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Professional Advice and Knowledge

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Balanced vs. Unbalanced Cables

Balanced refers to a “three-legged” type of electrical signal that has two legs independent of ground. One is generally considered positive and the other negative in voltage and current flow with respect to ground. Both legs carry the signal. The benefit is that any noise that gets induced into the line will be common to both the positive and negative sides and is thus canceled when it arrives at its destination, assuming the destination is balanced. This phenomenon is called "Common Mode Rejection” and happens because the receiving device sees the common noise in the signal as being out of phase with itself, and cancels it. Balanced lines are generally best for long cable runs due to their ability to reject induced noises. XLR and TRS type cables are designed to transmit balanced audio from one balanced device to another.

Unbalanced cables are less complicated and less expensive but they have limitations. Any audio signal requires two wires or conductors to function. In an unbalanced situation, one of those conductors is used to carry both the audio signal and ground (shield). Unbalanced cables are much more susceptible to induced noise problems than their balanced counterparts because any induced noise in one conductor is not canceled by similar noise in the other conductor and may be carried with the signal into connected equipment. In general, unbalanced lines should be kept as short as possible (certainly under 25-30' maximum) to minimize potential noise problems.

Cable Connectors Explained

In the live sound world there are five common cable connectors: TRS and XRL (for balanced connections); TS, RCA and banana plugs (for unbalanced connections).

TRS

TRS is the abbreviation for “Tip Ring Sleeve.” This is the accurate term for 1/4" (or 1/8") balanced connectors. A TRS plug can be found at the end of most headphone cords if you want to know what one looks like. It looks like a standard 1/4" plug with an extra “ring” on its shaft. Thus the three sections of the shaft are called the Tip, Ring, and Sleeve. TRS connectors are used wherever you need to have two conductors plus a ground (shield) in one plug. A common use is to connect balanced equipment. A useful cable is the Hosa (CSR103) CSR103.

XLR

XLR is the trademarked name for circular 3-pin connectors developed by Cannon (later bought by ITT). XLR has since evolved into a generic industry term, and many manufacturers now make this style connector, in which there are positive, negative, and ground connections. In audio, XLR connectors are normally used for transmitting balanced mic and line level signals to mixers or audio to speakers. Monster Cable's (P500M20) P500M20 is a good example of an XLR cable.

TS

TS is the abbreviation for Tip Sleeve and refers to a specific type of 1/4" connector that is set up for two-conductor unbalanced operation. An insulator separates the tip and sleeve. The tip is generally considered the "hot," or the carrier of the signal, while the sleeve is where the ground or shield is connected. TS cables are best known as guitar or line-level instrument cables, such as this one from (099-1210-090) Fender.

RCA

RCA connectors are the common name for phono connectors like the ones used to connect most consumer stereo equipment. These were so associated with the RCA Corporation in the early 1900s that they became known as the RCA connector. Some mixers have tape or CD inputs and outputs with RCA connectors. Hosa's (CRA206) CRA206 is an example.

Banana Plug

A Banana Plug is an electrical connector designed to join audio wires such as speaker wires to the binding posts on the back of many power amplifiers, or to special jacks called, of course, banana jacks. A common configuration of banana plugs is to have two of them molded together and spaced 3/4 of an inch apart, which is also the spacing of the binding post receptacles on the back of power amps. Here's an example of a Hosa cable (SKJ475BN) with a TS Plug on one end and a double banana plug on the other.

Cable Shielding Explained

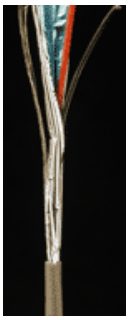
Cable Shielding Explained
Our partners at Pro Co have done an excellent job of describing this issue, so we'll let them take over: (Courtesy Pro Co)

Braided Shield

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 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 very low transfer impedance to high frequencies. This is important when the shield is supposed to be conducting interference harmlessly to ground. Drawbacks of the braided 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.

Serve Shield (spiral-wrapped)

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 impedance that rises with frequency and is not as effective in shunting interference to ground as a braid. From a cost viewpoint, the serve shield 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 the copper serve shield a very common choice for audio cables such as the Pro Co (XLR20) XLR 20.



Foil Shield

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

Cable Connectors Glossary

Balanced

In audio, the opposite of Unbalanced. For us balanced refers to a type of AC electrical signal having two "legs" independent of ground. One is generally considered positive (+) and the other negative (-) in voltage and current flow with respect to ground. Unlike unbalanced audio lines there is no "signal" carried in the shield or ground connection unless there is a fault. The main benefit is that any noise that gets induced into the line will be common to both the positive and negative sides and thus canceled when it arrives at its destination, assuming the destination is balanced. This phenomenon is called "Common Mode Rejection" and basically just means that any signals common to both the positive and negative legs of balanced lines get canceled. This happens because when the receiving device looks at the signal the common noise actually shows up as out of phase with itself, and gets cancelled. Think of it as if the negative (-) signal gets inverted to positive (+) before use, which puts the desired audio signal in phase with the already positive other leg and at the same time causes the undesired common noise to become out of phase with itself. Clear as mud? Balanced lines are generally much better for long cable runs due to their ability to reject induced noises. XLR and TRS type cables are designed to transmit balanced audio from one balanced device to another. A standard 1/4-inch guitar cable is an example of an unbalanced cable. Another (newer) application of balancing that is becoming popular in audio systems is the idea of balanced power systems. Fundamentally the concept is the same. There is a positive and negative (with respect to ground) leg of electricity at every electrical outlet. The idea is that the power supply of any devices connected can then reject any noise induced on the AC line and thus will produce cleaner audio. We'll talk more about balanced AC systems in the future.

Unbalanced

In electronics, a condition where the two legs of the circuit are unbalanced with respect to ground, usually because one leg is kept at ground potential. In other words: An audio signal requires two wires or conductors to function. In an unbalanced situation, one of those conductors is used to carry both signal and ground (shield). Unbalanced circuits tend to be less expensive to construct, but they are much more susceptible to induced noise problems than their balanced counterparts. This is because any induced noise in one conductor is not canceled by similar noise in the other conductor (as in a balanced line) and may be carried with signal into connected equipment. In general, unbalanced lines should be kept as short as possible (certainly under 25-30' maximum) to minimize potential noise problems.

1/8 (Mini)

1/8 inch diameter plug (or jack) used in smaller audio visual interconnects. The connector may be TRS or TS, as well as some other configurations. This is the size of most of the Walkman style headphone connectors.

AES

AES/EBU is the most common alternative to the S/PDIF standard and the most common AES/EBU physical interconnect is AES Type I Balanced - 3 conductor, 110 ohm twisted pair cabling with an XLR connector.

BNC

A type of coaxial connector often found on video and digital audio equipment, as well as on test devices like oscilliscopes. In audio gear, BNC connectors are normally used to carry synchronizing clock signals between devices. BNCs are bayonet-type connectors, rather than screw on, or straight plugs. They are named for their type (Bayonet), and their inventor, Neill Concelman.

DB25

A type of D-Sub connector. DB-25's are commonly found on computing equipment where they are employed to connect peripherals. They are common to parallel ports or RS-232 ports on PC computers, but also often used in a variety of ways in the audio community. For example, TASCAM commonly uses the DB-25 connector for analog and/or digital I/O on their products, as do some other brands.

Elco

A brand and type (like Crescent wrench) of multi pin connector used in audio systems and equipment for connecting multi pair cable with one connector (instead of many). Elco is made in the U.S. and Edac is made in Canada and both come in many different varieties. They both come in 20, 38, 56, 90, and 120 pin configurations. There are male and female connectors (plug and receptacle in Edac nomenclature). The male connector can be identified by its polarizing pins on the plug, whereas the female has polarizing sockets. Either sex can have the actuating screw or the fixed nut for attachment. All

that is required is that there is one each. On the back of an ADAT, for example, the Elco is a female 56 pin, with fixed nut. The cable you plug in, therefore, is a 56 pin male with actuator screw.

Insert/Y Cable

A cable used to split a signal into two parts or combine two signals into one. The term Y Cable is used because the cable is like (and looks like) the letter Y, where there are two parts joined into one, or one split into two, depending upon how you look at it. Y Cables are common throughout audio as a simple and easy way to accomplish these two tasks. There are times, however, where they can be used in inappropriate ways, sometimes with disastrous results. For example, two MIDI signals cannot be combined using a Y cable. Two outputs from power amps cannot (under most normal circumstances) be combined via a Y cable (this will usually result in a substantial repair bill). Even in situations where Y cables can "work" the results are sometimes less than ideal. One must consider the output and input impedances, signal levels, and other factors of the devices in question before indescriminately combining or splitting their signals.

Optical

Optical cables are for compatible two-channel S/PDIF connections and ADAT lightpipe connections. The ADAT optical connections for transferring digital data 8-tracks at a time have become a standard of the industry and are used in a wide range of products from many manufacturers.

RCA

The phono plug was so associated with RCA in the beginning (see WFTD Phono Plug) that it actually became known as the RCA plug. Today the majority of people refer to it as an RCA connector, even though that isn't the technically correct name.

S/PDIF

A format for interfacing digital audio equipment together, S/PDIF (Sony/Philips Digital Interface Format) is considered a consumer format, and is largely based on the AES/EBU standard. In fact, in many cases the two are compatible. There are, however differences between the two formats, particularly in the channel status and user bits.

S/PDIF typically uses either unbalanced, high impedance coaxial cables or fiber optic cables for transmission. When using coaxial cables for transmission, it is normally best to keep cable lengths to a minimum, and to use the best quality 75 ohm video-type cables available.

TDIF

Generally pronounced TEE'-dif, it is an acronym for Tascam Digital InterFace. This is the protocol Tascam developed to use in their MDM and digital mixing products for doing digital transfers of audio. TDIF connections are made via a 25-pin d_Sub connector and data is carried on shielded cable. The TDIF standard is currently one of two major formats (the other being ADAT optical) widely used in pro and semi-pro MDM related products for digital transfer of more than two tracks of audio simultaneously using only one cable.

TRS

Abbreviation for Tip Ring Sleeve. This is the descriptively accurate term used to describe 1/4" (or 1/8") balanced connectors. A TRS plug can be found at the end of most headphone cords if you want to know what one looks like. They look like a standard 1/4" plug with an extra section in them. The three sections of the shaft are called the Tip, Ring, and Sleeve (a "standard" 1/4" connector just has a tip and sleeve). TRS connectors are used wherever it is desired to have two conductors plus a ground (shield) in one plug. Common uses are as a way to connect balanced equipment (where the TRS plug has a positive, negative, and ground connection), or stereo unbalanced equipment (left and right are on the Tip and Ring, with a common ground) like headphones, or as an insert for your mixer or other processor (Tip or Ring is the send with the other being used as the return and again ground is common).

TS

Abbreviation for Tip Sleeve. Tip Sleeve refers to a specific type of phone plug (not phono plug) or 1/4" connector that is set up for two-conductor unbalanced operation. The tip and sleeve are separated by an insulator. The Tip is generally considered the "hot," or where the signal is applied, while the Sleeve is where the ground or shield is connected. Unlike balanced connections the shield connection of a TS cable is required for signal to be able to pass.

TT

(Tiny Telephone) A miniature version of what is known as a phone jack, (phone plug) which is short for telephone jack, from the old days of telecommunications. We commonly refer to this type of jack as a 1/4 inch jack (our modern version actually is slightly different in size), which could come in TS and TRS forms. Switchcraft invented the TT jack (and corresponding connectors) many years ago to serve as a more compact alternative to the phone jack. Later another company, ADC, built essentially the same type of product, but referred to it as a Bantam connector. Nowadays the two names are interchangeable. TT/Bantam jacks and corresponding cables are commonly used in recording studio patch bays.

XLR

Trademarked name for circular 3-pin connectors developed by Cannon (now owned by ITT). "XLR" was originally nothing more than Cannon's part designation for the connector. In fact, you'll also sometimes see these connectors referred to as "Cannon" connectors. XLR has since evolved into a generic industry term, and many manufacturers now make this style connector. In audio work, XLR connectors are normally used for transmitting balanced mic and line level signals.

Pin 1 of an XLR connector is always ground/shield. The connectors are designed so that pin 1 makes its connection first when inserted in a jack; this ensures that the ground connection is made first, helping prevent pops and thumps in the audio chain.

Either pin 2 or pin 3 may be hot (determined by the gear the connector is plugged into), with the remaining pin being cold. To maintain correct polarity in a signal path, it is important to be aware of which pin is hot or cold on all connections, and wire your cables accordingly.

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