

Ample Power Company



Ample Power Support

Editor's Note: This article was first published in August, 1990. The second part of the article deals with microwave oven efficiency using so-called modified sine waves.

In the 1960s we discovered that popcorn kernels in a brown bag could be popped in a microwave oven. It was quickly apparent that cooking time was critical ...a little too long made charcoal. To have a specific cooking time meant that the amount of popcorn kernels always be the same. That was no problem ...just use a measuring cup. This didn't completely solve the problem, however. Some days my kernels-to-time ratio worked perfectly. On other days there would be little popped corn, or lots of smoke. With kernels from the same bag, the only difference could be the AC input voltage, and so it was.

Recently we had reason to revisit the issue of AC voltage and microwave cook times. What got us started this time was making popcorn with an inverter driving the microwave. How sensitive is a microwave oven to AC voltage? A simple experiment could answer that question, so we gathered up the necessary gear.

The oven is a unit made by Sunbeam Appliance Company. Its label indicates a draw of 1.45 kilo-Watts. Since it also has a toaster/broiler element, we can't be sure that the rating applies to the microwave portion itself, but that isn't material in the outcome. Below we calculate its cooking power anyway. Other apparatus for the experiment consisted of a postage scale, a digital meter that measures AC with true RMS methods, a digital meter that measures temperature, a paper coffee cup, a variable transformer, and a couple gallons of water. The variable transformer was hooked up to the normal AC line.

The experiment itself was pretty simple. Put a known weight

of water in the paper cup. Measure its temperature. Put the covered cup into the oven for a fixed time, at a given AC input voltage. Measure the water temperature again to determine how much heat the water has absorbed. The paper cup held 11 ounces with room to spare. Three minutes at 125 VAC input didn't bring it to a boil, so there were no latent heat effects to worry about.

Heat is measured in British Thermal Units, or Btu. Raising one pound of water, one degree Fahrenheit is one Btu of heat. For the most part, the water went into the microwave at about 71 F. Depending on voltage, it came out between 146 and 172 F. We took heating measurements at 100, 105, 110, 115, 120, and 125 VAC. Two measurements at each voltage were close enough that we considered two to be sufficient for our purposes and we averaged the two for each voltage. The graph shows the results. As the graph shows, heating performance is quite dependent on the AC input voltage. There is about 21% difference between 52.2 and 66.30 Btu, and about that difference in the voltages for those outputs. As the plotted data shows, the effect is not exactly linear, with a large loss occurring between 110 and 105 Volts.

We measured the input current during cooking to discover that the oven draws a little over 650 Watts. To deliver 60 Btu in 3 minutes requires about 350 Watts in a straight engineering conversion, thus the microwave is a little over 50% efficient. This is probably typical of microwave ovens.

All in all, we didn't turn up any surprises. With the normal sinewave AC line voltage, microwave performance went up and down with voltage. What about the shape of the AC line? How does a quasi-sinewave stack up against a sinewave? Will the microwave oven work better or worse from an inverter? We'll report on the results of that experiment in the next issue.

