Northeast Energy Efficiency Partnerships

Advanced Power Strips Test Protocol

Version 0.1
Recommendations from the
Northeast Energy Efficiency Parternships (NEEP)
Testing Group to Assess the
Functionality and Usability of Residential APS

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PREFACE

Advance Power Strips (APS) are relatively new devices designed to deliver energy savings for common electronics in residential and commercial environments. They come in a number of different designs and configurations, and can be connected to many combinations of appliances.

To accelerate the inclusion of APS in utility Demand-Side Management (DSM) or government efficiency and rebate programs, a better understanding of their energy saving potential is required. Existing studies focus exclusively on market research and occupant behavior data, so the savings estimates do not account for how well the technology works. While these works provide key statistics that inform predictions of how much energy is available to be saved, they do not address the technical capabilities of specific APS products or product categories. To close this gap, a rigorous and standardized assessment of APS performance is needed to speed their adoption in the market place.

In June 2010, the Northeast Energy Efficiency Partnerships (NEEP), New York State Energy Research and Development Authority (NYSERDA), and Efficiency Vermont (EVT) jointly sponsored a Consumer Electronics / Plug Load Summit in Albany, New York. The event brought together key stakeholders in energy-efficient consumer electronics programs to discuss strategies for optimizing energy savings through application of APS technology. The event was attended by more than 60 stakeholders, including efficiency program managers and evaluators, APS manufacturers, and state and federal policy and regulatory interests. A key result of the meeting was the formation of a NEEP-led APS Working Group (WG), which was tasked to formulate an assessment method for APS devices. The WG includes a diversity of stakeholders, from manufacturers, utility program managers, research institutions including the National Renewable Energy Laboratory (NREL), and policy makers.

The testing and approval of APS devices for energy efficiency programs require a robust and repeatable test methodology, suited to all possible APS designs and operating environments. This laboratory testing procedure is intended to encourage further development of APS technologies by delivering an assessment methodology that promotes ease of use. Our goal is to help drive the market towards improving the cost-benefit analysis for APS devices as opposed to favoring the least expensive APS device that may not yield the best return on investment.

This Test Protocol was originally crafted by the Testing Subcommittee of the APS WG but has also been reviewed by the larger APS WG participants. This report reflects the opinions and judgments of the NEEP staff and the APS WG, and does not necessarily reflect the opinions and judgments of NEEP board members, NEEP Sponsors, or project participants and funders.

This document is one component of the overall effort of the NEEP APS WG to formulate a robust assessment methodology of APS to attain confidence in the energy savings potential of these devices. The sole purpose of the Test Protocol is to define a set of procedures that, when executed, provide quantitative data on the technical functionalities of each APS. The uniform metric applied to all test samples allows objective comparison of each feature across all products.

The Test Protocol is <u>not</u> an attempt to:

- determine preferred control strategies or algorithms,
- recommend particular products or brands, or
- make qualitative assessments of the relative merits of various features and functionalities.

The ultimate figure of merit for any product or system designed as an energy-efficiency measure is the amount of energy that can be saved by its successful implementation. In the case of APS, this "deemed savings" number is a complex function of the use-case scenario, consumer acceptance and persistence, and reliability of technology. Datasets obtained using this Test Protocol should be combined with results from market research and plug-load data from field studies to assess the cost-performance characteristics of any APS technology.

LIST OF ABBREVIATIONS

AHEM	Automated Home Energy Management
APS	Advanced Power Strip
AV	Audio-Visual
DSM	Demand-Side Management
EVT	Efficiency Vermont
MEL	Miscellaneous Electric Load
MPS	Mains Power Switch
NEEP	Northeast Energy Efficiency Partnerships
NREL	National Renewable Energy Lab
NYSERDA	New York State Energy Research and Development Authority
PC	Personal Computer
WG	Working Group

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1. OVERVIEW OF ASSESSMENT

This document outlines the testing process for assessing the functionality and usability of Advanced Power Strips (APS) for use in residential applications: either personal computer (PC) and/or audio-visual (AV) environments. It is intended as a guide for Regulators, Utilities and other interested parties to assess the performance of individual APS devices.

As a complementary effort to the development of this Test Protocol, the NEEP Data WG collected results from existing studies to determine the energy saving potential of APS as a general class of technology (NEEP Data Working Group 2012). Their analysis, combined with the results of this test, should give a starting-point estimate for the energy savings potential for any specific APS product.

1.1 Assessment Process

The objectives of the Test Protocol are to outline the types of APS that were considered by the NEEP WG and define a standard way to compare their basic operation. While there are a variety of controls employed by different APS products, the Test Protocol defined here is limited to APS that include load sensing in their control algorithms. Other requirements include a UL listing and a threshold for maximum standby power consumption. The full eligibility criteria are discussed in Section 2. The second part of this Test Protocol is the laboratory assessment that runs each APS through a standard test procedure to assess their functionality and usability. The functionality assessment is designed to ensure that the power strip works as intended, but it does not promote specific features or types of APS. The usability assessment categorizes the amount of user interaction required to set up and use the APS.

1.2 APS Control Strategies

Advanced power strips include a wide variety functionalities designed for different scenarios. Most APS are designed to be installed in home offices or home entertainment centers as there are high concentrations of plug loads in these areas. The following table lists the most common control strategies employed by APS and includes a description for each, adapted from Earle and Sparn (2012). This should not be considered a complete list as this is a rapidly developing technology. It should also be noted that some devices will fall into multiple categories.

Table 1. Description of the different control strategies employed by APS

Category	Control Strategy
Current-Sensing	Current-sensing APS monitor the current draw of the controlled outlets to determine when the connected devices are not turned on. Supply power to the controlled outlets is then shut off. Some action must be taken to restore power to those outlets. In an AV setting, an infrared (IR) signal is usually used to 'wake up' the power strip. For PC use, there is typically a button on the power strip that must be pressed by the user. The algorithm used by the APS to determine when the controlled appliances are off varies. Some look at peak power use for all the connected devices and shut off the supply to all outlets when the total power has dropped by a set percentage. Others monitor smaller groups of outlets and control each group independently.

Infrared (IR)-Remote	There are two ways that IR sensing can be used to control a power strip. A simple IR-controlled power strip uses the IR signal to activate a switch that turns the controlled outlets on and off; in this case the device is basically a traditional power strip with a remote switch. IR sensing can also be coupled with a current-sensing power strip. In this case, the IR signal is used to 'wake up' the power strip and restore power to the controlled outlets. Some IR detectors must first be paired with the IR signal from the user's remote; others can detect IR signals from any remote.
Master/ Controlled	Master/controlled power strips use the power state of the 'master' appliance to determine whether the supply power to 'controlled' outlets (or peripheral devices) should shut off. The master is typically the TV or computer, which is plugged into a special outlet that does not turn off. The peripheral devices are items such as DVD players or computer monitors. The controlled outlets are powered only when the master appliance is in use. Most master/controlled power strips use current sensing to determine power state of master device. Some power strips designed for home office environments rely on a USB connection to the computer to determine the power state of the computer, which is described in more detail below.
Motion-Sensing (Occupancy -Sensing)	Motion-sensing power strips turn off the controlled outlets when no nearby motion has been detected for some period of time. Unlike many APS's that target standby energy use, these power strips turn off power to appliances when they are no longer in use (assuming that motion is a good indicator of use). The motion sensor is typically connected to the power strip via a long cable so that the sensor may be located in the best place for occupancy detection. The occupancy sensing can include a more complex suite of sensors than just motion.
Remote Switch	The on/off switches on traditional power strips can be inconvenient to access if they are located behind entertainment centers or under computer workstations. Remote switches typically use IR or radio signals to allow users to turn outlets on or off remotely. Some products feature a subset of remotely controllable outlets on an otherwise conventional power strip.
Timer-Controlled	Power strips with a timer switch can be programmed to shut off supply power during periods of time when the user knows the appliances will not be needed. They typically have some controlled and some 'always-on' outlets. The primary advantage of the timer-controlled solution is that users do not need to remember to switch off their power strips. For enhanced automation, this feature can also be incorporated into current-sensing power strips, where the timer starts counting down once the appliance is determined by the APS to be in the off state.
USB Power-Sensing	This is a variation of the master/controlled approach that uses a USB cable rather than current sensing to determine the power state of the master appliance. Designed for PC use, these power strips rely on a USB sensor that must be plugged into one of the computer's USB ports. Some plugs are remote; others are physically tethered to the power strip. Power supply to peripherals is shut off if the computer is determined to be in an unused state.

Of the different types of APS listed above, the motion-sensing power strips were excluded from this Test Protocol since their performance is based primarily on how well the motion sensor works. Motion sensing control may be a good solution for some consumers, but testing the performance of motion sensing APS would be equivalent to testing the motion sensors, and that is not the intent of this Test Protocol. Similarly, the timer-controlled APS and remote switch APS do not contain automated controls, so they also are not covered in this Test Protocol. All three of these APS types can be effectively used to manage plug load energy use in the right situation but they are outside the scope of this Test Protocol. The remaining APS all have automated controls that include some form of current sensing.

1.3 Laboratory Assessment

The laboratory assessment is used to validate that the APS device meets all minimum technology and performance requirements. The laboratory assessment also includes the tests needed to determine Functionality and Usability Scores for each product. The goal is to verify that the products work as intended and to determine how much user interaction is required for correct operation.

As with many other automated home energy management (AHEM) products, usability can directly impact persistence. Programmable thermostats are a classic example of devices that can have very poor usability, which can result in little to no energy savings. In the case of APS, there has not been enough research to correlate usability challenges with lower energy savings, but usability is certainly a concern for consumers and efficiency programs alike. For this reason, the laboratory assessment determines a Usability Score in addition to a Functionality Score for each APS, so that the level of user interaction required to use the APS as intended can be compared across products.

1.4 A Note Regarding Tier 1 vs. Tier 2 APS Classification

There are a wide variety of control strategies employed by APS; some are fairly simple while others are more complex. As such, a distinction between the simpler APS (Tier 1) and the more complex (Tier 2) has emerged. To date, strict definitions that distinguish the two tiers have not been established, and this Test Protocol is agnostic whether the APS being tested is a Tier 1 or Tier 2 product. Generally, Tier 1 products have simpler controls that target passive or standby loads, and Tier 2 products have more complex control algorithms that aim to curb standby loads and some active load waste. The additional controls found in Tier 2 products may deliver higher energy savings but are still an emerging technology, so field studies are needed to quantify their energy savings potential. It is also possible that the energy savings potential for Tier 2 products cannot be generalized due to the diversity of control schemes employed by different product manufacturers.

2. ELIGIBILITY ASSESSMENT

The following list of requirements has been agreed on by the NEEP APS WG as the eligibility standards for APS that are tested using the procedures described in this document. Before any laboratory testing is done, the eligibility of the APS should be first assessed:

1. For a power strip to be considered an APS, it must have a feature that enables automatic shutting off of the supply power to unused appliances based on some form of current sensing.
2. The APS must connect and reconnect power according to the product specifications.
3. The APS must not use motion sensing to turn the controlled outlets on and off (See Section 1.2).
4. All products must comply with UL 1449 (Surge Protective Devices) and UL 1363 (Relocatable Power Taps) Standards. These are the same UL requirements for standard surge protection power strips.
5. The main power switching device must be rated for 100,000 switching cycles at full load (roughly equivalent to 10 years of use). It may be necessary to request this information from the manufacturer if not indicated on the product specification sheet.
6. The APS consumes 1 Watt or less at all times.
7. For APS that are applicable to PC environments, the APS must be suitable for use both desktop and laptop computers.

8. For APS that are applicable to AV environments, the APS must be suitable for use with all types and sizes of televisions.

3. LABORATORY TEST PROCEDURES

3.1 Setup for Laboratory Test

The laboratory test will evaluate the performance of the APS in an environment that mimics the home office or home entertainment center. A variety of master appliances should be tested in each environment to ensure that the APS is sufficiently adaptable. The specific setups for both the PC (home office) and AV (home entertainment center) environments are described in more detail below.

The general setup for testing any APS is similar to how the APS would be set up for use in a home, but with power meters included so that the power draw of all the connected devices can be monitored. A diagram of a possible configuration for the AV environment is shown in Figure 1 as one example. The setup in the PC environment is similar. Power meters are to be placed at the following locations:

- Upstream of the APS: Measure power consumption of the APS and all connected devices.
- Downstream at master device: Measure power consumption of the master appliance (computer or TV) alone.
- Downstream at peripherals: Measure power consumption of all controlled appliances. This can consist of multiple power measurements or a single measurement if all peripherals are plugged into single power strip and then plugged into the APS.

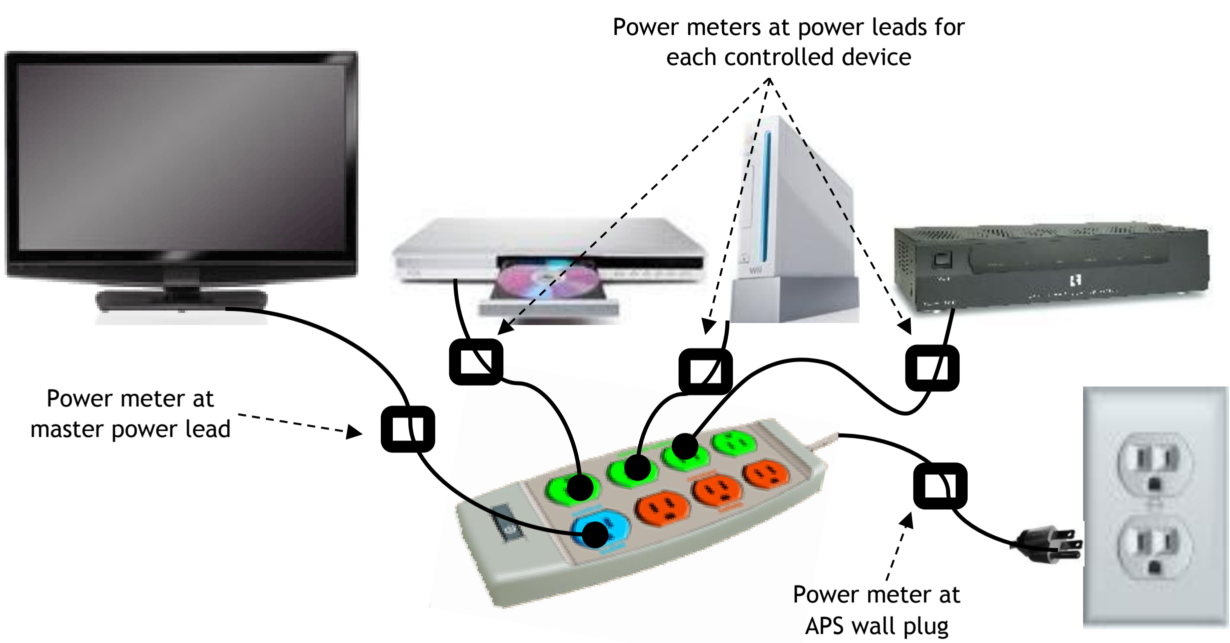

Figure 1. Diagram of AV setup including all points where power is measured

This configuration for monitoring power consumption allows the researchers to determine when peripherals are turned on and off and if this is consistent with the manufacturer's specifications. By measuring the total power consumption of the APS and all the connected devices, the power consumption of the APS alone can be calculated. All data should be logged at 1 second intervals throughout the tests.

3.1.1 Setup Details for PC Environment

Many APS devices can be used in both the PC and AV environment and if that is the case the user manual should indicate that. Any APS that claims to be suitable for use in the home office should be tested in the PC environment. To ensure that the APS is compatible with common computer configurations, it should be tested with a minimum of one laptop and one desktop. The laptop test should be repeated for a fully charged and partially charged battery scenario. So the three minimum configurations are:

- Laptop computer (battery installed and fully charged, connected to power supply or dock)
- Laptop computer (battery installed and 15%-25% charged, connected to power supply or dock)
- Desktop computer

Computers used in the tests should be no more than three years old. These requirements should be considered the minimum. It is recommended that the tests use as many different models of computers as time and budgets permit.

The master computer and a minimum of three controlled peripherals must be plugged into the APS, in a manner consistent with the manufacturer's instructions. Peripheral appliances for the home office include devices that are typically used with the computer, such as monitors, printers, scanners, and speakers.

3.1.2 Setup Details for AV Environment

Any APS that claims to be suitable for use with an entertainment center should be tested in the AV environment. To ensure that the APS is compatible with common television configurations, it should be tested with a minimum of three different master televisions, including the following:

- one Plasma screen
- one LCD screen, and
- one LED screen.

All televisions used in testing should be no more than three years old at the time of testing. These requirements should be considered the minimum. It is recommended that the tests use as many different models of televisions as time and budgets permit.

The TV and a minimum of three controlled peripherals must be plugged into the APS, in a manner consistent with the manufacturer's instructions. It is more common to see APS that do not conform to the master/controlled configuration in the AV environment, so care needs to be taken to ensure that the APS and all the controlled devices are connected correctly. Peripheral appliances for the home entertainment center include devices that are typically used with the master, such as a DVD player, game console, stereo amplifier, and speakers.

3.2 Scoring Method

Each APS is given a separate Usability and Functionality Score based on results of the laboratory tests.

A Usability Score is determined for each APS, with higher scores (a score of 5 being the highest) indicating that fewer interactions are required. Usability is a paramount concern for consumer acceptance and persistence. If the APS demands too many changes in the way users normally operate their appliances, they will be more likely to replace it with a standard surge protector. If the APS requires too much action from the users to reduce energy consumption, then the users are less likely to go through the required motions consistently. The Usability Score considers four test categories: ease of APS setup and installation, equipment usability when connected to the APS, degree of automation used to achieve energy savings, and ease of future configurability. In this first version of the Test Protocol the Usability Score treats each category equally, but for future revisions we plan to explore a sensible weighting system so that the interactions that have the most impact on long term retention are emphasized in the scoring method. For example, there may be a difference in adoption rate if a user must change how she turns on her TV every day, an action that requires a change in habit, compared to if she has to perform one extra task during the initial setup. A required habit change may make the APS less likely to be used consistently and for the long term.

Separately, the Functionality Score reflects whether the APS performed as expected, per the manufacturer's user manual. If the user manual describes additional controls that the baseline tests outlined here do not address, additional tests may be designed as needed to verify other functionalities. The Functionality Score does not provide an assessment of the suitability of the controls employed; it simply indicates whether the APS behaves as expected. Higher scores indicate better performance. Starting with a perfect Functionality Score of 5, a point is deducted each time the APS does not respond as expected (e.g. supply power is not restored as desired, standby mode is not detected). Expected operation is based on the descriptions given for each product in its user manual so it varies for different products.

A perfect score in both usability and functionality means that no additional setup or operational steps are required and that the device functions as expected in all cases.

3.2.1 Usability Tests

The usability tests are used to create a Usability Score for the APS in the applicable environments (AV, PC or both). The Usability Score reflects the amount of interaction required to use the connected appliances and realize the potential savings. A Usability Score of 5 indicates that the user does not have to do anything different than they would with a standard power strip. There are four categories that affect usability:

1. Installation and Setup
2. Connected Equipment Usability
3. Degree of Automation
4. Future Configurability

We recognize that there is a level of subjectivity in determining the usability of an APS in each category. Rather than following a prescribed test procedure, usability testing involves setting up the APS according to the manufacturer's instructions and using the connected appliances in a typical fashion.

To evaluate usability, record the answers to the following questions in each category.

Installation and Setup

1. After plugging the appliances into the appropriate receptacle, are there any other required steps during installation?
2. Are there any optional setup steps, such as adjusting a threshold dial or switch?
3. When installation is complete, does the APS behave as expected or are more adjustments needed?

Connected Equipment Usability

1. Are there any changes to how the master appliance can be turned on (if master/controlled APS)?
2. When using the master appliance with peripherals, are there any changes to the operation of the peripherals (if master/controlled APS)?
3. Does the user need to do anything to “wake up” the APS before one or more connected appliances will turn back on?
4. Is the functionality of remote controls for any of the appliances changed in anyway?

Degree of Automation

1. Does the user have to do anything to shut off the supply power to the controlled outlets?
2. Does the APS shut off power to the peripherals within 5 minutes of the master appliance turning off?

Future Configurability

1. When switching out the master appliance with another model (e.g. laptop vs. desktop computer, plasma vs. LED TV), are there any settings that must be adjusted for the new configuration? This should only include settings that are sufficiently complicated that the user would need to consult the user manual. Manually adjusting the switching threshold should not be counted against Future Configurability.

If, according to the user manual, there are control features that may not be triggered by simply turning on the appliances and using them for a few minutes, the usability testing provides a good opportunity to test out these features. All control features should be tested to ensure that they work as expected and to understand the usability of those features.

3.2.2 Functionality Tests

The functionality tests run each APS through a series of standard tasks to test the functionality and repeatability of the controls, and the results are used to generate a Functionality Score for the APS. A perfect Functionality Score implies that the APS behaves as expected in all situations.

The test procedures for master/controlled APS are described by the Standard Procedures for Functionality Tests (Section 3.2.2.1) because master/controlled is the most common type of APS. Other configurations are addressed in Section 3.2.2.2, but the list is not exhaustive. The test process outlined here should be sufficiently thorough to discover any control deficiencies for common configurations. To test the functionality of APS controls and configurations not addressed in Section 3.2.2.2, the researcher must modify the test instructions as needed to incorporate the functionality of the APS under test.

3.2.2.1 Standard Procedures for Master/Controlled devices:

The test procedures for the AV and PC environments are described below. If there are procedures specific to one environment and not the other, that distinction is noted. The master device for the AV and PC environments is the TV and the computer, respectively.

1. First On-Mode test:

a) Turn on the master device and allow its power consumption to reach steady state. In the AV environment, use the remote to turn the TV on.
b) Turn on all peripherals and allow them to reach steady state power.

c) Use the master device for a minimum of 3 minutes by performing a series of short tasks such as playing a DVD (AV environment) or editing files (PC environment).
d) While the master appliance and peripherals are actively operating, record power consumption data from all power meters. This will be used to calculate active power consumption of the APS.

2. Off-Mode test:

a) After at least 3 minutes of operation, turn the master device off. In the AV environment, use the remote to turn the TV off.
b) Record the time delay for the APS to disconnect power to the peripheral appliances after the master device has turned off.
c) Once the master appliance and peripherals have turned off, record power consumption data from all power meters for 2 minutes. This will be used to calculate off state power consumption of the APS.

3. Second On-Mode test:

a) After all the devices have been off for a few minutes, turn the master device back on. In the AV environment, use the remote to turn the TV on.
b) Record the time delay for the APS to reconnect power to the peripheral appliances. Note that some appliances will not turn back on by themselves.
c) Use the master device for a minimum of 3 minutes by performing a series of short tasks such as playing a DVD (AV environment) or editing files (PC environment).

4a. Sleep Mode test (PC Environment Only):

a) After the Second On-Mode test and the computer and peripheral appliances have been on for 3 minutes, force the computer to enter Sleep (or Standby) Mode.
b) Record whether the APS shuts off supply power to the peripheral appliances. If it does, record the time delay required.
c) Wake the computer up to bring it out of sleep mode.
d) Record the time delay for the APS to reconnect power to the peripheral appliances.

4b. Black Screen Test (AV Environment Only):

a) When a TV screen turns black, the power consumption drops substantially and can cause some master/controlled power strips to shut off power to the controlled outlets. The easiest way to prompt this behavior is to play a DVD from the beginning; usually a black screen appears after the previews and copyright warnings. Record whether the black screen prompts the APS to shut off power.

5. Turn the master device and all the peripheral appliances off.

6. Repeat Steps 1-5 two more times.

a) Be sure to note any changes in behavior of the APS from one series of tests to the next.
b) All APS should be tested using the same test procedures with all master devices for each environment. If an APS can be used in both AV and PC environments, it should be tested with all master appliances in both environments.

3.2.2.2 Alternate Procedures for Non-Master/Controlled devices:

Current-Sensing APS - These APS devices monitor the total power consumption of all the controlled outlets and when that drops by a certain amount, the controlled outlets are turned completely off.

There is no master device. To restore power to the controlled appliances, the user must press a button on the APS (in the PC environment) or press a button on the TV remote (AV environment).

1. **First On-Mode test:**
   To begin the test, "wake up" the APS by pressing the wake button (PC environment) or by using the TV remote (AV environment). This should prompt all of the connected appliances to turn on. The First On-Mode test then proceeds as described in Section 3.2.2.1.

2. **Off-Mode test:**
   The APS turns the controlled outlets off when the power consumption of the connected appliances drops by a certain amount. Begin the Off-Mode test by turning off all the controlled AV equipment. Depending on the appliance arrangement, it may be useful to experiment with the power states of the controlled appliances to see what combinations will trigger the power strip to turn off. At a minimum, turning off all connected appliances should trigger the APS to shut off the supply power.

3. **Second On-Mode test:**
   "Wake up" the power strip using appropriate method and proceed with Second On-Mode test.

4a. **Sleep Mode test (PC environment only):**
   Begin the Sleep Mode test by setting the computer to enter sleep mode. If possible, the other connected appliances, such as a monitor, should also be allowed to enter sleep mode. At a minimum, with both computer and monitor in sleep mode and all other appliances off, the power strip should shut off the controlled appliances.

4b. **Black Screen test (AV environment only):**
   This test should not be necessary with current-sensing APS, since the control is based on more than just the power draw of the TV.

5. **Turn the master device and all the peripheral appliances off.**

6. **Repeat Steps 1-5 two more times.**

The above basic procedures may need to be modified for APS that employ other control strategies. Because of the diversity of products on the market it is not feasible for this Test Protocol to address in detail all possible configurations.

3.3 Scoring

3.3.1 Usability Score

Following the usability tests, a Usability Score is tallied for each applicable environment. If an APS is intended for use in both the AV and PC environments, it will receive two separate Usability Scores. For each environment, the Usability Score is tallied as follows:

- Start with perfect score of 5.
- Subtract 1 point for each additional step required in the initial set up beyond simply plugging the appliances into the receptacles (e.g. need to adjust threshold, need to pair with TV remote).
- Subtract 1 point for each additional step required to operate the equipment (e.g. waking the power strip by pressing a button before the master appliance is turned on).

- Subtract 1 point for each further adjustment or setup changes required to reconfigure APS when appliances are changed out, keeping in mind as described in 3.2.1, this should only include settings that are sufficiently complicated that the user would need to consult the user manual. Manually adjusting the switching threshold should not be counted against Future Configurability.

3.3.2 Functionality Score

Following the functionality tests, a Functionality Score is tallied for each applicable environment. If an APS is intended for use in both the AV and PC environments, it will receive two Functionality Scores. For each environment, the Functionality Score is tallied as follows:

- Start with a perfect score of 5.
- Subtract 1 point for each instance of incorrect response (e.g. supply power not restored as desired, standby mode not detected).

A perfect score in both usability and functionality means that no additional setup or operational steps are required and that the device functions as expected in all cases.

3.4 Test Report

Record the following information in the test report:

- Details of all monitoring equipment used, including calibration dates.
- Details of all appliances used, including manufacture dates.
- Pictures of the test setup for both the AV and PC environments, if applicable.
- A time series graph that is representative of the operation of the APS. Note the operating mode of the master device and where the APS switching events occurred.
- Report the time needed for the APS to disconnect power from controlled appliances. Is the time less than 5 minutes?
- Report the time needed for the APS to reconnect power for controlled appliances. Is the time less than 10 seconds?
- Report the average power consumption of the APS when the controlled devices are switched off. Is it less than 1 W? Also report power consumption of the APS when the controlled devices are on.
- If any test procedures are modified to accommodate the specific technology found in the APS, note those changes in the report.

4. SUMMARY

This document outlines a Test Protocol that is intended to be used for objective comparison of the functionality and usability of different APS products.

Despite the fact that APS have been on the market for years, there have not been many technical assessments of APS to date. There are many questions about their operation and cost-effectiveness. As a basic first step, the laboratory assessment described in this document evaluates each APS relative to its intended functions. A Functionality Score indicates how well the actual operation of the APS matches its specifications. This information can then be combined with the Data WG's energy savings analysis to develop a range of "deemed savings" possible for a particular type of product.

5. RECOMMENDATIONS AND NEXT STEPS

This Test Protocol evaluates the basic functionality of APS but cannot evaluate the nuances to operation that occur in actual installations. To date, there have been relatively few field trials of APS with publicly available results. More field trials would be helpful when evaluating user preferences and their experience with different types of APS, including Tier 2 technologies. Studies that include APS installed in occupied homes will also help determine if the estimated energy savings is consistent with actual energy savings on average.

While efficiency programs each have their own goals and parameters for selecting products to promote, we recommend that programs initially promote products that receive a perfect (5) Functionality Score and a Usability Score of 4 or higher. There are effective products that do not meet these standards, but this restriction helps to ensure that the products are easy to use and reliable. As efficiency programs become more familiar with the variety of products on the market, the score requirements may be relaxed. Efficiency programs may also wish to consider incentive programs that include the direct installation of APS. Although APS are designed to be self-installed, direct installation may ensure that the APS are installed, and installed correctly.

It is important to consider consumer preferences and needs as APS technology continues to evolve. Different types of APS are designed for different purposes and connecting each user with the right APS to suit his needs will increase persistence. The differences in application should be emphasized on the packaging or on labeling in the stores. All APS packaging should make clear what the APS does and what problem it is designed to correct, since consumers currently know very little about APS technology. This Test Protocol should be considered a first step towards increasing programmatic success and consumer adoption of APS technology. Additional work and partnership between efficiency programs, industry, and advocates is necessary to determine what appropriate next steps can be taken to build off of the exiting APS work and have continued success in this space.

6. WORKS CITED

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