Company: SALTO Systems

Test of: AElement Wireless Lock

To: FCC Part 15.225 & IC RSS 210
+ NFC and Bluetooth Colocation Emisions

Report No.: APPU08-U2 Rev A

TEST REPORT

TEST REPORT

FROM

Test of: SALTO Systems AElement Wireless Lock

to

FCC Part 15.225 & IC RSS 210

Test Report Serial No.: APPU08-U2 Rev A

This report supersedes: None

Applicant: SALTO Systems
C/Arkotz nº9 Pol.
Lanbarren
Arkotz Kalea
Oiartzun 20180 Spain

Product Function: Wireless Lock

Issue Date: 7th June 2017

This Test Report is Issued Under the Authority of:

MiCOM Labs, Inc.
575 Boulder Court
Pleasanton, California 94566
USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
TESTING CERT #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

Contents

1. ACCREDITATION, LISTINGS & RECOGNITION 4
1.1. Test Accreditation 4
1.2. Recognition 5
1.3. Product Certification 6
2. DOCUMENT HISTORY 7
3. TEST RESULT CERTIFICATE 8
4. REFERENCES AND MEASUREMENT UNCERTAINTY 9
4.1. Normative References 9
4.2. Test and Uncertainty Procedure 10
5. PRODUCT DETAILS AND TEST CONFIGURATIONS 11
5.1. Technical Details 11
5.2. Scope Of Test Program 12
5.3. Equipment Model(s) and Serial Number(s) 14
5.4. Antenna Details 14
5.5. Cabling and I/O Ports 14
5.6. Test Configurations 14
5.7. Equipment Modifications 14
5.8. Deviations from the Test Standard 14
6. TEST SUMMARY 15
7. TEST EQUIPMENT CONFIGURATION(S) 16
7.1. Radiated Emissions 16
8. TEST RESULTS 19
8.1. Frequency Stability 19
8.2. Field Strength and Spurious Emissions 32
8.2.1. Radiated Emissions 32
8.2.2. Field Strength Measurement 39
8.3. 20 dB & 99% Occupied Bandwidth 43
8.4. AC Mains Power Input/Output Ports 45
8.5. Antenna Requirement 48
8.5.1. Scope 48
8.5.2. Test Result 48

1. ACCREDITATION, LISTINGS & RECOGNITION

1.1. Test Accreditation

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard ISO/IEC 17025:2005. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

ilac-MRA A2LA

Accredited Laboratory

A2LA has accredited

MICOM LABS

Pleasanton, CA

for technical competence in the field of

Electrical Testing

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

Presented this 4th day of February 2016.

Senior Director of Quality & Communications
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2017

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

1.2. Recognition

MiCOM Labs, Inc has widely recognized wireless testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA countries. MiCOM Labs test reports are accepted globally.

Country	Recognition Body	Status	Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Listing #: 102167
Canada	Industry Canada (IC)	FCB	APEC MRA 2	US0159 Listing #: 4143A-2 4143A-3
Japan	MIC (Ministry of Internal Affairs and Communication)	CAB	APEC MRA 2	RCB 210
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA	NB 2280
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	CAB	APEC MRA 1	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	CAB	APEC MRA 1	
Singapore	Infocomm Development Authority (IDA)	CAB	APEC MRA 1	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	CAB	APEC MRA 1	
Vietnam	Ministry of Communication (MIC)	CAB	APEC MRA 1	

EU MRA – European Union Mutual Recognition Agreement.
NB – Notified Body
APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement. Recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.
Phase I - recognition for product testing
Phase II – recognition for both product testing and certification

1.3. Product Certification

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard ISO/IEC 17065:2012. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf

Accredited Product Certification Body

A2LA has accredited

MICOM LABS

Pleasanton, CA

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC 17065:2012 *Requirements for bodies certifying products, processes and services*. This accreditation demonstrates technical competence for a defined scope and the operation of a management system.

Presented this 4th day of February 2016.

Senior Director of Quality & Communications
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2017

For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

United States of America – Telecommunication Certification Body (TCB)

Industry Canada – Certification Body, CAB Identifier – US0159

Europe – Notified Body (NB), NB Identifier - 2280

Japan – Recognized Certification Body (RCB), RCB Identifier - 210

2. DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	1st June 2017	Colocation testing for Bluetooth and Near Field Communications (13.56 MHz) device
Draft #2	6th June 2017	
Rev A	7th June 2017	Document Released
This report was originally issued under APPU01-U3 Rev A		
Draft	24th January 2017	
Draft #2	8th February 2017	
Rev A	9th February 2017	Initial Release

In the above table the latest report revision will replace all earlier versions.

3. TEST RESULT CERTIFICATE

Manufacturer:	SALTO Systems C/Arkotz nº9 Pol. Lanbarren Arkotz Kalea Oiartzun 20180 Spain	**Tested By:**	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California, 94566, USA
EUT:	Wireless Lock	**Telephone:**	+1 925 462 0304
Model:	AES	**Fax:**	+1 925 462 0306
S/N's:	4367/3		
Test Date(s):	19th May 2017 17th – 18th January 2017	**Website:**	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC CFR 47 Part 15 Subpart C 15.225 Industry Canada RSS-210	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

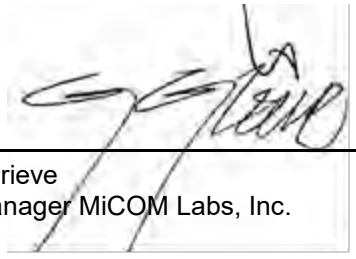
1. This document reports conditions under which testing was conducted and the results of testing performed.

2. Details of test methods used have been recorded and kept on file by the laboratory.

3. Test results apply only to the item(s) tested.

A2LA ACCREDITED
TESTING CERT #2381.01

Approved & Released for MiCOM Labs, Inc. by:



Graeme Grieve
Quality Manager MiCOM Labs, Inc.

Gordon Hurst
President & CEO MiCOM Labs, Inc.

4. REFERENCES AND MEASUREMENT UNCERTAINTY

4.1. Normative References

REF.	PUBLICATION	YEAR	TITLE
I	A2LA	June 2015	Reference to A2LA Accreditation Status – A2LA Advertising Policy
II	ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices
III	CISPR 22	2008	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
IV	ETSI TR 100 028	2001-12	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
V	FCC 47 CFR Part 15.247	2016	CFR Title 47 Part 15.247 – Radio Frequency Devices; Subpart C – Intentional Radiators
VI	LAB34	Edition 1 August 2002	The expression of uncertainty in EMC Testing
VII	M 3003	Edition 3 Nov. 2012	Expression of Uncertainty and Confidence in Measurements
VIII	RSS-247 Issue 1	May 2015	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices
IX	RSS-Gen Issue 4	November 13, 2014	General Requirements and Information for the Certification of Radio communication Equipment
XI	FCC 47 CFR Part 2.1033	2016	FCC requirements and rules regarding photographs and test setup diagrams.
XII	RSS-210 Issue 9	August 2016	License-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
XIII	FCC 47 CFR Part 15.225	2017	CFR Title 47 Part 15.225 – Radio Frequency Devices; Subpart C – Intentional Radiators

4.2. Test and Uncertainty Procedure

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

5. PRODUCT DETAILS AND TEST CONFIGURATIONS

5.1. Technical Details

Details	Description
Purpose:	Test of SALTO Systems AElement for compliance to FCC CFR 47 Part 15 Subpart C 15.225 and IC RSS-210.
Applicant:	SALTO Systems C/Arkotz nº9 Pol. Lanbarren Arkotz Kalea Oiartzun 20180 Spain
Manufacturer:	As Applicant
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court, Pleasanton, California 94566 USA
Test report reference number:	APPU08-U2 Draft
Date EUT received:	15th May 2017 5th January 2017
Standard(s) applied:	FCC CFR 47 Part 15 Subpart C 15.225 Industry Canada RSS-210
Dates of test (from - to):	19th May 2017 17th – 18th January 2017
No of Units Tested:	1
Type of Equipment:	13.56 MHz
Product Trade Name:	AElement
Model(s):	AES see Section 5.2 Scope of Test Program for description
Location for use:	Indoor
Declared Frequency Range(s):	13.553-13.567 MHz
Hardware Rev	1.0
Software Rev	Test Software
EUT Modes of Operation:	NFC & Bluetooth
Type of Modulation:	NFC: ASK Bluetooth: GFSK
Declared Nominal Output Power (Ave):	+8 dBm
Transmit/Receive Operation:	Transceiver - Simplex
System Beam Forming:	This device has no beam-forming capability
Rated Input Voltage and Current:	4.5 Vdc nominal (battery powered)
Operating Temperature Range:	Client Declared Range -20°C to 60°C
ITU Emission Designator:	33K3K1D
Equipment Dimensions:	65" x 116" x 25.5”
Weight:	2kg
Primary function of equipment:	Wireless Lock
Secondary function of equipment:	None provided

5.2. Scope Of Test Program

SALTO Systems AElement Wireless Lock

The scope of the test program was to test the SALTO Systems AElement Wireless Lock NFC radio model AES operating at 13.56 MHz for compliance to the requirements of FCC CFR 47 Part 15 Subpart C 15.225 & IC RSS-210 issue 9 specifications.

This program builds on the initial test program performed 9th February for the AEB model, see report APPU01-U3 Rev A. A full suite of tests were included in the initial report.

For the new AES model only colocation and digital emissions were performed. All the original conducted test data has been included in this report for similarity purposes.

AES FCC ID: UKCAEB
AES IC ID: 10088A-AEB

Product labeling on the NFC + BLE variant will be as follows;

Variant	Model Number	USA (FCC ID)	Canada (IC ID)
NFC + BLE	AES	UKCAEB	10088A-AEB

Pre-Certified BLE Module
The pre-certified BLE module used in the AES Wireless Lock, is the "DirectKey" module

FCC ID: TCZ-10103751G1
IC ID: 1175F-10103751G1.

Model Description
AElement BLE Mifare/iClass with Bluetooth technology Electronic Lock Series including all mechanical variants. See Technical File for more details.

Co-Location Testing

In order to satisfy test requirements for multiple transmitters co-location testing was performed NFC + BLE simultaneous transmission requirements, see Section 8.2.1 for 0.03 – 1 GHz and 1 – 18 GHz radiated spurious emission data. Both transmitters were active during these tests.

SALTO Systems AElement Wireless Lock

5.3. Equipment Model(s) and Serial Number(s)

Model / Description	Serial no.	Hardware version	Software version
AES	4367/3	1.0	Test Software

5.4. Antenna Details

Type	Manufacturer	Model	Gain (dBi)	Frequency Band (MHz)
PCB	SALTO Systems	NFC @13.56MHz	0	13.56

5.5. Cabling and I/O Ports

Number and type of I/O ports

1. None

5.6. Test Configurations

Operational Mode(s)	Channel Frequency (MHz)
NFC and Bluetooth	13.56 MHz and 2.4 GHz Frequency Hopping

Results for the above configuration are provided in this report

5.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. None

5.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. None

6. TEST SUMMARY

List of Measurements

Test Header	Result
Conducted Testing	
15.225(e) Frequency Stability [1]	Complies
Radiated Testing	
15.205, 15.209 & 15.225 (a) (d) Radiated Spurious Emissions (including Colocation Testing)	Complies
15.225(a) Field Strength Measurement [1]	Complies
15.215, RSS-Gen 20 dB and 99% Bandwidth [1]	Complies
15.207 Conducted Limits (AC)	Not Required*
15.203 Antenna Requirement [1]	Complies

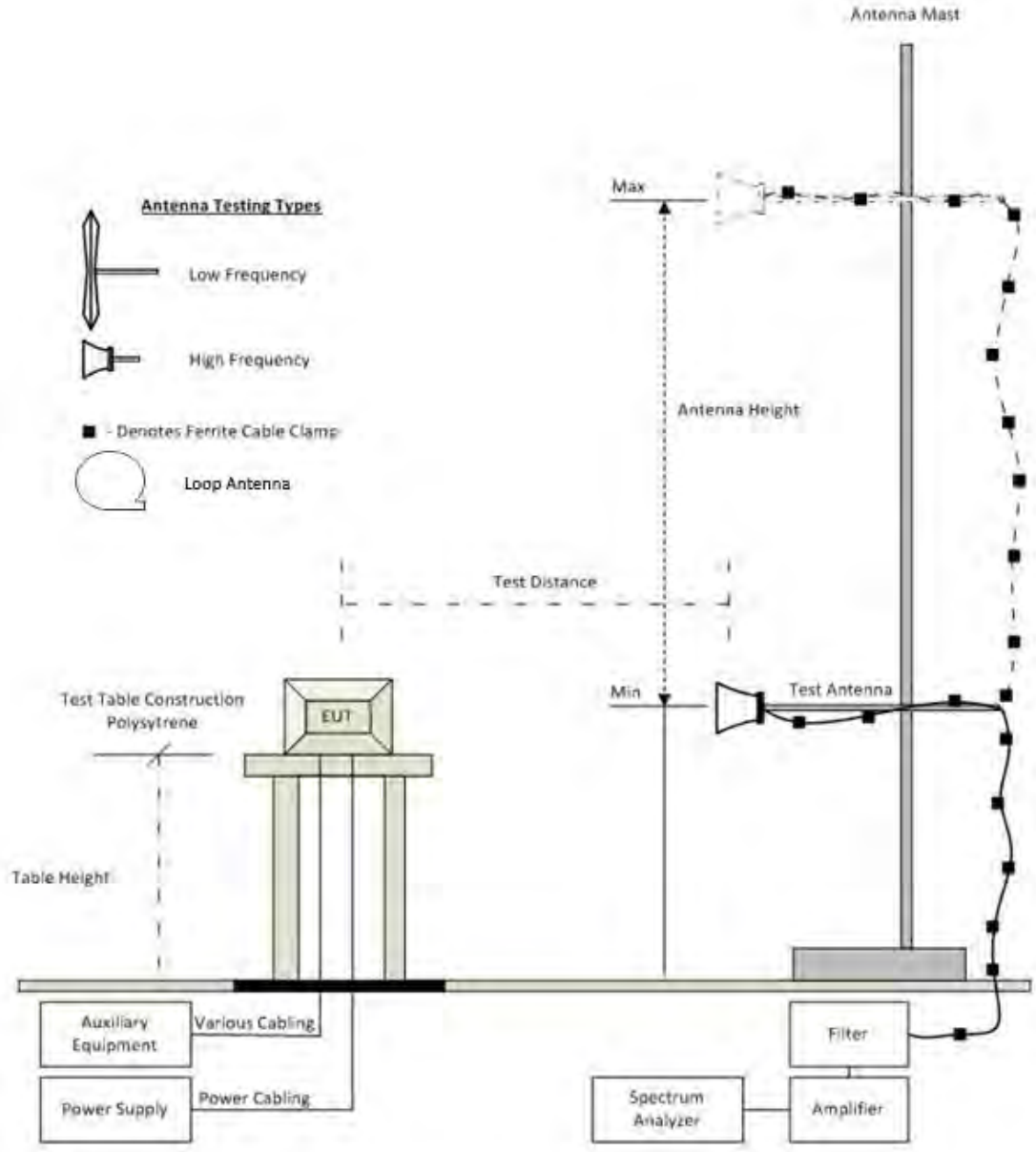
[1] parameter tested as part of the initial AEB test program (see test report APPU01-U3)

*EUT is battery powered with no connection to public mains network.

7. TEST EQUIPMENT CONFIGURATION(S)

7.1. Radiated Emissions

Radiated emissions testing above and below 1GHz was performed using the following test setup.



Radiated Emission Test Setup

A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	30 Nov 2017
170	Video System Controller for Semi Anechoic Chamber	Panasonic	WV-CU101	04R08507	Not Required
330	Variac 0-280 Vac	Staco Energy Co	3PN1020B	0546	Cal when used
336	Active loop Ant 10kHz to 30 MHz	EMCO	EMCO 6502	00060498	26 Sep 2017
338	Sunol 30 to 3000 MHz Antenna	Sunol	JB3	A052907	15 Aug 2017
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	4 Aug 2017
393	DC - 1050 MHz Low Pass Filter	Microcircuits	VLFX-1050	N/A	16 Aug 2017
396	2.4 GHz Notch Filter	Microtronics	BRM50701	001	16 Aug 2017
397	Amp 10 - 2500MHz	MiCOM Labs	Amp 10 - 2500 MHz	NA	9 Jun 2017
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	10 Apr 2017
406	Amplifier for Radiated Emissions	MiCOM Labs	40dB 1 to 18GHz Amp	0406	9 Jun 2017
410	Desktop Computer	Dell	Inspiron 620	WS38	Not Required
411	Mast/Turntable Controller	Sunol Sciences	SC98V	060199-1D	Not Required
412	USB to GPIB Interface	National Instruments	GPIB-USB HS	11B8DC2	Not Required
413	Mast Controller	Sunol Science	TWR95-4	030801-3	Not Required
414	DC Power Supply 0-60V	HP	6274	1029A01285	Cal when used
415	Turntable Controller	Sunol Sciences	Turntable Controller	None	Not Required
447	Rad Emissions Test Software	MiCOM	Rad Emissions Test Software Version 1.0.109	447	Not Required
462	Schwarzbeck cable from Antenna to Amplifier.	Schwarzbeck	AK 9513	462	31 May 2017
463	Schwarzbeck cable from Amplifier to Bulkhead.	Schwarzbeck	AK 9513	463	31 May 2017
464	Schwarzbeck cable from Bulkhead to Receiver	Schwarzbeck	AK 9513	464	31 May 2017

480	Cable - Bulkhead to Amp	SRC Haverhill	157-157-3050360	480	2 Jun 2017
481	Cable - Bulkhead to Receiver	SRC Haverhill	151-151-3050787	481	2 Jun 2017
482	Cable - Amp to Antenna	SRC Haverhill	157-157-3051574	482	2 Jun 2017
87	Uninterruptible Power Supply	Falcon Electric	ED2000-1/2LC	F3471 02/01	Cal when used
CC05	Confidence Check	MiCOM	CC05	None	26 Apr 2017

8. TEST RESULTS

8.1. Frequency Stability

FCC, Part 15 Subpart C §15.225(e)
Industry Canada RSS-210

Test Procedure

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Frequency Stability testing was performed using an environmental chamber to test EUT performance over temperature.

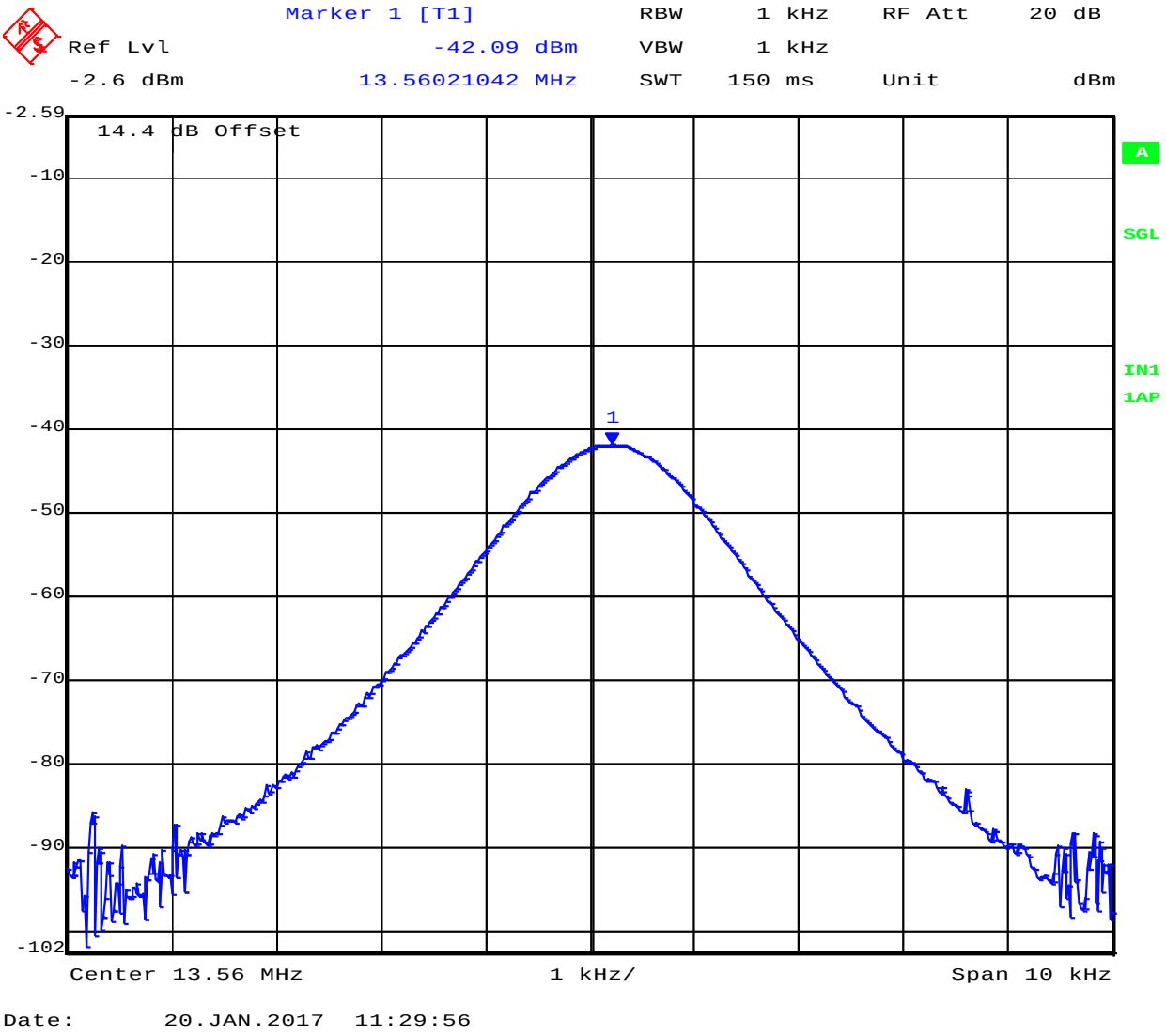
Equipment Configuration for Frequency Stability			
Variant:	NFC	**Duty Cycle (%):**	100
Data Rate:	106 Kbit/s	**Antenna Gain (dBi):**	0
Modulation:	Pulse Amplitude Modulation	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

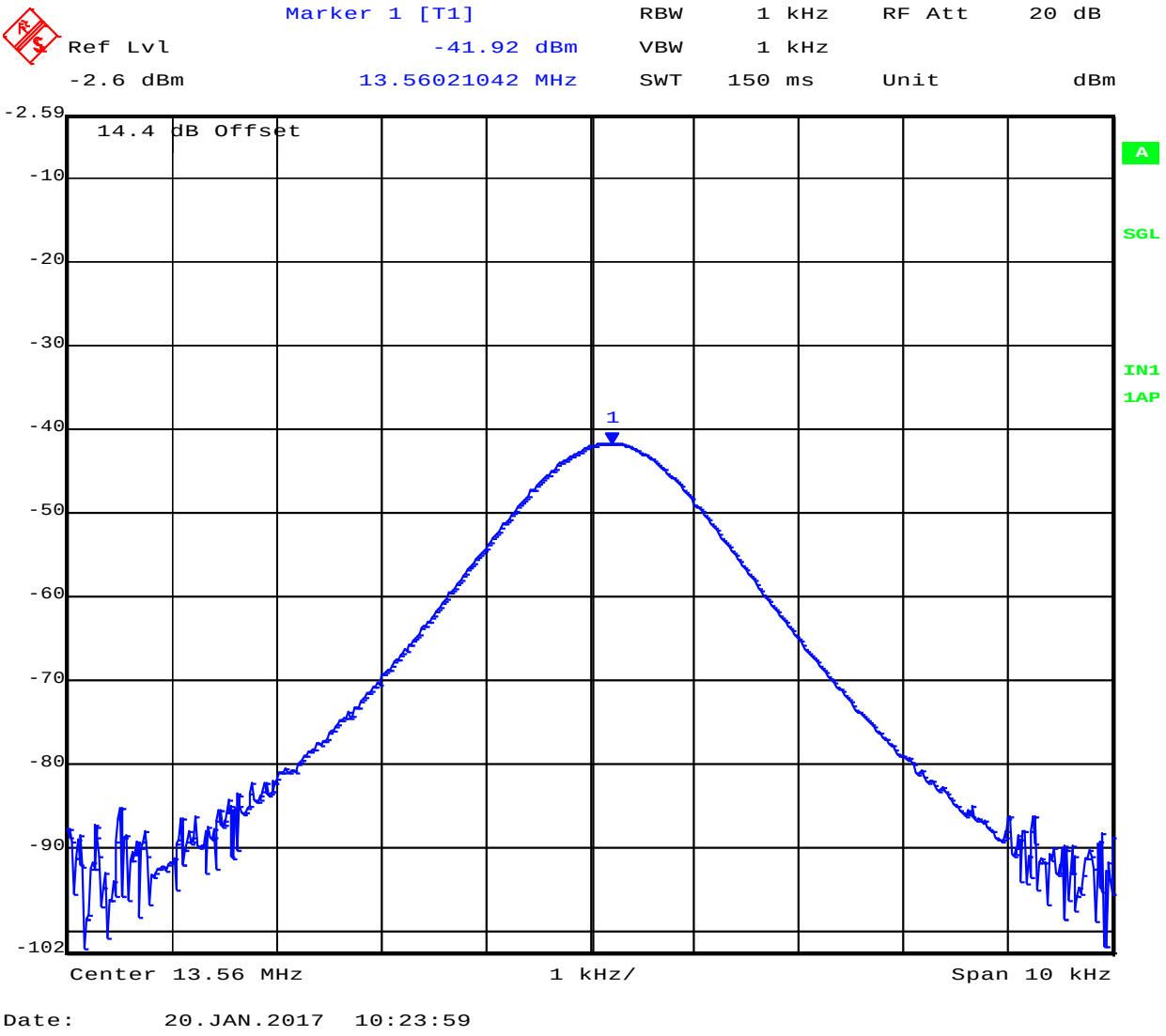
Test frequency: 13.56 MHz	Measured Frequency	Frequency Error	Limit	Margin
Temperature	**Hz**	**kHz**	**KHz**	**KHz**
+20 °C	13560210.42	0.21042	1.356	-1.15
-20 °C	13560210.42	0.21042	1.356	-1.15
-10 °C	13560270.54	0.27054	1.356	-1.09
0 °C	13560210.42	0.21042	1.356	-1.15
+10 °C	13560210.42	0.21042	1.356	-1.15
+30 °C	13560190.38	0.19038	1.356	-1.17
+40 °C	13560140.3	0.14030	1.356	-1.22
+50 °C	13560150.3	0.15030	1.356	-1.21
+60 °C	13560090.18	0.09018	1.356	-1.27
+20 °C (New Batteries)	13560210.42	0.21042	1.356	-1.15
+20 °C (Depleted Batteries 3.25 Vdc)	13560110.22	0.11022	1.356	-1.21

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-02 FREQUENCY MEASUREMENT
Measurement Uncertainty:	±0.86ppm

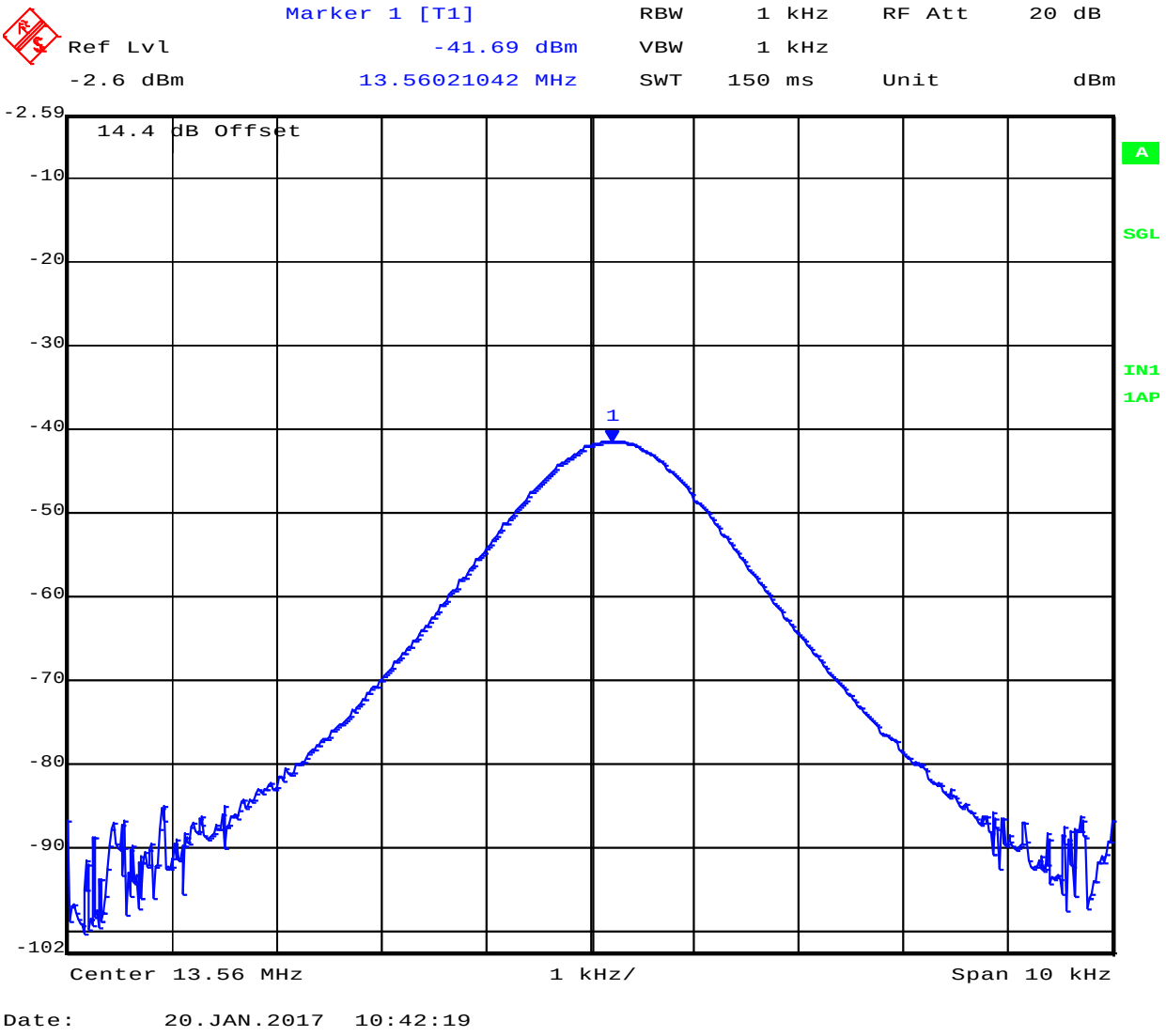
Frequency Stability +20°C



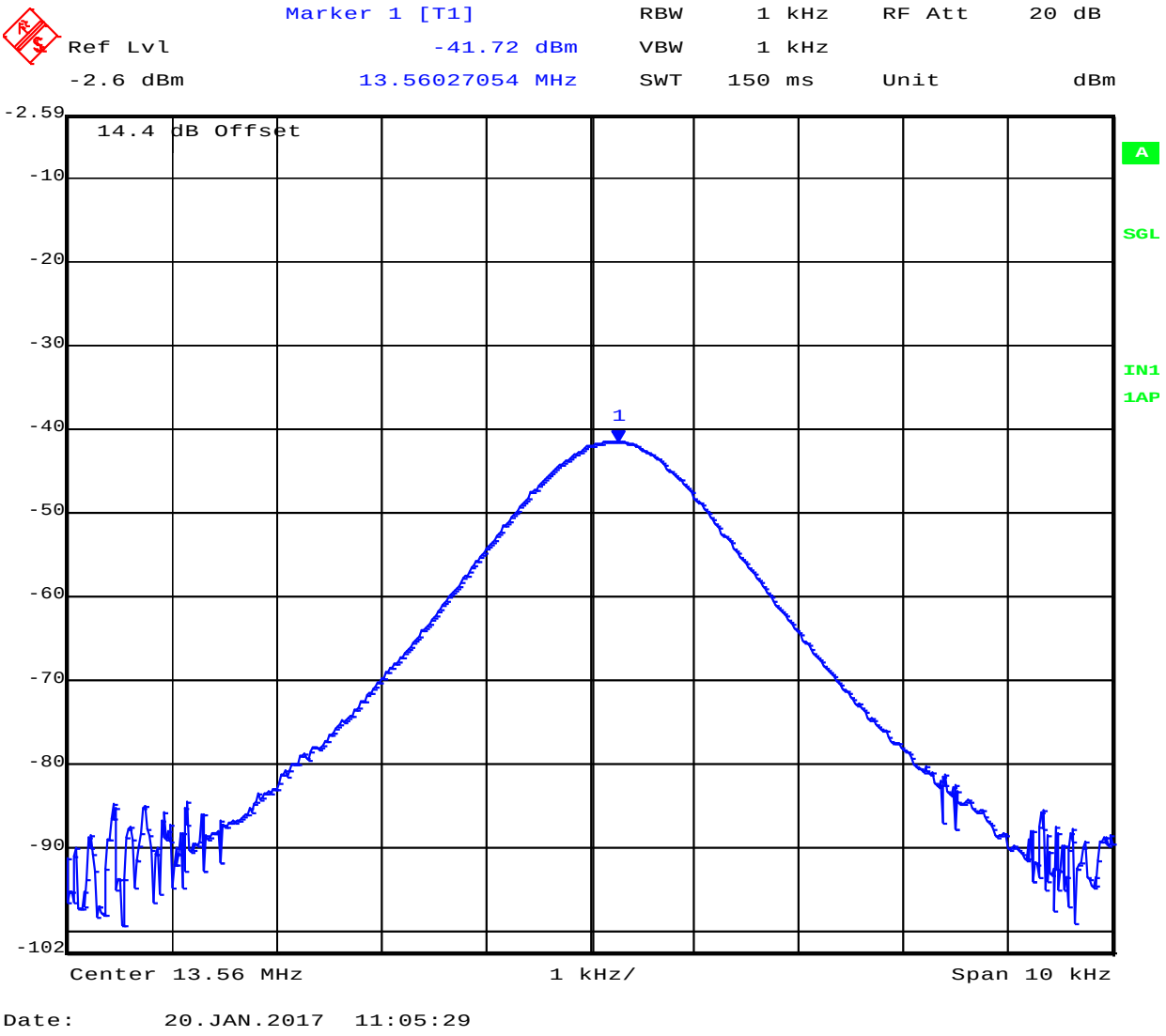
Frequency Stability -20°C



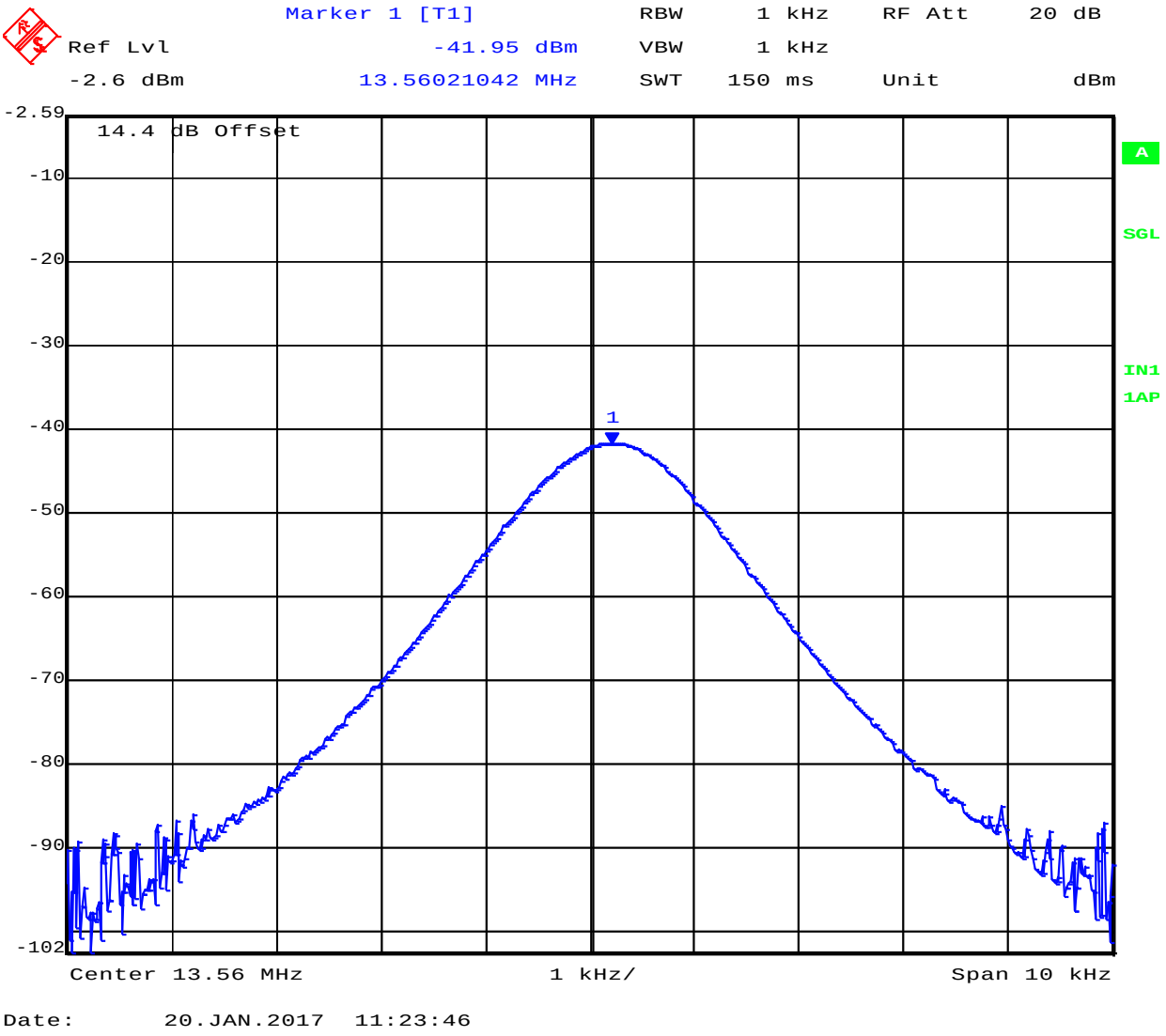
Frequency Stability -10°C



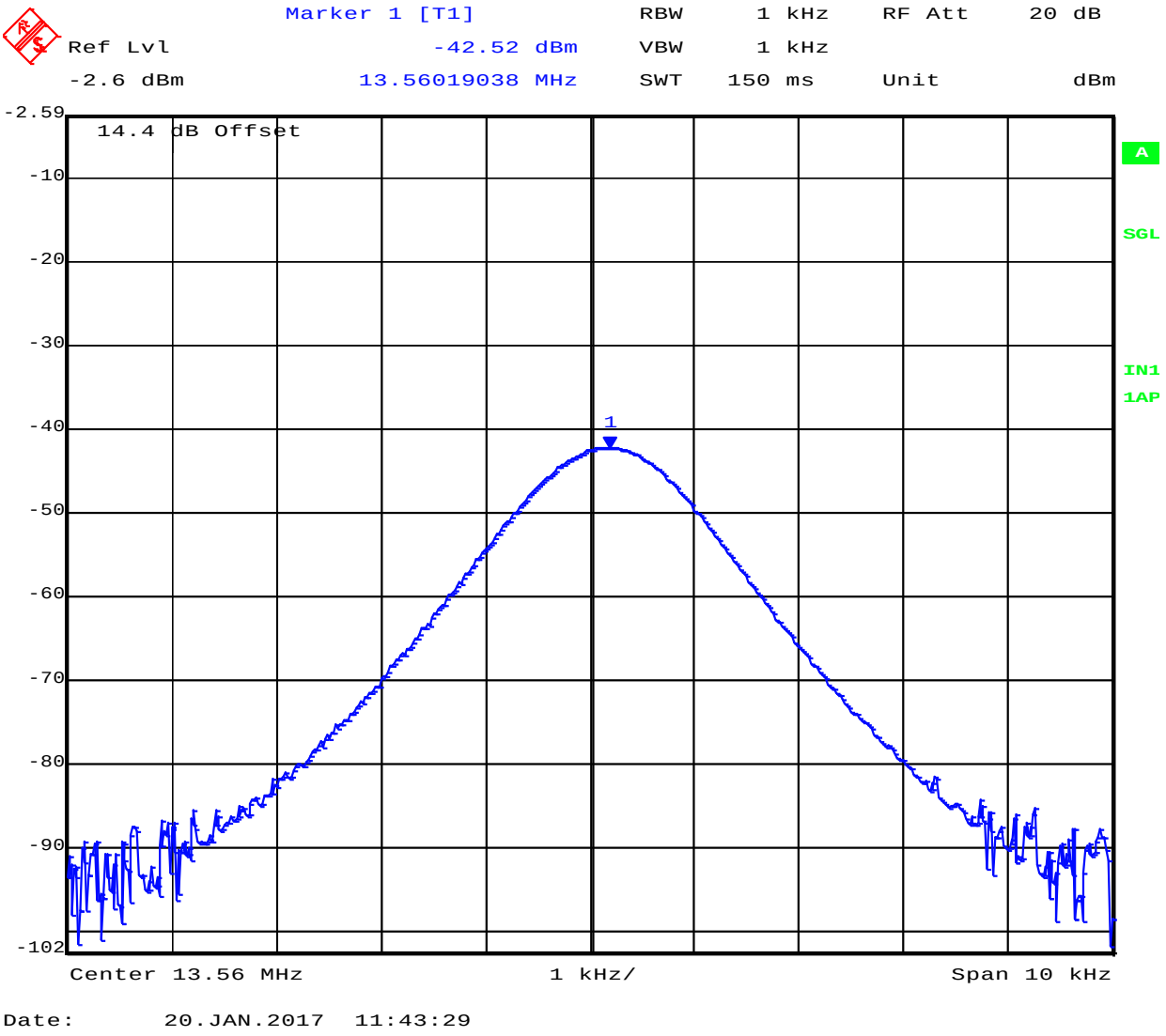
Frequency Stability 0°C



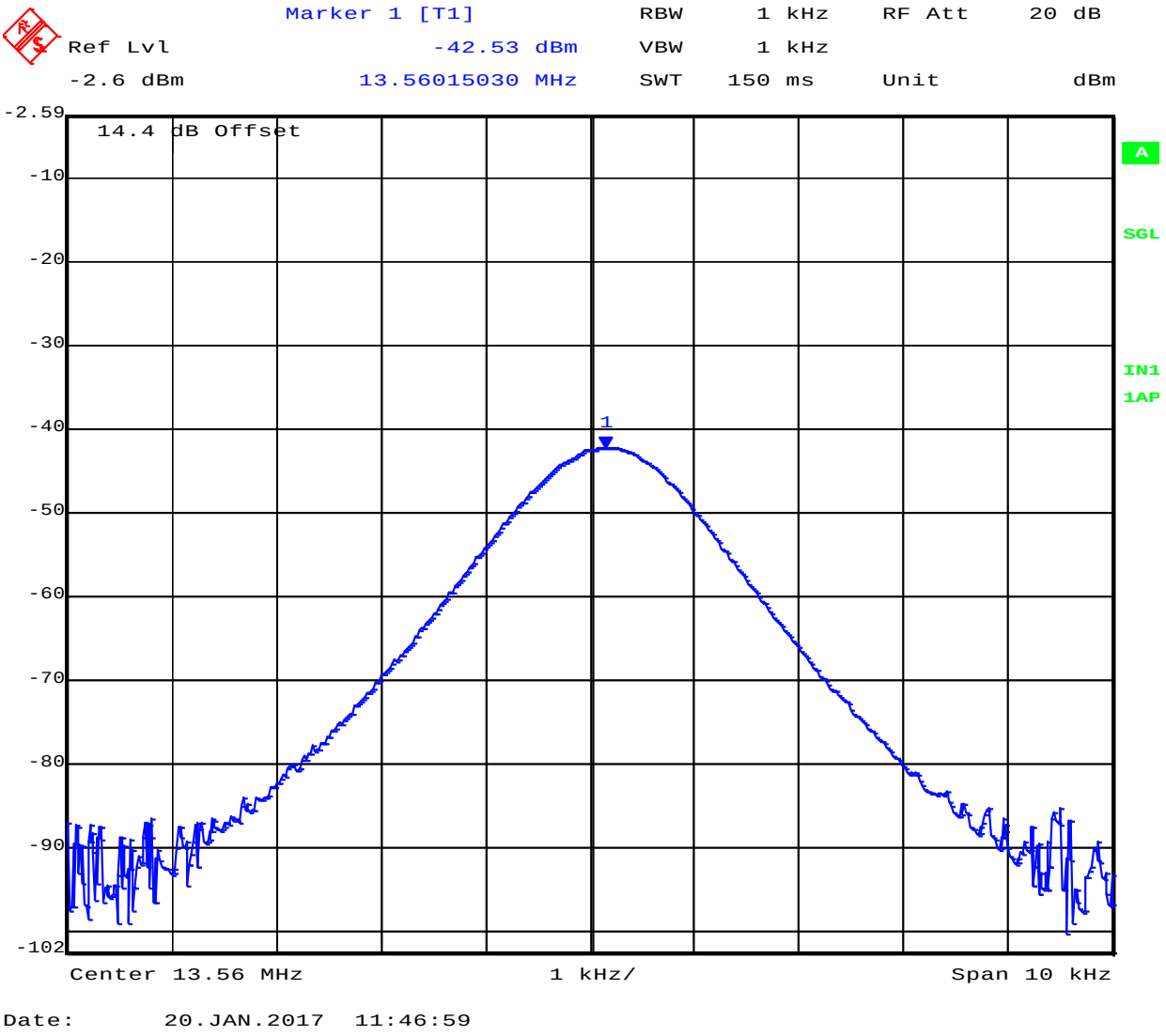
Frequency Stability +10°C



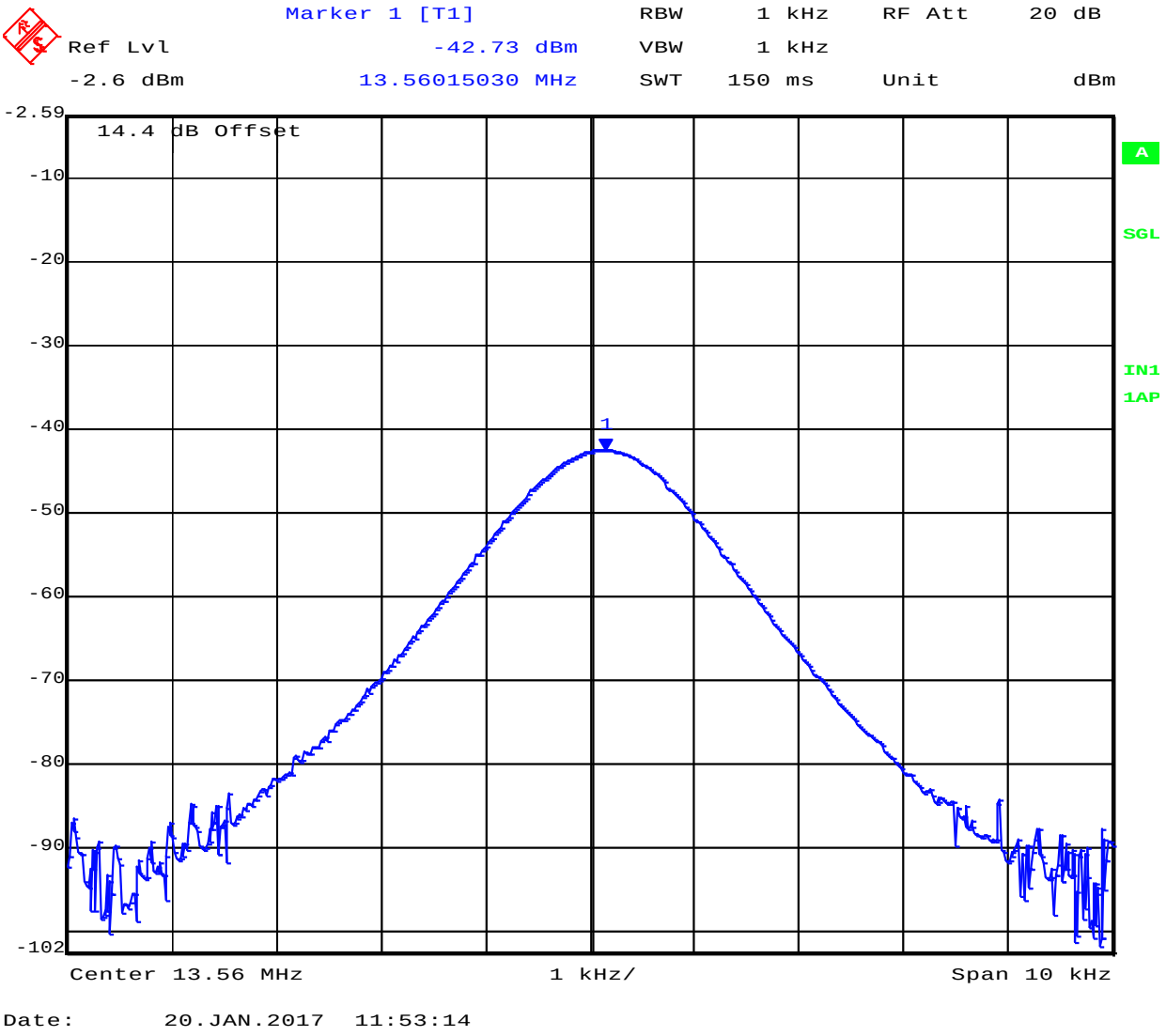
Frequency Stability +30°C



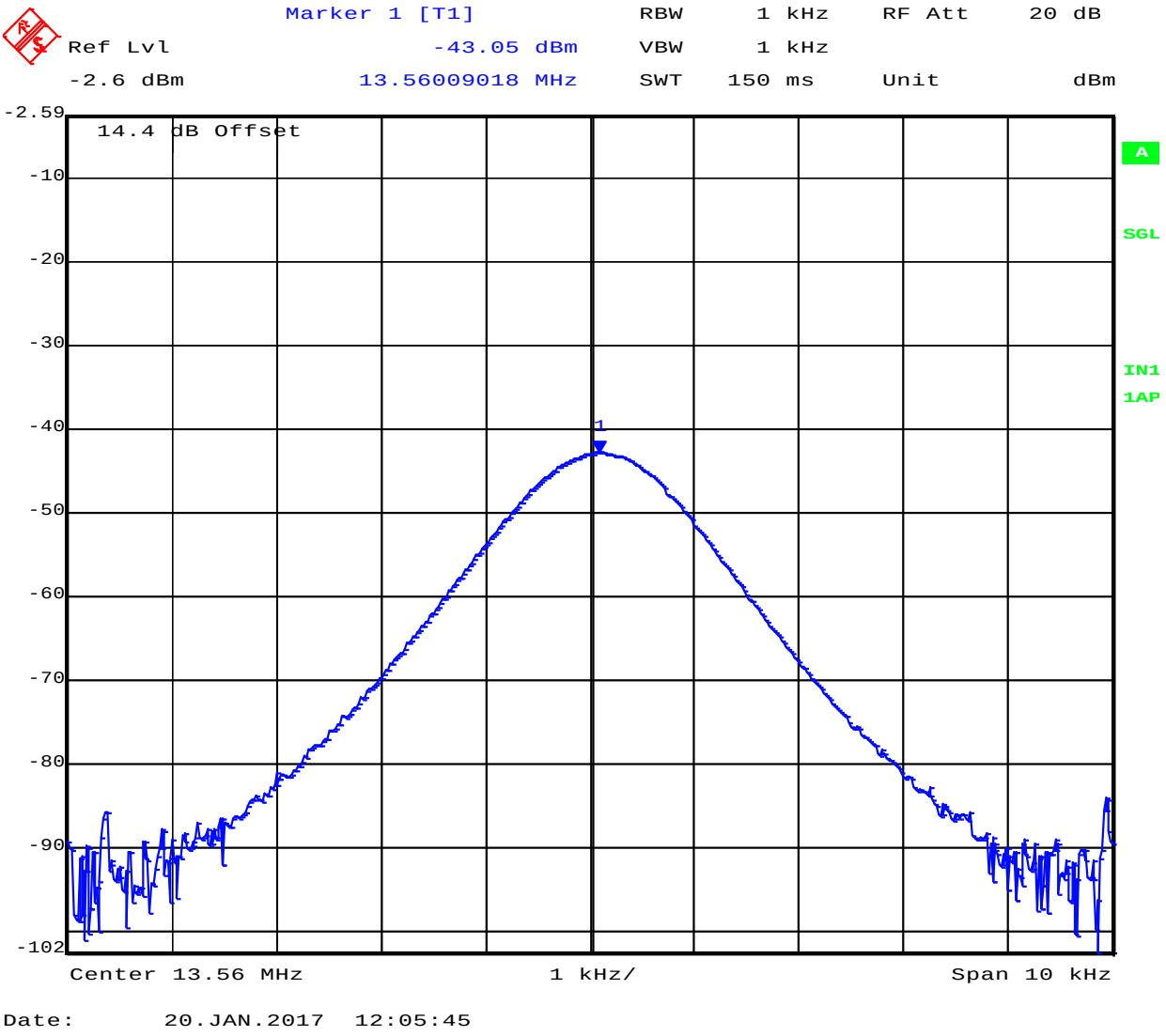
Frequency Stability +40°C



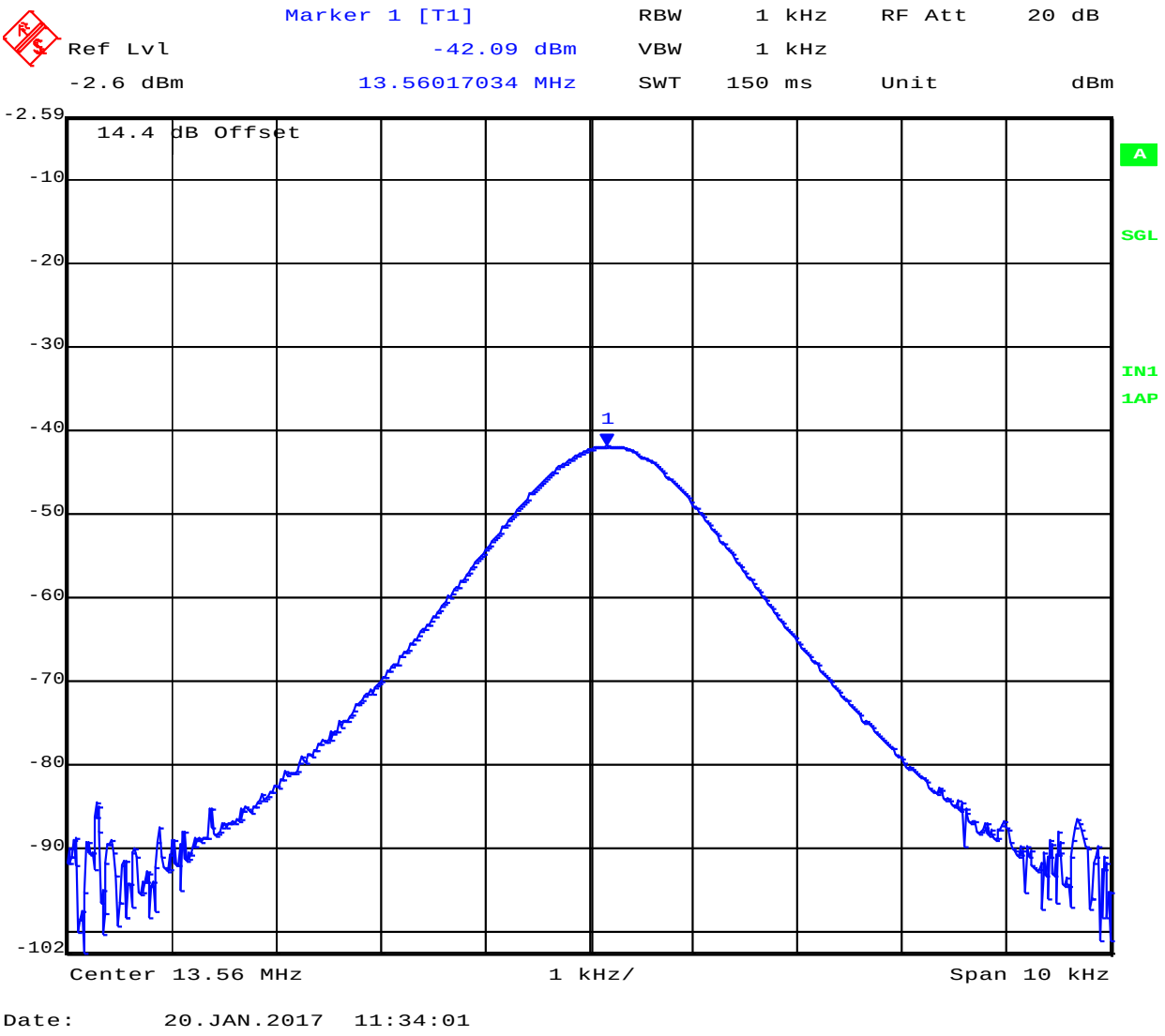
Frequency Stability +50°C



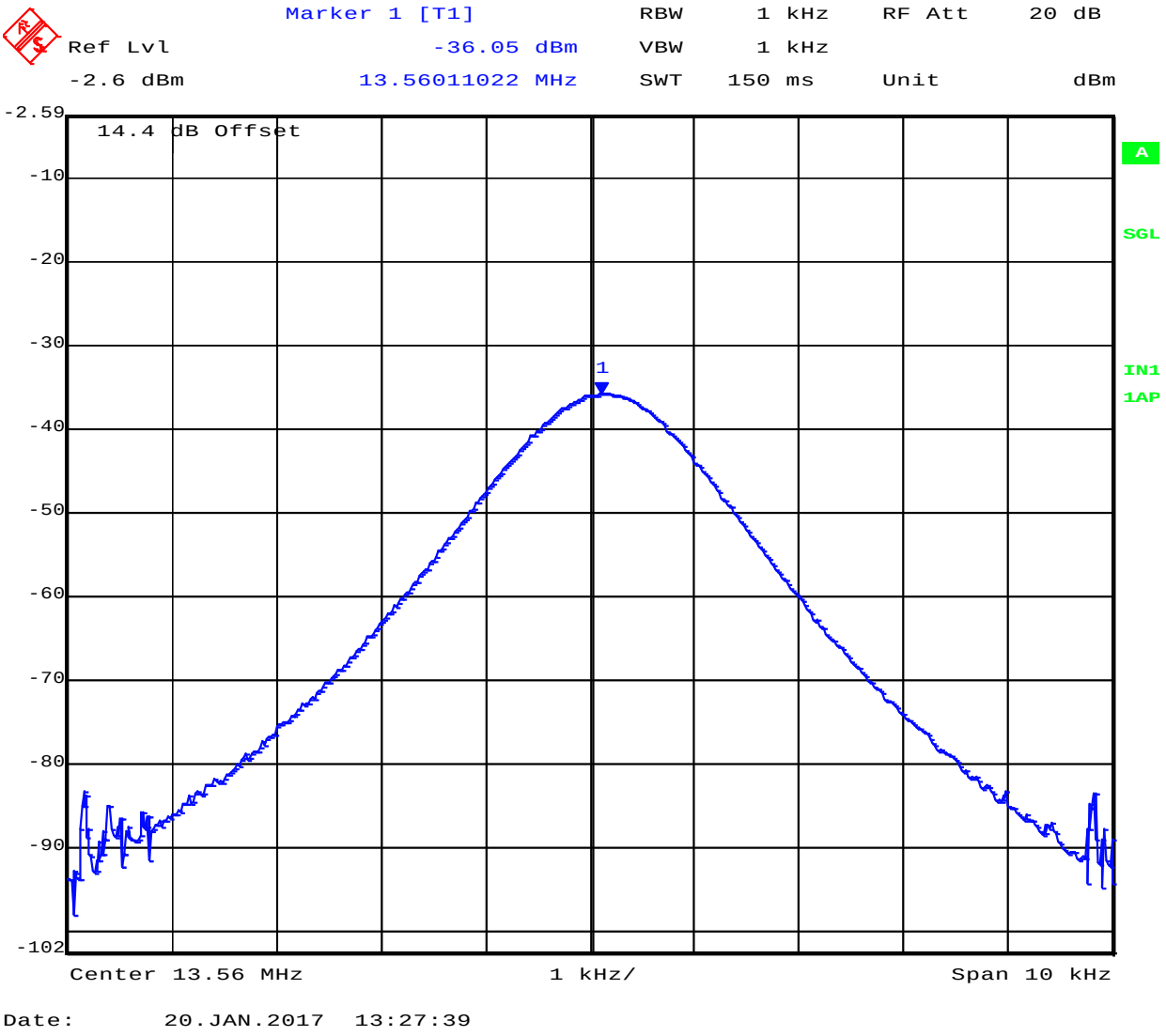
Frequency Stability + 60°C



Frequency Stability +20°C New Battery



Frequency Stability +20°C Depleted Batteries



8.2. Field Strength and Spurious Emissions

8.2.1. Radiated Emissions + Colocation

Radiated Test Conditions for Radiated Emissions (0.03 – 1 GHz)			
Standard:	FCC CFR 47:15.209, 15.225	**Ambient Temp. (ºC):**	20.0 - 24.5
Test Heading:	Radiated Emissions	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.209, 15.225/ANSI C63-10-2013, & IC-RSS 210	**Pressure (mBars):**	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Radiated Digital Emissions (9 – 150 KHz)
Testing 9KHz-150 KHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied from 0 degrees and 90 degrees. The emissions are recorded with receiver in peak hold mode. Only the highest emissions relative to the limit are listed.

Using ANSI C63-10-2013 section 6.10.5.2 Test methodology

i) Below 150 kHz: 300 Hz or CISPR 200 Hz

Test Procedure for Radiated Digital Emissions (150 KHz – 30 MHz)
Testing 150KHz-30MHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied from 0 degrees and 90 degrees. The emissions are recorded with receiver in peak hold mode. Only the highest emissions relative to the limit are listed.

Using ANSI C63-10-2013 section 6.10.5.2 Test methodology

iI) 150 kHz to 30 MHz: 10 kHz or CISPR 9 kHz

Test Procedure for Radiated Digital Emissions (0.03 – 1 GHz)
Testing 30MHz-1 GHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied between 1 and 4 meters. The emissions are recorded with receiver in peak hold mode. Only the highest emissions relative to the limit are listed.

Test configuration and setup for Radiated Spurious and Band-Edge Measurement were per the Radiated Test Set-up specified in this document.

Field Strength Calculation
The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

FS = R + AF + CORR

where:
FS = Field Strength
R = Measured Receiver Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBmV; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3dBmV/m

Conversion between dBmV/m (or dBmV) and mV/m (or mV) are done as:

Level (dBmV/m) = 20 * Log (level (mV/m))

40 dBmV/m = 100mV/m
48 dBmV/m = 250mV/m

Limits for Radiated Digital Emissions (0.03 – 1 GHz)

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

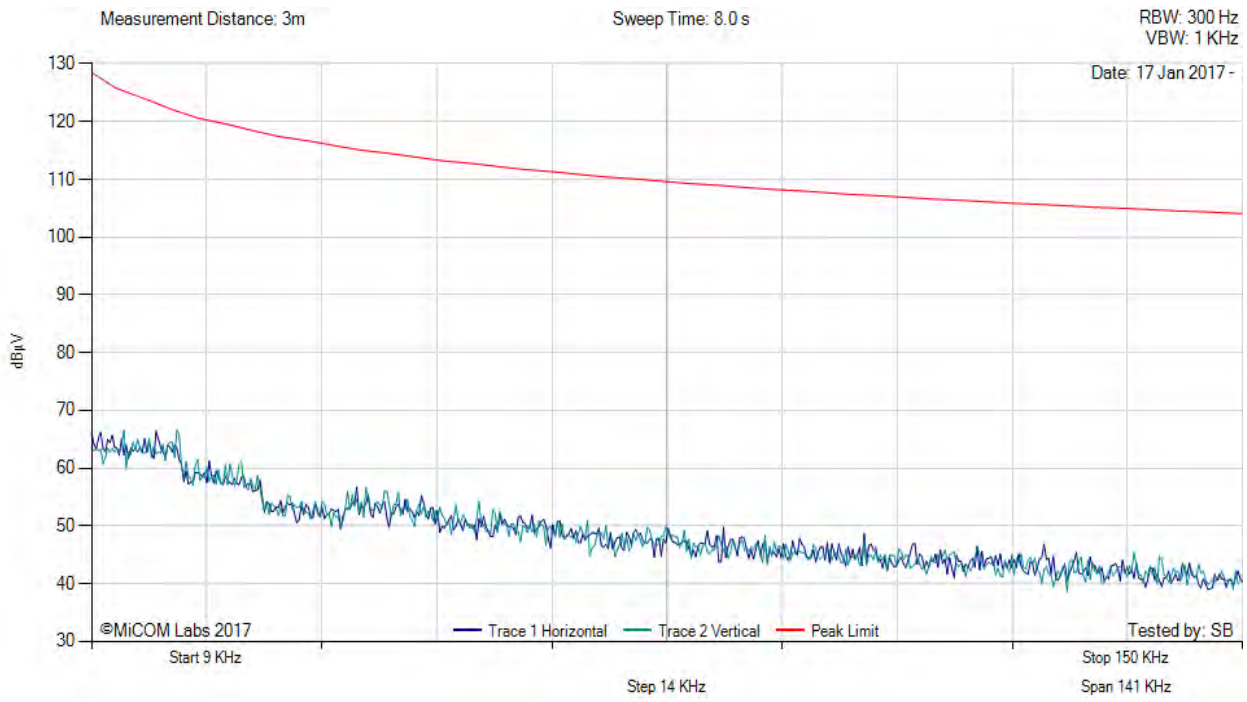
Frequency (MHz)	Field Strength		Measurement Distance (m)
	µV/m (microvolts/meter)	dBµV/m (dB microvolts/meter)	
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F(kHz)	--	30
1.705-30.0	30	29.5	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46.0	3
Above 960	500	54.0	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241. (b) In the emission table above, the tighter limit applies at the band edges. (c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency. (d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. (e) The provisions in §§15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part. (f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device. (g) Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

Equipment Configuration for Below 30MHz Emissions (9kHz - 150kHz)			
Antenna:	integral	**Variant:**	NFC & Bluetooth
Antenna Gain (dBi):	0	**Modulation:**	NFC & GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	13.56MHz/2.4GHz	**Data Rate:**	106 kBit/s
Power Setting:	Max	**Tested By:**	SB

Test Measurement Results

Variant: NFC & GFSK, Antenna: integral, Power Setting: Max, Duty Cycle (%): 99



There are no emissions found within 6dB of the limit line.

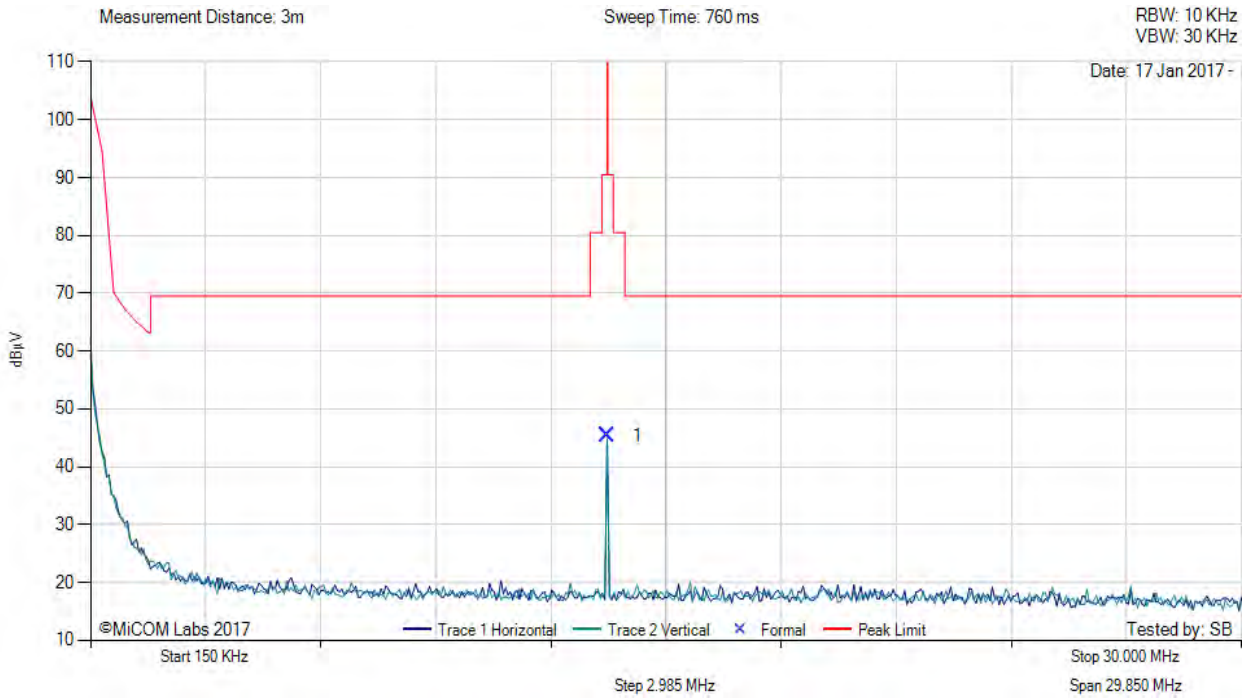
Test Notes: NFC & Bluetooth radios are active

Equipment Configuration for Below 30MHz Emissions (150kHz - 30Mhz)

Antenna:	integral	**Variant:**	NFC & Bluetooth
Antenna Gain (dBi):	0	**Modulation:**	ASK & GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	13.56MHz/2.4GHz	**Data Rate:**	106 kBit/s
Power Setting:	Max	**Tested By:**	SB

Test Measurement Results

Variant: NFC & GFSK, Antenna: integral, Power Setting: Max, Duty Cycle (%): 99

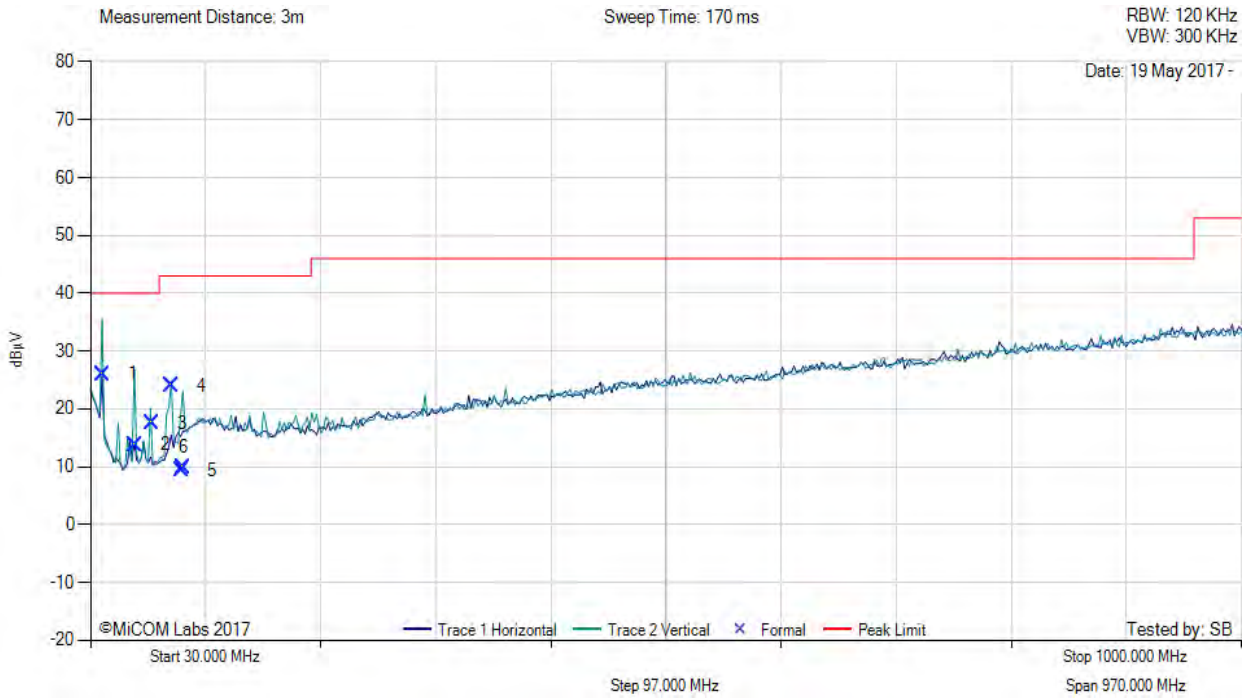


0.15.00 - 30.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	13.56	35.14	0.24	9.96	45.34	Peak (Scan)	--	0	0	80.5	-35.2	Pass

Test Notes: NFC & Bluetooth radios are active

Equipment Configuration for Digital Emissions (0.03 - 1 GHz) + BT and NFC Colocation			
Antenna:	integral	**Variant:**	NFC & Bluetooth
Antenna Gain (dBi):	0	**Modulation:**	ASK & GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	13.56MHz/2.4GHz	**Data Rate:**	106 kBit/s
Power Setting:	Max	**Tested By:**	SB
Test Measurement Results			

Test Freq: 13.56MHz & 2.4GHz, Power Setting: Max, Duty Cycle (%): 99



30.00 - 1000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	40.60	40.69	3.51	-18.16	26.04	MaxQP	Vertical	98	234	40.0	-14.0	Pass
2	67.78	33.45	3.69	-23.29	13.85	MaxQP	Vertical	385	181	40.0	-26.2	Pass
3	81.39	37.45	3.79	-23.66	17.58	MaxQP	Vertical	126	38	40.0	-22.4	Pass
4	98.07	41.73	3.87	-21.54	24.06	MaxQP	Vertical	111	0	43.0	-18.9	Pass
5	107.11	24.67	3.92	-19.22	9.37	MaxQP	Vertical	302	147	43.0	-33.6	Pass
6	108.65	24.95	3.93	-19.02	9.86	MaxQP	Vertical	363	356	43.0	-33.1	Pass

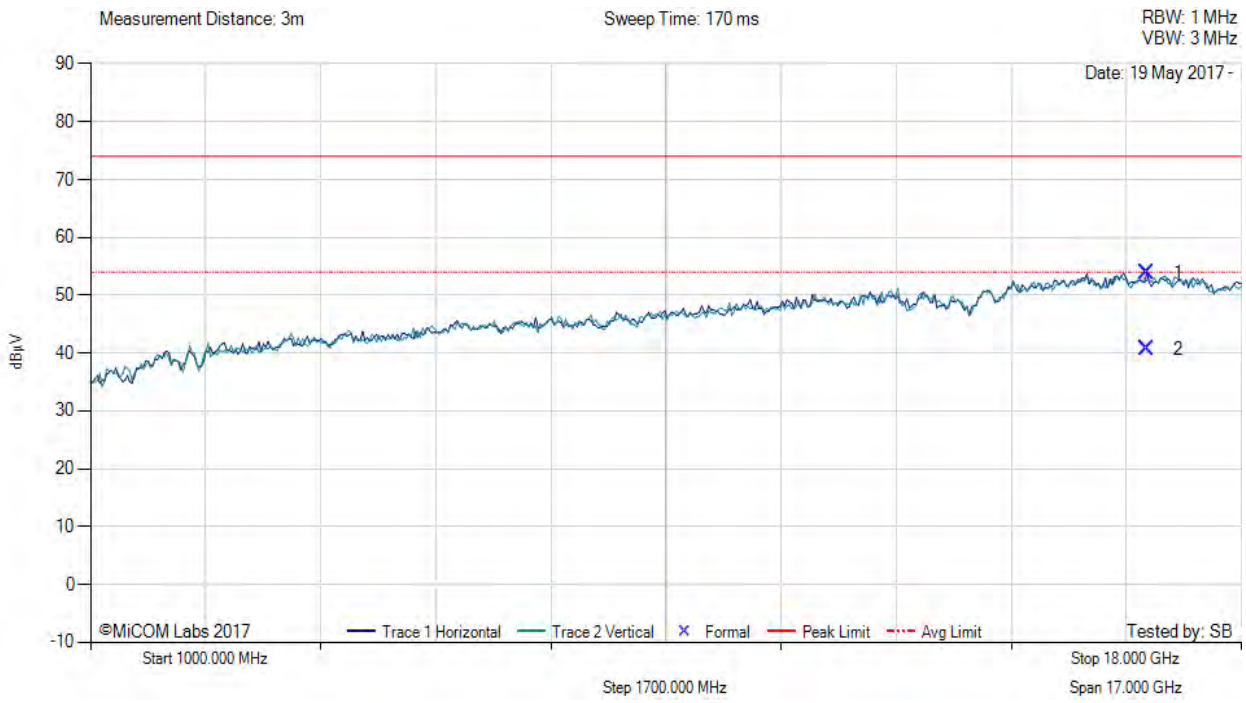
The above graphical includes both digital emissions and colocation results. With both transmitters switched ON no colocation emissions were found

Equipment Configuration for TX Spurious & Restricted Band Emissions + BT and NFC Colocation

Antenna:	integral	**Variant:**	NFC & Bluetooth
Antenna Gain (dBi):	0	**Modulation:**	ASK & GFSK
Beam Forming Gain (Y):	Not Applicable	**Duty Cycle (%):**	99
Channel Frequency (MHz):	13.56MHz/2.4GHz	**Data Rate:**	106 kBit/s
Power Setting:	Max	**Tested By:**	SB

Test Measurement Results

Variant: NFC & GFSK, Antenna: integral, Power Setting: Max, Duty Cycle (%): N/A



1000.00 - 18000.00 MHz												
Num	**Frequency MHz**	**Raw dBµV**	**Cable Loss dB**	**AF dB**	**Level dBµV/m**	**Measurement Type**	**Pol**	**Hgt cm**	**Azt Deg**	**Limit dBµV/m**	**Margin dB**	**Pass /Fail**
1	16608.77	46.25	6.05	1.59	53.89	Max Peak	Horizontal	156	240	74.0	-20.1	Pass
2	16608.77	33.04	6.05	1.59	40.68	Max Avg	Horizontal	156	240	54.0	-13.3	Pass

The above graphical includes both digital emissions and colocation results. With both transmitters switched ON no colocation emissions were found

8.2.2. Field Strength Measurement

FCC, Part 15 Subpart C §15.225(a)
Industry Canada RSS-210

Test Procedure

The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

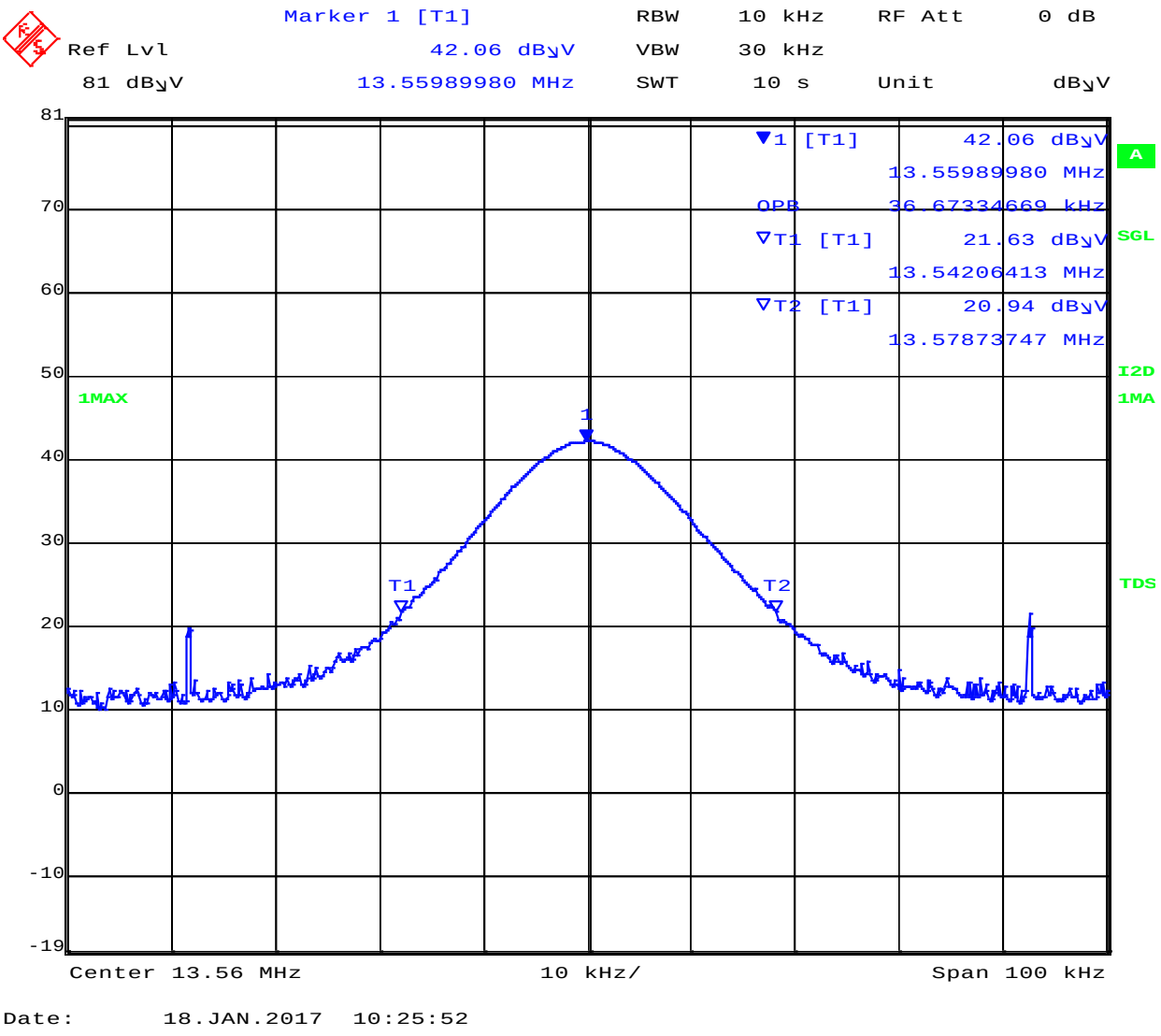
Equipment Configuration for Field Strength Measurement			
Variant:	NFC	**Duty Cycle (%):**	100
Data Rate:	106 Kbit/s	**Antenna Gain (dBi):**	0
Modulation:	Pulse Amplitude Modulation	**Beam Forming Gain (Y)(dB):**	Not Applicable
TPC:	Not Applicable	**Tested By:**	SB
Engineering Test Notes:			

Test Measurement Results

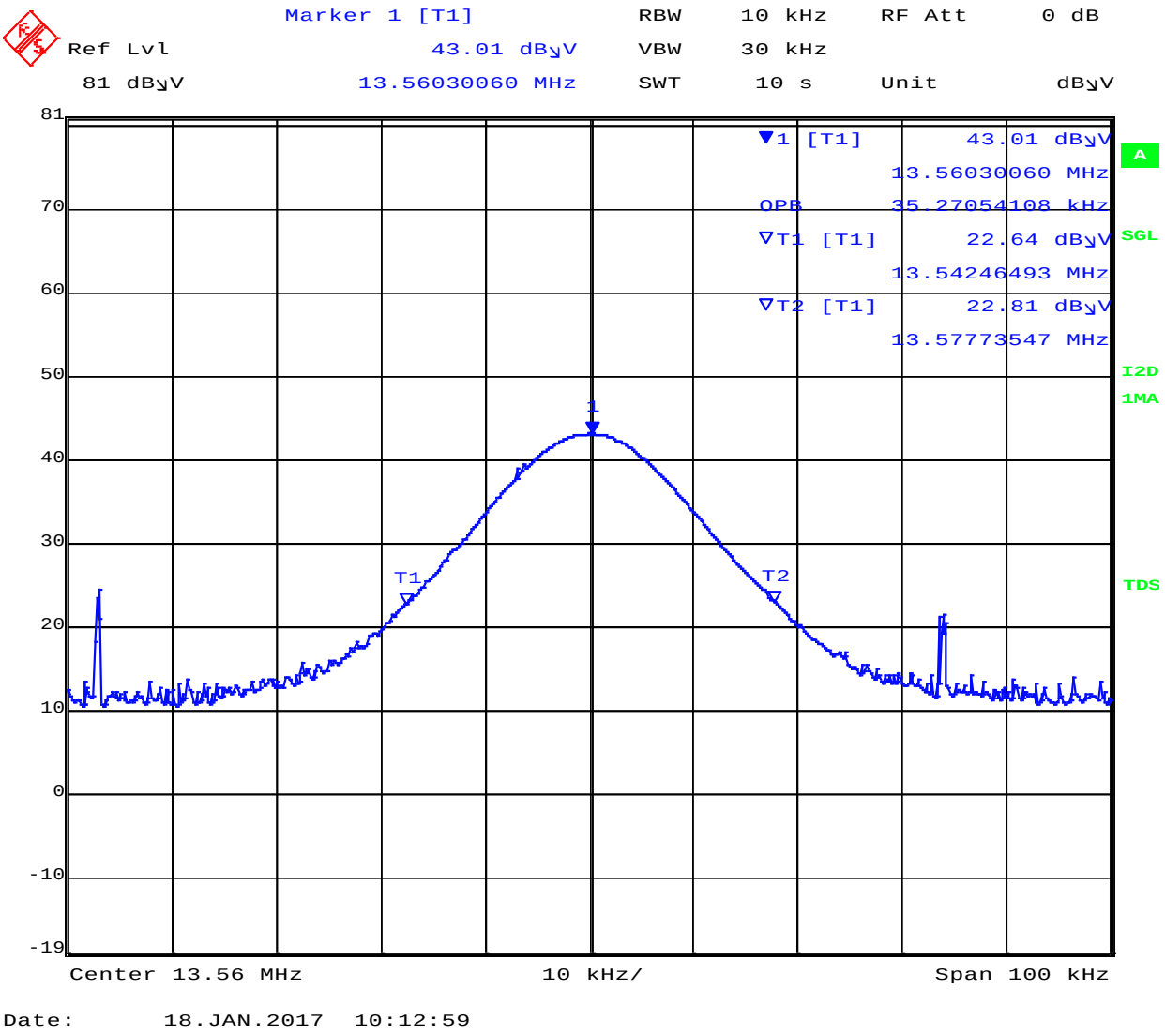
Test Frequency	13.56 MHz	Measured Frequency	Amplitude	Limit @ 3m dBuV/m	Margin @ 3m dB
Antenna Position		MHz	dBuV/m @ 3m		
0°		13.5598	42.06	124	-81.94
90°		13.5603	43.01	124	-80.99

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-01 MEASUREMENT OF RF POWER
Measurement Uncertainty:	±1.33 dB

Loop Antenna Position 0 degrees



Loop Antenna Position 90 degrees



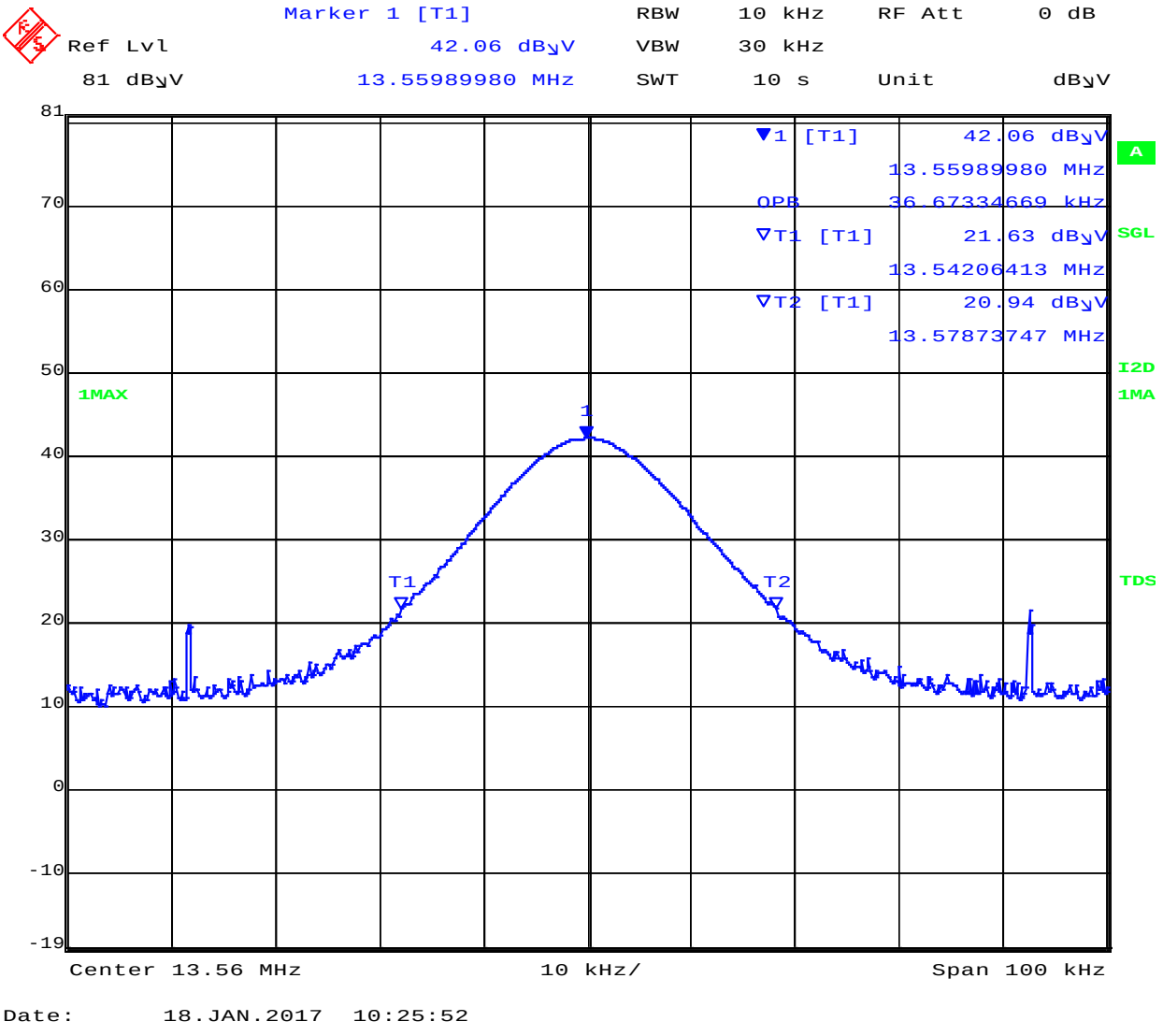
8.3. 20 dB & 99% Occupied Bandwidth

Conducted Test Conditions for 20 dB and 99% Bandwidth			
Standard:	FCC CFR 47:15.215, RSS-Gen	**Ambient Temp. (ºC):**	24.0 – 27.5
Test Heading:	20 dB and 99 % Bandwidth	**Rel. Humidity (%):**	32 – 45
Standard Section(s):	15.215, RSS-Gen	**Pressure (mBars):**	999 – 1001
Reference Document(s):	See Normative References		

Test Procedure for 20dB and 99% Bandwidth Measurement
The bandwidth at 20 dB and 99 % is measured with a spectrum analyzer connected to the antenna terminal (or for devices with a permanent antennas as a radiated measurement), while EUT is operating in transmission mode at the appropriate center frequency. The Resolution Bandwidth was set to approximately 1% of the emission bandwidth.
Testing was performed under ambient conditions at nominal voltage. Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured and reported.

Test configuration and setup used for the measurement was per the Radiated Test Set-up section specified in this document.

Equipment Configuration for 20 dB & 99% Occupied Bandwidth						
Test Measurement Results						
Test Frequency	**Measured 20 dB & 99% Bandwidth (KHz) Port(s)**				**20 dB Frequency of Operation Auth Band of Operation 13.110 – 14.010 MHz**	
MHz	**a**	**b**	**c**	**d**	**Low Freq**	**High Freq**
13.56	36.673				13.542	13.579



8.4. AC Mains Power Input/Output Ports

No tests required, EUT is battery powered with no connection to AC Mains Network.

Scope

This test assesses the ability of the EUT to limit its internal noise from being present on the AC mains power input/output ports.

Test Method

The test method shall be in accordance with CISPR 22 and the Artificial Mains Networks (AMNs) shall be connected to the AC mains power source.

The measurement frequency range extends from 150 kHz to 30 MHz. When the EUT is a transmitter operating at frequencies below 30 MHz, then the exclusion band for transmitters applies for measurements in the transmit mode of operation.

Test Procedure

The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

Limits

The equipment shall meet the class B limits given in CISPR 22. Alternatively, for equipment intended to be used in telecommunication centres only, the class A limits given in CISPR 22 may be used.

Class B Emissions

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

Class A Emissions

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	79	66
0.5-30	73	60

Traceability

All conducted emission measurements are traceable to national standards. The uncertainty of measurement at a confidence level of not less than 95 %, with a coverage factor of k=2, in the range 9 kHz – 30 MHz (Average & Quasi-peak) is ±2.64 dB.

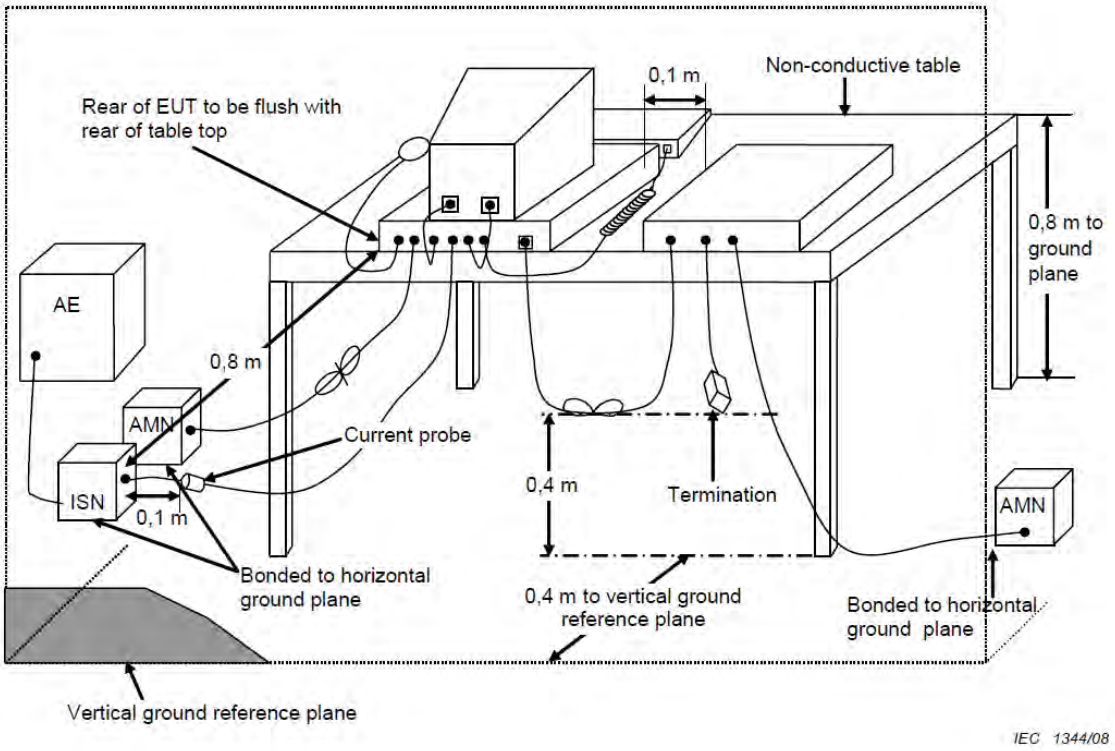
Laboratory Measurement Uncertainty	
Measurement uncertainty	±2.64 dB

Method
Measurements were made per work instruction WI-EMC-01 ‘Measurement of Conducted Emissions’

Test Equipment Utilized

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
158	Barometer/Thermometer	Control Company	4196	E2846	30 Nov 2017
184	Pulse Limiter	Rhode & Schwarz	ESH3Z2	357.8810.52	7 Apr 2017
190	LISN (two-line V-network)	Rhode & Schwarz	ESH3Z5	836679/006	29 Oct 2017
193	Receiver 20 Hz to 7 GHz	Rhode & Schwarz	ESI 7	838496/007	10 Oct 2017
307	BNC-CABLE	Megaphase	1689 1GVT4	15F50B002	6 Apr 2017
316	Dell desktop computer workstation with Vasona	Dell	Desktop	WS04	Not Required
351	Data Impedance Stabilization Network	Teseq	ISN T800	24809	30 Nov 2017
372	AC Variable PS	California Instruments	1251P	L06951	Cal when used
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	07 Jul 2017
388	LISN (3 Phase) 9kHz - 30MHz	Rohde & Schwarz	ESH2-Z5	892107/022	30 Oct 2017
ADAPT SMA#1	SMA Cable	Megaphase	SMA Cable #1	None	6 Apr 2017
CCEMC01	Confidence Check	MiCOM	CCEMC01	None	6 Apr 2017

Test Setup – Power Input / Output Port



8.5. Antenna Requirement

8.5.1. Scope

Per FCC 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.

8.5.2. Test Result

EUT has a permanently attached antenna (PCB) with no provision for removal. EUT meets antenna requirement.

575 Boulder Court
Pleasanton, California 94566, USA
Tel: +1 (925) 462 0304
Fax: +1 (925) 462 0306
www.micomlabs.com