# REGULATORY COMPLIANCE TEST REPORT

**FCC CFR 47 Part 15.225 & ISED RSS-210**

**Report No.: LYFT08-U7 Rev A**

**Company:** Lyft, Inc

**Model Name:** BIT041B

# REGULATORY COMPLIANCE TEST REPORT

**Company Name:** Lyft, Inc

**Model Name:** BIT041B

**To:** FCC CFR 47 Part 15.225 & ISED RSS-210

**Test Report Serial No.:** LYFT08-U7 Rev A

This report supersedes: NONE

Applicant: Lyft, Inc
185 Berry St #5000
San Francisco, California 94107
USA

Issue Date: 28th July 2021

**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

A2LA ACCREDITED
TESTING CERT #2381.01

**MiCOM Labs is an ISO 17025 Accredited Testing Laboratory**

# Table of Contents

# 1. ACCREDITATION, LISTINGS & RECOGNITION

## 1.1. TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard ISO/IEC 17025:2017. 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

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 17025:2017 *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 April 2017*).

Presented this 24th day of February 2020.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2021

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

## 1.2. RECOGNITION

MiCOM Labs, Inc is widely recognized for its wireless testing and certification capabilities. In addition to being recognized for Testing and Certification under Phase 2 Mutual Recognition Agreements (MRA) with Canada, Europe, United Kingdom and Japan, our international recognition includes Conformity Assessment Body (CAB) designation status under agreements with Asia Pacific (APEC) MRA Phase 1 countries giving acceptance of MiCOM Labs test reports. MiCOM Labs test reports are accepted globally.

| Country | Recognition Body | Status | MRA Phase | Identification No. |
|---|---|---|---|---|
| USA | Federal Communications Commission (FCC) | TCB | - | US0159<br>Test Firm Designation#: US1084 |
| Canada | Industry Canada (ISED) | FCB | APEC MRA 2 | US0159<br>ISED#: 4143A |
| Japan | MIC (Ministry of Internal Affairs and Communication) | CAB | Japan MRA 2 | RCB 210 |
| | Japan Approvals Institute for Telecommunication Equipment (JATE) | | | |
| | VCCI | -- | -- | A-0012 |
| Europe | European Commission | NB | EU MRA 2 | NB 2280 |
| United Kingdom | Department for Business, Energy & Industrial Strategy (BEIS) | AB | UK MRA 2 | AB 2280 |
| Mexico | Instituto Federal de Telecomunicaciones (IFT) | CAB | Mexico MRA 1 | US0159 |
| Australia | Australian Communications and Media Authority (ACMA) | CAB | APEC MRA 1 | US0159 |
| Hong Kong | Office of the Telecommunication Authority (OFTA) | | | |
| Korea | Ministry of Information and Communication Radio Research Laboratory (RRL) | | | |
| Singapore | Infocomm Development Authority (IDA) | | | |
| Taiwan | National Communications Commission (NCC)<br>Bureau of Standards, Metrology and Inspection (BSMI) | | | |
| Vietnam | Ministry of Communication (MIC) | | | |

TCB – Telecommunications Certification Bodies (TCB)
FCB – Foreign Certification Body
CAB – Conformity Assessment Body
NB – Notified Body
AB – Approved Body

MRA – Mutual Recognition Agreement
MRA 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 product certification body also meets the *A2LA R322 – Specific Requirements – Notified Body Accreditation Requirements* and *A2LA R308 - Specific Requirements - ISO-IEC 17065 - Telecommunication Certification Body Accreditation Program*. This accreditation demonstrates technical competence for a defined scope and the operation of a management system.

Presented this 24th day of February 2020

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2021

*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
UK – Approved Body (AB), AB Identifier - 2280
Japan – Recognized Certification Body (RCB), RCB Identifier - 210

## 2. DOCUMENT HISTORY

| Document History | | |
|---|---|---|
| Revision | Date | Comments |
| Draft | 25th July 2021 | Draft report for client for review.<br><br>For FCC ID: 2ASMP-BIT041B modifications were made to the device that triggers a verification test in order to prove continued compliance, see Section 5.2 Scope of Test Program for the extent of the modifications |
| Rev A | 28th July 2021 | Initial release |
| | | |
| | | |
| | | |
| | | |
| | | |

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





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

# 3. TEST RESULT CERTIFICATE

| | | | |
|---|---|---|---|
| **Manufacturer:** | Lyft, Inc<br>185 Berry St #5000<br>San Francisco<br>California 94107 USA | **Tested By:** | MiCOM Labs, Inc.<br>575 Boulder Court<br>Pleasanton<br>California 94566 USA |
| **Model:** | BIT041B | **Telephone:** | +1 925 462 0304 |
| **Type Of Equipment:** | E-Bike Location and Control Unit | **Fax:** | +1 925 462 0306 |
| **S/N's:** | Conducted: FK2114CVCU2NC0092<br>Radiated: FK2114CVCU2NC0155 | | |
| **Test Date(s):** | 20th July 2021 | **Website:** | www.micomlabs.com |

| STANDARD(S) | TEST RESULTS |
|---|---|
| FCC CFR 47 Part 15.225 & ISED 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 | KDB 662911 D01 & D02 | Oct 31 2013 | Guidance for measurement of output emission of devices that employ single transmitter with multiple outputs or systems with multiple transmitters operating simultaneously in the same frequency band |
| II | A2LA | 5th October 2020 | R105 - Requirement's When Making Reference to A2LA Accreditation Status |
| III | ANSI C63.10 | 2013 | American National Standard for Testing Unlicensed Wireless Devices |
| IV | ANSI C63.4 | 2014 | American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| V | CISPR 32 | 2015 | Electromagnetic compatibility of multimedia equipment - Emission requirements |
| VI | 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 |
| VII | FCC 47 CFR Part 15.225 | 2020 | Operation within the band 13.110-14.010MHz |
| VIII | ICES-003 | Issue 7 ; October 15, 2020 | Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement. |
| IX | M 3003 | Edition 3 Nov.2012 | Expression of Uncertainty and Confidence in Measurements |
| X | RSS-210 | Issue 10 December 2019 | RSS-210 — License-Exempt Radio Apparatus: Category I Equipment |
| XI | RSS-Gen Issue 5 | March 2019 Amendment 1 | General Requirements for Compliance of Radio Apparatus |
| XII | FCC 47 CFR Part 2.1033 | 2020 | FCC requirements and rules regarding photographs and test setup diagrams. |

## 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.





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

# 5. PRODUCT DETAILS AND TEST CONFIGURATIONS

## 5.1. Technical Details

| Details | Description |
|---|---|
| Purpose: | Test of the Lyft, Inc BIT041B to FCC CFR 47 Part 15.225 & ISED RSS-210 |
| Applicant: | Lyft, Inc<br>185 Berry St #5000<br>San Francisco California 94107, USA |
| Manufacturer: | Lyft, Inc |
| Laboratory performing the tests: | MiCOM Labs, Inc.<br>575 Boulder Court<br>Pleasanton California 94566, USA |
| Test report reference number: | LYFT08-U7 |
| Date EUT received: | 20th July 2021 |
| Standard(s) applied: | FCC CFR 47 Part 15.225 & ISED RSS-210 |
| Dates of test (from - to): | 20th July 2021 |
| No of Units Tested: | 2 |
| Type Of Equipment: | E-Bike Location and Control Unit |
| Model(s): | BIT041B |
| Location for use: | Indoor / Outdoor |
| Declared Frequency Range(s): | 13.56 MHz |
| Type of Modulation: | ASK |
| EUT Modes of Operation: | NFC |
| Transmit/Receive Operation: | Transceiver |
| Rated Input Voltage and Current: | 48VDC / 1A Battery |
| Operating Temperature Range: | -20ºC to +50ºC |
| ITU Emission Designator: | 2K00N0N |
| Equipment Dimensions: | 15.75cm x 8.8cm x 5.5cm |
| Weight: | 360 grams |
| Hardware Rev: | A |
| Software Rev: | 16b00bc1d102c |

## 5.2. Scope Of Test Program

**Lyft, Inc BIT041B**

The scope of the test program was to test the Lyft, Inc BIT041B NFC operating in the frequency range 13.110 – 14.010 MHz; for compliance against the following specifications:

**FCC CFR 47 Part 15.225**
Radio Frequency Devices; Operating in the band 13.110 – 14.010 MHz

**ISED RSS-210**
License-Exempt Radio Apparatus

Section 7. Technical Specifications; B.6 Band 13.110-14.010 MHz

## Device Modifications

DocuSign Envelope ID: 536CA031-C6E3-4458-9399-F2E1C95618C0

185 Berry Street
Suite 5000
San Francisco, CA 94107

Office of Engineering Technology
Federal Communications Commission
7435 Oakland Mills Road
Columbia, MD 21046
USA

Date: 7/28/2021

Subject: Description of Hardware Changes
FCC ID: 2ASMP-BIT041B

To Whom It May Concern,

The test reports for 2ASMP-BIT041B (Model BIT041B) make reference to measurements conducted on a previous version of the hardware design (tested under FCC ID 2ASMP-BIT040B, model BIT040B). The performance of model BIT041B is believed to be fundamentally similar to model BIT040B, and this was verified using spot checks in expected worst case scenarios.

The electrical changes between the two models are expected to have a minimal effect on the radiated and conducted RF measurements on the modules. The changes between model BIT040B and BIT041B are summarized on the next page.

There are no design changes on the RF path for the LTE, BLE, and WiFi transceivers; the emissions results for these transceivers are expected to be similar to those from the BIT040B test report.

There are changes in the RF path for the NFC transceiver, but the resulting emissions are expected to be similar to those from the BIT040B test report.

List of Changes

1. NFC PCBA (VCU_NFC)
    a. Remove series 0-ohm resistors (R14 & R16) on the NFC antenna path and replace them with PCB traces. Add test points on NFC antenna traces (ANT1 & ANT2).
    b. Remove excess GND polygon in the J3 area.
    c. Remove series 0-ohm resistor R10 and replace with a PCB trace.
    d. Remove series 0-ohm resistor R23 and replace with a PCB trace.
    e. Remove I2C address resistors (R3, R6, R7, and R8) and replace them with PCB traces to GND.
    f. Rename components FB1 and FB2 to L2 and L4 (respectively). Rotate L2 90 degrees in layout.
    g. Update bypass components on display connector to match vendor recommendation.
2. Main PCBA (VCU_MLB)
    a. Add vias to LTE antenna (U0410, U0470) mechanical mounting pads.
    b. Change L1440 and L1441 to a different ferrite bead (Murata NFZ18SM701SN10D).
    c. Change board revision resistors (R1018, R1019) to different resistance values.
    d. Change R0942 to a different resistance value to prevent power supply brownout.
    e. Connect the STATUS and RESET pins on the LTE module (U0100) to the main MCU (U0200). Add R0342, Q0341, and R0343 to make this connection.

Sincerely,

DocuSigned by:
Nik Hatzis
Name: Nik Hatzis
Title: Director, Micromobility Compliance and Safety

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

| Type (EUT/ Support) | Equipment Description (Including Brand Name) | Mfr. | Model No. | Serial No. |
|---|---|---|---|---|
| EUT | E-Bike Location and Control Unit | Lyft Inc | BIT041B | Conducted: FK2114CVCU2NC0092<br>Radiated: FK2114CVCU2NC0155 |
| Support | Laptop | Lenovo | N/A | N/A |

## 5.4. Antenna Details

| Type | Manufacturer | Model | Gain (dBi) | Frequency Band (MHz) |
|---|---|---|---|---|
| Integral | Lyft | PCB Loop Antenna | 0.0 | 13.110-14.010 |

## 5.5. Cabling and I/O Ports

| Port Type | Max Cable Length | Conn Type | Environment |
|---|---|---|---|
| Discrete I/O | <3m | Higo L810 CG | End-User\| |
| Analog | <3m | Higo L309 CM | End-User\| |
| Analog | <3m | Higo L609 CM | End-User\| |
| CAN+DC IN | <3m | Higo L409 CG | End-User\| |
| Power + Digital I/O | <3m | Higo L509 CM | End-User\| |

## 5.6. Test Configurations

Results for the following configurations are provided in this report:

| Operational Mode | Data Rate with Highest Power MBit/s | Channel Frequency (MHz) | | |
|---|---|---|---|---|
| | | Low | Mid | High |
| **13.110 – 14.010 MHz** | | | | |
| NFC | - | -- | 13.56 | -- |

## 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

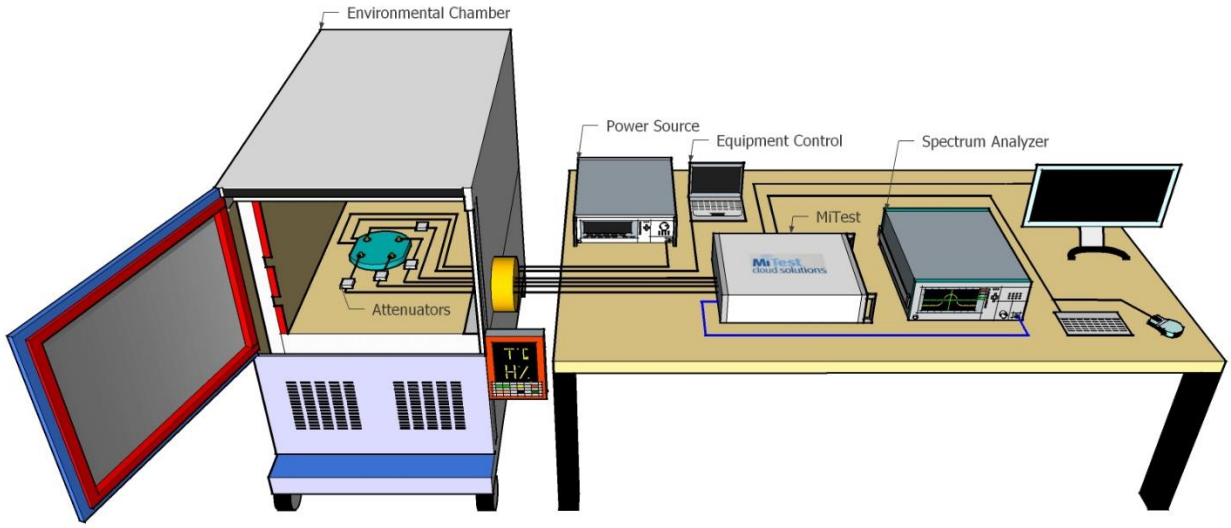
List of Measurements

| Test Header | Result | Data Link |
|---|---|---|
| Frequency Tolerance | Complies | View Data |
| Emissions | Complies | - |
| Radiated Emissions | Complies | - |
| (i) TX Spurious & Restricted Band Emissions | Complies | View Data |
| (ii) Field Strength | Complies | View Data |

# 7. TEST EQUIPMENT CONFIGURATION(S)

## 7.1. Conducted Test Setup

MiTest Automated Test System




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

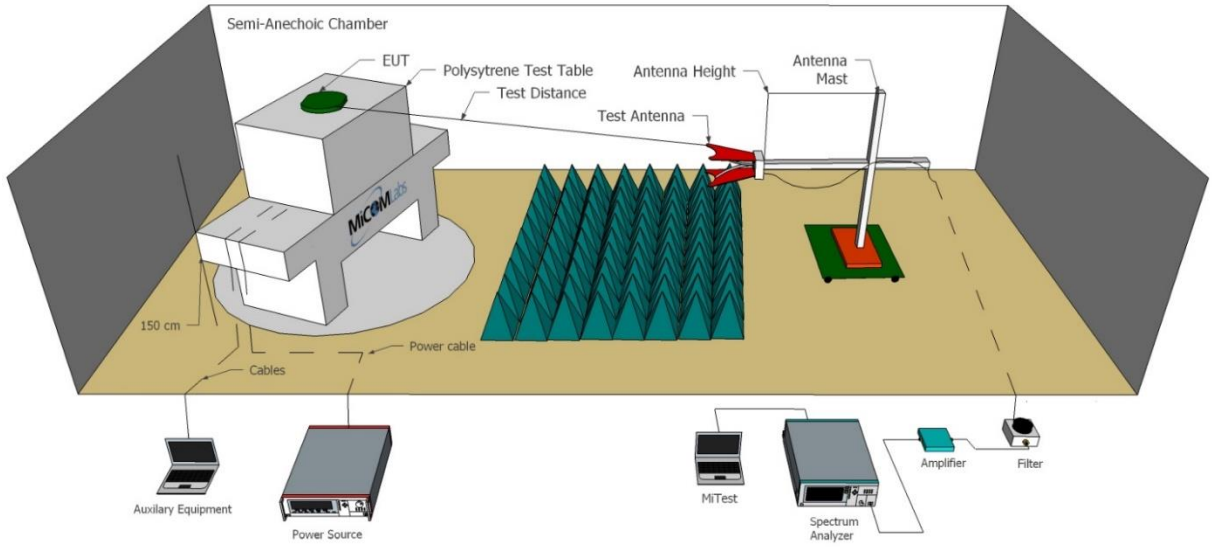
| Asset# | Description | Manufacturer | Model# | Serial# | Calibration Due Date |
|---|---|---|---|---|---|
| 127 | Power Supply | HP | 6674A | US36370530 | Cal when used |
| 248 | Resistance Thermometer | Thermotronics | GR2105-02 | 9340 #1 | 30 Oct 2021 |
| 287 | Rohde & Schwarz 40 GHz Receiver | Rhode & Schwarz | ESIB40 | 100201 | 8 Oct 2021 |
| 398 | MiTest RF Conducted Test Software | MiCOM | MiTest ATS | Version 4.2.3.0 | Not Required |
| 419 | Laptop with Labview Software | Lenova | W520 | TS02 | Not Required |
| 420 | USB to GPIB Interface | National Instruments | GPIB-USB HS | 1346738 | Not Required |
| 441 | USB Wideband Power Sensor | Boonton | 55006 | 9179 | 20 Sep 2021 |
| 445 | PoE Injector | D-Link | DPE-101GL | QTAH1E2000625 | Not Required |
| 461 | Spectrum Analyzer | Agilent | E4440A | MY46185537 | 20 Sep 2021 |
| 510 | Barometer/Thermometer | Control Company | 68000-49 | 170871375 | 20 Dec 2021 |
| 515 | MiTest Cloud Solutions RF Test Box | MiCOM | 2nd Gen with DFS | 515 | 4 Sep 2021 |

| | | | | | |
|---|---|---|---|---|---|
| 516 | USB Wideband Power Sensor | Boonton | RTP5006 | 10511 | 12 Sep 2021 |
| 517 | USB Wideband Power Sensor | Boonton | RTP5006 | 10510 | 12 Sep 2021 |
| 555 | Rhode & Schwarz Receiver | Rhode & Schwarz | ESW 44 | 101893 | 28 Jun 2023 |
| 74 | Environmental Chamber Chamber 3 | Tenney | TTC | 12808-1 | Not Required |
| RF#2 GPIB#1 | GPIB cable to Power Supply | HP | GPIB | None | Not Required |
| RF#2 SMA#1 | EUT to Mitest box port 1 | Flexco | SMA Cable port1 | None | 4 Sep 2021 |
| RF#2 SMA#2 | EUT to Mitest box port 2 | Flexco | SMA Cable port2 | None | 4 Sep 2021 |
| RF#2 SMA#3 | EUT to Mitest box port 3 | Flexco | SMA Cable port3 | None | 4 Sep 2021 |
| RF#2 SMA#4 | EUT to Mitest box port 4 | Flexco | SMA Cable port4 | None | 4 Sep 2021 |
| RF#2 SMA#SA | Mitest box to SA | Flexco | SMA Cable SA | None | 4 Sep 2021 |
| RF#2 USB#1 | USB Cable to Mitest Box | Dynex | USB Cable | None | Not Required |

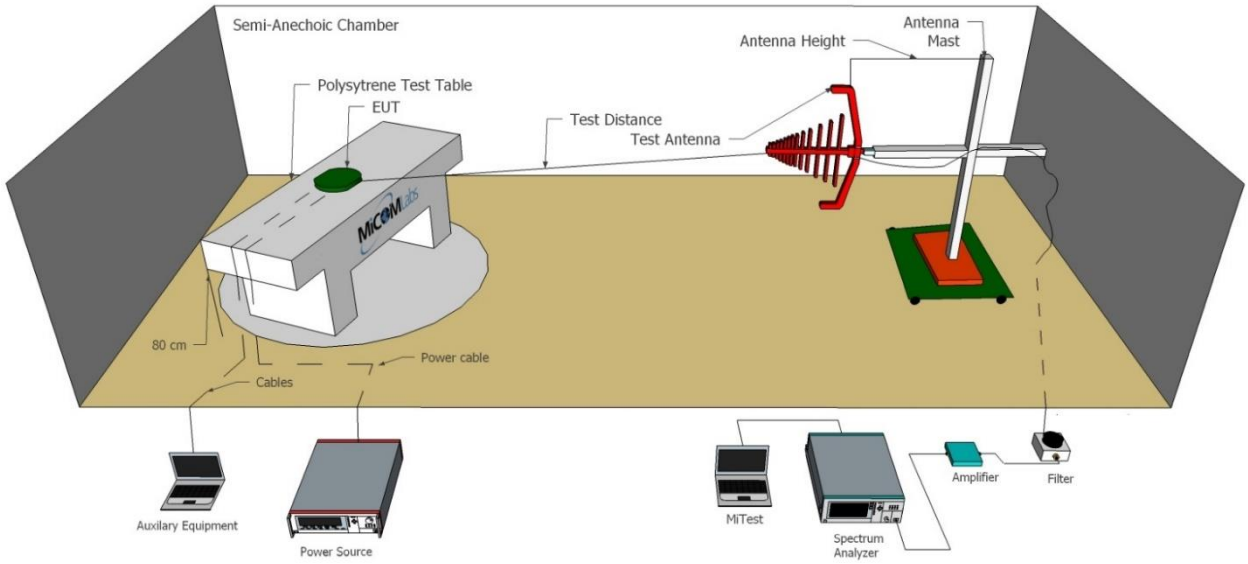
## 7.2. Radiated Emissions - 3m Chamber

The following tests were performed using the radiated test set-up shown in the diagram below. Radiated emissions above and below 1GHz.

Radiated Emissions Above 1GHz Test Setup




Radiated Emissions Below 1GHz Test Setup



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

| Asset# | Description | Manufacturer | Model# | Serial# | Calibration Due Date |
|---|---|---|---|---|---|
| 170 | Video System Controller for Semi Anechoic Chamber | Panasonic | WV-CU101 | 04R08507 | Not Required |
| 287 | Rohde & Schwarz 40 GHz Receiver | Rhode & Schwarz | ESIB40 | 100201 | 8 Oct 2021 |
| 298 | 3M Radiated Emissions Chamber Maintenance Check | MiCOM | 3M Chamber | 298 | 26 Sep 2021 |
| 336 | Active loop Ant 10kHz to 30 MHz | EMCO | EMCO 6502 | 00060498 | 29 Nov 2021 |
| 338 | Sunol 30 to 3000 MHz Antenna | Sunol | JB3 | A052907 | 4 Oct 2021 |
| 346 | 1.6 TO 10GHz High Pass Filter | EWT | EWT-57-0112 | H1 | 4 Sep 2021 |
| 373 | 26III RMS Multimeter | Fluke | Fluke 26 series III | 76080720 | 21 Sep 2021 |
| 396 | 2.4 GHz Notch Filter | Microtronics | BRM50701 | 001 | 4 Sep 2021 |
| 397 | Amp 10 - 2500MHz | MiCOM Labs | Amp 10 - 2500 MHz | NA | 9 Sep 2021 |
| 399 | ETS 1-18 GHz Horn Antenna | ETS | 3117 | 00154575 | 12 Sep 2021 |
| 406 | Amplifier for Radiated Emissions | MiCOM Labs | 40dB 1 to 18GHz Amp | 0406 | 9 Sep 2021 |
| 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 | MiTest Rad Emissions Test Software | MiCOM | Rad Emissions Test Software Version 1.0 | 447 | Not Required |
| 462 | Schwarzbeck cable from Antenna to Amplifier. | Schwarzbeck | AK 9513 | 462 | 4 Sep 2021 |
| 463 | Schwarzbeck cable from Amplifier to Bulkhead. | Schwarzbeck | AK 9513 | 463 | 4 Sep 2021 |
| 464 | Schwarzbeck cable from Bulkhead to Receiver | Schwarzbeck | AK 9513 | 464 | 4 Sep 2021 |
| 465 | Low Pass Filter DC-1000 MHz | Mini-Circuits | NLP-1200+ | VUU01901402 | 4 Sep 2021 |
| 466 | Low Pass Filter DC-1500 MHz | Mini-Circuits | NLP-1750+ | VUU10401438 | 4 Sep 2021 |
| 467 | 2495 to 2650 MHz notch | MicroTronics | BRM50709 | 011 | 4 Sep 2021 |

| | | | | | |
|---|---|---|---|---|---|
| | filter | | | | |
| 480 | Cable - Bulkhead to Amp | SRC Haverhill | 157-3050360 | 480 | 23 Jun 2022 |
| 481 | Cable - Bulkhead to Receiver | SRC Haverhill | 151-3050787 | 481 | 23 Jun 2022 |
| 510 | Barometer/Thermometer | Control Company | 68000-49 | 170871375 | 20 Dec 2021 |
| 554 | Precision SMA Cable | Fairview Microwave | SCE18060101-400CM | 554 | 23 Jun 2022 |
| CC05 | Confidence Check | MiCOM | CC05 | None | 4 Sep 2021 |

# 8. MEASUREMENT AND PRESENTATION OF TEST DATA

The measurement and graphical data presented in this test report was generated automatically using state-of-the-art technology creating an easy to read report structure. Numerical measurement data is separated from supporting graphical data (plots) through hyperlinks. Numerical measurement data can be reviewed without scrolling through numerous graphical pages to arrive at the next data matrix.

Plots have been relegated into the Appendix 'Graphical Data'.

Test and report automation was performed by MiTest. MiTest is an automated test system developed by MiCOM Labs. MiTest is the first cloud based modular test system enabling end-to-end automation of regulatory compliance testing for conducted RF testing.


The MiCOM Labs "MiTest" Automated Test System" (Patent Pending)

# 9. TEST RESULTS

## 9.1. Frequency Tolerance

| Conducted Test Conditions for Frequency Stability | | | |
|---|---|---|---|
| **Standard:** | FCC CFR 47:15.225<br>ISED RSS-210/Gen | **Ambient Temp. (ºC):** | 24.0 - 27.5 |
| **Test Heading:** | Frequency Stability | **Rel. Humidity (%):** | 32 - 45 |
| **Standard Section(s):** | 15.225(e)<br>RSS-Gen 6.11 | **Pressure (mBars):** | 999 - 1001 |
| **Reference Document(s):** | See Normative References | | |

**Test Procedure for Frequency Stability Measurement**

The Frequency Error was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency.

Testing was performed under ambient conditions at extreme voltages and over extreme temperatures at nominal voltages. 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 Conducted Test Set-up specified in this document.

**Limit:**
100 ppm

| Equipment Configuration for Nominal Centre frequencies | | | |
|---|---|---|---|
| **Variant:** | NFC | **Duty Cycle (%):** | Not Applicable |
| **Data Rate:** | Not Applicable | **Antenna Gain (dBi):** | Not Applicable |
| **Modulation:** | Not Applicable | **Beam Forming Gain (Y)(dB):** | Not Applicable |
| **TPC:** | Not Applicable | **Tested By:** | JRK |
| **Engineering Test Notes:** | | | |

**Test Measurement Results**

| Test frequency | 13.56 MHz | Measured Frequency | Frequency Error | | Limit | Margin |
|---|---|---|---|---|---|---|
| Temperature | Voltage | Hz | Hz | ppm | ppm | ppm |
| 50 °C | 48.0 Vdc | 13560009.00 | 9 | 0.6637 | ±100 | -99.3363 |
| 40 °C | 48.0 Vdc | 13560006.00 | 6 | 0.4425 | ±100 | -99.5575 |
| 30 °C | 48.0 Vdc | 13560024.00 | 24 | 1.7699 | ±100 | -98.2301 |
| 20 °C | 55.2 Vdc | 13560655.00 | 55 | 4.0566 | ±100 | -95.9434 |
| 20 °C | 48.0 Vdc | 13560558.00 | 58 | 4.2773 | ±100 | -95.7227 |
| 20 °C | 40.8 Vdc | 13560052.00 | 52 | 3.8348 | ±100 | -96.1652 |
| 10 °C | 48.0 Vdc | 13560082.00 | 82 | 6.6472 | ±100 | -93.3528 |
| 0 °C | 48.0 Vdc | 13560108.00 | 108 | 7.9646 | ±100 | -92.0354 |
| -10 °C | 48.0 Vdc | 13560128.00 | 128 | 9.4395 | ±100 | -90.5605 |
| -20 °C | 48.0 Vdc | 13560132.00 | 132 | 9.7345 | ±100 | -90.2655 |

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

# 9.2. Radiated Emissions

## 9.2.1.1. TX Spurious & Restricted Band Emissions

| Radiated Test Conditions for Radiated Spurious and Band-Edge Emissions (Restricted Bands) | | | |
|---|---|---|---|
| **Standard:** | FCC CFR 47 Part 15.225<br>ISED RSS-210/GEN | **Ambient Temp. (ºC):** | 20.0 - 24.5 |
| **Test Heading:** | Radiated Spurious and Band-Edge Emissions | **Rel. Humidity (%):** | 32 - 45 |
| **Standard Section(s):** | 15.205, 15.209<br>RSS-GEN 6.13 | **Pressure (mBars):** | 999 - 1001 |
| **Reference Document(s):** | See Normative References | | |

**Test Procedure for Radiated Spurious and Band-Edge Emissions** (Restricted Bands)
Radiated emissions for restricted bands above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned. Measurements on any restricted band frequency or frequencies above 1 GHz are based on the use of measurement instrumentation employing peak and average detectors. All measurements were performed using a resolution bandwidth of 1 MHz.

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

Limits for Restricted Bands
Peak emission: 74 dBuV/m
Average emission: 54 dBuV/m

Field Strength Calculation
The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.
FS = R + AF + CORR - FO

where:
FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

Example:
Given receiver input reading of 51.5 dBmV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength (FS) of the measured emission is:

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

Conversion between dBmV/m (or dBmV) and mV/m (or mV) are as follows:
Level (dBmV/m) = 20 * Log (level (mV/m))

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

**Restricted Bands of Operation (15.205)**

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| Frequency Band | | | |
|---|---|---|---|
| **MHz** | **MHz** | **MHz** | **GHz** |
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| 0.495-0.505 | 16.69475-16.69525 | 608-614 | 5.35-5.46 |
| 2.1735-2.1905 | 16.80425-16.80475 | 960-1240 | 7.25-7.75 |
| 4.125-4.128 | 25.5-25.67 | 1300-1427 | 8.025-8.5 |
| 4.17725-4.17775 | 37.5-38.25 | 1435-1626.5 | 9.0-9.2 |
| 4.20725-4.20775 | 73-74.6 | 1645.5-1646.5 | 9.3-9.5 |
| 6.215-6.218 | 74.8-75.2 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 108-121.94 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 123-138 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 149.9-150.05 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 156.52475-156.52525 | 2483.5-2500 | 17.7-21.4 |
| 8.37625-8.38675 | 156.7-156.9 | 2690-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 162.0125-167.17 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 167.72-173.2 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 240-285 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 322-335.4 | 3600-4400 | Above 38.6 |
| 13.36-13.41 | | | |

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

(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.

(d) The following devices are exempt from the requirements of this section:

(1) Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph (a) of this section, the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a) of this section, and the fundamental emission is outside of the bands listed in paragraph (a) of this section more than 99% of the time the device is actively transmitting, without compensation for duty cycle.

(2) Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.

(3) Cable locating equipment operated pursuant to §15.213.

(4) Any equipment operated under the provisions of §15.253, 15.255, and 15.256 in the frequency band 75-85 GHz, or §15.257 of this part.

(5) Biomedical telemetry devices operating under the provisions of §15.242 of this part are not subject to the restricted band 608-614 MHz but are subject to compliance within the other restricted bands.

(6) Transmitters operating under the provisions of subparts D or F of this part.

(7) Devices operated pursuant to §15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.

(8) Devices operated in the 24.075-24.175 GHz band under §15.245 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in §15.245(b).

(9) Devices operated in the 24.0-24.25 GHz band under §15.249 are exempt from complying with the requirements of this section for the 48.0-48.5 GHz and 72.0-72.75 GHz bands only, and shall not exceed the limits specified in §15.249(a).

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of §15.245 shall not exceed the limits specified in §15.245(b).





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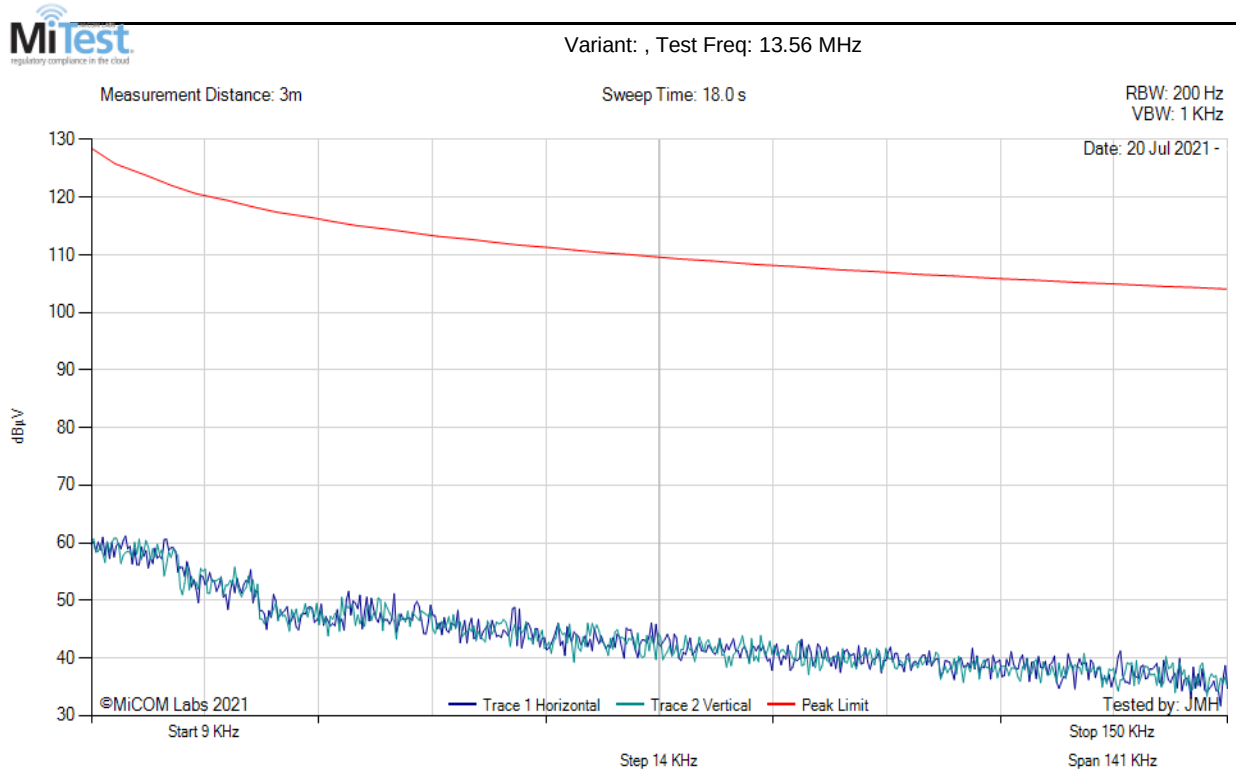
| Equipment Configuration for Below 30MHz Emissions (9kHz - 150kHz) | | | |
|---|---|---|---|
| **Antenna:** | Integral | **Variant:** | NFC |
| **Antenna Gain (dBi):** | Not Applicable | **Modulation:** | Not Applicable |
| **Beam Forming Gain (Y):** | Not Applicable | **Duty Cycle (%):** | 99 |
| **Channel Frequency (MHz):** | 13.56 | **Data Rate:** | Not Applicable |
| **Power Setting:** | Max | **Tested By:** | JMH |

**Test Measurement Results**

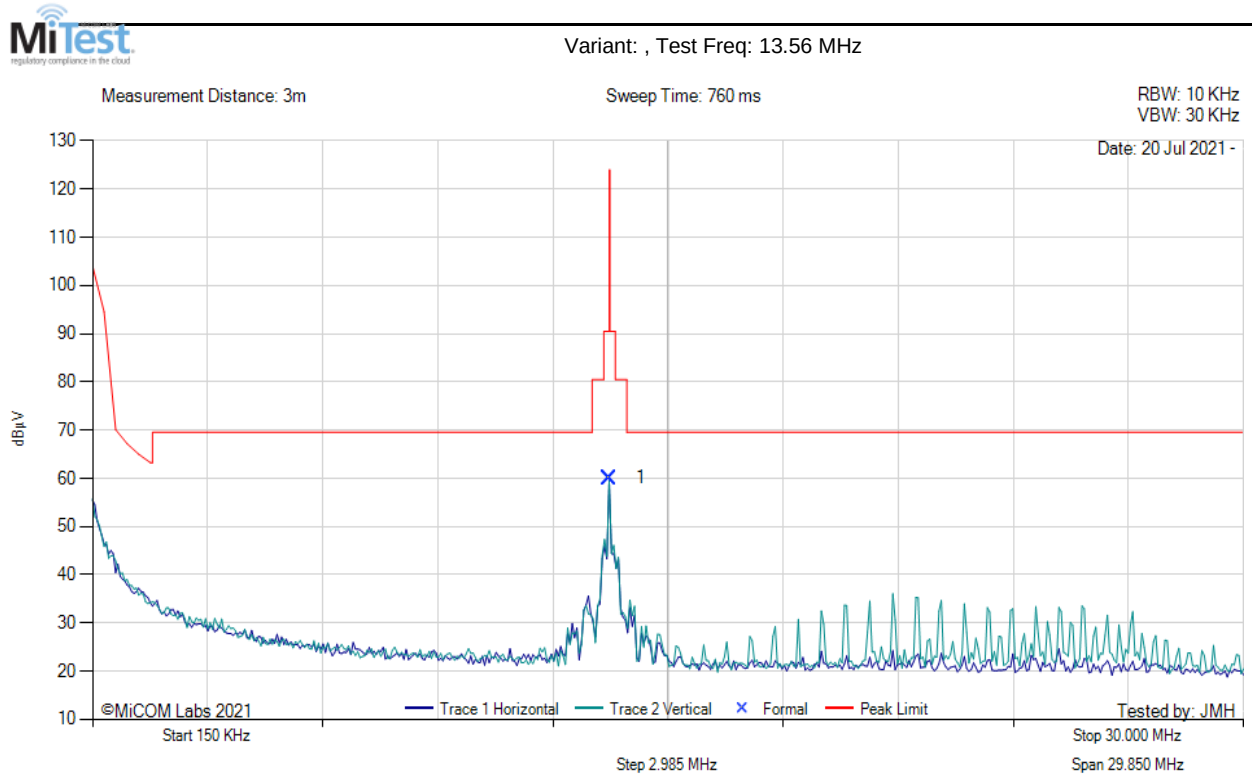



There are no emissions found within 6dB of the limit line.

**Test Notes:** COSMO VCU powered by 48 V DC. LTE call up band 3, WiFi BLE, NFC active

| Equipment Configuration for Below 30MHz Emissions (150kHz - 30Mhz) | | | |
|---|---|---|---|
| **Antenna:** | Integral | **Variant:** | NFC |
| **Antenna Gain (dBi):** | Not Applicable | **Modulation:** | Not Applicable |
| **Beam Forming Gain (Y):** | Not Applicable | **Duty Cycle (%):** | 99 |
| **Channel Frequency (MHz):** | 13.56 | **Data Rate:** | Not Applicable |
| **Power Setting:** | Max | **Tested By:** | JMH |

**Test Measurement Results**

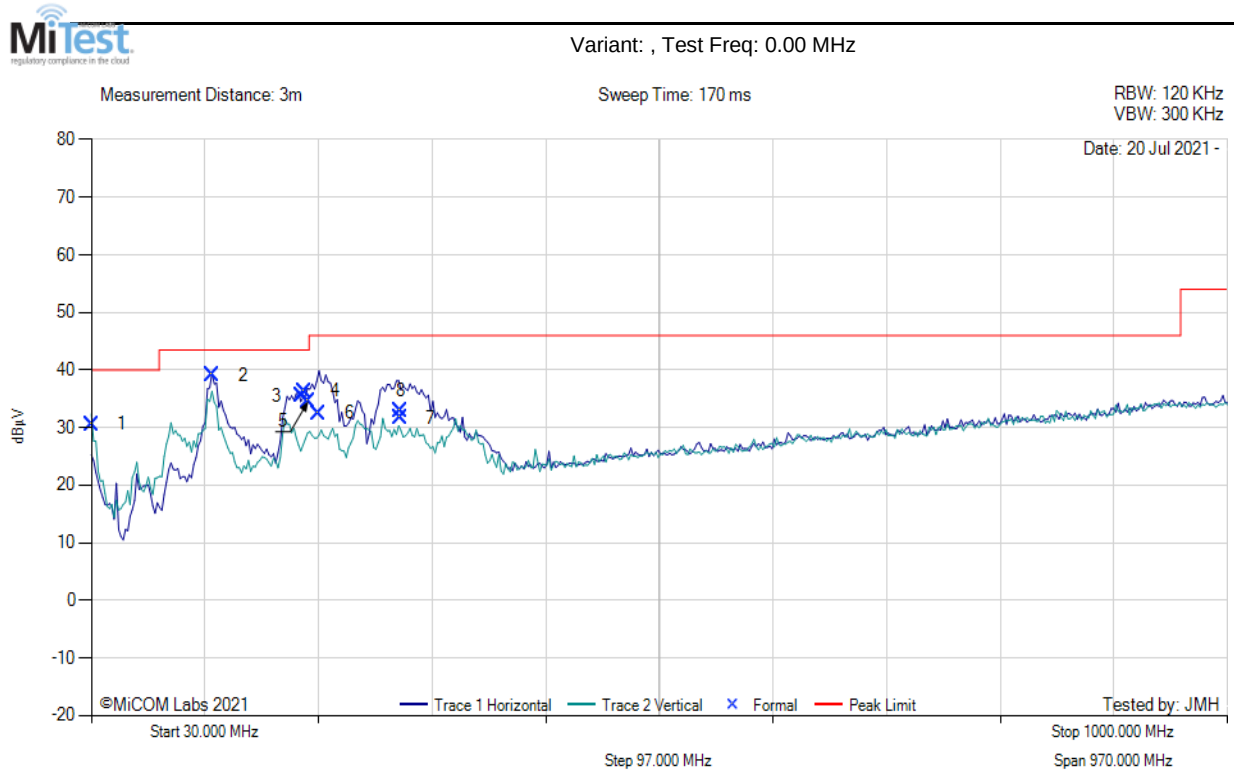



| 0.15.00 - 30.00 MHz | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Num** | **Frequency MHz** | **Raw dBµV** | **Cable Loss dB** | **AF dB/m** | **Level dBµV/m** | **Measurement Type** | **Pol** | **Hgt cm** | **Azt Deg** | **Limit dBµV/m** | **Margin dB** | **Pass /Fail** |
| 1 | 13.56 | 49.64 | 0.41 | 9.96 | 60.01 | Peak (NRB) | -- | 0 | 0 | -- | -- | Pass |

**Test Notes:** COSMO VCU powered by 48 V DC. LTE call up band 3, WiFi BLE, NFC active

| Equipment Configuration for Radiated Digital Emissions (Class B) | | | |
|---|---|---|---|
| **Antenna:** | Integral | **Variant:** | NFC |
| **Antenna Gain (dBi):** | Not Applicable | **Modulation:** | Not Applicable |
| **Beam Forming Gain (Y):** | Not Applicable | **Duty Cycle (%):** | 99 |
| **Channel Frequency (MHz):** | 13.56 | **Data Rate:** | Not Applicable |
| **Power Setting:** | Max | **Tested By:** | JMH |

**Test Measurement Results**



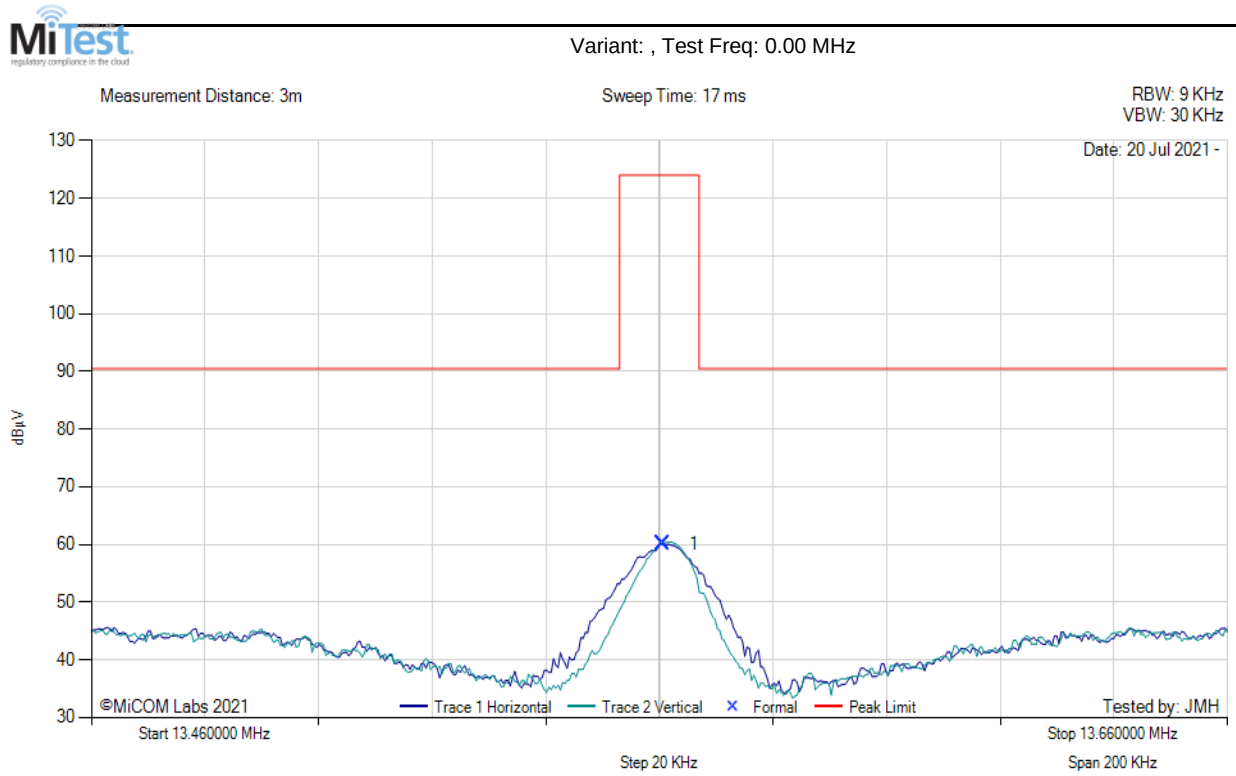

| 30.00 - 1000.00 MHz | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Num** | **Frequency MHz** | **Raw dBµV** | **Cable Loss dB** | **AF dB/m** | **Level dBµV/m** | **Measurement Type** | **Pol** | **Hgt cm** | **Azt Deg** | **Limit dBµV/m** | **Margin dB** | **Pass /Fail** |
| 1 | 30.43 | 35.22 | 3.54 | -8.20 | 30.56 | MaxQP | Vertical | 98 | 38 | 40.0 | -9.4 | Pass |
| 2 | 133.68 | 49.67 | 4.23 | -14.82 | 39.08 | MaxQP | Horizontal | 248 | 319 | 43.5 | -4.4 | Pass |
| 3 | 209.38 | 48.20 | 4.56 | -17.31 | 35.45 | MaxQP | Horizontal | 138 | 276 | 43.5 | -8.1 | Pass |
| 4 | 212.33 | 48.93 | 4.58 | -17.21 | 36.30 | MaxQP | Horizontal | 144 | 281 | 43.5 | -7.2 | Pass |
| 5 | 215.38 | 47.16 | 4.59 | -17.10 | 34.65 | MaxQP | Horizontal | 112 | 267 | 43.5 | -8.9 | Pass |
| 6 | 224.30 | 44.74 | 4.63 | -16.89 | 32.48 | MaxQP | Horizontal | 149 | 289 | 46.0 | -13.5 | Pass |
| 7 | 294.11 | 41.26 | 4.89 | -14.53 | 31.62 | MaxQP | Horizontal | 109 | 272 | 46.0 | -14.4 | Pass |
| 8 | 294.11 | 42.53 | 4.89 | -14.53 | 32.89 | MaxQP | Horizontal | 101 | 258 | 46.0 | -13.1 | Pass |

**Test Notes:** COSMO VCU powered by 48 V DC. LTE call up band 3, NFC, WiFi and BLE active

## 9.2.1.2. Field Strength

| Equipment Configuration for 13.56 MHz Field Strength | | | |
|---|---|---|---|
| **Antenna:** | Integral | **Variant:** | NFC |
| **Antenna Gain (dBi):** | Not Applicable | **Modulation:** | Not Applicable |
| **Beam Forming Gain (Y):** | Not Applicable | **Duty Cycle (%):** | 99 |
| **Channel Frequency (MHz):** | 13.56 | **Data Rate:** | Not Applicable |
| **Power Setting:** | Max | **Tested By:** | JMH |

**Test Measurement Results**




| 13.46.00 - 13.66.00 MHz | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Num** | **Frequency MHz** | **Raw dBµV** | **Cable Loss dB** | **AF dB/m** | **Level dBµV/m** | **Measurement Type** | **Pol** | **Hgt cm** | **Azt Deg** | **Limit dBµV/m** | **Margin dB** | **Pass /Fail** |
| 1 | 13.56 | 49.66 | 0.41 | 9.96 | 60.03 | MaxQP | Vertical | 0 | 352 | 124.0 | -64.0 | Pass |

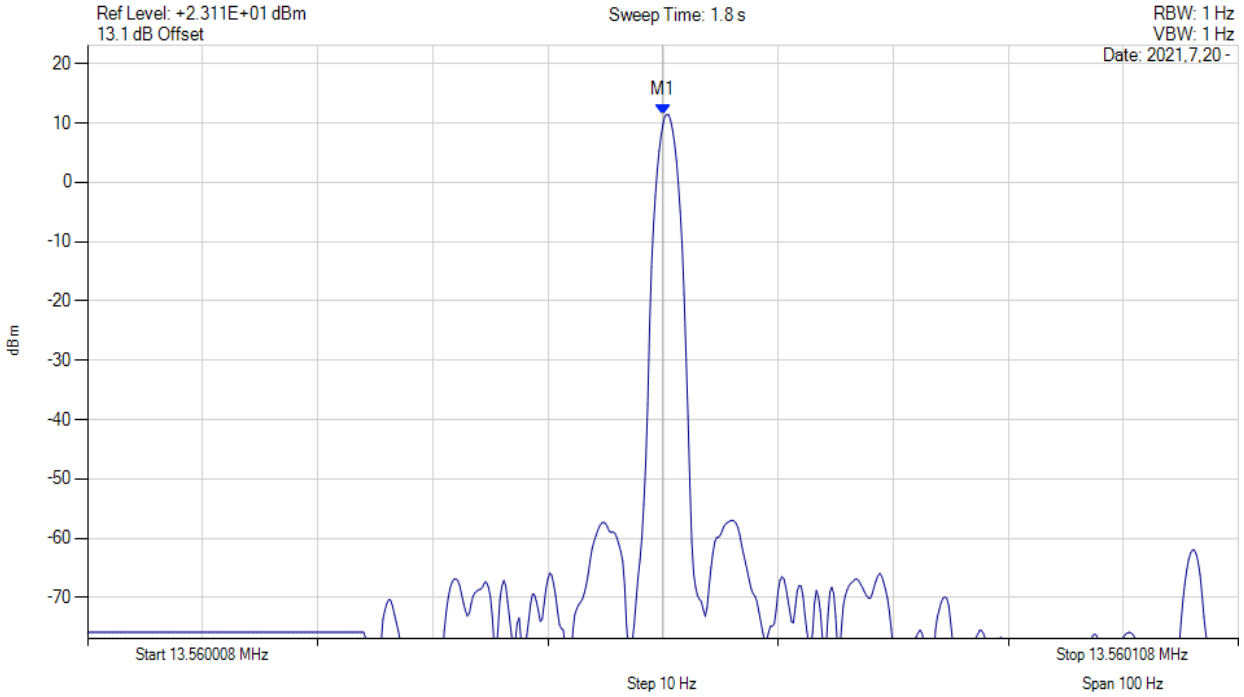
**Test Notes:** COSMO VCU powered by 48 V DC. NFC active

# A. Appendix A – Graphical Images

## A.1. Frequency Error

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 20, Voltage: 48 Vdc

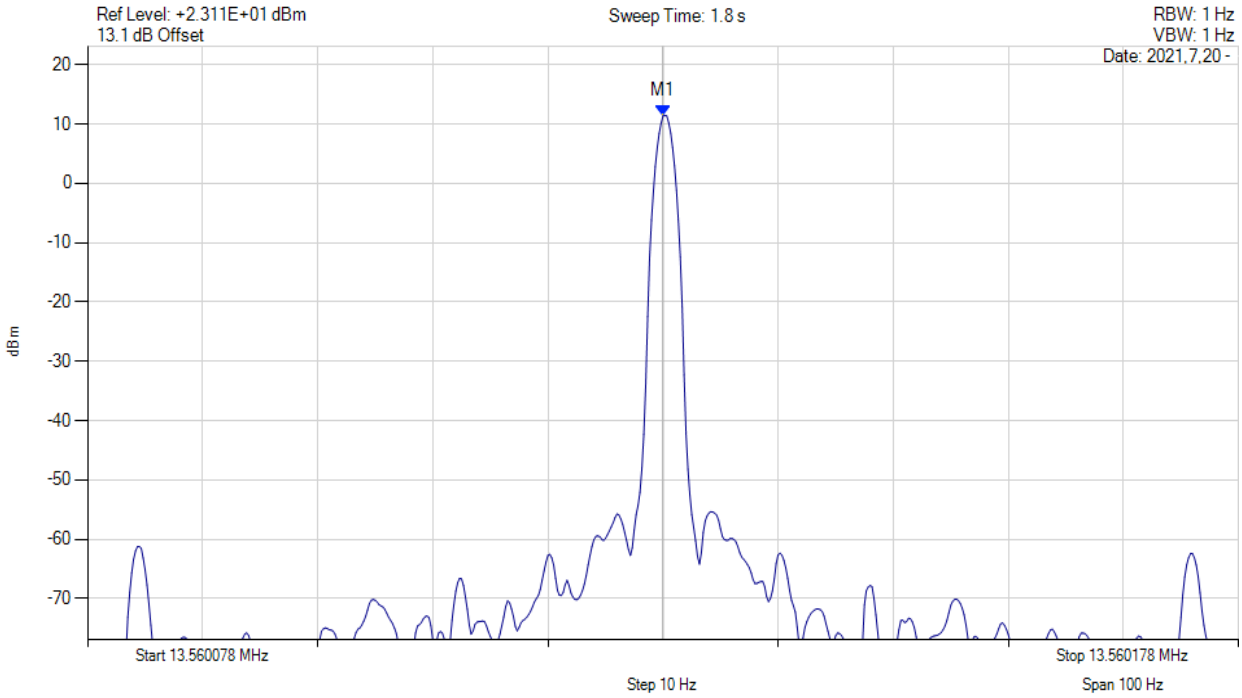



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.410 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: -10, Voltage: 48 Vdc

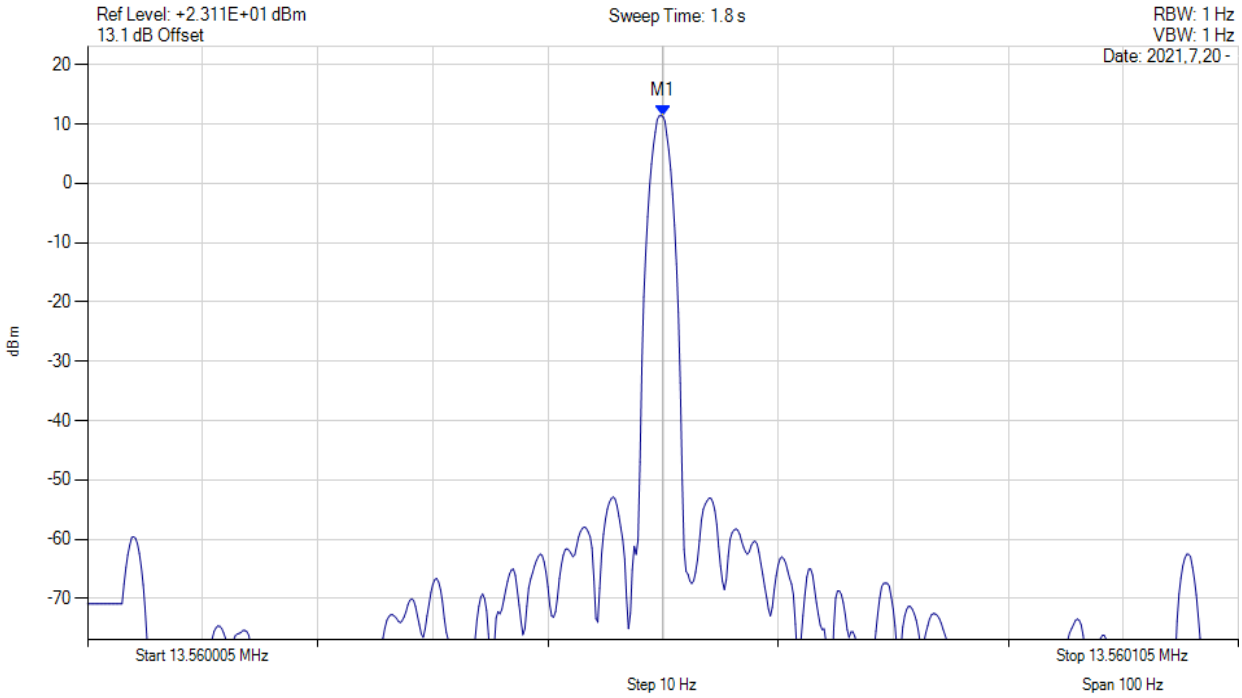



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.462 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 20, Voltage: 55.2 Vdc

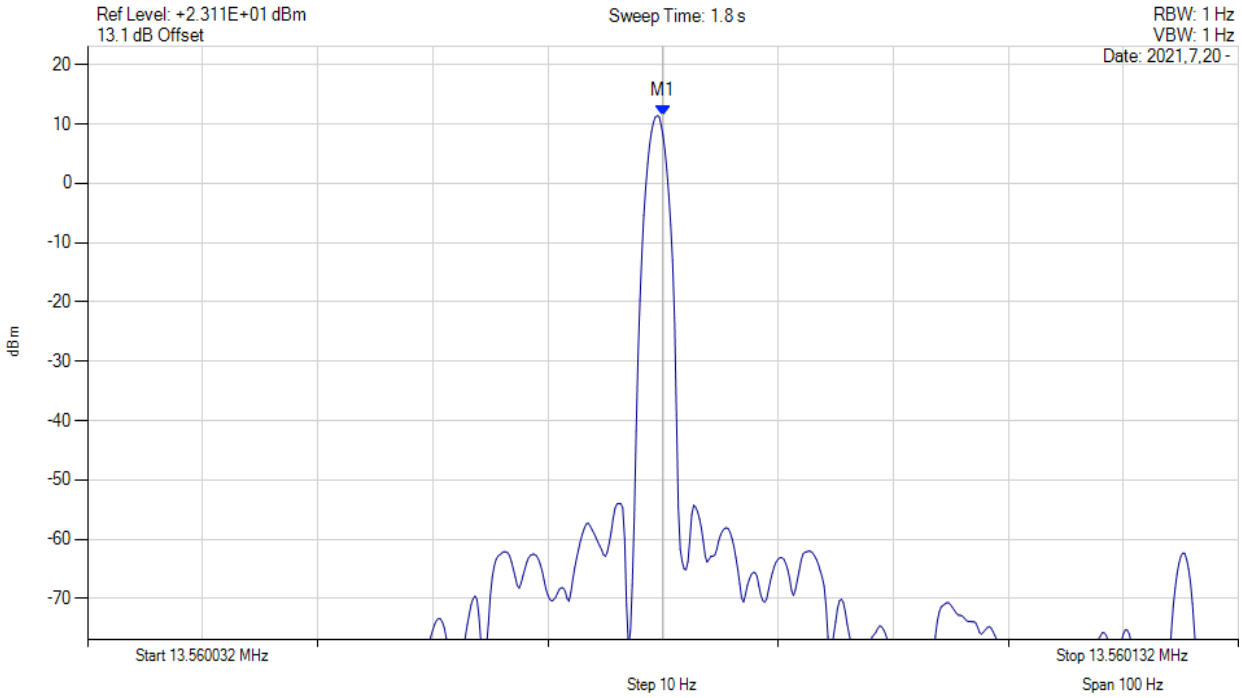



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.412 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 10, Voltage: 48 Vdc

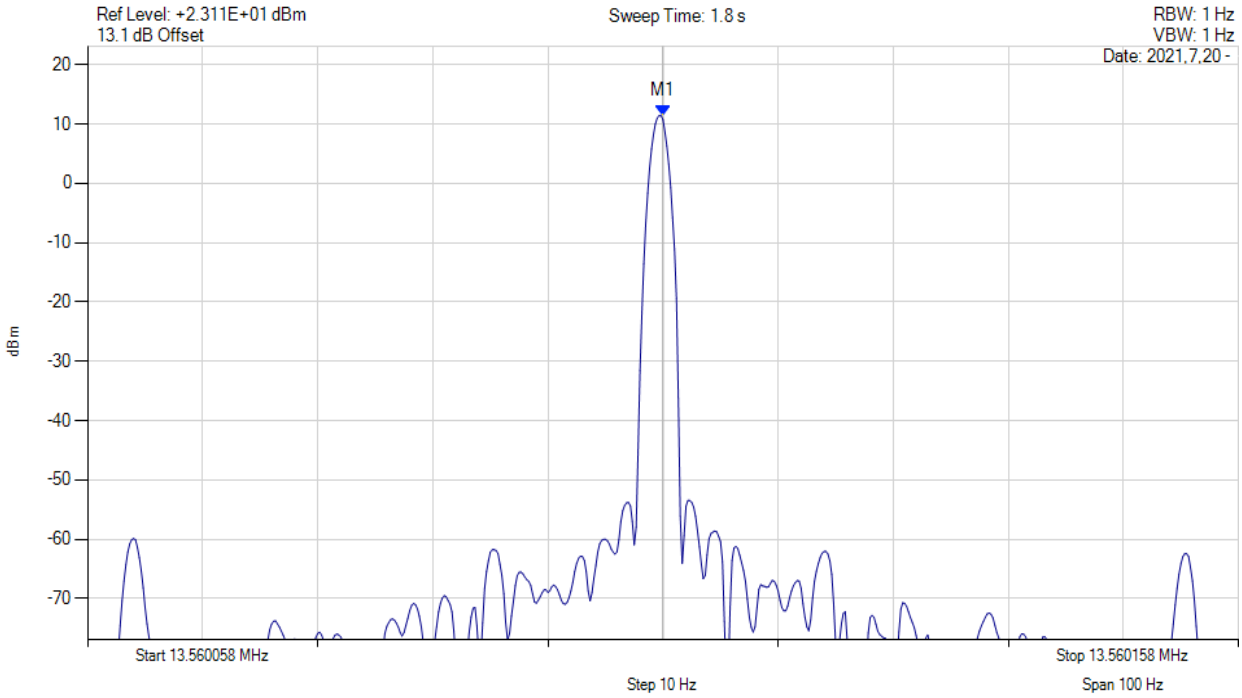



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.410 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 0, Voltage: 48 Vdc

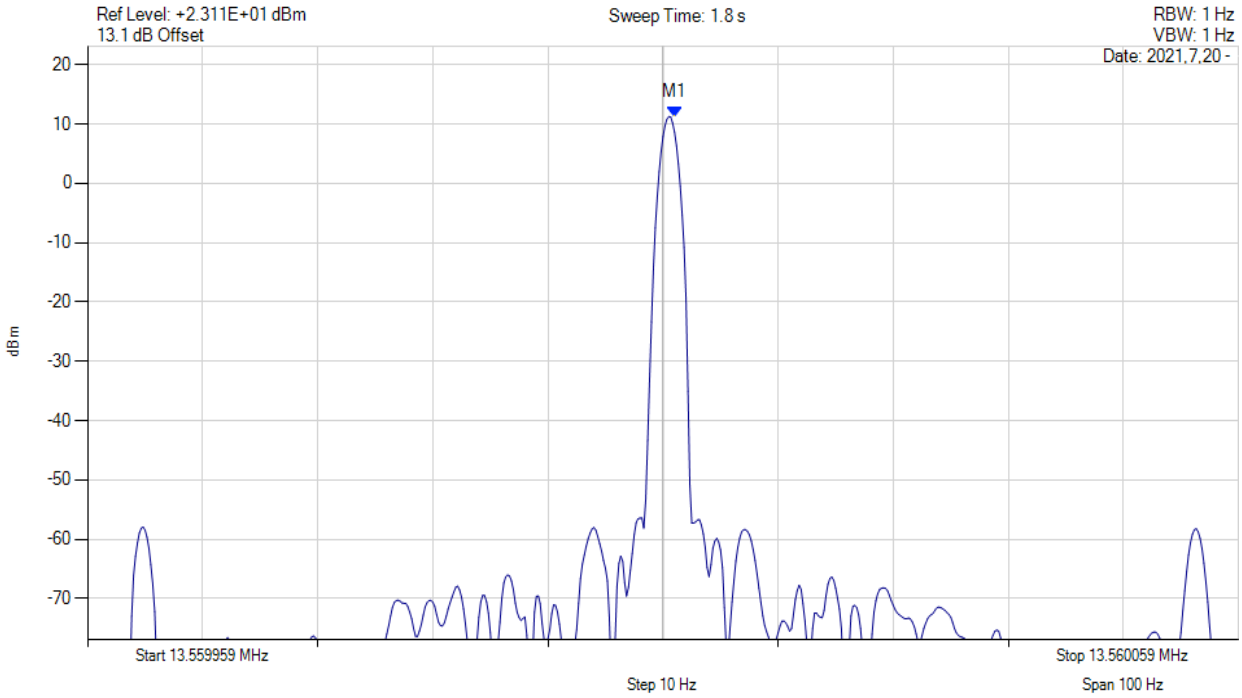



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.437 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 50, Voltage: 48 Vdc

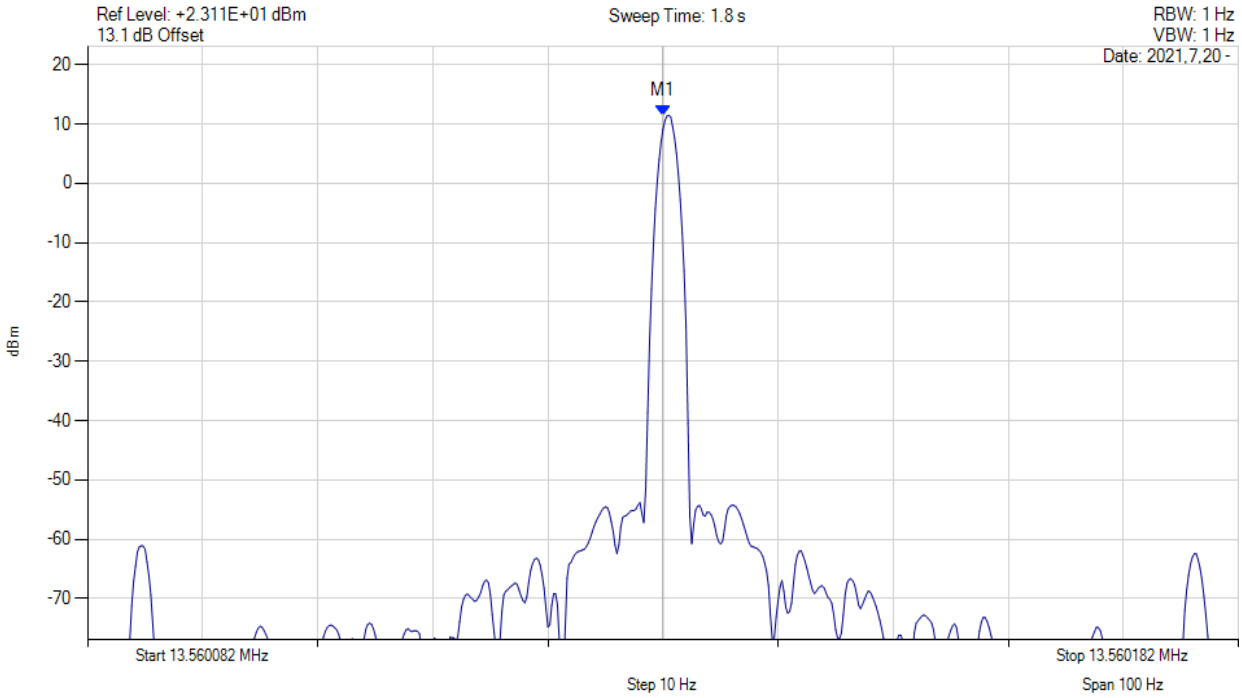



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.261 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: -20, Voltage: 48 Vdc

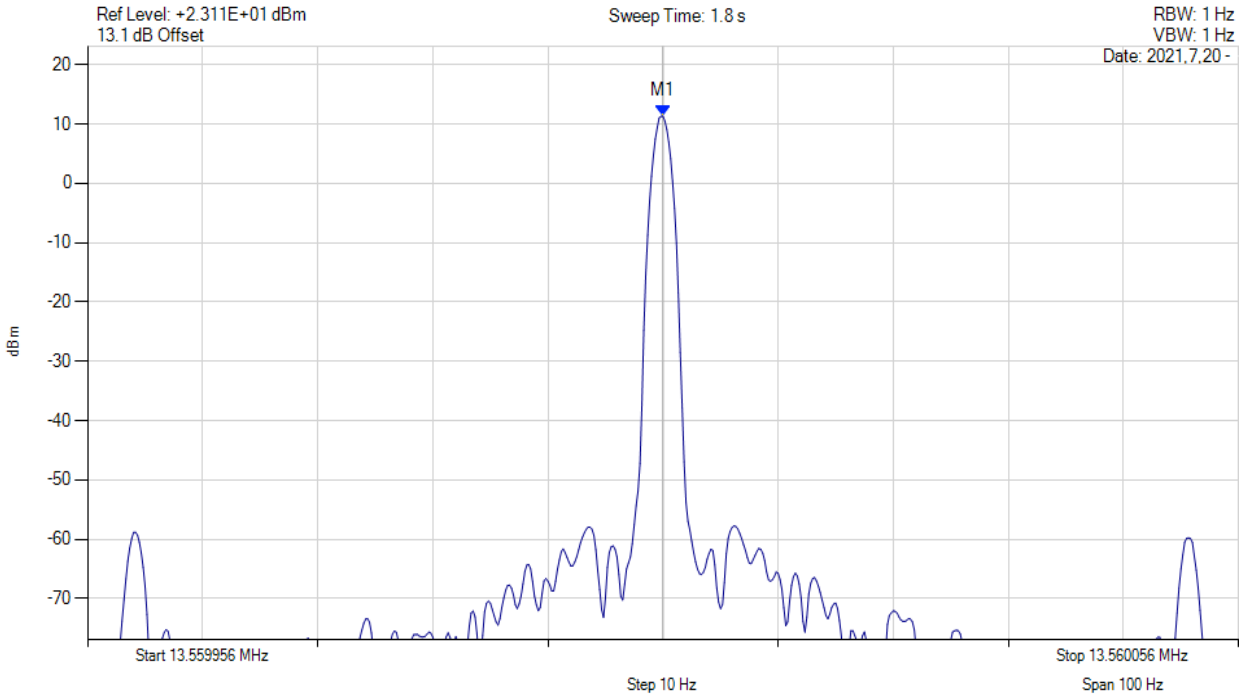



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.334 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 40, Voltage: 48 Vdc

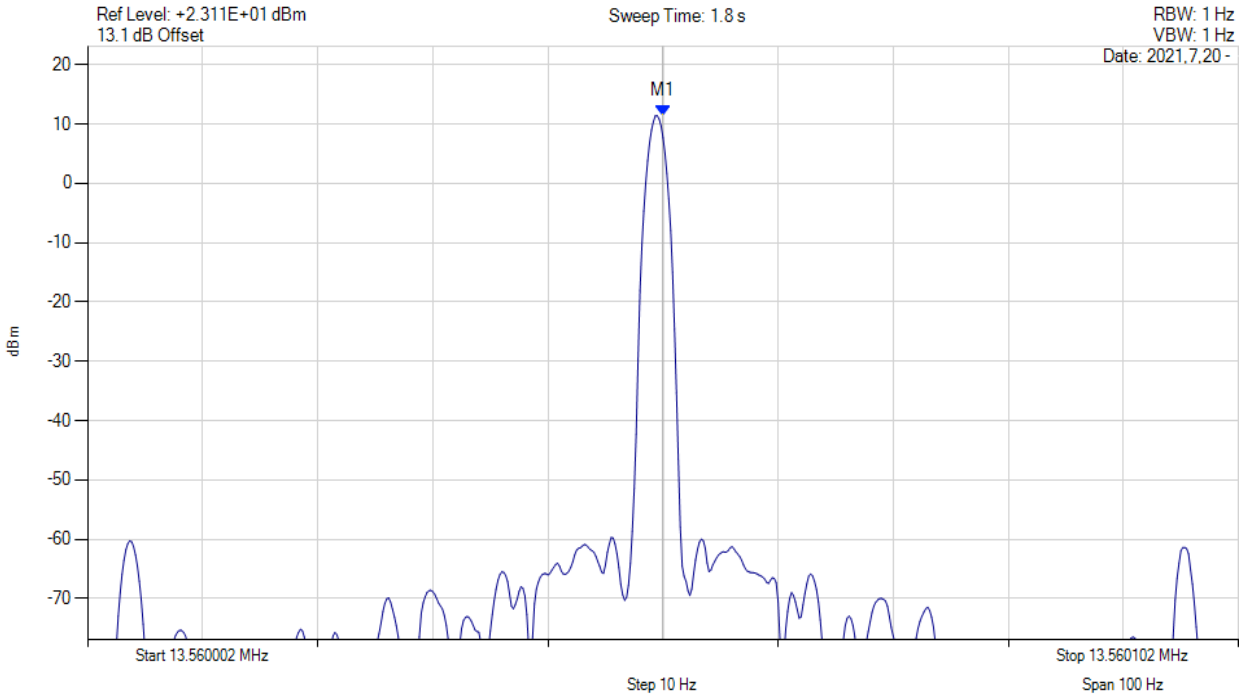



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.322 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 20, Voltage: 40.8 Vdc

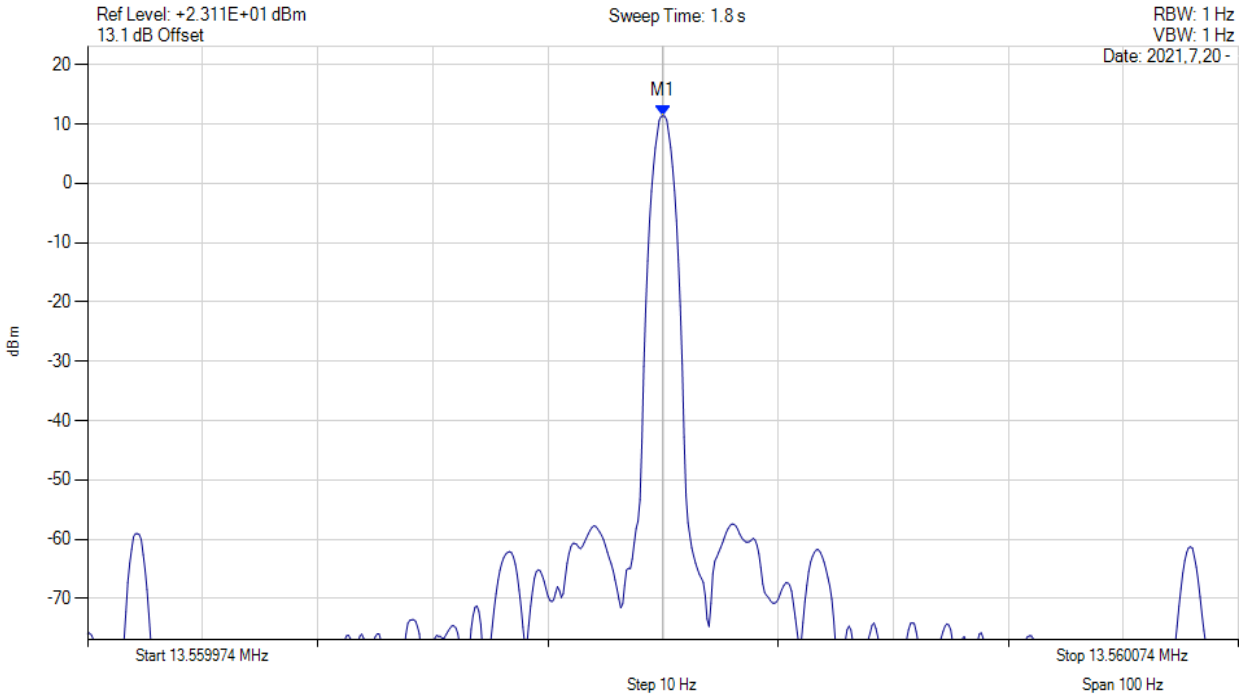



| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.398 dBm | Channel Frequency: 13.56 MHz |

back to matrix

Frequency Stability

Variant: NFC, Channel: 13.56 MHz, Chain a, Temp: 30, Voltage: 48 Vdc




| Analyzer Setup | Marker:Frequency:Amplitude | Test Results |
|---|---|---|
| Detector = NORM<br>Sweep Count = 0<br>RF Atten (dB) = 20<br>Trace Mode = WRIT | M1 : 13.560 MHz : 11.380 dBm | Channel Frequency: 13.56 MHz |

back to matrix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