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TEST REPORT

FCC Part 15
Radio Frequency Devices
Subpart C – Intentional Radiators

Report Reference No. ..... :	ETRB50102, Rev. B
Compiled by (+ signature) ..... :	Kevin Johnson.
Approved by (+ signature) ..... :	Vincent W. Greb
Date of issue ..... :	26 February 2015
Report Revision ..... :	Rev. B
Total number of pages ..... :	163
Testing Laboratory ..... :	EMC Integrity, Inc.
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Applicant's name ..... :	XetaWave, LLC
Address..... :	258 S. Taylor Avenue, Louisville, CO 80027
Model(s) Tested..... :	XETA24M-T
Test specification:	
Standard ..... :	FCC Part 15, Subpart C, , DTS 247 (v03r02), RSS-210 (Issue 8)
Test procedure..... :	ANSI C63.4:2009, ANSI C63.10: 2013
Non-standard test method ..... :	N/A
TRF Revision..... :	26 February 2015

Revision History

#	Description	Date
-	Initial Report Release	29 Jan 2015
A	Amended based on comments from TCB reviewer	19 Feb 2015
B	Amended based on more comments from TCB reviewer	26 Feb 2015

Notices:

1. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
2. The test results presented in this report relate only to the object tested.
3. The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.
4. "(see Enclosure #)" refers to additional information appended to the report.
5. Throughout this report a point is used as the decimal separator.
6. Dimensions in English units for convenience only, metric units prevail.

Table of Contents

Normative References

The following document(s) have been appropriately considered in the performance of the test results detailed in this report.

CFR Title 47, Part 15
Radio Frequency Devices

Guidance for Performing Compliance Measurements on Digtial Transmission Systems (DTS) Operating Under 15.247 (June 5, 2014)

RSS-210 (Issue 8, Dec 2010)
Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

ANSI C63.4: 2009
American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10: 2013
American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Equipment Under Test (EUT)

Details:

Test item description:

Model ..... : XETA24M-T
Serial Number ..... : E5014315
Production Status ..... : ☐ Production ☒ Pre-Production ☐ Prototype
*Production unit was specially modified with Mode Button
Other Status Info ..... : N/A.
EUT Received Date ..... : 5 January 2015.
Ratings ..... : 3.3 to 5.0 Vdc ☐ 1ϕ ☐ 3ϕ ☐ Internal Battery

General product description:

- The Xeta24 is an unlicensed radio module that automatically optimizes parameters across three axes - power output, channel size and modulation. This dynamic modulation allows for data transfer rates from 115 kbps to 4.4 Mbps, power output from 10mW to 1W, and channel sizing from 100 kHz to 1.5 MHz.

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Modifications to the EUT required for compliance:

There have been no modifications to the EUT as a result of this evaluation.

Deviations from Test Methodology:

There have been no deviations, additions to, or exclusions from the specified test standard.

Engineering Judgements:

No engineering judgments based on the results in this test report have been made.

Approved by (+ signature) ..... : Vincent W. Greb

Table 1 – EUT Internal Operating Frequencies

Frequency (MHz)	Description
26.0	Master clock
286.40	Second local oscillator (LO)
2110 – 2193	First local oscillator (LO)
2401.05 - 2478	RF output (hopping mode)
2402 - 2476	DTS modes

Table 2 – EUT Operating Modes Used During Testing

Mode #	Description
1	MSK 57 kbps (FHSS)
2	MSK 115 kbps (FHSS)
3	MSK 153 kbps (FHSS)
4	MSK 229 kbps (FHSS)
5	BPSK (DTS)
6	QPSK (DTS)
7	8 PSK (DTS)
8	16 PSK (DTS)
9	16 QAM (DTS)
10	32 QAM (DTS)

EUT Configuration

A minimum representative configuration, as defined by the manufacturer, has been used for the testing performed herein. The selection of hardware (including interface ports), software, and cables were chosen by the manufacturer as being representative of the product's intended use. The interconnection of various articles of equipment and the types of cables used has also been defined by the manufacturer.

Most of the testing was performed as conducted emissions at the antenna port. However, when radiated emissions testing was performed, it was done for all three orthogonal axes of the UUT, and the worst-case orientation was used for the final measurements. The final placement of the equipment under test has been, to the extent practical, arranged to maximize emissions. The UUT was operated using a continuous (i.e., 100%) duty cycle for all testing.

Cables, of the type and length specified by the manufacturer, were connected to at least one of each type of interface port provided by the EUT and if practical, were terminated by a device typical of actual usage. For multiple ports of the same type, the addition of cables did not significantly affect the emission level (i.e. < 2B variation).

The arrangement of external power supply units was as follows:

a) If the mains input cable of the external power supply unit is greater than 0,8 m, the external power supply unit shall be placed on the tabletop, with a nominal 0,1 m separation from the host unit.
b) If the external power supply unit has a mains input cable that is less than 0,8 m, the external power supply unit shall be placed at a height above the ground plane such that its power cable is fully extended in the vertical direction.
c) If the external power supply unit is incorporated into the mains power plug, it shall be placed on the tabletop. An extension cable shall be used between the external power supply unit and the source of

power. The extension cable should be connected in a manner such that it takes the most direct path between the external power supply unit and the source of power.

Figure 1 - EUT Configuration Diagram

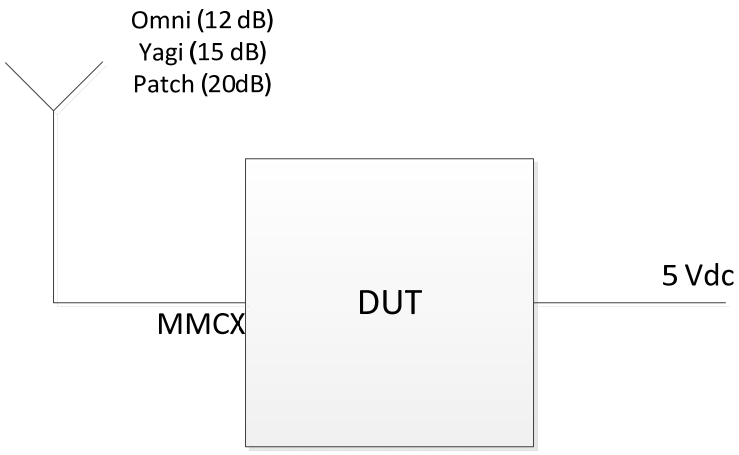


Table 3 – EUT & Auxiliary Equipment List

Item	Use*	Product Type	Manufacturer	Model	Serial No.
A	EUT	Radio	XetaWave	XETA24M-T	E5014315
B	AE	Support Equipment	XetaWave	Serial Carrier Board (SCB)	01000EDB

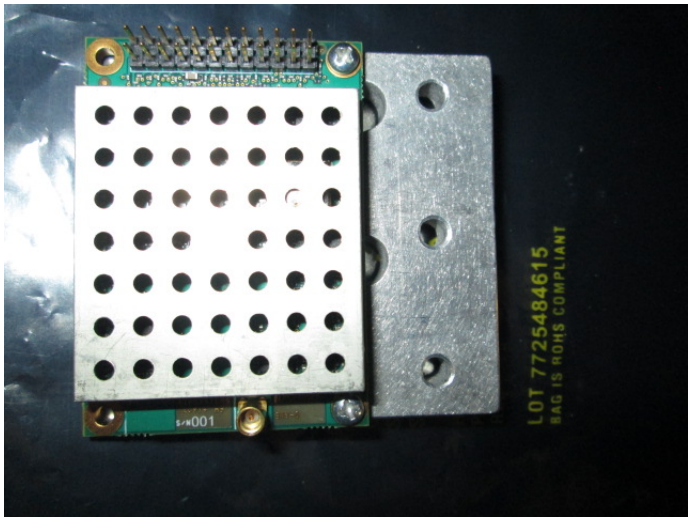
Note:
* Use = EUT - Equipment Under Test,
AE - Auxiliary/Associated Equipment, or
SIM - Simulator (Not Subjected to Test)

Table 4 - Interconnecting Cables List – Not applicable

Item	Use*	Cable Type
1		
2		
3		
4		
5		
6		
7		

EUT Photo(s)

Photo 1	EUT Photo – Front View	



Supplemental Information:

Photo 2	EUT Photo – Back View	

Supplemental Information:

Summary of Testing

Possible test case verdicts:

- test case does not apply to the test object : N/A
- test object does meet the requirement .....: P (Pass)
- test object does not meet the requirement : F (Fail)
- not tested (not part of this evaluation) .....: NT

Date(s) of performance of tests .....: Click here to enter text.

Clause	Test Description	Verdict	Comment
47 CFR			
15.203	Antenna Requirement	P	
15.207	Conducted Emissions - Mains	NT	Test was not applicable
15.209	Radiated Emissions – Spurious Out of Band Emissions and Restricted Bands	P	
15.247(a)(1)	99% Occupied Bandwidth	P	
15.247(b)	Peak RF Output Power	P	
15.247(d)	Band Edge	P	
15.247(e)	RF Exposure	P	
DTS Operating Under 15.247			
8.0	6 dB Occupied Bandwidth	P	
9.0	Fundamental Emission Output Power	P	
10.0	Power Spectral Density	P	
11.0	Emissions in non-Restricted Bands	P	
12.0	Emissions in Restricted Bands	P	
13.0	Spurious Emissions – Band Edge	P	
FHSS Operating Under 15.247			
15.247(a)(1)	Number of Hopping Channels	P	
15.247(a)(1)	Channel Separation	P	
15.247(a)(1)	Time of Occupancy	P	
15.247(a)(1)	20 dB Occupied Bandwidth	P	
15.247(b)	Peak Power Output	P	
15.247(d)	Spurious Emissions (Conducted)	P	

Notes:

General remarks:

Summary of compliance with national requirements:

Compliance with this standard provides a means of conformity with the United States Federal Communication Commission (FCC) verification, certification, or declaration of conformity authorization procedures and Industry Canada (IC) rules.

Testing Location		
Testing Laboratory:		
Testing location/ address	:	EMC Integrity, Inc. 1736 Vista View Drive Longmont, CO 80504
Testing procedure: TMP		
Tested by (name + signature)	:	Kevin Johnson 
Approved by (+ signature)	:	Vincent W. Greb 
Testing location/ address	:	EMC Integrity, Inc. 1736 Vista View Drive Longmont, CO 80504
Supplemental Information:		
Testing results contained herein were performed at the location(s) listed above.		

Procedural Requirements

The following requirements are taken from the appropriate rules, other rules may apply and the manufacturer should consult the full text of the appropriate laws prior to marketing any device.

United States

Mandated procedures for digital devices are defined in 47 CFR 15.201, *Equipment authorization requirement*. Details of the authorization procedures (verification, declaration of conformity, and certification) can be found in 47 CFR, Part 2, Subpart J, *Equipment Authorization Procedures*.

Information to the User and Labeling Requirements

The following requirements are taken from the appropriate rules, other rules may apply and the manufacturer should consult the full text of the appropriate laws prior to marketing any device.

United States

Labeling

47 CFR 2.925

(a) Each equipment covered in an application for equipment authorization shall bear a nameplate or label listing the following:

(1) FCC Identifier consisting of the two elements in the exact order specified in §2.926. The FCC Identifier shall be preceded by the term *FCC ID* in capital letters on a single line, and shall be of a type size large enough to be legible without the aid of magnification.

Example: FCC ID XXX123. XXX—Grantee Code 123—Equipment Product Code

47 CFR 15.19

(a) In addition to the requirements in part 2 of this chapter, a device subject to certification, or verification shall be labeled as follows:

(3) All other devices shall bear the following statement in a conspicuous location on the device:

> This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

47 CFR 15.19(b)(2) Label text and information should be in a size of type large enough to be readily legible, consistent with the dimensions of the equipment and the label. However, the type size for the text is not required to be larger than eight point.

47 CFR 15.19(b)(3): When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (b)(1) of this section on it, such as for a CPU board or a plug-in circuit board peripheral device, the text associated with the logo may be placed in a prominent location in the instruction manual or pamphlet supplied to the user. However, the unique identification (trade name and model number) and the logo must be displayed on the device.

47 CFR 15.19(b)(4): The label shall not be a stick-on, paper label. The label on these products shall be permanently affixed to the product and shall be readily visible to the purchaser at the time of purchase, as described in §2.925(d) of this chapter. “Permanently affixed” means that the label is etched, engraved, stamped, silkscreened, indelibly printed, or otherwise permanently marked on a permanently attached part of the equipment or on a nameplate of metal, plastic, or other material fastened to the equipment by welding, riveting, or a permanent adhesive. The label must be designed to last the expected lifetime of the equipment in the environment in which the equipment may be operated and must not be readily detachable.

Information to User

47 CFR 15.21: The user’s manual or instruction manual for an intentional or unintentional radiator shall caution the user that:

> Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

Technical Requirements

The testing requirements, as appropriate, were derived from ANSI C63.4; 47 CFR, Subpart A.

Conducted Emissions

The mains cable of the EUT or EUT host unit was connected to the LISN defined in this standard and is bonded to the reference plane. Where applicable, remaining auxiliary equipment was powered through an additional LISN (also bonded to the reference plane), using a multi-socket outlet strip if necessary. The LISNs were at least 0.8m away from the EUT. A vertical ground plane was used while the table-top EUTs were placed on a wooden table 0.8m high. Floor-standing EUTs were insulated from the ground plane and grounded according to the manufacturer's instructions.

Signal cables were positioned for their entire lengths, as far as possible, at a nominal distance of 0.4 m from the ground reference plane. Where the mains cable supplied by the manufacturer was longer than 1 m, the excess was folded at the centre into a bundle no longer than 0.4 m, so that its length is shortened to 1 m. If the 1 m cable length cannot be achieved owing to physical limitations of the EUT arrangement, the cable length shall be as near to 1 m as possible.

All telecommunication and signal ports were correctly terminated using either appropriate associated equipment or a representative termination during the measurement of the conducted disturbances at the mains. If an ISN is connected to a telecommunications port during the measurement of conducted disturbances at the mains port, then the ISN receiver port was terminated in 50Ω. The ISNs were at least 0.8m away from the EUT.

Mains

Any power cable(s) from the equipment under test that were directly connected to the AC Mains have been tested. In the event that the equipment under test had no direct connection to the Mains, that is, it was connected to a Host unit (example: USB powered); then conducted emissions was performed on the Mains of the Host unit. Battery powered equipment was not tested for conducted emissions; however, if the equipment makes provisions for connections to a battery charger that is connected to the Mains, then conducted emissions were performed on the battery charger.

Table 5 – Class B Conducted Emissions Limits - Mains

Frequency	Limits (dBµV)	
	Quasi-peak	Average
150 kHz – 500 kHz	66 - 56	5-46
500 kHz – 5 MHz	56	46
5 MHz – 30 MHz	60	50
NOTE 1: The lower limit shall apply at the transition frequency. NOTE 2: The limit decreases linearly with the logarithm of the frequency in the range 150 kHz to 500 kHz.		

Radiated Emissions – Restricted Bands

The arrangement of the equipment is typical of a normal installation practice and as was practical, the arrangement was varied and emissions investigated for maximum amplitude. Final measurements were performed in a semi-anechoic chamber. The equipment was rotated 360° and the antenna height has been varied between 1m and 4m. Measurements were taken at both horizontal and vertical antenna polarities. The receiver bandwidth was set to 120 kHz for measurements below 1 GHz, and 1 MHz for measurements above 1 GHz. A peak detector is used to detect an emission; a quasi-peak detector may be used to record a final measurement below 1 GHz and an average detector may be used above 1 GHz. An inverse proportionality factor of 20 dB/decade (10 dB) was used, as noted in 15.31(f)(1), to normalize the measured data to the specified test distance for determining compliance.

Frequency range of radiated measurements (15.33(a)):

Operating frequency of intentional radiator	Lowest frequency searched	Highest frequency searched
Below 10 GHz	9 kHz or lowest operating frequency generated in the device, whichever is highest	10th harmonic of highest fundamental frequency or 40 GHz, whichever is lower
10 – 30 GHz	9 kHz or lowest operating frequency generated in the device, whichever is highest	5th harmonic of highest fundamental frequency or 100 GHz, whichever is lower
At or above 30 GHz	9 kHz or lowest operating frequency generated in the device, whichever is highest	5th harmonic of highest fundamental frequency or 200 GHz, whichever is lower

Restricted Bands 47 CFR 15.205

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1]0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	([2])
13.36–13.41			

Radiated Emission Limit – Restricted Bands

Reading on the measuring receiver showing fluctuations close to the limit, were observed for at least 15 s at each measurement frequency; the highest reading was recorded.

Table 6 – Radiated Emissions Limits per 47 CFR 15.209(a) & RSS-GEN 7.2.5

Frequency Range	Field Strength (µV/m)	Field Strength (dBµV/m)	Measurement Distance (m)
9 kHz – 490 kHz	2400/F(kHz)	48.5 – 13.8	300
490 kHz – 1.705 MHz	24000/F(kHz)	33.6 – 23.0	30
1.705 MHz – 30 MHz	30	29.5	30
30 MHz – 88 MHz	100	40.0	3
88 MHz – 216 MHz	150	43.5	3
216 MHz – 960 MHz	200	46.0	3
Above 960 MHz	500	54.0	3

DTS - Bandwidth

Section 8.0: DTS bandwidth was measured using **Option 1** given under Section 8.0 of the FCC's "*Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247*", dated April 9, 2013. The following verbiage describes this procedure.

EUT configuration: The EUT is set to normal Tx mode for low, middle and high Tx frequencies.

Spectrum analyzer settings:

RBW = 100 kHz

VBW $\geq$ 3 x RBW

Detector = Peak

Sweep = auto

Allow trace to stabilize

Measure the maximum width of the emissions that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuation by 6 dB relative to the maximum level measured in the fundamental emission.

DTS - Fundamental Emission Output Power

Section 9.0: Fundamental emission output power was measured as outlined in **Section 9.1.1** of the FCC's "*Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247*", dated April 9, 2013. (This method was chosen as the DTS BW was less than 1 MHz.)The following verbiage describes this procedure.

EUT configuration: The EUT is set to normal Tx mode for low, middle and high Tx frequencies.

Spectrum analyzer settings:

RBW $\geq$ DTS Bandwidth, or 1 MHz

VBW $\geq$ 3 x RBW, or 3 MHz

Span $\geq$ 3 x RBW, or 3 MHz)

Detector = Peak

Trace = Max Hold

Allow trace to stabilize

Use peak marker to determine the peak amplitude level.

*Since the EUT had an integral antenna, the EIRP method was used.

DTS - Power Spectral Density

Section 10.0: Power spectral density was measured as outlined in **Section 10.2 Method PKPSD** of the FCC's "*Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247*", dated April 9, 2013. The following verbiage describes this procedure. Since the maximum peak conducted output power (EIRP) method was used to demonstrate compliance, the peak PSD method specified in Section 10.2 was used for this measurement, as follows:

EUT configuration: The EUT is set to normal Tx mode for low, middle and high Tx frequencies.

Analyzer center frequency was set to DTS channel center frequency.

Span was set to 1.5 x DTS bandwidth

RBW was 3 kHz $\leq$ RBW $\leq$ 100 kHz

Video Bandwidth was $\geq$ 3 x RBW

Sweep time = auto couple

Detector = Peak

Trace = Max Hold

Allow trace to stabilize

Use peak marker to determine the peak amplitude within the RBW. In the event that measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

DTS - 20 dB Occupied Bandwidth

15.247(a)(1)(i): The maximum 20 dB occupied bandwidth for…transmitters operating in the 902 – 928 MHz band is 500 kHz.

15.247(a)(1)(ii): The maximum 20 dB bandwidth of the hopping channel is 1 MHz for…systems operating in the 5725 – 5850 MHz.

The 20 dB Occupied Bandwidth is measured at low, mid, and high channels and with each modulation mode.

Spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW ≥ 1% of the 20 dB bandwidth

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

DTS - Emissions in Non-Restricted Bands

Section 12.0. Same method and data as for emissions in restricted bands.

DTS - Band-Edge

Section 13.0 Band-edge was measured as outlined in **Section 13.3.1 Peak Detection** of the FCC's "*Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247*", dated April 9, 2013. The following verbiage describes this procedure.

EUT test mode: The EUT is set in its normal Tx mode for lowest and highest channels.

Spectrum analyzer settings:

Set the spectrum analyzer center frequency to the frequency of the emission to be measured.

Span = 2 MHz

RBW = 100 kHz

VBW ≥ 3 x RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow sweep to continue until trace stabilizes.

Verify that emissions at band-edge and below/above band-edge comply with FCC 15.209 limit.

DTS - Peak RF Output Power

15.247(2)(b)(1):

Frequency Band	Minimum No. of Non-Overlapping Hopping Channels	Maximum Peak RF Power at antenna
2400-2483.5 MHz	75	1 watt
2400-2483.5 MHz	All other	0.125 watt
5725-5850 MHz	-	1 watt

15.247(2)(b)(2): For…systems operating in the 902–928 MHz band:

Frequency Band	Minimum No. of Non-Overlapping Hopping Channels	Maximum Peak RF Power at antenna
902-928 MHz	50	1 watt
902-928 MHz	<50 but at least 25	0.250 watt

EUT test mode: The peak rf output power shall be measured at low, mid, and high channels and for each modulation mode.

Spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

DTS - Spurious Emissions

15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits is not required. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits specified.

Spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Band edge spurious emissions:

Measurement shall be made in the following bands:

2310 – 2390 MHz

2483.5 – 2500 MHz

Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation

RBW ≥ 1% of the span

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

FHSS – Number of Hopping Channels

FHSS - Channel Separation

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

FHSS - Time of Occupancy

Minimum Standard:

Frequency Band (MHz)	20 dB Bandwidth	No. of Hopping Channels	Average Time of Occupancy
902 - 928	<250 kHz	50	=<0.4 sec. in 20 sec.
902 – 928	=>250 kHz	25	=<0.4 sec. in 10 sec.
2400 – 2483.5	-----	75	=<0.4 sec. in 0.4 seconds multiplied by the number of hopping channels employed.
5725 – 5850	-----	75	=<0.4 sec. in 30 sec.

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: 1 MHz

VBW: = RBW

Span: 0 Hz

LOG dB/div.: 10 dB

Sweep: Sufficient to see one hop time sequence.

Trigger: Video

The occupancy time of one hop is measured as above. The average time of occupancy is calculated over the appropriate period of time from above table

Avg. time of occupancy = (period from table/duration of one hop)/no. of channels multiplied by the duration of one hop.

For instance:

If a 2.4 GHz system has a measured hop duration time of 1 msec. and uses 75 channels, then the average time of occupancy would be:

(30 sec./.001 sec.)/75 chan. = 400 x 1 msec. = 400 msec. or 0.4 sec. in 30 sec.

FHSS - Occupied Bandwidth

Minimum Standard:

Frequency Band (MHz)	Maximum 20 dB Bandwidth
902 - 928	500 kHz
2400 – 2483.5	Not defined
5725 – 5850	1 MHz

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: At least 1% of span/div.

VBW: >RBW

Span: Sufficient to display 20 dB bandwidth

LOG dB/div.: 10 dB

Sweep: Auto

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

FHSS - Peak Power Output

Minimum Standard:

Frequency Band (MHz)	No. of Hopping Channels	Maximum Peak Power Output at Antenna Port
902 - 928	at least 50	1 watt
902 – 928	25 - 49	0.25 watts
2400 – 2483.5	75	1 watt
5725 – 5850	75	1 watt

If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point to point operation may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceed 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operation may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Direct Measurement Method For Detachable Antennas:

If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

FHSS – Spurious Emissions - Conducted

Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	**Field Strength (µV/m @ 3m)**	**Field Strength (dB @ 3m)**
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC

Method Of Measurement:

30 MHz - 10th harmonic plot

RBW: 100 kHz

VBW: 300 kHz

Sweep: Auto

Display line: -20 dBc

Lower Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz

Marker: Peak of fundamental emission

Marker Δ: Peak of highest spurious level below center frequency.

Upper Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz

Marker: Peak of fundamental emission

Marker Δ: Peak of highest spurious level above center frequency.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

FHSS – Spurious Emissions – Radiated

Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (µV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC

15.205 Restricted Bands

MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41	1718		

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

Measurement Uncertainty

Determining compliance with the limits in these standards was based on the results of the measurement, and does not take into account the measurement instrumentation uncertainty.

Referencing the measurement instrumentation uncertainty considerations contained in CISPR 16-4-2, the expanded measurement uncertainty numbers for each test is given in Table 7.

Table 7 – Measurement Uncertainty Summary

Type	Test	Measurement Uncertainty
DTS	Bandwidth	0.7 dB
	Fundamental Emission Output Power	0.5 dB
	Power Spectral Density	0.5 dB
	20 dB Occupied Bandwidth	0.7 dB
	Band-Edge	1%
	Peak RF Output Power	0.5 dB
	Spurious Emissions	3.2 dB
FHSS	Number of Hopping Channels	1%
	Channel Separation	1%
	Time of Occupancy	1%
	Occupied Bandwidth	0.7 dB
	Peak Power Output	0.5 dB
	Spurious Emissions – Radiated	5.01 dB (<1 GHz) 3.2 dB (>1 GHz)
	Spurious Emissions - Conducted	0.5 dB

List of Test Equipment

The following test equipment was used in the performance of the testing herein.

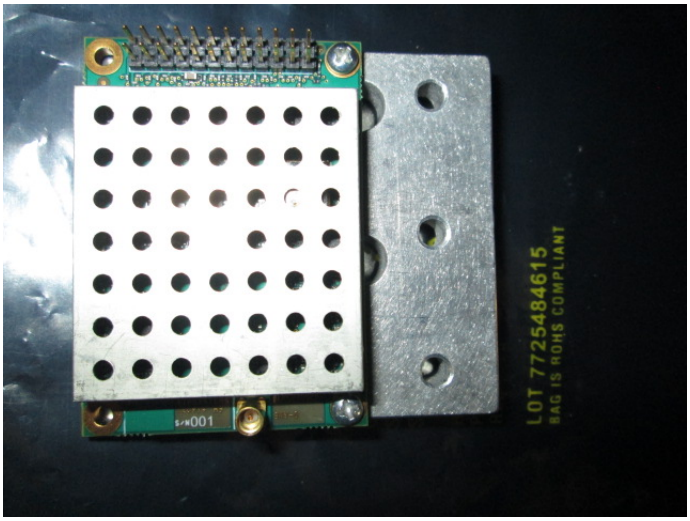
Table 8 – Test Equipment Used

ID Number	Manufacturer	Model #	Serial #	Description	Cal Date	Cal Due
1373	Hewlett Packard	8564E	3641A00613	Spectrum Analyzer 9 kHz -40 GHz	04/11/2014	04/11/2015
1196	EMCO	3115	00034810	DRG Horn 1-18 GHz	07/28/2014	07/28/2015
1197	EMCO	3116	00040962	DRG Horn 18-40 GHz	11/25/2014	11/25/2015
1220	Mini-Circuits	ZKL-2	NA	Preamp, 10 - 2000 MHz, 30 dB	02/17/2014	02/17/2015
1253	Narda West	1840N506	010-100	18 to 40 GHz Preamplifier, 40dB Gain Nominal	08/01/2014	08/01/2015
1337	Hewlett Packard	85685A	2833A00775	RF Preselector	06/06/2014	06/06/2015
1339	Hewlett Packard	8566B	2937A06103	Spectrum Analyzer with 2542A11546	06/06/2014	06/06/2015
1340	Hewlett Packard	8566B	2542A11546	Spectrum Analyzer Display	06/06/2014	06/06/2015
1341	Hewlett Packard	85650A	2811A01351	Quasi-Peak Adapter	06/06/2014	06/06/2015
1381	Sunol	JB1	A010411	0.03-2 GHz Broadband Hybrid Antenna	12/26/2013	12/26/2014
1396	CIR Enterprises	10m Chamber #2	002	10m Chamber with 4m turntable	07/22/2014	07/22/2015
1410	Sunol Sciences	SC110V	021611-1	System Controller 10meter #2	NA	NA
1500	Pacific Power Source	3060-MS/M93235	0871_08097	62KVA-175 AMP, Frequency 47-500Hz, Power Supply	NA	NA
1538	Extech Instruments	445715	Z315812	Hygro-Thermometer	03/21/2014	03/21/2015
1246	Micro-Tronics	BRM50701	038	2.4 GHz Notch Filter	03/10/2014	03/10/2015
1133	Sorenson	XTD12	4561	Dual Output DC Power Supply	NA	NA
1538	Extech Instruments	445715	Z315812	Hygro-Thermometer	03/21/2014	03/21/2015

Test Results – Antenna Requirement

Table No. 1	Antenna requirement	Verdict
		P

Type of antenna connection	☐ Integral antenna	☐ Permanently attached	☒ Unique connector
Type of unique connector	MMCX		
Method of permanent connection	N/A		



MMCX connector located at the bottom of the PCB.

Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

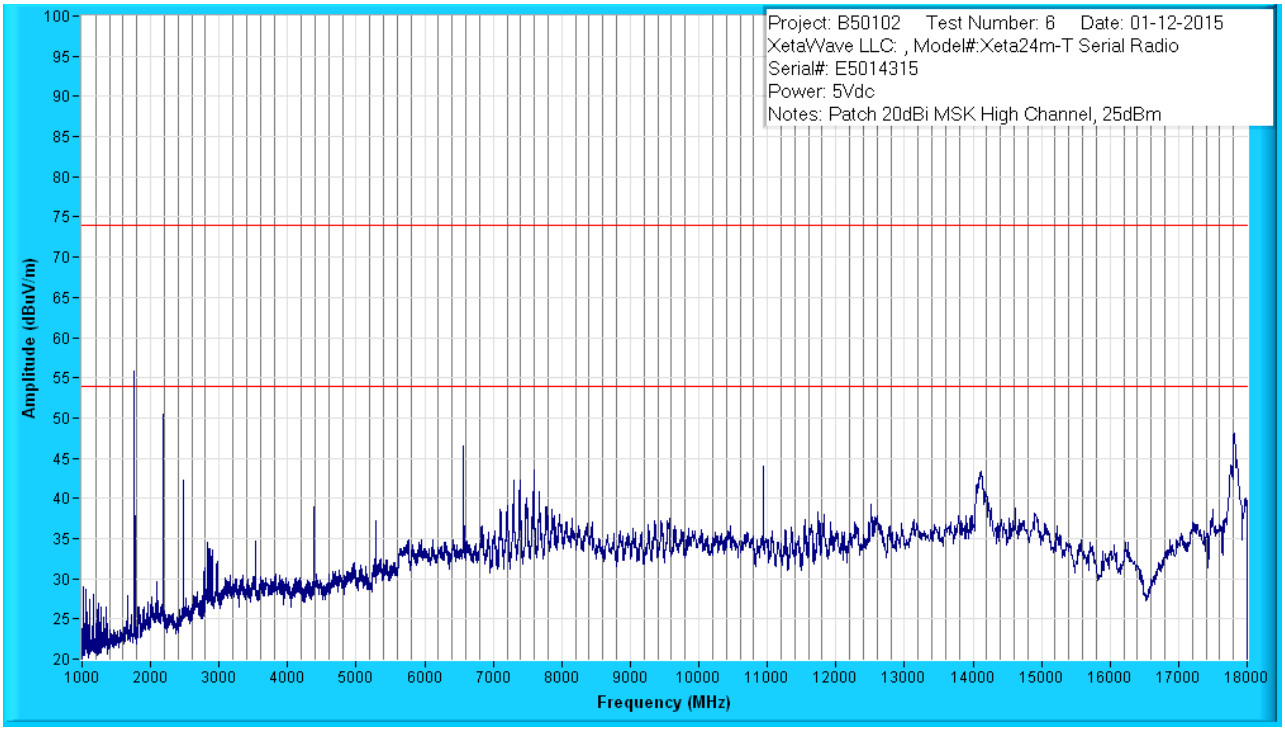
Test Results – Radiated Emissions – Spurious Out of Band Emissions & Restricted Bands

Table No. 2	**Radiated Emissions – Spurious Out of Band Emissions & Restricted Bands, Low, Mid and High Channels**	Verdict
		P

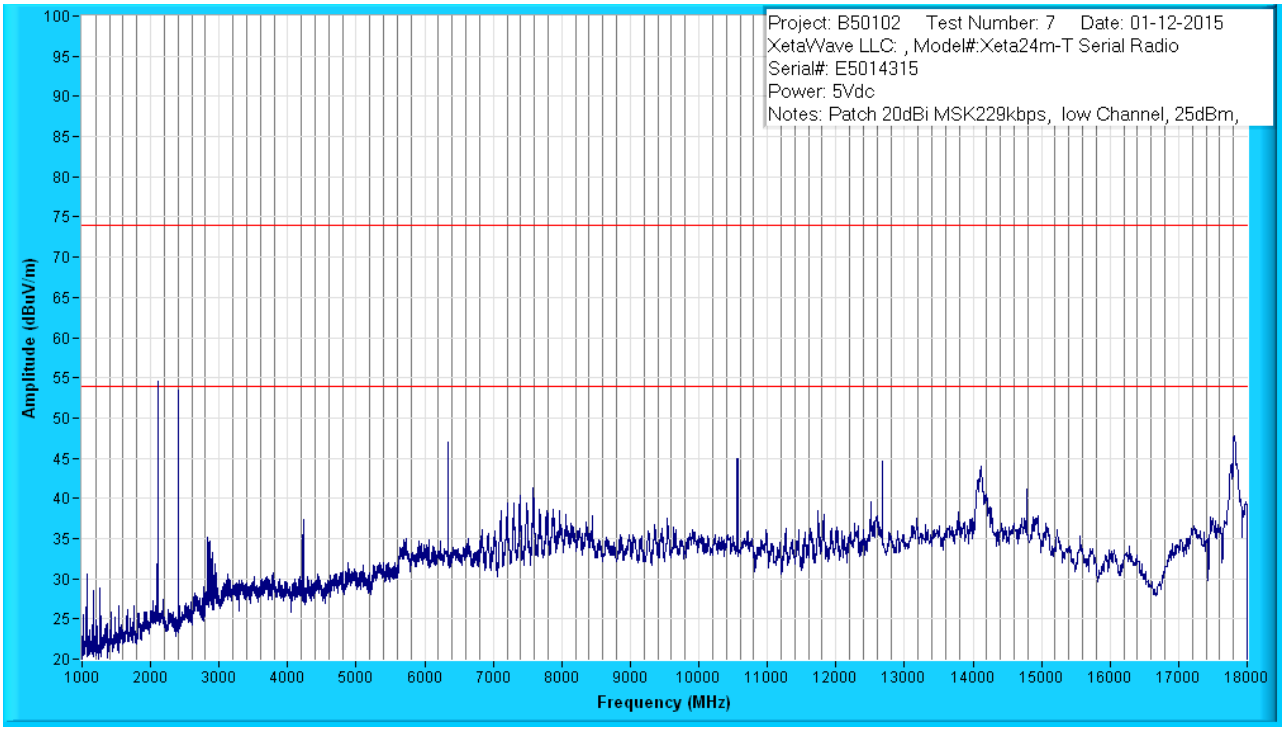
Frequency Range ..... :	30 MHz to 25 GHz	Test Location ..... :	10m Chamber #2
Test Method..... :	ANSI C63.4 & ANSI C63.10		
Test Distance ..... :	10 m (30 MHz to 1 GHz); 3 m (1-18 GHz); 1 m (18-25 GHz)		
EUT Configuration ..... :	See individual plots for antenna, modulation and channel details		
Test Date ..... :	1-12-2015.		
Temperature ..... :	22°C	Relative Humidity .... :	24 %
Test Equipment Asset Tag List :	1373, 1196, 1197, 1197, 1220, 1253, 1337, 1339, 1340, 1341, 1381, 1396, 1410, 1500, 1538		

Supplemental Information:

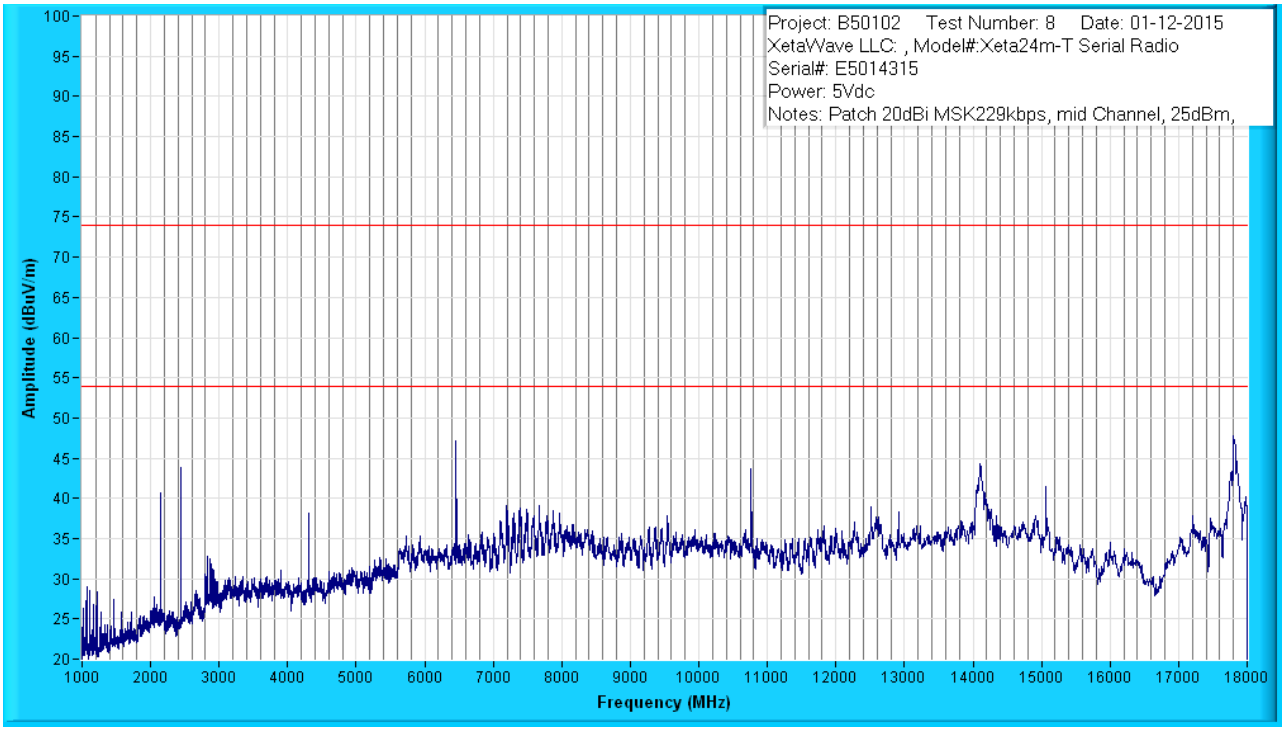
Tested by (+ signature) .....: Kevin Johnson.



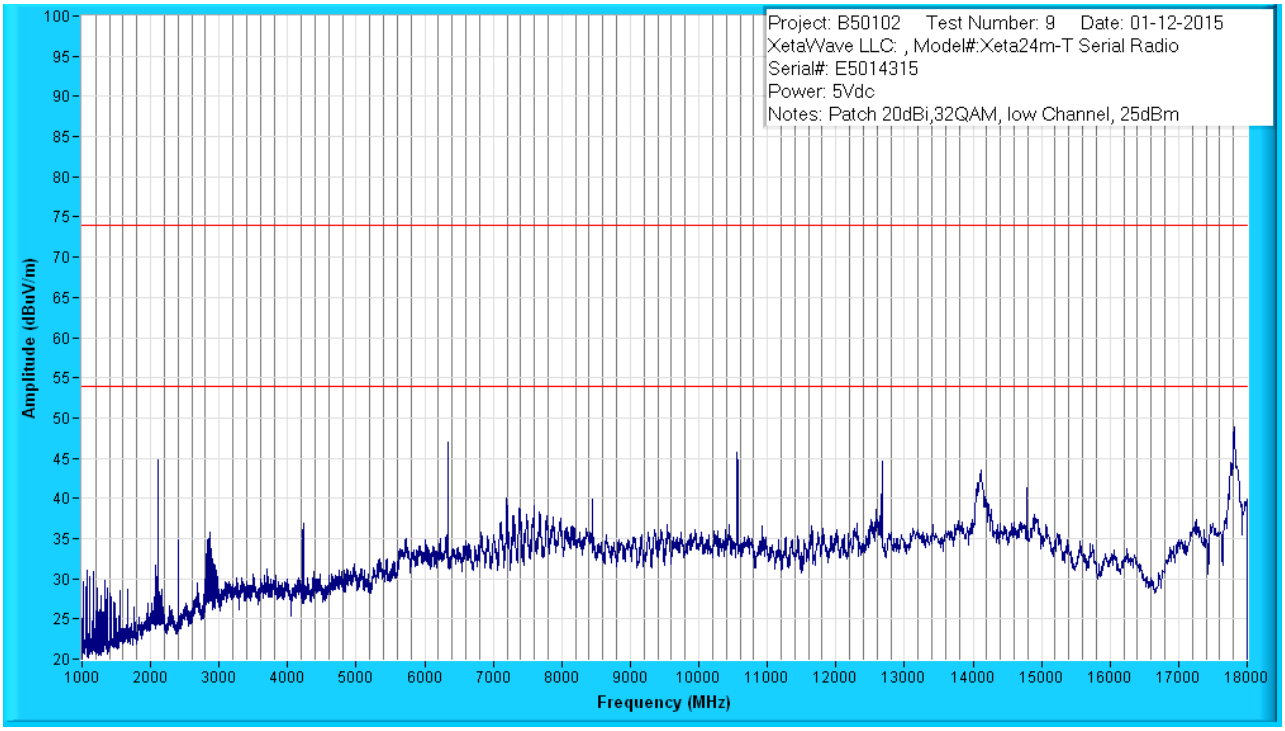
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
AV	1763.623	86.8	26.4	-77.3	35.9	212/H-Pole/2.19	-	18.10
PK	1763.623	88.5	26.4	-77.3	37.6	212/H-Pole/2.19	36.35	-
AV	4379.644	79.5	32.5	-72.6	39.4	157/V-Pole/1.02	-	14.56
PK	4379.644	85.1	32.5	-72.6	44.9	157/V-Pole/1.02	29.01	-
AV	6569.474	80.2	34.8	-69.1	46.0	227/V-Pole/1.98	-	7.93
PK	6569.474	83.9	34.8	-69.1	49.7	227/V-Pole/1.98	24.28	-
AV	10949.106	68.4	38.5	-66.9	40.0	151/V-Pole/3.29	-	13.98
PK	10949.106	72.7	38.5	-66.9	44.3	151/V-Pole/3.29	29.68	-



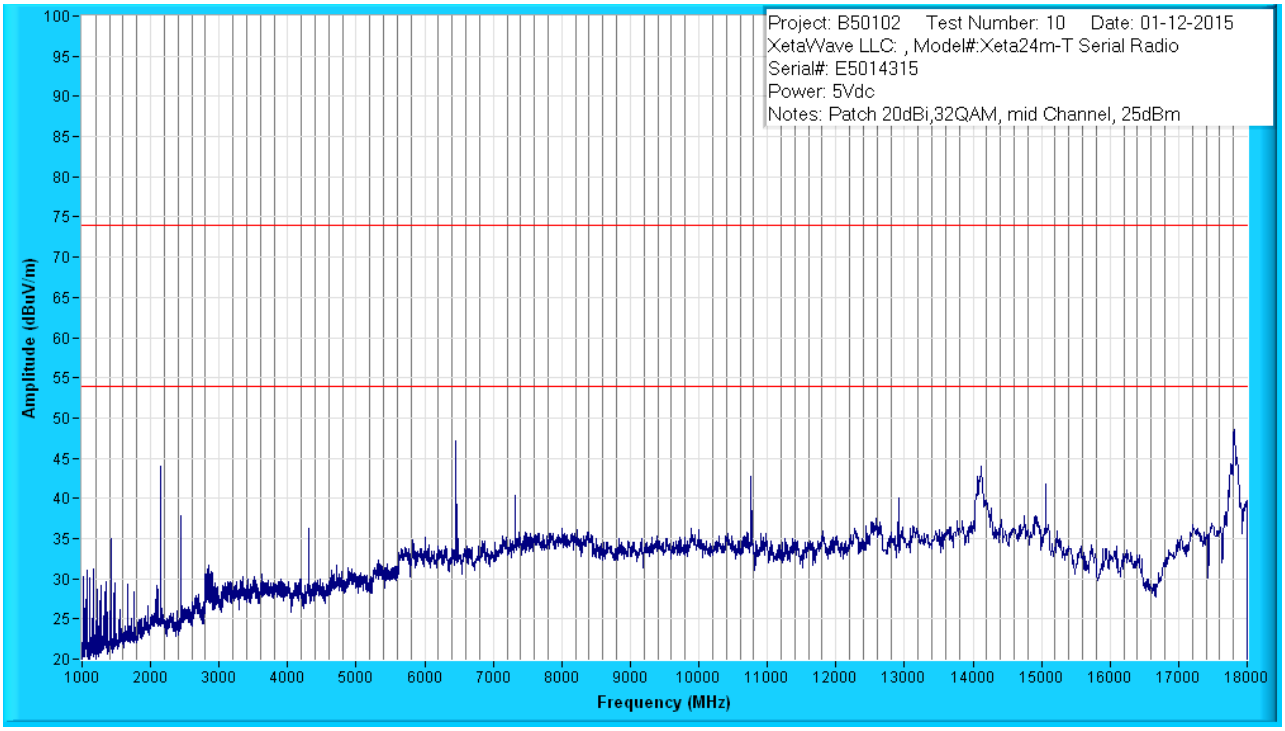
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
AV	6341.105	83.8	34.7	-70.1	48.4	314/H-Pole/2.61	-	5.53
PK	6341.105	86.2	34.7	-70.1	50.9	314/H-Pole/2.61	23.08	-
AV	10568.491	69.5	38.6	-66.9	41.1	186/V-Pole/3.68	-	12.82
PK	10568.491	73.7	38.6	-66.9	45.4	186/V-Pole/3.68	28.57	-
AV	12682.186	74.0	39.5	-67.0	46.4	263/V-Pole/1.88	-	7.60
PK	12682.186	79.3	39.5	-67.0	51.7	263/V-Pole/1.88	22.25	-
AV	14795.923	65.0	41.5	-65.5	41.0	178/V-Pole/2.61	-	12.93
PK	14795.923	71.5	41.5	-65.5	47.5	178/V-Pole/2.61	26.48	-



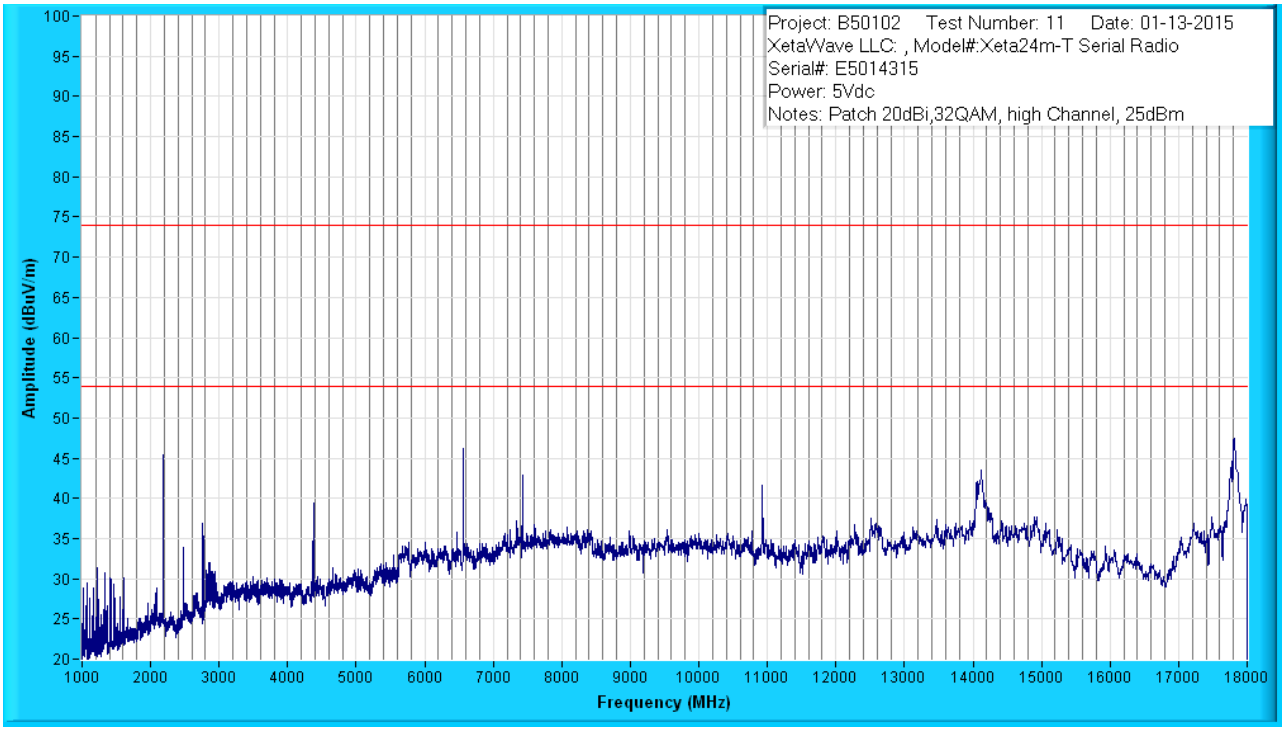
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
AV	4307.543	79.8	32.5	-73.5	38.8	164/V-Pole/1.18	-	15.11
PK	4307.543	85.8	32.5	-73.5	44.8	164/V-Pole/1.18	29.16	-
AV	6461.281	81.9	34.7	-69.5	47.1	177/V-Pole/2.13	-	6.86
PK	6461.281	85.0	34.7	-69.5	50.2	177/V-Pole/2.13	23.76	-
AV	10768.810	70.7	38.5	-66.9	42.4	150/V-Pole/3.16	-	11.58
PK	10768.810	74.6	38.5	-66.9	46.3	150/V-Pole/3.16	27.68	-
AV	15076.317	60.5	40.5	-65.9	35.1	134/H-Pole/1.73	-	18.82
PK	15076.317	70.0	40.5	-65.9	44.6	134/H-Pole/1.73	29.32	-



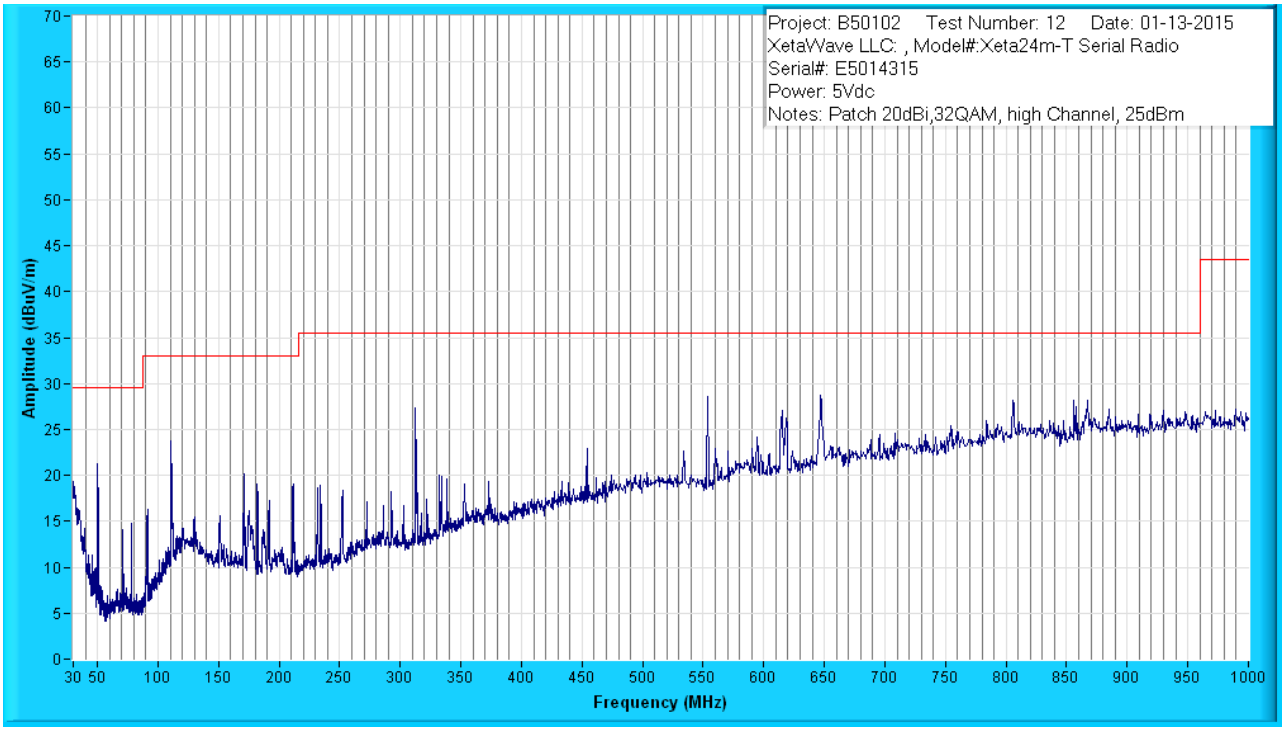
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
AV	6341.121	81.7	34.7	-70.1	46.4	302/H-Pole/3.03	-	7.58
PK	6341.121	83.5	34.7	-70.1	48.2	302/H-Pole/3.03	25.78	-
AV	10568.623	68.9	38.6	-66.9	40.6	175/V-Pole/2.99	-	13.37
PK	10568.623	73.9	38.6	-66.9	45.6	175/V-Pole/2.99	28.37	-
AV	12682.238	73.8	39.5	-67.0	46.2	175/V-Pole/1.70	-	7.75
PK	12682.238	79.0	39.5	-67.0	51.4	175/V-Pole/1.70	22.55	-
AV	4227.410	76.8	32.5	-73.1	36.2	200/V-Pole/2.18	-	17.72
PK	4227.410	82.7	32.5	-73.1	42.1	200/V-Pole/2.18	31.82	-



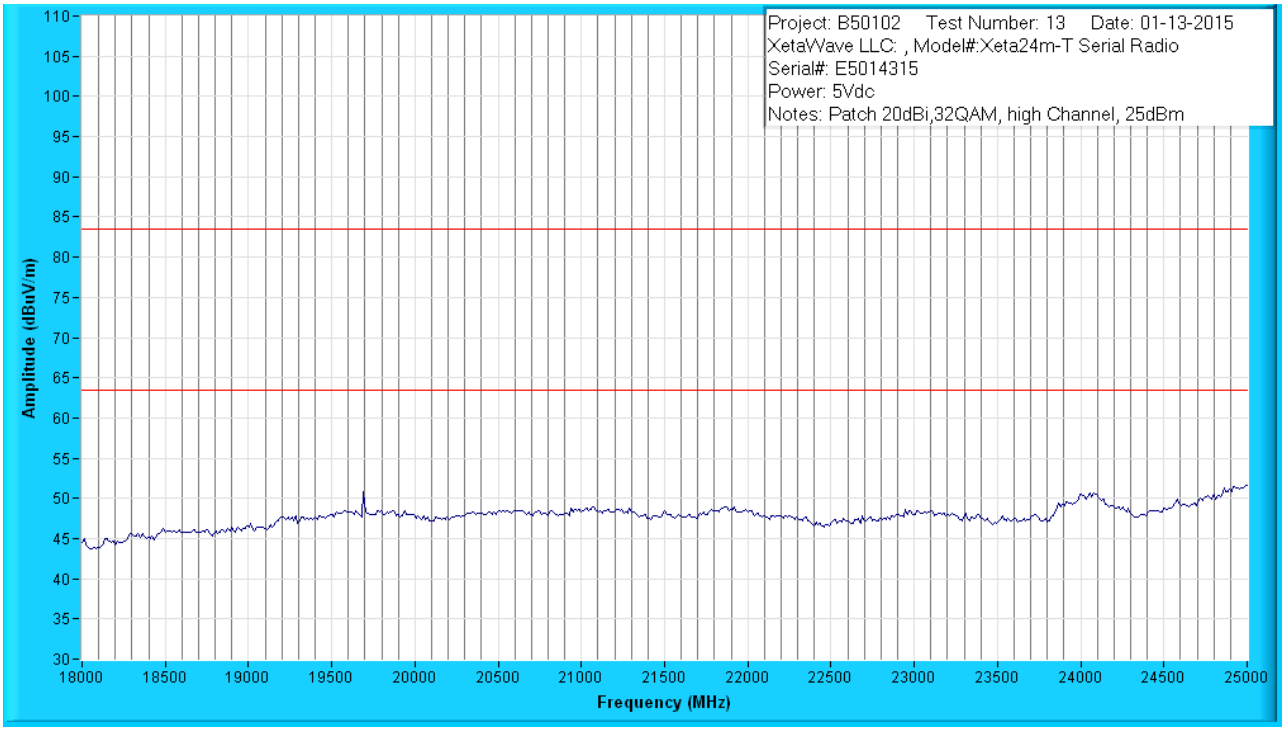
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
AV	4307.485	77.8	32.5	-73.5	36.7	156/H-Pole/1.17	-	17.21
PK	4307.485	84.3	32.5	-73.5	43.3	156/H-Pole/1.17	30.66	-
AV	6461.265	81.3	34.7	-69.5	46.5	130/V-Pole/1.37	-	7.41
PK	6461.265	85.0	34.7	-69.5	50.2	130/V-Pole/1.37	23.76	-
AV	10768.810	69.5	38.5	-66.9	41.1	170/V-Pole/3.70	-	12.83
PK	10768.810	74.2	38.5	-66.9	45.9	170/V-Pole/3.70	28.08	-
AV	15076.150	63.0	40.5	-65.9	37.6	202/V-Pole/1.99	-	16.36
PK	15076.150	70.8	40.5	-65.9	45.4	202/V-Pole/1.99	28.51	-



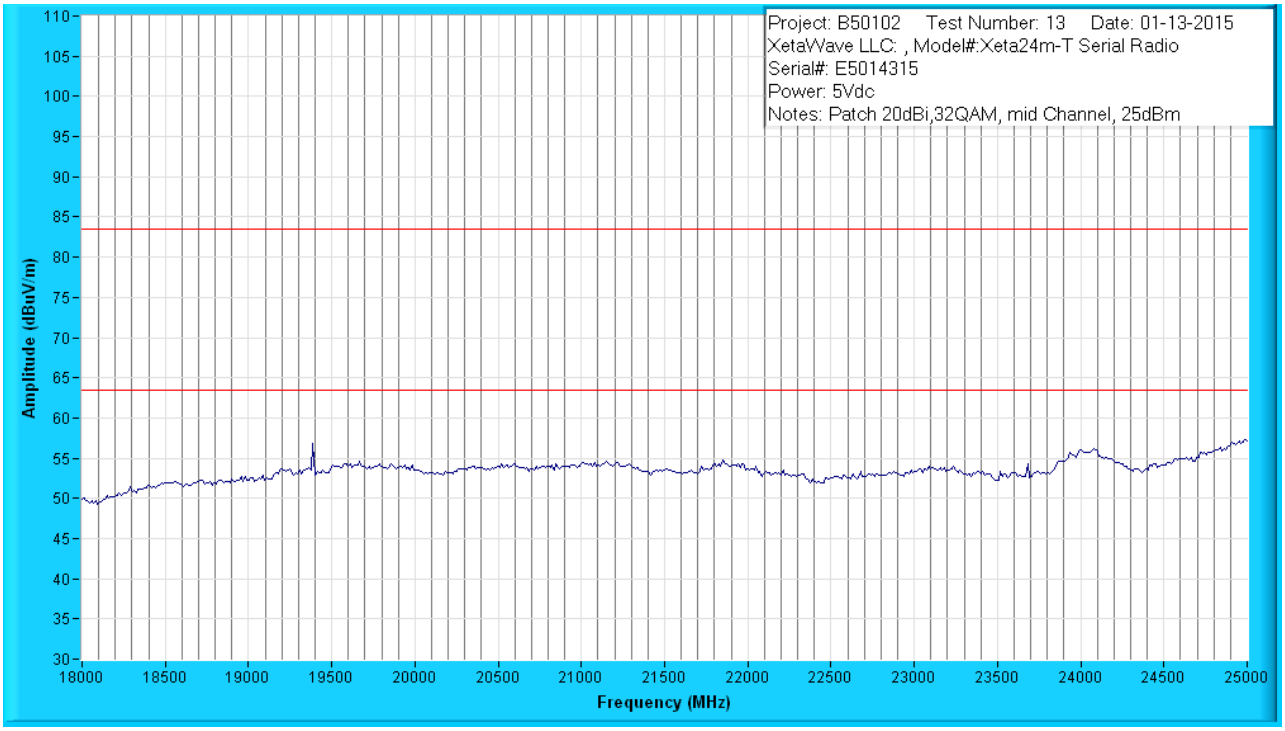
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
AV	4375.540	79.7	32.5	-72.7	39.5	156/H-Pole/1.14	-	14.46
PK	4375.540	85.4	32.5	-72.7	45.2	156/H-Pole/1.14	28.76	-
AV	6563.320	82.2	34.8	-69.1	48.0	226/V-Pole/1.68	-	5.97
PK	6563.320	83.3	34.8	-69.1	49.0	226/V-Pole/1.68	24.92	-
AV	7427.781	72.0	36.7	-69.3	39.5	322/V-Pole/1.10	-	14.43
PK	7427.781	77.8	36.7	-69.3	45.3	322/V-Pole/1.10	28.68	-
AV	10938.963	66.9	38.5	-66.9	38.6	180/V-Pole/2.43	-	15.39
PK	10938.963	72.7	38.5	-66.9	44.4	180/V-Pole/2.43	29.59	-



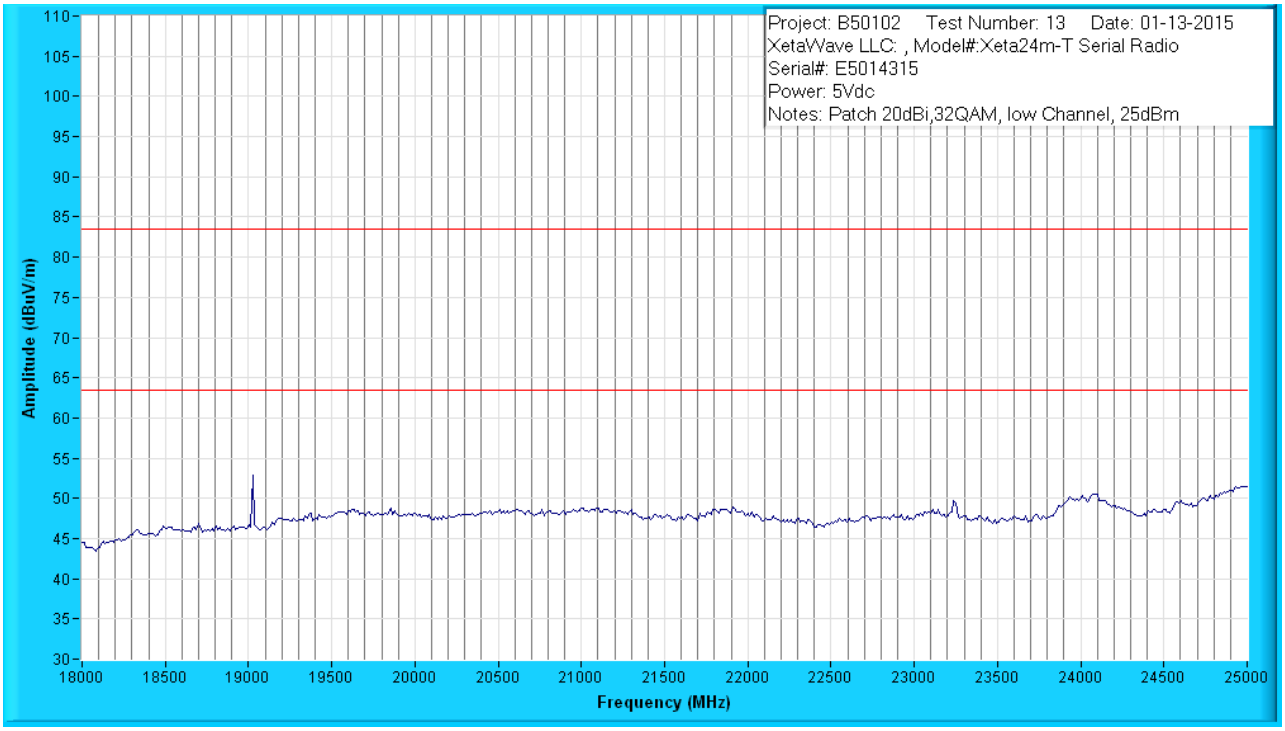
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B QP (dB)	Margin: FCC Class B AV (dB)
QP	49.901	43.2	8.1	-31.3	20.1	96/V-Pole/1.00	9.47	-
QP	110.569	39.9	12.7	-30.5	22.1	126/V-Pole/1.60	10.97	-
QP	171.306	38.3	11.6	-30.2	19.7	13/V-Pole/1.02	13.35	-
QP	312.081	43.5	13.6	-29.4	27.7	218/V-Pole/1.03	7.86	-
QP	554.125	42.1	17.8	-27.5	32.4	195/H-Pole/1.26	3.10	-
QP	647.100	33.7	19.5	-26.5	26.7	102/H-Pole/2.12	8.82	-



Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
32 QAM high channel								

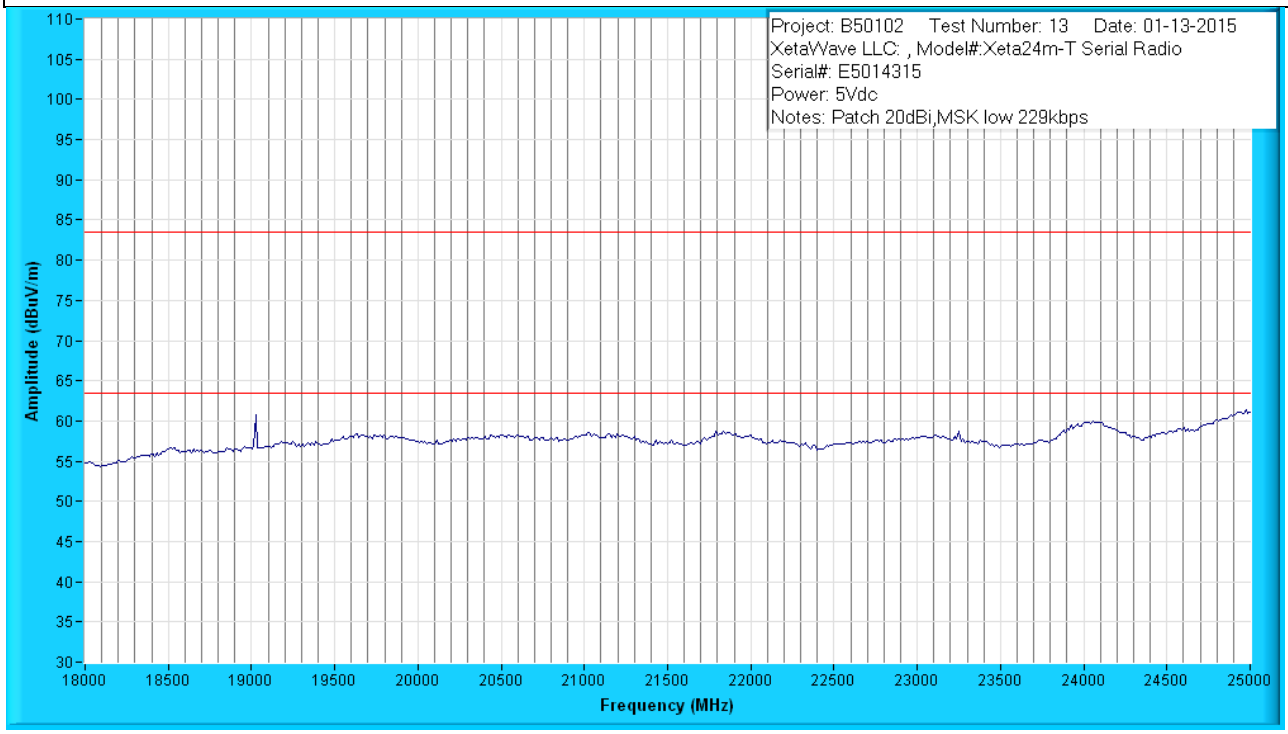


Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
PK	19388.333	51.5	44.9	-39.5	56.9		27.1 dB	N/A
32 QAM mid channel (maximized value is **peak** measurement taken at 1 meter spacing)								



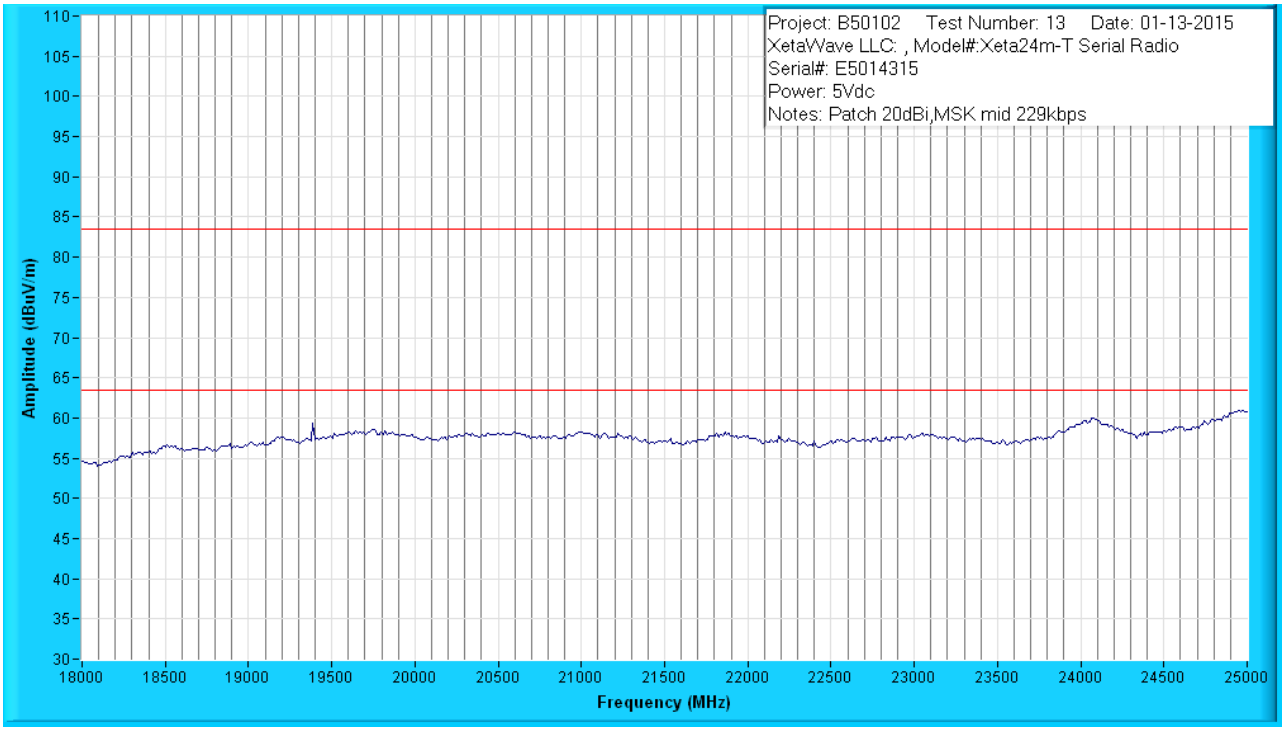
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
PK	19026.667	47.7	44.8	-39.6	52.8		31.2 dB	N/A

32 QAM low channel (maximized value is **peak** measurement taken at 1 meter spacing)

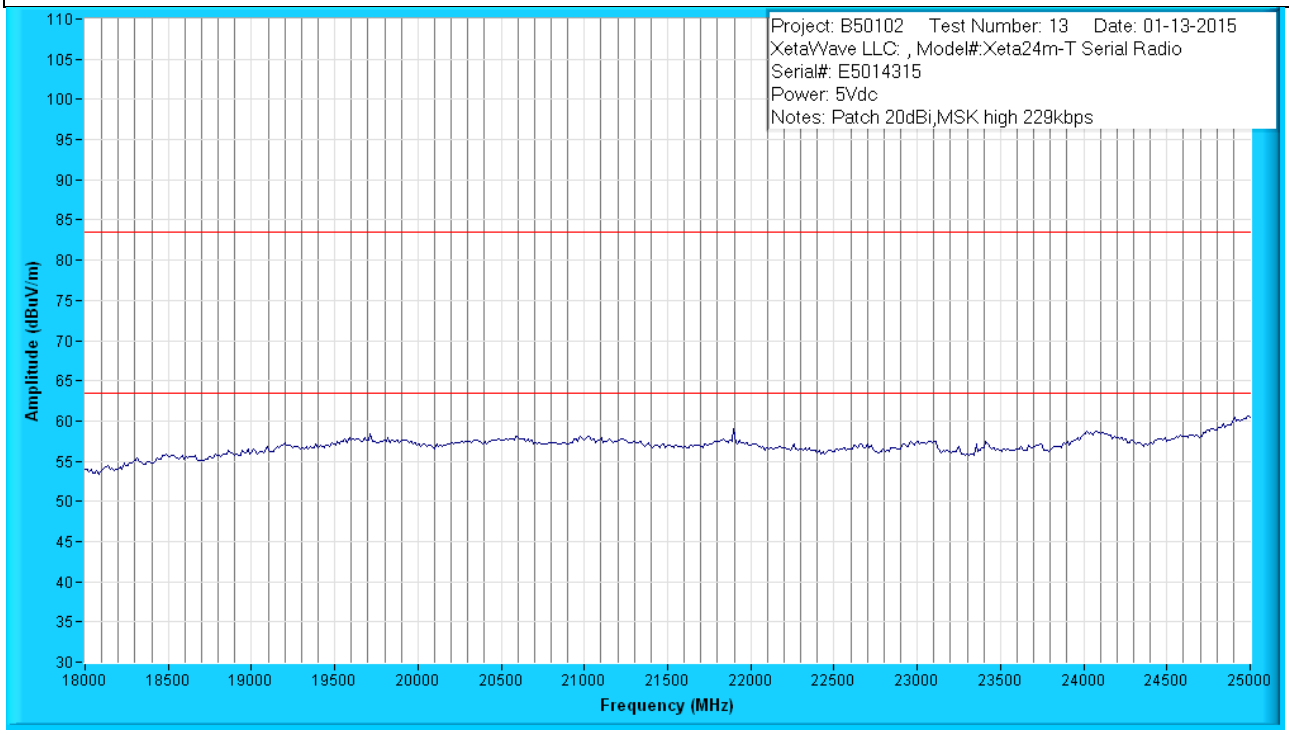


Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
PK	19026.667	55.7	44.8	-39.6	60.8		23.2 dB	N/A

MSK 229kbps low channel (maximized value is **peak** measurement taken at 1 meter spacing)



Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
PK	19388.333	54.0	44.9	-39.5	59.4		24.6 dB	N/A
MSK 229kbps low channel (maximized value is **peak** measurement taken at 1 meter spacing)								



Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)

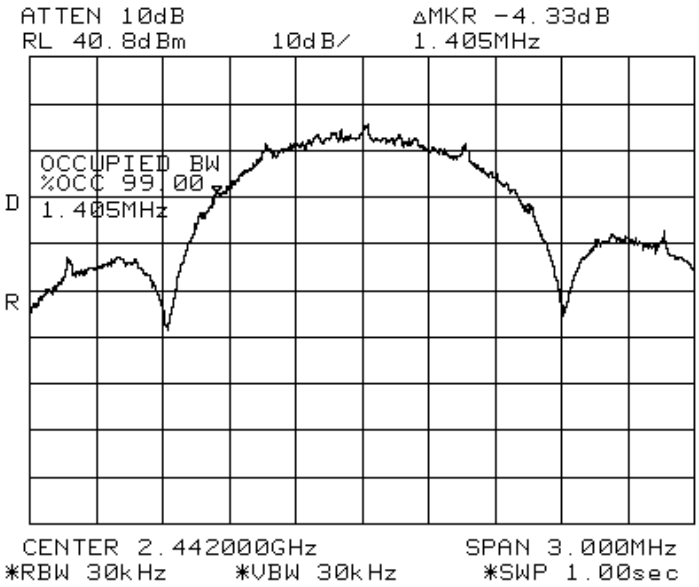
Test Results – 99% Occupied Bandwidth

Table No. 2	Radiated Emissions – 99% Occupied Bandwidth	Verdict
		P

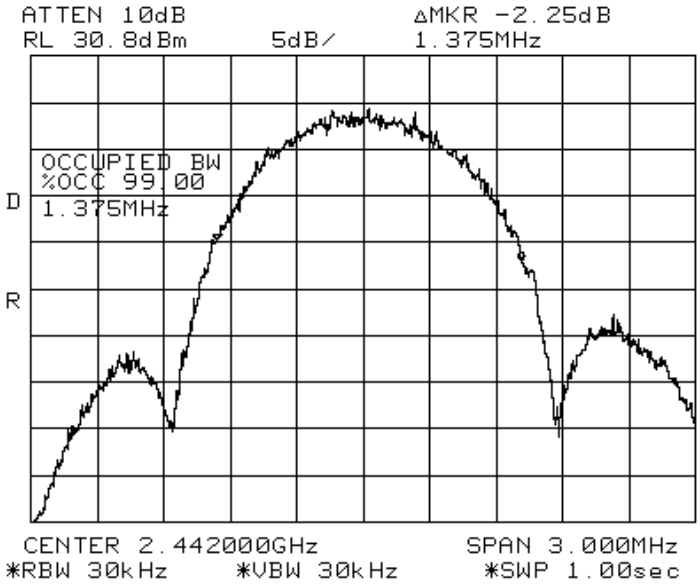
Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted measurement)
EUT Configuration ..... : See individual plots for modulation and channel details
Test Date ..... : 1-8-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

Supplemental Information:

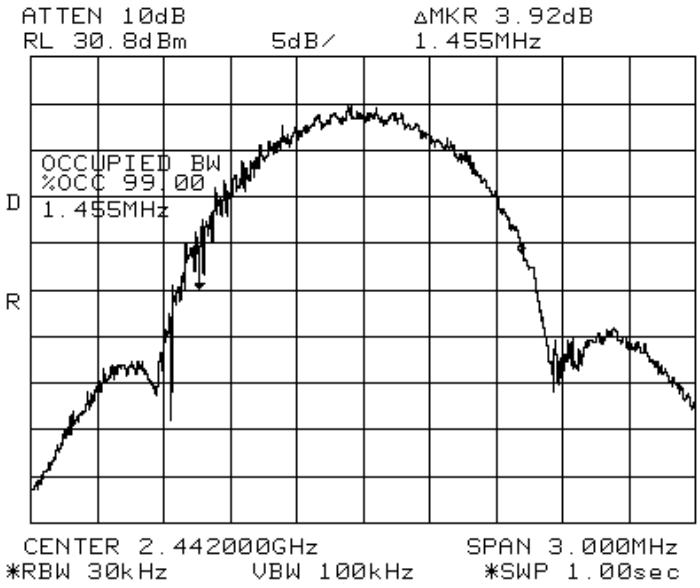
Tested by (+ signature) .....: Kevin Johnson.



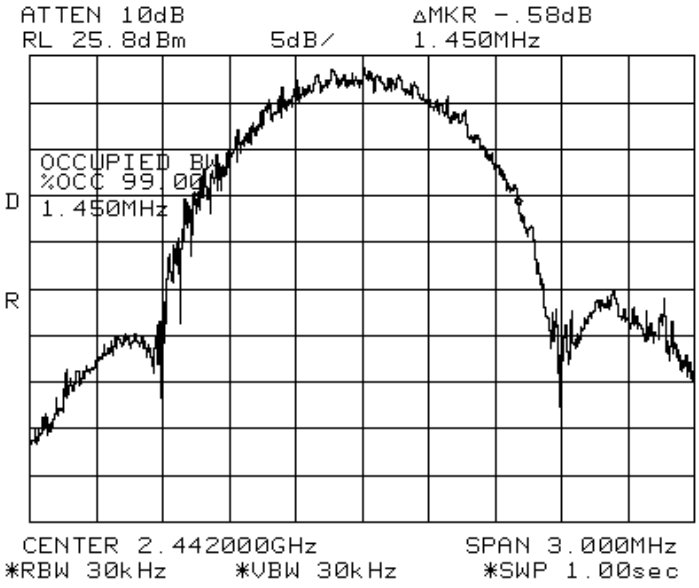
BPSK mid 99% OBW



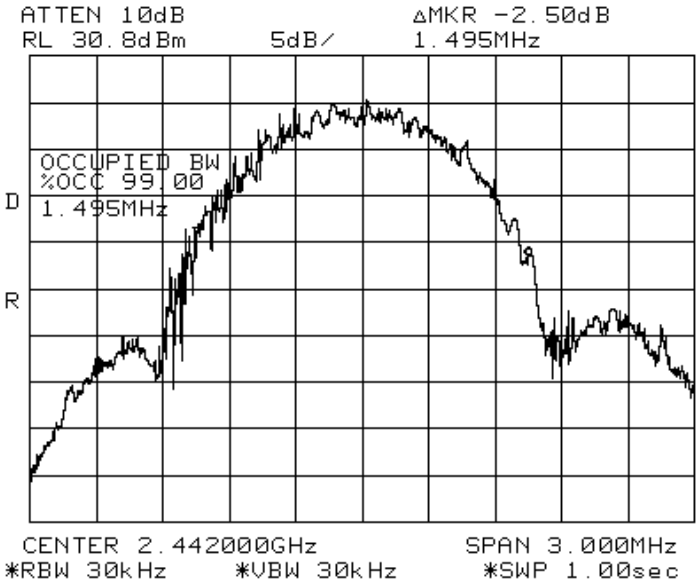
QPSK mid 99% OBW



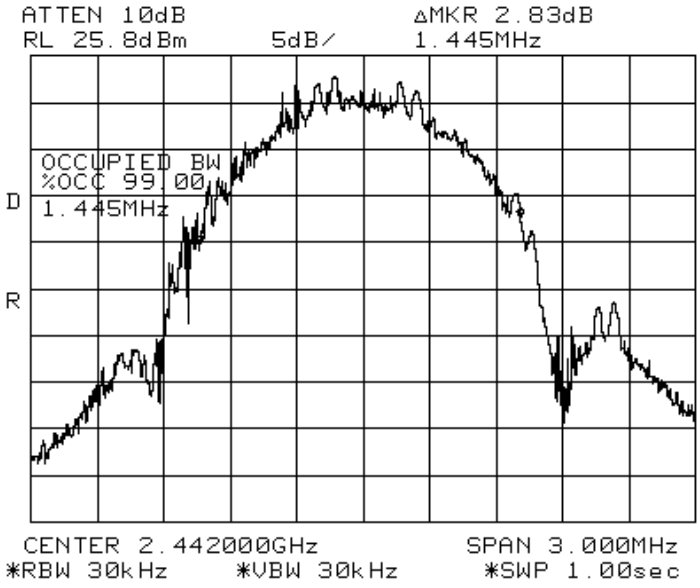
8PSK mid 99% OBW



16 PSK mid 99% OBW



16 QAM mid 99% OBW



32 QAM mid 99% OBW

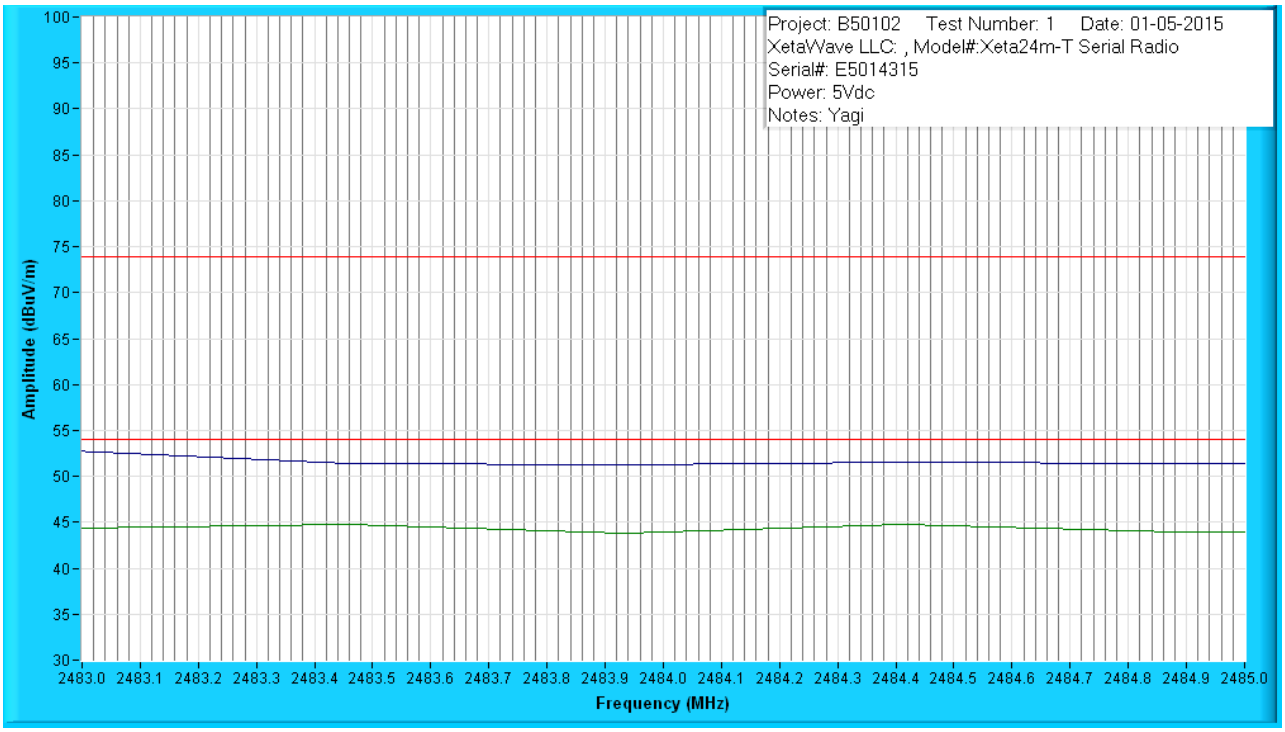
Test Results – Band Edge

Table No. 3	Radiated Emissions – Band Edge	Verdict
		P

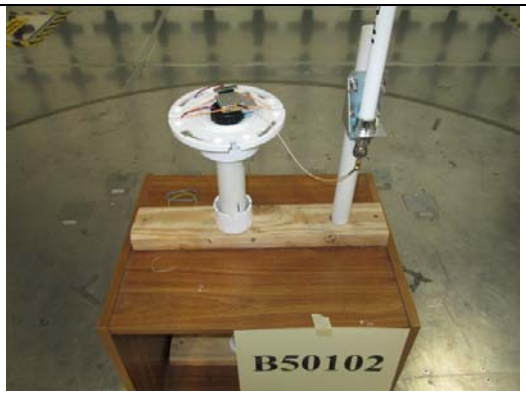
Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : 3 meters
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-5-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1196, 1197, 1197, 1220, 1253, 1337, 1339, 1340, 1341, 1381, 1396, 1410, 1500, 1538

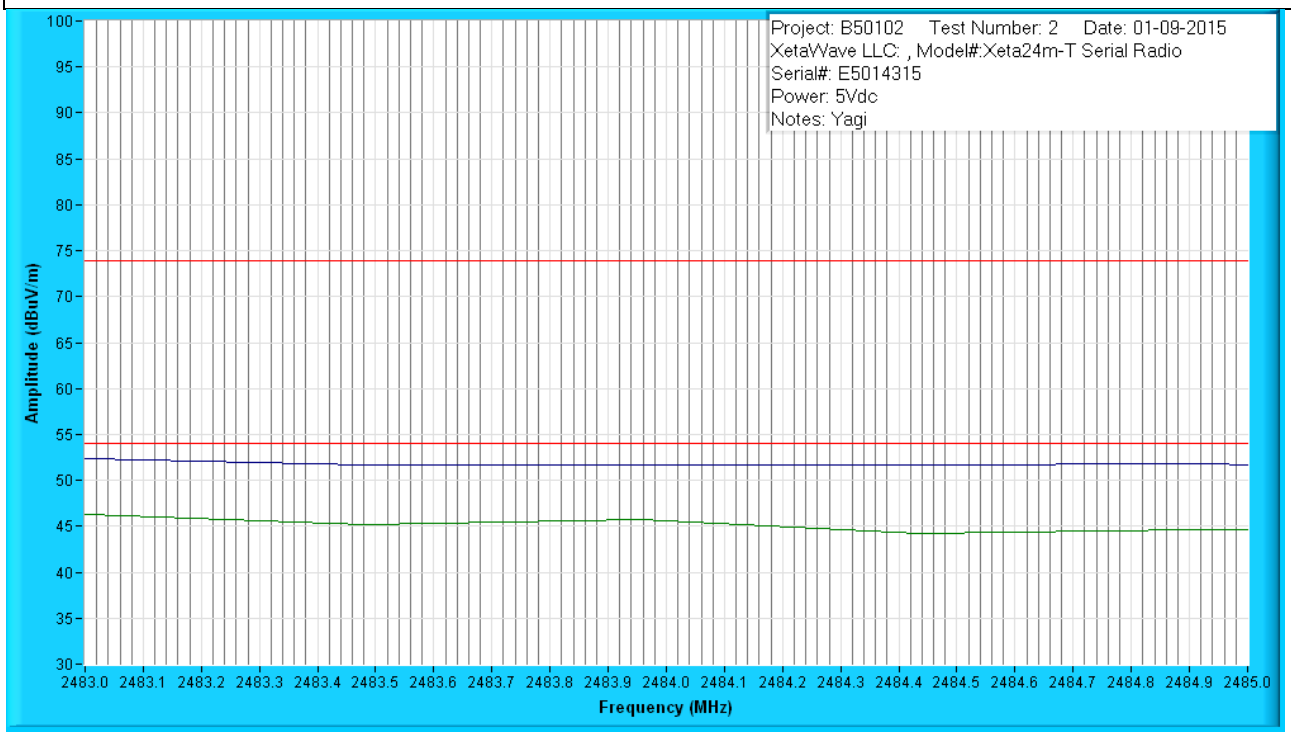
Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

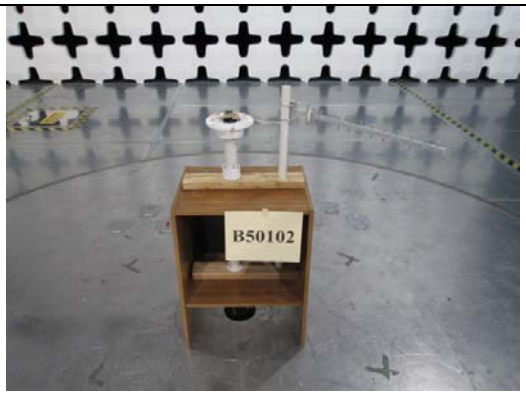


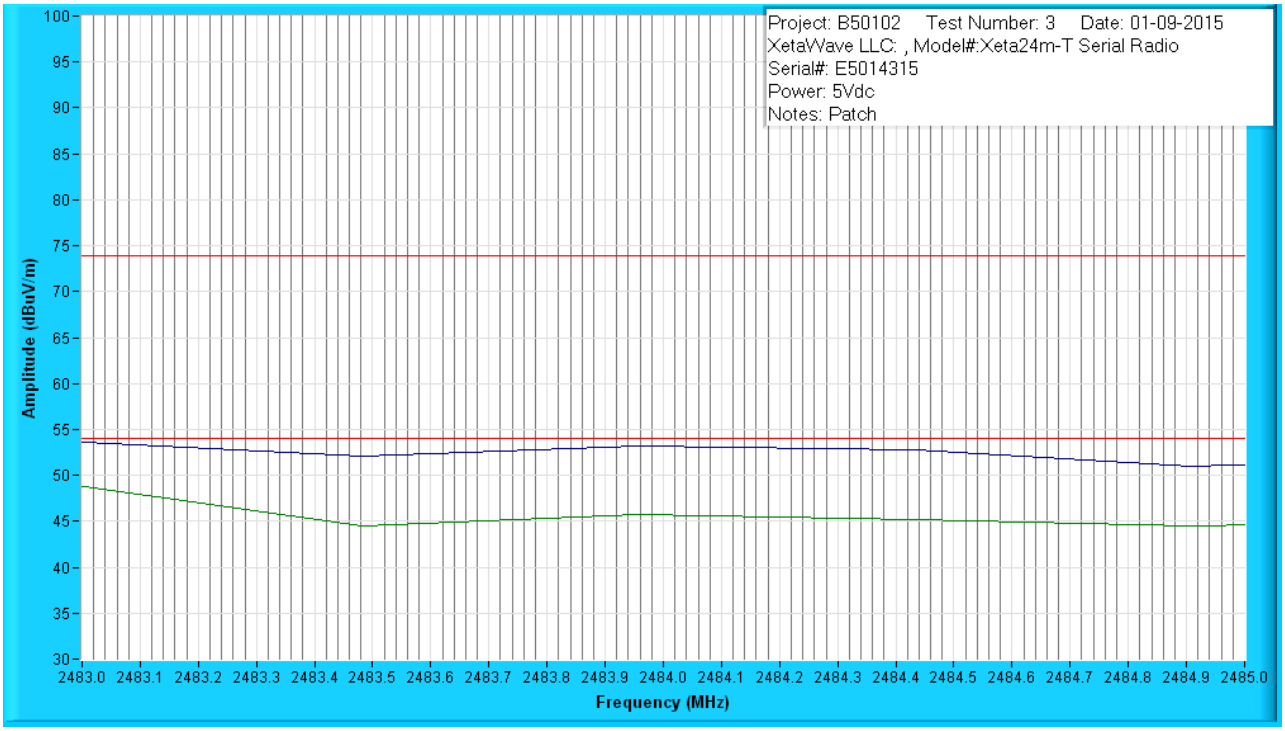
Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
Band Edge Omni								



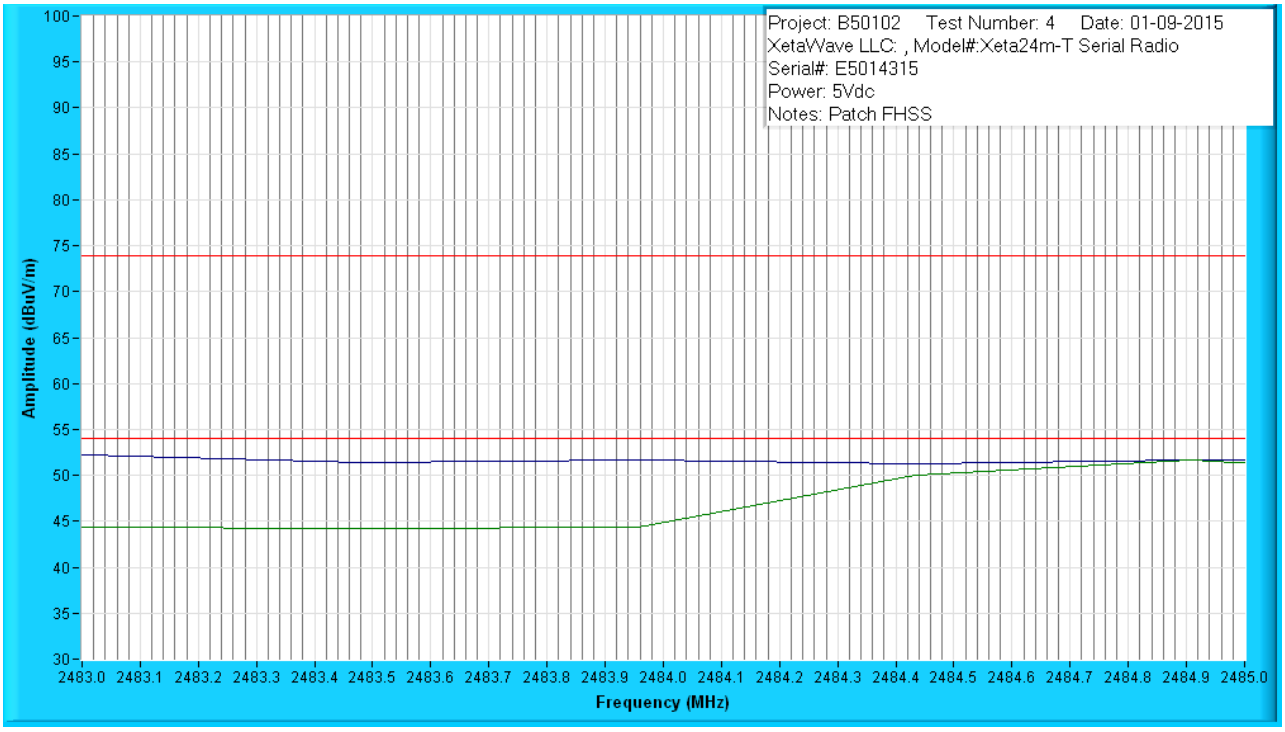


Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
Band edge Yagi								





Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
Patch								



Type	Frequency (MHz)	Level (dBuV)	Transducer (dB/m)	Gain / Loss (dB)	Final (dBuV/m)	Azm(deg)/Pol/Hgt(m)	Margin: FCC Class B >1GHz PK (dB)	Margin: FCC Class B >1GHz AV (dB)
Patch FHSS								

Test Results – DTS – 6 dB Occupied Bandwidth

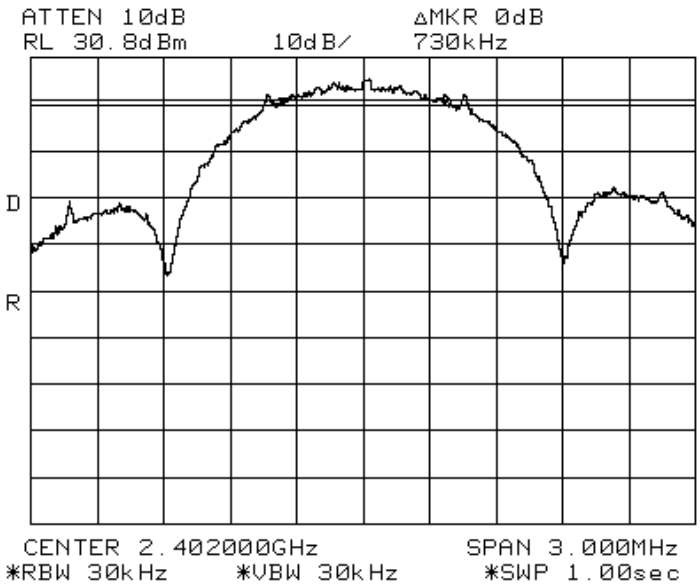
Table No. 4	DTS – 6 dB Occupied Bandwidth	Verdict
		P

Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-8-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

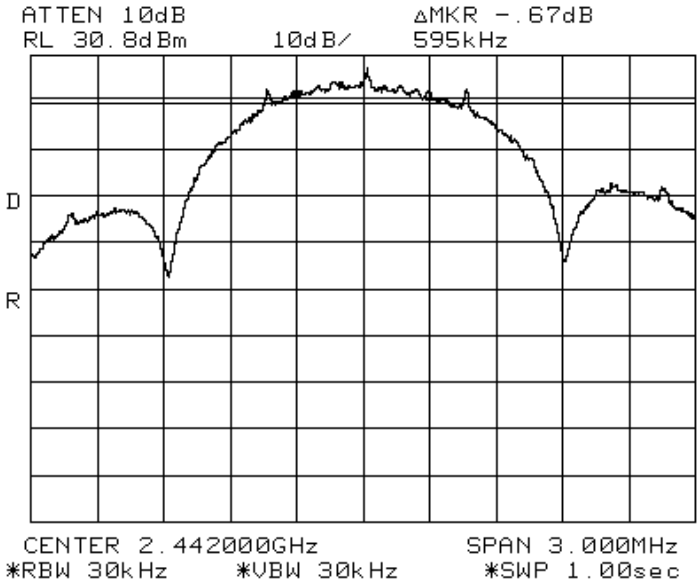
Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

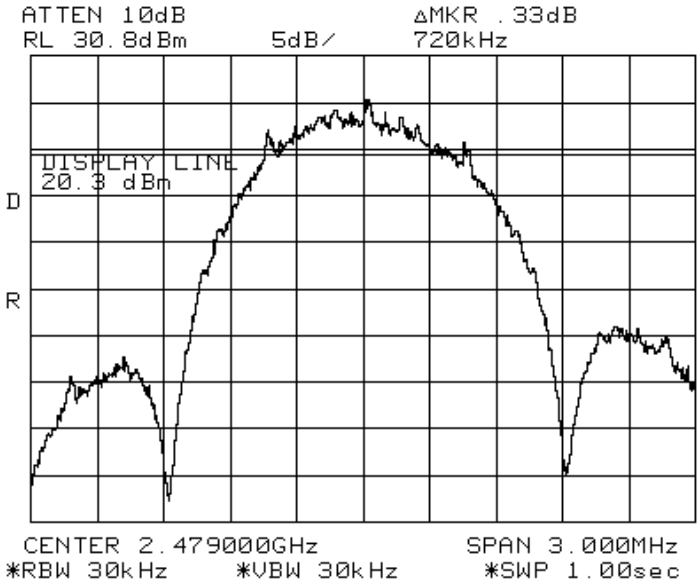
6dB Occupied BW



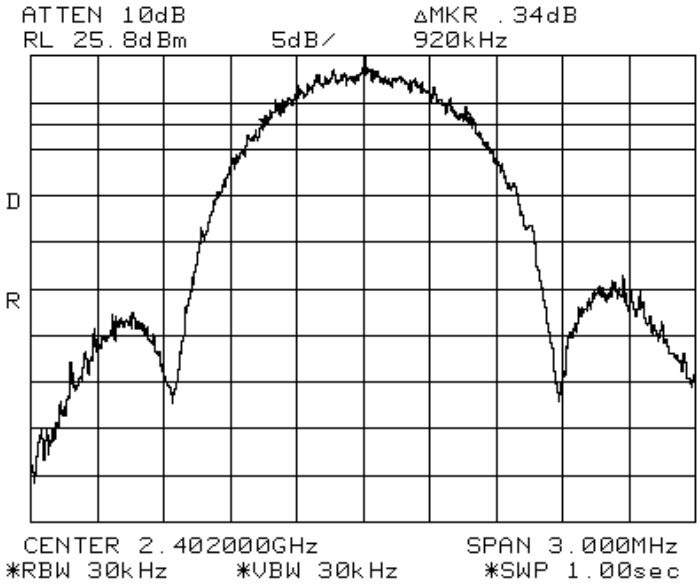
6dB occupied BW low BPSK



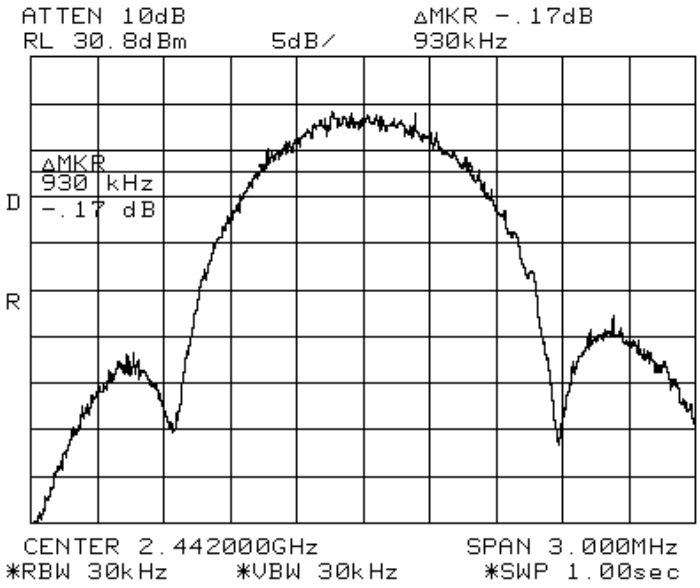
6dB occupied BW mid BPSK



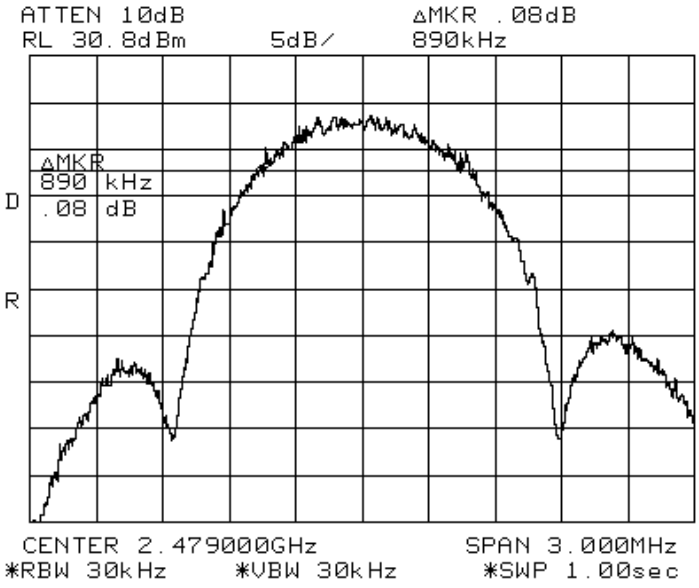
6dB occupied BW high BPSK



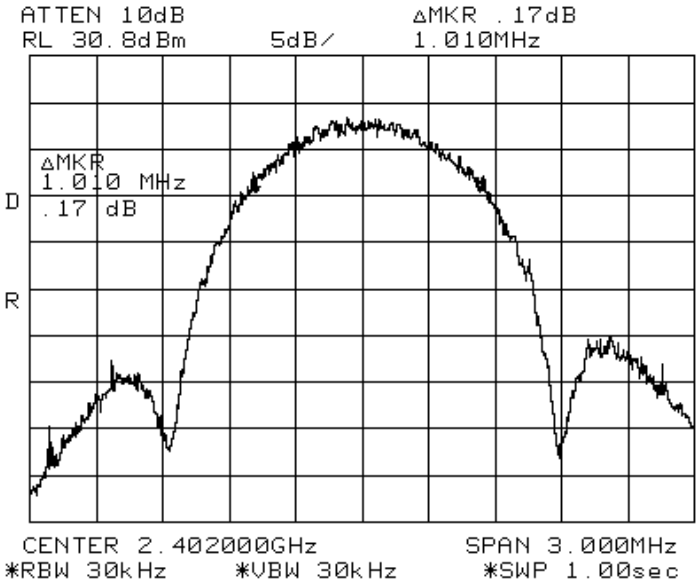
6dB occupied BW low QPSK



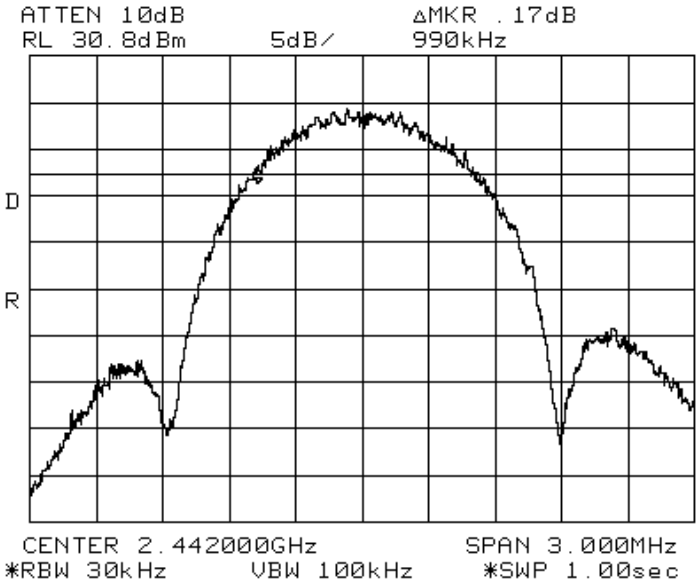
6dB occupied BW mid QPSK



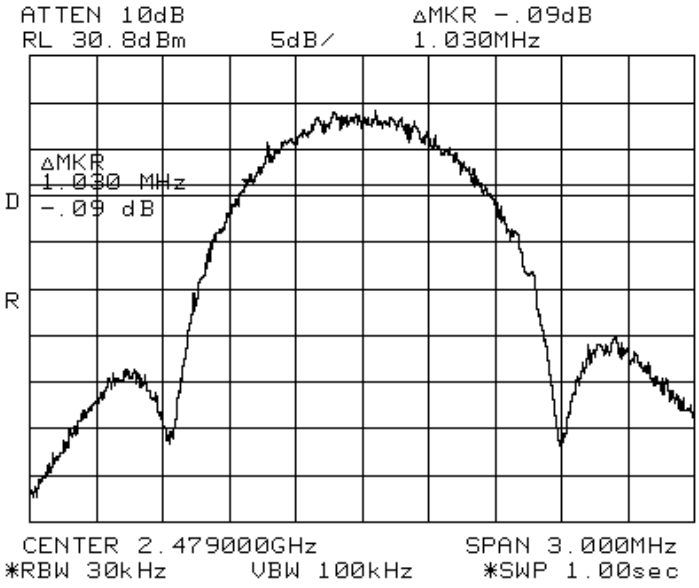
6dB occupied BW high QPSK



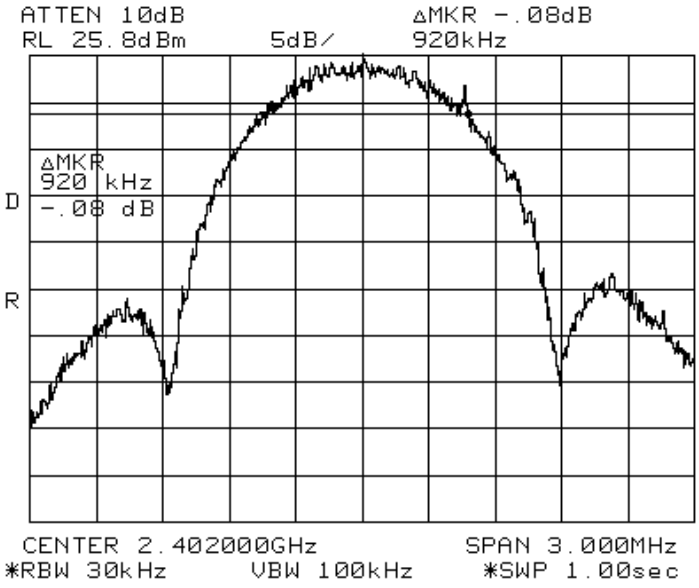
6dB occupied BW low 8PSK



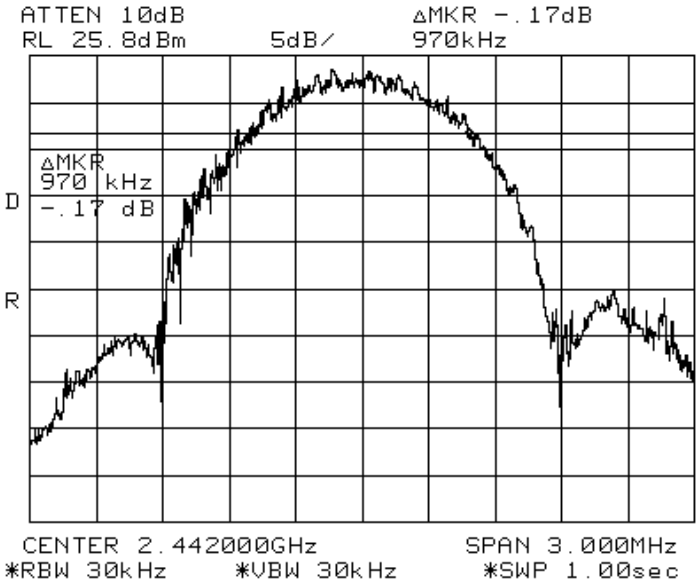
6dB occupied BW mid 8PSK



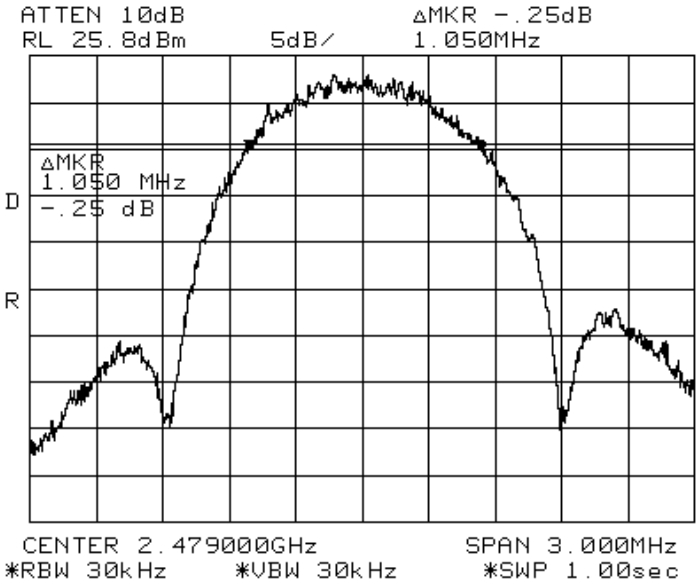
6dB occupied BW high 8PSK



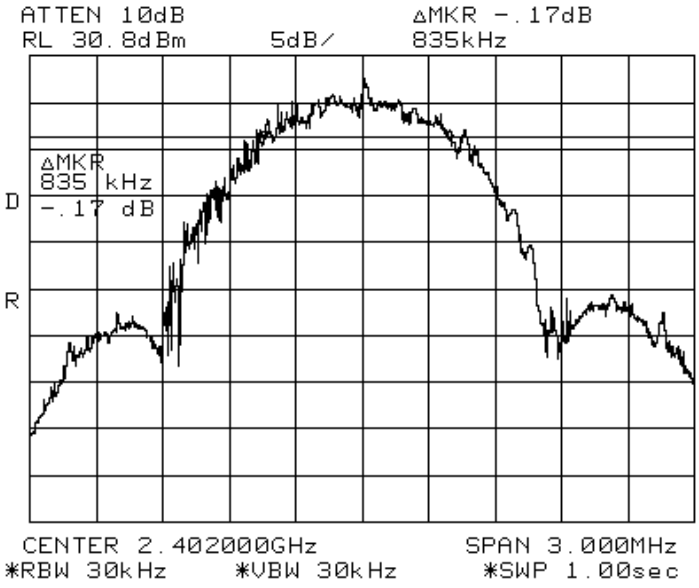
6dB occupied BW low 16PSK



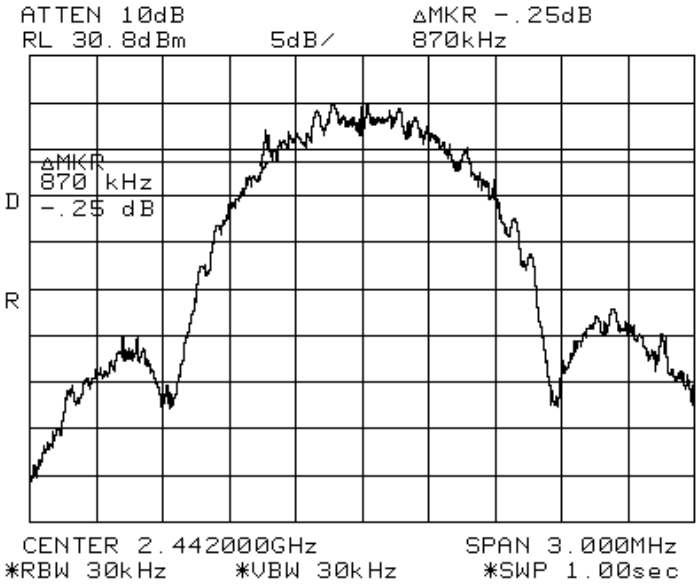
6dB occupied BW mid 16PSK



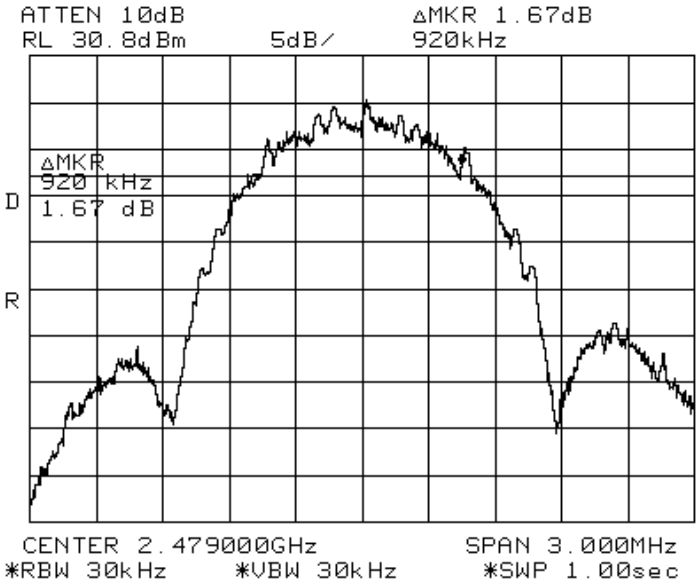
6dB occupied BW high 16PSK



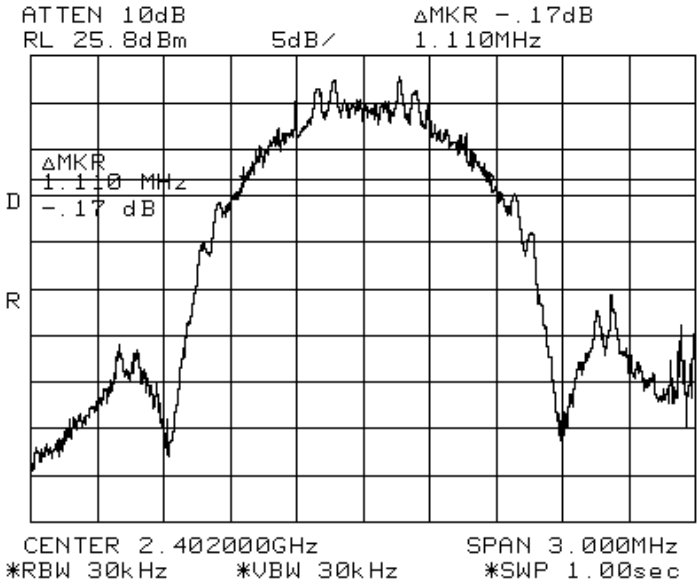
6dB occupied BW low 16QAM



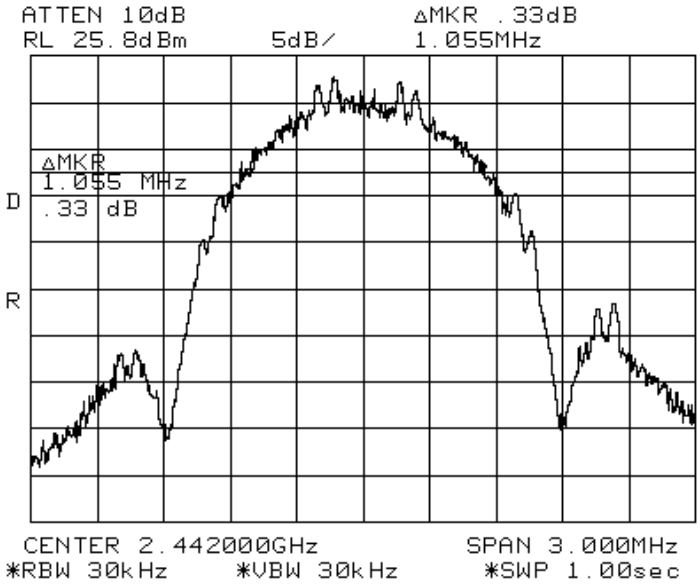
6dB occupied BW mid 16QAM



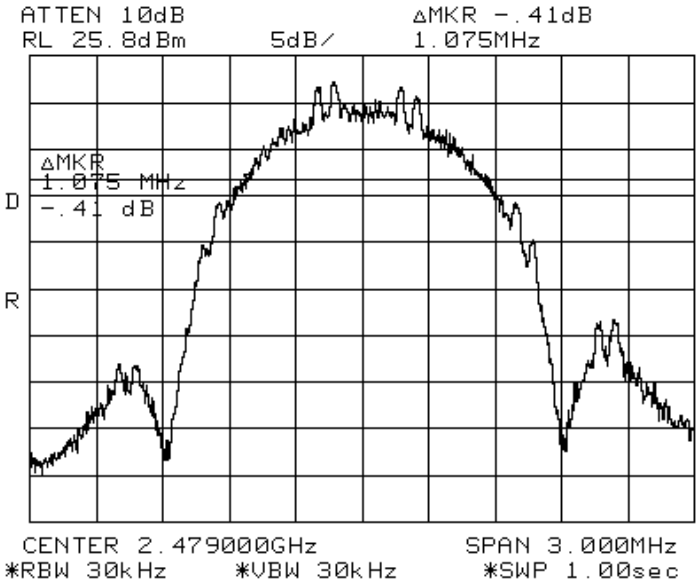
6dB occupied BW high 16QAM



6dB occupied BW low 32QAM



6dB occupied BW mid 32QAM



6dB occupied BW high 32QAM

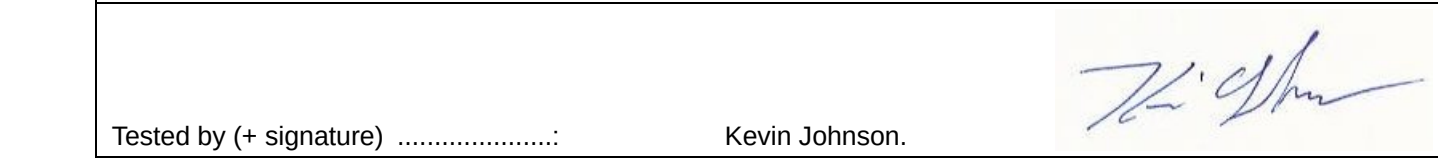
Test Results – DTS – Power Spectral Density

Table No. 5	DTS – Power Spectral Density	Verdict
		P

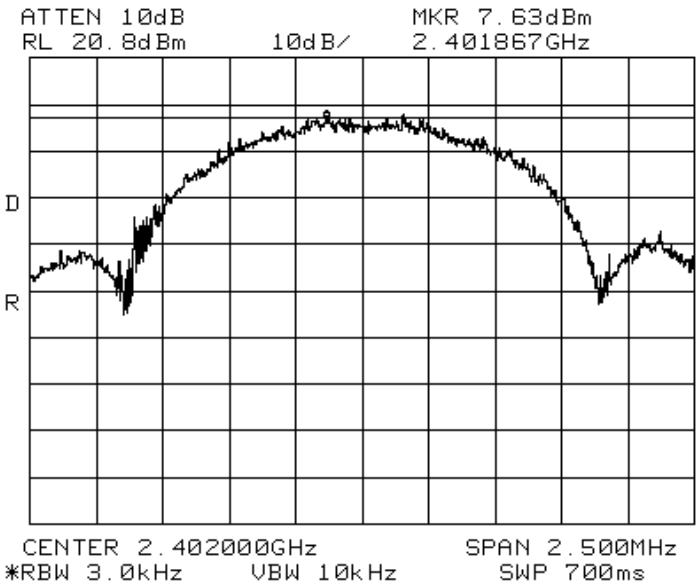
Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

Supplemental Information:

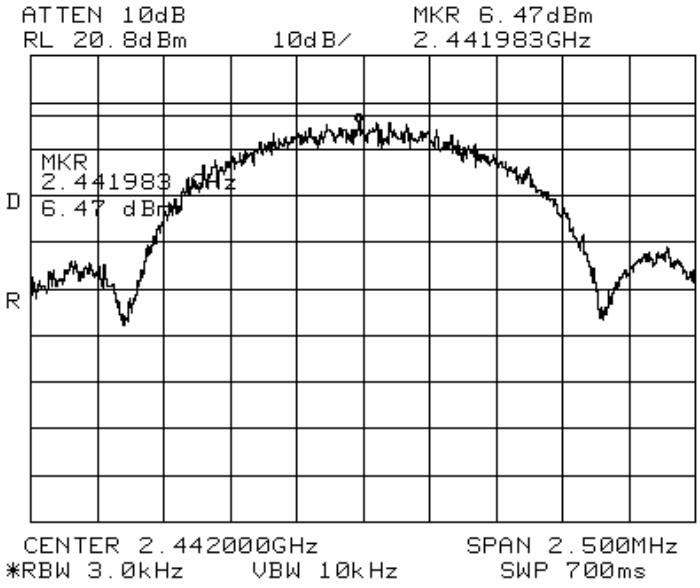
Tested by (+ signature) .....: Kevin Johnson.



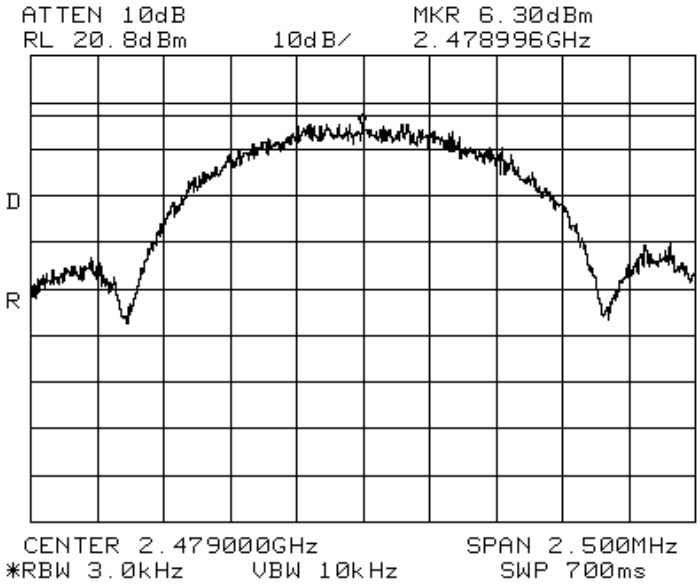
Power Density



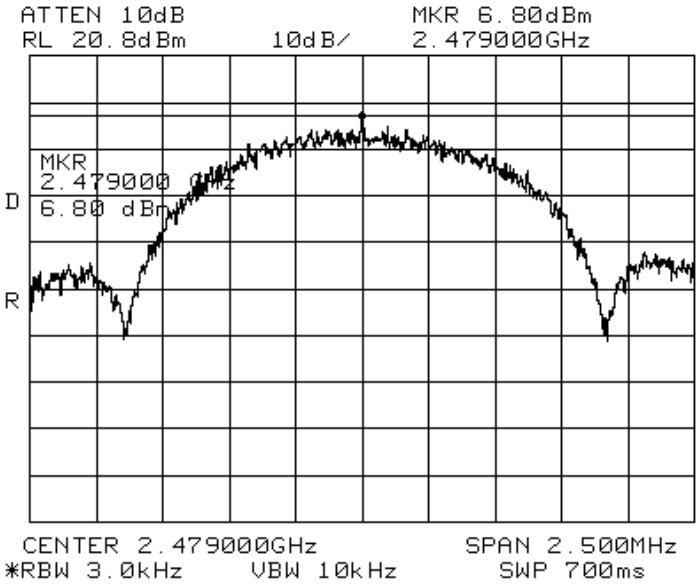
Power density 32 QAM low 2402MHz



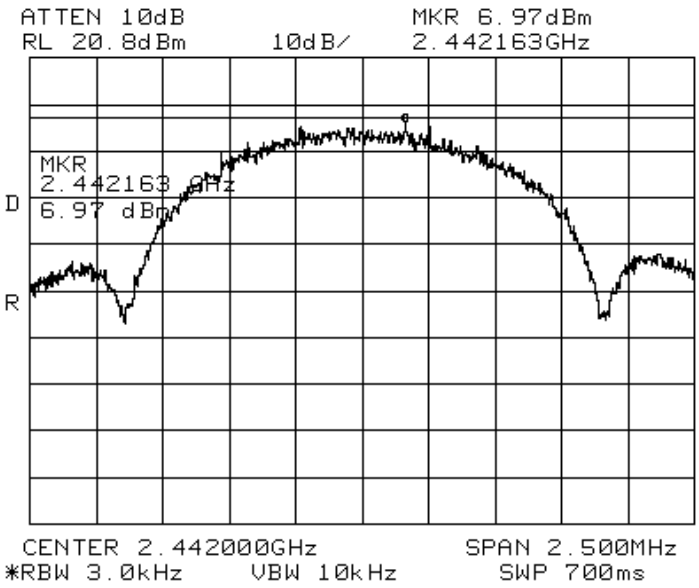
Power density 32 QAM mid 2442MHz



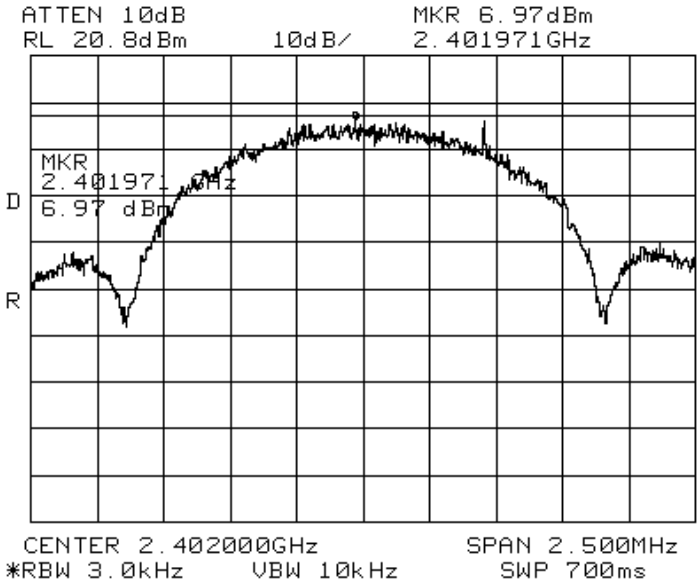
Power density 32 QAM high 2479MHz



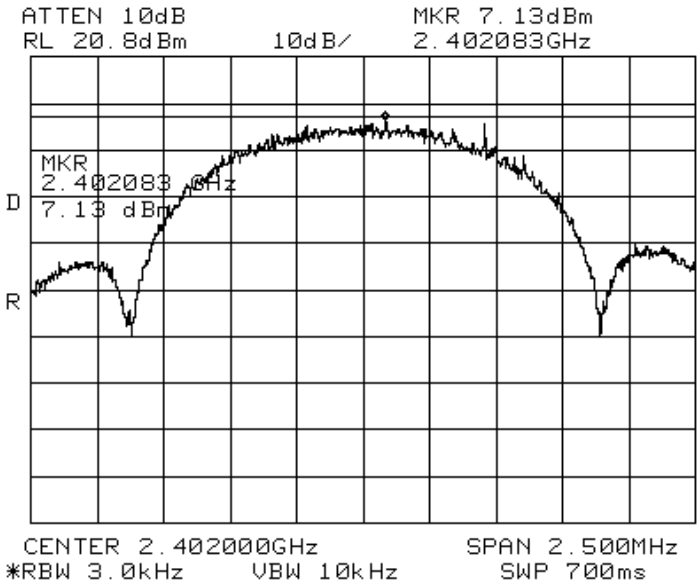
Power density 16 PSK high 2479MHz



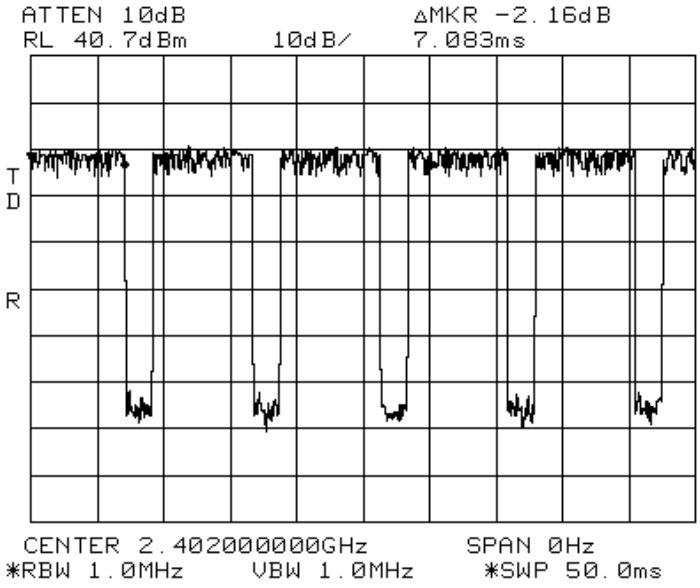
Power density 16 PSK mid 2442MHz



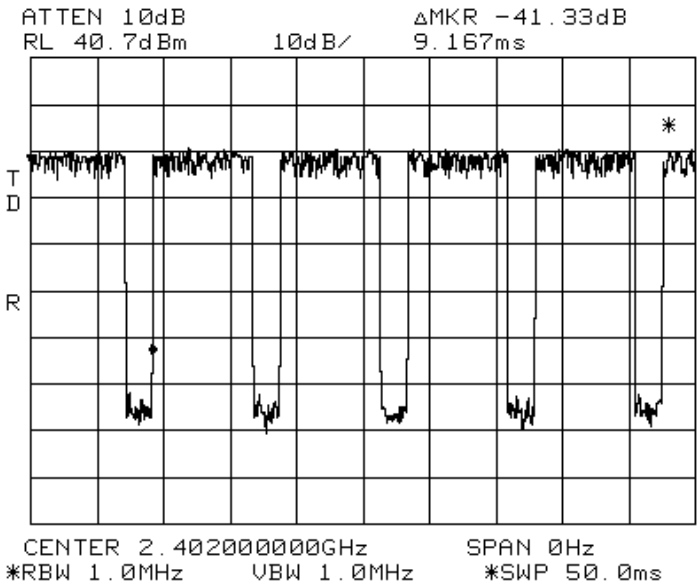
Power density 16 PSK low 2402MHz



Power density QPSK low 2402MHz

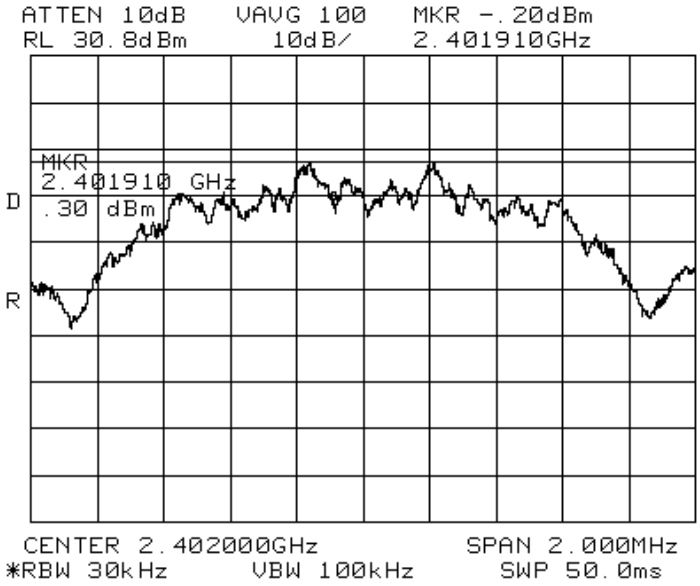


Power density duty cycle QPSK, RF on time = 7.083ms

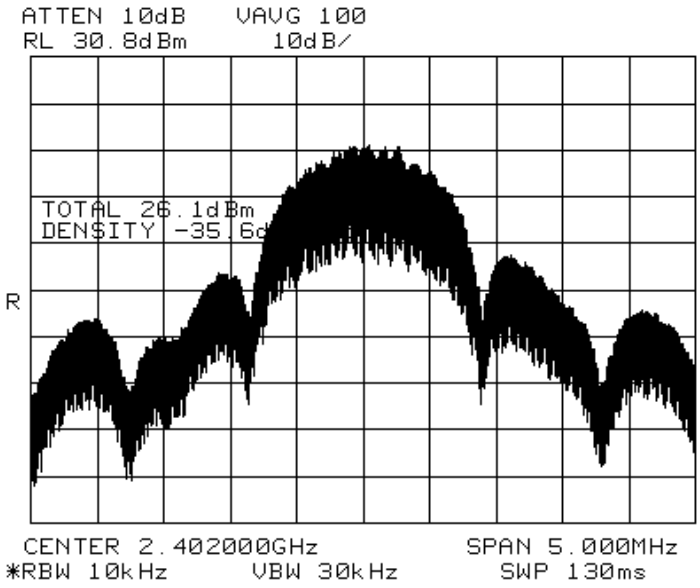


Power density QPSK, 7.083ms/9.167=.773

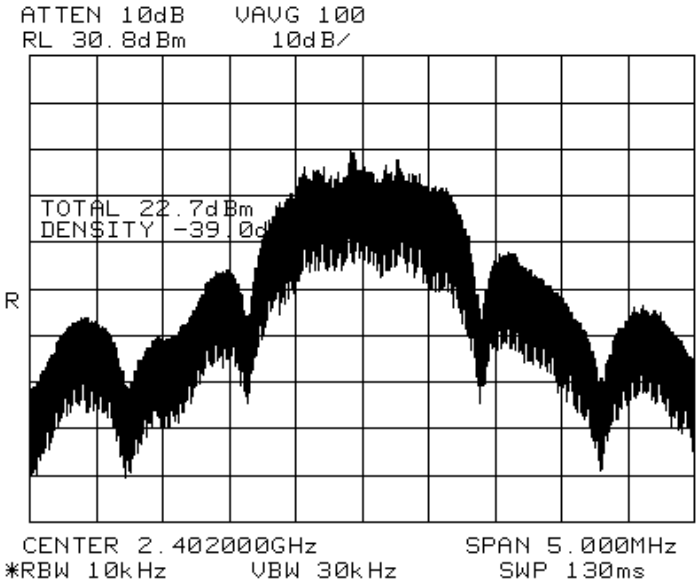
10 log 1/.77=1.14dB



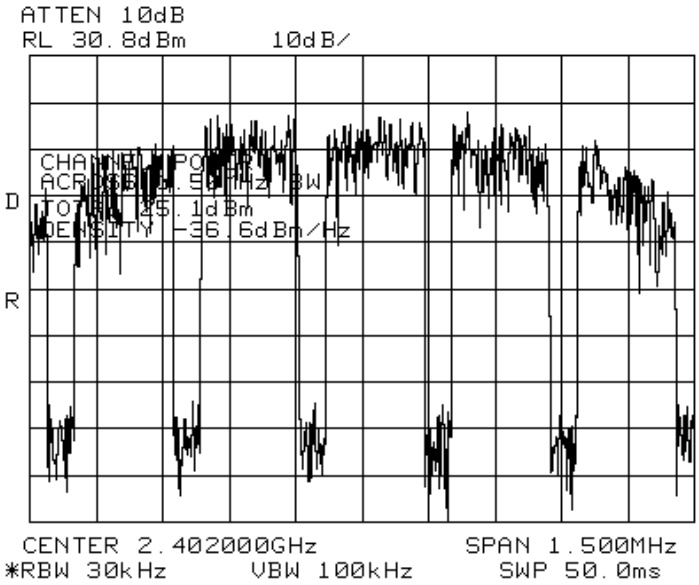
Power density QPSK, -.2+1.1=-2.89dBm



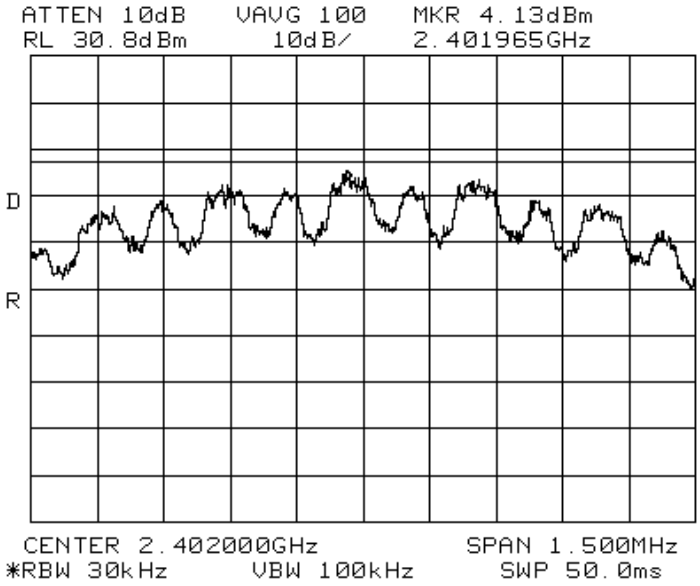
Average power QPSK



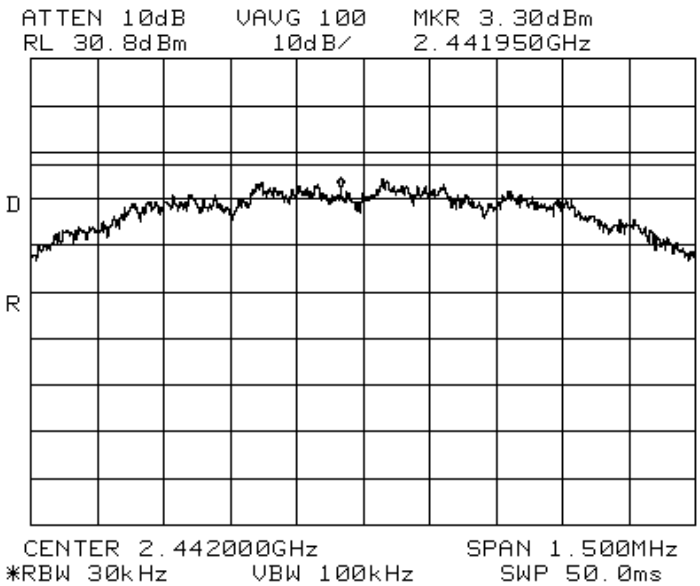
Average power QPSK



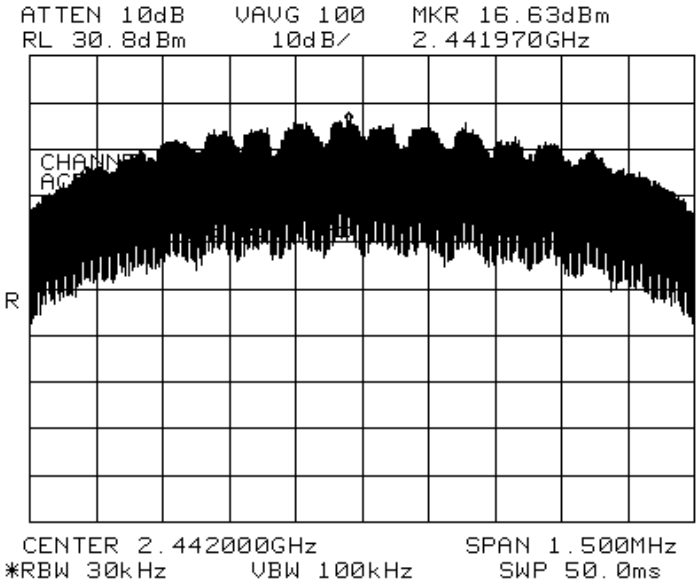
Power low QPSK=1.1dB=25.2dBm



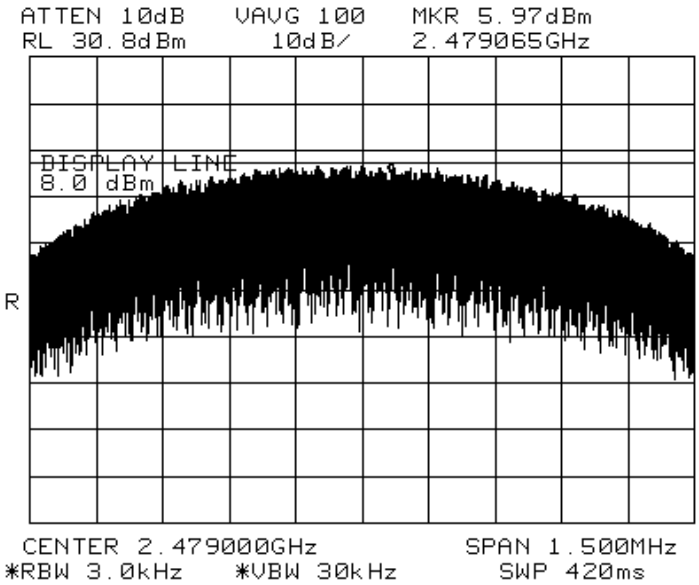
Power density low QPSK=1.1+ 4.13dB=5.2dBm



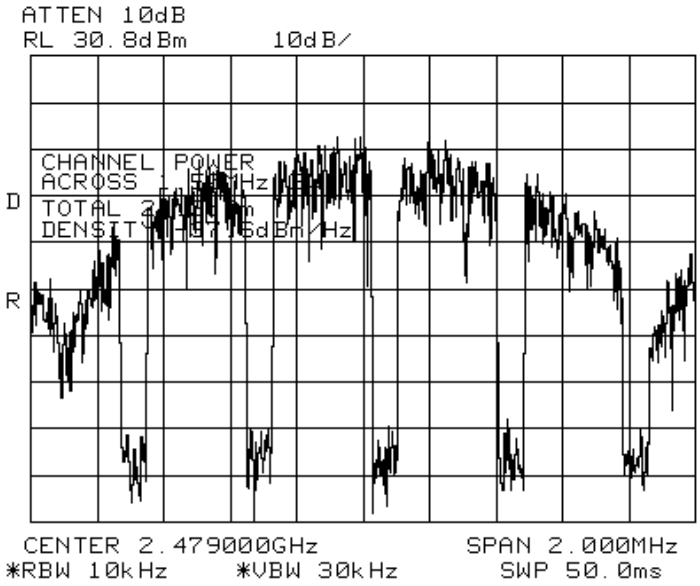
Power density mid 3.3+ 1.1=4.4dBm



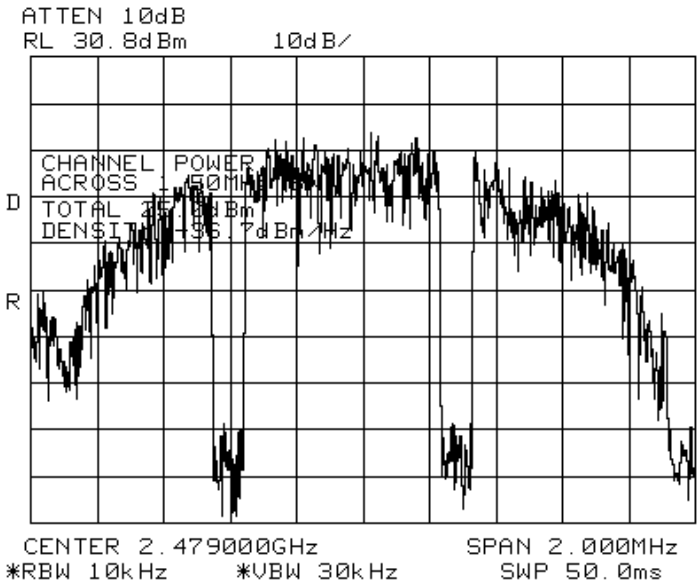
Power mid QPSK 25.7+1.1=26.8dBm



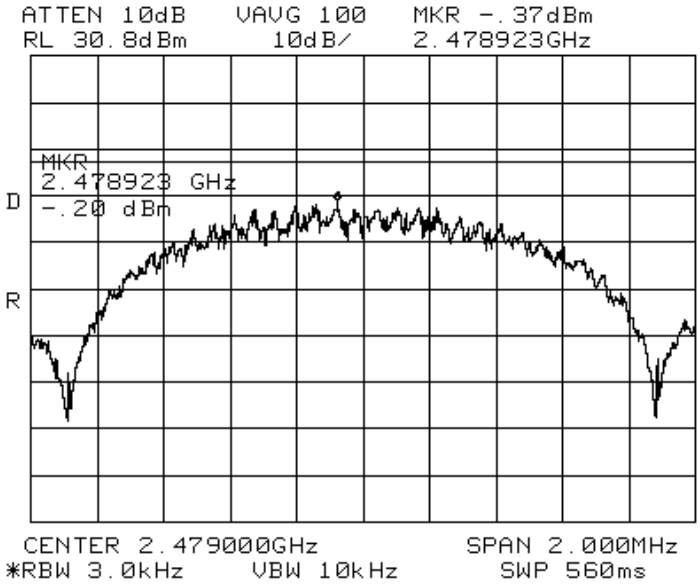
Power density high QPSK = 1.1+5.97=7.07dBm



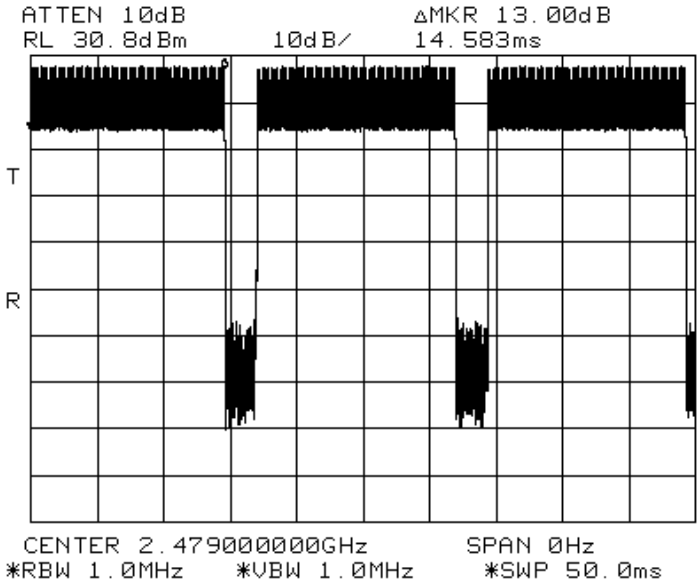
Power = 24.2+1.1= 25.3dBm



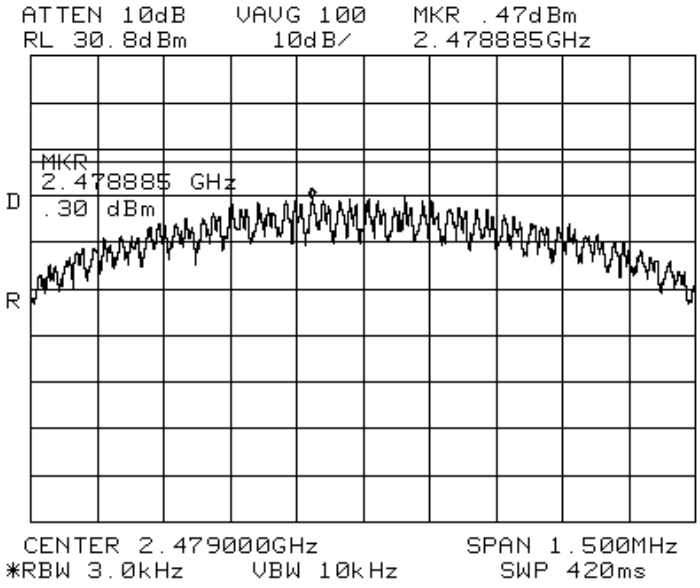
Power BPSK High 25+.79=25.79dBm



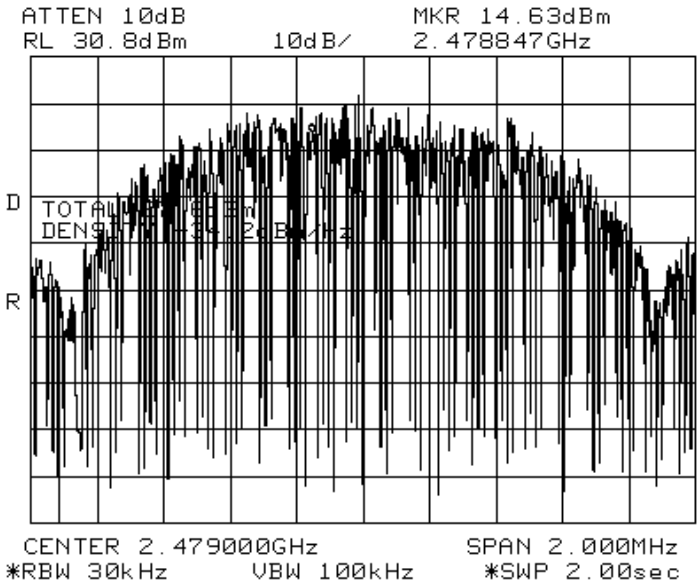
Power density BPSK High



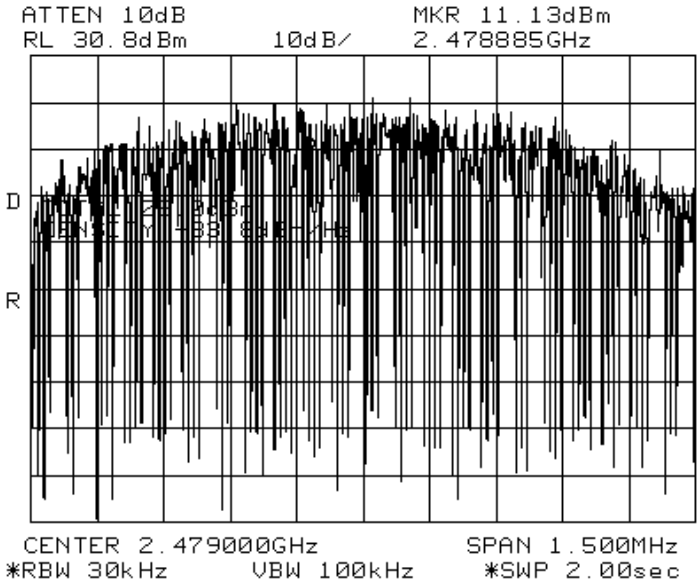
Power density duty cycle BPSK



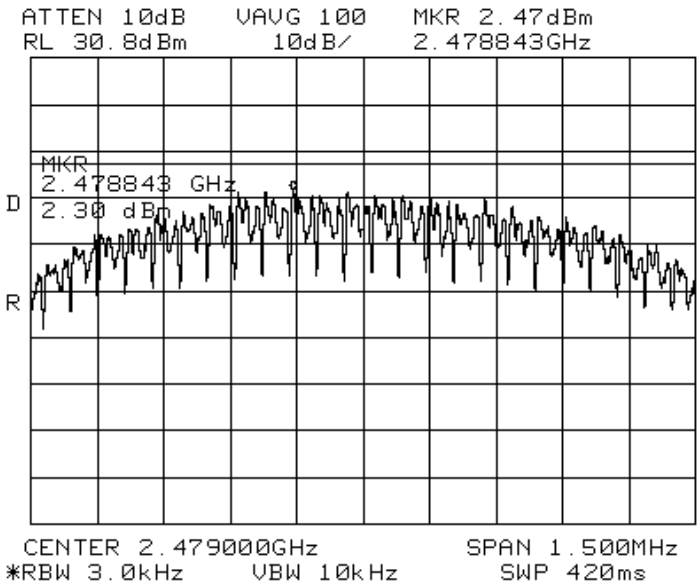
Power density BPSK high



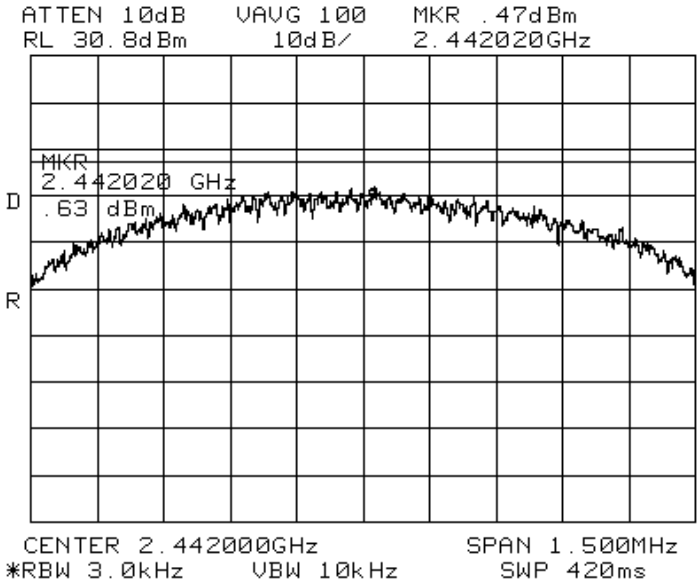
Power density BPSK High



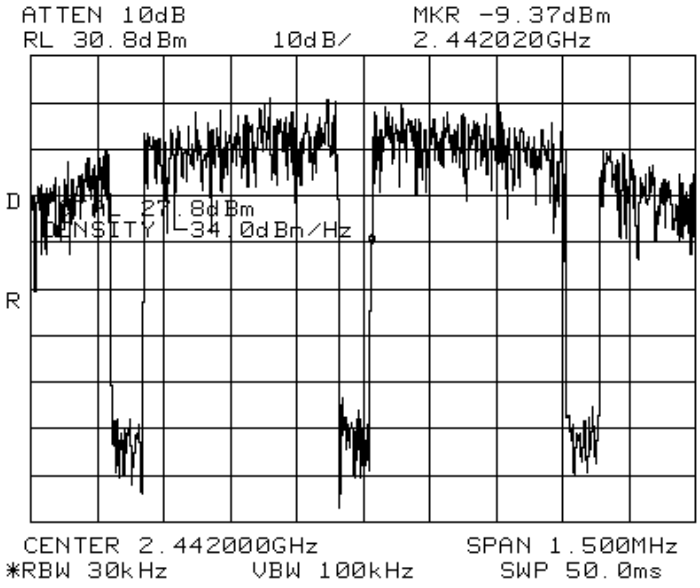
Power BPSK high 25 +.79=25.79dBm



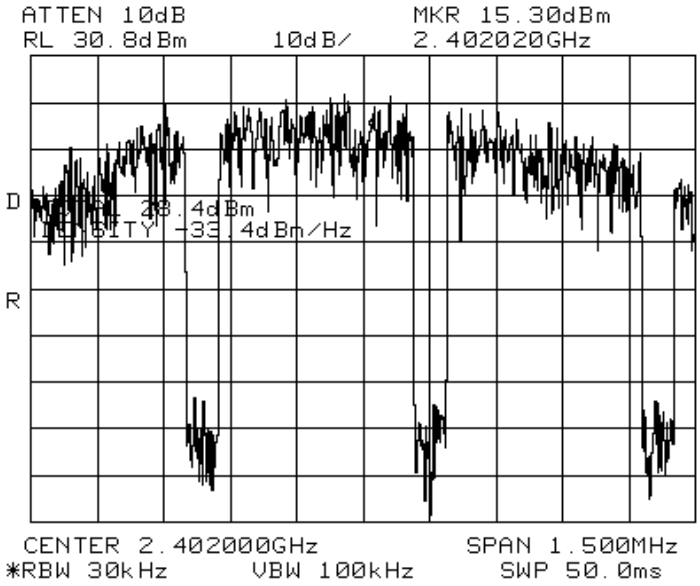
Power density BPSK high .79+2.47= 3.26dBm



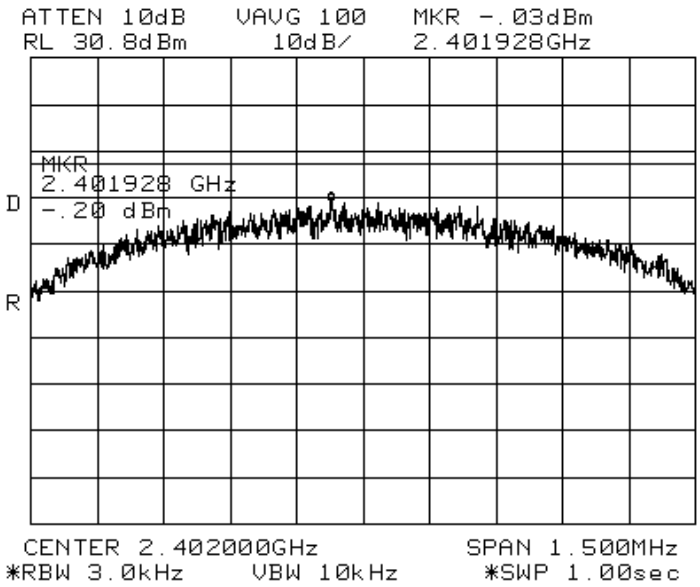
Power density BPSK mid .79+.47=1.26dBm



Power BPSK mid 27.8 +.79=28.59dBm



Power BPSK low 28.4+.79=29.19



Power density BPSK low .03+.79=1.2dBm

Test Results – DTS – RF Power Output

Table No. 6	DTS – RF Power Output	Verdict
		P

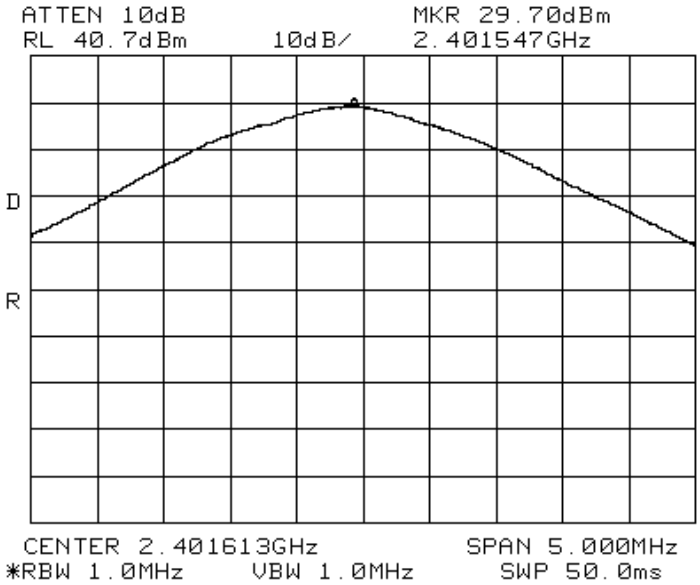
Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

Supplemental Information:

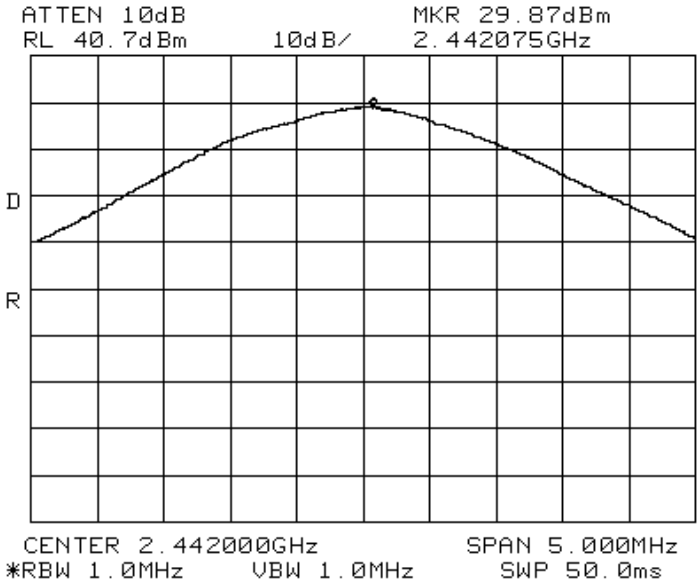
Tested by (+ signature) .....: Kevin Johnson.

DTS

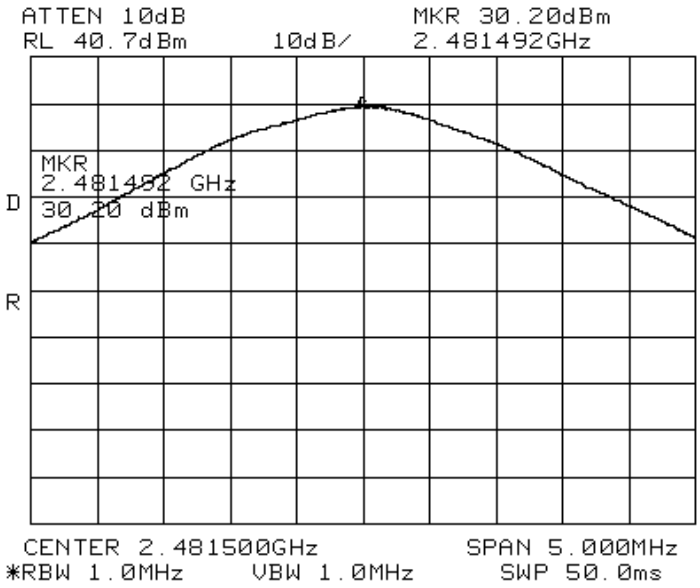
RF Power Output



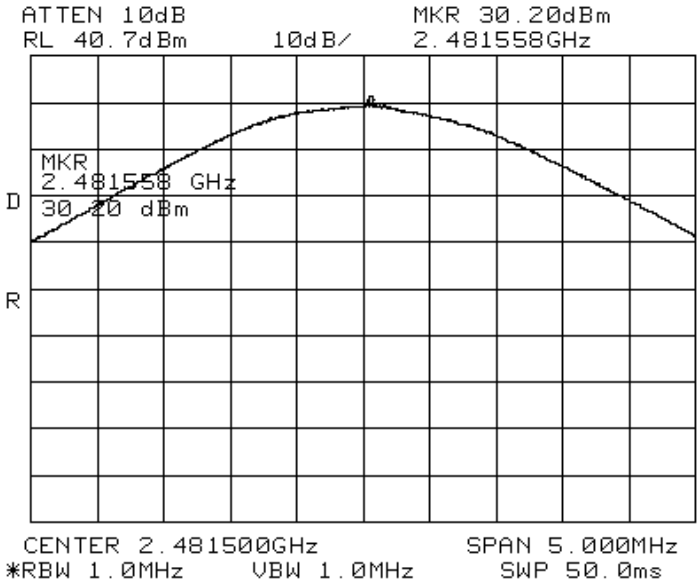
RF Power Output BPSK low 2401.5MHz



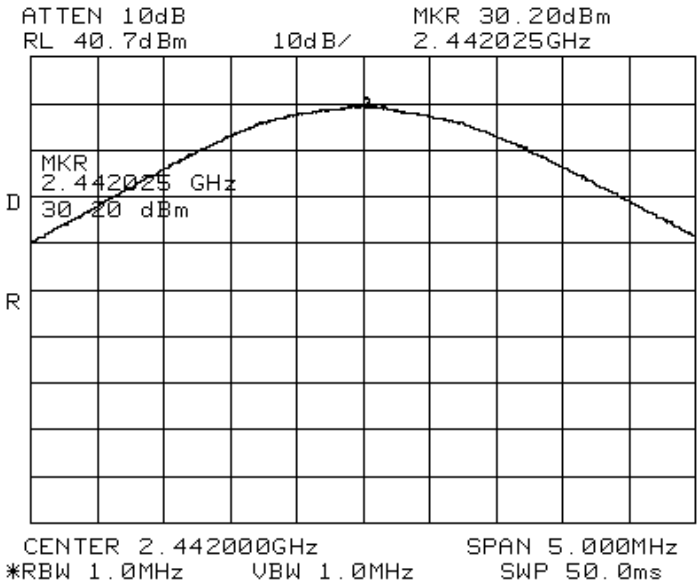
RF Power Output BPSK mid 2442MHz



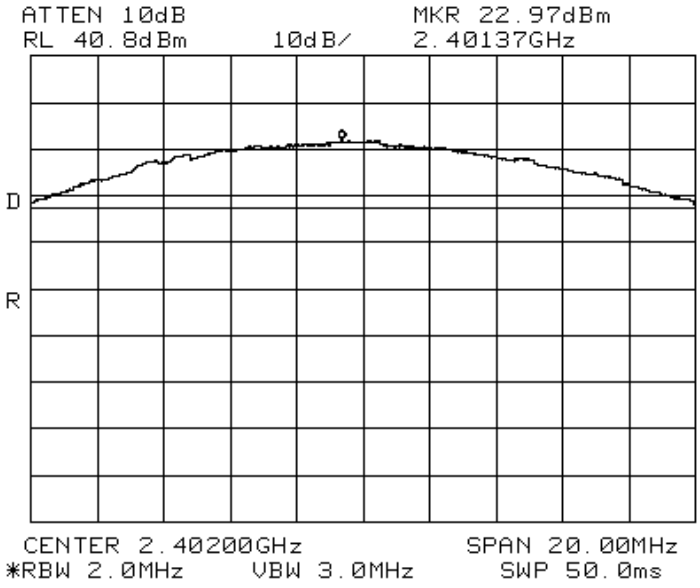
RF Power Output BPSK high 24815MHz



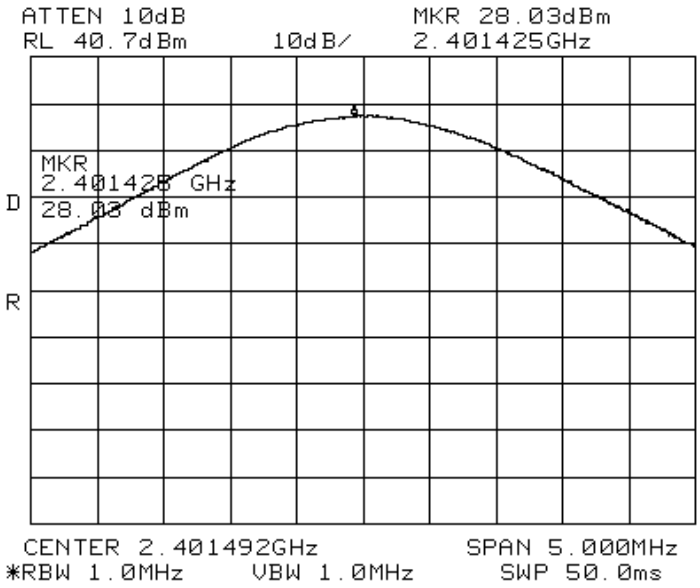
RF Power Output QPSK high 24815MHz



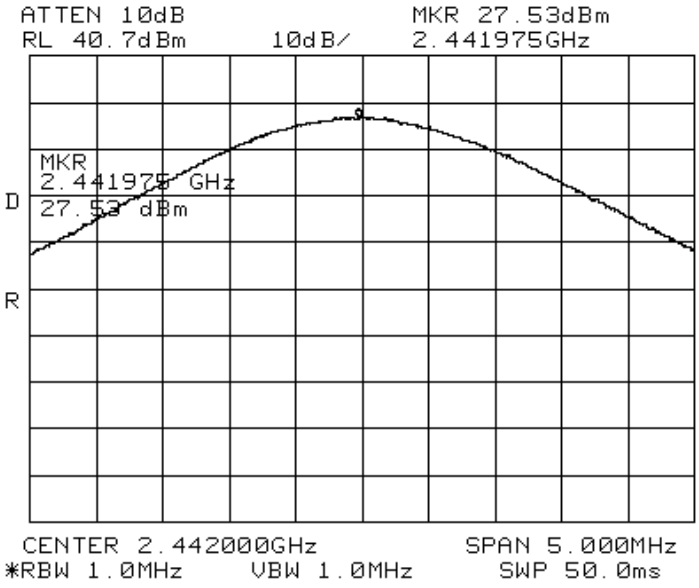
RF Power Output QPSK mid 2442MHz



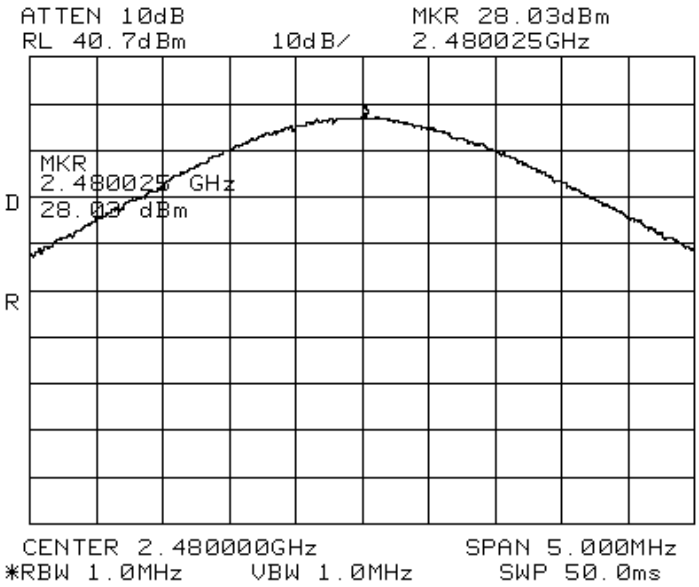
RF Power Output BPSK low 2401.5MHz



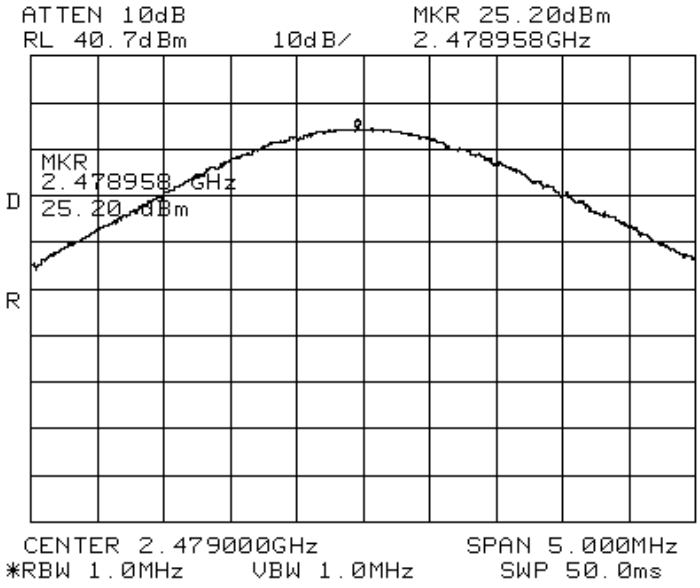
RF Power Output 16PSK low 2401.5MHz



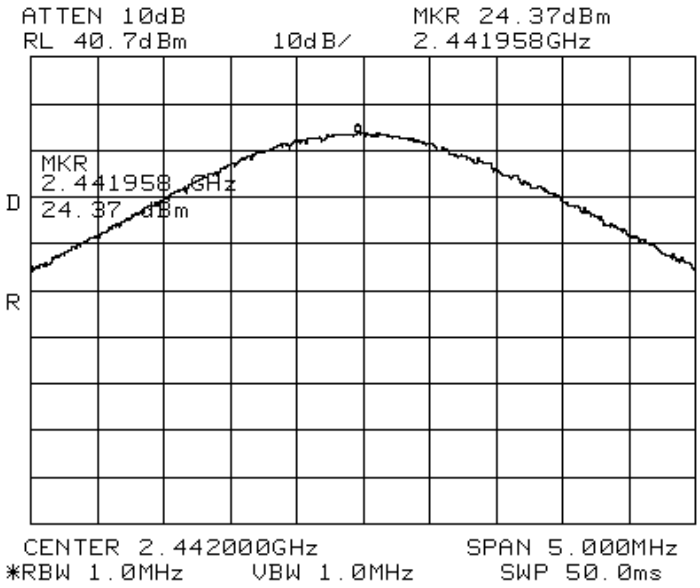
RF Power Output 16PSK mid 2442MHz



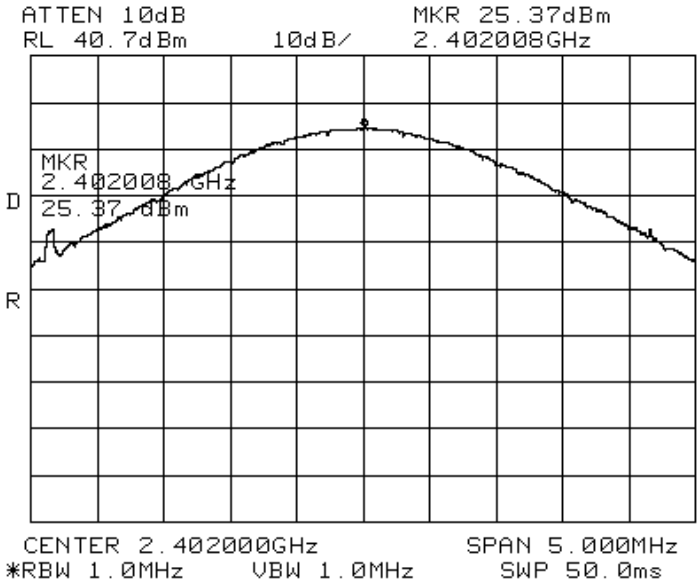
RF Power Output 16PSK high 2480MHz



RF Power Output 32QAM high 2479MHz



RF Power Output 32QAM mid 2442MHz



RF Power Output 32QAM low 2420MHz

Test Results – DTS – Spurious Emissions, Restricted Bands

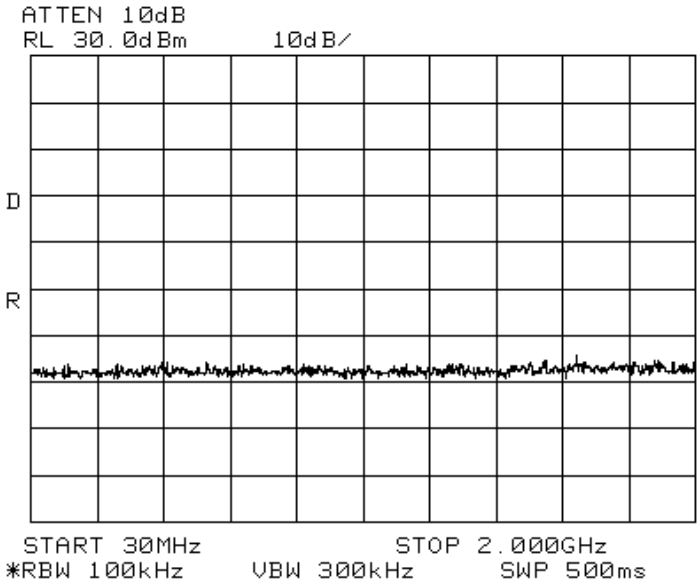
Table No. 7	DTS – Spurious Emissions, 30 MHz to 25 GHz (Including Restricted Bands)	Verdict
		P

Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

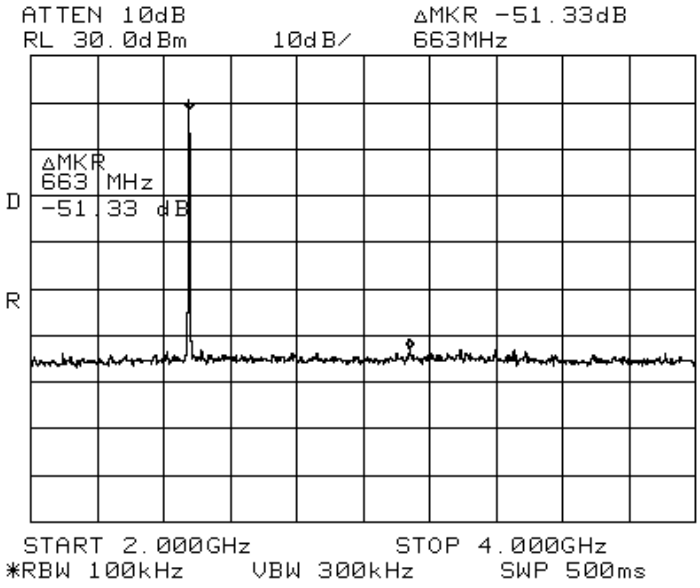
Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

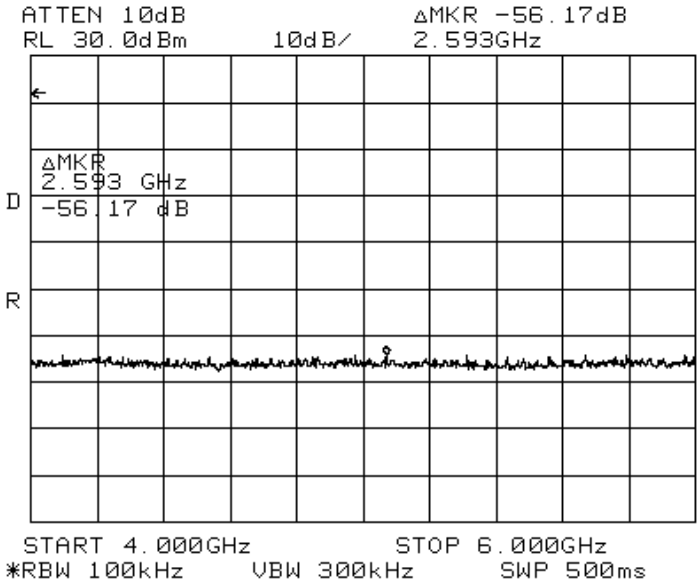
Spurious Emissions Conducted



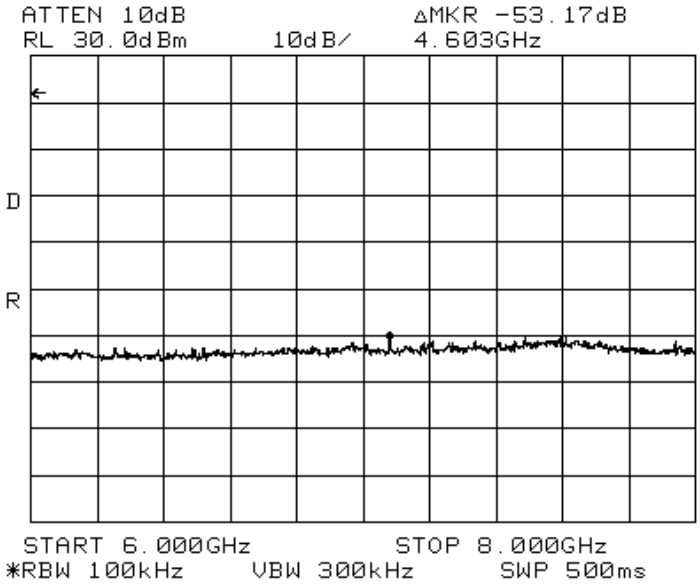
Spurious 32QAM 30MHz – 2GHz, high



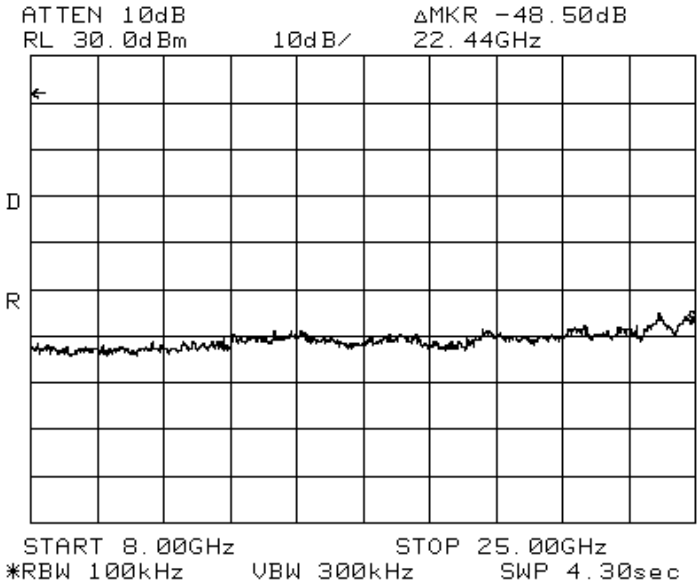
Spurious 32QAM 2GHz – 4GHz, high



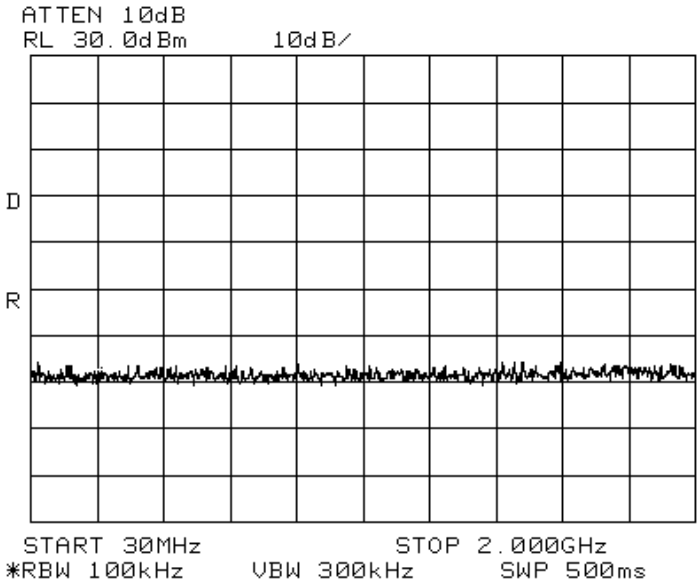
Spurious 32QAM 4GHz – 6GHz, high



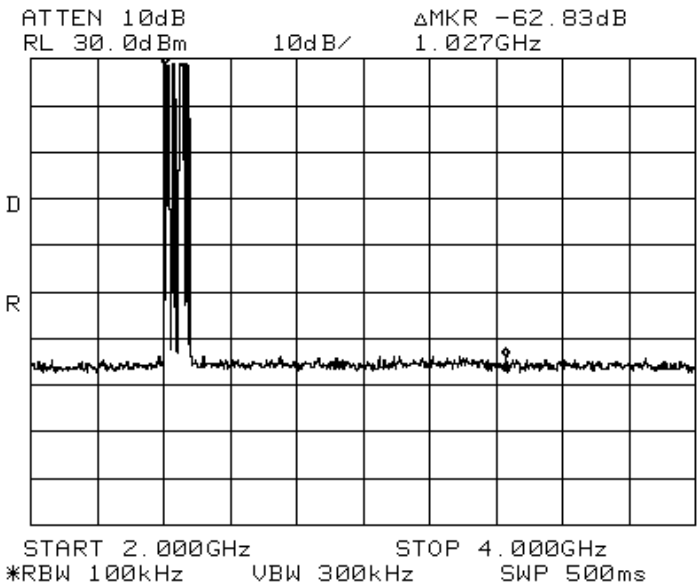
Spurious 32QAM 6GHz – 8GHz, high



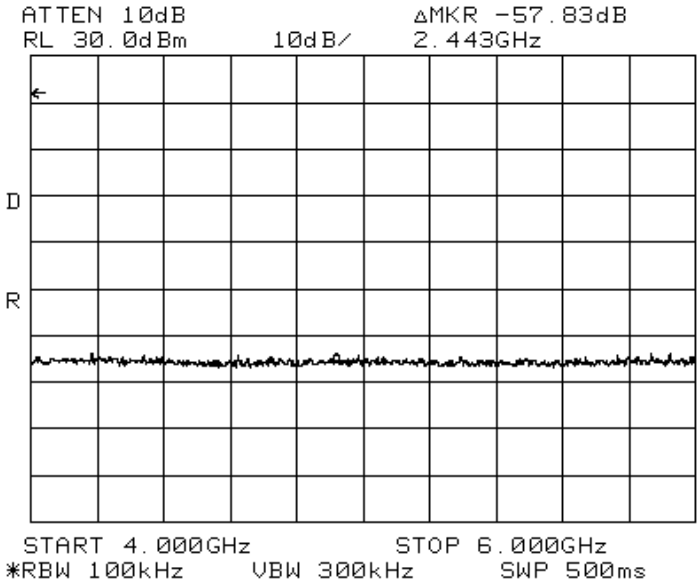
Spurious 32QAM 8GHz – 25GHz, high



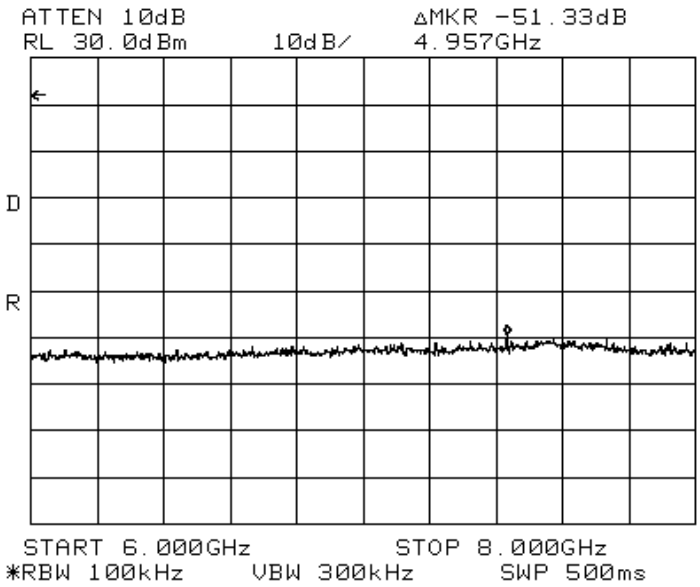
MSK 30MHz – 2GHz



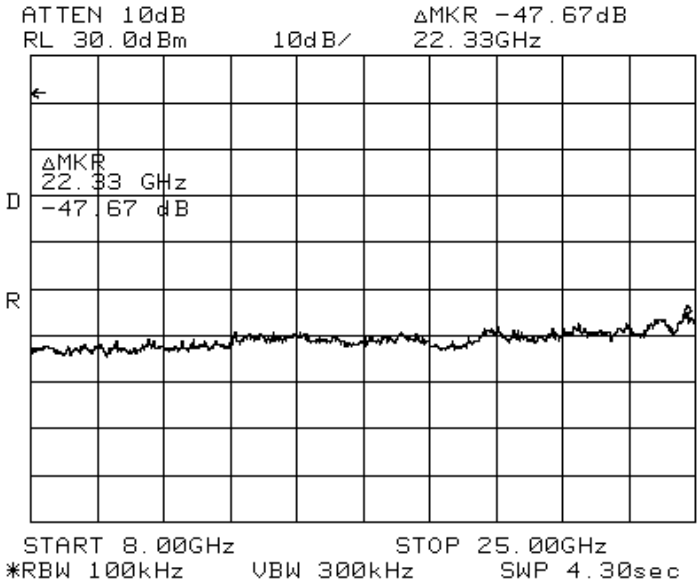
MSK 2GHz – 4GHz



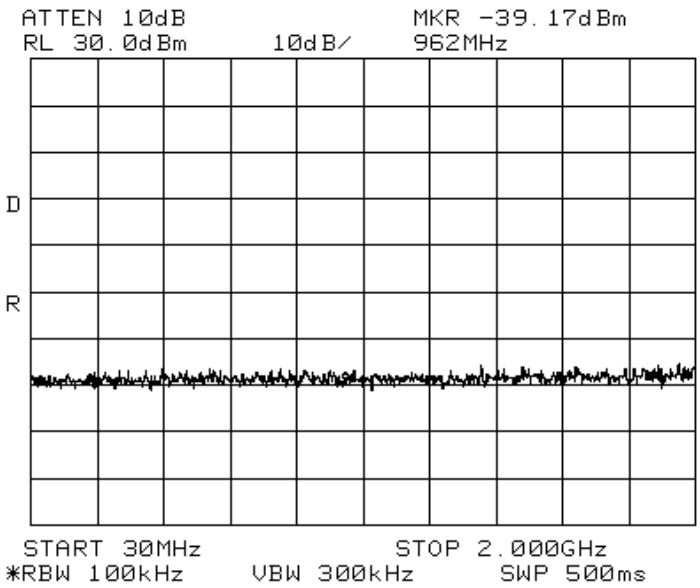
MSK 4GHz – 6GHz



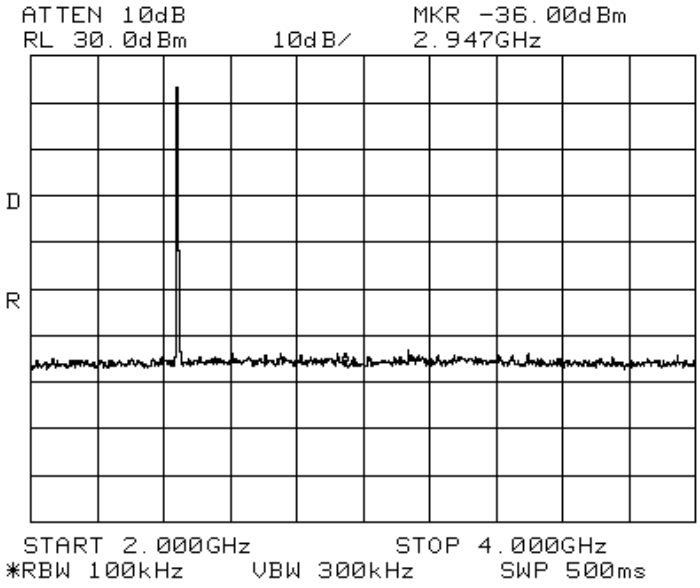
MSK 6GHz – 8GHz



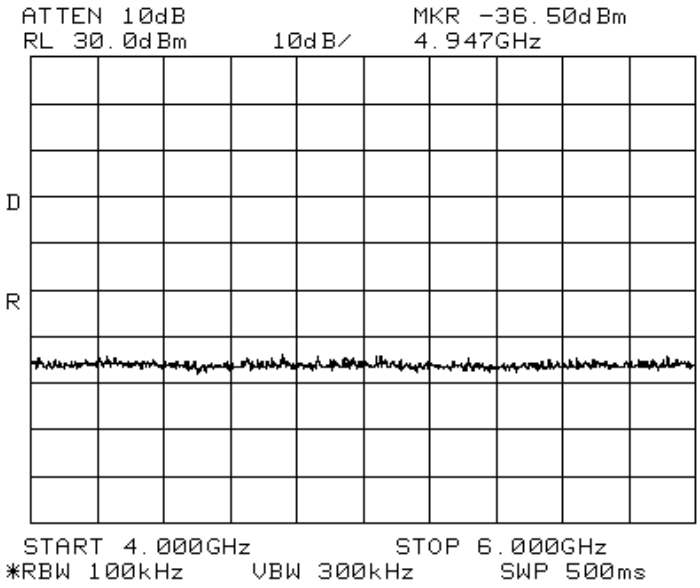
MSK 8GHz – 25GHz



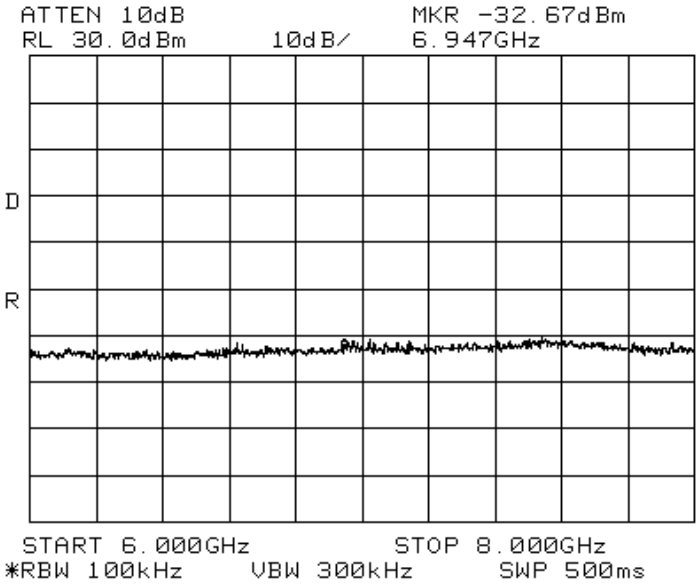
Spurious 32QAM 30MHz – 2GHz, mid



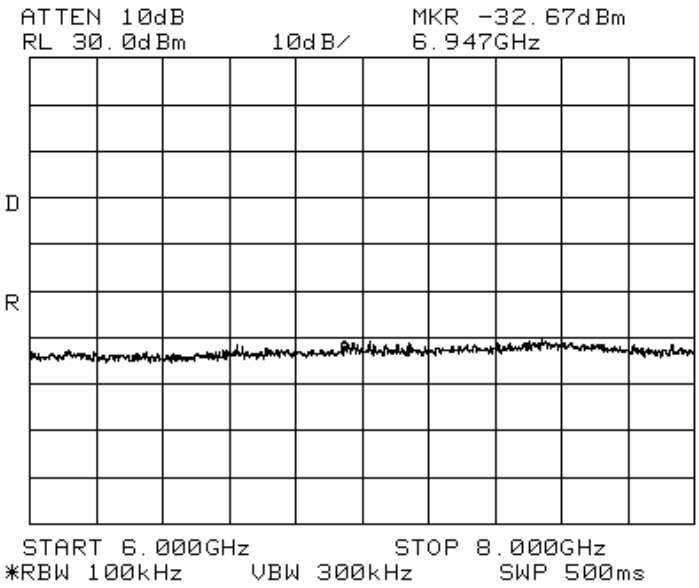
Spurious 32QAM 2GHz – 4GHz, mid



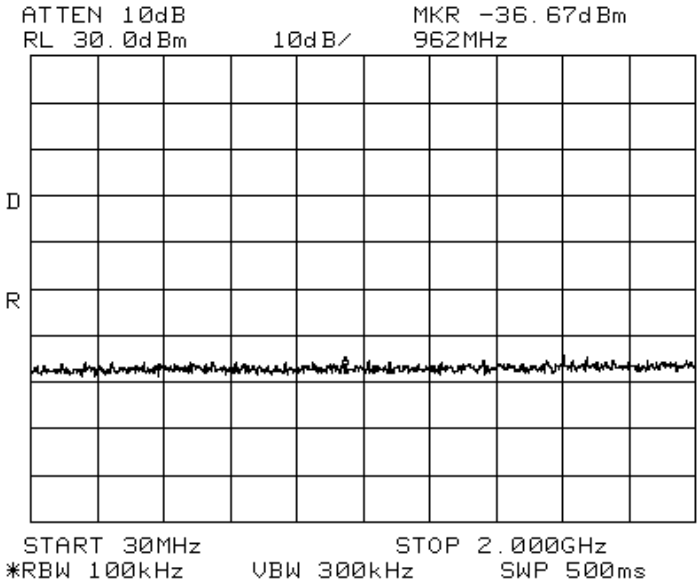
Spurious 32QAM 4GHz – 6GHz, mid



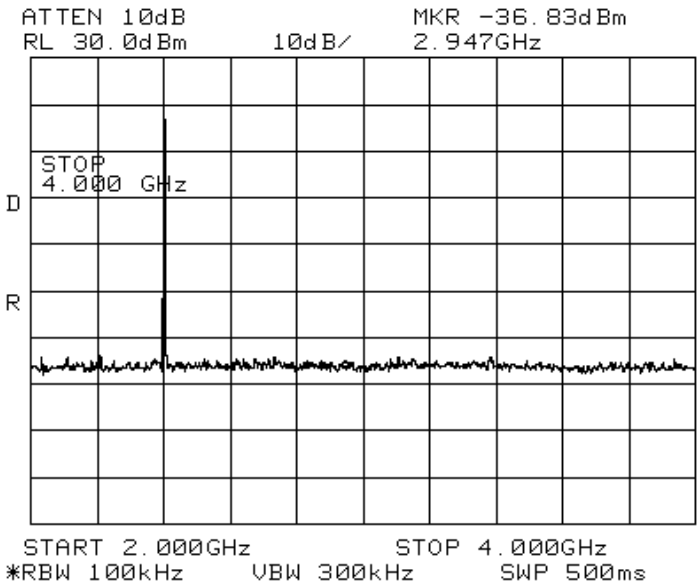
Spurious 32QAM 6GHz – 8GHz, mid



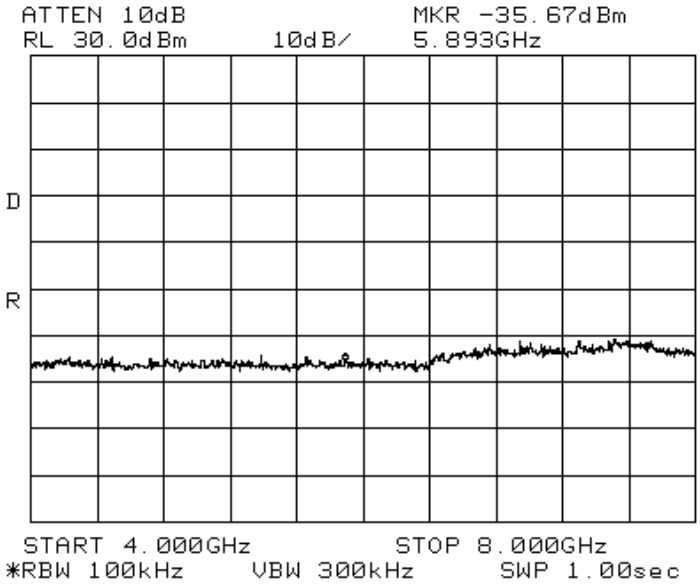
Spurious 32QAM 8GHz – 25GHz, mid



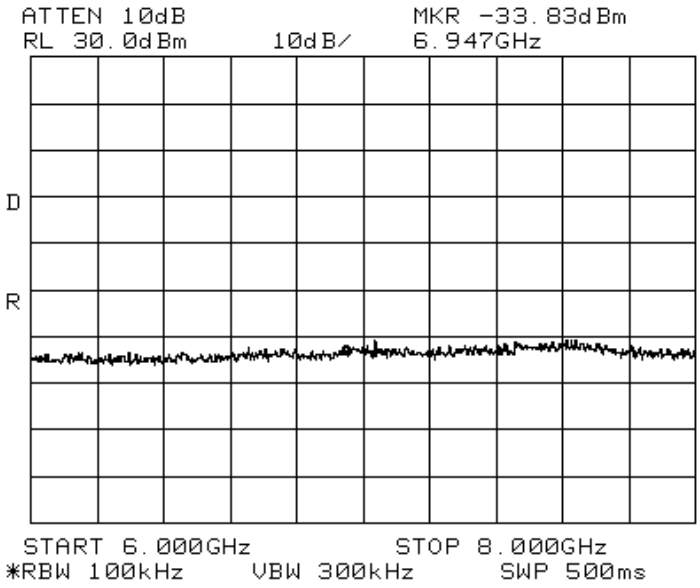
Spurious 32QAM 30MHz – 2GHz, low



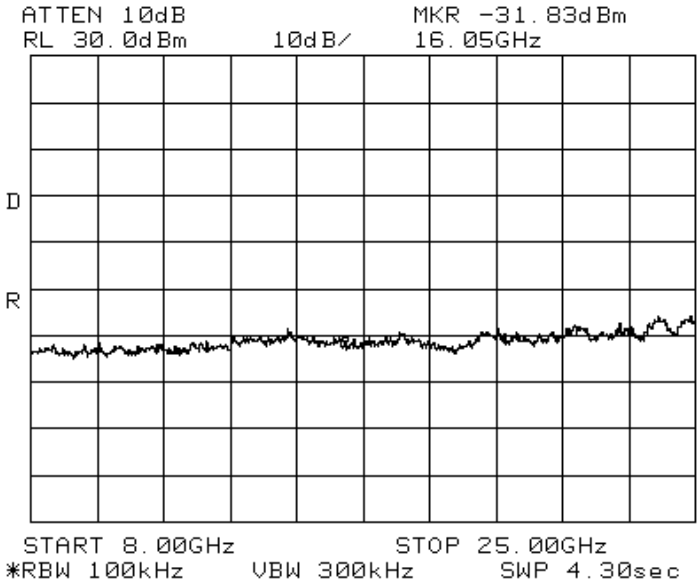
Spurious 32QAM 2GH – 4GHz, low



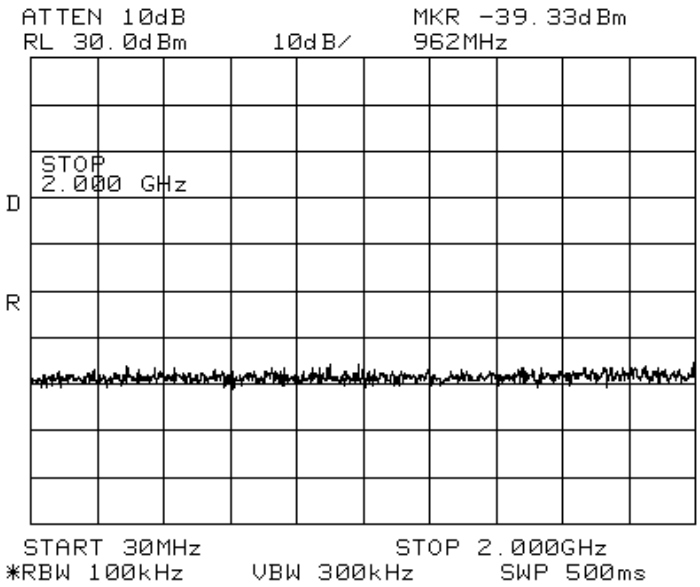
Spurious 32QAM 4GHz – 8GHz, low



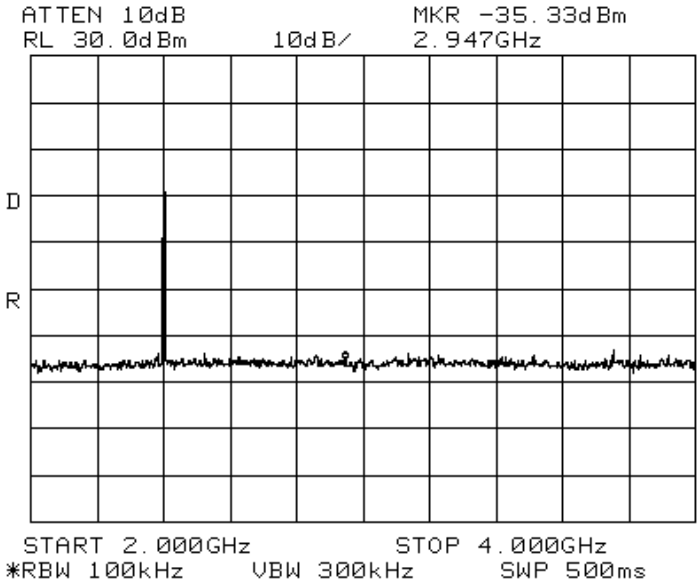
Spurious 32QAM 6GHz – 8GHz, low



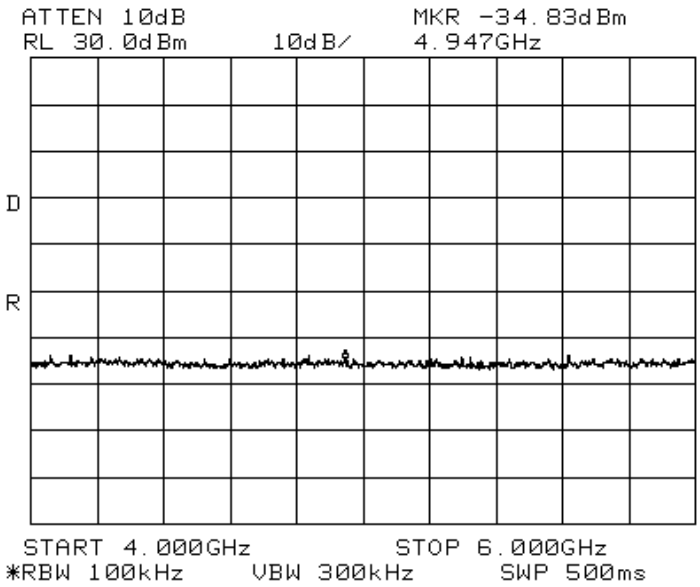
Spurious 32QAM 8GHz – 25GHz, low



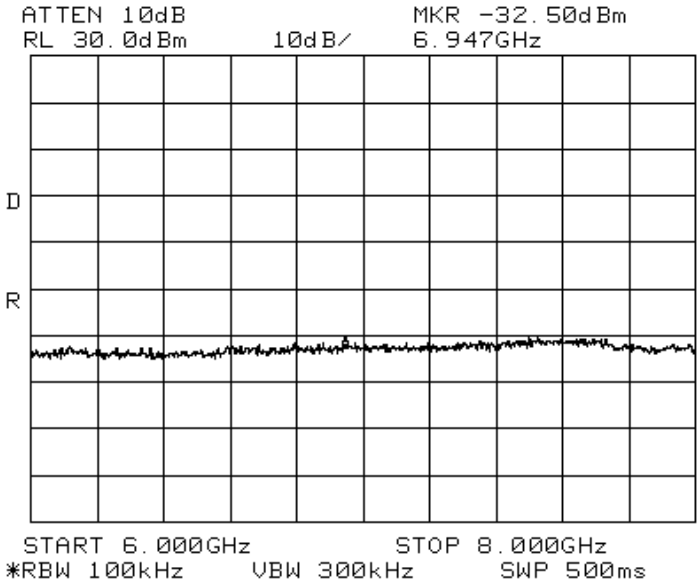
Spurious QPSK 30MHz – 2GHz, low



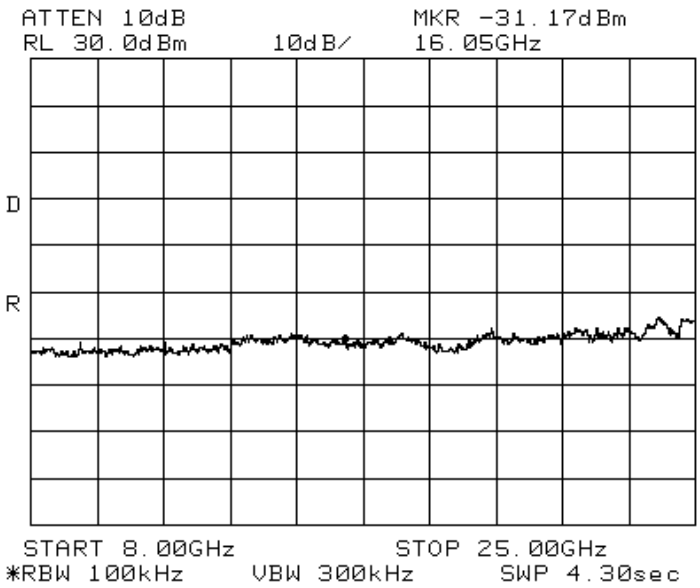
Spurious QPSK 2GHz – 4GHz, low



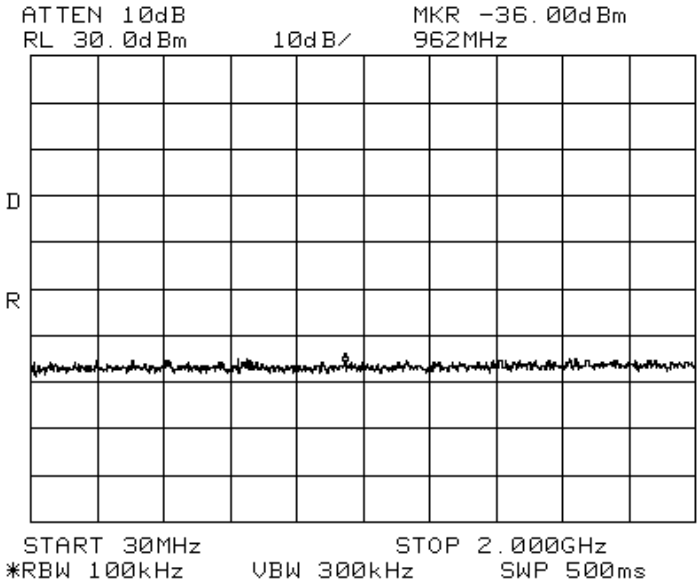
Spurious QPSK 4GHz – 6GHz, low



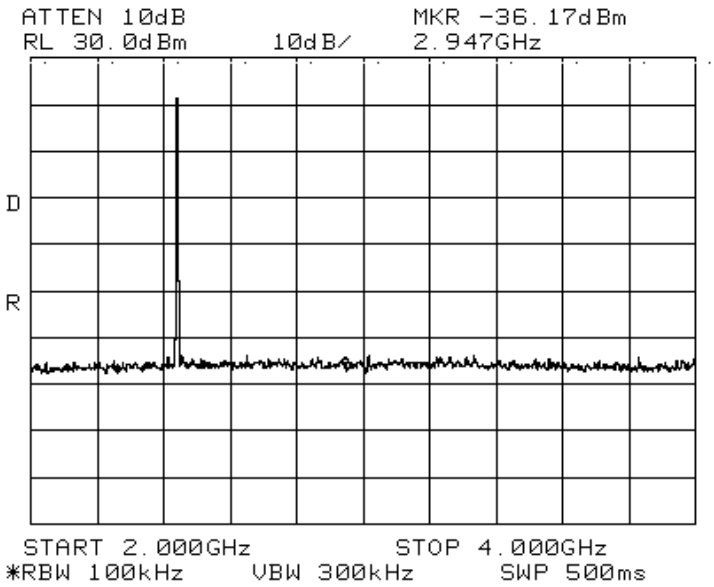
Spurious QPSK 6GHz – 8GHz, low



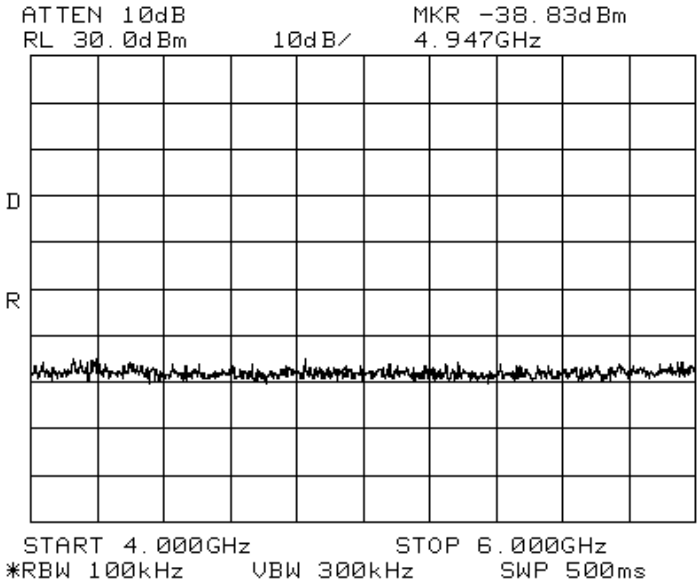
Spurious QPSK 8GHz – 25GHz, low



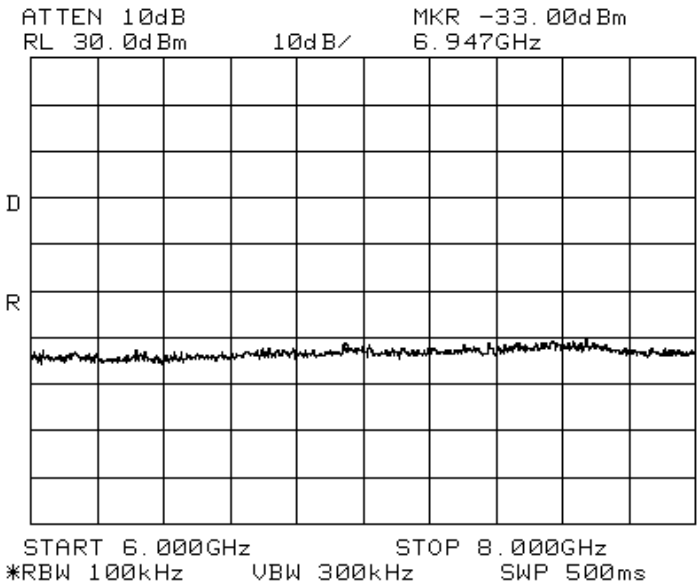
Spurious QPSK 30MHz – 2GHz, mid



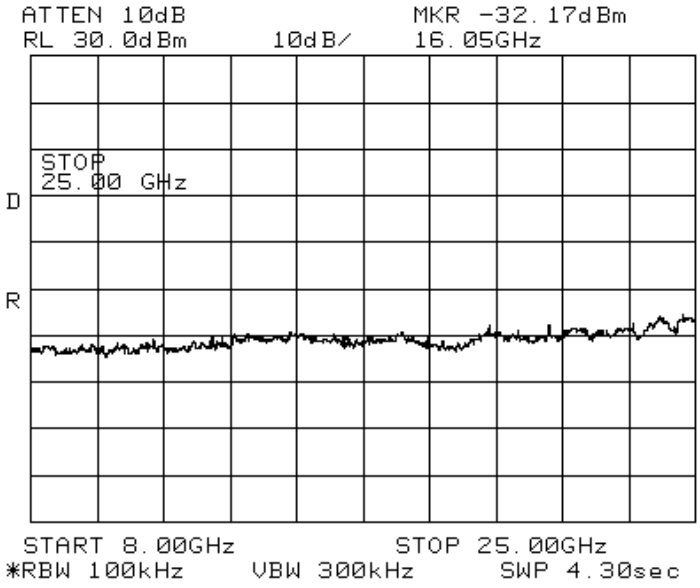
Spurious QPSK 2GHz – 4GHz, mid



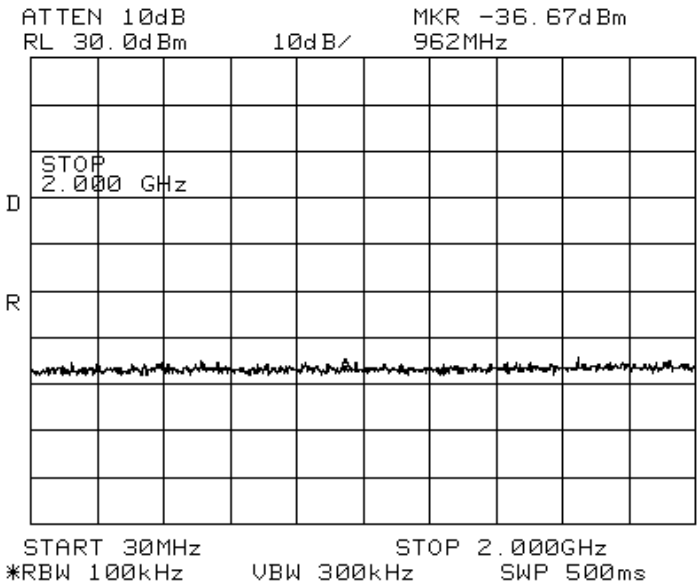
Spurious QPSK 4GHz – 6GHz, mid



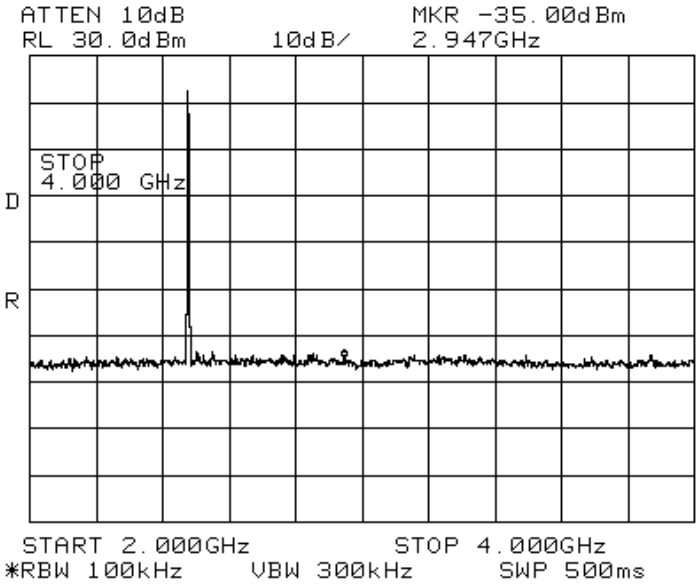
Spurious QPSK 6GHz – 8GHz, mid



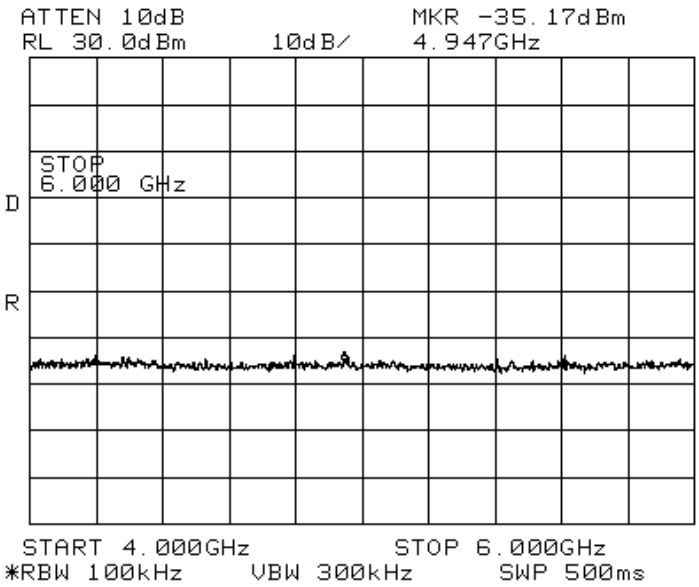
Spurious QPSK 8GHz – 25GHz, mid



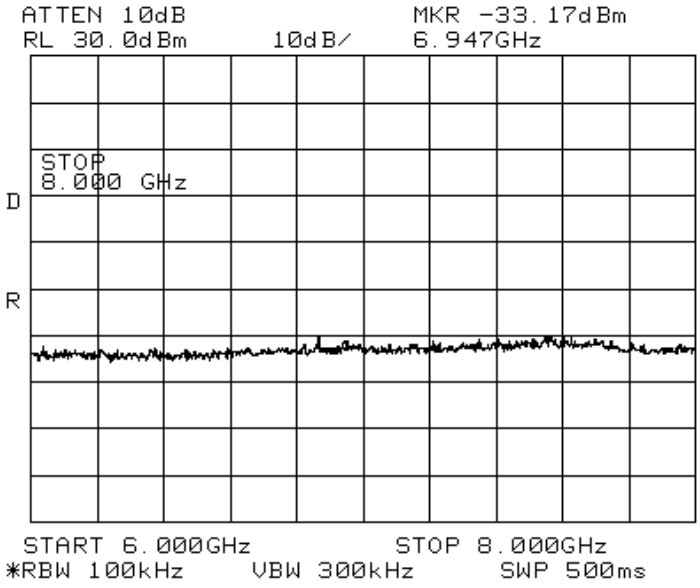
Spurious QPSK 30MHz – 2GHz, high



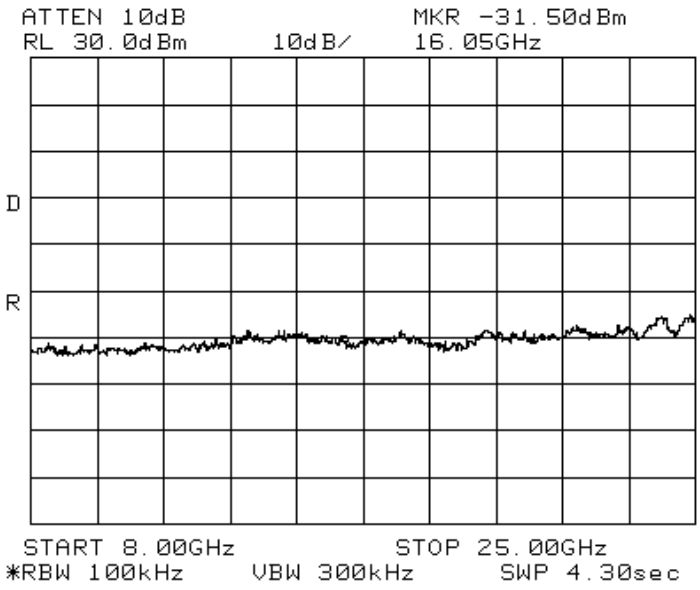
Spurious QPSK 2GHz – 4GHz, high



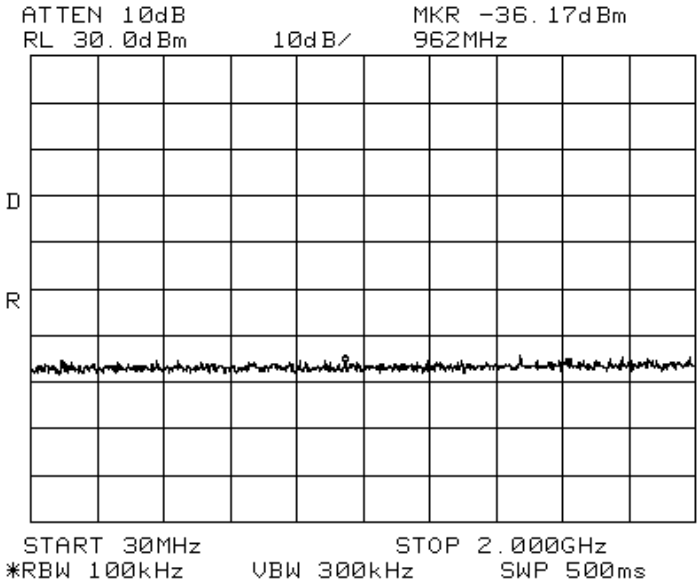
Spurious QPSK 4GHz – 6GHz, high



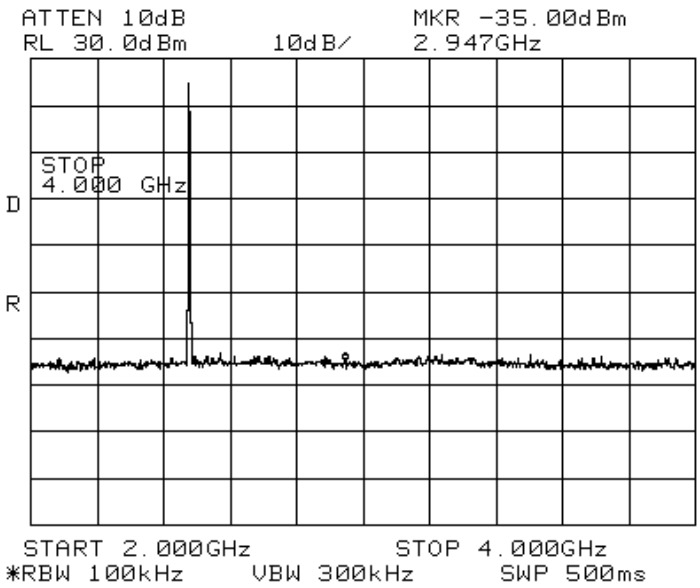
Spurious QPSK 6GHz – 8GHz, high



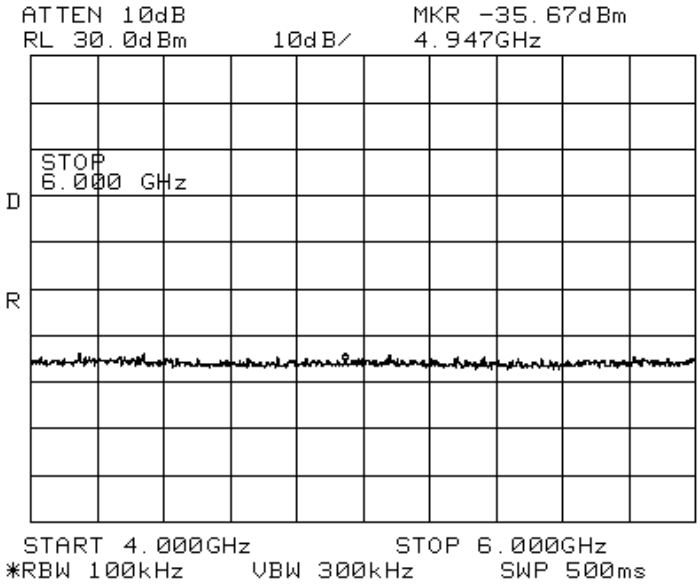
Spurious QPSK 8GHz – 25GHz, high



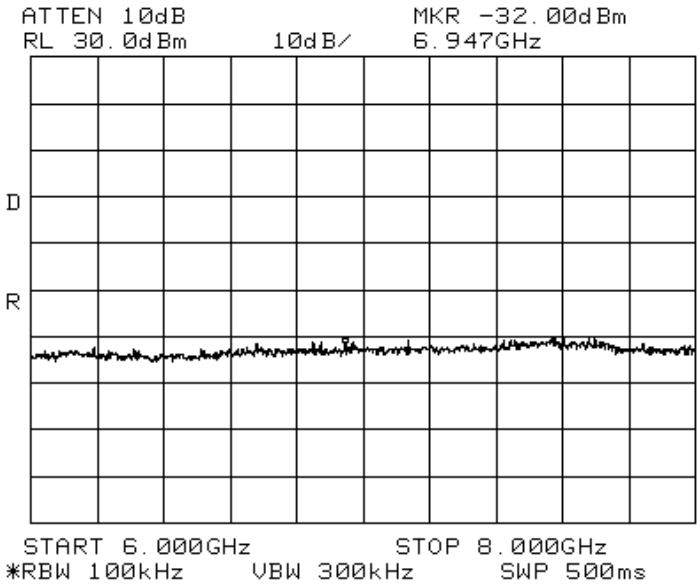
Spurious BPSK 30MHz – 2GHz, high



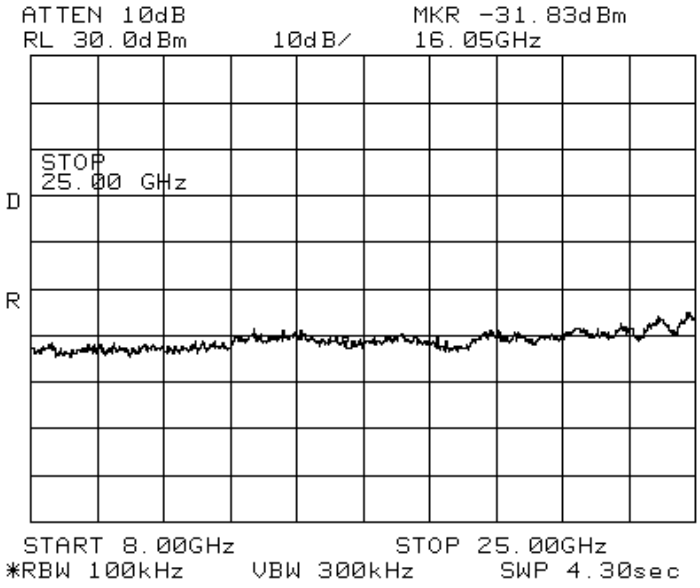
Spurious BPSK 2GHz – 4GHz, high



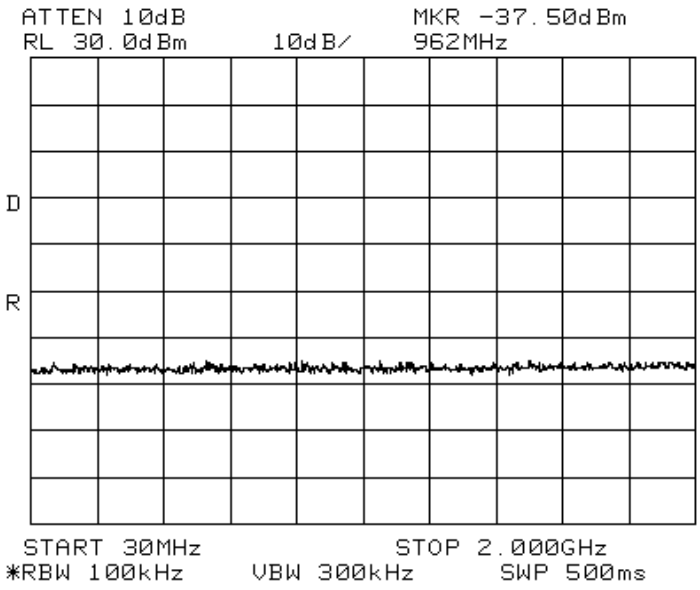
Spurious BPSK 4GHz – 6GHz, high



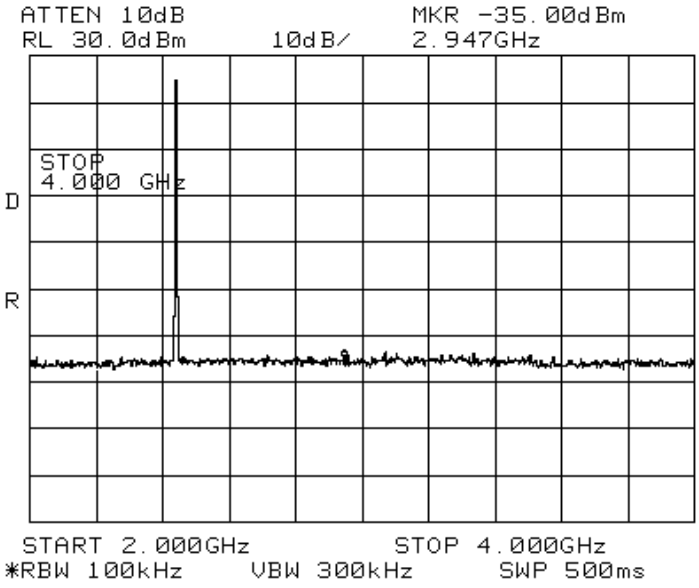
Spurious BPSK 6GHz – 8GHz, high



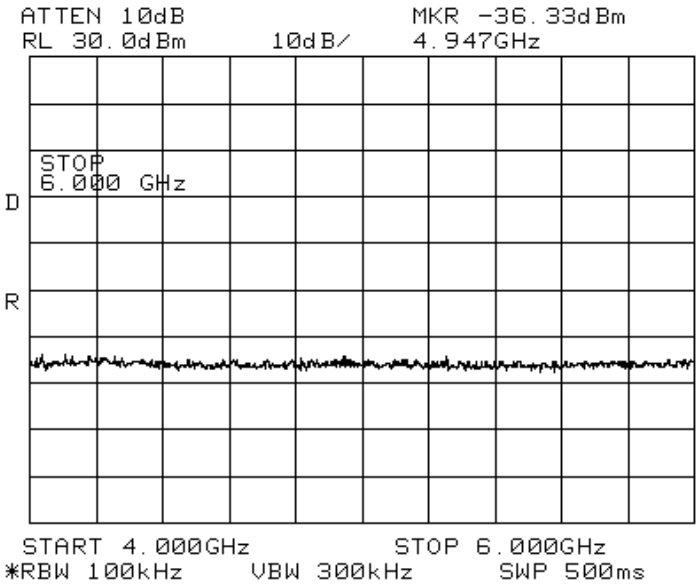
Spurious BPSK 8GHz – 25GHz, high



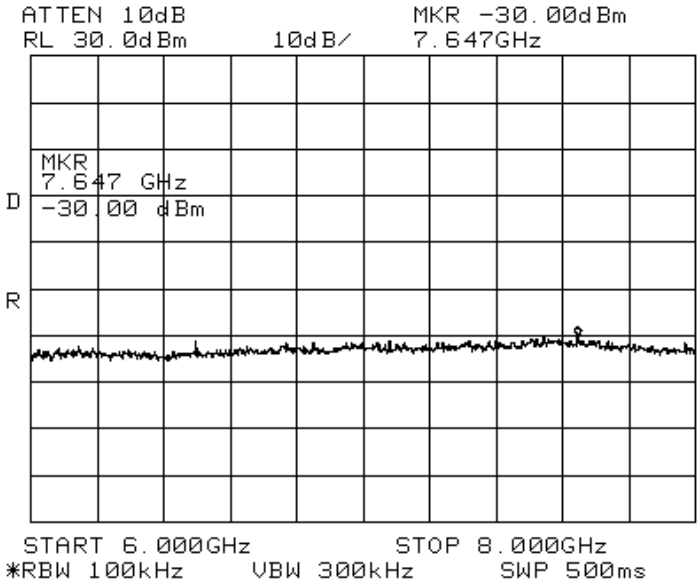
Spurious BPSK 30MHz – 2GHz, mid



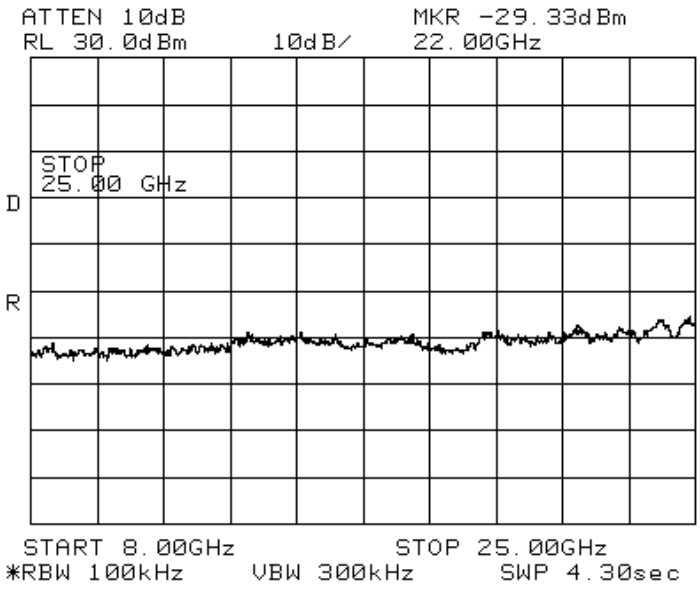
Spurious BPSK 2GMHz – 4GHz, mid



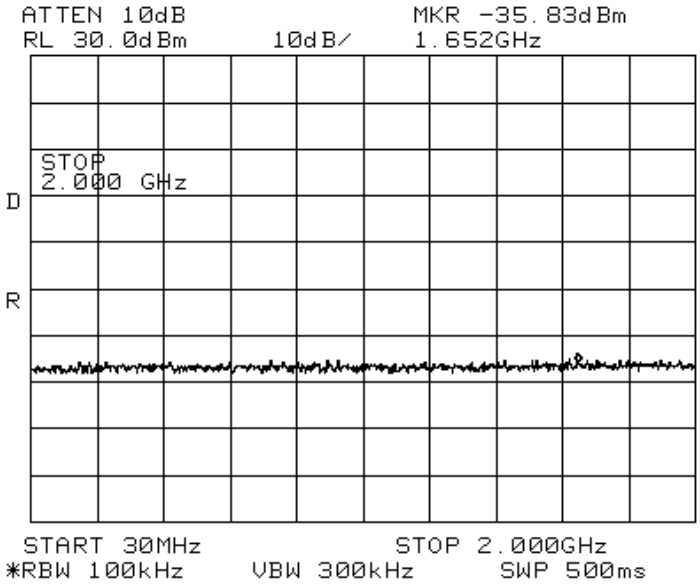
Spurious BPSK 4GMHz – 6GHz, mid



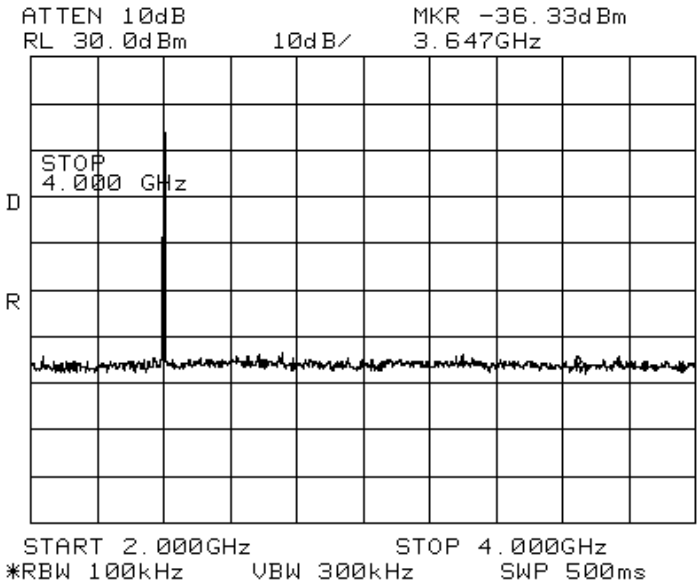
Spurious BPSK 6GHz – 8GHz, mid



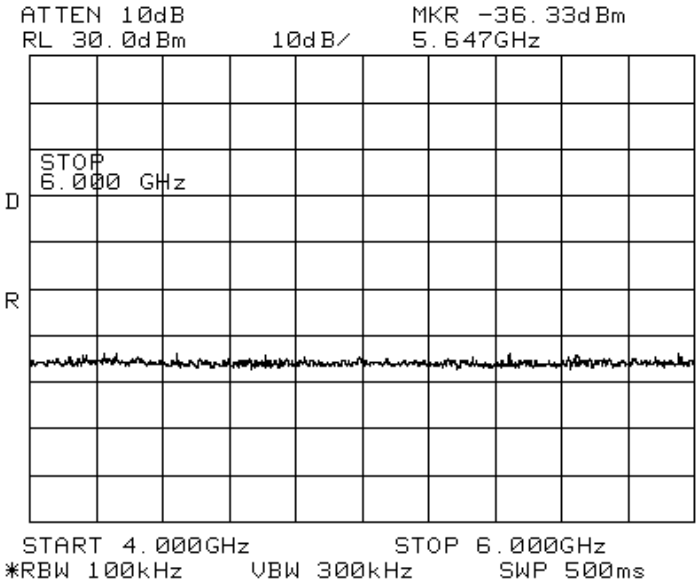
Spurious BPSK 8GHz – 25GHz, mid



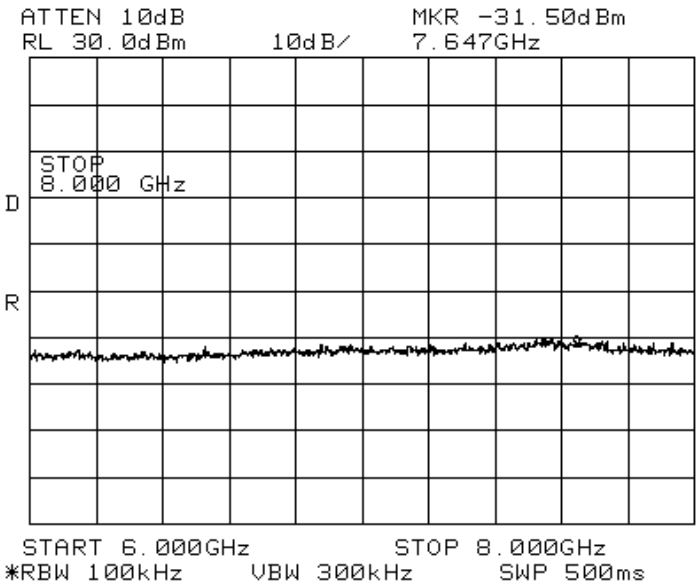
Spurious BPSK 30MHz – 2GHz low



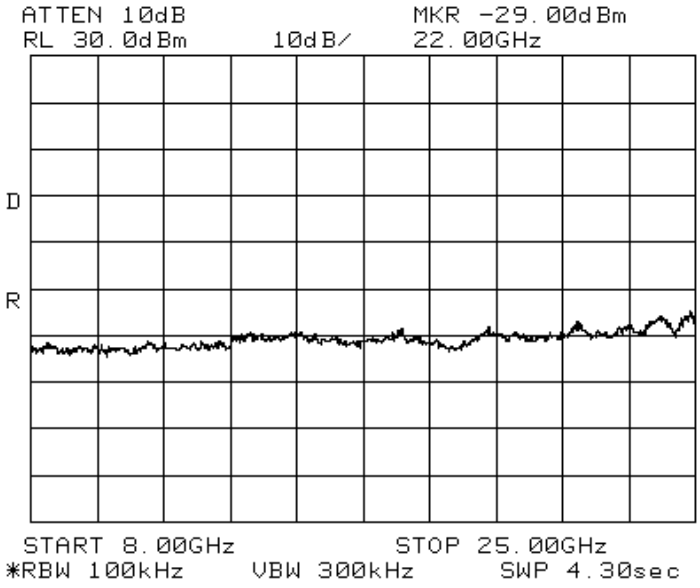
Spurious BPSK 2GHz – 4GHz low



Spurious BPSK 4GHz – 6GHz low



Spurious BPSK 6GHz – 8GHz low



Spurious BPSK 8GHz – 25GHz low

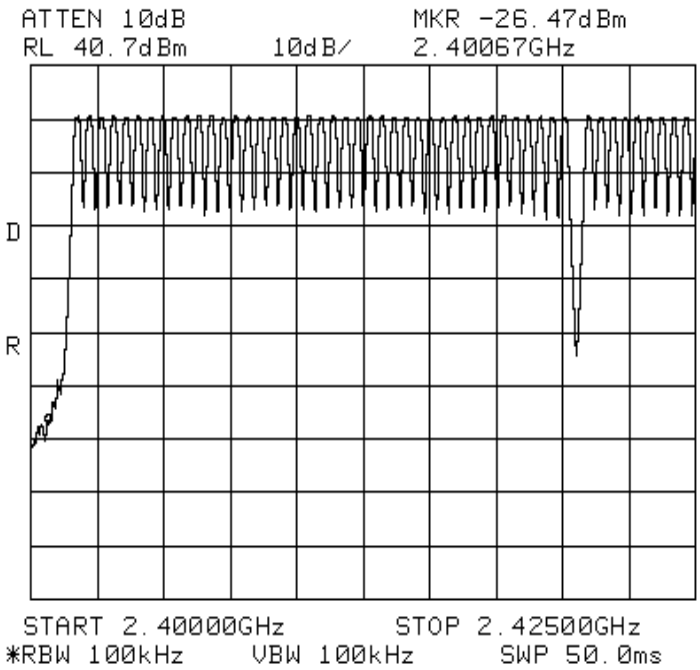
Test Results – FHSS – Number of Hopping Channels

Table No. 8	**FHSS – Number of Hopping Channels**	Verdict
		P

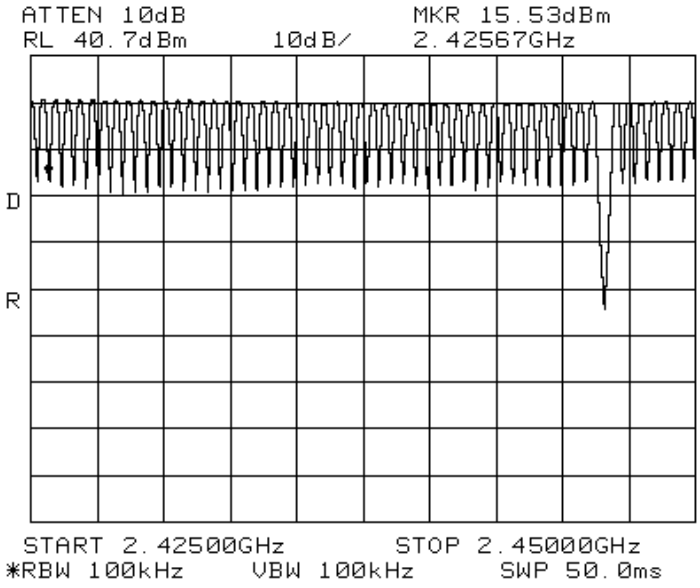
Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for channel details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

Supplemental Information:

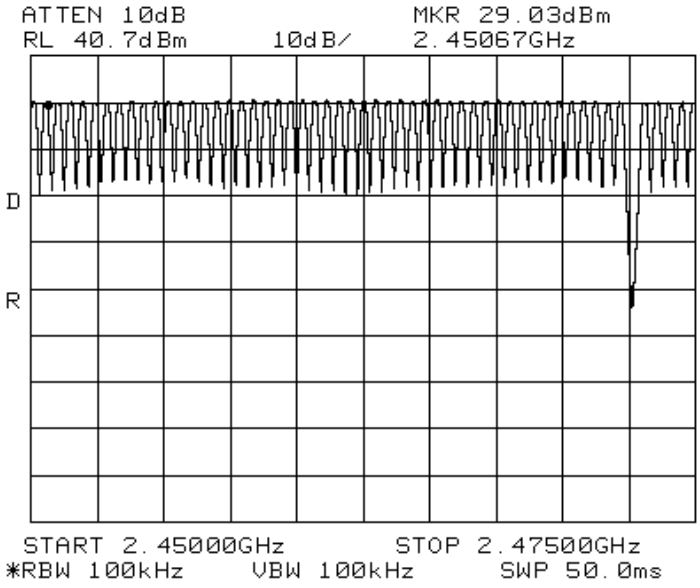
Tested by (+ signature) .....: Kevin Johnson.



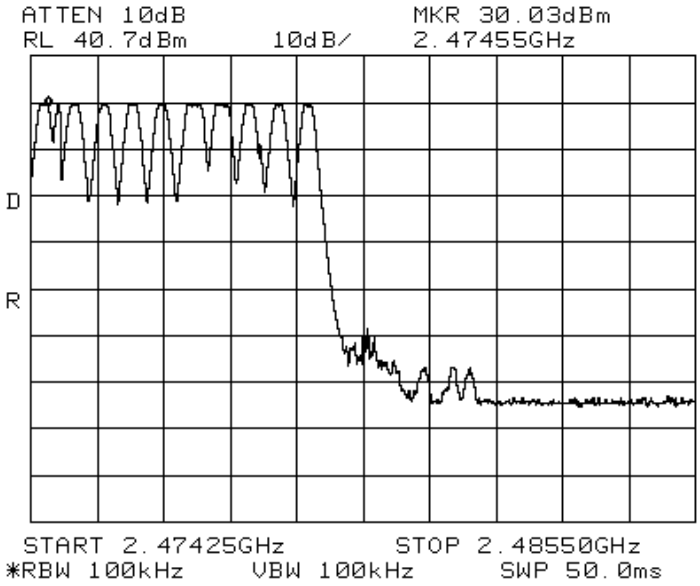
# of hopping channels, 2400-2425MHz, MSK **153kbps**- 50 channels



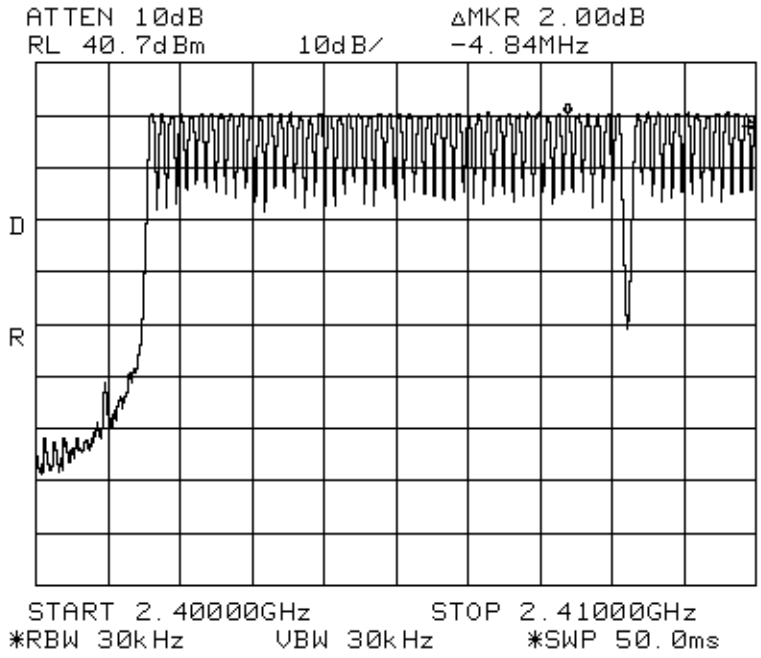
# of hopping channels, 2425-2450MHz,. MSK **153lbps**- 50 channels



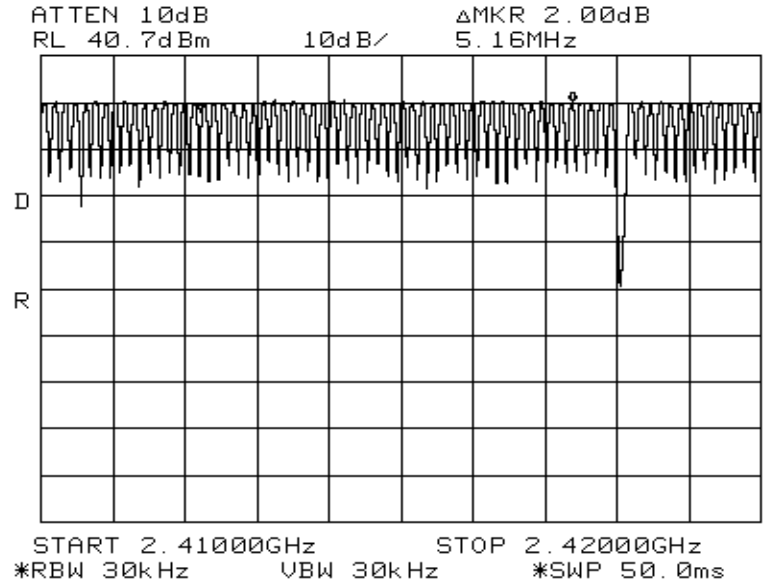
# of hopping channels, 2450-2475 MHz, MSK **153kbps**- 52 channels



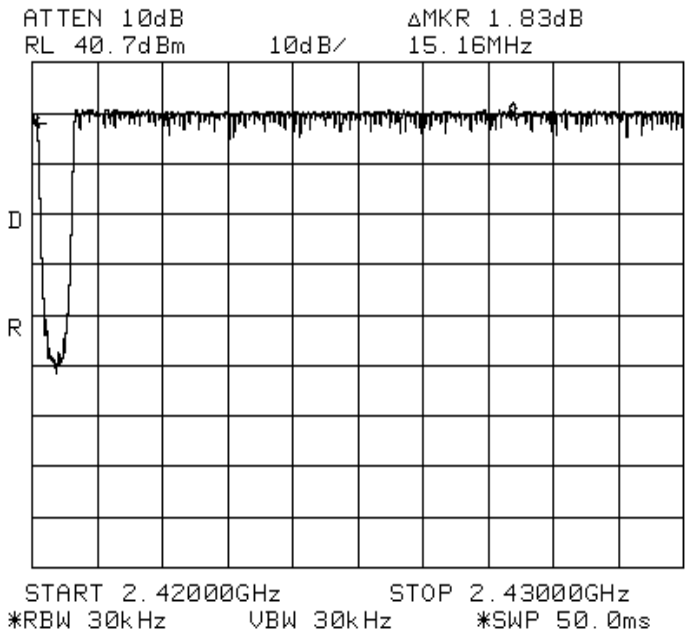
# of hopping channels, 2475-2483.5MHz, MSK **153kbps**- 11 channels



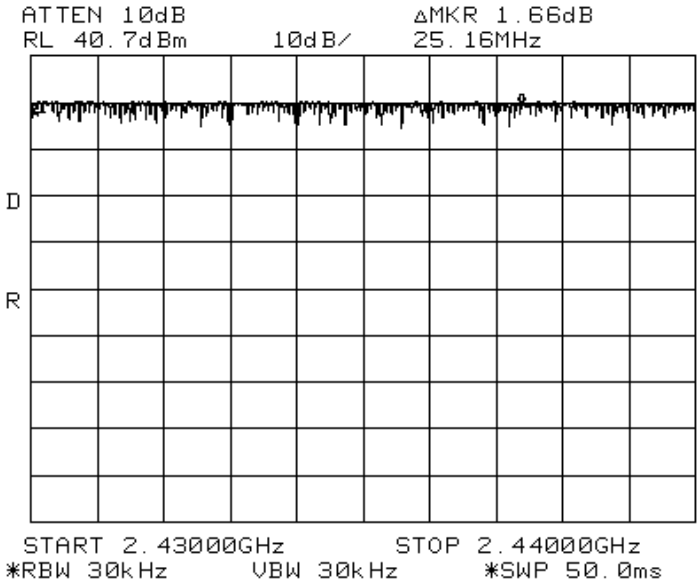
# of hopping channels, 2400-2410 MHz, MSK **57kbps-** 59 channels



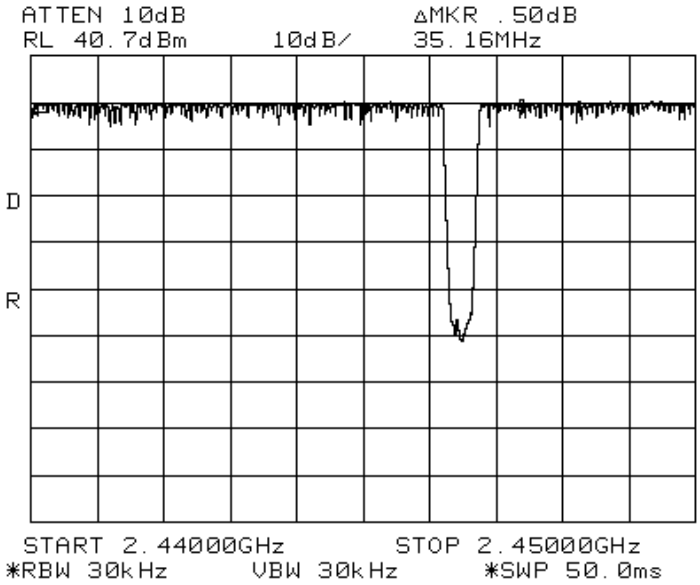
# of hopping channels, 2410-2420 MHz, MSK **57kbps-** 67 channels



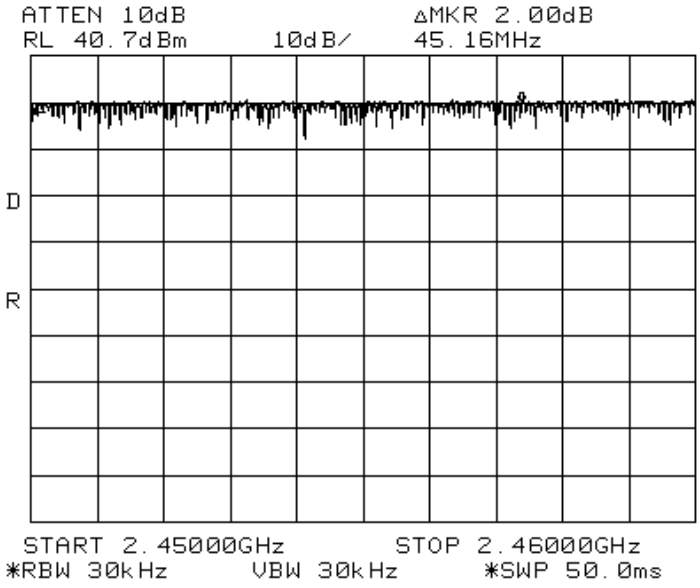
# of hopping channels, 2410-2420 MHz, MSK **57kbps-** 107 channels



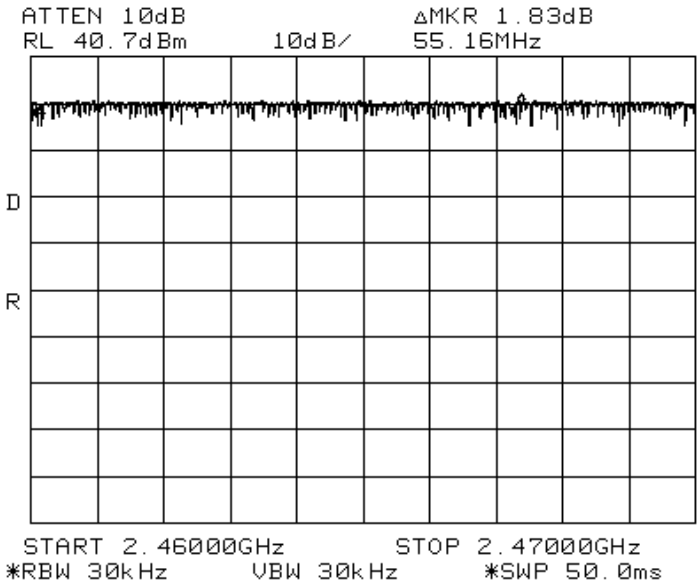
# of hopping channels, 2430-2440 MHz, MSK **57kbps-** 112 channels



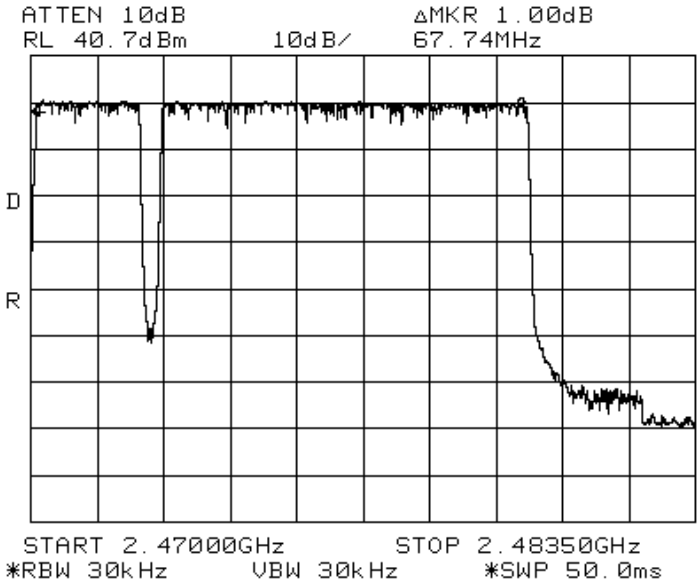
# of hopping channels, 2440-2450 MHz, MSK **57kbps-** 112 channels



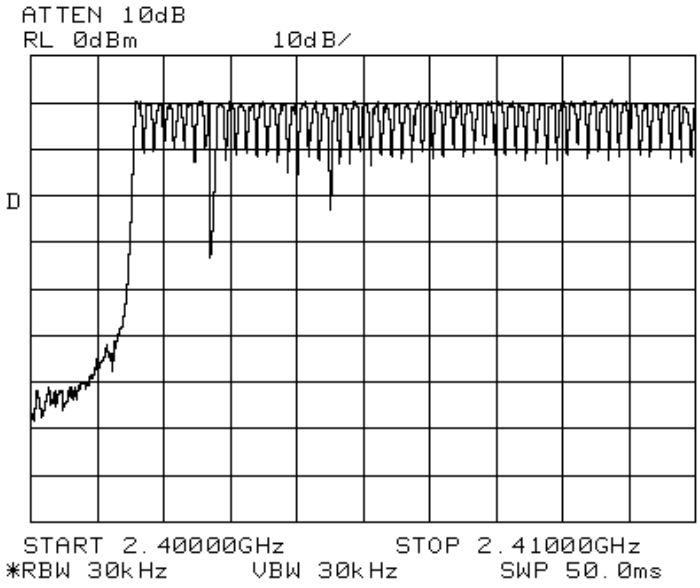
# of hopping channels, 2450-2460 MHz, MSK **57kbps-** 109 channels



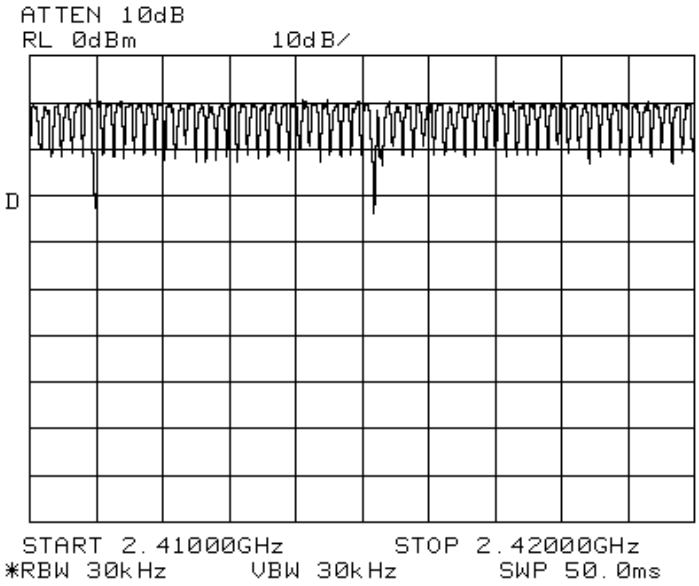
# of hopping channels, 2460-2470 MHz, MSK **57kbps-** 112 channels



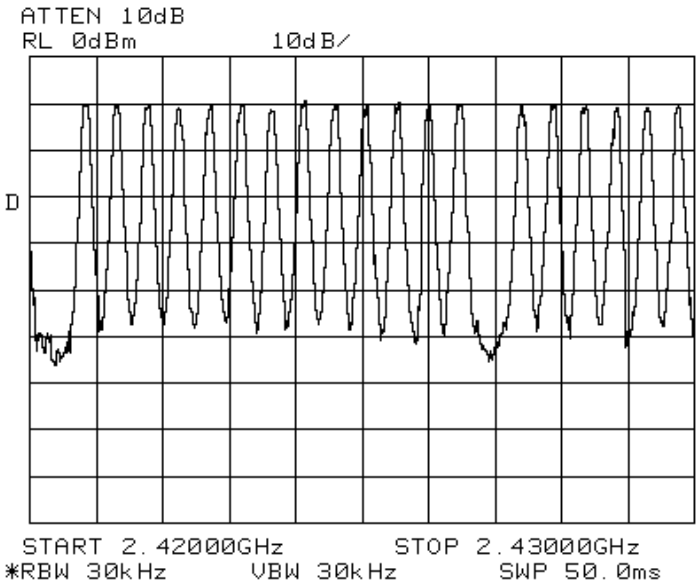
# of hopping channels, 2470-2480 MHz, MSK **57kbps-** 110 channels



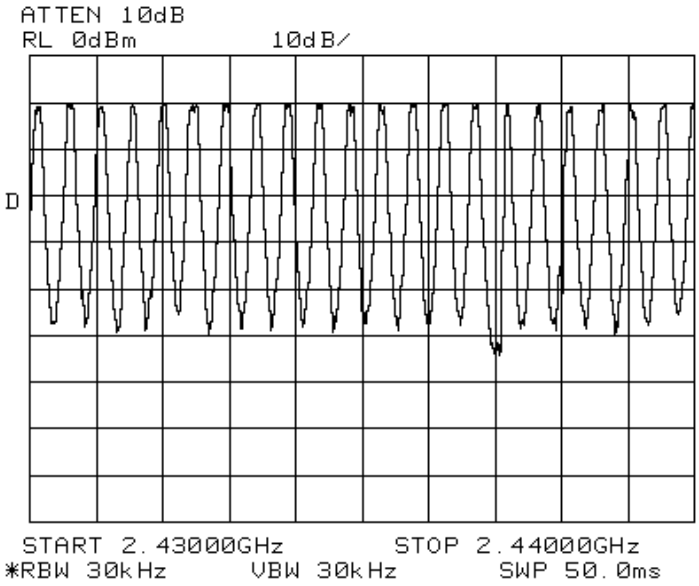
# of hopping channels, 2400-2410 MHz, MSK **115kbps-** 52 channels



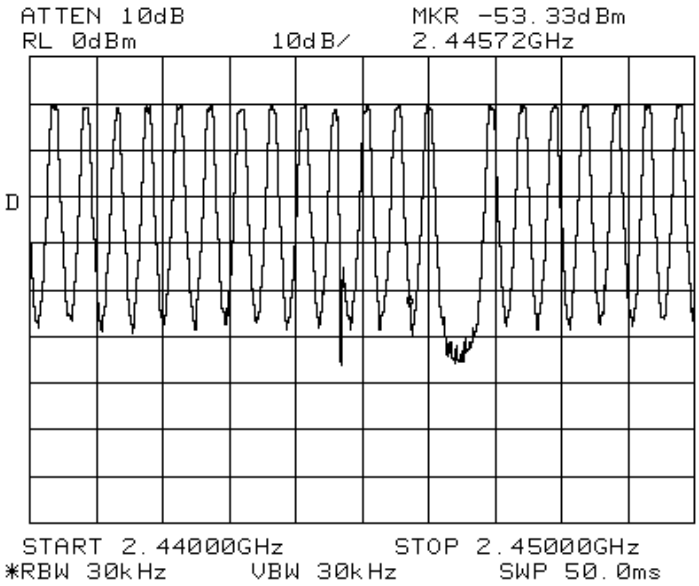
# of hopping channels, 2410-2420 MHz, MSK **115kbps-** 65 channels



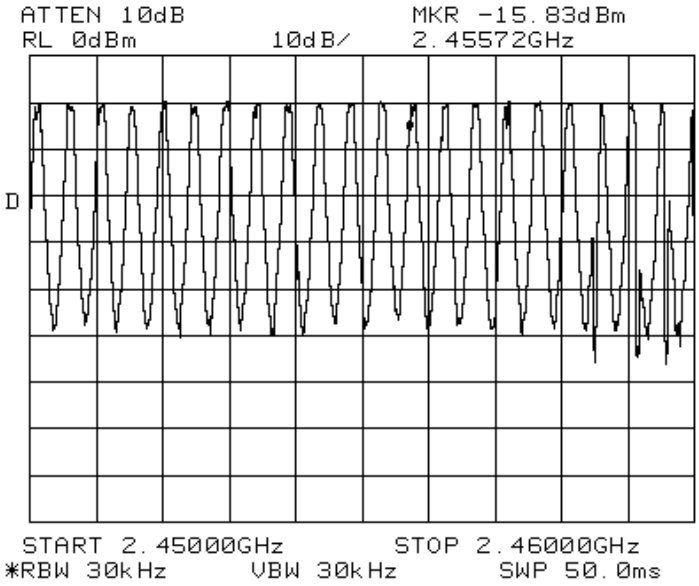
# of hopping channels, 2420-2430 MHz, MSK **115kbps-** 19 channels



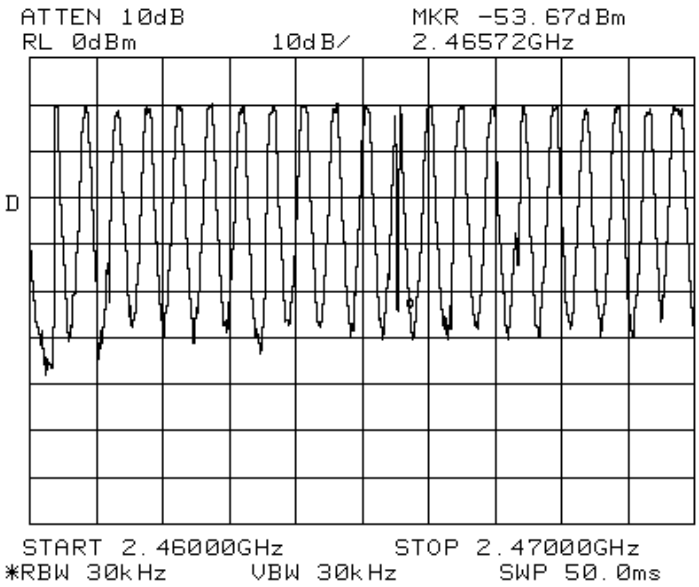
# of hopping channels, 2430-2440 MHz, MSK **115kbps-** 21 channels



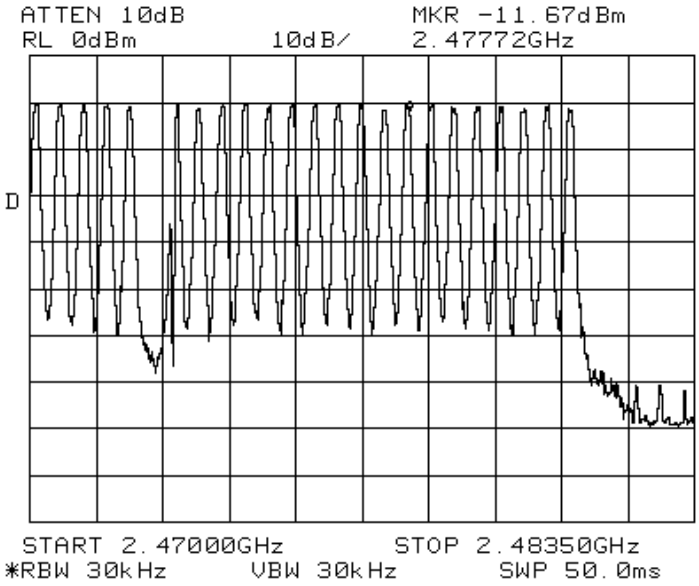
# of hopping channels, 2440-2450 MHz, MSK **115kbps-** 20 channels



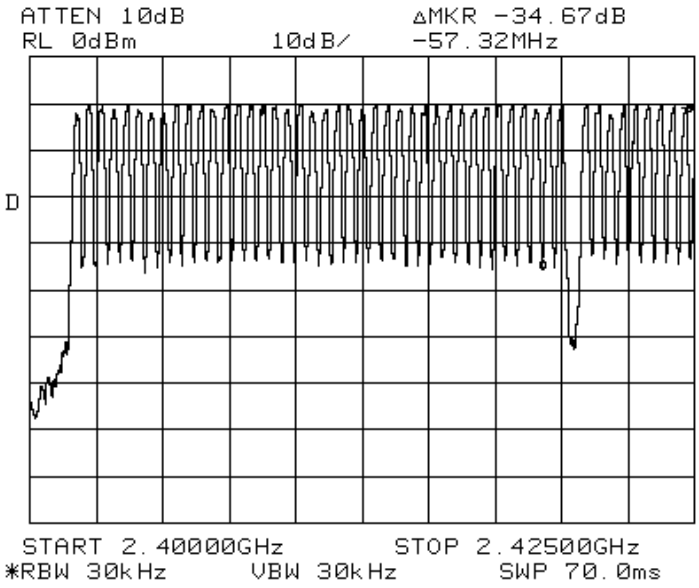
# of hopping channels, 2450-2460 MHz, MSK **115kbps-** 22 channels



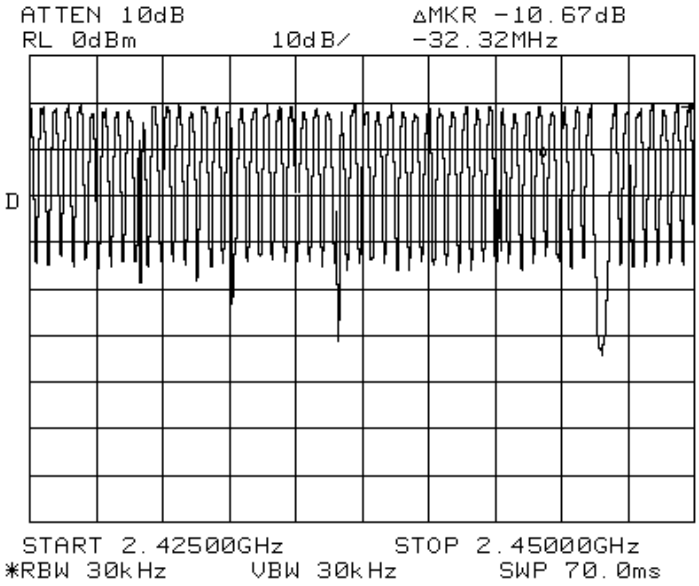
# of hopping channels, 2460-2470 MHz, MSK **115kbps-** 21 channels



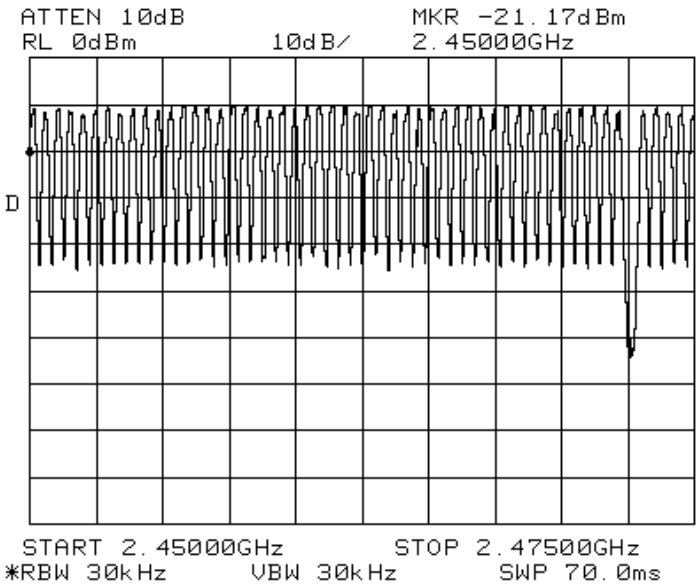
# of hopping channels, 2470-2483.5 MHz, MSK **115kbps-** 23channels



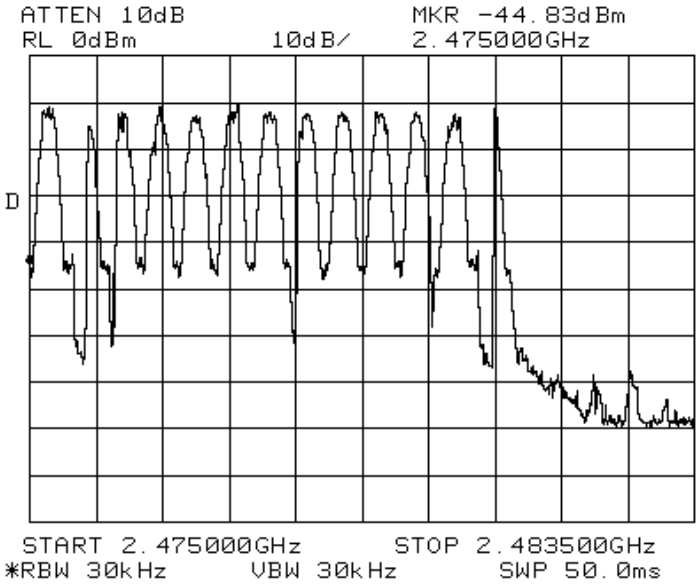
# of hopping channels, 2400-24250 MHz, MSK **229kbps-** 49 channels



# of hopping channels, 2425-24250 MHz, MSK **229kbps-** 53 channels



# of hopping channels, 2450-24275 MHz, MSK **229kbps-** 53 channels



# of hopping channels, 2475-24835.5 MHz, MSK **229kbps-** 13 channels

Test Results – FHSS – Carrier Frequency Separation

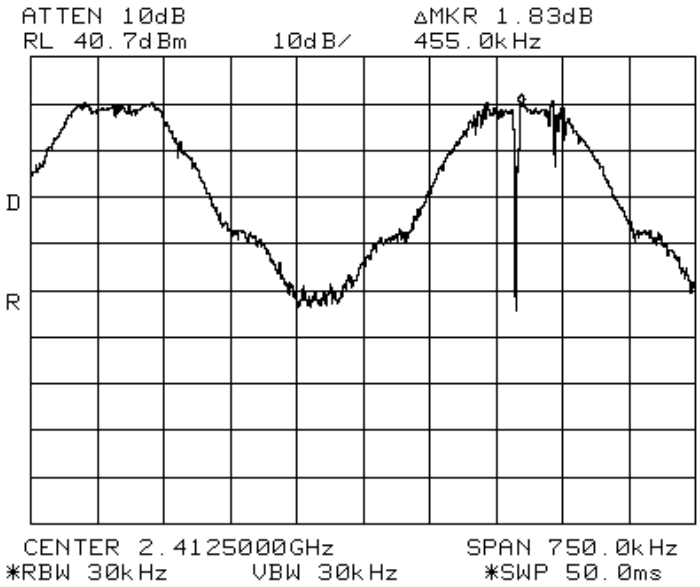
Table No. 9	FHSS – Carrier Frequency Separation	Verdict
		P

Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

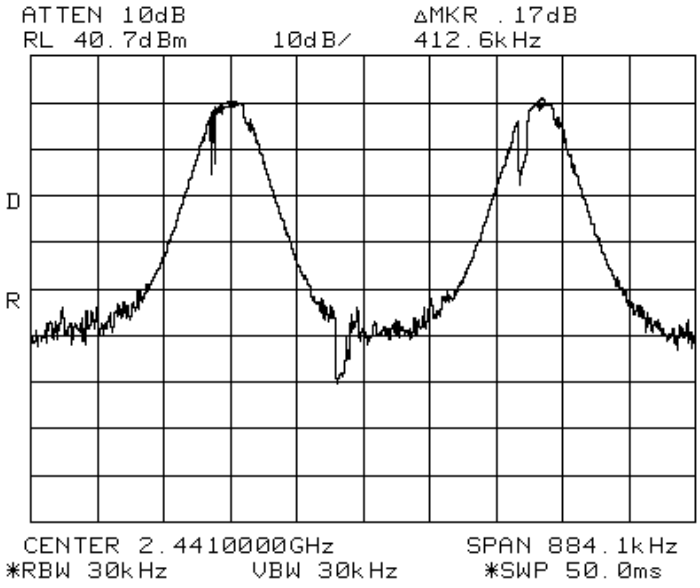
Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

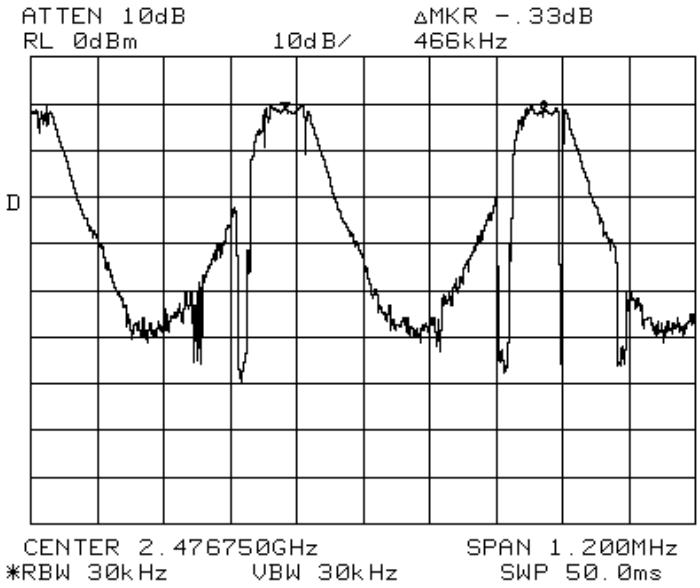
Carrier Frequency Separation



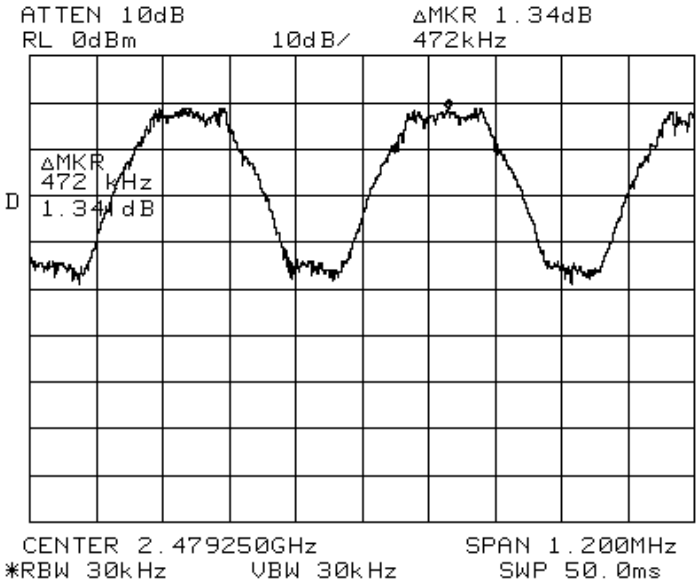
Carrier freq separation MSK 153kbps



Carrier freq separation MSK 57kbps



Carrier freq separation MSK115kbps



Carrier freq separation MSK 229kbps

Test Results – FHSS – Channel Occupancy Time

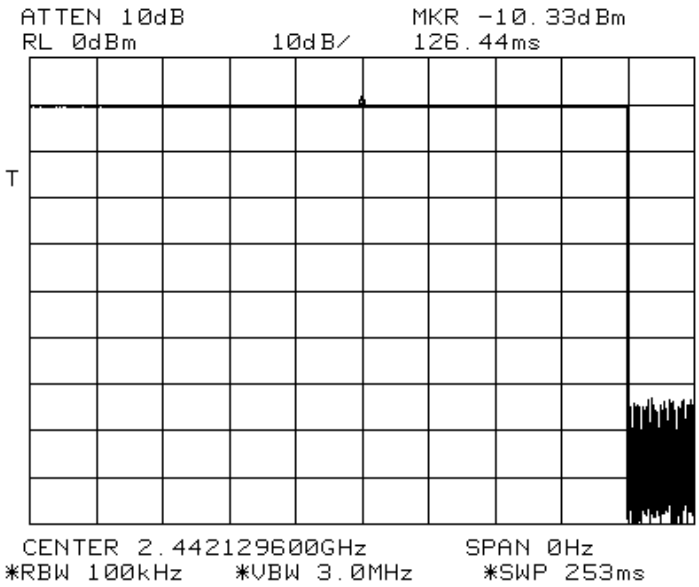
Table No. 10	FHSS – Channel Occupancy Time	Verdict
		P

Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

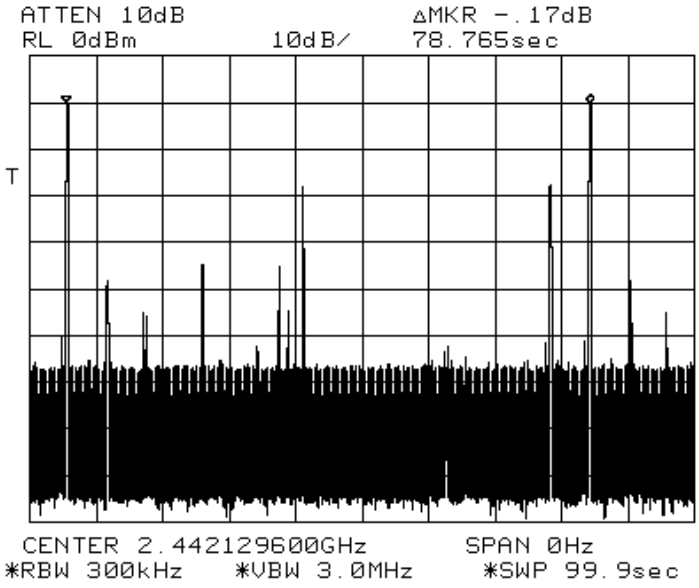
Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

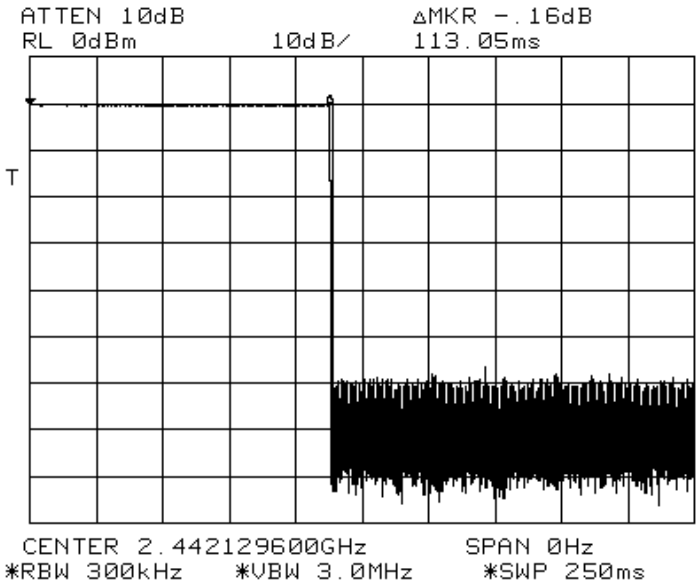
Channel Occupancy Time



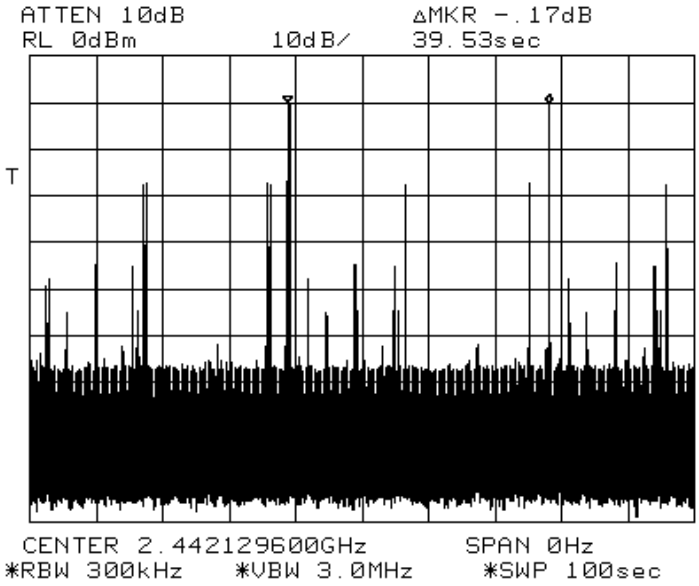
Channel Occupancy time **57kbp**s max payload



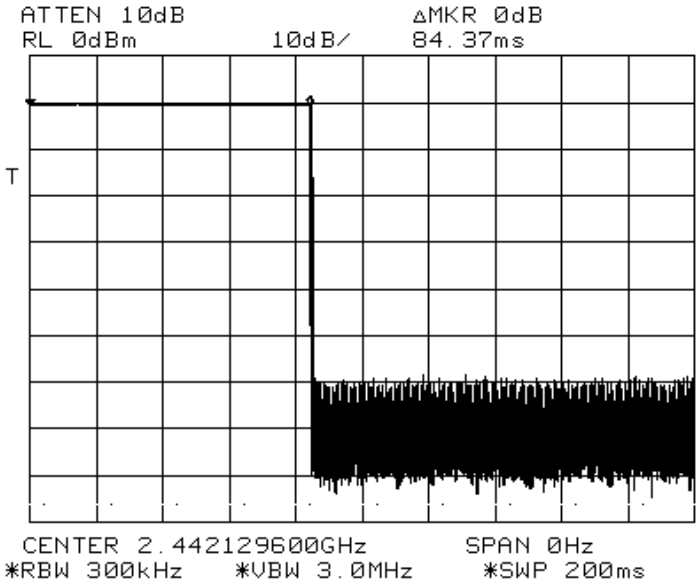
Channel Occupancy time sweep **57kbps**



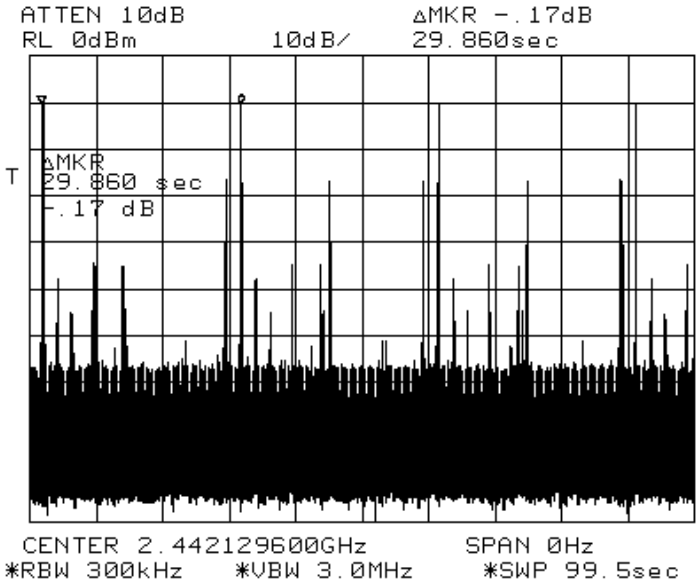
Channel Occupancy time **115kbp**s max payload



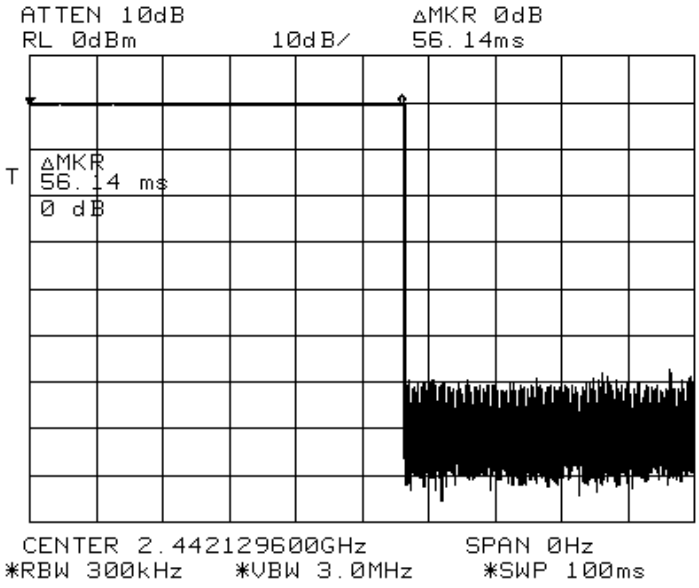
Channel Occupancy time sweep **115kbp**s



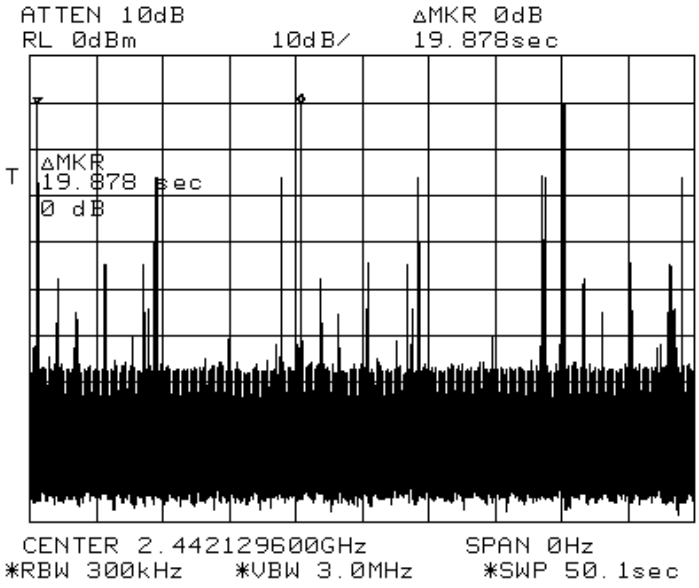
Channel Occupancy time **153 kbp**s



Channel Occupancy time sweep **153kbp**s



Channel Occupancy time **229 kbp**s



Channel Occupancy time sweep **229 kbp**s

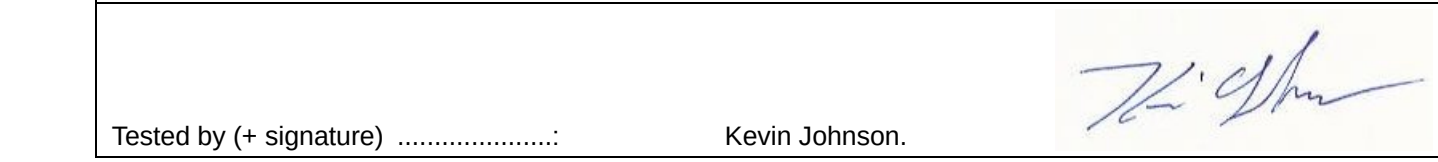
Test Results – FHSS 20 dB Occupied Bandwidth

Table No. 11	FHSS – 20 dB Occupied Bandwidth	Verdict
		P

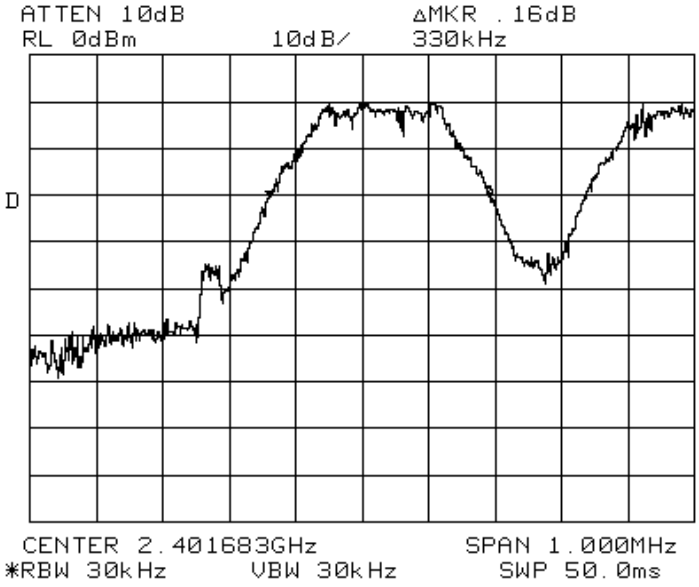
Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

Supplemental Information:

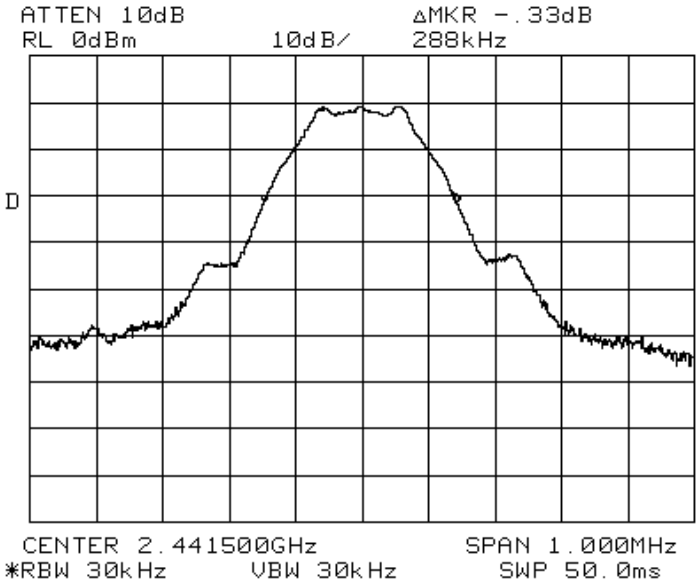
Tested by (+ signature) .....: Kevin Johnson.



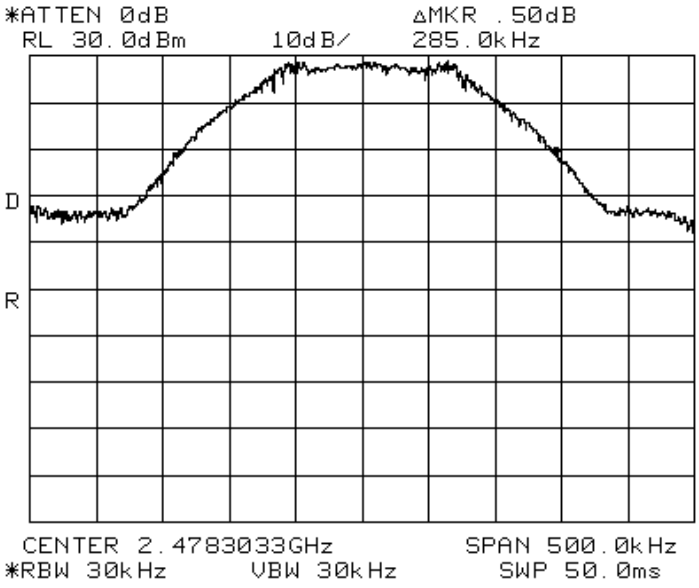
20dB Occupied Bandwidth



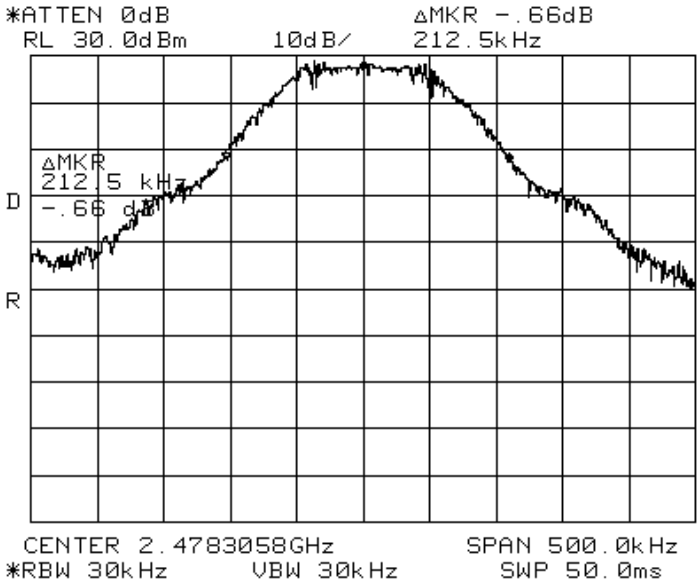
20dB OBW, MSK 229kbps, Low



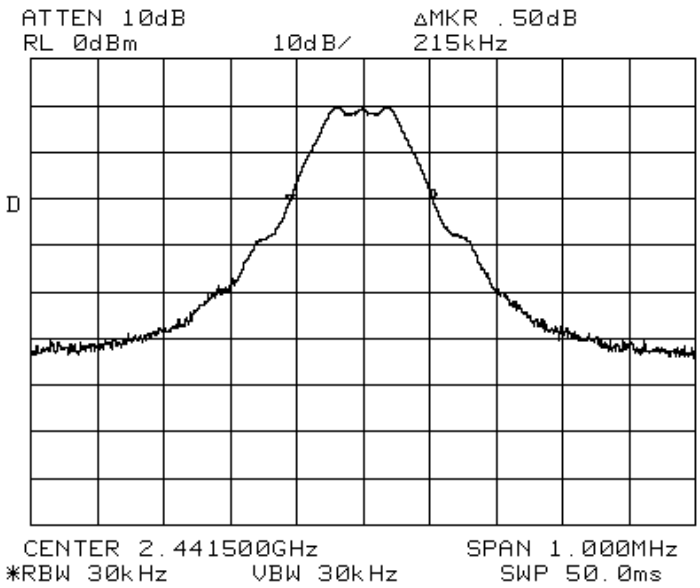
20dB OBW, MSK 229kbps Mid



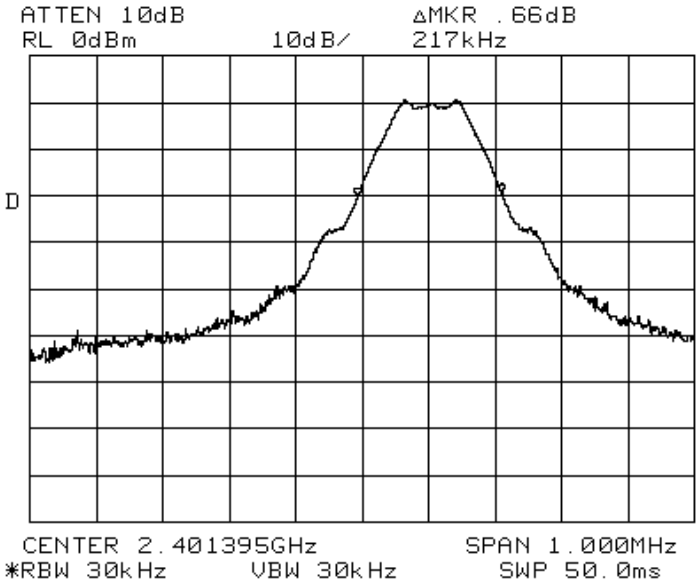
20dB OBW, MSK 229kbps High



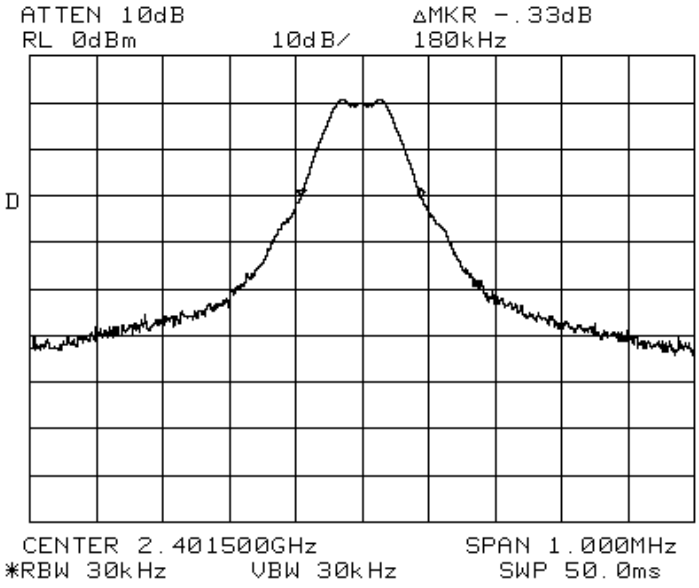
20dB OBW, MSK 153kbps High



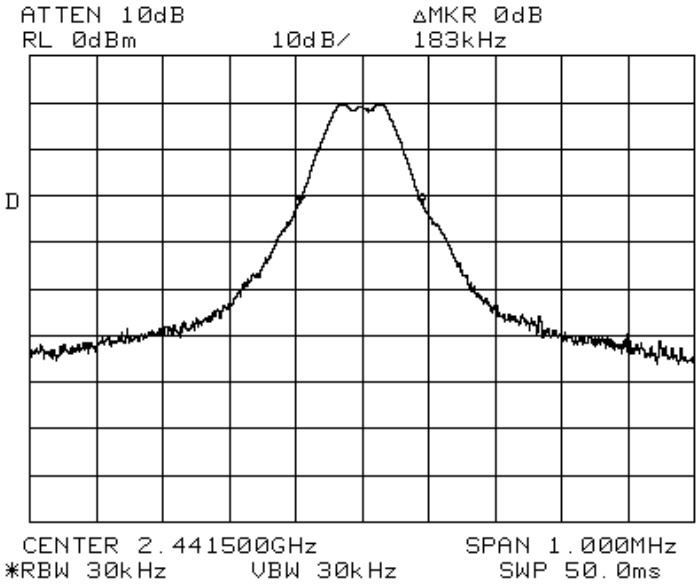
20dB OBW, MSK 153kbps Mid



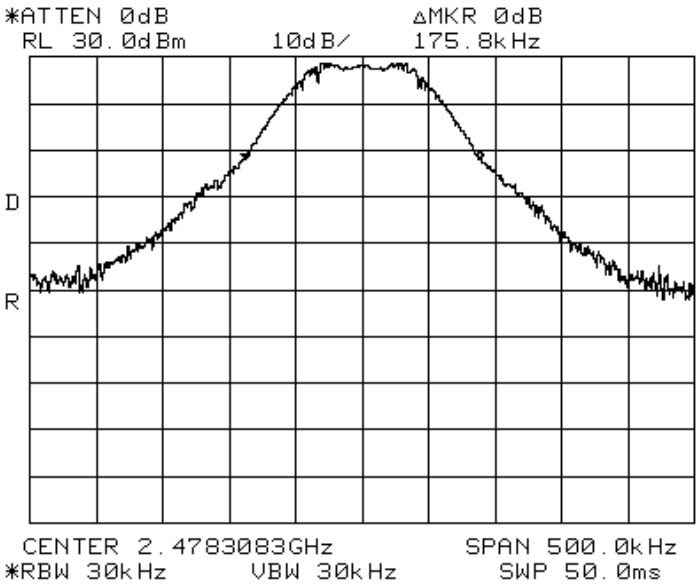
20dB OBW, MSK 153kbps Low



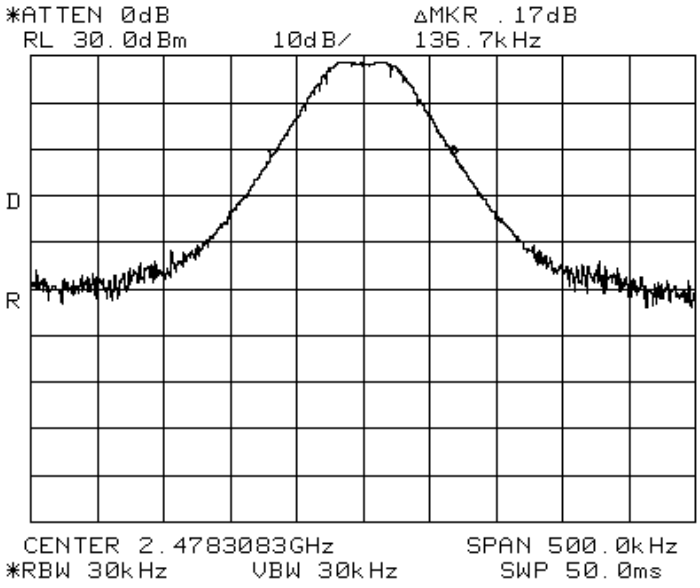
20dB OBW, MSK 115kbps Low



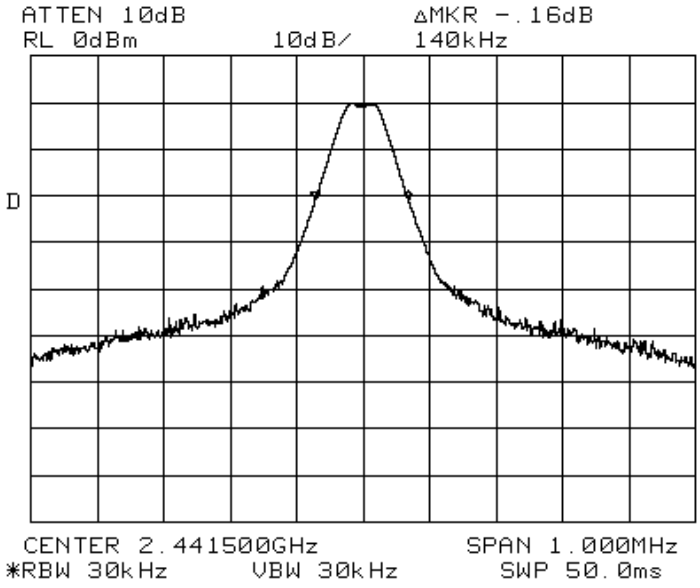
20dB OBW, MSK 115kbps Mid



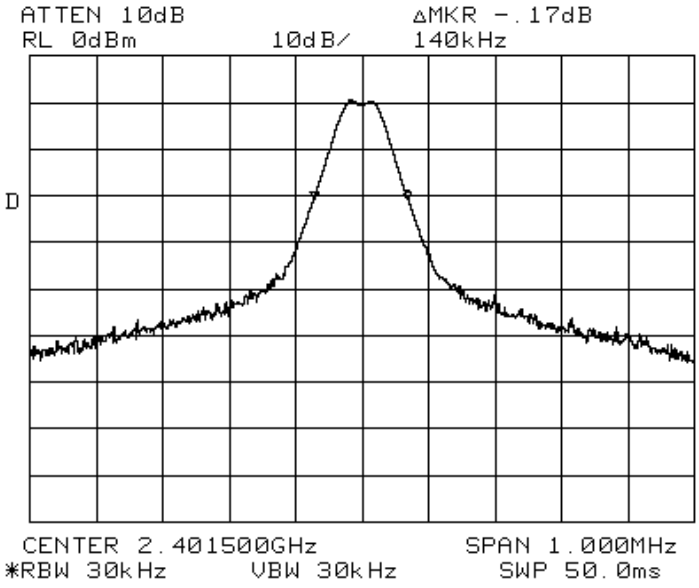
20dB OBW, MSK 115kbps high



20dB OBW, MSK 57kbps high



20dB OBW, MSK 57kbps mid



20dB OBW, MSK 57kbps low

Test Results – FHSS RF Output Power

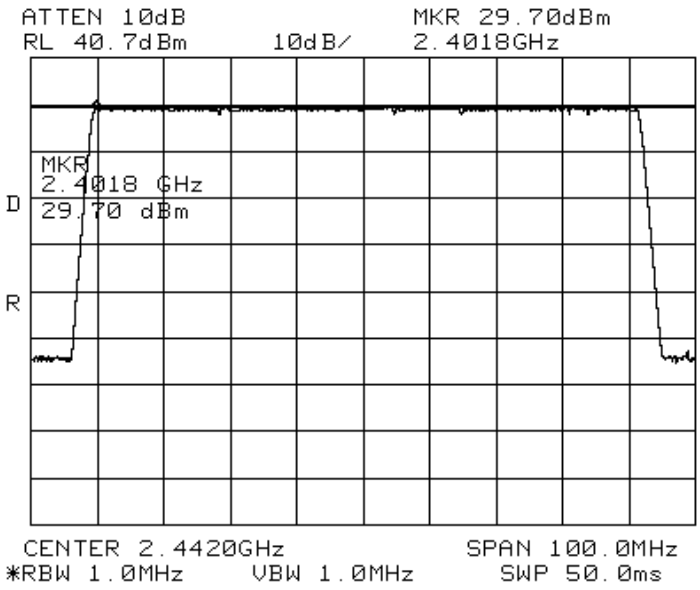
Table No. 12	FHSS – RF Output Power	Verdict
		P

Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

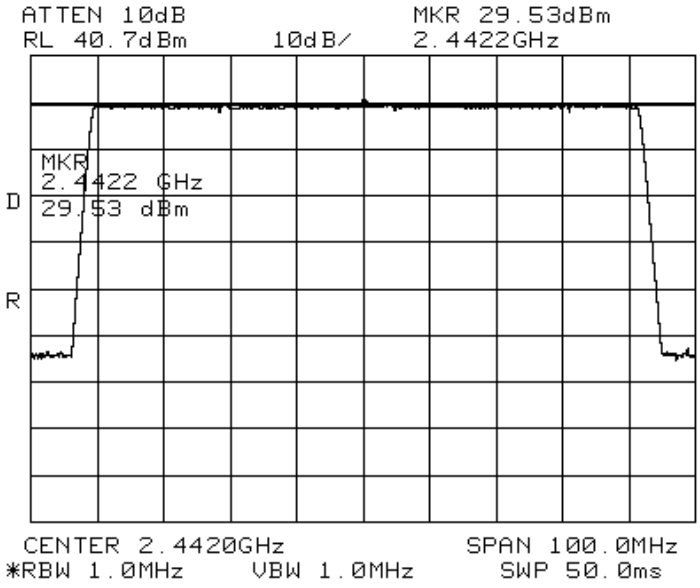
Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

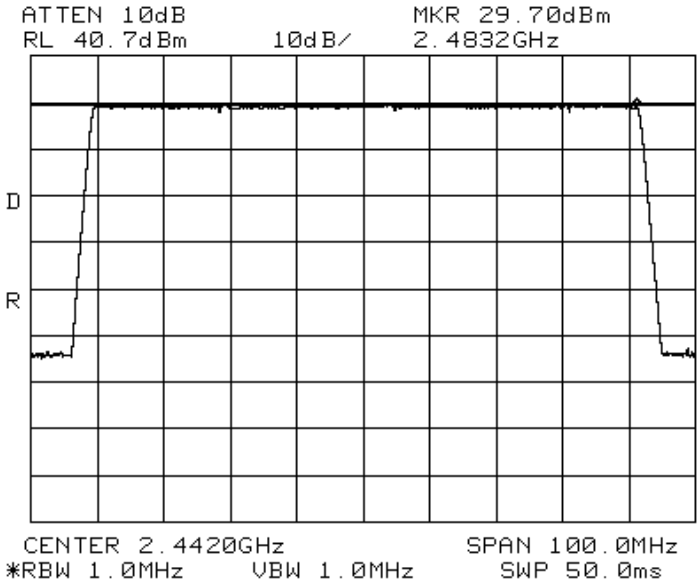
RF Power Output



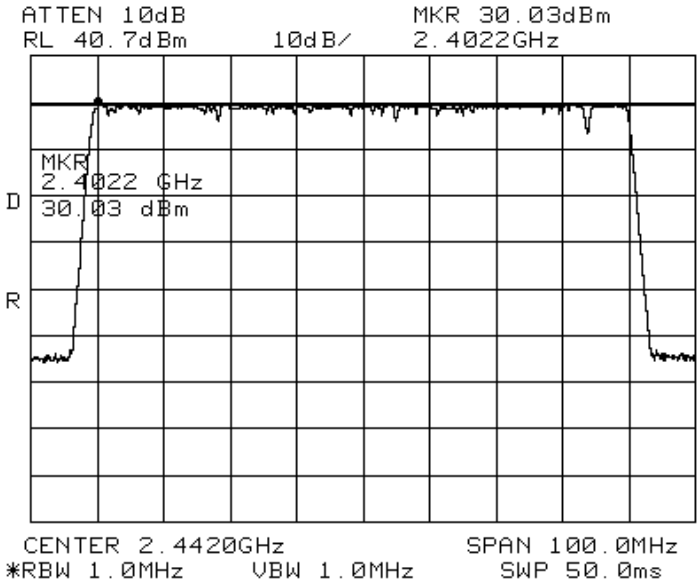
RF Power Output 229 kbps Low 2401.74 MHz



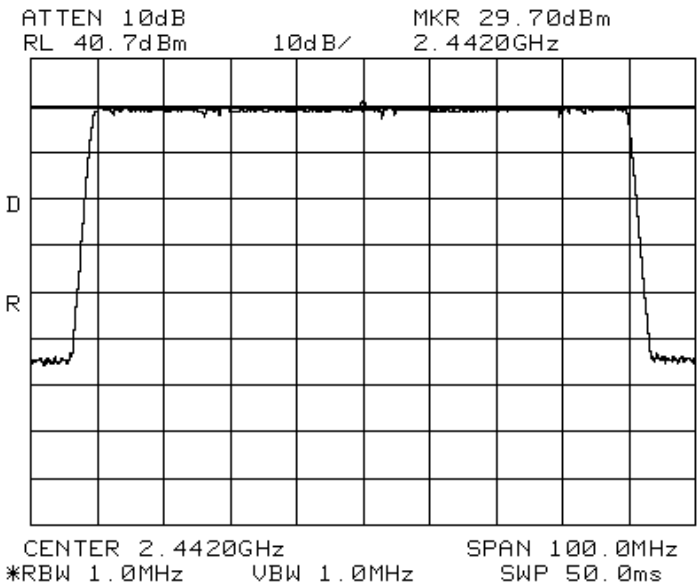
RF Power Output 229 kbps mid 2442 MHz



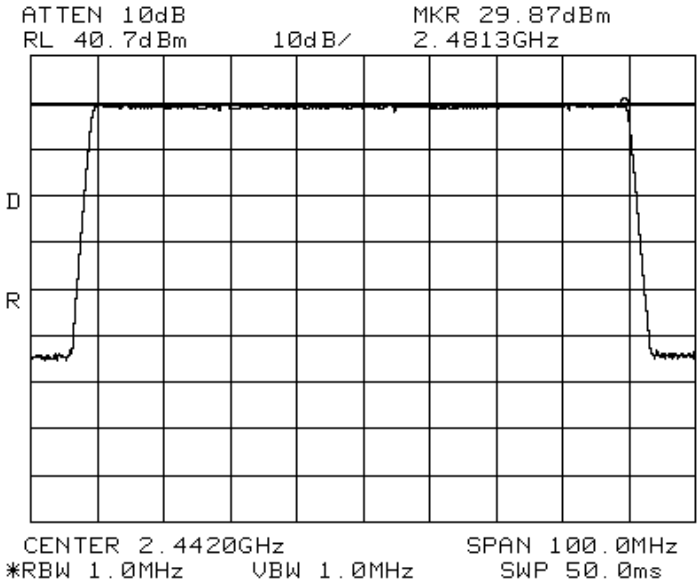
RF Power Output 229 kbps High 2480.8 MHz



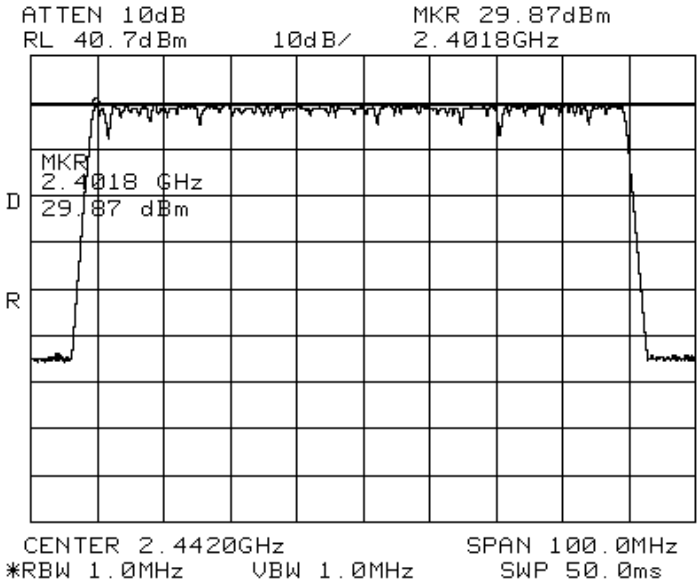
RF Power Output 153 kbps Low 2401.74 MHz



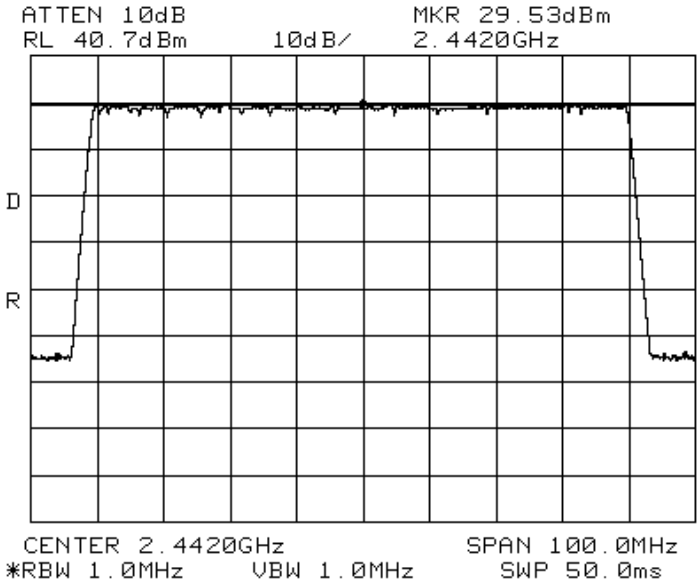
RF Power Output 153 kbps mid 2442 MHz



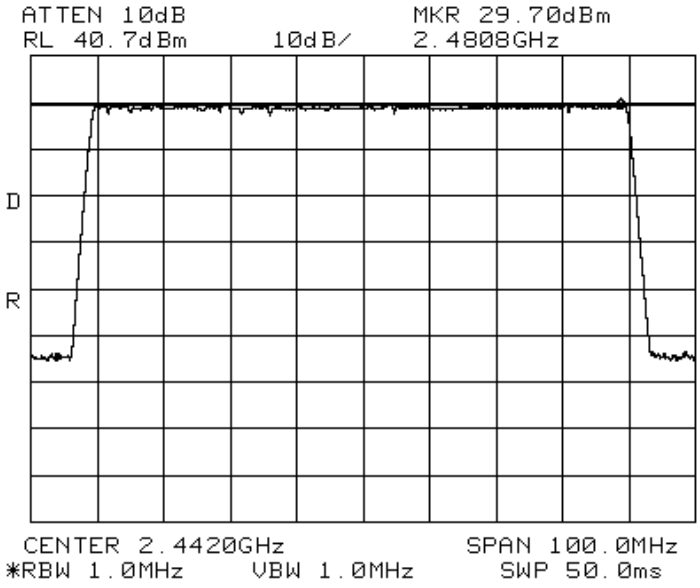
RF Power Output 153 kbps High 2480.8 MHz



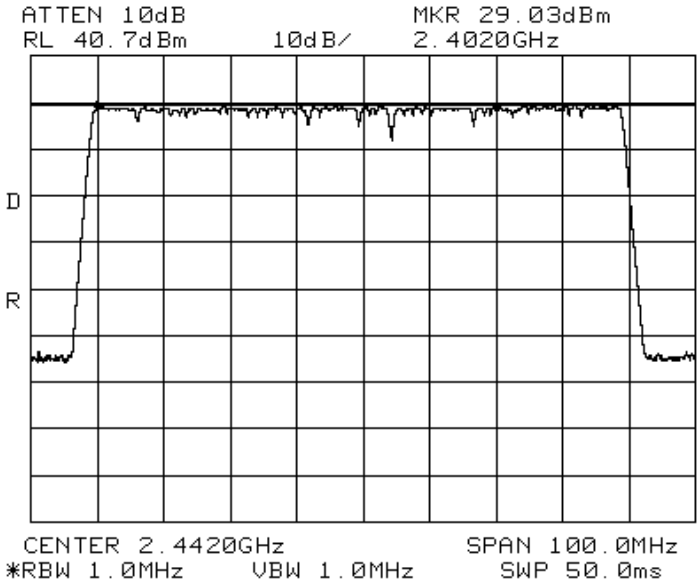
RF Power Output 115 kbps Low 2401.74 MHz



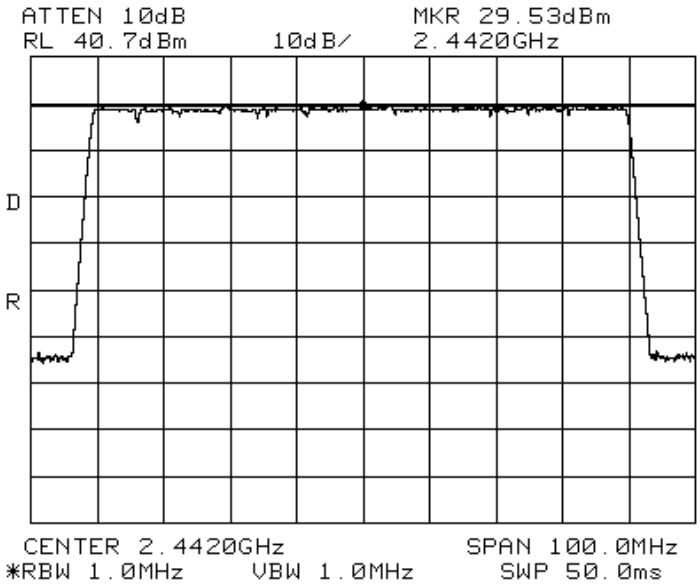
RF Power Output 115 kbps mid 2442 MHz



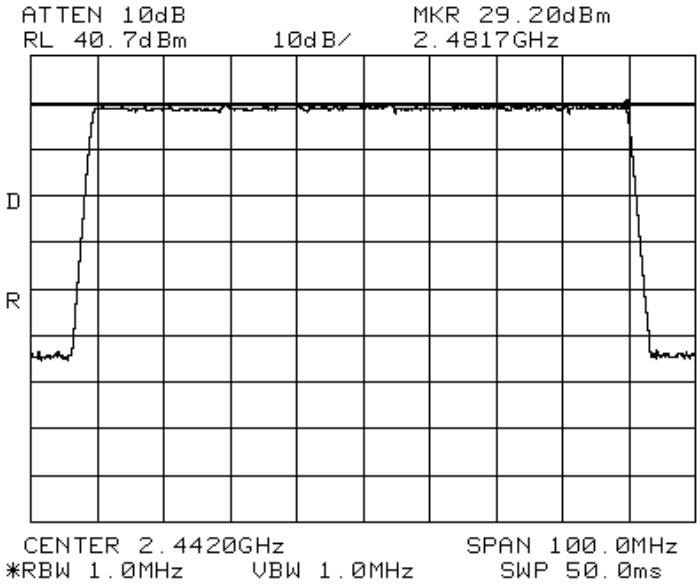
RF Power Output 115 kbps High 2480.8 MHz



RF Power Output 57 kbps Low 2401.74 MHz



RF Power Output 57 kbps mid 2442 MHz



RF Power Output 57 kbps High 2480.8 MHz

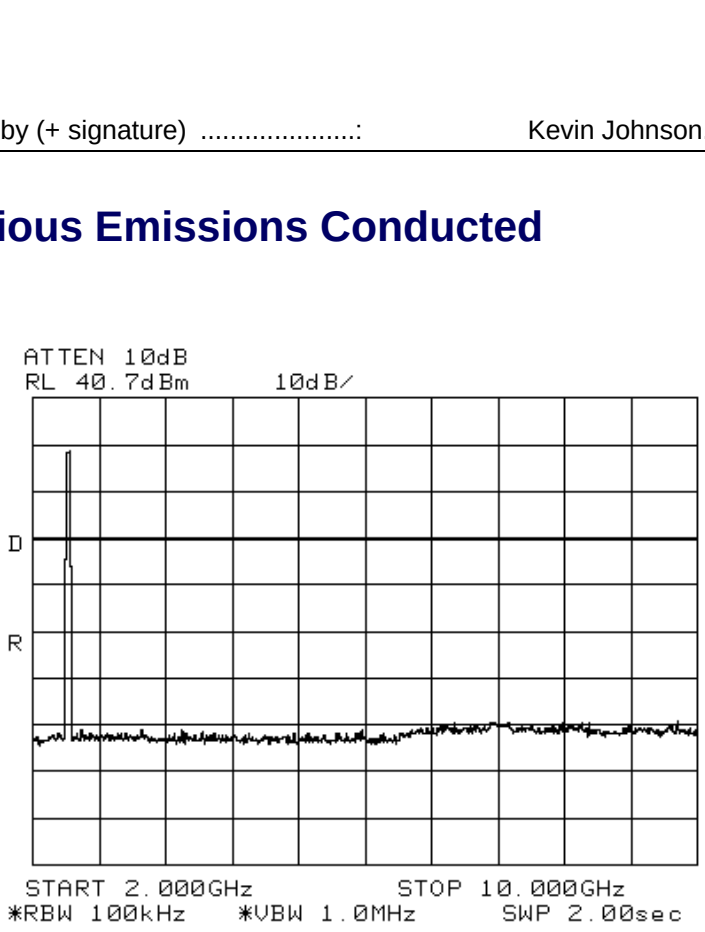
Test Results – FHSS Spurious Emissions Conducted

Table No. 13	FHSS – Spurious Emissions Conducted	Verdict
		P

Frequency Range ..... : 30 MHz to 25 GHz Test Location ..... : 10m Chamber #2
Test Method..... : ANSI C63.4 & ANSI C63.10
Test Distance ..... : N/A (conducted)
EUT Configuration ..... : See individual plots for antenna details
Test Date ..... : 1-7-2015
Temperature ..... : 22°C Relative Humidity .... : 24 %
Test Equipment Asset Tag List : 1373, 1133, 1538

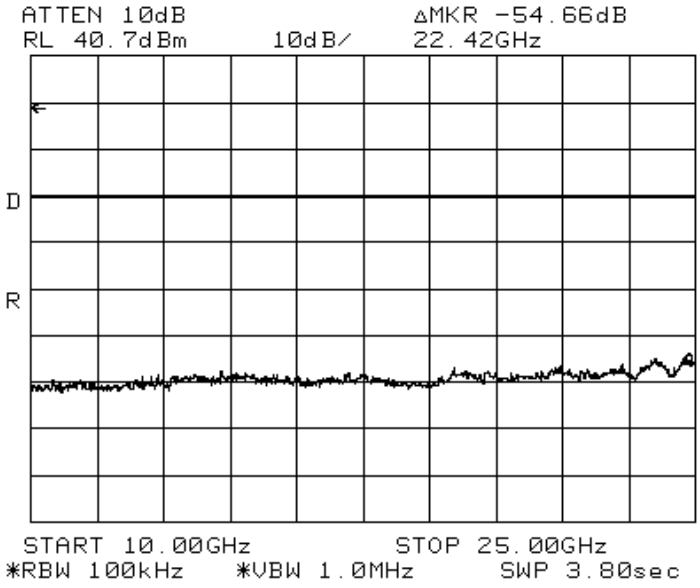
Supplemental Information:

Tested by (+ signature) .....: Kevin Johnson.

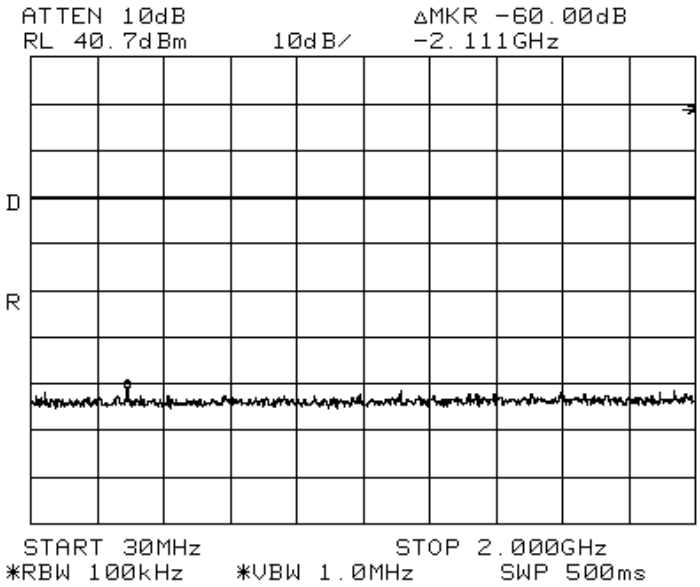


Spurious Emissions Conducted

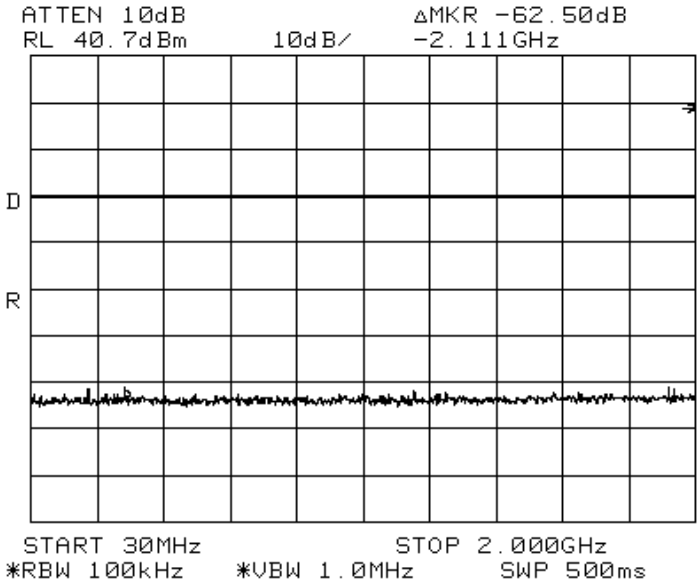
Spurious emissions 57 kbps 2-10GHz



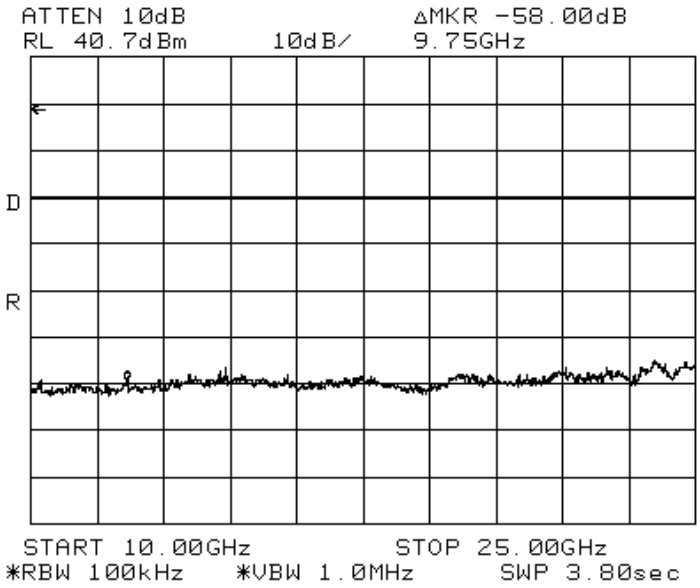
Spurious emissions 57 kbps 10-25GHz



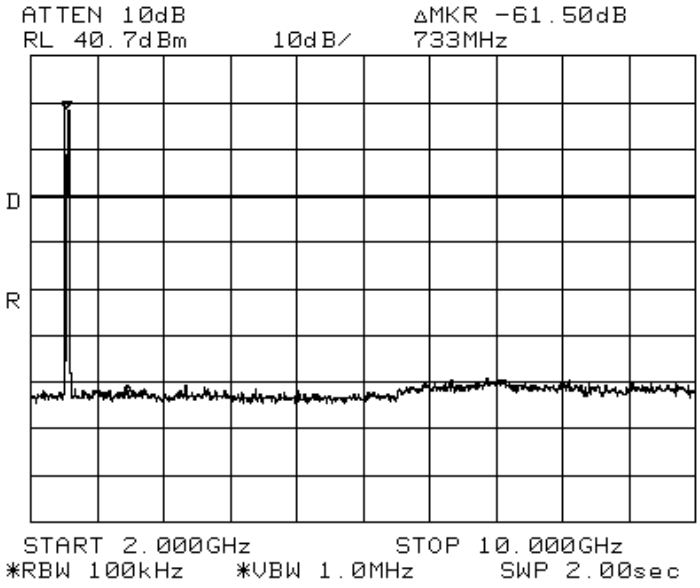
Spurious emissions 57 kbps 30MHz - 2GHz



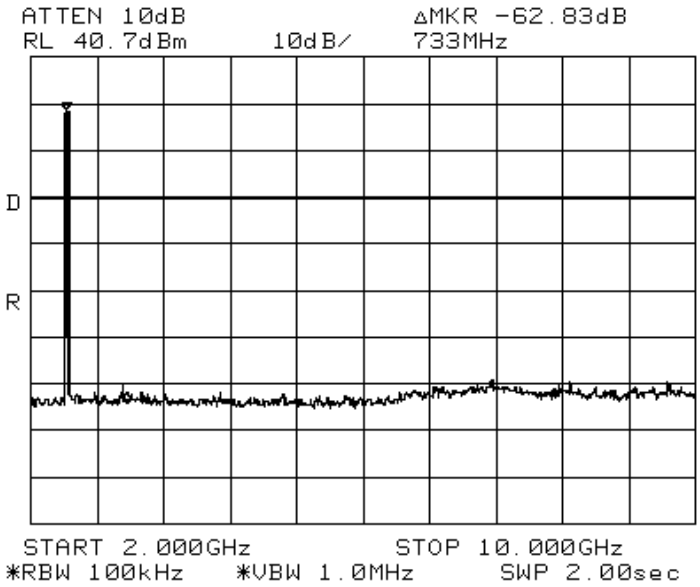
Spurious emissions 115 kbps 30MHz - 2GHz



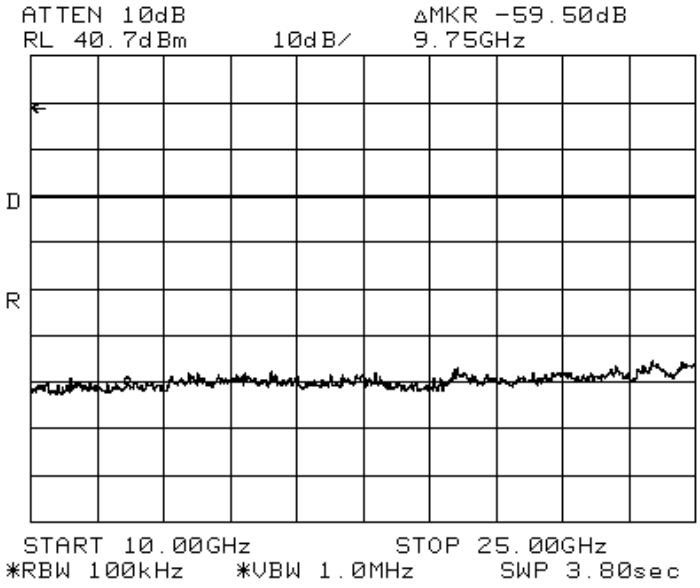
Spurious emissions 115 kbps 10 – 25GHz



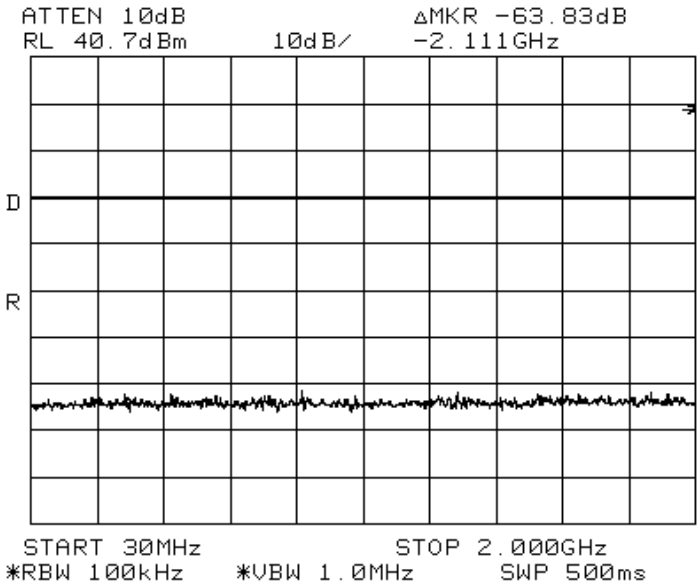
Spurious emissions 115 kbps 2 – 10GHz



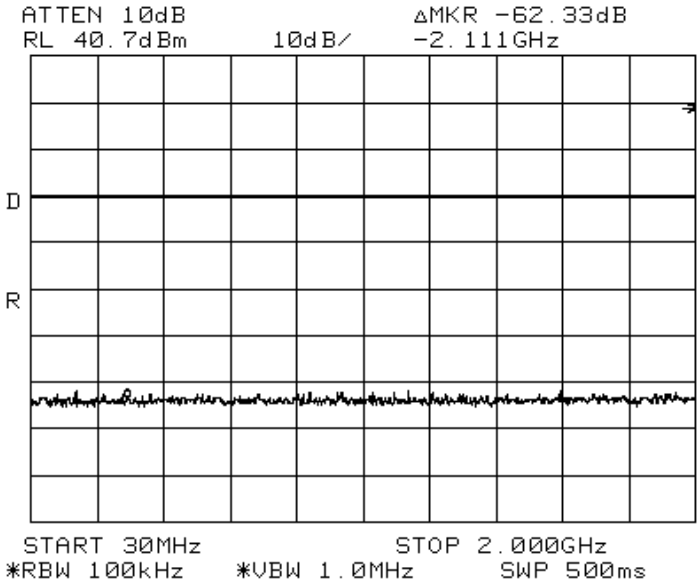
Spurious emissions 153 kbps 2 – 10GHz



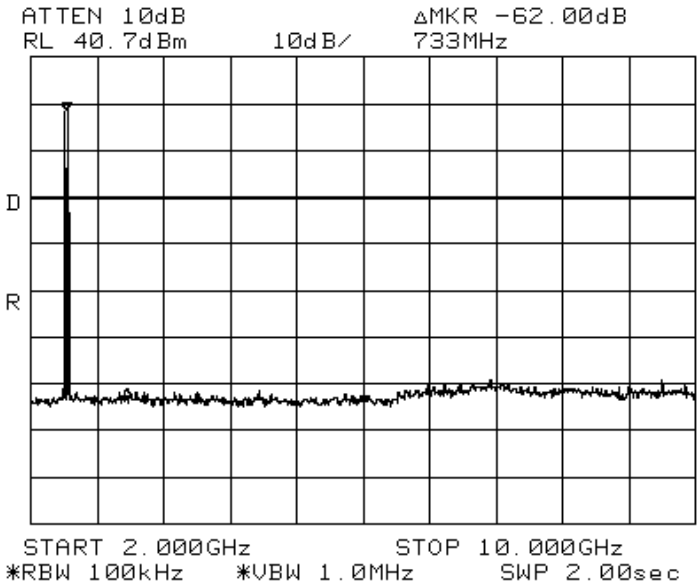
Spurious emissions 153 kbps 10 – 25GHz



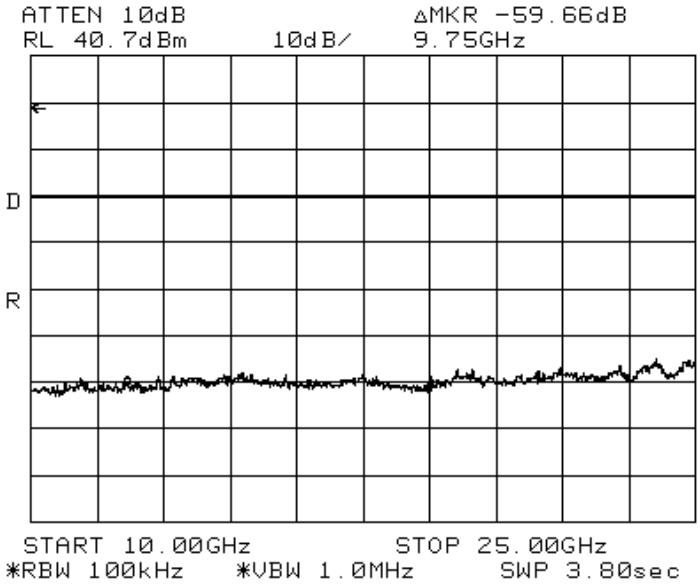
Spurious emissions 153 kbps 30MHz – 2GHz



Spurious emissions 229 kbps 30MHz – 2GHz



Spurious emissions 229 kbps 2GHz – 10GHz



Spurious emissions 229 kbps 10GHz – 25GHz

Test Results - RF Exposure

Table No. 2	RF Exposure	Verdict
		P

Test Method ..... : ANSI C63.4
EUT Configuration ..... :
Power Input ..... : 5 Vdc Hz ☐ 1ϕ ☐ 3ϕ
Test Date ..... : 1-8-2015
Temperature ..... : 21.5°C Relative Humidity .....: 29. %
Test Equipment Asset Tag List ..... : 1197, 1215, 1229, 1253, 1263, 1264, 1265, 1392, 1396, 1403, 1405, 1410, 1470

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	30.0	(dBm)	*
Maximum peak output power at antenna input terminal:	1000.0	(mW)	
Antenna gain(maximum):	20	(dBi)	*
Maximum antenna gain:	100.00	(numeric)	
Time Averaging:	93	(%)	*
Prediction distance:	86.03	(cm)	*
Prediction frequency:	2450	(MHz)	*
MPE limit for uncontrolled exposure at prediction frequency:	1.000	(mW/cm^2)	
Power density at prediction frequency:	1.0000	(mW/cm^2)	
This equates to:	10.0000	W/m^2	

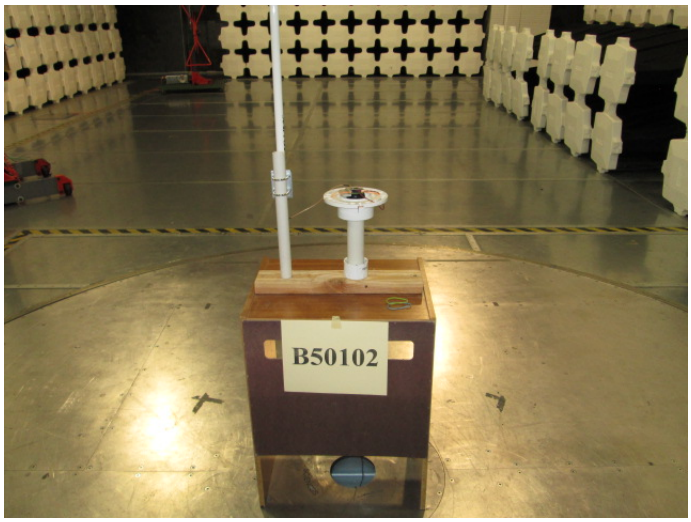
Supplemental Information:

Using the maximum RF power output and the highest gain antenna, the EUT complies with the RF exposure limit at 86.03 cm spacing.

Tested by (+ signature) ..... : Kevin Johnson.

Setup Photos

Photo 3	**Test Setup – Radiated Emissions (below 1 GHz)**	



Supplemental Information:

Photo 4	**Test Setup – Radiated Emissions (above 1 GHz)**	

Supplemental Information:

Photo 6	**Test Setup – Conducted Measurements**	

Supplemental Information: