Test Report No. 7191136534-EEC16/06
dated 21 Jun 2016

PSB Singapore

Choose certainty.
Add value.

Note: This report is issued subject to the Testing and Certification Regulations of the TÜV SÜD Group and the General Terms and Conditions of Business of TÜV SÜD PSB Pte Ltd. In addition, this report is governed by the terms set out within this report.

FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 2, 15, and 25
OF A
MARITIME COMMUNICATION SYSTEM
[Model : Fleet One V2]
[FCC ID : QO4-WEFLONEVTWO]

TEST FACILITY	TÜV SÜD PSB Pte Ltd Electrical & Electronics Centre (EEC), Product Services, No. 1 Science Park Drive, Singapore 118221
FCC REG. NO.	99142 (3m and 10m Semi-Anechoic Chamber, Science Park)
IND. CANADA REG. NO.	2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park)
PREPARED FOR	Addvalue Innovation Pte Ltd 8 Tai Seng Link, Level 5 (Wing 2) Singapore 534158 Tel: +65 6509 5700 Tel: +65 6509 5701
QUOTATION NUMBER	2191039334
JOB NUMBER	7191136534
TEST PERIOD	04 Jan 2016 – 16 Jun 2016

PREPARED BY

Quek Keng Huat
Higher Associate Engineer

APPROVED BY

Foo Kai Maun
Executive Engineer

TÜV SÜD PSB

ilac-MRA ACCREDITED LABORATORY SAC-SINGLAS

LA-2007-0380-A LA-2007-0381-F LA-2007-0382-B LA-2007-0383-G	LA-2007-0384-G LA-2007-0385-E LA-2007-0386-C LA-2010-0464-D

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council. Inspections/Calibrations/Tests marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our inspection body/laboratory.

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

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

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
1 Science Park Drive, #02-01
Singapore 118221

TABLE OF CONTENTS

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		
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 106 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	1.5251
Middle Channel	1.6435	Middle Channel	1.5420
Upper Channel	1.6600	Upper Channel	1.5589

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 (for Conducted Emissions)

4. All test measurement procedures are according to ANSI/TIA-603-D-2010.

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

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is a **MARITIME COMMUNICATION SYSTEM** named as **Fleet One V2.** It consists of i. Below Deck Unit (BDU) ii. Above Deck unit (ADU) iii. Fleet One V2 Primary Handset (PHS)
Applicant	:	Addvalue Innovation Pte Ltd 8 Tai Seng Link, Level 5 (Wing 2) Singapore 534158
Manufacturer	:	Addvalue Innovation Pte Ltd 8 Tai Seng Link, Level 5 (Wing 2) Singapore 534158
Factory (ies)	:	Beyonics Technology (Senai) Sdn Bhd No. 96 (Plot 128), Jalan i-Park 1/10, Kawasan Perindustrian i-Park, 81000 Bandar Indahpura, Kulaijaya, Johor, Malaysia
Brand	:	Wideye
Model Number	:	Fleet One V2
FCC ID	:	QO4-WEFLONEVTWO
Serial Number	:	Nil
Microprocessor	:	OMAP L138
Operating / Transmitting Frequency	:	Satellite Transmitting 1626.5 MHz – 1660.5 MHz Satellite Receiving 1518.0 MHz – 1559.0 MHz GPS Receiving 1575.42MHz
Clock / Oscillator Frequency	:	Baseband Board 32.768KHz, 4.9152MHz,24MHz,25MHz,16.384MHz RF Board 4.0MHz, 24.192MHz
Modulation / Emissions Designator	:	pi/4QPSK and 16QAM (Satellite Transmit) pi/4QPSK and 16QAM (Satellite Receive) QPSK (GPS)
Antenna Gain	:	WLAN Antenna Monopole , 2dBi Satelliate antenna, 10 dBi
Port / Connectors	:	1xRJ45 LAN Port 1xCircular Connector for Primary Handset 1xRJ11 Phone Port 1xRS232 serial Port GPS output NMEA 0183 1x10pin I/O Connector port for External devices
Rated Input Power	:	12Vdc / 24Vdc via Battery

SUPPORTING EQUIPMENT DESCRIPTION

The EUT was tested as a stand-alone unit without any supporting equipment.

EUT OPERATING CONDITIONS

47 CFR FCC Parts 2, 15 and 25
1. RF Output Power **2. Unwanted Emissions at Antenna Terminal** **3. Radiated Spurious Emissions** **4. Protection of Aeronautical Radio Navigation Satellite Service** **5. Frequency Stability (Temperature Variation)** **6. Frequency Stability (Voltage Variation)** **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, "RF_CALIB" <u>Satellite Transmission Mode</u> - Continuous RF transmission at lower channel at maximum RF power - Continuous RF transmission at middle channel at maximum RF power - Continuous RF transmission at upper channel at maximum RF power <u>Satellite Reception (Receive) Mode</u> - Continuous RF reception at lower channel - Continuous RF reception at middle channel - Continuous RF reception at upper channel <u>GPS Reception (Receive) Mode</u> - Continuous GPS signal reception

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
R&S Test Receiver – ESI1	ESI40	100010	14 Jul 2016
Schaffner Bilog Antenna –(30MHz-2GHz) BL3 (Ref)	CBL6112D	2549	29 Jan 2017
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2017
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2017
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	09 Oct 2016
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	13 Apr 2017
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	13 Apr 2017
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	06 Oct 2016
K&L Microwave Tunable Band Reject Filter	3TNF-1000/2000-N/N	436	Output Monitor

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 10th 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 = 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 = 37.0 - 31.0 = 6.0	i.e. 6.0 dB below Q-P limit

47 CFR FCC Part 15.109 Radiated Emission Results

Operating Mode	Continuous Satellite Transmission	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Chung Chuen Kai

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
61.4130	34.6	40.0	5.4	300	74	H
151.7260	26.9	43.5	16.6	202	169	H
181.1760	32.4	43.5	11.1	100	304	V
499.2350	28.0	46.0	18.0	300	257	H
864.4140	31.3	46.0	14.7	100	19	V
952.7640	34.9	46.0	11.1	100	19	V

Spurious Emissions above 1GHz – 18GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
1.6376	36.5	74.0	37.5	22.7	54.0	31.3	200	57	V
2.4168	44.7	74.0	29.3	25.8	54.0	28.2	100	256	H
2.8925	41.7	74.0	32.3	27.9	54.0	26.1	100	62	H
3.2872	50.5	74.0	23.5	43.6	54.0	10.4	100	80	V
4.6939	46.6	74.0	27.4	32.6	54.0	21.4	200	40	V
4.9368	47.6	74.0	26.4	33.4	54.0	20.6	300	356	H

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 "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a “negative” margin indicates a FAIL.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 3MHz
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 ±4.0dB.

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 θ: 0^O

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

   where θ 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	E4440A	MY45304764	12 Dec 2016
Mini-Circuits Precision Fixed Attenuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor

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.

47 CFR FCC Parts 2.1046 and 25.204 RF Output Power Results

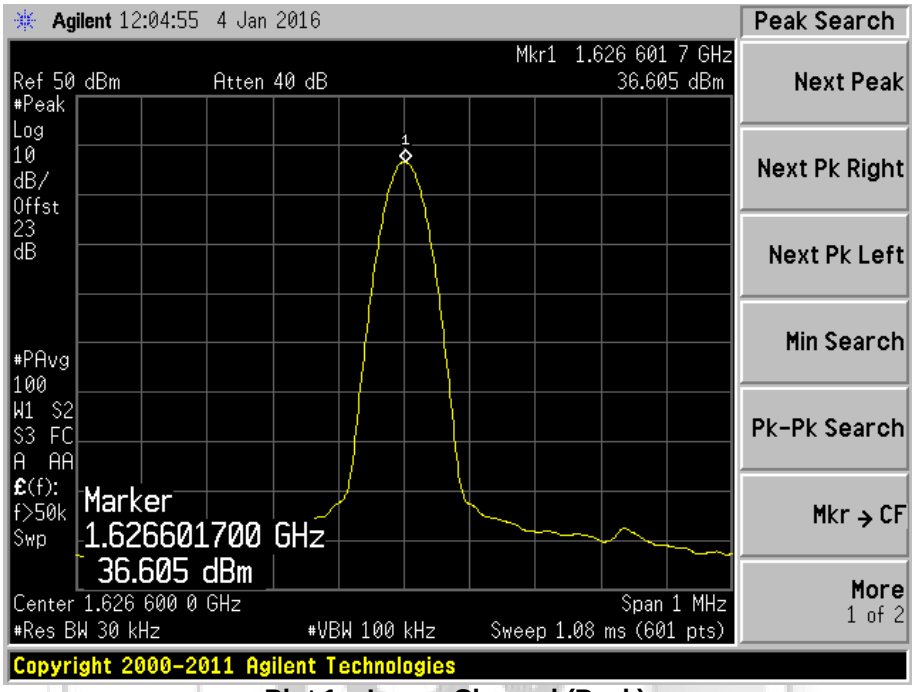
Operating Mode	Continuous Satellite Transmission	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Antenna Gain	10.0dBi	Atmospheric Pressure	1030mbar
Attached Plots	1 – 42	Tested By	Lim Poh Huat

Frequency (GHz)	Channel	Peak Output Power (dBm)		Average Output Power (dBm)		Bearer Type
		EIRP	ERP	EIRP	ERP	
1.6266	Lower	46.6	44.5	46.5	44.4	0
1.6435	Middle	46.6	44.5	46.4	44.3	
1.6604	Upper	45.6	43.5	45.4	43.3	
1.6266	Lower	46.0	43.9	45.2	43.1	1
1.6435	Middle	45.8	43.7	45.5	43.4	
1.6604	Upper	45.2	43.1	44.7	42.6	
1.6266	Lower	44.0	41.9	43.9	41.8	2
1.6435	Middle	44.4	42.3	44.3	42.2	
1.6604	Upper	43.5	41.4	42.8	40.7	
1.6266	Lower	41.0	38.9	40.7	38.6	3
1.6435	Middle	41.1	39.0	40.8	38.7	
1.6604	Upper	40.4	38.3	39.4	37.3	
1.6266	Lower	45.9	43.8	45.5	43.4	4
1.6435	Middle	46.2	44.1	45.6	43.5	
1.6604	Upper	45.4	43.3	45.0	42.9	
1.6266	Lower	44.4	42.3	43.7	41.6	5
1.6435	Middle	44.5	42.4	44.0	41.9	
1.6604	Upper	43.7	41.6	43.2	41.1	
1.6266	Lower	40.3	38.2	40.2	38.1	6
1.6435	Middle	41.8	39.7	40.7	38.6	
1.6604	Upper	40.4	38.3	39.3	37.2	

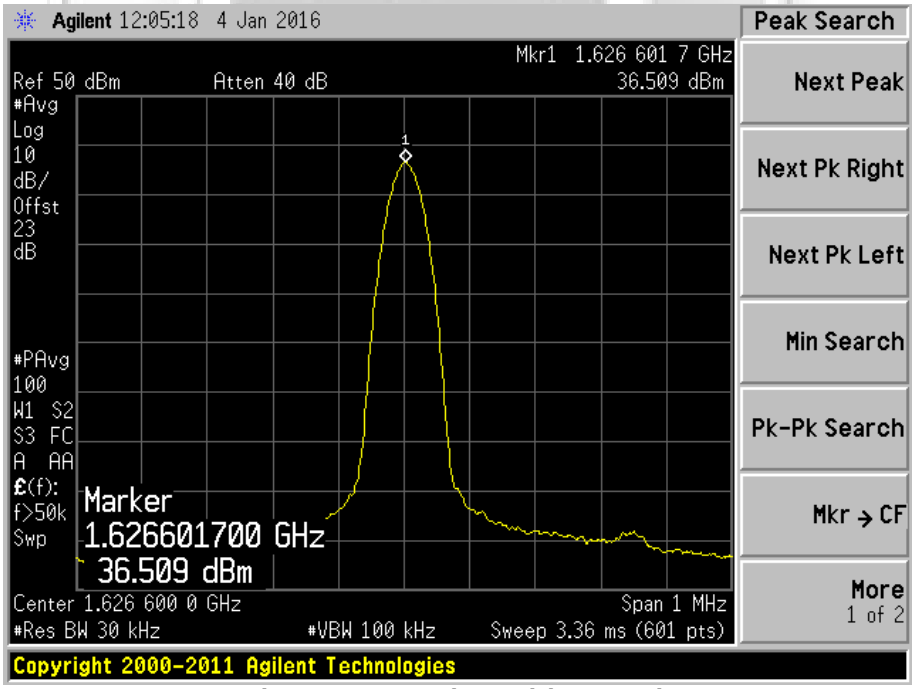
Notes

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 – Bear Type 0

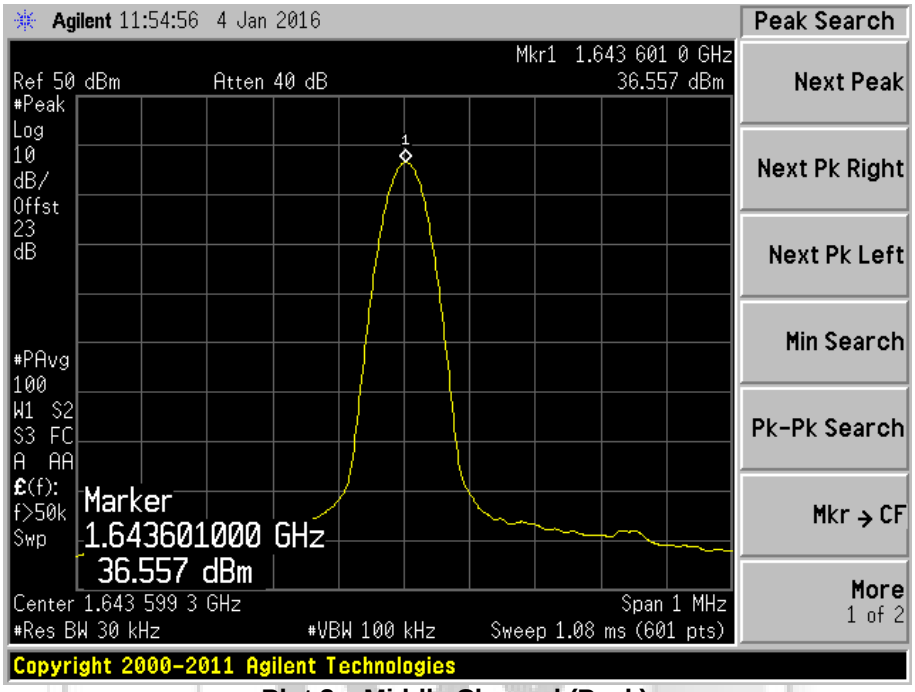


Plot 1 – Lower Channel (Peak)

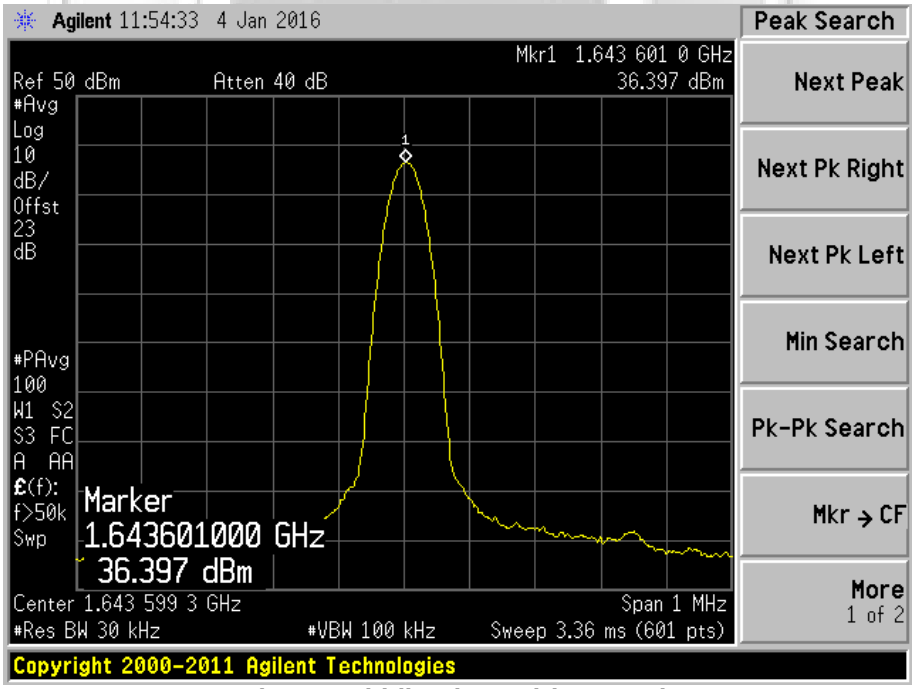


Plot 2 – Lower Channel (Average)

Output Power Plots – Bear Type 0

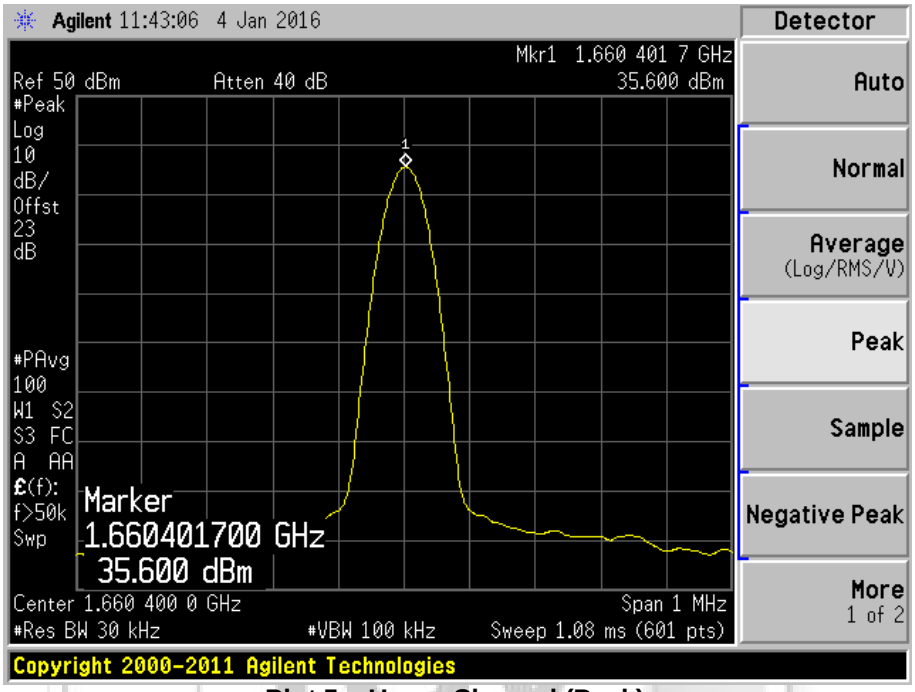


Plot 3 – Middle Channel (Peak)

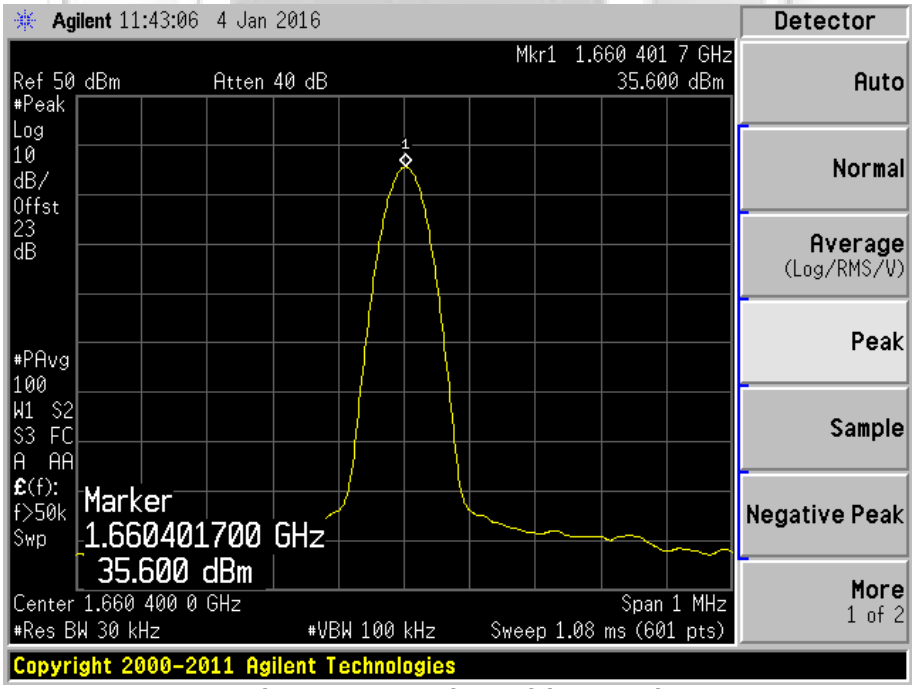


Plot 4 – Middle Channel (Average)

Output Power Plots – Bear Type 0

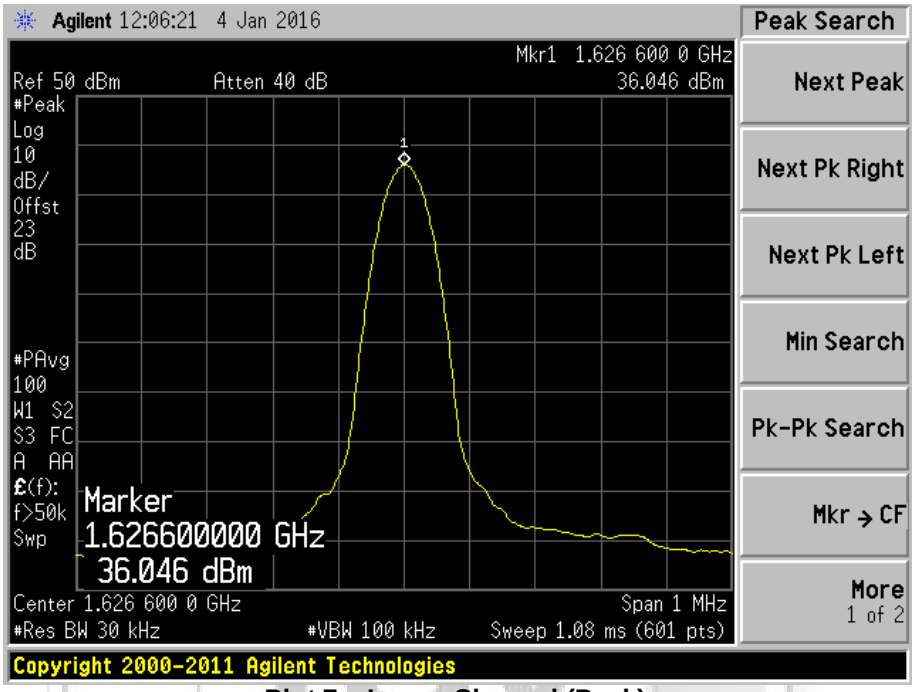


Plot 5 – Upper Channel (Peak)

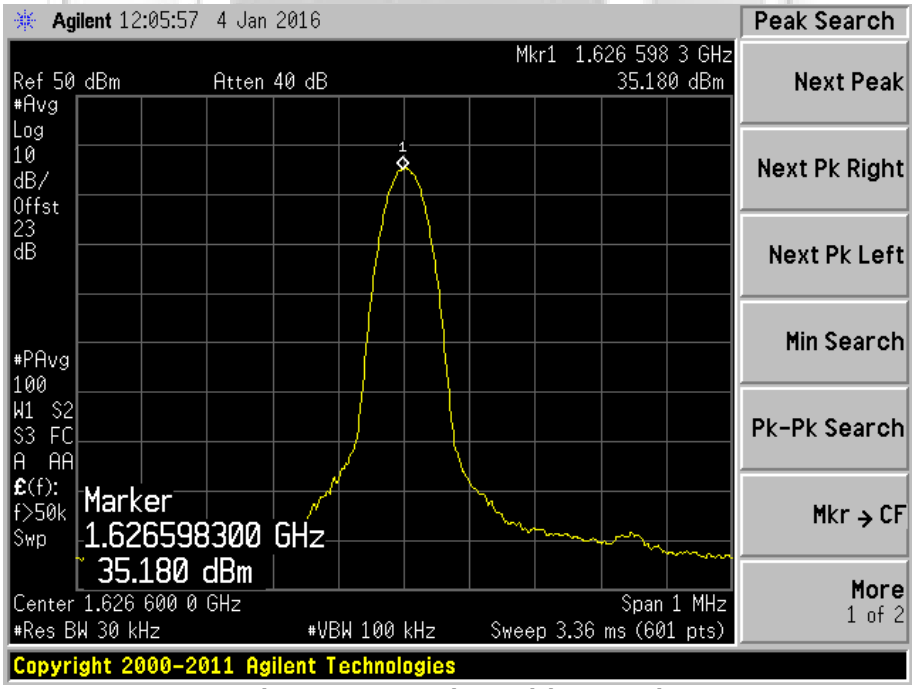


Plot 6 – Upper Channel (Average)

Output Power Plots – Bear Type 1

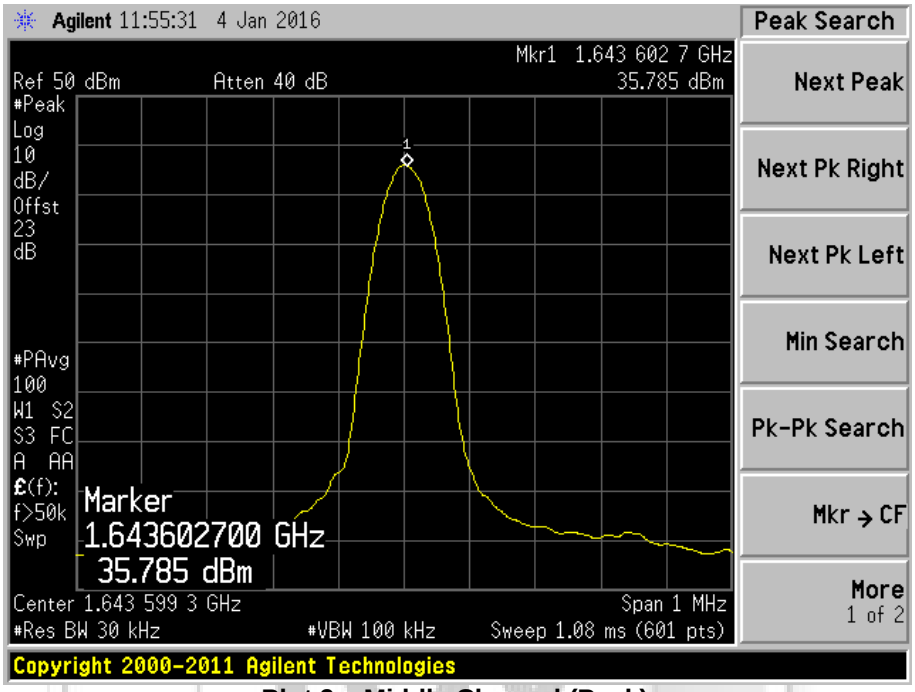


Plot 7 – Lower Channel (Peak)

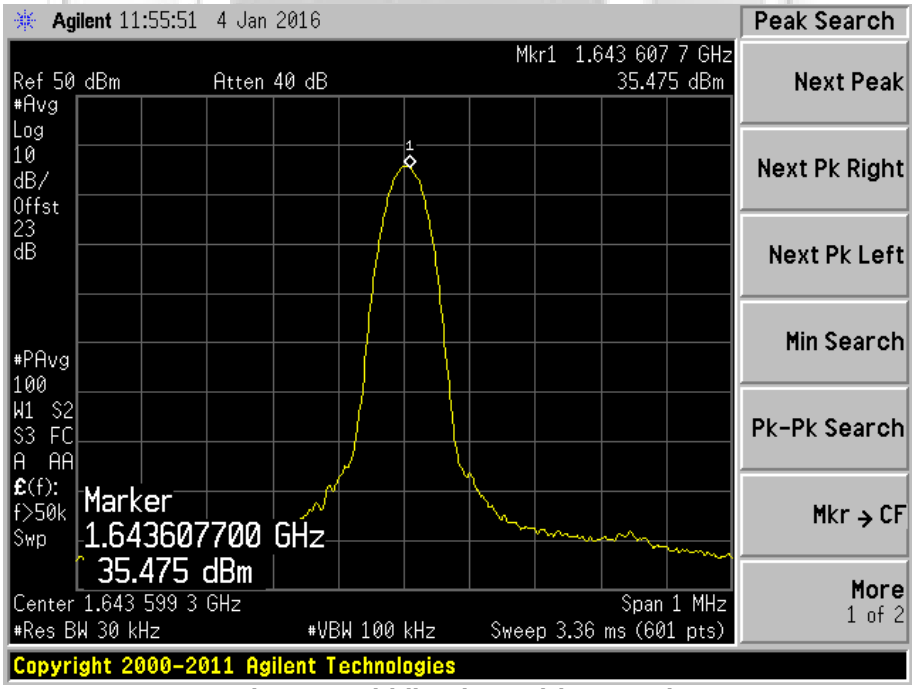


Plot 8 – Lower Channel (Average)

Output Power Plots – Bear Type 1

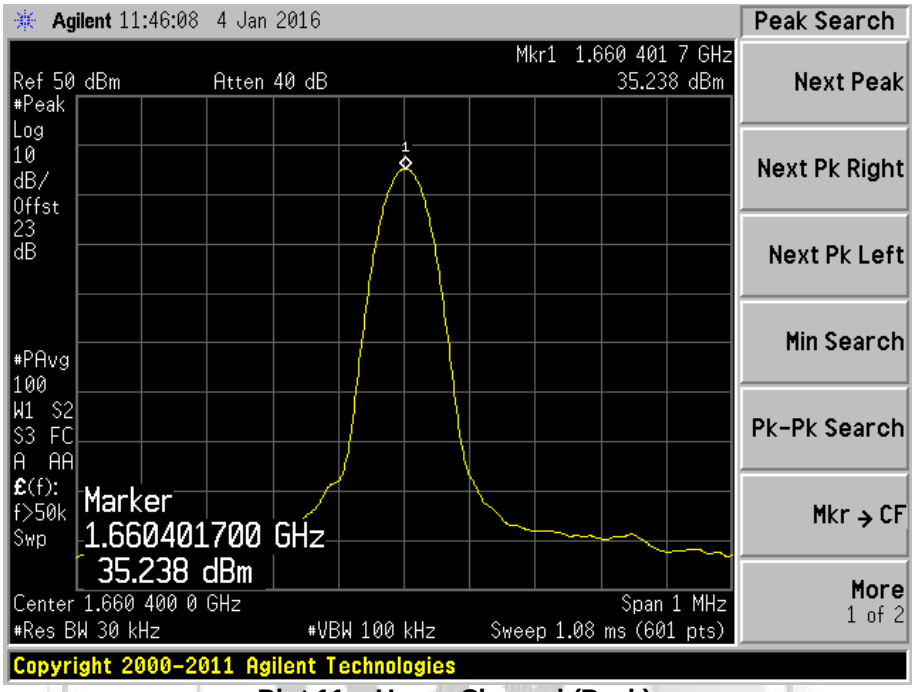


Plot 9 – Middle Channel (Peak)

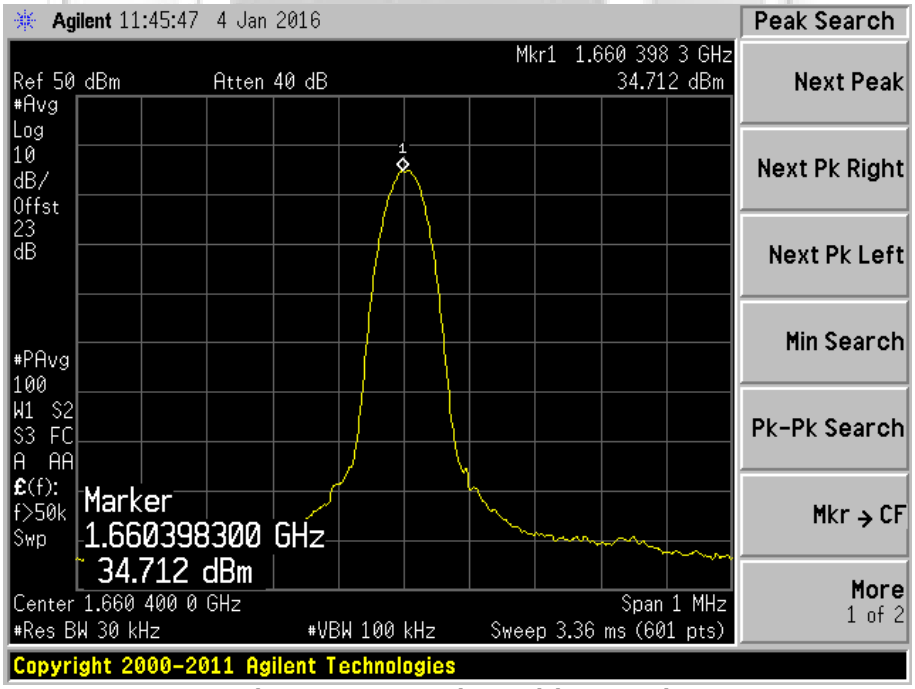


Plot 10 – Middle Channel (Average)

Output Power Plots – Bear Type 1

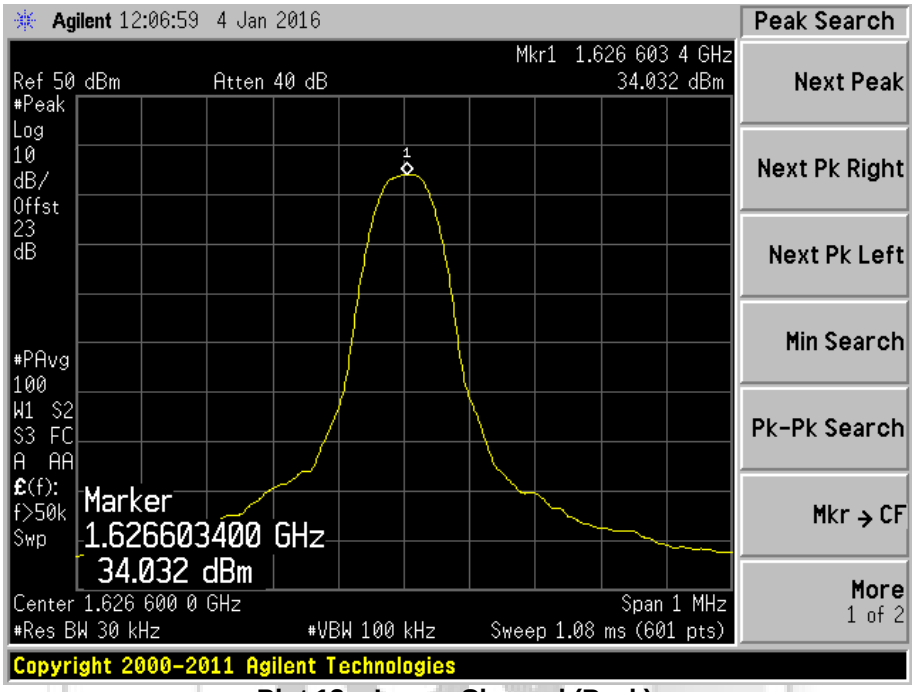


Plot 11 – Upper Channel (Peak)

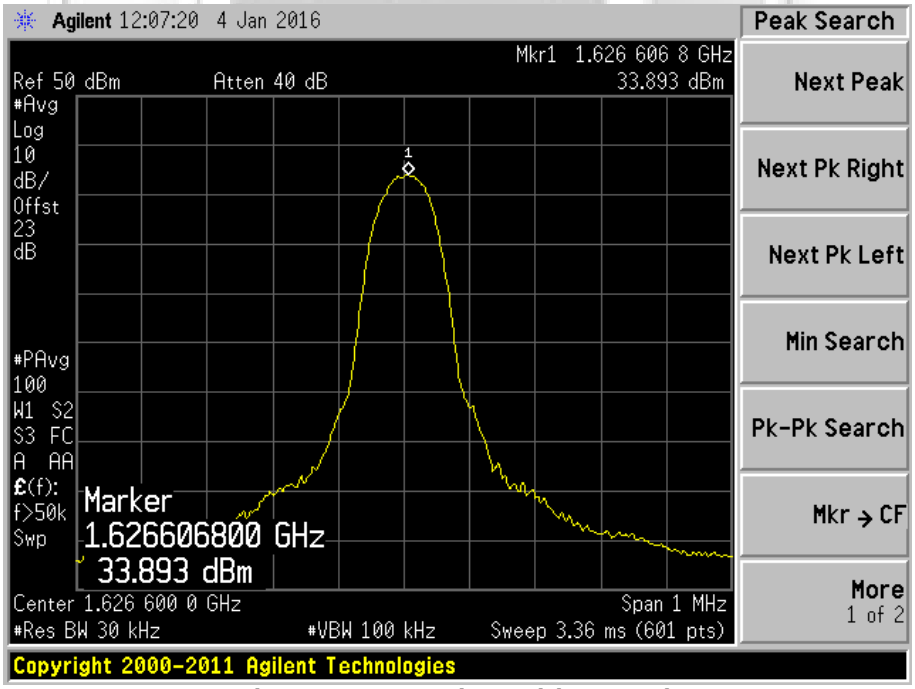


Plot 12 – Upper Channel (Average)

Output Power Plots – Bear Type 2

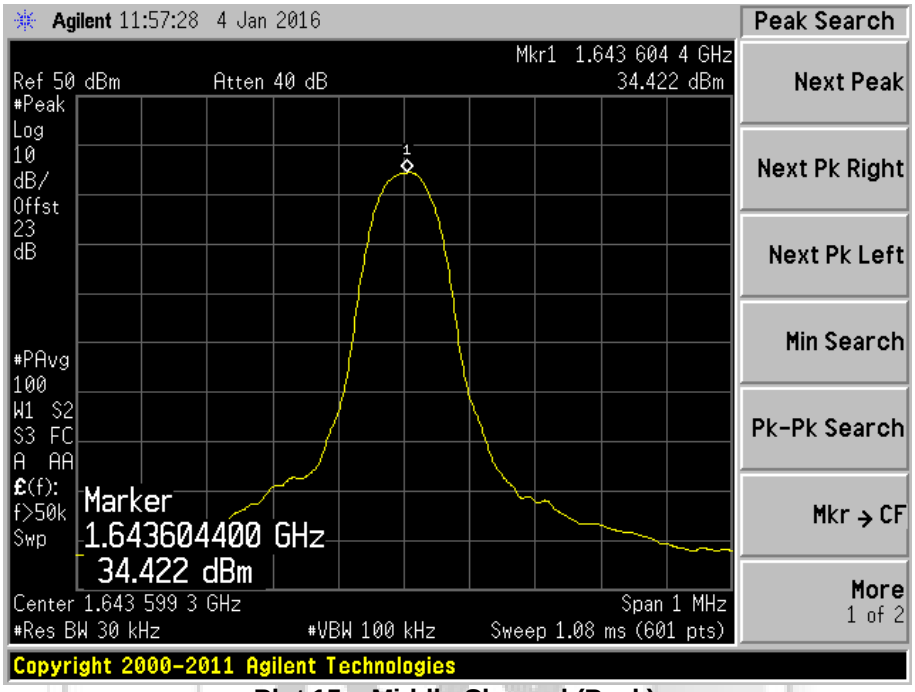


Plot 13 – Lower Channel (Peak)

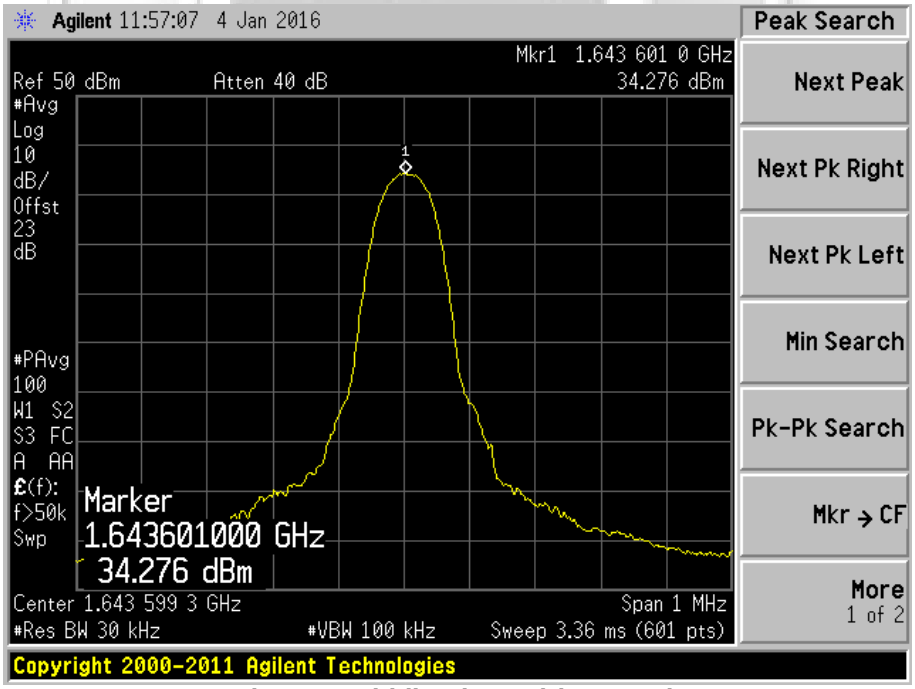


Plot 14 – Lower Channel (Average)

Output Power Plots – Bear Type 2

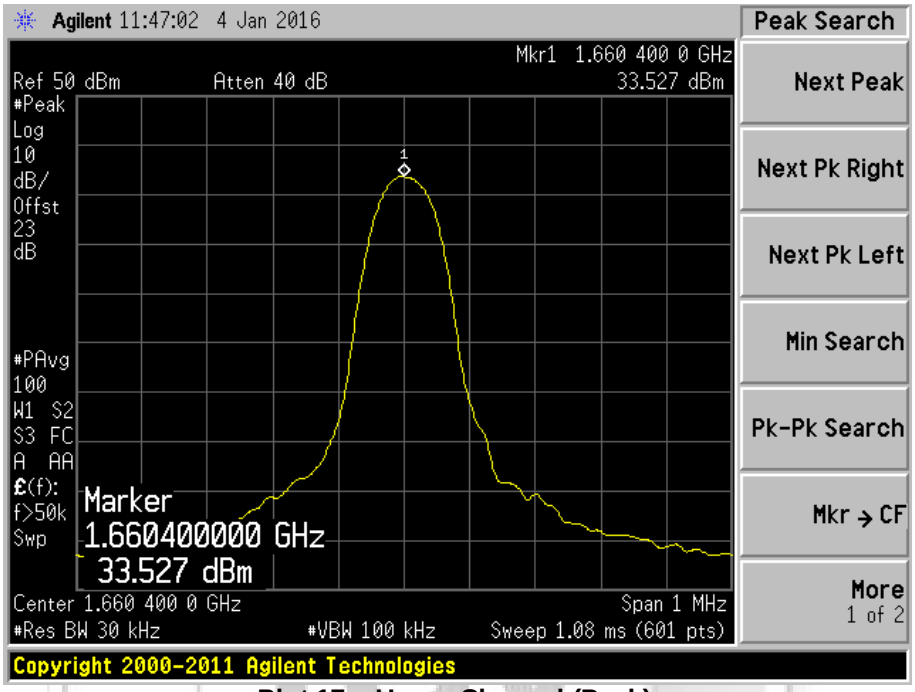


Plot 15 – Middle Channel (Peak)

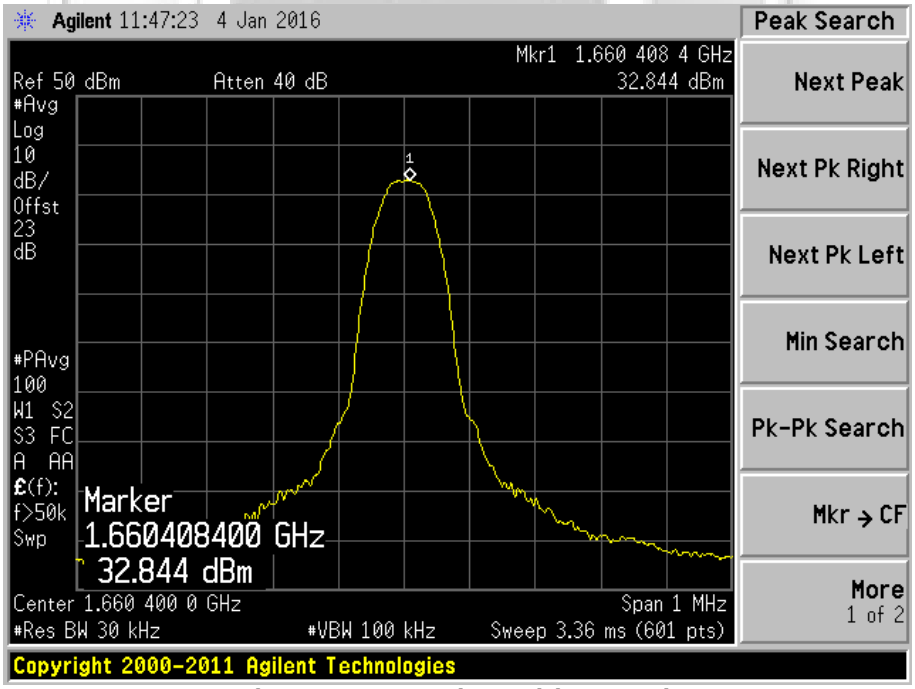


Plot 16 – Middle Channel (Average)

Output Power Plots – Bear Type 2

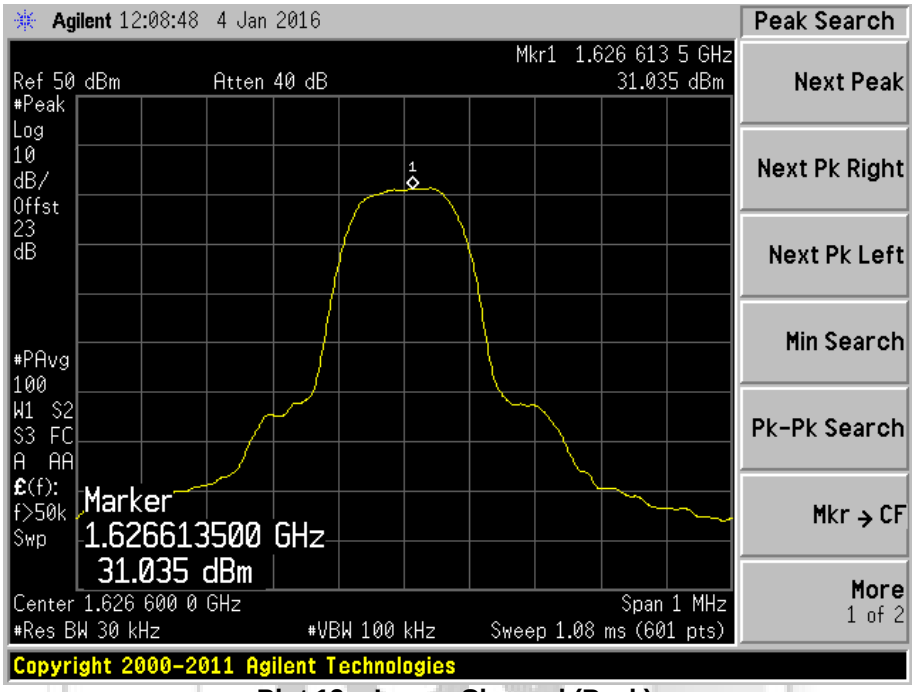


Plot 17 – Upper Channel (Peak)

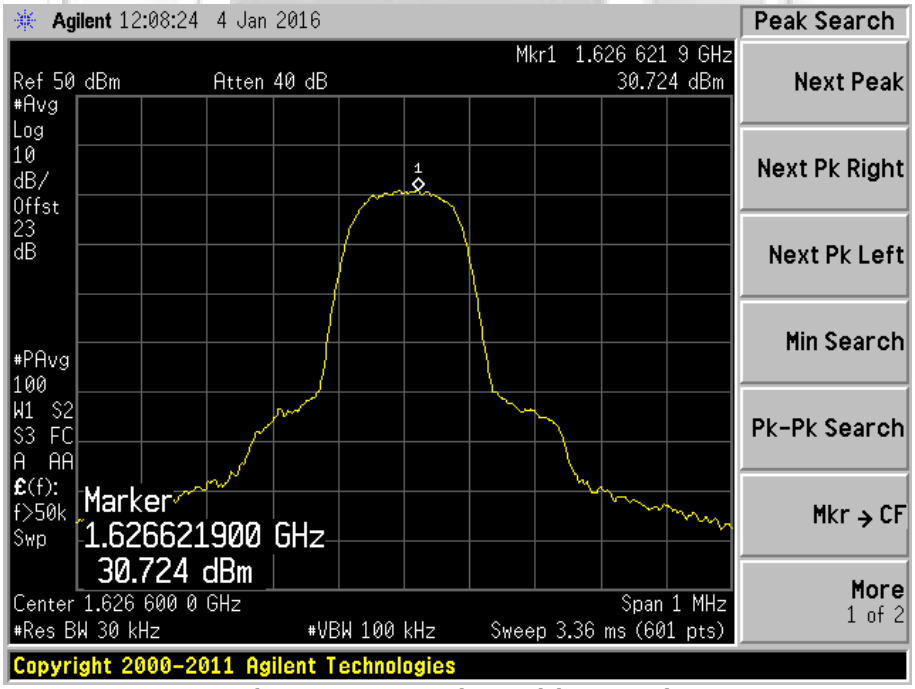


Plot 18 – Upper Channel (Average)

Output Power Plots – Bear Type 3

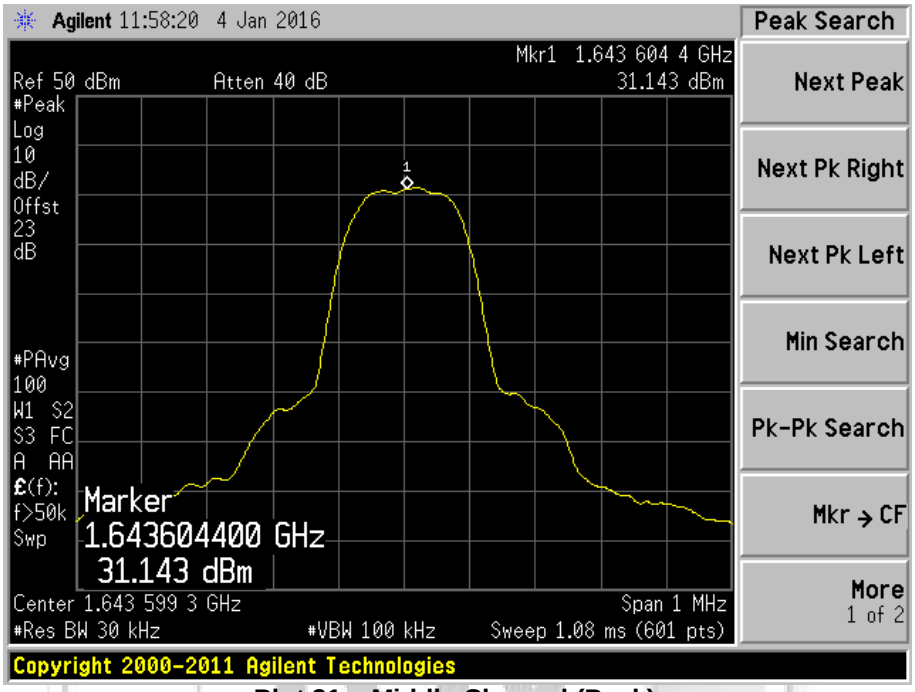


Plot 19 – Lower Channel (Peak)

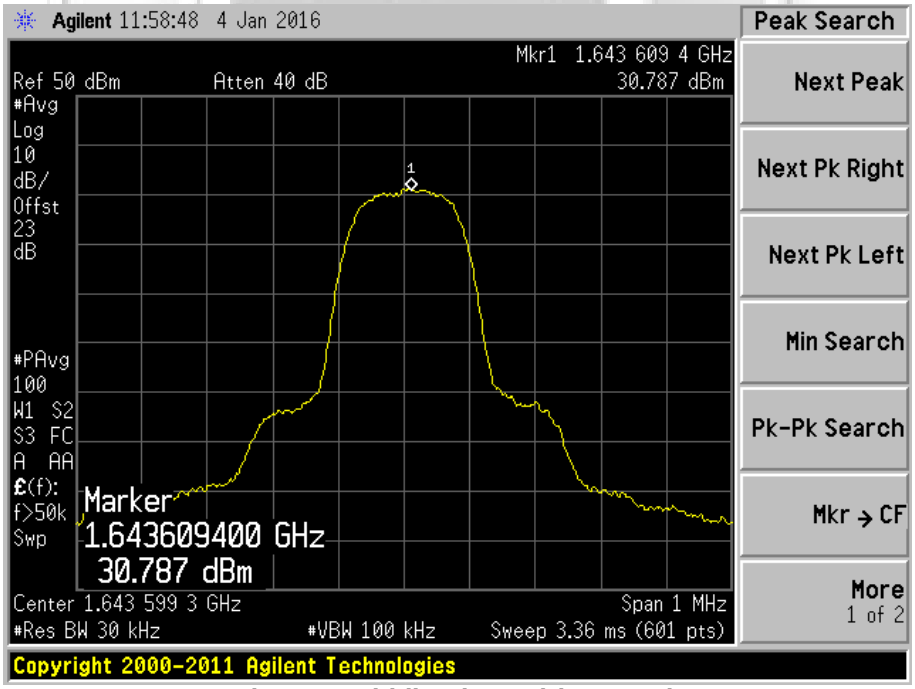


Plot 20 – Lower Channel (Average)

Output Power Plots – Bear Type 3

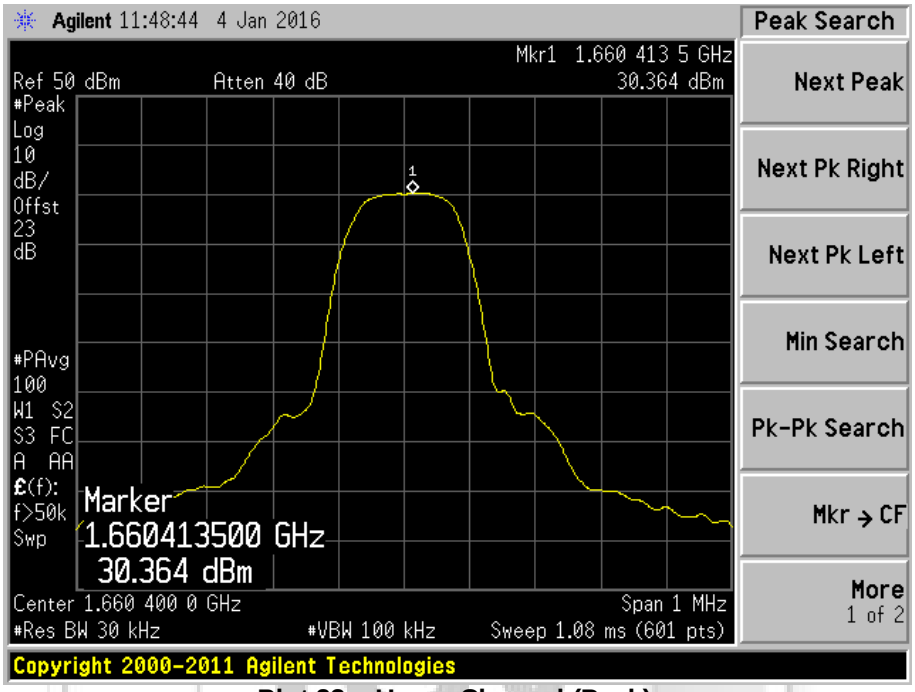


Plot 21 – Middle Channel (Peak)

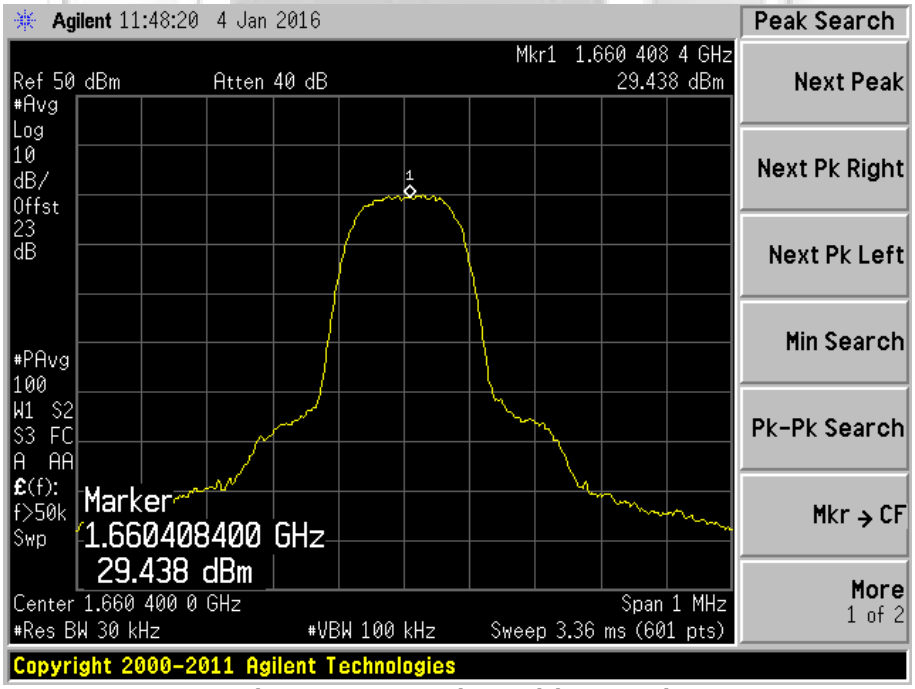


Plot 22 – Middle Channel (Average)

Output Power Plots – Bear Type 3

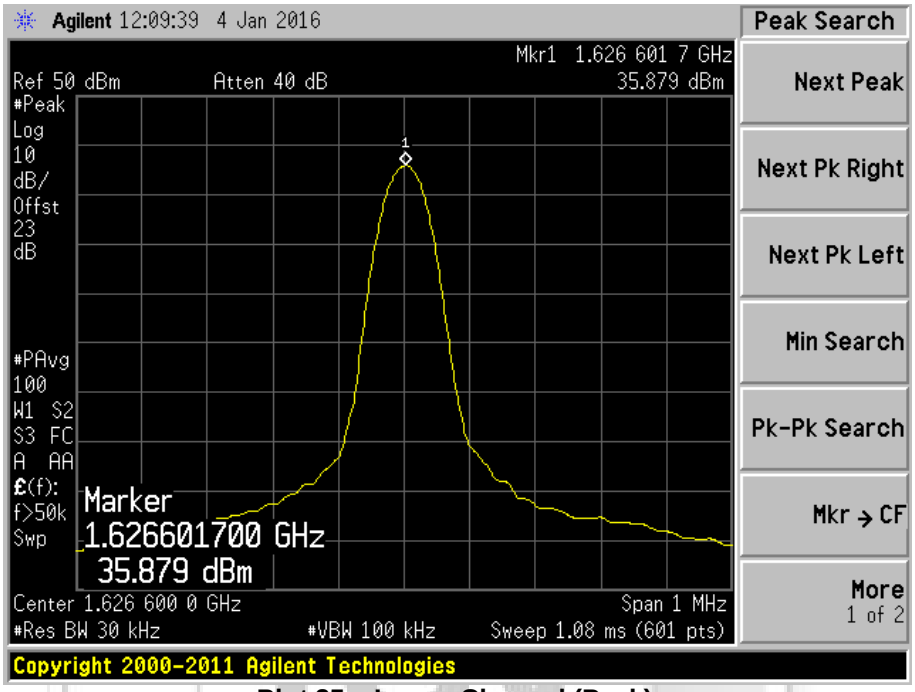


Plot 23 – Upper Channel (Peak)

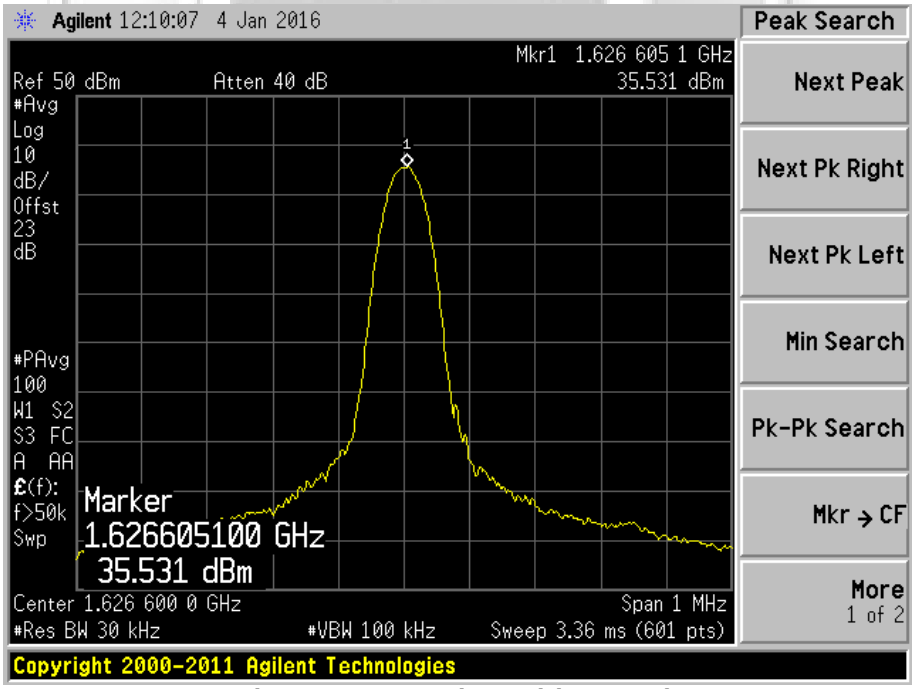


Plot 24 – Upper Channel (Average)

Output Power Plots – Bear Type 4

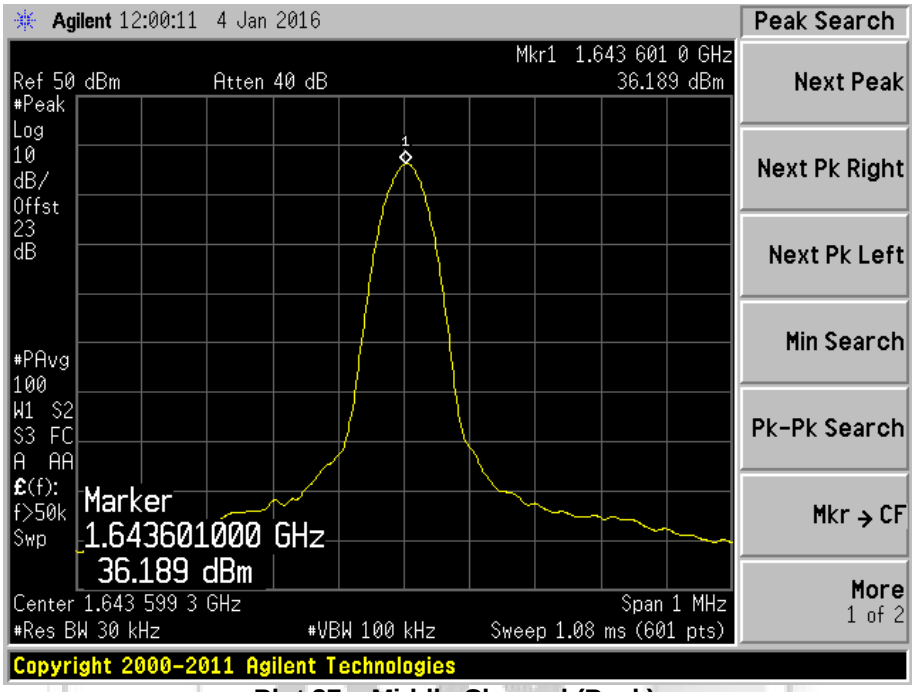


Plot 25 – Lower Channel (Peak)

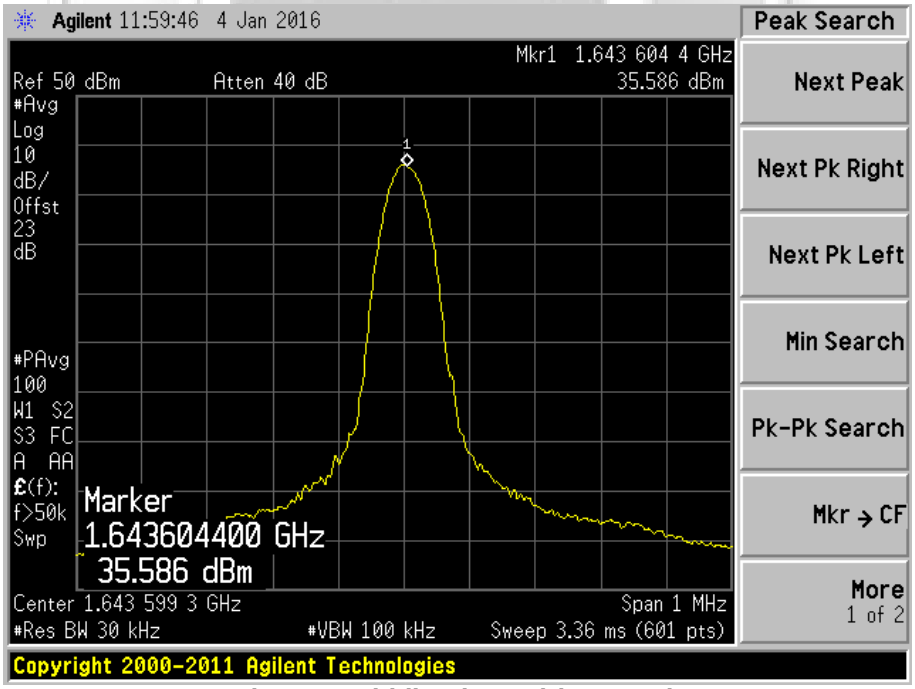


Plot 26 – Lower Channel (Average)

Output Power Plots – Bear Type 4

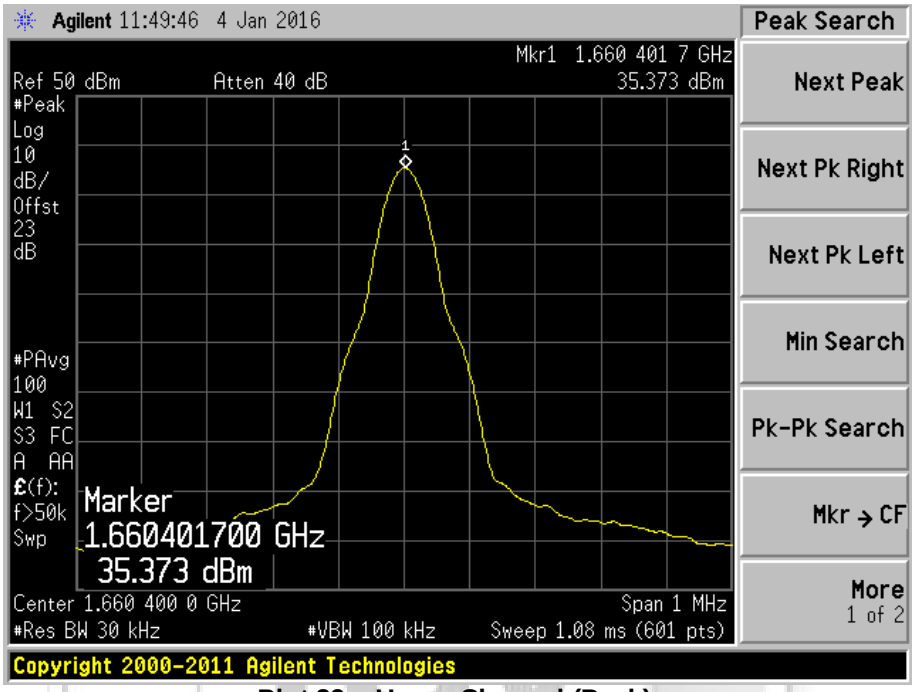


Plot 27 – Middle Channel (Peak)

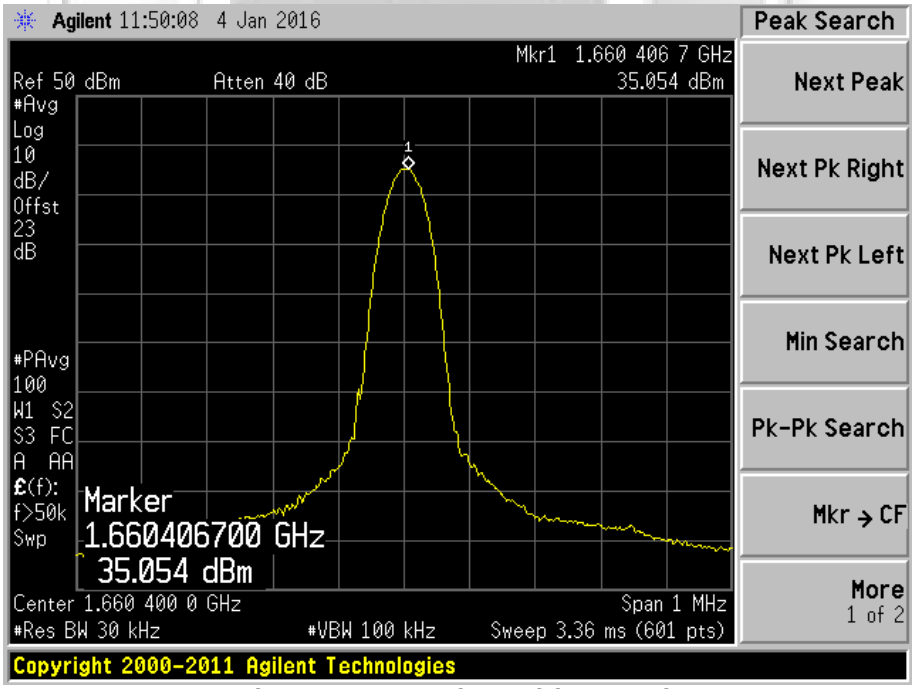


Plot 28 – Middle Channel (Average)

Output Power Plots – Bear Type 4

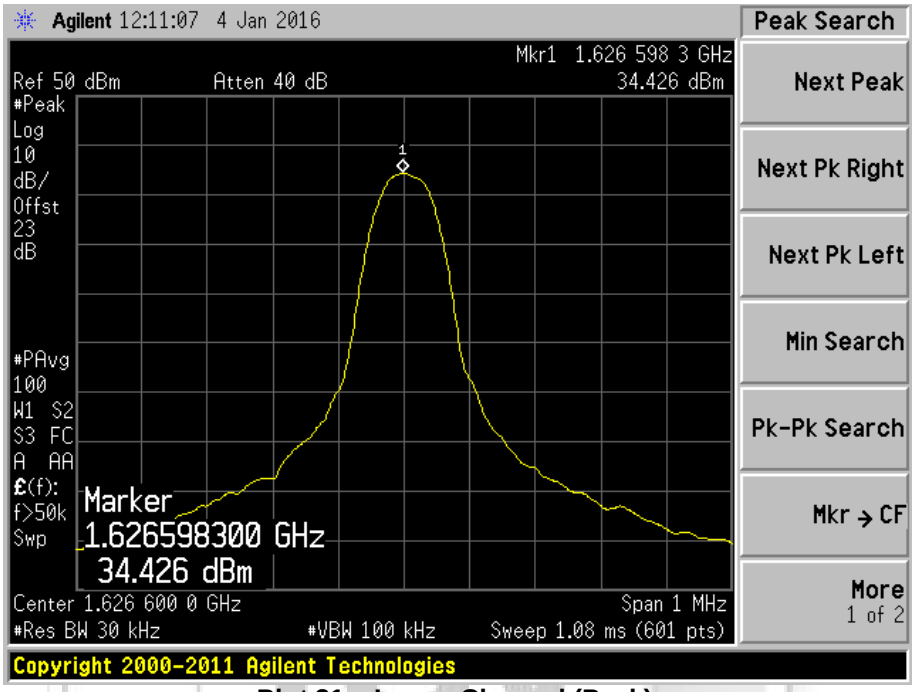


Plot 29 – Upper Channel (Peak)

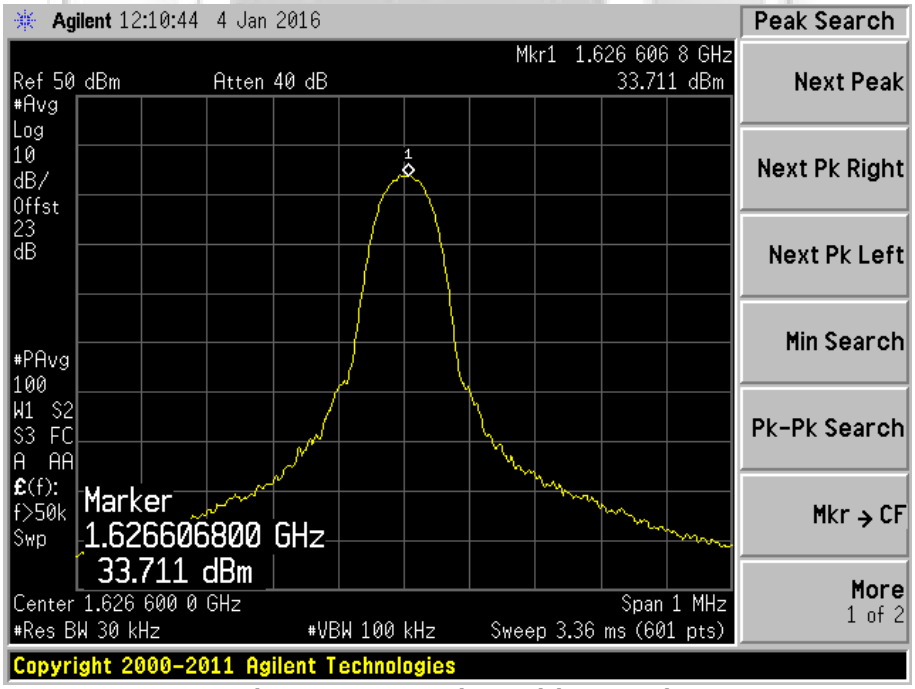


Plot 30 – Upper Channel (Average)

Output Power Plots – Bear Type 5

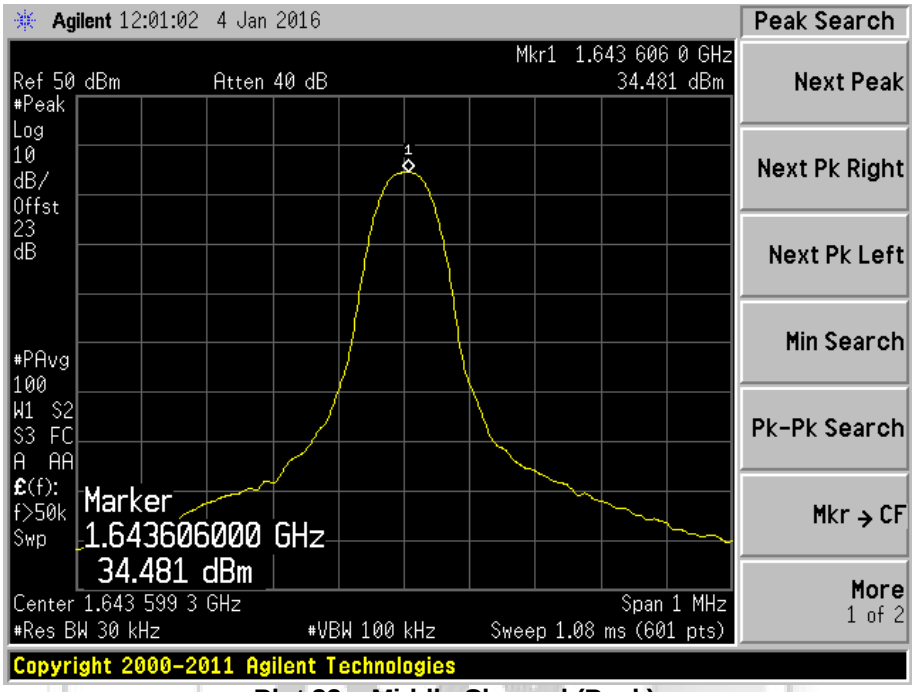


Plot 31 – Lower Channel (Peak)

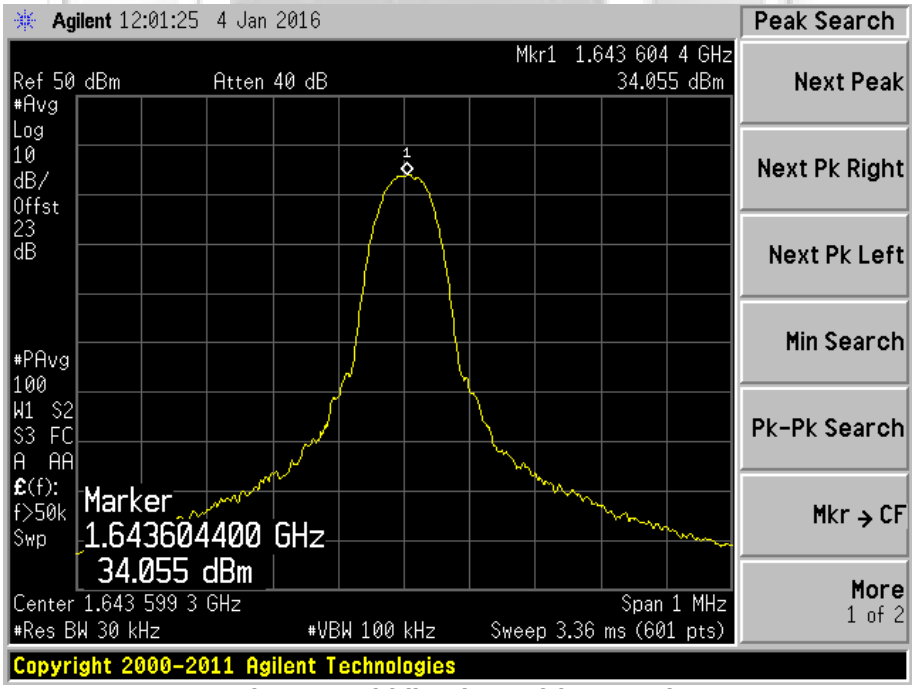


Plot 32 – Lower Channel (Average)

Output Power Plots – Bear Type 5

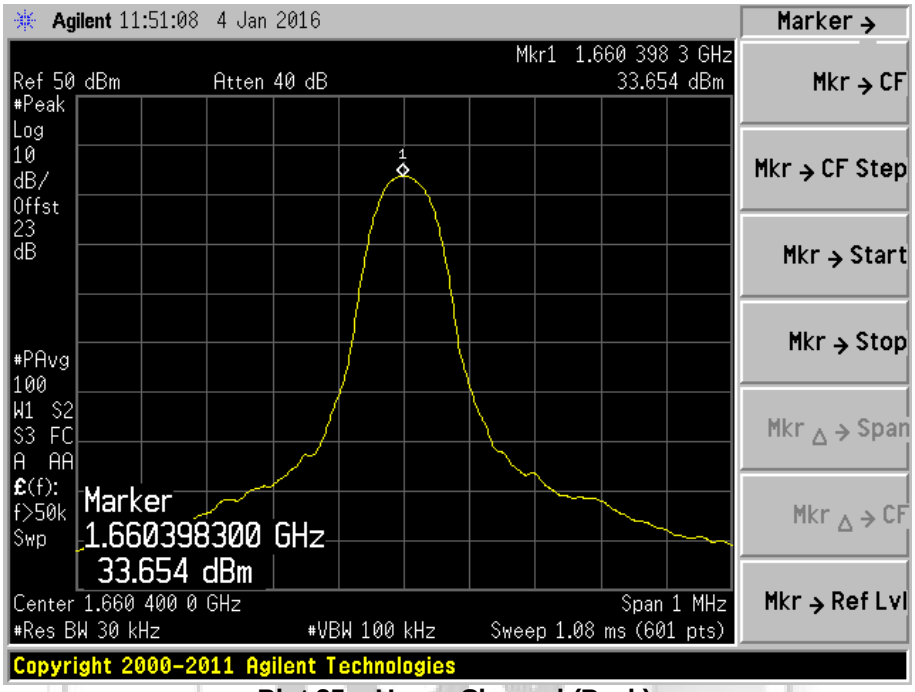


Plot 33 – Middle Channel (Peak)

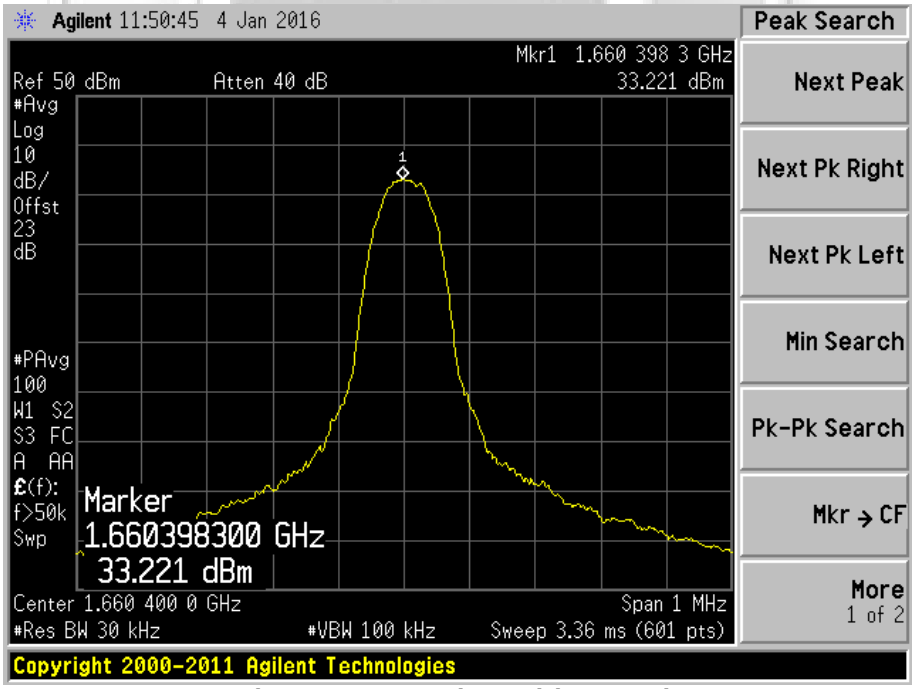


Plot 34 – Middle Channel (Average)

Output Power Plots – Bear Type 5

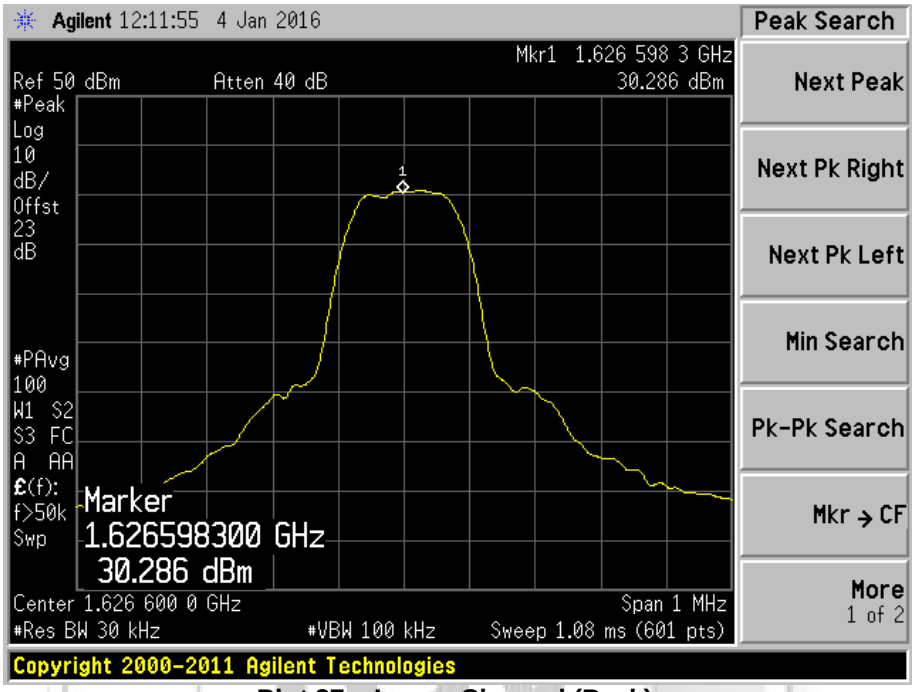


Plot 35 – Upper Channel (Peak)

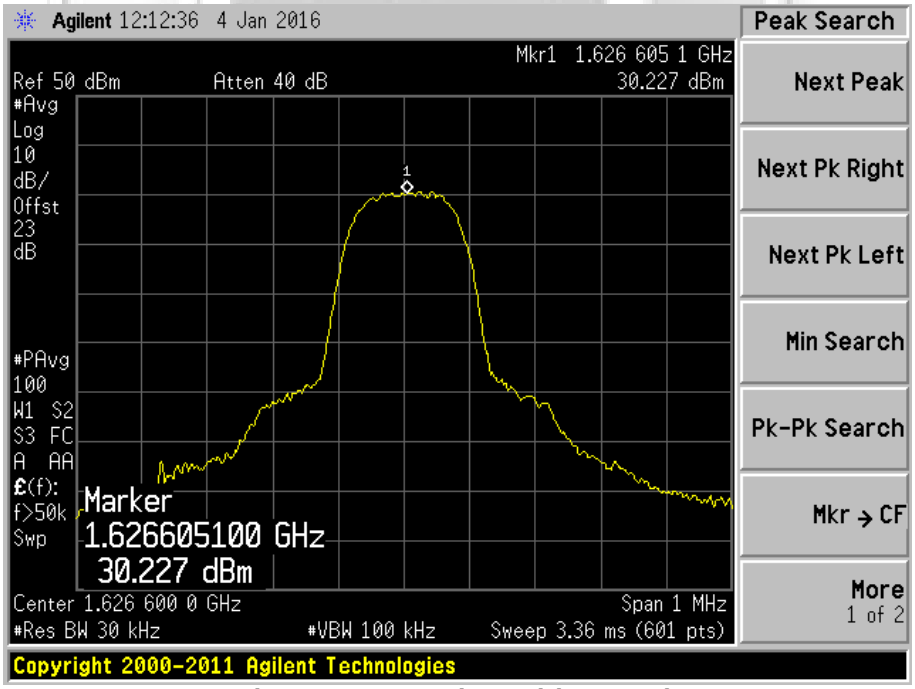


Plot 36 – Upper Channel (Average)

Output Power Plots – Bear Type 6

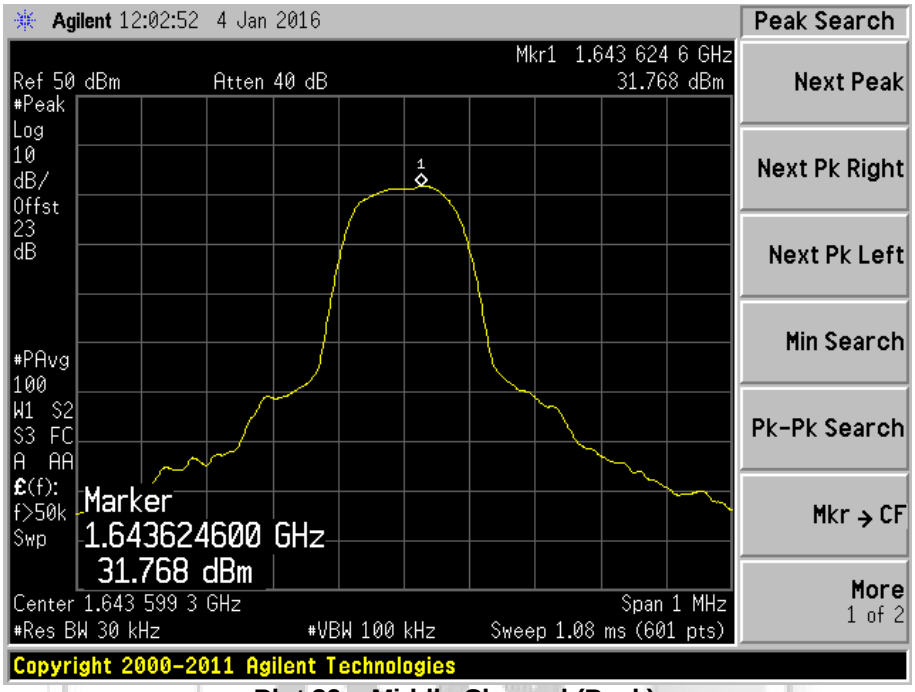


Plot 37 – Lower Channel (Peak)

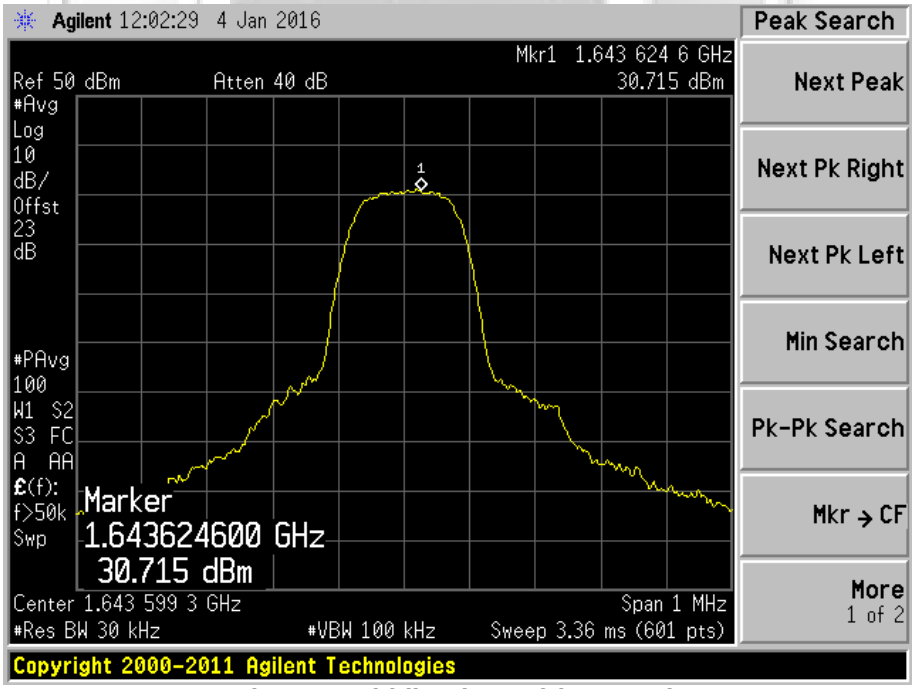


Plot 38 – Lower Channel (Average)

Output Power Plots – Bear Type 6

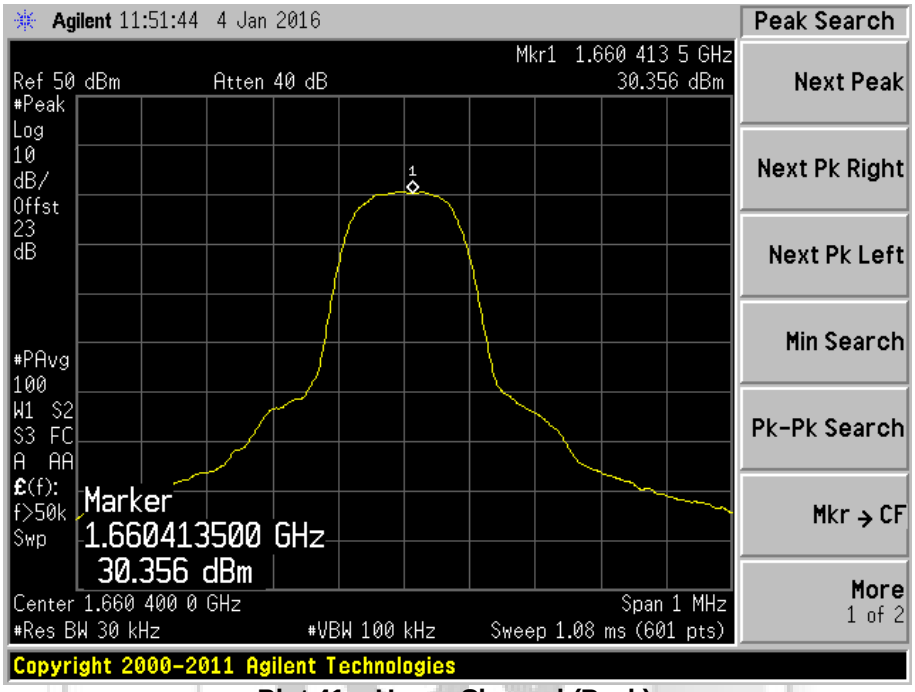


Plot 39 – Middle Channel (Peak)

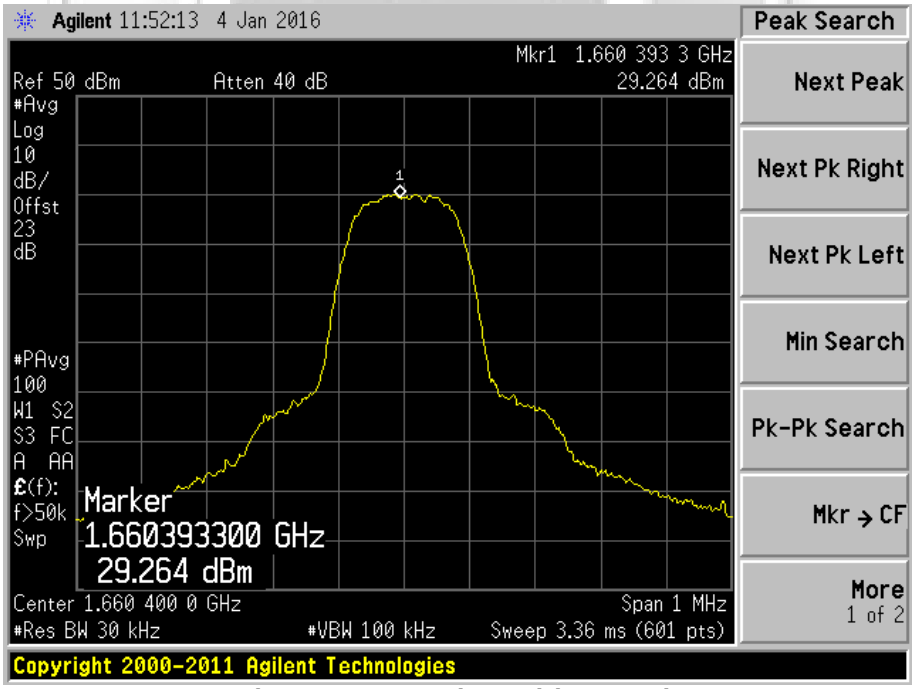


Plot 40 – Middle Channel (Average)

Output Power Plots – Bear Type 6



Plot 41 – Upper Channel (Peak)



Plot 42 – Upper Channel (Average)

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.

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	E4440A	MY45304764	12 Dec 2016
Mini-Circuits Precision Fixed Attenuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor

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.

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

Operating Mode	Continuous Satellite Transmission	Temperature	24°C
Test Input Power	12Vdc	Relative Humidity	60%
Antenna Gain	10.0dBi	Atmospheric Pressure	1030mbar
Attached Plots	43 – 63 (26dB Bandwidth) 64 – 84 (In Band Emissions) 85 – 126 (Out of Band Spurious)	Tested By	Lim Poh Huat

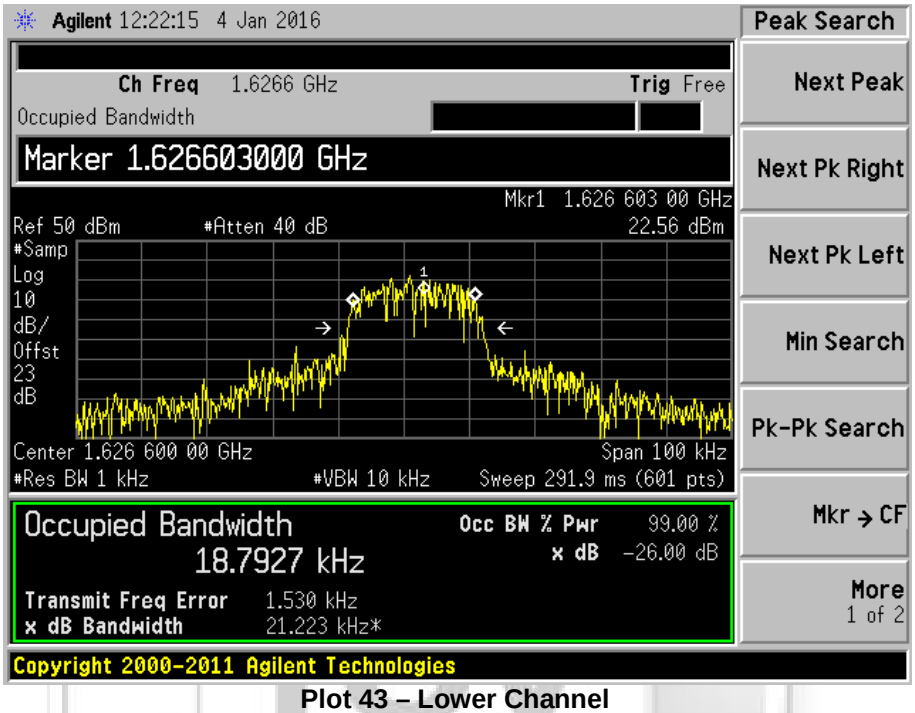
All emissions are within the emission mask. Please refer to the attached plots.

Notes

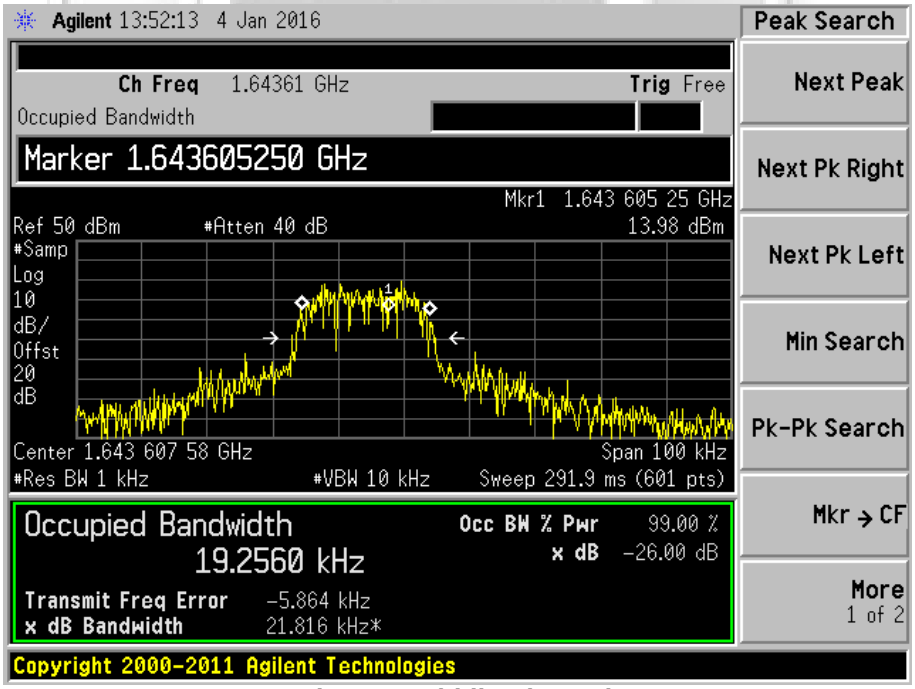
1. The Resolution Bandwidth (RBW) was corrected from 4kHz by $10\log_{10}$ [(used RBW) / 4kHz].
2. Emission limits are computed based on following:
   a. Emissions Limits (dBm) (50% - 100% authorised bandwidth) = P - 25 + CF
   b. Emissions Limits (dBm) (100% - 250% authorised bandwidth) = P - 35 + CF
   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 = Measured mean power in W
   CF = RBW correction factor (see Note 1)

26dB Bandwidth Plots (Bearer Type: 0)

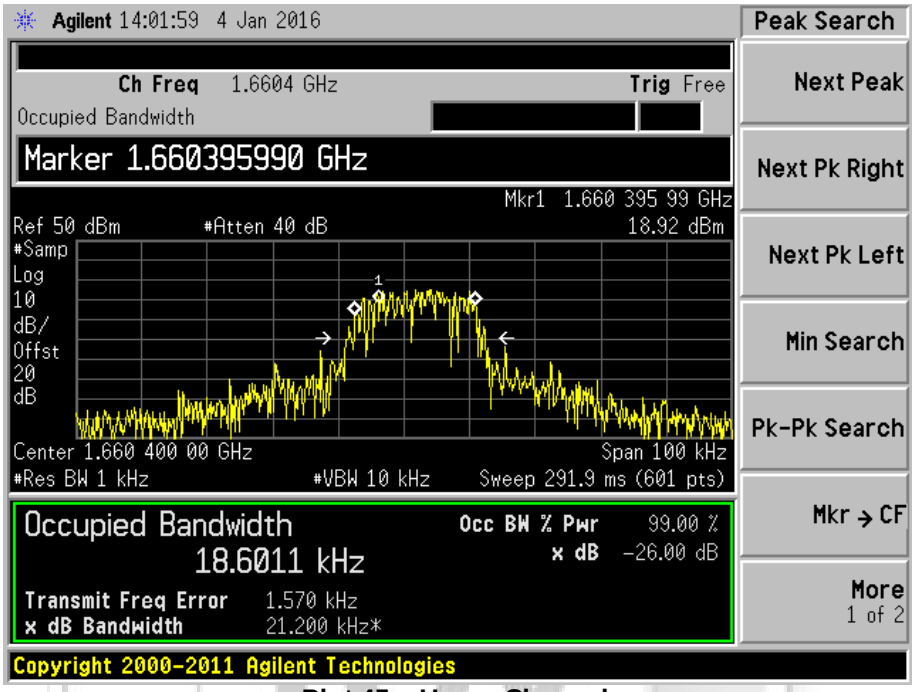


Plot 43 – Lower Channel



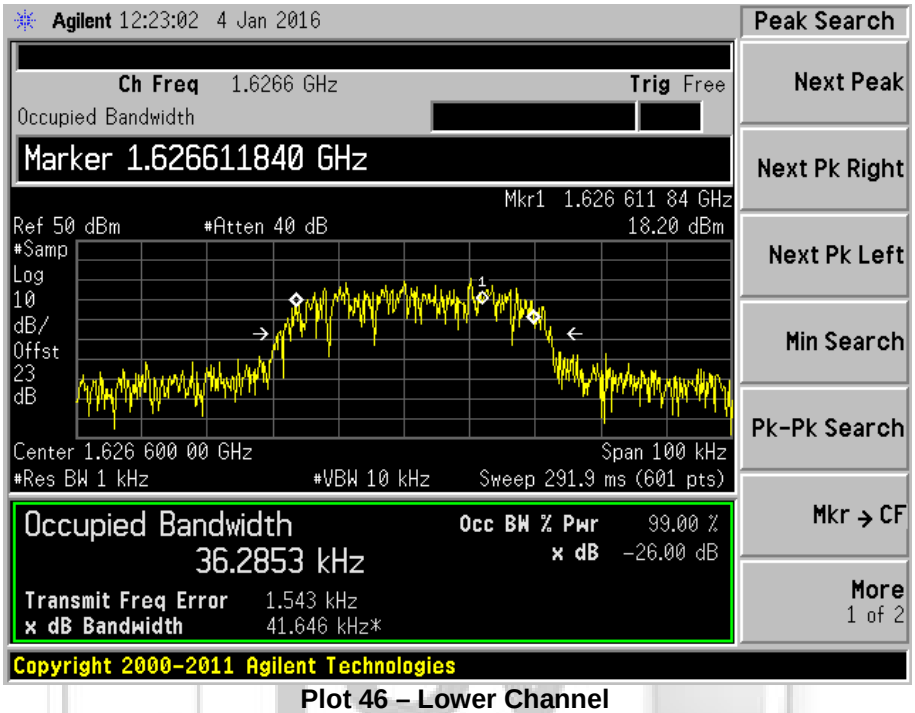
Plot 44 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 0)

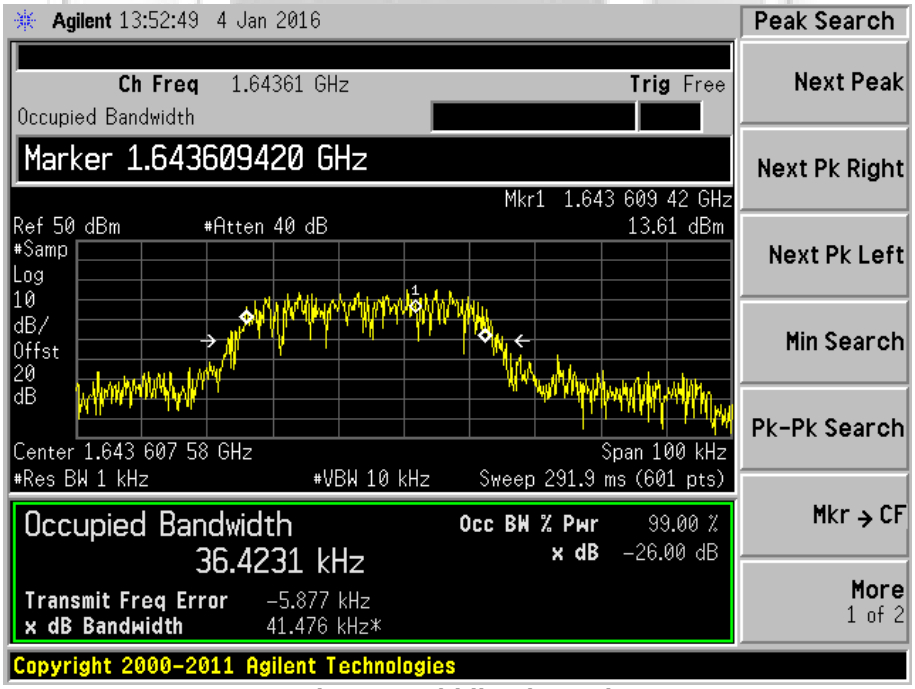


Plot 45 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 1)

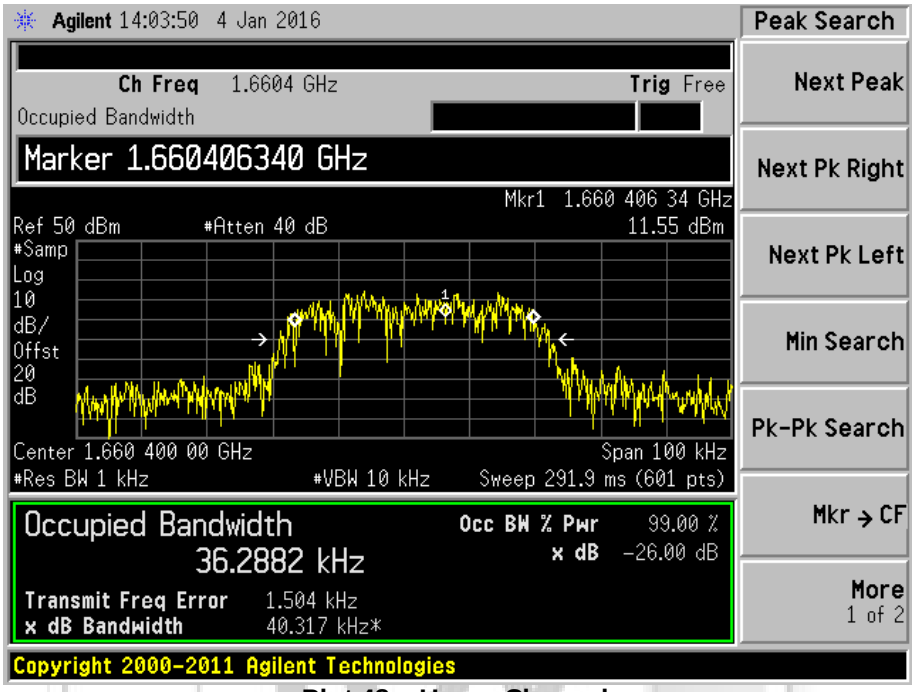


Plot 46 – Lower Channel



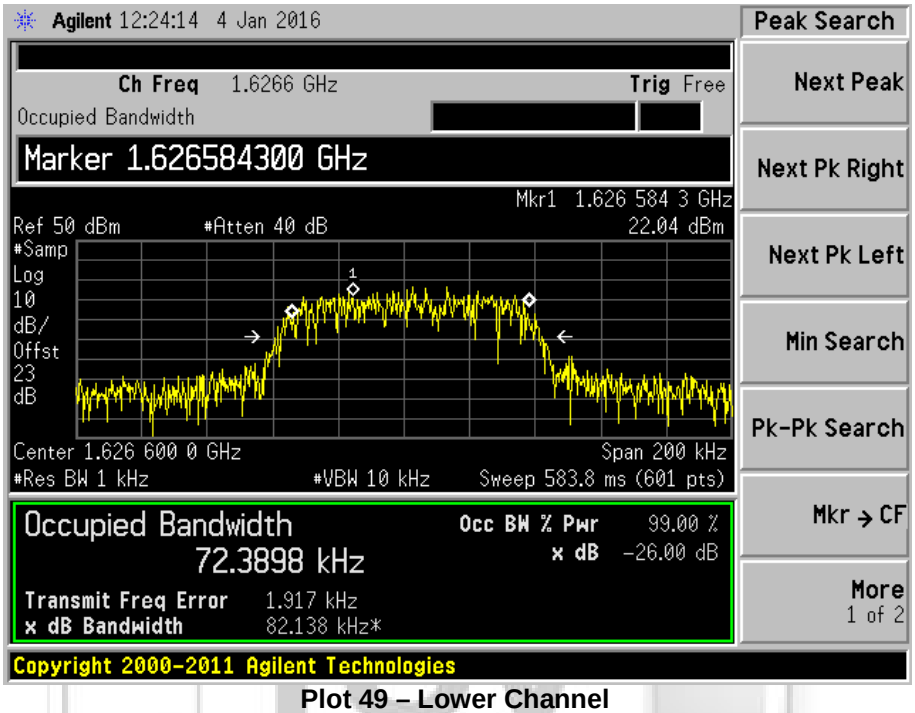
Plot 47 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 1)

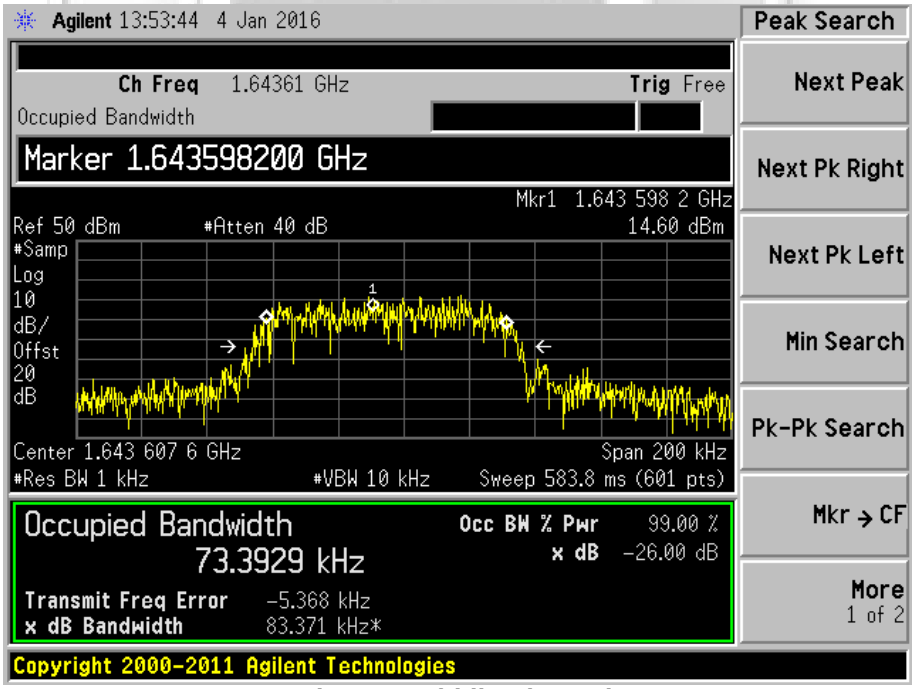


Plot 48 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 2)

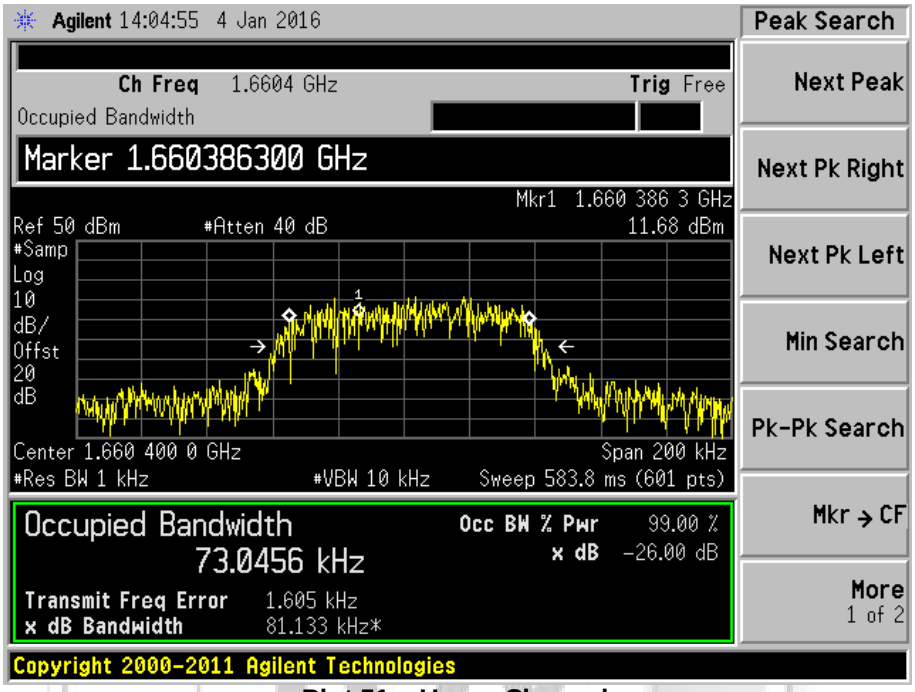


Plot 49 – Lower Channel



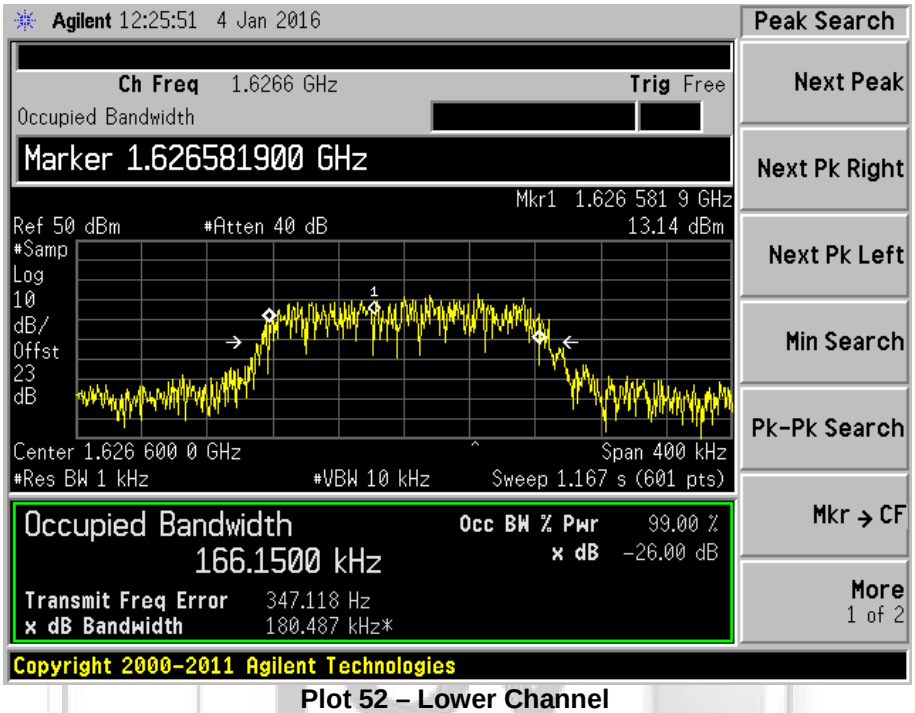
Plot 50 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 2)

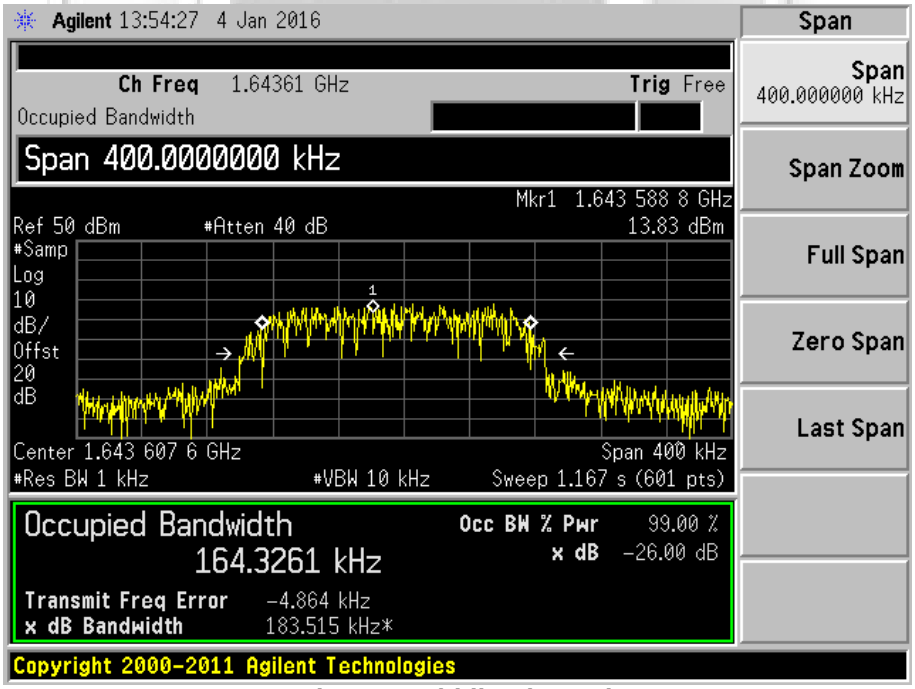


Plot 51 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 3)

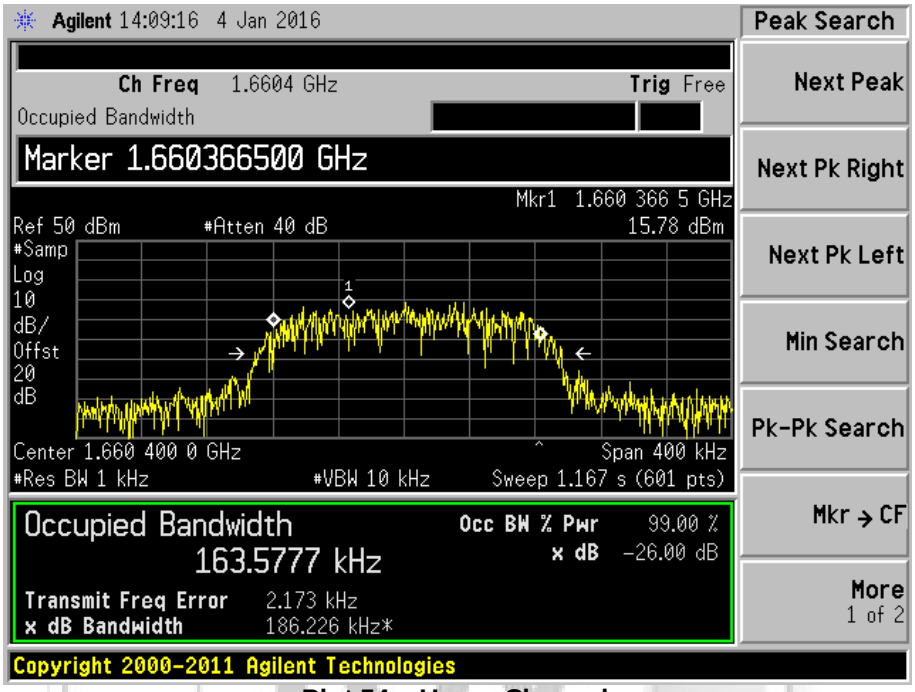


Plot 52 – Lower Channel



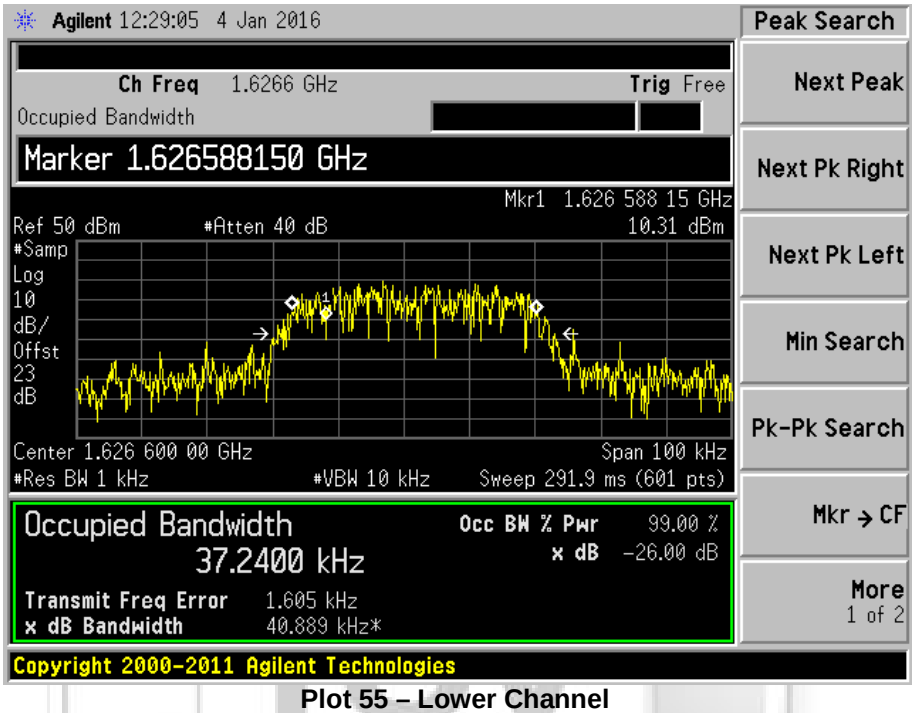
Plot 53 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 3)

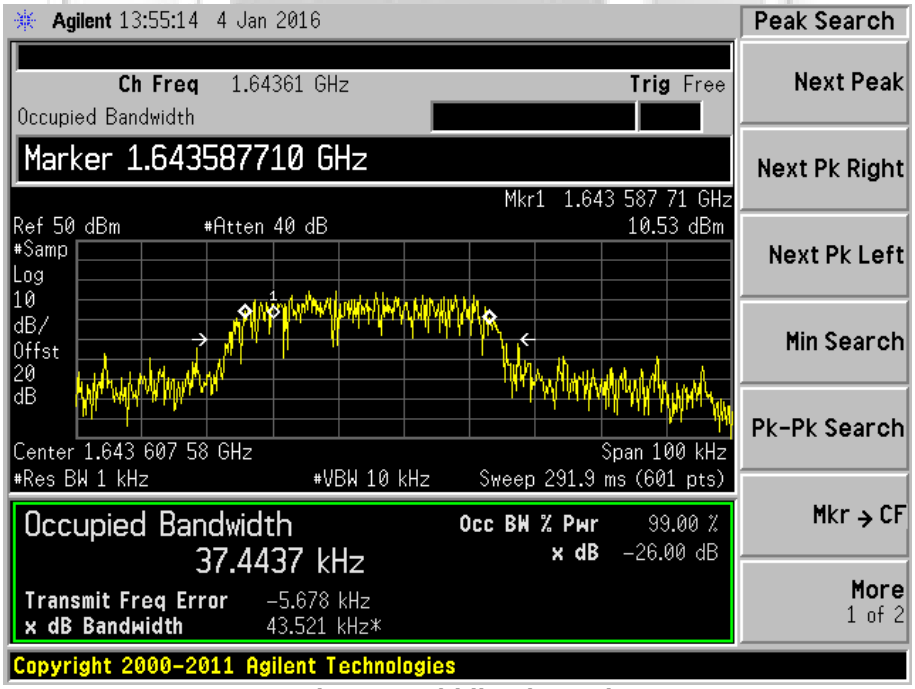


Plot 54 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 4)

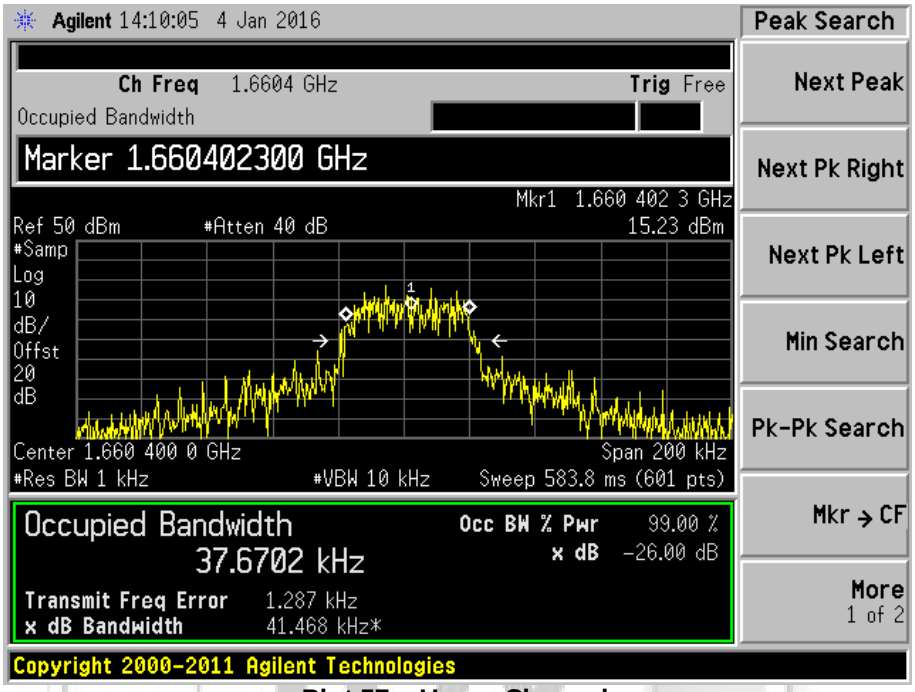


Plot 55 – Lower Channel



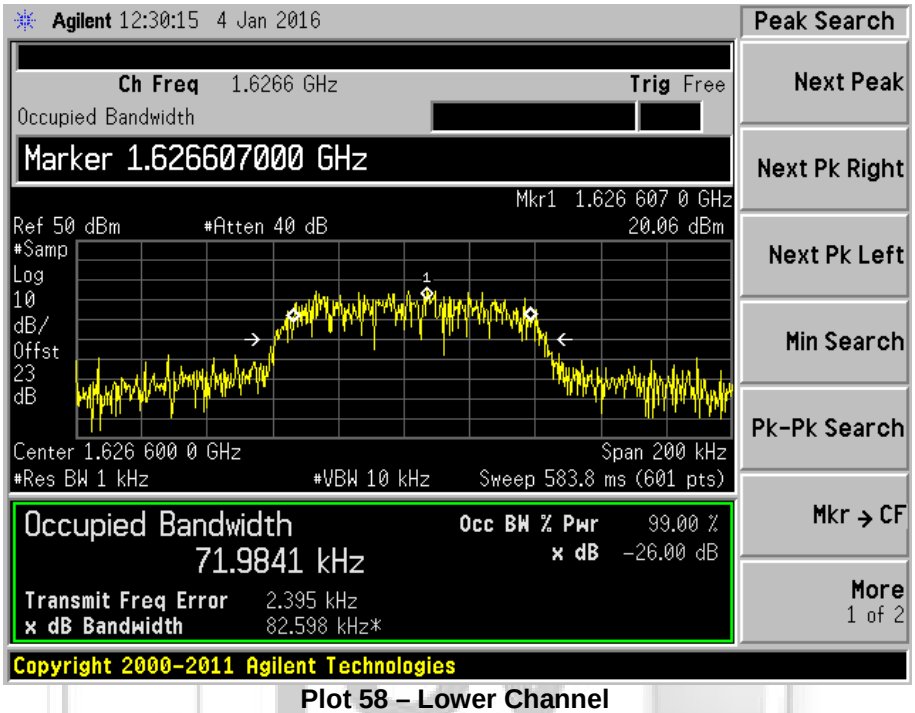
Plot 56 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 4)

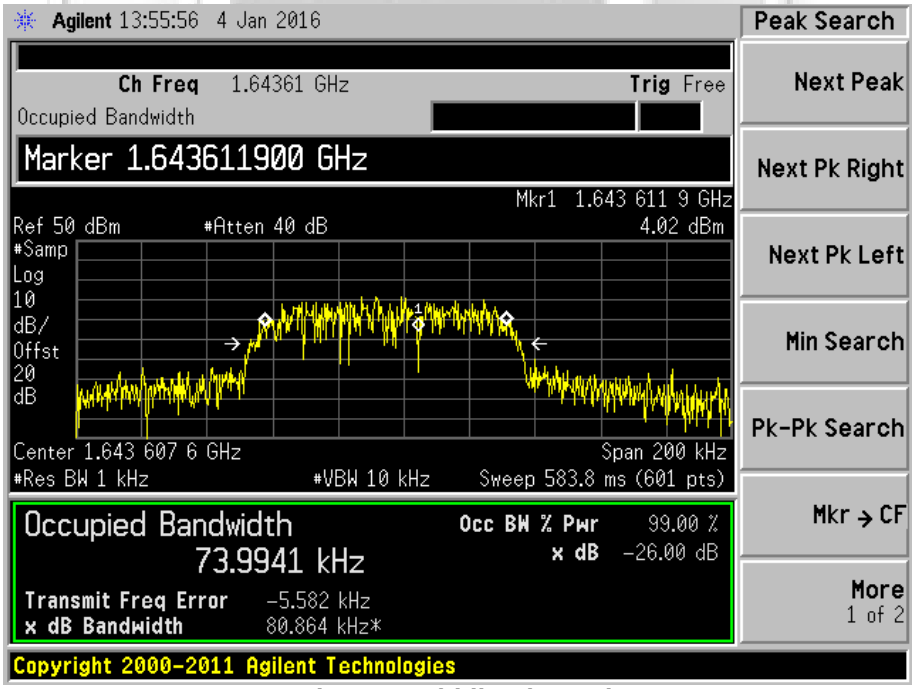


Plot 57 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 5)

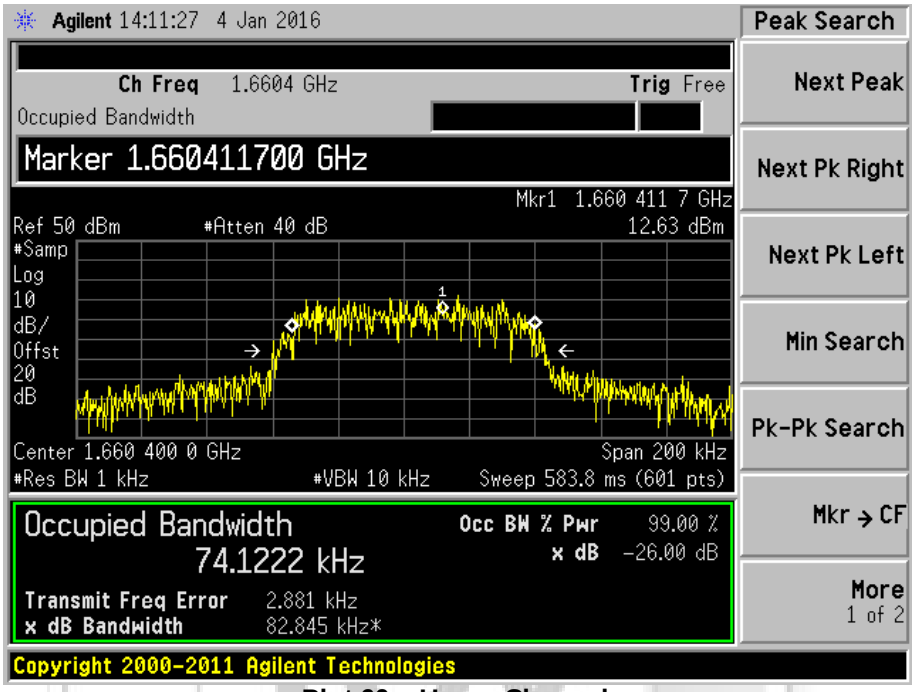


Plot 58 – Lower Channel



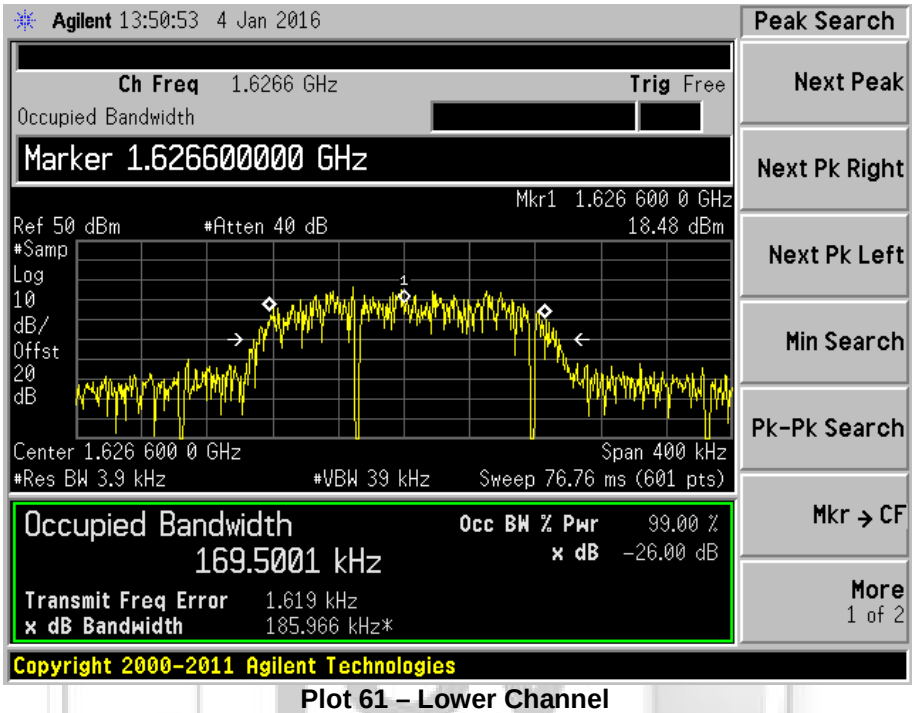
Plot 59 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 5)

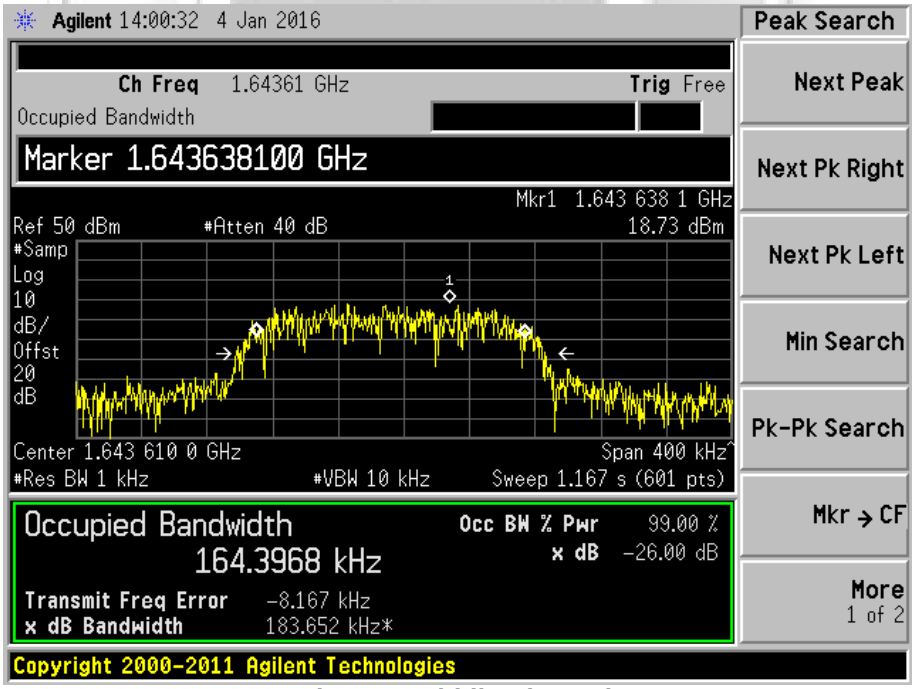


Plot 60 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 6)

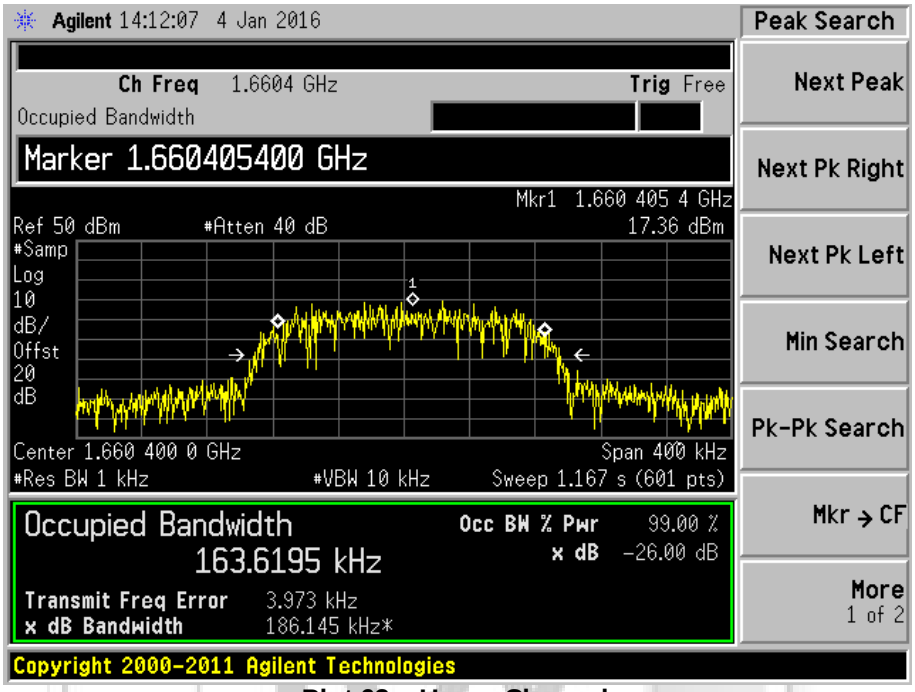


Plot 61 – Lower Channel



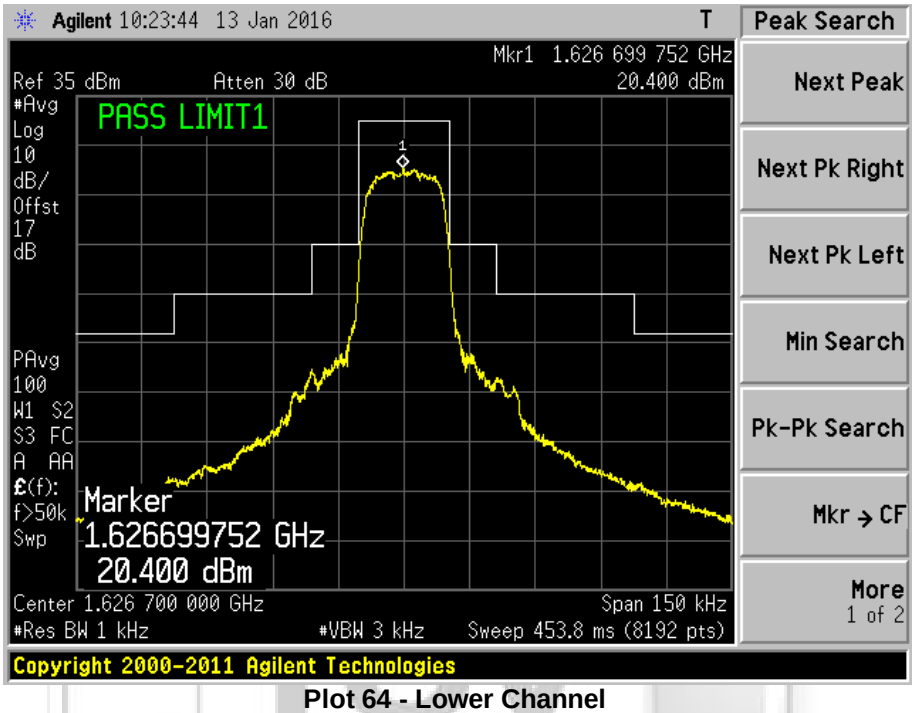
Plot 62 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 6)

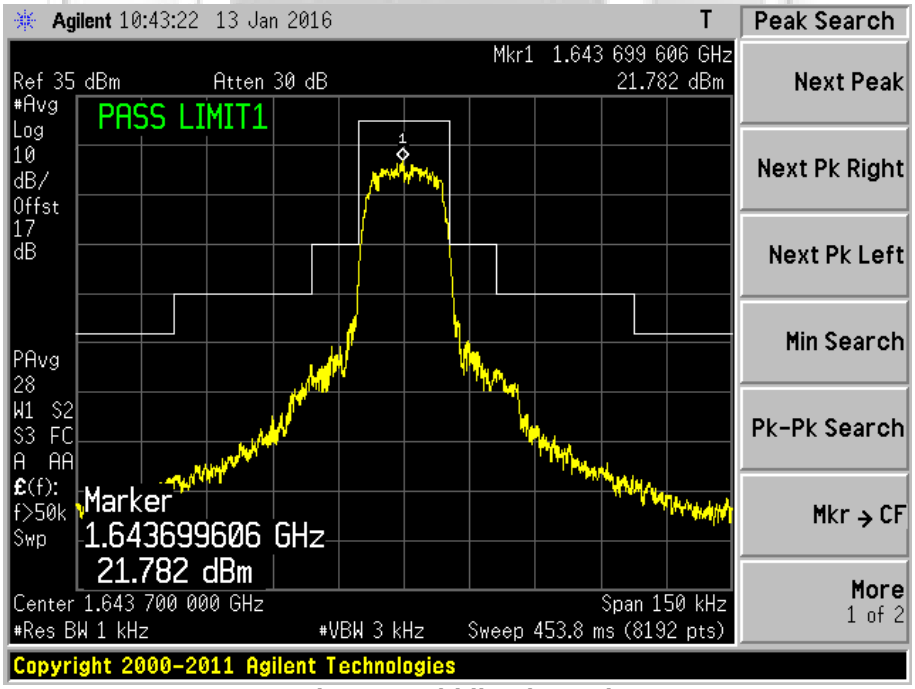


Plot 63 – Upper Channel

In Band Emissions Plots (Bearer Type: 0)

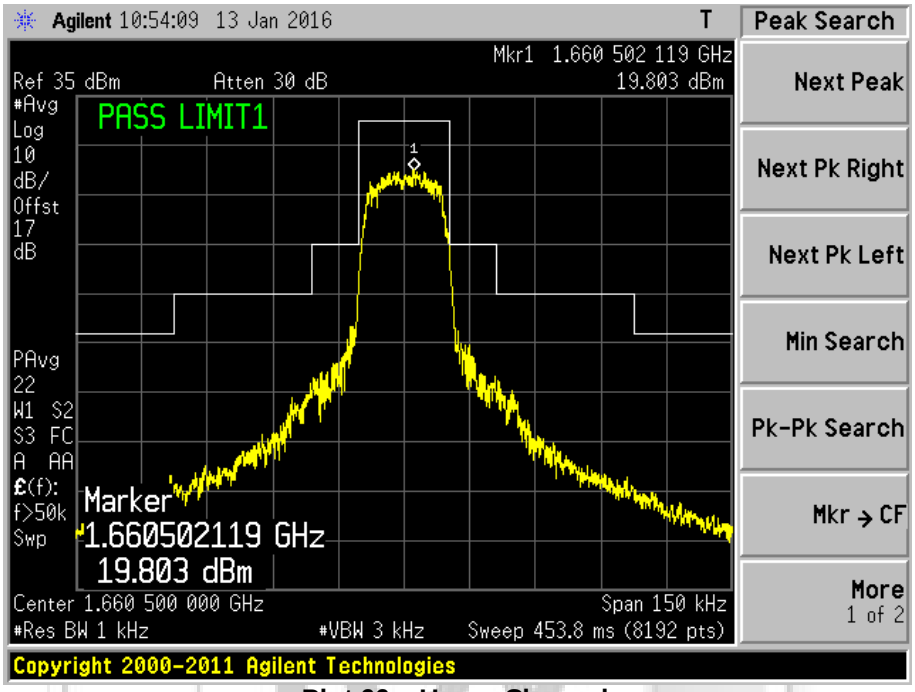


Plot 64 - Lower Channel



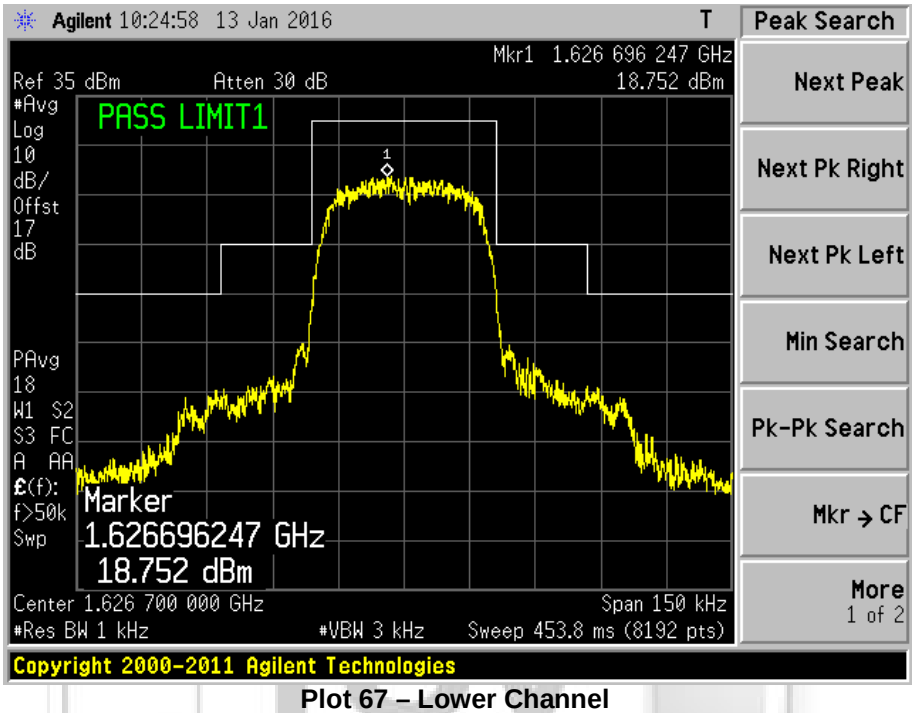
Plot 65 – Middle Channel

In Band Emissions Plots (Bearer Type: 0)

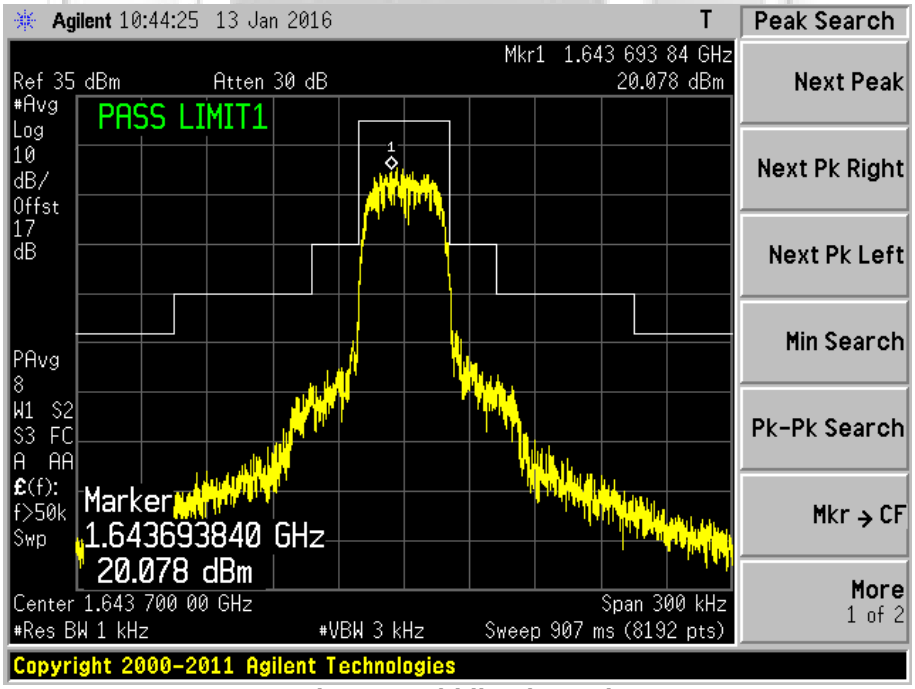


Plot 66 – Upper Channel

In Band Emissions Plots (Bearer Type: 1)

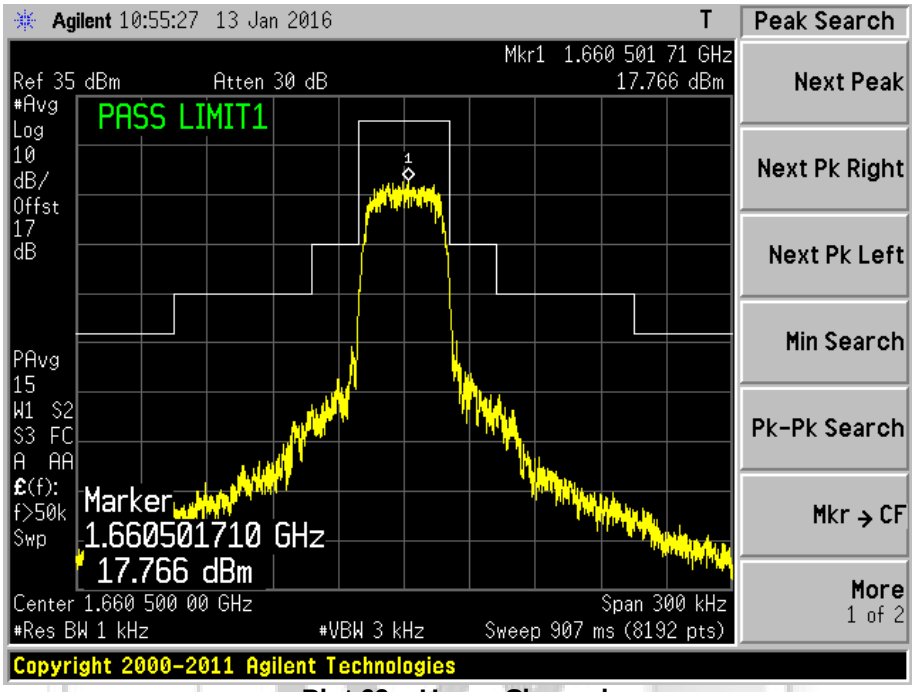


Plot 67 – Lower Channel



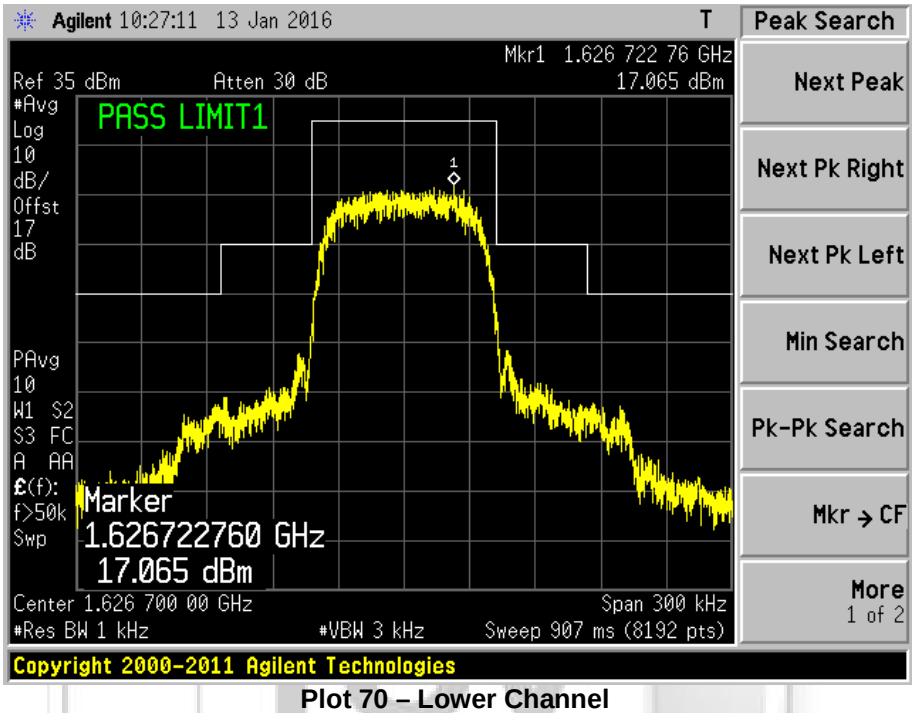
Plot 68 – Middle Channel

In Band Emissions Plots (Bearer Type: 1)

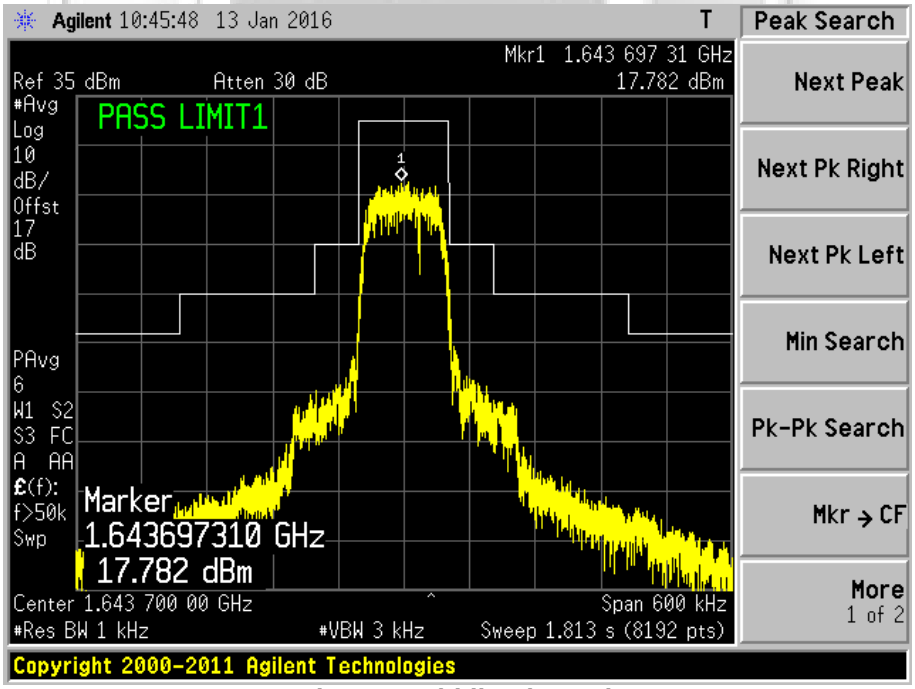


Plot 69 – Upper Channel

In Band Emissions Plots (Bearer Type: 2)

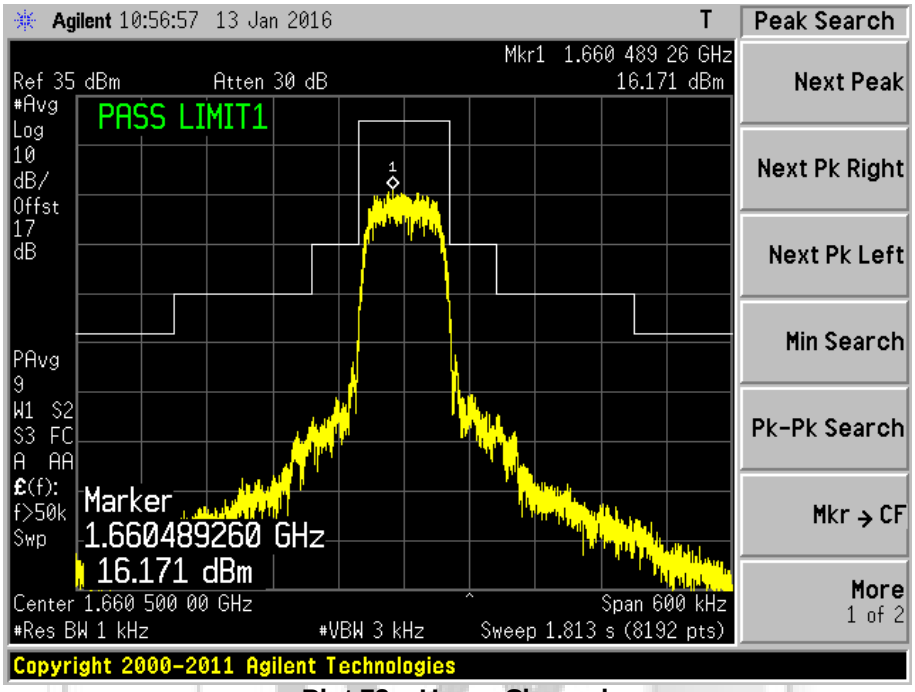


Plot 70 – Lower Channel



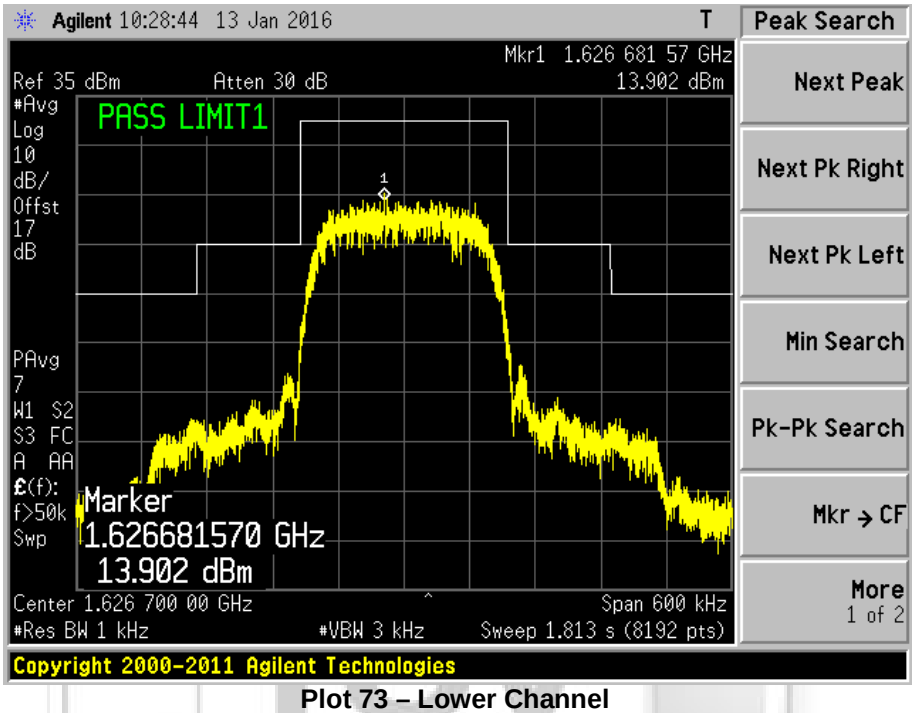
Plot 71 – Middle Channel

In Band Emissions Plots (Bearer Type: 2)

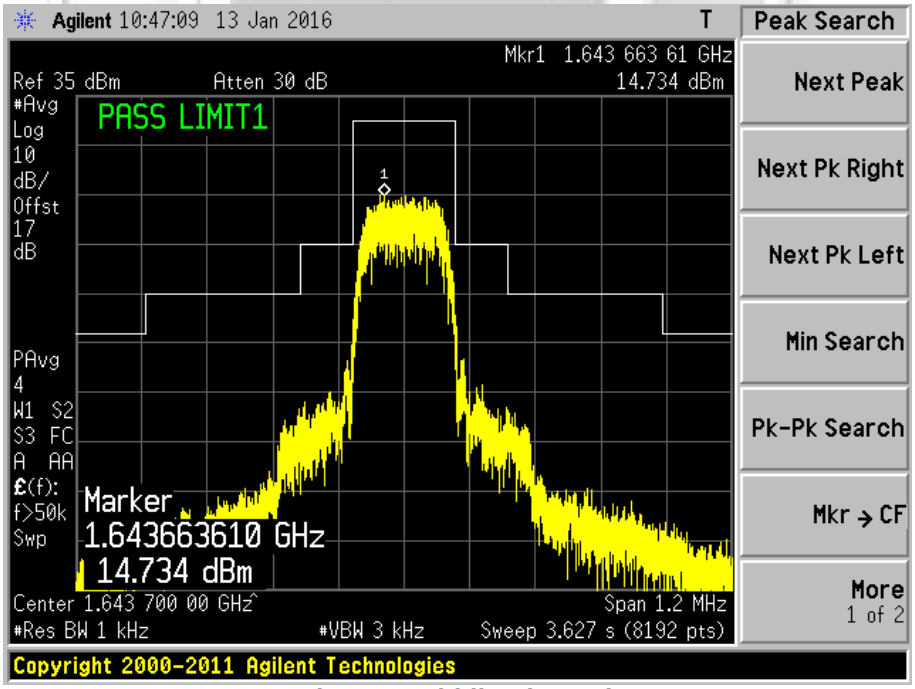


Plot 72 – Upper Channel

In Band Emissions Plots (Bearer Type: 3)

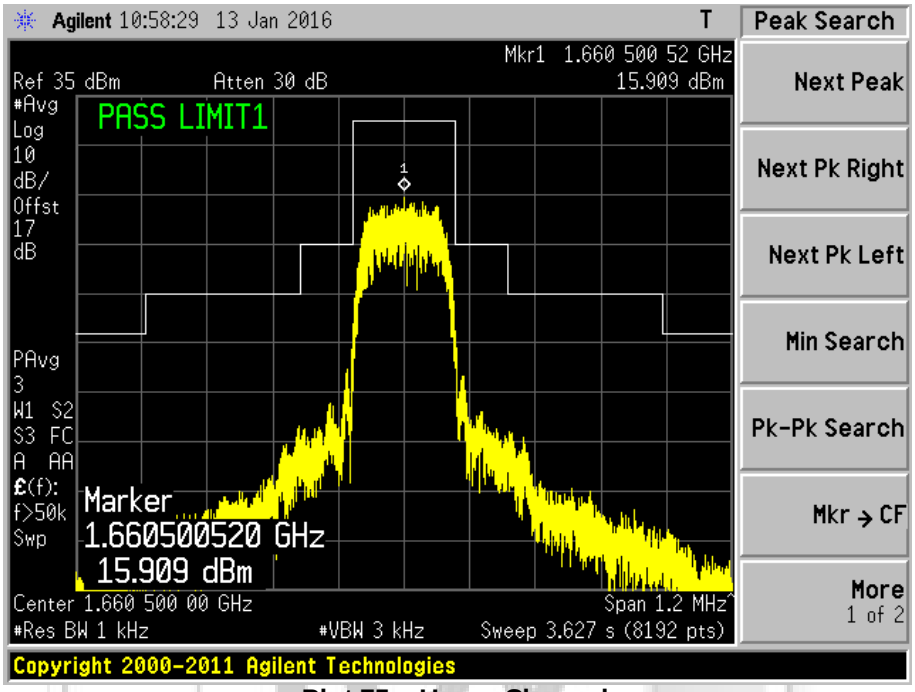


Plot 73 – Lower Channel



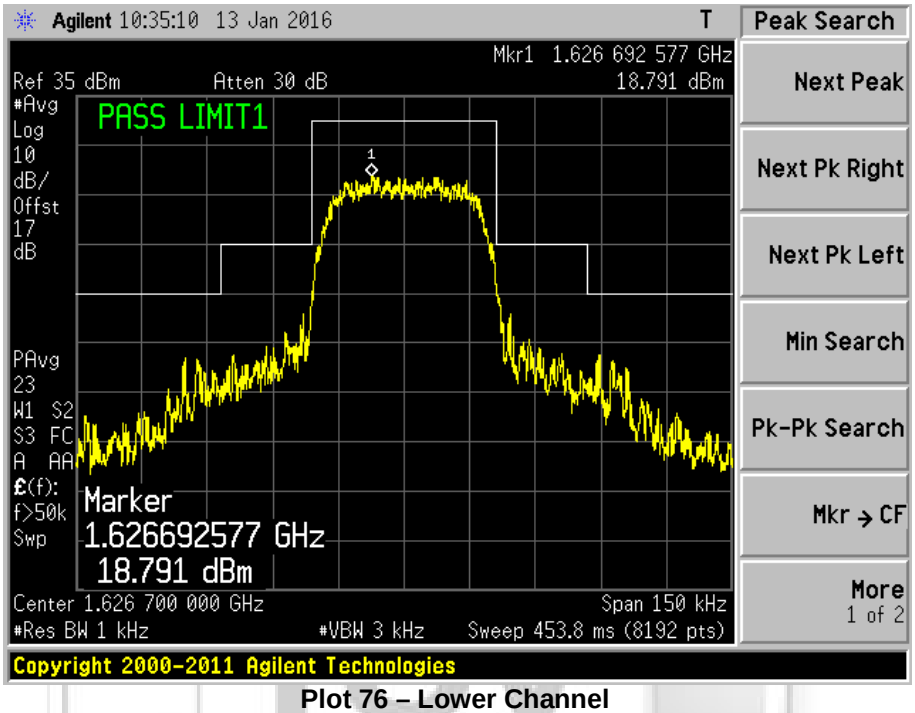
Plot 74 – Middle Channel

In Band Emissions Plots (Bearer Type: 3)

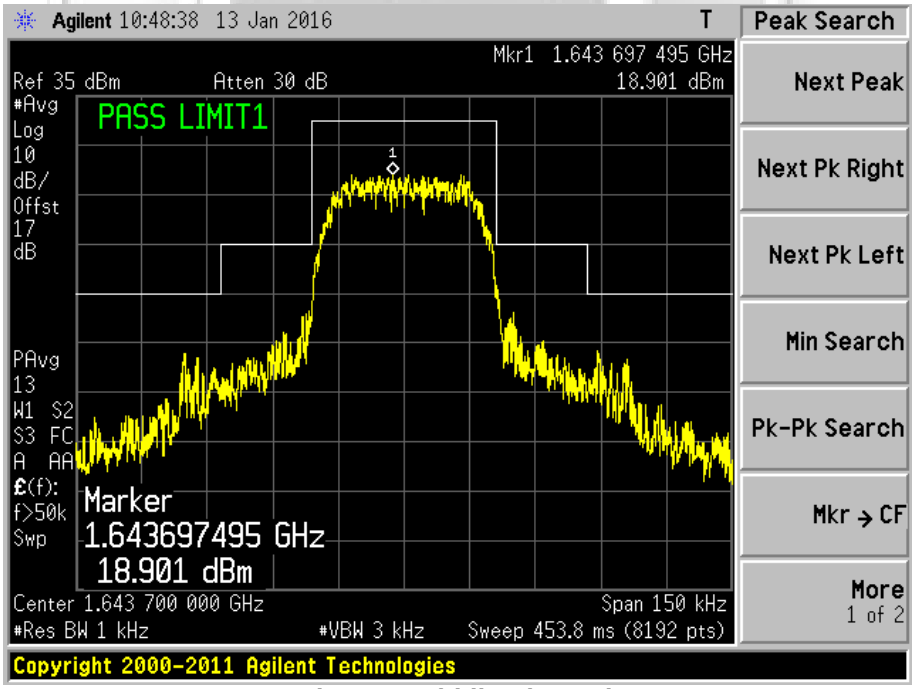


Plot 75 – Upper Channel

In Band Emissions Plots (Bearer Type: 4)

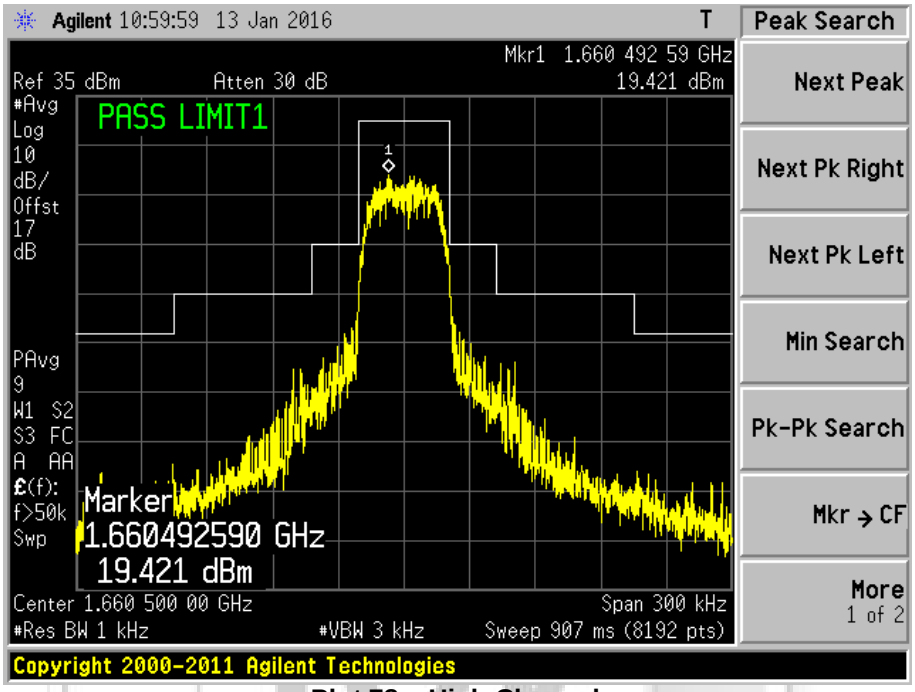


Plot 76 – Lower Channel



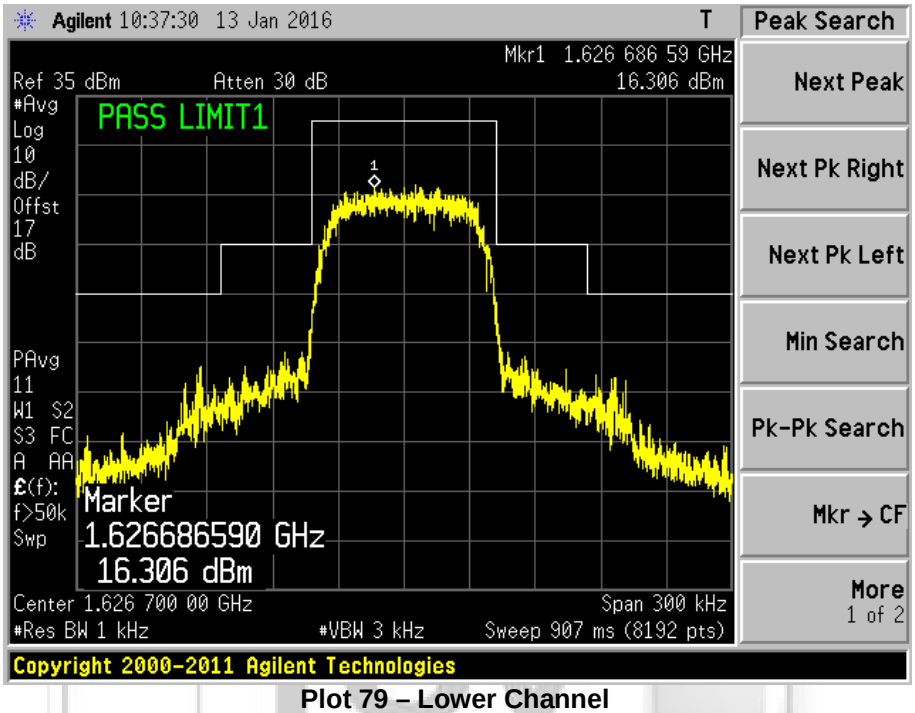
Plot 77 – Middle Channel

In Band Emissions Plots (Bearer Type: 4)

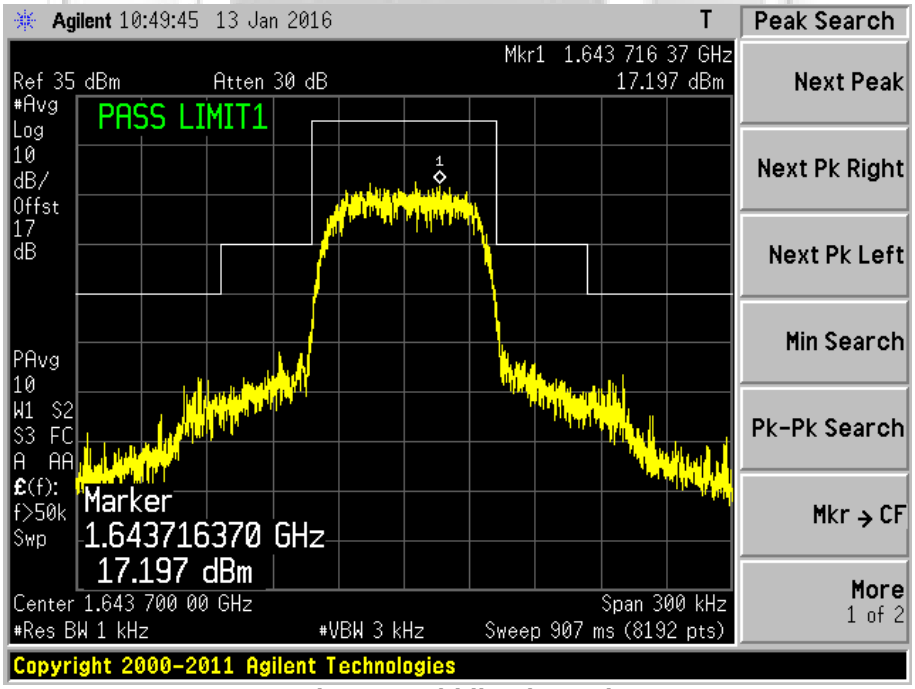


Plot 78 – High Channel

In Band Emissions Plots (Bearer Type: 5)

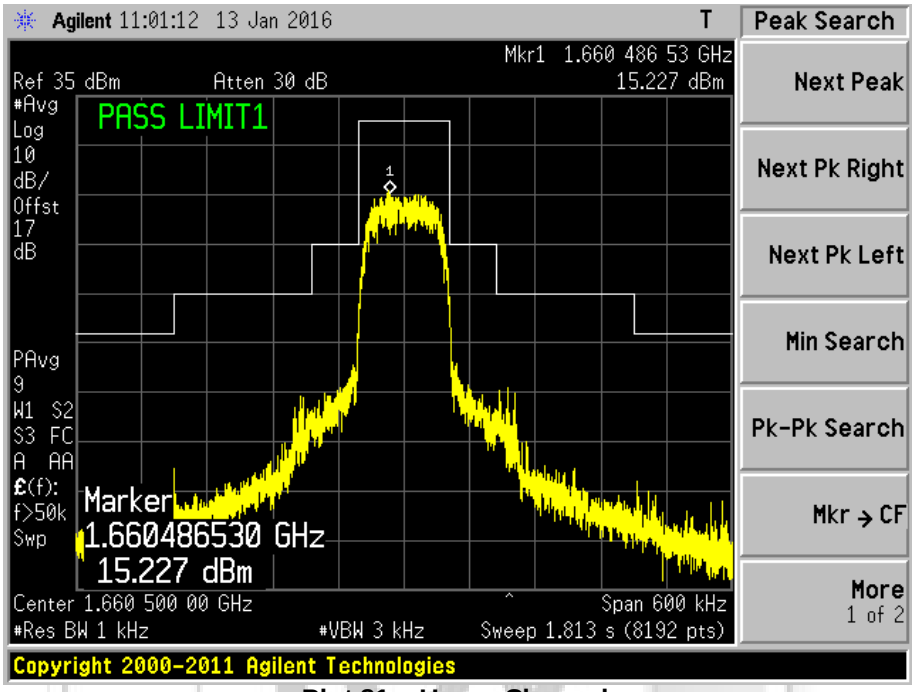


Plot 79 – Lower Channel



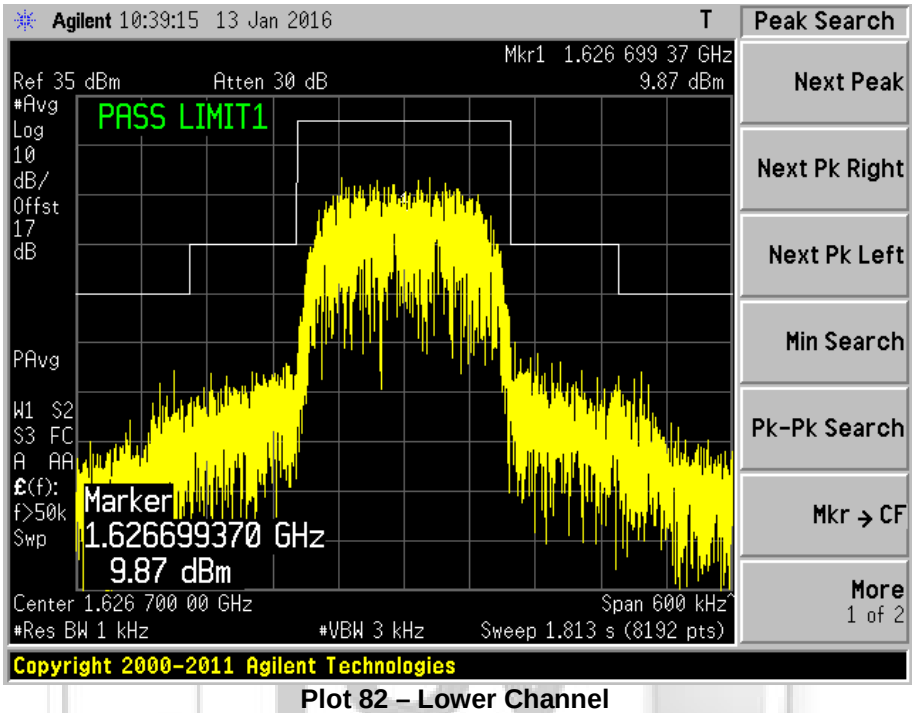
Plot 80 – Middle Channel

In Band Emissions Plots (Bearer Type: 5)

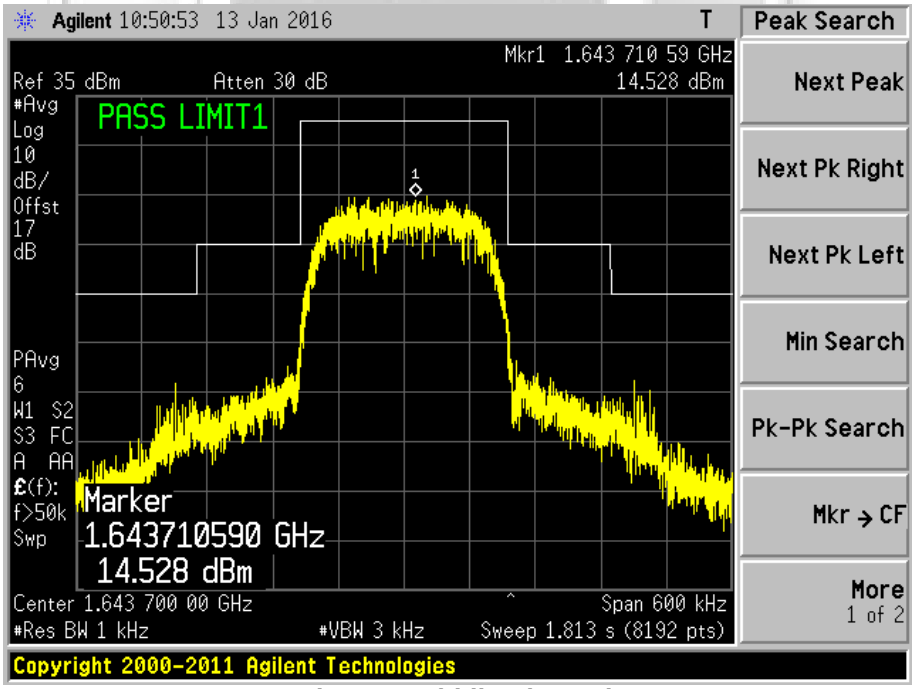


Plot 81 – Upper Channel

In Band Emissions Plots (Bearer Type: 6)

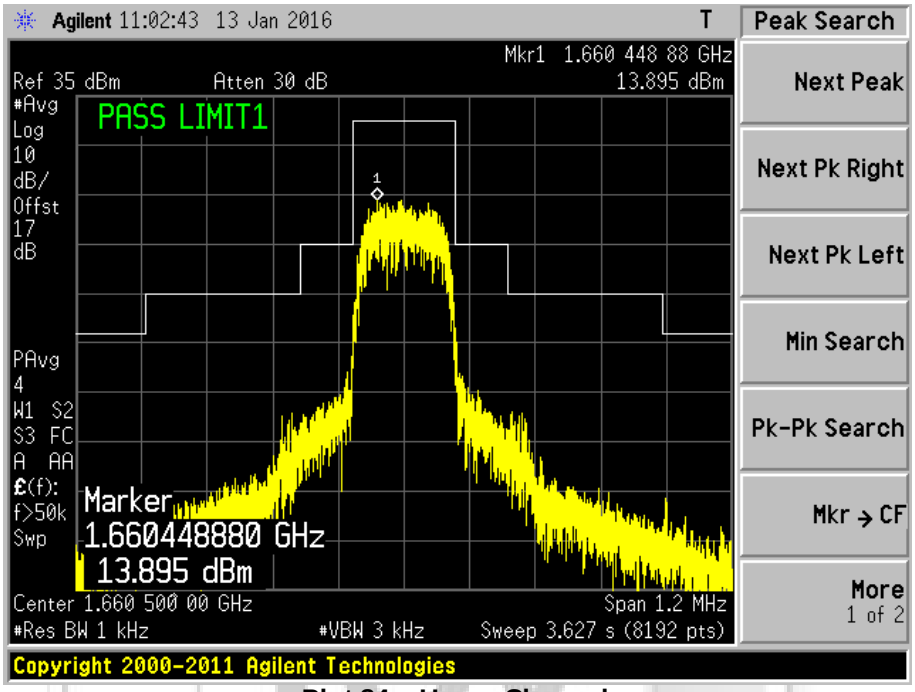


Plot 82 – Lower Channel



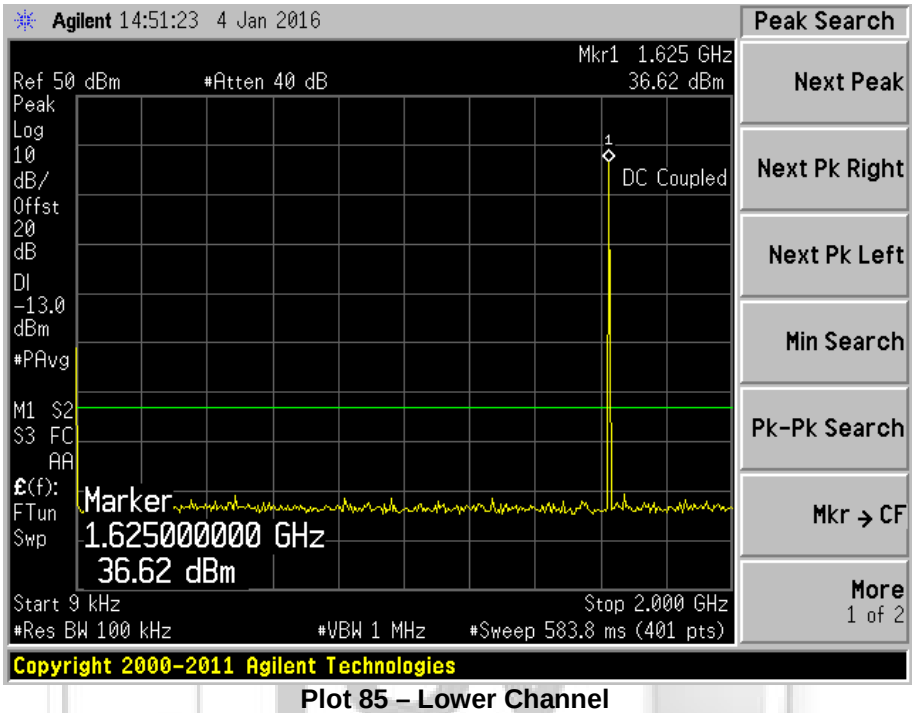
Plot 83 – Middle Channel

In Band Emissions Plots (Bearer Type: 6)

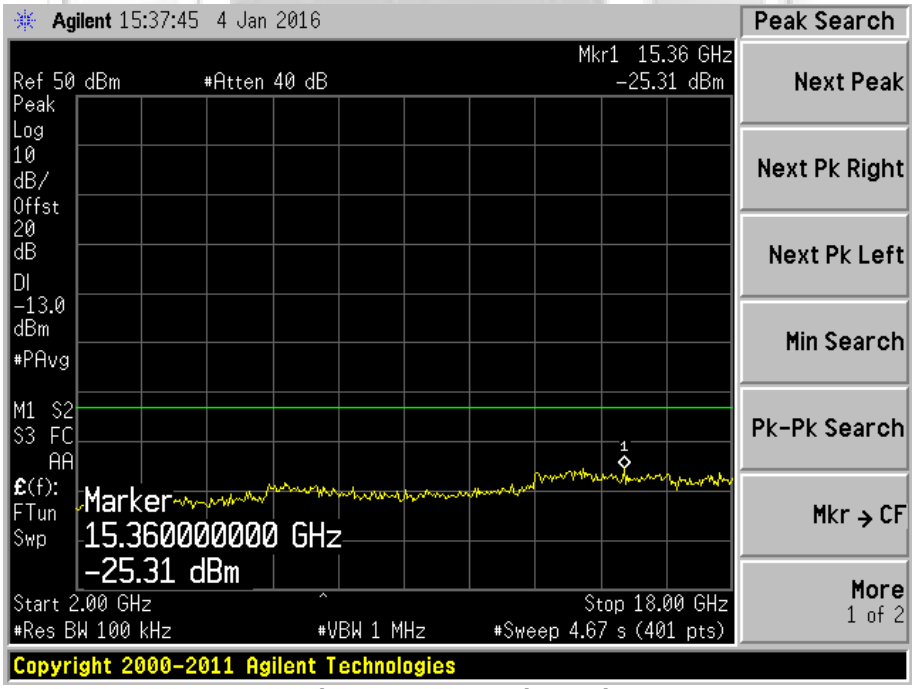


Plot 84 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 0)

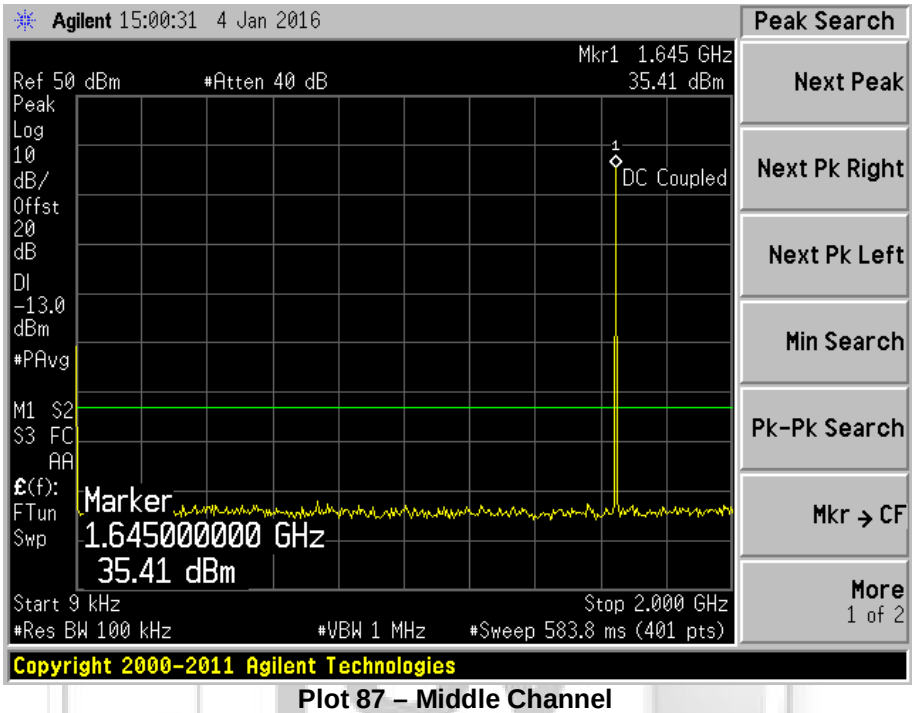


Plot 85 – Lower Channel

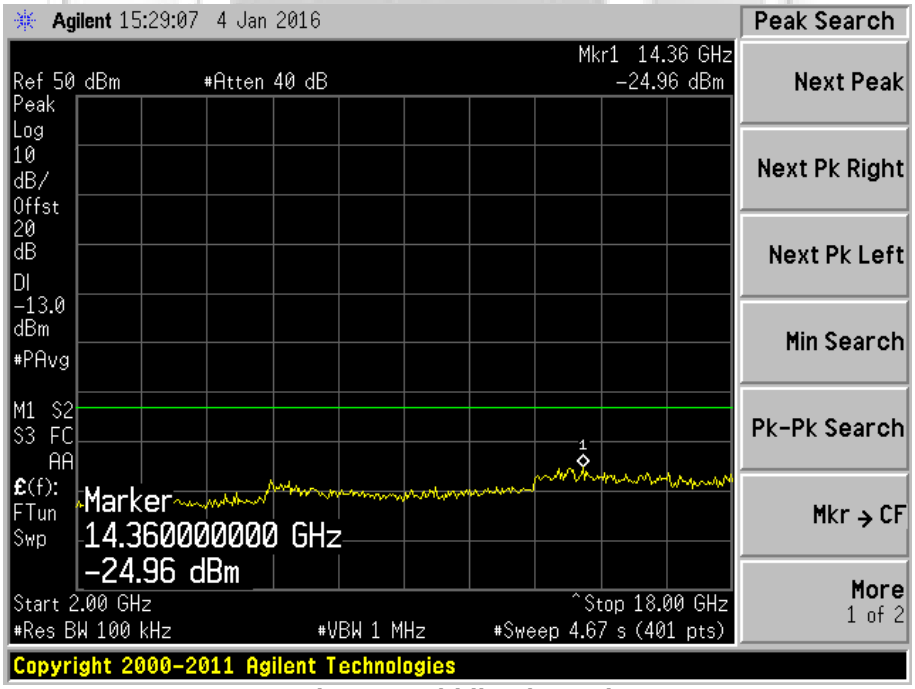


Plot 86 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 0)

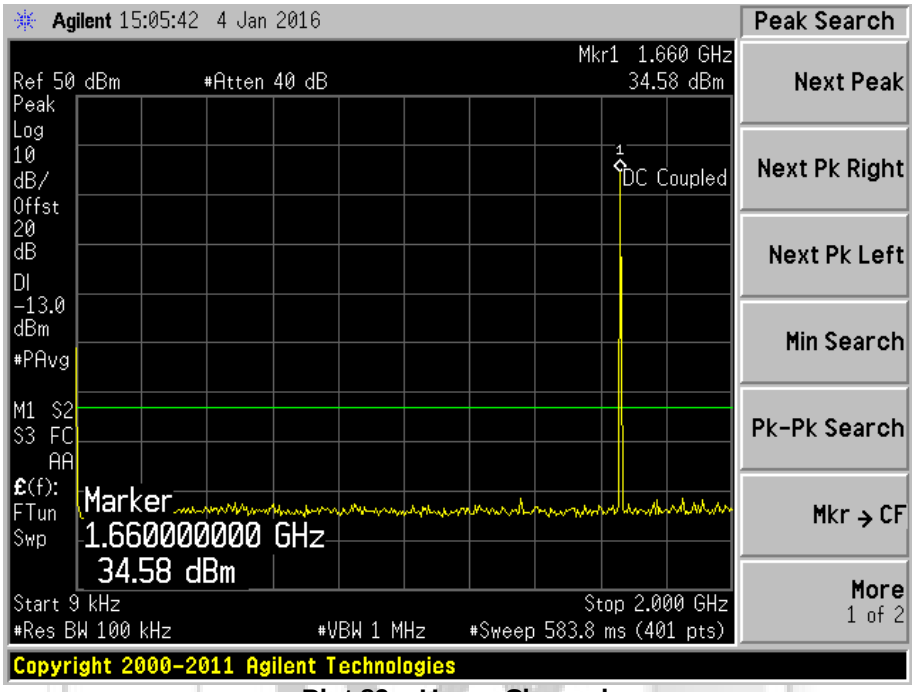


Plot 87 – Middle Channel

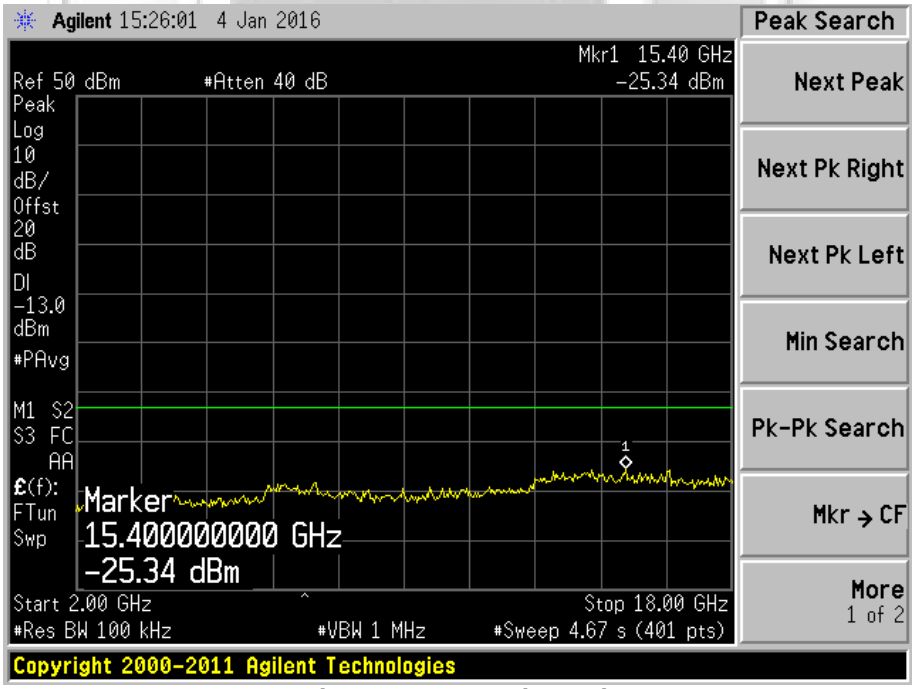


Plot 88 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 0)

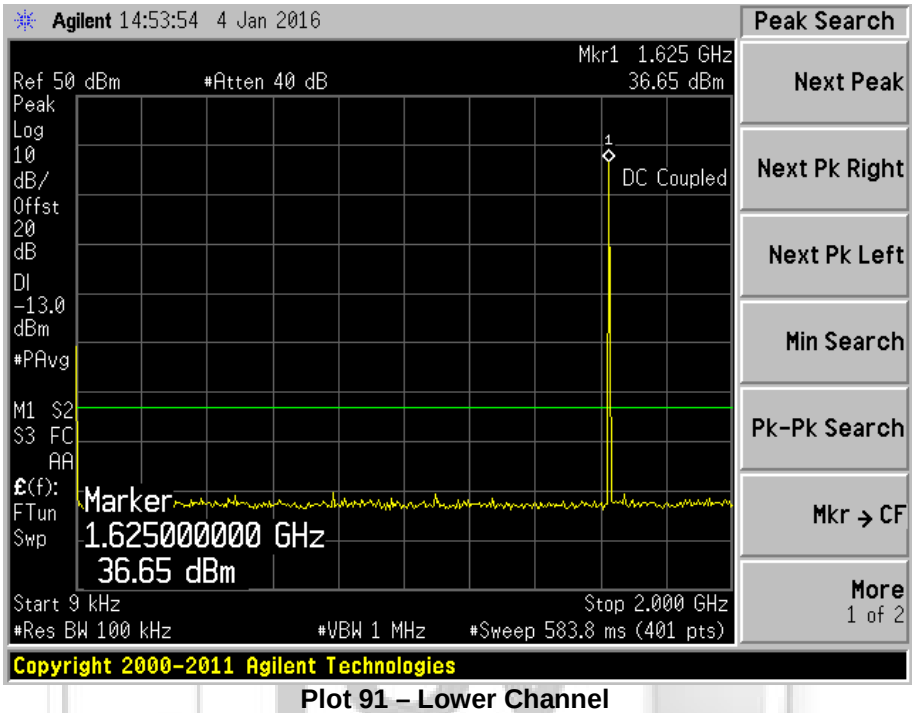


Plot 89 – Upper Channel

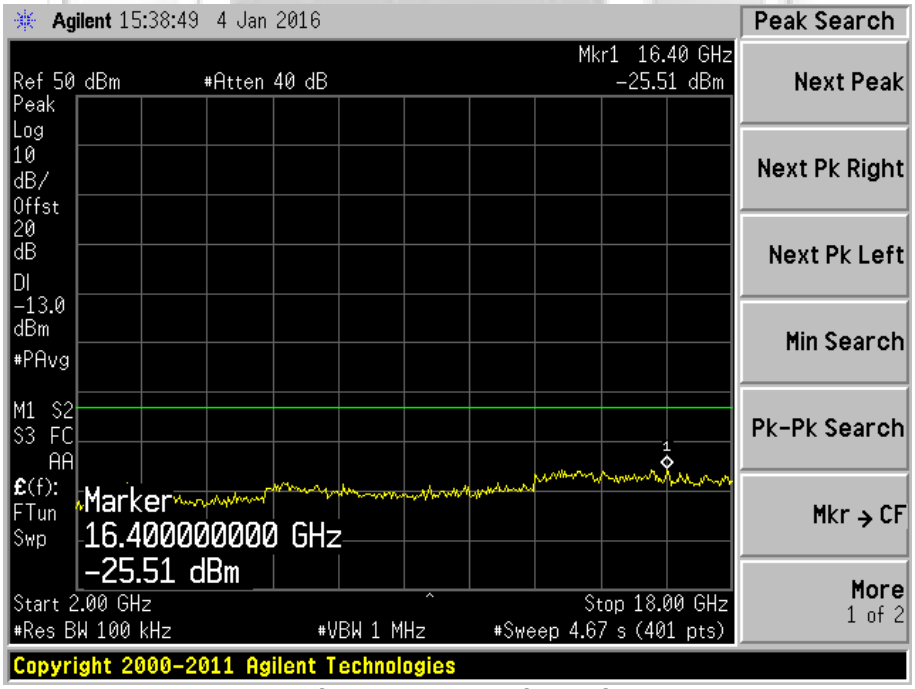


Plot 90 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 1)

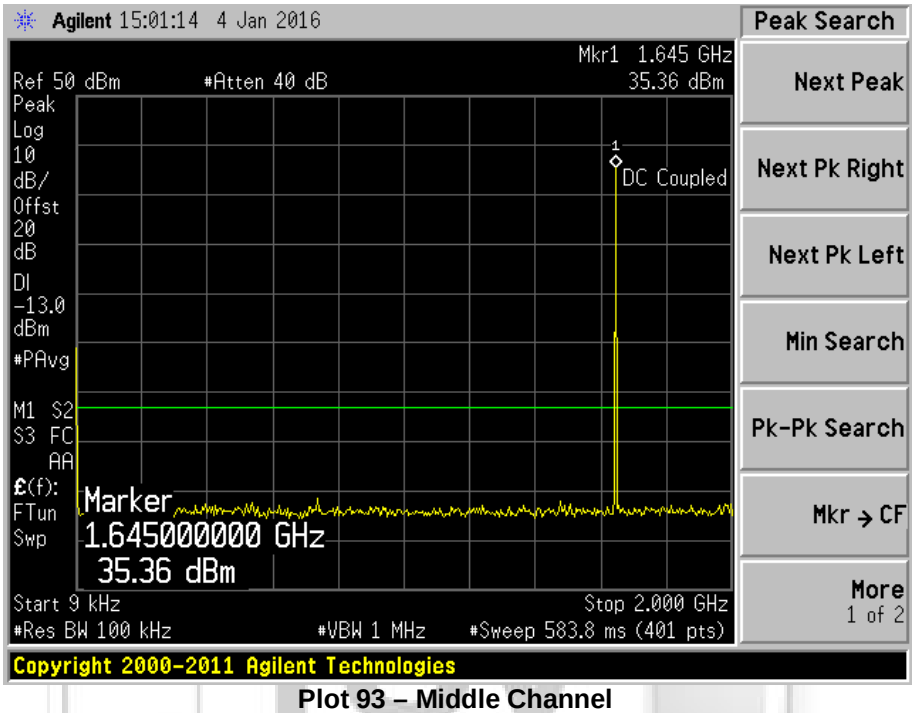


Plot 91 – Lower Channel

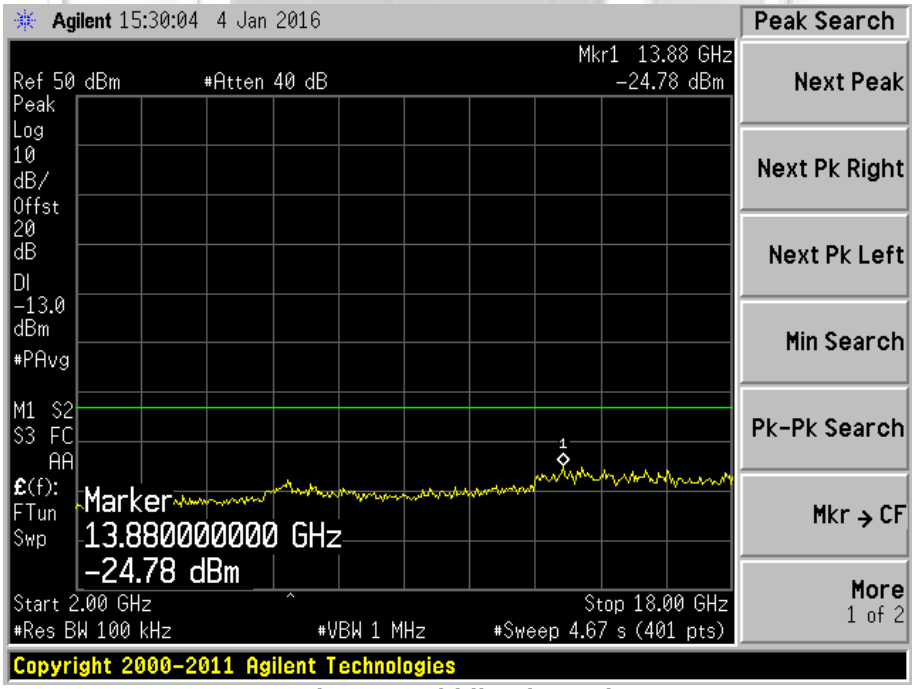


Plot 92 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 1)

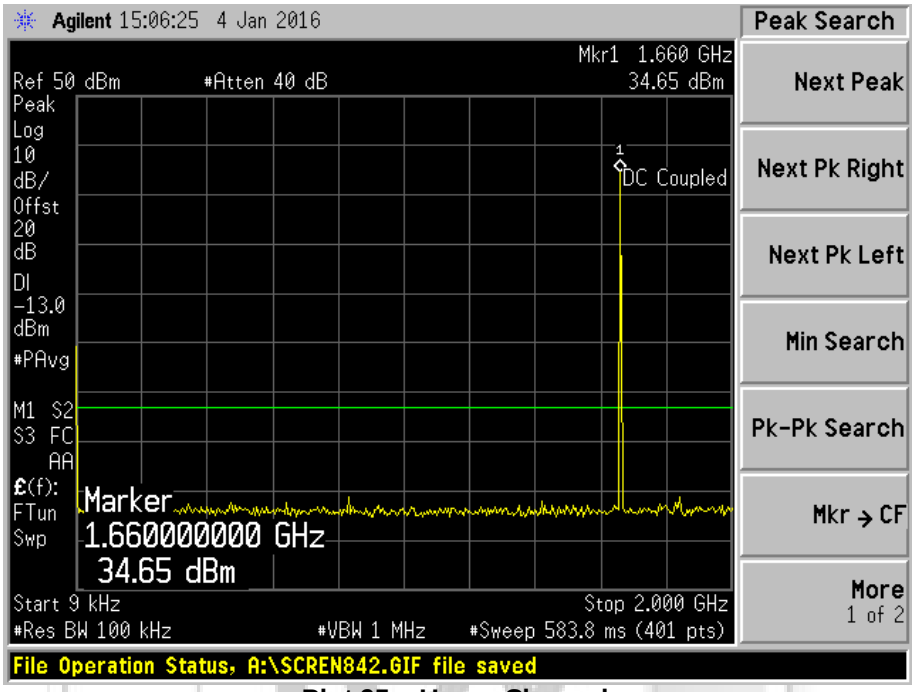


Plot 93 – Middle Channel

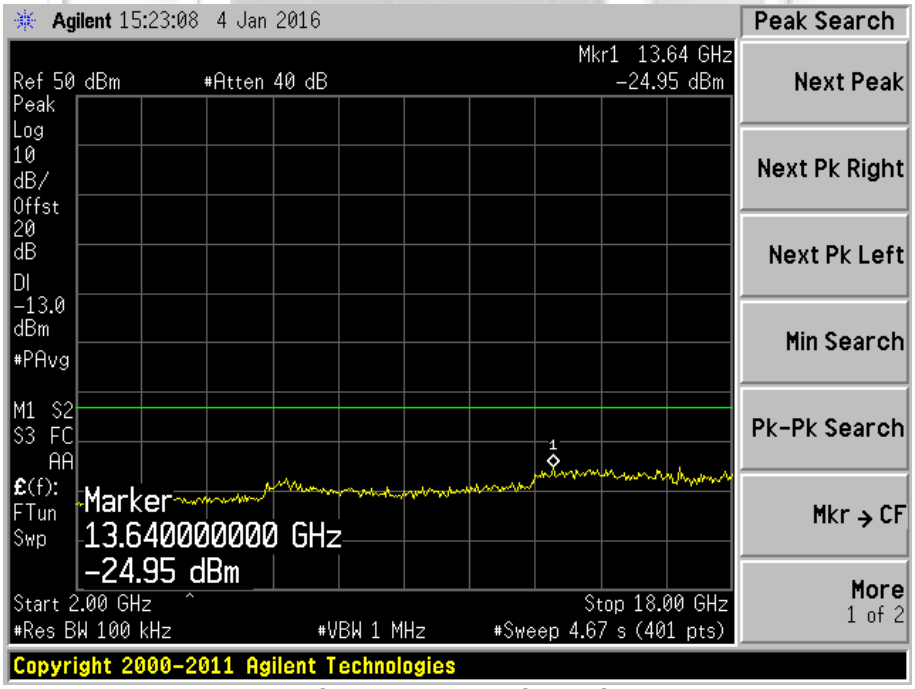


Plot 94 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 1)

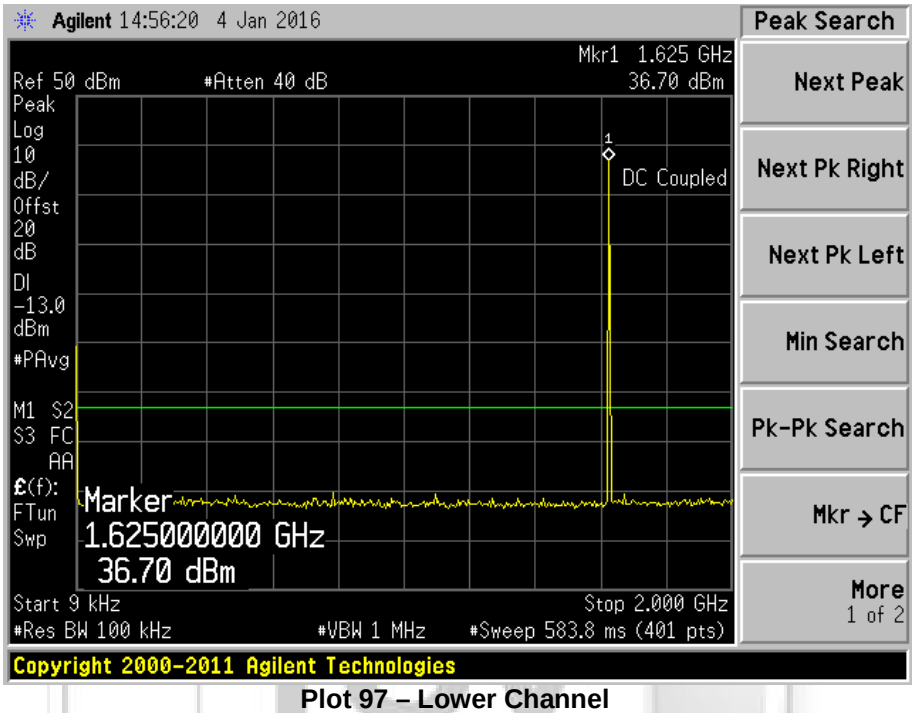


Plot 95 – Upper Channel

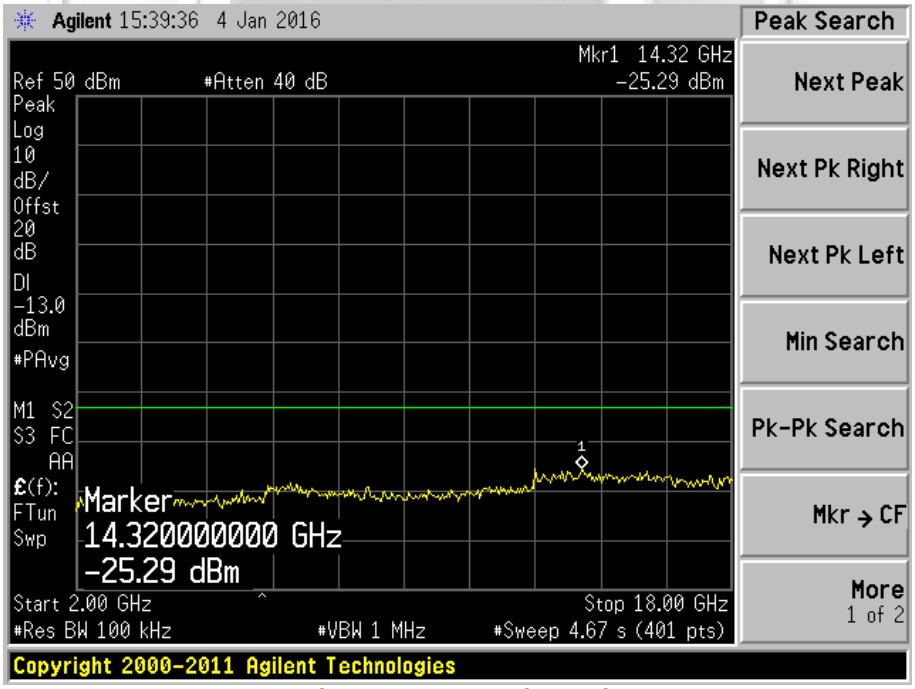


Plot 96 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 2)

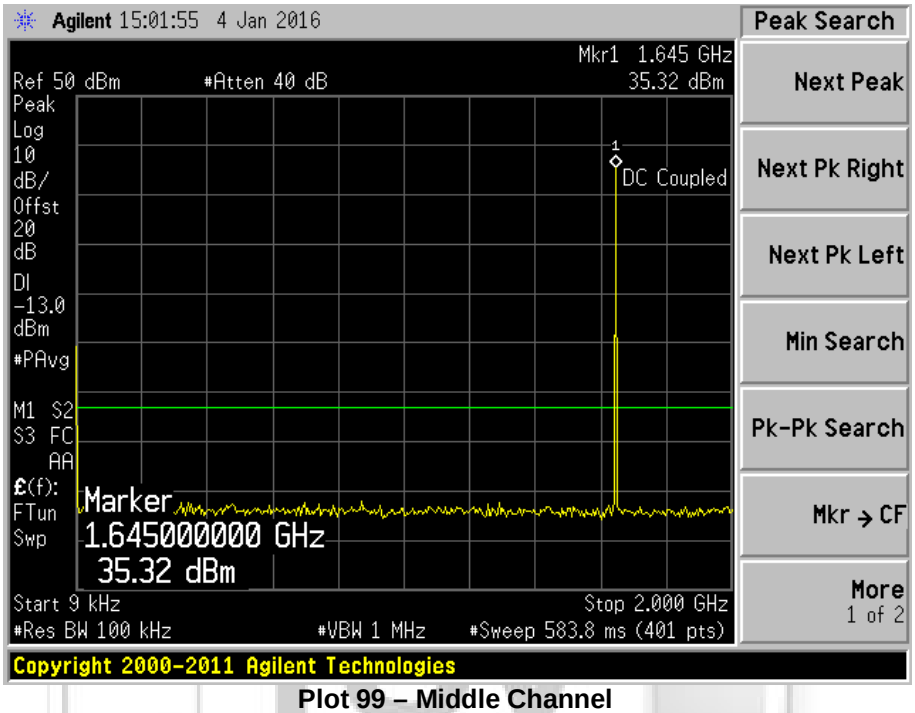


Plot 97 – Lower Channel

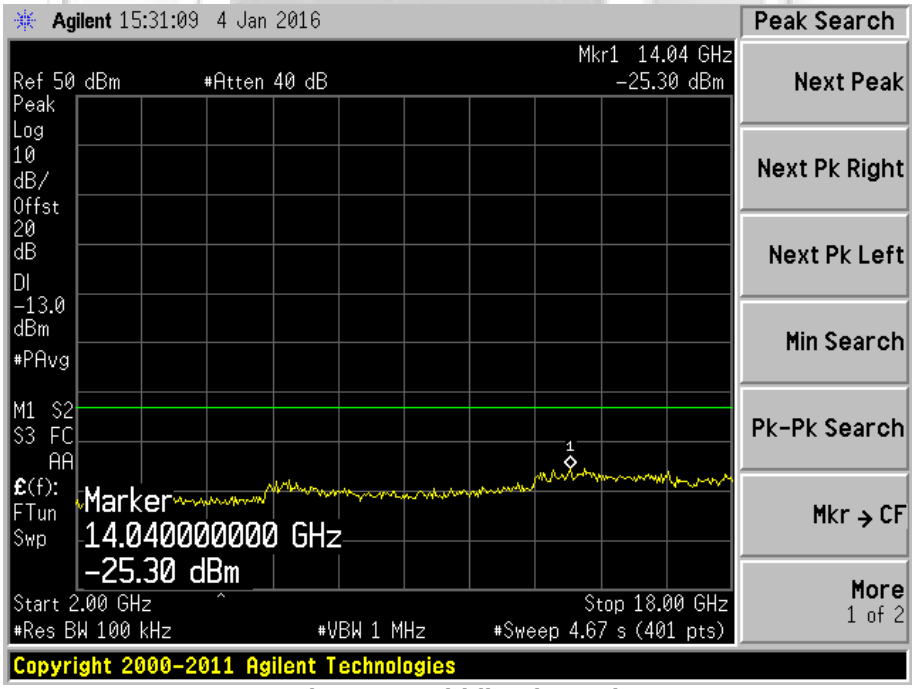


Plot 98 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 2)

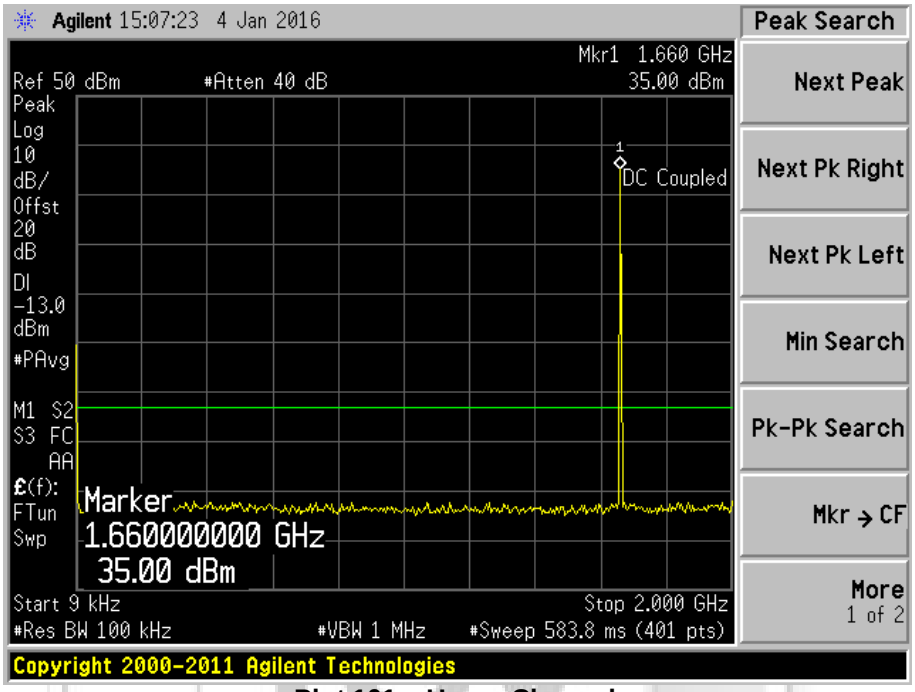


Plot 99 – Middle Channel

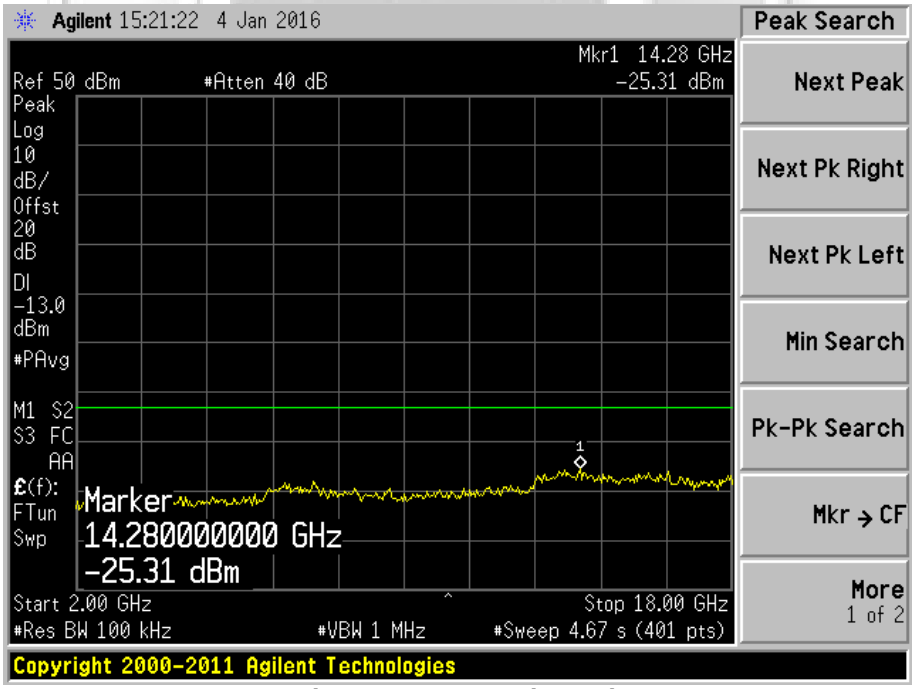


Plot 100 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 2)

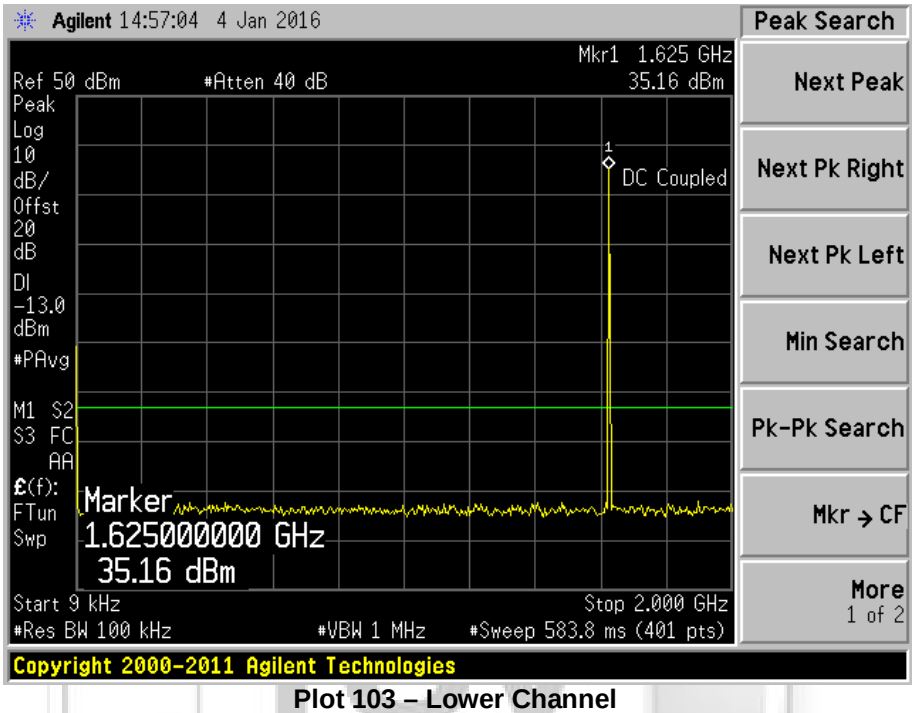


Plot 101 – Upper Channel

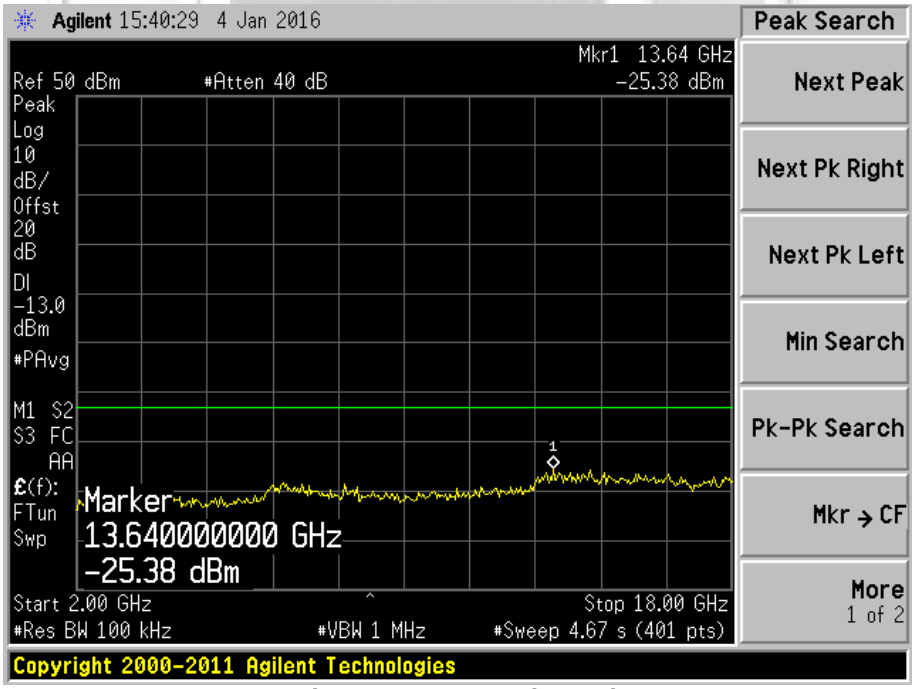


Plot 102 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 3)

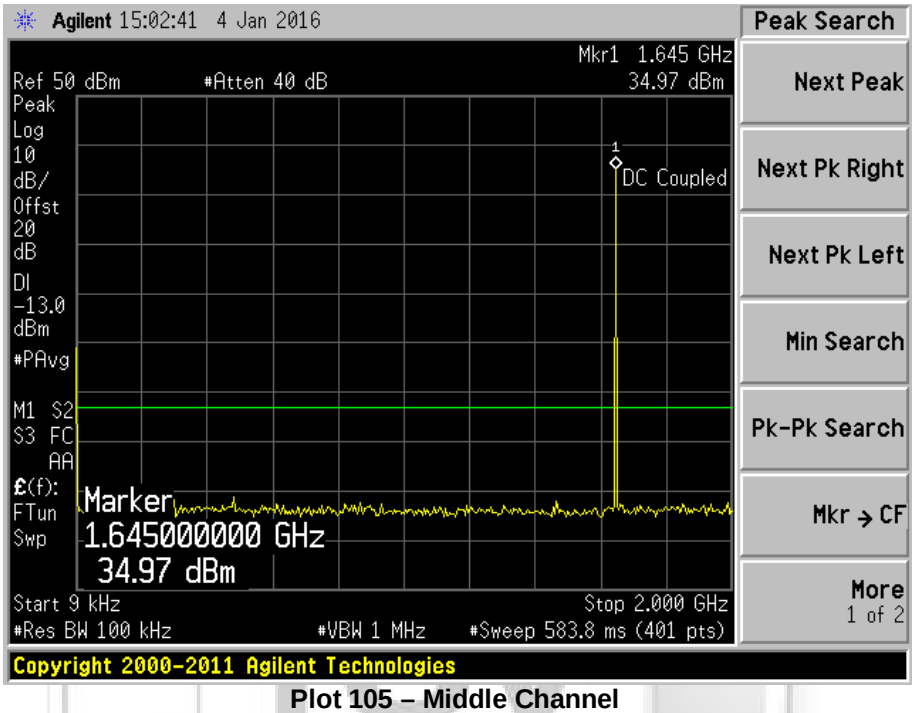


Plot 103 – Lower Channel

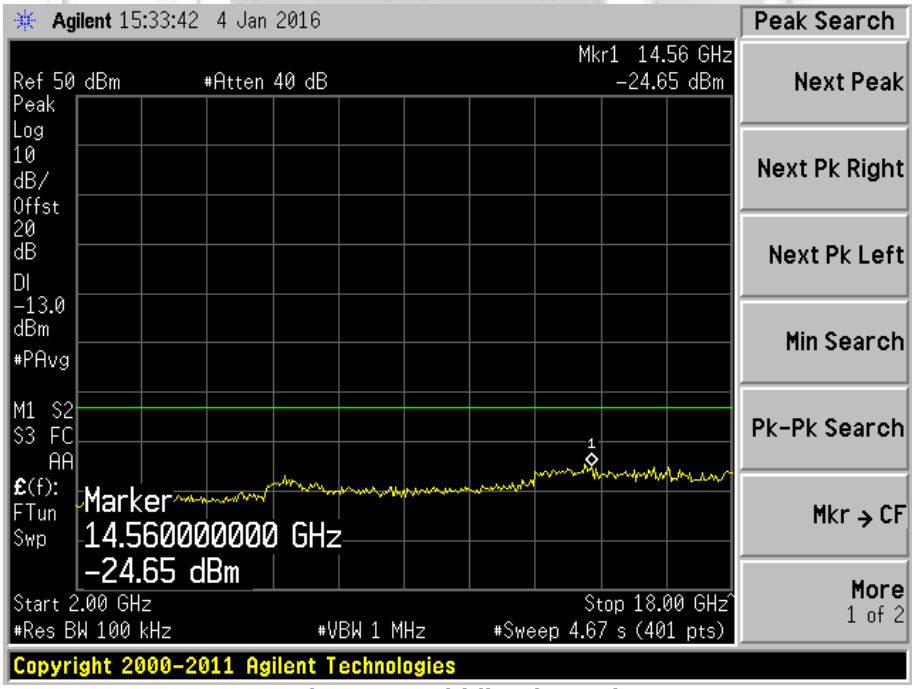


Plot 104 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 3)

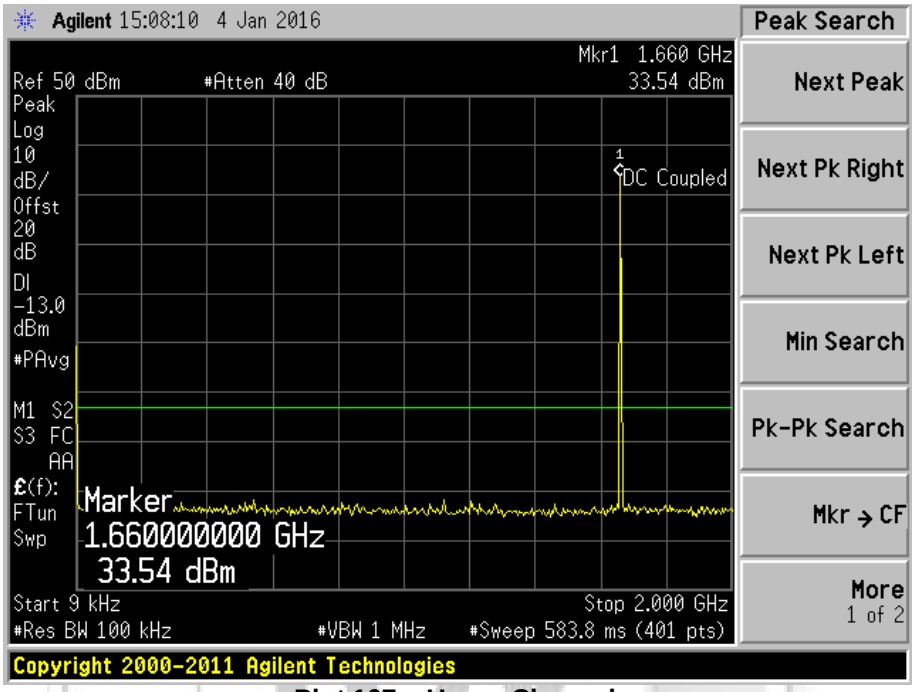


Plot 105 – Middle Channel

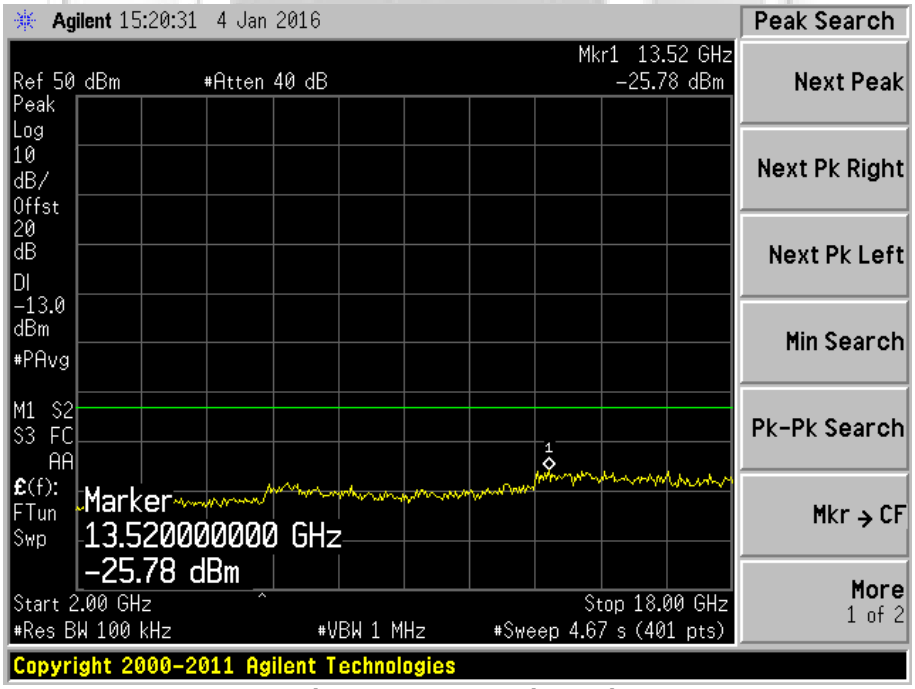


Plot 106 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 3)

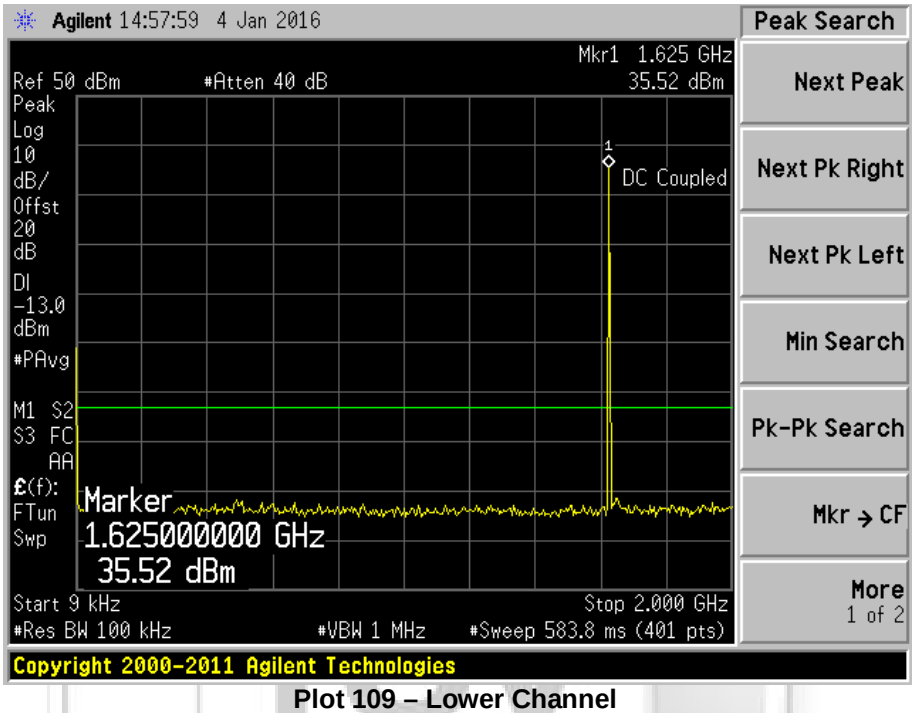


Plot 107 – Upper Channel

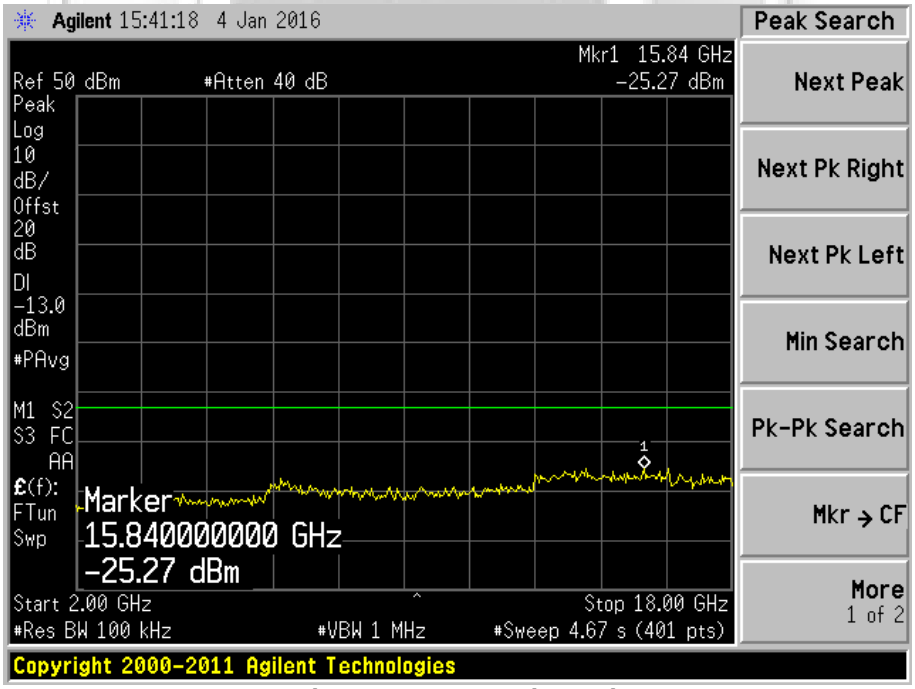


Plot 108 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 4)

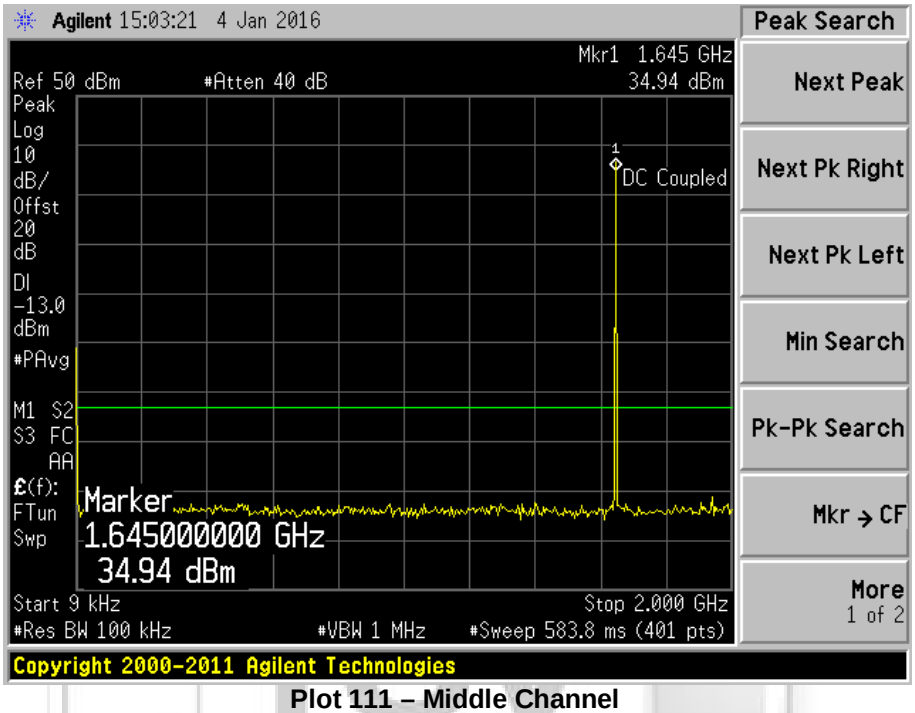


Plot 109 – Lower Channel

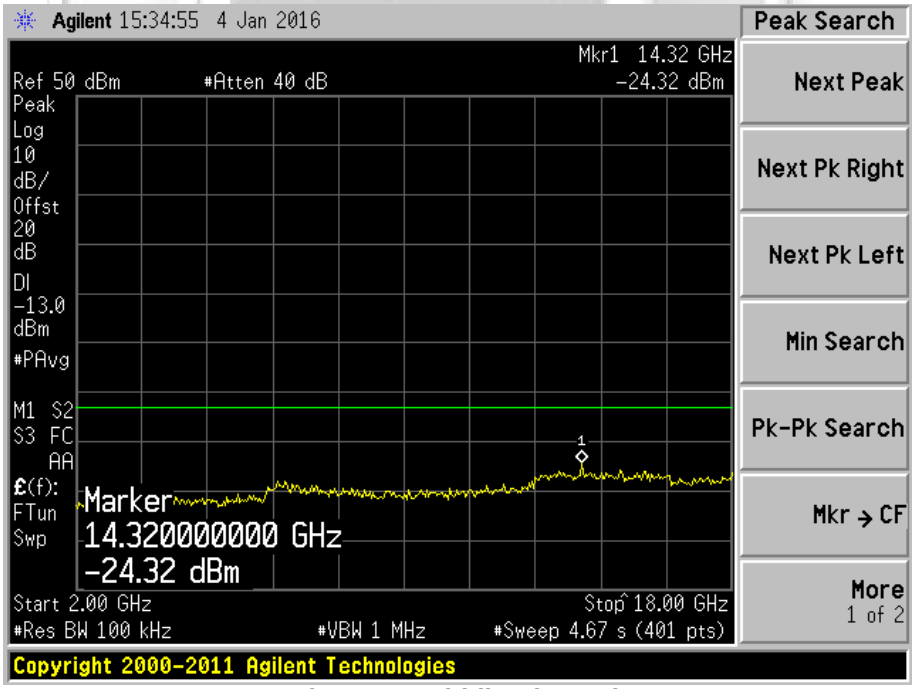


Plot 110 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 4)

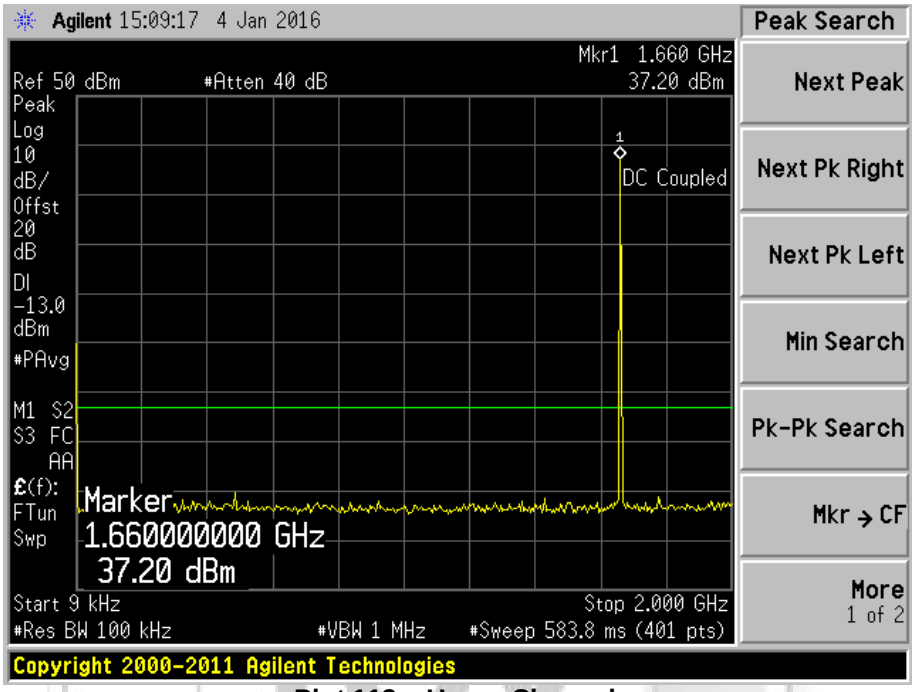


Plot 111 – Middle Channel

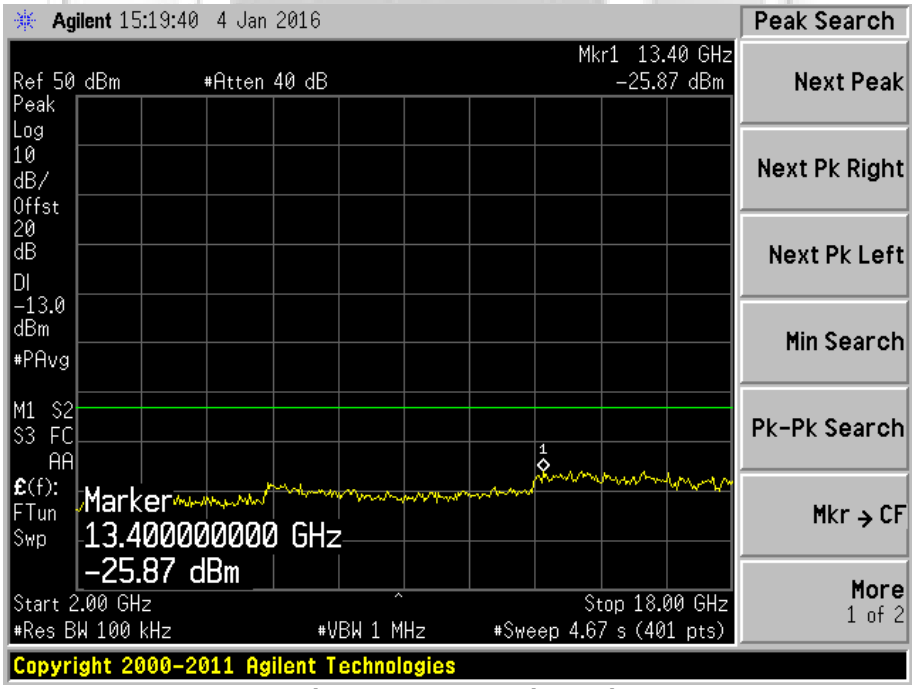


Plot 112 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 4)

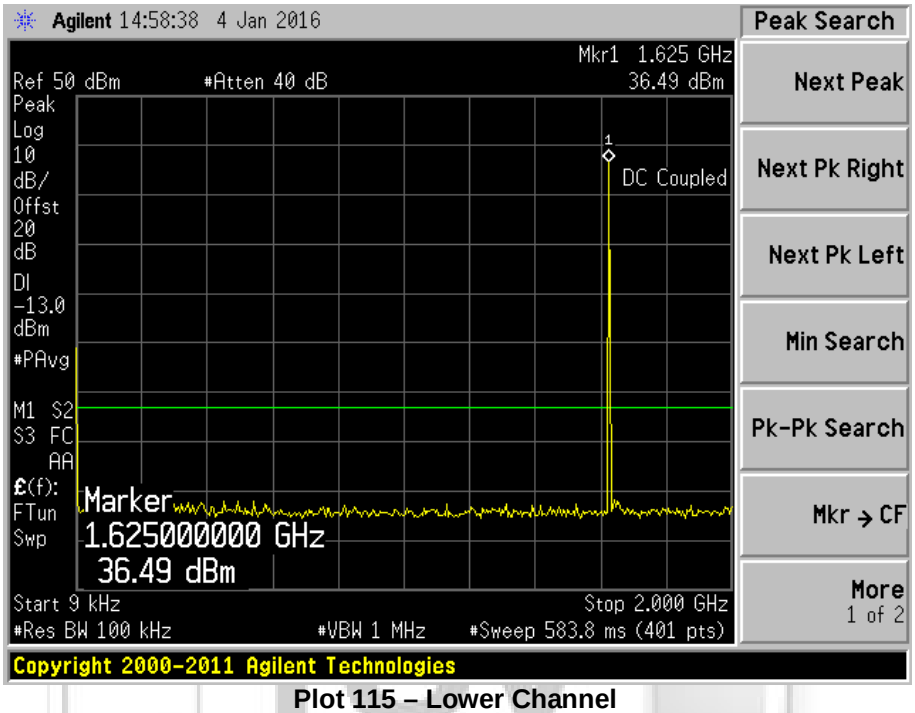


Plot 113 – Upper Channel

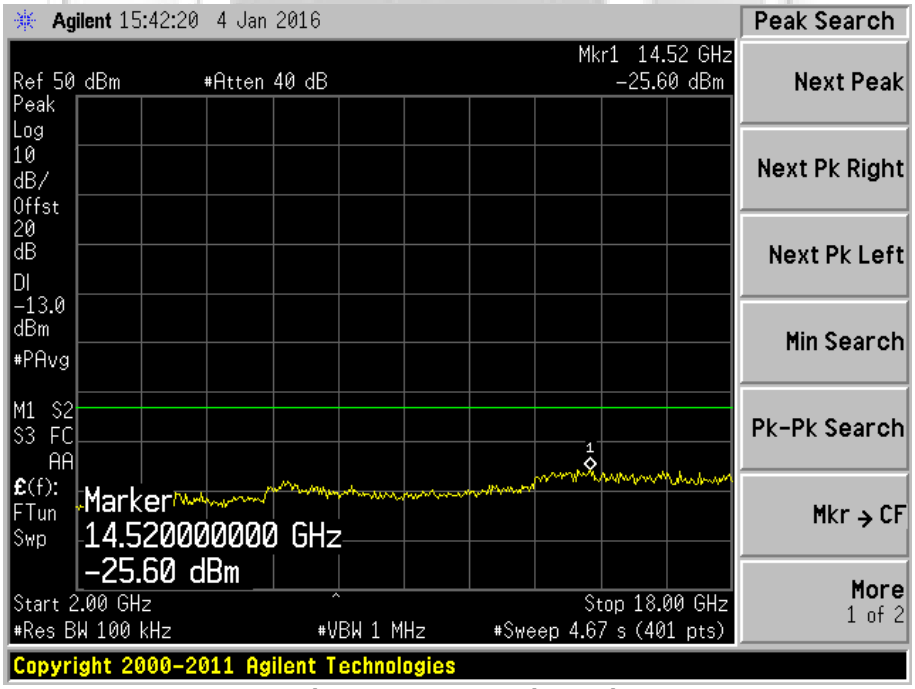


Plot 114 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 5)

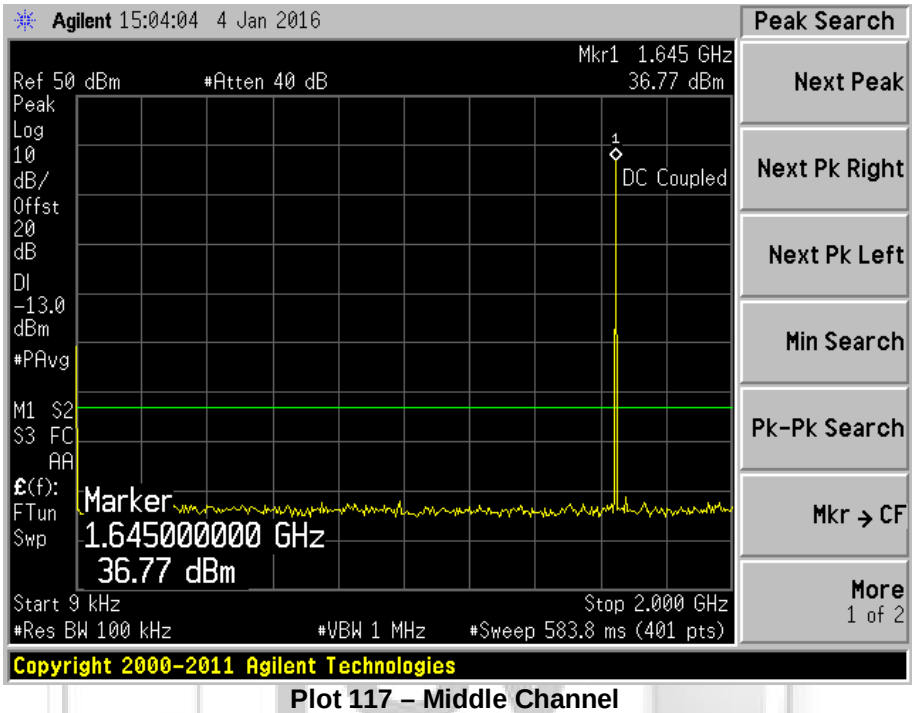


Plot 115 – Lower Channel

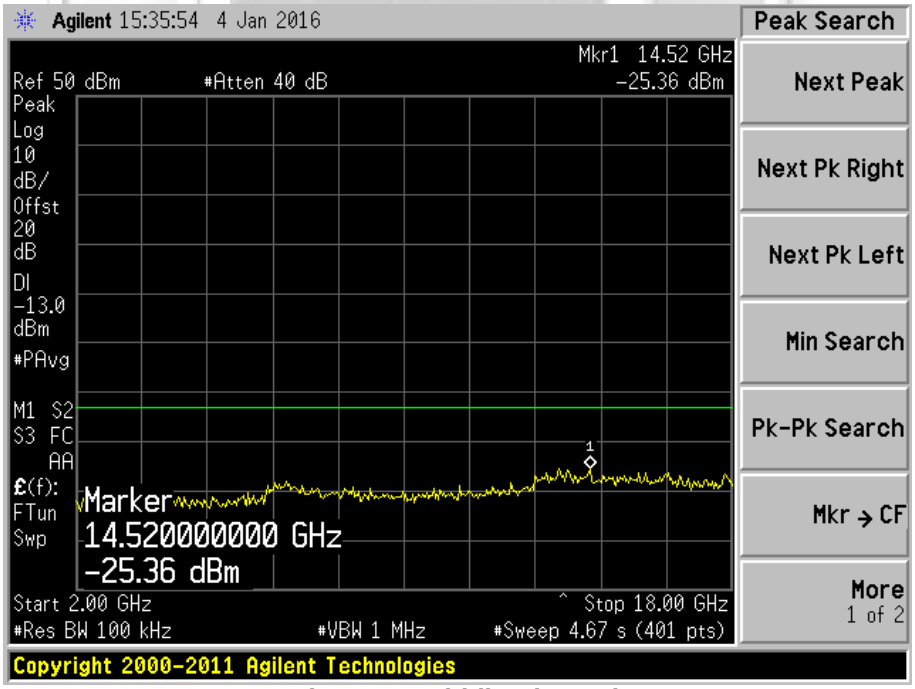


Plot 116 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 5)

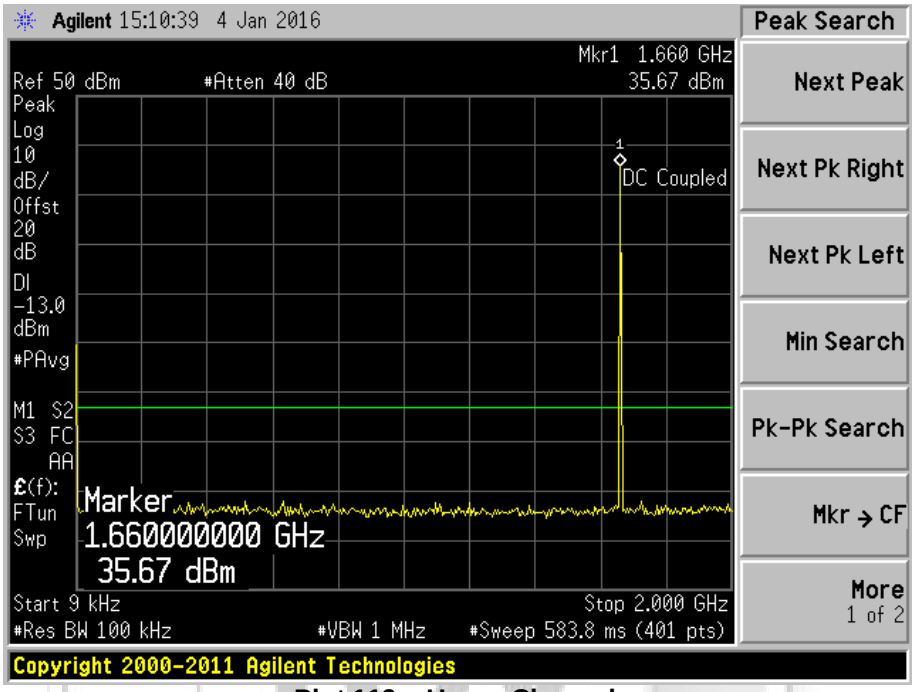


Plot 117 – Middle Channel

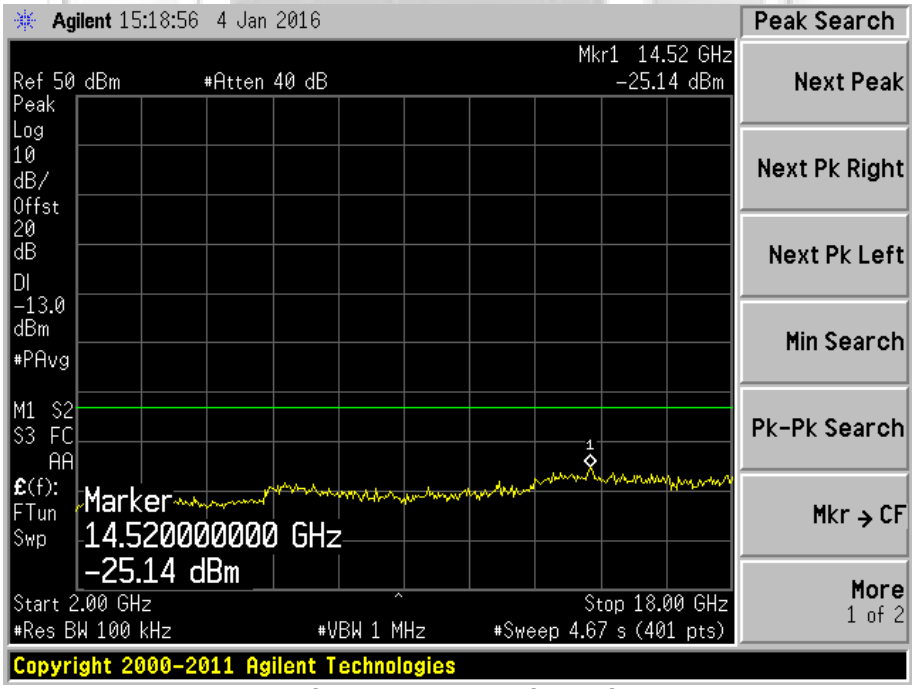


Plot 118 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 5)

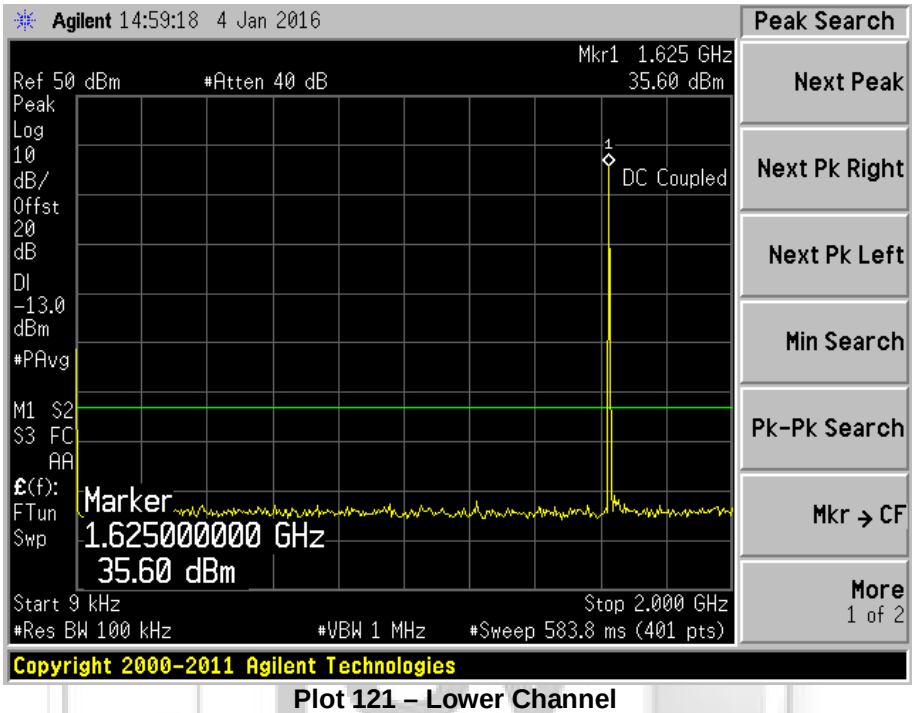


Plot 119 – Upper Channel

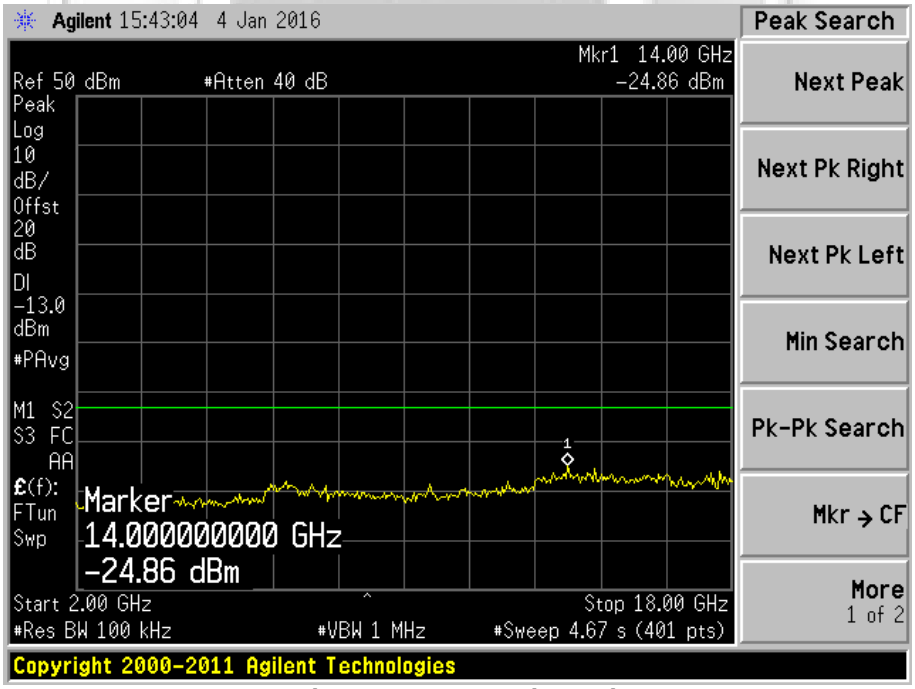


Plot 120 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 6)

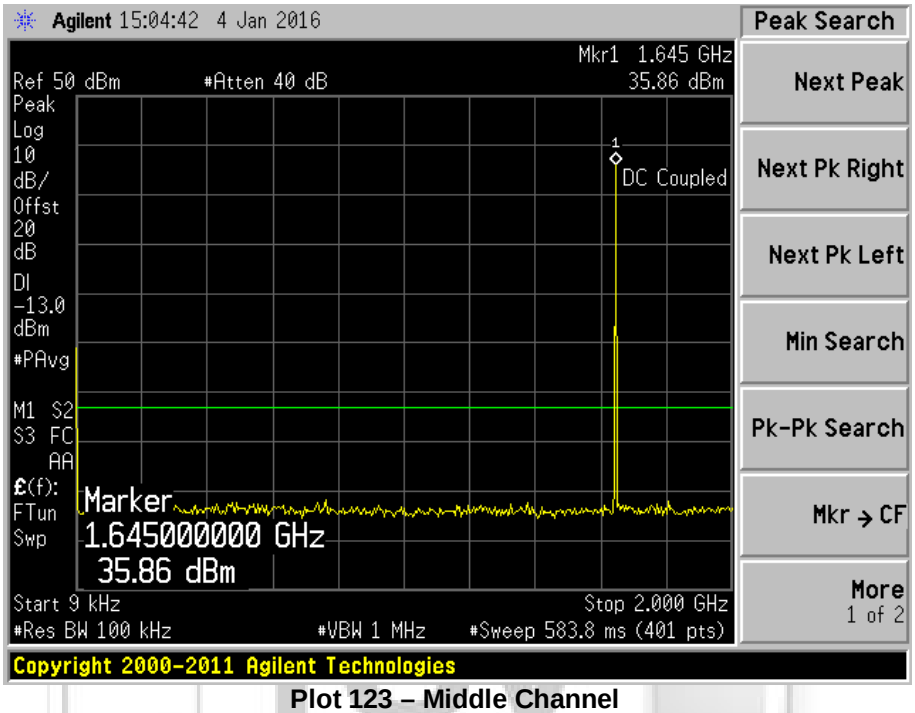


Plot 121 – Lower Channel

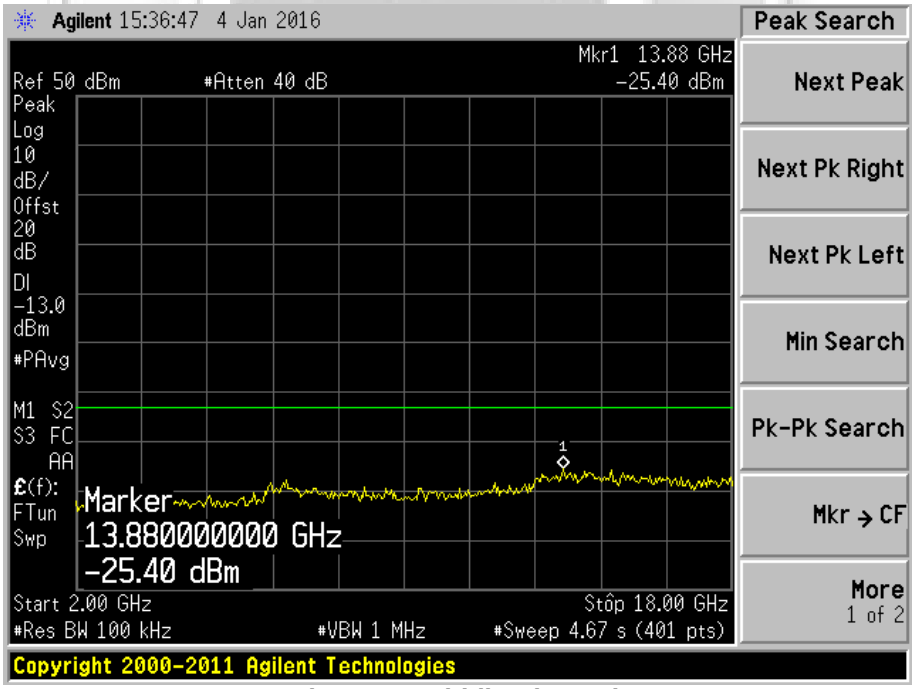


Plot 122 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 6)

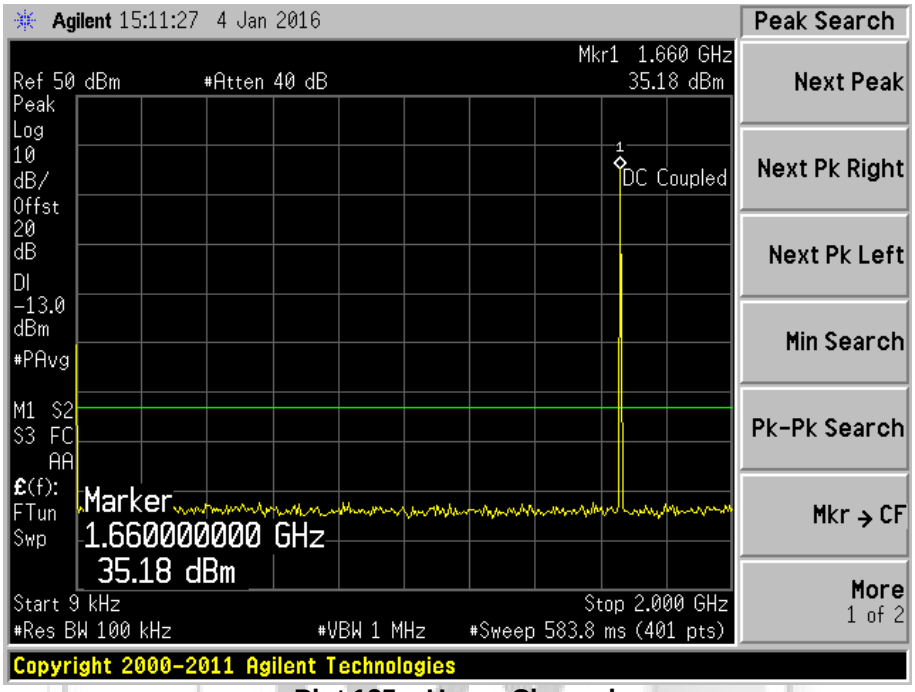


Plot 123 – Middle Channel

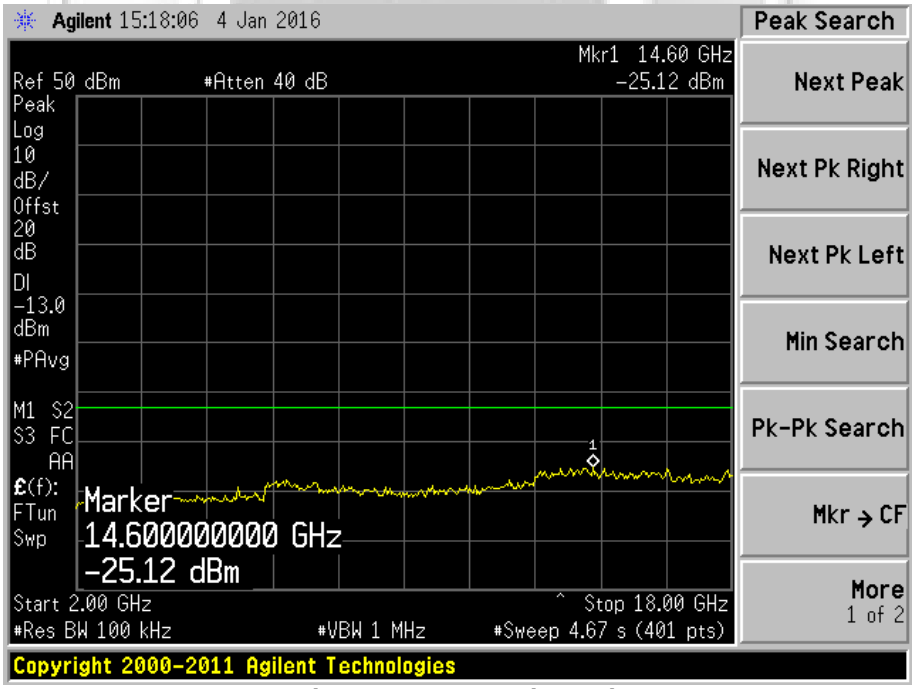


Plot 124 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 6)



Plot 125 – Upper Channel



Plot 126 – 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 from 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
Agilent Spectrum Analyzer	E7405A	MY45106084	01 Aug 2016
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	13 Dec 2016
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441056	15 Aug 2016
Toyo Preamplifier	TPA0118036	00000005	16 Oct 2016
EMCO Horn Antenna (1GHz-18GHz)	3115	9901-5671	13 Mar 2017
K&L Microwave Tunable Band Reject Filter	3TNF-1000/2000-N/N	436	Output Monitor

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 10th 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 respectively.

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

Operating Mode	Continuous Satellite Transmission	Temperature	28°C
Test Input Power	12Vdc	Relative Humidity	59%
Test Distance	3m	Atmospheric Pressure	1030mbar
Type Bearer	0 (Worst Bearer)	Tested By	Lim Kay Tak

30MHz – 1GHz

Lower Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
93.9330	-59.1	-13.0
113.6280	-62.5	-13.0
187.4840	-61.7	-13.0
785.7190	-62.0	-13.0
864.4990	-62.6	-13.0
953.1270	-60.2	-13.0

Middle Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
93.6810	-59.1	-13.0
181.8540	-63.0	-13.0
189.2010	-62.2	-13.0
500.2560	-62.7	-13.0
865.1940	-62.4	-13.0
950.9180	-60.3	-13.0

Upper Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
93.6810	-59.0	-13.0
113.2750	-63.5	-13.0
189.2010	-62.7	-13.0
500.2560	-63.4	-13.0
865.1940	-61.9	-13.0
950.9180	-59.8	-13.0

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

Operating Mode	Continuous Satellite Transmission	Temperature	28°C
Test Input Power	12Vdc	Relative Humidity	59%
Test Distance	3m	Atmospheric Pressure	1030mbar
Type Bearer	0 (Worst Bearer)	Tested By	Lim Kay Tak

1GHz – 17GHz

Lower Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
1023.7830	-55.1	-13.0
1118.9130	-59.1	-13.0
2603.1720	-51.5	-13.0
4828.9930	-47.0	-13.0
7231.0320	-36.2	-13.0
11725.9370	-46.5	-13.0

Middle Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
1010.1200	-53.6	-13.0
2537.0740	-42.7	-13.0
3600.9020	-44.0	-13.0
4876.0520	-38.4	-13.0
5402.3050	-44.8	-13.0
5948.7980	-43.5	-13.0

Upper Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
1023.7830	-53.8	-13.0
2550.7370	-51.4	-13.0
4924.1230	-46.3	-13.0
7397.5100	-35.9	-13.0
9847.1140	-44.1	-13.0
12320.5010	-44.7	-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 "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a “negative” margin indicates a FAIL.
3. The Resolution Bandwidth (RBW) was corrected from 4kHz by 10log10 [(used RBW) / 4kHz].
4. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 20GHz
   RBW: 100kHz VBW: 300kHz
5. 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 = Measured mean power in W
   CF = RBW correction factor (see Note 4)
6. 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 ±4.0dB.

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 Spectrum Analyzer	E7405A	MY45106084	01 Aug 2016
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	13 Dec 2016
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441056	15 Aug 2016
Toyo Preamplifier	TPA0118036	00000005	16 Oct 2016
EMCO Horn Antenna (1GHz-18GHz)	3115	9901-5671	13 Mar 2017

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).

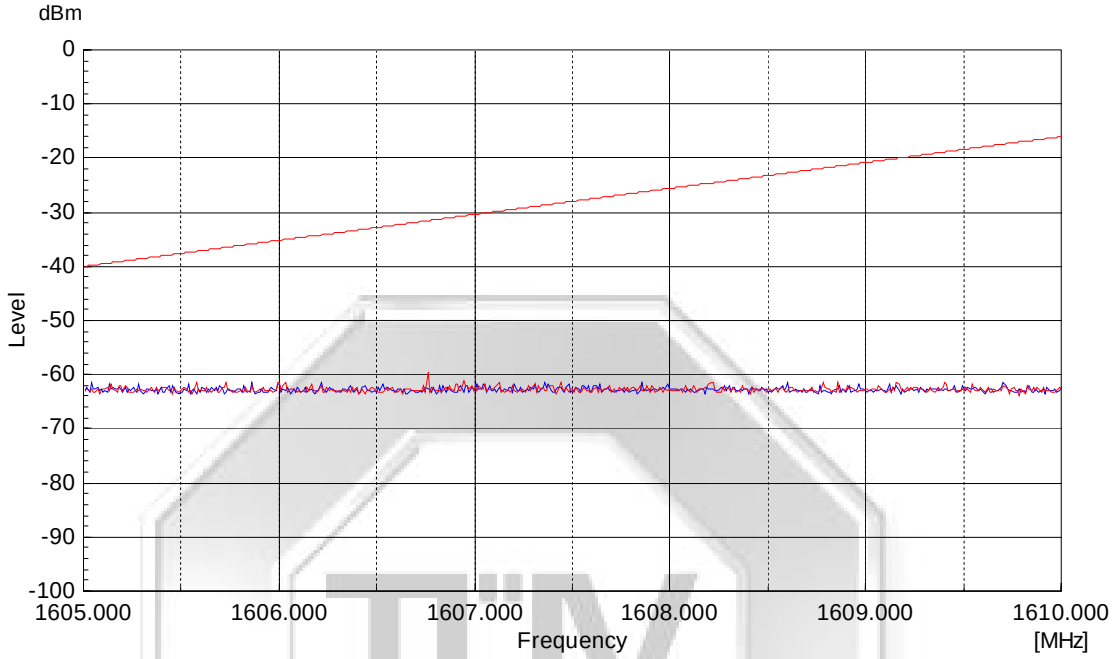
PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

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

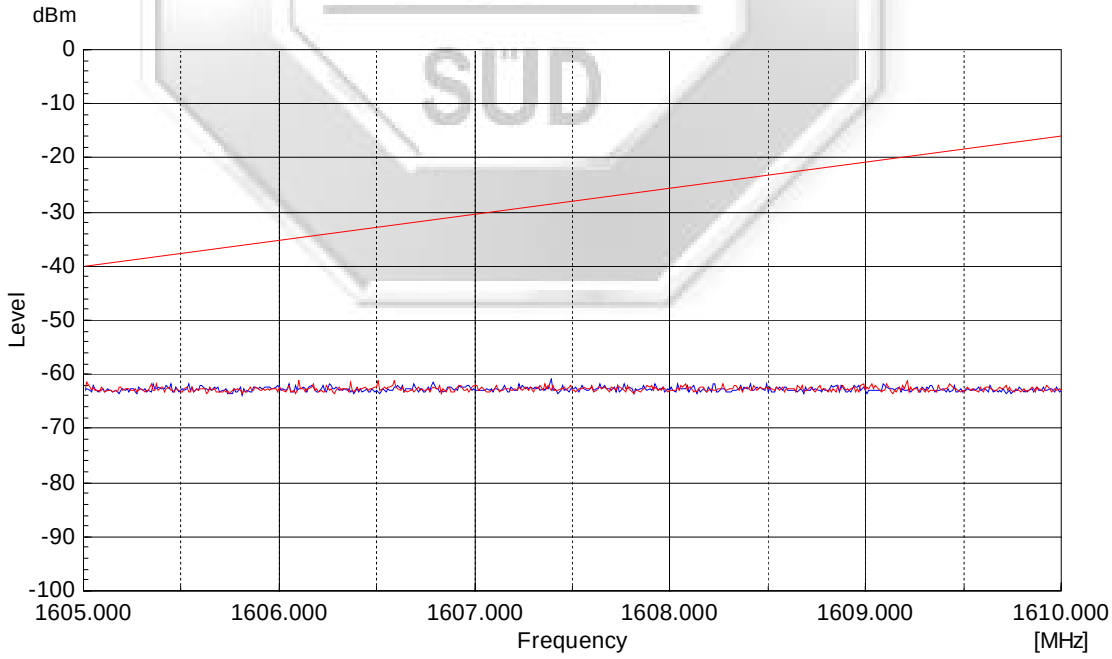
Operating Mode	Continuous Satellite Transmission	Temperature	28°C
Test Input Power	12Vdc	Relative Humidity	59%
Test Distance	3m	Atmospheric Pressure	1030mbar
Type Bearer	0 (worst bearer)	Tested By	Lim Kay Tak
Attached Plots	127 – 132		

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

Type Bearer: 0 - Transmitter On

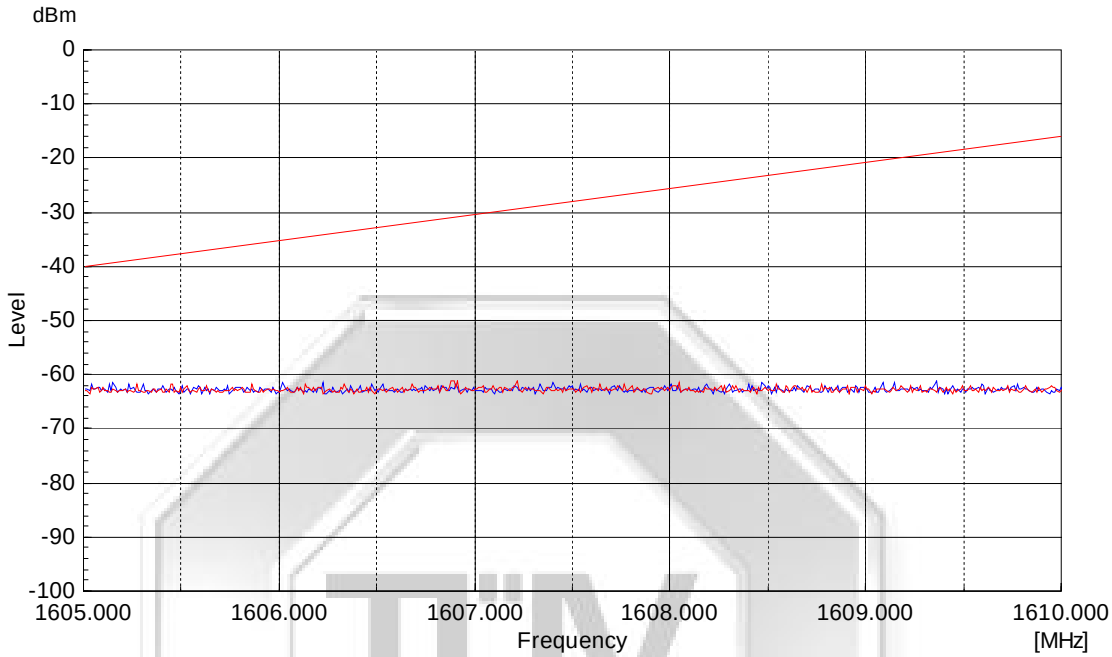


Plot 127 – Lower Channel



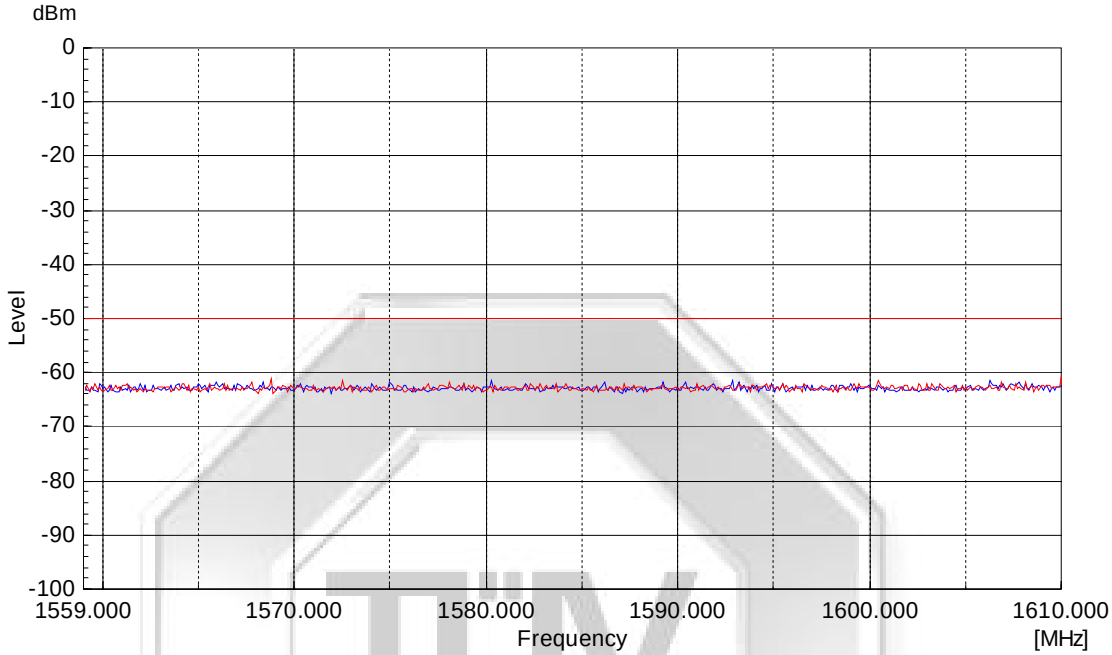
Plot 128 – Middle Channel

Type Bearer: 0 - Transmitter On

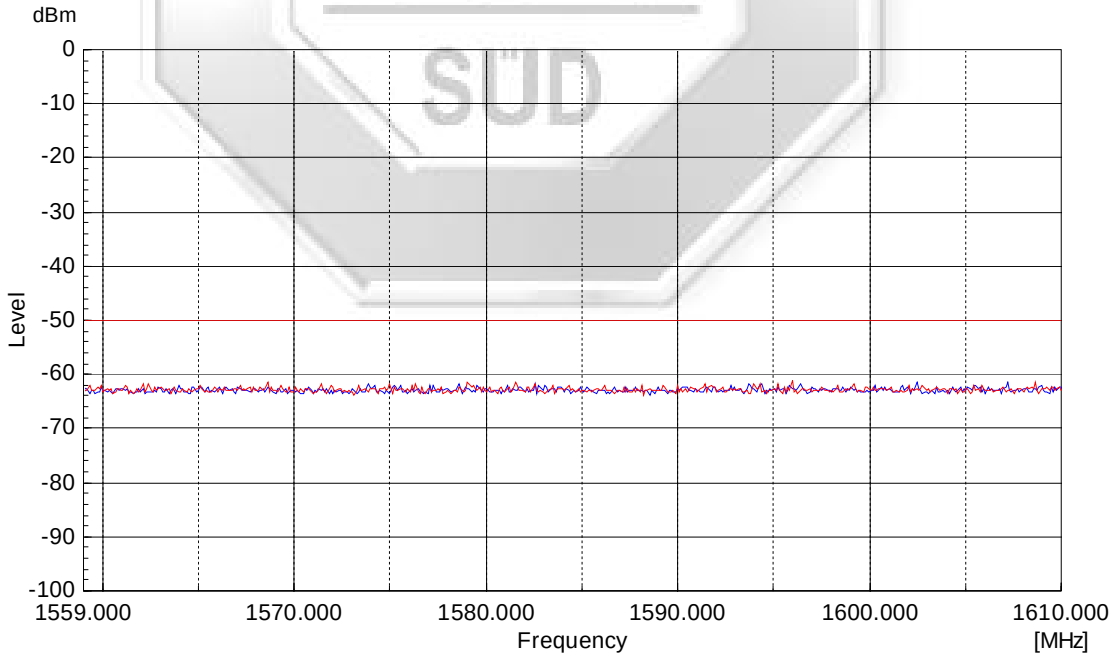


Plot 129 – Upper Channel

Carrier Off

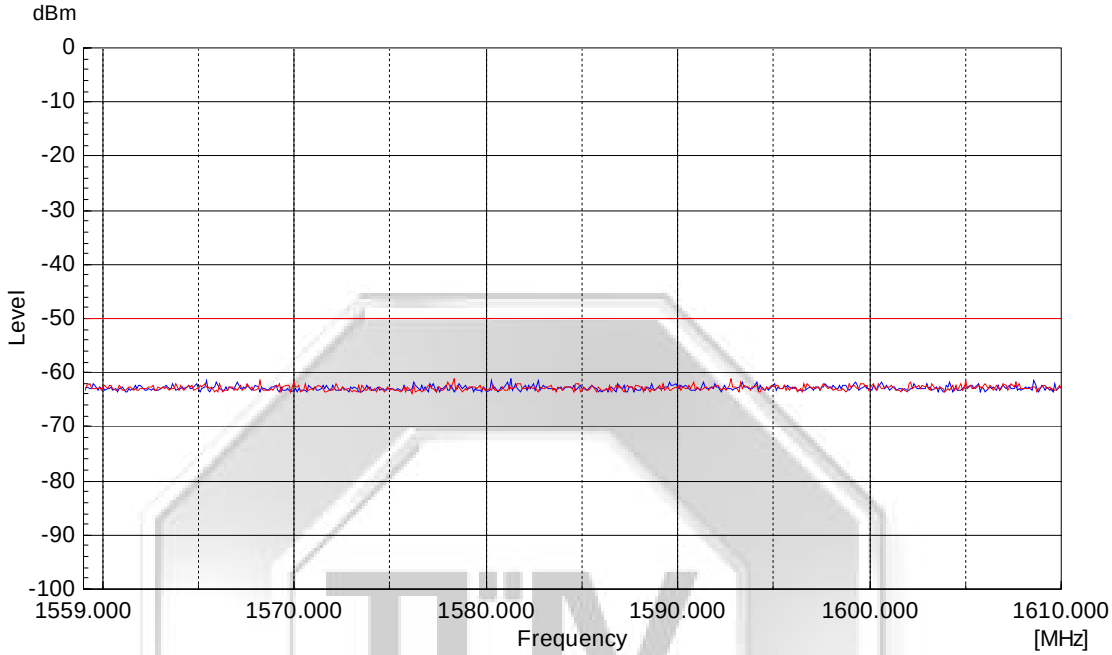


Plot 130 – Lower Channel



Plot 131 – Middle Channel

Carrier Off



Plot 132 – Upper Channel

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^{o}C to +50^{o}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^{o}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 Universal Counter	53132A	3736A0628	25 May 2017
Mini-Circuits Precision Fixed Attenuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor
Kikusui Regulated DC Power Supply	PAD 35-10L	1540254	Output Monitor

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^{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 With the EUT power removed, the temperature of the temperature chamber was set to -30^{o}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^{o}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^{o}C step until the temperature reached 50^{o}C.
7. The steps 1 to 6 were repeated with the EUT was set to operate at the middle and upper channels respectively.

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

Operating Mode	Continuous Satellite Transmission	Temperature	See table below
Test Input Power	12Vdc	Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Lower Channel

Temperature (°C)	Measured Frequency (GHz)	Reference Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
-30	1.6266014063	1.626600000	1406	+/-16266
-20	1.6266013706	1.626600000	1371	+/-16266
-10	1.6266013475	1.626600000	1348	+/-16266
0	1.6266013542	1.626600000	1354	+/-16266
10	1.6266014207	1.626600000	1421	+/-16266
20	1.6266014271	1.626600000	1427	+/-16266
30	1.6266014370	1.626600000	1437	+/-16266
40	1.6266014479	1.626600000	1448	+/-16266
50	1.6266014790	1.626600000	1479	+/-16266

Middle Channel

Temperature (°C)	Measured Frequency (GHz)	Reference Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
-30	1.6435014587	1.643500000	1459	+/-16435
-20	1.6435014211	1.643500000	1421	+/-16435
-10	1.6435013953	1.643500000	1395	+/-16435
0	1.6435014010	1.643500000	1401	+/-16435
10	1.6435014693	1.643500000	1469	+/-16435
20	1.6435014753	1.643500000	1475	+/-16435
30	1.6435014870	1.643500000	1487	+/-16435
40	1.6435014987	1.643500000	1499	+/-16435
50	1.6435015331	1.643500000	1533	+/-16435

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

Upper Channel

Temperature (°C)	Measured Frequency (GHz)	Reference Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
-30	1.6604014359	1.660400000	1436	+/-16604
-20	1.6604013957	1.660400000	1396	+/-16604
-10	1.6604013682	1.660400000	1368	+/-16604
0	1.6604013731	1.660400000	1373	+/-16604
10	1.6604014315	1.660400000	1431	+/-16604
20	1.6604014499	1.660400000	1450	+/-16604
30	1.6604014609	1.660400000	1461	+/-16604
40	1.6604014740	1.660400000	1474	+/-16604
50	1.6604015116	1.660400000	1512	+/-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 Universal Counter	53132A	3736A0628	25 May 2017
Mini-Circuits Precision Fixed Attenuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor
Kikusui Regulated DC Power Supply	PAD 35-10L	1540254	Output Monitor

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°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.

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

Operating Mode	Continuous Satellite Transmission	Temperature	20°C
Test Input Power	See table below	Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Poh Huat

Lower Channel

Voltage (V)	Measured Frequency (GHz)	Nominal Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
10.2	1.6266013452	1.626600000	1345	+/-16266
24.0 (Worst)	1.6266013498	1.626600000	1350	+/-16266
27.6	1.6266013510	1.626600000	1351	+/-16266

Middle Channel

Voltage (V)	Measured Frequency (GHz)	Nominal Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
10.2	1.6435013932	1.643500000	1393	+/-16435
24.0 (Worst)	1.6435013963	1.643500000	1396	+/-16435
27.6	1.6435014001	1.643500000	1400	+/-16435

Upper Channel

Voltage (V)	Measured Frequency (GHz)	Nominal Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
10.2	1.6604013667	1.660400000	1367	+/-16604
24.0 (Worst)	1.6604013681	1.660400000	1368	+/-16604
27.6	1.6604013735	1.660400000	1373	+/-16604

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 = 4.5709W
d = Test distance at 0.2m
G = Numerical isotropic gain, 10.00 (10.0dBi)

Substituting the relevant parameters into the formula:

$d = \sqrt{[(30GP) / 377S]}$
$= 0.603m$

∴ The EUT shall maintain at least at 0.61m from operators to comply with MPE criteria.

Please note that this Report is issued under the following terms :

1. 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.

2. 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.

3. Nothing in this report shall be interpreted to mean that TÜV SÜD PSB has verified or ascertained any endorsement or marks from any other testing authority or bodies that may be found on that sample.

4. This report shall not be reproduced wholly or in parts and no reference shall be made by the Client to TÜV SÜD PSB or to the report or results furnished by TÜV SÜD PSB in any advertisements or sales promotion.

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

July 2011