In-DI-spensible?

Essentials of direct injection boxes

By Al Keltz

Direct boxes are often referred to as "DI" (Direct Injection) boxes. Their primary purpose is to convert unbalanced and/or high-impedance instrument signals into a format suitable for direct connection to a mixing console's microphone input – without the use of a mic.

DI boxes also can provide several other basic functions:

- Convert a high-impedance signal to a low-impedance signal (although they will also accept a low-impedance signal from a preamplifier, keyboard, active pickup or other electronic device).
- Convert unbalanced signal to balanced.
- Reduce a strong instrument or line-level signal (and sometimes even loudspeaker level signal) to a microphone-level signal suitable for connection to the mic input of a mixing console.
- Isolate electronic equipment on stage from the mixing console, which can help eliminate interference and noise caused by electrical interaction or ground loops.

PASSIVE

The simplest form of DI is termed "passive," consisting of a box containing a transformer. (**Figure 1**) A high-quality transformer is critical for preserving the frequency characteristics of the signal.

The input connection is usually an unbalanced 1/4-inch guitar-type tip/sleeve jack, and usually two jacks are wired in parallel. These dual jacks allow an instrument to be connected into the DI and then out again in parallel. This could be used, for example, in a bass guitar setup where the bass is fed first to the DI and then back out to a bass guitar amplifier located on stage for monitoring. (**Figure 2,** next page)

Usually the primary (or input) side of the DI will offer an impedance of approximately 20 kOhms, while the secondary (or output side) will have an impedance of about 150 Ohms. It's this step-down characteristic of the transformer that reduces the level of the signal to mic level.

The high impedance of the primary side also presents a proper load for various source signals, whether from a high-impedance guitar pickup or low-impedance output from a keyboard, preamplifier or other active device. This helps preserve the frequency response of the input signal.

The secondary side of the transformer converts the signal to balanced and low-impedance, making it suitable for transmitting long distances to a mixing console.

The output connection is usually made via a male three-pin XLR connector, and the ground connected from the input jack's shield to pin 1 of the XLR is made through a switch on the DI. This switch provides the ability to break the ground connection between the input and the output.

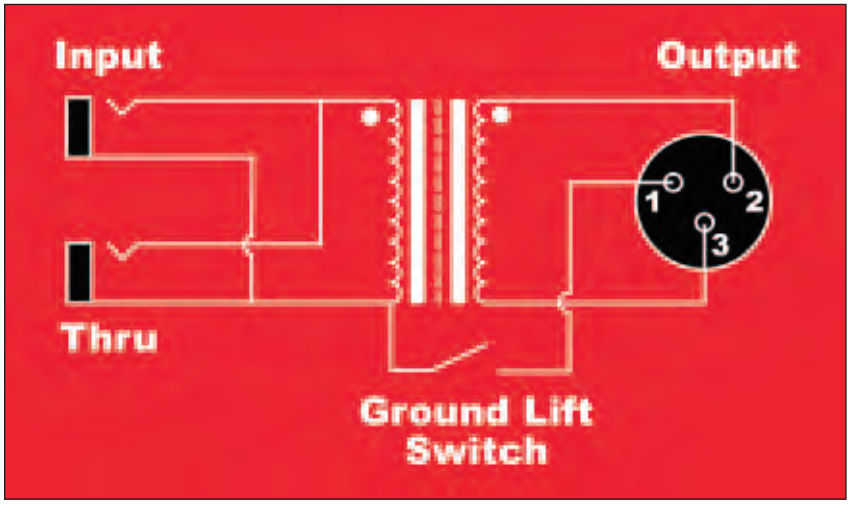

Figure 1: Schematic showing basic DI design.

GROUND LIFT?

A guitar with passive pickups and its cable shield get a ground connection from the mixing board through the DI's ground lift switch. However, if that instrument is connected through the DI to an amplifier, it also introduces a second grounding point at the amplifier.

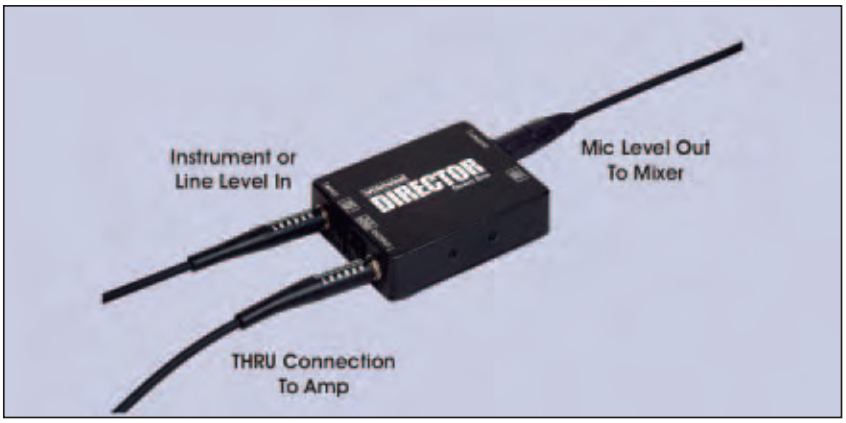

Figure 2: Dual jacks allow an instrument to be connected into the DI and then out again in parallel.

Slight differences in the actual resistance to ground can exist between the amplifier and the mixing console, and this can cause AC current to flow in the shield. This is called a ground loop, with the 60 Hz signal "riding" on the shield, radiating into the center conductor. The result is hum.

Similarly, in the case of AC-powered keyboards or preamps, a ground connection through the DI can also set up a ground loop.

As a rule of thumb, the ground switch is left in the "ground" position unless there is a hum problem. Isolating the grounds by placing the switch in the "lift" position can help reduce or eliminate it.

ACTIVE

The same conversion that occurs with a passive DI can also be accomplished with an active electronic circuit. An advantage of using an active circuit is that it can be fine-tuned to produce a wider frequency response than can be achieved with an entirely passive DI. However, active DIs require a power source – phantom power from the mixer or internal batteries.

When converting impedance with a transformer, the impedance and signal reduction required for the output dictates that the primary of the transformer be in about the 20 kOhm range. Although this is a fairly high impedance, the high-frequency component of the applied signal would be better preserved if the input impedance were even higher. Active DIs accomplish this with a very high input impedance of 1 million ohms or more. ■

Al Keltz heads up Whirlwind technical support and can be reached at alk@whirlwindusa.com.

DI PIONEER

In 1981, Whirlwind produced the first commercially available direct box. Until that time, sound companies had to create their own DI devices to eliminate the need to use a microphone for each input to the mixing console. Other DI benefits include the easing of mic placement and leakage problems.

Whirlwind saw the addition of DI boxes to its line as a natural progression, where they worked in tandem with the company's then-new Medusa cable snakes. A 1981 catalog shows the first models, IMP 1, IMP 2, IMP 3 and IMP AKG. They were housed in a plain aluminum box and identified with just a Whirlwind stick-on label.

Today, the company offers more than 25 different splitters, DIs, combiners and testers, while several other companies jumped on the trend and now also offer a wide range of similar products. (For more about the design of the early Whirlwind DI boxes, go to www.whirlwindusa.com.)