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Power quality tips

from a professional utility troubleshooter

Application Note

Testing Functions **Case Study**

Tool: Fluke VR1710 Voltage Quality Recorder

Profile: Chuck Thompson, PQ technician, Sacramento Municipal Utility District (SMUD)

Measurements: Voltage and events monitoring

Chuck Thompson is a power quality (PQ) technician for the Sacramento (Calif.) Municipal Utility District (SMUD). As a utility PQ tech, Thompson investigates power quality problems at customers' sites, initially to determine if the quality of the utility's service voltage is within specifications or if it's causing problems in a customer's home or facility.

It turns out that problems are usually internal (beyond the meter), but Thompson can often pinpoint the source of problems and recommend remedial action to a customer. Here, the PQ tech shares some of the insights and troubleshooting advice for problems that he encounters in his day-to-day diagnostic work.

Starting point

When a troubleshooter initially responds to a customer's call, in many cases, the problem is not occurring at that moment and the service voltage tests okay. A service request is then forwarded to SMUD's Power Quality Department, and Thompson sets up a recording device such as a single-phase, two-channel recorder, or a three-phase recorder. This allows the utility to verify the integrity of its service voltage.

"If we see that our service voltage is okay during short term monitoring, yet the customer reports a problem during this same period, we can determine the problem is caused internally," Thompson explains. "Then, we can give the customer advice, but we can't go much beyond the meter in doing the corrective work ourselves. A simple example in a residential application is a case of intermittent flickering lights caused by something as simple as a refrigerator or freezer in the garage."

Case-specific

Thompson describes a problem at a small fabrication shop. A CPU controlled mini-split heat pump kept failing and having to be reset. Company personnel called the utility and revealed, in the course of the conversation, that they were not having problems with other equipment throughout the facility. With that knowledge alone, Thompson could be pretty sure that this was not a utility caused problem, but he went to investigate anyway "as a common courtesy and to let the customer know that we're here to help."

In this case, Thompson used a three-phase power quality recorder to monitor the incoming voltage at the main panel and at the same time used a Fluke VR1710 Voltage Quality Recorder. He took the single-phase 1710 to an unused circuit served from the same subpanel as the mini-split system and plugged it in. What the dual monitoring revealed

The Fluke VR1710 is designed to be left behind for unobtrusive power supply monitoring.

was that the incoming service voltage to the building was fine, but there were significant voltage sags at the subpanel when the heavy loads, which were many and frequent, came on. In addition, the 1710 recorded significant neutral-to-ground voltage swells.

The monitoring correlated large neutral-to-ground voltage events with the malfunctioning of the heat pump. Next, Thompson played detective: "It was then a matter of elimination to figure out which piece of equipment was causing the disruptive events."

The problem turned out to be a blower with a dual voltage motor operating on 120 volts on the same sub-panel as the mini-split heat pump. When the blower came on line, it created a large neutral-to-ground voltage swell, and the heat pump hiccupped.

Asked to describe what he told the fabricator's personnel at this point, Thompson says he outlined three choices for them:

1) They could run a larger conductor to the subpanel serving these loads, which would have been complex and expensive
2) They could relocate the circuit of the blower motor to a different panel
3) Change the motor to the 240 volt setting

Thompson reasoned that by converting to a 240 volt setting, there would be no neutral-to-ground voltage swell when the motor started.

Fabrication shop personnel chose the third solution and have had no problems since.

Troubleshooting UPSs

Thompson says that a UPS (uninterruptible power supply) related problem is something that "we will always check out. Often people think, oh, it's not the utility's problem because the lights are still on. UPSs are very sensitive. They can sense things that we can't see, and it could be an indication that we have a connection starting to break down somewhere."

The SMUD team encounters two basic types of UPSs:

1) Stand-by units that run off utility power. When one of these senses some kind of a problem, it switches to batteries and sets off an audible alarm.
2) On-line systems that run off the battery constantly while the system charges the batteries. There's no transfer to or from the system and no switching time.

Using the Fluke VR1710 on the job

As mentioned, Chuck Thompson carries a Fluke VR1710 Voltage Quality Recorder on the job. The 1710 is a single-phase, plug-in unit and can record rms average voltage, transients, flicker and harmonics up to the 23rd, on a user selected interval from one second to 20 minutes. Then, the user downloads the data to a PC and uses the provided software to chart and graph the readings over time.

In one instance, Thompson used the 1710 in an office, where there was a computer problem in one particular area. The 1710 verified that certain voltage levels were dropping and neutral-ground voltage was going abnormally high. From this data, he concluded that there was an overloaded circuit. Not overloaded to the point of tripping the breaker, but overloaded such that it caused excessive neutral and ground voltage swells that commonly cause computer problems.

About other features of the 1710, Thompson says, "The rms graphs are great, especially since I can adjust vertical scales and preferences." He also manually adjusts the vertical scale on the harmonics displays.

How will Thompson use the harmonics monitoring capabilities in his work? He says, "Often when you have overloaded circuits or transformers, the voltage distortion increases. With this instrument, I'll be able to see that happening and identify those problems."

For a how-to guide on power logging with the VR1710, visit **www.fluke.com/FN-VR1710**

"Where customers experience the most problems," the PQ tech says, "is with stand-by UPSs, which are the most popular because they are the least expensive. When any anomaly happens, they set off an alarm and transfer to battery power, but the customer never sees the lights go out." This type of UPS is often accompanied with a software system that also reports large momentary voltage sags or swells. And often, the terminology used in these reports causes unnecessary alarm to the customer. Especially since the voltage sag or swell may be as small as two or three volts.

"Monitoring with reliable instruments allows us to see that it's often not so much a voltage-level problem," Thompson says. "Sometimes it may also be a small transient or even a waveshape problem. For example, whenever the capacitor banks in a substation on the utility side close in, a UPS can sense that. It's a momentary waveform distortion, but a sensitive UPS will sense that and switch to battery."

Once utility customers realize what's happening, they look for solutions. Many UPSs have adjustable sensitivity levels, and customers can adjust them to a lower sensitivity. The power quality technician points out that most adjustable units come from the factory set to their highest sensitivity as a default. He says, "In a lab or test environment that's great, but in the real world that's often too sensitive. In many cases, adjusting to a medium sensitivity will get rid of nearly all nuisance alarm problems."

Working with your utility PQ tech

If Thompson finds loose connections or other problems in a residential or small commercial customer's panel, he tightens them and, at the same time, visually checks the circuit breakers and circuit breaker to bus bar connections. If everything looks good, that's when he sets a recording device. He leaves it, but instructs the customer to immediately report any occurrence of the problem for which he's monitoring.

Thompson instructs the user to log the time of the event. Then, when he retrieves the recorder, he downloads the data and looks at the relevant time frame. "Diagnosing the problem is a process of elimination," he explains. "For example, if we have a connection going bad we'll see one voltage leg start to drop out. It may only be a few volts. Or we'll compare the voltage and amperage of all phases and that will help us to diagnose a connection problem, load, or conductor size/length problem. Never, ever, rule out the possibility of multiple problems!"

Thompson concludes by noting that many problems with computers and information systems require him to constantly learn about new technologies. In particular, he studies the robustness of components and how peripherals, such as laser printers, affect processors and other system aspects. He says he stays current through professional publications and the continuing education offered by professional associations, and he recommends that SMUD's customers do likewise.

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