

# APPENDIX A:

## ENERGY STAR Test Procedure for Audio/Video Products

**Note:** This revision of the test procedure contains updates resulting from the stakeholder conference call on July 8, 2009. To the extent possible, stakeholders are encouraged to perform product testing per these revised procedures and submit data to [AudioVideo@energystar.gov](mailto:AudioVideo@energystar.gov) by July 24, 2009 for consideration in the development of Version 2.0 ENERGY STAR qualification requirements. Changes have been highlighted in red and additional note boxes are included with details specific to this version of the test procedure.

### 1. Overview

The following protocol should be followed when measuring power consumption levels of audio/video products for compliance with the levels provided in the ENERGY STAR Version 2.0 Audio/Video Specification.

### 2. Applicability

Partners must measure a representative sample of the configuration as shipped to the customer. EPA has prepared the following guidelines for testing of Audio/Video products:

- a) Power mode tests described in Section 5 should be performed on every product,
- b) Video device tests (Section 6) should be performed on any product that offers storage for recording and playback of live video,
- c) Removable media player device tests (Section 7) should be performed on any product capable of playback or recording of audio and/or video stored on removable media (e.g. Flash drive, CD, DVD, Blu-ray Disc), and
- d) Single- and Dual-channel Amplifier tests (Section 8) should be performed on any product that offers one- or two-channel audio amplification. Multi-channel Amplifier tests (Section 9) should be performed on any product that offers surround sound multi-channel audio amplification.
- e) Under the guidelines, a HTIB system with an integrated DVD player/recorder and audio amplifiers would likely be subject to the power mode tests in Section 5, several of the removable media player tests in Section 6, and the multi-channel amplifier tests in Section 9. In contrast, a stand-alone rack-mount audio amplifier would likely only be subject to the power mode tests in Section 5 and the two-channel amplifier tests in Section 8.
- f) Audio/Video products must be tested in their as-shipped configuration. For products that offer a choice of user-configurable options (i.e. choice of surround sound processing modes), options shall be set to their default condition.

**Note:** Section 2.b has been updated to differentiate between two-channel and multi-channel amplifier testing. Section 2.f has been elaborated to account for user-configurable options. Section number cross-references have been corrected.

### 3. Definitions

Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the Version 2.0 ENERGY STAR Eligibility Criteria for Audio/Video Products.

### 4. Test Setup

#### 4.1. Test Equipment

The following test equipment is recommended for performing ENERGY STAR power consumption tests:

- a) Oscilloscope or Power Analyzer, with a current probe, to monitor AC line current waveform, amplitude, and frequency;
- b) True RMS volt meter, to measure voltage at the input of the unit being tested (optional if AC source output is sufficiently accurate);
- c) Frequency counter, to measure frequency at the input of the unit being tested (optional if AC source output is sufficiently accurate);
- d) Signal Generator(s), Analog or Digital, to produce signal inputs for amplifier testing, as appropriate; and
- e) Timer, for measuring test durations.

**Note:** EPA intends to update Section 4.1 to allow for use of a single power meter for product testing, when applicable.

## 4.2. Calibration

All test equipment shall be annually calibrated by a laboratory accredited to ISO/IEC 17025:2005 by an ILAC recognized accreditation body.

## 4.3. Power Measurement Test Conditions

- a) Test Setup: Test setup shall be in accordance with the requirements of IEC 62301, Ed. 1.0, "Measurement of Household Appliance Standby Power", Section 4, "General Conditions for Measurements", unless otherwise noted in this document. In the event of conflicting requirements, this test procedure shall take precedence.
- b) Measurement Location: All power measurements shall be made at a point between the AC power source and the UUT.
- c) Component-level Measurement: In the case of products that include many sub-components (e.g. a home theater system may include a receiver, powered subwoofer, and wireless speakers), all components shall be connected together in a typical end-use configuration. All components may be tested simultaneously, but each power-consuming device must be metered separately (e.g. power consumption must be measured at each plug connection to mains power). Power consumption data for each sub-component shall be summed to determine the total power consumption of the product.
- d) Measurement Methods: Average power consumption shall be determined in accordance with the requirements of IEC 62301, Ed. 1.0, "Measurement of Household Appliance Standby Power", Section 5.3.2, using either the average power or accumulated energy approaches outlined below.
  - 1) Average Power Approach: where the instrument can record a true average power over a user selected period, the period selected shall not be less than 10 minutes.
  - 2) Accumulated Energy Approach: where the instrument can accumulate energy over a user selected period, the period selected shall not be less than 10 minutes. The integrating period shall be such that the total recorded value for energy and time is more than 200 times the resolution of the meter for energy and time. Determine the average power by dividing the accumulated energy by the time for the monitoring period.

## 4.4. Source Signals

- a) Signal Input Location: If the UUT does not have accessible signal input terminals, test signal input shall be through the device antenna or other accessible means typical of customer use.
- b) Audio Sources: The following noise profiles shall be used for all audio testing:
  - 1) Pink Noise ( $A=1/f$ ): Pink noise is a random signal within the audible frequency range, whose amplitude is inversely proportional to frequency, maintaining constant audio power

per logarithmic frequency increment. Pink noise signals shall be band-pass filtered per the requirements of IEC-60268-1, Section 6.1 (also cross-referenced in IEC-60065, Annex C). Pink noise signals shall be mono, correlated between channels for dual-channel testing.

- 2) Sine Wave: All sine wave input signals used for single- and dual-channel amplifier testing shall have frequency of 1 kHz. For dual-channel testing, sine wave signals shall be in-phase, with identical frequency.

**Note:** Section 4.4.b has been updated with further clarification of pink noise and sine wave input signal requirements, per stakeholder feedback.

- c) Video Sources: All video source signals shall be from live sources (i.e. broadcast TV, cable TV, radio, streaming Internet content, etc.) of the type used under typical device operation. If the UUT does not have a tuner, a video signal input with equivalent content and resolution shall be provided. The following reference channels shall be used as inputs when video signals are required:

- 1) Reference Channel A: SD Network TV channel. This channel shall be at least 480i format.
- 2) Reference Channel B: SD/HD Sports channel. If the UUT is HD-capable, this channel shall be at least 720p format. If the UUT is not HD-capable, this channel shall be at least 480i format.
- 3) Reference Channel C: SD 24-hour News channel. This channel shall be at least 480i format.

Tuning to a broadcast video source is defined as one tuner acquiring an encrypted digital video service, where the video service is rendered on all analog audio/video outputs (e.g. RF modulated, S-Video, composite and component) and on all SPDIF audio outputs (if equipped).

- d) Option to Test with Only HD Video Sources: The video test procedures in Sections 6 and 7 are performed with both SD and HD video sources for devices capable of processing both SD and HD content. The overall average power consumption for the UUT is the average of the power consumption measurements from the SD and HD video source tests. This average is intended to reward devices that can scale back power consumption when processing SD video signals.

If the UUT is found to have negligible differences in power consumption when processing SD versus HD sources, the manufacturer may choose to perform and report results from only HD video source tests (per the definition of Reference Channel B), in order to expedite testing.

#### 4.5. UUT Operation

- a) UUT Control: The UUT shall be controlled with the factory-supplied remote control (I/R or RF) to the extent possible. For units that do not ship with a remote control, or for functions that cannot be accessed from the supplied remote control, control mechanisms on the face or body of the UUT may be used.
- b) Output Volume: The UUT output volume should be set to minimum for the duration of all tests except as noted in the Amplifier test procedures in Section 8.
- c) Battery Powered Devices: If the UUT contains rechargeable batteries, or can be integrated with another device that contains rechargeable batteries, all batteries should be in a fully charged state for the duration of testing.
- d) Optional Hardware: If the UUT uses Smart card or POD technology for conditional access system control, then insert the applicable card into the UUT prior to applying power.

#### 4.6. UUT Pre-test Configuration

Prior to the start of testing, the UUT must be configured as follows:

- 1) Set up the UUT per the instructions in the product operating manual. If the product manual contains several example configurations, select the most basic configuration that will allow for completion of the test procedure.

**Note:** EPA intends to evaluate UUT setup options as the specification development process continues. Stakeholders have commented that the use of certain product inputs (i.e. Video vs. HDMI) could have significant effects on product power consumption. EPA is interested in stakeholder feedback regarding appropriate and representative test configurations for various products in the AV market, along with test data regarding differences in power consumption for various product configurations.

- 2) If the UUT includes speaker outputs, connect a resistive load across each pair of output terminals equivalent to the nominal rated load impedance **or lowest impedance of the rated impedance range. (e.g. 6 ohm if rated 6-8 ohm)**. The same resistive load must be used for all amplifier tests.
- a. For self-powered or internal speakers with no accessible output terminals, output power shall be measured across the speaker input leads, using the attached speaker as a resistive load.

**Note:** Section 4.6.2 was updated to include the appropriate reference for products with a recommended range of output speaker impedance.

- 3) Connect the UUT to the power source.
- 4) Power on the UUT and perform initial system configuration, as applicable.
- a. Disable any wireless networking functionality (WiFi), unless wireless networking is the UUT's primary means of accessing a network.
- b. Disable any VOIP and Data services that are exposed to the user for external use such as broadband services.
- c. Ensure that all audio tone controls are set to mid-level.
- d. Ensure that UUT components (display brightness, etc.) are in their as-shipped configuration.
- 5) Connect the UUT to the signal source. The input signal shall comply to the requirements in Section 4.4, above.
- 6) Let the UUT sit for at least 15 minutes, or until the unit has completed initialization and is ready for use.
- 7) Measure and record the AC mains input voltage and frequency.
- 8) Measure and record the test room ambient temperature.

## 5. Test Procedures for All Products

The following tests shall be performed on all Audio/Video products<sup>1</sup>.

### 5.1. Auto Power-down (APD) Function

- 1) Configure the UUT in a typical On mode operational state.
- 2) **Stop the UUT from performing any primary functions (e.g. disc playback). APD shall initiate within 30 minutes.**

<sup>1</sup> NOTE: The APD test (5.1) is not required for products that do not offer an APD function. The Sleep Mode test (5.3) is not required for products that do not offer a Sleep mode.

- 3) Measure the average power consumption before APD over a 2 minute period.
- 4) Allow the UUT to automatically power-down. Record the time elapsed until the APD event.
- 5) Verify that the device is in the expected APD low-power state.
- 6) Measure the average power consumption after APD over a 2 minute period.

**Note:** Section 5.1 has been modified to include verification that the APD event occurs in no more than 30 minutes from the time the device stops performing a primary function.

## 5.2. Idle Condition

- 1) Configure the UUT in a typical Sleep or Off mode operational state.
- 2) Press the Power button to bring the unit into an On mode operational state, such that no active content is playing.
- 3) Measure the average power consumption over a 10 minute period.

## 5.3. Sleep Mode

- 1) Configure the UUT in a typical On or Idle mode operational state.
- 2) Press the Power button to bring the unit into a Sleep mode low-power operational state.
- 3) Measure the average power consumption over a 10 minute period.

# 6. Test Procedures for Video Devices

The following tests shall be performed on any product that offers storage for recording and playback of video.

## 6.1. Live Video Playback Test

- 1) Tune to Reference Channel A.
- 2) Measure the average power consumption over a 10 minute period.
  - a. Note: If the UUT has DVR functionality, the DVR shall be in Pause for 5% of the test period, Fast Forward for 10% of the test period, and Rewind for 10% of the test period.
- 3) Tune to Reference Channel B.
- 4) Measure the average power consumption over a 10 minute period.
  - a. Note: If the UUT has DVR functionality, the DVR shall be in Pause for 5% of the test period, Fast Forward for 10% of the test period, and Rewind for 10% of the test period.
- 5) Tune to Reference Channel C. If the UUT has one or more Additional Tuners, tune the primary tuner to Reference Channel C, and the secondary tuner to Reference Channel A.
  - a. Note: If the UUT has PIP functionality, render the secondary image in a PIP window as near to  $\frac{1}{4}$  of the total screen area as possible. If the UUT does not have PIP functionality, display the primary tuner image on the screen and record the secondary signal in the background.
- 6) Measure the average power consumption over a 10 minute period.
  - a. Note: If the UUT has DVR functionality, the DVR shall be in Pause for 5% of the test period, Fast Forward for 10% of the test period, and Rewind for 10% of the test period.
- 7) Calculate the average power consumption over the full test duration.

210 8) Repeat Section 6.1 using standard video content from IEC-62087. DVD content shall be  
211 used in place of Reference Channels A & C, and Blu-ray Disc content shall be used in place  
212 of Reference Channel B for products with HD capability.

## 213 6.2. *Live Video Recording Test*

- 214 1) Tune to and begin DVR recording of Reference Channel A.
- 215 a. Note: If the UUT has one or more Additional Tuners, record Reference Channel A  
216 with the secondary tuner for the duration of the test.
- 217 2) Measure the average power consumption over a 2 minute period.
- 218 3) Tune to and begin DVR recording of Reference Channel B.
- 219 4) Measure the average power consumption over a 2 minute period.
- 220 5) Tune to and begin DVR recording of Reference Channel C.
- 221 6) Measure the average power consumption over a 2 minute period.
- 222 7) Calculate the average power consumption over the full test duration.
- 223 8) If the UUT is capable of recording HD signals, repeat the test with an HD input signal  
224 (Reference Channel B) and record the average power consumption from both tests.
- 225 9) Save all DVR recordings for the Recorded Video Playback Test.
- 226 10) Repeat Section 6.2 using standard video content from IEC-62087. DVD content shall be  
227 used in place of Reference Channels A & C, and Blu-ray Disc content shall be used in place  
228 of Reference Channel B for products with HD capability.

## 229 6.3. *Recorded Video Playback Test*

- 230 1) Tune to Reference Channel A.
- 231 2) Using the on-screen menus, begin playback of a recorded program. Play back the recorded  
232 video for the duration of the test period. The playback shall be in Pause for 5% of the test  
233 period, Fast Forward for 10% of the test period, and Rewind for 10% of the test period.
- 234 3) Measure the average power consumption over a 10 minute period.
- 235 4) If the UUT is capable of recording HD signals, repeat the test with an HD input signal  
236 (Reference Channel B) and record the average power consumption from both tests.
- 237 5) Repeat Section 6.3 using standard video content from IEC-62087. DVD content shall be  
238 used in place of Reference Channels A & C, and Blu-ray Disc content shall be used in place  
239 of Reference Channel B for products with HD capability.

240 **Note:** Sections 6.1, 6.2, and 6.3 have been updated to include tests with video content per IEC-62087.  
241 EPA wishes to evaluate each test method at this time. The final version of the test procedure will include  
242 only one type of video content.

## 243 7. *Test Procedures for Removable Media Players*

244 The following tests shall be performed on any product capable of playback or recording of audio and/or  
245 video stored on removable media (e.g. Flash drive, CD, DVD, Blu-ray Disc).

### 246 7.1. *Video Playback Test*

- 247 1) Insert / install the removable media and begin playback of SD video content equivalent to  
248 Reference Channel A.
- 249 2) Measure the average power consumption over a 10 minute period.

250 3) If the UUT is capable of playing HD content, repeat the test with HD video content equivalent  
251 to Reference Channel B and record the average power consumption from each test.

252 4) Repeat Section 7.1 using standard video content from IEC-62087. DVD content shall be  
253 used as an SD source, and Blu-ray Disc content shall be used as an HD source for products  
254 with HD capability.

## 255 7.2. Video Recording Test

256 1) Insert / install the removable media and begin recording of SD video content equivalent to  
257 Reference Channel A.

258 2) Measure the average power consumption over a 10 minute period.

259 3) If the UUT is capable of recording HD content, repeat the test with HD video content  
260 equivalent to Reference Channel B and record the average power consumption from each  
261 test.

262 4) Repeat Section 7.2 using standard video content from IEC-62087. DVD content shall be  
263 used as an SD source, and Blu-ray Disc content shall be used as an HD source for products  
264 with HD capability.

## 265 7.3. Audio Playback Test

266 1) Insert / install the removable media and begin playback of a pink noise signal.

267 2) Measure the average power consumption over a 10 minute period.

268 **Note:** EPA intends to specify that recorded audio content for testing per Section 7.3 be played from a  
269 location on the optical disc media that is located 24 mm to 27.5 mm radially from the center of the disc.  
270 Stakeholders who submitted data using a different method are encouraged to resubmit data based on  
271 these test conditions.

## 272 7.4. Audio Recording Test

273 1) Insert / install the removable media and begin recording of a pink noise signal.

274 2) Measure the average power consumption over a 10 minute period.

275 **Note:** Sections 7.1 and 7.2 have been updated to include tests with video content per IEC-62087. EPA  
276 wishes to evaluate each test method at this time. The final version of the test procedure will include only  
277 one type of video content.

# 278 8. Test Procedures for Single- and Dual-channel Amplifiers

279 The following tests shall be performed on any product that contains a one- or two-channel audio power  
280 amplifier.

## 281 8.1. Active Mode Test

282 1) Connect the UUT to the output of the signal generator.

283 2) Generate a sine wave input signal per Section 4.4.b. For devices that accept only digital  
284 input signals, generate an appropriate representation of a 1 kHz sine wave.<sup>2</sup>

285 3) Increase the amplifier volume until the THD of the output is 1% or greater. This is considered  
286 the maximum undistorted power (MUP).<sup>3</sup>

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<sup>2</sup> If 1 kHz is outside of the range of the UUT, the signal frequency shall be the geometric mean of the upper and lower -3 dB response points of the device.



- 287 4) Measure & record the amplifier input and output power.
- 288 5) Turn down the amplifier until the output is 1/3 MUP.
- 289 6) Measure & record the amplifier input and output power.
- 290 7) Turn down the amplifier until the output is 1/8 MUP.
- 291 8) Measure & record the amplifier input and output power.
- 292 9) Generate and apply a pink noise input signal per Section 4.4.b. Do not alter the amplifier
- 293 settings from Step 8.1.7, to ensure that the output is still 1/8 MUP.
- 294 10) Measure & record the amplifier input and output power, averaged over a 2 minute period.

295 **Note:** Section 8.1 has been updated and modified per various stakeholder comments. At this time, EPA

296 is still interested in gathering test data with both sine wave and pink noise input signals to inform the

297 development of modal power limits. In the final version of the test procedure, data collection

298 requirements will be reduced to include only those items that are necessary for product qualification.

## 299 9. Test Procedures for Multi-channel Amplifiers

300 The following tests shall be performed on any product that contains a multi-channel audio power amplifier.

### 301 9.1. Active Mode Test

- 302 1) Connect the UUT to the output of the signal generator.
- 303 2) Generate a sine wave input signal per Section 4.4.b. If 1 kHz is outside the range of a
- 304 speaker in the UUT, a sine wave sweep between the upper and lower -3 dB response points
- 305 of the speaker should be performed until the maximum input power of the UUT is
- 306 obtained. Record the frequency when the input power is at its maximum.
- 307 3) Using the sine wave frequency determined in 9.1.2, monitor each speaker with a distortion
- 308 analyzer and power meter. Set the volume of the UUT to 100% and modify the amplitude of
- 309 the input signal until the THD of the output is 1% or greater. Record the output power
- 310 measured on each speaker at 1%THD. This shall be considered the maximum undistorted
- 311 power (MUP).
- 312 4) Monitor the speaker with the highest power draw as determined in step 9.1.3. Reduce the
- 313 sine wave input signal amplitude until the output power of the selected speaker is at 1/8th
- 314 MUP.
- 315 5) Measure & record the input power, averaged over a 2 minute period.
- 316 6) Measure & record the output power for all speaker terminals, averaged over a 2 minute
- 317 period. Record the sum of all the output power measurements.
- 318 7) Generate and apply a pink noise input signal per Section 4.4.b. Do not alter the amplifier
- 319 setting from Step 9.1.4, to ensure that the output is still 1/8th MUP.
- 320 8) Measure & record the input power, averaged over a 2 minute period.
- 321 9) Measure & record the output power at each speaker terminal, averaged over a 2 minute
- 322 period. Record the sum of all the output power measurements.

323 **Note:** Section 9.1 has been added to the test procedure for testing of multi-channel amplifiers.

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<sup>3</sup> If the UUT performs signal processing such that the amplifier output does not clip at 1% THD, maximum undistorted power shall be obtained by monitoring input signal amplitude and output power simultaneously to identify the point at which input signal amplitude is increased and output power remains constant.