the LEON AUDIO company

62 Edgeware Road, Aldgate, South Australia, 5154. Phone +61 8 8339 3865 Fax +61 8 8370 8780 www.LeonAudio.com.au

Active Direct Inject Box

Professional Active D.I. with Transformer Isolation

An Active Direct Box featuring the best of active and passive designs with none of their short comings.

- **Genuine earth isolation**
- **Class A FET input amplifier**
- **Low noise and distortion**
- **Transformer balanced output**

Description

This Active Direct Inject (D.I.) Box is designed for optimum performance with any musical instrument signal source, especially in electrically hostile environments such as live performance venues using light dimmers.

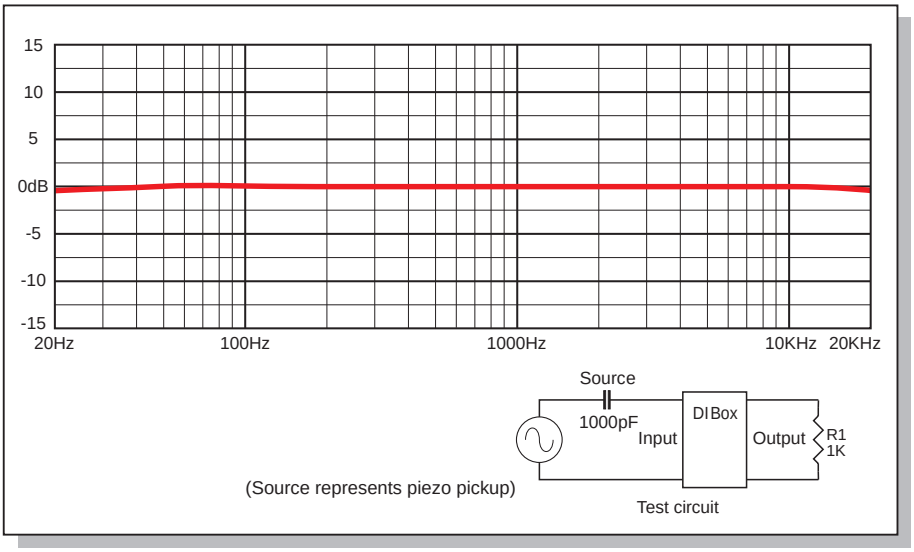
The input is buffered by a class “A” FET (Field Effect Transistor) amplifier which has a 30 Meg ohm input impedance . The XLR output is isolated via a custom made high performance audio transformer.
There are two unbalanced outputs for connection to a stage/musician’s amplifier. The first is connected directly in parallel with the input. The second provides a buffered output to prevent the musician’s stage amplifier from over loading the instrument’s pickup and degrading performance.

The active FET input stage provides the benefits of low noise, low distortion and high input impedance, while the heavily screened output transformer provides very high isolation between the input and XLR sides of the D.I. Box. The transformer provides maximum immunity to external electrical interference and also reduces earth noise to an absolute minimum.

The D.I. is designed to operate without compromise when the earth lift switch is lifted. Many other active D.I. boxes will not operate correctly, or at all, when the earth switch is lifted as there is no return path for the Phantom Power.
A DC/DC converter is used to power the active input stage via it’s own isolation transformer. This allows genuine earth isolation at all times.

Handling of high level inputs up to +15dBu means that a pad switch is not needed.

The D.I.’s high input impedance minimises loading of the signal source. This results in minimal loss of bass and treble when used with instruments with high source impedances. Piezo pickups are one example of high source impedances.
A high input impedance is also suitable for connection to low output impedances such as keyboards or mixers. Impedance matching is not required, nor is it even desirable, as we want to achieve the maximum possible *signal* transfer, not the maximum possible *power* transfer that a matched impedance offers. Matched impedances are generally undesirable and not normally used in audio systems.



Active D.I. Box frequency response with a typical source impedance.

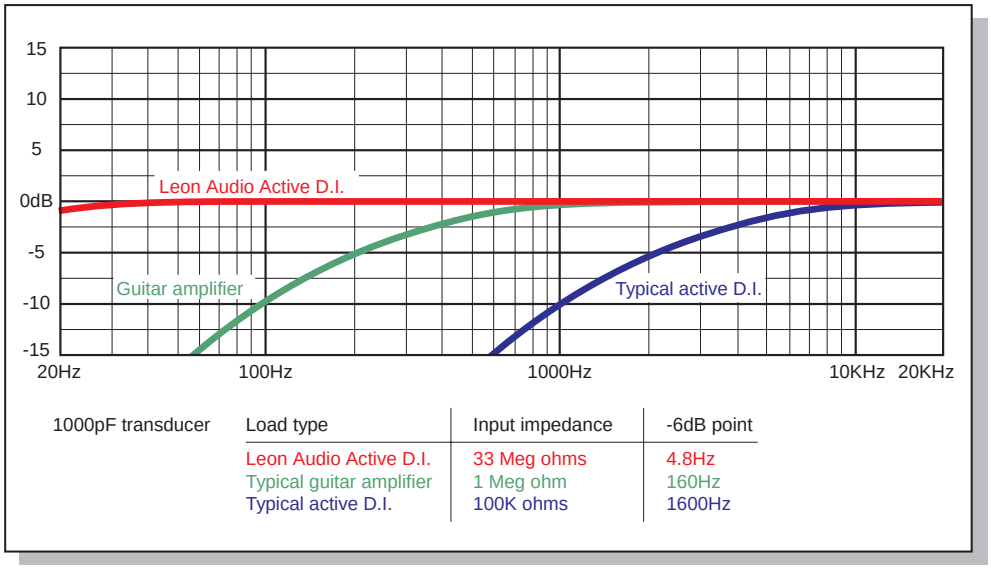
Piezo Pickups

Q: Why do many Piezo Pickups sound thin and bright?
A: Because the bass is heavily attenuated.

The capacitive characteristic of piezo pickups results in their output level decreasing as frequency decreases when connected to a typical instrument amplifier which has an input impedance of about 1 Megohm.
This is due to excessive loading of the pickup by the amplifier which was never designed to work with piezo pickups.

An extremely high load impedance, typically greater than 20 Meg ohms, is needed to provide negligible loss of bass frequencies.

The above situation is further compounded by connecting the piezo pickup to a D.I. box. The total load seen by the pickup is now that of the DI box *and* the instrument amplifier in parallel.
The input impedance of a typical D.I. is 100K-200K ohms, which results in a very heavy load on the piezo pickup and consequentially a heavy loss of low frequencies.



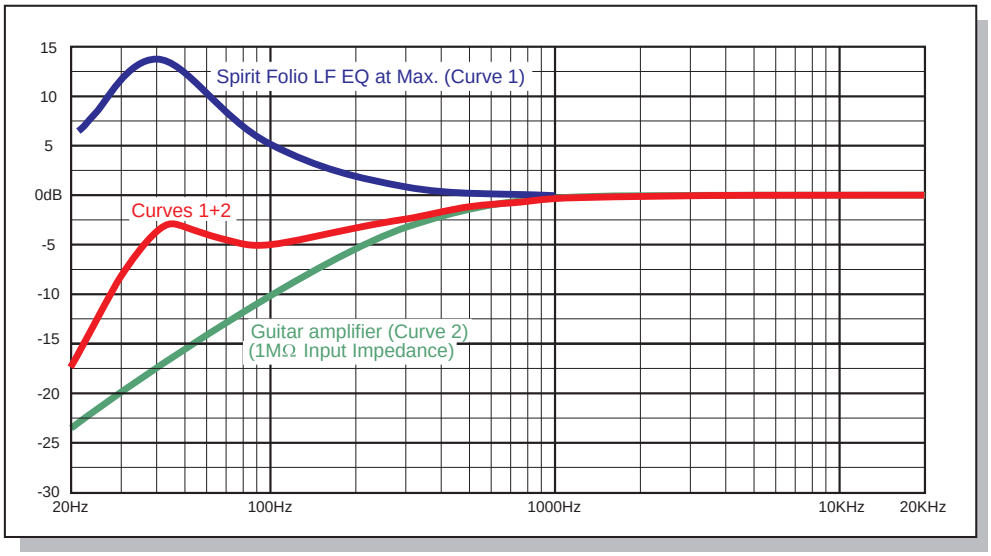
1000pF transducer	Load type	Input impedance	-6dB point
	Leon Audio Active D.I.	33 Meg ohms	4.8Hz
	Typical guitar amplifier	1 Meg ohm	160Hz
	Typical active D.I.	100K ohms	1600Hz

Piezo pickup frequency response Vs various load impedances

The solution is to use a D.I. box which provides an extremely high input impedance and a *buffered output* to drive to the instrument amplifier. With this arrangement, the piezo pickup is only loaded by the input impedance of the D.I. box, and everybody is happy.
The Leon Audio Active DI box is one such solution.

Attempts to recover the lost bass of an overloaded Piezo pickup using conventional tone controls is usually less than successful.
The problem is that the bass rolls off at the rate of 6dB per octave, and conventional tone controls can not create an inverse of this roll off.
Curve #2 in the graph below shows the response of a Piezo pickup rolling off at 6dB per octave.
Curve #1 is a typical bass tone control set at full boost.
The centre curve shows the bass boost applied to the signal lacking in bass. The result is still lacking in bass but more importantly, it is far from flat.

It is much better to cure the disease than to treat the symptoms.
Using a DI box with a very high input impedance to prevent the loss of bass in the first place, is much better than trying to patch it up later.



Low frequency roll off showing poor bass response even with +15dB of EQ

Two Output Jacks

A typical D.I. configuration has an instrument plugged into the input of the D.I., and a mixing desk into the XLR output. A stage amplifier can be connected to either the direct or buffered output jacks.
If the stage amplifier is connected to the *Buffered* output jack, the instrument will only see the 30 Megohm input impedance of the D.I. box. This results in the best possible frequency response when using high impedance pickups such as piezos. An extra octave of low end, or part thereof, can be obtained, compared to a regular D.I. Box. This may cause problems for the musician as his stage sound will be different.
If this increased low end is unacceptable, connect the stage amplifier to the *Direct* output jack. The instrument will now be loaded by the input of the stage amplifier. Depending on the type of pickup used, large amounts of bass roll-off may occur. The *Direct* output jack was provided so that the musician can retain their *normal but degraded sound* that they are used to.
Connect the stage amplifier to the *Buffered* output whenever possible.

Power Source

Power for the FET input amplifier needs to be returned to the XLR connector. This can not be achieved when the Earth Lift switch is open. There are 4 possible options ...

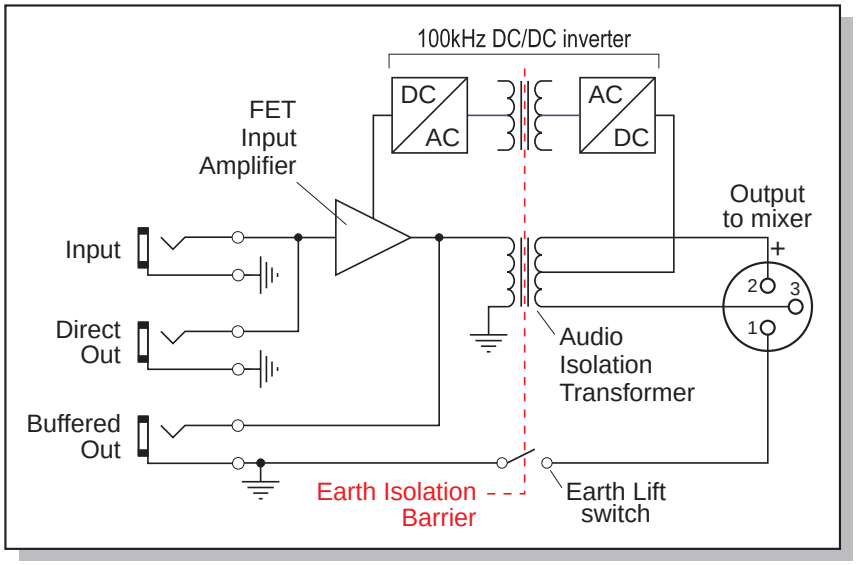
1: Use batteries. This option was considered unacceptable in a professional D.I. box

2: Do what other active D.I. boxes do and allow the Phantom Power to return via the instrument's mains earth connection.
A great way to pick up lots of electrical noise.

3: Do what other active D.I. boxes do and use a partial Earth Lift. This concept works well in the showroom. It fails in the real world when electrically noisy environments are encountered.

4: Use a complex isolated power source for the FET input amplifier.

Option 4 was chosen as it is the only one that offers genuine earth isolation between the input and the XLR output of the DI Box.



Block diagram of the Active D.I. Box

The drawing above shows that there is no direct electrical connection across the Earth Isolation Barrier.
A DC/DC inverter is used to get the FET amplifier's power across Earth Isolation Barrier. Phantom Power is first extracted from the centre tap on the bifilar wound secondary of the audio transformer. This drives a DC/AC converter running at 100kHz which in turn drives a small power transformer. The resultant 100kHz AC voltage on the secondary of the power transformer is rectified and filtered to provide 18 volts DC to run the FET amplifier. As a result, there is no interruption to the FET's power supply when the Earth Lift switch is operated.

As the FET amplifier is operating on an 18 volt supply, it is able to handle much higher signal levels than if it were operating from a 9 volt supply, such as a battery.
This means that the DI Box can handle input signals up to +15dBu without the need for an input Pad switch. (0dBu = 0.775Volts)

What's in a D.I. Box?

D.I. Boxes are constructed using one of two common techniques.

- The first type uses electronic circuitry and are known as *active* D.I. Boxes. They require either Phantom Power or a battery supply.

- The second variety uses an audio transformer and are known as either *transformer* or *passive* D.I. Boxes. They require no power supply.

A D.I. box is required to perform three separate basic tasks.
1. Impedance Conversion
2. Unbalanced to balanced conversion
3. Earth isolation

1. Impedance Conversion
The medium or high impedance of a signal source is converted to a low impedance suitable for feeding down a long multicore to a mixing desk's microphone input. A low impedance enables long cable runs, with very little quality loss, and also low susceptibility to external electrical interference which can cause hum and buzzes.

A D.I. box should provide a high input impedance for connection to a signal source, and a low output impedance for connection to the microphone input of a mixing desk.

2. Unbalanced to balanced conversion
The unbalanced (2 conductor) wiring of a signal source is converted to the balanced (3 conductor) wiring of a mixing desk's microphone input. A balanced cable provides good rejection of electrical interference, while an unbalanced cable does not.
Active D.I. Boxes are potentially capable of providing excellent unbalanced to balanced conversion, but due to cost restrictions, most are poor performers in this area.
D.I. Boxes that incorporate transformers provide excellent unbalanced to balanced conversion.

3. Earth isolation
A D.I. Box provides isolation between the earth wiring of a signal source (e.g. musical instrument) and the sound system to which it is being connected. This prevents earth loops from occuring. An earth loop occurs when a device, such as a keyboard, is connected to the mains earth via more than one path. The first path is via the instrument's own power cable to the mains earth. The second path is via the interconnecting audio cable to the sound system, then via the sound system's power cable to the main's earth. Any resultant circulating earth current is amplified and is heard as a hum or buzz. These unwanted earth currents are usually induced from nearby power and lighting cables.

Active D.I. Boxes are usually very poor at providing good earth isolation, because there is usually a direct electrical path between the instrument and the sound system, even if its earth lift switch is lifted. The Leon Audio Active D.I. Box uses a quality transformer to provide very good earth isolation.

Earth Lift Switches.
D.I. boxes have an *earth lift* switch to allow the earth connection between its input and output connectors to be broken to prevent earth loops.
Disconnecting the *signal* (audio) earth is not a safety issue, as the *Protective Earths* in all the mains cables are still connected and fully functional.

Specifications

Frequency Response	
10K ohm source, 1K ohm load	**20Hz - 20kHz ±0.15dB**
1,000 pF source, 1K ohm load	**20Hz - 20kHz ±0.45dB**
Nominal Input Impedance	**33,000,000 ohms**
Maximum Input Level	**+15dBu**
Nominal Output Impedance	**75 ohms @ 1kHz**
Output Level (0dBu input)	**-15dBu**
Recommended Load Impedance	**600 ohms or greater**
Power Supply	**48V Phantom Power with indicating LED**
Supply Current	**4.2 mA at 48 volts**
Finish	**Powder coated die cast aluminium**
Weight	**520 grams net 620 grams gross**
Dimensions	**W 95mm H 120mm D 67mm**

0dBu=0.775Volts

Warranty

The Leon Audio Active D.I. Box is guaranteed for two years from date of original purchase against defects in workmanship and materials. If such malfunction occurs, the item will be repaired or replaced (at our option) without charge for materials or labour if delivered prepaid to THE LEON AUDIO COMPANY. Unit will be returned prepaid. Warranty does not cover finish or malfunction due to abuse or operation at other than specified conditions. Repairs by other than THE LEON AUDIO COMPANY or authorized agents will void this guarantee.

the LEON AUDIO company

62 Edgeware Road, Aldgate, South Australia, 5154
Phone (08) 8339 3865 Fax (08) 8370 8780
Intn'l Phone +61 8 8339 3865 FAX +61 8 8370 8780
www.LeonAudio.com.au