

Astera LED Technology GmbH

TEST REPORT

SCOPE OF WORK

FCC TESTING—ART7-WIFI

REPORT NUMBER

221118015SZN-001

ISSUE DATE

14 December 2022

[REVISED DATE]

[-----]

PAGES

42

DOCUMENT CONTROL NUMBER

FCC ID 247_b

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Astera LED Technology GmbH

Application
For
Certification

FCC ID: X55ART7-WIFI**AsteraBox WIFI****Model: ART7-WIFI****2.4GHz Transceiver**

Report No.: 221118015SZN-001

We hereby certify that the sample of the above item is considered to comply with the
requirements of FCC Part 15, Subpart C for Intentional Radiator,
mention 47 CFR [10-1-21]

Prepared and Checked by:

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Engineer

Approved by:

Peter Kang
Sr. Technical Supervisor
Date: 14 December 2022

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Intertek Testing Service Shenzhen Ltd. Longhua Branch

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MEASUREMENT/TECHNICAL REPORT

This report concerns (check one:) Original Grant ☒ Class II Change ☐

Equipment Type: DSS - Part 15 Spread Spectrum Transmitter

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes ☐ No ☒

If yes, defer until: _____
date

Company Name agrees to notify the Commission by: _____
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes ☐ No ☒

If no, assumed Part 15, Subpart C for intentional radiator – the new 47 CFR [10-1-21 Edition] provision.

Report prepared by:

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1.0 Summary of Test Results

Applicant: Astera LED Technology GmbH

Address: Stahlgruberring 36, 81829 Munich, Germany

Manufacturer: Astera Manufacturing Limited

Address: Bldg. 3, CLT Science & Technology Park, No. 7, GanLiliu Road, Jihua subdistrict, Longgang District, Shenzhen, P.C.518112

Model: ART7-WIFI

FCC ID: X55ART7-WIFI

TEST	REFERENCE	RESULTS
Max. Output power / Max. e.i.r.p.	FCC 15.247(b)(1)	Pass
20dB Bandwidth	FCC 15.247(a)(1)	Pass
Channel Separation	FCC 15.247(a)(1)	Pass
Channel Number	FCC 15.247(a)(1) (iii)	Pass
Dwell Time	FCC 15.247(a)(1)(iii)	Pass
Out of Band Antenna Conducted Emission	FCC 15.247(d)	Pass
Radiated Emission in Restricted Bands	FCC 15.247(d), FCC 15.209, FCC 15.205	Pass
Band Edge	FCC 15.247(d), FCC 15.209, FCC 15.205	Pass
AC Conducted Emission	FCC 15.209	Pass

Notes: The EUT uses an Integral Antenna which in accordance to Section 15.203 is considered sufficient to comply with the provisions of this section.

2.0 General Description

2.1 Product Description

The equipment under test (EUT) is a UHF transmitter operating in 917~922.2MHz band. It contains two modules that have already been certified. One certified module is operating at 2.4GHz band and subjected to FCC ID: XRSCRMXTIMO101, another certified Bluetooth & 2.4G WIFI module is subjected to FCC ID: 2AC7Z-ESP32WROVERE. The EUT is powered by a 3.6VDC rechargeable battery which can be charged via a micro USB cable by an AC/DC adapter with the input of AC100-240V, 50/60Hz, and output of DC 5.0V, 1.5A. The EUT also has a 3.5" socket which can be used to connect to DMX controllers via an adapter cable that is 3.5" jack to 5-pin XLR male. When DMX port connected, the UHF transmitter will stop transmitting. When DMX port is disconnected, the UHF transmitter and Bluetooth and 2.4G WIFI can be transmitted Simultaneously.

Type of Modulation: GFSK

Antenna Type: Integral Antenna

Antenna Gain: 3.0 dBi

For electronic filing, the brief circuit description is saved with filename: descri.pdf.

2.2 Related Submittal(s) Grants

This is an application for certification of a transceiver for ART7 operating at 917-922.2MHz. Remaining portions are subject to the following procedures:

The Bluetooth&2.4G WIFI modular had been certified and subjected to FCC ID: 2AC7Z-ESP32WROVERE.

The 2.4GHz modular had been certified and subjected to the FCC ID: XRSCRMXTIMO101

Other Digital Function: Subject to FCC Part 15B SDOC.

2.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

2.4 Test Facility

The Semi-anechoic chamber and shielding room used to collect the radiated data and conducted data are **Intertek Testing Services Shenzhen Ltd. Longhua Branch** and located at 101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community, GuanHu Subdistrict, LongHua District, Shenzhen. This test facility and site measurement data have been fully placed on file with File Number: CN1188.

3.0 System Test Configuration

3.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.10 (2013).

The EUT was powered by rechargeable battery (DC 3.6V, 6700mAh) which was charged by AC 120V/60Hz during the test. UHF and Transmitted Simultaneously (UHF+BT+WIFI) have been conducted and only the worst-case data were recorded in this report.

For maximizing emissions below 30 MHz, the EUT was rotated through 360°, the bottom of the loop antenna was placed 1 meter above the ground, and the antenna polarization was changed. For maximizing emissions, the EUT was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported in Section 4.

The EUT and transmitting antenna was centered on the turntable.

The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). The EUT was placed on a turn table, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

3.2 EUT Exercising Software

The EUT exercise program (provided by client) used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use. The worst-case configuration is used in all specified testing.

The parameters of test software setting:

During the test, Channel and power controlling software provided by the applicant was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the application and is going to be fixed on the firmware of the end product.

3.3 Special Accessories

No special accessory attached.

3.4 Equipment Modification

Any modifications installed previous to testing by Astera LED Technology GmbH will be incorporated in each production model sold / leased in the United States.

No modifications were installed by Intertek Testing Services Shenzhen Ltd. Longhua Branch.

3.5 Measurement Uncertainty

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

3.6 Support Equipment List and Description

Description	Manufacturer	Model No.
USB Charging Adapter	Powertron Electronics Corp.	Model: PS1006-050SIB150 Input: AC 100~240V, 50-60Hz, 0.3A Output: 5Vdc, 1.5A, 7.5W Max
USB Charging Cable	(provided by applicant)	Unshielded, 110cm
DMX Cable	provided by applicant	Unshielded, 32cm
DMX Cable	provided by applicant	Unshielded, 65cm
DMX controller	provided by applicant	DMX-100

4.0 Test Results

Data is included worst-case configuration (the configuration which resulted in the highest emission levels).

4.1 Radiated Test Results

A sample calculation, configuration photographs and data tables of the emissions are included.

4.1.1 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

$$FS = RA + AF + CF - AG + PD + AV$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB/m
- AG = Amplifier Gain in dB
- PD = Pulse Desensitization in dB
- AV = Average Factor in -dB

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

$$FS = RA + AF + CF - AG + PD + AV$$

Assume a receiver reading of 62.0 dB μ V is obtained. The antenna factor of 7.4 dB/m and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted. The pulse desensitization factor of the spectrum analyzer was 0 dB, and the resultant average factor was -10 dB. The net field strength for comparison to the appropriate emission limit is 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 62.0 dB μ V
 AF = 7.4 dB/m
 CF = 1.6 dB
 AG = 29.0 dB
 PD = 0 dB
 AV = -10 dB

$FS = 62 + 7.4 + 1.6 - 29 + 0 + (-10) = 32 \text{ dB}\mu\text{V/m}$
 Level in $\mu\text{V/m}$ = Common Antilogarithm $[(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$

4.1.2 Radiated Emission Configuration Photograph

For electronic filing, the worst case radiated emission configuration photograph is saved with filename: radiated photos. pdf.

4.1.3 Radiated Emissions- FCC section 15.209

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Worst Case Radiated Emission

at 747.994000 MHz

Judgement: Passed by 8.4 dB

TEST PERSONNEL:

Sign on file

Allen Qin, Engineer
Typed/Printed Name

30 November 2022
Date

Applicant: Astera LED Technology GmbH

Date of Test: 30 November 2022

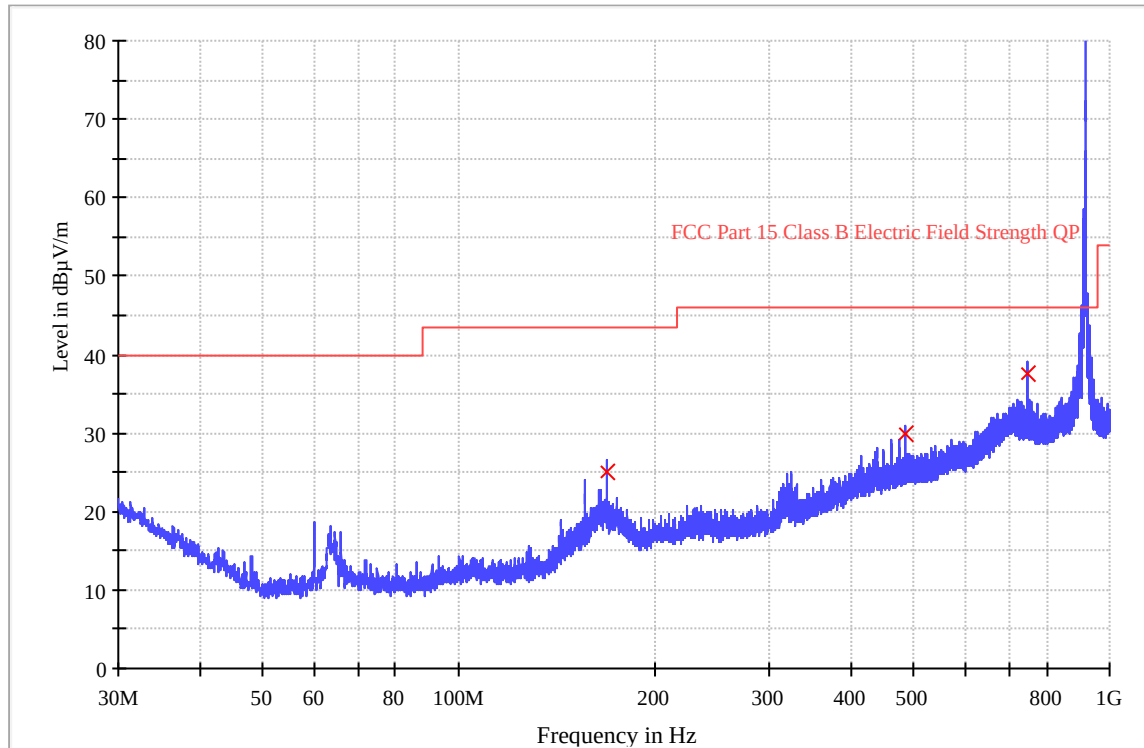
Model: ART7-WIFI

Worst-case operating Mode: transmitting 917MHz

Modulation type: GFSK

ANT Polarity: Horizontal

FCC Part 15



Frequency (MHz)	Quasi Peak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK dBμV/m)
168.968667	25.0	1000.0	120.000	H	16.8	18.5	43.5
486.029333	29.8	1000.0	120.000	H	26.4	16.2	46.0
747.994000	37.6	1000.0	120.000	H	32.0	8.4	46.0

Remark:

1. Corr. (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB)
2. Quasi Peak (dBμV/m) = Corr. (dB/m) + Read Level (dBμV)
3. Margin (dB) = Limit Line (dBμV/m) – Level (dBμV/m)

Applicant: Astera LED Technology GmbH

Date of Test: 30 November 2022

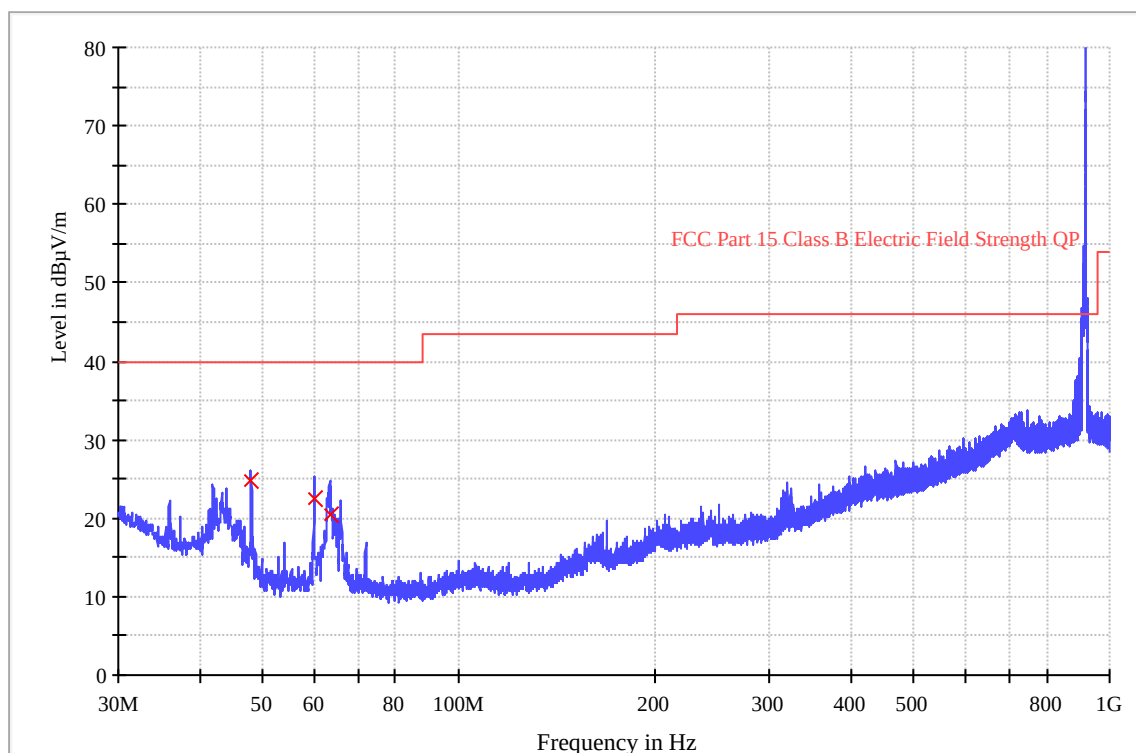
Model: ART7-WIFI

Worst-case operating Mode: transmitting 917MHz

Modulation type: GFSK

ANT Polarity: Vertical

FCC Part 15



Frequency (MHz)	Quasi Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK (dBµV/m)
47.977333	24.7	1000.0	120.000	V	13.8	15.3	40.0
59.973000	22.6	1000.0	120.000	V	13.5	17.4	40.0
63.368000	20.4	1000.0	120.000	V	13.6	19.6	40.0

Remark:

1. Corr. (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB)
2. Quasi Peak (dBµV/m) = Corr. (dB/m) + Read Level (dBµV)
3. Margin (dB) = Limit Line (dBµV/m) – Level (dBµV/m)

4.1.4 Transmitter Spurious Emissions (Radiated) - FCC section 15.209

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Worst Case Radiated Emission

at 1844.400 MHz

Judgement: Passed by 2.6 dB

TEST PERSONNEL:

Sign on file

Allen Qin, Engineer
Typed/Printed Name

30 November 2022
Date

Applicant: Astera LED Technology GmbH

Date of Test: 30 November 2022

Model: ART7-WIFI

Worst-case operating Mode: Transmit (917MHz)

Modulation type: GFSK

Table 1

Radiated Emissions

(917MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	**917.000	82.7	0	24.5	107.2	--	--
Horizontal	*1834.000	72.1	36.7	28.4	63.8	74.0	-10.2
Horizontal	*5502.000	58.0	35.6	33.6	56.0	74.0	-18.0

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Average Factor (-dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	**917.000	82.7	0.0	24.5	13.9	93.3	--	--
Horizontal	*1834.000	72.1	36.7	28.4	13.9	49.9	54.0	-4.1
Horizontal	*5502.000	58.0	35.6	33.6	13.9	42.1	54.0	-11.9

- NOTES:
1. Peak detector is used for the emission measurement.
 2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
 3. Negative value in the margin column shows emission below limit.
 4. Horn antenna used for the emission over 1000MHz.
- * Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.
- ** Fundamental emission was measured for determining band-edge compliance of using delta measurement technique.

Applicant: Astera LED Technology GmbH
Date of Test: 30 November 2022
Model: ART7-WIFI
Worst-case operating Mode: Transmit (919.6MHz)
Modulation type: GFSK

Table 2

Radiated Emissions

(919.6MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	*1839.200	72.5	36.7	28.4	64.2	74.0	-9.8
Horizontal	*5517.600	56.0	36.1	33.6	53.5	74.0	-20.5

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Average Factor (-dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	*1839.200	72.5	36.7	28.4	13.9	50.3	54.0	-3.7
Horizontal	*5517.600	56.0	36.1	33.6	13.9	39.6	54.0	-14.4

- NOTES:
1. Peak detector is used for the emission measurement.
 2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
 3. Negative value in the margin column shows emission below limit.
 4. Horn antenna used for the emission over 1000MHz.
- * Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: Astera LED Technology GmbH
Date of Test: 30 November 2022
Model: ART7-WIFI
Worst-case operating Mode: Transmit (922.2MHz)
Modulation type: GFSK

Table 3

Radiated Emissions

(922.2MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	**922.200	118.6	36.7	24.5	106.4	--	--
Horizontal	*1844.400	73.6	36.7	28.4	65.3	74.0	-8.7
Horizontal	*5533.200	58.0	36.1	33.6	55.5	74.0	-18.5

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Average Factor (-dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	**922.200	118.6	36.7	24.5	13.9	92.5	--	--
Horizontal	*1844.400	73.6	36.7	28.4	13.9	51.4	54.0	-2.6
Horizontal	*5533.200	58.0	36.1	33.6	13.9	41.6	54.0	-12.4

- NOTES:
1. Peak detector is used for the emission measurement.
 2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
 3. Negative value in the margin column shows emission below limit.
 4. Horn antenna used for the emission over 1000MHz.
- * Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.
- ** Fundamental emission was measured for determining band-edge compliance of using delta measurement technique.

4.2 Conducted Emission at Mains Terminal

4.2.1 Conducted Emissions Configuration Photograph

For electronic filing, the worst case conducted emission configuration photograph is saved with filename: conducted photos.pdf.

4.2.2 Conducted Emissions

Worst Case Conducted Configuration

at 0.470000 MHz

Judgement: Passed by 14.9 dB margin

TEST PERSONNEL:

Sign on file

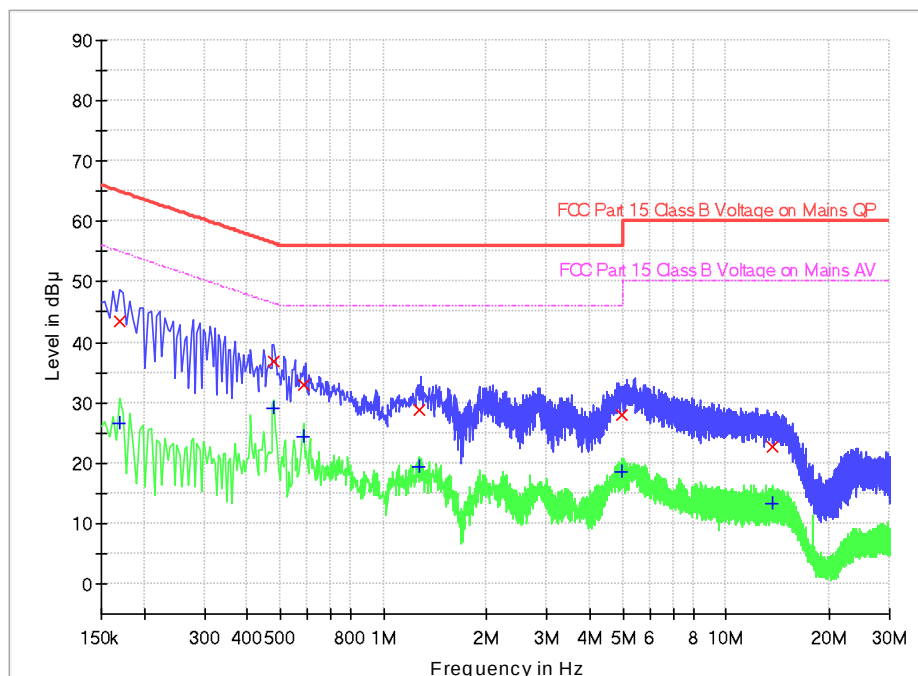
Allen Qin Engineer
Typed/Printed Name

30 November 2022
Date

Applicant: Astera LED Technology GmbH
Date of Test: 30 November 2022
Model: ART7-WIFI
Worst-case operating Mode: Transmit (CH0)
Modulation type: GFSK
Phase: Live

Conducted Emission Test - FCC

Conducted Emission Test FCC Part 15



Result Table QP

Frequency (MHz)	Quasi Peak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.170000	43.4	9.000	L1	9.6	21.6	65.0
0.478000	36.9	9.000	L1	9.6	19.5	56.4
0.582000	32.8	9.000	L1	9.6	23.2	56.0
1.266000	28.7	9.000	L1	9.7	27.3	56.0
4.966000	28.0	9.000	L1	9.8	28.0	56.0
0.170000	43.4	9.000	L1	9.6	21.6	65.0

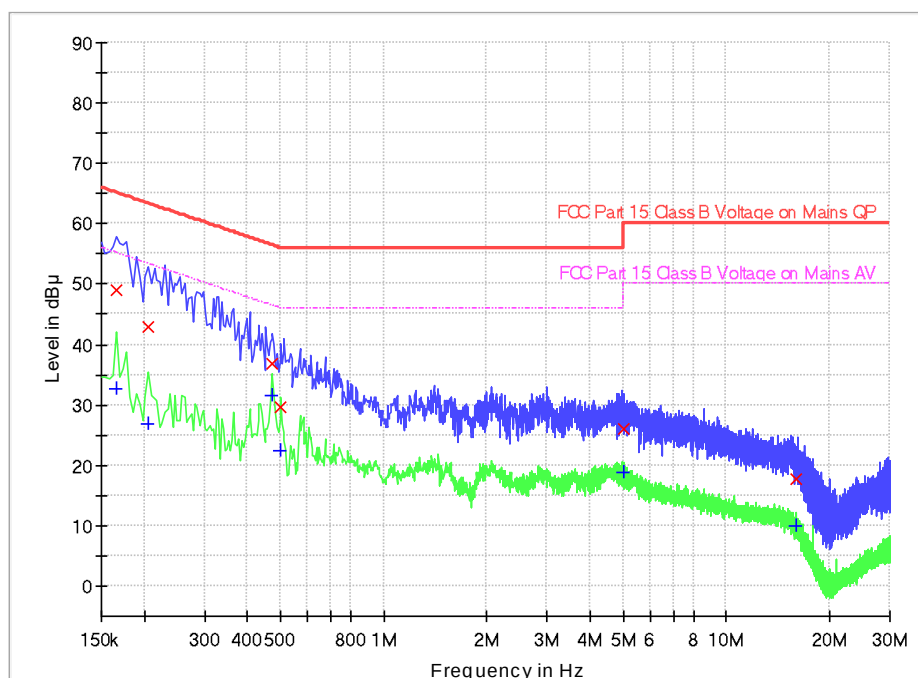
Result Table AV

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.170000	26.4	9.000	L1	9.6	28.5	55.0
0.478000	29.1	9.000	L1	9.6	17.3	46.4
0.582000	24.4	9.000	L1	9.6	21.6	46.0
1.266000	19.2	9.000	L1	9.7	26.8	46.0
4.966000	18.5	9.000	L1	9.8	27.5	46.0
0.170000	26.4	9.000	L1	10.1	36.6	50.0

Applicant: Astera LED Technology GmbH
Date of Test: 30 November 2022
Model: ART7-WIFI
Worst-case operating Mode: Transmit (CH0)
Modulation type: GFSK
Phase: Neutral

Conducted Emission Test - FCC

Conducted Emission Test FCC Part 15



Result Table QP

Frequency (MHz)	Quasi Peak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.166000	49.1	9.000	N	9.6	16.0	65.2
0.206000	43.0	9.000	N	9.6	20.4	63.4
0.470000	36.7	9.000	N	9.6	19.8	56.5
0.502000	29.5	9.000	N	9.6	26.5	56.0
4.998000	26.1	9.000	N	9.7	29.9	56.0
15.894000	17.7	9.000	N	10.2	42.3	60.0

Result Table AV

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.166000	32.6	9.000	N	9.6	22.5	55.2
0.206000	26.9	9.000	N	9.6	26.4	53.4
0.470000	31.6	9.000	N	9.6	14.9	46.5
0.502000	22.5	9.000	N	9.6	23.6	46.0
4.998000	18.8	9.000	N	9.7	27.2	46.0
15.894000	10.1	9.000	N	10.2	40.0	50.0

4.3 Peak Power

Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1).

The antenna port of the EUT was connected to the input of a spectrum analyzer. The analyzer was set for RBW > 20dB bandwidth and power was read directly in dBm.

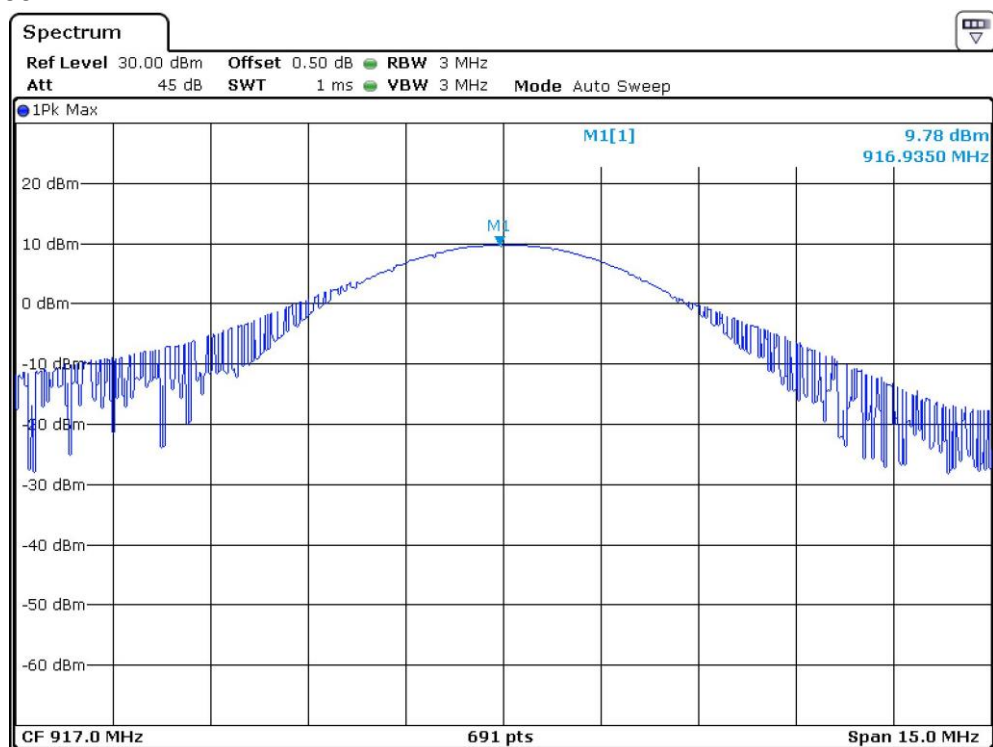
For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels.

Antenna Gain = 3dBi			
Modulation Type	Frequency (MHz)	Output Power (Peak Reading) (dBm)	Output Power (mW)
GFSK	917.00	9.78	9.51
	919.60	9.76	9.46
	922.20	9.80	9.55

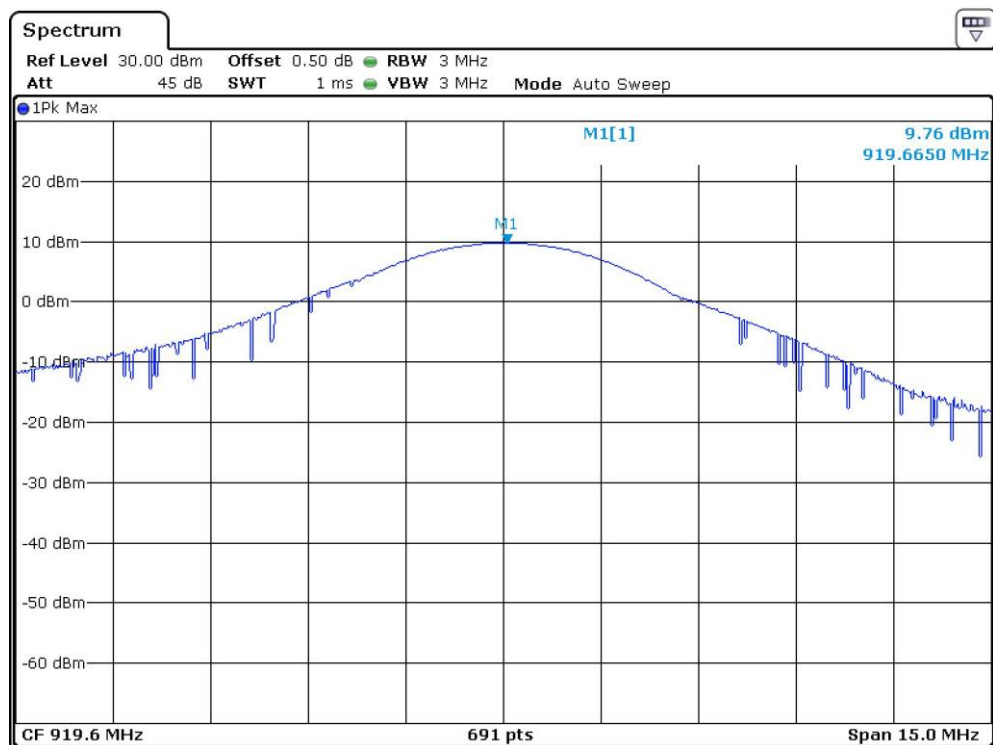
Cable loss: 0.5 dB External Attenuation: 0 dB

Modulation Type: GFSK

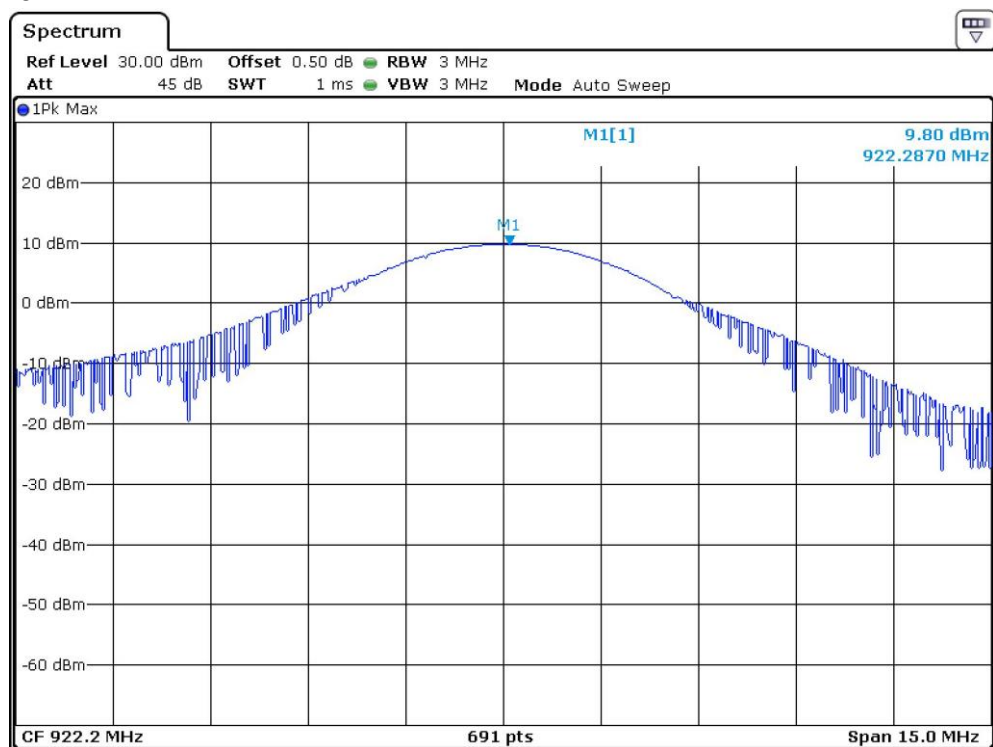
CH00 917.00MHz



CH26 919.60



CH52 922.20MHz



4.4 20dB Bandwidth

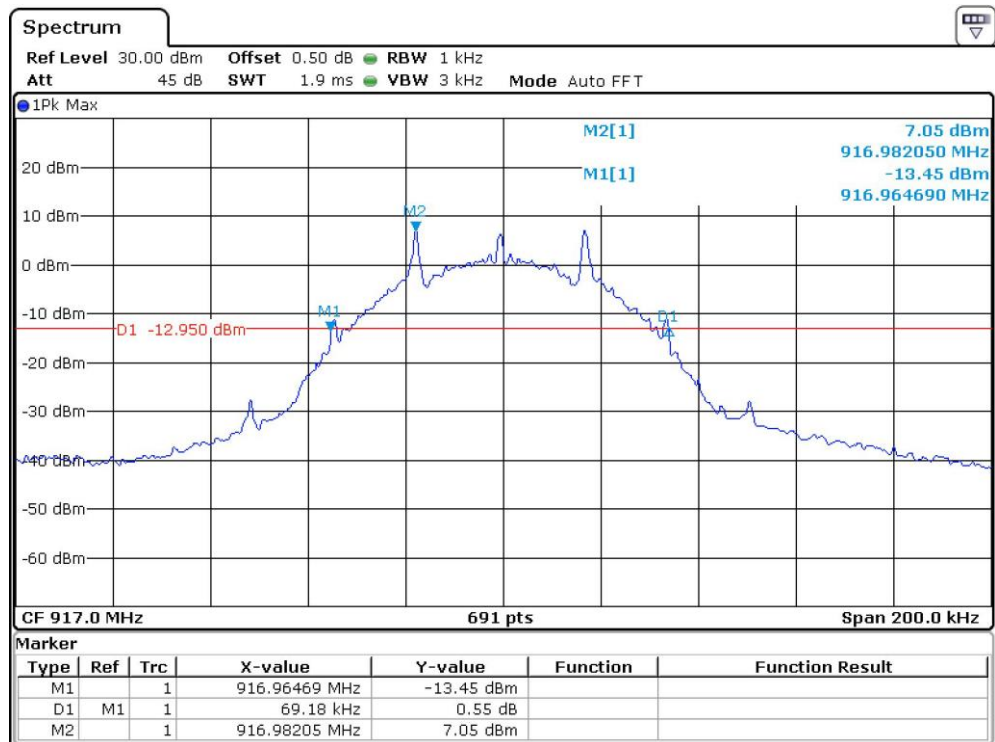
Maximum 20dB RF Bandwidth, FCC Rule 15.247(a) (1):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RBW was chosen so that the display was a result of the hopping channel modulation. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. Use the spectrum 20dB down delta function to measure the bandwidth.

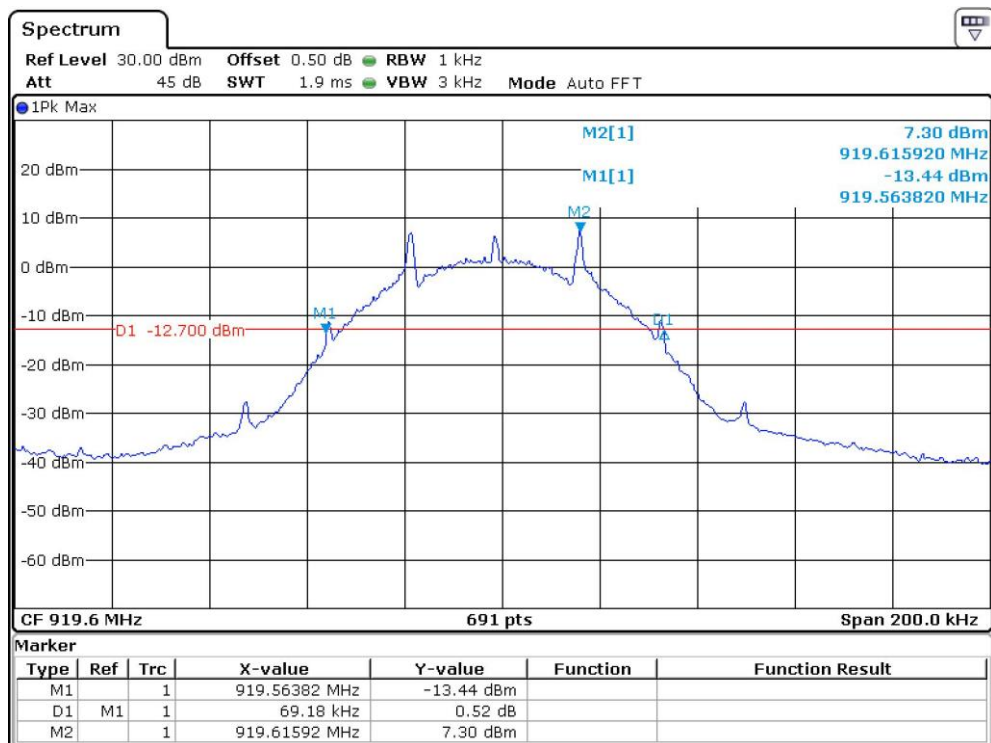
Frequency (MHz)	20 dB Bandwidth (KHz)
917.00	69.18
919.60	69.18
922.20	69.18

Modulation Type: GFSK

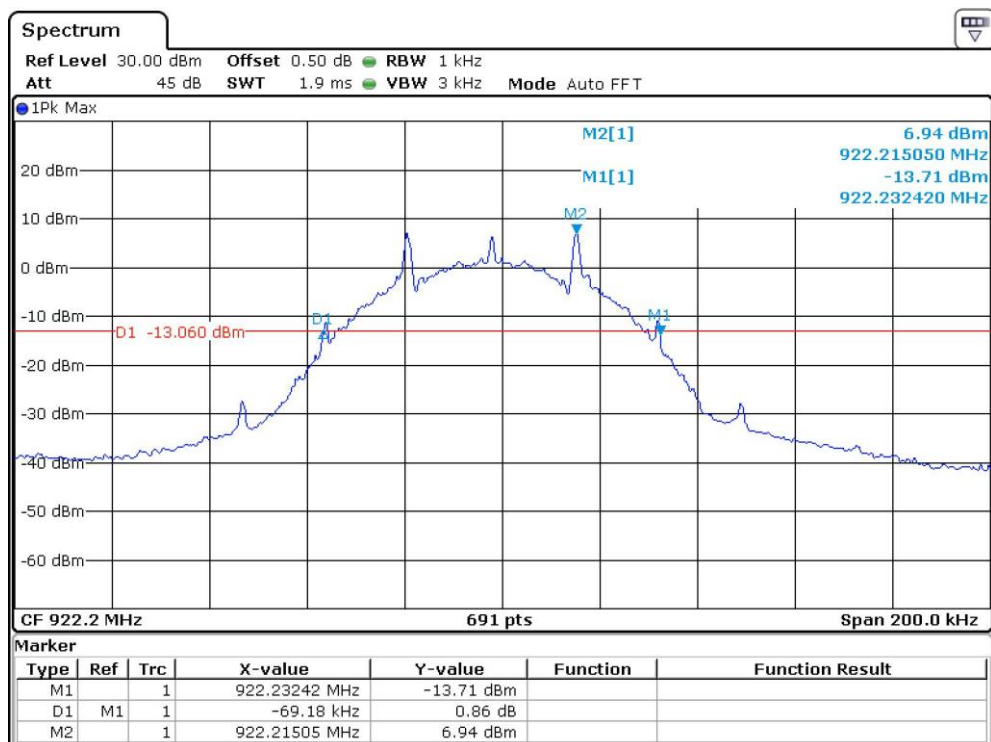
CH00 917.00MHz



CH26 919.60MHz



CH52 922.2MHz



4.5 Channel Number (Number of Hopping Frequencies)

Minimum Number of Hopping Frequencies, FCC Rule 15.247(a) (1) (iii):

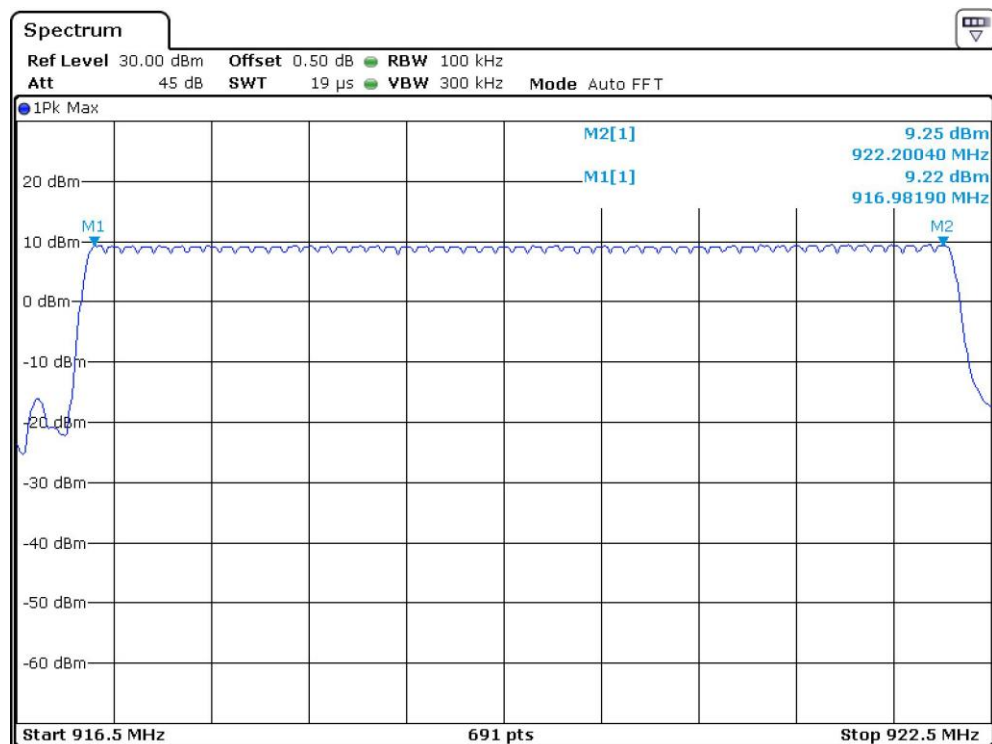
With the analyzer set to MAX HOLD readings were taken for 2-3 minutes. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

Number of hopping channels =

53

Modulation Type: GFSK

CH00-CH52



4.6 Channel Separation (Carrier Frequency Separation)

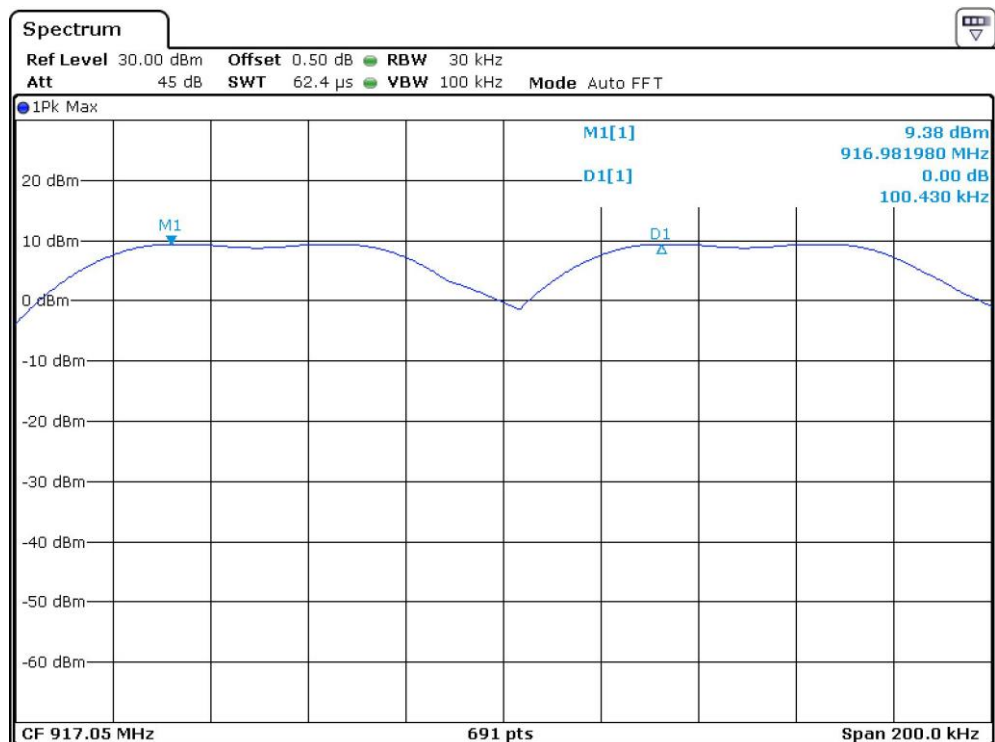
Minimum Hopping Channel Carrier Frequency Separation, FCC Ref: 15.247(a)(1):

Using the DELTA MARKER function of the analyzer, the frequency separation between two adjacent channels was measured and compared against the limit:

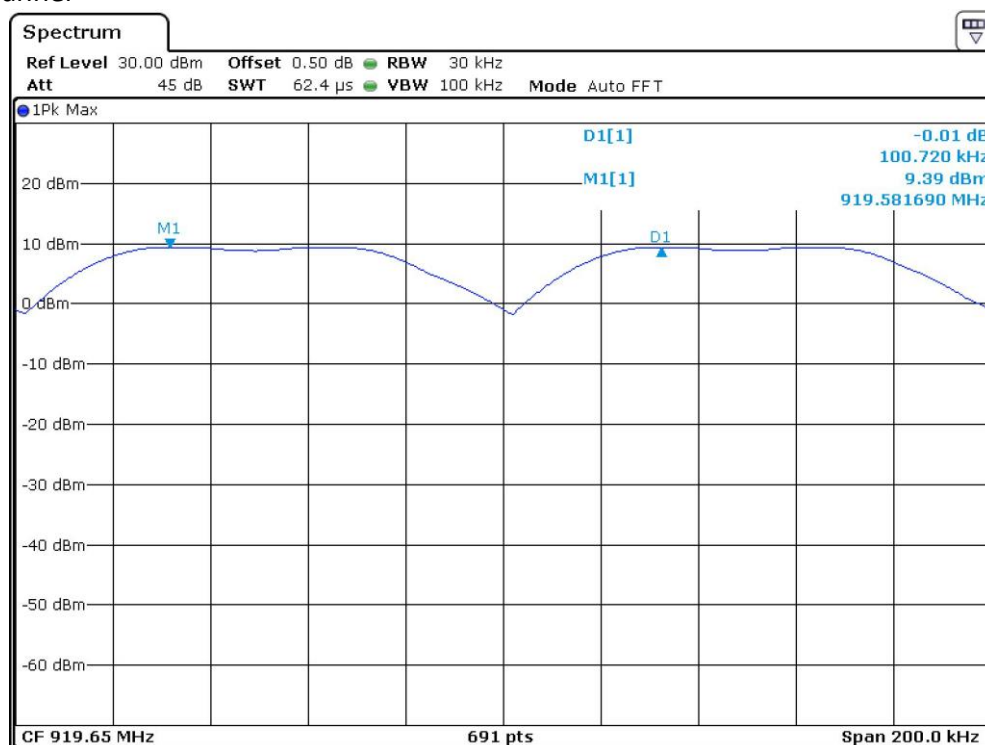
Not less than 20dB bandwidth of hopping channel: 69.18KHz

Modulation Type: GFSK

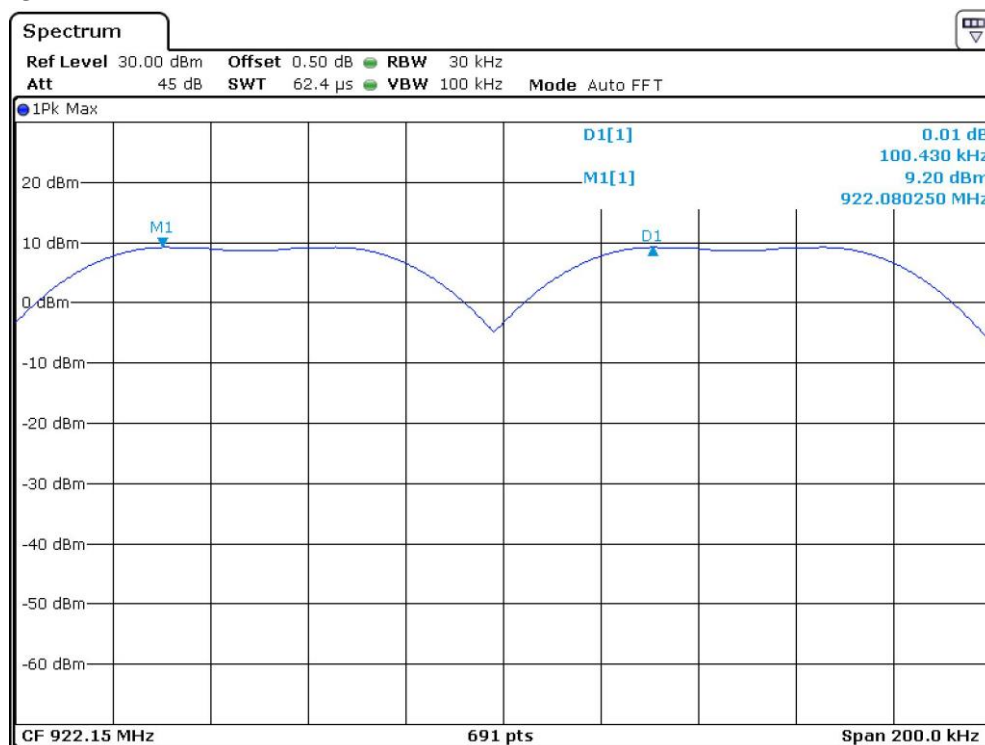
Low Channel



Middle Channel



High Channel



4.7 Dwell Time (Time of Occupancy)

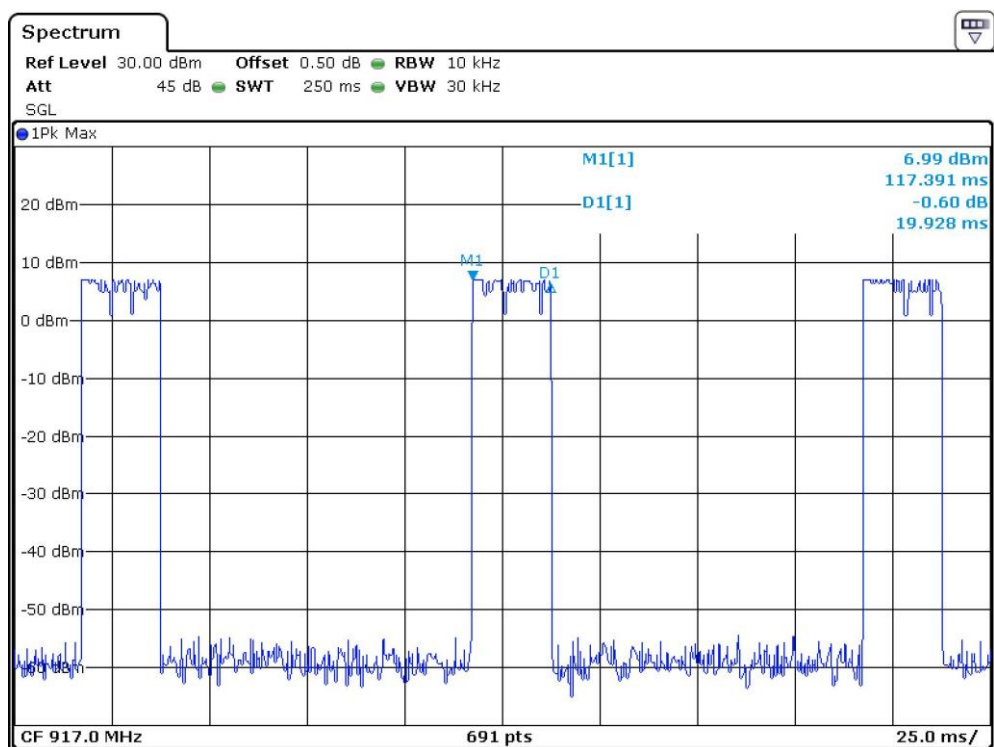
Average Channel Occupancy Time, FCC Ref: 15.247(a)(1)(i):

The spectrum analyzer center frequency was set to one of the known hopping channels. The SWEEP was set to 20s, the SPAN was set to ZERO SPAN, and the TRIGGER was set to VIDEO. The time duration of the transmissions so captured was measured with the MARKER DELTA function.

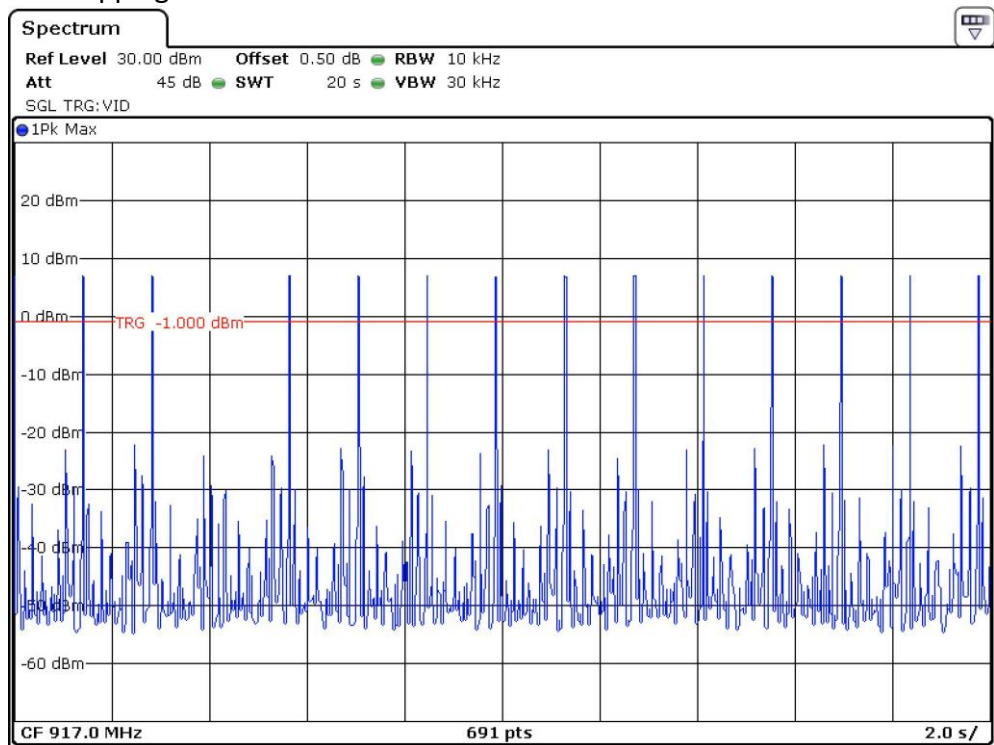
Note: For frequency hopping systems operating in the 902–928 MHz band: if the 20dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period

Frequency (MHz)	Dwell time Per Hop (s)	Number of hopping channels in 20s	Dwell time (s)	Limit (s)
917.00	0.019928	14	0.284	0.4
919.60	0.020290	14	0.284	0.4
922.20	0.020290	14	0.284	0.4

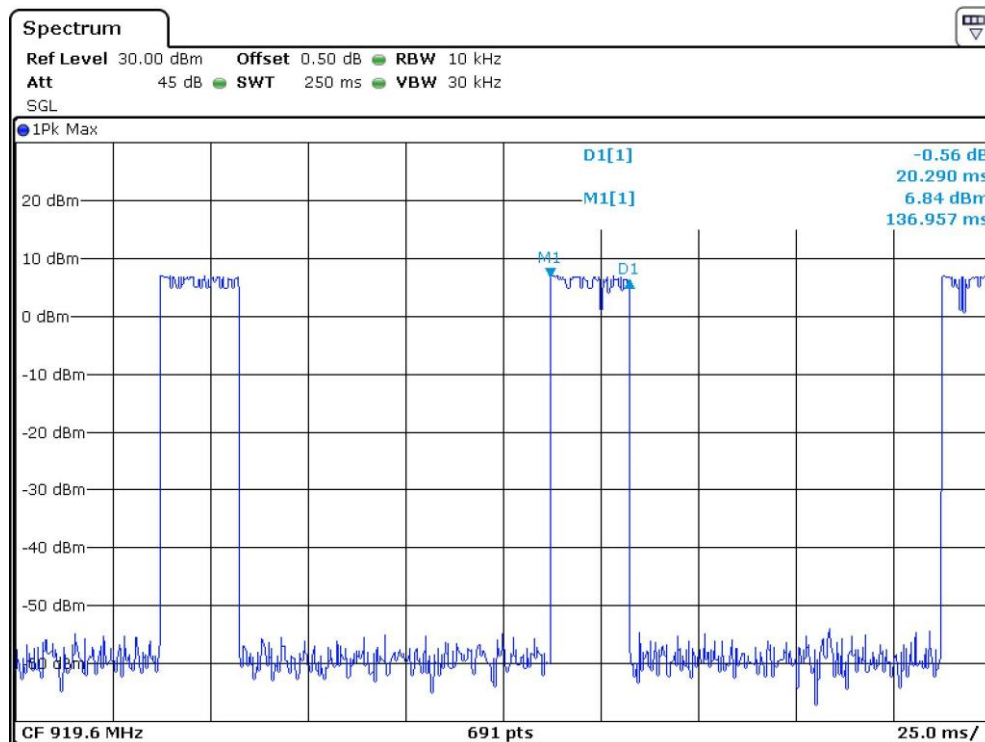
Modulation Type: GFSK
CH0 917.00 MHz



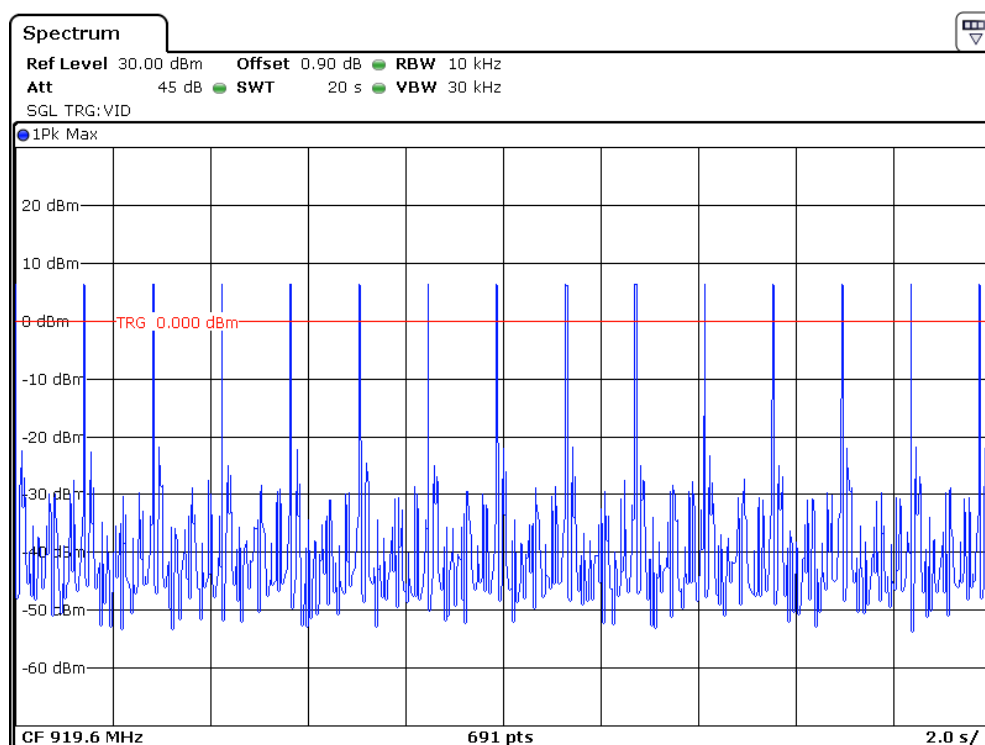
The number of hopping channels in 20s:



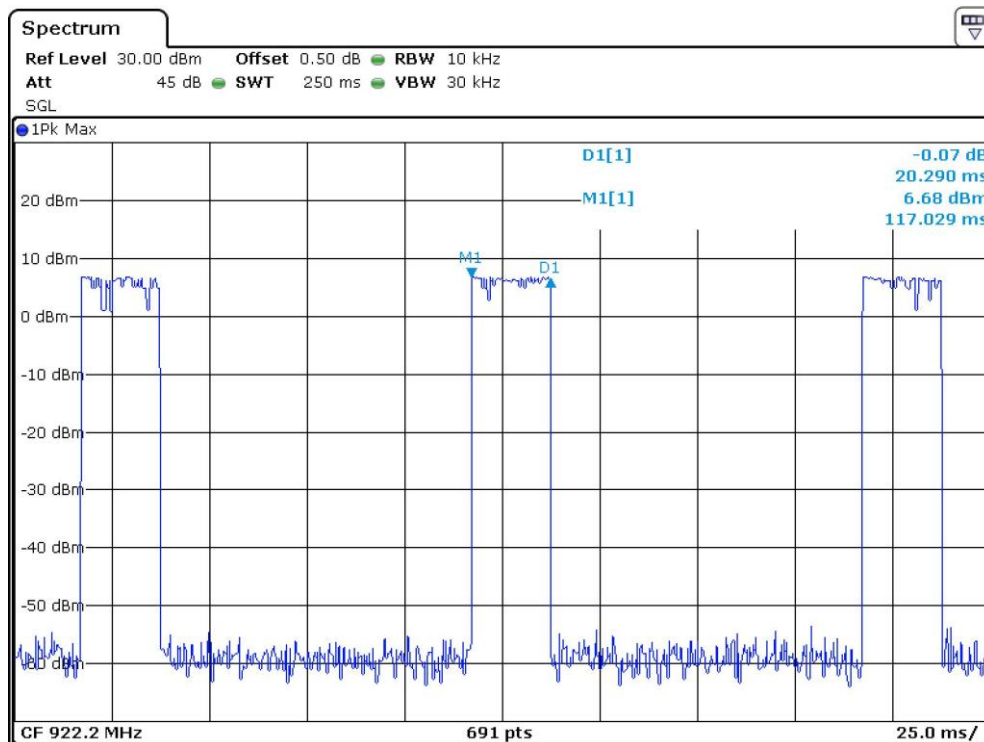
CH26 919.60MHz



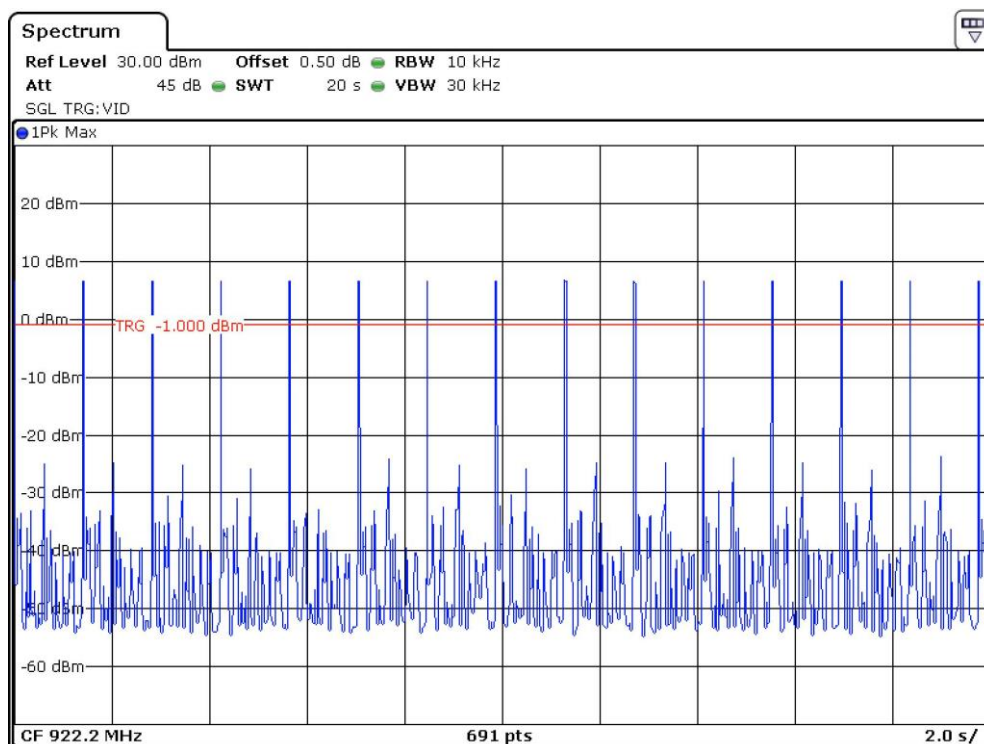
The number of hopping channels in 20s:



CH52 922.20MHz



The number of hopping channels in 20s:



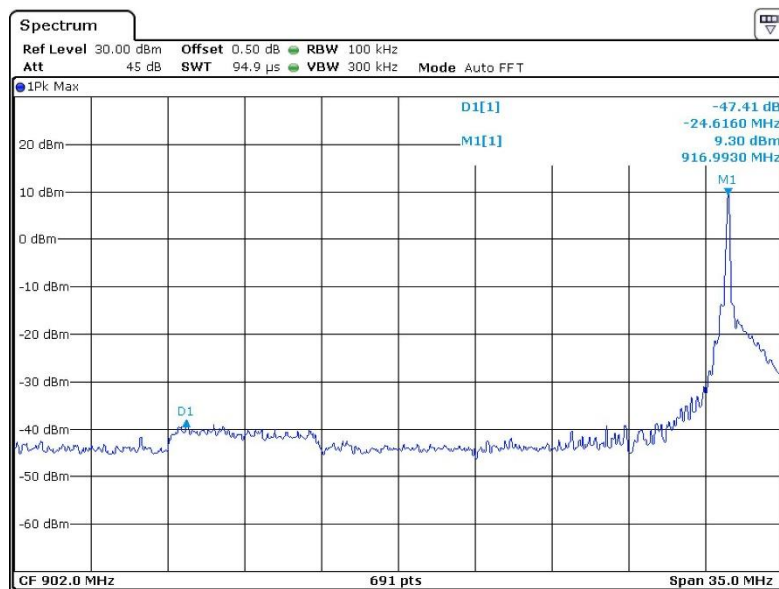
4.8 Band Edge

Out of Band Conducted Emissions, FCC Rule 15.247(d):

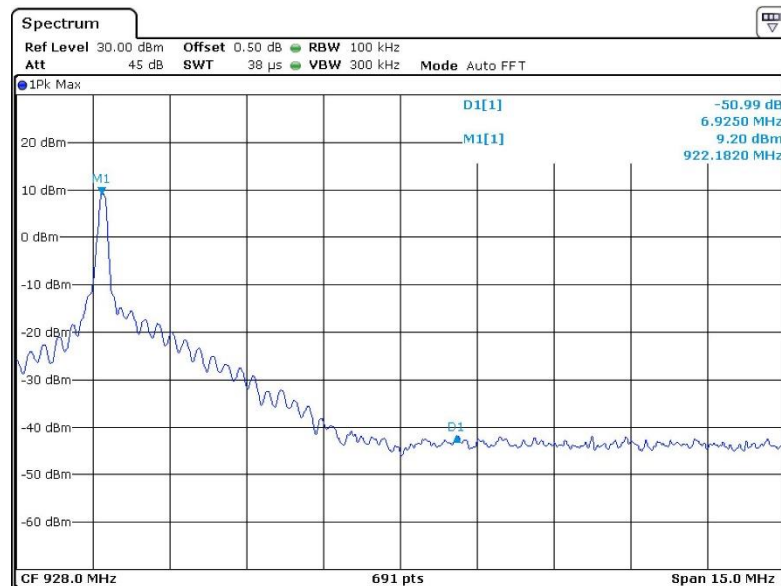
In any 100 KHz bandwidth outside the EUT passband, the RF power produced by the modulation products of the spreading sequence, the information sequence, and the carrier frequency shall be at least 20 dB below that of the maximum in-band 100 kHz emission, or else shall meet the general limits for radiated emissions at frequencies outside the passband, whichever results in lower attenuation.

Transmit on Single Channel

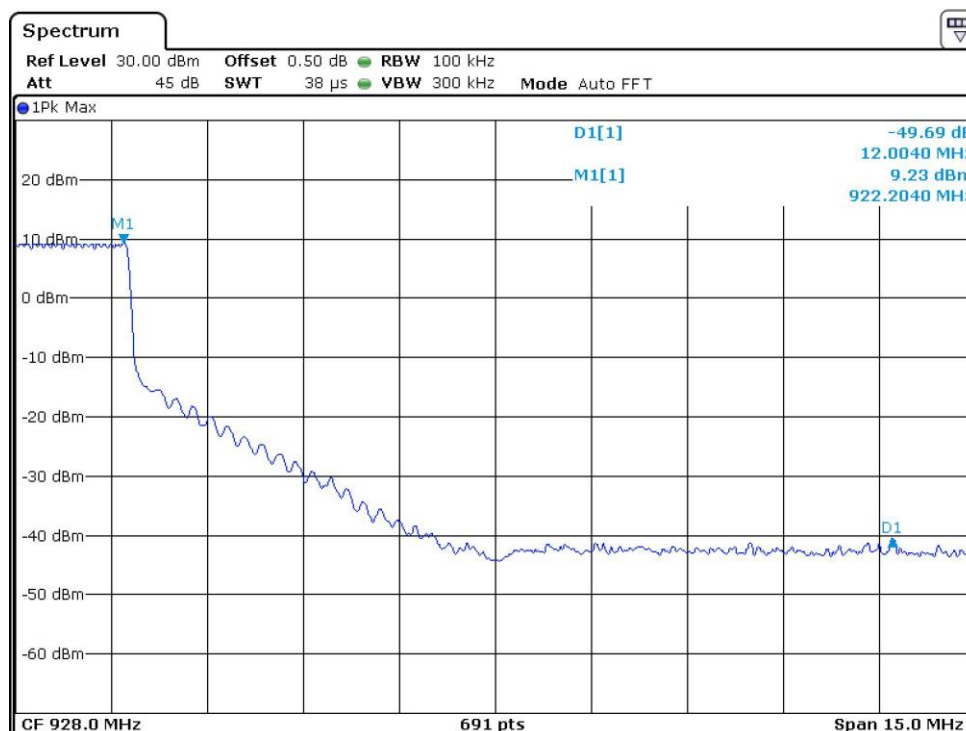
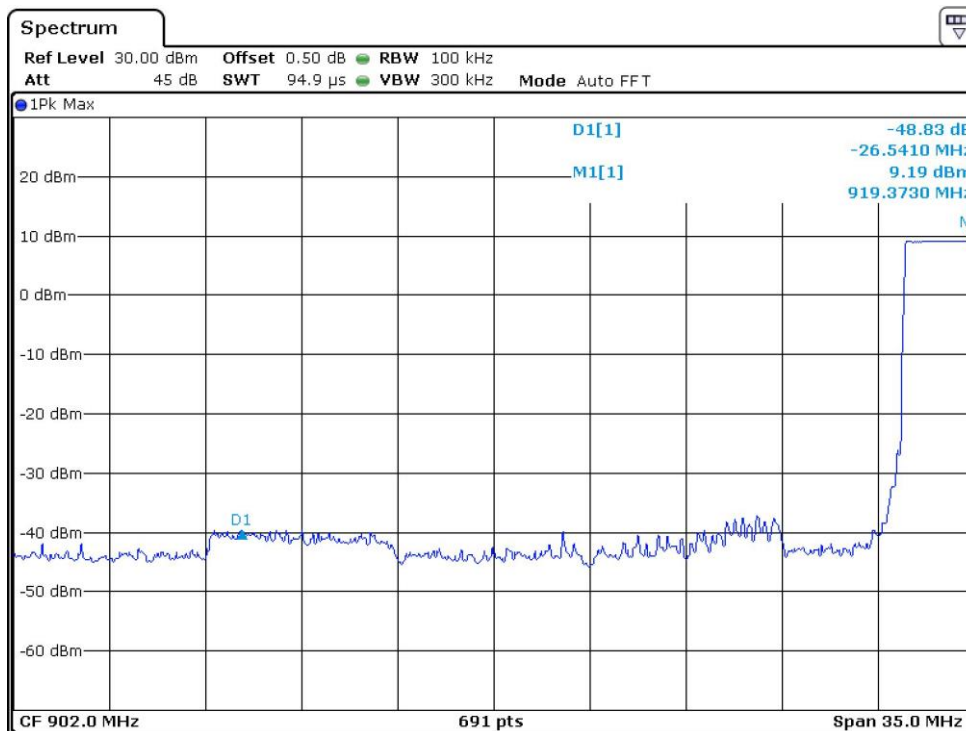
CH0 917.00 MHz



CH52 922.20MHz



Hopping mode



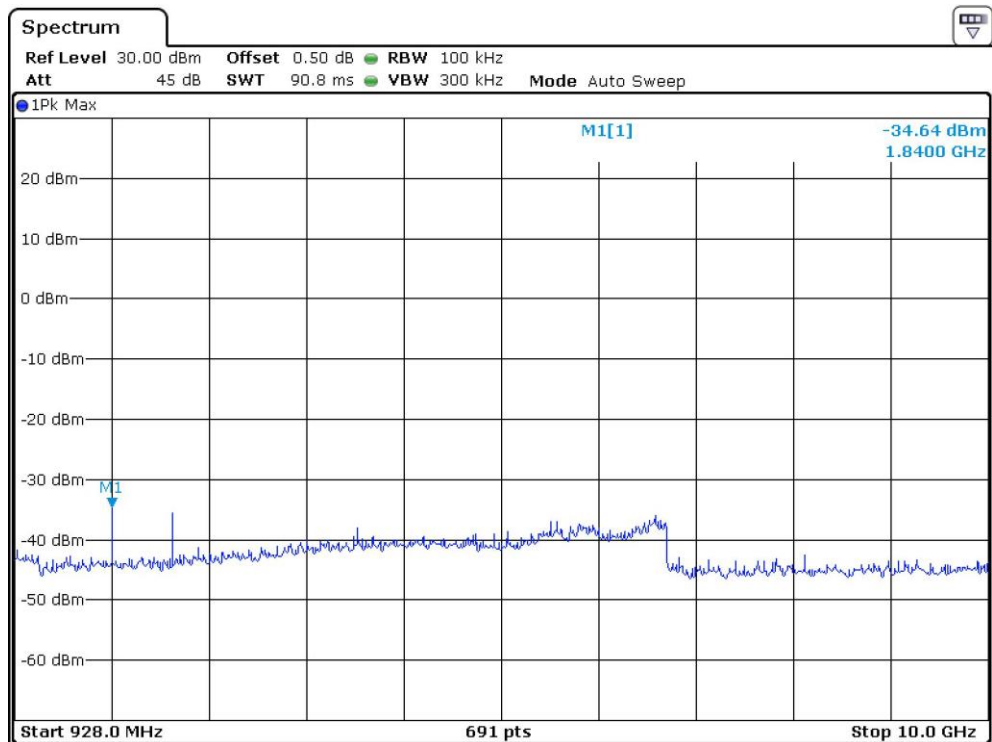
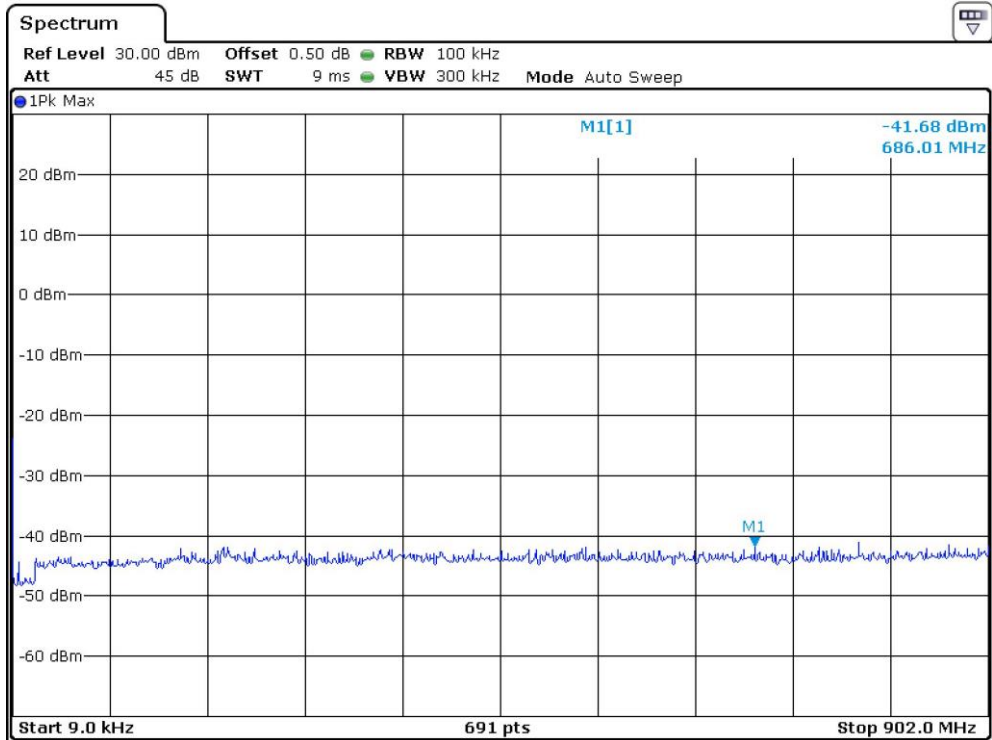
4.9 Transmitter Spurious Emissions (Conducted)

Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

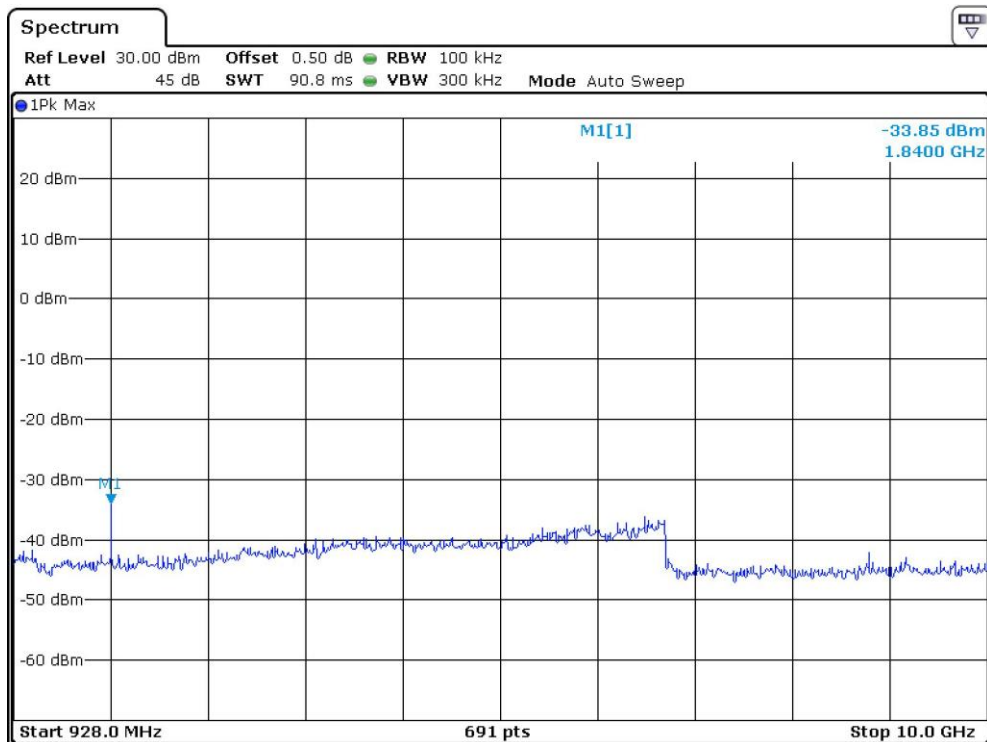
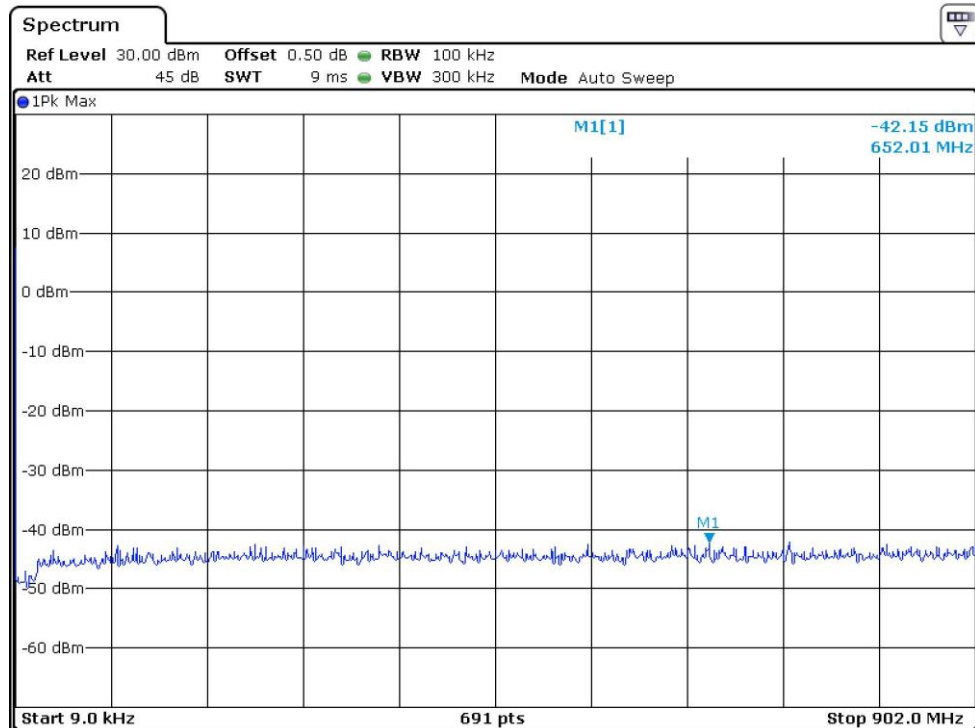
All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20 dB below the highest level of the desired power in the passband.

Modulation Type: GFSK

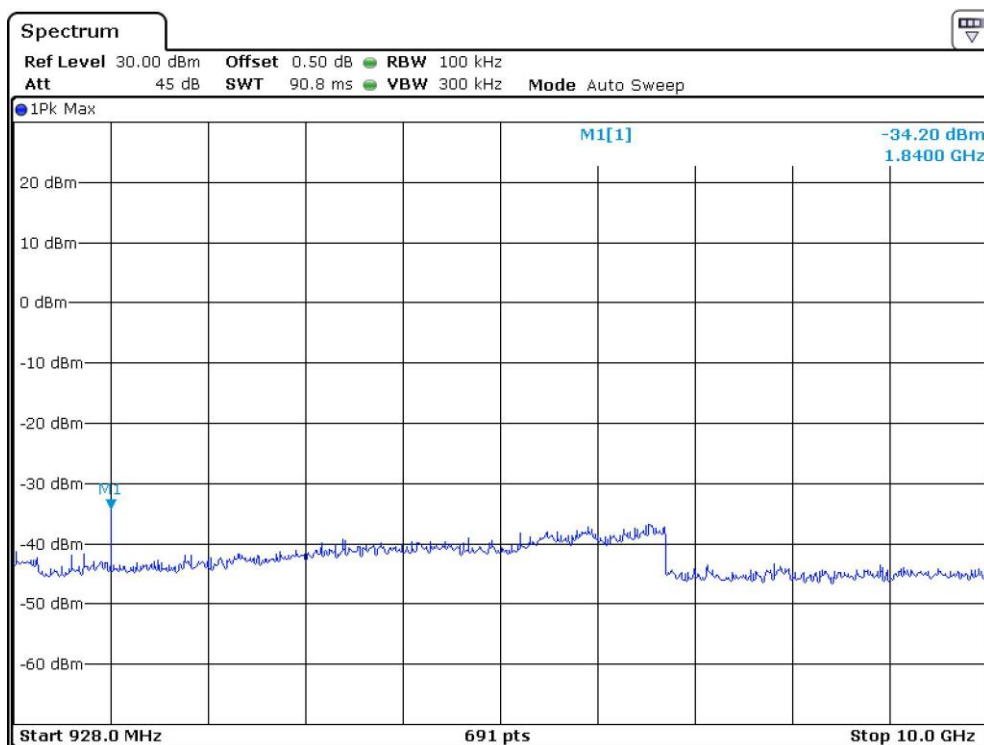
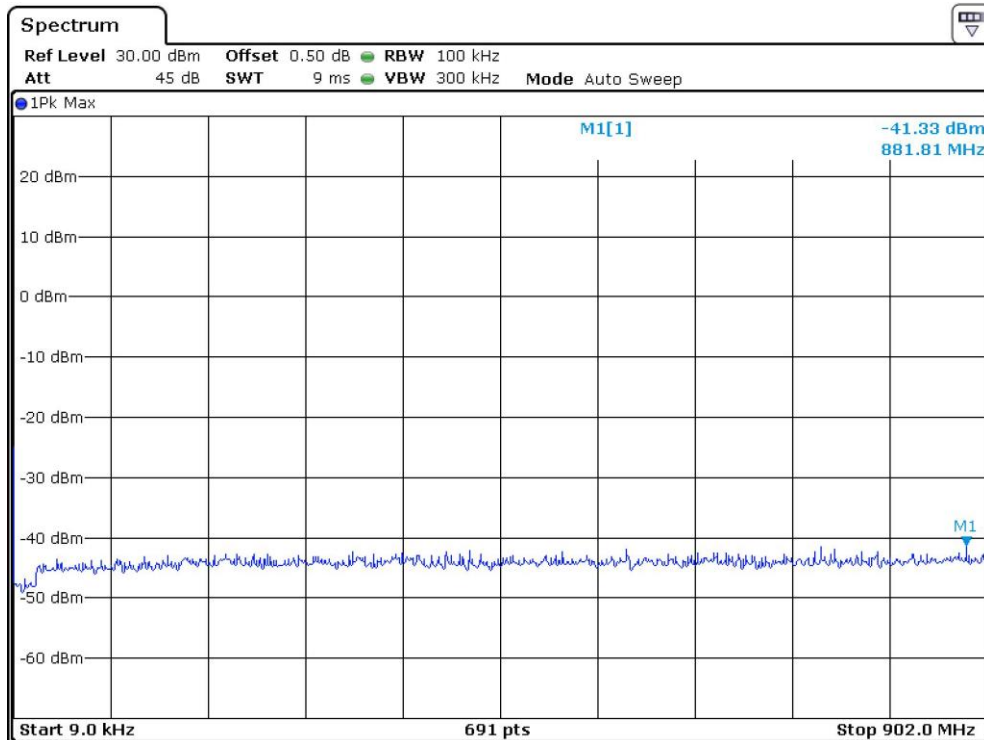
CH00



CH26



CH52



5.0 Equipment Photographs

For electronic filing, the photographs of the tested EUT are saved with filename: external photos.pdf & internal photos.pdf.

6.0 Product Labelling

For electronic filing, the FCC ID label artwork and the label location are saved with filename: label.pdf.

7.0 Technical Specifications

For electronic filing, the block diagram and schematics of the tested EUT are saved with filename: block.pdf and circuit.pdf respectively.

8.0 Instruction Manual

For electronic filing, a preliminary copy of the Instruction Manual is saved with filename: manual.pdf.

This manual will be provided to the end-user with each unit sold/leased in the United States.

9.0 Miscellaneous Information

This miscellaneous information includes details of the measured bandedge, the test procedure and calculation of factor such as pulse desensitization.

9.1 Discussion of Pulse Desensitization

Pulse desensitivity is not applicable for this device.

9.2 Calculation of Average Factor

Averaging factor in dB = $20 \log (\text{duty cycle})$

The specification for output field strengths in accordance with the FCC rules specify measurements with an average detector. During testing, a spectrum analyzer incorporating a peak detector was used. Therefore, a reduction factor can be applied to the resultant peak signal level and compared to the limit for measurement instrumentation incorporating an average detector.

The time period over which the duty cycle is measured is 100 milliseconds, or the repetition cycle, whichever is a shorter time frame. The worst case (highest percentage on) duty cycle is used for the calculation. The duty cycle is measured by placing the spectrum analyser in zero scan (receiver mode) and linear mode at maximum bandwidth (3 MHz at 3 dB down) and viewing the resulting time domain signal output from the analyser on a Tektronix oscilloscope. The oscilloscope is used because of its superior time base and triggering facilities.

A plot of the worst-case duty cycle as detected in this manner are saved with filename: af.pdf

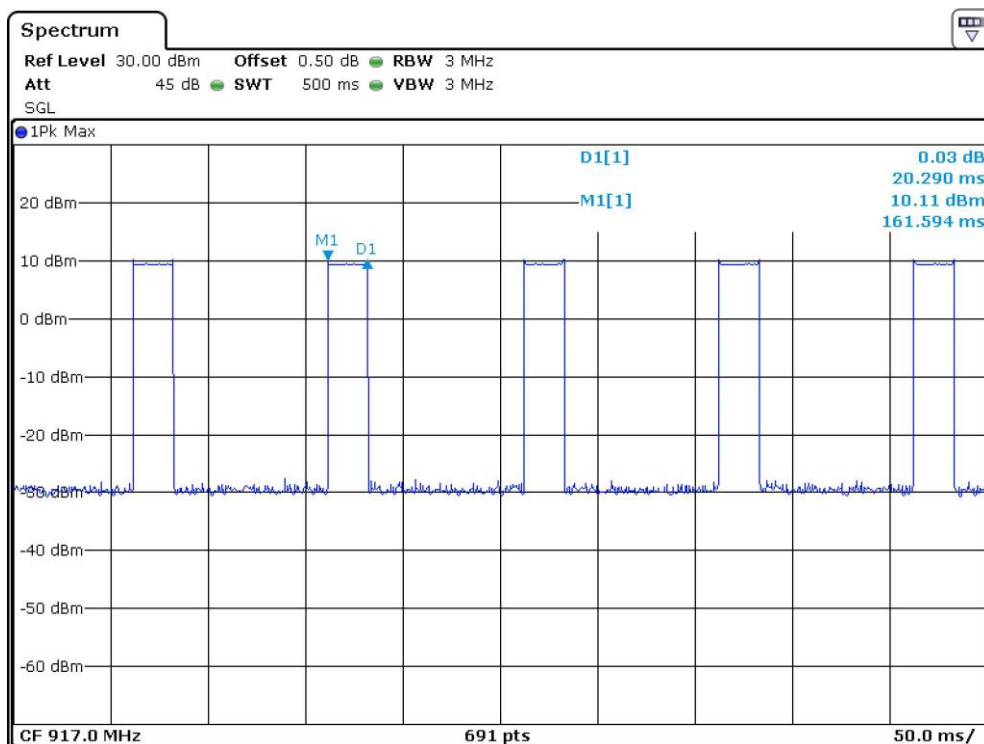
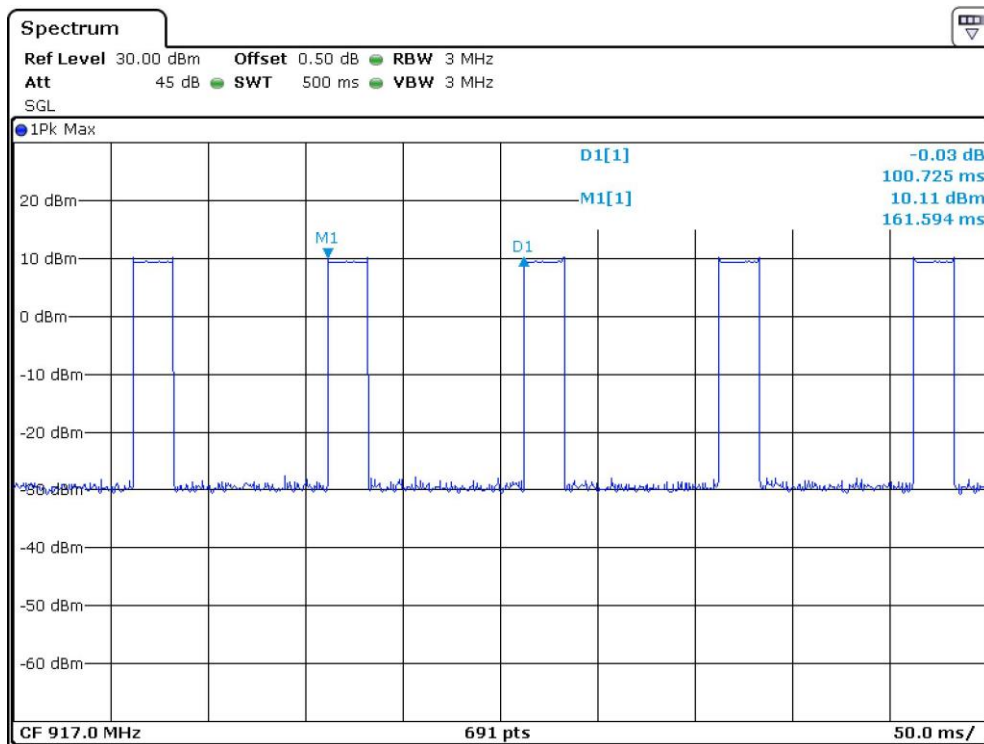
The duty cycle is simply the on-time divided by the period:

The duration of one cycle = 100 ms

Effective period of the cycle = 20.290 ms

DC = $20.290 \text{ ms} / 100 \text{ ms} = 0.2029$ or 20.29%

Therefore, the averaging factor is found by $20 \log_{10} 0.2029 = -13.9 \text{ dB}$



9.3 Emissions Test Procedures

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C rules.

The test set-up and procedures described below are designed to meet the requirements of ANSI C63.10: 2013.

The transmitting equipment under test (EUT) is placed on a styrene turntable which is four feet in diameter, up to 1GHz 0.8m and above 1GHz 1.5m in height above the ground plane. During the radiated emissions test, the turntable is rotated and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The EUT is adjust through all three orthogonal axes to obtain maximum emission levels. The antenna height and polarization are varied during the testing to search for maximum signal levels.

Detector function for radiated emissions is in peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings. A detailed description for the calculation of the average factor can be found in section 9.2.

The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower. For line conducted emissions, the range scanned is 150 kHz to 30 MHz with RBW 9KHz used.

9.3 Emissions Test Procedures (cont'd)

The EUT is warmed up for 15 minutes prior to the test.

AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new, fully charged battery is used.

Conducted measurements are made as described in ANSI C63.10: 2013.

The IF bandwidth used for measurement of radiated signal strength was 10 kHz for emission below 30 MHz and 120 kHz for emission from 30 MHz to 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application Note 150-2. Above 1000 MHz, a resolution bandwidth of 1 MHz is used (RBW 3MHz used for fundamental emission).

Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the restricted bands and above 1 GHz, signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

10 Test Equipment List

Equipment No.	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
SZ061-13	BiConiLog Antenna	ETS	3142E	00166158	2022-07-13	2025-07-13
SZ185-04	EMI Receiver	R&S	ESCI	102466	2022-11-14	2023-11-14
SZ061-08	Horn Antenna	ETS	3115	00092346	2021-09-05	2024-09-05
SZ061-06	Active Loop Antenna	Electro-Metrics	EM-6876	217	2021-05-18	2023-05-18
SZ056-03	Spectrum Analyzer	R&S	FSP 30	101148	2022-05-16	2023-05-16
SZ056-06	Signal Analyzer	R&S	FSV 40	101101	2021-12-20	2022-12-20
SZ181-04	Preamplifier	Agilent	8449B	3008A02474	2022-05-16	2023-05-16
SZ188-01	Anechoic Chamber	ETS	RFD-F/A-100	4102	2021-12-12	2024-12-12
SZ062-02	RF Cable	RADIAL	RG 213U	--	2022-10-17	2023-10-17
SZ062-05	RF Cable	RADIAL	0.04-26.5GHz	--	2022-10-17	2023-10-17
SZ062-12	RF Cable	RADIAL	0.04-26.5GHz	--	2022-05-17	2023-05-17
SZ067-04	Notch Filter	Micro-Tronics	BRM50702-02	--	2022-05-17	2023-05-17
SZ185-02	EMI Test Receiver	R&S	ESCI	100692	2022-07-08	2023-07-08
SZ187-02	Two-Line V-Network	R&S	ENV216	100072	2022-05-09	2023-05-09
SZ188-03	Shielding Room	ETS	RFD-100	4100	2020-01-07	2023-01-07

***** End of Report*****