FEATURE

DMM Sound Installations (part2)

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The DMM

Now let's bring these concepts into the real world. The most commonly used device for measuring volts, amps, resistance, power, and electrical db in the field are digital multimeters. DMMs cost anywhere from under $50 to several hundred dollars and more. Even a low-cost unit can do basic measurements but have at least three major drawbacks. First, they are pretty easy to blow up. When you are jammed upside down into the back of an equipment rack, flashlight in your mouth and DMM balanced on your chest, it sometimes happens that the DMM is on a different setting than what you assume. Applying 120VAC to a DMM that is in the continuity mode is one good way to blow up a low cost meter, but there are many other ways, as well.

Second, lower cost meters tend to be less accurate than the better ones. There are a lot of adjustments in audio that must be made with a highly accurate meter. For example, in replacing level-controlling componentry in an automated VCA mixer the slightest miscalibration can result in serious mismatching and performance problems.

Finally, and for the purpose of this article most importantly, a low-cost DMM usually lacks the features necessary to carry out many of the more critical operations we will be discussing. Probably everyone reading this article owns a DMM, but many field installers use it only for basic continuity and voltage tests so they don't think they need a sophisticated meter. As we will see, you cannot set up a sound system properly without certain sophisticated features like hold and relative db. If your meter doesn't have these features, you need one that does. In this article we will use the Fluke 45 as our reference DMM, and all the operations described can be accomplished with this meter. The Fluke 45 is an excellent choice for professional audio applications because it's affordable ($595) and has all the features that an installer and technician needs. Moreover, it is highly accurate, very rugged and well-protected against operator error and unexpected inputs, and incorporates features that no other meter in this price range has. @SUB-HEAD = **Measuring Voltage And Power**

There are many voltage measurements that should be made by the installer. The first voltage to be measured is the AC coming out of the wall. Sudden surges of voltage can cause damage to electronic equipment, and consistent overvoltages will, at the very least, reduce long-term reliability. Under voltages will result in reduced audio performance. So before you plug sound equipment into the house AC, it is important to check for voltage irregularities.

With a Fluke 45 you have the option of making these tests in several different ways. But regardless of the test procedure used, you should leave the DMM hooked up to an outlet for at least twenty-four hours, preferably on a weekday when industrial and commercial electrical use is usually heaviest. Using the "min/max" feature you can come back at the end of the test period and ask the DMM to read out the lowest and highest voltage monitored. Imagine how thankful you'll be for running the test when you find that the min/max range swung from 112 to 135VAC! You can also leave the DMM in the hold mode in which case you would have found 135VAC on the screen when you returned. Or you can preset a threshold that represents the upper limit of acceptable voltage, say 125 VAC; in this case the word "fail" would have appeared on the second readout.

However you choose to run the test, RUN THE TEST! If you have spikes and brown-out problems in a building, you can be guaranteed that the sound system equipment will not enjoy normal reliability.

Many installers don't realize that power supplies are often out of adjustment, even with new equipment. A power supply putting out too high a voltage can significantly reduce the reliability of ICs. Conversely, too low a voltage can result in diminished performance, particularly in terms of headroom and signal-to-noise. So a diligent installer should check all external and easily accessible internal supplies for voltage accuracy and ripple. The dual readout feature of the Fluke 45 makes this operation easy because it can read and display DC voltage and AC ripple, or voltage and frequency, simultaneously.

Another measurement that can save you a lot of headaches, but can only be made with a sophisticated meter, has to do with identifying ground loops and stray voltages. To eliminate ground loops and the concomitant buzzes a sound system must have only one path to ground. This is easier said than done. Electrons never miss a trick: if there is an alternate circuit open to them they will find it. They will go through your

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rack rail from mixer to equalizer to amp, they will use the shield of the interconnect cables, they will use the conduit in the building. But if we remember our basic electronics, we know that any length of cable will have some resistance, albeit very small in some cases. And if current is flowing through the cable, a voltage drop will occur. Thus we can detect and quantify the various legs of the ground loops. Alternately, we can measure the current directly by interrupting the circuit.

In any case, the ultimate goal is to eliminate all paths to ground except for one high quality ground. This can be a difficult task, particularly when unbalanced equipment is in use and when equipment is located in different locations. But a DMM sensitive and accurate enough to measure, and differentiate between, the small voltages and currents typical of multiple ground paths can help you identify and solve these problems.

One of the handy features of certain sophisticated DMMs is the ability to compute audio power. According to Ohm's law, if we know the voltage, current, and resistance — or any two of the three — we can compute power. Some meters can do this calculation for you. Thus you can "measure" audio power without worrying about miscalculating: just enter the appropriate value of resistance and the meter will do the rest. This, and other, test operations are made faster, easier, and more foolproof by the dual read-out feature of the Fluke 45.

Measuring DB

One of the biggest oversights in setting up a sound system is failing to make unity gain adjustments. Many installers simply hook up the mixer, processing, crossovers, and amps, and then crank them up until the system is loud enough. A system set up by this seat of the pants method is likely to result in unacceptable level variations at interconnect points. For example, the mixer and equalizer might be getting +16dbu, while the signal between the equalizer and crossover

might be getting -15dbu. It is true that modern audio equipment can accommodate a wide range of signals but it is very important to have each device operating at its optimal level. If you have some devices running near overload and other devices running with the signal way down in the noise floor, you are asking for problems: the result can be distortion, unsatisfactory headroom, unacceptable hiss and buzz, radio pick-up, reduced reliability of components, lack of operational flexibility, or in general terms, greatly diminished sonic performance.

So it is critical that the installer check and adjust signal levels in between each piece of gear until there is unity gain throughout the system. This will not be possible, of course, if there is mismatched equipment: a +4 equalizer hooked up to -10 compressor, for example, or a balanced output (of a type that cannot be unbalanced without a several db loss of level) hooked up to an unbalanced input. But assuming that all the equipment is +4 and has well designed inputs and outputs, the signal level carried by the interconnect cables should remain constant throughout the system.

The easy way to make these measurements and adjustments is to use a sine wave generator as source. Plug a 1 khz tone into the mixer, set the input channel to an optimum gain structure (as indicated in the mixer's user manual), attach your DMM leads to the output of the mixer, and raise the mixer's master output until your DMM (set on VAC, 3V scale) reads 1 volt (this is for dbv, set to .775 volt if you prefer to work with dbu). Then hit the "db ref" button on the DMM. Now your meter is calibrated to 1 volt = 0 dbv (or .775 volt = 0 dbu if you chose that reference). You may now adjust the mixer's level up or down and the DMM will read the change in + or - db. The meter will not read out dbv or dbu — it reads db only — so it is up to you to make sure you know what the zero reference is. Be careful to look closely at equipment specifications so that you don't confuse, say, dbm with dbv or dbu since these scales all have different 0 db references.

If the specifications on a mixer say that +4 dbu = 0 vu on the mixer's meter, then you might use +4 dbu as a handy reference level. So use .775 volt for the DMM set-up and raise the mixer level until the DMM reads +4 db. Now move your DMM leads to the output of the next component (probably a compressor or equalizer). Adjust the master gain of this device until you read +4 db. Repeat this process until you reach the output of the electronic crossover (if the system is active). Be careful here, because you will obviously have to sweep the oscillator frequency up or down so as to steer around the attenuation slopes. This can be best accomplished by using test tones mid-way between crossover points. At the outputs of the crossover, it may be necessary to adjust the level up or down from +4 db because, unlike most processing equipment, amplifiers do not necessarily subscribe to a nominal +4 level. Different amplifiers have different input sensitivities, and often those sensitivities will be specified in volts rather than db: some require 1V for full output power, others require 1.5V, still others require .7V, and so on. Refer to the amplifier's user manual to find how input voltages or decibel values correlate to output wattages, and adjust the signal levels accordingly. Of course, you can also adjust the input attenuators on the amp, but unless you have unusually sensitive amp inputs, you will usually find that it is better for the sake of system headroom to leave the attenuators wide open.

Once you have completed this system-wide set-up procedure, you can be sure that each component in the system is operating at an optimum level, and thus is providing optimum performance. We have now created the ideal starting point for the system. But realistically we cannot expect to maintain perfect unity gain throughout the system because once we make equalizer and compressor adjustments we are bound to change the levels a little. If you are doing extreme amounts of EQ and compression, then you should go back and readjust for unity gain; but if you are making only minor processing adjustments, then readjustment is unnecessary.

Checking The Phase

One final test that some installers make is a system phase check. More precisely this amounts to a polarity check, for if it turns out that the system output is not in phase with the system input, the installer is not able to dial in the phase a degree at a time like you can in setting up a tape recorder. Usually if a phase problem is detected it is a matter of being 180 degrees out of phase. This probably means either a cable or component is out of phase, so correction is easy. One easy method of checking phase with a DMM is to run a +4 dbu

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100 hz sine wave through the system while simultaneously sending that tone to the input of the amp, thus bypassing all the other equipment in the system. At the amp input (make sure the amps are turned off), use a resistive bridge to combine the original tone with the tone that is running through the system. If the system is in phase, the addition of the original signal to the amp input will increase the system signal by 6db on the DMM (this assumes you are using a db scale referenced to voltage and that each of the two signals being combined are of equal amplitude). Even if your signals are not equal, the effect will still be additive. But if the system is out of phase, the system signal at the amp input will decrease by at least several db due to phase cancellation.

If you wish to make a more comprehensive phase check of the system, one that uses the amplifier outputs, you should use a dual trace oscilloscope. If you are going to take a scope into the field with you anyway, you can also make system gain adjustments with it. Although a DMM can do this job just as well, a scope can compare signal levels simultaneously without repatching. Also if you prefer to use a program other than a sine wave (pink noise or music program) for system checks you will find a scope more suitable than a DMM. An oscilloscope suitable for sound system installations and maintenance should be portable, rugged, and reasonably priced. A Fluke PM3055 would be an excellent choice.

We have all seen how inattention to proper techniques can result in disastrous and costly system failures. In this article we have discussed how a sound system installer can greatly improve system reliability using a high quality DMM. The techniques described take only a few minutes, and can save a lot of frustration, time, and money in the long run. ❐