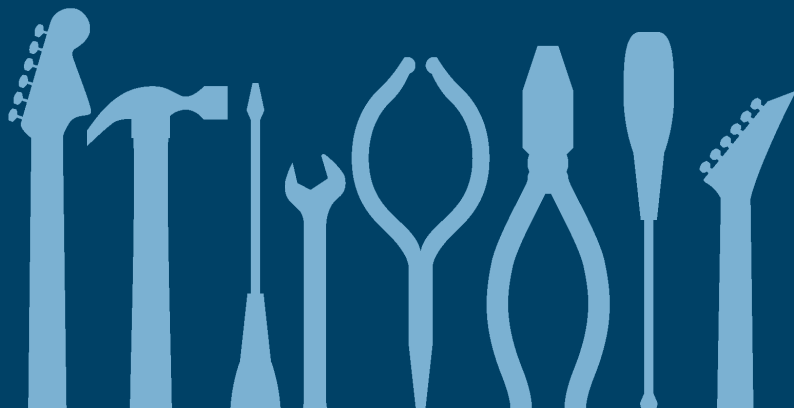


TECH  
TALK

# Buffer or bypass?

TRUE-BYPASS OR NOT TRUE-BYPASS? THAT IS THE QUESTION. WE UNRAVEL THE MYSTERIES OF BUFFERED EFFECTS PEDALS



## THE AUTHOR



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**Some of the most common questions I'm asked by dedicated stompbox fans relate to the pros and cons of 'true-bypass' and 'buffered' pedals. Both have their advantages, but to get the most out of your pedalboard, an understanding of each type and how they are going to affect your tone is essential.**

There seems to be a lot of confusion about the role buffers play in great guitar tone. Let's see if we can clear

this up for you. When we talk about 'buffered' and 'true-bypass' effects we're talking about the state of the pedal in bypass mode, when the effect is off. When a pedal is on, it is always buffering, that is to say changing the impedance of your signal in some way. You buy a pedal for the way it sounds when it's on, but it's the way it affects your signal when it's turned off that we're primarily concerned about here.

To understand the role that buffers play we need to look at two very

important elements of great guitar tone: 'impedance' and 'capacitance'. We're not going to get too technical here, but a general understanding of these factors will make a world of difference to your tone.

### WHAT IS A BUFFER?

A buffer is a device that changes a high impedance signal into a low impedance signal that can drive capacitance. So what on earth does that mean? Let's start at the

beginning and look at the signal from your guitar.

The pickups on your guitar will have an impedance rating measured as DC resistance in ohms. For example, the output of the neck pickup in my Telecaster is 6.2kohm (or 6,200 ohms). The bridge pickup is slightly 'hotter' at 6.7k. I'm sure a lot of you will have seen these figures on your pickups and wondered what they mean. In general terms, a higher impedance will mean more output, but let's look at the relationship that this figure has with the guitar cable.

### CABLE CAPACITANCE

The cable that you use to plug your guitar into your amp or effects will have a certain amount of capacitance, so what does this do? In the simplest of terms, the capacitance in a signal cable will affect the top end of your tone in the same way that the capacitor linked to the tone control inside your guitar lets you roll off high frequencies (although it actually does a whole lot more, including tuning the frequency hump of the pickups, but more on that later).

Your cable acts just like a capacitor and will allow a certain amount of the top end frequencies to pass to ground. You can easily check this yourself by plugging your guitar into your amp using first a long cable and then a short one. You'll hear more top end with the short cable. If you double the length of cable, you'll double the amount of capacitance, so you'll lose more top end in a longer cable.

It's the relationship between the capacitance in the cable and the output impedance of your pickups that causes the change in tone. The *higher* the output impedance is from your pickups, the more susceptible it is to the capacitance effect of your cable. This may seem confusing, as you might assume that the increased output from a 'hotter', higher-impedance pickup would make the signal more robust.

A very high output humbucker such as a Seymour Duncan Invader has an output impedance of 16.8k. This is very high for a passive pickup. These pickups do have a very aggressive sound and a lot more output than my humble Tele, but my Tele will lose less top end in a long cable run. You could have a pickup that was twice as loud as the Invader, but it would sound muddy and undefined. On the other hand, if the pickup doesn't have enough output it can sound thin and weedy. A big

## SWITCHING STYLES

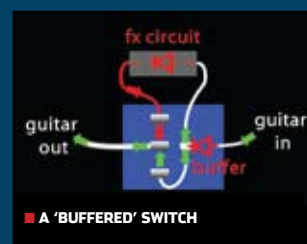
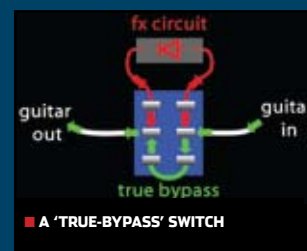
### BUFFERED AND TRUE-BYPASS SWITCHING IN DETAIL

#### ■ Let's have a look at simple 'true-bypass' and 'buffered' switches in an effect pedal.

In the true-bypass diagram, following the signal path you can see the guitar signal is connected to the centre pole of the switch. In this case it's a double pole, double throw switch (or DPDT). This means that there are basically two independent switches that are operated by the same footswitch. In one direction the two centre poles are connected to the two top poles engaging the effects circuit. Stepping on the footswitch disconnects the top poles and connects the centre poles to the bottom, which is a simple piece of wire connecting the guitar signal directly to the output of the pedal.

Now to the 'buffered' circuit.

There are several ways to do this, but the basic principle is the same, which is to use only one switch and put it on the output side. The guitar's input is connected to the switch (in this case an SPDT, or single pole, double throw) and to the input of the effects circuit the entire time. The switch simply chooses between the output of the effect or the output from the buffer. As the switching duty can easily be performed by a transistor, which is a much cheaper option than using a standard footswitch, most companies designing on a budget opt for this method, but that's not to say that top pedals don't use a buffered circuit. Many do and many sound fantastic because of the high quality of the buffers they use.



## "YOU WANT TO MAKE SURE THAT ANY BUFFER IN YOUR SIGNAL PATH IS TRANSPARENT"

part of designing a pickup is about balancing the output against this capacitance effect.

### PEDAL BUFFERS

So how does a buffer in an effects pedal interact with capacitance and impedance? A buffer is very similar to an amplifier. In fact, it's an amplifier with a 1:1 ratio. Now, like an amplifier, the design of the circuit is very important because it has the ability to change your tone. This is *not* desirable. You want to make sure that any buffer in your signal path is transparent.

If I plug my guitar into a buffer, the input of the buffer will see the impedance of the pickup coil. This is where we need to understand how the input impedance of the buffer works in relation to the output impedance of the pickups. Typically, a Boss-type pedal will have an input impedance of around 1 megohm (1,000,000 ohms). A good rule of thumb is to make sure the input impedance into a pedal is high. 1 meg is good.

It works like this. The pickup from my guitar has to drive the capacitance of the cable, and then drive the input impedance of the pedal/buffer. A *low* impedance signal from my guitar through a good quality lead will easily drive the *high* impedance signal of 1 megohm at the input of my buffer.

The guitar signal goes through the

cable, then through the pedal/buffer and even though the sound is the same and the output level is the same, the impedance has been changed and is now much lower. Typically this impedance, which was about 6-7k (6,000-7,000 ohms) from the guitar, is now around 1k (1,000 ohms) from the output of the buffer.

This lower impedance from the buffer is what we rely on to drive the long cables. With an impedance of 1kohm you can drive a massive amount of cable with very little tone loss – remember, a higher impedance results in more capacitance and more high frequency loss.

### BUFFER QUALITY

Many effects pedals, such as Boss and Ibanez stompboxes, employ a buffer in the signal path. Remember that this buffer is on even when the effect is turned off. The quality of these simple buffers has been debated over many years. The fact is that these are not bad buffers, although there are some much better dedicated signal buffers out there. Problems really occur when you start to chain these buffers together.

Like an amplifier, the buffers will have a signal-to-noise ratio, typically from 2-4 percent. With a single buffer, this amount of additional noise is very hard to hear, but as you chain these buffers/pedals together this can start to affect your tone adversely. →



**BUFFERED BOARD**

In my personal experience I get the best results going through no more than three buffers on one pedalboard. In the buffered board example below we have six, so let's cut that down to three.

The first thing that we're going to do is remove the buffer in the tuner with a simple AB switching box. Next, we're going to put a couple of the effects in true-bypass loops. I only know of a handful of overdrive pedals designed to take a buffered, low-impedance input. This isn't to say that they don't work with a buffered input, but generally when a designer sits down to make an OD pedal, he plugs the guitar straight into it, so we want our ODs to see the signal direct from our guitar. Getting the tuner out of the signal path with an AB box is a great start, but we also want to put the ODs in true-bypass loops so that when we bring them in they see the pickup impedance directly.

So, with an AB box and a simple true-bypass double looper, we have cut our buffers from six down to three. Our overdrive pedals are working the way they were designed to and our signal path is still buffered after the ODs, so we're getting the correct low impedance to drive the long cable from our pedalboard back to our amp, all without experiencing the negative effects of too many buffers. Here's the buffered board before (top) and after (bottom):



Many players love the tone of guitarists with simple boards only running a few effects and I have absolutely no doubt that it's the stacking of these buffers (or lack of) that adds to or detracts from the clarity and effectiveness of some of these great guitar sounds.

In response to this, many pedal builders started employing a 'true-bypass' design, something which has become very popular in modern boutique guitar effects. This means that when the effect is bypassed the signal does not go through a buffer, but effectively disconnects the effect circuit completely from the signal path. Problem solved? Not quite...

You see, even though you're getting rid of any adverse effects the buffers might have on the tone, by removing them completely you are now relying on the output impedance from your guitar to drive the capacitance from not only your cables, but also the footswitches and the patch leads of all your effects.

**WHAT'S THE ANSWER?**

The solution is a carefully thought-out combination of the two: both true-bypass and buffered pedals. Let's have a look at two typical pedalboards – one featuring buffered effects, the other true-bypass – and solve the problems on each.

Both of these setups have some issues. On the buffered board, the guitar signal is going through a whole heap of buffers, each adding its own thing to the sound, changing the dynamics and altering the transient response of the note. The true-bypass board has no buffers but has so much extra cable, including the patch leads,

**TRUE-BYPASS BOARD**

This 'true-bypass' pedalboard is an example of someone who really has put a lot of thought and money into getting some great boutique effects, but unfortunately as all the effects are true-bypass the impedance from the guitar has to drive not only the cable to the pedalboard, but all the patch leads between the effects and the long cable back to the amp.

Thankfully fixing this one is simple. All we need to do is place a really good buffer after the OD pedals. The buffer will drive all the capacitance so we get our top end back and the ODs still see the impedance straight from the guitar. So we have chosen an 'always on' dedicated buffer unit designed specifically for the job.

Remember that in true-bypass boards you should always use the best quality cable you can afford. It makes a big difference, especially up to the point of the buffer. There are loads of really good cable manufacturers out there, such as Horizon, Klotz, Evidence Audio and, of course, George L's. Don't skimp here and your tone will thank you. Here's the true-bypass board before (top) and after (bottom):



that the elusive 'plugged straight in' sound is nowhere in sight. Because the tone is dull, the amp is set to be bright, but the problem will now come when one of the pedals is engaged. The impedance of that pedal changes when it's turned on and acts like a buffer (because it is), so because the amp is set up with a lot more treble the

sound immediately becomes tinny and harsh. My solutions to each of these problems are outlined here.

**EXCEPTIONS TO THE RULE**

Before you race out and buy mega-expensive short guitar cables, it is important to note that ultra-low-capacitance cables do not always sound better. A certain amount of capacitance in your cable can be a good thing as it does more than just affect the top end. It also reacts with the frequency hump of the pickup.

The more capacitance in the cable, the more it loads the pickup and moves that frequency hump down towards the lower frequencies. Lower the level of capacitance and the hump moves towards the upper frequencies, accentuating the top end. What many perceive as simply the 'sound' of the cable is in fact the effect of the cable capacitance on the pickups.

There are examples of players like Brian May who famously used his curly cable for most of his career. That curly cable has loads of capacitance but, used in his setup, actually worked really well. Albert Collins used a 120-foot guitar cable because he liked the way it sounded.

There's no doubt that these guys are the exception to the rule and most players prefer the sound of good-quality low-capacitance cables, but as you all know by now, when it comes to great tone the rule book gets thrown out the window.

If you're in any way serious about your guitar sound, then I urge you to experiment with this. Go into a guitar shop that has a few examples from cheap to very expensive cables and use your ears to find which you like best. Once you've found the cable that works for you, employ the above techniques on your pedalboard to keep your tone consistent. **GB**