

EMC Test Report

Application for FCC Grant of Equipment Authorization

FCC Part 15, Subpart E

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

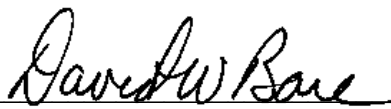
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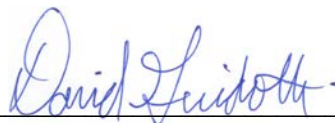
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PROGRAM MGR /
TECHNICAL REVIEWER:

QUALITY ASSURANCE DELEGATE /
FINAL REPORT PREPARER:



David W. Bare
Chief Engineer



David Guidotti
Senior Technical Writer



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REVISION HISTORY

Rev#	Date	Comments	Modified By
-	August 10, 2016	First release	
1	August 25, 2016	Corrected page 8, Modified directional gain calculations, removed note for 11a power and psd data, changed powers related to duty cycle corrections, removed 11a dual chain data for UNII-2A band	dwb
2	September 1, 2016	Corrected power and psd values on page 6	dwb
3	September 6, 2016	Corrected additional power and psd values shown on pages 6 and 7	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 E requirements for UNII Devices

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 General UNII Test Procedures KDB789033

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 E requirements for UNII Devices

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

UNII DEVICES

OPERATION IN THE 5.15 – 5.25 GHZ BAND – MOBILE AND PORTABLE CLIENT DEVICE

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result
15.407 (a) (1) (iv)		Output Power	802.11a: 18.7 dBm n20: 21.0 dBm n40: 20.8 dBm ac80: 14.6 dBm (Max eirp: 0.863 W)	24 dBm (250 mW)	Complies
15.407 (a) (1) (iv)		Power Spectral Density	802.11a: 7.5 dBm/MHz n20: 8.6 dBm/MHz n40: 6.3 dBm/MHz ac80: -2.2 dBm/MHz	11 dBm/MHz	Complies
15.407(b) (1) / 15.209		Spurious Emissions above 1GHz	53.8 dBμV/m @ 5149.6 MHz (-0.2 dB)	Refer to the limits section (p21) for restricted bands, all others -27 dBm/MHz EIRP	Complies

OPERATION IN THE 5.25 – 5.35 GHZ BAND

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.407(a) (2)		26dB Bandwidth	> 20MHz for all modes	N/A – limits output power if < 20MHz	N/A
		99% Bandwidth		N/A – limits EIRP if < 20MHz	N/A
15.407(a) (2)		Output Power	a: 17.3 dBm n20: 19.2 dBm n40: 19.6 dBm ac80: 13.0 dBm (Max eirp: 0.551 W)	24 dBm (250 mW) EIRP <= 1W	Complies
15.407(a) (2)		Power Spectral Density	a: 6.8 dBm/MHz n20: 8.0 dBm/MHz n40: 5.6 dBm/MHz ac80: -4.0 dBm/MHz	11 dBm/MHz	Complies
15.407(b) (2) / 15.209		Spurious Emissions above 1GHz	53.8 dBμV/m @ 5350.0 MHz (-0.2 dB)	Refer to the limits section (p21) for restricted bands, all others -27 dBm/MHz EIRP	Complies

OPERATION IN THE 5.47 – 5.725 GHZ BAND

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.407(a) (2)		26dB Bandwidth	> 20MHz for all modes	N/A – limits output power if < 20MHz	N/A
15.407(a) (2)		Output Power	a: 14.9 dBm n20: 19.4 dBm n40: 19.3 dBm ac80: 20.6 dBm (Max eirp: 0.856 W)	24 dBm (250 mW) EIRP <= 1W	Complies
15.407(a) (2)		Power Spectral Density	a: 4.3 dBm/MHz n20: 7.8 dBm/MHz n40: 4.9 dBm/MHz ac80: 5.7 dBm/MHz	11 dBm/MHz	Complies
15.407(b) (3) / 15.209		Spurious Emissions above 1GHz	53.6 dBμV/m @ 5458.2 MHz (-0.4 dB)	Refer to the limits section (p21) for restricted bands, all others -27 dBm/MHz EIRP	Complies

OPERATION IN THE 5.725 – 5.85 GHZ BAND

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.407(e)	RSS-247 6.2.4 (1)	6dB Bandwidth	All greater than 500 kHz	<= 500 kHz	Complies
15.407(a) (3)	RSS-210 A9.2(2)	Output Power (multipoint systems)	a: 16.5 dBm n20: 20.3 dBm n40: 20.1 dBm ac80: 21.1 dBm (Max eirp: 0.984 W)	30 dBm (1 W) EIRP <= 4W	Complies
15.407(a) (3)	RSS-247 6.2.3 (1)	Power Spectral Density	a: 5.2 dBmW/MHz n20: 9.1 dBm/MHz n40: 5.7 dBm/MHz ac80: 5.2 dBm/MHz	30 dBm / 500 kHz	Complies
15.407(b) (4) / 15.209	RSS-247 6.2.4 (2)	Spurious Emissions above 1GHz	67.6 dBμV/m @ 5649.6 MHz (-0.7 dB)	Refer to the limits section (p21) for restricted bands, all others -17 dBm/MHz EIRP bandedge and -27 dBm/MHz EIRP	Complies

REQUIREMENTS FOR ALL U-NII/LELAN BANDS

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result
15.407		Modulation	Digital Modulation is used (OFDM)	Digital modulation is required	Complies
15.407(b) (6) / 15.209		Spurious Emissions below 1GHz	30.9 dBμV/m @ 74.24 MHz (-9.1 dB)	Refer to page 22	Complies
15.31 (m)		Channel Selection	Emissions tested at outermost and middle channels in each band	Device was tested on the top, bottom and center channels in each band	N/A
15.407 (c)		Operation in the absence of information to transmit	Operation is discontinued in the absence of information (Operational Description page 13)	Device shall automatically discontinue operation in the absence of information to transmit	Complies
15.407 (g)		Frequency Stability	Frequency stability is better than 30 ppm.	Signal shall remain within the allocated band	Complies
15.407 (h1)		Transmit Power Control	TPC mechanism is discussed in the Operational Description page 12	The U-NII device shall have the capability to operate with a mean EIRP value lower than 24dBm (250mW)	Complies
15.407 (h2)		Dynamic frequency Selection (device without radar detection)	Refer to separate test report, reference R102438	Channel move time < 10s Channel closing transmission time < 260ms	Complies

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203		RF Connector	Integral Antenna	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 20	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 and RSS 102	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
Radiated emission (field strength)	dB μ V/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dB μ V	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 5 GHz bands, it uses 20, 40 and 80 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, 6, 11, 12, 13, 14, 15, 19, 20, 21 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.

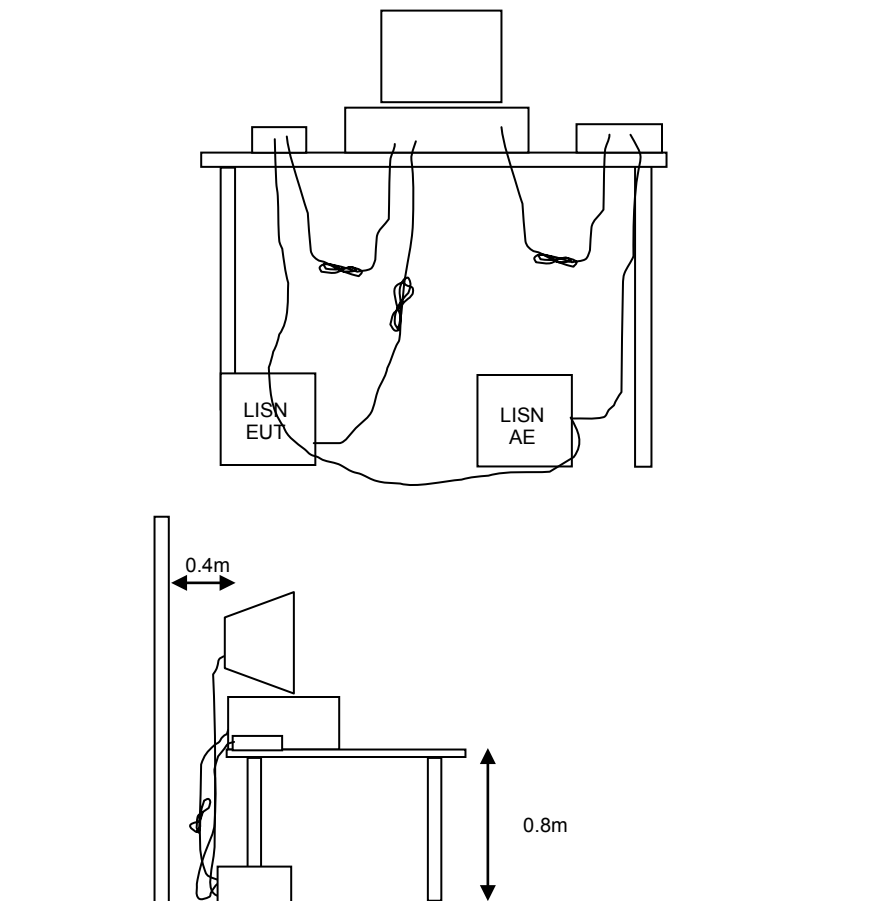


Figure 1 Typical Conducted Emissions Test Configuration

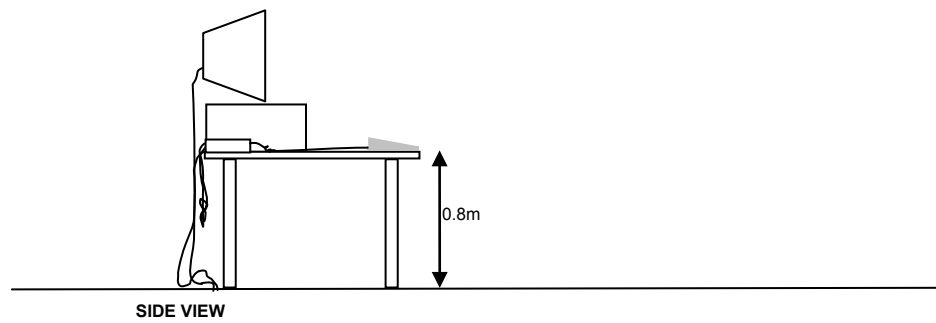
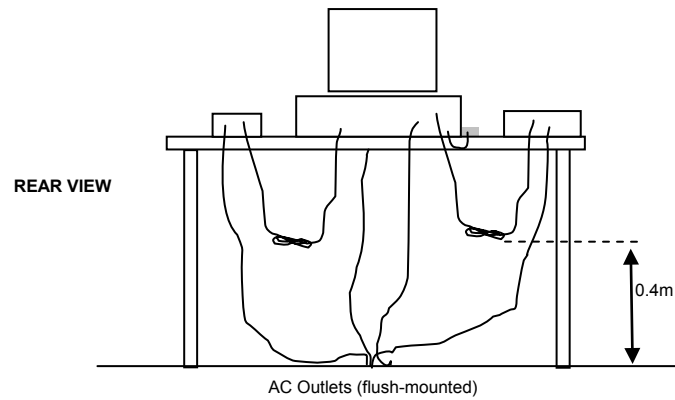
RADIATED EMISSIONS

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.

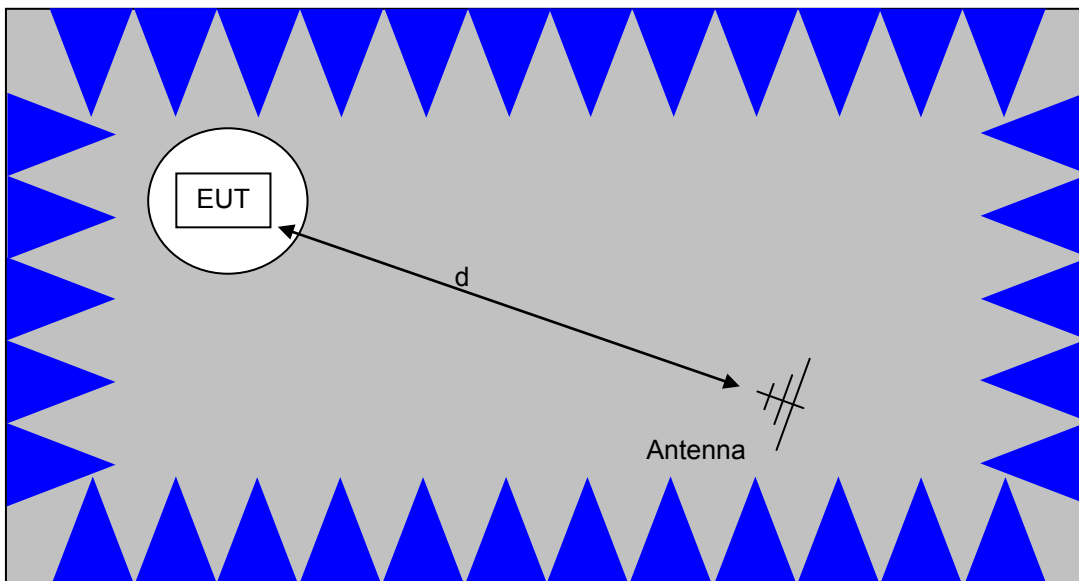
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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.

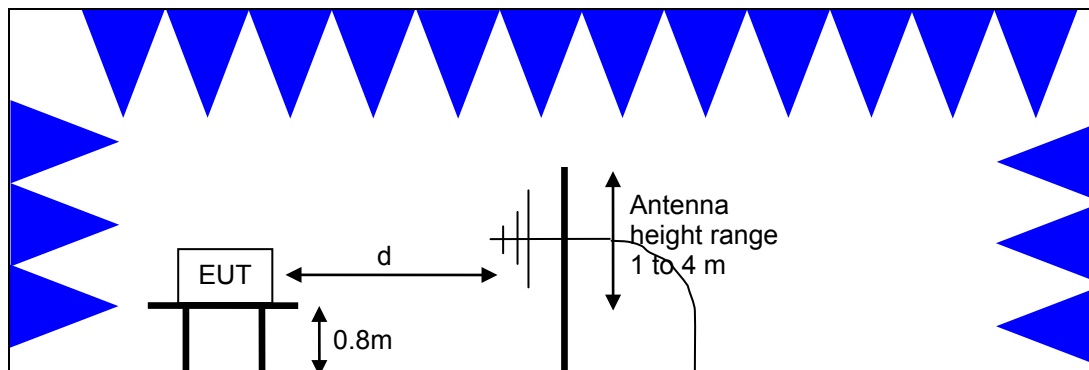


Typical Test Configuration for Radiated Field Strength Measurements



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.

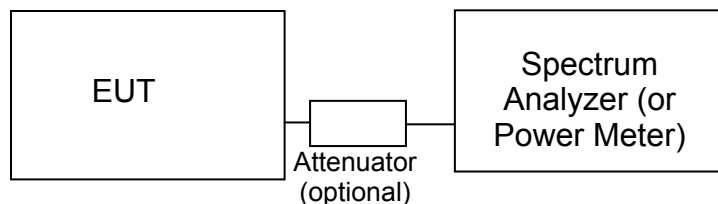
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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 bands¹.

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

FCC 15.407 (a) OUTPUT POWER LIMITS

The table below shows the limits for output power and output power density. For the 5250-5350 and 5470-5725 MHz bands, 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
5150 – 5250	1Watt (30 dBm)	17 dBm/MHz
5250 – 5350 and 5470-5725	250 mW (24 dBm)	11 dBm/MHz
5725 – 5825	1 Watt (30 dBm)	30 dBm/500kHz

For system using antennas with gains exceeding 6dBi, the output power and power spectral density limits are reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5825 MHz band may use antennas with gains of up to 23dBi without this limitation. If the gain exceeds 23dBi then the output power limit of 1 Watt is reduced by 1dB for every dB the gain exceeds 23dBi.

OUTPUT POWER LIMITS –LELAN DEVICES

The table below shows the limits for output power and output power density defined by RSS 247. 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
5150 – 5250	200mW (23 dBm) eirp	10 dBm/MHz eirp
5250 – 5350 and 5470 - 5725	250 mW (24 dBm) ² 1W (30dBm) eirp	11 dBm/MHz
5725 – 5825	1 Watt (30 dBm) 4W eirp	30 dBm/500kHz

Fixed point-to-point applications using the 5725 – 5825 MHz band may use antennas with gains of up to 23dBi without this limitation. If the gain exceeds 23dBi then the output power limit of 1 Watt is reduced by 1dB for every dB the gain exceeds 23dBi.

SPURIOUS EMISSIONS LIMITS –UNII and LELAN DEVICES

The spurious emissions limits for signals below 1GHz are the FCC/RSS-Gen general limits. For emissions above 1GHz, signals in restricted bands are subject to the FCC/RSS-Gen general limits. All other signals have a limit of –27dBm/MHz, which is field strength of 68.3dBuV/m/MHz at a distance of 3m. For devices operating in the 5725-5850 MHz bands under the LELAN/UNII rules, the limit within 10MHz of the allocated band is increased to –17dBm/MHz.

² If EIRP exceeds 500mW the device must employ TPC

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

<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
UNII RE BE, 05, 06-Jul-16					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/19/2015	12/19/2016
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
UNII Radiated Emissions, 1 - 11 GHz, 12-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
UNII 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	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
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	1730	5/9/2016	5/9/2017
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	6/29/2016	6/29/2017
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2239	9/16/2015	9/16/2016
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	1728	5/11/2016	5/11/2017
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



<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
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
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
Radiated Emissions, 30 - 1,000 MHz, 15-Jul-16					
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/19/2015	12/19/2016
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1548	9/17/2014	9/17/2016
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	1681	5/11/2016	5/11/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	9/16/2015	9/16/2016
Com-Power	Preamplifier, 30-1000 MHz	PA-103	2465	9/1/2015	9/1/2016
UNII-1 Conducted Emissions - Antenna Ports (MIMO), 20-Jul-16					
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/24/2016	6/24/2017



<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
UNII Conducted Emissions - Antenna Ports, 19, 21-Jul-16					
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/24/2016	6/24/2017
Frequency Stability, 21-Jul-16					
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/24/2016	6/24/2017
Watlow	Temp Chamber (w/ F4 watlow Controller)	96A0	2171	7/8/2016	7/8/2017
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 29 - 152

Client:	Tivo, Inc.	Job Number:	JD101876
Product	Mantis	T-Log Number:	T102023
System Configuration:	-	Project Manager:	Irene Radmacher
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
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	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
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	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	
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	
	180	14.5	
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	

<<-11ac mode only

<<-11ac mode only

<<-11ac mode only

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
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	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 - $10 \cdot \log(1/x)$

** Correction factor when using linear voltage average - $20 \cdot \log(1/x)$

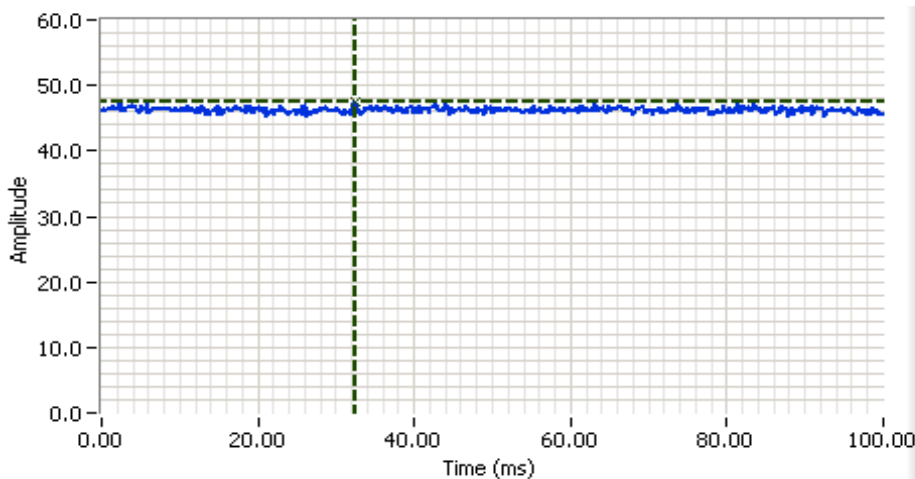
T = Minimum transmission duration

<< Insert duty cycle plots >>

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

Non-beamforming

b

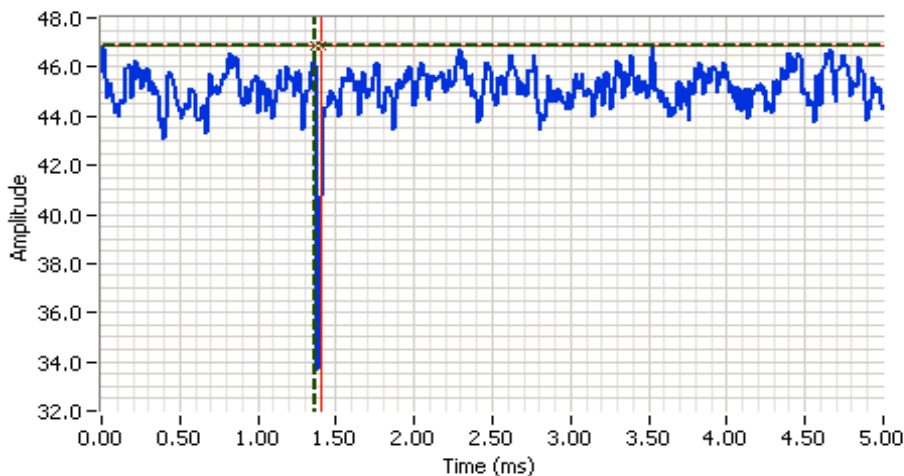
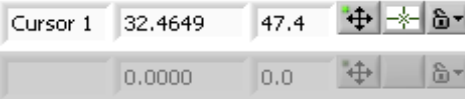


Analyzer Settings

Rohde&Schwarz, ESI
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 1.000 MHz
 VB: 10.0 kHz
 Detector: POS
 Attn: 0 DB
 RL Offset: 0.0 DB
 Sweep Time: 100.0ms
 Ref Lvl: 59.6 DBUV

Comments

802.11b mode

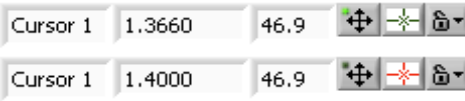


Analyzer Settings

Rohde&Schwarz, ESI
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 1.000 MHz
 VB: 10.0 kHz
 Detector: POS
 Attn: 0 DB
 RL Offset: 0.0 DB
 Sweep Time: 5.0ms
 Ref Lvl: 59.6 DBUV

Comments

802.11b mode, off time



Delta Time (ms) 0.034

Delta Amplitude 0.0



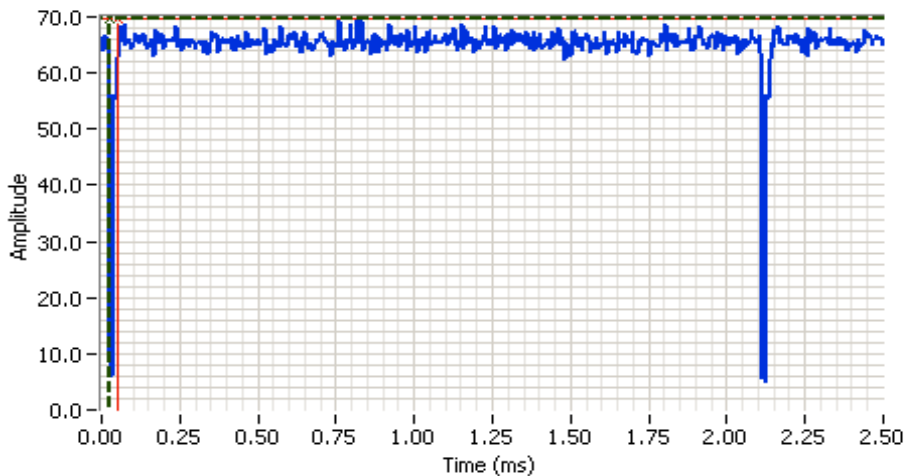
**NTS**

WE ENGINEER SUCCESS

EMC Test Data

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

g

**Analyzer Settings**

Rohde&Schwarz,ESI
CF: 2417.000 MHz
SPAN: 0.000 MHz
RB: 1.000 MHz
VB: 3.000 MHz
Detector: POS
Attn: 0 DB
RL Offset: 0.0 DB
Sweep Time: 2.5ms
Ref Lvl: 72.0 DBUV

Comments

Cursor 1 0.0258 69.7
Cursor 1 0.0515 69.7

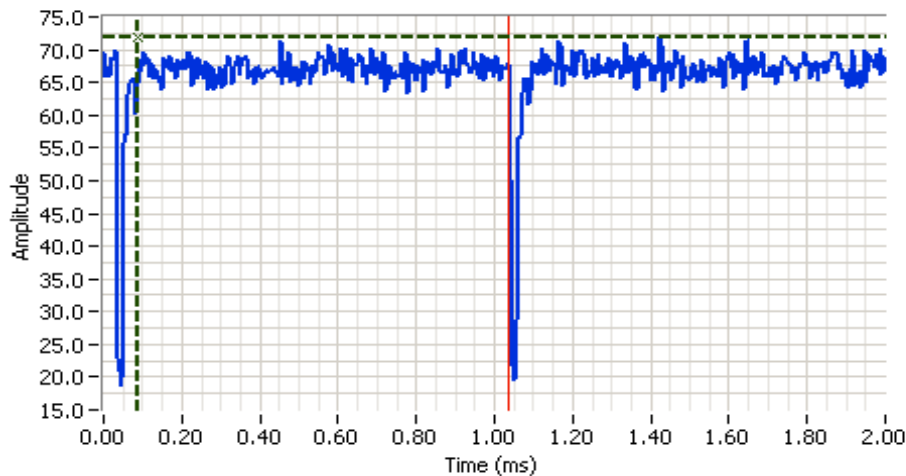
Delta Time (ms) 0.026
Delta Amplitude 0.0

**NTS**

WE ENGINEER SUCCESS

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

n20



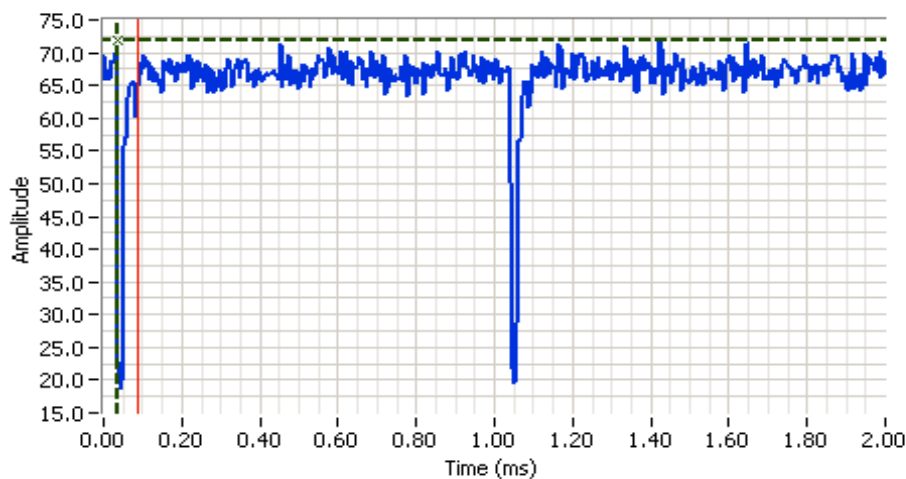
Analyzer Settings

Rohde&Schwarz, ESI
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 1.000 MHz
 VB: 3.000 MHz
 Detector: POS
 Attn: 0 DB
 RL Offset: 0.0 DB
 Sweep Time: 2.0ms
 Ref Lvl: 87.0 DBUV

Comments

802.11n20 mode

Cursor 1	0.0876	71.9		Delta Time (ms)	0.948
Cursor 1	1.0361	0.0		Delta Amplitude	71.9



Analyzer Settings

Rohde&Schwarz, ESI
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 1.000 MHz
 VB: 3.000 MHz
 Detector: POS
 Attn: 0 DB
 RL Offset: 0.0 DB
 Sweep Time: 2.0ms
 Ref Lvl: 87.0 DBUV

Comments

802.11n20 mode

Cursor 1	0.0361	71.9		Delta Time (ms)	0.052
Cursor 1	0.0876	0.0		Delta Amplitude	71.9



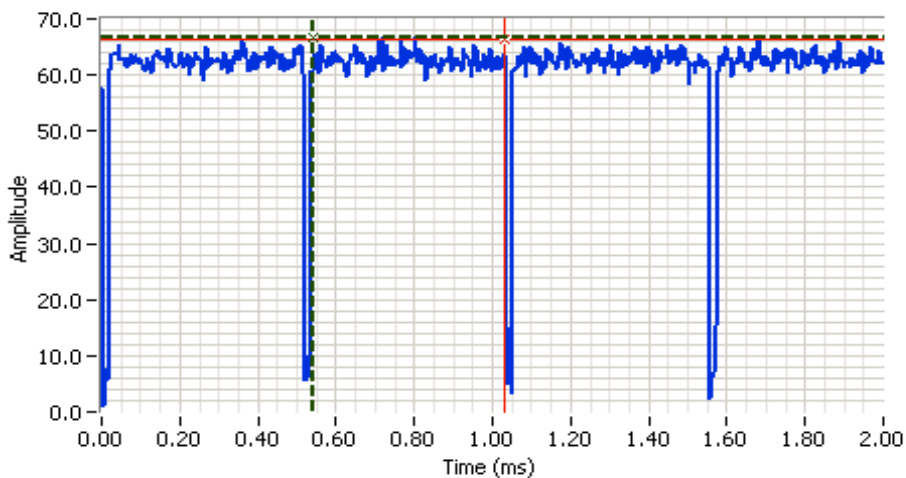
**NTS**

WE ENGINEER SUCCESS

EMC Test Data

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

n40

**Analyzer Settings**

Rohde&Schwarz,ESI
CF: 2425.000 MHz
SPAN: 0.000 MHz
RB: 1.000 MHz
VB: 3.000 MHz
Detector: POS
Attn: 0 DB
RL Offset: 0.0 DB
Sweep Time: 2.0ms
Ref Lvl: 67.0 DBUV

Comments

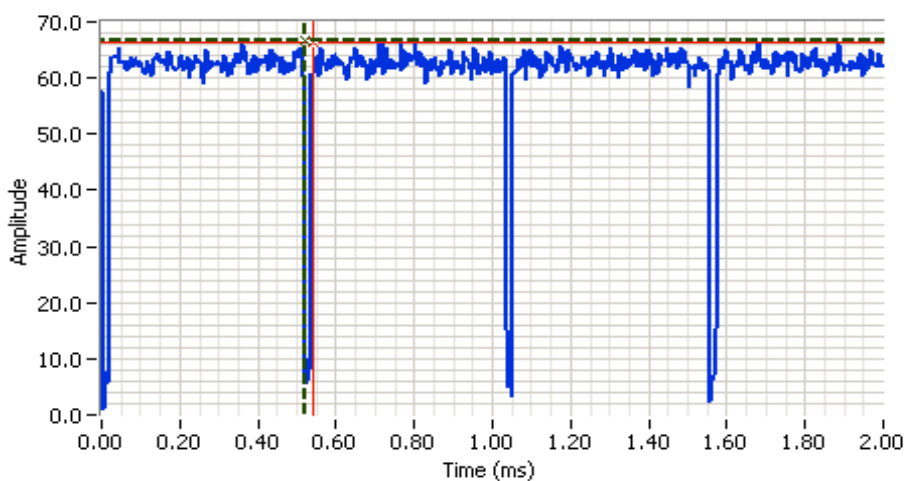
802.11n40 mode

Cursor 1 0.5412 66.5
Cursor 1 1.0309 66.5

Delta Time (ms) 0.490
Delta Amplitude 0.0

**NTS**

WE ENGINEER SUCCESS

**Analyzer Settings**

Rohde&Schwarz,ESI
CF: 2425.000 MHz
SPAN: 0.000 MHz
RB: 1.000 MHz
VB: 3.000 MHz
Detector: POS
Attn: 0 DB
RL Offset: 0.0 DB
Sweep Time: 2.0ms
Ref Lvl: 67.0 DBUV

Comments

802.11n40 mode

Cursor 1 0.5206 66.5
Cursor 1 0.5412 66.5

Delta Time (ms) 0.021
Delta Amplitude 0.0

**NTS**

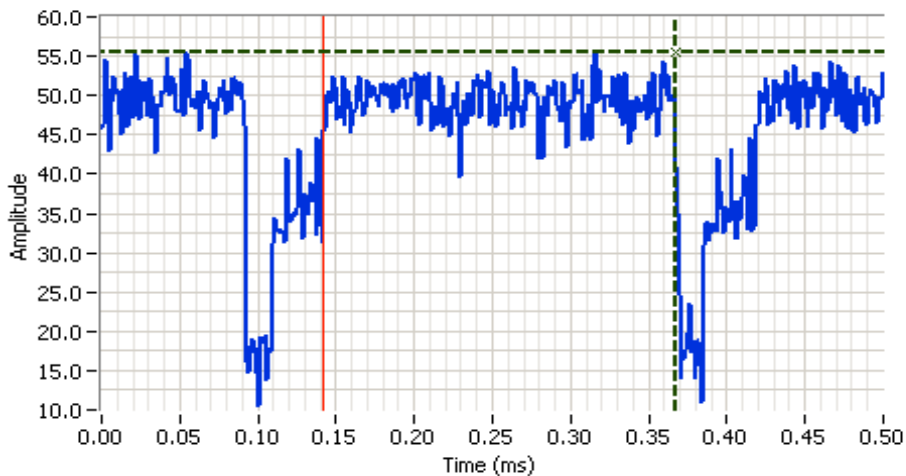
WE ENGINEER SUCCESS

**NTS**

WE ENGINEER SUCCESS

EMC Test Data

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

ac80**Analyzer Settings**

Rohde&Schwarz,ESI
CF: 5210.000 MHz
SPAN: 0.000 MHz
RB: 1.000 MHz
VB: 1.000 MHz
Detector: POS
Attn: 0 DB
RL Offset: 0.0 DB
Sweep Time: 0.5ms
Ref Lvl: 60.0 DBUV

Comments

ac80 mode, VHT0 x2
Duty Cycle = 82%

Cursor 1 0.3673 55.6

Cursor 1 0.1418 0.0

Delta Time (ms) 0.226

Delta Amplitude 55.6

**NTS**

WE ENGINEER SUCCESS

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

FCC 15.407(UNII) Antenna Port Measurements Power and PSD

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.

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Power, 5150 - 5250MHz	15.407(a) (1), (2), (3)	Pass	a: 74.1 mW n20: 124.8 mW n40: 121.5 mW ac80: 28.6 mW
1	PSD, 5150 - 5250MHz	15.407(a) (1), (2), (3)	Pass	a: 5.6 mW/MHz n20: 7.3 mW/MHz n40: 4.3 mW/MHz ac80: 0.6 mW/MHz

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators and cables used.

Ambient Conditions:

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

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
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 789033 D01

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11a	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	VHT0 x2	0.82	Yes	0.226	0.85	1.70	4425

Sample Notes

Sample S/N: 8FA0001901E2766

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

Run #1: Bandwidth, Output Power and Power Spectral Density - MIMO Systems

Date of Test: 7/19/2016, 7/20/2016

Config. Used: 3

Test Engineer: Kevin Wen, Yew-Kwong Soo

Config Change: -

Test Location: Fremont Lab 4B

EUT Voltage: 120V/60Hz

Note 1:	Duty Cycle $\geq 98\%$ for a, and n20 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, auto sweep, RMS detector, power averaging on (transmitted signal was continuous, duty cycle $\geq 98\%$) and power integration over the OBW (method SA-1 of ANSI C63.10).
Note 2:	Constant Duty Cycle < 98% for n40, and ac80 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, RMS detector, trace average 100 traces, power averaging on and power integration over the OBW. The measurements were adjusted by adding .18 dB for n40 and .85 dB for ac80. This is based on $10\log(1/x)$, where x is the duty cycle. (method SA-2 of ANSI C63.10)
Note 3:	Measured using the same analyzer settings used for output power.
Note 4:	For MIMO systems the total output power and total PSD are calculated from the sum of the powers of the individual chains (in linear terms). The antenna gain used to determine the EIRP and limits for PSD/Output power depends on the operating mode of the MIMO device. If the signals on the non-coherent between the transmit chains then the gain used to determine the limits is the highest gain of the individual chains and the EIRP is the sum of the products of gain and power on each chain. If the signals are coherent then the effective antenna gain is the sum (in linear terms) of the gains for each chain and the EIRP is the product of the effective gain and total power.

EMC Test Data

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

Antenna Gain Information

Freq	Antenna Gain (dBi) / Chain				BF	MultiChain Legacy	CDD	Sectorized / Xpol	Dir G (PWR)	Dir G (PSD)
	1	2	3	4						
5150-5250	5.6	5.2			No	No	Yes, n/ac modes only	No	8.4	8.4

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; GA (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.
Notes:	For systems with Beamforming and CDD, choose one the following options: Option 1: Delays are optimized for beamforming, rather than being selected from cyclic delay table of 802.11; Array gains calculated based on beamforming criteria. Option 2: Antennas are paired for beamforming, and the pairs are configured to use the cyclic delay diversity of 802.11; the array gain associated with beamforming with 2 antennas (3dB), and the array gain associated with CDD with two antennas (3dB for PSD and 0 dB for power)

FCC UNII-1 Limits		Pwr	PSD
	Outdoor AP	30	17
	Indoor AP	30	17
X	Station (e.g. Client)	24	11
	Outdoor AP (>30° Elv.)	21	-

EMC Test Data

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

MIMO Device - 5150-5250 MHz Band - FCC

Mode: 11a

Max EIRP (mW): 512.6

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power mW dBm		FCC Limit dBm	Max Power (W)	Result
5180	1	2		99	17.7	58.9	17.7	21.6	0.074	Pass
	3									
	4									
	2									
5200	1	1		99	18.3	67.6	18.3	21.6		Pass
	3									
	4									
	2									
5240	1	1		99	18.7	74.1	18.7	21.6	Pass	
	3									
	4									
	2									

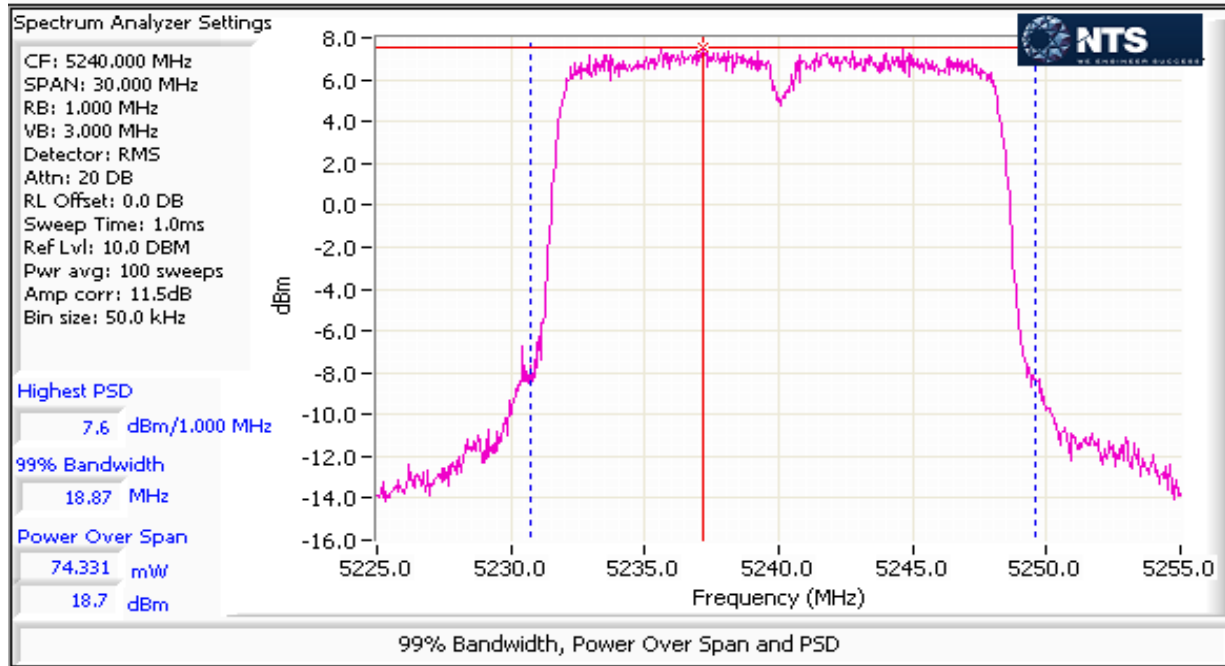
Note: Output power measured on chain with highest power. EUT uses one chain in 802.11a mode with diversity.

5150-5250 PSD - FCC

Mode: 11a

Frequency (MHz)	Chain	Software Setting	99% BW (MHz)	Duty Cycle %	PSD ³ dBm/MHz	Total PSD mW/MHz dBm/MHz		FCC Limit dBm/MHz	Result
5180	1	2		99	6.6	4.6	6.6	8.6	Pass
	3								
	4								
	2								
5200	1	1		99	6.9	4.9	6.9	8.6	Pass
	3								
	4								
	2								
5240	1	1		99	7.5	5.6	7.5	8.6	Pass
	3								
	4								
	2								

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



**NTS**

WE ENGINEER SUCCESS

EMC Test Data

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

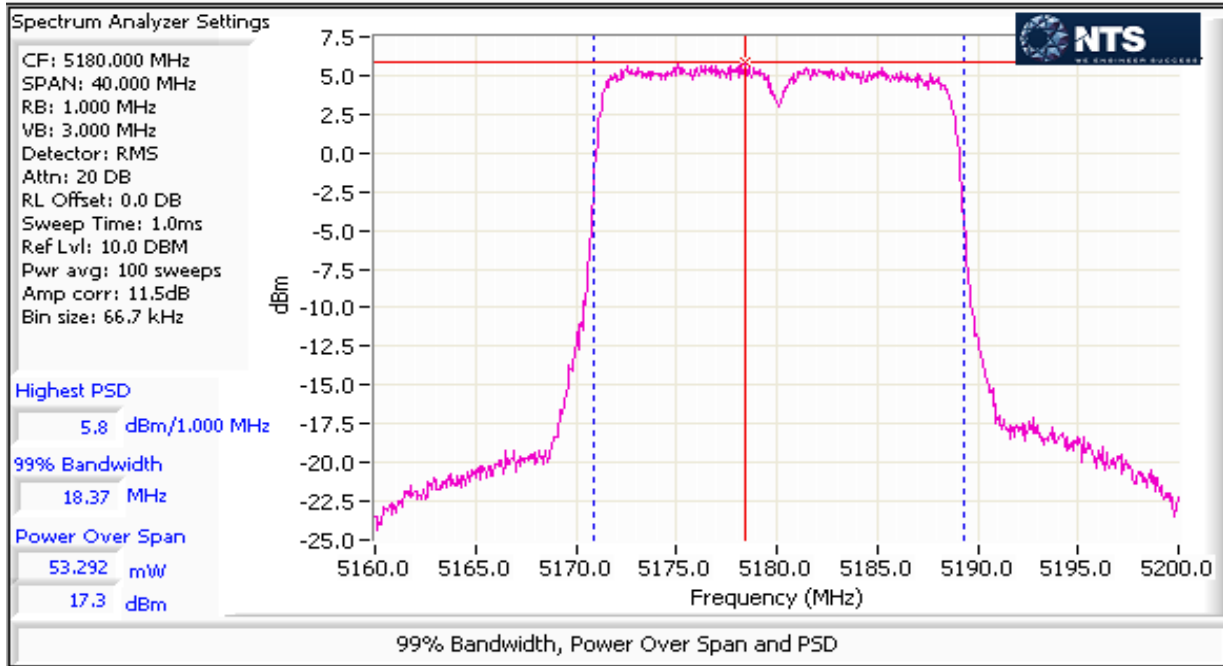
MIMO Device - 5150-5250 MHz Band - FCC**Mode:** n20**Max EIRP (mW):** 863.4

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power ⁴ mW dBm		FCC Limit dBm	Max Power (W)	Result
5180	1	5		99	16.8	101.6	20.1	21.6	0.125	Pass
	3									
	4									
	2				17.3					
5200	1	1		99	17.8	124.8	21.0	21.6		Pass
	3									
	4									
	2				18.1					
5240	1	1		99	17.7	122.0	20.9	21.6	Pass	
	3									
	4									
	2				18.0					

5150-5250 PSD - FCC**Mode:** n20

Frequency (MHz)	Chain	Software Setting	99% BW (MHz)	Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz dBm/MHz		FCC Limit dBm/MHz	Result
5180	1	5		99	5.4	7.2	8.6	8.6	Pass
	3								
	4								
	2								
5200	1	1		99	5.4	7.3	8.6	8.6	Pass
	3								
	4								
	2								
5240	1	1		99	5.4	7.1	8.5	8.6	Pass
	3								
	4								
	2								
					5.6				

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



MIMO Device - 5150-5250 MHz Band - FCC

Mode: n40

Max EIRP (mW): 840.6

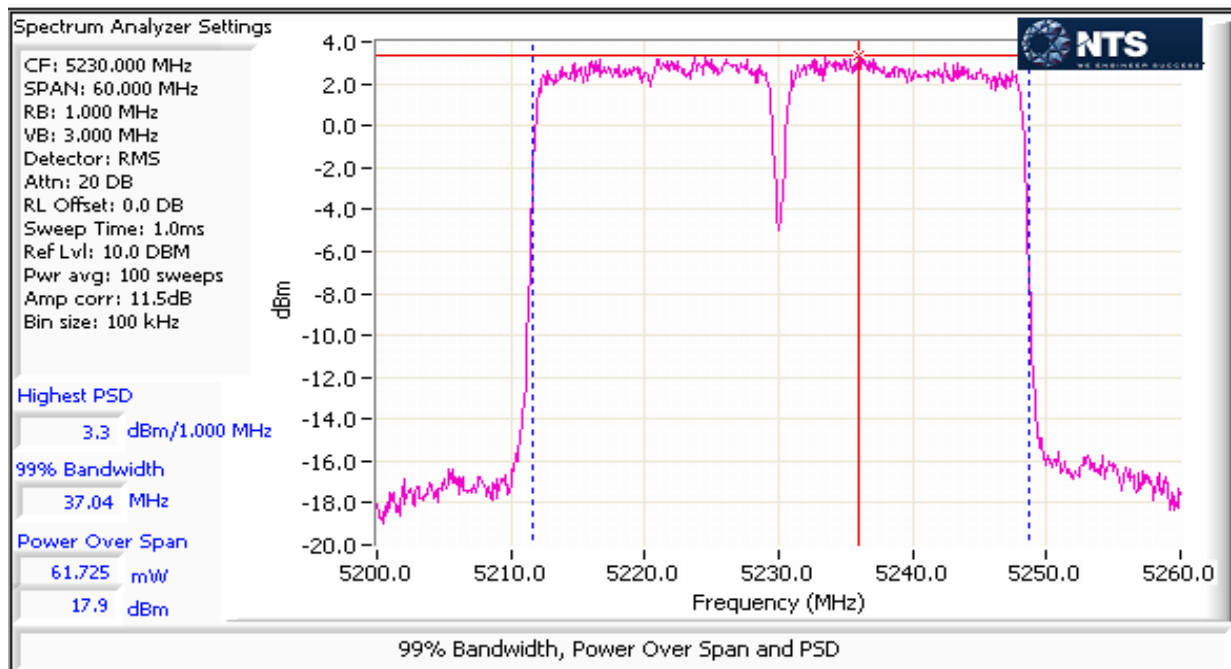
Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ² dBm	Total Power ⁴ mW	FCC Limit dBm	Max Power (W)	Result
5190	1	15		96	12.0	36.4	21.6	0.122	Pass
	3								
	4								
	2				12.8				
5230	1	1		96	17.4	121.5	21.6	0.122	Pass
	3								
	4								
	2				17.9				

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

5150-5250 PSD - FCC

Mode: n40

Frequency (MHz)	Chain	Software Setting	99% BW (MHz)	Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz	Total PSD ⁴ dBm/MHz	FCC Limit dBm/MHz	Result
5190	1	15		96	-2.5	1.3	1.1	8.6	Pass
	3								
	4								
	2				-1.8				
5230	1	1		96	3.0	4.3	6.3	8.6	Pass
	3								
	4								
	2				3.3				



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

MIMO Device - 5150-5250 MHz Band - FCC

Mode: ac80

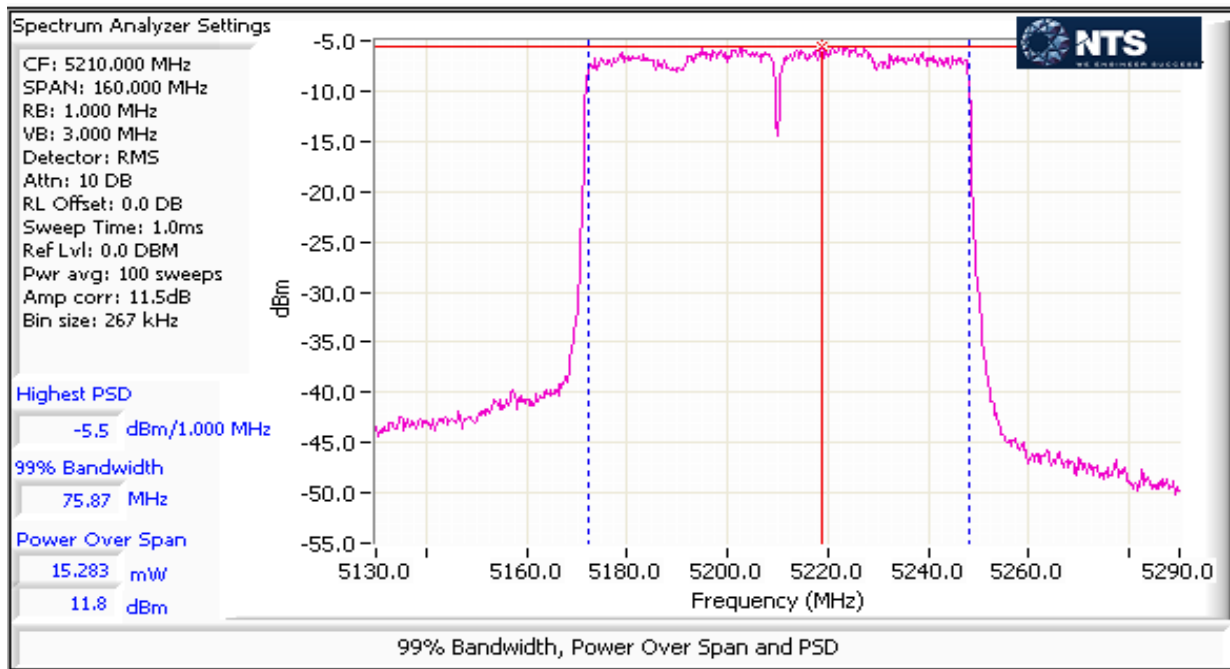
Max EIRP (mW): 197.9

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ² dBm	Total Power ⁴ mW	Total Power ⁴ dBm	FCC Limit dBm	Max Power (W)	Result
5210	1	14		82	9.2	28.6	14.6	21.6	0.029	Pass
	3									
	4									
	2				11.8					

5150-5250 PSD - FCC

Mode: ac80

Frequency (MHz)	Chain	Software Setting	99% BW (MHz)	Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz	Total PSD ⁴ dBm/MHz	FCC Limit dBm/MHz	Result
5210	1	14		82	-7.6	0.6	-2.2	8.6	Pass
	3								
	4								
	2				-5.5				



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

FCC 15.407(UNII) Antenna Port Measurements Power and PSD

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.

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Power, 5250 - 5350MHz	15.407(a) (1), (2), (3) RSS-247 6.2	Pass	a: 54.0 mW n20: 82.3 mW n40: 91.5 mW ac80: 19.8 mW
1	PSD, 5250 - 5350MHz	15.407(a) (1), (2), (3) RSS-247 6.2	Pass	a: 4.8 mW/MHz n20: 6.3 mW/MHz n40: 3.6 mW/MHz ac80: 0.4 mW/MHz
1	Max EIRP 5250 - 5350MHz	TPC required if EIRP ≥ 500mW (27dBm). EIRP ≥ 200mW (23dBm) DFS threshold = -64dBm.	-	EIRP = 24.6 dBm (291.2 mW)
1	26dB Bandwidth	15.407 (Information only)	-	> 20MHz for all modes

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators and cables used.

Ambient Conditions:

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

Modifications Made During Testing

No modifications were made to the EUT during testing

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

Deviations From The Standard

No deviations were made from the requirements of the standard.

Procedure Comments:

Measurements performed in accordance with FCC KDB 789033 D01

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11a	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	VHT0 x2	0.82	Yes	0.226	0.85	1.70	4425

Sample Notes

Sample S/N: 8FA0001901E2766

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

Run #1: Bandwidth, Output Power and Power Spectral Density - MIMO Systems

Date of Test: 7/20/2016

Config. Used: 3

Test Engineer: Kevin Wen, Yew-Kwong Soo

Config Change: -

Test Location: Fremont Lab 4B

EUT Voltage: 120V/60Hz

Note 1:	Duty Cycle $\geq 98\%$ for a, and n20 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, auto sweep, RMS detector, power averaging on (transmitted signal was continuous, duty cycle $\geq 98\%$) and power integration over the OBW (method SA-1 of ANSI C63.10).
Note 2:	Constant Duty Cycle < 98% for n40, and ac80 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, RMS detector, trace average 100 traces, power averaging on and power integration over the OBW. The measurements were adjusted by adding .18 dB for n40 and .85 dB for ac80. This is based on $10\log(1/x)$, where x is the duty cycle. (method SA-2 of ANSI C63.10)
Note 3:	Measured using the same analyzer settings used for output power.
Note 4:	For MIMO systems the total output power and total PSD are calculated from the sum of the powers of the individual chains (in linear terms). The antenna gain used to determine the EIRP and limits for PSD/Output power depends on the operating mode of the MIMO device. If the signals on the non-coherent between the transmit chains then the gain used to determine the limits is the highest gain of the individual chains and the EIRP is the sum of the products of gain and power on each chain. If the signals are coherent then the effective antenna gain is the sum (in linear terms) of the gains for each chain and the EIRP is the product of the effective gain and total power.

EMC Test Data

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

Antenna Gain Information

Freq	Antenna Gain (dBi) / Chain				BF	MultiChain Legacy	CDD	Sectorized / Xpol	Dir G (PWR)	Dir G (PSD)
	1	2	3	4						
5250-5350	4.7	4.9			No	No	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; GA (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.
Notes:	For systems with Beamforming and CDD, choose one the following options: Option 1: Delays are optimized for beamforming, rather than being selected from cyclic delay table of 802.11; Array gains calculated based on beamforming criteria. Option 2: Antennas are paired for beamforming, and the pairs are configured to use the cyclic delay diversity of 802.11; the array gain associated with beamforming with 2 antennas (3dB), and the array gain associated with CDD with two antennas (3dB for PSD and 0 dB for power)

EMC Test Data

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

MIMO Device - 5250-5350 MHz Band - FCC

Mode: 11a

Max EIRP (mW): 323.6

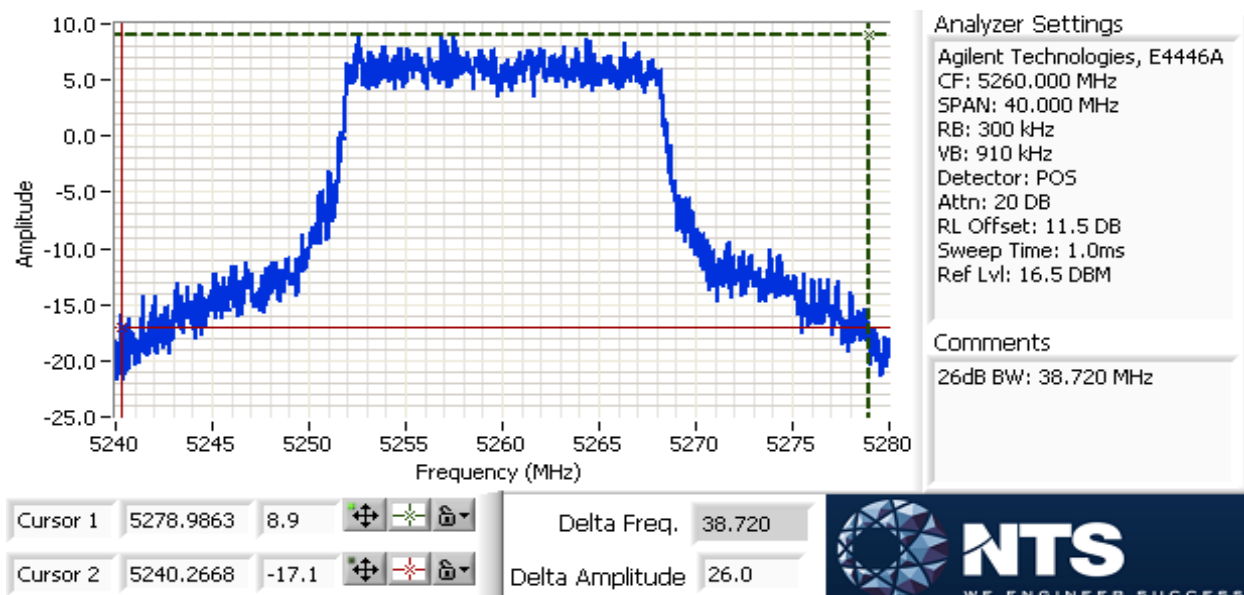
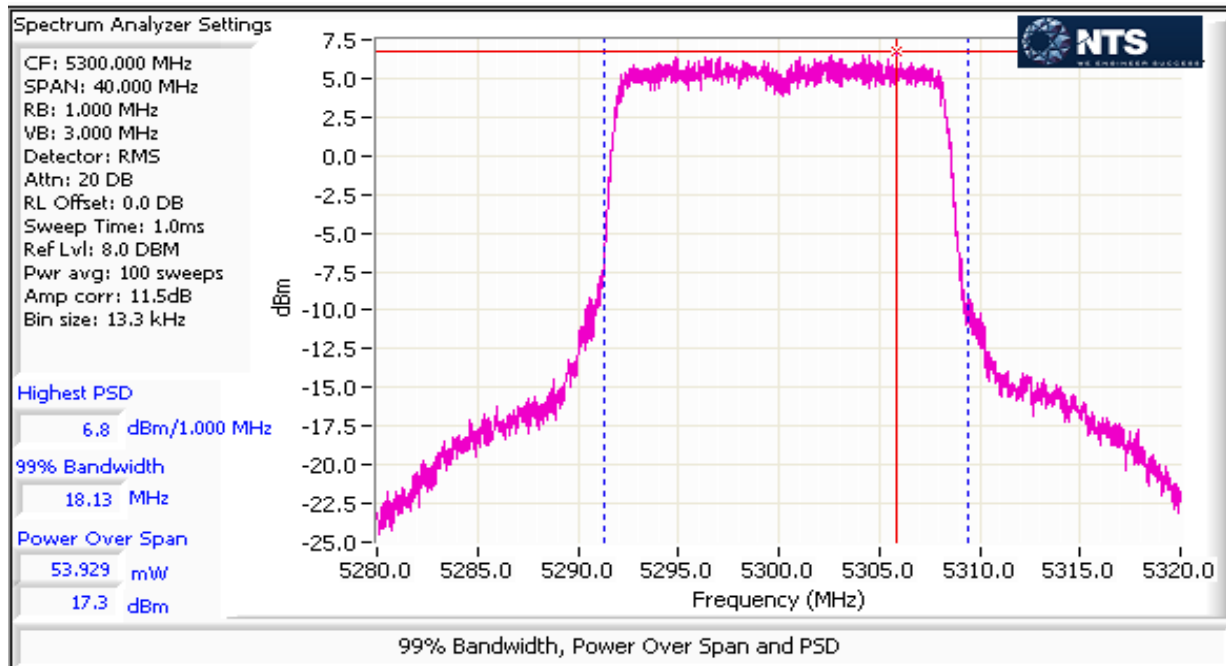
Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power		FCC Limit dBm	Max Power (W)	Result
						mW	dBm			
5260	1	1	38.7	99		50.1	17.0	22.2	0.054	Pass
	3									
	4									
	2				17.0					
5300	1	1	39.6	99		53.7	17.3	22.2		Pass
	3									
	4									
	2				17.3					
5320	1	2	39.7	99		53.7	17.3	22.2		Pass
	3									
	4									
	2				17.3					

5250-5350 PSD - FCC

Mode: 11a

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD mW/MHz dBm/MHz		FCC Limit dBm/MHz	Result
5260	1	1		99		4.3	6.3	9.2	Pass
	3								
	4								
	2				6.3				
5300	1	1		99		4.8	6.8	9.2	Pass
	3								
	4								
	2				6.8				
5320	1	2		99		4.7	6.7	9.2	Pass
	3								
	4								
	2				6.7				

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



EMC Test Data

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

MIMO Device - 5250-5350 MHz Band - FCC

Mode: n20

Max EIRP (mW): 495.9

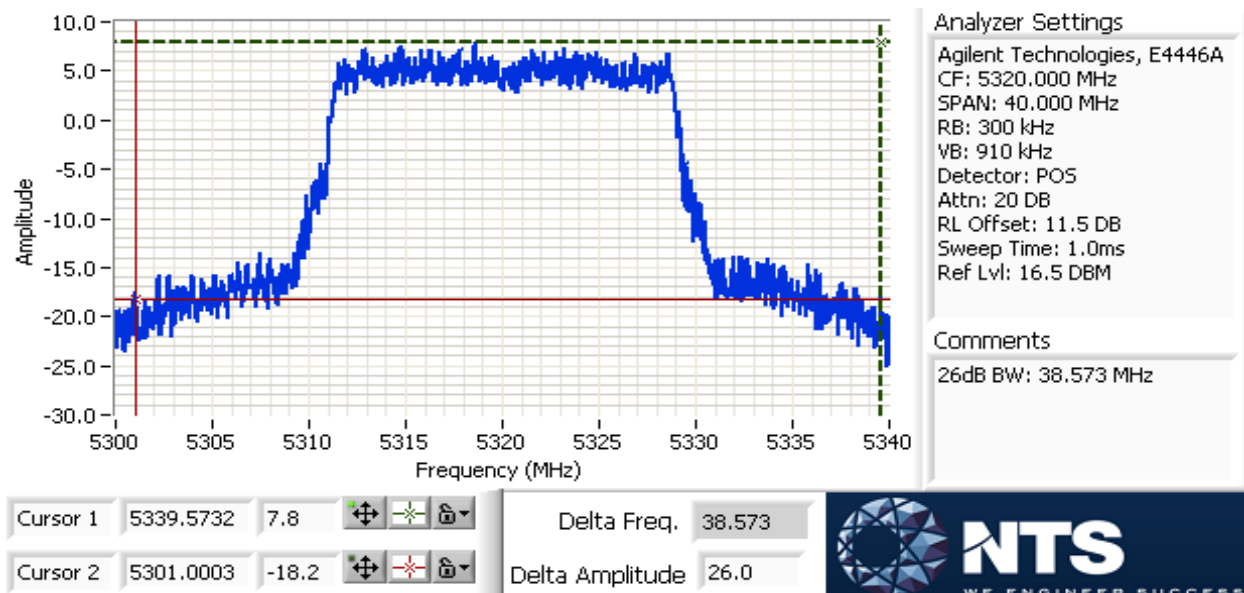
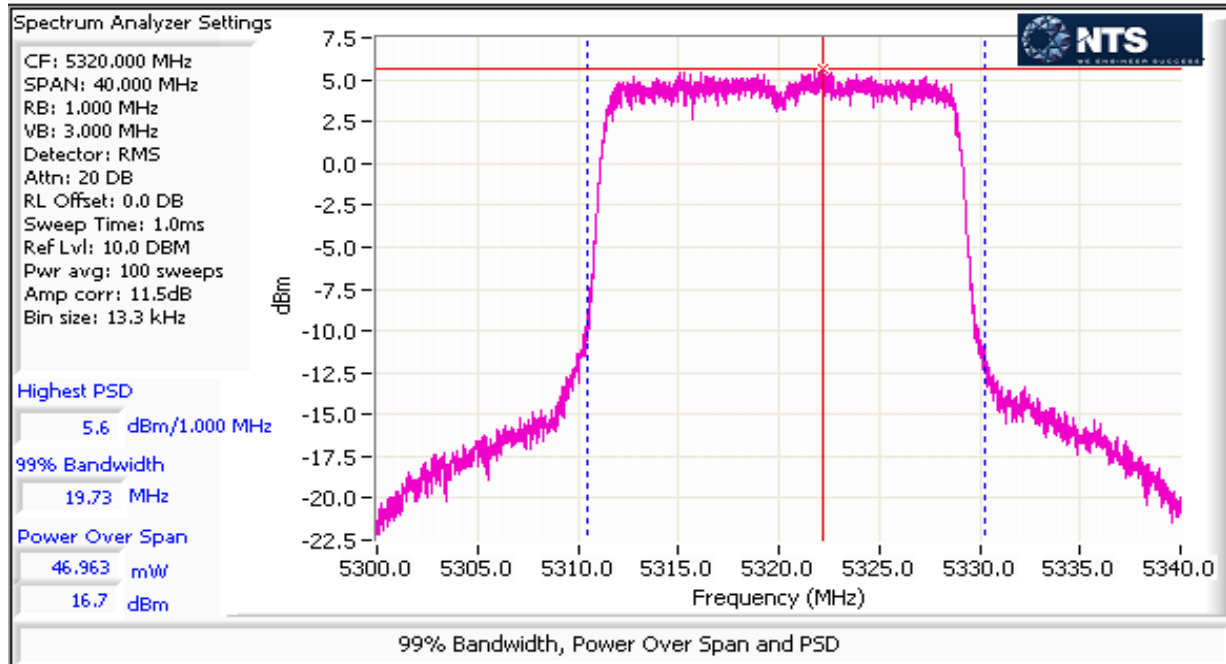
Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power ⁴ mW dBm		FCC Limit dBm	Max Power (W)	Result
5260	1	1	38.6	99	15.4	76.4	18.8	22.2	0.082	Pass
	3									
	4									
	2									
5300	1	1	39.5	99	15.4	78.3	18.9	22.2		Pass
	3									
	4									
	2									
5320	1	1	38.6	99	15.5	82.3	19.2	22.2	Pass	
	3									
	4									
	2									
					16.2					
					16.4					
					16.7					

5250-5350 PSD - FCC

Mode: n20

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz dBm/MHz		FCC Limit dBm/MHz	Result
5260	1	1		99	4.4	6.0	7.8	9.2	Pass
	3								
	4								
	2								
5300	1	1		99	4.3	6.2	7.9	9.2	Pass
	3								
	4								
	2								
5320	1	1		99	4.3	6.3	8.0	9.2	Pass
	3								
	4								
	2								

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



EMC Test Data

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

MIMO Device - 5250-5350 MHz Band - FCC

Mode: n40

Max EIRP (mW): 551.3

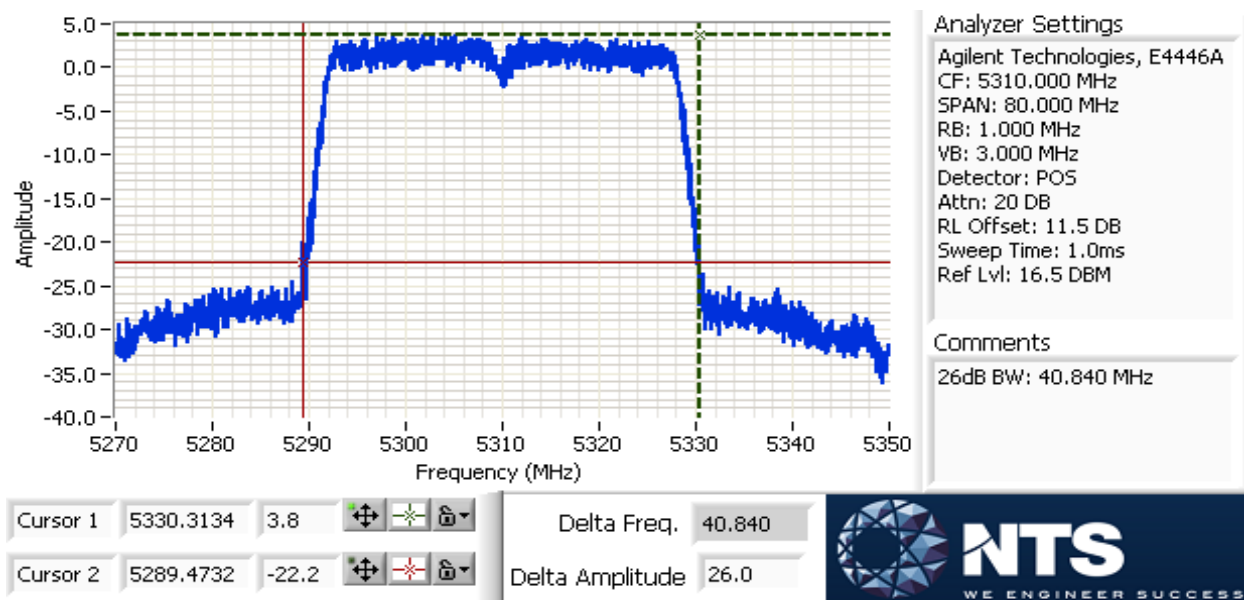
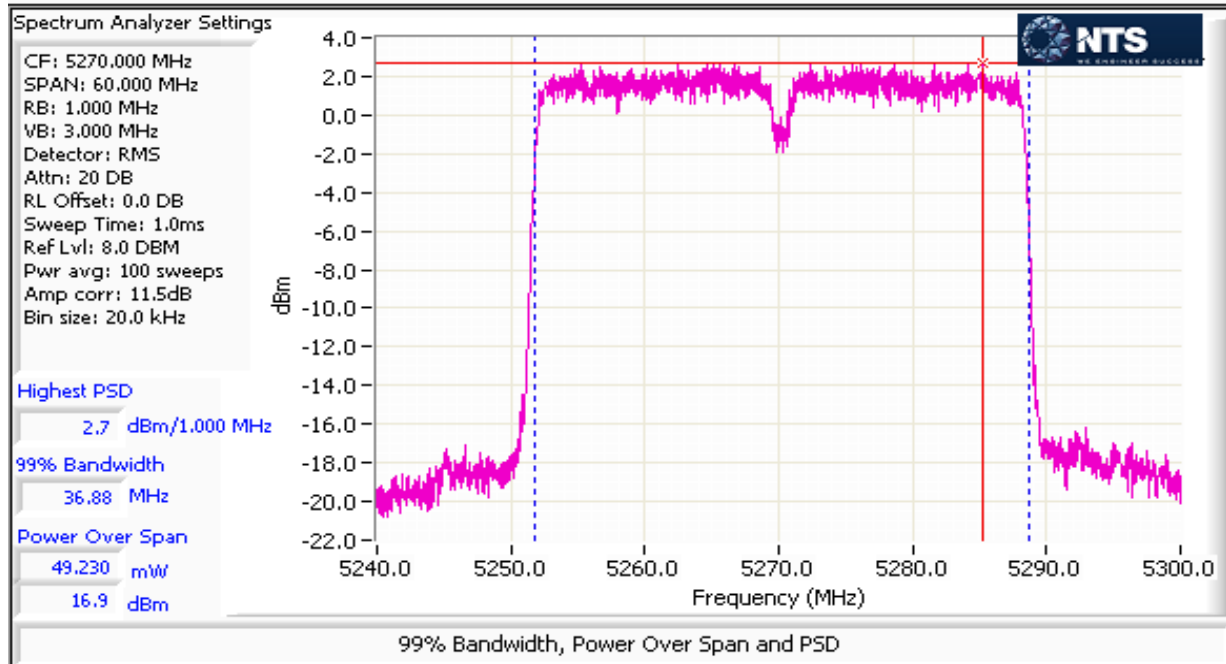
Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ² dBm	Total Power ⁴ mW dBm		FCC Limit dBm	Max Power (W)	Result
5270	1	1	79.1	96	15.9	91.5	19.6	22.2	0.092	Pass
	3									
	4									
	2				16.9					
5310	1	21	40.8	96	9.8	24.7	13.9	22.2		Pass
	3									
	4									
	2				11.5					

MIMO Device 5250-5350 PSD - FCC

Mode: n40

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz	Total PSD ⁴ dBm/MHz	FCC Limit dBm/MHz	IC Limit dBm/MHz	Result
5270	1	1		96	2.0	3.6	5.6	9.2	11.0	Pass
	3									
	4									
	2				2.7					
5310	1	21		96	-3.9	1.0	0.0	9.2	11.0	Pass
	3									
	4									
	2				-2.6					

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



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

MIMO Device - 5250-5350 MHz Band - FCC

Mode: ac80

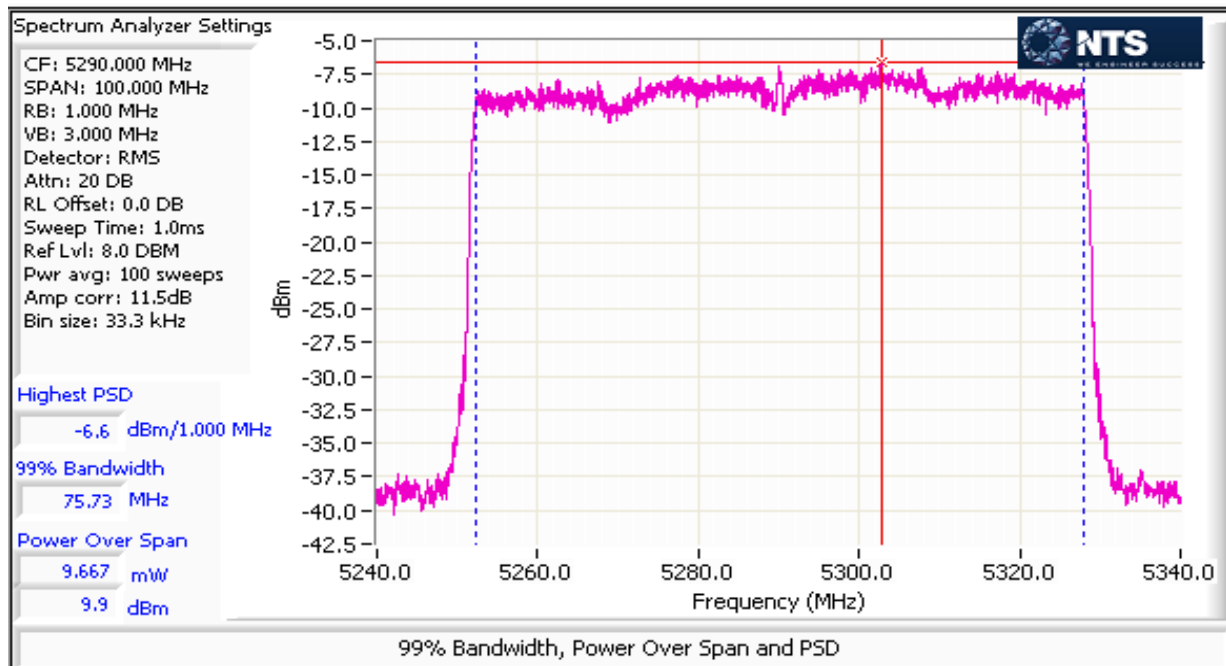
Max EIRP (mW): 119.3

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ² dBm	Total Power ⁴ mW	Total Power ⁴ dBm	FCC Limit dBm	Max Power (W)	Result
5290	1	22	81.5	82	8.1	19.8	13.0	22.2	0.020	Pass
	3									
	4									
	2				9.9					

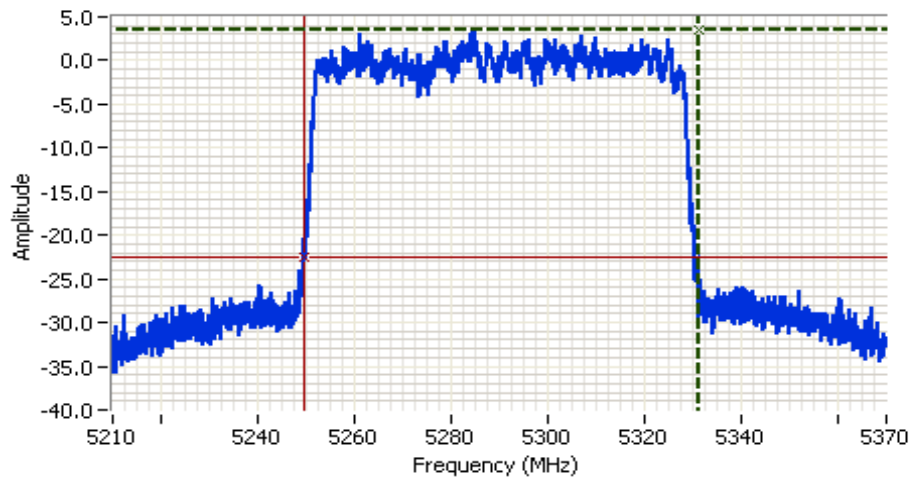
MIMO Device 5250-5350 PSD - FCC/IC

Mode: ac80

Frequency (MHz)	Chain	Software Setting	Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz	Total PSD ⁴ dBm/MHz	FCC Limit dBm/MHz	Result
5290	1	22	82	-8.4	0.4	-4.0	9.2	Pass
	3							
	4							
	2			-6.6				



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



Analyzer Settings

Agilent Technologies, E4446A
 CF: 5290.000 MHz
 SPAN: 160.000 MHz
 RB: 1.000 MHz
 VB: 3.000 MHz
 Detector: POS
 Attn: 20 DB
 RL Offset: 11.5 DB
 Sweep Time: 1.0ms
 Ref Lvl: 16.5 DBM

Comments

26dB BW: 81.467 MHz

Cursor 1	5331.0537	3.5	
Cursor 2	5249.5865	-22.5	

Delta Freq. 81.467

Delta Amplitude 26.0

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

FCC 15.407(UNII) Antenna Port Measurements Power and PSD

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.

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Power, 5470 - 5725MHz	15.407(a) (1), (2), (3)	Pass	a: 30.9 mW n20: 87.9 mW n40: 84.8 mW ac80: 115.4 mW
1	PSD, 5470 - 5725MHz	15.407(a) (1), (2), (3)	Pass	a: 2.7 mW/MHz n20: 6.0 mW/MHz n40: 3.1 mW/MHz ac80: 3.7 mW/MHz
1	Max EIRP 5470 - 5725MHz	TPC required if EIRP ≥ 500mW (27dBm). EIRP ≥ 200mW (23dBm) DFS threshold	-	EIRP = 27.1 dBm (518.4 mW)
1	26dB Bandwidth	15.407 (Information only)	-	> 20MHz for all modes

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators and cables used.

Ambient Conditions:

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

Modifications Made During Testing

No modifications were made to the EUT during testing

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

Deviations From The Standard

No deviations were made from the requirements of the standard.

Procedure Comments:

Measurements performed in accordance with FCC KDB 789033 D01

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11a	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	VHT0 x2	0.82	Yes	0.226	0.85	1.70	4425

Sample Notes

Sample S/N: 8FA0001901E2766

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

EMC Test Data

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

Run #1: Bandwidth, Output Power and Power Spectral Density - MIMO Systems

Date of Test: 7/20/2016, 7/21/2016 Config. Used: 3
 Test Engineer: Kevin Wen, Yew-Kwong Soo Config Change: -
 Test Location: Fremont Lab 4B EUT Voltage: 120V/60Hz

Note 1:	Duty Cycle $\geq 98\%$ for a, and n20 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, auto sweep, RMS detector, power averaging on (transmitted signal was continuous, duty cycle $\geq 98\%$) and power integration over the OBW (method SA-1 of ANSI C63.10).
Note 2:	Constant Duty Cycle < 98% for n40, and ac80 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, RMS detector, trace average 100 traces, power averaging on and power integration over the OBW. The measurements were adjusted by adding .18 dB for n40 and .85 dB for ac80. This is based on $10\log(1/x)$, where x is the duty cycle. (method SA-2 of ANSI C63.10)
Note 3:	Measured using the same analyzer settings used for output power.
Note 4:	For MIMO systems the total output power and total PSD are calculated from the sum of the powers of the individual chains (in linear terms). The antenna gain used to determine the EIRP and limits for PSD/Output power depends on the operating mode of the MIMO device. If the signals on the non-coherent between the transmit chains then the gain used to determine the limits is the highest gain of the individual chains and the EIRP is the sum of the products of gain and power on each chain. If the signals are coherent then the effective antenna gain is the sum (in linear terms) of the gains for each chain and the EIRP is the product of the effective gain and total power.

Antenna Gain Information

Freq	Antenna Gain (dBi) / Chain				BF	MultiChain Legacy	CDD	Sectorized / Xpol	Dir G (PWR)	Dir G (PSD)
	1	2	3	4						
5470-5725	6.1	5.2			No	No	Yes, n/ac modes only	No	8.7	8.7

For devices that support CDD modes

Min # of spatial streams: 1
 Max # of spatial streams: 2

EMC Test Data

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

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; GA (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.
Notes:	For systems with Beamforming and CDD, choose one the following options: Option 1: Delays are optimized for beamforming, rather than being selected from cyclic delay table of 802.11; Array gains calculated based on beamforming criteria. Option 2: Antennas are paired for beamforming, and the pairs are configured to use the cyclic delay diversity of 802.11; the array gain associated with beamforming with 2 antennas (3dB), and the array gain associated with CDD with two antennas (3dB for PSD and 0 dB for power)

MIMO Device - 5470-5725 MHz Band - FCC

Mode: 11a

Max EIRP (mW): 229.1

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power		FCC Limit dBm	Max Power (W)	Result
						mW	dBm			
5500	1	2	33.2	99		30.9	14.9	21.3	0.031	Pass
	3									
	4									
	2				14.9					
5580	1	1	31.1	99		30.9	14.9	21.3		Pass
	3									
	4									
	2				14.9					
5700	1	1	31.4	99		29.5	14.7	21.3		Pass
	3									
	4									
	2				14.7					
5720	1	1	32.1	99		24.5	13.9	21.3		Pass
	3									
	4									
	2				13.9					

Portion within 5725-5850 MHz band (UNII-3)

5720	1	1		99		6.6	8.2	27.3	0.007	Pass
	3									
	4									
	2				8.2					



EMC Test Data

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

5470-5700 PSD - FCC

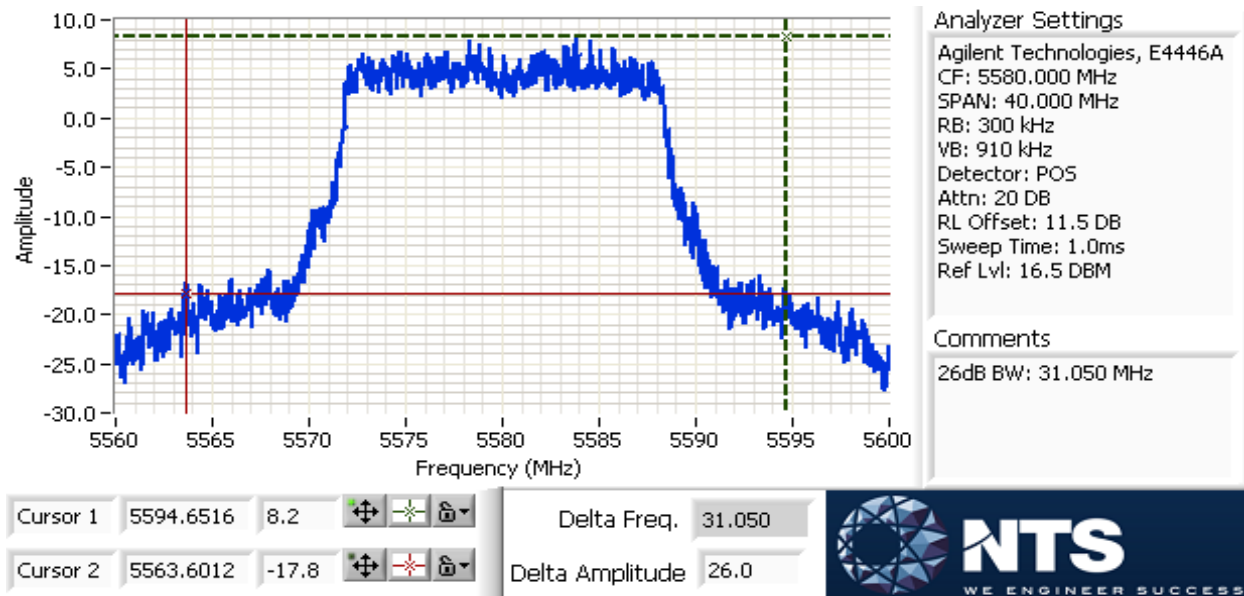
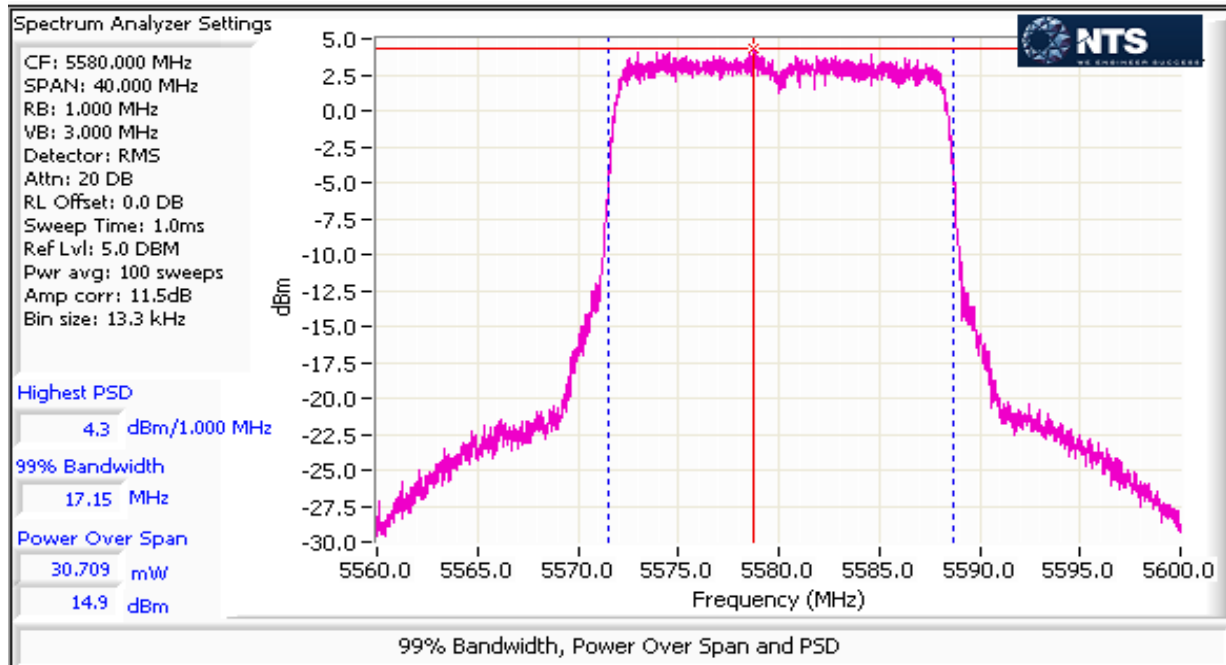
Mode: 11a

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD mW/MHz dBm/MHz		FCC Limit dBm/MHz	Result
5500	1	2		99		2.6	4.1	8.3	Pass
	3								
	4								
	2				4.1				
5580	1	1		99		2.7	4.3	8.3	Pass
	3								
	4								
	2				4.3				
5700	1	1		99		2.5	4.0	8.3	Pass
	3								
	4								
	2				4.0				
5720	1	1		99		2.7	4.3	8.3	Pass
	3								
	4								
	2				4.3				

Portion within 5725-5850 MHz band (UNII-3)

5720	1	1		99		2.7	4.3	27.3	27.3	Pass
	3									
	4									
	2									
					4.3					

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



EMC Test Data

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

MIMO Device - 5470-5725 MHz Band - FCC

Mode: n20

Max EIRP (mW): 651.6

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power ⁴ mW	FCC Limit dBm	Max Power (W)	Result
5500	1	1	36.5	99	13.7	55.1	17.4	21.3	Pass
	3								
	4								
	2				15.0				
5580	1	1	32.7	99	15.9	87.9	19.4	21.3	Pass
	3								
	4								
	2				16.9				
5700	1	4	33.1	99	14.9	67.2	18.3	21.3	Pass
	3								
	4								
	2				15.6				
5720	1	1	39.5	99	14.8	64.9	18.1	21.3	Pass
	3								
	4								
	2				15.4				

Portion within 5725-5850 MHz band (UNII-3)

5720	1	1		99	9.2	17.9	12.5	27.3	0.018	Pass
	3									
	4									
	2				9.8					

EMC Test Data

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

5470-5725 PSD - FCC

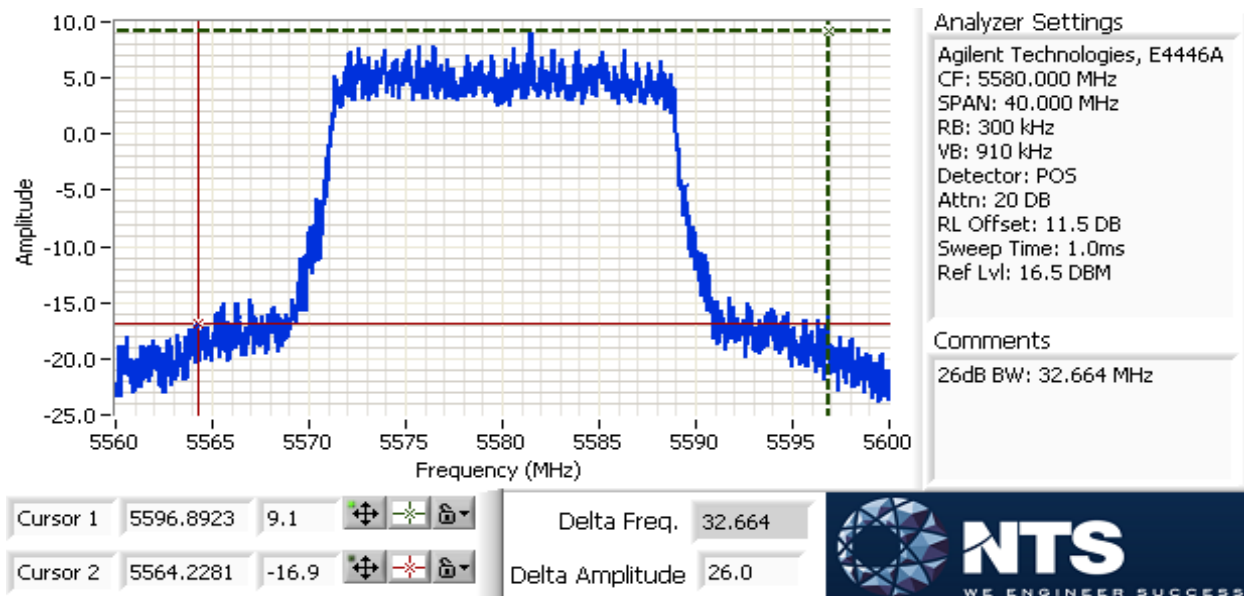
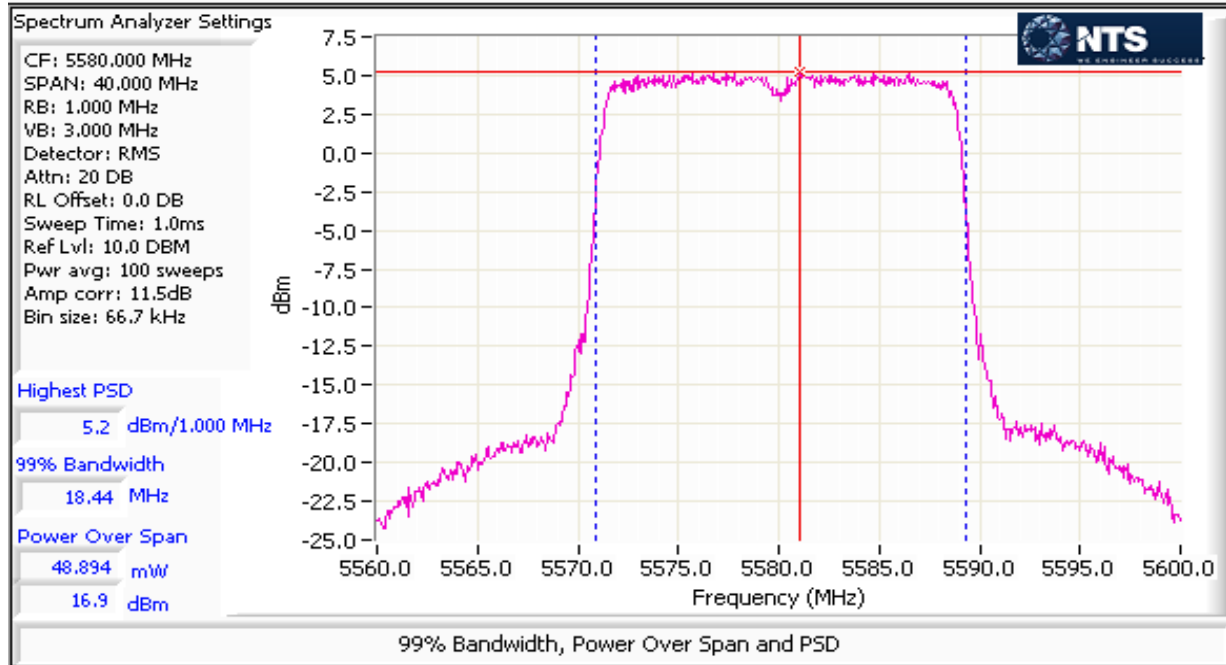
Mode: n20

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz dBm/MHz		FCC Limit dBm/MHz	Result
5500	1	1		99	2.1	3.8	5.8	8.3	Pass
	3								
	4								
	2								
5580	1	1		99	4.3	6.0	7.8	8.3	Pass
	3								
	4								
	2								
5700	1	4		99	3.3	4.6	6.6	8.3	Pass
	3								
	4								
	2								
5720	1	1		99	4.2	5.8	7.6	8.3	Pass
	3								
	4								
	2								

Portion within 5725-5850 MHz band (UNII-3)

5720	1	1		99	3.9	5.4	7.3	27.3	Pass
	3								
	4								
	2								
					4.7				

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



EMC Test Data

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

MIMO Device - 5470-5725 MHz Band - FCC

Mode: n40

Max EIRP (mW): 628.6

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ² dBm	Total Power ⁴ mW dBm		FCC Limit dBm	Max Power (W)	Result
5510	1	24	40.9	96	7.5	14.5	11.6	21.3	0.085	Pass
	3									
	4									
	2				9.2					
5550	1	1	75.5	96	15.4	84.8	19.3	21.3		Pass
	3									
	4									
	2				16.7					
5670	1	1	77.8	96	15.6	80.3	19.0	21.3		Pass
	3									
	4									
	2				16.1					
5710	1	1	79.84	96	15.4	75.7	18.8	21.3	Pass	
	3									
	4									
	2				15.8					

Portion within 5725-5850 MHz band (UNII-3)

5710	1	1		96	5.3	7.3	8.6	27.3	0.007	Pass
	3									
	4									
	2				5.6					

EMC Test Data

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

MIMO Device 5470-5725 PSD - FCC

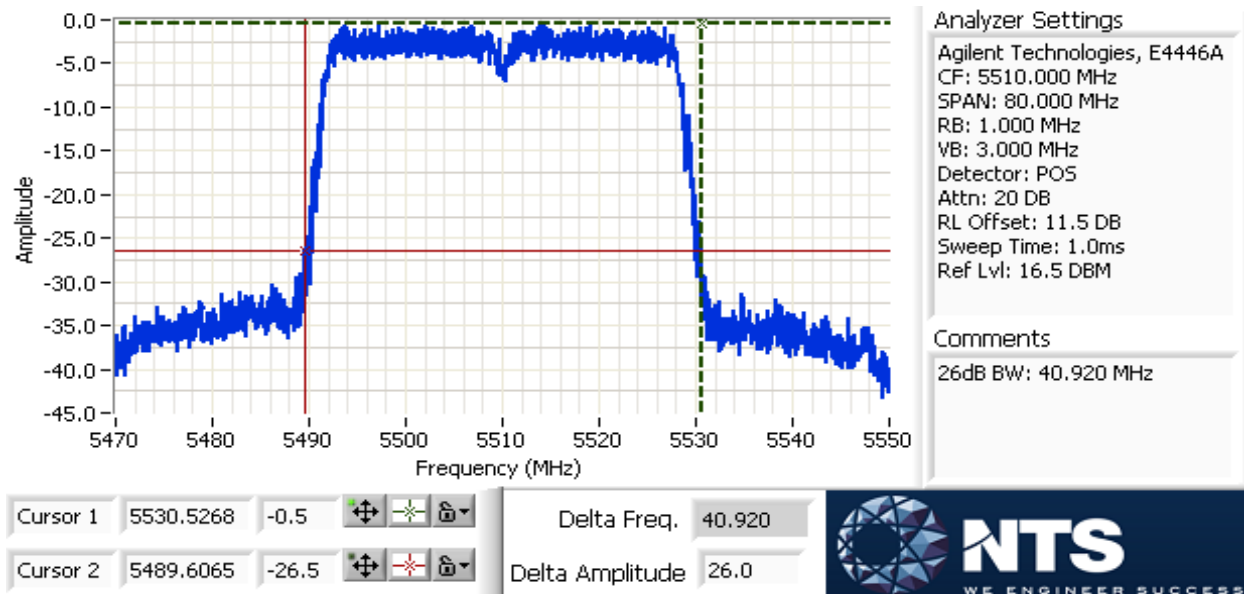
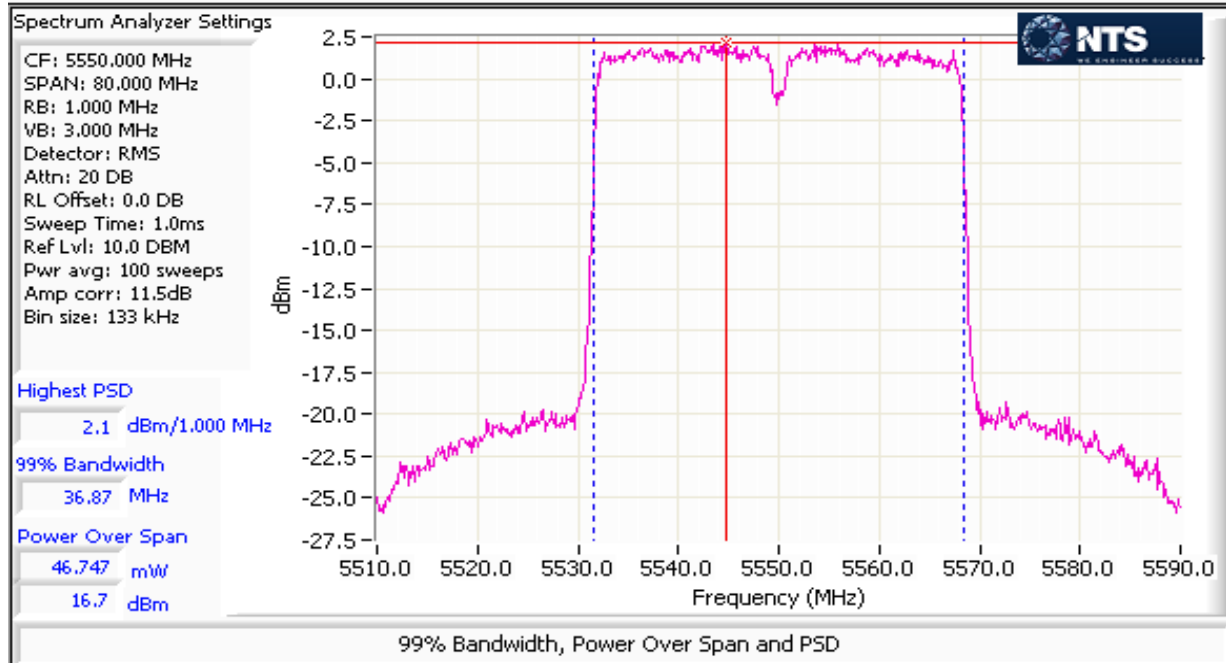
Mode: n40

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz		FCC Limit dBm/MHz	Result
5510	1	24		96	-6.9	0.5		8.3	Pass
	3								
	4								
	2				-5.2				
5550	1	1		96	1.2	3.1	4.9	8.3	Pass
	3								
	4								
	2				2.3				
5670	1	1		96	1.2	2.9	4.6	8.3	Pass
	3								
	4								
	2				1.8				
5710	1	1		96	1.4	3.0	4.8	8.3	Pass
	3								
	4								
	2				1.8				

Portion within 5725-5850 MHz band (UNII-3)

5710	1	1		96	1.0	2.7	4.3	27.3	Pass
	3								
	4								
	2				1.3				

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





EMC Test Data

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

MIMO Device - 5470-5725 MHz Band - FCC

Mode: ac80

Max EIRP (mW): 855.5

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ² dBm	Total Power ⁴ mW dBm		FCC Limit dBm	Max Power (W)	Result
5530	1	23	81.5	82	9.5	22.5	13.5	21.3	0.115	Pass
	3									
	4									
	2									
5610	1	1	119.9	82	16.8	115.4	20.6	21.3		Pass
	3									
	4									
	2									
5690	1	1	131.7	82	16.2	98.3	19.9	21.3	Pass	
	3									
	4									
	2									
					15.9					

Portion within 5725-5850 MHz band (UNII-3)

5690	1	1	131.7	82	1.2	3.3	5.2	21.3	0.003	Pass
	3									
	4									
	2				1.3					



EMC Test Data

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

5470-5725 PSD - FCC Mode: ac80

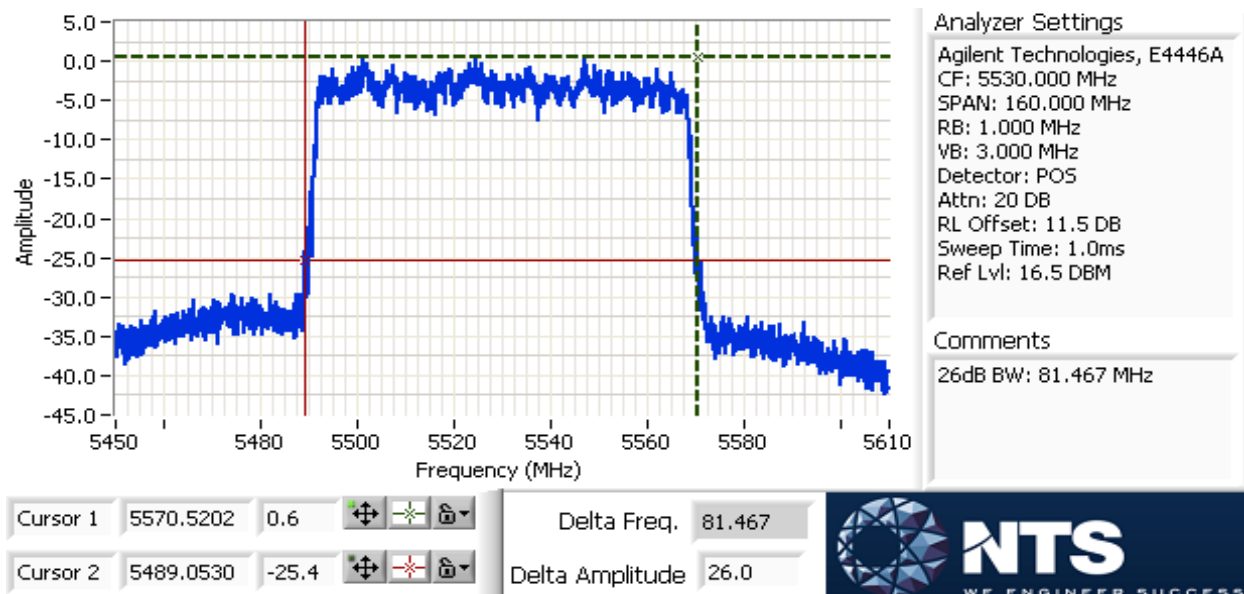
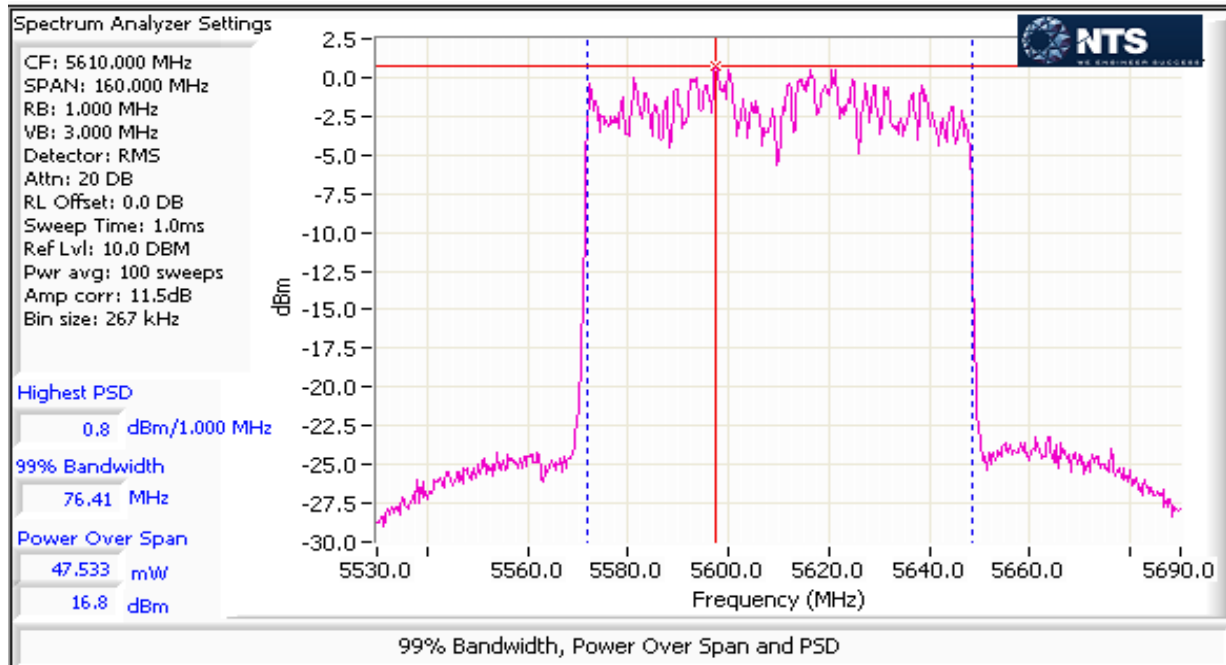
Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz		FCC Limit dBm/MHz	Result
5530	1	23		82	-4.9	0.8		8.3	Pass
	3								
	4								
	2				-4.9				
5610	1	1		82	1.7	3.7	5.7	8.3	Pass
	3								
	4								
	2				1.9				
5690	1	1		82	1.8	3.6	5.6	8.3	Pass
	3								
	4								
	2				1.6				

2.1

Portion within 5725-5850 MHz band (UNII-3)

5690	1	1		82	-1.4	1.7	2.3	27.3	Pass
	3								
	4								
	2				-1.6				

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



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

FCC 15.407(UNII) Antenna Port Measurements Power and PSD

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.

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Power, 5725 - 5850MHz	15.407(a) (1), (2), (3)	Pass	a: 44.7 mW n20: 106.4 mW n40: 103.3 mW ac80: 129.7 mW
1	PSD, 5725 - 5850MHz	15.407(a) (1), (2), (3)	Pass	a: 3.3 mW/MHz n20: 8.2 mW/MHz n40: 3.7 mW/MHz ac80: 3.3 mW/MHz

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators and cables used.

Ambient Conditions:

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

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
Contact:	Jim Inokuchi	Project Manager:	Irene Radamacher
Standard:	FCC Part 15	Project Coordinator:	-
		Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 789033 D01

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11a	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	VHT0 x2	0.82	Yes	0.226	0.85	1.70	4425

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
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Run #1: Bandwidth, Output Power and Power Spectral Density - MIMO Systems

Date of Test: 7/21/2016 Config. Used: 3
 Test Engineer: Kevin Wen, Yew-Kwong Soo Config Change: -
 Test Location: Fremont Lab 4B EUT Voltage: 120V/60Hz

Note 1:	Duty Cycle $\geq 98\%$ for a, and n20 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, auto sweep, RMS detector, power averaging on (transmitted signal was continuous, duty cycle $\geq 98\%$) and power integration over the OBW (method SA-1 of ANSI C63.10).
Note 2:	Constant Duty Cycle < 98% for n40, and ac80 modes. Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, Span > OBW, # of points in sweep $\geq 2 \times \text{span}/\text{RBW}$, RMS detector, trace average 100 traces, power averaging on and power integration over the OBW. The measurements were adjusted by adding .18 dB for n40 and .85 dB for ac80. This is based on $10\log(1/x)$, where x is the duty cycle. (method SA-2 of ANSI C63.10)
Note 3:	Measured using the same analyzer settings used for output power.
Note 4:	For MIMO systems the total output power and total PSD are calculated from the sum of the powers of the individual chains (in linear terms). The antenna gain used to determine the EIRP and limits for PSD/Output power depends on the operating mode of the MIMO device. If the signals on the non-coherent between the transmit chains then the gain used to determine the limits is the highest gain of the individual chains and the EIRP is the sum of the products of gain and power on each chain. If the signals are coherent then the effective antenna gain is the sum (in linear terms) of the gains for each chain and the EIRP is the product of the effective gain and total power.

Antenna Gain Information

Freq	Antenna Gain (dBi) / Chain				BF	MultiChain Legacy	CDD	Sectorized / Xpol	Dir G (PWR)	Dir G (PSD)
	1	2	3	4						
5725-5825	5.8	5.7			No	No	Yes, n/ac modes only	No	8.8	8.8

For devices that support CDD modes

Min # of spatial streams: 1
 Max # of spatial streams: 2

EMC Test Data

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

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; GA (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.
Notes:	For systems with Beamforming and CDD, choose one the following options: Option 1: Delays are optimized for beamforming, rather than being selected from cyclic delay table of 802.11; Array gains calculated based on beamforming criteria. Option 2: Antennas are paired for beamforming, and the pairs are configured to use the cyclic delay diversity of 802.11; the array gain associated with beamforming with 2 antennas (3dB), and the array gain associated with CDD with two antennas (3dB for PSD and 0 dB for power)

MIMO Device - 5725-5850 MHz Band - FCC

Mode: 11a

Max EIRP (mW): 339.1

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	Power ¹ dBm	Total Power		Limit dBm	Max Power (W)	Result
						mW	dBm			
5745	1	6		99		30.2	14.8	27.2	0.045	Pass
	3									
	4									
	2				14.8					
5785	1	1		99		44.7	16.5	27.2		Pass
	3									
	4									
	2				16.5					
5825	1	5		99		31.6	15.0	27.2		Pass
	3									
	4									
	2				15.0					

**NTS**

WE ENGINEER SUCCESS

EMC Test Data

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

5725-5850 PSD - FCC

Mode: 11a

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD mW/MHz	Total PSD dBm/MHz	FCC Limit dBm/MHz	Result
5745	1	6		99		2.3	3.6	27.2	Pass
	3								
	4								
	2				3.6				
5785	1	1		99		3.3	5.2	27.2	Pass
	3								
	4								
	2				5.2				
5825	1	5		99		2.5	4.0	27.2	Pass
	3								
	4								
	2				3.9				

Spectrum Analyzer Settings

CF: 5785.000 MHz
 SPAN: 40.000 MHz
 RB: 1.000 MHz
 VB: 3.000 MHz
 Detector: RMS
 Attn: 20 DB
 RL Offset: 0.0 DB
 Sweep Time: 1.0ms
 Ref Lvl: 10.0 DBM
 Pwr avg: 100 sweeps
 Amp corr: 11.5dB
 Bin size: 66.7 kHz

Highest PSD

5.2 dBm/1.000 MHz

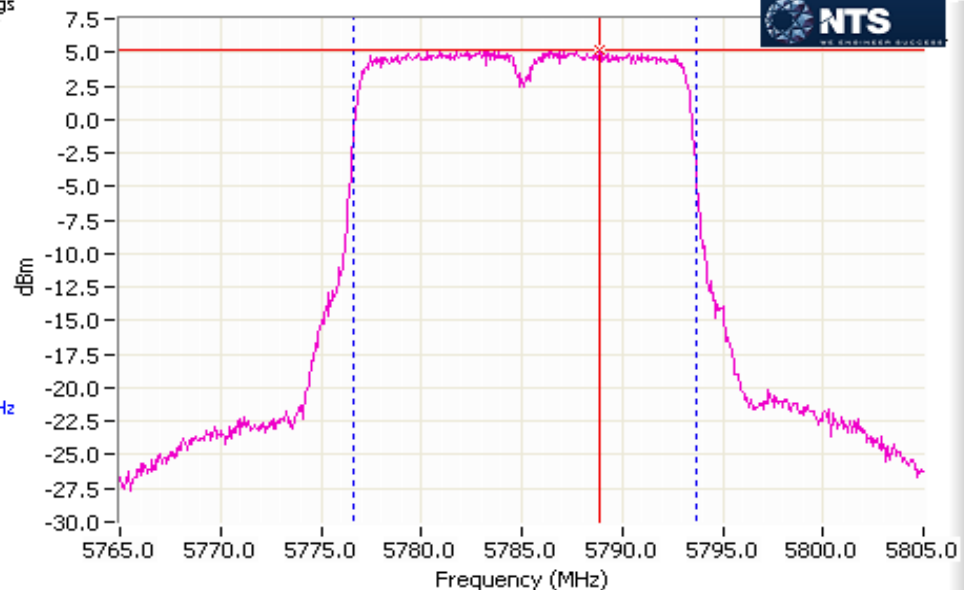
99% Bandwidth

17.04 MHz

Power Over Span

44.781 mW

16.5 dBm





NTS

WE ENGINEER SUCCESS

EMC Test Data

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

MIMO Device - 5725-5850 MHz Band - FCC

Mode: n20

Max EIRP (mW): 807.1

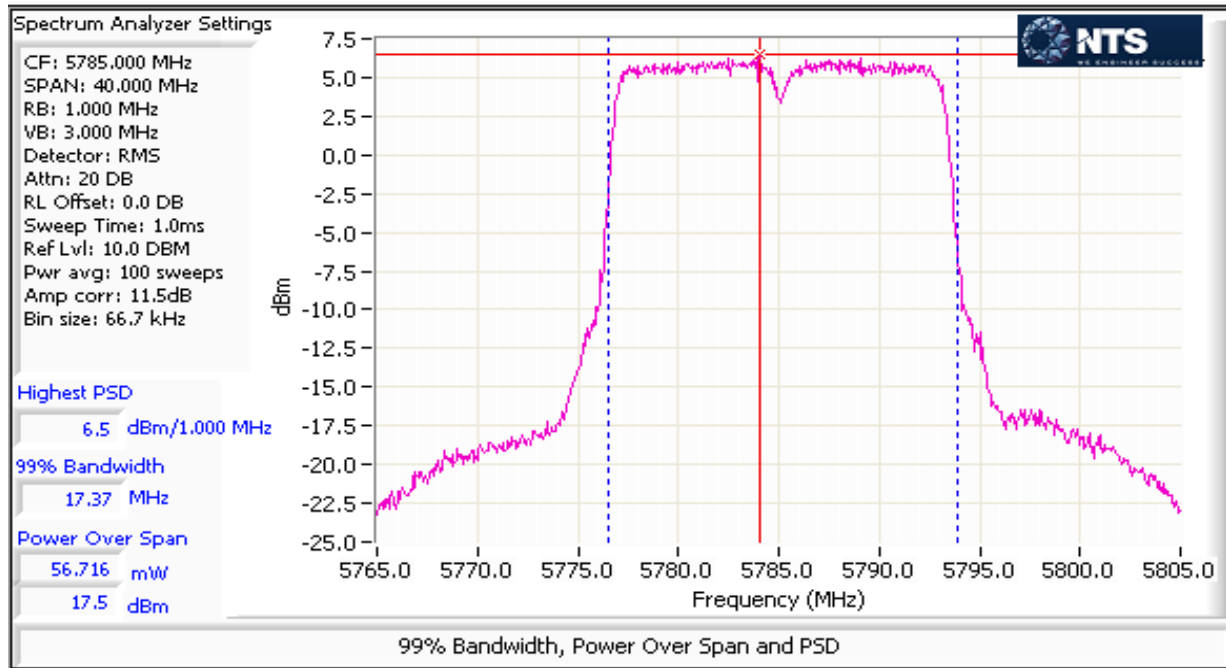
Frequency (MHz)	Chain	Software Setting		Duty Cycle %	Power ¹ dBm	Total Power ⁴ mW dBm		FCC Limit dBm	Max Power (W)	Result
5745	1	6		99	15.6	71.8	18.6	27.2	0.106	Pass
	3									
	4									
	2		15.5							
5785	1	1		99	17.0	106.4	20.3	27.2		Pass
	3									
	4									
	2		17.5							
5825	1	4		99	15.3	67.8	18.3	27.2	Pass	
	3									
	4									
	2		15.3							

5250-5350 PSD - FCC

Mode: n20

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz dBm/MHz		FCC Limit dBm/MHz	Result
5745	1	6		99	4.5	5.5	7.4	27.2	Pass
	3								
	4								
	2		4.3						
5785	1	1		99	5.7	8.2	9.1	27.2	Pass
	3								
	4								
	2		6.5						
5825	1	4		99	4.2	5.3	7.2	27.2	Pass
	3								
	4								
	2		4.2						

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



MIMO Device - 5725-5850 MHz Band - FCC

Mode: n40

Max EIRP (mW): 783.6

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	Power ² dBm	Total Power ⁴ mW	Total Power ⁴ dBm	FCC Limit dBm	Max Power (W)	Result
5755	1	1		96	16.8	103.3	20.1	27.2	0.103	Pass
	3									
	4									
	2				17.1					
5795	1	1		96	17.0	102.1	20.1	27.2	0.103	Pass
	3									
	4									
	2				16.8					

**NTS**

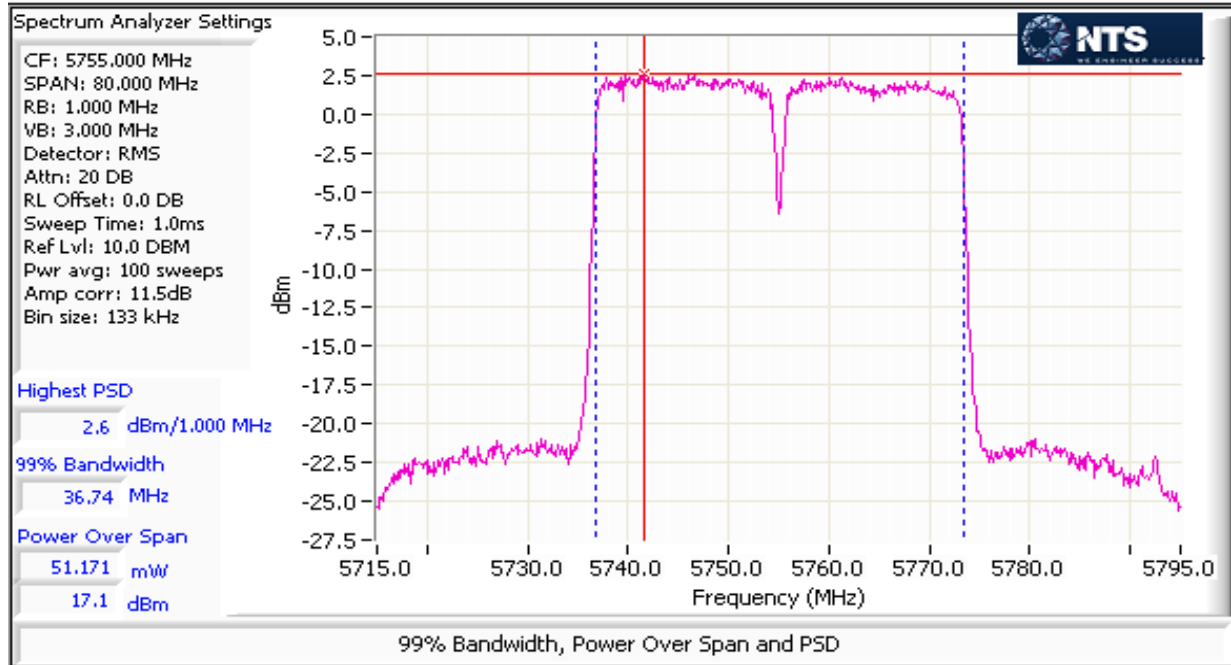
WE ENGINEER SUCCESS

EMC Test Data

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

MIMO Device 5250-5350 PSD - FCC**Mode: n40**

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz	Total PSD ⁴ dBm/MHz	FCC Limit dBm/MHz	Result
5755	1	1		96	2.1	3.6	5.6	27.2	Pass
	3								
	4								
	2				2.6				
5795	1	1		96	2.6	3.7	5.7	27.2	Pass
	3								
	4								
	2				2.3				



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

MIMO Device - 5725-5850 MHz Band - FCC

Mode: ac80

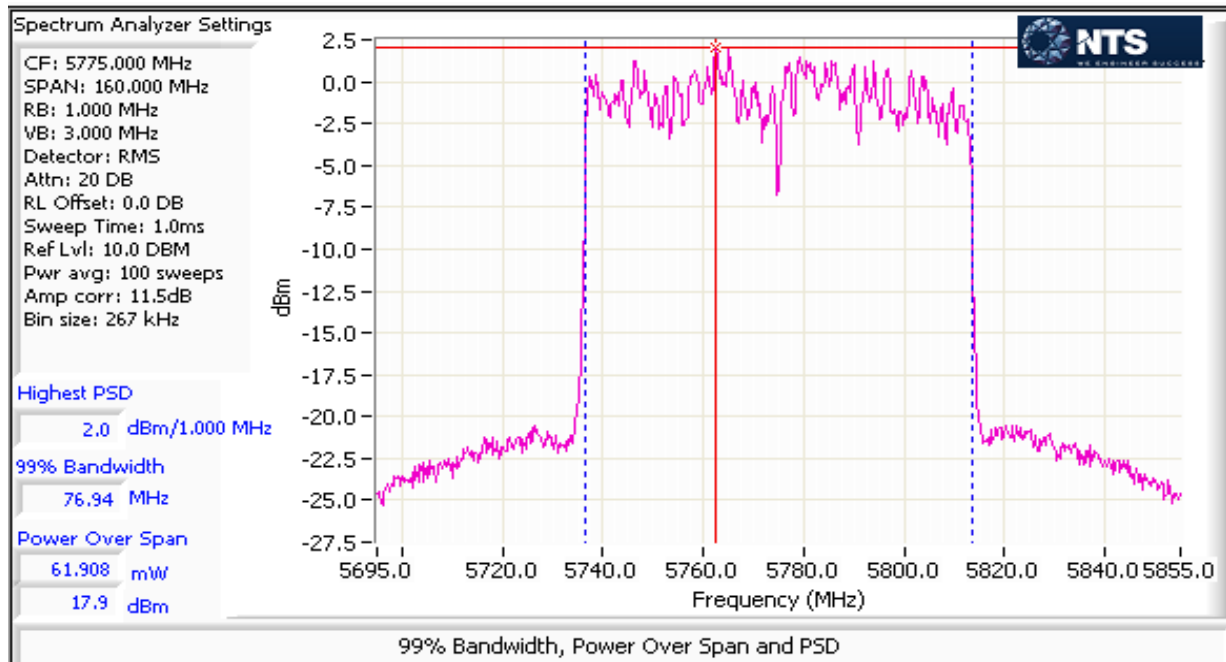
Max EIRP (mW): 983.9

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	Power ² dBm	Total Power ⁴ mW	dBm	FCC Limit dBm	Max Power (W)	Result
5775	1	1		82	17.9	129.7	21.1	27.2	0.130	Pass
	3									
	4									
	2				16.5					

MIMO Device 5250-5350 PSD - FCC

Mode: ac80

Frequency (MHz)	Chain	Software Setting		Duty Cycle %	PSD ³ dBm/MHz	Total PSD ⁴ mW/MHz	dBm/MHz	FCC Limit dBm/MHz	Result
5775	1	1		82	2.0	3.3	5.2	27.2	Pass
	3								
	4								
	2				0.4				



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

FCC Part 15.407 Frequency Stability

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

With the exception of the radiated spurious emissions tests, all measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was placed inside an environmental chamber.

Radiated measurements are made with the EUT located on a non-conductive table, 3m from the measurement antenna.

Ambient Conditions:

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

Summary of Results

Run #	Data Rate	Test Performed	Limit	Pass / Fail	Result / Margin
1	MCS0	Frequency Stability	Within allocated band	Pass	28.9 ppm

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.

Run #1: Frequency Stability

Date of Test: 7/21/2016	Config. Used: 3
Test Engineer: Kevin Wen, Yew-Kwong Soo	Config Change: None
Test Location: Fremont Lab 4B	EUT Voltage: 120V/60Hz

Nominal Frequency: 5700 MHz

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

Frequency Stability Over Temperature

The EUT was soaked at each temperature for a minimum of 30 minutes prior to making the measurements to ensure the EUT and chamber had stabilized at that temperature.

Temperature	Frequency Measured	Offset	
(Celsius)	(MHz)	(Hz)	(ppm)
0	5700.165000	165000	28.9
10	5700.150700	150700	26.4
20	5700.144900	144900	25.4
30	5700.126500	126500	22.2
40	5700.121500	121500	21.3
45	5700.126500	126500	22.2
Worst case:		165000	28.9

Frequency Stability Over Input Voltage

Nominal Voltage is 120 VAC

Voltage	Frequency Measured	Offset	
(aC)	(MHz)	(Hz)	(ppm)
85%	5700.125700	125700	22.1
115%	5700.128200	128200	22.5
Worst case:		128200	28.9

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

FCC 15.407 (UNII) 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.

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

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

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
20MHz Bandwidth Modes							
1	a	36 - 5180MHz	0	2	Restricted Band Edge at 5150 MHz	15.209	53.3 dBµV/m @ 5149.8 MHz (-0.7 dB)
2	a	64 - 5320MHz	0	2	Restricted Band Edge at 5350 MHz	15.209	51.4 dBµV/m @ 5350.8 MHz (-2.6 dB)
3	a	100 - 5500MHz	0	1	Restricted Band Edge at 5460 MHz	15.209	47.7 dBµV/m @ 5459.7 MHz (-6.3 dB)
	a	100 - 5500MHz	0	2	Band Edge 5460 - 5470 MHz	15E	67.5 dBµV/m @ 5465.9 MHz (-0.8 dB)
	a	140 - 5700MHz	0	1	Band Edge 5725MHz	15E	65.3 dBµV/m @ 5726.2 MHz (-3.0 dB)
4	a	149 - 5745MHz	0	6	Band Edge 5725 MHz	15E	67.1 dBµV/m @ 5724.7 MHz (-1.2 dB)
	a	165 - 5825MHz	0	5	Band Edge 5850MHz	15E	65.6 dBµV/m @ 5851.2 MHz (-2.7 dB)
5	n20	36 - 5180MHz	0	5	Restricted Band Edge at 5150 MHz	15.209	51.8 dBµV/m @ 5149.9 MHz (-2.2 dB)

EMC Test Data

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		
Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
20MHz Bandwith Modes							
6	n20	64 - 5320MHz	0	1	Restricted Band Edge at 5350 MHz	15.209	51.4 dBµV/m @ 5350.0 MHz (-2.6 dB)
7	n20	100 - 5500MHz	0	1	Restricted Band Edge at 5460 MHz	15.209	48.2 dBµV/m @ 5458.3 MHz (-5.8 dB)
	n20	100 - 5500MHz	0	1	Band Edge 5460 - 5470 MHz	15E	68.2 dBµV/m @ 5469.1 MHz (-0.1 dB)
	n20	140 - 5700MHz	0	4	Band Edge 5725MHz	15E	67.2 dBµV/m @ 5726.0 MHz (-1.1 dB)
8	n20	149 - 5745MHz	0	6	Band Edge 5725 MHz	15E	66.0 dBµV/m @ 5723.5 MHz (-2.3 dB)
	n20	165 - 5825MHz	0	4	Band Edge 5850MHz	15E	66.2 dBµV/m @ 5851.4 MHz (-2.1 dB)
40MHz Bandwith Modes							
9	n40	38 - 5190MHz	0	15	Restricted Band Edge at 5150 MHz	15.209	53.8 dBµV/m @ 5149.6 MHz (-0.2 dB)
	n40	46 - 5230MHz	0	1	Restricted Band Edge at 5150 MHz	15.209	53.0 dBµV/m @ 5148.5 MHz (-1.0 dB)
10	n40	62 - 5310MHz	0	21	Restricted Band Edge at 5350 MHz	15.209	53.8 dBµV/m @ 5350.0 MHz (-0.2 dB)
	n40	54 - 5270MHz	0	1	Restricted Band Edge at 5350 MHz	15.209	48.2 dBµV/m @ 5353.9 MHz (-5.8 dB)
11	n40	102 - 5510MHz	0	24	Restricted Band Edge at 5460 MHz	15.209	46.5 dBµV/m @ 5459.5 MHz (-7.5 dB)
	n40	102 - 5510MHz	0	24	Band Edge 5460 - 5470 MHz	15E	67.8 dBµV/m @ 5468.5 MHz (-0.5 dB)
	n40	110 - 5550MHz	0	1	Restricted Band Edge at 5460 MHz	15.209	46.4 dBµV/m @ 5460.0 MHz (-7.6 dB)
	n40	110 - 5550MHz	0	1	Band Edge 5460 - 5470 MHz	15E	62.5 dBµV/m @ 5465.2 MHz (-7.5 dB)
40MHz Bandwith Modes							
12	n40	134 - 5670MHz	0	0	Band Edge 5725MHz	15E	64.3 dBµV/m @ 5727.4 MHz (-4.0 dB)
	n40	151 - 5755MHz	0	0	Band Edge 5725 MHz	15E	56.8 dBµV/m @ 5629.2 MHz (-11.5 dB)
	n40	159 - 5795MHz	0	0	Band Edge 5850MHz	15E	57.3 dBµV/m @ 5508.6 MHz (-11.0 dB)

EMC Test Data

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

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
80MHz Bandwith Modes							
13	ac80	42 - 5210MHz	0	14	Restricted Band Edge at 5150 MHz	15.209	52.9 dBμV/m @ 5141.7 MHz (-1.1 dB)
14	ac80	58 - 5290MHz	0	22	Restricted Band Edge at 5350 MHz	15.209	53.6 dBμV/m @ 5352.7 MHz (-0.4 dB)
15	ac80	106 - 5530MHz	0	23	Restricted Band Edge at 5460 MHz	15.209	53.6 dBμV/m @ 5458.2 MHz (-0.4 dB)
	ac80	106 - 5530MHz	0	23	Band Edge 5460 - 5470 MHz	15E	67.1 dBμV/m @ 5465.7 MHz (-1.2 dB)
16	ac80	155 - 5775MHz	0	0	Band Edge 5725 MHz	15E	67.6 dBμV/m @ 5649.6 MHz (-0.7 dB)
	ac80	155 - 5775MHz	0	0	Band Edge 5850MHz	15E	59.7 dBμV/m @ 5926.4 MHz (-8.6 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.

Procedure Comments:

Measurements performed in accordance with FCC KDB 789033

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 50 traces. (method VB of KDB 789033)

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11a	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	VHT0 x2	0.82	Yes	0.226	0.85	1.70	4425



EMC Test Data

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

Sample Notes

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

Measurement Specific Notes:

Note 1:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector). Per KDB 789033 2) c) (i), compliance can be demonstrated by meeting the average and peak limits of 15.209, as an alternative.
Note 2:	Emission has a duty cycle ≥ 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces (method AD of KDB 789033)
Note 3:	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, max hold 50*1/DC traces (method VB of KDB 789033)
Note 4:	Emission has a duty cycle < 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100*1/DC traces, measurement corrected by Pwr correction factor (method AD of KDB 789033)
Note 5:	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, 5150-5250MHz

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

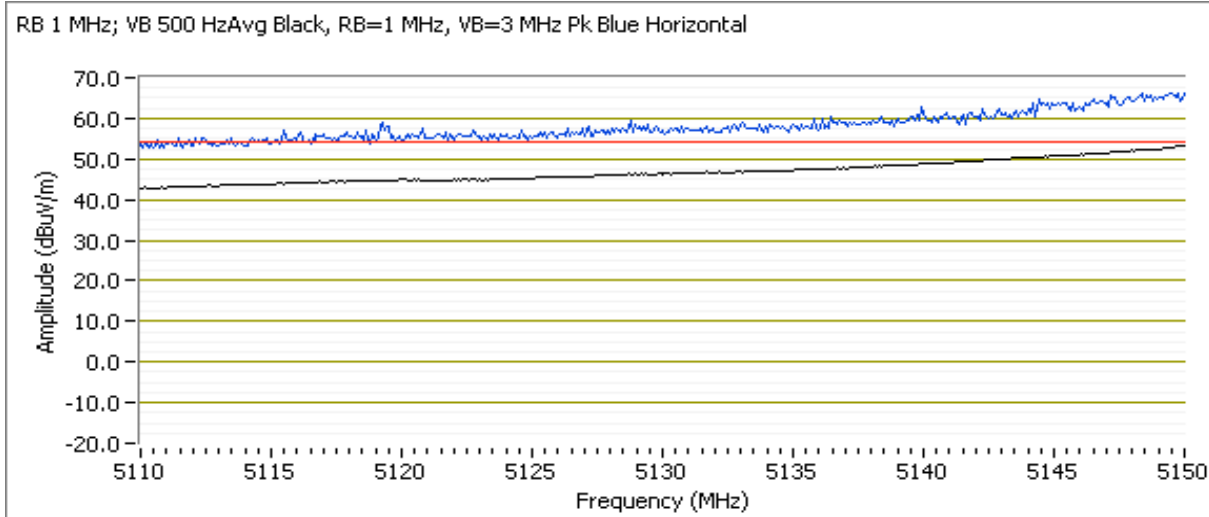
Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Channel: 36 - 5180 MHz
 Tx Chain: Both
 Mode: a
 Data Rate: 6 MB/s

5150 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5149.840	53.3	H	54.0	-0.7	Avg	360	1.4	POS; RB 1 MHz; VB: 500 Hz
5148.640	66.8	H	74.0	-7.2	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

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



Run #2: Radiated Bandedge Measurements, 5250-5350MHz

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

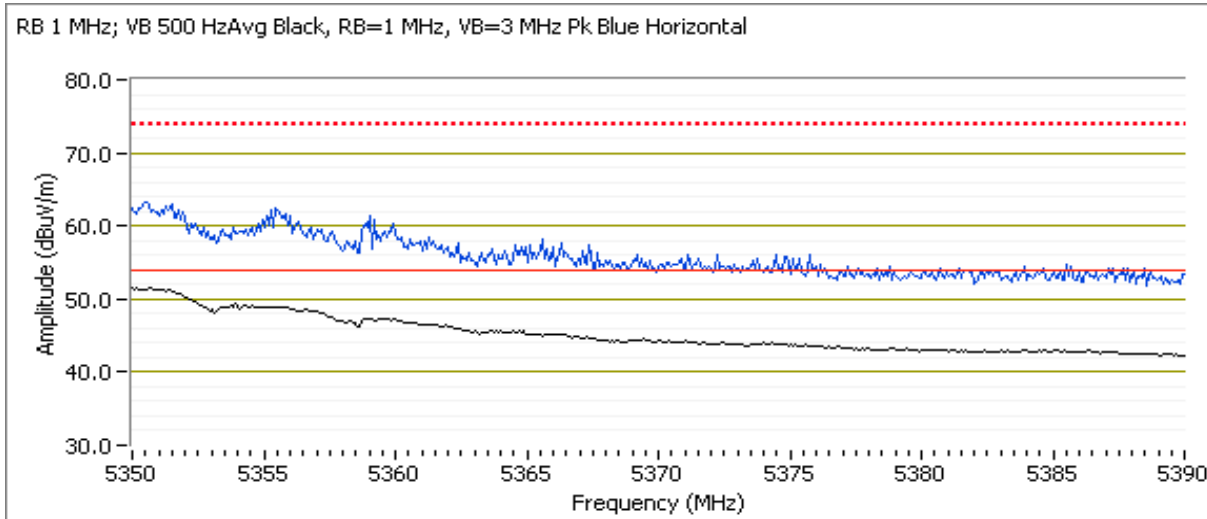
Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Channel: 64 - 5320MHz
 Tx Chain: Both
 Mode: a
 Data Rate: 6 MB/s

5350 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5350.800	51.4	H	54.0	-2.6	Avg	360	1.4	POS; RB 1 MHz; VB: 500 Hz
5350.800	63.9	H	74.0	-10.1	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

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



Run #3: Radiated Bandedge Measurements, 5470-5725MHz

Date of Test: 7/6/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

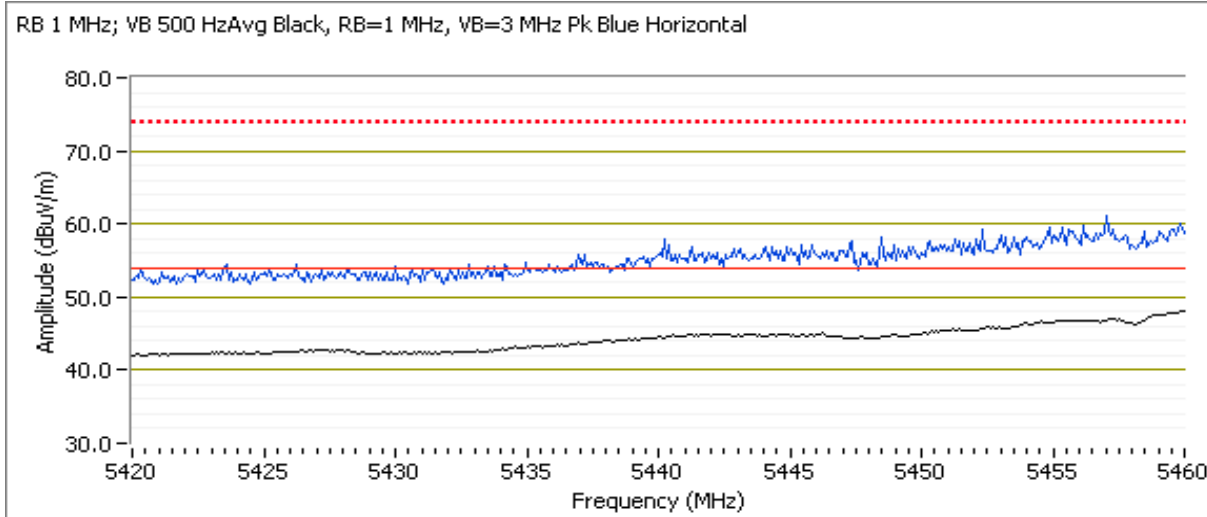
Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Channel: 100 - 5500MHz
 Tx Chain: Both
 Mode: a
 Data Rate: 6 MB/s

5460 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5459.680	47.7	H	54.0	-6.3	Avg	360	1.4	POS; RB 1 MHz; VB: 500 Hz
5455.910	59.9	H	74.0	-14.1	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

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



5470 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5465.930	67.5	H	68.3	-0.8	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

Channel: 140 - 5700MHz

Tx Chain: Both

Mode: a

Data Rate: 6 MB/s

5725 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5726.200	65.3	H	68.3	-3.0	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz



EMC Test Data

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

Run #4: Radiated Bandedge Measurements, 5725-5850MHz

Date of Test: 7/6/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

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

Channel: 149 - 5745MHz
 Tx Chain: Both
 Mode: a
 Data Rate: 6 MB/s

5725 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5724.680	67.1	H	68.3	-1.2	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

Channel: 165 - 5825MHz
 Tx Chain: Both
 Mode: a
 Data Rate: 6 MB/s

5850 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5851.200	65.6	H	68.3	-2.7	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

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

Run #5: Radiated Bandedge Measurements, 5150-5250MHz

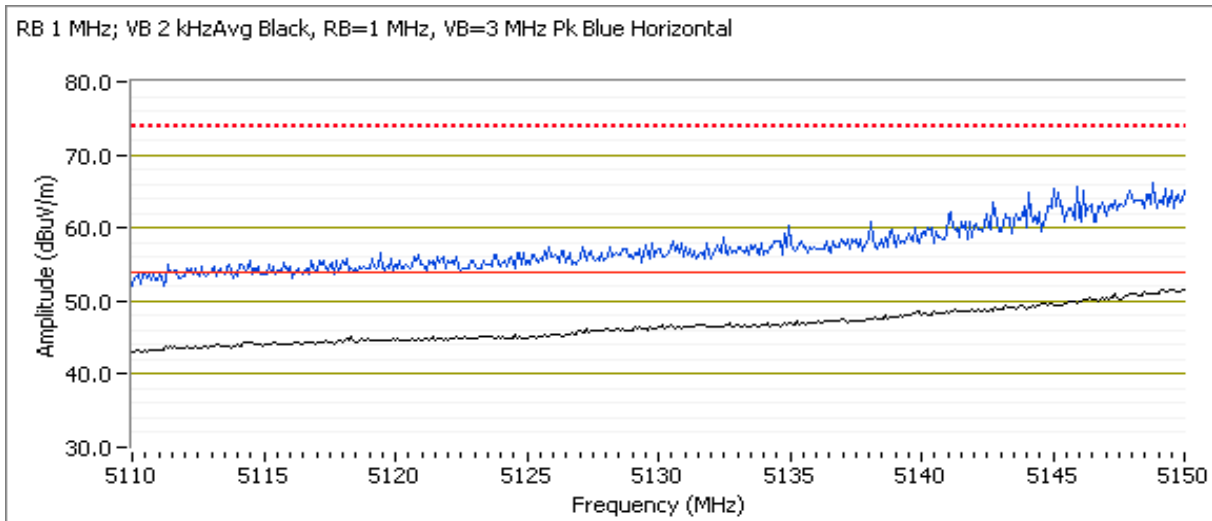
Date of Test: 7/5, 7/6/2016
 Test Engineer: Kevin Wen; Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

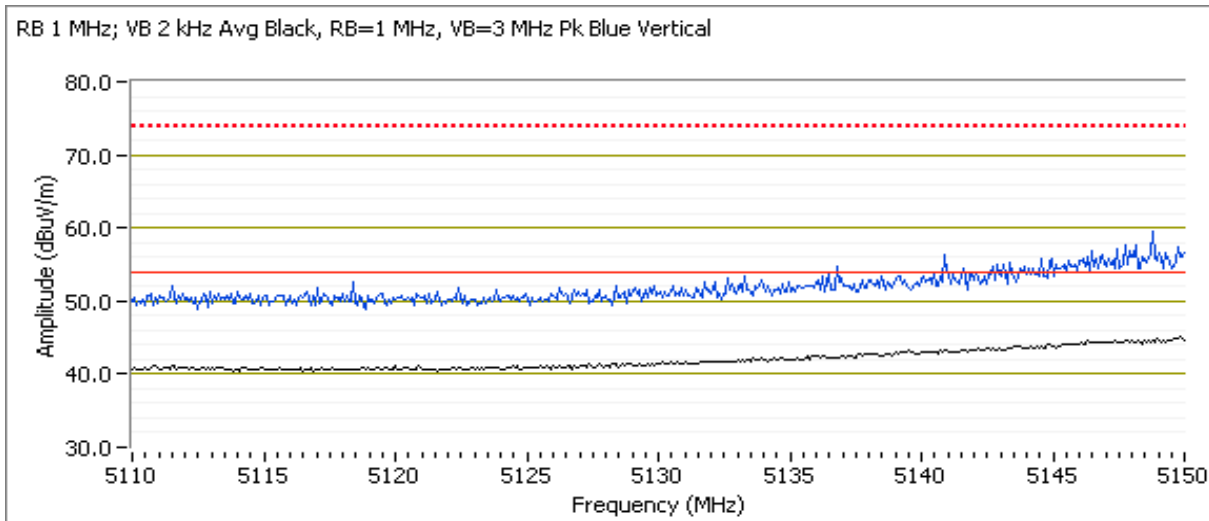
Channel: 36 - 5180 MHz
 Tx Chain: Both
 Mode: n20
 Data Rate: MCS 0

5150 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5149.920	51.8	H	54.0	-2.2	Avg	95	1.2	POS; RB 1 MHz; VB: 2 kHz
5149.360	66.4	H	74.0	-7.6	PK	95	1.2	POS; RB 1 MHz; VB: 3 MHz
5148.240	44.7	V	54.0	-9.3	Avg	148	1.3	POS; RB 1 MHz; VB: 2 kHz
5150.000	59.0	V	74.0	-15.0	PK	148	1.3	POS; RB 1 MHz; VB: 3 MHz



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



Run #6: Radiated Bandedge Measurements, 5250-5350MHz

Date of Test: 7/5, 7/6/2016
 Test Engineer: Kevin Wen; Yew-Kwong Soo
 Test Location: Fremont Chamber #5

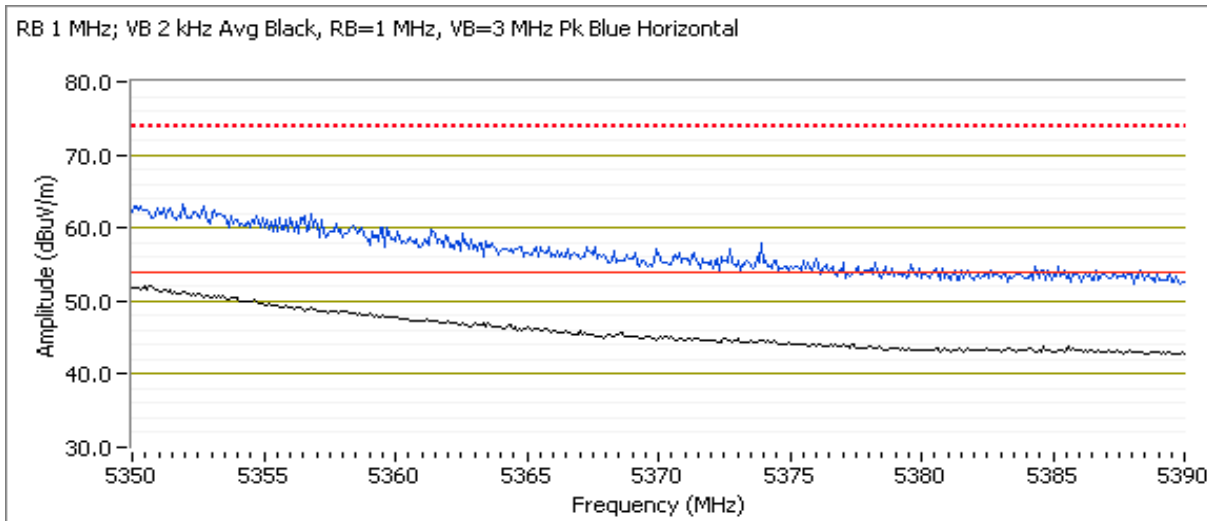
Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Channel: 64 - 5320MHz
 Tx Chain: Both
 Mode: n20
 Data Rate: MCS 0

5350 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5350.000	51.4	H	54.0	-2.6	Avg	360	1.4	POS; RB 1 MHz; VB: 2 kHz
5352.000	63.3	H	74.0	-10.7	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

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



Run #7: Radiated Bandedge Measurements, 5470-5725MHz

Date of Test: 7/5, 7/6/2016
 Test Engineer: Kevin Wen; Yew-Kwong Soo
 Test Location: Fremont Chamber #5

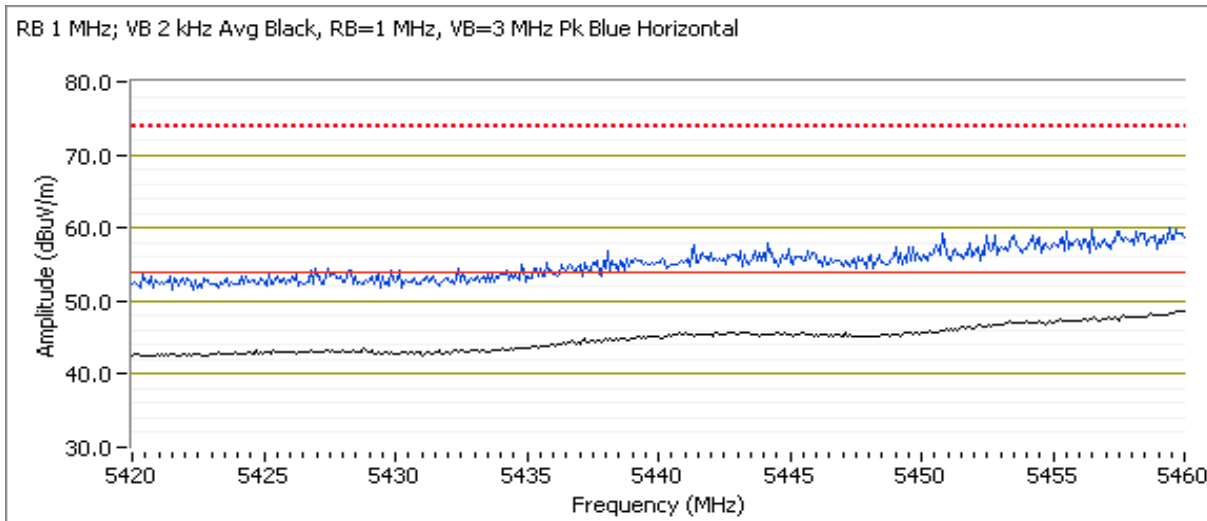
Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Channel: 100 - 5500MHz
 Tx Chain: Both
 Mode: n20
 Data Rate: MCS 0

5460 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5458.320	48.2	H	54.0	-5.8	Avg	360	1.4	POS; RB 1 MHz; VB: 2 kHz
5460.000	60.5	H	74.0	-13.5	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

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



5470 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5469.060	68.2	H	68.3	-0.1	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

Channel: 140 - 5700MHz

Tx Chain: Both

Mode: n20

Data Rate: MCS 0

5725 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5725.960	67.2	H	68.3	-1.1	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz



EMC Test Data

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

Run #8: Radiated Bandedge Measurements, 5725-5850MHz

Date of Test: 7/6/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

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

Channel: 149 - 5745MHz
 Tx Chain: Both
 Mode: n20
 Data Rate: MCS 0

5725 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5723.480	66.0	H	68.3	-2.3	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

Channel: 165 - 5825MHz
 Tx Chain: Both
 Mode: n20
 Data Rate: MCS 0

5850 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5851.440	66.2	H	68.3	-2.1	PK	360	1.4	POS; RB 1 MHz; VB: 3 MHz

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

Run #9: Radiated Bandedge Measurements, 5150-5250MHz

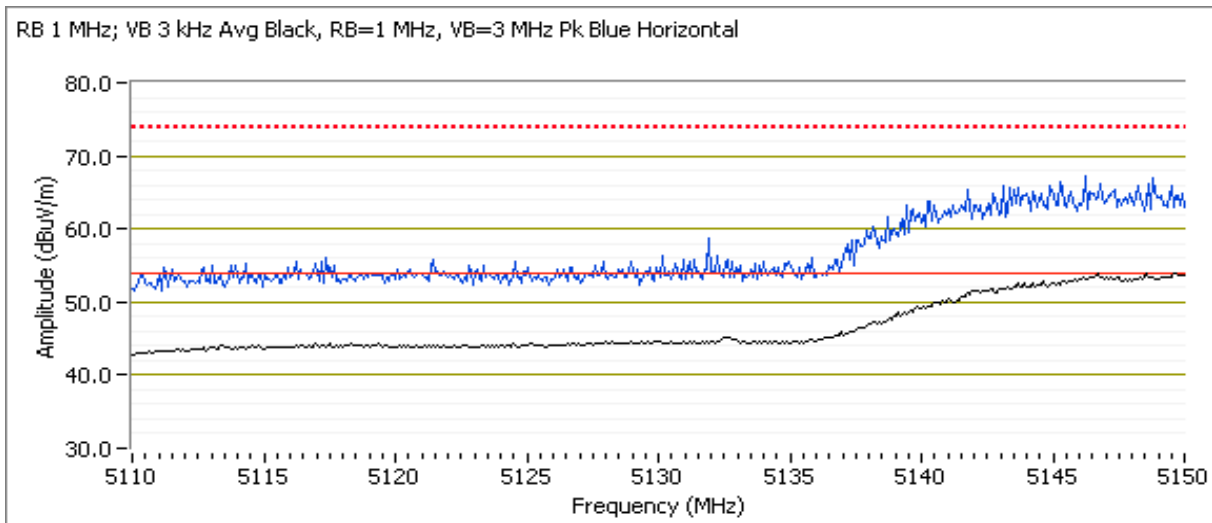
Date of Test: 7/6/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

Channel: 38 - 5190 MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS 0

5150 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5149.610	53.8	H	54.0	-0.2	Avg	89	1.2	POS; RB 1 MHz; VB: 3 kHz
5145.120	67.7	H	74.0	-6.3	PK	89	1.2	POS; RB 1 MHz; VB: 3 MHz



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

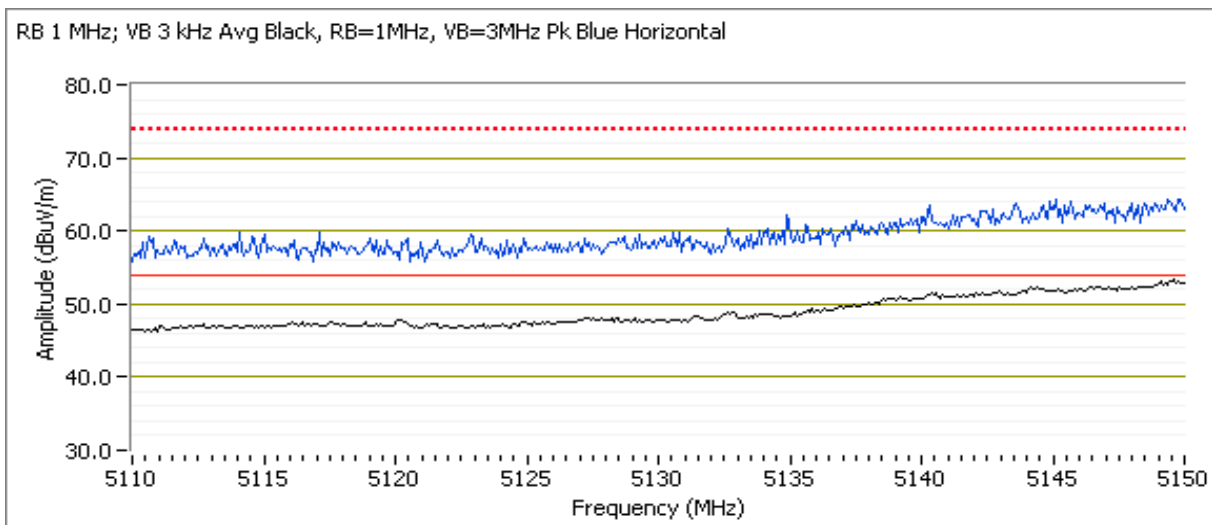
Date of Test: 7/15/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

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

Channel: 46 - 5230 MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS 0

5150 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5148.480	53.0	H	54.0	-1.0	Avg	99	1.2	POS; RB 1 MHz; VB: 3 kHz
5149.840	66.3	H	74.0	-7.7	PK	99	1.2	POS; RB 1 MHz; VB: 3 MHz
5149.040	60.5	V	54.0	6.5	Avg	310	1.2	POS; RB 1 MHz; VB: 3 MHz
5148.800	63.3	V	74.0	-10.7	PK	310	1.2	POS; RB 1 MHz; VB: 3 MHz



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

Run #10: Radiated Bandedge Measurements, 5250-5350MHz

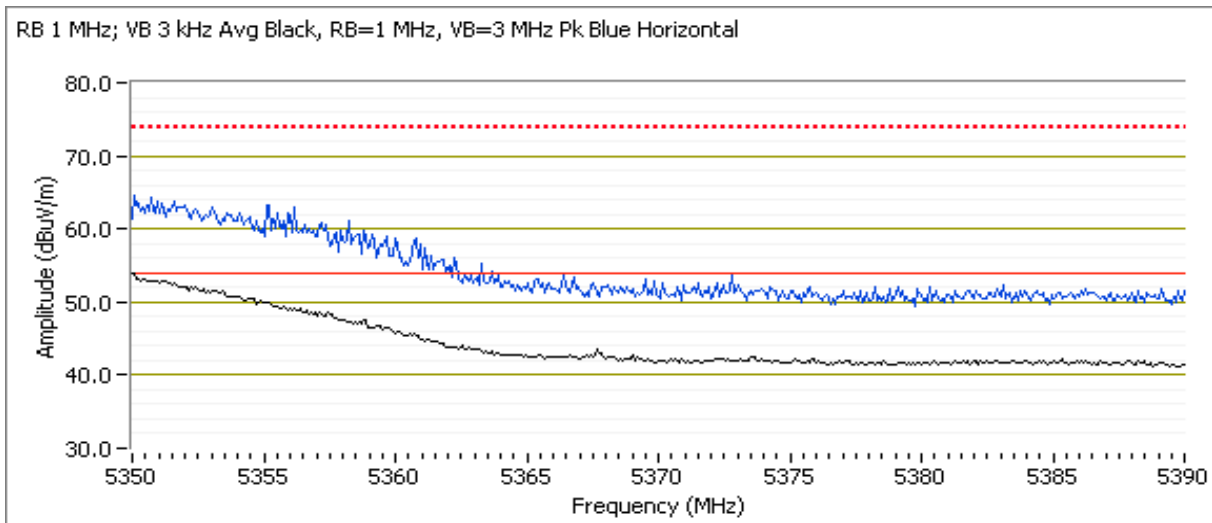
Date of Test: 7/6/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

Channel: 62 - 5310MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS 0

5350 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5350.030	53.8	H	54.0	-0.2	Avg	94	1.2	POS; RB 1 MHz; VB: 3 kHz
5350.850	66.6	H	74.0	-7.4	PK	94	1.2	POS; RB 1 MHz; VB: 3 MHz



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

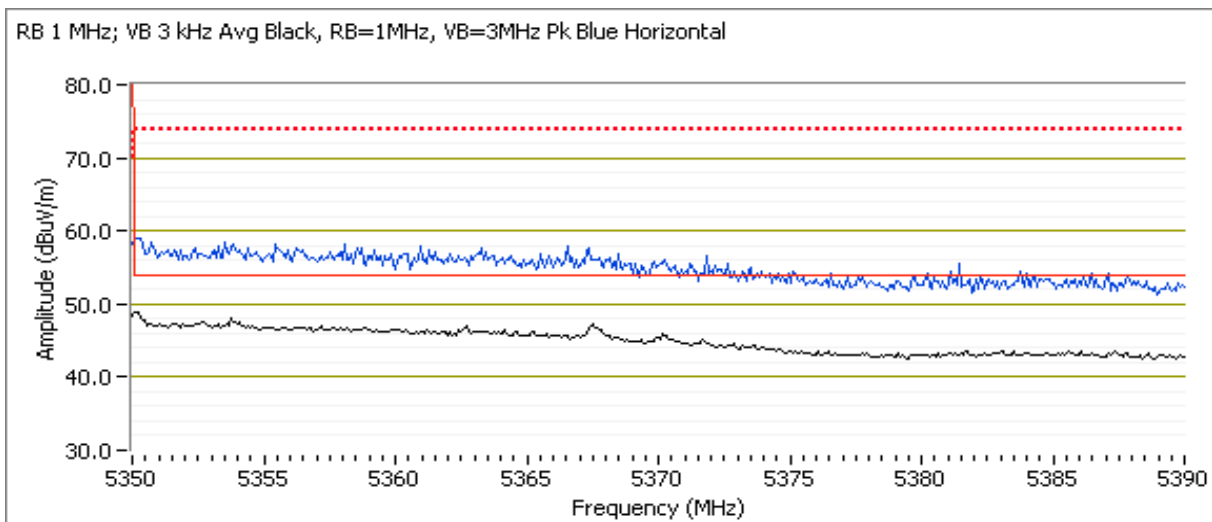
Date of Test: 7/15/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

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

Channel: 54 - 5270MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS 0

5350 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5353.930	48.2	H	54.0	-5.8	Avg	100	1.5	POS; RB 1 MHz; VB: 3 kHz
5350.320	58.9	H	74.0	-15.1	PK	100	1.5	POS; RB 1 MHz; VB: 3 MHz



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

Run #11: Radiated Bandedge Measurements, 5470-5725MHz

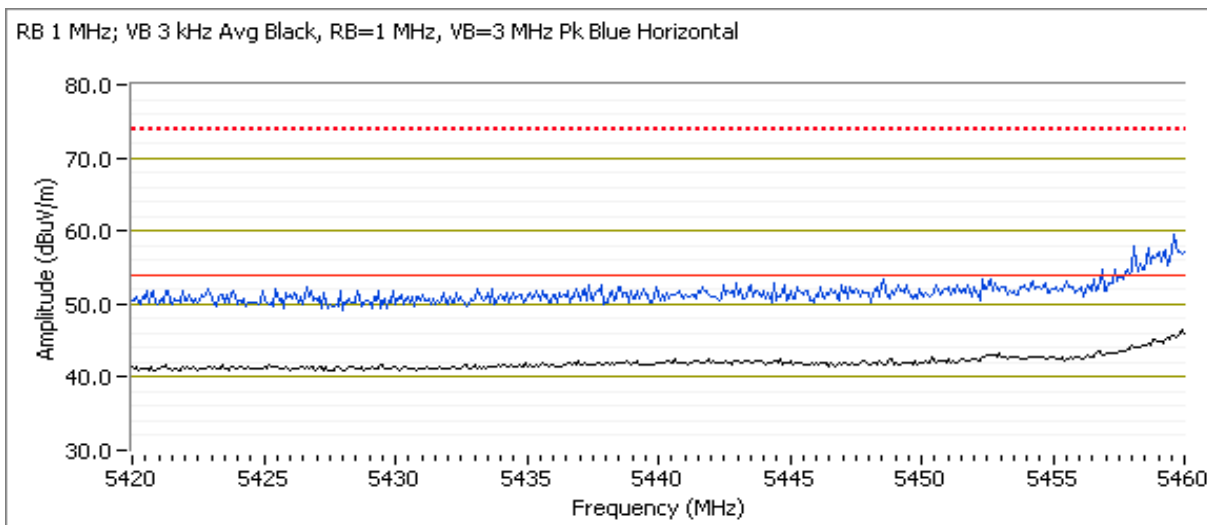
Date of Test: 7/6/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

Channel: 102 - 5510MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS0

5460 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5459.460	46.5	H	54.0	-7.5	Avg	64	1.3	POS; RB 1 MHz; VB: 3 kHz
5459.740	60.9	H	74.0	-13.1	PK	64	1.3	POS; RB 1 MHz; VB: 3 MHz



5470 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5468.480	67.8	H	68.3	-0.5	PK	64	1.3	POS; RB 1 MHz; VB: 3 MHz

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

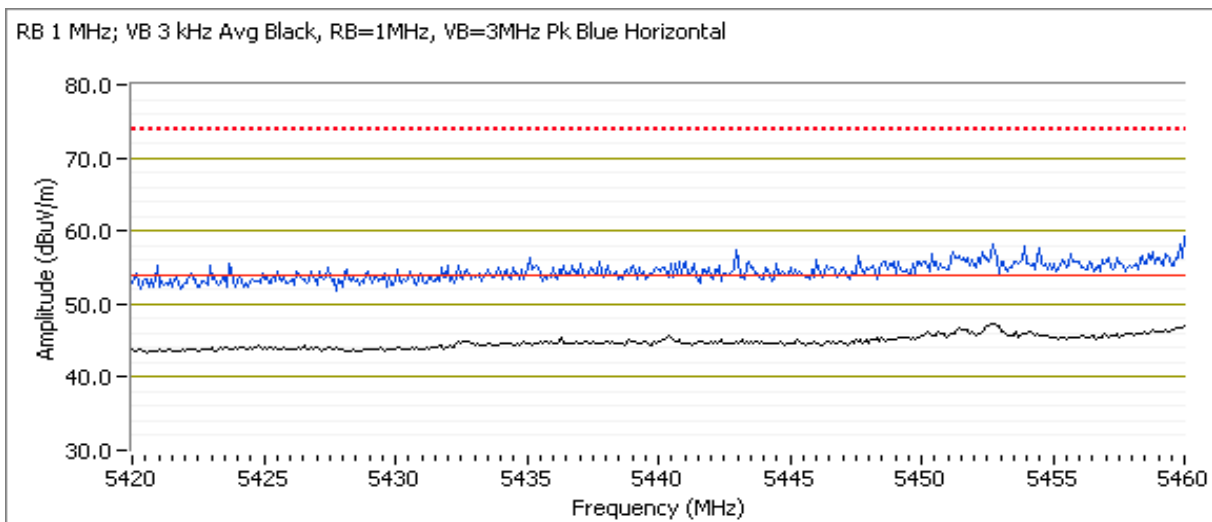
Date of Test: 7/15/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

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

Channel: 110 - 5550MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS0

5460 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5460.000	46.4	H	54.0	-7.6	Avg	100	1.4	POS; RB 1 MHz; VB: 3 kHz
5452.380	58.0	H	74.0	-16.0	PK	100	1.4	POS; RB 1 MHz; VB: 3 MHz





EMC Test Data

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

Date of Test: 7/15/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

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

Channel: 110 - 5550MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS0

5460 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5465.230	62.5	H	70.0	-7.5	PK	101	1.5	POS; RB 1 MHz; VB: 3 MHz

Channel: 134 - 5670MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS0

5725 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5727.400	64.3	H	68.3	-4.0	PK	104	1.1	POS; RB 1 MHz; VB: 3 MHz

Run #12: Radiated Bandedge Measurements, 5725-5850MHz

Date of Test: 7/6/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5

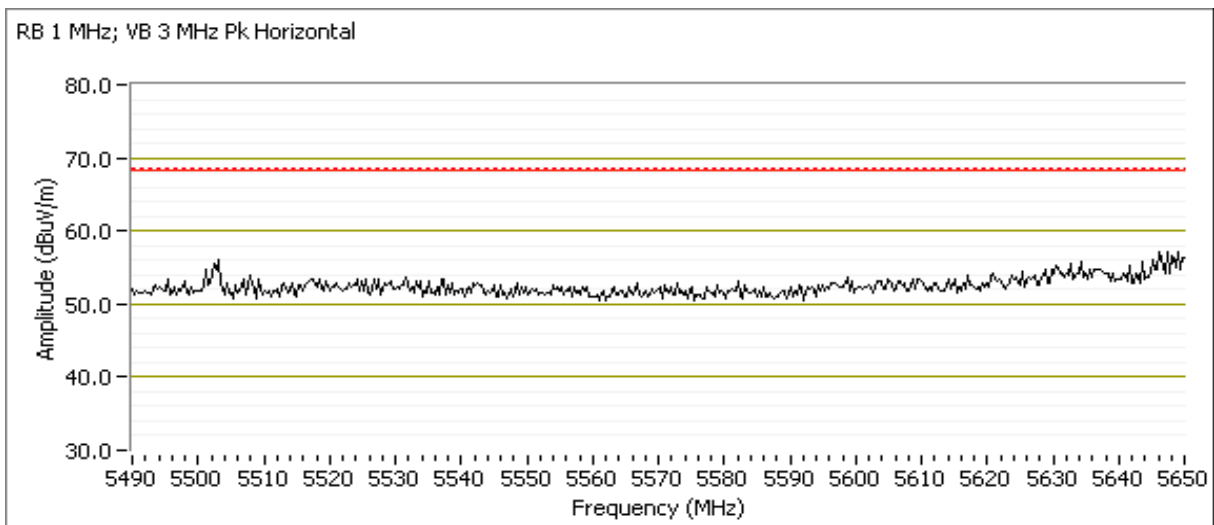
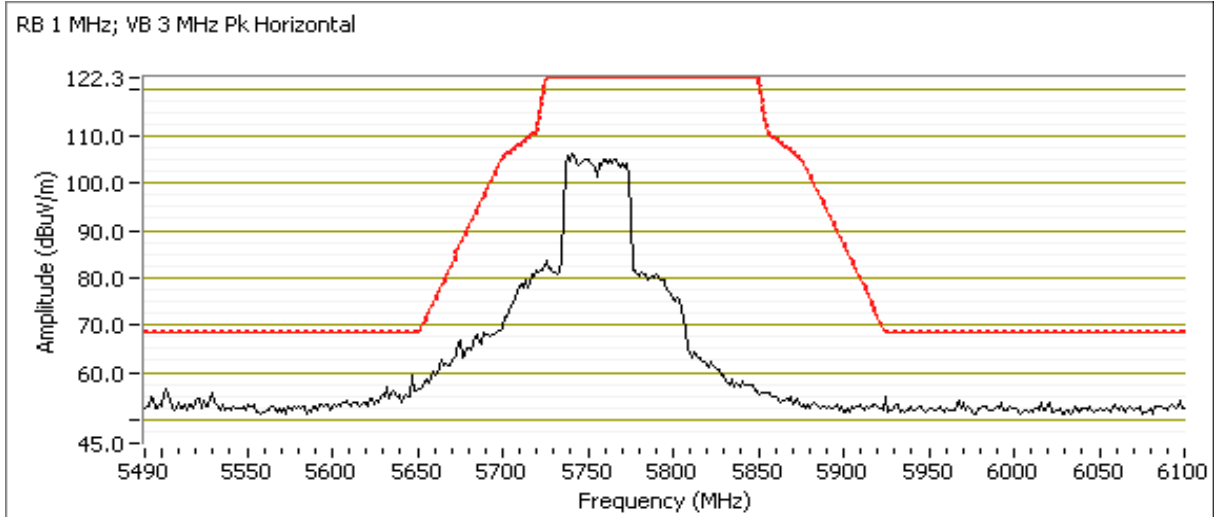
Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Channel: 151 - 5755MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS0

5725 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5629.160	56.8	H	68.3	-11.5	PK	105	1.5	POS; RB 1 MHz; VB: 3 MHz

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



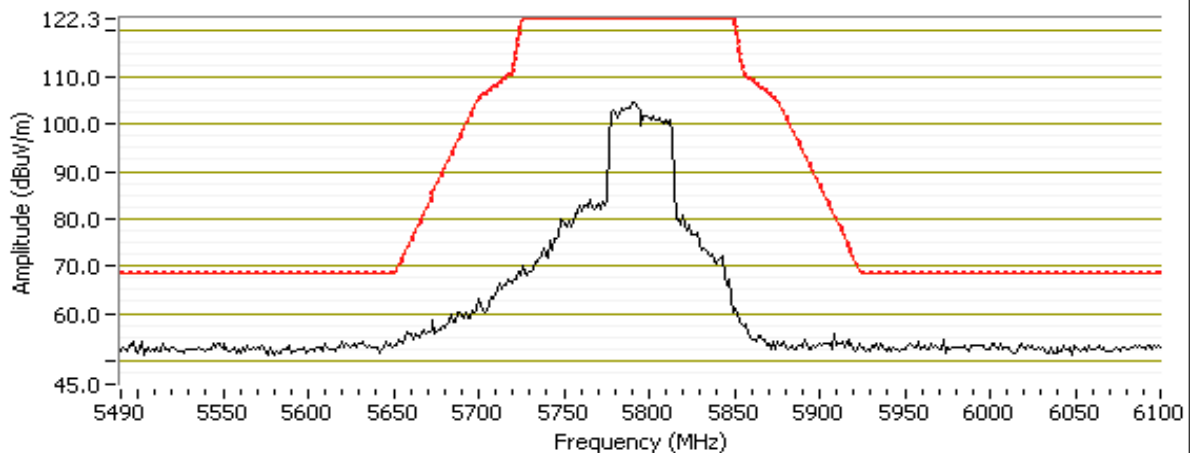
Client: Tivo, Inc.	Job Number: JD101876
Model: Mantis	T-Log Number: T102023
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Channel: 159 - 5795MHz
 Tx Chain: Both
 Mode: n40
 Data Rate: MCS0

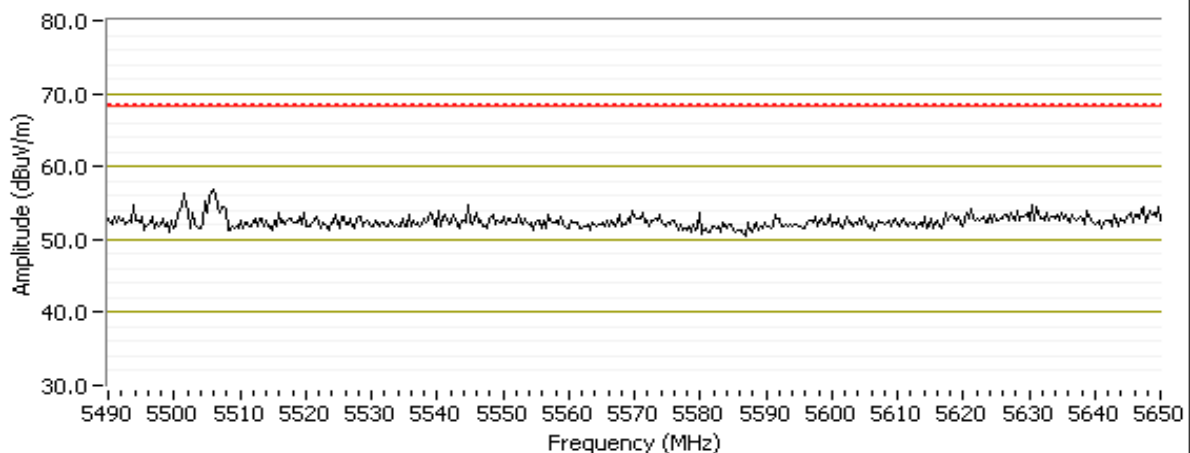
5850 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5508.600	57.3	H	68.3	-11.0	PK	105	1.5	POS; RB 1 MHz; VB: 3 MHz

RB 1 MHz; VB 3 MHz Pk Horizontal



RB 1 MHz; VB 3 MHz Pk Horizontal



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

Run #13: Radiated Bandedge Measurements, 5150-5250MHz

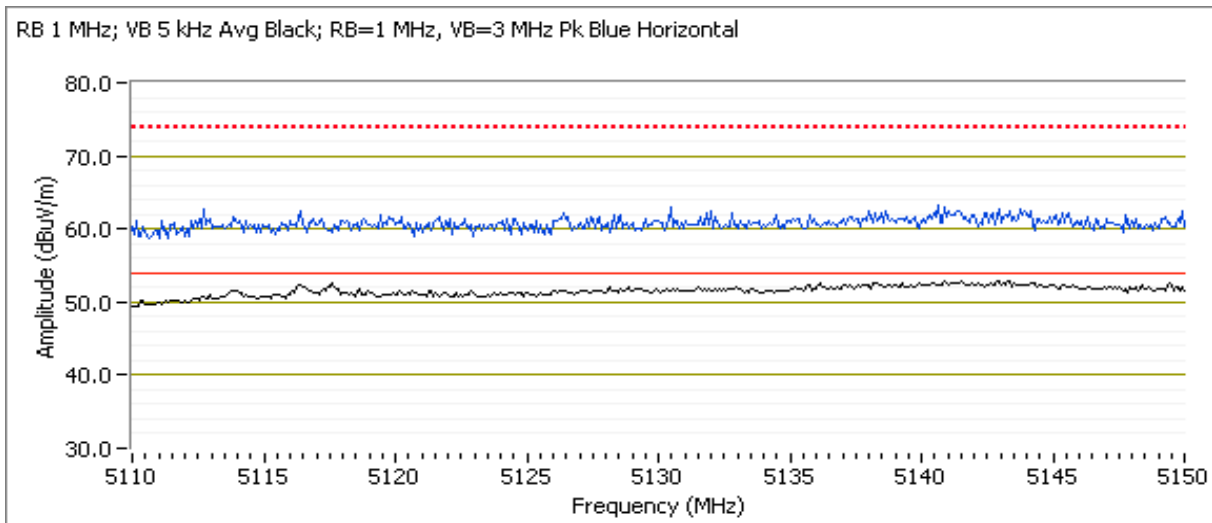
Date of Test: 7/6/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

Channel: 42 - 5210MHz
 Tx Chain: Both
 Mode: ac80
 Data Rate: VHT0 x2

5150 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5141.650	52.9	H	54.0	-1.1	Avg	101	1.1	POS; RB 1 MHz; VB: 5 kHz
5144.170	63.9	H	74.0	-10.1	PK	101	1.1	POS; RB 1 MHz; VB: 3 MHz



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

Run #14: Radiated Bandedge Measurements, 5250-5350MHz

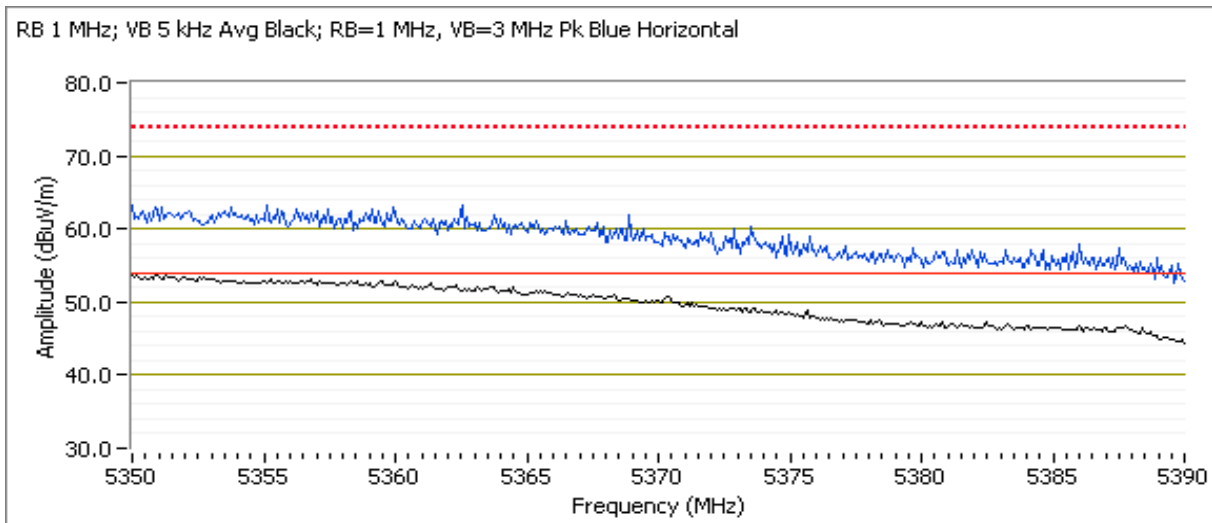
Date of Test: 7/6/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

Channel: 58 - 5290MHz
 Tx Chain: Both
 Mode: ac80
 Data Rate: VHT0 x2

5350 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5352.650	53.6	H	54.0	-0.4	Avg	96	1.3	POS; RB 1 MHz; VB: 5 kHz
5350.960	65.4	H	74.0	-8.6	PK	96	1.3	POS; RB 1 MHz; VB: 3 MHz



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

Run #15: Radiated Bandedge Measurements, 5470-5725MHz

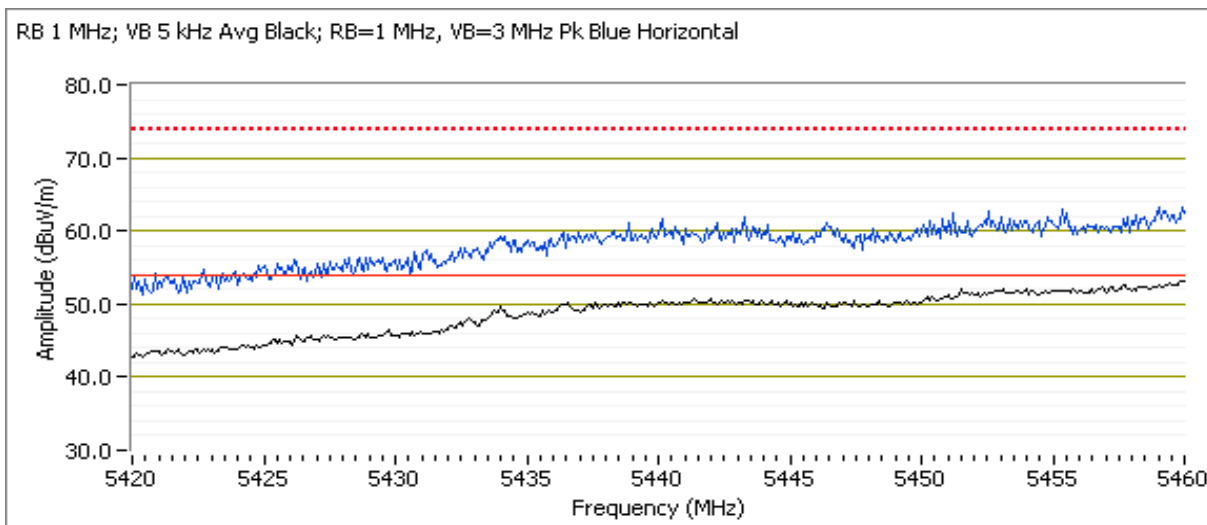
Date of Test: 7/6/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

Channel: 106 - 5530MHz
 Tx Chain: Both
 Mode: ac80
 Data Rate: VHT0 x2

5460 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5458.230	53.6	H	54.0	-0.4	Avg	76	1.5	POS; RB 1 MHz; VB: 5 kHz
5459.930	64.1	H	74.0	-9.9	PK	76	1.5	POS; RB 1 MHz; VB: 3 MHz



5470 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5465.670	67.1	H	68.3	-1.2	PK	76	1.5	POS; RB 1 MHz; VB: 3 MHz

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

Run #16: Radiated Bandedge Measurements, 5725-5850MHz

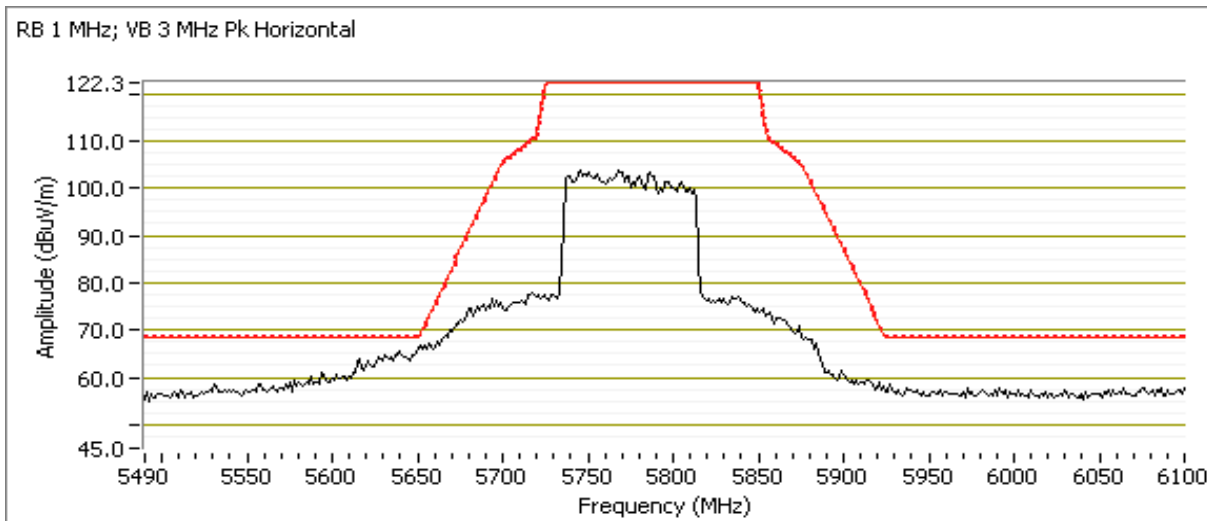
Date of Test: 7/6/2016, 7/14/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5, #4

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

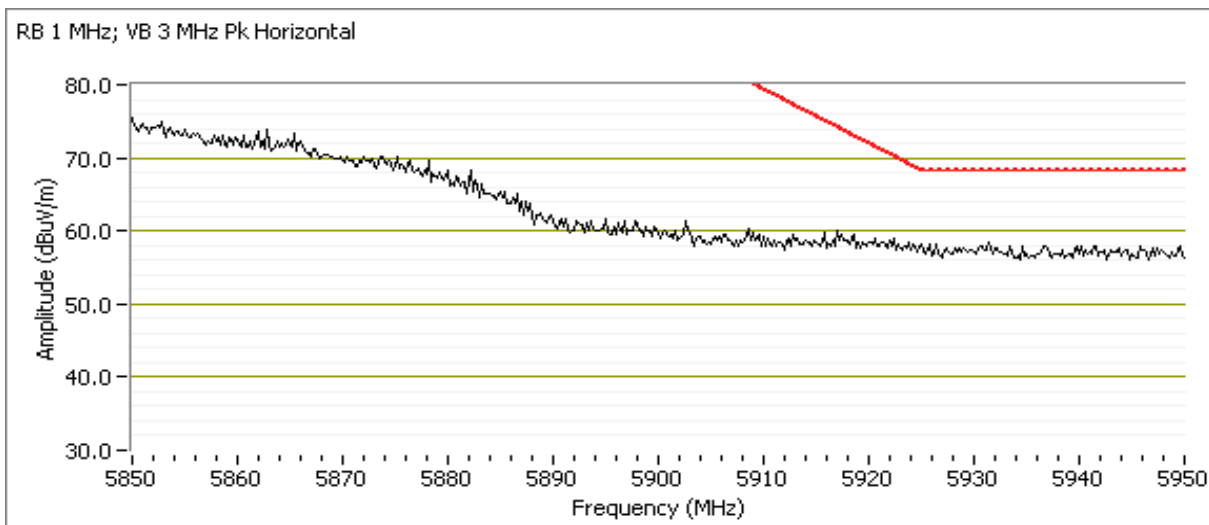
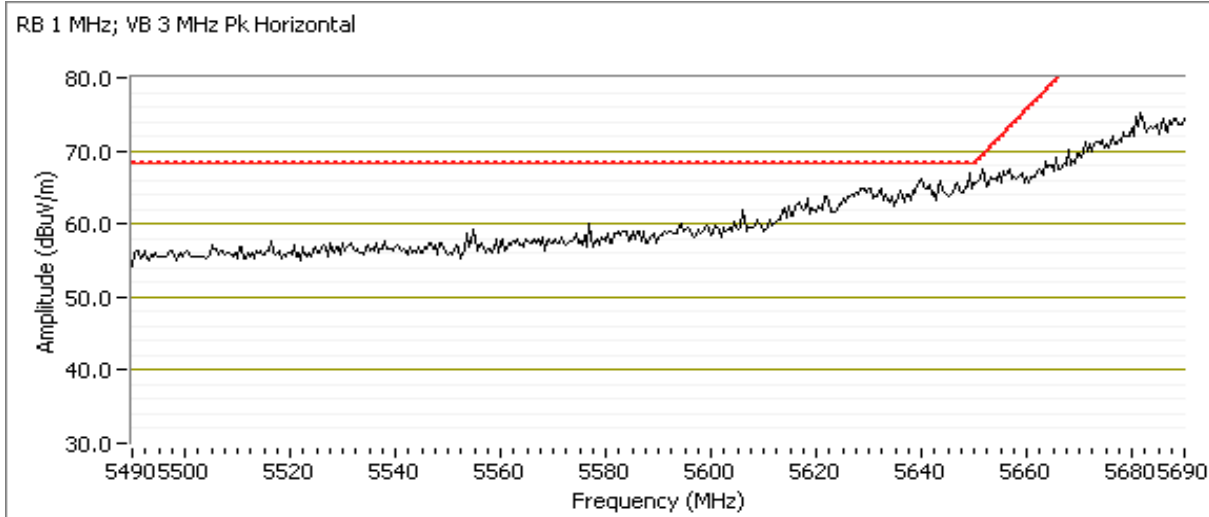
Channel: 155 - 5775MHz
 Tx Chain: Both
 Mode: ac80
 Data Rate: VHT0 x2

5725 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5646.470	66.6	H	68.3	-1.7	PK	104	1.6	POS; RB 1 MHz; VB: 3 MHz



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



5850 MHz Band Edge Signal Radiated Field Strength

Frequency	Level	Pol	15.E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
5926.410	59.7	H	68.3	-8.6	PK	104	1.6	POS; RB 1 MHz; VB: 3 MHz

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

FCC 15.407 (UNII) 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.

Date of Test: 7/11/2016, 7/12/2016
 Test Engineer: Kevin Wen, Yew-Kwong Soo
 Test Location: Fremont Chamber #5

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

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

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
Scans on "center" channel in all four OFDM modes to determine the worst case mode.							
1	a	40 - 5200MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	46.8 dBµV/m @ 1150.0 MHz (-7.2 dB)
	n20	40 - 5200MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.1 dBµV/m @ 1150.1 MHz (-6.9 dB)
	n40	38 - 5190MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.0 dBµV/m @ 1150.1 MHz (-7.0 dB)
	ac80	42 - 5210MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	51.2 dBµV/m @ 5037.6 MHz (-2.8 dB)
Measurements on low and high channels in worst-case OFDM mode.							
2	n20	36 - 5180MHz	1	1	Radiated Emissions, 1 - 11 GHz	FCC 15.209 / 15 E	45.4 dBµV/m @ 1150.1 MHz (-8.6 dB)
	n20	48 - 5240MHz	1	1	Radiated Emissions, 1 - 11 GHz	FCC 15.209 / 15 E	45.5 dBµV/m @ 1150.0 MHz (-8.5 dB)
Scans on "center" channel in all four OFDM modes to determine the worst case mode.							
3	a	60 - 5300MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	46.8 dBµV/m @ 1150.0 MHz (-7.2 dB)
	n20	60 - 5300MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.2 dBµV/m @ 1150.1 MHz (-6.8 dB)

EMC Test Data

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

Run #	Mode	Channel	Target Pwr Index	Power Index	Test Performed	Limit	Result / Margin
3	n40	54 - 5270MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	46.9 dBµV/m @ 1150.0 MHz (-7.1 dB)
	ac80	58 - 5290MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	48.8 dBµV/m @ 5435.0 MHz (-5.2 dB)

Measurements on low and high channels in worst-case OFDM mode.

4	n20	52 - 5260MHz	1	1	Radiated Emissions, 1 - 11 GHz	FCC 15.209 / 15 E	45.0 dBµV/m @ 1150.0 MHz (-9.0 dB)
	n20	64 - 5320MHz	1	1	Radiated Emissions, 1 - 11 GHz	FCC 15.209 / 15 E	45.2 dBµV/m @ 1150.0 MHz (-8.8 dB)

Scans on "center" channel in all four OFDM modes to determine the worst case mode.

5	a	116 - 5580MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.2 dBµV/m @ 1050.0 MHz (-6.8 dB)
	n20	116 - 5580MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.3 dBµV/m @ 1050.1 MHz (-6.7 dB)
	n40	110 - 5550MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.7 dBµV/m @ 1150.0 MHz (-6.3 dB)
	ac80	106 - 5530MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	48.5 dBµV/m @ 4915.7 MHz (-5.5 dB)

80MHz - use if worse case from 5 but must do highest 20 MHz channel also

6	ac80	138 - 5690MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	51.2 dBµV/m @ 5058.0 MHz (-2.8 dB)
	n20	144 - 5720MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	44.5 dBµV/m @ 1150.0 MHz (-9.5 dB)

Scans on "center" channel in all four OFDM modes to determine the worst case mode.

7	a	157 - 5785MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.1 dBµV/m @ 1050.0 MHz (-6.9 dB)
	n20	157 - 5785MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	47.0 dBµV/m @ 1050.0 MHz (-7.0 dB)
	n40	159 - 5795MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	46.9 dBµV/m @ 1050.1 MHz (-7.1 dB)
	ac80	155 - 5775MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	52.9 dBµV/m @ 5133.6 MHz (-1.1 dB)

Measurements on low and high channels in worst-case OFDM mode.

8	a	149 - 5745MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	44.6 dBµV/m @ 1150.1 MHz (-9.4 dB)
	a	165 - 5825MHz	1	1	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	44.8 dBµV/m @ 1150.1 MHz (-9.2 dB)

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

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 789033

Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time

Unless otherwise stated/noted, emission has duty cycle $\geq 98\%$ and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold 50 traces. (method VB of KDB 789033)

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11a	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	VHT0 x2	0.82	Yes	0.226	0.85	1.70	4425

Sample Notes

Sample S/N: 8FA0001901E2766

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

Antenna: Internal 2x2 Beamforming

Measurement Specific Notes:

Note 1:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB $\geq$ 3MHz, peak detector). Per KDB 789033 2) c) (i), compliance can be demonstrated by meeting the average and peak limits of 15.209, as an alternative.
Note 2:	Emission has a duty cycle $\geq 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces (method AD of KDB 789033)
Note 3:	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, max hold 50*1/DC traces (method VB of KDB 789033)
Note 4:	Emission has a duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100*1/DC traces, measurement corrected by Pwr correction factor (method AD of KDB 789033)



EMC Test Data

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

Run #1, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5150-5250 MHz Band

Date of Test: 7/11/2016, 7/12/2016

Config. Used: 2

Test Engineer: Kevin Wen, Yew-Kwong Soo

Config Change: None

Test Location: Fremont Chamber #5

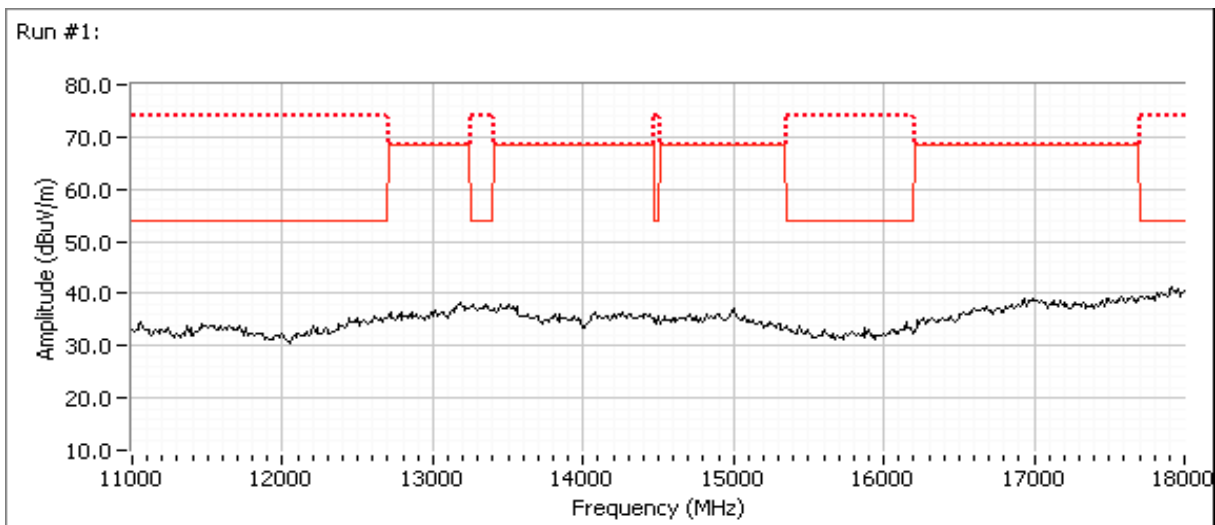
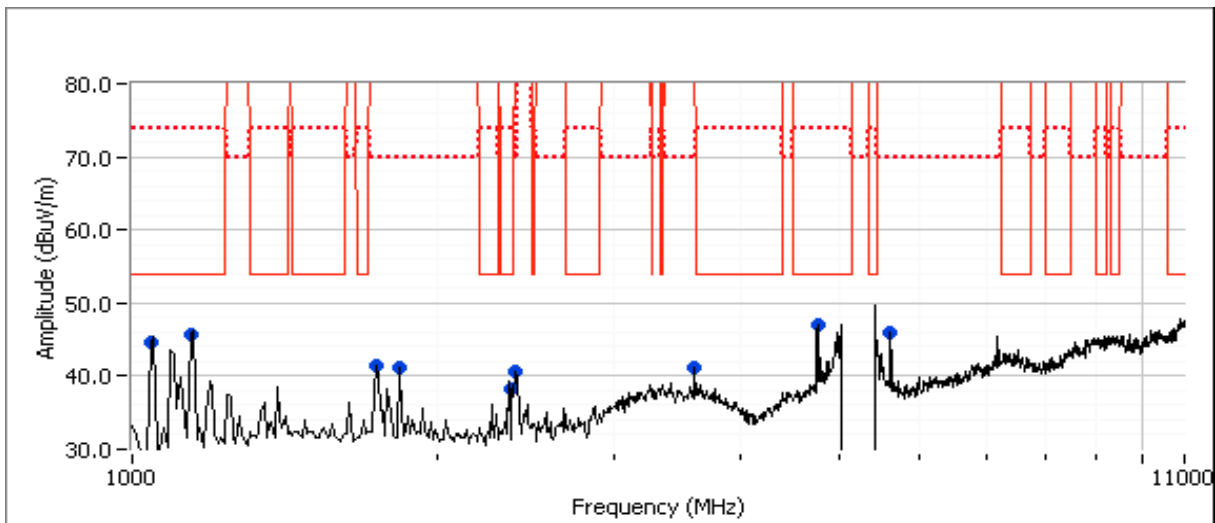
EUT Voltage: 120V/60Hz

Run #1a: Center Channel

Channel: 40 Mode: a
Tx Chain: Both Data Rate: 6 MB/s

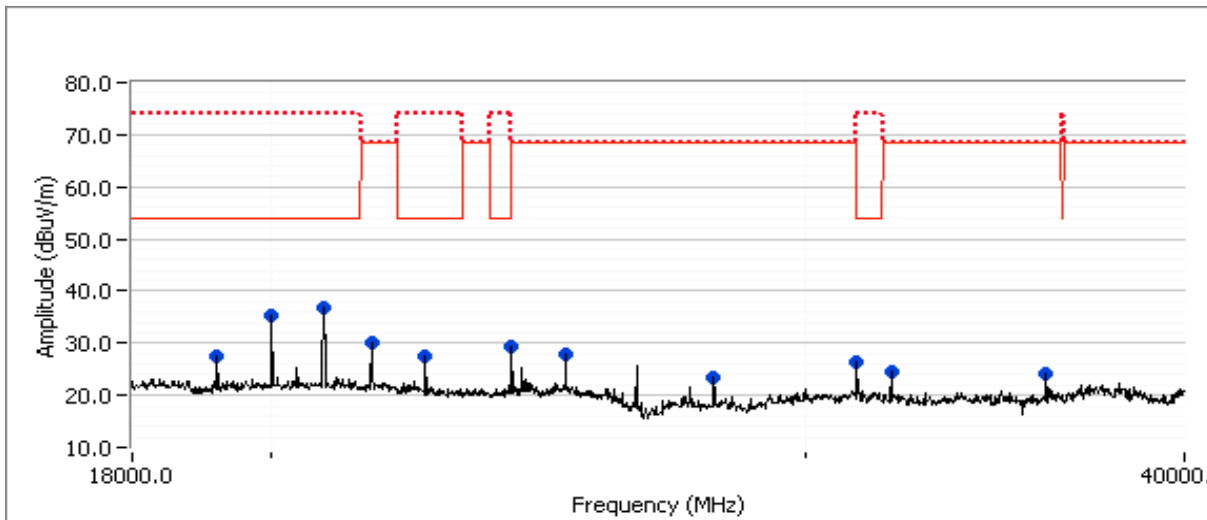
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1041.670	44.6	V	54.0	-9.4	Peak	116	1.0	
1141.670	45.8	V	54.0	-8.2	Peak	324	1.5	
1741.670	41.5	V	70.0	-28.5	Peak	359	2.5	
1841.670	41.2	V	70.0	-28.8	Peak	355	1.5	
2375.000	38.2	V	54.0	-15.8	Peak	223	1.5	
2391.670	40.7	V	70.0	-29.3	Peak	265	1.5	
3600.000	41.3	V	70.0	-28.7	Peak	97	1.0	
4766.670	47.0	H	54.0	-7.0	Peak	348	2.5	
5625.000	46.0	H	70.0	-24.0	Peak	353	2.5	
19190.000	27.4	V	54.0	-26.6	Peak	0	1.0	
20011.670	35.4	V	54.0	-18.6	Peak	0	1.0	
20819.170	36.7	V	54.0	-17.3	Peak	0	1.0	
21584.170	30.0	V	68.3	-38.3	Peak	0	1.0	
22476.670	27.6	V	54.0	-26.4	Peak	0	1.0	
24006.670	29.2	V	68.3	-39.1	Peak	0	1.0	
25012.500	27.9	V	68.3	-40.4	Peak	0	1.0	
27985.000	23.3	V	68.3	-45.0	Peak	0	1.0	
31180.000	26.2	V	68.3	-42.1	Peak	0	1.0	
32012.500	24.5	V	68.3	-43.8	Peak	0	1.0	
36017.500	24.2	V	68.3	-44.1	Peak	0	1.0	

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



Note 1: Scans made between 11 - 18 GHz with the measurement antenna positioned 1 meter from the EUT indicated there were no significant emissions in this frequency range.

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



Note 1:	Scans made between 18 - 40 GHz with the measurement antenna moved around the EUT 20-50cm from the device indicated there were no significant emissions in this frequency range.
Note 2:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 3:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.040	46.8	V	54.0	-7.2	Avg	307	1.5	RB 1 MHz;VB 1 kHz;Peak
1149.910	48.9	V	74.0	-25.1	PK	307	1.5	RB 1 MHz;VB 3 MHz;Peak
4762.530	44.2	H	54.0	-9.8	Avg	326	2.2	RB 1 MHz;VB 1 kHz;Peak
4762.240	54.9	H	74.0	-19.1	PK	326	2.2	RB 1 MHz;VB 3 MHz;Peak
1050.050	44.8	V	54.0	-9.2	Avg	122	1.0	RB 1 MHz;VB 1 kHz;Peak
1049.950	47.6	V	74.0	-26.4	PK	122	1.0	RB 1 MHz;VB 3 MHz;Peak
2367.650	37.9	V	54.0	-16.1	Avg	220	1.6	RB 1 MHz;VB 1 kHz;Peak
2367.660	43.8	V	74.0	-30.2	PK	220	1.6	RB 1 MHz;VB 3 MHz;Peak
5633.400	55.1	H	68.3	-13.2	PK	352	2.1	RB 1 MHz;VB 3 MHz;Peak
20820.260	35.3	V	54.0	-18.7	AVG	359	2.5	RB 1 MHz;VB 10 Hz;Peak
20818.890	47.8	V	74.0	-26.2	PK	359	2.5	RB 1 MHz;VB 3 MHz;Peak

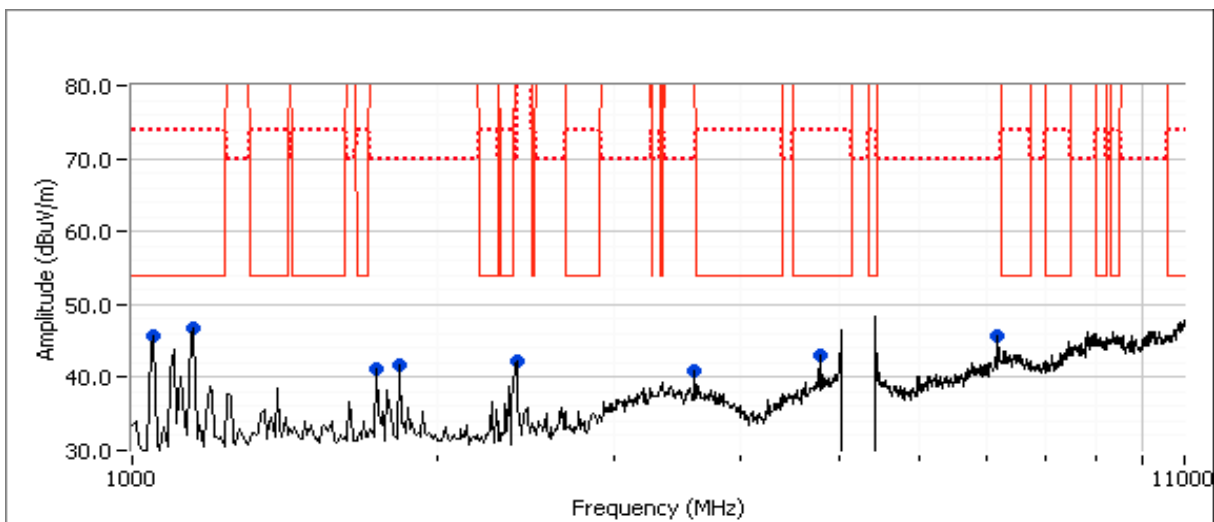
Note:	Measurements above 18 GHz performed at 3 meters were only of the measurement system noise.
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Client: Tivo, Inc.	Job Number: JD101876
Model: Mantis	T-Log Number: T102023
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Run #1b: Center Channel

Channel: 40 Mode: 11n20
 Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	45.7	V	54.0	-8.3	Peak	123	1.0	
1150.000	46.8	V	54.0	-7.2	Peak	317	1.5	
1741.670	41.1	V	70.0	-28.9	Peak	359	1.5	
1841.670	41.7	V	70.0	-28.3	Peak	355	1.5	
2400.000	42.2	H	70.0	-27.8	Peak	14	2.5	
3600.000	41.0	V	70.0	-29.0	Peak	296	1.0	
4791.670	42.9	V	54.0	-11.1	Peak	71	1.5	
7191.670	45.7	V	70.0	-24.3	Peak	104	2.5	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

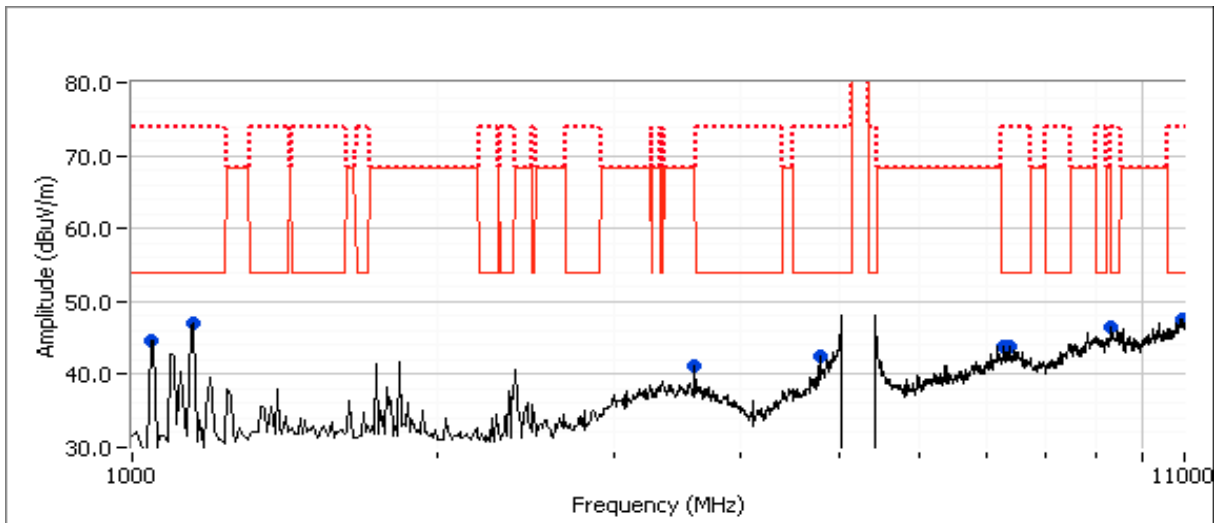
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.060	47.1	V	54.0	-6.9	Avg	309	1.5	RB 1 MHz;VB 3 kHz;Peak
1149.860	49.3	V	74.0	-24.7	PK	309	1.5	RB 1 MHz;VB 3 MHz;Peak
1050.070	44.6	V	54.0	-9.4	Avg	121	1.0	RB 1 MHz;VB 3 kHz;Peak
1050.170	47.1	V	74.0	-26.9	PK	121	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.220	42.1	V	54.0	-11.9	Avg	51	1.7	RB 1 MHz;VB 3 kHz;Peak
4795.270	48.8	V	74.0	-25.2	PK	51	1.7	RB 1 MHz;VB 3 MHz;Peak
7192.830	42.5	V	68.3	-25.8	Avg	104	2.5	RB 1 MHz;VB 3 kHz;Peak
7192.980	50.4	V	68.3	-17.9	PK	104	2.5	RB 1 MHz;VB 3 MHz;Peak

Run #1c: Center Channel

Channel: 38 Mode: 11n40
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.000	47.1	V	54.0	-6.9	Peak	319	1.5	
1041.670	44.6	V	54.0	-9.4	Peak	126	1.0	
3600.000	41.2	V	68.3	-27.1	Peak	304	1.0	
4791.670	42.4	V	54.0	-11.6	Peak	355	1.5	
7291.670	43.7	V	54.0	-10.3	Peak	23	1.0	
7375.000	43.7	H	54.0	-10.3	Peak	74	2.0	
9316.670	46.5	V	54.0	-7.5	Peak	360	2.0	
10933.330	47.5	V	54.0	-6.5	Peak	265	2.0	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

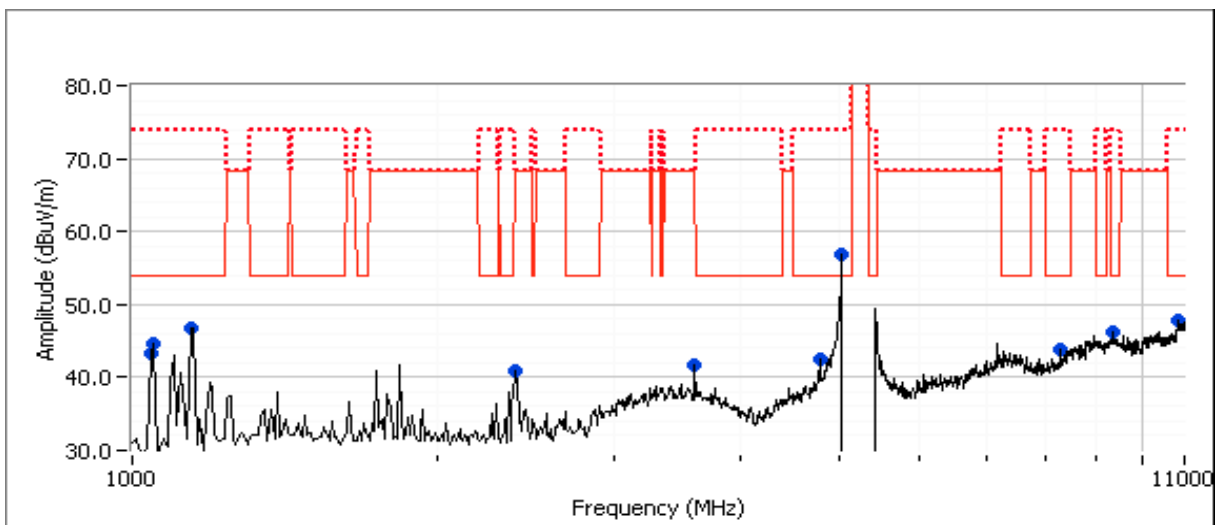
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.050	47.0	V	54.0	-7.0	Avg	306	1.5	RB 1 MHz;VB 3 kHz;Peak
1150.090	49.2	V	74.0	-24.8	PK	306	1.5	RB 1 MHz;VB 3 MHz;Peak
10935.100	42.3	V	54.0	-11.7	Avg	252	2.0	RB 1 MHz;VB 3 kHz;Peak
10932.360	54.7	V	74.0	-19.3	PK	252	2.0	RB 1 MHz;VB 3 MHz;Peak
9319.370	40.4	V	54.0	-13.6	Avg	360	2.0	RB 1 MHz;VB 3 kHz;Peak
9321.210	51.3	V	74.0	-22.7	PK	360	2.0	RB 1 MHz;VB 3 MHz;Peak
1049.990	44.7	V	54.0	-9.3	Avg	133	1.0	RB 1 MHz;VB 3 kHz;Peak
1050.020	47.3	V	74.0	-26.7	PK	133	1.0	RB 1 MHz;VB 3 MHz;Peak
7294.960	38.3	V	54.0	-15.7	Avg	23	1.0	RB 1 MHz;VB 3 kHz;Peak
7296.570	49.5	V	74.0	-24.5	PK	23	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.190	39.7	V	54.0	-14.3	Avg	349	1.6	RB 1 MHz;VB 3 kHz;Peak
4794.910	48.1	V	74.0	-25.9	PK	349	1.6	RB 1 MHz;VB 3 MHz;Peak

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

Run #1d: Center Channel

Channel: 42 Mode: ac80
 Tx Chain: Both Data Rate: VHT0 x2

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1041.670	43.3	V	54.0	-10.7	Peak	131	1.0	
1050.000	44.6	V	54.0	-9.4	Peak	125	1.0	
1141.670	46.8	V	54.0	-7.2	Peak	312	1.5	
2391.670	41.0	V	68.3	-27.3	Peak	244	1.5	
3600.000	41.8	V	68.3	-26.5	Peak	141	2.5	
4791.670	42.6	V	54.0	-11.4	Peak	77	1.5	
5041.670	56.9	H	54.0	2.9	Peak	324	1.5	Due to band-reject filter
8283.330	43.8	V	54.0	-10.2	Peak	335	1.5	
9350.000	46.1	V	54.0	-7.9	Peak	356	1.0	
10858.330	47.7	V	54.0	-6.3	Peak	19	1.5	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5037.640	51.2	H	54.0	-2.8	Avg	340	1.9	POS; RB 1 MHz; VB: 10 kHz
5046.840	61.4	H	74.0	-12.6	PK	340	1.9	POS; RB 1 MHz; VB: 3 MHz
1150.030	47.2	V	54.0	-6.8	Avg	309	1.5	RB 1 MHz;VB 10 kHz;Peak
1150.190	49.0	V	74.0	-25.0	PK	309	1.5	RB 1 MHz;VB 3 MHz;Peak
10858.060	44.0	V	54.0	-10.0	Avg	21	1.5	RB 1 MHz;VB 10 kHz;Peak
10855.150	53.1	V	74.0	-20.9	PK	21	1.5	RB 1 MHz;VB 3 MHz;Peak
9355.290	42.1	V	54.0	-11.9	Avg	355	1.0	RB 1 MHz;VB 10 kHz;Peak
9356.470	52.2	V	74.0	-21.8	PK	355	1.0	RB 1 MHz;VB 3 MHz;Peak
1050.060	44.7	V	54.0	-9.3	Avg	124	1.0	RB 1 MHz;VB 10 kHz;Peak
1049.960	47.2	V	74.0	-26.8	PK	124	1.0	RB 1 MHz;VB 3 MHz;Peak
8288.280	40.0	V	54.0	-14.0	Avg	337	1.5	RB 1 MHz;VB 10 kHz;Peak
8289.710	49.3	V	74.0	-24.7	PK	337	1.5	RB 1 MHz;VB 3 MHz;Peak
1050.070	44.9	V	54.0	-9.1	Avg	131	1.0	RB 1 MHz;VB 10 kHz;Peak
1049.940	47.1	V	74.0	-26.9	PK	131	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.160	42.7	V	54.0	-11.3	Avg	50	1.7	RB 1 MHz;VB 10 kHz;Peak
4794.960	48.6	V	74.0	-25.4	PK	50	1.7	RB 1 MHz;VB 3 MHz;Peak

Run #2: Radiated Spurious Emissions, 1,000 - 40000 MHz. Operating Mode: Worse case from Run #1

Date of Test: 7/13/2016

Config. Used: 2

Test Engineer: Kevin Wen

Config Change: None

Test Location: Fremont Chamber #5

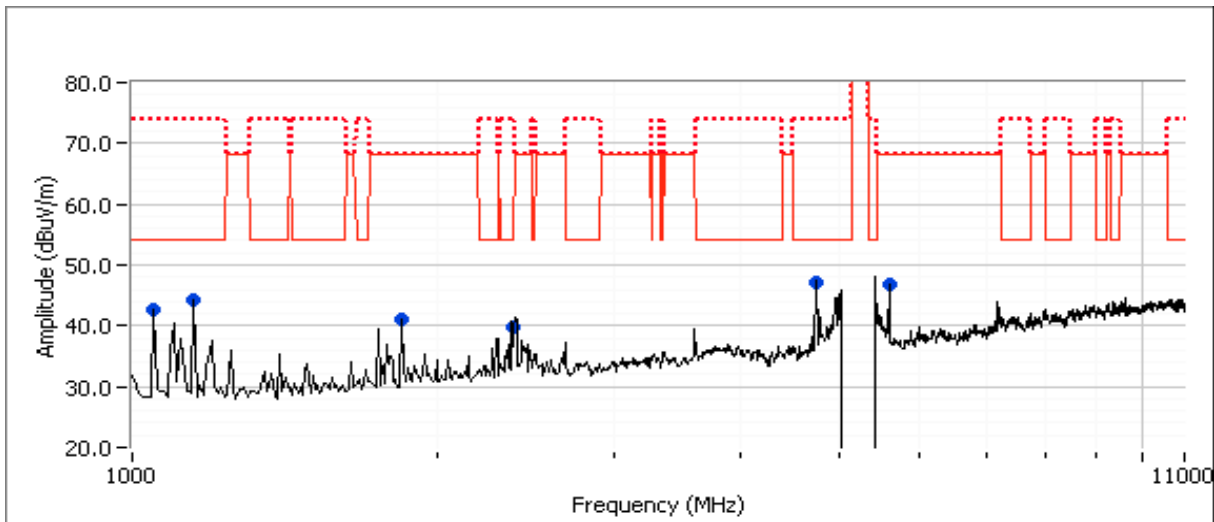
EUT Voltage: 120V/60Hz

Run #2a: Low Channel

Channel: 36 Mode: n20
Tx Chain: Both Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.250	42.6	V	54.0	-11.4	Peak	125	1.5	
1150.250	44.4	V	54.0	-9.6	Peak	337	1.5	
1850.000	41.1	V	68.3	-27.2	Peak	226	1.5	
2383.330	39.7	V	54.0	-14.3	Peak	220	1.5	
4756.000	47.0	H	54.0	-7.0	Peak	85	1.5	
5608.330	46.7	H	68.3	-21.6	Peak	128	1.5	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

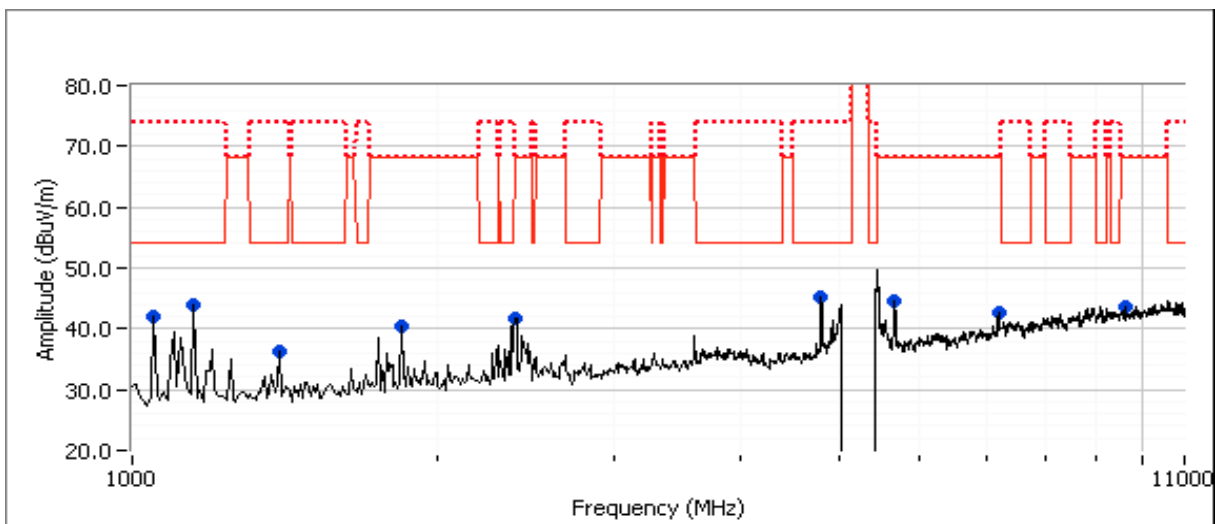
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.070	45.4	V	54.0	-8.6	Avg	328	1.6	RB 1 MHz;VB 3 kHz;Peak
1150.010	48.0	V	74.0	-26.0	PK	328	1.6	RB 1 MHz;VB 3 MHz;Peak
1050.020	43.0	V	54.0	-11.0	Avg	128	1.4	RB 1 MHz;VB 3 kHz;Peak
1050.050	45.9	V	74.0	-28.1	PK	128	1.4	RB 1 MHz;VB 3 MHz;Peak
4747.040	42.6	H	54.0	-11.4	Avg	91	1.5	RB 1 MHz;VB 3 kHz;Peak
4747.190	53.9	H	74.0	-20.1	PK	91	1.5	RB 1 MHz;VB 3 MHz;Peak

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

Run #2b: High Channel

Channel: 48 Mode: n20
 Tx Chain: Both Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.060	42.1	V	54.0	-11.9	Peak	131	2.0	
1150.060	43.9	V	54.0	-10.1	Peak	338	1.5	
1400.000	36.3	V	54.0	-17.7	Peak	173	1.5	
1850.000	40.4	V	68.3	-27.9	Peak	232	1.5	
2391.670	41.8	V	68.3	-26.5	Peak	240	1.5	
4795.240	45.3	H	54.0	-8.7	Peak	329	2.0	
5683.330	44.6	H	68.3	-23.7	Peak	73	1.0	
7200.000	42.6	V	68.3	-25.7	Peak	337	1.0	
9600.000	43.6	V	68.3	-24.7	Peak	0	2.0	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.030	45.5	V	54.0	-8.5	Avg	339	1.6	RB 1 MHz;VB 3 kHz;Peak
1150.070	48.0	V	74.0	-26.0	PK	339	1.6	RB 1 MHz;VB 3 MHz;Peak
1050.020	42.6	V	54.0	-11.4	Avg	125	1.9	RB 1 MHz;VB 3 kHz;Peak
1049.940	46.0	V	74.0	-28.0	PK	125	1.9	RB 1 MHz;VB 3 MHz;Peak
4805.820	40.6	H	54.0	-13.4	Avg	326	1.9	RB 1 MHz;VB 3 kHz;Peak
4807.820	52.1	H	74.0	-21.9	PK	326	1.9	RB 1 MHz;VB 3 MHz;Peak

Run #3, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5250-5350 MHz Band

Date of Test: 7/11/2016

Config. Used: 2

Test Engineer: Kevin Wen, Yew-Kwong Soo

Config Change: None

Test Location: Fremont Chamber #5

EUT Voltage: 120V/60Hz

Run #3a: Center Channel

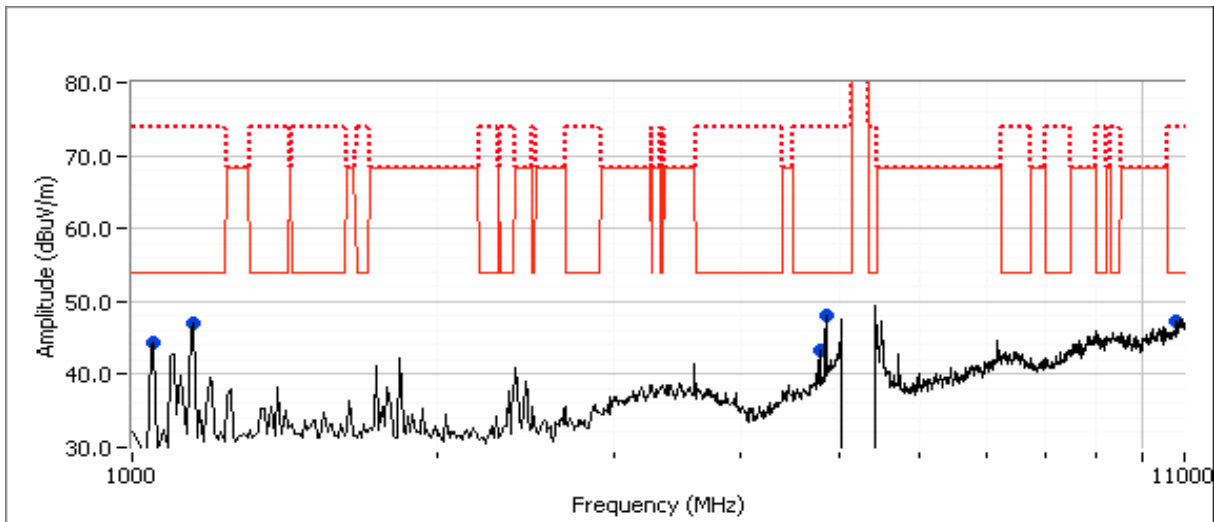
Channel: 60 Mode: a
Tx Chain: Both Data Rate: 6 MB/s

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	44.4	V	54.0	-9.6	Peak	111	1.5	
1150.000	47.1	V	54.0	-6.9	Peak	305	1.5	
4791.670	43.4	V	54.0	-10.6	Peak	53	2.0	
4858.330	48.2	H	54.0	-5.8	Peak	330	2.0	
10800.000	47.3	H	54.0	-6.7	Peak	22	2.5	

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

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

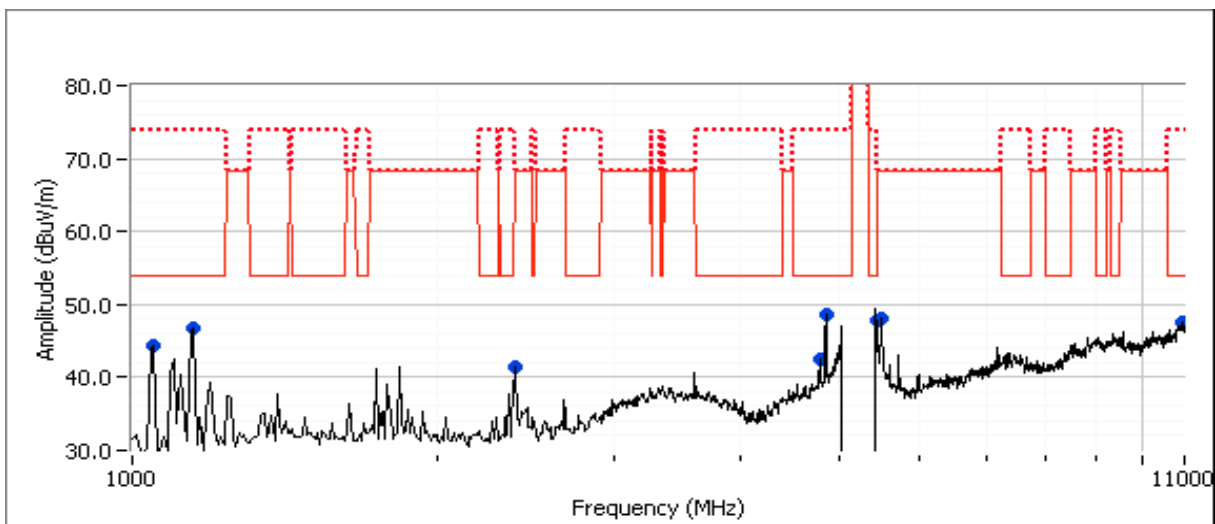
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.020	46.8	V	54.0	-7.2	Avg	307	1.5	RB 1 MHz;VB 1 kHz;Peak
1149.980	48.9	V	74.0	-25.1	PK	307	1.5	RB 1 MHz;VB 3 MHz;Peak
1050.000	44.4	V	54.0	-9.6	Avg	116	1.0	RB 1 MHz;VB 1 kHz;Peak
1050.010	47.0	V	74.0	-27.0	PK	116	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.230	41.8	V	54.0	-12.2	Avg	60	1.1	RB 1 MHz;VB 1 kHz;Peak
4795.270	49.0	V	74.0	-25.0	PK	60	1.1	RB 1 MHz;VB 3 MHz;Peak
4858.540	46.7	H	54.0	-7.3	Avg	335	1.9	RB 1 MHz;VB 1 kHz;Peak
4858.650	54.4	H	74.0	-19.6	PK	335	1.9	RB 1 MHz;VB 3 MHz;Peak
10784.540	41.1	H	54.0	-12.9	Avg	25	2.5	RB 1 MHz;VB 1 kHz;Peak
10799.270	52.9	H	74.0	-21.1	PK	25	2.5	RB 1 MHz;VB 3 MHz;Peak

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

Run #3b: Center Channel

Channel: 60 Mode: 11n20
 Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	44.4	V	54.0	-9.6	Peak	136	1.0	
1150.000	46.8	V	54.0	-7.2	Peak	247	1.5	
2391.670	41.5	V	68.3	-26.8	Peak	241	1.5	
4791.670	42.6	V	54.0	-11.4	Peak	47	1.0	
4858.330	48.5	H	54.0	-5.5	Peak	336	1.5	
5450.000	47.8	H	54.0	-6.2	Peak	95	1.5	
5516.670	48.0	H	68.3	-20.3	Peak	349	2.5	
10925.000	47.5	V	54.0	-6.5	Peak	356	2.0	



- Note 1: For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
- Note 2: For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

EMC Test Data

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

Maximized Readings

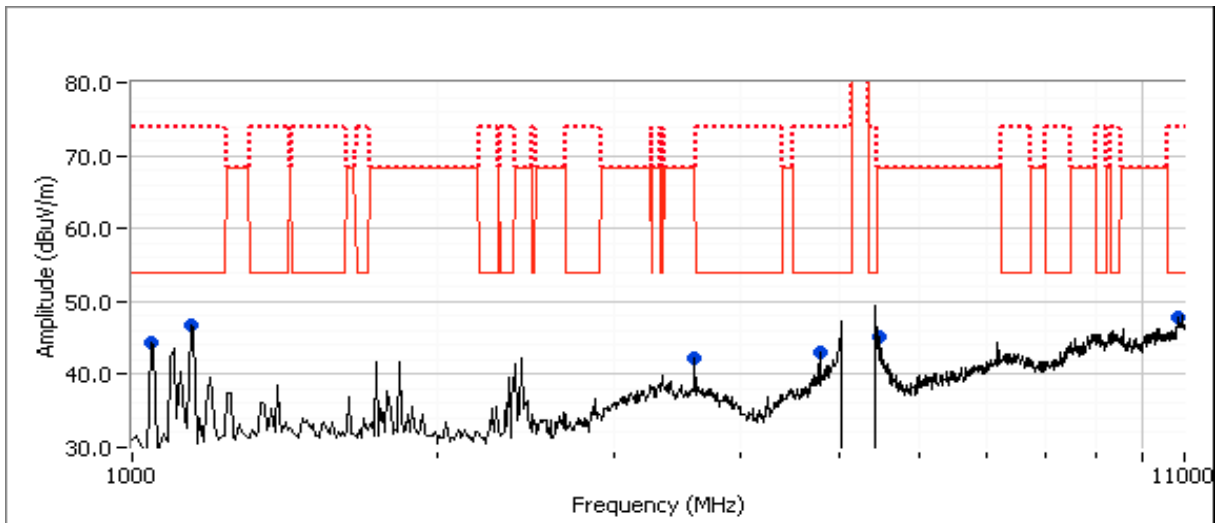
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.080	47.2	V	54.0	-6.8	Avg	246	1.5	RB 1 MHz;VB 3 kHz;Peak
1149.940	49.2	V	74.0	-24.8	PK	246	1.5	RB 1 MHz;VB 3 MHz;Peak
4858.430	47.1	H	54.0	-6.9	Avg	335	1.5	RB 1 MHz;VB 3 kHz;Peak
4858.410	55.3	H	74.0	-18.7	PK	335	1.5	RB 1 MHz;VB 3 MHz;Peak
5453.710	45.1	H	54.0	-8.9	Avg	95	1.9	RB 1 MHz;VB 3 kHz;Peak
5452.820	56.8	H	74.0	-17.2	PK	95	1.9	RB 1 MHz;VB 3 MHz;Peak
10925.070	42.4	V	54.0	-11.6	Avg	358	2.0	RB 1 MHz;VB 3 kHz;Peak
10924.210	53.7	V	74.0	-20.3	PK	358	2.0	RB 1 MHz;VB 3 MHz;Peak
1050.020	44.7	V	54.0	-9.3	Avg	126	1.0	RB 1 MHz;VB 3 kHz;Peak
1050.110	47.2	V	74.0	-26.8	PK	126	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.240	41.7	V	54.0	-12.3	Avg	59	1.6	RB 1 MHz;VB 3 kHz;Peak
4795.170	49.2	V	74.0	-24.8	PK	59	1.6	RB 1 MHz;VB 3 MHz;Peak
5514.350	45.4	H	68.3	-22.9	Avg	340	2.1	RB 1 MHz;VB 3 kHz;Peak
5513.410	55.5	H	68.3	-12.8	PK	340	2.1	RB 1 MHz;VB 3 MHz;Peak

Run #3c: Center Channel

Channel: 54 Mode: 11n40
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1041.670	44.3	V	54.0	-9.7	Peak	117	1.0	
1141.670	46.8	V	54.0	-7.2	Peak	252	1.5	
3600.000	42.3	V	68.3	-26.0	Peak	316	1.0	
4791.670	43.1	V	54.0	-10.9	Peak	65	1.5	
5500.000	45.1	H	68.3	-23.2	Peak	345	1.5	
10833.330	47.8	H	54.0	-6.2	Peak	46	2.5	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

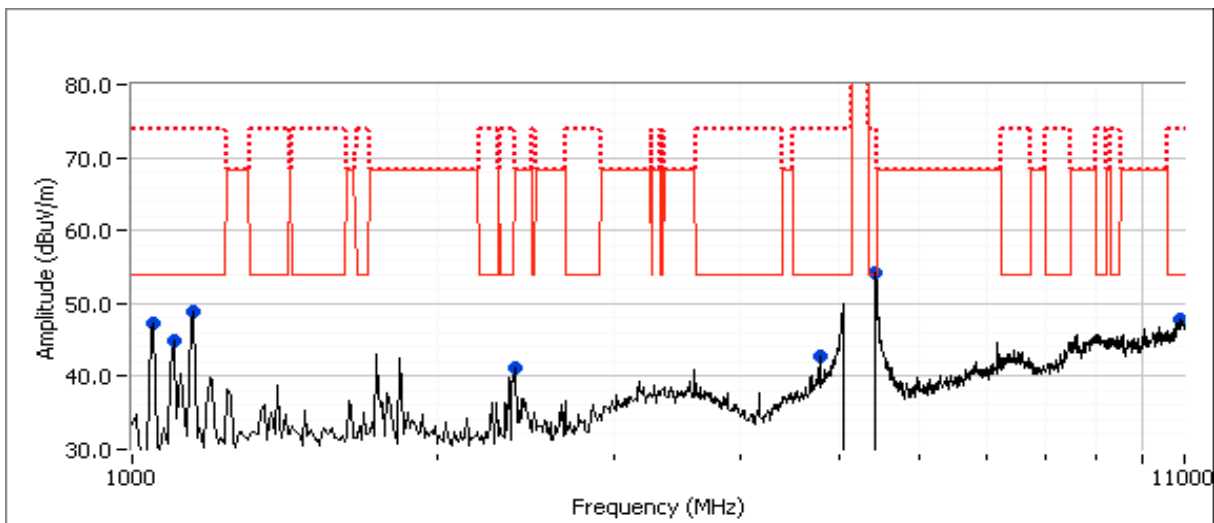
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.040	46.9	V	54.0	-7.1	Avg	241	1.5	RB 1 MHz;VB 3 kHz;Peak
1150.110	48.9	V	74.0	-25.1	PK	241	1.5	RB 1 MHz;VB 3 MHz;Peak
1050.060	44.7	V	54.0	-9.3	Avg	123	1.0	RB 1 MHz;VB 3 kHz;Peak
1049.940	47.2	V	74.0	-26.8	PK	123	1.0	RB 1 MHz;VB 3 MHz;Peak
3596.320	40.5	V	68.3	-27.8	Avg	309	1.4	RB 1 MHz;VB 3 kHz;Peak
3596.450	46.9	V	68.3	-21.4	PK	309	1.4	RB 1 MHz;VB 3 MHz;Peak
4795.240	41.4	V	54.0	-12.6	Avg	67	1.5	RB 1 MHz;VB 3 kHz;Peak
4795.290	48.5	V	74.0	-25.5	PK	67	1.5	RB 1 MHz;VB 3 MHz;Peak
5494.850	40.8	H	68.3	-27.5	Avg	343	1.3	RB 1 MHz;VB 3 kHz;Peak
5498.450	51.5	H	68.3	-16.8	PK	343	1.3	RB 1 MHz;VB 3 MHz;Peak
10833.920	42.7	H	54.0	-11.3	Avg	46	2.5	RB 1 MHz;VB 3 kHz;Peak
10833.040	53.3	H	74.0	-20.7	PK	46	2.5	RB 1 MHz;VB 3 MHz;Peak

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

Run #3d: Center Channel

Channel: 58 Mode: ac80
 Tx Chain: Both Data Rate: VHT0 x2

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	47.4	V	54.0	-6.6	Peak	343	1.0	
1100.000	44.8	V	54.0	-9.2	Peak	220	2.0	
1150.000	48.8	V	54.0	-5.2	Peak	228	1.5	
2391.670	41.3	V	68.3	-27.0	Peak	237	2.0	
4791.670	42.7	V	54.0	-11.3	Peak	63	1.5	
5441.670	54.3	H	54.0	0.3	Peak	69	1.0	Due to band reject filter
10875.000	47.8	H	54.0	-6.2	Peak	107	2.5	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5435.010	48.8	H	54.0	-5.2	Avg	70	1.4	POS; RB 1 MHz; VB: 10 kHz
5435.430	57.9	H	74.0	-16.1	PK	70	1.4	POS; RB 1 MHz; VB: 3 MHz
1150.070	48.4	V	54.0	-5.6	Avg	222	1.0	RB 1 MHz;VB 10 kHz;Peak
1150.060	50.1	V	74.0	-23.9	PK	222	1.0	RB 1 MHz;VB 3 MHz;Peak
10876.870	44.4	H	54.0	-9.6	Avg	107	2.5	RB 1 MHz;VB 10 kHz;Peak
10876.420	53.9	H	74.0	-20.1	PK	107	2.5	RB 1 MHz;VB 3 MHz;Peak
1050.000	48.3	V	54.0	-5.7	Avg	330	1.4	RB 1 MHz;VB 10 kHz;Peak
1049.990	49.8	V	74.0	-24.2	PK	330	1.4	RB 1 MHz;VB 3 MHz;Peak
1100.090	44.2	V	54.0	-9.8	Avg	240	2.0	RB 1 MHz;VB 10 kHz;Peak
1099.990	47.4	V	74.0	-26.6	PK	240	2.0	RB 1 MHz;VB 3 MHz;Peak
4795.250	44.2	V	54.0	-9.8	Avg	57	1.3	RB 1 MHz;VB 10 kHz;Peak
4795.310	49.1	V	74.0	-24.9	PK	57	1.3	RB 1 MHz;VB 3 MHz;Peak

Run #4: Radiated Spurious Emissions, 1,000 - 40000 MHz. Operating Mode: Worse case from Run #3

Date of Test: 7/13/2016
 Test Engineer: Kevin Wen
 Test Location: Fremont Chamber #5

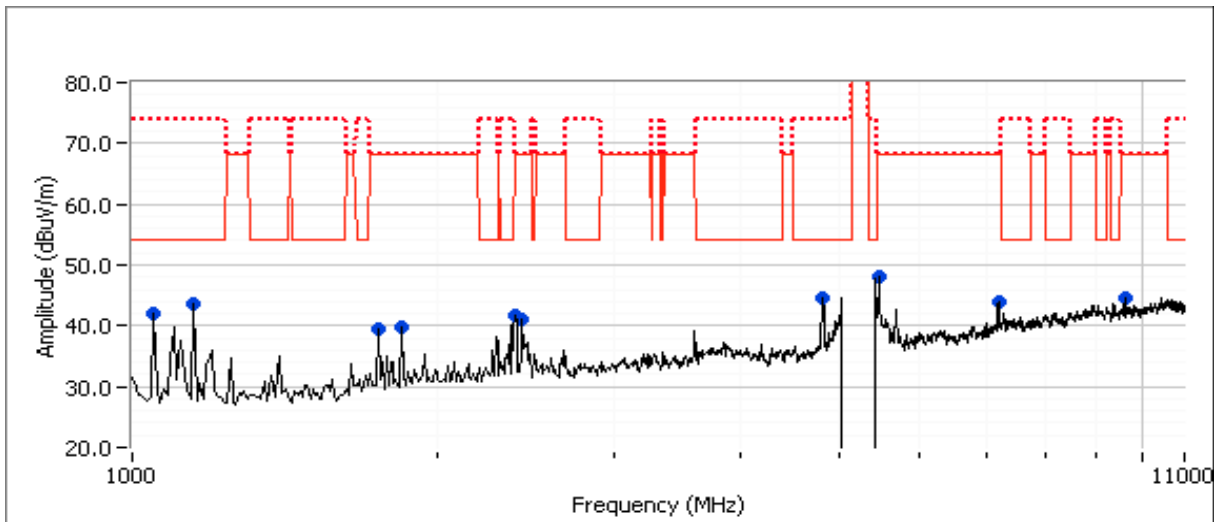
Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Run #4a: Low Channel

Channel: 52 Mode: n20
 Tx Chain: Both Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.110	41.9	V	54.0	-12.1	Peak	6	1.0	
1150.110	43.5	V	54.0	-10.5	Peak	326	1.5	
2391.670	41.6	V	68.3	-26.7	Peak	237	1.5	
2433.330	41.2	V	68.3	-27.1	Peak	64	1.5	
1850.000	39.9	V	68.3	-28.4	Peak	233	1.5	
1750.000	39.5	V	68.3	-28.8	Peak	237	1.0	
4821.840	44.7	H	54.0	-9.3	Peak	94	2.0	
5483.330	48.0	H	68.3	-20.3	Peak	335	1.5	
7200.000	43.9	V	68.3	-24.4	Peak	346	1.0	
9600.000	44.6	V	68.3	-23.7	Peak	360	2.0	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

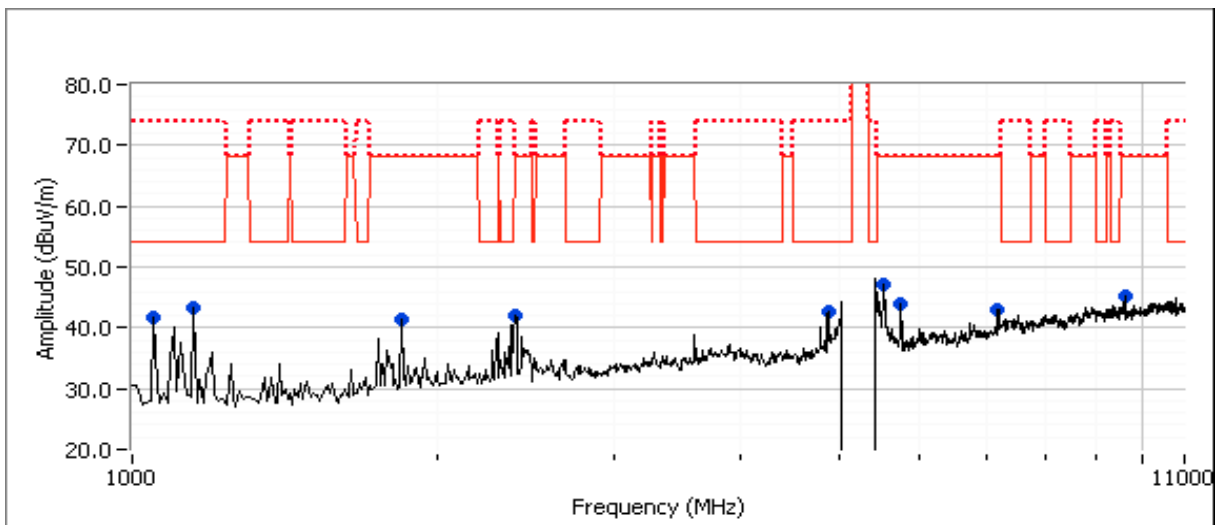
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1149.970	45.0	V	54.0	-9.0	Avg	329	1.6	RB 1 MHz;VB 3 kHz;Peak
1149.950	47.3	V	74.0	-26.7	PK	329	1.6	RB 1 MHz;VB 3 MHz;Peak
1050.020	41.9	V	54.0	-12.1	Avg	5	1.0	RB 1 MHz;VB 3 kHz;Peak
1049.900	45.1	V	74.0	-28.9	PK	5	1.0	RB 1 MHz;VB 3 MHz;Peak
4822.140	39.8	H	54.0	-14.2	Avg	97	1.9	RB 1 MHz;VB 3 kHz;Peak
4820.210	51.4	H	74.0	-22.6	PK	97	1.9	RB 1 MHz;VB 3 MHz;Peak

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

Run #4b: High Channel

Channel: 64 Mode: n20
Tx Chain: Both Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.170	41.7	V	54.0	-12.3	Peak	9	1.0	
1150.110	43.4	V	54.0	-10.6	Peak	341	1.5	
1850.000	41.4	V	68.3	-26.9	Peak	233	1.5	
2391.670	42.1	V	68.3	-26.2	Peak	249	1.5	
4876.870	42.6	H	54.0	-11.4	Peak	85	2.0	
5541.670	47.2	H	68.3	-21.1	Peak	90	2.0	
5758.330	43.9	H	68.3	-24.4	Peak	1	2.5	
7191.670	43.1	V	68.3	-25.2	Peak	332	1.0	
9600.000	45.1	V	68.3	-23.2	Peak	336	1.0	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.020	45.2	V	54.0	-8.8	Avg	340	1.6	RB 1 MHz;VB 3 kHz;Peak
1149.960	47.5	V	74.0	-26.5	PK	340	1.6	RB 1 MHz;VB 3 MHz;Peak
1050.050	41.9	V	54.0	-12.1	Avg	9	1.0	RB 1 MHz;VB 3 kHz;Peak
1050.120	45.0	V	74.0	-29.0	PK	9	1.0	RB 1 MHz;VB 3 MHz;Peak
4877.360	39.0	H	54.0	-15.0	Avg	90	2.1	RB 1 MHz;VB 3 kHz;Peak
4882.030	50.7	H	74.0	-23.3	PK	90	2.1	RB 1 MHz;VB 3 MHz;Peak

Run #5, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5470-5725 MHz Band

Date of Test: 7/12/2016

Config. Used: 2

Test Engineer: Kevin Wen, Yew-Kwong Soo

Config Change: None

Test Location: Fremont Chamber #5

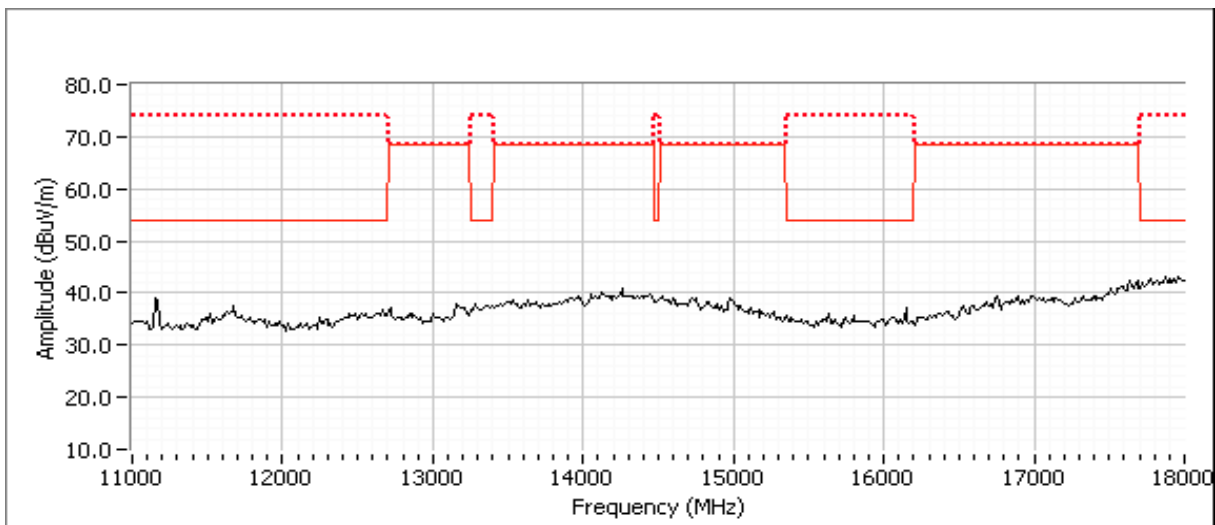
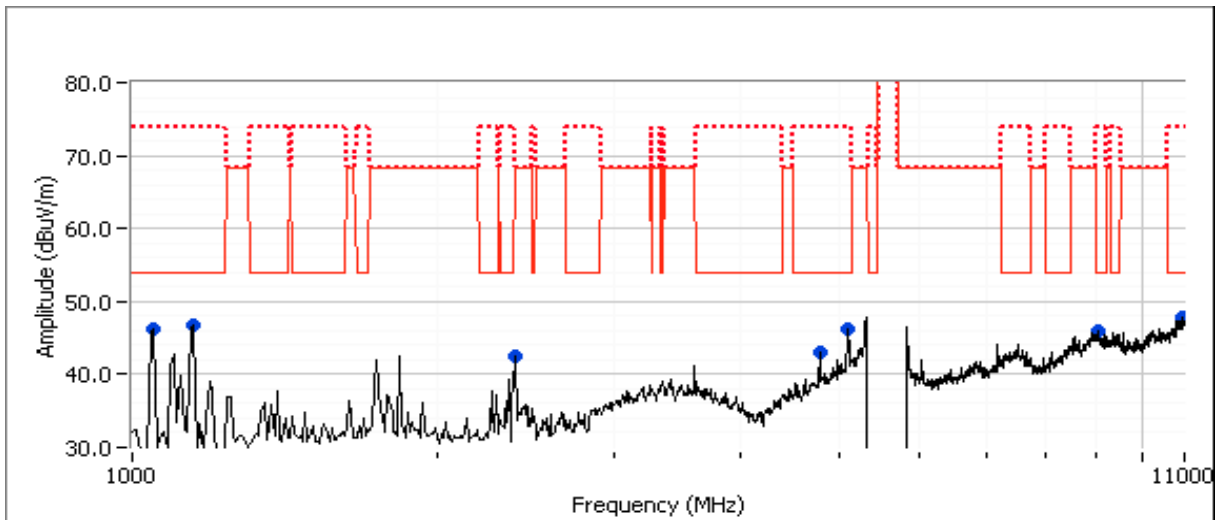
EUT Voltage: 120V/60Hz

Run #5a: Center Channel

Channel: 116 Mode: a
Tx Chain: Both Data Rate: 6 MB/s

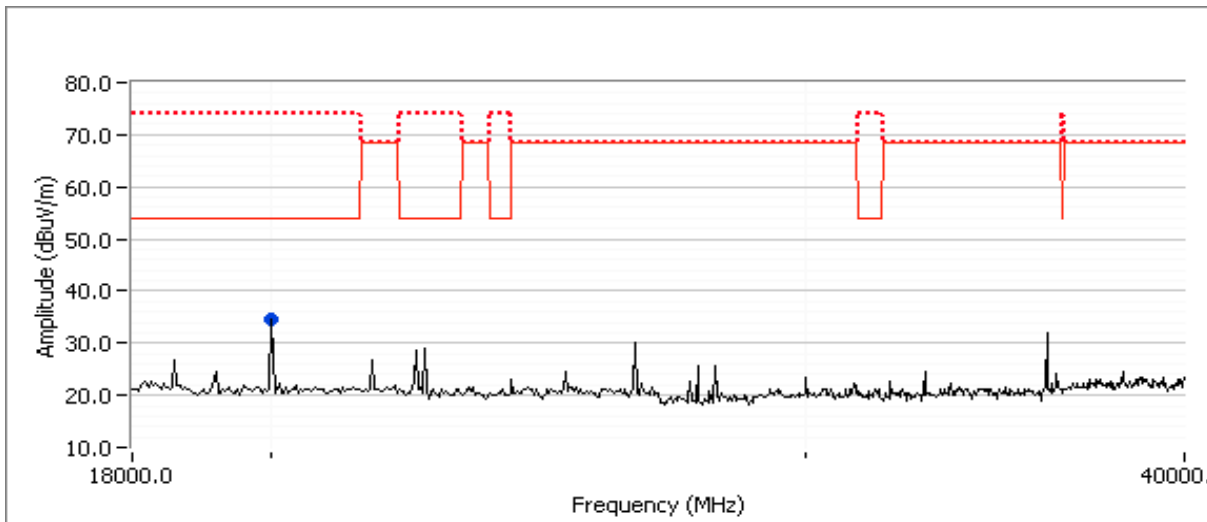
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	46.1	V	54.0	-7.9	Peak	345	1.0	
1150.000	46.7	V	54.0	-7.3	Peak	142	2.0	
2391.670	42.5	V	68.3	-25.8	Peak	239	1.5	
4791.670	42.9	V	54.0	-11.1	Peak	105	2.5	
5116.670	46.1	H	54.0	-7.9	Peak	103	1.0	
9041.670	46.0	V	54.0	-8.0	Peak	216	2.0	
10941.670	47.8	H	54.0	-6.2	Peak	330	1.0	
20016.670	34.6	V	54.0	-19.4	Peak	360	1.0	

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



Note 1: Scans made between 11 - 18 GHz with the measurement antenna positioned 1 meter from the EUT indicated there were no significant emissions in this frequency range.

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



Note 1:	Scans made between 18 - 40 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
Note 2:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 3:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.040	47.2	V	54.0	-6.8	Avg	329	1.4	RB 1 MHz;VB 1 kHz;Peak
1050.050	49.2	V	74.0	-24.8	PK	329	1.4	RB 1 MHz;VB 3 MHz;Peak
10946.420	41.9	H	54.0	-12.1	Avg	331	1.0	RB 1 MHz;VB 1 kHz;Peak
10948.440	53.7	H	74.0	-20.3	PK	331	1.0	RB 1 MHz;VB 3 MHz;Peak
1150.040	45.7	V	54.0	-8.3	Avg	139	2.0	RB 1 MHz;VB 1 kHz;Peak
1149.970	47.6	V	74.0	-26.4	PK	139	2.0	RB 1 MHz;VB 3 MHz;Peak
5115.270	45.6	H	54.0	-8.4	Avg	102	1.1	RB 1 MHz;VB 1 kHz;Peak
5115.000	55.7	H	74.0	-18.3	PK	102	1.1	RB 1 MHz;VB 3 MHz;Peak
9045.080	39.5	V	54.0	-14.5	Avg	216	2.0	RB 1 MHz;VB 1 kHz;Peak
9045.400	51.4	V	74.0	-22.6	PK	216	2.0	RB 1 MHz;VB 3 MHz;Peak
4795.260	40.7	V	54.0	-13.3	Avg	102	2.2	RB 1 MHz;VB 1 kHz;Peak
4795.240	48.7	V	74.0	-25.3	PK	102	2.2	RB 1 MHz;VB 3 MHz;Peak
2397.760	45.5	V	68.3	-22.8	PK	240	1.5	RB 1 MHz;VB 3 MHz;Peak
20016.850	36.4	V	54.0	-17.6	Avg	360	2.5	RB 1 MHz;VB 1 kHz;Peak
20015.620	48.0	V	74.0	-26.0	PK	360	2.5	RB 1 MHz;VB 3 MHz;Peak

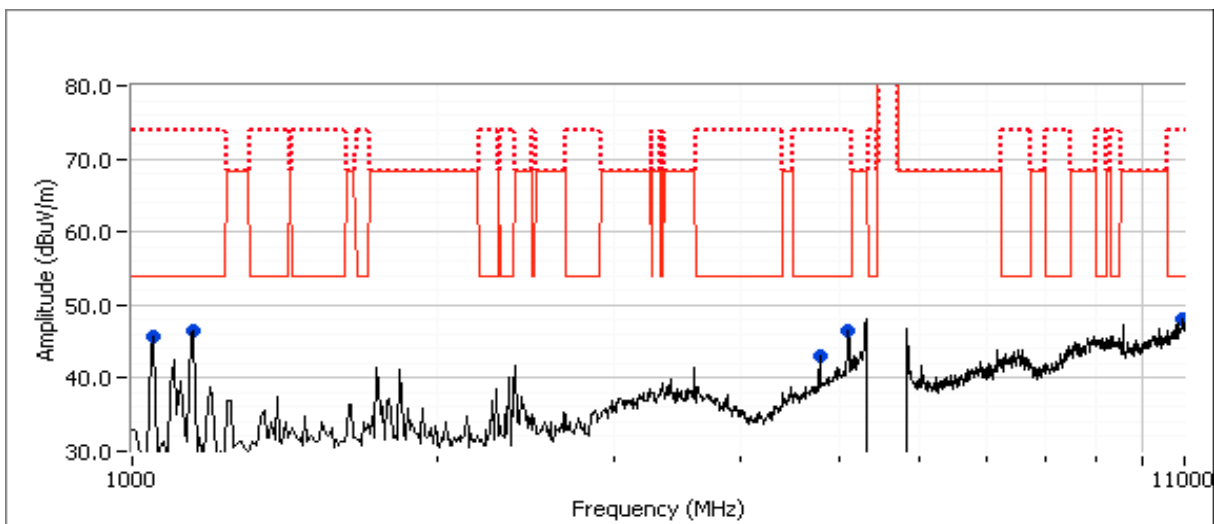
Note 4:	Measurements above 18 GHz performed at 3 meters were only of the measurement system noise.
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Client: Tivo, Inc.	Job Number: JD101876
Model: Mantis	T-Log Number: T102023
Contact: Jim Inokuchi	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Run #5b: Center Channel

Channel: 116 Mode: 11n20
 Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	45.7	V	54.0	-8.3	Peak	343	1.0	
1150.000	46.6	V	54.0	-7.4	Peak	230	1.5	
4791.670	43.0	V	54.0	-11.0	Peak	69	2.0	
5116.670	46.6	H	54.0	-7.4	Peak	92	1.0	
10933.330	48.0	H	54.0	-6.0	Peak	330	1.5	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

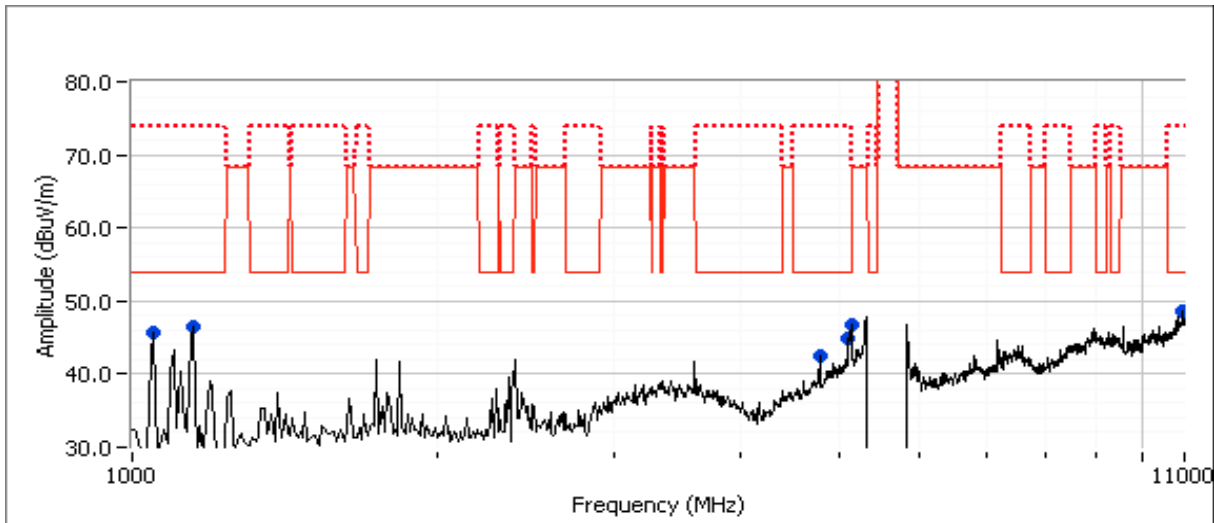
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.050	47.3	V	54.0	-6.7	Avg	334	1.4	RB 1 MHz;VB 3 kHz;Peak
1049.910	49.2	V	74.0	-24.8	PK	334	1.4	RB 1 MHz;VB 3 MHz;Peak
10936.740	42.8	H	54.0	-11.2	Avg	333	1.5	RB 1 MHz;VB 3 kHz;Peak
10934.080	53.6	H	74.0	-20.4	PK	333	1.5	RB 1 MHz;VB 3 MHz;Peak
5115.330	45.6	H	54.0	-8.4	Avg	96	1.1	RB 1 MHz;VB 3 kHz;Peak
5115.380	55.4	H	74.0	-18.6	PK	96	1.1	RB 1 MHz;VB 3 MHz;Peak
1149.970	45.8	V	54.0	-8.2	Avg	226	1.5	RB 1 MHz;VB 3 kHz;Peak
1150.190	47.6	V	74.0	-26.4	PK	226	1.5	RB 1 MHz;VB 3 MHz;Peak
4795.240	42.2	V	54.0	-11.8	Avg	54	1.7	RB 1 MHz;VB 3 kHz;Peak
4795.160	49.4	V	74.0	-24.6	PK	54	1.7	RB 1 MHz;VB 3 MHz;Peak

Run #5c: Center Channel

Channel: 110 Mode: 11n40
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	45.7	V	54.0	-8.3	Peak	335	1.0	
1150.000	46.6	V	54.0	-7.4	Peak	319	1.5	
4791.670	42.4	V	54.0	-11.6	Peak	68	1.5	
5150.000	46.7	H	54.0	-7.3	Peak	328	1.0	
5116.670	44.9	H	54.0	-9.1	Peak	318	1.0	
10950.000	48.6	H	54.0	-5.4	Peak	311	1.5	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

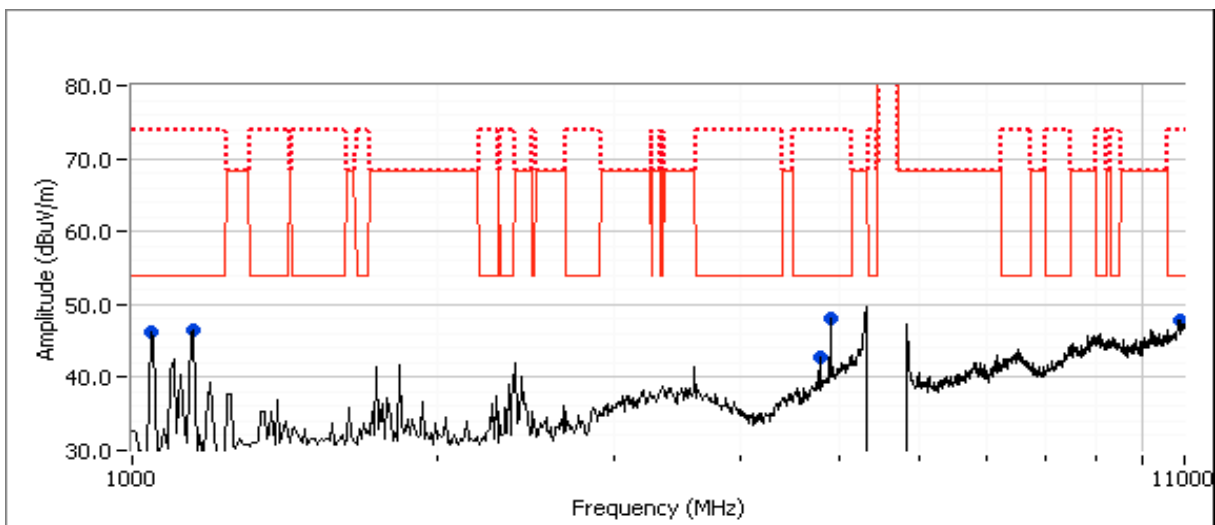
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.020	47.7	V	54.0	-6.3	Avg	314	1.6	RB 1 MHz;VB 3 kHz;Peak
1150.080	49.2	V	74.0	-24.8	PK	314	1.6	RB 1 MHz;VB 3 MHz;Peak
10947.340	42.6	H	54.0	-11.4	Avg	314	1.4	RB 1 MHz;VB 3 kHz;Peak
10949.260	53.6	H	74.0	-20.4	PK	314	1.4	RB 1 MHz;VB 3 MHz;Peak
5144.490	43.1	H	54.0	-10.9	Avg	330	1.1	RB 1 MHz;VB 3 kHz;Peak
5145.370	53.6	H	74.0	-20.4	PK	330	1.1	RB 1 MHz;VB 3 MHz;Peak
1050.040	47.1	V	54.0	-6.9	Avg	337	1.4	RB 1 MHz;VB 3 kHz;Peak
1049.940	49.0	V	74.0	-25.0	PK	337	1.4	RB 1 MHz;VB 3 MHz;Peak
4795.200	43.6	V	54.0	-10.4	Avg	56	1.3	RB 1 MHz;VB 3 kHz;Peak
4795.250	49.3	V	74.0	-24.7	PK	56	1.3	RB 1 MHz;VB 3 MHz;Peak

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

Run #5d: Center Channel

Channel: 106 Mode: ac80
 Tx Chain: Both Data Rate: VHT0 x2

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1041.670	46.1	V	54.0	-7.9	Peak	342	1.0	
1150.000	46.6	V	54.0	-7.4	Peak	320	1.5	
4791.670	42.7	V	54.0	-11.3	Peak	75	2.5	
4916.670	48.0	H	54.0	-6.0	Peak	330	1.5	
10875.000	47.7	V	54.0	-6.3	Peak	144	2.5	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4915.650	48.5	H	54.0	-5.5	Avg	335	1.5	RB 1 MHz;VB 10 kHz;Peak
4915.750	52.9	H	74.0	-21.1	PK	335	1.5	RB 1 MHz;VB 3 MHz;Peak
10875.680	44.7	V	54.0	-9.3	Avg	143	2.5	RB 1 MHz;VB 10 kHz;Peak
10875.880	53.4	V	74.0	-20.6	PK	143	2.5	RB 1 MHz;VB 3 MHz;Peak
1150.020	47.7	V	54.0	-6.3	Avg	322	1.6	RB 1 MHz;VB 10 kHz;Peak
1149.960	49.0	V	74.0	-25.0	PK	322	1.6	RB 1 MHz;VB 3 MHz;Peak
1050.010	46.3	V	54.0	-7.7	Avg	342	1.0	RB 1 MHz;VB 10 kHz;Peak
1050.110	48.1	V	74.0	-25.9	PK	342	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.250	41.9	V	54.0	-12.1	Avg	104	2.3	RB 1 MHz;VB 10 kHz;Peak
4795.310	48.3	V	74.0	-25.7	PK	104	2.3	RB 1 MHz;VB 3 MHz;Peak

Run #6: Radiated Spurious Emissions, 1,000 - 40000 MHz. Operating Mode: Worse case from Run #5

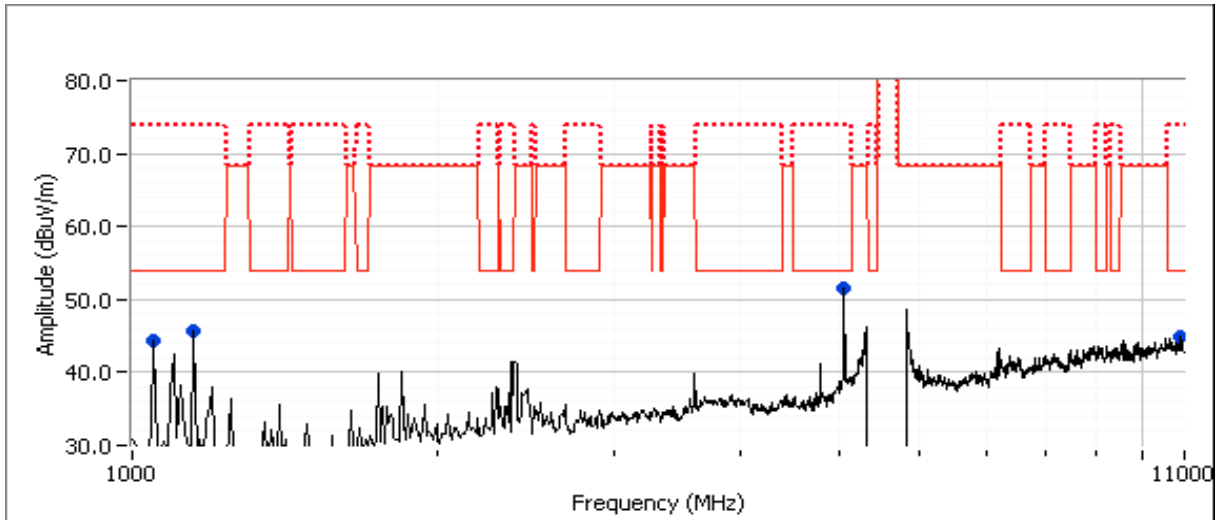
Date of Test: 7/13/2016
 Test Engineer: Yew-Kwong Soo
 Test Location: Fremont Chamber #5
 Config. Used: 2
 Config Change: None
 EUT Voltage: 120V/60Hz

Run #6a: Low Channel

Channel: 138
 Tx Chain: Both
 Mode: ac80
 Data Rate: VHT0 x2

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	44.4	V	54.0	-9.6	Peak	11	1.0	
1150.000	45.6	V	54.0	-8.4	Peak	139	2.0	
5066.670	51.5	H	54.0	-2.5	Peak	347	2.5	
10916.670	44.9	V	54.0	-9.1	Peak	275	2.5	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

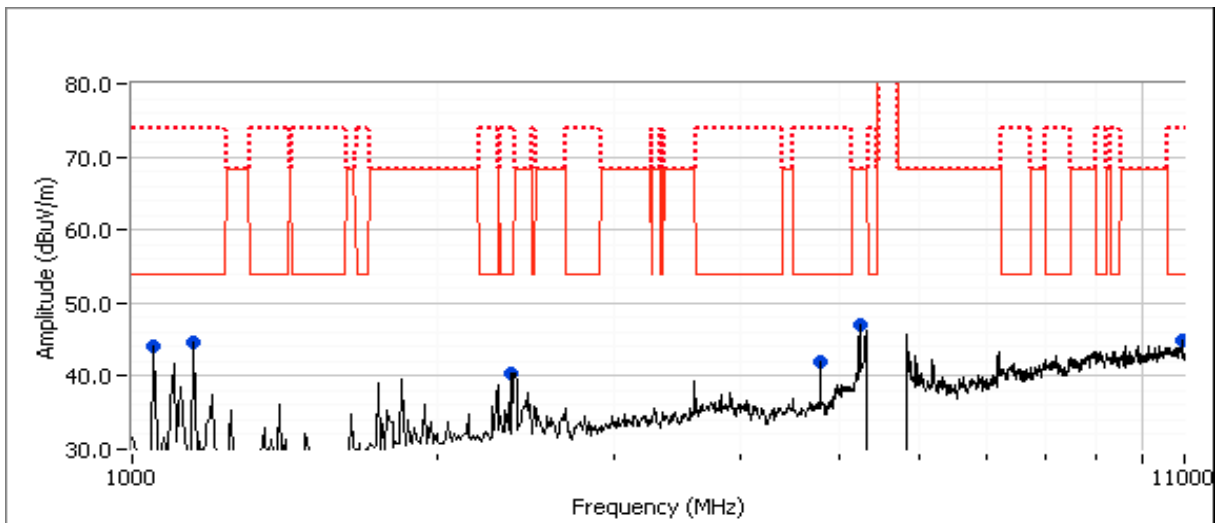
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5057.970	51.2	H	54.0	-2.8	Avg	341	2.3	RB 1 MHz;VB 10 kHz;Peak
5057.940	54.8	H	74.0	-19.2	PK	341	2.3	RB 1 MHz;VB 3 MHz;Peak
1150.080	45.2	V	54.0	-8.8	Avg	142	2.0	RB 1 MHz;VB 10 kHz;Peak
1150.050	47.2	V	74.0	-26.8	PK	142	2.0	RB 1 MHz;VB 3 MHz;Peak
10923.640	40.9	V	54.0	-13.1	Avg	277	2.5	RB 1 MHz;VB 10 kHz;Peak
10921.480	50.3	V	74.0	-23.7	PK	277	2.5	RB 1 MHz;VB 3 MHz;Peak
1050.040	44.4	V	54.0	-9.6	Avg	12	1.0	RB 1 MHz;VB 10 kHz;Peak
1049.840	46.2	V	74.0	-27.8	PK	12	1.0	RB 1 MHz;VB 3 MHz;Peak

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

Run #6b: High Channel

Channel: 144 Mode: n20
 Tx Chain: Both Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	44.1	V	54.0	-9.9	Peak	20	1.0	
1150.000	44.6	V	54.0	-9.4	Peak	144	2.0	
2366.670	40.4	V	54.0	-13.6	Peak	230	1.5	
4800.000	41.9	V	54.0	-12.1	Peak	67	1.5	
5250.000	47.0	H	68.3	-21.3	Peak	63	1.5	
10941.670	44.8	V	54.0	-9.2	Peak	16	2.0	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

EMC Test Data

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.030	44.5	V	54.0	-9.5	Avg	144	2.0	RB 1 MHz;VB 3 kHz;Peak
1150.010	46.3	V	74.0	-27.7	PK	144	2.0	RB 1 MHz;VB 3 MHz;Peak
10944.280	38.4	V	54.0	-15.6	Avg	17	2.0	RB 1 MHz;VB 3 kHz;Peak
10944.780	49.6	V	74.0	-24.4	PK	17	2.0	RB 1 MHz;VB 3 MHz;Peak
1050.030	43.9	V	54.0	-10.1	Avg	14	1.0	RB 1 MHz;VB 3 kHz;Peak
1049.970	46.3	V	74.0	-27.7	PK	14	1.0	RB 1 MHz;VB 3 MHz;Peak
5244.840	54.3	H	68.3	-14.0	PK	74	1.3	RB 1 MHz;VB 3 MHz;Peak
4795.250	40.8	V	54.0	-13.2	Avg	53	1.5	RB 1 MHz;VB 10 kHz;Peak
4795.170	46.6	V	74.0	-27.4	PK	53	1.5	RB 1 MHz;VB 3 MHz;Peak
2367.640	41.3	V	54.0	-12.7	Avg	219	1.5	RB 1 MHz;VB 3 kHz;Peak
2367.490	45.6	V	74.0	-28.4	PK	219	1.5	RB 1 MHz;VB 3 MHz;Peak

Run #7, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5725-5850 MHz Band

Date of Test: 7/12/2016

Config. Used: 2

Test Engineer: Kevin Wen, Yew-Kwong Soo

Config Change: None

Test Location: Fremont Chamber #5

EUT Voltage: 120V/60Hz

Run #7a: Center Channel

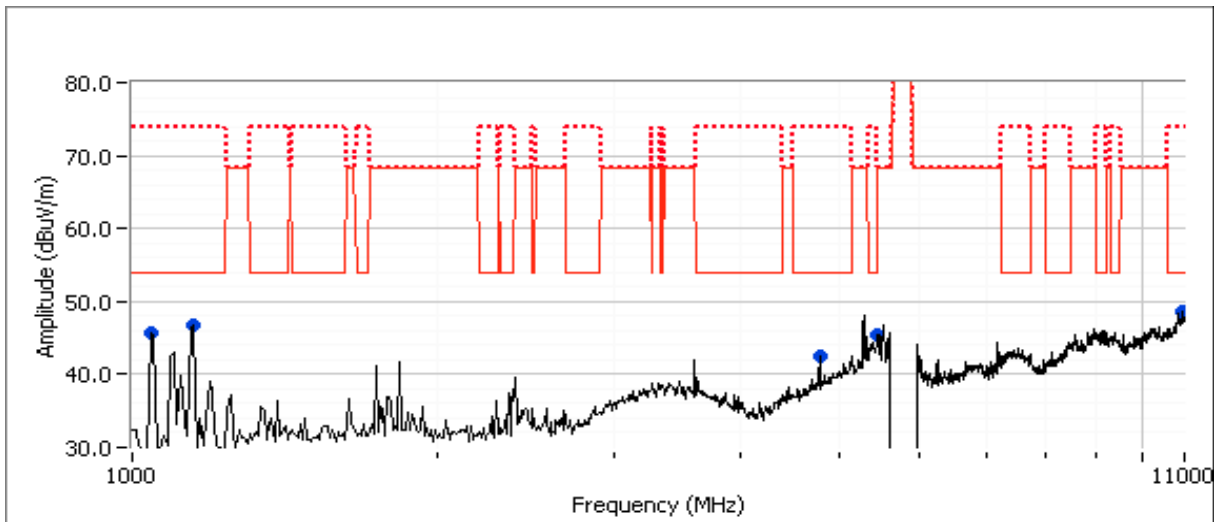
Channel: 157
 Tx Chain: Both
 Mode: a
 Data Rate: 6 MB/s

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1041.670	45.7	V	54.0	-8.3	Peak	345	1.0	
1150.000	46.8	V	54.0	-7.2	Peak	230	1.5	
4791.670	42.6	V	54.0	-11.4	Peak	65	1.5	
5466.670	45.3	H	68.3	-23.0	Peak	326	2.5	
10925.000	48.6	H	54.0	-5.4	Peak	218	2.0	

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

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

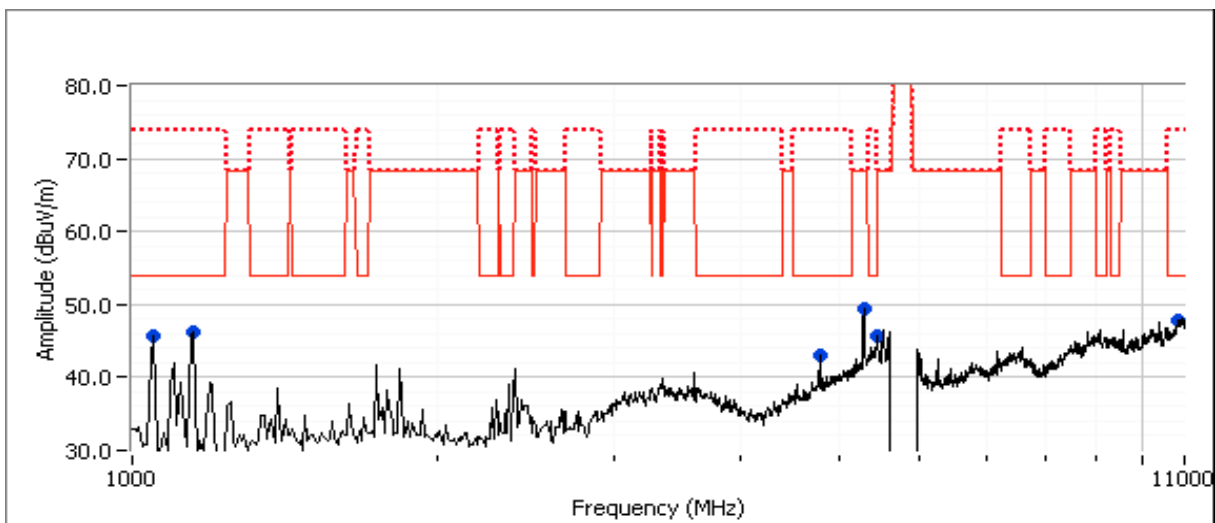
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.030	47.1	V	54.0	-6.9	Avg	333	1.4	RB 1 MHz;VB 1 kHz;Peak
1049.970	49.0	V	74.0	-25.0	PK	333	1.4	RB 1 MHz;VB 3 MHz;Peak
1150.010	46.2	V	54.0	-7.8	Avg	232	1.5	RB 1 MHz;VB 1 kHz;Peak
1149.920	48.1	V	74.0	-25.9	PK	232	1.5	RB 1 MHz;VB 3 MHz;Peak
4795.190	42.6	V	54.0	-11.4	Avg	60	1.5	RB 1 MHz;VB 1 kHz;Peak
4795.290	49.0	V	74.0	-25.0	PK	60	1.5	RB 1 MHz;VB 3 MHz;Peak
5462.150	42.6	H	68.3	-25.7	Avg	342	2.2	RB 1 MHz;VB 1 kHz;Peak
5462.880	53.8	H	68.3	-14.5	PK	342	2.2	RB 1 MHz;VB 3 MHz;Peak
10924.650	42.2	H	54.0	-11.8	Avg	217	2.0	RB 1 MHz;VB 1 kHz;Peak
10926.370	54.1	H	74.0	-19.9	PK	217	2.0	RB 1 MHz;VB 3 MHz;Peak

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

Run #7b: Center Channel

Channel: 157 Mode: 11n20
 Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	45.8	V	54.0	-8.2	Peak	333	1.0	
1150.000	46.2	V	54.0	-7.8	Peak	234	1.5	
4791.670	43.1	H	54.0	-10.9	Peak	47	2.5	
5300.000	49.3	H	68.3	-19.0	Peak	108	1.5	
5458.330	45.6	H	54.0	-8.4	Peak	99	1.5	
10866.670	47.8	V	54.0	-6.2	Peak	264	1.0	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

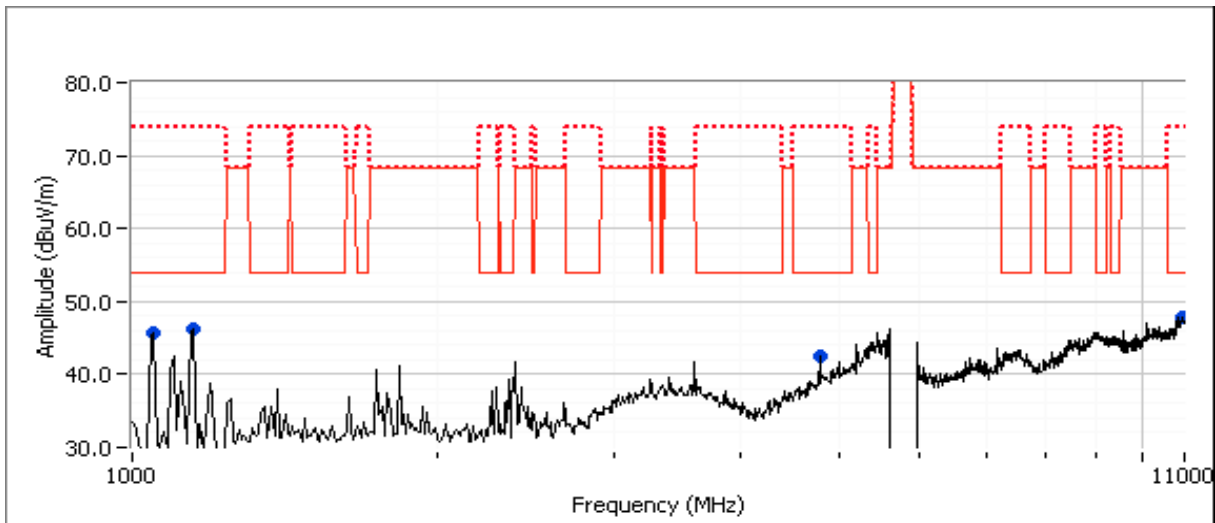
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.020	47.0	V	54.0	-7.0	Avg	334	1.4	RB 1 MHz;VB 3 kHz;Peak
1050.050	49.1	V	74.0	-24.9	PK	334	1.4	RB 1 MHz;VB 3 MHz;Peak
1150.000	46.4	V	54.0	-7.6	Avg	238	1.5	RB 1 MHz;VB 3 kHz;Peak
1149.950	48.2	V	74.0	-25.8	PK	238	1.5	RB 1 MHz;VB 3 MHz;Peak
4795.270	41.5	H	54.0	-12.5	Avg	43	2.2	RB 1 MHz;VB 3 kHz;Peak
4795.150	48.3	H	74.0	-25.7	PK	43	2.2	RB 1 MHz;VB 3 MHz;Peak
5303.370	57.2	H	68.3	-11.1	PK	83	1.4	RB 1 MHz;VB 3 MHz;Peak
5461.670	43.4	H	68.3	-24.9	Avg	102	1.5	RB 1 MHz;VB 3 kHz;Peak
5459.980	54.3	H	74.0	-19.7	PK	102	1.5	RB 1 MHz;VB 3 MHz;Peak
10858.810	43.0	V	54.0	-11.0	Avg	270	1.0	RB 1 MHz;VB 3 kHz;Peak
10859.410	54.1	V	74.0	-19.9	PK	270	1.0	RB 1 MHz;VB 3 MHz;Peak

Run #7c: Center Channel

Channel: 159 Mode: 11n40
Tx Chain: Both Data Rate: MCS 0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	45.8	V	54.0	-8.2	Peak	342	1.0	
1150.000	46.3	V	54.0	-7.7	Peak	233	1.0	
4791.670	42.5	V	54.0	-11.5	Peak	64	1.0	
10933.330	47.9	H	54.0	-6.1	Peak	316	1.5	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

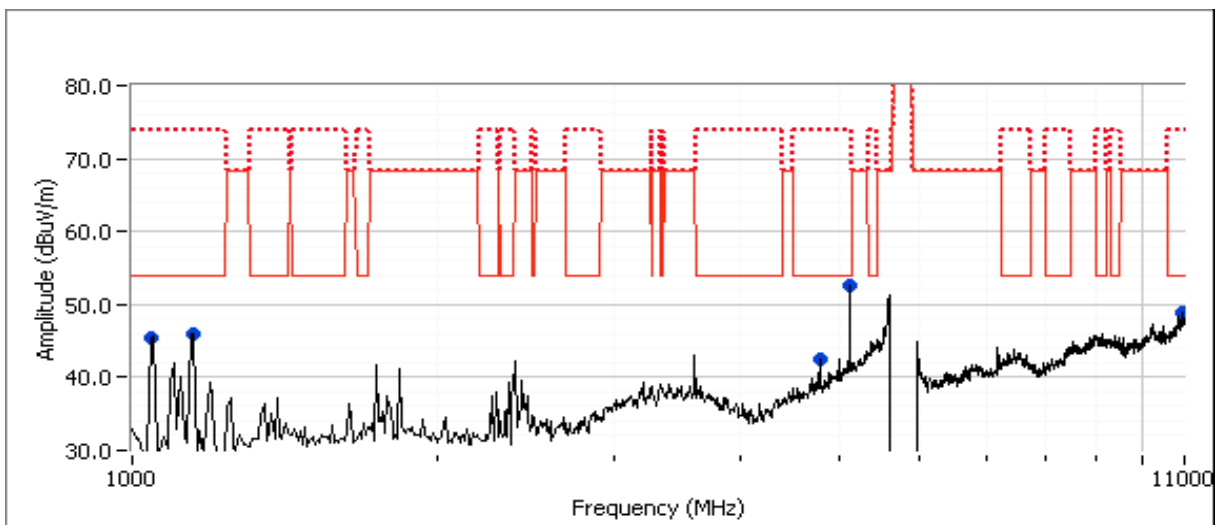
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.080	46.9	V	54.0	-7.1	Avg	336	1.4	RB 1 MHz;VB 3 kHz;Peak
1049.950	48.7	V	74.0	-25.3	PK	336	1.4	RB 1 MHz;VB 3 MHz;Peak
1150.060	45.9	V	54.0	-8.1	Avg	232	1.0	RB 1 MHz;VB 3 kHz;Peak
1149.970	47.8	V	74.0	-26.2	PK	232	1.0	RB 1 MHz;VB 3 MHz;Peak
4795.250	43.5	V	54.0	-10.5	Avg	56	1.3	RB 1 MHz;VB 3 kHz;Peak
4795.040	49.1	V	74.0	-24.9	PK	56	1.3	RB 1 MHz;VB 3 MHz;Peak
10925.620	43.0	H	54.0	-11.0	Avg	315	1.3	RB 1 MHz;VB 3 kHz;Peak
10925.610	54.3	H	74.0	-19.7	PK	315	1.3	RB 1 MHz;VB 3 MHz;Peak

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

Run #7d: Center Channel

Channel: 155 Mode: ac80
 Tx Chain: Both Data Rate: VHT0 x2

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1041.670	45.4	V	54.0	-8.6	Peak	331	1.0	
1150.000	46.0	V	54.0	-8.0	Peak	232	1.5	
5133.330	52.5	H	54.0	-1.5	Peak	336	2.5	
4791.670	42.6	V	54.0	-11.4	Peak	251	1.5	
10941.670	49.0	V	54.0	-5.0	Peak	272	2.5	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5133.550	52.9	H	54.0	-1.1	Avg	356	2.2	RB 1 MHz;VB 10 kHz;Peak
5133.460	56.9	H	74.0	-17.1	PK	356	2.2	RB 1 MHz;VB 3 MHz;Peak
10944.060	44.8	V	54.0	-9.2	Avg	270	2.5	RB 1 MHz;VB 10 kHz;Peak
10944.970	54.2	V	74.0	-19.8	PK	270	2.5	RB 1 MHz;VB 3 MHz;Peak
1150.090	46.8	V	54.0	-7.2	Avg	234	1.5	RB 1 MHz;VB 10 kHz;Peak
1150.060	48.3	V	74.0	-25.7	PK	234	1.5	RB 1 MHz;VB 3 MHz;Peak
1050.060	47.1	V	54.0	-6.9	Avg	336	1.4	RB 1 MHz;VB 10 kHz;Peak
1050.020	49.0	V	74.0	-25.0	PK	336	1.4	RB 1 MHz;VB 3 MHz;Peak
4795.220	42.5	V	54.0	-11.5	Avg	248	1.3	RB 1 MHz;VB 10 kHz;Peak
4795.350	48.0	V	74.0	-26.0	PK	248	1.3	RB 1 MHz;VB 3 MHz;Peak

Run #8: Radiated Spurious Emissions, 1,000 - 40000 MHz. Operating Mode: Worse case from Run #7

Date of Test: 7/13/2016

Config. Used: 2

Test Engineer: Yew-Kwong Soo

Config Change: None

Test Location: Fremont Chamber #5

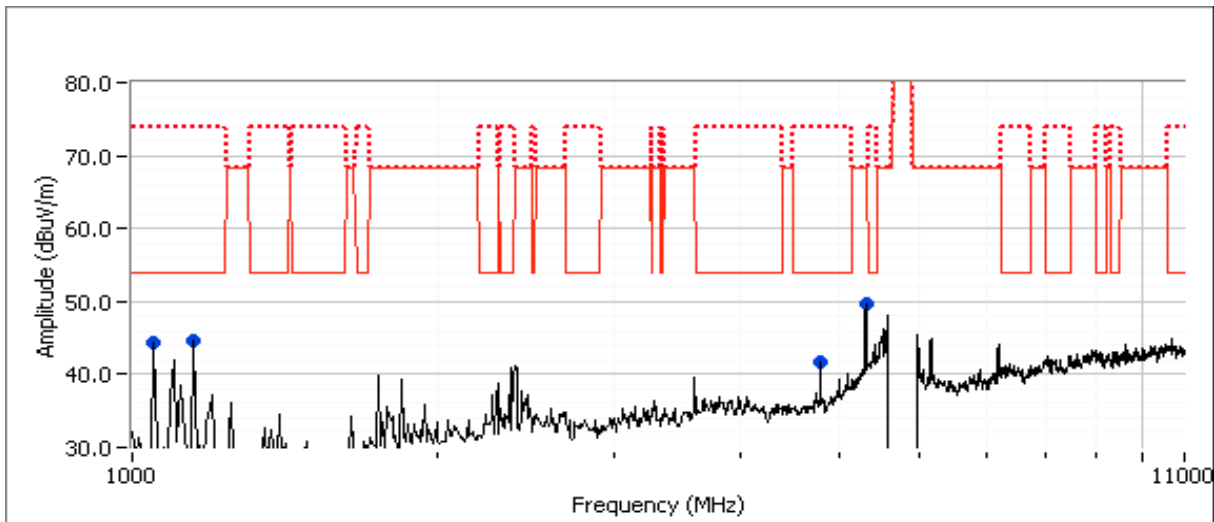
EUT Voltage: 120V/60Hz

Run #8a: Low Channel

Channel: 149 Mode: a
Tx Chain: Both Data Rate: 6 MB/s

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	44.3	V	54.0	-9.7	Peak	0	1.5	
1150.000	44.7	V	54.0	-9.3	Peak	322	1.5	
4800.000	41.8	V	54.0	-12.2	Peak	55	1.5	
5325.000	49.8	H	68.3	-18.5	Peak	20	1.0	

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



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).

Maximized Readings

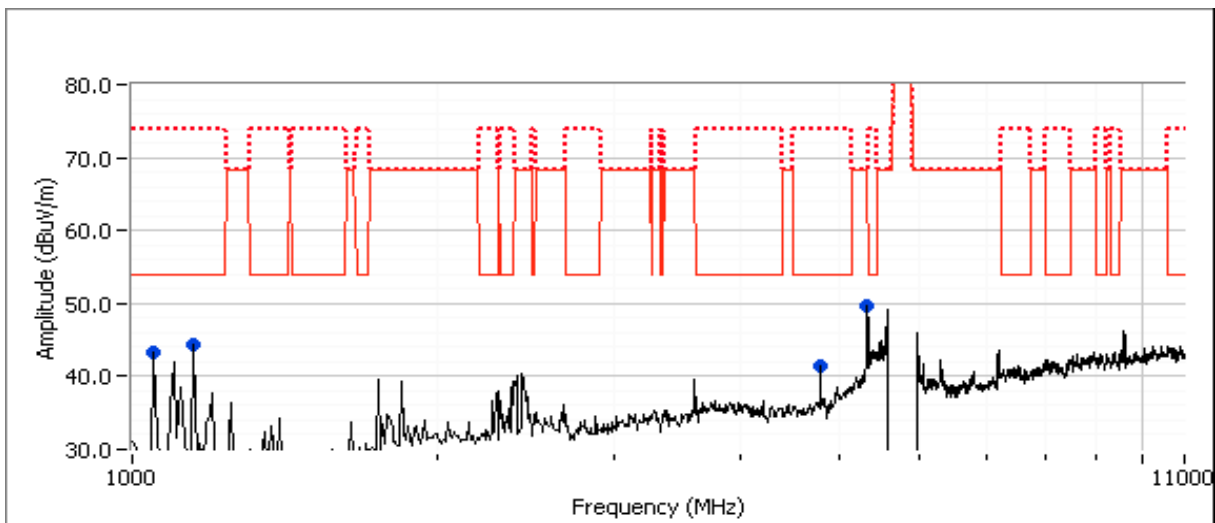
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.070	44.6	V	54.0	-9.4	Avg	318	1.5	RB 1 MHz;VB 1 kHz;Peak
1149.830	46.8	V	74.0	-27.2	PK	318	1.5	RB 1 MHz;VB 3 MHz;Peak
4795.280	40.3	V	54.0	-13.7	Avg	59	1.5	RB 1 MHz;VB 1 kHz;Peak
4795.150	46.4	V	74.0	-27.6	PK	59	1.5	RB 1 MHz;VB 3 MHz;Peak
5317.850	48.4	H	68.3	-19.9	Avg	22	1.0	RB 1 MHz;VB 1 kHz;Peak
5317.660	57.6	H	68.3	-10.7	PK	22	1.0	RB 1 MHz;VB 3 MHz;Peak
1050.050	44.4	V	54.0	-9.6	Avg	0	1.0	RB 1 MHz;VB 1 kHz;Peak
1050.130	46.8	V	74.0	-27.2	PK	0	1.0	RB 1 MHz;VB 3 MHz;Peak

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

Run #8b: High Channel

Channel: 165 Mode: a
 Tx Chain: Both Data Rate: 6 MB/s

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1050.000	43.3	V	54.0	-10.7	Peak	348	1.0	
1150.000	44.4	V	54.0	-9.6	Peak	321	1.5	
4800.000	41.4	V	54.0	-12.6	Peak	68	1.5	
5341.670	49.6	H	68.3	-18.7	Peak	71	1.0	



Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).



EMC Test Data

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

Maximized Readings

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1150.050	44.8	V	54.0	-9.2	Avg	321	1.5	RB 1 MHz;VB 1 kHz;Peak
1149.970	46.7	V	74.0	-27.3	PK	321	1.5	RB 1 MHz;VB 3 MHz;Peak
4795.260	40.0	V	54.0	-14.0	Avg	63	1.5	RB 1 MHz;VB 1 kHz;Peak
4795.230	46.5	V	74.0	-27.5	PK	63	1.5	RB 1 MHz;VB 3 MHz;Peak
5339.930	56.0	H	68.3	-12.3	PK	86	1.0	RB 1 MHz;VB 3 MHz;Peak
1050.010	44.1	V	54.0	-9.9	Avg	349	1.4	RB 1 MHz;VB 1 kHz;Peak
1049.950	46.4	V	74.0	-27.6	PK	349	1.4	RB 1 MHz;VB 3 MHz;Peak

End of Report

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