SONY

Sony Cinema Products Corporation

Tech Note

Connecting balanced and unbalanced circuits.

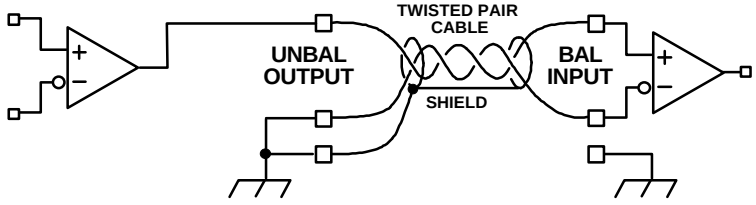
Product: All Sony cinema processors.
S/N: All units.
Document: **TN99060401**, CC
Summary: Wiring techniques for connecting balanced and unbalanced inputs and outputs.

Sony cinema processors have professionally balanced inputs and outputs. Unfortunately, many other products have unbalanced inputs that require special wiring techniques. The best results will be obtained if professionally balanced inputs are used throughout an installation, although this may require the additional expense of third-party equipment whose purpose is to create balanced inputs for equipment that does not already provide them.

The first thing to keep in mind is that the number of terminals that input or output connectors have is not a reliable indication of whether the circuits behind the terminals are balanced or unbalanced. Ideally, balanced connections will always have three terminals or contacts, but not all connector conventions provide this. If you are uncertain, there are sophisticated electrical tests that you can use to determine whether an input or output is balanced; the best approach is to refer to the manufacturers' technical documentation.

Unbalanced outputs.

Driving a balanced input from an unbalanced output is a reasonable approach to interconnecting equipment. Most of the benefit comes from the balanced input, so long as the impedance of the output is low and grounding of the shield is properly handled. Modern transformerless circuits do not require that the impedance of the input and output are matched; the input impedance should be much higher, making the circuit "bridging". Here is a simple drawing that shows an unbalanced output properly connected to a balanced input:



The triangles symbolize electronic amplifiers inside equipment and the larger squares symbolize connections to exterior wiring. Notice that the output circuit is unbalanced, even though it has three terminals, and the input remains balanced, even though only two terminals are used.

Avoiding hum caused by ground loops.

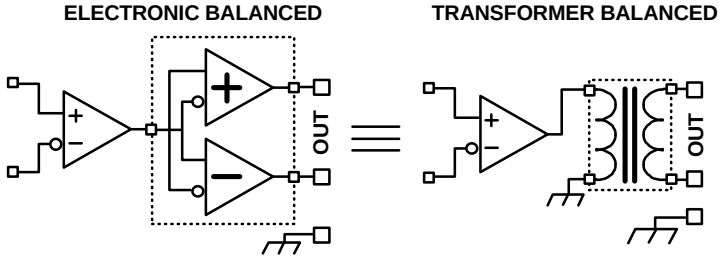
The shield of twisted pair cables should generally be connected only at one end and, of course, should not be used to carry any component of the audio signal. This is done to prevent joining together the ground systems of the two pieces of equipment, thus creating a “ground loop”. The chassis of the equipment may have different “ground” potentials, particularly if they are physically distant or plugged into different mains power systems. If this voltage difference is allowed to become mixed with the audio signal, the result could be audible hum at the power line frequency. Select the end of the shield to be connected to chassis ground according to which end has the most solid connection to ground and which is the easiest to connect up. Consistently connecting only the output-end shield simplifies troubleshooting. Never let shields float at both ends.

If you do have hum problems, check to ensure that your wiring has not created continuity between the chassis of the equipment you have interconnected. This is often difficult to do in practice, especially if the equipment is mounted in the same rack and the line cord safety terminals are in place. *Do not permanently remove the line cord safety ground of any piece of equipment in efforts to eliminate ground loops!* This potentially creates a shock hazard and violates electrical wiring codes. No equipment should require this to function properly.

The causes of ground loop hum are invariably unbalanced inputs, shields grounded at both ends, or using the shield as an audio signal return.

Balanced outputs.

There are three types of balanced outputs which you may encounter: transformer balancing, true electronic balancing, and pseudo-balanced or quasi-balanced outputs made by adding a polarity inverted signal. The first two are identical as far as most wiring schemes are concerned:

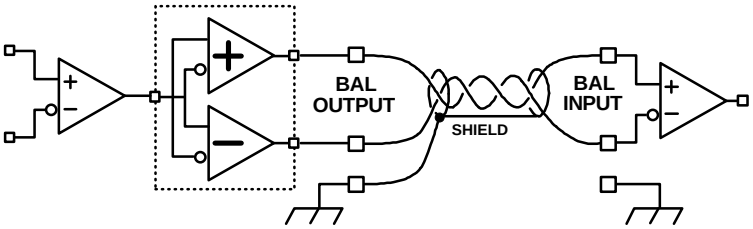


The circuit on the right uses a transformer to connect the output of an internal circuit stage to the outside world while isolating chassis ground from the audio signal. The circuit on the left uses a cross-coupled electronic circuit to achieve the equivalent result: true electronic balancing.

It is important to remember that both of these output circuits should be wired to in the same way. For example, you would never connect to only one polarity of the electronically balanced output any more than you would connect only to one side of the output transformer. For highest performance, Sony cinema processors employ modern, electronically balanced outputs.

Connecting to true balanced outputs.

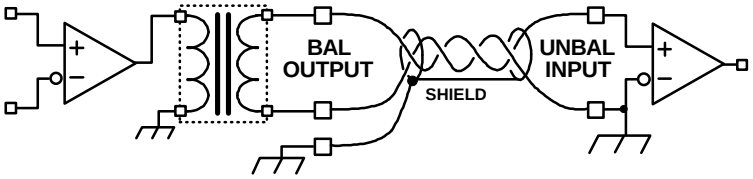
The proper way to connect either of the above true balanced outputs to a balanced input is the same. The electronically balanced output is illustrated:



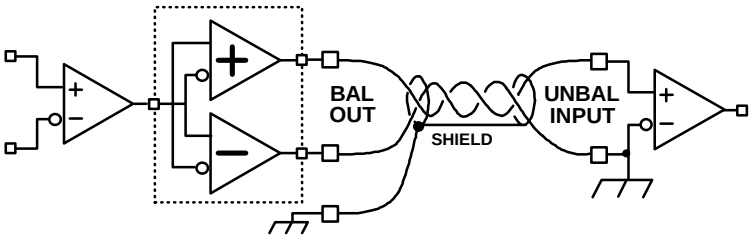
This circuit scheme gives the highest performance of all because it combines the benefits of balanced outputs with the even greater hum and interference reducing benefits of balanced inputs. It is the professional approach taken in the design of Sony cinema processors at both their inputs and outputs.

Balanced output to unbalanced input.

Connecting a true balanced output to an unbalanced input is not recommended; this approach will only compromise the isolation between the equipment. This approach should only be considered if absolutely necessary and only if the equipment being interconnected are mounted in the same physical rack. If this connection method should become necessary, here is an illustration of the best approach, using the transformer balanced circuit as an example.



Notice that this connection still provides electrical isolation between the chassis grounds of the two pieces of equipment, providing that the cable shield is managed as shown. Here is the equivalent electronically balanced version:



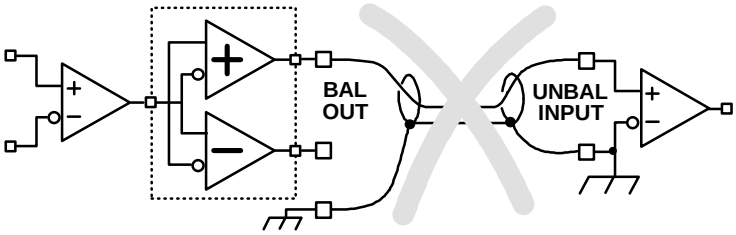
Once again the output signal must be properly terminated at the unbalanced input and the shield must be connected only at one of its ends so as to avoid connecting the two equipment grounds together and creating a ground loop. The cross-coupled circuit ensures that the signal level is properly maintained.

How not to do it.

Here are some DO NOTs to be aware of when making interconnections:

- DO NOT connect to only one side of a true balanced output.
- DO NOT connect the shield at both ends.
- DO NOT use the shield as an audio common.
- DO NOT use unshielded wires instead of shielded cable.

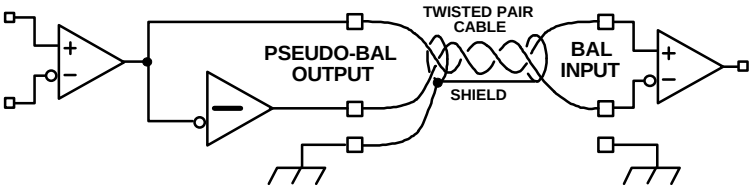
The following is an illustration of the absolutely wrong way to make the connection between a true balanced output and an unbalanced input.



Do not make your connections in this manner! This connection results in an undefined signal that could result in problems with stabilty, level, headroom, and frequency response. It also connects the grounds of the two pieces of equipment together using the return path of the audio signal, which could result in hum. Connecting the – phase of the balanced output to its own ground terminal is a poor compromise which should only be used as a last resort.

Quasi-balanced outputs.

Because of the inherent compromises, Sony cinema processors do not employ pseudo-balanced outputs, made by adding an inverted version of the signal. You may encounter them in the field however, so they will be mentioned briefly. Here is an illustration of a properly wired pseudo-balanced, or quasi-balanced output:

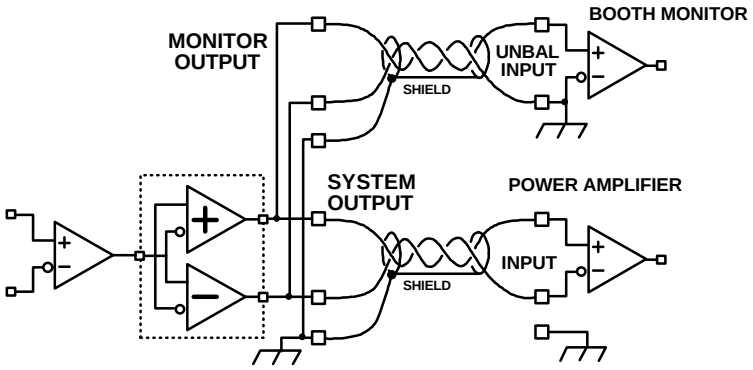


This schematic shows a polarity-flip type output properly wired to a balanced input, such as those of the DFP-D3000. Neither output polarity will be shorted to ground and equipment grounds remain isolated. Signal level is unaffected.

In most cases, neither the + nor – legs of pseudo-balanced outputs should be connected to ground as a means of obtaining an unbalanced signal. If you must connect a pseudo-balanced output to equipment with unbalanced inputs, it is probably best to treat each pseudo-balanced output as if it were two unbalanced, out-of-phase outputs (which is what it actually is) and connect to only one of them. This is not at all the same approach as is appropriate for true balanced outputs. Note that this will result in half the nominal signal level (a loss of 6 dB). Carefully consult the equipment manufacturers' recommendations when it is necessary to connect pseudo-balanced outputs to unbalanced inputs.

Multiple pieces of equipment.

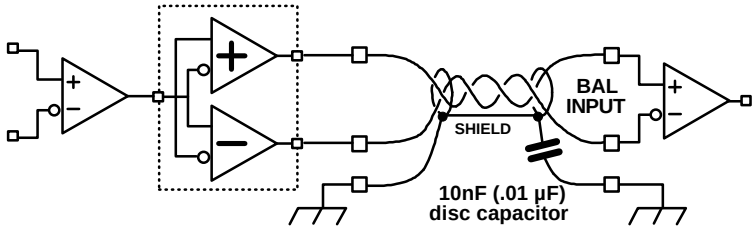
In the real world it is often necessary to interconnect the same signal several to pieces of equipment with different types of inputs or outputs. An example is connecting the balanced SYSTEM outputs of a DFP-D3000 to power amplifiers, which may have balanced inputs, and simultaneously connecting the DFP-D3000's MONITOR outputs to a booth monitor, which may have unbalanced inputs. The SYSTEM and MONITOR outputs are simply paralleled inside the DFP-D3000. Here is what the connection would look like:



Notice that the unbalanced input of the booth monitor effectively unbalances the output of the DFP-D3000, as it connects the – or "cold" out-of-phase side to the booth monitor's ground. Nevertheless, if the wiring is done as illustrated the power amplifiers will suffer no hum problems. Chassis grounds of all three pieces of equipment will not be connected together by the wiring, and no component of the audio signal flows in shields.

Advanced techniques for long cable runs.

On rare occasions when a long cable run is required, problems may be encountered with radio frequency interference. This is because the long shield becomes a poor ground at high frequencies and it can actually act as an antenna. An example of this situation might be the run from a DFP-D3000 to a power amplifier located near the screen in a theatre. The solution is to ground the shield at both ends for radio frequencies, but leave one end open for power line frequencies (thus avoiding a hum-causing ground loop). The illustration shows the technique:



A small disc ceramic capacitor is inserted into the connection between the shield and ground at one end only.

Real world installations.

Real world installations can be much more complex than the simple examples illustrated in the Tech Note. Audio grounds, logic grounds, power grounds, and computer grounds can all become mixed. Finding the cause of interconnection problems can be frustratingly difficult. Sometimes the offender is a piece of unbalanced consumer equipment used for non-sync; sometimes it is a tally line that causes problems only under certain conditions. Sometimes every piece of equipment must be isolated and re-connected one by one to track down the problem.

Various pieces of equipment can present unique challenges. For example, the THX crossover has balanced main inputs but its surround and subwoofer inputs

are unbalanced. Some equipment shares the same ground for audio and logic; if the logic ground ever becomes shared with mains powered external equipment there is great opportunity for creating intractable ground loops.

If you encounter difficulties installing Sony equipment, contact Sony Cinema Products' technical support staff for recommendations and troubleshooting assistance.