Electromagnetic Compatibility
Test Report

Test Report No: PCE 310113
Issued on: January 31, 2013

Product Name
BadgeTag V2

Tested According to
FCC 47 CFR, Part 15.247

Tests Performed for
Precyse Technologies, Inc.
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Certificate 1633.01
Electrical Testing

Test Personnel

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QualiTech EMC Laboratory

Test Report details:

Test commencement date:	14.01.2013
Test completion date:	17.01.2013
Customer's representative:	Yossi Nurok
Issued on:	31.01.2013

Assessment information:

This report contains an assessment of the EUT against Electromagnetic Compatibility based upon tests carried out on the samples submitted. The results contained in this report relate only to the items tested. Manufactured products will not necessarily give identical results due to production and measurement tolerances. QualiTech, EMC Lab does not assume responsibility for any conclusion and generalization drawn from the test results with regards to other specimens or samples of type of the equipment represented by test item.

The EUT was set up and exercised using the configuration, modes of operation and arrangements defined in this report only.

Modifications:

Modifications made to the EUT

None

Modifications made to the Test Standard

None

Summary of Compliance Status

Test Spec. Clause	Test Case	Remarks
47 CFR §15.247 (a) (2)	6 dB Bandwidth	Comply
47 CFR §15.247 (b) (3) (4)	Maximum Conducted (Average) Output Power	Comply
47 CFR §15.247 (e)	Maximum Power Spectral Density in the Fundamental Emissions	Comply
47 CFR §15.247 (d)	Unwanted Conducted Emissions into Non-Restricted Bands	Comply
47 CFR §15.247 (d), & §15.205, & §15.209(a)	Unwanted Radiated Emissions into Restricted Frequency Bands	Comply
47 CFR §15.203	Antenna Connector Requirements	Comply

Table of Contents

1. General Description

Description of the EUT system/test Item:

Product name:

FCC ID: WONSA91004005

Description:

The SA Tag is used to track assets in real time. It is based on an RF transceiver and a microcontroller. It uses the Precyse N3 proprietary protocol which provides a 2 way, half duplex communication with the base station. The unit is powered by a 3.6V 3xAA battery pack.

Frequency range: 902 – 928 MHz

Type of Modulation: 2-FSK

Antenna Gain: 902 – 928 MHz: 0 dBi

2. Method of Measurements

2.1. Conducted RF Measurements:

The RF output of the transmitter under test was directly connected to the input of the Spectrum analyzer through a specialized antenna connector provided by the manufacturer, and an attenuator as specified. The external attenuator and cable loss were added to the reading. Worst-case results of the various modulation modes (where applicable) were reported.

For PSD, emission peak was zoomed within the pass band with spectrum analyzer's settings as reported (Sweep time=Span/3 kHz)

For Maximum Conducted Output Power an Average Power Meter was used.

For spurious emissions measurement, the spectrum from 9 kHz to 40 GHz was investigated with the transmitter set to the lowest, middle and highest channel frequencies.

For bandedge measurement allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section. Submit this plot.

Emissions Measurements in the restricted bands:

For radiated emissions, which fall in the restricted bands the spectrum from 1MHz to 25GHz was investigated following the guidelines in ANSI C63.4-2003, with the transmitter set to the lowest, middle and highest channel frequencies. Measurements were performed with peak detector and repeated averaged with VBW=10 Hz. Only Peak detection plots are presented. Worst-case results of the various modulation modes (where applicable) were reported.

2.2. Radiated Emission measurements:

Measurements were performed at a 3-meter measurement distance in the semi-anechoic chamber in order to evaluate the radiated electromagnetic interference characteristics of the EUT. The EUT was placed on a non-metallic table/support, 0.8m above the turntable, was configured, arranged and operated in a manner consistent with typical application and load conditions. The test program of exercising the equipment ensured that various parts of the EUT were exercised to permit detection of all EUT disturbances.
An appropriate antenna depending upon the frequency range, per ANSI C63.4-2003 clause 4.1.5 was used. While the turntable was being rotated, the height of the antenna was varied from 1 to 4m for the frequency range of 30MHz to 1GHz. The highest radiated emission was detected by manipulating the EUT through three axis(x,y,z) and system cables, a worst-case results are reported by max hold function
This process was repeated for both antenna polarizations. The spectrum up to 40 GHz was investigated for spurious emissions, using a band-reject filter where appropriate.
The amplitudes of worst-case emission were measured with the detector modes and resolution bandwidths over various frequency ranges according to the requirements of ANSI C63.4-2003 clause 4.2.

2.3. Worst Case Results:

In order to determine the worst case emissions for all modes/data rates/tests, all modes/data rates were investigated for each required test to determine which produces the worst- case data and then full testing was performed in that mode/data rate

3. Test Facility & Uncertainty of Measurement

3.1. Accreditation/ Registration reference:

- *A2LA Certificate Number: 1633.01*

3.2. Test Facility description

The tests were performed at the EMC Laboratory, QualiTech Division, ECI Telecom Group

Address: 30, Hasivim St., Petah Tikva, Israel.
Tel: 972-3-926-8443

Semi Anechoic Configuration:

Measurement distance	3m
Chamber dimensions	9.5m x 6.5m x 5.2m
Antenna height	1 - 4m
Shielding Effectiveness	Magnetic field ≥80dB at 15 kHz ≥90dB at 100 kHz Electric field >120dB from 1MHz to 1GHz >110dB from 1GHz to 10GHz
Absorbing material	Ferrite tiles on the walls and ceiling Emerson Cumig hybrid absorbing material in selected positions on the walls
Normalized Site Attenuation measured at 5 positions	±3.49dB, 30MHz to 1GHz
Transmission Loss measured at 5 positions, at 1.5m height	±3dB, 1GHz to 18GHz

3.3. Uncertainty of Measurement:

Test Name	**Test Method & Range**	**Uncertainty**	
		Combined std. Uc(y) [dB]	**Expanded U** [dB]
Radiated Emission	30MHz÷230MHz, Horiz. polar. 30MHz÷230MHz, Ver. polar. 230MHz÷1000MHz, Horiz. polar. 230MHz÷1000MHz, Vert. polar.	1.8 2.0 1.5 1.5	3.6 3.9 3.0 3.0
Conducted Emission	9 kHz÷150 kHz 150 kHz÷30MHz	1.4 1.1	2.8 2.2

4. BadgeTag V2: Report of Measurements and Examinations

4.1. 6 dB Bandwidth

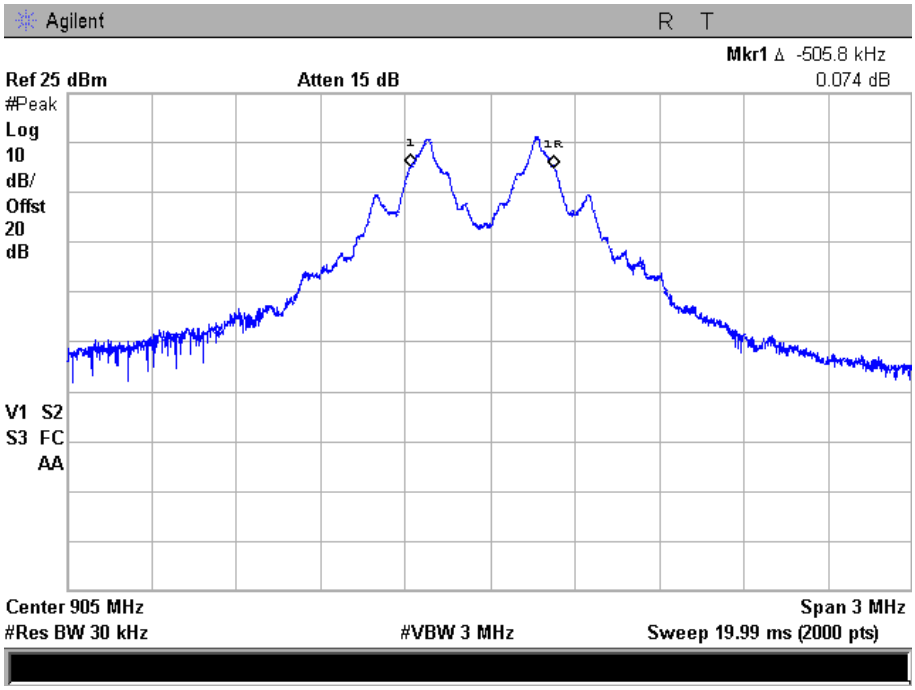
Reference document:	**47 CFR §15.247 (a)(2)**		
Test Requirements:	Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725–5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.		
Test setup:	See sec 2.1	**Pass**	
Method of testing:	KDB 558074 D01 v02, Sec.7.1 Conducted		
Operating conditions:	Under normal test conditions		
S.A. Settings:	RBW: 30 kHz, VBW: 3 MHz		
Environment conditions:	Ambient Temperature: 22 °C	Relative Humidity: 44.5 %	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 4.1.1 – Plot 4.1.6	

Test results:

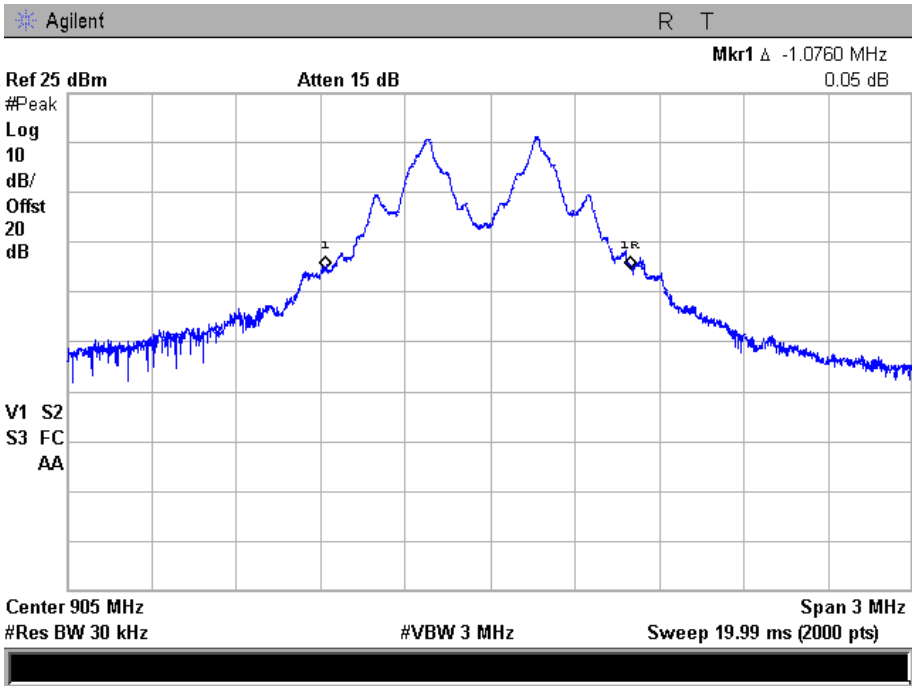
Fundamental Frequency [MHz]	6 dB DTS Bandwidth [kHz]	*26 dB Emission Bandwidth (EBW) [kHz]	Limit [kHz]	Margin [kHz]	Pass/Fail
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle					
905.00	505.8	1076.0	>500	5.8	Pass
911.47	504.3	1044.5	>500	4.3	Pass
917.14	505.8	1056.5	>500	5.8	Pass

* for information purpose only.

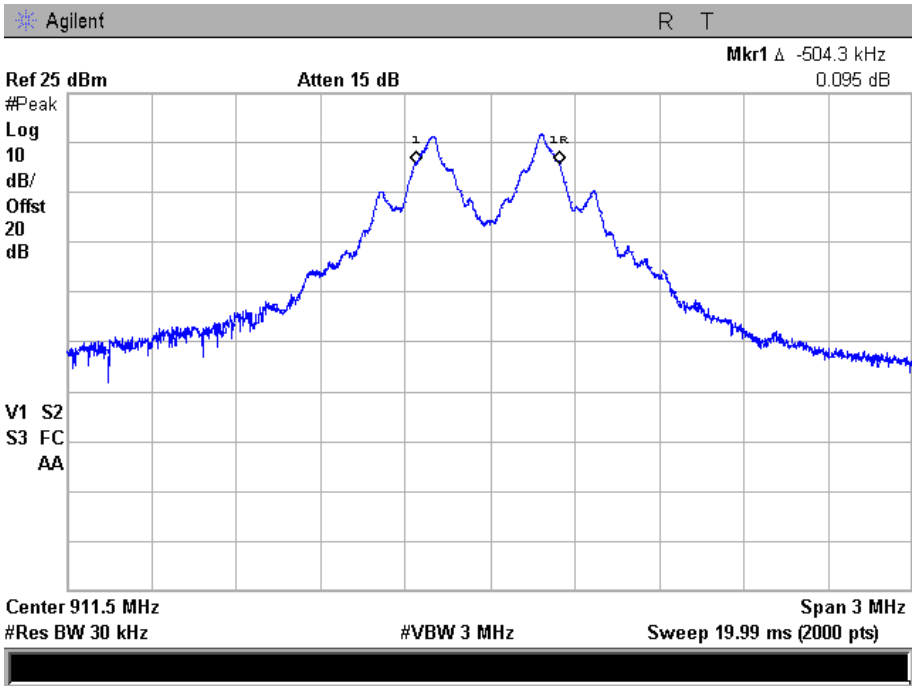
905 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
6 dB DTS Bandwidth
Plot 4.1.1



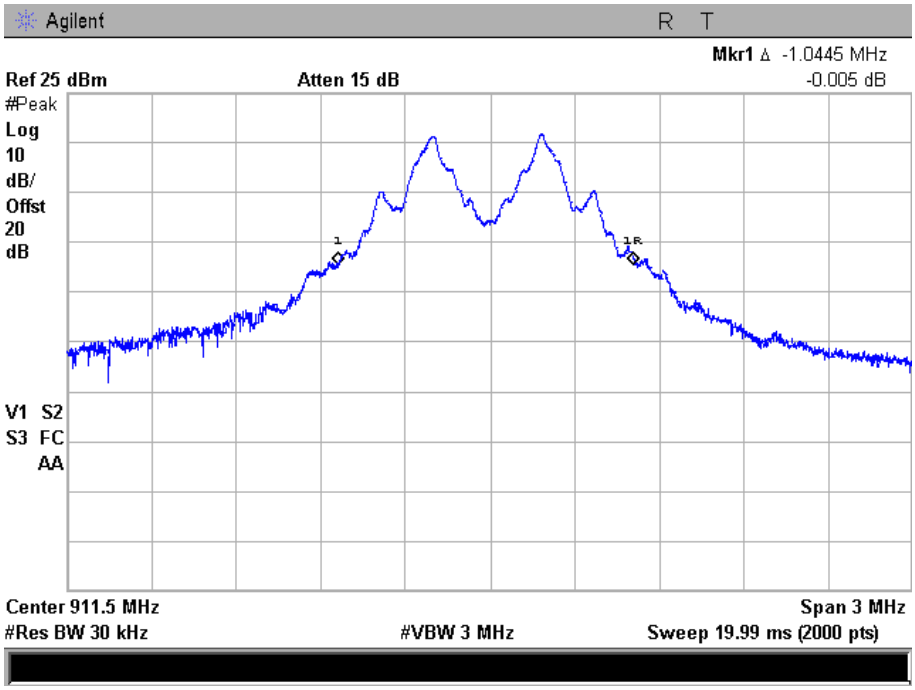
905 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
26 dB Emission Bandwidth (EBW)
Plot 4.1.2



911.47 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
6 dB DTS Bandwidth
Plot 4.1.3

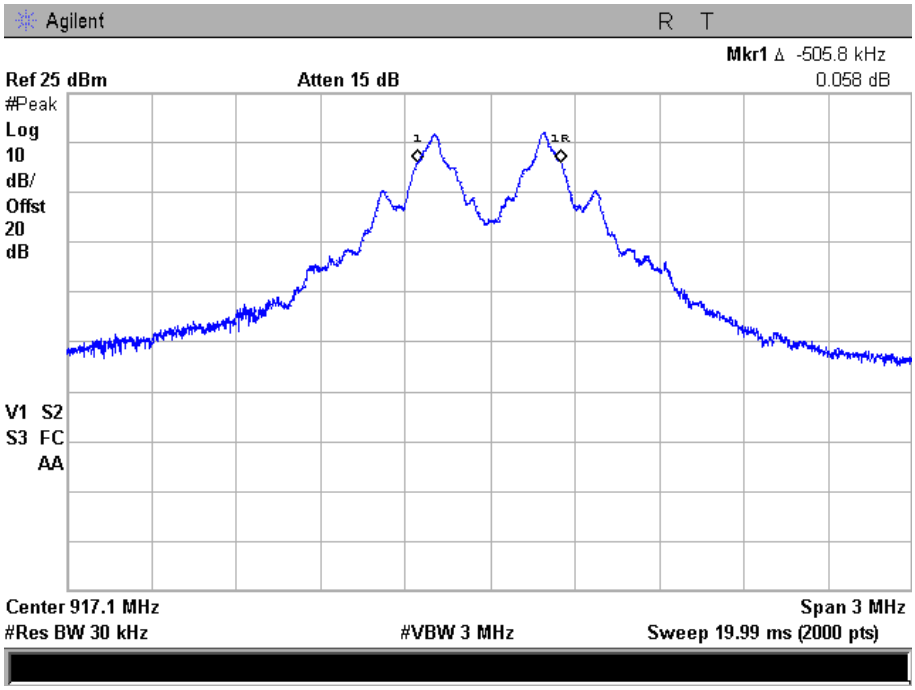


911.47 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
26 dB Emission Bandwidth (EBW)
Plot 4.1.4

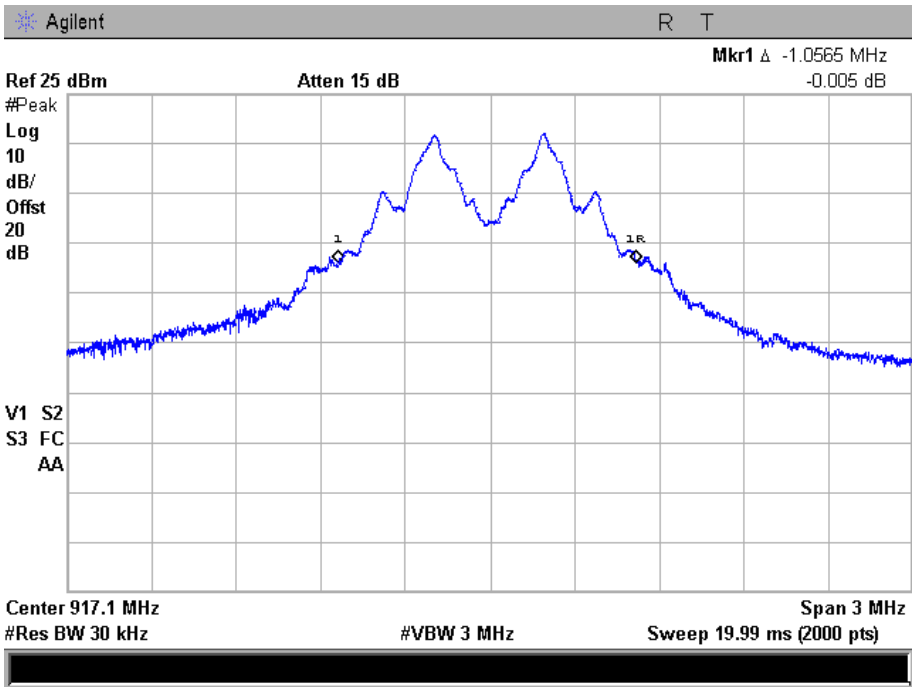


917.14 MHz

2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
6 dB DTS Bandwidth
Plot 4.1.5



917.14 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
26 dB Emission Bandwidth (EBW)
Plot 4.1.6



4.2. Maximum Conducted (Average) Output Power

Reference document:	**47 CFR §15.247 (b)(3)(4)**		
Test Requirements:	The maximum peak conducted output power of the intentional radiator for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands shall not exceed 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted (average) output power. 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.		
Test setup:	See sec 2.1	**Pass**	
Method of testing:	KDB 558074 D01 v02, Sec.8.2.3 Conducted		
Operating conditions:	Under normal test conditions		
Settings:	Triggered/signal-gated broadband power meter		
Environment conditions:	Ambient Temperature: 22 °C	Relative Humidity: 44.5 %	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	-----	

Test Results:

Fundamental Frequency [MHz]	Maximum Conducted (Average) Output Power [dBm]	Maximum Conducted (Average) Output Power [mW]	Limit [dBm]	Margin [dB]	Pass/Fail
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle					
905.00	16.09	40.64	30.00	13.91	Pass
911.47	16.17	41.40	30.00	13.83	Pass
917.14	16.21	41.78	30.00	13.79	Pass

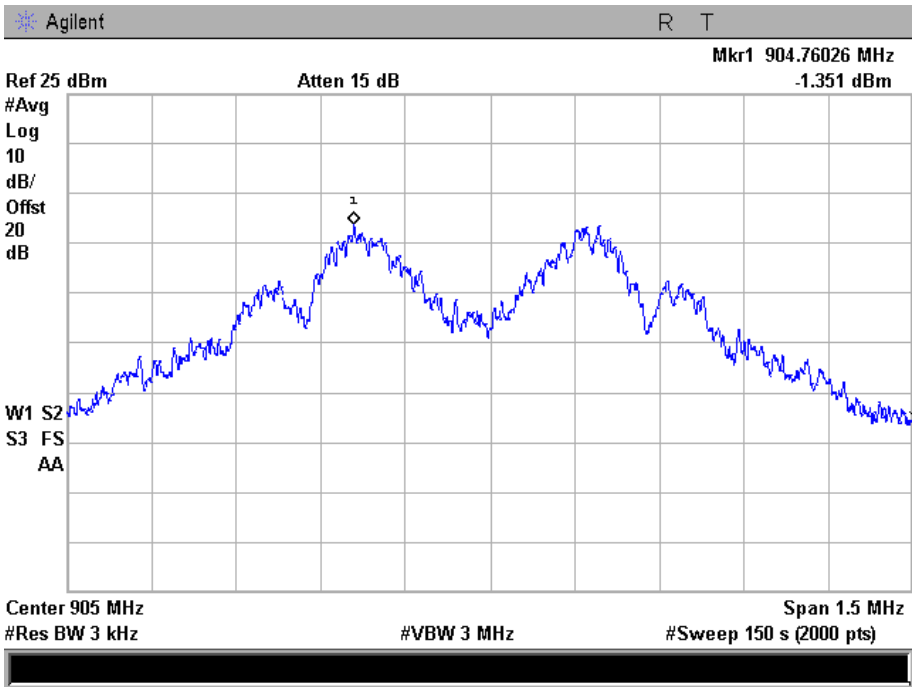
4.3. Maximum Power Spectral Density Level in the Fundamental Emissions

Reference document:	**47 CFR §15.247 (e)**		
Test Requirements:	For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.		
Test setup:	See sec 2.1	**Pass**	
Method of testing:	KDB 558074 D01 v02, Sec.9.3 & 9.4 Conducted		
Operating conditions:	Under normal test conditions		
S.A. Settings:	RBW: 3 kHz, VBW: 3 MHz, Sweep Time: 150 s		
Environment conditions:	Ambient Temperature: 23 °C	Relative Humidity: 45.1 %	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 4.3.1 - Plot 4.3.3	

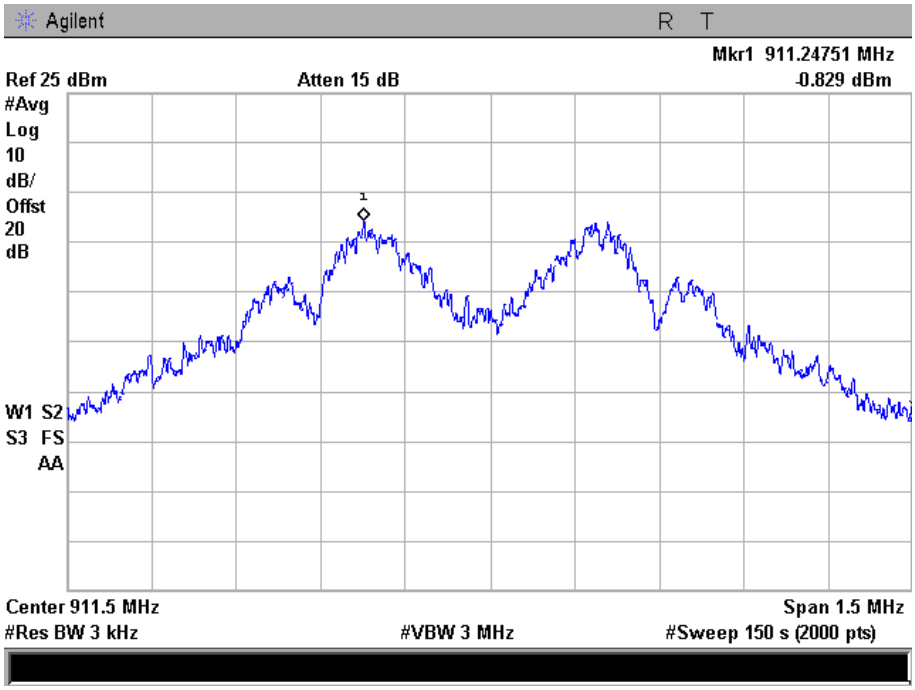
Test Results:

Fundamental Frequency [MHz]	PSD Measured [dBm/3kHz]	Duty cycle (x)	Correction factor 10log(1/x)	PSD Corrected [dBm/3kHz]	PSD Limit [dBm/3kHz]	Margin [dB]	Pass/Fail
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle							
905.00	-1.351	0.677	1.69	0.339	8.00	7.661	Pass
911.47	-0.829	0.677	1.69	0.861	8.00	7.139	Pass
917.14	-0.594	0.677	1.69	1.096	8.00	6.904	Pass

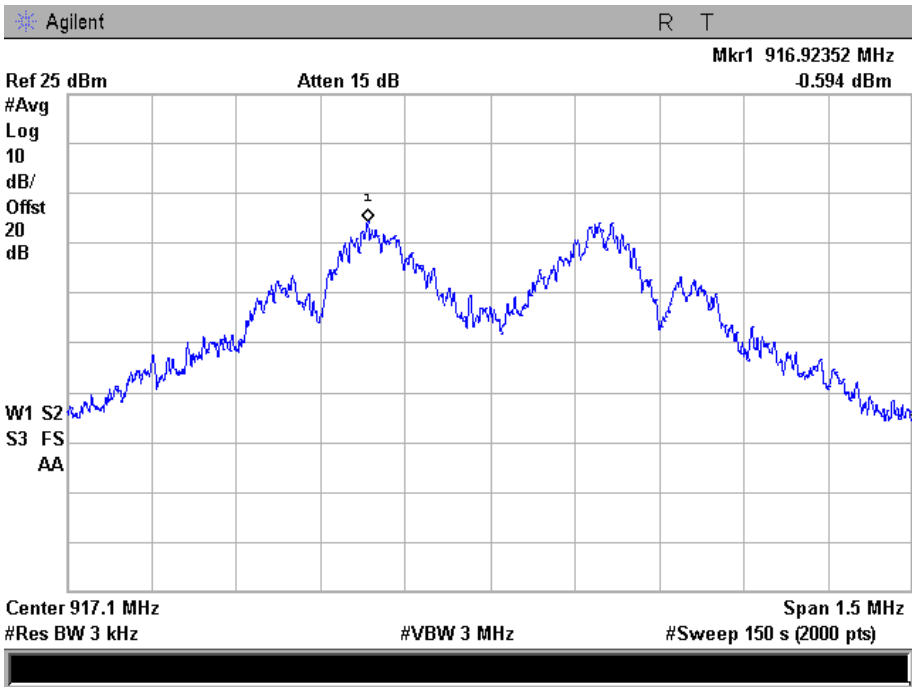
905 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.3.1



911.47 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.3.2



917.14 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.3.3



4.4. Unwanted Conducted Emissions into Non-Restricted Frequency Bands

Reference document:	**47 CFR §15.247 (d)**		
Test Requirements:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (See §15.205(c)).		
Test setup:	See sec 2.1	**Pass**	
Method of testing:	KDB 558074 D01 v02, Sec.10.1 Conducted		
Operating conditions:	Under normal test conditions		
S.A. Settings:	RBW: 100 kHz, VBW:3 MHz		
Environment conditions:	Ambient Temperature: 23 °C	Relative Humidity: 45.5 %	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 4.4.1- Plot 4.4.11	

Test results:

Unwanted Emissions Measurements:

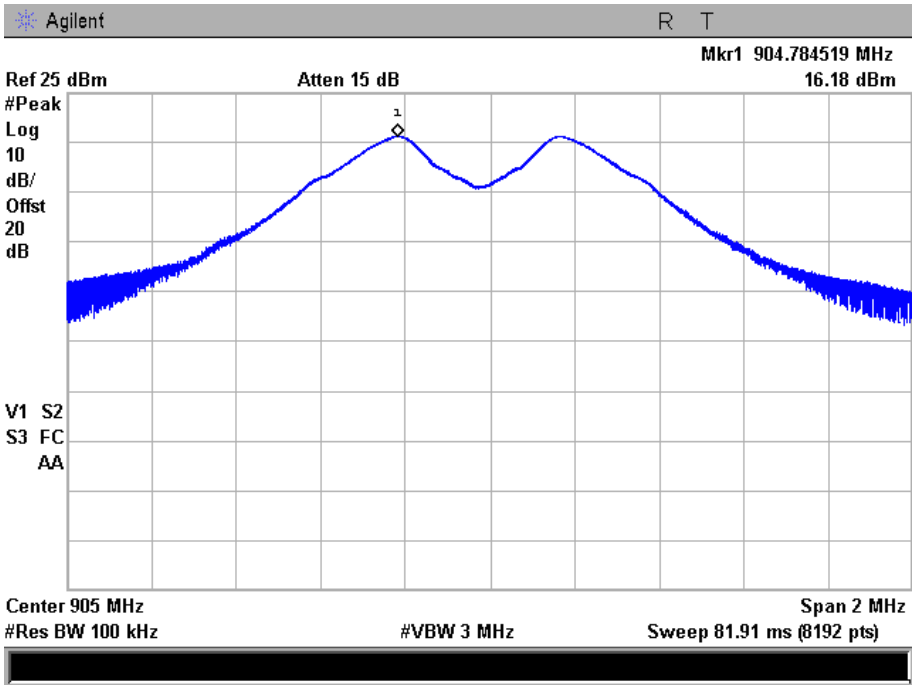
Fundamental Frequency [MHz]	Fundamental Emission Reference Level [dBm]	Unwanted Emissions Frequency [MHz]	Unwanted Emissions Level [dBm]	Calculated Attenuation below Reference Level [dB]	Limit for Attenuation below Reference Level [dB]	Margin [dB]	Pass/Fail
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle							
905.00	16.18	*	*	*	≥ 30	> 15	Pass
911.47	16.54	*	*	*	≥ 30	> 15	Pass
917.14	16.68	*	*	*	≥ 30	> 15	Pass

* - all unwanted emissions were at least 40 dB below the fundamental emission reference level

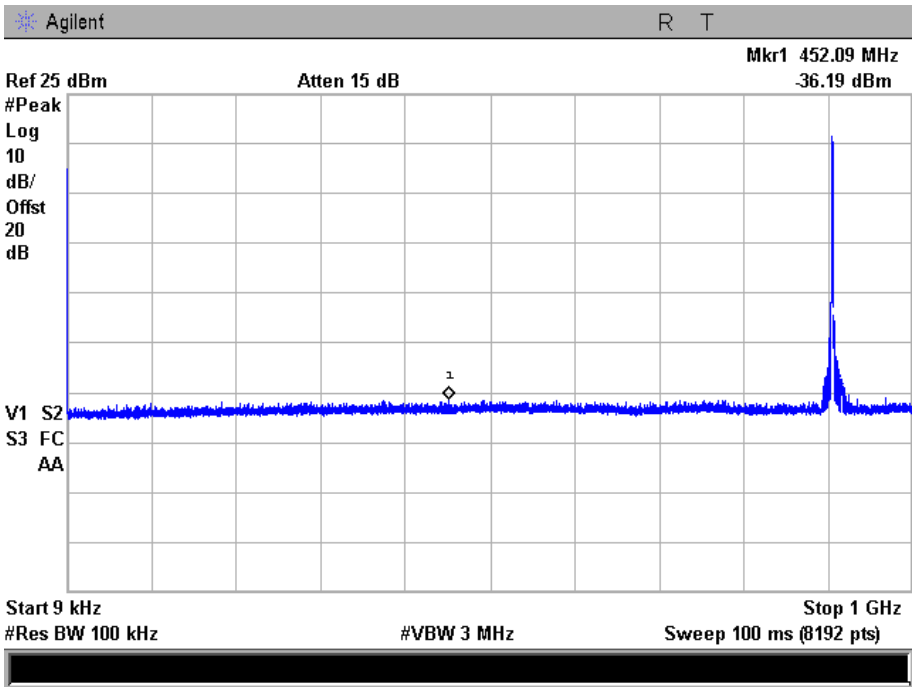
Band-Edge Measurements:

Fundamental Frequency [MHz]	Fundamental Emission Reference Level [dBm]	Unwanted Emissions Frequency [MHz]	Unwanted Emissions Level [dBm]	Calculated Attenuation below Reference Level [dB]	Limit for Attenuation below Reference Level [dB]	Margin [dB]	Pass/Fail
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle							
905.00	16.01	901.7467	-25.35	41.36	≥ 30	11.36	Pass
917.14	16.82	930.8005	-33.97	50.79	≥ 30	20.79	Pass

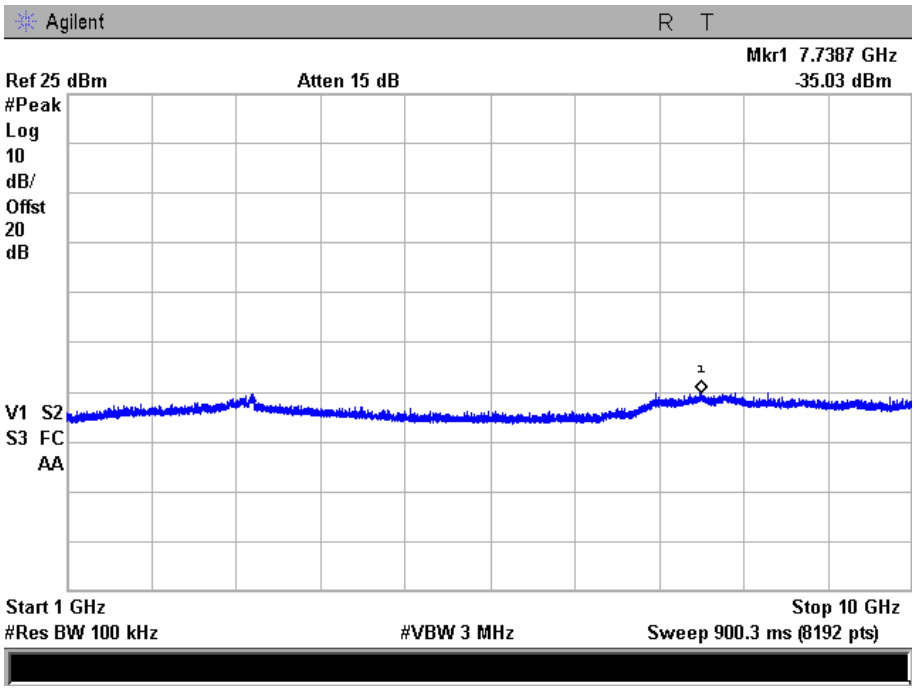
Fundamental Emission Reference Level 905 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.1



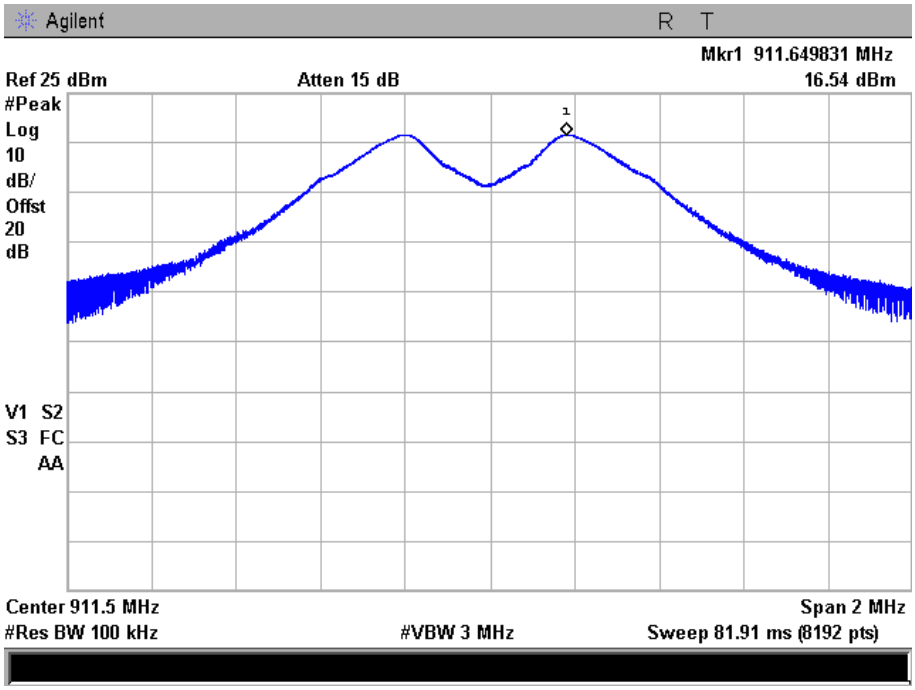
Unwanted Emissions 905 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.2



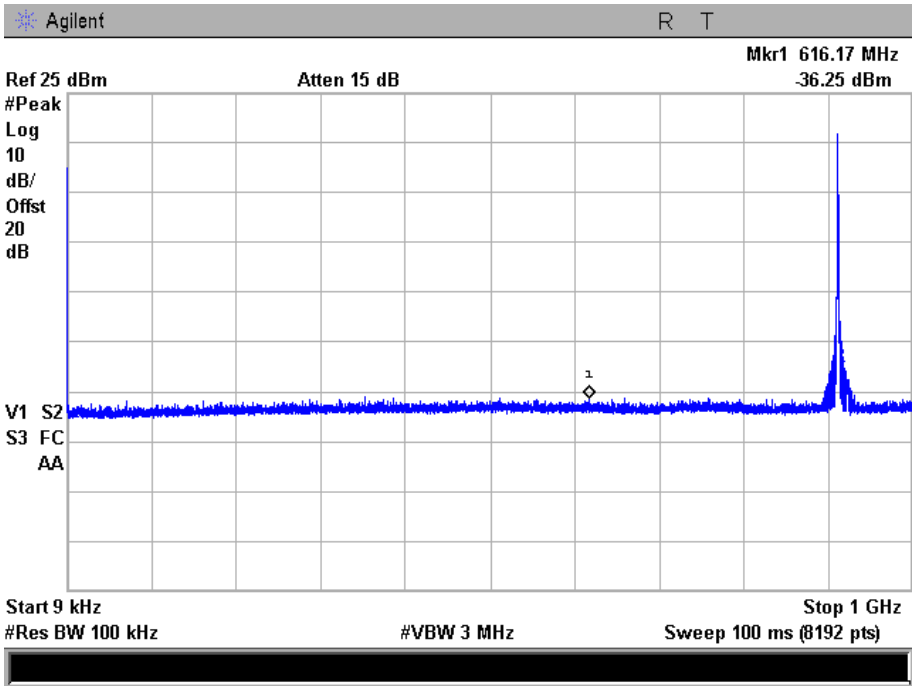
Plot 4.4.3



Fundamental Emission Reference Level 911.47 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.4

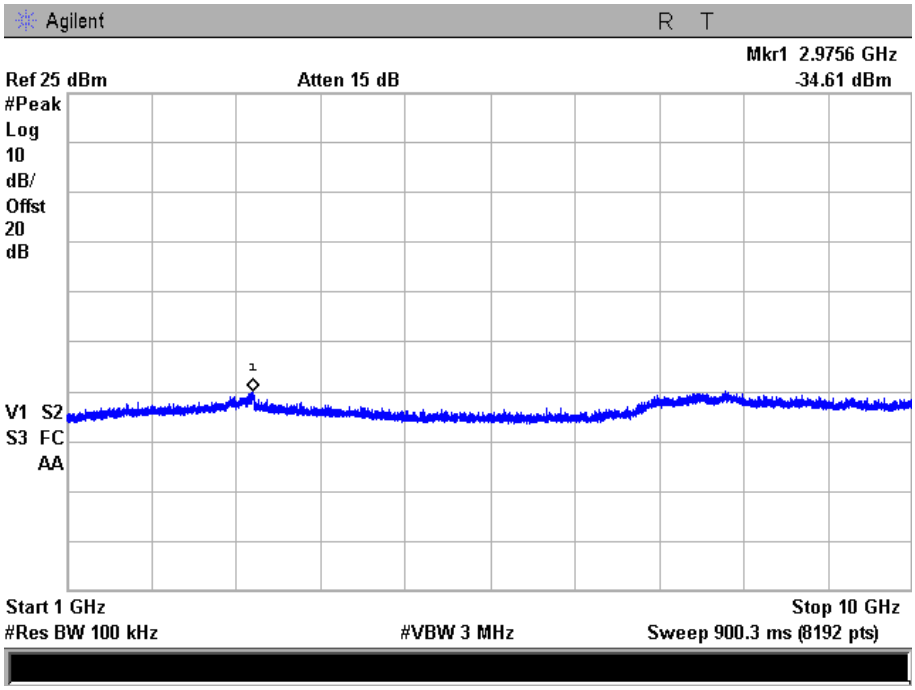


Unwanted Emissions 911.47 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.5

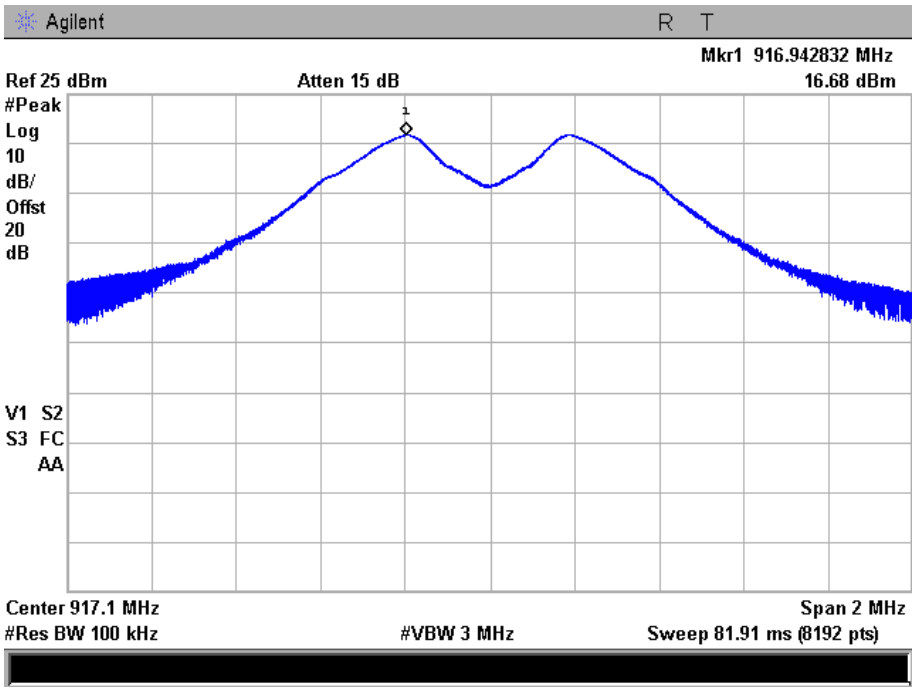


TITLE ???

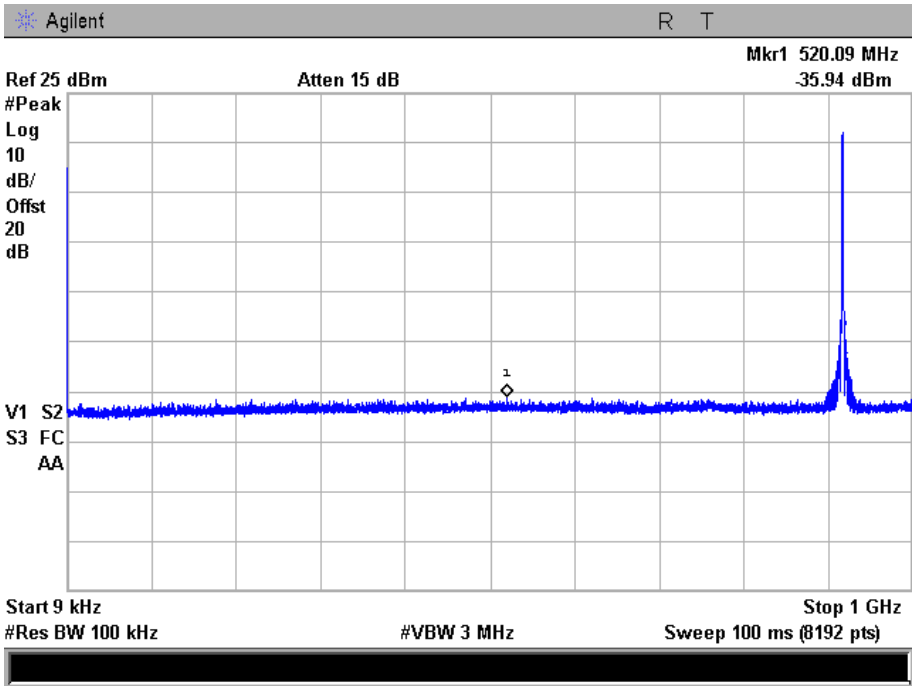
Plot 4.4.6



Fundamental Emission Reference Level 917.14 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.7

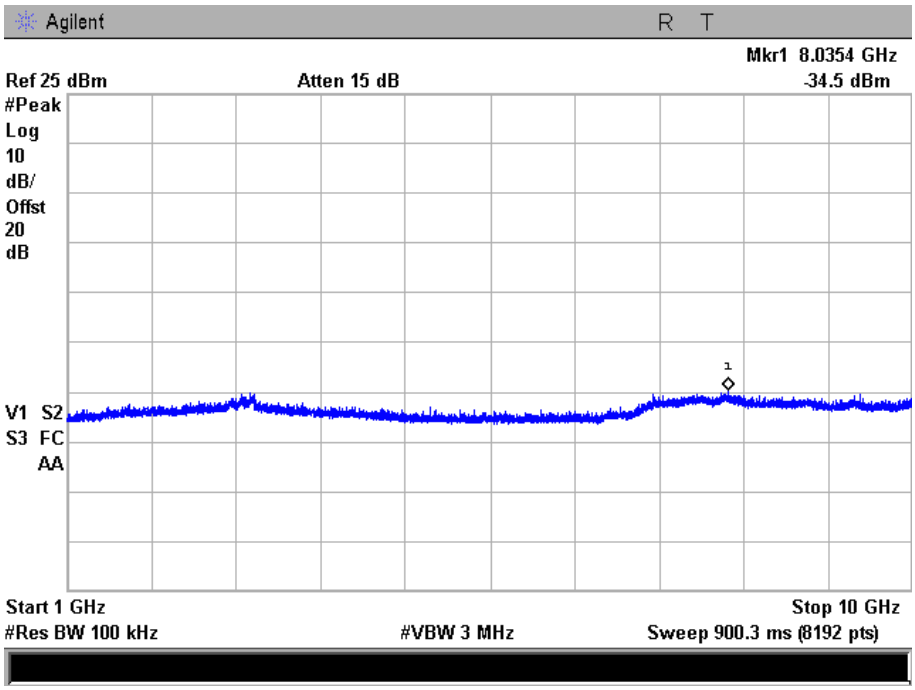


Unwanted Emissions 917.14 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.8

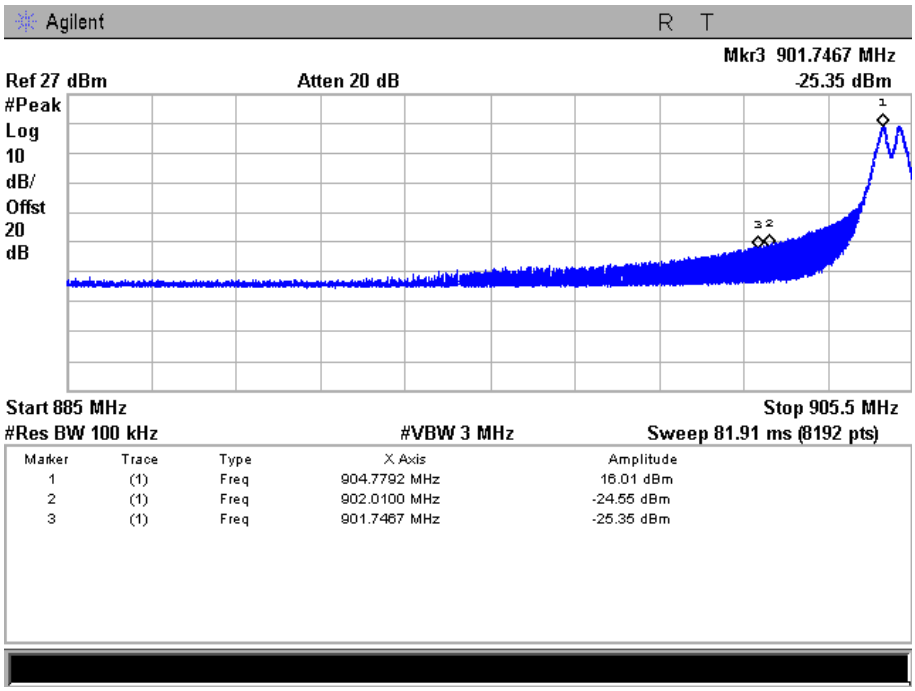


TITLE ???

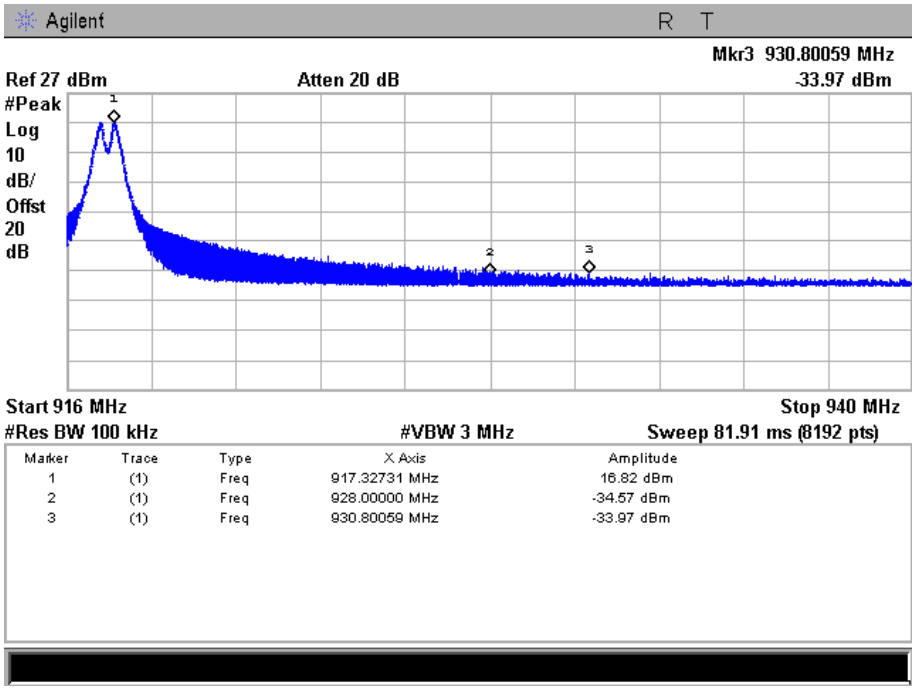
Plot 4.4.9



Band-Edge, 905 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.10



Band-Edge, 917.14 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Plot 4.4.11



4.5. Unwanted Radiated Emissions into Restricted Frequency Bands

Reference document:	**47 CFR §15.247 (d), & §15.205, & §15.209(a)**		
Test Requirements:	Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emissions limits specified in §15.209(a) (see §15.205(c)).		
Test setup:	See sec 2.2, with Band Reject filter	**Pass**	
Method of testing:	KDB 558074 D01 v02, Sec.10.2.1 Radiated		
Operating conditions:	Under normal test conditions		
S.A. Settings:	f < 1GHz: RBW: 120 kHz, VBW: 300 kHz f > 1 GHz: RBW: 1 MHz, VBW**:** 3 MHz		
Environment conditions:	Ambient Temperature: 22 °C	Relative Humidity: 45.5 %	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 4.6.1 - Plot 4.6.7	

Test results:

All measurements were performed in horizontal and vertical polarizations; the results show the worst case.

Fundamental Frequency [MHz]	Unwanted Emission Frequency [MHz]	Detector Type	Polarization H/V	Unwanted Emission Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Pass/Fail
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle							
905.00	2716	Peak	H	48.96	74	25.04	Pass
	2716	Average	H	38.27	54	15.73	Pass
	5431	Peak	H	52.09	74	21.91	Pass
	5431	Average	H	39.69	54	14.31	Pass
911.47	2735	Peak	H	51.37	74	22.63	Pass
	2735	Average	H	40.62	54	13.38	Pass
	4558	Peak	H	49.82	74	24.18	Pass
	4558	Average	H	39.29	54	14.71	Pass
917.14	2752	Peak	H	51.64	74	22.36	Pass
	2752	Average	H	41.72	54	12.28	Pass
	3669	Peak	H	49.58	74	24.42	Pass
	3669	Average	H	36.47	54	17.53	Pass

Note: Spurious Emission [dBµV/m] = measured [dBµV] + Correction-factor [dB (1/m)]
Correction Factor = Antenna factor + Cable Loss

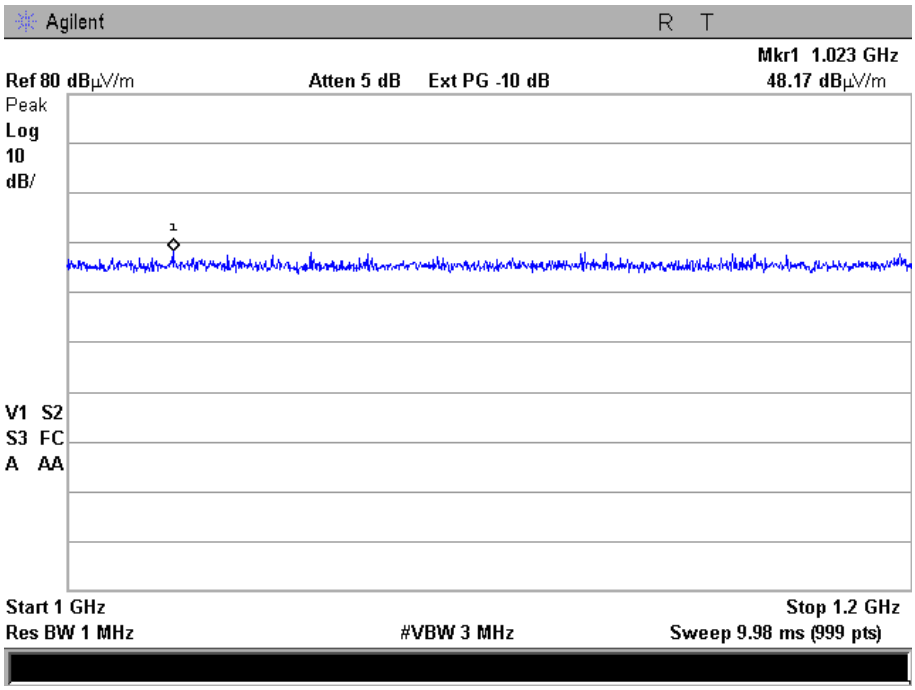
Test results below 1GHz:

All measurements were done in horizontal and vertical polarizations; the results show the worst case for all modes and frequencies.

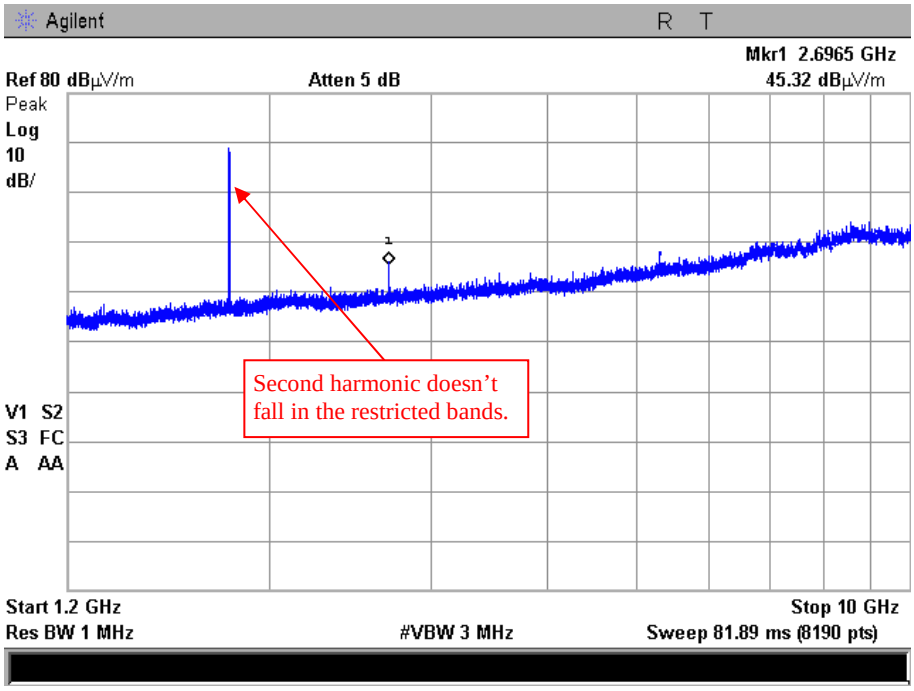
Unwanted Emission Frequency [MHz]	Detector Type	Polarization H/V	Unwanted Emission Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
All quasi-peak readings were at least 15 dB below the limit.					

Note: Spurious Emission [dBµV/m] = measured [dBµV] + Correction-factor [dB (1/m)]
Correction Factor = Antenna factor + Cable Loss +Filter I/L.

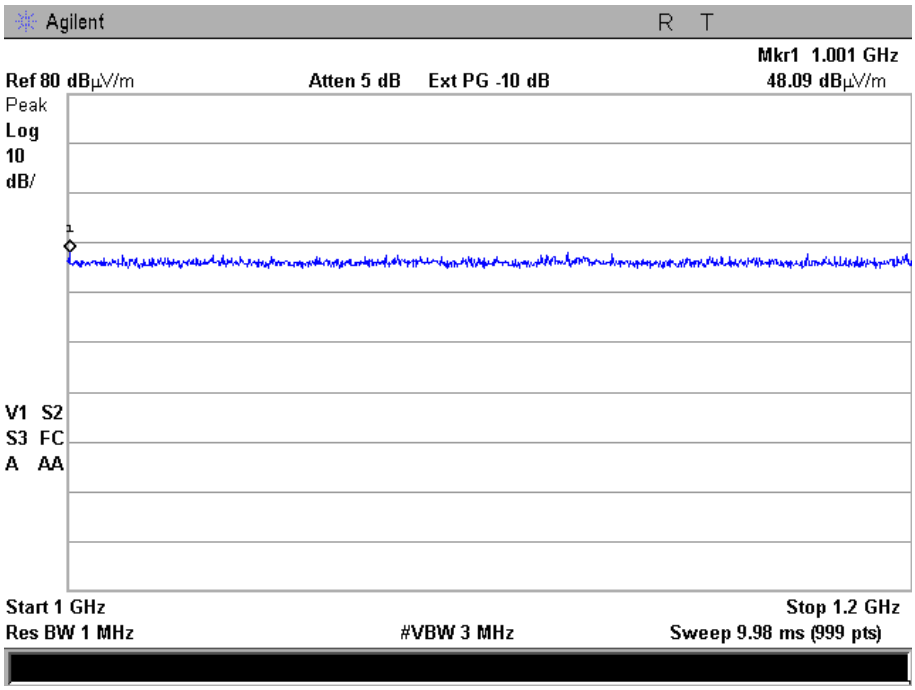
905 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Horizontal & Vertical Polarization
Plot 4.6.1



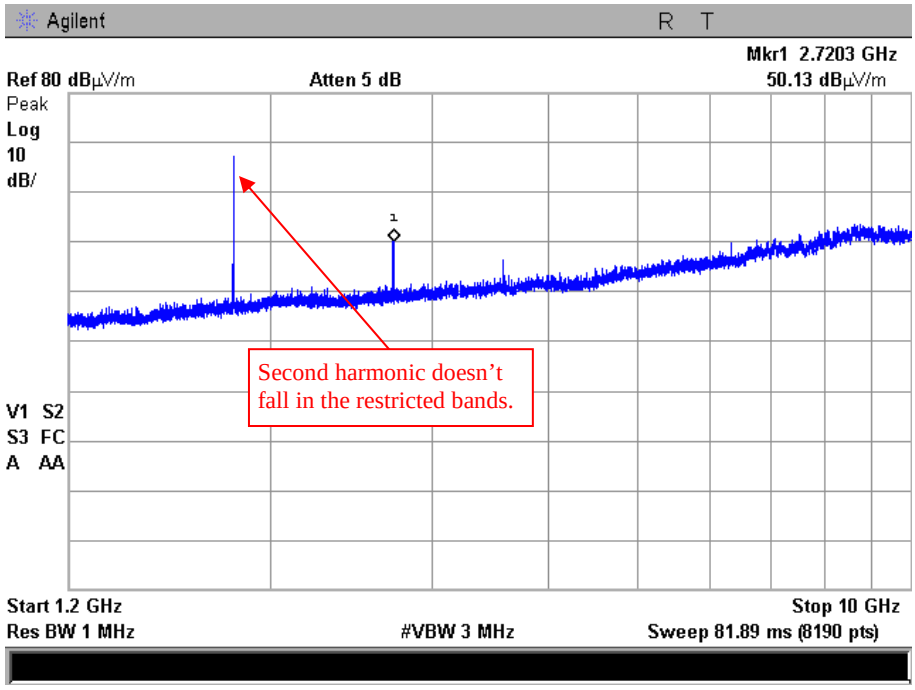
Horizontal & Vertical Polarization
Plot 4.6.2



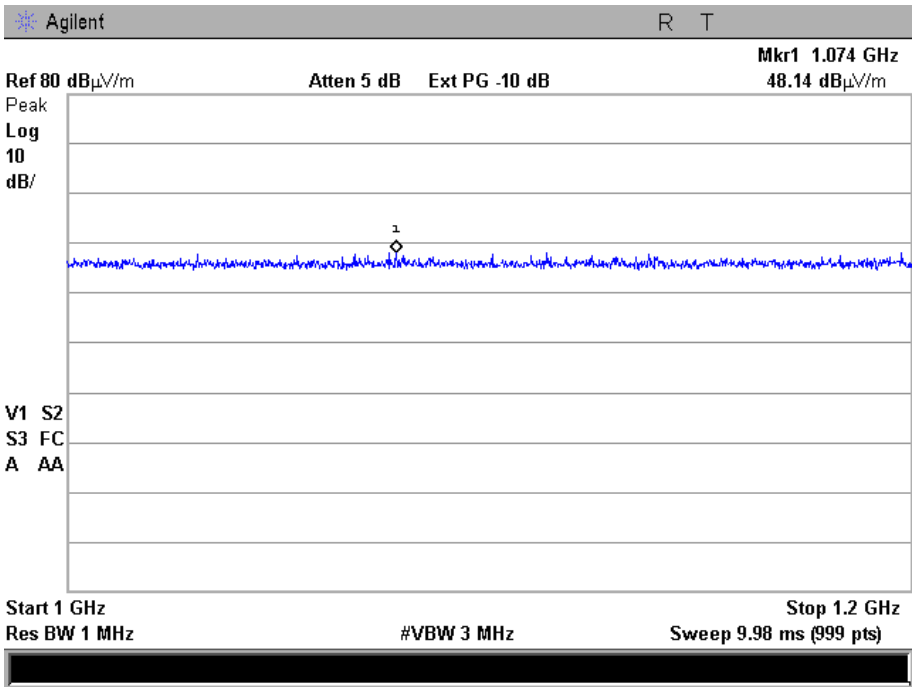
911.47 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Horizontal & Vertical Polarization
Plot 4.6.3



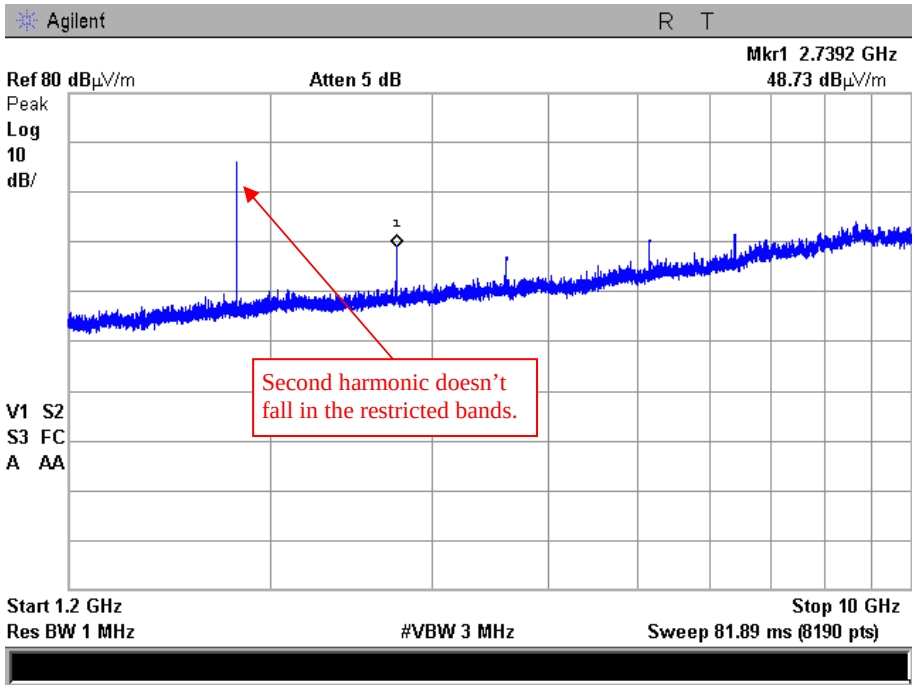
Horizontal & Vertical Polarization
Plot 4.6.4



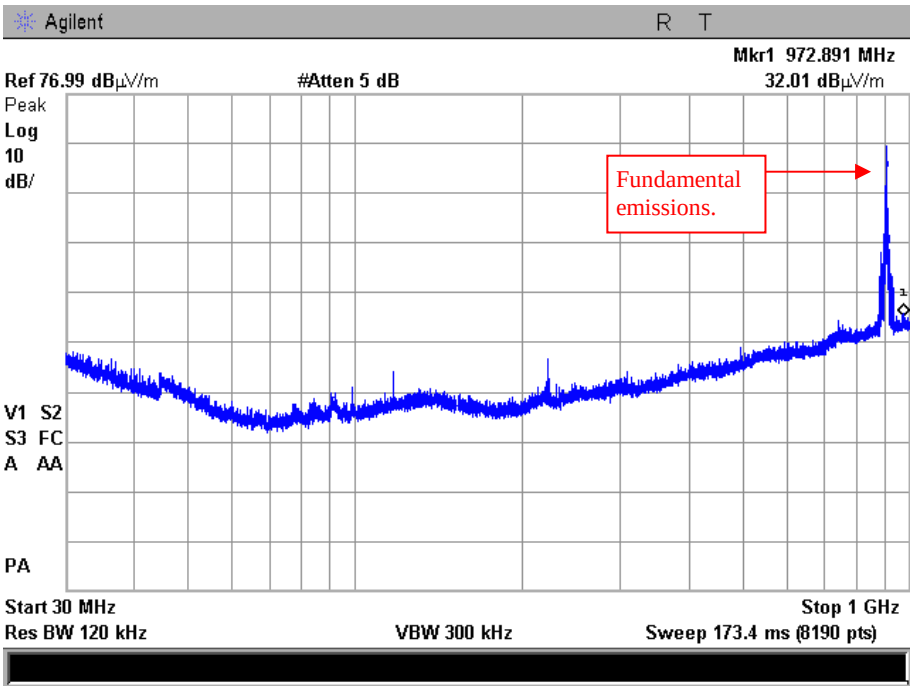
917.14 MHz
2-FSK, deviation 190.4 kHz, 67.7 % duty cycle
Horizontal & Vertical Polarization
Plot 4.6.5



Horizontal & Vertical Polarization
Plot 4.6.6



Unwanted Radiated Emissions Below 1 GHz
Worst case for all frequencies
Horizontal & Vertical Polarization
Plot 4.6.7



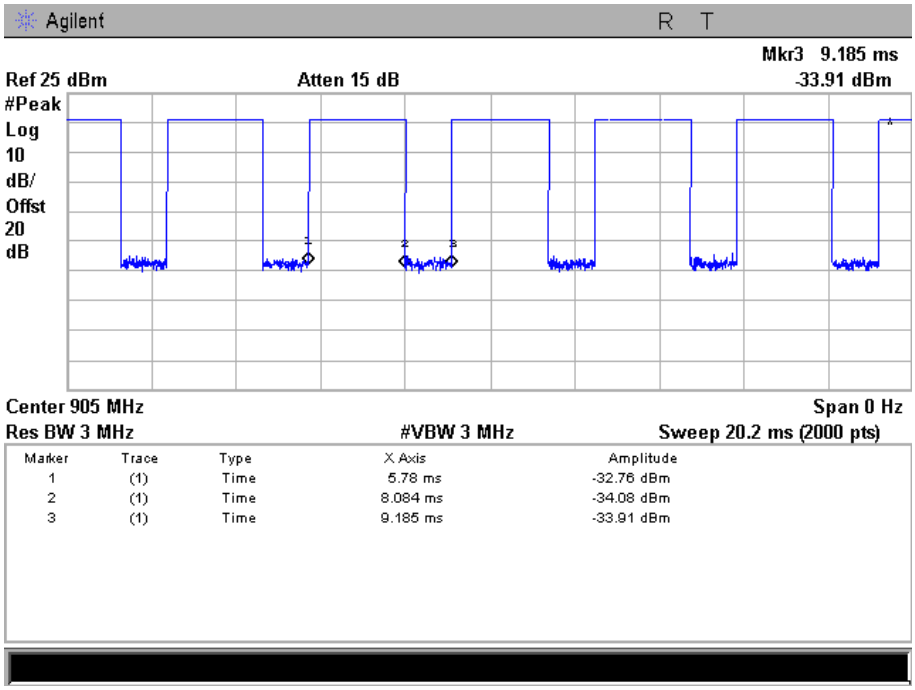
4.6. Antenna Connector Requirements

Reference document:	**47 CFR §15.203**	
Test Requirements:	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 provisions of this section.	
Test Result:	The antenna used is ANT-916-SP from Linx Technologies. The antenna is a permanently attached antenna (surface mount element) therefore this can be considered sufficient to comply with provisions of this section. **https://www.linxtechnologies.com/resources/data-guides/ant-916-sp.pdf**	

5. Appendix

Appendix A: Duty cycle

67.7% duty cycle used throughout the tests



Appendix B: List of test equipment used (updated on 30.01.2013)

Equipment	Manufacturer	Model No.	Serial No.	Calibration Due Date
CISPR16 EMI Receiver	HP	8546A	3710A00392	14.08.2013
EMC Analyzer	HP	8593EM	3536A00131	10.12.2013
Billog Antenna	Teseq	CBL 6141B	34119	03.07.2015
Double Ridge Guide Horn antenna	A.R.A	DRG-118/A	17188	22.01.2015
LISN	Fischer	50/250-25-2	9705	31.01.2013
V-LISN	Schwarzbeck	NNBL 8226-2	120	31.01.2013
Transient Limiter	Agilent	11947A	3107A04121	31.01.2013
Current Probe	Fischer	F35A	44	31.01.2013
CDN	Fischer	T2	9953	31.01.2013
CDN	Fischer	T4	9817	31.01.2013
Universal Telecom	Fischer	ISN F-071115-1057-1	20616	31.01.2013
Discharge Simulator	Noiseken	ESS-2000	8000c03235	31.01.2013
RF Signal Generator	Marconi (IFR)	2025	202301/940	12.11.2013
Power Meter	Boonton	4230	26203	04.12.2013
Power Sensor	Boonton	51015	31821	07.02.2013
EFT Generator	EMtest	EFT 500 N8	V114911192	27.04.2013
Coupling/Decoupling network for burst and surge	EMTest	CNI 503 A18/ 32A	V0947105536	04.05.2013
Surge Generator combination wave,	EMTest	VCS 500 N10	V0824103874	04.05.2013
RF Signal Generator	Marconi	2024	1122681029	08.11.2013
Power Meter	Boonton	4235	26203	07.02.2013
Power Sensor	Boonton	51015	31821	07.02.2013
EM Injection Clamp	Fischer	F2031	348	31.01.2013
CDN	Fischer	C1	9815	31.01.2013
CDN	Fischer	M2	9824	31.01.2013
CDN	Fischer	M3	9840	31.01.2013
CDN	Fischer	T4	9817	02.01.2014
ESD Generator	Noiseken	ESS-2000	8000C03235	10.08.2013
ELF Magnetic Field Meter,	Holaday	HI-3624A	00034615	20.01.2013
Power Source & Analyzer	Pacific Power	140TMX	0233	01.12.2012
Harmonics & Flickers Analyzer,	EM Test	DPA 500	V0627101584	01.03.2013

Appendix C: Accreditation Certificate

ilac-MRA

American Association for Laboratory Accreditation

Accredited Laboratory

A2LA has accredited

QUALITECH

Petach-Tikva, Israel

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 7th day of December 2012.

President & CEO
For the Accreditation Council
Certificate Number 1633.01
Valid to September 30, 2014

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

End of the Test Report