

1 **APPENDIX A:**
2 **ENERGY STAR Test Procedure for Audio/Video Products**

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

9 **1. Overview**

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

13 **2. Applicability**

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

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

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

36 **3. Definitions**

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

39 **4. Test Setup**

40 **4.1. Test Equipment**

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

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

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

53 *4.2. Calibration*

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

56 *4.3. Power Measurement Test Conditions*

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

81 *4.4. Source Signals*

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

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

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

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

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

101 1) Reference Channel A: SD Network TV channel. This channel shall be at least 480i format.

102 2) Reference Channel B: SD/HD Sports channel. If the UUT is HD-capable, this channel
103 shall be at least 720p format. If the UUT is not HD-capable, this channel shall be at least
104 480i format.

105 3) Reference Channel C: SD 24-hour News channel. This channel shall be at least 480i
106 format.

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

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

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

118 4.5. UUT Operation

119 a) UUT Control: The UUT shall be controlled with the factory-supplied remote control (I/R or RF)
120 to the extent possible. For units that do not ship with a remote control, or for functions that
121 cannot be accessed from the supplied remote control, control mechanisms on the face or body
122 of the UUT may be used.

123 b) Output Volume: The UUT output volume should be set to minimum for the duration of all tests
124 except as noted in the Amplifier test procedures in Section 8.

125 c) Battery Powered Devices: If the UUT contains rechargeable batteries, or can be integrated with
126 another device that contains rechargeable batteries, all batteries should be in a fully charged
127 state for the duration of testing.

128 d) Optional Hardware: If the UUT uses Smart card or POD technology for conditional access
129 system control, then insert the applicable card into the UUT prior to applying power.

130 4.6. UUT Pre-test Configuration

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

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

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

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

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

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

164 5. Test Procedures for All Products

165 The following tests shall be performed on all Audio/Video products¹.

166 5.1. Auto Power-down (APD) Function

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

¹ 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.

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

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

176 5.2. Idle Condition

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

181 5.3. Sleep Mode

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

185 6. Test Procedures for Video Devices

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

188 6.1. Live Video Playback Test

- 189 1) Tune to Reference Channel A.
190 2) Measure the average power consumption over a 10 minute period.
191 a. Note: If the UUT has DVR functionality, the DVR shall be in Pause for 5% of the test
192 period, Fast Forward for 10% of the test period, and Rewind for 10% of the test
193 period.
194 3) Tune to Reference Channel B.
195 4) Measure the average power consumption over a 10 minute period.
196 a. Note: If the UUT has DVR functionality, the DVR shall be in Pause for 5% of the test
197 period, Fast Forward for 10% of the test period, and Rewind for 10% of the test
198 period.
199 5) Tune to Reference Channel C. If the UUT has one or more Additional Tuners, tune the
200 primary tuner to Reference Channel C, and the secondary tuner to Reference Channel A.
201 a. Note: If the UUT has PIP functionality, render the secondary image in a PIP window
202 as near to $\frac{1}{4}$ of the total screen area as possible. If the UUT does not have PIP
203 functionality, display the primary tuner image on the screen and record the
204 secondary signal in the background.
205 6) Measure the average power consumption over a 10 minute period.
206 a. Note: If the UUT has DVR functionality, the DVR shall be in Pause for 5% of the test
207 period, Fast Forward for 10% of the test period, and Rewind for 10% of the test
208 period.
209 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.²

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).³

² 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.

³ 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.