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

CERTIFICATION TEST REPORT

For

Outdoor Siren

MODEL NUMBER: 5D22E2

FCC ID: 2AB2Q5D22E2

IC: 10256A-5D22E2

REPORT NUMBER: 4789787464-2

ISSUE DATE: March 3, 2021

Prepared for

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

Prepared by

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Revision History

Rev.	Issue Date	Revisions	Revised By
V0	03/03/2021	Initial Issue	

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	Conducted Emission Test for AC Power Port	FCC 15.207 RSS-GEN Clause 8.8	Pass
9	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 Siren
Model:	5D22E2
Brand:	ring
Sample Received Date:	January 22, 2021
Sample Status:	Normal
Sample ID:	3572444
Date of Tested:	January 22, 2021 ~ March 3, 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

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Checked By:

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Approved By:

Stephen Guo
Laboratory Manager

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.

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.	

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

EUT Name	Outdoor Siren		
Model	5D22E2		
Power Supply	Power Adapter	Input	100-240 V~ 50/60 Hz 0.5A
		Output	24.0 V 0.5 A 12.0 W
	Battery	DC 3.65 V 6040 mAh 22.046 Wh DC 1.5 V * 3	

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	GFSK		

5.2. MAXIMUM PEAK OUTPUT POWER

Data Rate	Number of Channels	Maximum Peak Output Power (dBm)	Maximum EIRP (dBm)
50 kbps	129	11.79	15.69
150 kbps	64	11.78	15.68
250 kbps	51	11.83	15.73

5.3. TEST CHANNEL CONFIGURATION

Test Mode	Test Channel	Frequency
GFSK-50 kbps	CH 0(Low Channel), CH 64(MID Channel), CH 129(High Channel)	902.2 MHz, 915 MHz, 927.8 MHz
GFSK-250 kbps	CH 193(Low Channel), CH 218(MID Channel), CH 243(High Channel)	902.5 MHz, 915 MHz, 927.5 MHz
GFSK-50 kbps	Hopping	902.2 - 927.8 MHz
GFSK-250 kbps	Hopping	902.5 – 927.5 MHz

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	/	/

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	/	/

5.5. WORST-CASE CONFIGURATIONS

Modulation Technology	Modulation Type	Data Rate
FHSS	GFSK	50 kbps
FHSS	GFSK	250 kbps

Note: Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates. Only 50 kbps and 250 kbps test data were report in this report.

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
GGFSK-50 kbps	1	80(raw)	80(raw)	80(raw)
GGFSK-250 kbps	1	80(raw)	80(raw)	80(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	3.9

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

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

5.8. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Item	Equipment	Brand Name	Model Name	Remarks
1	Laptop	Lenovo	TP00094A	/
2	Plug-In Adapter	/	DSA-12PF16-24 FUS	Input: 100-240 V~ 50/60 Hz 0.5 A Output: 24.0 V0.5 A 12.0 W
3	Solar Panel V5	ring	8ASPS7	Max Power: 2.4 W, Max voltage: 5.2 Vdc, Max current: 460 mA
4	UART	/	/	/

I/O PORT

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

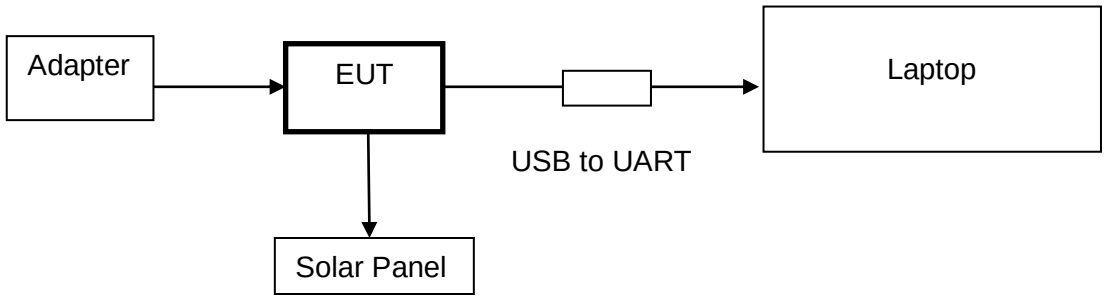
ACCESSORY

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



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	130960	Aug. 11, 2018	Aug. 10, 2021
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	#691	Aug. 11, 2018	Aug. 11, 2021
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

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

7. ANTENNA PORT TEST RESULTS

7.1. ON TIME AND DUTY CYCLE

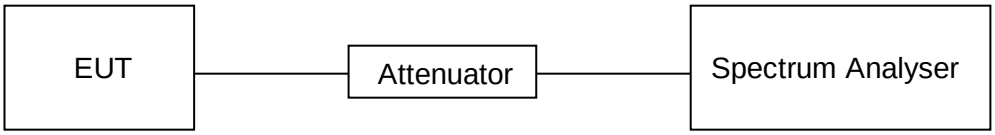
LIMITS

None; for reporting purposes only.

PROCEDURE

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

TEST SETUP



TEST ENVIRONMENT

Temperature	23.1 °C	Relative Humidity	53.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

Please refer to appendix A.

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

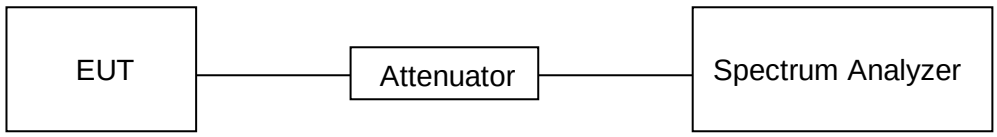
TEST PROCEDURE

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



TEST ENVIRONMENT

Temperature	23.1 °C	Relative Humidity	53.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

Please refer to appendix B and C.

7.3. CONDUCTED OUTPUT POWER

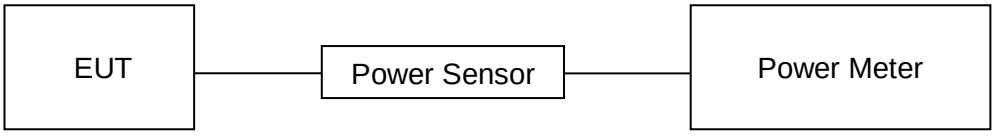
LIMITS

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	23.1 °C	Relative Humidity	53.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

Please refer to appendix D.

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

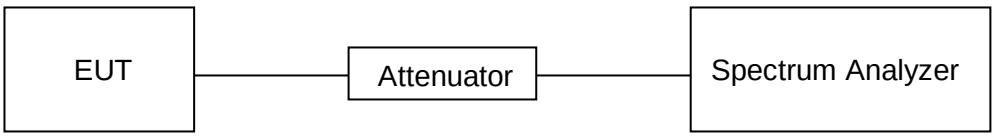
TEST PROCEDURE

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



TEST ENVIRONMENT

Temperature	23.1 °C	Relative Humidity	53.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

Please refer to Appendix E.

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

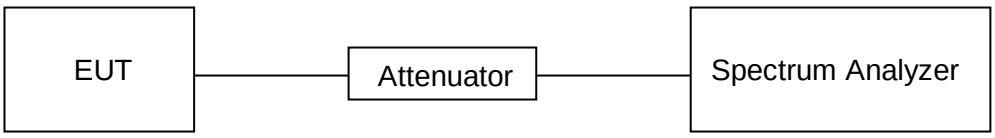
TEST PROCEDURE

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



TEST ENVIRONMENT

Temperature	23.1 °C	Relative Humidity	53.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

Please refer to appendix F.

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.

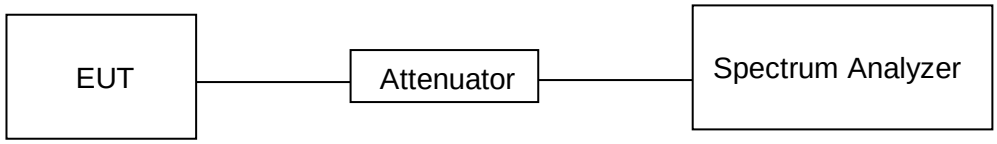
TEST PROCEDURE

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



TEST ENVIRONMENT

Temperature	23.1 °C	Relative Humidity	53.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

Please refer to appendix G.

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.

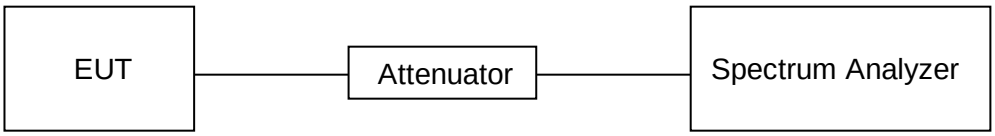
Allow trace to fully stabilize and use the peak marker function to determine the maximum PSD level.

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.

TEST SETUP



TEST ENVIRONMENT

Temperature	23.1 °C	Relative Humidity	53.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

Please refer to appendix H.

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.

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.

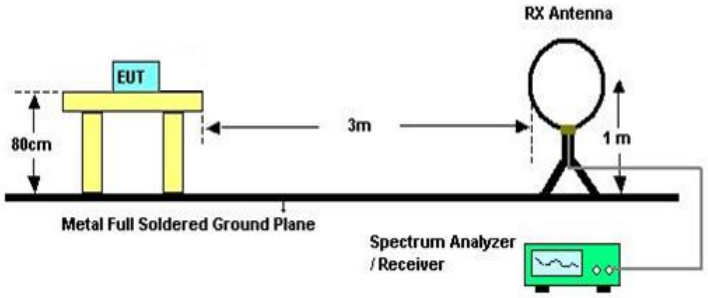
FCC Restricted bands of operation refer to FCC §15.205 (a):

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

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.

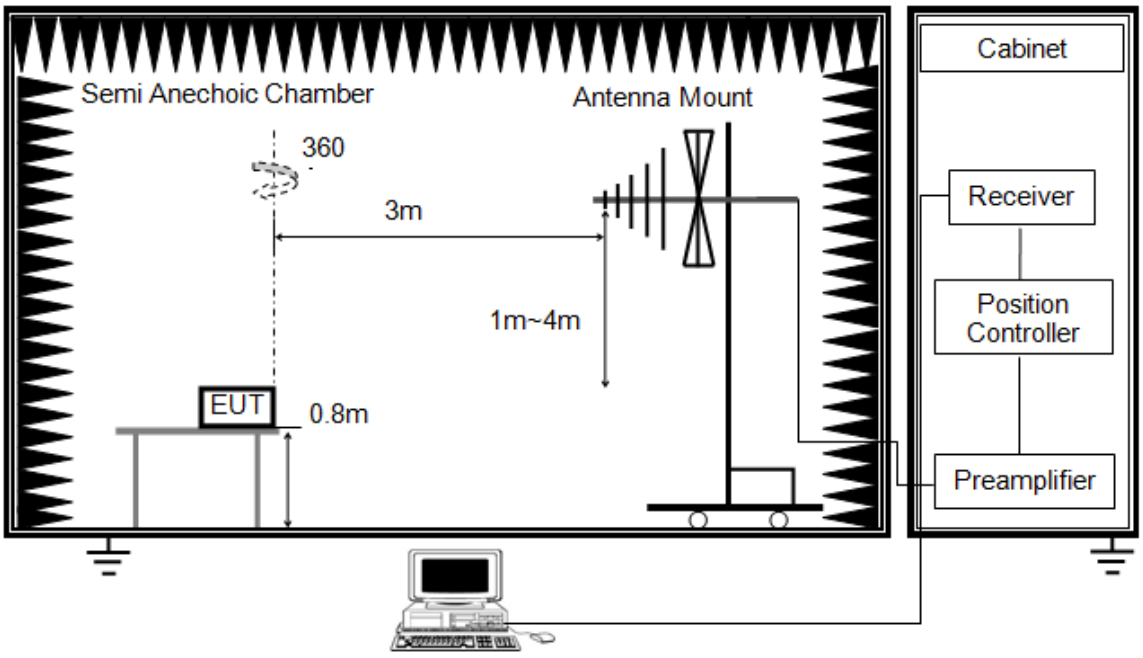
5. The radiated emission limits are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

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.

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.

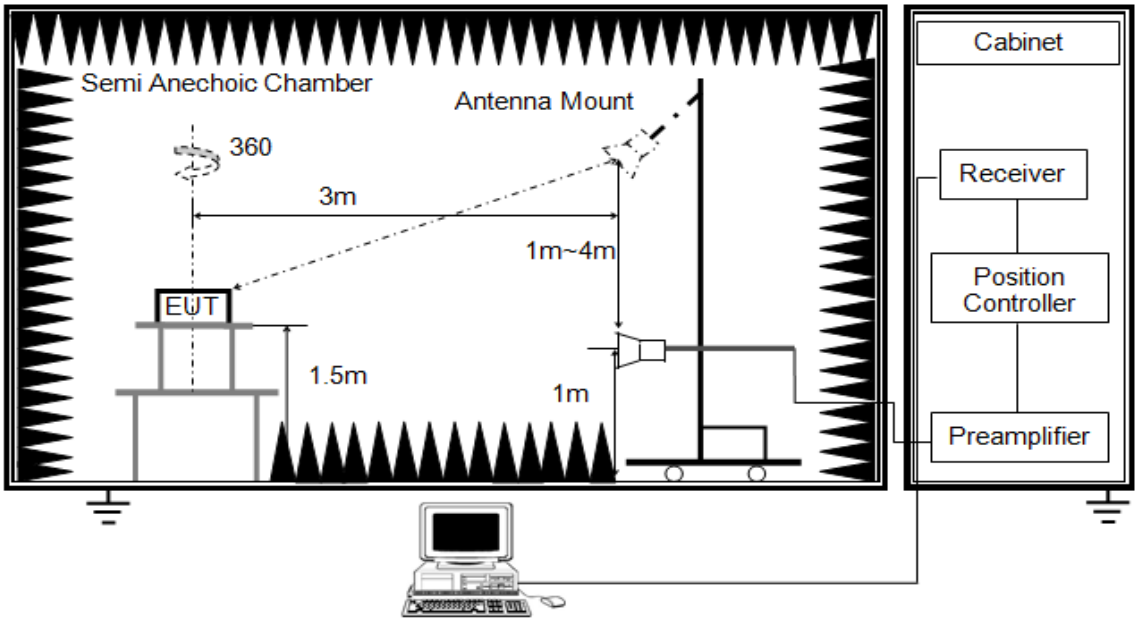
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level. Both horizontal and vertical polarizations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

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.

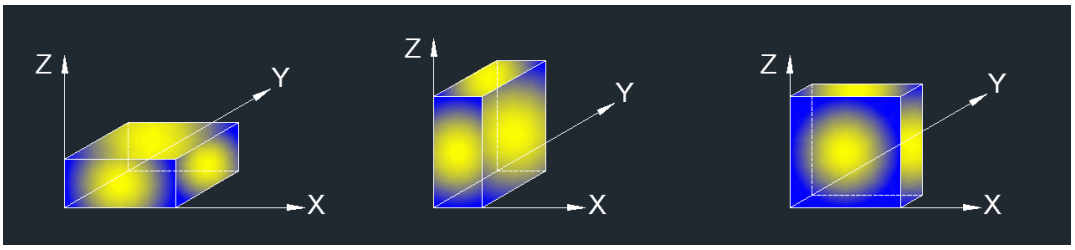
3. The EUT was placed on a turntable with 1.5 m above ground.

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.

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

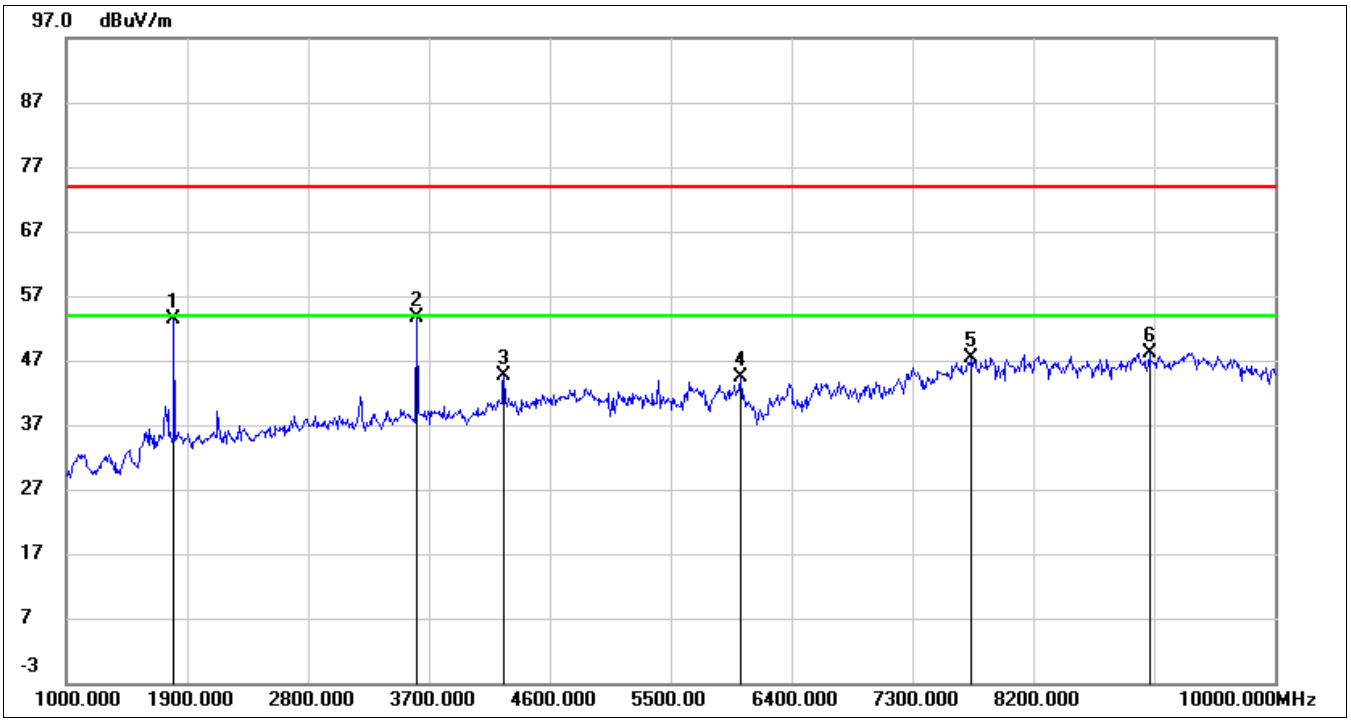
Temperature	23.7 °C	Relative Humidity	51.2 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V / 60 Hz

RESULTS

8.1. SPURIOUS EMISSIONS (1 GHz ~ 10 GHz)

8.1.1. GFSK - 50 kbps MODE

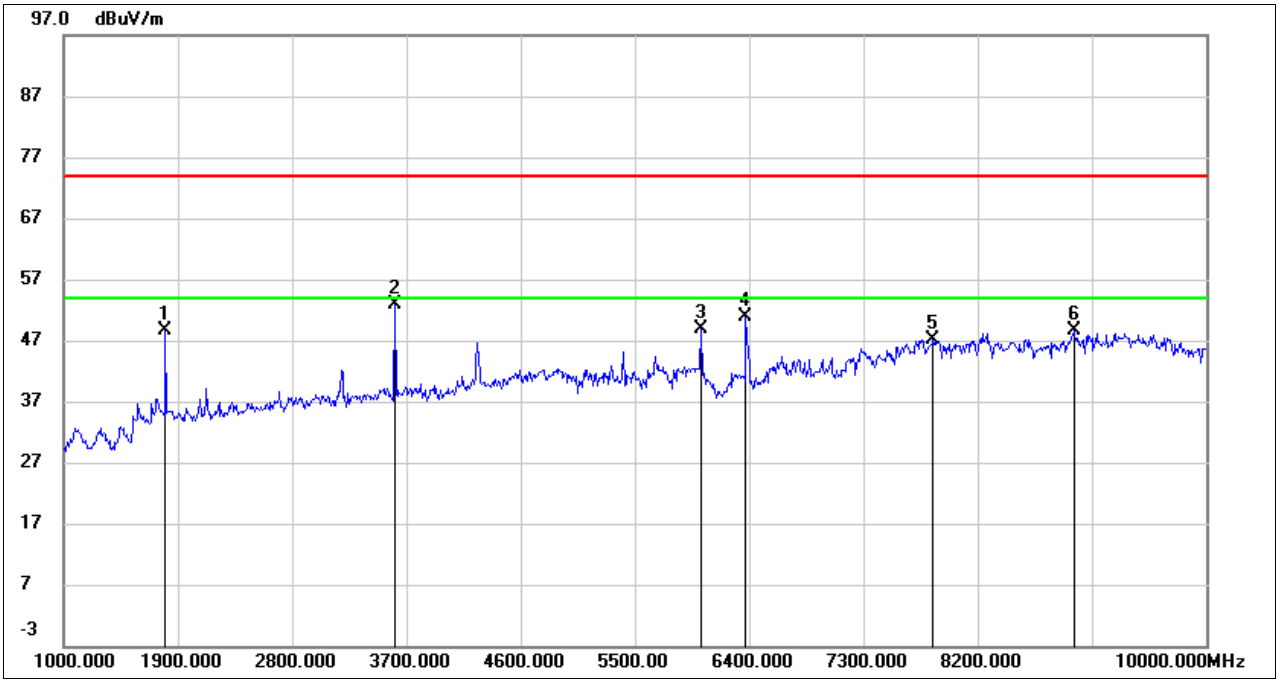
HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1801.000	63.54	-10.05	53.49	74.00	-20.51	peak
2	3610.000	57.75	-4.14	53.61	74.00	-20.39	peak
3	4258.000	46.30	-1.73	44.57	74.00	-29.43	peak
4	6022.000	41.10	3.30	44.40	74.00	-29.60	peak
5	7741.000	39.29	8.02	47.31	74.00	-26.69	peak
6	9064.000	38.03	10.20	48.23	74.00	-25.77	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.

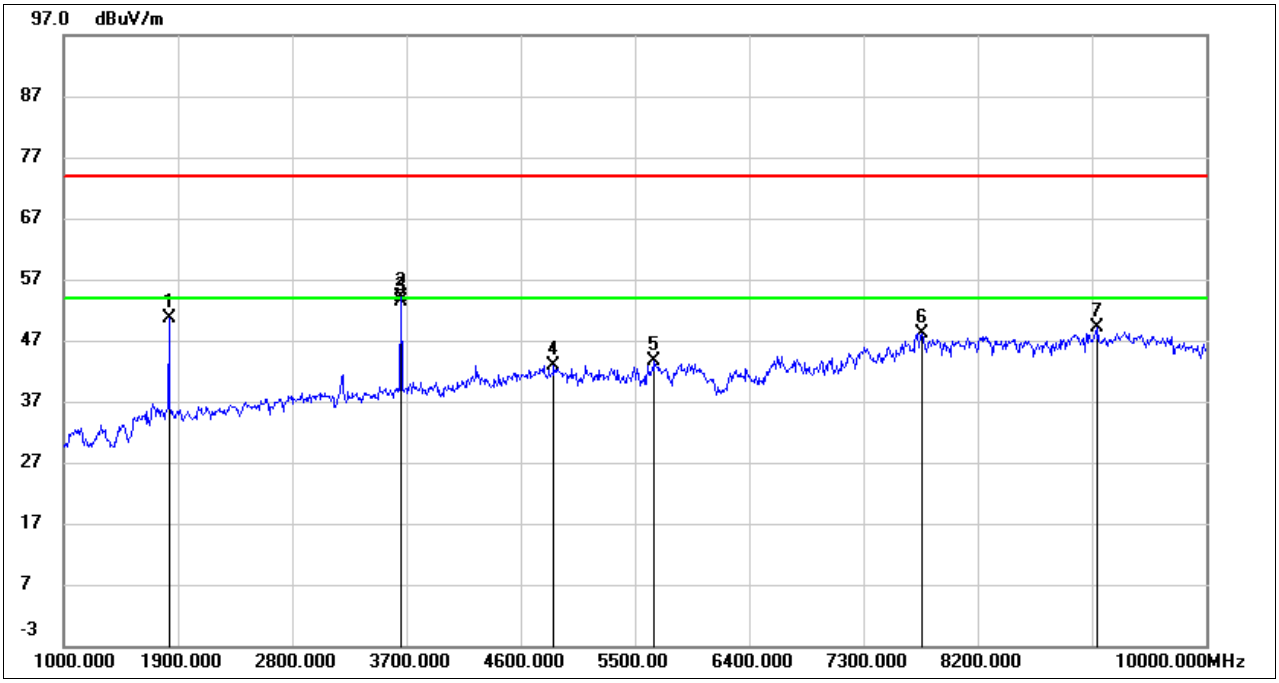
HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1801.000	58.71	-10.05	48.66	74.00	-25.34	peak
2	3610.000	57.10	-4.14	52.96	74.00	-21.04	peak
3	6022.000	45.63	3.30	48.93	74.00	-25.07	peak
4	6373.000	46.77	4.23	51.00	74.00	-23.00	peak
5	7849.000	39.14	8.11	47.25	74.00	-26.75	peak
6	8956.000	38.53	10.16	48.69	74.00	-25.31	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.

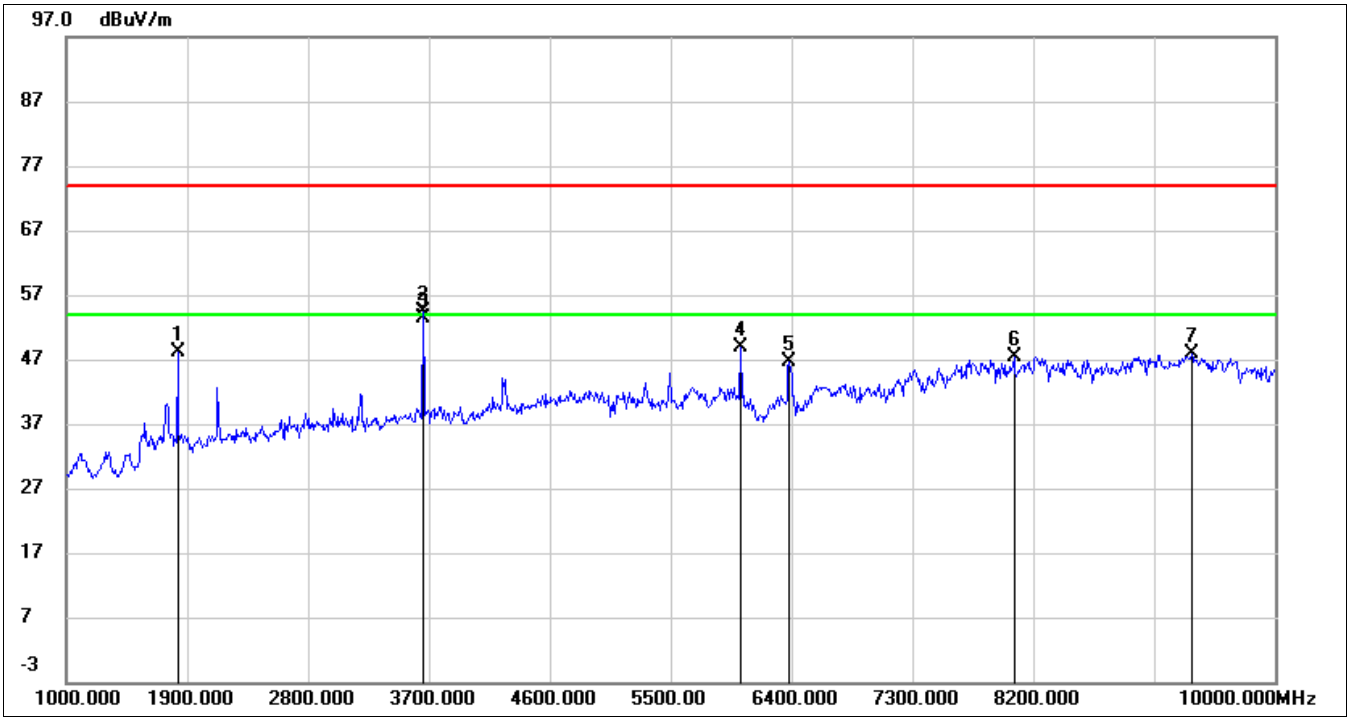
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1828.000	60.74	-10.06	50.68	74.00	-23.32	peak
2	3655.000	58.01	-3.94	54.07	74.00	-19.93	peak
3	3655.000	57.35	-3.94	53.41	54.00	-0.59	AVG
4	4861.000	42.17	0.68	42.85	74.00	-31.15	peak
5	5653.000	41.23	2.46	43.69	74.00	-30.31	peak
6	7759.000	39.99	8.09	48.08	74.00	-25.92	peak
7	9145.000	39.42	9.66	49.08	74.00	-24.92	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.

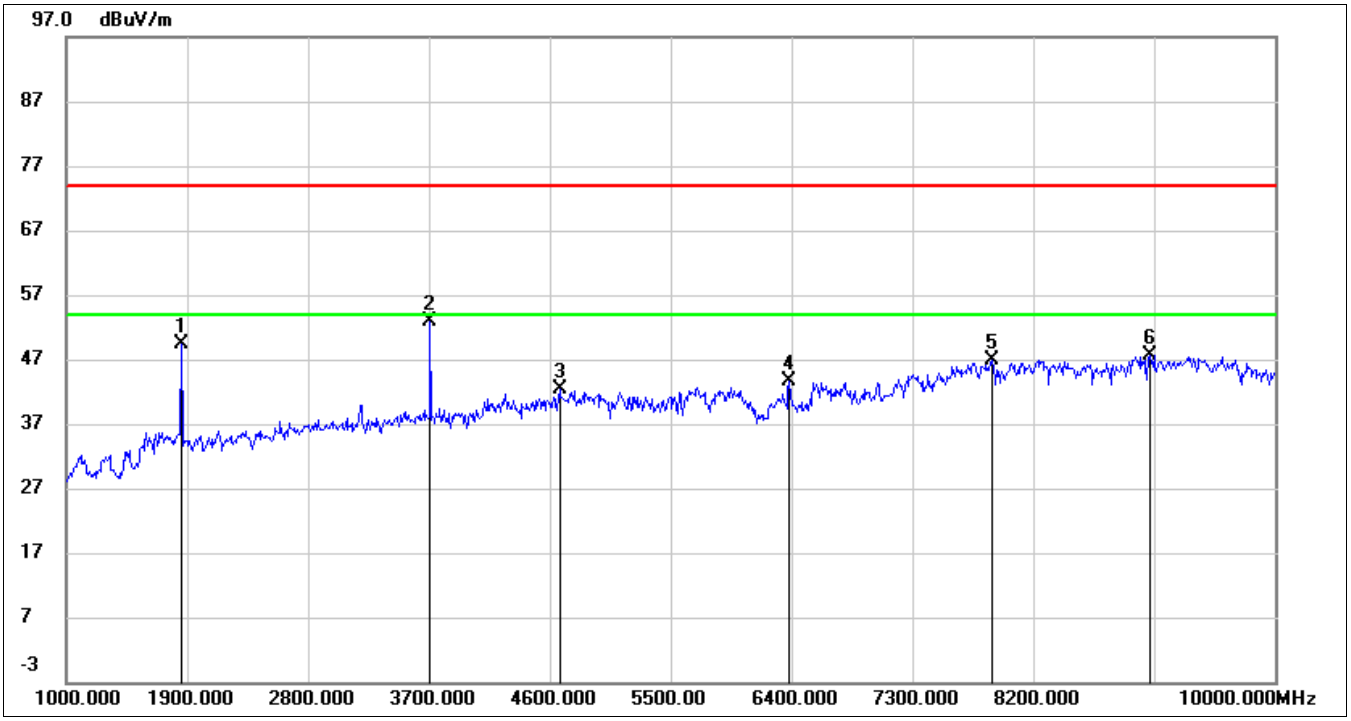
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1828.000	58.23	-10.06	48.17	74.00	-25.83	peak
2	3655.000	58.26	-3.94	54.32	74.00	-19.68	peak
3	3655.000	57.34	-3.94	53.40	54.00	-0.60	AVG
4	6022.000	45.68	3.30	48.98	74.00	-25.02	peak
5	6382.000	42.30	4.27	46.57	74.00	-27.43	peak
6	8056.000	39.28	8.14	47.42	74.00	-26.58	peak
7	9379.000	37.63	10.20	47.83	74.00	-26.17	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.

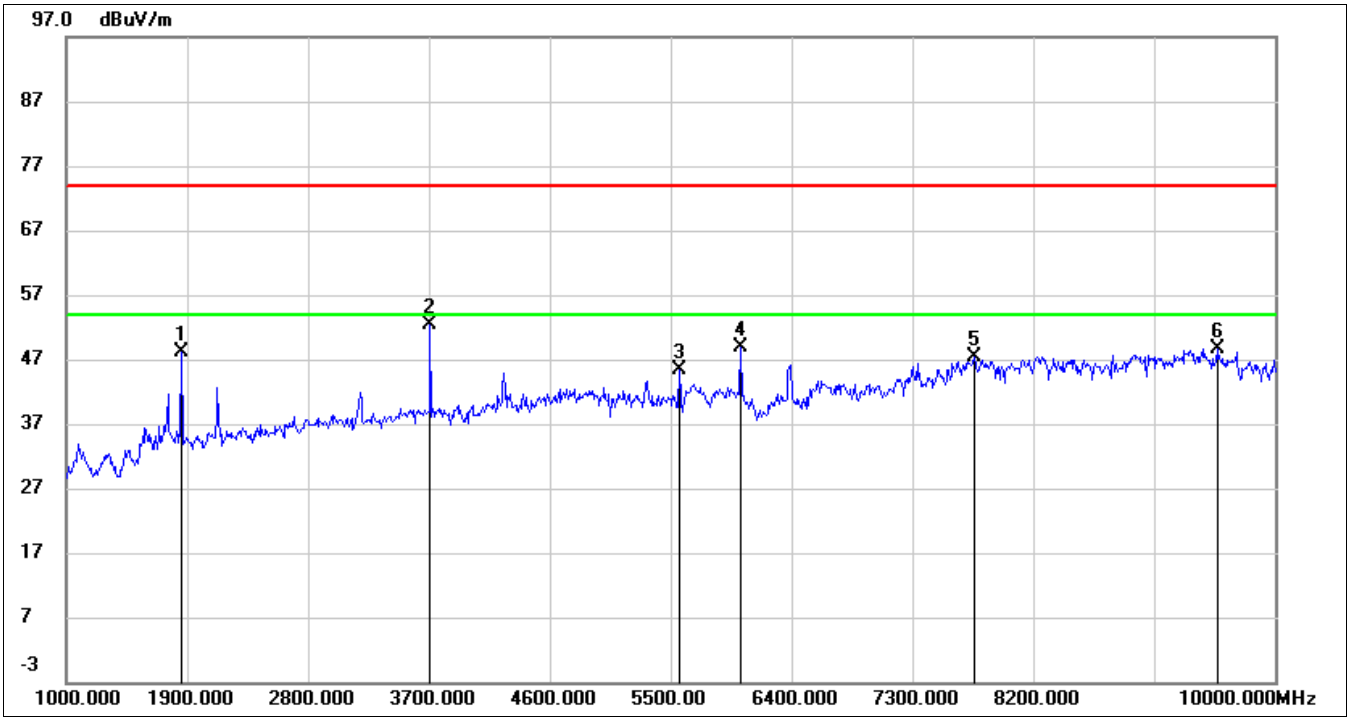
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1855.000	59.48	-10.09	49.39	74.00	-24.61	peak
2	3709.000	56.58	-3.68	52.90	74.00	-21.10	peak
3	4672.000	42.42	-0.15	42.27	74.00	-31.73	peak
4	6382.000	39.28	4.27	43.55	74.00	-30.45	peak
5	7894.000	38.94	7.98	46.92	74.00	-27.08	peak
6	9064.000	37.45	10.20	47.65	74.00	-26.35	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.

HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, VERTICAL)

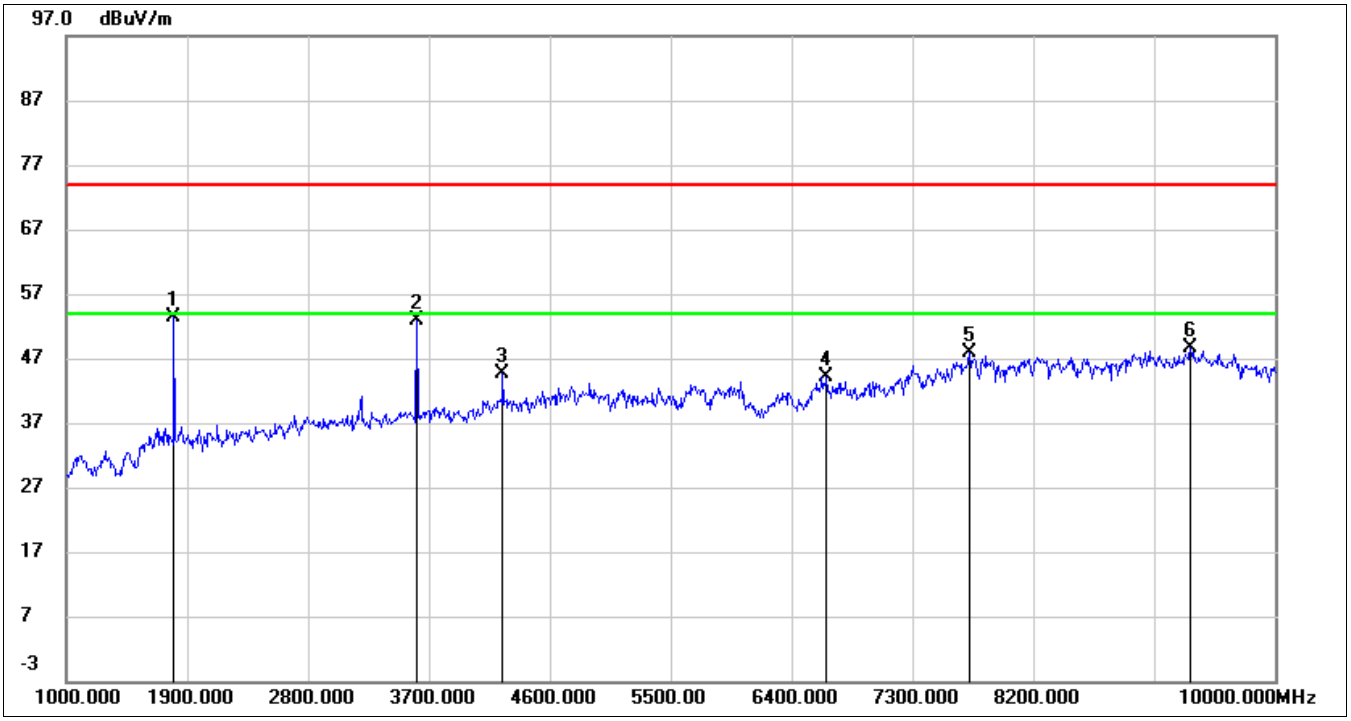


No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1855.000	58.28	-10.09	48.19	74.00	-25.81	peak
2	3709.000	55.98	-3.68	52.30	74.00	-21.70	peak
3	5563.000	42.93	2.35	45.28	74.00	-28.72	peak
4	6022.000	45.49	3.30	48.79	74.00	-25.21	peak
5	7759.000	39.24	8.09	47.33	74.00	-26.67	peak
6	9568.000	38.10	10.46	48.56	74.00	-25.44	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.

8.1.2. GFSK - 250 kbps MODE

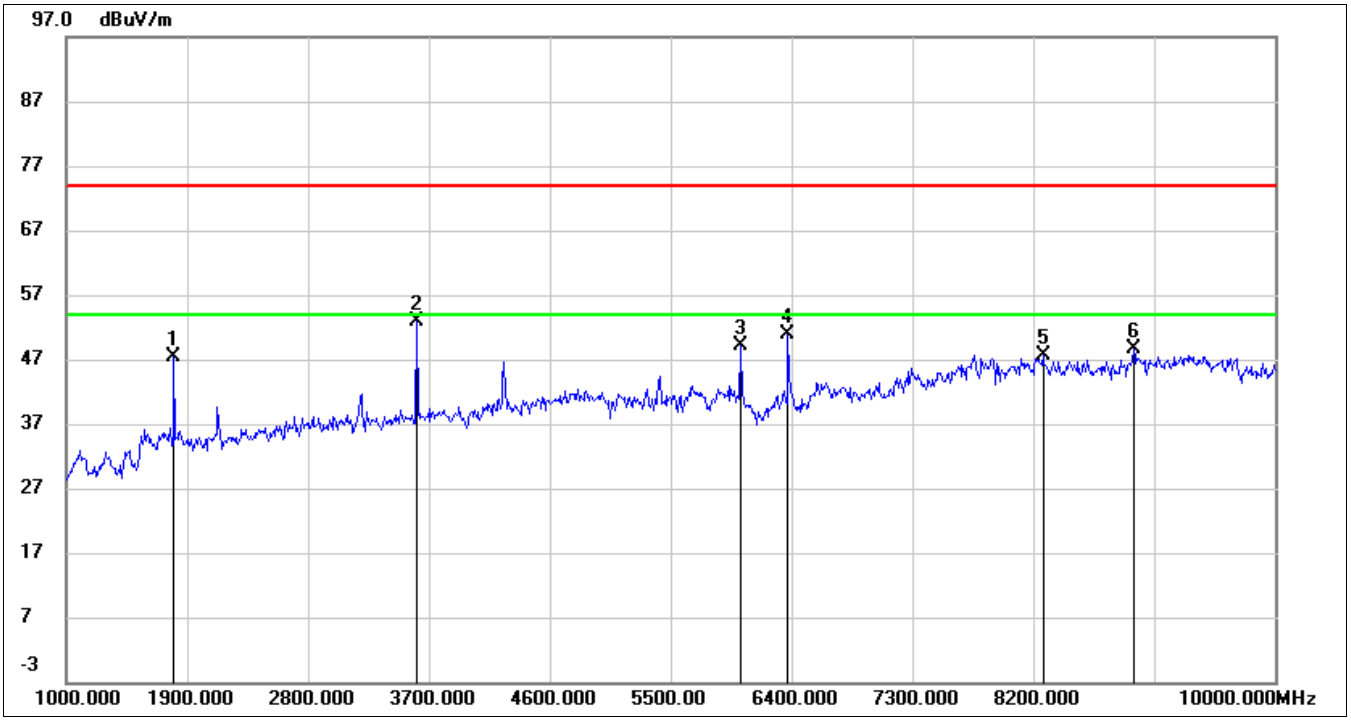
HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1801.000	63.36	-10.05	53.31	74.00	-20.69	peak
2	3610.000	56.92	-4.14	52.78	74.00	-21.22	peak
3	4249.000	46.23	-1.71	44.52	74.00	-29.48	peak
4	6661.000	38.58	5.52	44.10	74.00	-29.90	peak
5	7723.000	39.83	7.95	47.78	74.00	-26.22	peak
6	9370.000	38.45	10.16	48.61	74.00	-25.39	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.

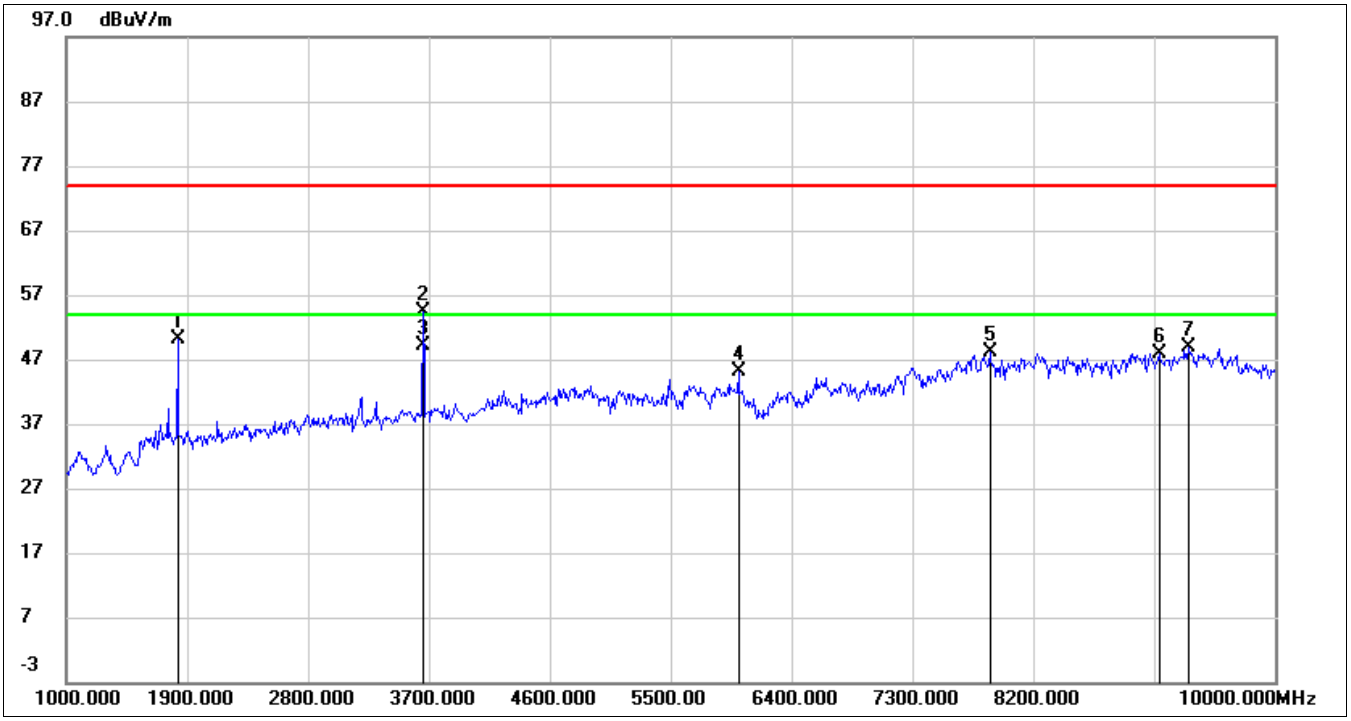
HARMONICS AND SPURIOUS EMISSIONS (LOW CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1801.000	57.55	-10.05	47.50	74.00	-26.50	peak
2	3610.000	57.05	-4.14	52.91	74.00	-21.09	peak
3	6022.000	45.91	3.30	49.21	74.00	-24.79	peak
4	6373.000	46.77	4.23	51.00	74.00	-23.00	peak
5	8272.000	38.48	9.09	47.57	74.00	-26.43	peak
6	8947.000	38.52	10.07	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.

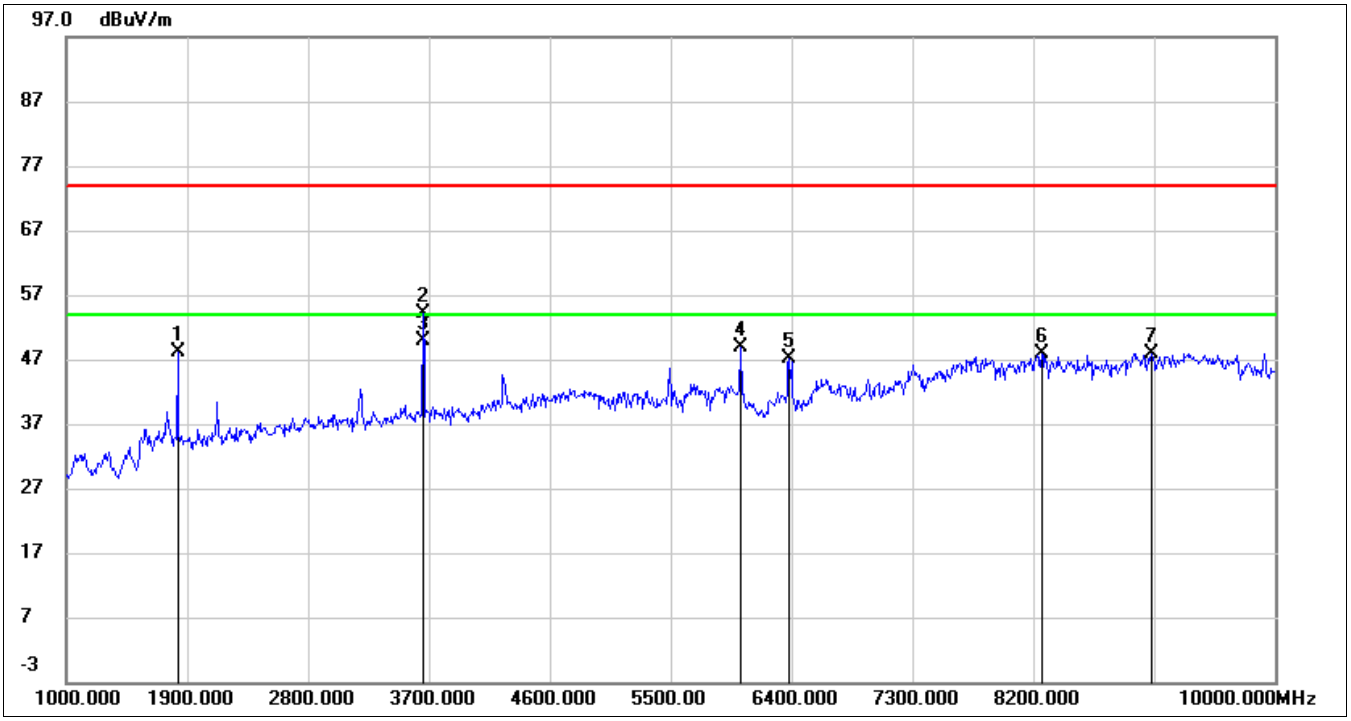
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1828.000	60.30	-10.06	50.24	74.00	-23.76	peak
2	3655.000	58.29	-3.94	54.35	74.00	-19.65	peak
3	3655.000	53.16	-3.94	49.22	54.00	-4.78	AVG
4	6004.000	41.79	3.30	45.09	74.00	-28.91	peak
5	7876.000	40.15	8.02	48.17	74.00	-25.83	peak
6	9136.000	38.20	9.72	47.92	74.00	-26.08	peak
7	9361.000	38.67	10.12	48.79	74.00	-25.21	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.

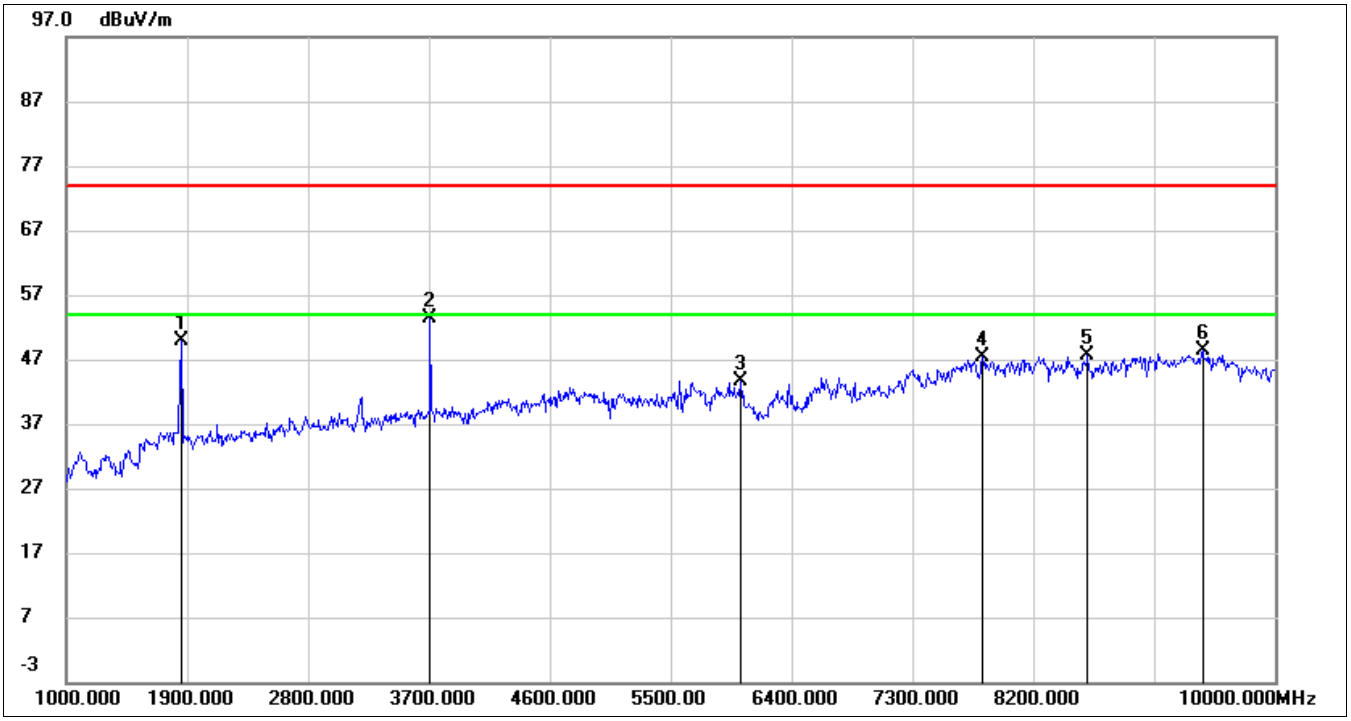
HARMONICS AND SPURIOUS EMISSIONS (MID CHANNEL, VERTICAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1828.000	58.26	-10.06	48.20	74.00	-25.80	peak
2	3655.000	58.11	-3.94	54.17	74.00	-19.83	peak
3	3655.000	53.90	-3.94	49.96	54.00	-4.04	AVG
4	6022.000	45.65	3.30	48.95	74.00	-25.05	peak
5	6382.000	42.90	4.27	47.17	74.00	-26.83	peak
6	8263.000	38.65	9.12	47.77	74.00	-26.23	peak
7	9082.000	37.91	10.08	47.99	74.00	-26.01	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.

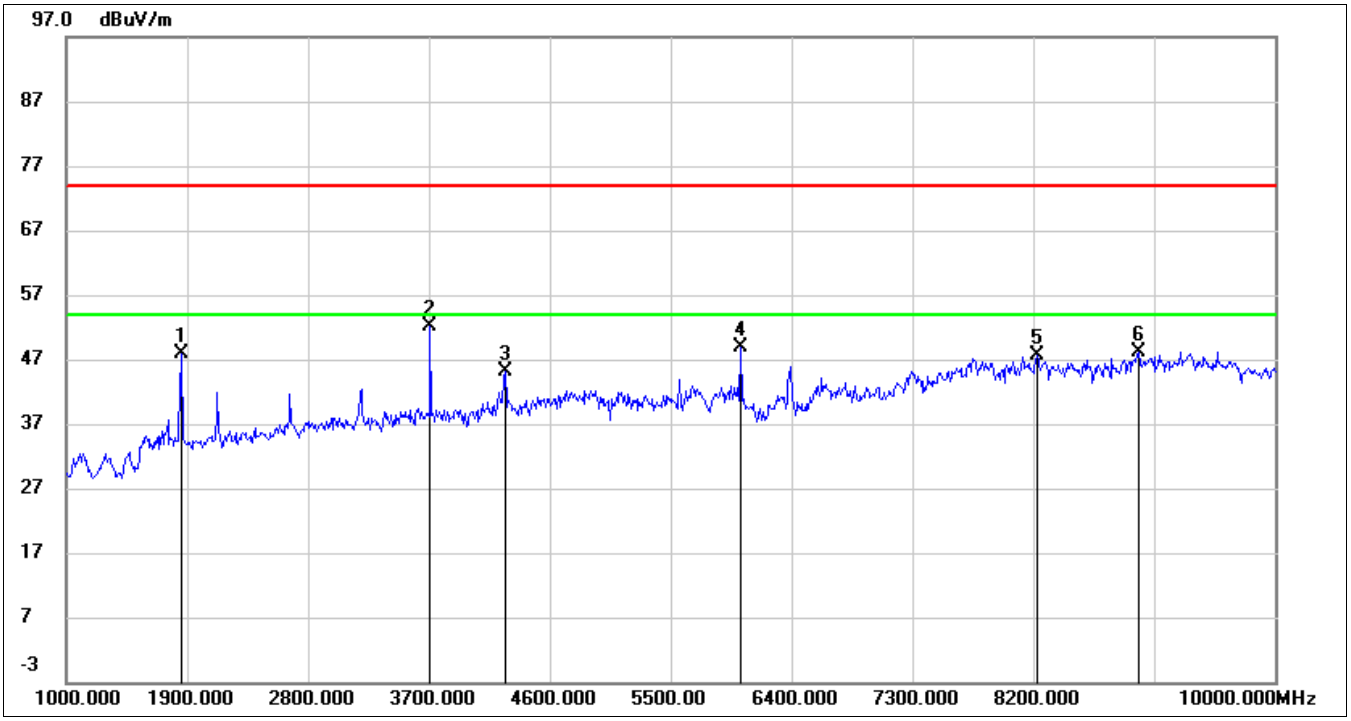
HARMONICS AND SPURIOUS EMISSIONS (HIGH CHANNEL, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1855.000	60.01	-10.09	49.92	74.00	-24.08	peak
2	3709.000	57.03	-3.68	53.35	74.00	-20.65	peak
3	6022.000	40.41	3.30	43.71	74.00	-30.29	peak
4	7822.000	39.20	8.19	47.39	74.00	-26.61	peak
5	8605.000	39.04	8.55	47.59	74.00	-26.41	peak
6	9460.000	37.86	10.40	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.

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	1855.000	58.02	-10.09	47.93	74.00	-26.07	peak
2	3709.000	55.69	-3.68	52.01	74.00	-21.99	peak
3	4267.000	46.88	-1.74	45.14	74.00	-28.86	peak
4	6022.000	45.53	3.30	48.83	74.00	-25.17	peak
5	8227.000	38.38	9.25	47.63	74.00	-26.37	peak
6	8983.000	37.69	10.45	48.14	74.00	-25.86	peak

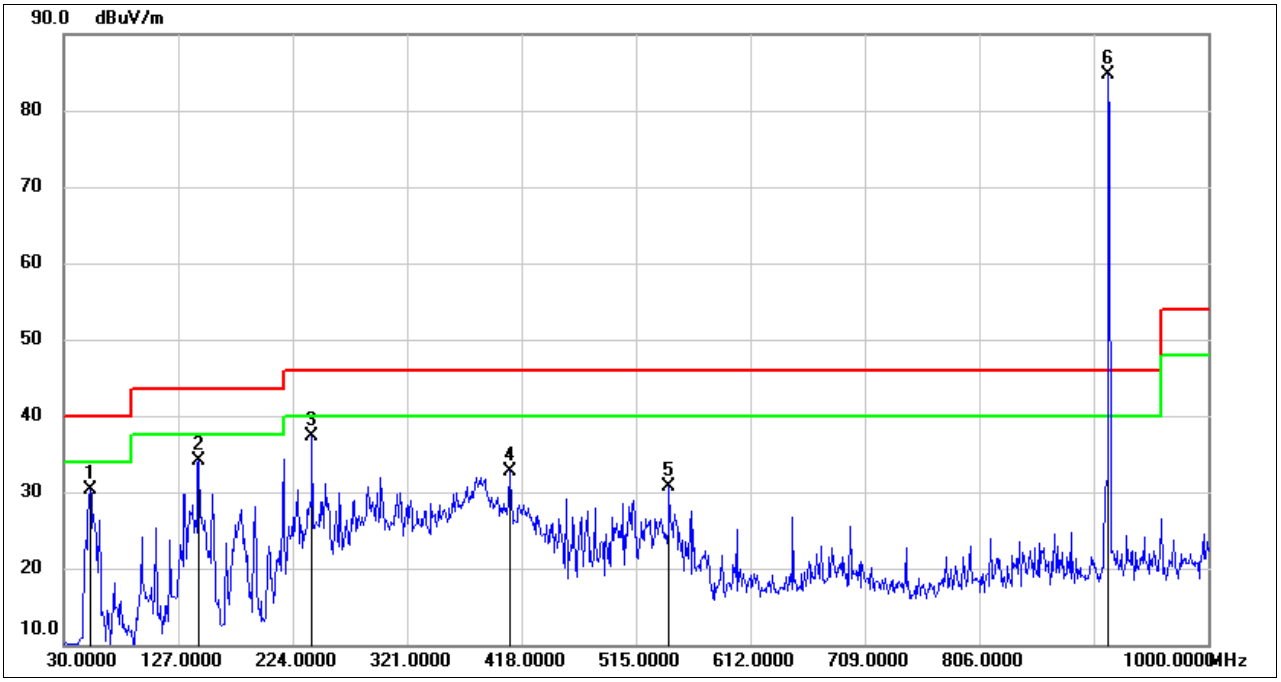
Note: 1. Measurement = Reading Level + Correct Factor.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Peak: Peak detector.
4. Only the worst data was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.

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

8.2. SPURIOUS EMISSIONS (30 MHz ~ 1 GHz)

8.2.1. GFSK - 250 kbps MODE

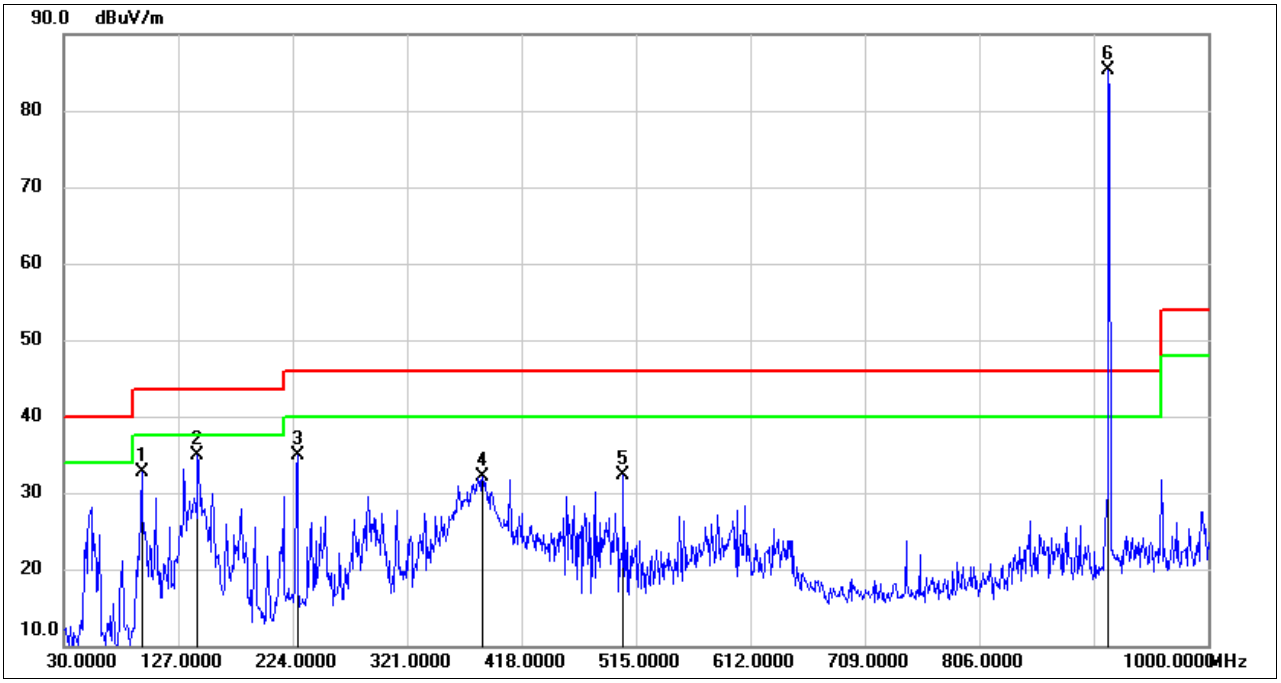
SPURIOUS EMISSIONS (HIGH CHANNEL, WORST-CASE CONFIGURATION, HORIZONTAL)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	52.3100	51.07	-20.71	30.36	40.00	-9.64	QP
2	144.4600	52.72	-18.60	34.12	43.50	-9.38	QP
3	240.4900	56.54	-19.17	37.37	46.00	-8.63	QP
4	408.3000	45.84	-13.17	32.67	46.00	-13.33	QP
5	543.1300	41.27	-10.49	30.78	46.00	-15.22	QP
6	915.1100	89.46	-4.85	84.61	/	/	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.

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	95.9600	54.08	-21.44	32.64	43.50	-10.86	QP
2	143.4900	53.56	-18.66	34.90	43.50	-8.60	QP
3	227.8800	53.47	-18.55	34.92	46.00	-11.08	QP
4	385.0200	45.68	-13.56	32.12	46.00	-13.88	QP
5	504.3300	43.59	-11.37	32.22	46.00	-13.78	QP
6	915.1100	90.09	-4.85	85.24	/	/	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

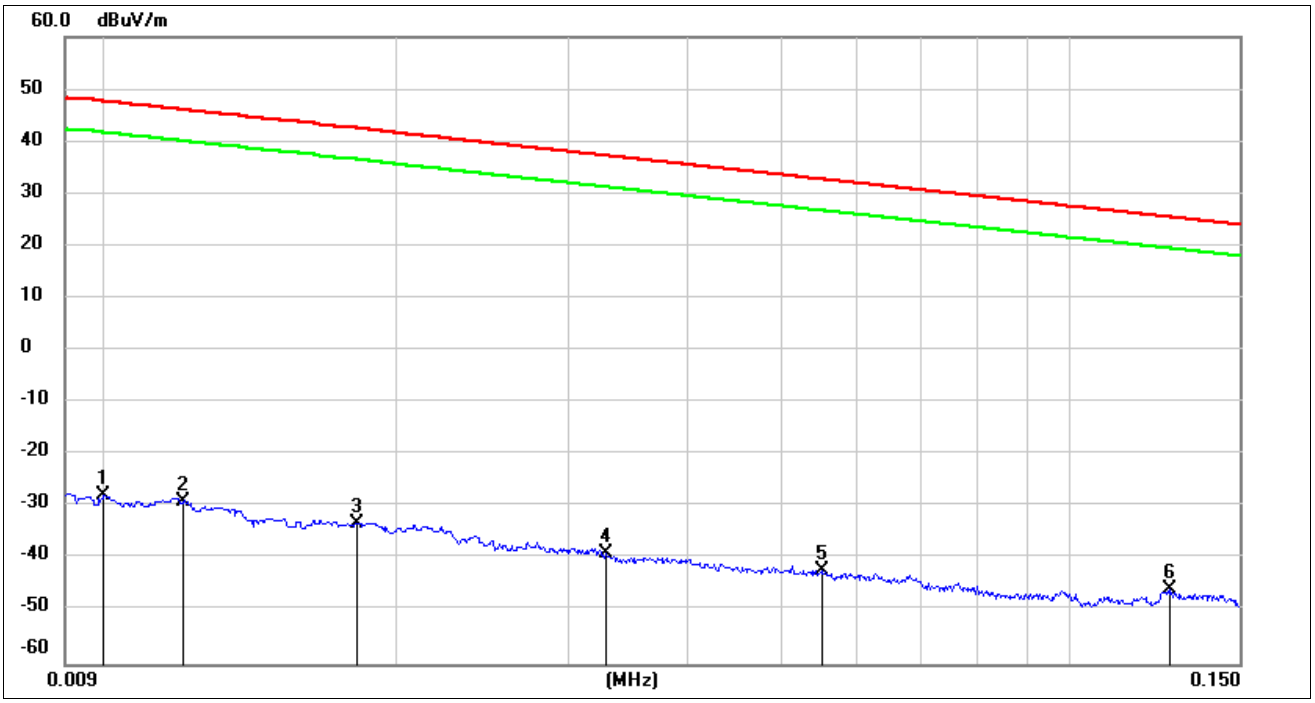
Note: All the modes and channels have been tested, only the worst data was recorded in the report.

8.3. SPURIOUS EMISSIONS BELOW 30 MHz

8.3.1. GFSK - 250 kbps MODE

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

9 kHz~ 150 kHz



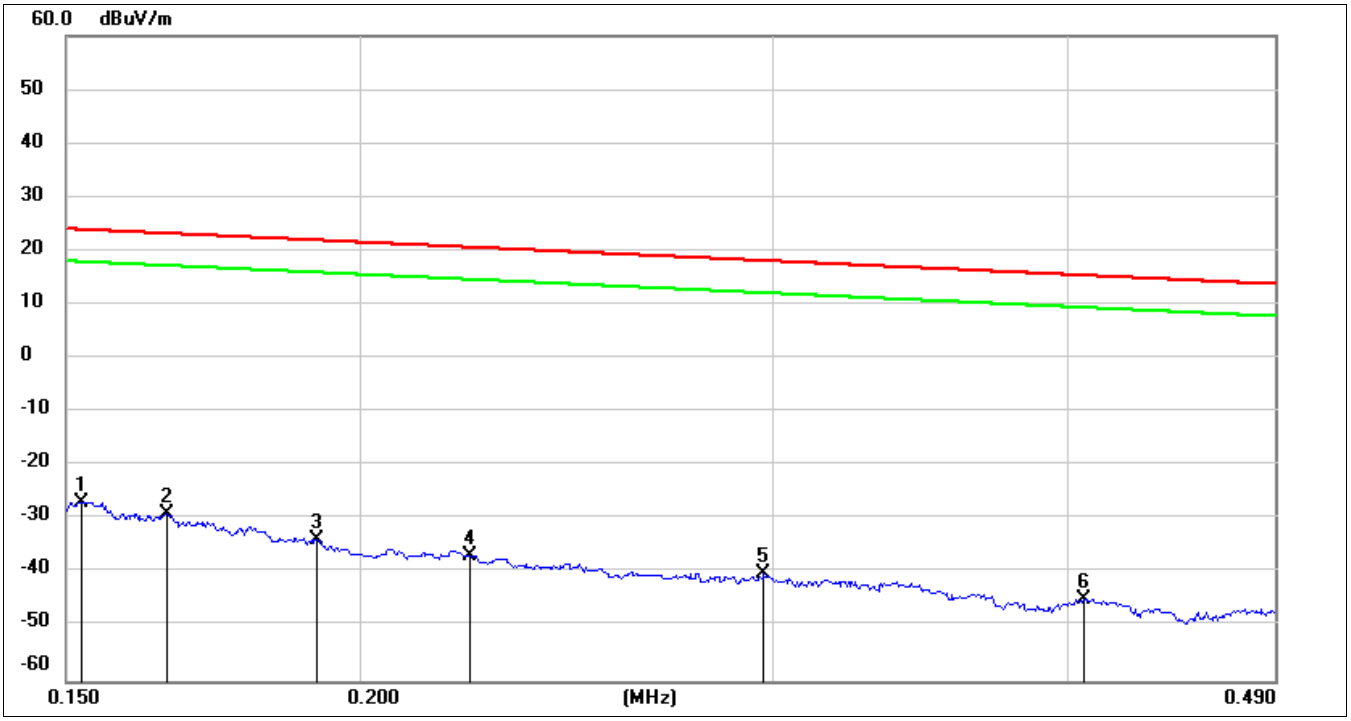
No.	Frequency	Reading	Correct	FCC Result	FCC Limit	ISED Result	ISED Limit	Margin	Remark
	(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dBuA/m)	(dBuA/m)	(dB)	
1	0.01	73.72	-101.4	-27.68	47.6	-79.18	-3.9	-75.28	peak
2	0.012	72.36	-101.39	-29.03	46.02	-80.53	-5.48	-75.05	peak
3	0.0181	68.35	-101.36	-33.01	42.45	-84.51	-9.05	-75.46	peak
4	0.0328	62.48	-101.4	-38.92	37.28	-90.42	-14.22	-76.20	peak
5	0.0551	59.45	-101.5	-42.05	32.78	-93.55	-18.72	-74.83	peak
6	0.1272	55.85	-101.71	-45.86	25.52	-97.36	-25.98	-71.38	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.

150 kHz ~ 490 kHz



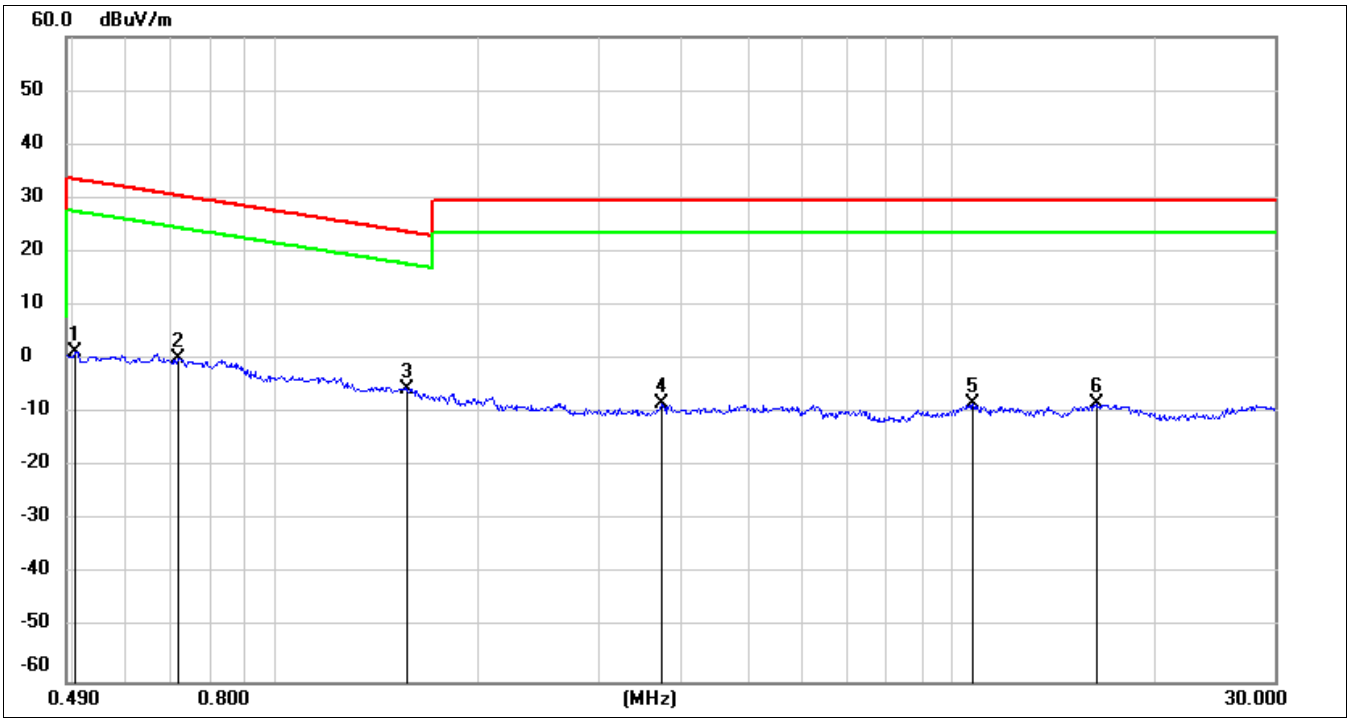
No.	Frequency	Reading	Correct	FCC Result	FCC Limit	ISED Result	ISED Limit	Margin	Remark
	(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dBuA/m)	(dBuA/m)	(dB)	
1	0.1524	74.8	-101.63	-26.83	23.94	-78.33	-27.56	-50.77	peak
2	0.1655	72.83	-101.66	-28.83	23.23	-80.33	-28.27	-52.06	peak
3	0.1917	68.04	-101.7	-33.66	21.95	-85.16	-29.55	-55.61	peak
4	0.2227	65.15	-101.75	-36.6	20.65	-88.1	-30.85	-57.25	peak
5	0.2972	61.66	-101.85	-40.19	18.14	-91.69	-33.36	-58.33	peak
6	0.4062	57.14	-101.96	-44.82	15.43	-96.32	-36.07	-60.25	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.

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	63.44	-62.07	1.37	33.56	-50.13	-17.94	-32.19	peak
2	0.7184	62.21	-62.1	0.11	30.47	-51.39	-21.03	-30.36	peak
3	1.5625	56.46	-62.02	-5.56	23.73	-57.06	-27.77	-29.29	peak
4	3.71	53.2	-61.41	-8.21	29.54	-59.71	-21.96	-37.75	peak
5	10.7299	52.48	-60.83	-8.35	29.54	-59.85	-21.96	-37.89	peak
6	16.3959	52.67	-60.96	-8.29	29.54	-59.79	-21.96	-37.83	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.

9. AC POWER LINE CONDUCTED EMISSIONS

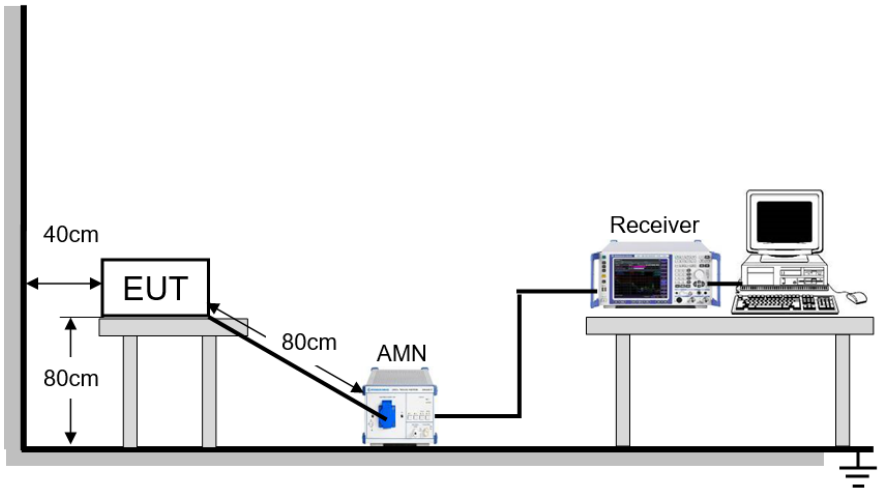
LIMITS

Please refer to CFR 47 FCC §15.207 (a) and ISED RSS-Gen Clause 8.8

FREQUENCY (MHz)	Quasi-peak	Average
0.15 -0.5	66 - 56 *	56 - 46 *
0.50 -5.0	56.00	46.00
5.0 -30.0	60.00	50.00

TEST SETUP AND PROCEDURE

Refer to ANSI C63.10-2013 clause 6.2.



The EUT is put on a table of non-conducting material that is 80 cm high. The vertical conducting wall of shielding is located 40 cm to the rear of the EUT. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.). A EMI Measurement Receiver (R&S Test Receiver ESR3) is used to test the emissions from both sides of AC line. According to the requirements in Section 6.2 of ANSI C63.10-2013.Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-Peak and average detector mode. The bandwidth of EMI test receiver is set at 9 kHz.

The arrangement of the equipment is installed to meet the standards and operating in a manner, which tends to maximize its emission characteristics in a normal application.

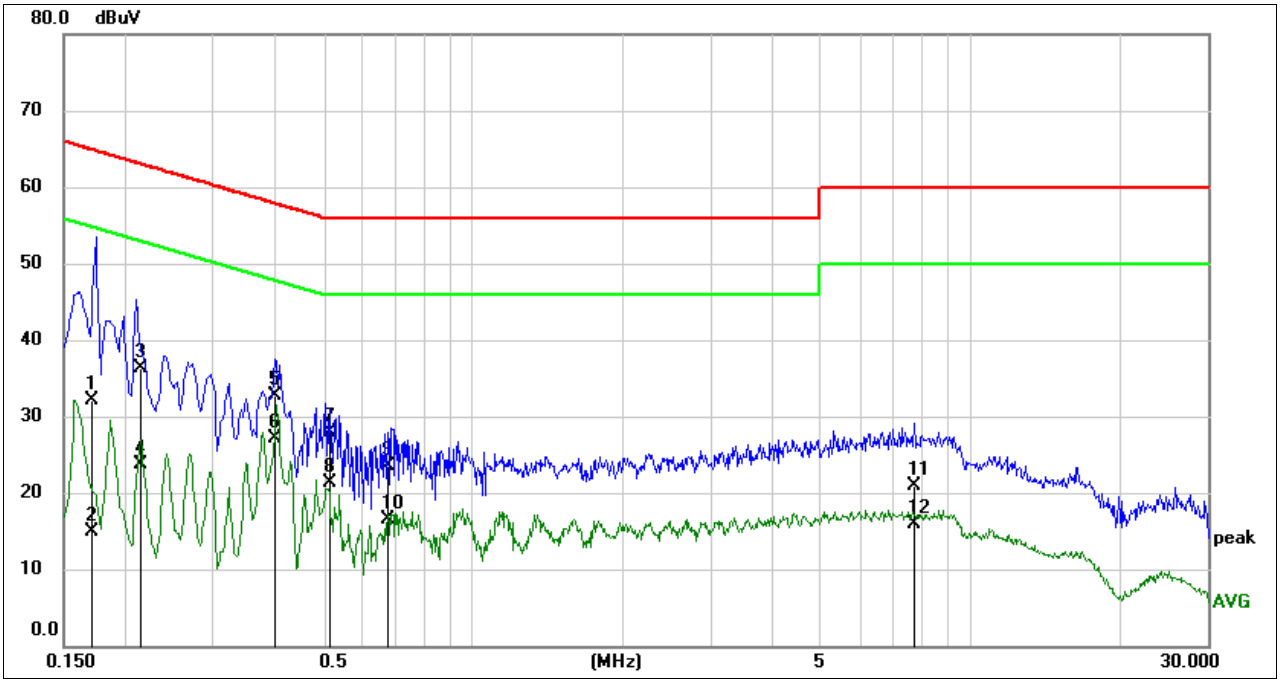
TEST ENVIRONMENT

Temperature	19.8 °C	Relative Humidity	40.3 %
Atmosphere Pressure	101 kPa	Test Voltage	AC 120 V/60 Hz

TEST RESULTS

9.1.1. GFSK - 250 kbps MODE

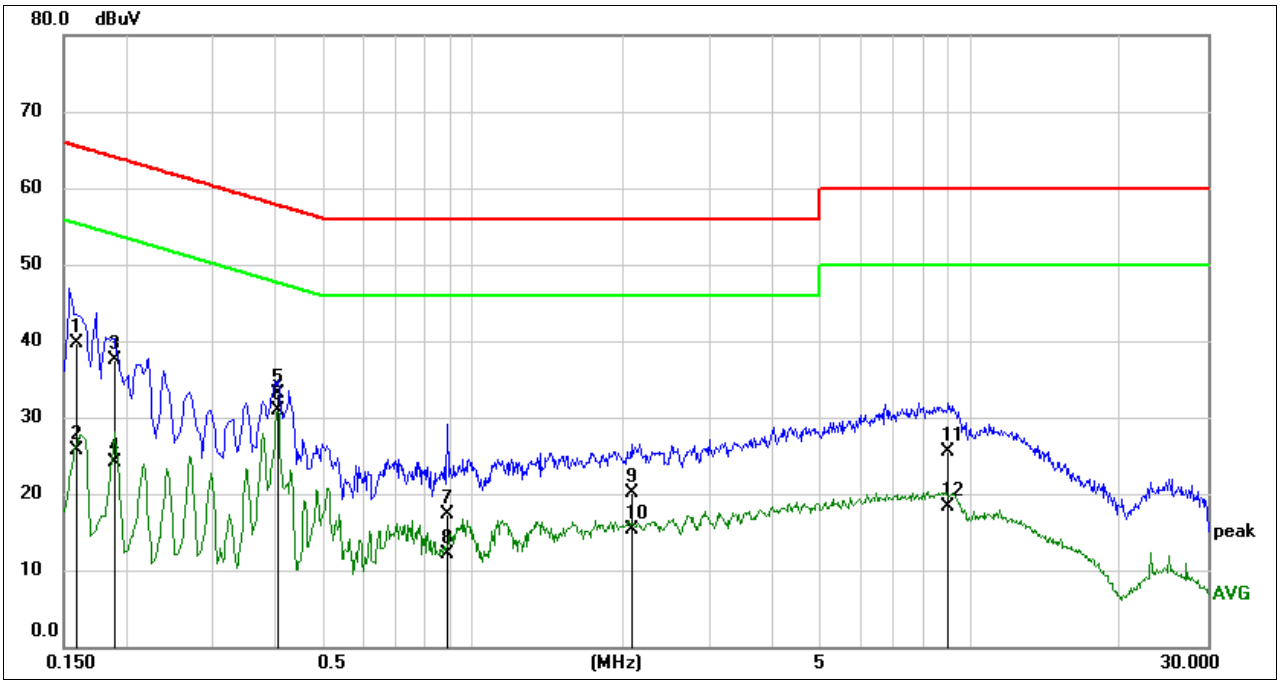
LINE L RESULTS (MID CHANNEL, WORST-CASE CONFIGURATION)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1710	22.57	9.59	32.16	64.91	-32.75	QP
2	0.1710	5.22	9.59	14.81	54.91	-40.10	AVG
3	0.2149	26.72	9.59	36.31	63.01	-26.70	QP
4	0.2149	14.20	9.59	23.79	53.01	-29.22	AVG
5	0.3983	23.06	9.59	32.65	57.89	-25.24	QP
6	0.3983	17.49	9.59	27.08	47.89	-20.81	AVG
7	0.5109	18.27	9.60	27.87	56.00	-28.13	QP
8	0.5109	11.71	9.60	21.31	46.00	-24.69	AVG
9	0.6722	14.00	9.60	23.60	56.00	-32.40	QP
10	0.6722	6.93	9.60	16.53	46.00	-29.47	AVG
11	7.7392	11.21	9.62	20.83	60.00	-39.17	QP
12	7.7392	6.26	9.62	15.88	50.00	-34.12	AVG

Note: 1. Result = Reading + Correct Factor.
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 200 Hz (9 kHz ~ 150 kHz), 9 kHz (150 kHz ~ 30 MHz).
4. Step size: 80 Hz (0.009 MHz ~ 0.15 MHz), 4 kHz (0.15 MHz ~ 30 MHz), Scan time: auto.

LINE N RESULTS (MID CHANNEL, WORST-CASE CONFIGURATION)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1590	30.04	9.59	39.63	65.52	-25.89	QP
2	0.1590	16.07	9.59	25.66	55.52	-29.86	AVG
3	0.1886	27.86	9.59	37.45	64.10	-26.65	QP
4	0.1886	14.43	9.59	24.02	54.10	-30.08	AVG
5	0.4044	23.48	9.60	33.08	57.76	-24.68	QP
6	0.4044	21.37	9.60	30.97	47.76	-16.79	AVG
7	0.8853	7.64	9.60	17.24	56.00	-38.76	QP
8	0.8853	2.41	9.60	12.01	46.00	-33.99	AVG
9	2.0818	10.53	9.63	20.16	56.00	-35.84	QP
10	2.0818	5.76	9.63	15.39	46.00	-30.61	AVG
11	9.0405	15.95	9.61	25.56	60.00	-34.44	QP
12	9.0405	8.78	9.61	18.39	50.00	-31.61	AVG

Note: 1. Result = Reading + Correct Factor.
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 200 Hz (9 kHz ~ 150 kHz), 9 kHz (150 kHz ~ 30 MHz).
4. Step size: 80 Hz (0.009 MHz ~ 0.15 MHz), 4 kHz (0.15 MHz ~ 30 MHz), Scan time: auto.

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

10. 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

APPENDIX A: DUTY CYCLE

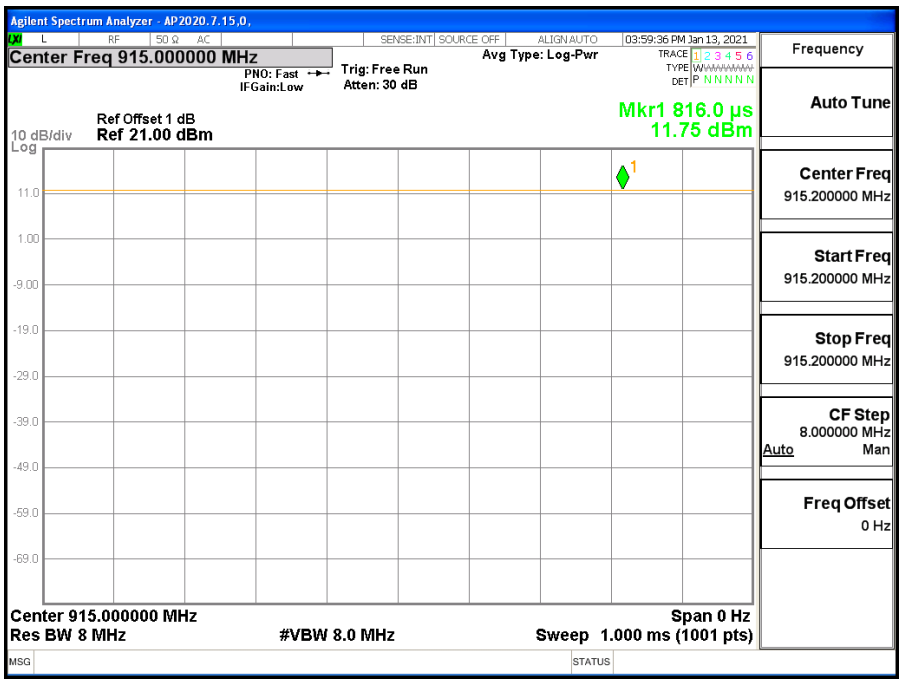
Test Result

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)
GFSK-50 kbps	100	100	0.1	100	0	0.01	0.01
GFSK-250 kbps	100	100	0.1	100	0	0.01	0.01

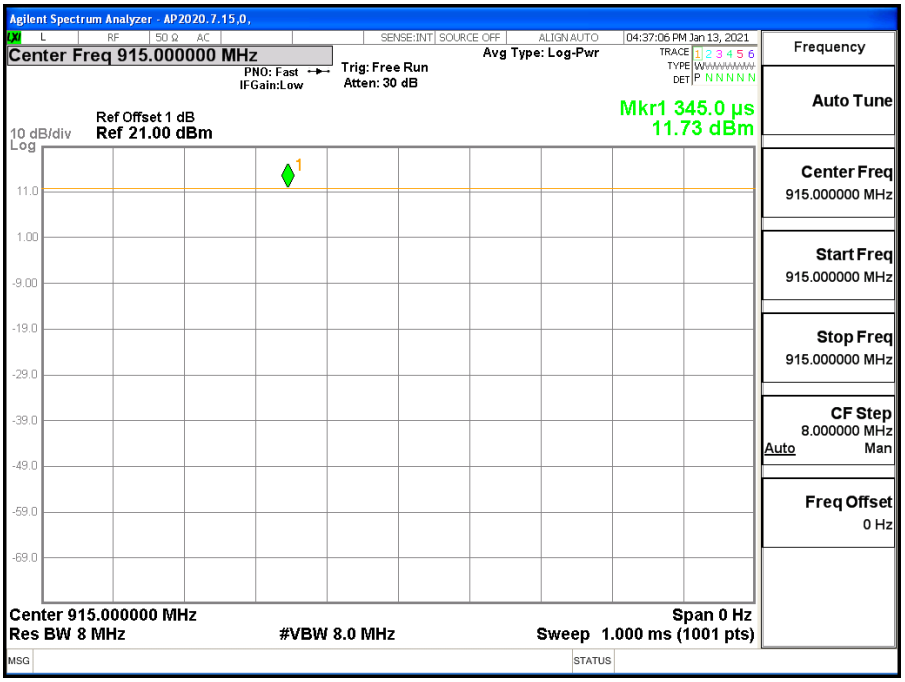
Note:
Duty Cycle Correction Factor=10log (1/x).
Where: x is Duty Cycle (Linear)
Where: T is On Time
If that calculated VBW is not available on the analyzer then the next higher value should be used.

Test Graphs

GFSK-50 kbps



GFSK-250 kbps



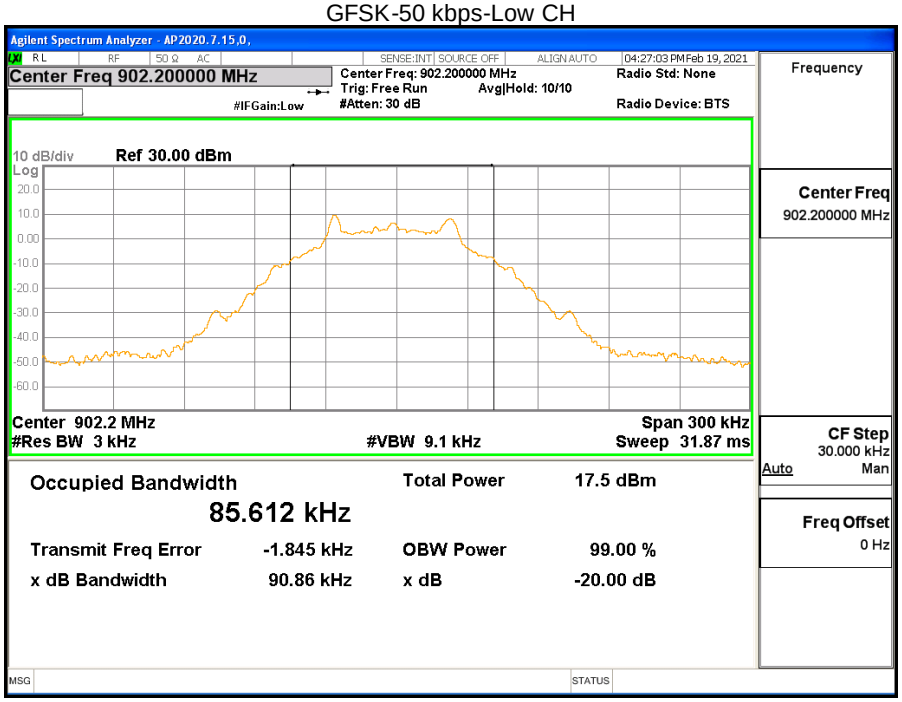
APPENDIX B: 20DB BANDWIDTH

Test Result

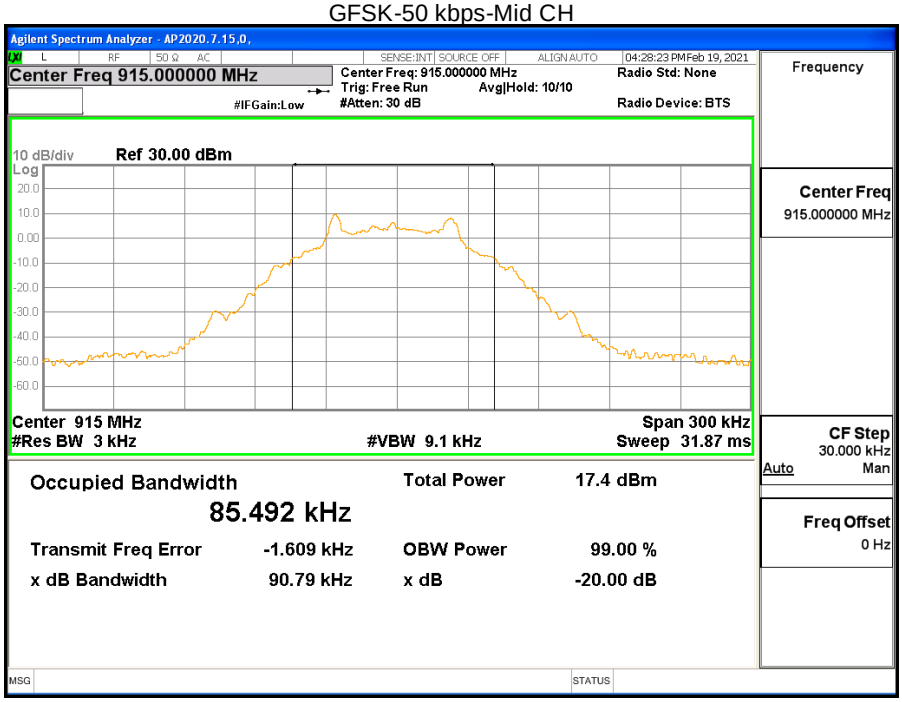
Test Mode	Antenna	Channel	20db EBW[MHz]	Verdict
GFSK-50 kbps	Ant1	Low	0.091	PASS
		Mid	0.091	PASS
		High	0.091	PASS
GFSK-250 kbps	Ant1	Low	0.385	PASS
		Mid	0.385	PASS
		High	0.386	PASS

Test Graphs

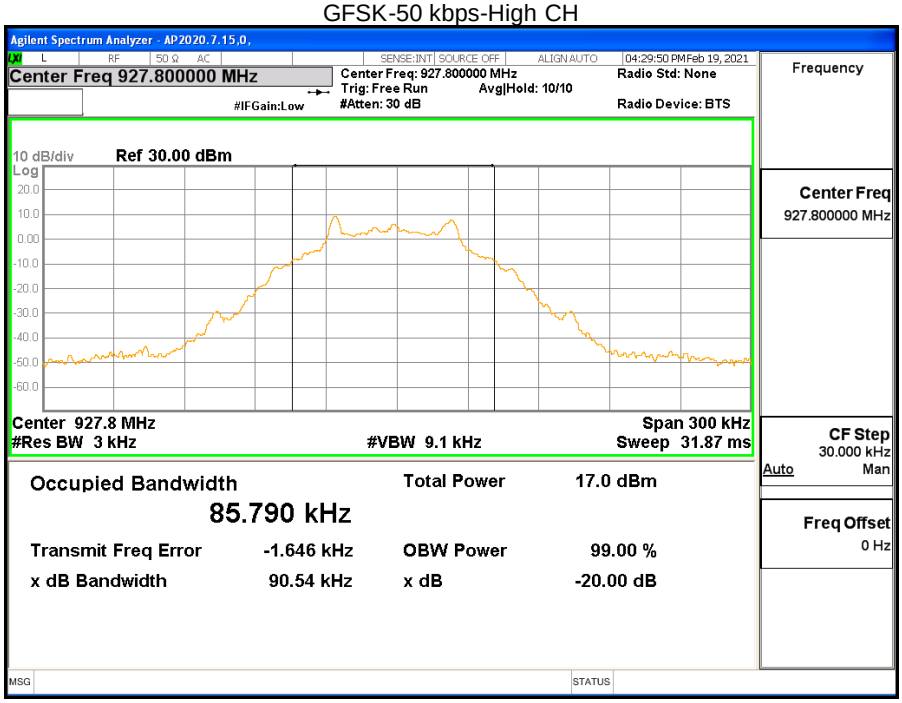
GFSK-50 kbps-Low CH



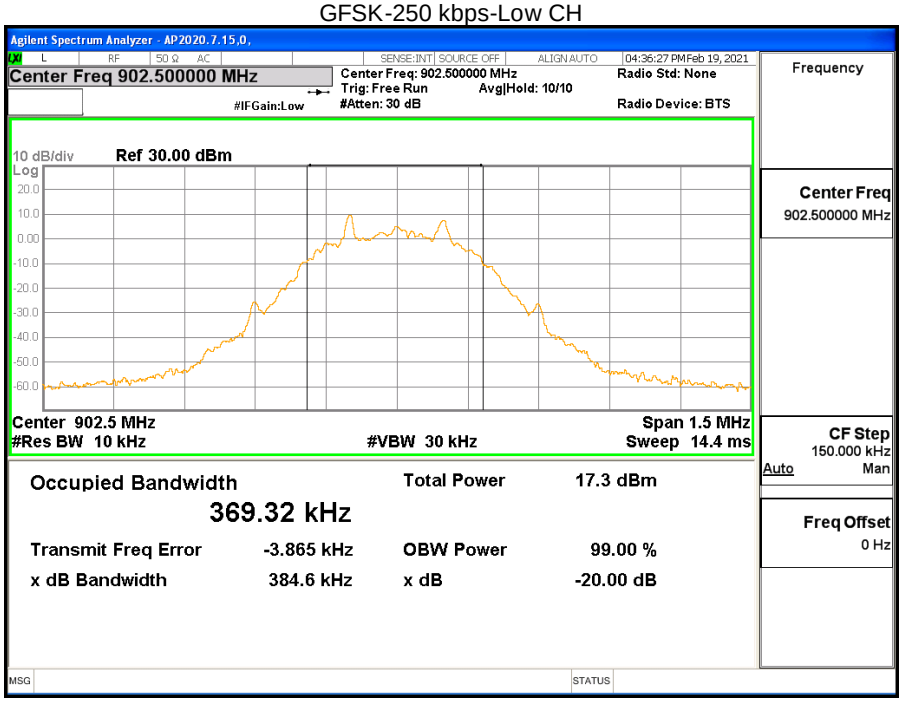
GFSK-50 kbps-Mid CH



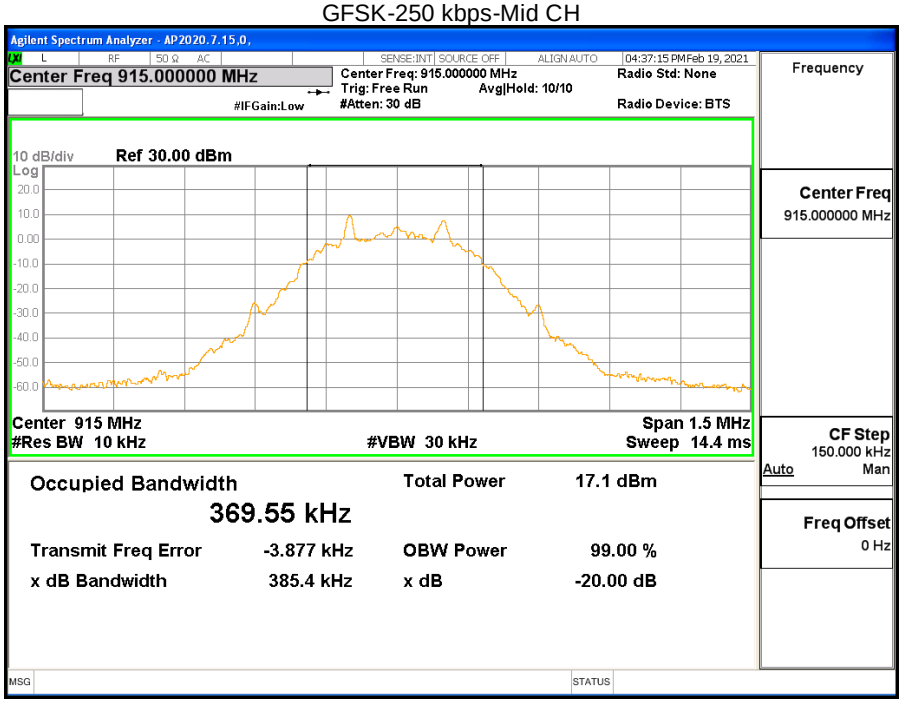
GFSK-50 kbps-High CH



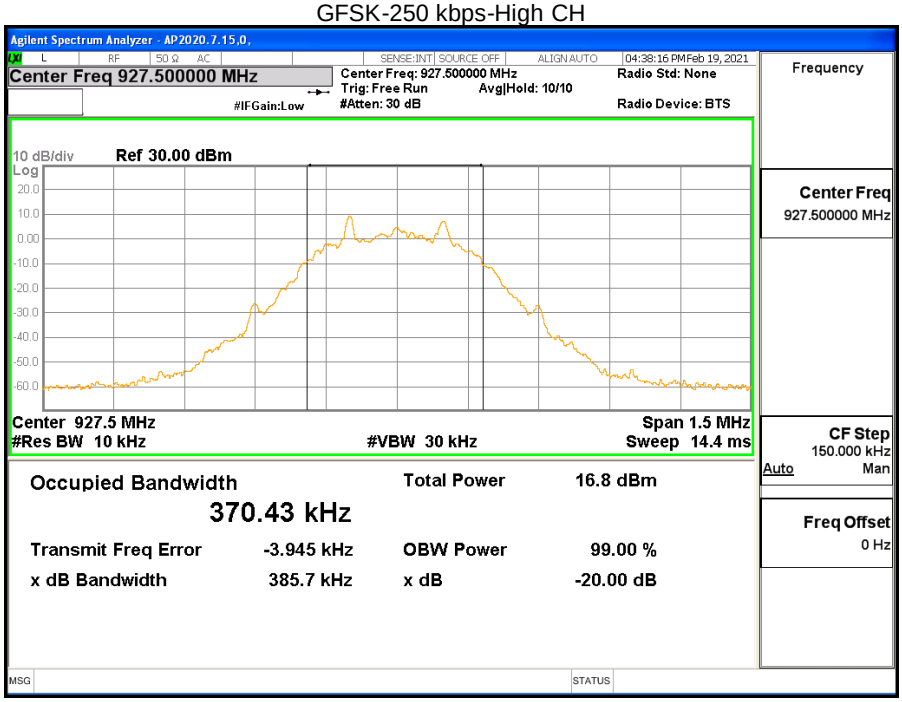
GFSK-250 kbps-Low CH



GFSK-250 kbps-Mid CH



GFSK-250 kbps-High CH



APPENDIX C: OCCUPIED CHANNEL BANDWIDTH

Test Result

Test Mode	Antenna	Channel	OCB [MHz]	Verdict
GFSK-50 kbps	Ant1	Low	0.086	PASS
		Mid	0.085	PASS
		High	0.086	PASS
GFSK-250 kbps	Ant1	Low	0.369	PASS
		Mid	0.370	PASS
		High	0.370	PASS

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

APPENDIX D: PEAK CONDUCTED OUTPUT POWER

Test Result

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
GFSK-50 kbps	Ant1	Low	11.54	<=30	PASS
		Mid	11.73	<=30	PASS
		High	**11.79**	<=30	PASS
GFSK-150 kbps	Ant1	Low	11.54	<=30	PASS
		Mid	11.72	<=30	PASS
		High	**11.78**	<=30	PASS
GFSK-250 kbps	Ant1	Low	11.63	<=30	PASS
		Mid	11.76	<=30	PASS
		High	**11.83**	<=30	PASS

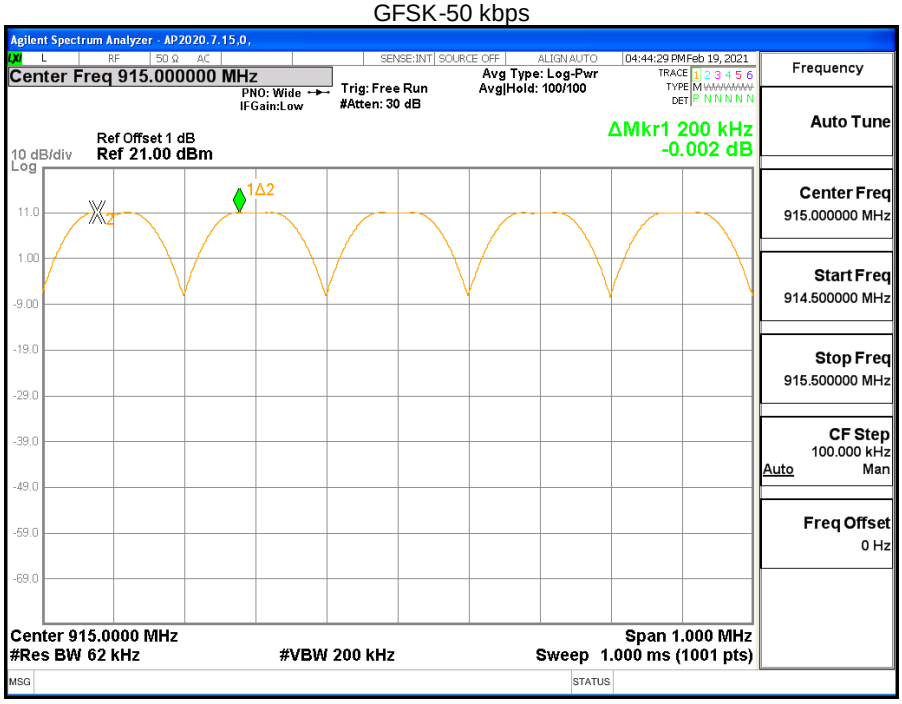
APPENDIX E: CARRIER FREQUENCY SEPARATION

Test Result

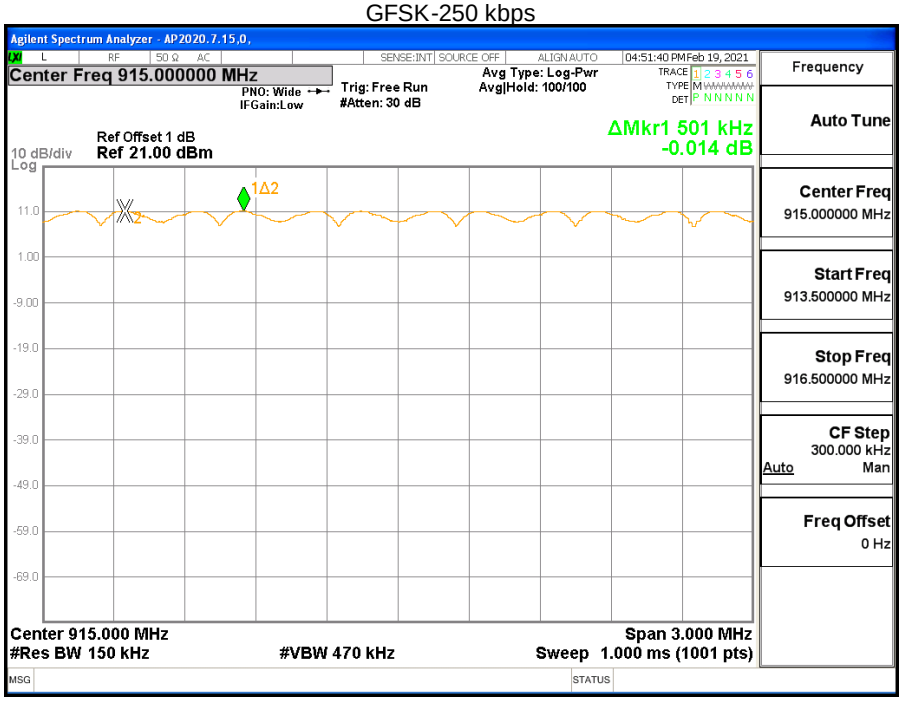
Test Mode	Antenna	Channel	Result[MHz]	Limit[kHz]	Verdict
GFSK-50 kbps	Ant1	Hop	0.2	>=91	PASS
GFSK-250 kbps	Ant1	Hop	0.5	>=385	PASS

Test Graphs

GFSK-50 kbps



GFSK-250 kbps



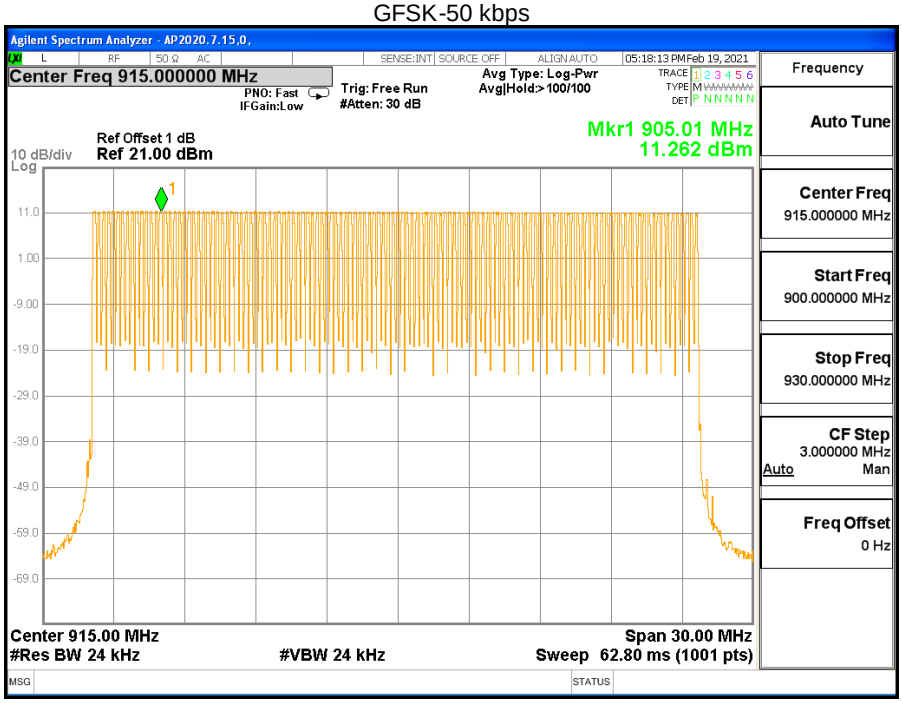
APPENDIX F: NUMBER OF HOPPING FREQUENCIES

Test Result

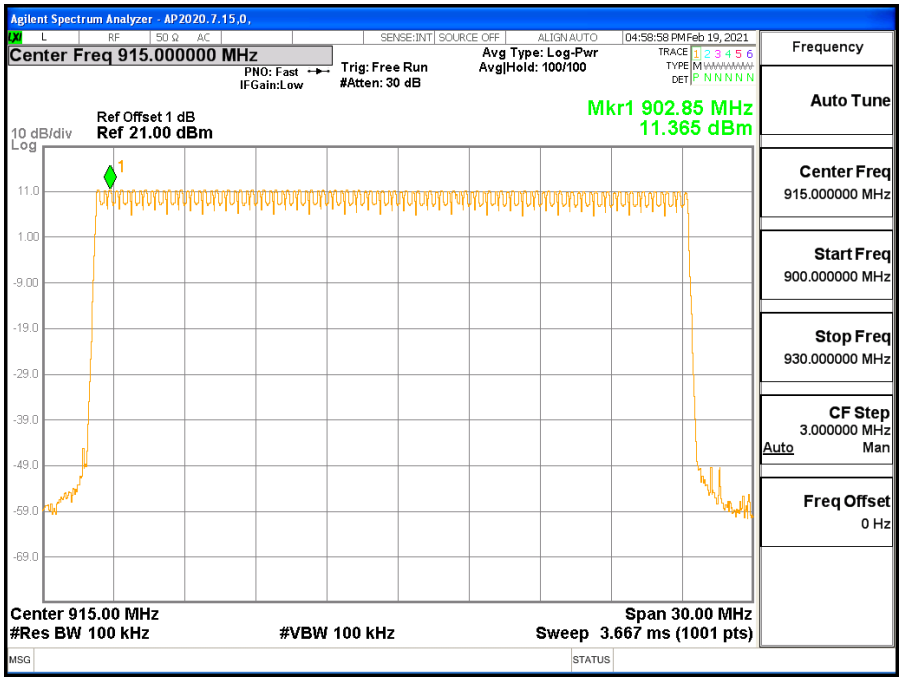
Test Mode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
GFSK-50 kbps	Ant1	Hop	129	>=50	PASS
GFSK-250 kbps	Ant1	Hop	51	>=25	PASS

Test Graphs

GFSK-50 kbps



GFSK-250 kbps



APPENDIX G: TIME OF OCCUPANCY (DWELL TIME)

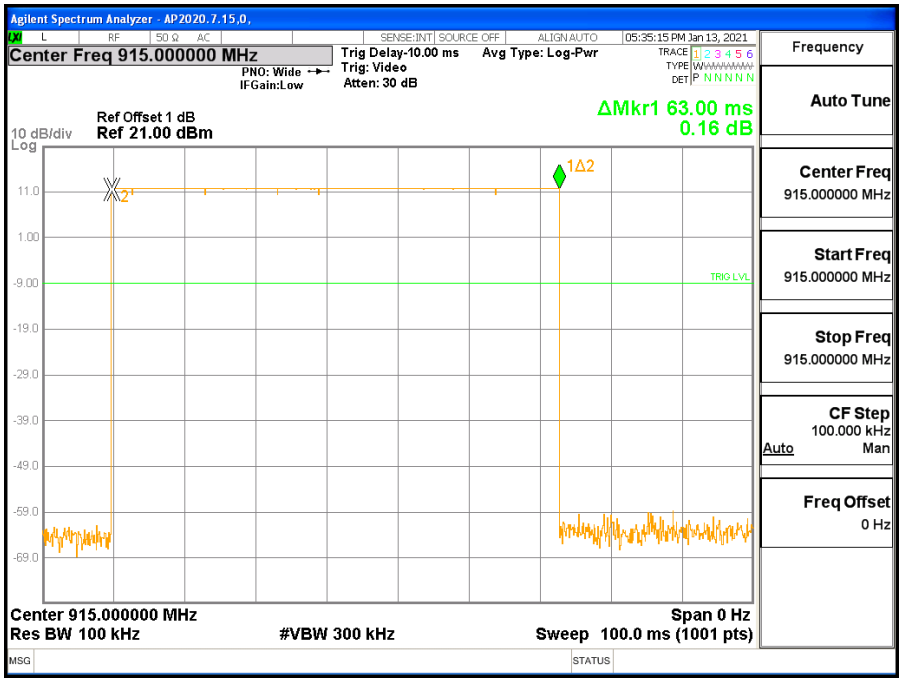
Test Result

Test Mode	Antenna	Channel	Burst Width [ms/hop/ch]	Dwell Time [s]	Limit [s]	Results
GFSK-50 kbps	Ant1	Hop	63	0.32	0.4	PASS
GFSK-250 kbps	Ant1	Hop	63	0.19	0.4	PASS

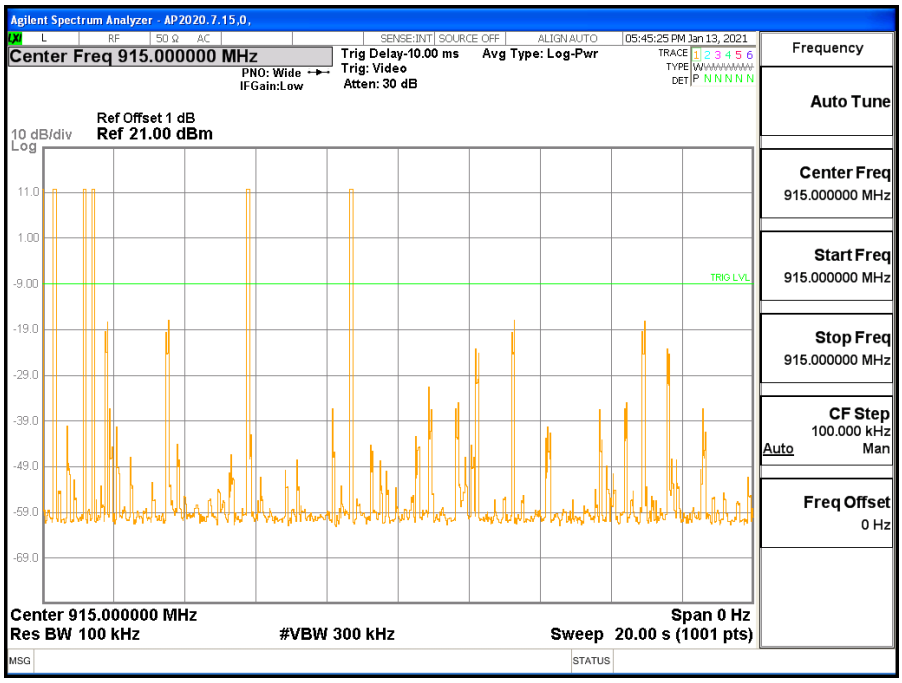
Note:
GFSK-50 kbps: The dwell time = Time of single slot * The number of hop channel appear within 20s
GFSK-250 kbps: The dwell time = Time of single slot * The number of hop channel appear within 10s

Test Graphs

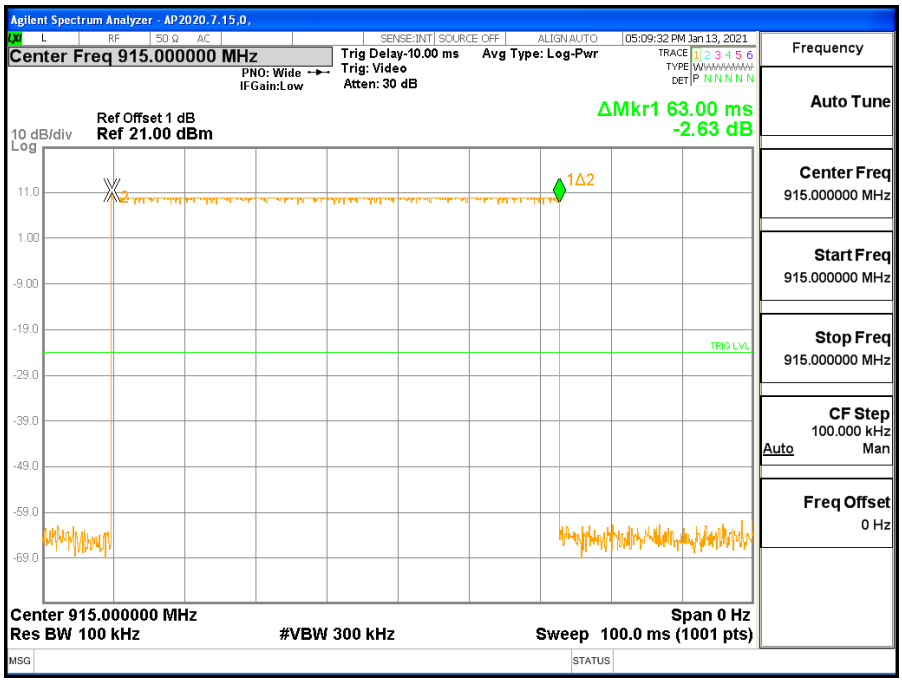
Time of single slot, GFSK-50 kbps



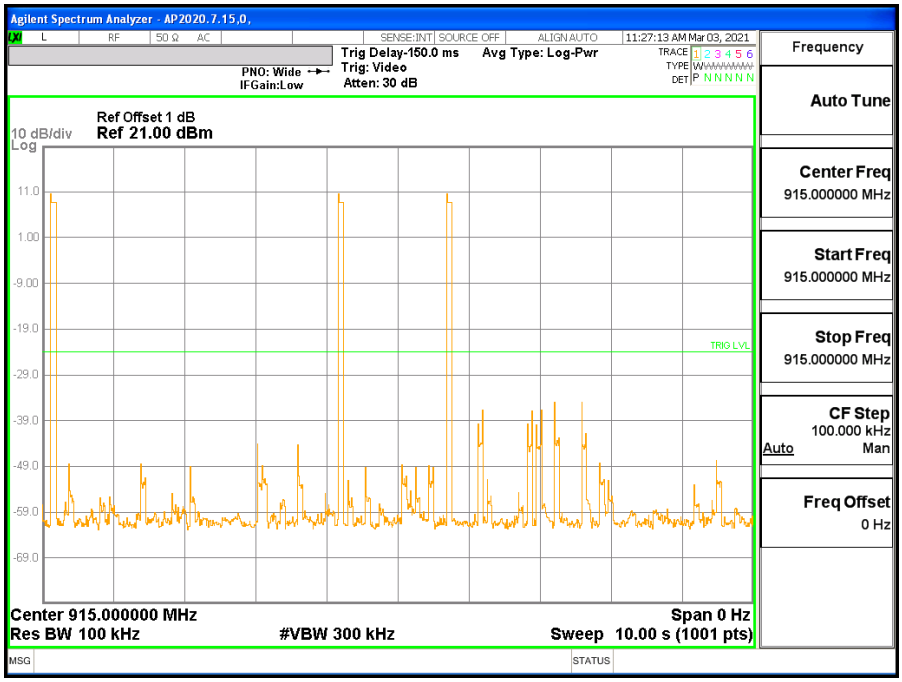
The number of hop channel appear, GFSK-50 kbps



Time of single slot, GFSK-250 kbps



The number of hop channel appear, GFSK-250 kbps



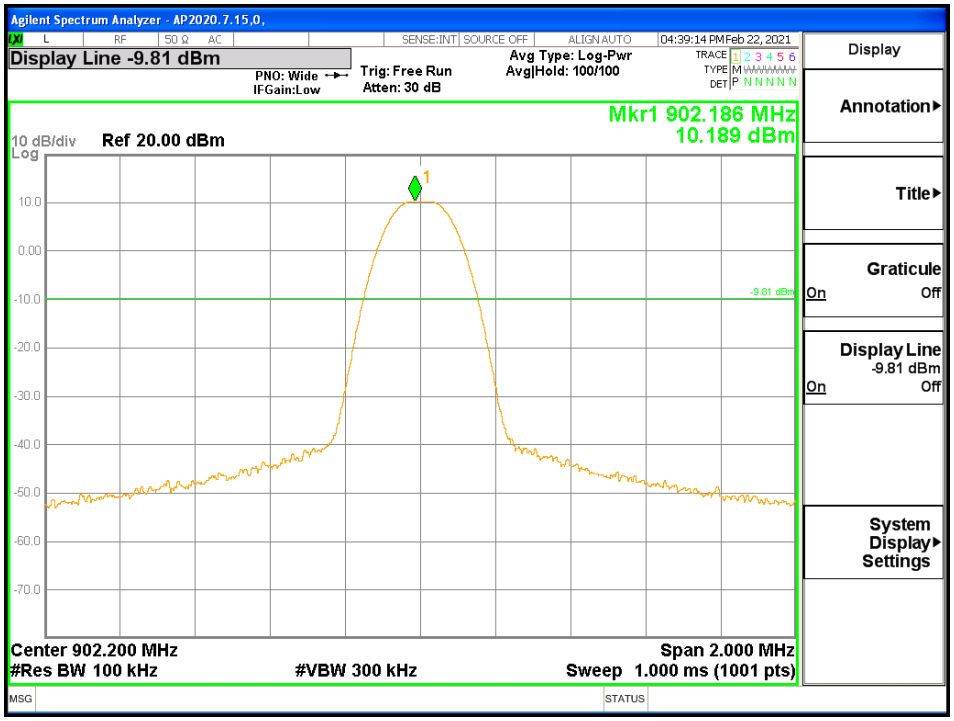
APPENDIX H: CONDUCTED SPURIOUS EMISSION

Test Result

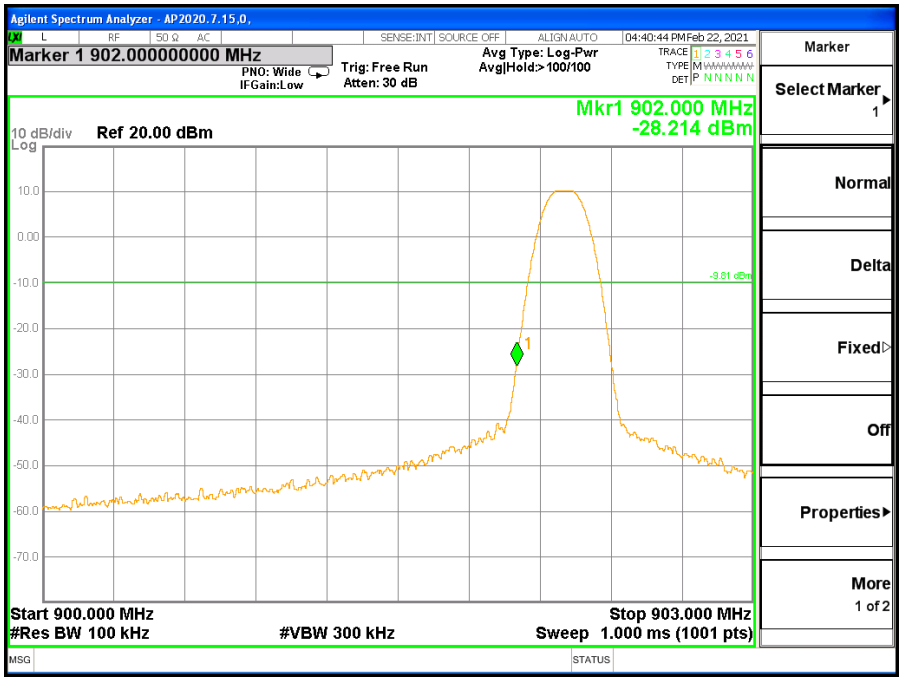
Test Mode	Antenna	ChName	Test Result	Verdict
GFSK-50 kbps	Ant1	Low	See the below graphs	PASS
		High		PASS
		Hop_Low		PASS
		Hop_High		PASS
GFSK-250 kbps	Ant1	Low		PASS
		High		PASS
		Hop_Low		PASS
		Hop_High		PASS

Test Graphs

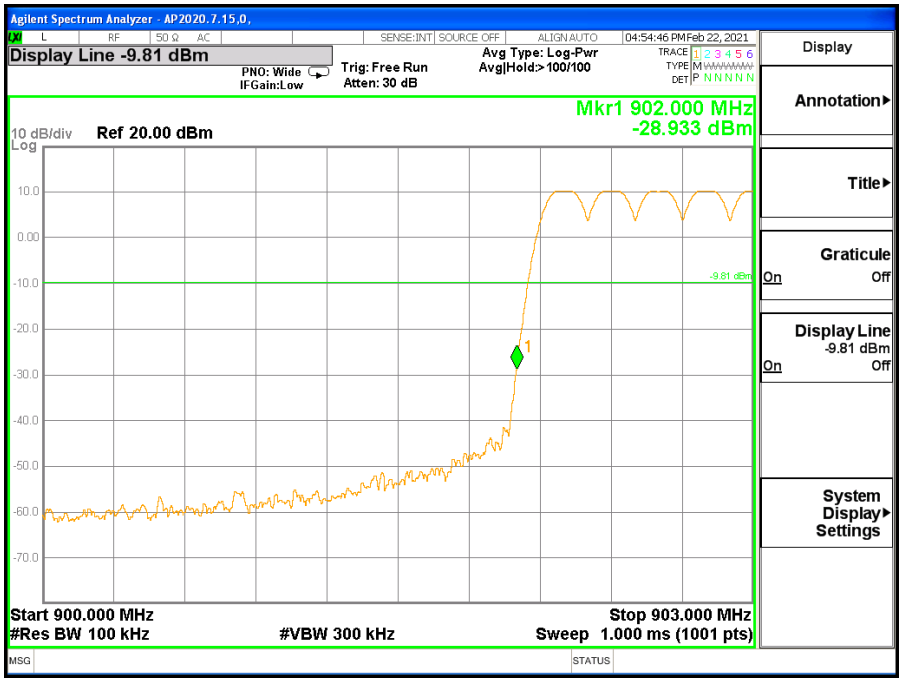
GFSK-50 kbps, Low CH, Reference



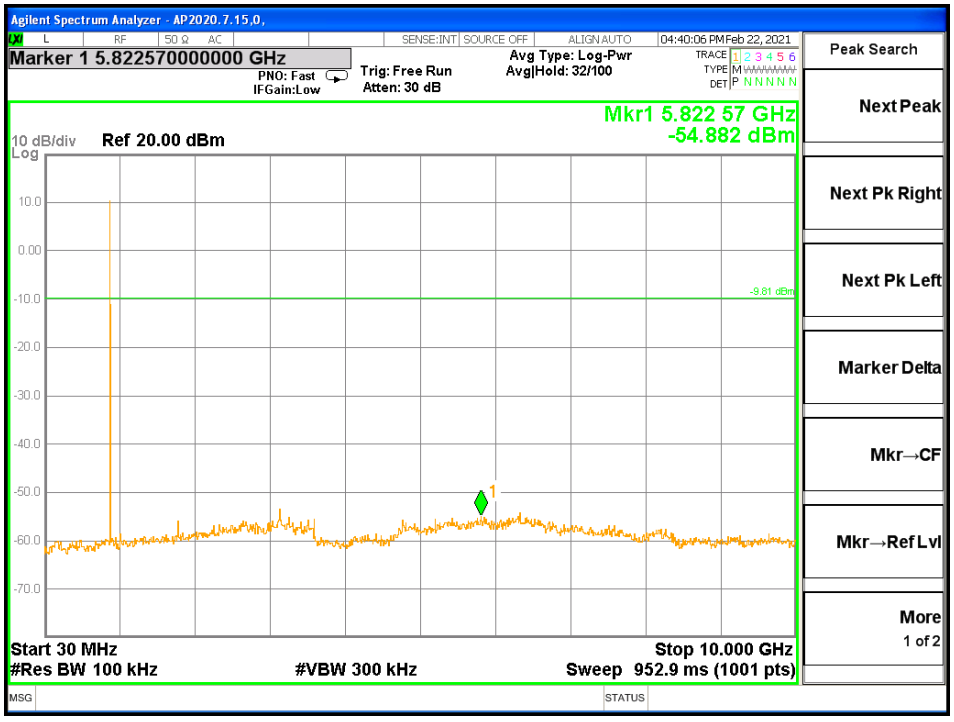
GFSK-50 kbps, Low CH, Bandedge



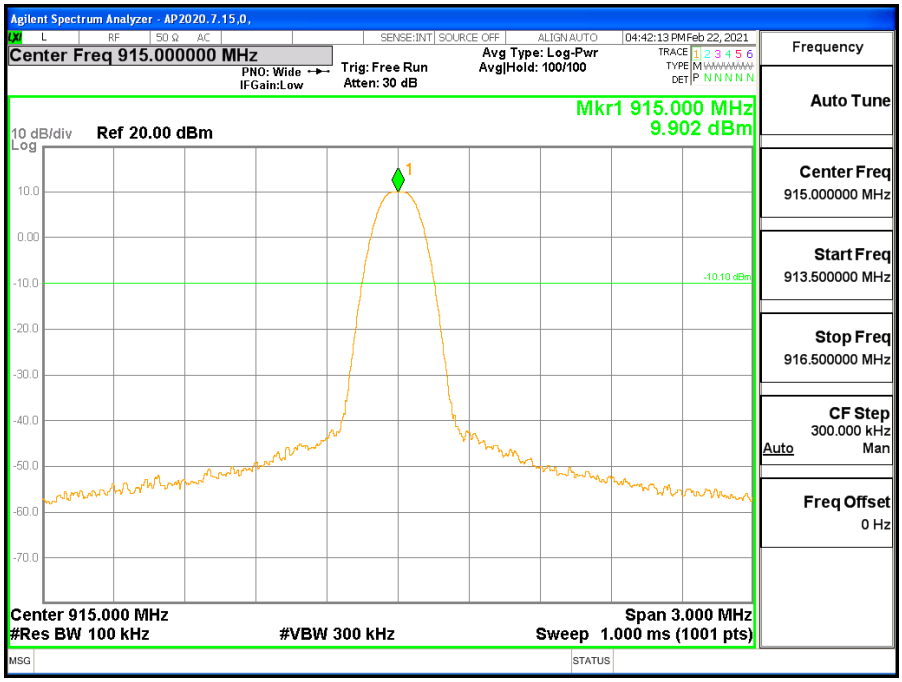
GFSK-50 kbps, Low CH, Hopping on



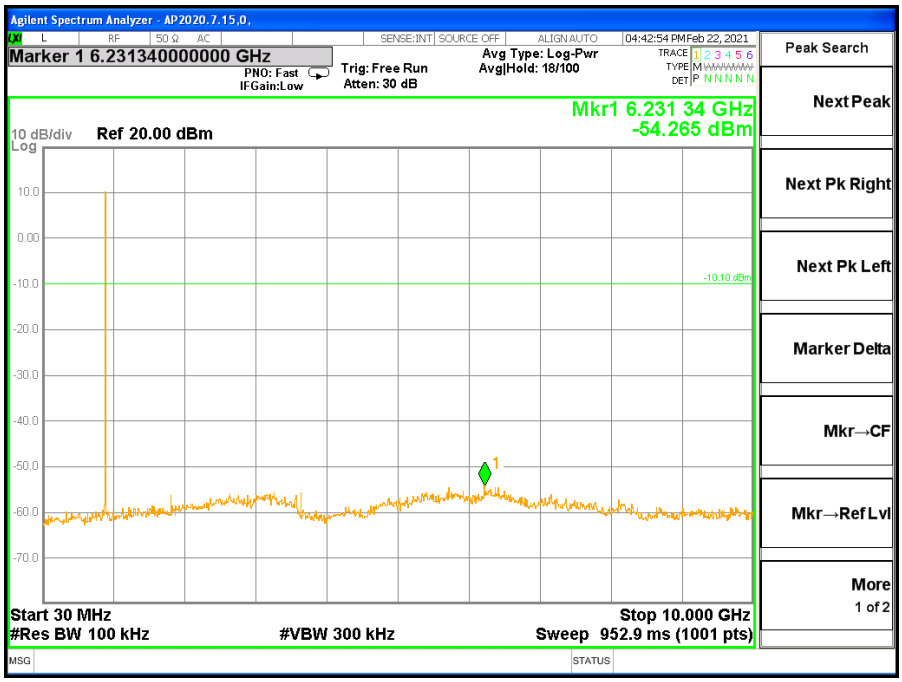
GFSK-50 kbps, Low CH, Spurious



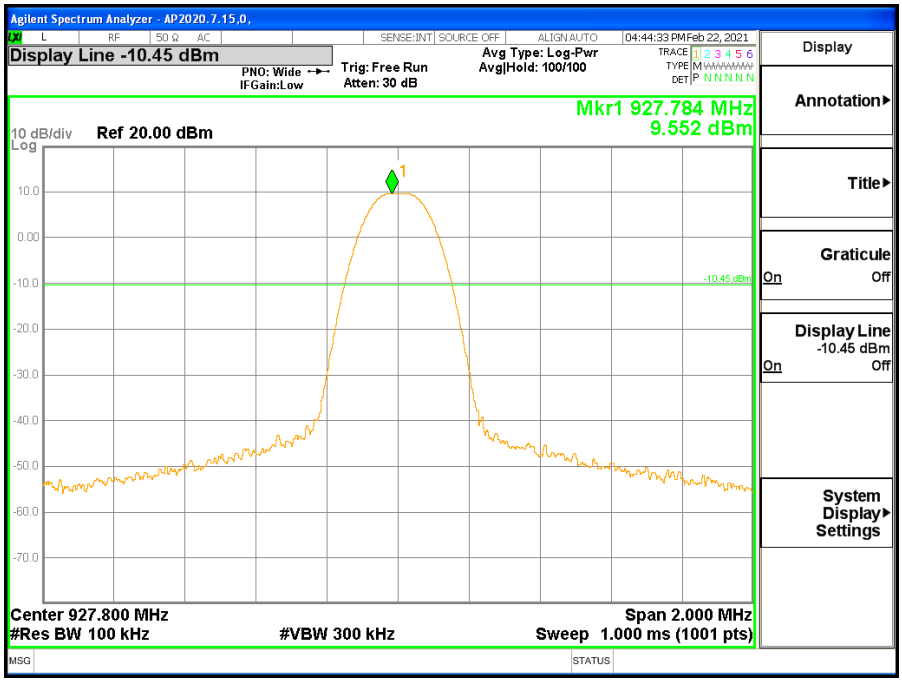
GFSK-50 kbps, Mid CH, Reference



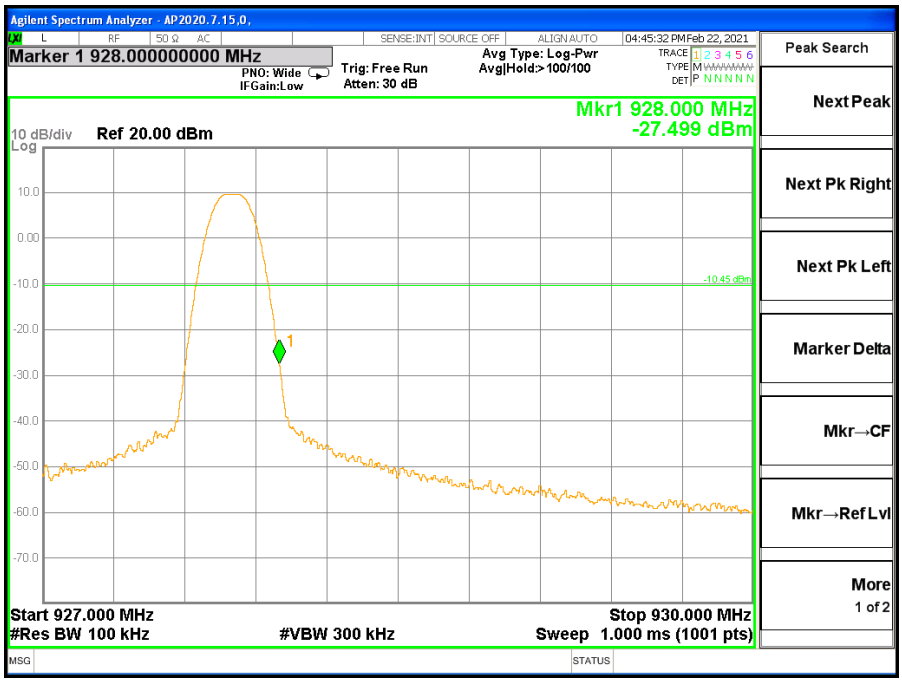
GFSK-50 kbps, Mid CH, Spurious



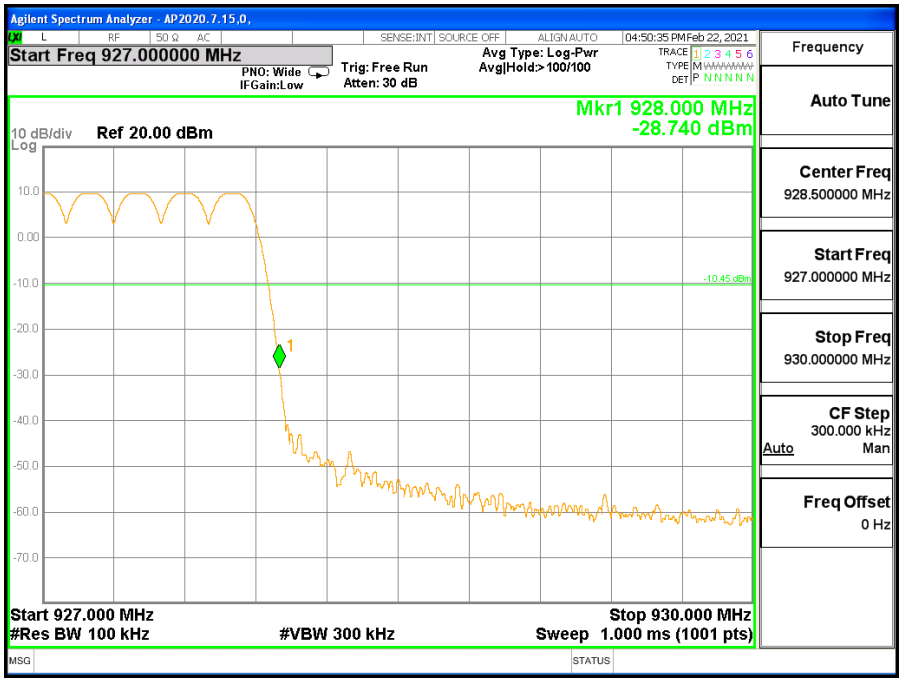
GFSK-50 kbps, High CH, Reference



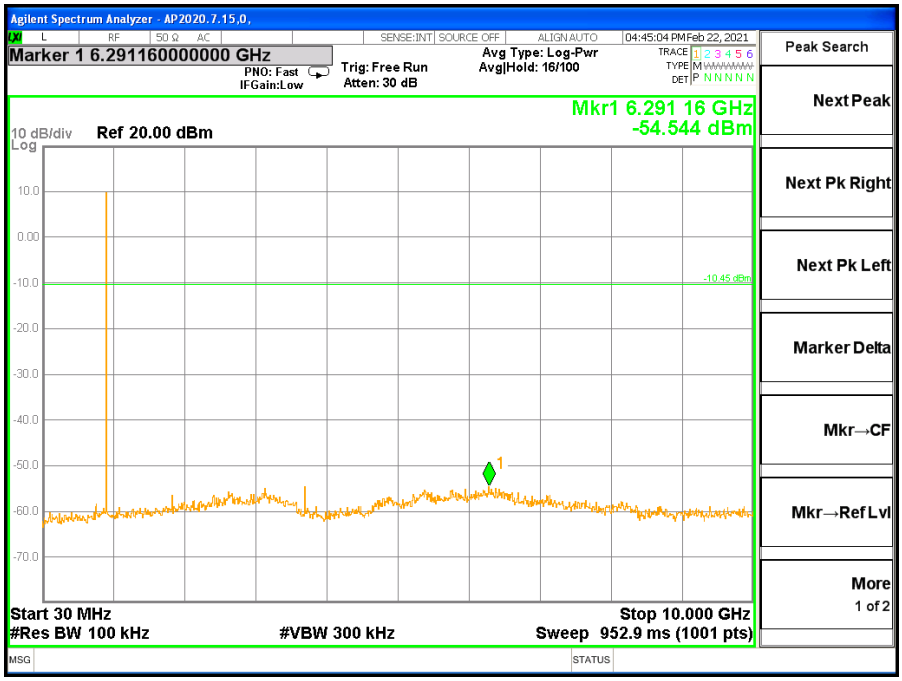
GFSK-50 kbps, High CH, Bandedge



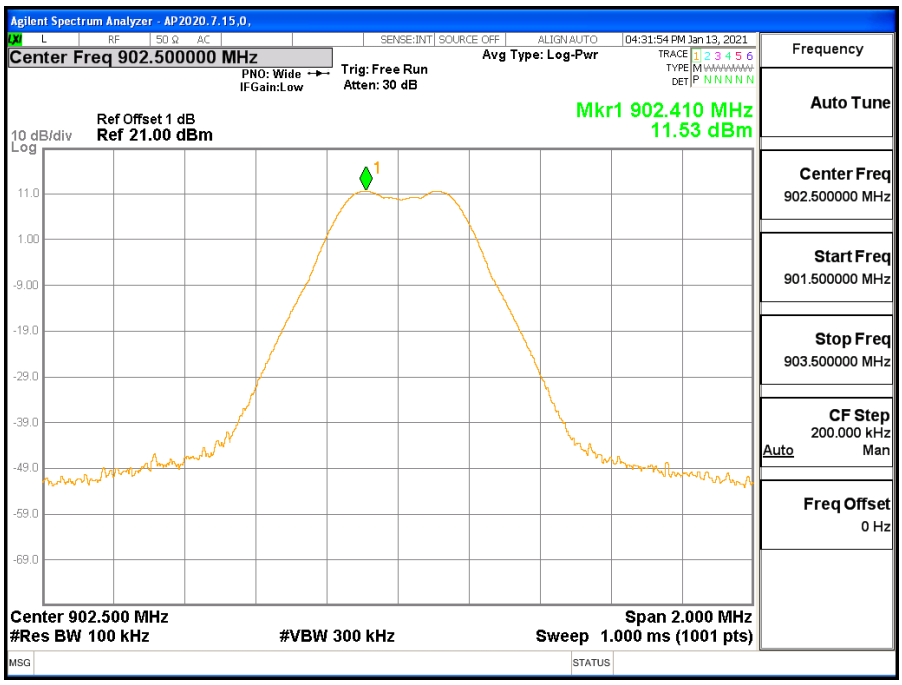
GFSK-50 kbps, High CH, Hopping on



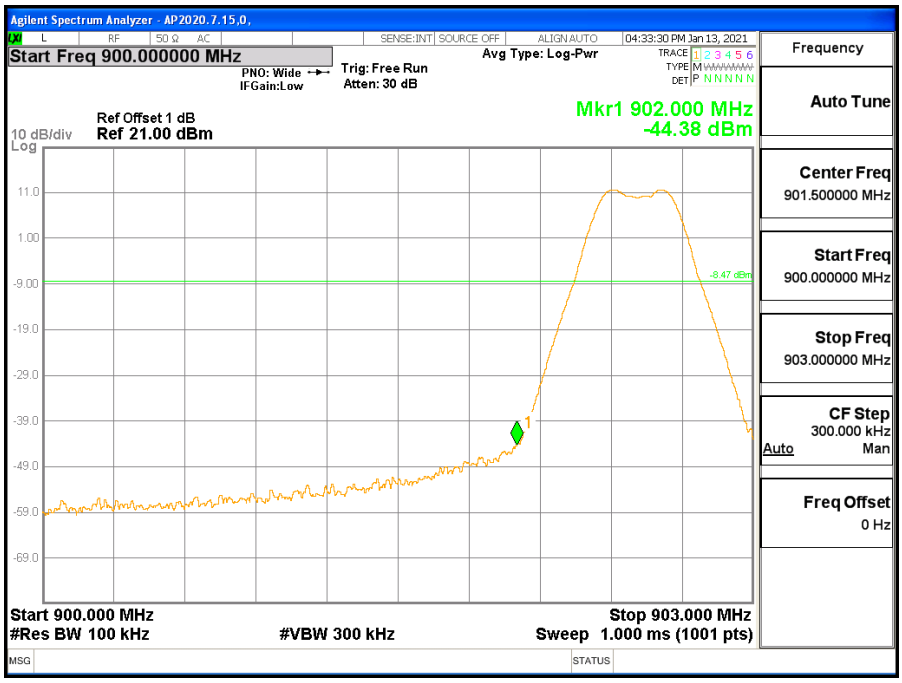
GFSK-50 kbps, High CH, Spurious



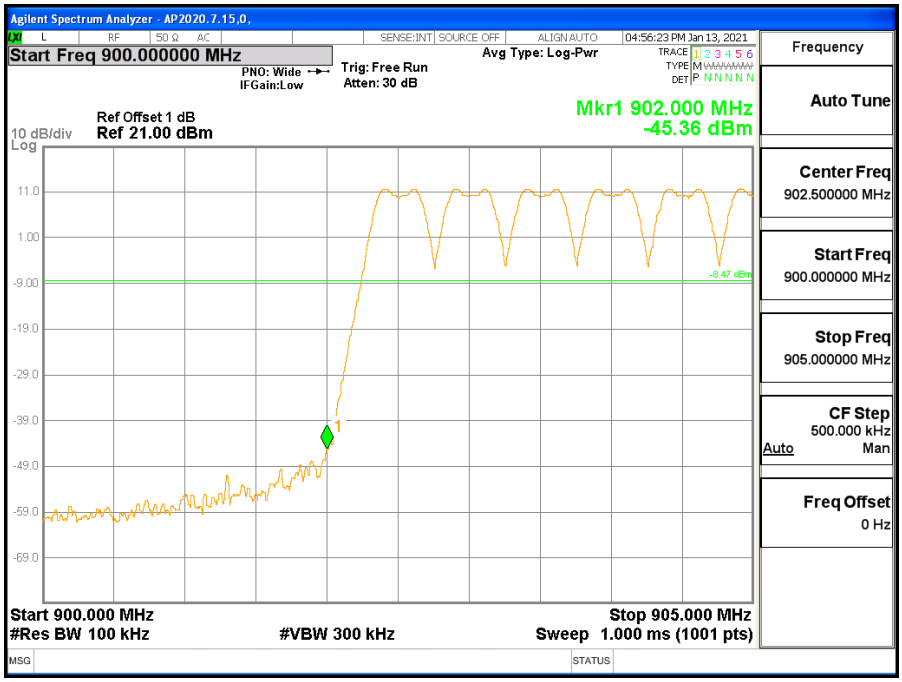
GFSK-250 kbps, Low CH, Reference



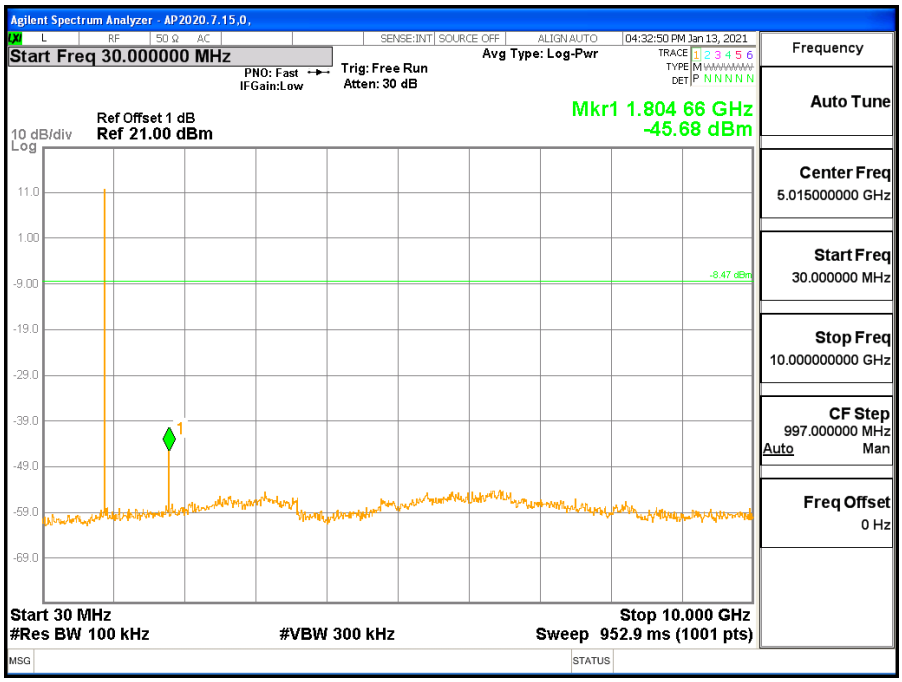
GFSK-250 kbps, Low CH, Bandedge



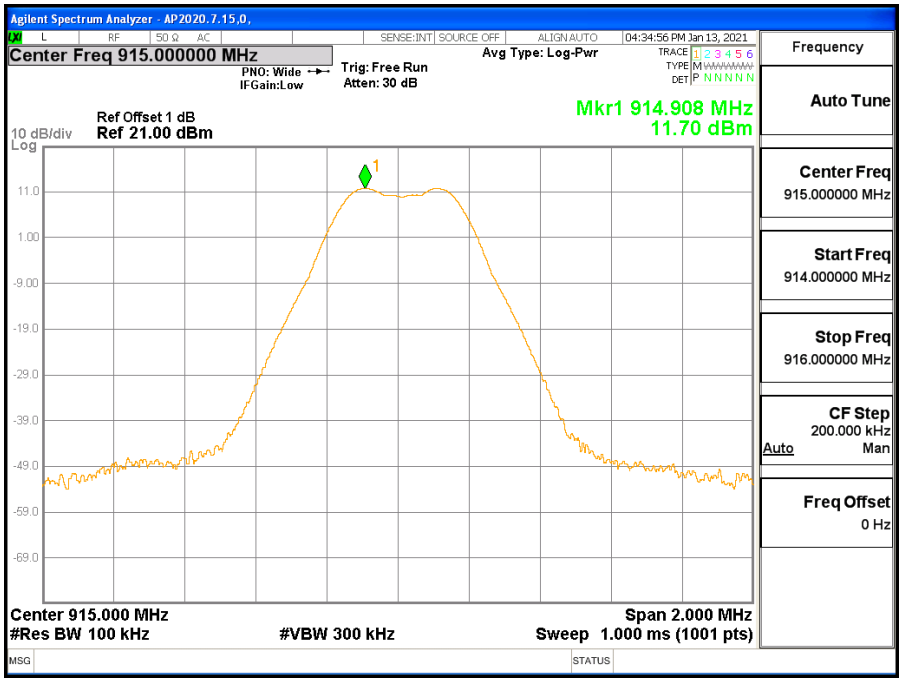
GFSK-250 kbps, Low CH, Hopping on



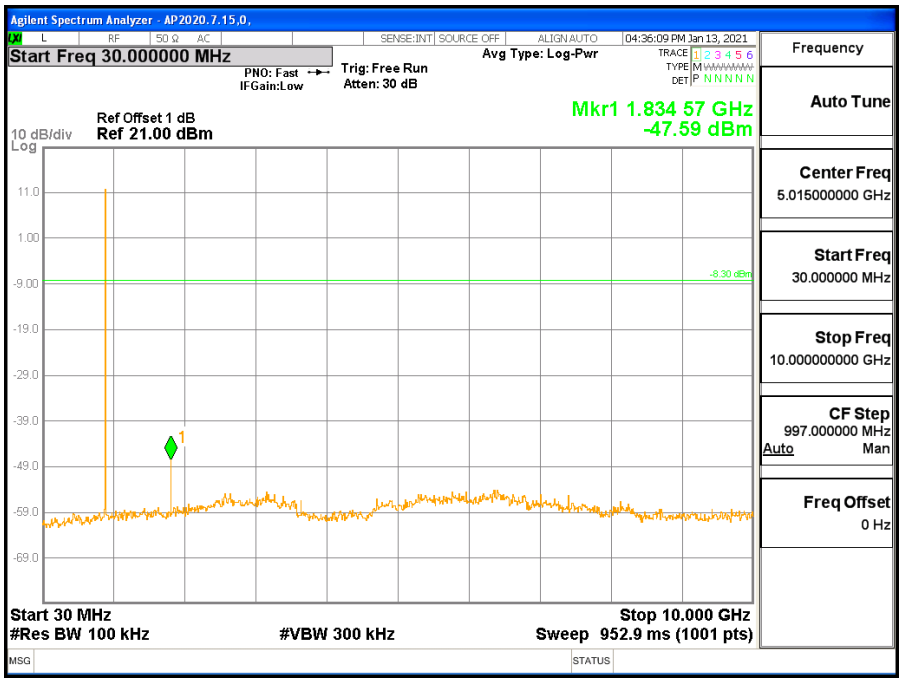
GFSK-250 kbps, Low CH, Spurious



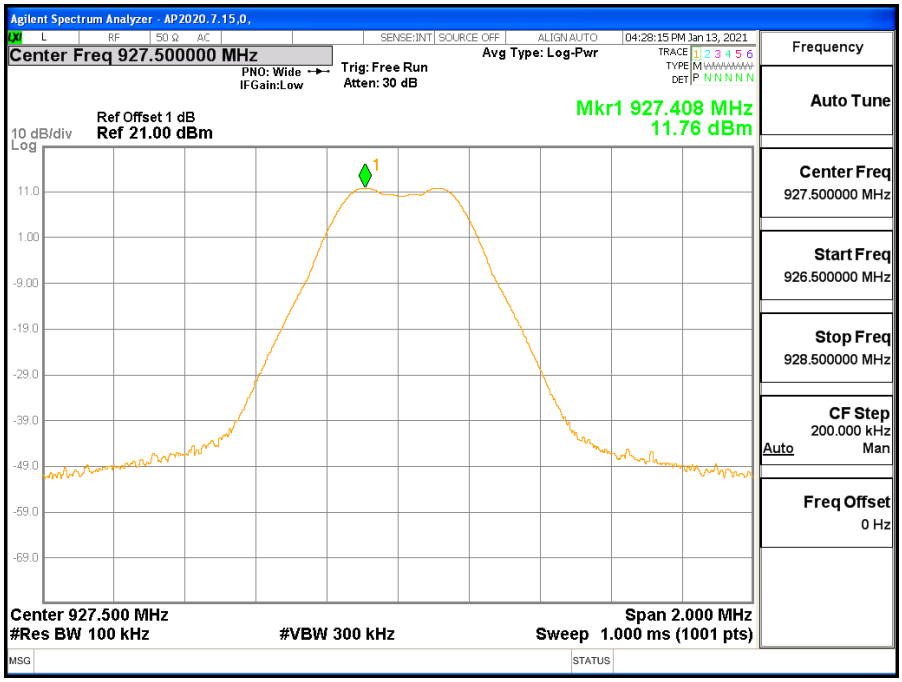
GFSK-250 kbps, Mid CH, Reference



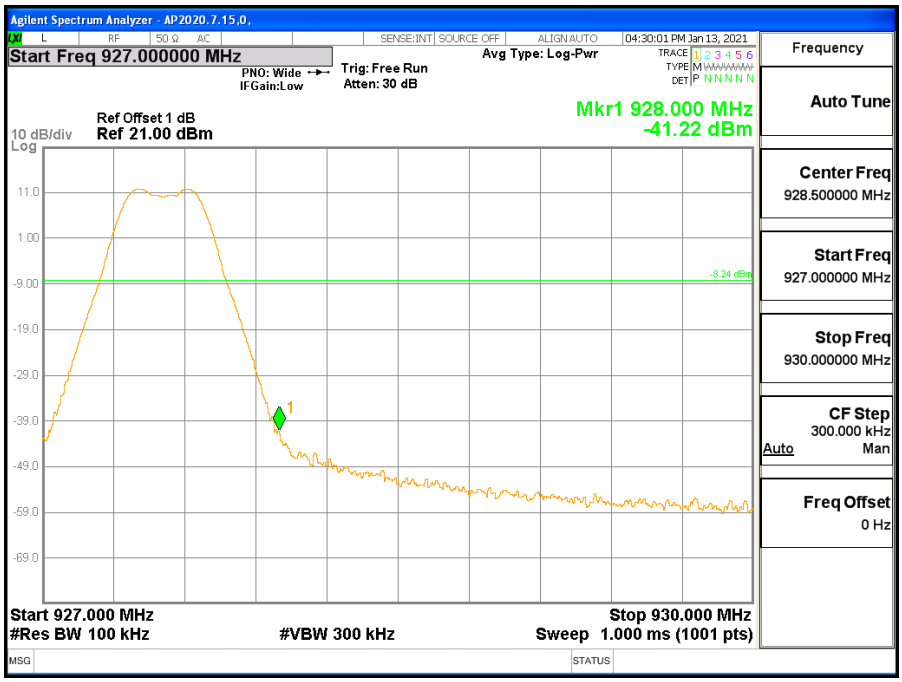
GFSK-250 kbps, Mid CH, Spurious



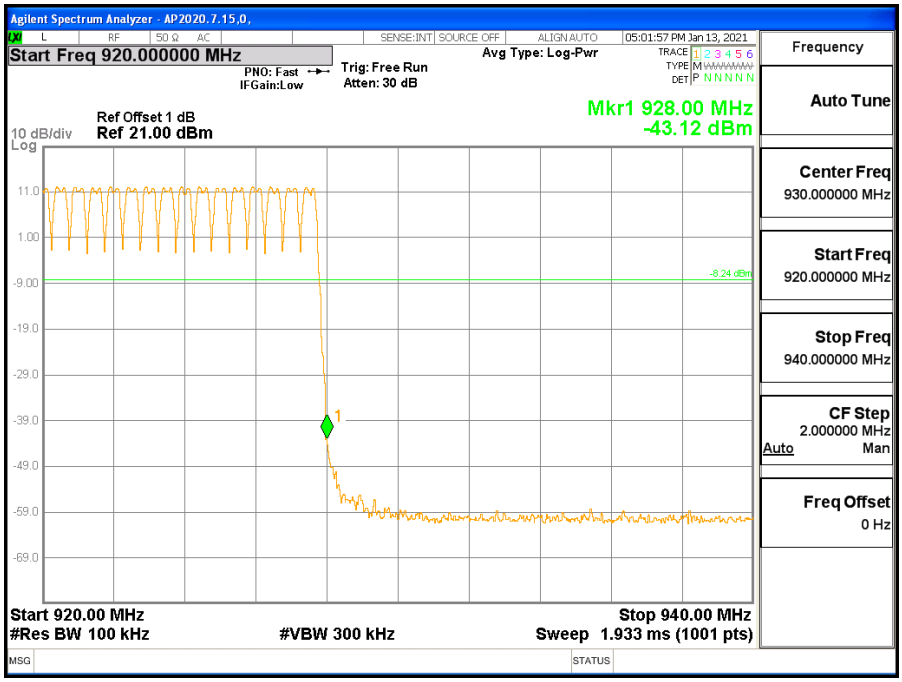
GFSK-250 kbps, High CH, Reference



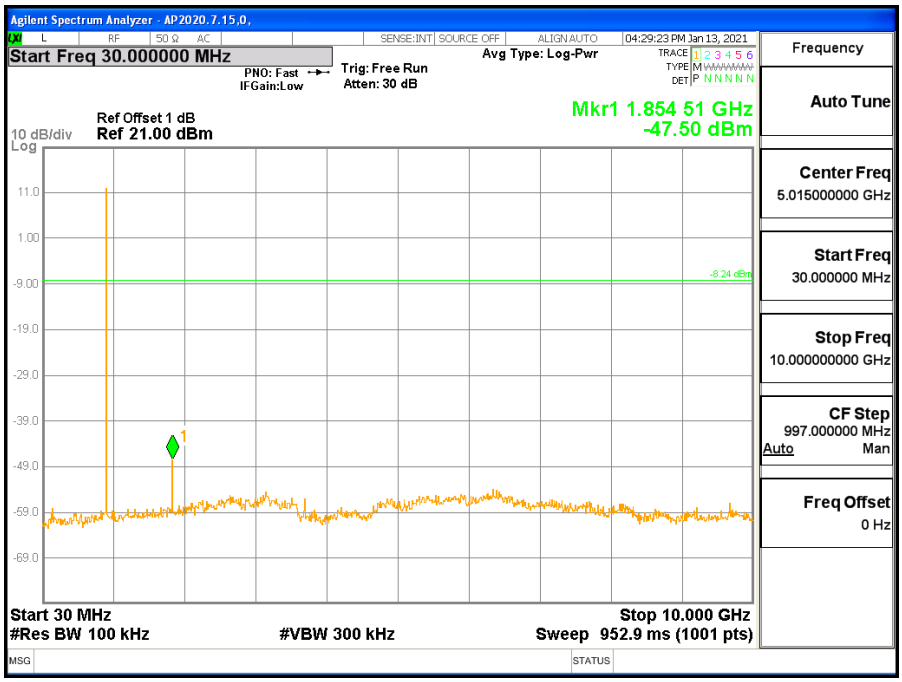
GFSK-250 kbps, High CH, Bandedge



GFSK-250 kbps, High CH, Hopping on



GFSK-250 kbps, High CH, Spurious



END OF REPORT