

APPLICATION NOTE

MEASURING UNBALANCED DEVICES USING THE SIM-3022 AUDIO ANALYZER



Unbalanced audio devices and/or sources must sometimes be used within a sound reinforcement system, and integrated with balanced inputs and outputs. These unbalanced sources include CD and tape players, DAT machines, DVD players and similar — usually introduced to the system via channels in a mixing console. Unbalanced in-line devices include older signal processors and vintage musical equipment. The unbalanced devices typically have RCA jacks or 1/4" tip-sleeve connectors, or occasionally may have barrier-strip terminals.

These unbalanced devices present an unknown variety of grounding, wiring and powering schemes, and can create excess noise and hum in the system, as well as level differences and frequency anomalies. Measuring them beforehand to learn their characteristics will help with integrating them more successfully, in terms of output level, frequency spectrum, and noise level. SIM 3 provides tools to measure many performance parameters of electronic devices, including gain stages and maximum levels, frequency response, phase response, THD, and more.

As a guide to minimizing the problems that can occur when interfacing unbalanced devices with a balanced audio system, this document will suggest wiring methods between the output of unbalanced devices and balanced inputs (including the Console or Processor inputs of SIM 3), and between the Generator output of SIM 3 and the input of unbalanced devices.



NOTE: For the Frequency Response measurement, SIM 3 compares the audio signal at one measurement point with the next measurement point, and displays the differences between the two points. Its inputs are differentially balanced 3-pin XLR connectors, and for the most accurate and consistent measurements the balanced circuit between Pin 2 and Pin 3 must be used. Pin 1 does not play a direct role in the measurement.

UNBALANCED OUTPUT TO BALANCED INPUT WIRING METHODS

The following are recommended methods of wiring an unbalanced device connector to the SIM 3 balanced input for measurement. Try these wiring methods in the order presented — simplest first. The method used will depend on how the unbalanced device is designed and grounded, and may require some experimentation.



NOTE: In the unbalanced output to balanced input wiring methods, 2-conductor twisted-pair shielded cable is highly recommended.



NOTE: Make all of these cables as short as possible for the measurement task or application.

Method 1: Simple Interface, Tie Pin 3 to Pin 1 (Shield) in Unbalanced Connector

The simplest wiring is to use a 2-conductor twisted-pair shielded cable, and wire the XLR-3 connector normally. On the unbalanced side, connect the Pin 2 conductor to the center pin of the RCA or tip of the 1/4" connector. Connect Pin 3 to the shield on the unbalanced side, and then to the sleeve. This is sometimes known as a “pseudo-balanced” direct connection. Depending on the grounding scheme of the unbalanced device and the exact design of the XLR input, this method may reduce common-mode “ground-loop” noise.

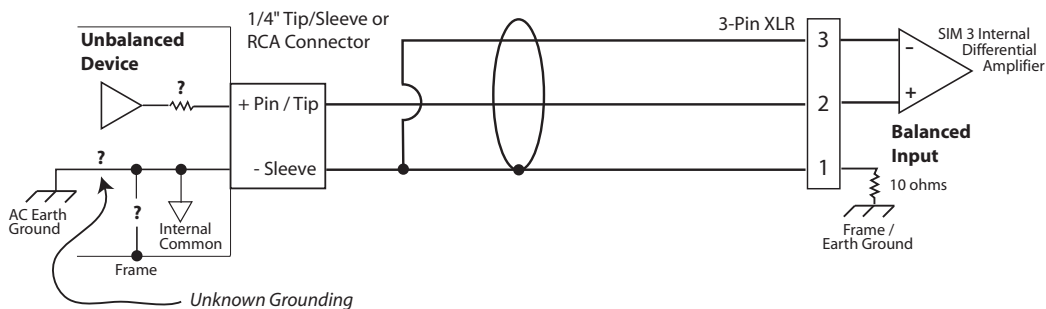


Figure 1. Simple unbalanced output to balanced input wiring



NOTE: The typical cable wiring to go from an unbalanced connection (usually an RCA “phono” or quarter-inch tip/sleeve “phone” connector) to a balanced one is to connect the center pin or tip of the unbalanced connector to Pin 2 on the XLR, and to connect the “sleeve” to both Pin 3 and Pin 1. The connection is likely to have less immunity to noise than a balanced-to-balanced one.



NOTE: Check for noise and hum in the system using the spectrum measurements in SIM 3 — Band Spectrum and Line Spectrum. Look for excess levels at 60 Hz and its harmonics of 120 Hz, 180 Hz, etc.

Method 2: Same Wiring as Simple Interface, Plus External Ground Wire Between Devices

In certain cases, the simple wiring method shown in Figure 1 will not solve the problem because the unbalanced device may have quite a bit of 50/60 Hz voltage on its internal common (due to its power transformer and 2-wire AC connection). This 50/60 Hz voltage will cause current to flow on the shield of the XLR cable and may induce hum and/or noise.

In these circumstances, use an external conductor that ties the two frames together. Pin 2 goes to the pin/tip of the unbalanced connector, and Pin 3 goes to the sleeve. The sleeve is internally or externally grounded to the unbalanced device chassis or frame, and a ground wire is run between the frames of both the unbalanced and balanced devices.

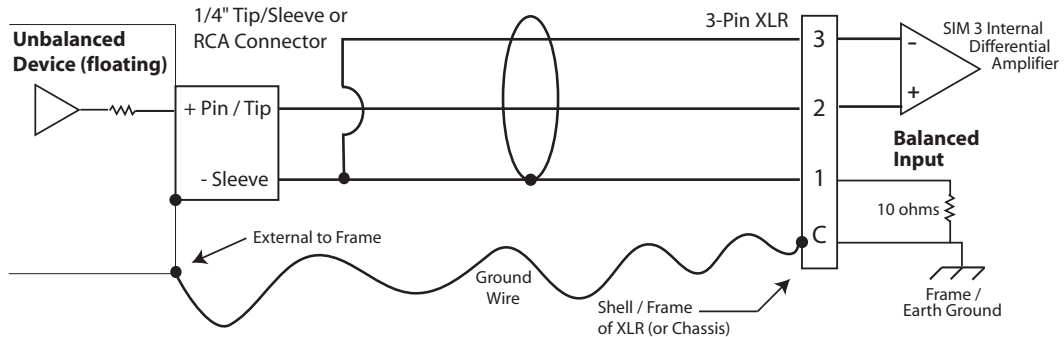


Figure 2. Unbalanced output to balanced input wiring with external ground wire



TIP: Use a wire with alligator clips on each end, and clip one end to a chassis screw or similar on the unbalanced device and the other end to the SIM-3022 analyzer or other balanced device.

Method 3: Unbalanced Output to Balanced Input Connection with Dropped Shield

After trying the first two methods and not achieving the desired result, the following method may work in some cases. Connect Pin 2 to the pin/tip of the unbalanced connector, Pin 3 to the sleeve, and lift the shield. However, this method is more likely than the preceding ones to produce noise and be unstable, and is not usually recommended.

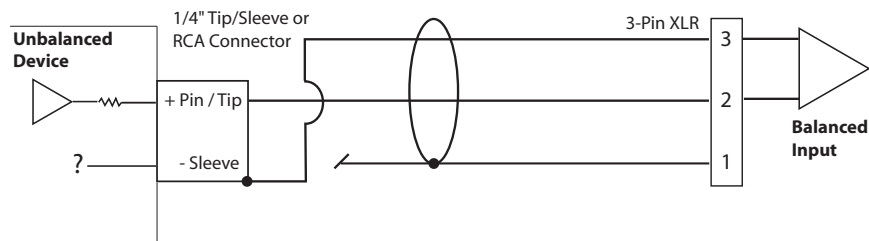


Figure 3: Pin 2 and 3 wiring with dropped shield (not typically recommended)



NOTE: Do not use a single-conductor shielded (coaxial) or two-conductor unshielded cable to connect unbalanced outputs to balanced inputs (Figure 4). The resulting connection will be unstable and allow noise and hum to pass between devices.

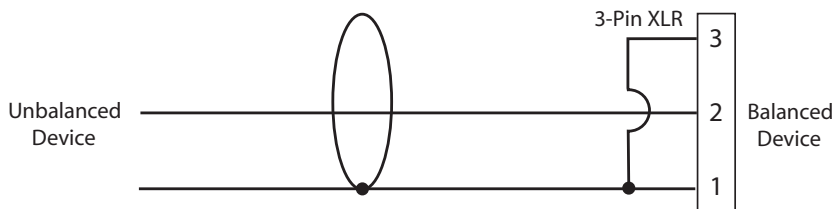


Figure 4. Single-conductor shielded wiring to a balanced input, not recommended

BALANCED OUTPUT TO UNBALANCED INPUT METHODS

When an unbalanced device is being integrated into the signal path of a balanced system, or when it is being measured using the output signal from the SIM 3 Generator, the cabling also must take a balanced output and introduce it to an unbalanced input. Use the following wiring methods to connect the devices together.

Method 1: Simple Wiring, Using Pin 2 and Shield Connections

Wire the XLR-3 connector from the balanced output in the following manner. Connect the Pin 2 connector of the balanced device to the center pin or tip of the unbalanced connector. Connect the shield to Pin 1 and to the sleeve on the other side. Do not make a connection on Pin 3. In this case, the cable can be either 2-conductor twisted-pair shielded cable (use only one of the inner conductors plus the shield) or single-conductor shielded cable (coax).

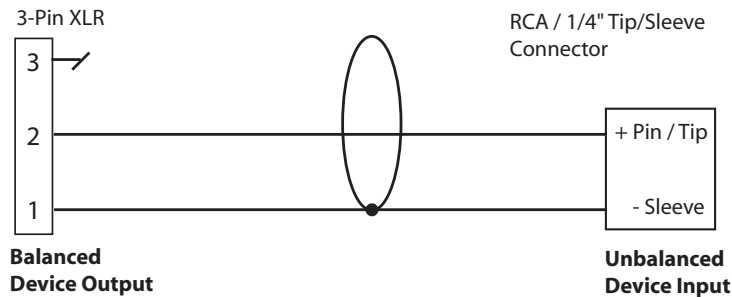


Figure 5. Connecting a balanced output to an unbalanced input



NOTE: When connecting the SIM 3 Generator output to an unbalanced device and then measuring the output of that device with the SIM-3022 analyzer, the trace shown on the screen will show a 6-dB loss in level. This difference occurs because the unbalanced device is only receiving the signal from Pin 2, and the additional signal level from Pin 3 is not being delivered to the input.



CAUTION: Do not wire the balanced output to the unbalanced input using Pin 2 and Pin 3; use only Pin 2 (using Pin 3 alone would invert the polarity of the signal).

Method 2: Adding an External Ground Wire to Method 1

If hum or noise is still present in the signal from the balanced output to the unbalanced input when wired as in Method 1, add an external ground wire between the chassis of the two devices. See Method 2 in the previous section for details.



NOTE: The input cables and output cables connecting unbalanced devices with a balanced system are wired differently.



NOTE: As much as possible, isolate the unbalanced-to-balanced cables from other cables, AC wiring, transformers, and other sources that might induce noise into the cable.



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