

Test of: Comotech Corporation - Airlight

To: FCC CFR 47 Part 101

Test Report Serial No.: COMO01-U2 Rev C





Test of Comotech Corporation - Airlight  
to  
To FCC CFR 47 Part 101

Test Report Serial No.: COMO01-U2 Rev C

This report supersedes: None

**Manufacturer:** Comotech Corporation  
908-6, UKIC, 812-1, Hyomun-Dong  
Buk-Gu, Ulsan-City  
South Korea 683-360

**Product Function:** Point to Point Radio Link for  
network backhaul

**Copy No:** pdf    **Issue Date:** 31st May 2016

**This Test Report is Issued Under the Authority of:**

**MiCOM Labs, Inc.**  
575 Boulder Court  
Pleasanton, CA 94566 USA  
Phone: +1 (925) 462-0304  
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TESTING CERT # 2381.01

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



**Title:** Comotech Corporation - Airlight  
**To:** FCC CFR 47 Part 101  
**Serial #:** COMO01-U2 Rev C  
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## 1 ACCREDITATION, LISTINGS & RECOGNITION

### 1.1 ACCREDITATION - TESTING

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) [www.a2la.org](http://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>



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## 1.2 RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA\*\* countries. Our test reports are widely accepted for global type approvals.

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

\*\*APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.

Is a 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

N/A – Not Applicable

\*\*EU MRA – European Union Mutual Recognition Agreement.

Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

\*\*NB – Notified Body

### 1.3 PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC 17065. The company is accredited by the American Association for Laboratory Accreditation (A2LA) [www.a2la.org](http://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>



#### **United States of America – Telecommunication Certification Body (TCB)**

TCB Identifier – US0159

#### **Industry Canada – Certification Body**

CAB Identifier – US0159

#### **Europe – Notified Body**

Notified Body Identifier - 2280

#### **Japan – Recognized Certification Body (RCB)**

RCB Identifier - 210

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## 2 DOCUMENT HISTORY

| Document History |                                |                                                                                |
|------------------|--------------------------------|--------------------------------------------------------------------------------|
| Revision         | Date                           | Comments                                                                       |
| Draft            | 11 <sup>th</sup> May 2016      | Report update to include high-band operation                                   |
|                  |                                |                                                                                |
|                  |                                |                                                                                |
|                  |                                |                                                                                |
| Rev C            | 31 <sup>st</sup> May 2016      | Included test results for High Band 80 GHz                                     |
| Rev B            | 8 <sup>th</sup> October 2015   | Correction to Section 7.1.2 Transmitter Output Power, amended the power limits |
| Rev A            | 8 <sup>th</sup> September 2015 | Initial Release                                                                |
|                  |                                |                                                                                |

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### 3 TEST RESULT CERTIFICATE

|                |                                                                                                      |            |                                                                               |
|----------------|------------------------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------|
| Manufacturer : | Comotech Corporation<br>908-6, UKIC, 812-1, Hyomun-Dong<br>Buk-Gu, Ulsan-City<br>South Korea 683-360 | Tested By: | MiCOM Labs, Inc.<br>575 Boulder Court<br>Pleasanton<br>California, 94566, USA |
| EUT:           | Point to Point Radio Link for<br>network backhaul                                                    | Telephone: | +1 925 462 0304                                                               |
| Model:         | Unknown                                                                                              | Fax:       | +1 925 462 0306                                                               |
| S/N:           | BGWVBW10430022                                                                                       |            |                                                                               |
| Test Date(s):  | 22nd July 2015 - 3rd May 2016                                                                        | Website:   | www.micomlabs.com                                                             |

| STANDARD(S)         | TEST RESULTS       |
|---------------------|--------------------|
| FCC CFR 47 Part 101 | 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.

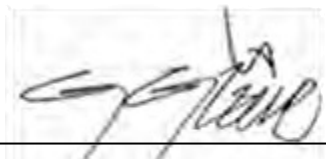
**Notes:**

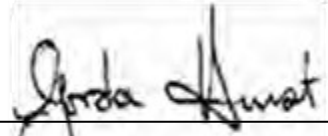
1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

**Approved & Released for MiCOM Labs, Inc. by:**



TESTING CERT # 2381.01

  
\_\_\_\_\_  
Graeme Grieve  
Quality Manager MiCOM Labs,

  
\_\_\_\_\_  
Gordon Hurst  
President & CEO MiCOM Labs, Inc.

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## 4 REFERENCES AND MEASUREMENT UNCERTAINTY

### 4.1 Normative References

| REF.   | PUBLICATION         | YEAR                | TITLE                                                                                                                                                                |
|--------|---------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (i)    | FCC 47 CFR Part 101 | 2015                | Code of Federal Regulations                                                                                                                                          |
| (iii)  | ANSI C63.4          | 2009                | 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 |
| (iv)   | CISPR 22/ EN 55022  | 2008 / 2010         | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment                                                          |
| (v)    | M 3003              | Nov. 2012 Edition 3 | Expression of Uncertainty and Confidence in Measurements                                                                                                             |
| (vi)   | LAB34               | Edition 1 Aug 2002  | The expression of uncertainty in EMC Testing                                                                                                                         |
| (vii)  | ETSI TR 100 028     | 2001-12             | Parts 1 and 2<br>Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics          |
| (viii) | A2LA                | June 2015           | Reference to A2LA Accreditation Status – A2LA Advertising Policy                                                                                                     |

### 4.2 Test and Uncertainty Procedures

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 TEST SUMMARY

### List of Measurements

The following table represents the list of measurements required under the FCC CFR47 Part 101.

| Section(s)         | Test Items                              | Description                                          | Condition   | Result                  | Test Report Section |
|--------------------|-----------------------------------------|------------------------------------------------------|-------------|-------------------------|---------------------|
| 101.113            | Transmitter Output Power                |                                                      | Conducted   | Complies                | 7.1.1               |
| 101.109<br>101.111 | Spectral Mask + 99% Bandwidth           | Occupied Bandwidth                                   | Conducted   | Complies                | 7.1.2               |
| 101.107            | Frequency Tolerance + Voltage Variation | Frequency measurement<br>Variation of supply voltage | Conducted   | Complies                | 7.1.3               |
| 1.1310             | Maximum Permissible Exposure            | MPE for fixed location transmitters                  | Calculation | Not Performed           | 7.1.4               |
| 101.111            | Spurious Emissions                      | Conducted Spurious Emissions 1 - 110 GHz             | Conducted   | Complies                | 7.1.5               |
| 15.205 /<br>15.209 | Digital Emissions                       | Radiated digital emissions<br>(0.03 - 6 GHz)         | Radiated    | Complies Class B limits | 7.1.6               |

**Note 1:** Test results reported in this document relate only to the items tested

**Note 2:** The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria

## 6 PRODUCT DETAILS AND TEST CONFIGURATIONS

### 6.1 Technical Details

| Details                                | Description                                                                                                |
|----------------------------------------|------------------------------------------------------------------------------------------------------------|
| Purpose:                               | Test of the Comotech Corporation - Airlight Point to Point Radio Link for network backhaul to FCC Part 101 |
| Applicant:                             | As Manufacturer                                                                                            |
| Manufacturer:                          | Comotech Corporation<br>908-6, UKIC, 812-1, Hyomun-Dong<br>Buk-Gu, Ulsan-City<br>South Korea 683-360       |
| Laboratory performing the tests:       | MiCOM Labs, Inc.<br>575 Boulder Court<br>Pleasanton, California 94566 USA                                  |
| Test report reference number:          | COMO01-U2 Rev C                                                                                            |
| Date EUT received:                     | 22nd June 2015                                                                                             |
| Standard(s) applied:                   | FCC CFR 47 Part 101                                                                                        |
| Dates of test (from - to):             | 22nd July 2015 - 3rd May 2016                                                                              |
| No of Units Tested:                    | 1                                                                                                          |
| Serial Number(s):                      | S1011506002                                                                                                |
| Type of Equipment:                     | Point to Point Radio Link for network backhaul                                                             |
| Manufacturers Trade Name:              | Comotech Corporation                                                                                       |
| Model:                                 | Airlight                                                                                                   |
| Location for use:                      | Outdoor use only                                                                                           |
| Declared Frequency Range(s):           | 71 – 76 GHz and 81 – 86 GHz                                                                                |
| Type of Modulation:                    | QPSK, 16QAM, 64QAM, ACM                                                                                    |
| Declared Nominal Average Output Power: | +14 dBm                                                                                                    |
| EUT Modes of Operation:                | 10/100/1000 MBit/s                                                                                         |
| Transmit/Receive Operation:            | Full Duplex                                                                                                |
| T/R Spacing:                           | 10 GHz                                                                                                     |
| Rated Input Voltage and Current:       | Nominal: -48 Vdc, 2.5 Amps<br>Minimum: -42.5 Vdc<br>Maximum: -57 Vdc                                       |
| Operating Temperature Range:           | Declared range -40° to +60°C                                                                               |
| ITU Emission Designator:               | 250M0G7W                                                                                                   |
| Equipment Dimensions:                  | Radio: 230x230x90(mm) +<br>Antenna 2' : 620x620x490(mm)<br>Antenna 1' : 340x340x220(mm)                    |
| Weight:                                | 10.5kg (with 2ft antenna), 6.0kg (with 1ft antenna)                                                        |
| Primary function of equipment:         | Point to Point Radio Link for network backhaul                                                             |

## 6.2 Scope of Test Program

The scope of the test program was to test Comotech Corporation - Airlight Point to Point Radio Link for network backhaul in the frequency ranges 71 – 76 GHz and 81 – 86 GHz for compliance against FCC 47 CFR Part 101 subpart Q.

The Comotech Corporation - Airlight has an integral antenna which was not tested as part the radiated test program. The Comotech Corporation - Airlight has a 10.0 GHz duplex spacing.

The high and low transmit bands (QPSK) were tested in this program (71 – 76 & 81 – 86 GHz).

### §101.1507 FCC Permissible operations.

Licensees may use the 70 GHz, 80 GHz and 90 GHz bands for any point-to-point, non-broadcast service. The segments may be unpaired or paired, but pairing will be permitted only in a standardized manner (e.g., 71-72.25 GHz may be paired only with 81-82.25 GHz, and so on). The segments may be aggregated without limit.

## 6.3 Frequency Allocation

| Frequency Band (GHz) | Emissions Bandwidth (MHz) | Band Designator | Note    |
|----------------------|---------------------------|-----------------|---------|
| 71-76                | 250.0                     | E Band          | Note 17 |
| 81-86                | 250.0                     | E Band          | Note 17 |

<sup>(17)</sup> FCC Part 101.147 Frequencies in these bands are shared with Government fixed stations and stations in the Private Operational Fixed Point-to-Point Microwave Service.

## 6.4 Equipment Model(s) and Serial Number(s)

| Type (EUT/Support) | Equipment Description (Including Brand Name)   | Mfr                  | Model No. | Serial No.  |
|--------------------|------------------------------------------------|----------------------|-----------|-------------|
| EUT                | Point to Point Radio Link for network backhaul | Comotech Corporation | Airlight  | S1011506002 |
| Support            | Laptop PC                                      | HP                   | --        | None        |



## 6.5 Antenna Details

Antennas were not tested as part of the test program. Antenna details are provided for MPE (Maximum Permissible Exposure) calculations and information purposes.

| Manufacturer | Antenna Type | Model Number | Frequency Band | Gain (dBi) |
|--------------|--------------|--------------|----------------|------------|
| Cassegrain   | 1' Parabolic | Unknown      | 71-86 GHz      | 45.0       |
| Cassegrain   | 2' Parabolic | Unknown      | 71-86 GHz      | 51.0       |

## 6.6 Cabling and I/O Ports

| Type of I/O Ports | Description                                        | Shielded (Y/N) | Length       | Qty | Tested (Y/N) |
|-------------------|----------------------------------------------------|----------------|--------------|-----|--------------|
| Ethernet          | Tributary & Management 10/100/1000 Base T with POE | N              | > 100 meters | 1   | Y            |
| dc                | Vdc Input                                          | N              | > 3 meters   | 1   | Y            |
| RSSI Out          | BNC-f                                              | Y              | Unknown      | 1   | N            |
| RF Tx/Rcr         | Circular Waveguide                                 | N/A            | N/A          | 1   | Y            |

## 6.7 Test Configurations

Number of available operational channels: 12

- 1).. 72.125/82.125
- 2).. 72.375/82.375
- 3).. 72.625/82.625
- 4).. 72.875/82.875
- 5).. 73.125/83.125
- 6).. 73.375/83.375
- 7).. 73.625/83.625
- 8).. 73.875/83.875
- 9).. 74.125/84.125
- 10).. 74.375/84.375
- 11).. 74.625/84.625
- 12).. 74.875/84.875



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## **6.8 Equipment Modifications**

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

1. NONE

## **6.9 Deviations from the Test Standard**

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

1. NONE

## 7 TEST RESULTS

### 7.1 Device Characteristics

#### 7.1.1 Occupied Bandwidth

##### **FCC 47 CFR Part 101 Subpart 101.109**

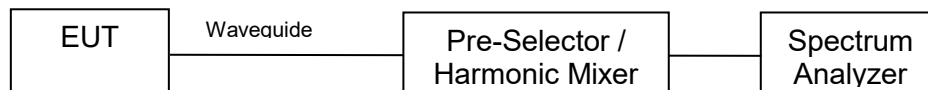
##### **Test Procedure**

The transmitter output was connected to a spectrum analyzer and the Occupied Bandwidth was measured with a modulated carrier.

Occupied Bandwidth was measured under ambient conditions, nominal voltage for all modulations and rule parts on low, mid and high channels. The spectrum analyzer was set for a 2 MHz RBW and 3 MHz VBW which was based on the bandwidth of the output spectrum.

To position the mask relative to the output spectrum the EUT was initially set to transmit a CW (single) tone at the frequency of interest. The mask was then lined up with the peak of the CW tone. The EUT was then set to modulate each modulation of interest and measurements reported.

##### **Emissions above 40 GHz Test Configuration**



Emission measurement configuration(s)

##### **Laboratory Measurement Uncertainty for Power Measurements**

|                         |               |
|-------------------------|---------------|
| Measurement uncertainty | $\pm 1.33$ dB |
|-------------------------|---------------|

##### **Traceability**

| Method                                                                              | Test Equipment Used                    |
|-------------------------------------------------------------------------------------|----------------------------------------|
| Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask' | 088, 095, 0158, 0227, 0252, 0293, 0304 |



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### **Occupied Bandwidth Limits FCC Part §101.109**

(a) Each authorization issued pursuant to these rules will show, as the emission designator, a symbol representing the class of emission which must be prefixed by a number specifying the necessary bandwidth. This figure does not necessarily indicate the bandwidth actually occupied by the emission at any instant. In those cases where part 2 of this chapter does not provide a formula for the computation of the necessary bandwidth, the occupied bandwidth may be used in the emission designator.

(b) Stations in this service will be authorized any type of emission, method of modulation, and transmission characteristic, consistent with efficient use of the spectrum and good engineering practice, except that Type B, damped-wave emission will not be authorized.

(c) The maximum bandwidth which will be authorized per frequency assigned is set out in the table that follows. Regardless of the maximum authorized bandwidth specified for each frequency band, the Commission reserves the right to issue a license for less than the maximum bandwidth if it appears that a lesser bandwidth would be sufficient to support an applicant's intended communications.

Occupied Bandwidth Limit 71 – 76 GHz, 81 – 86 GHz bands  
Limit = 5000 MHz

Ambient conditions.

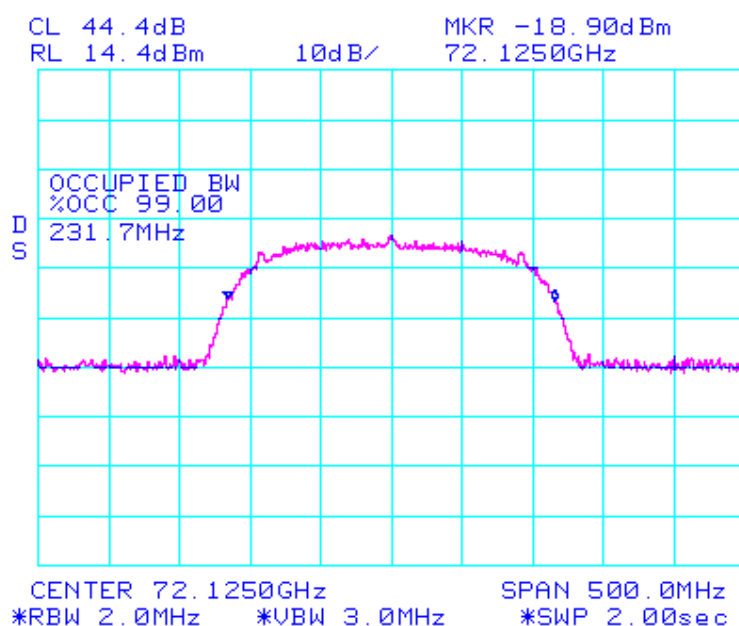
Temperature: **17 to 23 °C**      Relative humidity: **31 to 57 %**      Pressure: **999 to 1012 mbar**

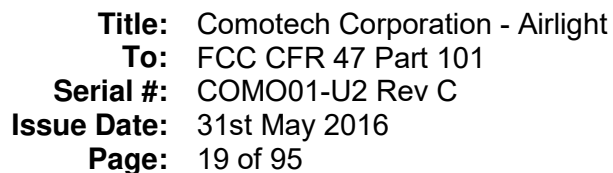
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| Channel Frequency (GHz) | Voltage (Vdc) | Temperature (°C) | 99% Occupied Bandwidth (MHz) | Limit (MHz) | Margin (MHz) |
|-------------------------|---------------|------------------|------------------------------|-------------|--------------|
| 72.125                  | 48.0          | 20               | 231.7                        | 5000        | -4768.30     |
| 73.375                  | 48.0          | 20               | 241.7                        | 5000        | -4758.30     |
| 74.875                  | 48.0          | 20               | 230.8                        | 5000        | -4769.20     |

### CHANNEL FREQUENCY 72.125 GHz





CL 44.4 dB  
RL 14.4 dBm 10 dB/ 126.7 MHz ΔMKR 17.00 dB

OCCUPIED BW  
%OCC 99.00  
241.7 MHz

D S

CENTER 73.3750 GHz SPAN 500.0 MHz  
\*RBW 2.0 MHz \*VBW 3.0 MHz \*SWP 2.00 sec

CL 44.4dB      ΔMKR 18.17dB  
RL 14.4dBm      10dB/      1.6567GHz

OCCUPIED BW  
%OCC 99.00  
230.8MHz

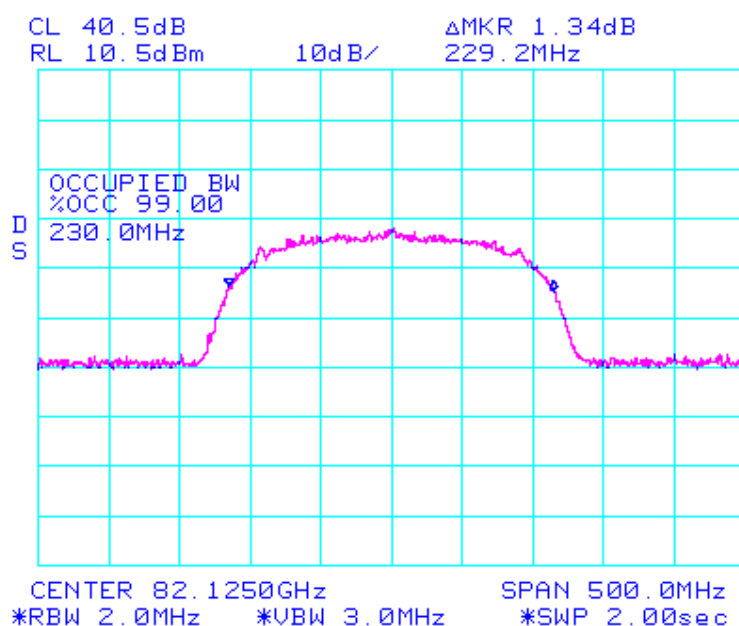
D  
S

CENTER 74.8750GHz      SPAN 500.0MHz  
\*RBW 2.0MHz      \*VBW 3.0MHz      \*SWP 2.00sec

MiCOM Labs, 575 Boulder Court, Pleasanton, California 94566 USA, Phone: 925.462.0304, Fax: 925.462.0306, [www.micomlabs.com](http://www.micomlabs.com)

| Channel Frequency (GHz) | Voltage (Vdc) | Temperature (°C) | 99% Occupied Bandwidth (MHz) | Limit (MHz) | Margin (MHz) |
|-------------------------|---------------|------------------|------------------------------|-------------|--------------|
| 82.125                  | 48.0          | 20               | 230.0                        | 5000        | -4770.00     |
| 83.375                  | 48.0          | 20               | 228.3                        | 5000        | -4771.70     |
| 84.875                  | 48.0          | 20               | 226.7                        | 5000        | -4773.30     |

### CHANNEL FREQUENCY 82.125 GHz



CL 40.5dB  
RL 10.5dBm 10dB/

OCCUPIED BW  
%OCC 99.00  
228.3MHz

D  
S

CENTER 83.3750GHz SPAN 500.0MHz  
\*RBW 2.0MHz VBW 3.0MHz \*SWP 2.00sec

CL 40.5dB      MKR -44.17dBm  
RL 10.5dBm      10dB/      85.0183GHz

OCCUPIED BW  
%OCC 99.00  
226.7MHz

D  
S

CENTER 84.8750GHz      SPAN 500.0MHz  
\*RBW 2.0MHz      VBW 3.0MHz      \*SWP 2.00sec

### 7.1.2 Transmitter Output Power

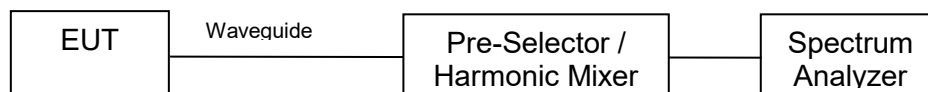
#### **FCC 47 CFR Part 101 Subpart 101.113**

##### **Test Procedure**

The transmitter output was connected to spectrum analyzer and the Output Power was calculated on a modulated carrier.

Output Power was measured under ambient conditions, nominal voltage for the applicable frequency channels.

##### **Emissions above 40 GHz Test Configuration**



Emission measurement configuration(s)

Ambient conditions.

Temperature: **17 to 23 °C**      Relative humidity: **31 to 57 %**      Pressure: **999 to 1012 mbar**

##### **Power Limits**

- (a) On any authorized frequency, the average power delivered to an antenna in this service must be the minimum amount of power necessary to carry out the communications desired. Application of this principle includes, but is not to be limited to, requiring a licensee who replaces one or more of its antennas with larger antennas to reduce its antenna input power by an amount appropriate to compensate for the increased primary lobe gain of the replacement antenna(s). In no event shall the average equivalent isotropically radiated power (EIRP), as referenced to an isotropic radiator, exceed the values specified below. In cases of harmful interference, the Commission may, after notice and opportunity for hearing, order a change in the effective radiated power of this station. Further, the output power of a transmitter on any authorized frequency in this service may not exceed the following:

71 – 76 and 81 – 86 GHz = +55 dBW/EIRP



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### Laboratory Measurement Uncertainty for Power Measurement

|                         |               |
|-------------------------|---------------|
| Measurement uncertainty | $\pm 1.33$ dB |
|-------------------------|---------------|

### Traceability

| Method                                                                             | Test Equipment Used                    |
|------------------------------------------------------------------------------------|----------------------------------------|
| Measurements were made per work instruction WI-03 'Measurement of RF Output Power' | 088, 095, 0158, 0227, 0252, 0293, 0304 |

### Measurement Results

45 dBi Antenna

| Part 101.113           | Maximum Conducted Output Power (dBm) | EIRP dBm<br>(1' * 45 dBi Antenna) | EIRP dBW<br>(1' * 45 dBi Antenna) |
|------------------------|--------------------------------------|-----------------------------------|-----------------------------------|
| Center Frequency (GHz) | Ambient, 48Vdc                       |                                   |                                   |
| 72.125                 | -4.17 (0.383 mW)                     | +40.83                            | 10.8                              |
| 73.375                 | +9.6 (9.12 mW)                       | +54.6                             | 24.6                              |
| 74.875                 | +9.2 (8.32 mW)                       | +54.2                             | 24.2                              |

51 dBi Antenna

| Part 101.113           | Maximum Conducted Output Power (dBm) | EIRP dBm<br>(1' * 51 dBi Antenna) | EIRP dBW<br>(1' * 51 dBi Antenna) |
|------------------------|--------------------------------------|-----------------------------------|-----------------------------------|
| Center Frequency (GHz) | Ambient, 48Vdc                       |                                   |                                   |
| 72.125                 | -4.17 (0.383 mW)                     | +46.8                             | 16.8                              |
| 73.375                 | +9.6 (9.12 mW)                       | +60.6                             | 30.6                              |
| 74.875                 | +9.2 (8.32 mW)                       | +60.2                             | 30.2                              |

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45 dBi Antenna

| Part 101.113           | Maximum Conducted Output Power (dBm) | EIRP dBm<br>(1' * 45 dBi Antenna) | EIRP dBW<br>(1' * 45 dBi Antenna) |
|------------------------|--------------------------------------|-----------------------------------|-----------------------------------|
| Center Frequency (GHz) | Ambient, 48Vdc                       |                                   |                                   |
| 82.125                 | -2.65 (0.543 mW)                     | +42.35                            | 12.4                              |
| 83.375                 | -4.61 (0.346 mW)                     | +40.39                            | 10.4                              |
| 84.875                 | -6.52 (0.223 mW)                     | +38.48                            | 8.5                               |

51 dBi Antenna

| Part 101.113           | Maximum Conducted Output Power (dBm) | EIRP dBm<br>(1' * 51 dBi Antenna) | EIRP dBW<br>(1' * 51 dBi Antenna) |
|------------------------|--------------------------------------|-----------------------------------|-----------------------------------|
| Center Frequency (GHz) | Ambient, 48Vdc                       |                                   |                                   |
| 82.125                 | -2.65 (0.543 mW)                     | +48.35                            | 18.4                              |
| 83.375                 | -4.61 (0.346 mW)                     | +46.39                            | 16.4                              |
| 84.875                 | -6.52 (0.223 mW)                     | +44.48                            | 14.5                              |

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### 7.1.3 Emission Mask

#### **FCC 47 CFR Part 101 Subpart 101.111**

##### **Test Procedure**

The transmitter output was connected to a spectrum analyzer and the Occupied Bandwidth was measured with a modulated carrier.

Spectrum mask was measured under ambient conditions, nominal voltage for all modulations on the low, mid and high frequency channels of operation. The spectrum analyzer was set for a 1 MHz RBW and 3 MHz VBW which was based on spectrum bandwidth.

To position the mask relative to the output spectrum the EUT was initially set to transmit a CW (single) tone at the frequency of interest. The mask was then lined up with the peak of the CW tone. The EUT then was then set to modulate each modulation of interest and measurements reported.

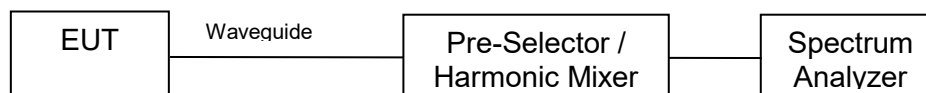
##### **Emission Mask Limits**

(ii) For operating frequencies above 15 GHz, in any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

$A = 11 + 0.4(P-50) + 10 \log_{10} B$ . (Attenuation greater than 56 decibels or to an absolute power of less than -13 dBm/1MHz is not required.)

(iii) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least  $43 + 10 \log_{10}$  (the mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation. The authorized bandwidth includes the nominal radio frequency bandwidth of an individual transmitter/modulator in block-assigned bands. Equipment licensed prior to April 1, 2005 shall only be required to meet this standard in any 4 kHz band.

#### **Emissions above 40 GHz Test Configuration**



Emission measurement configuration(s)



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#### Laboratory Measurement Uncertainty for Power Measurements

|                         |               |
|-------------------------|---------------|
| Measurement uncertainty | $\pm 1.33$ dB |
|-------------------------|---------------|

#### Traceability

| Method                                                                              | Test Equipment Used                    |
|-------------------------------------------------------------------------------------|----------------------------------------|
| Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask' | 088, 095, 0158, 0227, 0252, 0293, 0304 |

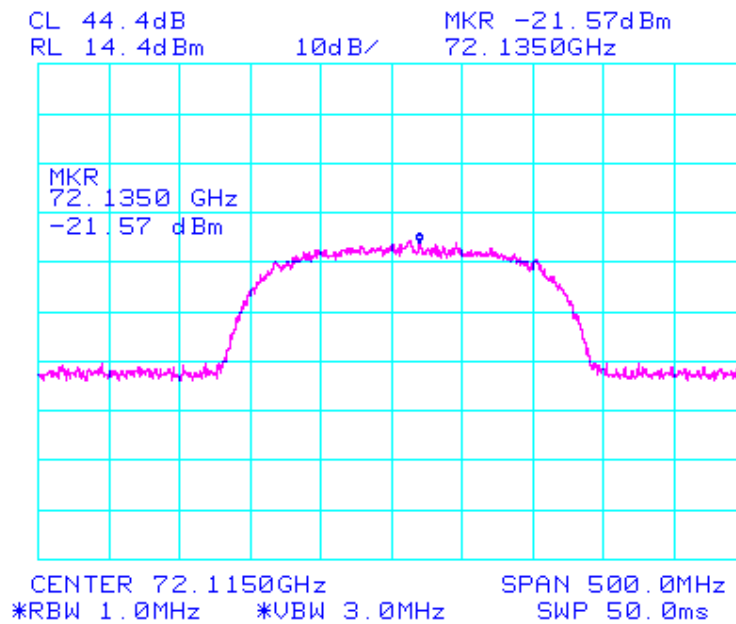
Ambient conditions.

Temperature: **17 to 23 °C**      Relative humidity: **31 to 57 %**      Pressure: **999 to 1012 mbar**

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## CHANNEL FREQUENCY 72.125 GHz



Emission Bandwidth (B) = 231.7 MHz

Limit at 50% Bandwidth = Power – Attenuation = -4.17 dBm – 14.6 dB attenuation = -18.8 dBm

Limit cannot be less than -13 dBm at 50% Bandwidth (115.85 MHz) = -13 dBm

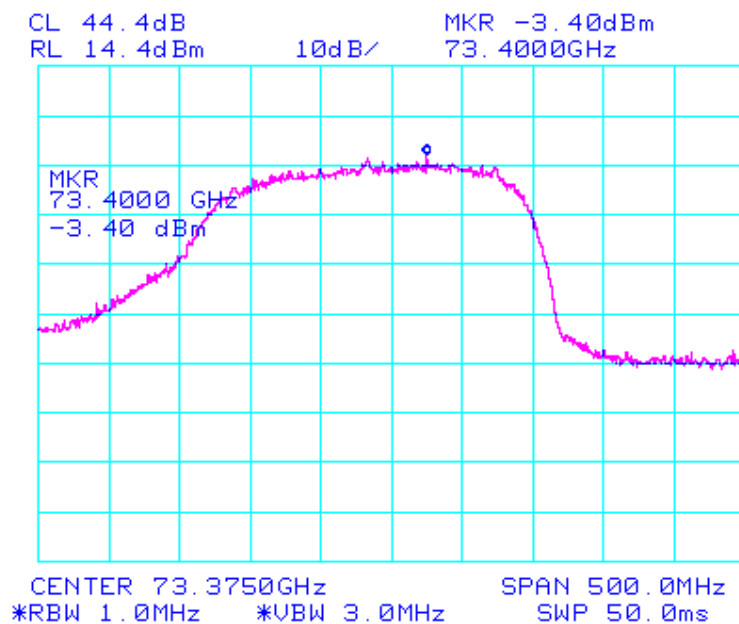
Limit > 50% bandwidth = -13 dBm

Equipment complies with the emission mask criteria



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### CHANNEL FREQUENCY 73.375 GHz



Emission Bandwidth (B) = 241.7 MHz

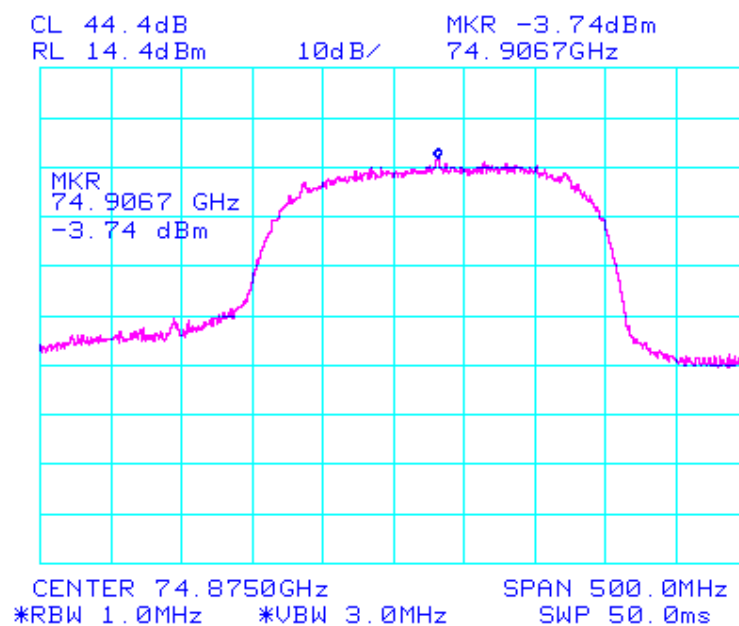
Limit at 50% Bandwidth = Power – Attenuation = +9.6 dBm – 14.8 dB attenuation = -5.2 dBm

Limit at 50% Bandwidth (120.85 MHz) = -5.2 dBm

Equipment complies with the emission mask criteria

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## CHANNEL FREQUENCY 74.875 GHz



Emission Bandwidth (B) = 230.8 MHz

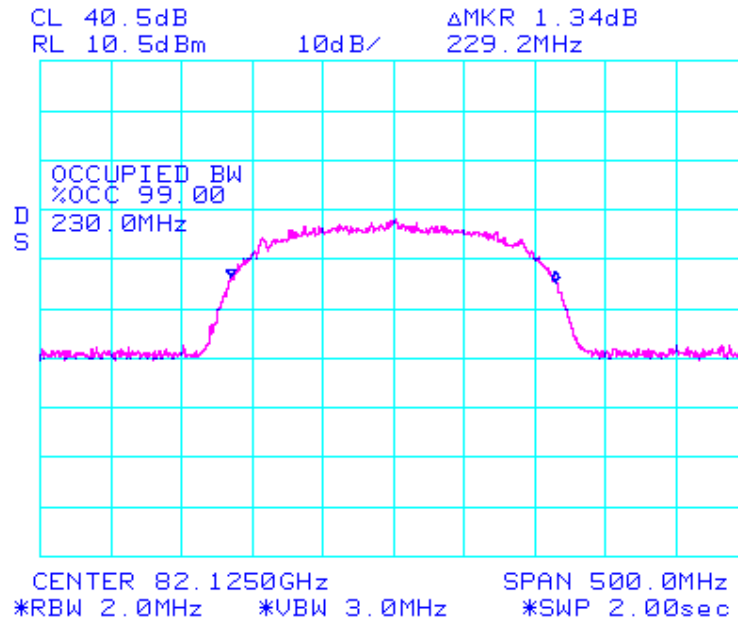
Limit at 50% Bandwidth = Power – Attenuation = +9.2 dBm – 14.6 dB attenuation = -5.4 dBm

Limit at 50% Bandwidth (120.85 MHz) = -5.4 dBm

Equipment complies with the emission mask criteria



**CHANNEL FREQUENCY 82.125 GHz**



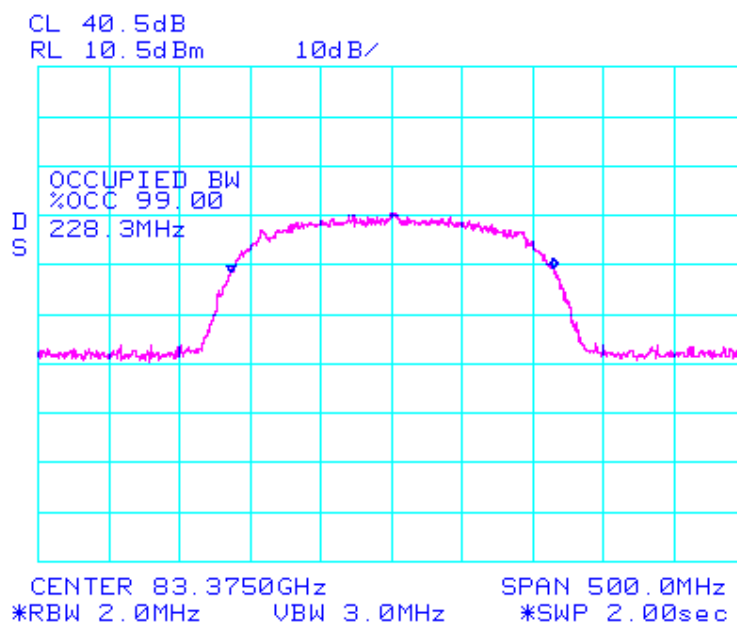
Emission Bandwidth (B) = 230.0 MHz

Limit at 50% Bandwidth = Power – Attenuation = -2.65 – 24.7 dB attenuation = -27.35 dBm

Limit cannot be less than -13 dBm at 50% Bandwidth (115.0 MHz) = -13 dBm

Equipment complies with the emission mask criteria

## CHANNEL FREQUENCY 83.375 GHz



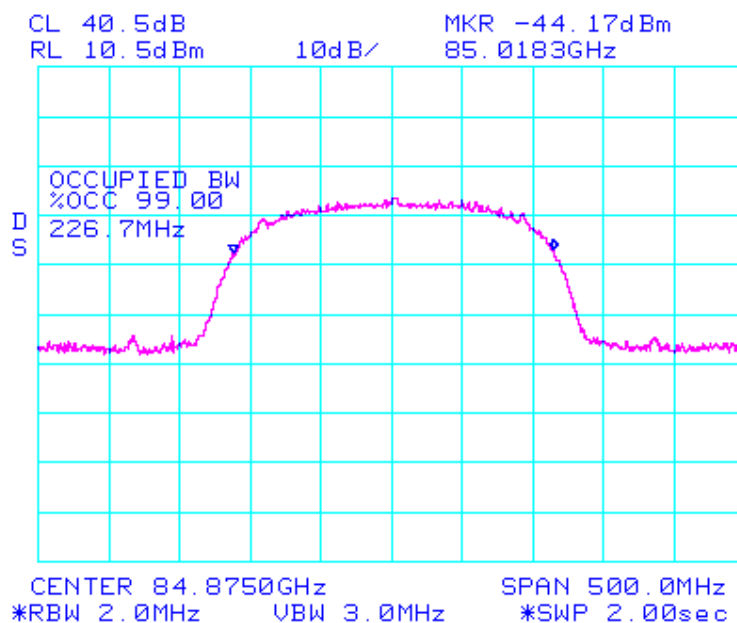
Emission Bandwidth (B) = 228.30 MHz

Limit at 50% Bandwidth = Power – Attenuation = -4.61 dBm – 25.0 dB attenuation = -29.61 dBm

Limit cannot be less than -13 dBm at 50% Bandwidth (114.15 MHz) = -13 dBm

Equipment complies with the emission mask criteria

## CHANNEL FREQUENCY 84.875 GHz



Emission Bandwidth (B) = 226.7.0 MHz

Limit at 50% Bandwidth = Power – Attenuation = -6.52 dBm – 25.5 dB attenuation = -32.02 dBm

Limit cannot be less than -13 dBm at 50% Bandwidth (113.35 MHz) = -13 dBm

Equipment complies with the emission mask criteria

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#### 7.1.4 Frequency Stability

##### **FCC 47 CFR Sections 101.107**

##### **Test Procedure**

The EUT was placed inside an environmental chamber. The transmitter output was connected to a spectrum analyzer via a pre-selector mixer and the frequency stability was measured using a modulated carrier. A thermocouple was used to monitor chamber temperature. The EUT was attached to a variable power supply providing the primary supply voltage.

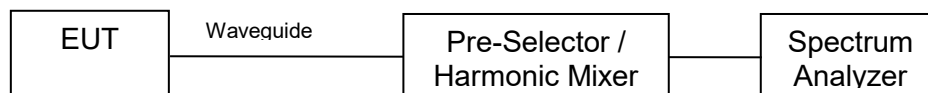
Frequency stability was measured through the extremes of temperature and voltage on the mid channel. Before measurements were taken at each temperature the equipment waited until thermal balance was obtained.

The delta marker method was used to measure frequency stability. A marker was placed on the rising edge of the occupied bandwidth at 10 dB below the peak of the spectrum. A delta marker was placed on the falling edge of the occupied bandwidth and the center frequency  $f_c$  calculated by using the following equation;

$$f_c = \text{Marker 1} + (\frac{1}{2} * \text{Delta Marker})$$

At +20°C the primary voltage was varied  $\pm 10\%$  and measurements were taken at each voltage level.

##### **Emissions above 40 GHz Test Configuration**



Emission measurement configuration(s)



## Limits

### § 101.107 Frequency tolerance.

(a) The carrier frequency of each transmitter authorized in these services must be maintained within the following percentage of the reference frequency except as otherwise provided in paragraph (b) of this section or in the applicable subpart of this part (unless otherwise specified in the instrument of station authorization the reference frequency will be deemed to be the assigned frequency):

### Frequency Tolerance Limits

For the frequency bands 71 – 76 and 81 – 86 GHz no frequency tolerance is specified.

### Laboratory Uncertainty for Frequency Measurements

|                              |          |
|------------------------------|----------|
| Measurement uncertainty (dB) | ±0.86ppm |
|------------------------------|----------|

### Traceability

| Method                                                                    | Test Equipment Used                         |
|---------------------------------------------------------------------------|---------------------------------------------|
| Measurements were made per work instruction WI-02 'Frequency Measurement' | 074, 088, 095, 0158, 0227, 0252, 0293, 0304 |

Center Frequency = 73.375 GHz

| Temperature (°C) | Voltage (Vdc) | Marker 1 | Delta Marker 1 | Calculated Center Frequency (GHz) | % error |
|------------------|---------------|----------|----------------|-----------------------------------|---------|
| -40              | 48.0          | 73.2887  | 0.2018         | 73.3896                           | -0.0199 |
| -30              | 48.0          | 73.2735  | 0.2158         | 73.3814                           | -0.0087 |
| -20              | 48.0          | 73.2805  | 0.21           | 73.3855                           | -0.0143 |
| -10              | 48.0          | 73.2758  | 0.0213         | 73.2864                           | 0.1207  |
| 0                | 48.0          | 73.2712  | 0.2205         | 73.3815                           | -0.0088 |
| 10               | 48.0          | 73.2648  | 0.224          | 73.3768                           | -0.0025 |
| 20               | 48.0          | 73.2706  | 0.2193         | 73.3803                           | -0.0072 |
| 20               | 43.2          | 73.2729  | 0.2129         | 73.3794                           | -0.0059 |
| 20               | 52.8          | 73.2776  | 0.2059         | 73.3806                           | -0.0076 |
| 30               | 48.0          | 73.2729  | 0.2141         | 73.3800                           | -0.0067 |
| 40               | 48.0          | 73.2688  | 0.2217         | 73.3797                           | -0.0063 |
| 50               | 48.0          | 73.2776  | 0.2067         | 73.3810                           | -0.0081 |
| 60               | 48.0          | 73.2755  | 0.2115         | 73.3813                           | -0.0085 |

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Center Frequency = 83.375 GHz

| Temperature (°C) | Voltage (Vdc) | Marker 1 | Delta Marker 1 | Calculated Center Frequency (GHz) | % error |
|------------------|---------------|----------|----------------|-----------------------------------|---------|
| -40              | 48.0          | 83.4699  | 0.2109         | 83.3644                           | -0.0199 |
| -30              | 48.0          | 83.4746  | 0.2059         | 83.3717                           | -0.0087 |
| -20              | 48.0          | 83.4840  | 0.2008         | 83.3836                           | -0.0143 |
| -10              | 48.0          | 83.3956  | 0.2253         | 83.2929                           | -0.0121 |
| 0                | 48.0          | 83.3961  | 0.2116         | 83.2903                           | -0.0089 |
| 10               | 48.0          | 83.4035  | 0.2222         | 83.2924                           | -0.0025 |
| 20               | 48.0          | 83.4035  | 0.2102         | 83.2984                           | -0.0072 |
| 20               | 43.2          | 83.4038  | 0.2009         | 83.3034                           | -0.0060 |
| 20               | 52.8          | 83.4179  | 0.2163         | 83.3098                           | -0.0076 |
| 30               | 48.0          | 83.4280  | 0.2251         | 83.3154                           | -0.0068 |
| 40               | 48.0          | 83.4260  | 0.2105         | 83.3208                           | -0.0064 |
| 50               | 48.0          | 83.4357  | 0.2163         | 83.3276                           | -0.0082 |
| 60               | 48.0          | 83.4455  | 0.2215         | 83.3348                           | -0.0086 |

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### 7.1.5 Conducted Spurious Emissions

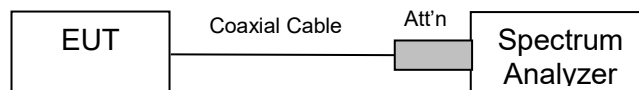
#### FCC, Part 101 Subpart 101.111 Emission Limitations

##### Test Procedure

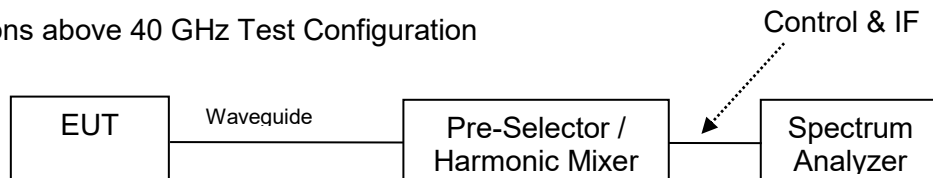
Conducted emissions were measured at a limit of -13 dBm/MHz. Emissions below 40 GHz were measured through direct connection to the spectrum analyzer. Emissions above 40 GHz were measured using a pre-selector or harmonic mixer. A 1 MHz resolution bandwidth was used to complete all measurements.

##### Test Measurement Set up

Emissions below 40 GHz Test Configuration



Emissions above 40 GHz Test Configuration



Conducted Spurious Emissions measurement configuration(s)

##### Measurement Results of Conducted Spurious Emissions

Ambient conditions.

Temperature: 17 to 23°C    Relative humidity: 31 to 57%    Pressure: 999 to 1012 mbar

Radio Parameters

Duty Cycle: 100%

Output: Modulated Carrier (QPSK)

Power: Maximum



#### **7.1.5.1 Conducted Spurious Emissions 1 – 40 GHz**

Due to the waveguide cut-off frequency spurious emissions below 40 GHz were not performed, see equation below;

***Lowest cut-off frequency for circular waveguide 1.549 mm radius;***

$$F_{\text{cut-off}} = (1.8412 \times c) / (2 \times \pi \times r)$$

c = speed of light ( $3 \times 10^8$  m/s)

r = radius of circular cross section of waveguide

$$F_c = \underline{56.7 \text{ GHz}}$$

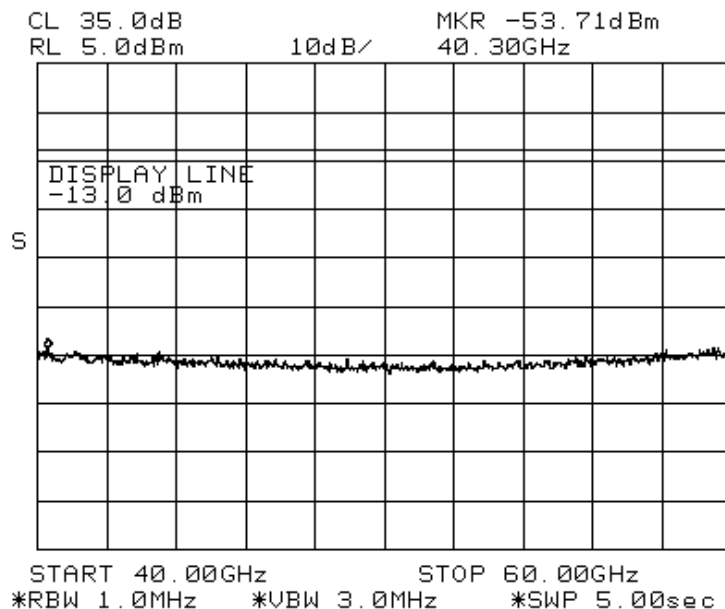
The initial test start frequency is 40 GHz.

Frequency scans were performed with a maximum step size of 10 GHz. In some cases these plots have been replaced with different spans.

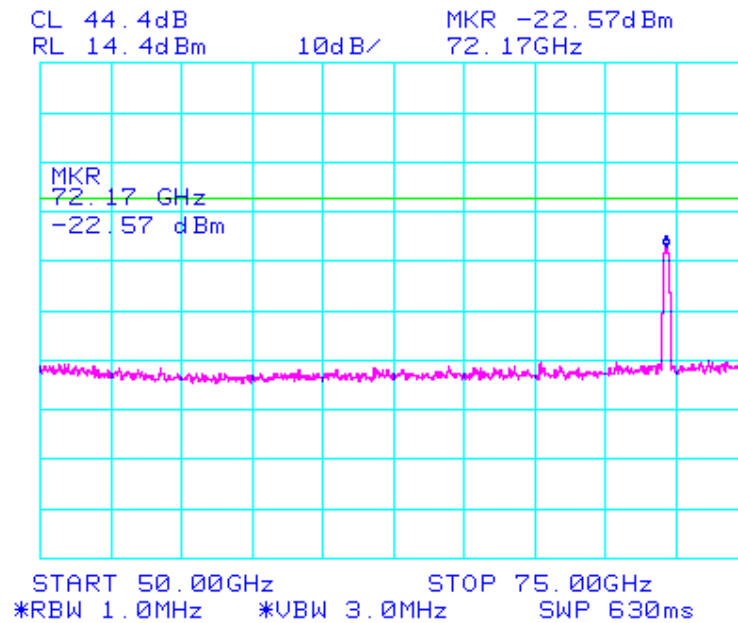
### 7.1.5.2 Low Band Conducted Spurious Emissions

Pre-selector Mixer

#### Conducted Spurious Emissions 40 - 50 GHz Channel 72.125 GHz



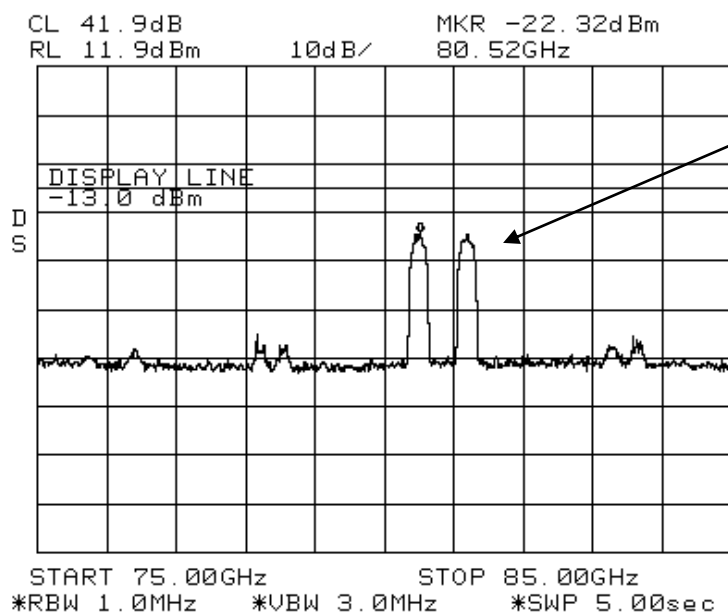
### Pre-selector Mixer



The emission close to the limit line is the fundamental frequency

Harmonic Mixer

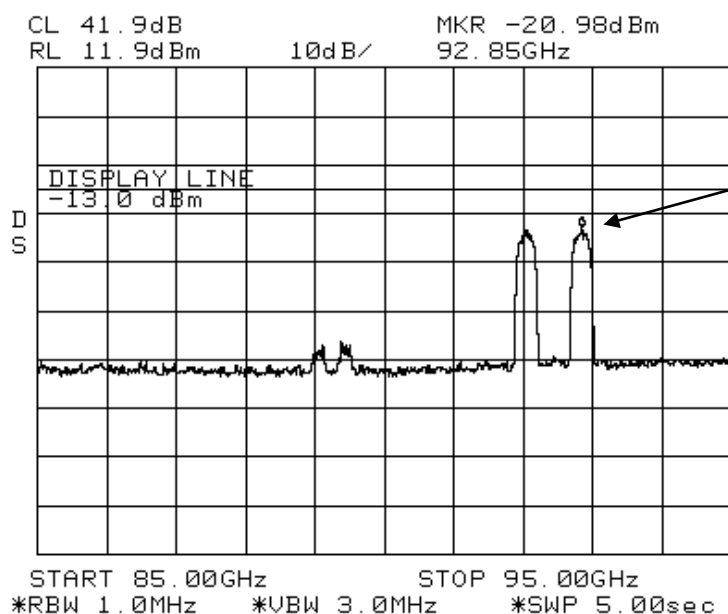
**Conducted Spurious Emissions 75 - 85 GHz Channel 72.125 GHz**



GHOST IMAGE DUE  
 TO HARMONIC  
 MIXER LIMITATIONS

## Harmonic Mixer

### Conducted Spurious Emissions 85 - 95 GHz Channel 72.125 GHz



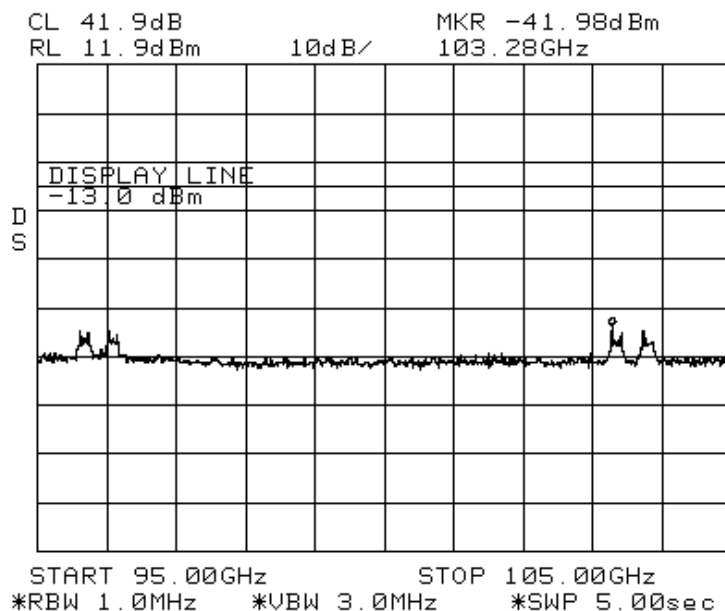
GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS



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Harmonic Mixer

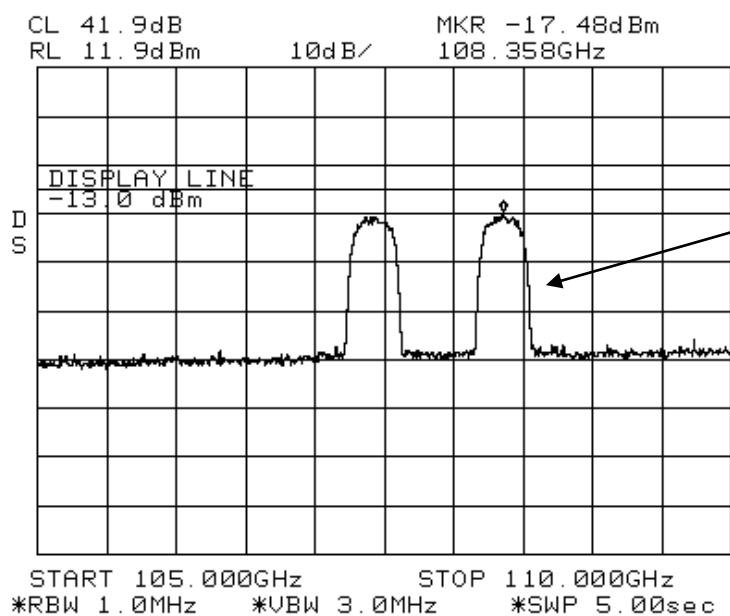
### Conducted Spurious Emissions 95 - 105 GHz Channel 72.125 GHz



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## Harmonic Mixer

### Conducted Spurious Emissions 105 - 110 GHz Channel 72.125 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

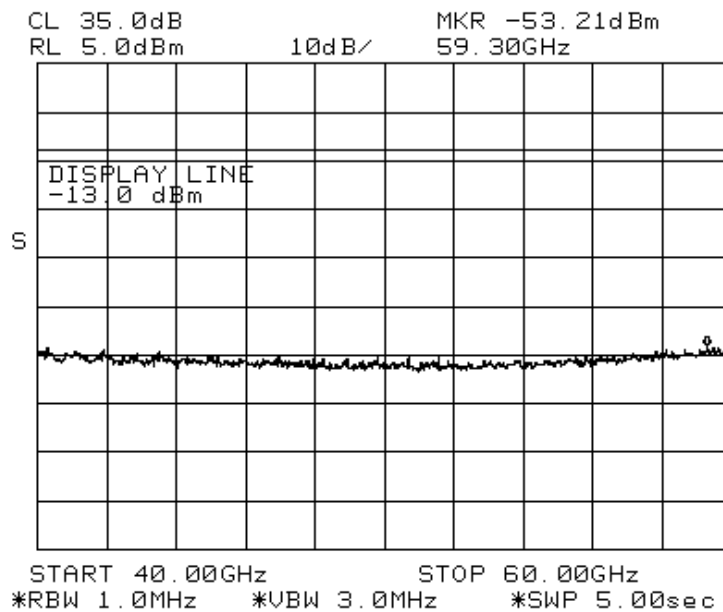


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Pre-selector Mixer

**Conducted Spurious Emissions 40 - 50 GHz Channel 73.375 GHz**

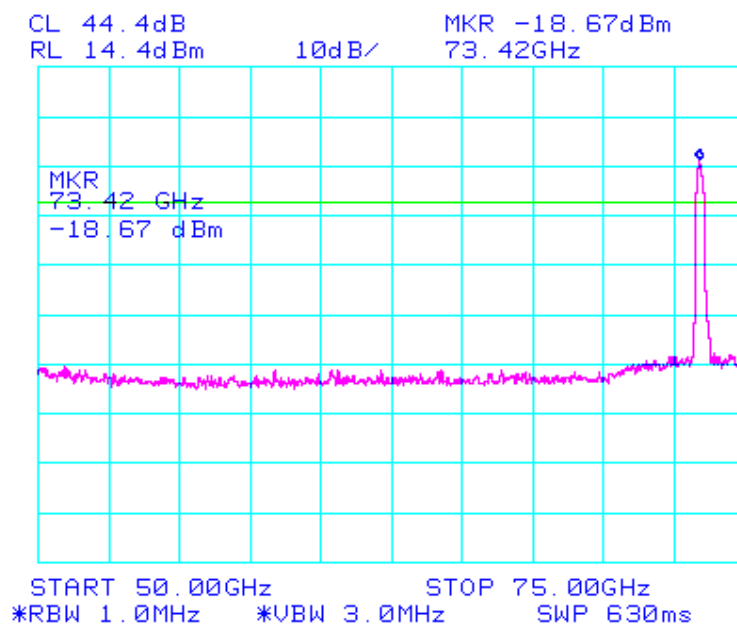


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Pre-selector Mixer

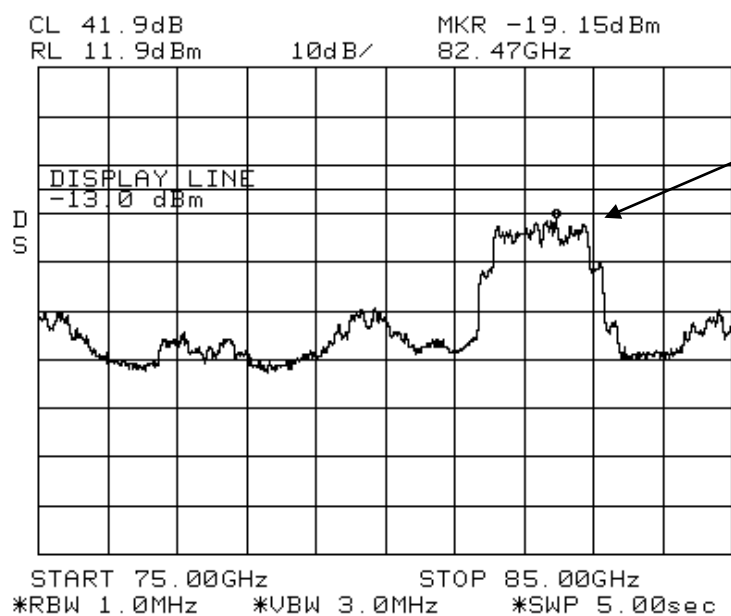
### Conducted Spurious Emissions 50 - 75 GHz Channel 73.375 GHz



The emission breaking the limit line is the fundamental frequency

## Harmonic Mixer

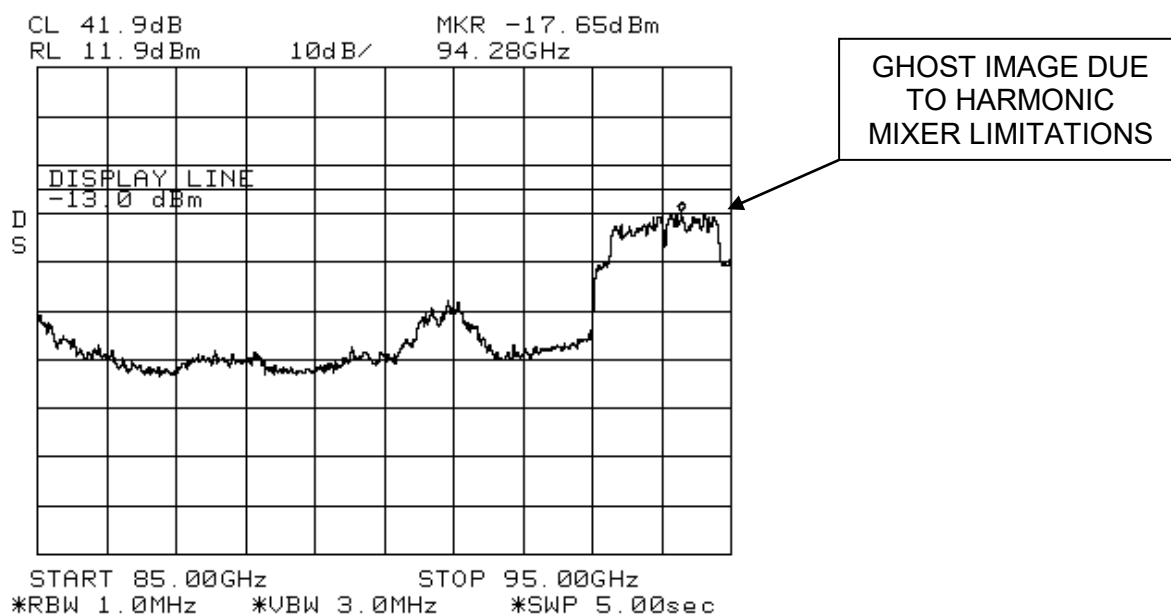
### Conducted Spurious Emissions 75 - 85 GHz Channel 73.375 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

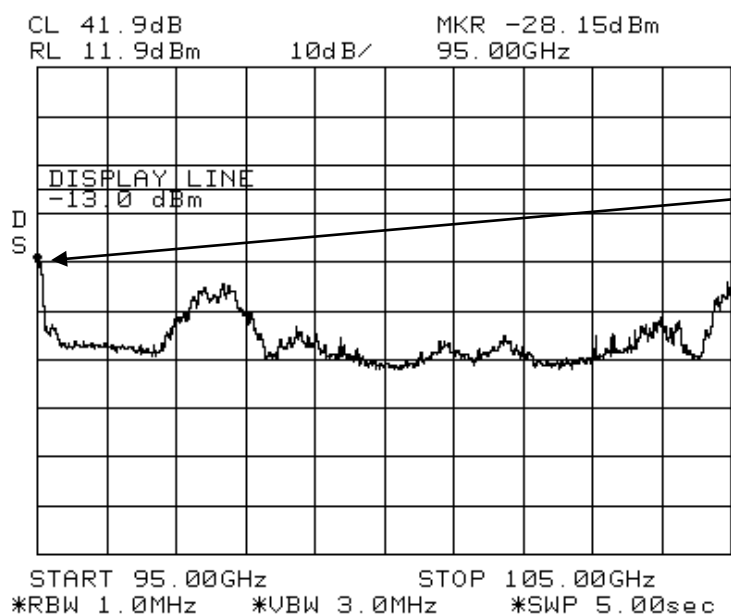
Harmonic Mixer

**Conducted Spurious Emissions 85 - 95 GHz Channel 73.375 GHz**



## Harmonic Mixer

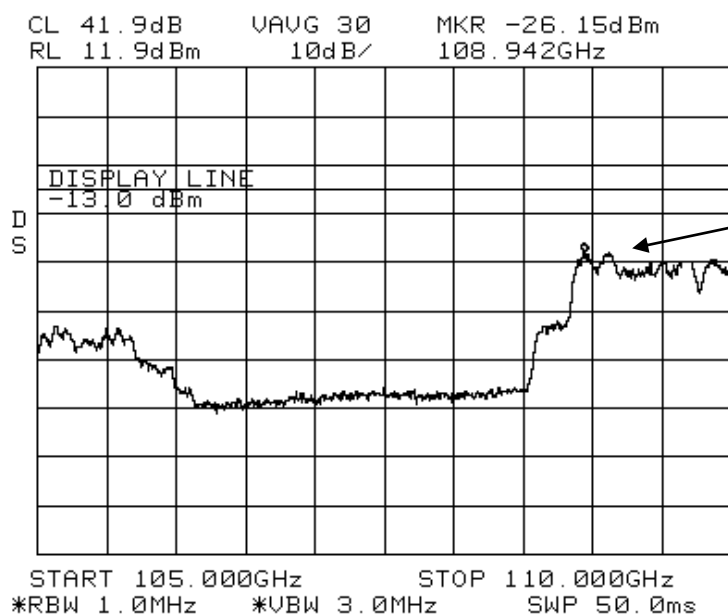
### Conducted Spurious Emissions 95 - 105 GHz Channel 73.375 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

### Conducted Spurious Emissions 105 - 110 GHz Channel 73.375 GHz



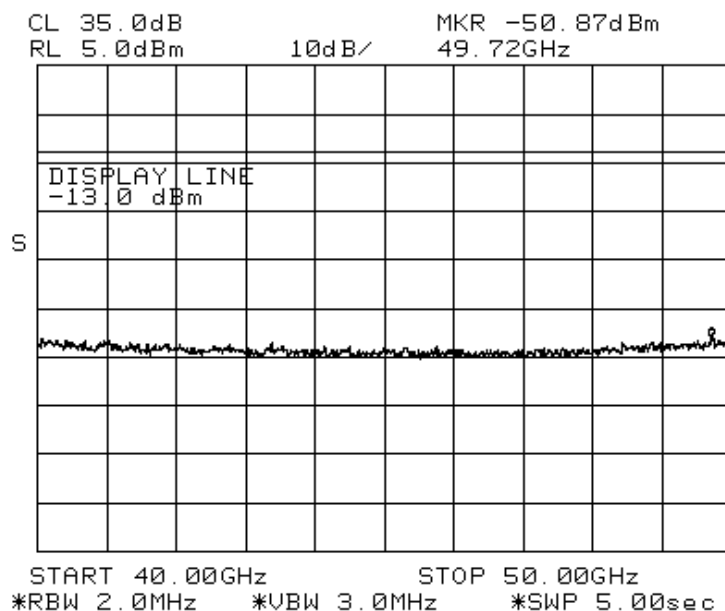
GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS



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Pre-selector Mixer

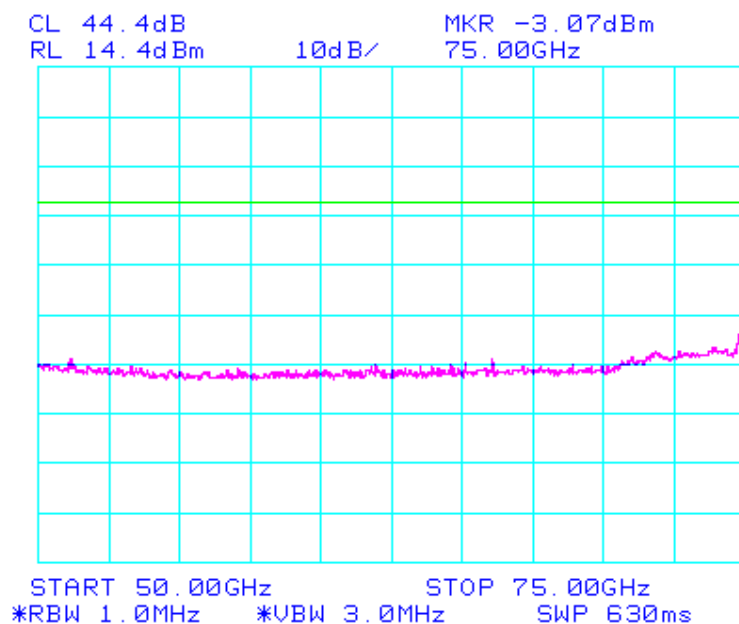
### Conducted Spurious Emissions 40 - 50 GHz Channel 74.875 GHz



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Pre-selector Mixer

### Conducted Spurious Emissions 50 - 75 GHz Channel 74.875 GHz



The emission breaking the limit line is the fundamental frequency

## Harmonic Mixer

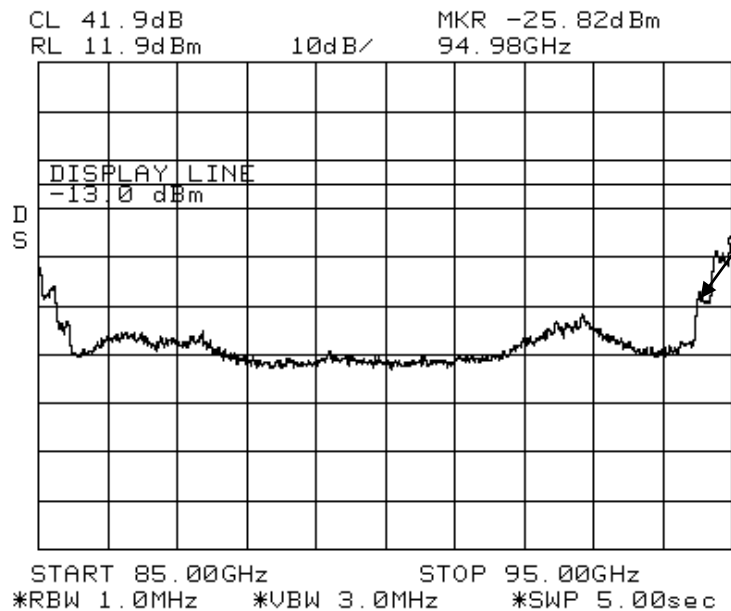
### Conducted Spurious Emissions 75 - 85 GHz Channel 74.875 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

Harmonic Mixer

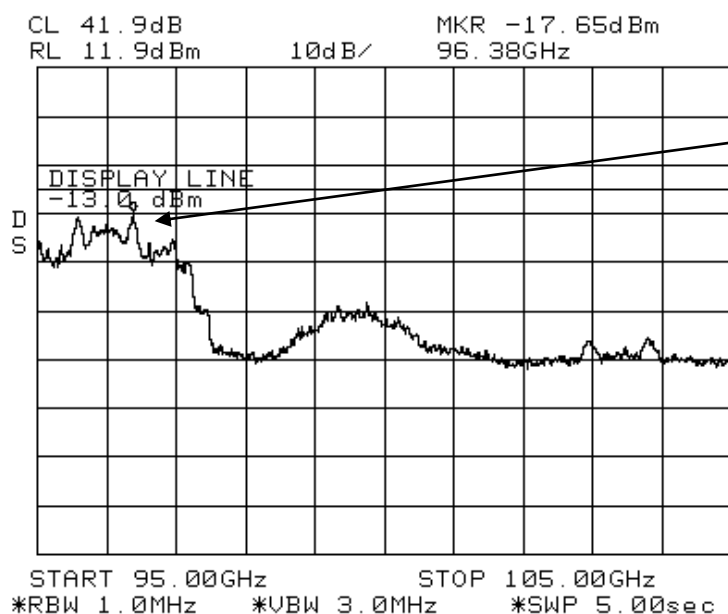
**Conducted Spurious Emissions 85 - 95 GHz Channel 74.875 GHz**



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

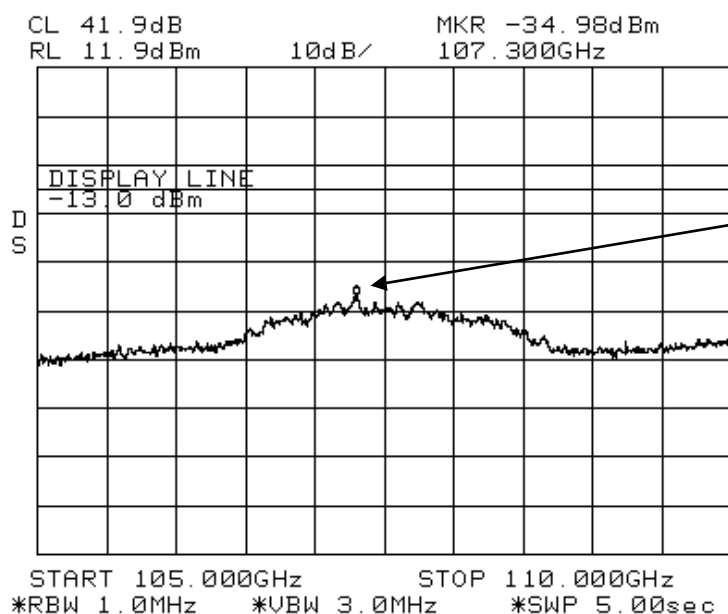
### Conducted Spurious Emissions 95 - 105 GHz Channel 74.875 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

### Conducted Spurious Emissions 105 - 110 GHz Channel 74.875 GHz



GHOST IMAGE DUE  
 TO HARMONIC  
 MIXER LIMITATIONS



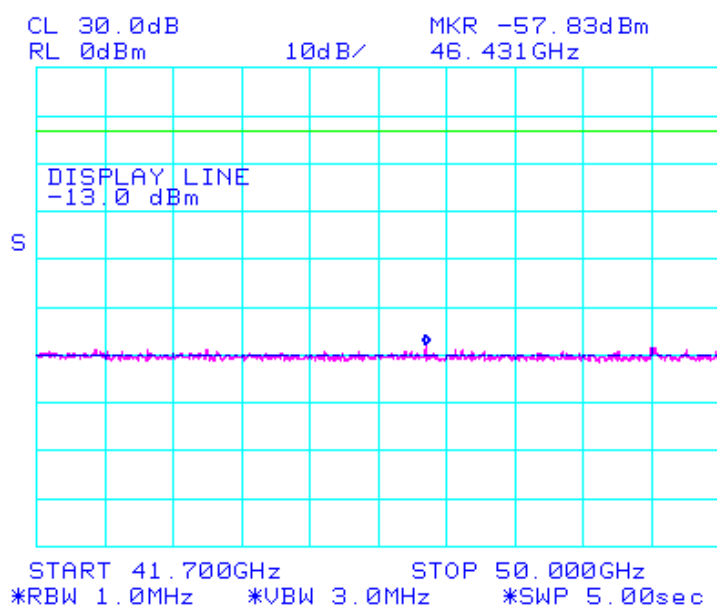
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### 7.1.5.3 High Band Conducted Spurious Emissions

Pre-selector Mixer

#### Conducted Spurious Emissions 40 - 50 GHz Channel 82.125 GHz



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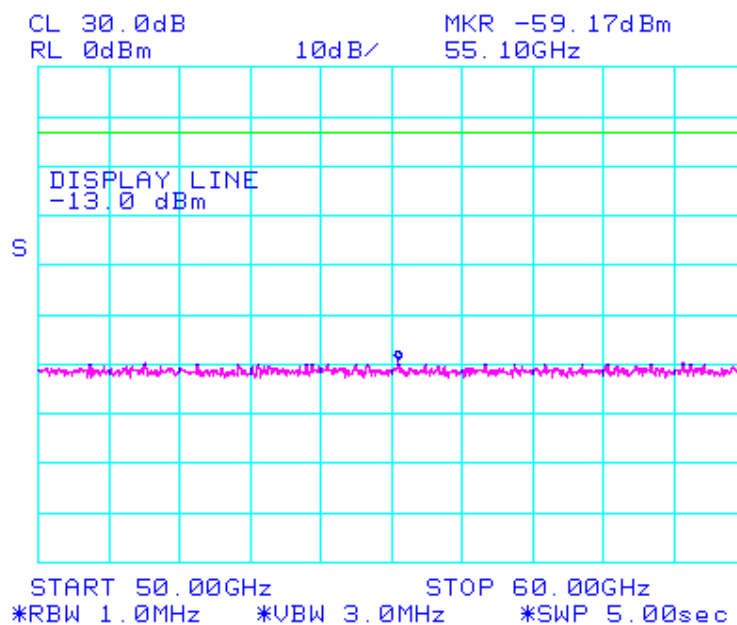
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Pre-selector Mixer

### Conducted Spurious Emissions 50 - 60 GHz Channel 82.125 GHz



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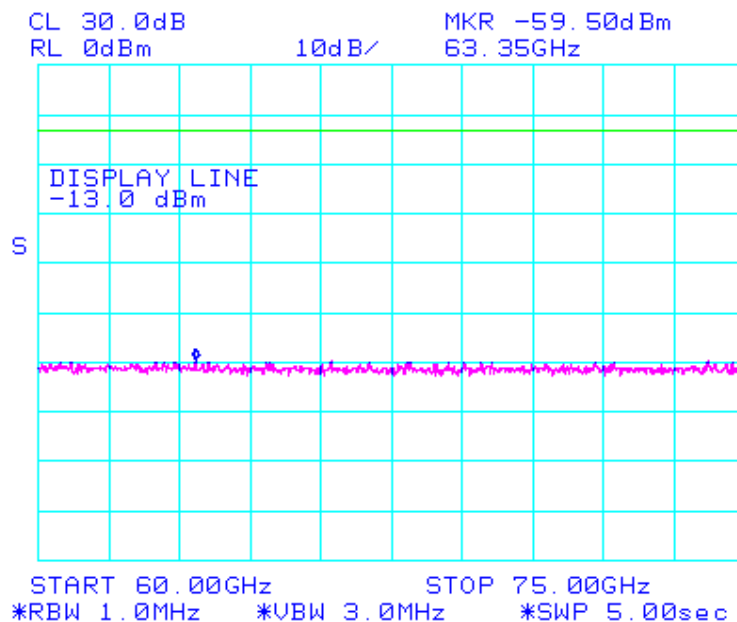


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Pre-selector Mixer

### Conducted Spurious Emissions 60 - 75 GHz Channel 82.125 GHz



---

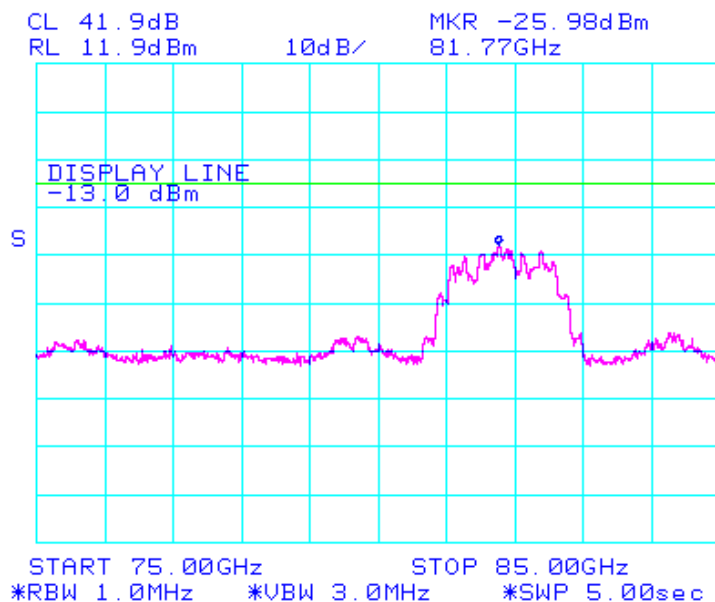
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## Harmonic Mixer

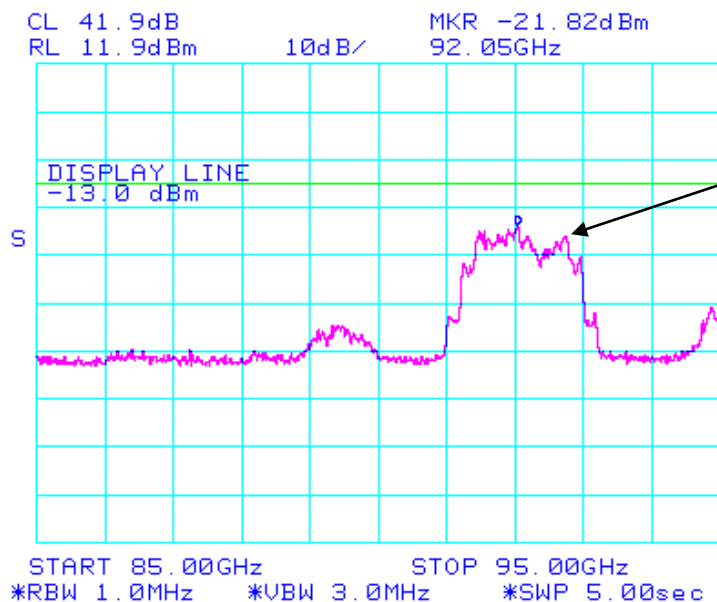
### Conducted Spurious Emissions 75 - 85 GHz Channel 82.125 GHz



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## Harmonic Mixer

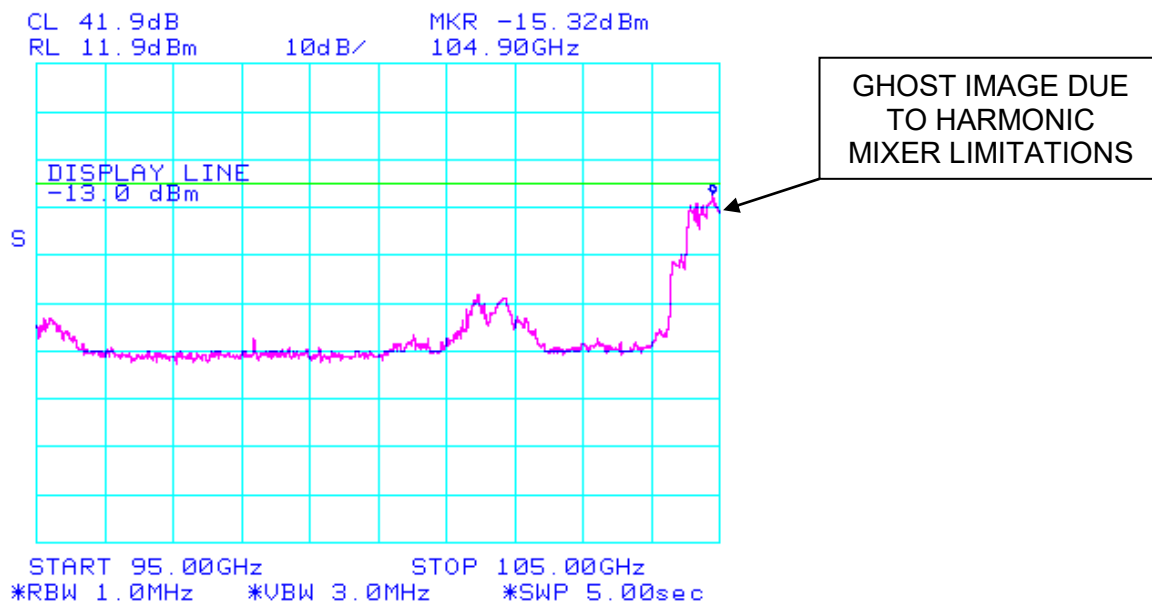
### Conducted Spurious Emissions 85 - 95 GHz Channel 82.125 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

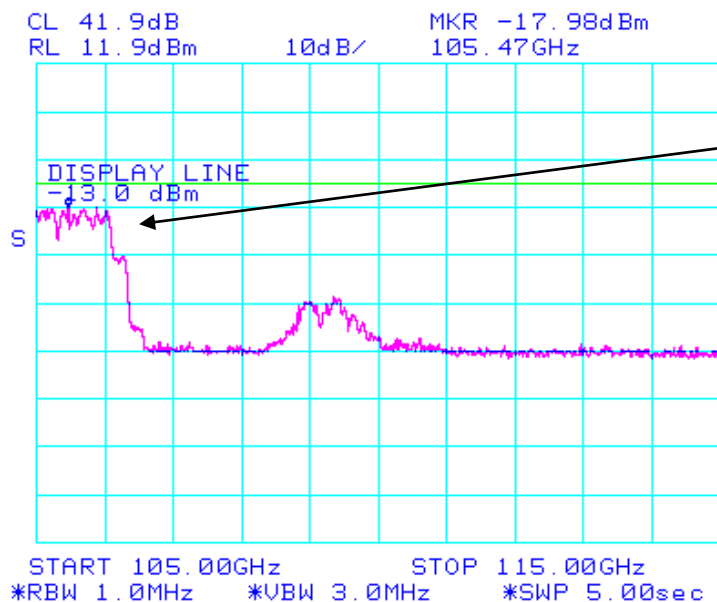
## Harmonic Mixer

### Conducted Spurious Emissions 95 - 105 GHz Channel 82.125 GHz



## Harmonic Mixer

### Conducted Spurious Emissions 105 - 110 GHz Channel 82.125 GHz



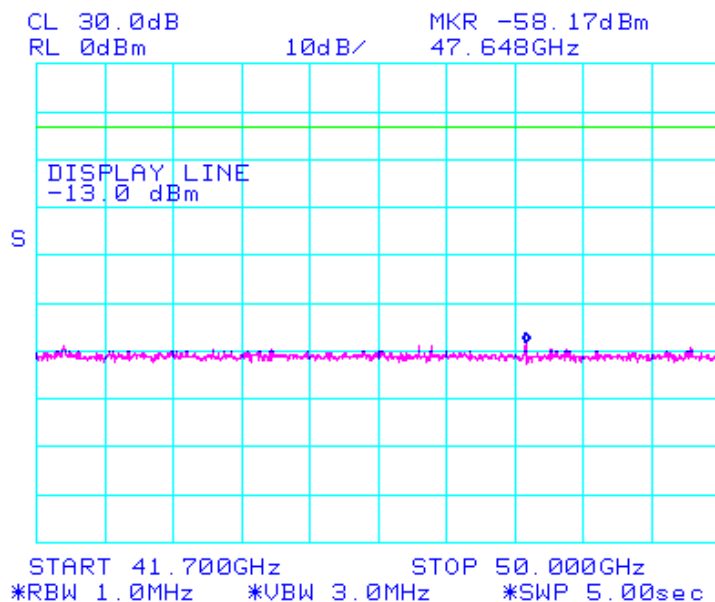
GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS



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Pre-selector Mixer

### Conducted Spurious Emissions 40 - 50 GHz Channel 83.375 GHz



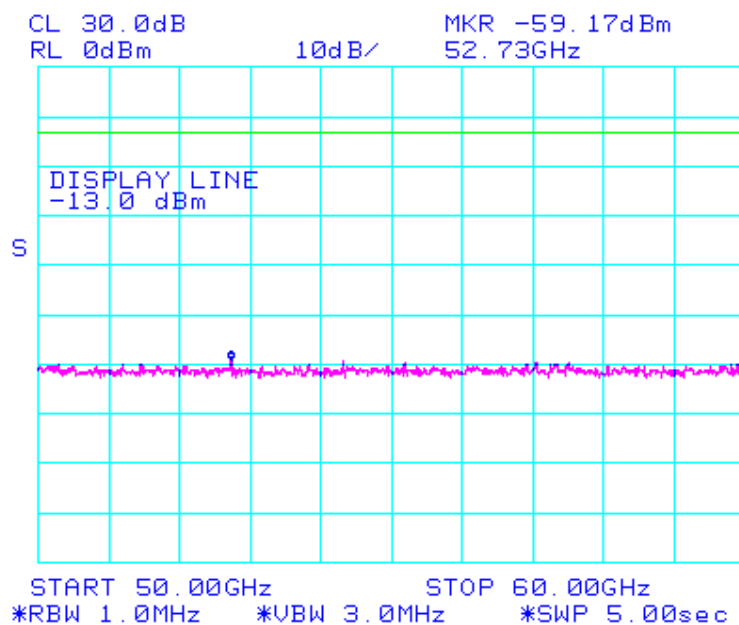
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Pre-selector Mixer

### Conducted Spurious Emissions 50 - 60 GHz Channel 83.375 GHz



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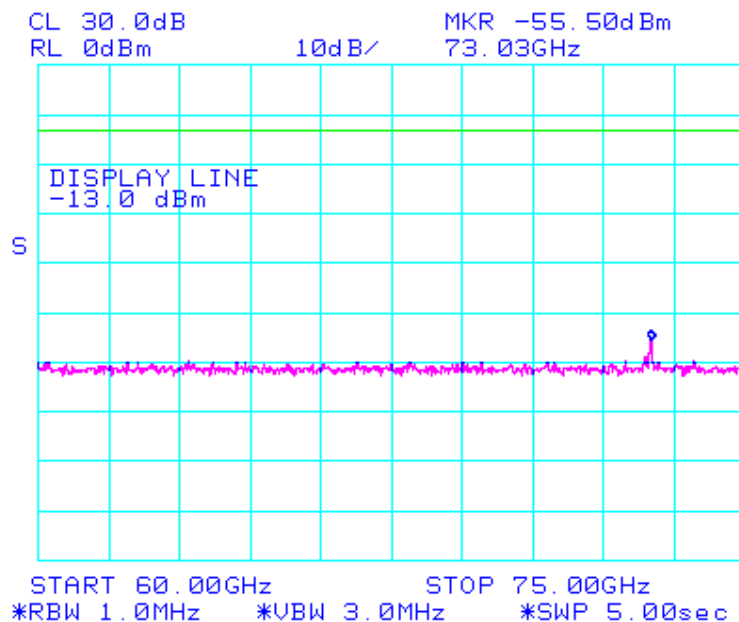


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Pre-selector Mixer

**Conducted Spurious Emissions 60 - 75 GHz Channel 83.375 GHz**

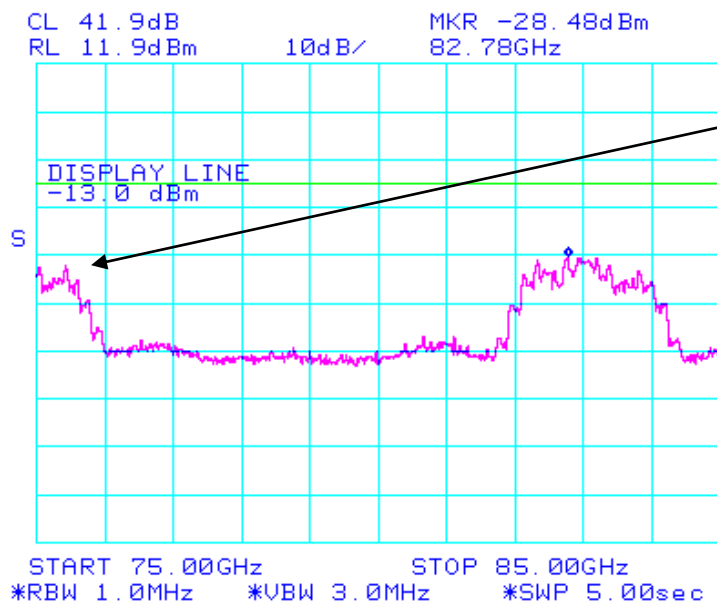


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## Harmonic Mixer

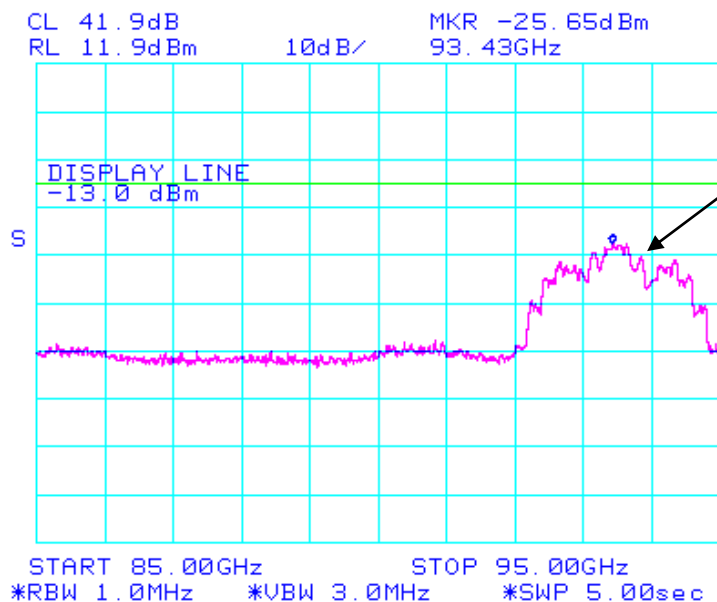
### Conducted Spurious Emissions 75 - 85 GHz Channel 83.375 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

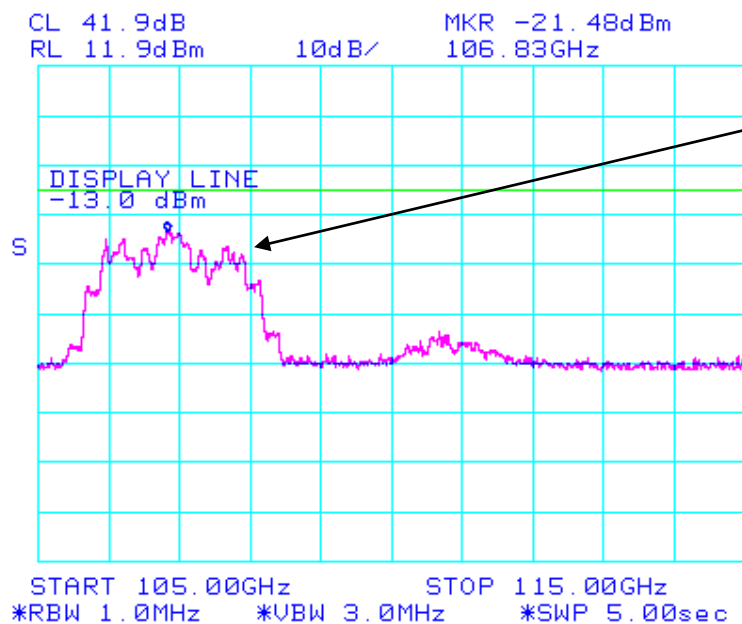
### Conducted Spurious Emissions 85 - 95 GHz Channel 83.375 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

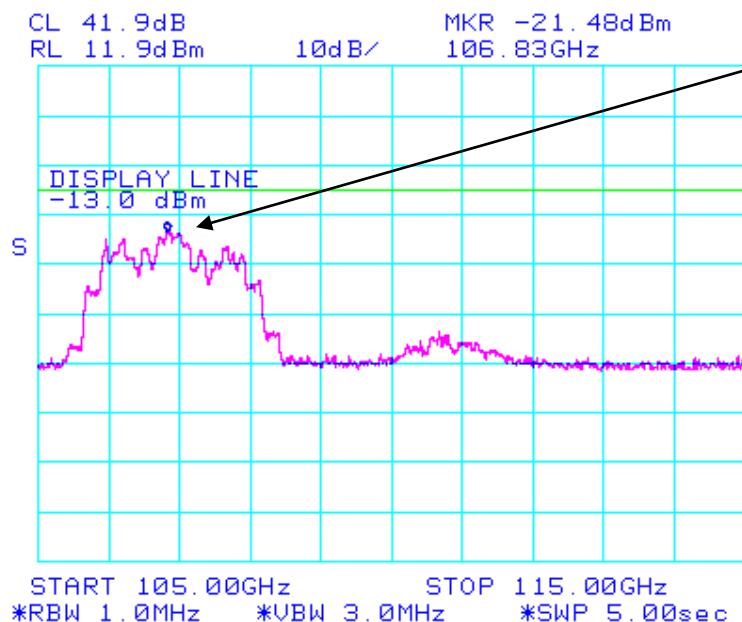
### Conducted Spurious Emissions 95 - 105 GHz Channel 83.375 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

### Conducted Spurious Emissions 105 - 110 GHz Channel 83.375 GHz



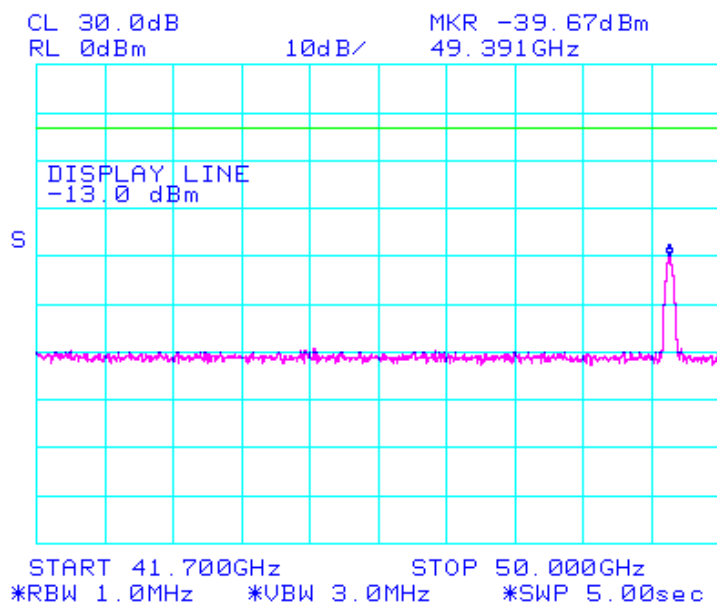
GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS



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Pre-selector Mixer

### Conducted Spurious Emissions 40 - 50 GHz Channel 84.875 GHz



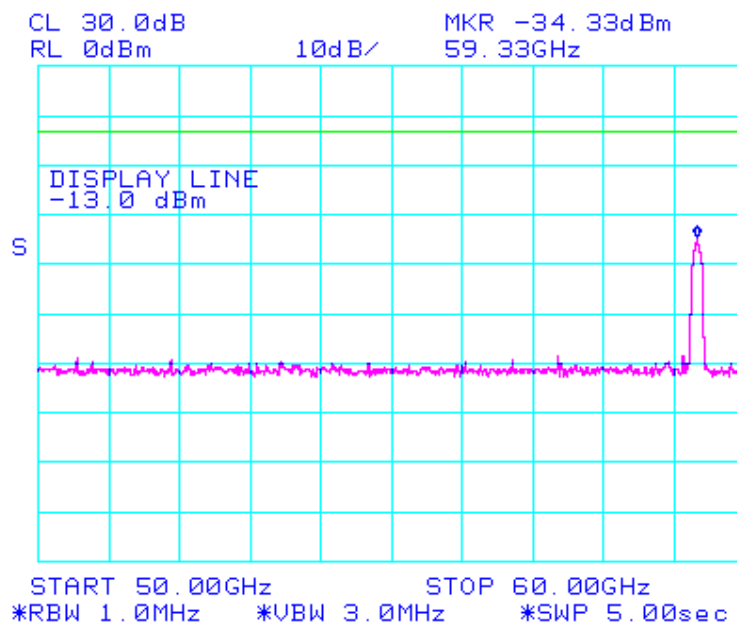
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Pre-selector Mixer

### CONDUCTED SPURIOUS EMISSIONS 50 - 60 GHz CHANNEL 84.875 GHz



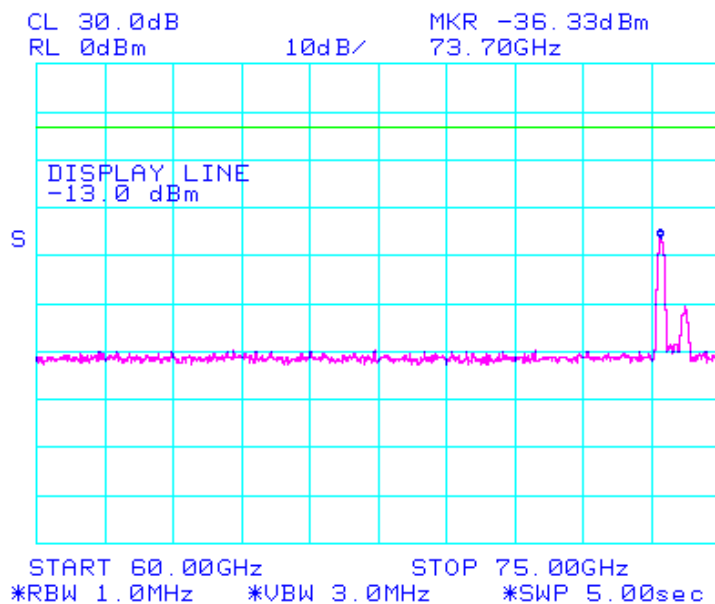
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Harmonic Mixer

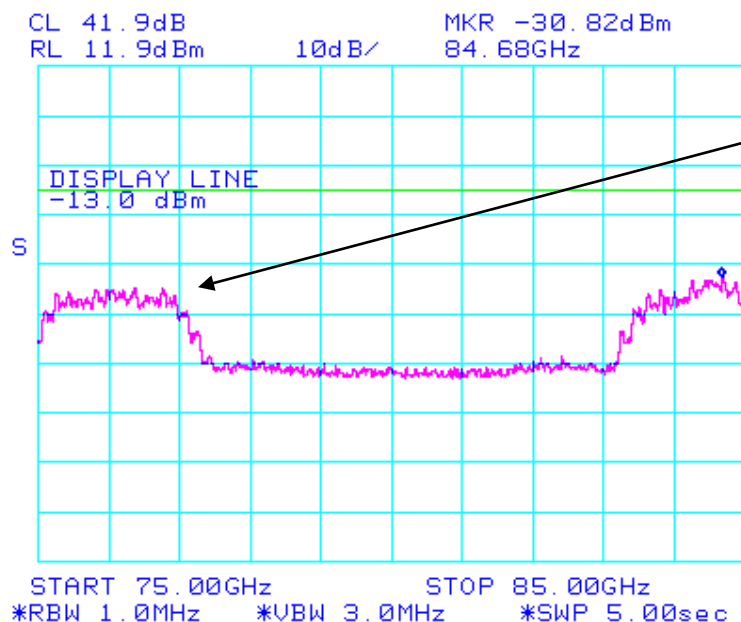
### Conducted Spurious Emissions 60 - 75 GHz Channel 84.875 GHz



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## Harmonic Mixer

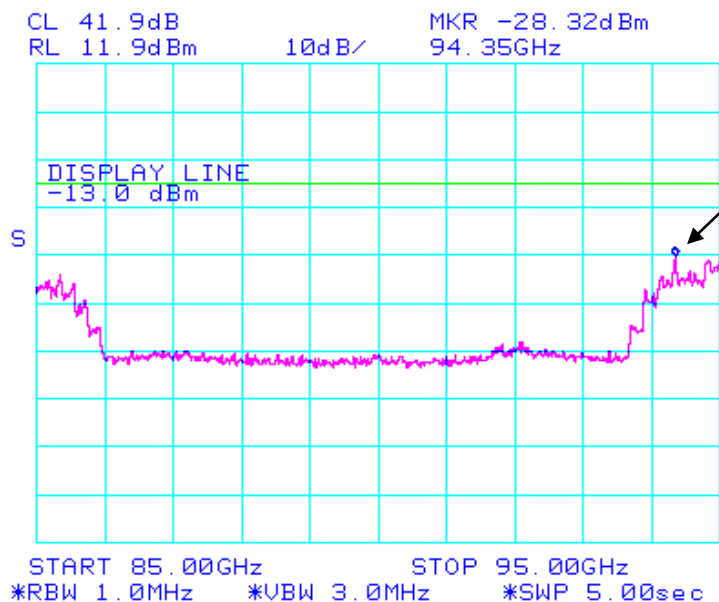
### Conducted Spurious Emissions 75 - 85 GHz Channel 84.875 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

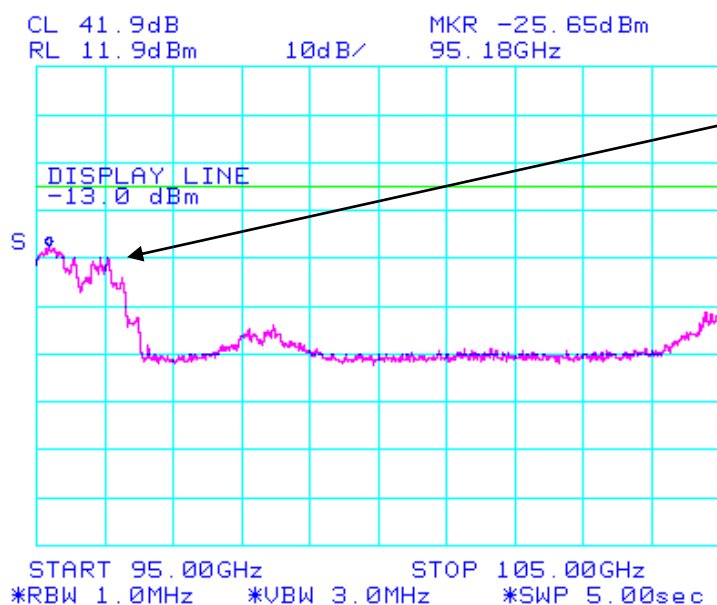
### Conducted Spurious Emissions 85 - 95 GHz Channel 84.875 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

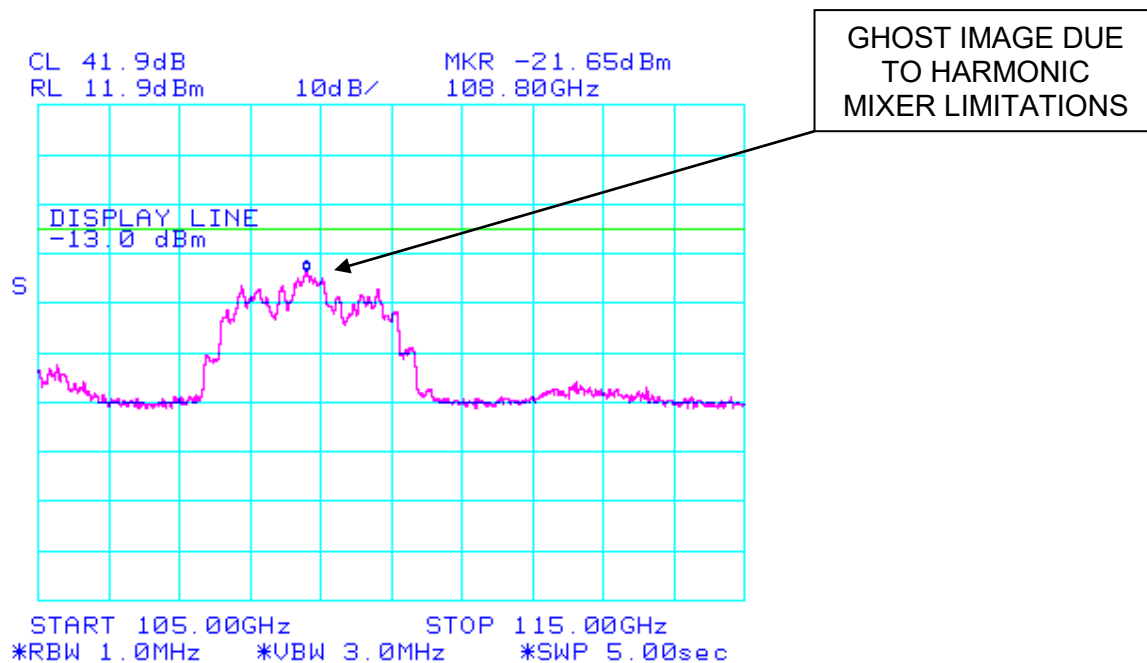
### Conducted Spurious Emissions 95 – 105 GHz Channel 84.875 GHz



GHOST IMAGE DUE  
TO HARMONIC  
MIXER LIMITATIONS

## Harmonic Mixer

### Conducted Spurious Emissions 105 – 110 GHz Channel 84.875 GHz





### Specification

#### §101.111

(ii) For operating frequencies above 15 GHz, in any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

$$A = 11 + 0.4(P-50) + 10 \log_{10} B.$$

Where;

A = Attenuation (in decibels) below the mean output power level.

P = Percent removed from the center frequency of the transmitter bandwidth.

B = Authorized bandwidth in MHz.

(Attenuation greater than 56 decibels or to an absolute power of less than -13 dBm/1MHz is not required).

(iii) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least  $43 + 10 \log_{10}$  (the mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation.

### Laboratory Measurement Uncertainty for Conducted Spurious Emissions

|                         |               |
|-------------------------|---------------|
| Measurement uncertainty | $\pm 2.37$ dB |
|-------------------------|---------------|

### Traceability

| Method                                                                                | Test Equipment Used                               |
|---------------------------------------------------------------------------------------|---------------------------------------------------|
| Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions' | 074, 088, 095, 0128, 0158, 0227, 0252, 0293, 0304 |



#### **7.1.6 Digital Emissions (0.03 – 6 GHz)**

##### **FCC, Part 15 Subpart C 15.205; 15.209**

##### **Test Procedure**

Testing 0.03-6 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 the analyzer in peak hold mode. Emissions closest to the limit(s) are investigated in detail;

Emissions below 1 GHz are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz

Emissions above 1 GHz are measured with an average detector with the tuned receiver using a bandwidth of 1 MHz

Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

The EUT had two methods of powering on ac/dc converter and Power over Ethernet (POE). Both modes were tested for emissions below 1GHz.

##### **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



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For example:

Given a Receiver input reading of 51.5dB $\mu$ V; 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:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3\text{dB}\mu\text{V/m}$$

Conversion between dB $\mu$ V/m (or dB $\mu$ V) and  $\mu$ V/m (or  $\mu$ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (\mu V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100\mu\text{V/m}$$

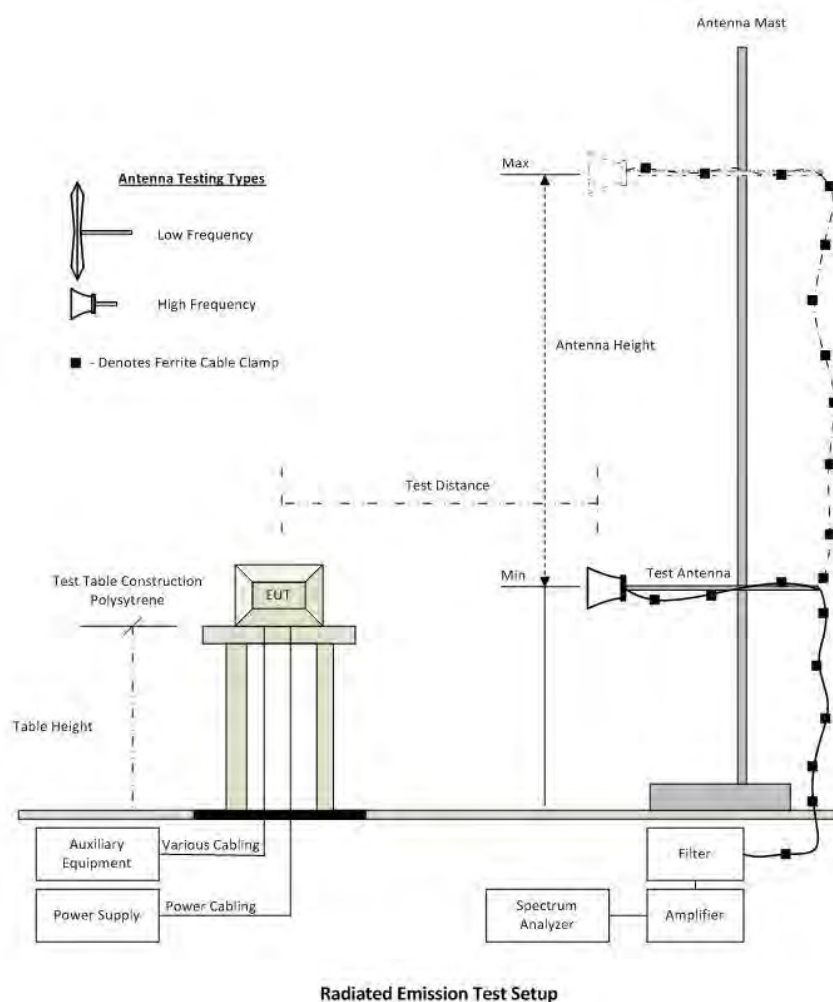
$$48 \text{ dB}\mu\text{V/m} = 250\mu\text{V/m}$$

---

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The following tests were performed using the conducted test set-up shown in the diagram below.

1. Digital Emissions (0.03 - 1GHz and 1 - 6 GHz)



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.

Ambient test conditions.

Temperature: 17 to 23 °C      Relative humidity: 31 to 57 %      Pressure: 999 to 1012 mbar



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## Measurement Results for Spurious Emissions (30 MHz – 1 GHz)

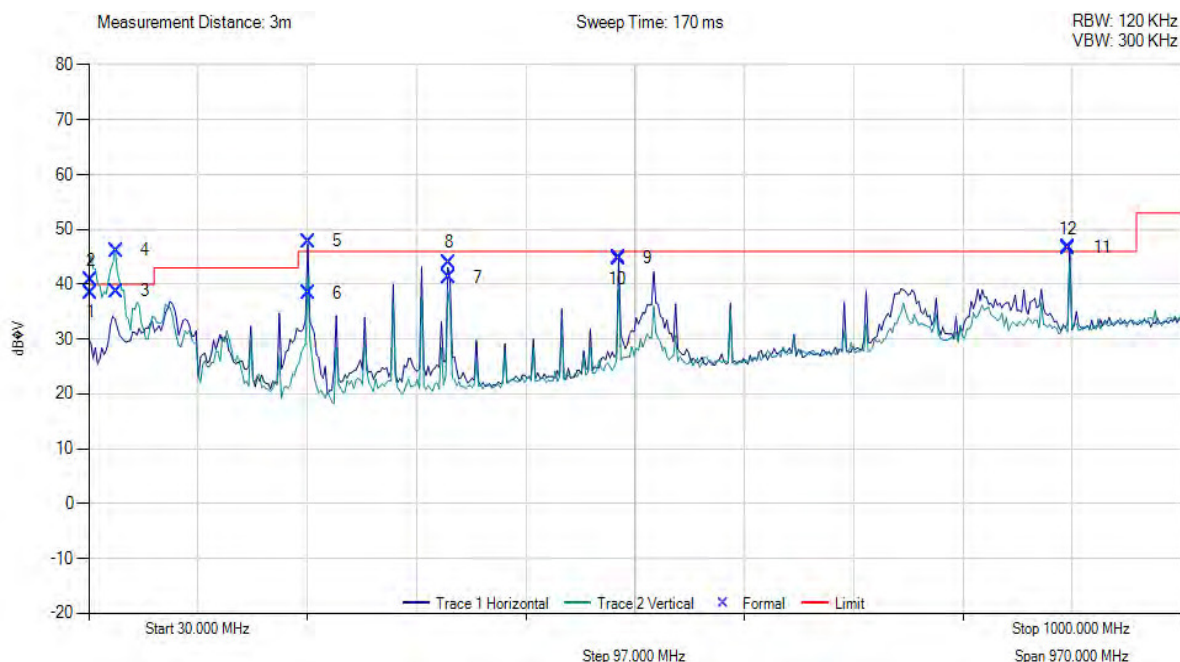
### Equipment Configuration for Digital Emissions (0.03 - 1 GHz)

|                                 |                |                        |             |
|---------------------------------|----------------|------------------------|-------------|
| <b>Antenna:</b>                 | Not Connected  | <b>Variant:</b>        | Airlight    |
| <b>Antenna Gain (dBi):</b>      | Not Applicable | <b>Modulation:</b>     | QPSK        |
| <b>Beam Forming Gain (Y):</b>   | Not Applicable | <b>Duty Cycle (%):</b> | 100         |
| <b>Channel Frequency (MHz):</b> | 72.125 GHz     | <b>Data Rate:</b>      | 1000 Mbit/s |
| <b>Power Setting:</b>           | Maximum        | <b>Tested By:</b>      | JMH         |

### Test Measurement Results



Variant: Airlight, Test Freq: 72.125 GHz



| Num | Frequency MHz | Raw dBμV | Cable Loss | AF dB  | Level dBμV/m | Measurement Type | Pol        | Hgt cm | Azt Deg | Limit dBμV/m | Margin dB | Pass /Fail |
|-----|---------------|----------|------------|--------|--------------|------------------|------------|--------|---------|--------------|-----------|------------|
| 1   | 31.94         | 46.27    | 3.44       | -11.21 | 38.50        | MaxQP            | Vertical   | 100    | 308     | 40.0         | -1.5      | Pass       |
| 2   | 31.94         | 48.57    | 3.44       | -11.21 | 40.80        | Peak (Scan)      | Vertical   |        |         |              |           |            |
| 3   | 54.21         | 59.04    | 3.60       | -23.93 | 38.71        | MaxQP            | Vertical   | 117    | 193     | 40.0         | -1.3      | Pass       |
| 4   | 54.21         | 66.52    | 3.60       | -23.93 | 46.19        | Peak (Scan)      | Vertical   |        |         |              |           |            |
| 5   | 224.99        | 61.15    | 4.44       | -19.65 | 45.94        | MaxQP            | Horizontal | 124    | 115     | 46.0         | -0.6      | Pass       |
| 6   | 224.99        | 53.62    | 4.44       | -19.65 | 38.41        | Peak (Scan)      | Horizontal |        |         |              |           |            |
| 7   | 349.96        | 52.06    | 4.87       | -15.73 | 41.20        | MaxQP            | Horizontal | 106    | 316     | 46.0         | -4.8      | Pass       |
| 8   | 349.96        | 54.89    | 4.87       | -15.73 | 44.03        | Peak (Scan)      | Horizontal |        |         |              |           |            |
| 9   | 499.98        | 52.43    | 5.33       | -12.85 | 44.91        | Peak (Scan)      | Horizontal |        |         |              |           |            |
| 10  | 499.98        | 52.10    | 5.33       | -12.85 | 44.58        | MaxQP            | Horizontal | 188    | 348     | 46.0         | -1.4      | Pass       |
| 11  | 899.98        | 48.23    | 6.34       | -7.87  | 46.70        | Peak (Scan)      | Horizontal |        |         |              |           |            |
| 12  | 899.98        | 45.7     | 6.34       | -7.87  | 44.17        | MaxQP            | Horizontal | 157    | 1       | 46.0         | -1.83     | Pass       |

**Test Notes:** POE non shielded cables

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## Measurement Results for Spurious Emissions (1 - 6 GHz)

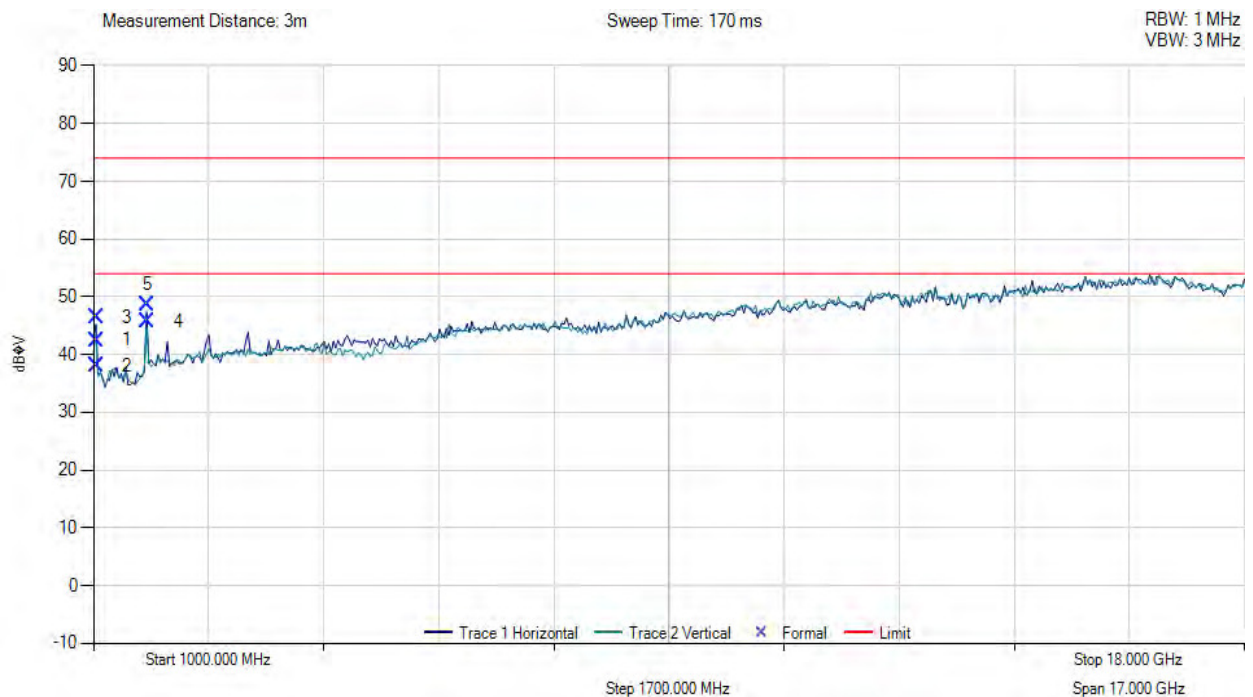
### Equipment Configuration for Radiated Spurious - Restricted Band Emissions

|                                 |                |                        |             |
|---------------------------------|----------------|------------------------|-------------|
| <b>Antenna:</b>                 | Not Connected  | <b>Variant:</b>        | Airlight    |
| <b>Antenna Gain (dBi):</b>      | Not Applicable | <b>Modulation:</b>     | QPSK        |
| <b>Beam Forming Gain (Y):</b>   | Not Applicable | <b>Duty Cycle (%):</b> | 100         |
| <b>Channel Frequency (MHz):</b> | 72.125 GHz     | <b>Data Rate:</b>      | 1000 Mbit/s |
| <b>Power Setting:</b>           | Maximum        | <b>Tested By:</b>      | JMH         |

### Test Measurement Results



Variant: Airlight, Test Freq: 72.125 GHz



| Num | Frequency MHz | Raw dBμV | Cable Loss | AF dB  | Level dBμV/m | Measurement Type | Pol        | Hgt cm | Azt Deg | Limit dBμV/m | Margin dB | Pass /Fail |
|-----|---------------|----------|------------|--------|--------------|------------------|------------|--------|---------|--------------|-----------|------------|
| 1   | 1050.00       | 57.50    | 2.09       | -17.11 | 42.48        | Peak (NRB)       | Horizontal |        |         |              |           |            |
| 2   | 1050.00       | 53.07    | 2.09       | -17.11 | 38.05        | Max Avg          | Horizontal | 121    | 149     | 54.0         | 16.0      | Pass       |
| 3   | 1050.00       | 61.44    | 2.09       | -17.11 | 46.42        | Max Peak         | Horizontal | 121    | 149     | 74.0         | -27.6     | Pass       |
| 4   | 1800.08       | 56.89    | 2.47       | -13.65 | 45.71        | Max Avg          | Horizontal | 100    | 114     | 54.0         | 8.3       | Pass       |
| 5   | 1800.08       | 59.77    | 2.47       | -13.65 | 48.59        | Max Peak         | Horizontal | 100    | 114     | 74.0         | -25.4     | Pass       |

**Test Notes:** POE non shielded cables

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## Specification

### Limits

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown 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 Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (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.

#### §15.209 (a) Limit Matrix

| Frequency(MHz) | Field Strength<br>( $\mu\text{V/m}$ ) | Field Strength<br>( $\text{dB}\mu\text{V/m}$ ) | Measurement Distance<br>(meters) |
|----------------|---------------------------------------|------------------------------------------------|----------------------------------|
| 30-88          | 100                                   | 40.0                                           | 3                                |
| 88-216         | 150                                   | 43.5                                           | 3                                |
| 216-960        | 200                                   | 46.0                                           | 3                                |
| Above 960      | 500                                   | 54.0                                           | 3                                |

## Laboratory Measurement Uncertainty for Radiated Emissions

|                         |               |
|-------------------------|---------------|
| Measurement uncertainty | +5.6/ -4.5 dB |
|-------------------------|---------------|

## Traceability

| Method                                                                                | Test Equipment Used                                                    |
|---------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions' | 0158, 0193, 0252, 0310, 0312, 0338, 0397, 0399, 0406, 0411, 0413, 0415 |

### 7.1.7 ac Wireline Emissions (0.15 – 30 MHz)

#### FCC, Part 15 Subpart C §15.207

#### Test Procedure

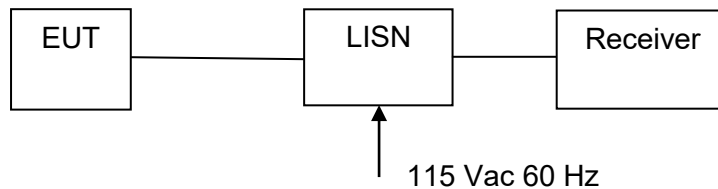
The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

#### Test Set-Up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. ac Wireline Conducted Emissions

#### Test Measurement Set up



Measurement set up for ac Wireline Conducted Emissions Test

#### Laboratory Measurement Uncertainty for Conducted Emissions

|                         |          |
|-------------------------|----------|
| Measurement uncertainty | ±2.64 dB |
|-------------------------|----------|

#### Traceability

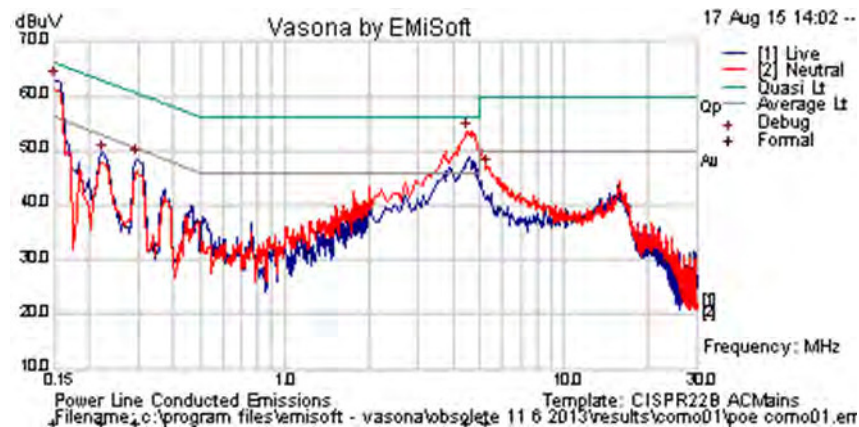
| Method                                                                                     | Test Equipment Used                |
|--------------------------------------------------------------------------------------------|------------------------------------|
| Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions' | 0158, 0184, 0190, 0287, 0310, 0312 |

#### Ambient test conditions.

Temperature: 17 to 23 °C    Relative humidity: 31 to 57 %    Pressure: 999 to 1012 mbar

### Measurement Results for ac Wireline Conducted Emissions (150 kHz – 30 MHz)

|                      |                                                                |                       |    |
|----------------------|----------------------------------------------------------------|-----------------------|----|
| <b>Test Freq.</b>    | N/A                                                            | <b>Engineer</b>       | SB |
| <b>Variant</b>       | AC Line Emissions                                              | <b>Temp (°C)</b>      |    |
| <b>Freq. Range</b>   | 0.150 MHz - 30 MHz                                             | <b>Rel. Hum.(%)</b>   |    |
| <b>Power Setting</b> | N/A                                                            | <b>Press. (mBars)</b> |    |
| <b>Antenna</b>       | Integral                                                       |                       |    |
| <b>Test Notes 1</b>  | SMC Networks 802.3at/af Gigabit PoE Adapter; Model:SMCPWR-INJ6 |                       |    |
| <b>Test Notes 2</b>  | S/N:A91305000070                                               |                       |    |



### Formally measured emission peaks

| Frequency MHz                                                                                  | Raw dBuV | Cable Loss | Factors dB | Level dBuV | Measurement Type | Line    | Limit dBuV | Margin dB | Pass /Fail | Comments |
|------------------------------------------------------------------------------------------------|----------|------------|------------|------------|------------------|---------|------------|-----------|------------|----------|
| 3.906                                                                                          | 40.2     | 9.8        | 0.2        | 50.1       | Quasi Peak       | Live    | 56         | -5.9      | Pass       |          |
| 0.150                                                                                          | 47.1     | 9.8        | 0.1        | 57.0       | Quasi Peak       | Live    | 66         | -9.0      | Pass       |          |
| 0.274                                                                                          | 38.2     | 9.8        | 0.1        | 48.1       | Quasi Peak       | Live    | 61.01      | -13.0     | Pass       |          |
| 4.498                                                                                          | 38.1     | 9.8        | 0.2        | 48.0       | Quasi Peak       | Live    | 56         | -8.0      | Pass       |          |
| 0.150                                                                                          | 46.7     | 9.8        | 0.1        | 56.6       | Quasi Peak       | Live    | 66         | -9.4      | Pass       |          |
| 3.899                                                                                          | 41.9     | 9.8        | 0.2        | 51.8       | Quasi Peak       | Neutral | 56         | -4.2      | Pass       |          |
| 4.495                                                                                          | 38.7     | 9.8        | 0.2        | 48.6       | Quasi Peak       | Neutral | 56         | -7.4      | Pass       |          |
| 1.852                                                                                          | 32.4     | 9.8        | 0.1        | 42.3       | Quasi Peak       | Neutral | 56         | -13.7     | Pass       |          |
| 3.906                                                                                          | 29.4     | 9.8        | 0.2        | 39.3       | Average          | Live    | 46         | -6.7      | Pass       |          |
| 0.150                                                                                          | 30.4     | 9.8        | 0.1        | 40.3       | Average          | Live    | 56         | -15.8     | Pass       |          |
| 0.274                                                                                          | 24.8     | 9.8        | 0.1        | 34.6       | Average          | Live    | 51.01      | -16.4     | Pass       |          |
| 4.498                                                                                          | 34.1     | 9.8        | 0.2        | 44.0       | Average          | Live    | 46         | -2.0      | Pass       |          |
| 0.150                                                                                          | 30.2     | 9.8        | 0.1        | 40.1       | Average          | Live    | 56         | -15.9     | Pass       |          |
| 3.899                                                                                          | 30.7     | 9.8        | 0.2        | 40.7       | Average          | Neutral | 46         | -5.3      | Pass       |          |
| 4.495                                                                                          | 34.1     | 9.8        | 0.2        | 44.0       | Average          | Neutral | 46         | -2.0      | Pass       |          |
| 1.852                                                                                          | 31.3     | 9.8        | 0.1        | 41.2       | Average          | Neutral | 46         | -4.8      | Pass       |          |
| Legend: DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency |          |            |            |            |                  |         |            |           |            |          |
| NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band              |          |            |            |            |                  |         |            |           |            |          |

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## Specification

### Limits

**§15.207 (a)** Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50  $\mu\Omega$  line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

### §15.207 (a) Limit Matrix

The lower limit applies at the boundary between frequency ranges

| Frequency of Emission (MHz) | Conducted Limit (dB $\mu$ V) |           |
|-----------------------------|------------------------------|-----------|
|                             | 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

### Traceability

| Test Methodology                                                                           | Laboratory Measurement Uncertainty |
|--------------------------------------------------------------------------------------------|------------------------------------|
| Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions' | $\pm 2.64$ dB                      |

## 8 PHOTOGRAPHS

### 8.1 RF Conducted

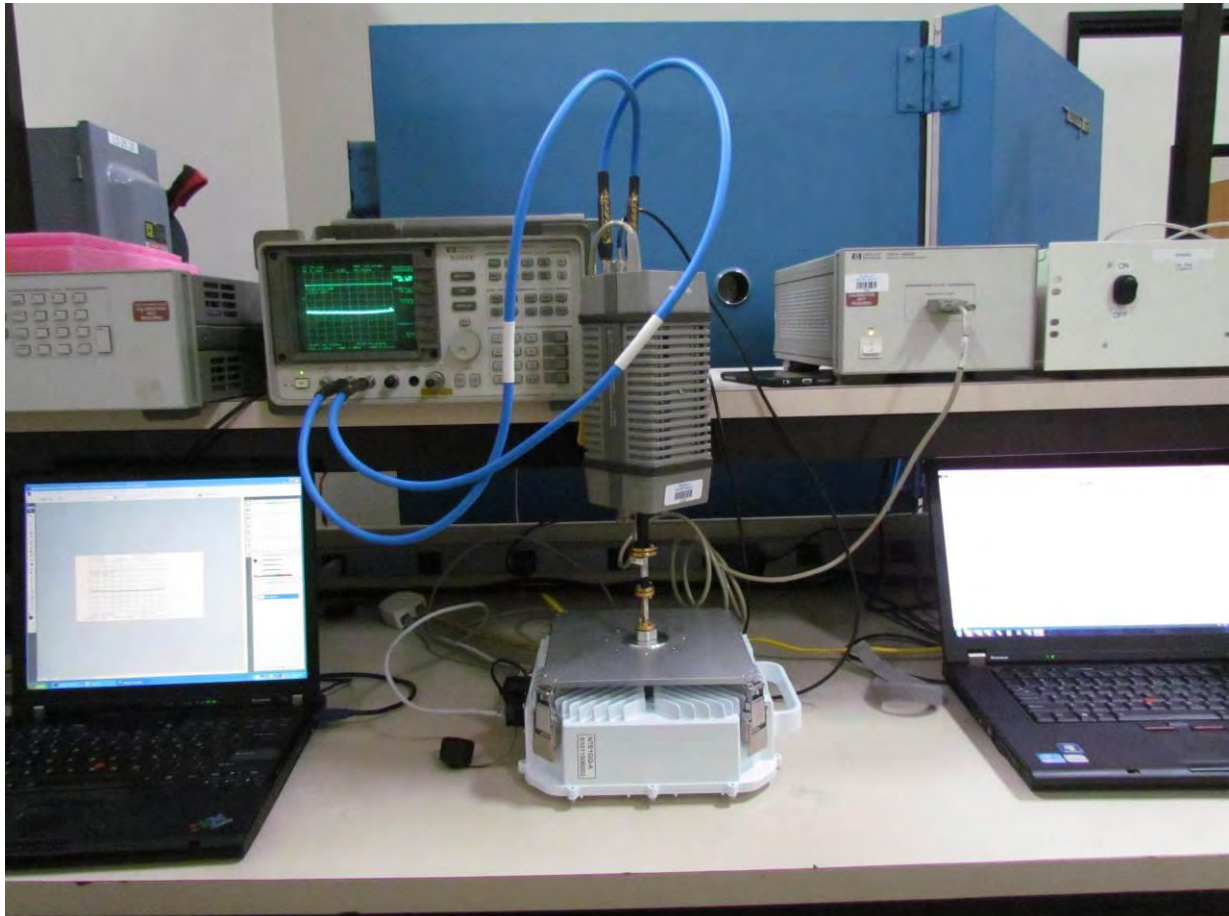


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## 8.2 Conducted Spurious Emissions – Pre-Selector Mixer (40 – 75 GHz)



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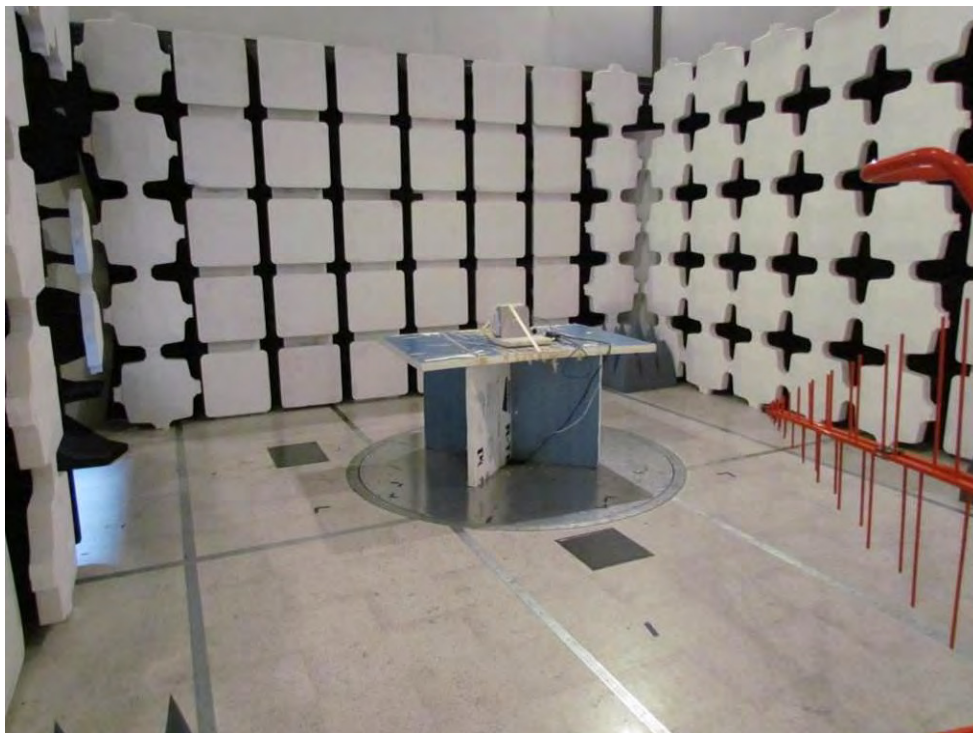
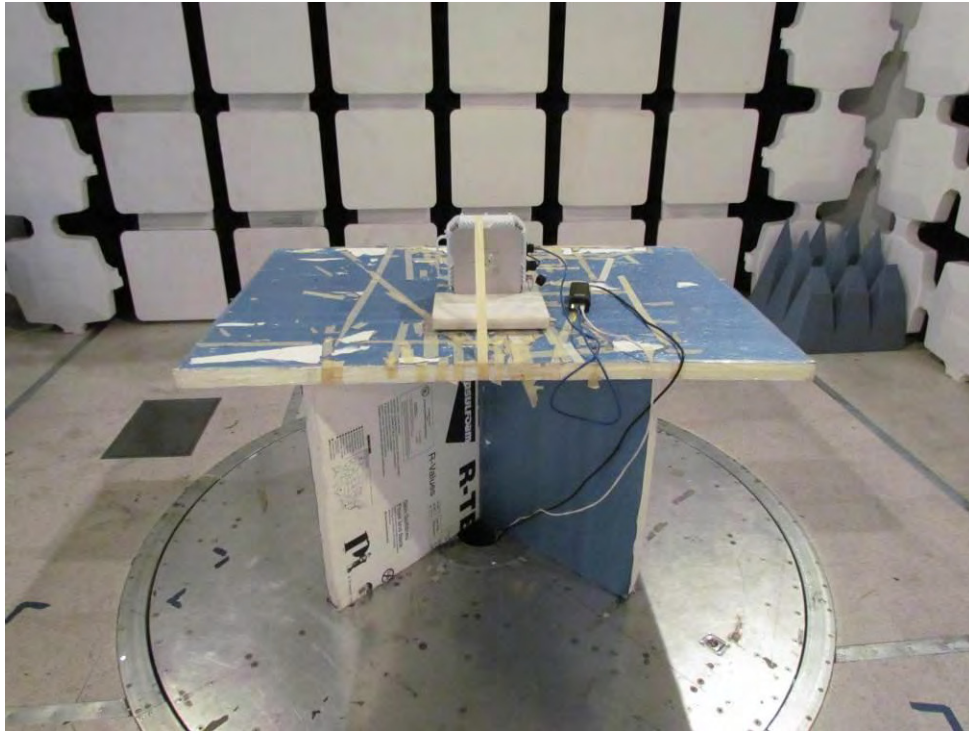
### 8.3 Conducted Spurious Emissions – Harmonic Mixer (75 – 110 GHz)



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#### 8.4 Digital Emissions – 0.03 - 1 GHz

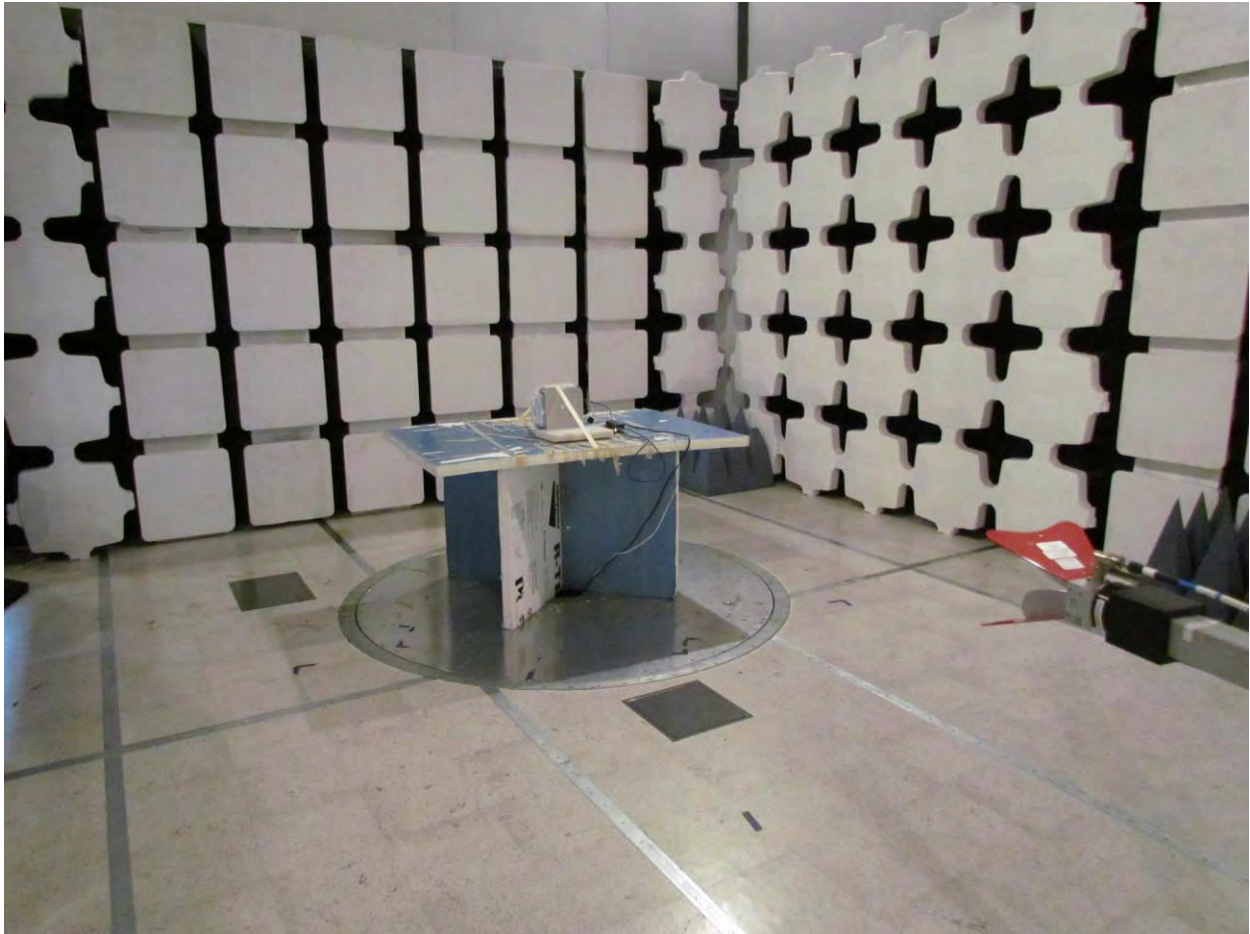


Equipment tested for digital emissions without integral antenna connected

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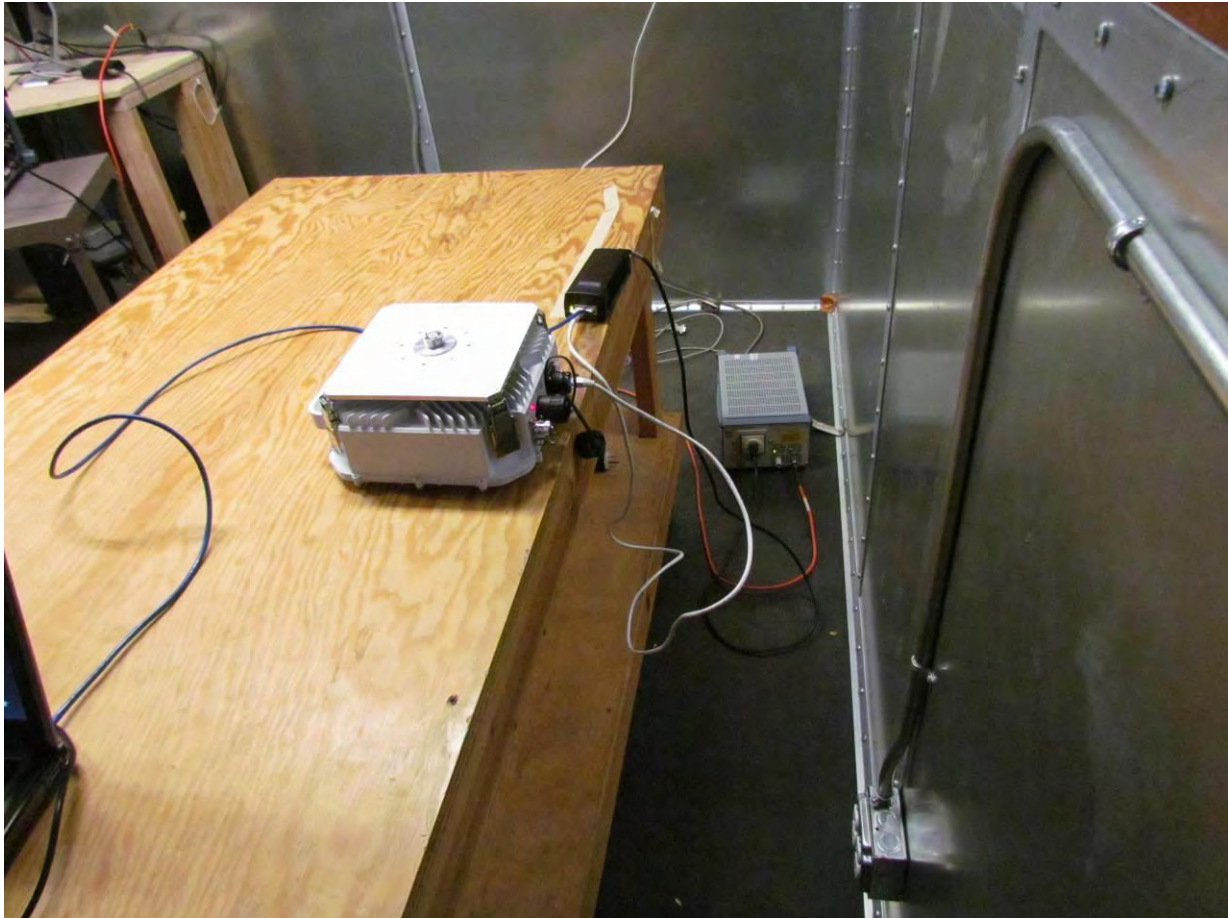
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## 8.5 Digital Emissions 1 – 6 GHz



Equipment tested for digital emissions without integral antenna connected

## 8.6 ac Wireline Emissions (0.15 – 30 MHz)



Equipment tested for digital emissions without integral antenna connected



**Title:** Comotech Corporation - Airlight  
**To:** FCC CFR 47 Part 101  
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## 9 TEST EQUIPMENT DETAILS

| Asset # | Instrument             | Manufacturer     | Part #                | Serial #    |
|---------|------------------------|------------------|-----------------------|-------------|
| 0074    | Environmental Chamber  | Tenney           | TTC                   | 12808-1     |
| 0088    | Spectrum Analyzer      | Hewlett Packard  | 8564E                 | 3410A00141  |
| 0095    | Pre-Selector PSU       | Hewlett Packard  | HP11974-60028         | 3001A00134  |
| 0128    | Pre-Selector Mixer     | Hewlett Packard  | HP 11974U             | 3001A00107  |
| 0158    | Barometer /Thermometer | Control Co.      | 4196                  | E2846       |
| 0184    | Pulse Limiter          | Rhode & Schwartz | ESH3Z2                | 357.8810.52 |
| 0190    | LISN                   | Rhode & Schwartz | ESH3Z5                | 836679/006  |
| 0193    | EMI Receiver           | Rhode & Schwarz  | ESI 7                 | 838496/007  |
| 0227    | Pre-Selector Mixer     | Hewlett Packard  | HP 11974V             | 3001A00134  |
| 0252    | SMA Cable              | Megaphase        | Sucoflex 104          | None        |
| 0287    | EMI Receiver           | Rhode & Schwartz | ESI 40                | 100201      |
| 0293    | BNC Cable              | Megaphase        | 1689 1GVT4            | 15F50B001   |
| 0304    | Harmonic Mixer         | Hewlett Packard  | HP11970W              | 2521A01085  |
| 0310    | 2m SMA Cable           | Micro-Coax       | UFA210A-0-0787-3G03G0 | 209089-001  |
| 0312    | 3m SMA Cable           | Micro-Coax       | UFA210A-1-1181-3G0300 | 209092-001  |
| 0338    | Antenna                | Sunol Sciences   | JB-3                  | A052907     |
| 397     | Preamp 10-2500 MHz     | MiCOM Labs       |                       | 0397        |
| 399     | Horn Antenna 1-18G     | ETS              | 3117                  | 00154575    |
| 406     | Preamp 1-18 GHz        | MiCOM Labs       |                       | 0406        |
| 411     | Mast/Turntable Control | Sunol Sciences   | SC98V                 | 060199-1D   |
| 413     | Mast Controller        | Sunol Sciences   | TWR95-4               | 030801-3    |
| 415     | Turntable Controller   | Sunol Sciences   |                       | 0415        |

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