Microphone Cables

Isn't the Use of Balanced Lines the Biggest Advantage of Low-Impedance Microphones? What is a Balanced Line? (part 1)

Balanced lines are wonderful, but they are sometimes given credit for benefits that they are not actually responsible for. Balanced, unbalanced, low-impedance and high-impedance are all individual properties. Many people erroneously refer to anything with a 3-pin XLR-type connector as "low impedance" and assume it to be "balanced". Others call any line connecting two pieces of equipment with 1/4" phone jacks "high-Z". In reality, a lot of equipment has unbalanced inputs and outputs that are carried on XLR connectors, and there are even more low-Z lines on phone jacks. Medical instrumentation uses a lot of high-impedance balanced lines for sensors, and most line-level unbalanced outputs are very low-impedance.

Electrical systems need a reference point for their voltages. Generally referred to as common or ground, although it may not be actually connected with the earth, this reference remains at "zero volts" while the "hot" signal voltage "swings" positive (above) and negative (below) it. This is referred to as an unbalanced configuration. Physically, the common may be a wire, a trace on a printed-circuit board, a metal chassis - virtually anything that conducts electricity.

continued...

MICROPHONE CABLES

ISN'T THE USE OF BALANCED LINES THE BIGGEST ADVANTAGE OF LOW-IMPEDANCE MICROPHONES? WHAT IS A BALANCED LINE? (PART 2)

...continued from Part 1

Ideally it is a perfect conductor - that is, it must have no resistance or impedance. In a cable connecting two pieces of equipment, the shield is used as signal common.

As the complexity and size of the system is increased, the imperfect conductivity of the common (ground) conductor inevitably causes problems. Since it is made of a real material, it must have some resistance, which must (Ohm's Law says) cause voltage drop when current flows through it, which means it cannot be at a perfect "zero volts" at both ends. The larger the system and the greater the distances between the source and load, the less effective this unbalanced configuration becomes.

The voltages of a balanced line are not referenced to the ground or common. Instead, the signal is carried on a pair of conductors with the signal applied to this pair differentially. The signals are electrical "mirror images" of each other - their levels are the same, but their polarities are opposite. in other words, as the applied signal "swings", one conductor will be negative with respect to the common, the other will be positive. These polarities alternate with the frequency of the signal, and the total signal level is the difference

continued...

MICROPHONE CABLES

ISN'T THE USE OF BALANCED LINES THE BIGGEST ADVANTAGE OF LOW-IMPEDANCE MICROPHONES? WHAT IS A BALANCED LINE? (PART 3)

...continued from Part 2

between the two individual voltages. For example, if one conductor is at +5 volts, the other will be at -5 volts, and the signal level is +5 volts minus -5 volts or 10 volts. If, for some reason, the two conductors were both at +5 volts simultaneously, the level would be +5 volts minus +5 volts, which is zero volts. Very tricky!

Because of this differential signal transmission, two very valuable things happen when using balanced lines. First of all, each piece of equipment can have its circuitry referenced to its own common, because the interconnection of the equipment does not require that the commons are connected in order to move the signal around. This eliminates the major cause of a lot of noisy audio gremlins, ground loops. Secondly, because the signal is differentially transmitted and received, any common-mode interference signal superimposed on the signal in the line will be carried by both sides at identical level and polarity. In other words, if the line has +5 volts of external noise induced, both conductors will have +5 volts of noise on them. This equals a total interference level of +5 volts minus +5 volts, or, zero volts.

continued...

MICROPHONE CABLES

ISN'T THE USE OF BALANCED LINES THE BIGGEST ADVANTAGE OF LOW-IMPEDANCE MICROPHONES? WHAT IS A BALANCED LINE? (PART 4)

...continued from Part 3

The interference cancels itself. This is called common-mode rejection. There are several ways to balance lines (actually, the term "balanced" is very often used incorrectly to refer to lines that are actually floating. Properly speaking, a balanced line is one which has equal impedance from each side to ground. An unbalanced signal may be derived from it by using one side of the pair as "hot" and ground as common. A floating line has no reference to ground, and must have one side of the line tied to common to "unfloat" it). The input transformers once required by low-Z mic preamps also provided a floating input as long as neither side of the transformer's primary winding was tied to common. This is where the "low-impedance-is-balanced" misconception began. The use of balanced lines was actually just a by-product of the requirement for a transformer to step up the low signal level. Using modern low-noise integrated-circuit design, a low-Z mic preamp can be clean, quiet, balanced and a lot cheaper to build - without a transformer.