

## Selecting a DI box for bass

### *Selecting a direct box ... Passive versus Active... which is better?*

When it comes to bass, the question we get asked all the time is 'which direct box works best: active or passive?' The answer is easy: it depends. In fact, more than anything else, it depends on what kind of bass you have. To understand the options, we must first know some of the history and how the direct box has evolved over the years.

When it comes to signal flow, there are two types of bass guitars: passive and active. The first electric basses i.e.: the original Fender Precision was passive and still is today. It employs magnetic pickups to generate the signal. As the string moves in and out of the magnetic field, a low level alternating current is generated. The signal from the bass travels through the cable to the amplifier which in turn increases the voltage level so that it is sufficiently powerful to drive another electromagnetic device called a loudspeaker. In essence, the signal is amplified by a series of buffers that work together to increase the voltage and/or current as needed.

For years this worked well... until bands like the Beatles messed everything up! The problem was that the fans that attended the concerts were so loud that the bass amp was unable to produce enough 'thump' to overtake the screaming. The solution: send the bass guitar signal through the PA system. Eureka! The amazing direct box was born. The term DI or direct injection literally means take a signal directly from the bass and inject it into the PA.

The first direct boxes were basically hand-made black boxes that had transformers inside. These passive devices would tap a signal off the bass and split it so that part of the sound would go to the bass amp on stage, and the rest of it would go to the PA system some 50 to 100 feet away. As the PA systems got larger, so did the dance halls. Eventually, things escalated to the point where concerts moved to arenas and stadiums. Today, big concert snake systems will often have 300 foot cables and multiple splits that will drive monitors, the front-of-house mixing console and even a broadcast truck some 500 feet away in the parking lot.

Bass players complained. They noticed that when their bass was connected to all of the cable, the sound changed. It was not as beefy. No more thud. Of course! This should come to no surprise... if you take the signal from a magnetic pickup and ask it to drive hundreds of feet of cable in addition to the bass amp on stage, the level will be weaker. And it will not sound the same. This effect is known today as 'loading'.

The solution: buffer the bass signal. (*What? Please translate into English!*) Sorry... Place a small amplifier inside the direct box so that 99% of the signal is directed to the bass amp and 1% is split off to drive the PA. Euphoria! The active DI box is born! Ye old Fender P-Bass is now happy. The thud has returned.

So for the next bunch of years, everything works just ducky until one day, some guy decides to put a 9 volt battery inside the bass and buffers the signal. Yup, now all of a sudden, instead of the bass producing around one volt, the battery powered preamp inside the bass is now kicking out 5 to 7 volts! "*We can do better exclaim the CEO of Acme Bass Co., let's put in a second battery!*" The latest 6 string bass can now deliver a whopping 18 volts of mayhem! Bass players rejoice! You can now overload the front end

of 'ye olde SVT' and finally out-blast that pesky lead guitarist and his lowly Marshall. *Boom, boom Arghh! Boom... ha ha ha! (add devilish smile)*

All good expect for one problem... the 18 volt output is now overloading the direct box. It distorts... the bass sound through the PA system is now indistinguishable, muddy, no punch. It sounds just plain bad.

Solution? Simple... dust off the old passive direct box, connect it up and bingo! Great tone – the thud is back. *“What? To solve the problem we have gone back 40 years? Please explain and this had better be good!”*

Here's the deal. Early active direct boxes were powered by batteries and in fact, some still are. But the problem with batteries is that they go dead... usually right in the middle of the second set. So some years ago, DI manufacturers started to use phantom power as a means to supply the needed voltage and current to the active DI box (buffering amplifier). Phantom power was invented by Mr. Neumann as a means to supply a polarizing voltage to his condenser microphones. He needed high voltage and very little current to do the job. Phantom power was never intended to be a power source for an amplifier. Without current, you do not get headroom. Think of playing bass through a miniature guitar amp, turn it up... they distort like crazy. DI boxes are exactly the same. Without headroom, high output bass signals will cause the buffering amplifier in the DI to distort. But remember, back then, basses were all passive so for the most part, they worked fine with regular phantom power as the buffers only had to process 1 to 3 volts. The advent of active basses with their huge output levels changed the rules.

*“So what does all of this mean to me as a bass player?”*

The rule of thumb is that if you have a high output bass that already has built in buffer; a passive direct box will likely do a great job for you as your bass will produce the drive. If on the other hand, you have a low output passive bass, an active DI will leave your bass unaffected while generating the drive for the PA system or recorder.

Just keep in mind that just like studio preamps, mixing consoles and even bass guitar amplifiers, the quality of the sound varies depending on the circuit design and parts that are being used. Best of all, you can actually measure how these devices will work in the laboratory and simulate real world environments to ensure they will work when placed under various loads. Better designs focus on eliminating all types of 'bad' distortion such as harmonic distortion, phase distortion and inter-modulation distortion.

These designs are then categorized into two groups, whereby some direct boxes are designed to transfer the signal without artifact or distortion so that the original sound of the bass is delivered as purely and naturally as possible. Others such as tube DI boxes tend to be designed to color the sound with good distortion to create new bass tones and exciting textures. Both are useful depending on your desired outcome.

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## **What does a DI box do? (Sidebar)**

A direct box is designed to perform two functions: (1) To convert the high output impedance of the pickup to a low impedance signal and (2) to convert the unbalanced connection to a balanced line.

High impedance signals such as those generated by guitars are susceptible to noise. The susceptibility to noise increases proportionately to the cable length. The longer the cable the more noise you get. This is especially true under stage lights, dimmers and magnetic fields generated by big power transformers. By lowering the impedance, you get less noise.

But this opens a small can of worms... low impedance signals do not travel well over coaxial cable. The telephone companies developed balanced lines some 100 years ago for this very reason. A balanced line works by splitting the signal into two components of equal intensity with one being 'in phase' while the other is purposely transmitted 'out-of-phase'. As outside noise attacks the cable, the noise that manages to pass through the shield is picked up equally by both wires. When the two signals are brought back together, the inverted signal is brought back into phase along with the noise it has collected. The wanted signal is now in phase while the noise becomes out of phase with its counterpart and basically cancels itself out. Balanced audio systems work extremely well... before digital, you could speak with someone across the continent over balanced twisted pair wire. We still use this for telephones today.

It is also important to note that the reason the direct box produces a low level is that it must coincide with the microphones on stage. For the most part, the microphones take the signal from voices, guitars and drums and send them through a stage splitter snake that splits the signal between the monitor console and front-of-house mixer. These splitters are designed to manage mic level signals. If you send a line level signal into their input, they will overload and distort. By maintaining the entire signal chain on stage at standard mic level, moving things around becomes easy. This is of particular importance when something goes wrong... all you do is re-patch and the show will go on!