| Date | Rev | Revision Record | Approved |
|---|---|---|---|
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| | | | |
| | | | |

# PMP 38.6 to 40 GHz
# Agency Certification Test Report
# For
# SUB Low Band

Prepared for
Hughes Network Systems
11717 Exploration Lane
Germantown, MD 20876

## Hughes Proprietary II



| Job | Approvals | Date | |
|---|---|---|---|
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| **Checked:** | | | **Title: Point to Multipoint (PMP) FCC Part 101 Type Acceptance Test Results** |
| | | | |
| | **Sheet** 1 **of** 57 | | **CAGE No.** **52571** **No.** **HNS-18122** |

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# 1.0 OVERVIEW

This test plan has been prepared by Hughes Network Systems to document the required RF Type Acceptance FCC101 subparts C& H (Fixed Microwave Services) on the Point to Multipoint-Aireach product (PMP). The purpose of this testing is to determine performance against the requirements for the FCC 101 subsections mentioned.

## 1.1 PRODUCT DESCRIPTION

This test plan and report will demonstrate the compliance with the FCC 101 for the Low Band (LB) and High Band (HB) Subscriber systems. This test plan and report will be later be updated with the data for the High Band (HB) Subscriber test data. The following 38-40 GHz subsystem units are/will be tested and submitted:

LB SUB (Low Band Subscriber unit) Tx (38606.25- 38943.75) MHz

LB HUB (Low Band HUB unit) Tx (38606.25- 38943.75) MHz

HB SUB (High Band Subscriber unit) Tx (38606.25- 38943.75) MHz

LB HUB (Low Band Hub unit) Tx (38606.25- 38943.75) MHz

In this test plan and report we are verifying the LB Sub, the LB HUB data will be in another HNS test report HNS 1028991.

The HNS PMP provides services to carry voice and data efficiently and economically. The system is based upon multi-sector cells with TDMA/TDMA air Interface. It provides sophisticated multi-mode modulation (QPSK, 64-QAM, and 16-QAM) on a per-burst basis to efficiently handle broad ranging requirements for sector capacity and sector size.

The overall PMP network Architecture includes several elements, including the radios, the transmission equipment, and the central office equipment. The HNS portion of this system is the HNS 38 GHz Point-to Multi-point (PMP). This includes subscriber premises equipment, PMP HUB radio equipment, and interfaces to commercially available multiplexing equipment. These interfaces include the (SONET) backbone and dedicated trunks to the voice switch, as well as IP routers and other data delivery systems.
The PMP product is broken into two terminals, a hub terminal (HT) and a remote Terminal (RT). The HT is responsible on routing the data/voice signals from one RT to another. The RT is at the customer premises and comprises 3 components:

ODU: Outdoor Unit: which is an integrated 38 GHz Transceiver and antenna,

IDU: Indoor Unit that provides modem and remote multiplexed function, and finally,

The Inter-facility Link (IFL): which is a single coaxial cable that interconnects the ODU and IDU. The HT has the same main components; it supports one sector with one over-the air frequency (12.5 MHz sub-channel).

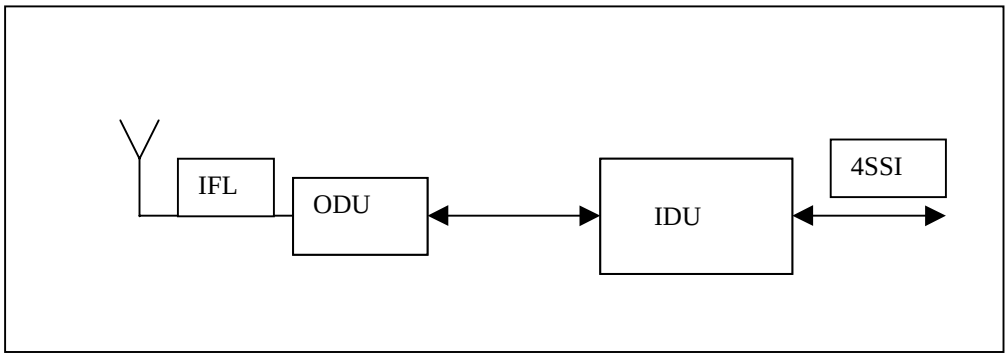



**Figure 1 Basic PMP RT/HT terminal**

Figure 1 shows a basic block diagram for the RT/HT system. The IFL cable shown carries DC power signal, reference carrier frequency, the Up-link and the Downlink IF signals and the telemetry control link signals. The IDU is installed indoors, often in a wiring closet. It includes the IF, modem, air frame formatting login, the IFL interface, and the subscriber interface multiplexer function in one unit. Each IDU has four multiport SSI slots to allow for several different user interfaces. For more description of product, it's operation and functionality, please refer to the DDD (Detailed Design document) HNS –13880.

## 1.2 CHANALIZATION

The channalization, taken from the FCC regulations, CFR-47& 101.147 Frequency assignments, is given in Table 1. The HNS product further breaks each 50 MHz license into four 12.5 MHz sub-channels (see figure 2) The first number and the first letter of each designator are the FCC number for the channel. The last number is the sub-channel designator. The figure shows the designation of FCC channel 1-A. Each of these sub-channels operates at a symbol rate of 10.0Msps in the TDMA mode. The QPSK Spectral Density is 20Mbps in 12.5 MHz or 1.6 bits/s/Hz and the 64-QAM spectral density is 60Mbps in 12.5 MHz or 4.8 bits/s/Hz

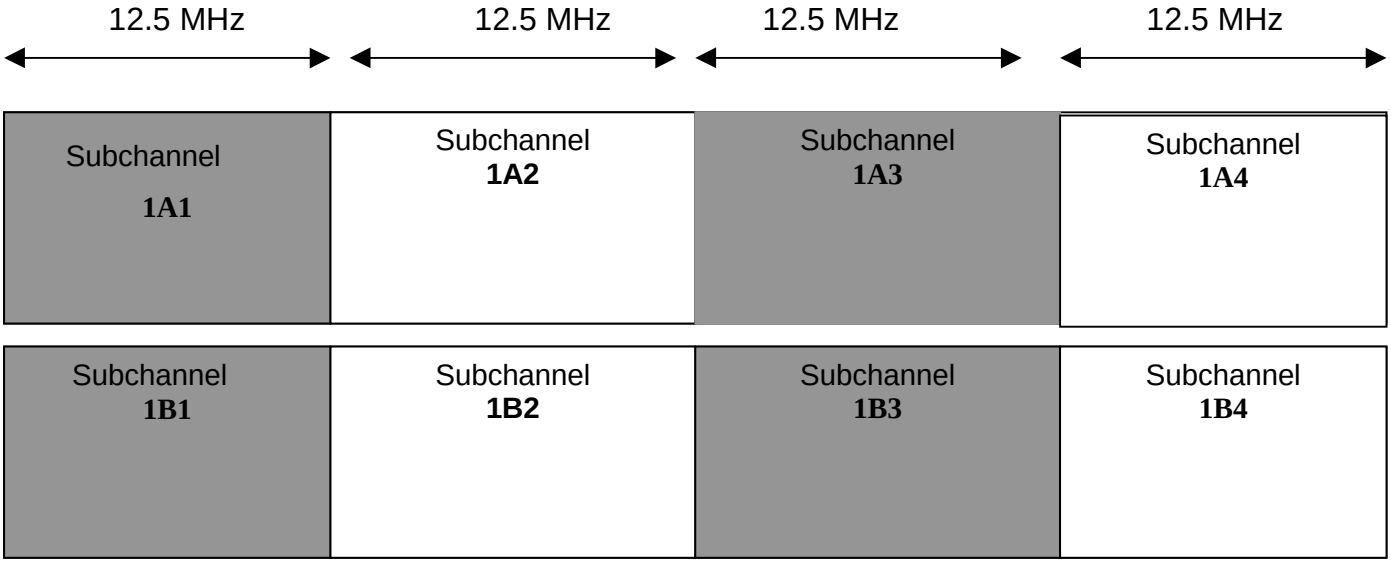



**Figure 2 HNS Channalization**

| Channel Group A- Subscriber Transmitting channels | | |
|---|---|---|
| LB | | |
| **Channel #** | **Tx Frequency Band Limits (MHz)** | **Rx Frequency Band Limits (MHz)** |
| 1-B | 38600-38650 | 38300-38350 |
| 2-B | 38650-38700 | 38350-38400 |
| 3-B | 38700-38750 | 38400-38450 |
| 4-B | 38800-38850 | 38450-38500 |
| 5-B | 38850-38900 | 38500-38550 |
| 6-B | 38850-38900 | 38550-38600 |
| 7-B | 38900-38950 | 38600-38650 |

| Low Band SUB SubChannels | | |
|---|---|---|
| **Channel #** | **Tx Center Frequency (MHz)** | **Rx Center Frequency (MHz)** |
| 1B1 | 38606.25 | 39306.25 |
| 1B2 | 38618.75 | 39318.75 |
| 1B3 | 38631.25 | 39331.25 |
| 1B4 | 38643.75 | 39343.75 |
| 2B1 | 38656.25 | 39356.25 |
| 2B2 | 38668.75 | 39368.75 |
| 2B3 | 38681.25 | 39381.25 |
| 2B4 | 38693.75 | 39393.75 |
| 3B1 | 38706.25 | 39406.25 |
| 3B2 | 38718.75 | 39418.75 |
| 3B3 | 38731.25 | 39431.25 |
| 3B4 | 38743.75 | 39443.75 |
| 4B1 | 38756.25 | 39456.25 |
| 4B2 | 38768.75 | 39468.75 |
| 4B3 | 38781.25 | 39481.25 |
| 4B4 | 38793.75 | 39493.75 |
| 5B1 | 38806.25 | 39506.25 |
| 5B2 | 38818.75 | 39518.75 |
| 5B3 | 38831.25 | 39531.25 |
| 5B4 | 38843.75 | 39543.75 |
| 6B1 | 38856.25 | 39556.25 |
| 6B2 | 38868.75 | 39568.75 |
| 6B3 | 38881.25 | 39581.25 |
| 6B4 | 38893.75 | 39593.75 |
| 7B1 | 38906.25 | 39606.25 |
| 7B2 | 38918.75 | 39618.75 |
| 7B3 | 38931.25 | 39631.25 |
| 7B4 | 38943.75 | 39643.75 |
| | | |

**Table 1 HNS Transmitting Sub-channels**

### 1.3 APPLICABLE STANDARDS

The considered standards are as follows:

1. FCC CFR 47 Part 101 Subparts C & H - Fixed Microwave Services
2. FCC CFR 47 Part 15 - Radio Frequency Devices
3. FCC CFR 47 Part 2 - General Rules and Regulations

## 1.4 REFERENCE DOCUMENTS

1. HNS-13880, 38GHz Point to Multipoint radio System Detailed Design and Requirements Documents
2. HNS 1024668, 38 GHz Radio Integrated Outdoor units for Subscribers and Hub Stations
3. ODU Detailed test data for Subscriber Remote Terminal ODU S/N 201.
4. HP 8564E Spectrum Analyzer Manual
5. Specification for the parts used during the type acceptance test.
6. 38- 40 GHz Antenna Specification HNS #

# 2.0 SETUP

This section documents the RF transmit and receive test setup, parts and test equipment used. Table 2 section 2.1 lists the EUT (Equipment Under Test) that are subject for testing for FCC 101, with part numbers and revision levels. Table 3 and the test equipment used in the evaluations. Section 2.2 shows the various test configuration diagrams. The measurements will be done using a HP 8564E series Spectrum Analyzer as the final measuring device. All the data plots will be captured via HP Bench screen capture software and saved as *.GIF images which may then be inserted into test report documents digitally. The EUT is configured for transmission mode using custom software prepared by Hughes Network Systems for channel selection and simulation of the signals that are normally transmitted to the Hub terminal

## 2.1 EQUIPMENT LIST

| PART NUMBER | DESCRIPTION | SERIAL NUMBER | REVISION LEVEL |
|---|---|---|---|
| 1028585-0001 | Out Door unit ODU SUB LB | 201 | Gamma |

**Table 2 Equipment under Test (EUT) that is subject to the FCC 101 filling**

| PART NUMBER | DESCRIPTION | SERIAL NUMBER | REVISION LEVEL |
|---|---|---|---|
| 1027181-001 | Channel and Control module (CCM) HUB Terminal HT [Indoor unit} IDU | 123 | B |
| 1027181-002 | Channel and Control module (CCM) SUB (Remote Terminal RT [Indoor unit} IDU | 146 | B |
| 1027094-001 | DS3 TDM module [Indoor unit} IDU | 9 | A |
| 1027070-001 | Quad DS1 module [Indoor unit} IDU | 8 | 12 |
| 1027070-001 | Quad DS1 module [Indoor unit} IDU | 3 | 12 |
| 1027070-001 | Quad DS1 module [Indoor unit} IDU | 56 | B |
| 1024668-0017 | 38-40 GHz Antenna Assembly Subscriber | 42 | 12 |

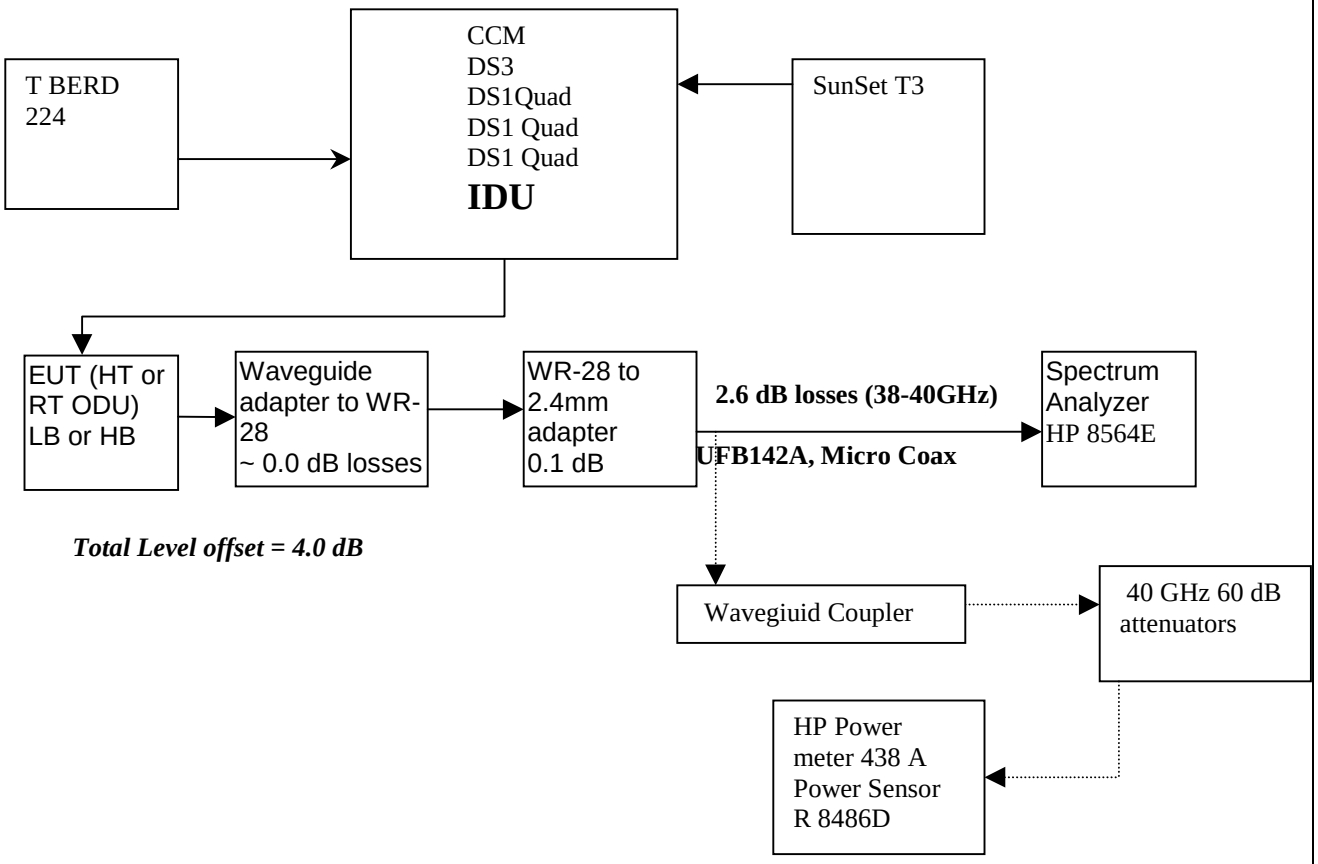
**Table 3 Equipment that were used to generate the traffic to the ODU**

| REF # | PART NUMBER | MANUFACTURER | DESCRIPTION | Calibration Dates | SERIAL NUMBER |
|---|---|---|---|---|---|
| 1 | 8564E | HP | 40 GHz Spectrum Analyzer | 12/16/00 | 3846A01362 |
| 2 | UFB142A-0-0394-110110 | Micro Coax | Low Loss 40 GHz cable | NA | 99A0483 |
| 3 | ETS42S-28S<br>ETS28S-19R,<br>ET28S-12R,<br>ET28S-8R,<br>ET28S-5R | Custom Microwave | Waveguide transitions | NA | -<br>S0550<br>S0725<br>S0680<br>S0320<br>S0957 |
| 4 | R281A | HP | Waveguide to Cable adapter 2.4mm to WR-28 | NA | 2687- |
| 5 | WA-42K | Dorado International | Waveguide to Cable adapter 3.5mm to WR-42 | NA | - |
| 6 | 3142 | EMCO | BI-Log Antenna 30 to 1000 MHz | NA | 9701-1120 |
| 7 | 3115 | EMCO | Horn Antenna 1 to 18 GHz | NA | 9701-5069 |
| 8 | HO42S,<br>HO28S,<br>HO19R,<br>HO12R,<br>HO8R,<br>HO5R | Custom Microwave | Standard Gain Horn Antennas Covering 18 to 220 GHz ranges | NA | -<br>S0656<br>S0750<br>S0746<br>S0683<br>NA |
| 9 | M19HW,<br>M12HW,<br>MO8HW,<br>MO5HW,<br>O/IFDIPLEXER | Olsen Microwave | Harmonic Mixers covering 40 to 220 GHz ranges | NA | U90108-2<br>E90108-1<br>F90108-1<br>G90222-1<br>OS 26805- |
| 10 | - | Antenna port to WR-28 adapter | - | NA | |
| 11 | N/A | Circular Waveguide to Rectangular wave Guide adapter | 00010 | NA | 1 |
| 12 | | T- BERD 224 | Metrology | 06/29/00 | 12825 |
| 13 | SS300e | SunSet T3 SS300e by Sunrise telecom | Sunrise telecom | NA | 07373 |
| 14 | HP 438 | Power meter ( HP) | Hewlett Packard | | H-D24993770 |
| 15 | | | | | |
| 16 | | | | | |
| 17 | | | | | |
| 18 | | | | | |

**Table 4 Test Equipment used**

## 2.2 TEST SETUPS

This section documents the test plan, and requirements for the transmitter testing.




*Total Spectrum Analyzer offset Level offset = 4.0 dB*

*0.1 dB WR 28*
*0.1 dB F/F 2.4mm Adapter*
*2.6 dB cable losses*
*1.2 dB is the difference in the reading between the Power meter and CW power.*

*Actual Measured Transmitted power = Power meter Reading + 59.8 dB (due to attenuators and waveguide coupler)*

**Figure 3 Transmitter Test Setup Configuration**

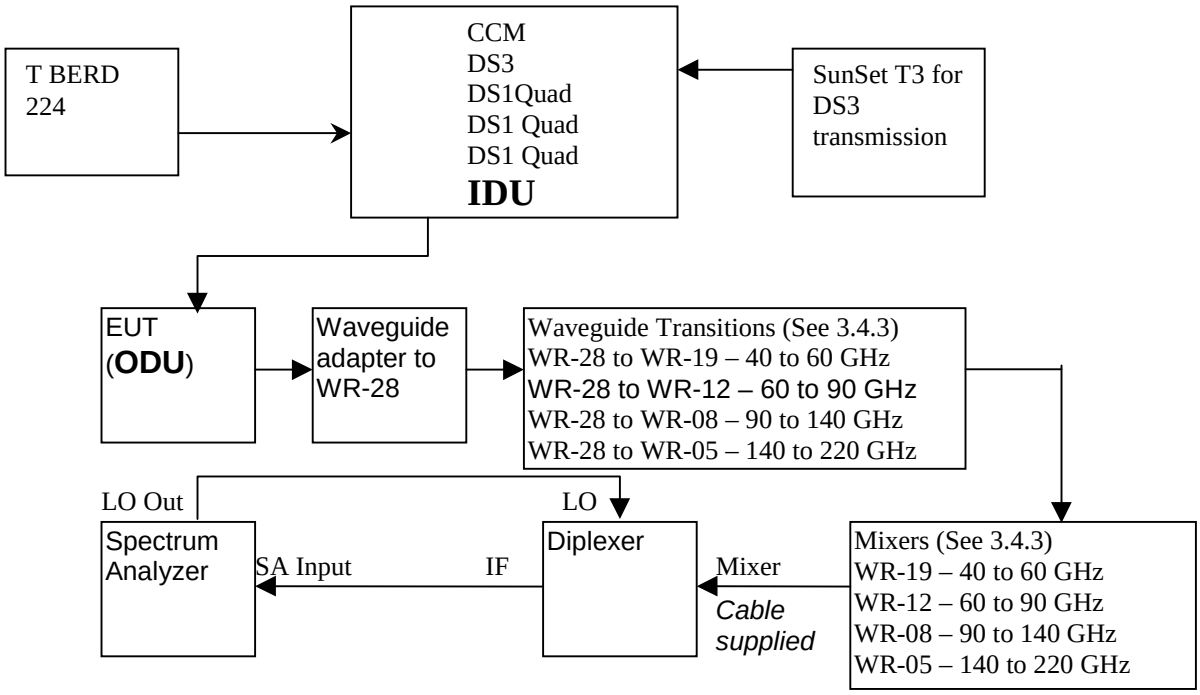



**Figure 4 Transmitter Test Setup Configuration - Conducted Spurious Emissions**

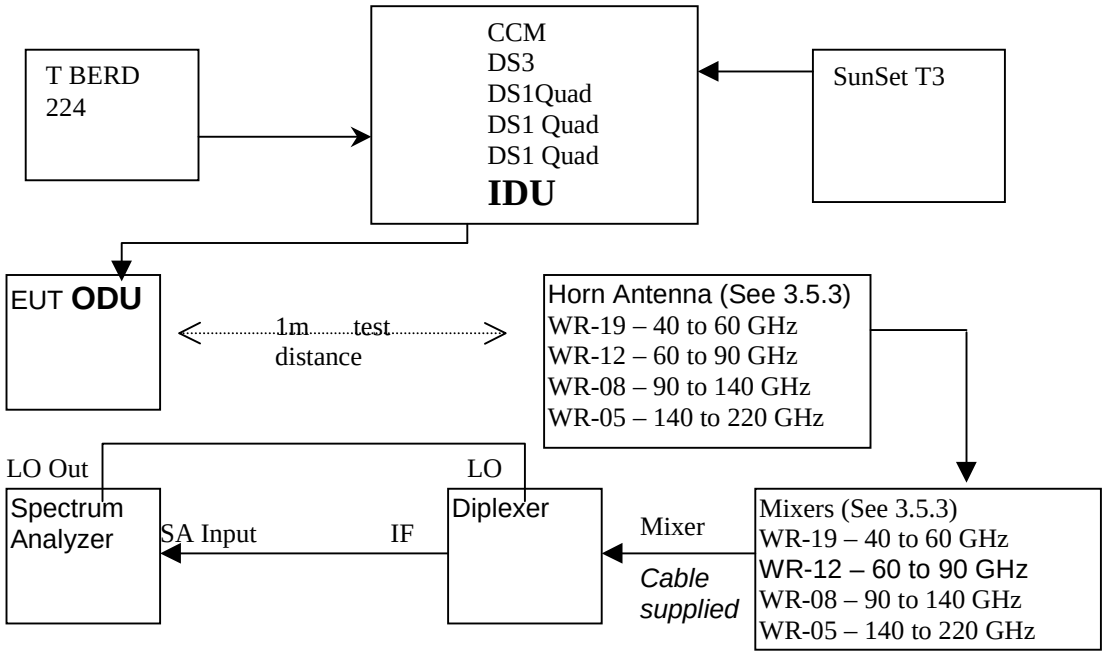



**Figure 5 Transmitter Test Setup Configuration - Radiated Spurious Emissions**

# 3.0 FCC PART 101 TESTS

## 3.1 THE OUTPUT POWER

This test demonstrates the maximum transmitter power level of the EUT antenna output. The maximum power transmitted will be 18.0 dBm and the minimum output power transmitted will be –12 dBm at the Antenna port. All the measurements are within < ± 1dB of tolerance. The power measurement procedure was followed over the entire test suit.

### 3.1.1 Performance Specifications

As per FCC CFR 47 Part 2.1046 (previously 2.985) and 101.113
EIRP Max = +55dBW after the antenna. The Subscriber Antenna has a gain of 40.5dBi.

Therefore the maximum allowable limit is dBm is

Maximum EIRP (dBW) = 10 log (1mw*10 $^{\text{EIRP (dBm)/10}}$)
55dBw= 85 dBm
Maximum allowable transmitted power from the Antenna port is for the transmitting bands (:

PTx max = 85dBm- 40.5 dB = 44.5 dBm This is @ 1MHz resolution Bandwidth (RBW)

To get a more accurate readings, and after consulting with the FCC, we have done all the test measurements RBW = 100 kHz and eventually dropped the limit 10 dB down to 35dBm. The transmitted power level of the ODU will be compared to that power limit.

### 3.1.2 Test Procedures

The equipment under test will be operated at different frequencies across the transmit frequency band (low end, center, and high end of the FCC authorized bands. The modulated carrier (TDMA signal) and CW power levels will be monitored and data plots will be obtained for each modulation type. There are 3 types of modulations (QPSK, 16-QAM, and 64-QAM). The RMS power of the Tx signal is measured using a HP power meter with a power sensor adapter that ranges up to 50 GHz. The spectral analyzer will also be used to display the modulated Tx signal in addition to the power level of the signal. Since the spectral analyzer can't give a very accurate reading in reading the power of a modulated signal, we will base our reading on the power meter reading. The reading was taken from the Power meter, and the difference between the SA reading of the CW transmitted power (1.2 dB) was taken into account by adding an offset to the reference level in the SA. Total offset level was 4 dB as described in Figure 3.

The following channels will be used according to the band tested.

### 3.1.3 Test Configuration

Please reference to Figure 2.2.1 for the test configuration used during this test.

**a. Spectrum Analyzer setup:**

Channel Power test was not used.
Channel spacing -(12.5 MHz)
Channel Bandwidth (12.5Mhz)
Resolution Bandwidth – 100 kHz
Video Bandwidth – 100 kHz
Amplitude Units dBm

**b. Power Meter Setup**

The actual RMS Tx power =The power meter reading + 58.9 dB attenuation and coupler losses

### 3.1.4 Test Results

| LB SUB | | | | |
|---|---|---|---|---|
| Modulation type | | | | |
| **Channel** | **Frequency (MHz)** | **QPSK** | **16-QAM** | **64-QAM** |
| | | **$P_{Tx}$(dBm)** | **$P_{Tx}$(dBm)** | **$P_{Tx}$(dBm)** |
| 1B1 | 38606.25 | 18.5 | 18.5 | 18.3 |
| 4B3 | 38781.25 | 18.5 | 18.5 | 18.33 |
| 7B4 | 38943.75 | 18.5 | 18.5 | 18.2 |
| | | | | |

**Table 5 Test Results for the Output Power**

Please refer to the attached plots

PASS: X Fail: __

High Power level (18 dBm)

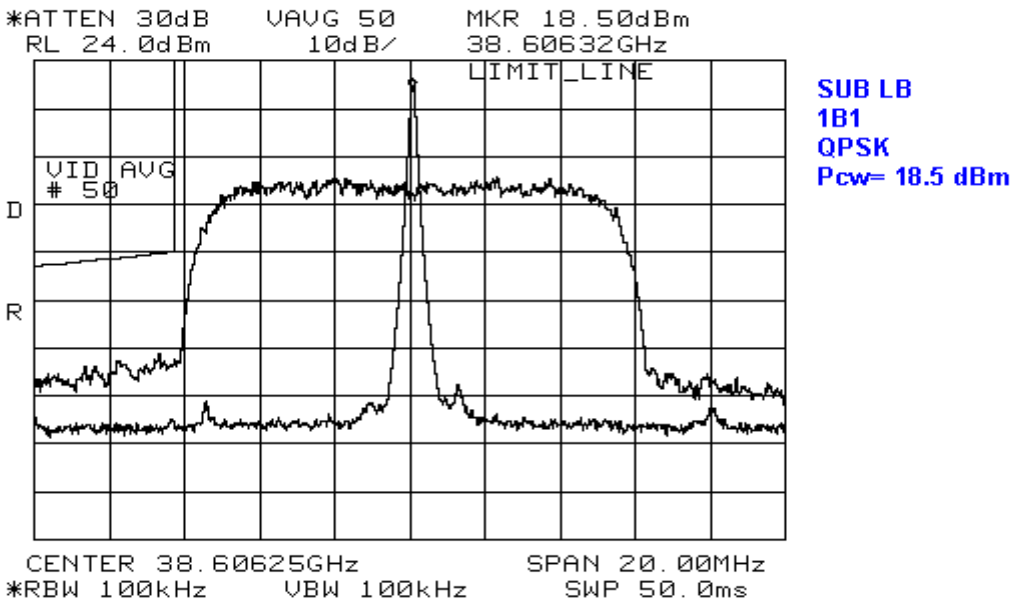



**Figure 6 Output Power for QPSK modulation on ch. 1B1**

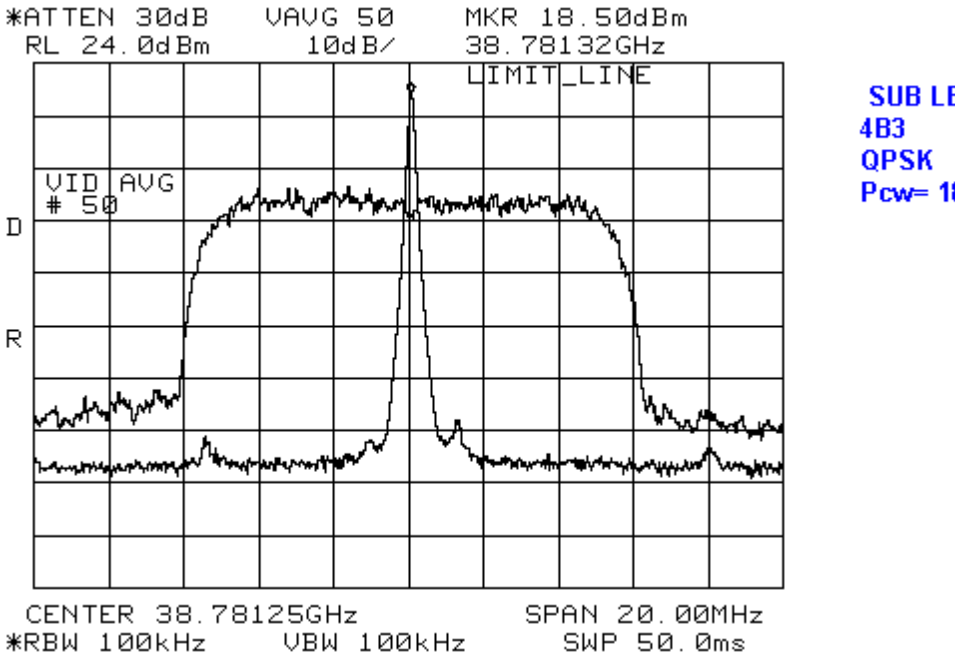
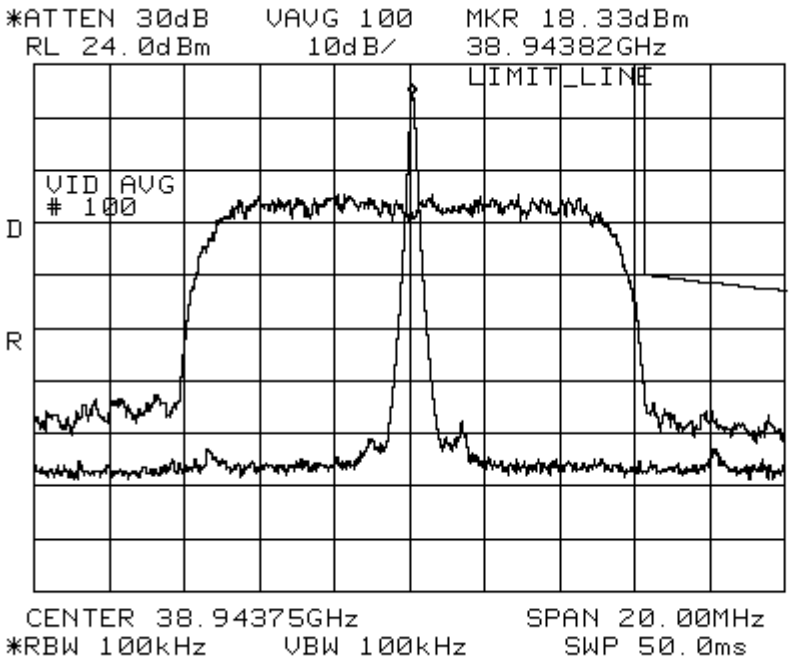
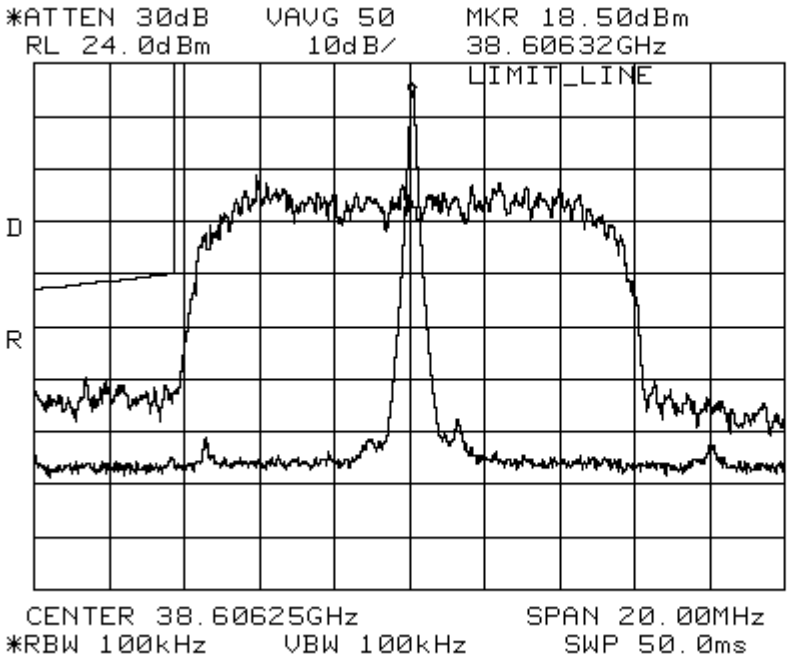



**Figure 7 Output Power for QPSK modulation on ch. 4B3**




LB SUB
channel 7B4
QPSK
Pcw= 18.33 dBm

**Figure 8 Output Power for QPSK modulation on ch. 7B4**




SUB LB
channel 1B1
64- QAM
Pcw= 18.5 dBm

**Figure 9 Output Power for 64-QAM modulation on ch. 1B1**

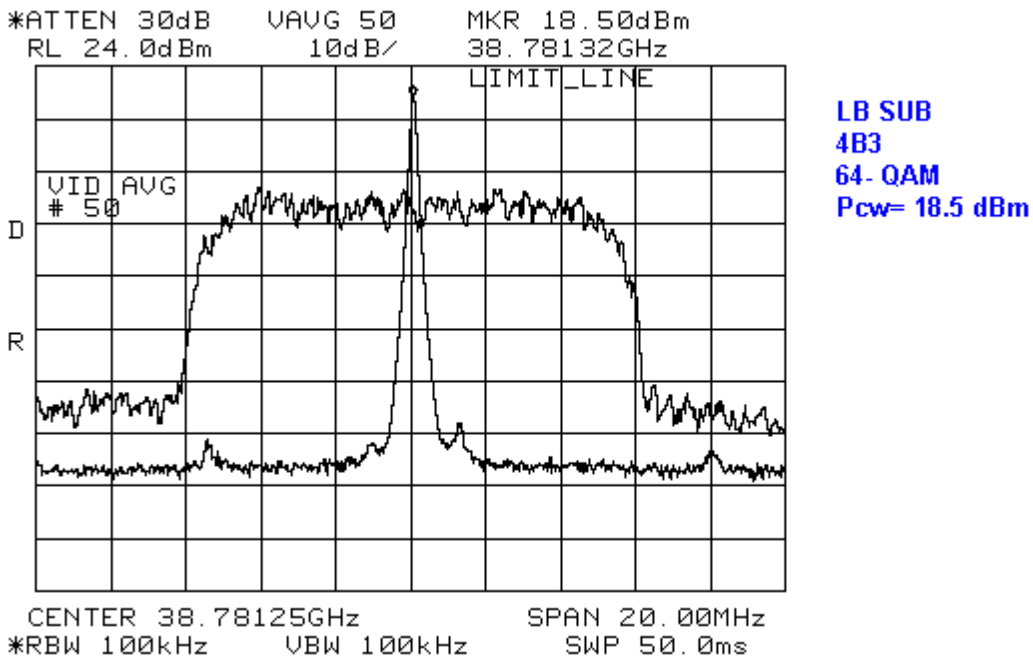



**Figure 10 Output Power for 64-QAM modulation on ch. 4B3**

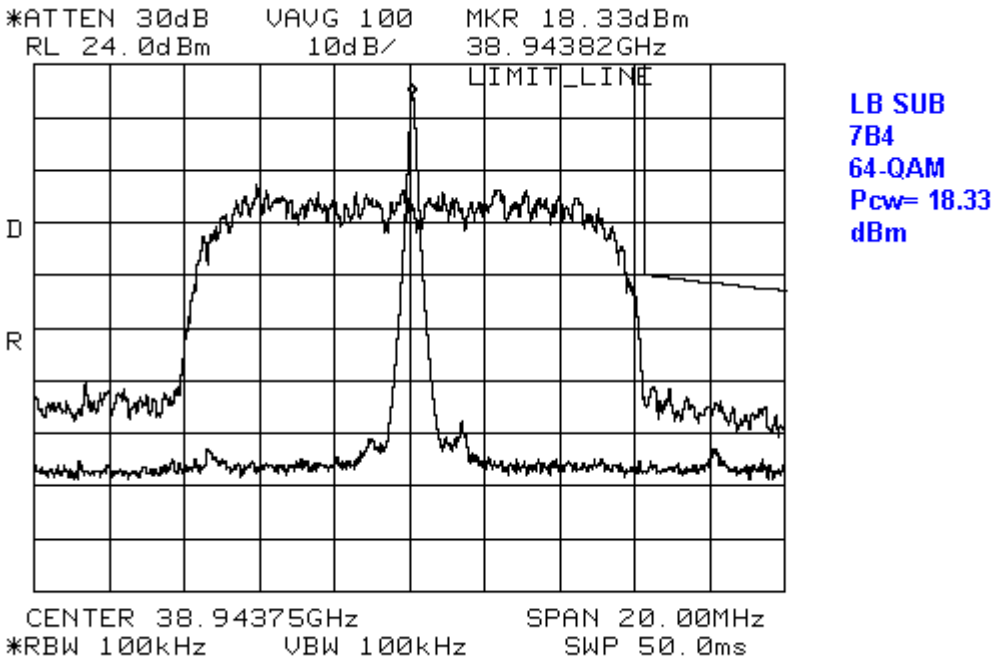



**Figure 11 Output Power for 64-QAM modulation on ch. 7B4**

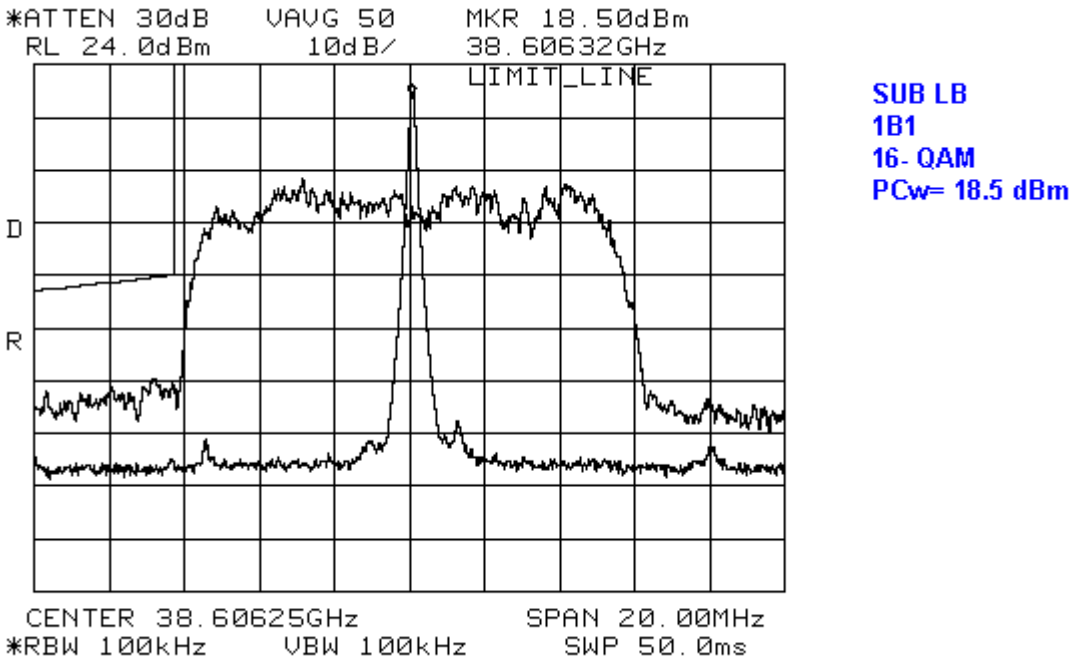



**Figure 12 Output Power for 16-QAMmodulation on ch. 1B1**

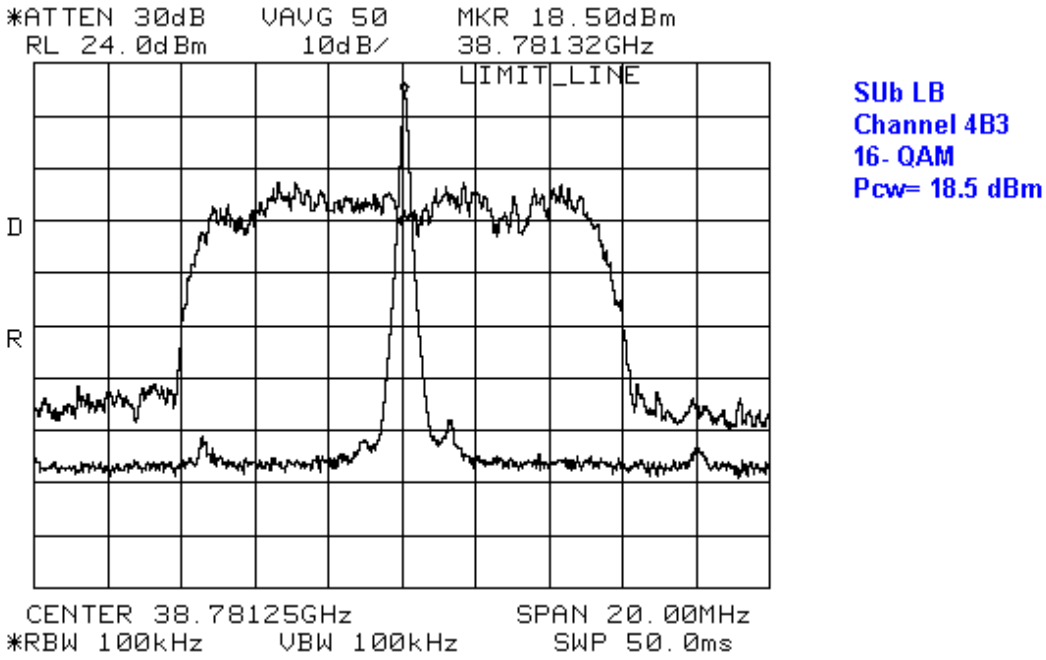



**Figure 13 Output Power for 16-QAMmodulation on ch. 4B3**

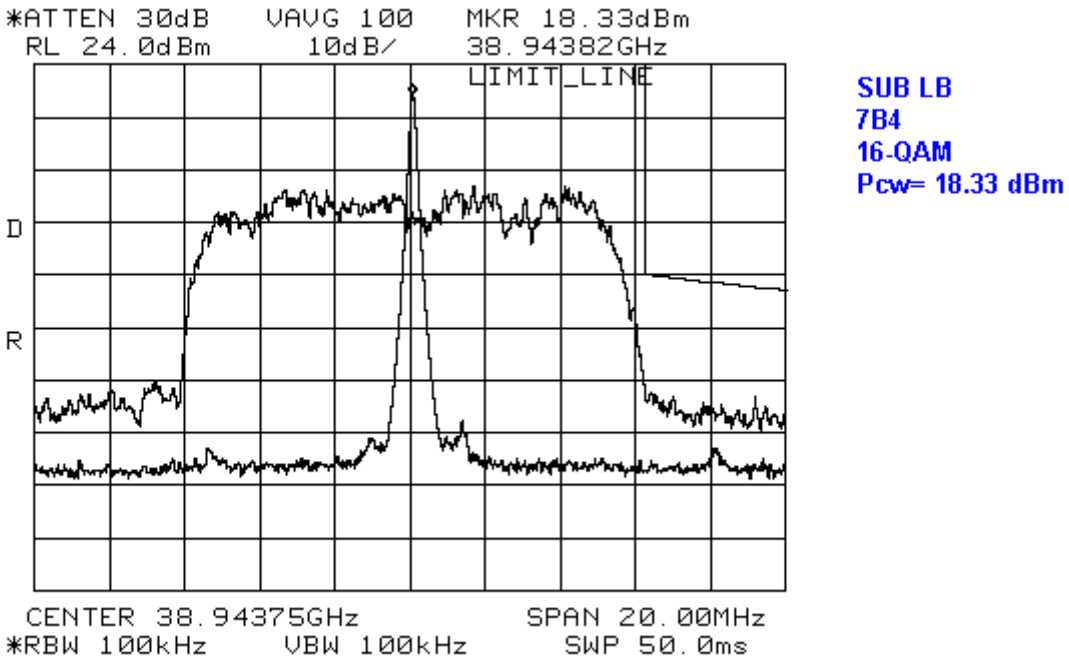



**Figure 14 Output Power for 16-QAMmodulation on ch. 7B4**

## 3.2 OCCUPIED BANDWIDTH

This test demonstrates that occupied bandwidth of the transmitter is within the FCC 101.109 requirements.

### 3.2.1 Performance Specifications

As per FCC CFR 47 Part 2.1050 (previously 2.989) and 101.109
Maximum authorized bandwidth 50MHz.Unwanted emissions must be suppressed at the aggregate channel block edges based on the same roll-off rate as specified for a single channel block in 101.111 (a) (ii) and (iii).

(a) (2)(ii) In 1 MHz Band: 50% to 250%: A=11+0.4(P-50)+10log(B) or no less than 11dB down but no more than 56dB down is required

Where: A = Attenuation in dB below mean output power level

P = percent removed from center frequency

B= Authorized bandwidth in MHz

Example calculation:

Since the authorized bandwidth is 50MHz,
At 50 % for the authorized bandwidth (f=38600, 389500 MHz)
: A=11+. 4 (50-50)+10log(50) = 27.9 ~ 28dB down from the maximum transmitted power
The Maximum power is 18 dBm when 1 MHz RBW is used,
@ 100 kHz, the levels 18 –10 dB = 8 dBm

Therefore the limit @ f = 38600 MHz and 39500 MHz should be 8dBm- 28 dB = -20 dBm
At 125 %: A=11+. 4 (125-50)+10log(50) = 58 dB or 56 whichever is lower
Therefore the limit will be 8dBm- 56 = -48 dBm

(a)(2)(iii) In 4kHz band >250% at least 43+10log(output power in Watts) or 80dB

Example calculation:

If your power were = 18 dBm = 63.09 mW
250% and out: A = 43+10log(0.06309) = -30.9dB down from the 18 dBm
Therefore limit = - 13 dBm

### 3.2.2 Test Procedures

The equipment under test will be operated at different frequencies across the transmit frequency band (low end, center, and high end). The modulated carrier will be examined and the occupied bandwidth will be viewed for compliance.

| Test Frequencies | |
|---|---|
| Channel | Frequency MHz |
| 1-A | 38600-38650 |
| 1-B | 39300-39350 |

**Table 6 Occupied Bandwidth Test Frequencies**

### 3.2.3 Test Configuration

Please reference to Figure 3 for the test configuration used during this test.

The test limit has been determined as shown in the following figure. The mask is based on 100kHz Resolution Bandwidth. According to the FCC, the maximum allowable power is 34.5dBm. However, the maximum output transmit power is 18dBm.

50 % points = 38600 MHz, 38950MHz, allowable level = -20dBm
From 50% to 250% points = based on the given equation, limited to –48dBm. This point is reached at about 120% points.
250% points = 39500 MHz, 39050 MHz., allowable level = -48dBm
250% and beyond, allowable level = -13dBm.

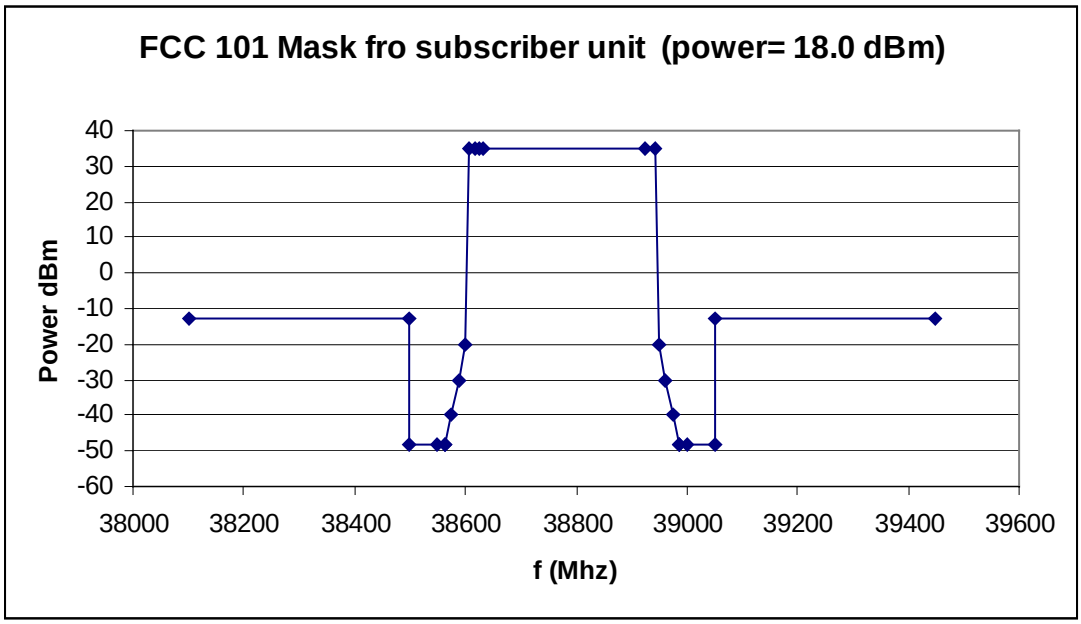



**Figure 15 FCC Mask for the HUB**

**Spectrum Analyzer Setup:**

Occupied bandwidth test
Resolution Bandwidth 100 kHz
Video Bandwith=100 kHz

### 3.2.4 Test Results

The test for occupied bandwidth is identical to the conducted emission testing, please refer to the following section for the results

PASS: X Fail: __

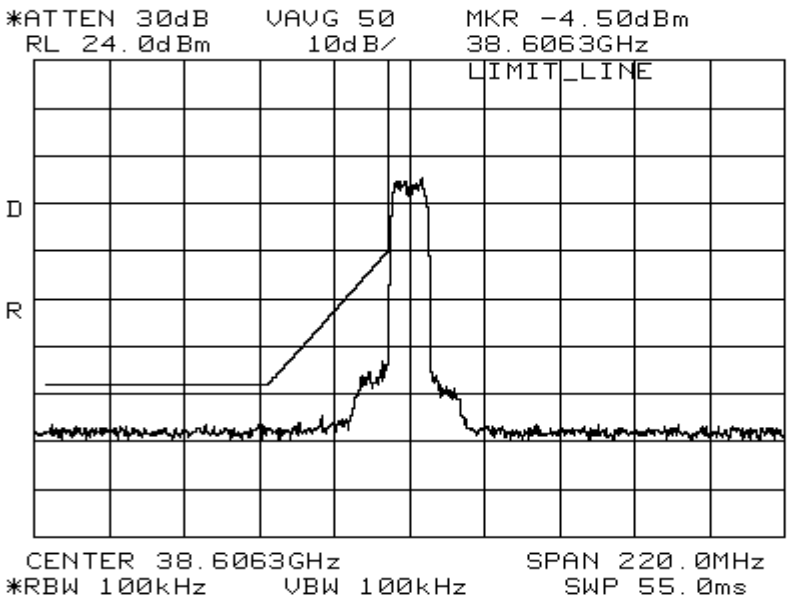



**Figure 16 Bandwidth for QPSK modulated signal on channel 1B1**

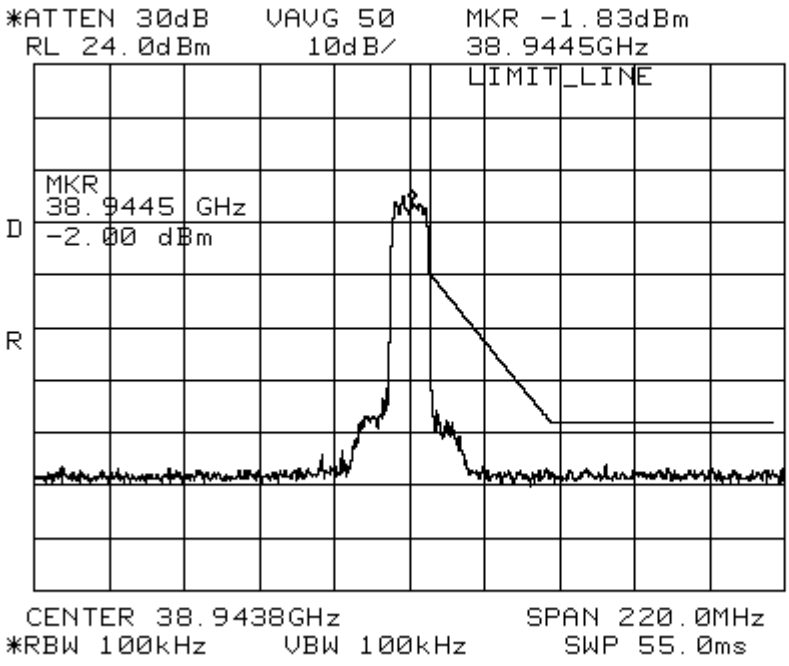



**Figure 17 Bandwidth for QPSK modulated signal on channel 7B4**

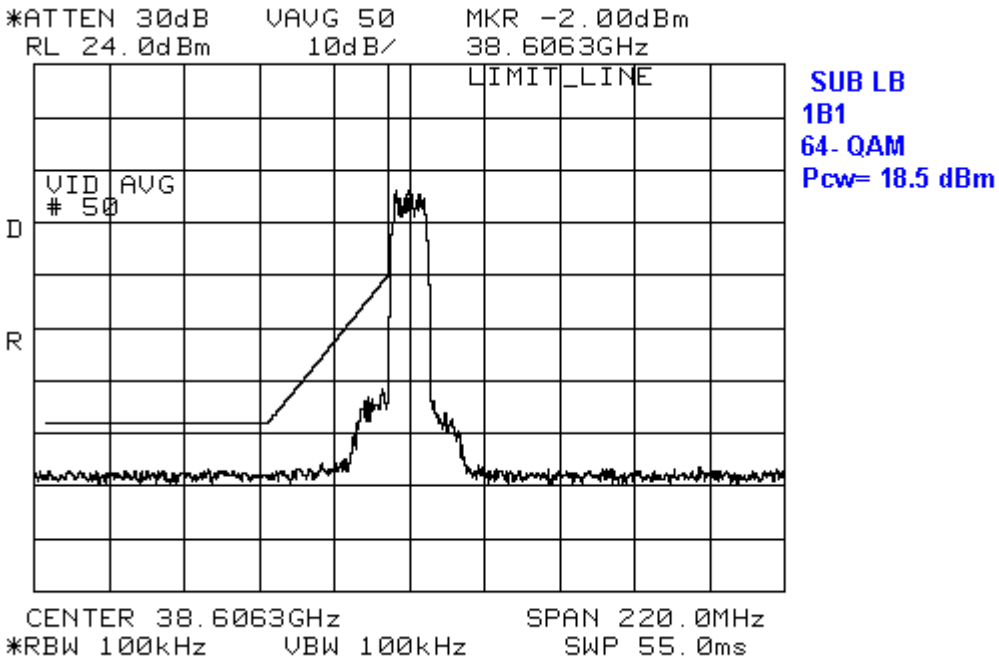



**Figure 18 Bandwidth for 64-QAM modulated signal on channel 1B1**

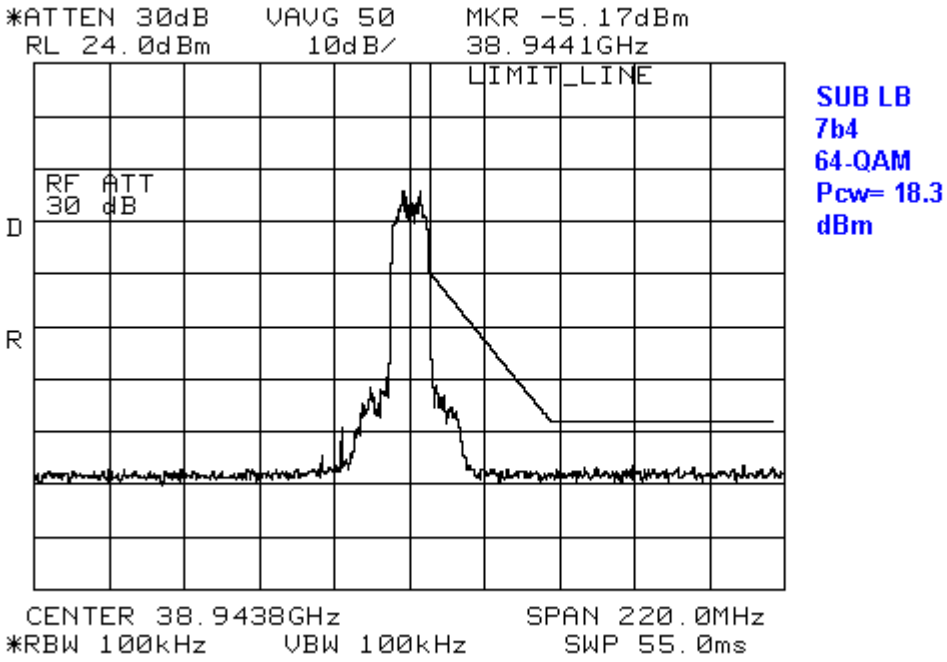



**Figure 19 Bandwidth for 64-QAM modulated signal on channel 7B4**

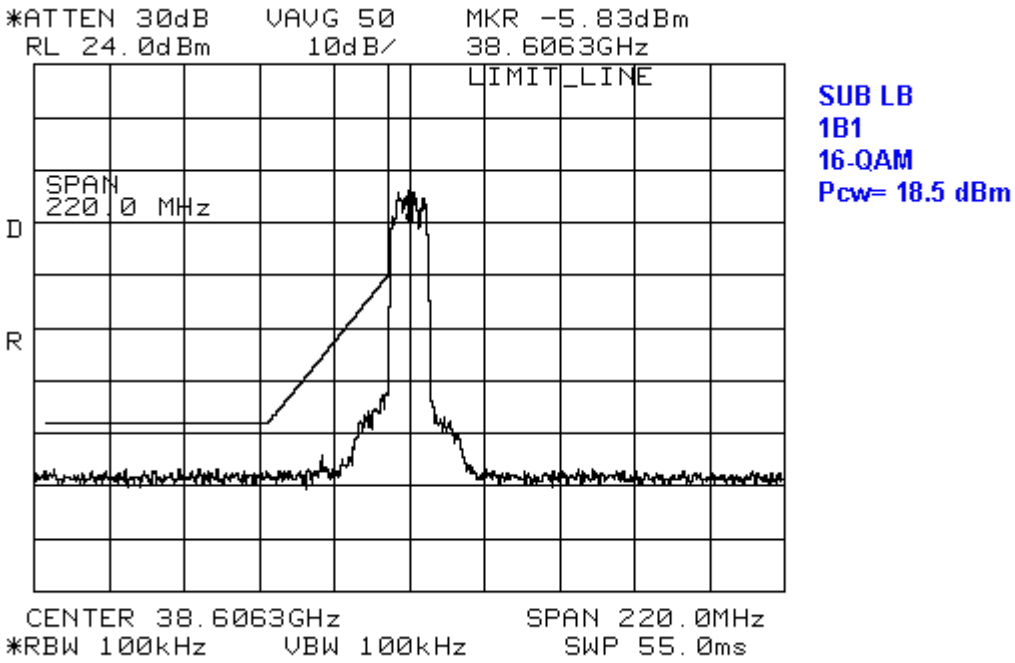



**Figure 20 Bandwidth for 16-QAM modulated signal on channel 1B1**

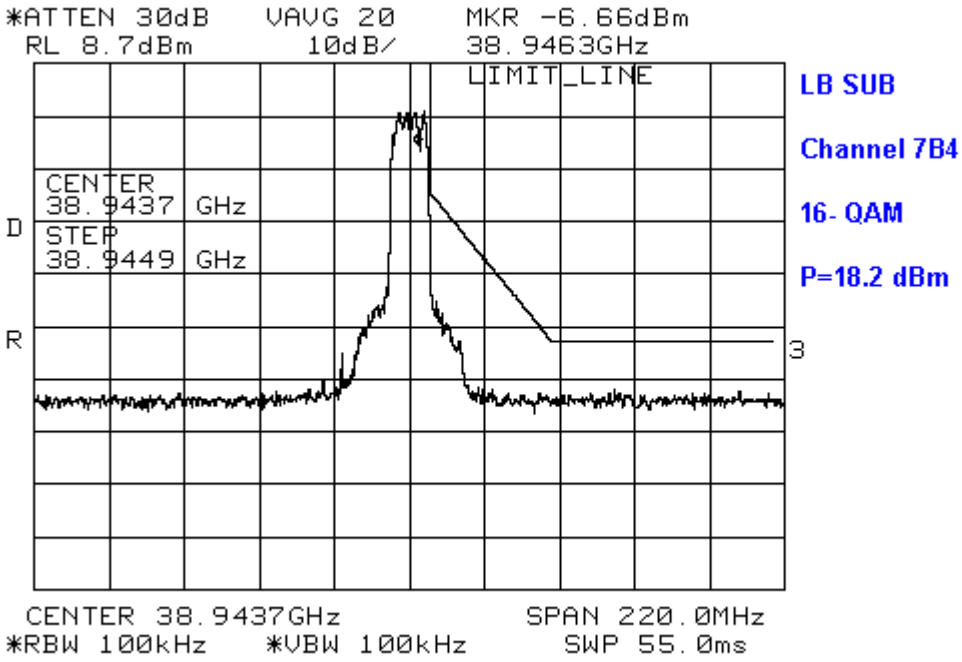



**Figure 21 Bandwidth for 16-QAM modulated signal on channel 7B4**

## 3.3 CONDUCTED SPURIOUS EMISSIONS FROM THE TRANSMITTER

These tests demonstrate the spurious emission levels, which are produced by EUT at the antenna terminals. The tests for the conducted emissions document the spurious levels conducted from the transmit filter output port (antenna connector), which connects to the transmit antenna.

### 3.3.1 Performance Specifications

As per FCC CFR 47 Part 2.1050 (previously 2.989) and 101.109
Maximum authorized bandwidth 50MHz.Unwanted emissions must be suppressed at the aggregate channel block edges based on the same roll-off rate as specified for a single channel block in 101.111 (a) (ii) and (iii).

(a)(2)(ii) In 1 MHz Band: 50 % to 250 %: A=11+0.4(P-50)+10log(B) or no less than 11dB down but no more than 56dB down is required

Where: A = Attenuation in dB below mean output power level

P = percent removed from center frequency

B = Authorized bandwidth in MHz

Example calculation:
Since the authorized bandwidth is 50MHz,
At 50 % for the authorized bandwidth (f=38600, 389500 MHz)
: A=11+. 4 (50-50)+10log(50) = 27.9 ~ 28dB down from the maximum transmitted power

The Maximum power is 18 dBm when 1MHz RBW is used,

@ 100 kHz, the levels 18 –10 dB = 8 dBm

Therefore The limit @ f = 38600 MHz and 39500 MHz should be 8dBm- 28 dB = -20 dBm

At 125%: A=11+. 4 (125-50)+10log(50) = 58dB or 56 whichever is lower

Therefore the limit will be 8dBm- 56 = -48 dBm

(a)(2)(iii) In 4kHz band >250% at least 43+10log(output power in Watts) or 80dB

Example calculation:

If your power were = 18 dBm = 63.09 mW

250% and out: A = 43+10log(0.06309) = -30.9dB down from the 18 dBm

Therefore limit = - 13 dBm

**Note:** 4 kHz Bandwidth will be difficult to use. You may adjust the limit accordingly. If it passes and the higher Bandwidth, it will certainly pass at 4 kHz

### 3.3.2 Test Procedures

The EUT will be initialized in the transmit mode. The transmit output will be connected to the spectrum analyzer. Spurious emissions measurements will be done in the frequency bands detailed above.
The equipment under test will be operated at different frequencies across the transmit frequency band (low end, center, and high end). The entire frequency spectrum from as low as possible to 200 GHz shall be investigated and any spur or emission shall be documented.

| Test Frequencies | |
|---|---|
| Channel | Frequency MHz |
| 1-B1 | 38606.25 |
| 7B4 | 38943.75 |

**Table 7 Conducted Spurious Emissions Test Frequencies**

### 3.3.3 Test Configuration

Refer to Fig. 4 for the Basic Test configuration.
Transitions and waveguide adapters will need to be used to connect the EUT transmit port to the various harmonic mixers. The mixers along with a Diplexer will be used to connect the signal to the spectrum analyzer and mix it down to a frequency range that can be measured. This must be done since the analyzer used only goes to 40 GHz and signals must be measured up to 200 GHz. Please refer to the documentation supplied with the mixers for instructions on how to make measurements. Also note that any measurements made over 40 GHz will not be calibrated, they will only be referenced upon the factors supplied by the mixer manufacturer. There are no NIST traceable measurements above 75GHz(they may be up to 97GHz now). Therefore, we must use engineering judgment when taking these measurements. Care must be taken to not overload the mixers. Also care must be taken when connecting and disconnecting the waveguide pieces.

The following connections will need to be made:
EUT has WR-28

| **Adapter** | **Cable** | **Frequency Range** |
|---|---|---|
| WR-28 to 2.4mm connector | Low loss to 40 GHz | 0 to 40 GHz |
| **Transition** | **Mixer** | **Frequency Range** |
| WR-28 to WR-19 | WR-19 | 40 to 60 GHz |
| WR-28 to WR-12 | WR-12 | 60 to 90 GHz |
| WR-28 to WR-08 | WR-08 | 90 to 140 GHz |
| WR-28 to WR-05 | WR-05 | 140 to 220 GHz |

### 3.3.4 Tests Results

PASS: X Fail: __

### 3.3.4.1 High Power (18 dBm) channel 1B1

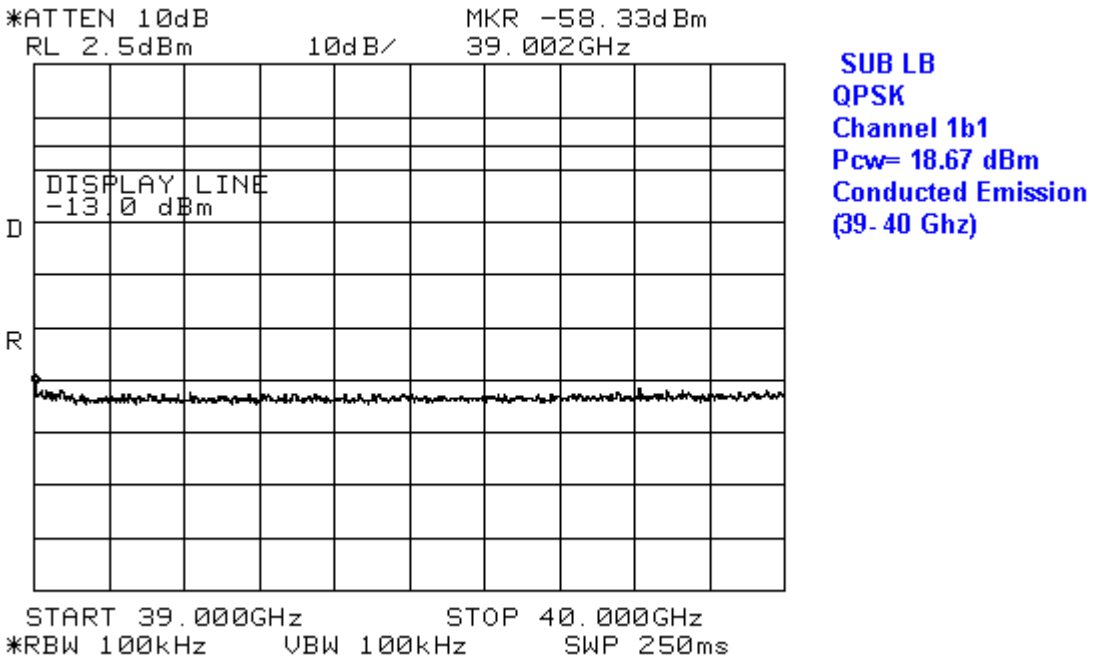



**Figure 22 Conducted Emissions in 0 – 40 GHz, for transmitting 18 dBm on channel 1B1**

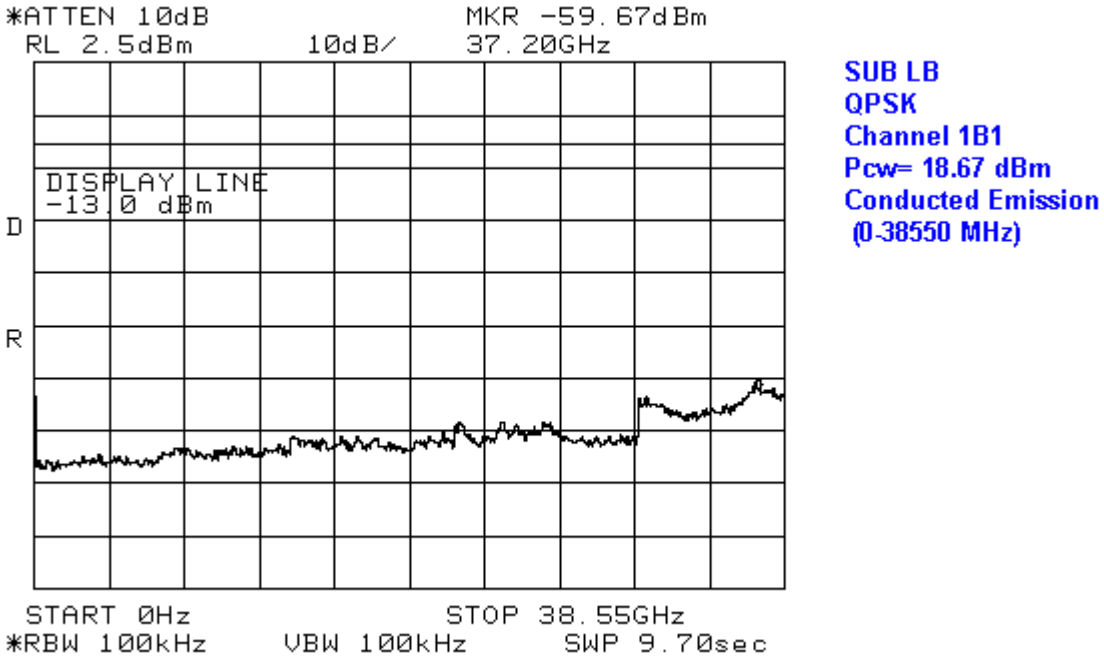



**Figure 23 Conducted Emissions in 0 – 38.55 GHz, for transmitting 18 dBm on channel 1B1**

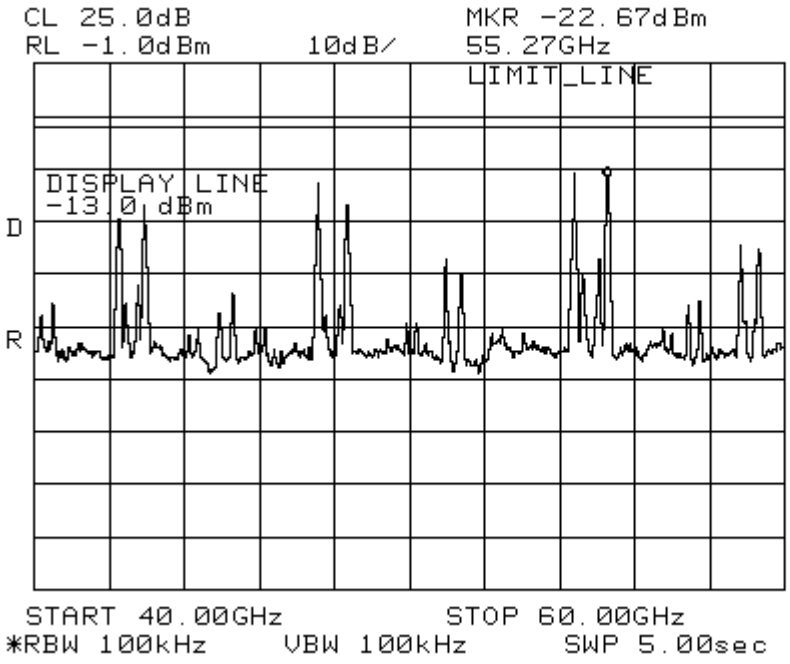



**Figure 24 Conducted Emissions in 40 - 60 GHz, for transmitting 18 dBm on channel 1B1**

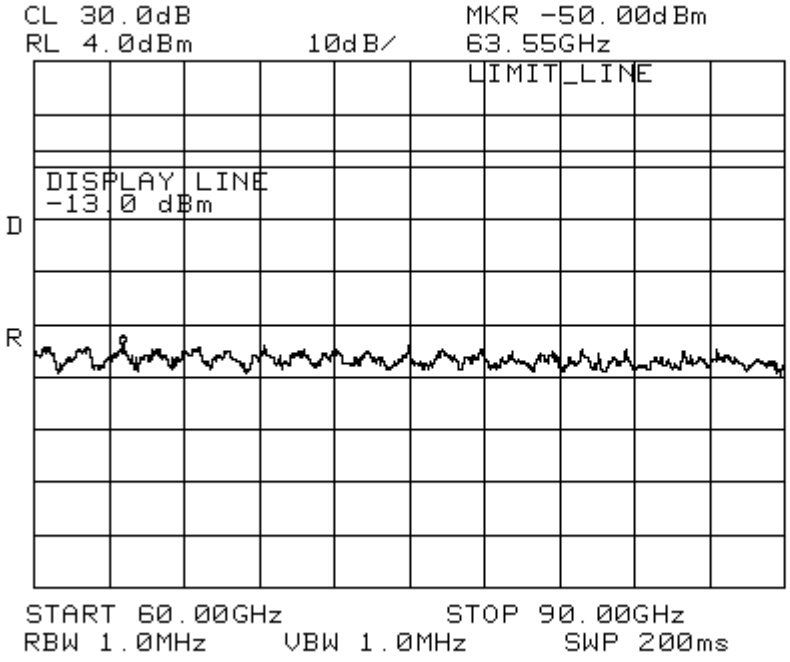



**Figure 25 Conducted Emissions in 60 - 90 GHz, for transmitting 18 dBm on channel 1B1**

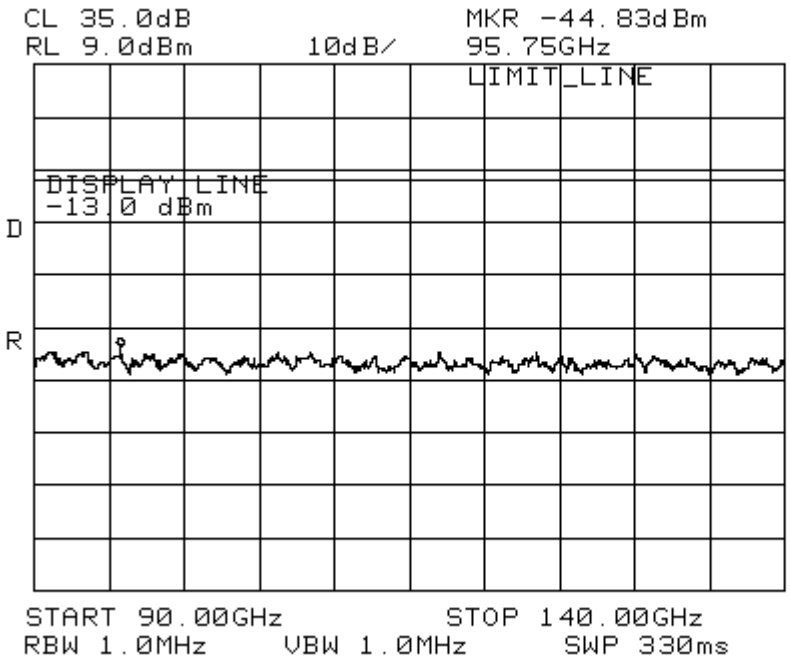



**Figure 26 Conducted Emissions in 90 – 140 GHz, for transmitting 18 dBm on channel 1B1**

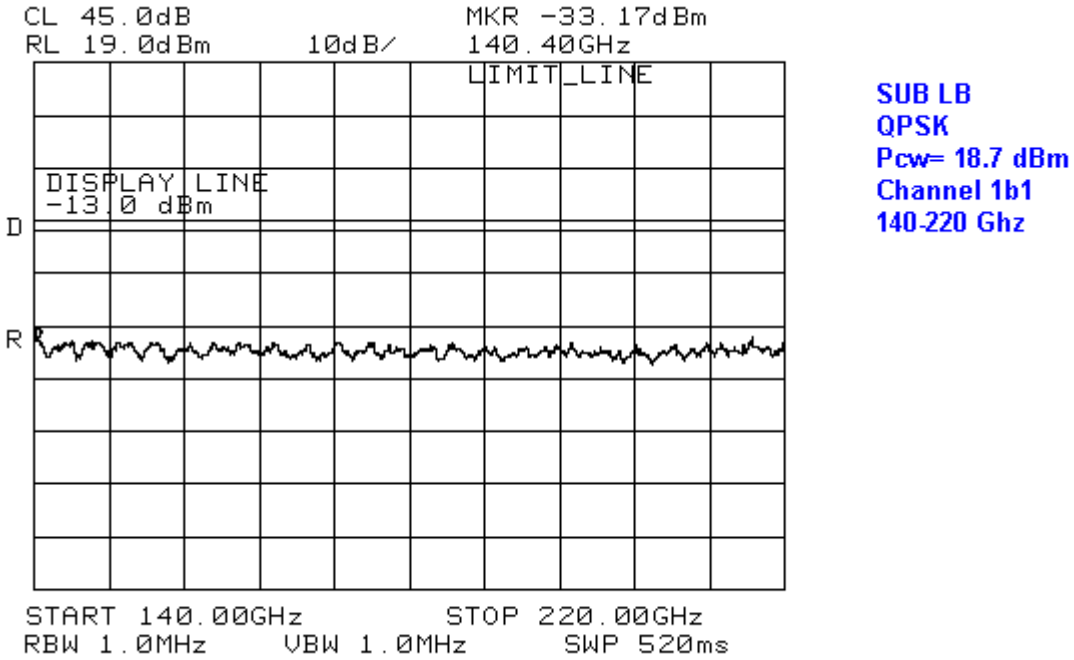



**Figure 27 Conducted Emissions in 140 – 200 GHz, for transmitting 18 dBm on channel 1B1**

### 3.3.4.2 High Power (18 dBm) , channel 7B4

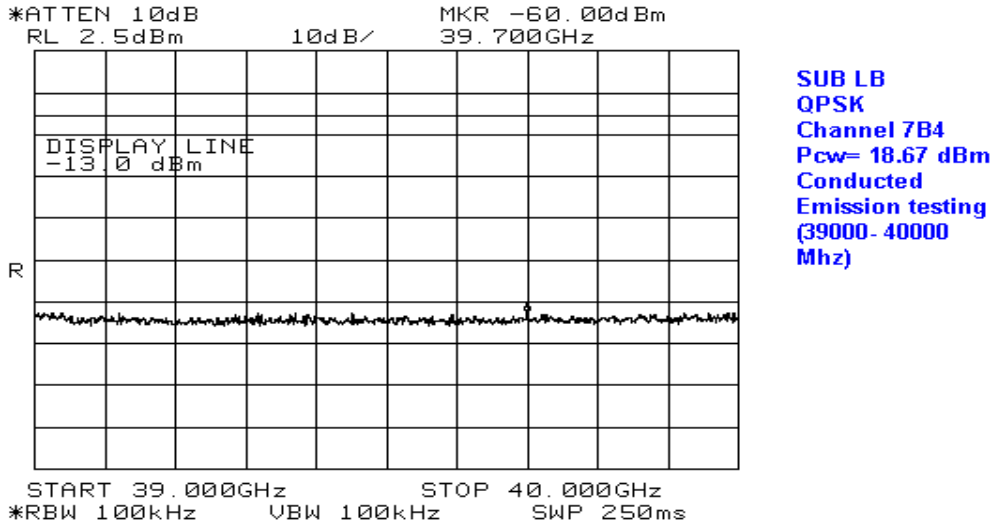



**Figure 28 Conducted Emissions in 39 – 40 GHz, for transmitting 18 dBm on channel 7B4**

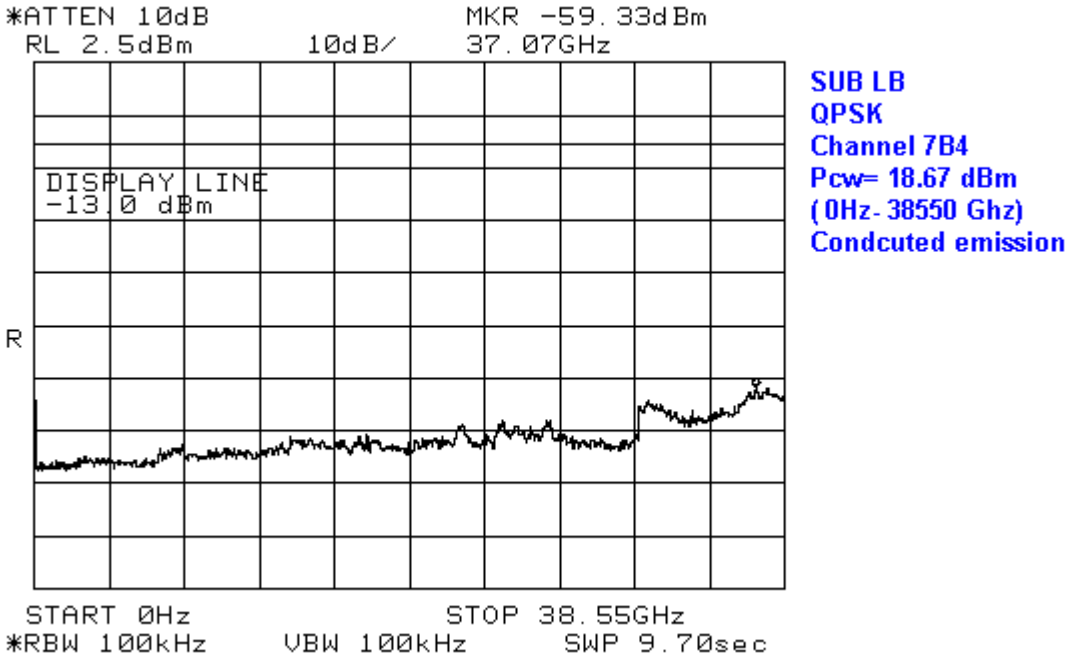
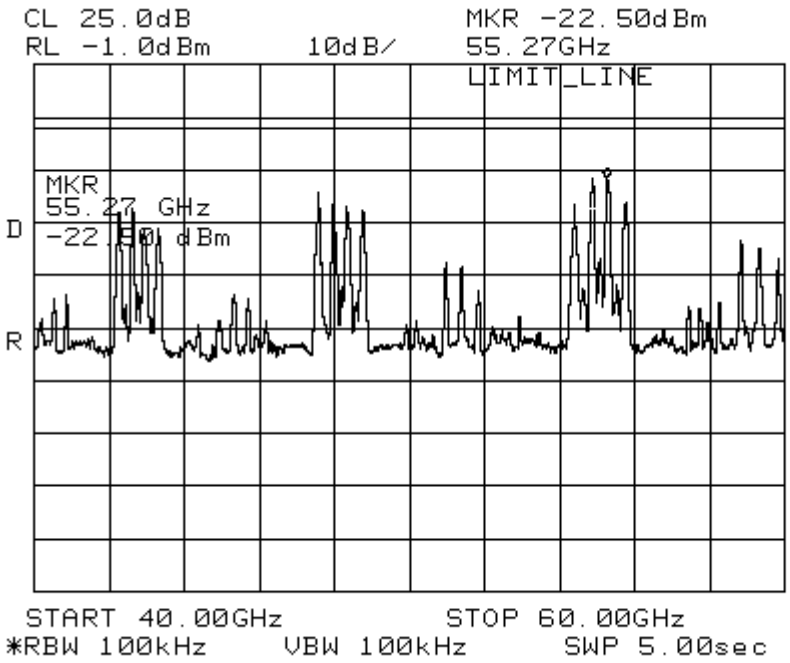


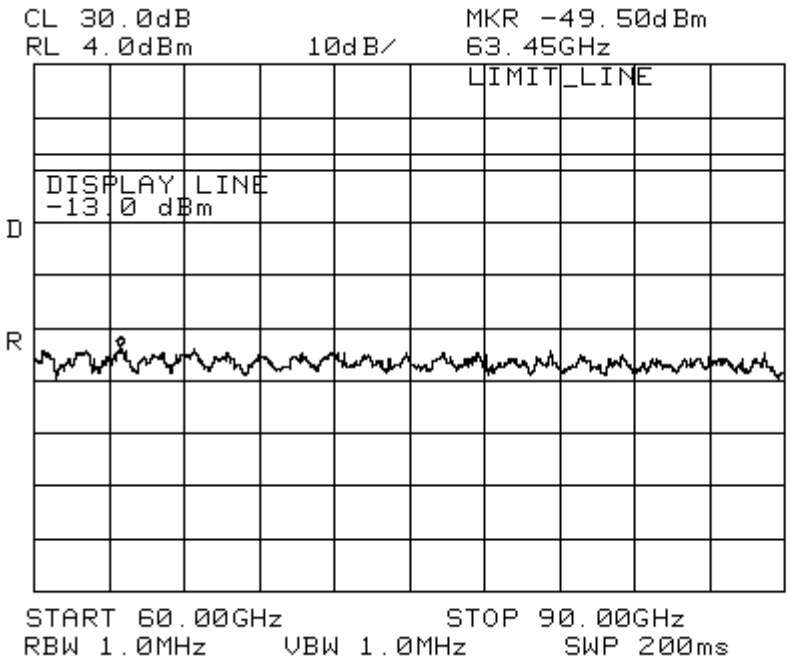

**Figure 29 Conducted Emissions in 0 – 38.55 GHz, for transmitting 18 dBm on channel 7B4**




SUB LB
QPSK Modulated
Pcw= 18.33 dBm
Channel 7B4
Display line - 13 dBm

MAx and hold enabled

**Figure 30 Conducted Emissions in 40 – 60 GHz, for transmitting 18 dBm on channel 7B4**




SUB LB
QPSK Modulation
Pcw= 18.7 dBm
Channel 7B4
60-90 Ghz

**Figure 31 Conducted Emissions in 60 – 90 GHz, for transmitting 18 dBm on channel 7B4**

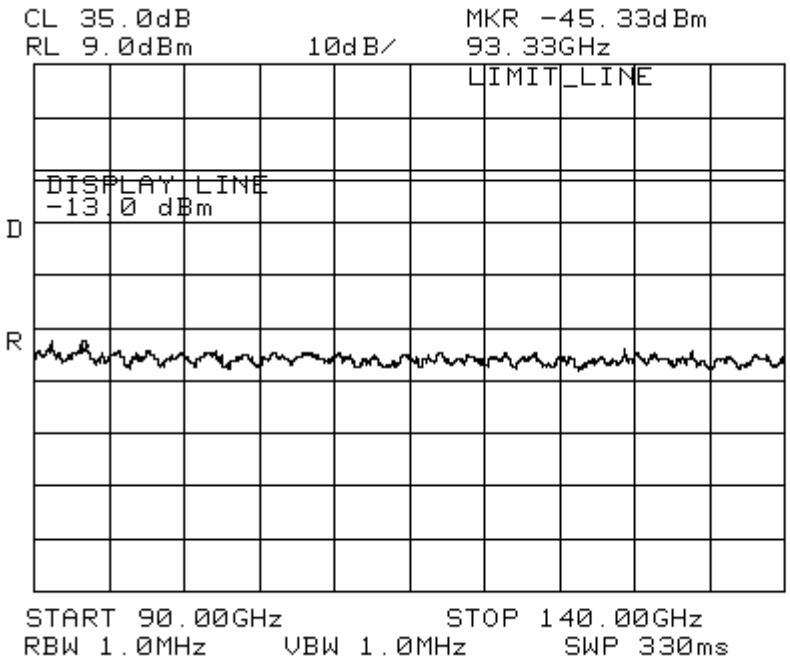



**Figure 32 Conducted Emissions in 90 – 140 GHz, for transmitting 18 dBm on channel 7B4**

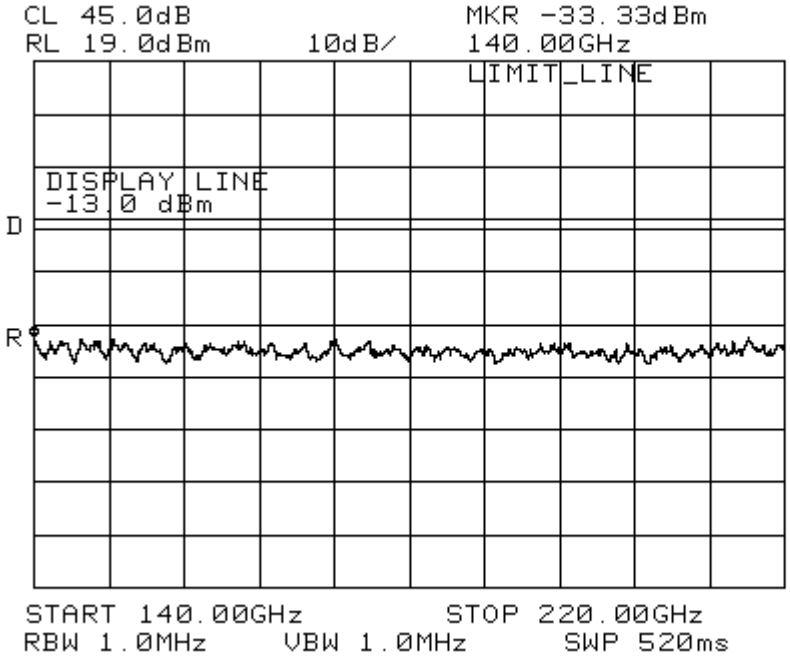



**Figure 33 Conducted Emissions in 140 – 220 GHz, for transmitting 18 dBm on channel 7B4**

### 3.3.4.3 Low power (-12 dBm) channel 1B1

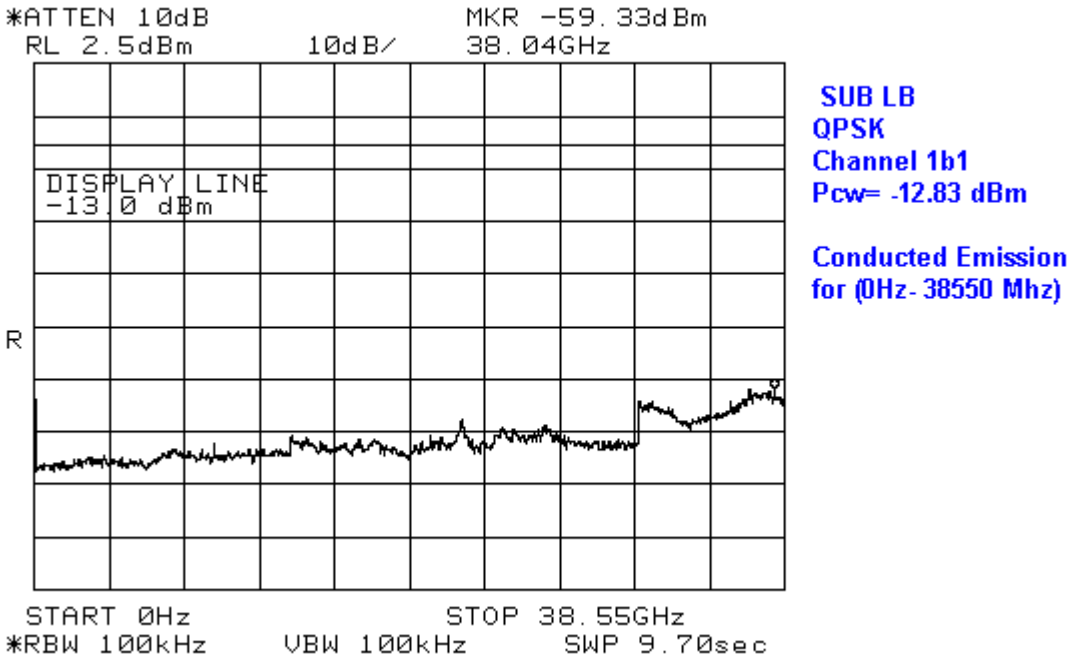
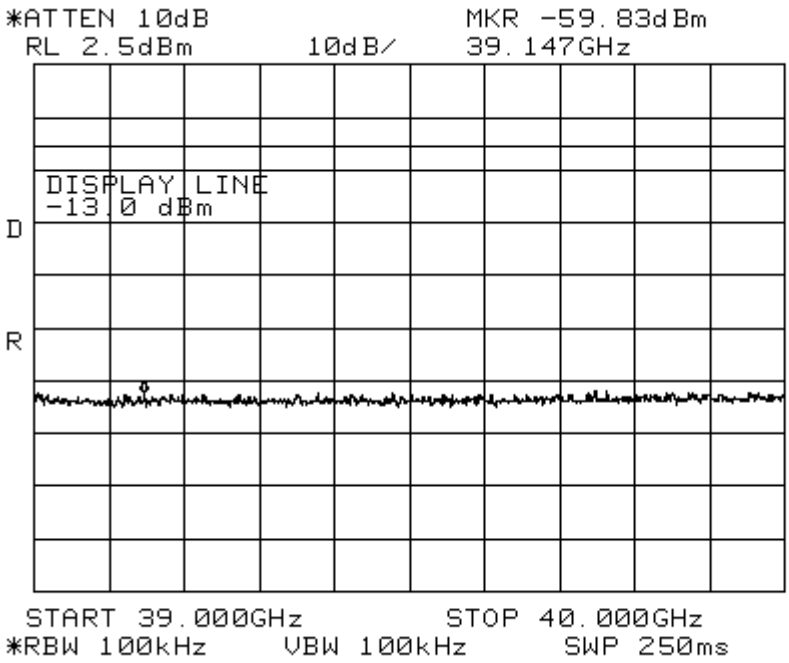
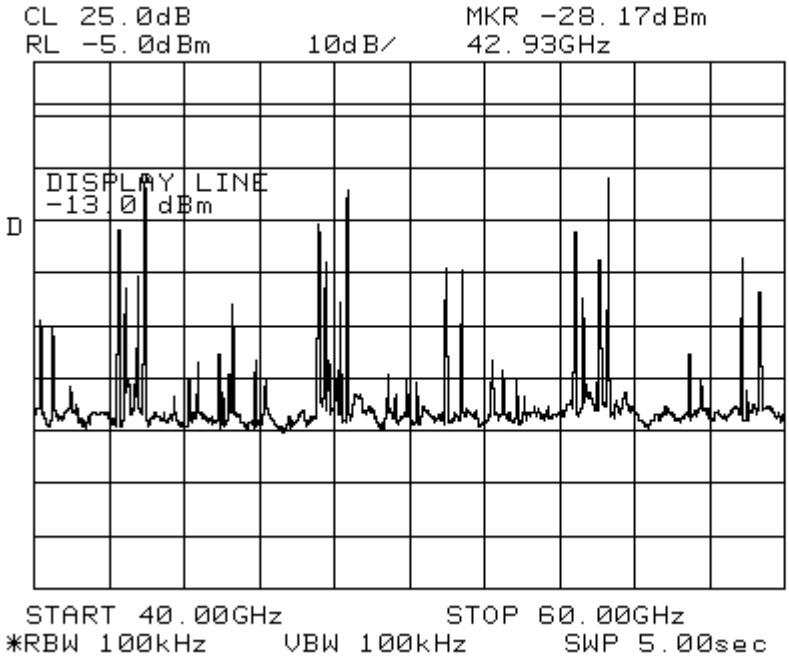



**Figure 34 Conducted Emissions in 0 – 38.55 GHz, for transmitting -12 dBm on channel 1B1**




SUB LB
QPSK
Pcw= -12.83 dBm
Channel 1b1
Condcuted emission
(39-40 GHz)

**Figure 35 Conducted Emissions in 39 – 40 GHz, for transmitting -12 dBm on channel 1B1**




SUB LB
Channel 1b1
QPSK
Pcw= -12.8 dBm
40-60 Ghz U band

**Figure 36 Conducted Emissions in 40 – 60 GHz, for transmitting -12 dBm on channel 1B1**

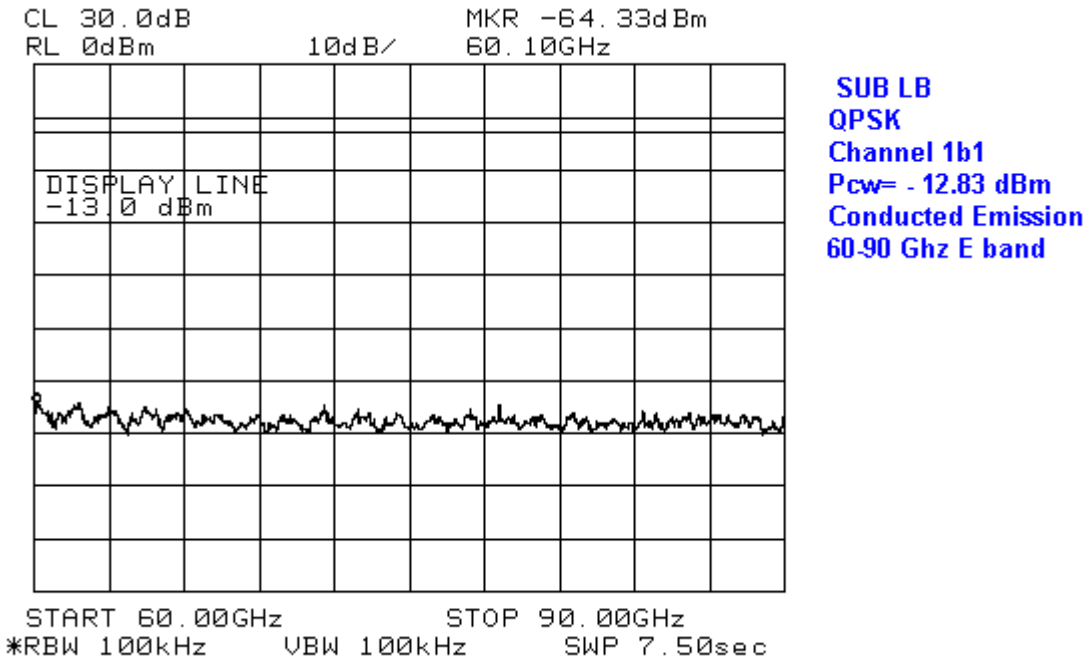



**Figure 37 Conducted Emissions in 60 – 90 GHz, for transmitting -12 dBm on channel 1B1**

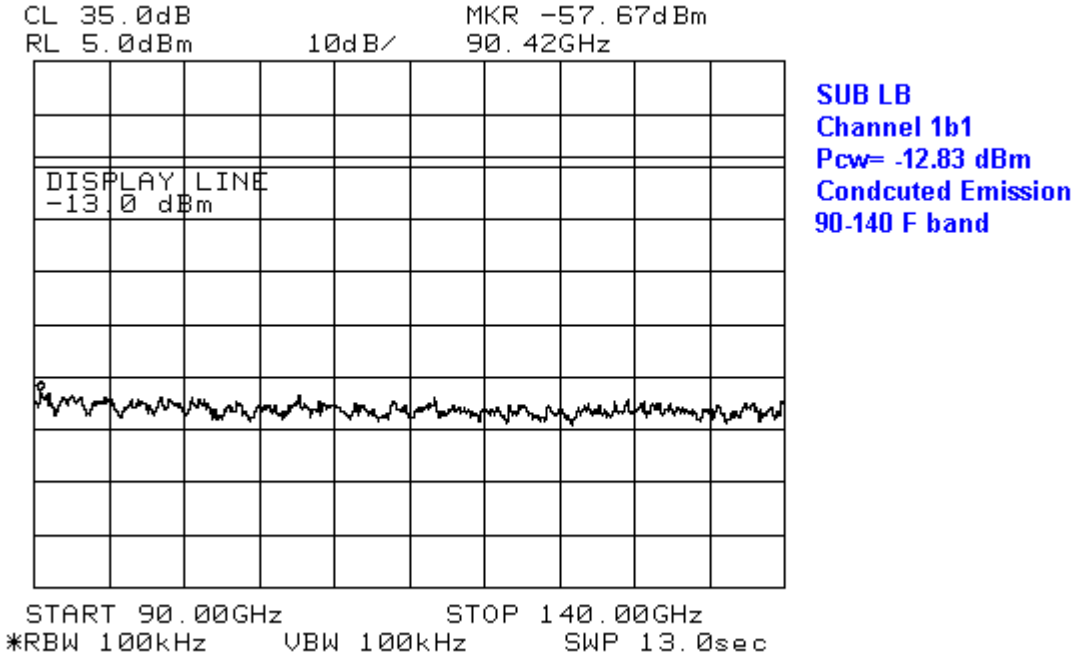



**Figure 38 Conducted Emissions in 90 – 140 GHz, for transmitting -12 dBm on channel 1B1**

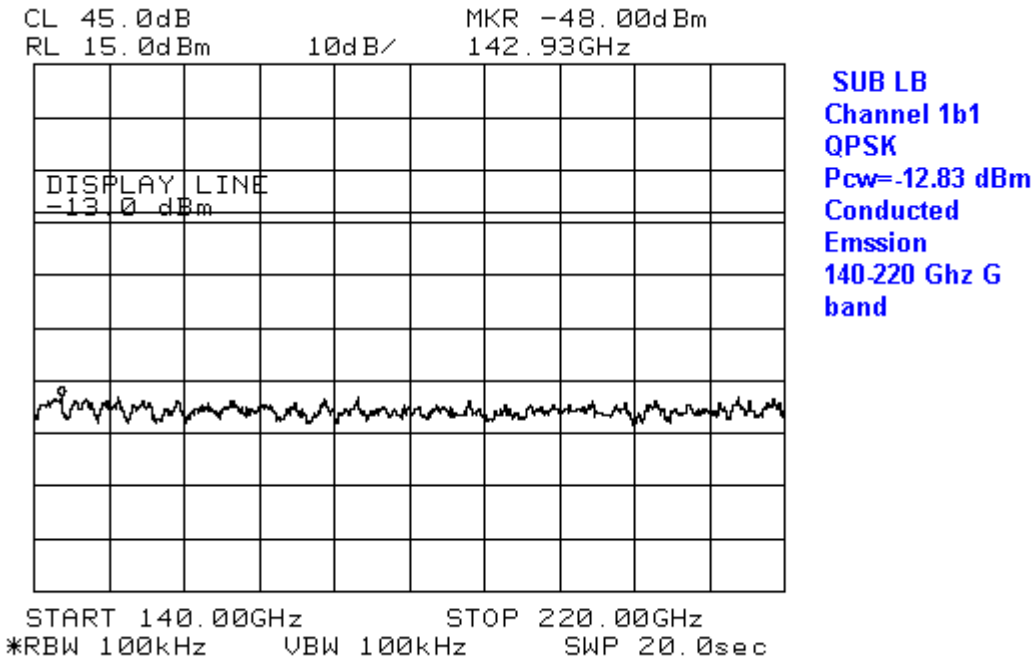



**Figure 39 Conducted Emissions in 140 – 220 GHz, for transmitting -12 dBm on channel 1B1**

### 3.3.4.4 Low Power (-12 dBm), channel 7B4

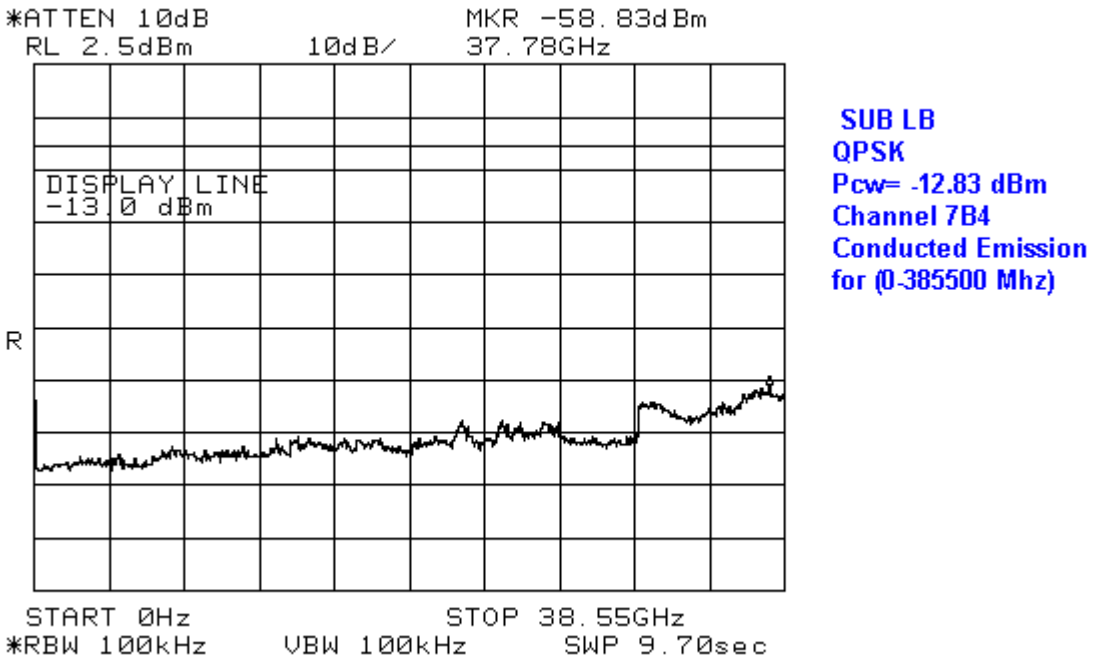



**Figure 40 Conducted Emissions in 0 – 38.55 GHz, for transmitting -12 dBm on channel 7B4**

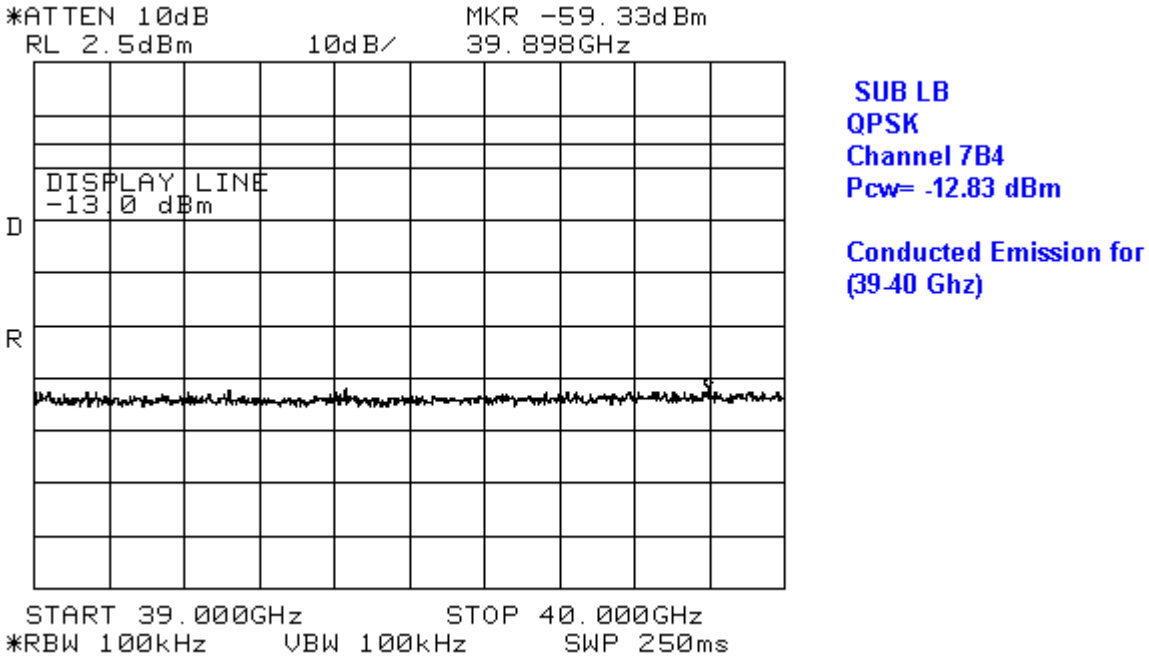



**Figure 41 Conducted Emissions in 39 – 40 GHz, for transmitting -12 dBm on channel 7B4**

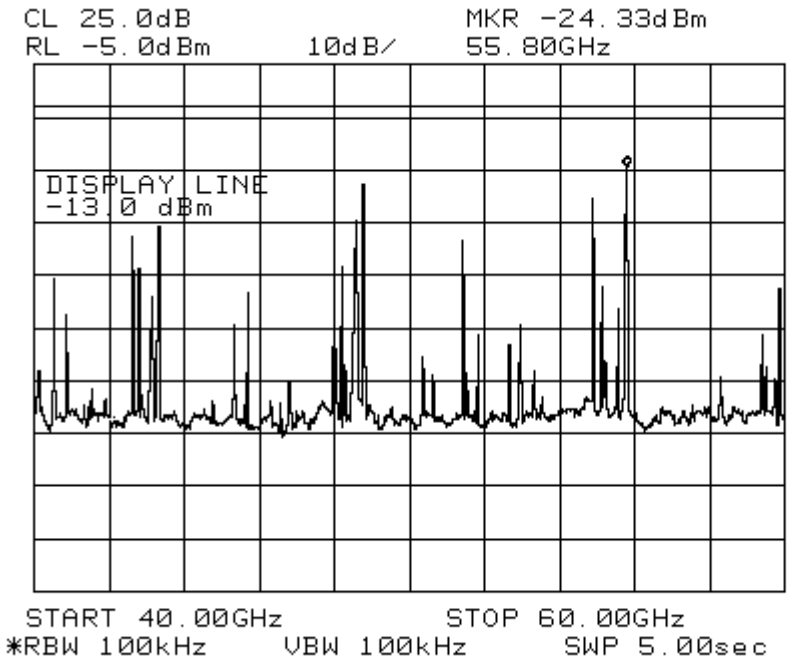



**Figure 42 Conducted Emissions in 40 – 60 GHz, for transmitting -12 dBm on channel 7B4**

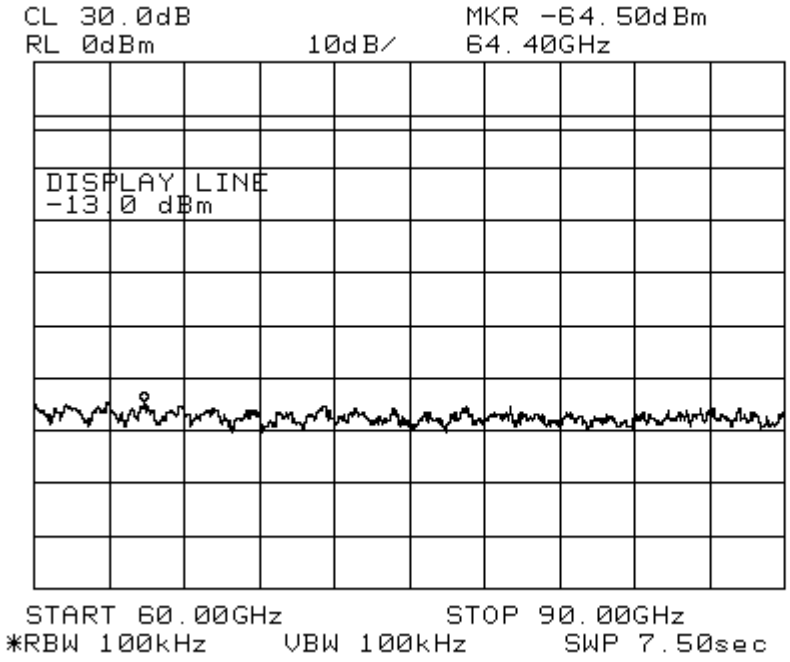



**Figure 43 Conducted Emissions in 60 – 90 GHz, for transmitting -12 dBm on channel 7B4**

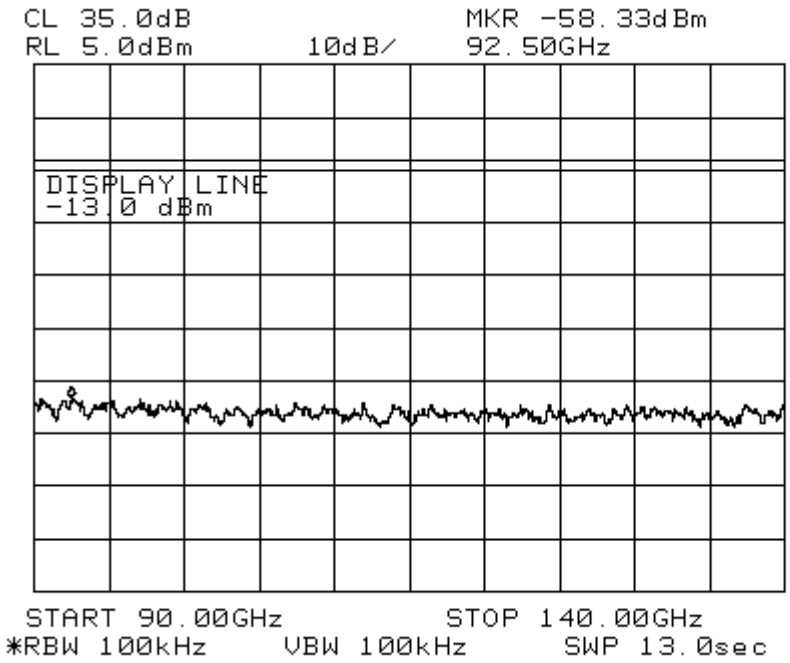



**Figure 44 Conducted Emissions in 90 – 140 GHz, for transmitting -12 dBm on channel 7B4**

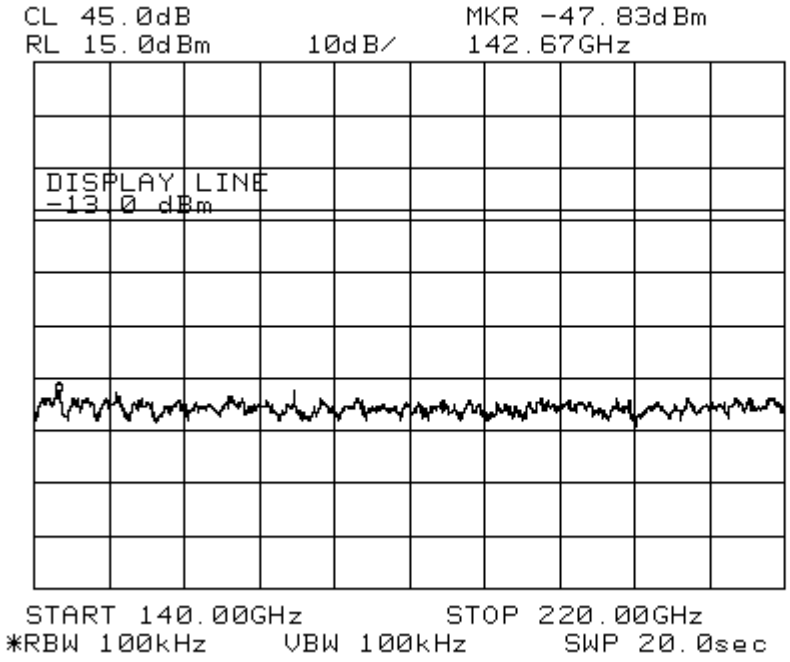



**Figure 45 Conducted Emissions in 140 – 220 GHz, for transmitting -12 dBm on channel 7B4**

## 3.4 RADIATED SPURIOUS EMISSIONS FROM THE TRANSMITTER

These tests demonstrate the spurious emission levels, which are produced by EUT. The tests for the radiated emissions document the spurious levels radiated from the EUT enclosure and cables, while the transmit output port (antenna connector) will be terminated by a "dummy load".

### 3.4.1 Performance Specifications

As per FCC CFR 47 Part 2.1050 (previously 2.989) and 101.109
Maximum authorized bandwidth 50MHz.Unwanted emissions must be suppressed at the aggregate channel block edges based on the same roll-off rate as specified for a single channel block in 101.111 (a) (ii) and (iii).

(a)(2)(ii) In 1 MHz Band: 50% to 250%: A=11+0.4(P-50)+10log(B) or no less than 11dB down but no more than 56dB down is required
Where: A = Attenuation in dB below mean output power level
P = percent removed from center frequency
B = Authorized bandwidth in MHz

Example calculation:

Since the authorized bandwidth is 50MHz,
At 50 % for the authorized bandwidth (f=38600, 389500 MHz)
: A=11+. 4 (50-50)+10log(50) = 27.9 ~ 28dB down from the maximum transmitted power
The Maximum power is 18 dBm when 1MHz RBW is used,
@ 100 kHz, the levels 18 –10 dB = 8 dBm

Therefore the limit @ f = 38600 MHz and 39500 MHz should be 8dBm- 28 dB = -20 dBm
At 125%: A=11+. 4 (125-50)+10log(50) = 58 dB or 56 whichever is lower
Therefore the limit will be 8dBm- 56 = -48 dBm

(a)(2)(iii) In 4kHz band >250% at least 43+10log(output power in Watts) or 80dB
Example calculation:
If your power were = 18 dBm = 63.09 mW
250% and out: A = 43+10log(0.06309) = -30.9dB down from the 18 dBm
Therefore limit = - 13 dBm

### 3.4.2 Test Procedures

The EUT will be initialized in the transmit mode. The transmit output will be terminated by a "dummy load = 50 Ohms". Spurious emissions measurements will be done in the frequency bands detailed above. The equipment under test will be operated at different frequencies across the transmit frequency band (low end, and high end). The entire frequency spectrum from as low as possible (18 GHz to 220 GHz shall be investigated and any spur or emission shall be documented.

| Test Frequencies | |
|---|---|
| Channel | Frequency |
| 4B3 | 38781.25 MHz |

**Table 8 Radiated Spurious Emissions Test Frequencies**

### 3.4.3 Test Configuration

Refer to Fig. 5 for the Basic Test configuration.
Standard gain horn antennas and harmonic mixers will be used to take the measurements. The mixers along with a Diplexer will be used to connect the signal to the spectrum analyzer and mix it down to a frequency range that can be measured. This must be done since the analyzer used only goes to 40 GHz and signals must be measured up to 220 GHz. Please refer to the documentation supplied with the mixers for instructions on how to make measurements. Also note that any measurements made over 40 GHz will not be calibrated, they will only be referenced upon the factors supplied by the mixer manufacturer. There are no NIST traceable measurements above 75GHz (they may be up to 97GHz now). Therefore, we must use engineering judgment when taking these measurements. Care must be taken to not overload the mixers. Also care must be taken when connecting and disconnecting the waveguide pieces and horn antennas.

The following connections will need to be made:

| **Antenna** | **Connector** | **Adapter** | **Frequency Range** |
|---|---|---|---|
| Bi-Log | Type N | N/A | 30 to 1000 MHz |
| Horn | Type N | N/A | 1 to 18 GHz |
| Standard Gain Horn | WR-42 | WR-42 to 3.5mm connector | 18 to 26.5GHz |
| Standard Gain Horn | WR-28 | WR-28 to 2.4mm connector | 26.5 to 40 GHz |
| **Antenna** | **Connector** | **Mixer** | **Frequency Range** |
| Standard Gain Horn | WR-19 | WR-19 | 40 to 60 GHz |
| Standard Gain Horn | WR-12 | WR-12 | 60 to 90 GHz |
| Standard Gain Horn | WR-08 | WR-08 | 90 to 140 GHz |
| Standard Gain Horn | WR-05 | WR-05 | 140 to 220 GHz |

**Table 9 Equipment for Radiated Emissions Test**

Recommend that test distance be 3m below 1GHz and 1m above. Tests may need to be made closer due to low field levels.

### 3.4.4 Test Results

PASS: X Fail: __

### 3.4.4.1 Horizontal and Vertical, 1-18 GHz

WASHINGTON LABORATORIES, LTD
7560 LINDBERGH DRIVE
GAITHERSBURG, MD 20879
(301) 417-0220 FAX: (301) 417-9069

TABLE 2

FCC CLASS B 3M RADIATED EMISSIONS DATA - SITE 2

CLIENT: HNS
MODEL NO: ODU(PMP) Sub Unit
DATE: 11/29/1999
CLK SPEED(S): 160 MHz LO
BY: Herb Meadows
JOB #: 5535

CONFIGURATION: Ouptut Transmitting into 40 db pad- No load
38.94375 GHz TX Fund.
Scanned 30MHz-18 GHz

| FREQ MHz | POL H/V | Azimuth Degree | Ant Height m | SA LEVEL (QP) dBuV | AFc dB/m | E-FIELD dBuV/m | E-FIELD uV/m | LIMIT uV/m | MRGN dB |
|---|---|---|---|---|---|---|---|---|---|
| 160.00 | V | 0.0 | 1 | 8.4 | 10.2 | 18.6 | 8.5 | 150.0 | -24.9 |
| 321.00 | V | 0.0 | 1 | 5.4 | 16.7 | 22.1 | 12.7 | 200.0 | -24.0 |
| 449.45 | V | 0.0 | 1 | 13.4 | 19.7 | 33.1 | 45.2 | 200.0 | -12.9 |
| 498.36 | V | 0.0 | 1 | 7.8 | 21.0 | 28.8 | 27.7 | 200.0 | -17.2 |
| 699.23 | V | 0.0 | 1 | 9.2 | 25.5 | 34.7 | 54.2 | 200.0 | -11.3 |
| 960.00 | V | 0.0 | 1 | 10.1 | 29.0 | 39.1 | 90.6 | 200.0 | -6.9 |

**Figure 46 Radiated Spurious Emissions from 1-18 GHz**

Radiated spurious emissions from 1 to 18 GHz were evaluated at Washington Laboratories, Ltd. The results are enclosed above. Both horizontal and vertical polarizations were tested. There were no spurs found.

### 3.4.4.2 Horizontal Polarization, 18 – 40 GHz

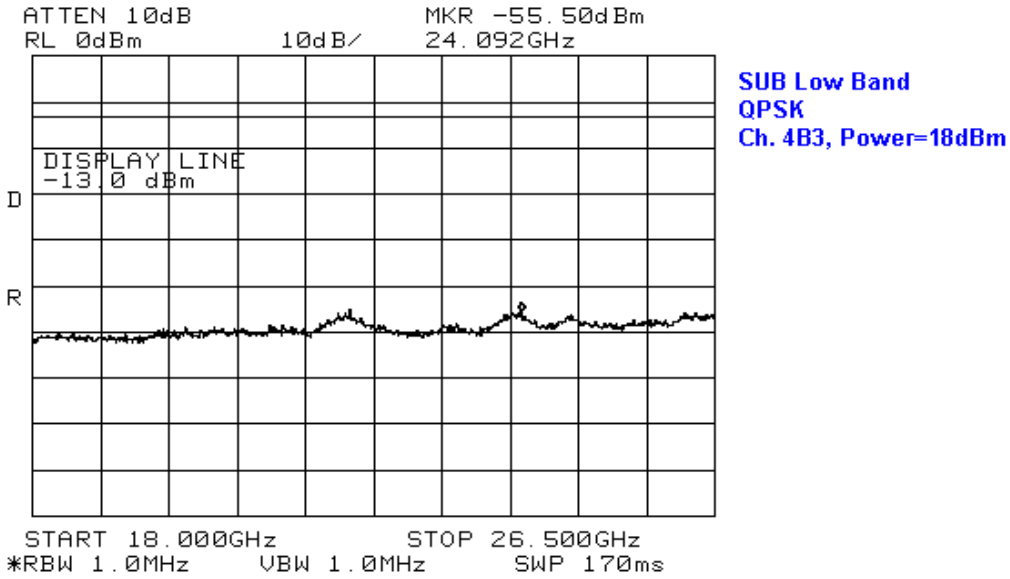



**Figure 47 Radiated Emissions in 18 – 26.5 GHz, for transmitting 18 dBm on channel 4B3**

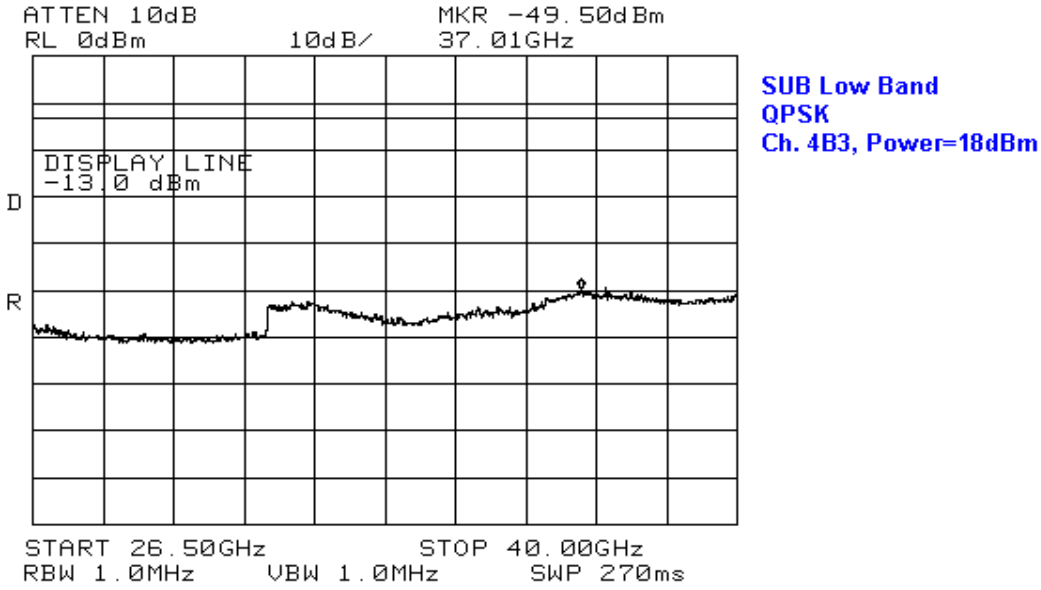



**Figure 48 Radiated Emissions in 26.5 – 40 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.3 Horizontal Polarization, 40 – 60 GHz

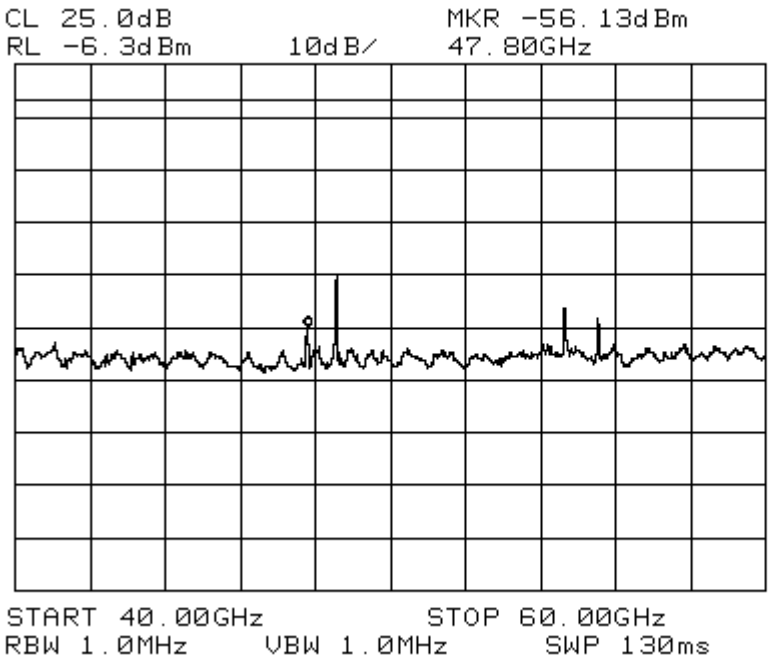



**Figure 49 Radiated Emissions in 40 – 60 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.4 Horizontal Polarization, 60 – 90 GHz

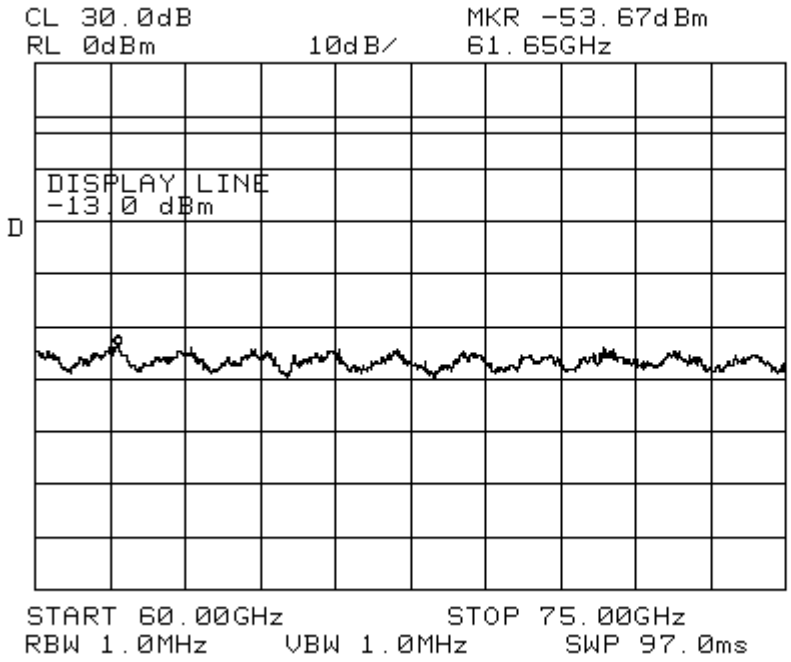



**Figure 50 Radiated Emissions in 60 – 75 GHz, for transmitting 18 dBm on channel 4B3**

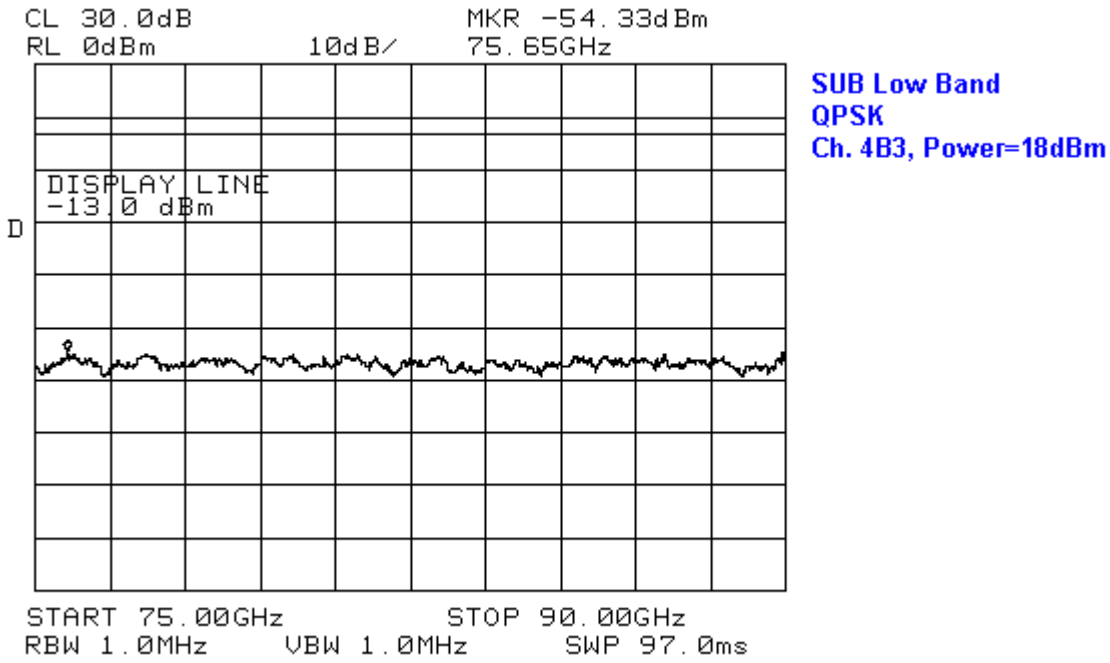



**Figure 51 Radiated Emissions in 75 – 90 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.5 Horizontal Polarization, 90 – 140 GHz

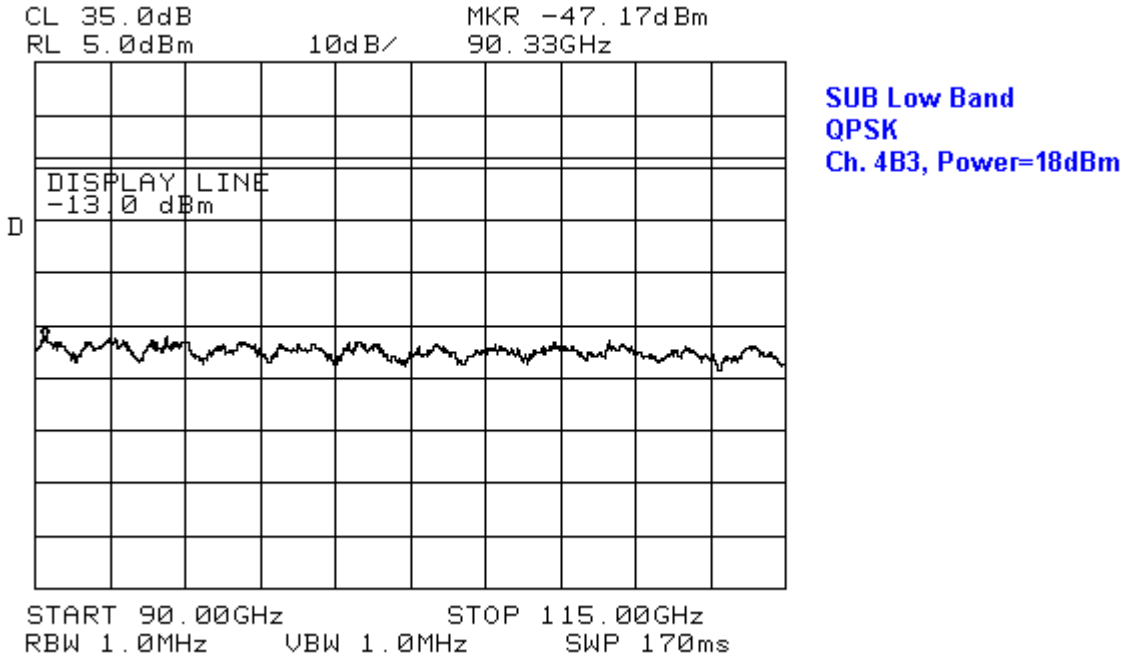



**Figure 52 Radiated Emissions in 90 – 115 GHz, for transmitting 18 dBm on channel 4B3**

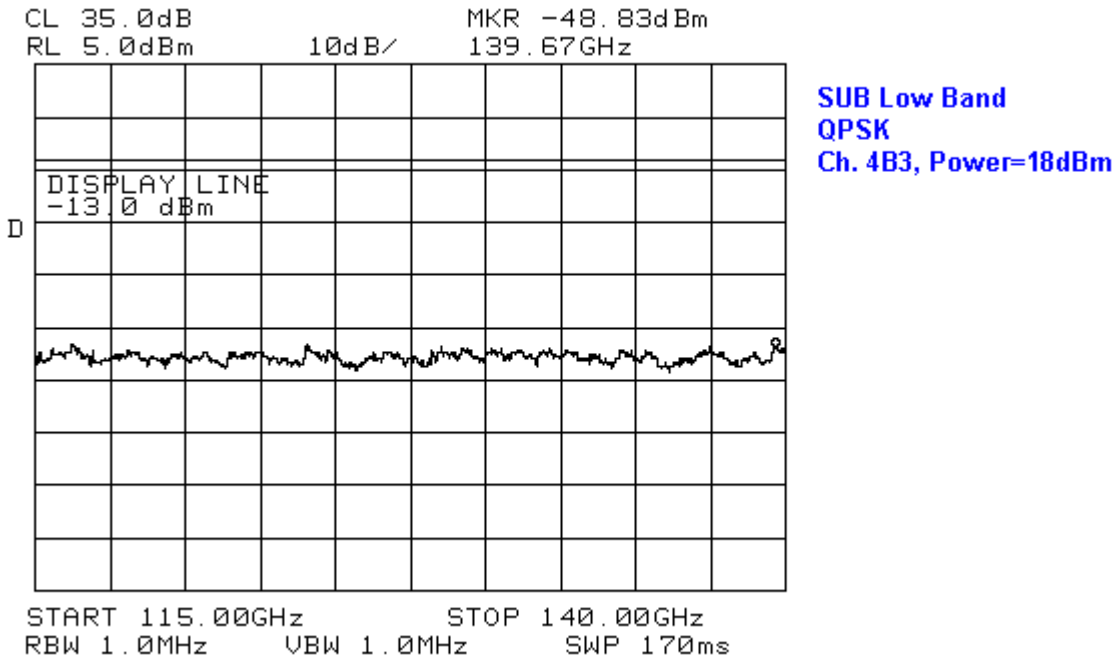



**Figure 53 Radiated Emissions in 115 – 140 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.6 Horizontal Polarization, 140 – 220 GHz

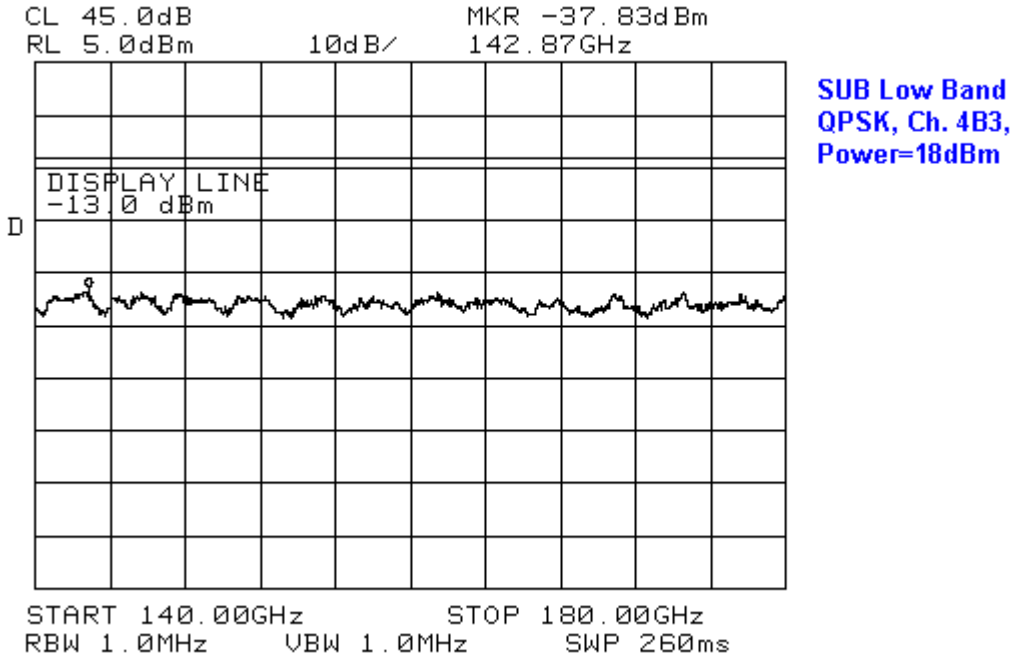



**Figure 54 Radiated Emissions in 140 – 180 GHz, for transmitting 18 dBm on channel 4B3**

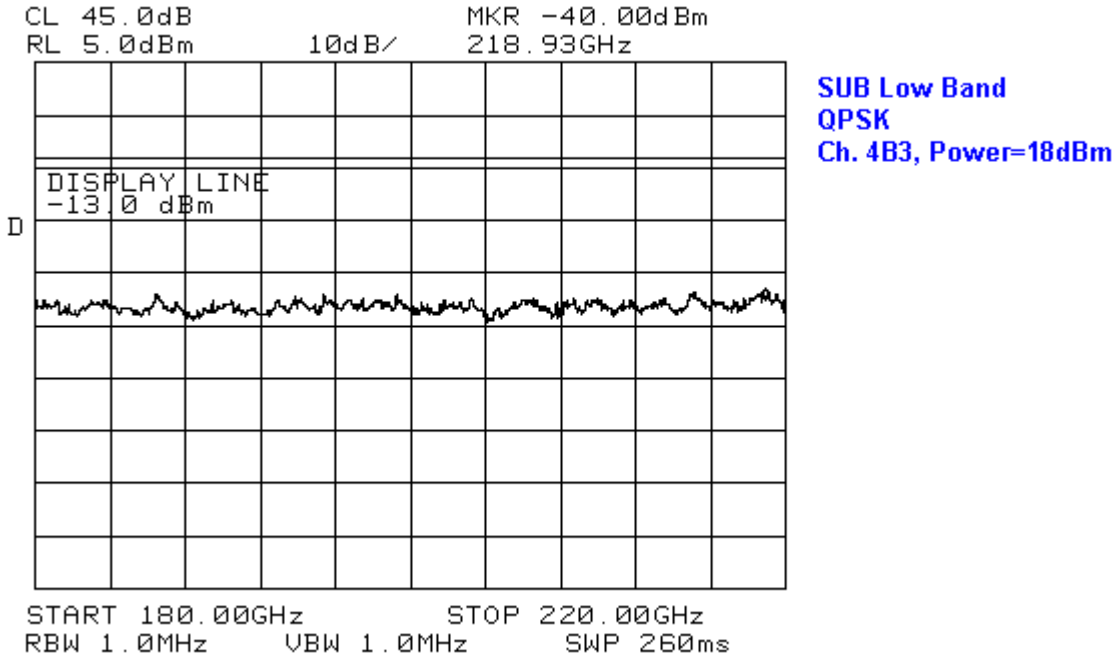



**Figure 55 Radiated Emissions in 180 – 220 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.7 Vertical Polarization, 18 – 40 GHz

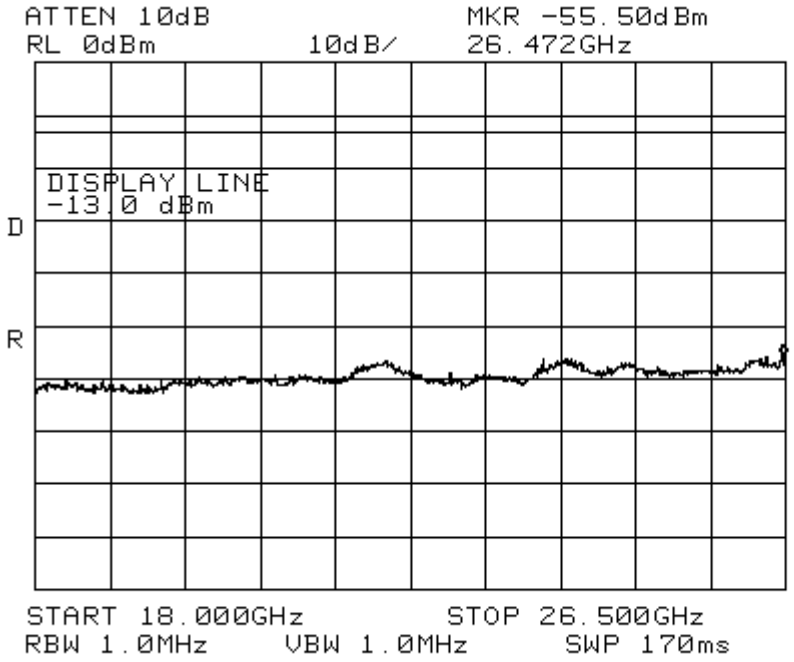



**Figure 56 Radiated Emissions in 18 – 26.5 GHz, for transmitting 18 dBm on channel 4B3**

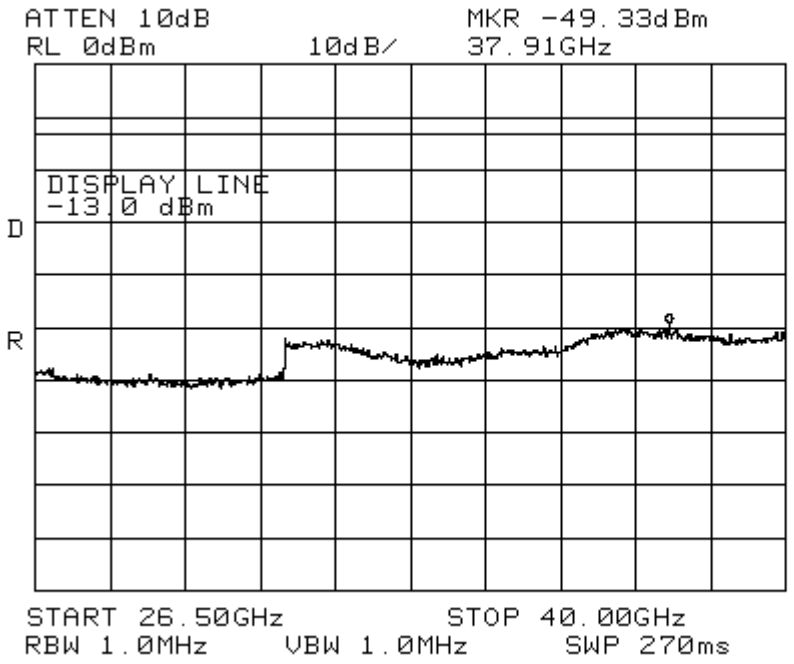



**Figure 57 Radiated Emissions in 26.5 – 40 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.8 Vertical Polarization, 40 – 60 GHz

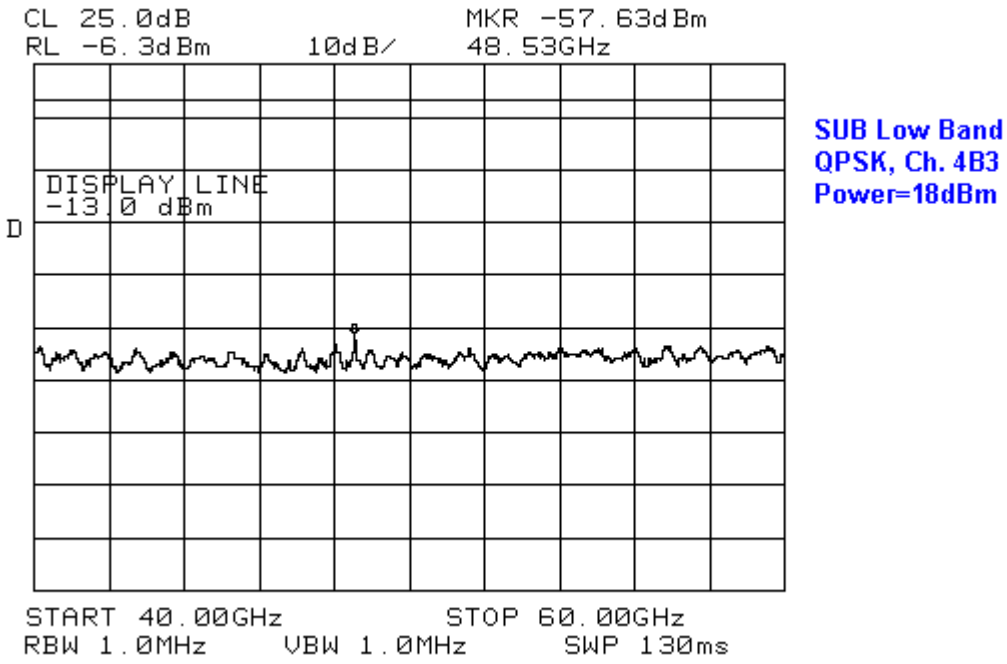



**Figure 58 Radiated Emissions in 40 – 60 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.9 Vertical Polarization, 60 – 90 GHz

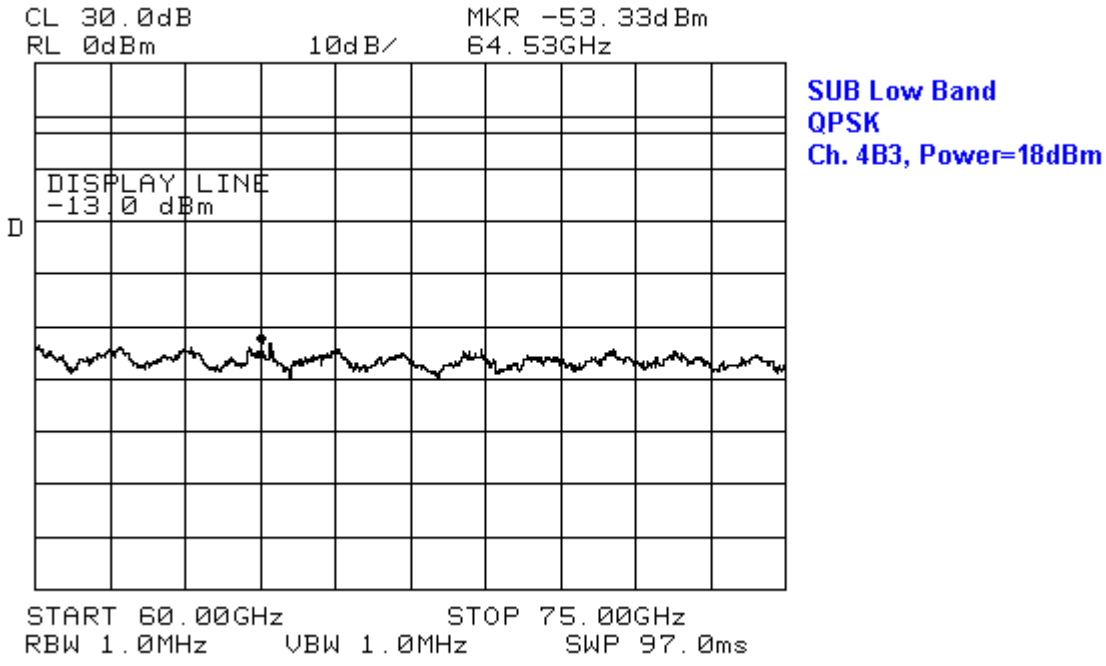



**Figure 59 Radiated Emissions in 60 – 75 GHz, for transmitting 18 dBm on channel 4B3**

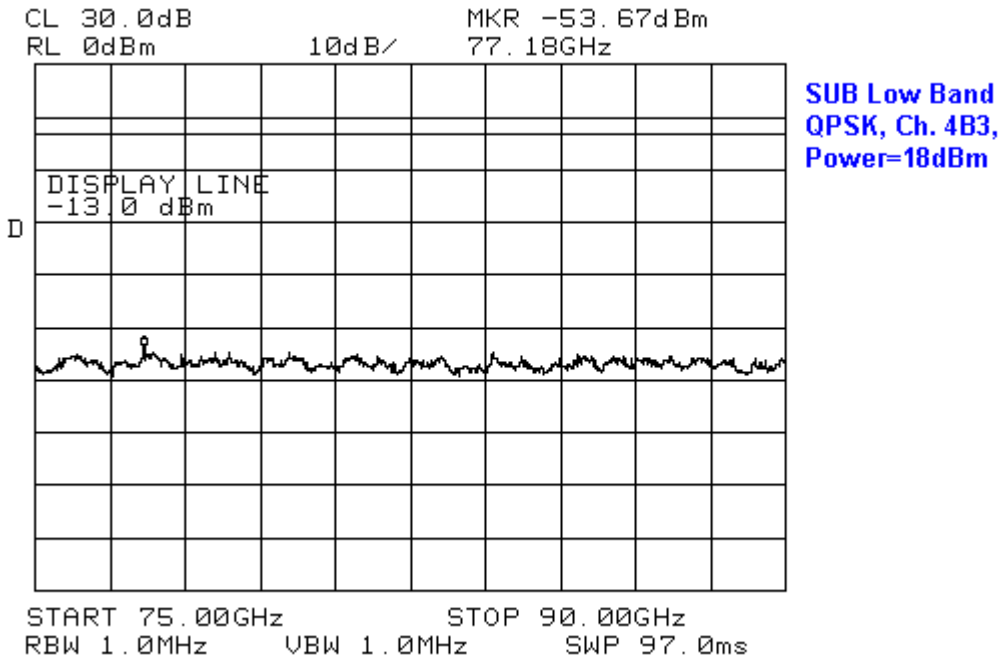



**Figure 60 Radiated Emissions in 75 – 90 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.10 Vertical Polarization, 90 – 140 GHz

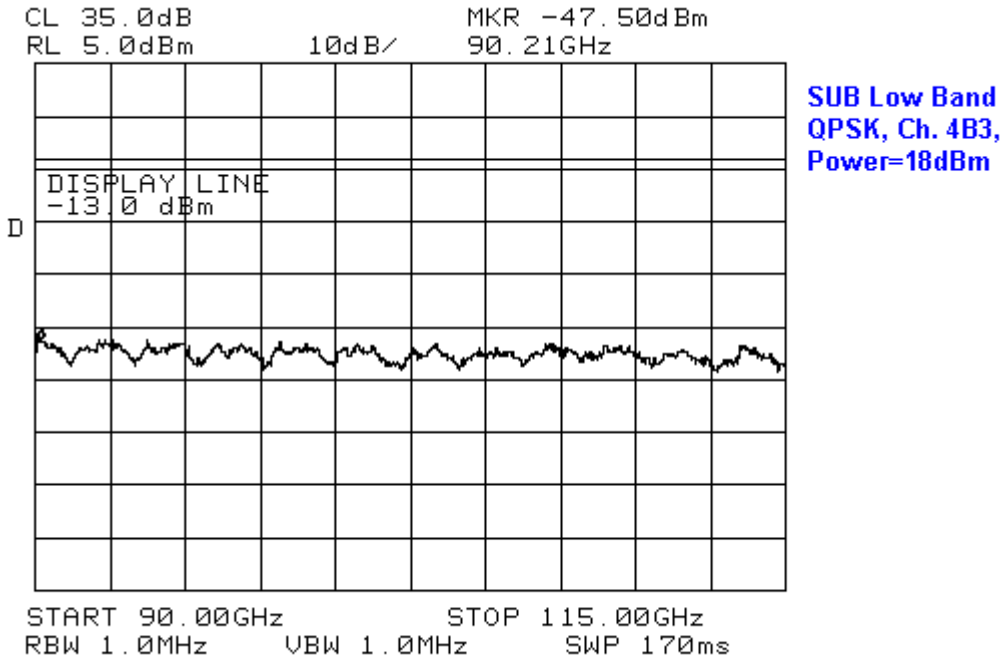



**Figure 61 Radiated Emissions in 90 – 115 GHz, for transmitting 18 dBm on channel 4B3**

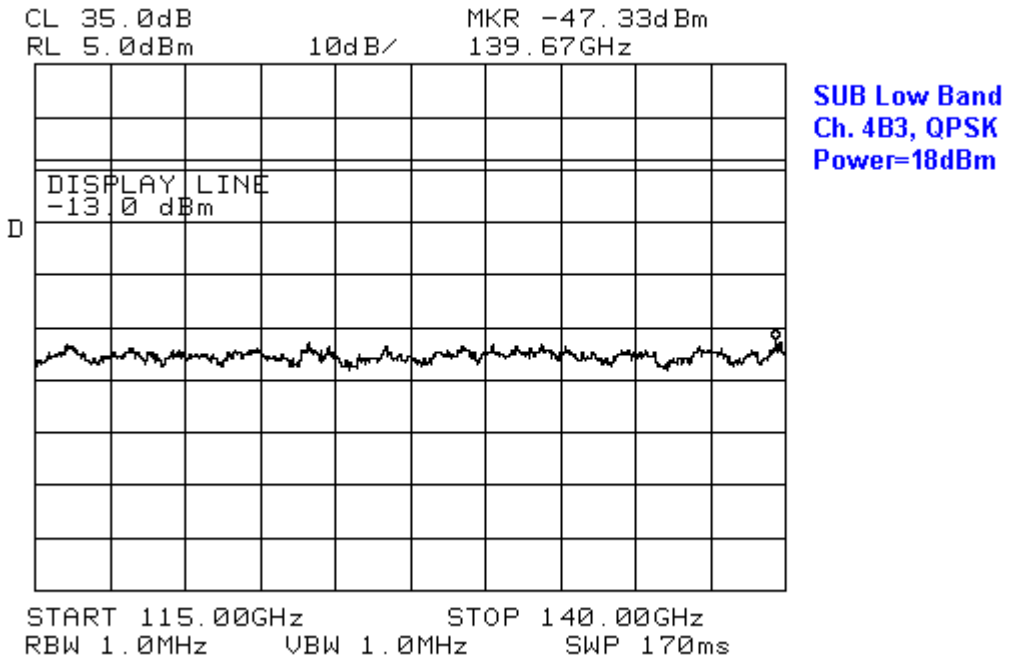



**Figure 62 Radiated Emissions in 115 – 140 GHz, for transmitting 18 dBm on channel 4B3**

### 3.4.4.11 Vertical Polarization, 140 – 220 GHz

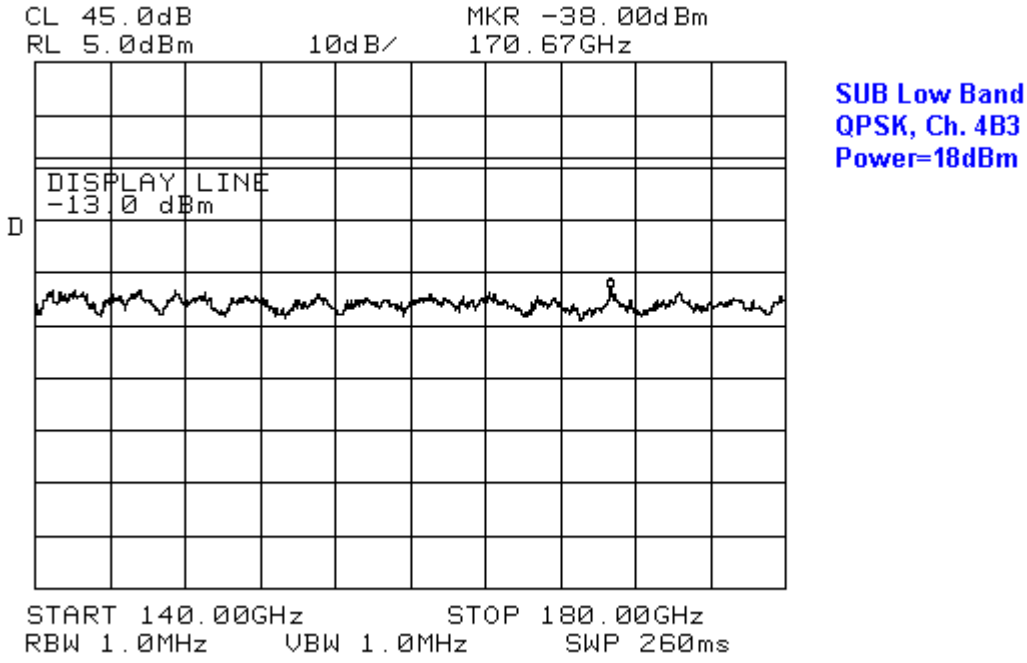



**Figure 63 Radiated Emissions in 140 – 180 GHz, for transmitting 18 dBm on channel 4B3**

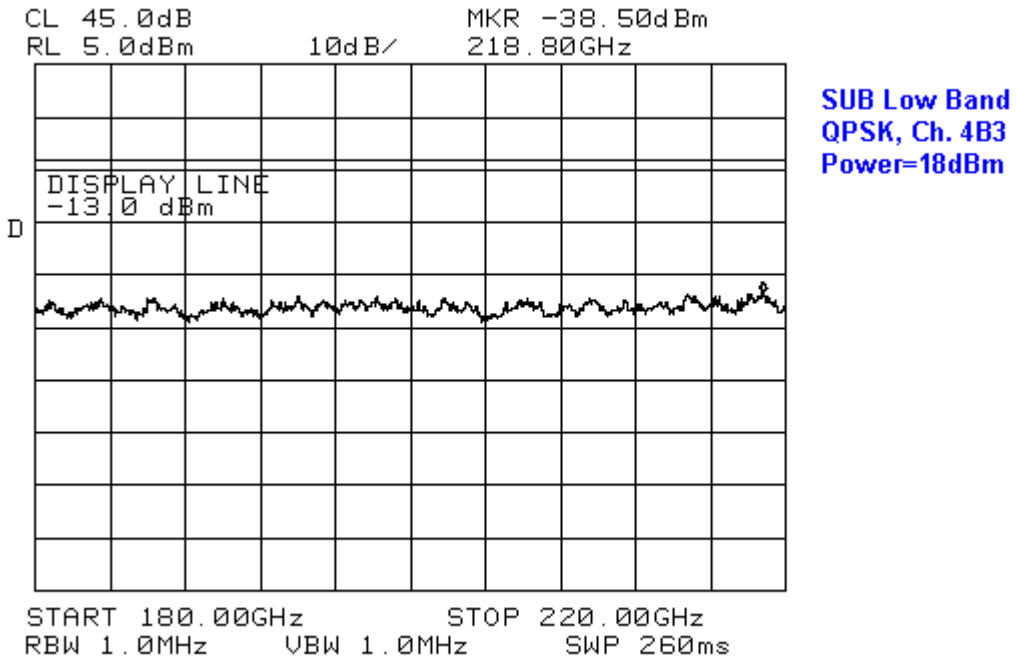



**Figure 64 Radiated Emissions in 180 – 220 GHz, for transmitting 18 dBm on channel 4B3**

## 3.5 FREQUENCY STABILITY

This test demonstrates the frequency stability of the EUT over the temperature ranges of the equipment.

### 3.5.1 Performance Specifications

**NOTE**: Equipment in the 38.6 to 40 GHz range is exempt from this requirement under 101.107

### 3.5.2 Test Results

Our Engineering department has performed frequency stability evaluation and has provided letter that is shown on the next page.

# Memo

To: John Rymkiewicz

From: Harry Johnson

CC: Jim Worley, Dan Wendling

Date: 05/07/01

Re: Point to Multipoint Frequency Tolerance

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The point to multipoint equipment frequency stability is traceable to the CCM crystal time base, which in turn is phase locked to network timing with Sonet Stratum 3 stability or better. This results in frequency stability of the RF systems to within ± 4.6 ppm.

This meets the FCC 101.107 and Frequency Tolerance requirements.