Testing Tomorrow's Technology

Application

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.225

And

Industry Canada, RSS-210, Annex 2.6 Band 13.110-14.010 MHz

For the

Inventek Systems

Model: ISM4334X-M4G-L44

FCC ID: O7P-341
IC: 10147A-341

UST Project: 15-0107
Issue Date: November 18, 2015

Total Pages in This Report: 21

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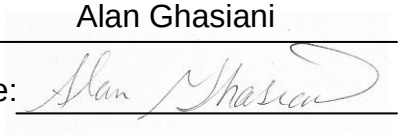
Testing Tomorrow's Technology

I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date November 18, 2015

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Inventek Systems

MODEL: ISM4334X-M4G-L44 Module

FCC ID: O7P-341

IC: 10147A-341

DATE: November 18, 2015

This report concerns (check one): Original grant [X]
Class II change

Equipment type: 13.56 MHz Near Field Communications Transmitter Module

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: _____N/A_____
date
agrees to notify the Commission by N/A
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

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Table of Contents

List of Figures

Figures **Title** **Page**

List of Tables

Table **Title** **Page**

List of Attachments

Agency Agreement
Application Forms
Letter of Confidentiality
Equipment Label(s)
Block Diagram(s)
Schematic(s)
Test Configuration Photographs
Internal Photographs
External Photographs
Antenna Photographs
Theory of Operation
RF Exposure
User's Manual

1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the FCC Rules and Regulations Part 15, Section 225 and IC RSS 210 Issue 8.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on June 18, 2015 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Inventek Systems Model ISM4334X-M4G-L44 Module. The ISM4334X-M4G-L44 Module is an embedded wireless internet connectivity module that operates in the 2.4 and 5.0 GHz spectrum. The Wi-Fi modules' hardware consists of an ARM Cortex M4 host processor, Broadcom BCM43341/0 Dual-Band 802.11 g/n MAC/Baseband/Radio with integrated Bluetooth 4.0 and NFC support.

The Model Numbers to be included in the approval are:

ISM43340-M4G-L44-C
ISM43340-M4G-L44-U
ISM43341-M4G-L44-C
ISM43341-M4G-L44-U
ISM43340-M4G-L44-10CFH
ISM43340-M4G-L44-10UFH
ISM43341-M4G-L44-10CFH
ISM43341-M4G-L44-10UFH
ISM341-USB

The different model numbers are for marketing purposes: The ISM43340 does not support NFC, the ISM43341 supports NFC. The C or U is for the antenna to be used, either the chip (C) or the external antenna path (U). The F is for an optional external Flash memory, and the H is for Apple HomeKit. The final part number, ISM341-USB, is for a specific customer and includes the NFC filter circuit.

The EUT has two antenna options when it comes to operation in the 2.4 GHz band and 5 GHz band, they are dual band chip antenna or a U.FL connector for use with an approved external antenna. For the NFC radio the EUT uses an approved PCB loop antenna.

The 5.0 GHz & 2.4 GHz Wi-Fi and integrated Bluetooth radio features have been tested and the results detailed in a separate report. This report only covers the NFC radio feature.

Antenna: Pulse Electronics model: W7001, NFC antenna
Modulation: ASK

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2009, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2009)* for FCC subpart A Digital equipment Verification requirements and *ANSI C63.10:2010, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (2013)*.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

a) Certification under section 15.247 as a transmitter.
b) Verification under 15.101 as a digital device and receiver.
c) Certification under section 15.249 as a transmitter.
d) Certification under section 15.225 as a transmitter.
e) Certification under section 15.407 as a transmitter

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Inventek Systems	ISM4334X-M4G-L44 Module	Engineering Sample	FCC ID: O7P-341 (pending) IC : 10147A-341 (Pending)	1.5 m U D
HP Laptop	Various	Various	Various	0.5 m UD 1 m UP
Antenna See antenna details	--	--	--	--

U= Unshielded
S= Shielded
P= Power
D= Data

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	8566B	HEWLETT-PACKARD	2747A05665	5/7/2015
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	1/28/2015
LOOP ANTENNA	SAS-200/562	A.H. Systems	142	9/28/2015 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9306-1708	11/24/2014 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	11/19/2014 2 yr.
HORN ANTENNA	SAS-571	A.H. Systems	605	8/25/2015 2 yr.
HORN ANTENNA	3115	EMCO	9107-3723	7/8/2014 2 yr.
HORN ANTENNA	3116	EMO	9505-2255	1/27/2015 2 yr.
PRE-AMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	12/5/2014
PRE-AMPLIFIER	8477E	HEWLETT-PACKARD	1145A00307	11/21/2014
PRE-AMPLIFIER	8447D	HEWLETT-PACKARD	1937A02980	12/4/2014
LISN x 2	9247-50-TS-50-N	SOLAR ELECTRONICS	955824 and 955825	12/30/2014

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (Receiver and Digital Device) Requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates at 13.56 MHz only therefore only one test frequency could be used.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10th harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to 5 times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

2.5.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz, the Resolution Bandwidth shall be at least 1 MHz.

2.6 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Only the antenna(s) listed in Table 4 will be used with this module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
1	Pulse Electronics	Magnetic Wire Loop	W7001	N/A	MOLEX locking pin connector

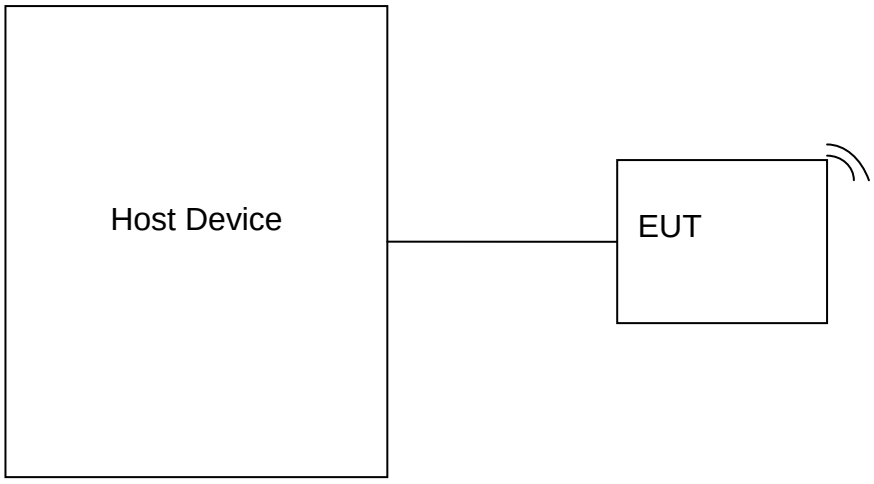


Figure 1. Block Diagram of Test Configuration

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious cannot exceed the limits of 15.209. Radiated harmonics and other Spurious are examined for this requirement see paragraph 2.1

2.8 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

The EUT was indirectly connected through AC mains through the host board, therefore AC Power line Conducted emissions were performed on the host Board with the EUT fully operating. Power line conducted emissions testing was performed to ensure that with the EUT in operation (exercising all transmitter functions), the complete system continues to meet the applicable requirements for CFR 15.207. These measurements were completed and are displayed below.

Table 5. Transmitter Power Line Conducted Emissions Test Data, Part 15.207

150KHz to 30 MHz with Class B Limits						
Test: Power Line Conducted Emissions				**Client:** Inventek Systems		
Project: 15-0107				**Model:** ISM4334X-M4G-L44 Module		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
120 VAC, 60 Hz Phase						
0.21	50.70	0.88	51.58	63.1*	11.5	**QP**
0.21	46.80	0.88	47.68	53.1	5.4	**AVG**
0.53	39.80	0.42	40.22	46.0	5.8	**AVG**
1.94	39.00	0.36	39.36	46.0	6.6	**AVG**
6.03	42.70	0.47	43.17	50.0	6.8	**AVG**
19.35	42.30	0.61	42.91	50.0	7.1	**AVG**
20.26	42.00	0.62	42.62	50.0	7.4	**AVG**
120VAC, 60 Hz Neutral						
0.1511	61.30	1.41	62.71	65.9*	3.2	**QP**
0.1511	44.30	1.41	45.71	55.9	10.2	**AVG**
0.5992	40.40	0.39	40.79	46.0	5.2	**AVG**
1.1920	39.00	0.35	39.35	46.0	6.6	**AVG**
5.2000	41.10	0.44	41.54	50.0	8.5	**AVG**
12.7600	40.80	0.64	41.44	50.0	8.6	**AVG**
22.4800	40.90	0.65	41.55	50.0	8.4	**AVG**

Note: * denotes QP Limits

SAMPLE CALCULATION at 0.21 MHz:

Magnitude of Measured Frequency	50.70	dBuV
+ Cable Loss+ LISN Loss	0.88	dB
=Corrected Result	51.58	dBuV
Limit	63.10	dBuV
-Corrected Result	51.58	dBuV
Margin	11.5	dB

Test Date: August 3, 2015
Tested By
Signature: Sina Sobhaniyan Name: Sina Sobhaniyan

2.9 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.225(a),(d)) (IC RSS 210, A2.4)

Radiated Spurious measurements: the EUT was placed into a continuous transmit mode of operation (>98% duty cycle) and tested per ANSI C63.10:2013. A preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the device. To obtain worse case results the EUT was tested in X, Y, and Z axes or in the orientation of normal operation if the device is designed to operation in a fixed position.

Radiated measurements testing was then conducted between the frequency range of 9KHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (no greater than 40 GHz). In the band below 30 MHz a resolution bandwidth (RBW) of 9 kHz was used, emissions below 1 GHz were tested with a RBW of 120 KHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

Radiated emissions testing per CFR 15.209 was performed to address the concerns of unwanted emissions that may radiate from the EUT cabinet, control circuits, harmonics due the fundamental, or power leads. The results for this test can be found in section 2.14 below.

Radiated emissions testing per CFR 15.225 was performed to address the field strength limits of the fundamental emission of the NFC radio. The EUT operates in the band 13.553 – 15.567 MHz the field strength was compared to a limit of 15,848 microvolts per meter at 30 meters. The limit table is shown below. This limit was converted to dBuV at 3 meters. See the calculation below.

15,848 microvolts per meter at 30 m = $20*LOG_{10}(15848)$ dBuV/m at 30 m
= 84 dBuV/m at 30 m
= 84 dBuV/m +$40LOG_{10}$(30 m / 3 m) at 3 m
= 104 dBuV/m at 3 meters

Table 6. Limit Table

Frequency (MHz)	Field Strength @ 30m (uV/m)	Field Strength @ 30m (dBuV/m)	Field Strength @ 3m (dBuV/m)
13.553-13.567	15848	84	124
13.410-13.553	334	50.5	90.5
13.567-13.710	334	50.5	90.5
13.110-13.410	106	40.5	80.5
13.710-14.010	106	40.5	80.5
Any emissions outside of the band 13.110-14.010 MHz shall not exceed the limits in 15.209			

Note: formula 1: dBuV/m= 20 log (uV/m)
2: 3m distance = (dBuV/m@30m) + 40 log (30/3)

Table 7. Radiated Spurious Emissions (15.225, 15.209)

Test: FCC Part 15, Para 15.209, 15.225(a),(d)					**Client:** Inventek Systems			
Project: 15-0107					**Model:** ISM4334X-M4G-L44 Module			
Frequency (MHz)	**Test Data (dBuV)**	**Duty Cycle Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance**	**Margin (dB)**	**Detector Mode**
13.56	41.68	-	15.90	57.58	124.0	3.0 m	66.42	**PK**
27.12	25.30	-	-10.47	14.83	49.5	3m/HORZ	34.7	**PK**
40.66	30.50	-	-14.01	16.49	40.0	3m/HORZ	23.5	**PK**
27.12	33.80	-	-12.07	21.73	49.5	3m/VERT	27.8	**PK**
40.66	37.90	-	-15.41	22.49	40.0	3m/VERT	17.5	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~)Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 13.56 MHz:

Magnitude of Measured Frequency	41.68	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	15.90	dB/m
Corrected Result	57.58	dBuV/m

Test Date: October 5, 2015
Tested By
Signature: _____ Name: Carrie Ingram

2.10 Fundamental Emission Bandwidth (CFR 15.225 (a))

The Occupied Bandwidth was performed with the EUT transmitting continuously. The RBW was set to 1 kHz and the VBW was set to 3 kHz. All emissions from the EUT are within the 13.553 – 13.567 MHz frequency range.

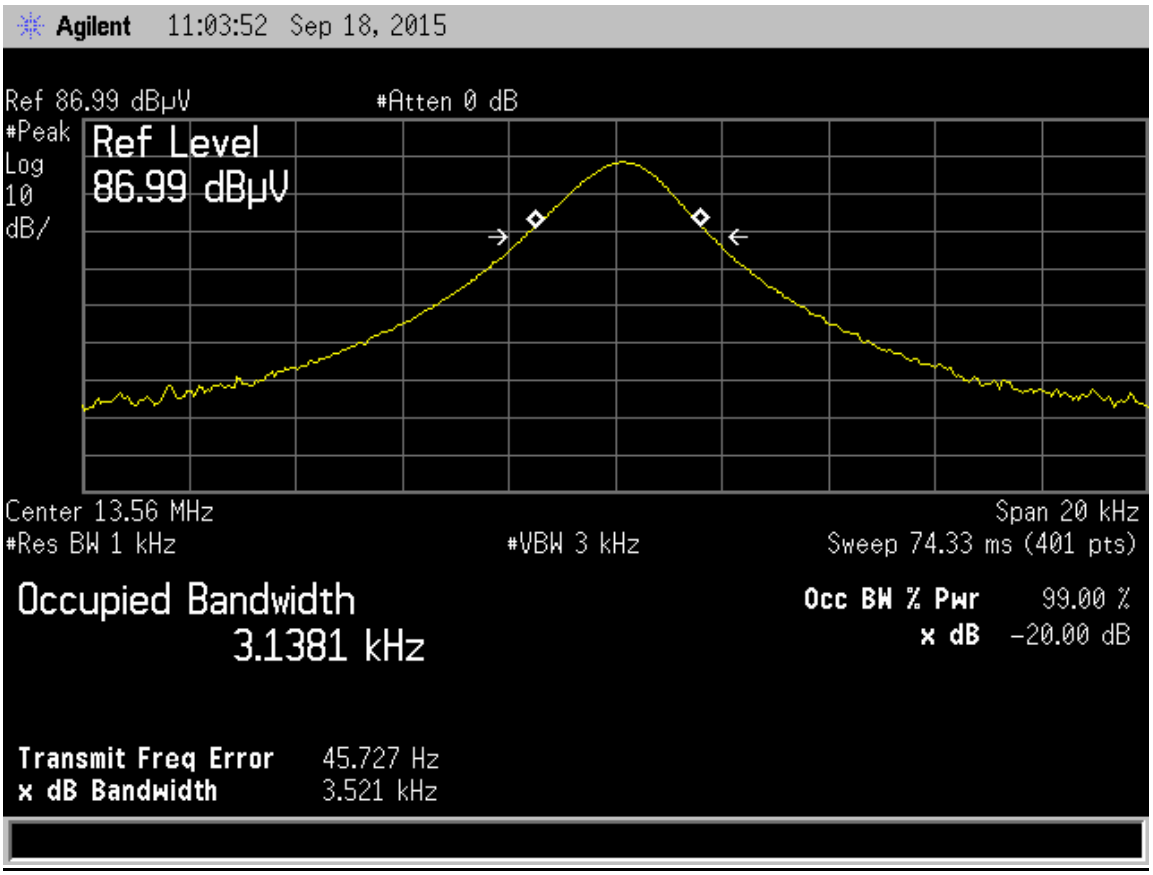


Figure 2. Occupied Channel Bandwidth of Fundamental Emission

2.11 Frequency Stability (CFR 15.225 (e))

The Frequency Stability measurements were performed with the EUT continuously transmitting. The span, RBW, and VBW on the spectrum analyzer were adjusted to ensure significant accuracy when measuring the center frequency. The center frequency of the carrier was measured from -20˚C to 50˚C in 10˚ increments and at normal supply voltage. The voltage was varied from 85 % to 115 % of the rated supply through the host board at a temperature of 20˚C. The results are displayed and compared to the tolerance limit of ±0.01% or 100 ppm.

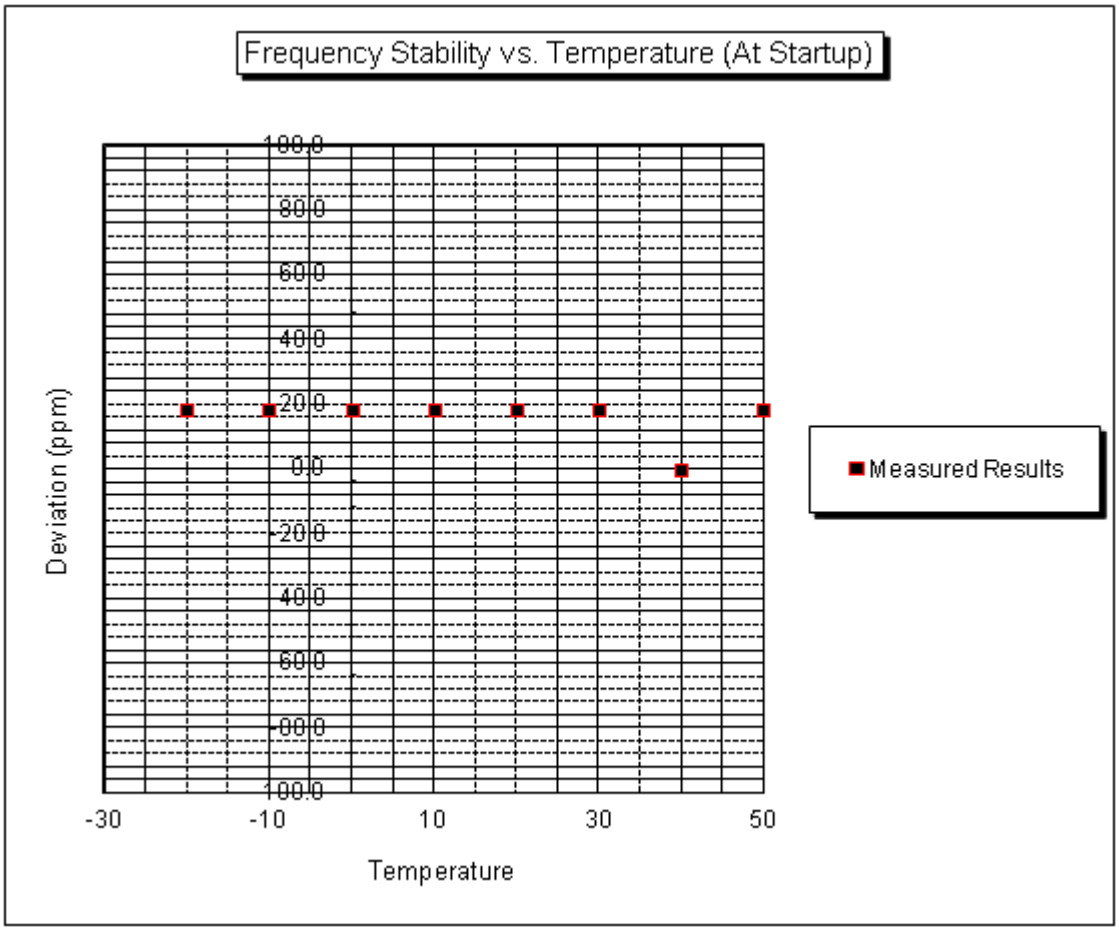


Table 8. Frequency Stability vs. Temperature

Temperature (˚C)	Measured Frequency (MHz)	Deviatation (ppm)	Limit (ppm)	Margin (ppm)
-20	13.5603	18.4	100.0	81.6
-10	13.5603	18.4	100.0	81.6
0	13.5603	18.4	100.0	81.6
10	13.5603	18.4	100.0	81.6
20	13.5603	18.4	100.0	81.6
30	13.5603	18.4	100.0	81.6
40	13.5600	0.0	100.0	100.0
50	13.5603	18.4	100.0	81.6

Actual TX Frequency: 13.56 MHz

Maximum Allowed deviation: ±0.01% or ±100 ppm

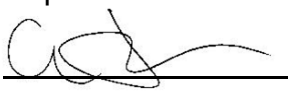
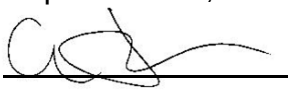
Test Date: September 18 and 29, 2015
Tested By
Signature:  Name: Carrie Ingram

Table 9. Frequency Stability vs. Voltage

Voltage (% of Nominal)	Measured Frequency (MHz)	Deviatation (ppm)	Limit (ppm)	Margin (ppm)
85%	13.5603	18.4	100.0	81.6
100%	13.5603	18.4	100.0	81.6
115%	13.5603	18.4	100.0	81.6

Test Date: September 29, 2015
Tested By
Signature:  Name: Carrie Ingram

2.12 Unintentional Radiator, Powerline Emissions (CFR 15.107)

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.107, per ANSI C63.4:2009, Paragraph 7, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmission.

This data is presented in US Tech Test report 15-0108.

2.13 Unintentional Radiator, Radiated Emissions (CFR 15.109)

Radiated emissions disturbance Measurements were performed with an instrument having both peak and quasi-peak detectors over the frequency range of 30 MHz to 25 GHz. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

This data is presented in US Tech Test report 15-0108.

2.14 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.