

## For this A/V Engineer, appearances are *not* deceiving

### Application Note

#### Using a DMM to test A/V systems

For Tom Grieshaber, of Seattle-based Vulcan, Inc., every new audiovisual (A/V) system the company develops is virtually a custom project. Although each uses many of the same components as its predecessors, the requirements of Vulcan's customers virtually guarantee that the next system on the drawing board will be a new adventure.

As manager of the systems-engineering group, Grieshaber is responsible for designing and commissioning all of these new A/V systems. Commissioning a system invariably involves two distinct processes:

1. **Set-up.** Testing system components offline. All of the infrastructure, core routing components, and control systems must work, or must have been tested to specifications.
2. **Live testing.** Testing the system design once power is applied, and making adjustments dynamically.

Grieshaber's process orientation helps bring order to the more complex process involved in system building. Design incorporates a wide range of technologies and requires various control software components (some of which are proprietary), and a separate integration team builds each new system from the ground up.

#### A first line of analysis

Although the group uses a number of specialized instruments, perhaps the one tool that is common to all of the engineers on Grieshaber's team is a Fluke digital multimeter. "We typically use a DMM to bring a system online once it's designed and built, or to troubleshoot a problem that needs preliminary engineering analysis," says Grieshaber.

"In a twist on a phrase, I'd say that we bring out the DMM as a tool for a 'first line of analysis,' he says, "identifying problems when we're still early in the design integration stage."

Grieshaber says that when the cabling infrastructure for a new design is complete, the next step is to isolate discrete logical blocks so that he can then certify individually. "At one time I may test all of the 100 or more coaxial cables that will go from room A to room B," he says. "In theory, if not always in practice, I can do that with my entire infrastructure before I ever turn anything on. At this point, by using continuity or load testing, I'm using the DMM to look for shorts, opens, mislabeled cables, and similar problems." A common practice, he says, is to terminate one end of a cable with a load, view the load from the other end, and determine whether the load is what he expects to see.



Grieshaber and his team custom-built this test rack to support software burn-in and performance testing for over 20 LCD touch panels, before installing the panels in the field. The touch panels are also a custom manufacture, and together with a PC they run proprietary Vulcan software for controlling A/V and environmental applications (from video to lighting).

“For a video cable, I can put a 75 Ω terminator on one side. If I go to the other end of the cable and check for DC resistance, I can get a ‘quick pass’ feel for the impedance I will see on the cable. In short, I should find a DC resistance of about 75 Ω. If that’s what appears, I can continue with confidence. If not, there’s a problem. Higher or lower resistance measurements could indicate an open circuit, bad termination, short, or other cabling anomaly.”

According to Grieshaber, the use of a DMM simply reinforces the application of good common sense. “When we build a system and test the infrastructure, we’re looking for absolutely anything that could go wrong once we turn it on.”

### Checking gain stages

Once the various logical blocks in the system have been fully tested, it’s time to energize the system.

“Assume that the destination is a video display, and my source is a server that serves out high-definition video content. To perform measurements on that signal chain, I would use a signal generator to provide a specific test signal. I need a good reference signal – something that has fixed amplitude at fixed frequency ranges.”

In the process of commissioning a system, Grieshaber performs a series of gain adjustments. This process involves a signal that goes through multiple devices, each with an adjustable amplifier. “I’ll be looking at the outputs of these amplifiers at several places in the circuit – also called gain stages – and I can use the DMM to measure voltage at each stage. Using this process, I work my way, one stage at a time, from source to destination, adjusting the output voltage at each stage to control the voltage gain or loss that I want to see at each amplifier.”

If Grieshaber finds variability in the outputs of the amplifiers, he can ‘push’ the gain up or down to compensate for factors such as cabling loss or connector loss. “I need to optimize how those gain stages interact with each other, in order to reduce the overall noise floor and provide a stable signal.”

### An army of one

The DMM is an “incredibly multifaceted tool,” says Grieshaber. “It’s like a Swiss Army knife. With it I can confirm or deny preliminary assumptions, suspicions or theories about what’s going on. And then, only if I need to, I can resort to more specialized, application-specific instruments.”

“If I want to put the system through its paces, I’ll specify a voltage – let’s say for the color black – because I’m using black as a reference point. Black, from the perspective of a signal generator, has a specific voltage and amplitude at fixed frequencies. I’ll

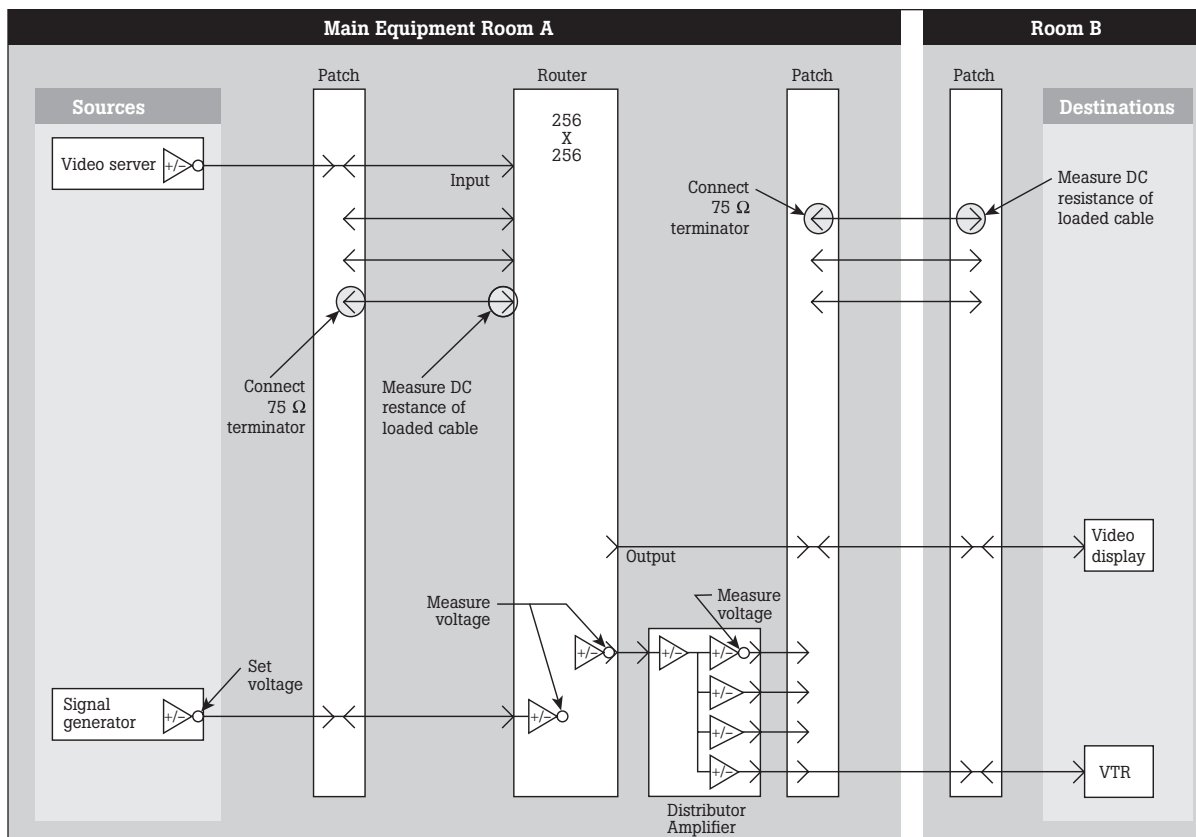
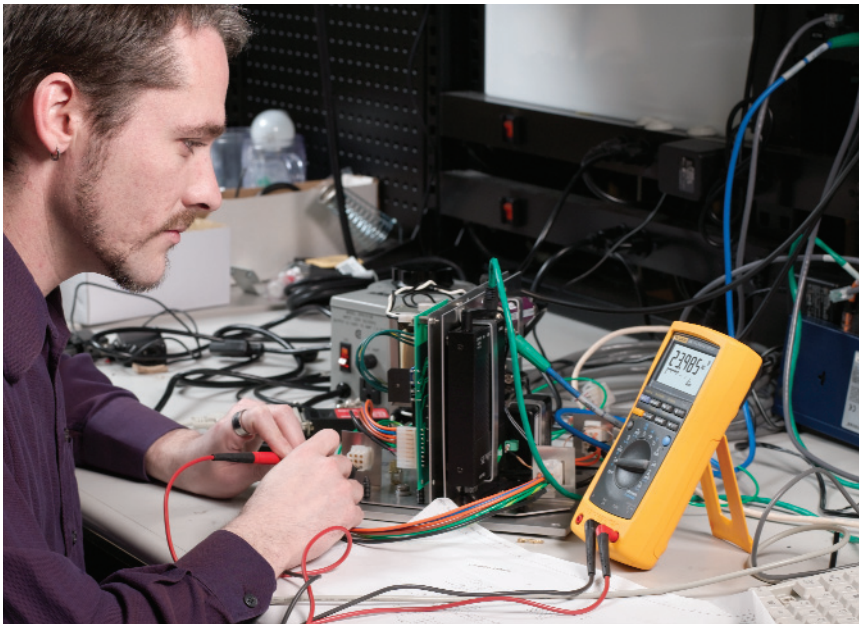


Figure 1. Load testing and gain structure optimization.



To power and network a particular PTZ (Pan Tilt Zoom) camera installation, Grieshaber's team built specialized a control assembly that could supply 24 V AC, 24 V DC and 5 V DC regulated. The load components include an analog-digital converter for video, an electrical-optical converter, a hardened serial server, and the camera. Grieshaber uses the Fluke to measure voltage and current on the PCB board power supply, confirming regulation on the 5 V side and testing how well the power supply deals with irregular input voltage.

check various points along the path and ask "have I incurred a voltage loss, or a voltage gain?"

"I'll take my DMM out and stick it on various nodes to look at voltages and currents; typically, with analog audio or video signals, I'm looking at voltage. At the input and output of a particular stage, I should find the voltage within a narrow range, as specified by the test signal I am using. If I find what I expect with the DMM, I can say, for the most part, that things are working properly."

### Power considerations

While system testing is key to performance, Grieshaber is just as focused on requirements for clean power. "With the high-level power infrastructure, we are concerned that, if the provided power is either at the wrong voltage or exhibits strong harmonics, we'll see the consequences ripple throughout the system."

For that reason, he conducts two types of power-supply testing for every system:

- Testing of the high-voltage power infrastructure

- Testing of system power supplies and how they respond to the delivered power

"Often we specify an isolated ground system for power to the A/V and IT systems, and that means testing for isolation between two isolated ground systems. The DMM makes it very easy to get a quick read on how well an isolated ground has been implemented. One way to do that is to test for continuity between the two systems." (See Figure 2, Test 1.)

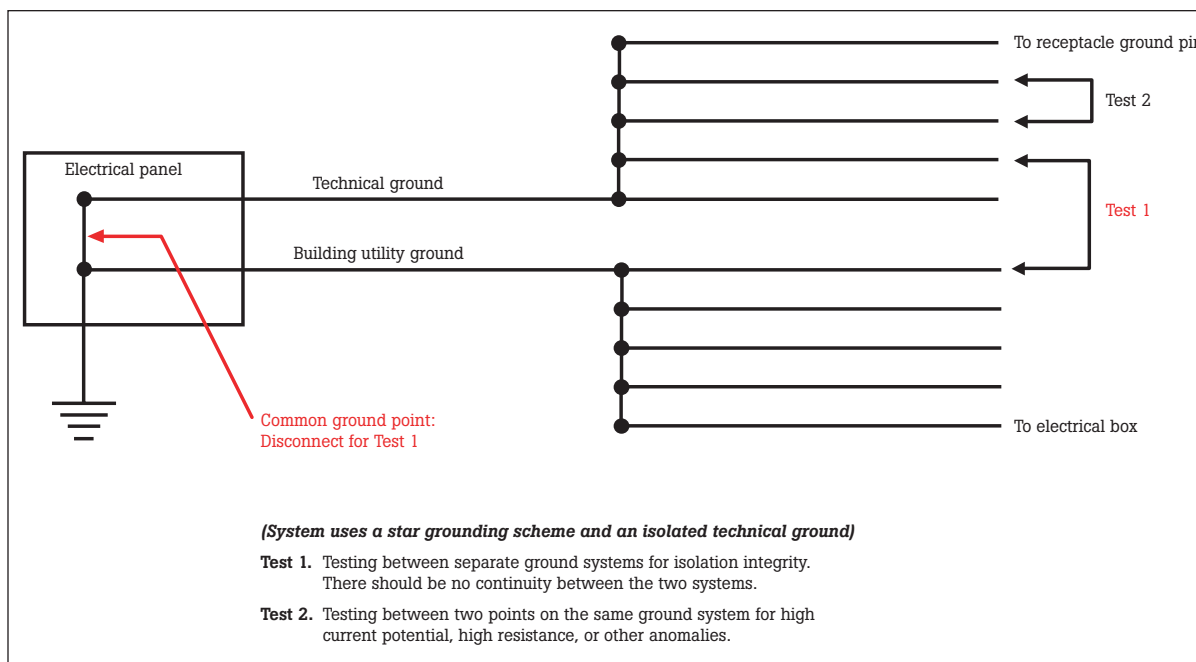


Figure 2. Grounding tests.



This matrix patch point for coax cable from across the building allows technicians to reconfigure the system on the fly. Here, Grieshaber is performing a quick DC resistance test. Resistance lower than 75 ohms, the standard impedance for video line, could indicate a short, while higher resistance indicates an open circuit or bad termination. With a second technician on the other end of the cable to supply the load, this test can be used to quickly verify cable identity from the lab side.

“Another critical test with the DMM is to look for current leakage and/or current potential *between different ground points in the same system.*” (See Figure 2, Test 2.) Grieshaber will typically test a ground point from one side of the room to the other, a test that can reveal a good deal of information about the power system. “If I have an unusually high current potential between two ground points, I know that I may have a problem. I may need to take corrective action to fix the problem. Or, if that’s not an option, I’ll take some action in the A/V system to compensate for it. Audio comes to mind. It’s very easy to get audible noise, and a lot of times that noise relates directly to the grounding scheme and power system in use.”

### Back to basics

In Grieshaber’s approach to testing complex A/V systems, simplicity and common sense are recurring themes.

“Audio and video engineers tend to want to use the most specialized piece of test equipment for troubleshooting. But, from my experience as an integrator, I’ve learned there are a lot of things you can do, and should do, with a DMM. These are first-line-of-analysis tests that don’t require hauling around a big piece of test equipment. If I can use the DMM as a ‘discovery tool,’ I can go back later and pull out more specialized equipment if required.”

**Tip:** The Fluke 189 DMM has a dB measurement function that allows technicians to make gain measurements in audio stages. If you’re going from stage to stage, use this function to more quickly measure gain or loss. The 189 is accurate to within 0.025 %.

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