	
<p>According to Bluetooth Core Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONES; i.e. the shift register is initialized with nine ones.</p> <ul style="list-style-type: none"> • Number of shift register stages: 9 • Length of pseudo-random sequence: $2^9 - 1 = 511$ bits • Longest sequence of zeros: 8 (non-inverted signal) <div data-bbox="301 1323 1356 1473" style="text-align: center;">  </div> <p style="text-align: center;"><i>Linear Feedback Shift Register for Generation of the PRBS sequence</i></p> <p>An example of Pseudorandom Frequency Hopping Sequence as follow:</p> <div data-bbox="276 1570 1264 1720" style="text-align: center;">  </div> <p>Each frequency used equally on the average by each transmitter. According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.</p>	
<p>Compliance for section 15.247(g)</p>	
<p>According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.</p>	
<p>Compliance for section 15.247(h)</p>	

According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.

According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

5.11. Radiated Spurious Emission & Restricted bands

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10: 2013				
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Peak	100 kHz	300kHz	Peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
Peak		1MHz	10Hz	Average	
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz-88MHz	100	40.0	Quasi-peak	3
	88MHz-216MHz	150	43.5	Quasi-peak	3
	216MHz-960MHz	200	46.0	Quasi-peak	3
	960MHz-1GHz	500	54.0	Quasi-peak	3
	Above 1GHz	500	54.0	Average	3
<p>Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.</p>					

Test Setup:

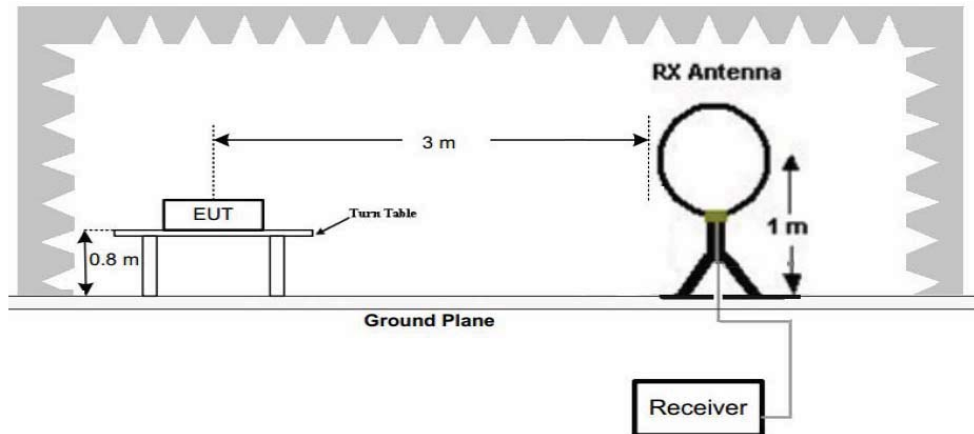


Figure 1. Below 30MHz

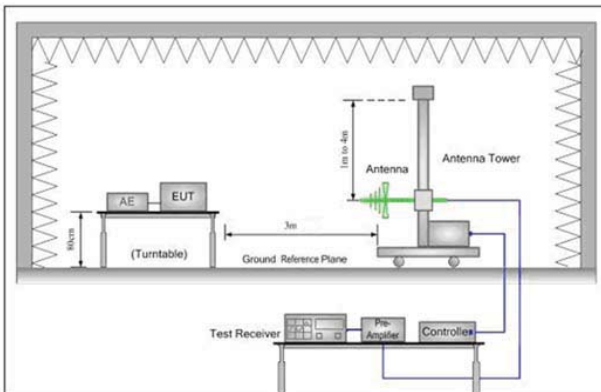


Figure 2. 30MHz to 1GHz

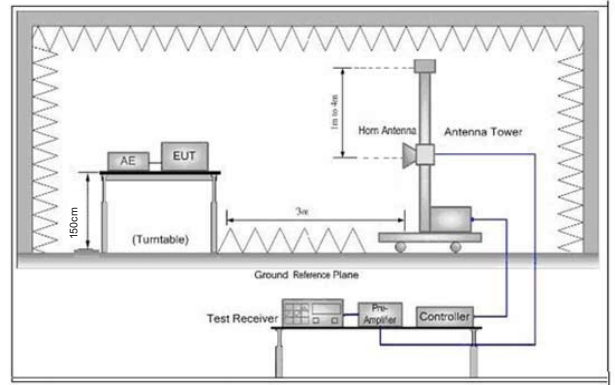


Figure 3. Above 1 GHz

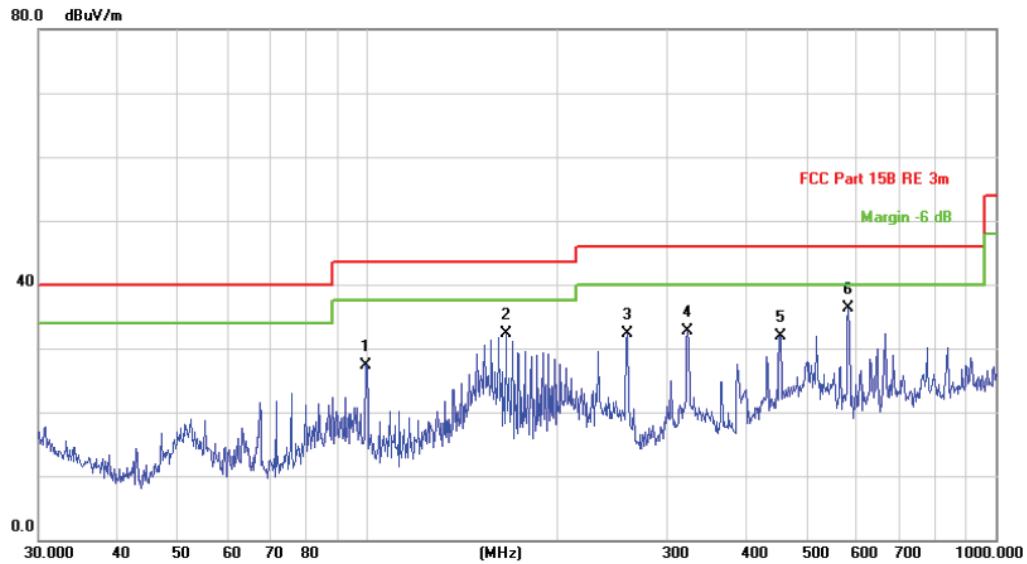
Test Procedure:

- a. 1) Below 1G: The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2) Above 1G: The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- Note: For the radiated emission test above 1GHz:
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.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

	<ul style="list-style-type: none"> d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet. g. Test the EUT in the lowest channel (2402MHz),the middle channel (2441MHz),the Highest channel (2480MHz) h. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. i. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type
Final Test Mode:	<p>Through Pre-scan, find the DH5 of data type is the worst case.</p> <p>For below 1GHz part, through pre-scan, the worst case is the lowest channel.</p> <p>Only the worst case is recorded in the report.</p>
Test Results:	Pass

5.11.1. Radiated Emission below 1GHz

30MHz~1GHz		
Test mode:	Transmitting	Vertical



No. Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB/m	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree degree	Comment
1	99.5279	42.48	-15.10	27.38	43.50	-16.12	QP		
2	166.0680	45.61	-13.29	32.32	43.50	-11.18	QP		
3	259.2337	44.58	-12.22	32.36	46.00	-13.64	QP		
4	323.3204	43.57	-10.94	32.63	46.00	-13.37	QP		
5	454.3100	39.50	-7.54	31.96	46.00	-14.04	QP		
6	* 582.7424	41.53	-5.27	36.26	46.00	-9.74	QP		

Remark:

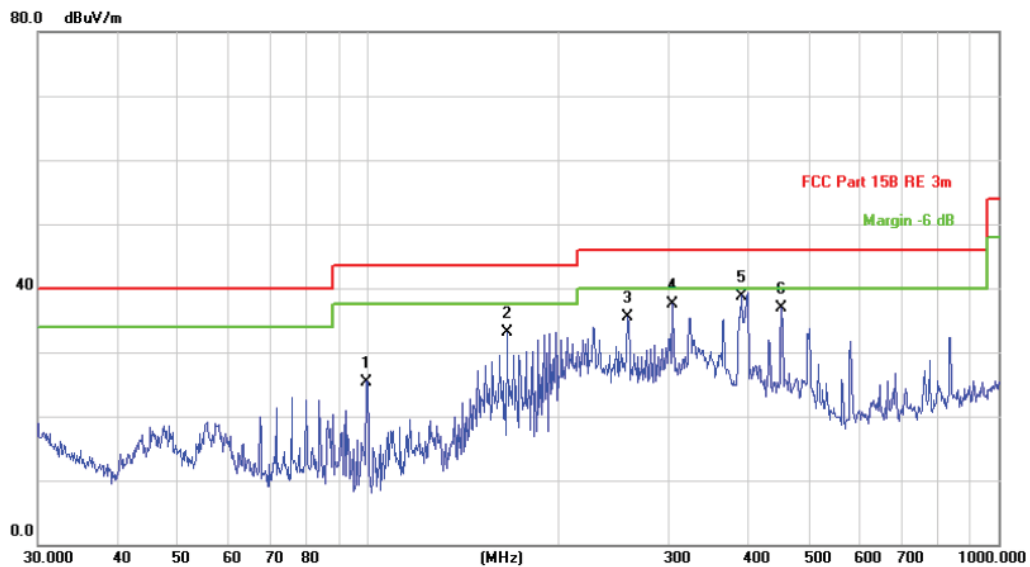
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Test mode:	Transmitting	Horizontal
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No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB/m	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree	Comment
1		99.5281	41.22	-15.82	25.40	43.50	-18.10	QP		
2		166.0680	46.55	-13.41	33.14	43.50	-10.36	QP		
3		258.3264	48.07	-12.48	35.59	46.00	-10.41	QP		
4		303.5437	48.41	-10.97	37.44	46.00	-8.56	QP		
5	*	390.7226	47.62	-8.82	38.80	46.00	-7.20	QP		
6		452.7197	44.27	-7.29	36.98	46.00	-9.02	QP		

Remark:

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

5.11.2. Transmitter Emission above 1GHz

mode:		GFSK(DH5)		Test channel:		Lowest	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dB μ V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)		H/V
2390	54.02	-9.2	44.82	74	-29.18	Peak	H
2400	51.69	-9.39	42.30	74	-31.70	Peak	H
4804	51.66	-4.33	47.33	74	-26.67	Peak	H
7206	49.81	1.01	50.82	74	-23.18	Peak	H
2390	53.51	-9.2	44.31	74	-29.69	Peak	V
2400	52.60	-9.39	43.21	74	-30.79	Peak	V
4804	50.81	-4.33	46.48	74	-27.52	Peak	V
7206	48.45	1.01	49.46	74	-24.54	Peak	V

mode:		GFSK(DH5)		Test channel:		Middle	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dB μ V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)		H/V
4882	53.40	-4.11	49.29	74	-24.71	Peak	H
7323	51.76	1.51	53.27	74	-20.73	Peak	H
4882	51.25	-4.11	47.14	74	-26.86	Peak	V
7323	49.78	1.51	51.29	74	-22.71	Peak	V

mode:		GFSK(DH5)		Test channel:		Highest	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dB μ V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)		H/V
2483.5	54.91	-9.29	45.62	74	-28.38	Peak	H
4960	51.19	-4.04	47.15	74	-26.85	Peak	H
7440	51.06	1.57	52.63	74	-21.37	Peak	H
2483.5	54.67	-9.29	45.38	74	-28.62	Peak	V
4960	52.16	-4.04	48.12	74	-25.88	Peak	V
7440	51.36	1.57	52.93	74	-21.07	Peak	V

mode:		$\pi/4$ DQPSK (2DH5)		Test channel:		Lowest	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dB μ V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)		H/V
2390	54.75	-9.2	45.55	74	-28.45	Peak	H
2400	51.72	-9.39	42.33	74	-31.67	Peak	H
4804	52.14	-4.33	47.81	74	-26.19	Peak	H
7206	49.94	1.01	50.95	74	-23.05	Peak	H
2390	54.59	-9.2	45.39	74	-28.61	Peak	V
2400	52.99	-9.39	43.60	74	-30.40	Peak	V
4804	52.01	-4.33	47.68	74	-26.32	Peak	V
7206	50.04	1.01	51.05	74	-22.95	Peak	V

mode:		$\pi/4$ DQPSK (2DH5)		Test channel:		Middle	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dB μ V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)		H/V
4882	53.88	-4.11	49.77	74	-24.23	peak	H
7323	52.38	1.51	53.89	74	-20.11	peak	H
4882	54.65	-4.11	50.54	74	-23.46	peak	V
7323	52.92	1.51	54.43	74	-19.57	peak	V

mode:		$\pi/4$ DQPSK (2DH5)		Test channel:		Highest	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dB μ V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)		H/V
2483.5	53.66	-9.29	44.37	74	-29.63	Peak	H
4960	51.90	-4.04	47.86	74	-26.14	Peak	H
7440	52.56	1.57	54.13	74	-19.87	Peak	H
2483.5	54.65	-9.29	45.36	74	-28.64	Peak	V
4960	51.95	-4.04	47.91	74	-26.09	Peak	V
7440	52.10	1.57	53.67	74	-20.33	Peak	V

mode:		8DPSK (3DH5)		Test channel:		Lowest	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V
2390	53.04	-9.2	43.84	74	-30.16	Peak	H
2400	52.65	-9.39	43.26	74	-30.74	Peak	H
4804	51.58	-4.33	47.25	74	-26.75	Peak	H
7206	49.51	1.01	50.52	74	-23.48	Peak	H
2390	54.61	-9.2	45.41	74	-28.59	Peak	V
2400	51.86	-9.39	42.47	74	-31.53	Peak	V
4804	52.33	-4.33	48.00	74	-26.00	Peak	V
7206	48.85	1.01	49.86	74	-24.14	Peak	V

mode:		8DPSK (3DH5)		Test channel:		Middle	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V
4882	54.31	-4.11	50.20	74	-23.80	peak	H
7323	51.94	1.51	53.45	74	-20.55	peak	H
4882	54.95	-4.11	50.84	74	-23.16	peak	V
7323	51.49	1.51	53.00	74	-21.00	peak	V

mode:		8DPSK (3DH5)		Test channel:		Highest	
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V
2483.5	53.21	-9.29	43.92	74	-30.08	Peak	H
4960	52.17	-4.04	48.13	74	-25.87	Peak	H
7440	51.07	1.57	52.64	74	-21.36	Peak	H
2483.5	53.12	-9.29	43.83	74	-30.17	Peak	V
4960	52.57	-4.04	48.53	74	-25.47	Peak	V
7440	52.06	1.57	53.63	74	-20.37	Peak	V

Remark:

- 1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
Final Test Level = Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor
- 2) Scan from 9kHz to 25GHz, the disturbance above 10GHz and below 30MHz was very low. As shown in this section, for frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. So, only the peak measurements were shown in the report.

6. Photographs - EUT Test Setup

6.1. Radiated Emission

Below 30MHz



30MHz~1GHz

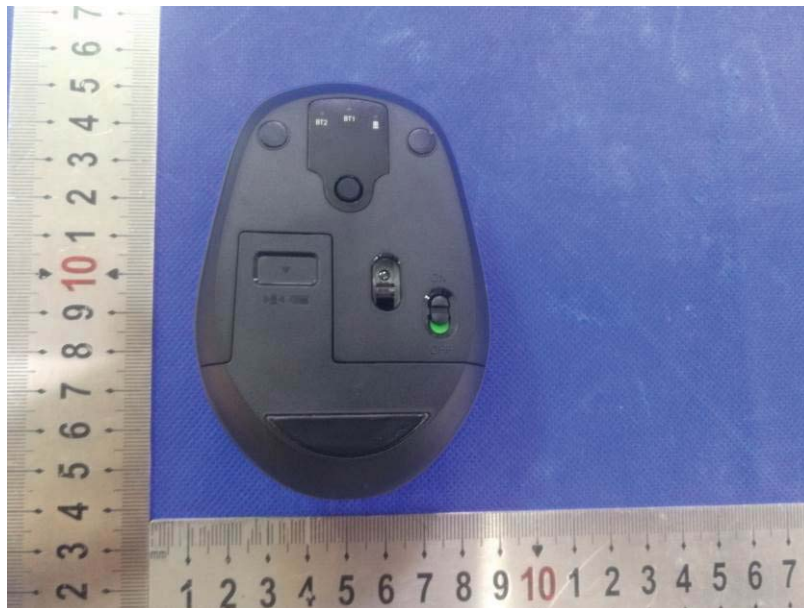
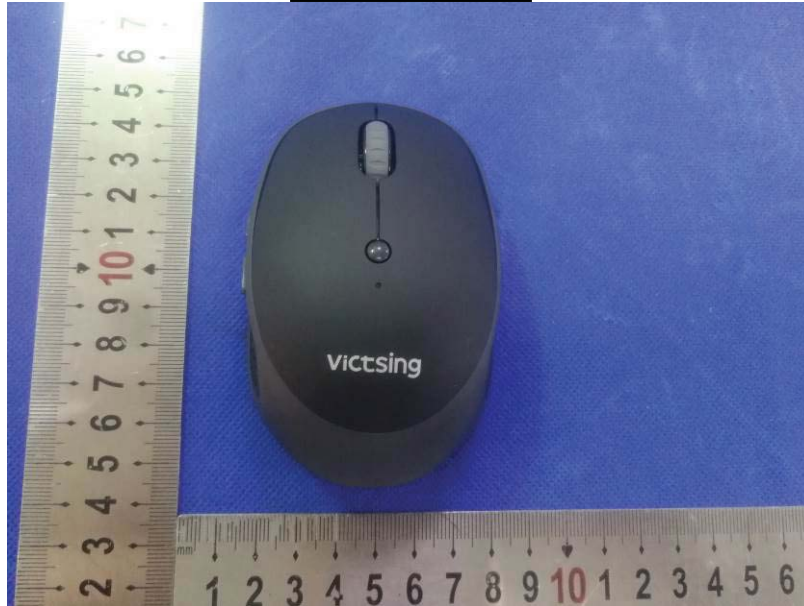


Above 1GHz

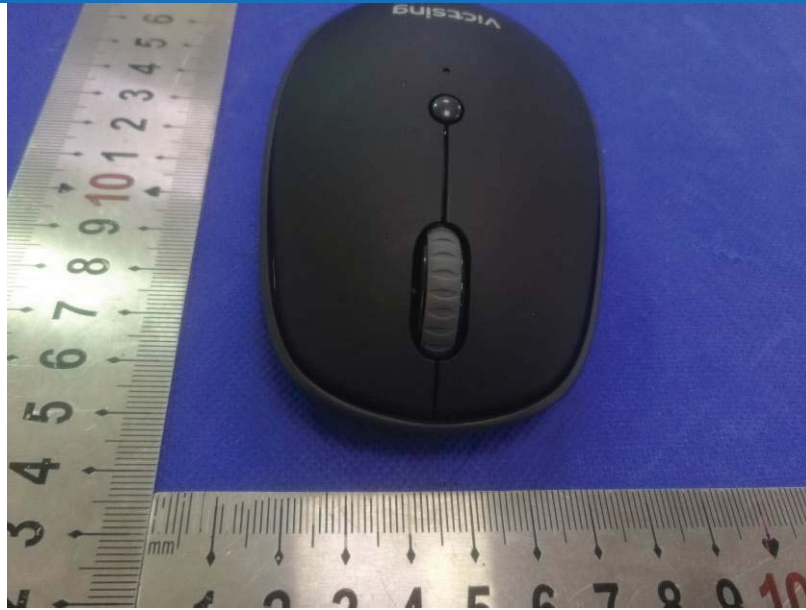


7. Photographs - EUT Constructional Details

External photos









Internal photos



