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EMC Test Report

Application for FCC Grant of Equipment Authorization

FCC Part 15 Subpart C

Model: TCD84A000 (Mantis)

FCC ID:	TGN-TCD84A
APPLICANT:	TiVO Inc. 2160 Gold St. Alviso, CA 95002
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
REPORT DATE:	August 10, 2016
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ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	August 10, 2016	First release	
1	August 25, 2016	Removed references to beamforming in report, added analyzer settings used for pages 49-65	dwb
2	September 1, 2016	Corrected power values listed on page 6	dwb
3	September 6, 2016	Corrected eirp value on page 6	dwb

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SCOPE

An electromagnetic emissions test has been performed on the TiVO Inc. model TCD84A000 (Mantis), pursuant to the following rules:

FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems - Silicon Valley test procedures:

ANSI C63.10-2013
FCC DTS Measurement Guidance KDB558074

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of TiVO Inc. model TCD84A000 (Mantis) complied with the requirements of the following regulations:

FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of TiVO Inc. model TCD84A000 (Mantis) and therefore apply only to the tested sample. The sample was selected and prepared by Jim Inokuchi of TiVO Inc.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

DIGITAL TRANSMISSION SYSTEMS (2400 – 2483.5MHz)

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)		Digital Modulation	Systems uses OFDM / DSSS techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)		6dB Bandwidth	11b: 8.042 MHz 11g: 16.339 MHz n20: 17.556 MHz n40: 36.279 MHz	>500kHz	Complies
15.247 (b) (3)		Output Power (multipoint systems)	11b: 22.3 dBm 11g: 21.8 dBm n20: 22.0 dBm n40: 17.8 dBm Max EIRP = 1.033 W Note 1	1Watt, EIRP limited to 4 Watts.	Complies
15.247(e)		Power Spectral Density	11b: 6.2 dBm / 10kHz (-1.8 dB) 11g: 3.9 dBm / 10kHz (-4.1 dB) n20: 3.8 dBm / 10 kHz (-4.2 dB) N40: -3.0 dBm / 10 kHz (-11.0 dB)	8dBm/3kHz	Complies
15.247(d)		Antenna Port Spurious Emissions 30MHz – 25 GHz	All emissions < -30 dBc	< -30dBc Note 2	Complies
15.247(d) / 15.209		Radiated Spurious Emissions 30MHz – 25 GHz	53.7 dBµV/m @ 2389.9 MHz (-0.3 dB)	Refer to the limits section (p20) for restricted bands, all others <-30dBc Note 2	Complies

Note 1: EIRP calculated using antenna gains of 4.8 dBi () for the highest EIRP system.
Note 2: Limit of -30dBc used because the power was measured using the UNII test procedure (maximum power averaged over a transmission burst).
Note 3: the device is operating under the smart antenna rules as detailed in FCC 15.247(c) (2). Refer to the operational description for additional justification.

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203		RF Connector	Integral	Unique or integral antenna required	Complies
15.407 (b) (6)		AC Conducted Emissions	64.1 dBµV @ 0.150 MHz (-1.9 dB)	Refer to page 19	Complies
15.247 (i) 15.407 (f)		RF Exposure Requirements	Refer to MPE calculations in separate exhibit and User Manual statements.	Refer to OET 65, FCC Part 1	Complies

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The TiVO Inc. model TCD84A000 (Mantis) is a network DVR that is designed to receive OTA broadcast video and transcodes and send it out as a network stream either wired or wireless. The EUT incorporates an 802.11 a/b/g/n/ac transceiver. In the 2.4 GHz band, it uses 20 and 40 MHz nominal bandwidths. Since the EUT would be placed on a tabletop during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 100-120 Volts, 50/60 Hz, 0.4 Amps.

The sample was received on June 9, 2016 and tested on July 5, 8, 11, 13, 14, 15, 18, 19 and 22, 2016. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Tivo Inc	TCD84A000	Network DVR	8FA0000001F48C5	TGN-TCD84A
Tivo Inc	TCD84A000	Network DVR	8FA0001901E2766	TGN-TCD84A
Tivo Inc	ADP-12AW BA	Power Adapter	R1115	-

ANTENNA SYSTEM

The antenna system consists of two integral antennas.

ENCLOSURE

The EUT enclosure is primarily constructed of uncoated plastic. It measures approximately 14 cm wide by 14 cm deep by 4 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Configuration #2

Company	Model	Description	Serial Number	FCC ID
None	-	-	-	-

Configuration #3

Company	Model	Description	Serial Number	FCC ID
IBM	Thinkpad	Notebook	AK-VTZNM 03/07C	-
Netgear	GS605	Network Switch	1YG2073H02D60	-

The following equipment was used as remote support equipment for emissions testing:

Configuration #2

Company	Model	Description	Serial Number	FCC ID
Samsung	NP940X5J	Notebook	JL5791JFA00253M	-
Netgear	GS605	Network Switch	1YG2073H02D60	-
-	-	Antenna	-	-

Configuration #3

Company	Model	Description	Serial Number	FCC ID
Non	-	-	-	-

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Configuration #2

Port		Cable(s)		
From	To	Description	Shielded/Unshielded	Length(m)
Ant In	Remote Antenna	Coax	Shielded	30
Ethernet	Remote Switch	Cat 5	Unshielded	10
DC input	AC Adapter	Two wire	Unshielded	1.5
AC Adapter	Mains	Two wire	Unshielded	1.2

Configuration #2 (Additional on Support Equipment)

Port		Cable(s)		
From	To	Description	Shielded/Unshielded	Length(m)
Ethernet Switch	MacBook	Cat 5	Unshielded	2

Configuration #3

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Ethernet	Remote Switch	Cat 5	Unshielded	1
DC input	AC Adpater	Two wire	Unshielded	1.5
AC Adapter	Mains	Two wire	Unshielded	2

Configuration #3 (Additional on Support Equipment)

Port		Cable(s)		
From	To	Description	Shielded/Unshielded	Length(m)
Ethernet Switch	MacBook	Cat 5	Unshielded	2

EUT OPERATION

During emissions testing the EUT was set to transmit continuously on the selected channel at the selected power level via Ethernet through the Notebook.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 4	US0027	2845B-4	41039 Boyce Road Fremont, CA 94538-2435
Chamber 5	US0027	2845B-5	

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

Software is used to view and convert receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers. The software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.10 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor as specified in ANSI C63.4. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.10, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

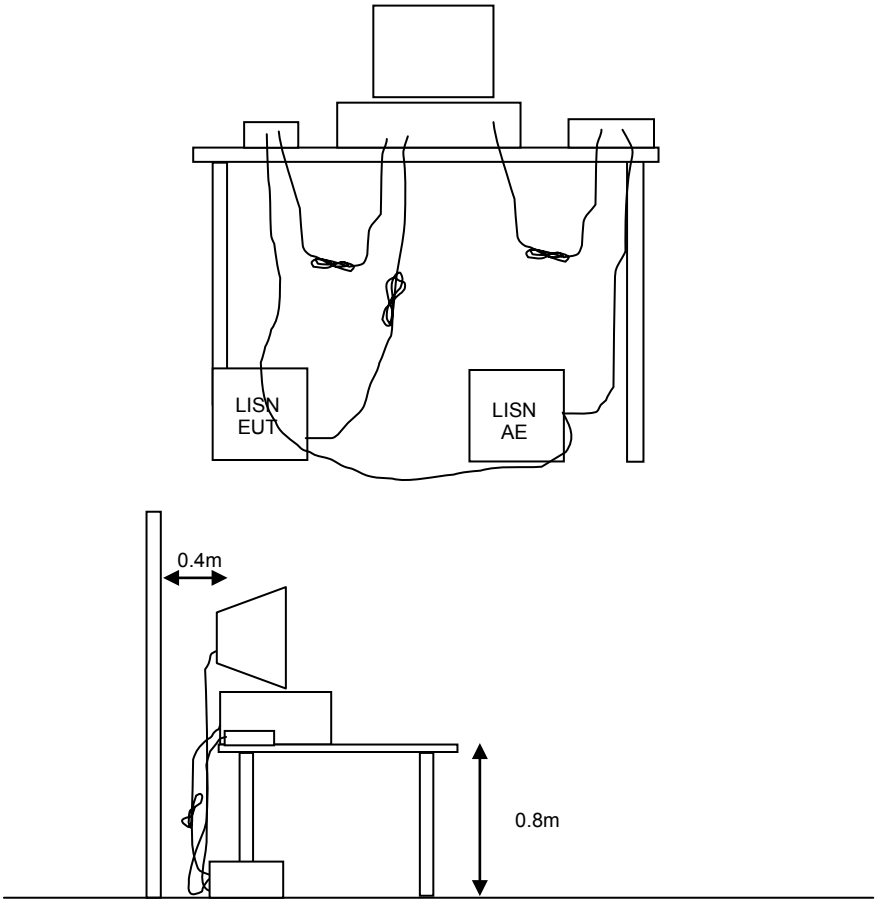


Figure 1 Typical Conducted Emissions Test Configuration

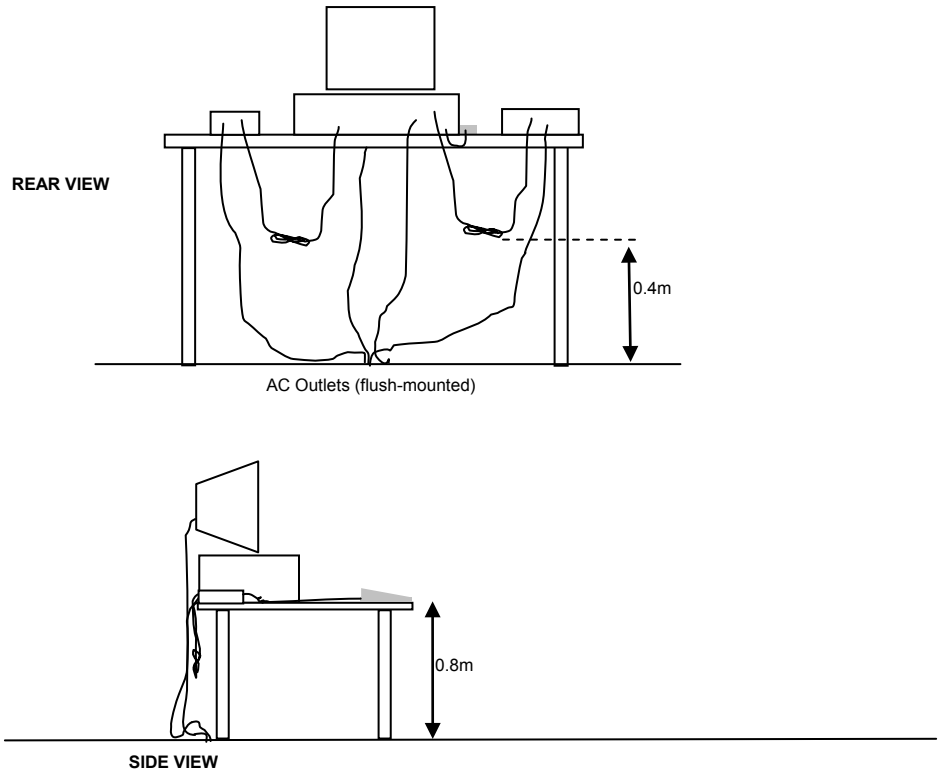
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

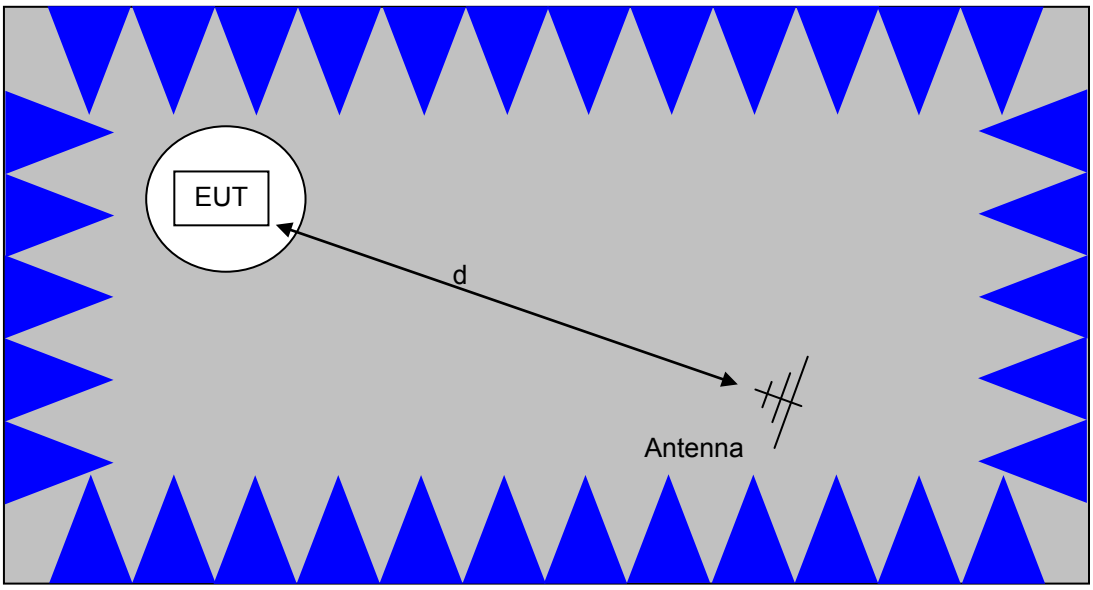
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.

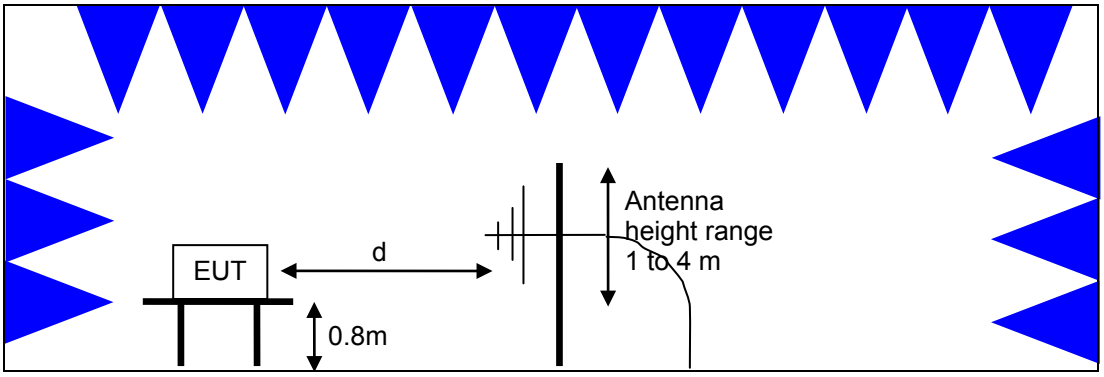


Typical Test Configuration for Radiated Field Strength Measurements



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

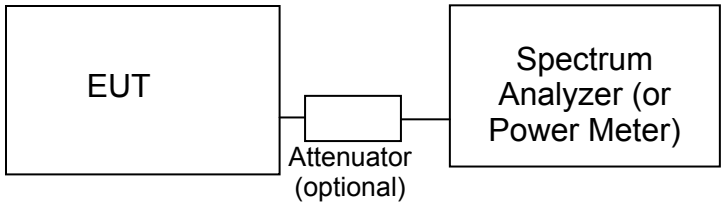
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.



Test Configuration for Antenna Port Measurements

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB, 26dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10 and RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1].

Frequency Range (MHz)	Limit (uV/m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from receivers as detailed in FCC Part 15.109 and RSS GEN Table 2. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109 and receivers that are not stand-alone are exempt from the ISED Canada requirements per RSS-GEN.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

[1] The restricted bands are detailed in FCC 15.205 and RSS-Gen Table 6

OUTPUT POWER LIMITS – DIGITAL TRANSMISSION SYSTEMS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watt (30 dBm)	8 dBm/3kHz
2400 – 2483.5	1 Watt (30 dBm)	8 dBm/3kHz
5725 – 5850	1 Watt (30 dBm)	8 dBm/3kHz

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level (30dB if the power is measured using the sample detector/power averaging method).

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:
R_r = Receiver Reading in dBuV
S = Specification Limit in dBuV
M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:
F_d = Distance Factor in dB
D_m = Measurement Distance in meters
D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:
R_r = Receiver Reading in dBuV/m
F_d = Distance Factor in dB
R_c = Corrected Reading in dBuV/m
L_s = Specification Limit in dBuV/m
M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of d (meters) from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{d} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For a measurement at 3m the conversion from a logarithmic value for field strength (dBuV/m) to an eirp power (dBm) is -95.3dB.

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
2.4GHz Wifi Spurious Emissions, 1,000 - 25,000 MHz, 08-Jul-16					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	10/12/2015	10/12/2016
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	3/28/2016	3/28/2017
HP / Miteq	SA40 Head (Blue)	TTA1840-45-5P-HG-S	1620	3/8/2016	3/8/2017
A. H. Systems	Red System Horn, 18-40GHz	SAS-574, p/n: 2581	2161	7/16/2015	7/16/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	9/16/2015	9/16/2016
Radiated Emissions, 1,000 - 25,000 MHz, 11-Jul-16					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	10/12/2015	10/12/2016
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	3/28/2016	3/28/2017
HP / Miteq	SA40 Head (Blue)	TTA1840-45-5P-HG-S	1620	3/8/2016	3/8/2017
A. H. Systems	Red System Horn, 18-40GHz	SAS-574, p/n: 2581	2161	7/16/2015	7/16/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	9/16/2015	9/16/2016
Radiated Emissions, 11 - 18,000 MHz, 13-Jul-16					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Hewlett Packard	High Pass filter, 8.2 GHz	P/N 84300-80039	1152	6/28/2016	6/28/2017
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	10/9/2015	10/9/2016
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/19/2016	3/19/2017
Radiated Emissions, 18 - 40 GHz, 13-Jul-16					
HP / Miteq	SA40 Head (Purple)	TTA1840-45-5P-HG-S	1772	12/21/2015	N/A
A. H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	7/29/2015	7/29/2017
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/19/2016	3/19/2017
Radiated Emissions, 1 - 11 GHz, 13-Jul-16					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	10/9/2015	10/9/2016
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2251	9/16/2015	9/16/2016
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/19/2016	3/19/2017
2.4GHz Wifi / UNII Radiated Emissions, 1 - 40 GHz, 14-Jul-16					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Hewlett Packard	High Pass filter, 8.2 GHz	P/N 84300-80039	1152	6/28/2016	6/28/2017
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	1730	5/9/2016	5/9/2017
HP / Miteq	SA40 Head (Purple)	TTA1840-45-5P-HG-S	1772	12/21/2015	N/A
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	10/9/2015	10/9/2016
A. H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	7/29/2015	7/29/2017
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	2241	9/16/2015	9/16/2016
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	9/16/2015	9/16/2016
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/19/2016	3/19/2017
2.4G Wifi Radiated Emissions / 2.4G Wifi & UNII BE, 1 - 12 GHz, 15-Jul-16					
EMCO	Antenna, Horn, 1-18GHz	3115	868	6/30/2016	6/30/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	10/9/2015	10/9/2016
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	9/16/2015	9/16/2016
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/19/2016	3/19/2017
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESIB40 (1088.7490.40)	2493	2/20/2016	2/20/2017
2.4G Wifi Conducted Emissions - Antenna Ports, 18, 19-Jul-16					
Rohde & Schwarz	Power Sensor 300 uW - 30 Watts (+ 25dB pad)	NRV-Z54	1788	9/23/2015	9/23/2016
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/24/2016	6/24/2017
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	3268	4/22/2016	2/22/2017
2.4G WiFi Conducted Emissions - Antenna Ports, 19-Jul-16					
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/24/2016	6/24/2017
Conducted Emissions - AC Power Ports, 22-Jul-16					
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	4/26/2016	4/26/2017
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	6/29/2016	6/29/2017
Fischer Custom Comm	LISN, 25A, 150kHz to 30MHz, 25 Amp,	FCC-LISN-50-25-2-09	2001	7/24/2015	7/24/2016

Appendix B Test Data

T102023 Pages 27 – 103

Client:	Tivo, Inc.	Job Number:	JD101876
Product	Mantis	T-Log Number:	T102023
System Configuration:	-	Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Emissions Standard(s):	FCC Part 15	Class:	B
Immunity Standard(s):	-	Environment:	Radio, Multimedia

EMC Test Data

For The

Tivo, Inc.

Product

Mantis

Date of Last Test: 7/26/2016

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

Power vs. Data Rate

In normal operating modes the card uses power settings stored on EEPROM to set the output power. For a given nominal output power the actual transmit power normally is reduced as the data rate increases, therefore testing was performed at the data rate in the mode with highest power to determine compliance with the requirements.
The following power measurements were made using a GATED average power meter and with the device configured in a continuous transmit mode on Chain 1 at the various data rates in each mode to verify the highest power mode:

Sample Notes

Sample S/N: 8FA0001901E2766
Driver: 01-EA4417DA firmware and wl 1.201 RC70.0 scripts

Date of Test: 7/5/2016
Test Engineer: Kevin Wen, Yew-Kwong Soo
Test Location: Fremont Chamber #5

Mode	Data Rate	Power (dBm)	Power setting
802.11a	6	**15.1**	10
	9	14.7	
	12	15.0	
	18	14.7	
	24	14.8	
	36	14.8	
	48	14.8	
	54	14.8	
802.11b	1	**14.8**	10
	2	14.7	
	5.5	14.7	
	11	14.7	
802.11a/g	6	**14.3**	10
	9	14.2	
	12	14.2	
	18	14.2	
	24	14.3	
	36	14.3	
	48	14.3	
	54	14.3	

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

Mode	Data Rate	Power (dBm)	Power setting	
802.11n/ac 20MHz	6.5	**15.2**	10	
	13	15.2		
	19.5	15.0		
	26	15.1		
	39	15.0		
	52	15.0		
	58.5	14.9		
	65	15.0		
	78	14.9		<<-11ac mode only
802.11n/ac 40MHz	13.5	**14.7**	10	
	27	14.6		
	40.5	14.4		
	54	14.7		
	81	14.6		
	108	14.5		
	121.5	14.5		
	135	14.4		
	162	14.5		<<-11ac mode only
	180	14.5		<<-11ac mode only
802.11ac 80MHz	29.3	**13.6**	10	
	58.5	13.2		
	87.8	13.1		
	117.0	13.4		
	175.5	13.4		
	234.0	13.3		
	263.3	13.3		
	292.5	13.3		
	351.0	13.2		
	390.0	13.2		

Note : Power setting - the software power setting used during testing, included for reference only.

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

Duty Cycle

Date of Test: 7/5/2016
Test Engineer: Kevin Wen, Yew-Kwong Soo
Test Location: Fremont Chamber #5

Duty cycle measurements performed on the worse case data rate for power.

Notes: Measurements taken with maximum RBW/VBW settings allowed.
Non-beamforming

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mb/s	1.00	Yes	100	0	0	10
11g	6 MB/s	0.99	Yes	2.1	0	0	476
n20	MCS 0	0.99	Yes	0.948	0	0	1055
n40	MCS 0	0.96	Yes	0.49	0.18	0.36	2041
ac80	VHT8 x 2	0.41	Yes	0.035	3.85	7.71	28571
ac80	VHT8 x1	0.46	Yes	0.044	3.39	6.78	22727
ac80	VHT0 x1	0.89	Yes	0.428	0.50	1.00	2336
ac80	VHT0 x2	0.82	Yes	0.226	0.85	1.70	4425

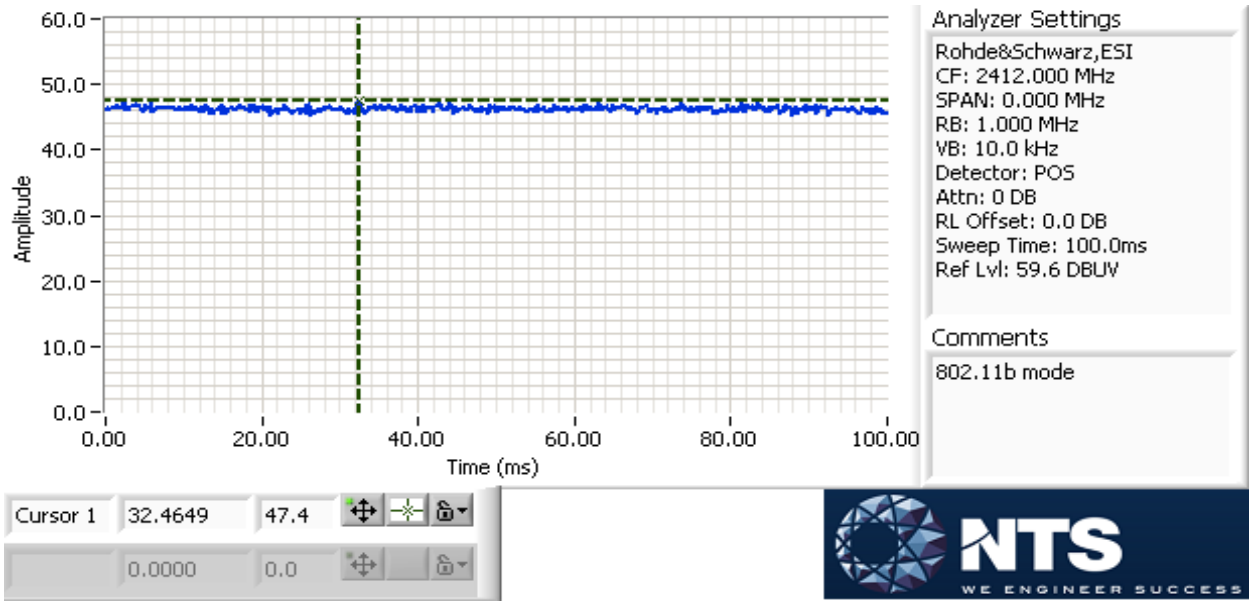
* Correction factor when using RMS/Power averaging - 10*log(1/x)
** Correction factor when using linear voltage average - 20*log(1/x)
T = Minimum transmission duration

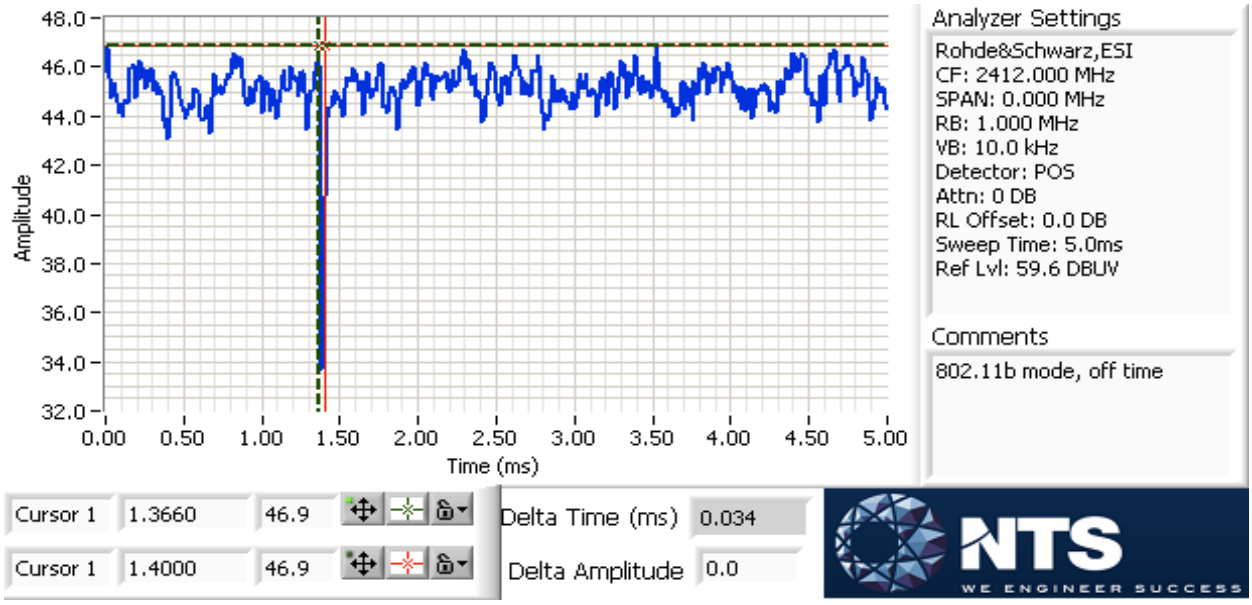
<< Insert duty cycle plots>>

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

Non-beamforming

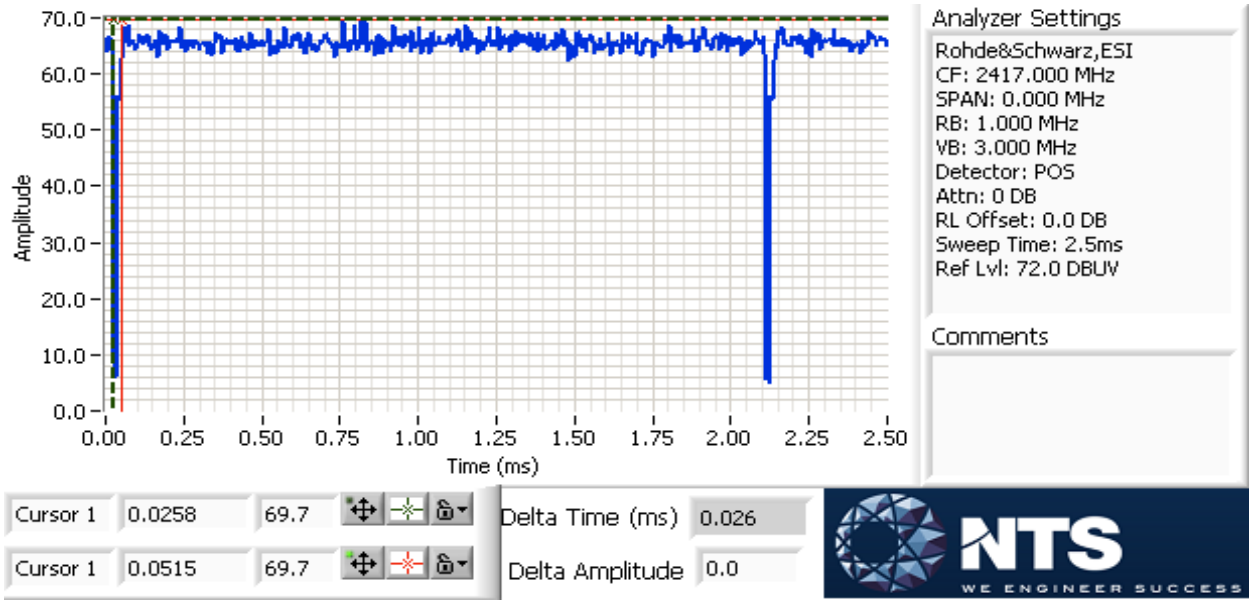
b





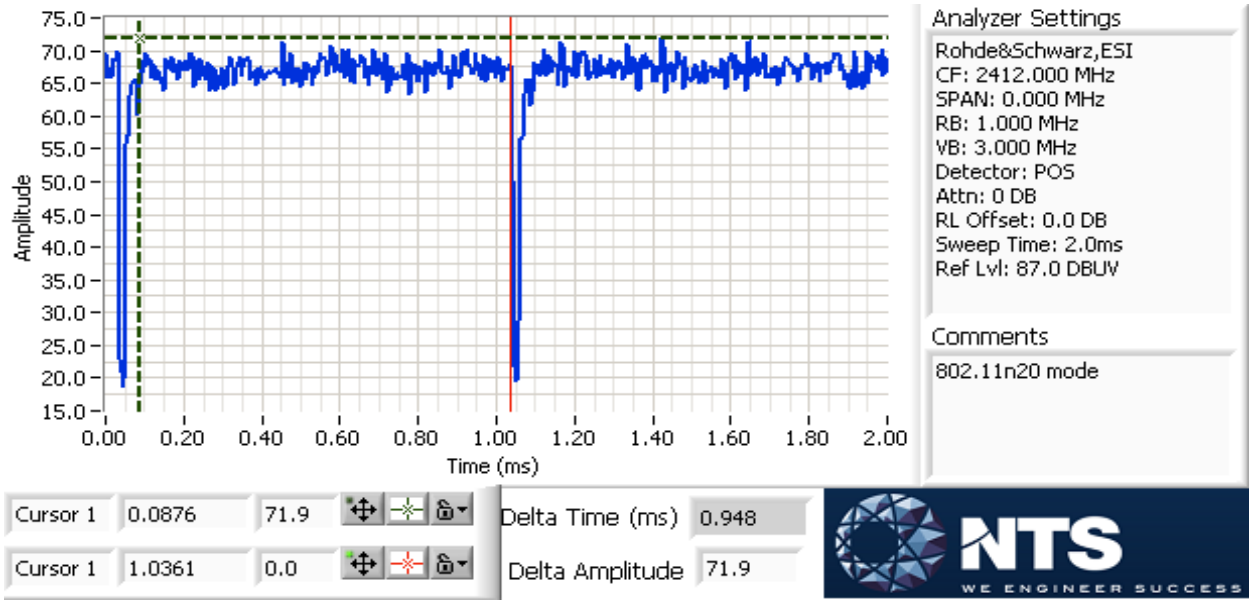
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

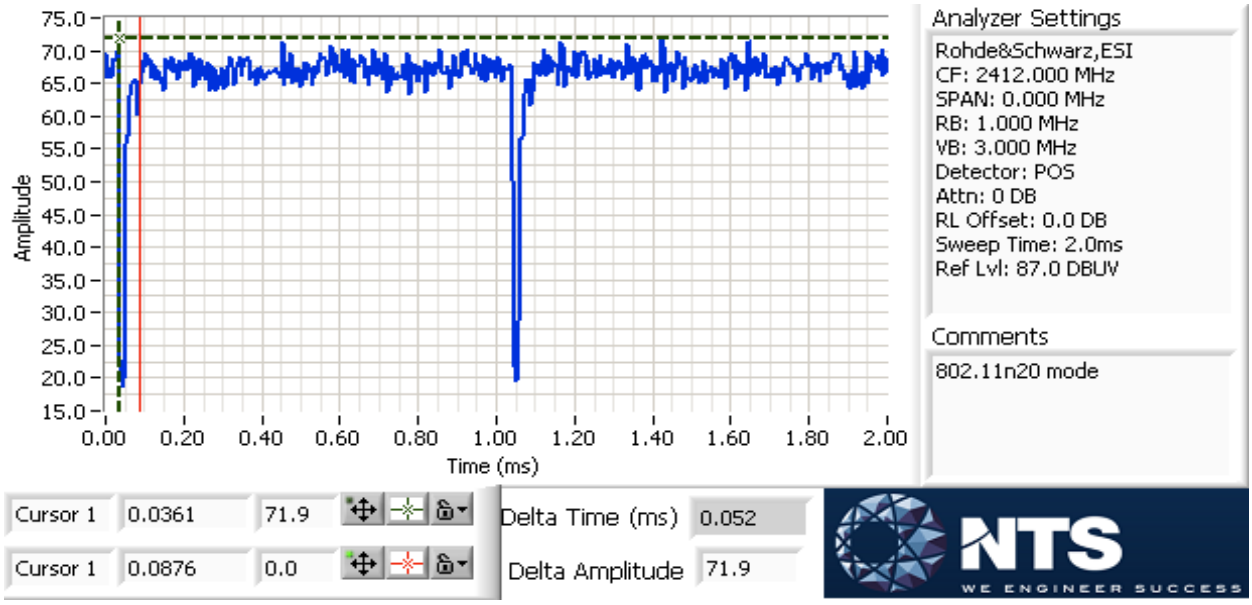
g



Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

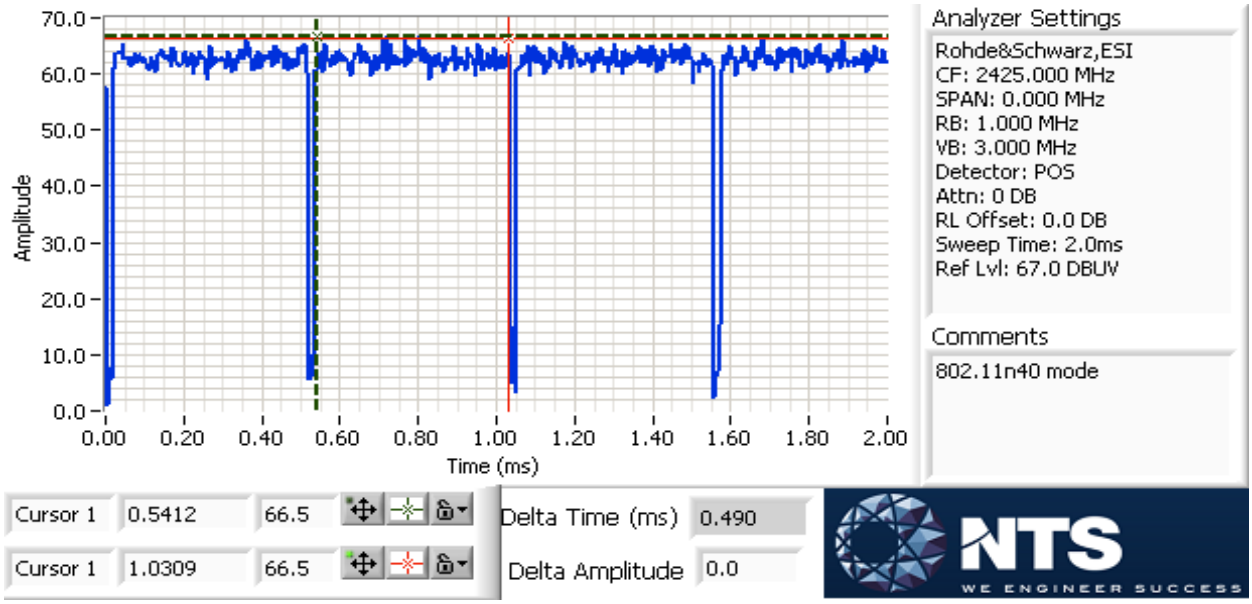
n20

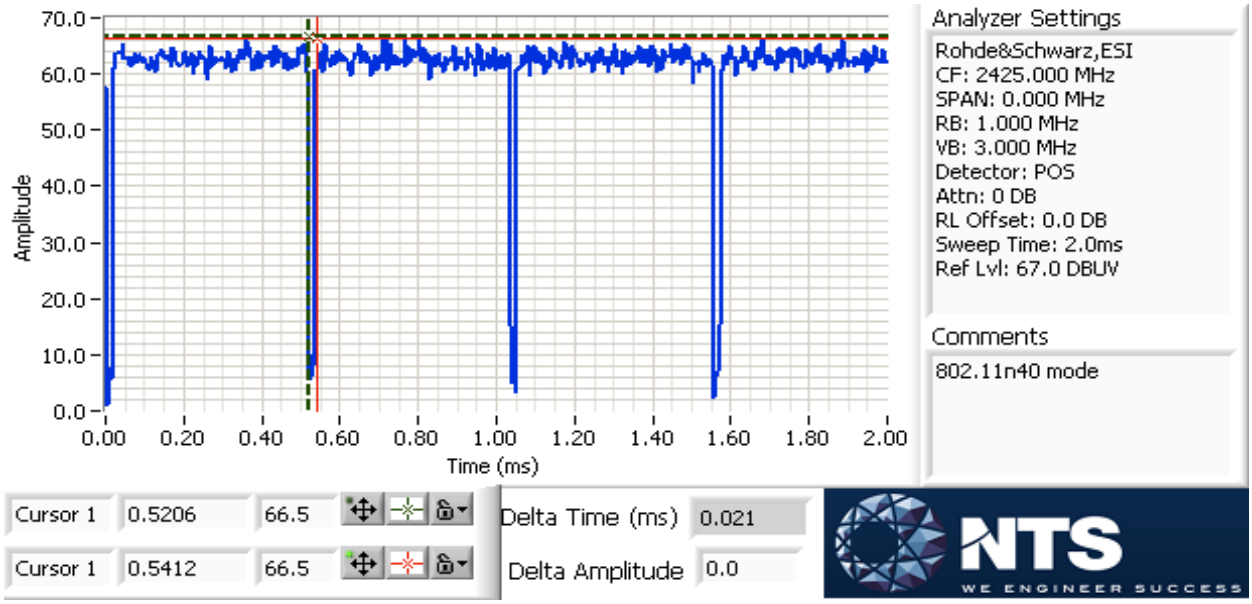




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

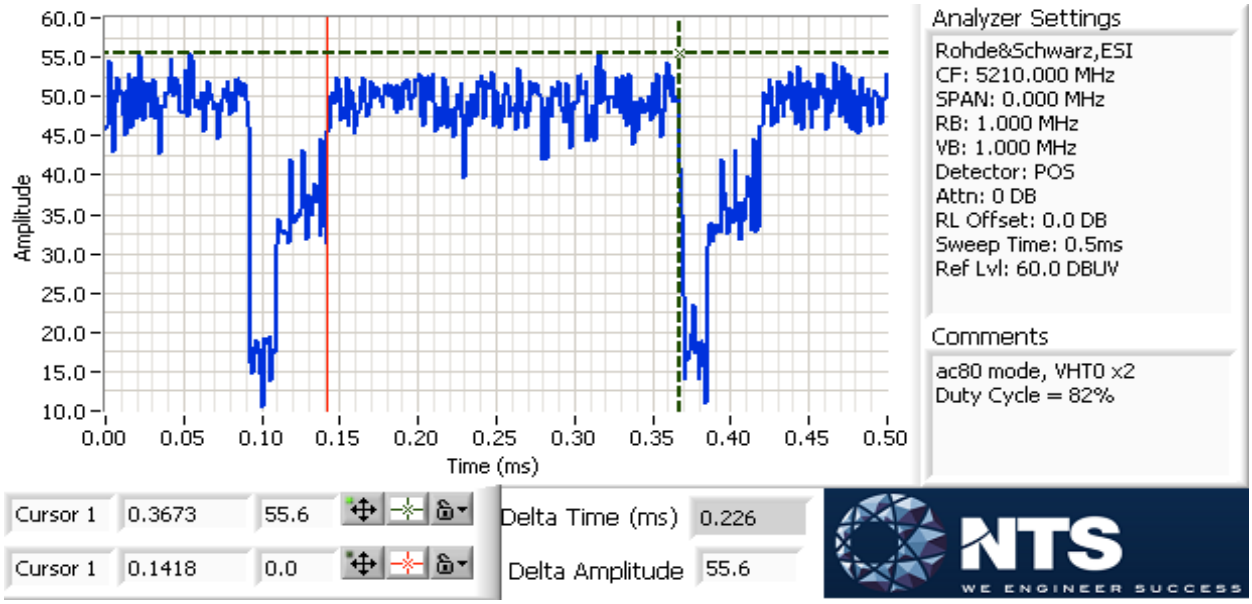
n40





Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	N/A

ac80



Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

RSS-247 and FCC 15.247 (DTS) Antenna Port Measurements
MIMO and Smart Antenna Systems
Power, PSD, Bandwidth and Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 7/18/2016, 7/19/2016
Test Engineer: Kevin Wen, Yew-Kwong Soo
Test Location: Fremont Lab 4B

Config. Used: 3
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT was connected to the spectrum analyzer or power meter via a suitable attenuator. All measurements were made on a single chain.
All measurements have been corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 20-25 °C
Rel. Humidity: 30-40 %

Summary of Results

Run #	Pwr Index	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	3		Output Power	15.247(b)	Pass	11b: 22.3 dBm
	3					11g: 21.8 dBm
	3					n20: 22.0 dBm
	10					n40: 17.8 dBm

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run #	Pwr Index		Test Performed	Limit	Pass / Fail	Result / Margin
2	3		Power spectral Density (PSD)	15.247(d)	Pass	11b: 6.2 dBm/10kHz (-1.8 dB)
	3					11g: 3.9 dBm/10kHz (-4.1 dB)
	3					n20: 3.8 dBm/10kHz (-4.2 dB)
	10					n40: -3.0 dBm/10kHz (-11.0 dB)
3	9		Minimum 6dB Bandwidth	15.247(a)	Pass	11b: 8.042 MHz
	15					11g: 16.339 MHz
	14					n20: 17.556 MHz
	10					n40: 36.279 MHz
3	3		99% Bandwidth	RSS GEN	Pass	11b: 11.608 MHz
	3					11g: 17.128 MHz
	3					n20: 18.200 MHz
	15					n40: 36.320 MHz
4			Spurious emissions	15.247(b)	Pass	All emissions < -30 dBc

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mb/s	1.00	Yes	100	0	0	10
11g	6 MB/s	0.99	Yes	2.1	0	0	476
n20	MCS 0	0.99	Yes	0.948	0	0	1055
n40	MCS 0	0.96	Yes	0.49	0.18	0.36	2041

Sample Notes

Sample S/N: 8FA0001901E2766

Driver: 01-EA4417DA firmware and wl 1.201 RC70.0 scripts

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Antenna Gain Information

Freq	Antenna Gain (dBi) / Chain				BF	MultiChain Legacy	CDD	Sectorized / Xpol	Dir G (PWR)	Dir G (PSD)
	1	2	3	4						
2412-2462 MHz	4.5	5.0			No	Yes	Yes, n/ac modes only	No	7.8	7.8

For devices that support CDD modes

Min # of spatial streams: 1

Max # of spatial streams: 2

Notes:	BF = beamforming mode supported, Multichain Legacy = 802.11 legacy data rates supported for multichain transmissions, CDD = Cyclic Delay Diversity (or Cyclic Shift Diversity) modes supported, Sectorized / Xpol = antennas are sectorized or cross polarized
Notes:	Dir G (PWR) = total gain (Gant + Array Gain) for power calculations; Dir G (PSD) = total gain for PSD calculations based on FCC KDB 662911. Depending on the modes supported, the Array Gain value for power could be different from the PSD value.
Notes:	Array gain for power/psd calculated per KDB 662911 D01, v01r02.

Run #1: Output Power

Operating Mode: b

Directional Gain (dBi): 7.8

Max EIRP (mW): 1032.6

Frequency (MHz)	Chain	Software Setting	Power[2]		Total		Max Power (W)	Limit dBm	Result	Power (dBm)[3]
			dBm	mW	mW	dBm				
2412	1	12	14.0	24.9	63.7	18.0	0.171	30.0	Pass	
	3									
	4									
	2		15.9	38.7						
2437	1	3	18.3	67.6	171.4	22.3				
	3									
	4									
	2		20.2	103.8						
2462	1	9	14.5	28.3	73.9	18.7				
	3									
	4									
	2		16.6	45.6						

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Operating Mode: g
Directional Gain (dBi): 7.8

Max EIRP (mW): 920.3

Frequency (MHz)	Chain	Software Setting	Power[2] dBm	Power[2] mW	Total mW	Total dBm	Max Power (W)	Limit dBm	Result	Power (dBm)[3]
2412	1	15	11.5	14.1	36.5	15.6	0.153	30.0	Pass	
	3									
	4									
	2		13.5	22.4						
2437	1	3	17.8	60.3	152.7	21.8				
	3									
	4									
	2		19.7	92.5						
2462	1	14	11.5	14.1	36.3	15.6				
	3									
	4									
	2		13.5	22.2						

Operating Mode: n20
Directional Gain (dBi): 7.8

Max EIRP (mW): 964.5

Frequency (MHz)	Chain	Software Setting	Power[2] dBm	Power[2] mW	Total mW	Total dBm	Max Power (W)	Limit dBm	Result	Power (dBm)[3]
2412	1	14	12.4	17.3	44.0	16.4	0.160	30.0	Pass	
	3									
	4									
	2		14.3	26.7						
2437	1	3	18.1	64.6	160.1	22.0				
	3									
	4									
	2		19.8	95.5						
2462	1	10	13.8	24.0	60.3	17.8				
	3									
	4									
	2		15.6	36.3						

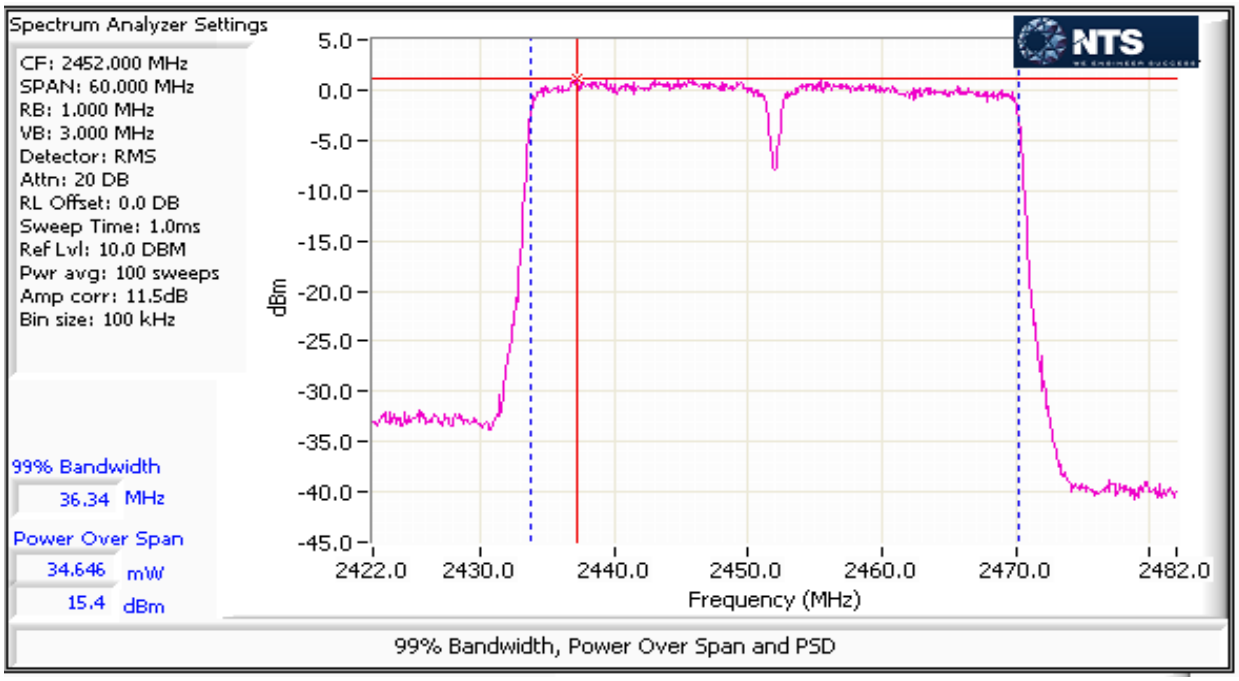
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Operating Mode: n40
Directional Gain (dBi): 7.8
Max EIRP (mW): 361.7

Frequency (MHz)	Chain	Software Setting	Power[1] dBm	Power[1] mW	Total mW	Total dBm	Max Power (W)	Limit dBm	Result	Power (dBm)[3]
2422	1	19	9.1	8.1	20.3	13.1	0.060	30.0	Pass	
	3									
	4									
	2		10.9	12.2						
2437	1	15	11.3	13.4	33.8	15.3				
	3									
	4									
	2		13.1	20.3						
2452	1	10	13.8	23.9	60.0	17.8				
	3									
	4									
	2		15.6	36.1						

Note 1:	Constant Duty Cycle < 98%. Output power measured using a spectrum analyzer (see plots below) with RBW= 1-5% of OBW and ≤ 1 MHz, VB≥3* RBW, Span ≥ 1.5 of OBW, RMS detector, auto sweep time, power averaging on, and power integration over the OBW, trace average 100 traces (option AVGSA-2 in ANSI C63.10) for n40 mode. Measurement corrected by Pwr Cor Factor. Spurious limit becomes -30dBc.
Note 2:	Constant Duty Cycle. Output power measured using an average power meter for b, g and n20 modes. Measurement corrected by Pwr Cor Factor. (option AVGPM in ANSI C63.10). Spurious limit becomes -30dBc.
Note 3:	Power setting - the software power setting used during testing, included for reference only.

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Run #2: Power spectral Density

Mode: 11b

Power Index	Frequency (MHz)	PSD (dBm/10kHz) Note 1					Limit dBm/3kHz	Result
		Chain 1	Chain 2	Chain 3	Chain 4	Total		
12	2412	-2.4	-1.0			1.4	8.0	Pass
3	2437	1.9	4.2			6.2	8.0	Pass
9	2462	-0.6	0.2			2.8	8.0	Pass

Mode: 11g (or 11a)

Power Index	Frequency (MHz)	PSD (dBm/10kHz) Note 1					Limit dBm/3kHz	Result
		Chain 1	Chain 2	Chain 3	Chain 4	Total		
15	2412	-7.0	-4.8			-2.8	8.0	Pass
3	2437	0.0	1.7			3.9	8.0	Pass
14	2462	-7.4	-3.0			-1.7	8.0	Pass

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

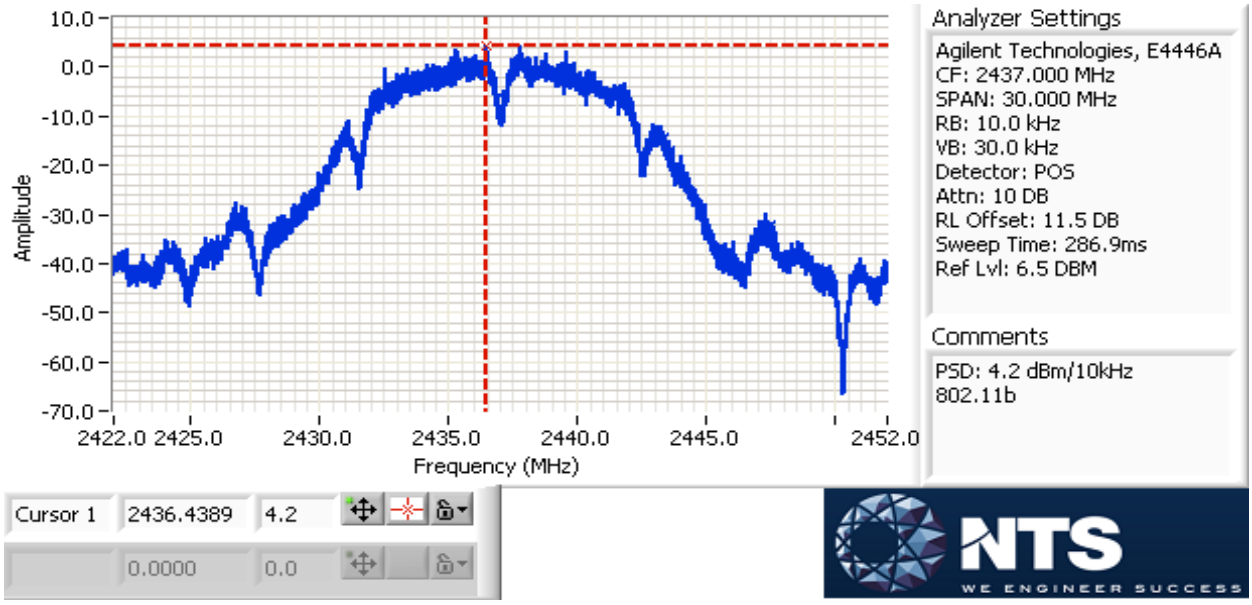
Mode: n20

Power Index	Frequency (MHz)	PSD (dBm/10kHz) Note 1 Chain 1	Chain 2	Chain 3	Chain 4	Total	Limit dBm/3kHz	Result
14	2412	-6.5	-3.7			-1.9	8.0	Pass
3	2437	-0.7	1.9			3.8	8.0	Pass
10	2462	-4.1	-2.3			-0.1	8.0	Pass

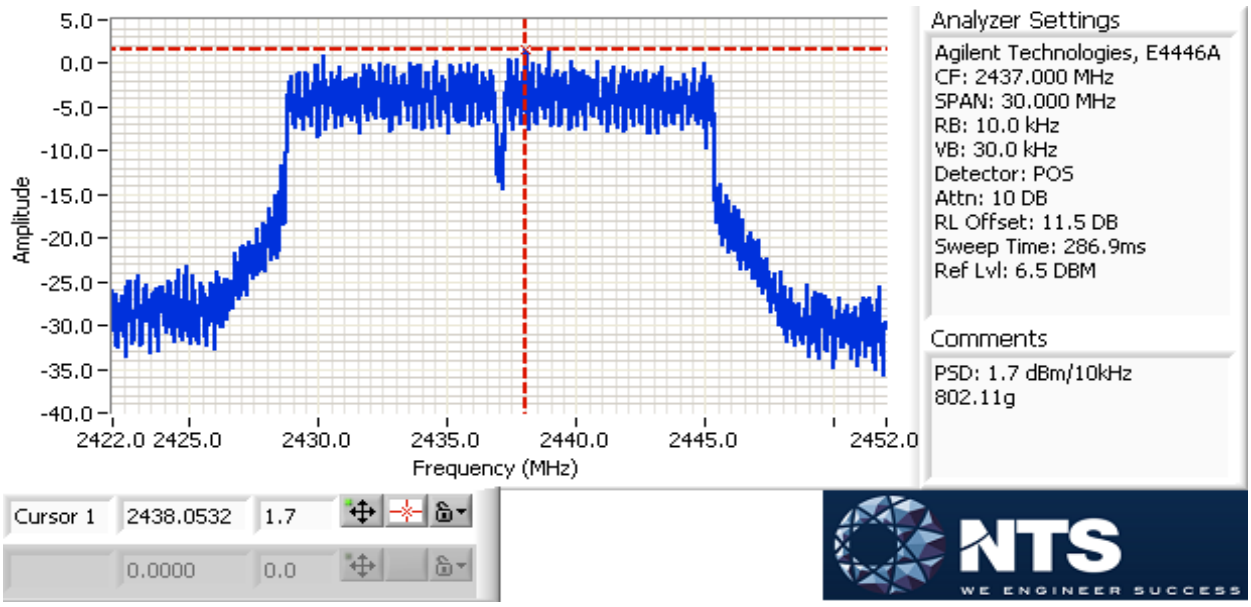
Mode: n40

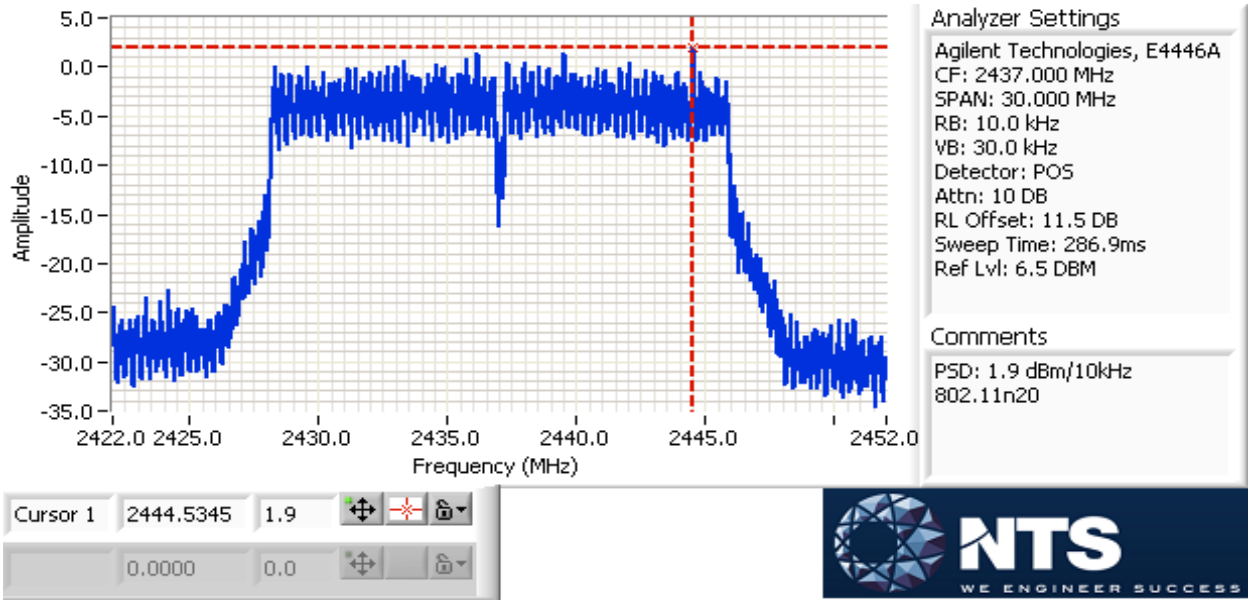
Power Index	Frequency (MHz)	PSD (dBm/10kHz) Note 1 Chain 1	Chain 2	Chain 3	Chain 4	Total	Limit dBm/3kHz	Result
19	2422	-11.7	-10.5			-8.0	8.0	Pass
15	2437	-9.5	-7.3			-5.3	8.0	Pass
10	2452	-8.0	-4.6			-3.0	8.0	Pass

Note 1:	Test performed per method PKSPD, in KDB 558074. Power spectral density measured using: 3kHz ≤ RBW ≤ 100kHz, VBW=3*RBW, peak detector, span = 1.5*DTS BW, auto sweep time, max hold.



Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B





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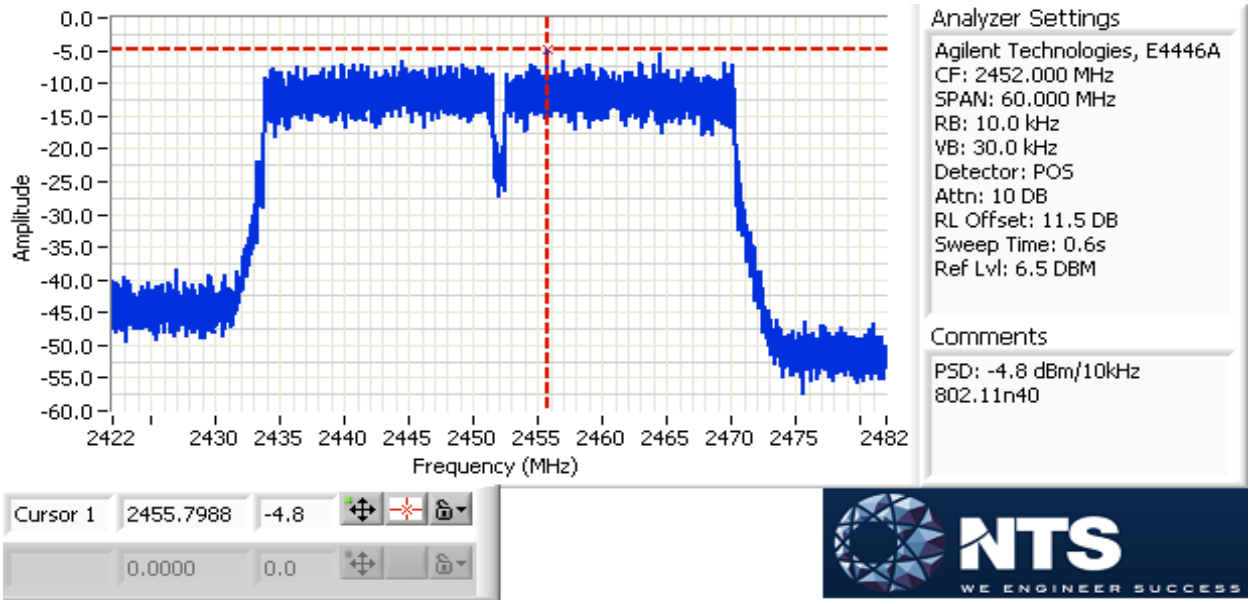
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Run #3: Signal Bandwidth

Mode: 11b

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		6dB	99%	6dB	99%
12	2412	8.058	10.896	0.1	200
3	2437	8.066	11.608	0.1	200
9	2462	8.042	10.864	0.1	200

Mode: 11g

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		6dB	99%	6dB	99%
15	2412	16.339	16.752	0.1	200
3	2437	16.363	17.128	0.1	200
14	2462	16.363	16.752	0.1	200

Mode: n20

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		6dB	99%	6dB	99%
14	2412	17.556	17.888	0.1	200
3	2437	17.588	18.200	0.1	200
10	2462	17.604	17.872	0.1	200

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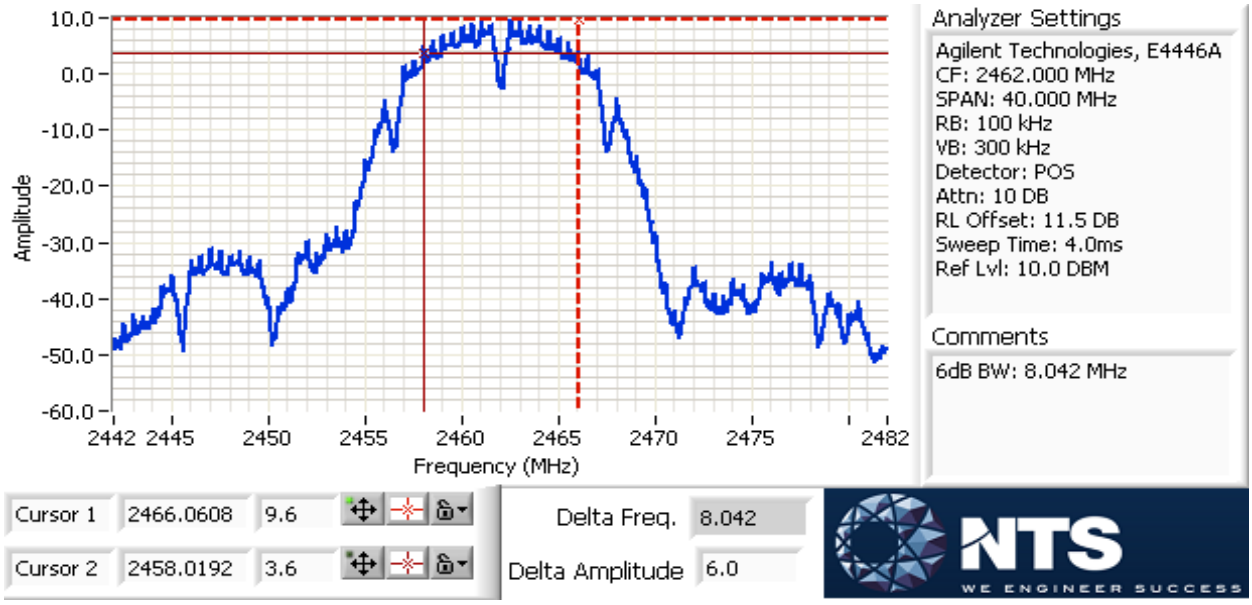
Standard:	FCC Part 15	Class:	B

Mode: n40

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		6dB	99%	6dB	99%
19	2422	36.311	36.256	0.1	390
15	2437	36.343	36.320	0.1	390
10	2452	36.279	36.304	0.1	390

Note 1:	DTS BW: RBW=100kHz, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time, Span 2-5 times measured BW. 99% BW: RBW=1-5% of 99%BW, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time. Span 1.5-5 times OBW.
Note 2:	Measurements performed on chain 2



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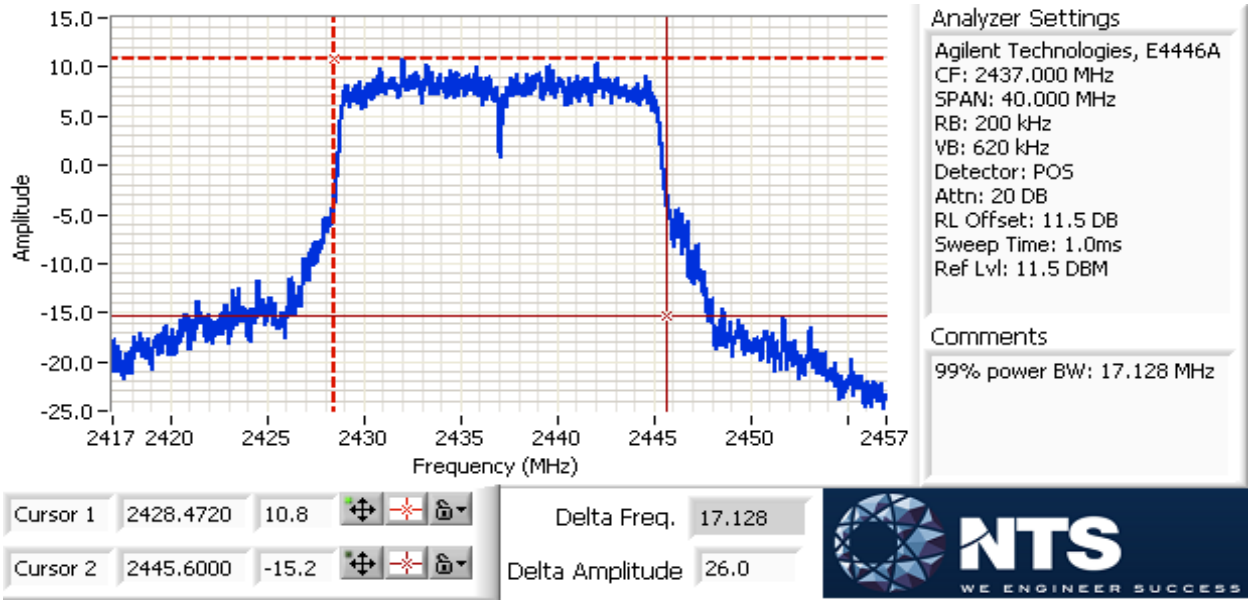
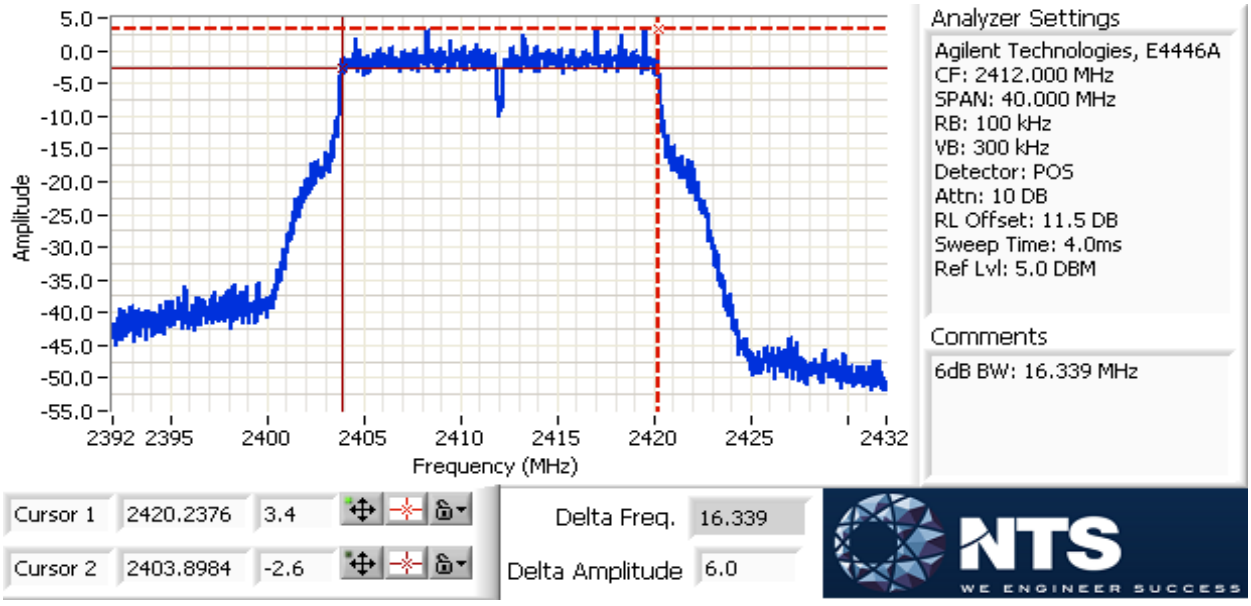
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B





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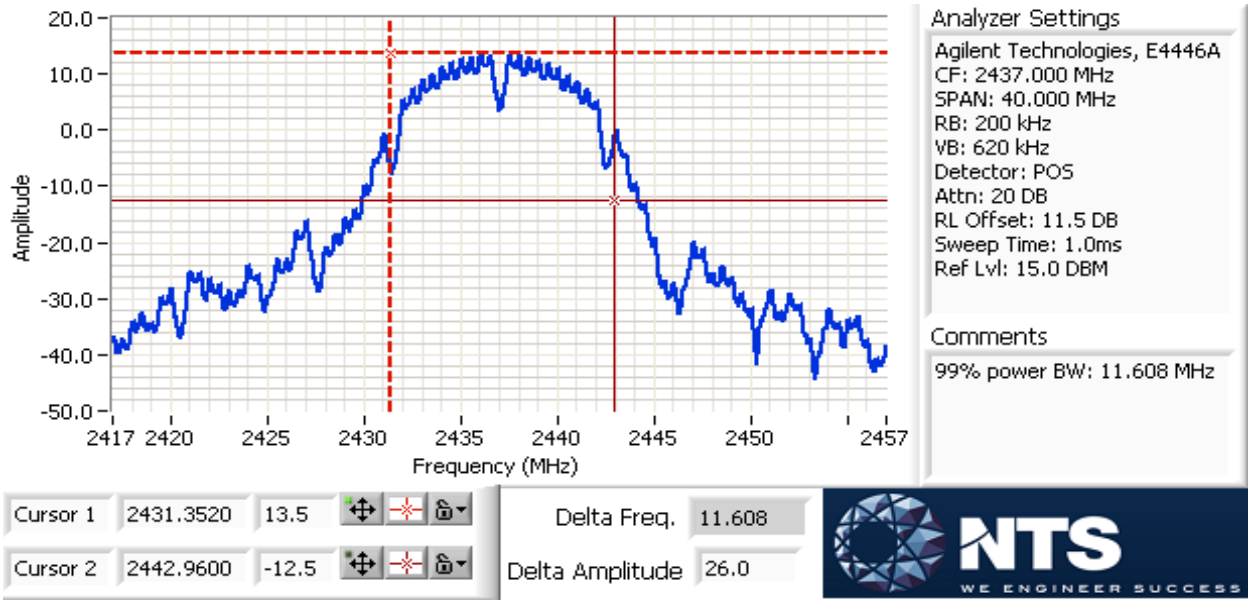
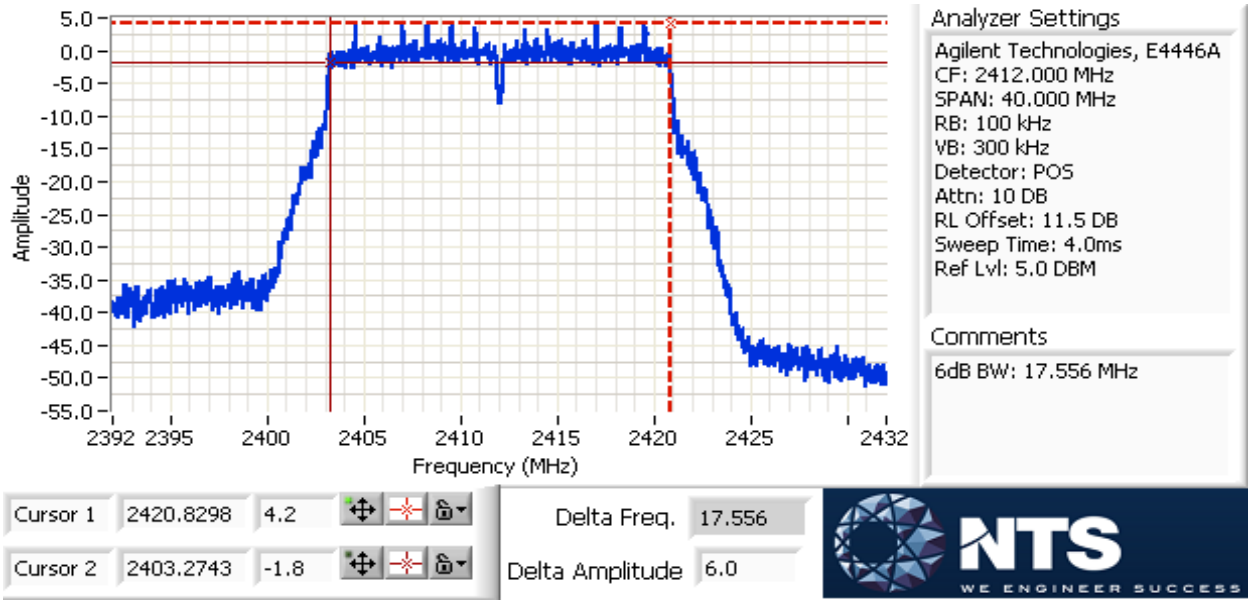
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B





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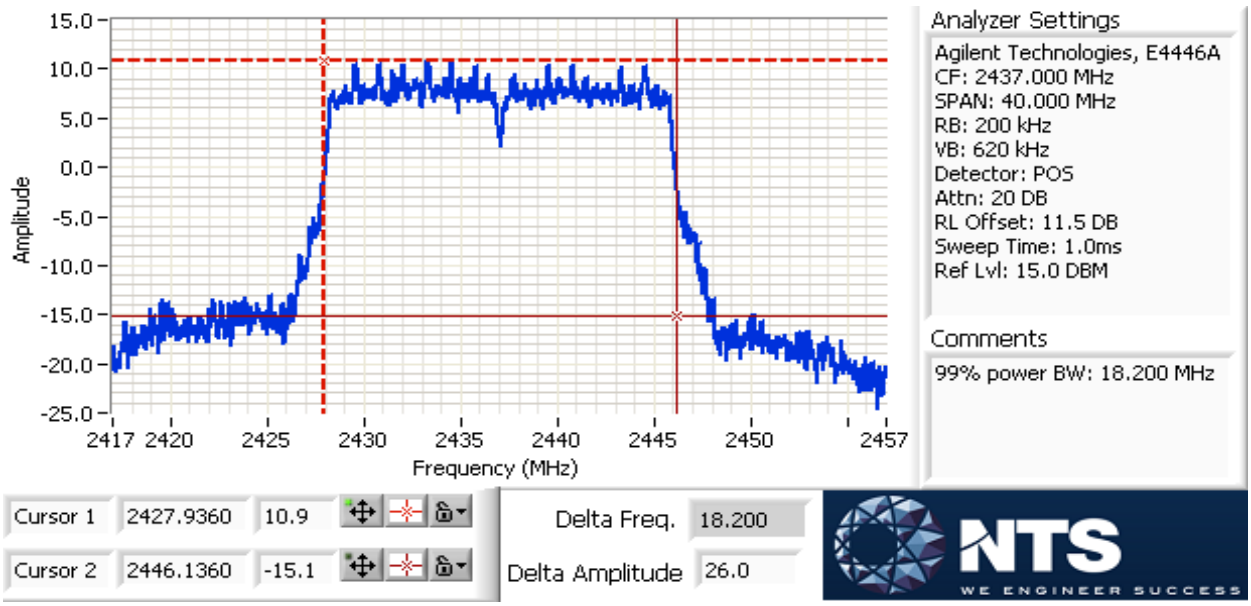
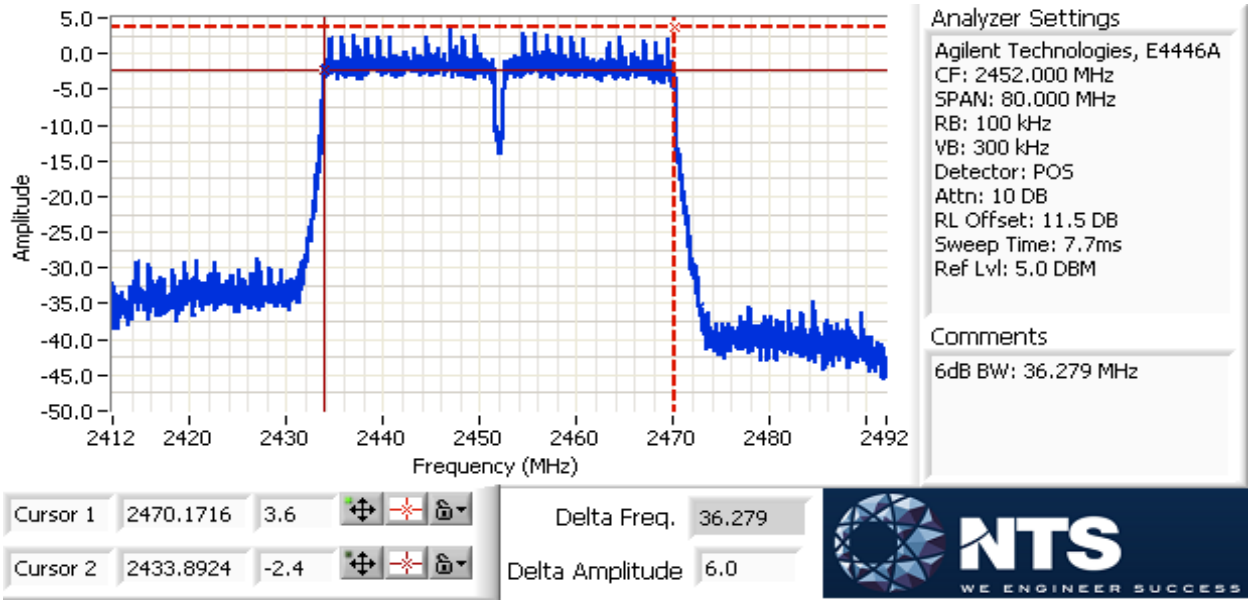
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B





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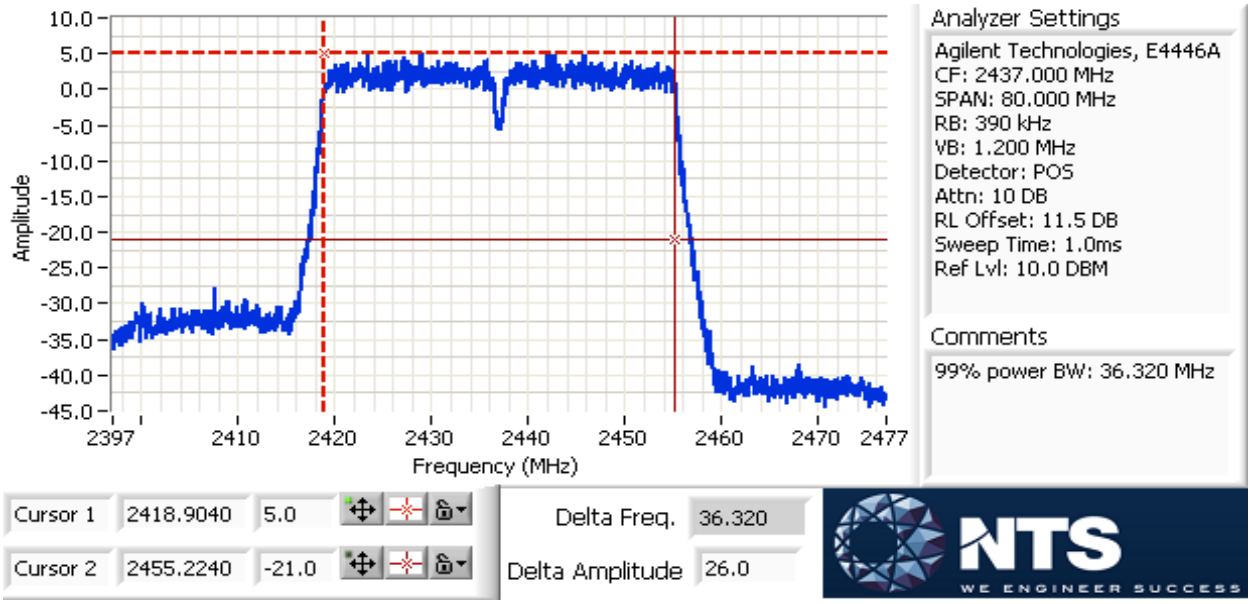
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Run #4: Out of Band Spurious Emissions

Power Index Per Chain #1	#2	#3	#4	Mode	Frequency (MHz)	Limit	Result
12	12			b	2412	-30dBc	Pass
3	3			b	2437	-30dBc	Pass
9	9			b	2462	-30dBc	Pass
15	15			g	2412	-30dBc	Pass
3	3			g	2437	-30dBc	Pass
14	14			g	2462	-30dBc	Pass
14	14			n20	2412	-30dBc	Pass
3	3			n20	2437	-30dBc	Pass
10	10			n20	2462	-30dBc	Pass
19	19			n40	2422	-30dBc	Pass
15	15			n40	2437	-30dBc	Pass
10	10			n40	2452	-30dBc	Pass

Note 1:	Measured on each chain individually at single chain ouptut power setting
Note 2:	Measured using RBW = 100 kHz and VBW = 300 kHz.

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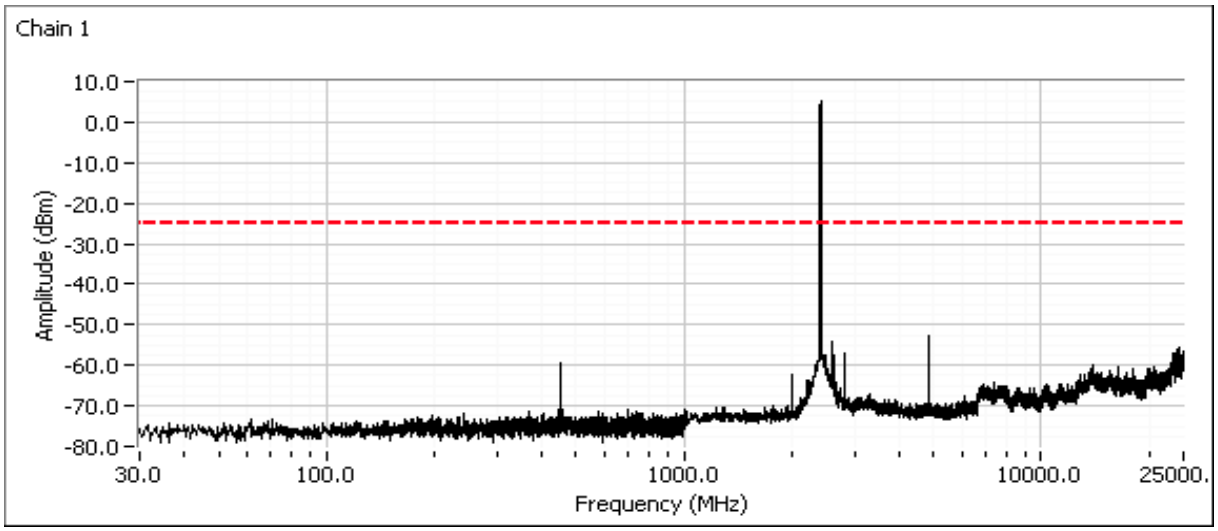
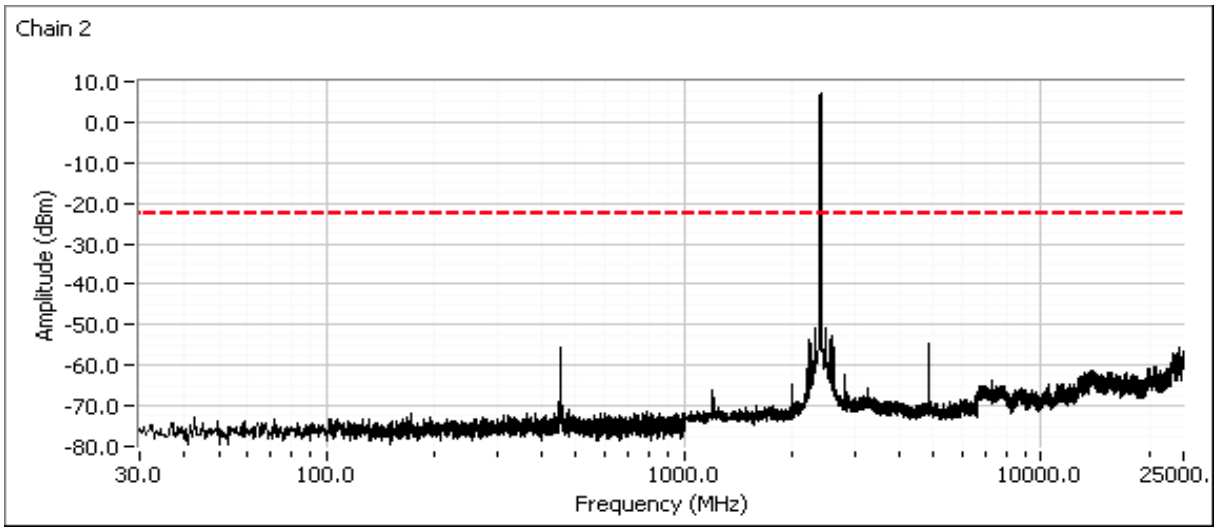
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Plots for low channel, 802.11b mode





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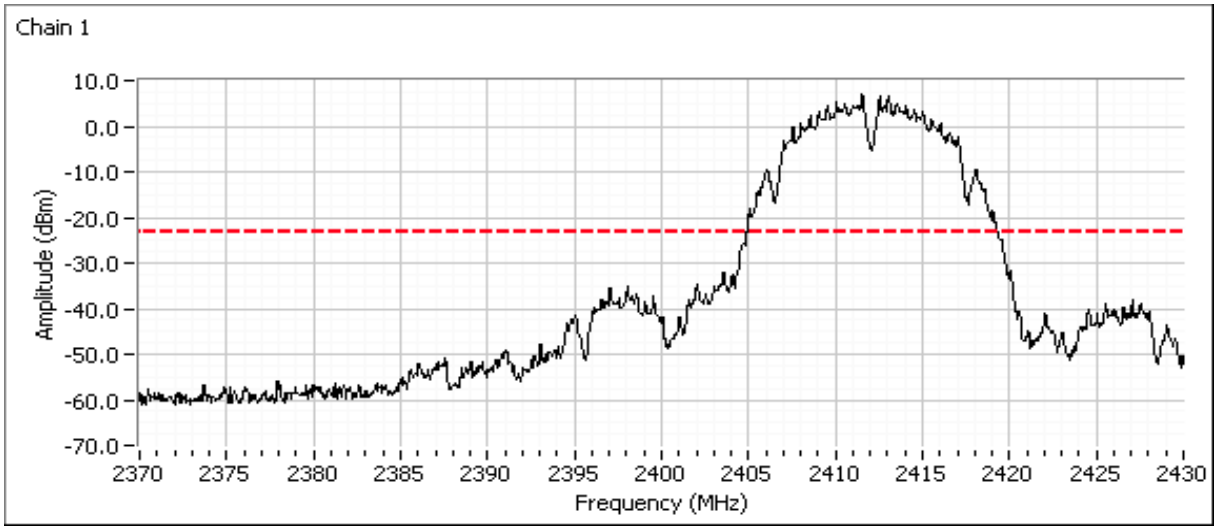
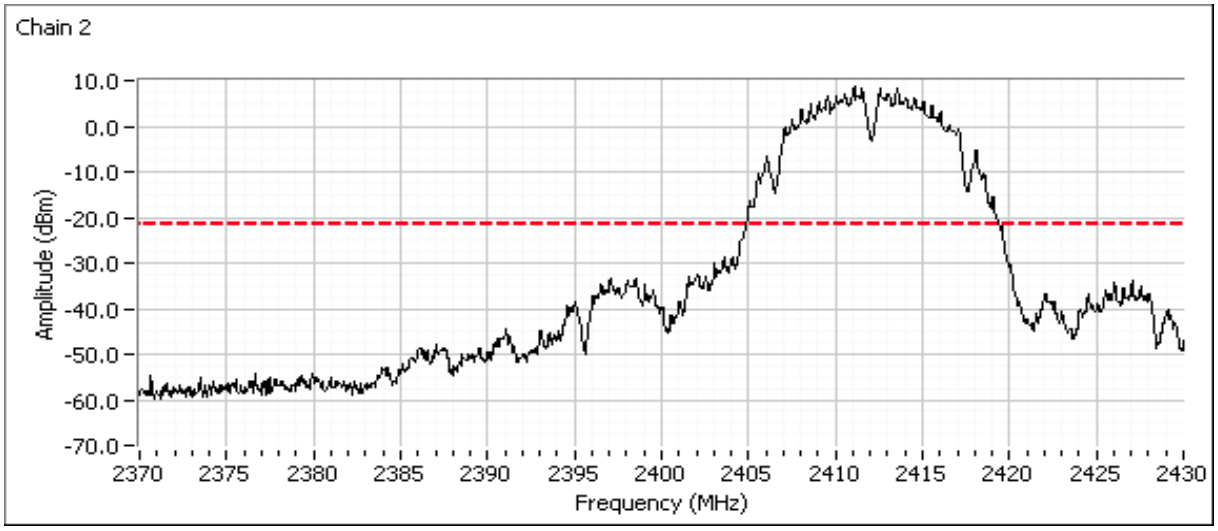
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.





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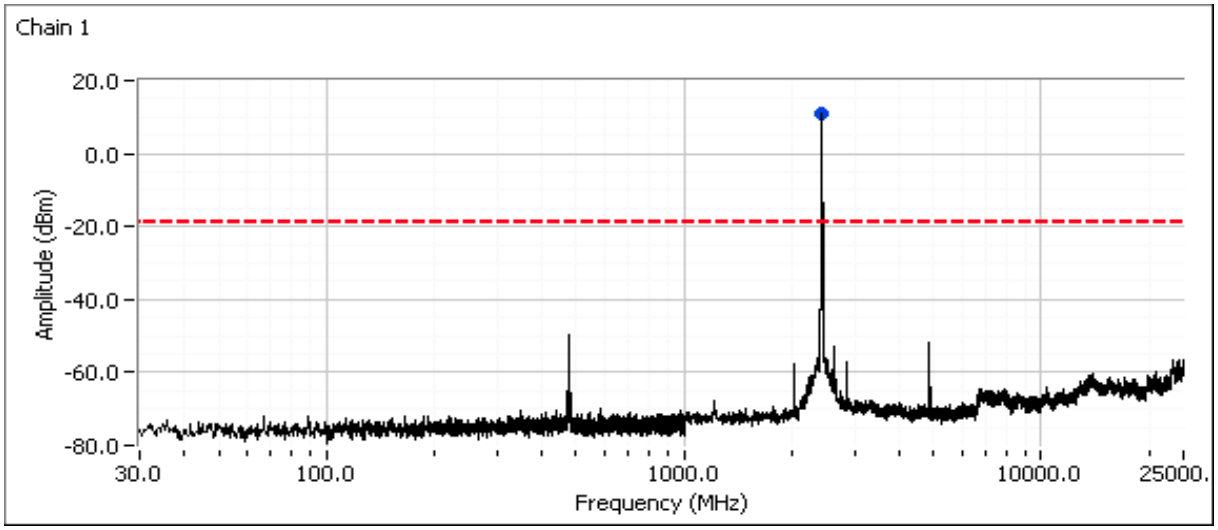
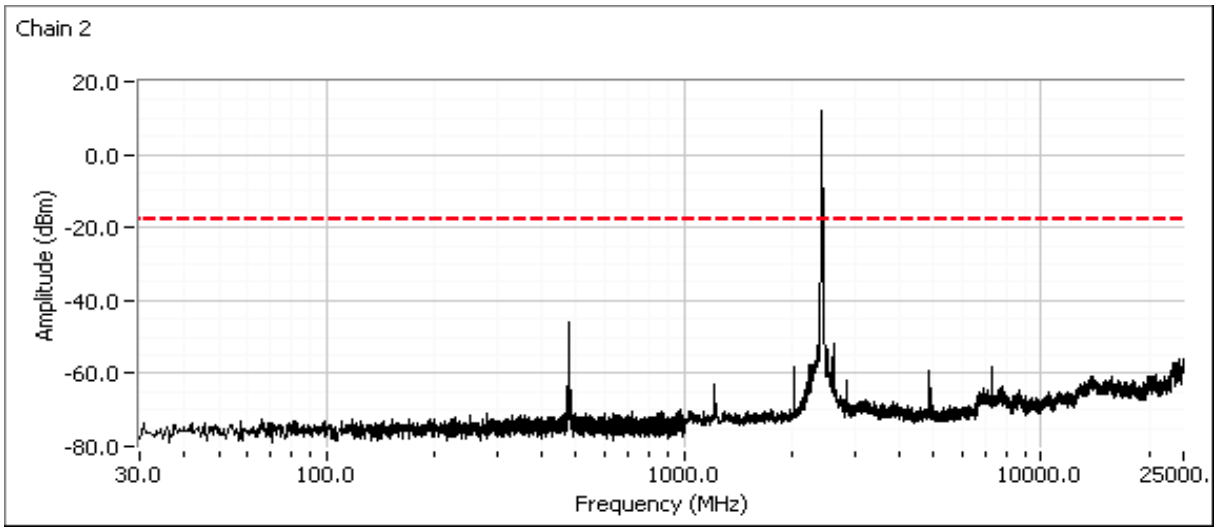
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

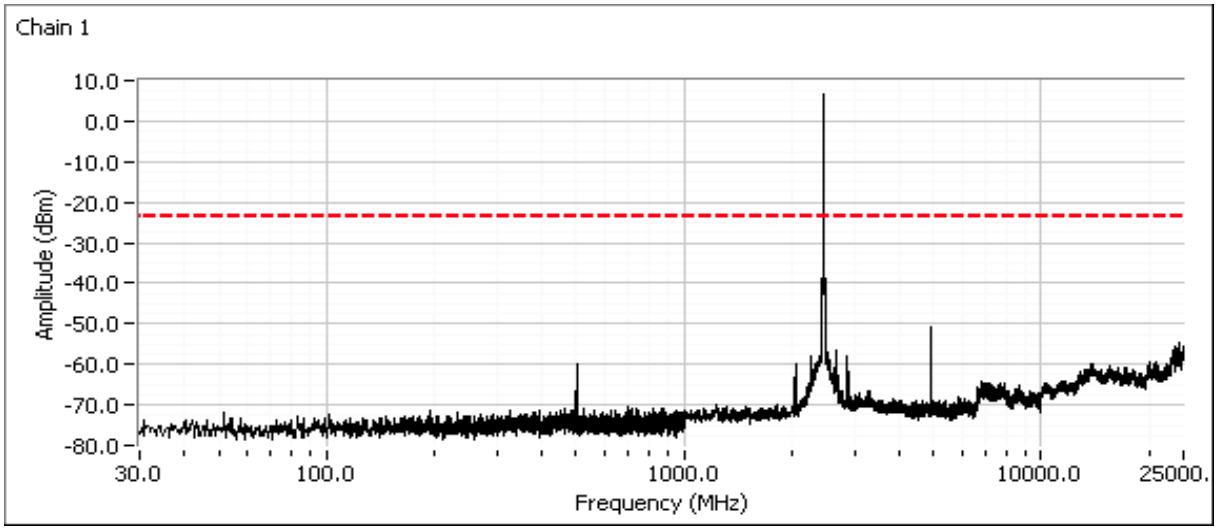
Plots for center channel, 802.11b Mode

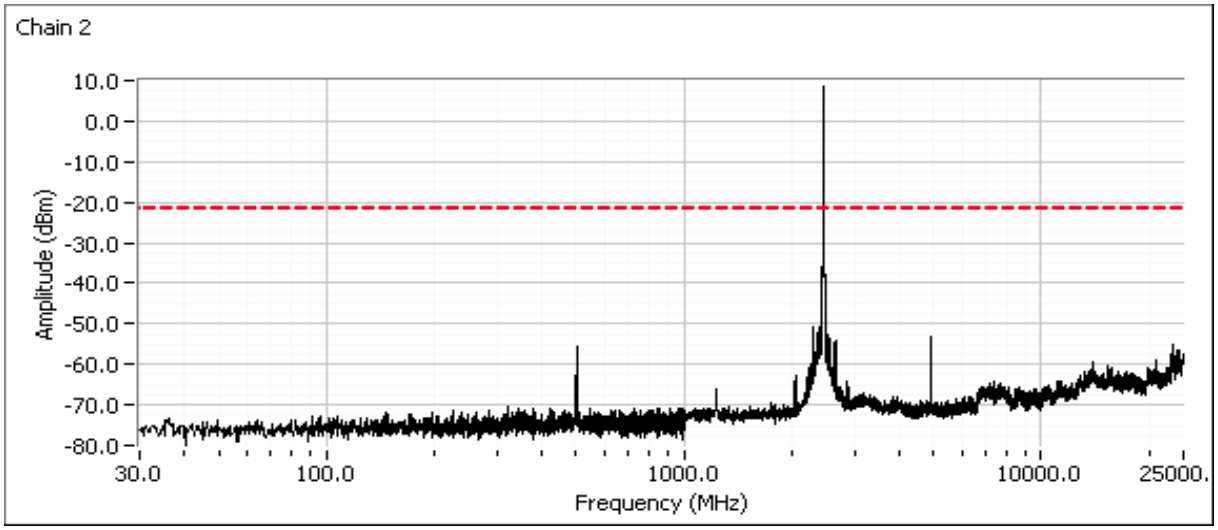




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

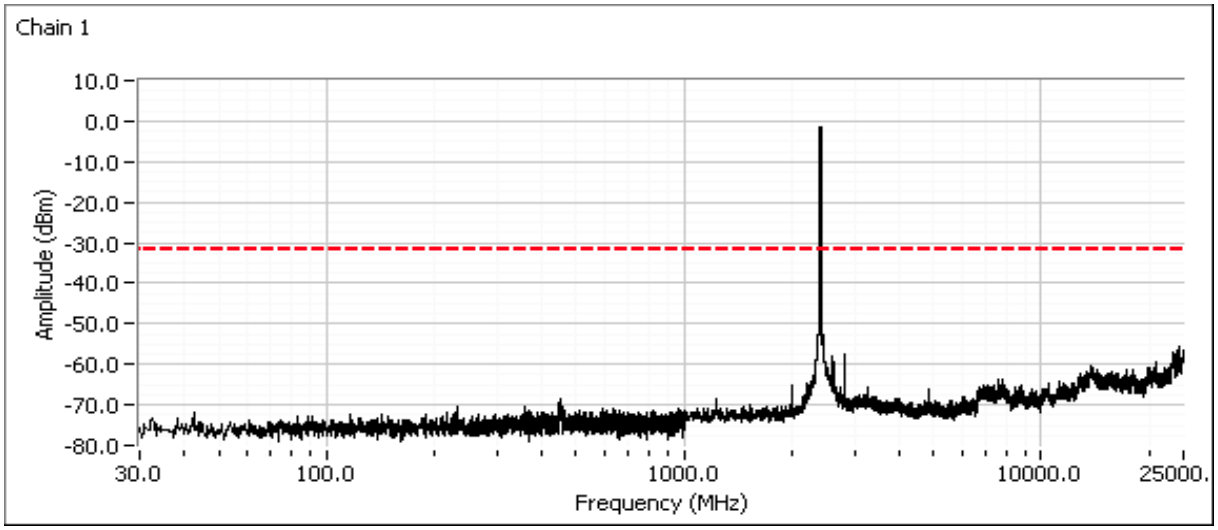
Plots for high channel, 802.11b Mode

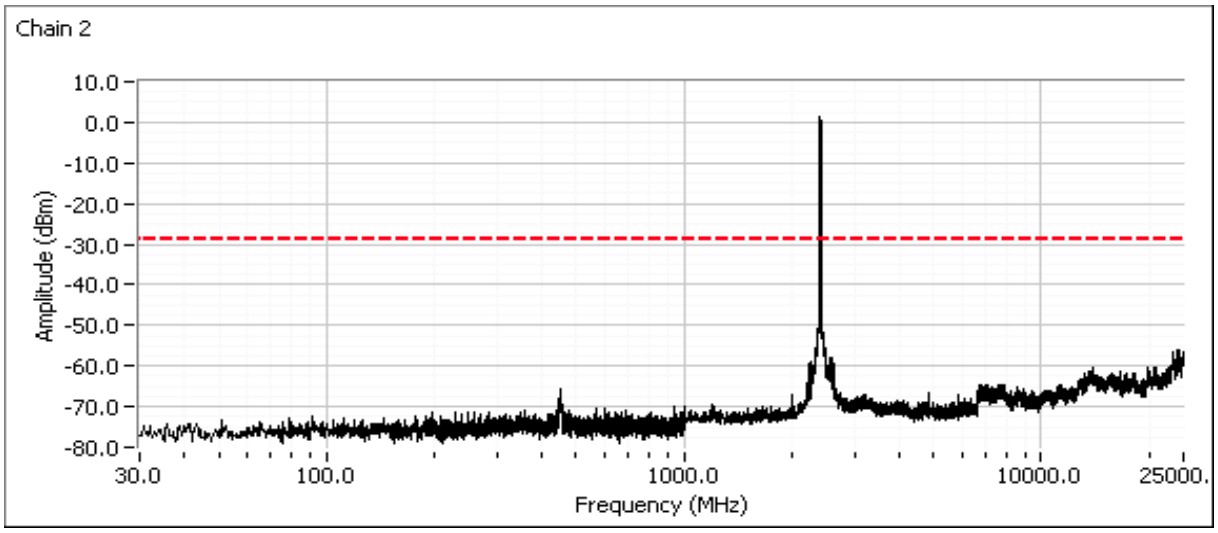




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

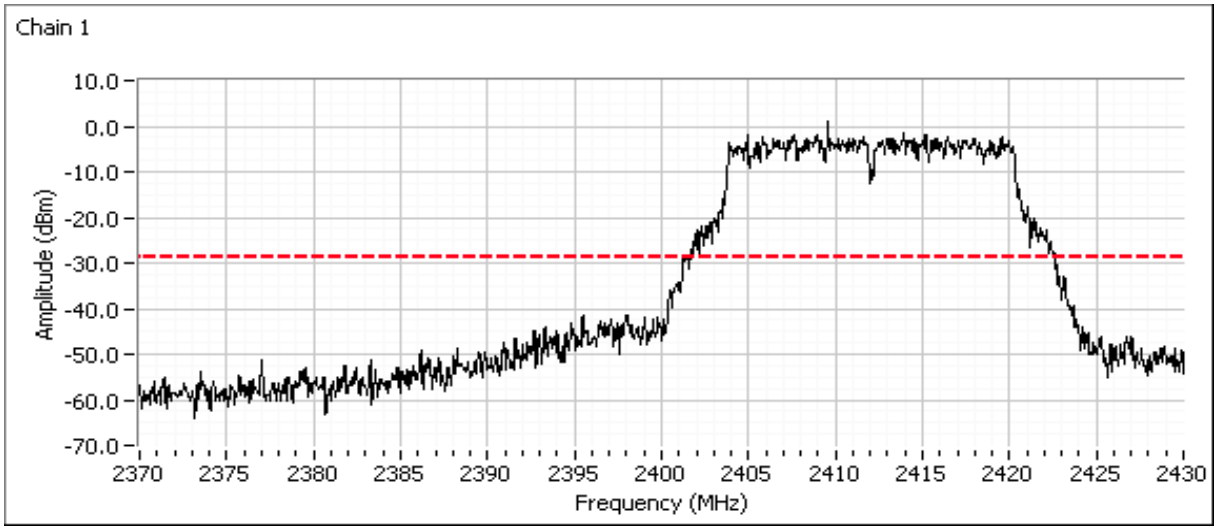
Plots for low channel, 802.11g mode

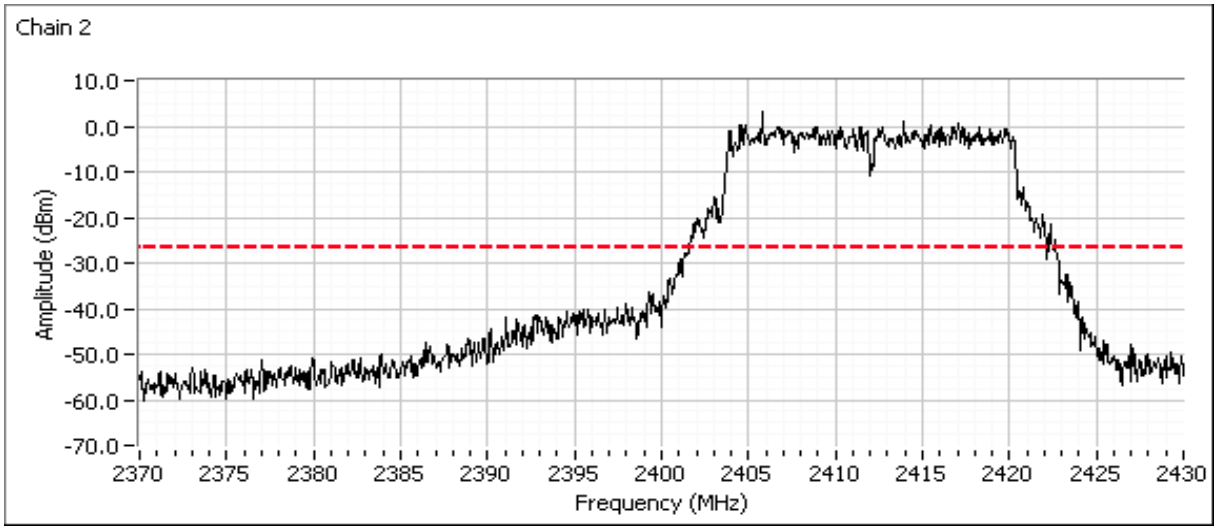




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.





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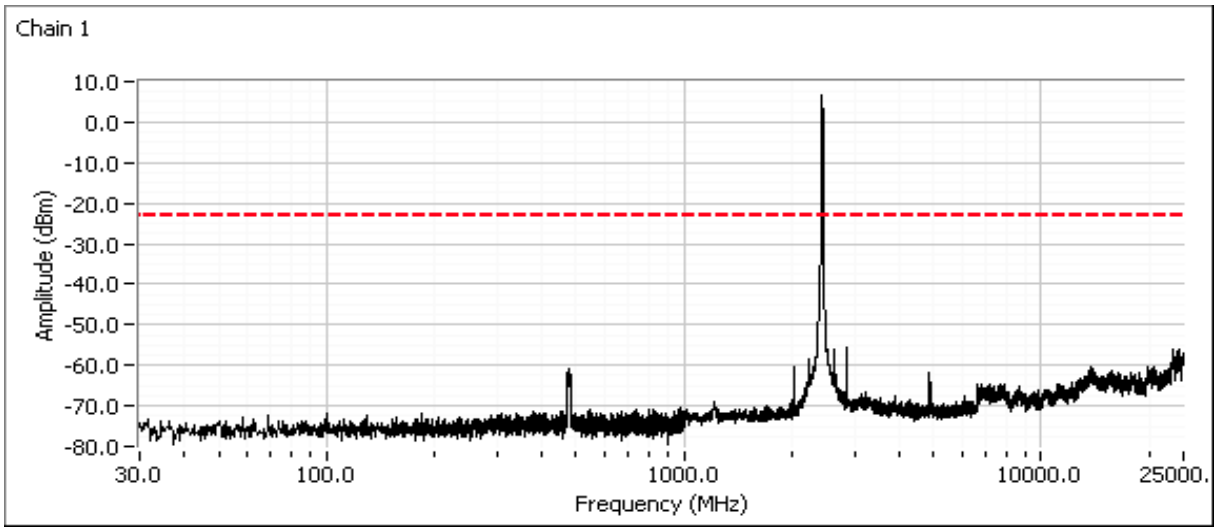
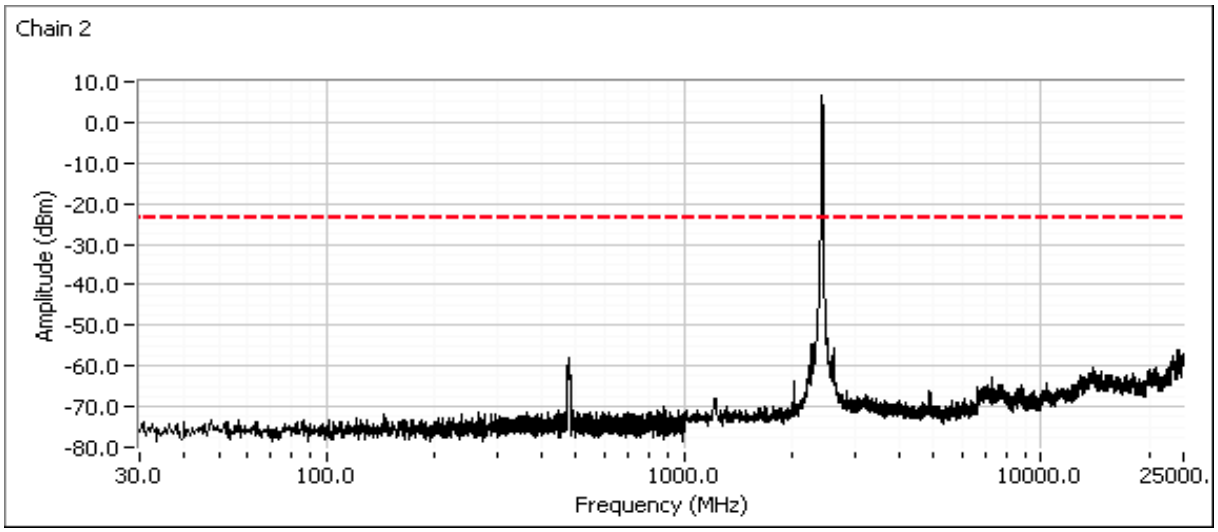
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Plots for center channel, 802.11g Mode





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Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
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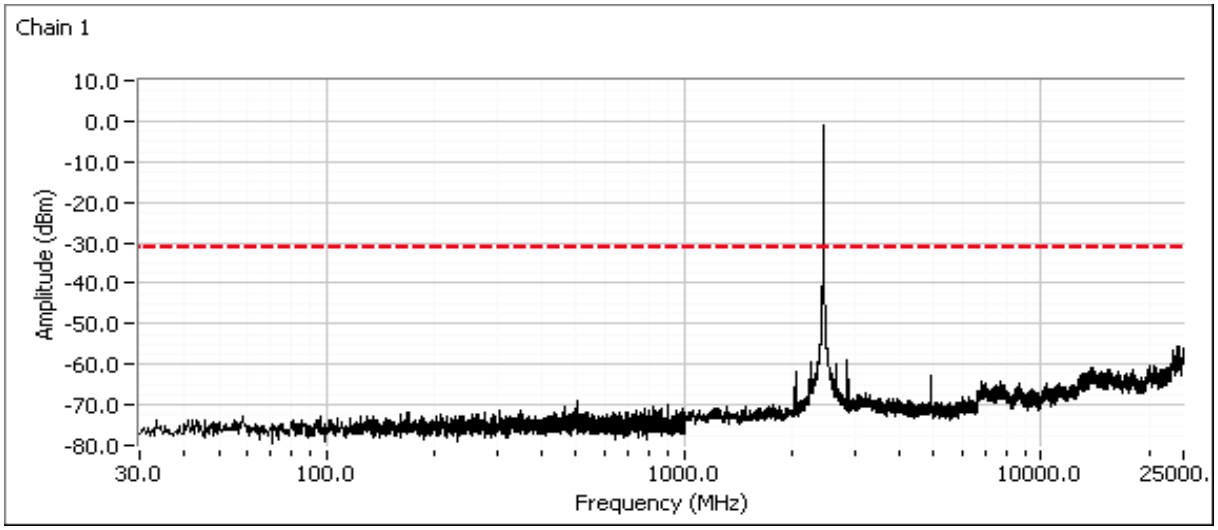
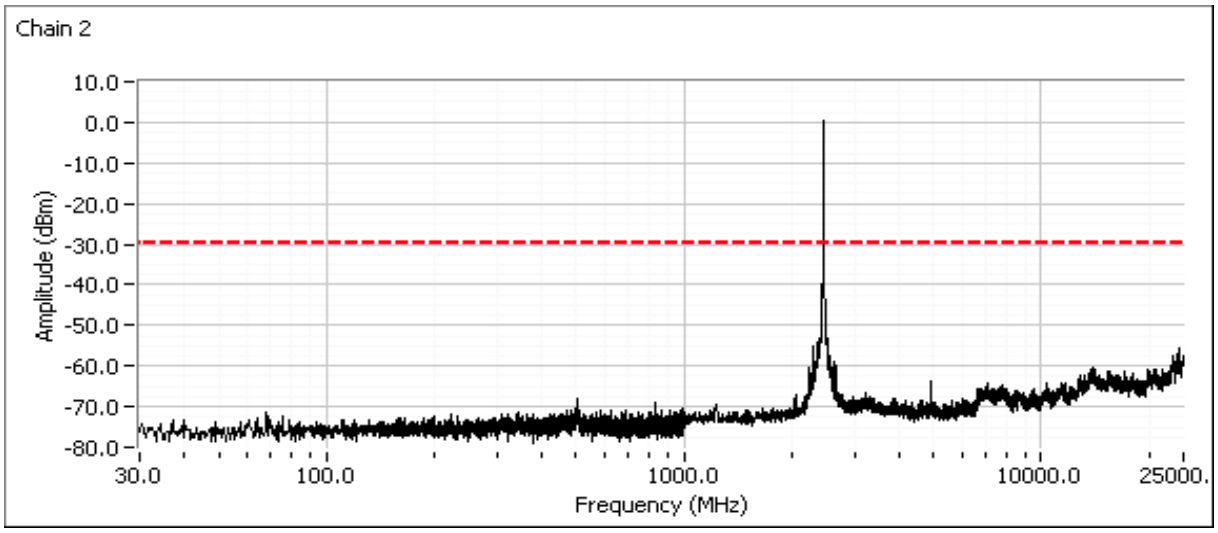
Standard:	FCC Part 15	Class:	B

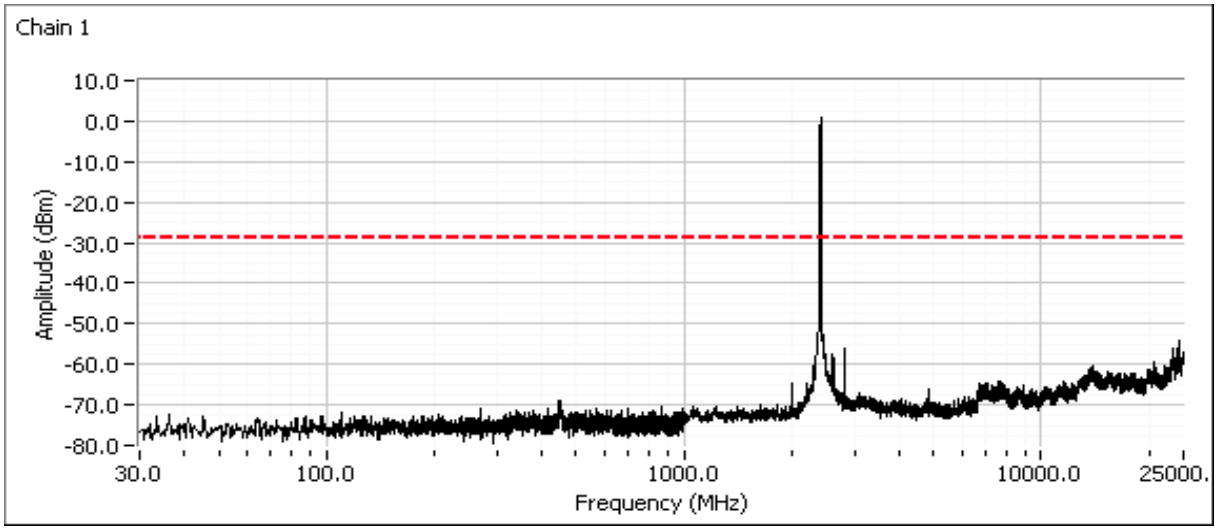
Plots for high channel, 802.11g Mode

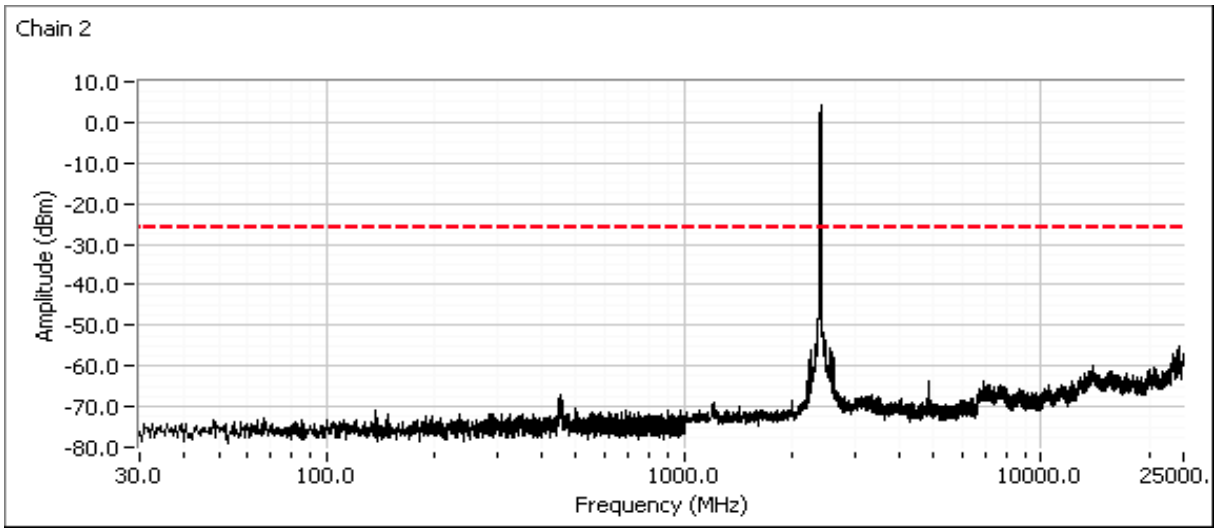




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

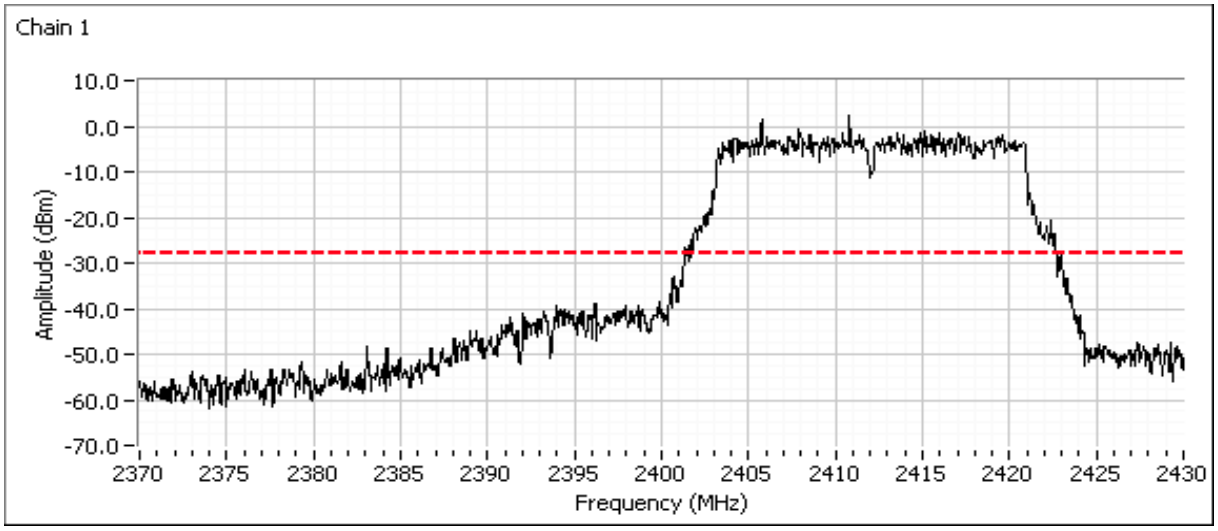
Plots for low channel, 802.11nn20 mode

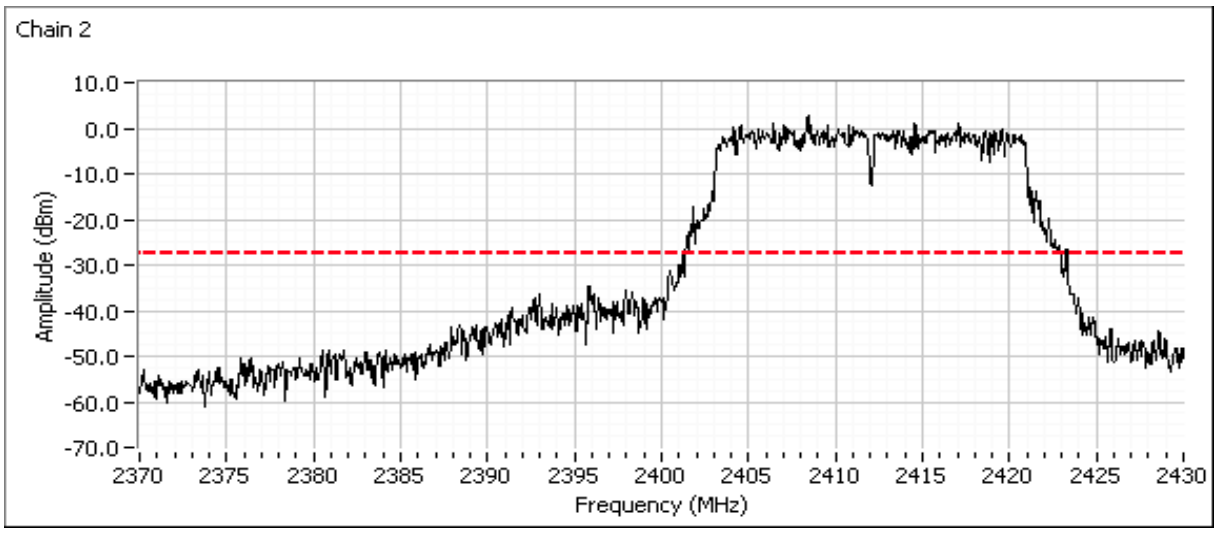




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.





Client:	Tivo, Inc.	Job Number:	JD101876
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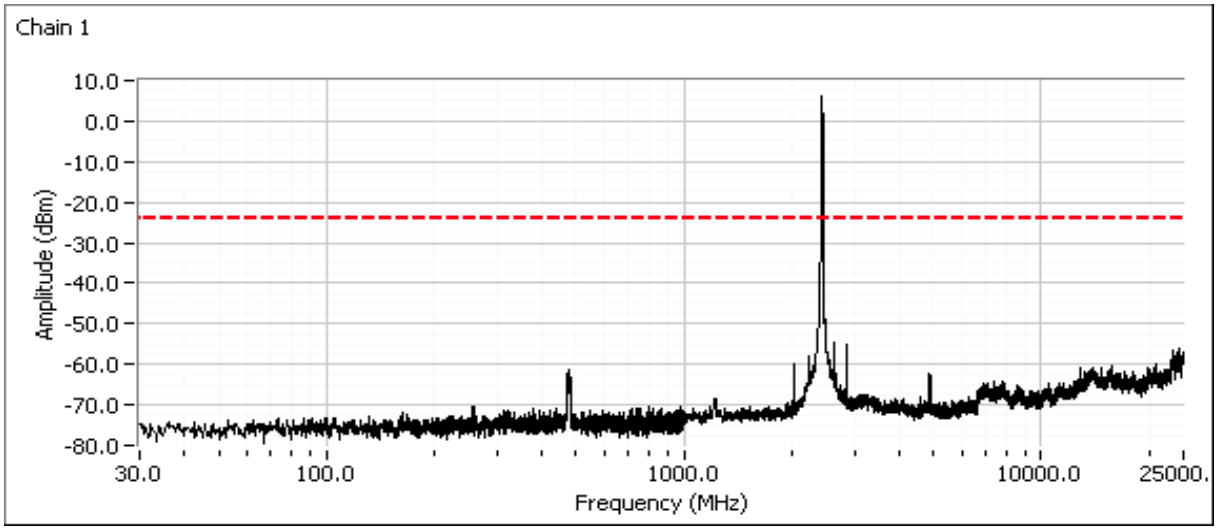
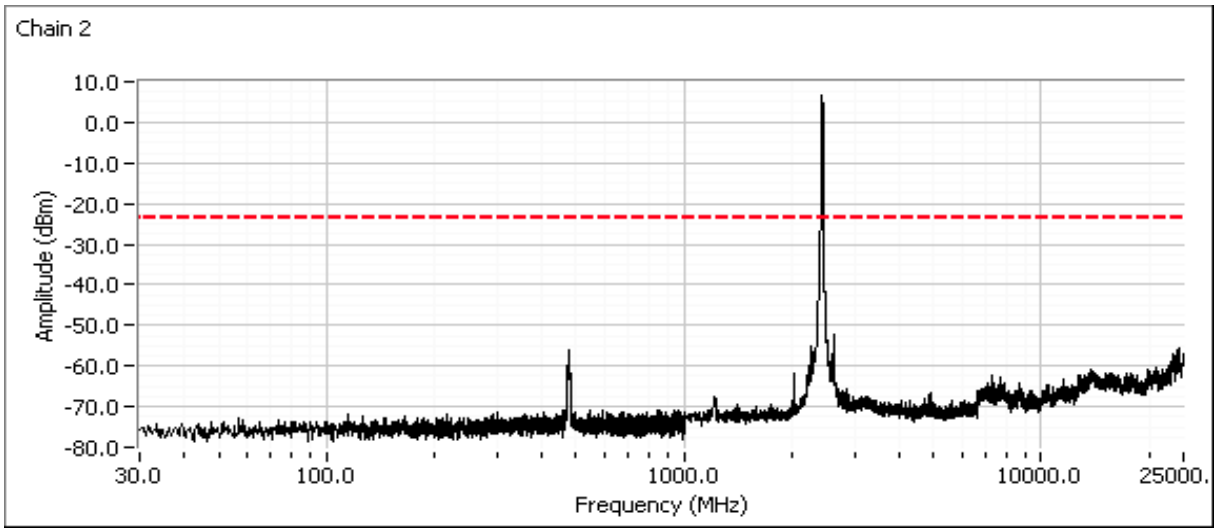
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

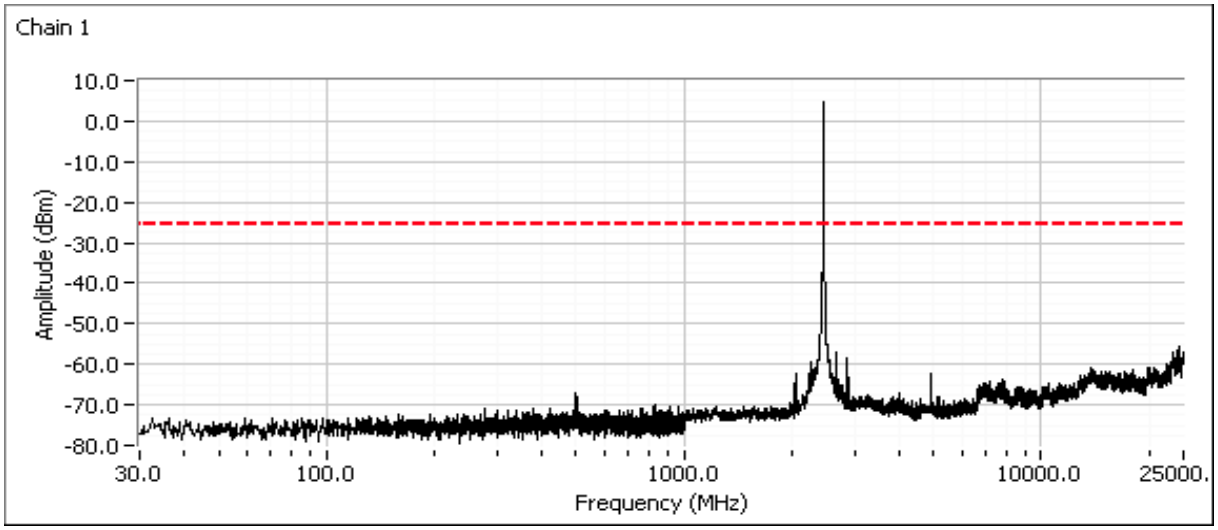
Plots for center channel, 802.11n20 mode

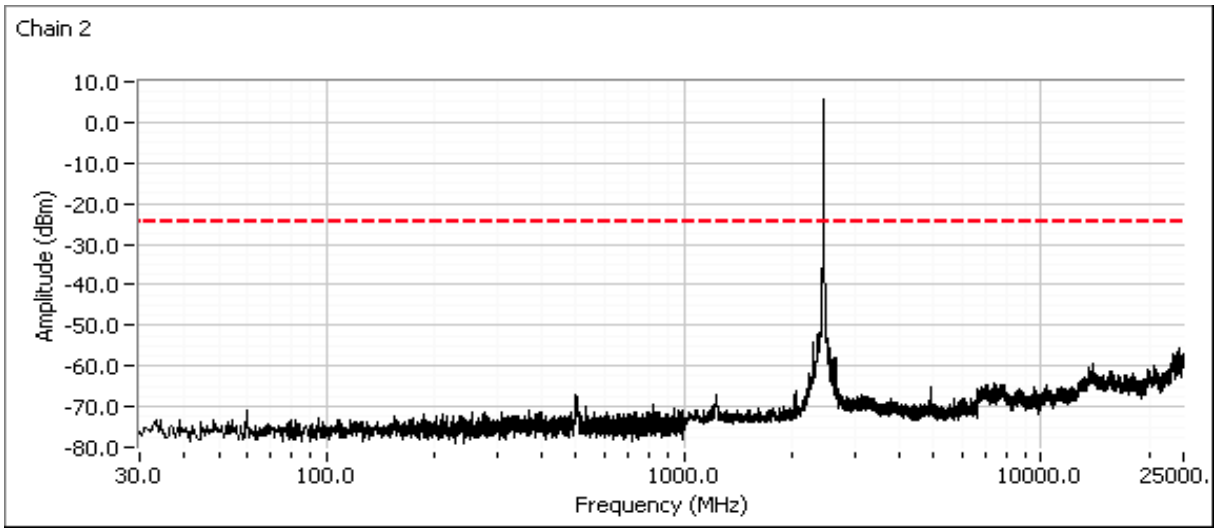




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Plots for high channel, 802.11n20 mode





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		Project Manager:	Irene Radamacher
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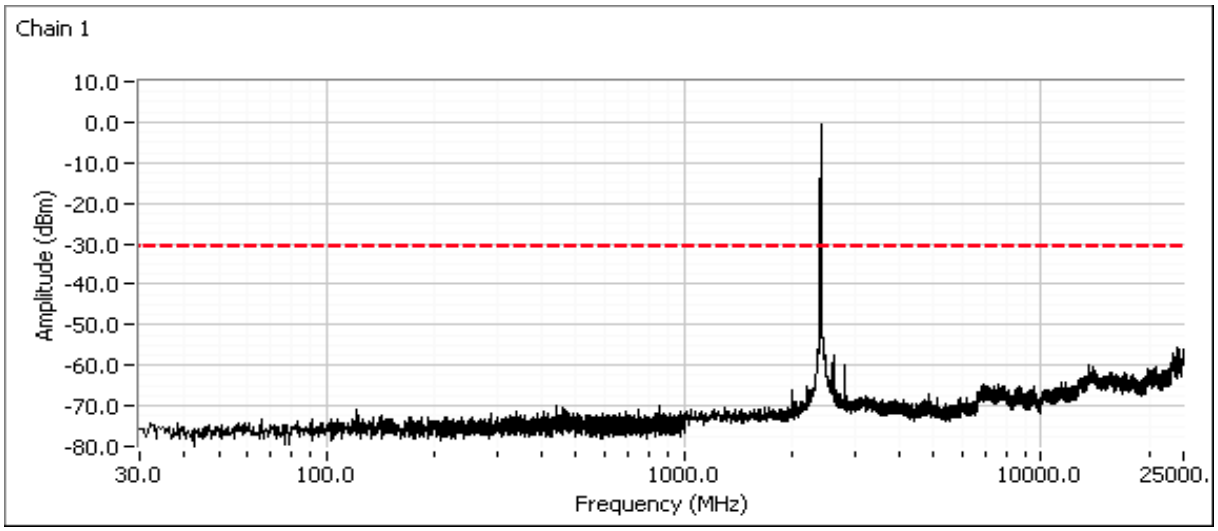
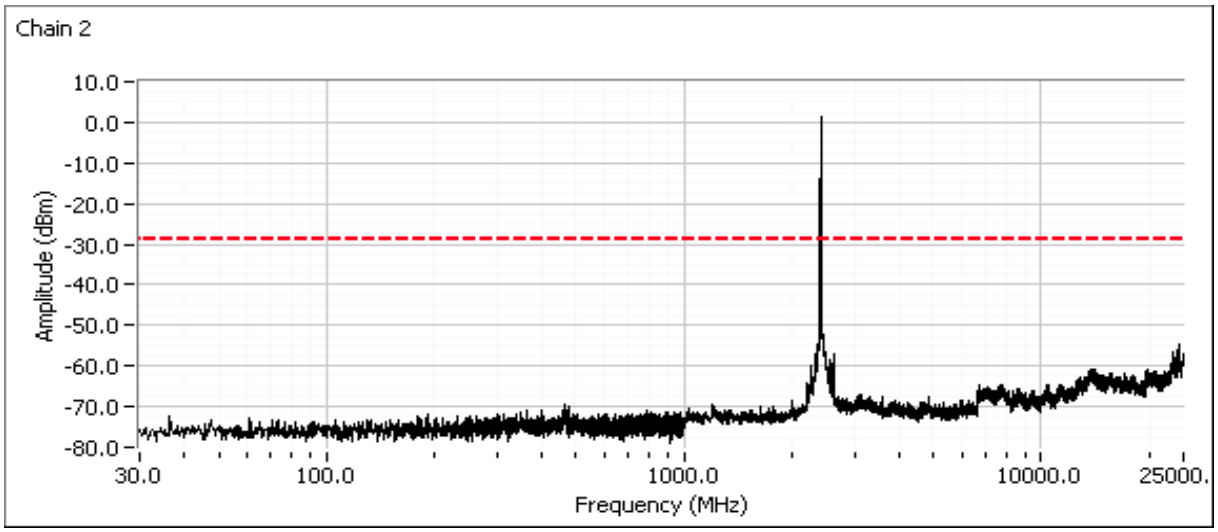
Standard:	FCC Part 15	Class:	B

Plots for low channel, 802.11n40 mode





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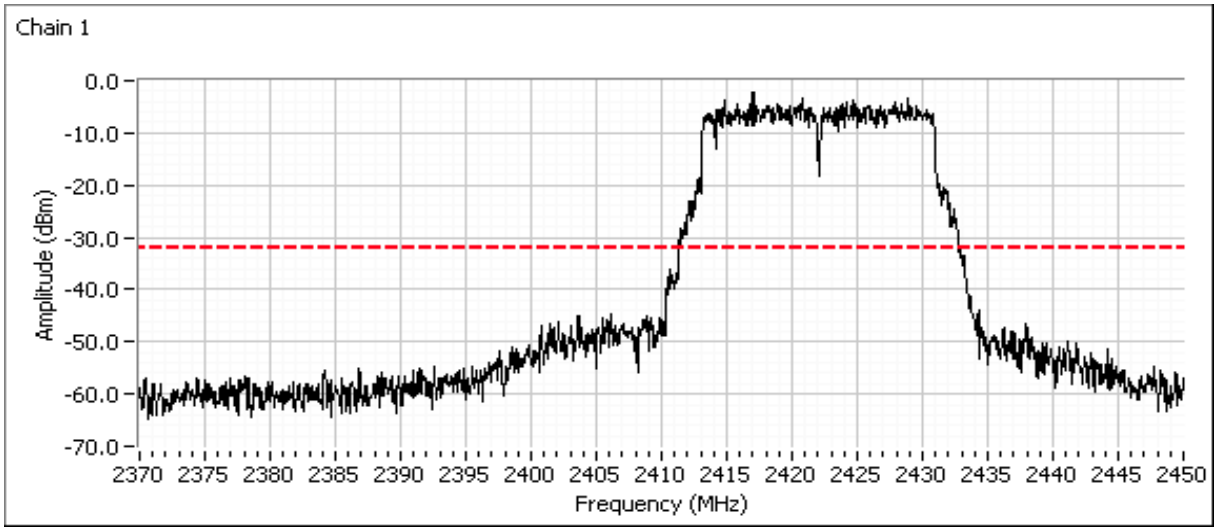
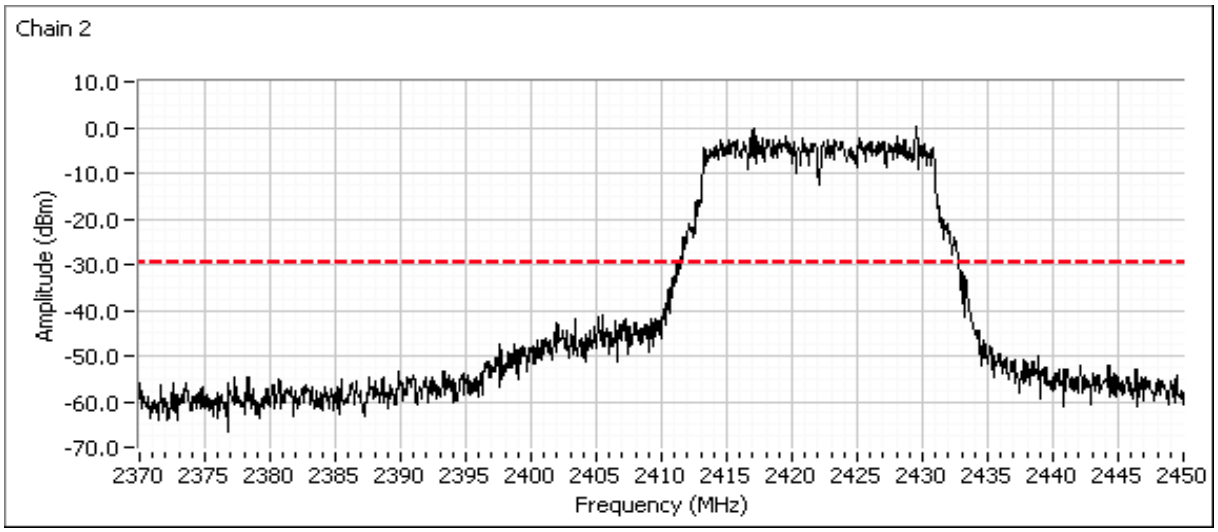
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

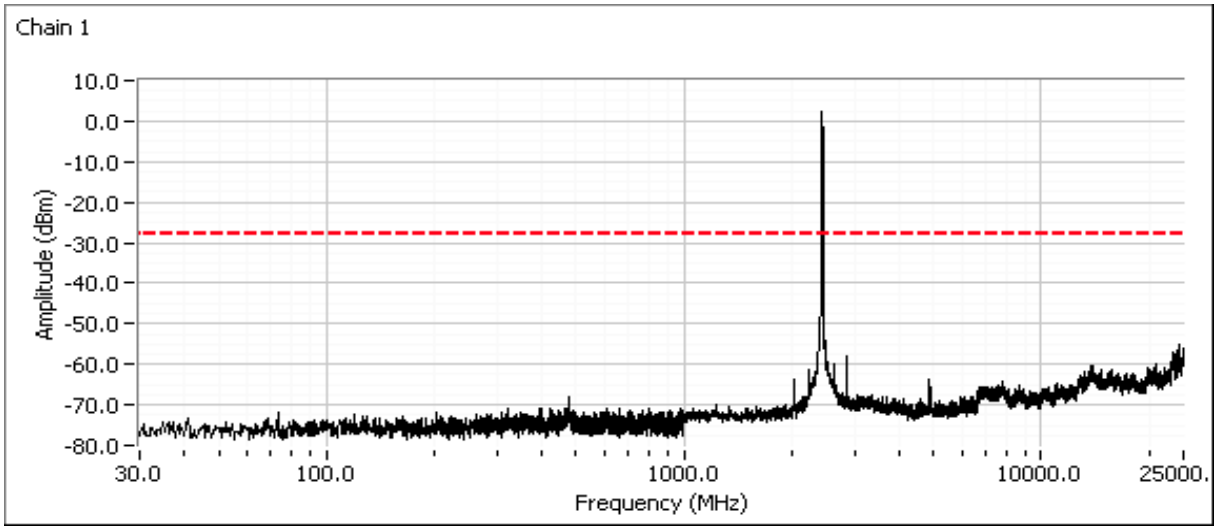
Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

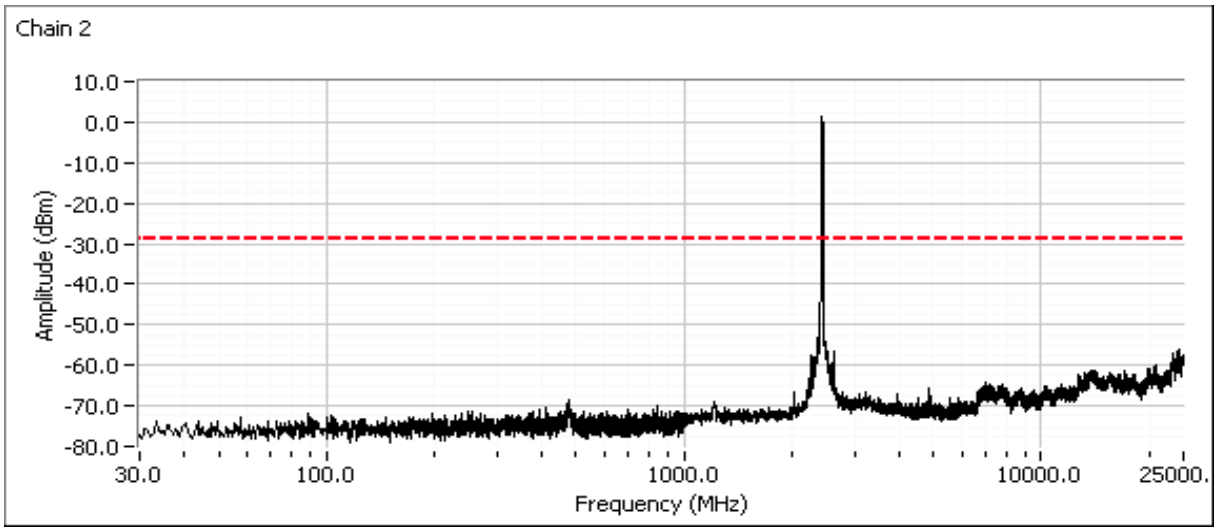




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

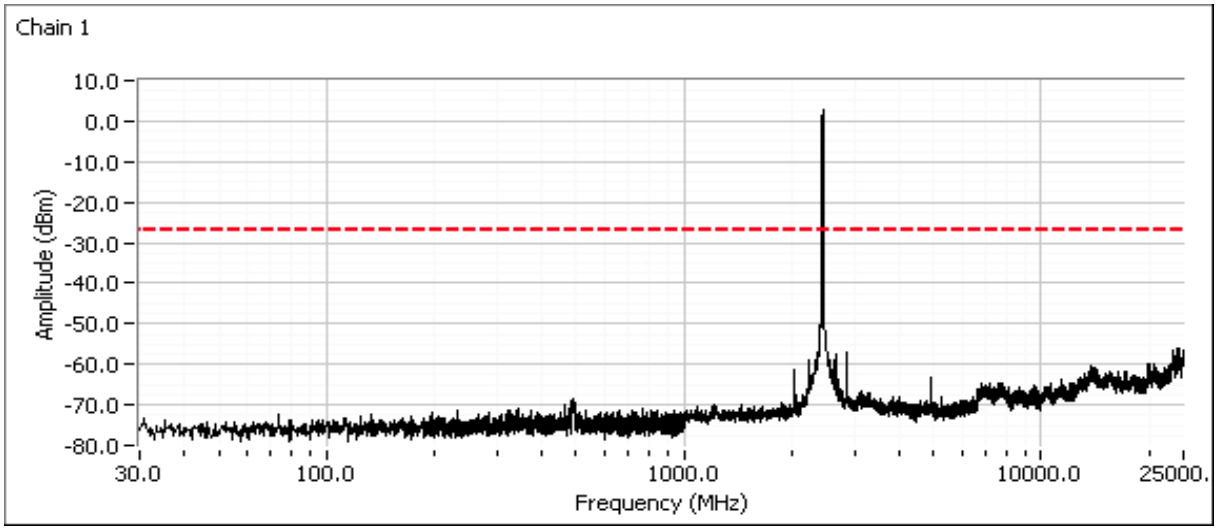
Plots for center channel, 802.11n40 mode

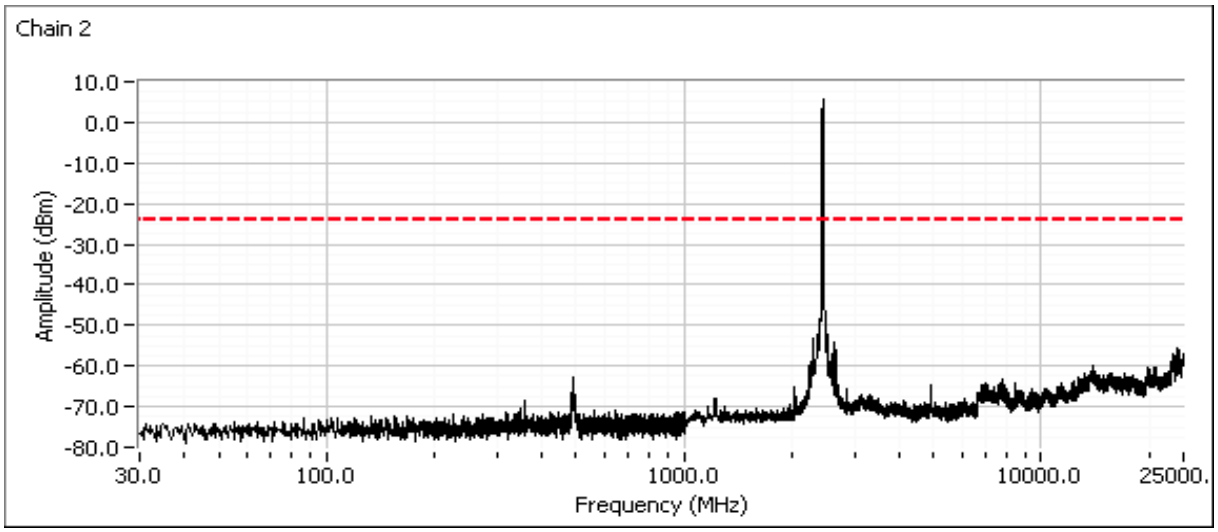




Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Plots for high channel, 802.11n40 mode





Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 22 - 25 °C
Rel. Humidity: 35 - 40 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
1	b	1 - 2412MHz	0	12	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.0 dBµV/m @ 2387.3 MHz (-1.0 dB)
	b	2 - 2417MHz	0	3	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	52.9 dBµV/m @ 2390.0 MHz (-1.1 dB)
	b	11 - 2462MHz	0	9	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	52.3 dBµV/m @ 2483.5 MHz (-1.7 dB)
2	g	1 - 2412MHz	0	15	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	52.9 dBµV/m @ 2390.0 MHz (-1.1 dB)
	g	2 - 2417MHz	0	10	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.7 dBµV/m @ 2389.9 MHz (-0.3 dB)
	g	10 - 2457MHz	0	7	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	52.8 dBµV/m @ 2484.1 MHz (-1.2 dB)
	g	11 - 2462MHz	0	14	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	53.5 dBµV/m @ 2483.5 MHz (-0.5 dB)
3	n20	1 - 2412MHz	0	14	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	52.2 dBµV/m @ 2389.9 MHz (-1.8 dB)
	n20	2 - 2417MHz	0	8	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	52.1 dBµV/m @ 2389.0 MHz (-1.9 dB)
	n20	9 - 2452MHz -	0	7	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	52.2 dBµV/m @ 2484.6 MHz (-1.8 dB)
	n20	10 - 2457MHz	0	8	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	52.6 dBµV/m @ 2483.9 MHz (-1.4 dB)
	n20	11 - 2462MHz	0	10	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	52.2 dBµV/m @ 2483.5 MHz (-1.8 dB)

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
4	n40	3 - 2422MHz	0	19	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.6 dBµV/m @ 2389.6 MHz (-0.4 dB)
	n40	4 - 2427MHz	0	20	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.6 dBµV/m @ 2389.4 MHz (-0.4 dB)
	n40	5 - 2432MHz	0	17	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.2 dBµV/m @ 2388.0 MHz (-0.8 dB)
	n40	6 - 2437MHz	0	15	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.1 dBµV/m @ 2389.8 MHz (-0.9 dB)
	n40	7 - 2442MHz	0	12	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.3 dBµV/m @ 2384.3 MHz (-0.7 dB)
	n40	8 - 2447MHz	0	8	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.6 dBµV/m @ 2389.5 MHz (-0.4 dB)
	n40	9 - 2452MHz	0	6	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	53.5 dBµV/m @ 2387.0 MHz (-0.5 dB)
	n40	6 - 2437MHz	0	7	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	52.9 dBµV/m @ 2484.3 MHz (-1.1 dB)
	n40	7 - 2442MHz	0	11	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	53.2 dBµV/m @ 2484.7 MHz (-0.8 dB)
	n40	8 - 2447MHz	0	12	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	52.6 dBµV/m @ 2484.4 MHz (-1.4 dB)
	n40	9 - 2452MHz	0	10	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	53.4 dBµV/m @ 2483.6 MHz (-0.6 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: 8FA0001901E2766
Driver: 01-EA4417DA firmware and wl 1.201 RC70.0 scripts
Antenna: Internal 2x2 Non-Beamforming

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has a duty cycle ≥ 98% and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mb/s	1.00	Yes	100	0	0	10
11g	6 Mb/s	0.99	Yes	2.1	0	0	476
n20	MCS 0	0.99	Yes	0.948	0	0	1055
n40	MCS 0	0.96	Yes	0.49	0.18	0.36	2041

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 3:	Emission has a duty cycle ≥ 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 4:	Emission has constant duty cycle < 98%, average measurement performed: RBW=1MHz, VBW>1/T but not less than 10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear voltage correction factor
Note 5:	Emission has constatnt duty cycle < 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Emission has non constant duty cycle < 98%, average measurement performed: RBW=1MHz, VBW> 1/T, peak detector, linear average mode, sweep time auto, max hold. Max hold for 50*(1/DC) traces
Note 7:	Emission has non constant duty cycle < 98%, average measurement performed: RBW=1MHz, VBW> 1/T, RMS detector, sweep time auto, max hold. Max hold for 50*(1/DC) traces
Note 8:	Plots of the average and peak bandedge do not account for any duty cycle correction. Refer to the tabular results for final measurements.

Run #1: Radiated Bandedge Measurements

Date of Test: 7/5/2016 Config. Used: 2

Test Engineer: Kevin Wen, Yew-Kwong Soo Config Change: None

Test Location: Fremont Chamber #5 EUT Voltage: 120V/60Hz

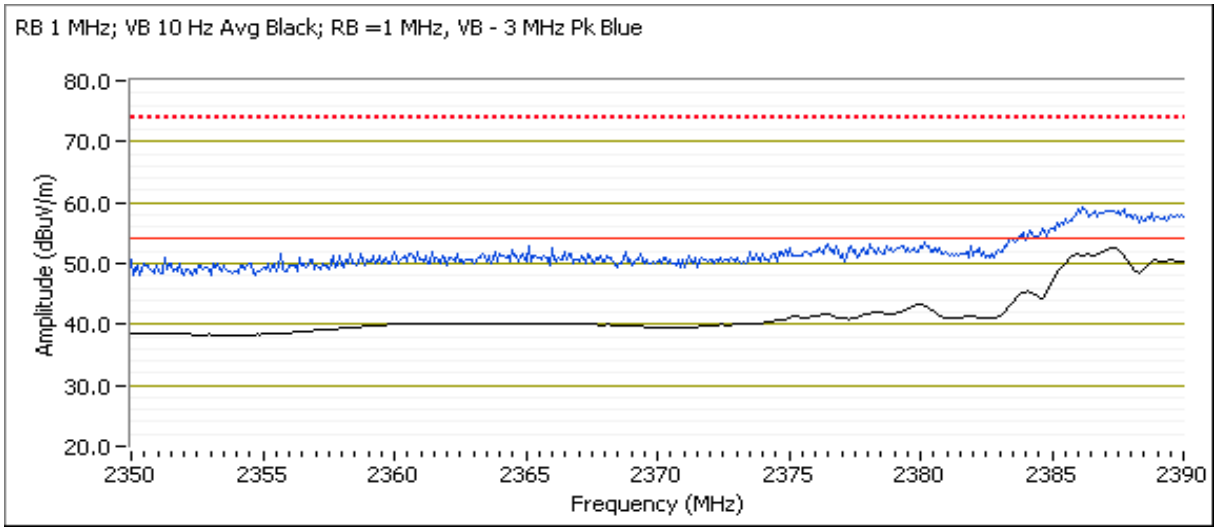
Channel: 1 Mode: b

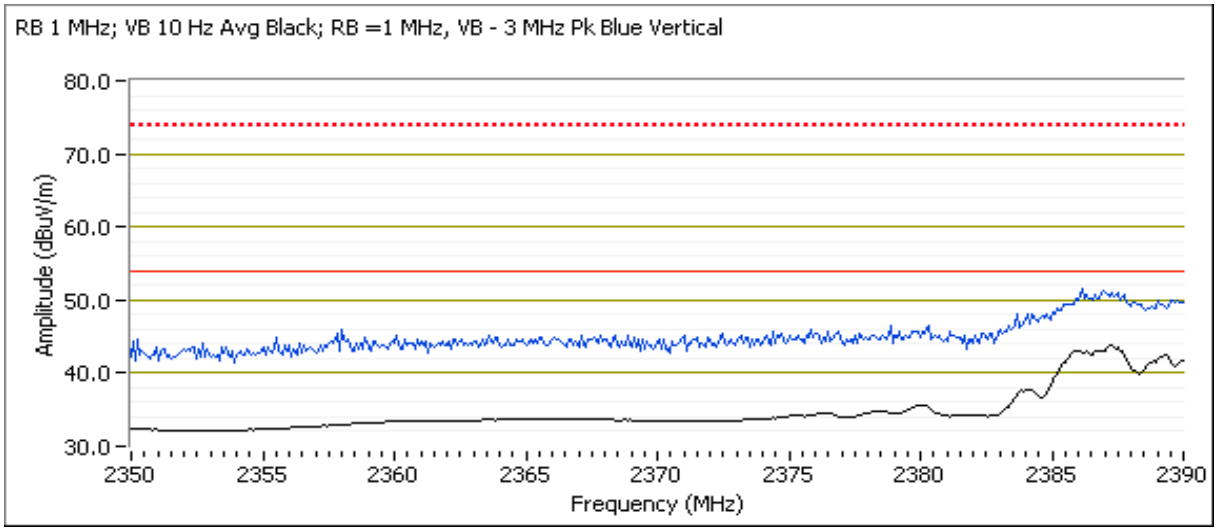
Tx Chain: Both Data Rate: 1 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2387.320	53.0	H	54.0	-1.0	AVG	70	1.9	POS; RB 1 MHz; VB: 10 Hz
2386.130	60.2	H	74.0	-13.8	PK	70	1.9	POS; RB 1 MHz; VB: 3 MHz
2387.290	44.4	V	54.0	-9.6	AVG	136	2.6	POS; RB 1 MHz; VB: 10 Hz
2385.940	51.7	V	74.0	-22.3	PK	136	2.6	POS; RB 1 MHz; VB: 3 MHz

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



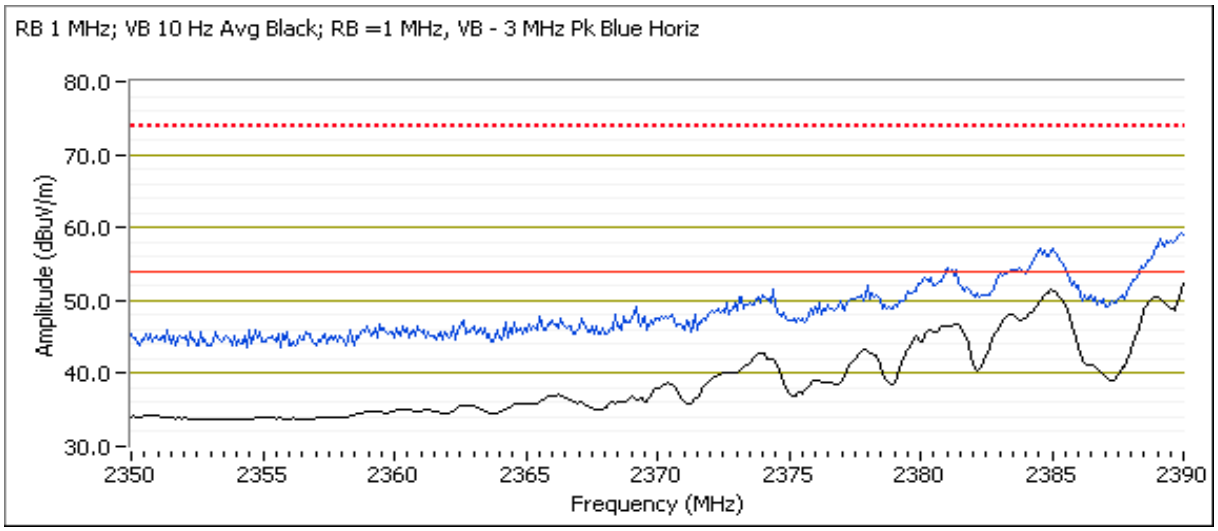


Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Channel: 2 Mode: b
Tx Chain: Both Data Rate: 1 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2390.000	52.9	H	54.0	-1.1	AVG	136	2.6	POS; RB 1 MHz; VB: 10 Hz
2390.000	59.3	H	74.0	-14.7	PK	136	2.6	POS; RB 1 MHz; VB: 3 MHz

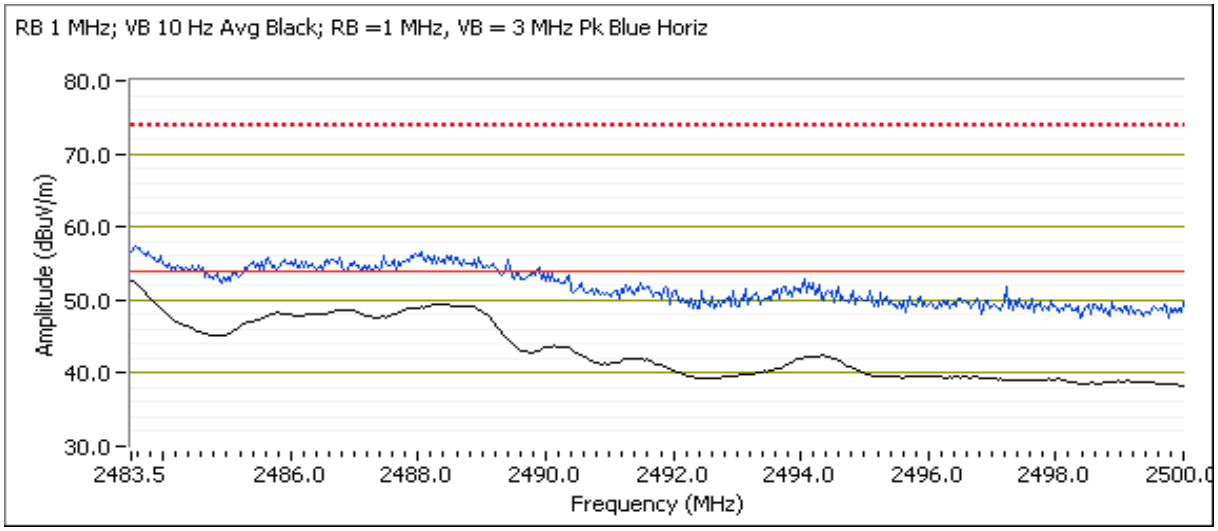


Channel: 11 Mode: b
Tx Chain: Both Data Rate: 1 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.500	52.3	H	54.0	-1.7	AVG	42	1.8	POS; RB 1 MHz; VB: 10 Hz
2483.660	57.8	H	74.0	-16.2	PK	42	1.8	POS; RB 1 MHz; VB: 3 MHz

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Run #2: Radiated Bandedge Measurements

Date of Test: 7/5/2016
Test Engineer: Kevin Wen, Yew-Kwong Soo
Test Location: Fremont Chamber #5

Config. Used: 2
Config Change: None
EUT Voltage: 120V/60Hz

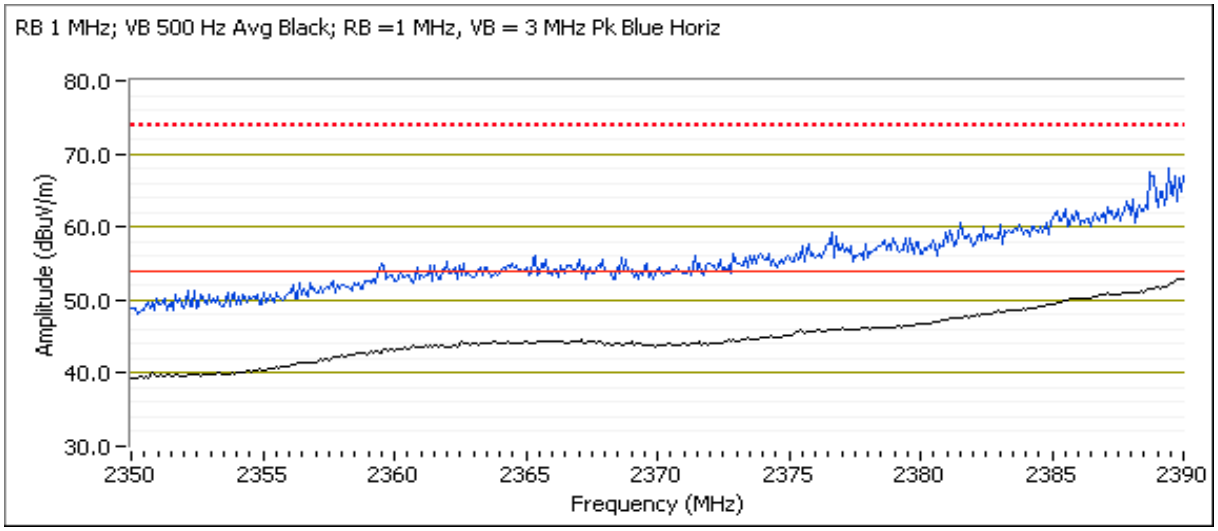
Channel: 1
Tx Chain: Both

Mode: g
Data Rate: 6 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.960	52.9	H	54.0	-1.1	AVG	82	2.1	POS; RB 1 MHz; VB: 500 Hz
2389.130	69.5	H	74.0	-4.5	PK	82	2.1	POS; RB 1 MHz; VB: 3 MHz

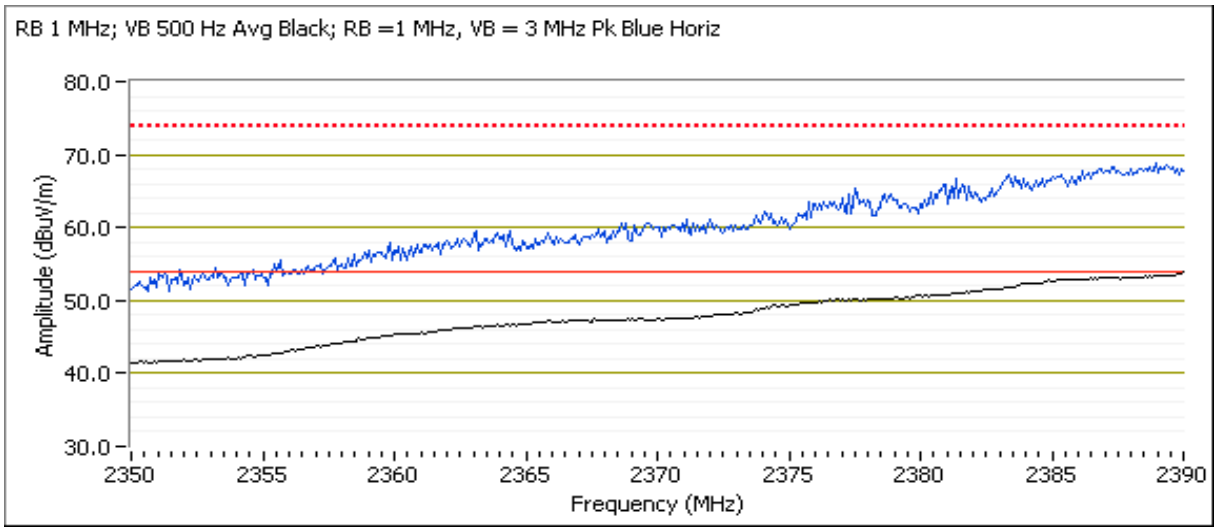
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Channel: 2 Mode: g
Tx Chain: Both Data Rate: 6 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.900	53.7	H	54.0	-0.3	AVG	98	2.1	POS; RB 1 MHz; VB: 500 Hz
2388.440	69.8	H	74.0	-4.2	PK	98	2.1	POS; RB 1 MHz; VB: 3 MHz

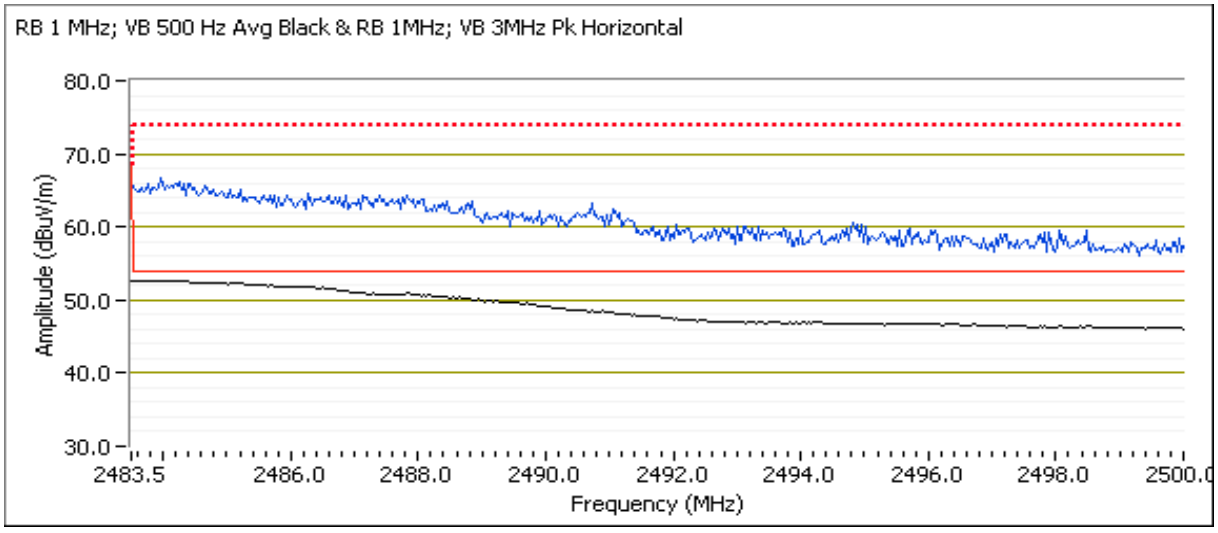


Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Channel: 10 Mode: g
Tx Chain: Both Data Rate: 6 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.110	52.8	H	54.0	-1.2	Avg	0	2.2	POS; RB 1 MHz; VB: 500 Hz
2483.620	67.2	H	74.0	-6.8	PK	0	2.2	POS; RB 1 MHz; VB: 3 MHz

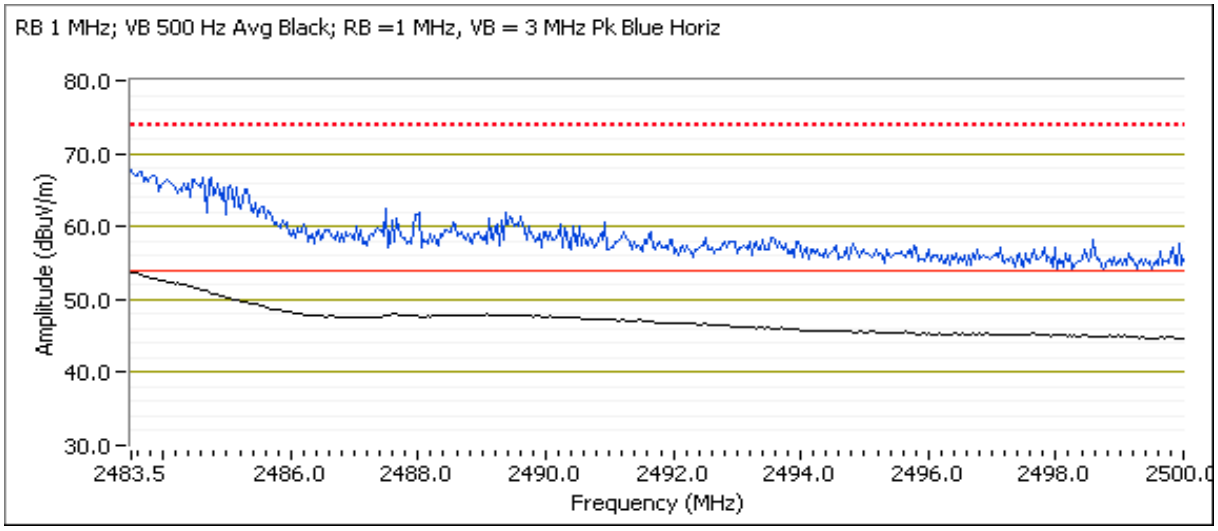


Channel: 11 Mode: g
Tx Chain: Both Data Rate: 6 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.540	53.5	H	54.0	-0.5	AVG	355	1.6	POS; RB 1 MHz; VB: 500 Hz
2484.050	68.1	H	74.0	-5.9	PK	355	1.6	POS; RB 1 MHz; VB: 3 MHz

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Run #3: Radiated Bandedge Measurements

Date of Test: 7/5/2016
Test Engineer: Kevin Wen, Yew-Kwong Soo
Test Location: Fremont Chamber #5

Config. Used: 2
Config Change: None
EUT Voltage: 120V/60Hz

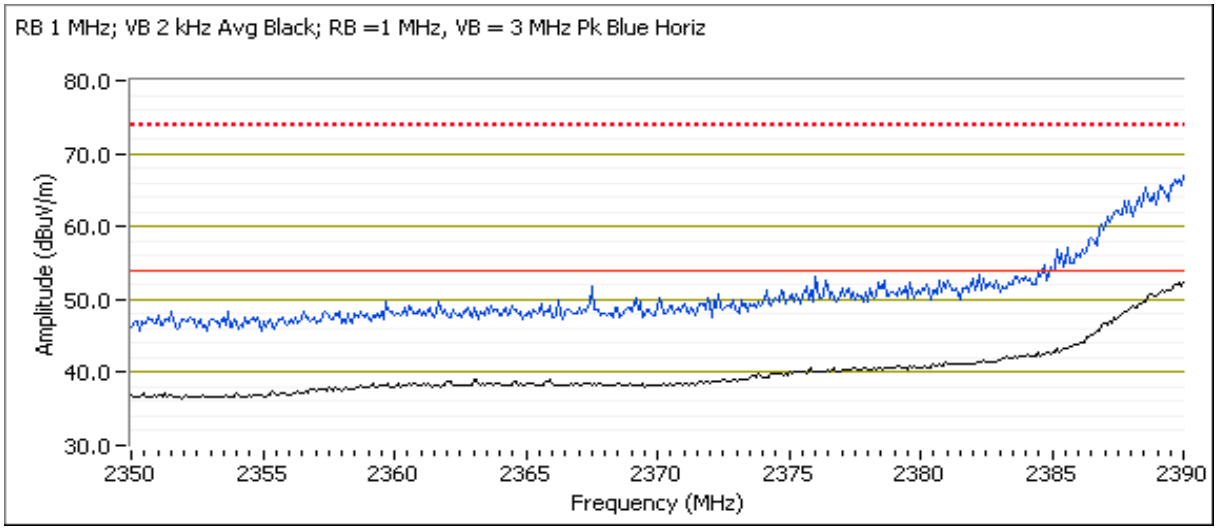
Channel: 1
Tx Chain: Both

Mode: n20
Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.900	52.2	H	54.0	-1.8	Avg	136	2.6	POS; RB 1 MHz; VB: 2 kHz
2389.510	67.7	H	74.0	-6.3	PK	136	2.6	POS; RB 1 MHz; VB: 3 MHz

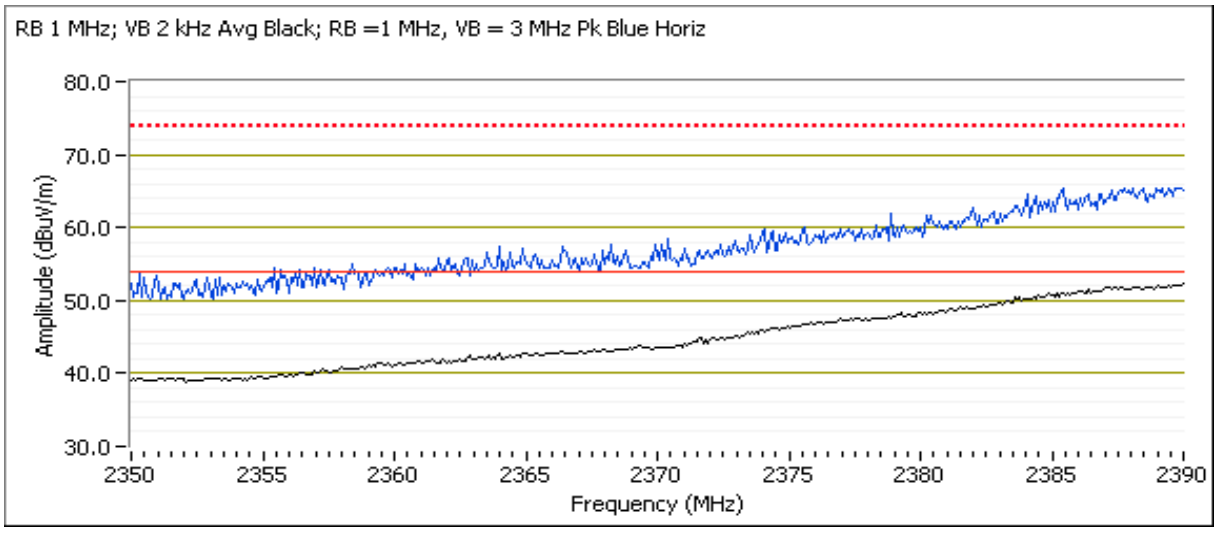
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Channel: 2 Mode: n20
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.040	52.1	H	54.0	-1.9	Avg	136	2.6	POS; RB 1 MHz; VB: 2 kHz
2389.760	65.1	H	74.0	-8.9	PK	136	2.6	POS; RB 1 MHz; VB: 3 MHz

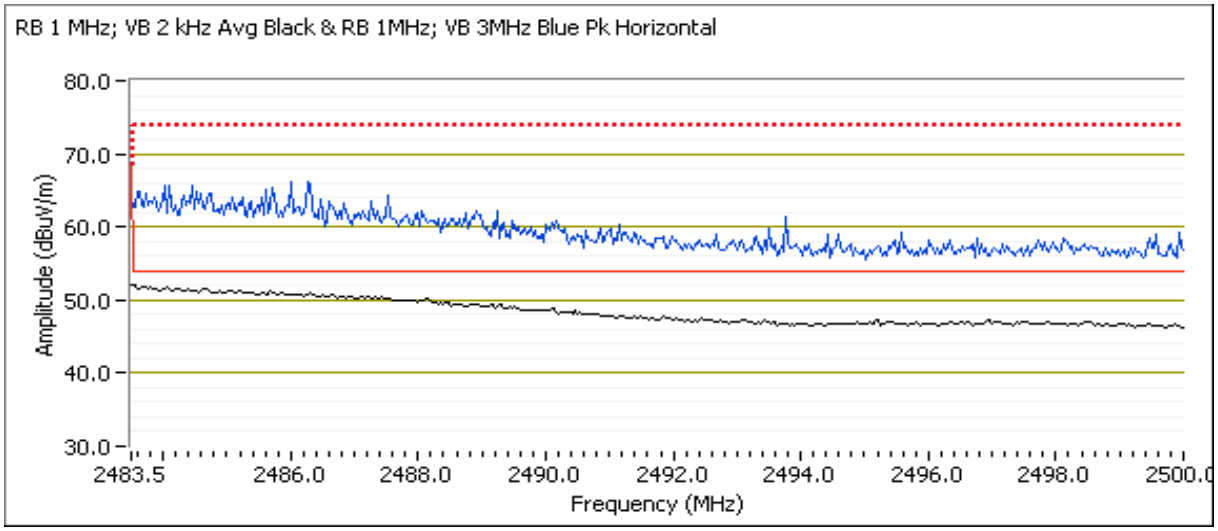


Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Channel: 9 Mode: n20
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.560	52.2	H	54.0	-1.8	Avg	1	2.2	POS; RB 1 MHz; VB: 2 kHz
2484.000	66.6	H	74.0	-7.4	PK	1	2.2	POS; RB 1 MHz; VB: 3 MHz

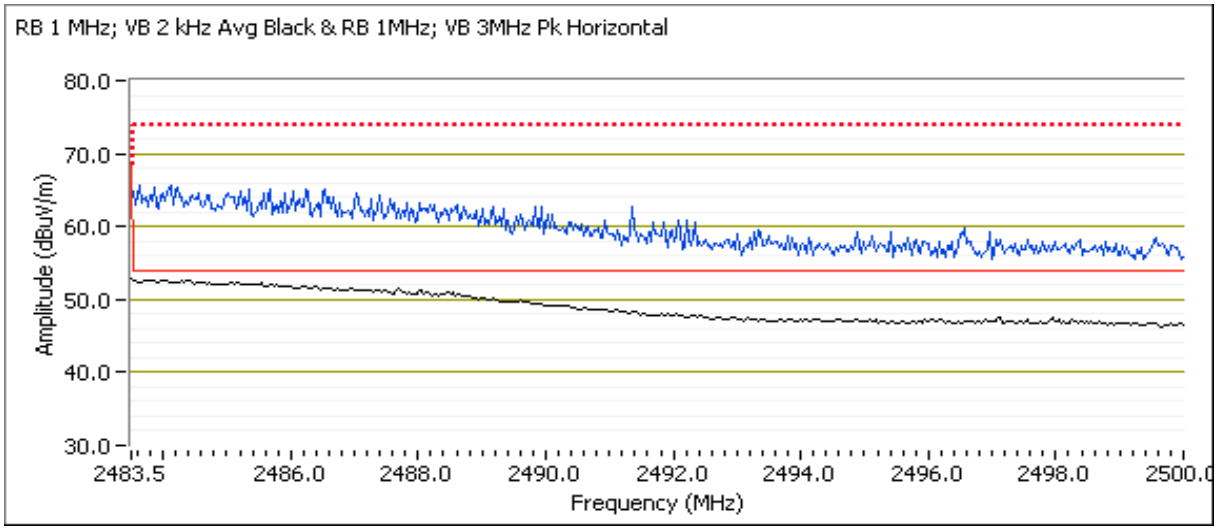


Channel: 10 Mode: n20
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.920	52.6	H	54.0	-1.4	Avg	349	2.2	POS; RB 1 MHz; VB: 2 kHz
2484.070	67.1	H	74.0	-6.9	PK	349	2.2	POS; RB 1 MHz; VB: 3 MHz

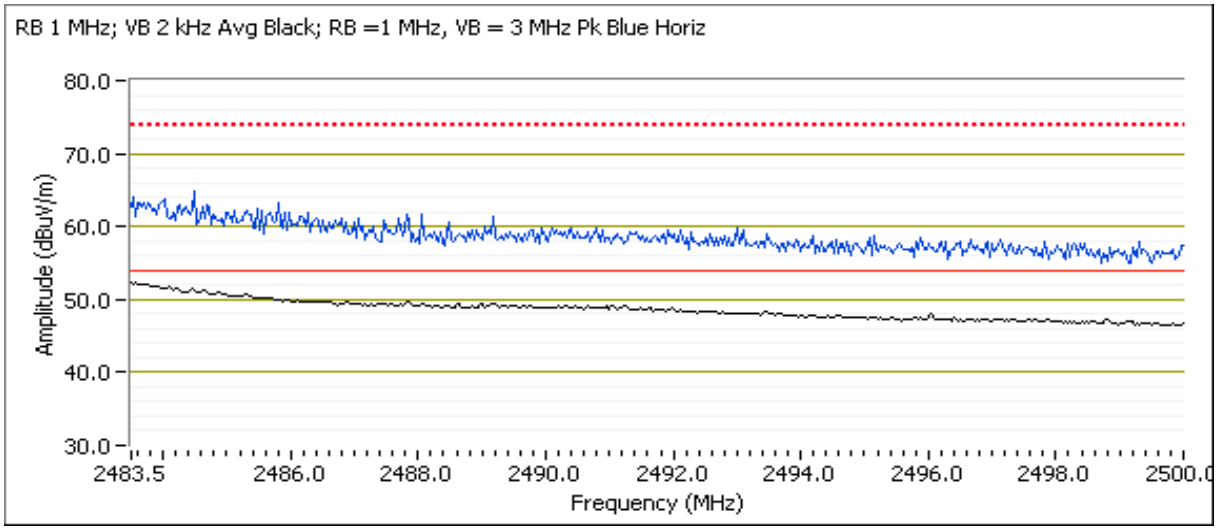
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Channel: 11 Mode: n20
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.510	52.2	H	54.0	-1.8	AVG	0	1.6	POS; RB 1 MHz; VB: 2 kHz
2483.970	65.7	H	74.0	-8.3	PK	0	1.6	POS; RB 1 MHz; VB: 3 MHz



Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

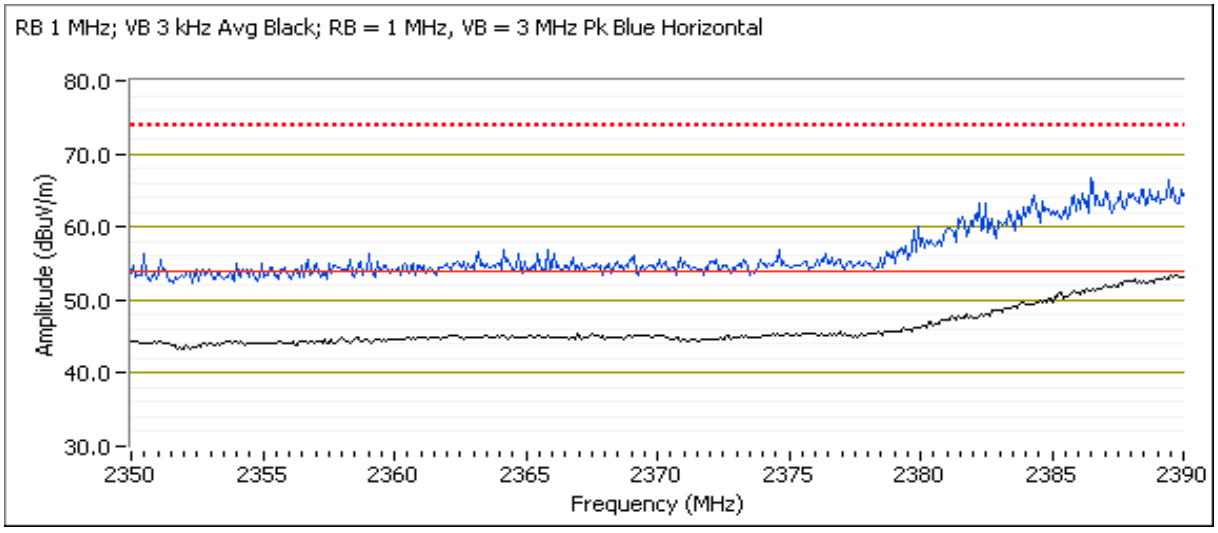
Run #4: Radiated Bandedge Measurements

Date of Test: 7/5/2016 Config. Used: 2
Test Engineer: Kevin Wen, Yew-Kwong Soo Config Change: None
Test Location: Fremont Chamber #5 EUT Voltage: 120V/60Hz

Channel: 3 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.600	53.6	H	54.0	-0.4	Avg	88	1.8	POS; RB 1 MHz; VB: 3 kHz
2389.040	66.4	H	74.0	-7.6	PK	88	1.8	POS; RB 1 MHz; VB: 3 MHz

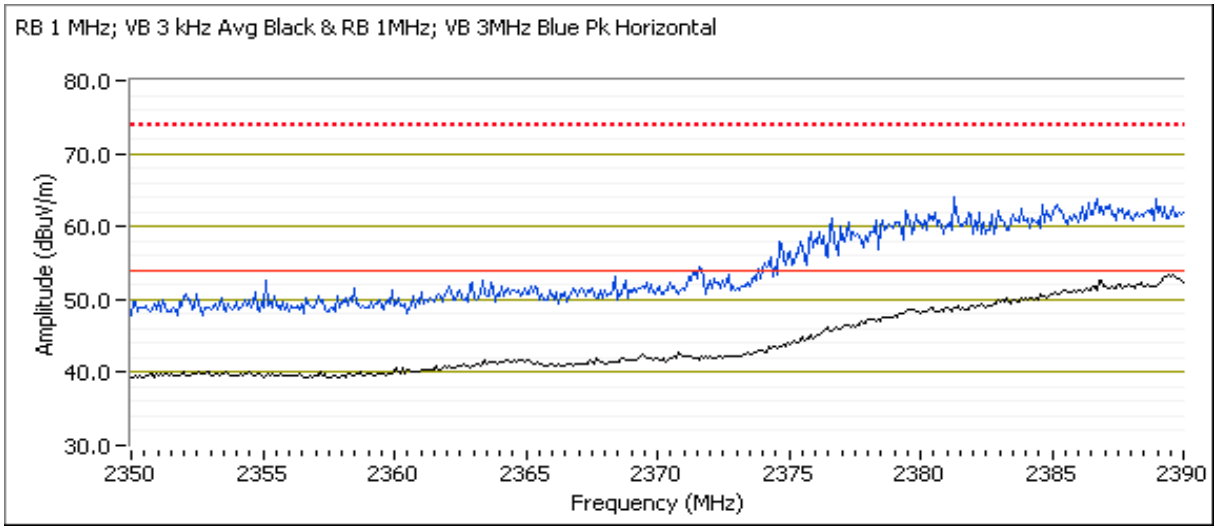


Channel: 4 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.430	53.6	H	54.0	-0.4	Avg	86	1.8	POS; RB 1 MHz; VB: 3 kHz
2385.960	65.1	H	74.0	-8.9	PK	86	1.8	POS; RB 1 MHz; VB: 3 MHz

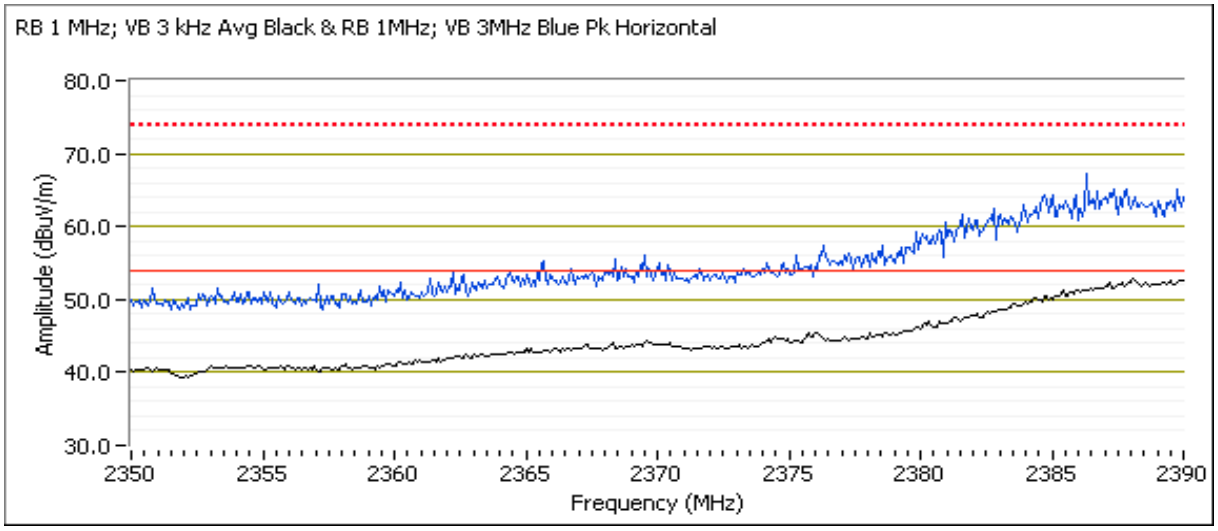
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Channel: 5 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2388.020	53.2	H	54.0	-0.8	Avg	88	1.8	POS; RB 1 MHz; VB: 3 kHz
2387.870	66.5	H	74.0	-7.5	PK	88	1.8	POS; RB 1 MHz; VB: 3 MHz

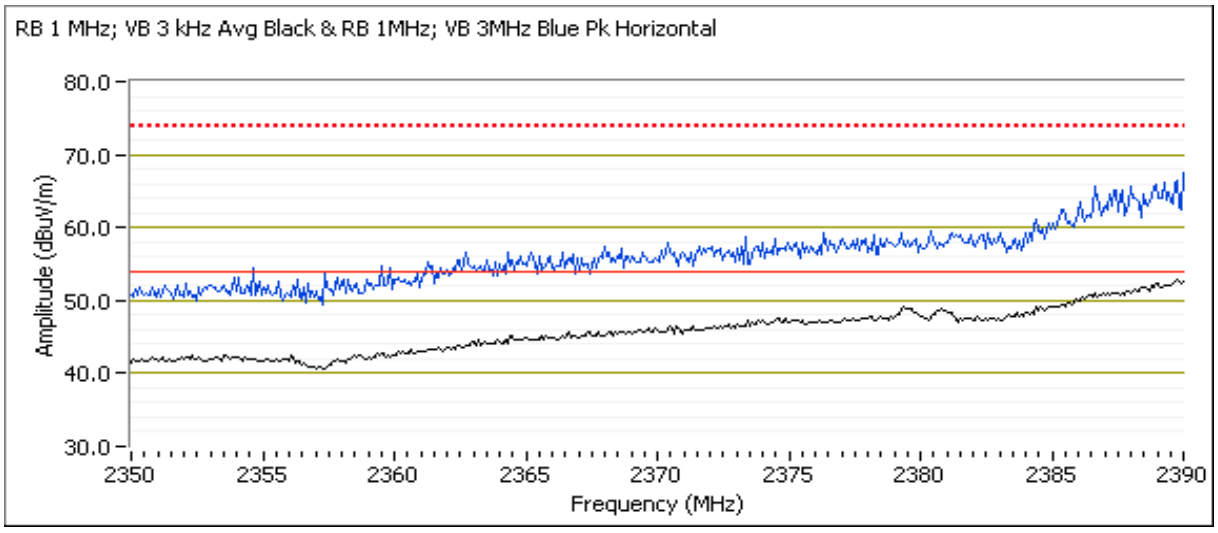


Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Channel: 6 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.800	53.1	H	54.0	-0.9	Avg	89	1.8	POS; RB 1 MHz; VB: 3 kHz
2387.180	68.2	H	74.0	-5.8	PK	89	1.8	POS; RB 1 MHz; VB: 3 MHz

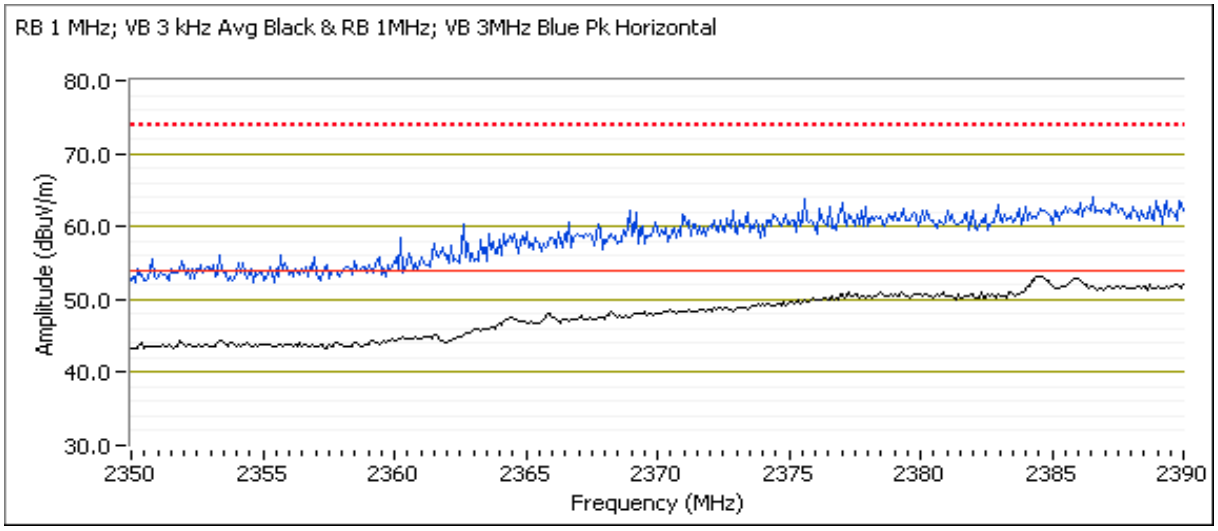


Channel: 7 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2384.310	53.3	H	54.0	-0.7	Avg	93	1.8	POS; RB 1 MHz; VB: 3 kHz
2385.320	66.1	H	74.0	-7.9	PK	93	1.8	POS; RB 1 MHz; VB: 3 MHz

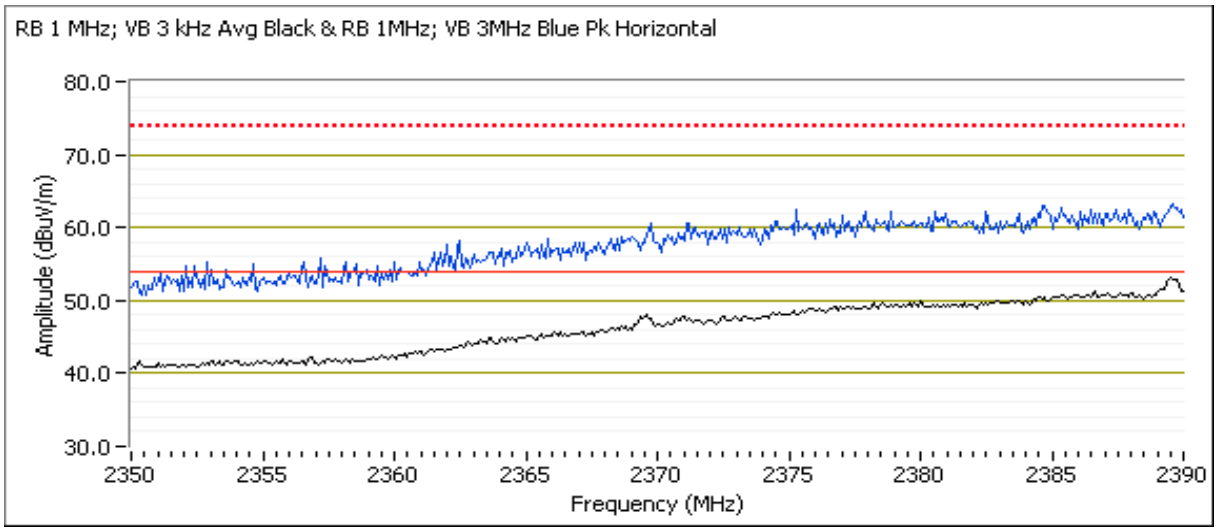
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Channel: 8 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.540	53.6	H	54.0	-0.4	Avg	358	1.5	POS; RB 1 MHz; VB: 3 kHz
2389.710	64.5	H	74.0	-9.5	PK	358	1.5	POS; RB 1 MHz; VB: 3 MHz

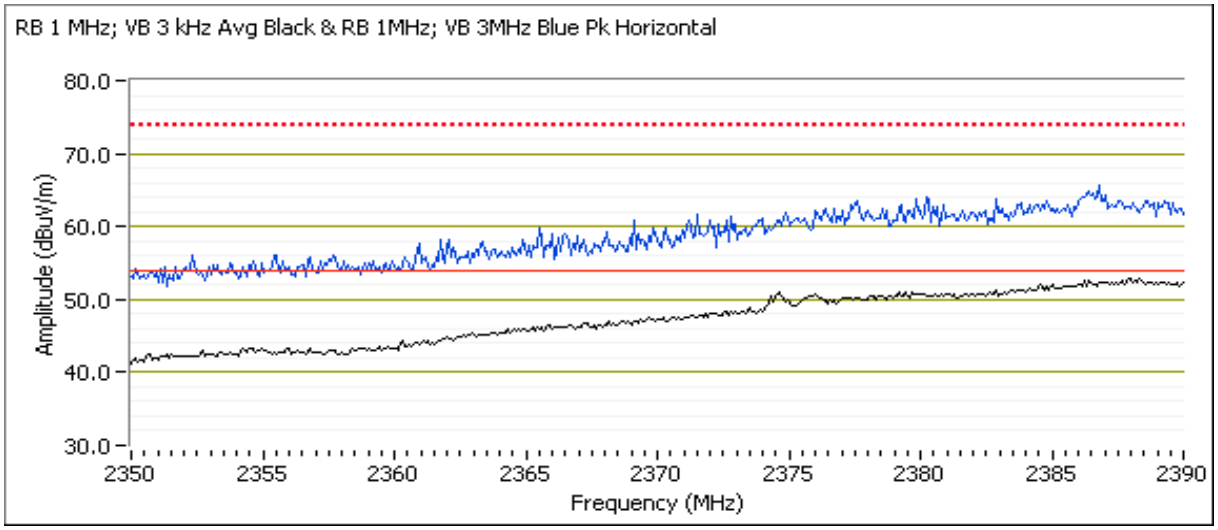


Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Channel: 9 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2387.000	53.5	H	54.0	-0.5	Avg	349	1.5	POS; RB 1 MHz; VB: 3 kHz
2386.400	67.1	H	74.0	-6.9	PK	349	1.5	POS; RB 1 MHz; VB: 3 MHz

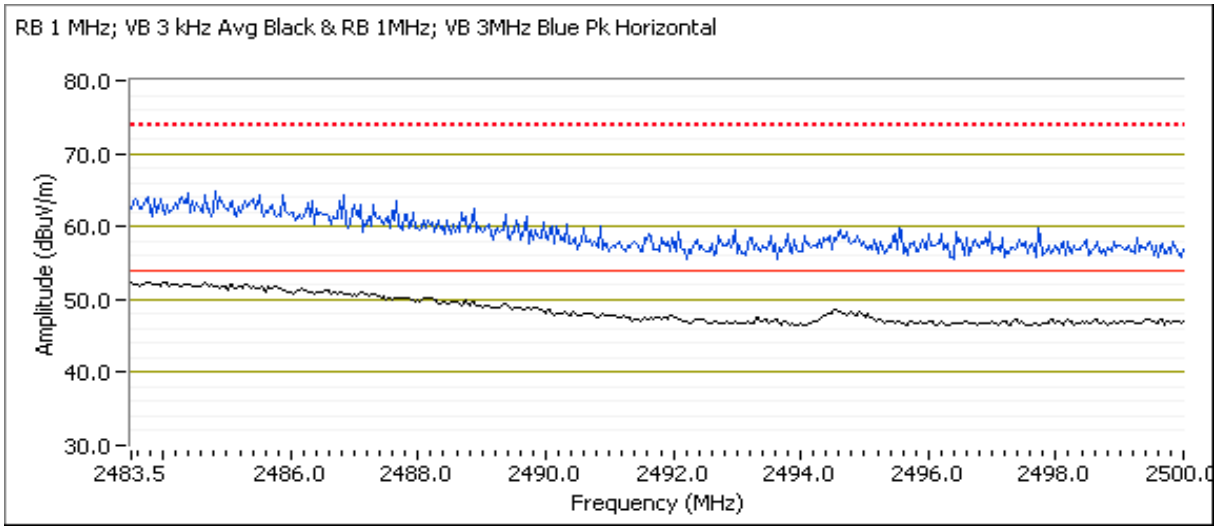


Channel: 6 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.250	52.9	H	54.0	-1.1	Avg	355	2.2	POS; RB 1 MHz; VB: 3 kHz
2484.660	65.9	H	74.0	-8.1	PK	355	2.2	POS; RB 1 MHz; VB: 3 MHz

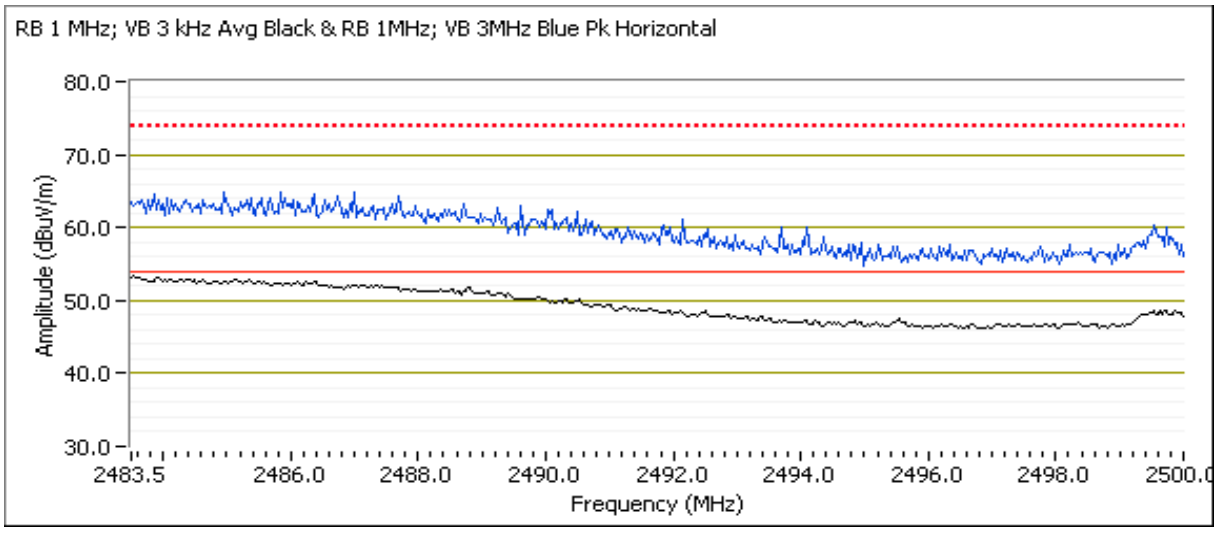
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Channel: 7 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.680	53.2	H	54.0	-0.8	Avg	348	2.0	POS; RB 1 MHz; VB: 3 kHz
2484.160	65.8	H	74.0	-8.2	PK	348	2.0	POS; RB 1 MHz; VB: 3 MHz

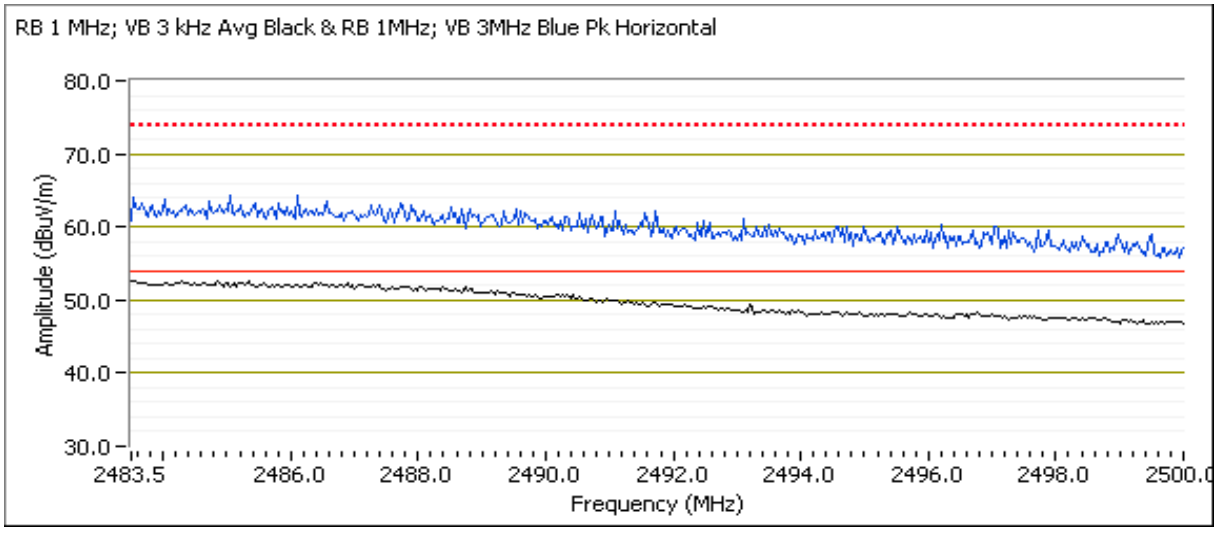


Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Channel: 8 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.360	52.6	H	54.0	-1.4	Avg	349	1.6	POS; RB 1 MHz; VB: 3 kHz
2483.790	64.6	H	74.0	-9.4	PK	349	1.6	POS; RB 1 MHz; VB: 3 MHz

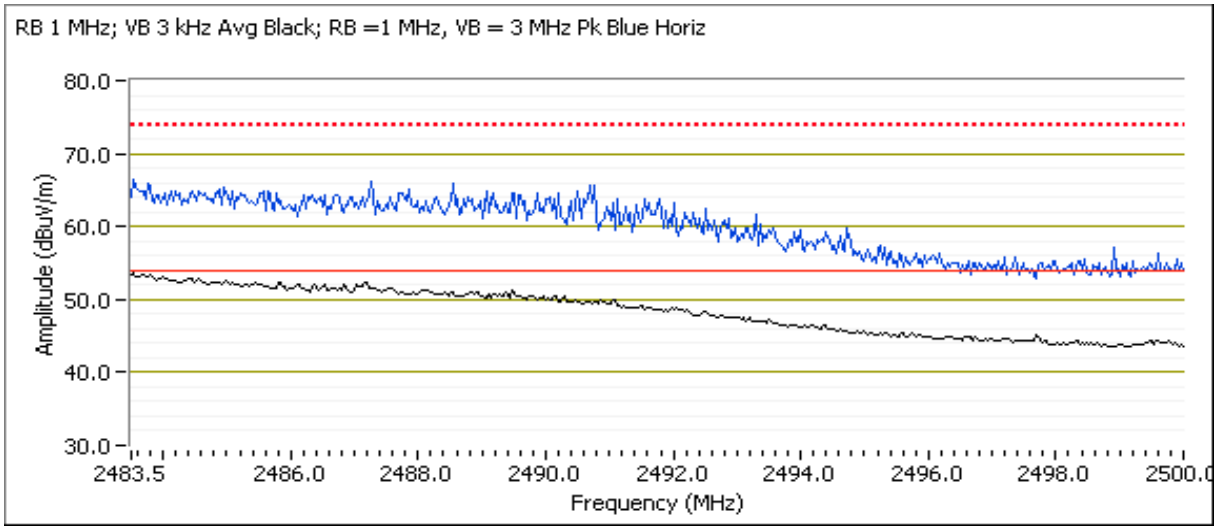


Channel: 9 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.610	53.4	H	54.0	-0.6	AVG	86	2.0	POS; RB 1 MHz; VB: 3 kHz
2484.120	66.1	H	74.0	-7.9	PK	86	2.0	POS; RB 1 MHz; VB: 3 MHz

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 22-25 °C
Rel. Humidity: 30-35 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
1	b	1 - 2412MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	49.5 dBµV/m @ 4824.2 MHz (-4.5 dB)
	b	6 - 2437MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	46.7 dBµV/m @ 4874.2 MHz (-7.3 dB)
	b	11 - 2462MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	46.8 dBµV/m @ 4924.2 MHz (-7.2 dB)
Scans on center channel in all three OFDM modes to determine the worst case mode.							
2	g	6 - 2437MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	45.5 dBµV/m @ 1150.0 MHz (-8.5 dB)
	n20	6 - 2437MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	45.6 dBµV/m @ 1150.0 MHz (-8.4 dB)
	n40	6 - 2437MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	44.4 dBµV/m @ 1150.1 MHz (-9.2 dB)
Measurements on low and high channels in worst-case OFDM mode.							
3	n20	1 - 2412MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	45.6 dBµV/m @ 1150.0 MHz (-8.4 dB)
	n20	11 - 2462MHz	1	1	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	45.5 dBµV/m @ 1150.0 MHz (-8.5 dB)

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: 8FA0001901E2766
Driver: 01-EA4417DA firmware and wl 1.201 RC70.0 scripts
Antenna: Internal 2x2 Non-Beamforming

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 98% and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.
2.4GHz band reject filter used

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mb/s	1.00	Yes	100	0	0	10
11g	6 MB/s	0.99	Yes	2.1	0	0	476
n20	MCS 0	0.99	Yes	0.948	0	0	1055
n40	MCS 0	0.96	Yes	0.49	0.18	0.36	2041

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 3:	Emission has a duty cycle ≥ 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 4:	Emission has constant duty cycle < 98%, average measurement performed: RBW=1MHz, VBW>1/T but not less than 10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear voltage correction factor
Note 5:	Emission has constatnt duty cycle < 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Emission has non constant duty cycle < 98%, average measurement performed: RBW=1MHz, VBW> 1/T, peak detector, linear average mode, sweep time auto, max hold. Max hold for 50*(1/DC) traces
Note 7:	Emission has non constant duty cycle < 98%, average measurement performed: RBW=1MHz, VBW> 1/T, RMS detector, sweep time auto, max hold. Max hold for 50*(1/DC) traces

Run #1: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: 802.11b

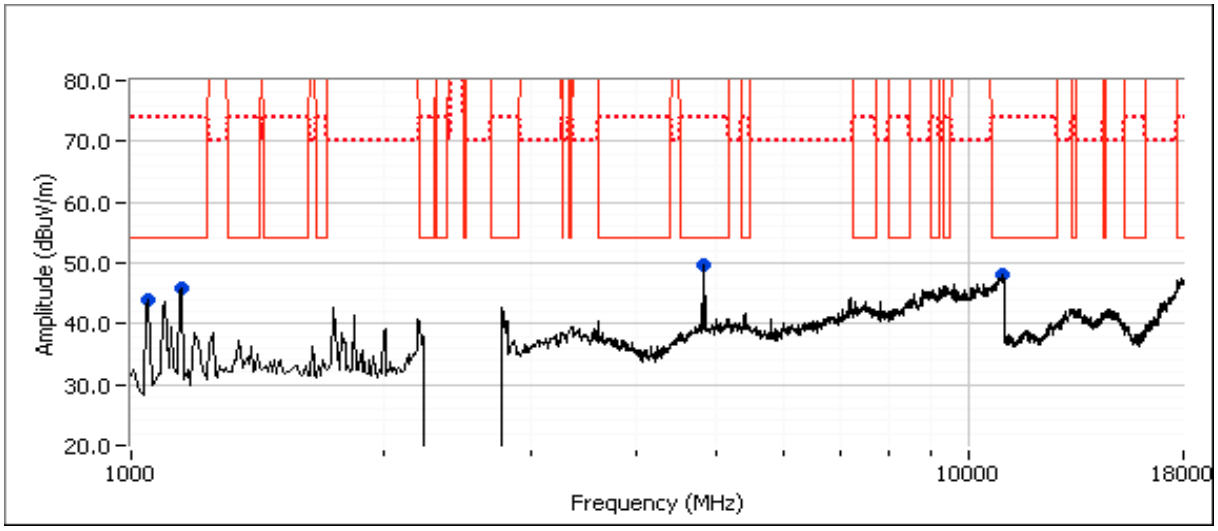
Date of Test:	7/8, 7/13, 7/14/2016	Config. Used:	2
Test Engineer:	Kevin Wen, Yew-Kwong Soo	Config Change:	None
Test Location:	Fremont Chamber #5, #4	EUT Voltage:	120V/60Hz

Run #1a: Low Channel

Channel:	1	Mode:	b
Tx Chain:	Both	Data Rate:	1 Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*43.9*	*V*	*54.0*	*-10.1*	*Peak*	*158*	*1.0*	
1150.000	*45.9*	*V*	*54.0*	*-8.1*	*Peak*	*322*	*1.5*	
4825.000	*49.8*	*H*	*54.0*	*-4.2*	*Peak*	*333*	*1.5*	
10966.670	*48.1*	*V*	*54.0*	*-5.9*	*Peak*	*63*	*2.5*	

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Note: From 11 - 18 GHz, the horn antenna is 1m away from the EUT. No emissions above the noise floor observed

Maximized Readings

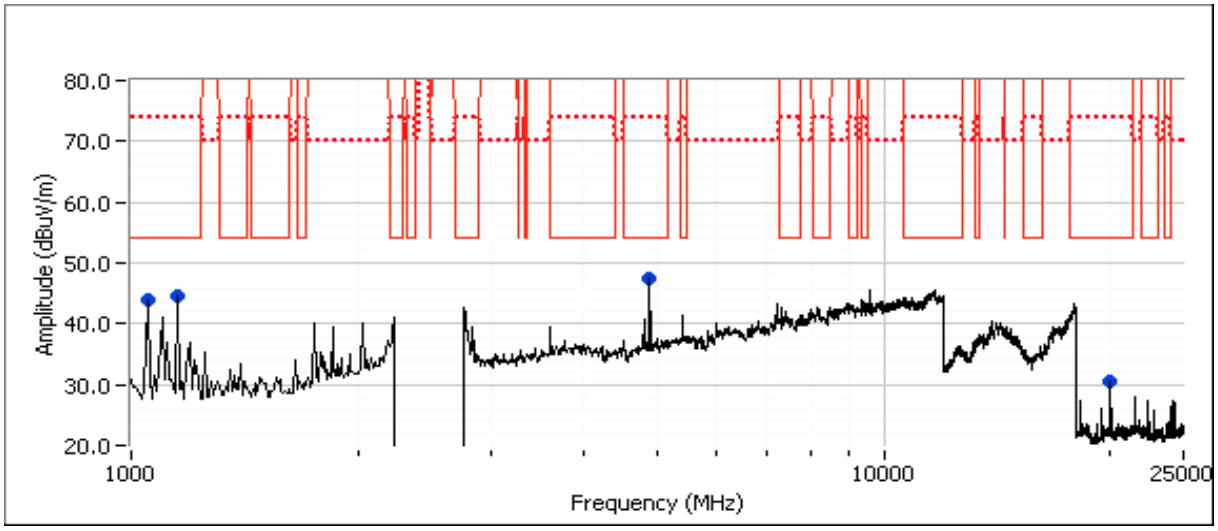
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4824.190	49.5	H	54.0	-4.5	AVG	319	1.4	RB 1 MHz;VB 10 Hz;Peak
4824.040	53.2	H	74.0	-20.8	PK	319	1.4	RB 1 MHz;VB 3 MHz;Peak
10969.960	41.6	V	54.0	-12.4	AVG	66	2.5	RB 1 MHz;VB 10 Hz;Peak
10970.420	53.5	V	74.0	-20.5	PK	66	2.5	RB 1 MHz;VB 3 MHz;Peak
1050.030	44.8	V	54.0	-9.2	AVG	149	1.0	RB 1 MHz;VB 10 Hz;Peak
1049.960	47.5	V	74.0	-26.5	PK	149	1.0	RB 1 MHz;VB 3 MHz;Peak
1150.020	46.2	V	54.0	-7.8	AVG	317	1.4	RB 1 MHz;VB 10 Hz;Peak
1150.030	48.6	V	74.0	-25.4	PK	317	1.4	RB 1 MHz;VB 3 MHz;Peak

Run #1b: Center Channel

Channel: 6 Mode: b
Tx Chain: Both Data Rate: 1 Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*43.9*	*V*	*54.0*	*-10.1*	*Peak*	*347*	*1.0*	
1150.000	*44.5*	*V*	*54.0*	*-9.5*	*Peak*	*139*	*2.0*	
4875.000	*47.4*	*H*	*54.0*	*-6.6*	*Peak*	*354*	*2.0*	
20018.330	*30.6*	*V*	*54.0*	*-23.4*	*Peak*	*359*	*1.0*	

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B



Note:	From 12 - 18 GHz, the horn antenna is 1m away from the EUT. No emissions above the noise floor observed
Note:	Scans made between 18 - 25 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

Maximized Readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4874.160	46.7	H	54.0	-7.3	AVG	346	2.0	RB 1 MHz;VB 10 Hz;Peak
4874.190	49.9	H	74.0	-24.1	PK	346	2.0	RB 1 MHz;VB 3 MHz;Peak
1050.030	44.0	V	54.0	-10.0	AVG	345	1.4	RB 1 MHz;VB 10 Hz;Peak
1050.150	46.5	V	74.0	-27.5	PK	345	1.4	RB 1 MHz;VB 3 MHz;Peak
1150.020	44.8	V	54.0	-9.2	AVG	141	2.0	RB 1 MHz;VB 10 Hz;Peak
1150.120	46.7	V	74.0	-27.3	PK	141	2.0	RB 1 MHz;VB 3 MHz;Peak
20018.950	36.2	V	54.0	-17.8	AVG	360	2.5	RB 1 MHz;VB 10 Hz;Peak
20017.370	48.3	V	74.0	-25.7	PK	360	2.5	RB 1 MHz;VB 3 MHz;Peak

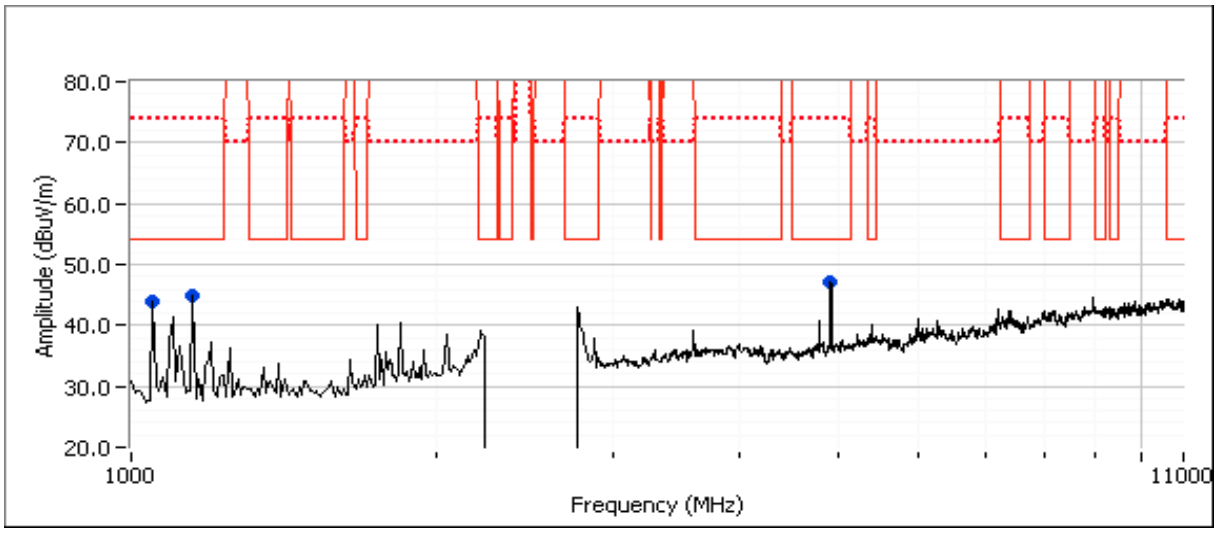
Note:	Measurements at 20GHz at 3 meter were just noise floor.

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run #1c: High Channel

Channel: 11 Mode: b
Tx Chain: Both Data Rate: 1 Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*43.9*	*V*	*54.0*	*-10.1*	*Peak*	*348*	*1.0*	
1150.000	*45.0*	*V*	*54.0*	*-9.0*	*Peak*	*145*	*2.0*	
4925.000	*47.1*	*H*	*54.0*	*-6.9*	*Peak*	*66*	*2.0*	



Maximized Readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4924.170	46.8	H	54.0	-7.2	AVG	67	2.0	RB 1 MHz;VB 10 Hz;Peak
4924.210	50.4	H	74.0	-23.6	PK	67	2.0	RB 1 MHz;VB 3 MHz;Peak
1150.030	44.9	V	54.0	-9.1	AVG	146	2.0	RB 1 MHz;VB 10 Hz;Peak
1150.180	47.0	V	74.0	-27.0	PK	146	2.0	RB 1 MHz;VB 3 MHz;Peak
1050.000	44.0	V	54.0	-10.0	AVG	343	1.4	RB 1 MHz;VB 10 Hz;Peak
1050.030	46.4	V	74.0	-27.6	PK	343	1.4	RB 1 MHz;VB 3 MHz;Peak

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

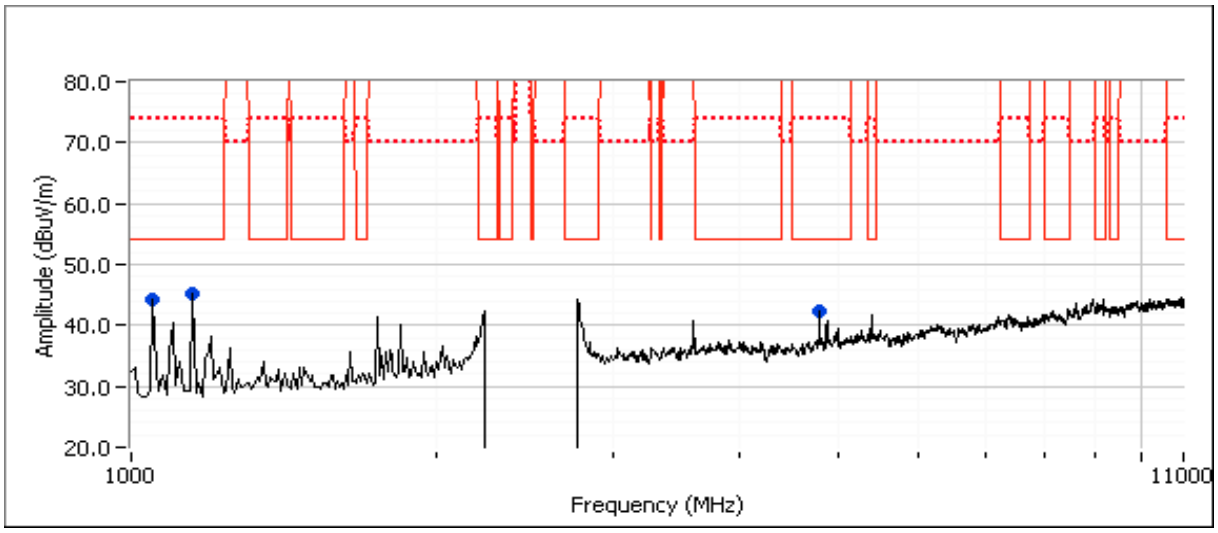
Run #2: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: OFDM

Date of Test: 7/8, 7/14/2016 Config. Used: 2
Test Engineer: Kevin Wen, Yew-Kwong Soo Config Change: None
Test Location: Fremont Chamber #5, #4 EUT Voltage: 120V/60Hz

Run #2a: Center Channel

Channel: 6 Mode: g
Tx Chain: Both Data Rate: 6 MB/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*44.1*	*V*	*54.0*	*-9.9*	*Peak*	*107*	*1.0*	
1150.000	*45.2*	*V*	*54.0*	*-8.8*	*Peak*	*129*	*1.5*	
4800.000	*42.3*	*V*	*54.0*	*-11.7*	*Peak*	*60*	*1.5*	



Maximized Readings

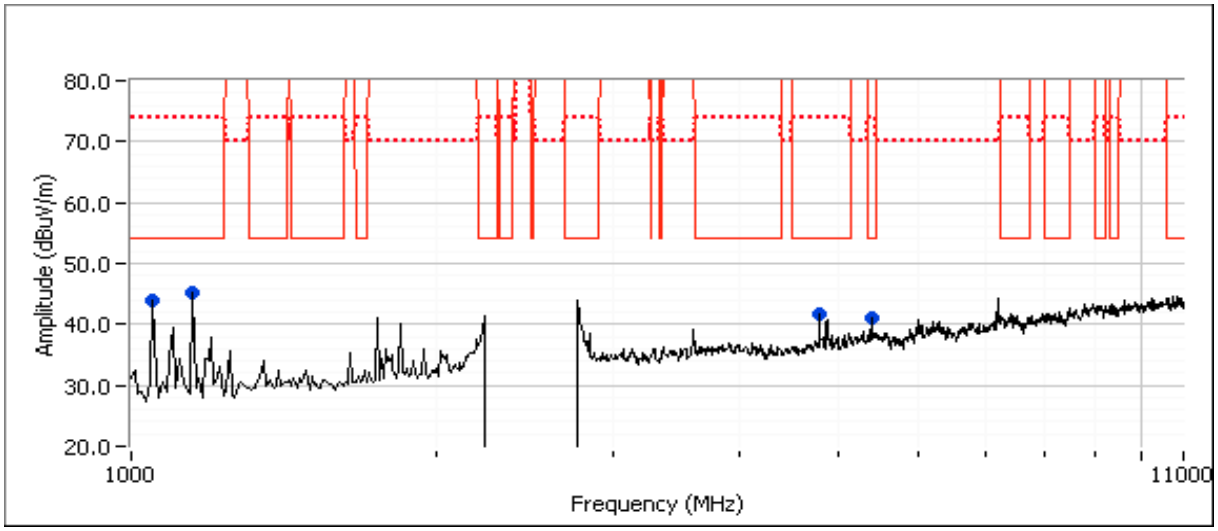
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.020	45.5	V	54.0	-8.5	Avg	128	1.5	RB 1 MHz;VB 1 kHz;Peak
1149.970	47.4	V	74.0	-26.6	PK	128	1.5	RB 1 MHz;VB 3 MHz;Peak
1050.000	43.0	V	54.0	-11.0	Avg	146	1.0	RB 1 MHz;VB 1 kHz;Peak
1049.960	45.7	V	74.0	-28.3	PK	146	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.280	41.1	V	54.0	-12.9	Avg	60	1.7	RB 1 MHz;VB 1 kHz;Peak
4795.230	47.0	V	74.0	-27.0	PK	60	1.7	RB 1 MHz;VB 3 MHz;Peak

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run #2b: Center Channel

Channel: 6 Mode: n20
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*43.8*	*V*	*54.0*	*-10.2*	*Peak*	*297*	*1.0*	
1150.000	*45.1*	*V*	*54.0*	*-8.9*	*Peak*	*127*	*1.5*	
4800.000	*41.6*	*V*	*54.0*	*-12.4*	*Peak*	*61*	*1.5*	
5408.330	*41.2*	*H*	*54.0*	*-12.8*	*Peak*	*63*	*1.0*	



Maximized Readings

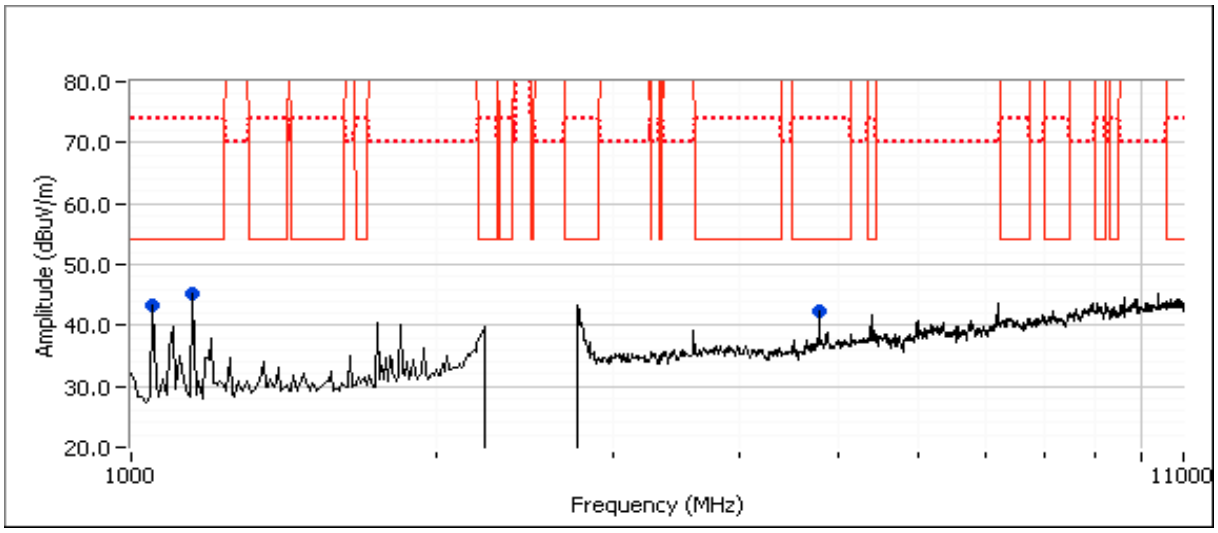
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.000	45.6	V	54.0	-8.4	Avg	128	1.5	RB 1 MHz;VB 3 kHz;Peak
1150.040	47.5	V	74.0	-26.5	PK	128	1.5	RB 1 MHz;VB 3 MHz;Peak
4795.250	41.0	V	54.0	-13.0	Avg	62	1.5	RB 1 MHz;VB 3 kHz;Peak
4795.480	47.2	V	74.0	-26.8	PK	62	1.5	RB 1 MHz;VB 3 MHz;Peak
5399.980	41.4	H	54.0	-12.6	Avg	64	1.3	RB 1 MHz;VB 3 kHz;Peak
5399.960	47.8	H	74.0	-26.2	PK	64	1.3	RB 1 MHz;VB 3 MHz;Peak
1050.030	43.9	V	54.0	-10.1	Avg	290	1.4	RB 1 MHz;VB 3 kHz;Peak
1050.040	46.1	V	74.0	-27.9	PK	290	1.4	RB 1 MHz;VB 3 MHz;Peak

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run #2d: Center Channel

Channel: 6 Mode: n40
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*43.3*	*V*	*54.0*	*-10.7*	*Peak*	*287*	*1.0*	
1150.000	*45.2*	*V*	*54.0*	*-8.8*	*Peak*	*130*	*1.5*	
4800.000	*42.3*	*V*	*54.0*	*-11.7*	*Peak*	*63*	*1.5*	



Maximized Readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.060	44.4	V	54.0	-9.6	Avg	131	1.5	RB 1 MHz;VB 3 kHz;Peak
1150.170	46.4	V	74.0	-27.6	PK	131	1.5	RB 1 MHz;VB 3 MHz;Peak
1050.070	43.3	V	54.0	-10.7	Avg	290	1.0	RB 1 MHz;VB 3 kHz;Peak
1049.850	45.8	V	74.0	-28.2	PK	290	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.210	40.8	V	54.0	-13.2	Avg	63	1.5	RB 1 MHz;VB 3 kHz;Peak
4795.270	47.2	V	74.0	-26.8	PK	63	1.5	RB 1 MHz;VB 3 MHz;Peak

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

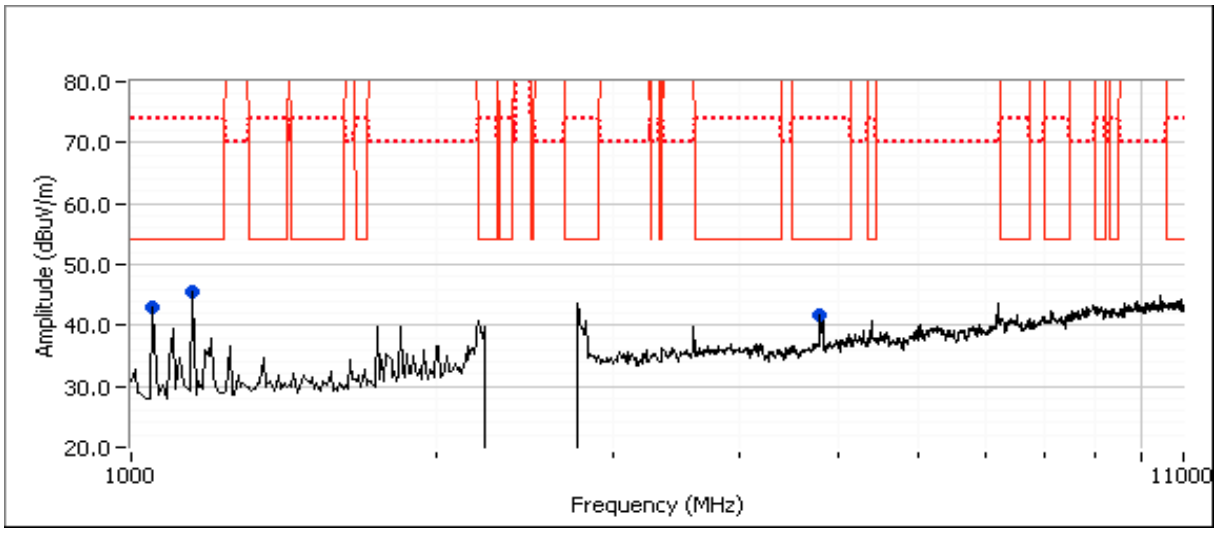
Run #3: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: Worse case from Run #2

Date of Test: 7/11, 7/14/2016 Config. Used: 2
Test Engineer: Kevin Wen, Yew-Kwong Soo Config Change: None
Test Location: Fremont Chamber #5, #4 EUT Voltage: 120V/60Hz

Run #3a: Low Channel

Channel: 1 Mode: n20
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*43.1*	*V*	*54.0*	*-10.9*	*Peak*	*109*	*1.0*	
1150.000	*45.4*	*V*	*54.0*	*-8.6*	*Peak*	*132*	*1.5*	
4800.000	*41.8*	*V*	*54.0*	*-12.2*	*Peak*	*57*	*2.0*	



Maximized Readings

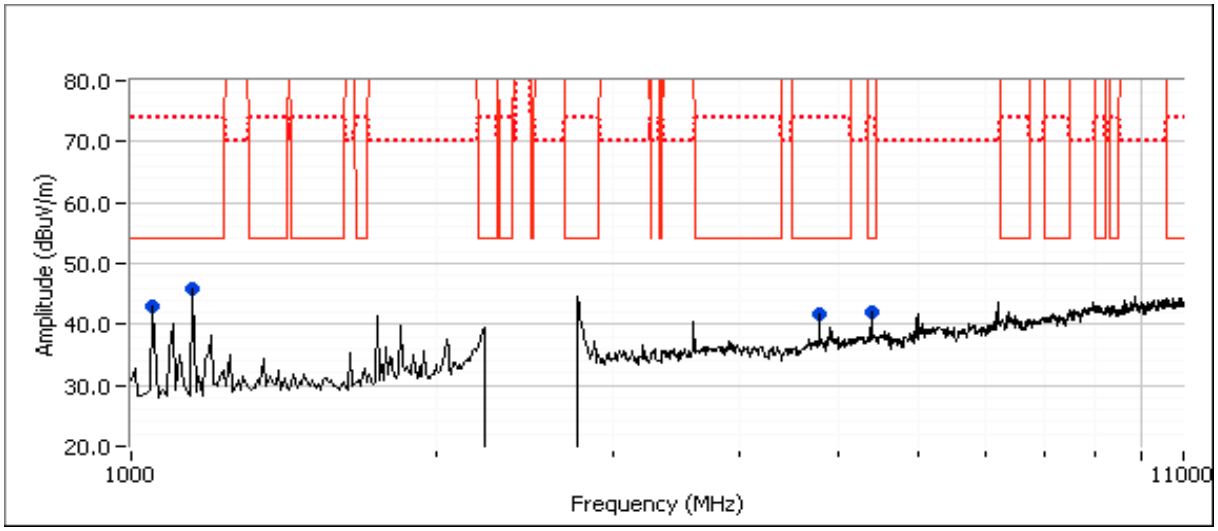
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1149.990	45.6	V	54.0	-8.4	Avg	130	1.6	RB 1 MHz;VB 3 kHz;Peak
1149.960	47.3	V	74.0	-26.7	PK	130	1.6	RB 1 MHz;VB 3 MHz;Peak
4795.210	41.5	V	54.0	-12.5	Avg	55	1.5	RB 1 MHz;VB 3 kHz;Peak
4795.210	47.1	V	74.0	-26.9	PK	55	1.5	RB 1 MHz;VB 3 MHz;Peak
1049.990	43.2	V	54.0	-10.8	Avg	144	1.0	RB 1 MHz;VB 3 kHz;Peak
1050.010	45.6	V	74.0	-28.4	PK	144	1.0	RB 1 MHz;VB 3 MHz;Peak

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run #3b: High Channel

Channel: 11 Mode: n20
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	*43.1*	*V*	*54.0*	*-10.9*	*Peak*	*157*	*1.0*	
1150.000	*45.7*	*V*	*54.0*	*-8.3*	*Peak*	*127*	*1.5*	
4800.000	*41.8*	*V*	*54.0*	*-12.2*	*Peak*	*68*	*1.5*	
5408.330	*42.0*	*H*	*54.0*	*-12.0*	*Peak*	*65*	*1.0*	



Maximized Readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.020	45.5	V	54.0	-8.5	Avg	129	1.6	RB 1 MHz;VB 3 kHz;Peak
1150.040	47.2	V	74.0	-26.8	PK	129	1.6	RB 1 MHz;VB 3 MHz;Peak
5400.130	41.3	H	54.0	-12.7	Avg	64	1.2	RB 1 MHz;VB 3 kHz;Peak
5400.090	47.6	H	74.0	-26.4	PK	64	1.2	RB 1 MHz;VB 3 MHz;Peak
4795.230	41.2	V	54.0	-12.8	Avg	62	1.5	RB 1 MHz;VB 3 kHz;Peak
4795.090	47.0	V	74.0	-27.0	PK	62	1.5	RB 1 MHz;VB 3 MHz;Peak
1049.990	43.4	V	54.0	-10.6	Avg	142	1.0	RB 1 MHz;VB 3 kHz;Peak
1049.990	45.6	V	74.0	-28.4	PK	142	1.0	RB 1 MHz;VB 3 MHz;Peak

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 22-25 °C
Rel. Humidity: 30-40 %

Summary of Results

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
1	b	6 - 2437MHz	1	1	Radiated Emissions, 30 - 1,000 MHz	FCC Part 15.209 / 15.247(c)	33.5 dBµV/m @ 74.73 MHz (-6.5 dB)
2	n20	100 - 5500MHz	1	1	Radiated Emissions, 30 - 1,000 MHz	FCC Part 15.209 / 15.247(c)	30.9 dBµV/m @ 74.24 MHz (-9.1 dB)

If no difference between modes and channels, then no additional modes or channels need be tested.

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: 8FA0001901E2766
Driver: 01-EA4417DA firmware and wl 1.201 RC70.0 scripts
Antenna: Internal 2x2 Non-Beamforming

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Procedure Comments:

Measurements performed in accordance with ANSI C63.10

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 3:	Run #1 and Run #2 measurements did not show difference. Therefore additioanl measurments for different modes and bands are not nexcessary.

Run #1: Radiated Spurious Emissions, 30 - 1,000 MHz

Date of Test: 7/15/16 Config. Used: 2

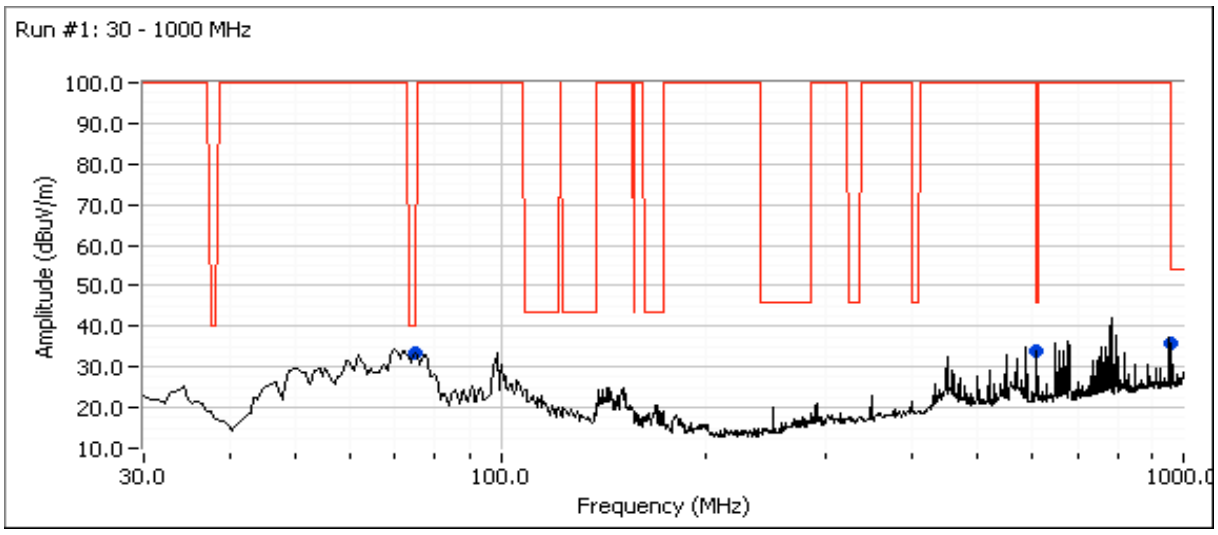
Test Engineer: Kevin Wen Config Change: None

Test Location: Fremont Chamber #5 EUT Voltage: 120V/60Hz

Channel: 6 Mode: b

Tx Chain: All Data Rate:

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
74.725	33.5	V	40.0	-6.5	Peak	188	1.0	
609.445	33.7	V	46.0	-12.3	Peak	331	1.0	
960.017	35.9	H	54.0	-18.1	Peak	197	1.5	

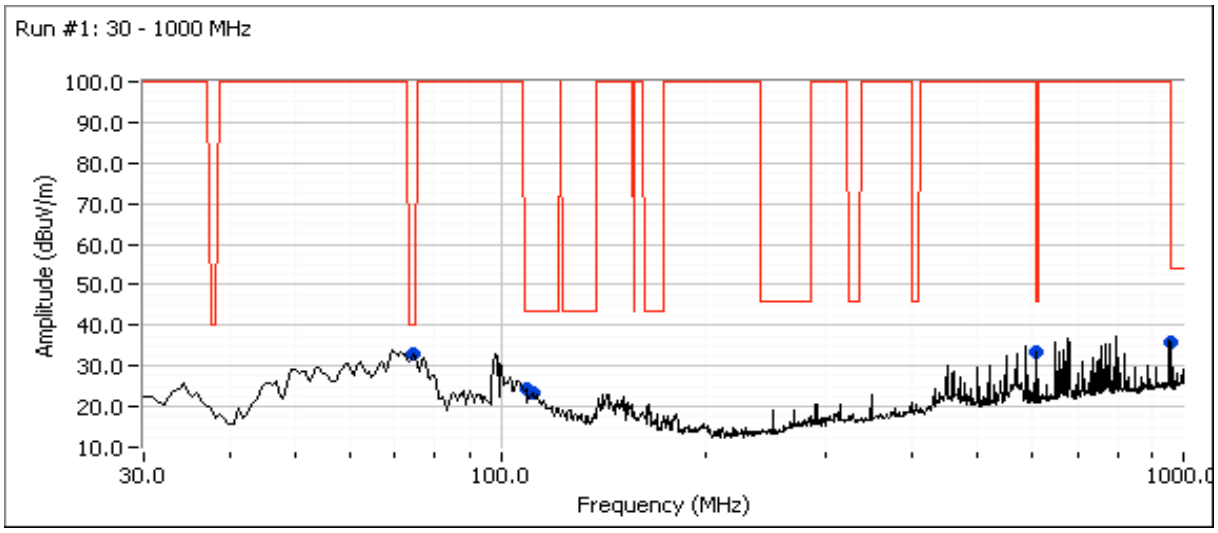


Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run 2: Radiated Spurious Emissions, 30 - 1,000 MHz

Channel: 100 Mode: n20
Tx Chain: All Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
74.115	32.8	V	40.0	-7.2	Peak	132	1.0	
108.998	*24.2*	*V*	*43.5*	*-19.3*	*Peak*	*263*	*1.0*	
111.703	*23.5*	*V*	*43.5*	*-20.0*	*Peak*	*344*	*1.0*	
609.442	33.6	V	46.0	-12.4	Peak	297	1.0	
960.017	35.9	H	54.0	-18.1	Peak	183	1.5	



Maximized Readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
74.236	30.9	V	40.0	-9.1	QP	150	1.0	POS; RB 100 kHz; VB: 300 kHz
609.435	33.4	V	46.0	-12.6	QP	309	1.0	POS; RB 100 kHz; VB: 300 kHz
960.003	35.4	H	54.0	-18.6	QP	175	1.5	POS; RB 100 kHz; VB: 300 kHz

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Conducted Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 7/22/2016
Test Engineer: Yew-Kwong Soo
Test Location: Fremont Chamber #5
Config. Used: 2
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT and power source were located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN. A second LISN was used for all local support equipment. Remote support equipment was located outside of the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:

Temperature: 22-25 °C
Rel. Humidity: 35-40 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	FCC 15.207	Pass	64.1 dBµV @ 0.150 MHz (-1.9 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

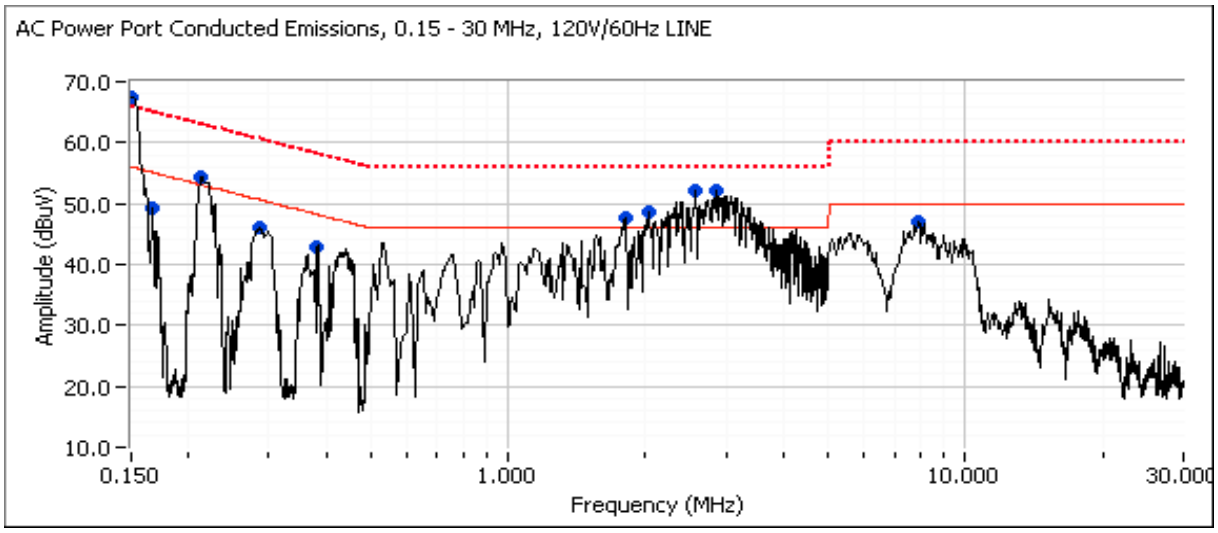
No deviations were made from the requirements of the standard.

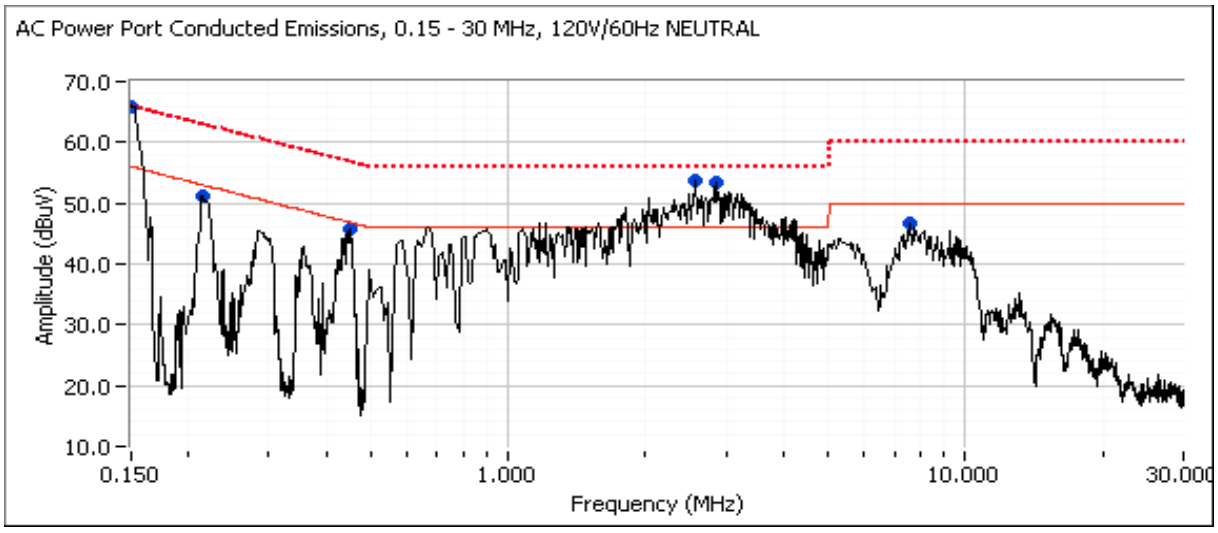
Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz

Mode: 802.11n 20MHz (VHT0x2) Power Index: 1

Channel: 40 (5200 MHz)





Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	AC	FCC 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.151	*67.5*	*Line 1*	*56.0*	*11.5*	*Peak*	
0.214	*54.3*	*Line 1*	*53.1*	*1.2*	*Peak*	
0.167	*49.1*	*Line 1*	*55.1*	*-6.0*	*Peak*	
0.286	*46.0*	*Line 1*	*50.6*	*-4.6*	*Peak*	
0.383	*43.0*	*Line 1*	*48.2*	*-5.2*	*Peak*	
1.808	*47.7*	*Line 1*	*46.0*	*1.7*	*Peak*	
2.024	*48.6*	*Line 1*	*46.0*	*2.6*	*Peak*	
2.565	*52.0*	*Line 1*	*46.0*	*6.0*	*Peak*	
2.845	*52.2*	*Line 1*	*46.0*	*6.2*	*Peak*	
7.856	*47.0*	*Line 1*	*50.0*	*-3.0*	*Peak*	
0.151	*66.0*	*Neutral*	*56.0*	*10.0*	*Peak*	
0.215	*51.1*	*Neutral*	*53.0*	*-1.9*	*Peak*	
0.451	*45.7*	*Neutral*	*46.9*	*-1.2*	*Peak*	
2.556	*53.8*	*Neutral*	*46.0*	*7.8*	*Peak*	
2.863	*53.5*	*Neutral*	*46.0*	*7.5*	*Peak*	
7.605	*46.7*	*Neutral*	*50.0*	*-3.3*	*Peak*	

Client:	Tivo, Inc.	Job Number:	JD101876
Model:	Mantis	T-Log Number:	T102023
		Project Manager:	Irene Radamacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15	Class:	B

Final quasi-peak and average readings

Frequency	Level	AC	FCC 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.150	64.1	Line 1	66.0	-1.9	QP	QP (1.00s)
0.150	51.2	Line 1	56.0	-4.8	AVG	AVG (0.10s)
0.213	42.4	Line 1	53.1	-10.7	AVG	AVG (0.10s)
0.213	53.6	Line 1	63.1	-9.5	QP	QP (1.00s)
0.166	22.1	Line 1	55.2	-33.1	AVG	AVG (0.10s)
0.166	41.0	Line 1	65.2	-24.2	QP	QP (1.00s)
0.285	26.9	Line 1	50.7	-23.8	AVG	AVG (0.10s)
0.285	42.2	Line 1	60.7	-18.5	QP	QP (1.00s)
0.382	21.1	Line 1	48.2	-27.1	AVG	AVG (0.10s)
0.382	38.6	Line 1	58.2	-19.6	QP	QP (1.00s)
1.806	26.9	Line 1	46.0	-19.1	AVG	AVG (0.10s)
1.806	44.0	Line 1	56.0	-12.0	QP	QP (1.00s)
2.030	27.1	Line 1	46.0	-18.9	AVG	AVG (0.10s)
2.030	43.7	Line 1	56.0	-12.3	QP	QP (1.00s)
2.552	29.2	Line 1	46.0	-16.8	AVG	AVG (0.10s)
2.552	46.6	Line 1	56.0	-9.4	QP	QP (1.00s)
2.844	30.5	Line 1	46.0	-15.5	AVG	AVG (0.10s)
2.844	47.9	Line 1	56.0	-8.1	QP	QP (1.00s)
7.833	27.8	Line 1	50.0	-22.2	AVG	AVG (0.10s)
7.833	40.5	Line 1	60.0	-19.5	QP	QP (1.00s)
0.150	51.5	Neutral	56.0	-4.5	AVG	AVG (0.10s)
0.150	63.8	Neutral	66.0	-2.2	QP	QP (1.00s)
0.214	41.1	Neutral	53.0	-11.9	AVG	AVG (0.10s)
0.214	52.1	Neutral	63.0	-10.9	QP	QP (1.00s)
0.451	31.3	Neutral	46.9	-15.6	AVG	AVG (0.10s)
0.451	43.2	Neutral	56.9	-13.7	QP	QP (1.00s)
2.570	31.3	Neutral	46.0	-14.7	AVG	AVG (0.10s)
2.570	47.9	Neutral	56.0	-8.1	QP	QP (1.00s)
2.846	31.8	Neutral	46.0	-14.2	AVG	AVG (0.10s)
2.846	48.2	Neutral	56.0	-7.8	QP	QP (1.00s)
7.541	27.8	Neutral	50.0	-22.2	AVG	AVG (0.10s)
7.541	39.9	Neutral	60.0	-20.1	QP	QP (1.00s)

End of Report

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