

MACKIE. Church Sound NOTEBOOK™

Summer
1998



Un-joyful noises...

How to keep hum, hiss, clicks, pops and local radio stations out of your mix.

Are quiet moments during worship services accompanied by a persistent hummmmm? Is something hissing at your pastor? Are your choir and soloists being joined by uninvited guest artists from the radio?

Even a simple church sound system contains enough cables and equipment to attract a veritable cacophony of unwanted noises. All of these detract from the quality audio you're working hard to achieve. And all can be minimized or eliminated entirely when you know how to trace un-joyful noises to their sources.

In general, sound system noise falls into two broad categories: *intermittent* sounds such as clicks, pops or sudden bursts of 2-way radio transmission, and *steady* "background" problems including hiss and hum.

The first type is immediately noticeable (and annoying). However background noise can "sneak up" on you — a system can start out relatively quiet and then degrade over months or years for reasons we'll explain farther on in this article. You — and the congregation — might not immediately notice the reduction in what is called the sound reinforcement system's **SIGNAL-TO-NOISE RATIO**. But these more subtle forms of noise reduce sound quality nonetheless.

Start with that plug in the wall.

Even if electricity were pure stuff, it has to go through a distribution system that can include noise-inducing elements.

Begin by studying the circuits supplying electricity to the various elements of your sound system — don't forget musical instruments and power amplifiers in different parts of the sanctuary from your main mixer and equipment setup.

Have an electrician remove the covers from the wall sockets you're using and do a little reconnaissance. They might run across a socket without a neutral wire or ground, or one with the neutral wires tied together or reversed. In the absence of a paid professional, an inexpensive phase-test plug can help you make these determinations yourself without removing socket cover plates. If any improper wiring is found, have an electrician correct the problems.

Become familiar with current events.

Now examine what else is plugged into the same outlets and what other outlets share the same circuit. Pay a visit to the main electrical box, count the breakers (or, perish the thought, fuses) to see just how many separate circuits are in your church. In many older buildings with less-than-generous electrical service, you may be sharing a circuit with space heaters, motorized kitchen

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We're back!

In our first issue, we dubbed this newsletter an "on-going church sound seminar."

Trouble is, Greg Silsby, the intrepid organizer of this newsletter is also in charge of organizing and presenting actual live Mackie church sound seminars in cities all over America. If you've had the opportunity to hear Greg's presentation, you know he does a great job. However, you can only do a great job in one place at a time. Which has led to Mackie Church Sound Notebook "deadline creep."

Hopefully we've fixed this problem (we taught Greg to type with three fingers instead of two). From now on you can count on a fresh MCSN every quarter.

Sincerely,



P.D. Chihuahua
The real boss around Mackie

MACKIE DESIGNS' QUARTERLY GUIDE TO "BLESSED MIXINGS"

Plugging into the wonderful world of connectors.

Webster's Dictionary defines a connector as "A device that joins or links two items together." Well, probably too loose a definition for us. If your church sound system includes pipe connectors, explosive space shuttle bolt connectors or 556-pin krypton-coated satellite uplink connectors, please send us a photo.

What we're interested in are **analog audio** connectors. Without 'em you'd just have a pile of electronics. With them, you have the magic of a functioning audio system, or total confusion — or a little of both.

It's all semantics, Jack.

A connector is also called a *plug*. As in phone plug. Or RCA plug. It's the (how do we put this delicately...) *male* part of a connector. However, XLR-type connectors aren't called "XLR plugs." Just XLR connectors. Go figure.

The receptacle that a plug plugs into is called a *jack*, or *socket*.

Trick question: What kind of connector should I use?

Actually, it's a trick answer: "Whatever fits the sockets in the equipment." To a certain extent that's correct. Big round XLR-type connectors don't fit into 1/4" jacks. RCA plugs don't work with pro audio amplifiers. But there are enough connector variations to

make this article worthwhile — and "whatever fits" to be only partly the right answer.

Dialing for signals — 1/4" phone connectors.

Quarter-inch phone connectors are one of the most widely used types in pro audio today. They're relatively cheap, quite durable, and got their name because they were actually once used on telephone switchboard

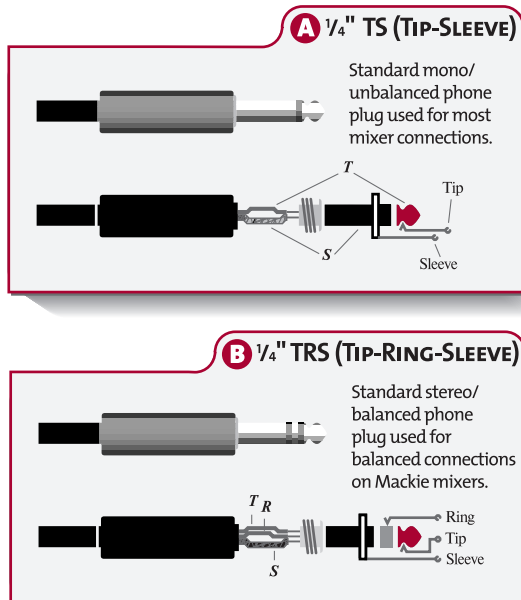
distance runs between high-impedance equipment. The major disadvantage of an unbalanced line is that it's more susceptible to picking up noise (see *A Delicate Balance* on the back page of this issue).

A three-conductor phone plug (Fig. B) has a tip, a ring and a sleeve (TRS). There are three common ways to use this type of connector: First, as a balanced connection which uses two of the conductors (tip and ring) carrying the same signal (one of which is inverted in polarity in respect to the other); while the sleeve acts as a shield. This provides far better noise rejection than an unbalanced connector.

The second use for a three-conductor plug is for headphones. In this circuit configuration, the tip and ring carry left and right stereo channels respectively; the sleeve is used as a ground/return connection.

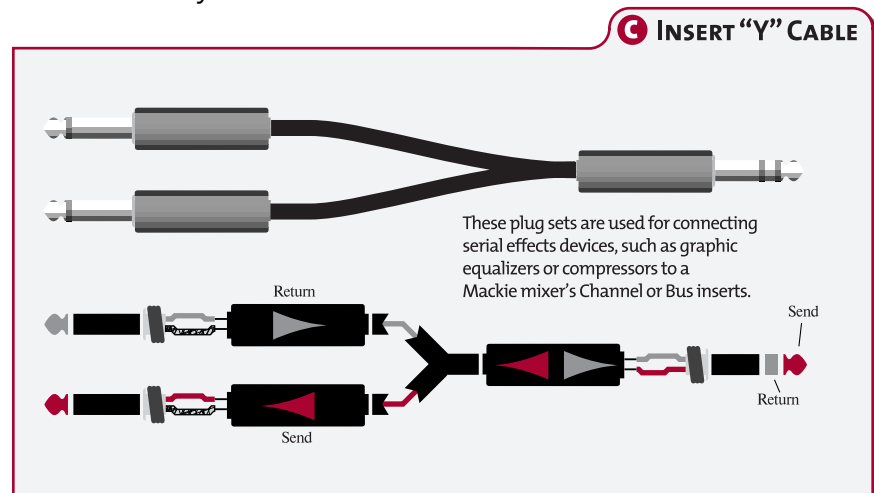
Y? To conserve space...that why.

Finally, you can put the three conductors to work as both send and return lines in a hybrid "Y-insertion cable" (Fig. C). While we didn't invent this, we certainly pioneered its widespread use. When designing our first mixers, Greg wanted to cram every conceivable feature into as small a space as possible. Big mixing consoles



exchanges.

There are two types of 1/4" phone plugs: two-conductor and three conductor. A two conductor phone plug (Fig. A) is a connector that has a tip and a sleeve (which is why jargon-prone pro audio types call them TS plugs). The tip carries the actual signal and the sleeve acts as a ground, or return. This is an unbalanced connection and is mainly used for short-



have a 1/4" socket for signals heading out to outboard processors and another 1/4" socket to receive the signal coming back. Great idea if you have the space. But all you have to do is look at the back of one of our mixers to know that we conserve "real estate" whenever possible.

The Y-insertion cable lets one 1/4" mixer socket handle both input and output. On one end is a TRS (3-conductor) plug; on the other are two TS (2-conductor) plugs. The tip of the TRS connector is wired to the tip of one of the two TS connectors. This unbalanced circuit sends a signal to the input of a signal processor. The ring of the TRS connector is wired to the tip of the other TS connector. This returns a signal from the output of the signal processor back to the mixer, creating an unbalanced effect send/return loop.



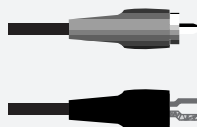
First phones. Now turntables. No wonder this is confusing.

We're talking about phono plugs, also called RCA connectors (Fig. D). Invented by the Radio Corporation of America, they were originally used as an internal chassis connector for radios and phonographs.

Then they evolved into the standard for consumer stereo components such as turntables, VCRs, CD players and cassette decks. Their advantage is that they're extremely inexpensive and can be grouped together in small areas (count how many there are on the back of a typical A/V receiver!). The disadvantages of RCA/phono plugs are that they're an UNbalanced connection...plus they tend to be pretty fragile.

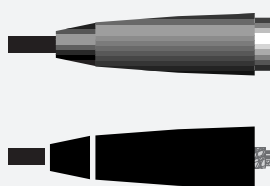
Why do Mackie Designs mixers include phono-style connections at all? Because we know that a lot of consumer audio components get connected to our products — specifically cassette decks and CD players. That's why the TAPE IN and TAPE OUT

D RCA/PHONO



Connection used for consumer electronics such as CD players. Used for tape deck input & output on Mackie compact mixers.

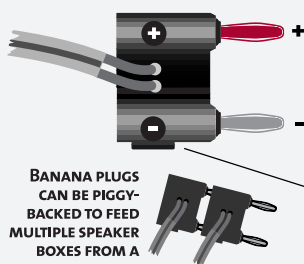
E BALANCED XLR-TYPE



Standard XLR microphone connector

Hot
Cold
Common

F BANANA PLUG



BANANA PLUGS CAN BE PIGGYBACKED TO FEED MULTIPLE SPEAKER BOXES FROM A SINGLE AMPLIFIER.

The **banana plug** provides a quick, positive connection between speaker cables and power amp terminals. **Important!** Banana plugs have definite POLARITY. Look for a little molded RECTANGLE that sticks out on one side of the plug. That's GROUND or MINUS.

sockets on the MS1202-VLZ, MS1402-VLZ, CR1604-VLZ and small SR Series consoles are designed to handle RCA-style connectors.

The biggies: XLR connectors.

Also called Cannon connectors, after the company who first popularized them, these are the serious barrel-shaped thingees most often associated with microphones (Fig. E). Most XLR connectors are balanced and have three wires connected to three separate pins. These connectors are almost always used for low-impedance, balanced connections such as, duh, microphones. Another common use is for cable runs between a mixer and a power amplifier.

The advantage of an XLR connector is that they're extremely sturdy and reliable. They are, however, more ex-

pensive than other types of connectors. If you buy one "off the shelf," it will be wired so that Pin 1 is ground, Pin 2 is "hot" (positive), and Pin 3 is "cold" (negative). Occasionally you will encounter audio equipment that requires a different configuration of hot/cold/ground. Make sure to consult the owner's manual if the standard XLR configuration doesn't work.

BananaRama.

And now for something completely different (Fig. F). A connector that is only used for high-voltage, high-current speaker outputs. Banana plugs provide a tight positive fit into the "5-way binding posts" on professional power amplifiers such as our M•1400i. They're designed to accommodate really thick speaker cable instead of the skinny stuff used for line level audio connections. As you can see from Fig. F, banana plugs can be piggybacked so that one amplifier can drive two

sets of loudspeakers or stage monitors.

Changing genders and species.

Not surprisingly, you're going to encounter situations where the connectors on one audio component don't match those on another — or on the only available hookup cable you can lay your hands on ten minutes before the early service starts.

Adaptors are available for just about every possible combination of connectors including:

- XLR to TRS
- RCA to TS
- mini-phone to 1/4" TS phone
- stereo mini-phone to 1/4" TRS phone
- male XLR to female XLR
- male 1/4" phone to female 1/4" socket

The main thing to remember is no

continued on page 7

Truth turns forty... 40•8, that is.

Waaay back in our first issue, we covered the popular Christian musical group TRUTH. We reported that they had spread God's word through over 8,000 concerts, had logged over two million miles of travel... and really loved their CR1604-VLZ®, MS1202-VLZ® and MS1402-VLZ®. The caption under the photo of live mixing in Nicaragua ended with, "...wait until they get their SR40•8!"

Well, almost two years have passed.

Truth is *still* popular, still ministers through over 300 concerts per year... and really loves their SR40•8.

According to Truth FOH mixer, Justin Zebell (proudly posed at right with their road-cased 40•8), the console truly *is* built to handle the rigors of constant travel. It's been through over hundreds of concerts and counting without so much as a hiccup.

Even if your console stays in one place, you couldn't find a more durable, versatile, large-format mixer for input-intensive music ministries.


The 40•8 output matrix means



that you can set up different stage monitor mixes, create unique mixes for different zones, or separate live feeds for broadcast and taping.

And the intuitive muting system

lets you select common mix combinations (choir plus musicians, soloist plus accompanist, minister plus choir) without changing fader levels.

Call us for more info! 

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TRANSIENT RESPONSE *

...upon seeing an impressive rack of signal processing equipment next to an SR24•4...

Gee, no wonder the choir sounds so good...

* The unsolicited comments of congregation members as they pass by the mixer.



Getting rid of un-joyful noises

continued from page 1

appliances or office equipment that can send buzzes and hum back into the same outlets you're using for electronics. If possible, try to relocate some of these noise-inducing devices to circuits you're not using for sound equipment.

Hum a few bars...

Blame Thomas Edison for that annoying 60-cycle hum that can creep into your system. He advocated alternating current instead of direct current for municipal power delivery systems. The "juice" that comes out of the wall alternates direction sixty times every second. Unless your sanctuary has a pretty awesome system, you're probably not hearing actual 60-cycle (60 Hz) hum...few sound reinforcement systems put out a lot of sound at this low frequency. More likely, the speakers are transmitting *even harmonics* at 120, 240, 480, 760, 1520Hz, etc. But whatever frequency it's audible at, hum is still annoying.

When we talk about reducing hum by level-setting, we're referring to minimizing the hum that is generated in tiny amounts by even the best pro audio electronics.

But the biggest source of hum is caused by poor grounding (you didn't snip off that round ground plug on any of your cords, did you?), or by tightly bundling power cables with audio lines. When running cables from your mixing booth to the front of the church, avoid the temptation to run them right next to each other or worse yet, bundle them with cable ties.

In your equipment rack, use cable ties to group all of the power cords together; then run them down one side of the rack *well away* from audio cables.

Also keep in mind that few electrical circuits are rated for more than 20 amps and most are just 15 amps. If you're sharing a circuit with even one space heater, hot plate or large coffee maker (which often require most of those 15 amps), the additional demand of a couple of power amplifiers can potentially trip the breaker, leading to embarrassing silence in the middle of a service (and a coffee-less Coffee Hour afterwards).

Sound from lights.

To be more exact, *light switches*. Older wall switches can send a disturbing POP back through the line and into your sound system. Turn on your entire signal chain (from mics, instruments, mixer, signal processors, power amplifiers) and then have someone switch lights on and off in all parts of the church building. If you find an offending switch, have it replaced.

Incandescent light dimmers—often used to control key lighting above dais and pulpit areas—are notorious for "broadcasting" high-frequency interference. As part of the same audio system test, have someone slowly turn dimmers from full off to full on. Another method of diagnosis is to tune a battery-operated AM radio to a space between stations. Turn up the volume control. If you hear a hiss, it's okay. If you hear a buzz, it's probably coming from a light dimmer. Again, the solution is to replace the dimmer: newer designs are generally less prone to generating radio frequency interference.

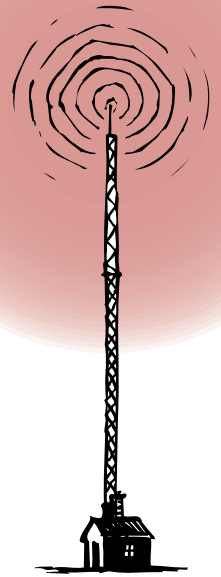
The First Church of The Gigantic Antenna Array.

Ever since Marconi invented the wireless set, radio waves have been collected by stringing a long length of wire and connecting it to a rectifying device. A church sound system roughly fits this description. Every foot of the signal chain can act as an antenna that soaks up *Radio Frequency Interference* (RFI). When you total up all of the mic and line level cable threading through an average sanctuary, you can see the possibilities for getting an unwanted talk radio host or salty truck driver's CB transmission superimposed over a sermon. Along with these obvious intermittent RFI problems there's an even more insidious one: constant low levels of background RFI that

degrade the system's overall signal-to-noise ratio.

While mixers (including our own) do a good job of rejecting normal amounts of RFI, they're all challenged by extremely long cable runs—especially those over 25 feet. If inputs must be far away from you and your mixer:

- 1) use balanced lines whenever possible*, 2) use high-grade cable, 3) consider wireless transmission systems for low level microphone signals.



A guarded note on shielding...

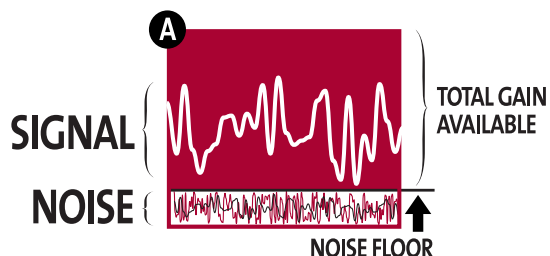
The next layer down below the visible insulation on a cable is the metallic shielding. Braided (woven) shielding provides good protection from electromagnetic interference (EMI). Because it's quite durable and can stand to be bent and kinked, it's used for "exposed" cables such as those used to connect microphones. The tighter the weave of the shielding, the more EMI it can reject. Good-quality cable with dense shielding cable is rated at 80% or better EMI rejection. That's why we suggest "high-grade" cable.

Cable with foil shielding is better at rejecting RFI (Radio Frequency Interference). However, it's much more delicate and should only be used for permanent cable installations (such as those built into a wall).

While Mackie Designs' mixers can suppress most incoming RFI, there's also the problem of cable runs between the mixer output and power amplifier(s). Be sure that you use balanced cables. When using our MS1202-VLZ®, MS1402-VLZ®, SR24•4, SR32•4 or analog 8•Bus, take your amplifier feeds from the balanced

*See "A Delicate Balance", page 8

continued on the next page



NOISE continued from the previous page

XLR outputs instead of the 1/4" jacks.

Needless to say, wireless mics are an RFI

source in themselves.

We won't get into it

here, but the obvious solution is to use high quality wireless systems...and then read the instruction manual carefully and install them right!

Cleaning the tarnish off of the signal chain.

Even if you've followed all of our suggestions and have eliminated all exterior sound problems, your system itself is a whole series of potential noise generators. Improperly adjusted, the finest electronics with pristine specifications can still bury your mix in a sea of hiss and hum.

Here's the reality: Everything in your church's sound system generates noise. The microphones. Electronic instruments. Your mixer and sound processors. And the power amplifiers connected to the speakers. It's a reality of physics and thermodynamics (moving electrons create thermal noise; 60-cycle alternating current causes hum). The engineers at companies like Mackie spend their time coming up with ways to minimize this inevitable noise.

Understanding signal and noise and ratios thereof.

Check out Drawing A at the top of this page. It represents the parts of an audio component's output signal. There's the *signal* (large white line), whose output strength is often variable... and there's the residual *noise* (lower squiggly lines) produced by the component's electronics.

Note that the noise floor stays the

same when you adjust the output level (Drawings A1 thru A3). But the **RATIO** of signal to noise changes.

The idea is to maximize the amount of

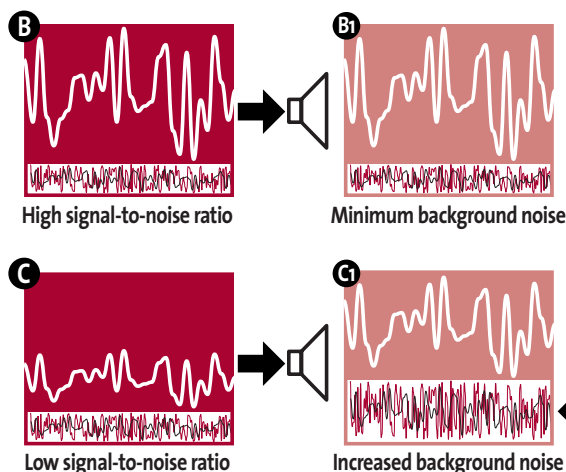
signal so that you have a high ratio of *signal-to-noise*. Drawing B shows a high signal-to-noise ratio. In other

words, more good stuff and less bad stuff. When this signal becomes audible, the noise is very low com-

pared to the signal (Drawing B1).

Conversely, a *low* signal-to-noise ratio (Drawing C) results in more bad stuff and less good stuff — resulting in a higher amount of audible noise at the loudspeakers (Drawing C1).

To review this concept, the amount of noise a component generates internally stays constant. The amount of output gain can be controlled by



the user. When the gain is low, the *apparent* amount of noise is higher — and more audible down the signal chain. What does that have to do with your sound system? Simply this:

Improperly adjusted, electronic instruments, your mixer, signal processors and power amplifiers can ALL individually misbehave like the example in Drawing C. Plus they can boost each other's noise to unacceptably high levels.

Here's an example (Drawing D on page 7). Your congregation's ace MIDI keyboardist is using a tone module with a typically marginal signal-to-noise ratio. To make matters worse, the musician doesn't have the output level set very high (after all, the church bought those super new Mackie M•1400i amplifiers... **they** can do the amplification). So the apparent noise floor is quite high (D1).

You're on vacation and your trusty occasional assistant is running the SR24•4 mixer. Sadly, said assistant hasn't read the delightful illustrated manual and doesn't know *The Secret of Level Setting* (see Issue 1, page 8 of the *Mackie Church Sound Notebook*). The Trim control on the keyboard's mixer channel has been improperly set far too low.

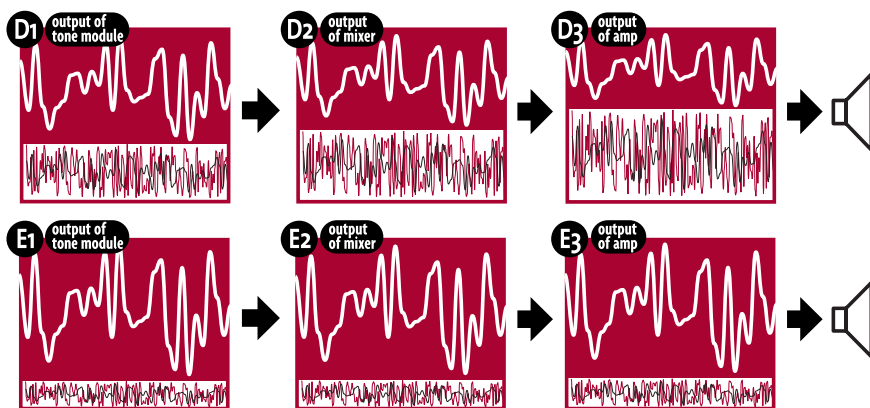
Your stand-in assistant simply takes advantage of all that wonderful gain (amplification) we build into our mixers and boosts the keyboard channel fader a bunch. To the ear, the normally low noise floor of the SR24•4 has apparently been boosted — along with the noise from the keyboard tone module (D2).

Wanting to get full value from the new amplifiers, your assistant makes sure that the input level controls on the M•1400i's are turned way, waaay up. Unfortunately, your assistant has now com-

promised the signal to-noise-ratio of the amplifier as well (D3).

When you return from vacation the next Sunday, you're surrounded by members of the congregation telling you how glad they are to have you back running the sound system — a sure sign things didn't go too well in your absence.

Let's return to the beginning and see how adjusting input and output levels to maximize signal-to-noise ratio could have made your assistant



more popular.

First, the output gain on the keyboardist's tone module should be increased to "lower" the apparent noise floor (E1). That's not to say it should necessarily be turned up all the way. Remember, noise comes out even when no music is being sent to the mixer. Boosting output gain too far also boosts the noise floor. It's a matter of listening and adjusting, then listening and adjusting some more.

Quieting the mixer is a far easier matter. Greg Mackie has always been emphatic about making level setting as easy as possible. Maximizing signal and minimizing noise takes all of ten seconds per mixer channel. When

properly set, the SR24•4 (or any of our other models) will have both head-room **and** extra gain if you need it (E2).

Just as with other electronic components, a power amplifier generates a certain (albeit extremely minimal) amount of hum and hiss. When input levels are properly set, the amp's noise floor is very low and masked by music. But, as with electronic instruments and the mixer, if you force it to "boost" input levels to the extreme, it's also going to have to boost its own apparent noise floor — which results in audible hiss and hum during quiet moments in the service. To avoid this, start at the mixer. At times of maximum volume during the service, for example, during hymns or

a choir anthem with full instrumental accompaniment, try to keep the mixer's master output fader(s) at or just below the Unity Gain setting. Based on that level of output, you can now set the power amplifier's input gain setting. In the case of the M•1400i, that means the -6dB LEDs stay constantly lit and the -3dB LEDs flash occasionally (E3).

At this point, tech support would like to chime in with the warning that there are exceptions to the general rule of keeping output gain fairly high. Some — uh, shall we say *extremely low-budget* — signal processors put out the least noise at relatively low output level settings. In fact, that's why Greg and the engineering department have built extra gain into our aux sends. Sometimes 'tis better to boost the effect at the mixer than at the processor.

This concludes our noisy epic. We hope that at least a few of the tips can help make what comes out of your church's PA system sound better. In a future article, we'll tackle the subject of the actual loudspeakers.

Connectors

continued from page 2

magic happens in terms of balancing or level when you use an adaptor.

For example, you're out of mic preamp inputs on your MS1402-VLZ, so you use an adaptor to convert a low-level balanced input from a microphone into a 1/4" TRS jack. You then plug this into one of the 1402's 1/4" line-level inputs — and discover that the adaptor did NOT magically boost the signal level.

Another example: You read the article on the back page of this issue titled "A Delicate Balance" and appreciate the advantages of balanced cables. You also read your CR1604-VLZ manual and noted that even the line level inputs on each 1604 channel are

balanced. So you connect your CD player (RCA jack) to a 1/4" adaptor... then run a 50-foot cable to the "balanced" 1/4" inputs of the CR1604-VLZ.

OOPS! The sound at the mixer channel, if there's any at all, is weak and lacks high frequencies due to the extremely high capacitance of the long unbalanced cable run. It's also prone to picking up noise. Bottom line: The adaptor did not magically balance the signal.

A cable manufacturer paid us to say this.

In closing, let us exhort you to use the best possible grade of connectors — which often means the most *expensive* grade of connectors. Audio-ophile claims about superior "sound" aside, there's a really practical reason:

high quality connectors are less likely to fail (physically or electrically). They're built to stand lots of hard use such as being pulled out by the cable, a practice that can quickly break a cheap connector with minimal strain relief.

One of the basic rules of live sound is that things will fail at the worst possible moment.

This maxim definitely applies to connectors. If a connector is regularly plugged and unplugged, eliminate problems in advance by choosing a sturdy specimen of its breed. Good ones cost more — and no music ministry budget is ever as lavish as it could be — but by not compromising on cables, you've eliminated a critical variable when it comes to troubleshooting.



- The lavalier mic tips we promised you last issue
- ALT 3-4 mysteries revealed
- The Digital 8•Bus (you can dream can't you?)
- Answers to readers' questions

A Delicate Balance

The term "balanced" crops up constantly in the pro audio world. It applies to cables and of course the connectors on their ends.

If you're not into tech stuff, here's the short version. Balanced lines...

1. ...reject noise better
2. ...let you run much longer cable lengths without signal degradation
3. ...only work if the audio equipment on both ends of the connection is designed to handle balanced signals. Now for the tech explanation.

An unbalanced cable requires only two conductors, "hot" and "ground" (ground returns the signal back down the wire and is not of concern in this brief explanation). The longer a balanced cable is, the more it acts as an antenna to pick up *electromagnetic interference* (EMI) or *radio frequency interference* (RFI).

A balanced circuit has TWO live conductors plus a "ground." Both conductors are isolated from each other

but have the same impedance to ground. They also typically carry opposite polarities.


This double signal conductor system doesn't magically repel noise. In fact, the noise is actually present equally in both conductors. But, because the polarities of the conductors are opposite, the noise is cancelled when it arrives at a balanced input.



the ring is tied to ground through a resistor. Its value mimics the impedance of the tip circuit. Thus when

you plug in a balanced TRS connector, both the tip and ring have identical impedance. That lets our mixers reject common mode (duplicate) noise extremely well.

Does this mean that you can't use unbalanced TS plugs? Nope. Shove an unbalanced connector into a Mackie Designs compact mixer 1/4" socket and mysterious innards automatically unbalance the input and make all the right connections.

Bye for now and stay balanced! 



A balanced cable and plug only work with a balanced socket.

XLR receptacles on the Mackie CR1604-VLZ®, MicroSeries, 8•Bus and SR 24•4/SR32•4 are *active*

(3-conductor) balanced connections. Quarter-inch jacks (except headphone and inserts) are *impedance* balanced and accept TRS plugs. The tip contact carries the signal while

For more information about Mackie products, check out our web site:



www.mackie.com

Want to see our products in color? Want to see more hookups? Why not call us and ask for a copy of IN YOUR FACE? Tell 'em MCSN sent you.

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