Cable Anatomy 101

Defining six factors to keep in mind

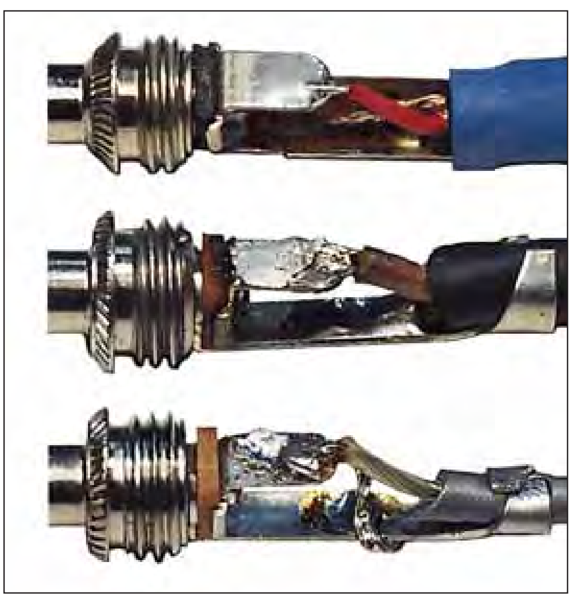
By E. Victor Brown

Cable selection presents two primary challenges: myriad choices and overall quality.

I've explored these challenges and have defined six factors that can help point you in the right direction. These factors include appearance, durability, flexibility, sonics, conductivity and shielding. Let's have a look.

APPEARANCE

Understand the difference between the look of quality - like shiny gold-plated connector housings - and actual quality construction and materials. A primary problem arises when assumptions are made that the materials inside a cable housing are as fancy as those that can be easily seen in the connector. For example, molded cable housings can hide poor construction, such as inadequate shielding.



The good (top), the bad, and the ugly when it comes to solder.

Copper is the most widely used material cable component, offering high conductivity. (Silver is also highly conductive, but cost can make it impractical.)

It only makes sense that signal should travel through copper, tip to tip.

If possible, when evaluating cable, open the connector and check the soldering. Make sure there are no blobs (too much solder) and no contaminates from wire insulation or foreign particles. The solder should have a smooth, slightly shiny surface. A dull solder joint indicates poor workmanship and a poor or non-existent connection (termination).

Other termination methods avoid foreign materials (like solder), which can increase the risk of interfering with signal flow. One process is IDC (insulation displacement connection), done by creating a cradle for the wire in the shape of a "V." When the wire is inserted into the cradle, it's pushed to the smallest point of the V, stripping away the cable insulation at the contact points. (This technique does require sturdy strain relief; more on this later.)

A more recent termination technique relies upon ultra-sonic welding, a process by which the center conductor and the connector are vibrated together at a high rate of speed while being compressed. This causes them to intermingle and fuse together as one.

DURABILITY & FLEXIBILITY

Exposure to temperature, humidity, chemicals, floor traffic and the like can wreak havoc on cables and connectors. Dirt is an extreme abrasive, while foot (and wheel) traffic frequently shred many types of shielding, internal insulation and even the center conductor - sometimes without showing noticeable outer jacket damage.

Durability and flexibility may be opposing demands. One can come at the expense of the other. Durability may come in the form of strain relief, termination, the outer jacket and the materials used inside the cable.

The outer jacket surrounds the individual conductors and is intended to protect the shielding and conductors from the elements. While outer jackets are commonly made of polyvinyl chloride, differing chemical compositions and blends can yield a similar look with vastly differing strengths and ranges of flexibility.

A cable that is thicker might look and feel more durable, and if that size is due to a double-thick outer jacket, flexibility can actually be increased. Simply, the cable can be more impervious to damage, meaning it can be used in more applications.

The size of conductors, as well as the types of shielding, also impact durability and flexibility. Understand that everything comes at a price. A more durable cable will (and should) cost more. You get what you pay for.

The term strain relief refers to the relief of strain at the point where a connector attaches to a cable - the termination point. Strain can come from several different sources, such as pulling on the cable rather than grasping the connector to disconnect; stepping and pulling on the cable; repeated tight coiling, flexing and other common abuses.

SONICS

The sonics of a cable (or its "sound quality") can be assessed in several ways. Like loudspeakers and amplifiers, cable can "color" sound - this can be good or bad depending on individual taste and desired effect. To each his/her own.

Colorization of sound by a cable is based on shielding and/or conductivity. Some combinations and proportions are potentially pleasing.

Capacitance and inductance affect frequency response the most. Look at the capacitance per foot figure to evaluate how the high frequency response may be affected over long runs. It's usually measured in per foot (pF), so short lengths aren't affected much. The materials used as the inner conductor insulators also affect the capacitance and the signal propagation.

Beyond this, it's vital to listen for noise and hum, both with and without signal present. Any extraneous noise can be prime indicator of poor construction techniques or substandard materials. It's important to listen to a length of cable with it terminated properly at the source end. An open-ended cable will have an extremely high impedance, making it act like an antenna - as soon as a mic is plugged in, the noise disappears.

CONDUCTIVITY

While copper has a certain amount of resistance to signal flow, steel and aluminum have significantly more. This resistance dissipates in the form of heat. (It's why steel and aluminum alloys are great for constructing toasters and space heaters but not so great for cables.)

Some cable conductors are made with a combination of aluminum (slightly better than steel) clad in copper. This is a more cost-effective approach and can be effective in meeting conductivity needs, but the more copper (preferably high purity or oxygen-free), the better the conductivity.

The more electrons to move, the larger the conductors must be. This is the overriding reason that an instrument or patch cable shouldn't be used in place of a loudspeaker cable.

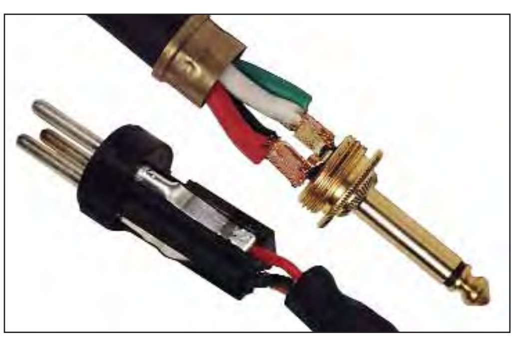
According to the AWG (American Wire Gauge) system, conductor area doubles with each reduction of three in AWG. For example, a 13 AWG conductor has twice the copper of a 16 AWG conductor, while a 10 AWG has twice the copper of a 13 AWG, and so on.

Unlike instrument and microphone cables, which typically carry currents of only a few milliamps (thousandths of an amp) or less, the current to drive a loudspeaker is much higher. An eight-ohm speaker driven with a 100-watt amplifier will pull about 3.5 amps of current. By comparison, a 600-ohm input driven by a line-level output only pulls less than two milliamps. (0 dB = .775 volts / 600 Ohms = 1.29 mA) (For more about cable gauge, lengths, Ohms Law and more, see "More Dollars Than Sense?" beginning on page 48 of this issue.)

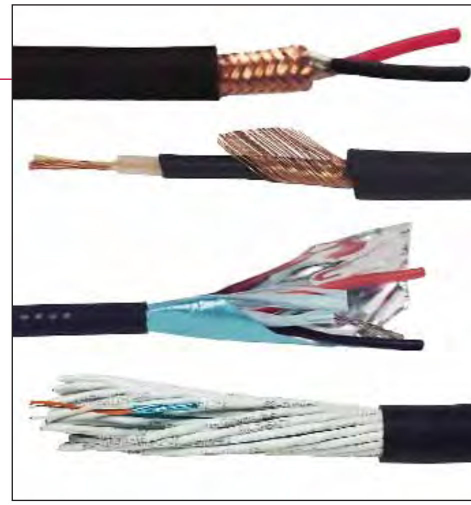
SHIELDING

Cable conductors need to be shielded from noise, of which there are two common types. The first is handling noise, in the form of cracking, swishing, scratching, popping, buzzing or humming sounds.

Handling noise can be heard with the cable plugged in but no source audio present. This can be due to substandard electrical termination at the connectors, worn or partially broken center conductor, or inferior wiring in general. The actual cable construction and the relationship between inner conductors, shielding and outer jacket also affect handling noise.



Other connector termination methods include IDC (left) and ultra-sonic welding.



Top to bottom: Braided shield, spiral shield, foil shield with drain and a snake cable with foil shield.

The second type of noise is interference, of which there are two common types: RFI (radio frequency interference) and EMI (electromagnetic interference).

RFI can be caused by very high radio band frequencies. (You might actually hear a radio station through your system, or high-pitched squeals or hiss.) EMI can be caused by electromagnetic fields that emit low frequencies. These fields can surround transformers, power lines and other devices that use or transport large amounts of electrical current. (It's also often heard as hum or buzz.)

Three primary types of shielding are employed to combat these problems: braid, spiral and foil. In terms of cost, braid shielding is the most expensive, involving copper strands woven into a braided pattern around the center conductor's inner jacket.

The braided approach works best with microphone cables because of their low inductance. (Inductance is the storage of magnetic energy. Magnetic energy is stored as long as current keeps flowing).

Spiral shielding is more flexible than braiding, and is commonly used in guitar cables. A drawback to spiral wrap is that, like a slinky in motion, one side compresses while the other separates. It's through these separated strands that RFI can enter.

To compensate for the rejection loss of RFI, sometimes a secondary shield is added, using carbon as a semi-conductor. This is generally effective over very short distances. The carbon is not a solid sheet, rather, microscopic bits of carbon mixed into another, more flexible material (usually a plastic composite). The bits of carbon conduct current from bit to bit.

Foil wrap shielding is the least expensive shielding method, and some provide full 100 percent coverage. It can be very effective against RFI. A drain wire runs next to the foil, providing a way to terminate the foil at the connectors, and is a technique is most often used in the construction of snakes. (Note: The drain wire runs along the foil shield to provide a means to connect the foil shield to the connector. The drain wire itself doesn't actually do much shielding at all.)

JOURNEY'S END

It's often true that the last thing on the system professionals mind is cable. After all, like roads and highways, they can be utilitarian by nature.

But as with roads and highways, making the right choices is the optimum way to get to your destination, which in this case is good, clean optimized audio. All it takes is some attention to the basics combined with critical evaluation. ■

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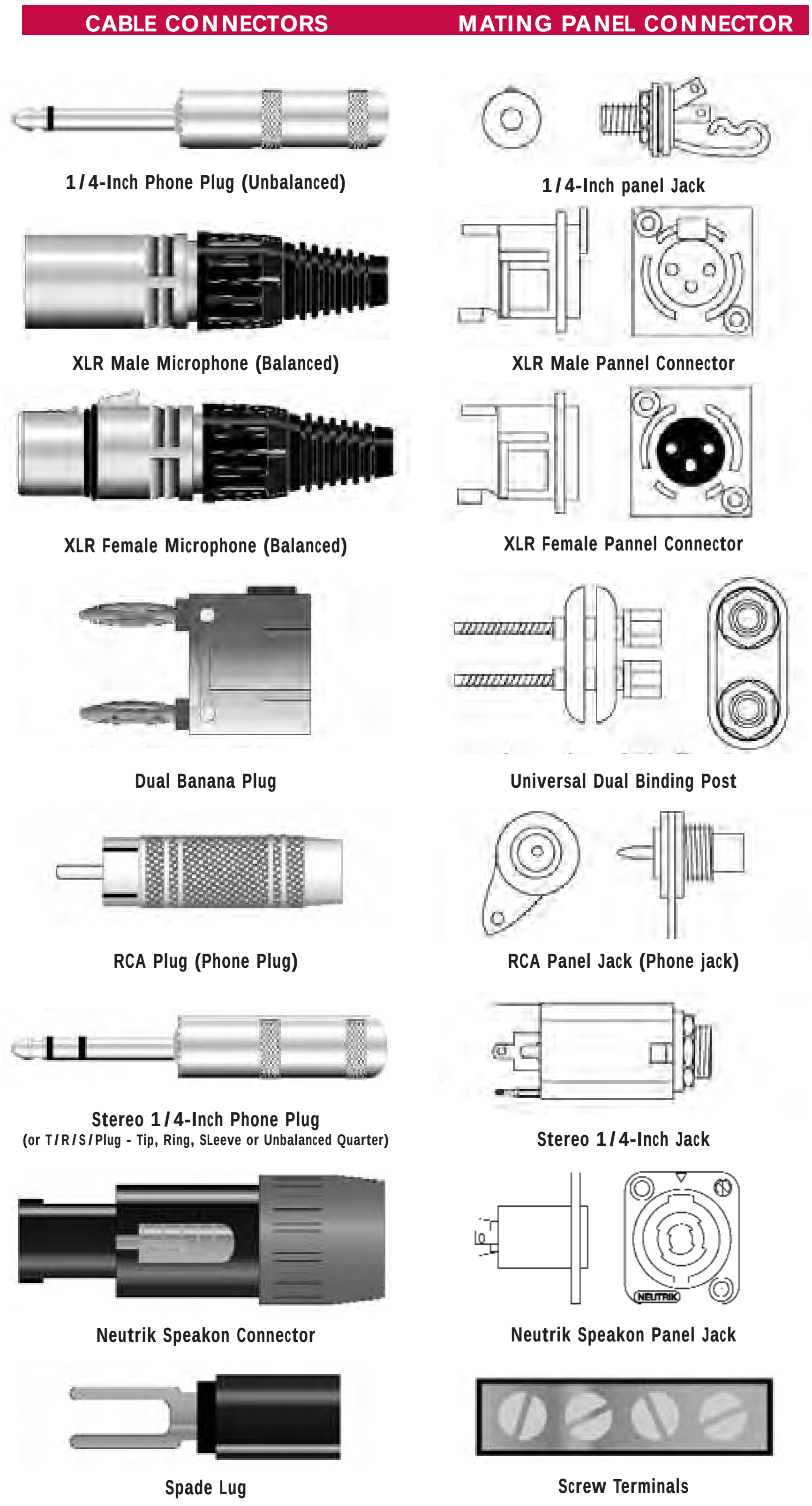
Guitar and Bass Connectors
- 1/4-Inch Phone Plug

Microphone Connectors
- XLR Female
- XLR Male
- 1/4-Inch Stereo
- 1/8-Inch Stero

Patch Connectors
- All

Speaker Connectors
- 1/4-Inch Phone Plug
- Dual Banana
- Speakon
- Spade Lug

COMMON CONNECTORS OF THE PRO AUDIO INDUSTRY



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