NORTHERN ARIZONA UNIVERSITY

Reduction of Harmonic Distortion in Off-Grid Renewable Energy Systems

Project Requirements and Specifications

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Requirements and Specifications

Following is a set of requirements and specifications for the project that ensure it will meet the needs of the client, Dr. Allison Kipple. Specifications listed as “ideal” are the performance goals for the team, but may not be feasible. For this reason, “acceptable” specifications are given. These specifications must be met if not exceeded. These specifications have not been altered since the original project description was submitted.

Mechanical

The device created by the team must be able to plug into a standard North American AC outlet. It must also have a standard North American input. The actual circuit must be contained in a 'small' box, and this box will have mounting brackets attached to help provide a user with more placement options. Since this product is designed for household use, it must be child proof and pet proof. That is, the device should be safe and tamper proof. The specifications for weight and size of the product can be found in Table 1.

Table 1: Table of mechanical specifications.

	Size	Weight	Outlets (Output)	Outlets (Input)
Ideal	5''x5''x5''	5 lbs	4	1
Acceptable	1'x1'x1'	20 lbs	1	1

Electrical

Any appliance which can be plugged into a standard North American wall outlet must operate as expected when the device is being used to reduce the appliance's THD, and as such, a wide range of currents must be able to pass through the device. The THD reducing effect of the device must consistently reduce the THD of any appliance attached by at least 25%. In order to protect against current surges, the device will feature a simple fuse as they are less expensive than circuit breakers. A table of additional electrical specifications can be found in Table 2.

Table 2: Table of electrical specifications.

	Voltage Range	Current Range	Lifespan	THD Reduction
Ideal	110-130 V RMS	>30 A	10 Years	25%
Acceptable	115-125 V RMS	>20 A	5 Years	15%

Environment

The device is designed for indoor use, but should be rugged enough to operate in hot, humid climates as well as cold, dry climates. To ensure proper operation in humid conditions the product must be moisture resistant. Furthermore, minor perturbations (e.g. small vibrations, falls from distances of less than 2 feet) should not damage the device by impairing its ability to operate effectively or negate its moisture resistance. Environmental specifications can be found in Table 3.

Table 3: Table of environmental specifications.

	Size	Weight	Outlets (Output)	Outlets (Input)
Ideal	5''x5''x5''	5 lbs	4	1
Acceptable	1'x1'x1'	20 lbs	1	1

Documentation

Documentation provided includes a user's manual that must detail which appliances will benefit from using the device (i.e. which appliances are non-linear loads). In addition, the manual will have safety precautions and a troubleshooting guide. Furthermore, the device will have information regarding input/output voltages, currents, frequencies and any other relevant electrical information imprinted, as is standard with many electrical products. Finally, as mentioned in the mechanical section the device will be designed to be tamper proof, therefore the team expects no maintenance manual to be offered.

Miscellaneous

In addition to the THD reducing device, the team will also give the client a short report on the effect of using capacitors and super-capacitors to mitigate transients in off-grid battery systems. The data from this report will be gathered by the team during the Spring, 2013 semester at various off-grid homes using equipment provided by the client. In order to fully study the topic, test will be done at least two houses. If possible, more houses will be tested, particularly those with more modern inverter topologies.

Testing

In order to ensure that the product reduces THD, a power quality meter will be used to measure THD for a range of devices with and without the product. The power meter will be supplied by the client and appliances tested will be those commonly found in off-grid households. The devices to be tested are a refrigerator, CFL light bulbs, a washing machine, a vacuum cleaner, and a microwave oven. More appliances may be added as the project goes on. These appliances will be supplied by Northern Arizona University and will be tested first when connected to a conventional power grid. After the product has been shown to be successful, the appliances will be tested again in an off-grid system.