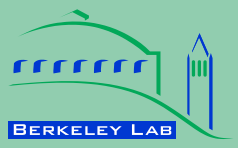

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Comparison of Test Procedures and Energy Efficiency Criteria in Selected International Standards & Labeling Programs for Copy Machines, External Power Supplies, LED Displays, Residential Gas Cooktops and Televisions

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Abstract

This report presents a technical review of international minimum energy performance standards (MEPS), voluntary and mandatory energy efficiency labels and test procedures for five products being considered for new or revised MEPS in China: copy machines, external power supply, LED displays, residential gas cooktops and flat-screen televisions. For each product, an overview of the scope of existing international standards and labeling programs, energy values and energy performance metrics and description and detailed summary table of criteria and procedures in major test standards are presented.

Copy machine standards and labeling programs exist in the U.S., EU, Japan, Hong Kong and Korea and the product is typically classified by paper size and copying speed. Japan excludes multifunctional copy machines from its Top Runner standards program, while the U.S. ENERGY STAR program distinguishes between color and monochrome copiers. For energy efficiency metrics, Japan and U.S. ENERGYSTAR evaluates maximum electricity consumption for active or operational mode – but not directly comparable due to different calculation formulas – in addition to standby and off-mode. The other three regions only specified standby and off-mode power consumption, with the EU and U.S. having the most stringent requirements currently and EU having the most stringent requirement of 0.5 W set for 2013. There is currently no harmonized international test method for measuring active power consumption, but ENERGY STAR and Japanese test procedures exist, and the IEC 62301, Ed. 1 test method is used for standby and off-mode power consumption.

The four leading MEPS for external power supplies in the U.S., Canada, Australia and EU all follow the harmonized, international definition of Class A external power supplies and were all enacted within the last five years. All four standards specify minimum efficiency for external power supplies' active mode for three categories based on rated output and maximum power consumption for no-load mode. The harmonized MEPS requirements for active mode means U.S., Canada and EU all have identical efficiency formulas while Australia has slightly different efficiency coefficients. All four standards also have MEPS requirements for no-load mode, with slight variations in classifications for energy requirements. The test procedure is also harmonized for all four programs, based on the "Test Method for Calculating the Energy Efficiency of Single Voltage External AC-DC and AC-AC Power Supplies" adopted by the U.S. EPA on August 11, 2004.

There are currently no standards or mandatory labeling programs for LED displays but U.S. ENERGYSTAR and Hong Kong have voluntary endorsement labels. Both voluntary energy labeling programs for displays specifies maximum power requirements for on-mode, but differ in the product classification for energy requirements and efficiency formula. For standby and off-mode power consumption requirements, Hong Kong's Phase 2 values are the same as ENERGY STAR but with the additional specification of minimum default times for mode switching after inactivity. U.S. ENERGYSTAR uses its own test method for LED displays while Hong Kong's test method is unspecified.

The U.S. and Japan have the only two national standards programs for residential gas cooktops, with proposed requirements currently under consideration for EU Ecodesign. Very different efficiency metrics exist across the three programs: U.S. only mandates that all gas cooking products not have a constant burning pilot light; Japan specifies energy consumption efficiency by stove type; and EU proposes using limits on total final energy consumption per cooking cycle for gas cooktops. Likewise, each country also

uses its own method for measuring gas cooktop energy consumption in the absence of any international or leading test method.

Leading national MEPS programs for flat-screen televisions include Canada, Australia, EU Ecodesign and Japan Top Runner while mandatory labeling programs exist in Australia, the EU and Korea. Besides ENERGYSTAR, the U.S. also has existing and proposed mandatory MEPS in two states (California and Connecticut). The U.S. ENERGY STAR and California MEPS, EU, Australia and Japan all have maximum power consumption values set for active mode, while Canada, Hong Kong and Korea only specify standby and off mode power consumption values. ENERGYSTAR and the EU specify both active and standby requirements, and both uses efficiency values as a function of screen area but with slightly different classifications for efficiency requirements. For standby and off-mode requirements, EU Ecodesign and Canada Tier 2 requirements are the most stringent with a limit of 0.5 W, with EU requirements becoming most stringent at 0.3 W in August 2011. In addition to active and standby/off-mode power consumption requirements, some programs have additional performance requirements including default time for switching to low power consumption mode, external power supply efficiency and luminance requirements. There is general harmonization across the different television standards and labeling programs in adopting the IEC 62087 test method for measuring on-mode power consumption and IEC 62301 for standby and off mode measurements, with the one notable variation being ENERGY STAR which also uses industrial test standards.

1. Copy Machines

1.1 Overview of Scope of International Standards and Labels

The major countries and regions with minimum energy performance standards (MEPS), mandatory and/or voluntary energy labels for household clothes washers include the United States (U.S.), the European Union (EU), Japan, Hong Kong and Korea. For these different international standards and labeling (S&L) programs, the product scope of copy machines are typically determined by the largest accepted paper size and the copying speed, measured in copies per minute (cpm). For example, Japan and Korea specifically exclude large format copy machines with paper size larger than A3 but the U.S. includes a category for large format copiers in its ENERGY STAR specification scope. Japan also excludes multifunction copy machines (i.e., copier/printer/scanner units). The U.S. ENERGY STAR program is also notable in that it is the only program that distinguishes between color and monochrome copiers in its specifications, and also differs in that the specification covers a wider spectrum of imaging equipment which also includes printers, scanner, fax machines, multifunction device, digital duplicator and mailing machines. In some programs, copiers with a very high copying speeding are excluded from the energy requirements such as the exclusion of copiers with speed of greater than 86 cpm in Japan and exclusion of copiers with speed of greater than 60 cpm in Korea. Because the EU, Hong Kong, and Korean programs only specify standby and off mode energy requirements, there is less emphasis on differentiating product categories in terms of energy limits as is the case for the U.S. and Japan.

1.2 Energy Values in Existing Programs

In terms of energy efficiency criteria, only the U.S. ENERGY STAR program and Japanese Top Runner standards evaluated maximum electricity consumption for active or operational mode, whereas the other three programs only specified standby and off-mode power consumption. In the U.S., on mode power consumption is a function of copy speed, with distinctions between monochrome and color copiers. In Japan, there are more categories for copy machines with energy requirements specified for a total of 36 categories based on four different sizes and nine speed increments. Because there are no linkages in the energy requirements set in the U.S. and Japan, the limits for active mode maximum electricity consumption are not directly comparable between the two countries. For Hong Kong and Korea, low power and off mode power consumption are also divided into broader product categories by copy speed. In general, Korea has relatively low allowable off mode consumption for copiers with speed of < 44 cpm. However, both Japan and Korea have relatively high allowable power consumption for off mode, especially for copiers with higher copy speeds, when compared to the 1 W and 0.5 W allowed in the U.S. and EU. Specifically, the EU and U.S. have the most stringent off-mode and standby power consumption as of 2010 with the EU having the most stringent values in place for 2013.

1.3 Major Test Procedures

As a relatively new product with mandated energy efficiency requirements, there is no leading or harmonized international test method for measuring the active power consumption of copy machines. The U.S. ENERGY STAR program uses its own ENERGY STAR Imaging Equipment Test Method, Revision August 2010. This test method distinguishes between a specific test procedure for Typical Electricity Consumption applicable to all copiers except large format copiers and a test procedure for operational

mode applicable only for large copiers. The ENERGY STAR test method uses test pattern from ISO/IEC standard 10561 and requires copying in simplex (single-side) mode. The specific measurement processes of the two test methods are included in Appendix 1.2. Japan and Hong Kong do not have a specified test method, although Japan does have its own specific pattern for measuring on-mode electricity consumption of printers as shown in Appendix 1.3. For standby and off mode power consumption, all programs use the specified test method from IEC 62301, Edition 1.

1.4 Summary of Selected International S&L Programs and Test Methods for Copy Machines

	U.S. ENERGY STAR Voluntary Label	**EU Ecodesign (Standby)** Mandatory Standard	**Japan Top Runner** Mandatory Standard	**Hong Kong** Voluntary Label	**Korea** Mandatory Label
Classification/Scope	Size: large format (A2 or larger), standard format Color and monochrome	Unspecified, standby regulation applies to all "information technology equipment."	Monochrome (non-color) copiers, with speed of less than 86 copies/minute. Exclude copier for large-sized paper (A2 or larger) and multifunctional devices	Unspecified photocopiers	Includes digital copiers with multiple functions, but excludes large copiers with speed > 60 copies/minute
Effective Dates	7/1/2009	Effective 1/2009 Phase I: 1/2010 Phase II: 1/2013	Fiscal year 2007	1/1/2010 - 12/31/2012	Voluntary from 11/1/2004 Mandatory from 7/1/2010
Energy Values	Maximum typical electricity consumption (kWh/day), depending on product speed, s, in copies/minute	Power consumption for specified modes, in watts:	Energy consumption (Wh) = (A + 7 x B)/8, where A=Wh 1 hour after machine is on; B = second hour after measurement of A	Maximum allowable power rating for low-power and off-mode, in watts	Maximum allowable power rating for low-power and off-mode, in watts
	Monochrome: s ≤ 15: 1.0 15 < s ≤ 40: (s x 0.1)-0.5 40 < s ≤ 82: (s x 0.35) - 10.3 s > 82: (s x 0.7) - 39 **Color:** s ≤ 32: (s x 0.1) + 2.8 32 < s ≤ 58: (s x 0.35)-5.2	**Phase 1:** Off-mode ≤ 1 W Standby ≤ 1 W Standby with information display ≤ 2 W **Phase 2:** Off-mode ≤ 0.5 W Standby ≤ 0.5 W Standby with information display ≤ 1 W	See Appendix 1.1 for specific values: varies by copying speed and machine type, ranges from 11 Wh to 483 Wh	**Low Power Mode:** 20 < s ≤ 44: (3.85 x s)+5 s > 44: (3.85 x s)+5 **Off Mode:** 0 < s ≤ 20: ≤ 5 W 20 < s ≤ 44: ≤ 15 W s > 44: ≤ 20 W	**Low Power Mode:** 20 < s ≤ 44: (3.85 x s)+5 s > 44: (3.85 x s)+5 **Off Mode:** 0 < s ≤ 20: ≤ 1 W 20 < s ≤ 44: ≤ 5 W s > 44: ≤ 20 W

	s > 58: (s x 0.7) - 26 Sleep Mode: 30 watts Standby Mode: 1 watt	Power management capability required			
Additional Requirements				maximum allowable default times for automatically switching to low power or off mode	maximum allowable default times for automatically switching to low power or off mode
Test Method/Specs	Energy Star Imaging Equipment Test Method, Rev. Aug-2010 Standby: IEC 62301 Ed 1.0 Jobs per day: depends on s, range from 8 to 32 Test Image: Test Pattern A from ISO/IEC standard 10561:1999; simplex mode Duplexing: simplex mode Accuracy: potential error limit of 5% Measurement process: see appendix	Standby: IEC 62301, Ed 1.0 Accuracy: uncertainty of less than or equal to 2% at 95% confidence level	Unspecified standard for test procedure Paper: A5 size Accuracy: ±0.5% Specified number of pages to be calculated depending on average of monthly copies Measurement process: see appendix	Unspecified Accuracy: ± 1% Measurement time: 1 hour for each mode Total number of measurements: 5	Energy Star Imaging Equipment Test Method, Rev. Aug-2010 Standby: IEC 62301 Ed 1.0

2. External Power Supply

2.1 Overview of Scope of International Standards and Labels

There are currently four leading mandatory energy-related standards and requirements for external power supplies: the U.S. MEPS, Canada MEPS, Australia MEPS and EU Ecodesign requirements. All four for these mandatory standards program defined the product scope of external power supplies as Class A external power supplies, which is a device:

"designed to convert line voltage AC into lower voltage AC or DC output; able to convert to only 1 AC or DC output voltage at a time; sold with or intended to be used with a separate end-use product that constitutes the primary load; contained in a separate physical enclosure from the end-use product; connected to the end-use product via removable or hard-wired male/female electrical connection, cable, cord or other wiring; and has nameplate output power less than or equal to 250 W." (U.S. DOE 2010).

For external power supplies, the state of California adopted mandatory standards in 2005, effective in 2006 (CEC 2005). Most of the mandatory standards were enacted within the last five years, with U.S. and Australia having the earliest national standards in place in 2008 and Canada having the most recent standard adopted in 2012. In addition, the U.S. is currently pursuing a rulemaking to evaluate the need to revise the current version of external power supply standards and to issue standards for battery chargers. Thus far, the Notice of Proposed Rulemaking and Public Meeting have been issued and a public meeting is scheduled for May 2012.

Because there is an international efficiency marking protocol for external power supplies in place, there are no other separate energy labeling programs for external power supplies.

2.2 Energy Values in Existing Programs

All four standards specify minimum efficiency for external power supplies' active mode and maximum power consumption for no-load mode. For active mode, minimum efficiency is calculated as a function of rated output and divided into three categories based on the external power supply's rated output: <1 W, between 1 to 51 W, and >51 W. In general, the active mode minimum efficiency requirements of external power supplies are harmonized, with the U.S., Canada and the EU all having the exact same efficiency formulas for the three product categories. Australia, interestingly, has slightly different efficiency coefficient requirements, with a coefficient of 0.49 instead of 0.50 used elsewhere for external power supplies less than 51 W. Australia also mandates a minimum efficiency of 0.84 for external power supplies with greater than 51 W, rather than the 0.85 required by the U.S., Canada and EU. Of all four programs, the EU has the most stringent requirements for active mode minimum efficiency set for Phase 2 after April 2011, which is set at the high efficiency V marking level.

In addition to active mode, all four standards also specified the maximum power consumption for external power supplies in a no-load mode, although there are slight variations in the energy requirements. Australia divides the no-load maximum power consumption requirements into two product classes: external power supplies with rated output of less than 10 W, which has the same 0.5 W requirement as the U.S., Canada, and EU; and those with rated output between 10 to 250 W with greater allowable power consumption of 0.75 W. In addition, the EU also specifies different and lower allowable power consumption of 0.3 W for AC-DC external power supplies and 0.3 W for low voltage external power supplies.

2.3 Major Test Procedures

All four national standards for external power supplies have adopted a harmonized test method for measuring active mode efficiency and no load mode power consumption following the "Test Method for Calculating the Energy Efficiency of Single Voltage External AC-DC and AC-AC Power Supplies" adopted by the U.S. EPA on August 11, 2004. Because all four programs use essentially the same test method, the details are not discussed area but rather included in Appendix 2.1. It should be noted that unlike most other products, external power supplies are tested at four active load conditions, with loads of 100% ± 2%, 75% ± 2%, 50% ± 2% and 25% ± 2% and an average energy measurement is taken.

2.4 Summary of Selected International S&L Programs and Test Methods for External Power Supplies

	U.S. MEPS Mandatory Standard	**Canada MEPS** Mandatory Standard	**Australia MEPS** Mandatory Standard	**EU Ecodesign** Mandatory Standard
Classification/Scope	Class A	Class A definition	Class A definition	Class A definition Low voltage EPS: <6 volts output, ≥550 mAmp
Effective Dates	7/1/2008	4/12/2012 Replacement EPS: 7/1/2013	12/1/2008	Phase I: 4/6/2010 Phase 2: 4/6/2011
Energy Values	**Active Mode: minimum efficiency** < 1 W rated output: 0.5 x rated output 1 < rated output < 51 W: 0.09*ln(output) + 0.5 rated output > 51 W: 0.85 **No-Load Mode: maximum power consumption**	**Active Mode: minimum efficiency** < 1 W rated output: 0.5 x rated output 1 < rated output < 51 W: 0.09*ln(output) + 0.5 rated output > 51 W: 0.85 **No-Load Mode: maximum power consumption**	**Active Mode: minimum efficiency** < 1 W rated output: ≥0.49 x rated output 1 < rated output < 49 W: ≥ 0.09*ln(output) + 0.49 rated output > 49 W: ≥ 0.84 **No-Load Mode: maximum power consumption**	**Phase 1 Active Mode: minimum efficiency** < 1 W rated output: 0.5 x rated output 1 < rated output < 51 W: 0.09*ln(output) + 0.5 rated output > 51 W: 0.85 **Phase II No-Load Mode: maximum power consumption**
	rated output < 250 W: 0.5 W	rated output < 250 W: 0.5 W	rated output < 10 W: ≤ 0.5 W 10 - 250 W output: ≤ 0.75 W	rated output ≤ 51W: 0.5 W for AC-AC EPS, 0.3W for AC-DC, 0.3W for low voltage EPS rated output ≥ 51W: 0.5 W for AC-AC EPS, 0.3W for AC-DC EPS

				Phase II Active Mode: efficiency for AC-AC and AC-DC EPS = High Efficiency V marking Output ≤ 1W = 0.48*output + 0.14 1W < Output ≤ 51W = 0.063*ln(output)+0.622 Output > 51W = 0.87
Additional Requirements	Markings in accordance with EPS International Efficiency Marking Protocol		High efficiency (performance mark IV) EPS: same requirements as US/Canada MEPS	
Test Method/Specs	"Test Method for Calculating the Energy Efficiency of Single Voltage External AC-DC and AC-AC Power Supplies (Aug 11 2004)" by US EPA	CSA-C 381.1-08	AS/NZS4665-2005, identical to US EPA test procedure	"Test Method for Calculating the Energy Efficiency of Single Voltage External AC-DC and AC-AC Power Supplies (Aug 11 2004)" by US EPA

3. LED Displays

3.1 Overview of Scope of International Standards and Labels

There are currently no mandatory energy standards, mandatory or voluntary energy labeling programs specific to LED displays. There are, however, two voluntary labeling programs targeted at electronic displays in the U.S. and Hong Kong. The U.S. ENERGY STAR program include all commercially available displays while the Hong Kong voluntary label has a more restrictive scope limited to standard LCD monitors designed for use with computers only. The current U.S. ENERGY STAR requirements for displays replaced older version of ENERGY STAR requirements for computer monitors.

3.2 Energy Values in Existing Programs

Both voluntary energy labeling programs for displays specifies maximum power requirements for on-mode, sleep mode and off mode. For on mode power requirements, the U.S. ENERGY STAR requirements separate displays with and without automatic brightness control. For displays without automatic brightness control, ENERGY STAR sets power requirements as a function of display resolution and viewable screen area and divides products into three classes by size and resolution. In Hong Kong, the on-mode power requirements are more simplistic and are directly dependent on resolution. For the sleep mode and off mode power requirements, the phase 2 requirements of 2 W for sleep mode and 1 W for off mode adopted by Hong Kong in October 2007 are the same as the current ENERGY STAR specifications. In addition, Hong Kong also specifies minimum default times for switching to sleep and off modes after inactivity. Besides energy, the U.S. ENERGY STAR program also requires that qualifying

displays be equipped with external power supplies with international energy efficiency marking and have power management feature by default while Hong Kong has additional luminance and contrast ratio requirements.

3.3 Major Test Procedures

The U.S. ENERGY STAR program uses its own ENERGY STAR Test Method for Displays (revised August 2010) in addition to international standards IEC 62087, Ed. 2.0 for measuring large displays and IEC 62301 for measuring power consumption of non-active modes. The U.S. test method is included in Appendix 3.1. Hong Kong does not use a specific test method, but similar testing conditions exist between Hong Kong and U.S. programs. For example, both programs specify that power measurements be taken after measurements are stable to within 1% over a three minute period. Both programs also take light measurements at the center of and perpendicular to the display screen. There are, however, slightly different designated refresh rates in the two countries' test methods: with 60 hertz for fixed pixel displays and 75 hertz for cathode ray tube displays in the U.S. and 50 hertz refresh rates for the Hong Kong test method.

3.4 Summary of Selected International S&L Programs and Test Methods for Displays

	U.S. ENERGY STAR v5.1 Voluntary Label	**Hong Kong** Voluntary Label
Classification/Scope	Commercially available display intended for use with computer, workstation or server; USB flash drive; memory card; wireless connection	Standard LCD monitors designed for use with computers only
Effective Dates	Diagonal screen size < 30 inch: 10/30/2009 Diagonal screen size 30 - 60 inches: 1/20/2010	Phase I: 12/22/2003 - 9/30/2007 Phase II: 10/1/2007
Energy Values	Maximum Power Requirements, in Watts **On-Mode, with Automatic Brightness Control (ABC): Power ≤ (0.8 x Ph) + (0.2 x Pl)** where Ph = measured power in high ambient lighting (300 lux) Pl = measured power in low ambient lighting (0 lux) **On-Mode, without ABC:** size < 30 inches and resolution (r) ≤ 1.1 megapixels: Power = (6.0 x r) + (0.05 x A) + 3.0, where A = viewable screen area size < 30 inches and resolution (r) > 1.1 megapixels: Power = (9.0 x r) + (0.05 x A) + 3.0, where A = viewable screen area	Maximum Power Requirements, in Watts **On-Mode:** Phase I: Power = 30 + 2 x Megapixels (MP) Phase II: If X < 1 MP, Power = 23 If X > 1 MP; Power = 28* MP **Sleep Mode:** Phase I: ≤ 4 W (with ≤ 15 min default time)

	size between 30 to 60 inches for any resolution: Power = (0.27 x A) + 8.0 **Sleep Mode:** Maximum Power Requirement < 2 W **Off Mode:** Maximum Power Requirement < 1 W	Phase II: ≤ 2 W (with ≤ 30 min default time) **Off Mode:** Phase I: ≤ 2 W Phase II: ≤ 1 W (with ≤ 30 min default time)
Additional Requirements	International Energy Efficiency Marking for EPS, power management feature by default	Luminance: minimum of 100 Cd/m2 Contrast ratio: minimum of 200:1
Test Method/Specs	ENERGY STAR Test Method for Displays rev Aug 2010; IEC 62087, Ed 2.0; IEC 62301 Ed. 1.0 for Standby Measurement accuracy: ±2% at 95% confidence level Refresh rate: 60 Hz for fixed pixel displays, 75 Hz for CRT displays Power measurements: measured after stable to within 1% over 3 minute period Light measurement: measured with device at center of, and perpendicular to screen On Mode Fixed Pixel Displays: luminance setting of 175 Cd/m2 for resolution ≤1.1 MP; 200 Cd/m2 for resolution > 1.1 MP	Unspecified Refresh rate: 50 Hz Power measurements: 20 minute warm up period; measured after stable to within 1% over 3 minute period Light measurement: measured with device at center of, and perpendicular to screen

4. Residential Gas Cooktops

4.1 Overview of Scope of International Standards and Labels

There are currently two national programs for mandatory energy-related requirements for residential gas cooktops: the U.S. and Japan. The U.S. MEPS covers a broader range of cooking products, including conventional ranges, conventional cook tops, conventional ovens from gas or electric and microwave ovens, microwave/conventional ranges and other cooking products. Japan's Top Runner standard is specific to household gas cooking appliances that use city gas or LPG gas and do not include grills, ovens or portable butane stoves. The EU Ecodesign is also evaluating proposed mandatory requirements for domestic gas hobs, or cooking ranges. Of these three programs, the U.S. was the first to enact a standard which bans pilot lights in gas cooking products with an electrical supply cord in 1987 (effective 1990), followed by Japan's energy standard for gas cooking appliances in 2006. More recently, the U.S.

has re-evaluated its energy standard for gas cooktops and energy requirements for gas cooking products are being considered in the EU.

4.2 Energy Values in Existing Programs

Across the three mandatory programs for residential gas cooktops, including the proposed EU Ecodesign program, very different efficiency metrics are adopted. The recent U.S. MEPS rulemaking which goes into effect in April 2012 actually found that proposed energy efficiency standard levels cannot be economically justified and thus the proposed energy values for residential cooktops were not adopted. Rather, the U.S. program requires that all gas cooking products, including those without an electrical supply cord, not have a constant burning pilot light. Japan, on the other hand, specifies energy consumption efficiency for different types of gas cooking products: stoves, table-top type, built-in type and gas ranges. For stoves with fuel consumption greater than 1.5 liters per hour, Japan also calculates efficiency as a function of fuel consumption and takes into consideration multiple burners by using a size-weighted average. The EU proposal currently includes a single energy value which measures the total final energy consumption per cooking cycle. As a result, the energy values for gas cooktops cannot be compared between Japan's standard and the emerging standards in the U.S. and the EU.

4.3 Major Test Procedures

There is currently no international or leading test method for residential gas cooking products in the world as each country seems to use its own method for measuring energy. In the U.S., the Department of Energy has a Uniform Test Method for Measuring Energy Consumption of Cooking Products published in the Federal Register 62 FR 51976 in October 1997. This test method is used to measure the energy consumption of all cooking products, including the testing of gas cooktops in the rulemaking process, and current revisions are underway to incorporate the IEC 62301 test method for standby and off mode power consumption for certain electric and microwave cooking products. Additionally, both the Japanese and proposed EU test method for measuring energy consumption of gas cooktops are based on measurements of heat energy acquired in the cooking process of a water load. However, the specific details of these two test methods are not readily available.

4.4 Summary of Selected International S&L Programs and Test Methods for Residential Gas Cooking Products

	U.S. MEPS Mandatory Requirement	**Japan Top Runner** Mandatory Standard	**EU Ecodesign Proposal** Proposed Mandatory Standard
Classification/Scope	Gas, electric and microwave energy cooking products including: conventional ranges, conventional cook tops, conventional ovens, microwave ovens, microwave/conventional ranges and other cooking products	Household gas cooking appliances that use city gas 13A or LPG gas, excluding grills, ovens and portable butane stoves	Domestic gas hob, where hob is defined as "an appliance or part of an appliance which incorporates one or more cooking zones, where a cooking zone is part of the hob or area marked on the surface of the hob where pans are placed for heating."

Effective Dates	4/9/2012	Fiscal Year 2006	Proposed Tier 1 for 2014, to be determined after test procedure is developed
Energy Values	Not applicable; Rulemaking finds that proposed energy efficiency standard levels cannot be economically justified and that only prescriptive requirements are technologically feasible and economically justified. For gas ranges, the prescriptive requirement is that there cannot be constant pilot burning light.	Energy Consumption Efficiency (%)	Final energy consumption in kWh per cooking cycle and per year
		Stoves with fuel consumption of <1.5 L/hr, efficiency = 67% Stoves with fuel consumption of >1.5 L/hr, efficiency = -3 x fuel consumption in liters/hour + 71.5. For cookers with more than 2 burners, weighted average is calculated using 1 for small burners (<2.02 kW gas consumption), 2.1 for medium burners (2.03-3.49 kW gas consumption) and 3.5 for large burners (3.5-5.9 kW gas consumption) Table-top type: 51% Built-in type: 48.5% Gas range: 48.4%	Tier 1: 0.716 kWh/cycle; 313.5 kWh/year
Additional Requirements	Gas ranges without electrical power supply cord also cannot have constant burning pilot lights		

Test Method/Specs	DOE Uniform Test Method for Measuring Energy Consumption of Cooking Products as specified in Federal Register on October 3, 1997 (62 FR 51976). Test procedure revisions seek to incorporate IEC 62301 for standby and off mode power consumption.	JIS S 2103 "Household Gas Cooking Appliances": divides quantity of heat acquired by water in testing kettle by calorific value of consumed gas (input)	Draft being developed by CEN/TC49/WG2, based on cooking process of a water load including a heating up phase and a simmering phase with fixed duration of 20 minutes. Reference pot size and water quantity defined, and energy consumption of whole hob is averaged across all cooking zones and normalized per kg of water.

5. Flat-screen Televisions

5.1 Overview of Scope of International Standards and Labels

As a major consumer electronics product, televisions have been regulated under mandatory energy efficiency standards as well as mandatory and voluntary energy labeling programs worldwide. Some of the leading MEPS programs include Canada, Australia, EU Ecodesign and Japan Top Runner while mandatory labeling programs exist in Australia, the EU and Korea. While the U.S. does not have a national television MEPS, the state of California adopted mandatory state energy standards for TVs in 2011 and the state of Connecticut also adopted standards for TVs to be in effect in 2014. Hong Kong also has a voluntary energy labeling programs for televisions. Most of the existing standards and labeling programs for televisions were adopted or revised very recently between 2007 and 2011 and often include further phase-in of stringent requirements over the next few years.

The scope of product coverage is generally very similar amongst the different international programs and includes television sets, component televisions, and television combination units (e.g., televisions with built-in VCR/VCD/DVD players). Additionally, the EU, Hong Kong and Korea also include television monitors without a tuner or receiver in their programs while the U.S. includes a distinction for hospitality televisions with bidirectional communication capabilities. Some countries - specifically Canada, Japan, Hong Kong and Korea – also specify the specific television display technologies covered under each program, ranging from cathode ray tubes (CRT) to liquid crystal display (LCD), plasma and light-emitting diodes (LED) displays.

5.2 Energy Values in Existing Programs

The international standards and labeling programs for televisions vary by the mode for which the energy values are set. The U.S. ENERGY STAR and California MEPS, EU, Australia and Japan all have maximum power consumption values set for active mode, while Canada, Hong Kong and Korea only specify standby and off mode power consumption values. The U.S. and the EU Ecodesign programs are the only ones that specify both active and standby/off mode power consumption values for televisions. For on mode power consumption, both the U.S. and EU adopted values that are a function of screen area (albeit measured in different units). The U.S. ENERGY STAR specifications divide televisions into three size categories, in addition to separate power consumption requirements for hospitality televisions. In the first phase of the Ecodesign requirements, the EU further differentiates between high definition and non-high definition televisions in terms of maximum power consumption values, with a 12% additional

power consumption allowance for high definition televisions. Australia specifies a single maximum annual energy consumption value for televisions as a function of the screen area, and is thus both technology and feature neutral. Japan, on the other hand, have very specific energy consumption requirements for individual classes of televisions differentiated by display technology, scanning method, aspect ratio, shape of tube and added functions (see Appendix 5.1). As a result of the different product classifications, it is not feasible to directly compare the maximum active model power consumption requirements for televisions across the different programs.

In comparing the range of standby and off mode power requirements across the different programs, it appears that EU Ecodesign and Canada Tier 2 requirements are the most stringent for standby mode with a limit of 0.5 W. Similarly, the EU also has the most stringent requirement of 0.3 W for off mode power consumption of televisions effective in August 2011. For EU and Korea which also set power consumption requirements for television monitors, there is lower power consumption allowance for monitors than televisions.

Besides on mode and/or standby and off mode power consumption requirements, some programs also adopted additional energy-related performance requirements for televisions in their standards programs. California's television MEPS and the EU Ecodesign requirements both have default time requirements for automatically switching to standby mode after a certain period of inactivity. The U.S. ENERGY STAR program also requires that external power supplies of qualifying televisions meet the highest International Energy Efficiency Marking Level 5 requirements. Lastly, ENERGY STAR, California MEPS, Australia MEPS and EU Ecodesign all adopted luminance requirements for television, where "home" picture mode must be greater than or equal to 65% of measured peak luminance in retail mode to prevent significant differences in luminance between the mode of testing and common mode of usage.

In terms of categorical energy information labeling programs for televisions, the three major programs are Australia's mandatory energy information label, the mandatory EU energy label, and Hong Kong's voluntary energy label. Australia and EU's label grades are based on energy efficiency indices relative to their respective minimum MEPS requirement. Hong Kong's voluntary energy label is also based on energy efficiency indices of on mode power consumption but in the absence of its own MEPS requirements, Hong Kong uses the EU Ecodesign phase 1 requirement as a baseline for calculating the efficiency index.

5.3 Major Test Procedures

There is general harmonization across the different television standards and labeling programs in adopting the IEC 62087 test method for measuring on-mode power consumption and IEC 62301 for standby and off mode measurements. The one notable variation in test methods is that the U.S. ENERGY STAR program also uses American National Standards Institute and Consumer Electronics Association industrial standard (ANSI/CEA-2037) for measuring input signal accuracy and for broadcast test materials. Additionally, ENERGY STAR also includes specific CEA test method for download acquisition mode testing, which is not included in the IEC 62087 test method. These variations in the ENERGY STAR test method are included in Appendix 5.2. Hong Kong, which adopted the international standards, have slightly tighter measurement accuracy requirement of ±1%, instead of the default ±2% adopted internationally.

5.4 Summary of Selected International S&L Programs and Test Methods for Televisions

	U.S. ENERGY STAR Voluntary Label	**California MEPS** Mandatory Standard	**Canada MEPS (Standby)** Mandatory Standard
Classification/Scope	TV, TV combination units, Hospitality TVs, Component TVs		Residential TVs, component TVs and TV combination units. Technologies may include cathode-ray tube (CRT), liquid crystal display (LCD) or plasma display.
Effective Dates	9/30/2011	Phase 1: 1/1/2011 Phase 2: 1/1/2013	Tier 1: 4/12/2012 (manufactured after 5/1/2011) Tier 2: 1/1/2013
Energy Values	Maximum Power Consumption, P, in watts **On Mode with Default Automatic Brightness Control (ABC):** A = viewable screen area, in square inches A < 275: P = (0.130 x A)+ 5 275 ≤ A ≤1068: P=(0.084 x A)+18 A > 1068: P = 108 **Sleep Mode: P ≤ 1.0 W** **Download Acquisition Mode:** energy consumption ≤ 40 Wh/day or 0.04 kWh/day	Maximum Power Consumption, P, in watts **On-Mode** A = viewable screen area, in square inches **Phase 1:** P ≤ 0.20 x A + 32 **Phase 2:** P ≤ 0.12 x A + 25 Standby-Passive Mode: **Phase 1 & 2:** 1 W	Maximum power consumption, P, in watts **Tier 1:** Off Mode: 1 W Standby Mode: 4 W **Tier 2:** Off Mode: 0.5 W Standby Mode with Display: 1 W Standby Mode without Display: 0.5 W
	U.S. ENERGY STAR Voluntary Label	**California MEPS** Mandatory Standard	**Canada MEPS (Standby)** Mandatory Standard
	Hospitality TV Energy Consumption Requirement:		

	Maximum Typical Energy Consumption (TEC) = (Power on-mode x 5)+ (Power sleep mode x 19) + DAM energy A < 275: TEC = (0.65 x A)+ 84 275 ≤ A ≤1068: TEC (0.42 x A)+184 A > 1068: TEC = 599		
Additional Requirements	External Power Supply: meet Level V performance requirements	TV automatically enter TV standby mode after maximum of 15 minutes without video and/or audio input on selected input mode	Reporting requirements for on-mode power and luminance in home and retail modes

	Australia MEPS Mandatory Standard	**Australia Energy Label** Mandatory Label	**EU Ecodesign** Mandatory Standard
Classification/Scope	TVs, component TVs and TV combination units.	TVs, component TVs and TV combination units.	TVs, component TVs and TV combination units. TV monitors without tuner or receiver.
Effective Dates	Tier 1: 10/1/2009 Tier 2: 10/1/2012	10/1/2009	On Mode, Tier 1: 8/20/2010 On Mode, Tier 2: 4/1/2012 Standby/Off Mode Tier 1: 1/7/2010 Standby/Off Mode Tier 2: 8/20/2011
Energy Values	Maximum annual energy consumption, E, in kWh/year **Tier 1:** E = 127.75 + (0.1825 x screen area in cm2) **Tier 2:** E = 90.1 + (0.1168 x screen area in cm2)	Star Rating Index = 1 + [log(energy label energy consumption/MEPS level)/log(1-0.2)] **1 Star to 6-Stars rating with 0.5 Star increments** 1 Star: MEPS 2-Stars: 20% reduction from MEPS 3-Stars: 20% reduction from 2-Stars; 36% reduction from MEPS 4-Stars: 20% reduction from 3-Stars; 49% reduction from MEPS 5-Stars: 20% reduction from 4-Stars; 59% reduction from MEPS 6-Stars: 20% reduction from 5-Stars; 67% reduction from MEPS	Maximum power consumption, P, in watts **On-Mode** A = visible screen area, in dm2 **Tier 1** TV, Full HD: 20 + A x 1.12 x 4.3224 TV, non-HD: 20 + A x 4.3224 TV monitors, Full HD: 15 + A x 1.12 x 4.3224 TV monitors, non-HD: 15 + A x 4.3224 **Tier 2** TV: 16 + A x 3.4579 TV monitors: 12 + A x 3.4579

	Australia MEPS Mandatory Standard	**Australia Energy Label** Mandatory Label	**EU Ecodesign** Mandatory Standard
			Standby/Off Modes, power consumption in watts: Tier 1: Off mode: 1 W Standby Mode: 1 W Standby with information or status display: 2 W Tier 2: Off mode: 0.3 W Standby Mode: 0.5 W Standby with display: 1 W
Additional Requirements			Automatic switch from on mode to off mode or standby mode after 4 hours of inactivity
	Luminance: measured peak luminance in "home" picture mode ≥ 50% of measured peak luminance in retail mode		Luminance: measured peak luminance in "home" picture mode ≥ 65% of measured peak luminance in retail mode
Test Method/Specs	AS/NZS 62087.1 (Int): 2009 based on IEC 62087, Ed. 2.0	AS/NZS 62087.1 (Int): 2009 based on IEC 62087, Ed. 2.1	EN 62087 (same as IEC 62087) Power measurement based on average over 10 consecutive minutes Accuracy: uncertainty of ±2% at 95% confidence level

	EU Energy Label Mandatory Label	**Japan Top Runner** Mandatory Standard
Classification/Scope	TVs, component TVs and TV combination units. TV monitors without tuner or receiver.	Cathode ray tube, liquid crystal display, plasma display TV sets running on AC
Effective Dates	11/30/2011	CRTs: FY 2003 Tier 1 for LCD and Plasma: FY 2008 Tier 2 for LCD and Plasma: FY 2012
Energy Values	Energy efficiency class, defined as actual on-mode power consumption/MEPS level **Label Classes and EEI:** A+++: EEI < 0.10 A++: 0.1 ≤ EEI < 0.16 A+: 0.16 ≤ EEI < 0.23 A: 0.23 ≤ EEI < 0.30 B: 0.30 ≤ EEI < 0.42 C: 0.42 ≤ EEI < 0.60 D: 0.60 ≤ EEI < 0.80 E: 0.80 ≤ EEI < 0.90 F: 0.90 ≤ EEI < 1.00 G: 1.00 ≤ EEI	Standard energy consumption efficiency (assuming daily active period of 4.5 hours), in kWh/year Specific energy consumption efficiency for individual TV classes by scanning method, aspect ratio, shape of tube, and added functions

	EU Energy Label Mandatory Label	**Japan Top Runner** Mandatory Standard
Additional Requirements		
Test Method/Specs	EN 62087 (same as IEC 62087) Power measurement based on average over 10 consecutive minutes Accuracy: uncertainty of ±2% at 95% confidence level	Unknown

	Hong Kong Voluntary Label	**Korea (Standby)** Mandatory Label
Classification/Scope	TVs, component TVs and TV combination units. TV monitors without tuner or receiver. Technologies include CRT, LCD, plasma and LED.	TVs, component TVs and TV combination units. TV monitors without tuner or receiver. Technologies include CRT, LCD, and plasma.
Effective Dates	Phase I: 12/22/2003-9/30/2007 Phase II: 10/1/2007-2/28/2011 Phase III: 3/1/2011	Phase I: 1/1/2003-12/31/2005 Phase II: 1/1/2006 - 6/30/2007 Phase III: 7/1/2007
Energy Values	Maximum allowable power consumption, in Watts **Standby Mode, TV and Component TV:** Phase 1: ≤ 3 W Phase 2 & 3: ≤ 1 W **Standby Mode, TV/VCR combination:** Phase 1: ≤ 6 W Phase 2 & 3: ≤ 1 W **Standby Mode, Other TV Combination Units:** Phase 1: ≤ 4 W Phase 2 & 3: ≤ 1 W **Standby Mode, TV monitors:** Phase 1: Analog ≤ 1 W; Digital ≤ 3 W Phase 2 & 3: ≤ 1 W **On Mode: EEI as defined by actual power/reference power** P(ref) = 20 + (A/100) x 4.3224 Grade 1: EEI ≤ 0.4 Grade 2: 0.4 < EEI ≤ 0.64 Grade 3: 0.64 < EEI ≤ 1.0 Grade 4: 1.0 < EEI ≤ 1.44 Grade 5: EEI > 1.44	Standby power consumption, in Watts **Phase 1, Standby Mode** TV, TV monitor, component TV: ≤ 3 W Combination TVs: ≤ 4W **Phase 2, Standby Mode** TV/TV monitor - analog: ≤ 1 W TV/TV monitor - digital: ≤ 3 W Component TV: ≤ 3 W Combination TV: ≤ 3 W **Phase 3, Standby Mode** TV, TV monitor, component TV, combination TVs: ≤ 1 W

	Hong Kong Voluntary Label	**Korea (Standby)** Mandatory Label
Additional Requirements		
Test Method/Specs	On Mode: IEC 62087: 2008 (Ed. 2) Standby Mode: IEC 62301: 2005 (Ed. 1) Minimum Frequency Response: 3.0 kHz Power measurement based on average over 10 consecutive minutes Measurement accuracy: ±1%	KS C IEC 62301

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Appendix 1.1 Japan's Specific Energy Requirements for Copy Machines

Category	Standard energy consumption efficiency			
Copying speed	A4 machines	B4 machines	A3 machines	A3Y machines
Up to 10 sheets per minute	11	17	19	27
11~20 sheets per minute	17	20	55	77
21~30 sheets per minute	69	85	99	139
31~40 sheets per minute	88	108	125	175
41~50 sheets per minute	123	151	176	246
51~60 sheets per minute	144	176	205	287
61~70 sheets per minute	180	221	257	383
71~80 sheets per minute	200	246	286	433
81~85 sheets per minute	258	317	369	483

Remarks : 1. "A4 machines," "B4 machines," "A3 machines," and "A3Y machines," refer to copies whose maximum input width is A4 width, B4 width, A3 width and length respectively.

2. "Copying speed" refers to the maximum number of plain A4 paper sheets copied per minute continuously.

Note: the unit for standard energy consumption efficiency is watt-hour (Wh).

Source: Japan Ministry of Economy, Trade and Industry (METI). 2010. "Top Runner Program." Revised Edition March 2010. http://www.enecho.meti.go.jp/policy/saveenergy/toprunner2011.03en-1103.pdf

Appendix 1.2 U.S. ENERGY STAR Program Requirements for Imaging Equipment – Test Method (Rev. Dec. 2010)

Source: U.S. Environmental Protection Agency. 2010. "U.S. ENERGY STAR Program Requirements for Imaging Equipment Version 1.2."
http://www.energystar.gov/ia/partners/product_specs/program_reqs/Imaging_Equipment_Program_Requirements.pdf

3.3.2 Typical Electricity Consumption:

i. Calculated Typical Electricity Consumption (TEC) per Equation 1 or Equation 2 shall be less than or equal to the Maximum TEC Requirement (TEC_{MAX}) specified in Table 4, to the nearest 0.1 kilowatt-hour.

ii. For imaging products with a Type 2 DFE, the energy consumption of the DFE, calculated per the example below, should be excluded when comparing the product's measured TEC value to TEC_{MAX}. The DFE must not interfere with the ability of the imaging product to enter or exit its lower-power modes. In order to take advantage of this exclusion, the DFE must meet the definition in Section 1 and be a separate processing unit that is capable of initiating activity over the network.

Example: A printer's total TEC result is 24.5 kWh/week and its internal DFE consumes 50W in Ready mode. 50W x 168 hours/week = 8.4 kWh/week, which is then subtracted from the tested TEC value: 24.5 kWh/week – 8.4 kWh/week = 16.1 kWh/week. 16.1 kWh/week is then compared to the following criteria.

iii. For printers, fax machines, digital duplicators with print capability, and MFDs with print capability, TEC shall be calculated per Equation 1.

Equation 1: TEC Calculation for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability

$$TEC = 5 \times \left[E_{JOB\_DAILY} + (2 \times E_{FINAL}) + \left[24 - (N_{JOBS} \times 0.25) - (2 \times t_{FINAL})\right] \times \frac{E_{SLEEP}}{t_{SLEEP}} \right] + 48 \times \frac{E_{SLEEP}}{t_{SLEEP}},$$

Where:

- *TEC is the typical weekly energy consumption for printers, fax machines, digital duplicators with print capability, and MFDs with print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh;*
- *E_{JOB_DAILY} is the daily job energy, as calculated per Equation 3, in kWh;*
- *E_{FINAL} is the final energy, as measured in the test procedure in kWh;*
- *N_{JOBS} is the number of jobs per day, as calculated in the test procedure,*
- *t_{FINAL} is the final time to Sleep, as measured in the test procedure, in hours;*
- *E_{SLEEP} is the Sleep energy, as measured in the test procedure in kWh; and*
- *t_{SLEEP} is the Sleep time, as measured in the test procedure, in hours.*

iv. For copiers, digital duplicators without print capability, and MFDs without print capability, TEC shall be calculated per Equation 2.

Equation 2: TEC Calculation for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

$$TEC = 5 \times \left[E_{JOB\_DAILY} + (2 \times E_{FINAL}) + \left[24 - (N_{JOBS} \times 0.25) - (2 \times t_{FINAL})\right] \times \frac{E_{AUTO}}{t_{AUTO}} \right] + 48 \times \frac{E_{AUTO}}{t_{AUTO}},$$

Where:

- *TEC is the typical weekly energy consumption for copiers, digital duplicators without print capability, and MFDs without print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh;*
- *E_{JOB_DAILY} is the daily job energy, as calculated per Equation 3, in kWh;*
- *E_{FINAL} is the final energy, as measured in the test procedure, in kWh;*
- *N_{JOBS} is the number of jobs per day, as calculated in the test procedure;*
- *t_{FINAL} is the final time to Sleep, as measured in the test procedure, in hours;*
- *E_{AUTO} is the Auto-off energy, as measured in the test procedure, in kWh; and*
- *t_{AUTO} is the Auto-off time, as measured in the test procedure, in hours.*

v. Daily Job Energy shall be calculated per Equation 3.

Equation 3: Daily Job Energy Calculation for TEC Products

$$E_{JOB\_DAILY} = (2 \times E_{JOB1}) + \left((N_{JOBS} - 2) \times \frac{E_{JOB2} + E_{JOB3} + E_{JOB4}}{3} \right),$$

Where:

- *E_{JOB_DAILY} is the daily job energy, expressed in kilowatt-hours (kWh);*
- *E_{JOBi} is the energy of the i^{th} job, as measured in the test procedure, in kWh; and*
- *N_{JOBS} is the number of jobs per day, as calculated in the test procedure.*

8 TYPICAL ELECTRICITY CONSUMPTION (TEC) TEST PROCEDURE

8.1 Job Structure

A) Jobs per Day: The number of jobs per day (N_{JOBS}) is specified in Table 6.

Table 6: Number of Jobs per Day (N_{JOBS})

Monochrome Product Speed, s (ipm)	Jobs per Day (N_{JOBS})
$s \leq 8$	8
$8 < s < 32$	s
$s \geq 32$	32

B) Images per Job:

1) Except for fax machines, the number of images shall be computed according to Equation 2, below. For convenience, Table 10 at the end of this document provides the resultant images per job computation for each integer product speed up through 100 images per minute (ipm).

Equation 2: Calculation of Number of Images per Job

$$N_{IMAGES} = \text{int}\left[\frac{\left(0.5 \times s^2\right)}{N_{JOBS}}\right],$$

Where:

- *N_{IMAGES} is the number of images per job, rounded down (truncated) to the nearest integer,*
- *s is the (monochrome) maximum reported speed in images per minute (ipm), calculated in section 6.1.A), of this test procedure, and*
- *N_{JOBS} is the number of jobs per day, as calculated per Table 6.*

C) Test Image: Test Pattern A from ISO/IEC standard 10561:1999 shall be used as the original image for all testing.

1) Test images shall be rendered in 10 point size in a fixed-width Courier font (or nearest equivalent)

2) German-specific characters need not be reproduced if the product is incapable of German character reproduction.

D) Print Jobs: Print jobs for the test may be sent over non-network connections (e.g., USB), even on those units that are network-connected.

1) Each image in a print job shall be sent separately, i.e., all images may be part of the same document, but shall not be specified in the document as multiple copies of a single original image (unless the product is a digital duplicator).

2) For printers and MFDs that can interpret a page description language (PDL) (e.g., PCL, Postscript), images shall be sent to the product in a PDL.

E) Copy Jobs:

1) For copiers with speed less than or equal to 20 ipm, there shall be one original per required image.

2) For copiers with speed greater than 20 ipm, it may not be possible to match the number of required original images (e.g., due to limits on document feeder capacity). In this case, it is permissible to make multiple copies of each original, and the number of originals shall be greater than or equal to ten.

Example: For a 50 ipm unit that requires 39 images per job, the test may be performed with four copies of 10 originals or three copies of 13 originals.

3) Originals may be placed in the document feeder before the test begins.

i) Products without a document feeder may make all images off of a single original placed on the platen.

8.2 Measurement Procedures

A) Measurement of TEC shall be conducted according to Table 7 for printers, fax machines, digital duplicators with print capability, and MFDs with print capability, and Table 8 for copiers, digital duplicators without print capability and MFDs without print capability, subject to the following provisions:

1) Paper: There shall be sufficient paper in the device to perform the specified print or copy jobs.

2) Duplexing: Products shall be tested in simplex mode. Originals for copying shall be simplex images.

3) Service/Maintenance Modes: Service/maintenance modes (including color calibration) should generally not be included in TEC measurements.

i) Any service/maintenance modes that occur during the test shall be noted.

ii) If a service/maintenance mode occurs during a job other than the first job, the results from the job with the service/maintenance mode may be replaced with results from a substitute job. In this case, the substitute job shall be inserted into the test procedure immediately following Job 4. The 15-minute job interval shall be maintained at all times.

4) Accuracy: The specifications of the metering equipment and ranges used in each measurement shall be reported. Measurements must be conducted so as to result in a total potential error of the TEC value of no more than 5%. Accuracy does not need to be reported for cases where the potential error is below 5%. When the potential measurement error is close to 5%, manufacturers should take measures to confirm that it complies with the 5% limit.

5) Energy Measurement Method: All measurements shall be recorded as accumulated energy over time, in watt-hours (Wh); all time shall be recorded in seconds or minutes.

i) "Zero meter" references may be accomplished by recording the accumulated energy consumption at that time rather than literally zeroing the meter.

Table 8: TEC Test Procedure for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

Step	Initial State	Action	Record	Unit of Measure	Possible States Measured
1	Off	Connect the unit under test to the meter. Ensure the unit is powered and in Off Mode. Zero the meter; measure energy over 5 minutes or more. Record both energy and time.	Off energy	Watt-hours (Wh)	Off
			Testing Interval time	Hours (h)	
2	Off	Turn on unit. Wait until unit has entered Ready Mode.	–	–	–
3	Ready	Copy a job of at least one image but no more than a single job per Job Table. Measure and record time to first sheet exiting unit	Active0 time	Hours (h)	–
4	Ready (or other)	Wait until the meter shows that the unit has entered its final Sleep Mode or 4 hours.	–	–	–
5	Sleep	Zero meter; measure energy and time over 1 hour or until unit enters Auto-Off Mode. Record the energy and time.	Sleep energy	Watt-hours (Wh)	Sleep
			Sleep time (≤ 1 hour)	Hours (h)	
6	Sleep	Zero meter and timer. Copy one job (calculated above). Measure and record energy and time to first sheet exiting unit. Measure energy over 15 minutes from job initiation. The job must finish within the 15 minutes.	Job1 energy, E_{JOB1}	Watt-hours (Wh)	Recovery, Active, Ready, Sleep, Auto-off
			Active1 time	Hours (h)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, E_{JOB2}	Hours (h)	Same as above
			Active2 time	Watt-hours (Wh)	
8	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job3 energy, E_{JOB3}	Watt-hours (Wh)	Same as above
9	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job4 energy, E_{JOB4}	Watt-hours (Wh)	Same as above
10	Ready (or other)	Zero meter and timer. Measure energy and time until meter and/or unit shows that unit has entered its Auto-off Mode or 4 hours. Record energy and time; if unit began this step already in Auto-off Mode, report both energy and time values as zero.	Final energy, E_{FINAL}	Watt-hours (Wh)	Ready, Sleep
			Final time, t_{FINAL}	Hours (h)	
11	Auto-off	Zero the meter; measure energy and time over 5 minutes or more. Record both energy and time.	Auto-off energy, E_{AUTO}	Watt-hours (Wh)	Auto-off
			Auto-off time, t_{AUTO}	Hours (h)	

9 OPERATIONAL MODE (OM) TEST PROCEDURE

9.1 Measurement Procedures

A) Measurement of OM power and delay times shall be conducted according to Table 9, subject to the following provisions:

1) All power figures shall be recorded in watts (W) in accordance with IEC 62301, unless otherwise specified in this document.

2) Accuracy: The accuracy requirement for this OM test procedure is 2% for all measurements except for Ready power, where it is 5%. The 2% figure is consistent with IEC 62301, although the IEC standard expresses it as a confidence level.

3) Service/Maintenance Modes: Service/maintenance modes (including color calibration) generally should not be included in measurements. Any adaptation of the procedure needed to exclude such modes that occur during the test shall be noted.

Table 9: Operational Mode (OM) Test Procedure

Step	Initial State	Action(s)	Record	Unit of Measure
1	Off	Plug the unit into meter. Turn on unit. Wait until unit indicates it is in Ready Mode.	–	
2	Ready	Print, copy, or scan a single image.	–	
3	Ready	Measure Ready power.	Ready power, P_{READY}	Watts (W)
4	Ready	Wait and measure default delay-time to Sleep.	Sleep default-delay time, t_{SLEEP}	Minutes (min)
5	Sleep	Measure Sleep power.	Sleep power, P_{SLEEP}	Watts (W)
6	Sleep	Wait and measure default delay time to Auto-off. (Disregard if no Auto-off Mode)	Auto-off default-delay time	Minutes (min)
7	Auto-off	Measure Auto-off power. (Disregard if no Auto-off Mode)	Auto-off power $P_{AUTO-OFF}$	Watts (W)
8	Auto-off	Manually turn device off and wait until unit is off. (If no manual on-off switch, note and wait for lowest-power Sleep state).	–	–
9	Off	Measure Off power. (If no manual on-off switch, note and measure Sleep Mode power).	Off power P_{OFF}	Watts (W)

Notes:

- *Step 1 – If the unit has no Ready indicator, use the time at which the power consumption level stabilizes to the Ready level, and note this detail when reporting the product test data.*
- *Steps 4 and 5 – For products with more than one Sleep level, repeat these steps as many times as necessary to capture all successive Sleep levels and report this data. Two Sleep levels are typically used in large-format copiers and MFDs that use high-heat marking technologies. For products lacking this Mode, disregard Steps 4 and 5.*
- *Steps 4 and 6 – Default-delay time measurements are to be measured in parallel fashion, cumulative from the start of Step 4. For example, a product set to enter a Sleep level in 15 minutes and enter a second Sleep level 30 minutes after entering the first Sleep level will have a 15-minute default-delay time to the first level and a 45 minute default-delay time to the second level.*

Appendix 1.3 Japanese Measuring Method for Energy Consumption of Copy Machines

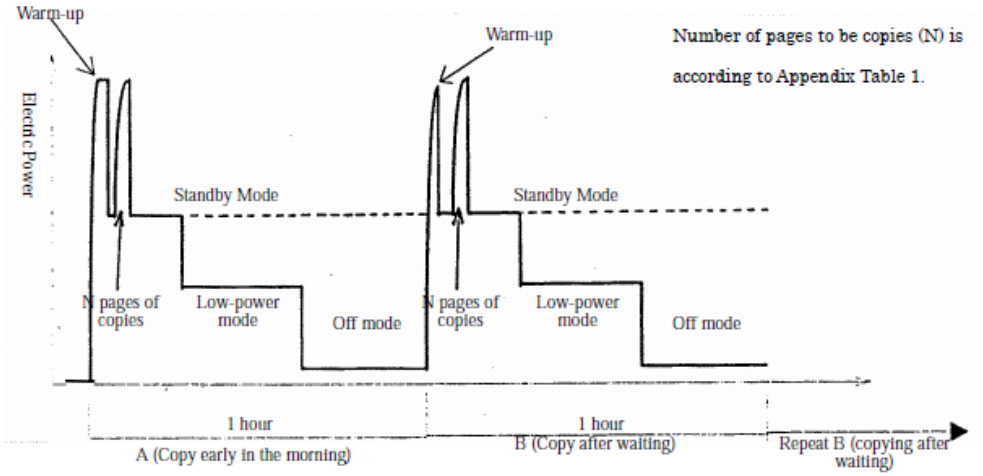
Measuring method of energy consumption

(1) Measuring Conditions

1) Environment: 20±2 °C, 65±10%RH
2) Power Supply: 100/200V, within ±3% of rated voltage to load fluctuation.
   50/60 Hz, within ±0.5Hz of rated frequency
3) Paper: Recommend paper of A4 size
4) Temperature and humidity regulation: Both a copier and paper shall be left under the measuring environment for one hour or longer.
5) Measuring equipment: Accuracy ±0.5% (when the power factor is 1)
6) Test chart: Image ratio 4-7%
7) Conditions for copy setting: Magnification: Same size
   Exposure: Automatic or appropriate
   Others: Factory default basic setting
   Copying shall be in basic mode (place a sheet on the glass surface).
8) Equipment configuration: Only basic configuration as a copier shall be accepted, and no peripheral device such as a sorter, automatic sheet feeder, etc. shall be included.
   Note, however, that in the case in which peripheral devices are attached according to the standard specification, and when power required for basic control lies on the copier side, it shall be measured with the peripheral devices attached.

(2) Measuring Method

1) Measuring Pattern



* The energy saving mode functions such as low-power mode and off mode for power reduction in a standby shall be added to the current measuring method.

2) Calculating Method

Measure energy consumption A (Wh) of the power measurement pattern A and energy consumption B (Wh) of the pattern B and calculate energy consumption per hour, by using the following expression:

Energy Consumption per Hour = (A+7B)÷8 (Wh/h)

Appendix Table 1

・ Measuring conditions (Number of pages to be copied vs. copying speed)

	Low Speed 1	Low Speed 2	Medium Speed 1	Medium Speed 2	High Speed 1	High Speed 2
Copying Speed (CPM)	～10	11～20	21～30	31～40	41～60	61～85
Number of pages to be copied (copy/hour)	2	10	30	50	100	300
Average of monthly number of pages to be copied (copy)	320	1,600	4,800	8,000	16,000	48,000

CPM: COPY PER MINUTE

The number of pages to be copied shall be calculated from the average of monthly number of pages to be copied (Estimation by Japan Business Machine Makers Association), assuming that the copier works 20 days in a month and that working hour of a day is 8 hours.

Source: Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy. 1998. "Final Report by Copying Machine Criteria Standard Subcommittee, Energy Efficiency Standards Subcommittee of the Advisory Committee on Energy."
http://www.eccj.or.jp/top_runner/pdf/tr_copying_machines.pdf

Appendix 2.1 Test Method for External Power Supplies

4. General Conditions for Measurement

a. General

Unless otherwise specified, measurements shall be made under test conditions and with equipment specified below.

b. Measuring Equipment

Power measurements shall be made with a suitably calibrated voltmeter and ammeter, or power analyzer. As is specified in IEC 62301, measurements of active power of 0.5 W or greater shall be made with an uncertainty of ≤ 2%. Measurements of active power of less than 0.5 W shall be made with an uncertainty of ≤ 0.01 W. The power measurement instrument shall have a resolution of 0.01W or better for active power. Measurements of voltage and current shall be made with an uncertainty of ≤ 2%.

c. Test Room

As is specified in IEC 62301, the tests shall be carried out in a room that has an air speed close to the UUT of ≤ 0.5 m/s, and the ambient temperature shall be maintained at 23°C ± 5°C throughout the test. There shall be no intentional cooling of the UUT by use of separately powered fans, air conditioners, or heat sinks. The UUT shall be tested on a thermally non-conductive surface. Products intended for outdoor use may be tested at additional temperatures, provided those are in addition to the conditions specified above and are noted in a separate section on the test report.

d. Test Voltage

An ac reference source shall be used to provide input voltage to the UUT. As is specified in IEC 62301, the input to the UUT shall be the specified voltage ± 1% and the specified frequency ± 1%. The UUT shall be tested at two voltage and frequency combinations: 115 V at 60 Hz and 230 V at 50 Hz if its nameplate input voltage and frequency indicate that it can operate safely under both conditions. If testing at both conditions is not possible, the UUT shall be tested at one of the above voltage and frequency combinations that is closest to its nameplate input voltage and frequency. If voltage and/or frequency ranges are not specified by the manufacturer (or the nameplate value is unclear), the UUT shall not be tested.

e. Input ac reference source

The input voltage source shall be capable of delivering at least 10 times the nameplate input power of the UUT (as is specified in IEEE 1515-2000). Regardless of the ac source type, the THD of the supply voltage when supplying the UUT in the specified mode shall not exceed 2%, up to and including the 13th harmonic (as specified in IEC 62301). The

peak value of the test voltage shall be within 1.34 and 1.49 times its rms value (as specified in IEC 62301).

f. Test leads

All leads used in the test set-up should be of large gauge and short length in order to avoid the introduction of errors in the testing process. For further guidance, see Table B.2, "Commonly used values for wire gages and related voltage drops" in IEEE 1515-2000.

5. Measurement Approach

a. Preparing UUT for Test

Any built-in switch in the UUT controlling power flow to the ac input shall be in the "on" position for this measurement, and the existence of such a switch shall be noted in the final test report.

Power supplies that are packaged for consumer use to power a product must be tested with the output cord supplied by the manufacturer. There are two options for connecting metering equipment to the output of this type of power supply: cut the cord immediately adjacent to the output connector, or attach leads and measure the efficiency from the output connector itself. If the power supply is attached directly to the product that it is powering, cut the cord immediately adjacent to the powered product and connect output measurement probes at that point. If the product has more than two output wires, the tests should be conducted on the two output wires that supply the output power. The other output wires (sometimes used for battery monitoring) should be left electrically disconnected.

It is also possible to utilize this procedure to test the efficiency of a bare circuit board power supply prior to its incorporation into a finished housing and the attachment of its dc output cord. For example, a power supply manufacturer or component manufacturer may wish to assess the efficiency of a design that it intends to provide to an OEM for incorporation into a finished external power supply. However, the efficiency of the bare circuit board power supply may not be used to characterize the efficiency of the final product (once enclosed in a case and fitted with an output cord). Power supplies must be tested in their final, completed configuration in order to represent their measured efficiency on product labels or specification sheets.

b. Load Conditions

All single voltage external power supplies have a nameplate output current, as shown in Figure 1. This is the value used to determine the four active mode load conditions and the no load condition required by this test procedure. The UUT shall be tested at the following load conditions:

Table 1 – Load Conditions for UUT

	Percentage of Nameplate Output Current
Load Condition 1	100 % ± 2%
Load Condition 2	75% ± 2%
Load Condition 3	50% ± 2%
Load Condition 4	25% ± 2%
Load Condition 5	0%

The 2% allowance is of nameplate output current, not of the calculated current value. For example, a UUT at Load Condition 3 may be tested in a range from 48% to 52% of rated output current.

Additional load conditions may be selected at the technician's discretion, as described in IEEE 1515-2000, but are not required by this test procedure.

Figure 1– Example of Ac-Dc Power Supply Nameplate Output Voltage and Current

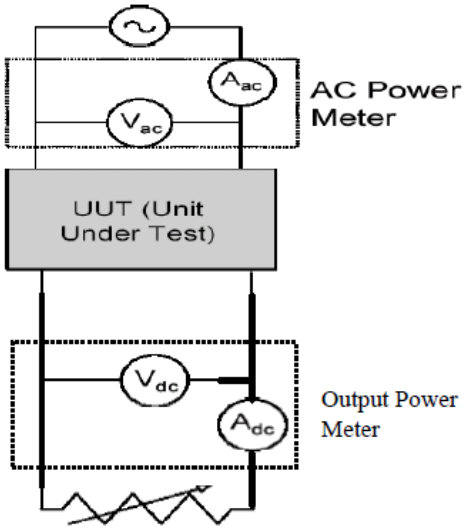
c. Loading Guideline

In order to load the power supply to produce all four active mode load conditions, a set of variable resistive or electronic loads shall be used. While these loads may have different characteristics than the electronic loads power supplies are intended to power, they provide standardized and readily repeatable references for testing and product comparison.

Note that resistive loads need not be measured precisely with an ohmmeter. A variable resistor is simply adjusted to the point where the ammeter confirms that the desired percentage of nameplate output current is flowing. Figure 2 shows a simplified schematic of an external power supply test set-up using variable resistance as the load. For

electronic loads, the desired output current should be adjusted in constant current (CC) mode rather than adjusting the required output power in constant power (CP) mode.

Figure 2 - Generic Test Set-up Using a Variable Resistance Load



d. Testing Sequence

As noted in IEC 62301, instantaneous measurements are appropriate when power readings are stable in a particular load condition. The UUT shall be operated at 100% of nameplate current output for at least 30 minutes immediately prior to conducting efficiency measurements.

After this warm-up period, the technician shall monitor ac input power for a period of 5 minutes to assess the stability of the UUT. If the power level does not drift by more than 5% from the maximum value observed, the UUT can be considered stable and the measurements can be recorded at the end of the 5 minute period. Subsequent load conditions (see below) can then be measured under the same 5 minute stability guidelines. Note that only one warm-up period of 30 minutes is required for each UUT at the beginning of the test procedure.

If ac input power is not stable over a 5 minute period, the technician shall follow the guidelines established by IEC 62301 for measuring average power or accumulated energy over time for both ac input and dc output.

Efficiency measurements shall be conducted in sequence from Load Condition 1 to Load Condition 5 as indicated in Table 1 above. If testing of additional, optional load

conditions is desired, that testing should be conducted in accordance with this test procedure and subsequent to completing the sequence described above.

e. Efficiency Calculation

Efficiency shall be calculated by dividing the UUT's measured active output power at a given load condition by the active ac input power measured at that load condition. Average efficiency shall also be calculated and reported as the arithmetic mean of the efficiency values calculated at Test Conditions 1, 2, 3, and 4 in Table 1. This is a simple arithmetic average of active mode efficiency values, and is not intended to represent weighted average efficiency, which would vary according to the duty cycle of the product powered by the UUT.

f. Power Consumption Calculation

Power consumption of the UUT at each Load Condition 1 – 4 is the difference between the active output power (W) at that Load Condition and the ac active input power (W) at that Load Condition. The power consumption of Load Condition 5 (no load) is equal to the ac active input power (W) at that Load Condition.

Source: Calwell, C. et. al. 2004. "Test Method for Calculating the Energy Efficiency of Single-Voltage External AC-DC and AC-AC Power Supplies." August 11, 2004. http://www.efficientpowersupplies.org/pages/External_Power_Supply_Efficiency_Test_Method_8-11-04.pdf

Appendix 3.1 U.S. ENERGY STAR Test Method for Displays (revised August 2010)

4 TEST REQUIREMENTS

4.1 Test Methods

4.1.1 When testing Display products, the test methods identified in Table 4 shall be used to determine ENERGY STAR qualification.

Table 4: Test Methods for ENERGY STAR Qualification

Diagonal Screen Size, *d* (inches)	Test Method
$d < 30.0$	ENERGY STAR Test Method for Displays Rev. Aug 2010. VESA Flat Panel Display Measurements (FPDM) Standard, Version 2.0
$30.0 \leq d \leq 60.0$	ENERGY STAR Test Method for Displays Rev. Aug 2010. IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment
All Screen Sizes	IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power

4.2 Number of Units Required for Testing

4.2.1 Representative Models shall be selected for testing per the following requirements:

i. For qualification of an individual product model, a product configuration equivalent to that which is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model;

ii. For qualification of a product family, any product configuration within the family may be considered the Representative Model.

4.2.2 If the steady-state power consumption of the UUT is greater than 85% of the ENERGY STAR qualification limit in *any* of the three operating modes, two additional units of the same model shall be tested.

4.2.3 Testing of additional units is not required if the steady-state power consumption of the first test unit is less than or equal to 85% of the ENERGY STAR qualification limit in *all* of the three operating modes.

4.2.4 All tested units shall meet ENERGY STAR qualification requirements.

4.3 International Market Qualification

4.3.1 Products shall be tested for qualification at the relevant input voltage/frequency combination for each market in which they will be sold and promoted as ENERGY STAR.

5 USER INTERFACE

5.1.1 Partners are encouraged to design products in accordance with the user interface standard IEEE P1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments. For details, see http://eetd.LBL.gov/Controls.

ENERGY STAR® Program Requirements
Product Specification for Displays

Test Method

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1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Displays.

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation. The following guidelines shall be used to determine the applicability of each section of this document:

1) Test procedures in Section 8 shall be performed on all products with viewable diagonal screen size less than 30 inches.

2) Test procedures in Section 9 shall be performed on all products with viewable diagonal screen size from 30 to 60 inches, inclusive.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Displays.

4 TEST SETUP

A) Test Setup and Instrumentation: Test setup and instrumentation for all portions of this procedure 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, the ENERGY STAR test method shall take precedence.

B) Input Power:

1) AC Input Power: Products intended to be powered from AC mains shall be connected to an external power supply shipped with the unit (if applicable) and then connected to a voltage source appropriate for the intended market, as specified in Table 1 and Table 2.

Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 1.0 %	2.0 %	50 Hz/60 Hz	+/- 1.0 %

Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater Than 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 4.0 %	5.0 %	50 Hz/ 60 Hz	+/- 1.0 %

C) Low-voltage DC Input Power:

1) Products may only be powered with a low-voltage DC source (e.g., via network or data connection) if the DC source is the only available source of power for the product (e.g., no AC plug or EPS is available).

2) Products powered by low-voltage DC shall be configured with an AC source of the DC power for testing (e.g., an AC-powered USB hub).

3) Reported UUT power shall be equal to the AC power consumption of the low-voltage DC source with the UUT as the load, minus the AC power consumption of the low-voltage DC source with no load (P_S), as measured per Section 6 of this procedure.

D) Ambient Temperature: Ambient temperature shall be from 18 °C to 28 °C.

E) Relative Humidity: Relative humidity shall be from 10% to 80%.

F) Power Meter: Power meters shall possess the following attributes[1]:

1) Crest Factor:

i) An available current crest factor of 3 or more at its rated range value; and

ii) Lower bound on the current range of 10mA or less.

2) Minimum Frequency Response: 3.0 kHz

3) Minimum Resolution:

i) 0.01 W for measurement values less than 10 W;

ii) 0.1 W for measurement values from 10 W to 100 W; and

iii) 1.0 W for measurement values greater than 100 W.

G) Measurement Accuracy:

1) Power measurements with a value greater than or equal to 0.5 W shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level.

2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

5 TEST CONDUCT

A) Power Measurements:

1) Power measurements shall be taken from a point between the power source and the unit under test (UUT).

2) Power measurements shall be recorded in watts and rounded to the nearest tenth of a watt.

3) Power measurements shall be recorded after instrument readings are stable to within 1% over a three-minute period.

B) Dark Room Conditions:

1) Unless otherwise specified, the display screen illuminance measured with the UUT in Off Mode shall be less than or equal to 1.0 lux.

C) Light Measurements:[2]

1) Light measurements shall be performed with the Light Measurement Device (LMD) located at the center of, and perpendicular to, the display screen.[3]

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[1] Characteristics of approved meters taken from IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power.
[2] VESA FPDM Standard 2.0, Section 301-2H
[3] VESA FPDM Standard 2.0, Appendix A115

2) The LMD shall measure a rectangular area that is the greater of (1) an area each side of which is 10% as long as the corresponding side of the viewable screen area, or (2) 500 pixels.

3) The LMD measurement area shall be no larger than the illuminated screen area.

D) UUT Configuration and Control:

1) As-shipped Condition: The UUT shall be tested in its "as-shipped" configuration. For products that offer a choice of user-configurable options, all options, including color controls, shall be set to thei default conditions.

2) Peripherals:

i) External devices shall not be connected to Universal Serial Bus (USB) ports.

ii) Built-in speakers, TV tuners, and other product features and functions not specifically addressed by the ENERGY STAR eligibility criteria or test method may be configured in a minimum power configuration, as adjustable by the user.

3) Signal Interface: Displays that offer both an analog and a digital interface shall be tested with the analog interface.

E) Resolution and Refresh Rate:

1) Fixed-pixel Displays:

i) Pixel format shall be set to the native level.

ii) Refresh rate shall be set to 60 Hz, unless a different default refresh rate is specified in the product manual, in which case the specified default refresh rate shall be used.

2) CRT Displays:

i) Pixel format shall be set to the highest resolution that is designed to be driven at a 75 Hz refresh rate, as specified in the product manual. VESA Discrete Monitor Timing (DMT) or other industry standard pixel format timing shall be used for testing.

ii) Refresh rate shall be set to 75 Hz.

F) Battery Operated Products: For products designed to operate using batteries when not connected to the mains, the battery shall be fully charged before the start of testing and shall be left in place for the test.

6 LOW-VOLTAGE DC SOURCE MEASUREMENT

1) Connect the DC source to the power meter and relevant AC supply as specified in Table 1.

2) Verify that the DC source is unloaded.

3) Allow the DC source to warm up for a minimum of 30 minutes.

4) Measure and record the unloaded DC source power (P_S) according to IEC 62301 Ed. 1.0.

7 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS

A) Prior to the start of testing, the UUT shall be initialized as follows:

1) Set up the UUT per the instructions in the supplied operating manual.

2) Connect the power meter to the power source and connect the UUT to the power outlet on the power meter.

3) Set the ambient light level such that the measured display screen illuminance is less than 1 lux.

4) Power on the UUT and perform initial system configuration, as applicable.

5) Ensure that UUT settings are in their as-shipped configuration.

6) Warm up the UUT for at least 20 minutes and until the unit has completed initialization and is ready for use.[4]

7) Measure and record the ac input voltage and frequency.

8) Measure and record the test room ambient temperature.

8 TEST PROCEDURES FOR PRODUCTS WITH VIEWABLE DIAGONAL SCREEN SIZE LESS THAN 30 INCHES

8.1 On Mode Test for CRT Displays

1) Ensure that the UUT has been initialized per Section 7.

2) Display the VESA FPDM Standard 2.0, A112-2F, AT01P test pattern.

3) Set the UUT image size to the manufacturer's recommended image size (typically slightly smaller than maximum viewable screen size).

4) Display the VESA FPDM2, A112-2F, SET01K test pattern (8 shades of gray from full black (0 volts) to full white (0.7 volts)).[5]

5) Verify that input signal levels conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002.

6) If possible, adjust display brightness control until the lowest black-bar luminance level is just slightly visible, per VESA FPDM Section 301-3K.

7) Display the VESA FPDM A112-2H, L80 test pattern (full white (0.7 volts) box that occupies 80% of the image).

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[4] VESA FPDM Standard 2.0, Section 301-2D or 305-3 for warm-up test.

[5] For digital-interface displays, image brightness shall correspond to voltage as follows:

- 0.0 V (black) = a setting of 0
- 0.1 V (darkest shade of gray analog) = 36 digital gray
- 0.7 V (full white analog) = 255 digital gray

8) Ensure that the LMD measurement area falls entirely within the illuminated portion of the test pattern.

9) Adjust the contrast control until the measured luminance of the white area of the screen is 100 cd/m^2 or nearest achievable value.

10) Measure and record display luminance. Note: Following this point in the test procedure, dark room conditions are no longer required.

11) Measure and record On Mode power (P_{ON}) and total pixel format (horizontal x vertical).

8.2 On Mode Test for Fixed-pixel Displays

1) If the UUT does not have ABC Enabled by Default:

   i) Ensure that the UUT has been initialized per Section 7.

   ii) Display the VESA FPDM2, A112-2F, SET01K test pattern (8 shades of gray from full black (0 volts) to full white (0.7 volts)).

   iii) Verify that input signal levels conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002.

   iv) With the brightness and contrast controls at maximum, verify that the white and near-white-grey levels can be distinguished. If necessary, adjust contrast controls until the white and near-white-grey levels can be distinguished

   v) Display the VESA FPDM2, A112-2H, L80 test pattern (full white (0.7 volts) box that occupies 80% of the image).

   vi) Ensure that the LMD measurement area falls entirely within the white portion of the test pattern.

   vii) Adjust the brightness control until the luminance of the white area of the screen is as specified in Table 3. If the UUT cannot achieve the specified luminance, set display luminance to the nearest achievable value.

Table 3: Luminance Settings for On Mode Testing of Fixed-Pixel Displays

Screen Resolution	Luminance (Cd/m^2)
Less than or equal to 1.1 MP resolution	175
Greater than 1.1 MP resolution	200

   viii) Measure and record display luminance. Note: Following this point in the test procedure, dark room conditions are no longer required.

   ix) Measure and record On Mode power (P_{ON}) and total pixel format (horizontal x vertical).

2) If the UUT has ABC Enabled by Default:

   i) Ensure that the UUT has been initialized per Section 7.

ii) Set the ambient light level to 300 lux, as measured at the face of the product's ambient light sensor.

iii) Measure and record On Mode power in high ambient lighting conditions (P_H) and total pixel format (horizontal x vertical).

iv) Set the ambient light level to 0 lux, as measured at the face of the product's ambient light sensor.

v) Measure and record On Mode power in low ambient lighting conditions (P_L).

8.3 Sleep Mode

1) At the conclusion of the On Mode test, initiate Sleep Mode.

2) Document the method of adjustment and sequence of events required to reach Sleep Mode.

3) If the product has a variety of Sleep Modes that can be manually selected, measurements shall be performed in the most energy consumptive Sleep Mode. If the product automatically cycles through its various Sleep Modes, measurement time shall be long enough to obtain a true average of all Sleep Modes.

4) Measure and record Sleep Mode power (P_{SLEEP}).

8.4 Off Mode

1) At the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power switch.

2) Document the method of adjustment and sequence of events required to reach Off Mode.

3) Any input sync signal check cycle may be ignored when measuring Off Mode power.

4) Measure and record Off Mode power (P_{OFF}).

9 TEST PROCEDURES FOR PRODUCTS WITH VIEWABLE DIAGONAL SCREEN SIZE FROM 30 TO 60 INCHES, INCLUSIVE

Table 4: Test Procedures

Requirement	Test Protocol
On Mode Power	IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment, Section 11, "Measuring conditions of television sets for On (average) mode."

9.1 On Mode

A) Products shall be tested in On Mode according to the method specified in Table 4, subject to the following guidance:

1) Accuracy of Input Signal Levels: Video inputs shall be within ±2% of reference white and black levels.

2) Signal Input: HDMI inputs should be used for testing wherever possible.

3) True Power Factor: Due to increased awareness of the importance of power quality on the part of EPA and electric utilities, Partners shall indicate the true power factor of their displays during On Mode measurement.

4) Test Materials: "Dynamic Broadcast Content" shall be used for testing, as specified in IEC-62087 Ed. 2.0, Section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."

5) As-shipped Conditions: The UUT shall be tested in its as-shipped factory-default condition. All picture adjustments required for On Mode testing shall be performed per IEC-62087, Ed. 2.0, 11.4.8, "Picture level adjustments."

6) Forced Menu: If the product includes a "forced menu" upon initial start-up for user selection of a picture mode, "standard" or "home" picture mode shall be selected.

B) If the UUT has ABC Enabled by Default:

1) Ensure that the UUT has been initialized per Section 7.

2) Set the ambient light level to 300 lux as measured at the face of an ambient light sensor.

3) Measure the high ambient lighting On Mode power consumption, P_h, as described in section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."

4) Set the ambient light level to 0 lux as measured at the face of an ambient light sensor.

5) Measure the low ambient lighting On Mode power consumption, P_l, as described in section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."

6) Calculate average On Mode power consumption using the equation in section 3.A.3., Displays with Automatic Brightness Control.

9.2 Luminance

7) At the conclusion of the On Mode test, display a three bar (L_t) static video signal per section 11.5 of IEC 62087.

8) Measure and record the center point, axial luminance of the display (per VESA FPDM Version 2.0, section 301-2H).

9.3 Sleep Mode

1) At the conclusion of the Luminance test, initiate Sleep Mode.

2) Document the method of adjustment and sequence of events required to reach Sleep Mode.

3) If the product has a variety of Sleep Modes that can be manually selected, measurements shall be performed in the most energy consumptive Sleep Mode. If the product automatically cycles through its various Sleep Modes, measurement time shall be long enough to obtain a true average of all Sleep Modes.

4) Measure and record Sleep Mode power (P_{SLEEP}).

9.4 Off Mode

1) At the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power switch.

2) Document the method of adjustment and sequence of events required to reach Off Mode.

3) Any input sync signal check cycle may be ignored when measuring Off Mode power.

4) Measure and record Off Mode power (P_{OFF}).

Source: U.S. EPA, 2009. "ENERGY STAR Program Requirements for Displays Version 5.1." http://www.energystar.gov/ia/partners/product_specs/program_reqs/Displays_Program_Requirements.pdf?4a12-d4e7

Appendix 5.1 Japanese Top Runner Standards for Televisions

Source: Japan Ministry of Economy, Trade and Industry (METI). 2010. "Top Runner Program." Revised Edition March 2010. http://www.enecho.meti.go.jp/policy/saveenergy/toprunner2011.03en-1103.pdf

In the target fiscal year and each subsequent fiscal year, energy consumption efficiency in each category shall be at or lower than the target standard value.
(1) Ones whose target year is FY 2003 or any subsequent fiscal year
Cathode ray tube TV (20 categories)

Category						Standard energy consumption efficiency
Scanning method	Aspect ratio	Deflection angle	Shape of tube	Function	Category name	
Normal scanning method	4:3	Up to 100 degrees	Other than flat type	Other than those having built-in VCR (or DVD)	AA	E=2.5S+32
				Those having built-in VCR (or DVD)	AB	E=2.5S+60
			Flat type	Other than those having built-in VCR (or DVD)	AC	E=2.5S+42
				Those having built-in VCR (or DVD)	AD	E=2.5S+70
		Over 100 degrees	Other than flat type	Other than those having built-in VCR (or DVD)	AE	E=5.1S−4
				Those having built-in VCR (or DVD)	AF	E=5.1S+24
			Flat type	Other than those having built-in VCR (or DVD)	AG	E=5.1S+21
				Those having built-in VCR (or DVD)	AH	E=5.1S+49
	16:9		Other than flat type	Other than those having built-in VCR (or DVD), and having no additional function	AI	E=5.1S−11
				Those having built-in VCR (or DVD)	AJ	E=5.1S+17
				Other than those having built-in VCR (or DVD), and having 1 additional function	AK	E=5.1S+6
				Other than those having built-in VCR (or DVD), and having 2 additional functions	AL	E=5.1S+13
				Other than those having built-in VCR (or DVD), and having 3 additional functions	AM	E=5.1S+59
			Flat type	Other than those having built-in VCR (or DVD), and having no additional function	AN	E=5.1S−1
				Those having built-in VCR (or DVD)	AO	E=5.1S+27
				Other than those having built-in VCR (or DVD), and having 1 additional function	AP	E=5.1S+16
				Other than those having built-in VCR (or DVD), and having 2 additional functions	AQ	E=5.1S+23
				Other than those having built-in VCR (or DVD), and having 3 additional functions	AR	E=5.1S+69
Double speed scanning type				Those having analog high-vision TV	AS	E=5.5S+72
				Other than those having analog high-vision TV	AT	E=5.5S+41

Remarks : 1. "Television receiver size" refers to the centimeter- denominated quotient, rounded at the decimal point, of division of the diagonal dimension of the driven display area of the display screen by 2.54.

2. "Flat type" means a TV set whose percentage of the maximum gap value between the center and the peripheral portion on a cathode-ray-tube surface to the diagonal dimensions of a cathode-ray-tube is 0.5% or less (provided that the measurement position of the peripheral portion and the diagonal dimension shall be within the effective area plus 5 mm).

3. "Analog high-vision TV" means a cathode-ray-tube TV with 1,125 scanning lines and a screen of 16:9 aspect ratio that also has a MUSE decoder and satellite broadcasting receiving function.

4. "Additional function" refers to dual-tuner & split-screen function, text broadcast reception function, and MUSE-NTSC converter*.
   * Built-in converters that convert MUSE high-vision broadcast signals to current NTSC signals.

5. "E" and "S" represent the following numeric values.
   E : standard energy consumption efficiency (kWh per year)
   S : Television receiver size

(2) Ones whose target year is FY 2008 or any subsequent fiscal year (but not later than FY 2011)

○ Liquid crystal TV (38 categories)

Category						Standard energy consumption efficiency or calculation formula thereof
Aspect ratio	Number of pixels	Television receiver size	Function	Additional function	Category name	
4:3	Vertical pixel count of less than 650	Below 15 V size	Other than those having DVD play function only	Other than the following	BA	E=44
				With 1 additional function	BB	E=58
				With 2 additional functions	BC	E=72
			Those having DVD play function only	Other than the following	BD	E=58
				With HDD	BE	E=72
		15 V size or larger	Other than those having DVD play function only	Other than the following	BF	E=5.9S−45
				With 1 additional function	BG	E=5.9S−31
				With 2 additional functions	BH	E=5.9S−16
			Those having DVD play function only	Other than the following	BI	E=5.9S−31
				With HDD	BJ	E=5.9S−16
	Vertical pixel count of 650 or more	Below 15 V size	Other than those having DVD play function only	Other than the following	BK	E=49
				With 1 additional function	BL	E=64
				With 2 additional functions	BM	E=78
			Those having DVD play function only	Other than the following	BN	E=59
				With HDD	BO	E=73
		15 V size or larger	Other than those having DVD play function only	Other than the following	BP	E=5.4S−32
				With 1 additional function	BQ	E=5.4S−17
				With 2 additional functions	BR	E=5.4S−3
			Those having DVD play function only	Other than the following	BS	E=5.4S−22
				With HDD	BT	E=5.4S−8
16:9	Vertical pixel count of less than 650			Those capable of receiving analog broadcast signals only, and falling in a category other than the following	BU	E=8.1S−86
				With 1 additional function	BV	E=8.1S−72
				With 2 additional functions	BW	E=8.1S−58
				Those capable of receiving digital broadcast signals, and falling in a category other than the following	BX	E=7.5S−45
				With 1 additional function	BY	E=7.5S−31
				With 2 additional functions	BZ	E=7.5S−17
				With 3 additional functions	BAA	E=7.5S−3
	Vertical pixel count of 650 or more, and less than 1080			Those capable of receiving analog broadcast signals only, and falling in a category other than the following	BBB	E=8.1S−66
				With 1 additional function	BCC	E=8.1S−52
				With 2 additional functions	BDD	E=8.1S−38
				Those capable of receiving digital broadcast signals, and falling in a category other than the following	BEE	E=7.5S−40
				With 1 additional function	BFF	E=7.5S−25
				With 2 additional functions	BGG	E=7.5S−11
				With 3 additional functions	BHH	E=7.5S+3
	Vertical pixel count of 1080 or more			Other than the following	BII	E=8.9S−55
				With 1 additional function	BJJ	E=8.9S−41
				With 2 additional functions	BKK	E=8.9S−26
				With 3 additional functions	BLL	E=8.9S−12

Remarks : 1. "Television receiver size" refers to the centimeter- denominated quotient, rounded at the decimal point, of division of the diagonal dimension of the driven display area of the display screen by 2.54.

2. "Additional function(s)" refers to DVD (solely what has a video recording function), HDD and double digital tuner.

3. E and S represent the following values, respectively.
   E: Standard energy consumption efficiency (in kWh/year)
   S: Television receiver size

○ Plasma TV sets (8 categories)

Category			Calculation formula of standard energy consumption efficiency
Television receiver size	Additional function(s)	Category name	
Smaller than 43 V size	Other than the following	CA	E=7.9S+30
	With 1 function	CB	E=7.9S+44
	With 2 functions	CC	E=7.9S+58
	With 3 functions	CD	E=7.9S+73
43 V size or larger	Other than the following	CE	E=15.9S−314
	With 1 function	CF	E=15.9S−300
	With 2 functions	CG	E=15.9S−286
	With 3 functions	CH	E=15.9S−272

Remarks : 1. "Television receiver size" refers to the centimeter- denominated quotient, rounded at the decimal point, of division of the diagonal dimension of the driven display area of the display screen by 2.54.
2. "Additional function(s)" refers to DVD (solely what has a video recording function), HDD and double digital tuner.
3. E and S represent the following values, respectively.
E: Standard energy consumption efficiency (in kWh/year)
S: Television receiver size

(3) Ones whose target year is FY 2012 or any subsequent fiscal year

○ Liquid crystal TV sets and plasma TV sets (64 categories)

Category					Standard energy consumption efficiency or calculation formula thereof
No. of pixels	Television receiver size	Dynamic image display	Additional function(s)	Category name	
FHD	Below 19 V size	Liquid crystal normal	Other than the following	DA	E=59
			With 1 function	DA1	E=71
			With 2 functions	DA2	E=83
			With 3 functions	DA3	E=95
		Liquid crystal double speed	Other than the following	DB	E=74
			With 1 function	DB1	E=86
			With 2 functions	DB2	E=98
			With 3 functions	DB3	E=110
	Not below 19 V size, but below 32 V size	Liquid crystal normal	Other than the following	DC	E=2.0S+21
			With 1 function	DC1	E=2.0S+33
			With 2 functions	DC2	E=2.0S+45
			With 3 functions	DC3	E=2.0S+57
		Liquid crystal double speed	Other than the following	DD	E=2.0S+36
			With 1 function	DD1	E=2.0S+48
			With 2 functions	DD2	E=2.0S+60
			With 3 functions	DD3	E=2.0S+72
		Liquid crystal quadruple speed or plasma	Other than the following	DE	E=2.0S+58
			With 1 function	DE1	E=2.0S+70
			With 2 functions	DE2	E=2.0S+82
			With 3 functions	DE3	E=2.0S+94
	32 V size or larger	Liquid crystal normal	Other than the following	DF	E=6.6S-126
			With 1 function	DF1	E=6.6S-114
			With 2 functions	DF2	E=6.6S-102
			With 3 functions	DF3	E=6.6S-90
		Liquid crystal double speed	Other than the following	DG	E=6.6S-111
			With 1 function	DG1	E=6.6S-99
			With 2 functions	DG2	E=6.6S-87
			With 3 functions	DG3	E=6.6S-75

Category					Standard energy consumption efficiency or calculation formula thereof
No. of pixels	Television receiver size	Dynamic image display	Additional function(s)	Category name	
		Liquid crystal quadruple speed or plasma	Other than the following	DH	E=6.6S-89
			With 1 function	DH1	E=6.6S-77
			With 2 functions	DH2	E=6.6S-65
			With 3 functions	DH3	E=6.6S-53
Others	Below 19 V size	Liquid crystal normal	Other than the following	DI	E=44
			With 1 function	DI1	E=56
			With 2 functions	DI2	E=68
			With 3 functions	DI3	E=80
		Liquid crystal double speed	Other than the following	DJ	E=59
			With 1 function	DJ1	E=71
			With 2 functions	DJ2	E=83
			With 3 functions	DJ3	E=95
	Not below 19 V size, but below 32 V size	Liquid crystal normal	Other than the following	DK	E=2.0S+6
			With 1 function	DK1	E=2.0S+18
			With 2 functions	DK2	E=2.0S+30
			With 3 functions	DK3	E=2.0S+42
		Liquid crystal double speed	Other than the following	DL	E=2.0S+21
			With 1 function	DL1	E=2.0S+33
			With 2 functions	DL2	E=2.0S+45
			With 3 functions	DL3	E=2.0S+57
		Liquid crystal quadruple speed or plasma	Other than the following	DM	E=2.0S+43
			With 1 function	DM1	E=2.0S+55
			With 2 functions	DM2	E=2.0S+67
			With 3 functions	DM3	E=2.0S+79
	32 V size or larger	Liquid crystal normal	Other than the following	DN	E=6.6S-141
			With 1 function	DN1	E=6.6S-129
			With 2 functions	DN2	E=6.6S-117
			With 3 functions	DN3	E=6.6S-105
		Liquid crystal double speed	Other than the following	DO	E=6.6S-126
			With 1 function	DO1	E=6.6S-114
			With 2 functions	DO2	E=6.6S-102
			With 3 functions	DO3	E=6.6S-90
		Liquid crystal quadruple speed or plasma	Other than the following	DP	E=6.6S-104
			With 1 function	DP1	E=6.6S-92
			With 2 functions	DP2	E=6.6S-80
			With 3 functions	DP3	E=6.6S-68

Remarks : 1. "FHD" refers to ones having 1080 or more pixels in the vertical direction and 1920 or more in the horizontal direction.

2. "Television receiver size" refers to the centimeter- denominated quotient, rounded at the decimal point, of division of the diagonal dimension of the driven display area of the display screen by 2.54.

3. "Dynamic image display" refers to or another of the following.

Liquid crystal normal: What uses a liquid crystal panel to display 60 or more but less than 120 still frames per second.

Liquid crystal double speed: What uses a liquid crystal panel to display 120 or more but less than 240 still frames per second.

Liquid crystal quadruple speed: What uses a liquid crystal panel to display 240 or more still frames per second.

Plasma: What performs displaying by using a plasma display panel.

4. "Additional function(s)" refers to DVD (solely those having a video recording function), HDD, double digital tuner and blue ray disk recorder.

5. E and S represent the following values, respectively.

E: Standard energy consumption efficiency (in kWh/year)

S: Television receiver size

Appendix 5.2 ENERGY STAR Test Method for Televisions

Source: U.S. EPA, 2011. "Energy Star Program Requirements for Televisions, Version 5.3." http://www.energystar.gov/ia/partners/product_specs/program_reqs/Televisions_Program_Requirements_V5_3.pdf?61a1-f457

ENERGY STAR® Program Requirements
Product Specification for Televisions

Test Method

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1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Televisions.

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation. The following guidelines shall be used to determine the applicability of each section of this document:

1) Test procedures in section 6 shall be performed on all products;

2) Test procedures in section 6.3 shall be performed on products without automatic brightness control (ABC) enabled by default;

3) Test procedures in section 6.4 shall be performed on products with ABC enabled by default;

4) Test procedures in section 6.5 shall be performed on products with download acquisition mode (DAM).

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Televisions.

4 TEST SETUP

A) Test Setup and Instrumentation: Test setup and instrumentation for all portions of this procedure 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, the ENERGY STAR test method shall take precedence.

B) Input Power: Input power shall be as specified in Table 1 or Table 2.

Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 1.0 %	2.0 %	50 Hz/ 60 Hz	+/- 1.0 %

Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater Than 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 4.0 %	5.0 %	50 Hz/60 Hz	+/- 1.0 %

C) Ambient Temperature: Ambient temperature shall be from 18 °C to 28 °C.

D) Relative Humidity: Relative humidity shall be from 10% to 80%.

Note: EPA has revised all references to IEC 62301 to refer to Edition 1.0. References to Edition 2.0 were included in previous versions of this specification, but as of this writing Edition 2.0 remains in draft status with IEC and has recently undergone substantial changes. EPA will revisit the use of references to IEC 62301 Ed. 2.0 in future versions of this specification.

E) Power Meter: Power meters shall possess the following attributes[1]:

1) Crest Factor:

i) An available current crest factor of 3 or more at its rated range value; and Lower bound on the current range of 10mA or less.

2) Minimum Frequency Response: 3.0 kHz

3) Minimum Resolution:

[1]Characteristics of approved meters taken from IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power.

i) 0.01 W for measurement values less than 10 W;

ii) 0.1 W for measurement values from 10 W to 100 W; and

iii) 1.0 W for measurement values greater than 100 W.

F) Measurement Accuracy:

1) Power measurements with a value greater than or equal to 0.5 W shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level.

2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

3) All power measurements shall be reported in watts and rounded to the second decimal place. For measurements greater than or equal to 10 W, three significant figures shall be reported.

5 TEST CONDUCT

5.1 Guidance for Implementation of IEC 62301

A) Testing at Factory Default Settings: Power measurements shall be performed with the product in its as-shipped condition for the duration of Sleep Mode testing, with all user-configurable options set to factory defaults, except as otherwise specified by the test procedure.

B) POD Modules: Optional POD modules shall not be installed.

C) Network Connection: Products that offer networking capability (e.g., Ethernet, WiFi) shall be configured with networking features deactivated.

D) Multiple Sleep Modes: If the product offers multiple Sleep Modes, the power during all Sleep Modes shall be measured and recorded.

5.2 Guidance for Implementation of IEC 62087 and CEA-2037

A) Testing at Factory Default Settings:

1) Power measurements shall be performed with the product in its as-shipped condition for the duration of On Mode testing, with all user-configurable options set to factory defaults, except as otherwise specified by the test procedure.

2) Picture level adjustments shall be performed per the instructions in IEC 62087, Ed. 2.0, Section 11.4.8.

3) Products that include a "forced menu" upon initial start-up shall be tested in "standard" or "home" picture mode. Products that do not include a forced menu shall be tested in the default picture mode. In the case that no "standard" mode or equivalent exists, the first mode listed in the on-screen menus shall be used for testing and noted in the test report.

B) Input Signal Accuracy: Follow guidance provided in Section 4.3 of CEA-2037.

C) Broadcast Test Materials: Follow guidance provided in Section 4.1 of CEA-2037.

D) True Power Factor: Due to increased awareness of the importance of power quality on the part of EPA and electric utilities, manufacturers shall indicate the true power factor of their sets during On Mode measurement.

E) Signal Input: If the UUT has an HDMI input, the HDMI input shall be used for display of test signals during testing. If HDMI is not available, then the component interface shall be used. The VGA interface shall not be used.

Note: EPA has added additional detail about the use of various signal inputs for testing.

F) Automatic Brightness Control: Follow guidance provided in Section 4.4.3.2 of CEA-2037.

G) Network Connection: Products that offer networking capability (e.g., Ethernet, WiFi) shall be configured with networking features deactivated.

5.3 Guidance for Implementation of CEA: Procedure for DAM Testing

A) The "Ideal" CEA: Procedure for DAM Testing is the preferred protocol for ENERGY STAR DAM testing, though the "Practical" protocol may also be used.

B) Energy consumption for all DAM functionalities, both frequent and infrequent, shall be declared on the data collection sheet.

C) Energy consumption from DAM functionalities meeting the definition of "infrequent" may be excluded from the calculation of total DAM energy consumption.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 Sleep Mode Testing

A) Sleep Mode power (P_{SLEEP}) shall be measured according to IEC 62301, Ed 1.0: Household Electrical Appliances – Measurement of Standby Power, with the additional guidance in section 5.

6.2 Luminance Testing

A) Luminance testing shall be performed in dark room conditions. Display screen illuminance (E) as measured with the UUT in Off Mode shall be less than or equal to 1.0 lux.

B) Luminance shall be measured perpendicular to the center of the display screen using a Light Measuring Device (LMD). A 500 mm measurement distance is recommended for LMDs that cannot be operated in close proximity to the screen.

C) The position of the LMD relative to the display screen shall remain fixed throughout the duration of testing.

D) For products with Automatic Brightness Control, luminance measurements shall be performed with ABC disabled. If ABC cannot be disabled, luminance measurements shall be performed with light entering directly into the television's ambient light sensor at greater than or equal to 300 lux.

E) Luminance measurements shall be performed per the following procedure:

1) Verify that the product is in the "home" picture mode, or the default as-shipped picture mode.

2) Immediately following the conclusion of On Mode power testing, begin to display the three-bar video signal specified in IEC 62087 Ed. 2.0, Section 11.5.5 (three bars of white (100%) over a black (0%) background).

3) Display the three-bar video signal for not less than 10 minutes to allow the display luminance to stabilize. This 10-minute stabilization period may be reduced if luminance measurements are stable to within 2% over a period of not less than 60 seconds.

4) Measure and record luminance in the home, or default as-shipped picture mode (L_{HOME}).

5) Within 1 minute of performing the measurement, set the television to "retail" picture mode, or the brightest-selectable preset picture mode.

6) Display the three-bar video signal for not less than 10 minutes to allow the display luminance to stabilize. This 10-minute stabilization period may be reduced if luminance measurements are stable to within 2% over a period of not less than 60 seconds.

7) Measure and record luminance in the retail, or brightest-selectable, preset picture mode (L_{RETAIL}).

6.3 On Mode Testing for Products without ABC Enabled by Default

A) On mode power (P_{ON}) shall be measured according to IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment; Section 11: Measuring Conditions for Television Sets in On (average) Mode; with the additional guidance in section 5.

6.4 On Mode Testing for Products with ABC Enabled by Default

A) On mode power in various lighting conditions for TVs with ABC enabled ($P_{o\_BROADCAST}$ and $P_{ABC\_BROADCAST}$) shall be measured according to IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment; Section 11: Measuring Conditions for Television Sets in On (average) Mode; with the additional guidance in section 5.

6.5 Download Acquisition Mode Testing

A) Energy consumption in Download Acquisition Mode (E_{DAM}) shall be measured per the CEA: Procedure for DAM Testing, with the additional guidance in Section 5.

1 SCOPE

This is the CEA Test Method for the determination of Download Acquisition Mode (DAM) energy consumption (E_DAM), as applicable to the ENERGY STAR Program Requirements for Televisions. The test procedure herein is applicable to any television using a DAM as defined in the ENERGY STAR Program Requirements document.

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3 REFERENCE DOCUMENTS

1. Energy Star TV Program Requirements – Procedure for DAM Testing
2. ENERGY STAR® Program Requirements for Televisions Eligibility Criteria Versions 4.2 and 5.1

4 Definition of DAM mode

In Energy Star 4.2, the EPA defines the following:

Download Acquisition Mode (DAM): Where the product is connected to a mains power source, is not producing a sound or a picture, and is actively downloading data, to include but not limited to, channel listing information according to a defined schedule for use by the electronic programming guide, TV setup data, channel map updates, TV firmware updates, monitoring for emergency messaging/communications and/or otherwise communicating through a network protocol. The power use in this mode is typically greater than the power requirement in Sleep and less than that in On Mode.

This test procedure introduces the following definitions:

Infrequent Download: Any DAM download that occurs no more than four times per year and has a duration of less than six hours per instance (i.e., total of less than 24 hours/year or 0.27%). Some examples of infrequent downloads are TV firmware updates, TV setup data downloads, and the Rovi EPG Setup State.

Frequent Download: Any DAM download that does not meet the definition of an Infrequent Download.

5 Qualifications to the DAM mode power usage

5.1 All frequent downloads must be included in the DAM mode power measurement. Note: All DAM functionalities, both frequent and infrequent must be declared, but those meeting the definition of infrequent can be excluded from the calculation of total DAM energy consumption (This declaration is so that the EPA is made aware of, and thereby has the option to evaluate the validity of, and test for the occurrences of, those downloads defined as infrequent.)

5.1.1. Downloads that happen at a frequency of less than once per day, but do not meet the definition of infrequent , must be averaged to come up with an equivalent daily value for the DAM measurement.

5.2 There are also various triggers for the initiation of a DAM sequence. It may be a daily trigger at a certain time of day (as an EPG download), or a TV power state trigger (as a clock update that is performed each time the TV "turned off" before it actually enters Sleep mode.) There are also other asynchronous external triggers possible. Daily triggers need no further discussion, a TV power state trigger will be assumed to happen five times per day. Asynchronous triggers must be estimated in good faith, conservatively towards the high side of expected occurrence. (Significant underestimation is clearly grounds for de-listing.)

6 DAM mode power measurement

To test for the power consumed in DAM, the Ideal or the Practical test method may be used.

6.1 Ideal

6.1.1 To ideally measure the DAM mode power consumption, the TV should be connected to power meter that measures the total energy consumed (E_TOTAL) and a signal source that can provide a signal containing the same type and amount or duration of data that the TV will acquire in its actual application DAM use. The following procedure should be followed:

1. UUT shall be connected to a power meter that will measure the total energy consumed over duration of the test.
2. A signal source shall be prepared that can provide a signal containing the same type and amount or duration of data that the TV will acquire over the course of an average 24 hour period. This signal shall include representative segments from all Frequent Downloads.
3. The energy consumption of the UUT shall be measured over a 24 hour period (E_TOTAL), during which the TV is turned on for 1 hour then turned off for 1.5 hours 4 times then turned on for 1 hour and off for 13 hours.
4. The following equation shall be used to derive the energy used in DAM (E_DAM):

E_DAM = E_TOTAL – (P_ON * 5 Hours) – (P_SLEEP * 19 Hours)

Where:

E_TOTAL – Total energy used by the UUT over a 24 hour period
P_ON – On mode power consumption
P_SLEEP – Sleep mode power consumption
Time_DAM – Average time spent in DAM per day

6.2 Practical

6.2.1 For practical measurement of DAM mode power consumption, it can be verified that the E_DAM can be calculated by simply multiplying the instantaneous (P_DAM - P_SLEEP) by the time in DAM mode. The following steps should be followed:

1. The TV shall be connected to a power meter and power source.
2. The TV shall be connected to an appropriate signal source for communicating with the DAM function being tested.
3. The signal which causes the TV to activate the DAM function should be applied.

4. Confirm that the TV has activated the DAM function and is communicating with the DAM signal source as appropriate for the DAM function being tested.
5. Record "P_DAM" (watts) power consumption in DAM using the power meter.
6. Confirm "Time_DAM" (hours) time of DAM per day, and calculate "E_DAM" by
   the following equation:
   E_DAM = (P_DAM - P_SLEEP) x Time_DAM
7. If there are different DAM functions for the same TV, repeat steps 1 through 6 for each DAM function. In this case, the total E_DAM is calculated:

   E_DAM = SUM((P_DAM – P_SLEEP) x Time_DAM)

   Where:

   P_SLEEP – Sleep mode power consumption
   P_DAM – DAM power consumption for each DAM function
   Time_DAM - Time spent per day in DAM for each DAM function

6.3 Verification

6.3.1 The average time per day spent in DAM mode is easily estimated and easily verified by connecting the TV into its intended application and monitoring the energy usage. It is self evident when the TV is in On mode. When the TV is off and drawing less than 1W it must be in Sleep mode, and when it is off and drawing more than 1W, it must be in DAM mode. The verification should be repeated for several days in case a less frequent download occurs on one day.

7 Connection Diagram