# Test Report No. 7191007525-EEC11/04
**dated 07 Jun 2011**

PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 2, 15 and 25 : 2011
OF AN
**INMARSAT BGAN LAND MOBILE SATELLITE TERMINAL**
**[ Model : SAFARI ]**
**[ FCC ID : QY9-WESAFARI ]**

| | |
|---|---|
| **TEST FACILITIES** | TÜV SÜD PSB Pte Ltd,<br>Electrical & Electronics Centre (EEC), Product Services,<br>No. 1 Science Park Drive, Singapore 118221<br><br>TÜV SÜD PSB Pte Ltd,<br>Electrical & Electronics Centre (EEC), Product Services,<br>13 Internatonal Business Park #01-01, Singapore 609932 |
| **FCC REG. NO.** | 99142 (3m and 10m Semi-Anechoic Chamber, Science Park)<br>160581 (3m and 10m Semi-Anechoic Chamber, International Business Park) |
| **IND. CANADA REG. NO.** | 2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park)<br>2932N-1 (10m Semi-Anechoic Chamber, International Business Park) |
| **PREPARED FOR** | Addvalue Communications Pte Ltd<br>28 Tai Seng Street #06-02<br>Singapore 534106<br><br>Tel : +65 6509 5700 Tel : +65 6509 5700 |
| **QUOTATION NUMBER** | 219130074 & 219129102 |
| **JOB NUMBER** | 7191007525 & 7191005878 |
| **TEST PERIOD** | 23 May 2011 – 03 Jun 2011 |

| **PREPARED BY** | **APPROVED BY** |
|---|---|
| Quek Keng Huat<br>Associate Engineer | Lim Cher Hwee<br>Assistant Vice President |

TÜV SÜD PSB

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Laboratory:
TÜV SÜD PSB Pte. Ltd.
Testing Services
No.1 Science Park Drive
Singapore 118221

Phone : +65-6885 1333
Fax : +65-6776 8670
E-mail: testing@tuv-sud-psb.sg
www.tuv-sud-psb.sg
Co. Reg : 199002667R

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
3 Science Park Drive, #04-01/05
The Franklin, Singapore 118223

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| | | |
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**TEST SUMMARY**

The product was tested in accordance with the customer's specifications.

**Test Results Summary**

| Test Standard | Description | Pass / Fail |
|---|---|---|
| 47 CFR FCC Parts 2, 15 and 25: 2011 | | |
| 15.107(a), 15.207 | Conducted Emissions | Not Applicable *See Note 3 |
| 15.109 | Radiated Emissions (Class B) | Pass |
| 2.1046(a), 25.204 | RF Output Power | Pass |
| 2.1051, 25.202(f) | Unwanted Emissions at Antenna Terminal | Pass |
| 2.1053, 25.202(f) | Radiated Spurious Emissions | Pass |
| 25.216(h)(i)(j) | Protection of Aeronautical Radio Navigation Satellite Service | Pass |
| 2.1055, 25.202(d) | Frequency Stability (Temperature Variation) | Pass |
| 2.1055, 25.202(d) | Frequency Stability (Voltage Variation) | Pass |
| 1.1310 | Maximum Permissible Exposure | Refer to page 96 for details |

**Notes**

1. Three channels as listed below, which respectively represent the lower, middle and upper channels (transmit and receive) of the Equipment Under Test (EUT) when it was configured to operate under test mode condition.

| Transmit Channel | Frequency (GHz) | Receive Channel | Frequency (GHz) |
|---|---|---|---|
| Lower Channel | 1.6266 | Lower Channel | 1.5250 |
| Middle Channel | 1.6435 | Middle Channel | 1.5421 |
| Upper Channel | 1.6604 | Upper Channel | 1.5590 |

2. The following tests were based on conducted measurement method:
   a. RF Output Power
   b. Unwanted Emissions at Antenna Terminal
   c. Frequency Stability (Temperature Variation)
   d. Frequency Stability (Voltage Variation)

3. The Equipment Under Test (EUT) is a DC operated device and contains no provision for public utility connections.

4. All test measurement procedures are according to ANSI/TIA-603-B-2002.

5. The EUT is a Class B device when in non-transmitting state and meets the FCC Part15B Class B requirements.

**TEST SUMMARY**

**Modifications**

No modifications were made.

## PRODUCT DESCRIPTION

| | | |
|---|---|---|
| Description | : | The Equipment Under Test (EUT) is an **INMARSAT BGAN LAND MOBILE SATELLITE TERMINAL**. |
| Manufacturers | : | Addvalue Communications Pte Ltd<br>28 Tai Seng Street #06-02<br>Singapore 534106 |
| Model Number | : | SAFARI |
| FCC ID | : | QY9-WESAFARI |
| Serial Number | : | Nil |
| Microprocessor | : | Refer to manufacturer |
| Operating / Transmitting Frequency | : | Satellite<br>a. Transmit: 1626.5MHz – 1660.5MHz<br>b. Receive: 1525MHz – 1559MHz<br><br>802.11b/g<br>2412MHz – 2462MHz<br><br>GPS<br>1575.42MHz |
| Clock / Oscillator Frequency | : | Baseband Board<br>32.768kHz, 12.0MHz, 16.384MHz, 25.0MHz, 39.3216MHz<br><br>RF Board<br>4MHz, 24.192MHz<br><br>Wi-Fi Board<br>25.0MHz |
| Modulation | : | Pi/4 QPSK and 16QAM (Satellite)<br>DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM (802.11b/g)<br>QPSK (GPS) |
| Antenna Gain | : | 10.0dBi (Satellite)<br>0.0dBi (802.11b/g) |
| Port / Connectors | : | 2 x RJ45 Ethernet port<br>1 x primary handset connector<br>1 x GPS output connector<br>1 x Antenna connector<br>2 x RJ11 port<br>1 x DC input port<br>1 x ground stud connector<br>1 x GPIO signal port connector |

## PRODUCT DESCRIPTION

| | | |
|---|---|---|
| Rated Input Power | : | 12VDC to 31.2VDC |
| Accessories | : | Primary Handset<br>BGAN-X Class 11 Antenna |

## SUPPORTING DESCRIPTION DESCRIPTION

| Equipment Description (Including Brand Name) | Model, Serial & FCC ID Number | Cable Description (List Length, Type & Purpose) |
|---|---|---|
| Antenna ADU | M/N: AS BGAN FB250<br>S/N: 10080008<br>FCC ID: Nil | Nil |
| Globe i250 Phone | M/N: Globe i250<br>S/N: EH250SM09520018<br>FCC ID: Nil | 3.2m RJ11 cable |

## EUT OPERATING CONDITIONS

| **47 CFR FCC Parts 2, 15 and 25** |
|---|
| **1. RF Output Power**<br>**2. Unwanted Emissions at Antenna Terminal**<br>**3. Radiated Spurious Emissions**<br>**4. Protection of Aeronautical Radio Navigation Satellite Service**<br>**5. Frequency Stability (Temperature Variation)**<br>**6. Frequency Stability (Voltage Variation)**<br>**7. Maximum Permissible Exposure** |
| The EUT was exercised by operating in following modes with the EUT simulating the transmission and reception using the client's provided test programs, "3CDaemon" and "UT Console_Serial".<br><br>Satellite Transmission Mode<br>- Continuous RF transmission at lower channel at maximum RF power<br>- Continuous maximum RF transmission at middle channel at maximum RF power<br>- Continuous maximum RF transmission at upper channel at maximum RF power<br><br>Satellite Reception (Receive) Mode<br>- Continuous RF reception at lower channel<br>- Continuous RF reception at middle channel<br>- Continuous RF reception at upper channel<br><br>GPS Reception (Receive) Mode<br>- Continuous GPS signal reception<br><br>8021.11b/g Transmission Mode<br>- Continuous 802.11b/g transmit / receive signal |

**47 CFR FCC Part 15.109 Radiated Emission Limits (Class B)**

| Frequency Range (MHz) | Quasi-Peak Limit Values (dBµV/m) @ 3m |
|---|---|
| 30 - 88 | 40.0 |
| 88 - 216 | 43.5 |
| 216 - 960 | 46.0 |
| Above 960 | 54.0* |
| * Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply. | |

**47 CFR FCC Part 15.109 Radiated Emission Test Instrumentation**

| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| Rohde & Schwarz EMI Test Receiver (20Hz – 26.5GHz) | ESMI | 829179/002<br>829179/005 | 28 Jul 2011 |
| TDK RF Solutions Hybrid Log Periodic Antenna (30MHz-3GHz) | HLP-3003C | 130238 | 19 Mar 2012 |
| Sonoma Preamplifier (9kHz – 1GHz) | 310N | 270640 | 13 Sep 2011 |
| TDK RF Solution Horn Antenna (1GHz-18GHz) | HRN-0118 | 130256 | 15 Mar 2012 |
| Schwarzbeck Horn Antenna (2-18GHz) / Pre-amplifier assembly HAP-series | BBHA 9120 C/ HAP06-18W | 00000004 | 25 Mar 2012 |
| Sonoma Preamplifier (9kHz – 1GHz) | 310N | 270640 | 13 Sep 2011 |
| Toyo MicroWave Preamplifier (1GHz - 8GHz) | TPA0108-40 | 0443 | 02 Feb 2012 |
| ETS Horn Antenna (18GHz – 40GHz) | 3116 | 0004-2474 | 19 Apr 2012 |
| Micro-Tronics Bandstop Filter (2.4-2.5 GHz) | BRM50701 | 017 | 13 Aug 2011 |

## 47 CFR FCC Part 15.109 Radiated Emission Test Setup

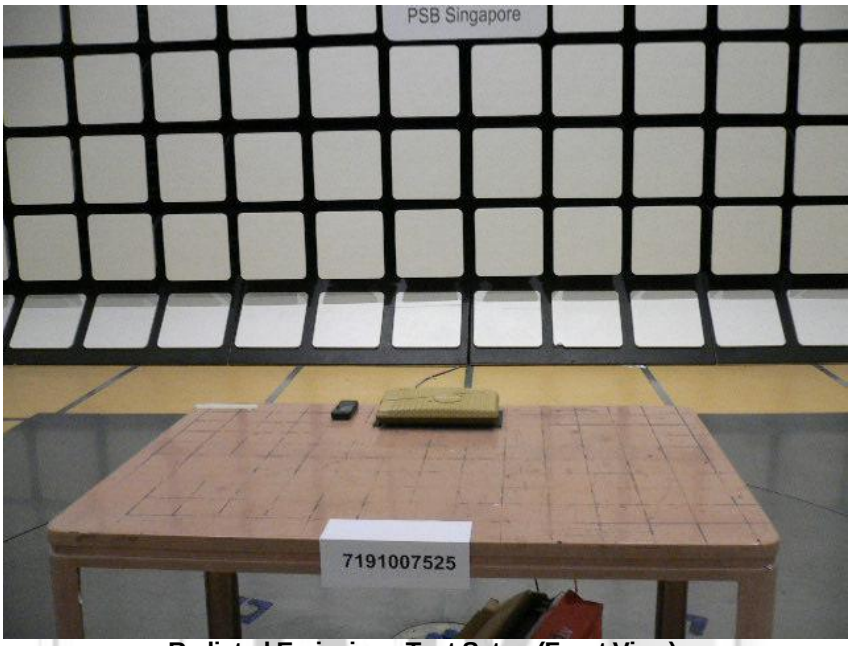
1. The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

## 47 CFR FCC Part 15.109 Radiated Emission Test Method

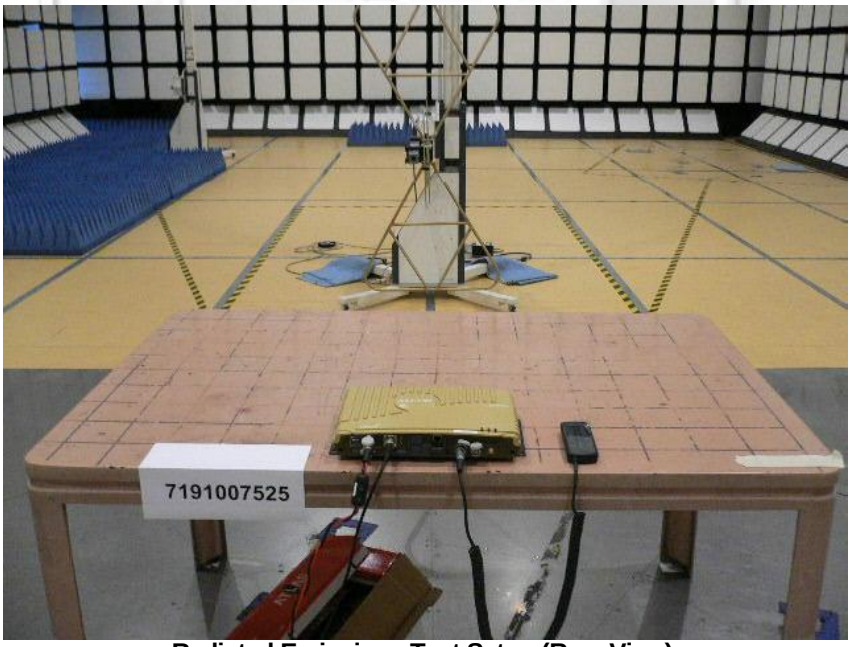
1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from 30MHz to 5$^{th}$ harmonic of the highest frequency used or generated by the EUT, using the Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

**Sample Calculation Example**

| | |
|---|---|
| At 300 MHz | Q-P limit (Class B) = 70.8 μV/m = 37.0 dBμV/m |
| Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB | |
| Q-P reading obtained directly from EMI Receiver = 31.0 dBμV/m (Calibrated level including antenna factors & cable losses) | |
| Therefore, Q-P margin = 31.0 - 37.0 = -6.0 | i.e. 6 dB below Q-P limit |




**Radiated Emissions Test Setup (Front View)**




**Radiated Emissions Test Setup (Rear View)**

## 47 CFR FCC Part 15.109 Radiated Emission Results

| | | | |
|---|---|---|---|
| Operating Mode | GPS | Temperature | 22°C |
| Test Input Power | 24VDC (Worst Voltage) | Relative Humidity | 51% |
| Test Distance | 3m | Atmospheric Pressure | 1025mbar |
| | | Tested By | Derrick Ng |

Spurious Emissions ranging from 30MHz – 1GHz

| Frequency (MHz) | Q-P Value (dBµV/m) | Q-P Margin (dB) | Azimuth (Degrees) | Height (cm) | Polarisation (H/V) |
|---|---|---|---|---|---|
| 42.2310 | 22.4 | -17.6 | 63 | 105 | V |
| 246.6230 | 26.9 | -19.1 | 291 | 100 | H |
| 247.7110 | 27.3 | -18.7 | 83 | 101 | H |
| 311.3020 | 25.0 | -21.1 | 290 | 102 | H |
| 328.2640 | 29.8 | -16.2 | 294 | 101 | H |
| 863.8770 | 27.8 | -18.2 | 68 | 115 | V |

Spurious Emissions above 1GHz

| Frequency (GHz) | Peak Value (dBµV/m) | Peak Margin (dB) | Average Value (dBµV/m) | Average Margin (dB) | Azimuth (Degrees) | Height (cm) | Pol (H/V) |
|---|---|---|---|---|---|---|---|
| -- | -- | - | -- | -- | -- | -- | -- |
| -- | -- | - | -- | -- | -- | -- | -- |
| -- | -- | - | -- | -- | -- | -- | -- |
| -- | -- | - | -- | -- | -- | -- | -- |
| -- | -- | - | -- | -- | -- | -- | -- |
| -- | -- | - | -- | -- | -- | -- | -- |

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
4. "--" indicates no emissions were found and shows compliance to the limits.
5. Radiated Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 25.0GHz is ±4.6dB.

**47 CFR FCC Part 15.109 Radiated Emission Results**

| | | | |
|---|---|---|---|
| Operating Mode | GPS + 802.11b/g + Satellite | Temperature | 22°C |
| Test Input Power | 24VDC (Worst Voltage) | Relative Humidity | 51% |
| Test Distance | 3m | Atmospheric Pressure | 1025mbar |
| | | Tested By | Derrick Ng |

Spurious Emissions ranging from 30MHz – 1GHz

| Frequency (MHz) | Q-P Value (dBµV/m) | Q-P Margin (dB) | Azimuth (Degrees) | Height (cm) | Polarisation (H/V) |
|---|---|---|---|---|---|
| 52.1390 | 24.9 | -15.1 | 1 | 113 | V |
| 67.5660 | 34.4 | -5.6 | 109 | 112 | V |
| 275.9910 | 27.0 | -19.0 | 124 | 106 | H |
| 327.6640 | 32.0 | -14.1 | 294 | 102 | H |
| 368.0180 | 32.1 | -13.9 | 108 | 102 | H |
| 863.8770 | 23.6 | -22.5 | 86 | 102 | H |

Spurious Emissions above 1GHz

| Frequency (GHz) | Peak Value (dBµV/m) | Peak Margin (dB) | Average Value (dBµV/m) | Average Margin (dB) | Azimuth (Degrees) | Height (cm) | Pol (H/V) |
|---|---|---|---|---|---|---|---|
| 1643.6670 | 44.2 | -29.8 | 44.2 | -9.8 | 56 | 116 | V |
| 3337.6350 | 27.2 | -46.8 | 27.1 | -26.9 | 210 | 272 | V |
| 3814.0120 | 28.8 | -45.2 | 28.7 | -25.3 | 206 | 199 | V |
| 4791.7680 | 32.6 | -41.4 | 32.5 | -21.5 | 278 | 235 | V |
| 4996.1670 | 34.5 | -39.5 | 34.4 | -19.6 | 95 | 194 | V |
| 5259.1120 | 33.9 | -40.1 | 34.0 | -20.0 | 359 | 119 | V |

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
4. Radiated Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 25.0GHz is ±4.6dB.

## 47 CFR FCC Parts 2.1046 and 25.204 RF Output Power Test Limits

1. 25.204 Power Limits
   (a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1GHz and 5GHz, shall not exceed the following limits except as provided for in paragraph (c) of this section:

   +40dBW in any 4kHz band for $\theta$: $0^O$

   +40dBW + 3.$\theta$dBW in any 4kHz band for $0^O < \theta \leq 5^O$

   where $\theta$ is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

   (c) For angles of evaluation of the horizon greater than $5^O$ there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

   (d) Notwithstanding the e.i.r.p and e.i.r.p density limits specified in the station authorization, each earth station transmission shall be conducted at the lowest power level that will provide the required signal quality as indicated in the application and further amended by coordination agreements.

2. 2.1046 Measurements Required: RF Power Output
   (a) For transmission other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

   (c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

## 47 CFR FCC Parts 2.1046 and 25.204 RF Output Power Test Instrumentation

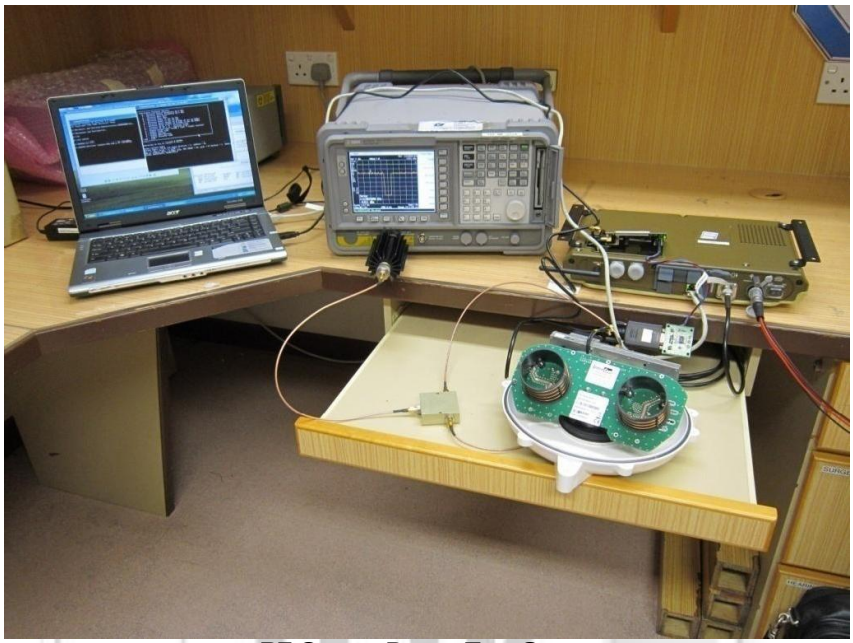
| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| Agilent Spectrum Analyzer | E7405A | MY45106084 | 11 Jan 2012 |
| Bird 20dB Attenuator | 25-A-MFN-20 | 0209 | 25 May 2012 |

## 47 CFR FCC Parts 2.1046 and 25.204 RF Output Power Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the Universal Radio Communication Tester, which set into power analyser mode via a RF attenuator and a low-loss coaxial cable.
4. The spectrum analyser was then calibrated to the power meter level as shown by the Universal Radio Communicator Tester with a calibrated RF signal source.
5. All other supporting equipment were powered separately from another filtered mains.

## 47 CFR FCC Parts 2.1046 and 25.204 RF Output Power Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, transmitting frequency at lower channel.
2. The maximum peak power of the transmitting frequency was measured and recorded.
3. The RF carrier peak and average pots were plotted.
4. The steps 2 to 4 were repeated with the transmitting frequency was set to middle and upper channels respectively.



**RF Output Power Test Setup**

**47 CFR FCC Parts 2.1046 and 25.204 RF Output Power Results**

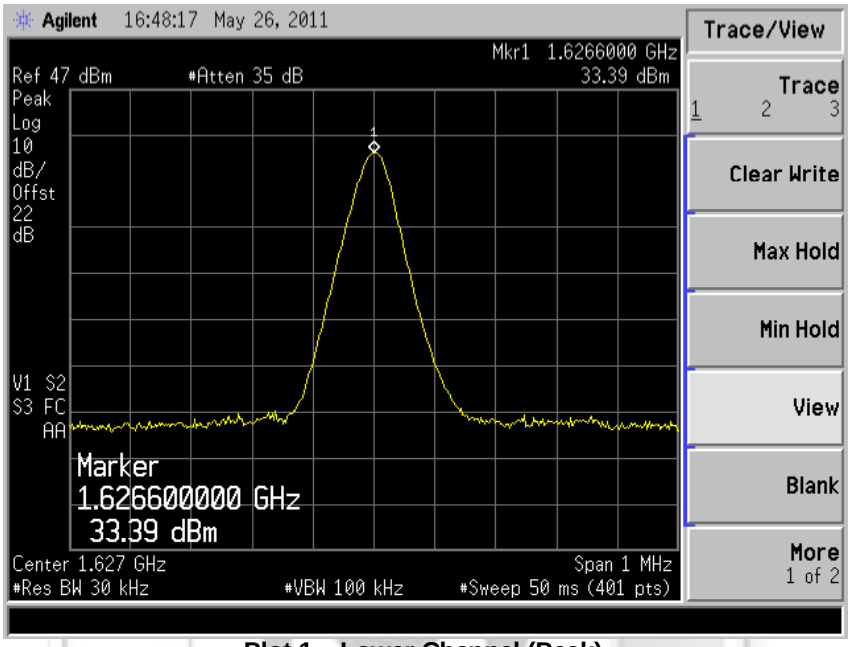
| | | | |
|---|---|---|---|
| Operating Mode | Satellite Transmission (CW) | Temperature | 24°C |
| Test Input Power | 24VDC | Relative Humidity | 54% |
| Antenna Gain | 10.0dBi | Atmospheric Pressure | 1027mbar |
| Attached Plots | 1 - 6 | Tested By | Foo Kai Maun |

| Frequency (GHz) | Channel | Peak Output Power (dBm) | | Average Output Power (dBm) | |
|---|---|---|---|---|---|
| | | EIRP | ERP | EIRP | ERP |
| 1.6266 | Lower | 43.39 | 33.39 | 43.39 | 33.39 |
| 1.6435 | Middle | 42.26 | 32.26 | 42.26 | 32.26 |
| 1.6604 | Upper | 43.60 | 33.60 | 43.60 | 33.60 |

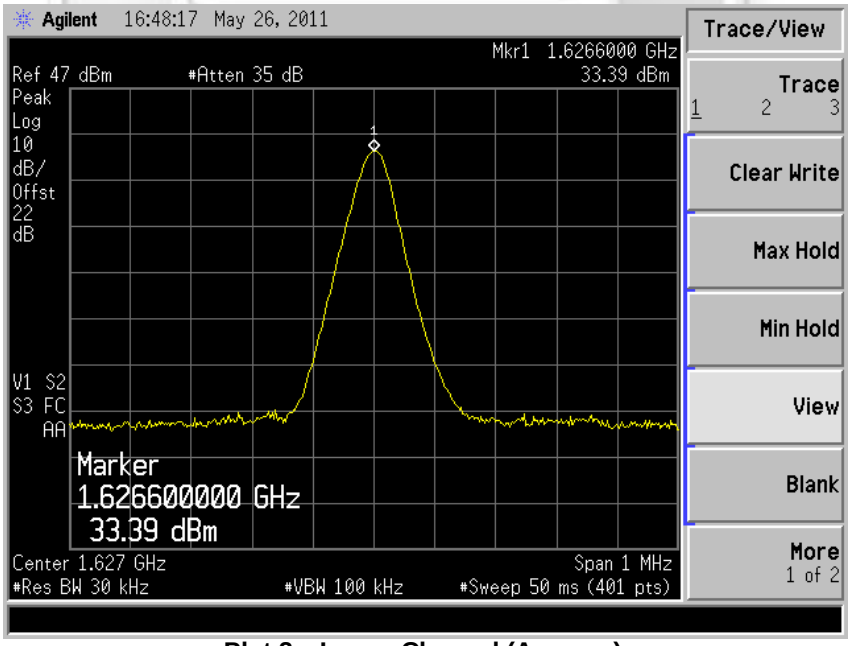
Notes

1. RF Output Power Measurement Uncertainty
All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of 95%, with a coverage factor of 2 is ±1.0dB.

**Output Power Plots**

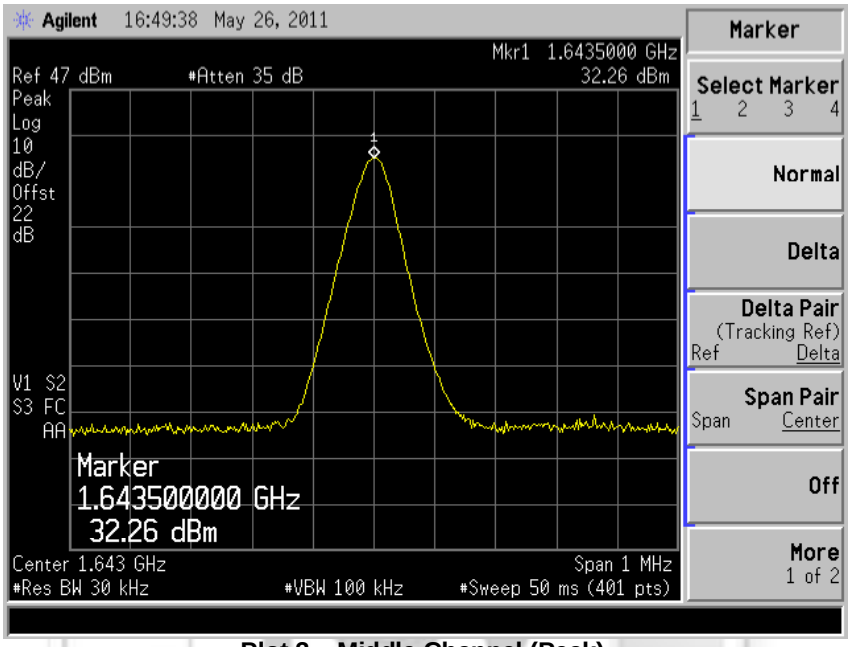



**Plot 1 – Lower Channel (Peak)**

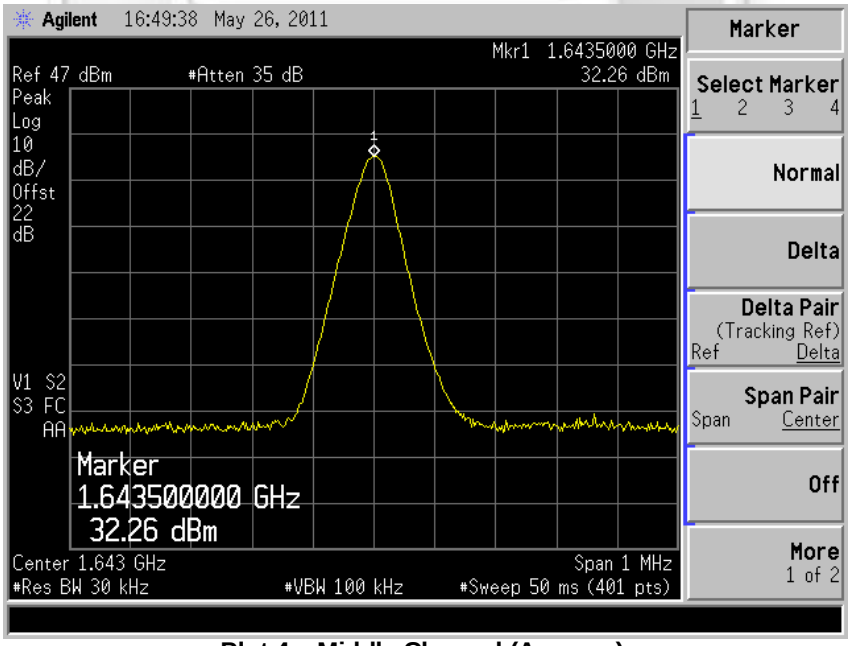



**Plot 2 – Lower Channel (Average)**

**Output Power Plots**

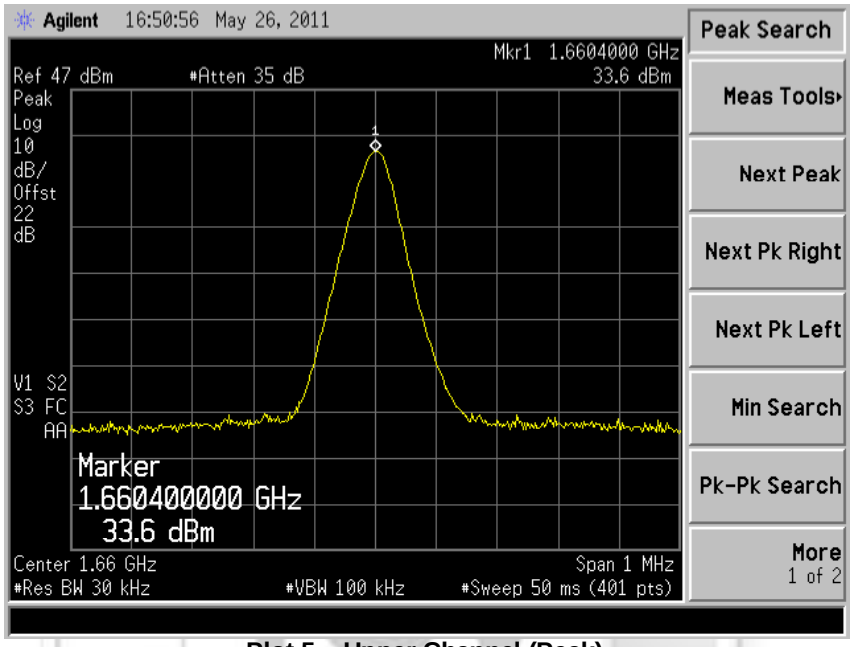



**Plot 3 – Middle Channel (Peak)**

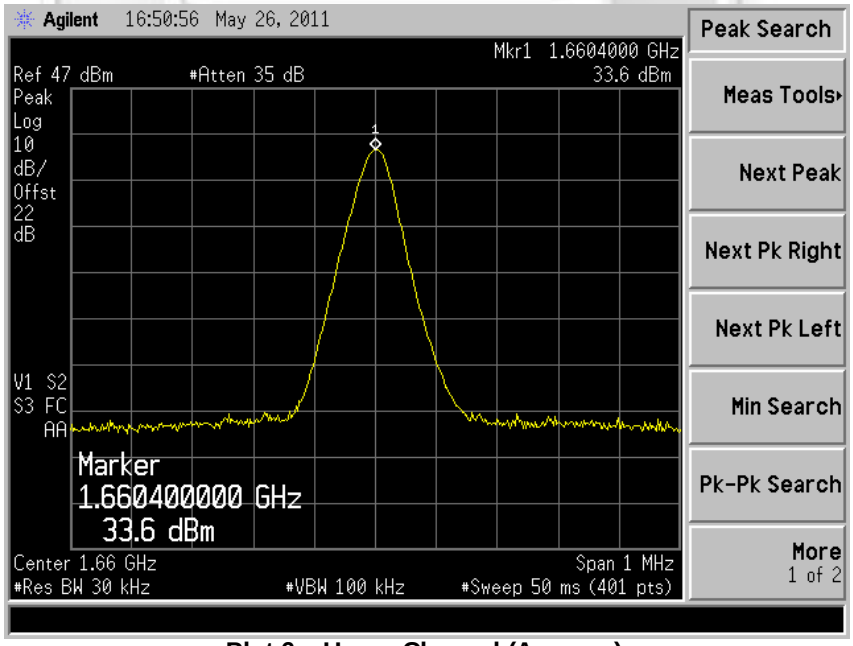



**Plot 4 – Middle Channel (Average)**

**Output Power Plots**




**Plot 5 – Upper Channel (Peak)**




**Plot 6 – Upper Channel (Average)**

## UNWANTED EMISSIONS AT ANTENNA TERMINAL TEST

**47 CFR FCC Parts 2.1051 and 25.202(f) Unwanted Emissions at Antenna Terminal Test Limits**

1. 25.202 Emissions Limitations
   (f) The mean power of the emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:
   (1) In any 4kHz band, the center frequency of which is removed from the assigned frequency by more than 50% up to and including 100% of the authorized bandwidth: 25 decibels;
   (2) In any 4kHz band, the center frequency of which is removed from the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth: 35 decibels;
   (3) In any 4kHz band, the center frequency of which is removed from the assigned frequency by more than 250% of the authorized bandwidth: an amount equal to 43 decibels plus 10 times logarithm (to the base 10) of the transmitter power in watts.

2. 2.1051 Measurements Required: Spurious Emissions at Antenna Terminals
   The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20dB below the permissible value needed not be specified.

**47 CFR FCC Parts 2.1051 and 25.202(f) Unwanted Emissions at Antenna Terminal Test Instrumentation**

| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| Agilent Spectrum Analyzer | E7405A | MY45106084 | 11 Jan 2012 |
| Bird 20dB Attenuator | 25-A-MFN-20 | 0209 | 25 May 2012 |

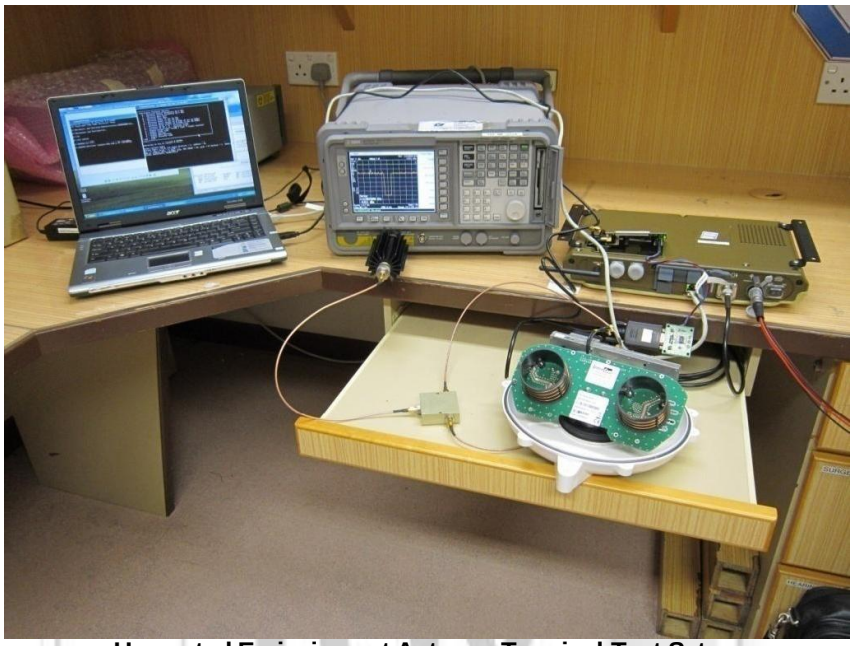
## UNWANTED EMISSIONS AT ANTENNA TERMINAL TEST

**47 CFR FCC Parts 2.1051 and 25.202(f) Unwanted Emissions at Antenna Terminal Test Setup**

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a RF attenuator and a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another filtered mains.

**47 CFR FCC Parts 2.1051 and 25.202(f) Unwanted Emissions at Antenna Terminal Test Method**

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, transmitting frequency at lower channel.
2. The 26dB bandwidth of the transmitting channel was measured.
3. The emission mask was drawn based on the authorized bandwidth and the measured average output power.
4. The transmitting channel emissions were plotted.
5. The steps 2 to 5 were repeated with the transmitting frequency was set to middle and upper channels respectively.



**Unwanted Emissions at Antenna Terminal Test Setup**

## UNWANTED EMISSIONS AT ANTENNA TERMINAL TEST

**47 CFR FCC Parts 25.254(d)(6) and 2.1049 Occupied Bandwidth Results**

| | | | |
|---|---|---|---|
| Operating Mode | Satellite Transmission | Temperature | 24°C |
| Test Input Power | 24VDC | Relative Humidity | 54% |
| Antenna Gain | 10.0dBi | Atmospheric Pressure | 1027mbar |
| Attached Plots | 7 – 27 (26dB Bandwidth)<br>28 – 48 (In Band Emissions)<br>49 – 90 (Out of Band Spurious) | Tested By | Foo Kai Maun |

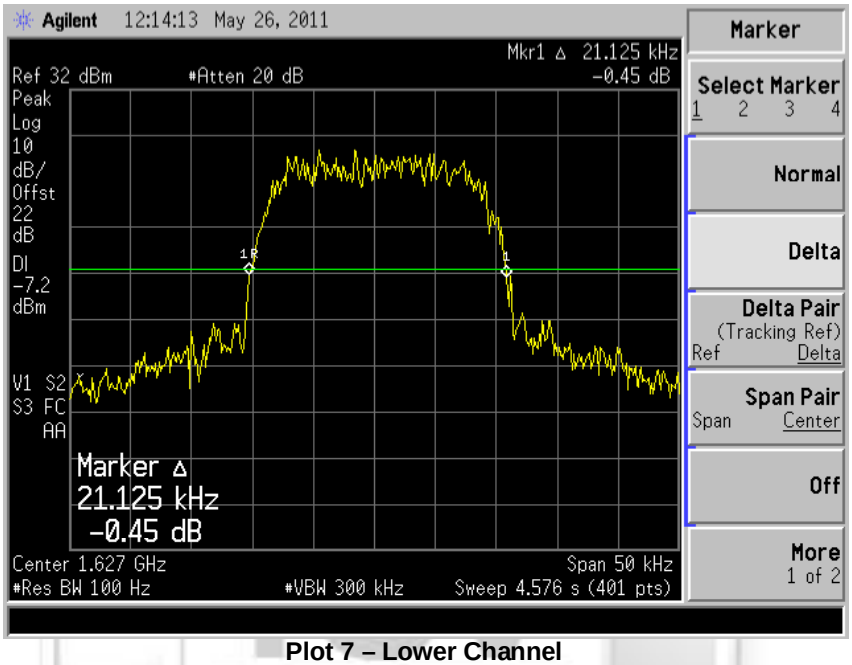
All emissions are within the emission mask. Please refer to the attached plots.

Notes

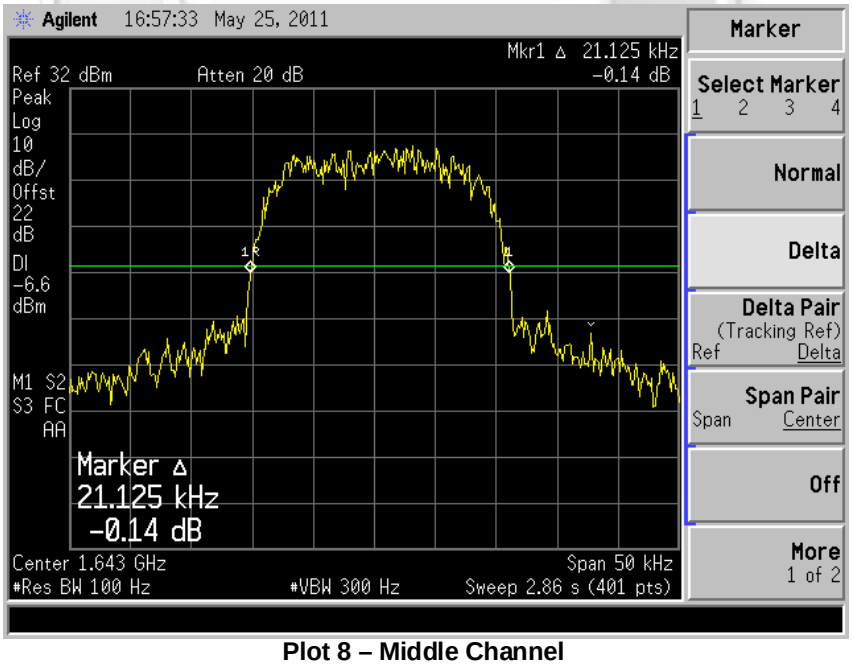
1. The Resolution Bandwidth (RBW) was corrected from 4kHz by $10\log_{10}$ [(used RBW) / 4kHz].
2. Emission limits are computed based on following:
   a. Emissions Limits (dBm) (50% - 100% authorised bandwidth) = P - 25 + CF
   b. Emissions Limits (dBm) (100% - 250% authorised bandwidth) = P - 35 + CF
   c. Emissions Limits (dBm) (> 250% authorised bandwidth) = $P - [43 + 10 \log_{10} P_W] + 30 + CF$

   where P = Measured mean power in dBm
   $P_W$ = Meausred mean power in W
   CF = RBW correction factor (see Note 1)

**26dB Bandwidth Plots (Bearer Type: 0)**

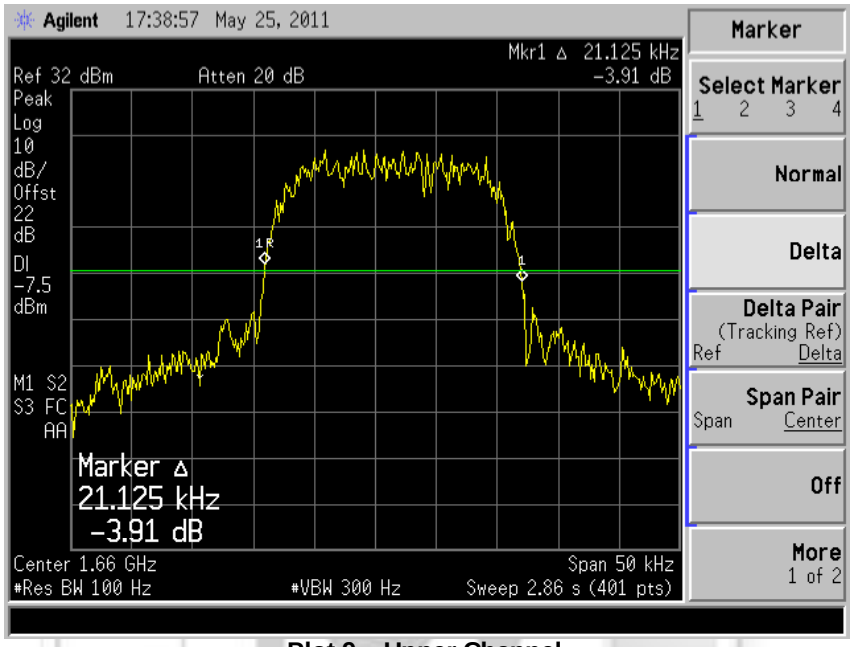



**Plot 7 – Lower Channel**



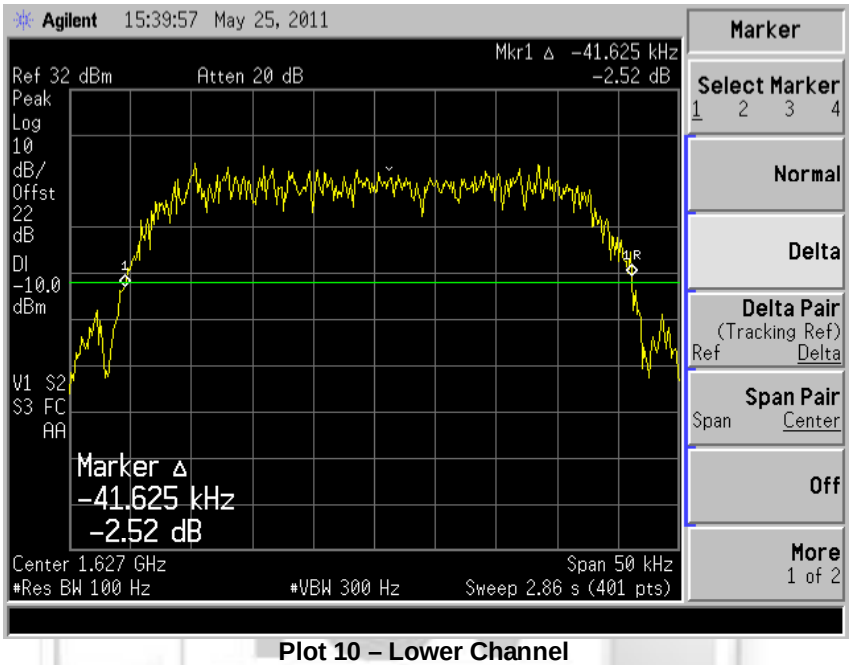

**Plot 8 – Middle Channel**

**26dB Bandwidth Plots (Bearer Type: 0)**

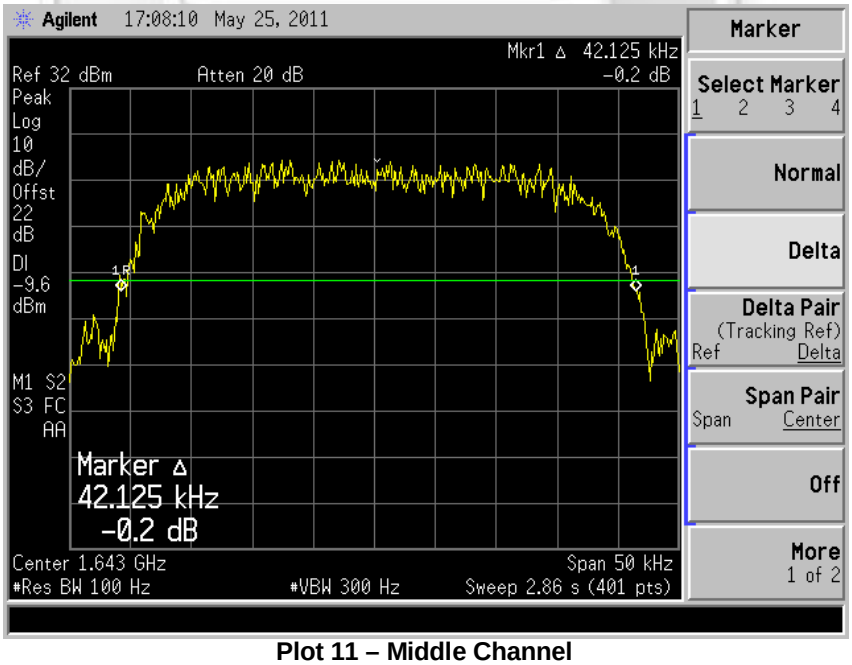



**Plot 9 – Upper Channel**

**26dB Bandwidth Plots (Bearer Type: 3)**

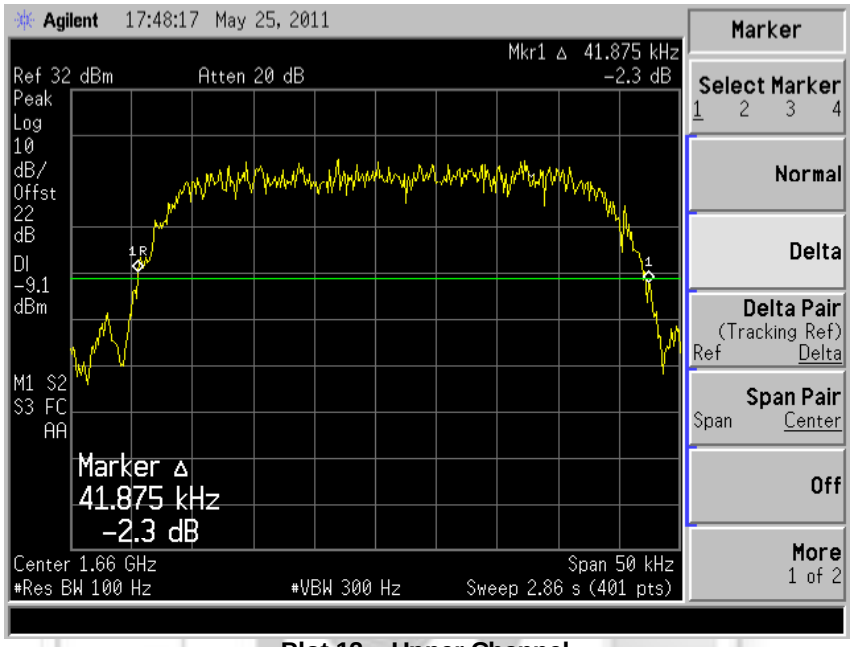



**Plot 10 – Lower Channel**



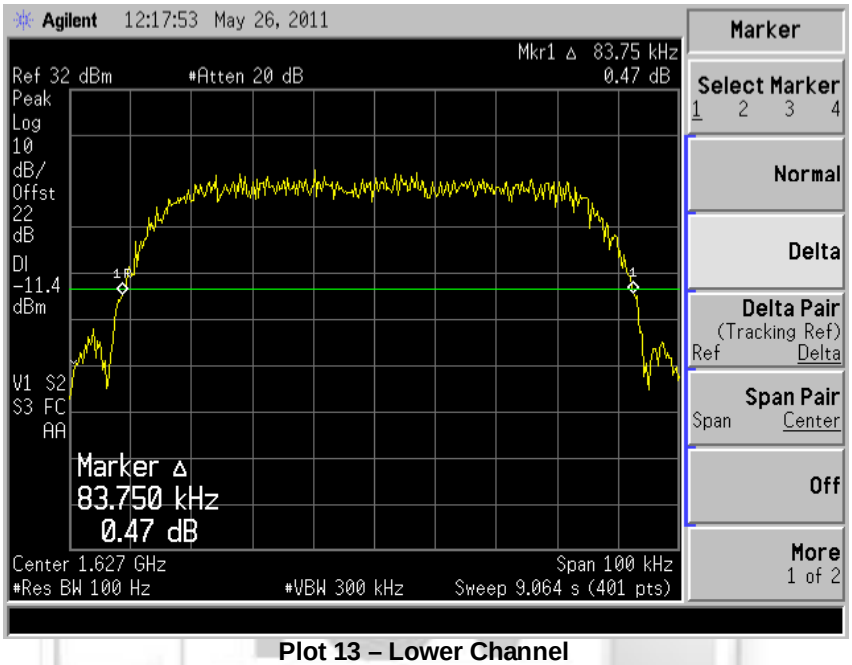

**Plot 11 – Middle Channel**

**26dB Bandwidth Plots (Bearer Type: 3)**

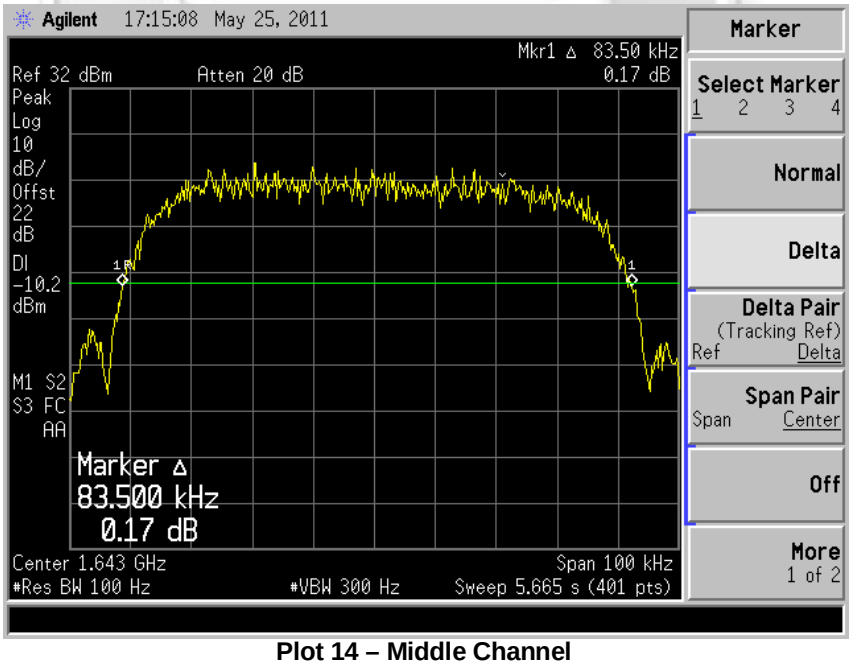



**Plot 12 – Upper Channel**

**26dB Bandwidth Plots (Bearer Type: 5)**

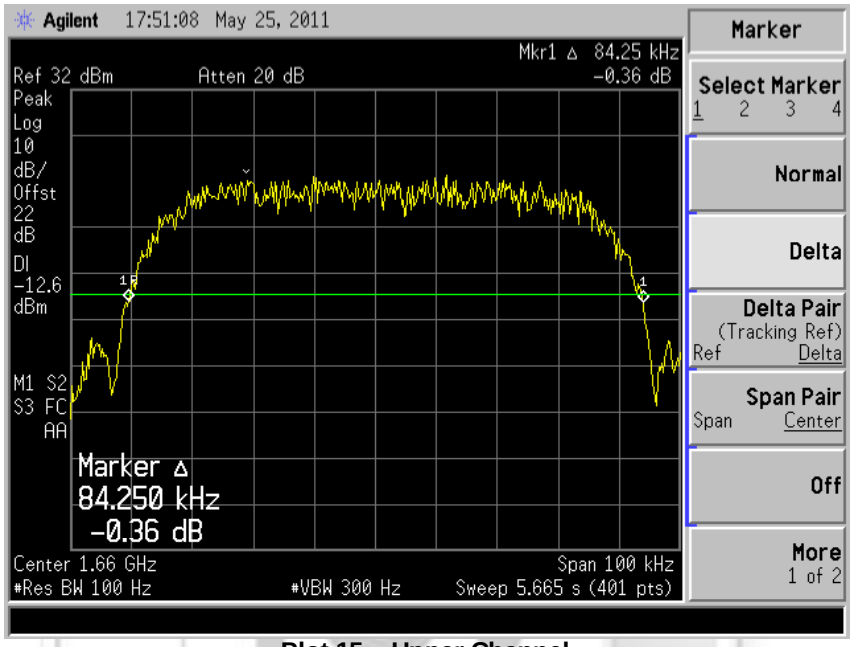



**Plot 13 – Lower Channel**



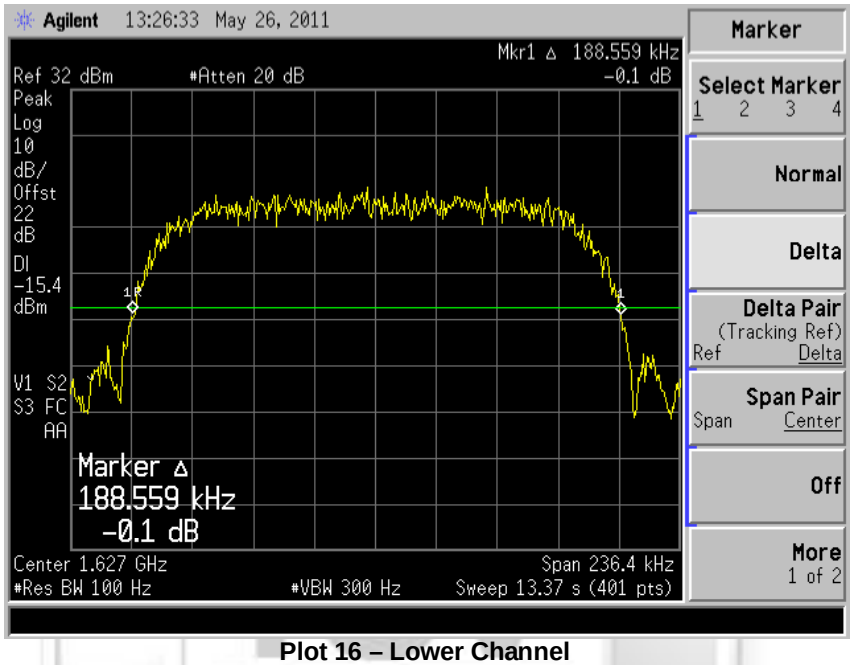

**Plot 14 – Middle Channel**

**26dB Bandwidth Plots (Bearer Type: 5)**

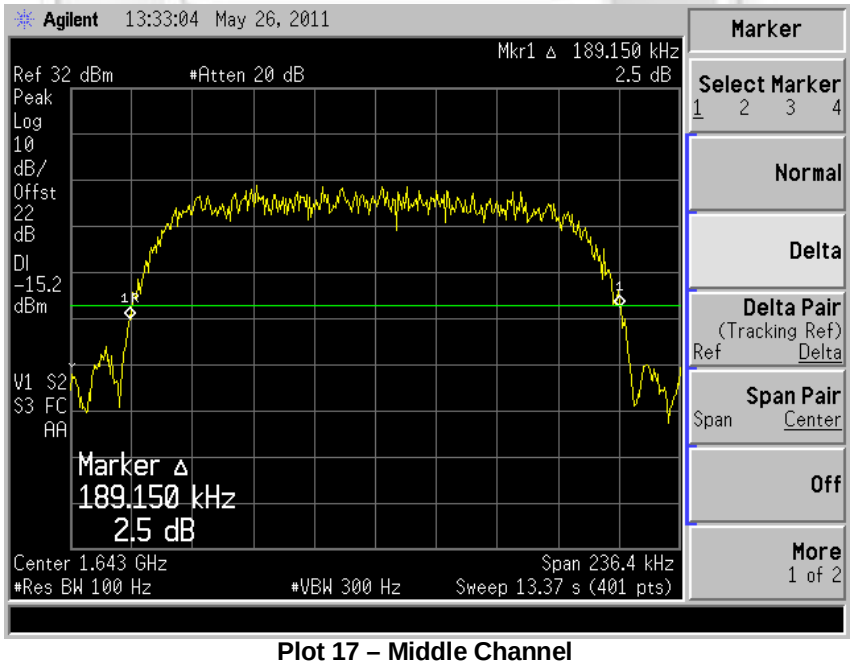



**Plot 15 – Upper Channel**

**26dB Bandwidth Plots (Bearer Type: 7)**

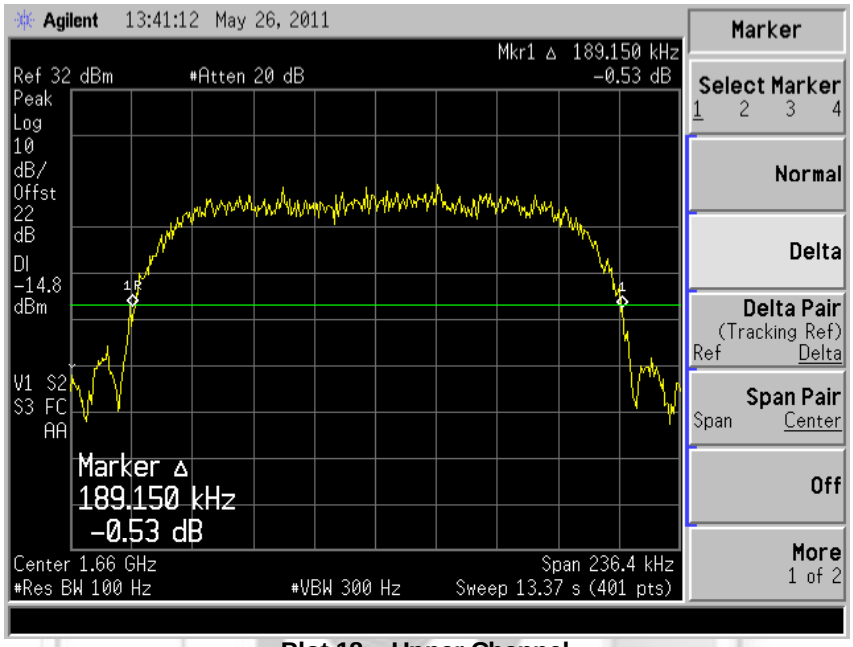



**Plot 16 – Lower Channel**



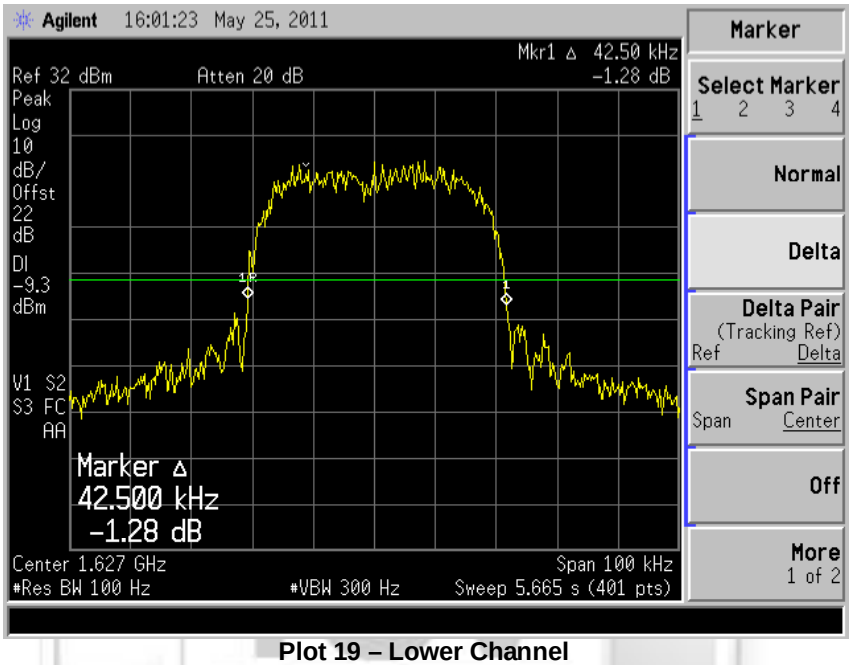

**Plot 17 – Middle Channel**

**26dB Bandwidth Plots (Bearer Type: 7)**

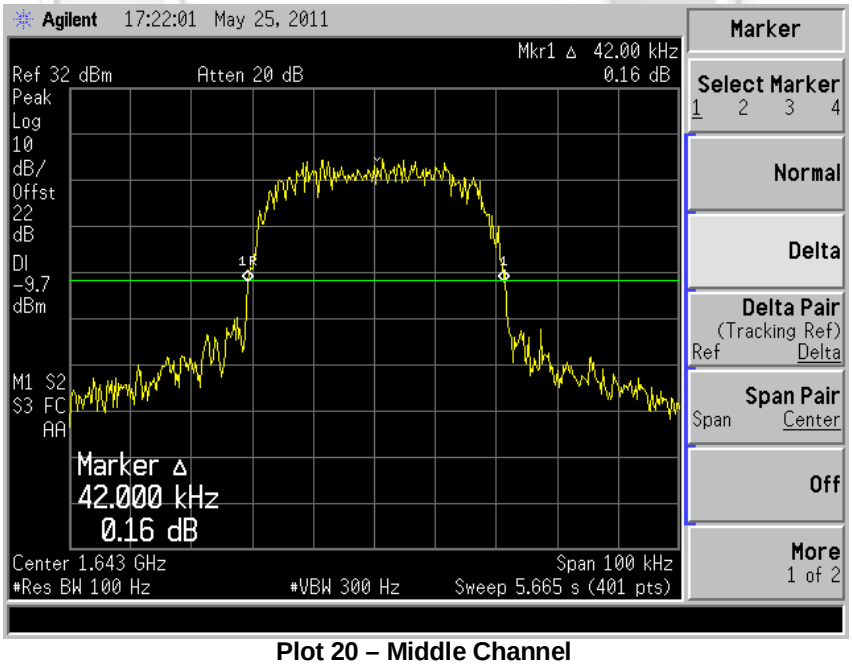



**Plot 18 – Upper Channel**

**26dB Bandwidth Plots (Bearer Type: 11)**

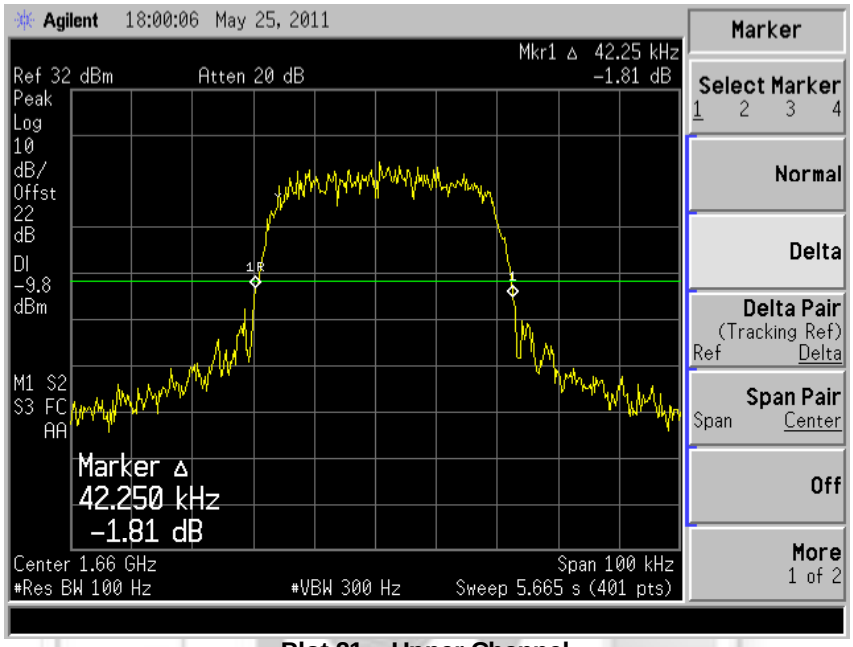



**Plot 19 – Lower Channel**



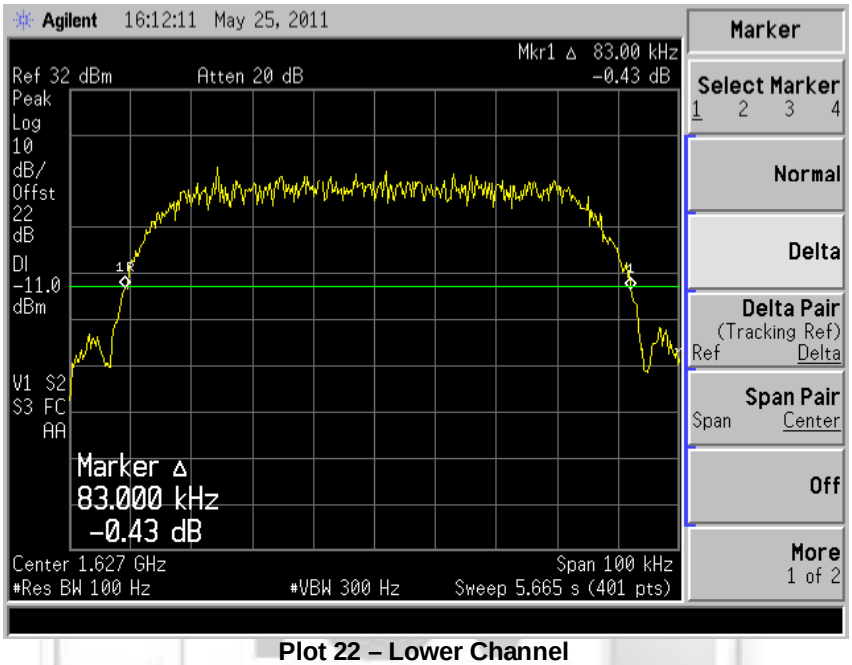

**Plot 20 – Middle Channel**

**26dB Bandwidth Plots (Bearer Type: 11)**

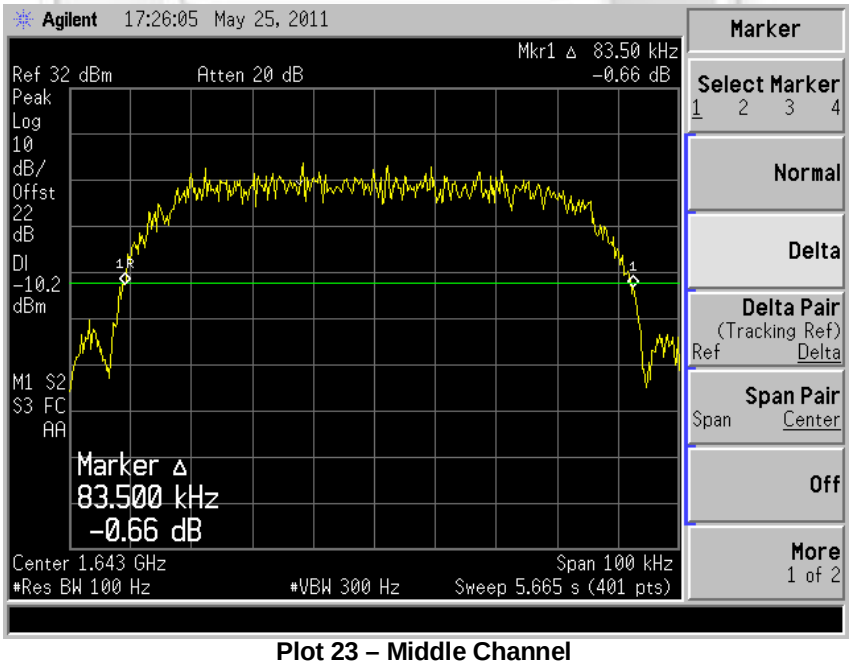



**Plot 21 – Upper Channel**

**26dB Bandwidth Plots (Bearer Type: 13)**

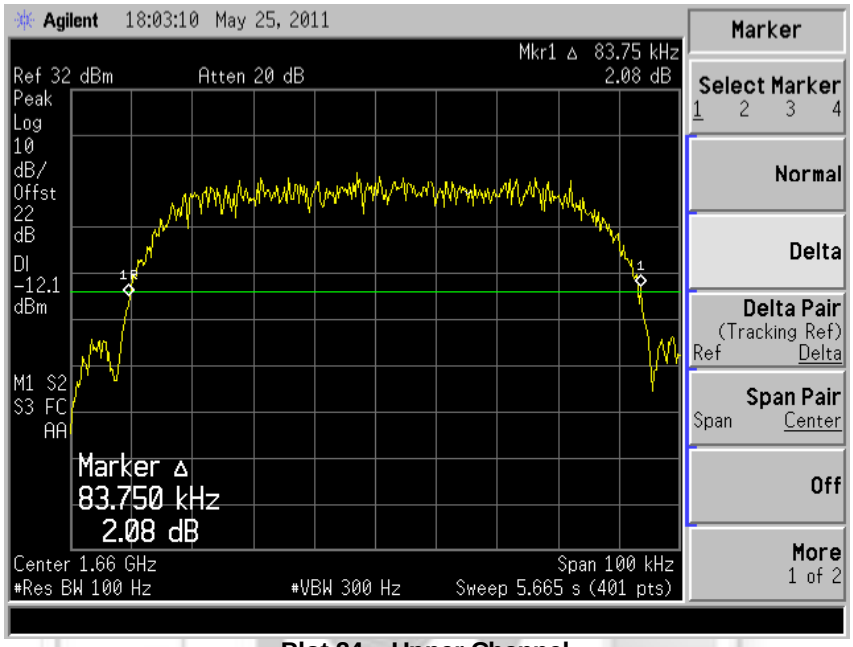



**Plot 22 – Lower Channel**



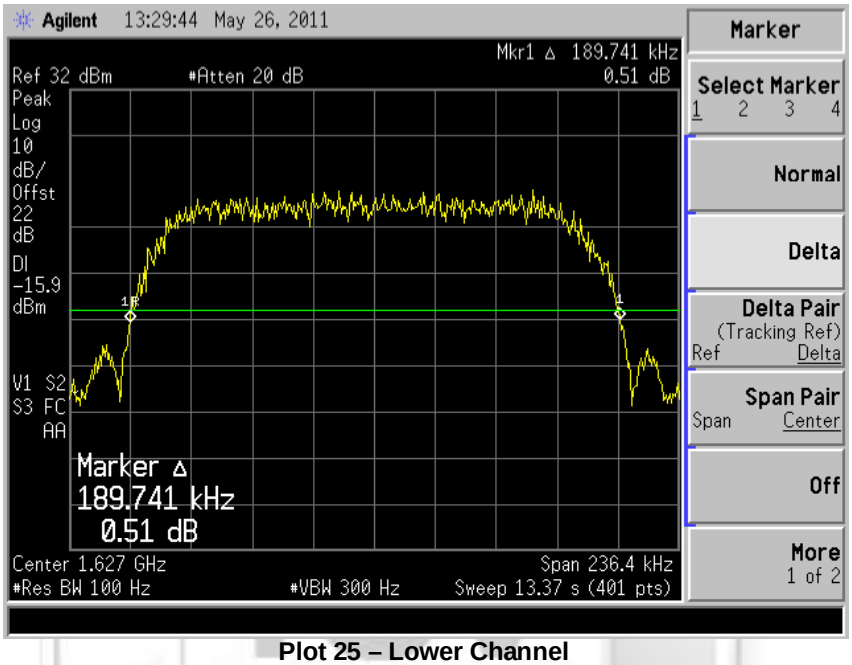

**Plot 23 – Middle Channel**

**26dB Bandwidth Plots (Bearer Type: 13)**

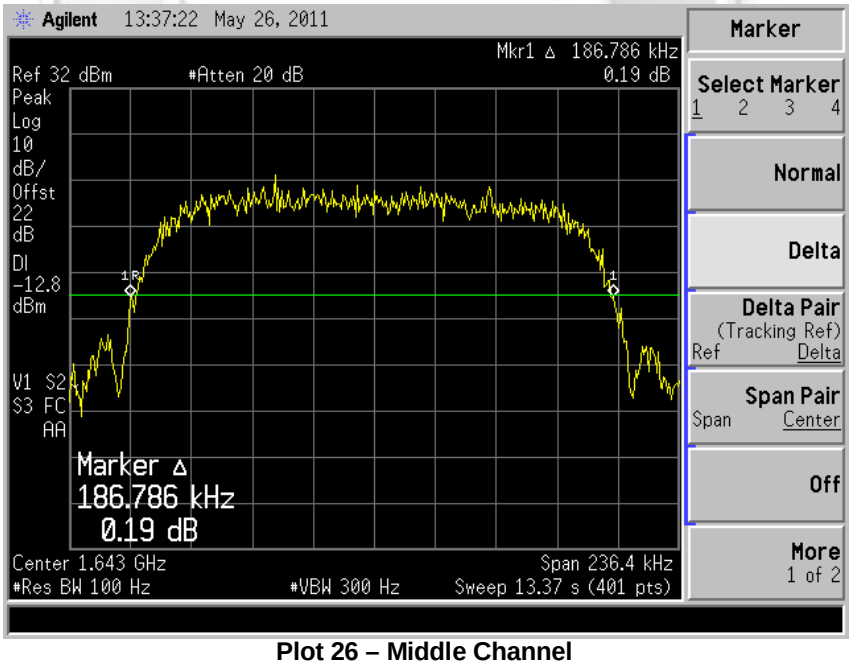



**Plot 24 – Upper Channel**

**26dB Bandwidth Plots (Bearer Type: 15)**

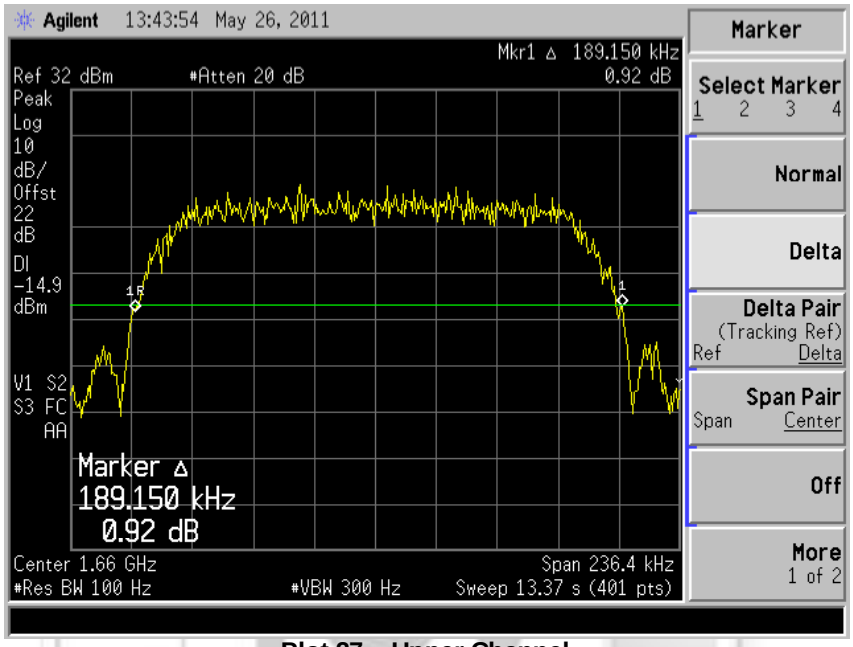



**Plot 25 – Lower Channel**



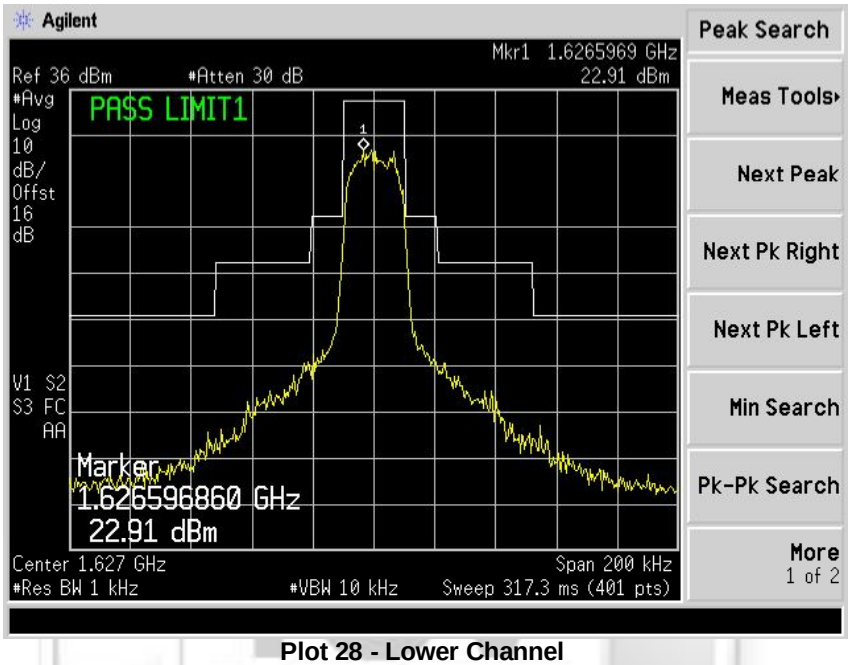

**Plot 26 – Middle Channel**

**26dB Bandwidth Plots (Bearer Type: 15)**

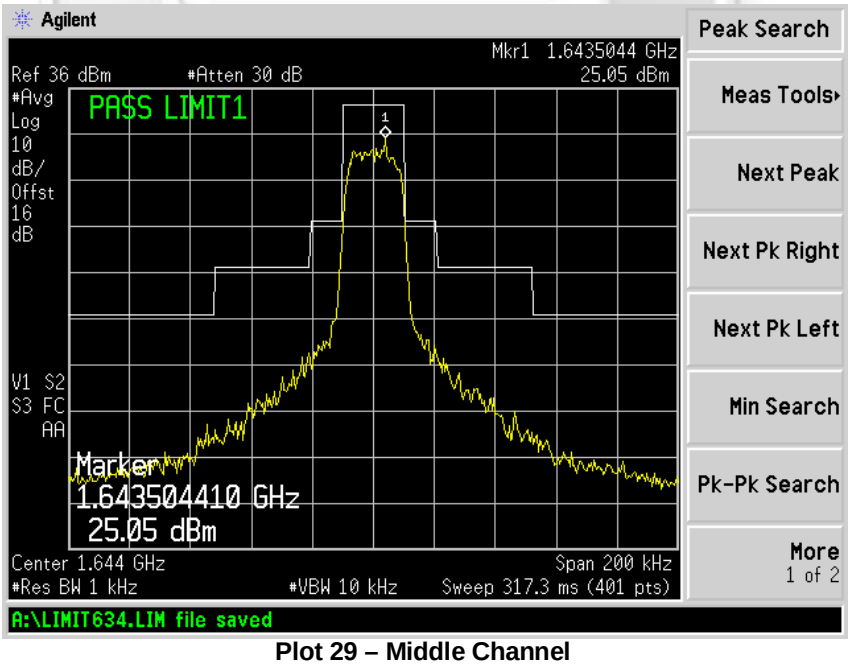



**Plot 27 – Upper Channel**

**In Band Emissions Plots (Bearer Type: 0)**

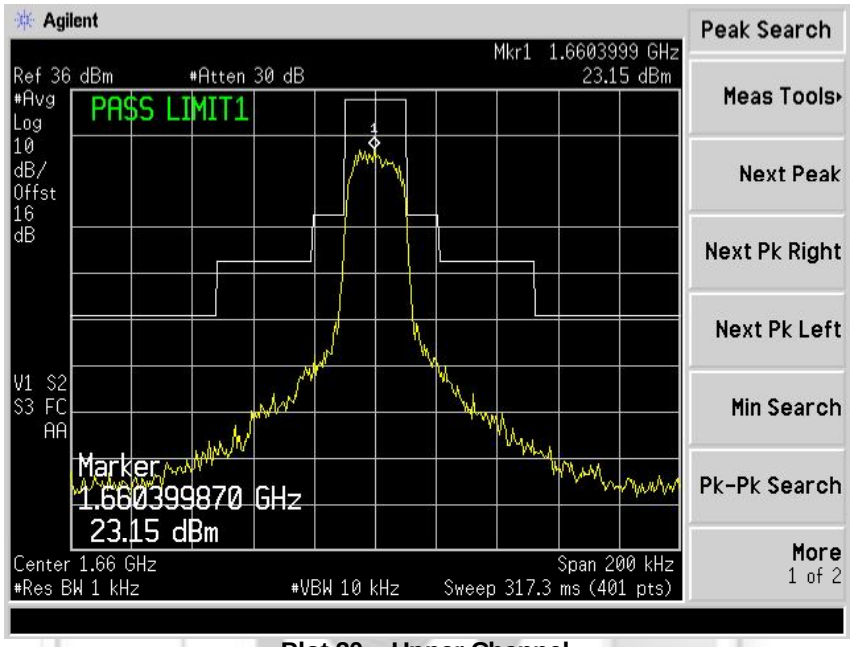



**Plot 28 - Lower Channel**



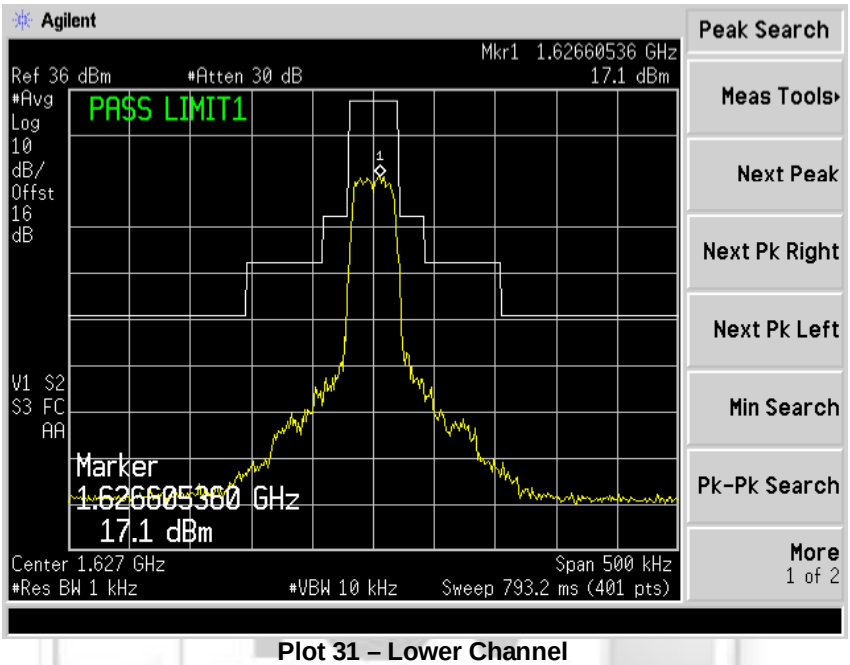

**Plot 29 – Middle Channel**

**In Band Emissions Plots (Bearer Type: 0)**

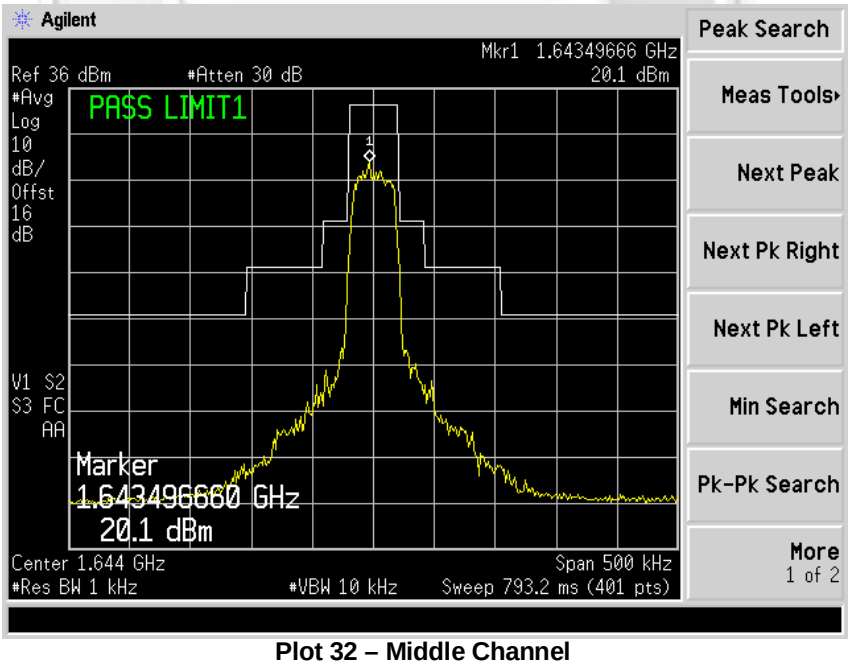



**Plot 30 – Upper Channel**

**In Band Emissions Plots (Bearer Type: 3)**

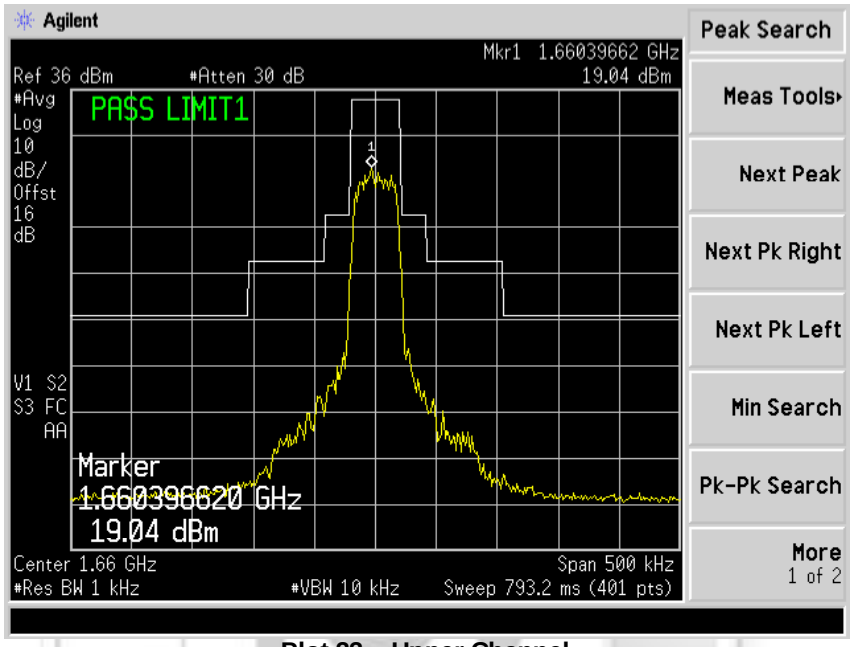



**Plot 31 – Lower Channel**



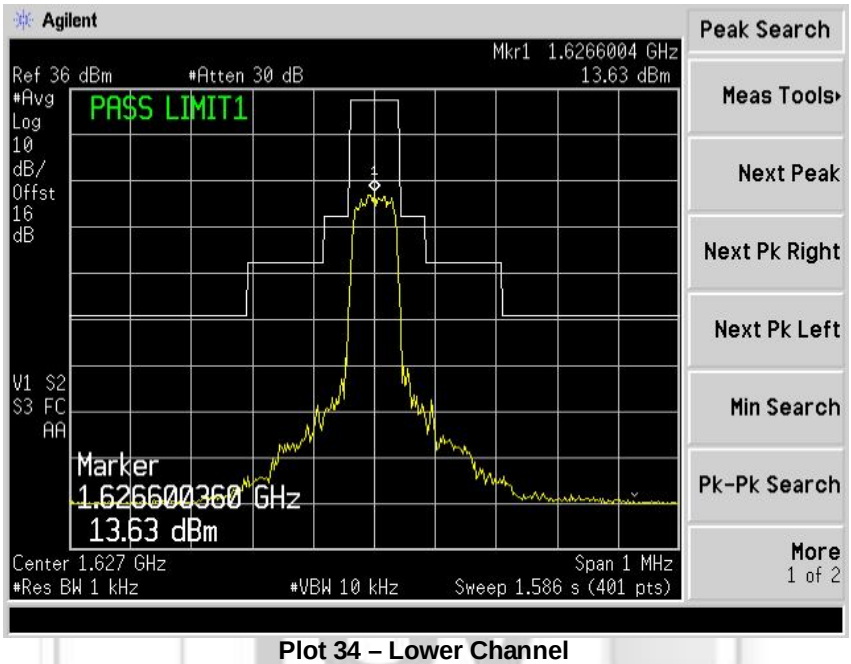

**Plot 32 – Middle Channel**

**In Band Emissions Plots (Bearer Type: 3)**

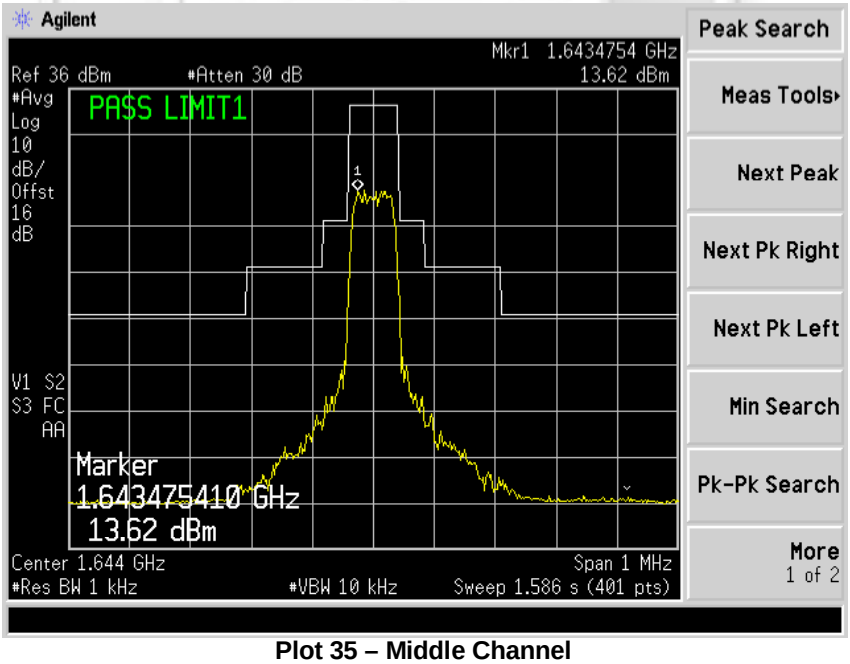



**Plot 33 – Upper Channel**

**In Band Emissions Plots (Bearer Type: 5)**

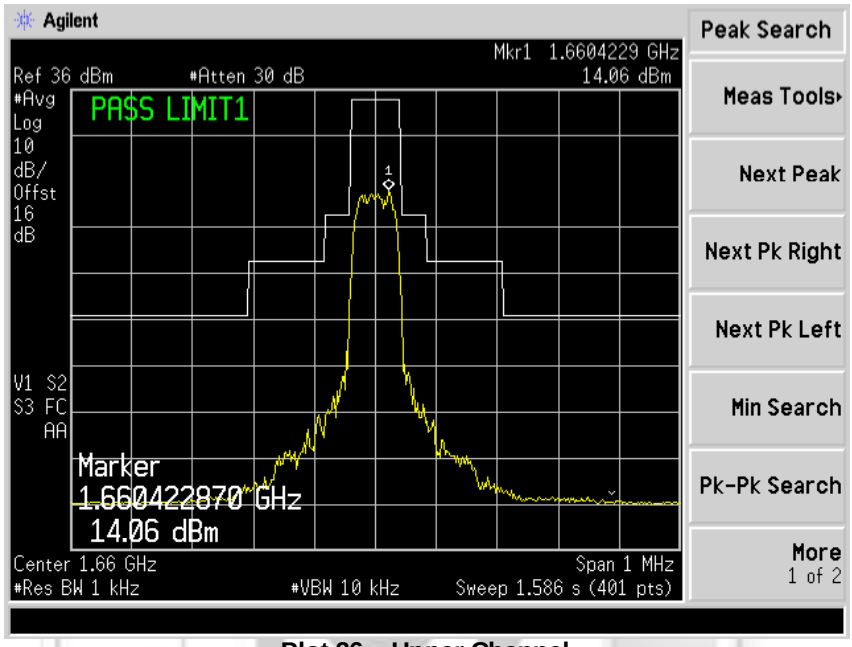



**Plot 34 – Lower Channel**



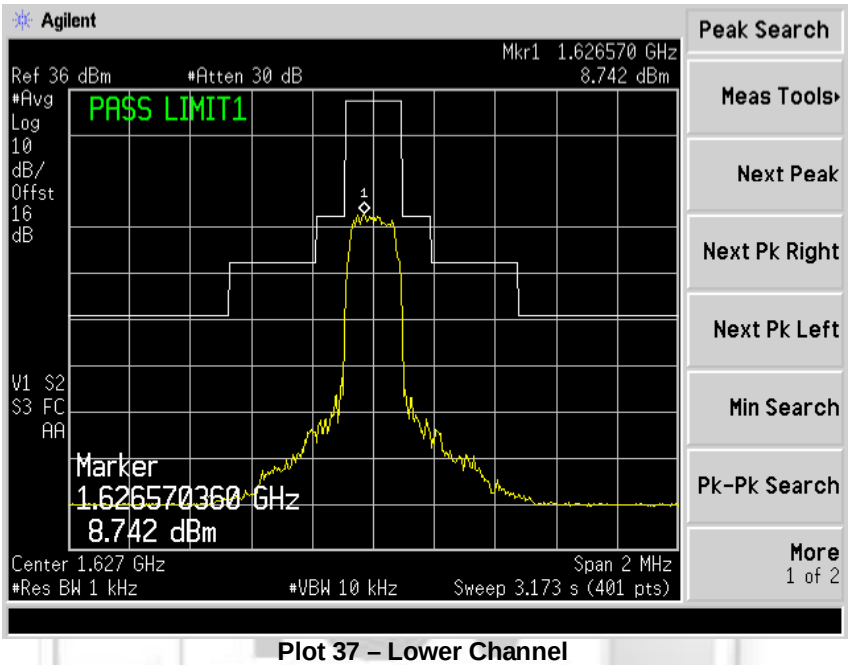

**Plot 35 – Middle Channel**

**In Band Emissions Plots (Bearer Type: 5)**

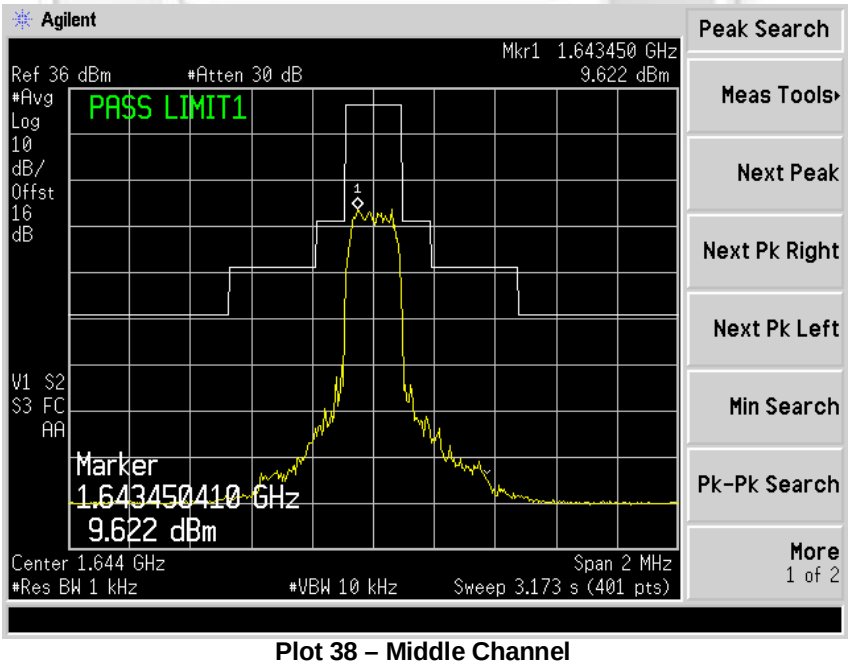



**Plot 36 – Upper Channel**

**In Band Emissions Plots (Bearer Type: 7)**

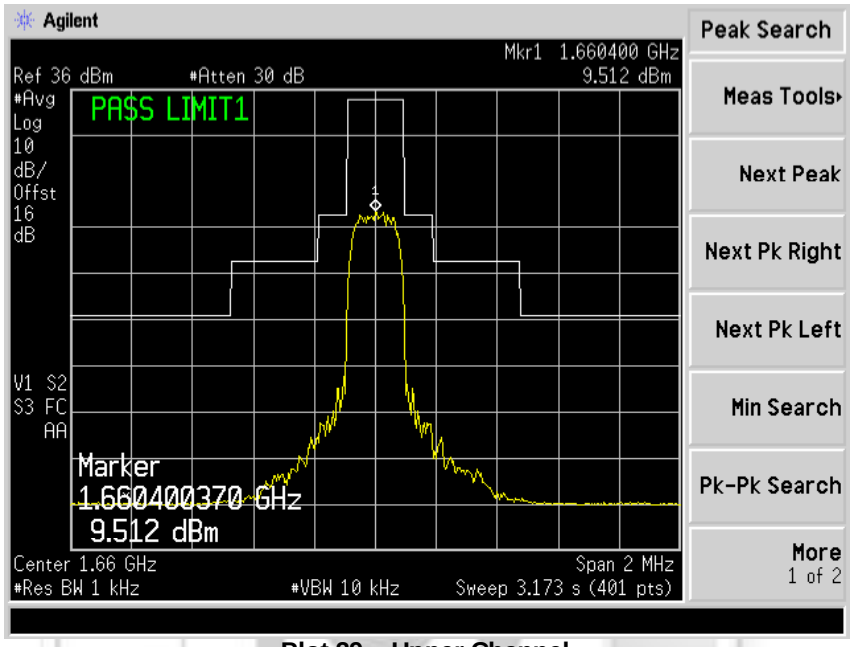



**Plot 37 – Lower Channel**



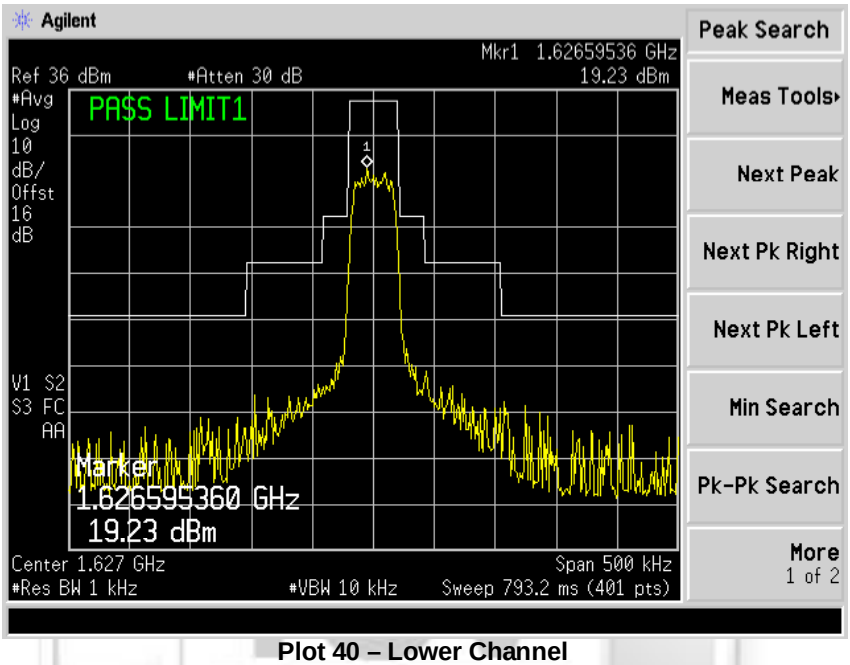

**Plot 38 – Middle Channel**

**In Band Emissions Plots (Bearer Type: 7)**

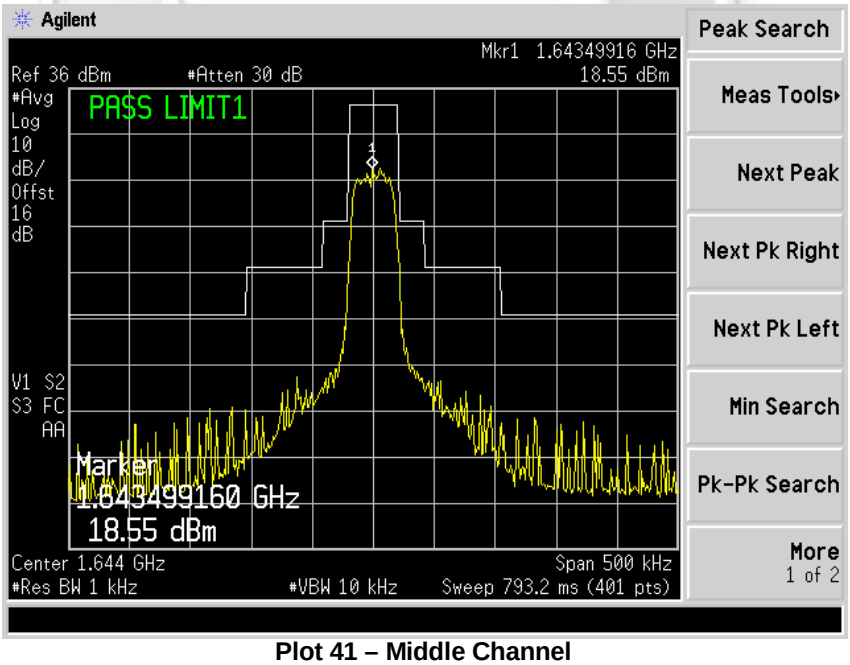



**Plot 39 – Upper Channel**

**In Band Emissions Plots (Bearer Type: 11)**

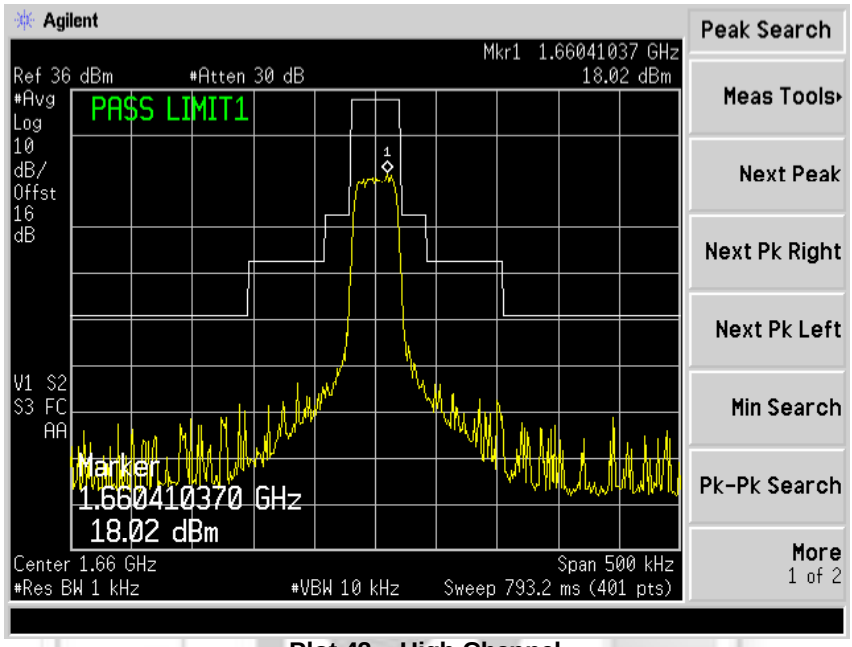



**Plot 40 – Lower Channel**



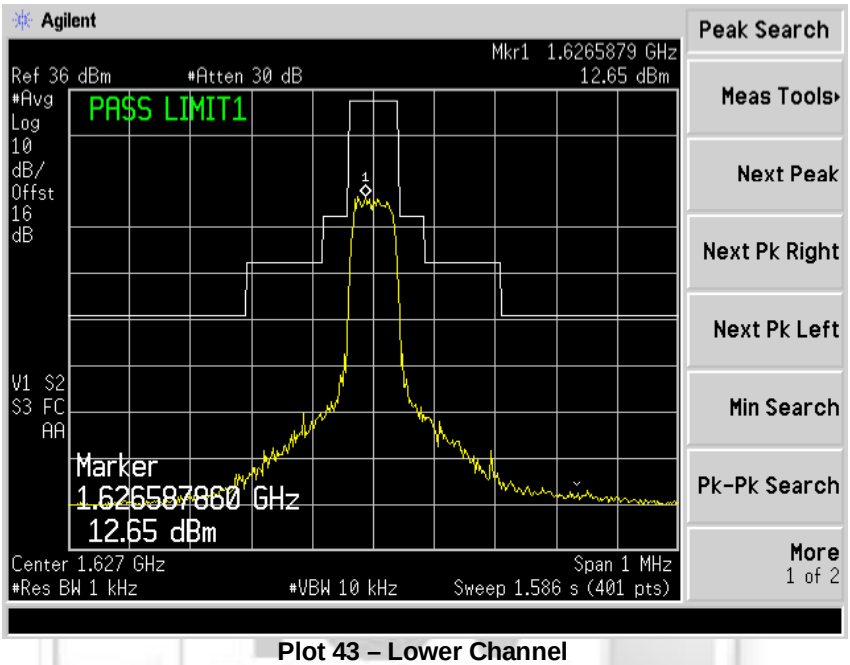

**Plot 41 – Middle Channel**

**In Band Emissions Plots (Bearer Type: 11)**

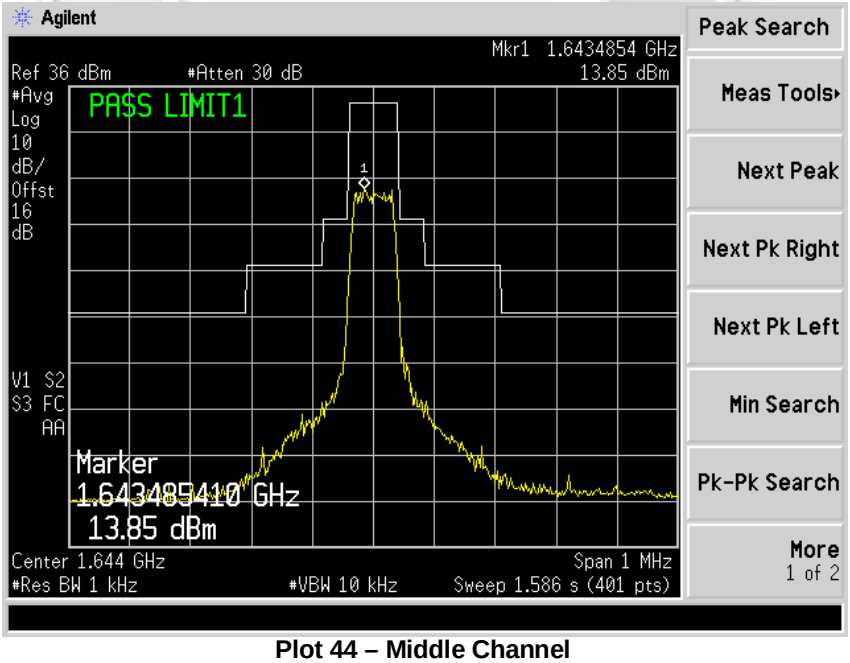



**Plot 42 – High Channel**

**In Band Emissions Plots (Bearer Type: 13)**

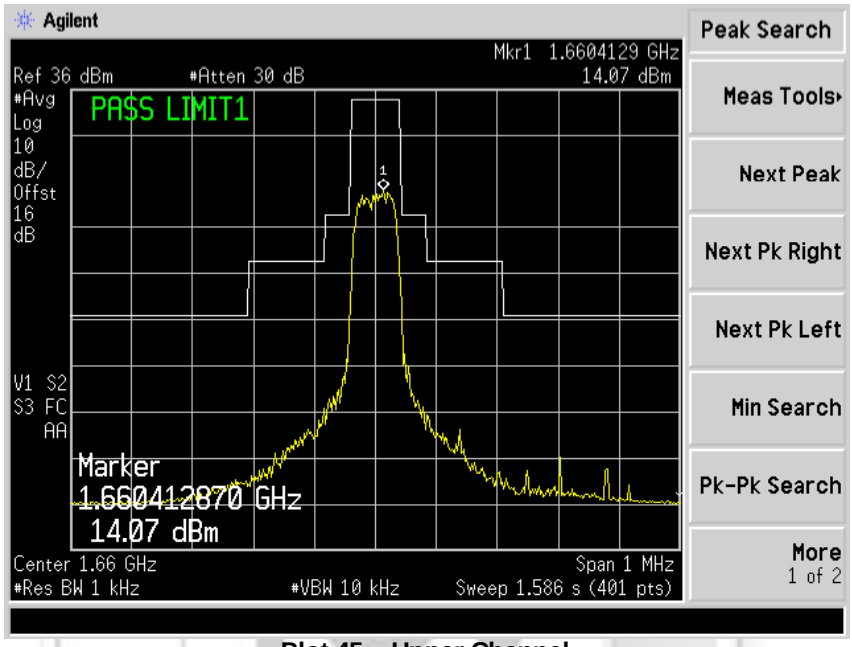



**Plot 43 – Lower Channel**



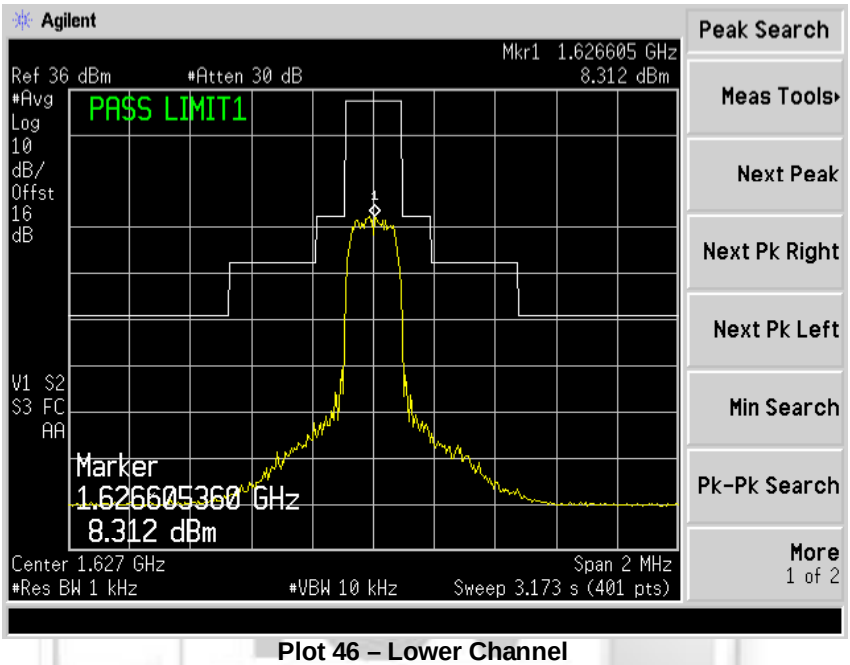

**Plot 44 – Middle Channel**

**In Band Emissions Plots (Bearer Type: 13)**

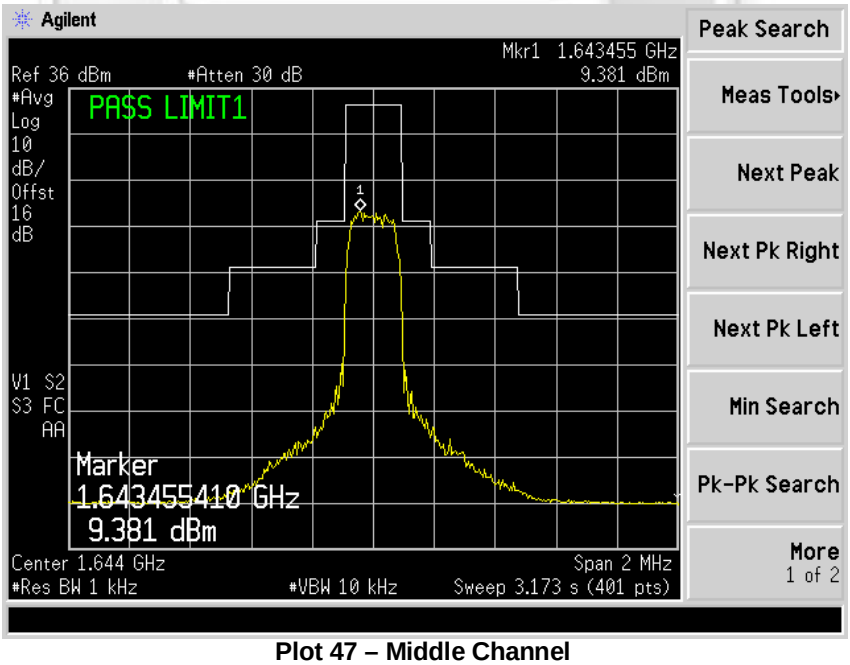



**Plot 45 – Upper Channel**

**In Band Emissions Plots (Bearer Type: 15)**

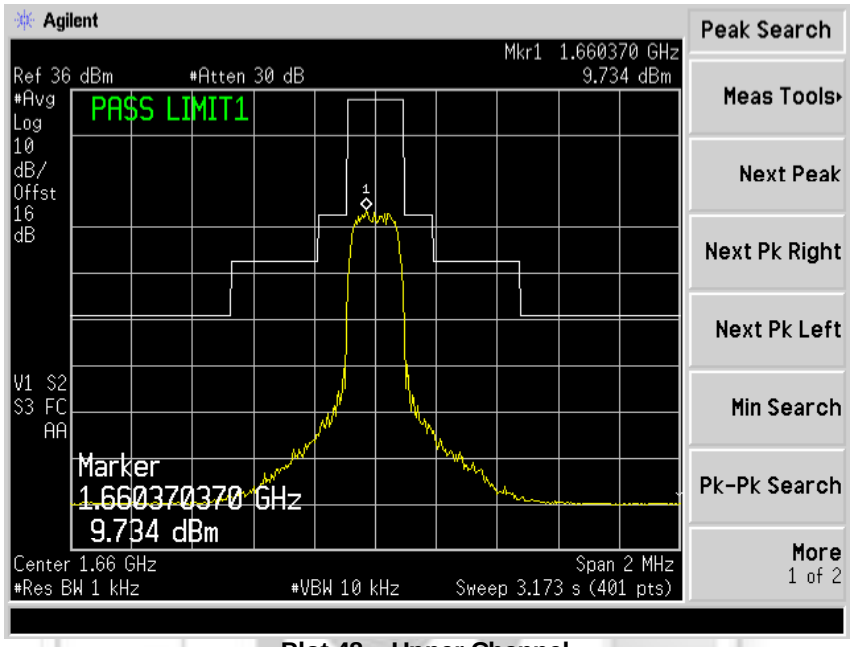



**Plot 46 – Lower Channel**



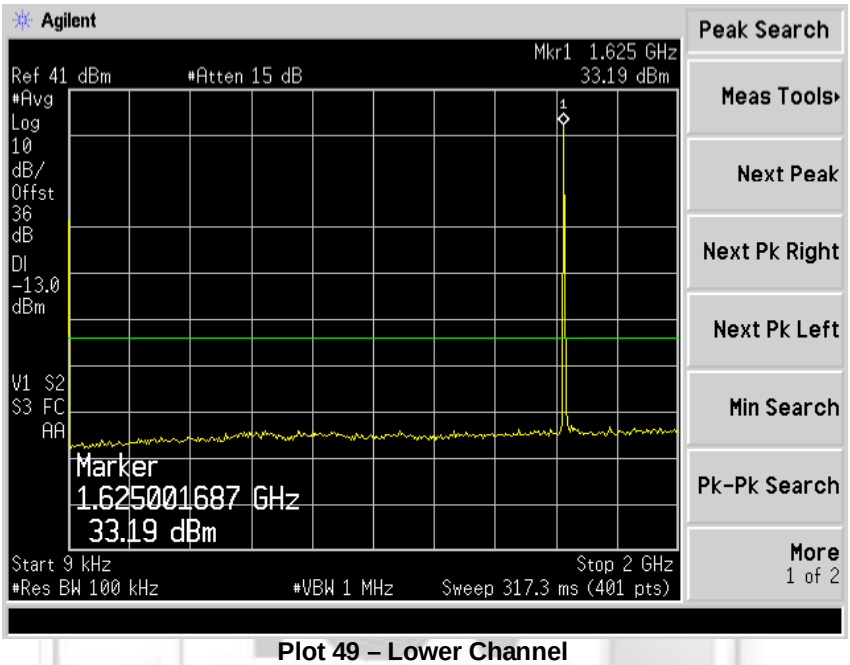

**Plot 47 – Middle Channel**

**In Band Emissions Plots (Bearer Type: 15)**

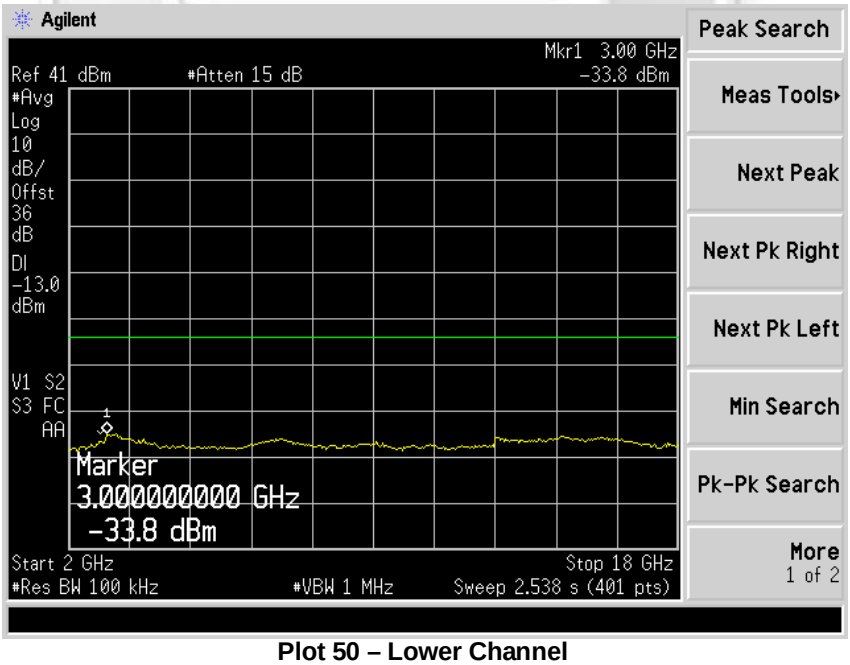



**Plot 48 – Upper Channel**

**Out of Band Spurious Plots (Bearer Type: 0)**

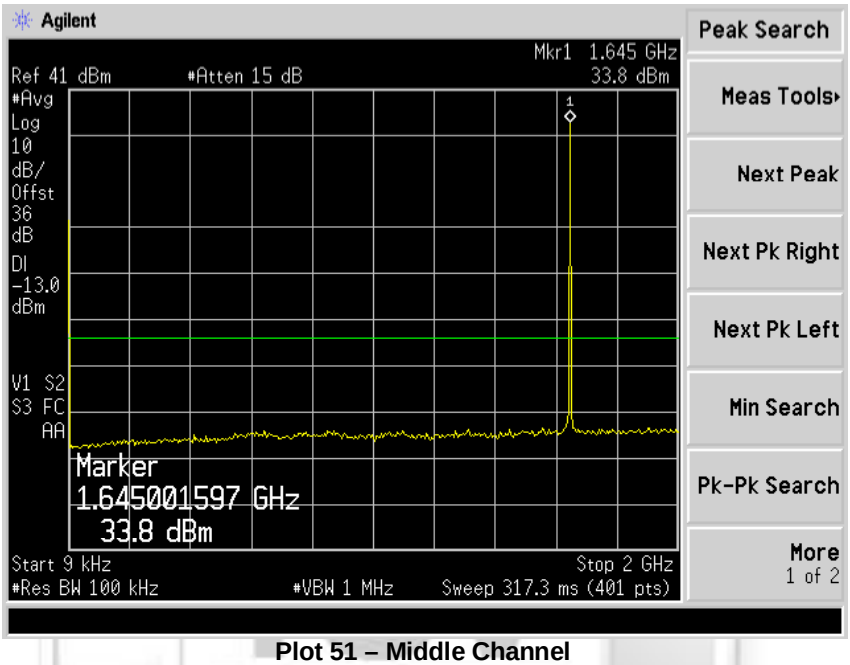



**Plot 49 – Lower Channel**

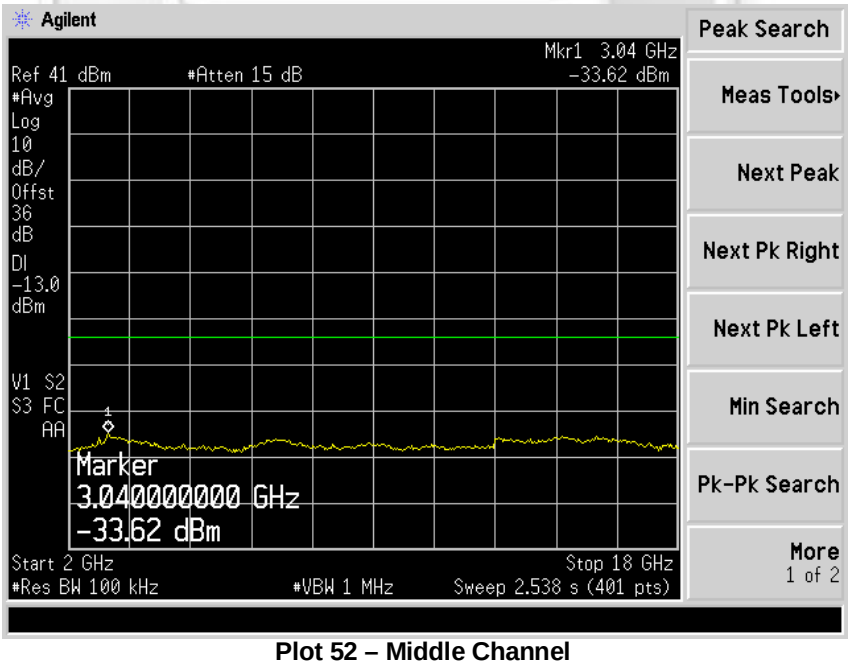



**Plot 50 – Lower Channel**

**Out of Band Spurious Plots (Bearer Type: 0)**

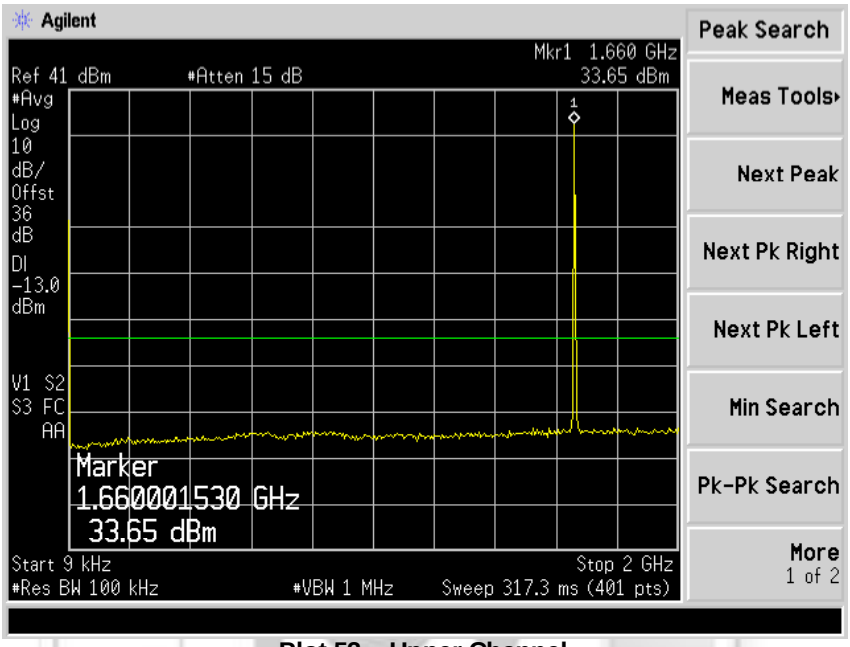



**Plot 51 – Middle Channel**

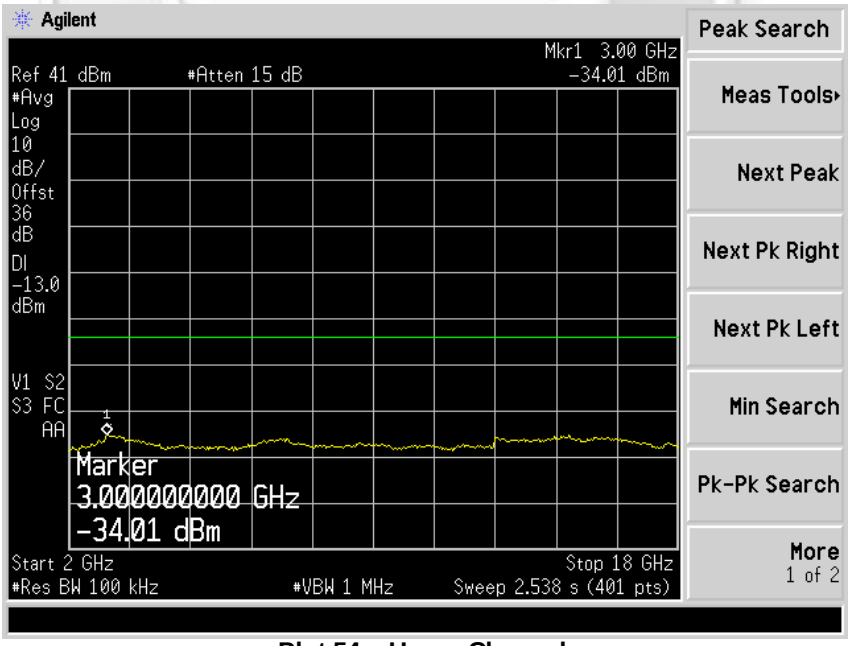



**Plot 52 – Middle Channel**

**Out of Band Spurious Plots (Bearer Type: 0)**

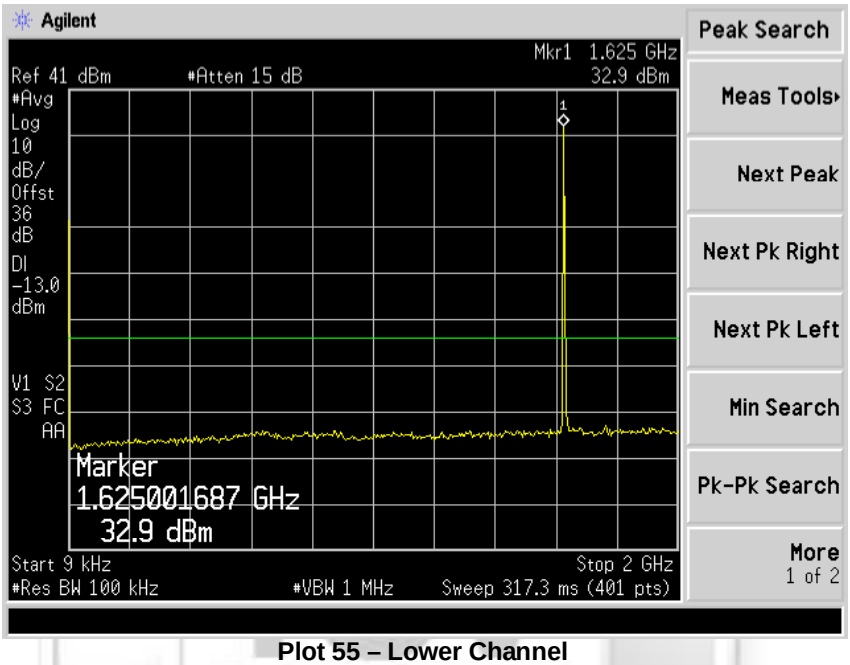



**Plot 53 – Upper Channel**

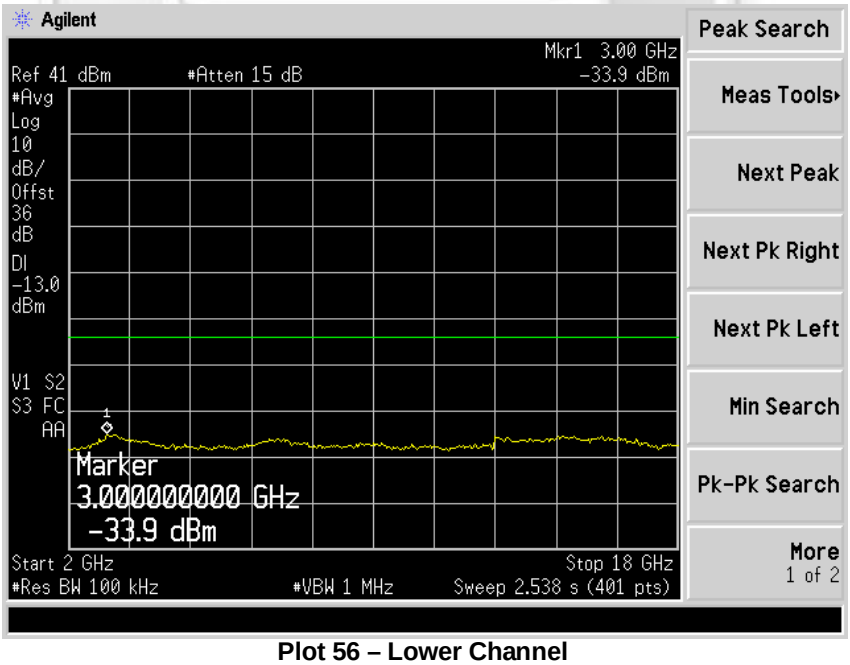



**Plot 54 – Upper Channel**

**Out of Band Spurious Plots (Bearer Type: 3)**

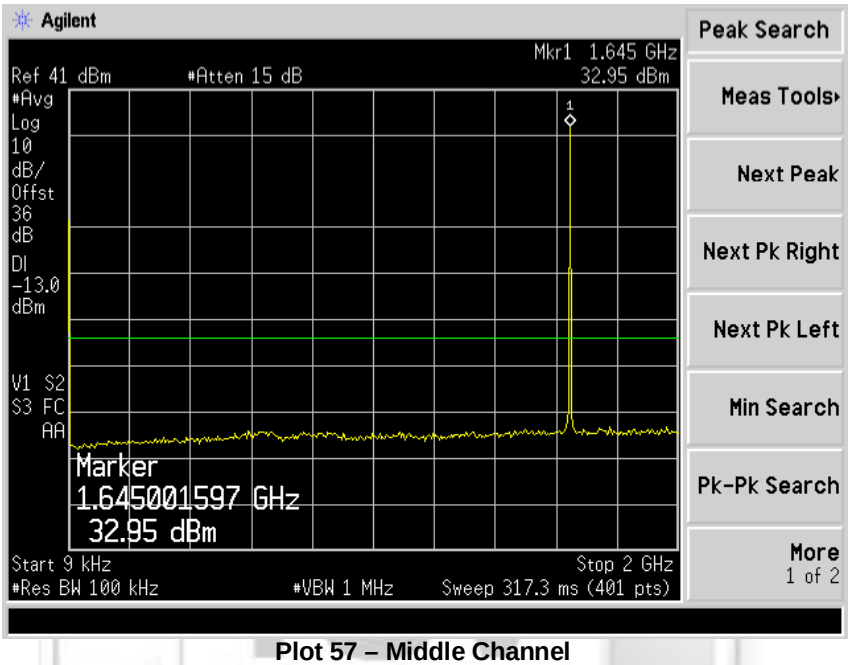



**Plot 55 – Lower Channel**

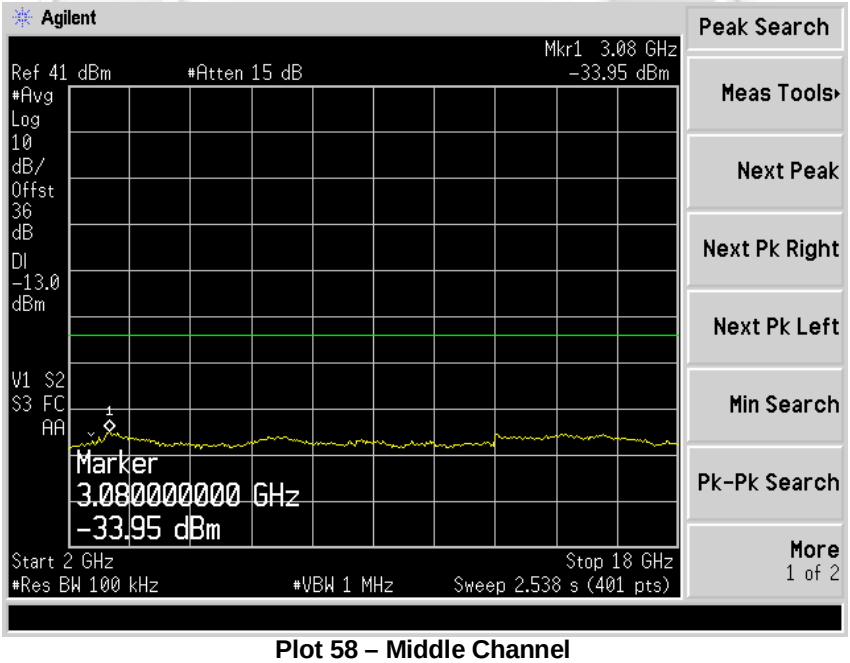



**Plot 56 – Lower Channel**

**Out of Band Spurious Plots (Bearer Type: 3)**

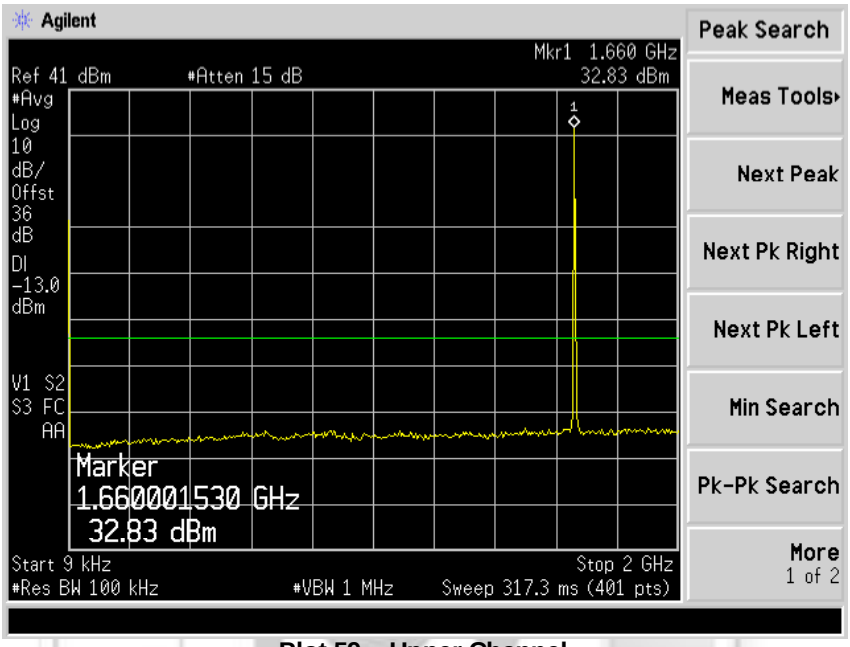



**Plot 57 – Middle Channel**

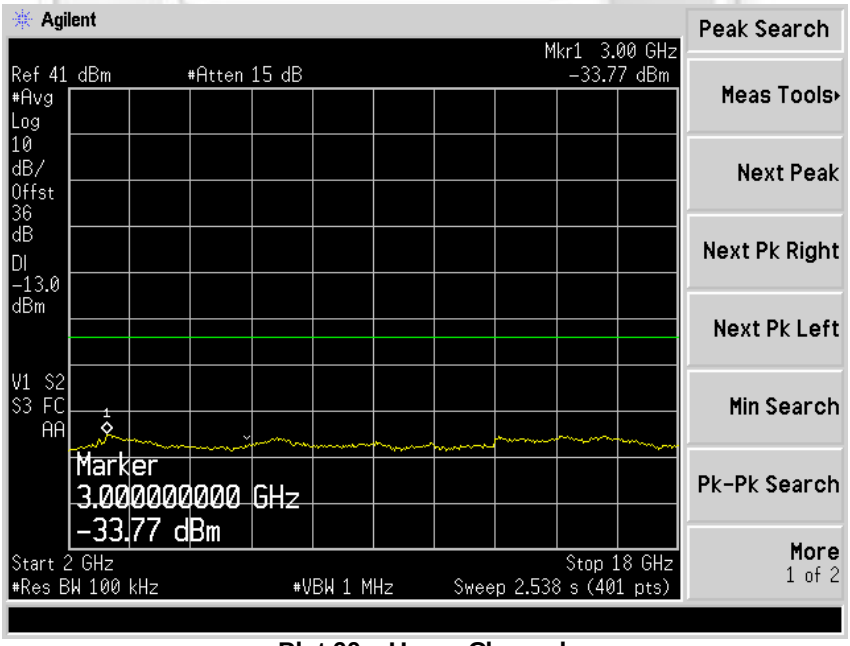



**Plot 58 – Middle Channel**

**Out of Band Spurious Plots (Bearer Type: 3)**

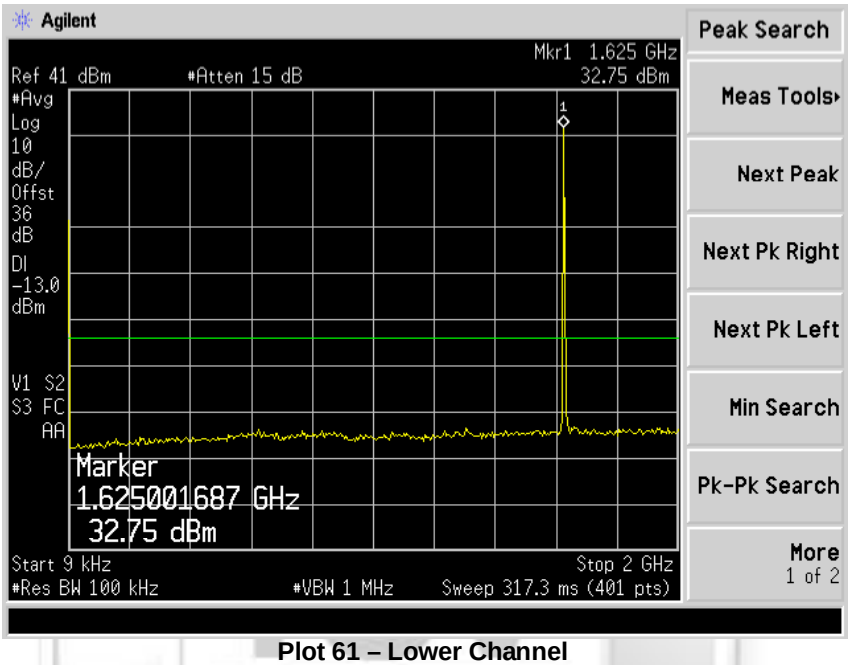



**Plot 59 – Upper Channel**

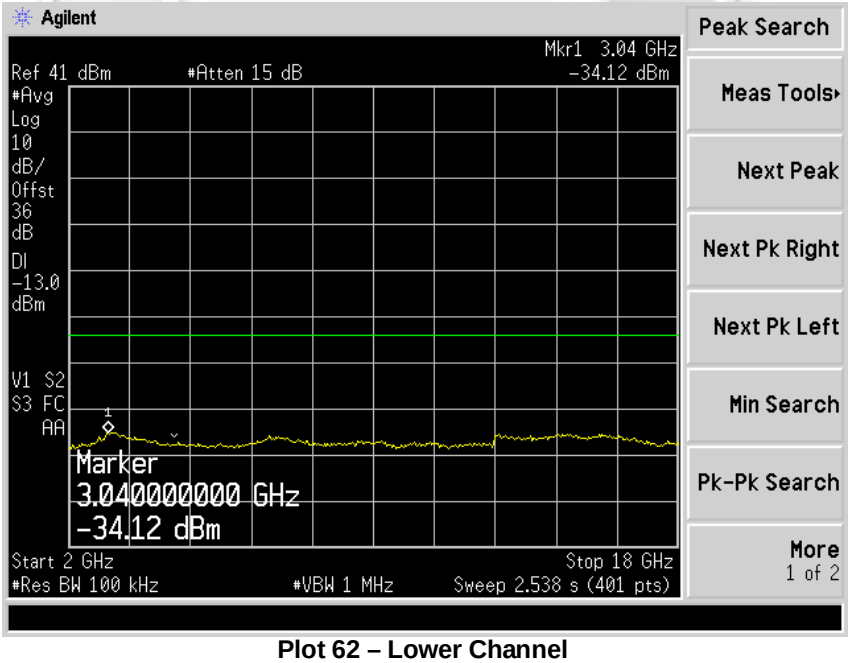



**Plot 60 – Upper Channel**

**Out of Band Spurious Plots (Bearer Type: 5)**

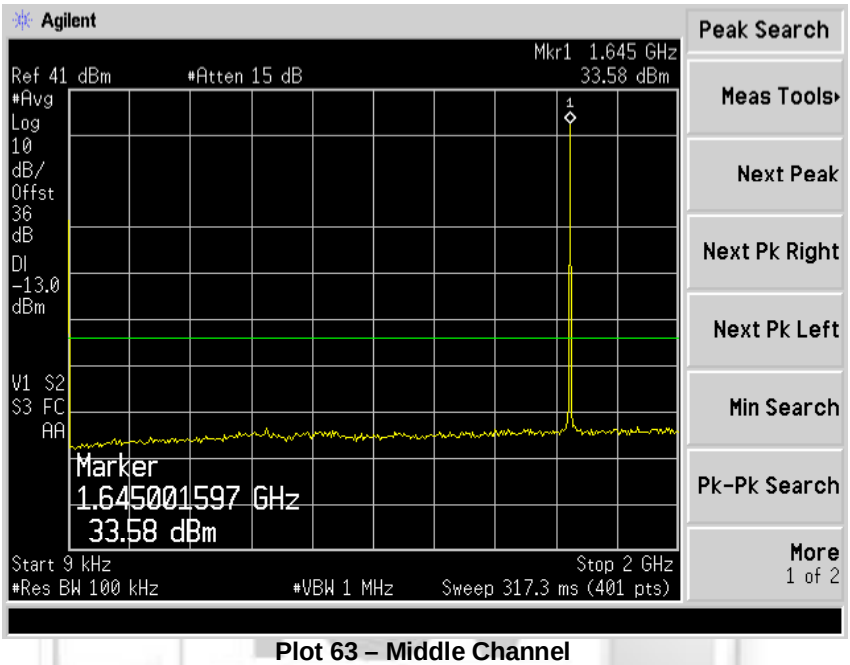



**Plot 61 – Lower Channel**

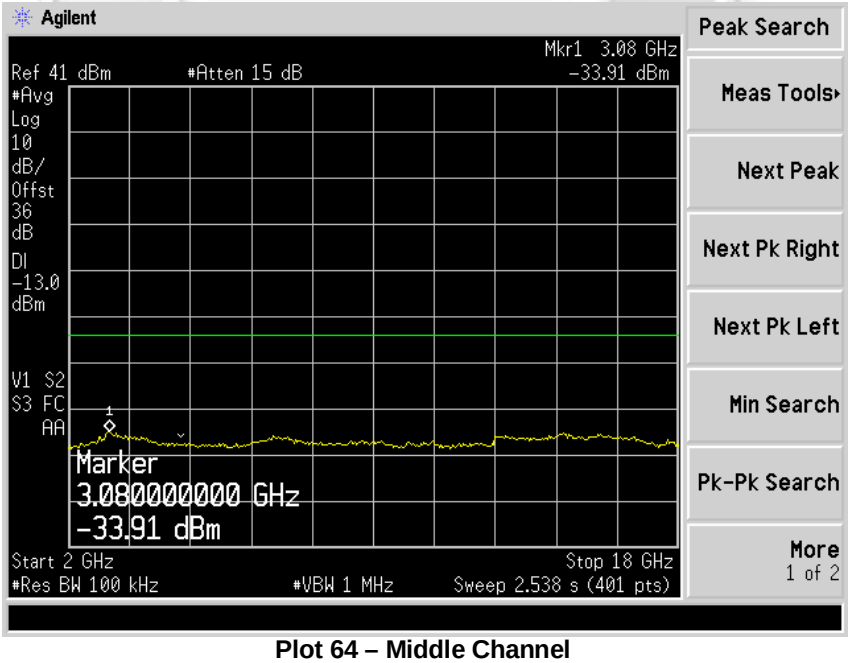



**Plot 62 – Lower Channel**

**Out of Band Spurious Plots (Bearer Type: 5)**

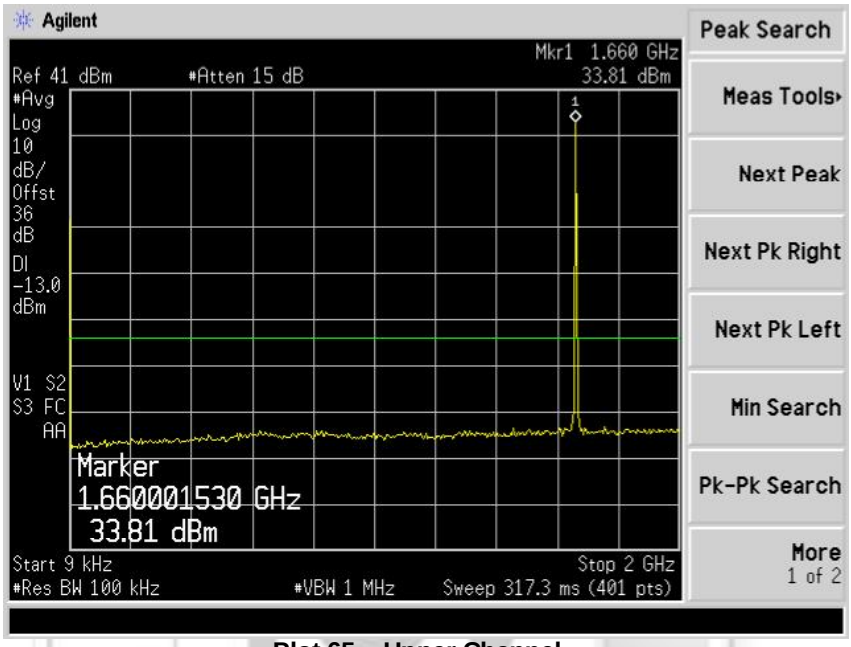



**Plot 63 – Middle Channel**

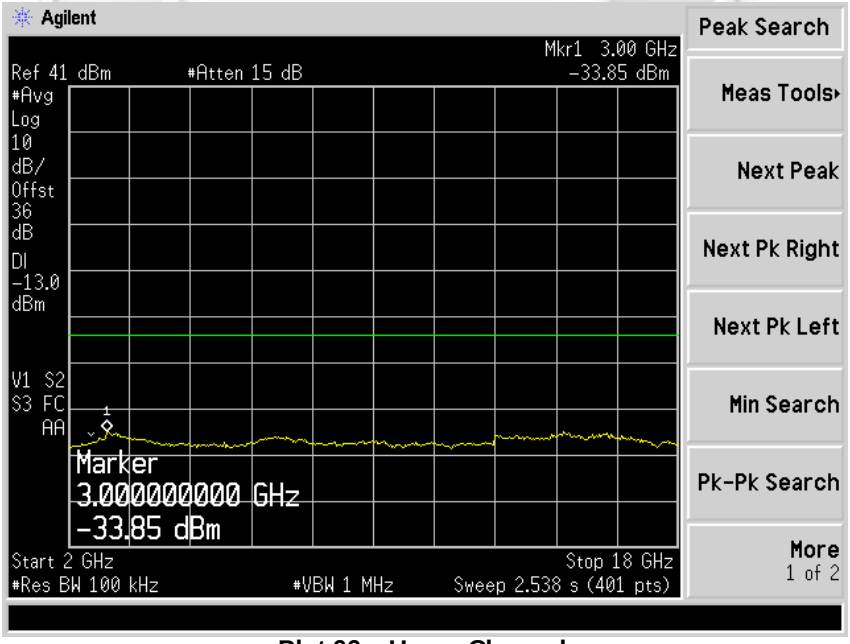



**Plot 64 – Middle Channel**

**Out of Band Spurious Plots (Bearer Type: 5)**

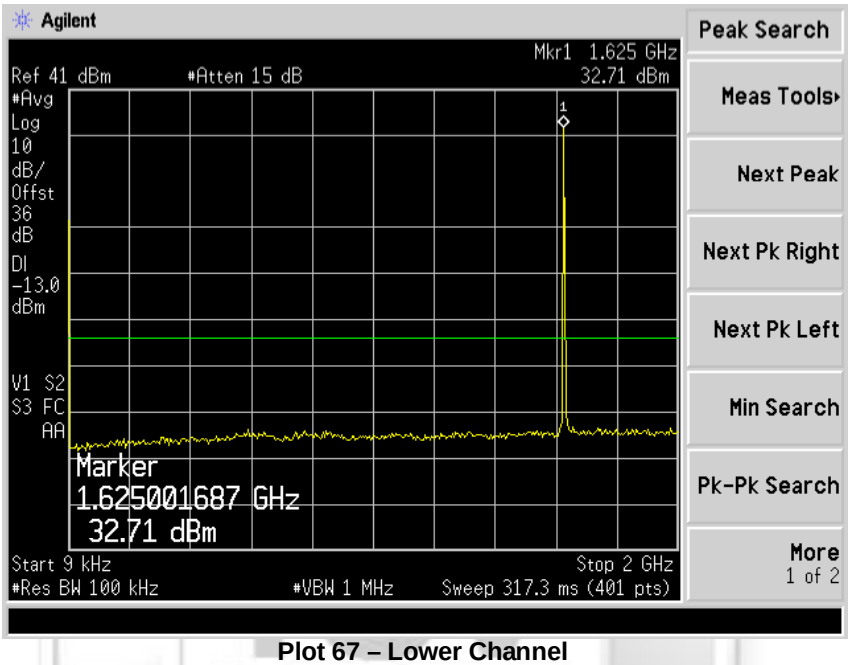



**Plot 65 – Upper Channel**

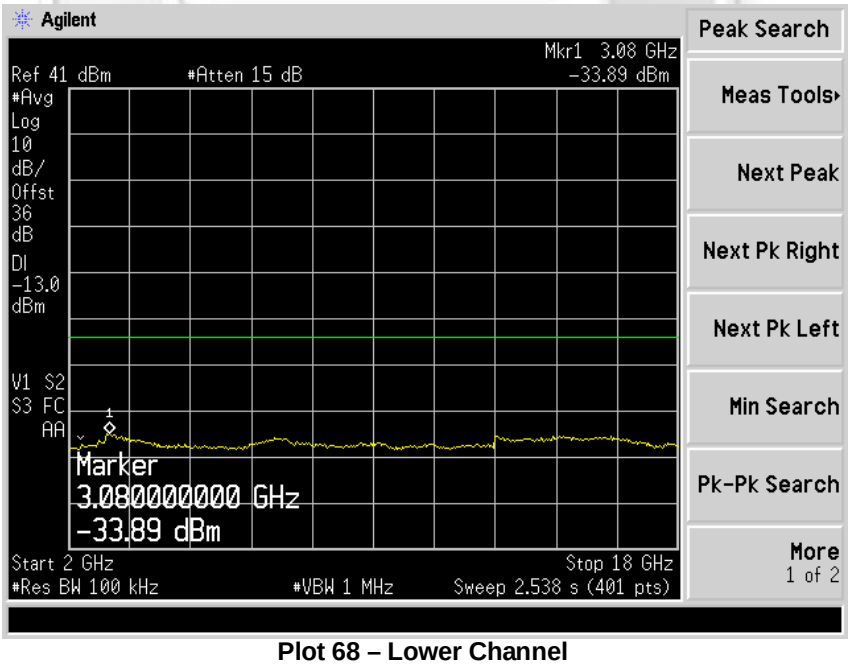



**Plot 66 – Upper Channel**

**Out of Band Spurious Plots (Bearer Type: 7)**

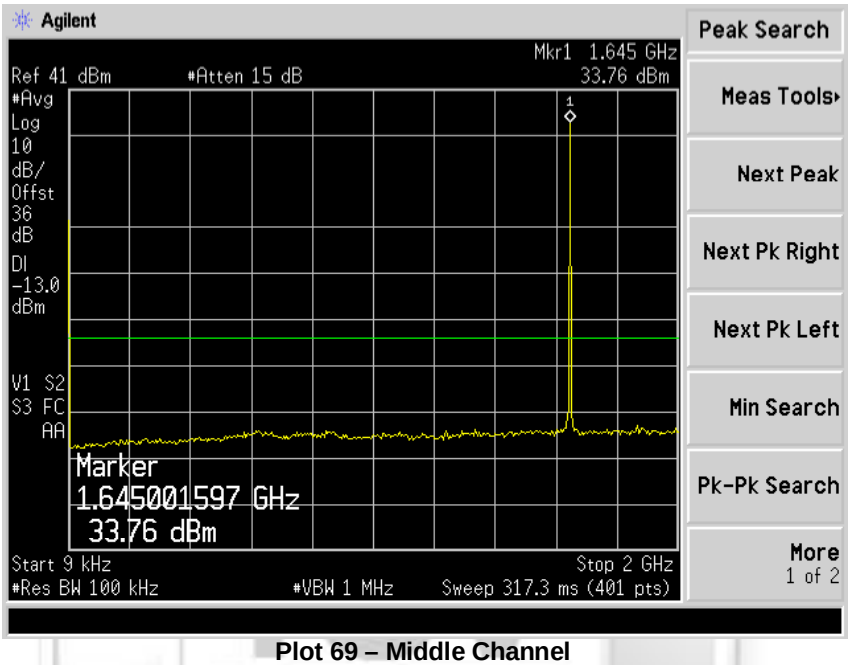



**Plot 67 – Lower Channel**

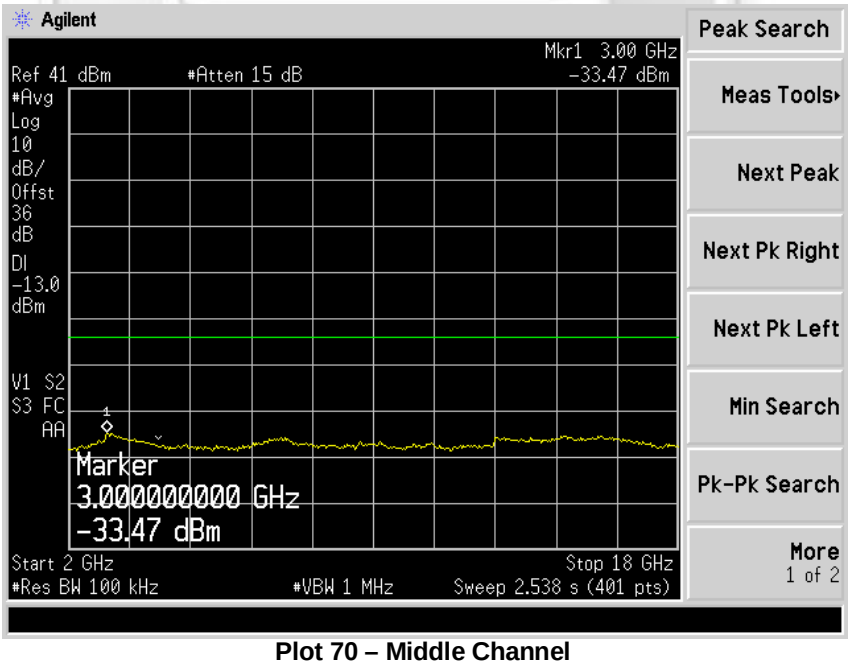



**Plot 68 – Lower Channel**

**Out of Band Spurious Plots (Bearer Type: 7)**

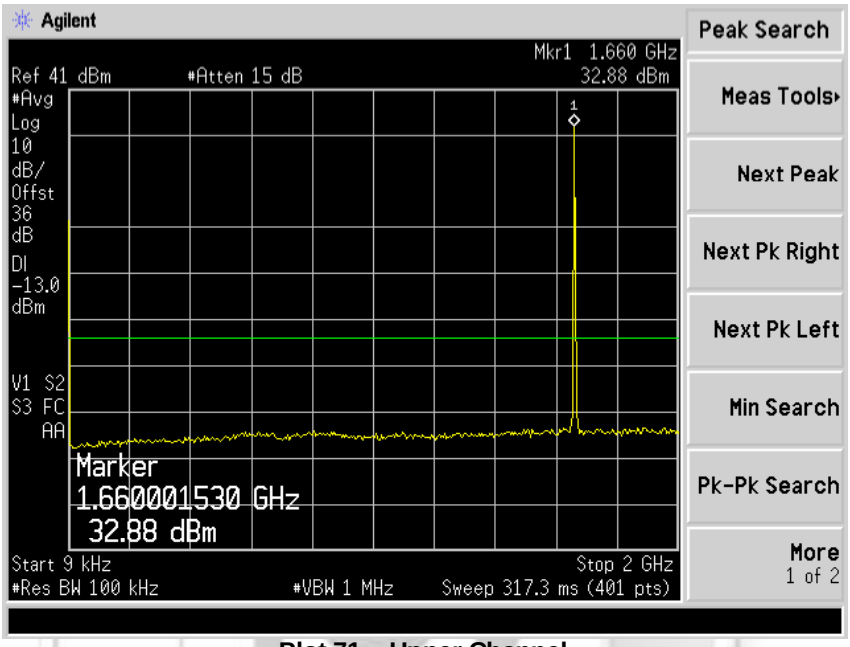



**Plot 69 – Middle Channel**

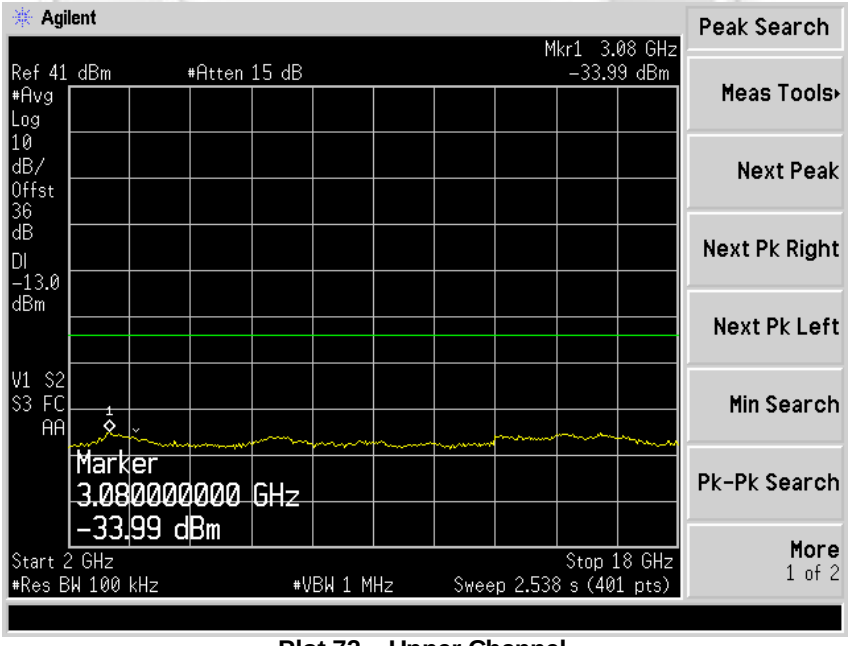



**Plot 70 – Middle Channel**

**Out of Band Spurious Plots (Bearer Type: 7)**

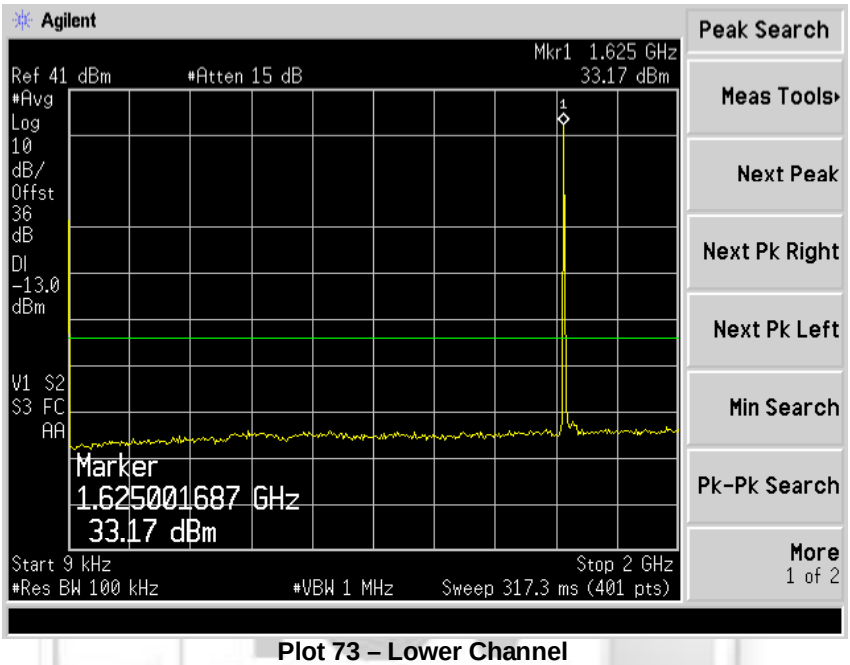



**Plot 71 – Upper Channel**

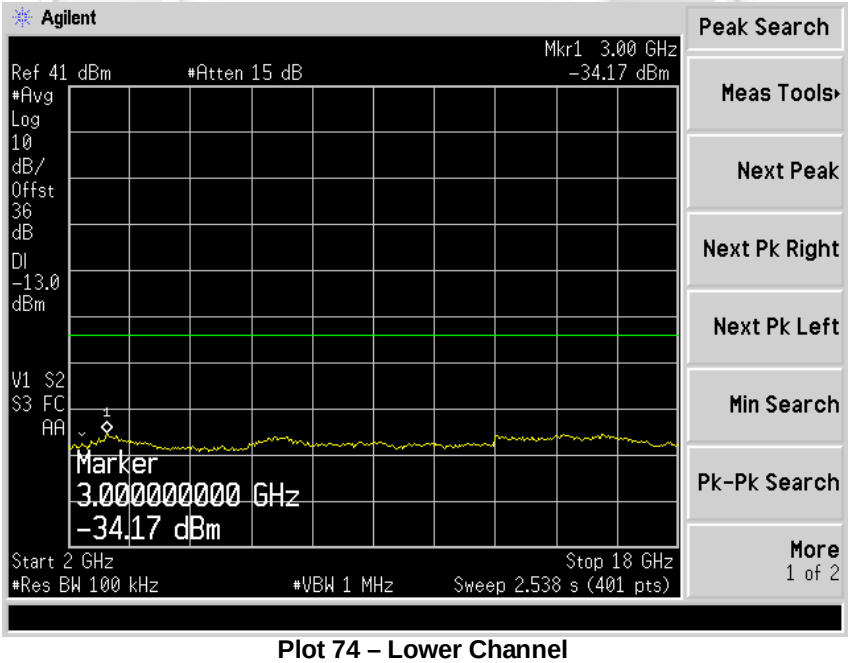



**Plot 72 – Upper Channel**

**Out of Band Spurious Plots (Bearer Type: 11)**

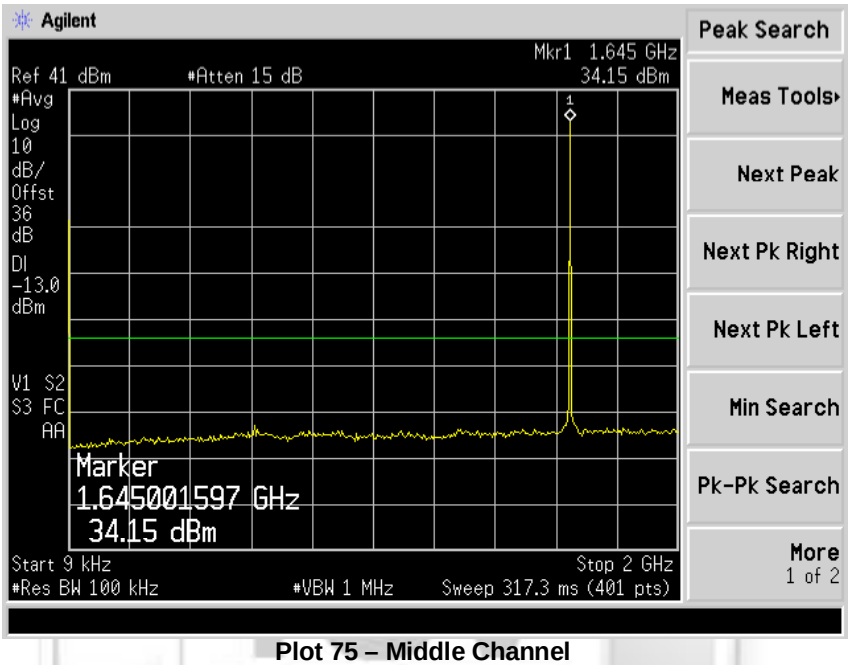



**Plot 73 – Lower Channel**

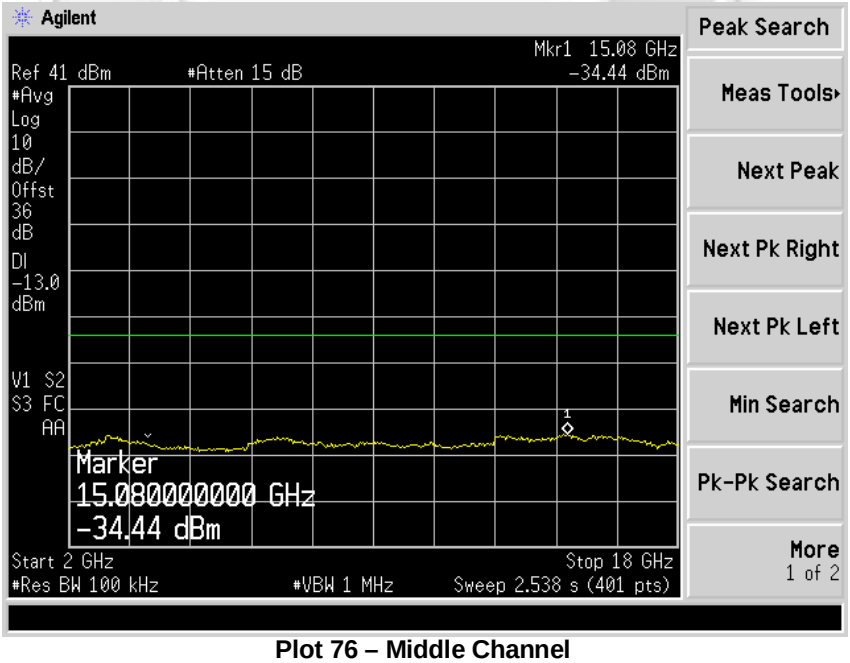



**Plot 74 – Lower Channel**

**Out of Band Spurious Plots (Bearer Type: 11)**

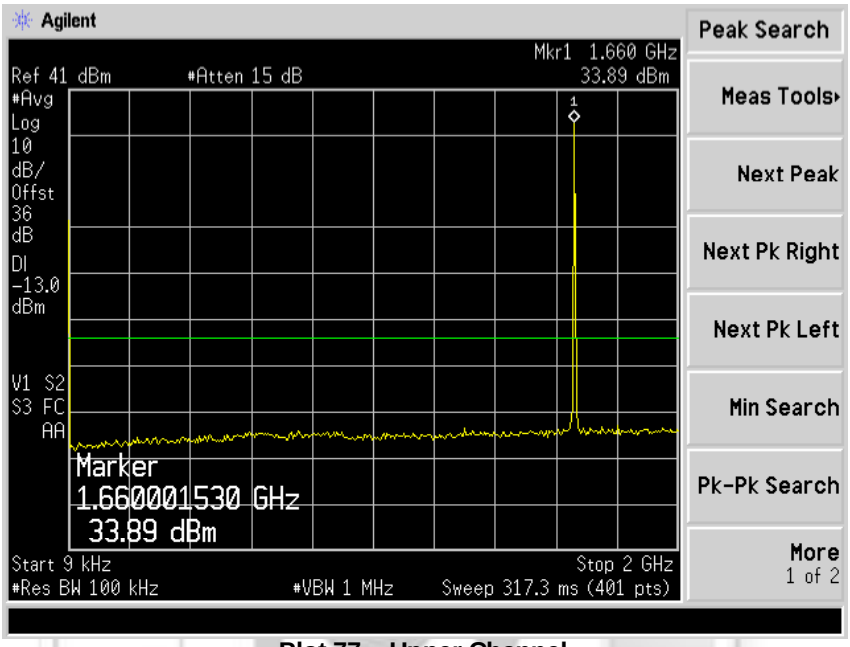



**Plot 75 – Middle Channel**

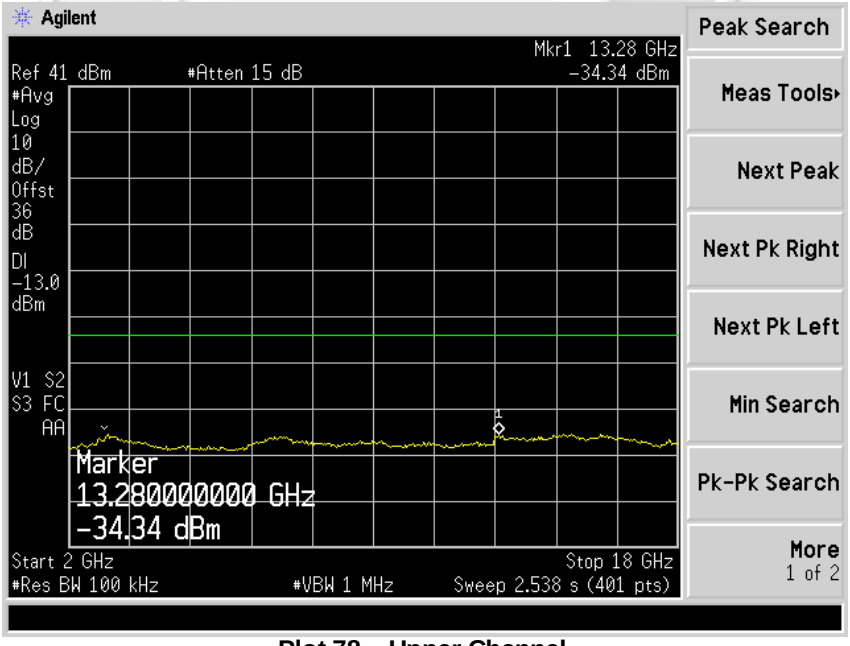



**Plot 76 – Middle Channel**

**Out of Band Spurious Plots (Bearer Type: 11)**

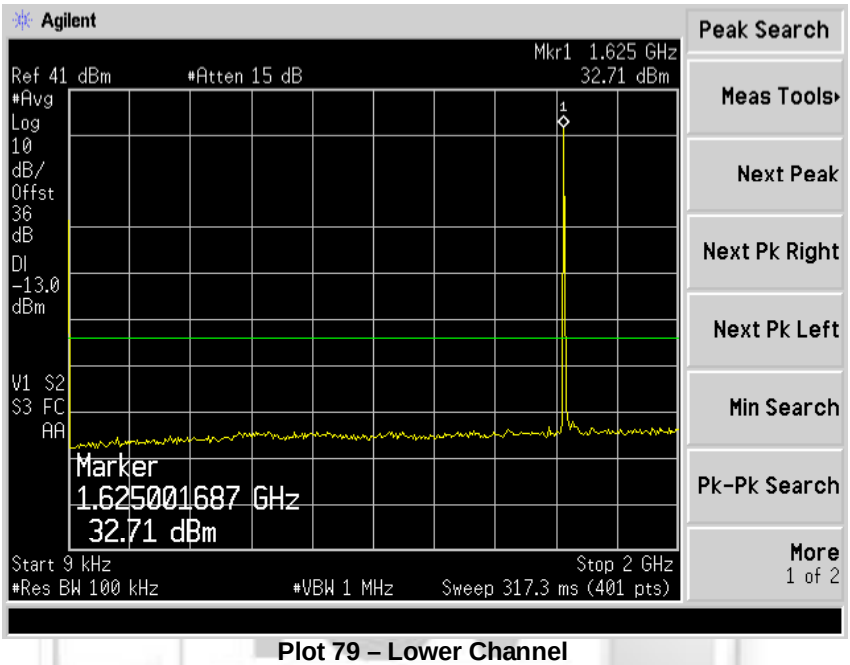



**Plot 77 – Upper Channel**

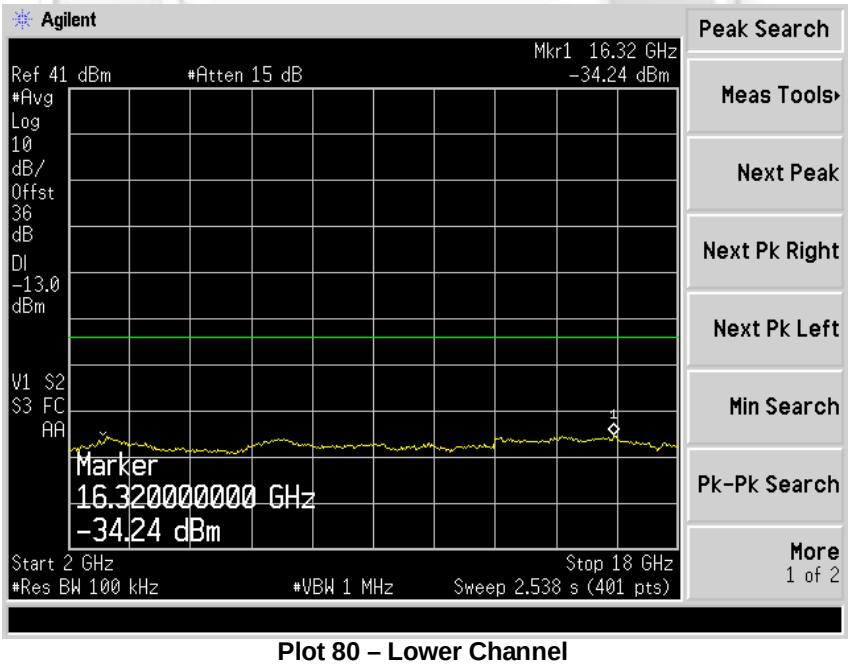



**Plot 78 – Upper Channel**

**Out of Band Spurious Plots (Bearer Type: 13)**

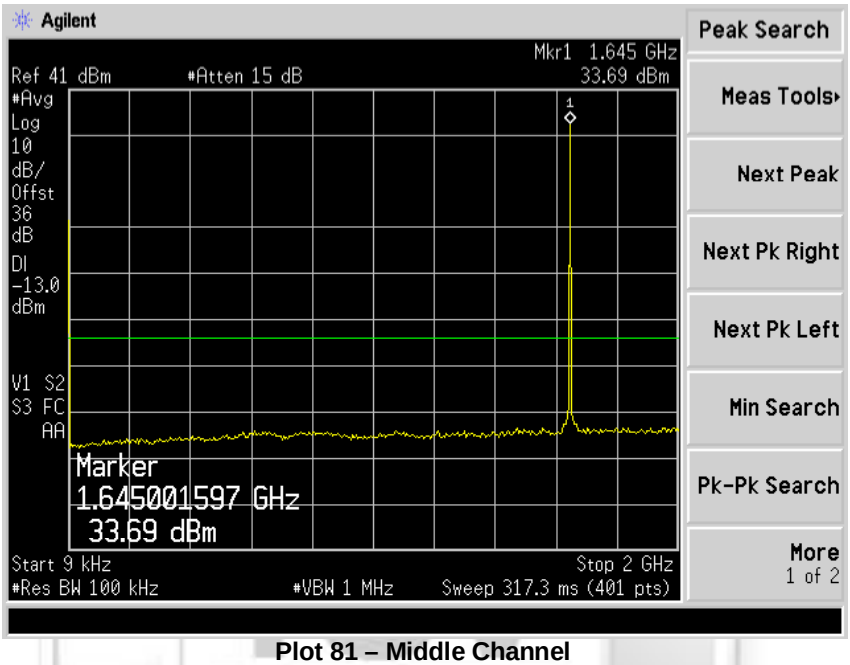



**Plot 79 – Lower Channel**

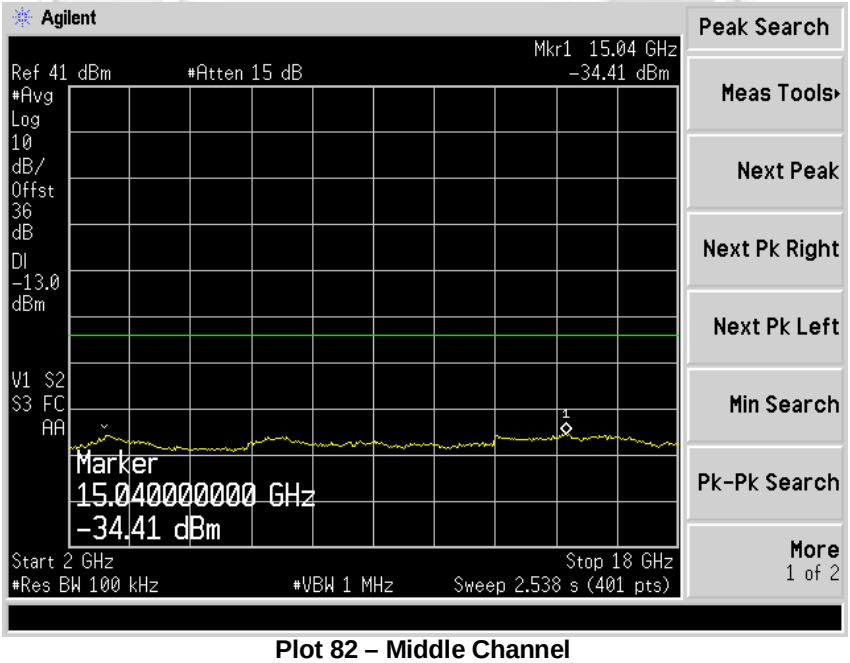



**Plot 80 – Lower Channel**

**Out of Band Spurious Plots (Bearer Type: 13)**

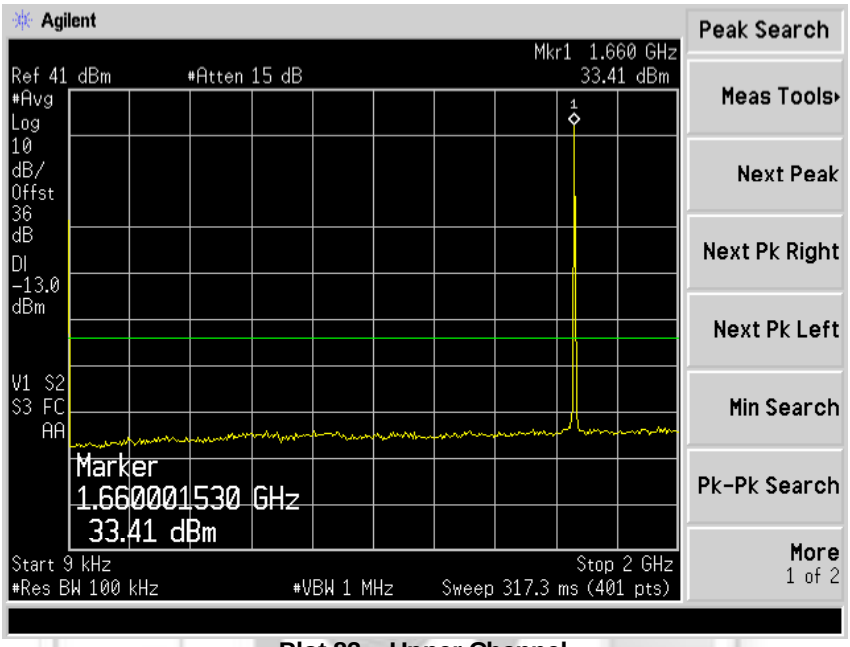



**Plot 81 – Middle Channel**

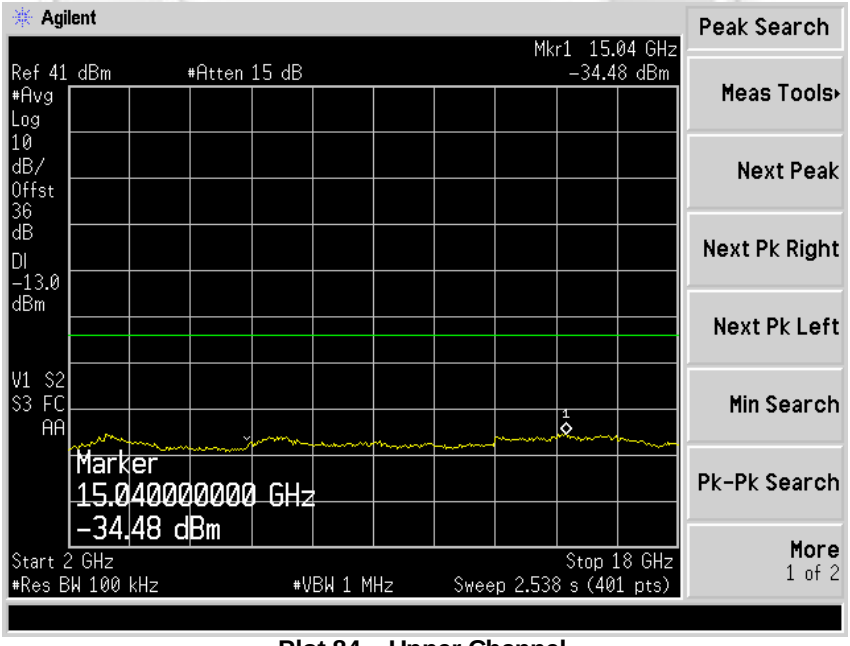



**Plot 82 – Middle Channel**

**Out of Band Spurious Plots (Bearer Type: 13)**

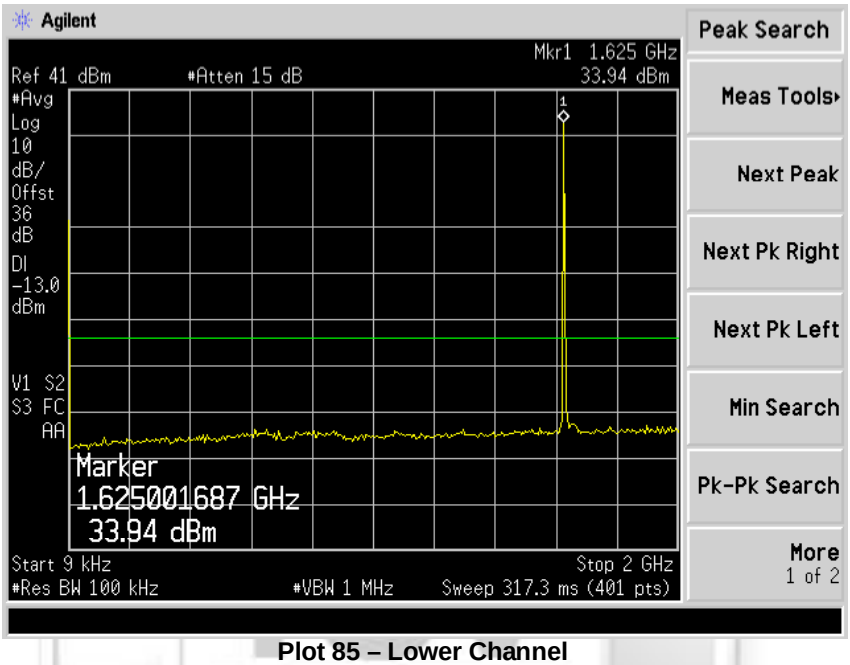



**Plot 83 – Upper Channel**

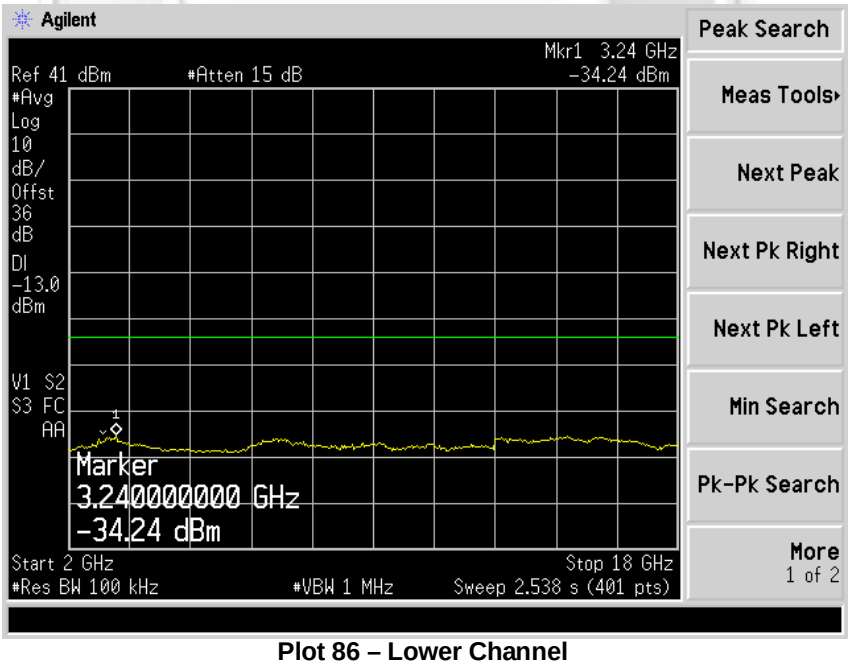



**Plot 84 – Upper Channel**

**Out of Band Spurious Plots (Bearer Type: 15)**

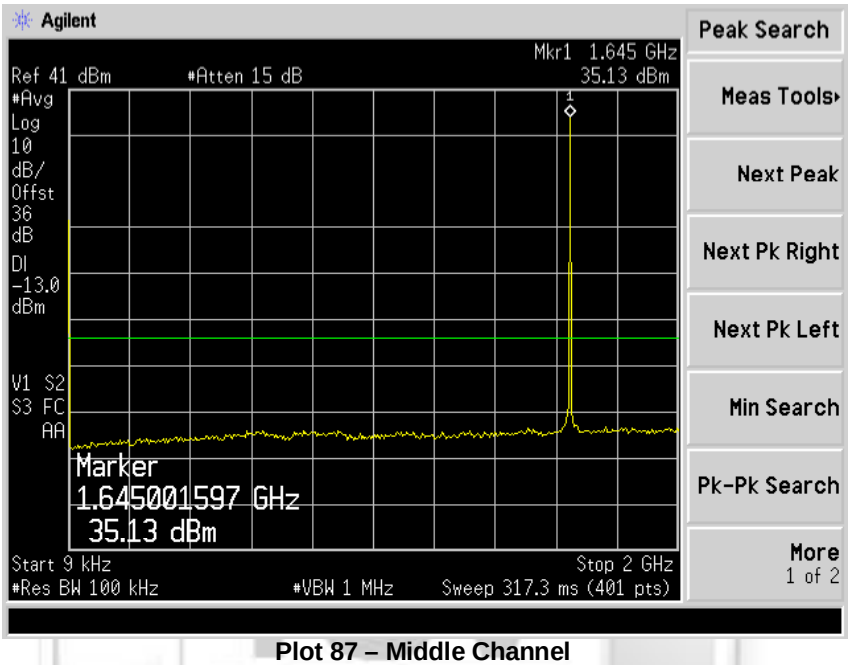



**Plot 85 – Lower Channel**

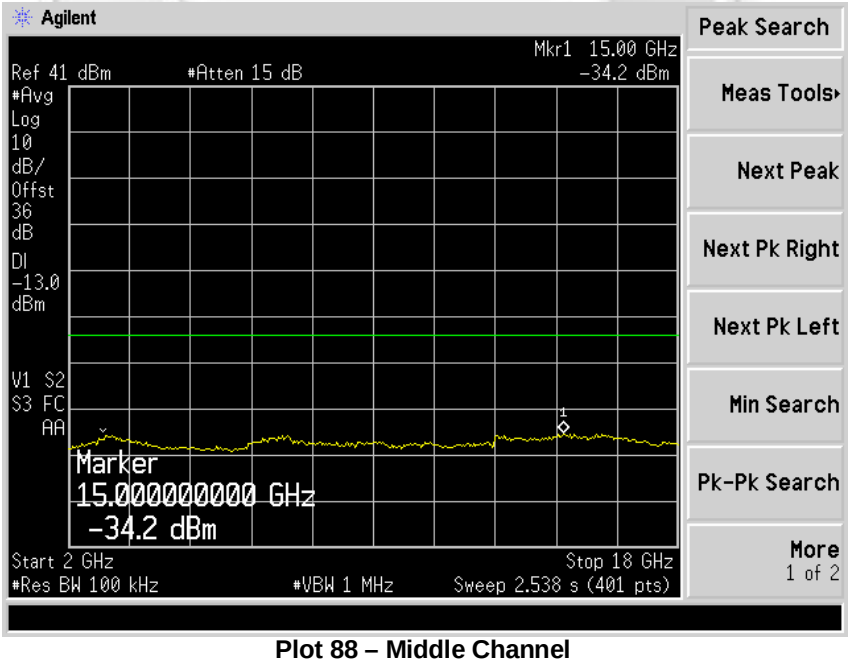



**Plot 86 – Lower Channel**

**Out of Band Spurious Plots (Bearer Type: 15)**

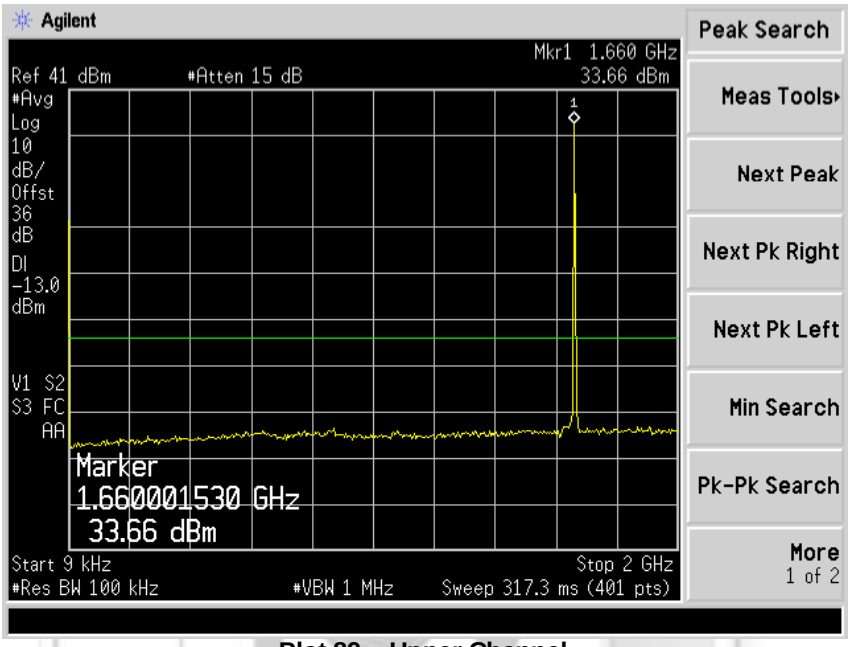



**Plot 87 – Middle Channel**

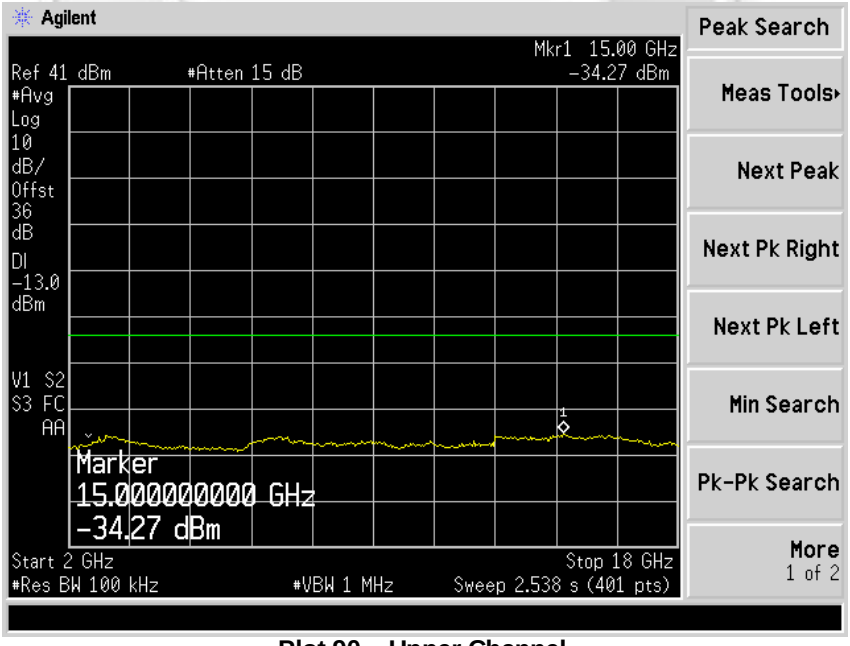



**Plot 88 – Middle Channel**

**Out of Band Spurious Plots (Bearer Type: 15)**




**Plot 89 – Upper Channel**




**Plot 90 – Upper Channel**

**47 CFR FCC Parts 2.1053 and 25.202(f) Radiated Spurious Emission Limits**

1. 25.202 Emissions Limitations
   (f) The mean power of the emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:
   (1) In any 4kHz band, the center frequency of which is removed from the assigned frequency by more than 50% up to and including 100% of the authorized bandwidth: 25 decibels;
   (2) In any 4kHz band, the center frequency of which is removed from the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth: 35 decibels;
   (3) In any 4kHz band, the center frequency of which is removed from the assigned frequency by more than 250% of the authorized bandwidth: an amount equal to 43 decibels plus 10 times logarithm (to the base 10) of the transmitter power in watts.

2. 2.1053 Measurements Required: Field Strength of Spurious Emissions
   (a) Measurement shall be made to detect spurious emissions that may be radiated directly form the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of 2.1049, as appropriate. For equipment operating on frequencies below 890MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.
   (b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
   (1) Those in which the spurious emission are required to be 60dB or more below the mean power of the transmitter.
   (2) All equipment operating on frequencies higher than 25MHz.
   (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
   (4) Other types of equipment as required, when deemed necessary by the Commission.

**47 CFR FCC Parts 2.1053 and 25.202(f) Radiated Spurious Emission Test Instrumentation**

| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| Rohde & Schwarz EMI Test Receiver (20Hz – 26.5GHz) | ESMI | 829179/002<br>829179/005 | 28 Jul 2011 |
| TDK RF Solutions Hybrid Log Periodic Antenna (30MHz-3GHz) | HLP-3003C | 130238 | 19 Mar 2012 |
| Sonoma Preamplifier (9kHz – 1GHz) | 310N | 270640 | 13 Sep 2011 |
| TDK RF Solution Horn Antenna (1GHz-18GHz) | HRN-0118 | 130256 | 15 Mar 2012 |
| Schwarzbeck Horn Antenna (2-18GHz) / Pre-amplifier assembly HAP-series | BBHA 9120 C/ HAP06-18W | 00000004 | 25 Mar 2012 |
| Sonoma Preamplifier (9kHz – 1GHz) | 310N | 270640 | 13 Sep 2011 |
| Toyo MicroWave Preamplifier (1GHz - 8GHz) | TPA0108-40 | 0443 | 02 Feb 2012 |

**47 CFR FCC Parts 2.1053 and 25.202(f) Radiated Spurious Emission Test Setup**

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant antenna was set at the required test distance away from the EUT and supporting equipment boundary

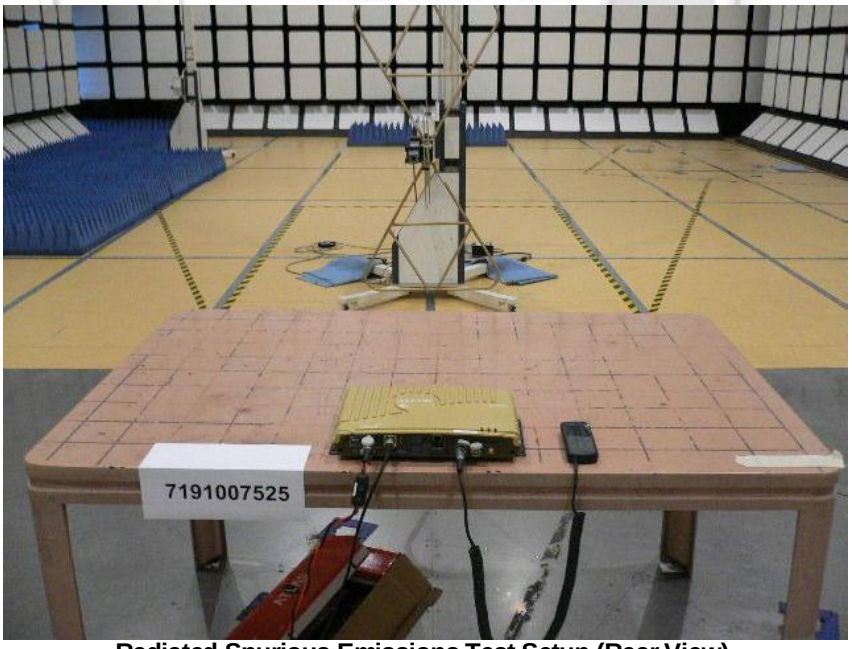
**47 CFR FCC Parts 2.1053 and 25.202(f) Radiated Spurious Emission Test Method**

1. The EUT was set to transmit at the maximum power at the lower channel with the modulation on at normal test condition.
2. The receiving antenna (test antenna) was set at vertical polarization with the height of 1m.
3. With the spectrum analyser was set to max hold enabled (peak detector mode), the spurious emissions were searched and recorded. For EUT which is a portable device, the spurious emission search was carried out by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces worst emissions.
4. For each spurious emission found, the test antenna was raised or lowered through the specified range of heights (1m – 4m) until a maximum signal level was detected on the test receiver.
5. The EUT was then rotated through 360º in the horizontal plane until the maximum signal was received. The maximum received signal level was recorded as A (in dBm).
6. The EUT was replaced with the substitution antenna with the antenna input was connected to the signal generator via a 10dB attenuator (if required).
7. The signal generator was set to the found spurious frequency. The output level of the signal generator was adjusted until the test receiver was at least 20dB above the level when the signal generator was switched off.
8. The test antenna was raised and lowered through the specified range of heights (1m – 4m) until the maximum signal level was received on the test receiver.
9. The substitution antenna was rotated until the maximum level was detected on the test receiver.
10. The output level of the signal generator was adjusted until the received signal level at the test receiver was equal to the level recorded in step 5 (A dBm). The signal generator output level was recorded as B (in dBm).
11. The spurious emission level, P (e.i.r.p) was computed as followed:

| | | | |
|---|---|---|---|
| P (e.i.r.p) | | = | B – C – D + E |
| where | C | = | cable loss between the signal generator and the substitution |
| | D | = | attenuation level if attenuator is used |
| | E | = | substitution antenna gain |

12. The steps 2 to 11 were repeated with the receiving antenna was set to horizontal polarization.
13. Comparison was made on both measured results with vertical and horizontal polarizations. The highest value out of vertical and horizontal polarizations was recorded.
14. The steps 2 to 13 were repeated until all the spurious emissions (up to $10^{th}$ harmonics of the carrier frequency) were measured.
15. The steps 1 to 14 were repeated with the EUT was set to operate at the middle and upper channels respectivley.


**Radiated Spurious Emissions Test Setup (Front View)**




**Radiated Spurious Emissions Test Setup (Rear View)**

**47 CFR FCC Parts 2.1053 and 25.202(f) Radiated Spurious Emission Results**

| | | | |
|---|---|---|---|
| Operating Mode | Satellite Transmission | Temperature | 22°C |
| Test Input Power | 12VDC (Worst Voltage) | Relative Humidity | 51% |
| Test Distance | 3m | Atmospheric Pressure | 1025mbar |
| Type Bearer | 15 (Worst Bearer) | Tested By | Derrick Ng |

**30MHz – 1GHz**

**Lower Channel**

| Frequency (MHz) | Amplitude (dBm) | Limit (dBm) |
|---|---|---|
| 68.0990 | -73.4 | -13.0 |
| 95.3130 | -75.8 | -13.0 |
| 148.6530 | -76.0 | -13.0 |
| 197.6380 | -76.4 | -13.0 |
| -- | -- | -- |
| -- | -- | -- |

**Middle Channel**

| Frequency (MHz) | Amplitude (dBm) | Limit (dBm) |
|---|---|---|
| 37.6200 | -71.5 | -13.0 |
| 69.1880 | -74.2 | -13.0 |
| 313.0240 | -76.4 | -13.0 |
| 329.3530 | -75.2 | -13.0 |
| 866.0110 | -71.7 | -13.0 |
| -- | -- | -- |

**Upper Channel**

| Frequency (MHz) | Amplitude (dBm) | Limit (dBm) |
|---|---|---|
| 68.0990 | -74.4 | -13.0 |
| 94.2250 | -75.9 | -13.0 |
| 146.4750 | -76.3 | -13.0 |
| 198.7260 | -75.9 | -13.0 |
| 329.3530 | -75.2 | -13.0 |
| 247.7110 | -78.9 | -13.0 |

**RADIATED SPURIOUS EMISSIONS TEST**

**1GHz – 17GHz**

**Lower Channel**

| Frequency (GHz) | Amplitude (dBm) | Limit (dBm) |
|---|---|---|
| 2.2120 | -61.5 | -13.0 |
| 3.1434 | -61.6 | -13.0 |
| 3.9458 | -63.5 | -13.0 |
| 5.0007 | -63.2 | -13.0 |
| 5.5001 | -63.0 | -13.0 |
| -- | -- | -- |

**Middle Channel**

| Frequency (GHz) | Amplitude (dBm) | Limit (dBm) |
|---|---|---|
| 2.2456 | -61.9 | -13.0 |
| 2.7338 | -62.2 | -13.0 |
| 3.0817 | -61.7 | -13.0 |
| 3.7213 | -64.1 | -13.0 |
| 5.0007 | -62.5 | -13.0 |
| -- | -- | -- |

**Upper Channel**

| Frequency (GHz) | Amplitude (dBm) | Limit (dBm) |
|---|---|---|
| 2.2344 | -61.7 | -13.0 |
| 2.9582 | -61.4 | -13.0 |
| 3.7662 | -65.1 | -13.0 |
| 4.3049 | -63.2 | -13.0 |
| 5.0007 | -62.2 | -13.0 |
| -- | -- | -- |

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. "--" indicates no emissions were found and shows compliance to the limits.
4. The Resolution Bandwidth (RBW) was corrected from 4kHz by 10log10 [(used RBW) / 4kHz].
5. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 20GHz
   RBW: 100kHz VBW: 300kHz
6. Emission limits are computed based on following:
   a. Emissions Limits (dBm) (50% - 100% authorised bandwidth) = P - 25 + CF
   b. Emissions Limits (dBm) (100% - 250% authorised bandwidth) = P - 35 + CF
   c. Emissions Limits (dBm) (> 250% authorised bandwidth) = $P - [43 + 10 \log_{10} P_W] + 30 + CF$

   where P = Measured mean power in dBm
   $P_W$ = Meausred mean power in W
   CF = RBW correction factor (see Note 4)
7. Radiated Spurious Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 25GHz is ±4.6dB.

## PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

**47 CFR FCC Part 25.216(h)(i)(j) Protection of Aeronautical Radio Navigation Satellite Service Limits**

25.216(h)(i)(j) Limits on Emissions from Mobile Earth Stations for Protection of Aeronautical Radionavigation-Satellite Service

(h) Mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FC 03-283 (from November 6, 2003) with assigned uplink frequencies in the 1626.5MHz - 1660.5MHz band shall suppress the power density of emissions in the 1605MHz - 1610MHz band-segment to an extent determined by linear interoperation from -70dBW/MHz at 1605MHz to -46dBW/MHz at 1610MHz, averaged over any 2ms active transmission interval. The e.i.r.p of discrete emissions of less than 700Hz bandwidth from such stations shall not exceed a level determined by linear interoperation from -80dBW at 1605MHz to -56dBW at 1610MHz, averaged over any 2ms active transmission interval.

(i) The e.i.r.p density of carrier-off state emissions from mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies between 1GHz and 3GHz shall not exceed -80dBW/MHz in the 1559MHz - 1610MHz band averaged over any 2ms interval.

(j) A Root-Mean-Square detector shall be used for all power density measurements.

**47 CFR FCC Part 25.216(h)(i)(j) Protection of Aeronautical Radio Navigation Satellite Service Test Instrumentation**

| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| Agilent EMC Analyzer | E7403A | US41160165 | 04 Nov 2011 |
| TDK RF Solution Horn Antenna (1GHz-18GHz) | HRN-0118 | 130256 | 15 Mar 2012 |
| Toyo MicroWave Preamplifier (1GHz - 8GHz) | TPA0108-40 | 0443 | 02 Feb 2012 |

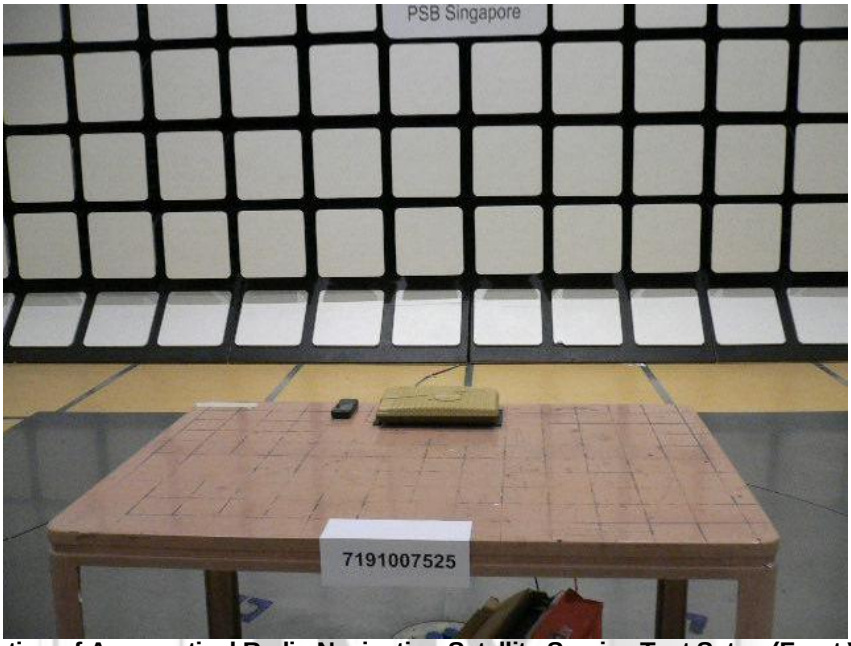
## PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

**47 CFR FCC Part 25.216(h)(i)(j) Protection of Aeronautical Radio Navigation Satellite Service Test Setup**

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant antenna was set at the required test distance away from the EUT and supporting equipment boundary

**47 CFR FCC Part 25.216(h)(i)(j) Protection of Aeronautical Radio Navigation Satellite Service Test Method**

1. The EUT was set to transmit at the maximum power at the lower channel with the modulation on at normal test condition.
2. The receiving antenna (test antenna) was set at vertical polarization with the height of 1m.
3. A prescan was carried out in the frequency range under investigations with the EMI receiver set to max hold mode. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces such emissions.
4. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
5. The maximized emissions were plotted with inclusion of corrector factor of measured radiated emissions to EIRP.
6. The steps 1 to 5 were repeated with the EUT was set to operate at the middle and upper channels respectively.
7. The measurements were repeated with the EUT in carrier off state (standby).




**Protection of Aeronautical Radio Navigation Satellite Service Test Setup (Front View)**


**Protection of Aeronautical Radio Navigation Satellite Service Test Setup (Rear View)**

**PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST**

**47 CFR FCC Part 25.216(h)(i)(j) Protection of Aeronautical Radio Navigation Satellite Service Results**

| | | | |
|---|---|---|---|
| Operating Mode | Satellite Transmission | Temperature | 23°C |
| Test Input Power | 12VDC (Worst Voltage) | Relative Humidity | 52% |
| Test Distance | 3m | Atmospheric Pressure | 1027mbar |
| Type Bearer | 15 (worst bearer) | Tested By | Jason Lai |
| Attached Plots | 91 - 93 | | |

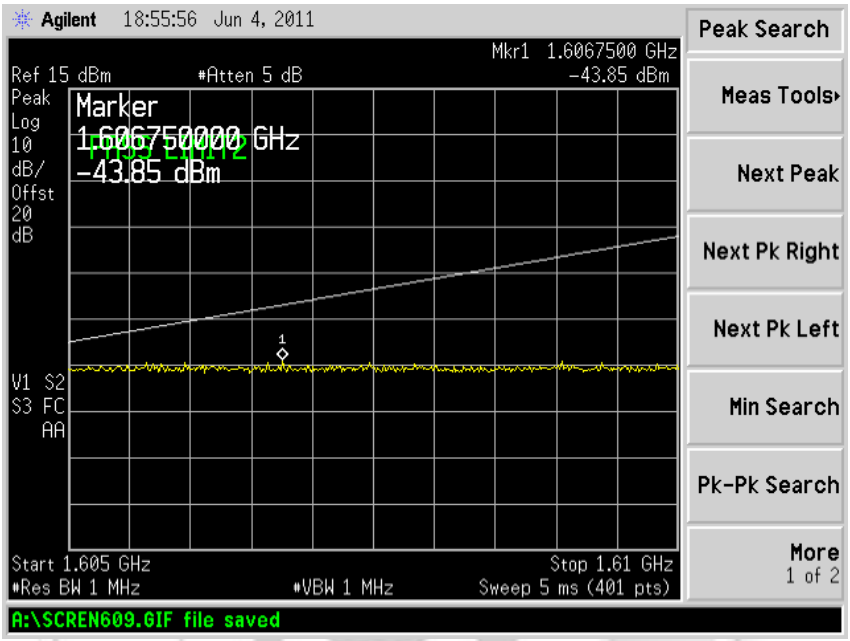
All spurious signals found were below the specified limit. Please refer to the attached plots.

| | | | |
|---|---|---|---|
| Operating Mode | Satellite Off (Standby) | Temperature | 23°C |
| Test Input Power | 12VDC (Worst Voltage) | Relative Humidity | 52% |
| Test Distance | 3m | Atmospheric Pressure | 1027mbar |
| Type Bearer | -- | Tested By | Jason Lai |
| Attached Plots | 94 | | |

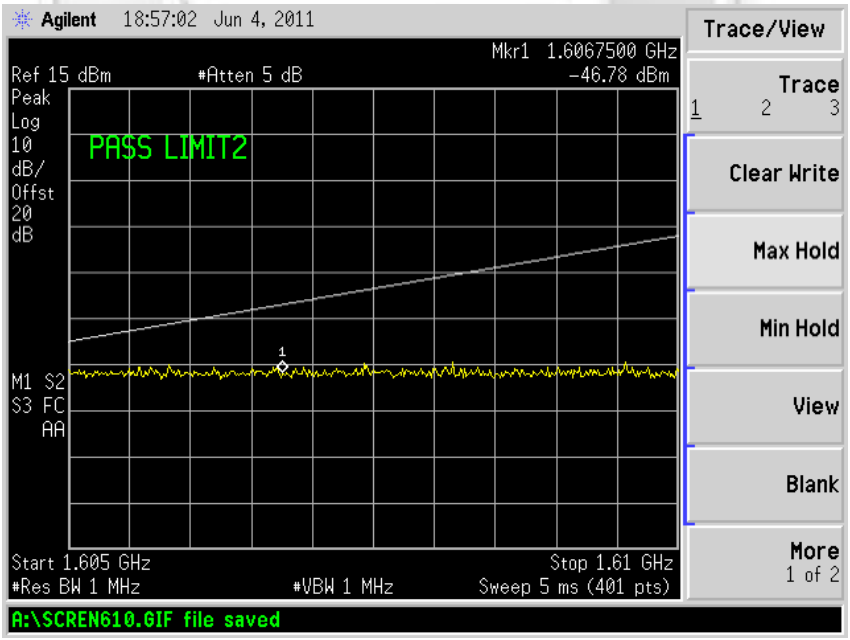
All spurious signals found were below the specified limit. Please refer to the attached plots.

**PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST**

**Type Bearer: 15 - Transmitter On**



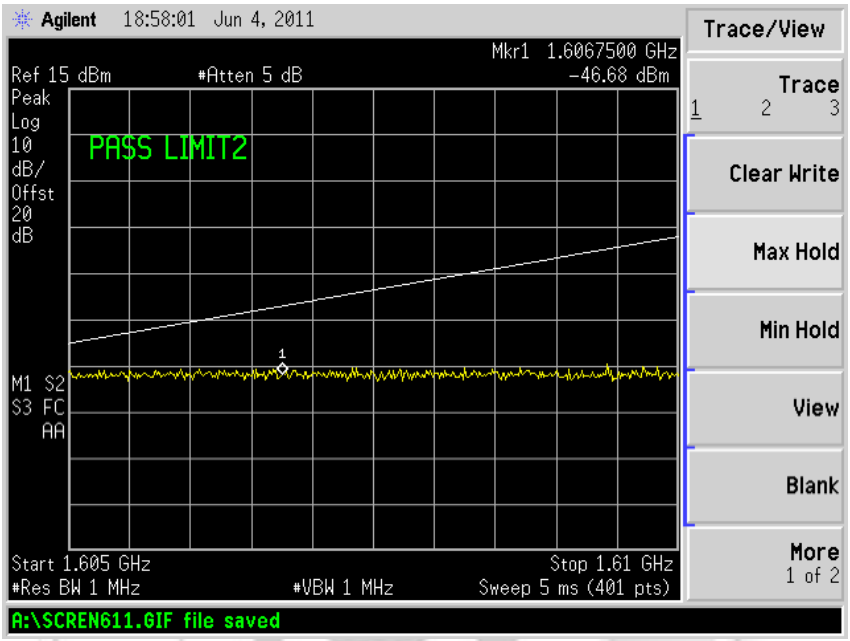

**Plot 91 – Lower Channel**




**Plot 92 – Middle Channel**

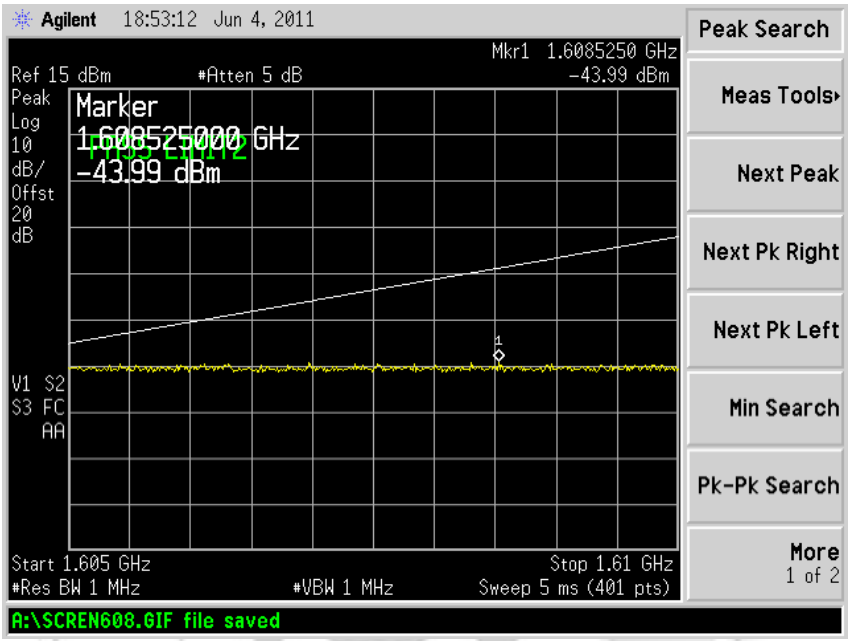
**PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST**

**Type Bearer: 15 - Transmitter On**




**Plot 93 – Upper Channel**

**Carrier Off**




**Plot 94**

## FREQUENCY STABILITY (TEMPERATURE VARIATION) TEST

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Temperature Variation) Test Limits**

1. 25.202(d) Frequency Tolerance, Earth Stations
   The carrier frequency of each earth station transmitter authorised in these services shall be maintained within 0.001% (10ppm) of the reference frequency.

2. 2.1055 Measurements Required: Frequency Stability
   (a) The frequency stability shall be measured with variation of ambient temperature as follows:

   (1) From -30°C to +50°C for all equipment except that specified in paragraphs (a)(2) and (3) of this section.
   (b) Frequency measurements shall be made at the extremes of the specified temperature range and at interval of not more than 10°C throughout the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion of portions of the transmitter containing the frequency determining and stabilizing circuitry need to be subjected to the temperature variation test.
   (d) The frequency stability shall be measured with variation of primary supply voltage as follows:
   (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
   (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
   (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Temperature Variation) Test Instrumentation**

| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| Agilent Spectrum Analyzer | E7405A | MY45106084 | 11 Jan 2012 |
| Bird 20dB Attenuator | 25-A-MFN-20 | 0209 | 25 May 2012 |
| CSZ Temperature Chamber | ZH-8-1-1-H/AC | ZF9624410 | 21 Oct 2011 |

## FREQUENCY STABILITY (TEMPERATURE VARIATION) TEST

### 47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Temperature Variation) Test Setup

1. The EUT and supporting equipment were set up as shown in the test setup photo. A temperature-controlled chamber was used.
2. The EUT was connected to an appropriate power source while all other supporting equipment were powered separately from another power source.
3. The RF antenna connector of the EUT was connected to the spectrum analyser via a RF attenuator and a low-loss coaxial cable.

### 47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Temperature Variation) Test Method

1. The temperature chamber was set at 20°C and permitted to stabilize. The EUT was set to transmit at lower channel without modulation. The carrier frequency was measured as the reference frequency.
2 With the EUT power removed, the temperature of the temperature chamber was set to -30°C and permitted to stabilize.
3. The EUT was turned on and set to operate at lower channel without modulation. The maximum change in the carrier frequency was recorded within a minute.
4. The EUT was powered off and the temperature was raised to -20°C.
5. The EUT was left stabilized for at least an hour before next measurement was taken as described in step 3.
6. The steps 4 and 5 were repeated with increment of temperature in 10°C step until the temperature reached 50°C.
7. The steps 1 to 6 were repeated with the EUT was set to operate at the middle and upper channels respectively.


**Frequency Stability (Temperature Variation) Test Setup**

**FREQUENCY STABILITY (TEMPERATURE VARIATION) TEST**

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Temperature Variation) Results**

| | | | |
|---|---|---|---|
| Operating Mode | Satellite Transmission (CW) | Temperature | See table below |
| Test Input Power | 24VDC | Relative Humidity | 52% |
| | | Atmospheric Pressure | 1025mbar |
| | | Tested By | Foo Kai Maun |

**Lower Channel**

| Temperature (°C) | Measured Frequency (GHz) | Reference Channel Frequency (GHz) | Deviation (Hz) | Limit (Hz) |
|---|---|---|---|---|
| -30 | 1.626599795 | 1.626600000 | -205.000000 | +/-16266 |
| -20 | 1.626599959 | 1.626600000 | -41.000000 | +/-16266 |
| -10 | 1.626599896 | 1.626600000 | -104.000000 | +/-16266 |
| 0 | 1.626599804 | 1.626600000 | -196.000000 | +/-16266 |
| 10 | 1.626600187 | 1.626600000 | 187.000000 | +/-16266 |
| 20 | 1.626600262 | 1.626600000 | 262.000000 | +/-16266 |
| 30 | 1.626600216 | 1.626600000 | 216.000000 | +/-16266 |
| 40 | 1.626600219 | 1.626600000 | 219.000000 | +/-16266 |
| 50 | 1.626600211 | 1.626600000 | 211.000000 | +/-16266 |

**Middle Channel**

| Temperature (°C) | Measured Frequency (GHz) | Reference Channel Frequency (GHz) | Deviation (Hz) | Limit (Hz) |
|---|---|---|---|---|
| -30 | 1.643499811 | 1.643500000 | -189.000000 | +/-16435 |
| -20 | 1.643499701 | 1.643500000 | -299.000000 | +/-16435 |
| -10 | 1.643499713 | 1.643500000 | -287.000000 | +/-16435 |
| 0 | 1.643499812 | 1.643500000 | -188.000000 | +/-16435 |
| 10 | 1.643500192 | 1.643500000 | 192.000000 | +/-16435 |
| 20 | 1.643500274 | 1.643500000 | 274.000000 | +/-16435 |
| 30 | 1.643500304 | 1.643500000 | 304.000000 | +/-16435 |
| 40 | 1.643500287 | 1.643500000 | 287.000000 | +/-16435 |
| 50 | 1.643500236 | 1.643500000 | 236.000000 | +/-16435 |

## FREQUENCY STABILITY (TEMPERATURE VARIATION) TEST

**Upper Channel**

| Temperature (°C) | Measured Frequency (GHz) | Reference Channel Frequency (GHz) | Deviation (Hz) | Limit (Hz) |
|---|---|---|---|---|
| -30 | 1.660399876 | 1.660400000 | -124.000000 | +/-16604 |
| -20 | 1.660399977 | 1.660400000 | -23.000000 | +/-16604 |
| -10 | 1.660399849 | 1.660400000 | -151.000000 | +/-16604 |
| 0 | 1.660399755 | 1.660400000 | -245.000000 | +/-16604 |
| 10 | 1.660400135 | 1.660400000 | 135.000000 | +/-16604 |
| 20 | 1.660400222 | 1.660400000 | 222.000000 | +/-16604 |
| 30 | 1.660400303 | 1.660400000 | 303.000000 | +/-16604 |
| 40 | 1.660400309 | 1.660400000 | 309.000000 | +/-16604 |
| 50 | 1.660400308 | 1.660400000 | 308.000000 | +/-16604 |

## FREQUENCY STABILITY (VOLTAGE VARIATION) TEST

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Voltage Variation) Test Limits**

1. 25.202(d) Frequency Tolerance, Earth Stations
   The carrier frequency of each earth station transmitter authorised in these services shall be maintained within 0.001% (10ppm) of the reference frequency.

2. 2.1055 Measurements Required: Frequency Stability
   (a) The frequency stability shall be measured with variation of ambient temperature as follows:

   (1) From -30°C to +50°C for all equipment except that specified in paragraphs (a)(2) and (3) of this section.
   (b) Frequency measurements shall be made at the extremes of the specified temperature range and at interval of not more than 10°C throughout the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion of portions of the transmitter containing the frequency determining and stabilizing circuitry need to be subjected to the temperature variation test.
   (d) The frequency stability shall be measured with variation of primary supply voltage as follows:
   (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
   (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
   (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Voltage Variation) Test Instrumentation**

| Instrument | Model | S/No | Cal Due Date |
|---|---|---|---|
| Agilent Spectrum Analyzer | E7405A | MY45106084 | 11 Jan 2012 |
| Bird 20dB Attenuator | 25-A-MFN-20 | 0209 | 25 May 2012 |
| CSZ Temperature Chamber | ZH-8-1-1-H/AC | ZF9624410 | 21 Oct 2011 |

**FREQUENCY STABILITY (VOLTAGE VARIATION) TEST**

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Voltage Variation) Test Setup**

1. The EUT and supporting equipment were set up as shown in the test setup photo. A temperature-controlled chamber was used.
2. The EUT was connected to an appropriate power source while all other supporting equipment were powered separately from another power source.
3. The RF antenna connector of the EUT was connected to the spectrum analyser via a RF attenuator and a low-loss coaxial cable.

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Voltage Variation) Test Method**

1. The temperature chamber was set at 20$^{o}$C and permitted to stabilize. The EUT was set to transmit at lower channel without modulation. The carrier frequency was measured as the reference frequency.
2. The EUT was powered from 85% of the nominal supplied voltage and set to operate at lower channel without modulation.
3. The EUT power was varied from 85% to 115% of the nominal supplied voltage. The carrier frequency variation was recorded.
4. The steps 1 to 3 were repeated with the EUT was set to operate at the middle and upper channels respectively.


**Frequency Stability (Voltage Variation) Test Setup**

**FREQUENCY STABILITY (VOLTAGE VARIATION) TEST**

**47 CFR FCC Parts 2.1055 and 25.202(d) Frequency Stability (Voltage Variation) Results**

| | | | |
|---|---|---|---|
| Operating Mode | Satellite Transmission (CW) | Temperature | 20°C |
| Test Input Power | See table below | Relative Humidity | 52% |
| | | Atmospheric Pressure | 1025mbar |
| | | Tested By | Foo Kai Maun |

**Lower Channel**

| Voltage (V) | Measured Frequency (GHz) | Nominal Channel Frequency (GHz) | Deviation (Hz) | Limit (Hz) |
|---|---|---|---|---|
| 12.0 | 1.626600174 | 1.626600000 | 174.000000 | 16266 |
| 24.0 | 1.626600137 | 1.626600000 | 137.000000 | 16266 |
| 31.2 | 1.626600045 | 1.626600000 | 45.000000 | 16266 |

**Middle Channel**

| Voltage (V) | Measured Frequency (GHz) | Nominal Channel Frequency (GHz) | Deviation (Hz) | Limit (Hz) |
|---|---|---|---|---|
| 12.0 | 1.643500306 | 1.643500000 | 306.000000 | 16435 |
| 24.0 | 1.643500308 | 1.643500000 | 308.000000 | 16435 |
| 31.2 | 1.643500110 | 1.643500000 | 110.000000 | 16435 |

**Upper Channel**

| Voltage (V) | Measured Frequency (GHz) | Nominal Channel Frequency (GHz) | Deviation (Hz) | Limit (Hz) |
|---|---|---|---|---|
| 12.0 | 1.660400292 | 1.660400000 | 292.000000 | 16604 |
| 24.0 | 1.660400285 | 1.660400000 | 285.000000 | 16604 |
| 31.2 | 1.660400092 | 1.660400000 | 92.000000 | 16604 |

**MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST**

## 47 CFR FCC Part 1.1310 Maximum Permissible Exposure (MPE) Limits

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density ($mW/cm^2$) | Average Time (min) |
|---|---|---|---|---|
| 0.3 - 1.34 | 614 | 1.63 | 100 Note 2 | 30 |
| 1.34 - 30 | 824 / f | 2.19 / f | $180 / f^2$ Note 2 | 30 |
| 30 - 300 | 27.5 | 0.073 | 0.2 | 30 |
| 300 - 1500 | - | - | f / 1500 | 30 |
| 1500 - 100000 | - | - | 1.0 | 30 |
| Notes | | | | |
| 1. f = frequency in MHz | | | | |
| 2. Plane wave equivalent power density | | | | |

## 47 CFR FCC Part 1.1310 Maximum Permissible Exposure Computation

The power density at 20cm distance was computed from the following formula:

$S = (30GP) / (377d^2)$

where S = Power density in $W/m^2$
P = 2.2909W
d = Test distance at 0.2m
G = Numerical isotropic gain, 10.0 (10.0dBi)

Substituting the relevant parameters into the formula:

$S = [(30GP) / 377d^2]$
$= 0.2026 W/m^2$
$= 0.02026 mW/cm^2$

∴ The power density of the EUT at 20cm distance is $0.02026 mW/cm^2$ based on the above computation and found to be lower thant the power density limit of $1.0 mW/cm^2$.

This Report is issued under the following conditions:

1. Results of the testing/calibration in the form of a report will be issued immediately after the service has been completed or terminated.

2. Unless otherwise requested, this report shall contain only technical results carried out by TÜV SÜD PSB. Analysis and interpretation of the results and professional opinion and recommendations expressed thereupon, if required, shall be clearly indicated and additional fee paid for, by the Client.

3. This report applies to the sample of the specific product/equipment given at the time of its testing/calibration. The results are not used to indicate or imply that they are applicable to other similar items. In addition, such results must not be used to indicate or imply that TÜV SÜD PSB approves, recommends or endorses the manufacturer, supplier or user of such product/equipment, or that TÜV SÜD PSB in any way "guarantees" the later performance of the product/equipment. Unless otherwise stated in this report, no tests were conducted to determine long term effects of using the specific product/equipment.

4. The sample/s mentioned in this report is/are submitted/supplied/manufactured by the Client. TÜV SÜD PSB therefore assumes no responsibility for the accuracy of information on the brand name, model number, origin of manufacture, consignment or any information supplied.

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10. Unless otherwise stated, the tests were carried out in TÜV SÜD PSB Pte Ltd, No.1 Science Park Drive Singapore 118221.

March 2010

**FCC LABEL & POSITION** **ANNEX B**

# ANNEX A

# EUT PHOTOGRAPHS / DIAGRAMS

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

**EUT PHOTOGRAPHS – MAIN UNIT**


**Front View**


**Rear View**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

**EUT PHOTOGRAPHS – MAIN UNIT**


**Left View**


**Right View**

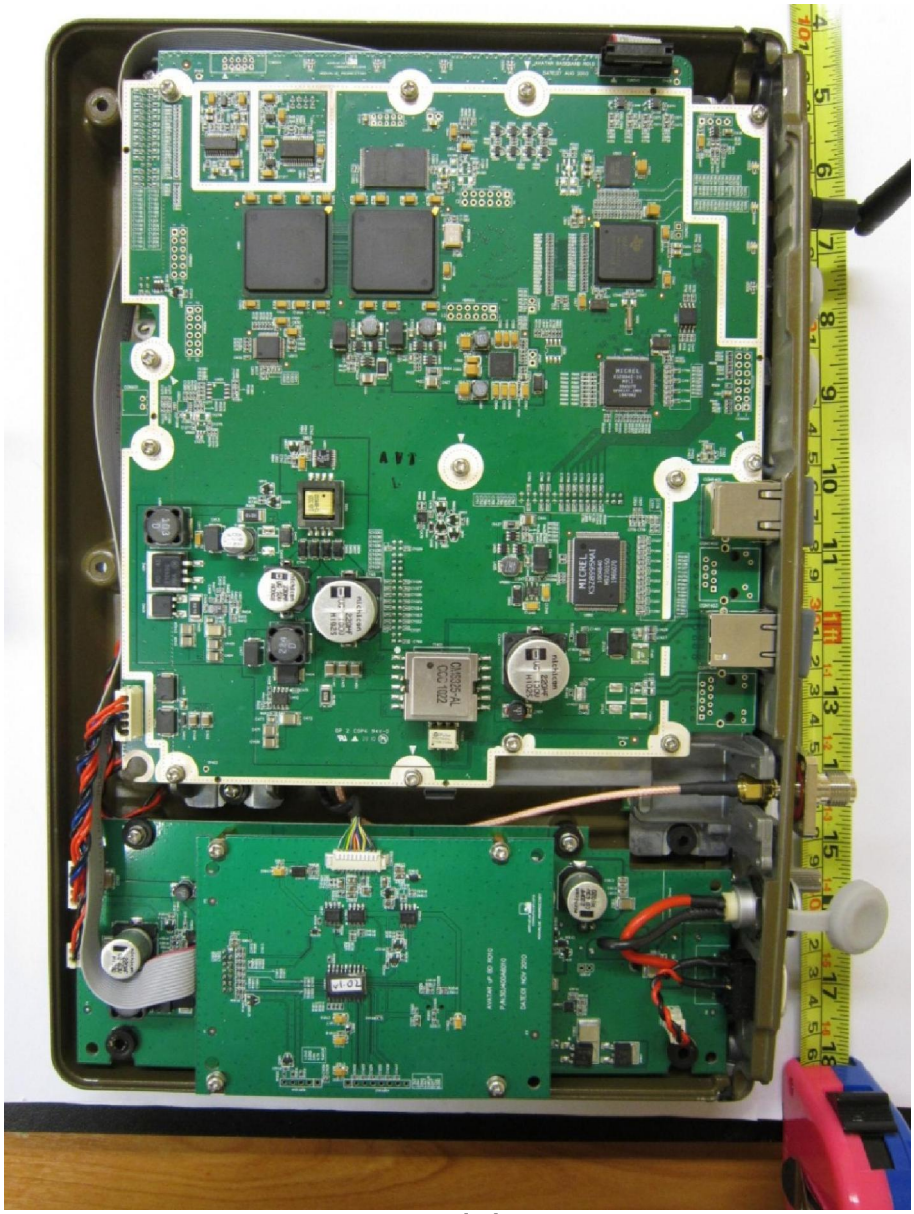
## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

### EUT PHOTOGRAPHS – MAIN UNIT

**Bottom View**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

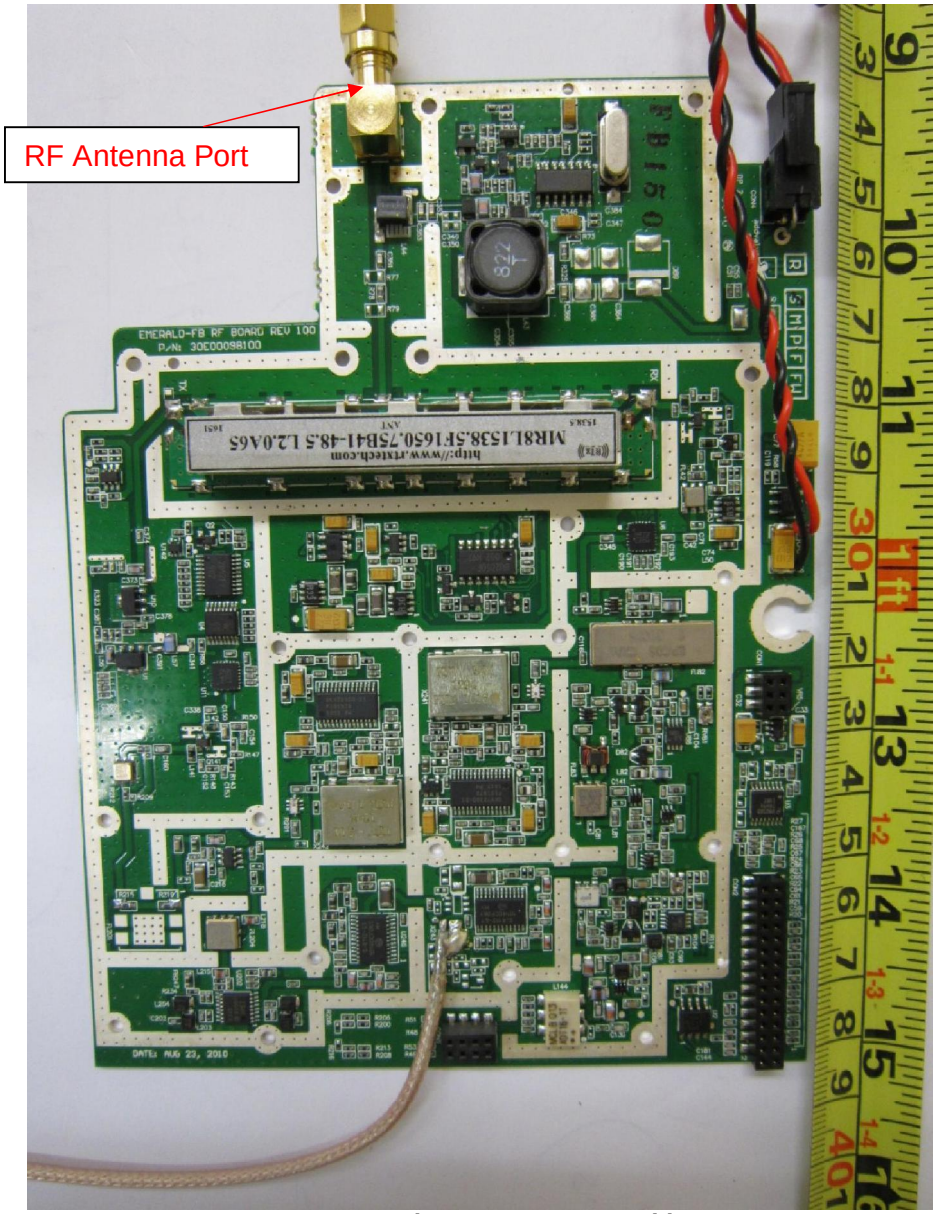
### EUT PHOTOGRAPHS – MAIN UNIT



**Internal View**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

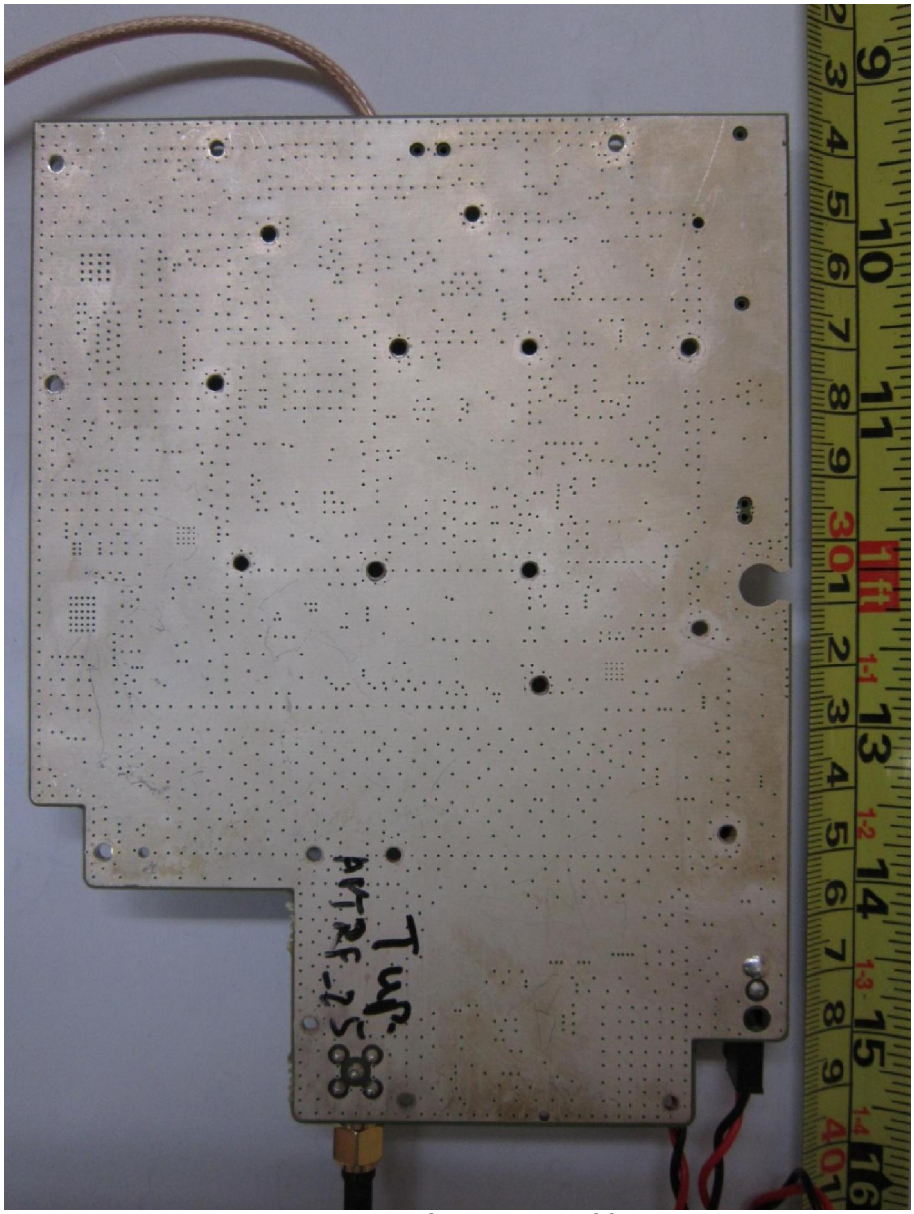
### EUT PHOTOGRAPHS – MAIN UNIT




**Base Band PCB Component Side**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

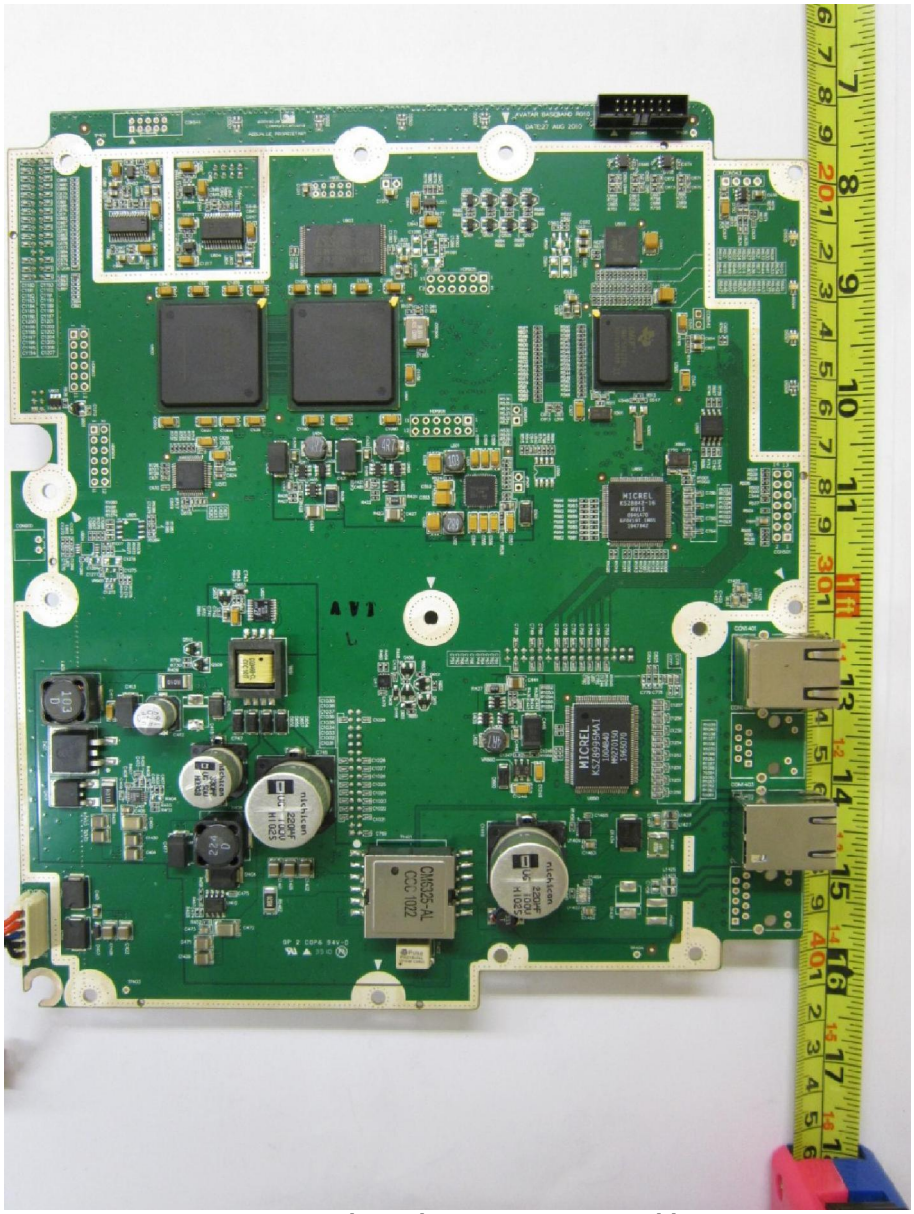
**EUT PHOTOGRAPHS – MAIN UNIT**



**Base Band PCB Trace Side**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

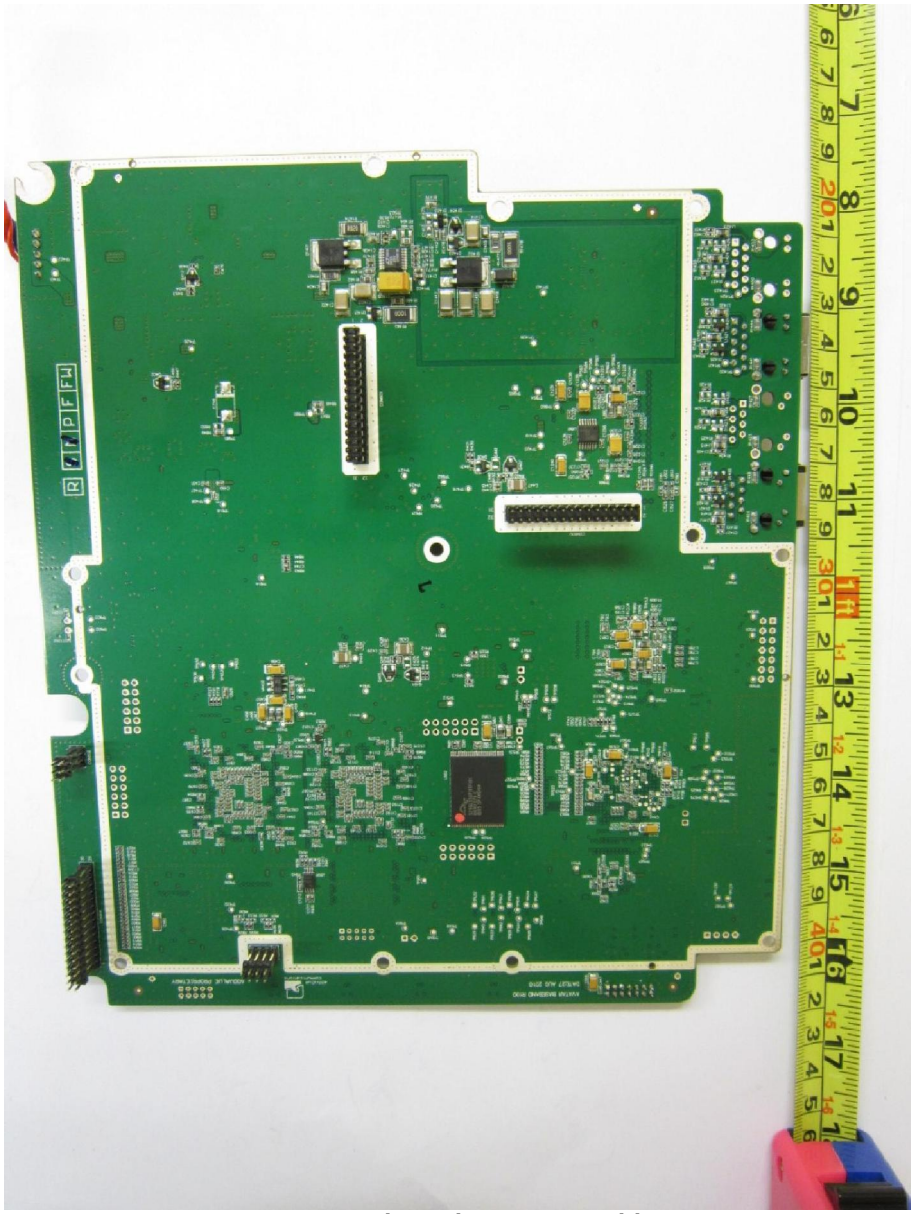
### EUT PHOTOGRAPHS – MAIN UNIT




**RF Broad Band PCB Component Side**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

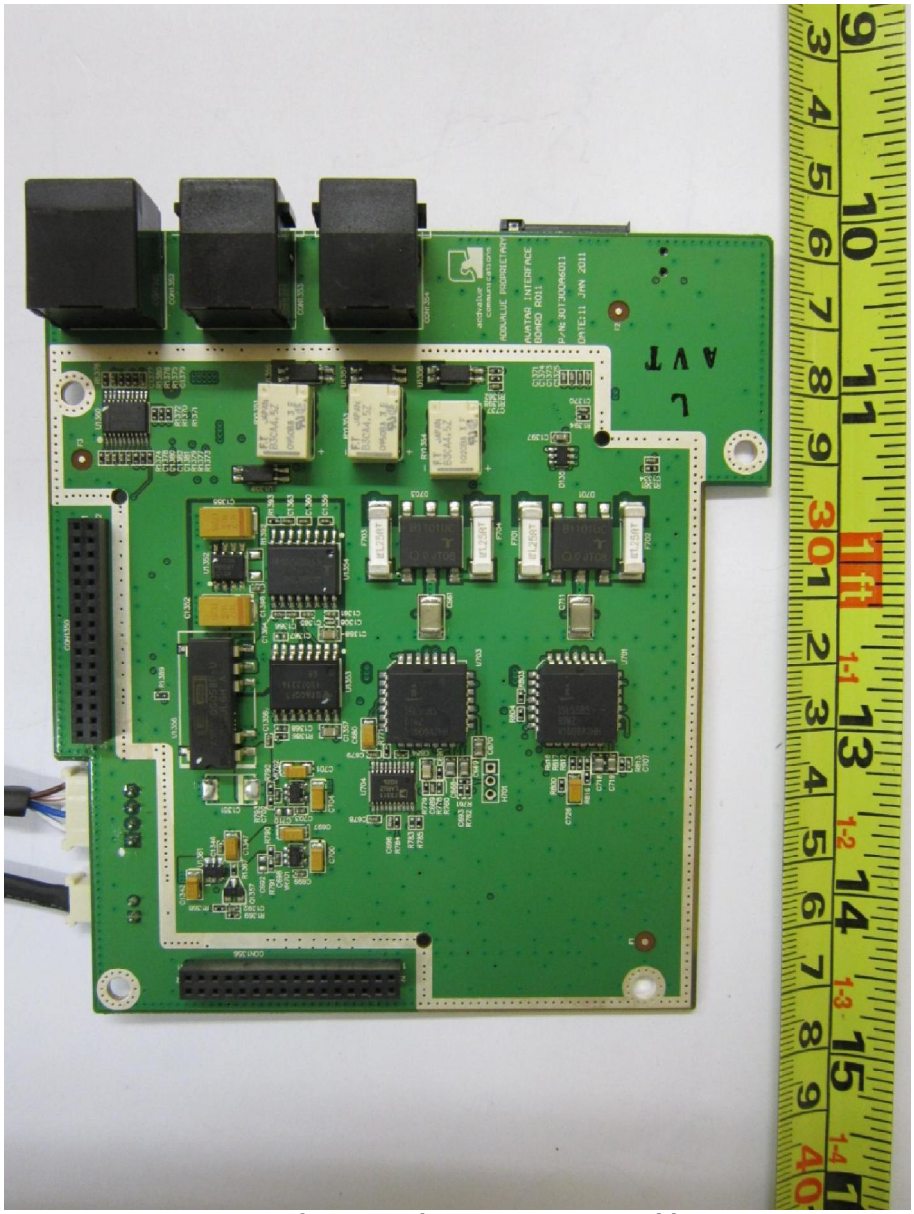
### EUT PHOTOGRAPHS – MAIN UNIT



**RF Broad Band PCB Trace Side**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

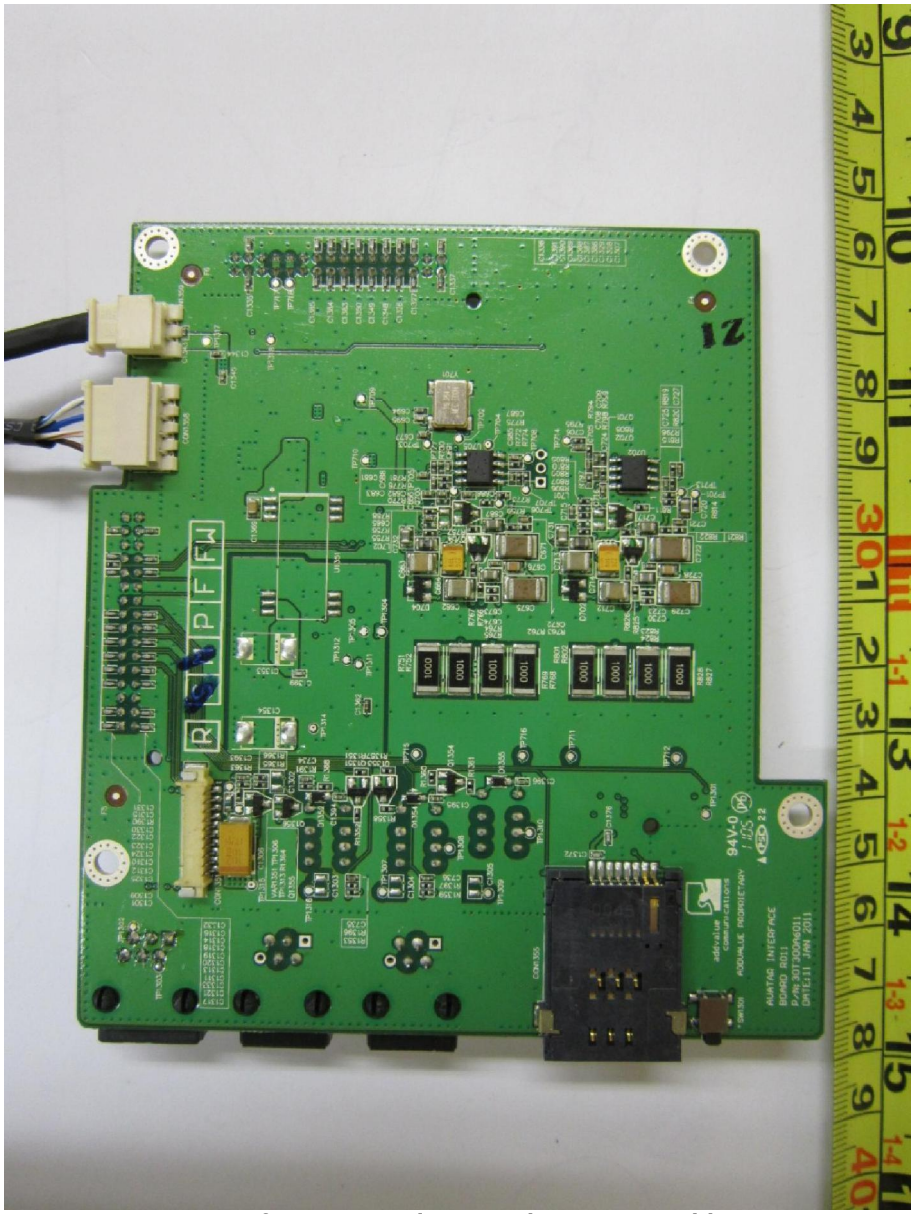
### EUT PHOTOGRAPHS – MAIN UNIT



**Interface Board PCB Component Side**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

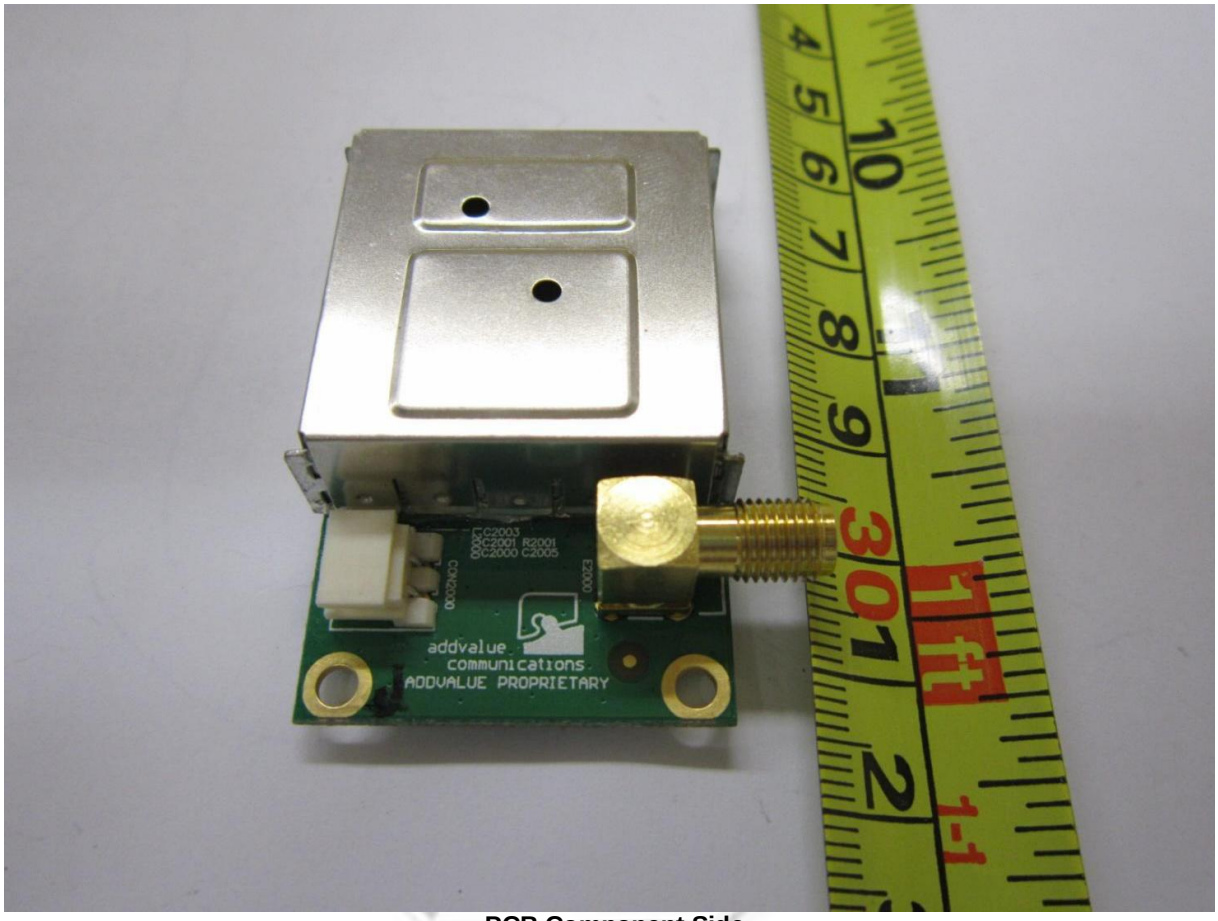
### EUT PHOTOGRAPHS – MAIN UNIT



**Interface Connecting Board PCB Trace Side**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

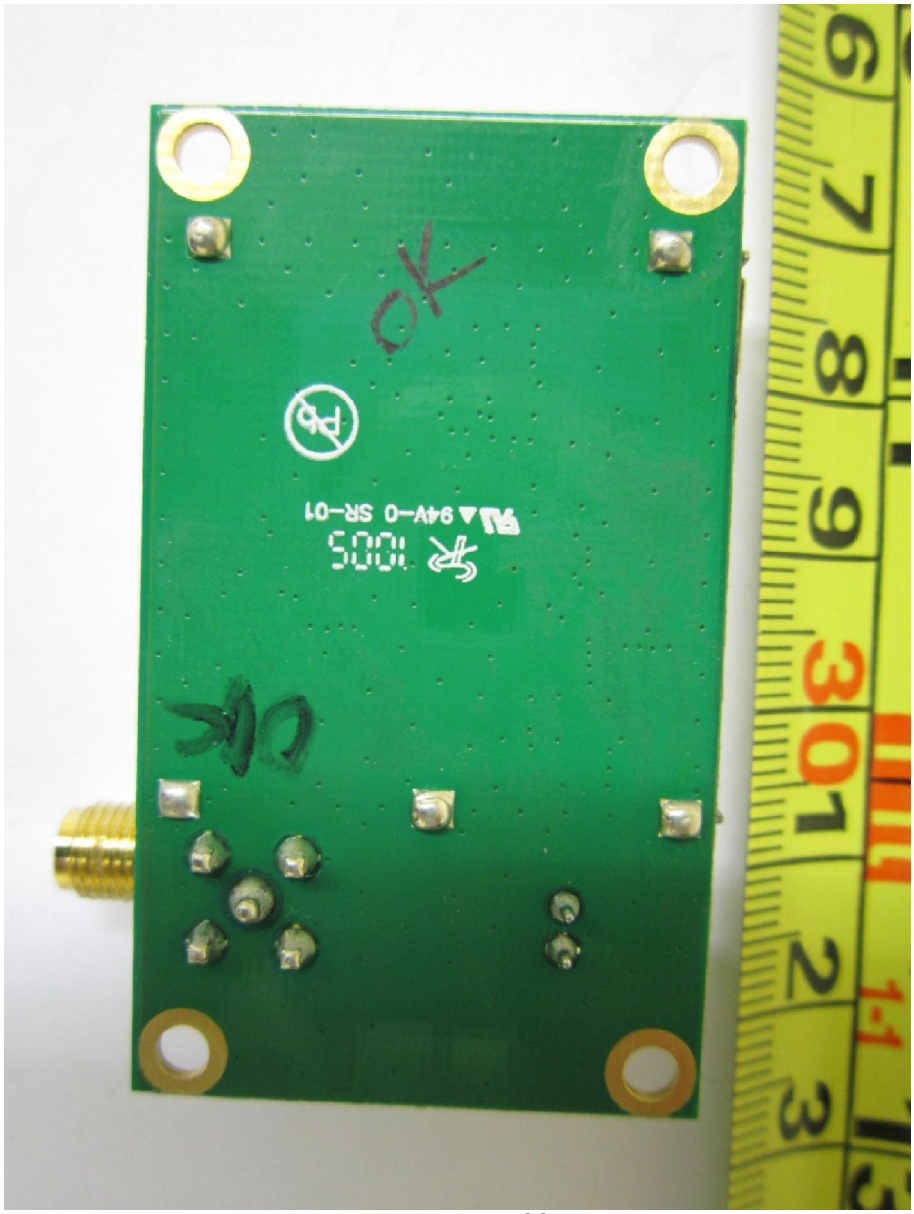
### EUT PHOTOGRAPHS – MAIN UNIT




**PCB Component Side**

## EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

**EUT PHOTOGRAPHS – MAIN UNIT**




**PCB Trace Side**