

CHAPTER 3 The Studio: Equipment and Wiring

equipment; they're stable and latch in place, and if kept clean are reliable. The fiber optic cables provide isolation so ground loops can't form; however, length is limited to about 30 feet, even with high-quality fibers. Toslink jacks usually ship with a snap-out blocking plug to keep them clean.

Toslink just substitutes bursts of light for standard s/pdif signals, so converting between the two formats is electrically very simple. Powered adapters start around \$30, and let you extend the optical signals over almost unlimited lengths of RG-59 video cable. Toslink connectors are also used by Alesis ADAT recorders to carry eight simultaneous audio signals in digital format. These can also be converted for standard copper wiring, but the converters are much more expensive.

Some equipment uses combination optical/electrical mini-jacks. They work just like standard analog ones for normal consumer analog signals. If you insert a Toslink/mini adapter (about \$2 at audio suppliers), the circuits use the optical signal instead. However, the springs on a mini-jack aren't very secure and there's nothing to keep dirt from getting into an empty jack, so these connections are often unreliable.



Gotcha

AES/EBU as consumer? s/pdif as pro? We've discussed standards for the **electrical** connection between devices because at digital audio frequencies, wiring can get tricky. But AES has also specified two **data** standards: consumer and professional.

In general, the differences between the data formats are minor. Most have to do with things like copy protection (ignored in pro equipment) or pre-emphasis (obsolete). One specifies the number of bits in the audio sample—pro can handle 24 bits, consumer only 16 bits—but other than bit depth, there's no difference in audio quality. A 16-bit signal will sound exactly the same in both data formats, and the formats are so similar that for many purposes most equipment will accept either one.

GUERRILLA PROBLEM SOLVING

Generally, audio wiring problems show up with three kinds of symptoms: hum, other noises, and intermittent audio. Once it's there, none of these can be eliminated from a track without affecting dialog.

Hum

The dreaded 60-cycle hum is inaccurately named. It's actually more of a buzz with harmonics much higher than 60 Hz. They extend through voice and music frequencies and are almost impossible to remove. It's most common in unbalanced setups where shield and equipment grounds are shared with the signal. Tiny audio currents loop around these multiple paths, acting like antennas

picking up noise ... particularly the low-frequency noise radiated by the high currents in standard electrical wiring. Even worse, the three-prong AC plugs on most gear tie these *ground loops* to hundreds of more feet of wire inside the walls.

So the first step in cleaning up hum is to unplug every non-audio cable. That includes the video cables in your audio/video editor, data cables on CD-ROM drives that also have audio connections, and even shielded RS-422 control cables on a video deck. (Before you start unplugging, make sure the wires are labeled with their corresponding jacks.) Go all the way back to your monitor amplifier. Then reconnect the wires one at a time, starting at the monitor amplifier and working down the signal chain from output to input. Listen for hum after each connection. When you hear it, you'll know which cable is causing the loop and you can apply some of the following cures.



Gotcha

Ground loops without wires. Sometimes loops form because two grounded equipment chassis are making electrical contact. This can be hard to diagnose if the equipment is mounted in a rack, where the metal screws and rack rails complete the circuit. But if nothing else seems to be the culprit, suspect this.

It's easy to cure. Large audio dealers can sell you low-cost kits of fiber tabs or insulated shoulder washers and nylon screws. These isolate the gear while still providing support.

Two of the most common hum culprits are cable TV feeds and grounded power cords. If a VCR or monitor/receiver is connected to both cable TV and your audio system, you can get giant ground loops, even when the video equipment is turned off. It's easy to diagnose; just unscrew the cable TV and listen. To diagnose power-cord ground problems, use a three- to two-prong molded AC adapter from a hardware store. Don't connect its metal grounding foot to anything. But use this only as a temporary diagnostic! It defeats an important safety feature, and makes any line noise filtering less effective. There are better solutions.

Once you've located the offending connection, you have to break its loop. You can often do this by disconnecting one of the grounds in an audio, video, or control cable. Turn your monitor down before trying this with audio cables—while breaking the ground may fix the hum, it might also raise it to speaker-rattling levels. If an audio cable uses RCA connectors, just pull the plug partway out so the center pin connects but the outer shield doesn't. If the cable has phone plugs, use clip leads or plug a short phone-to-phone patch cord into the jack and

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FIGURE 3.7
An icon like this indicates a grounding screw on equipment.

touch the tip of its other end to the cable being tested. If this eliminates the hum, rig up a more permanent way to disconnect the ground and you're done.

You may also be able to reduce ground loop noise by providing a better, lower-resistance audio ground. Run a heavy cable—such as 14-gauge speaker cable or automotive primary wire—from a grounding point on each device to one central point in your studio (often a mixer or computer audio input). For just this purpose, most audio equipment has a screw on the back marked with one of the icons in Figure 3.7. If you don't see a ground screw, connect your ground wire to the exposed metal shell of an input plug. However, this "better ground" strategy often isn't as effective as actually breaking the ground loop.

Of course, some grounds can't be cut. Power line third-pin grounds are there for safety reasons. Cable TV systems won't function without their ground. In these cases, you'll need a transformer to pass the signal while not letting the grounds through: in effect, this balances a tiny part of the unbalanced wiring. If the loop is on a TV cable, the cure is trivial: get a pair of $75\Omega/300\Omega$ antenna transformers and wire the 300Ω sides back-to-back. If the loop is because of a power-line ground, you can get AC-power isolation transformers at electronics suppliers. They're used for servicing TV sets safely, and start around \$75 for a unit capable of 300 watts. Bigger ones—including systems capable of providing balanced AC power to an entire studio—are also available.

Ground loops in audio cables can be broken the same way. Electronic dealers sell small isolation transformers with RCA jacks, designed for car stereo systems, for less than \$20. They're not really hi-fi, but it's surprisingly good for the price. Or get higher-quality transformers from a pro audio dealer for about \$35 per channel. Ground loops can also affect analog video, usually appearing as a darkened horizontal band that slowly crawls up the screen. If that video cable is also forming an audio ground loop, fix both problems at the same time with a video hum-stopping transformer—about \$150 at pro video houses.

The ultimate solution is to use balanced wiring exclusively. When done right, ground loops can't form.

Random Noise

You might also encounter some mystery hummers that sound like loops but aren't. The audio heads in an analog video or audio deck can pick up hum, particularly if there's a big power transformer nearby. All dynamic and some condenser mics have tiny transformers that can pick up hum from other equipment (or even the power wiring in walls). Moving things a few inches—or turning them 90 degrees—usually helps. Defective or badly designed AC supplies

in AC/battery equipment can also cause hum: run the equipment on batteries until things get fixed.

Audio heads and transformers may also pick up high-frequency noise from CRT video monitors. Turn off the monitor if you think this is the culprit. The only long-term cure is to move things around, or use an LCD display.

Sporadic high-frequency noise can leak from building wiring into audio cables, particularly microphone and unbalanced line-level ones. The problem frequently has to be cured at the source, so it may need some detective work and might require an electrician to fix. Large electric motors in elevators and oil burners have tiny sparks that can radiate through the building power. Wall-mounted light dimmers work by slicing up low-frequency electric power and create nasty harmonics throughout the audio band. This radiation is the worst when the lights are only partially on. The easiest cure, if dimmers in an edit suite are causing problems, is to replace all the bulbs with lower-wattage ones and stop dimming. Or look for low-noise dimmers at large electric supply houses.

Sudden Death

Your room has been working perfectly. Then you start hearing clicking, bursts of static, or nothing at all. First do a little deductive reasoning:

- Have you changed anything? New software might require new drivers for your hardware. If you used borrowed equipment on the last job or patched in a client's camera, have you returned everything to its normal condition?
- Can you isolate it to one piece of equipment? Are some meters bouncing even though you don't hear anything from the speakers? Work backwards from your monitors or forwards using headphones. If you've got a patch-bay, it's a great diagnostic tool; patch around suspect equipment until you determine which is causing the problem.
- Can you isolate it to one place in the project? If a certain part of your mix always has static, it's probably an overload or bad media. Lower the levels or insert a replacement.
- Did it fail overnight? Something that worked last night but not this morning probably died on power-up. It could be as simple as a user-replaceable fuse—but if a replacement fuse immediately fails, call for service. Some equipment hides user-replaceable fuses in odd places (on a circuit board, or hidden in a battery compartment) so check the manual.
- Are any tiny buttons in the wrong position? Pressing the wrong solo on a mixer can turn off the output. Selecting the wrong reference in a piece of digital audio gear can create clicking mixed with the sound.

One of the most common failure points in prosumer equipment is the input and output connection. Mini-jack springs stop making contact, and the inner sleeves in phono jacks start to let go. If you suspect this is the problem, try wiggling the plug in its jack and listen for anything. A bad jack will frequently respond to manhandling, if only for a moment. If this seems to work, you can

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often temporarily fix things by flexing the cable in different directions until you find a position that produces sound. Then tape or tie the cable to keep it there. Ultimately, you'll have to replace the jack.

Modular power supplies—wall warts and line lumps—are popular with a lot of equipment, because they can be mass produced. But they're often sealed, and an internal fuse or rectifier can burn out. If you suspect that's the problem, unplug the supply from the equipment and check its output with a voltmeter. It should be at or somewhat higher than the rated voltage. Otherwise, contact the manufacturer or take a trip to your local electronics store for a replacement.

One of the best pieces of problem-solving advice I ever heard was, "Walk the dog." Get away from the problem, ideally out of the room, for a few minutes. A fresh outlook always helps.

Some problems might be beyond your ability to diagnose or fix. But before you call a tech, write down everything you know about the problem: when it developed, what the symptom is, any unusual meter or panel readings, and what you've done so far to fix it. Gathering that information first can save hours of repair time.