

## **Small Generator Voltage Regulation and Electronic Voltage Regulators**

We are all used to connecting electrical equipment to the local utility and getting all of the power that our equipment demands. That's because the utility is part of a grid that is powered by generating plants with combined capacities measured in hundreds of millions of kW (kilowatts). Even a large industrial load represents but a very small fraction of the capacity of the power available from the grid. So, when you turn on your washing machine or home theater, the impact on the grid is so insignificant as to be almost incalculable.

### Small/Home Generators

Due to recent power interruptions caused by weather and other situations, many people have felt the need to invest in small engine-driven generators in order to have power when utility service is unavailable. Unfortunately, many purchasers have the expectation that their small generator will deliver power just like the utility, and many sellers of these small generators do little or nothing to dispel this notion. The truth is that small generators cannot deliver power in the same unlimited fashion that the utility does. This may be why you could be having an issue with your small generator.

### Small Generator Power Problems

In technical terms, the issue with small generators and their inability to provide smooth, steady power is a matter of rotating mass and generator size.

To a small generator, the starting of a home appliance or tool can represent a significant step change in load. For example, refrigerators, freezers, HVAC, etc. can all be seen as major changes in load to a small generator. The small generator simply does not have enough rotating mass to absorb this change, so the generator controls have to call on the engine to produce more power (torque) to permit the generator to produce more electrical power.

As an analogy, imagine your 5 hp push-type lawnmower running into a patch of tall, thick grass. Because of your mower's engine size and the small mass of the blade, the mower bogs down in the heavy grass. Now, think about cutting the same grass but with a 75 hp industrial riding mower; it probably barely notices the heavy grass because of the power of the engine and the rotating mass of the huge blade. Now, imagine mowing the same grass with a 10,000,000 hp mower, then you can get an idea of the difference between getting your power from the utility and a small generator.

When a small generator tries to respond to a significant load change (the heavy grass), the speed of the generator likely drops, the output voltage can drop significantly and the frequency may become erratic. The poor power from the small generator responding to a load change will continue until the engine-generator can develop enough power to match the higher load, and it is this characteristic of small generators that usually causes most people a problem. Lights dim, electronics shut off or malfunction, etc., etc., etc. On less expensive small generators, the controls tend to be of a simple analog type and this only aggravates the problem. Digital controls found on some better small generators are faster and more accurate but may still not be able to overcome the problematic characteristics of the small generator.

## Solving the Power Problem

This is also the point that many people go looking for a way to correct the poor power problem with their small generator. **STOP LOOKING.** Unless you are prepared to invest tens of thousands of dollars, there is no way to really resolve this problem.

Here's why:

### Mechanical Voltage Regulators

In general, mechanical voltage regulators will be too slow to respond to the small generator power problems to avoid seeing problems with most electronic devices.

### Electronic Voltage Regulators

As a small generator tries to respond to a load change, the electronic voltage regulator will see the generator's poor output and will attempt to correct the voltage - adding more load to the already straining generator. This correction by the regulator will then be seen by the generator as another load change. In certain situations an oscillatory action between the generator and the regulator can develop (due to the fast response of the conditioner and slow response of the generator) even if the load is not changing. While the generator and the regulator will perform as best they can in this situation, it is not a good idea to have this go on for long periods of time as it unnecessarily exercises the generator and may result in a constantly changing voltage being delivered to the load. A general rule of thumb is that to use an electronic voltage regulator with a small generator, the load to be protected should be less than 15% of the generator rating.

### Uninterruptible Power Supply (UPS)

A UPS is not an acceptable load for many small generators for a variety of reasons such as harmonics and power factor. If you contemplate this approach, get assurances from the generator and UPS manufacturers that their products will work with each other. Only an online UPS (the most expensive type) might be able to deliver any sort of correction for the poor power from a small generator. Then again, the UPS will expect to have a constant supply of power to charge the batteries, and if the generator is used infrequently, the batteries may be drained when the generator is started. A constant deep drain and recharge of the batteries significantly shortens the battery life resulting in frequent battery replacement.

### A Larger Generator

Buying a generator that is several times larger than the total load is not only expensive, but may not solve the problems of a smaller unit. At very light loads, like less than 10% of the generator rating, the generator may suffer from poor regulation. Running a generator at light loads can result in a problem often called "wet stacking". In this instance, engine exhaust gases condense in the exhaust stack/muffler because the exhaust is not hot enough to evaporate the gases. You see this in car exhausts (as water dripping out the exhaust pipe) when the car has not been driven long enough for the muffler and tailpipe to heat up. Wet stacking can lead to premature failure of engine exhausts and other engine problems.

### What to do?

Recognize that your small generator should supply power that can be fairly well tolerated by many appliances/devices that do not rely on sensitive electronics (i.e. refrigerators, freezers, incandescent

lighting, resistance heaters, etc.). Computers, TVs, stereos, home theaters, etc. will probably not be very tolerant of the power fluctuations from the small generator during a substantial load change. If you only have one generator, don't count on being able to use your electronic devices and keep your food frozen at the same time.

### Some Potential Help

If you have a generator larger than 20 kW, want to spend a bunch of money to try to solve the poor power problem, and have a good understanding of your electrical system and your loads and your generator, then there is a chance that some add-on controls might help you somewhat. There are a few manufactures that offer a brain-numbing variety of products for generator operation and control. If your generator is less than 20 kW or you're not an electrical wizard (or don't want to hire one), it is probably a waste of your time, and theirs, to even go there.

You can find some of these manufacturers by searching the internet for "protective relays", "generator controls" or "static excitation systems."

### The Last Word

While we wish we had the solution to the small generator power problem (because we would be stinking rich), the fact is that we don't know any way to or any one who can solve this problem at a price that anyone would be willing to pay. Once you get into the larger size generators, the typical problems experienced by the smaller units tend to go away. However, few people are willing to spend tens of thousands of dollars just to watch *Lawrence of Arabia* on DVD when the power goes out.

You should contact the manufacturer or supplier of your generator to find out what solutions they might have for you. Chances are they will tell you to get a power conditioner. Well, you now know what that advice is worth. You might try to get them to take the unit back, but they will likely tell you that it is working to its specifications.

We think it is really a shame that these small generators for home and small business applications are sold without the buyer being told that it might not work well with all of their equipment. The typical buyer shouldn't be expected to be smart enough to ask these sorts of questions. You can probably figure out why the sellers don't bring up that type of information when they are trying to sell a unit.

If you are connected to the utility and are having problems with the power that you are getting from them ... then we would be very happy and capable of working with you to solve that problem.

## **UTILITY SYSTEMS TECHNOLOGIES**

<b>Phone: 888 403-9084</b> <b>Fax: 518 377-2207</b>	<b>Email: <a href="mailto:sales@ustpower.com">sales@ustpower.com</a></b> <b>Website: <a href="http://www.ustpower.com">www.ustpower.com</a></b>	<b>2315 Cayuga Rd.</b> <b>Niskayuna, NY 12309</b>
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