Testing Tomorrow's Technology

Permissive Change 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-Gen Issue 4 and RSS-210 Issue 8 (2015), Annex 2.6

For the

Elatec

Model: TWN4 MIFARE NFC

FCC ID: WP5TWN4F1
IC: 7948A-TWN4F1

UST Project: 15-0269
Issue Date: December 22, 2015

Total Pages in This Report: 22

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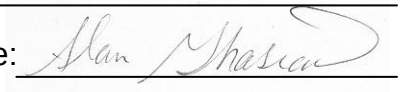
I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date December 22, 2015

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Elatec

MODEL: TWN4 MIFARE NFC Module

FCC ID: WP5TWN4F1

IC: 7948A-TWN4F1

DATE: December 22, 2015

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

Equipment type: 125 kHz & 13.56 MHz Near Field Communications Device

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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Alpharetta, GA 30004

Phone Number: (770) 740-0717
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1 General Information

1.1 Purpose of this Report

The originally tested radio product has been modified to optimize the performance of the transmit antenna. The following components were replaced for this modification:

Location	Reference	Old Value	New Value	Remark
Reader Module	U300	PN5120A0HN1/C1	PN5120A0HN1/C2	New revision of RF frontend 13.56MHz
Carrier Board	C141	33pF	68pF	Optimized capacitor for RF antenna matching 13.56MHz
Carrier Board	C144	150pF	120pF	Optimized capacitor for RF antenna matching 13.56MHz
Reader Module	R620	820Ω	680Ω	Optimized value for LF receiver (125kHz, 134.2kHz)
Reader Module	U600	IRF5851	BSL215C	2nd source MOSFET for LF transmitter (125kHz, 134.2kHz)
Reader Module	C108, C109	2,2µF	1,0µF	Optimized value for core voltage regulator
Reader Module	U100	STM32F205VCT6	STM32F205VET6	Change flash memory from 128kByte flash to 512kByte
Carrier Board	SP1	SMD13D03	CT-1205	2nd source speaker
Carrier Board	D110	LGN971	Osram LGN971 or Kingbright KPT-3216-CW386	2nd source LED
Carrier Board	D111	LHN974	Osram LHN974 or Kingbright KPT-3216-OS131	2nd source LED
Carrier Board	R110	330Ω	100Ω (Osram) 220Ω (Kingbright)	Adapted resistor for LED
Carrier Board	R111	330Ω	150Ω (Osram) 1.0kΩ (Kingbright)	Adapted resistor fo LED

Note: Highlighted items directly affect the RF circuitry.

Figure 1. Component Change Matrix

The test report shows that the product continues the meet the applicable subpart for CFR 47, Part 15, Parts 15.209 and 15.225. Based on the changes, only the radiated spurious emissions and the bandwidth measurements have been retested. No other testing was deemed necessary.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on November 2, 2015 in good operating condition.

1.3 Product Description

The EUT is an RFID device that operates at two discrete frequencies, either 125 kHz or 13.56 MHz. The EUT is part of the TWN4 family of transponder readers and writers and allows users to read and write to 125 kHz and 13.56 MHz tags and/or labels. It supports all major transponders from various suppliers like ATMEL, EM, ST, NXP, TI, HID, LEGIC, etc. and ISO standards like ISO14443A (T=CL), ISO14443B (T=CL), ISO15693, ISO18092 / ECMA-340 (NFC).

Antenna: Wire loop antenna
Modulation: ASK

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2009 & 2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2009 & 2014)* 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)*.

Elatec provided the necessary firmware to place the EUT into constant transmit mode and normal operation mode. An executable file, TWN Keyboard Commander V1.01 was used for constant transmit; Appblaster 1.64 was used to load Firmware Core Module Keyboard V1.64, App Keyboard Standard V1.07 for normal operating mode simulation.

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) Declaration of Conformity (DoC) under 15.101 has been performed.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Elatec	TWN4 MIFARE NFC Module	Engineering Sample	FCC ID: WP5TWN4F1 IC : 7948A-TWN4F1	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

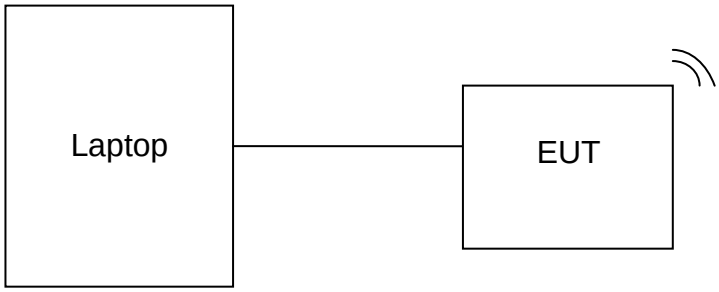


Figure 2. Block Diagram of Test Configuration

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	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 Ext. 30 days
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	Elatec	Wire Loop	None	N/A	Through hole solder

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 emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement; see paragraph 2.1

2.8 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.225(a),(d)) (IC RSS Gen, 8, 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 test data section 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 – 13.567 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
Note: additional factor of -40 dB was applied to extrapolate from 30 m to 3 m.

EUT operating at 125 kHz

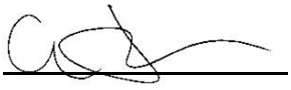
Table 5. Radiated Spurious Emissions (15.209)

Test: FCC Part 15, Para 15.209					**Client:** Elatec			
Project: 15-0269					**Model:** TWN4 MIFARE NFC Module			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance**	**Margin (dB)**	**Detector Mode**
0.125	14.74	-80.00	51.96	-13.30	25.7	3m./Loop	39.0	**QP**
No other emissions seen greater than 20 dB from the limit.								

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 3 meter were extrapolated to 300 meters using a factor of (-80.0 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 0.125 MHz:

Magnitude of Measured Frequency	14.74	dBuV
+Antenna Factor	-80.00	dB
+ Cable Loss+ Amplifier Gain	51.96	dB/m
Corrected Result	-13.30	dBuV/m

Test Date: December 1, 2015
Tested By
Signature:  Name: Carrie Ingram

EUT Operating at 13.56 MHz

Table 6. 15.225 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)

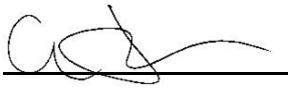
Table 7. Radiated Spurious Emissions (15.225, 15.209)

Test: FCC Part 15, Para 15.209, 15.225(a),(d)					**Client:** Elatec			
Project: 15-0269					**Model:** TWN4 MIFARE NFC 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	40.50	-40.00	5.45	5.95	84.0	3m/Loop	78.1	**QP**
40.69	36.98	0.00	-15.68	21.30	40.0	3m./HORZ	18.7	**QP**
38.44	27.71	0.00	-15.26	12.45	40.0	3m./HORZ	27.6	**QP**
108.26	38.38	0.00	-15.44	22.94	43.5	3m./HORZ	20.6	**QP**
112.93	34.40	0.00	-15.07	19.33	43.5	3m./HORZ	24.2	**QP**
176.29	36.36	0.00	-11.99	24.37	43.5	3m./HORZ	19.1	**QP**
No other emission seen greater than 20 dB from the limit.								

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 3 meters were extrapolated to 30 meters using a factor of (-40.0 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	40.50	dBuV
+Antenna Factor	-40.00	dB
+ Cable Loss+ Amplifier Gain	5.45	dB/m
Corrected Result	5.95	dBuV/m

Test Date: December 1, 2015
Tested By
Signature:  Name: Carrie Ingram

2.9 Fundamental Emission Bandwidth (CFR 15.225 (a))

The Occupied Bandwidth testing was performed with the EUT transmitting continuously on 125 kHz. The RBW was set to 1 kHz and the VBW was set to 3 kHz.

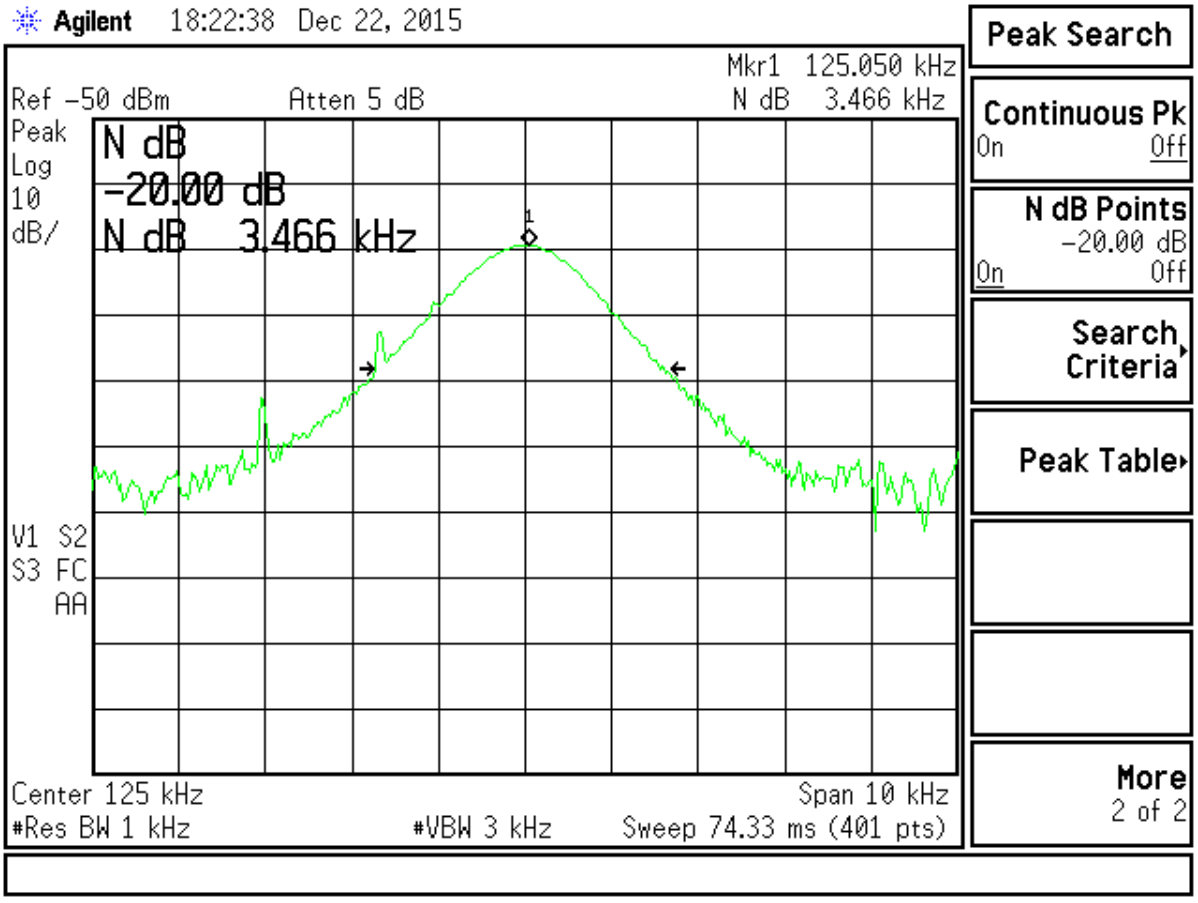


Figure 3. Occupied Channel Bandwidth of Fundamental Emission, 125 kHz

The Occupied Bandwidth testing was performed with the EUT transmitting continuously on 13.56 MHz. The RBW was set to 10 kHz and the VBW was set to 30 kHz. All emissions from the EUT are within the 13.553 – 13.567 MHz frequency range.

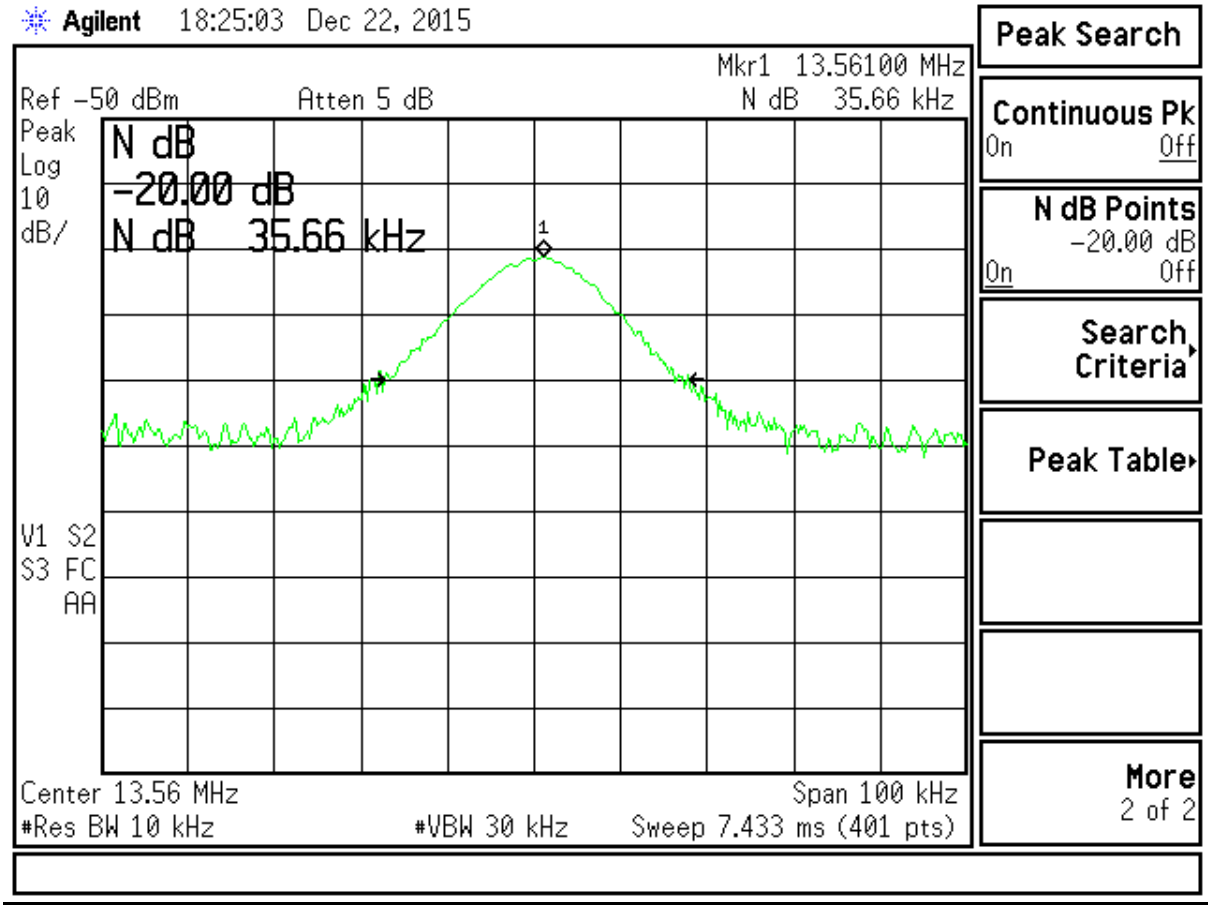


Figure 4. Occupied Channel Bandwidth of Fundamental Emission, 13.56 MHz

2.10 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 1 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.

For measurements at above 30 MHz 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.

EUT operating at 125 kHz

Table 8. Radiated Unintentional Emissions (15.109)

Test: FCC Part 15, Para 15.109				**Client:** Elatec			
Project: 15-0269				**Model:** TWN4 MIFARE NFC Module			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance**	**Margin (dB)**	**Detector Mode**
38.55	42.40	-7.81	34.59	40.0	3m./VERT	5.4	**PK**
173.35	37.90	-4.68	33.22	43.5	3m./VERT	10.3	**PK**
308.97	37.50	-2.33	35.17	46.0	3m./HORZ	10.8	**PK**
338.98	42.70	-3.32	39.38	46.0	3m./HORZ	6.6	**PK**
386.10	36.70	-2.65	34.05	46.0	3m./HORZ	12.0	**PK**
420.35	43.20	-1.72	41.48	46.0	3m./HORZ	4.5	**PK**
239.99	43.40	-6.98	36.42	46.0	3m./VERT	9.6	**PK**
420.35	46.30	-2.02	44.28	46.0	3m./VERT	1.7	**QP**
447.48	35.10	-1.09	34.01	46.0	3m./VERT	12.0	**PK**

1. No other signals detected within 20 dB of specification limit.

Sample Calculation at 38.55 MHz:

Magnitude of Measured Frequency	42.40	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-7.81	dB/m
Corrected Result	34.59	dBuV/m

Test Date: December 17, 2015
Tested By
Signature: Sina Sobhaniyan Name: Sina Sobhaniyan

EUT Operating at 13.56 MHz

Table 9. Radiated Unintentional Emissions (15.109)

Test: FCC Part 15, Para 15.109				**Client:** Elatec			
Project: 15-0269				**Model:** TWN4 MIFARE NFC Module			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance**	**Margin (dB)**	**Detector Mode**
166.13	36.58	-12.46	24.12	43.5	3m./HORZ	19.4	**PK**
39.36	38.72	-16.36	22.36	40.0	3m./VERT	17.6	**QP**
176.23	34.09	-10.89	23.20	43.5	3m./VERT	20.3	**QP**
299.97	38.19	-9.94	28.25	46.0	3m./HORZ	17.8	**QP**
257.49	42.36	-11.96	30.40	46.0	3m./HORZ	15.6	**QP**
311.99	52.83	-9.15	43.68	46.0	3m./HORZ	2.3	**QP**
298.37	48.31	-9.94	38.37	46.0	3m./HORZ	7.6	**QP**
339.1200	42.62	-9.43	33.19	46.0	3m./HORZ	12.8	**QP**
240.0900	42.09	-12.76	29.33	46.0	3m./VERT	16.7	**QP**
311.9400	43.85	-9.35	34.50	46.0	3m./VERT	11.5	**QP**
314.9900	36.98	-9.38	27.60	46.0	3m./VERT	18.4	**QP**
433.9900	24.87	-7.51	17.36	46.0	3m./VERT	28.6	**QP**

1. No other signals detected within 20 dB of specification limit.

Sample Calculation at 166.13 MHz:

Magnitude of Measured Frequency	36.58	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-12.46	dB/m
Corrected Result	24.12	dBuV/m

Test Date: December 1, 2015
Tested By
Signature:  Name: Carrie Ingram

2.11 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.