those shields! So the most important shortcoming of these splitters is that the only way to isolate shields between consoles is to break the shield at the consoles that don't provide phantom power. This makes them no better than hard-wired splitters! The other limitation of these transformers is that they provide relatively poor common-mode isolation between windings. So while these types appear to be "el-cheapo" variations of the splitter in Figure 2, they actually have far more in common with the hard-wired split of Figure 1, because their shields cannot be isolated.

Now, let's study how the first three types work. ALL passive splitters put all of the mix consoles connected to them in parallel across the mic. That is, the mic is driving two or three consoles in parallel, depending on how many are connected. The mic sees the parallel combination of the input impedances (mostly R and parallel C) of all three consoles, and the capacitance of all the cable that connects them! In many (most?) systems, the cable capacitance dominates the equivalent circuit, especially at high audio frequencies, with only one console connected. But add one or two more consoles and the resistive loading can cause many condenser mics to produce lots of distortion. We'll talk more about that later.

It should be obvious that these three main types of passive splitters also vary widely in cost. The first type is least expensive – the only costs are the box, the connectors, and the labor to assemble and wire it. The second type is more costly because of the transformer. The third type is the most costly, first because it includes a phantom supply, but also because of the additional transformer winding that is required. Each Faraday shield also makes the transformer, and thus the splitter, a bit more expensive. As with all engineering problems, the obvious question is, what do you get for your money?

When a transformer is used, especially one with a Faraday shield for each winding, the transformer provides common mode isolation on the signal pair between consoles and isolation of the shields -- in other words, it prevents noise transfer both via the shield and via the signal pair. A transformer also functions as an effective low pass filter to block the differential-mode transfer of RF (radio frequency) interference between inputs and outputs.

Now, let's look at our simple hard-wired split (Figure 1). The mic cable, including the shield, is a continuous run from the stage to the console providing phantom, and it isn't grounded until it hits that console. This means that the entire length of the cable from the mic to each console is an antenna for any RF that is floating around. The longer the cable, the better it will work as an antenna for AM broadcast signals and dimmer noise, so more RF will get onto the signal pair by SCIN. It also means that unless there is an isolated ground system, the only way to prevent audio-frequency shield current between consoles is to lift the shield at one end. Since Bill Whitlock has shown that the receiving end is where to lift the shield, this means no shield connection at the consoles that don't provide phantom power (or a connection of the shield through a capacitor). And finally, any AM broadcast RF on that signal pair will show up at all the consoles.

Another downside of the hard-wired split is that a few poorly designed consoles aren't happy if both they and another mix console are providing phantom power. Rick Chinn has a prepared very nice applications note about this, which you can find on his website. See http://www.uneeda-audio.com/#phantom

Our second type of splitter (Figure 2) still has the mic cable running all the way from the mic on stage to the console providing phantom, so that entire cable is still the antenna. But the transformer, with its Faraday shields, prevents the other consoles from seeing the RF. Even better, since the cable shield for each split output is tied to the Faraday shield of each output transformer and isolated from all other shields, it can be connected at the receiving end but still not pass audio-frequency shield current. Not only that, the output cables to the other console(s) is (are) a shorter antenna and thus less able to pick up RF (AM broadcast or light dimmer noise).

The third type of splitter (the one with its own phantom supply) is even better, because it breaks the antennas up even more effectively, and it allows all the shields to be connected at both ends with no audio-frequency connection between the console enclosures. From an RF point of view, the cable con-

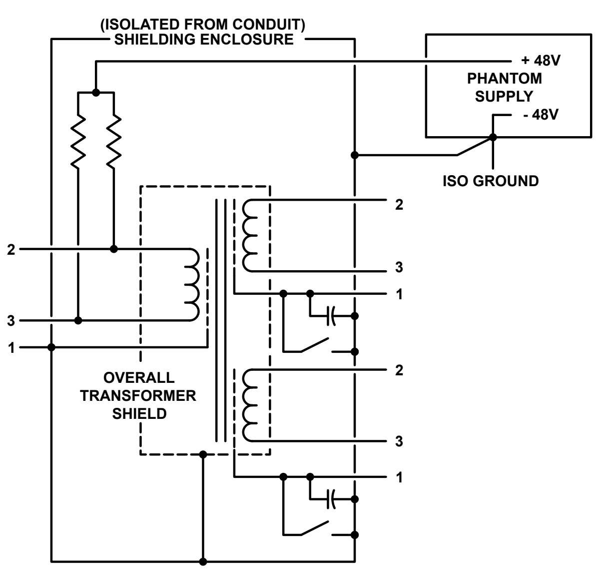

Figure 3 – A splitter with its own phantom power supply provides the greatest isolation.

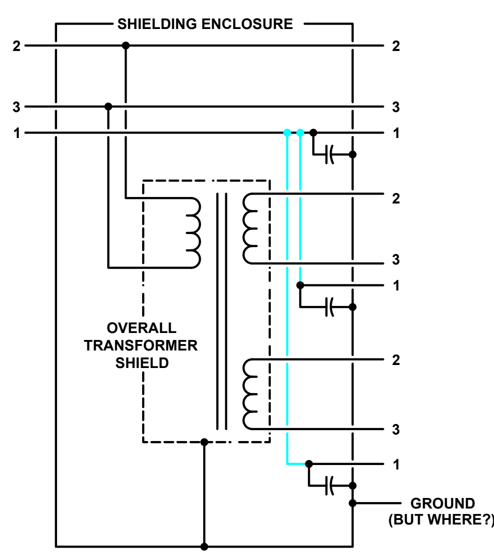

Figure 4 - A split transformer with no Faraday shield

by the various output configurations between consoles is the same as for a passive split, except that all variations isolate the mic from the outputs. If there is no split transformer, the shields of the split outputs should be connected directly to the shielding enclosure of the splitter. If the shields need to be interrupted to band-aid a pin 1 problem, they should be interrupted at the console that has the pin 1 problem. And if a split transformer with a Faraday shield for each winding is used, the shields should be connected as in a passive splitter that uses the same type of transformers.

The principal virtues of an active splitter are that 1) it shortens the RF length of the cables in the same manner as in the passive splitter with a phantom power supply; 2) it allows the mic to drive only one preamp (the one in the splitter) and only the lower capacitance of the shorter cable between the mic and the splitter, so it sees a much higher load impedance; 3) the longer run between the splitter and the mix consoles is generally at a higher signal level, so it takes a stronger interfering signal to cause audible interference.

Item #2 (loading of the mic's output stage by multiple input stages and cable capacitance) can be quite significant, especially with poorly designed condenser mics whose output stages are current starved. Ray Rayburn observes, "Take the example of a three way split where each console has a 1500 ohm input impedance (1,000 – 2,000 ohms is typical). The resulting resistive load is 500 ohms which will drive these mics into distortion. One popular podium mic loses 15 dB of headroom as the resistive load goes from 1000 ohms to 700 ohms." For a three way split, each console would need an input impedance of 3000 ohms or higher to work with that microphone. David Josephson (Josephson mics, and chair of the AES Standards Committee Working Group on microphones) makes it his business to know what is going on with his competitors. He says that his mics and the better pro mics of his major competitors are designed with considerably more robust output stages. One clue that a mic can't drive multiple consoles is its phantom current - in that it doesn't draw much phantom current.

Ray also notes that the most common inline (barrel) pads were designed to load the mic to 150 ohms. When you added one of them inline to solve an overload problem, things got worse rather than better, because it demanded far more current than the mic could supply. Rick Chinn reports that a new A15AS he recently bought has been redesigned so that it now loads the mic to a safe impedance. Rick has looked at a lot of console designs, and reports that all of those he's looked at have been careful to maintain a constant resistive load the mic with and without the pad. Certainly if you're going to pad a mic like the one Ray had trouble with, you'd better use the right kind of pad and put it ahead of the split! Another inexpensive way out of this mess (cheaper than an active splitter) is to add a decent preamp for the problematic mic(s) and feed the split with the output of the preamp(s).

But this discussion, which has (so far) involved Josephson, Whitlock, Rayburn, Olson, Chinn, and myself highlights a VERY important issue – many manufacturers need to do a much better job of understanding the big picture with respect to how their products are used. In most churches and performance facilities, every microphone is working into at least two mix consoles, and often three (I specify both an automix and a live mix console for nearly every church and public venue, and many of these facilities also have another console for on-stage monitor mixing). Add a recording console and you're up to three or four! Virtually none of these facilities can afford an active splitter, so ALL microphones need to be designed to work into at least three consoles – especially the podium mics!. And the corollary is also true – mix consoles need to be designed to present the greatest practical load impedance at their mic inputs consistent with good performance! I would like to see 3K ohms as a minimum input impedance of a mic stage.

And then there's capacitance. In large facilities there is lots of high capacitance cable (most analog cables) hanging across each mic (remember, all the split outputs are in parallel). 1,000 ft of 8451 looks like 240 ohms at 20 kHz, and 120 ohms at 40 kHz, well below the 1,000 ohm rated load of most mics. (Current microphone standards define the impedance of a mic as one-fifth of its rated load impedance, so a 200 ohm mic should not be loaded below 1,000 ohms.) The output stage of a condenser mic is very likely to clip or slew limit on high frequency transients (cymbals, snare, hat, muted trumpets, etc.) when working into a load like this. Simply switching to cables designed to carry AES3 audio reduces this capacitance by more than half as compared with the best analog cables, and by a factor of 1:3 as compared to older cables like 8451. Star quad cables are real dogs for capacitance, and I've always avoided them. Since more than 90% of the cost of snakes and tie lines system is in the panels, connectors, and the labor to terminate them (and pull the cable in a permanent installation), using top quality cable with low capacitance is the only good decision.

Active splitters have one major disadvantage in addition to their cost – someone needs to be available to adjust their gain trims during a live performance, and do so very quickly. But even that isn't enough – everyone mixing from the split must make equal and opposite gain changes in their mix precisely in sync with the gain trim at the preamp! Not easy, which, combined with their added cost and pin 1 problems have confined active splits mostly to high-budget studio operations. For at least ten years, I've been suggesting to the manufacturers of digital snakes that effective remote control of mic preamps with logic that protected each mixer from losing track of the mix was an important part of any successful system. Lots of digital snakes have come and gone, but I've yet to see that problem solved (or even addressed).

In summary: The main reason for using the best mic splitters is to prevent hum and buzz with mix consoles that have pin 1 problems, and to shorten the antennas. Hard-wired splits are an economical solution for facilities where power and grounding are well under control. When power and grounding are less well controlled, or when consoles with pin 1 problems will be used, or both, a split transformer with a Faraday shield per winding and a phantom power supply at the splitter provides the greatest protection from hum, buzz, and RF interference. The transformer must have one more winding than the number of outputs. Second best isolation is provided by a split transformer with the number of windings equal to the number of outputs and a Faraday shield per winding. Transformers with no Faraday shield or with only one Faraday shield offer only slightly more isolation than a hard-wired split, and are a waste of money. And if there is a passive mic splitter in a system, don't be surprised if a few mics don't work very well with it! *jb*