HOW TO USE THIS GUIDE ON AUDIO CABLES

"How to choose the Right Audio Cable" is divided into chapters each of which describes a different type of professional audio cable or related topic. The guide initially describes the Universal Attributes of audio cables — which define the real needs of the customers who will use them.

Then, the chapters are broken down into the various cable functions (types):

- instrument cables (the primary cables used to connect guitars, basses and keyboards to their amplifiers or mixers)
- speaker cables, connecting amplifiers to loudspeakers
- microphone cables, connecting microphones to mixing consoles
- patch cables, 100's of "behind the scenes" short jumper cables to connect all the various hardware components to each other
- multipair audio cables (snakes), the audio superhighway between the stage and the soundman
- M.I.D.I. digital cables (AES/EBU and S/P-DIF), to hook up all the new digital equipment

Although the chapters are arranged by product type, they also discuss the proper connecting of equipment for:

- guitarists
- bassists
- keyboardists
- vocalists

The guide also describes various interface (typically black box) products needed to run a bandstand:

- mic splitters and combiners
- line level balancing transformers
- direct boxes (D.I.s if you are British, "direct injection")
- Kwik Fixers, problem solvers for fast-fixes when emergencies occur.

Another topic discussed is getting signals to a monitor system and/or a recording console during live performances.

We talk about a very ignored (really boring) product — the standard A/C electrical extension cord, so necessary to proper band hookup and sound.

Icons at the top of each page will help you to quickly find what cable types you are looking for in the guide. Each chapter will describe a particular cable, tell about different constructions with their pros and cons, include a "Let's get technical" section and a "So, what cable should I buy?" recommendation.

To simplify your selection process, there is a color code by skill level (advanced, intermediate and beginner) to help you discover the best cables for your use, depending on your personal level of performance, your needs, and your pocketbook.


Advanced


Intermediate


Beginner

Be sure to watch for the color-coding that appears throughout the cable guide. The color-coding identifies information and products for beginner, intermediate and advanced performers.

Table of Contents

A little history

Pro Co Sound was founded in 1974 to build portable sound systems for touring musicians. There were no companies manufacturing cables then so, out of self-defense, we learned to build cables that our customers could not break. From 1974 to 1979 we built a touring P.A. (public address) system a day for bands, over 1,500 of them. From 1979 to the present, we have helped over 10 million musicians cable their bandstands, studios and yes, even their bedrooms and basements. In 1979, a friend said we should sell our unbreakable "Lifelines" to musicians. Now Pro Co cables sell in sixty countries and in great music stores everywhere. However, cabling the band was a hobby that got way out of hand. We build over 8,500 different products for our customers every year, and not because we are thrilled about building that many products. It is simply that entertainers need that many cables and related interface products to get their gear to do what they want it to do. **We are, in essence, plumbers to the audio trades; we do whatever it takes to hook up the band.**

CHOOSING THE RIGHT GUITAR CABLES

A guitar cable is the primary cable connecting an electric guitar's output to its amplifier's input or to the input on the first effect pedal in the musician's pedalboard. Guitar cables are also used to hook basses to bass amps and keyboards to mixers. The broad category for these types of cables is "instrument".

Guitar cables are constructed using single-conductor audio cable (also called coax) with an overall shield, terminated in 1/4" phone plugs.

This chapter provides a really quick way to select your next guitar cable, plus it provides lots of information for those of you who want to know more about how your equipment should be connected.

The Benchmark

It is really difficult to buy a really flexible, really reliable, really rugged, really quiet, really great-sounding, really good looking 10' guitar cable for under 20 bucks.

The guitar cable situation

There is a wide variety of guitar cables because there is a wide variety of guitarists. It is almost impossible to get two guitarists to agree on what a truly great "sound" is. Even if they did, one of them would change his/her mind by midnight.

In any case, to keep pace with the needs of this wide variety of players, we build eight different guitar cables in a wide variety of lengths, each with different standards for reliability, shielding, sonic quality, flexibility, appearance and price.

The primary guitar cable is the most abused on stage (besides the lead singer's microphone cable). Therefore, it must be built to withstand extreme trauma during performance. Also, in acts where appearance is critical, it also has to look like a million bucks.

Although the patch cables used between the effect pedals and between the last effect and the amplifier (or pre amp) need to sound good and be very quiet, the stress on them is not as severe as the stress on the primary cable. Light duty patch cables can be used here without much fear of failure. (Wait a minute. This is not a license to go out and buy cheap molded cables for your equipment).

Because of the placement of the output jack on some guitars, a right angle plug may be needed, especially if your output is on the face of your guitar. Not all dealers carry right angle-equipped cables so you may have to special order one if you need it.

Also, for those of you who want to change from one instrument to another quickly on stage, Pro Co builds two "silent plug" equipped cables, each with a mechanical switch on one end that allows quick on-stage transfer from one instrument to another instrument, while preventing "popping" as you change. (The tip on a regular plug hits ground as you plug and unplug without turning down your amplifier, and this makes an irritating pop.)

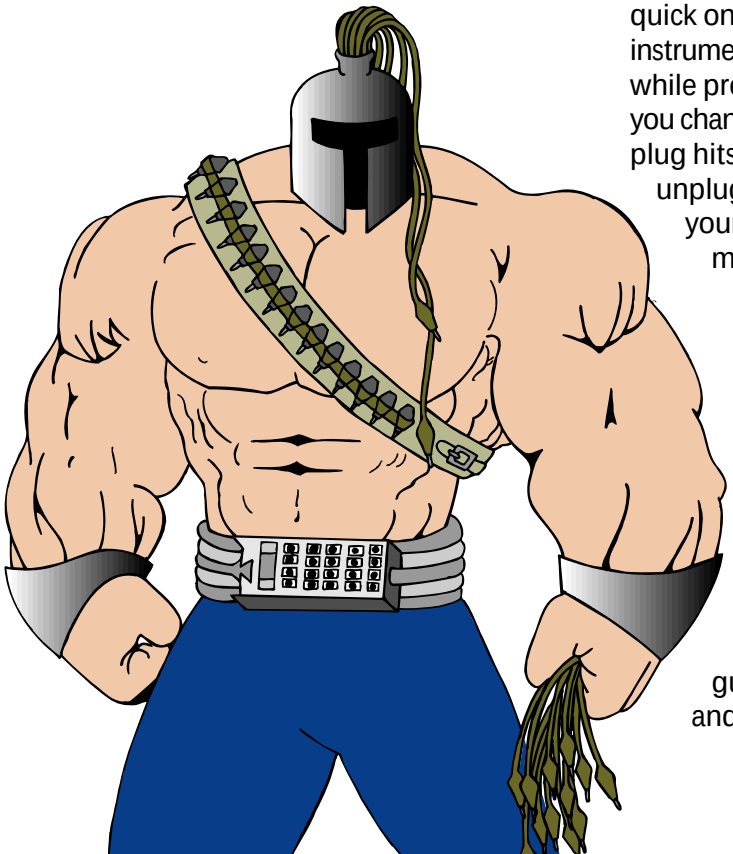
The Quick Way

(for those of you with only 30 seconds to spend on this purchase decision)

Ask yourself:

Do I only want an inexpensive 10' guitar cable?
If so, your base price is $5.00
Do I want it to be reliable?
If so, add five bucks $10.00
Do I want it to be quiet, with no hum or buzz?
If so, add five bucks $15.00
Do I want it to be flexible?
If so, add five bucks $20.00
Do I want it to sound good?
If so, add five bucks $25.00
Do I want it to look great?
If so, add five bucks $30.00
Do I want it to last forever and be guaranteed, regardless of cause, event abuse?
If so, double the price $60.00

"One of my problems is when the musician stomps his/her boot heel into the cable 500 times an hour on stage."



The real world problems with guitar cables

Guitar cables have all sorts of potential problems. They are noisy. They are stiff and do not lie flat on stage (this alone is a huge irritant to players). Many guitar cables are unreliable and/or intermittent.

One of the biggest problems is when the musician stomps his/her boot heel into the cable 500 times an hour on stage. Cables literally get destroyed through use.

Then, when the gig or rehearsal is over, cables get wadded up and stuck in the back of the guitar amplifier because they will not fit in the guitar case.

There are ways to wind cables so they stay nice and round. The 55 people on earth who do this correctly have cables that will last a lifetime. This section is for the rest of you.

It is really difficult to buy a really flexible, really reliable, really rugged, really quiet, really great-sounding, really good looking 10' guitar cable for under 20 bucks.

The solutions

Here are the three most important rules governing guitar cables:

Rule One for guitar cables is, "Buy the shortest cable you can live with".

Rule Two for guitar cables is, "If it doesn't have a copper tip on the connectors, don't buy it."

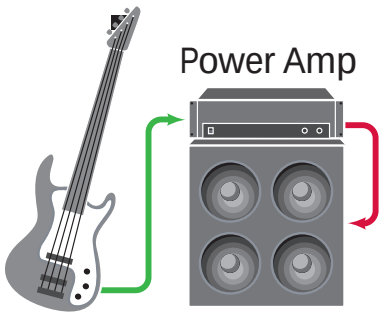
That's because the only 1/4" plugs we believe in are Show Savers™ brand, 100% made in America by G & H Industries in Centerville, Michigan. These are the best plugs made for musical instrument cables on the planet and are the only 1/4" plugs we will use for our guitar cables.

Rule Three for guitar cables is to "find a cable that is as flexible and tangle-free as you need for your performance". The wire in your cable must be flexible and sturdy. "Thin" is generally not as reliable as "thick" cable, and thin is generally not as flexible as thick (yet, "thick" can also hide a multitude of "cheap").

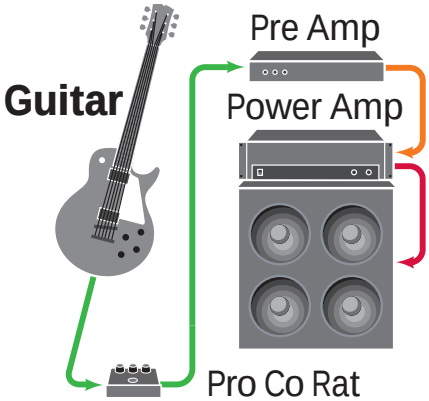
The things that matter most in guitar cable construction are strength, flexibility, sonics, shielding and appearance.

Strength in a guitar cable's wire is derived from the size (gauge) of the center conductor, the type and percentage of coverage of shield, the thickness and material making up the jacket and in the case of Pro Co's Guardian brand of cables, Kevlar-in-the-core, to prevent cable stretching and breaking — forever.

Flexibility in a wire is accomplished with the type of shield and its lay (pattern), flexible jacket compounds help, cable geometry helps (the way



Bass Guitar



Let's talk technical about guitar cables

There is a natural roll-off of high frequencies (they get "quieter") in any high impedance cable that is caused by cable capacitance.

This is also enabled by guitar pickups which have a very high output impedance. (There are active guitar pickups available, with line level outputs which correct this problem.)

Depending on you ears, you will begin to notice this roll-off around 20' to 25'. This may or may not irritate you. If it does, use a shorter cable.

Capacitance is measured in picofarads per foot (pf/ft) and should be in the mid 20's to high 30's for a satisfactory guitar cable. Over 40 pf/ft., the high end drops quicker. Under 20 pf/ft. the high end is great, but the cable becomes extremely microphonic (mechanically noisy) as you move around on stage.

Many cheap guitar plugs use steel center conductors for strength. Steel is a poor conductor for audio and can set up a magnetic field, which severely distorts the sound that goes through it.

We use only G & H Industries Show Saver brand plugs in all our guitar cables. Their center conductors are 12 gauge oxygen-free copper — the best practical conductor for audio cable.

One of our competitors talks about how their cable improves your sound. We don't believe that for a minute, but even if a passive component like a cable could change your sound (oh, they change it all right by designing a capacitor into the wire, which does as much bad as good), we think cables should take what came in one end and deliver it to the other end with no change. If you want a different sound, that's why the Gods of the audio industry made tone controls, equalizers and processing equipment. We believe in making all attempts to send signals to your equipment, unaltered, from one component to another — flawlessly.

CHOOSING THE RIGHT GUITAR CABLES

it all fits together), the thickness of the outer jacket (the bigger the better) and the number of strands in the center conductor.

With good plugs and good wire and good soldering and a good mechanical strain relief, we generally get a good cable.

Appearance is in the eye of the beholder and the need for an attractive, or flat-out exotic cable depends on personal preference and the visual aspects of the performance. We think cables should at least look like they were worth what you paid for them.

Guitar cables carry minuscule signals that must be kept away from noisy light dimmers and audio frequency interference that can jump into a cable's signal path at any time. The cable's shield helps to prevent this. Braided shields work better than spiral shields, but they tend to saw themselves in two when you stomp your boot heel into them night after night. Shielding is so important that there is an entire chapter devoted to it in this guide.

Appearance is in the eye of the beholder and the need for an attractive, or flat-out exotic cable depends on personal preference and the visual aspects of the performance.

Finally we need to talk about "sonics", how our cable sounds. A beginning guitarist who cannot yet tune his/her guitar on the fly, does not need to have a real good cable. Anything will do, as long as it works and is relatively quiet (lets in little hum, buzz or crackle).

We can now put all this together so you can start making decisions about your next guitar cable purchase:

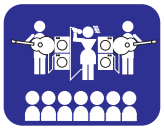
Since we said earlier that a really good 10' guitar cable is going to cost you $20 or more and say you want to buy one for $10, what would you want us to leave out to get the cable down from $20 to $10?

- We can make the cable shorter. How about 3 inches?
- We can get rid of some of the shielding and add lots of buzz.
- We can extrude a thinner jacket on the cable, reducing reliability and flexibility.
- We can put less copper in the center conductor, reducing the cable's reliability.
- We can add clay to the jacket, replacing some of the exotic compounds we have designed to improve flexibility, sound and long flex life. It will look the same, but for a lot shorter period of time.
- We can use plugs which are sturdy but change your sound.

A final thought. Warrantees and well-built products often have nothing to do with each other. Cheap cable manufacturers put "lifetime" warrantees on poorly built cables, hoping you will just throw them away as they break. Or worse yet, do not put their company's name on the wire jacket, so that, when you need to use the warranty, you cannot determine who built the product or where you got it. That does not help much when it breaks during the best solo of your life or the best take of the day. Buy the good stuff. Ten years from now, when you get bored with your cable, then throw it away and buy another Pro Co cable for the next ten years of boring absolute reliability.

To find out what really matters to you, take the following test. When you are through, add up the points you have scored then decide which cable is right for you.

So, what kind of guitar cable do I need?

		Pro Co Brands:		
	**Advanced**	Defender	$57.50	(also available with right angle plug)
		Sir Tweed	$57.50	(also available with right angle plug)
		Black Jack	$57.50	
		Excalibur	$40.18	
	**Intermediate**	Line Cable	$21.35	(also available with right angle plug)
		Starguard	$20.95	(equipped with Silent Plug)
		Silent Knight	$15.73	(equipped with Silent Plug)
	**Beginner**	Excellines	$13.10	(also available with right angle plug)

How to choose the right guitar cable for you

Circle the right fit for you

Flexibility											
Doesn't matter much to me	1	2	3	4	5	6	7	8	9	10	My cable must lie down flat and follow me everywhere
Reliability											
I don't abuse my cables	1	2	3	4	5	6	7	8	9	10	My cables must be bulletproof. I stomp on it with my boot heel 500 times an hour
Sonics											
I can't hear the difference	1	2	3	4	5	6	7	8	9	10	I want to hear the natural sound of my guitar, with no change in tone from my cables
Shielding											
A little noise is OK with me	1	2	3	4	5	6	7	8	9	10	I want a dead quiet rig — no noise, just my music
Appearance											
All I want is a sturdy cable that works	1	2	3	4	5	6	7	8	9	10	A professional, even flashy look is important to my show

Attributes	**Add up your points below**
Flexibility	_____
Reliability	_____
Sonics	_____
Shielding	_____
Appearance	_____
Total Points =	_____

Suppose your points are dollars. Which cable is best for your use?

Pro Co's Instrument Cables

	10' MSRP		10' MSRP
Black Jack	$57.50	Lifelines	$21.35
Defender	$57.50	Star Guards	$20.95
Sir Tweed	$57.50	Silent Knight	$15.23
Excalibur	$40.18	Excellines	$13.10

CHOOSING THE RIGHT MICROPHONE CABLES

In this chapter, you will learn about microphone cable construction and selection with recommended products for various types of use. We will cover:

- XLR connectors
- Balanced and unbalanced connections
- Wiring of the different types of microphones
- The right wire for microphone cables, including shielding
- A short section for vocalists only

Benchmark

It is really difficult to buy a really flexible, really reliable, really quiet, really good-sound, really good-looking 25' microphone cable for under 30 bucks.

The mic cable situation

Microphone cables connect microphones to mixers (desk, consoles, whatever you want to call them). In pro audio, microphones are low impedance (Lo-Z) and are terminated in 3-pin XLR connectors.

Pin 1	(X)ternal	Shield
Pin 2	(L)ive	Hot (+)
Pin 3	(R)eturn	Cold (-)

Another typical configuration is emerging which includes an XLR female (the output of all professional microphones is a 3-pin XLR male)

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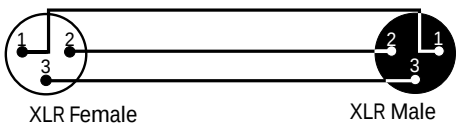


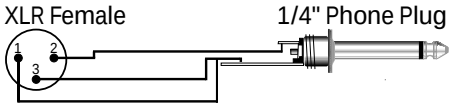
XLR Female XLR Male

Lo-Z Microphone Cable

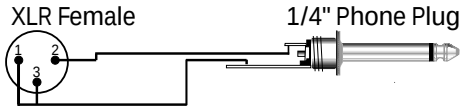
"One of my problems is making sure the minister does not trip on a microphone cable."

connector to a 3-pin mini male (1/8" or 3.5mm) connector for inputs to laptop computers and other devices where space is at a premium.

Most professional mixer's microphone inputs are designed with "balanced" circuits to help decrease or eliminate noise and unwanted radio frequency interference (RFI). The understanding of balanced circuits and low-impedance is complicated and is addressed in Pro Co's white papers on microphone cables, which can be found at our website: **www.procosound.com.**



Lo-Z Unbalanced Microphone Cable



Hi-Z Microphone Cable

Lo-Z Microphone cables can also be wired "unbalanced" and "Hi-Z" (high impedance) microphones are available, for high impedance sound systems (didn't take long to get confusing, did it?).

Hi-Z cables allow the user to plug a Hi-Z microphone directly into the input of, say, a guitar amp or the input of a Hi-Z mixer.

Lo-Z to Hi-Z Transformer

Unbalancing a balanced microphone by using an unbalanced cable allows it to sometimes be used in the input of a Hi-Z mixer. This does not always work, depending on the input impedance of the mixer. When this does not work, a Lo-Z to Hi-Z transformer must be placed in line at the end of a standard Lo-Z mic cable. These commercially available transformers make the proper change from XLR to 1/4" for you.

The real world problems with microphone cables

The quality and type of cables needed depend on the application:

"Cannot fail" situations:

- Cables used for live concerts, amateur and professional, TV/ Radio recording and broadcast, ENG (electronic news gathering), recording studios and churches and all other situations where perfection is demanded and failure and noise are not options.

Brutal environments:

- Workhorse cables for touring bands and hard use situations such as A/V (audio visual) rental.

Normal duty use:

- Light-duty church and auditorium use, weekend bands and rehearsal halls.

Light duty/little use

- Beginner use and "thrown-in-with-the-deal" while buying the microphone, that work enough to get you started.

Mission Impossible:

- Lead signers in rock bands who tend to try to destroy mic cables, a real life test of durability.

Note: With the addition of Kevlar to our Ameriquad and Merlin brands of microphone cable assemblies (1998), these cables can be used in situations where everything else breaks.

The Solutions

About Microphone Wire

Microphone wire consists of a twisted pair of copper conductors (typically 22 - 24 AWG — American Wire Gauge). These conductors are covered with one of three types of shielding: braided, spiral (also called "serve" shield), and foil shielding which includes a drain wire. Foil shields work great in snakes, but prove to be unreliable in cables designed for portable use.

Braided shield is best for mic cables and spiral is a little more flexible and less expensive than braid.

Microphone Connectors

XLR audio connectors come in a variety of contact materials, gold, silver and tin. The trade generally likes silver for sound, gold for tarnish-free contacts and tin for price.

With the addition of Kevlar to our Ameriquad and Merlin brands of microphone cable assemblies (1998), these cables can be used in situations where everything else breaks.

There are about four good suppliers of XLR connectors on the planet and 20 or so copy houses, which wreck havoc on the trade, since they look like industry standard connectors, but are not properly dimensioned.

Microphone cables, unlike guitar cables, use a female connector on one end and a male connector on the other. This enables microphone cables to be daisy-chained, hooked end to end, to increase length when necessary.

This requires a very narrow tolerance for size and pin locations in the connectors, to ensure that the female XLR (the one with the locking mechanism) will lock and unlock when mated to its male counterpart.

Complicating these problems is one manufacturer in America who uses English measurements, a lot of oriental copiers who have approximated the English measurement with metric measurements, and the manufacturers who are not copiers and make great, "to spec" connectors using metric measurements.

Yup! You guessed it. There are compatibility problems. Furthermore, there are some budget minded equipment manufacturers who will use oriental knockoffs in their back panels, exacerbating the problem.

This gets you a cheaper price on the original unit and lots of headaches hooking it up, night after night.

Aside from these occasional compatibility problems and types of connector contact finishes, most XLR connectors will work just fine for most situations. We suggest buyng cables which use Neutrik or Amphenol (the original ITT-Canon) connectors for best results.

Let's talk technical about mic cables

Try at all costs to avoid Hi-Z and Lo-Z unbalanced mics. You are not doing your performances any favors by using these products, regardless of price.

4-conductor (quad) mic cable is so dramatic in its noise reduction that the only reason not to use quad mic cables everywhere in your sound system is price.

As sound system operators find out how much quad mic wire reduces noise compared to well-designed and built two conductor assemblies, they are turning to the wire as a logical step up in their system performance.

A friend of Pro Co's, who operates several county fair P.A. systems, working in the absolutely worst conditions imaginable, has found that with the use of Pro Co's Ameriquad wire to help eliminate "hiss" from his systems, that the artists, often times, are unable to detect that the sound system is "on". They are so used to listening to hiss as an indicator that the equipment is working that this unsettles them greatly. From an engineering standpoint all we can say is, "We get it right and they still complain". Good grief!

CHOOSING THE RIGHT MICROPHONE CABLES

Solutions

Most professional Lo-Z microphone outputs can easily be run up to 500 feet. However, Hi-Z microphones have the same roll off problems that guitar cables have and their lengths should be limited to 20' or less to avoid high frequency attenuation.

Microphone wire comes in a wide variety of diameters. Lavalier mics require tiny, yet sturdy cables. Nature-sound recording enthusiasts need small cables that will roll up into the compartment provided in their Nagra tape recorders to conserve space. Most microphone cables are about the diameter of a normal pencil (1/4") to provide the user with a reliable cable.

We have found that to present an audience with totally no-hum, no-buzz, no-crackle sound systems requires the use of quad (4-conductor) microphone cables.

In situations such as TV studios with huge hum fields created by TV cameras and county fairs with lots of stray radio frequency interference, 4-conductor mic cables can lower hum and noise up to 20 dB (20 decibels — a lot) comparted to any two-conductor microphone cable.

XLR Female to XLR Male Balanced Lo-Z Microphone Cable

XLR Female to Balanced Mini (1/8") Male Microphone Cable

XLR Female to Unbalanced 1/4" Phone Plug,
either Unbalanced Lo-Z or Hi-Z depending on how it is wired

Why does quad mic cable work?

For vocalist only: spending more on a great vocal mic that sounds like you, and picks up your tone and your emotions, is something you owe yourself and your audience.

Here's the easiest way to think about it. Balanced mic cables are quieter than unbalanced mic cables because 1/2 of the signal travels on one of the two conductors and they tend to cancel out extraneous signals that jump on both conductors. The tighter the two conductors are twisted together, and the shorter their twist, the better the wire is at canceling out noise. When two pairs of conducts are twisted together (four conductors total), this makes the conductors much more tightly wound, and, subsequently, ten times better at defending against interference.

25' Lo-Z microphone cables run in price from about $15 to $75, depending upon the connectors and wire used. The watertight cables used to film the "Titanic" are worlds apart from the "thrown-in-with-the-mic" cables given away by retailers to "clinch the deal".

So, what kind of mic cables do I need:

	Pro Co Brand	25' Model #	MSRP
Advanced	Merlin	ME-25	$77.50
	Ameriquad	AQ-25	$50.00

If you are an advanced play, look for a cable with: a braided shield, 95% or better shield coverage, gold contacts, Kevlar reinforced core and 4 conductor cable.

Intermediate	Mastermike	M-25	$38.75

If you are an intermediate player, look for a cable with: a braided shield, 90% + shield coverage and silver/gold contacts.

Beginner	Excellines	EXM-25	$28.70

If you are a beginning player, look for a cable with: a spiral shield, 70-90% shield coverage and silver/tin contacts.

For vocalists only

Your microphone is your instrument. There are wireless mics now that sound nearly as good as mics with cables and allow you complete freedom of motion on stage. That is, when they cost $3,000 each.

For the rest of you, spending more on a great vocal mic that sounds like you, and picks up your tone and your emotions, is something you owe yourself and your audience. It also has to have great feedback rejection if you are using a monitor system.

If you have spent the money to get yourself a great microphone, get a great cable to go with it, one that transmits your sound and your emotions to your audience, without noise and without adding any tone of its own. We build cables that can to that. They are called "Merlin", and they are truly magicians at work.

A LOT ABOUT SHIELDING

In this chapter, you will learn way more about shielding than you need. We'll start with what shielding does. Then we will discuss what makes one shield better than another and talk about the characteristics of each and which is "best".

What does the shield do?

The copper shield of a coaxial cable acts as the return conductor for the signal current and as a barrier to prevent interference from reaching the "hot" center conductor. Unwanted types of interference encountered and blocked with varying degrees of success by cable shielding include radio frequency (RFI) (CB and AM radio), electromagnetic (EMI) (power transformers) and electrostatic (ESI) (SCR dimmers, relays, fluorescent lights).

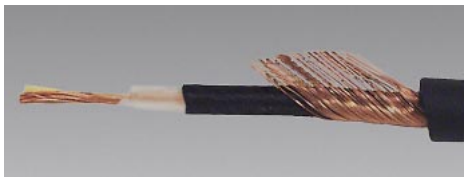
What makes one shield better than another?

To be most effective the cable shield is tied to a ground — usually a metal amplifier or mixer chassis that is in turn grounded to the AC power line. Cable shielding effectiveness against high-frequency interference fields is accomplished by minimizing the transfer impedance of the shield. At frequencies below 100 kHz, the transfer impedance is equal to the DC resistance — hence, more copper equals better shielding. Above 100kHz the skin effect previously referred to comes into play and increases the transfer impedance, reducing the shielding effectiveness. Another important parameter to consider is the optical coverage of the shield, which is simply a percentage expressing how complete the coverage of the center conductor by the shield is.

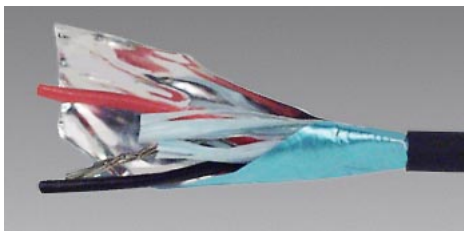
What are the characteristics of the three basic types of cable shields? Which is best?

A braided shield is applied by braiding bunches of copper strands called picks around the insulated, electrostatically shielded center conductor. The braided shield offers a number of advantages. Its coverage can be varied from less than 50% to nearly 97% by changing the angle, the number of picks and the rate at which they are applied. It is very consistent in its coverage, and remains so as the cable is flexed and bent. This can be

Braided Shield



Spiral Shield



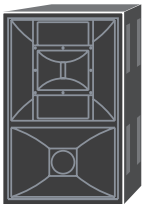
Foil Shield

crucial in shielding the signal from interference caused by radio-frequency sources, which have very short wavelengths that can enter very small "holes" in the shield. This RF-shielding superiority is further enhanced by very low inductance, causing the braid to present a very low transfer impedance to high frequencies. This is very important when the shield is supposed to be conducting interference harmlessly to ground. Drawbacks of the braid shield include restricted flexibility, high manufacturing costs because of the relatively slow speed at which the shield-braiding machinery works, and the laborious "picking and pigtailing" operations required during termination.

A serve shield, also know as a spiral-wrapped shield, is applied by wrapping a flat layer of copper strands around the center in a single direction (either clockwise or counter-clockwise). The serve shield is very flexible, providing very little restriction to the "bendability" of the cable. Although its tensile strength is much less than that of a braid, the serve's superior flexibility often makes it more reliable in "real-world" instrument applications. Tightly braided shields can be literally shredded by being kinked and pulled, as often happens in performance situations, while a spiral-wrapped serve shield will simply stretch without breaking down. Of course, such treatment opens up gaps in the shield which can allow interference to enter. The inductance of the serve shield is also a liability when RFI is a problem; because it literally is a coil of wire, it has a transfer impendance that rises with frequency and is not as effective in shunting interference to ground as a braid. The serve shield is most effective at frequencies below 100 kHz. From a cost viewpoint, the serve requires less copper, is much faster and hence cheaper to manufacture, and is quicker and easier to terminate than a braided shield. It also allows a smaller overall cable diameter, as it is only composed of a single layer of very small (typically 36 AWG) strands. These characteristics make copper serve a very common choice for audio cables.

The foil shield is composed of a thin layer of mylar-backed aluminum foil in contact with a copper drain wire used to termintate it. The foil shield/drain wire combination is very cheap, but it severely limits flexibility and indeed breaks down under repeated flexing. The advantage of the 100% coverage offered by foil is largely compromised by its high transfer impedance (aluminum being a poorer conductor of electricity than copper), especially at low frequencies.

CHOOSING THE RIGHT SPEAKER CABLES



Speaker cables hook audio amplifiers to speaker cabinets.

Benchmark

The ideal speaker cable has zero-length wire, with no resistance, no capacitance, no inductance, and no change in sound from amplifier to speaker.

The ideal speaker cable does not exist. In its place are literally dozens of hi-fi speaker cable companies touting that their tech-babble-supported cable is a lot better than those other pseudo-voodoo-audio guys. Most of these companies know nothing about live sound and stay out of our hair. A couple of them have wandered into our market, clouding the main issues with lots of technical nonsense.

Speaker cable selection depends on the output connectors on your power amplifier and the input connectors on your speaker cabinet, which have been pre-determined by their manufacturers.

Regardless of which connectors you need on either end, cable manufacturers make cables with all the combinations you will need. Your responsibility is to buy the absolute shortest speaker cables you can use with the absolute largest conductors you can afford.

The speaker cable situation:

Because live performance has acoustics (often rotten) to deal with — acoustics that you do not have in your home hi-fi or home theatre, there are lots of problems to deal with besides exotic cables. We believe that current needs copper and lots of it. More about this later.

At Pro Co we believe in two basic rules for speaker cables:

- Less is best. Buy the shortest cable possible for the application.
- More is best. Buy the largest gauge speaker cables you can afford (the smaller the gauge number, the bigger the wire. Go figure.)

The three basic types of connectors used for speakers in live performance are: 1/4" connectors (the same ones used in your guitar's output), dual banana plugs (designed 50 years ago to connect test leads to diagnostic equipment, many of which are too small or cheaply made in the orient and will not hold together), and Neutrik Speakons, wonderful connec-tors designed specifically for speaker applications. There are other methods of connecting amplifiers to speakers (spade lugs, bare wire) but these three connectors, 1/4" phone plugs, dual banana plugs and Speakons are the three standards. We suggest you use only G & H Industries Show Savers 1/4" plugs and their Boss dual banana plugs with all speaker cables needing these connectors.

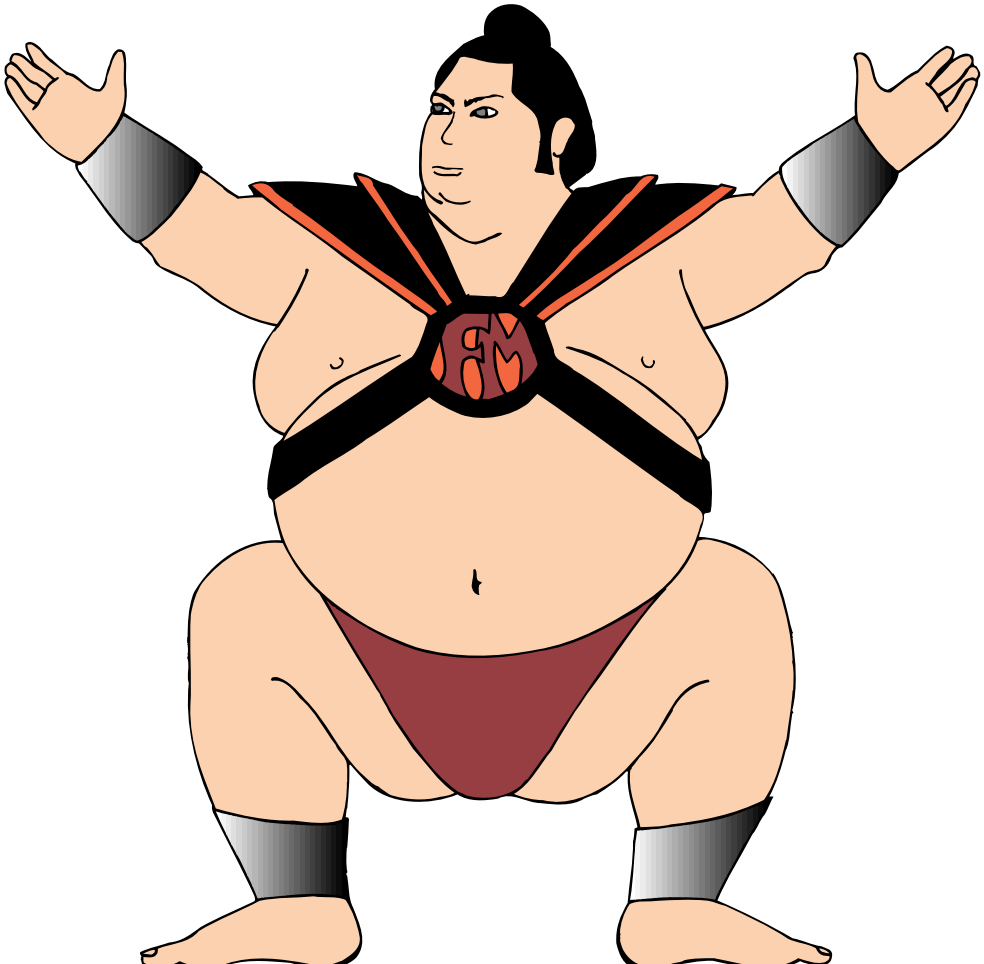
The ideal speaker cable has zero-length wire, with no resistance, no capacitance, no inductance, and no change in sound from amplifier to speaker.

Speaker level is not the place to buy cheap cables. If a speaker cable shorts out, the amplifier's protection circuit will turn on (hopefully) during performance to protect the amplifier from damage. Also, (hopefully) the amp's protection circuit will turn off after the cable is replaced so the show can go on.

Having intermittent signal at speaker level because of faulty cables is a very bad thing to have happen to your audience.

Besides being reliable, speaker cables need to be flexible. Flexibility comes from using more (smaller) stranding in the conductors of the wire. The smaller copper stranding has to be drawn through smaller and plugs and new banana plugs and we

One of my problems is teaching technicians that "Current Needs Copper."



smaller dies, taking longer to manufacturer than larger strands thus they cost more. Flexibility also is enhanced by using fillers in the cable to make the wire round and easy to coil and uncoil. Using larger strands of copper and no filler is cheaper, but creates handling problems that just aren't worth the few extra bucks difference.

The real world problems with speaker cables

Getting back to **current needs copper**, there are two basic specifications to discuss regarding speaker cables:

- Loss of power in the wire as heat (because of resistance).

  This loss of SPL (sound pressure level) caused by different gauges of speaker cables is basically unnoticeable in live performance, yet loss of power is talked about all the time because it is an easy concept to discuss.
- What is more important to discuss is damping factor, a complex concept which matters more to your sound and is not easy to discuss.

Mackie Designs, says, "Damping factor is a number that represents the ratio of the impedance of the load (speaker) to the output impedance of the amplifier. In practical terms, it is a measure of how well the amplifier can control the movement of a speaker's cone. The greater the damping factor, the better its ability to control the cone's movement. A low damping factor (under 20) allows a woofer to continue to move after the signal stops, resulting in an indistinct and mushy low frequency response.

Once the damping factor increases beyond 200, the audible effects of the damping become vanishingly small.

Community Professional Loudspeakers' Chuck McGregor continues the explanation:

"The main effect of damping in a loudspeaker is to reduce the SPL produced by the loudspeaker's diaphragm moving because of its own inertia after the signal stops. The frequency of the sound it produces with this movement will be at the resonant frequency of the moving system. A common term for this is "overhang". In severe cases this can translate into "one note bass". Your bass guitar no longer sounds like you bass guitar; it sounds like the free air resonance of your speaker cabinet. Yuck.

Your responsibility is to buy the absolute shortest speaker cables you can use with the absolute largest conductors you can afford.

The Solution

To repeat this for the third time, "Current Needs Copper". We make cables using wires with these gauges: 16 ga., 14 ga., 13 ga., 12 ga., 11 ga., 10 ga. and 8 ga.

Pro Co makes 8 gauge cable for all industry standard connectors normally used. However, G & H Industires had to design new 1/4"

Let's get technical about speaker cables:

Flexibility in speaker cables comes from using high strand count conductors. Pro Co uses the highest standard strand count available in all its speaker cables to enhance flexibility. Underneath the outer jacket, the two (or four) conductors are twisted about each other. The length of each twist helps to determine the flexibility of the assembly.

In an emergency, if the connectors are compatible, a guitar cable can be substituted for a speaker cable for a short period of time. It's tiny center conductor will cause great resistance compared to its larger shield gauge, and will cause power loss and poor damping factor. It may cause damage to your power amp as well.

Conversely, if a guitar cable goes bad, never, never, never use a speaker cable to replace it. The hum (the speaker cable has no shield) will be so bad that you will not be able to stand it. This will give you a real good indication of why we need good shields in microphone, instrument and digital cables.

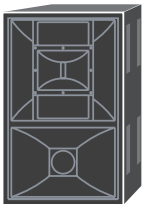
Pro Co is heading, as quickly as possible, away from soldering as a termination technique. Solder is not a particularly good conductor and the ability to make good quality solder joints is an art that takes many years to perfect (as least we spend that much time with our assemblers working on improvement).

Two relatively new termination techniques have gained interest in audio cables. The first is currently used in microphone cables and is called IDC (insulation displacement connector), and we have had excellent results in the past five years with our Excellines mic cables using this construction.

The other is ultrasonic welding, a cold weld process where the plug terminal and the wire are scrubbed and compressed at the same time, literally bonding the brass terminals to the copper wires (brass is 70% copper) in under a second. All 8 gauge Pro Co cables are ultrasonically welded to their terminals.

Both techniques create solid connections (IDC connectors require a sturdy strain relief), take very little time for human beings to master, and sound better than their soldered counterparts.

CHOOSING THE RIGHT SPEAKER CABLES



had to create methods to allow us to fit the 8 gauge Fat Max wire into Neutrik Speakons. Also, because we know that getting as much DC (direct current) resistance out of our speaker cables is best for you, we do not solder the 8 gauge cables. We ultrasonically weld our 8 gauge cable to its especially-designed terminals. This reduces DC resistance in the cables to an immeasurable number, and creates a cable worthy of a place on any stage on earth.

So, what kind of speaker cable do I need?

		Pro Co Brand	50' Model #	MSRP
	**Advanced**	Fat Max	FM-50	$185.00 8 gauge
		PowerPlus	S12-50	$75.95 12 gauge
	**Intermediate**	Excellines	S14-50	$50.78 14 gauge
	**Beginner**	Excellines	S16-50	$37.73 16 gauge

These prices are for 1/4" to 1/4" cables only. Dual bananas cost about the same as the quarter inch products. Neutrik Speakons are a few dollars more.

Here are the statistics, if you are interested

Pounds of copper in 25' of speaker cable (both conductors):

Gauge	Pounds of Copper
16 gauge	0.39 lbs.
14 gauge	0.62 lbs.
12 gauge	0.99 lbs
10 gauge	1.53 lbs
8 gauge	2.50 lbs

Length of cable that can be made with one pound of Copper:

Gauge	Length of Cable
16 gauge	64.0'
14 gauge	40.2'
12 gauge	25.3'
10 gauge	15.9'
8 gauge	10.0'

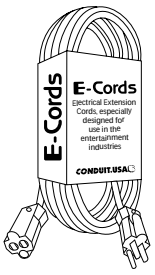
	Damping Factor at 8 ohms				Damping Factor at 4 ohms			
Gauge	**10'**	**25'**	**50'**	**100'**	**10'**	**25'**	**50'**	**100'**
16 gauge	90	38	21	10	45	19	10	5
14 gauge	138	60	31	16	69	30	16	8
12 gauge	201	91	48	25	101	46	24	12
8 gauge			113	64			56	30

Damping factor must be 20 or above to optimize live performance. Damping factor over 200 will add no appreciable performance to the system. Note: the damping factors noted above in red are acceptable for use at the stated length and impedance (in ohms), but they are in no way optimized for reduction in power loss.

Damping factor at the outputs of the amplifier must be added to the damping factor of the cables to arrive at the system damping factor (alas, there are also more factors to consider that just these to determine an optimum system, but this represents the lion's share need to make a decision).

Gauge acceptability for run lengths are noted above in red. Pro Co's recommendations are to use 16 gauge under 25 feet, 12 gauge under 100 feet, and if you can afford it, use 8 gauge everywhere.

CHOOSING THE RIGHT A/C EXTENSION CORDS



A/C electrical extension cords hook the power cords of musical equipment to whatever A/C power source is available. The power source may be the outlets on the stage, your own "clean" power distribution system or a generator at outdoor concerts.

Nobody knows much about power cords, because they are an essential part of our lives. Most of the power cords we use on stage are too small a gauge and are orange (ugly).

Benchmark

Nobody knows much about power cords, because they are an essential part of our lives. Most of the power cords we use on stage are too small a gauge and are orange (ugly).

Pro Co is going to raise the bar on this sorry benchmark, if (and it will) it takes 20 years to do it.

The situation

Electrical extension cords are a way of life for electronic musicians. Everything with a power cord or an outboard power supply (wall wart) needs to end up in a power strip or A/C cord.

Since music stores do not yet sell the proper A/C cords that musicians need, the musicians buy their audio cables at the music store, then go to Home Depot to buy their orange 25', 16-gauge $4.99 economy-deal cables.

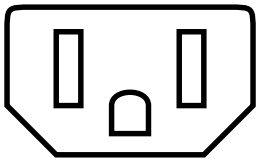
The Problems

Our equipment on stage, especially the power amps, needs lots of current to operate properly. Guess what? Power cords are about as close to speaker cables as it gets.

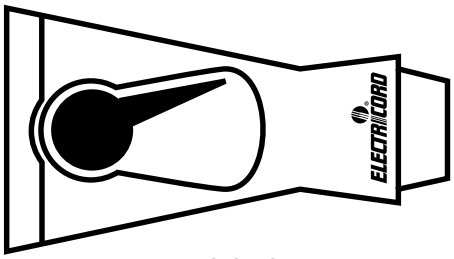
They have three conductors (one for ground) instead of two. They are generally offered in 16 ga., 14 ga., and 12 ga. versions in various lengths from 3 feet to 100 feet.

They have the same problems as speaker cables — resistance (power lost into the cable). Remember, the smaller the gauge, the more resistance it takes to get all the power to your equipment.

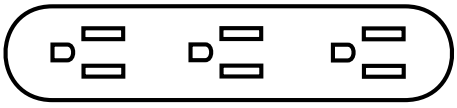
Gang, this is a no-brainer. If you want your equipment to work right, you need to give it all the power it needs to do the job. That is why so many traveling acts take along their own power distribution systems that they tie into a clean (hopefully) 220 amp source in the club or whatever the venue.



Regular Plug



Tru Link Plug



Power Block Plug

Solutions

Short of your own power distribution system, which is expensive and a luxury, here are some solutions to your power cable problems.

Buy short 16- or 14-gauge cables for equipment like mixers and processing gear. There is so little current use that gauge is insignificant.

For power amps, guitar and bass amps and powered mixers, use 12 gauge cables, period.

For feeds from A/C outlets on the stage, use 12 gauge cables, period.

None of this guarantees you will get all the power you need to run your stage, but it will certainly help.

Here's the only sales pitch in the whole cable guide

Pro Co sells the first A/C cables designed specifically for entertainers. They are called E-Cords™ brand and have four redeeming factors:

- They are built to take the rigors of the road; they are not whimpy.
- The are available in 16-, 14- and 12 gauges and several end configurations.
- They are black. No orange cables allowed.
- They are priced the same as other manufacturers interior products.

These are just now (2000) starting to be sold at smart music stores everywhere.

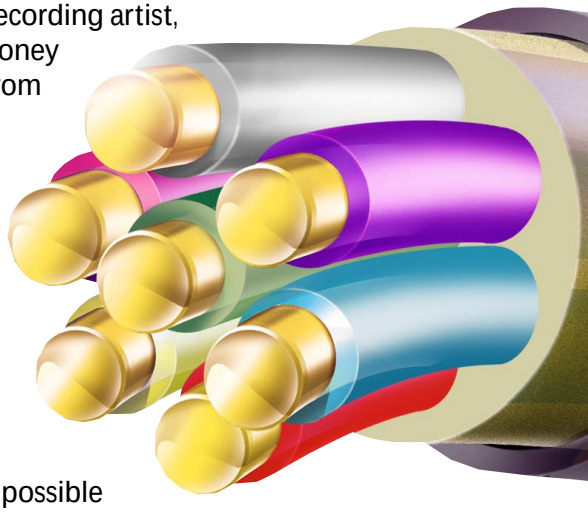
UNIVERSAL ATTRIBUTES OF AUDIO CABLES

Reliability

If your bedroom or your basement is your stage, you can tolerate some equipment failures. If your passion and livelihood depend on making live music in clubs, theaters, studios or arenas, you need the confidence that your equipment will get you reliably through the gig.

Cables, like all products, come in a wide variety of quality and prices. With cheap prices come cheap materials (bad for you) and cheap labor (good for you, if the workmanship is good). With expensive cables come (we hope) great materials and expensive labor (good for you if the workmanship is good and very efficiently done), plus with expensive cables you usually get some "hype" to justify the high price.

You may need only an inexpensive cable or you may need the best in the business. As you grow from beginner to recording artist, the environment changes (and so does the money involved). With any change in environment, from bedroom to concert hall, your needs will change over time.



As you change environments, reliability will become more and more important to you, as the cost you have to pay for it will become less and less important.

Appearance

Most professional audio cables are round and black. Some are white with blue stripes. Some wires look like old tweed amplifier coverings.

Understanding the difference between the cool look and the construction and function of a really well designed cable is almost impossible without destroying the cable to get at the answer.

If the connectors on a cable look too fancy or delicate and look like they belong in your home stereo, they probably do. They probably do not belong hooking up a stage full of professional musical equipment.

Stage presence and appearance are crucial to performing groups. Cables can add or detract from the overall visual effects.

Having clean, uncluttered stages is difficult at best, depending on the equipment and show involved. Keeping your cables basic black so they disappear or blend in with the set is another part of becoming a professional artist.

Shielding

Musicians face two types of noise problems.

First of all they face mechanical handling noise, created on stage by moving microphonic cables around on stage and/or by stamping your boot heel into the cable jacket 500 times an hour. As cables are moved and bent, the shield moves and can create noise in your system. Properly designed wire prevents this noise.

Secondly, interference — hum, buzz and crackle, caused by RFI (radio frequency interference) and less obvious types of interference. Shielding cannot solve all your noise problems for you, since your stage A/C (electrical power) and P.A. system A/C grounding must be done correctly to completely quiet the stage.

Nonetheless, keeping audio signals pure, without the noise, requires well-shielded cables. Otherwise, cables can make dandy radio antennas. Creating a quiet cable that is still flexible requires tradeoffs in shield coverage, type of shield and the overall reliability of the cable

Our challenge is to build you a cable that is quiet enough for your needs (and nerves) that is flexible enough for your use, that is strong enough for your responsibilities.

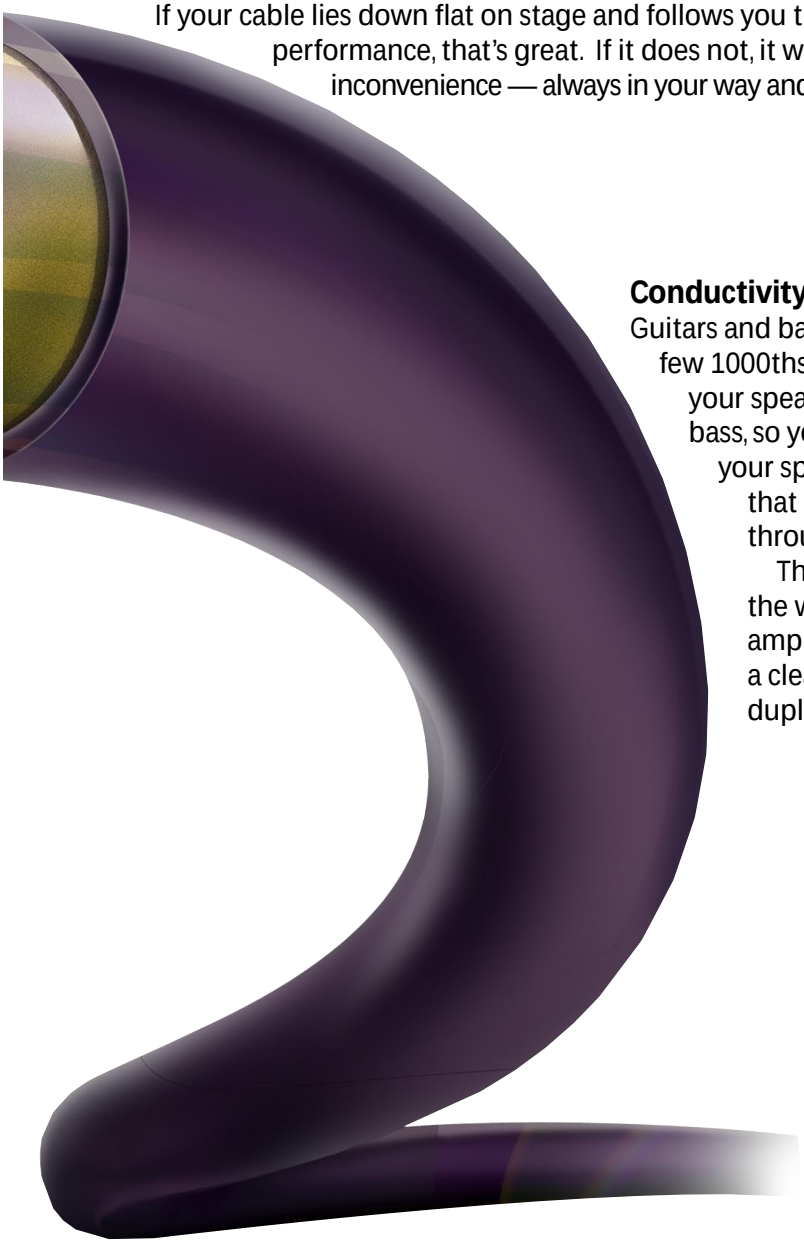
Flexibility

Flexibility and reliability are contradictory elements in cable design. To get both flexibility and durability takes good engineering, the right materials and consistent manufacturing techniques.

Until the last few years, if we built flexible, lie-down-on-the-stage cables, we gave up reliability. New developments in jacket materials, plus wise choices concerning the type, percent of coverage and lay (shape) of the shield, plus more choices available for the insulating (dialectric) materials used, allow us to get very flexible cables with very good shields that are very durable.

By adding Kevlar to the core as a strength member on our Guardian cables, reliability has become a non-issue.

If your cable lies down flat on stage and follows you throughout your performance, that's great. If it does not, it will be an irritation and inconvenience — always in your way and always in your mind.



Conductivity (for speaker cables only)

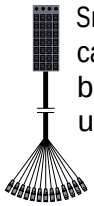
Guitars and basses put out very small signals (measured in milliamps — a few 1000ths of an amp). Power amps can put out nearly 20 amps into your speaker cable. In order for you to get loud, really tight, punchy bass, so you can hear the tonality of your instrument crystal clear, your speaker cables need lots of copper in their conductors. All that current from the power amp needs lots of copper to travel through to efficiently transport clean signals to your speakers.

The more copper in the speaker cables, the less resistance in the wire. The more signal that gets to your speaker, the less your amp has to work for a given volume. Your rig works easier, sends a cleaner sound to your speakers, improving its ability to duplicate the sound of your instrument dramatically.

Sonics

The more critical your ear becomes, as you progress in your journey to becoming a respected player, the more you will be looking for "your sound". Cables can change your sound. Some manufacturers promote this as a plus. We do not think that this is a plus. Pro Co believes that you need control over your instrument's tone and that cables should be only a neutral conduit. We believe that what exactly left your instrument should exactly be transmitted to your amplifier, without changes in tone, volume or frequency and without sacrifice to your personal musical flexibility.

CHOOSING THE RIGHT SNAKE



Snakes are the most complicated part of cabling the band because of the large variety of user needs, wide variety of options available to fulfill those needs and the often times astronomical costs involved in getting everything to work correctly.

Not all acts need a snake. Snakes (multipair audio cables) become a necessity when an act needs a soundman or soundwoman to mix their sound for live audiences.

Before we begin our discussion about snakes, we have to describe the ingredients in a Public Address system (aka a sound system or P.A. system).

Then we need give you the questions you need to ask before buying your first snake.

A basic P.A. system consists of:

- Microphones, mic stands and mic cables
- A mixer to plug the microphones into, to control tone and volume.
- A power amplifier to amplify the signal from the mixer
- Speakers and speaker cables

Larger P.A. systems include some or all of the following equipment:

- Microphones, mic stands and cables
- An FOH (front of house) mixing console
- Effects and equalization (E.Q.) usually in an effects rack
- The snake
- Lots of patch cables
- A monitor system with a mixer, effects and E.Q., power amps and speakers
- Microphone splitters
- Direct Boxes
- Electronic crossovers, as most larger P.A.s are bi- or tri-amped
- FOH speakers and power amps
- Feeds to the recording truck
- Feeds to the satellite uplink for live broadcasts.
- Lots of road cases

Sometimes the mixer and amplifier are combined into one unit called a powered mixer. These are wonderful systems for wedding bands and other small groups that do not need a soundman.

However, when it is time to increase the size and versatility of the sound system, it is time to unload the powered mixer and buy a separate mixer and power amplifier.

The snake is the audio superhighway needed to make larger sound systems work at all.

From this modest beginning, sound system size, complexity and costs go straight up to and including systems that take three semi-trailers of equipment for big venue acts.

By the time P.A.'s have all this equipment, they are so expensive that they are much cheaper to rent than own (at $20,000 a day and up to rent, they're still a bargain). There are several top-quality national touring companies capable of providing great sound for any size audience.

We are ahead of ourselves, so let's go back to the start of the journey.

Benchmark

It is really difficult to buy a flexible, reliable, rugged, easy to coil and uncoil long-lasting 100' 20-channel snake for under $500.

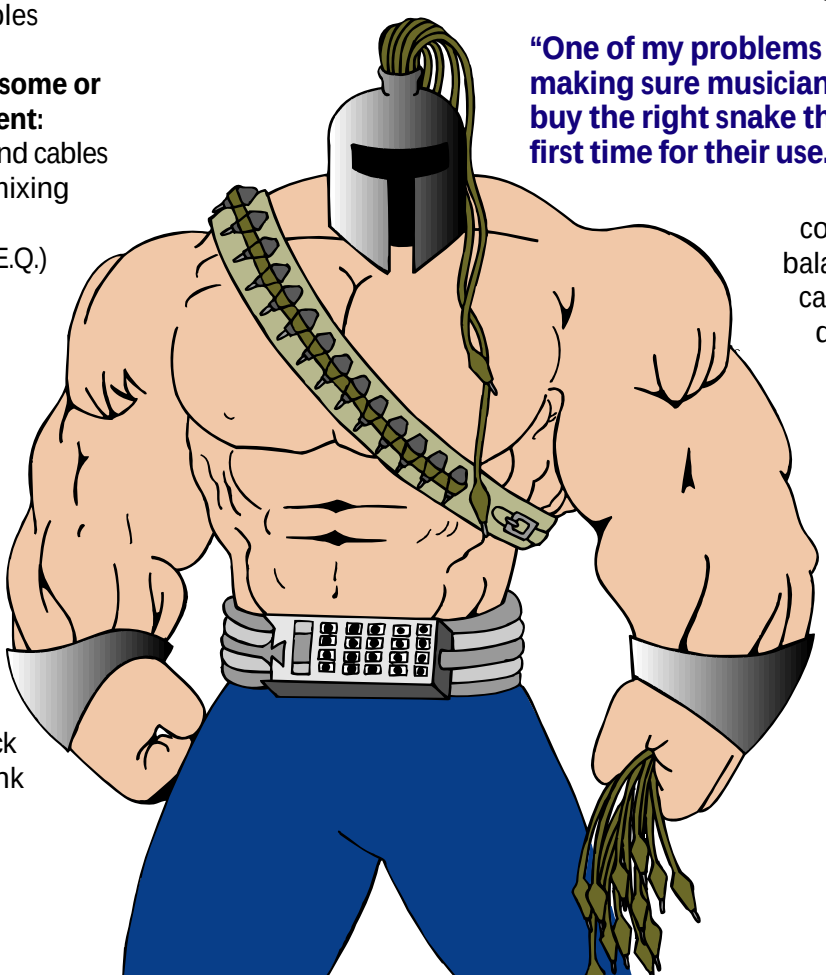
The snake situation

The snake is the audio superhighway needed to make larger sound systems work at all.

When the decision has been made to add a soundman or soundwoman to the act, the next challenge a band has in cabling is how to buy the right snake.

Snakes are confusing at first, expensive and have lots of points to consider before being purchased. Later on, snakes become really confusing, really expensive and have even more things to consider. The point of all this is to never make the same mistake once.

"One of my problems is making sure musicians buy the right snake the first time for their use."



Snakes allows us to combine several balanced (microphone) cables into one smaller diameter multipair cable, making setup and teardown much faster and easier, with less spaghetti than would otherwise be the case.

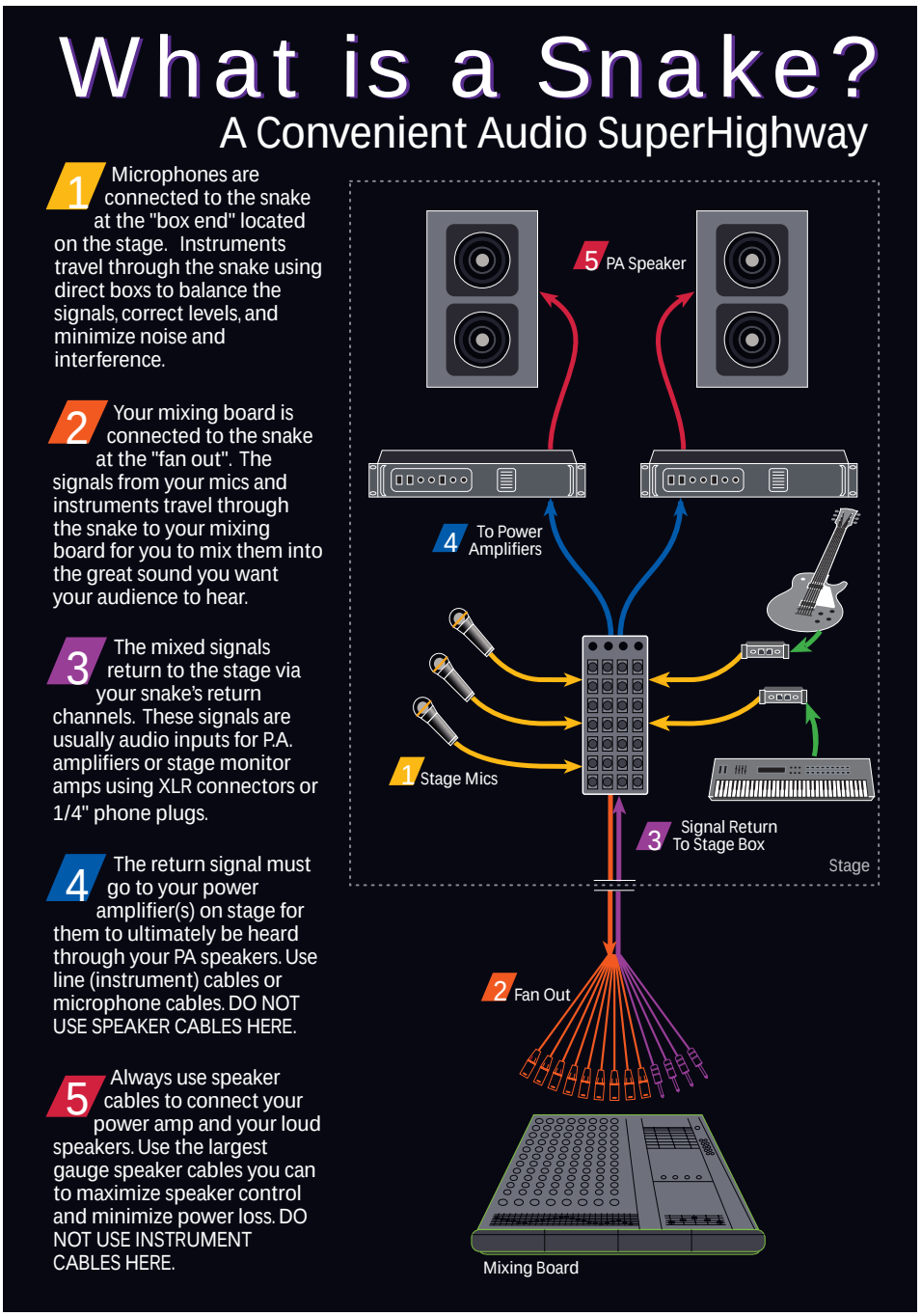
The real-world problems with snakes

First of all, there are several questions that must be asked before the purchase of a first snake:

- How many microphones and instrument signals do I need to send from the stage to the FOH mixing board? You also need to ask yourself if you are going to need more channels later on. That way you can decide whether it is practical or not to buy a larger channel count snake than you currently need. Include in your thoughts that you may have to add an additional sub mixer or buy a new, larger mixer to accommodate all those microphones.
- How many returns do I need to send back to the stage (as drive lines to get signal back from the FOH mixer? Drive lines are a fancy term for the line level signals returned to the stage to "drive" a signal to the power amps from the mixer.

Special Note: Those of you with powered mixers absolutely cannot send speaker level signals back to the stage through standard snakes. The wires are too small to accommodate that amount of current necessary. Doing this ***will*** cause either the power amp in your mixer or your speakers to blow up.

If you have a powered mixer, you need a powered snake, one with speaker lines built in. Nobody recommends the use of these for long runs (over 50 feet). There is



Let's talk technical about snakes

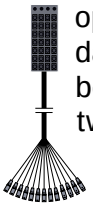
Each individual pair of conductors in a snake is 100% foil shielded for maximum protection. The aluminum foil is attached to a mylar tape which needs to be 3/4" wide to shield the entire bend radius of the cable, no matter how "kinked up" the snake becomes during setup.

Most manufacturers use 1/2" foil. This just isn't good enough to do the job right.

Snakes have to be CL2 fire rated to meet national electrical codes. Building flexible CL2 rated flat-black-jacketed snake wire is a tough job. Also, there are trade-offs in flexibility and reliability in a snake. We opt, always, for reliability first, and flexibility second. Our goal is to build reliable snakes for you that you will not swear at during setup.

Pro Co makes two grades of snakes. RoadMASTER, for tough night after night professional use, and StageMASTER, for once to twice a month use for weekend warriors, church youth groups and school presentations. We use the same wire so they sound the same. The hardware, connectors, strain relief and cosmetics are completely different.

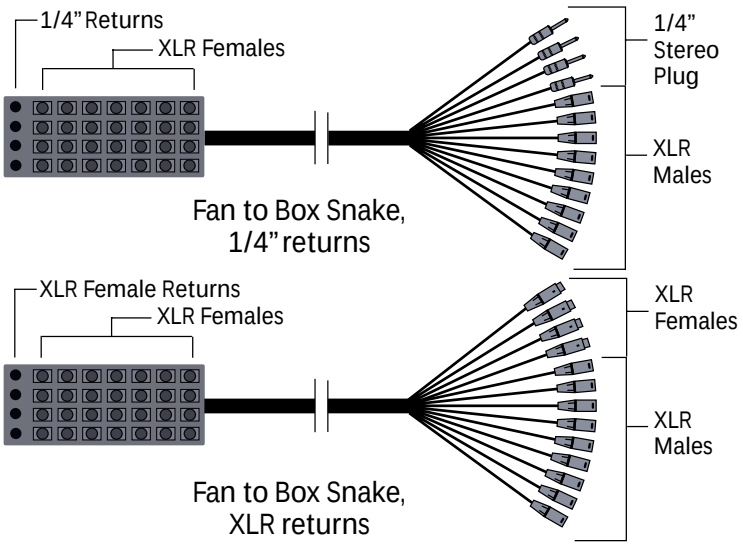
CHOOSING THE RIGHT SNAKE



opportunity for crosstalk and damage to your equipment. A better way to do this is to tape two 12-gauge speaker cables to the outside of a standard snake. Clumsy and ugly, but functional and safe.

- How long do I need the snake to be? Pro Co's snake wire is capable of transmitting a balanced signal 2,000 feet without much loss. Most portable snakes average 100' in length.
- A weird question you should ask yourself is "Is the snake I am considering flexible?"

Many snakes are not very flexible, and the time that you will notice this is the first time you use it. Check flexibility before you buy. If you are going to be setting up several times a week, this is very important. Also, if you are going to be coiling and uncoiling your snake every week or more often, you will need to buy a more sturdy snake than you would need if you only move a couple times a month.



If the wire used in your new snake was designed correctly, it will last for years, even with rough use. If the wire was poorly designed, it will not last long. Building very flexible, yet very sturdy snake cable is a science that few manufacturers develop correctly.

So, what kind of a snake do I need?

Advanced

You would probably purchase a custom designed snake that allowed for at least one split to the monitor system, with or without isolation transformers and ground lift switches (although Pro Co's rack-mount mic splitters could allow you to continue to use your old snake if it has enough channels). You would buy short sub-snakes to go from the mics on stage to the splitter and short mic cables to go from the splitter to the monitor board and to the snake.

Or you can buy a complete concert system snake, customized to you band's specific needs.

When you become a star, the P.A. will be provided for you and you will not have to worry about your snake any more. You will be glad to pawn that responsibility off onto the P.A. guys. Let them worry about it.

Intermediate

A hardwired standard fan to box snake, configured for your mixer inputs/outputs and the length you need. Most popular mixers today have either 12, 16 or 24 mic inputs and four returns to the stage. You would ask for a 12x4, 100' (or whatever length you need) snake (12 mics, 4 returns, 100' long), or a 16x4, 75' snake, etc.

Beginner

None

Solutions:

Mixer input connectors are XLR females. Mixer left and right stereo outputs are XLR males or 1/4" phone jacks, usually balanced. The "fan" end of the snake must be ordered to match the panel connectors on your mixer. If these are not ordered correctly, you may have to change out the correct connectors yourself, probably voiding the factory warrantee for the product.

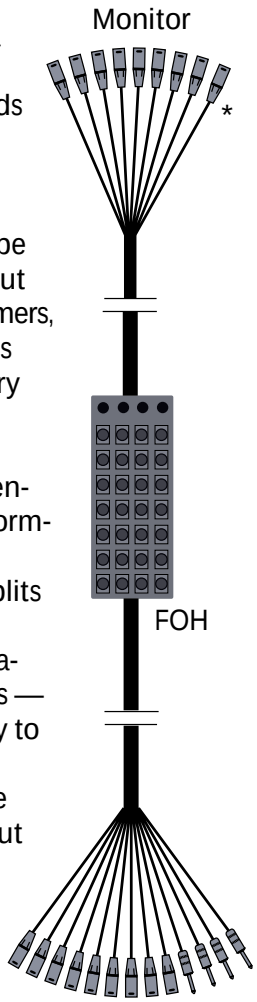
On stage, microphone inputs in the stage box are all XLR females. Outputs from the snake to the on-stage amplifiers (or electronic crossovers) are either XLR males or 1/4" phone jacks, usually balanced.

You will need to purchase balanced or unbalanced patch cables that have the correct ends on them to convert from the snake's outputs to the inputs on your power amps. See the section in this manual on patch cables.

The secret is to get your power amplifiers as close to your speakers as possible and run the shortest speaker cables you can — for good sound, for less strain on the power amplifier(s), and less chance of tripping on the cables all over the stage.

Microphone splitters

A single microphone signal (feed) may have to be split to the FOH board, the recording board, the monitor board and the satellite uplink if the performance is a live broadcast.



Each split needs to be isolated from the others to prevent hum. These splits can be hardwired without isolation transformers, dangerous unless you are using very expensive (like Yamaha 4000s) mixers with expensive input transformers as factory equipment, or, splits can be accomplished with isolation transformers — a much safer way to separate the mic signals into more than one path, but considerably more expensive (however, not as expensive as buying Yamaha 4000s).

For years we designed custom splitter snakes, with transformers and ground lift switches built in the snake's stage box to help with noise and hum problems. Then we designed off-the-shelf 19" (industry standard) rack-mountable splitters to make everyone's life easier) and lots cheaper.

To see just how complicated a concert snake system can be, visit pages 16-17 of this guide. A full-sized poster of this diagram is available from Pro Co for six bucks, including postage. Check our website **www.procosound.com** for details.

Snakes allows us to combine several balanced (microphone) cables into one smaller diameter multipair cable, making setup and teardown much faster and easier, with less spaghetti than would otherwise be the case.

The Big Stuff

As already discussed, snakes typically are built with a fan (to plug into the mixer) on one end, and a box (into which you plug the cables on stage coming from the microphones and going to the power amps). There are "quick disconnects" available that allow you to detach the fans and boxes from the trunk of the snake. This cuts setup time way down and if you are moving constantly, they are a great investment.

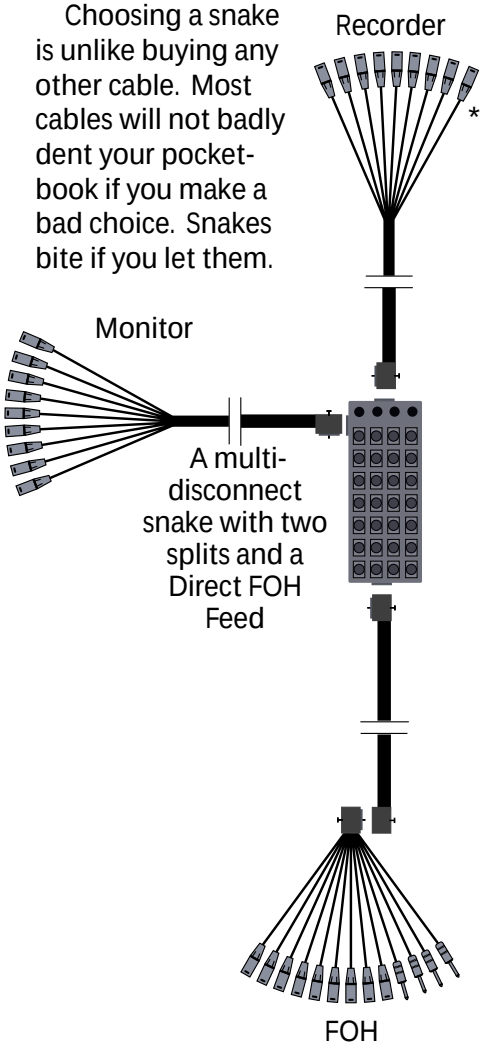
These snakes are built using time-tested multipin connectors which are extremely reliable. Nonetheless, they must be handled with more care than a hardwired version of the same snake.

You will not find disconnect snakes in a store. They are all built to order, one at a time, because of customization requirements requested by the particular act needing the snake.

Regardless of which manufacturer builds your snake for you, although price is always a consideration in any purchase, do not buy something beneath your band's needs. Pay the long dollar and get a snake that works for you. You may spend $100 to $300 more to get what you really need. That's a lot, but a normal 20-channel, 100' snake is going to cost $400 to $750. Plan that into your budget. Talk to your musical equipment supplier about options and costs up front. If you need a snake and have not budgeted for it, the sticker shock can be numbing.

If you are strapped for cash, try to find a good used Pro Co snake. Unfortunately, used snakes are always at a premium and hard to find. People call us every week to see if we have any used snakes to sell. Alas, we do not manufacturer "used" snakes, although if we did, we would sell all we could build.

Choosing a snake is unlike buying any other cable. Most cables will not badly dent your pocketbook if you make a bad choice. Snakes bite if you let them.



** For those observant ones in the audience, yes, the monitor fan only has mic inputs, no returns. No returns are necessary here, so the monitor fan is four channels less into the FOH send.*

CHOOSING THE RIGHT PATCH CABLES

Patch cables are short cables which connect two or more pieces of musical equipment that are generally less than 5' away from each other.

There are 100's of different types of patch cables used:

- in equipment racks
- in keyboard rigs
- in pedalboards or between effects
- in patchbays
- to "Y" two or three pieces of equipment together
- to "jumper" from one speaker cabinet to another

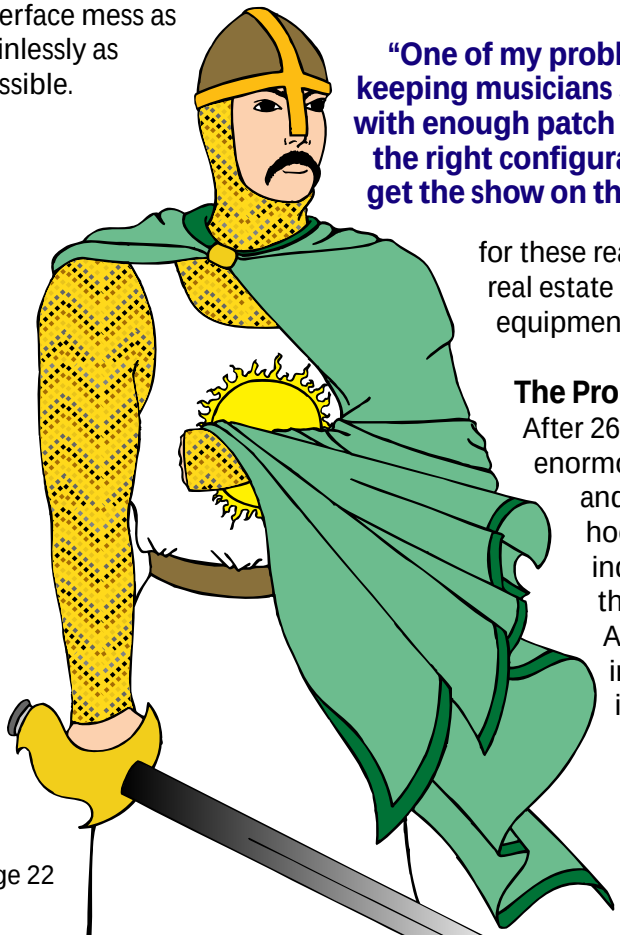
The Benchmark

There is no patch cable benchmark. They come in all shapes and sizes and the connector combinations possible are mind boggling.

The patch cable situation

Patch cables are used for guitar level signals, line level signals, microphone level signals and speaker level signals.

The biggest problem with patch cables is having the right ones at the right time to get through today's interface mess as painlessly as possible.



"One of my problems is keeping musicians supplied with enough patch cables in the right configuration to get the show on the road."

The reason the audio industry needs so many different patch cables is that, over 50 years, we have been unable to standardize on one connector for one job.

If you get a new TV or get cable TV in your home, the connector on the TV and the one in the wall are always the same. The connector is called an "F" connector and is universal.

Instrument and line level connectors can be 1/4" phone plugs, RCA phono plugs, 1/8" mini plugs, or any combination depending on the hardware we need to connect together.

Balanced signals can terminate at XLR male and female connectors, as well as 1/4" balanced connectors and balanced 1/8" mini plugs.

Professional patchbays usually use either military style 1/4" plugs (also widely known as long frame or PJ connectors), or tini-telephone (TT or bantam) plugs.

Typically keyboards and P.A. equipment are at line level, different from instrument, mic and speaker level.

Confused yet? All of these connectors have evolved over 50 years and are used interchangeably for these reasons: cost, reliability or real estate (on the back panels of equipment).

The Problems

After 26 years of spending enormous amounts of time and money learning to hook up this complicated industry, we are in awe of the standard bearers (the A.E.S. — Audio Engineering Society) total inability to get anyone to agree to anything.

By its very call out the XLR connector is Pin 1 ground, Pin 2 hot, Pin 3 cold. There is still debate in some camps on whether Pin 2 or Pin 3 is hot.

Manufacturers use whatever jacks they want to use, depending on back panel real estate, and costs. In fact, we are concerned enough to feel that equipment manufacturers ignore the real world after their output panels.

Their concern is not making it easy or simple for you to hook up their gear to anyone else's. Fortunately for Pro Co, that falls on our shoulders.

Although 43% of all the items we build are 1-off products, never to be built again (at least this year), we think that is a sad commentary on the state of the industry.

Our industry flat does not have its act together; it does not have an "F" connector. Does that mean we, as an industry, get an "F" in our ability to make and demand adherence to a standard. We think so. But enough soapboxing for one cable guide.

The solutions

Patch cables typically do not need the durability and flexibility of primary guitar cables or microphone cables. They do need good shielding and good sonics. Cosmetics do not matter a whole lot, since no one will ever see them except you or your roadie.

Nonetheless, Pro Co still makes great looking, great sounding, reliable, flexible, well-shielded patch cables because many musicians still want the assurance that their rig will sound great, every where, every time. Sacrificing that for a few bucks is not worth the money.

A word of caution

There are patch cables available that are bubble-packed like fishing lures in a hardware store. There are generally very inexpensive and have very little copper in them (they do not need much copper to get the signals around, but there is no strength to the wire itself). These cables have a tendency to quickly "open" (break) or short together the conductors or one of the conductors to the shield. We do not recommend them, but in a pinch or if you are on a tight budget, they will work to "get you by". If you are going to buy one of these cables, at least buy it in a music store. These cables can also be purchased at stores that sell radios, and theirs are not as good.

Typical patch cables include:

Unbalanced Patch Cables

- 1/4" Phone to 1/4" Phone
- 1/4" Phone to RCA Phono
- RCA Phono to RCA Phono

Balanced Patch Cables

- XLR Male to Balanced 1/4"
- XLR Female to Balance 1/4"
- Balanced 1/4" to Balanced 1/4"
- Balanced 1/8" Mini to Balanced 1/4"
- Balanced 1/8" Mini to Balanced 1/8" Mini
- Balanced 1/8" Mini to XLR male
- Balanced 1/8" Mini to XLR female
- XLR Female to XLR Male (standard microphone cable)
- TT (tiny telephone) to everything else
- PJ's to everything else.
- Sound card cables from your computer to your speakers (or to balanced inputs on a mixer, or whatever the presenter of a speech wants his/her computer hooked into.
- Sound card balanced Mini output to a summed 1/4" phone plug input.

Get the picture? It never ends. Now we have professional (XLRs), semi-professional (1/4" phone), consumer (1/8" balanced Mini) and computer (pick whatever you want) and our job is to hook it all together so anything can talk to anything else — so your music, your speech, your convention or your message can be heard, with complete clarity, like the 1920 inaugural speech we told you about in the Digital chapter.

A DISSCUSSION ABOUT DIGITAL CABLES

30 years ago a very wise man said, "Music is a product of the technology of the times". Stradivarius had the technology to make violins in the 1600's. In 1723, technology was there to build the piano. Pipe organs preceded them by many years.

James B. (Jim) Lansing was the founder of the modern-day JBL loudspeaker manufacturing company. He had the technology to provide sound for the 1920 presidential inauguration with complete intelligibility for 250,000 people. Many of today's modern airport paging and announcement sound systems have little to no intelligibility. That's not much progress for 80 years.

Audio has been analog in its technology until now. With computers controlling more and more of our world, audio is becoming digital in its transmission.

Analog refers to electronic transmission accomplished by adding signals of varying frequency or amplitude to carrier waves of a given frequency of alternating electromagnetic current. Broadcast and phone transmissions are both examples of transmitting through analog technology.

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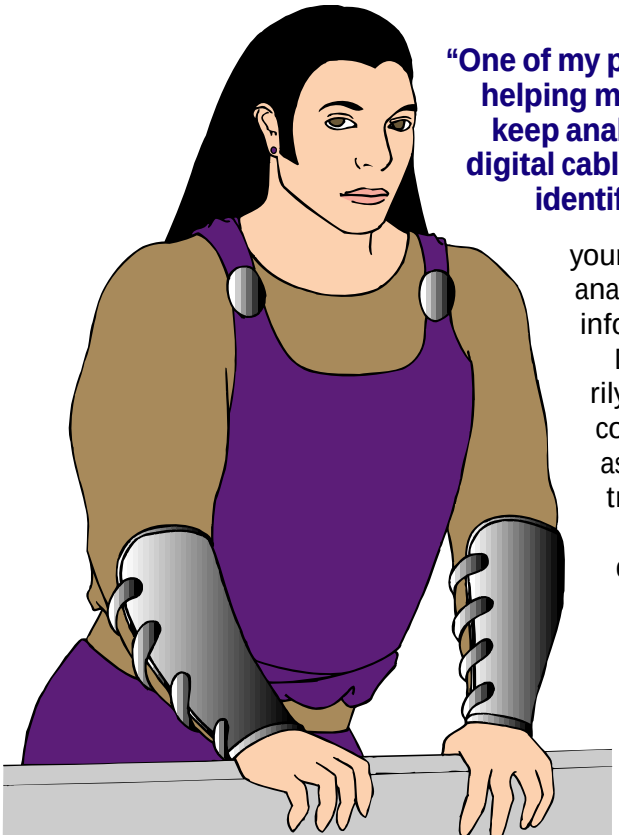
Digital describes electronic technology that generates, stores, and processes data in terms of two states: positive and non-positive. Positive is expressed or represented by the number "1" and non-positive by the number "0". Thus, data transmitted or stored with digital technology is expressed as a string of 0's and 1's. Each of these state digits is referred to as a bit (and a string of bits that a computer can address individually as a group is a byte).

There are times when a modem is used to convert the digital information from a computer to analog signals for your phone line and to convert analog phone signals to digital information for your computer.



"One of my problems is helping musicians keep analog and digital cables clearly identifed."

Digital technology is primarily used with new physical communications media, such as satellite and fiber optic transmission.

So what does this have to do with audio and what are the standards for the new digital audio?

The "AES/EBU" (Audio Engineering Society/European Broadcast Union) digital audio standard is probably the most popular digital audio standard today. Most consumer and professional digital audio devices (CD players, DAT decks, etc.) that feature digital audio I/O support AES/EBU.

AES/EBU provides both "professional" and "consumer" modes. The big difference is in the format of their channel status bits. The professional mode bits include alphanumeric channel origin and destination data, time of day codes, sample number codes, word length, and other goodies. The consumer mode bits have much less information, but do include information on copy protection (naturally). Additionally, the standard provides for "user data", which is a bit stream containing user-defined (i.e., manufacturer-defined) data.

The physical connection media used with AES/EBU are differential, using two wires and shield in (standard looking) three-wire microphone cable (however, with a specific impedance).

Alas, this will add great confusion to the world of audio. Now analog connectors (XLR's and RCA's, along with mini balanced and 1/4' balanced and unbalanced) look just like digital connectors and the wire used looks the same, but the impedance required for optimum digital transmission is different for analog and digital. In analog, the two conductors of the cable carry half of a balanced signal. In digital one cable carries both left- and right-channel audio data to the receiving device.

Adding confusion to this is the S/P-DIF standard. "S/P-DIF" (Sony/Philips Digital Interface Format) typically refers to AES/EBU operated in consumer mode over unbalanced RCA cables. Note that S/P-DIF and AES/EBU mean different things depending on how much of a purist you are in the digital audio world.

S/P-DIF is a standard audio transfer file format. It is usually found on digital audio equipment such as a DAT machine or audio processing device. It allows the transfer of audio from one file to another without the conversion to and from an analog format, which could degrade the signal quality.

M.I.D.I. is a standard for moving digital signals around in a musical setting between digital keyboards, computers and all the peripheral M.I.D.I. gear used to create today's electronic music.

The most common connector used with a S/P-DIF interface is the RCA connector, the same one used for most consumer audio products. Also, optical connectors are sometimes used.

As far as the wire is concerned, for the most accurate transmission, AES/EBU requires a two-conductor, shielded wire with a constant impedance of 110 ohms (61.7 ohms/km). A stable impedance is specified to help keep interface jitter to a minimum. Typically polypropylene insulation material is used to maintain the stable impedance. Working conditions can limit the useful lengths between terminations. Polypropylene is a great insulating material for audio cables as well, second only to Teflon, which is expensive and difficult to extrude into a cable. However, this makes for a less flexible cable overall.

For S/P-DIF, a coax (single-conductor wire with overall shield) cable is used, with a constant impedance of 75 ohms specified.

For comparison purposes, standard microphone wire is typically about 95 ohms impedance.

The audio cable manufacturers are just beginning to offer specific cables for AES/EBU and S/P-DIF use. Proper impedance for accurate transmission is important, shielding is crucial, durability is a really big deal, and clear marking on the wire jacket will become an issue as users try to keep their audio and digital cables clearly identified and separated for proper use, especially in portable situations.

A M.I.D.I. discussion — where digital all began in audio

M.I.D.I. (musical instrument digital interface) cables are not audio cables. M.I.D.I. is a standard for moving digital signals around in a musical setting between digital keyboards, computers and all the peripheral M.I.D.I. gear used to create today's electronic music.

Conceived in 1984, M.I.D.I. uses German standard 5-pin "DIN" connectors and foil-shielded microphone wire to transmit its signals, but uses only three of the five terminals available on the connector.

A major concern for M.I.D.I. cables is shielding. Pro Co uses only 100%-foil-shielded wire in its M.I.D.I. cables. Like computers, it is critical that the digital signals be transmitted absolutely accurately without interference from the outside world. It is also really important to keep the digital signals between equipment contained so that the M.I.D.I. signals do not interfere with the lighting controllers or other musicians' rigs or the recording board.

M.I.D.I. cables typically do not take the stress of instrument and speaker cables, and can be lighter-duty in nature. Also, since they are not flexed much, foil shields are adequate from a reliability standpoint, while offering the best shielding available.

M.I.D.I. is still very much around as a standard. Conceived by some very bright people, it is not without its foibles, but has withstood the test of time.

WHAT TO LOOK FOR IN INTERFACE BOXES

There are some points in a sound system where a signal has to be sent to more than one place.

Direct Boxes

We need direct boxes to send a signal from a guitar rig to the P.A. system while still allowing the guitarist the freedom to control his/her own tone and volume on stage. A direct box also allows the guitar signal to be properly split to a Lo-Z balanced line so that the soundman or woman can have control over the guitar sound for the audience.

There are 100's of different direct boxes to choose from, from single-use models to rack-mounted 4-unit models.

Let's talk technical about transformers

Transformers are held responsible for being cure-alls for all P.A. diseases. All a transformer does is split a signal into two parts (3 or 4) , a primary and a secondary (or two secondaries or three secondaries), while (hopefully) allowing each part of the transformer to be isolated from the others to get rid of "hum" in the system or to match mismatched impedances in two different pieces of equipment.

There is an art to developing effective, sweet sounding transformers with full range and good isolation. If you plan to buy a cheap direct box (under $50), do not waste your time. It's a toy and will not work for audio.

Good transformers are expensive. You cannot sleaze a transformer's quality and expect that you will be satisfied with the sound that comes out of it.

Microphone Combiners

We need microphone combiners to help us "cheat" a little when we need extra channels. One scenario would be that we have two bass drums to mic and only one channel left on the mixer. We can combine the two bass drum mics into a mic combiner with a balanced Lo-Z output and get the solution we need.

Yes, this can also be done with microphone Y-cables, but this way affects the tone and output of the mics significantly.

Mic combiners are generally designed for single-use applications.

Microphone Splitters

We need microphone splitters to separate the feed from one microphone to two, three or four different systems (FOH, monitor, recording, uplink). All these signals must be properly isolated from each other to prevent problems within one of the feeds from affecting the purity of the feed to the others.

Mic splitters are almost always used in large quantities — 16, 24, 32 or 40 channels of split (usually to the monitor system) is common. Rack-mounted versions are common, in order to obtain enough channels to get the job done. Lot's of mic cables, or snakes with multipin disconnects are used to be able to hook this all together to the rest of the system.

Isolators

We need isolators on stage to break pesky ground loops between pieces of equipment connected with unbalanced lines. Also, there are times when an act has to perform in an area of high RFI concentration (dirty). The isolation provided by the mixing console(s) may just not be enough to filter out unwanted noise and the system needs a little extra help.

These fast-fixers can be as simple as inline units, designed to be a quick solution to an individual problem. There include ground lifts, phase reversers, isolation transformers, Lo-Z to Hi-Z adapter transformers, line output transformers and microphone pads.

Isolators can be simple inline units or be found in 4- and 8-channel versions suitable for rack-mounting.