CFR 47 FCC PART 15 SUBPART C
ISED RSS-247 ISSUE 2

CERTIFICATION TEST REPORT

For

Outdoor contact sensor

MODEL NUMBER: 5F49E9

FCC ID: 2AB2Q5F49E9

IC: 10256A-5F49E9

REPORT NUMBER: 4790026122.1-3

ISSUE DATE: September 02, 2021

Prepared for

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Prepared by

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The results reported herein have been performed in accordance with the laboratory's terms of accreditation. This report shall not be reproduced except in full without the written approval of the Laboratory. The results in this report apply to the test sample(s) mentioned above at the time of the testing period only and are not to be used to indicate applicability to other similar products.

Revision History

Rev.	Issue Date	Revisions	Revised By
V0	09/02/2021	Initial Issue	

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Summary of Test Results			
Clause	**Test Items**	**FCC/ISED Rules**	**Test Results**
1	20dB Bandwidth and 99% Occupied Bandwidth	FCC 15.247 (a) (i) RSS-247 Clause 5.1 (c) RSS-Gen Clause 6.7	Pass
2	Conducted Output Power	FCC 15.247 (b) (2) RSS-247 Clause 5.4 (a)	Pass
3	Carrier Hopping Channel Separation	FCC 15.247 (a) (1) RSS-247 Clause 5.1 (c)	Pass
4	Number of Hopping Frequency	15.247 (a) (i) RSS-247 Clause 5.1 (c)	Pass
5	Time of Occupancy (Dwell Time)	15.247 (a) (i) RSS-247 Clause 5.1 (c)	Pass
6	Conducted Bandedge	FCC 15.247 (d) RSS-247 Clause 5.5	Pass
7	Radiated Bandedge and Spurious	FCC 15.247 (d) FCC 15.209 FCC 15.205 RSS-247 Clause 5.5 RSS-GEN Clause 8.9 RSS-GEN Clause 8.10	Pass
8	Antenna Requirement	FCC 15.203 RSS-GEN Clause 6.8	Pass

Note:
1.This test report is only published to and used by the applicant, and it is not for evidence purpose in China.
2. The measurement result for the sample received is <Pass> according to < CFR 47 FCC PART 15 SUBPART C >< ISED RSS-247 > when <Accuracy Method> decision rule is applied.

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1. ATTESTATION OF TEST RESULTS

Applicant Information

Company Name:	LEEDARSON LIGHTING CO., LTD.
Address:	Xingda Road, Xingtai Industrial Zone, Changtai County, Zhangzhou, Fujian, China

Manufacturer Information

Company Name:	Ring LLC
Address:	1523 26th Street, Santa Monica CA 90404, USA

EUT Information

EUT Name:	Outdoor contact sensor
Model:	5F49E9
Brand:	ring
Sample Received Date:	July 15, 2021
Sample Status:	Normal
Sample ID:	4072704
Date of Tested:	July 15, 2021~ August 30, 2021

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 FCC PART 15 SUBPART C	PASS
ISED RSS-247 Issue 2	PASS
ISED RSS-GEN Issue 5	PASS

Prepared By:

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with KDB 558074 D01 15.247 Meas Guidance v05r02, 414788 D01 Radiated Test Site v01r01, CFR 47 FCC Part 2, CFR 47 FCC Part 15, ANSI C63.10-2013, ISED RSS-247 Issue 2 and ISED RSS-GEN Issue 5.

3. FACILITIES AND ACCREDITATION

Accreditation Certificate	**A2LA (Certificate No.: 4102.01)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. has been assessed and proved to be in compliance with A2LA. **FCC (FCC Designation No.: CN1187)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. Has been recognized to perform compliance testing on equipment subject to the Commission's Delcaration of Conformity (DoC) and Certification rules **ISED (Company No.: 21320)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. has been registered and fully described in a report filed with ISED. Body Identifier (CABID) is CN0046. **VCCI (Registration No.: G-20019, R-20004, C-20012 and T-20011)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. has been assessed and proved to be in compliance with VCCI, the Membership No. is 3793. Facility Name: Chamber D, the VCCI registration No. is G-20019 and R-20004 Shielding Room B , the VCCI registration No. is C-20012 and T-20011

Note 1: All tests measurement facilities use to collect the measurement data are located at Building 10, Innovation Technology Park, Song Shan Lake Hi tech Development Zone, Dongguan, 523808, China

Note 2: The test anechoic chamber in UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch had been calibrated and compared to the open field sites and the test anechoic chamber is shown to be equivalent to or worst case from the open field site.

Note 3: For below 30 MHz, lab had performed measurements at test anechoic chamber and comparing to measurements obtained on an open field site. And these measurements below 30 MHz had been correlated to measurements performed on an OFS.

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4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations and is traceable to recognized national standards.

4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Test Item	Uncertainty
Conduction emission	3.62 dB
Radiated Emission (Included Fundamental Emission) (9 kHz ~ 30 MHz)	2.2 dB
Radiated Emission (Included Fundamental Emission) (30 MHz ~ 1 GHz)	4.00 dB
Radiated Emission (Included Fundamental Emission) (1 GHz to 26 GHz)	5.78 dB (1 GHz ~ 18 GHz)
	5.23 dB (18 GHz ~ 26 GHz)
Duty Cycle	±0.028%
20dB Emission Bandwidth and 99% Occupied Bandwidth	±0.0196%
Carrier Frequency Separation	±1.9%
Maximum Conducted Output Power	±0.743 dB
Number of Hopping Channel	±1.9%
Time of Occupancy	±0.028%
Conducted Band-edge Compliance	±1.328 dB
Conducted Unwanted Emissions In Non-restricted Frequency Bands	±0.746 dB (9 kHz ~ 1 GHz)
	±1.328dB (1 GHz ~ 26 GHz)
Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.	

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

EUT Name	Outdoor contact sensor
Model	5F49E9
Battery	1.5 Vdc X 2

Transmit Frequency Range	902.2 ~ 927.8 MHz	902.4 ~ 927.6 MHz	902.5 ~ 927.5 MHz
Bit Rate	50 kbps	150 kbps	250 kbps
Number of Channels	129	64	51
Channel Separation (kHz)	200	400	500
Modulation	FSK-FHSS		

5.2. MAXIMUM PEAK OUTPUT POWER

Data Rate	Number of Channels	Maximum Peak Output Power (dBm)	Maximum EIRP (dBm)
50 kbps	129	10.98	12.65
150 kbps	64	10.96	12.63
250 kbps	51	10.92	12.59

5.3. TEST CHANNEL CONFIGURATION

Test Mode	Test Channel	Frequency
FSK-50 kbps	CH 0(Low Channel), CH 64(MID Channel), CH 128(High Channel)	902.2 MHz, 915 MHz, 927.8 MHz
FSK-150 kbps	CH 129(Low Channel), CH 161(MID Channel), CH 192(High Channel)	902.4 MHz, 915.2 MHz, 927.6MHz
FSK-250 kbps	CH 193(Low Channel), CH 218(MID Channel), CH 243(High Channel)	902.5 MHz, 915 MHz, 927.5 MHz
FSK-50 kbps	Hopping	902.2 - 927.8 MHz
FSK-150 kbps	Hopping	902.4 - 927.6 MHz
FSK-250 kbps	Hopping	902.5 - 927.5 MHz

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5.4. CHANNEL LIST

Data Rate: 50 kbps							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	902.2	33	908.8	66	915.4	99	922.0
1	902.4	34	909.0	67	915.6	100	922.2
2	902.6	35	909.2	68	915.8	101	922.4
3	902.8	36	909.4	69	916.0	102	922.6
4	903.0	37	909.6	70	916.2	103	922.8
5	903.2	38	909.8	71	916.4	104	923.0
6	903.4	39	910.0	72	916.6	105	923.2
7	903.6	40	910.2	73	916.8	106	923.4
8	903.8	41	910.4	74	917.0	107	923.6
9	904.0	42	910.6	75	917.2	108	923.8
10	904.2	43	910.8	76	917.4	109	924.0
11	904.4	44	911.0	77	917.6	110	924.2
12	904.6	45	911.2	78	917.8	111	924.4
13	904.8	46	911.4	79	918.0	112	924.6
14	905.0	47	911.6	80	918.2	113	924.8
15	905.2	48	911.8	81	918.4	114	925.0
16	905.4	49	912.0	82	918.6	115	925.2
17	905.6	50	912.2	83	918.8	116	925.4
18	905.8	51	912.4	84	919.0	117	925.6
19	906.0	52	912.6	85	919.2	118	925.8
20	906.2	53	912.8	86	919.4	119	926.0
21	906.4	54	913.0	87	919.6	120	926.2
22	906.6	55	913.2	88	919.8	121	926.4
23	906.8	56	913.4	89	920.0	122	926.6
24	907.0	57	913.6	90	920.2	123	926.8
25	907.2	58	913.8	91	920.4	124	927.0
26	907.4	59	914.0	92	920.6	125	927.2
27	907.6	60	914.2	93	920.8	126	927.4
28	907.8	61	914.4	94	921.0	127	927.6
29	908.0	62	914.6	95	921.2	128	927.8
30	908.2	63	914.8	96	921.4	/	/
31	908.4	64	915.0	97	921.6	/	/
32	908.6	65	915.2	98	921.8	/	/

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Data Rate: 150 kbps							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
129	902.4	145	908.8	161	915.2	177	921.6
130	902.8	146	909.2	162	915.6	178	922.0
131	903.2	147	909.6	163	916.0	179	922.4
132	903.6	148	910.0	164	916.4	180	922.8
133	904.0	149	910.4	165	916.8	181	923.2
134	904.4	150	910.8	166	917.2	182	923.6
135	904.8	151	911.2	167	917.6	183	924.0
136	905.2	152	911.6	168	918.0	184	924.4
137	905.6	153	912.0	169	918.4	185	924.8
138	906.0	154	912.4	170	918.8	186	925.2
139	906.4	155	912.8	171	919.2	187	925.6
140	906.8	156	913.2	172	919.6	188	926.0
141	907.2	157	913.6	173	920.0	189	926.4
142	907.6	158	914.0	174	920.4	190	926.8
143	908.0	159	914.4	175	920.8	191	927.2
144	908.4	160	914.8	176	921.2	192	927.6

Data Rate: 250 kbps							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
193	902.5	206	909.0	219	915.5	232	922.0
194	903.0	207	909.5	220	916.0	233	922.5
195	903.5	208	910.0	221	916.5	234	923.0
196	904.0	209	910.5	222	917.0	235	923.5
197	904.5	210	911.0	223	917.5	236	924.0
198	905.0	211	911.5	224	918.0	237	924.5
199	905.5	212	912.0	225	918.5	238	925.0
200	906.0	213	912.5	226	919.0	239	925.5
201	906.5	214	913.0	227	919.5	240	926.0
202	907.0	215	913.5	228	920.0	241	926.5
203	907.5	216	914.0	229	920.5	242	927.0
204	908.0	217	914.5	230	921.0	243	927.5
205	908.5	218	915.0	231	921.5	/	/

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5.5. WORST-CASE CONFIGURATIONS

Modulation Technology	Modulation Type	Data Rate
FHSS	FSK-FHSS	50 kbps
FHSS	FSK-FHSS	150 kbps
FHSS	FSK-FHSS	250 kbps

5.6. THE WORSE CASE POWER SETTING PARAMETER

The Worse Case Power Setting Parameter				
Test Software		sscom5.13.1		
Test Mode	Transmit Antenna Number	Test Software Setting Value		
		Low	Middle	High
FSK-50 kbps	1	130(raw)	130(raw)	130(raw)
FSK -150 kbps	1	130(raw)	130(raw)	130(raw)
FSK -250 kbps	1	130(raw)	130(raw)	130(raw)

Note: raw is the test software setting description provide by customer.

5.7. DESCRIPTION OF AVAILABLE ANTENNAS

Antenna	Frequency Band (MHz)	Antenna Type	MAX Antenna Gain (dBi)
1	902-928	Built-in	1.67

Modulation	Transmit and Receive Mode	Description
FSK-FHSS	☒1TX, 1RX	Antenna 1 can be used as transmitting/receiving antenna.

Note: The value of the antenna gain was declared by customer.

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5.8. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Item	Equipment	Brand Name	Model Name	Remarks
1	Laptop	Lenovo	TP00094A	/
2	UART	/	/	/

I/O PORT

Cable No	Port	Connector Type	Cable Type	Cable Length(m)	Remarks
1	USB	/	/	1.0	/

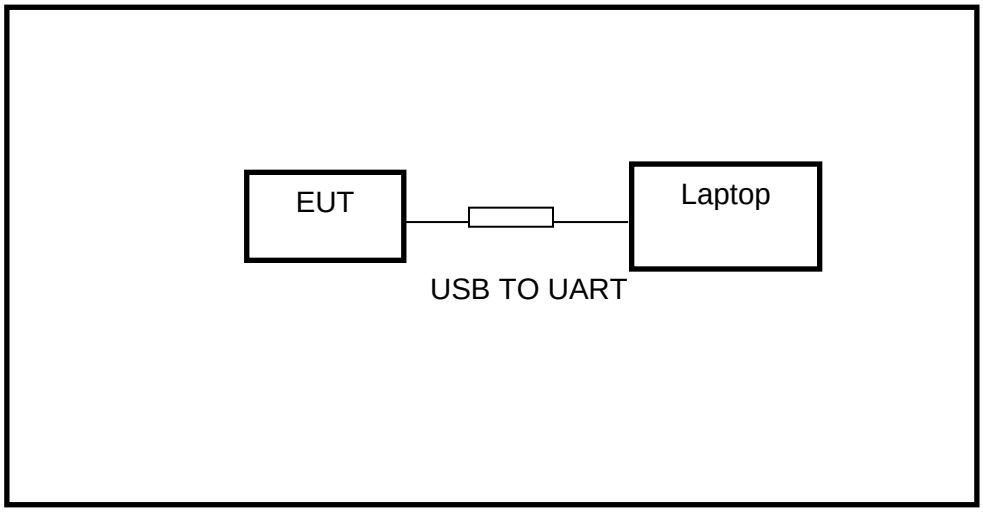
ACCESSORY

Item	Accessory	Brand Name	Model Name	Description
/	/	/	/	/

TEST SETUP

The EUT can work in an engineering mode though the laptop before the testing.

SETUP DIAGRAM FOR TESTS



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6. MEASURING INSTRUMENT AND SOFTWARE USED

Conducted Emissions					
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Due Date
EMI Test Receiver	R&S	ESR3	101961	Nov. 12, 2020	Nov. 11, 2021
Two-Line V-Network	R&S	ENV216	101983	Nov. 12, 2020	Nov. 11, 2021
Artificial Mains Networks	Schwarzbeck	NSLK 8126	8126465	Nov. 12, 2020	Nov. 11, 2021
Software					
Description			Manufacturer	Name	Version
Test Software for Conducted Emissions			Farad	EZ-EMC	Ver. UL-3A1

Radiated Emissions					
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Due Date
MXE EMI Receiver	KESIGHT	N9038A	MY56400036	Nov. 12, 2020	Nov. 11, 2021
Hybrid Log Periodic Antenna	TDK	HLP-3003C	130959	April 24, 2020	April 23, 2023
Preamplifier	HP	8447D	2944A09099	Nov. 12, 2020	Nov. 11, 2021
EMI Measurement Receiver	R&S	ESR26	101377	Nov. 12, 2020	Nov. 11, 2021
Horn Antenna	TDK	HRN-0118	130939	Sept. 17, 2018	Sept. 17, 2021
Preamplifier	TDK	PA-02-0118	TRS-305-00067	Nov. 20, 2020	Nov. 19, 2021
Horn Antenna	Schwarzbeck	BBHA9170	#697	July 20, 2021	July 19, 2024
Preamplifier	TDK	PA-02-2	TRS-307-00003	Nov. 12, 2020	Nov. 11, 2021
Preamplifier	TDK	PA-02-3	TRS-308-00002	Nov. 12, 2020	Nov. 11, 2021
Loop antenna	Schwarzbeck	1519B	00008	Jan.17, 2019	Jan.17,2022
Preamplifier	TDK	PA-02-001-3000	TRS-302-00050	Nov. 12, 2020	Nov. 11, 2021
Preamplifier	Mini-Circuits	ZX60-83LN-S+	SUP01201941	Nov. 20, 2020	Nov. 19, 2021
Software					
Description			Manufacturer	Name	Version
Test Software for Radiated Emissions			Farad	EZ-EMC	Ver. UL-3A1

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Other instruments					
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Spectrum Analyzer	Keysight	N9030A	MY55410512	Nov. 20, 2020	Nov. 19, 2021
Dual Channel Power Meter	Keysight	N1912A	MY55416024	Nov. 20, 2020	Nov. 19, 2021
Power Sensor	Keysight	USB Wideband Power Sensor	MY5100022	Nov. 20, 2020	Nov. 19, 2021

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7. ANTENNA PORT TEST RESULTS

7.1. ON TIME AND DUTY CYCLE

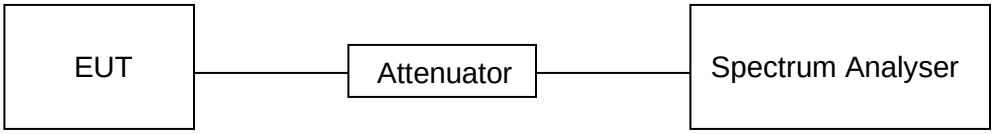
LIMITS

None; for reporting purposes only.

PROCEDURE

Refer to ANSI C63.10-2013 Zero – Span Spectrum Analyzer method.

TEST SETUP



TEST ENVIRONMENT

Temperature	25.3 °C	Relative Humidity	58 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

Please refer to appendix A.

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7.2. 20 dB BANDWIDTH AND 99 % OCCUPIED BANDWIDTH

LIMITS

CFR 47FCC Part15 (15.247) Subpart C ISED RSS-247 ISSUE 2			
Section	Test Item	Limit	Frequency Range (MHz)
CFR 47 FCC 15.247 (a) (i) RSS-247 Clause 5.1 (a)	20 dB Bandwidth	250 kHz	902 - 928
ISED RSS-Gen Clause 6.7	99 % Occupied Bandwidth	None; for reporting purposes only.	902 - 928

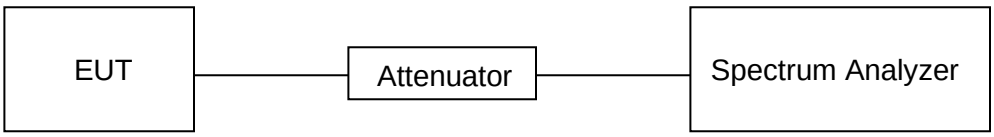
TEST PROCEDURE

Connect the EUT to the spectrum analyser and use the following settings:

Center Frequency	The center frequency of the channel under test
Detector	Peak
RBW	For 20 dB Bandwidth: 1 % to 5 % of the 20 dB bandwidth For 99 % Occupied Bandwidth: 1 % to 5 % of the occupied bandwidth
VBW	For 20 dB Bandwidth: approximately 3×RBW For 99 % Occupied Bandwidth: ≥ 3×RBW
Span	Approximately 2 to 3 times the 20dB bandwidth
Trace	Max hold
Sweep	Auto couple

a) Use the occupied bandwidth function of the instrument, allow the trace to stabilize and report the measured 99 % occupied bandwidth and 20 dB Bandwidth.

TEST SETUP



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TEST ENVIRONMENT

Temperature	25.3 °C	Relative Humidity	58 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

Please refer to appendix B and C.

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7.3. CONDUCTED OUTPUT POWER

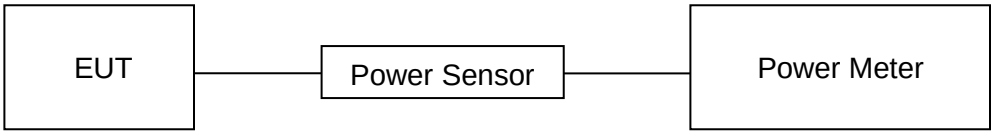
LIMITS

CFR 47 FCC Part15 (15.247), Subpart C ISED RSS-247 ISSUE 2			
Section	Test Item	Limit	Frequency Range (MHz)
CFR 47 FCC 15.247 (b) (2) ISED RSS-247 Clause 5.4 (a)	Peak Conducted Output Power	1 watt for systems employing at least 50 hopping channels	902 - 928

TEST PROCEDURE

Connect the EUT to a low loss RF cable from the antenna port to the power sensor (video bandwidth is greater than the occupied bandwidth).
Measure peak emission level, the indicated level is the peak output power, after any corrections for external attenuators and cables.

TEST SETUP



TEST ENVIRONMENT

Temperature	25.3 °C	Relative Humidity	58 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

Please refer to appendix D.

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7.4. CARRIER FREQUENCY SEPARATION

LIMITS

CFR 47 FCC Part15 (15.247), Subpart C ISED RSS-247 ISSUE 2			
Section	Test Item	Limit	Frequency Range (MHz)
CFR 47 FCC 15.247 (a) (1) ISED RSS-247 Clause 5.1 (b)	Carrier Frequency Separation	25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.	902 - 928

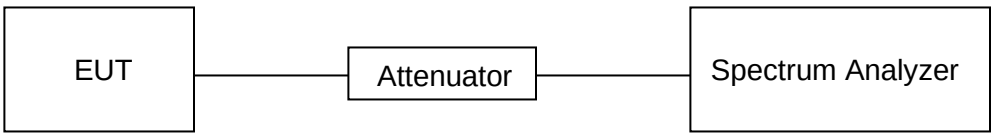
TEST PROCEDURE

Connect the EUT to the spectrum analyzer and use the following settings:

Center Frequency	The center frequency of the channel under test
Span	wide enough to capture the peaks of two adjacent channels
Detector	Peak
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.
VBW	≥RBW
Trace	Max hold
Sweep time	Auto couple

Allow the trace to stabilize and use the marker-delta function to determine the separation between the peaks of the adjacent channels.
Compliance of an EUT with the appropriate regulatory limit shall be determined.

TEST SETUP



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TEST ENVIRONMENT

Temperature	25.3 °C	Relative Humidity	58 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

Please refer to Appendix E.

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7.5. NUMBER OF HOPPING FREQUENCIES

LIMITS

CFR 47 FCC Part15 (15.247), Subpart C ISED RSS-247 ISSUE 2		
Section	Test Item	Limit
CFR 47 15.247 (a) (i) ISED RSS-247 Clause 5.1 (c)	Number of Hopping Frequency	1. if the 20 dB bandwidth of the hopping channel is less than 250 kHz, at least 50 hopping channels 2. if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, at least 25 hopping channels

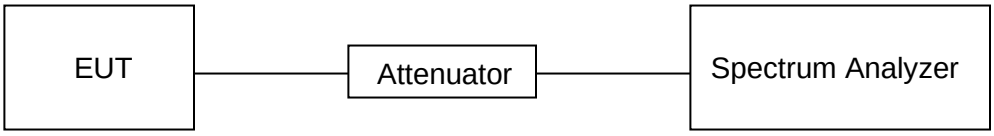
TEST PROCEDURE

Connect the EUT to the spectrum Analyzer and use the following settings:

Detector	Peak
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.
VBW	≥RBW
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.
Trace	Max hold
Sweep time	Auto couple

Set EUT to transmit maximum output power and switch on frequency hopping function. then set enough count time (larger than 5000 times) to get all the hopping frequency channel displayed on the screen of spectrum analyzer, count the quantity of peaks to get the number of hopping channels.

TEST SETUP



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TEST ENVIRONMENT

Temperature	25.3 °C	Relative Humidity	58 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

Please refer to appendix F.

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7.6. TIME OF OCCUPANCY (DWELL TIME)

LIMITS

CFR 47 FCC Part15 (15.247), Subpart C ISED RSS-247 ISSUE 2		
Section	Test Item	Limit
CFR 47 15.247 (a) (i) ISED RSS-247 Clause 5.1 (c)	Time of Occupancy (Dwell Time)	1.If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period. 2. if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

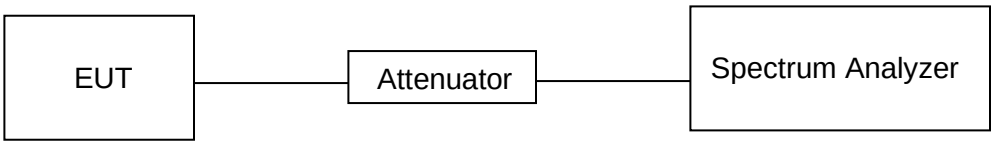
TEST PROCEDURE

Connect the EUT to the spectrum Analyzer and use the following settings:

Center Frequency	The center frequency of the channel under test
Detector	Peak
RBW	1 MHz
VBW	≥RBW
Span	Zero span, centered on a hopping channel
Trace	Max hold
Sweep time	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. The transmitter output (antenna port) was connected to the spectrum analyzer
b. Set RBW of spectrum analyzer to 1MHz and VBW to 1MHz.
c. Use a video trigger with the trigger level set to enable triggering only on full pulses.
d. Sweep Time is more than once pulse time.
e. Set the center frequency on any frequency would be measure and set the frequency span to zero span.
f. Measure the maximum time duration of one single pulse.
g. Measure the maximum time duration of one single pulse.
A Period Time = (channel number)*0.4

TEST SETUP



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TEST ENVIRONMENT

Temperature	25.3 °C	Relative Humidity	58 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

Please refer to appendix G.

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7.7. CONDUCTED BANDEDGE AND SPURIOUS EMISSION

LIMITS

CFR 47 FCC Part15 (15.247), Subpart C ISED RSS-247 ISSUE 2		
Section	Test Item	Limit
CFR 47 FCC §15.247 (d) ISED RSS-247 5.5	Conducted Spurious Emission	at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

TEST PROCEDURE

Connect the EUT to the spectrum analyser and use the following settings for reference level measurement:

Center Frequency	The center frequency of the channel under test
Detector	Peak
RBW	100 kHz
VBW	≥3 × RBW
Span	1.5 x DTS bandwidth
Trace	Max hold
Sweep time	Auto couple.

Allow trace to fully stabilize and use the peak marker function to determine the maximum PSD level.

Change the settings for emission level measurement:

Span	Set the center frequency and span to encompass frequency range to be measured
Detector	Peak
RBW	100 kHz
VBW	≥3 × RBW
measurement points	≥span/RBW
Trace	Max hold
Sweep time	Auto couple.

Allow trace to fully stabilize and use the peak marker function to determine the maximum PSD level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements.

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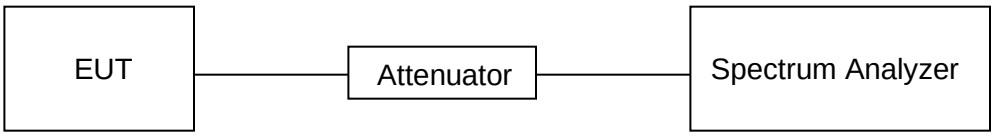
TEST SETUP



TEST ENVIRONMENT

Temperature	25.3 °C	Relative Humidity	58 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

Please refer to appendix H.

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8. RADIATED TEST RESULTS

LIMITS

Please refer to CFR 47 FCC §15.205 and §15.209.

Please refer to ISED RSS-GEN Clause 8.9 and Clause 8.10.

Radiation Disturbance Test Limit for FCC (Class B) (9 kHz-1 GHz)

Emissions radiated outside of the specified frequency bands above 30 MHz			
Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m	
		Quasi-Peak	
30 - 88	100	40	
88 - 216	150	43.5	
216 - 960	200	46	
Above 960	500	54	
Above 1000	500	Peak	Average
		74	54

FCC Emissions radiated outside of the specified frequency bands below 30 MHz		
Frequency (MHz)	Field strength (microvolts/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

ISED General field strength limits at frequencies below 30 MHz

Table 6 – General field strength limits at frequencies below 30 MHz		
Frequency	**Magnetic field strength (H-Field) (µA/m)**	**Measurement distance (m)**
9 - 490 kHz[Note 1]	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

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ISED Restricted bands please refer to ISED RSS-GEN Clause 8.10

Table 7 – Restricted frequency bands[Note 1]		
MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 – 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 – 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 – 8500	
108 – 138		

Note 1: Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

FCC Restricted bands of operation refer to FCC §15.205 (a):

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

Note: [1]Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2]Above 38.6c

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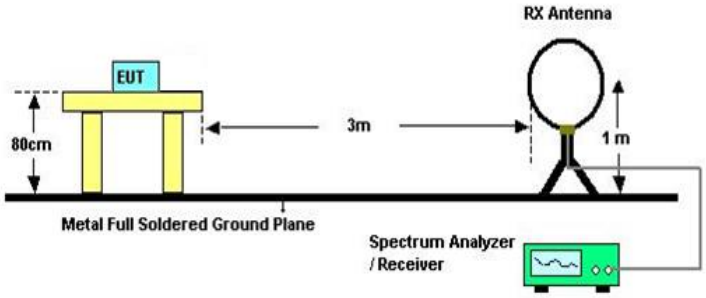
TEST SETUP AND PROCEDURE

Below 30 MHz



The setting of the spectrum analyser

RBW	200 Hz (From 9 kHz to 0.15 MHz)/ 9 kHz (From 0.15 MHz to 30 MHz)
VBW	200 Hz (From 9 kHz to 0.15 MHz)/ 9 kHz (From 0.15 MHz to 30 MHz)
Sweep	Auto
Trace	Max hold

1. The testing follows the guidelines in ANSI C63.10-2013 clause 6.4.

2. The EUT was arranged to its worst case and then turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level. Both Horizontal, Face-on and Face-off polarizations of the antenna are set to make the measurement.

3. The EUT was placed on a turntable with 80 cm above ground.

4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a 1 m height antenna tower.

5. The radiated emission limits are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

6. For measurement below 1 GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak and average detector mode re-measured. 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 and average detector and reported.

7. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field site based on KDB 414788.

8. The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X KHz resulted in a level of Y dBuV/m, which is equivalent to Y-51.5 = Z dBuA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to be 15.209(a) limit.

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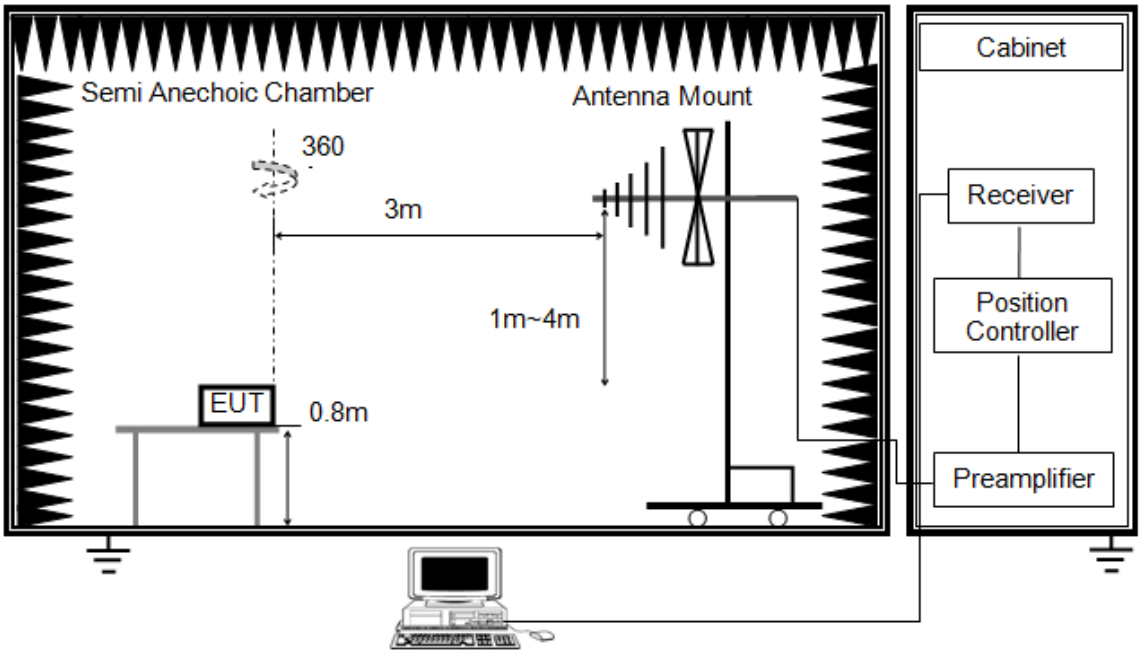
Below 1 GHz and above 30 MHz



The setting of the spectrum analyser

RBW	120 kHz
VBW	300 kHz
Sweep	Auto
Detector	Peak/QP
Trace	Max hold

1. The testing follows the guidelines in ANSI C63.10-2013 clause 6.5.

2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

3. The EUT was placed on a turntable with 80 cm above ground.

4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.

5. For measurement below 1 GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. 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.

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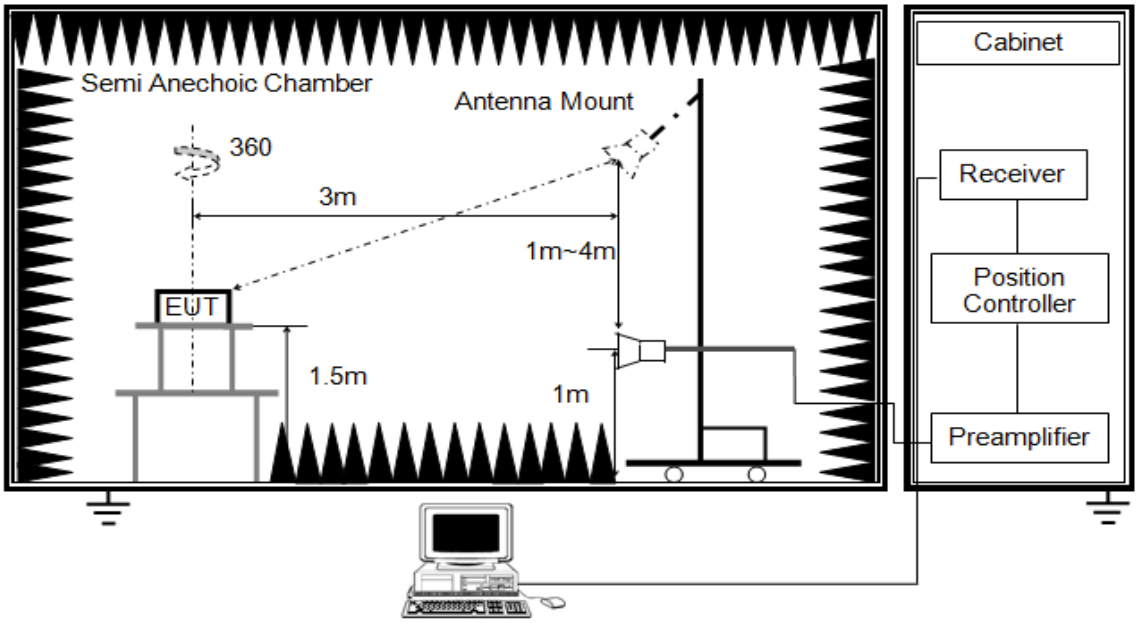
Above 1 GHz



The setting of the spectrum analyser

RBW	1 MHz
VBW	PEAK: 3 MHz AVG: see note 6
Sweep	Auto
Detector	Peak
Trace	Max hold

1. The testing follows the guidelines in ANSI C63.10-2013 clause 6.6.

2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

3. The EUT was placed on a turntable with 1.5 m above ground.

4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.

5. For measurement above 1 GHz, the emission measurement will be measured by the peak detector. This peak level, once corrected, must comply with the limit specified in Section 15.209.

6. For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 3 MHz for peak measurements and 1 MHz resolution bandwidth with 1/T video bandwidth with peak detector for average measurements. For the Duty Cycle please refer to clause 7.1.ON TIME AND DUTY CYCLE.

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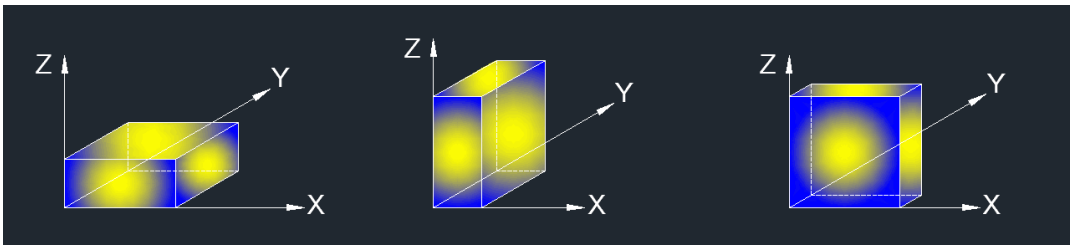
X axis, Y axis, Z axis positions:



Note 1: For all radiated test, EUT in each of three orthogonal axis emissions had been tested, but only the worst case (X axis) data recorded in the report.

Note 2: The EUT was fully exercised with external accessories during the test. In the case of multiple accessory external ports, an external accessory shall be connected to one of each type of port.

TEST ENVIRONMENT

Temperature	24.6 °C	Relative Humidity	46 %
Atmosphere Pressure	101 kPa	Test Voltage	DC 3 V

RESULTS

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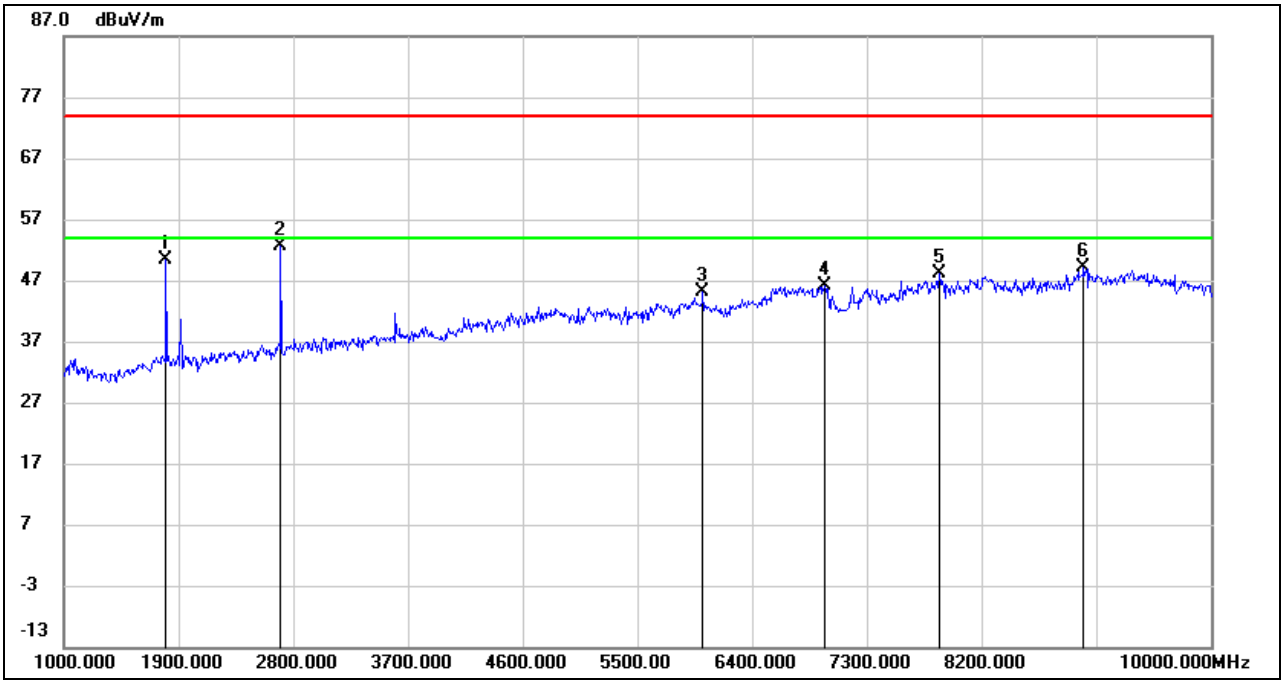
8.1. SPURIOUS EMISSIONS (1 GHz ~ 10 GHz)

8.1.1. FSK - 50 kbps MODE

HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1804.600	60.31	-10.05	50.26	74.00	-23.74	peak
2	2706.700	59.83	-7.17	52.66	74.00	-21.34	peak
3	6013.600	41.82	3.30	45.12	74.00	-28.88	peak
4	6971.200	40.18	6.05	46.23	74.00	-27.77	peak
5	7874.500	40.03	8.03	48.06	74.00	-25.94	peak
6	9004.600	38.65	10.59	49.24	74.00	-24.76	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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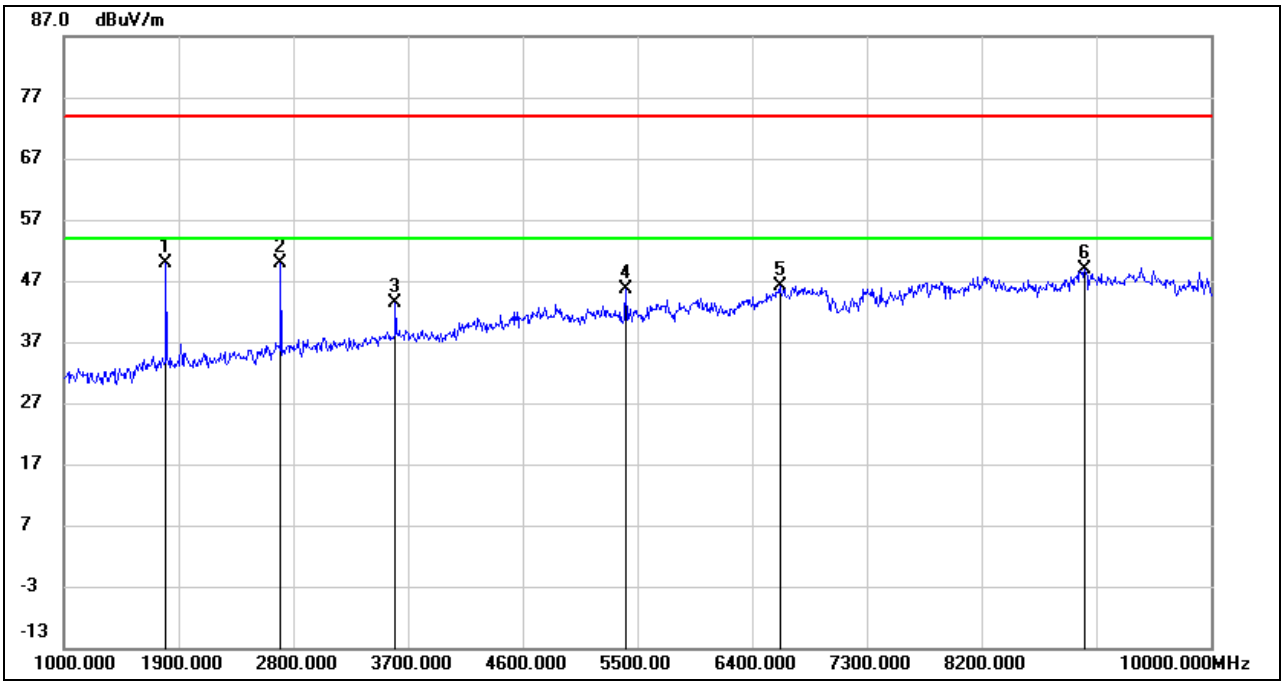
HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1804.300	60.04	-10.05	49.99	74.00	-24.01	peak
2	2706.700	56.94	-7.17	49.77	74.00	-24.23	peak
3	3608.800	47.41	-4.15	43.26	74.00	-30.74	peak
4	5413.300	43.73	1.92	45.65	74.00	-28.35	peak
5	6623.200	40.62	5.50	46.12	74.00	-27.88	peak
6	9014.200	38.45	10.53	48.98	74.00	-25.02	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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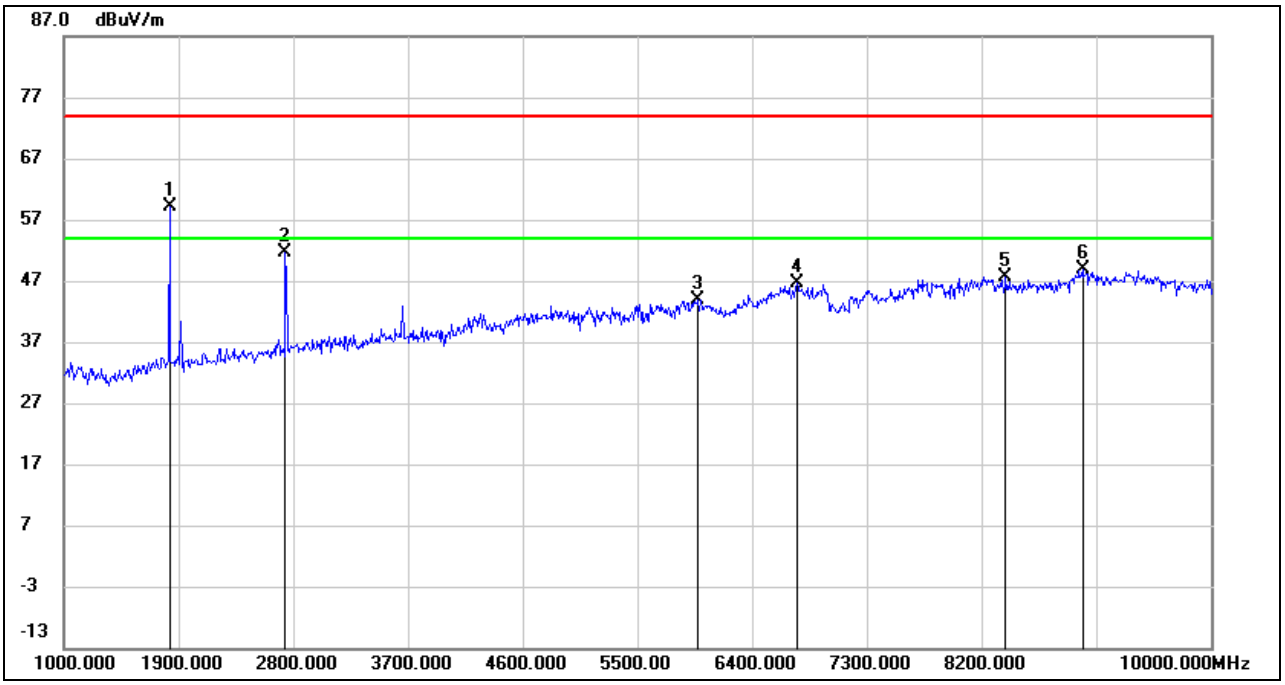
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1*	1830.100	69.20	-10.07	59.13	/	/	peak
2	2745.100	58.54	-6.91	51.63	74.00	-22.37	peak
3	5977.300	40.77	3.20	43.97	74.00	-30.03	peak
4	6759.100	41.09	5.56	46.65	74.00	-27.35	peak
5	8391.400	39.01	8.62	47.63	74.00	-26.37	peak
6	9000.700	38.16	10.62	48.78	74.00	-25.22	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
5.*-indicates frequency is out of the restricted bands and the limit is referring to 15.247 (d) and RSS-247 clause 5.5. We had already performed the conducted non-restricted bands test, please refer to clause 7.5.

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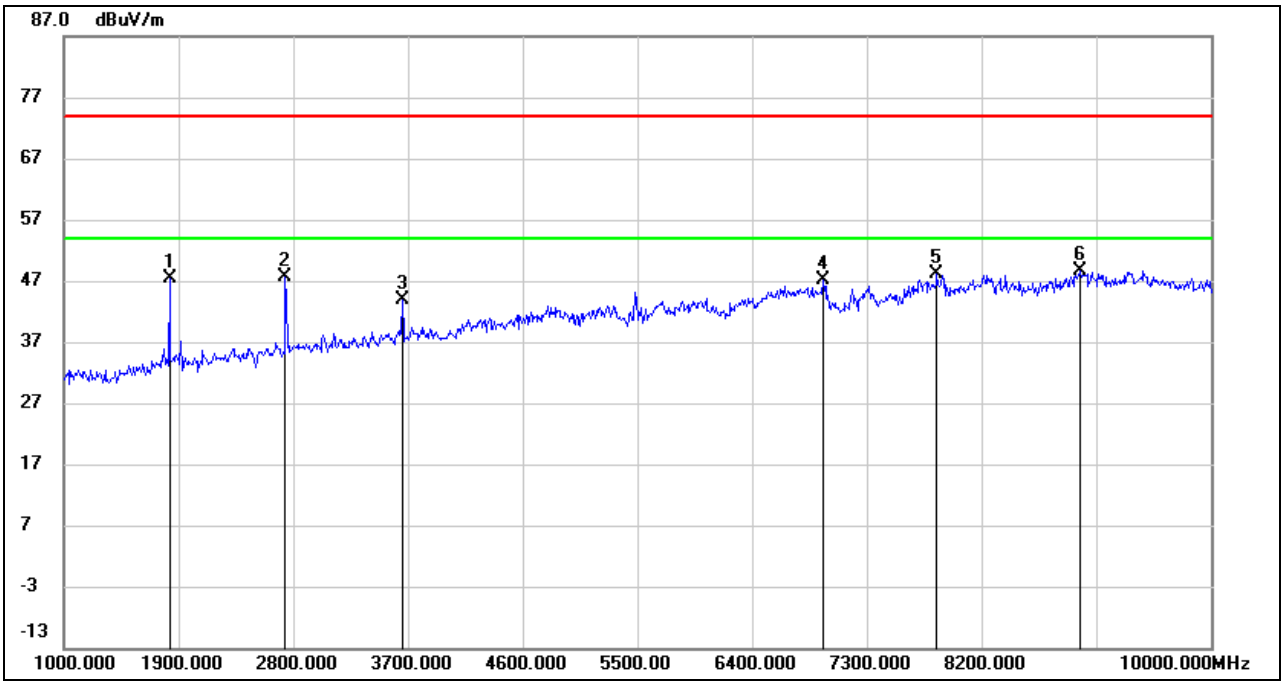
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1830.100	57.35	-10.07	47.28	74.00	-26.72	peak
2	2745.100	54.51	-6.91	47.60	74.00	-26.40	peak
3	3660.100	47.82	-3.91	43.91	74.00	-30.09	peak
4	6963.100	40.99	6.03	47.02	74.00	-26.98	peak
5	7852.600	40.04	8.09	48.13	74.00	-25.87	peak
6	8980.300	38.22	10.42	48.64	74.00	-25.36	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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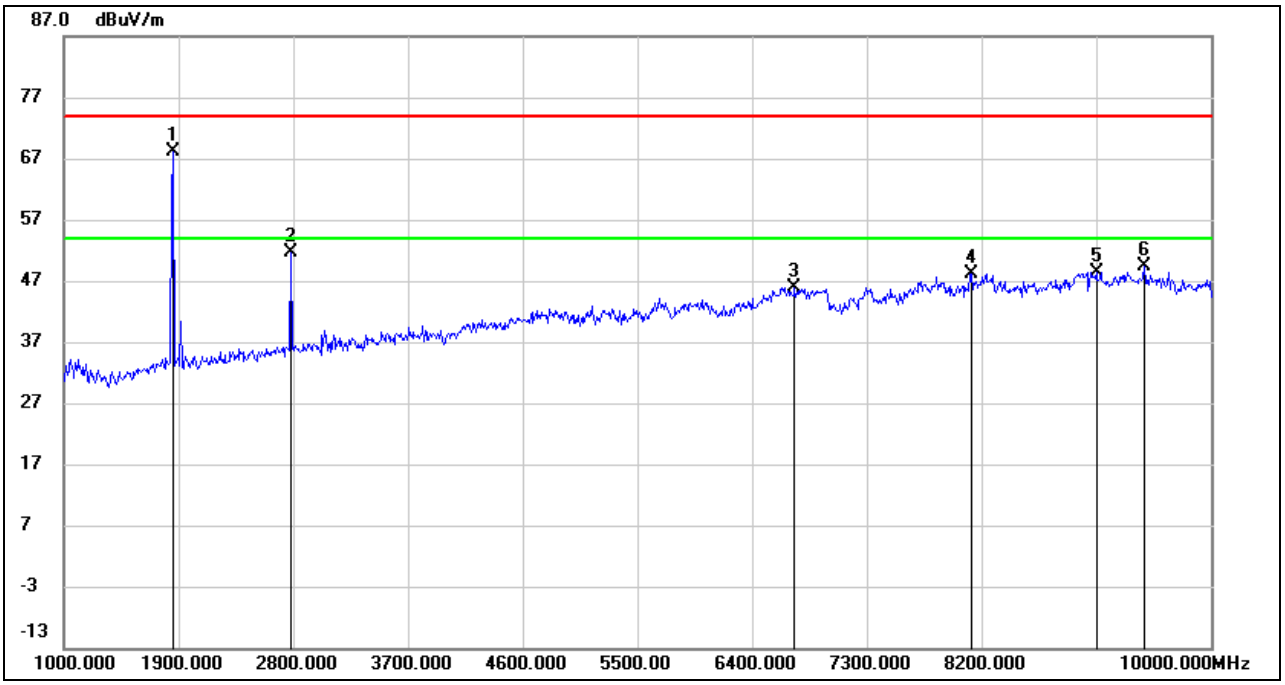
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1*	1855.600	78.16	-10.09	68.07	/	/	peak
2	2783.800	58.37	-6.66	51.71	74.00	-22.29	peak
3	6740.800	40.40	5.55	45.95	74.00	-28.05	peak
4	8126.200	39.49	8.73	48.22	74.00	-25.78	peak
5	9103.300	38.38	9.94	48.32	74.00	-25.68	peak
6	9484.300	39.01	10.44	49.45	74.00	-24.55	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
5.*-indicates frequency is out of the restricted bands and the limit is referring to 15.247 (d) and RSS-247 clause 5.5. We had already performed the conducted non-restricted bands test, please refer to clause 7.5.

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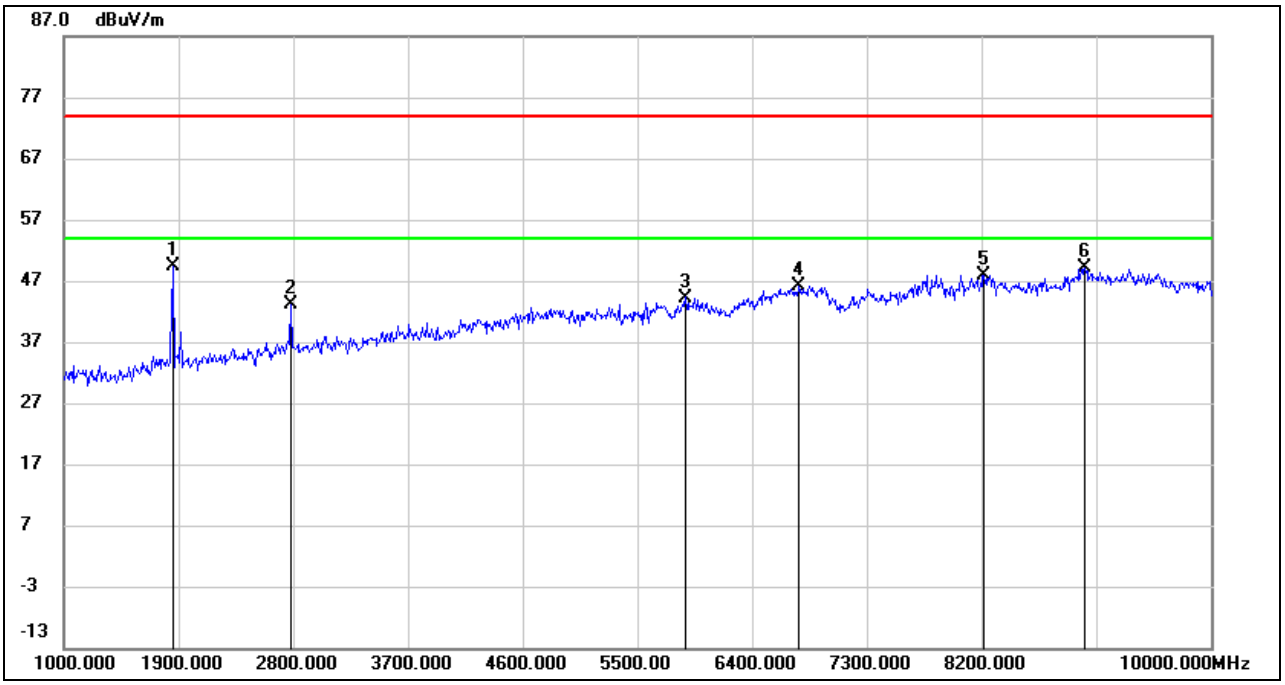
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1855.600	59.44	-10.09	49.35	74.00	-24.65	peak
2	2783.500	49.69	-6.66	43.03	74.00	-30.97	peak
3	5886.400	41.41	2.84	44.25	74.00	-29.75	peak
4	6771.400	40.65	5.57	46.22	74.00	-27.78	peak
5	8221.900	38.67	9.28	47.95	74.00	-26.05	peak
6	9010.300	38.45	10.57	49.02	74.00	-24.98	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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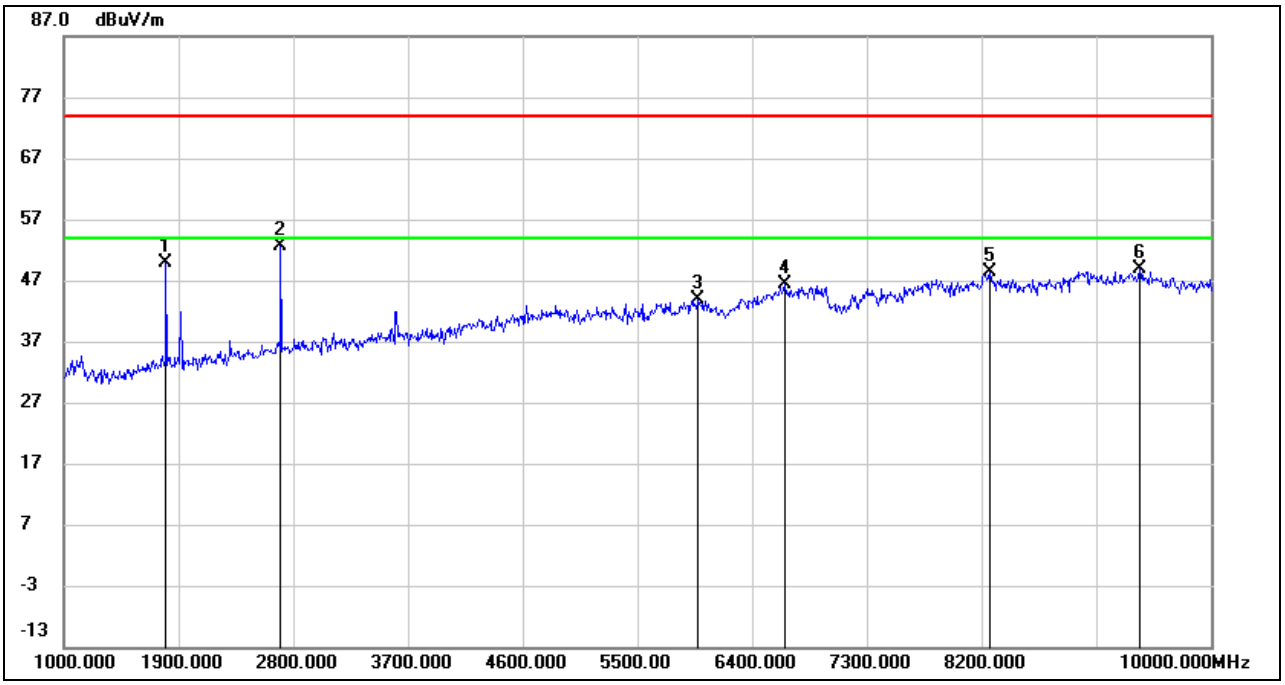
8.1.1. FSK - 150 kbps MODE

HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1804.900	59.94	-10.05	49.89	74.00	-24.11	peak
2	2707.600	59.71	-7.15	52.56	74.00	-21.44	peak
3	5983.900	40.74	3.24	43.98	74.00	-30.02	peak
4	6657.400	40.77	5.52	46.29	74.00	-27.71	peak
5	8267.200	39.21	9.10	48.31	74.00	-25.69	peak
6	9442.600	38.52	10.37	48.89	74.00	-25.11	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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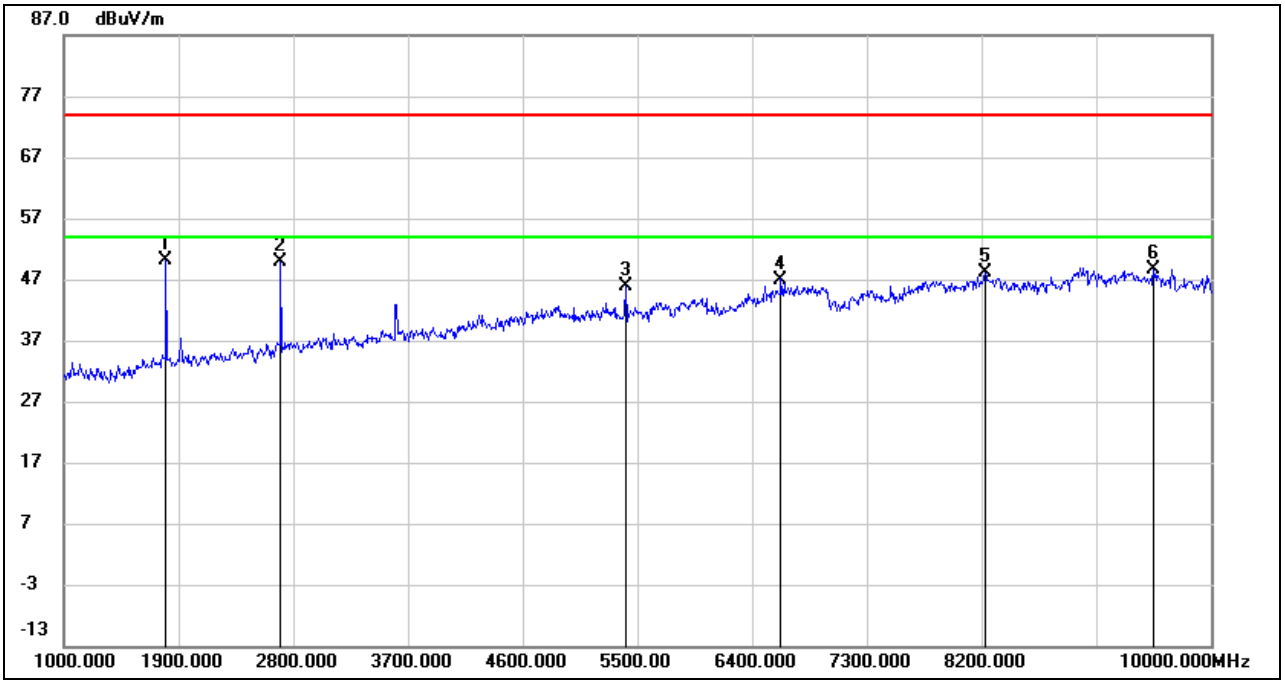
HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1804.600	60.08	-10.05	50.03	74.00	-23.97	peak
2	2707.900	56.95	-7.15	49.80	74.00	-24.20	peak
3	5415.400	44.00	1.92	45.92	74.00	-28.08	peak
4	6626.800	41.49	5.51	47.00	74.00	-27.00	peak
5	8230.600	38.82	9.24	48.06	74.00	-25.94	peak
6	9557.500	38.20	10.46	48.66	74.00	-25.34	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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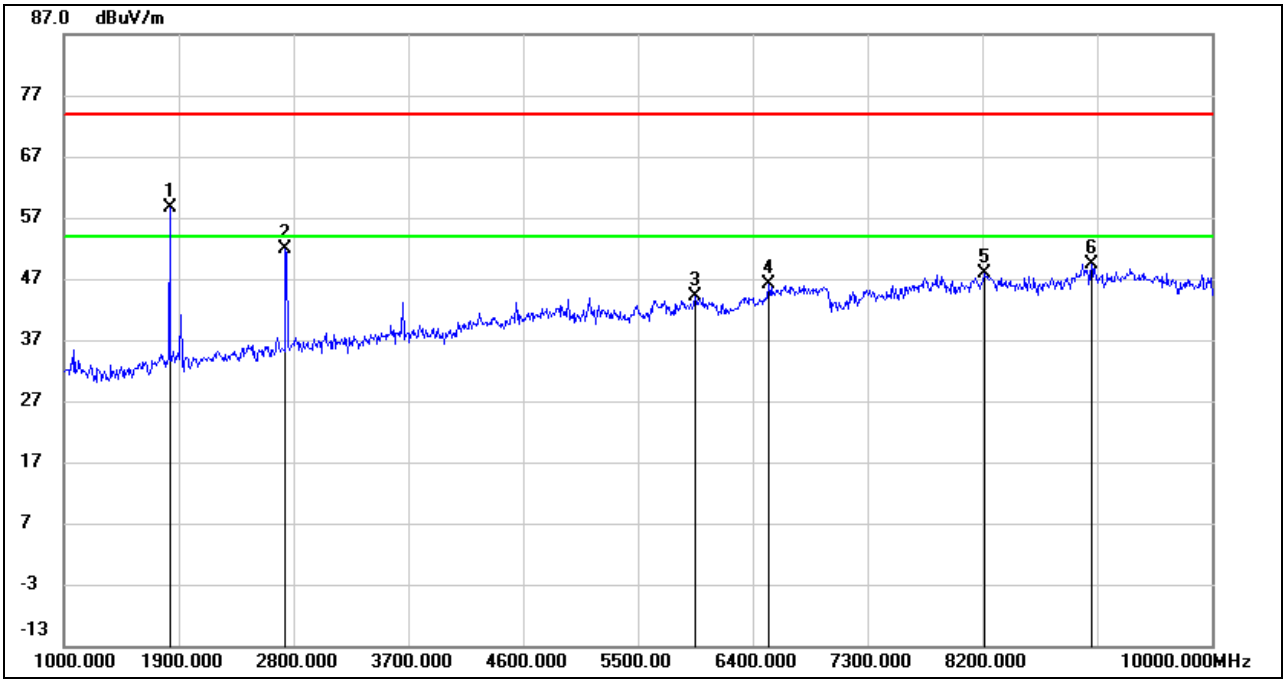
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1*	1830.400	68.61	-10.06	58.55	/	/	peak
2	2745.400	58.82	-6.91	51.91	74.00	-22.09	peak
3	5953.300	40.97	3.12	44.09	74.00	-29.91	peak
4	6534.100	41.11	5.12	46.23	74.00	-27.77	peak
5	8218.900	38.63	9.29	47.92	74.00	-26.08	peak
6	9063.100	39.22	10.21	49.43	74.00	-24.57	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
5.*-indicates frequency is out of the restricted bands and the limit is referring to 15.247 (d) and RSS-247 clause 5.5. We had already performed the conducted non-restricted bands test, please refer to clause 7.5.

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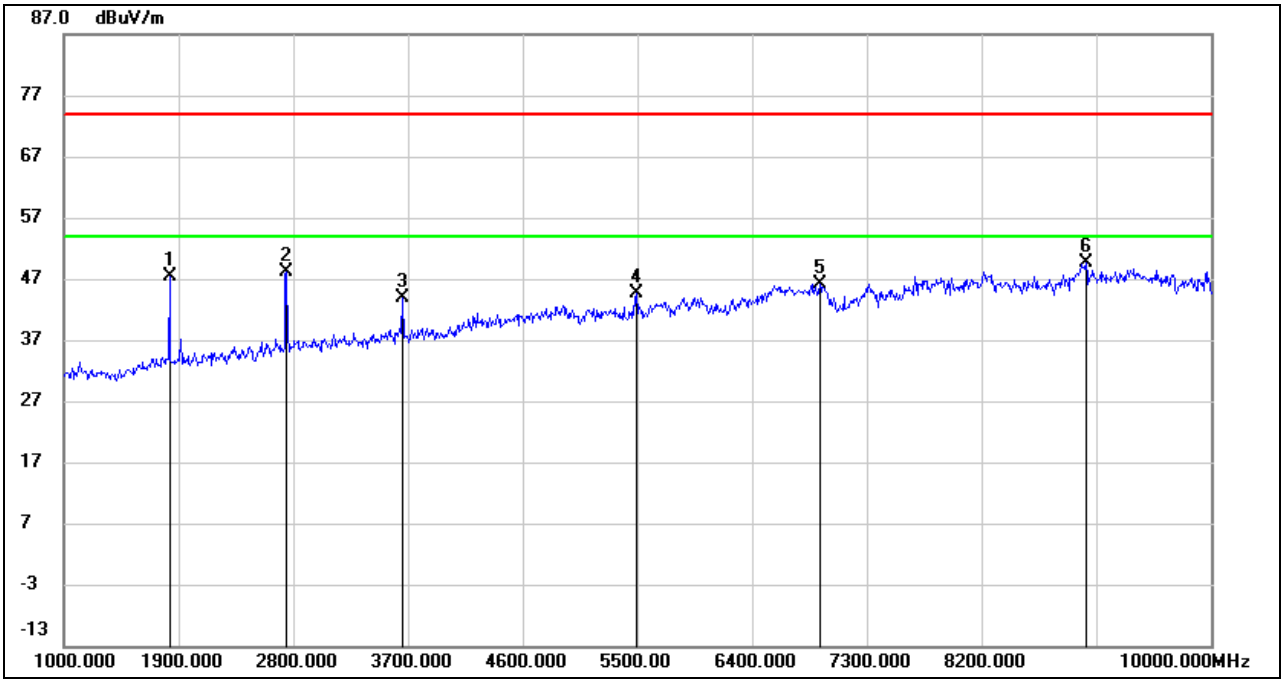
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1830.700	57.35	-10.06	47.29	74.00	-26.71	peak
2	2746.000	54.96	-6.90	48.06	74.00	-25.94	peak
3	3660.700	47.74	-3.91	43.83	74.00	-30.17	peak
4	5491.000	42.54	2.14	44.68	74.00	-29.32	peak
5	6932.200	40.14	5.94	46.08	74.00	-27.92	peak
6	9026.200	39.28	10.46	49.74	74.00	-24.26	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
5.*-indicates frequency is out of the restricted bands and the limit is referring to 15.247 (d) and RSS-247 clause 5.5. We had already performed the conducted non-restricted bands test, please refer to clause 7.5.

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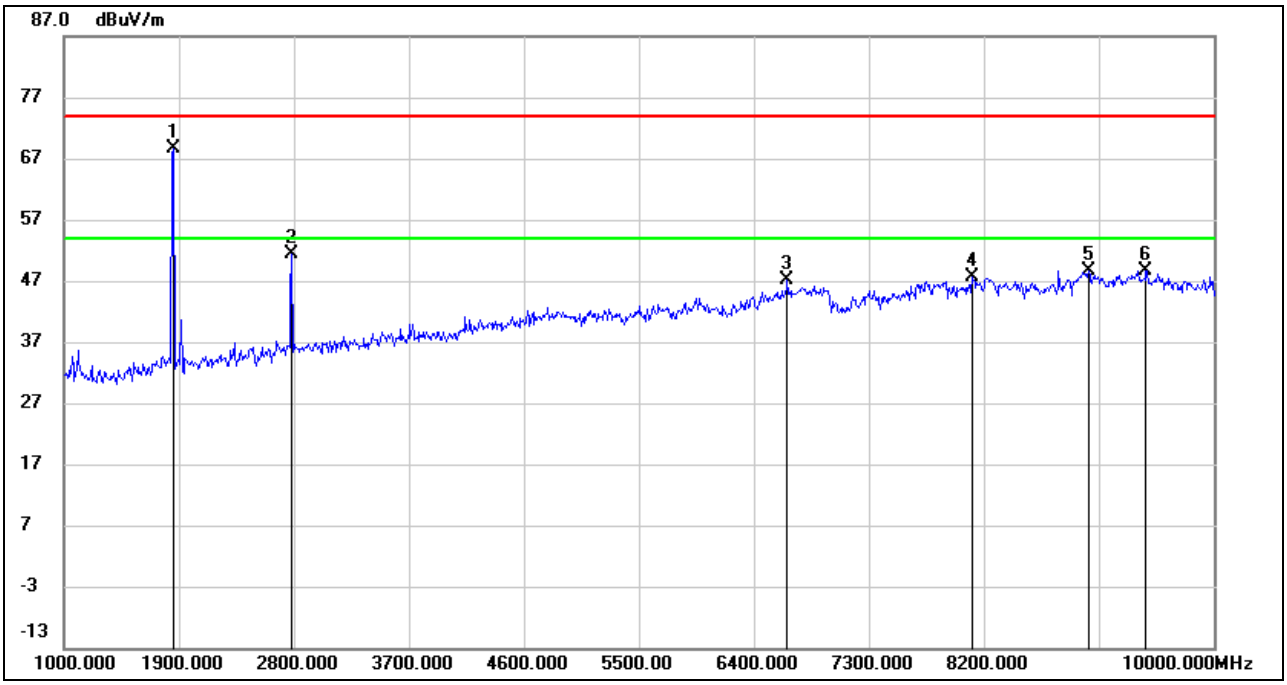
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1*	1855.600	78.77	-10.09	68.68	/	/	peak
2	2783.200	58.10	-6.66	51.44	74.00	-22.56	peak
3	6661.600	41.61	5.52	47.13	74.00	-26.87	peak
4	8116.600	38.93	8.65	47.58	74.00	-26.42	peak
5	9027.400	38.21	10.45	48.66	74.00	-25.34	peak
6	9471.700	38.17	10.42	48.59	74.00	-25.41	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
5.*-indicates frequency is out of the restricted bands and the limit is referring to 15.247 (d) and RSS-247 clause 5.5. We had already performed the conducted non-restricted bands test, please refer to clause 7.5.

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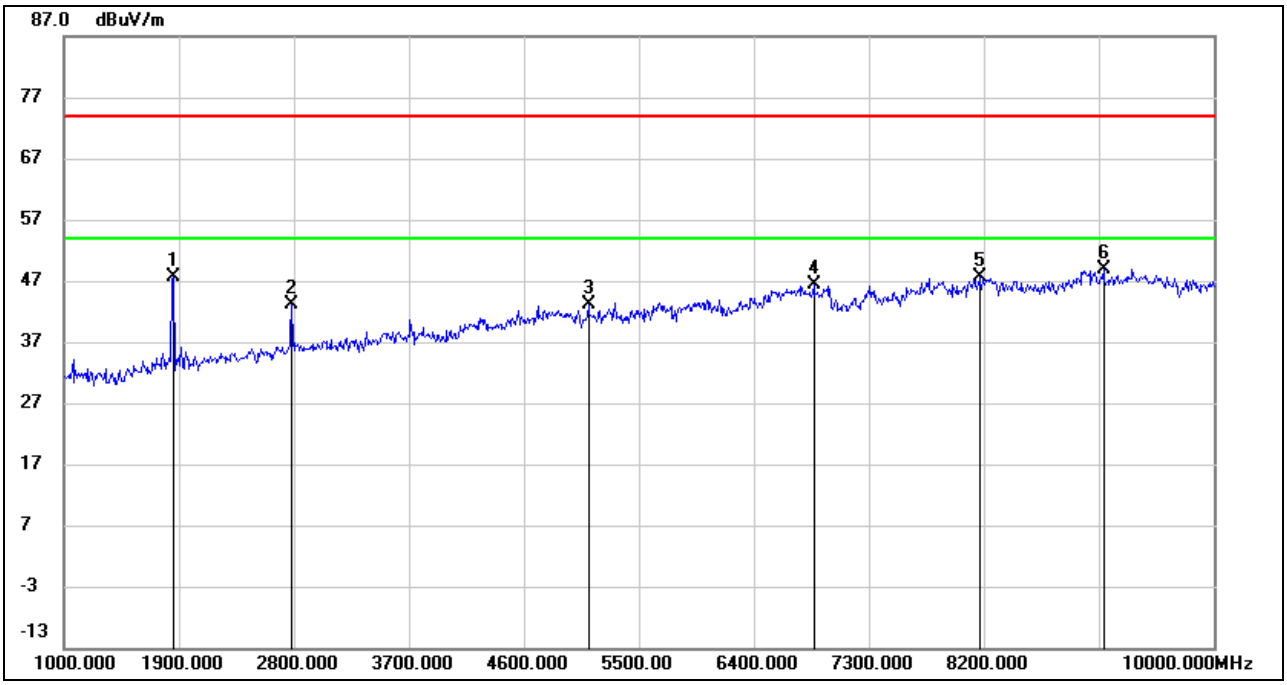
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1855.600	57.81	-10.09	47.72	74.00	-26.28	peak
2	2783.200	49.70	-6.66	43.04	74.00	-30.96	peak
3	5110.300	41.59	1.56	43.15	74.00	-30.85	peak
4	6872.200	40.69	5.78	46.47	74.00	-27.53	peak
5	8178.400	38.39	9.17	47.56	74.00	-26.44	peak
6	9142.000	39.24	9.67	48.91	74.00	-25.09	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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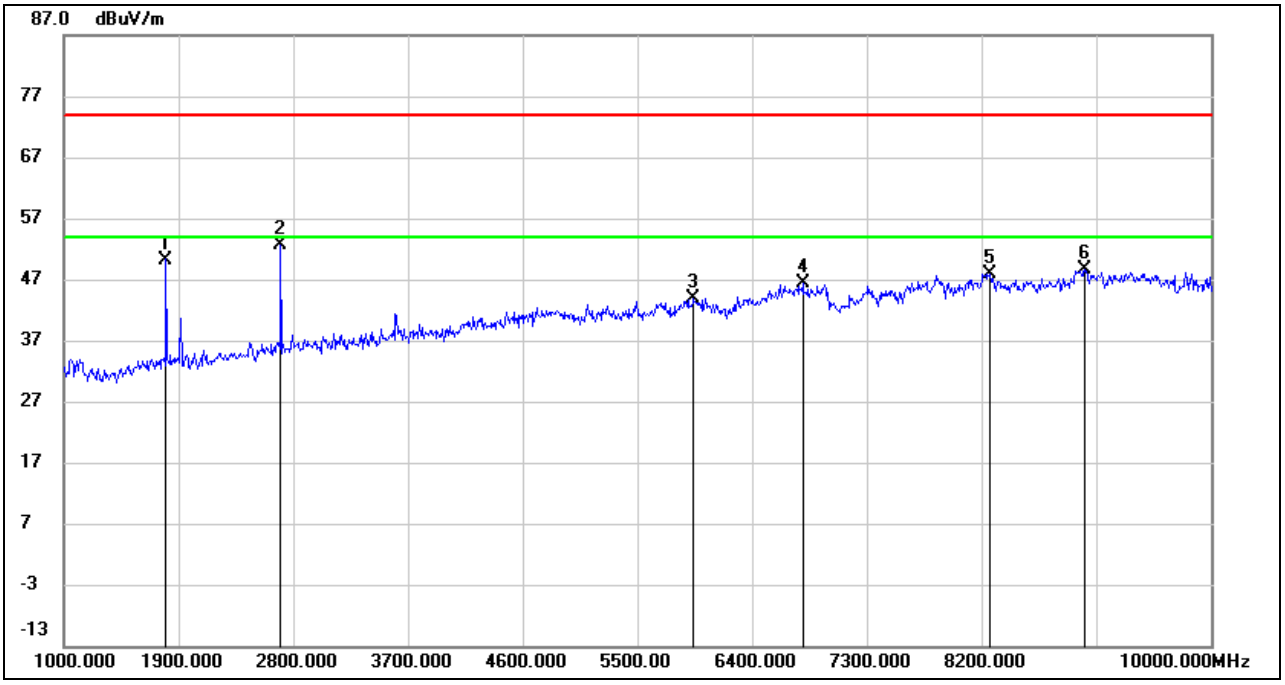
8.1.2. FSK - 250 kbps MODE

HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1805.200	60.30	-10.05	50.25	74.00	-23.75	peak
2	2707.600	59.75	-7.15	52.60	74.00	-21.40	peak
3	5946.700	40.90	3.09	43.99	74.00	-30.01	peak
4	6796.300	40.77	5.57	46.34	74.00	-27.66	peak
5	8265.700	38.82	9.11	47.93	74.00	-26.07	peak
6	9016.300	38.00	10.52	48.52	74.00	-25.48	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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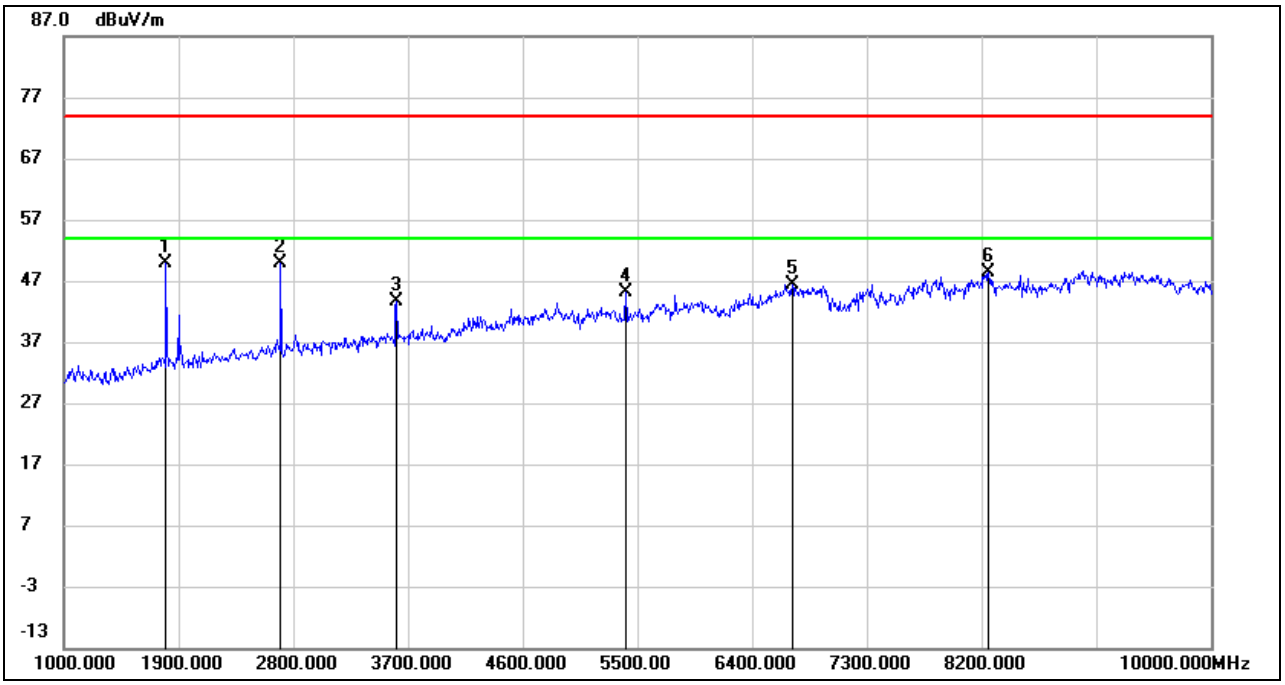
HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1804.900	59.86	-10.05	49.81	74.00	-24.19	peak
2	2707.900	57.05	-7.15	49.90	74.00	-24.10	peak
3	3610.600	47.81	-4.14	43.67	74.00	-30.33	peak
4	5414.800	43.28	1.92	45.20	74.00	-28.80	peak
5	6718.300	40.89	5.54	46.43	74.00	-27.57	peak
6	8254.000	39.11	9.15	48.26	74.00	-25.74	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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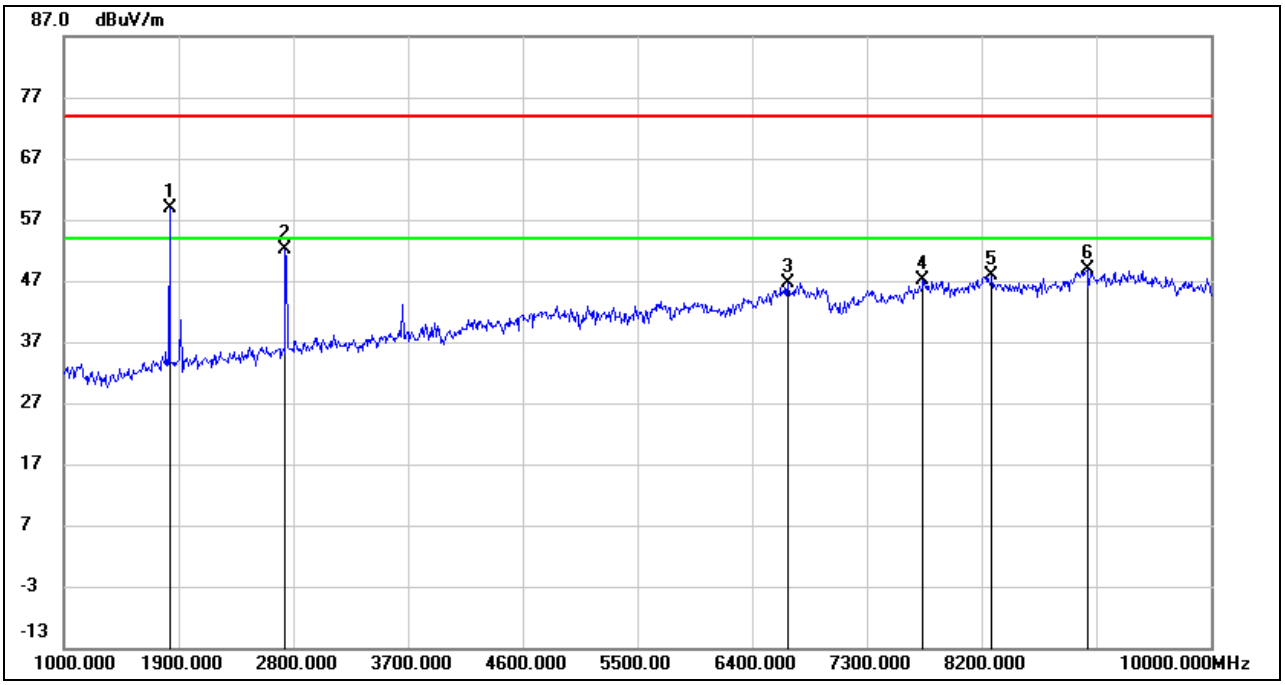
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1*	1830.100	68.88	-10.07	58.81	/	/	peak
2	2745.400	58.93	-6.91	52.02	74.00	-21.98	peak
3	6684.700	41.10	5.53	46.63	74.00	-27.37	peak
4	7745.800	38.98	8.04	47.02	74.00	-26.98	peak
5	8283.400	38.73	9.04	47.77	74.00	-26.23	peak
6	9030.100	38.45	10.42	48.87	74.00	-25.13	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
5.*-indicates frequency is out of the restricted bands and the limit is referring to 15.247 (d) and RSS-247 clause 5.5. We had already performed the conducted non-restricted bands test, please refer to clause 7.5.

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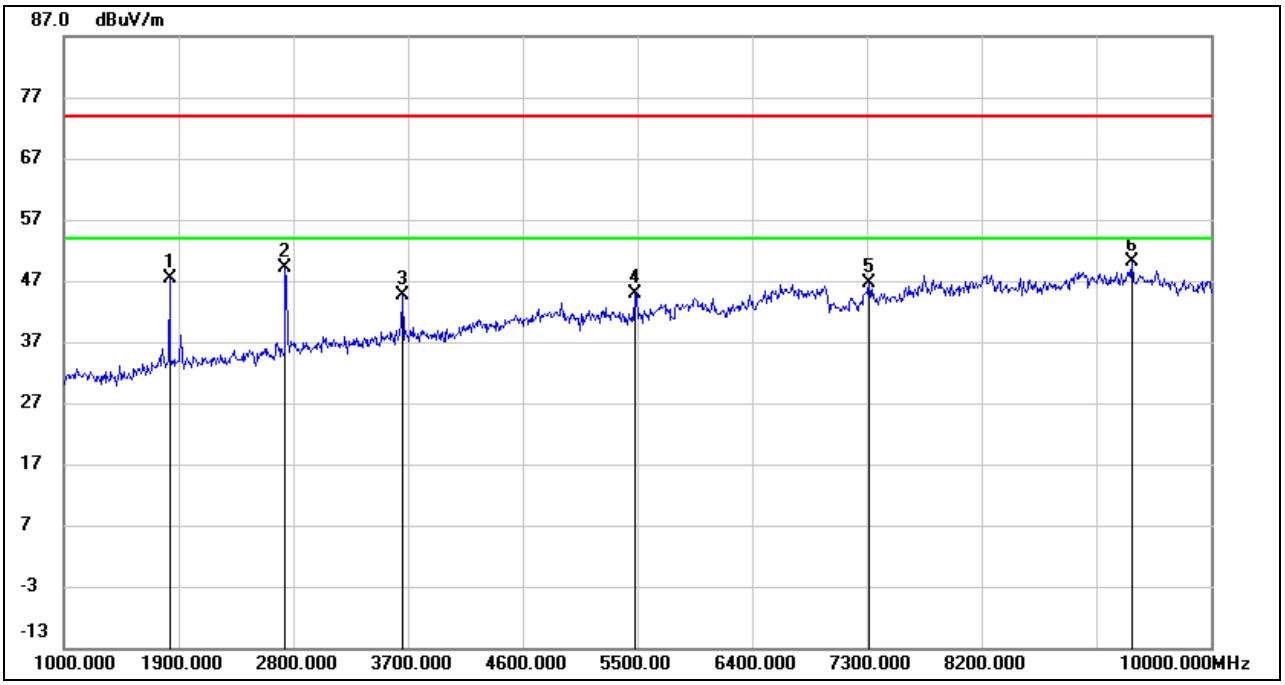
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1830.100	57.38	-10.07	47.31	74.00	-26.69	peak
2	2744.800	55.94	-6.91	49.03	74.00	-24.97	peak
3	3659.800	48.52	-3.92	44.60	74.00	-29.40	peak
4	5490.700	42.70	2.14	44.84	74.00	-29.16	peak
5	7320.400	39.16	7.43	46.59	74.00	-27.41	peak
6	9384.700	39.96	10.23	50.19	74.00	-23.81	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. Peak: Peak detector.
3. AVG: VBW=1/Ton, where: Ton is the transmitting duration.
4. For the transmitting duration, please refer to clause 7.1.
5. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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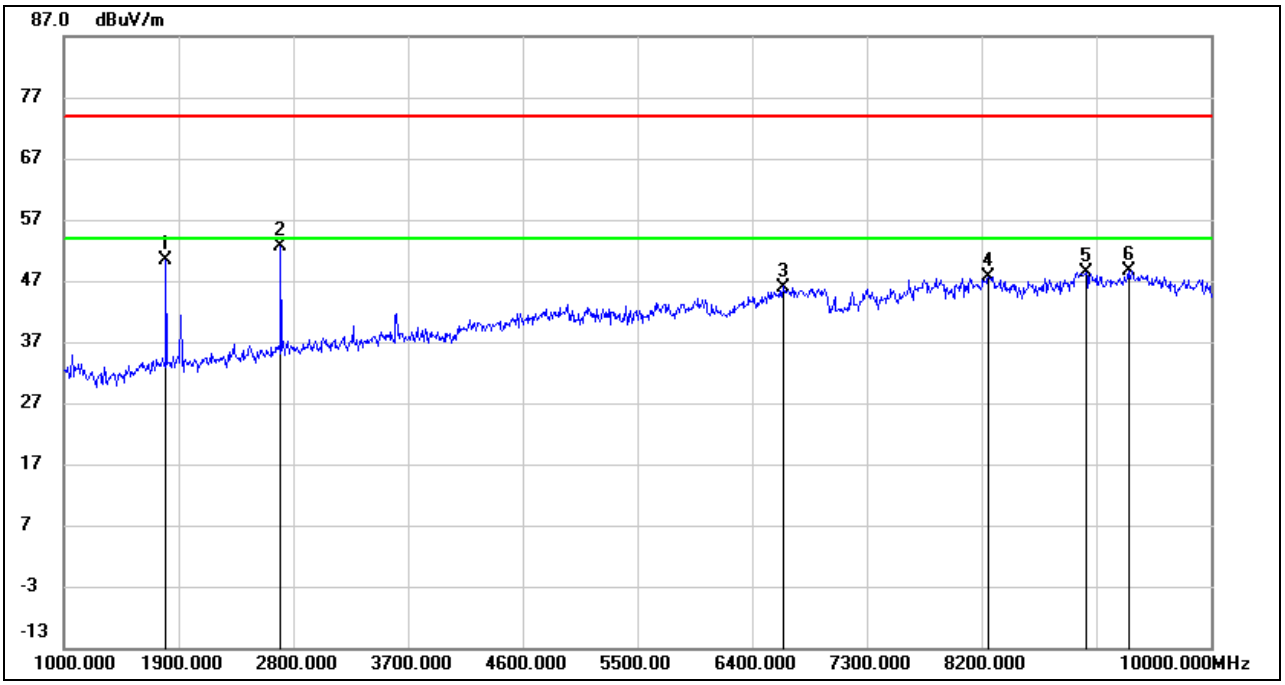
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1805.200	60.42	-10.05	50.37	74.00	-23.63	peak
2	2707.000	59.86	-7.16	52.70	74.00	-21.30	peak
3	6650.500	40.48	5.52	46.00	74.00	-28.00	peak
4	8257.600	38.45	9.14	47.59	74.00	-26.41	peak
5	9023.500	37.88	10.47	48.35	74.00	-25.65	peak
6	9352.300	38.48	10.06	48.54	74.00	-25.46	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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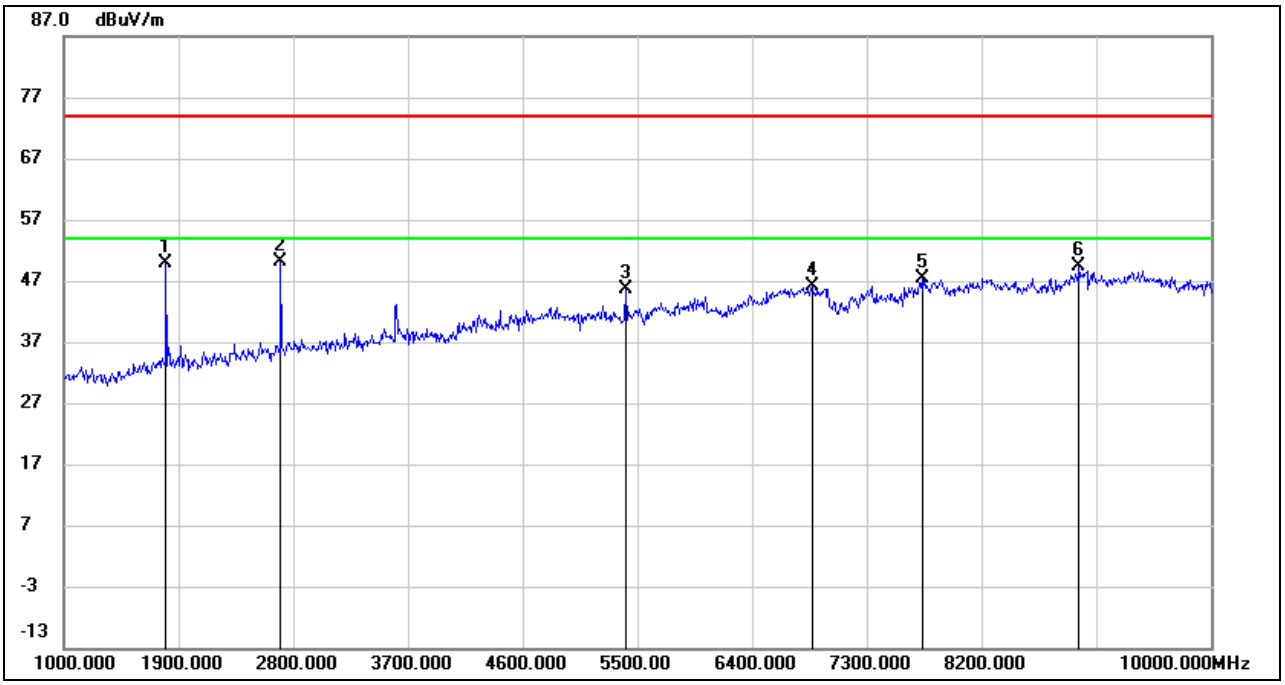
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1804.900	59.95	-10.05	49.90	74.00	-24.10	peak
2	2707.900	57.22	-7.15	50.07	74.00	-23.93	peak
3	5413.900	43.79	1.92	45.71	74.00	-28.29	peak
4	6869.200	40.25	5.76	46.01	74.00	-27.99	peak
5	7739.800	39.42	8.02	47.44	74.00	-26.56	peak
6	8969.800	38.96	10.32	49.28	74.00	-24.72	peak

Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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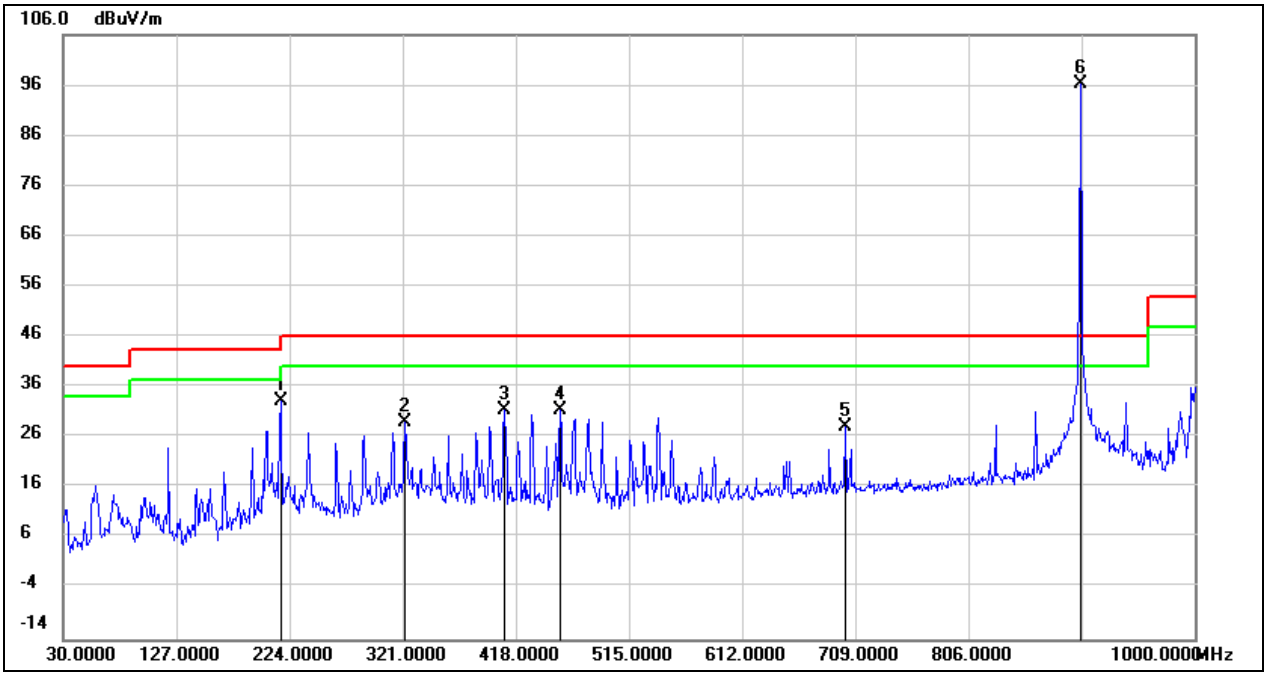
8.2. SPURIOUS EMISSIONS (30 MHz ~ 1 GHz)

8.2.1. FSK - 250 kbps MODE

SPURIOUS EMISSIONS (MID CHANNEL, WORST-CASE CONFIGURATION, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	216.2400	50.95	-17.84	33.11	46.00	-12.89	peak
2	322.9400	43.82	-14.75	29.07	46.00	-16.93	peak
3	408.3000	44.50	-13.17	31.33	46.00	-14.67	peak
4	455.8300	43.61	-12.27	31.34	46.00	-14.66	peak
5	700.2700	36.61	-8.31	28.30	46.00	-17.70	peak
6	902.2000	101.43	-5.16	96.27	/	/	fundamental

Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with QP limit, QP Result is deemed to comply with QP limit.
3. Test setup: RBW: 120 kHz, VBW: 300 kHz, Sweep time: auto.

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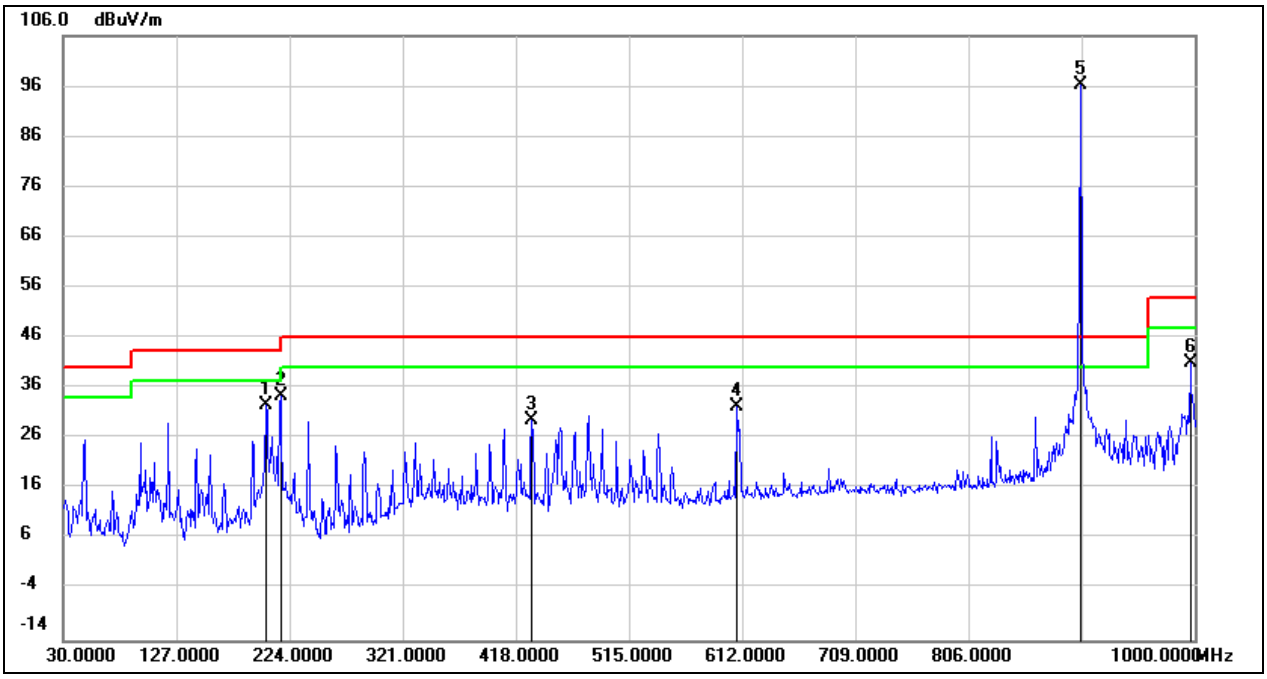
SPURIOUS EMISSIONS (HIGH CHANNEL, WORST-CASE CONFIGURATION, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	203.6300	49.35	-16.70	32.65	43.50	-10.85	peak
2	216.2400	52.30	-17.84	34.46	46.00	-11.54	peak
3	431.5800	42.29	-12.70	29.59	46.00	-16.41	peak
4	607.1500	41.75	-9.45	32.30	46.00	-13.70	peak
5	902.2000	101.54	-5.16	96.38	/	/	fundamental
6	996.1200	45.29	-4.20	41.09	54.00	-12.91	peak

Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with QP limit, QP Result is deemed to comply with QP limit.
3. Test setup: RBW: 120 kHz, VBW: 300 kHz, Sweep time: auto

Note: All the modes and channels have been tested, only the worst data was recorded in the report.

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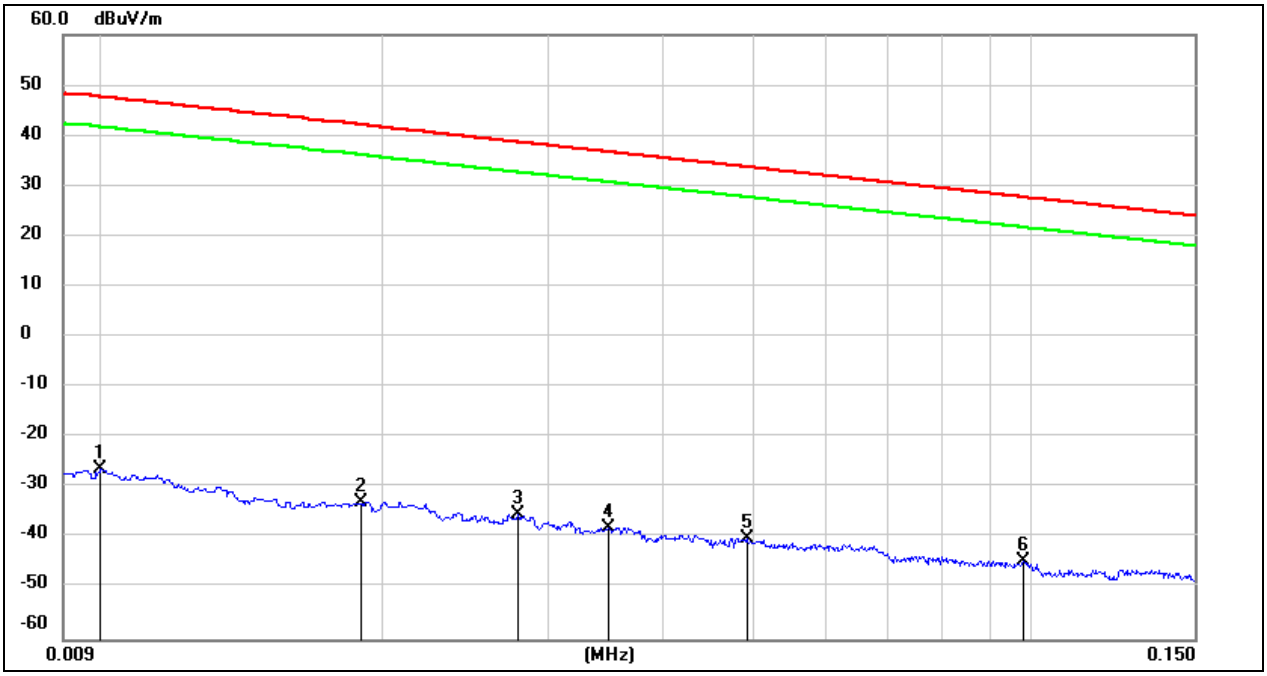
8.3. SPURIOUS EMISSIONS BELOW 30 MHz

8.3.1. FSK - 250 kbps MODE

SPURIOUS EMISSIONS (HIGH CHANNEL, LOOP ANTENNA FACE ON TO THE EUT, WORST-CASE CONFIGURATION)

9 kHz~ 150 kHz



No.	Frequency	Reading	Correct	FCC Result	FCC Limit	ISED Result	ISED Limit	Margin	Remark
	(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dBuA/m)	(dBuA/m)	(dB)	
1	0.0100	75.22	-101.40	-26.18	47.6	-77.68	-3.90	-73.78	peak
2	0.0189	68.49	-101.35	-32.86	42.07	-84.36	-9.43	-74.93	peak
3	0.0279	66.17	-101.38	-35.21	38.69	-86.71	-12.81	-73.90	peak
4	0.0349	63.53	-101.41	-37.88	36.75	-89.38	-14.75	-74.63	peak
5	0.0492	61.55	-101.47	-39.92	33.76	-91.42	-17.74	-73.68	peak
6	0.0981	57.27	-101.78	-44.51	27.77	-96.01	-23.73	-72.28	peak

Note: 1. Measurement = Reading Level + Correct Factor (dBuA/m= dBuV/m- 20Log10[120π] = dBuV/m- 51.5).

2. If Peak Result complies with AV and QP limit, AV and QP Result are deemed to comply with AV limit.

3. All 3 polarizations (Horizontal, Face-on and Face-off) of the loop antenna had been tested, but only the worst data recorded in the report.

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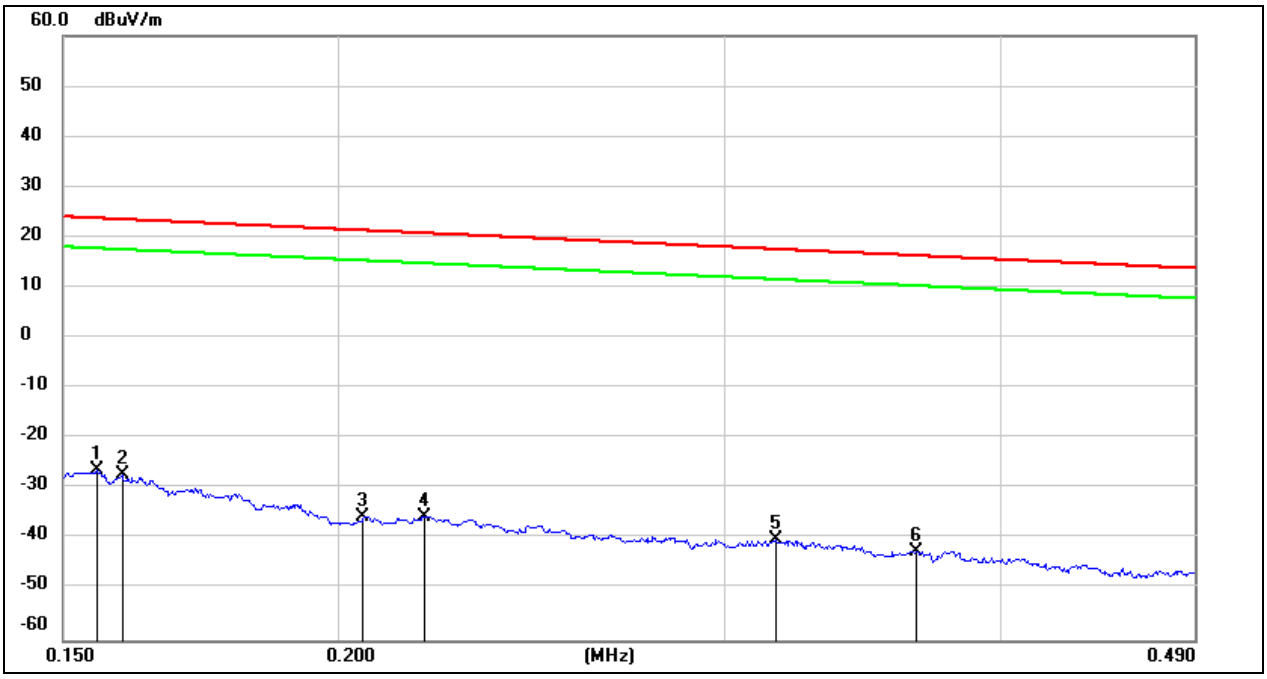
150 kHz ~ 490 kHz



No.	Frequency	Reading	Correct	FCC Result	FCC Limit	ISED Result	ISED Limit	Margin	Remark
	(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dBuA/m)	(dBuA/m)	(dB)	
1	0.1554	75.27	-101.65	-26.38	23.77	-77.88	-27.73	-50.15	peak
2	0.1595	74.36	-101.65	-27.29	23.55	-78.79	-27.95	-50.84	peak
3	0.2053	66.29	-101.73	-35.44	21.35	-86.94	-30.15	-56.79	peak
4	0.2190	66.27	-101.75	-35.48	20.79	-86.98	-30.71	-56.27	peak
5	0.3163	61.70	-101.87	-40.17	17.6	-91.67	-33.90	-57.77	peak
6	0.3662	59.58	-101.93	-42.35	16.33	-93.85	-35.17	-58.68	peak

Note: 1. Measurement = Reading Level + Correct Factor (dBuA/m= dBuV/m- 20Log10[120π] = dBuV/m- 51.5).

2. If Peak Result complies with AV and QP limit, AV and QP Result are deemed to comply with AV limit.

3. All 3 polarizations (Horizontal, Face-on and Face-off) of the loop antenna had been tested, but only the worst data recorded in the report.

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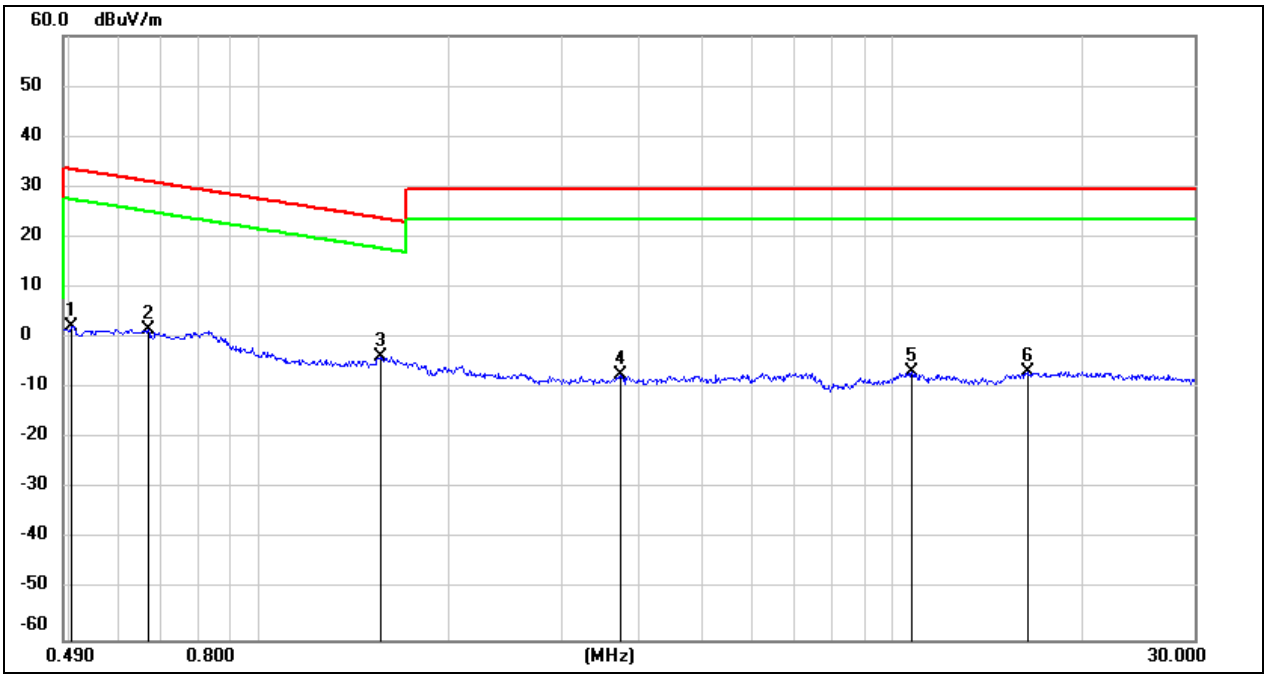
490 kHz ~ 30 MHz



No.	Frequency	Reading	Correct	FCC Result	FCC Limit	ISED Result	ISED Limit	Margin	Remark
	(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dBuA/m)	(dBuA/m)	(dB)	
1	0.5039	64.44	-62.07	2.37	33.56	-49.13	-17.94	-31.19	peak
2	0.6671	63.75	-62.10	1.65	31.12	-49.85	-20.38	-29.47	peak
3	1.5564	58.18	-62.02	-3.84	23.76	-55.34	-27.74	-27.60	peak
4	3.7100	54.20	-61.41	-7.21	29.54	-58.71	-21.96	-36.75	peak
5	10.7299	53.98	-60.83	-6.85	29.54	-58.35	-21.96	-36.39	peak
6	16.3959	54.17	-60.96	-6.79	29.54	-58.29	-21.96	-36.33	peak

Note: 1. Measurement = Reading Level + Correct Factor (dBuA/m= dBuV/m- 20Log10[120π] = dBuV/m- 51.5).

2. If Peak Result complies with AV and QP limit, AV and QP Result are deemed to comply with AV limit.

3. All 3 polarizations (Horizontal, Face-on and Face-off) of the loop antenna had been tested, but only the worst data recorded in the report.

Note: All the modes and channels have been tested, only the worst data was recorded in the report.

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9. ANTENNA REQUIREMENTS

APPLICABLE REQUIREMENTS

Please refer to FCC §15.203
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Please refer to FCC §15.247(b)(4)
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RESULTS

Complies

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APPENDIX A: DUTY CYCLE

Test Result

Mode	On Time (msec)	Period (msec)	Duty Cycle x (Linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/T Minimum VBW (kHz)	Final setting For VBW (kHz)
FSK-50 kbps	100	100	0.1	100	0	0.01	0.01
FSK-150 kbps	100	100	0.1	100	0	0.01	0.01
FSK-250 kbps	100	100	0.1	100	0	0.01	0.01

Note:
Duty Cycle Correction Factor=10log (1/x).
Where: x is Duty Cycle (Linear)
Where: T is On Time
If that calculated VBW is not available on the analyzer then the next higher value should be used.

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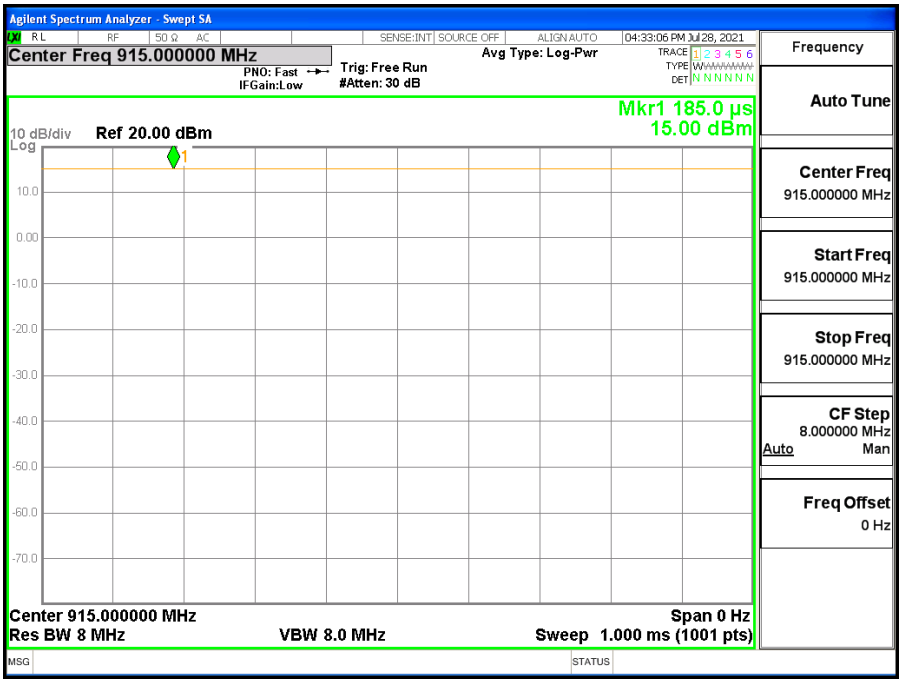
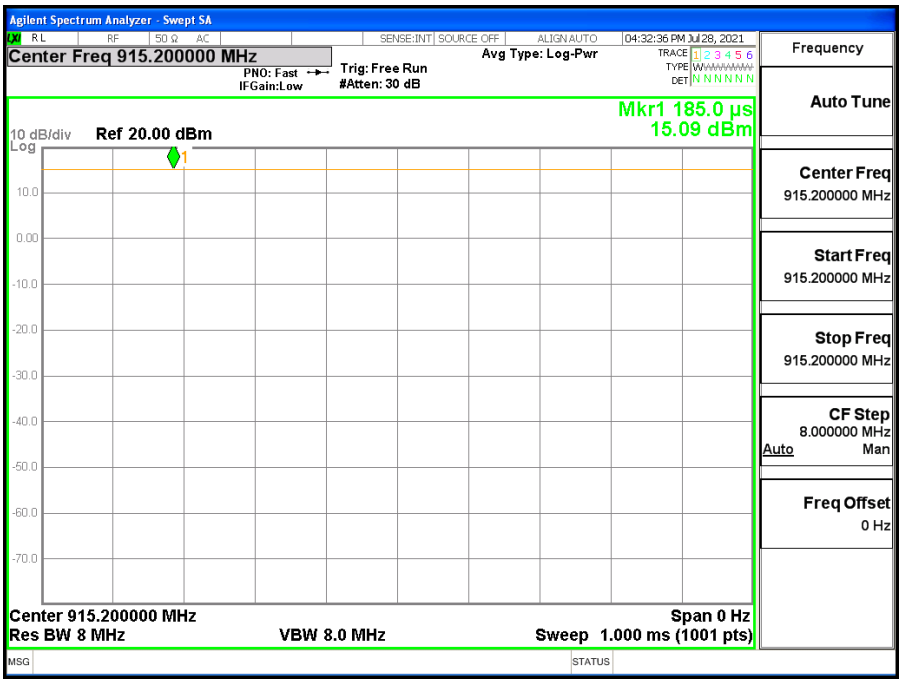
Test Graphs

FSK-50 kbps



FSK-150 kbps



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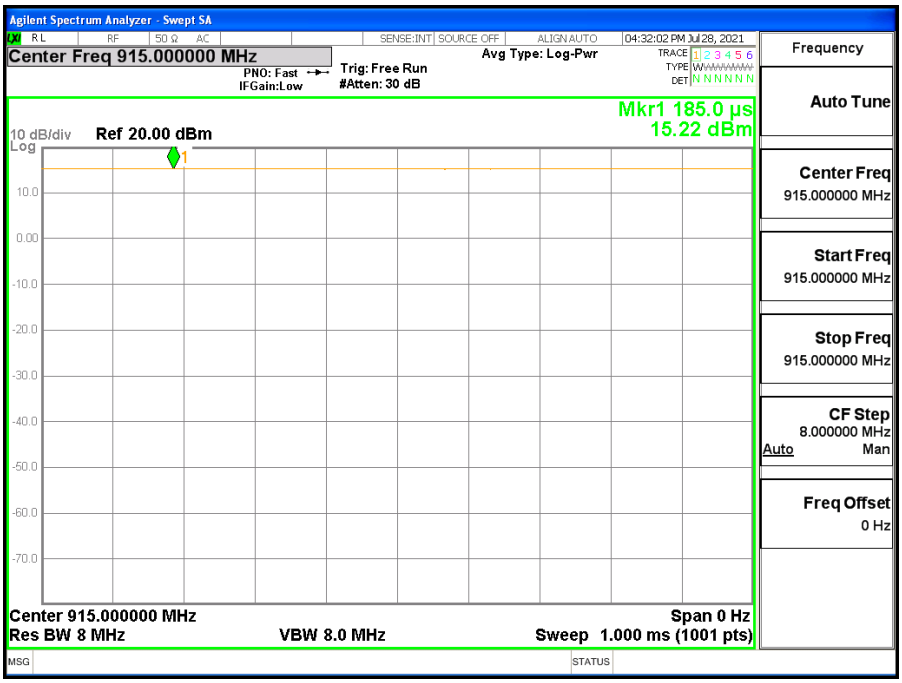
FSK-250 kbps



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APPENDIX B: 20DB BANDWIDTH

Test Result

Test Mode	Antenna	Channel	20db EBW[MHz]	Verdict
FSK-50 kbps	Ant1	Low	0.089	PASS
		Mid	0.090	PASS
		High	0.088	PASS
FSK-150 kbps	Ant1	Low	0.349	PASS
		Mid	0.350	PASS
		High	0.347	PASS
FSK-250 kbps	Ant1	Low	0.380	PASS
		Mid	0.367	PASS
		High	0.353	PASS

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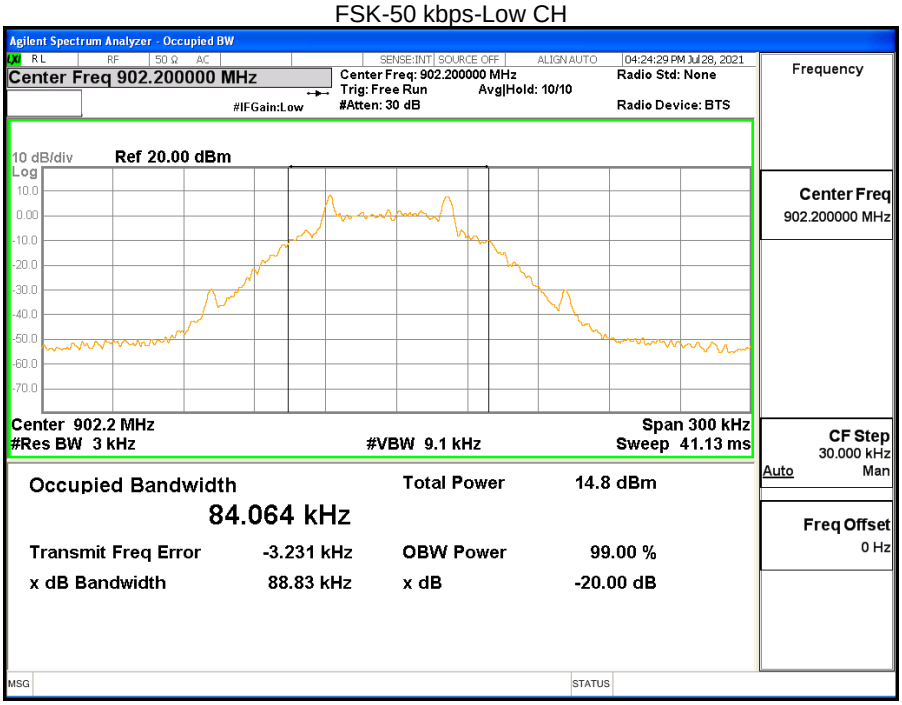
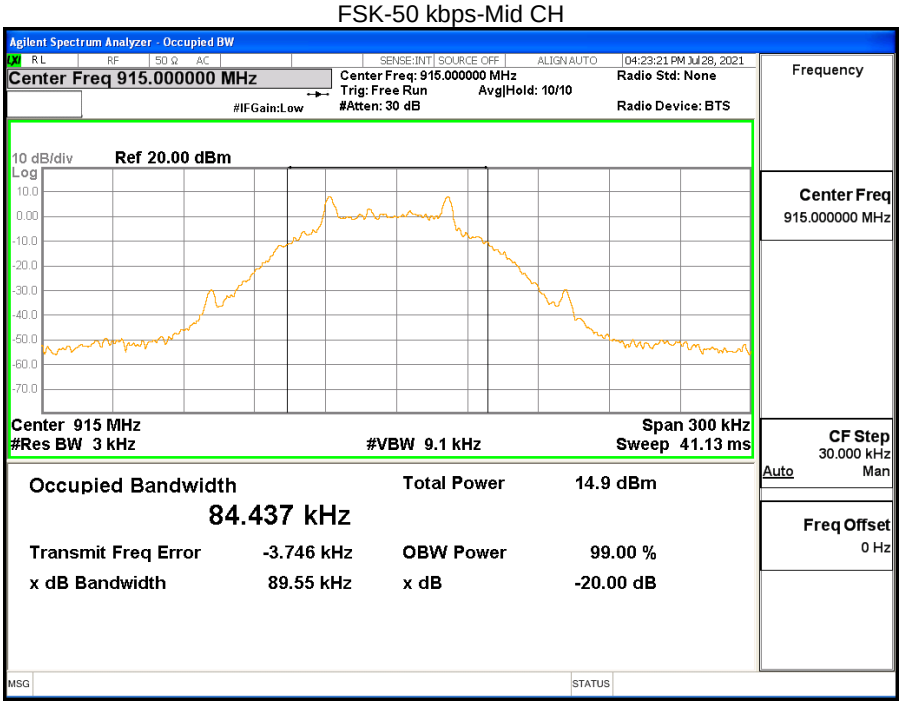
Test Graphs

FSK-50 kbps-Low CH



FSK-50 kbps-Mid CH



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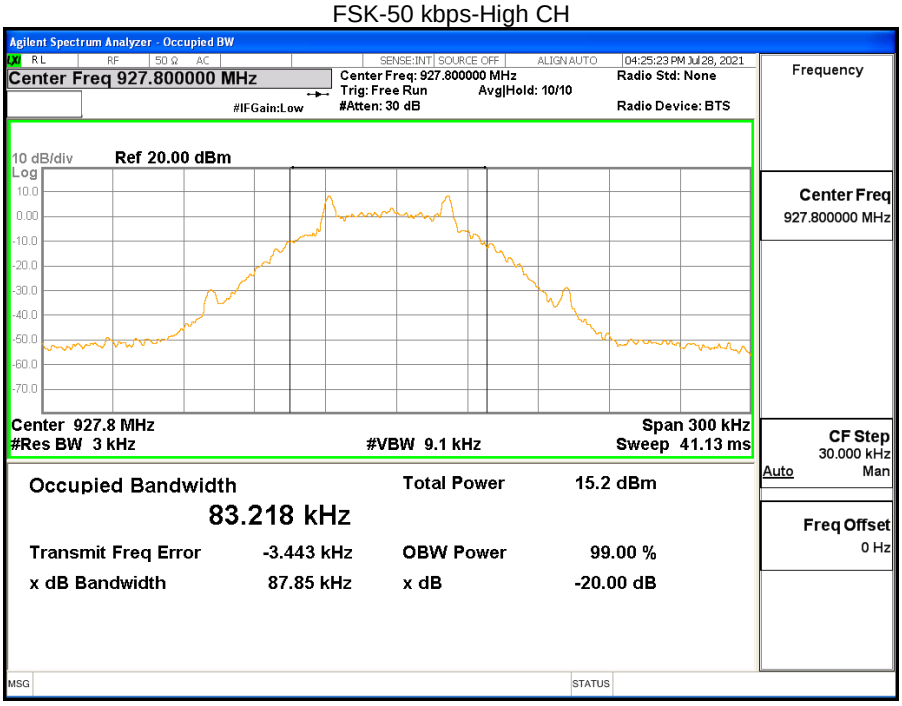
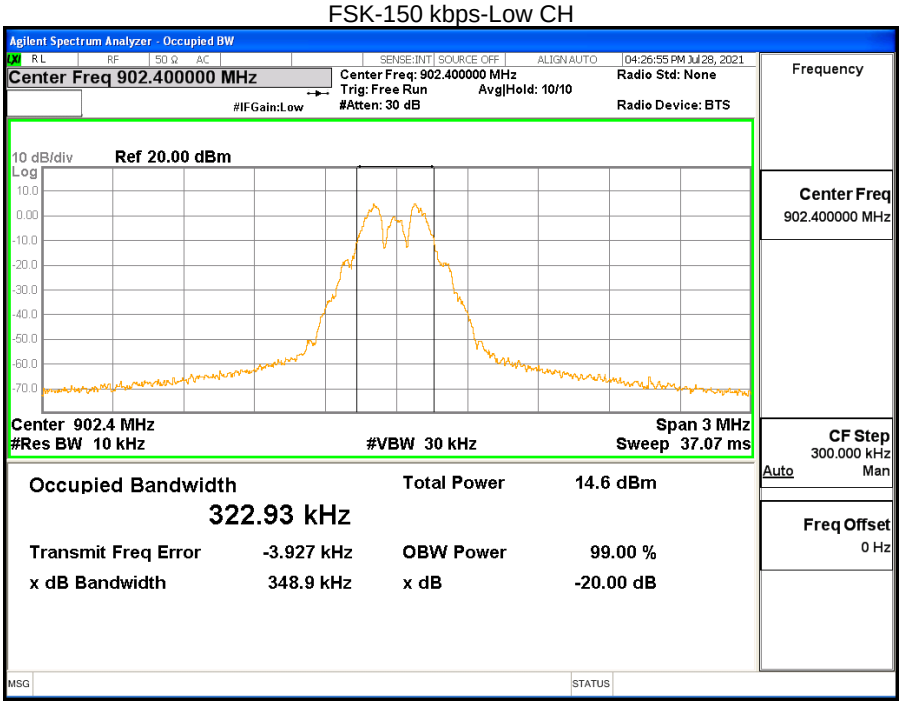
FSK-50 kbps-High CH



FSK-150 kbps-Low CH



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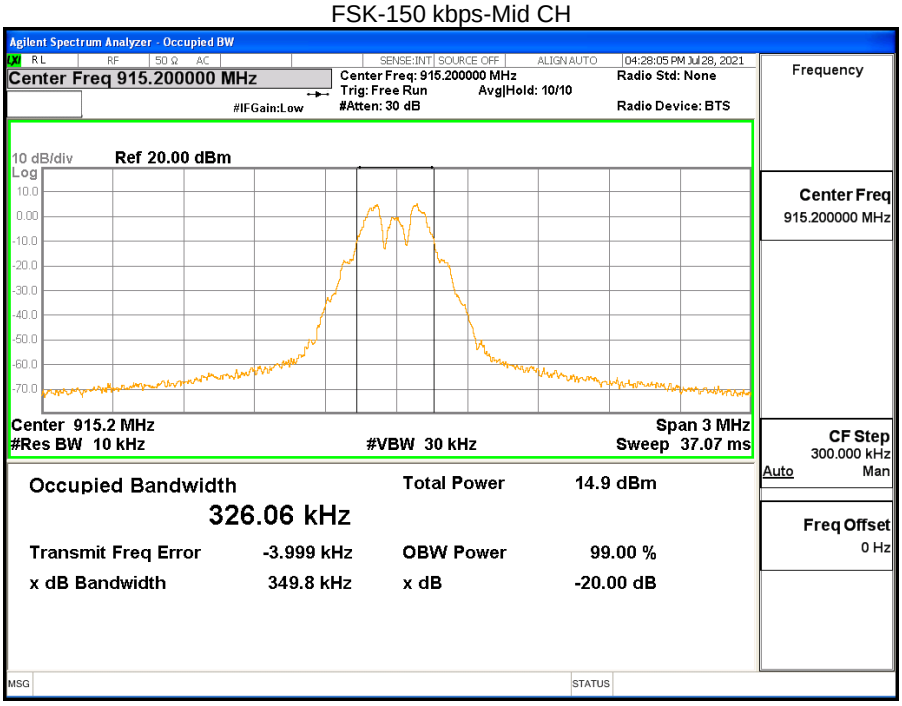
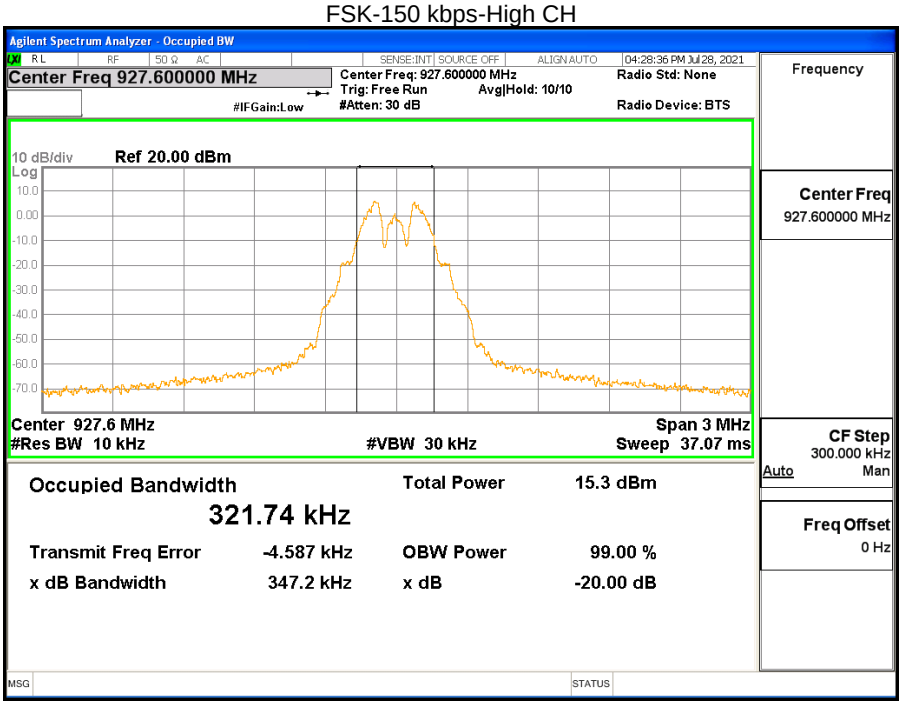
FSK-150 kbps-Mid CH



FSK-150 kbps-High CH



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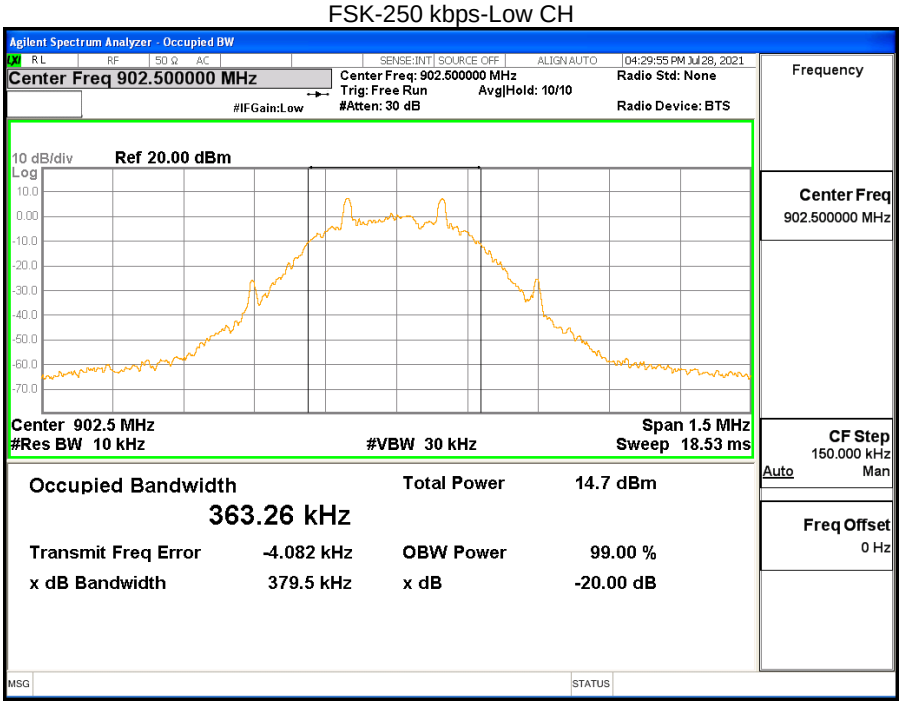
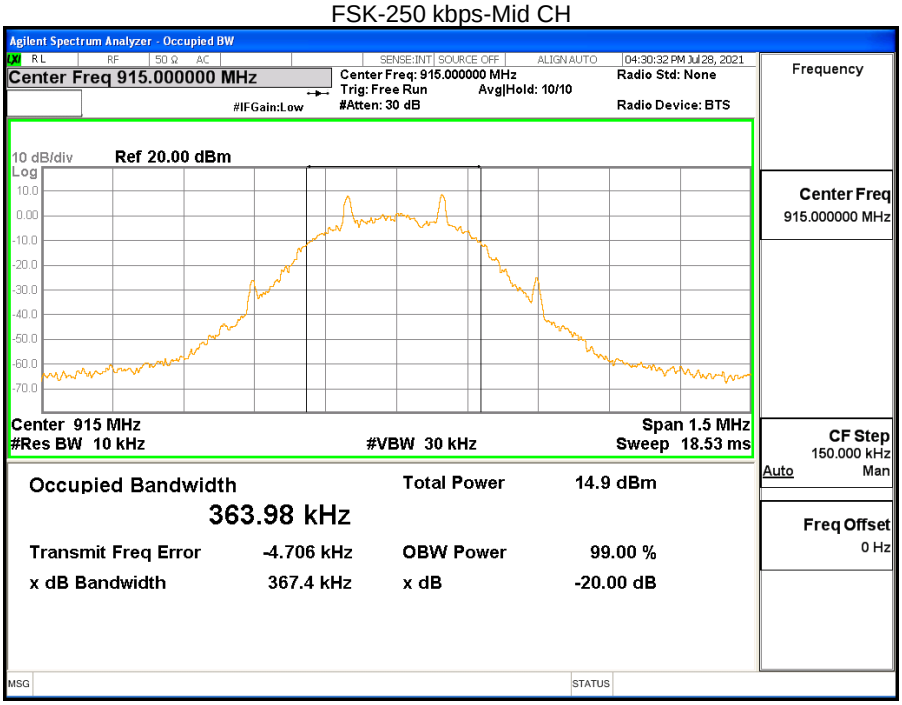
FSK-250 kbps-Low CH



FSK-250 kbps-Mid CH



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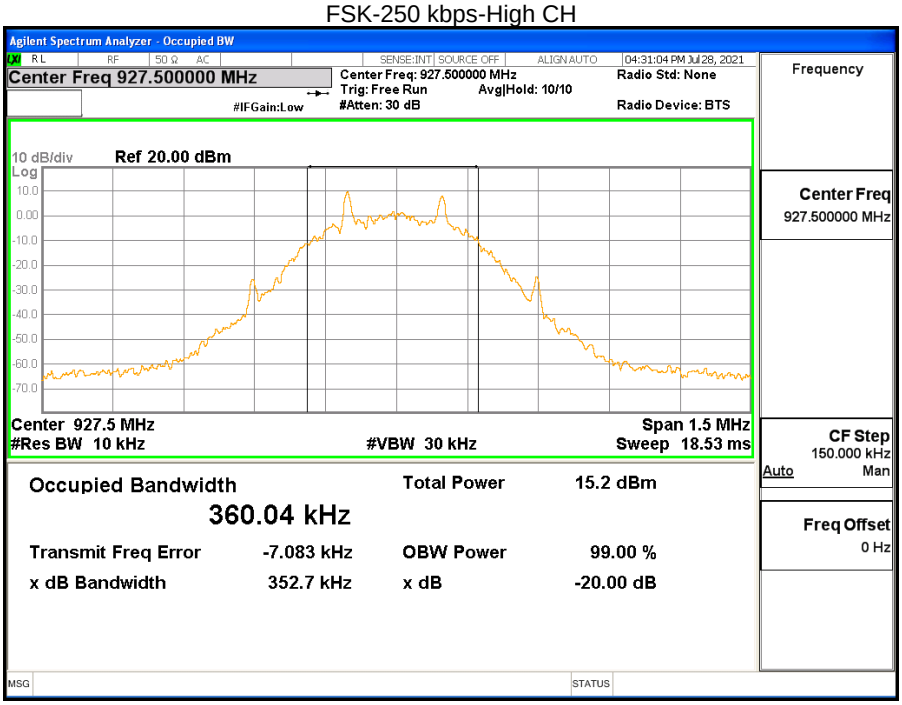
FSK-250 kbps-High CH



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APPENDIX C: OCCUPIED CHANNEL BANDWIDTH

Test Result

Test Mode	Antenna	Channel	OCB [MHz]	Verdict
FSK-50 kbps	Ant1	Low	0.084	PASS
		Mid	0.084	PASS
		High	0.083	PASS
FSK-150 kbps	Ant1	Low	0.323	PASS
		Mid	0.326	PASS
		High	0.322	PASS
FSK-250 kbps	Ant1	Low	0.363	PASS
		Mid	0.364	PASS
		High	0.360	PASS

Note: For the test graphs, please refer to appendix B

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APPENDIX D: PEAK CONDUCTED OUTPUT POWER

Test Result

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
FSK-50 kbps	Ant1	Low	10.98	<=30	PASS
		Mid	10.57	<=30	PASS
		High	10.13	<=30	PASS
FSK-150 kbps	Ant1	Low	10.96	<=30	PASS
		Mid	10.54	<=30	PASS
		High	10.12	<=30	PASS
FSK-250 kbps	Ant1	Low	10.92	<=30	PASS
		Mid	10.52	<=30	PASS
		High	10.10	<=30	PASS

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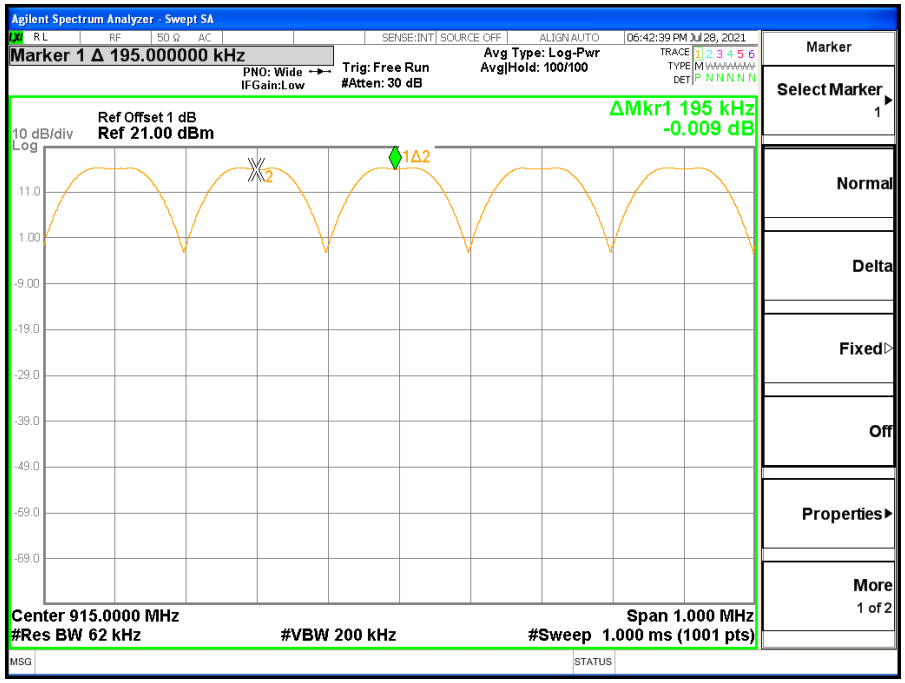
APPENDIX E: CARRIER FREQUENCY SEPARATION

Test Result

Test Mode	Antenna	Channel	Result[MHz]	Limit[kHz]	Verdict
FSK-50 kbps	Ant1	Hop	0.195	>=90	PASS
FSK-150 kbps	Ant1	Hop	0.382	>=350	PASS
FSK-250 kbps	Ant1	Hop	0.492	>=380	PASS

Test Graphs

FSK-50 kbps



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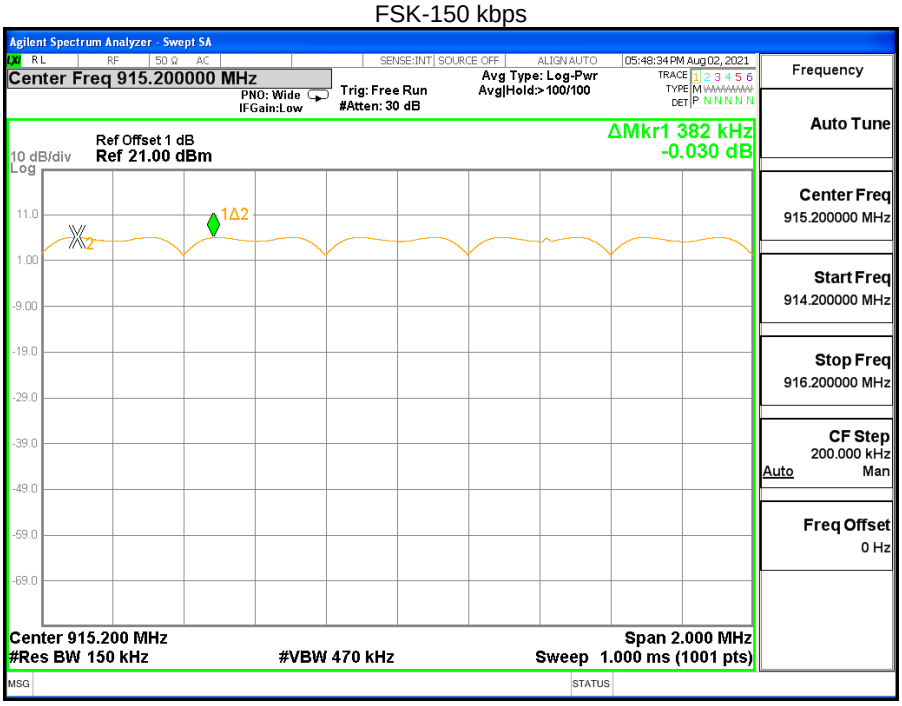
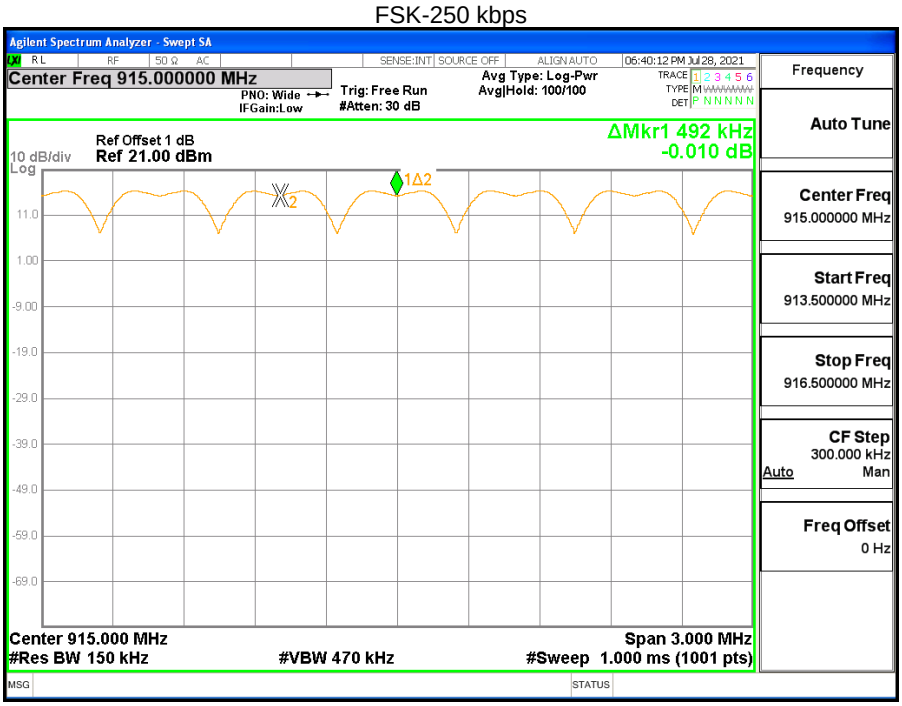
FSK-150 kbps



FSK-250 kbps



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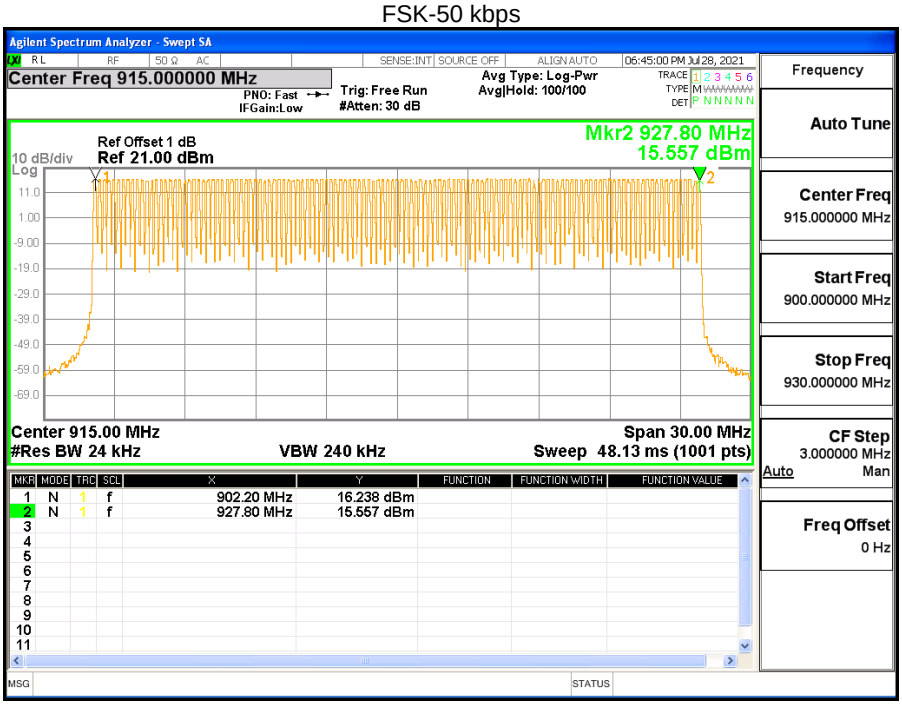
APPENDIX F: NUMBER OF HOPPING FREQUENCIES

Test Result

Test Mode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
FSK-50 kbps	Ant1	Hop	129	>=50	PASS
FSK-150 kbps	Ant1	Hop	64	>=25	PASS
FSK-250 kbps	Ant1	Hop	51	>=25	PASS

Test Graphs

FSK-50 kbps



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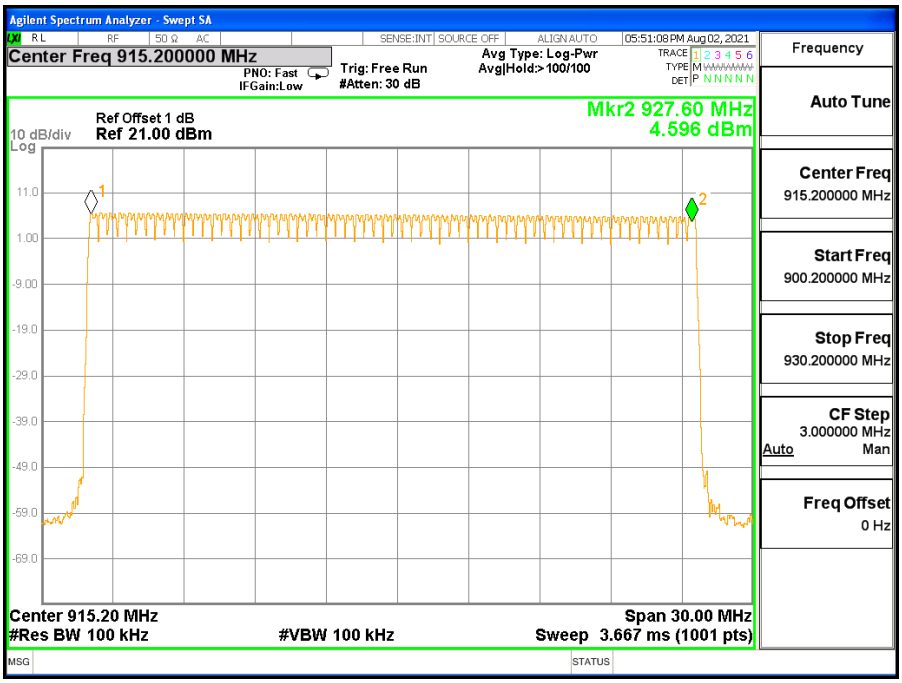
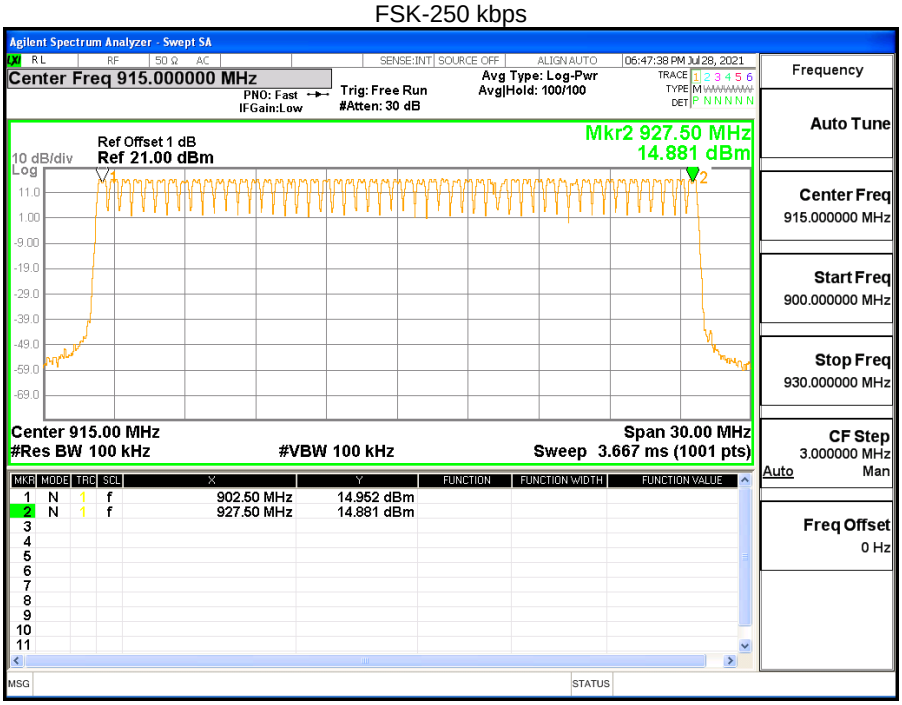
FSK-150 kbps



FSK-250 kbps



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APPENDIX G: TIME OF OCCUPANCY (DWELL TIME)

Test Result

Test Mode	Antenna	Channel	Burst Width [ms/hop/ch]	Dwell Time [s]	Limit [s]	Results
FSK-50 kbps	Ant1	Hop	62.9	0.19	0.4	PASS
FSK-150 kbps	Ant1	Hop	63.0	0.25	0.4	PASS
FSK-250 kbps	Ant1	Hop	62.9	0.13	0.4	PASS

Note:
FSK-50 kbps: The dwell time = Time of single slot * The number of hop channel appear within 20s
FSK-150 kbps & FSK-250 kbps: The dwell time = Time of single slot * The number of hop channel appear within 10s

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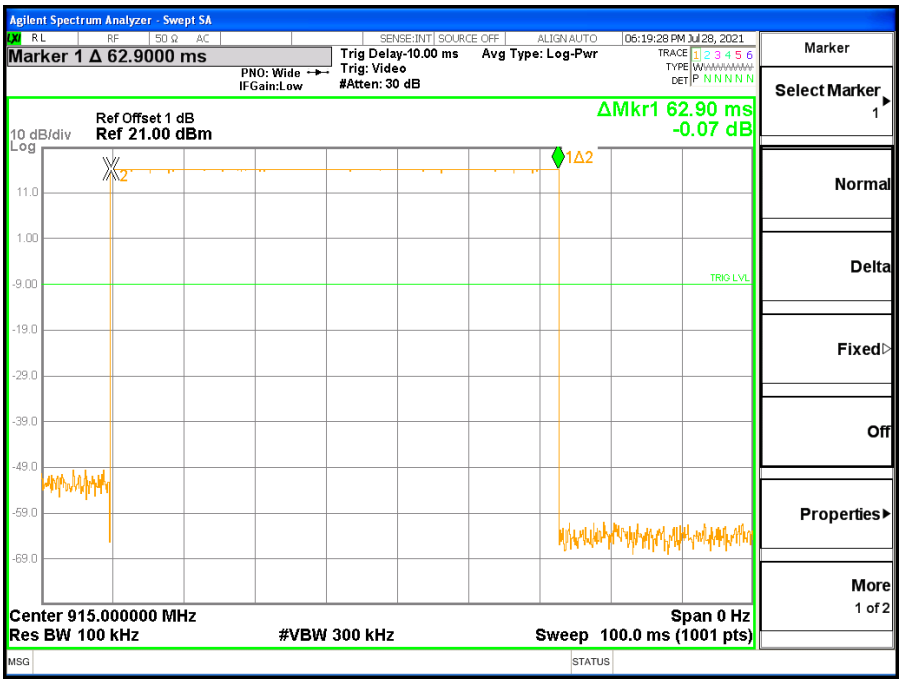
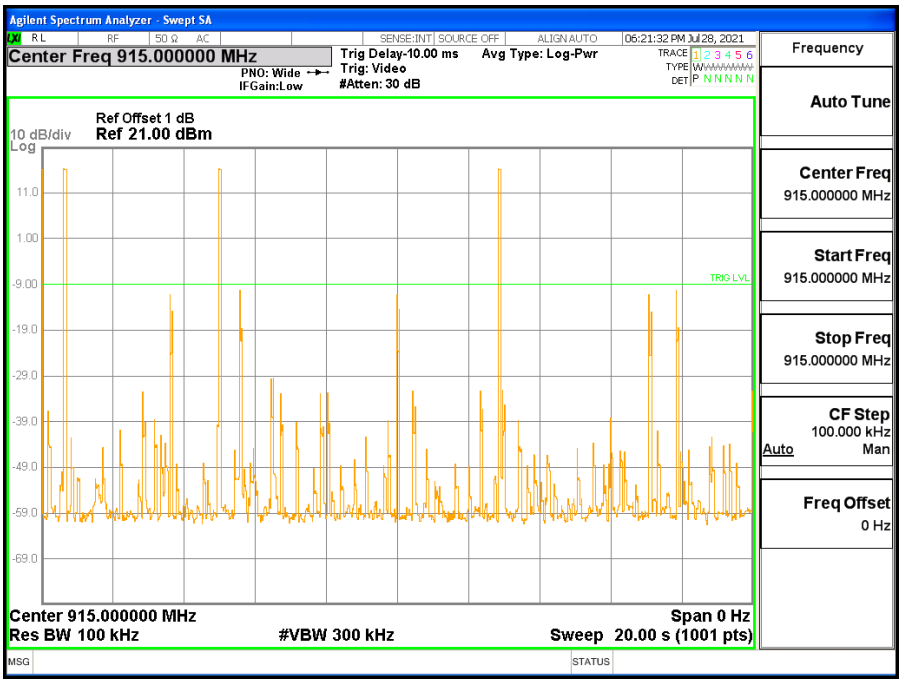
Test Graphs

Time of single slot, FSK-50 kbps



The number of hop channel appear, FSK-50 kbps



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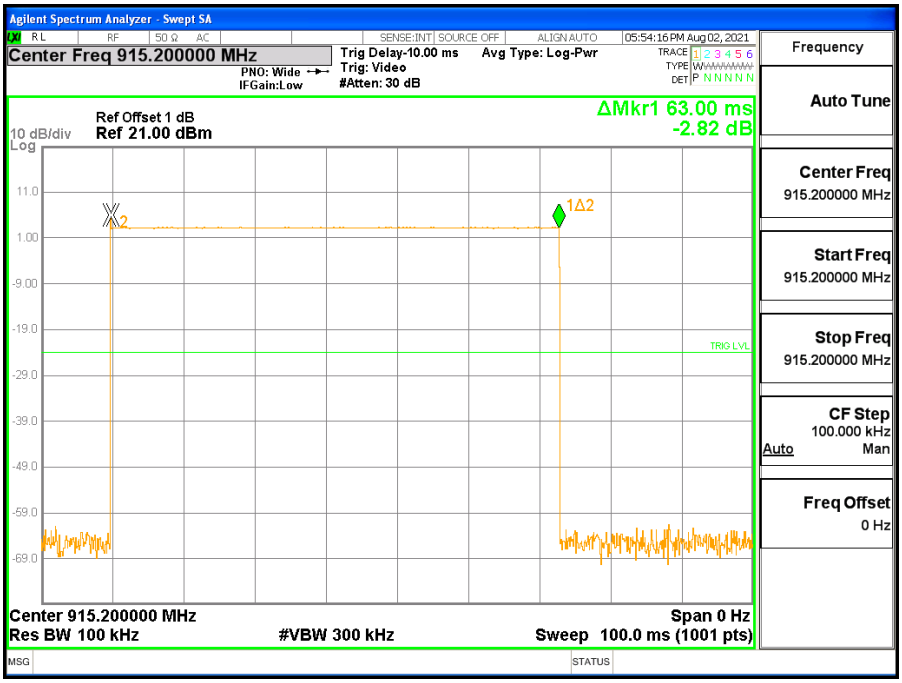
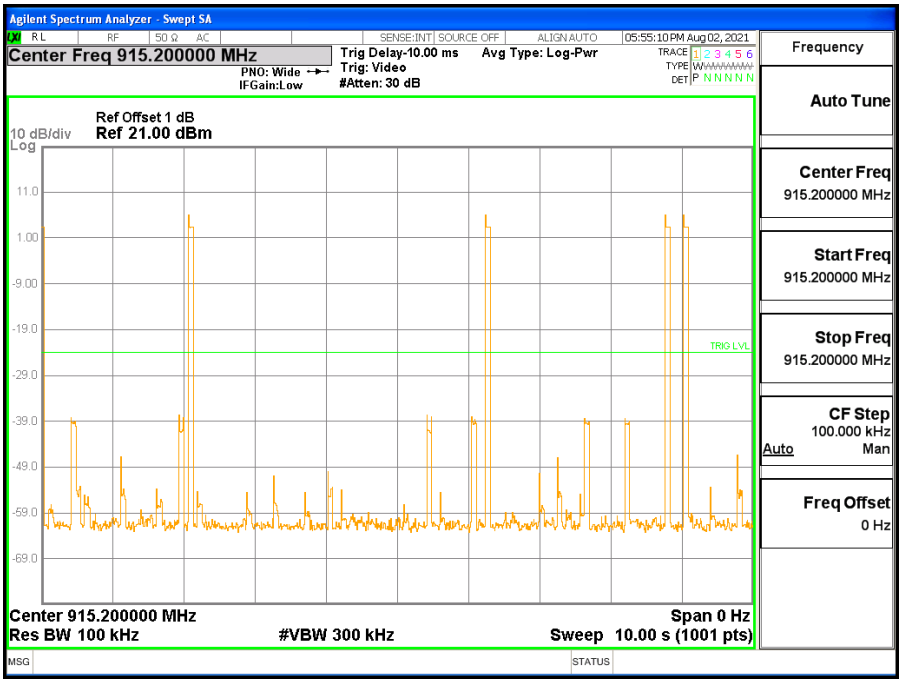
Time of single slot, FSK-150 kbps



The number of hop channel appear, FSK-150 kbps



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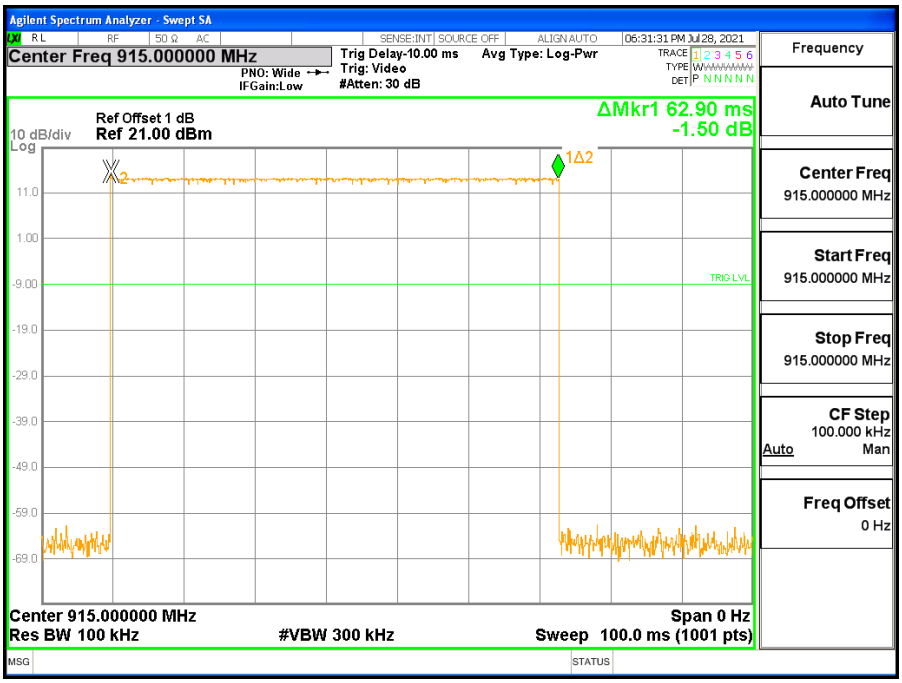
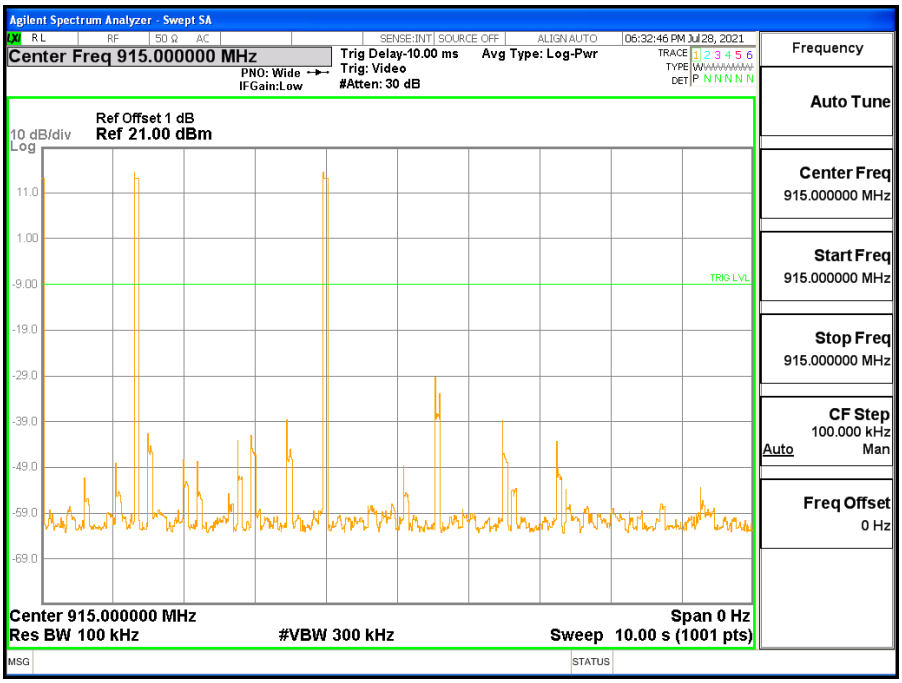
Time of single slot, FSK-250 kbps



The number of hop channel appear, FSK-250 kbps



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APPENDIX H: CONDUCTED SPURIOUS EMISSION

Test Result

Test Mode	Antenna	ChName	Test Result	Verdict
FSK-50 kbps	Ant1	Low	See the below graphs	PASS
		High		PASS
		Hop_Low		PASS
		Hop_High		PASS
FSK-150 kbps	Ant1	Low		PASS
		High		PASS
		Hop_Low		PASS
		Hop_High		PASS
FSK-250 kbps	Ant1	Low		PASS
		High		PASS
		Hop_Low		PASS
		Hop_High		PASS

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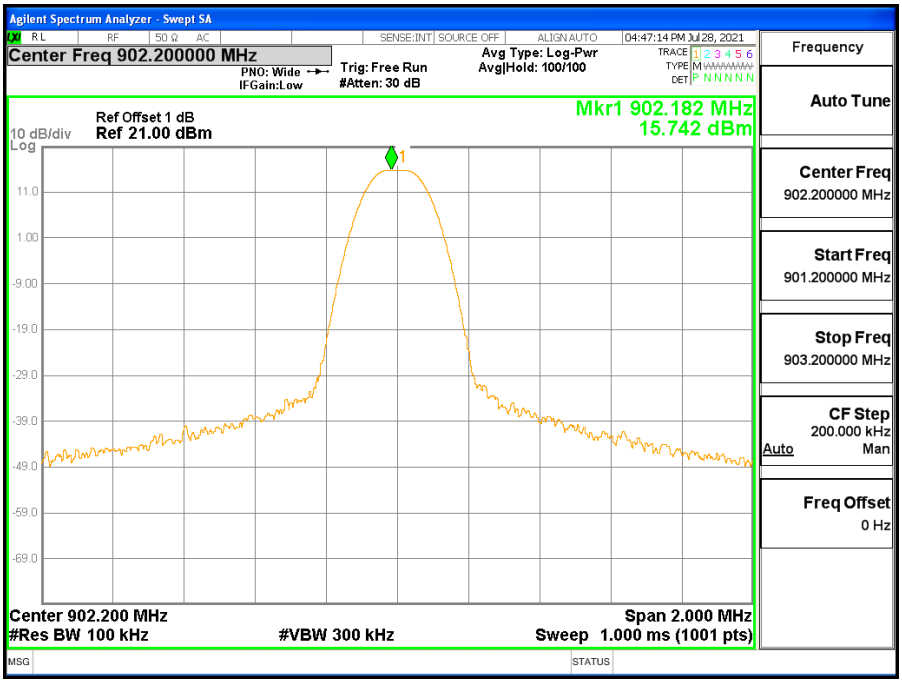
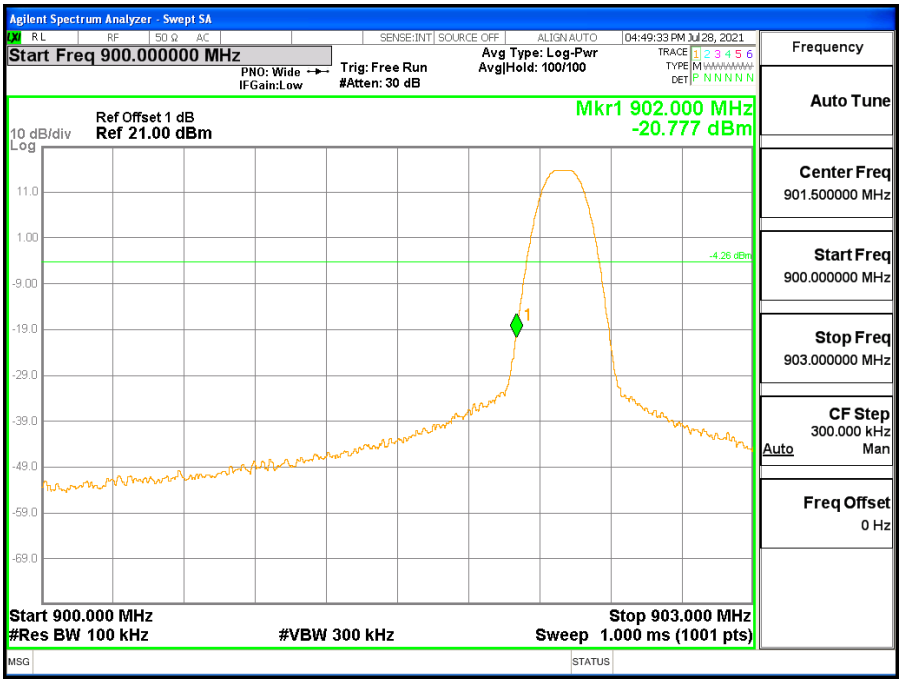
Test Graphs

FSK-50 kbps, Low CH, Reference



FSK-50 kbps, Low CH, Bandedge



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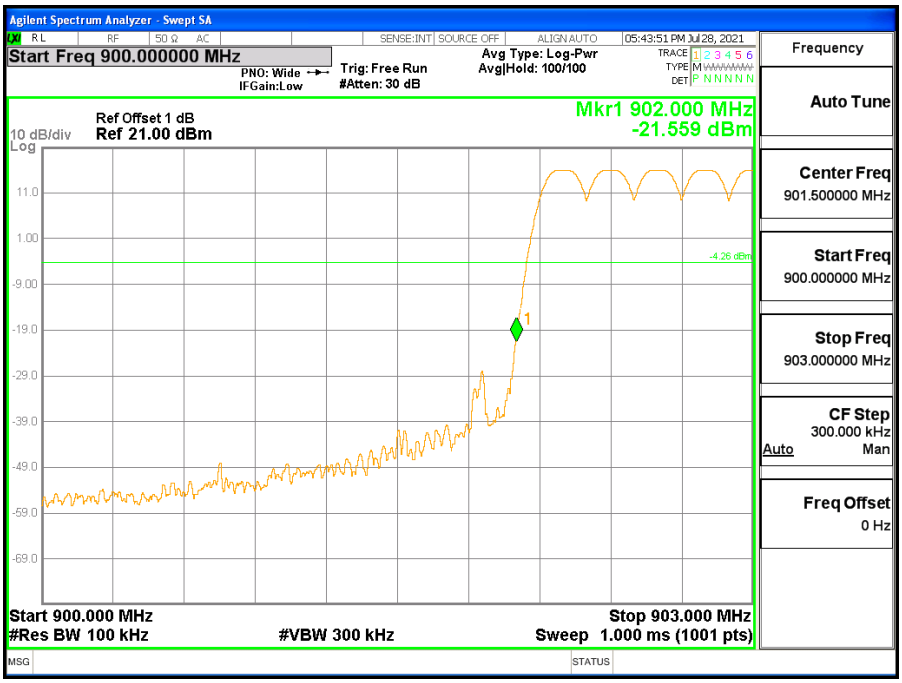
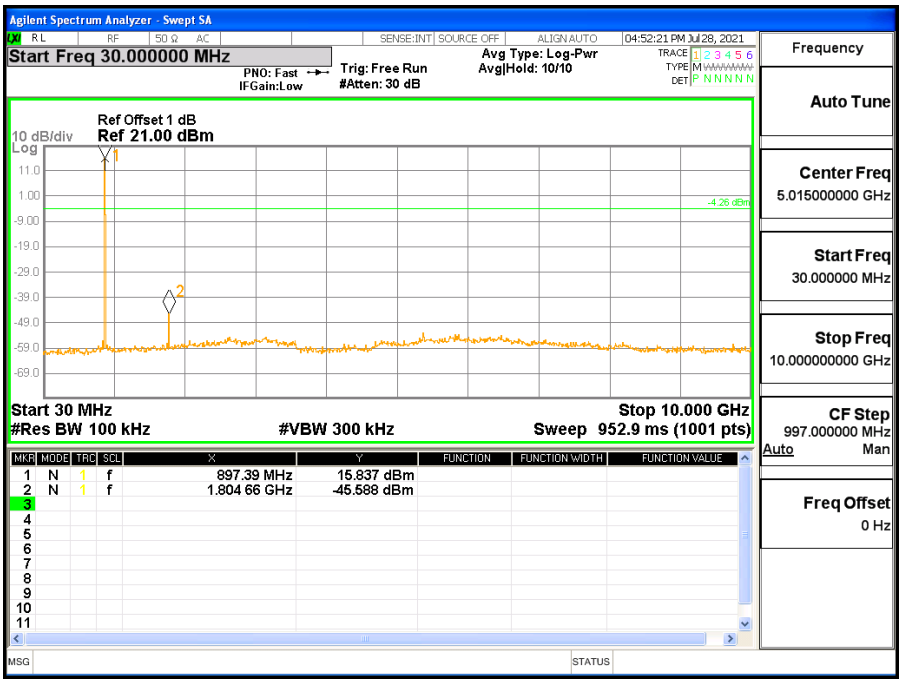
FSK-50 kbps, Low CH, Hopping on



FSK-50 kbps, Low CH, Spurious



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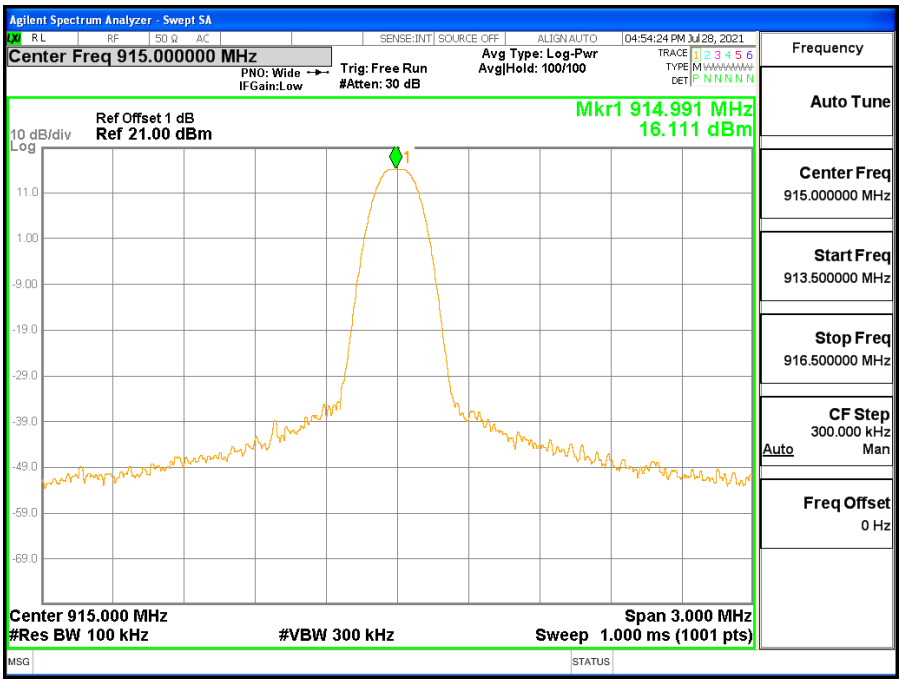
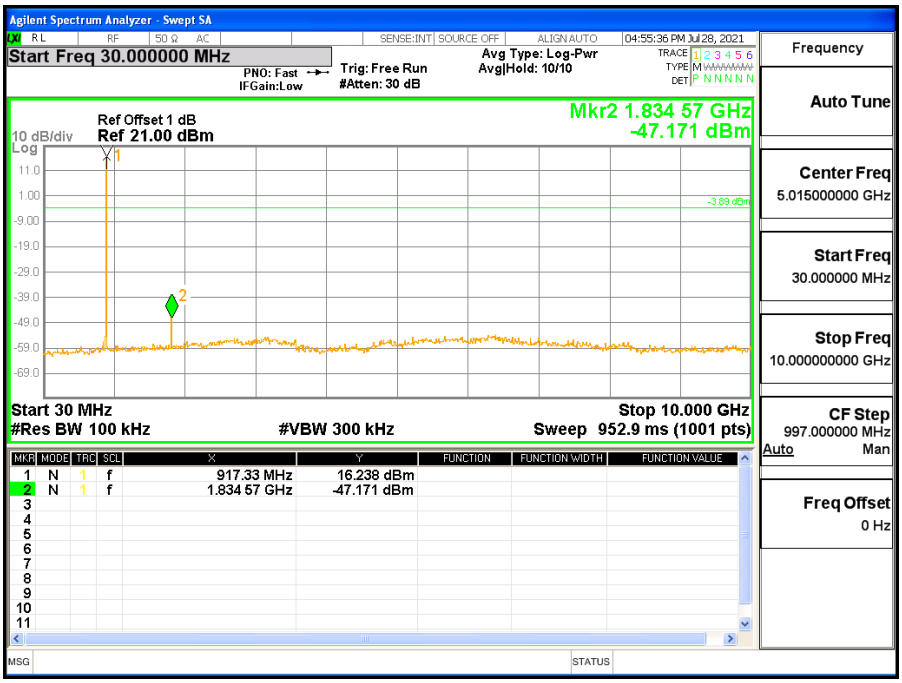
FSK-50 kbps, Mid CH, Reference



FSK-50 kbps, Mid CH, Spurious



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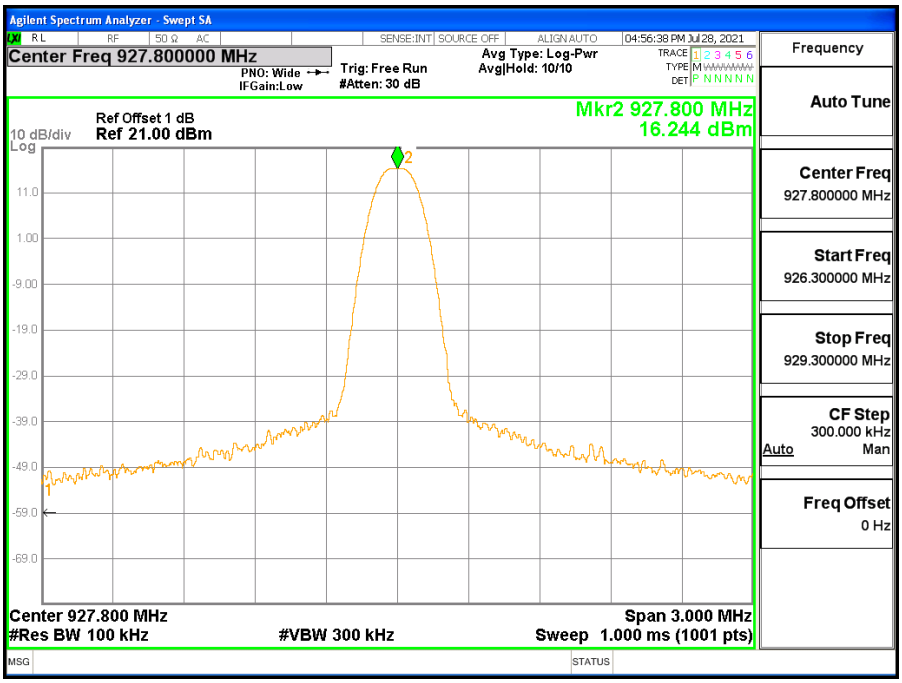
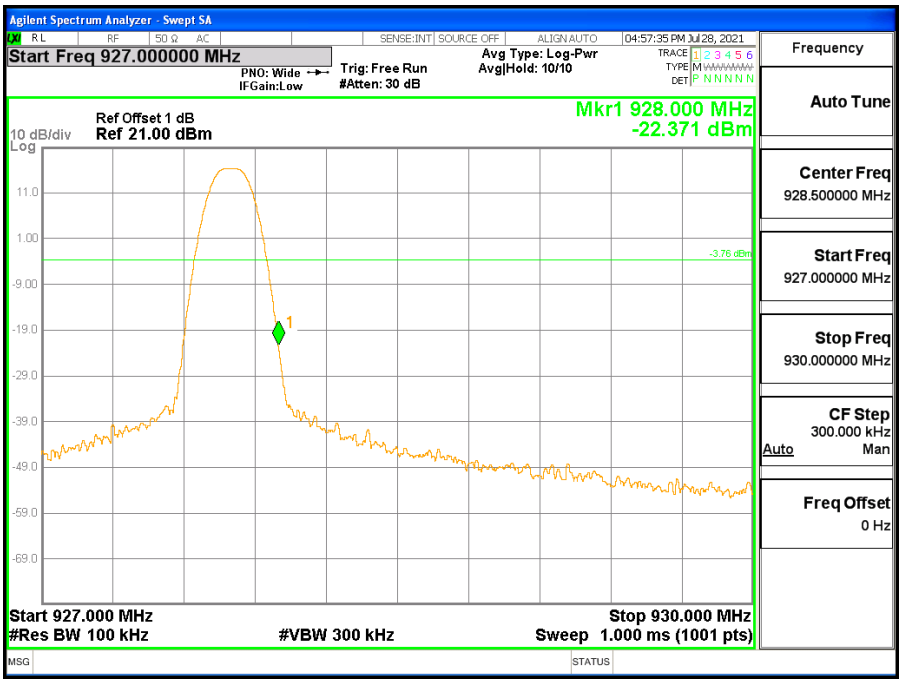
FSK-50 kbps, High CH, Reference



FSK-50 kbps, High CH, Bandedge



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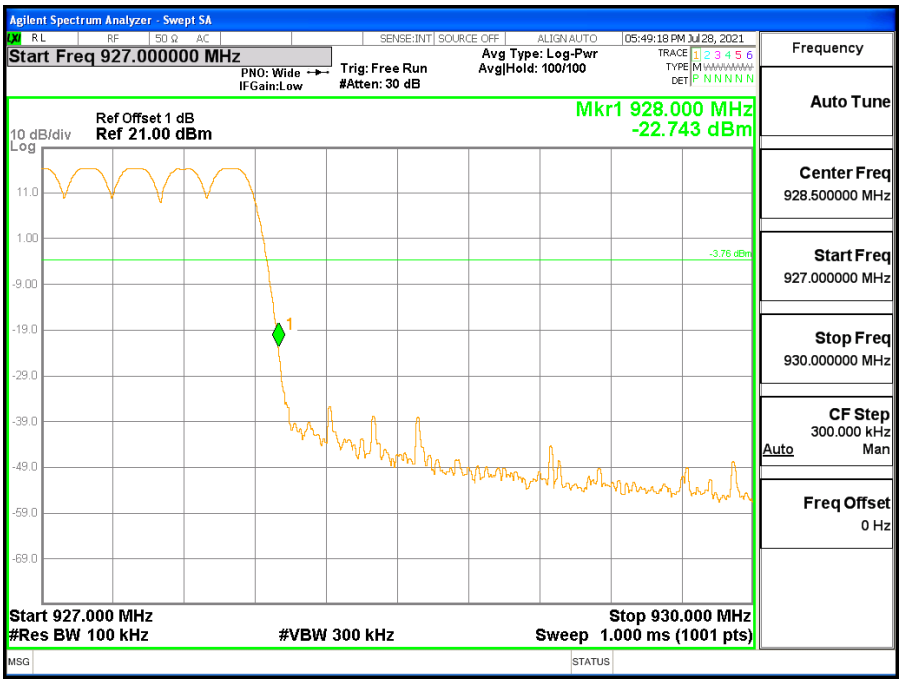
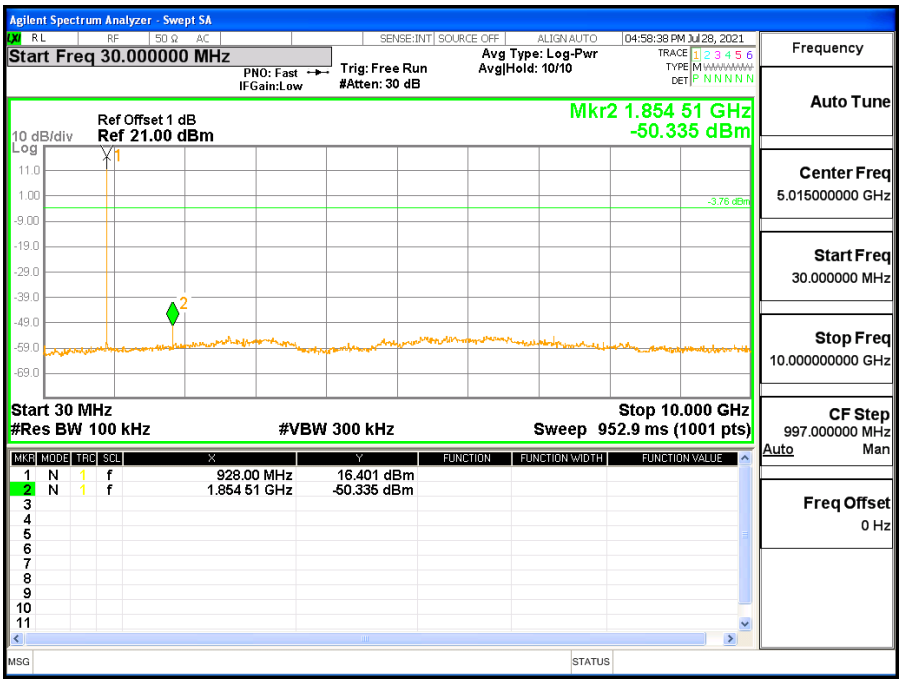
FSK-50 kbps, High CH, Hopping on



FSK-50 kbps, High CH, Spurious



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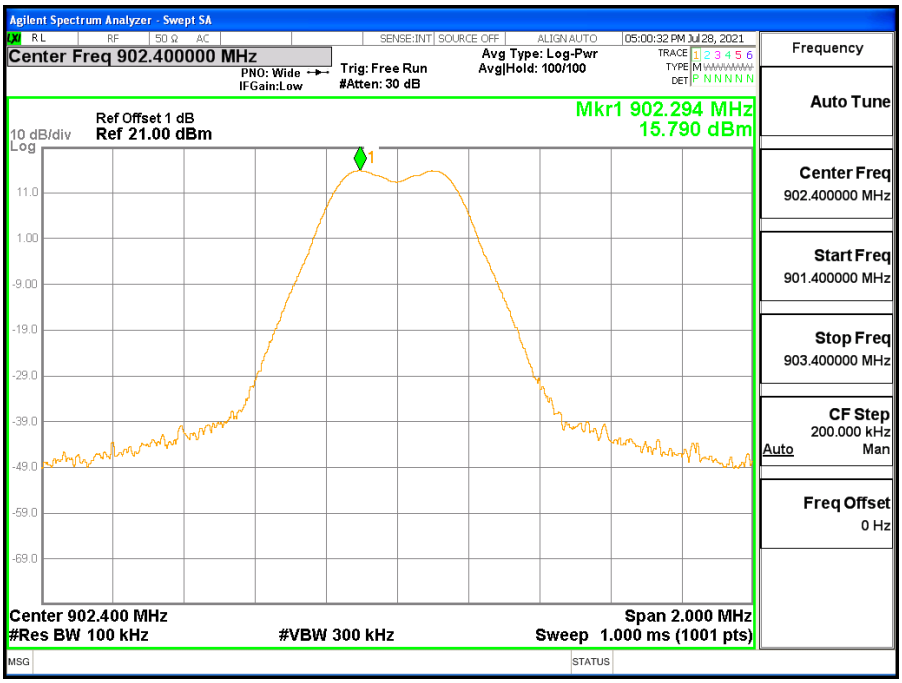
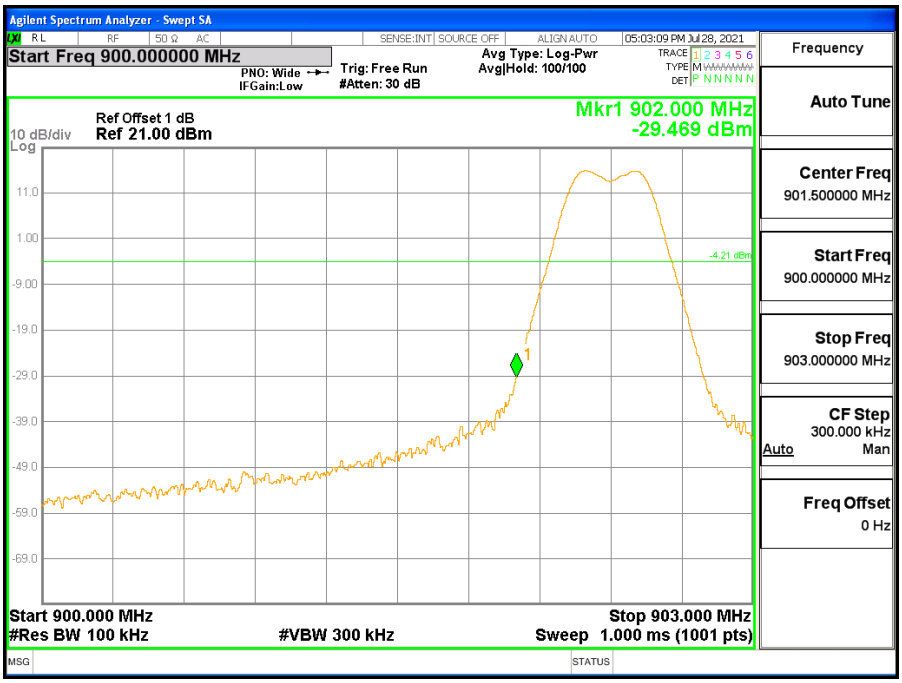
FSK-150 kbps, Low CH, Reference



FSK-150 kbps, Low CH, Bandedge



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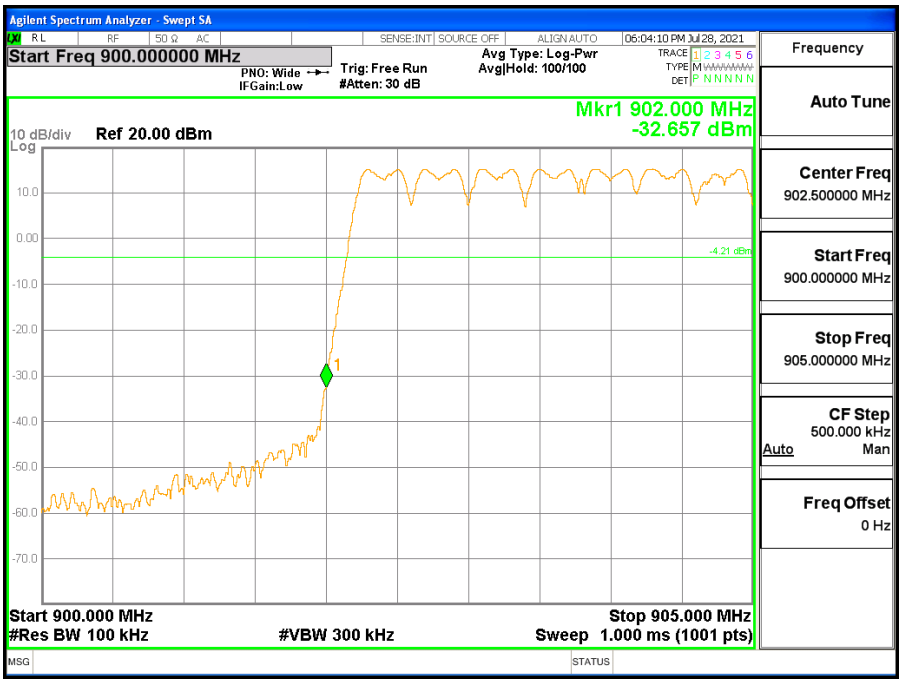
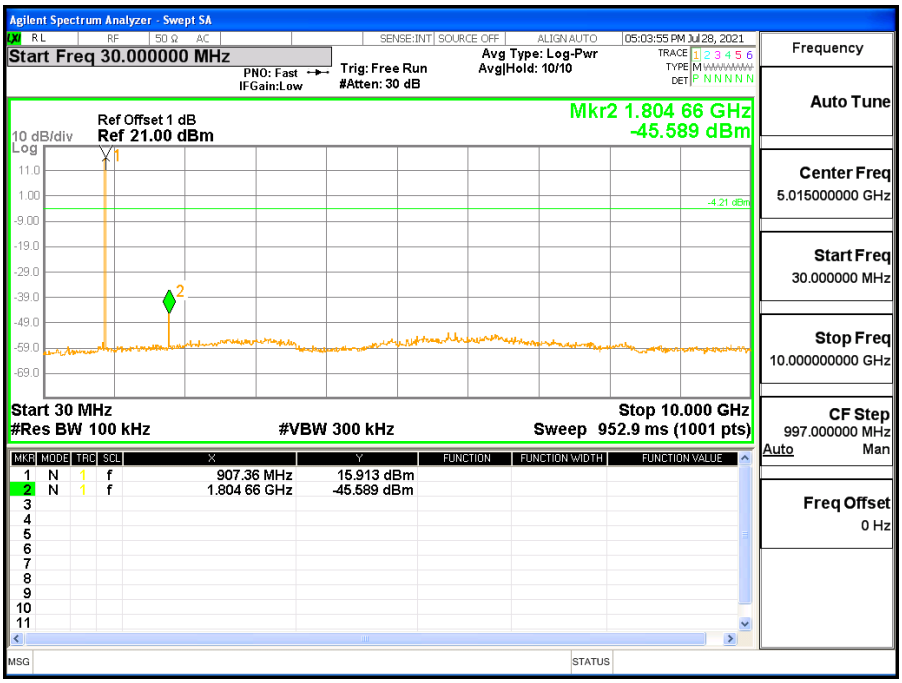
FSK-150 kbps, Low CH, Hopping on



FSK-150 kbps, Low CH, Spurious



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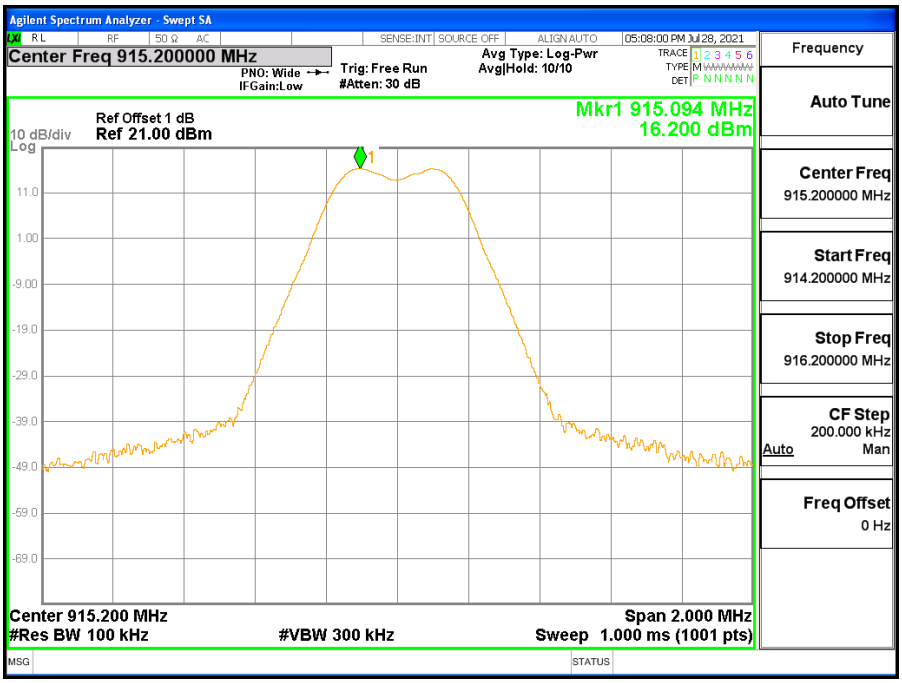
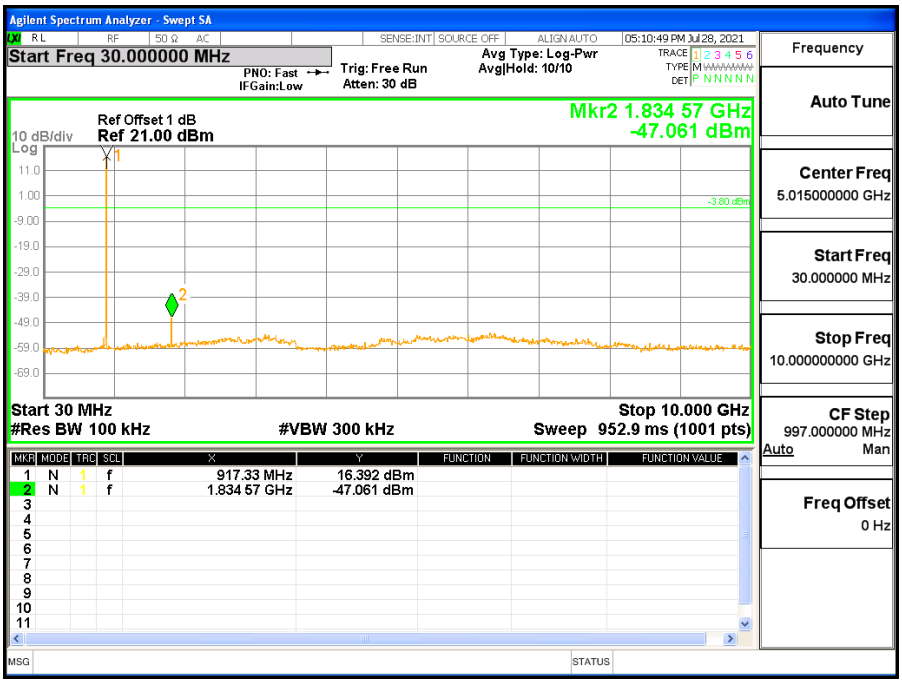
FSK-150 kbps, Mid CH, Reference



FSK-150 kbps, Mid CH, Spurious



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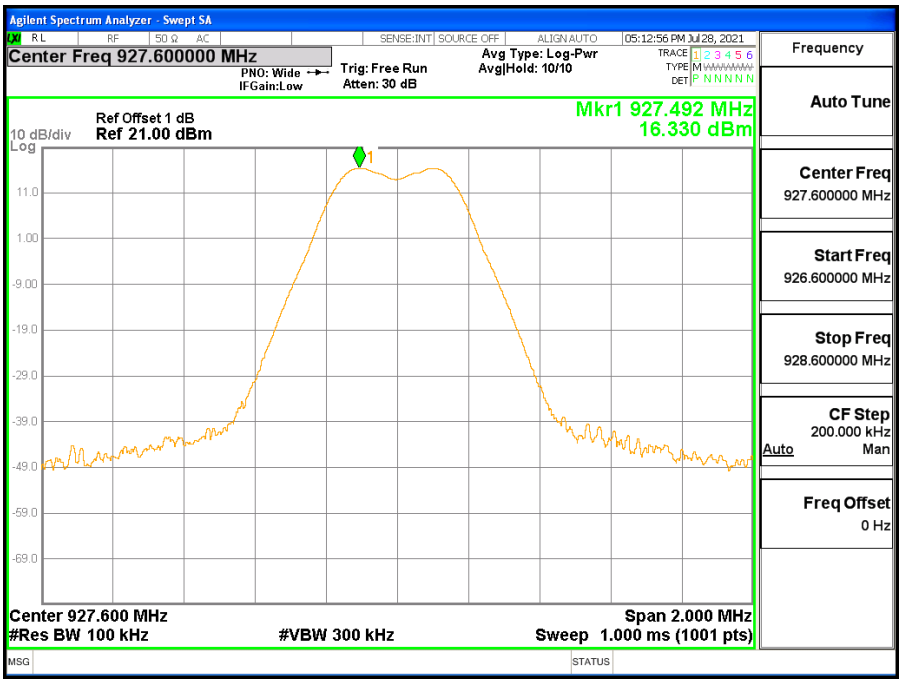
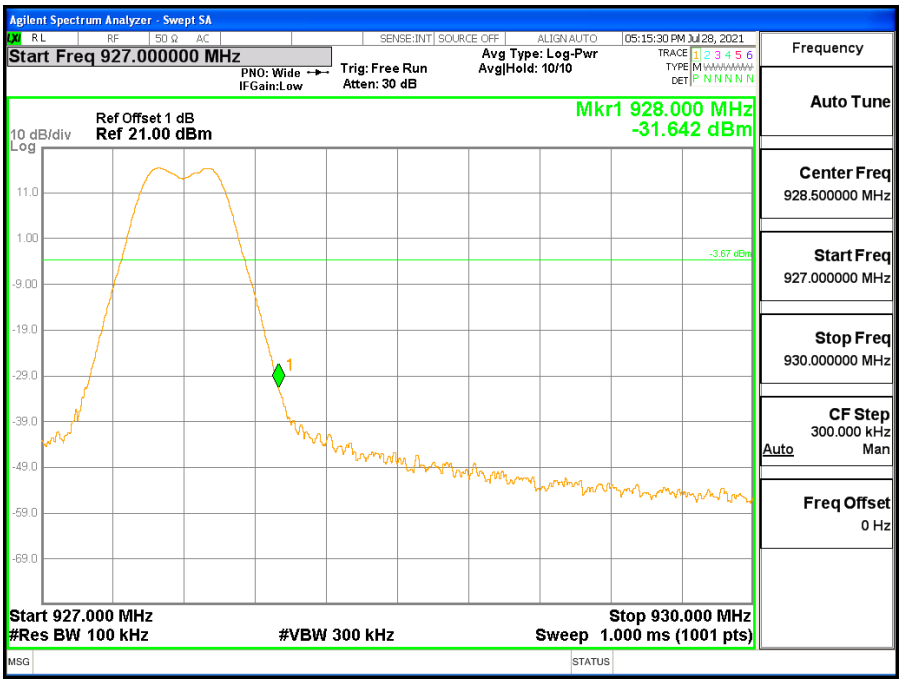
FSK-150 kbps, High CH, Reference



FSK-150 kbps, High CH, Bandedge



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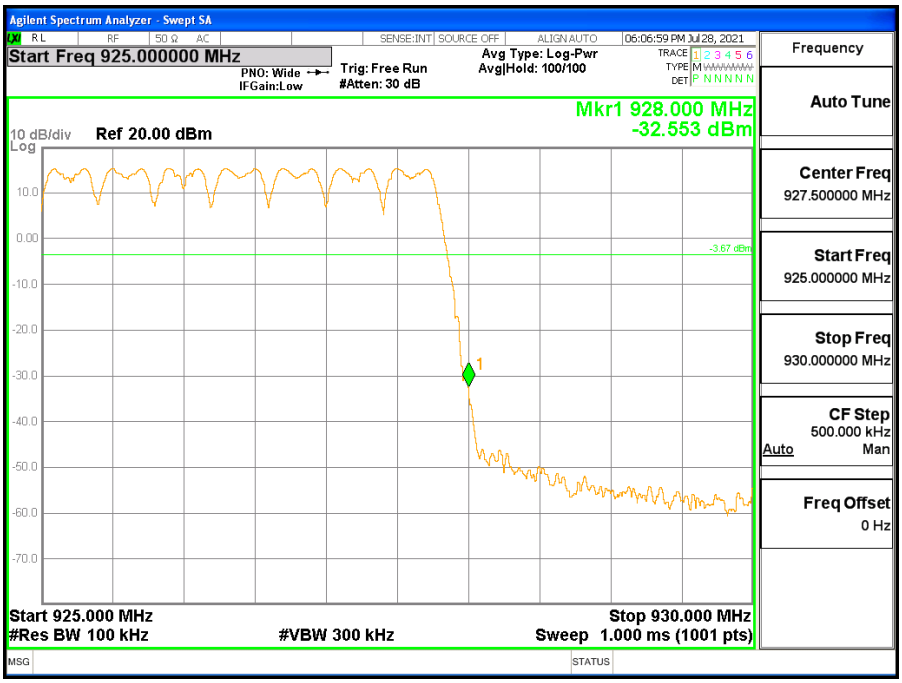
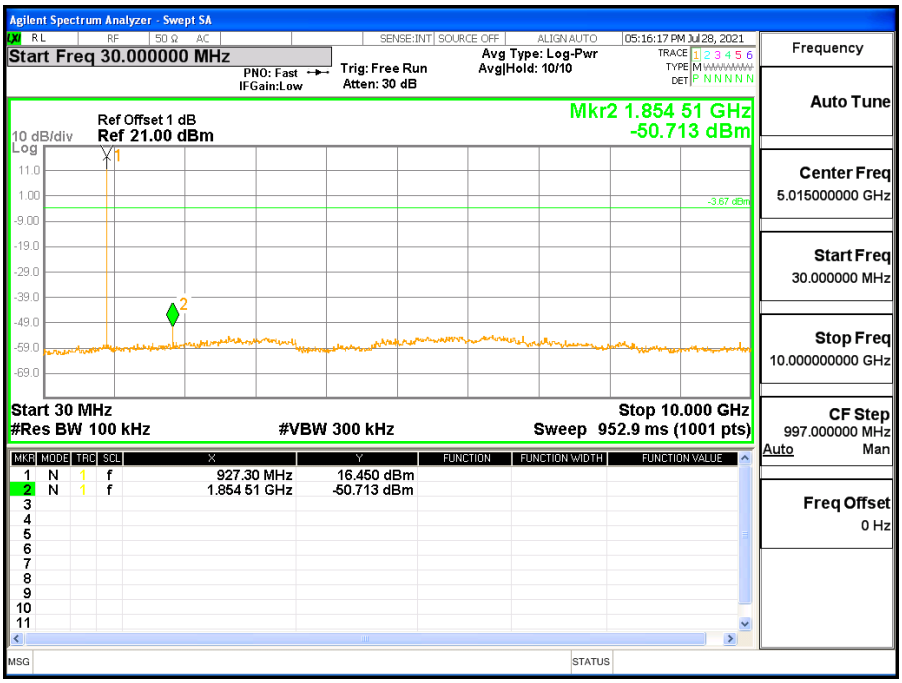
FSK-150 kbps, High CH, Hopping on



FSK-150 kbps, High CH, Spurious



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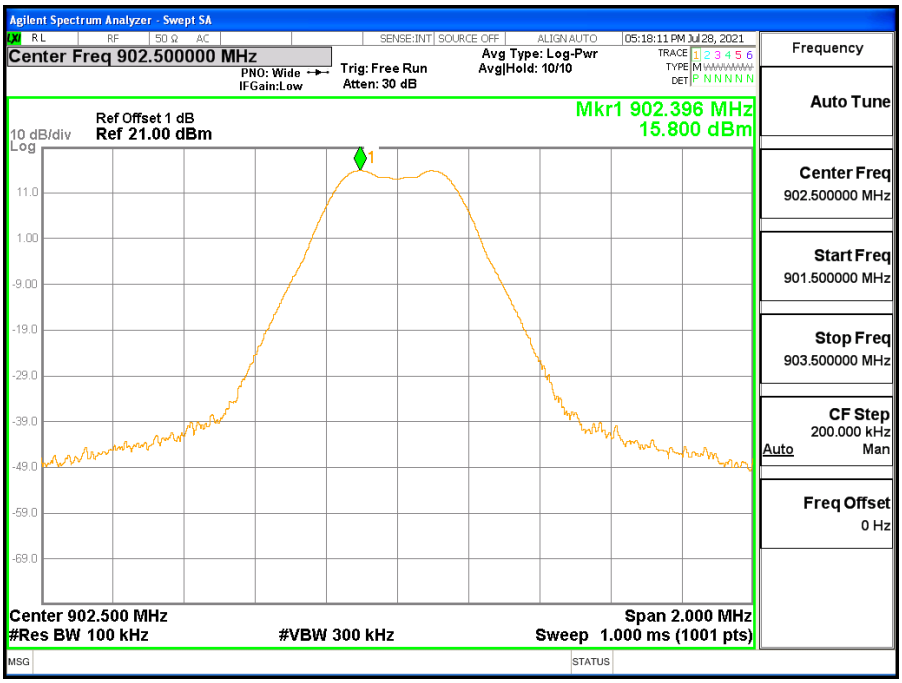
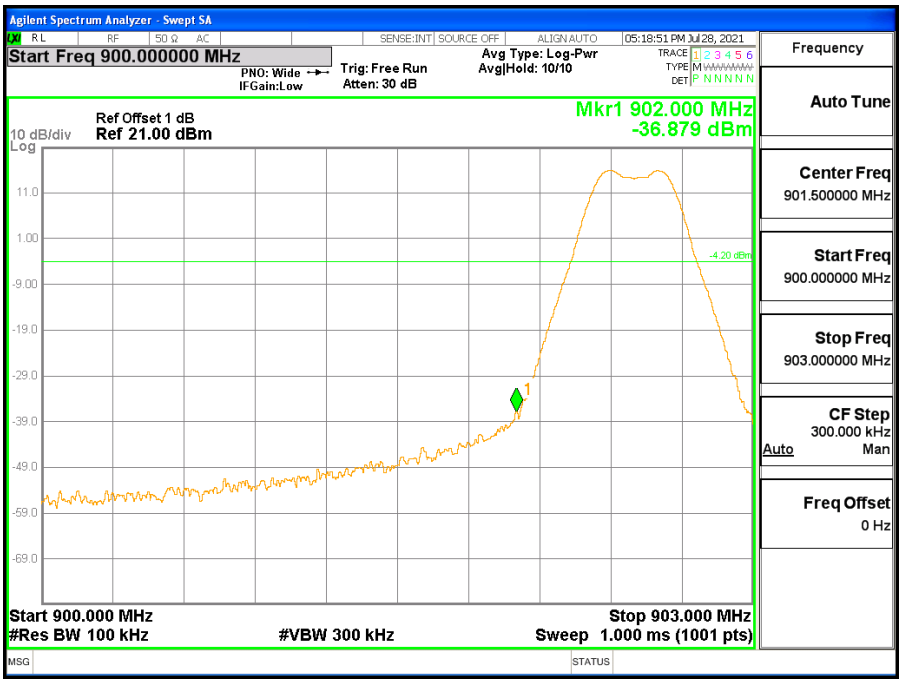
FSK-250 kbps, Low CH, Reference



FSK-250 kbps, Low CH, Bandedge



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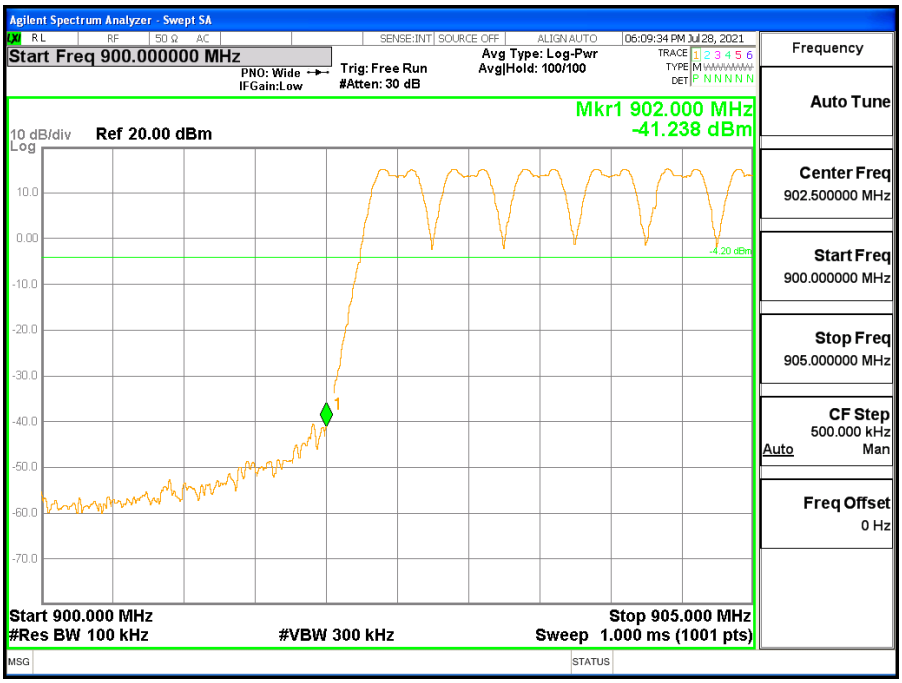
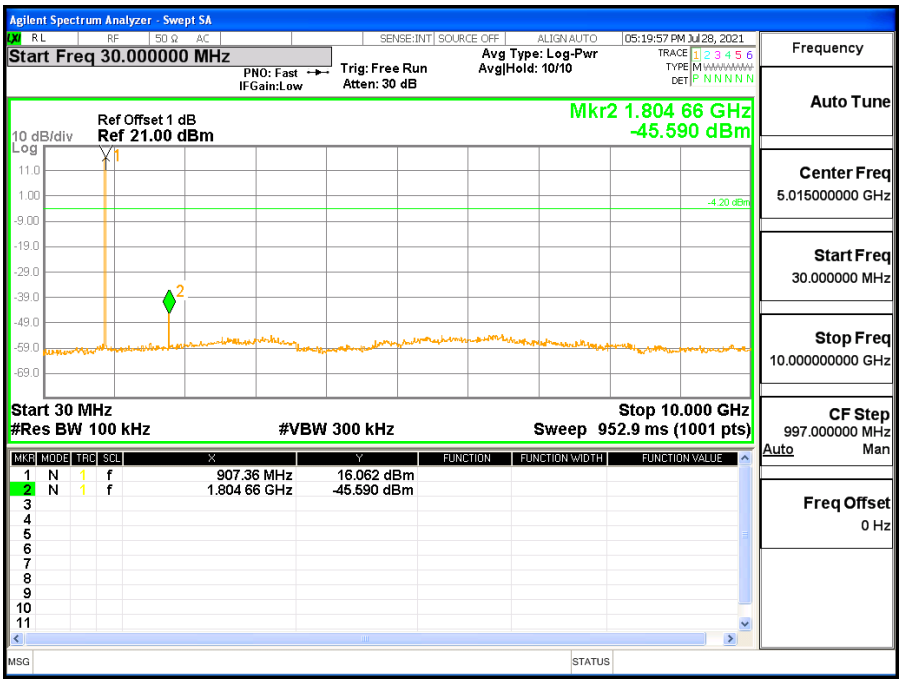
FSK-250 kbps, Low CH, Hopping on



FSK-250 kbps, Low CH, Spurious



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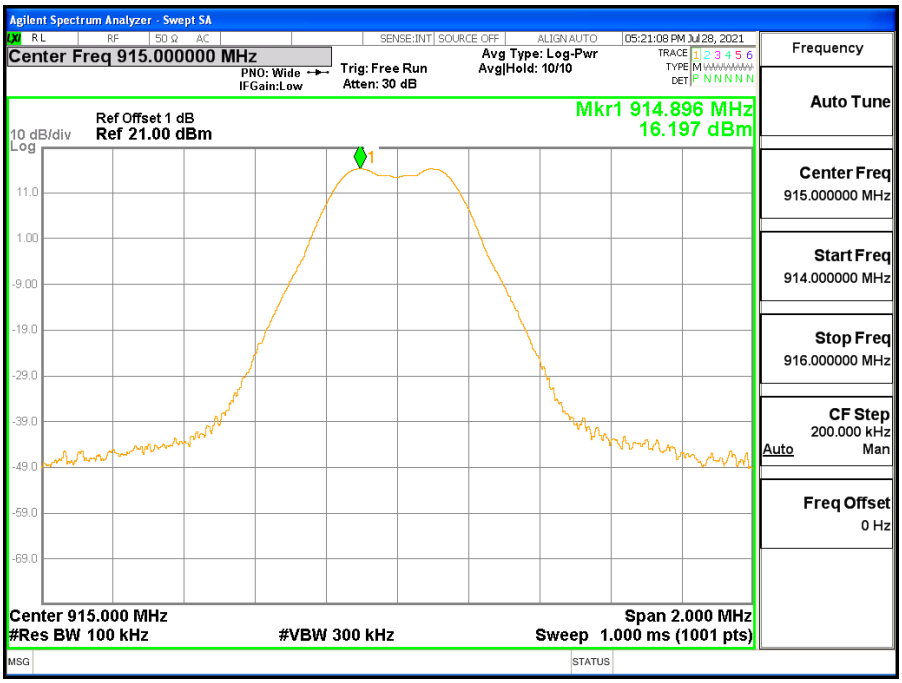
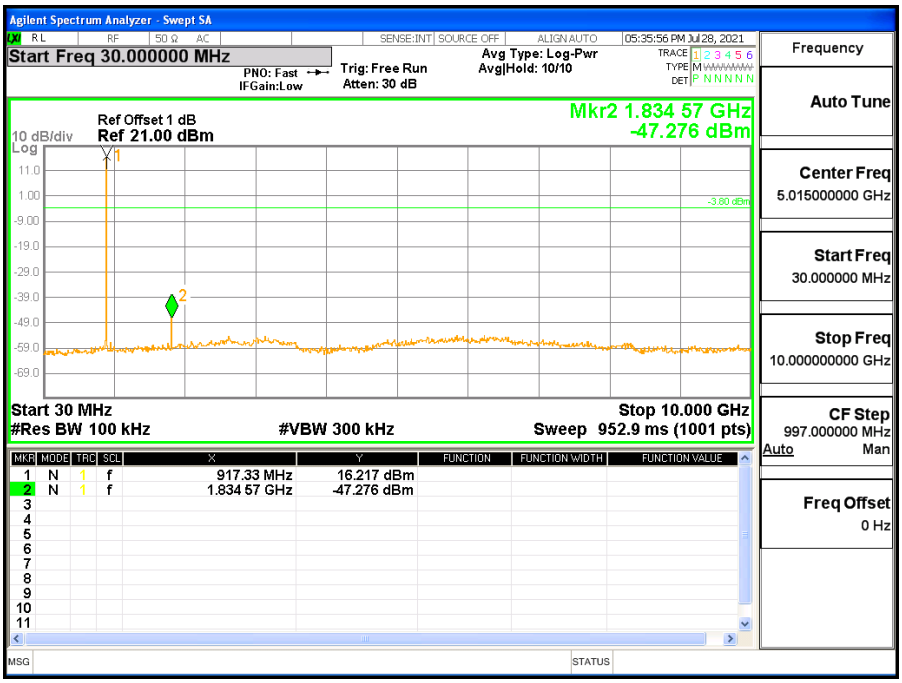
FSK-250 kbps, Mid CH, Reference



FSK-250 kbps, Mid CH, Spurious



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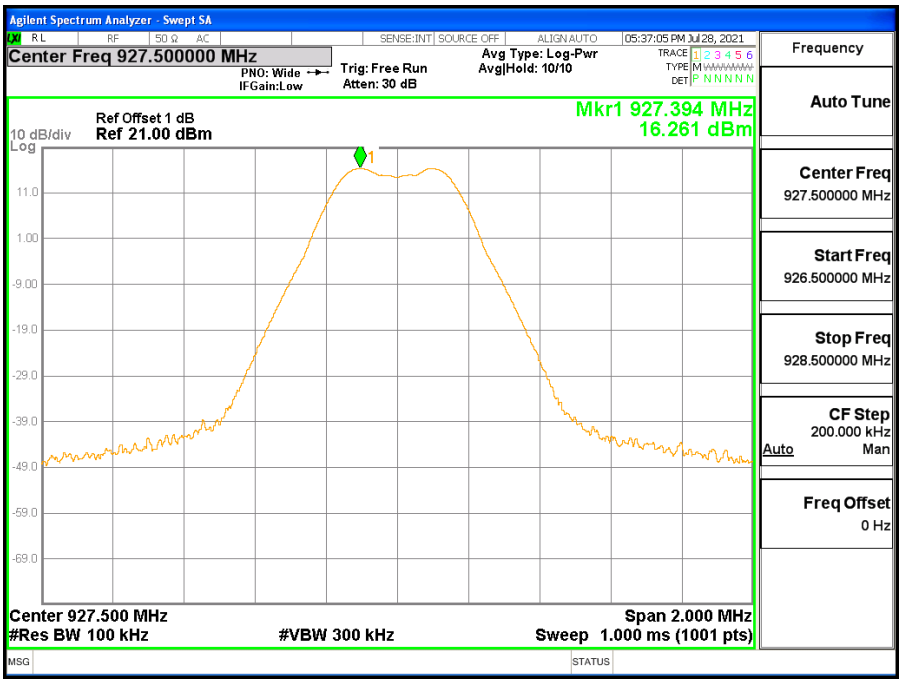
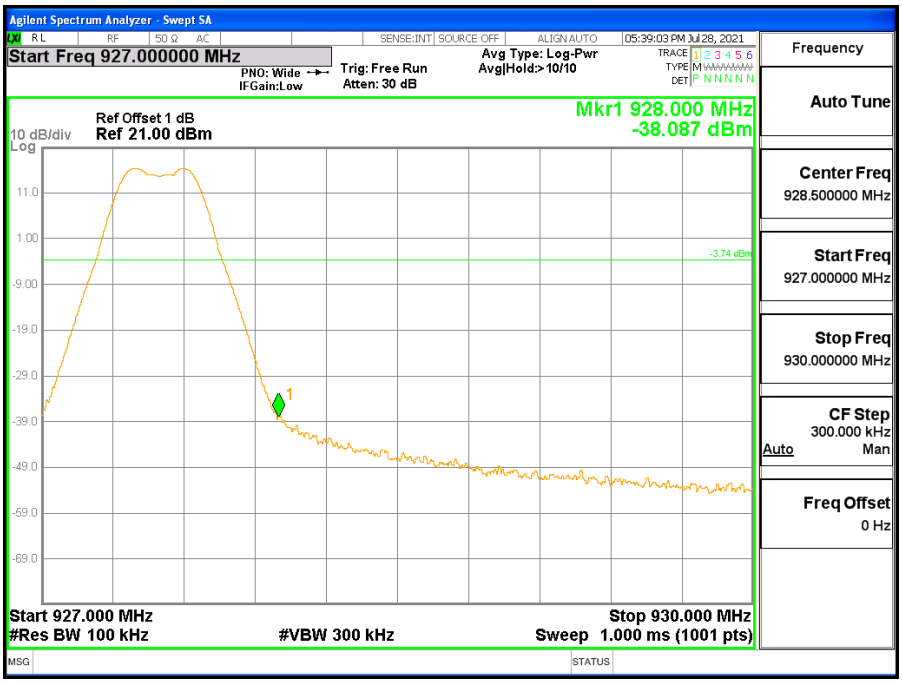
FSK-250 kbps, High CH, Reference



FSK-250 kbps, High CH, Bandedge



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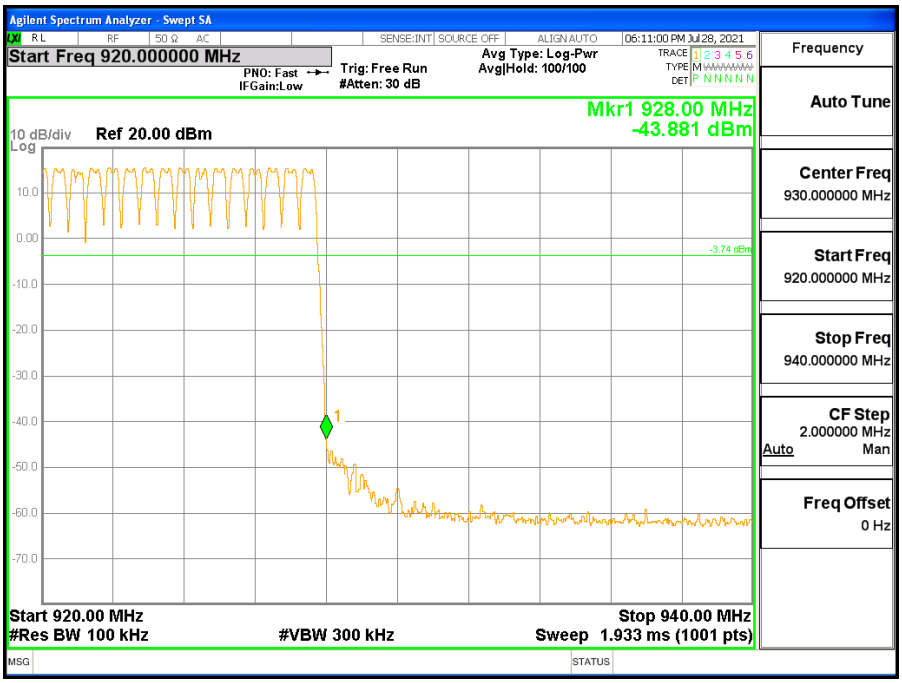
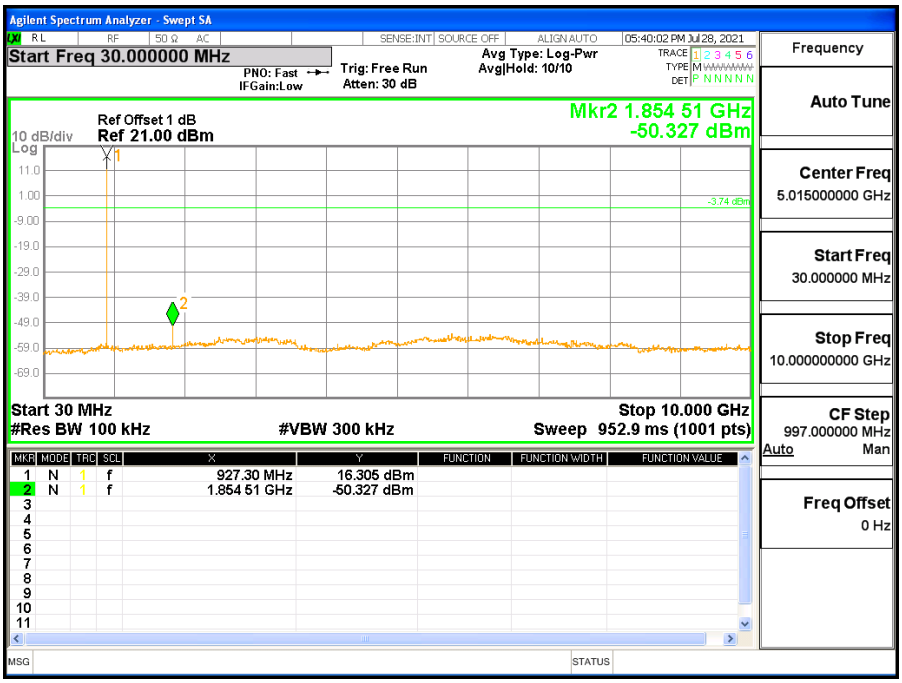
FSK-250 kbps, High CH, Hopping on



FSK-250 kbps, High CH, Spurious



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