Test Report No. 7191157733-EEC17/05
dated 28 Mar 2017

PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 2, 15, and 25
OF A
Marine Fleet Broadband Terminal & Antenna System
[Model : FB250R]
[FCC ID : 2AHE2-FB250R]

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	Intellian Technologies Inc 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri), Pyeongteak-si, Gyeonggi-do, South Korea 17709 Tel: +82 31 379 1000 Fax : +82 31 377 6185
QUOTATION NUMBER	2191058104
JOB NUMBER	7191157733
TEST PERIOD	13 Mar 2017 – 29 Mar 2017

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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.

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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		
15.107(a), 15.207	Conducted Emissions	Pass
15.109	Radiated Emissions (Class B)	Pass
2.1046(a), 25.204	RF Output Power	Not Tested *See Note 4
2.1051, 25.202(f)	Unwanted Emissions at Antenna Terminal	Not Tested *See Note 4
2.1053, 25.202(f)	Radiated Spurious Emissions	Pass
25.216(h)(i)(j)	Protection of Aeronautical Radio Navigation Satellite Service	Not Tested *See Note 4
2.1055, 25.202(d)	Frequency Stability (Temperature Variation)	Not Tested *See Note 4
2.1055, 25.202(d)	Frequency Stability (Voltage Variation)	Not Tested *See Note 4
1.1310	Maximum Permissible Exposure	Refer to page 20 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. All test measurement procedures are according to ANSI/TIA-603-D-2010.

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

4. Refer to TÜV SÜD PSB Pte Ltd's issued test report 7191127111-EEC15/04 dated 11 Jan 2016.

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is a **Marine Fleet Broadband Terminal & Antenna System.**
Applicant	:	Addvalue Innovation Pte Ltd 8 Tai Seng Link, Level 5 (Wing 2) Singapore 534158
Manufacturer	:	Intellian Technologies Inc 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri), Pyeongteak-si, Gyeonggi-do, South Korea 17709
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	:	Intellian
Model Number	:	FB250R
FCC ID	:	2AHE2-FB250R
Serial Number	:	Nil
Microprocessor	:	OMAP5912
Operating / Transmitting Frequency	:	Satellite Transmitting 1626.5 MHz – 1660.5 MHz, 1668.0 – 1675.0 MHz Satellite Receiving 1518.0 MHz – 1559.0 MHz GPS Receiving 1575.42MHz
Clock / Oscillator Frequency	:	Baseband Board 32.768kHz, 12.0MHz, 16.384MHz, 25.0MHz RF Board 24.192MHz
Modulation / Emissions Designator	:	pi/4QPSK and 16QAM (Satellite Transmit) pi/4QPSK and 16QAM (Satellite Receive) GPS
Antenna Gain	:	10.0dBi

(Continued)

Port / Connectors	:	4xRJ45 LAN Port (2 with POE) 2xRJ11 Phone, Fax Port 1xRJ 11 Offset latch GPS output Port 1x10pin circular connector for Handset & 1x8 for GPIO Output
Rated Input Power	:	100~240VAC 50/60Hz 4.7A
Accessories	:	Primary Handset (Model FBB -PH)

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Addvalue Primary Handset	M/N: FBB-HS S/N: EHFBGIM133400220 FCC ID: Nil	1.00m twisted Handset cable
Intellian Antenna	M/N: AS FB500DIN V2.2 S/N: LQX14490025 FCC ID: Nil	Nil
IBM Laptop	M/N: 1834-A58 S/N: LV-AV826 FCC ID: Nil	Nil
IBM AC Adapter	M/N: 08K8203 S/N:11S08K8202Z1ZAC755N0NJ FCC ID: Nil	1.80m unshielded power cable

47 CFR FCC Parts 2, 15 and 25
1. Conducted Emissions **2. Radiated Emissions** **3. Radiated Spurious Emissions** **4. 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, "Hyper Terminal" & "3CDaemon" <u>Satellite Transmission Mode</u> - Continuous maximum RF transmission at lower channel at maximum RF power - Continuous maximum RF transmission at middle channel at maximum RF power - Continuous maximum 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 Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (Q-P)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver – ESPI3	ESPI3	100349	25 Oct 2017
Agilent EMC Analyzer-SA7	E7403A	US41160166	21 Jul 2017
Schaffner LISN –LISN10 (EUT)	NNB42	04/10055	04 Oct 2017

47 CFR FCC Parts 15.107(a) and 15.207 Conducted 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 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit = 60.0 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)
Therefore, Q-P margin = 60.0 - 40.0 = 20.0 i.e. 20.0 dB below Q-P limit

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Test Input Power	120V 60Hz	Temperature	22°C
Line Under Test	AC Mains	Relative Humidity	55%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line	Channel
0.1865	51.0	64.2	13.2	46.5	54.2	7.7	Neutral	Low
0.1870	51.4	64.2	12.8	46.7	54.2	7.5	Live	Low
0.1887	53.0	64.1	11.1	48.5	54.1	5.6	Live	Low
0.1894	52.8	64.1	11.3	48.4	54.1	5.7	Neutral	Low
0.2470	34.4	61.9	27.5	32.0	51.9	19.9	Live	Low
0.2480	33.8	61.8	28.0	31.1	51.8	20.7	Neutral	Low

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. 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:
   9kHz - 30MHz
   RBW: 9kHz VBW: 30kHz
4. Conducted 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 9kHz – 30MHz is ±2.2dB.

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	11 Oct 2017
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441056	22 Jul 2017
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	18 Jan 2018
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	24 Mar 2018
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	10 Mar 2018
K&L Microwave Tuneable 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	Satellite Transmit / Receive and GPS Reception and Continuous Pinging	Temperature	22°C
Test Input Power	120V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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)	Channel (Worst)
38.7170	6.1	40.0	33.9	348	228	H	Low
74.1090	15.7	40.0	24.3	170	360	V	Low
88.2930	21.7	43.5	21.8	360	282	H	Low
245.6030	22.4	46.0	23.6	177	359	V	Low
327.6540	30.3	46.0	15.7	100	286	H	Low
499.9390	23.9	46.0	22.1	100	119	V	Low

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)	Ch (Worst)
1.6315	29.6	74.0	44.4	29.5	54.0	24.5	200	299	V	Low
11.1313	44.8	74.0	29.2	43.8	54.0	10.2	400	314	H	Low
12.1697	47.0	74.0	27.0	46.2	54.0	7.8	300	238	H	Low
14.0460	47.7	74.0	26.3	46.7	54.0	7.3	100	238	H	Low
17.1427	47.5	74.0	26.5	45.3	54.0	8.7	100	333	H	Low
17.6892	49.1	74.0	24.9	48.2	54.0	5.8	100	164	V	Low

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 2.1053 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
R&S Test Receiver – ESI1	ESI40	100010	11 Oct 2017
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441056	22 Jul 2017
Schaffner Bilog Antenna –(30MHz-2GHz) BL4	CBL6112B	2593	18 Jan 2018
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	24 Mar 2018
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	10 Mar 2018
K&L Microwave Tuneable 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	24ºC
Test Input Power	120V 60Hz	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Type Bearer	15 (Worst Bearer)	Tested By	Chang Wai Kit

30MHz – 1GHz

Lower Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
206.6990	-51.1	-13.0
298.9760	-55.7	-13.0
310.7560	-56.3	-13.0
432.4820	-56.0	-13.0
454.0790	-52.1	-13.0
491.3820	-56.0	-13.0

Middle Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
310.7560	-56.5	-13.0
479.6020	-57.7	-13.0
491.3820	-56.4	-13.0
499.2350	-54.5	-13.0
666.1180	-56.5	-13.0
797.6610	-57.0	-13.0

Upper Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
298.9760	-56.0	-13.0
310.7560	-57.3	-13.0
432.4820	-55.6	-13.0
634.7050	-58.1	-13.0
666.1180	-58.0	-13.0
797.6610	-57.6	-13.0

1GHz – 17GHz

Lower Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
1333.9680	-48.0	-13.0
1465.5310	-57.9	-13.0
1536.3730	-51.0	-13.0
1586.9740	-55.2	-13.0
1860.2210	-55.6	-13.0
2123.3470	-56.0	-13.0

Middle Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
1202.4050	-52.2	-13.0
1323.8480	-47.7	-13.0
1465.5310	-56.2	-13.0
1597.0940	-54.8	-13.0
1860.2210	-55.7	-13.0
2123.3470	-54.4	-13.0

Upper Channel

Frequency (MHz)	Amplitude (dBm)	Limit (dBm)
1465.5310	-57.9	-13.0
1597.0940	-54.8	-13.0
1728.6570	-57.9	-13.0
1870.3410	-54.9	-13.0
2133.4670	-55.1	-13.0
3317.5350	-55.1	-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.

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 minimum distance to the EUT was computed from the following formula:

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

where $S = 10W/m^2$
$P = 5.2119W$
$d =$ Test distance
$G =$ Numerical isotropic gain, 10.0 (10.0dBi)

Substituting the relevant parameters into the formula:

$d = \sqrt{[(30GP) / 377S]}$
$= 0.65m$

∴ The EUT shall maintain at least at 0.65m from operators to comply with MPE criteria.

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

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

July 2011

Test Report No. 7191127111-EEC15/04
dated 11 Jan 2016

PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 2, 15, and 25
OF A
MARINE FLEET BROADBAND ANTENNA SYSTEMS
[Model : FB500R]
[FCC ID : 2AHE2-FB500R]

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	Intellian Technologies Inc 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri), Pyeongteak-si, Gyeonggi-do, South Korea 17709 Tel: +82 31 379 1000 Fax : +82 31 377 6185
QUOTATION NUMBER	2191030590
JOB NUMBER	7191127111
TEST PERIOD	30 Nov 2015 – 21 Dec 2015

PREPARED BY	**APPROVED BY**
Quek Keng Huat	Lim Cher Hwee
Higher Associate Engineer	Assistant Vice President

TÜV SÜD PSB

ilac-MRA

ACCREDITED LABORATORY SAC-SINGLAS

LA-2007-0380-A	LA-2007-0384-G	The results reported herein have been performed in accordance with the laboratory's terms of accreditation under the Singapore Accreditation Council - Singapore Laboratory Accreditation Scheme. Tests/Calibrations marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our laboratory.
LA-2007-0381-F	LA-2007-0385-E	
LA-2007-0382-B	LA-2007-0386-C	
LA-2007-0383-G	LA-2010-0464-D	

Laboratory:
TÜV SÜD PSB Pte. Ltd.
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Singapore 118221

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Co. Reg : 199002667R

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

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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		
15.107(a), 15.207	Conducted Emissions	Pass
15.109	Radiated Emissions (Class B)	Pass
2.1046(a), 25.204	RF Output Power	Pass *See Note 5
2.1051, 25.202(f)	Unwanted Emissions at Antenna Terminal	Pass *See Note 5
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 *See Note 5
2.1055, 25.202(d)	Frequency Stability (Voltage Variation)	Pass *See Note 5
1.1310	Maximum Permissible Exposure	Refer to page 103 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. All test measurement procedures are according to ANSI/TIA-603-B-2002.

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

5. These test results were reproduced from TÜV SÜD PSB's issued test report, 7191058477-EEC13/05 dated 07 Jun 2013 as per Addvalue Communication Pte Ltd's declaration that the RF module is identical in term of components, circuitry design, PCB layouts and mechanical structures. No changes were made to the RF module in integrating the RF module to this product.

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is a **MARINE FLEET BROADBAND ANTENNA SYSTEMS.**
Applicant	:	Addvalue Innovation Pte Ltd 8 Tai Seng Link, Level 5 (Wing 2) Singapore 534158
Manufacturer	:	Intellian Technologies Inc 18-7, Jinwisandan-ro, Jinwi-myeon (Chungho-ri), Pyeongteak-si, Gyeonggi-do, South Korea 17709
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	:	Intellian
Model Number	:	FB500R
FCC ID	:	2AHE2-FB500R
Serial Number	:	Nil
Microprocessor	:	OMAP5912
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, 12.0MHz, 16.384MHz, 25.0MHz and 39.3216MHz RF Board 24.192MHz
Modulation / Emissions Designator	:	pi/4QPSK and 16QAM (Satellite Transmit) pi/4QPSK and 16QAM (Satellite Receive) QPSK (GPS)
Antenna Gain	:	18.0dBi
Port / Connectors	:	2xRJ45 PoE Port 2xRJ45 LAN Port 2xRJ11 Phone, Fax Port 1xRJ 11 Offset latch GPS output Port 2x10pin circular connectors for Handset & GPIO Output
Rated Input Power	:	100~240VAC 50/60Hz 4.7A
Accessories	:	Primary Handset (Model FBB -PH)

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Acer Laptop PC	M/N: Travelmate 2420 S/N: XTB205106613077CFKS00 FCC ID: DoC	2.00m unshielded power cable 2.00m communication cable
Delta Electronics Power Adapter (Laptop)	M/N: SADP-65KB D S/N: 94W0610190186 FCC ID: Nil	2.00m unshielded power cable
SeaTel Primary Handset	M/N: SAFARI-PH S/N: AVHSS1P113800071 FCC ID: Nil	1x 1m shielded telephone cord
Above Deck Unit Antenna	M/N: BGAN-FB500 S/N: 41104 FCC ID: Nil	1x 25m shielded RF cable 1x 15m shielded RF cable
Wideye Wired Telephone	M/N: SB/AH-100 S/N: Nil FCC ID: Nil	1x 1.5m telephone cable
2x12Vdc Battery	M/N: MF160G51 S/N: Nil FCC ID: Nil	2.00m unshielded battery cable

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, "Hyper Terminal" <u>Satellite Transmission Mode</u> - Continuous RF transmission at lower channel at maximum RF power - Continuous maximum RF transmission at middle channel at maximum RF power - Continuous maximum 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 Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (Q-P)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Schaffner EMI Receiver	SMR4503	040	11 Feb 2017
Agilent EMC Analyzer-SA7	E7403A	US41160167	28 May 2016
Schaffner LISN –LISN7 (Ref)	NNB42	00008	28 Jan 2017
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	31 Oct 2016

47 CFR FCC Parts 15.107(a) and 15.207 Conducted 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 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit = 60.0 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)
Therefore, Q-P margin = 60.0 - 40.0 = 20.0 i.e. 20.0 dB below Q-P limit

47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Test Input Power	120V 60Hz	Temperature	22°C
Line Under Test	AC Mains	Relative Humidity	55%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line	Channel
0.1869	53.3	64.2	10.9	47.1	54.2	7.1	Neutral	Low
0.1873	53.1	64.2	11.1	46.6	54.2	7.6	Live	Low
11.2310	48.5	60.0	11.5	42.1	50.0	7.9	Live	Low
11.4252	50.3	60.0	9.7	43.9	50.0	6.1	Neutral	Low
11.5948	50.3	60.0	9.7	43.5	50.0	6.5	Neutral	Low
11.6260	50.5	60.0	9.5	44.0	50.0	6.0	Live	Low

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. 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:
   9kHz - 30MHz
   RBW: 9kHz VBW: 30kHz
4. Conducted 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 9kHz – 30MHz is ±2.2dB.

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 2016
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2016
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	09 Oct 2016
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	13 Apr 2016
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	13 Apr 2016
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	06 Oct 2016

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	18°C
Test Input Power	120V 60Hz	Relative Humidity	58%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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)
37.8530	25.0	40.0	15.0	100	44	V
49.6330	23.2	40.0	16.8	198	350	V
59.4500	24.8	40.0	15.2	198	183	V
84.9730	21.0	40.0	19.0	100	195	V
141.9100	21.6	43.5	21.9	100	328	V
499.2350	30.8	46.0	15.2	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)
1.6315	29.6	74.0	44.4	29.5	54.0	24.5	200	299	V
11.1313	43.8	74.0	30.2	44.8	54.0	9.2	400	314	H
12.1697	46.2	74.0	27.8	47.0	54.0	7.0	300	238	H
14.0460	46.7	74.0	27.3	47.7	54.0	6.3	100	238	H
17.1427	47.5	74.0	26.5	45.3	54.0	8.7	100	333	H
17.6892	48.2	74.0	25.8	49.1	54.0	4.9	100	164	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 "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: 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 ±4.0dB.

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	25 May 2012
Mini-Circuits Precision Fixed Attentuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor
GW Instek Programmable Power Supply	PSH-3630A	RK200168	30 Jan 2013

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

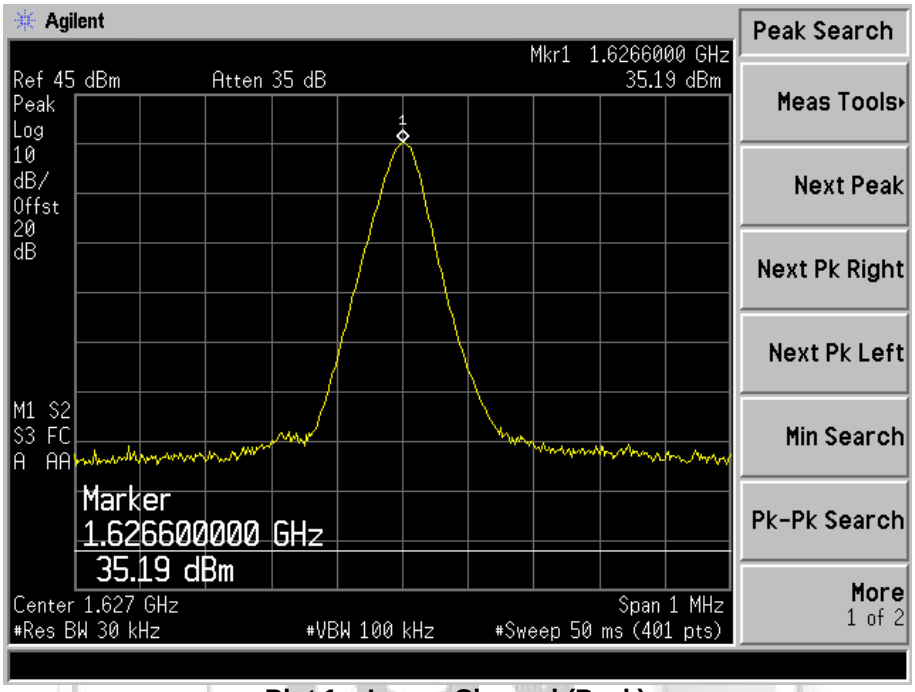
Operating Mode	Continuous Satellite Transmission	Temperature	24°C
Test Input Power	230V 50Hz	Relative Humidity	60%
Antenna Gain	18.2dBi	Atmospheric Pressure	1030mbar
Attached Plots	1 – 6	Tested By	Liau Lee Yin

Frequency (GHz)	Channel	Peak Output Power (dBm)		Average Output Power (dBm)	
		EIRP	ERP	EIRP	ERP
1.6266	Lower	53.4	51.3	53.4	51.3
1.6435	Middle	55.4	53.3	55.4	53.3
1.6600	Upper	54.5	52.4	54.5	52.4

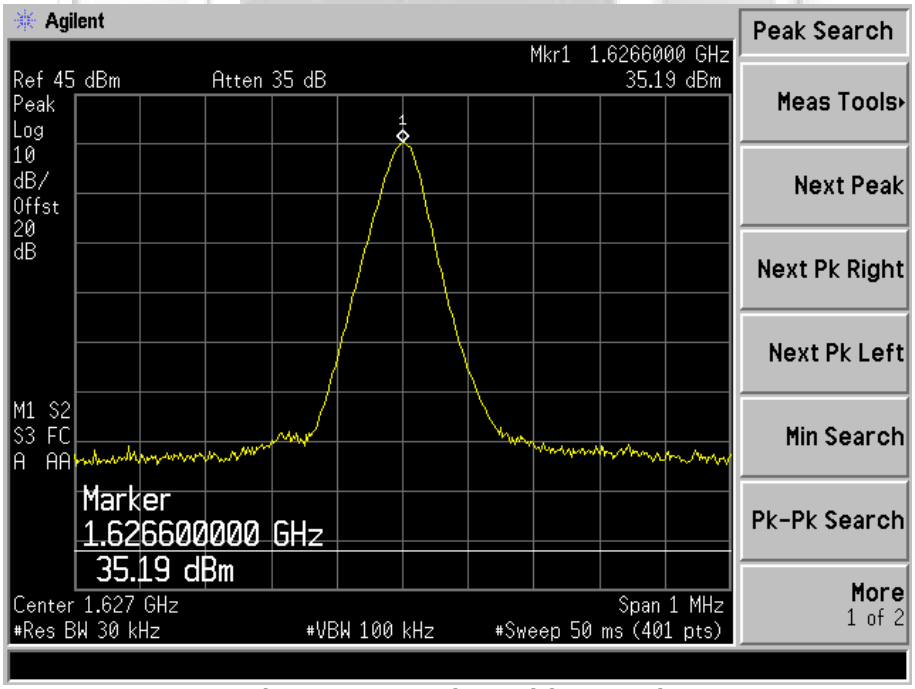
Notes

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

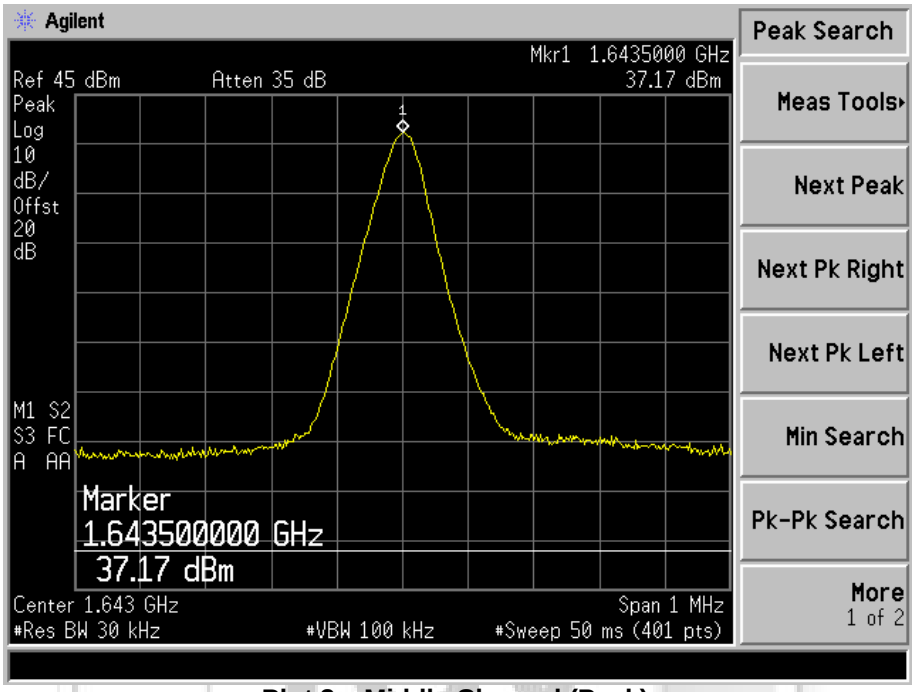


Plot 1 – Lower Channel (Peak)

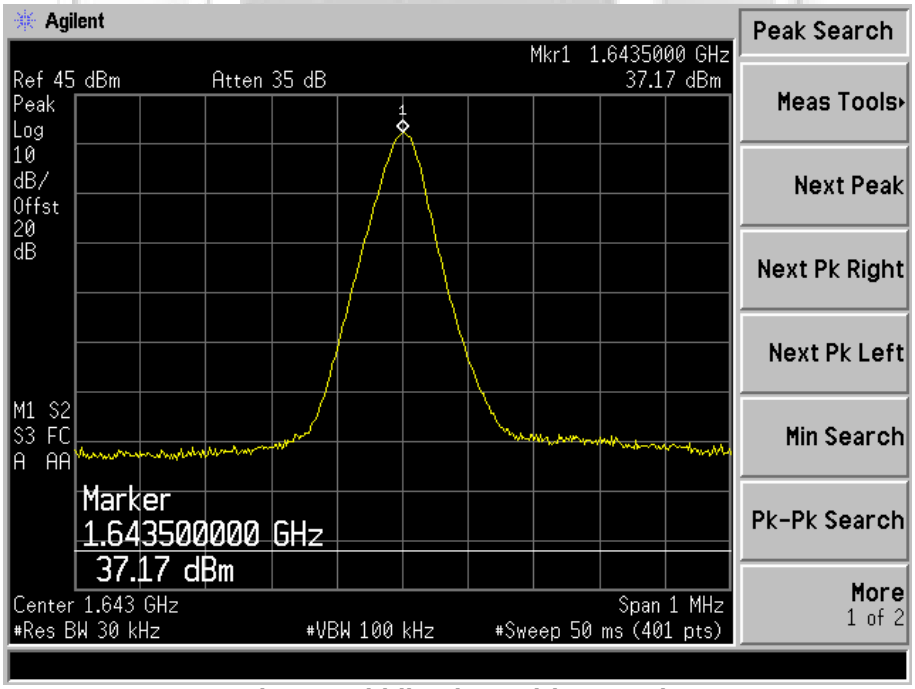


Plot 2 – Lower Channel (Average)

Output Power Plots

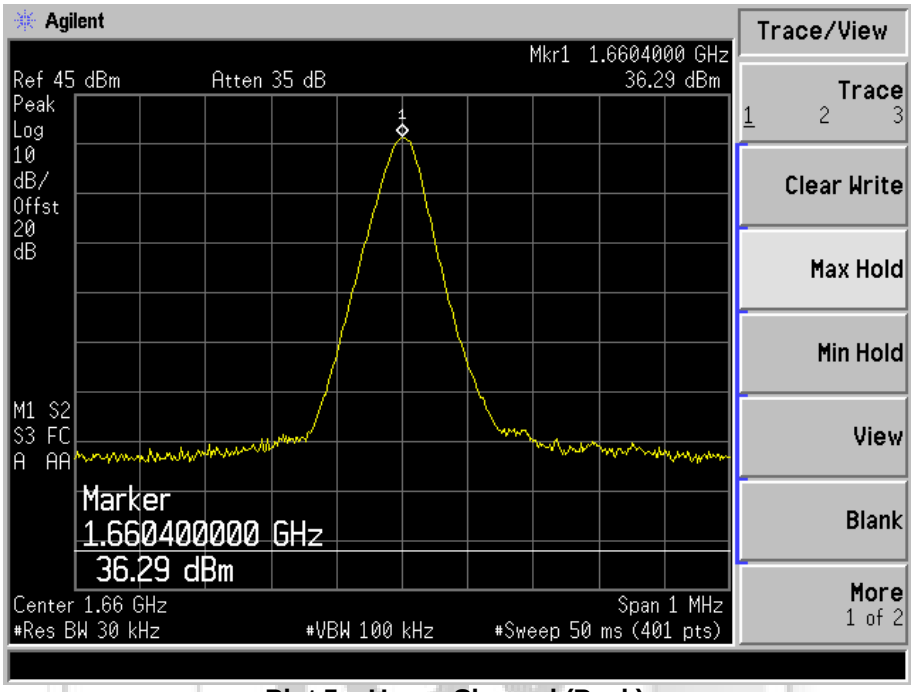


Plot 3 – Middle Channel (Peak)

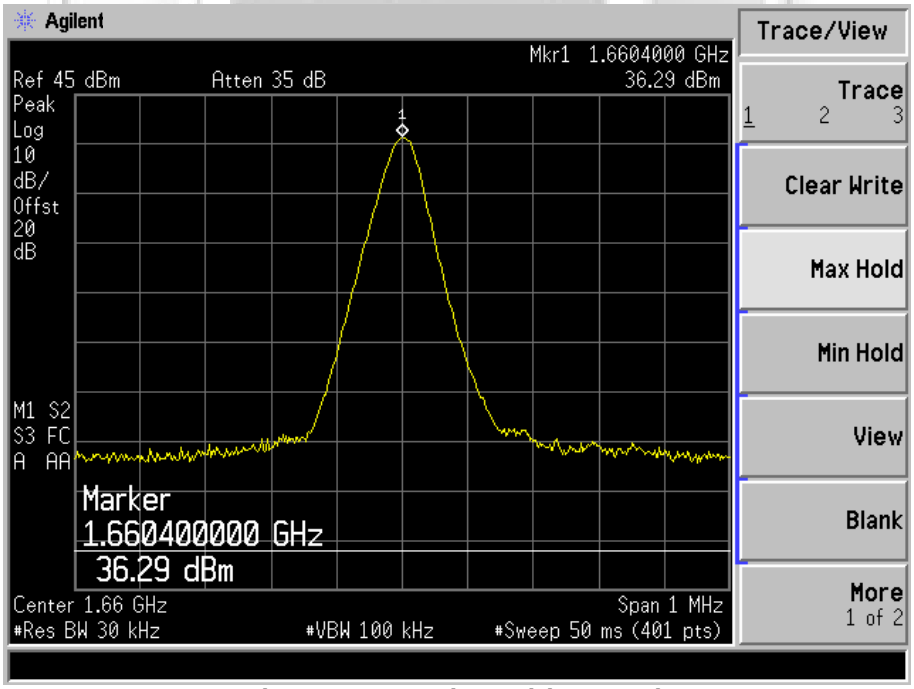


Plot 4 – Middle Channel (Average)

Output Power Plots



Plot 5 – Upper Channel (Peak)



Plot 6 – Upper Channel (Average)

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	25 May 2012
Mini-Circuits Precision Fixed Attentuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor
GW Instek Programmable Power Supply	PSH-3630A	RK200168	30 Jan 2013

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	23°C
Test Input Power	230V 50Hz	Relative Humidity	55%
Antenna Gain	18.2dBi	Atmospheric Pressure	1030mbar
Attached Plots	7 – 27 (26dB Bandwidth) 28 – 48 (In Band Emissions) 49 – 90 (Out of Band Spurious)	Tested By	Liau Lee Yin

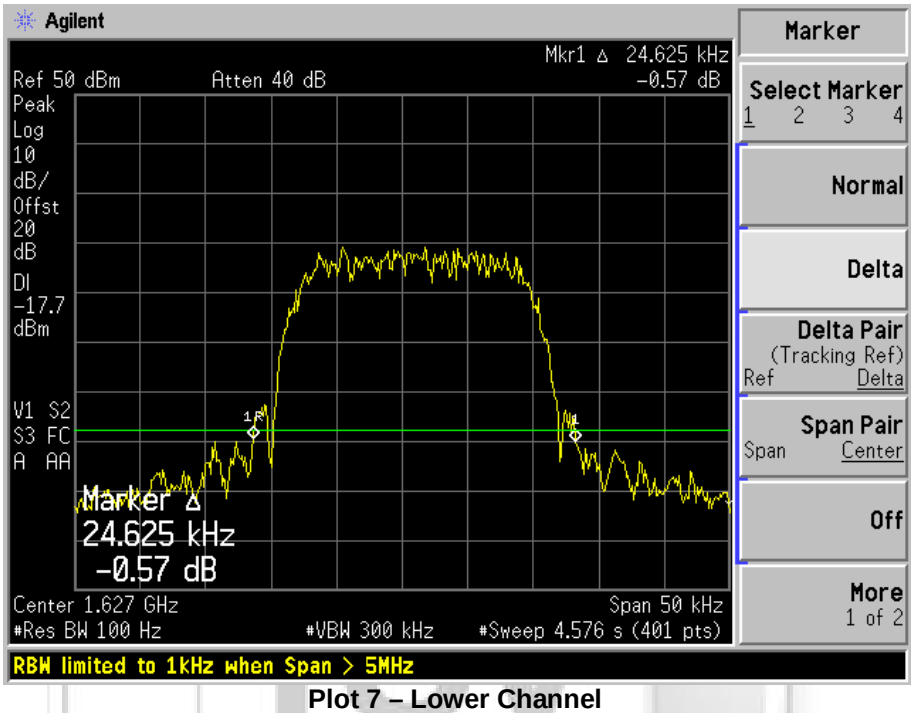
All emissions are within the emission mask. Please refer to the attached plots.

Notes

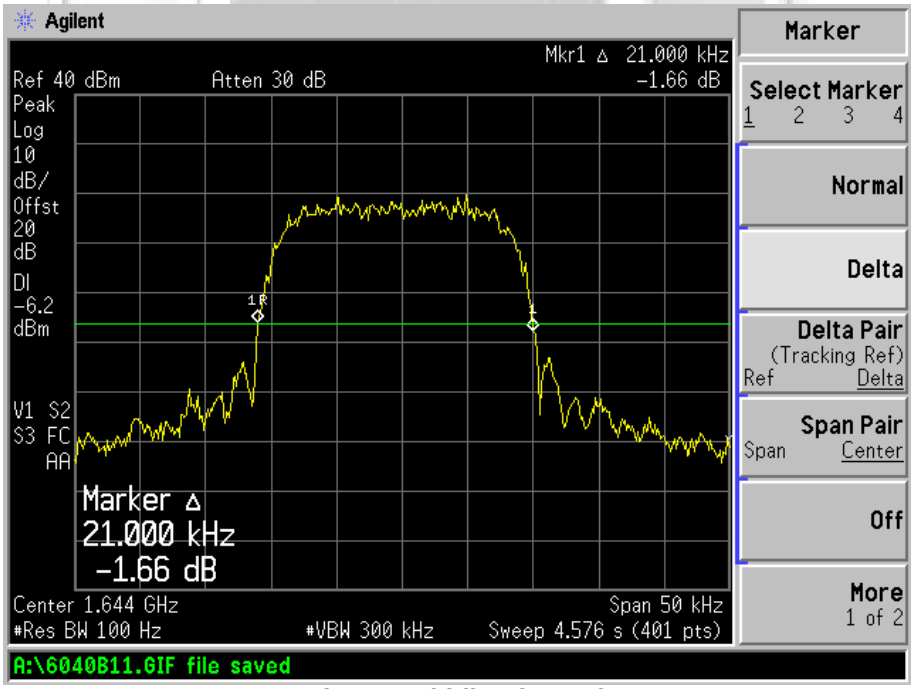
1. The Resolution Bandwidth (RBW) was corrected from 4kHz by $10\log_{10}$ [(used RBW) / 4kHz].
2. Emission limits are computed based on following:
   a. Emissions Limits (dBm) (50% - 100% authorised bandwidth) = P - 25 + CF
   b. Emissions Limits (dBm) (100% - 250% authorised bandwidth) = P - 35 + CF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

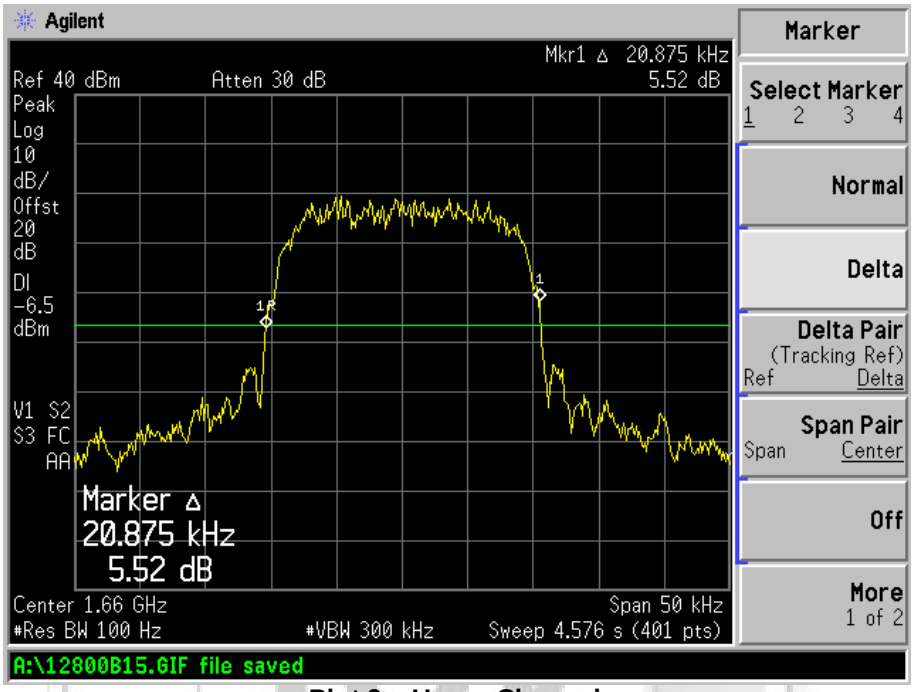


Plot 7 – Lower Channel



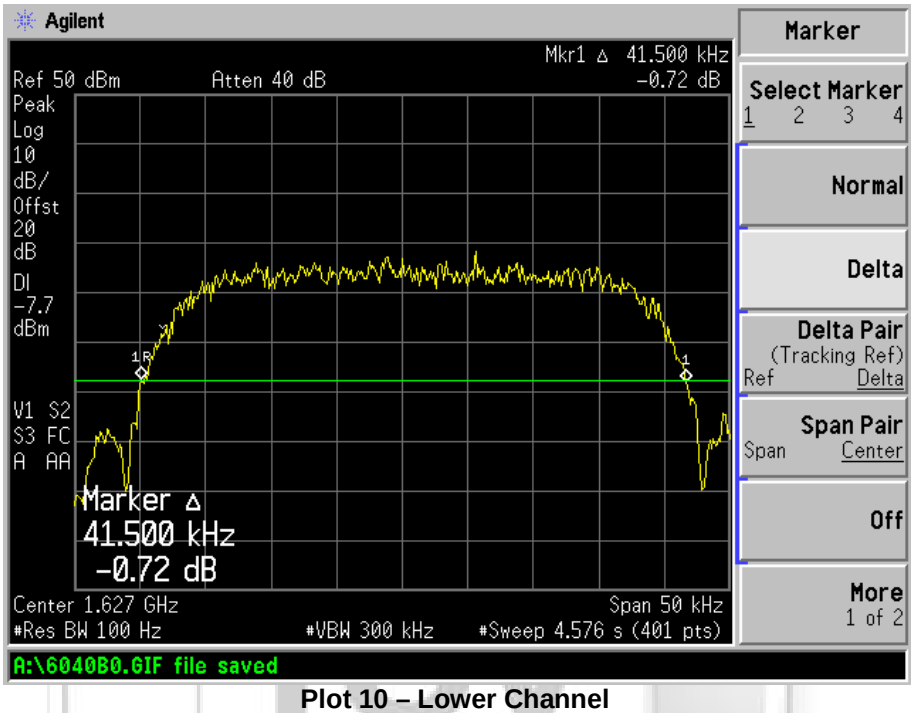
Plot 8 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 0)

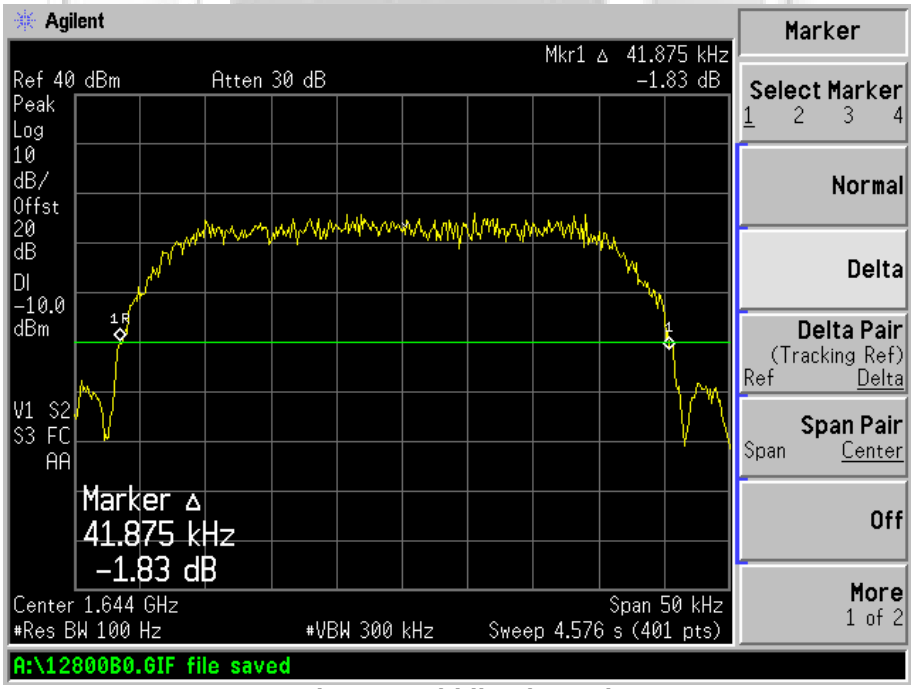


Plot 9 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 3)

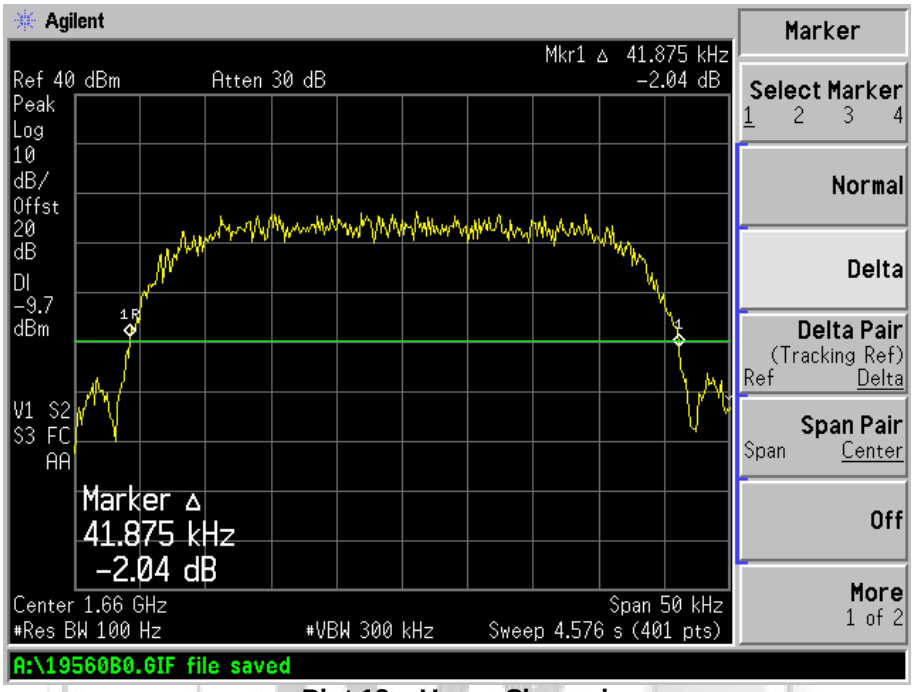


Plot 10 – Lower Channel



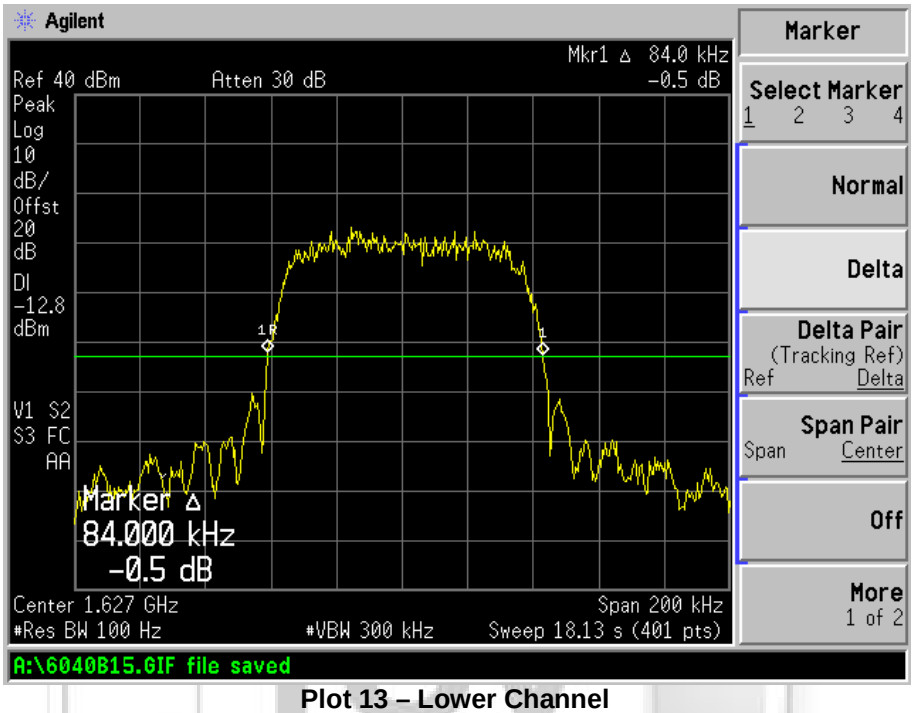
Plot 11 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 3)

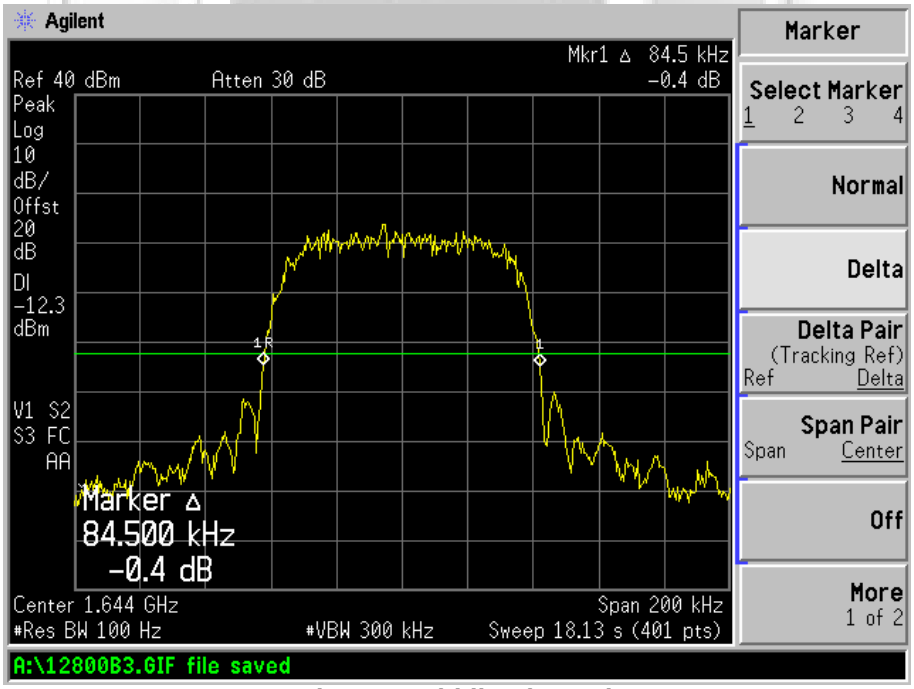


Plot 12 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 5)

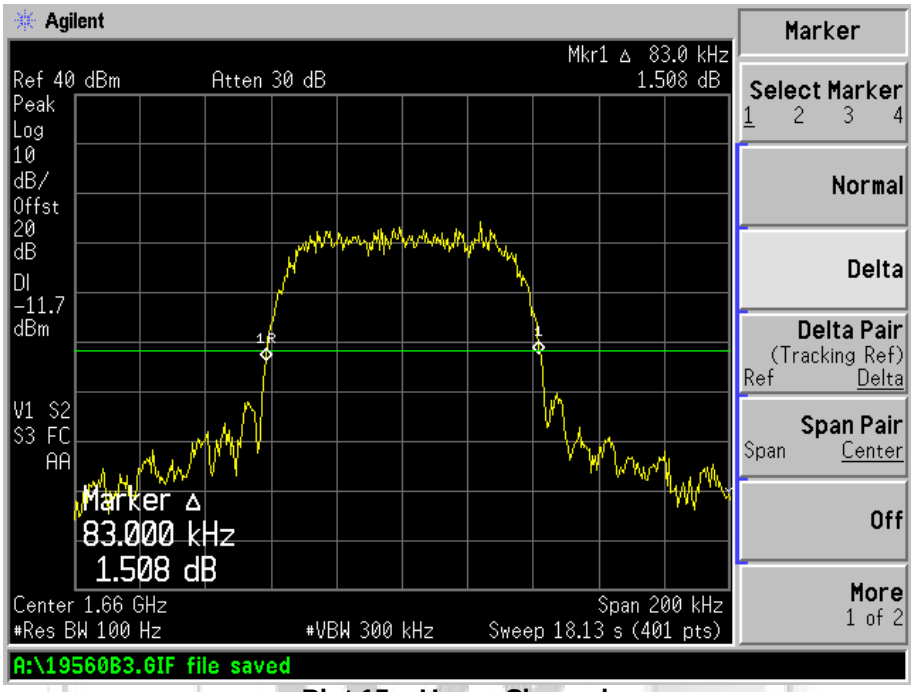


Plot 13 – Lower Channel



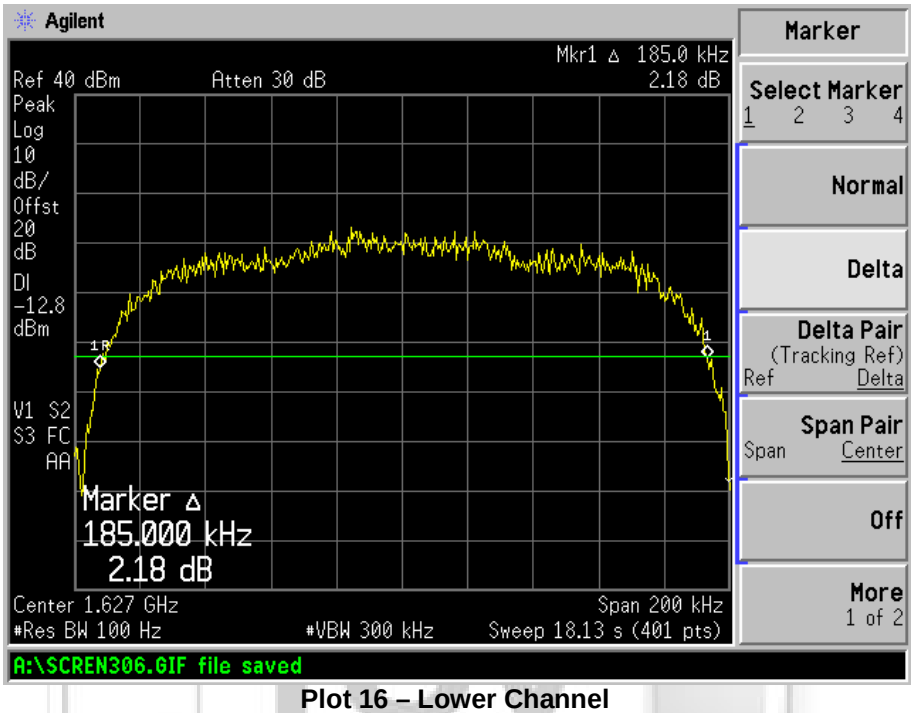
Plot 14 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 5)

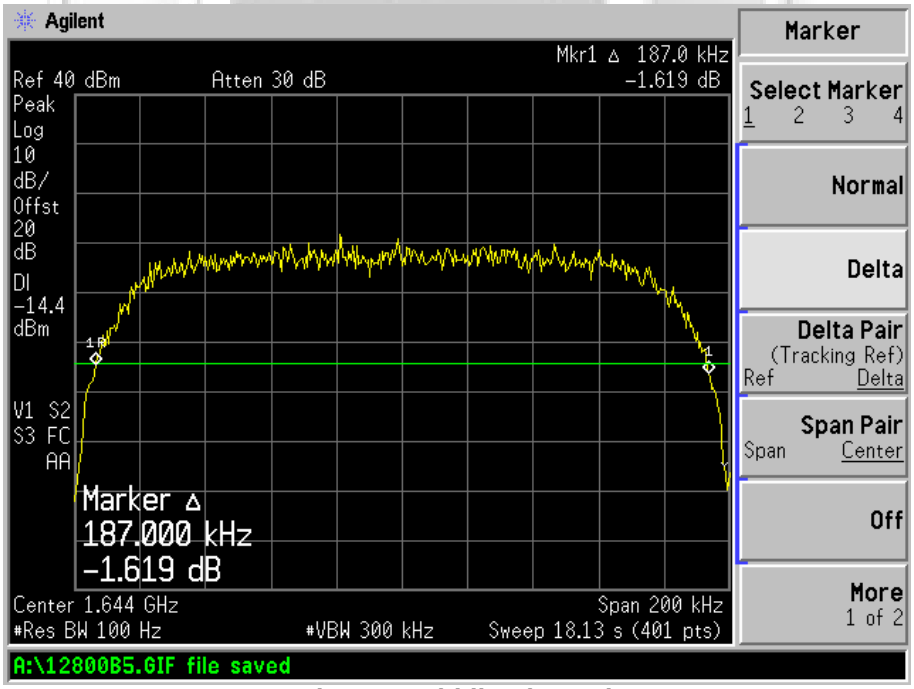


Plot 15 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 7)

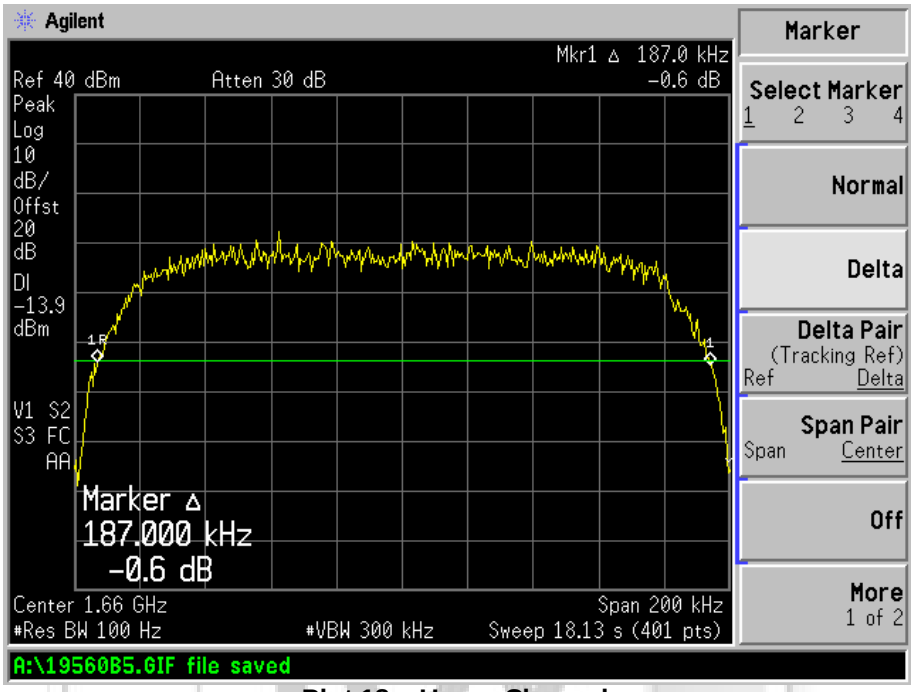


Plot 16 – Lower Channel



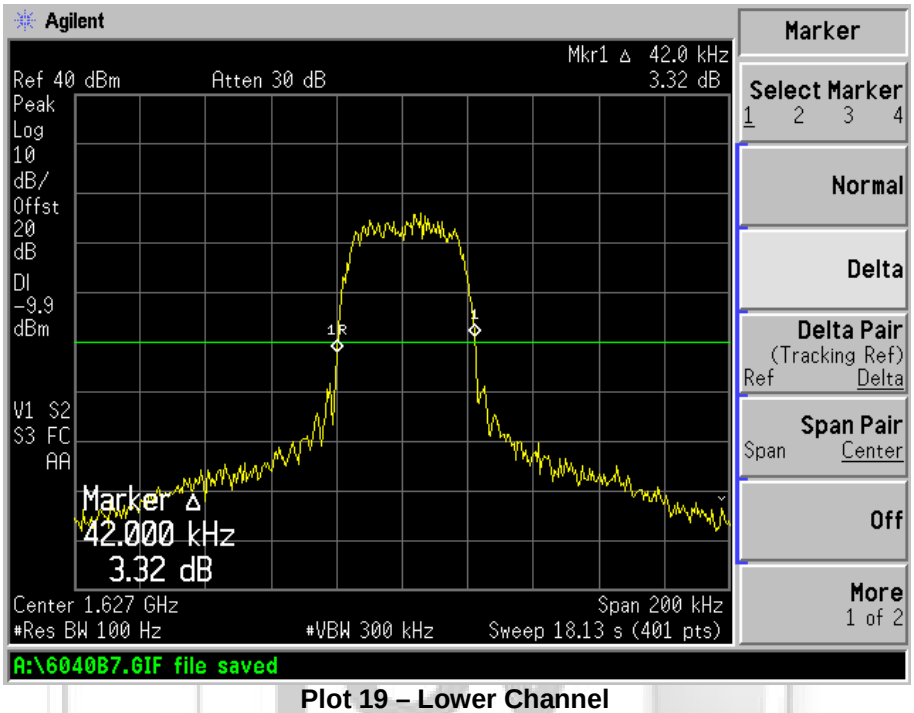
Plot 17 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 7)

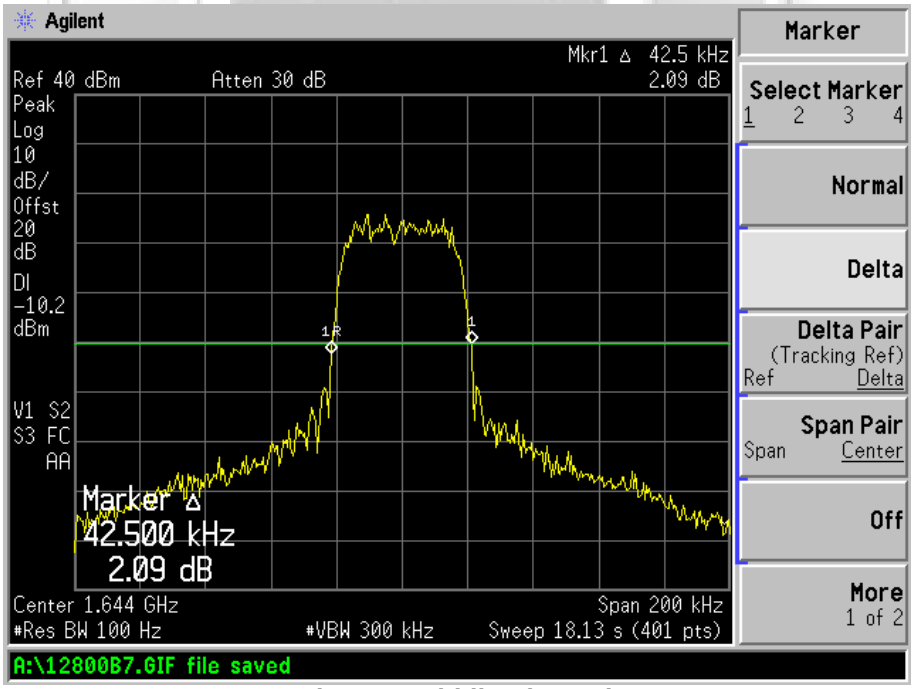


Plot 18 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 11)

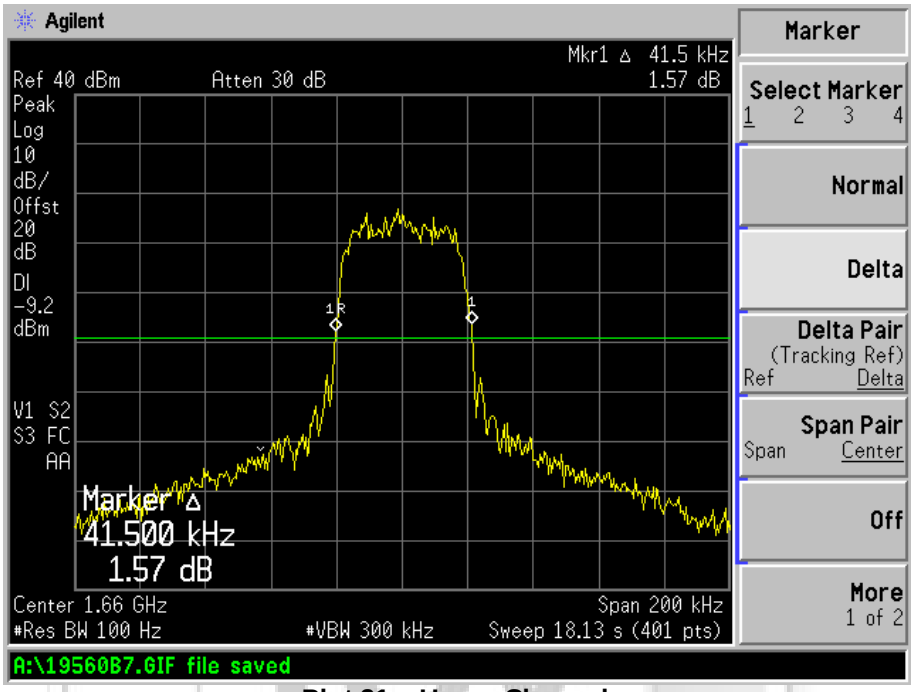


Plot 19 – Lower Channel



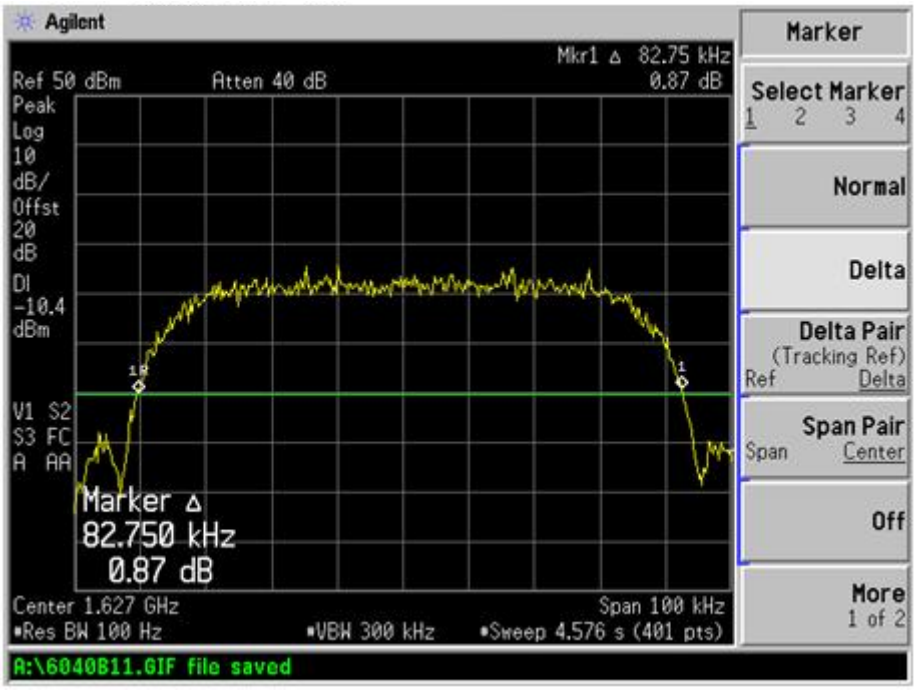
Plot 20 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 11)

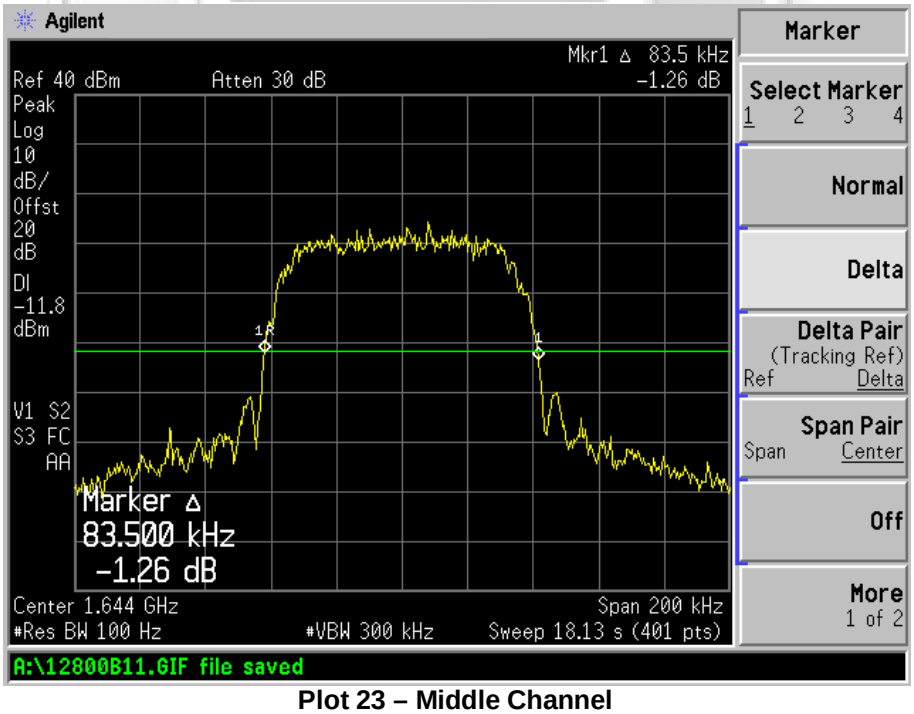


Plot 21 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 13)

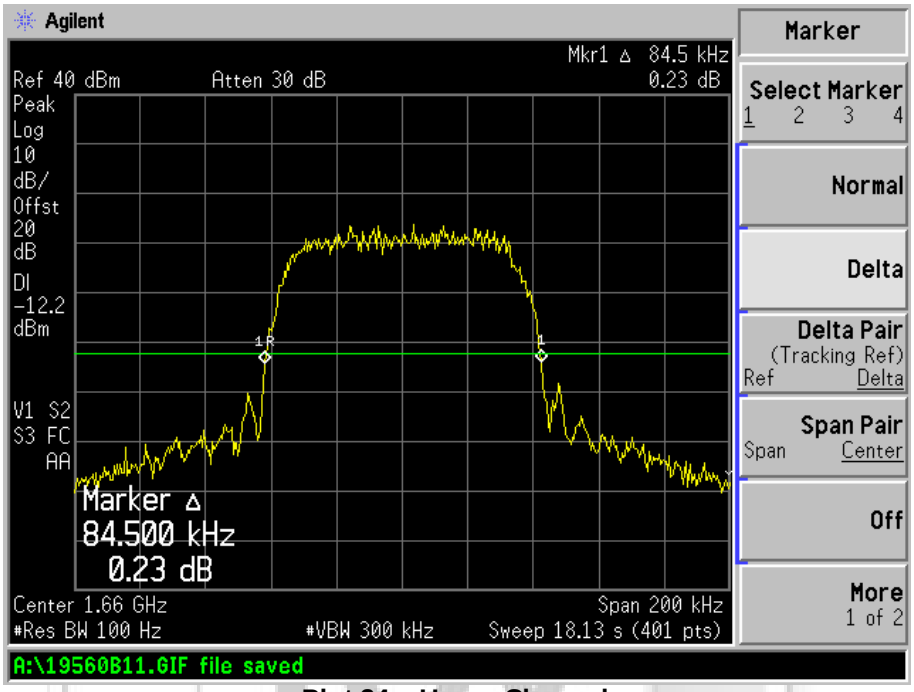


Plot 22 – Lower Channel



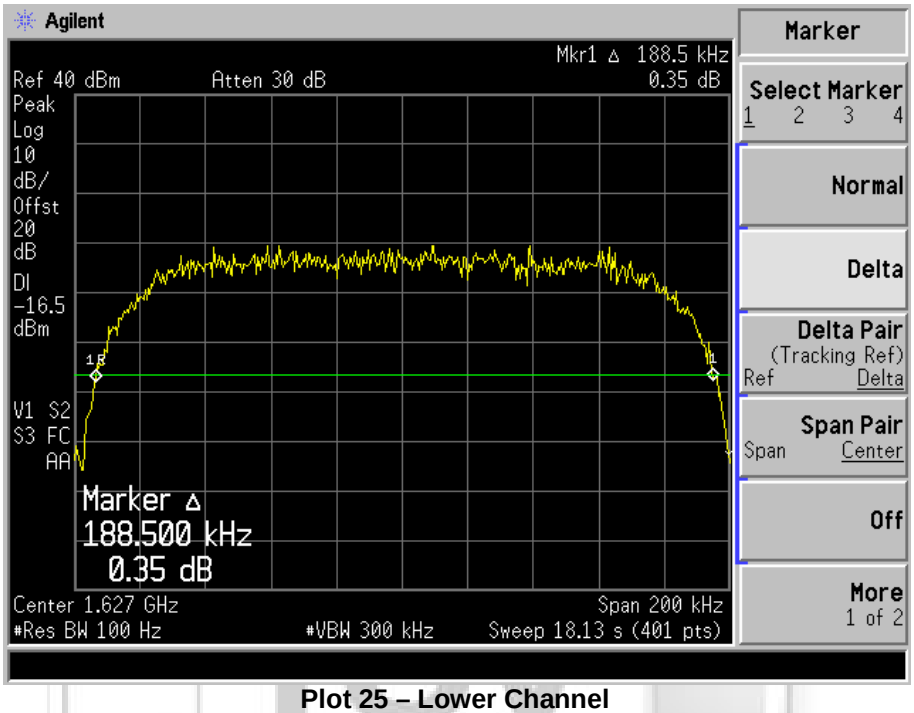
Plot 23 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 13)

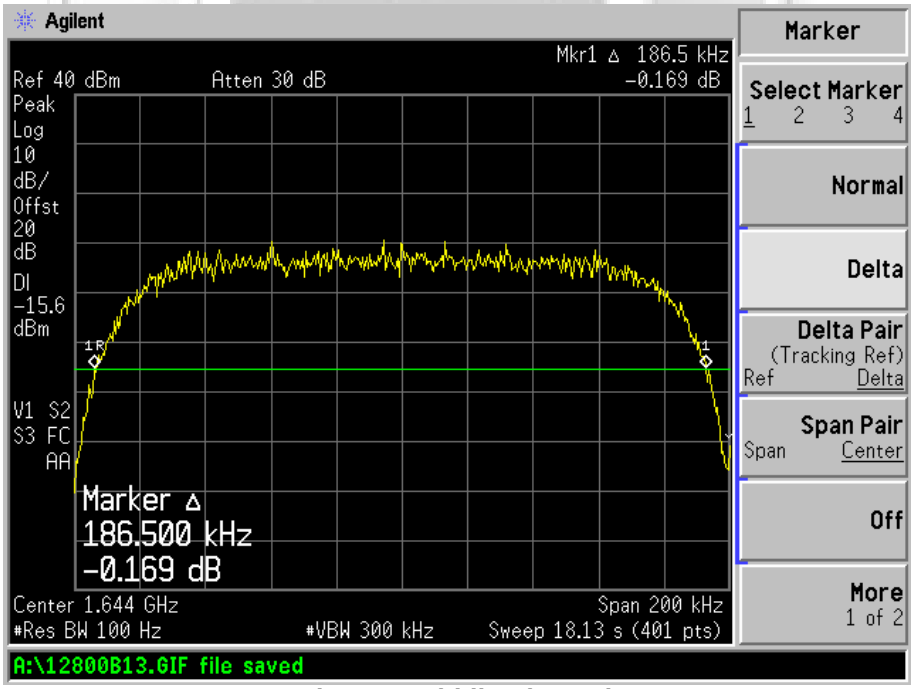


Plot 24 – Upper Channel

26dB Bandwidth Plots (Bearer Type: 15)

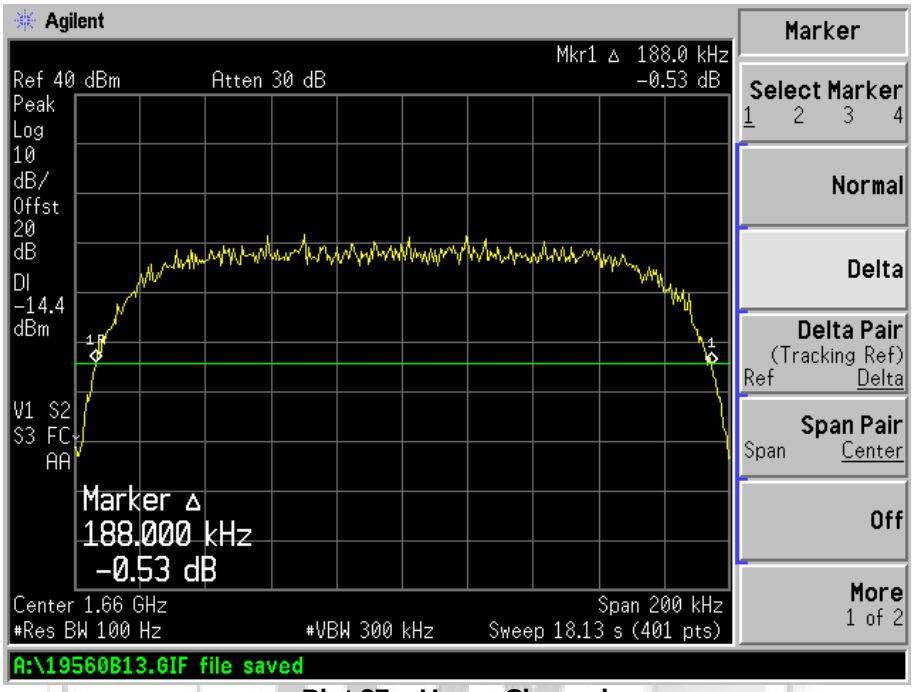


Plot 25 – Lower Channel



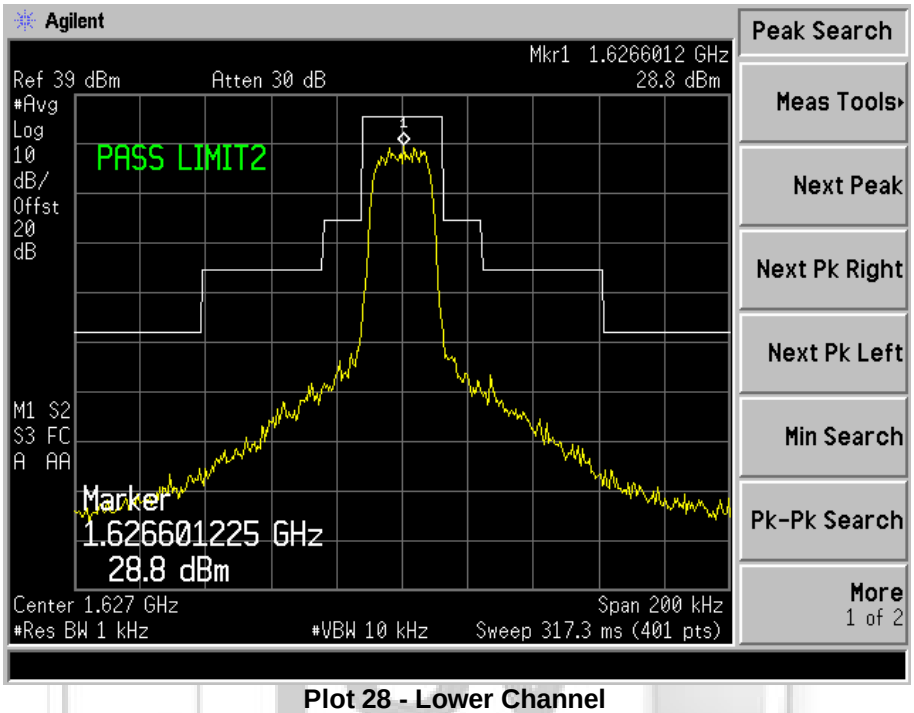
Plot 26 – Middle Channel

26dB Bandwidth Plots (Bearer Type: 15)

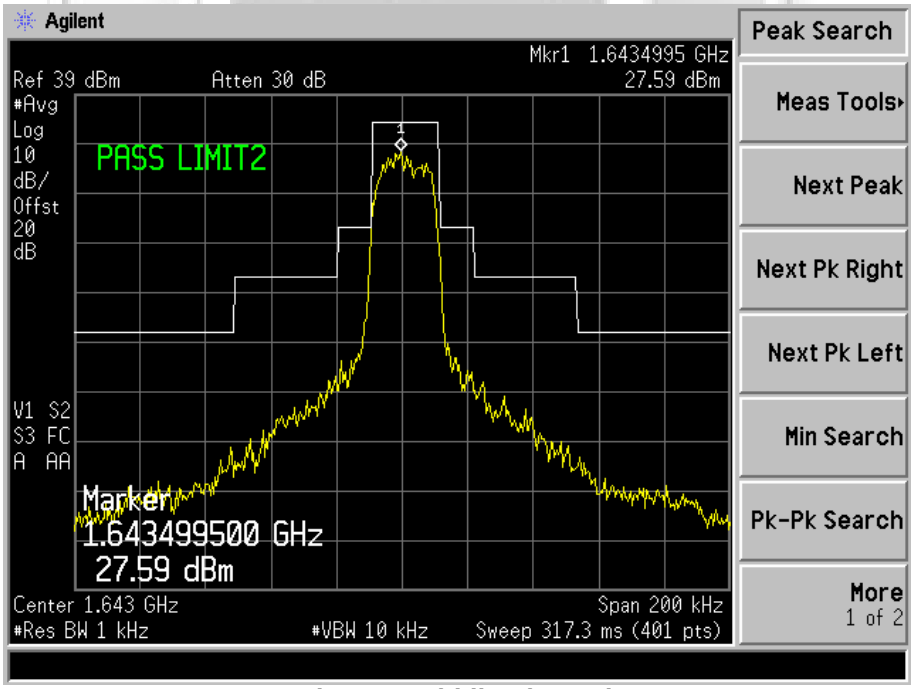


Plot 27 – Upper Channel

In Band Emissions Plots (Bearer Type: 0)

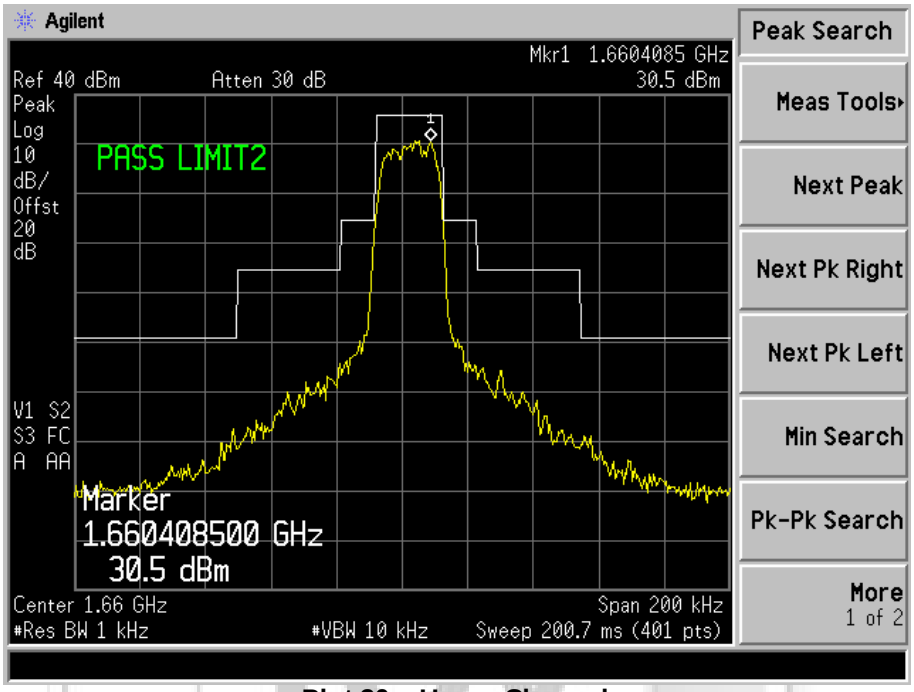


Plot 28 - Lower Channel



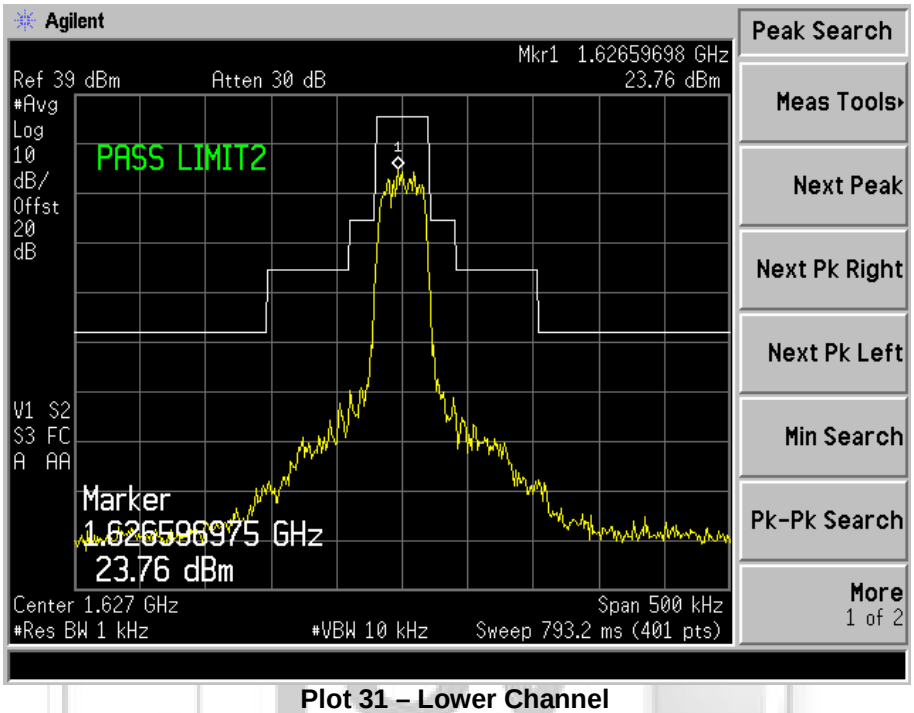
Plot 29 – Middle Channel

In Band Emissions Plots (Bearer Type: 0)

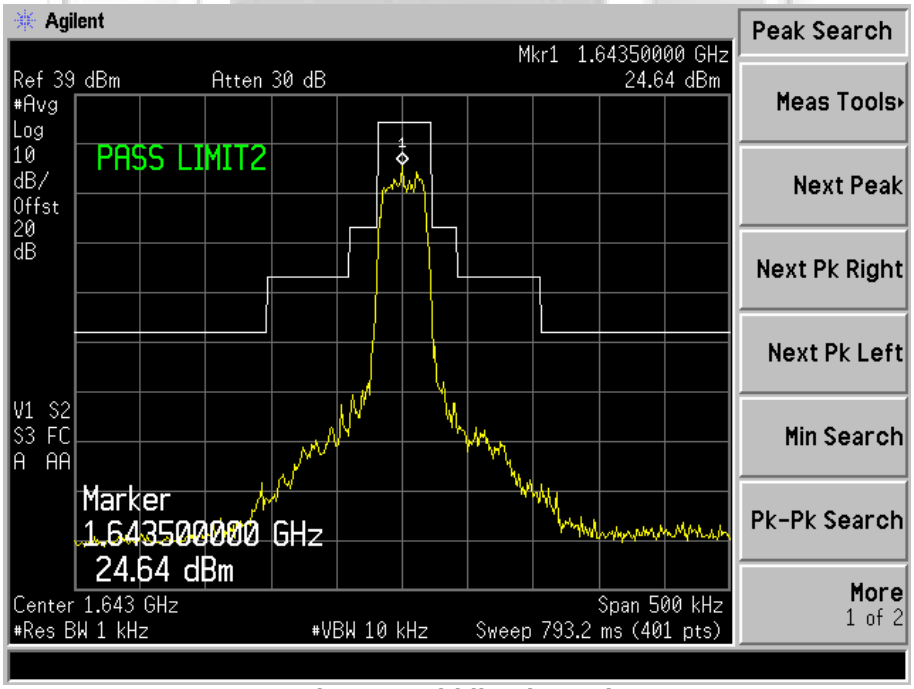


Plot 30 – Upper Channel

In Band Emissions Plots (Bearer Type: 3)

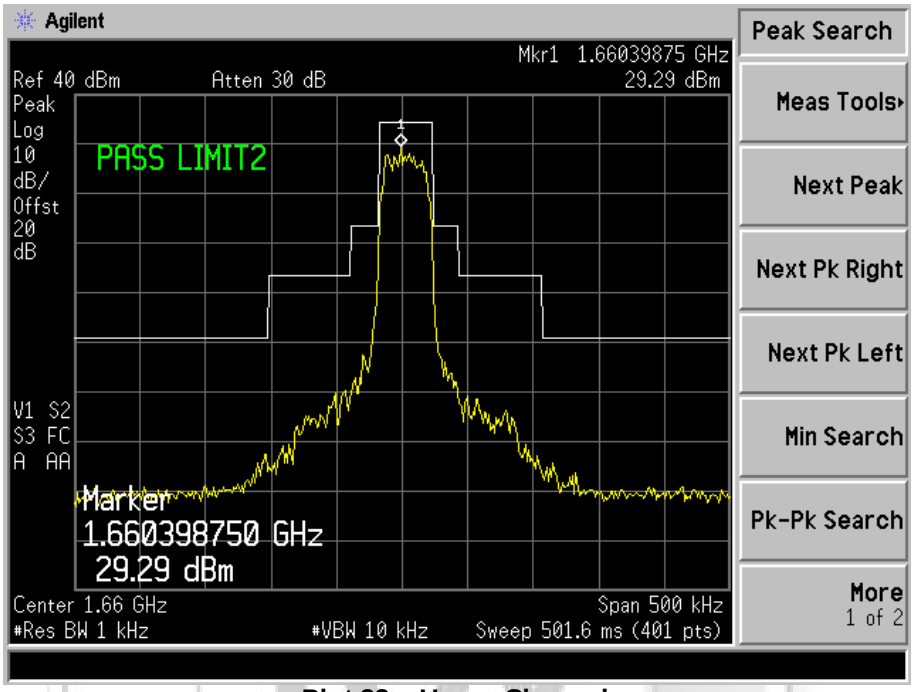


Plot 31 – Lower Channel



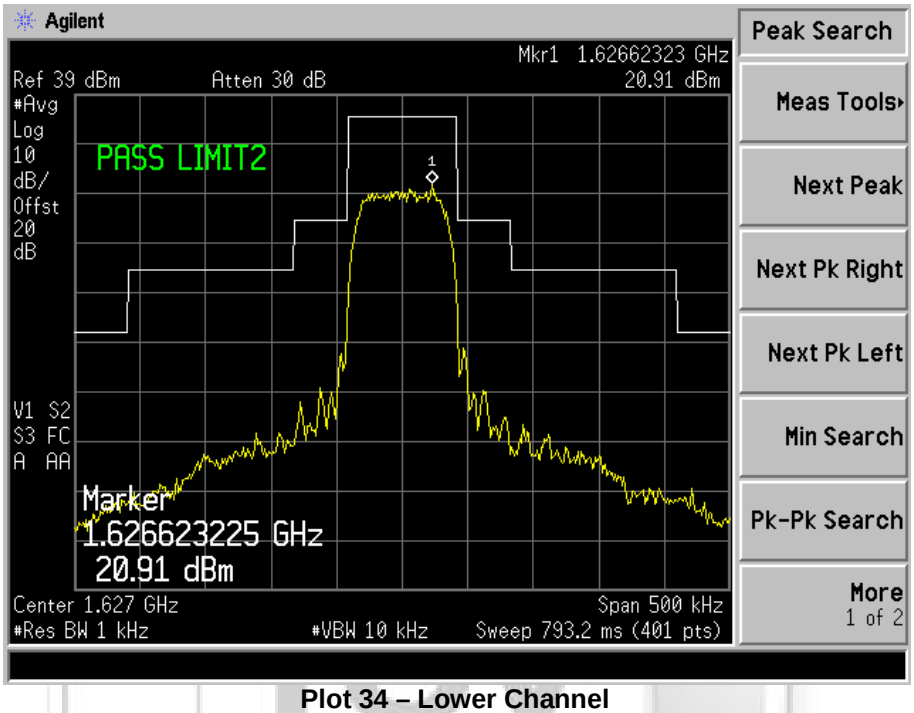
Plot 32 – Middle Channel

In Band Emissions Plots (Bearer Type: 3)

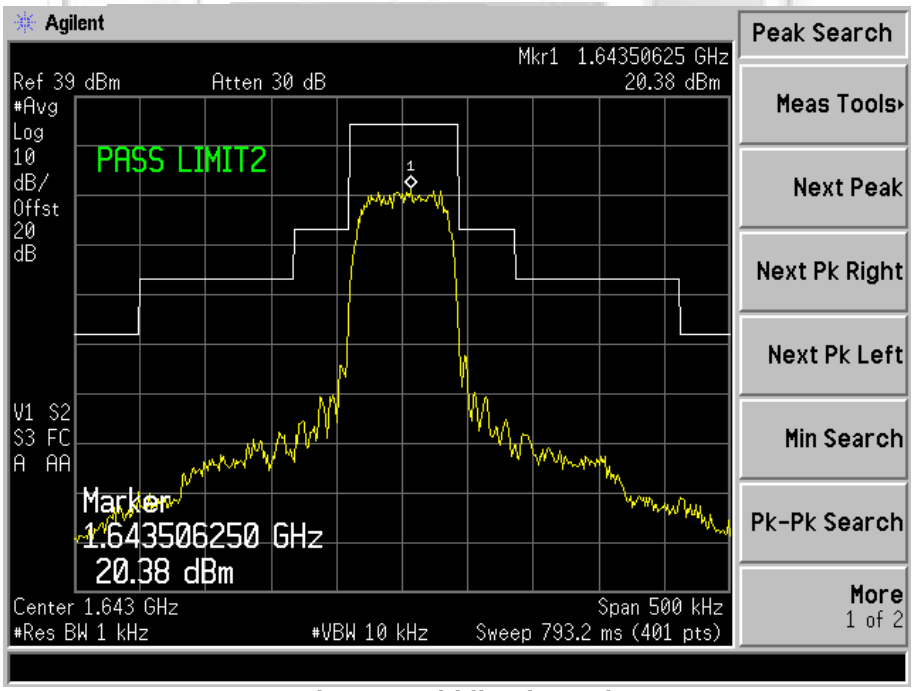


Plot 33 – Upper Channel

In Band Emissions Plots (Bearer Type: 5)

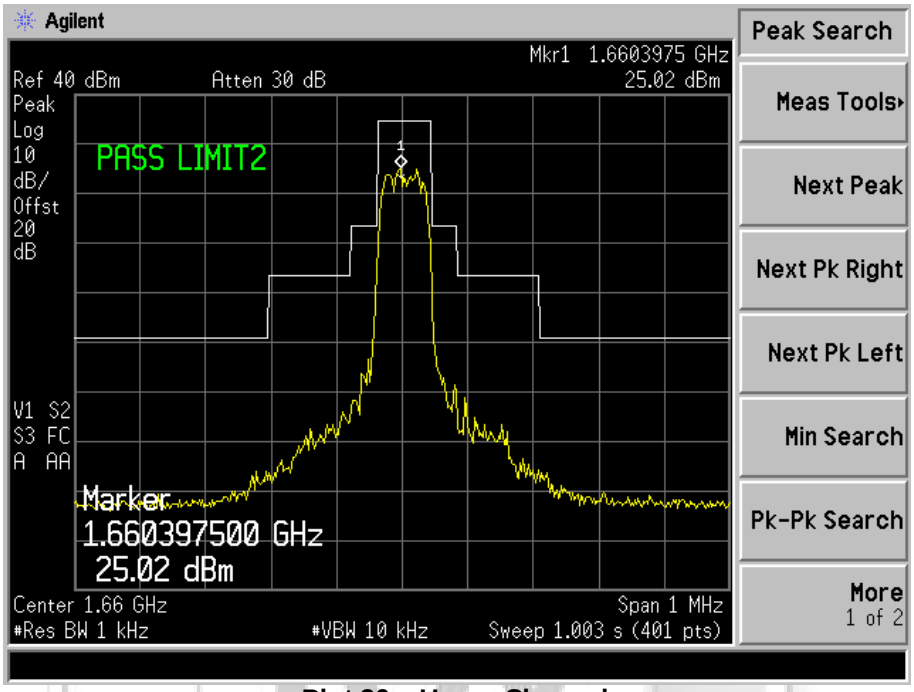


Plot 34 – Lower Channel



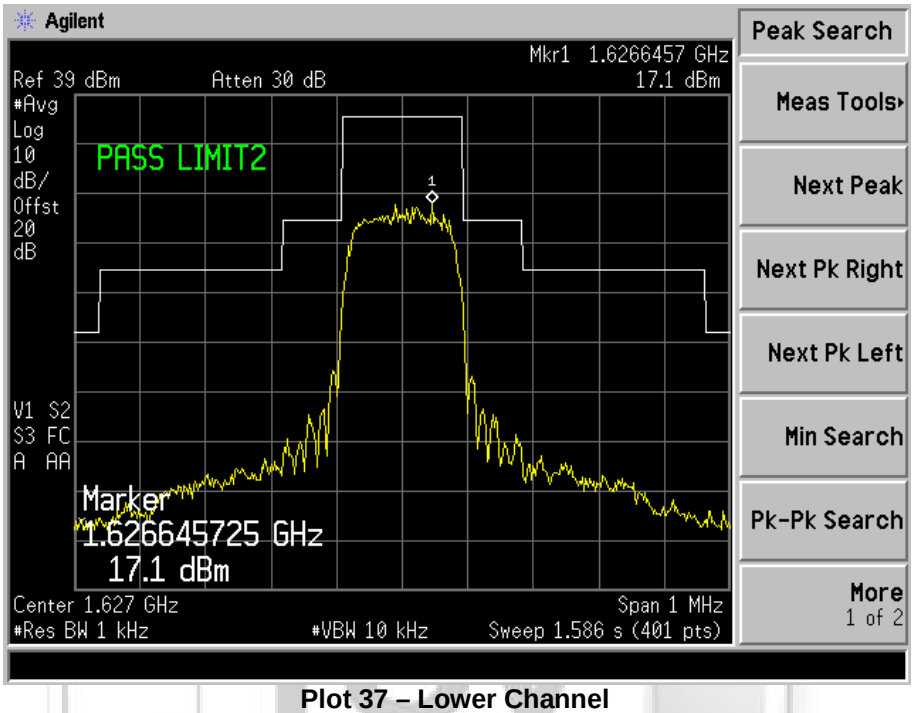
Plot 35 – Middle Channel

In Band Emissions Plots (Bearer Type: 5)

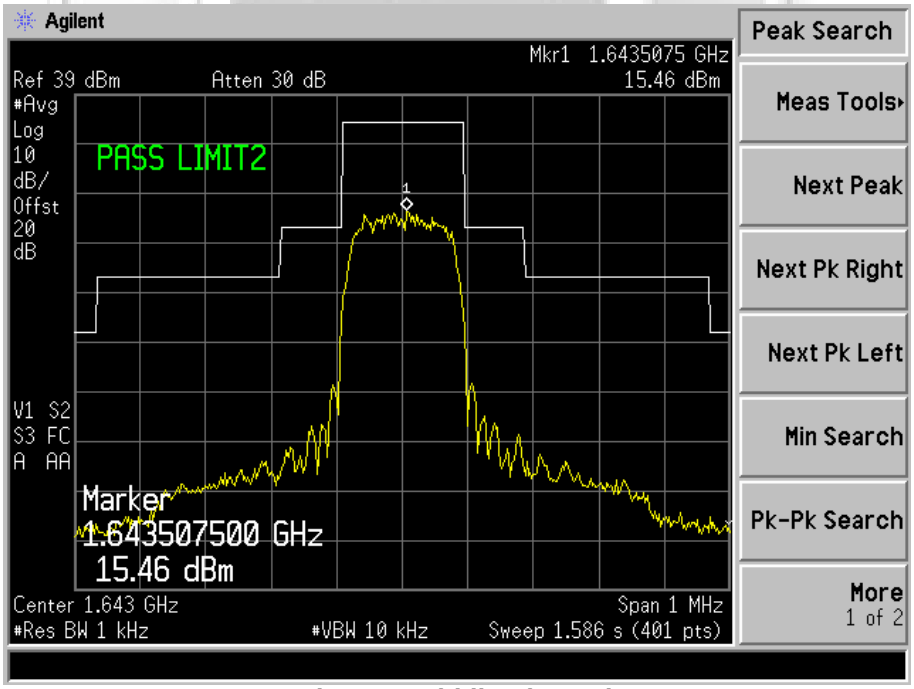


Plot 36 – Upper Channel

In Band Emissions Plots (Bearer Type: 7)

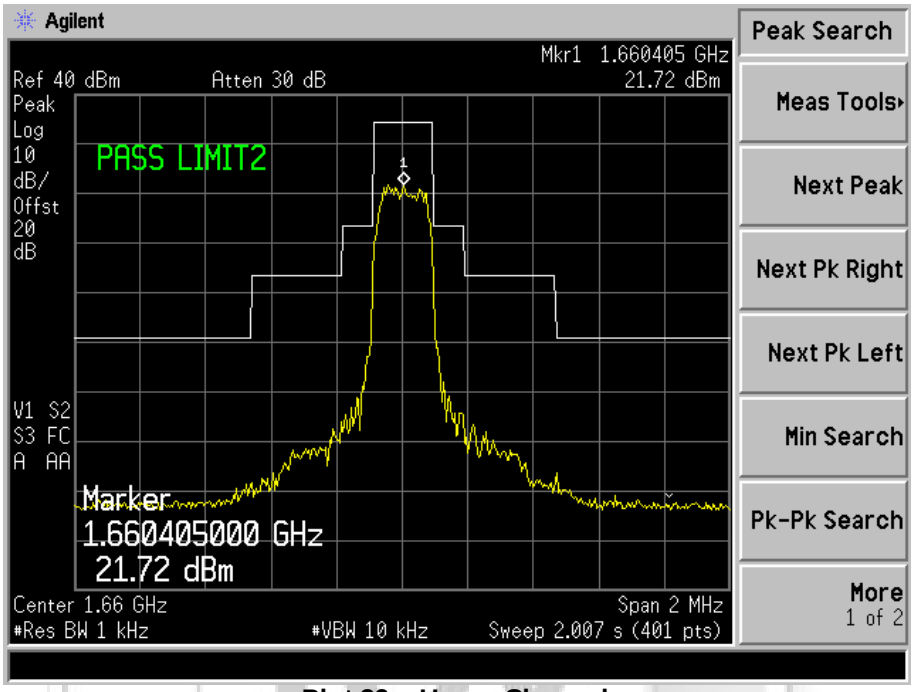


Plot 37 – Lower Channel



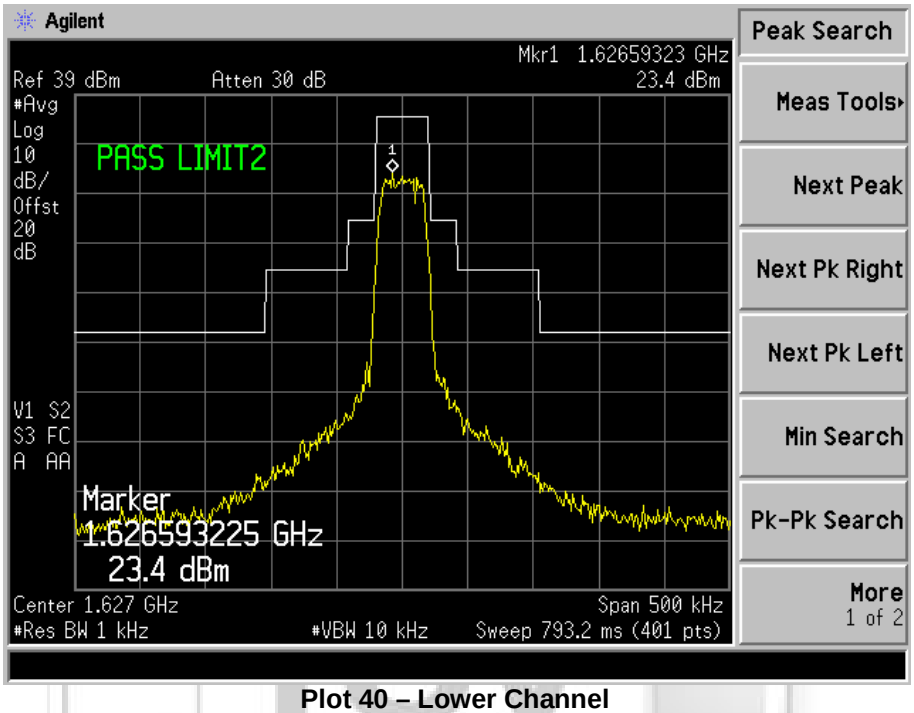
Plot 38 – Middle Channel

In Band Emissions Plots (Bearer Type: 7)

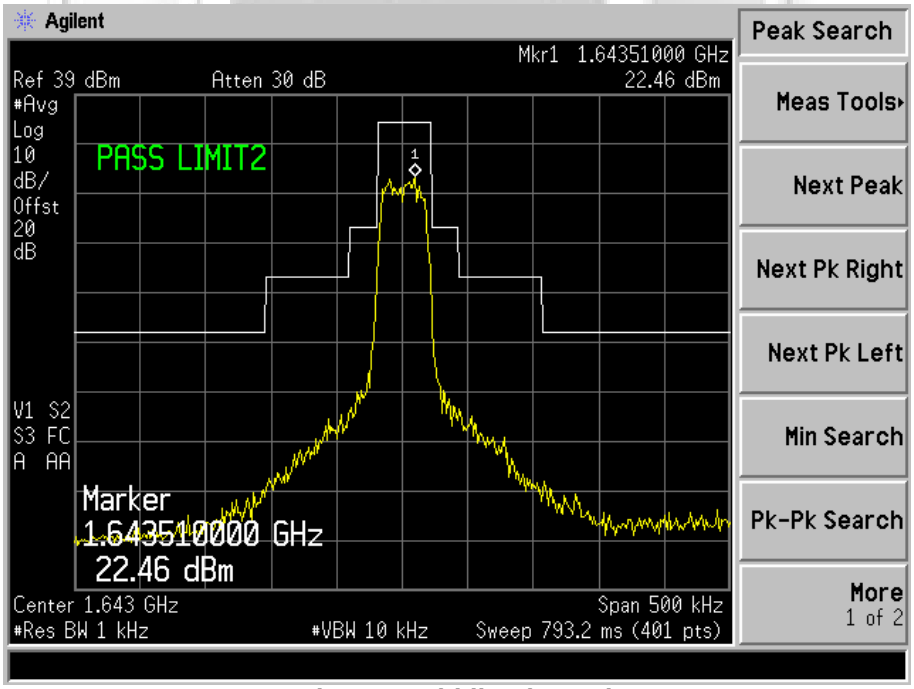


Plot 39 – Upper Channel

In Band Emissions Plots (Bearer Type: 11)

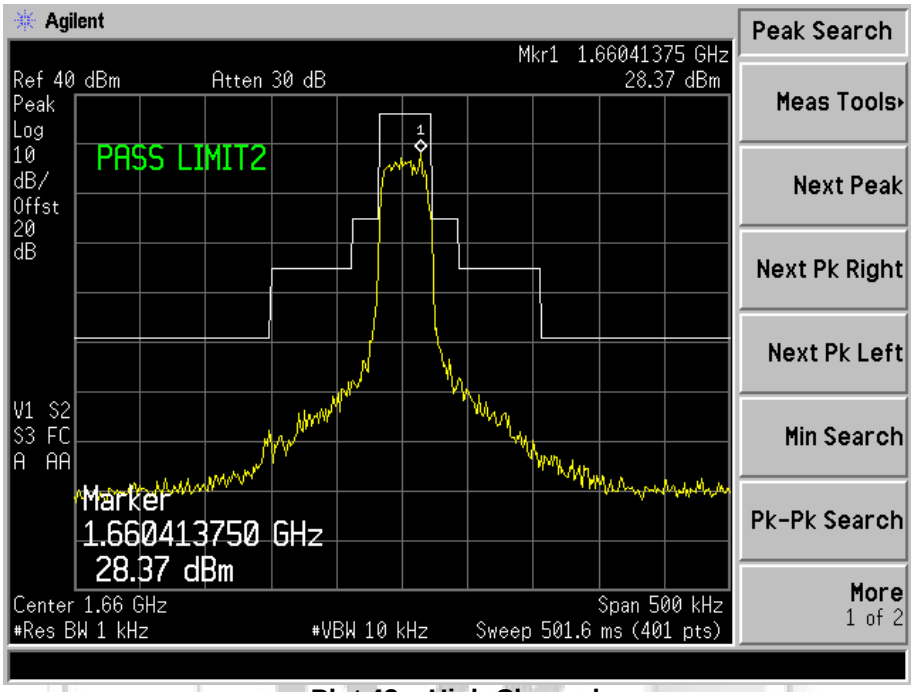


Plot 40 – Lower Channel



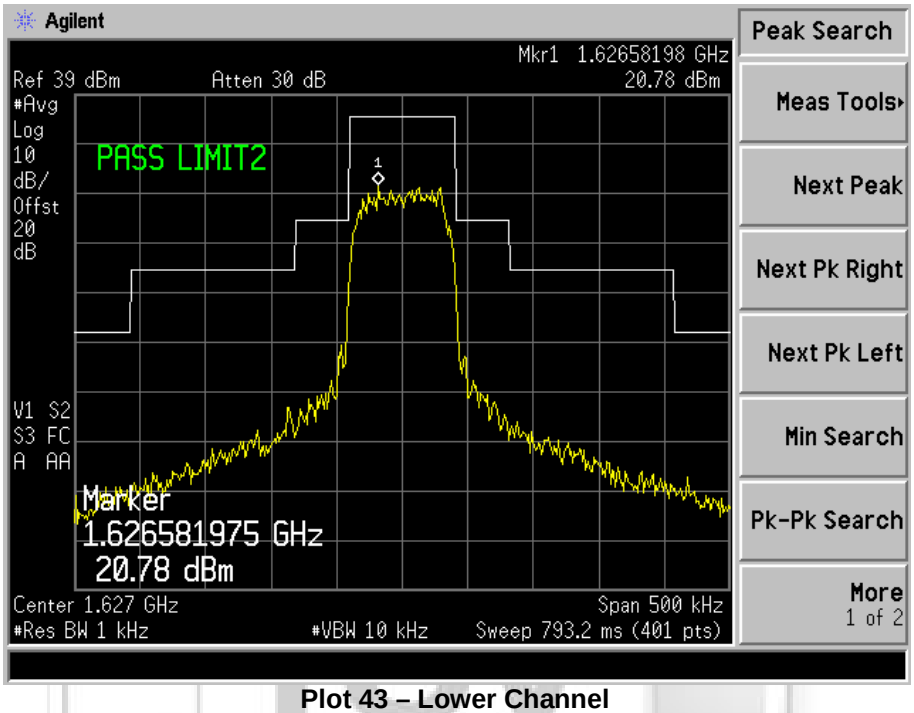
Plot 41 – Middle Channel

In Band Emissions Plots (Bearer Type: 11)

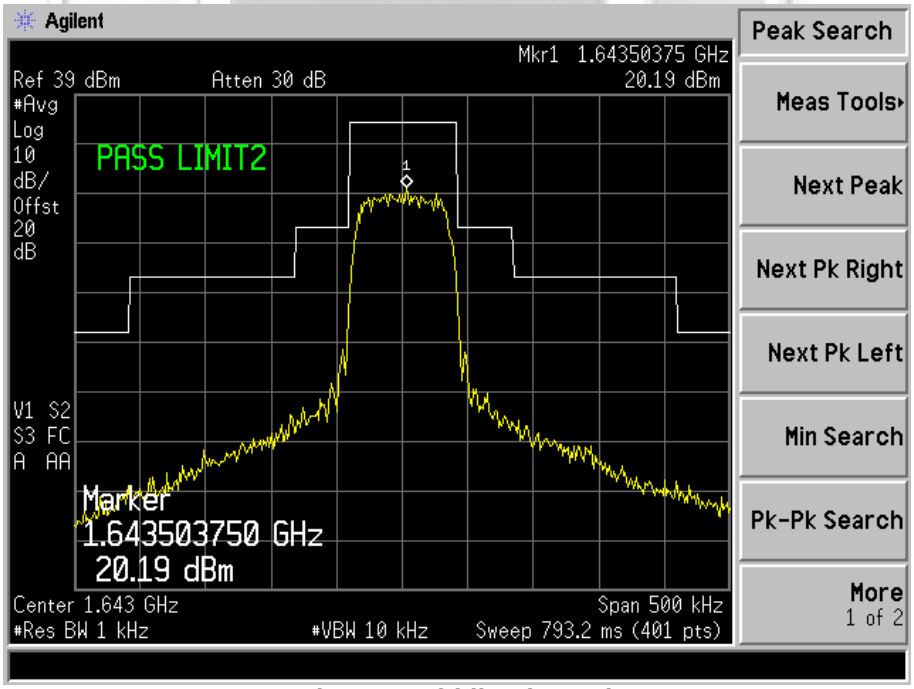


Plot 42 – High Channel

In Band Emissions Plots (Bearer Type: 13)

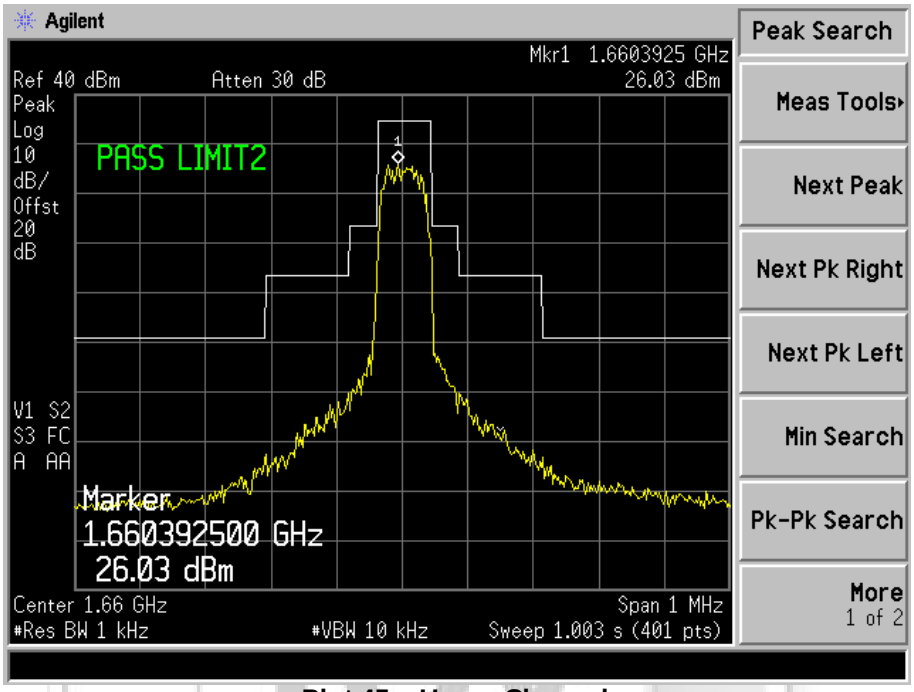


Plot 43 – Lower Channel



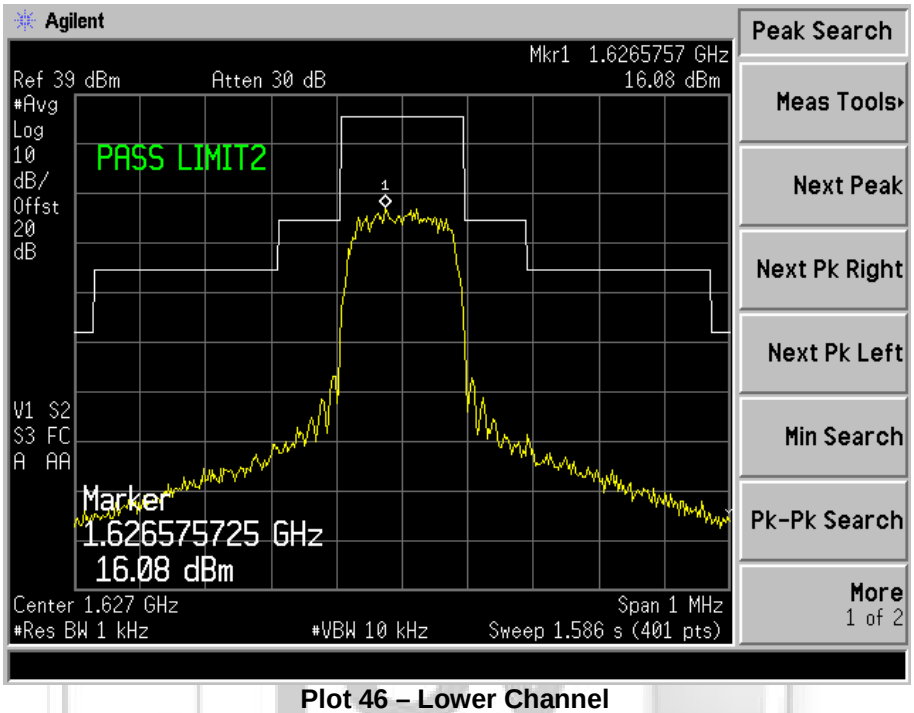
Plot 44 – Middle Channel

In Band Emissions Plots (Bearer Type: 13)

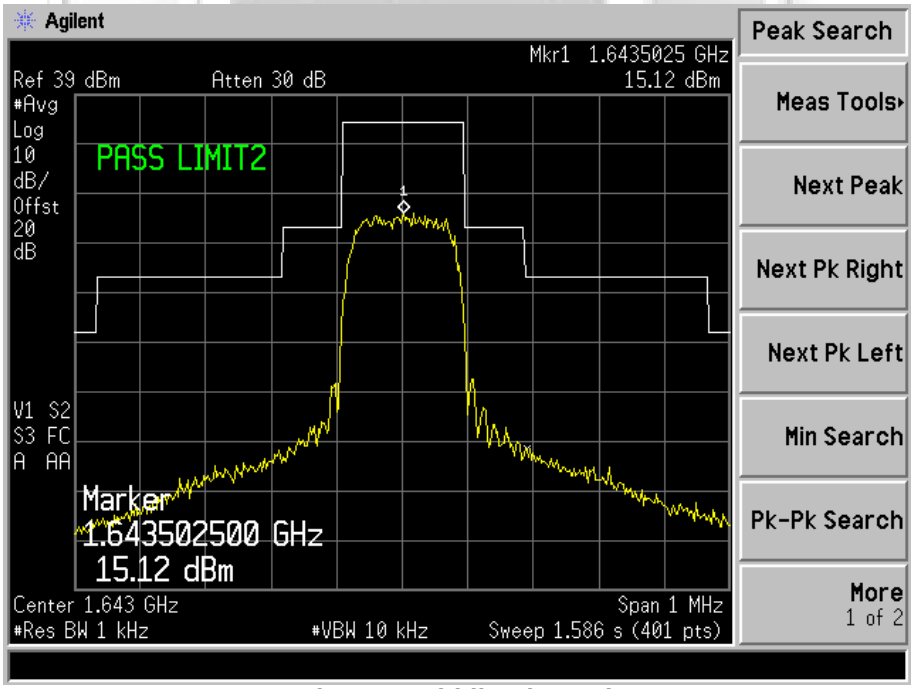


Plot 45 – Upper Channel

In Band Emissions Plots (Bearer Type: 15)

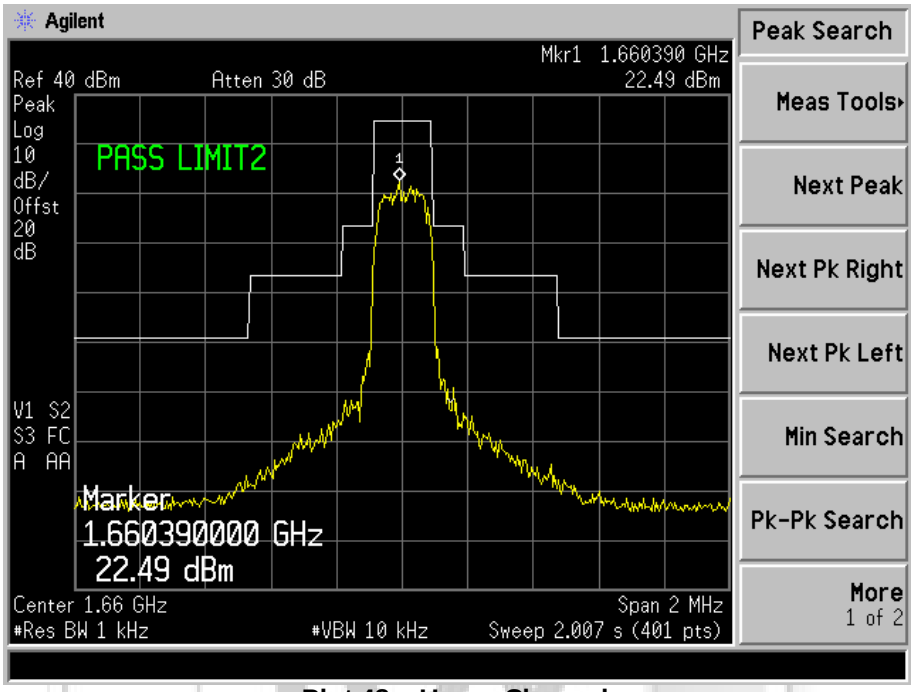


Plot 46 – Lower Channel



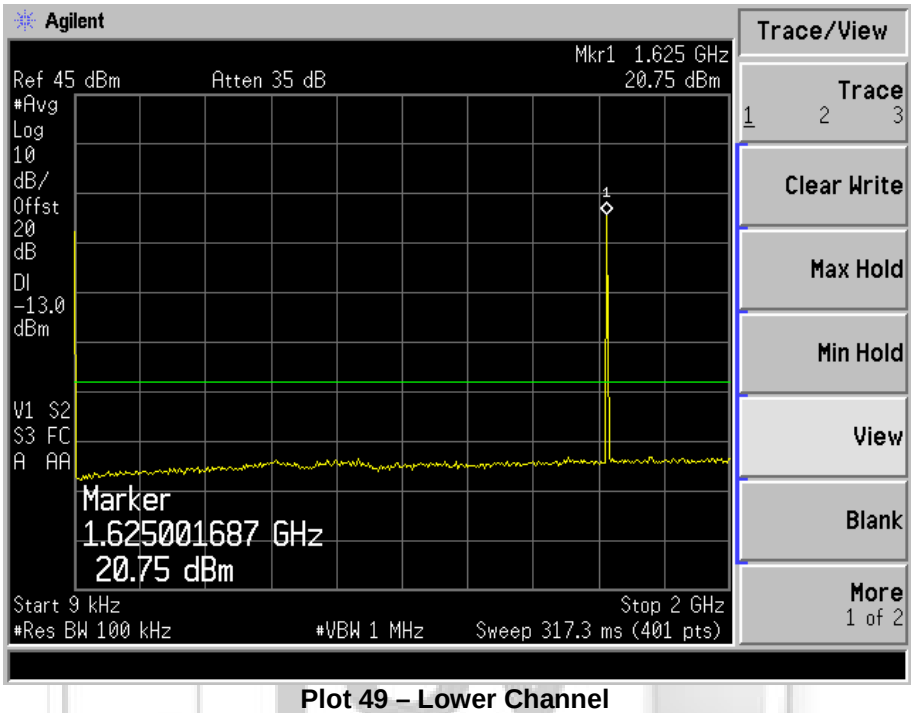
Plot 47 – Middle Channel

In Band Emissions Plots (Bearer Type: 15)

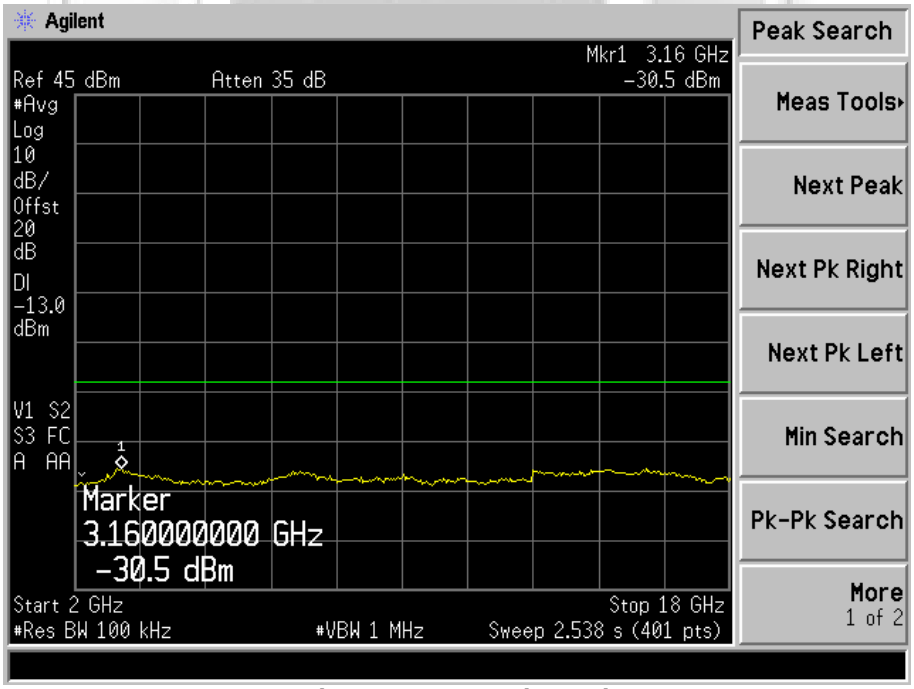


Plot 48 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 0)

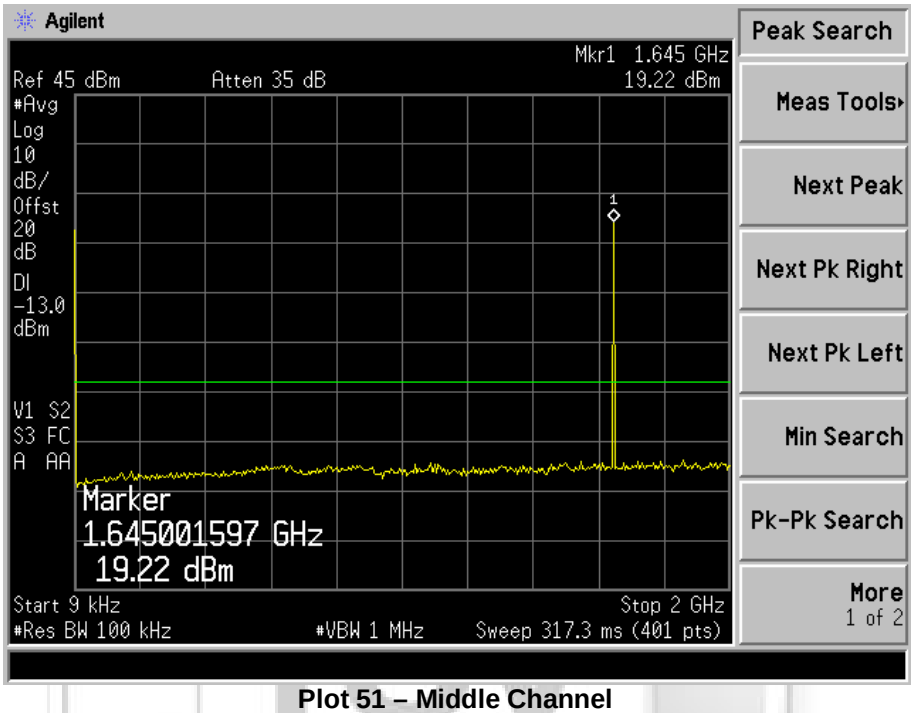


Plot 49 – Lower Channel

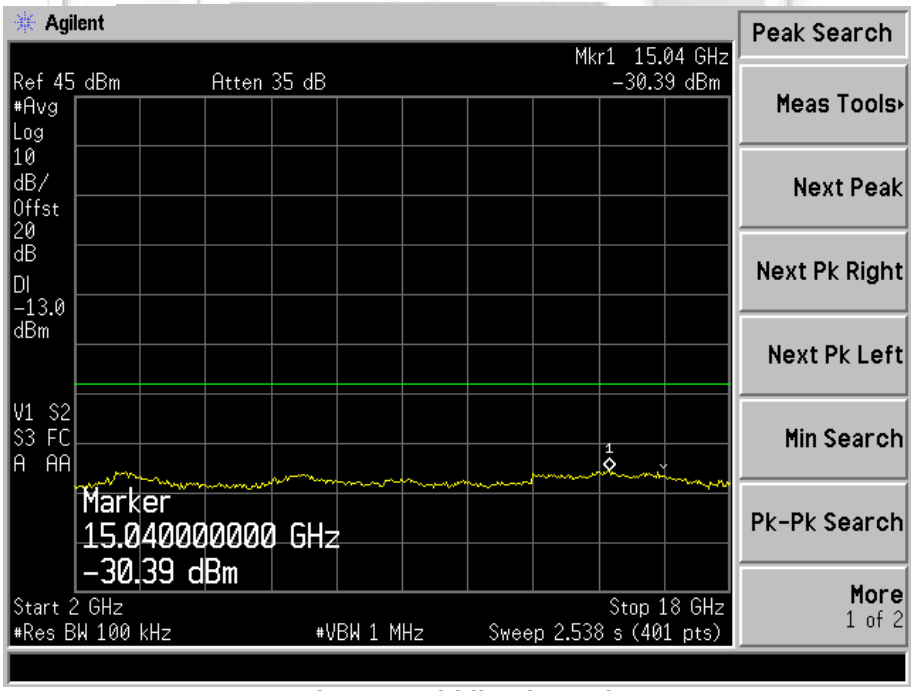


Plot 50 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 0)

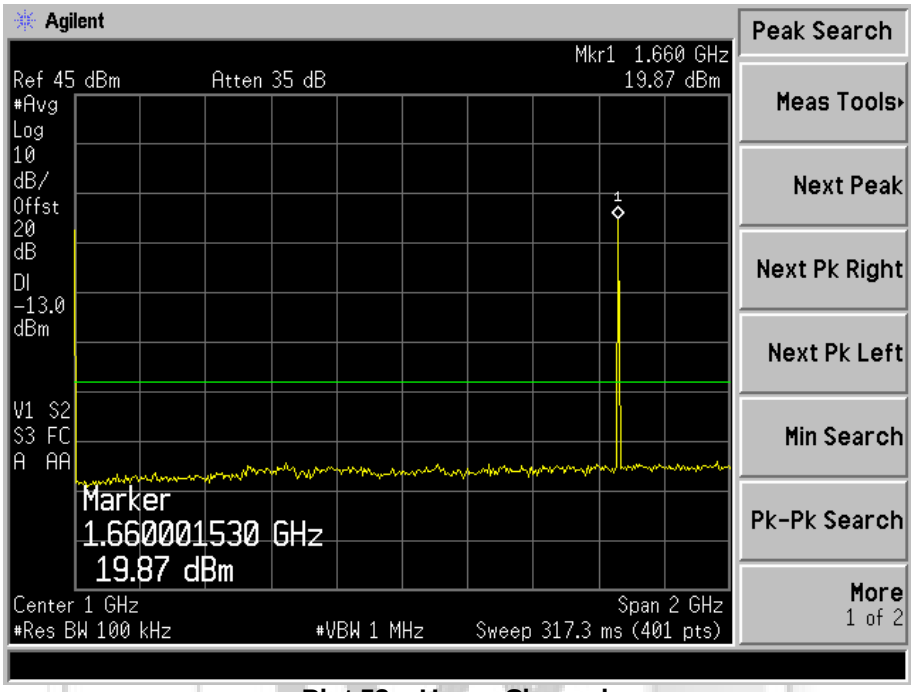


Plot 51 – Middle Channel

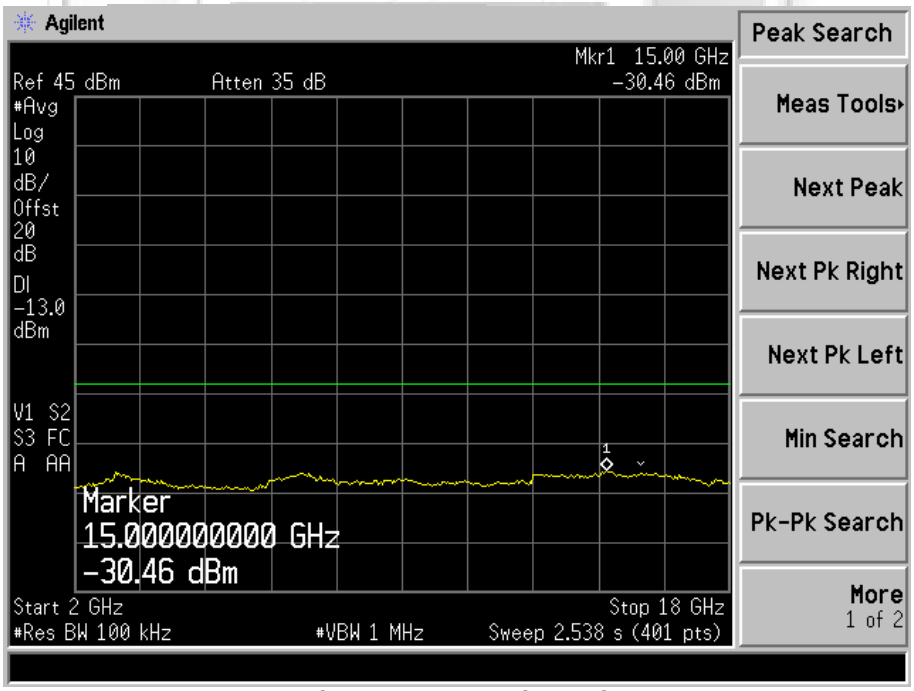


Plot 52 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 0)

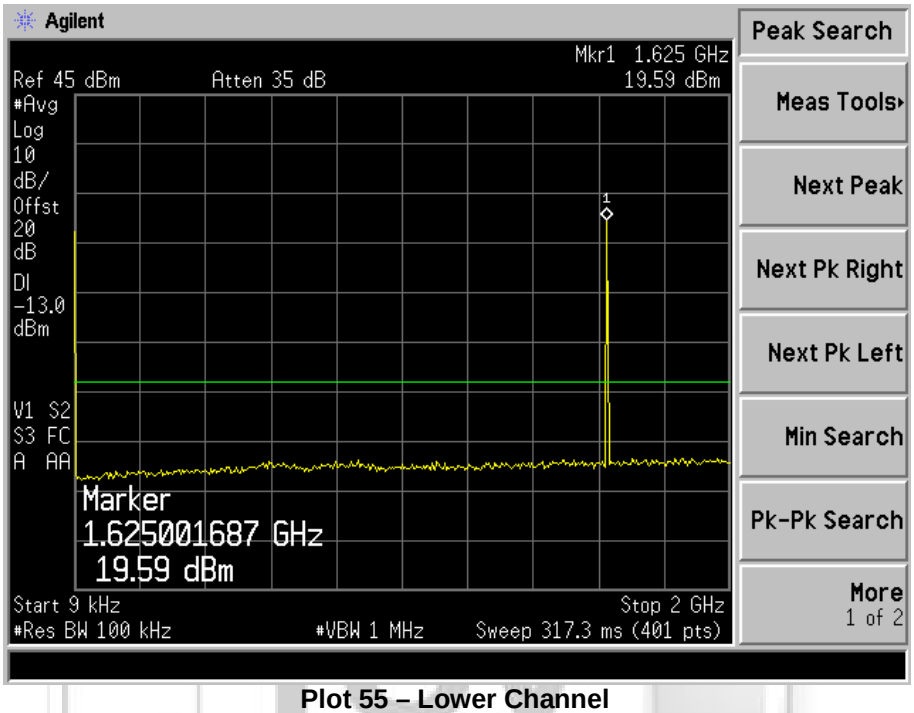


Plot 53 – Upper Channel

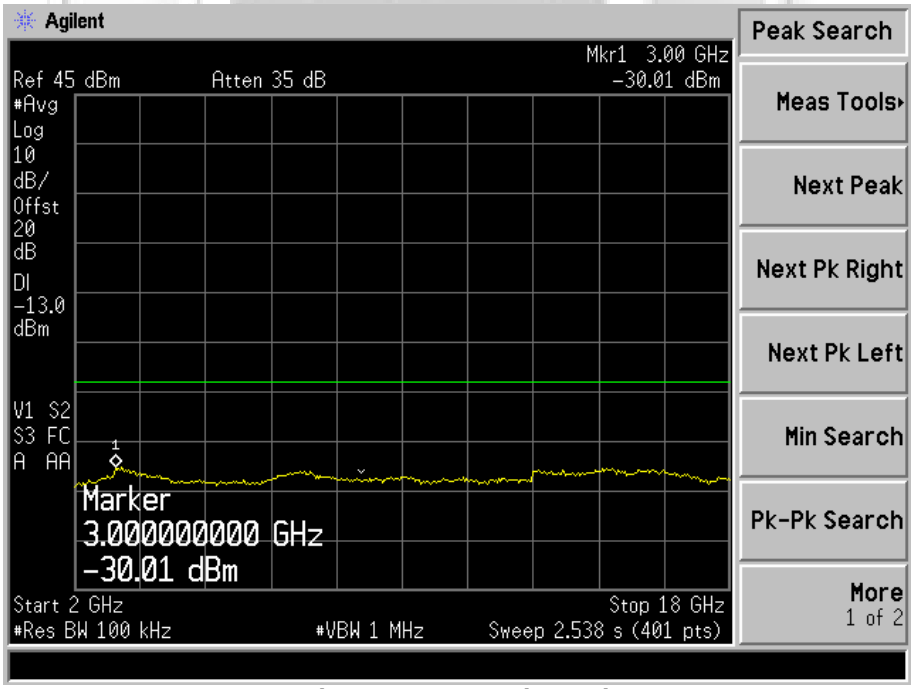


Plot 54 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 3)

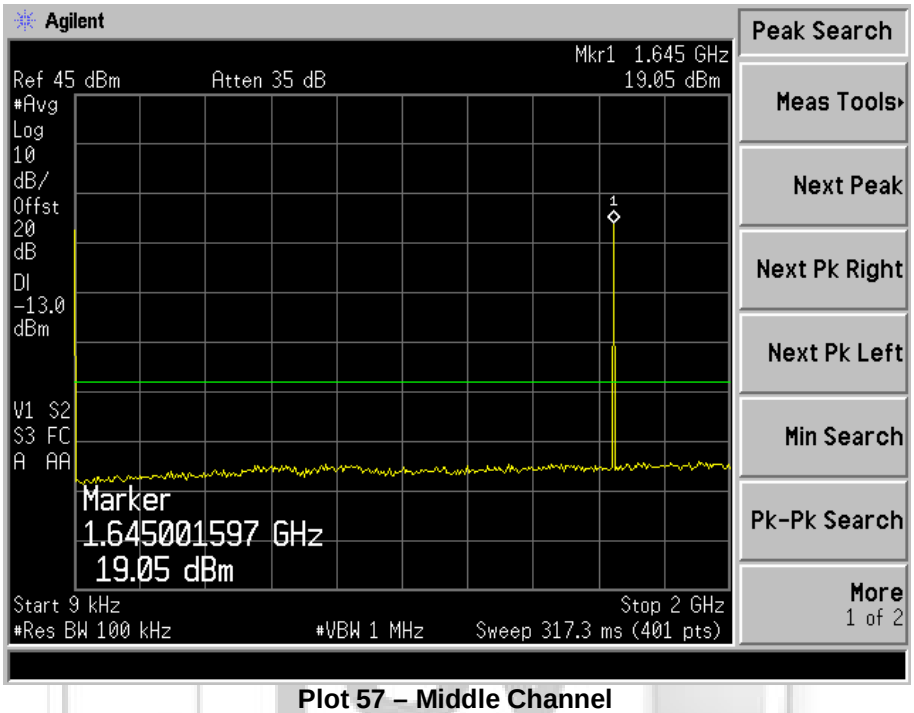


Plot 55 – Lower Channel

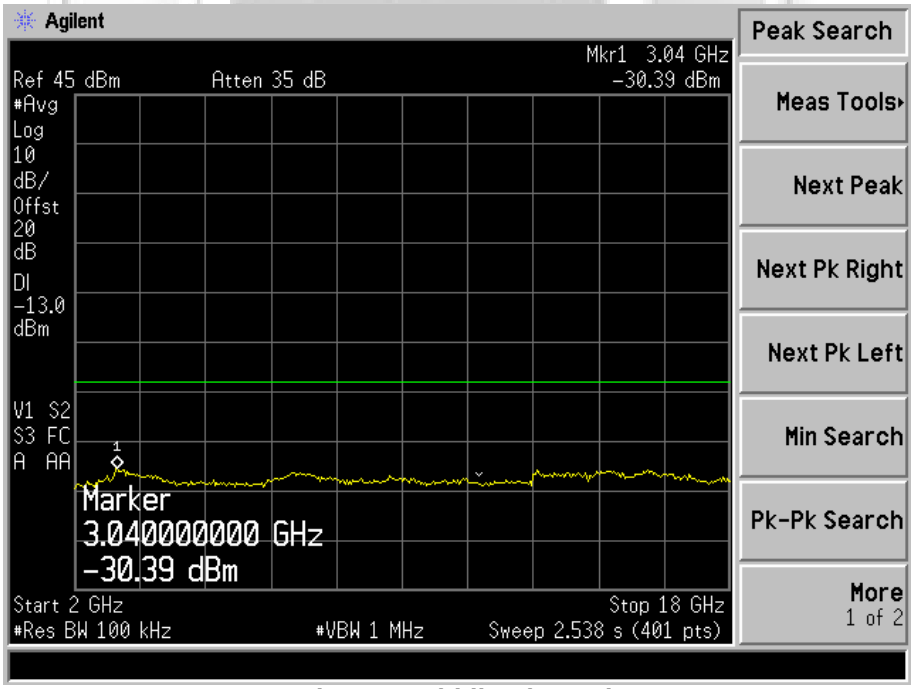


Plot 56 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 3)

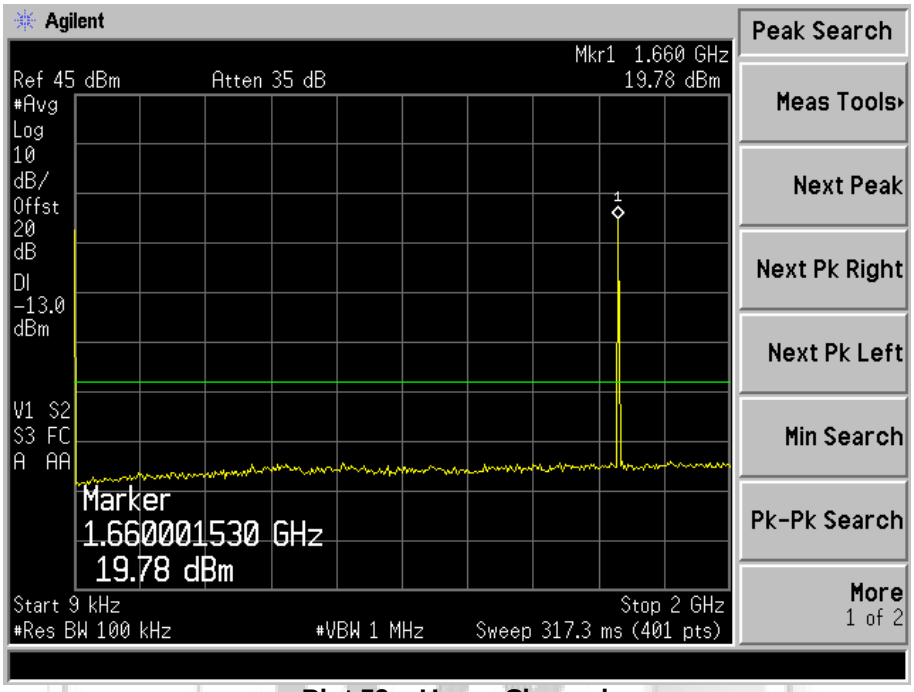


Plot 57 – Middle Channel

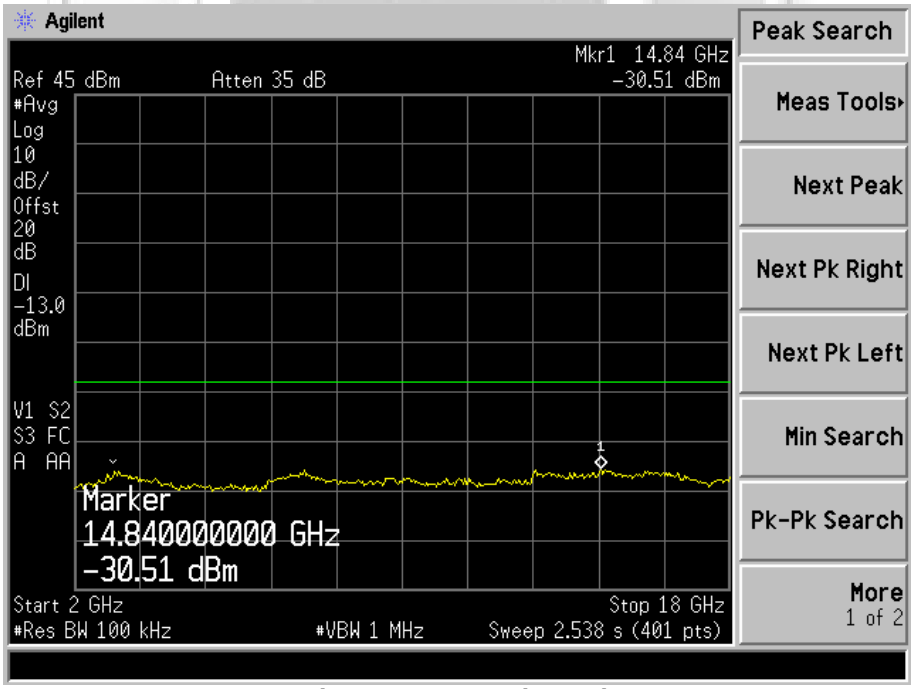


Plot 58 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 3)

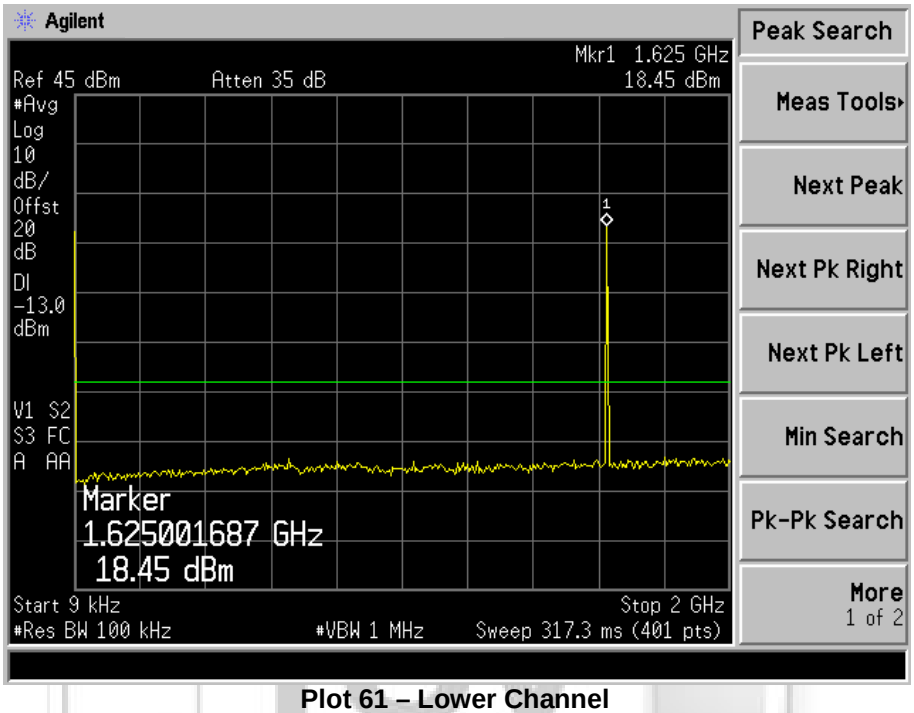


Plot 59 – Upper Channel

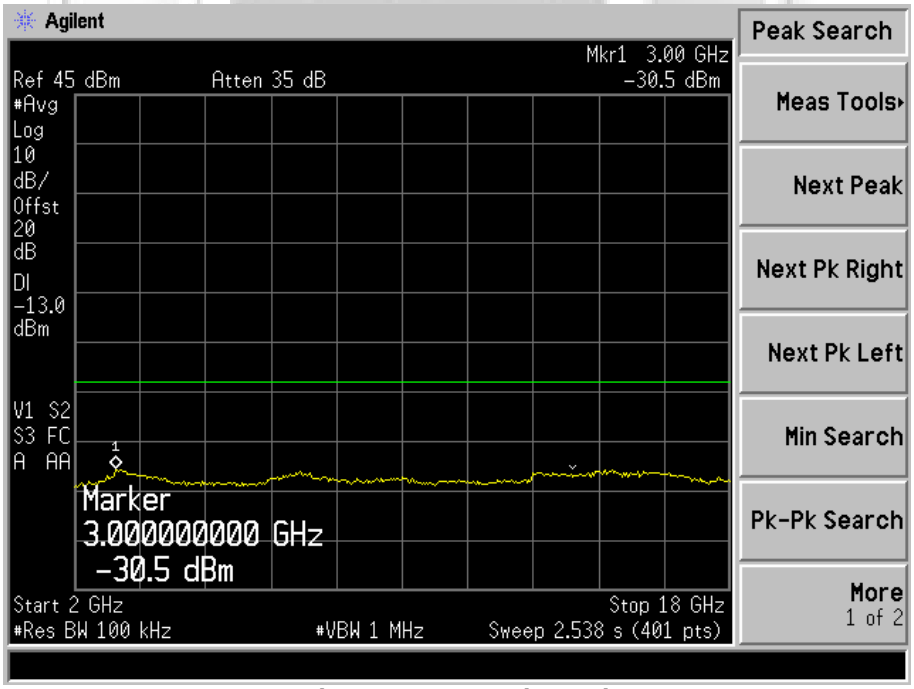


Plot 60 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 5)

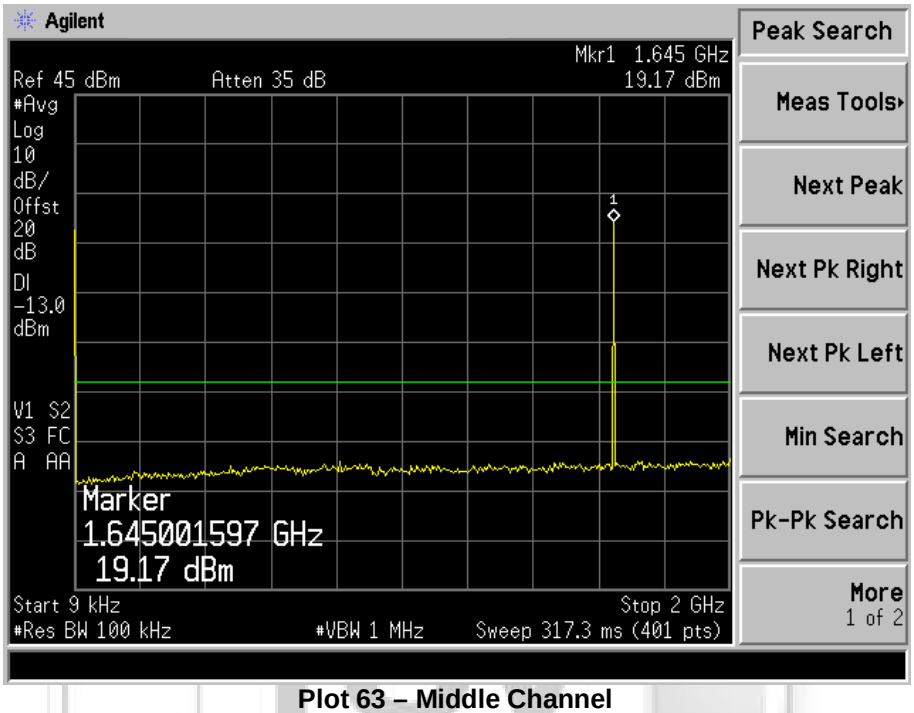


Plot 61 – Lower Channel

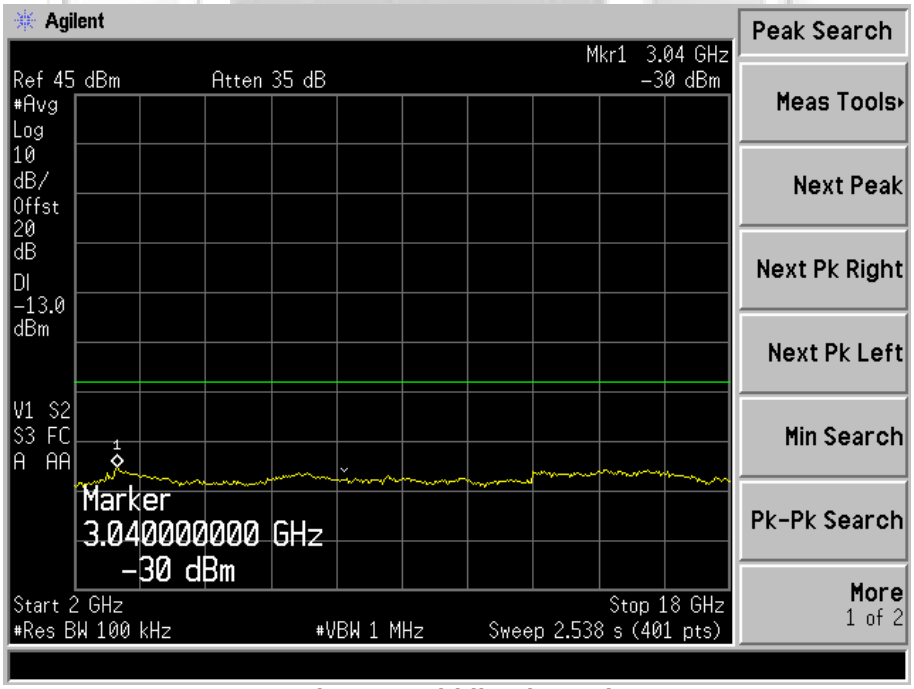


Plot 62 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 5)

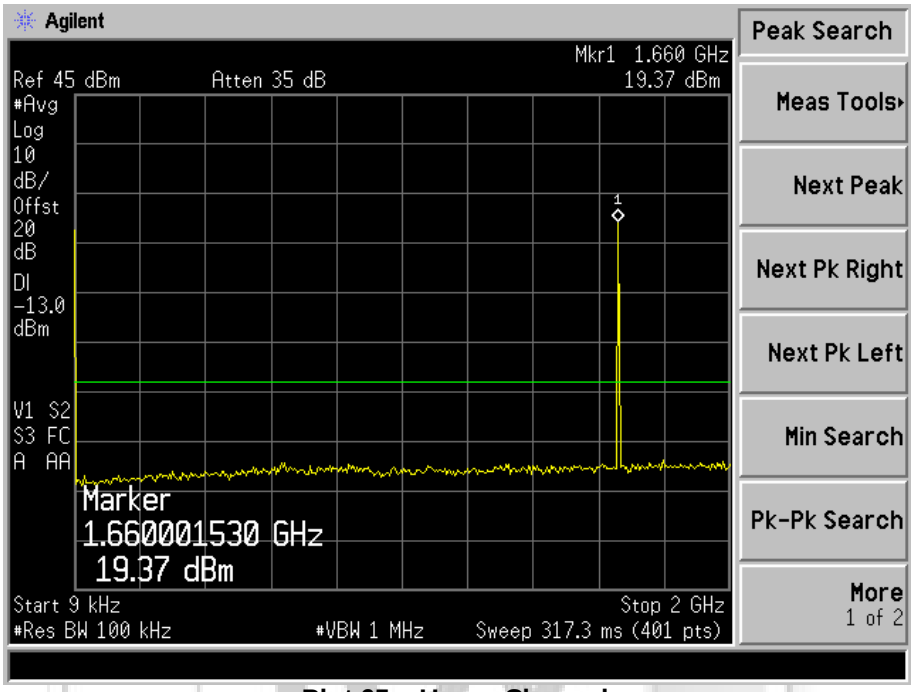


Plot 63 – Middle Channel

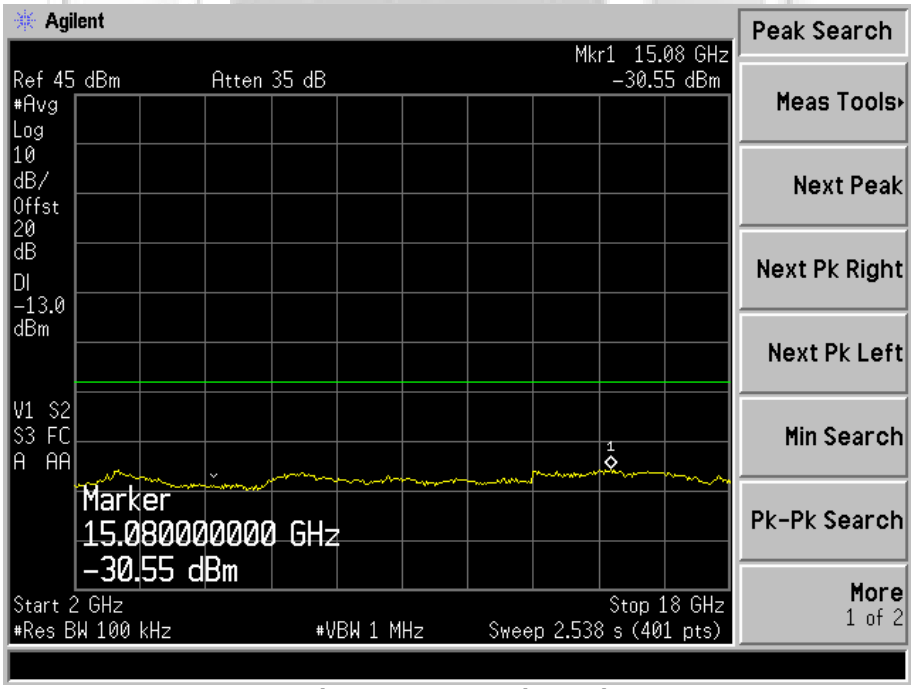


Plot 64 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 5)

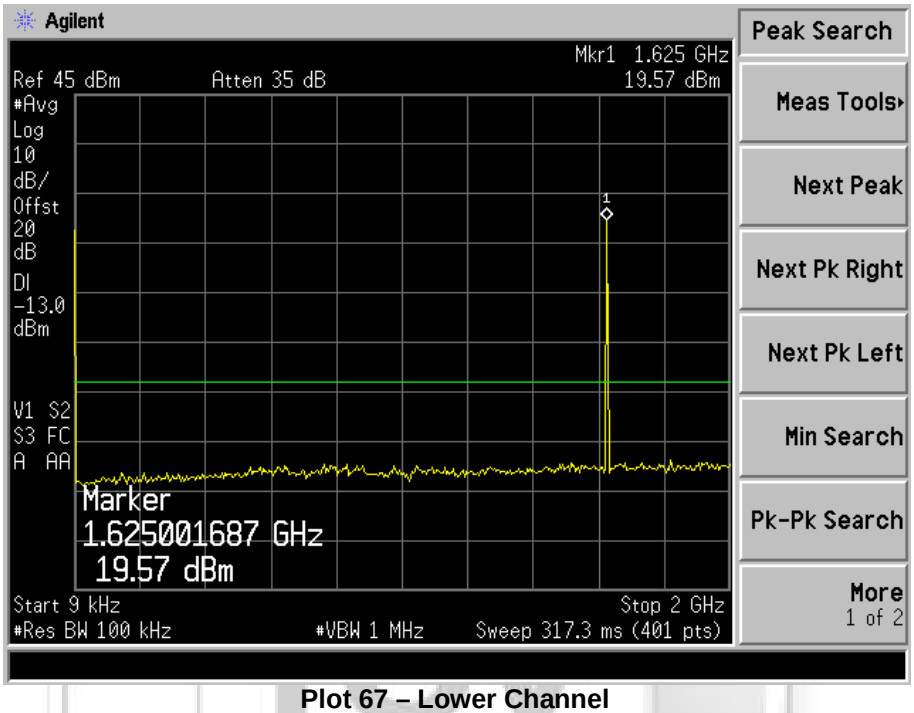


Plot 65 – Upper Channel

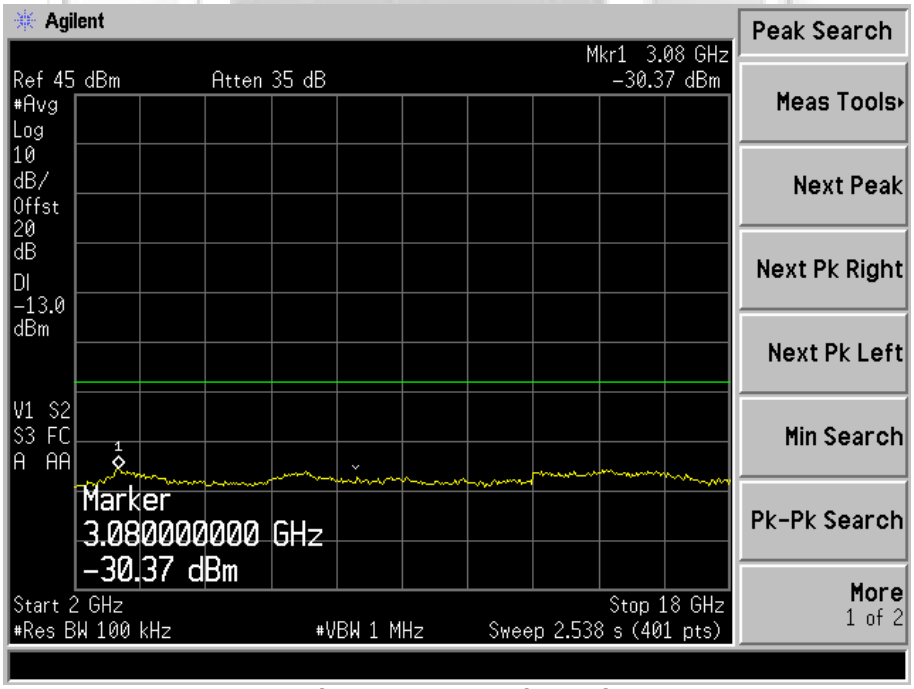


Plot 66 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 7)

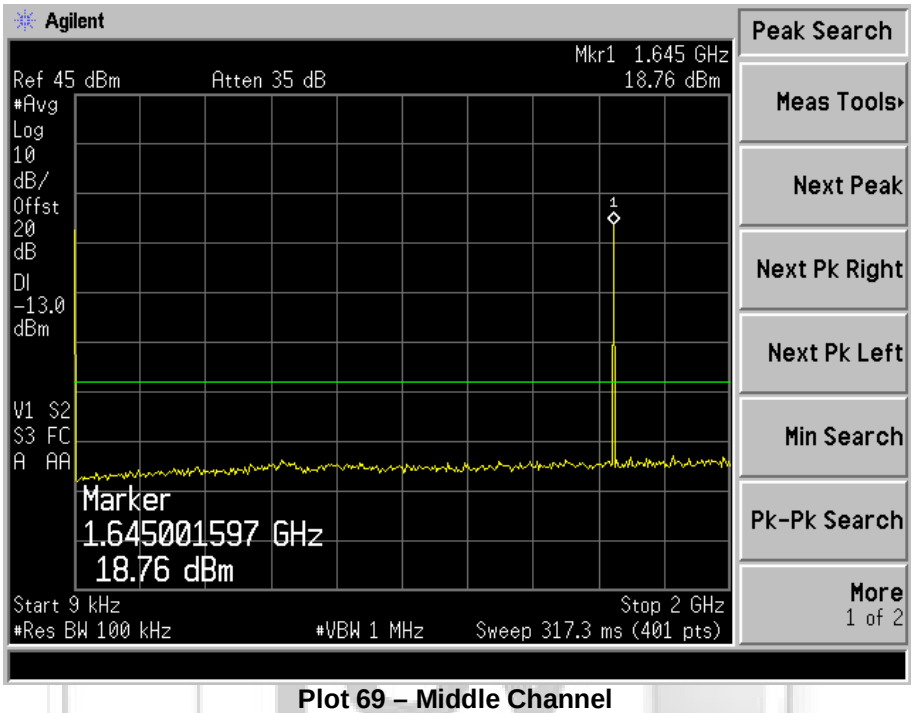


Plot 67 – Lower Channel

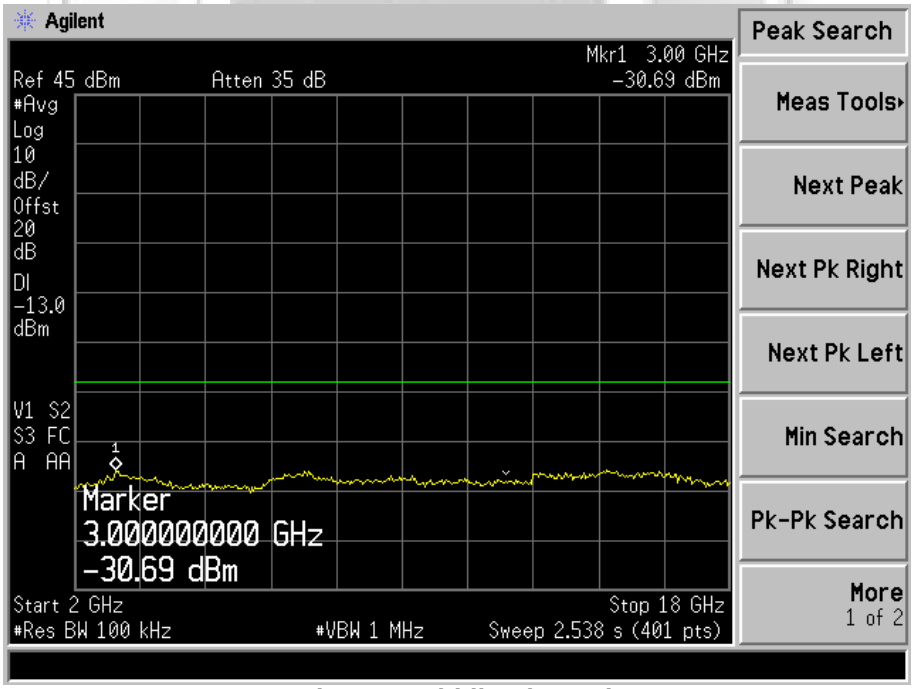


Plot 68 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 7)

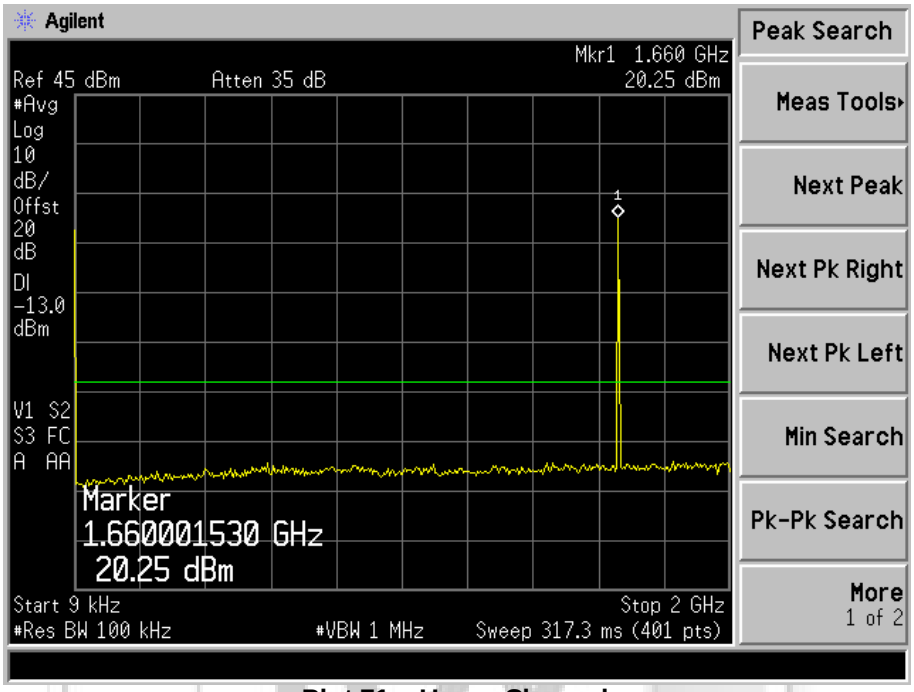


Plot 69 – Middle Channel

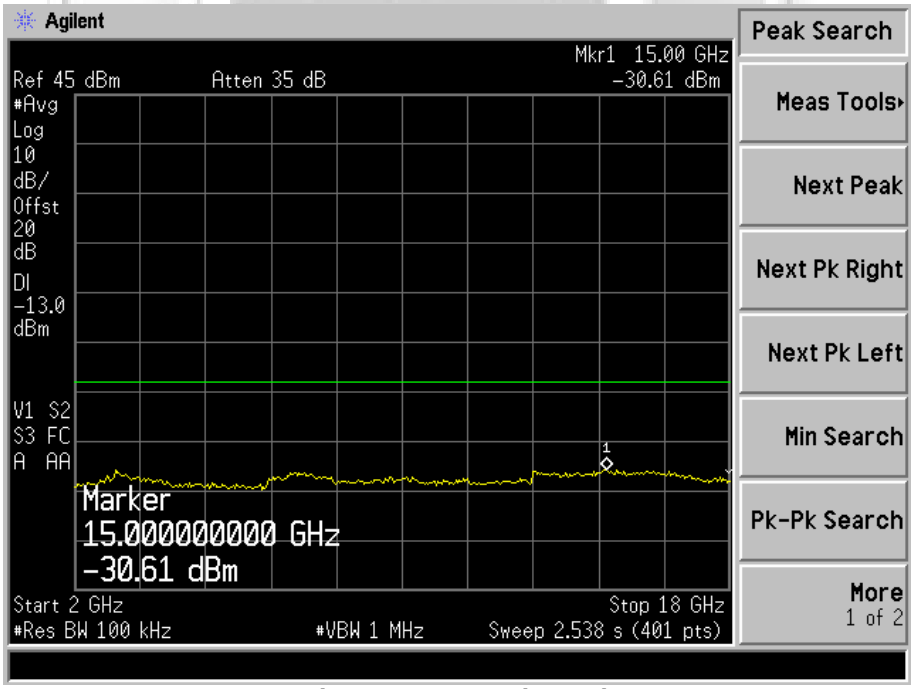


Plot 70 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 7)

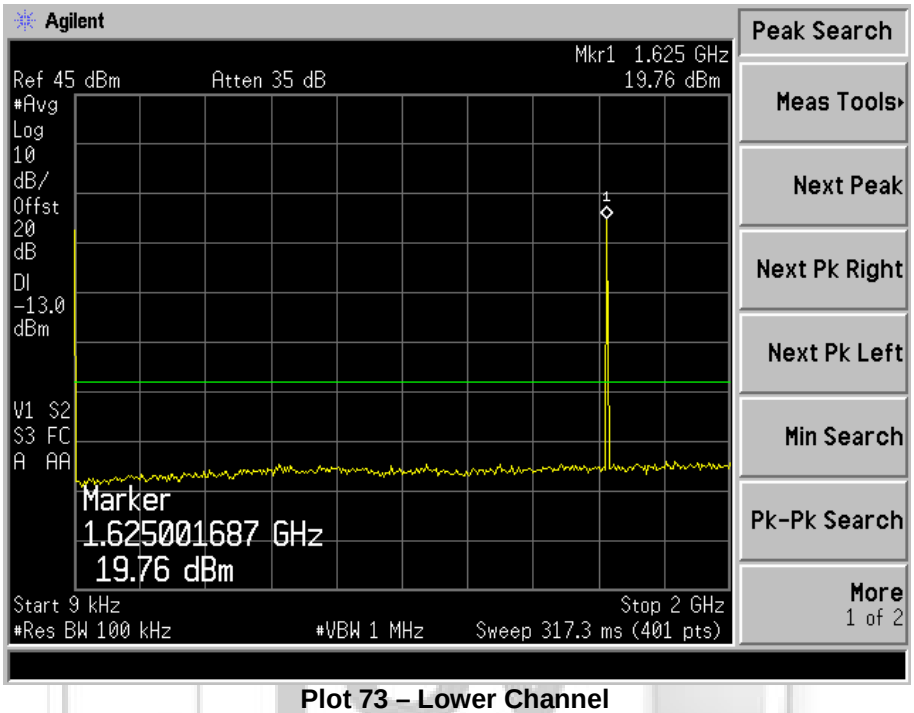


Plot 71 – Upper Channel

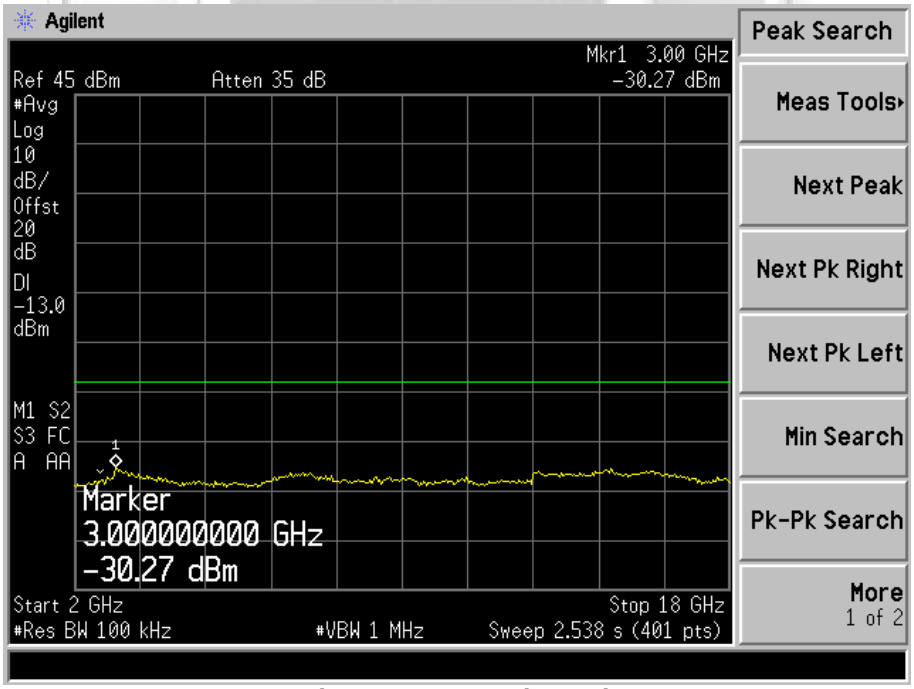


Plot 72 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 11)

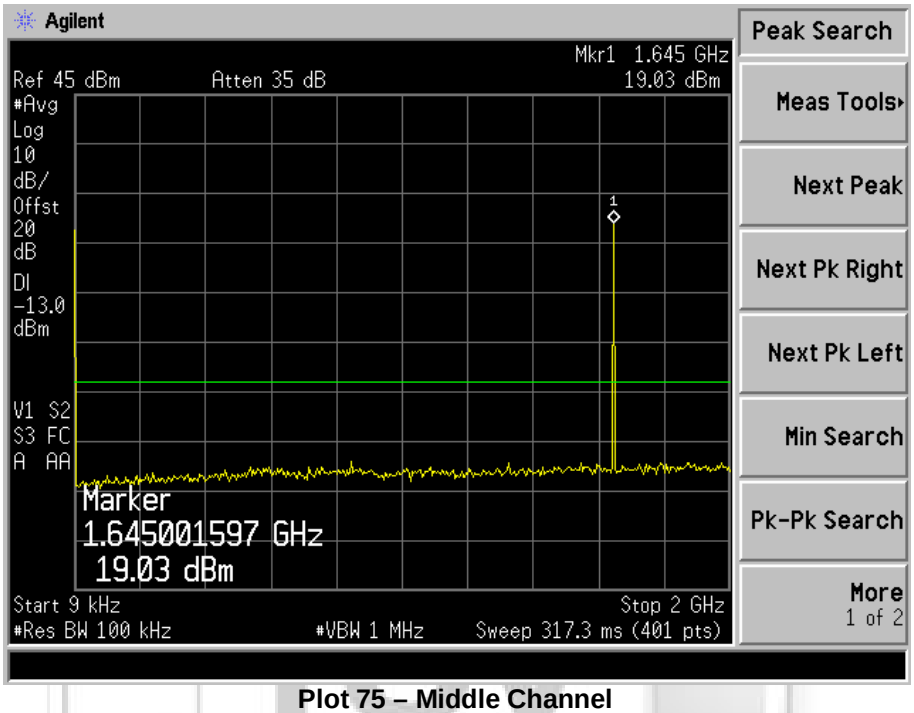


Plot 73 – Lower Channel

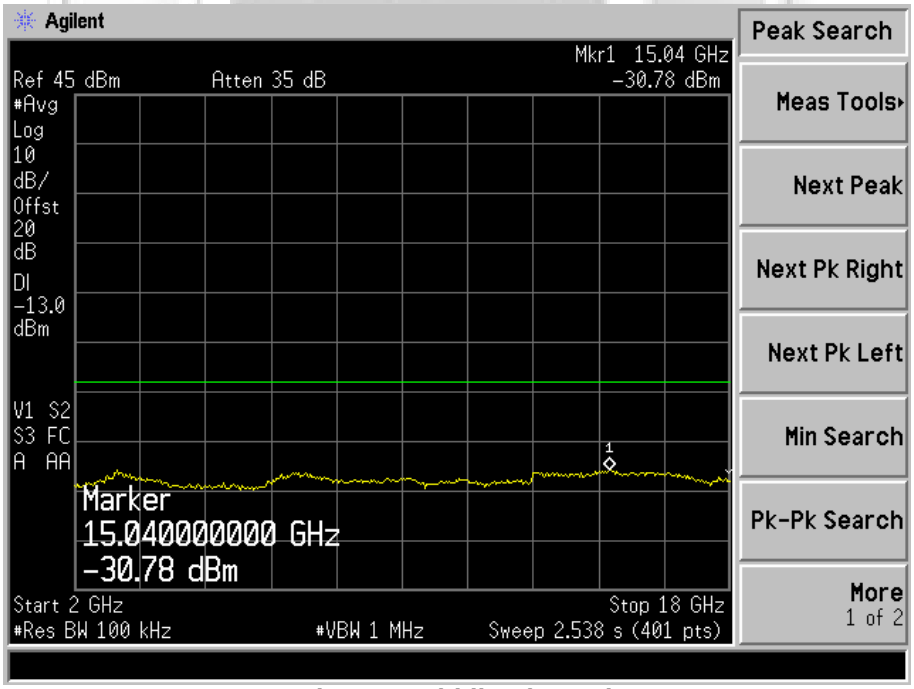


Plot 74 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 11)

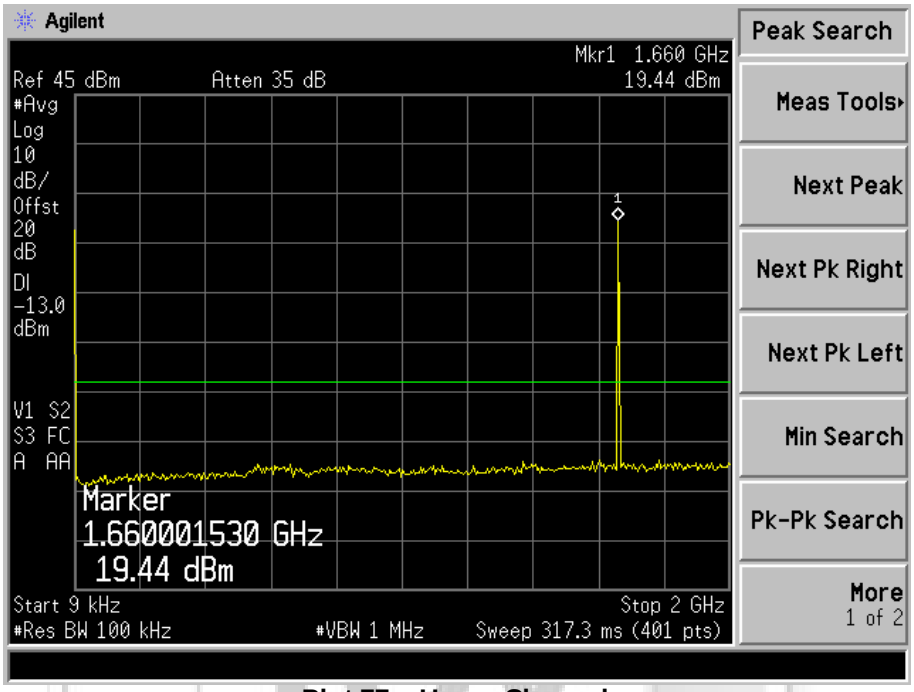


Plot 75 – Middle Channel

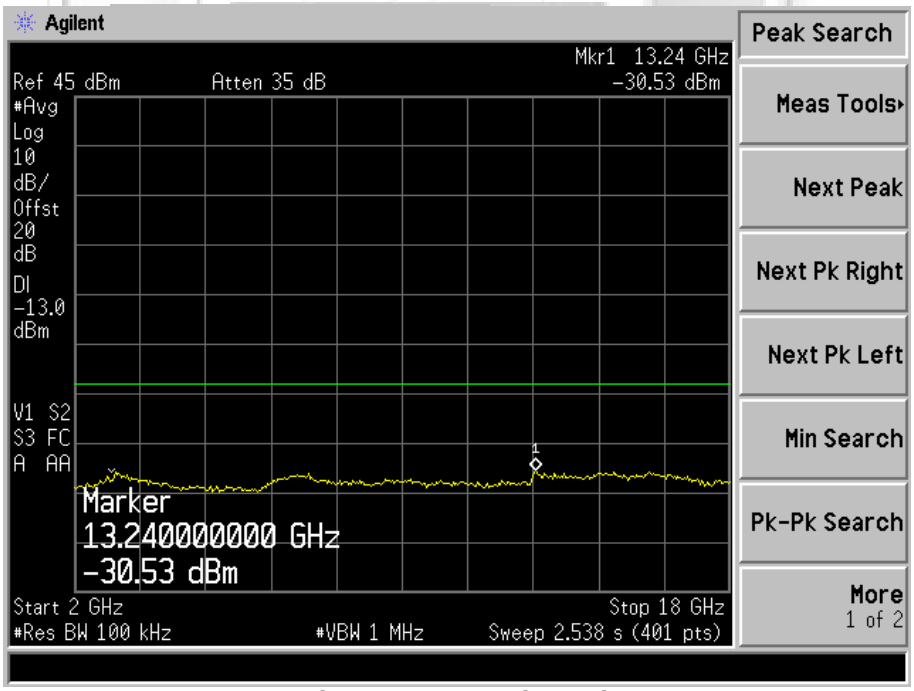


Plot 76 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 11)

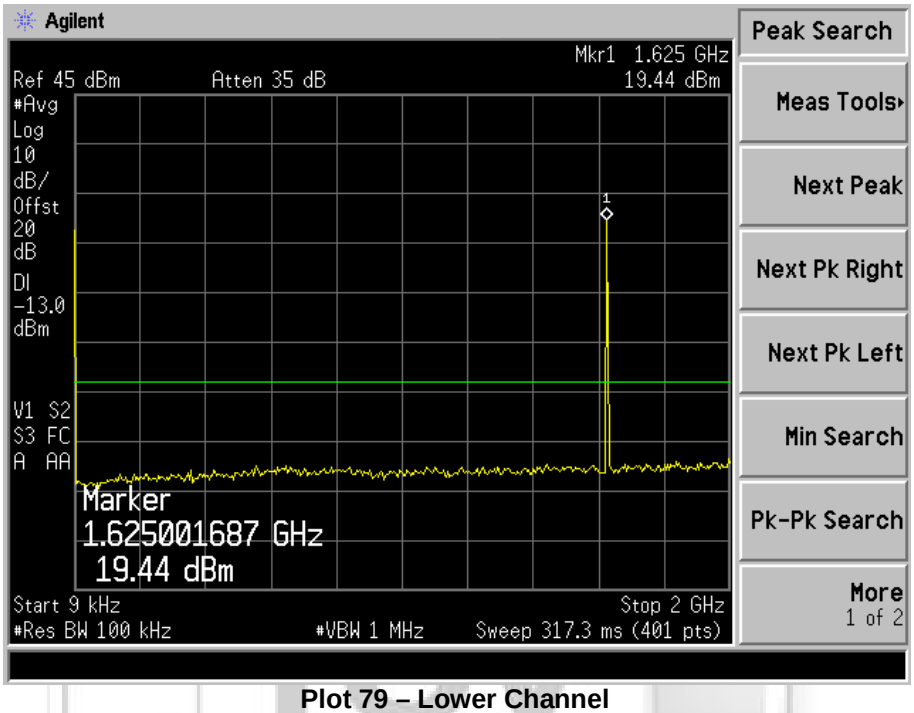


Plot 77 – Upper Channel

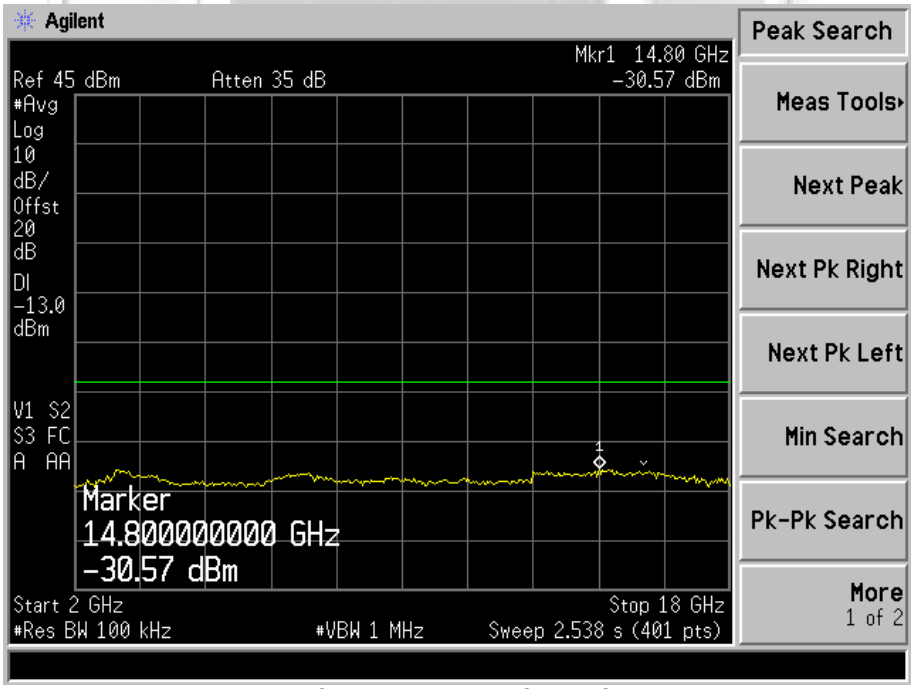


Plot 78 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 13)

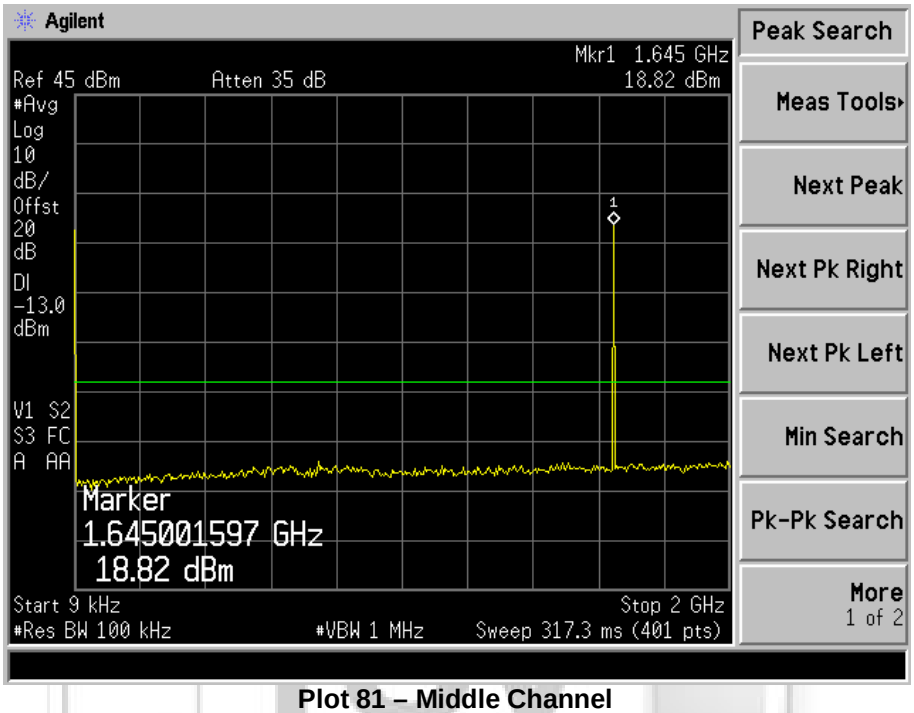


Plot 79 – Lower Channel

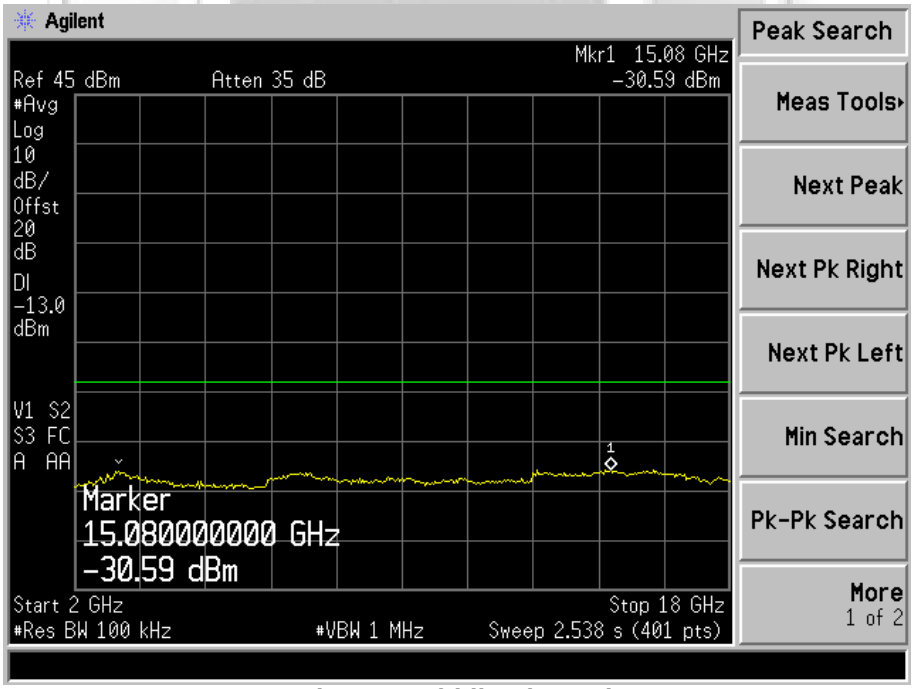


Plot 80 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 13)

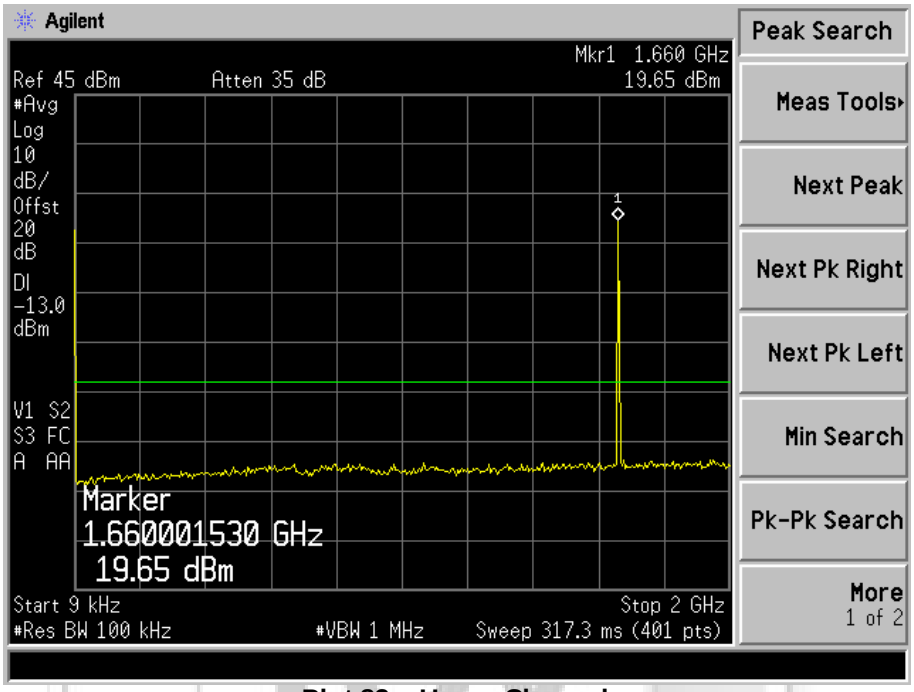


Plot 81 – Middle Channel

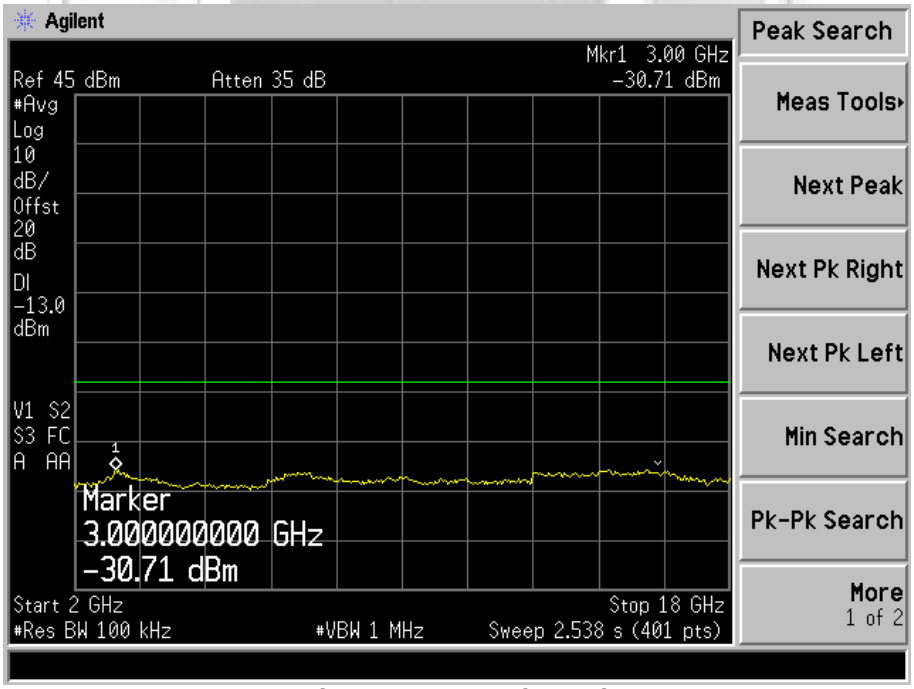


Plot 82 – Middle Channel

Out of Band Spurious Plots (Bearer Type: 13)

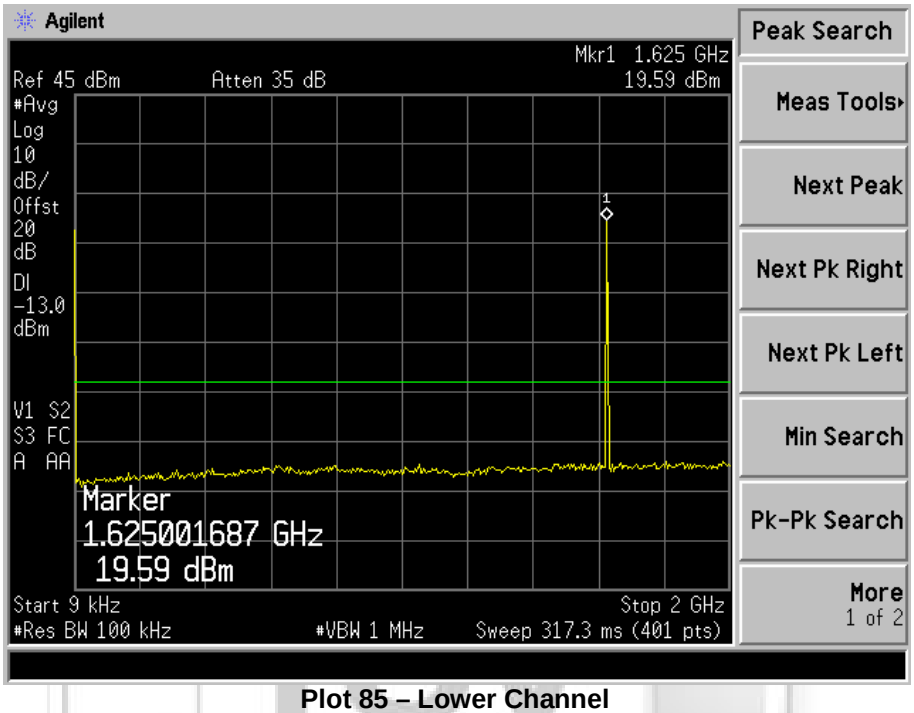


Plot 83 – Upper Channel

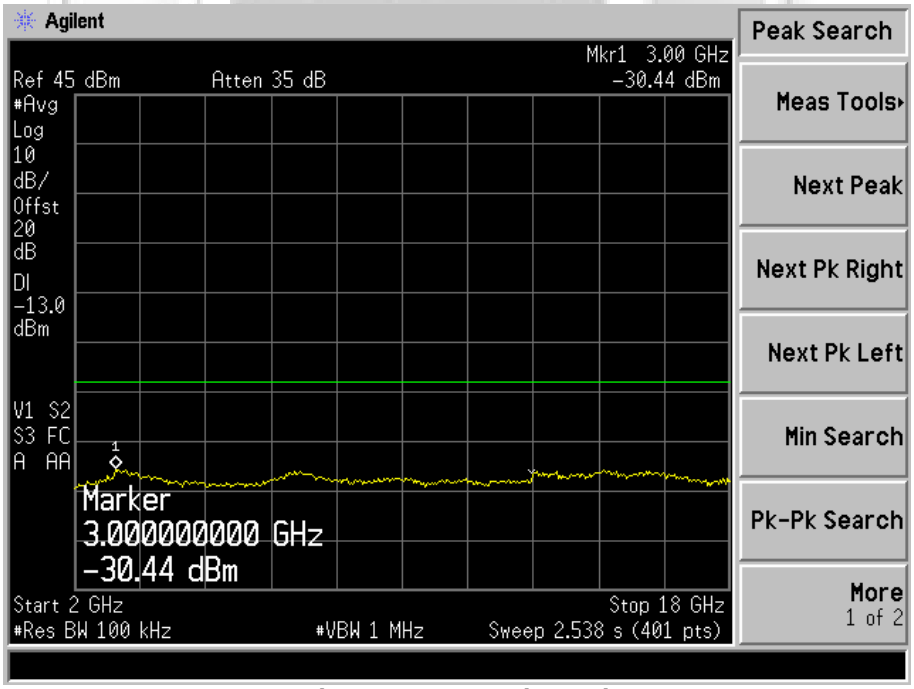


Plot 84 – Upper Channel

Out of Band Spurious Plots (Bearer Type: 15)

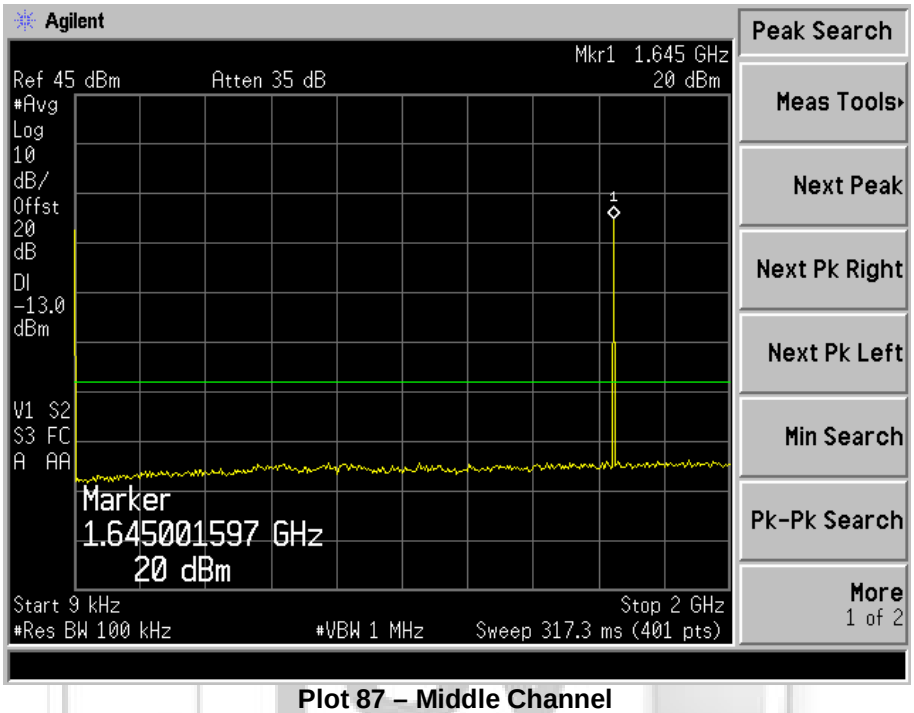


Plot 85 – Lower Channel

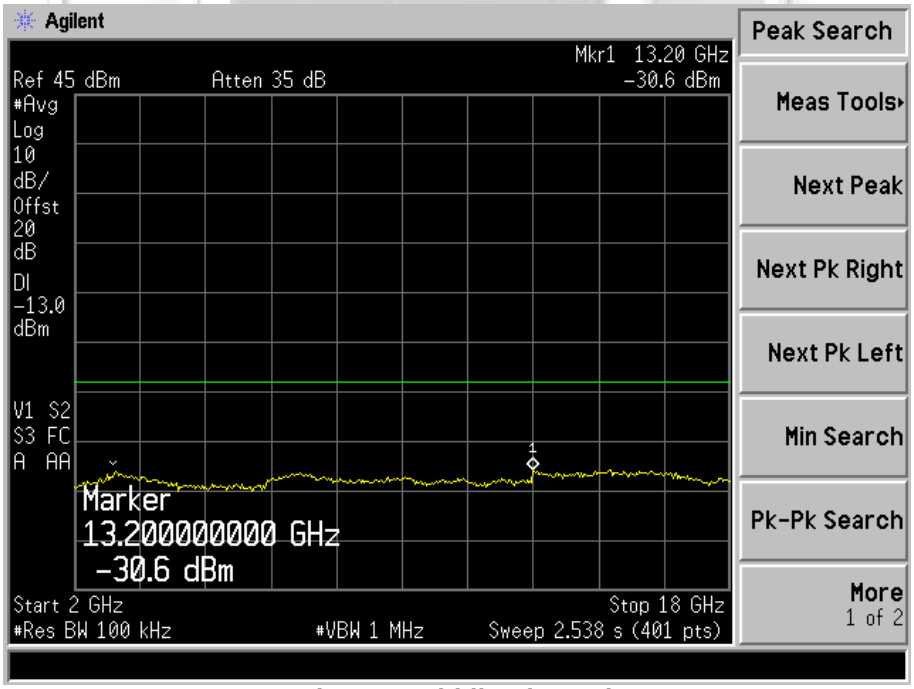


Plot 86 – Lower Channel

Out of Band Spurious Plots (Bearer Type: 15)

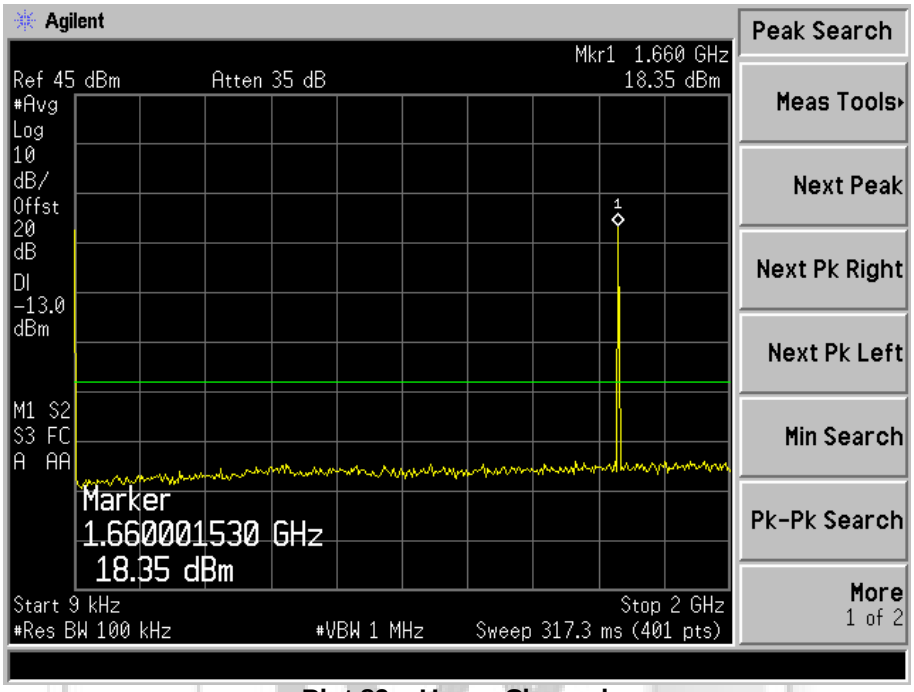


Plot 87 – Middle Channel

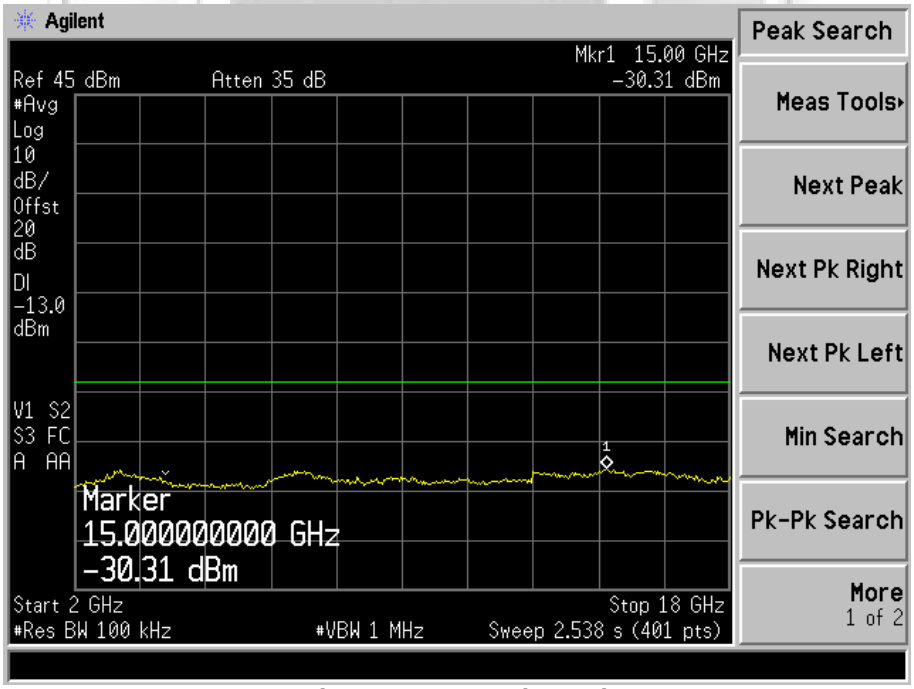


Plot 88 – Middle Channel

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 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 2016

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 respectively.

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

Operating Mode	Continuous Satellite Transmission	Temperature	24°C
Test Input Power	120V 60Hz	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Type Bearer	15 (Worst Bearer)	Tested By	Chang Wai Kit

30MHz – 1GHz

Lower Channel

Frequency (GHz)	Amplitude (dBm)	Limit (dBm)
204.7360	-52.7	-13.0
206.6990	-51.1	-13.0
454.0790	-52.1	-13.0
499.2350	-54.8	-13.0
666.1180	-55.3	-13.0
797.6610	-55.3	-13.0

Middle Channel

Frequency (GHz)	Amplitude (dBm)	Limit (dBm)
210.6260	-51.3	-13.0
298.9760	-56.3	-13.0
401.0690	-54.5	-13.0
432.4820	-55.9	-13.0
454.0790	-53.8	-13.0
499.2350	-54.5	-13.0

Upper Channel

Frequency (GHz)	Amplitude (dBm)	Limit (dBm)
206.6990	-52.1	-13.0
298.9760	-56.0	-13.0
432.4820	-55.6	-13.0
454.0790	-54.4	-13.0
491.3820	-57.1	-13.0
499.2350	-55.1	-13.0

1GHz – 17GHz

Lower Channel

Frequency (GHz)	Amplitude (dBm)	Limit (dBm)
1060.7220	-53.7	-13.0
1192.2850	-51.9	-13.0
1333.9680	-48.0	-13.0
1536.3730	-51.0	-13.0
1586.9740	-55.2	-13.0
1860.2210	-55.6	-13.0

Middle Channel

Frequency (GHz)	Amplitude (dBm)	Limit (dBm)
1060.7220	-54.5	-13.0
1202.4050	-52.2	-13.0
1323.8480	-47.7	-13.0
1536.3730	-51.1	-13.0
1597.0940	-54.8	-13.0
2123.3470	-54.4	-13.0

Upper Channel

Frequency (GHz)	Amplitude (dBm)	Limit (dBm)
1060.7220	-53.7	-13.0
1202.4050	-51.6	-13.0
1323.8480	-47.3	-13.0
1536.3730	-50.7	-13.0
1597.0940	-54.8	-13.0
3904.5090	-54.8	-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 2016

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).

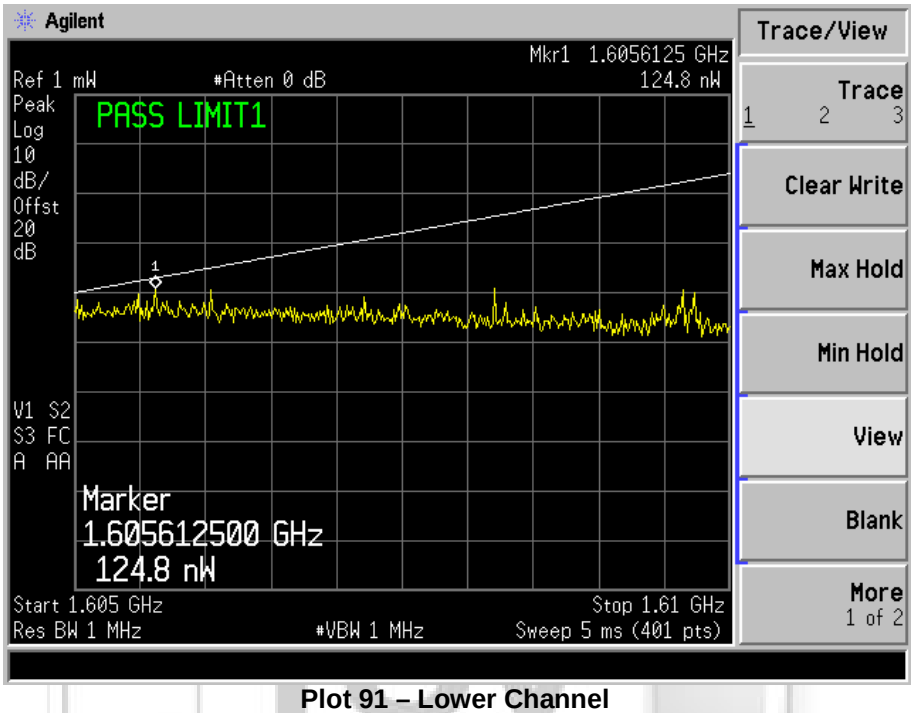
PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

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

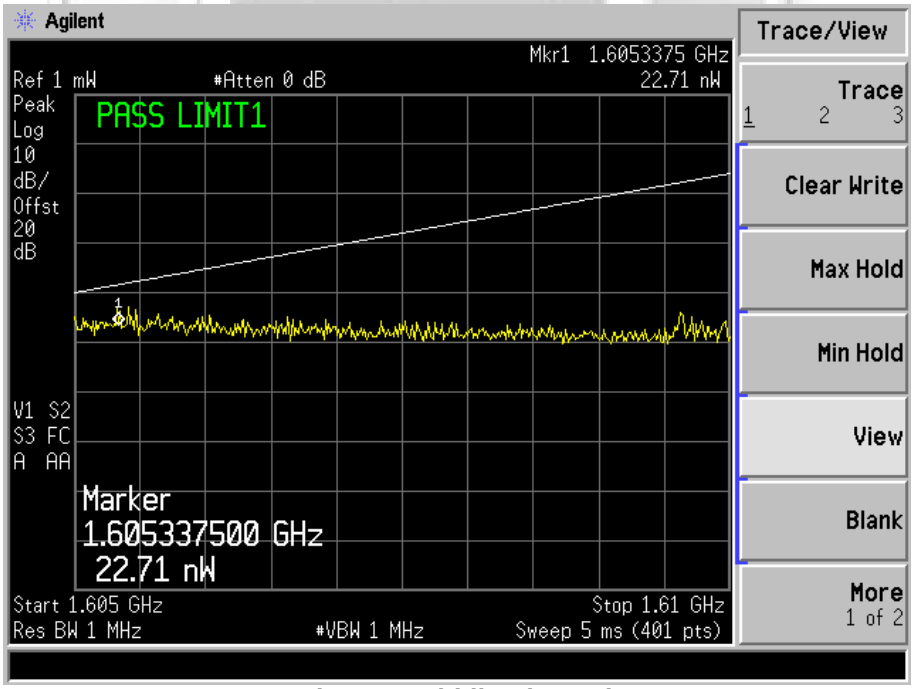
Operating Mode	Continuous Satellite transmission	Temperature	24°C
Test Input Power	120V 60Hz	Relative Humidity	60%
Test Distance	3m	Atmospheric Pressure	1030mbar
Type Bearer	15 (worst bearer)	Tested By	Dylan Lin
Attached Plots	91 – 111		

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

Type Bearer: 0 - Transmitter On

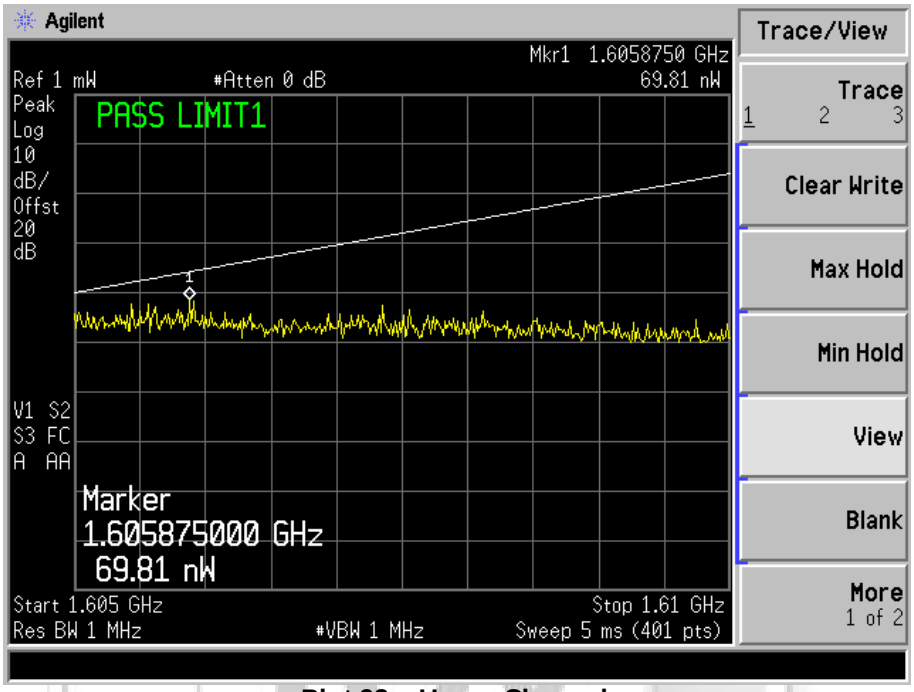


Plot 91 – Lower Channel



Plot 92 – Middle Channel

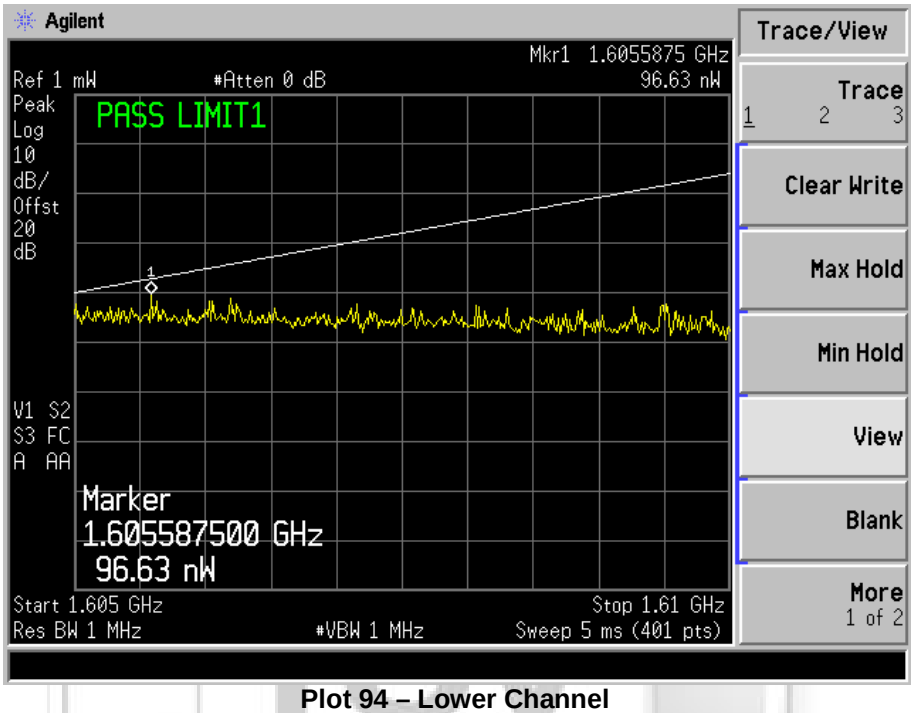
Type Bearer: 0 - Transmitter On



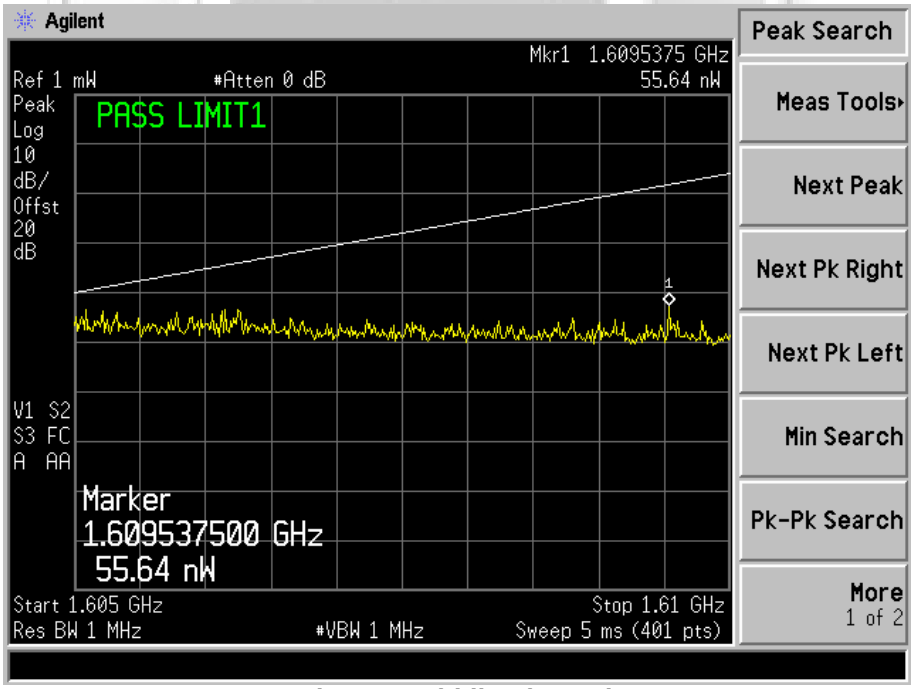
Plot 93 – Upper Channel

PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

Type Bearer: 3 - Transmitter On

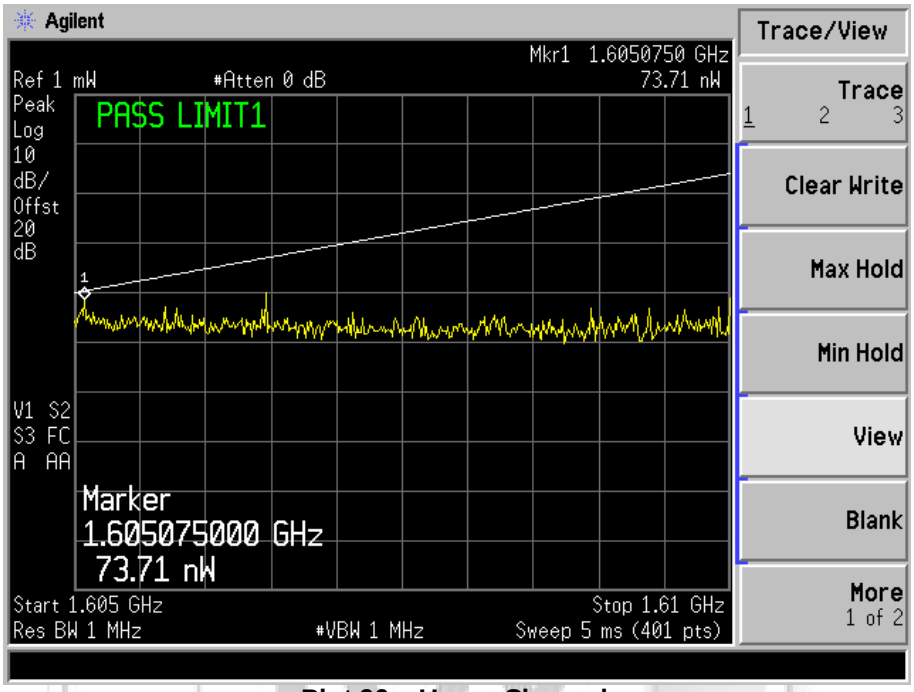


Plot 94 – Lower Channel



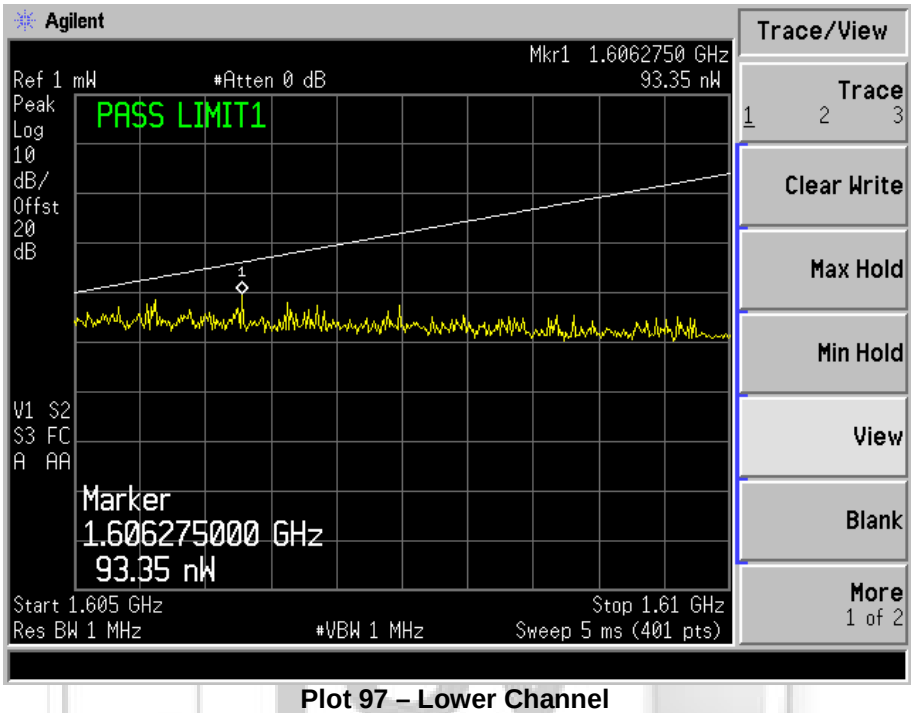
Plot 95 – Middle Channel

Type Bearer: 3 - Transmitter On

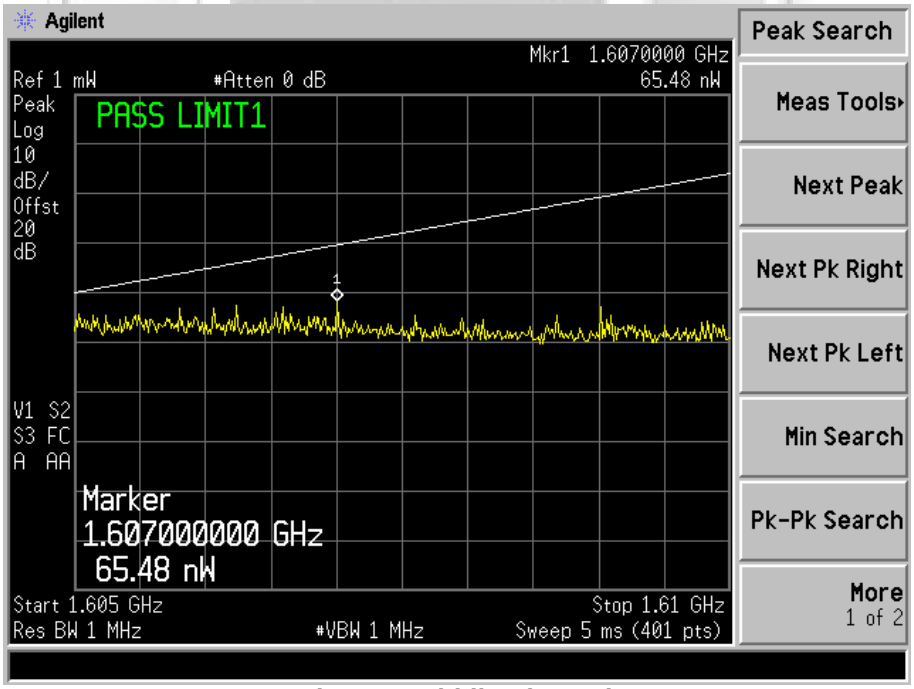


Plot 96 – Upper Channel

Type Bearer: 5 - Transmitter On

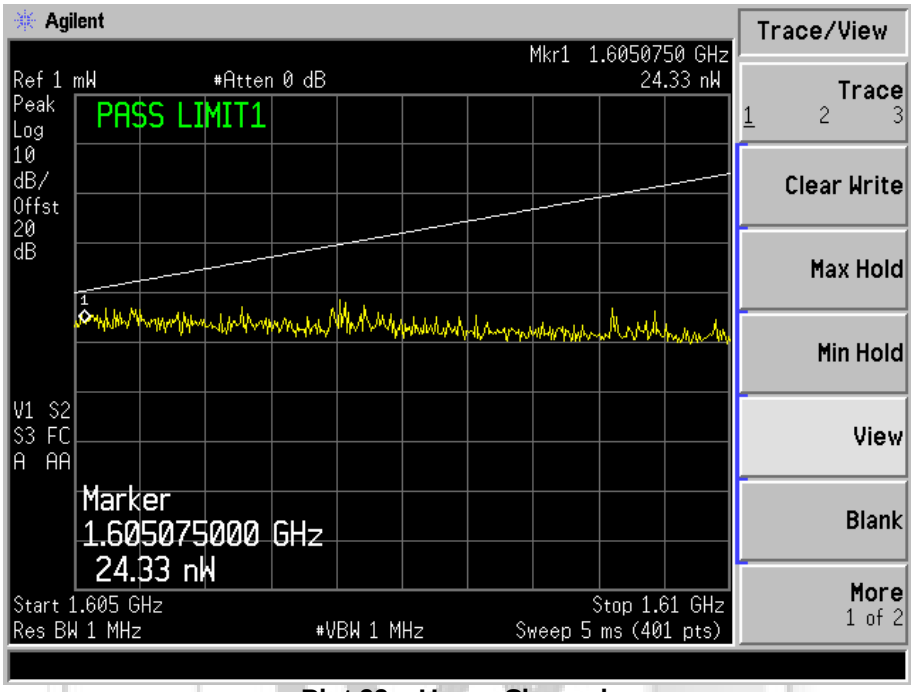


Plot 97 – Lower Channel



Plot 98 – Middle Channel

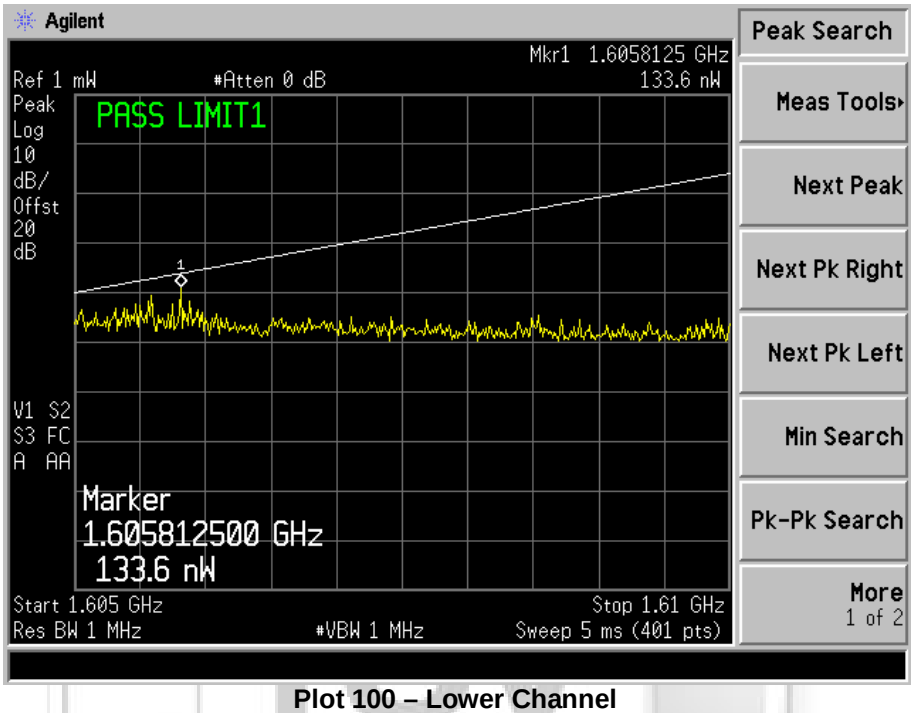
Type Bearer: 5 - Transmitter On



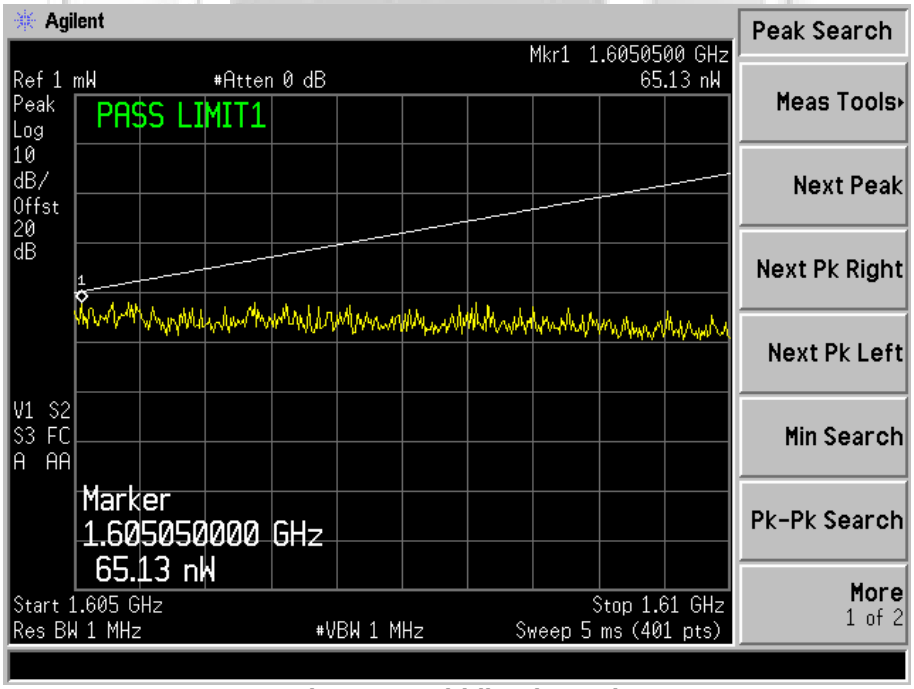
Plot 99 – Upper Channel

PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

Type Bearer: 7 - Transmitter On

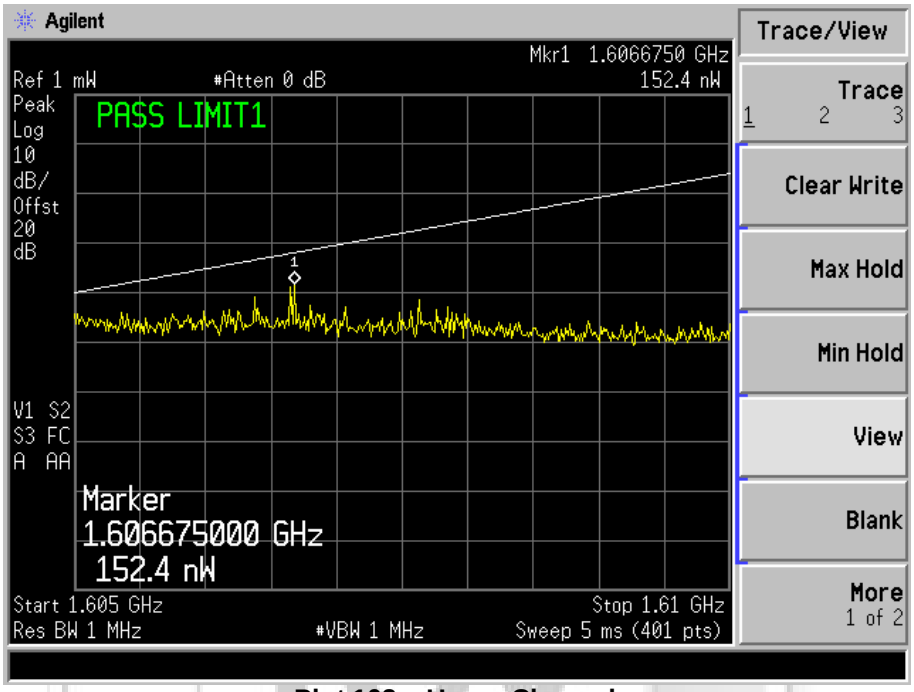


Plot 100 – Lower Channel



Plot 101 – Middle Channel

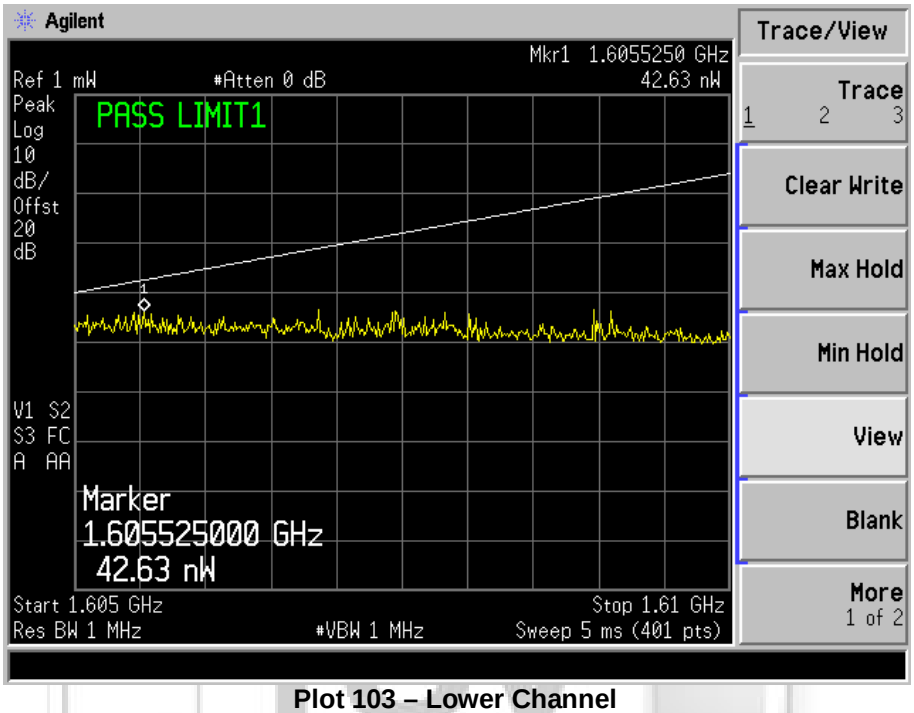
Type Bearer: 7 - Transmitter On



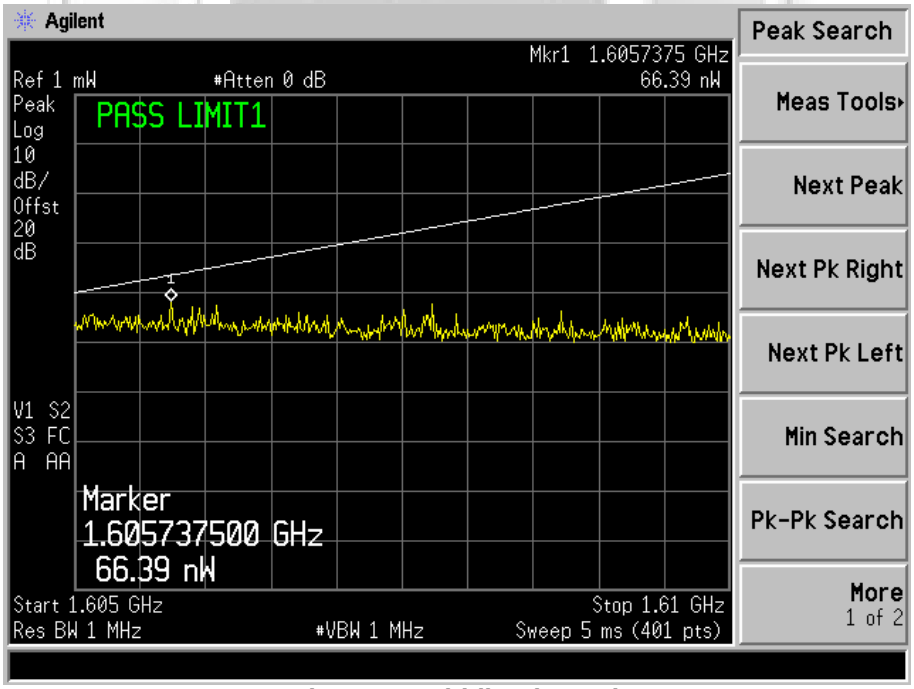
Plot 102 – Upper Channel

PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

Type Bearer: 11 - Transmitter On

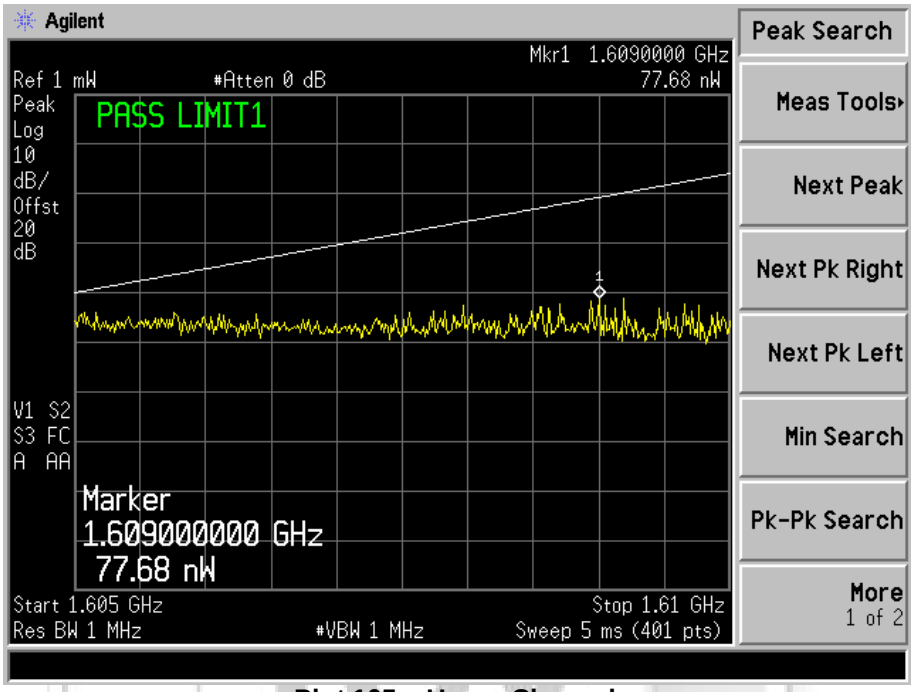


Plot 103 – Lower Channel



Plot 104 – Middle Channel

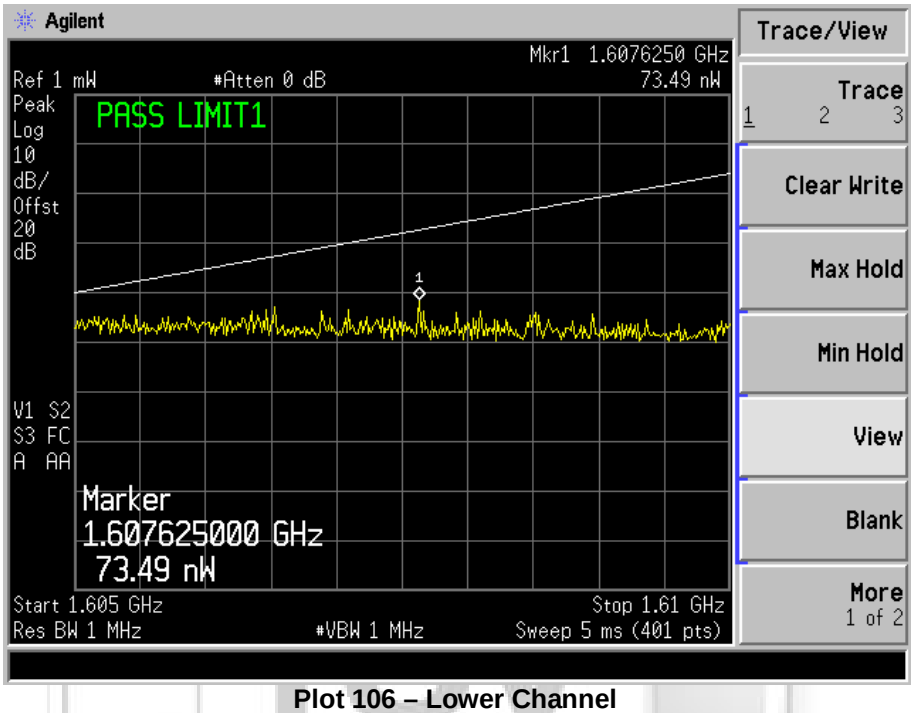
Type Bearer: 11 - Transmitter On



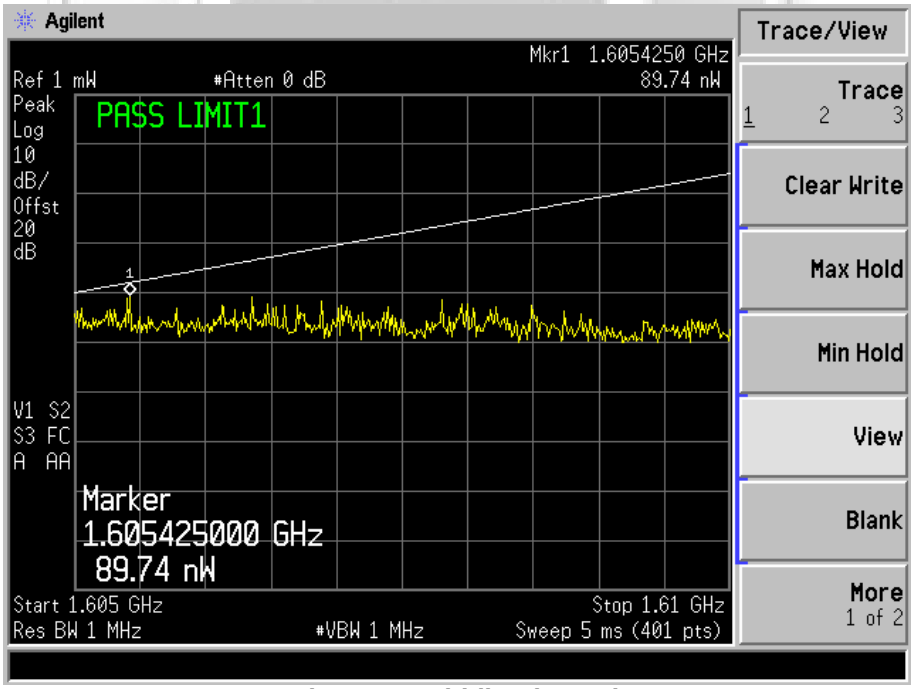
Plot 105 – Upper Channel

PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

Type Bearer: 13 - Transmitter On

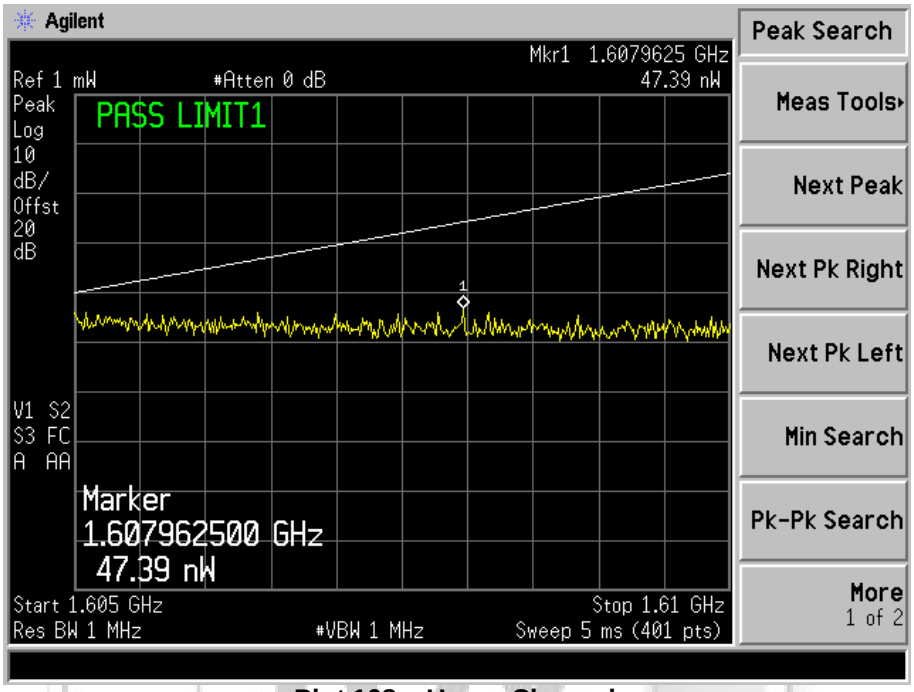


Plot 106 – Lower Channel



Plot 107 – Middle Channel

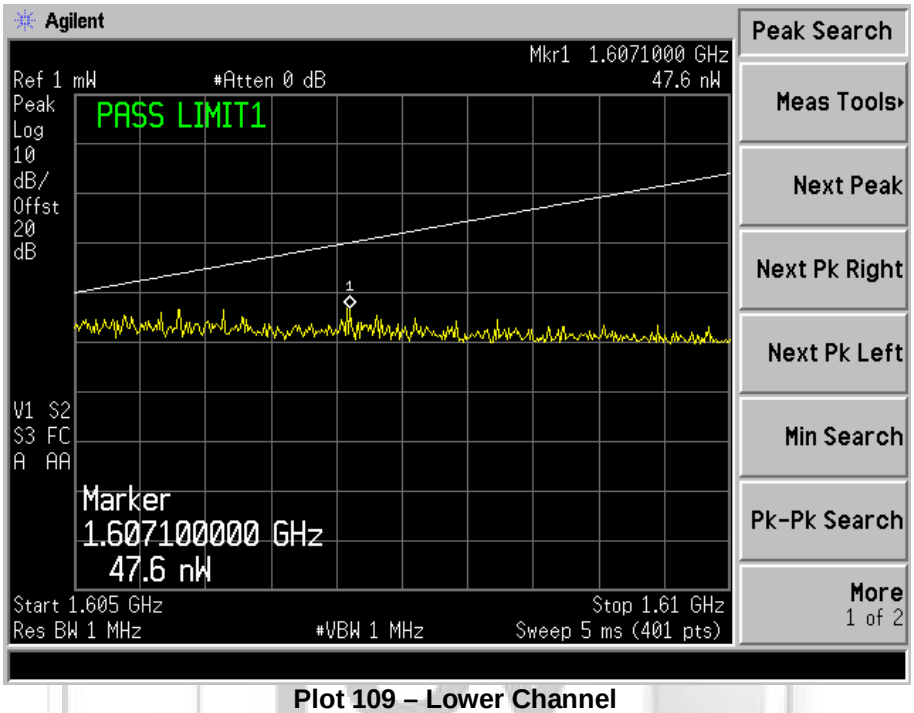
Type Bearer: 13 - Transmitter On



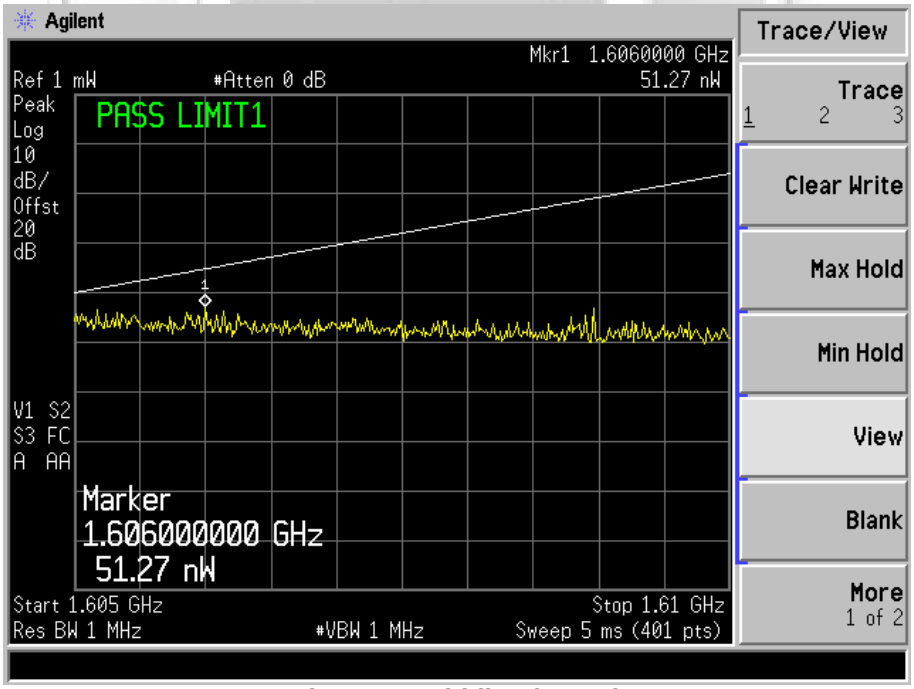
Plot 108 – Upper Channel

PROTECTION OF AERONAUTICAL RADIO NAVIGATION SATELLITE SERVICE TEST

Type Bearer: 15 - Transmitter On

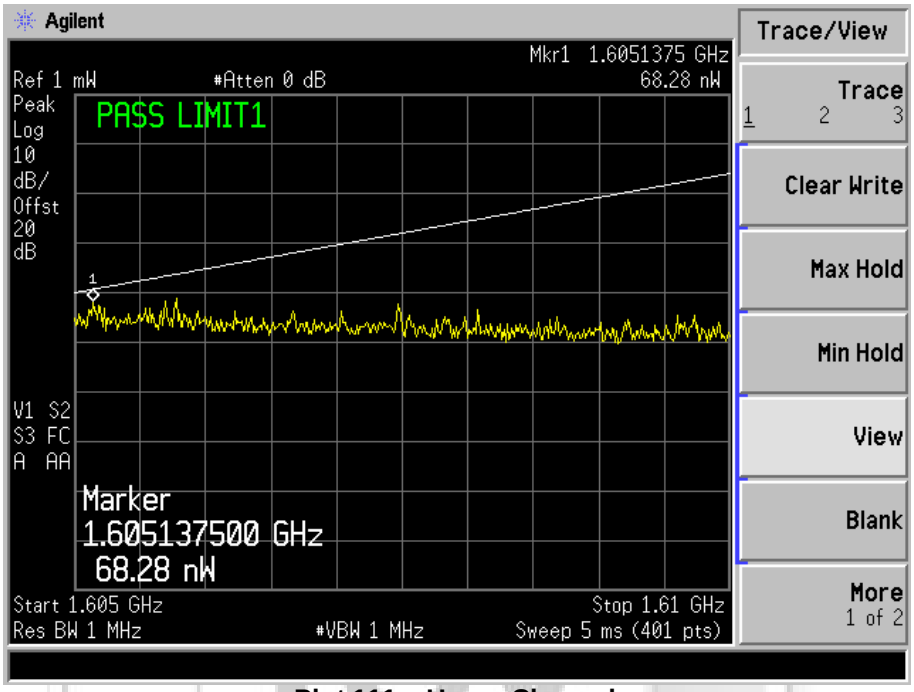


Plot 109 – Lower Channel



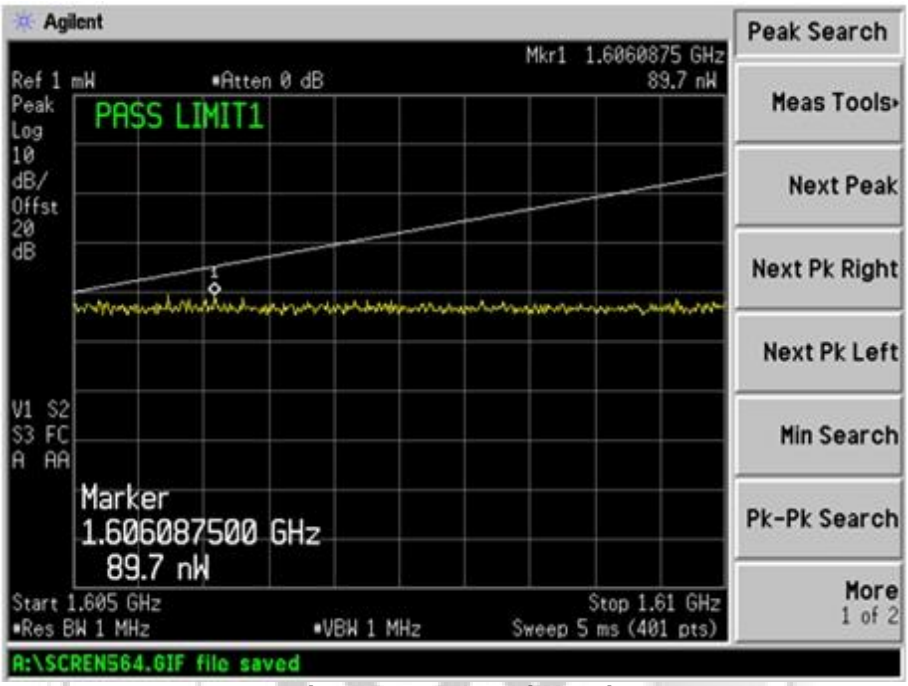
Plot 110 – Middle Channel

Type Bearer: 15 - Transmitter On



Plot 111 – Upper Channel

Carrier Off



Plot 112 – Lower 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 2012
Mini-Circuits Precision Fixed Attentuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor
GW Instek Programmable Power Supply	PSH-3630A	RK200168	30 Jan 2013

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	120V 60Hz	Relative Humidity	70%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Lower Channel

Temperature (°C)	Measured Frequency (GHz)	Reference Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
-30	1.626600518	1.626600000	518.000000	+/-16266
-20	1.626600457	1.626600000	457.000000	+/-16266
-10	1.626600477	1.626600000	477.000000	+/-16266
0	1.626600718	1.626600000	718.000000	+/-16266
10	1.626600834	1.626600000	834.000000	+/-16266
20	1.626600845	1.626600000	845.000000	+/-16266
30	1.626600907	1.626600000	907.000000	+/-16266
40	1.626600936	1.626600000	936.000000	+/-16266
50	1.626600988	1.626600000	988.000000	+/-16266

Middle Channel

Temperature (°C)	Measured Frequency (GHz)	Reference Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
-30	1.643500582	1.643500000	582.000000	+/-16435
-20	1.643500449	1.643500000	449.000000	+/-16435
-10	1.643500546	1.643500000	546.000000	+/-16435
0	1.643500782	1.643500000	782.000000	+/-16435
10	1.643500883	1.643500000	883.000000	+/-16435
20	1.643500887	1.643500000	887.000000	+/-16435
30	1.643500959	1.643500000	959.000000	+/-16435
40	1.643500983	1.643500000	983.000000	+/-16435
50	1.643501032	1.643500000	1032.000000	+/-16435

FREQUENCY STABILITY (TEMPERATURE VARIATION) TEST

Upper Channel

Temperature (°C)	Measured Frequency (GHz)	Reference Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
-30	1.660400491	1.660400000	491.000000	+/-16604
-20	1.660400418	1.660400000	418.000000	+/-16604
-10	1.660400542	1.660400000	542.000000	+/-16604
0	1.660400774	1.660400000	774.000000	+/-16604
10	1.660400856	1.660400000	856.000000	+/-16604
20	1.660400857	1.660400000	857.000000	+/-16604
30	1.660400938	1.660400000	938.000000	+/-16604
40	1.660400952	1.660400000	952.000000	+/-16604
50	1.660401008	1.660400000	1008.000000	+/-16604

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 2012
Mini-Circuits Precision Fixed Attentuator	BW-S20W5+	Nil	Output Monitor
Instock Wireless Components Combiner	PD7120	Nil	Output Monitor
GW Instek Programmable Power Supply	PSH-3630A	RK200168	30 Jan 2013

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.

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	70%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Lower Channel

Voltage (V)	Measured Frequency (GHz)	Nominal Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
10.8	1.626600878	1.626600000	878.000000	+/-16266
24.0	1.626600863	1.626600000	863.000000	+/-16266
31.2	1.626600897	1.626600000	897.000000	+/-16266

Middle Channel

Voltage (V)	Measured Frequency (GHz)	Nominal Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
10.8	1.643500930	1.643500000	930.000000	+/-16435
24.0	1.643500887	1.643500000	887.000000	+/-16435
31.2	1.643500942	1.643500000	942.000000	+/-16435

Upper Channel

Voltage (V)	Measured Frequency (GHz)	Nominal Channel Frequency (GHz)	Deviation (Hz)	Limit (Hz)
10.8	1.660400900	1.660400000	900.000000	+/-16604
24.0	1.660400857	1.660400000	857.000000	+/-16604
31.2	1.660400913	1.660400000	913.000000	+/-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 minimum distance to the EUT was computed from the following formula:

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

where S = $10W/m^2$
P = 5.2119W
d = Test distance
G = Numerical isotropic gain, 66.07 (18.2dBi)

Substituting the relevant parameters into the formula:

$d = \sqrt{[(30GP) / 377S]}$
$= 1.66m$

∴ The EUT shall maintain at least at 1.66m from operators to comply with MPE criteria.

PSB Singapore

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.

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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.

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

July 2011

ANNEX A

TEST SETUP / EUT PHOTOGRAPHS / DIAGRAMS