

## Guitar Effect Systems and Recording Interface Basics

Most guitar players when asked what their favourite guitar player solo is will refer to a specific cut or track from a vinyl album or CD. Very few will refer to a live performance as the experience of relating their joy of hearing their guitar hero live can only be shared by someone who was also there. This may seem obvious but it is highly relevant as almost all reference material available to guitarists is heard through their own sound system at various volume levels in a wide range of surroundings. It is therefore unreasonable to assume that the sound they struggle to emulate can be easily obtained e.g. in their bedroom with a couple of pedals and an amp without any basic understanding of the signal path and knowledge of sound recording techniques. Listen to a CD player plugged into your Hi Fi sound system and then into a guitar amp and you will find a huge difference in sound quality. That is the first basic step in understanding that your favourite tone was produced by a guitar amp then recorded and gone through a complicated mastering process and the final end product be it vinyl or CD produced by a plastic injection moulding machine. This is then played on an electronic system designed to reproduce all sorts of music. So where do you start and how is it possible to succeed you may ask. As with almost all problems you start at the beginning with a keen understanding of basics and a firm objective to finally achieve. There are no simple answers or any rules that can't be broken but success can only be achieved by following a logical plan that has been designed to aid further understanding. Jimi and I broke a lot of new ground and created revolutionary sounds when we recorded but I can assure you that we both certainly knew our objectives and were committed to follow a path that would lead to ultimate success and the results achieved were not down to luck and I hope that the following hints will help you to achieve your sound.

**Guitar Basics:** Always judge the acoustic properties of any guitar without plugging it in. This is done best in a quiet place where it will be easy to hear the natural sustain of the instrument and any nasty fret buzz. Put your ear close to the bridge and then the nut listening closely and checking for any rattles or strange twanging sounds as faulty seating of the strings can cause this. Most production bridges and nuts are cut and optimised for a particular set of strings and these may not be perfect for the set you are using. Make sure that the screws holding down the scratchplate are tight and that the machine head mounting screws or nuts are also tight. The importance of getting the guitar to mechanical perfection should always be the first step as this is the source of tone and problems in this area can sound horrendous at maximum volume. I am assuming of course that the guitar is in tune and that the string intonation has been set correctly.

**Pickup and Guitar Control Basics:** Magnetic coil type of pickups converts the change of magnetism caused by the string vibrating into an electrical signal. They are made in varying configurations e.g. Single Coil and Humbucking and have varying tone qualities. These types of pickups all suffer a loss of high frequency detail by cable or internal capacitance. The optimal output signal can only be heard by connecting the guitar into a high impedance low capacitance type of input e.g. a typical guitar amp front end. A typical guitar volume control value is 250K or 500K and the tone controls of most guitars actually connects a capacitor across the pickup to produce a bass tone. Once high frequency detail has been lost to capacitance it cannot be restored by subsequent equalisation.

**Guitar Lead and Connector Basics:** The optimal guitar lead has no capacitance and zero resistance whilst providing total screening from all electrical signals and freedom from any form of handling or vibration induced noise. In the real world capacitance, resistance, screening and handling noise are all directly proportional to length so the shorter the better. You can easily hear the difference between a lead 10 feet long and one 30 feet. The connectors should all be spotlessly clean as the magnitude of signal

current is very small indeed and any dirt especially nicotine coatings can cause problems and even radio pick up. Use a cotton bud soaked in cleaning fluid to clean jack sockets on your guitar, amp and effects to remove dirt.

**Microphonic Noise:** After the above procedures connect the guitar straight into your favourite amp with a 10ft lead and start by setting the amp up for a basic clean tone. Check the guitar for any microphonics by tapping the guitar around the pickups with the rubber tip of a pencil to see if any rattles from screws, dry solder joints, mounting springs or the pickup just hitting the scratchplate occurs. Check the volume and tone pots also by tapping lightly on the knobs listening for crackles etc. Pickup selector switches must also be checked and cleaned from time to time as the contacts are not sealed. The actual pickups can sometimes become microphonic themselves and will squeal when used at high gain due to the coil vibrating relative to the magnet. All microphonic noise becomes a problem with maximum gain and feedback scenarios and it is nice to know your feedback is intentional.

**Understanding Amplifier Characteristics:** Use the guitar straight into the amp as above with a short lead and take some care and time to understand the action and interaction of the controls as there are many combinations. Remember that small diameter control knobs should be turned very carefully in small increments, as it is very easy to miss that sweet spot on your amp. Once you find a sweet spot take note of it. The sweet spot will change, as the overall volume changes so understand the changes that have occurred. You also have the added fact that your ears change their frequency response with volume and time spent listening to high sound pressure levels so it is important to take a few notes of settings used and come back to them. The object of the tests is to form a mental picture of how the controls work and interact with each other without any effects. Guitar amps normally have their first volume control after the 1st Valve/Tube stage and effects often exploit the merits of overdriving the front end so try the amp out with just a guitar.

The above hints may sound obvious but I can assure you that any time spent making sure your guitar is mechanically perfect before you start adding effects will pay you back tenfold as you progress along the way to your ultimate tone. Playing the guitar unplugged will also improve your picking technique as it is much easier to hear any fret buzz from bad fingering techniques and Jimi did this all the time to improve his chops. We will now get down to the more interesting part of connecting up effects in the signal path.

**Connecting Effects into the Signal Path:** The guitar should connect to the first effect by the shortest lead that gives the freedom of movement on stage. This will ensure optimal tone quality up to the input of the first effect. Now in the case of say just one effect an additional cable connection must be made to the amplifier that may be some distance away. There are various effect bypass techniques and tone sucking problems that may occur and an understanding of these is important.

**Hard Wire Bypass:** Often hailed as the magical simple answer but it has several drawback which include increasing the total system cable length as now the guitar cable and effect / amplifier cable are effectively as one. This means less detail and the possibility of picking up cable and electrical interference due to the fact that the amplifier cable acts like an antenna with a pickup coil at the end. Also the high output impedance of the guitar is carried through to the next device in line. Not all effects are happy with pickup coils connected directly to their inputs as due to the high impedance and the reactive nature of the coil, problems can occur which include high/low frequency oscillation and various radio pickup problems. Switching clicks and pops are always a problem when coils are passively switched and are impossible to eliminate due to the energy stored in the coil itself.

**Tone Sucking:** This is best described as a loss of tone quality when in bypass and can be caused by several factors. The input of the effect is now always connected to the guitar even in bypass mode but this will only cause a problem if the input impedance of the effect is not high enough or if capacitance has been added to the signal path.

Tone sucking achieved notoriety with the early Wah designs and the adoption of a high impedance buffer in front of the wah was pioneered by me in 1967 and is used as the solution nowadays in the standard Cry

Baby pedals and described as a Hendrix modification. When FET/electronic switching as opposed to a stomp box switch is used great care must be exercised in design to ensure that the signal path and buffering used is of the highest audio quality and careful checks should be made to compare bypass performance. Always remember to check bypass performance with the effect connected to the amp with the shortest lead possible thus isolating cable length losses.

**Using High Impedance/Low Output Impedance Buffers.** These are standard building blocks in any audio recording system and the fact of life is that any recording you have heard will have had your favourite guitar tone passing through them many times over. They have many uses and advantages in audio and not widely used in the early retro guitar effects due to cost considerations as low noise transistors were both expensive and hard to find. When I worked on recording studio console design for Olympic Studios where Jimi recorded the recording chain contained many such buffers so there should be no doubts as to overall performance. The audio performance of a well designed buffer will not contribute any discernible coloration or add noise to the guitar and transforms the pickup output impedance to a much lower value that will enable long leads to be driven with no audio high frequency loss. The buffer also allows the splitting of the signal for multi- path processing, connecting to a tuner, and direct connection to medium impedance inputs of recording consoles and machines. The use of a buffered output to an amplifier is to be preferred as you effectively create a zero lead length low noise connection that is impervious to electrical interference and in fact a speaker lead can be used with no hum or noise. Switching low impedance audio to various devices becomes easy and click free.

**Recording Interface:** The simultaneous direct recording of guitar signals is very helpful in obtaining the final tone as it gives full control of the many possibilities of adding echo or other effects. The guitar should be connected to a direct box or a buffered splitting device and then to the console. The effects chain then follows with the final buffered output connected to the amp or if two amps are used via splitting device which preferably has an isolated output to eliminate ground loop problems. A multi- path recording chain was used for Jimi's studio recordings to give flexibility of using several different amplifier types as well a direct signal to the console. The final tone you hear on the record uses a blend of direct and microphone signals with additional limiting and or compression plus EQ and multi- path techniques to produce the final sound design required.

The actual subjects of recording methods and performance set-ups deserve a book, as does the complexities of various guitar effects. A basic approach should always be used to eliminate any blind alleys or outrageous manufacturer claims and to confirm progress when trying out and evaluating system changes. Above all don't change more than one thing at a time or your quest will never end. The answers will be different for all scenarios e.g. Live Playing in Small Club/Large Club/Stadium/Bedroom, Recording in Live Situations/Large Studios/Small Studios but all share the same basics of understanding signal path problems and limitations and I hope I have answered some questions and prompted you to take things easy and have fun in making progress.

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