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Emissions
Test Report

EUT Name: OMNIKEY Desk Top Reader

Model No.: OMNIKEY 5023 CL

CFR 47 Part 15.225:2016 and RSS 210:2016

Prepared for:

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Statement of Compliance

Manufacturer:	HID Global 15730 Barranca Parkway Irvine, CA 92618 (303) 404-6801
Requester / Applicant:	Robert Cresswell
Name of Equipment:	OMNIKEY Desk Top Reader
Model No.	OMNIKEY 5023 CL
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.225:2016 and RSS 210:2016
Test Dates:	September 30, 2016 to October 4, 2016

Guidance Documents:

Emissions: ANSI C63.10: 2013

Test Methods:

Emissions: ANSI C63.10: 2013

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

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Kerwinn Corpuz	14 October 2016	David Spencer	14 October 2016
Test Engineer	Date	A2LA Signatory	Date

Industry Canada

Testing Cert #3331.02 **US5254** **2932M-1**

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1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.225:2016 and RSS 210:2016 based on the results of testing performed on September 30, 2016 through October 4, 2016 on the OMNIKEY Desk Top Reader Model OMNIKEY 5023 CL manufactured by HID Global. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.10	Test Parameters (from Standard)	Result
Transmitter Spurious Emissions	CFR47 15.209, RSS-GEN Sect.8.9	Class B	**Complied**
Restricted Bands of Operation	CFR47 15.205, RSS 210 Sect.4.1	Class B	**Complied**
AC Power Conducted Emissions	CFR47 15.207, RSS-GEN Sect.8.8	Class B	**Complied**
Occupied Bandwidth	CFR47 15.215 (c), RSS GEN Sect.6.6	Per Standard	**Complied**
Carrier Field Strength	CFR47 15.225 (a), RSS 210 Sect. B.6	124 dBuV/m at 3 meter	**Complied**
Out of Band Emissions	CFR47 15.225 (b), (c) RSS 210 Sect. B.6 (d)	Per Standards.	**Complied**
Frequency Stability	CFR47 15.225 (e), RSS 210 Sect. B.6	100ppm / +0.01%	**Complied**
Voltage Variation	CFR47 15.31 (e), RSS-GEN Sect. 6.11(b)	100ppm / +0.01%	**Complied**
RF Exposure	CFR47 Part 1.1310, RSS-102 Issue 5	General Population	**Complied**

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None.

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America at 1279 Quarry Lane, Ste. A., Pleasanton, CA 94566, is accredited by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (FRN # US5254). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TUV Rheinland of North America is accredited by the A2LA Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2005 and ISO 9002 (Testing Cert #3331.02). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Canada – Industry Canada

Industry Canada

TUV Rheinland of North America at the 1279 Quarry Ln, Pleasanton, CA 94566 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at 1279 Quarry Lane, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures. (Registration Nos. A-0031).

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Ste. A, Pleasanton, California 94566, USA. The 2305 Mission College, Santa Clara, 95054, USA location is considered a Pleasanton annex.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4:2009, at test distances of 3 and 5 meters. The site is listed with the FCC and accredited by A2LA (Testing Cert #3331.02). The 3/5-meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4:2009, at test distances of 3 meters and 5 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7 m x 4.8 m x 3.175 mm thick aluminum floor connected to PE ground.

For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 10^9 Ohms/square on a 1.6 m x 0.8 m x 0.8 m high non-conductive table with a 3.175 mm aluminum top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors. The Vertical Coupling Plane consists of an aluminum plate 50 cm x 50 cm x 3.175 mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors.

For EFT, Surge, PQF, the HCP and VCP are removed.

RF Field Immunity testing is performed in a 7.3m x 4.3m x 4.1m anechoic chamber.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.8m x 3.7m x 3.175mm thick aluminum ground plane.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

The Expanded Uncertainty defines an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measured. The fraction may be viewed as the coverage probability or level of confidence of the interval.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainties

Table 2: Summary of Uncertainties

	U_{lab}	U_{cispr}
Radiated Disturbance		
30 MHz – 25,000 MHz	3.2 dB	5.2 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	2.4 dB	3.6 dB
Disturbance Power		
30 MHz – 300 MHz	3.92 dB	4.5 dB

Note: U_{lab} is the calculated Combined Standard Uncertainty
U_{cispr} is the measurement uncertainty requirement per CISPR 16.

Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is ± 4.1%.
The estimated combined standard uncertainty for radiated immunity measurements is ± 2.7dB.
The estimated combined standard uncertainty for conducted immunity measurements is ± 1.4dB.
The estimated combined standard uncertainty for damped oscillatory wave immunity measurements is ± 8.8%.
The estimated combined standard uncertainty for harmonic current and flicker measurements is ± 0.45%.

Measurement Uncertainty – Radio Testing

The estimated combined standard uncertainty for frequency error measurements is ± 3.88 Hz
The estimated combined standard uncertainty for carrier power measurements is ± 1.59 dB.
The estimated combined standard uncertainty for adjacent channel power measurements is ± 1.47 dB.
The estimated combined standard uncertainty for modulation frequency response measurements is ± 0.46 dB.
The estimated combined standard uncertainty for transmitter conducted emission measurements is ± 4.01 dB

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Guide 17025:2005.

3 Product Information

3.1 Product Description

The OMNIKEY® 5023 CL contactless smart card reader provides convenience, speed and security for applications such as PC with USB interface and operates at 13.56 MHz.

3.2 Equipment Configuration

A description of the equipment configuration is given in Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of an EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.3 Operating Mode

A description of the operation mode is given in Test Plan Section. In the case of an EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.4 Unique Antenna Connector

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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

The OMNIKEY 5023 CL uses the permanently attached antenna.

- PCB antenna integrated in RFID Reader PCB
- Antenna Type: PCB trace loop antenna, 2-turns
- Antenna gain: 1 dBi

4 Emissions

Testing was performed in accordance with CFR 47 Part 15.225:2016 and RSS 210 Annex B:2016. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in ANSI C63.10: 2013 were used.

4.1 Carrier Field Strength Requirements

The RF fundamental field strength requirement is the power radiated in the direction of the maximum level under specified conditions of measurements in the presence of modulation.

The RF fundamental field strengths shall not exceed CFR47 Part 15.225 (a):2016 and RSS 210 B.6:2016.

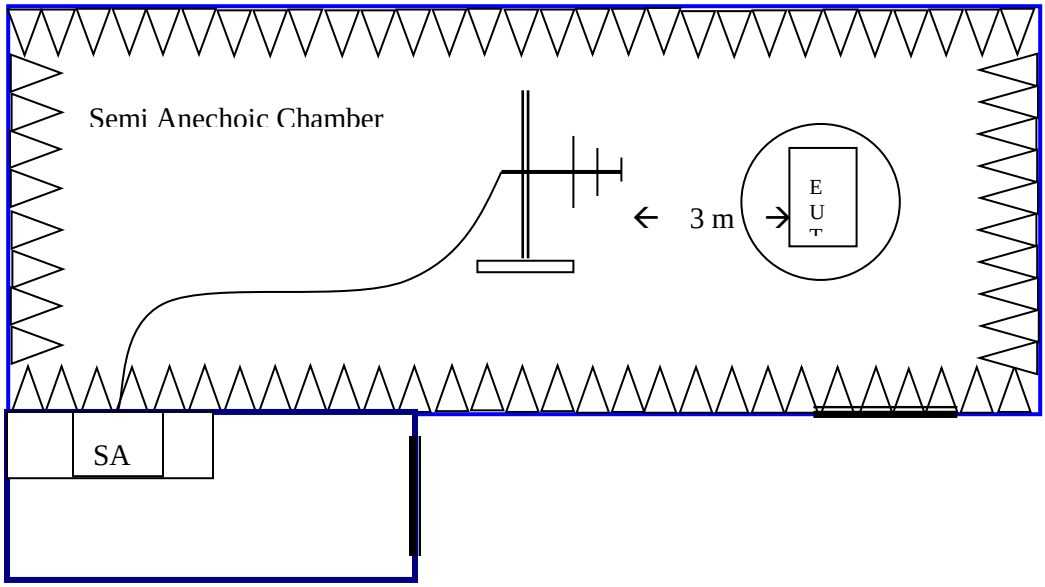
The field strength of any emission in the band of 13.553 and 13.567MHz shall be less than 84 dBuV/m at 30 meter distance; or 124 dBuV/m at 3 meter.

4.1.1 Test Method

The radiated method was used to measure the field strength of the fundamental signal according to ANSI C63.10:2013 Section 6.3. The measurement was performed with modulation. The worst result indicated below.

Mode Tested:
"Card in-field" where the card reader detected the card (the card is 4 cm away from the reader).

Test Setup:



4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 3: RF Fundamental Field Strength – Test Results

Test Conditions: Radiated Measurement, Normal Temperature only						
Antenna Type: Integrated			**Power Setting:** Fixed			
Signal State: Modulated			**Duty Cycle:** 100 %			
Ambient Temp.: 24 °C			**Relative Humidity:**39 %			
Operating Frequency:	**Test Results**					
13.56 MHz	**Measured Level [dBuV/m]**	**Loop Position**	**Table [degree]**	**Antenna [cm]**	**Limit [dBuV/m]**	**Margin [dB]**
Card in-field	70.71	0°	192	100	124.00	-53.29
Card in-field	74.24	90°	105	100	124.00	-49.76
Note: 1. Measurements were taken at 3 meter distance, and the limit was extrapolated accordingly. 2. "Card in-field" where the card reader detected the card (the card is 4 cm away from the reader).						

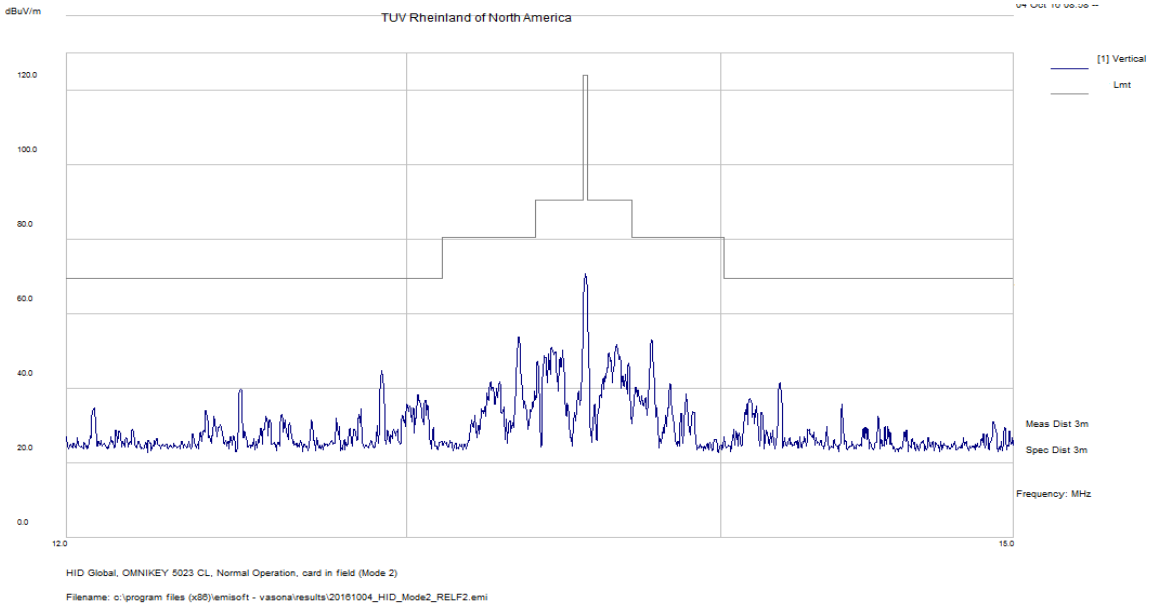


Figure 1: Carrier Field Strength – Loop Antenna Facing EUT (0°)

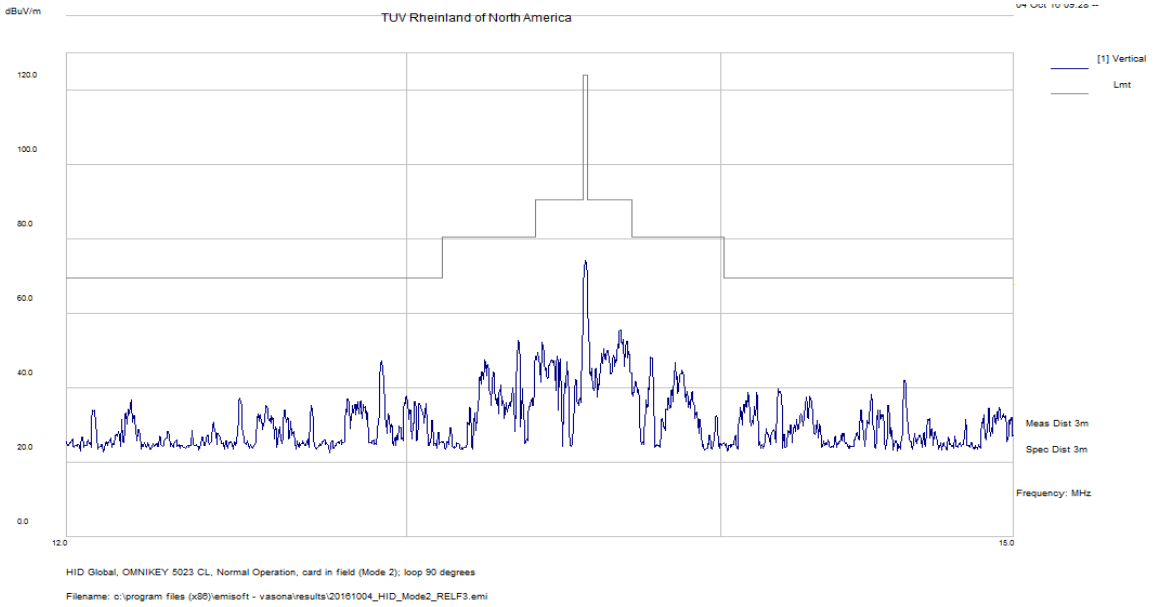


Figure 2: Carrier Field Strength – Loop Antenna Facing EUT (90°)

4.2 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

The 20dB bandwidth is defined the bandwidth of 20 dBr from highest transmitted level of the fundamental frequency.

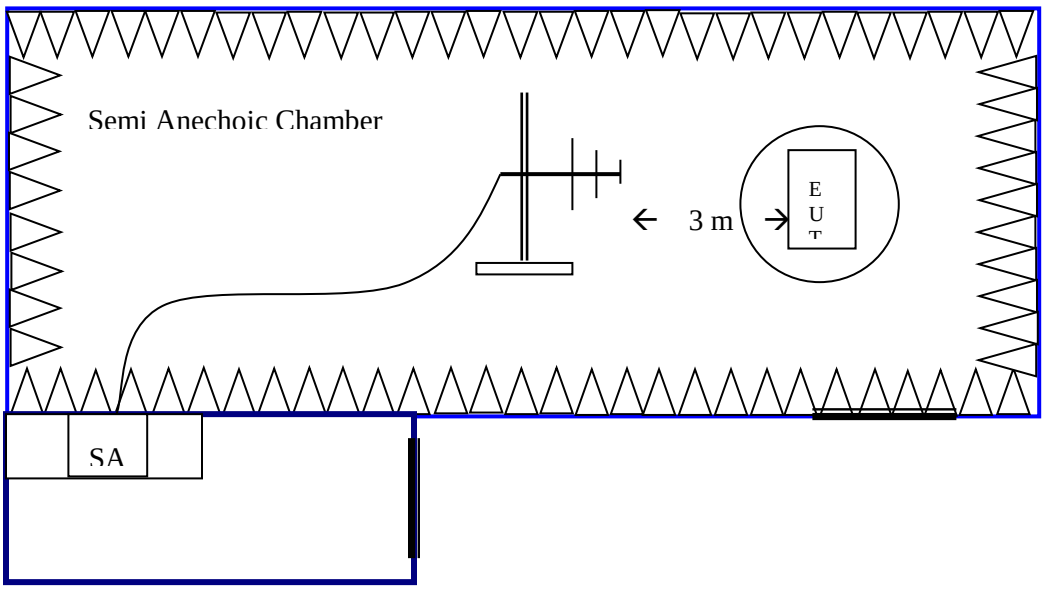
The bandwidth shall be documented per Section CFR47 15.215(c) 2016 and RSS Gen Sect. 6.6: 2016. Intentional radiators operating under the alternative provisions to the general emission limits, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If the frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

4.2.1 Test Method

The radiated method was used to measure the occupied bandwidth according to ANSI C63.10:2013. The measurement was performed with modulation. The worst sample result indicated below.

Mode Tested:
"Card in-field" where the card reader detected the card (the card is 4 cm away from the reader). This is worse than the card resting on the card reader, 0 cm.

Test Setup:



4.2.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Occupied Bandwidth – Test Results

Test Conditions: Radiated Measurement, Normal Temperature only				
Antenna Type: Integrated			**Power Setting:** Fixed	
Signal State: Modulated			**Duty Cycle:** 100 %	
Ambient Temp.: 24 °C			**Relative Humidity:**39 %	
Occupied Bandwidth for 13.56 MHz RFID				
Sample	**Limit (kHz)**	**99% BW (kHz)**	**20 dB BW (kHz)**	**Results**
RFID Reader	NA	2.357	2.615	Pass
Note: All lower and upper markers of 99% Bandwidth and 20 dB Bandwidth are within the allowable band; 13.553 MHz to 13.567MHz				

Table 5: 20 dB Bandwidth Frequency – Test Results

Test Conditions: Radiated Measurement, Normal Temperature only				
Antenna Type: Integrated			**Power Setting:** Fixed	
Signal State: Modulated			**Duty Cycle:** 100 %	
Ambient Temp.: 24 °C			**Relative Humidity:**38 %	
20 dB Bandwidth Frequencies for 13.56 MHz RFID				
Sample	**Occupied Band Limit (MHz)**	**Lower Freq. (MHz)**	**Upper Freq. (MHz)**	**Results**
RFID Reader	13.553 < X < 13.567	13.5586925	13.5613075	Pass
Note: All lower and upper markers of 20 dB Bandwidth are within the allowable band; 13.553 MHz to 13.567MHz; where X is the lower frequency and upper frequency.				

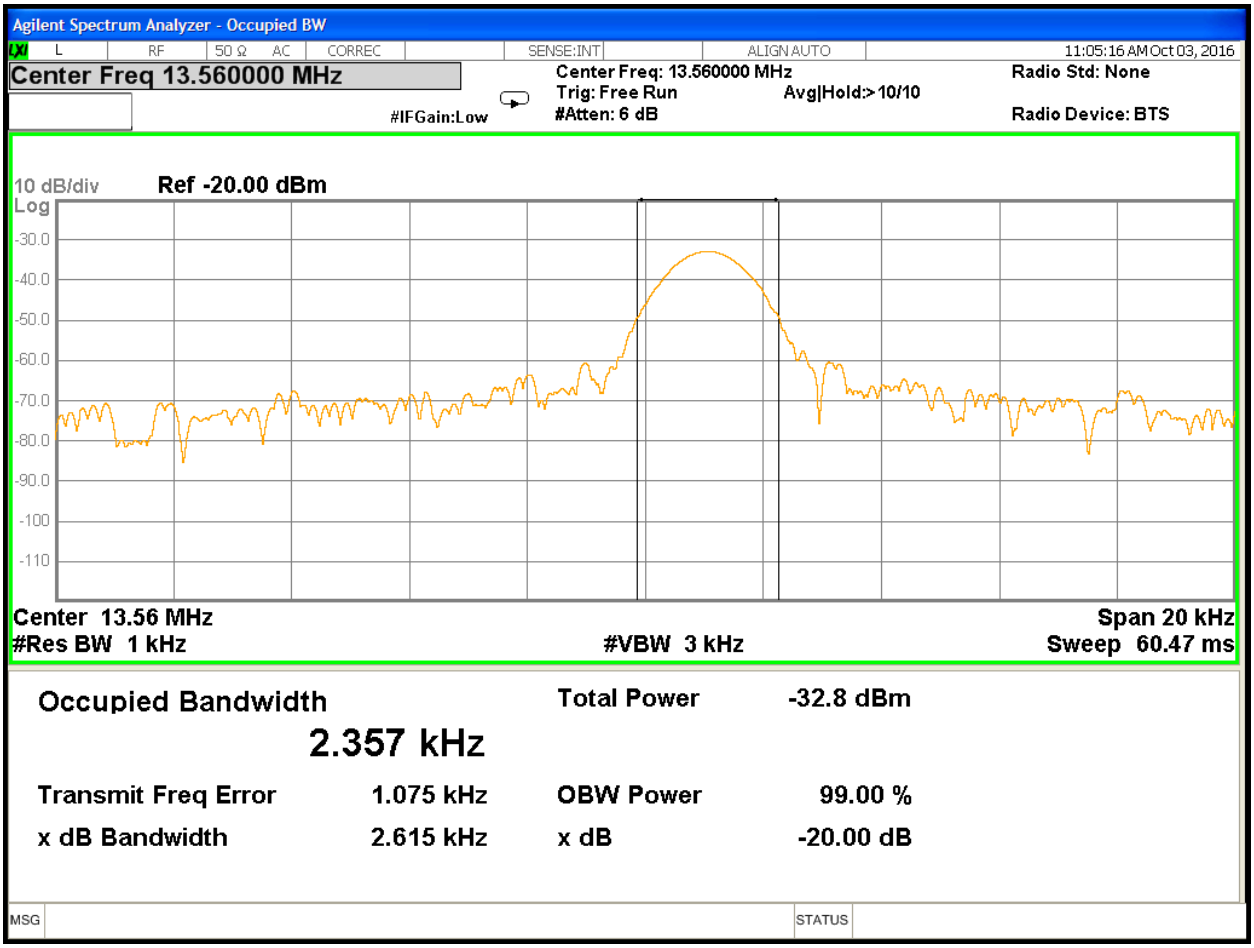


Figure 3: 99% and 20dB Bandwidth

4.3 Out-of-Band Emissions

The out of band emission is leakage measurement of the main carrier outside the allocated operating frequency band; 13.553 MHz to 13.567 MHz.
According to CFR47 Part 15.225: 2016 and RSS210 B.6: 2016, the out of band emission shall;
-Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter (50.5 dBuV/m) at 30 meters,
-Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter (40.5 dBuV/m) at 30 meters.

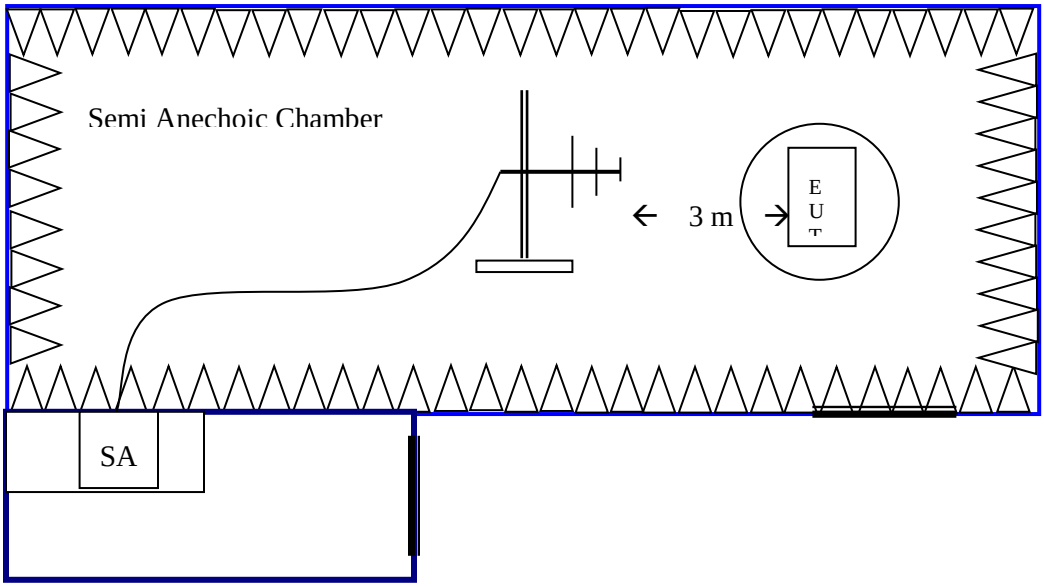
Table 6: Out of Band Emissions Limit

Frequency (MHz)	*Limit at 30m (dBuV/m)*	*Limit at 3m (dBuV/m)*	*Comment*
<13.110	*29.5*	*69.5*	*CFR47 15.225 (d), RSS210 B.6 (d). Out of Band*
13.110-13.410	*40.5*	*80.5*	*CFR47 15.225 (c), RSS210 B.6 (c). Out of Band*
13.410-13.533	*50.5*	*90.5*	*CFR47 15.225 (b), RSS210 B.6 (b). Out of Band*
13.553-13.567	*84.0*	*124.0*	*CFR47 15.225 (a), RSS210 B.6 (a), Inband (Carrier)*
13.567-13.710	*50.5*	*90.5*	*CFR47 15.225 (b), RSS210 B.6 (b), Out of Band*
13.710-14.010	*40.5*	*80.5*	*CFR47 15.225 (c), RSS210 B.6 (c), Out of Band*
>14.010	*29.5*	*69.5*	*CFR47 15.225 (d), RSS210 B.6 (d), Out of Band*
Note: The limit was extrapolated 40dB/decade per CFR47 Part 15.31 (f)(3).			

4.3.1 Test Method

The radiated method was used to measure the out-of-band emission requirement. The measurement was performed with modulation per CFR47 15.225 (b), (c), (d) 2016 and RSS 210 B.6 (b), (c), (d): 2016. The worst result indicated below.

Test Setup:



4.3.2 Test Result

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 7: Out of Band Emissions – Test Results

Test Conditions: Radiated Measurement, Normal Temperature only				
Antenna Type: Integrated			**Power Setting:** Fixed	
Signal State: Modulated			**Duty Cycle:** 100 %	
Ambient Temp.: 24 °C			**Relative Humidity:**38 %	
Sample	**Limit**	**Loop Antenna Position**	**Spectrum Mask (13.410 to 14.010MHz)**	**Result**
RFID card reader	See Table 6	0°	Figure # 4	Pass
		90°	Figure # 5	Pass
Note: All maximized emissions within 12 MHz to 15 MHz are below the spectrum mask limit per Table 6.				

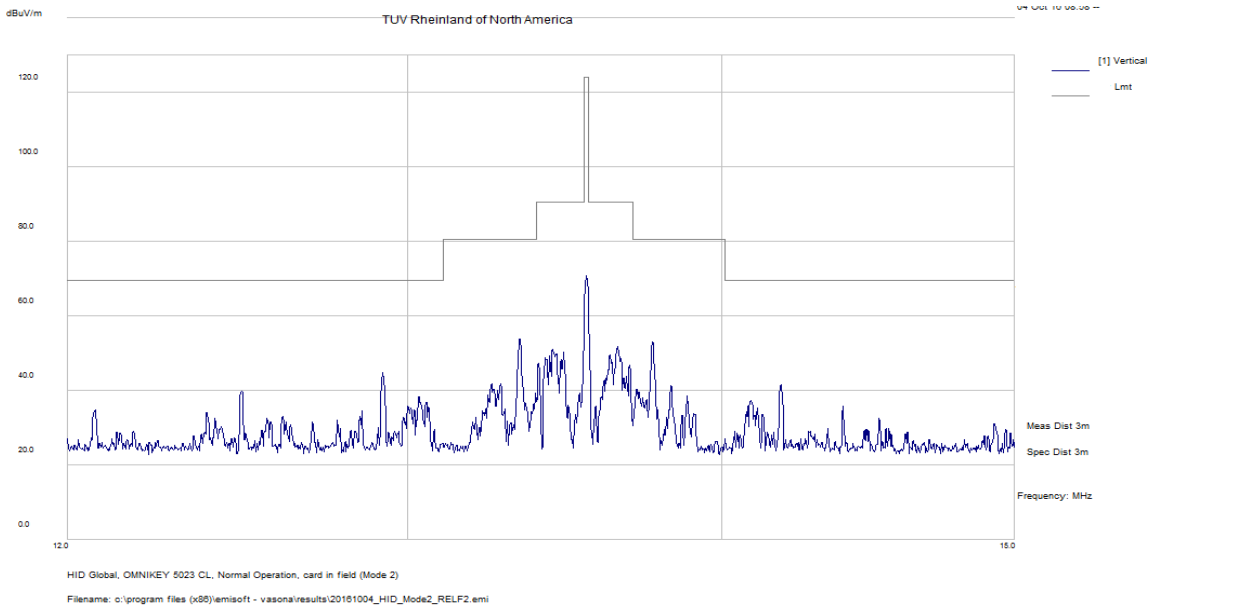


Figure 4: Out of Band Spectrum Mask for RFID Card Reader – Loop Antenna Facing EUT (0°)

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
12.08	21.80	2.29	10.80	34.89	Pk	V	155	191	69.50	-34.61
12.50	26.79	2.30	10.80	39.88	Pk	V	155	33	69.50	-29.62
12.86	21.50	2.30	10.80	34.60	Pk	V	155	6	69.50	-34.90
12.93	31.64	2.30	10.80	44.74	Pk	V	155	178	69.50	-24.76
13.04	25.28	2.30	10.80	38.38	Pk	V	155	32	69.50	-31.12
13.06	23.80	2.30	10.80	36.90	Pk	V	155	196	69.50	-32.60
13.35	40.75	2.30	10.80	53.86	Pk	V	155	202	80.50	-26.64
13.50	22.86	2.31	10.80	35.97	Pk	V	155	122	90.50	-54.53
13.56	57.60	2.31	10.80	70.71	Pk	V	155	192	124.00	-53.29
13.59	22.74	2.31	10.80	35.85	Pk	V	155	326	90.50	-54.65
13.77	39.82	2.31	10.80	52.93	Pk	V	155	192	80.50	-27.57
14.10	24.20	2.31	10.80	37.31	Pk	V	155	203	69.50	-32.19
14.12	22.25	2.31	10.80	35.36	Pk	V	155	1	69.50	-34.14
14.20	28.40	2.31	10.80	41.52	Pk	V	155	171	69.50	-27.98
14.41	22.71	2.32	10.80	35.83	Pk	V	155	179	69.50	-33.67

Table 8: Out of Band Spectrum Mask for RFID Card Reader – Loop Antenna Facing EUT (0°)

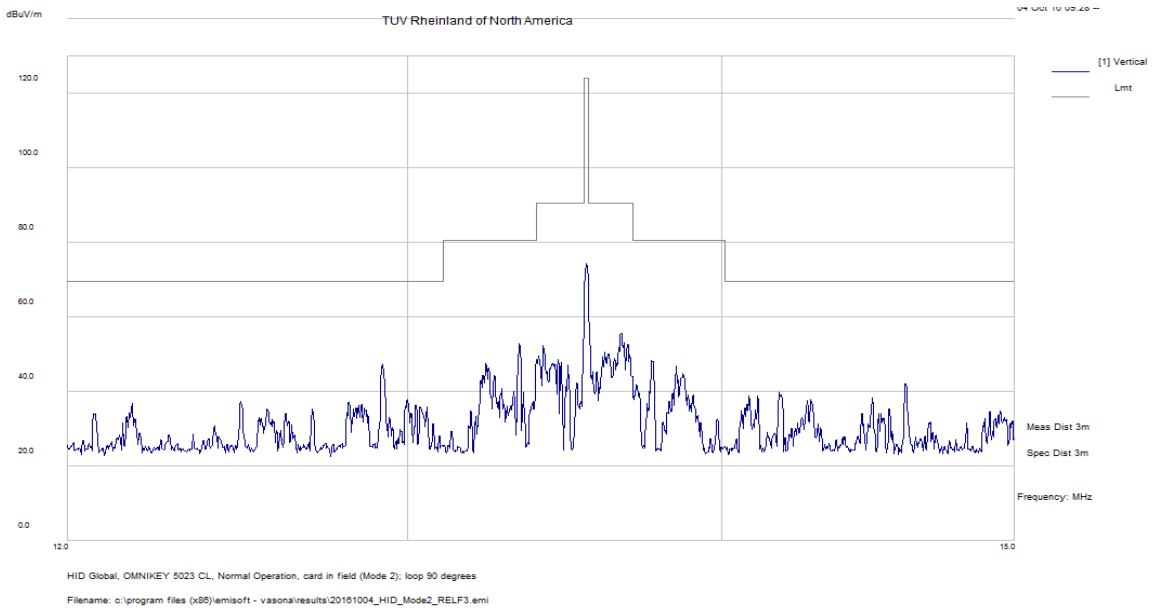


Figure 5: Out of Band Spectrum Mask for RFID Card Reader – Loop Antenna Facing EUT (90°)

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
12.50	24.10	2.30	10.80	37.20	Pk	V	155	360	69.50	-32.30
12.92	34.17	2.30	10.80	47.27	Pk	V	155	128	69.50	-22.23
13.00	24.66	2.30	10.80	37.76	Pk	V	155	196	69.50	-31.74
13.35	39.62	2.30	10.80	52.72	Pk	V	155	23	80.50	-27.78
13.53	29.32	2.31	10.80	42.42	Pk	V	155	89	90.50	-48.08
13.56	61.14	2.31	10.80	74.24	Pk	V	155	105	124.00	-49.76
13.59	32.10	2.31	10.80	45.20	Pk	V	155	68	90.50	-45.30
13.77	35.11	2.31	10.80	48.22	Pk	V	155	265	80.50	-32.28
14.09	25.74	2.31	10.80	38.85	Pk	V	155	338	69.50	-30.65
14.12	25.64	2.31	10.80	38.76	Pk	V	155	107	69.50	-30.74
14.19	26.72	2.31	10.80	39.83	Pk	V	155	78	69.50	-29.67
14.51	25.22	2.32	10.80	38.34	Pk	V	155	96	69.50	-31.16
14.62	28.85	2.32	10.80	41.97	Pk	V	155	62	69.50	-27.53
15.36	25.42	2.33	10.76	38.51	Pk	V	155	132	69.50	-30.99

Table 9: Out of Band Spectrum Mask for RFID Card Reader – Loop Antenna Facing EUT (90°)

4.4 Maximum Permissible Exposure

4.4.1 Test Methodology

In this document, we try to prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this product is measured in a Semi-Anechoic Chamber, and also the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

4.4.2 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
(A) Limits For Occupational / Controlled Exposure				
0.3 – 300	614	1.63	*100	6
3.0 – 30	1842/f	4.89/f	*900/f^2	6
30 – 300	61.4	0.163	1.0	6
300 – 1,500	…	…	f/300	6
1,500 – 100,000	…	…	5	6
(B) Limits For General Population / Uncontrolled Exposure				
0.3 – 1.34	614	1.63	*100	30
1.34 – 30	824/f	2.19/f	*180/f^2	30
30 – 300	27.5	0.073	0.2	30
300 – 1,500	…	…	f/1500	30
1,500 – 100,000	…	…	1.0	30

f = frequency in MHz. * = Plane-wave equivalent power density

4.4.3 EUT Operating Condition

The software provided by Manufacturer enabled the EUT to transmit at the regulated power for the RFID Card Reader.

4.4.4 Classification

The antenna of the product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance with the antenna should be included in user's manual. So, this device is classified as a **Mobile Device**.

4.4.5 Test Results

4.4.5.1 Antenna Gain

The transmitting antenna was integrated or attached. Carrier field strength of RFID was measured.

4.4.5.2 Output Power into Antenna & RF Exposure value at distance 20cm:

Calculations for this report are based on highest carrier field strength measurement.

The highest carrier field strength was +74.24 dBuV/m at 3 meter distance.

The calculated EIRP is -20.99dBm or 0.007962mW

Using the Friss transmission formula, the EIRP is Pout*G, and R is 20cm.

Pd = (0.007962) / (1600π) = 1.5839E-6 mW/cm^2, which is well below to the limit.

The RFID main carrier is not regulated per FCC 1.1310; furthermore, the calculated power density of RFID Module is less than 1mW.cm2 which meet limit stated above.

As stated, the EUT was found to be compliant to the requirements of the test standard(s).

4.4.6 Sample Calculation

The Friss transmission formula: $Pd = (Pout*G) / (4*\pi*R^2)$

Where;

Pd = power density in mW/cm2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator in cm

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

4.5 Transmitter Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.225(d), RSS GEN Sect. 8.9

4.5.1 Test Methodology

4.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

4.5.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

The final spurious emission scans performed on the Z-Axis.

4.5.1.3 Deviations

None.

4.5.2 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2016 and RSS GEN 8.9: 2016.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490.....	2400/F(kHz)	300
0.490-1.705.....	24000/F(kHz)	30
1.705-30.0.....	30	30
30-88.....	100 **	3
88-216.....	150 **	3
216-960.....	200 **	3
Above 960.....	500	3

4.5.3 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and 1.5.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

SOP 1 Radiated Emissions

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EUT Name	OMNIKEY Desk Top Reader	**Date**	October 4, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24°C / 37%rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC / Freq**	5Vdc from HOST
Standard	CFR47 Part 15 Subpart C / RSS 210	**RBW / VBW**	See Note
Dist/Ant Used	3m / 6511	**Performed by**	Kerwinn Corpuz

9 kHz – 30 MHz; Loop Antenna Facing EUT (0°)

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m	PK/AVG	H/V	cm	deg	dBuV/m	dB
0.64	33.61	2.06	10.30	45.97	Pk	V	155	68	71.52	-25.55
0.93	29.90	2.08	10.47	42.45	Pk	V	155	224	68.21	-25.76
1.43	25.04	2.10	10.60	37.74	Pk	V	155	64	64.49	-26.75
12.93	31.64	2.30	10.80	44.74	Pk	V	155	178	69.50	-24.76
13.29	28.67	2.30	10.80	41.78	Pk	V	155	184	69.50	-27.72
13.35	40.75	2.30	10.80	53.86	Pk	V	155	202	69.50	-15.64
13.41	34.19	2.30	10.80	47.29	Pk	V	155	6	69.50	-22.21
13.43	35.66	2.30	10.80	48.77	Pk	V	155	13	69.50	-20.74
13.45	37.93	2.30	10.80	51.03	Pk	V	155	13	69.50	-18.47
13.49	37.10	2.30	10.80	50.21	Pk	V	155	20	69.50	-19.29
13.64	36.35	2.31	10.80	49.46	Pk	V	155	179	69.50	-20.04
13.66	38.58	2.31	10.80	51.69	Pk	V	155	222	69.50	-17.81
13.70	33.63	2.31	10.80	46.74	Pk	V	155	208	69.50	-22.76
13.72	27.27	2.31	10.80	40.38	Pk	V	155	234	69.50	-29.12
13.77	39.82	2.31	10.80	52.93	Pk	V	155	192	69.50	-16.57
13.83	28.32	2.31	10.80	41.43	Pk	V	155	196	69.50	-28.08
14.20	28.40	2.31	10.80	41.52	Pk	V	155	171	69.50	-27.98

Spec Margin = E-Field QP – Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty
Total CF= Amp Gain + Cable Loss + ANT Factor

Combined Standard Uncertainty $u_c(y)$ = ± 3.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Note: RBW/VBW Setting:
9 kHz to 150 kHz; RBW = 200Hz, VBW = 1kHz
150 kHz to 30 MHz; RBW = 9kHz, VBW = 30kHz
30 MHz to 1000 MHz; RBW = 120kHz, VBW = 300kHz

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EUT Name	OMNIKEY Desk Top Reader	**Date**	October 4, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24°C / 37%rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC / Freq**	5Vdc from HOST
Standard	CFR47 Part 15 Subpart C / RSS 210	**RBW / VBW**	See Note
Dist/Ant Used	3m / 6511	**Performed by**	Kerwinn Corpuz

9 kHz – 30 MHz; Loop Antenna Facing EUT (90°)

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m	PK/AVG	H/V	cm	deg	dBuV/m	dB
0.70	33.79	2.06	10.30	46.15	Pk	V	155	300	70.73	-24.57
1.58	31.38	2.10	10.60	44.08	Pk	V	155	76	63.64	-19.56
1.60	25.88	2.10	10.60	38.58	Pk	V	155	52	63.53	-24.96
12.92	34.17	2.30	10.80	47.27	Pk	V	155	128	69.50	-22.23
13.24	34.43	2.30	10.80	47.53	Pk	V	155	134	69.50	-21.97
13.35	39.62	2.30	10.80	52.72	Pk	V	155	23	69.50	-16.78
13.41	36.44	2.30	10.80	49.54	Pk	V	155	138	69.50	-19.96
13.42	39.23	2.30	10.80	52.33	Pk	V	155	144	69.50	-17.17
13.45	34.34	2.30	10.80	47.45	Pk	V	155	311	69.50	-22.05
13.47	35.41	2.30	10.80	48.52	Pk	V	155	73	69.50	-20.98
13.48	34.62	2.30	10.80	47.72	Pk	V	155	232	69.50	-21.78
13.50	33.83	2.31	10.80	46.93	Pk	V	155	4	69.50	-22.57
13.59	32.10	2.31	10.80	45.20	Pk	V	155	68	69.50	-24.30
13.62	37.43	2.31	10.80	50.54	Pk	V	155	107	69.50	-18.96
13.67	42.50	2.31	10.80	55.60	Pk	V	155	139	69.50	-13.90
13.69	39.52	2.31	10.80	52.63	Pk	V	155	144	69.50	-16.87
13.77	35.11	2.31	10.80	48.22	Pk	V	155	265	69.50	-21.28

Spec Margin = E-Field QP – Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty
Total CF= Amp Gain + Cable Loss + ANT Factor

Combined Standard Uncertainty $u_c(y)$ = ± 3.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Note: RBW/VBW Setting:
9 kHz to 150 kHz; RBW = 200Hz, VBW = 1kHz
150 kHz to 30 MHz; RBW = 9kHz, VBW = 30kHz
30 MHz to 1000 MHz; RBW = 120kHz, VBW = 300kHz

SOP 1 Radiated Emissions

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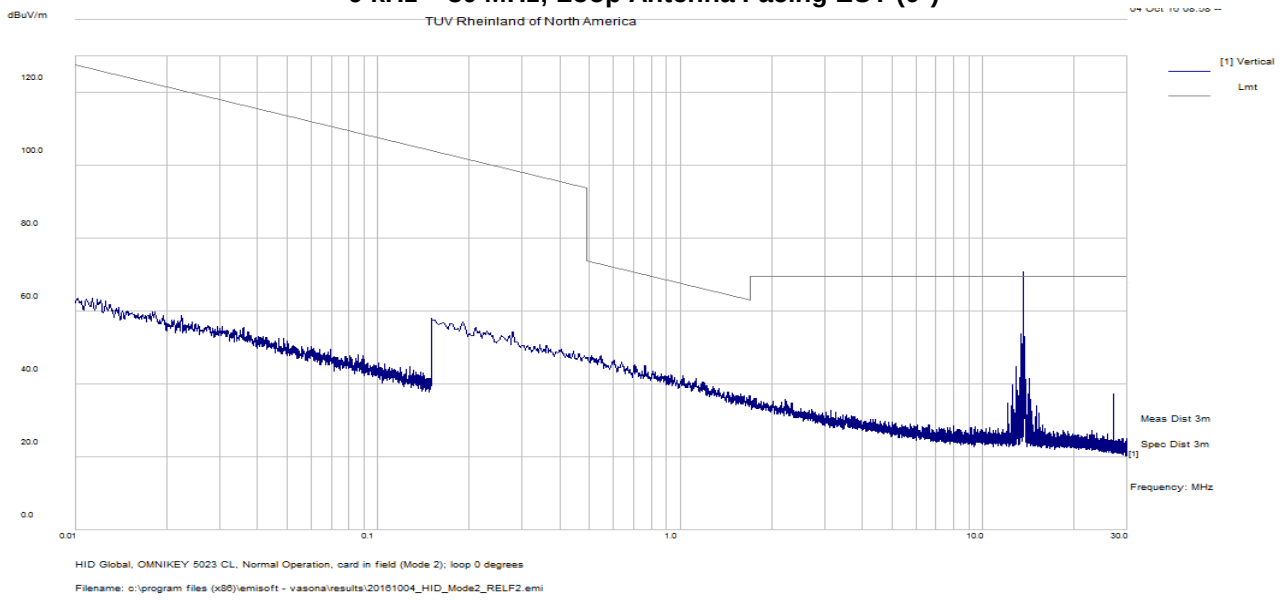
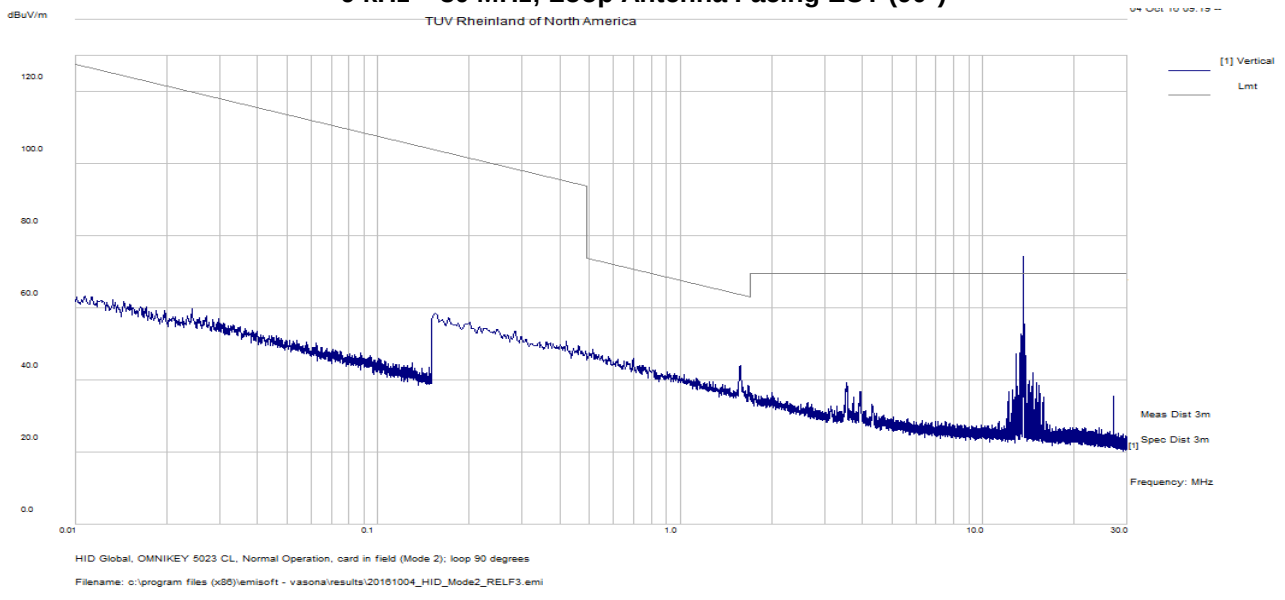
EUT Name	OMNIKEY Desk Top Reader	**Date**	October 4, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24°C / 37%rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC**	5Vdc from HOST
Standard	CFR47 Part 15 Subpart C / RSS 210	**RBW / VBW**	See Note
Dist/Ant Used	3m / 6511	**Performed by**	Kerwinn Corpuz

9 kHz – 30 MHz; Loop Antenna Facing EUT (0°)



9 kHz – 30 MHz; Loop Antenna Facing EUT (90°)



Note: 1. 9 kHz to 150 kHz (RBW = 200Hz, VBW = 1kHz); 150 kHz to 30 MHz (RBW = 9kHz, VBW = 30kHz)
2. Emission above the limit is the fundamental (13.56 MHz). The radio was not possible to terminate the antenna port with 50 ohm or disable the radio.

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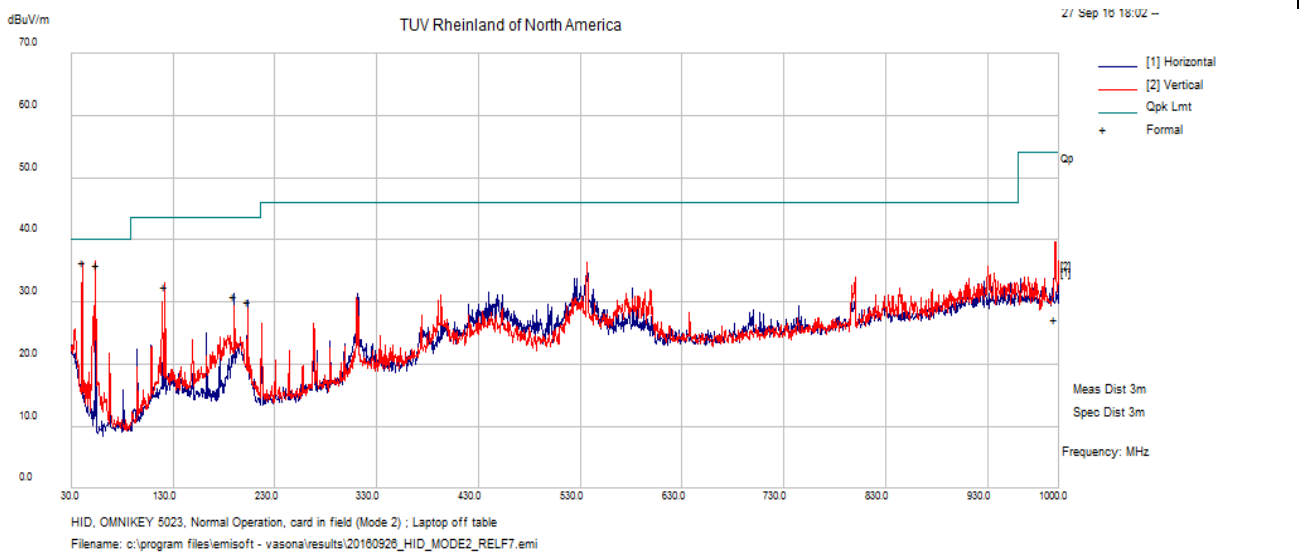
EUT Name	OMNIKEY Desk Top Reader	**Date**	September 27, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24°C / 38%rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC / Freq**	5Vdc from HOST
Standard	CFR47 Part 15 Subpart C / RSS 210	**RBW / VBW**	See Note
Dist/Ant Used	3m / JB3	**Performed by**	Kerwinn Corpuz

30 MHz – 1000 MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m	PK/QP	H/V	cm	deg	dBuV/m	dB
54.26	55.10	1.74	-20.86	35.97	QP	V	100	31	40.00	-4.03
122.04	44.78	2.15	-14.38	32.55	QP	V	100	108	43.50	-10.95
189.87	44.76	2.50	-16.37	30.89	QP	H	144	270	43.50	-12.61
203.43	43.67	2.56	-16.20	30.02	QP	H	161	292	43.50	-13.48
996.24	25.68	4.72	-3.17	27.23	QP	V	112	302	54.00	-26.77
40.69	49.48	1.64	-14.73	36.39	QP	V	100	350	40.00	-3.61



Spec Margin = E-Field QP – Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty
Total CF= Amp Gain + Cable Loss + ANT Factor

Combined Standard Uncertainty $u_c(y)$ = ± 3.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Note: RBW/VBW Setting:
9 kHz to 150 kHz; RBW = 200Hz, VBW = 1kHz
150 kHz to 30 MHz; RBW = 9kHz, VBW = 30kHz
30 MHz to 1000 MHz; RBW = 120kHz, VBW = 300kHz

4.5.4 Sample Calculation

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = FIM - AMP + CBL + ACF

Where: FIM = Field Intensity Meter (dBμV)
AMP = Amplifier Gain (dB)
CBL = Cable Loss (dB)
ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

4.6 AC Conducted Emissions

Testing was performed in accordance with ANSI C63.10: 2013. These test methods are listed under the laboratory's A2LA Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207: 2016 and RSS 210: 2016.

4.6.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50μH / 50Ω LISNs.

Testing is either performed in Lab 2. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

4.6.1.1 Deviations

There were no deviations from this test methodology.

4.6.2 Test Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 10: AC Conducted Emissions – Test Results

Test Conditions: Conducted Measurement at Normal Conditions only		
Antenna Type: Integrated	**Power Level:** Fixed	
AC Power: 120 Vac/60 Hz	**Configuration:** Tabletop	
Ambient Temperature: 24° C	**Relative Humidity:** 42% RH	
Configuration	**Frequency Range**	**Test Result**
Line 1 (Hot)	0.15 to 30 MHz	Pass
Line 2 (Neutral)	0.15 to 30 MHz	Pass

SOP 2 Conducted Emissions

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EUT Name	OMNIKEY Desk Top Reader	**Date**	September 28, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24° C / 42% rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC / Freq**	110Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #2 /Com-Power, Line 1	**Performed by**	Kerwinn Corpuz

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV		Line	dBuV	dB	
2.82	29.13	10.16	0.03	39.31	QP	Live	56.00	-16.69	Pass
2.82	22.94	10.16	0.03	33.13	Ave	Live	46.00	-12.87	Pass
3.06	27.96	10.16	0.03	38.15	QP	Live	56.00	-17.85	Pass
3.06	20.42	10.16	0.03	30.61	Ave	Live	46.00	-15.39	Pass
3.21	26.97	10.16	0.03	37.16	QP	Live	56.00	-18.84	Pass
3.21	20.55	10.16	0.03	30.74	Ave	Live	46.00	-15.26	Pass
0.15	37.39	10.11	0.09	47.59	QP	Live	66.00	-18.41	Pass
0.15	23.98	10.11	0.09	34.18	Ave	Live	56.00	-21.82	Pass
9.86	24.58	10.28	0.00	34.86	QP	Live	60.00	-25.14	Pass
9.86	18.75	10.28	0.00	29.03	Ave	Live	50.00	-20.97	Pass
0.17	33.19	10.11	0.08	43.37	QP	Live	64.84	-21.46	Pass
0.17	20.93	10.11	0.08	31.12	Ave	Live	54.84	-23.72	Pass

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

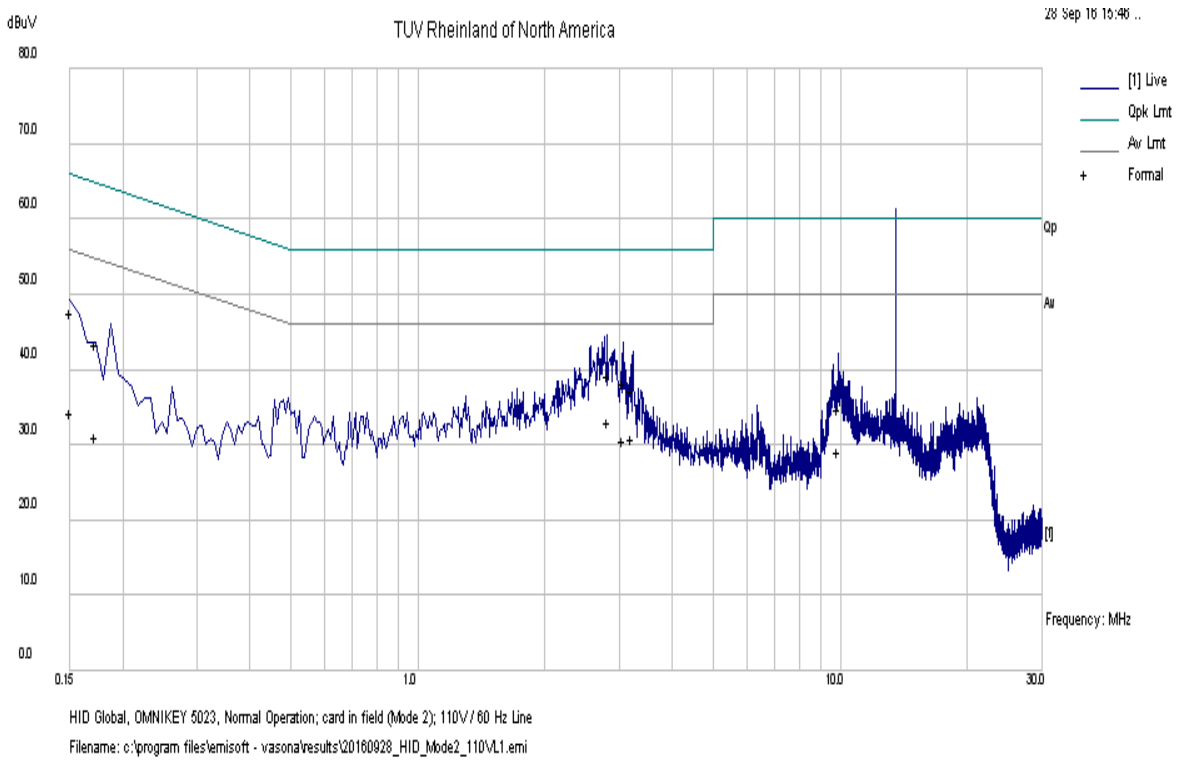
Notes: EUT was setup as table top equipment and transmitted at 13.56 MHz.

SOP 2 Conducted Emissions

Tracking # 31662997.001 Page 2 of 4

EUT Name	OMNIKEY Desk Top Reader	**Date**	September 28, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24° C / 42% rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC**	110Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #2 /Com-Power, Line 1	**Performed by**	Kerwinn Corpuz

150 kHz to 30 MHz Plot for Line 1 (Hot)



Note: 1. Met FCC / RSS Class B limit.
2. Emission above the limit is the fundamental (13.56 MHz). The radio was not possible to terminate the antenna port with 50 ohm or disable the radio.

SOP 2 Conducted Emissions

Tracking # 31662997.001 Page 3 of 4

EUT Name	OMNIKEY Desk Top Reader	**Date**	September 28, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24° C / 42% rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC / Freq**	110Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #2 /Com-Power, Line 2	**Performed by**	Kerwinn Corpuz

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV		Line	dBuV	dB	
2.74	27.66	10.16	0.03	37.85	QP	Neutral	56.00	-18.15	Pass
2.74	22.27	10.16	0.03	32.45	Ave	Neutral	46.00	-13.55	Pass
13.69	21.83	10.33	-0.04	32.12	QP	Neutral	60.00	-27.88	Pass
13.69	11.47	10.33	-0.04	21.76	Ave	Neutral	50.00	-28.24	Pass
3.11	25.47	10.16	0.03	35.66	QP	Neutral	56.00	-20.34	Pass
3.11	19.64	10.16	0.03	29.84	Ave	Neutral	46.00	-16.16	Pass
9.50	23.91	10.28	0.00	34.19	QP	Neutral	60.00	-25.81	Pass
9.50	17.50	10.28	0.00	27.78	Ave	Neutral	50.00	-22.22	Pass
3.38	22.53	10.17	0.03	32.73	QP	Neutral	56.00	-23.27	Pass
3.38	15.65	10.17	0.03	25.85	Ave	Neutral	46.00	-20.15	Pass
0.16	33.62	10.11	0.08	43.81	QP	Neutral	65.28	-21.47	Pass
0.16	19.50	10.11	0.08	29.69	Ave	Neutral	55.28	-25.59	Pass

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

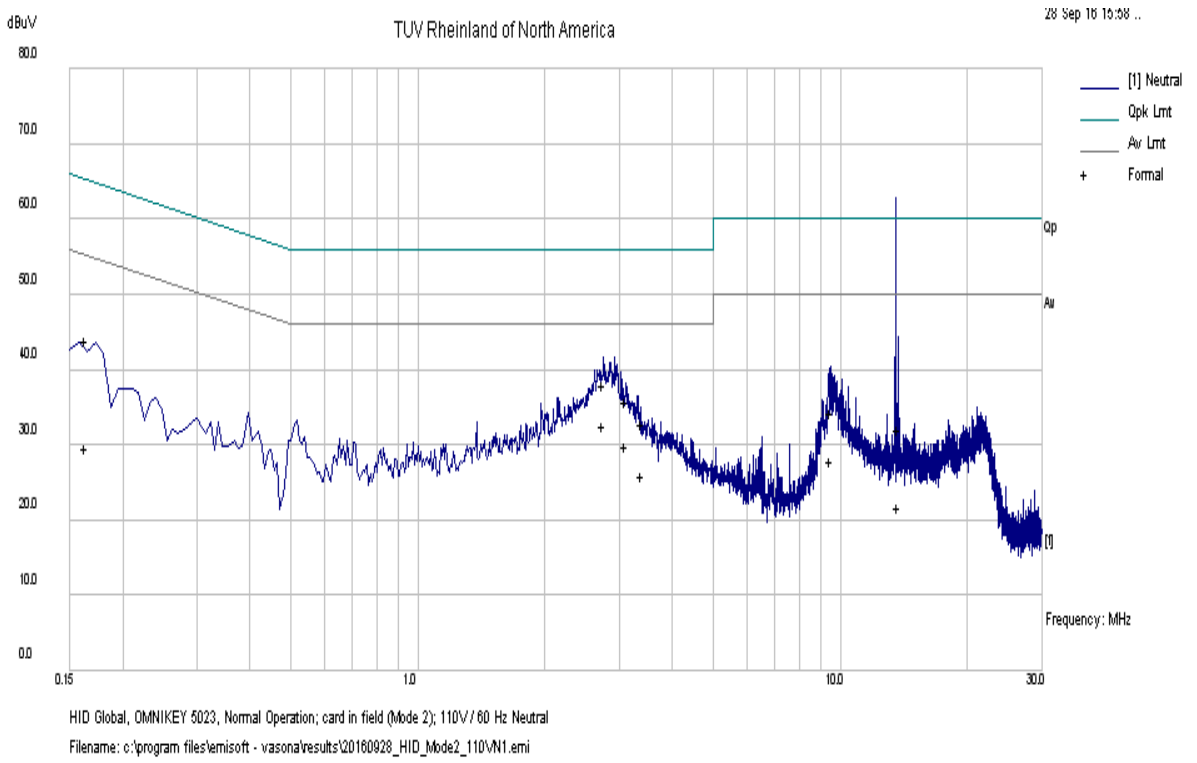
Notes: EUT was setup as table top equipment and transmitted at 13.56 MHz

SOP 2 Conducted Emissions

Tracking # 31662997.001 Page 4 of 4

EUT Name	OMNIKEY Desk Top Reader	**Date**	September 28, 2016
EUT Model	OMNIKEY 5023 CL	**Temp / Hum in**	24° C / 42% rh
EUT Serial	54	**Temp / Hum out**	N/A
EUT Config.	Standalone EUT with Card 4cm away	**Line AC**	110Vac / 60Hz
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #2 /Com-Power, Line 2	**Performed by**	Kerwinn Corpuz

150 kHz to 30 MHz Plot for Line 2 (Neutral)



Note: 1. Met FCC / RSS Class B Limit.
2. Emission above the limit is the fundamental (13.56 MHz). The radio was not possible to terminate the antenna port with 50 ohm or disable the radio.

4.7 Frequency Stability

In accordance with 47 CFR Part 15.225(e) and RSS 210 B.6 the frequency stability of RFID devices must be such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual. The Manufacturer declares the operating temperature ranges of +0º to +55º C.

4.7.1 Test Methodology

The manufacturer of the equipment is responsible for ensuring that the frequency stability is such that emissions are always maintained within the band of operation under all conditions. This test performs according to ANSI C63.10: 2013 Section 6.8

4.7.2 Manufacturer Declaration

The frequency stability of the reference oscillator sets the frequency stability of the RF transceiver signals. Per CFR47 Part 15.225 (e) and RSS 210 Sect. B.6, all of the RF signal should have ±0.01% or ±100ppm stability.
This stability accounts for room temp tolerance of the crystal oscillator circuit, frequency variation across temperature, and crystal ageing.

Worst case:
±100ppm at 13.56 GHz translates to a maximum frequency shift of ±1.356 kHz.

4.7.3 Test results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 11: Frequency Stability – Test Results

Temperature	Time	-6 dB Lower Edge (MHz)	+6 dB Upper Edge (MHz)	Center Frequency (MHz)	PPM
0°C	Start	13.560815211	13.561250156	13.561032683	76.16
	2 Min.	13.560815836	13.561253281	13.561034558	76.29
	5 Min.	13.560818960	13.561253281	13.561036120	76.43
	10 min.	13.560815211	13.561253281	13.561034246	76.27
10°C	Start	13.560805837	13.561243907	13.561024872	75.58
	2 Min.	13.560821460	13.561259530	13.561040495	76.73
	5 Min.	13.560827709	13.561263905	13.561045807	77.12
	10 min.	13.560833958	13.561271404	13.561052681	77.63
20°C	Start	13.560842082	13.561280777	13.561061430	78.28
	2 Min.	13.560850831	13.561285152	13.561067992	78.76
	5 Min.	13.560848956	13.561287652	13.561068304	78.78
	10 min.	13.560854581	13.561292026	13.561073303	79.15
30°C	Start	13.560838958	13.561272653	13.561055806	77.86
	2 Min.	13.560875828	13.561310149	13.561092988	79.94
	5 Min.	13.560885202	13.561320147	13.561102675	81.32
	10 min.	13.560890201	13.561322022	13.561106112	81.57
40°C	Start	13.560873328	13.561307024	13.561090176	80.40
	2 Min.	13.560899575	13.561331396	13.56115486	82.26
	5 Min.	13.560913948	13.561346394	13.561130171	83.35
	10 min.	13.560927697	13.561361392	13.561144544	84.41
50°C	Start	13.560897700	13.561333896	13.561115798	82.29
	2 Min.	13.560939570	13.561376390	13.561157980	85.40
	5 Min.	13.560967692	13.561402012	13.561184852	87.38
	10 min.	13.560983940	13.561418885	13.561201412	88.60
55°C	Start	13.560938945	13.561375141	13.561157043	85.33
	2 Min.	13.560980190	13.561417635	13.561198913	88.42
	5 Min.	13.561013311	13.561443257	13.561228284	90.58
	10 min.	13.561040807	13.561473253	13.561257030	92.70

Note: 1. All frequency drifts from 13.56 MHz were less than ±100 ppm.
2. Highlighted is the worst case measured and plots are in the following pages.

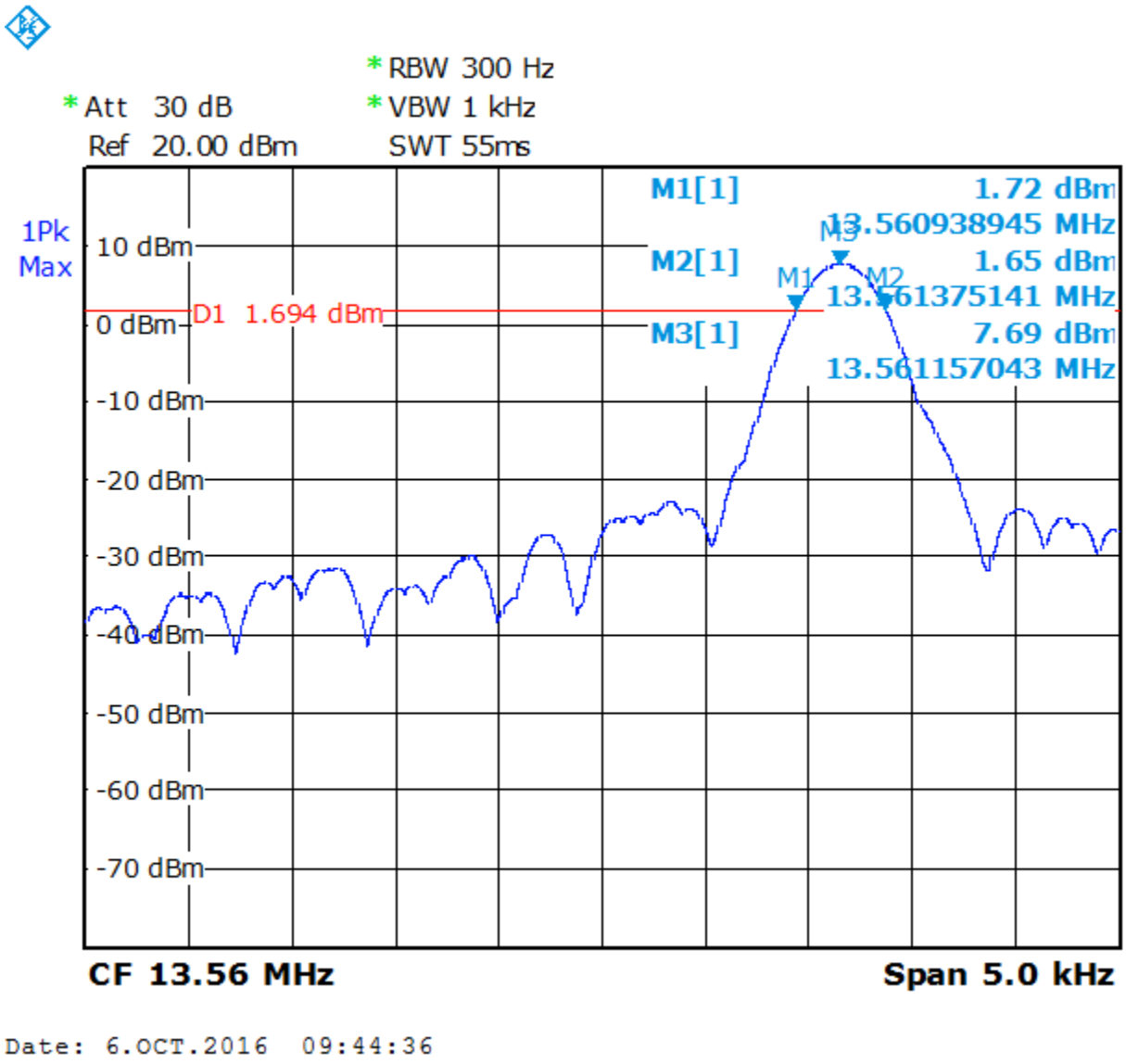


Figure 6: Frequency Stability at 55 °C (Start)

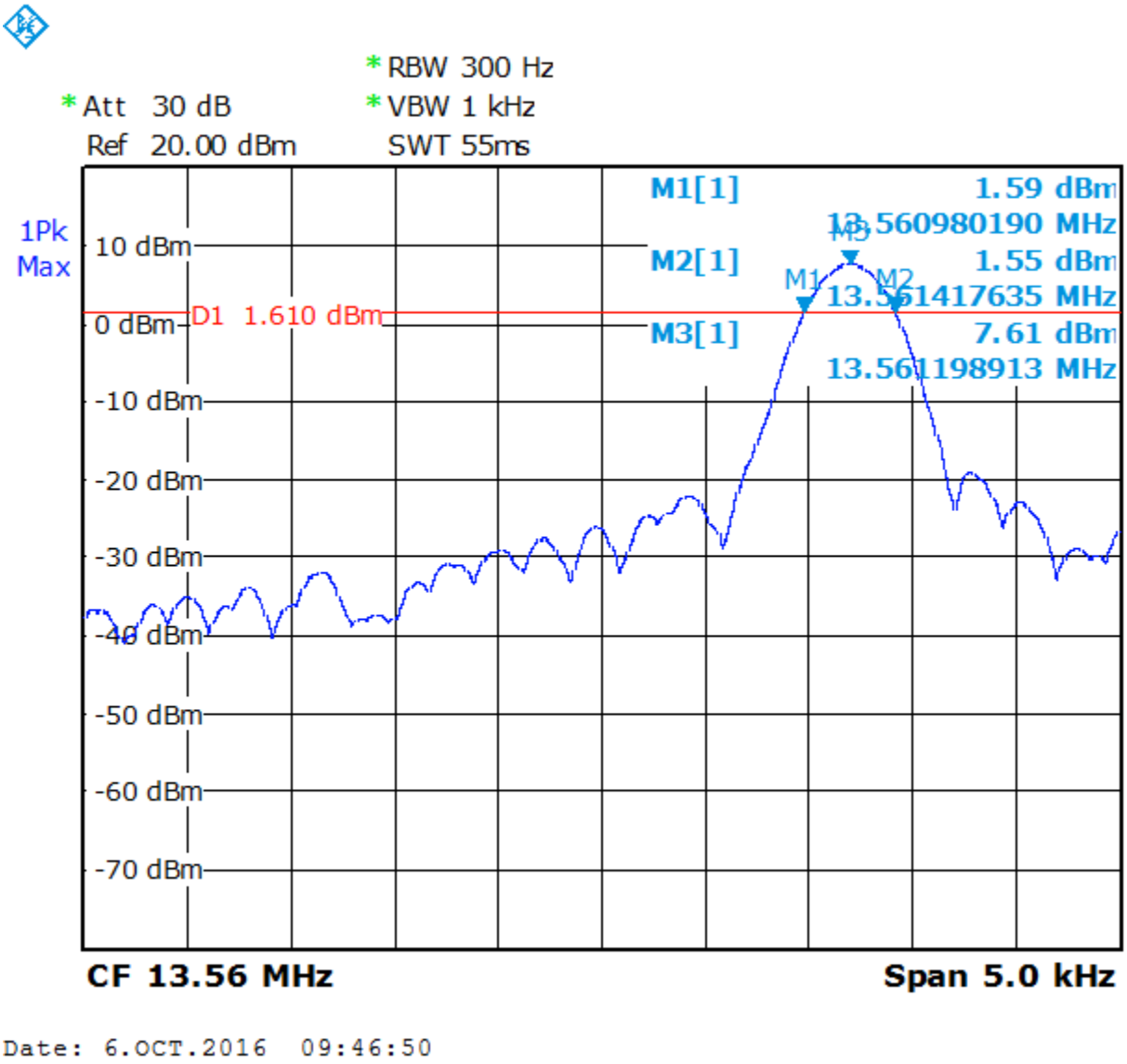


Figure 7: Frequency Stability at 55 °C (2 min.)

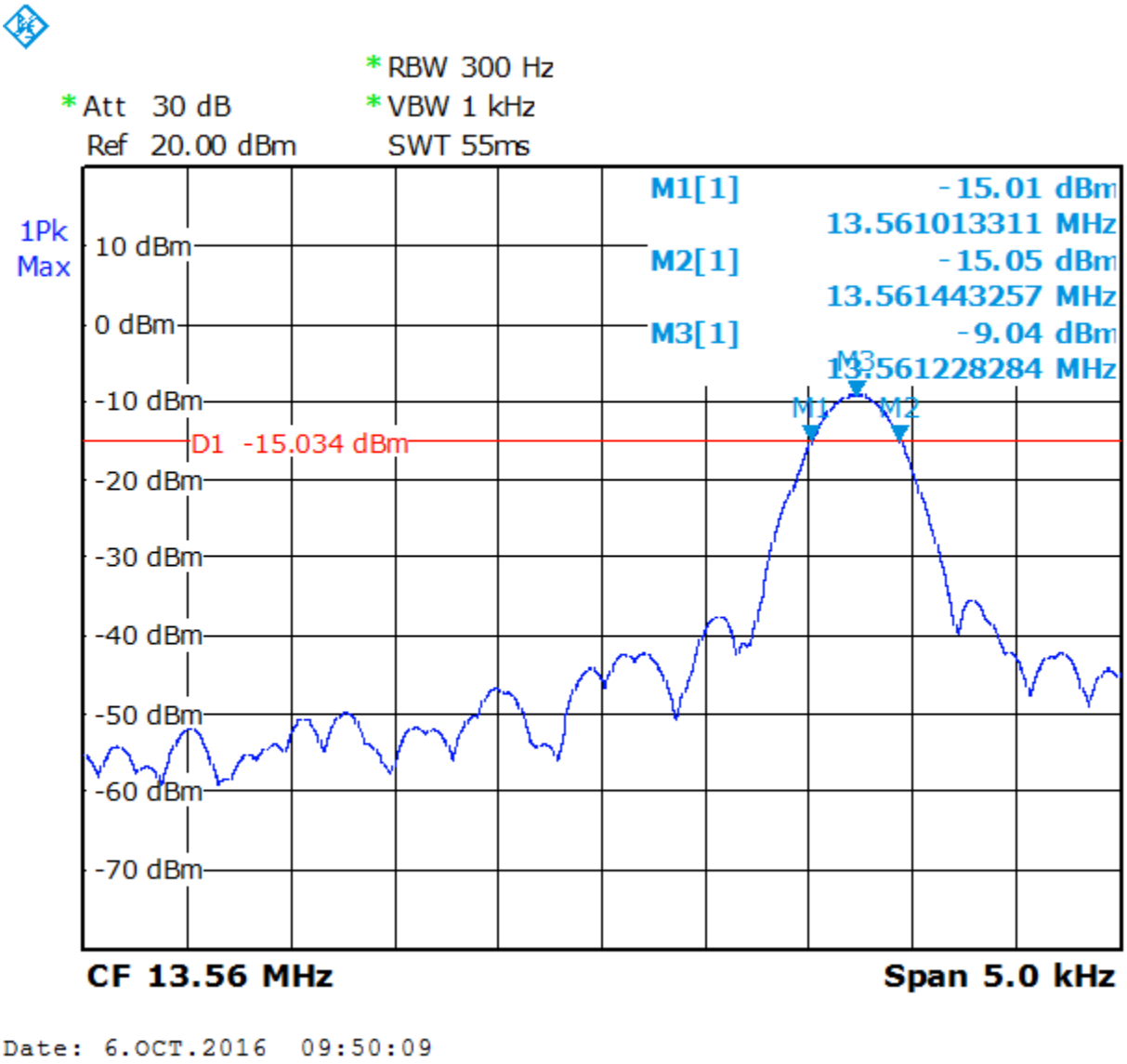


Figure 8: Frequency Stability at 55 °C (5 min.)

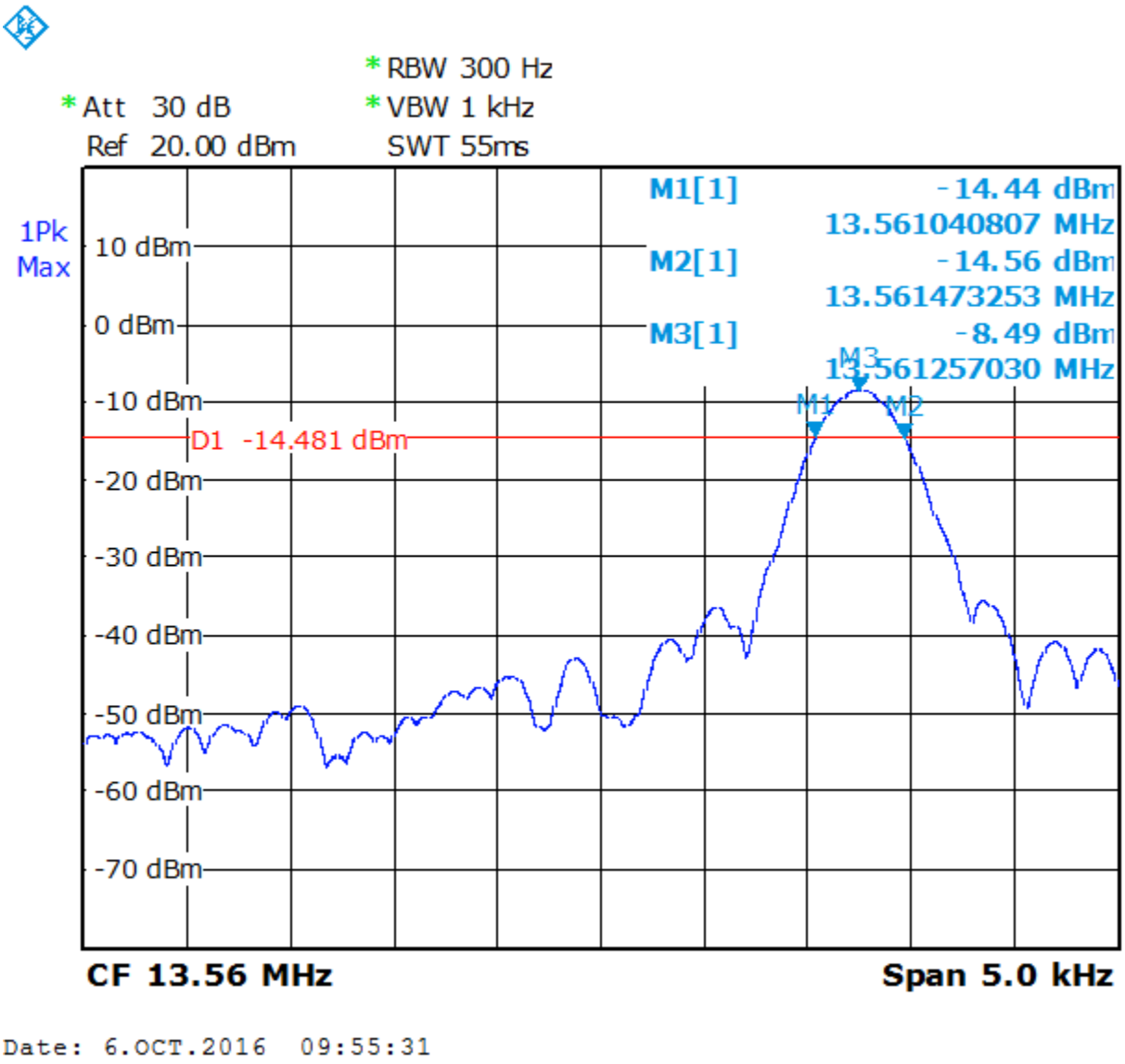


Figure 9: Frequency Stability at 55 °C (10 min.)

4.8 Voltage Variation

In accordance with 47 CFR Part 15.31 (e) intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

4.8.1 Test Methodology

The ac supply voltage was varied between 85% and 115% of the nominal rated supply voltage. The fundamental frequency was observed during the variation. The RF ID standalone module was powered 5V DC by programmable power supply. The voltage was varied from 4.25VDC to 5.75VDC mean while the fundamental frequencies were observed and recorded for the maximum drift in ppm; part per millions.

4.8.2 Test results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s). The fundamental frequencies drifted less than ±100ppm.

Table 12: Voltage Variation – Test Results

Temperature	-6 dB Lower Edge (MHz)	+6 dB Upper Edge (MHz)	Center Frequency (MHz)	PPM
4.25V DC	13.560868329	13.561302025	13.561085177	80.35
5.00V DC	13.560873953	13.561308274	13.561091114	80.47
5.75V DC	13.560872078	13.561307024	13.561089551	80.03
Note: All frequency drifts were less than ±100 ppm from 13.56 MHz No frequency change was observed with time.				

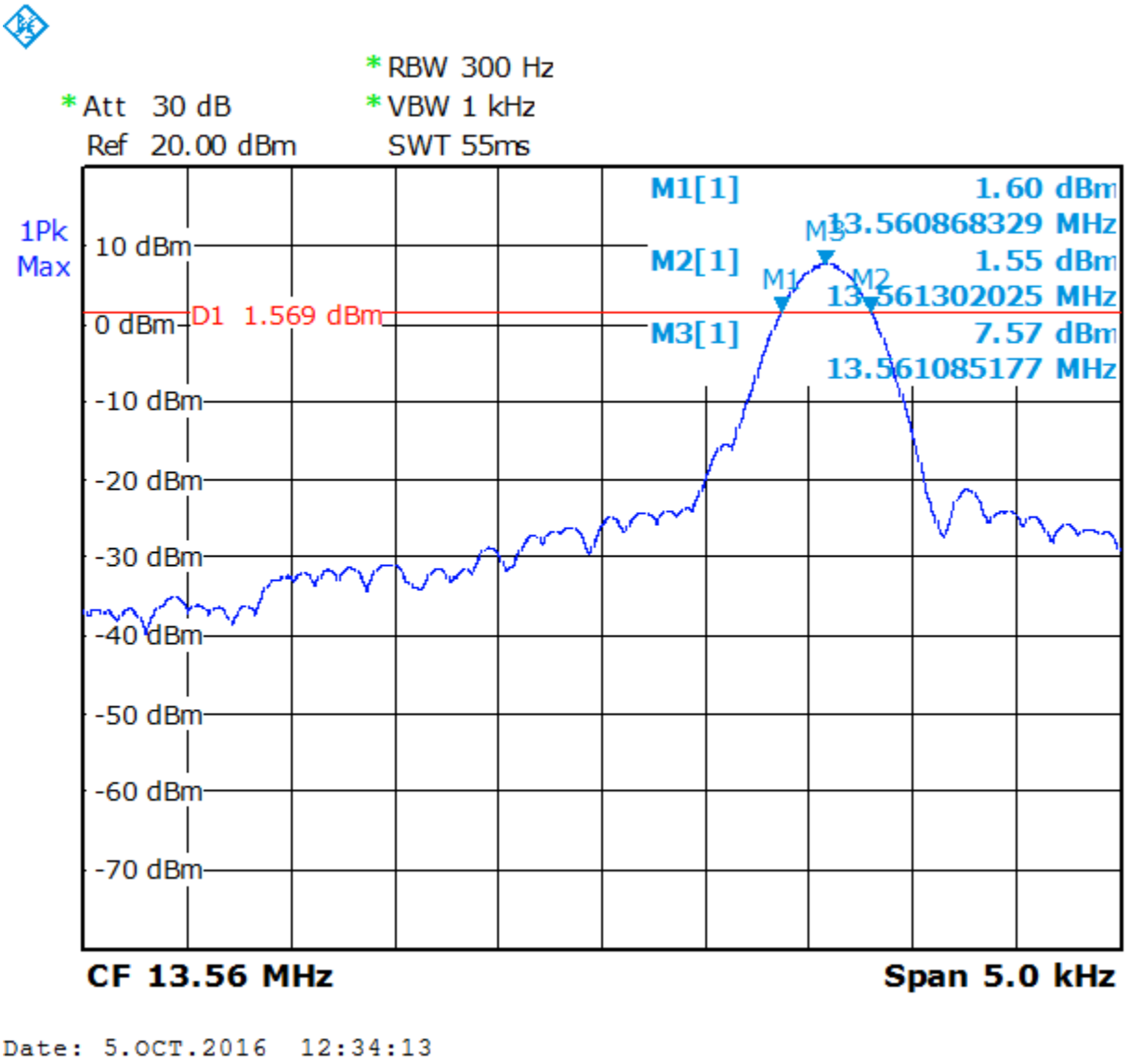


Figure 10: Voltage Variation at 4.25V DC

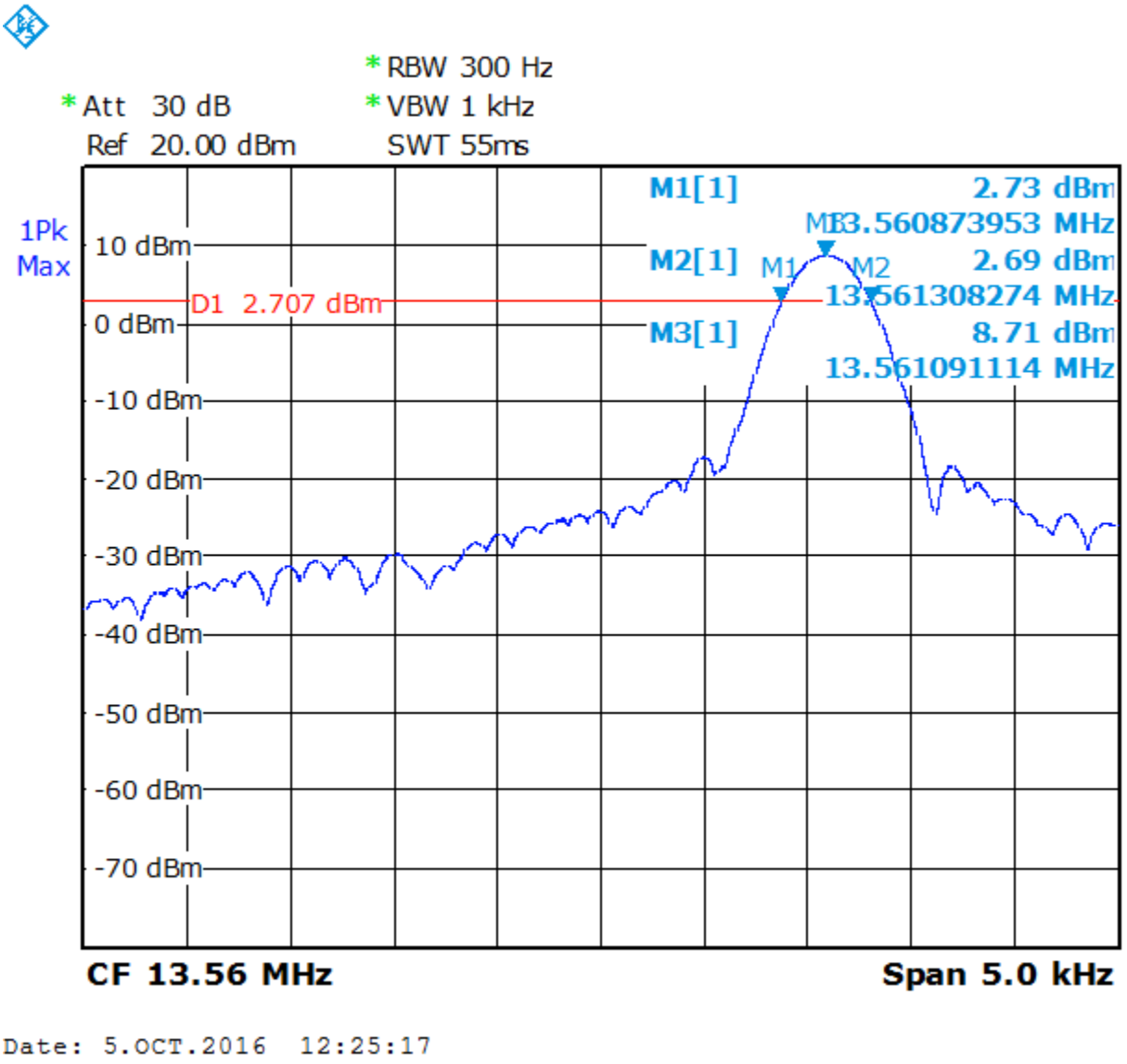


Figure 11: Voltage Variation at 5.00V DC

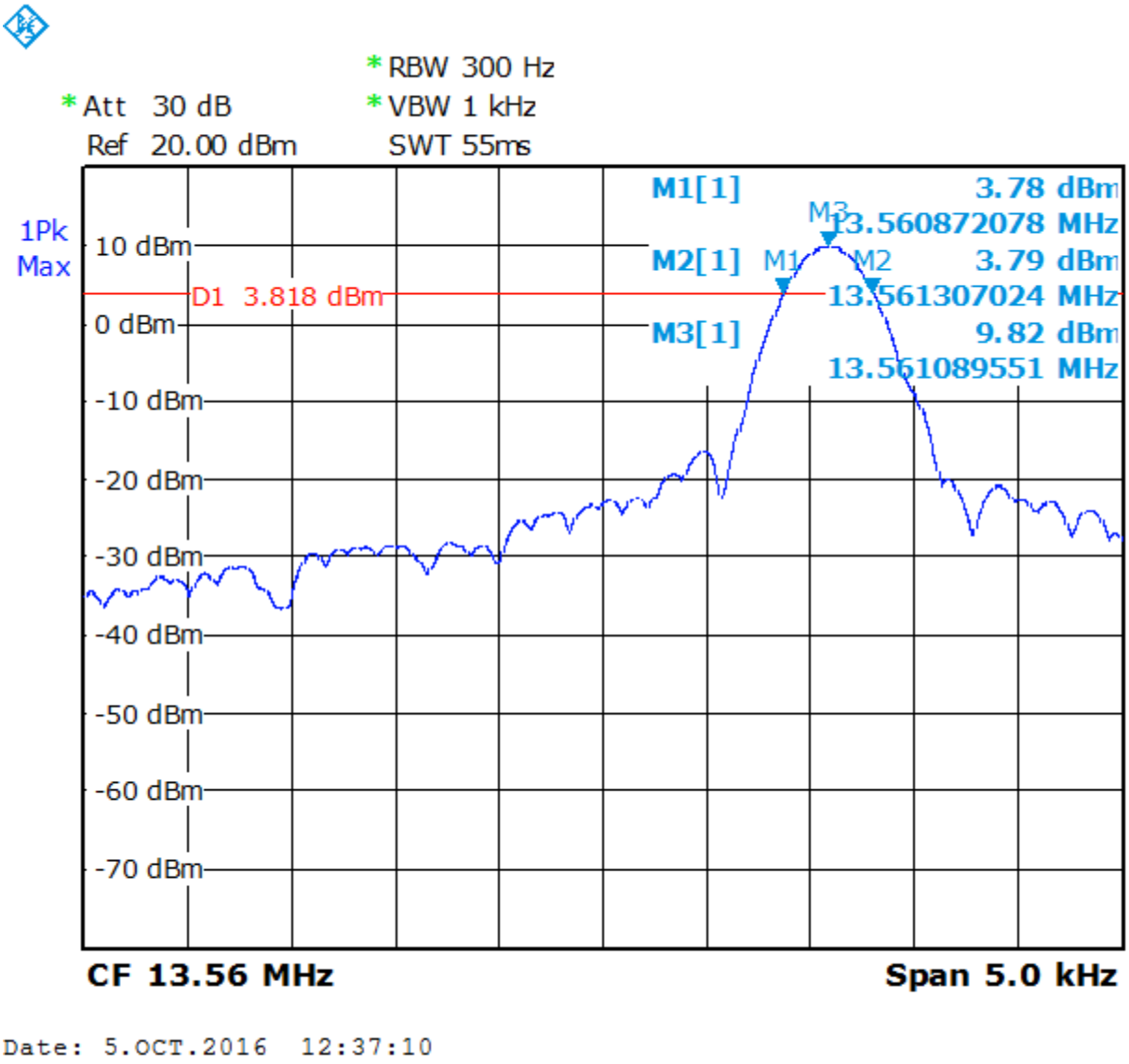


Figure 12: Voltage Variation at 5.75V DC

5 Test Equipment List

5.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yyyy	Next Cal dd/mm/yyyy
EMI Receiver	Agilent	MXE N9038A	MY52260210	01/18/2016	01/18/2017
Preamplifier	Sonoma Instruments	310	185516	01/18/2016	01/18/2017
Bilog Antenna	Sunol Science	JB3	AC020502	2/17/2016	02/15/2018
EMI Receiver	Rohde & Schwarz	ESIB40	100180	01/19/2016	01/19/2017
L.I.S.N.	Com-Power	LI-215	12100	01/20/2016	01/20/2017
Transient Limiter	Com-Power	LIT-930	531582	01/19/2016	01/19/2017
EMI Receiver	Agilent	N9038A	MY51210195	01/26/2016	01/26/2017
Active Loop Antenna (10k-30MHz)	EMCO	6502	9110-2683	06/13/2016	06/13/2017
EMI Receiver	Rohde & Schwarz	FSL6	100169	01/20/2016	01/20/2017
Thermo Chamber	ESPEC	BTZ-133	0613436	01/20/2016	01/20/2017
Digital Multimeter	Fluke	177	92780314	01/19/2016	01/19/2017

*** Calibration of equipment past due for re-calibration will be performed expeditiously. If any equipment is found to be out of tolerance at that time, affected customers will be notified accordingly.**

6 EMC Test Plan

6.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

6.2 Customer

Table 13: Customer Information

Company Name	HID Global
Address	15730 Barranca Parkway
City, State, Zip	Irvine, CA 92618
Country	USA
Phone	(303) 404-6801
Fax	(303) 404-6888

Table 14: Technical Contact Information

Name	Robert Cresswell
E-mail	rcresswell@hidglobal.com
Phone	(303) 404-6801
Fax	(303) 404-6888

6.3 Equipment Under Test (EUT)

Table 15: EUT Specifications

EUT Specification	
Dimensions:	2.32” (59mm) X 2.32” (59mm) X 0.44” (11.4mm)
Power Supply:	5 VDC, 150 mA
Environment	Controlled Laboratory
Operating Temperature Range:	0 to 55 degrees C
Multiple Feeds:	☐ Yes and how many ☒ No. RFID receives 5 Vdc from Host System power supply.
Product Marketing Name (PMN)	OMNIKEY 5023 CL
Hardware Version Identification Number (HVIN)	OMNIKEY 5023 CL
Firmware Version Identification Number (FVIN)	OK5023-1.0.0.416-20160818T140321-EEC2C531273B
Operating Mode	RFID Reader
Transmitter Frequency Band	13.56 MHz
Chipset Rated Power Output	45 µW
Power Setting @ Operating Channel	Fixed. Power controls by HF Aviator Chip.
Antenna Type	Attached on board
Modulation Type	☐ AM ☐ FM ☐ Phase ☒ Other describe: ASK: (AM)
Data Rate	424 kbit/s.
Max. Duty Cycle	100%
Type of Equipment	☒ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☐ Other *describe: Host System*

Table 16: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
N/A	--	--	--	--
Note: No supporting device was used for testing				

Table 17: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
RFID Tag	HID	N/A	N/A	All testing
Laptop	Dell	Latitude E7440	2LLPL32	To power and turn ON EUT.
Note: None				

Table 18: Description of Sample used for Testing

Device	Serial Number	Configuration	Used For
RFID Reader	54	Radiated Sample	Max. Carrier Field Strength Occupied Bandwidth Out of Band Emission TX Spurious Radiated Emission RX Spurious Radiated Emission AC Conducted Emission Frequency Stability Voltage Variation
Note: None			

Table 19: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup Description
RFID Reader	Internal	Transmit & Receive	EUT: laid flat and up right
Note: Test was performed in 2 orientation, laid flat and up right.			

6.4 Test Specifications

Testing requirements

Table 20: Test Specifications

Emissions and Immunity	
Standard	Requirement
CFR 47 Part 15.225: 2016	All
RSS 210 Issue 9 2016	All

END OF REPORT