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DFS TEST REPORT

REPORT NO.: RF990810E06-2

MODEL NO.: 2100X

RECEIVED: Aug. 11, 2010

TESTED: Aug. 26, 2010

ISSUED: Sep. 06, 2010

APPLICANT : Roku, LLC

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ISSUED BY: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory

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1. LAB DECLARATION

PRODUCT: IP Set Top Box

MODEL: 2100X

BRAND: RoKu

APPLICANT: Roku, LLC

TESTED: Sep. 02, 2010

TEST SAMPLE: ENGINEERING SAMPLE

STANDARDS: FCC Part 15, Subpart E (Section 15.407)

FCC 06-96

The above equipment (model: 2100X) has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

PREPARED BY : Midoli Peng , DATE: Sep. 06, 2010
(Midoli Peng, Specialist)

**TECHNICAL
ACCEPTANCE** : Hank Chung , DATE: Sep. 06, 2010
(Hank Chung, Deputy Manager)

APPROVED BY : May Chen , DATE: Sep. 06, 2010
(May Chen, Deputy Manager)



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2. EUT INFORMATION

2.1 OPERATING FREQUENCY BANDS AND MODE OF EUT

TABLE 1: OPERATING FREQUENCY BANDS AND MODE OF EUT

| OPERATIONAL MODE | OPERATING FREQUENCY RANGE | |
|--|---------------------------|--------------|
| | 5250~5350MHz | 5470~5725MHz |
| Client without radar detection and ad hoc function | ✓ | ✓ |

2.2 EUT SOFTWARE AND FIRMWARE VERSION

TABLE 2: THE EUT SOFTWARE/FIRMWARE VERSION

| NO. | PRODUCT | MODEL NO. | SOFTWARE/FIRMWARE VERSION |
|-----|----------------|-----------|---------------------------|
| 1 | IP Set Top Box | 2100X | 2.6.19.1. |

2.3 DESCRIPTION OF AVAILABLE ANTENNAS TO THE EUT

TABLE 3: ANTENNA LIST

| MODEL NAME | ANTENNA TYPE | OPERATION FREQUENCY RANGE (MHz) | GAIN (dBi) | Cable Loss (dB) |
|------------|--------------|---------------------------------|------------|-----------------|
| Main | PCB Printed | 5150 – 5750 MHz | 3.88 | 0 |
| Aux | PCB Printed | 5150 – 5750 MHz | 3.03 | 0 |



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2.4 EUT MAXIMUM CONDUCTED POWER

TABLE 4: THE MEASURED CONDUCTED OUTPUT POWER

IEEE 802.11a

| FREQUENCY BAND (MHz) | MAX. POWER | |
|-------------------------|----------------------|---------------------|
| | OUTPUT POWER(dBm) | OUTPUT POWER(mW) |
| 5250~5350 | 21.7 | 147.9 |
| 5470~5725 | 21.4 | 138.0 |

DRAFT 802.11n (20MHz)

| FREQUENCY BAND (MHz) | MAX. POWER | |
|-------------------------|----------------------|---------------------|
| | OUTPUT POWER(dBm) | OUTPUT POWER(mW) |
| 5250~5350 | 20.8 | 119.1 |
| 5470~5725 | 20.8 | 119.1 |

DRAFT 802.11n (40MHz)

| FREQUENCY BAND (MHz) | MAX. POWER | |
|-------------------------|----------------------|---------------------|
| | OUTPUT POWER(dBm) | OUTPUT POWER(mW) |
| 5250~5350 | 22.8 | 188.8 |
| 5470~5725 | 22.5 | 178.4 |



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2.5 EUT MAXIMUM E.I.R.P. POWER

TABLE 5: THE E.I.R.P OUTPUT POWER LIST

IEEE 802.11a

| FREQUENCY BAND (MHz) | MAX. POWER | |
|-------------------------|----------------------|---------------------|
| | OUTPUT POWER(dBm) | OUTPUT POWER(mW) |
| 5250~5350 | 25.58 | 361.41 |
| 5470~5725 | 25.28 | 337.29 |

802.11n (20MHz)

| FREQUENCY BAND (MHz) | MAX. POWER | |
|-------------------------|----------------------|---------------------|
| | OUTPUT POWER(dBm) | OUTPUT POWER(mW) |
| 5250~5350 | 24.68 | 293.77 |
| 5470~5725 | 24.68 | 293.77 |

802.11n (40MHz)

| FREQUENCY BAND (MHz) | MAX. POWER | |
|-------------------------|----------------------|---------------------|
| | OUTPUT POWER(dBm) | OUTPUT POWER(mW) |
| 5250~5350 | 26.68 | 465.59 |
| 5470~5725 | 26.38 | 434.51 |



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2.6 TRANSMIT POWER CONTROL (TPC)

U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW.

Maximum E.I.R.P of this device is 465.59mW which less than 500mW, therefore it's not require TPC function.

From Web, End user can not set the power.

2.7 STATEMENT OF MANUFACTURER

This device (Client) is without radar detection, then the manufacturer statement confirming that information regarding the parameters of the detected Radar Waveforms is not available to the end user. **And the device doesn't have Ad Hoc mode on DFS frequency band.**



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3. U-NII DFS RULE REQUIREMENTS

3.1 WORKING MODES AND REQUIRED TEST ITEMS

The manufacturer shall state whether the UUT is capable of operating as a Master and/or a Client. If the UUT is capable of operating in more than one operating mode then each operating mode shall be tested separately. See tables 1 and 2 for the applicability of DFS requirements for each of the operational modes.

TABLE 6: APPLICABILITY OF DFS REQUIREMENTS PRIOR TO USE A CHANNEL

| REQUIREMENT | OPERATIONAL MODE | | |
|---------------------------------|------------------|--------------------------------|-----------------------------|
| | MASTER | CLIENT WITHOUT RADAR DETECTION | CLIENT WITH RADAR DETECTION |
| Non-Occupancy Period | ✓ | ✓ | ✓ |
| DFS Detection Threshold | ✓ | Not required | ✓ |
| Channel Availability Check Time | ✓ | Not required | Not required |
| Uniform Spreading | ✓ | Not required | Not required |
| U-NII Detection Bandwidth | ✓ | Not required | ✓ |

TABLE 7: APPLICABILITY OF DFS REQUIREMENTS DURING NORMAL OPERATION

| REQUIREMENT | OPERATIONAL MODE | | |
|-----------------------------------|------------------|--------------------------------|-----------------------------|
| | MASTER | CLIENT WITHOUT RADAR DETECTION | CLIENT WITH RADAR DETECTION |
| DFS Detection Threshold | ✓ | Not required | ✓ |
| Channel Closing Transmission Time | ✓ | ✓ | ✓ |
| Channel Move Time | ✓ | ✓ | ✓ |
| U-NII Detection Bandwidth | ✓ | Not required | ✓ |



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3.2 TEST LIMITS AND RADAR SIGNAL PARAMETERS

DETECTION THRESHOLD VALUES

TABLE 8: DFS DETECTION THRESHOLDS FOR MASTER DEVICES AND CLIENT DEVICES WITH RADAR DETECTION

| MAXIMUM TRANSMIT POWER | VALUE (SEE Note 1 and 2) |
|------------------------|--------------------------|
| ≥ 200 milliwatt | -64 dBm |
| < 200 milliwatt | -62 dBm |

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.

Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.

TABLE 9: DFS RESPONSE REQUIREMENT VALUES

| PARAMETER | VALUE |
|-----------------------------------|---|
| Non-occupancy period | Minimum 30 minutes |
| Channel Availability Check Time | 60 seconds |
| Channel Move Time | 10 seconds See Note 1. |
| Channel Closing Transmission Time | 200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2. |
| U-NII Detection Bandwidth | Minimum 80% of the UNII 99% transmission power bandwidth. See Note 3. |



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Note 1: The instant that the Channel Move Time and the Channel Closing Transmission Time begins is as follows:

- For the Short Pulse Radar Test Signals this instant is the end of the Burst.
- For the Frequency Hopping radar Test Signal, this instant is the end of the last radar Burst generated.
- For the Long Pulse Radar Test Signal this instant is the end of the 12 second period defining the Radar Waveform.

Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the U-NII Detection Bandwidth detection test, radar type 1 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

PARAMETERS OF DFS TEST SIGNALS

Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

TABLE 10: SHORT PULSE RADAR TEST WAVEFORMS

| RADAR TYPE | PULSE WIDTH (μsec) | PRI (μsec) | NUMBER OF PULSES | MINIMUM PERCENTAGE OF SUCCESSFUL DETECTION | MINIMUM NUMBER OF TRIALS |
|-----------------------------|--------------------|------------|------------------|--|--------------------------|
| 1 | 1 | 1428 | 18 | 60% | 30 |
| 2 | 1-5 | 150-230 | 23-29 | 60% | 30 |
| 3 | 6-10 | 200-500 | 16-18 | 60% | 30 |
| 4 | 11-20 | 200-500 | 12-16 | 60% | 30 |
| Aggregate (Radar Types 1-4) | | | | 80% | 120 |



TABLE 11: LONG PULSE RADAR TEST WAVEFORM

| RADAR TYPE | PULSE WIDTH (μsec) | CHIRP WIDTH (MHz) | PRI (μsec) | NUMBER OF PULSES PER BURST | NUMBER OF BURSTS | MINIMUM PERCENTAGE OF SUCCESSFUL DETECTION | MINIMUM NUMBER OF TRIALS |
|------------|--------------------|-------------------|------------|----------------------------|------------------|--|--------------------------|
| 5 | 50-100 | 5-20 | 1000-2000 | 1-3 | 8-20 | 80% | 30 |

TABLE 12: FREQUENCY HOPPING RADAR TEST WAVEFORM

| RADAR TYPE | PULSE WIDTH (μsec) | PRI (μsec) | PULSES PER HOP | HOPPING RATE (kHz) | HOPPING SEQUENCE LENGTH (msec) | MINIMUM PERCENTAGE OF SUCCESSFUL DETECTION | MINIMUM NUMBER OF TRIALS |
|------------|--------------------|------------|----------------|--------------------|--------------------------------|--|--------------------------|
| 6 | 1 | 333 | 9 | 0.333 | 300 | 70% | 30 |



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4. TEST & SUPPORT EQUIPMENT LIST

4.1 TEST INSTRUMENTS

TABLE 1: TEST INSTRUMENTS LIST.

| DESCRIPTION & MANUFACTURER | MODEL NO. | BRAND | CALIBRATED UNTIL |
|----------------------------|-----------|-----------|------------------|
| R&S Spectrum analyzer | FSP40 | R&S | May 16, 2011 |
| Signal generator | 8645A | Agilent | Aug. 30, 2010 |
| Oscilloscope | TDS 5104 | Tektronix | May 18, 2011 |

4.2 DESCRIPTION OF SUPPORT UNITS

TABLE 2: SUPPORT UNIT INFORMATION.

| NO. | PRODUCT | BRAND | MODEL NO. | ID | SPEC. |
|-----|----------------------------|-------|--------------------|-----------|--|
| 1 | 802.11a/b/g/n Access Point | Cisco | AIR-AP1252A G-A-K9 | LDK102061 | The maximum EIRP is 26 dBm, Antenna Gain is 3.5dBi |

NOTE: This device was functioned as a Master Slave device during the DFS test.

TABLE 3: SOFTWARE/FIRMWARE INFORMATION.

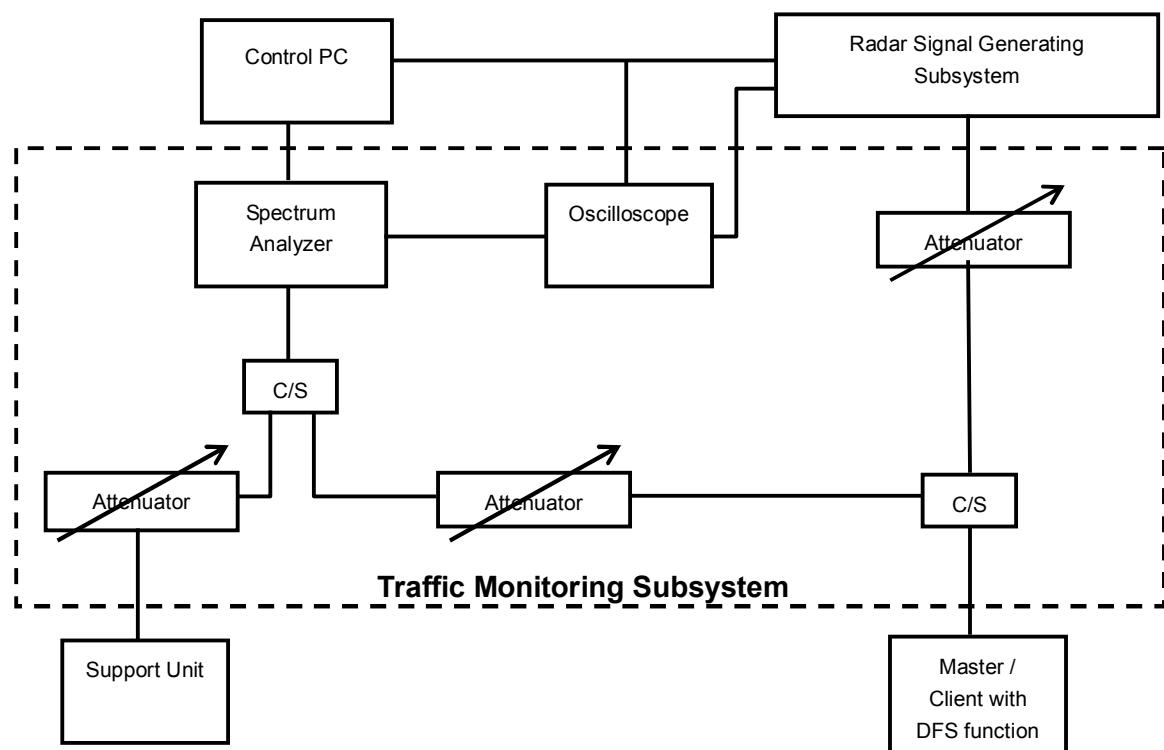
| NO. | PRODUCT | MODEL NO. | SOFTWARE/FIRMWARE VERSION |
|-----|----------------------------|-------------------|---------------------------|
| 1. | 802.11a/b/g/n Access Point | AIR-AP1252AG-A-K9 | 12.4(10b)JA1 |

5. TEST PROCEDURE

5.1 ADT DFS MEASUREMENT SYSTEM:

A complete ADT DFS Measurement System consists of two subsystems: (1) the Radar Signal Generating Subsystem and (2) the Traffic Monitoring Subsystem. The control PC is necessary for generating the Radar waveforms in Table 6, 7 and 8. The traffic monitoring subsystem is specified to the type of unit under test (UUT).

CONDUCTED SETUP CONFIGURATION OF ADT DFS MEASUREMENT SYSTEM

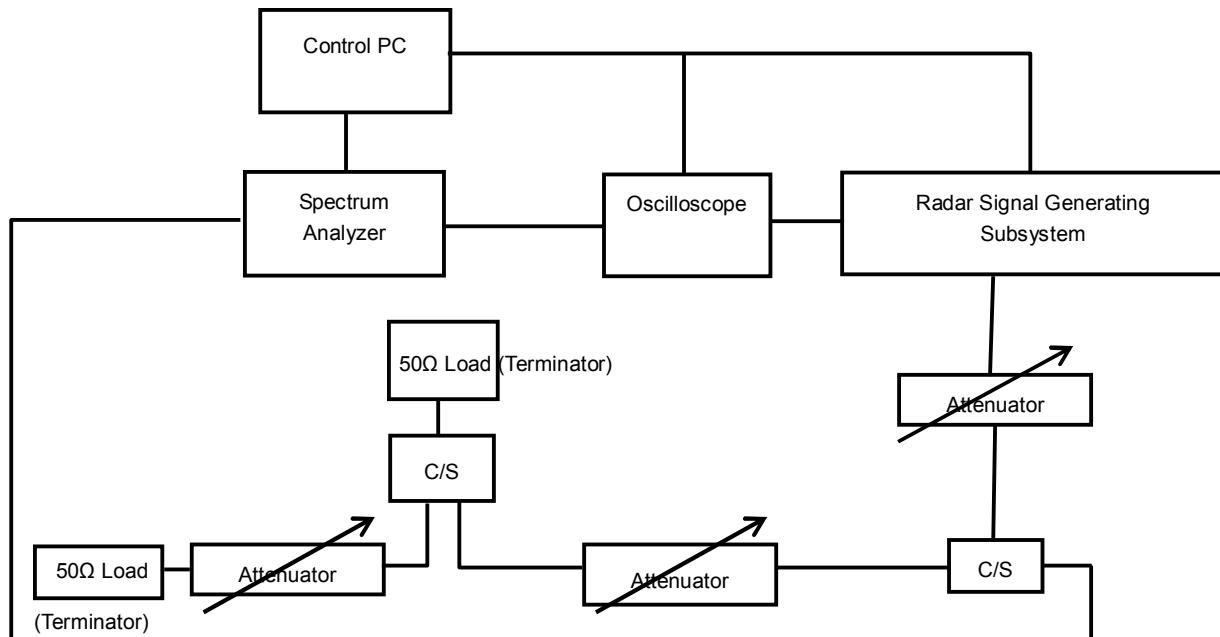


The test transmission will always be from the Master Device to the Client Device. While the Client device is set up to associate with the Master device and play the MPEG file from Master device, the designated MPEG test file and instructions are located at: <http://ntiacsd.ntia.doc.gov/dfs/>.

5.2 CALIBRATION OF DFS DETECTION THRESHOLD LEVEL:

The measured channel is 5500 MHz. The radar signal was the same as transmitted channels, and injected into the antenna port of AP (master) or Client Device with Radar Detection, measured the channel closing transmission time and channel move time. The Master antenna gain is 3.5dBi and required detection threshold is -59.5dBm (= -64 +1+3.5)dBm. The calibrated conducted detection threshold level is set to -59.5 dBm.

CONDUCTED SETUP CONFIGURATION OF CALIBRATION OF DFS DETECTION THRESHOLD LEVEL

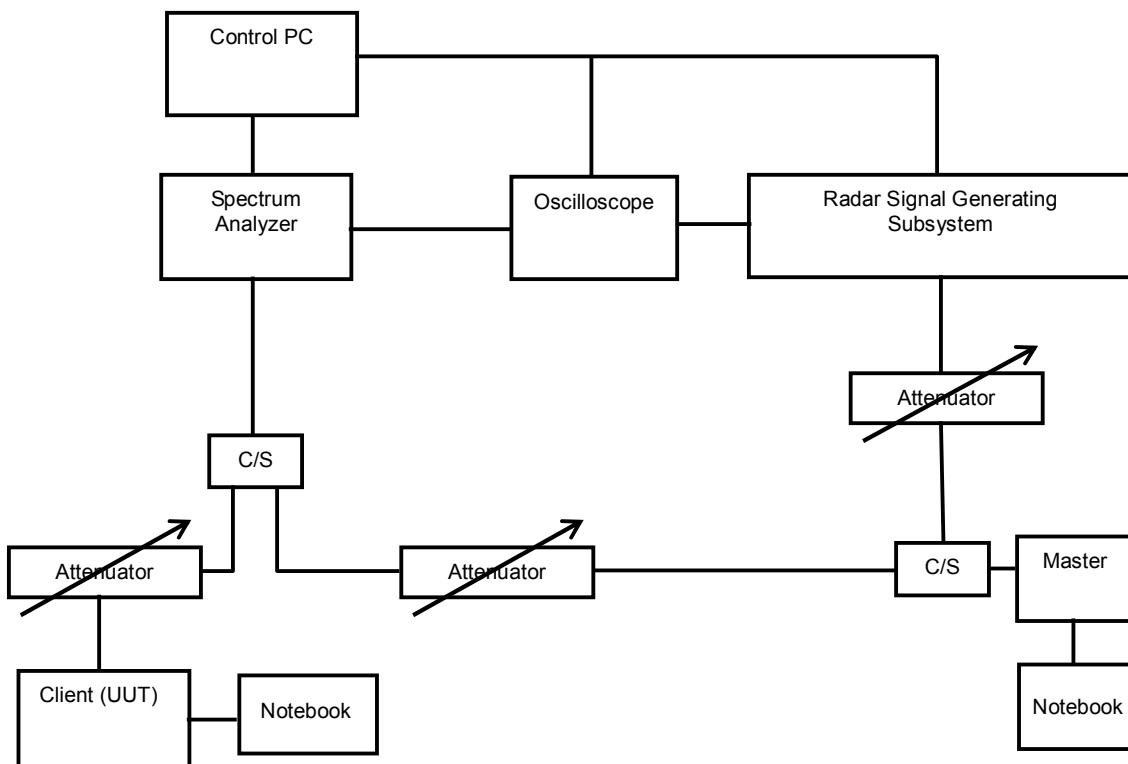


5.3 DEVIATION FROM TEST STANDARD

No deviation.

5.4 CONDUCTED TEST SETUP CONFIGURATION

5.4.1 CLIENT WITHOUT RADAR DETECTION MODE



The UUT is a U-NII Device operating in Client mode without radar detection. The radar test signals are injected into the Master Device.

Since the UUT can not play the MPEG file (6 $\frac{1}{2}$ Magic Hours) from Master device, an alternative set up configuration was performed as which is described in Appendix-B.



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6. TEST RESULTS

6.1 SUMMARY OF TEST RESULTS

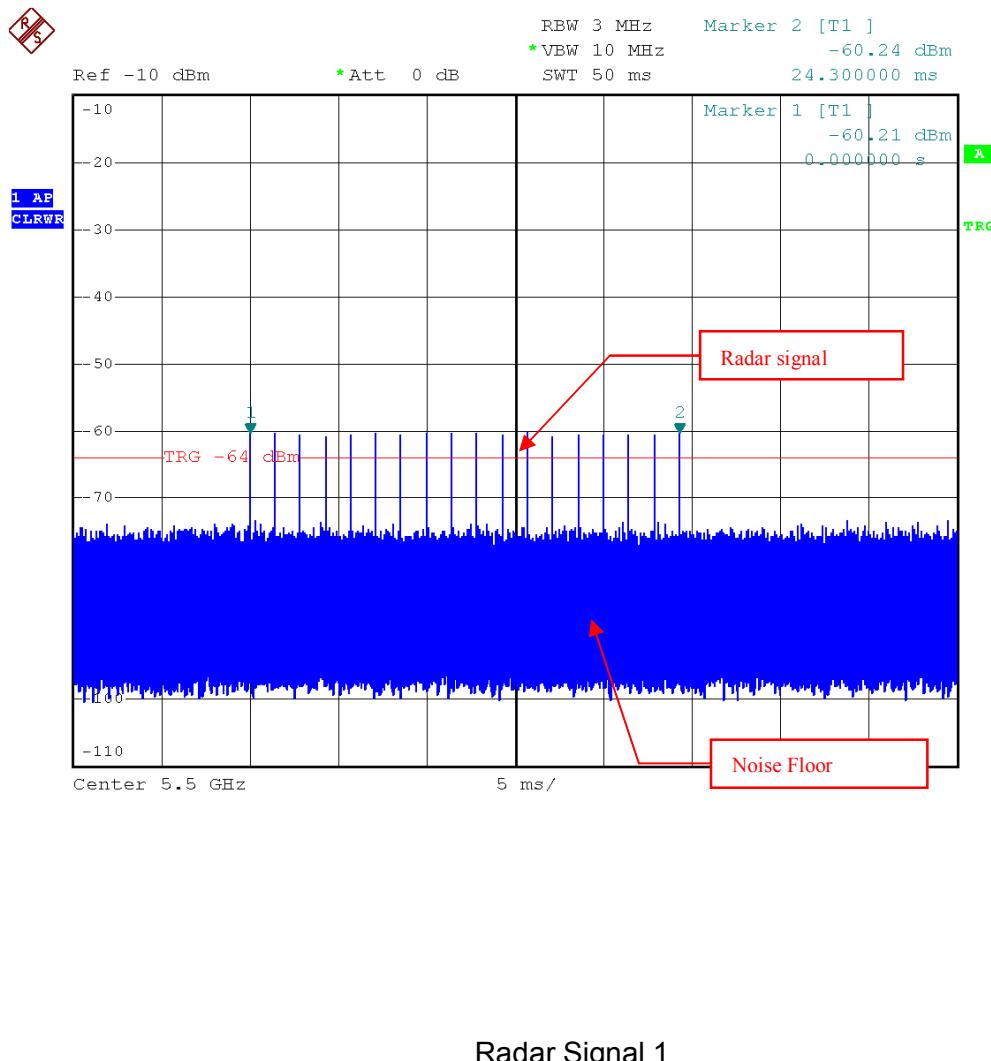
| CLAUSE | TEST PARAMETER | REMARKS | PASS/FAIL |
|--------|-----------------------------------|----------------|-----------|
| 15.407 | DFS Detection Threshold | Not Applicable | NA |
| 15.407 | Channel Availability Check Time | Not Applicable | NA |
| 15.407 | Channel Move Time | Applicable | Pass |
| 15.407 | Channel Closing Transmission Time | Applicable | Pass |
| 15.407 | Non- Occupancy Period | Applicable | Pass |
| 15.407 | Uniform Spreading | Not Applicable | NA |
| 15.407 | U-NII Detection Bandwidth | Not Applicable | NA |
| 15.407 | Non-associated test | Applicable | Pass |
| 15.407 | Non-Co-Channel test | Applicable | Pass |

6.2 DETAIL TEST RESULTS

6.2.1 Test Mode: Device operating in Client without Radar Detection mode.
 Client with injection at the Master. (The radar test signals are injected into the Master Device.)

6.2.1.1 DFS DETECTION THRESHOLD

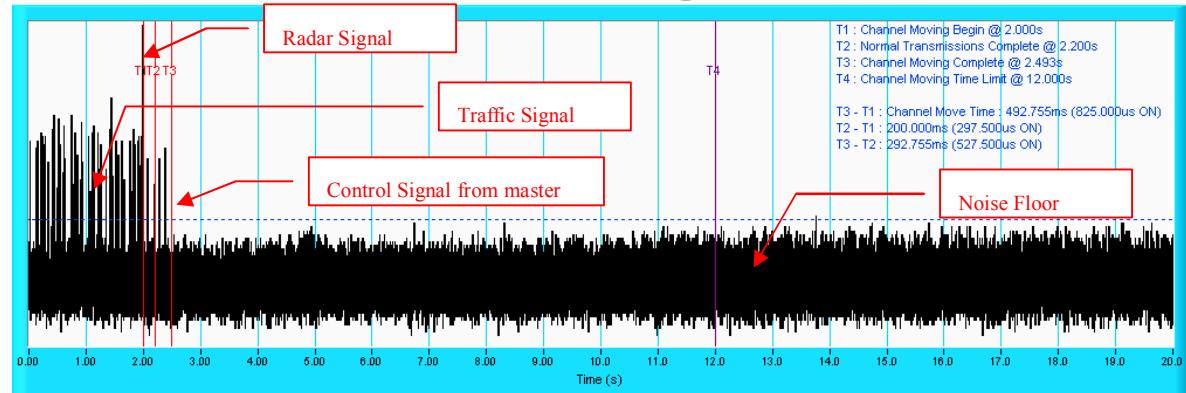
For a detection threshold level of -64dBm and the Master antenna gain is 3.5dBi . The Required detection threshold is -59.5dBm ($= -64 + 1 + 3.5$) dBm . The conducted radar burst level is set to -59.5dBm .



6.2.1.2 CHANNEL CLOSING TRANSMISSION AND CHANNEL MOVE TIME

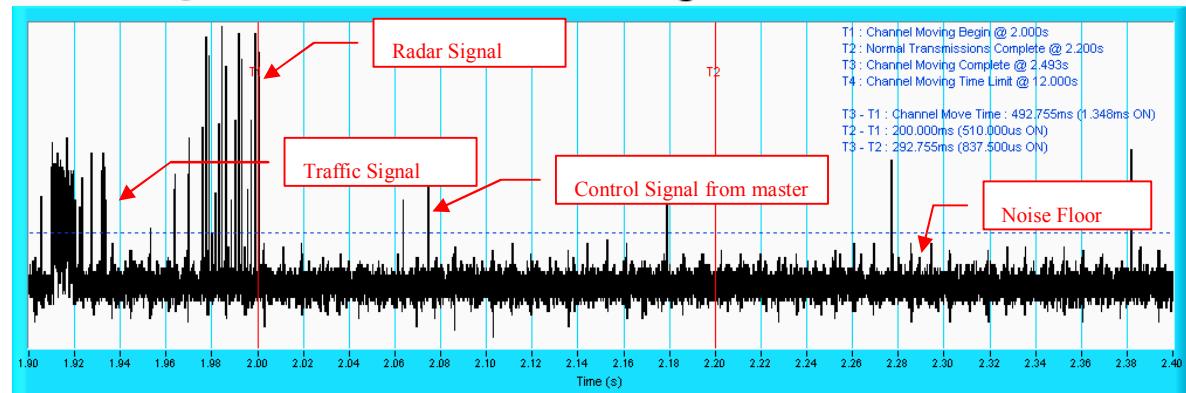
IEEE 802.11a

Channel Closing Transmission Time & Channel Move Time @ CH100 - 5500MHz



NOTE: T1 denotes the start of Channel Move Time upon the end of the last Radar burst. T2 denotes the data transmission time of 200ms from T1. T3 denotes the end of Channel Move Time. T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.

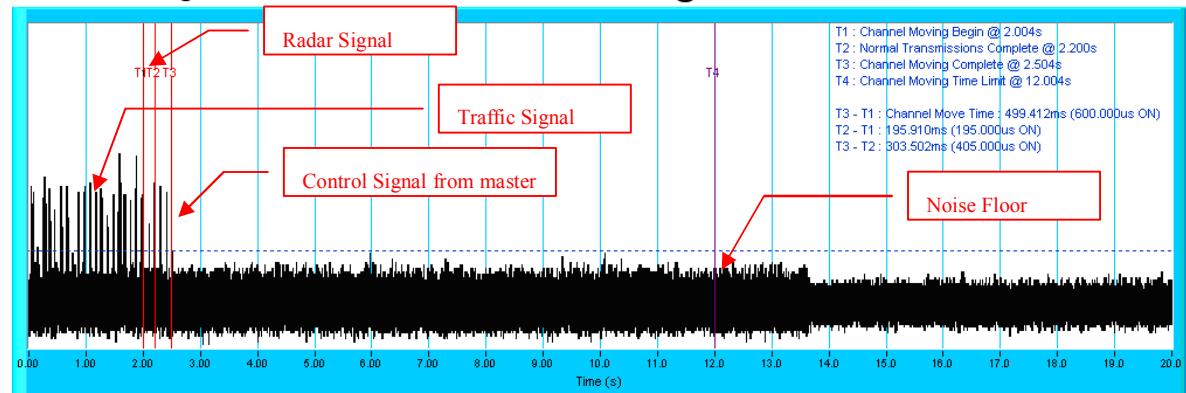
Channel Closing Transmission Time & Channel Move Time @ CH100 - 5500MHz



NOTE: An expanded plot for the device vacates the channel in the required 200ms.

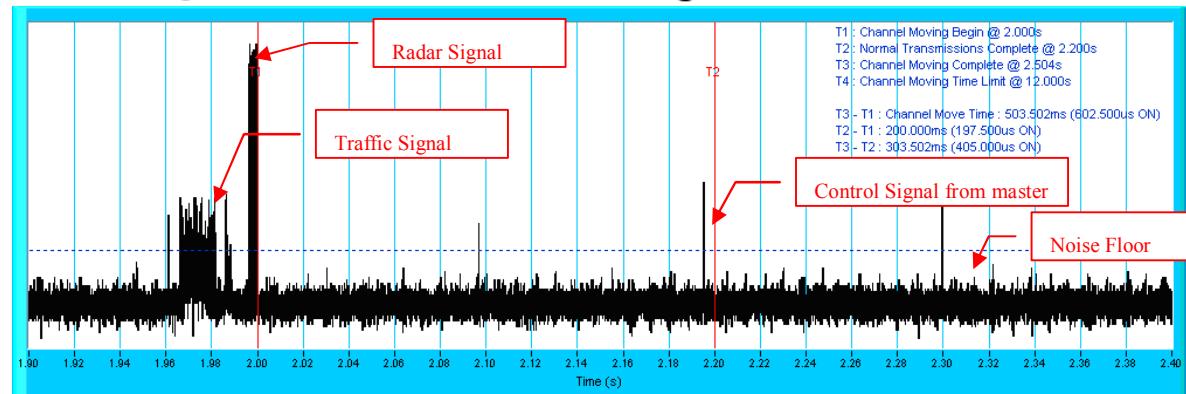
IEEE 802.11n HT40

Channel Closing Transmission Time & Channel Move Time @ CH102 - 5510MHz



NOTE: T1 denotes the start of Channel Move Time upon the end of the last Radar burst. T2 denotes the data transmission time of 200ms from T1. T3 denotes the end of Channel Move Time. T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.

Channel Closing Transmission Time & Channel Move Time @ CH102 - 5510MHz

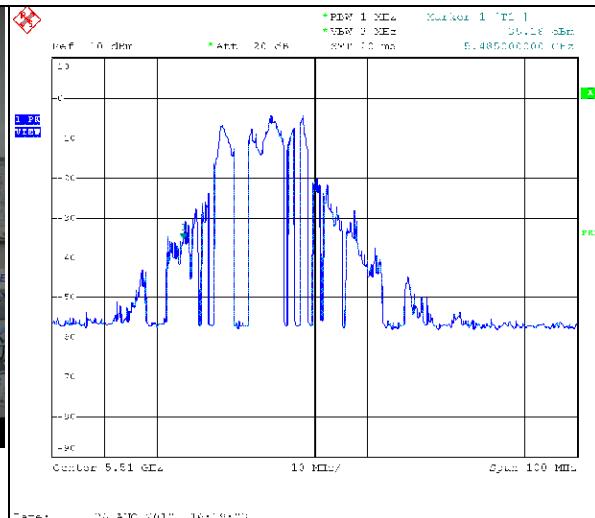


NOTE: An expanded plot for the device vacates the channel in the required 200ms.

6.2.1.3 NON- OCCUPANCY PERIOD

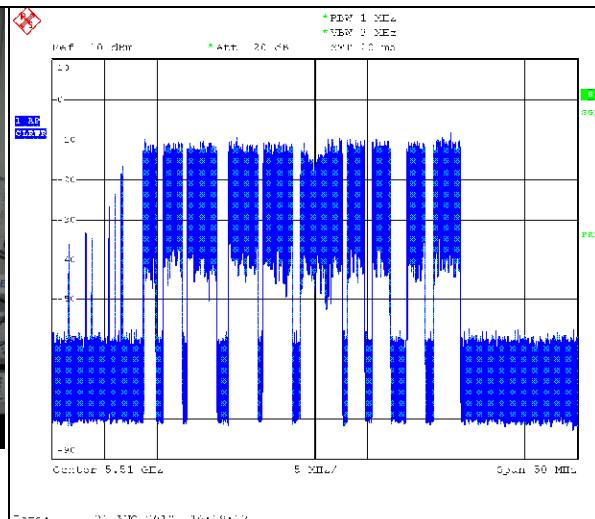
ASSOCIATED TEST

1) Test results demonstrating an associated client link is established with the master on a test frequency.



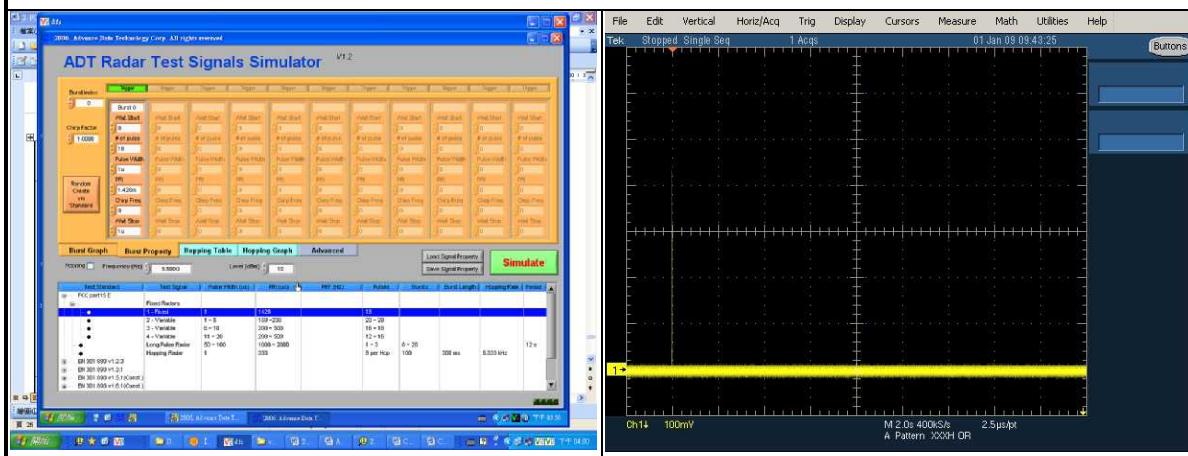
EUT (Client) links with master on 5500MHz

2) The client and DFS-certified master device are associated, and the movie can be streamed as specified in the DFS Order for a non-occupancy period test.



Client plays a specified files via master.

3). The device transmits one type of radar as specified in the DFS Order.



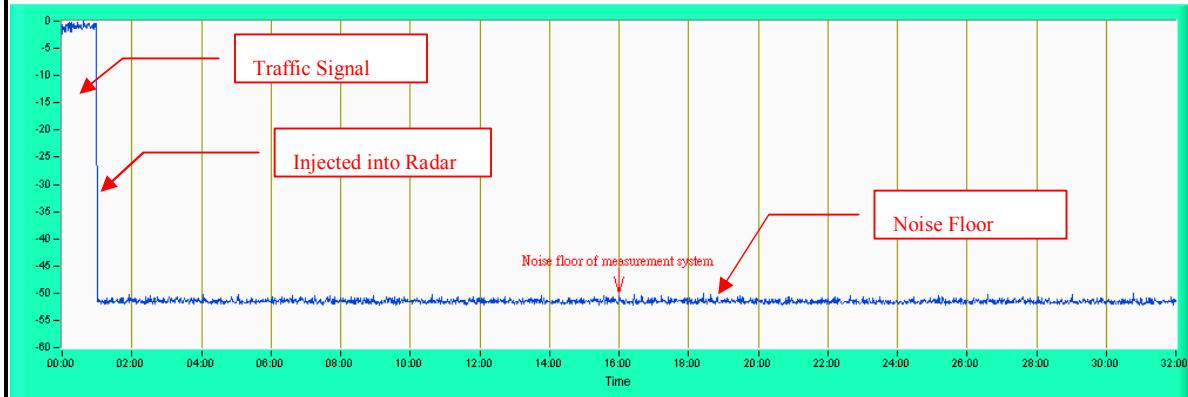
Radar 1 is used to test during DFS testing.

4) The test frequency has been monitored to ensure no transmission of any type has occurred for 30 minutes;

Note: If the client moves with the master, the device is considered compliant if nothing appears in the client nonoccupancy period test. For devices that shut down (rather than moving channels), no beacons should appear;

5) An analyzer plot that contains a single 30-minute sweep on the original test frequency.

Non - Occupancy Period @ CH100 - 5500MHz

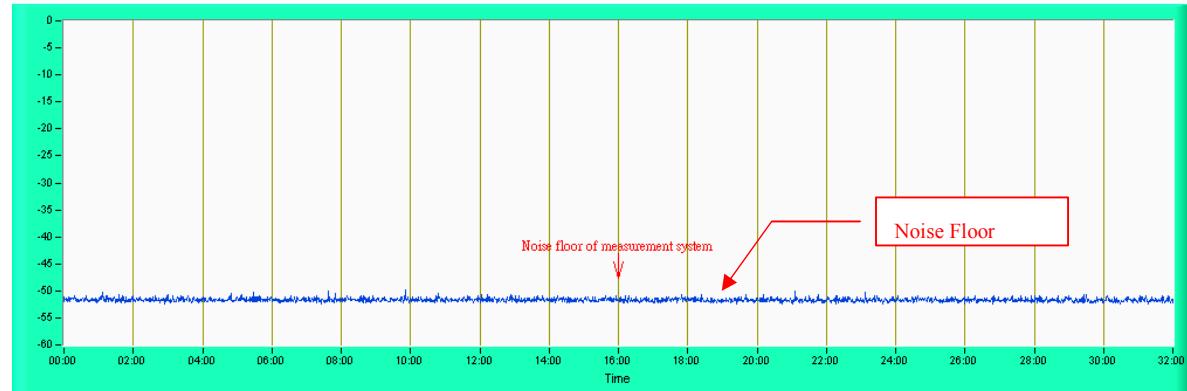


NON-ASSOCIATED TEST

Master was off.

During the 30 minutes observation time, The UUT did not make any transmissions in the DFS band after UUT power up.

Non-Associated Test @ CH100 - 5500MHz



6.2.1.4 NON-CO-CHANNEL TEST

The UUT was investigated after radar was detected the channel and made sure no co-channel operation with radars.



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7. INFORMATION ON THE TESTING LABORATORIES

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

Copies of accreditation certificates of our laboratories obtained from approval agencies can be downloaded from our web site:
www.adt.com.tw/index.5/phtml. If you have any comments, please feel free to contact us at the following:

Linko EMC/RF Lab:

Tel: 886-2-26052180
Fax: 886-2-26052943

Hsin Chu EMC/RF Lab:

Tel: 886-3-5935343
Fax: 886-3-5935342

Hwa Ya EMC/RF/Safety Telecom Lab:

Tel: 886-3-3183232
Fax: 886-3-3185050

Web Site: www.adt.com.tw

The address and road map of all our labs can be found in our web site also

8. APPENDIX

8.1 APPENDIX-A

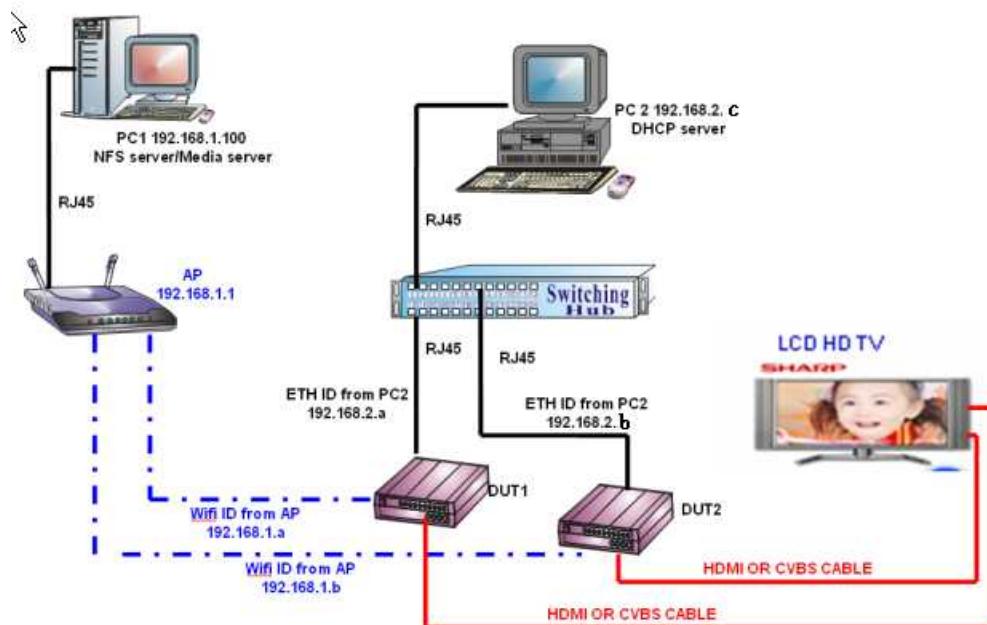
MODIFICATIONS OR ADDING COMPONENTS DURING THE TEST

No any modifications are made to the EUT by the lab during the test.

8.2 APPENDIX-B

TEST CONFIGURATION AND SUPPORT VIDEO FORMATS.

8.2.1 TEST CONFIGURATION.





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8.2.2 SUPPORT VIDEO FORMATS.

| | H.264 SD | H.264 HD | WMV9 SD | VC-1 HD |
|------------------------------------|------------------------|------------------------|------------------------|------------------------|
| Aspect Ratio ¹ | 4:3 | 16:9 | 4:3 | 16:9 |
| Dimension | Various to 720x480 | Various to 1280x720 | Various to 720x480 | Various to 1280x720 |
| Progressive/Interlaced | Progressive | Progressive | Progressive | Progressive |
| File Format | .mp4 (MPEG-4 Pt 14) | .mp4 (MPEG-4 Pt 14) | ASF | ASF |
| Frame Rate ² | Fixed/Source Dependent | Fixed/Source Dependent | Fixed/Source Dependent | Fixed/Source Dependent |
| Color Space | YUV | YUV | YUV | YUV |
| Video Codec | H.264/AVC | H.264/AVC | WMV9 | VC-1 AP (WVC1) |
| Profile | Main/High | High | Main | Advanced |
| Level/Complexity | 4.0 | 4.0 | 4.0 | 4.0 |
| Video Mode | Constrained VBR | Constrained VBR | Constrained VBR | Constrained VBR |
| Average Video Bitrate ³ | 384Kbps - 1.6Mbps | 1.6Kbps – 2.5Mbps | 500Kbps-2.2Mbps | 2.6Mbps - 3.8Mbps |
| Peak Video Bitrate | 1.5x average | 1.5x average | 1.5x-3.0x average | 1.5x average |
| Key Frame Interval | 10s | 10s | 18s | 3s |
| DRM | None | None | WMDRM10 (Janus) | WMDRM10 (Janus) |
| Audio Codec | AAC LC (CBR) | AAC LC (CBR) | WMA 9.2 (CBR) | WMA 9.2 (CBR) |
| Audio Bit Rate | 128-256Kbps | 32-256Kbps | 64-128Kbps | 64-256Kbps |
| Audio Sample Rate | 44.1 Khz or 48Khz | 44.1 Khz or 48 Khz | 44.1 Khz or 48Khz | 44.1 Khz or 48Khz |
| Audio Sample Size | 16-Bit | 16-Bit | 16-bit | 16-bit |
| Audio Channels | 2-Ch Stereo | 2-Ch Stereo | 2-CH Stereo | 2-CH Stereo |

Notes: Important notes on video playback

- 1) The dimensions vary on a title-by-title basis depending on the source material and the target aspect ratio for the encode (e.g. 4:3 or 16:9). Content is always encoded at full width and the height is adjusted. For example, a 1.66 aspect ratio source is encoded as a 720x432 video and displayed as letterboxed for a 4:3 display.
- 2) The frame rate used for encoding is dependent on the source material. Film content is generally 23.976 fps, while video content is generally at 29.97.
- 3) For typical streaming video applications, we recommend a range of ~384Kbps to 3.8Mbps. This provides a good balance between quality and support for a wide number of users. In some cases lower and higher bitrates have been used, but this frequently results in poor quality or limits the percent of the installed base that can view this encoding.
- 4) It is critical that the StreamURLs, StreamBitrates, StreamQualities and StreamStickyHttpRedirects arrays are all aligned with each other. For example, the first stream listed would be the 0th element of all of these arrays. You may have multiple streams in the arrays and the system will automatically pick the most appropriate stream based on the users available bandwidth and video settings.



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- 5) The StreamQualities array identifies streams as either SD or HD. If the user is configured for SD the system will not select HD streams for playback.
- 6) The optional StreamStartTimeOffset is the offset into the stream which is considered to be the new origin of playback.
- 7) Live – declares the video as live and replaces the time remaining text in the progress bar with “live”.