REGULATORY COMPLIANCE REPORT

TITLE: FCC & ISED Test Report for title 15.247 and RSS-247 Frequency Hopping Device 500GC
AUTHOR: Mark Kvamme

REV	CCO	DESCRIPTION OF CHANGE	DATE	APPROVALS	
001		initial upload		Engineering	
				Regulatory	

REVISION HISTORY

002		update power output test, 150kbps		Engineering	
				Regulatory	
				Engineering	
				Regulatory	
				Engineering	
				Regulatory	

Test Data Summary

FCC 15.247 / ISED RSS-247; Frequency Hopping Transmitter;
500GC Commercial, 902.2MHz – 927.75 MHz, HVIN 5U and 6U, for EUT

Rule	Description	Spec Limit	Max. Reading	Pass/ Fail
Part 15.247 (a)(1) / RSS-247 5.1(2)	System Receivers	see below	Match this device	PASS
Part 15.31(e)	Variation of Input Voltage – Conducted	n/a	n/a	n/a
Part 15.207 / RSS-Gen 8.8	AC Power line Conducted Emissions	n/a	n/a	n/a
Part 15.247(a)(1)(i) / RSS-247 5.1(3)	Number of Hopping Channels – conducted	≥ 50	120 channels AM OOK 64 channels FM 150 512 channels FM 10	PASS
Part 15.247(a)(1)(i) / RSS 247 5.1 (3)(2)(1)	20dB Bandwidth – conducted	<250KHz	power level 1 AM OOK 76 kHz power level 3 AM OOK 82 kHz power level 3 FM 150 212 kHz power level 3 FM 10 23.5 kHz	PASS
Part 15.247(a)(1) / RSS 247 5.1 (3)(2)	Carrier Frequency Separation – conducted	> 20dB BW	AM OOK 200kHz FM 150 400kHz FM 10 50kHz	PASS
Part 15.247(a)(1)(i);(g); (h) / RSS 247 5.1 (3)	Time of Occupancy, Short Burst, Intelligence	< 400mS in 20sec	All modes are <400ms in 20 second period	PASS
Part 15.247(b) (2) / RSS 247 5.4 (1)	Power Output – conducted	< 1.0W	power level 1 AM OOK = 0.005W power level 3 AM OOK = 0.413W power level 3 FM 150 = 0.461W power level 3 FM 10 = 0.425W	PASS
15.247(d) / RSS 247 5.5, RSS-GEN 8.9	Spurious Emissions – radiated	Limit @ +10dbm 82.4 dbuv/m +27dbm 103.3dbuv/m	power level 1 OOK 55.4 dbuv/m power level 3 OOK 70.7dBuV/m power level 3 71.2 dbuv/m	PASS
15.205, 15.209(Radiated) / RSS-247 5.5, RSS-GEN 8.10	Restricted Bands / Spurious Emissions – radiated	Limit @ Peak 74dbuv/m Average 54dbuv/m	power level 1 OOK 52.1 dBuV/m power level 1OOK 57.3 peak / 35.6 avg dbuv/m power level 3 OOK 47.6 dBuV.m power level 3 peak 49.5 dbuv/m (peak meets avg)	PASS
RSS-Gen 7.1.2 Part 15.109 Class B	Receiver Spurious Emissions – radiated	table	34dBuV/m (noise floor)	PASS
15.247 (d) / *RSS 247 5.5*	Band-edge compliance of RF Conducted Emissions	same as spurious	dBc @902MHz: power level 1 AM OOK= -43.74dbc power level 3 AM OOK= -43.28dbc power level 3 FM 150= -64.56dbc power level 3 FM 10= -63.19dbc dbc @928MHz: power level 1 OOK = -45.38dbc power level 3 AM OOK= -45.54dbc power level 3 FM 150 = -63.09dbc power level 3 FM 10= -66.89dbc	PASS
15.247 (d) / RSS 247 5.5	Band-edge compliance of RF Radiated Emissions	same as spurious	power level 1 AM OOK= -27.3dbc power level 3 AM OOK= -34.5 power level 3 FM 150= -39.1dbc power level 3 FM 10= -22.3dbc dbc @928MHz: power level 1 OOK = -29.48dbc power level 3 AM OOK= -35.9 power level 3 FM 150 = -38.39dbc power level 3 FM 10= -29.94dbc	PASS

Rule versions: FCC Part 1; FCC Part 2; FCC Part 15, RSS-102 Issue 5 (03-2015); RSS-Gen Issue 4 (11-2014); RSS-247 Issue 1 (05-2015)
Reference docs: ANSI C63.4-2003(2009,2014); ANSI C63.10-2003(2009,2013); DA 00-705 (03-30-2000); OET65 (08-1997); OET65C (06-2001); IEEE C95.3-2002.(2003, 2010); RSP100 issue11; SDR KDB 442812 D01 (07-2014); Exposure KDB 227498D01 (02-2014)

Cognizant Personnel		
Name Mark Kvamme		Title Test Technician
Name Jay Holcomb		Title Spectrum Regulatory
Name Johann De Jager		Title R&D Manager

CONDITIONS DURING TESTING

No Modifications to the EUT were necessary during the testing.

FCC 15.31(m) – IC _n/a_; Number of Channels
This device was tested on three channels.

ANSI C63.4 - Temperature and Humidity During Testing
The temperature during testing was within +10º C and +40º C.
The Relative humidity was between 10% and 90%.

EQUIPMENT UNDER TEST (EUT) DESCRIPTION
Itron declares that the EUT tested was representative of a production unit.

EQUIPMENT UNDER TEST

EUT Module

Manuf:	Itron, Inc.
Part Number(s)	ERG-7000-007,-008
Serial Number(s)	Listed Below
Power source	Fresh Batteries were used

Plot Information
In the zero span measurements, the line in the display is the trigger level.

Peripheral Devices
None

15.31(e)

Variation of Supply Voltage

Vary the supply voltage from 85% to 115% of the nominal voltage. If the power level of the fundamental signal varies with supply voltage, record the voltage level at which the fundamental signal is at its highest and use that voltage level for all further testing.

DEVICE IS BATTERY OPERATED NOT CONNECTED TO THE POWER LINE. BATTERY IS NOT RECHARGABLE. THERFORE THIS TEST IS N/A.

15.207 / RSS-Gen 8.8

Power line Conducted Emissions

Measure the AC power line conducted emissions from 150kHz to 30 MHz using a 50mH/50ohm line impedance stabilization network (LISN) according to the procedure specified in ANSI C63.4. Verify that no emissions exceed the following limits:

Frequency (MHz)	Quasi-Peak (dBuV)	Average (dBuV)
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of frequency

DEVICE IS BATTERY OPERATED NOT CONNECTED TO THE POWER LINE. BATTERY IS NOT RECHARGABLE. THERFORE THIS TEST IS N/A.

15.247(a) (1) (i) / RSS-247 5.1(3)

Number of Hopping Channels, conducted

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = Peak
Trace = max hold

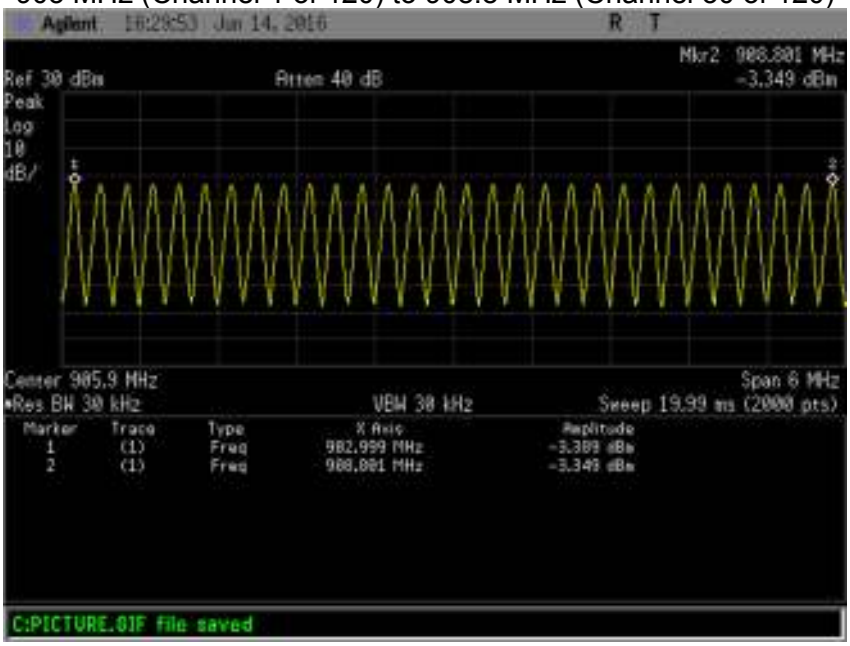
Allow the trace to stabilize. It may prove necessary to break the span up into sections, in order to clearly show all of the hopping frequencies.

Equipment Used	Serial Number	Cal Date	Due
Agilent E7405A	MY45113415	4/21/2016	4/21/2017
Date	Tested by		
June/2016	Mark Kvamme		

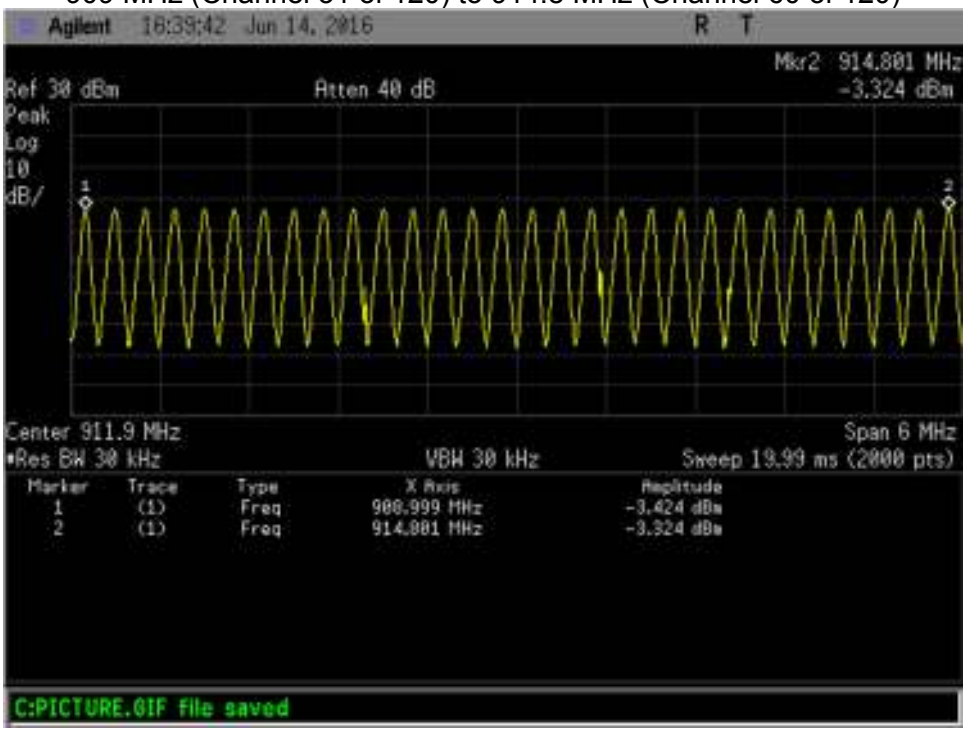
Unit tested with a fresh Battery: 12

There are 120 channels in the Itron OOK AM mode.
There are 64 channels in the Itron 150 kps FM modulation mode.
There are 512 channels in the Itron 10 kps FM modulation mode.

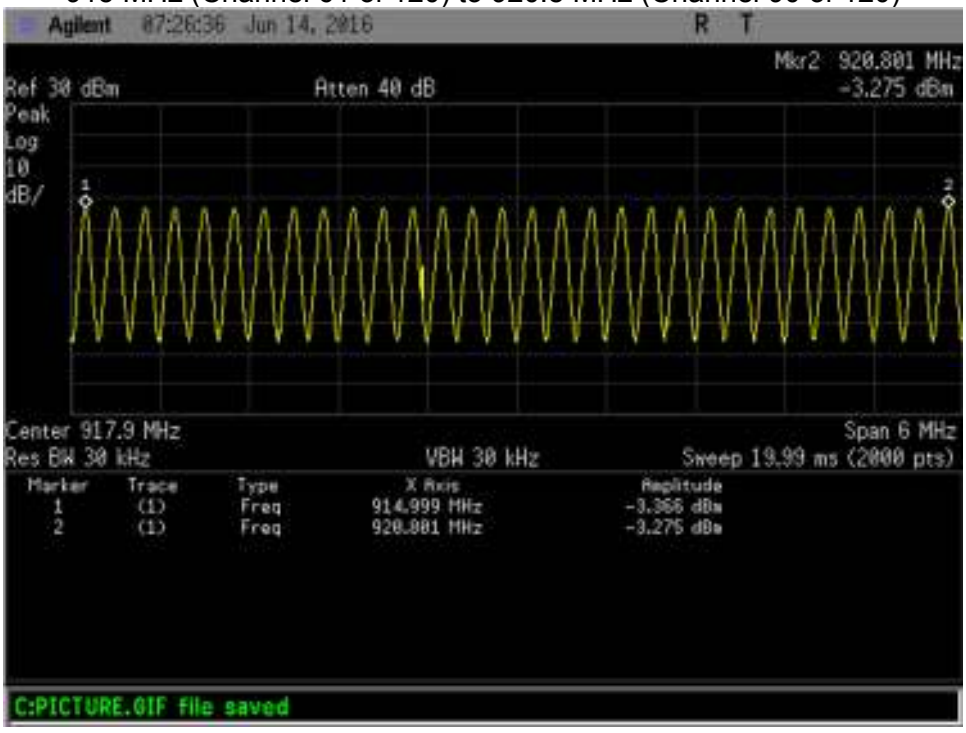
903 MHz (Channel 1 of 120) to 908.8 MHz (Channel 30 of 120)



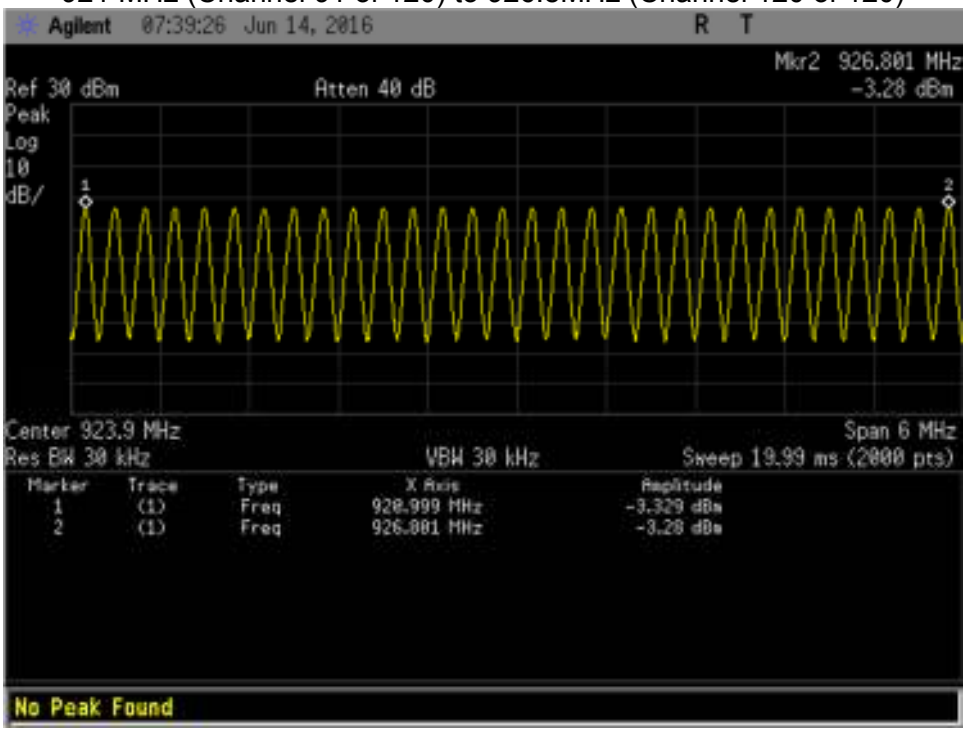
909 MHz (Channel 31 of 120) to 914.8 MHz (Channel 60 of 120)



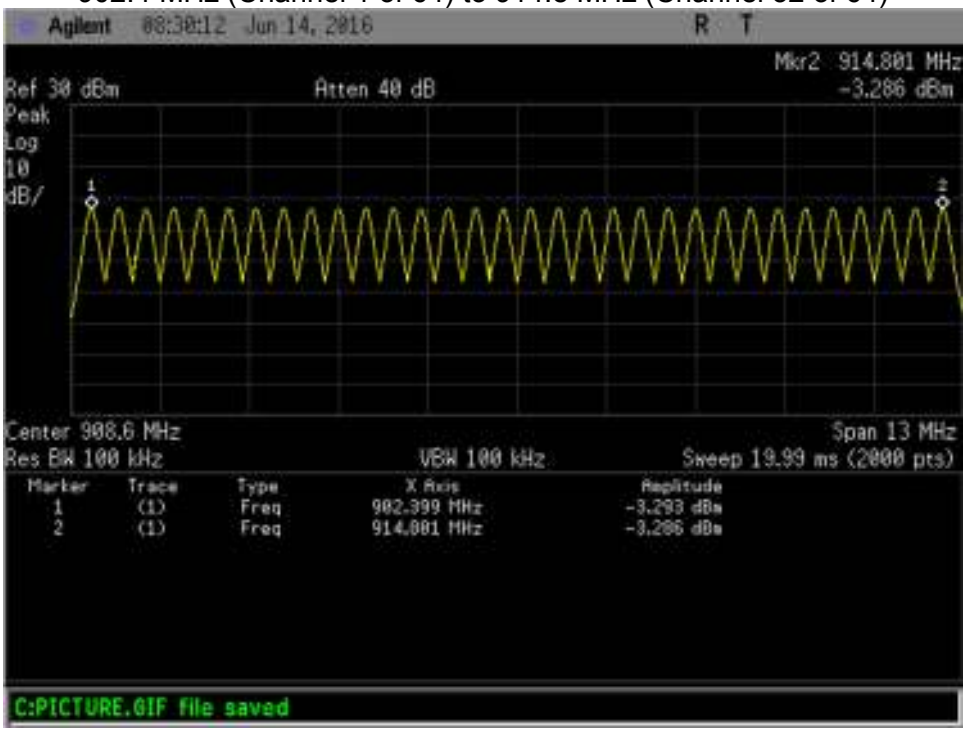
915 MHz (Channel 61 of 120) to 920.8 MHz (Channel 90 of 120)



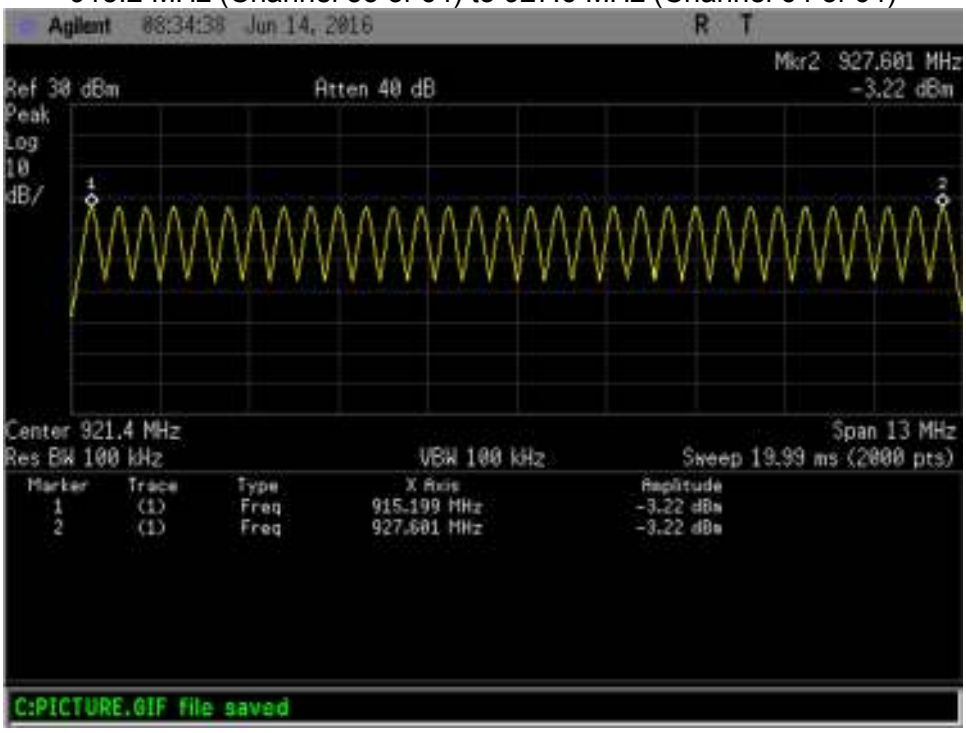
921 MHz (Channel 91 of 120) to 926.8MHz (Channel 120 of 120)



902.4 MHz (Channel 1 of 64) to 914.8 MHz (Channel 32 of 64)



915.2 MHz (Channel 33 of 64) to 927.6 MHz (Channel 64 of 64)

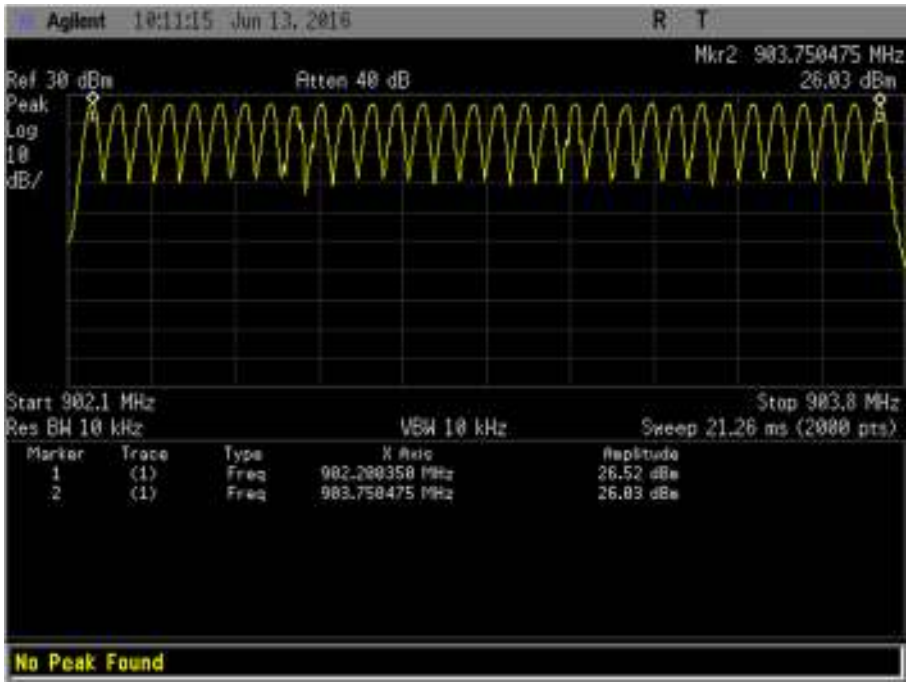


For the 512 channels in the Itron 10 kbps FM modulation mode, only the lowest, middle and highest 32 channels are shown, for a total of 96 channels. Here is the equation to get to all 512 channels:

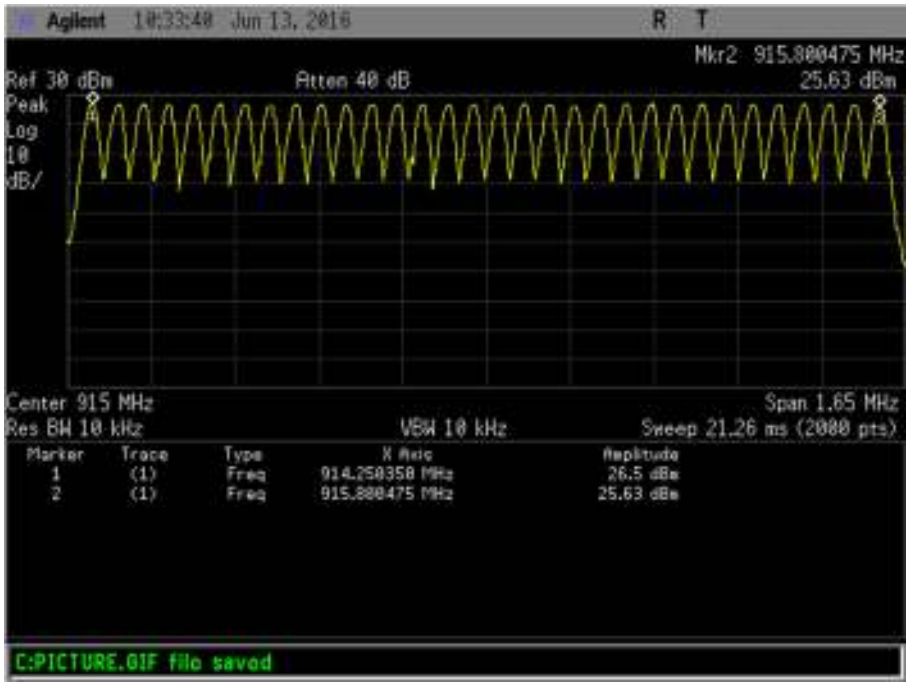
CHANNEL EQUATION:
FC = ((C-1) * S) +F1

VARIABLES:
C=Channel Number (real numbers from 1 to 512)
S=Channel Spacing (0.05 MHZ)
F1=Channel 1 Frequency (902.2 MHZ)
FC=Channel C Frequency (MHZ)

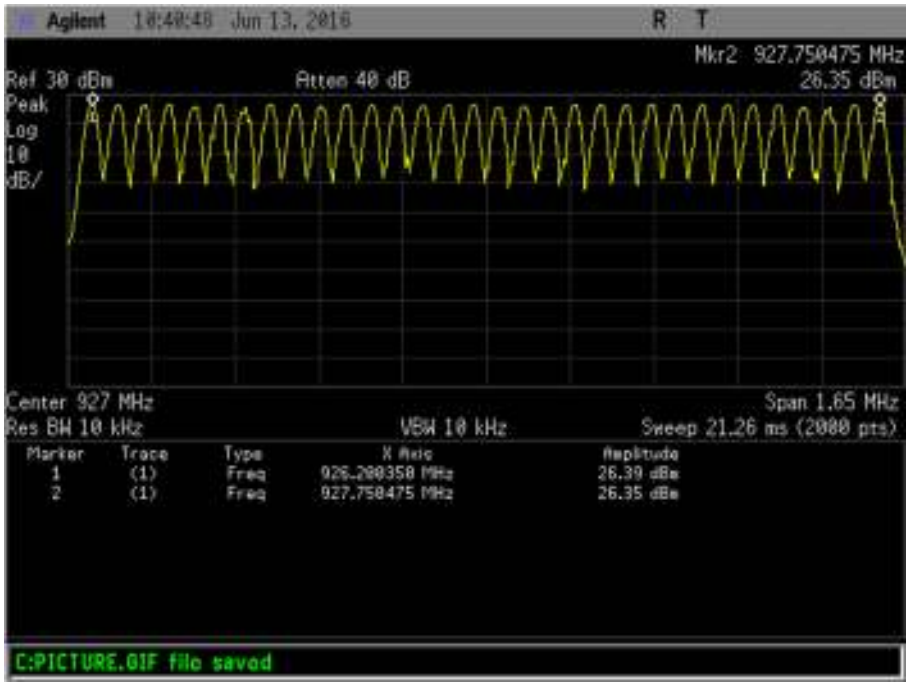
CALCULATIONS: Channel 1 = ((1-1) X 0.05 MHZ) +902.2 MHZ = 902.2 MHZ
Channel 32 = ((32-1) X 0.05 MHZ) +902.2 MHZ = 903.75 MHZ
Channel 1 to 32 of 512 channels



CALCULATIONS: Channel 242 = ((242-1) X 0.05 MHZ) +902.2 MHZ = 914.25 MHZ
Channel 273 = ((273-1) X 0.05 MHZ) +902.2 MHZ = 915.8 MHZ
Channel 242 to 273 of 512 channels



CALCULATIONS: Channel 481 = ((481-1) X 0.05 MHZ) +902.2 MHZ = 926.2 MHZ
Channel 512 = ((512-1) X 0.05 MHZ) +902.2 MHZ = 927.75 MHZ
Channel 481 to 512 of 512 channels



15.247(a) (1) (i) / RSS 247 5.1 (3)(2)(1)

20 dB Bandwidth, Conducted

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel.
RBW ≥ 1% of the 20 dB bandwidth
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the mission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation.

Equipment Used	Serial Number	Cal Date	Due
Agilent E7405A	MY45113415	4/21/2016	4/21/2017
Date	Tested by		
June/July/2016	Mark Kvamme		

Unit tested with a fresh Battery: 12

power level	system channel	system frequency (MHz)	message modulation type	20 db bandwidth (KHz)
+10db nominal	1	903	Itron AM OOK(1)	76
+10db nominal	60	915	Itron AM OOK(1)	64
+10db nominal	120	926.8	Itron AM OOK(1)	74
+24db nominal	1	903	Itron AM OOK(1)	73
+24db nominal	60	915	Itron AM OOK(1)	75
+24db nominal	120	926.8	Itron AM OOK(1)	74
+27db nominal	1	903	Itron AM OOK(1)	82
+27db nominal	60	915	Itron AM OOK(1)	81
+27db nominal	120	926.8	Itron AM OOK(1)	81
+27db nominal	1	902.4	Itron FM 150(2)	212
+27db nominal	32	914.8	Itron FM 150(2)	212
+27db nominal	64	927.6	Itron FM 150(2)	212
+27db nominal	1	902.2	Itron FM 10(3)	23.5
+27db nominal	257	915	Itron FM 10(3)	23.5
+27db nominal	512	927.75	Itron FM 10(3)	23

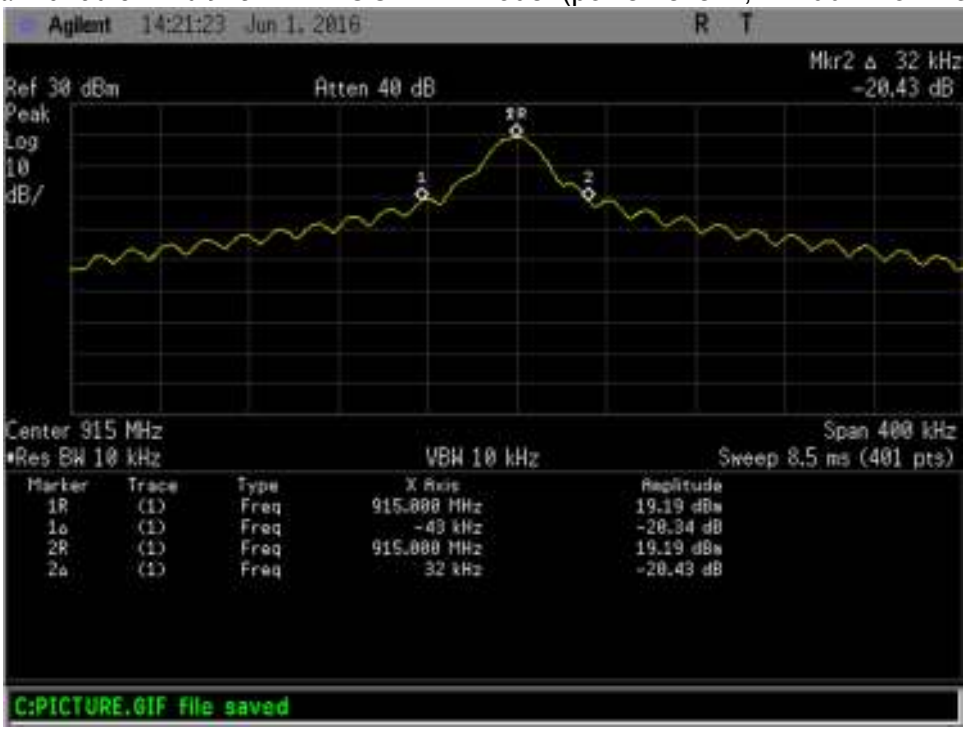
(1)Channel spacing is 200KHz for Itron AM OOK

(2)Channel spacing is 400KHz for Itron FM 150

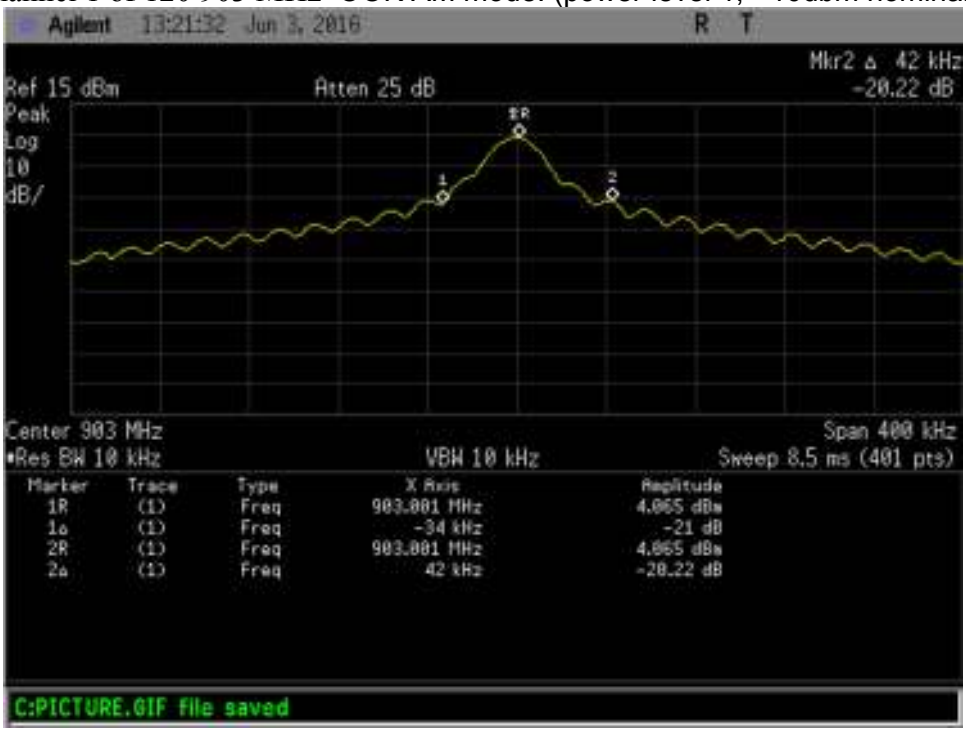
(3)Channel spacing is 50KHz for Itron FM 10

channel 32 of 64 914.8 MHz Itron FM 150

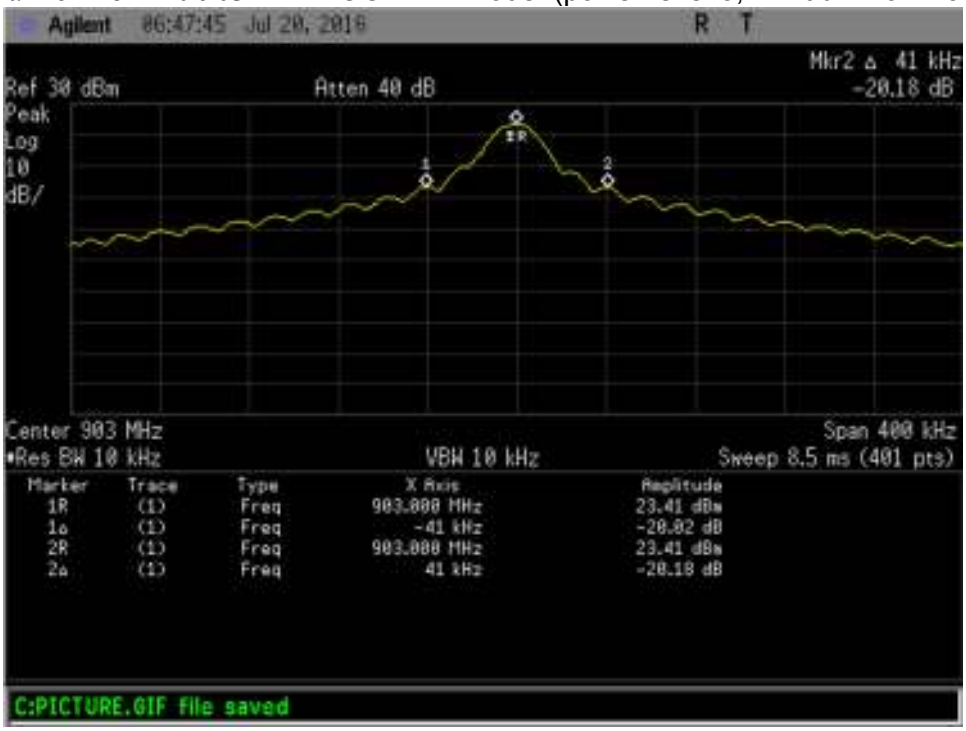
channel 60 of 120 915 MHz OOK AM mode. (power level 2, +24dbm nominal)



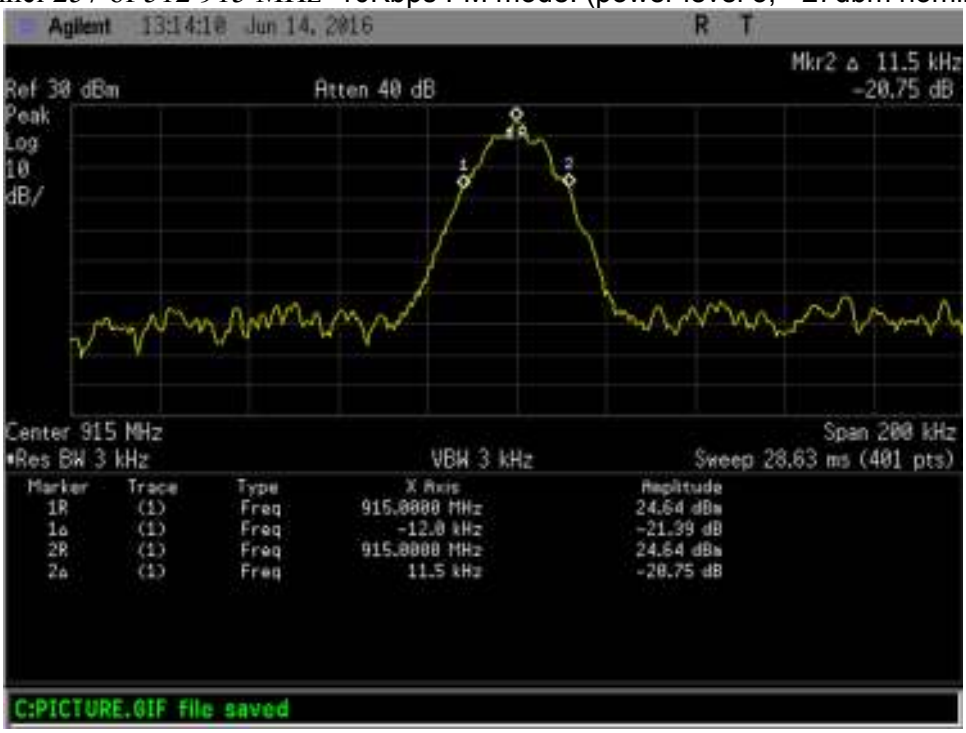
channel 1 of 120 903 MHz OOK AM mode. (power level 1, +10dbm nominal)



channel 1 of 120 903 MHz OOK AM mode. (power level 3, +27dbm nominal)



channel 257 of 512 915 MHz 10Kbps FM mode. (power level 3, +27dbm nominal)



15.247(a) (1) / RSS 247 5.1 (3)(2)

Carrier Frequency Separation, conducted

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Verify that the channel separation is > the 20dB bandwidth of a single transmission.
The EUT must have its hopping function enabled. Use the following analyzer settings:

RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Equipment Used	Serial Number	Cal Date	Due
Agilent E7405A	MY45113415	4/21/2016	4/21/2017
Date	Tested by		
June/2016	Mark Kvamme		

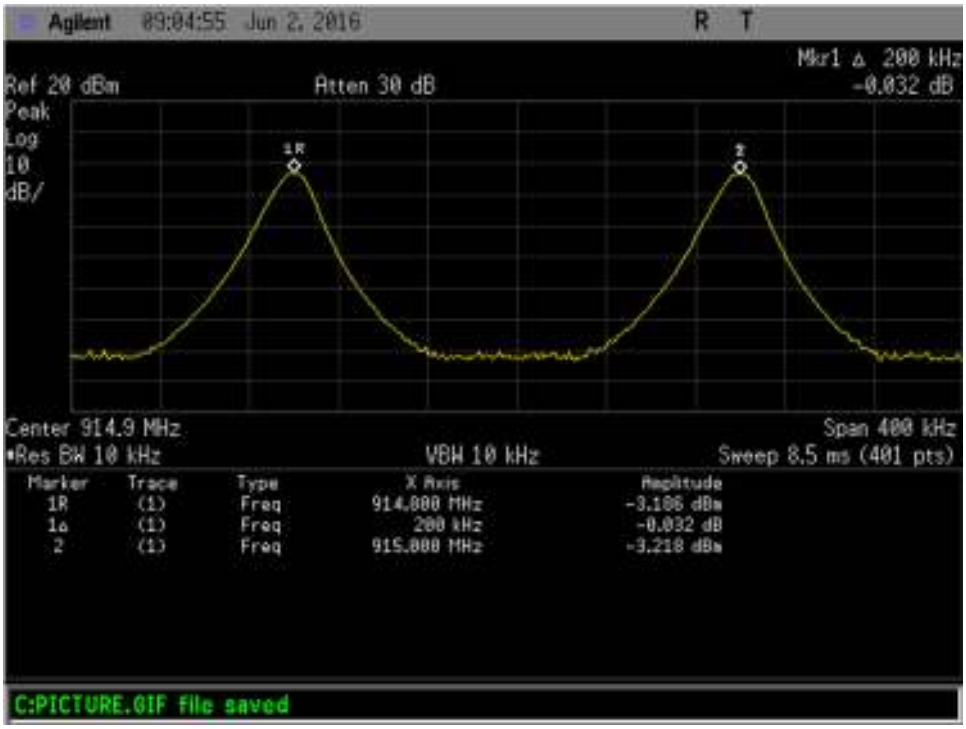
Unit tested with a fresh Battery: 12

OOK AM mode.
150 kps FM modulation mode
10 kps FM modulation mode.

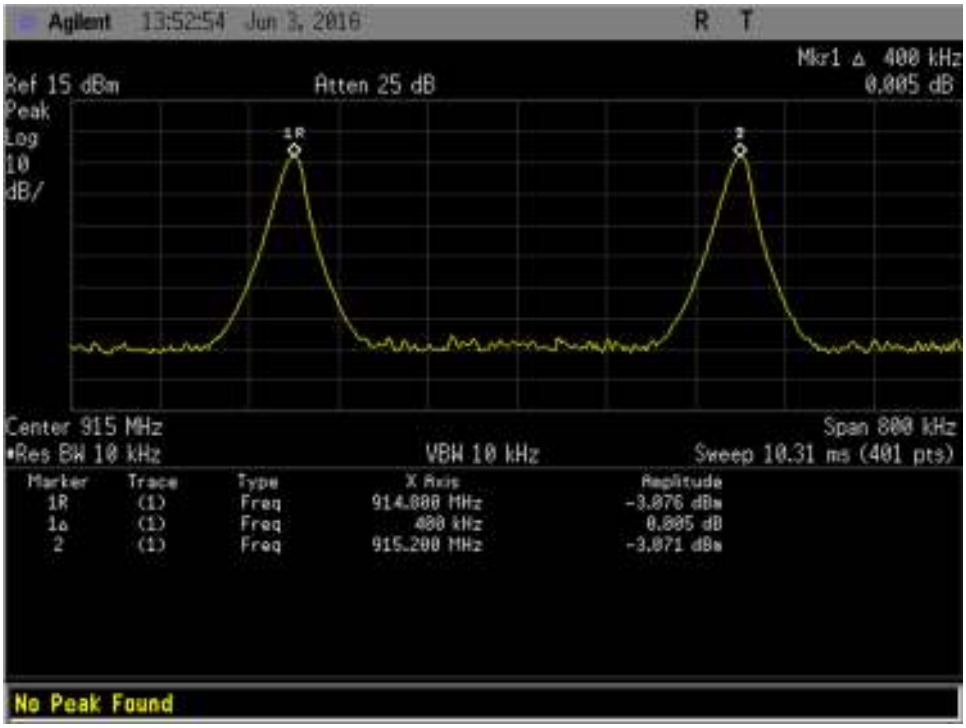
Channels[(1)]	Frequency (MHz)	Modulation type	Channel Spacing
Low	903.0	AM OOK	200 KHz
Middle	915	AM OOK	200 KHz
High	926.8	AM OOK	200 KHz
Low	902.4	FM 150	400 KHz
Middle	914.8	FM 150	400 KHz
High	927.6	FM 150	400 KHz
Low	902.2	FM 10	50 kHz
Middle	915	FM 10	50 kHz
High	927.75	FM 10	50 kHz

[(1)]Channel spacing is : 200kHz for AM OOK: 400kHz for FM 150 : 50 kHz for FM 10

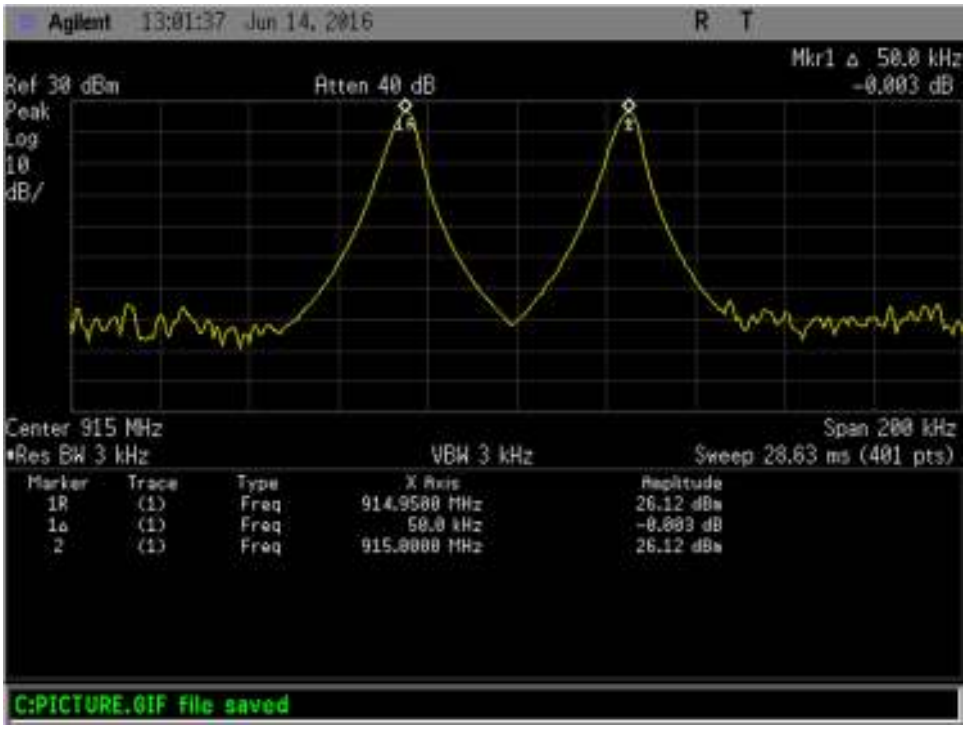
channel 59 and 60 of 120 914.8 MHz and 915 MHz OOK AM mode.



Channel 32 and 33 of 64 914.8 MHz and 915.2 MHz Itron FM 150



Channel 256 and 257 of 512 914.95 MHz and 915 MHz Itron FM 10



15.247(a) (1) (i); (g); (h) / RSS 247 5.1 (3)

Time of Occupancy, conducted

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter.

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB 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;

Short Bursts 15.247 (g)

… a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

Intelligence 15.247 (h)

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

See "Operational Description 500S, Occupancy" for full description of time of occupancy for each mode of operation.

15.247(b) (2) / RSS 247 5.4 (1)

Power Output - Conducted

The maximum peak conducted output power of the intentional radiator shall not exceed the following: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel.
RBW > the 20 dB bandwidth of the emission being measured.
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Set RF level offset=cable loss

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power. The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.

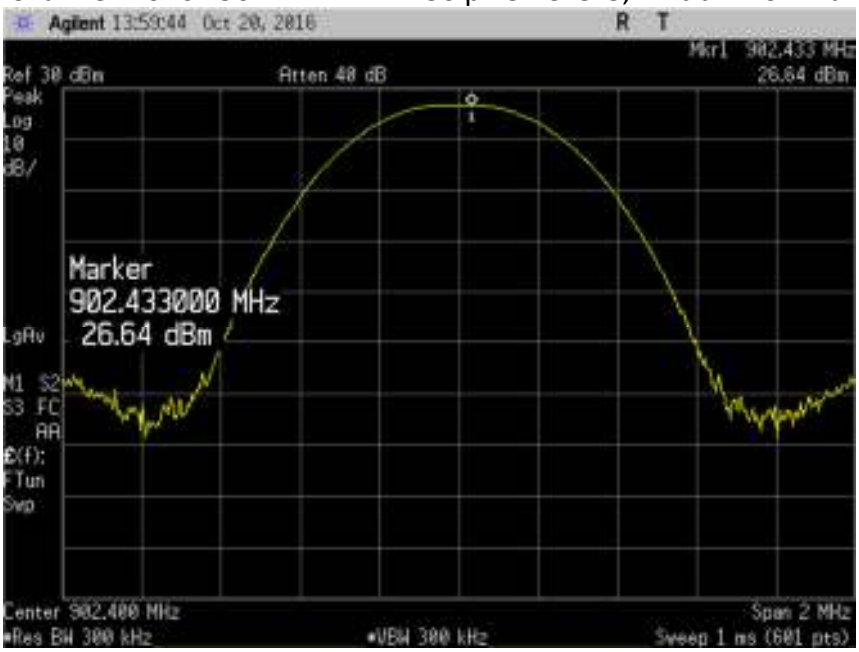
Equipment Used	Serial Number	Cal Date	Due
Agilent E7405A	MY45113415	4/21/2016	4/21/2017
E4440A	MY45305142	18-Apr-16	18-Apr-17
Date	Tested by		
June/July/October2016	Mark Kvamme		

Unit tested with a fresh Battery: 12

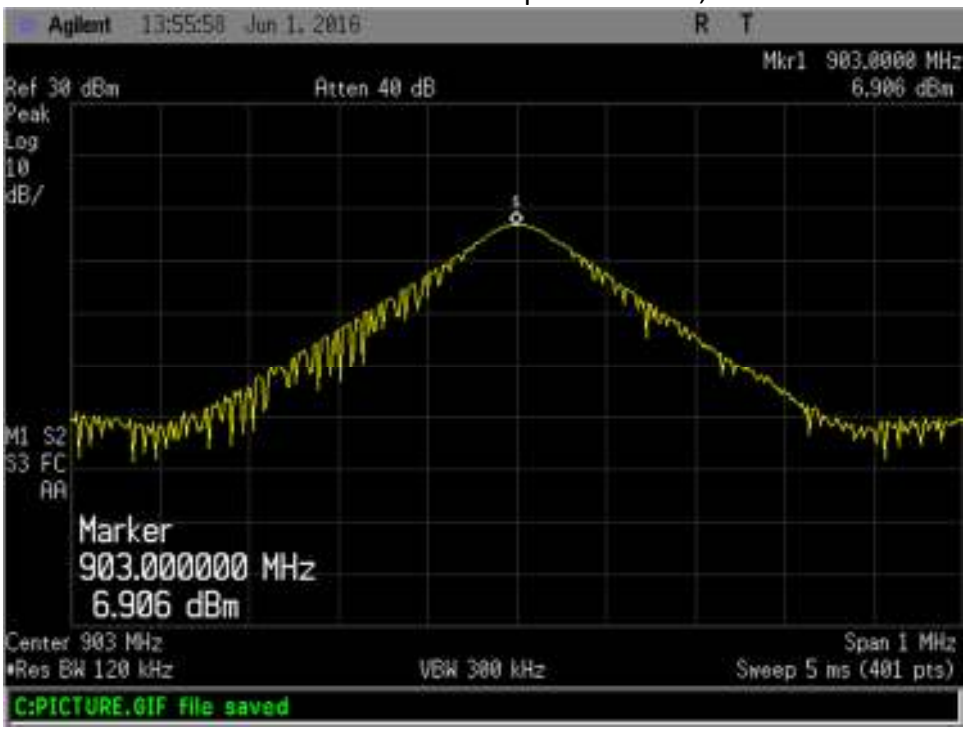
system channel	Channel Frequency (MHz)	message modulation type [1]	conducted power (dbm)
1 of 120	903.0	AM OOK +10dbm nominal / pwr lvl 1	6.91/0.0049W
60 of 120	915.0	AM OOK +10dbm nominal	6.88
120 of 120	926.8	AM OOK +10dbm nominal	6.85
1 of 120	903.0	AM OOK +24dbm nominal / pwr lvl 2	22.33
60 of 120	915.0	AM OOK +24dbm nominal	22.21
120 of 120	926.8	AM OOK +24dbm nominal	21.98
1 of 120	903.0	AM OOK +27dbm nominal / pwr lvl 3	26.16/0.413W
60 of 120	915.0	AM OOK +27dbm nominal	26.05
120 of 120	926.8	AM OOK +27dbm nominal	26
1 of 64	902.4	FM 150 +27dbm nominal / pwr lvl 3	26.64/0.461W
32 of 64	914.8	FM 150+27dbm nominal	26.54
64 of 64	927.6	FM 150 +27dbm nominal	26.36
1 of 512	902.2	FM10 +27dbm nominal / pwr lvl 3	26.28/0.425W
256 of 512	915	FM10 +27dbm nominal	26.17
512 of 512	927.75	FM10 +27dbm nominal	26.09

[1]Channel spacing is : 200KHz for AM OOK : 400kHz for FM 150 : 50kHz for FM 10

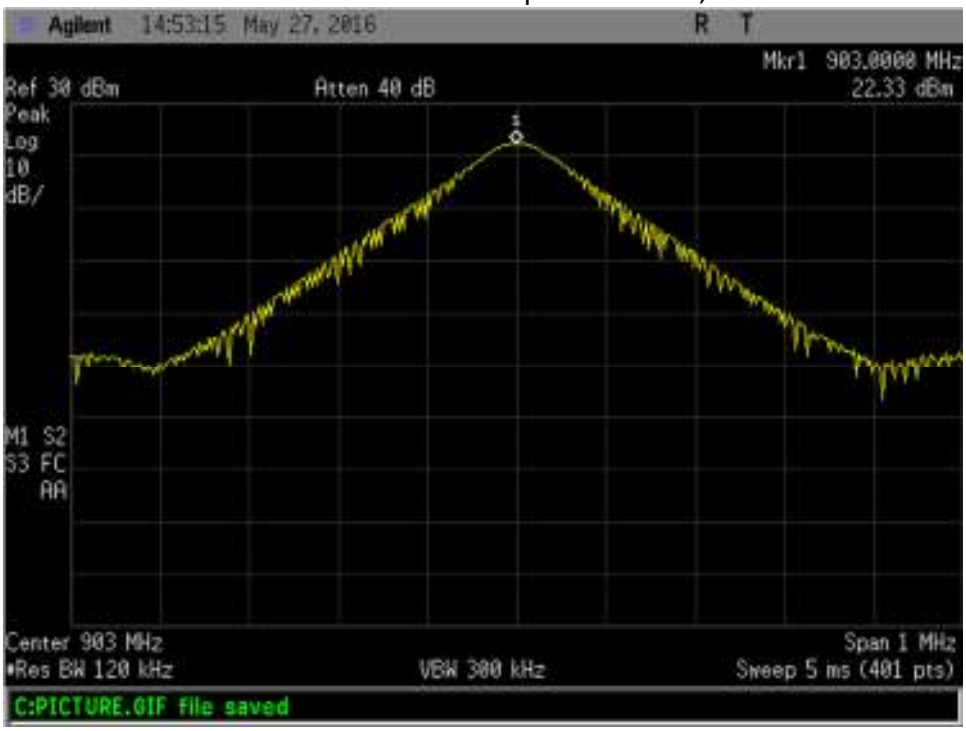
Channel 1 of 64 902.4MHz FM 150 pwer level 3,+27dbm nominal



Channel 1 of 120 903.0 MHz AM OOK power level 1, +10dbm nominal

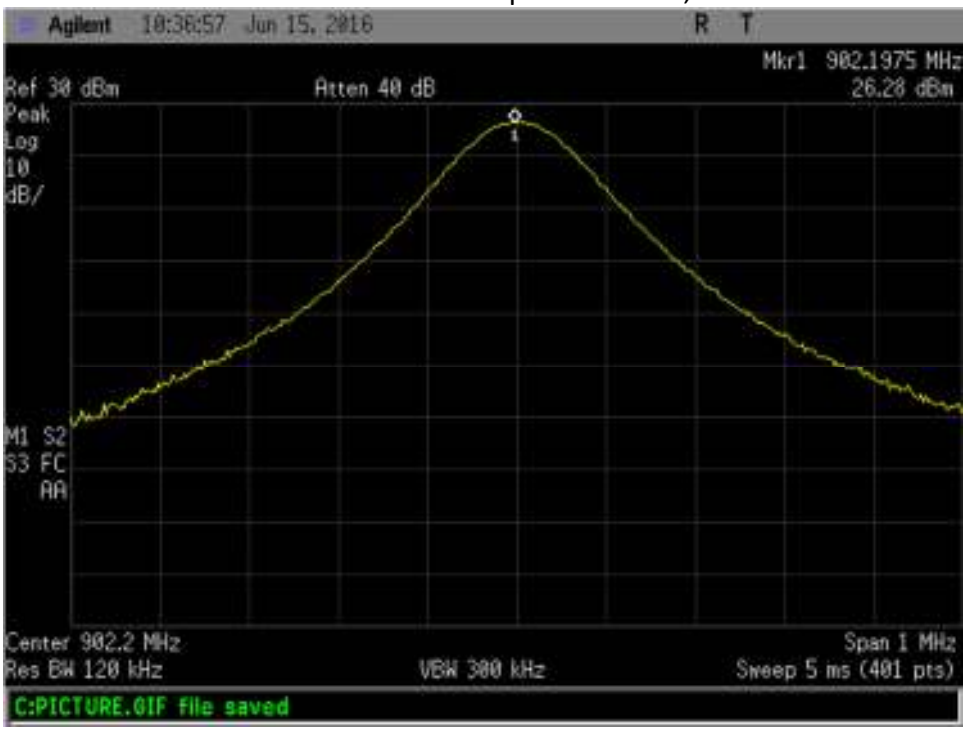


Channel 1 of 120 903.0 MHz AM OOK power level 2, +24dbm nominal



Channel 1 of 120 903.0 MHz AM OOK power level 3, +27dbm nominal

Channel 1 of 512 902.2 MHz FM 10 power level 3, +27dbm nominal



15.247(d) / RSS 247 5.5

Spurious Emissions - Radiated

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 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 30 dB instead of 20 dB. 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)).*

**note: 15.247 (b)(3) is for digital modulation, which is not being used with this device.*

MHz	power	Modulation	peak/average	DbuV/m	Site	report	page	report	page	limit
6368.6	+10dbm	OOK	peak	55.4	CKC	98972-4	12	98972-6	13	82.4
1853.6	+27dbm	OOK	peak	70.7	CKC	98972-4	19	98972-6	20	103.3
1804.4	+27dbm	CW	peak	71.2	CKC	98972-4	18	98972-6	19	103.3

15.205, 15.209(Radiated) / RSS-210 2.2, 2.6

Restricted Bands Spurious Emissions - radiated

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:
(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

Measure the field strength of all transmitter spurious emissions in the restricted bands listed below. Follow the procedure outlined in Annex A and B of this document.

MHz	MHz	MHz	GHz
0.090-0.110	13.36-13.41	399.9-410	5.35-5.46
0.495-0.505 (FCC)	16.42-16.423	608-614	7.25-7.75
2.1735-2.1905	16.69475-16.69525	960- 1427*	8.025-8.5
4.125-4.128	16.80425-16.80475	1435-1626.5	9.0-9.2
4.17725-4.17775	25.5-25.67	1645.5-1646.5	9.3-9.5
4.20725-4.20775	37.5-38.25	1660-1710	10.6-12.7
5.677-5.683 (IC)	73-74.6	1718.8-1722.2	13.25-13.4
6.215-6.218	74.8-75.2	2200-2300	14.47-14.5
6.26775-6.26825	108-121.94	2310-2390	15.35-16.2
6.31175-6.31225	123-138	2483.5-2500	17.7-21.4
8.291-8.294	149.9-150.05	2655-2900**	22.01-23.12
8.362-8.366	156.52475-156.52525	3260-3267	23.6-24.0
8.37625-8.38675	156.7-156.9	3332-3339	31.2-31.8
8.41425-8.41475	162.0125-167.17	3345.8-3358	36.43-36.5
12.29-12.293	167.72-173.2	3600-4400	Above 38.6
12.51975-12.52025	240-285	4.5-5.15	
12.57675-12.57725	322-335.4		

- for reference the FCC has relaxed some of the restricted bands and IC has not. In the FCC rules today: *960-1240 and *1300-1427MHz; **2690-2900MHz;

MHz	power	Modulation	peak/average	DbuV/m	Site	report	page	report	page	limit
8188.25	+10dbm	OOK	peak	57.3	CKC	98972-4	10	98972-6	11	74
8188.25	+10dbm	OOK	average	35.6	CKC	98972-4	10	98972-6	11	54
8235.01	+10dbm	OOK	peak	57.3	CKC	98972-4	10	98972-6	11	74
8235.01	+10dbm	OOK	average	33.3	CKC	98972-4	10	98972-6	11	54
2709.0	+10dBm	OOK	peak	52.1	CKC	98972-4	9	98972-6	10	74
4634	+27dbm	OOK	peak	47.6	CKC	98972-4	16	98972-6	17	74
4575	+27dbm	CW	peak	49.5	CKC	98972-4	16	98972-6	17	74

RSS-Gen 7.2.3 (RSS-GEN 4.10) and Part 15.109 Class B Receiver Spurious Emission Limits

7.2.3.2 Radiated Measurement

All spurious emissions shall comply with the limits of Table 1.

Receiver Spurious Emissions

The receiver shall be operated in the normal receive mode near the mid-point of the band over which the receiver is designed to operate. Unless otherwise specified in the applicable RSS, the radiated emission measurement is the standard measurement method (with the device's antenna in place) to measure receiver spurious emissions. Radiated emission measurements are to be performed using a calibrated open-area test site. As an alternative, the conducted measurement method may be used when the antenna is detachable. In such a case, the receiver spurious signal may be measured at the antenna port. If the receiver is super-regenerative, stabilize it by coupling to it an un-modulated carrier on the receiver frequency (antenna conducted measurement) or by transmitting an un-modulated carrier on the receiver frequency from an antenna in the proximity of the receiver (radiated measurement). Taking care not to overload the receiver, vary the amplitude and frequency of the stabilizing signal to obtain the highest level of the spurious emissions from the receiver. For either method, the search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

Receiver Spurious Emission Standard

The following receiver spurious emission limits shall be complied with:

(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 1. The resolution bandwidth of the spectrum analyzer shall be 100 kHz for spurious emission measurements below 1.0 GHz, and 1.0 MHz for measurements above 1.0 GHz.

Table 1- Spurious Emission Limits for Receivers

Spurious Frequency (MHz)	Field Strength (microvolt/m at 3 meters)	in dBuV/m
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

FS(uV/m) = 10 raised to the power of {(dBuV/m)/20}

Frequency range investigated was 30MHz to 5 GHz. All emissions were below limits, refer to International Certification Services Report **#220616A**

15.247 (d)
Band-edge compliance of RF Conducted Emissions
see spurious emissions section above for rules.

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and 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.

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

Equipment Used	Serial Number	Cal Date	Due
Agilent E7405A	MY45113415	4/21/2016	4/21/2017
Date	Tested by		
June/July/2016	Mark Kvamme		

Unit tested with a fresh Battery: 12

Measurement setup	channel	Channel Frequency (MHz)	message modulation type [1]	Band Edge DBc
conducted	1	903	AM OOK pwr lvl 1	-43.74
conducted	1	903	AM OOK pwr lvl 2	-43.92
conducted	1	903	AM OOK pwr lvl 3	-43.28
conducted	1	902.4	FM 150	-64.56
conducted	1	902.2	FM 10	-63.19
conducted	120	926.8	AM OOK pwr lvl 1	-45.38
conducted	120	926.8	AM OOK pwr lvl 2	-47.42
conducted	120	926.8	AM OOK pwr lvl 3	-45.54
conducted	64	927.6	FM 150	-63.09
conducted	512	927.75	FM 10	-66.89
Radiated[2]	1	903	AM OOK pwr lvl 1	-30.4
Radiated[2]	1	903	AM OOK pwr lvl 2	-32.7
Radiated[3]	1	903	AM OOK pwr lvl 3	-34.5
Radiated[2]	1	902.4	FM 150	-39
Radiated[2]	1	902.2	FM 10	-21.91
Radiated[2]	120	926.8	AM OOK pwr lvl 1	-31.68
Radiated[2]	120	926.8	AM OOK pwr lvl 2	-36.58
Radiated[3]	120	926.8	AM OOK pwr lvl 3	-35.9
Radiated[2]	64	927.6	FM 150	-38.09
Radiated[2]	512	927.75	FM 10	-29.49

[1] Channel spacing is : 200KHz for AM OOK : 400kHz for FM 150 : 50kHz for FM 10
[2] Radiated values from International Certification Services report 210616B
[3] Radiated values from CKC report 98972-4 and 98972-6.

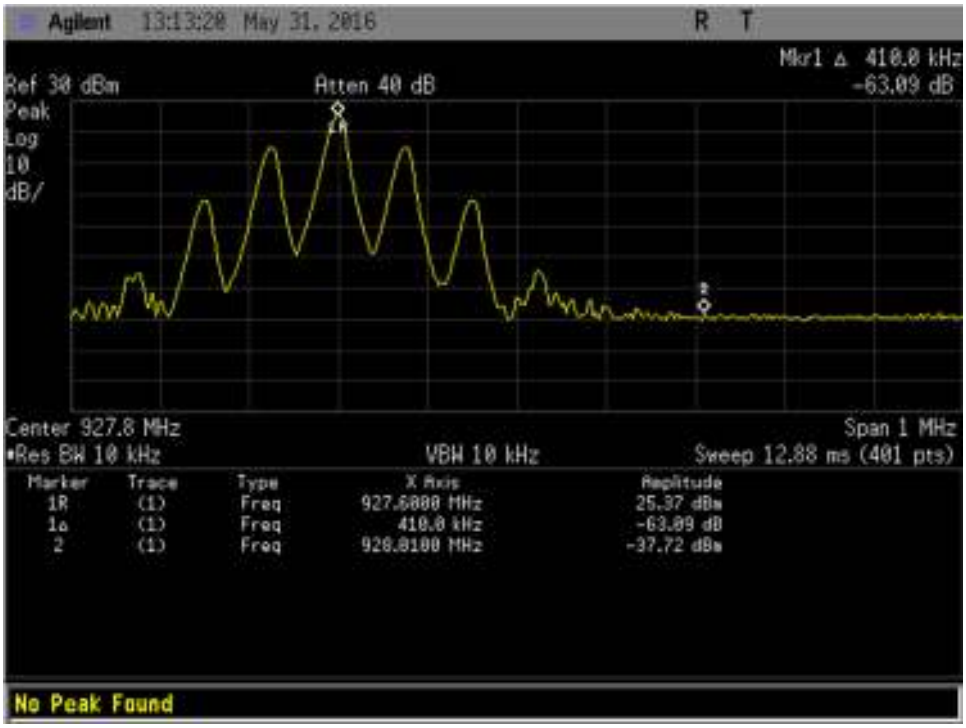
MHz	DbuV/m	Dbc	Site	report	page	report	page
	123.3		CKC	98972-4	14	98972-6	15
902	88.8	-34.5	CKC	98972-4	21	98972-6	21
928	87.4	-35.9	CKC	98972-4	21	98972-6	21

Conducted AM OOK power level 1 Channel 1

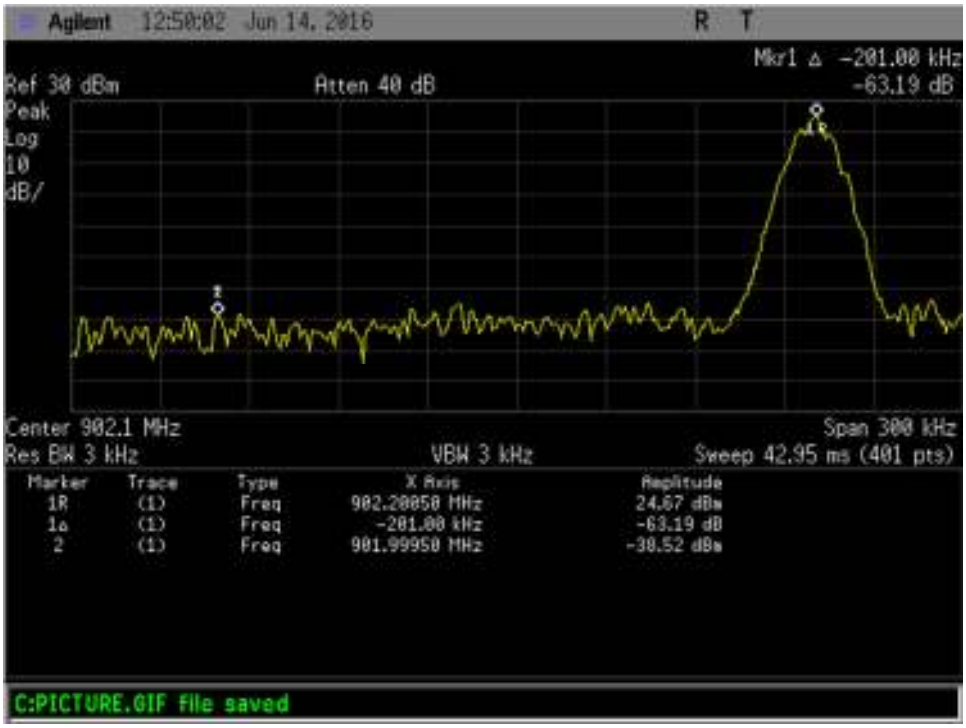
Conducted AM OOK power level 2 Channel 1

Conducted AM OOK power level 3 Channel 1

Conducted FM 150 Channel 64



Conducted FM 10 Channel 1



ANNEX A

direct from FCC DA-00-705, March 30, 2000

(ANSI references updated however)

Spurious RF Conducted Emissions

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section. Submit these plots.

Spurious Radiated Emissions

This test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Follow the guidelines in ANSI C63.4-2003 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.

Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from 20log(dwell time/100 ms), in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

If the emission on which a radiated measurement must be made is located at the edge of the authorized band of operation, then the alternative "marker-delta" method, listed at the end of this document, may be employed.

Alternative Test Procedures

If antenna conducted tests cannot be performed on this device, radiated tests to show compliance with the peak output power limit specified in Section 15.247(b) (2) and the spurious RF conducted emission limit specified in Section 15.247(d) are acceptable. A pre-amp, and, in the latter case, a high pass filter, are required for the following measurements.

1) Calculate the transmitter's peak power using the following equation:

$$E = \frac{\sqrt{30PG}}{d}$$

Where: E is the measured maximum fundamental field strength in V/m, utilizing a RBW ≥ the 20 dB bandwidth of the emission, VBW > RBW, peak detector function. Follow the procedures in C63.4-2003 with respect to maximizing the emission.

G is the numeric gain of the transmitting antenna with reference to an isotropic radiator.

d is the distance in meters from which the field strength was measured.

P is the power in watts for which you are solving:

$$P = \frac{(E \times d)^2}{30G}$$

2) To demonstrate compliance with the spurious RF conducted emission requirement of Section 15.247(d), use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 100 kHz

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Measure the field strength of both the fundamental emission and all spurious emissions with these settings. Follow the procedures in C63.4-2003 with respect to maximizing the emissions. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.247(d). Note that if the emission falls in a Restricted Band, as defined in Section 15.205, the procedure for measuring spurious radiated emissions, listed above, must be followed.

Marker-Delta Method

In making radiated band-edge measurements, there can be a problem obtaining meaningful data since a measurement instrument that is tuned to a band-edge frequency may also capture some in-band signals when using the resolution bandwidth (RBW) required by measurement procedure ANSI C63.4-2003 (hereafter C63.4). In an effort to compensate for this problem, we have developed the following technique for determining band-edge compliance.

STEP 1) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required by C63.4 and our Rules for the frequency being measured. For example, for a device operating in the 902-928 MHz band under Section 15.249, use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW may alternatively be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 1 MHz VBW, and a peak detector (as required by Section 15.35). Repeat the measurement with an average detector (i.e., 1 MHz RBW with 10 Hz VBW). Note: For pulsed emissions, other factors must be included. Please contact the FCC Lab for details if the emission under investigation is pulsed. Also, please note that radiated measurements of the fundamental emission of a transmitter operating under 15.247 are not normally required, but they are necessary in connection with this procedure.

STEP 2) Choose a spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1% of the total span (but never less than 30 kHz) with a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band-edge relative to the highest fundamental emission level.

STEP 3) Subtract the delta measured in step (2) from the field strengths measured in step (1). The resultant field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge compliance as required by Section 15.205.

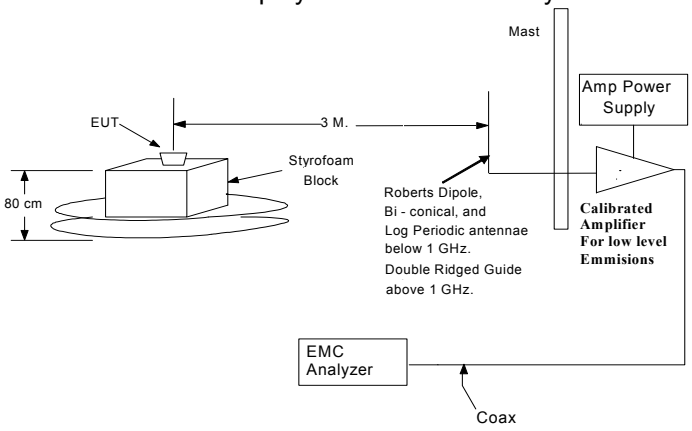
STEP 4) The above "delta" measurement technique may be used for measuring emissions that are up to two "standard" bandwidths away from the band-edge, where a "standard" bandwidth is the bandwidth specified by C63.4 for the frequency being measured. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, C63.4 specifies a measurement bandwidth of at least 1 MHz. Therefore you may use the "delta" technique for measuring emissions up to 2 MHz removed from the band-edge. Radiated emissions that are removed by more than two “standard” bandwidths must be measured in the conventional manner.

ANNEX B

Field Strength Measurement Procedure

This test measures the field strength of radiated emissions using a spectrum analyzer and a receiving antenna in accordance with ANSI C63.4-2003. During the test, the EUT is to be placed on a non-conducting support at 80 cm above the horizontal ground plane of the OATS. The horizontal distance between the antenna and the EUT is to be 3 meters. The bandwidths used shall be; 200 Hz from 9 kHz to 150 kHz, 9 kHz from 150 kHz to 30 MHz, 120 kHz from 30 MHz to 1000 MHz, and 1 MHz from 1 GHz to 40 GHz, with the detector set to peak hold.

1) The antenna correction factor, preamplifier gain (if the preamplifier is installed), and cable loss may be stored in tables in the EMC analyzer and the level at the analyzer is then the corrected level in dBuV/m. Otherwise it is calculated externally.
2) Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.
3) If appropriate, manipulate the system cables to produce the highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.
4) Rotate the EUT 360° to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat step 3). Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.
5) Move the antenna over its fully allowed range of travel to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to step 3) with the antenna fixed at this height. Otherwise, move the antenna to the height that repeats the highest amplitude observation and proceed.
6) Change the polarity of the antenna and repeat step 3), step 4), and step 5). Compare the resulting suspected highest amplitude signal with that found for the other polarity. Select and note the higher of the two signals.
7) The final maximized level displayed on the EMC analyzer is the field strength.



ANNEX C

Several of the FCC / IC rules that are referenced.

Section 15.247(b) (3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 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 output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

1997 FCC Decisions, Amendment of Parts 2 and 15. 7 CR 534, 12 FCC Rcd 7488, 62 FR 26239, 1997 FCC LEXIS 1927. FCC 917-114 Report and Order, Released: April 10, 1997:
Section 15.247(c): Spurious emissions. The following tests are required:

(1) RF antenna conducted test: Set RBW = 100 kHz, Video bandwidth (VBW) > RBW, scan up through 10th harmonic. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
(2) Radiated emission test: Applies to harmonics/spurs that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209. A pre-amp (and possibly a high-pass filter) is necessary for this measurement. For measurements above 1 GHz, set RBW = 1 MHz, VBW = 10 Hz, Sweep: Auto. If the emission is pulsed, modify the unit for continuous operation, use the settings shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

§15.33 Frequency range of radiated measurements.
(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Section 15.33 (b) - Frequency range of radiated measurements. For unintentional radiators: see part. (9kHz or lowest generated to 5GHz or 5th harmonic)

Section 15.35 Measurement detector functions and bandwidths. - The conducted and radiated emission limits shown in this part are based on the following, unless otherwise specified elsewhere in this part:

(a) …((a) does not apply to this report)

(b) Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§15.250, 15.252, 15.255, and 15.509-15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, e.g., the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

(c) Unless otherwise specified, e.g. §15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to Declaration of Conformity or verification.

RSS-GEN 4.9 Transmitter Unwanted Emissions:
The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate or carrier frequency), or from 30 MHz, whichever is the lower, to the 5th harmonic of the highest frequency generated without exceeding 40 GHz.