

Guitar Tech

Pickup your licks and tricks

Know the difference between single coil and humbuckers? **Ciarán Robinson** looks at how different pickups work and how to get the best out of your setup.

Pickups play a major role in defining a guitar's tonal characteristics, but are frequently overlooked. All too often musicians go into the studio, happy with the action and feel of their guitar, but with badly selected or adjusted pickups. Getting the right pickup for the job and setting them up correctly will result in a much better sound and even a superior string response. In this article, we're going to take a look at how pickups work, how to choose and install them, and how to get the best out of the pickups you have.

A brief history

Pickups were first fitted to instruments such as the viola and mandolin, and although various people experimented with putting them on guitars, the first dedicated guitar pickup wasn't introduced until 1931 by Rickenbacker. Over the next few years, manufacturers were making electric Hawaiian guitars, and even electric banjos, but it was the Gibson ES 150 (Electric Spanish) guitar with the 'Charlie Christian' pickup that popularised the idea.

How pickups work

If an electrical conductor is exposed to a fluctuating magnetic field, a current is induced in the conductor. And if you move a conductor (for example, a guitar string) near a magnet, it changes the shape of the magnetic field that the magnet produces. A guitar pickup consists of a magnet (or magnets) with a coil of wire wrapped around it, so as the metal string vibrates near the magnet, it alters the magnetic field and thereby exposes the coil to a fluctuating magnetic field. This

induces a current in the wire coil of the pickup – your guitar's electrical output signal.

To concentrate the magnetic field through the coil and at the guitar string, polepieces are used. These connect to the magnet, and rise above the coil (in some vintage designs, the polepiece is the magnet). Often the polepieces are individually adjustable, enabling you to set up the sensitivity of each string's coil.

The effect of different magnet materials

As you would imagine, the type of magnet used in the pickup will contribute to the quality of the sound it produces. The stronger the magnet used, the greater the tendency towards a stronger treble response, all else being equal. The first Rickenbacker pickup used tungsten steel magnets, but these would be prohibitively expensive these days. The most common pickup materials now are Alnico and ceramic. Alnico is a mixture of aluminium, nickel and cobalt. It's available in various formulae, but Alnico II and V are the types most commonly found in pickups. Alnico V results in slightly stronger magnets than Alnico II, so pickups made of Alnico V tend to have a brighter tone and a higher output level.

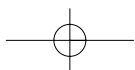
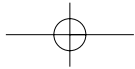
Ceramic magnets are generally much cheaper, to produce and can be very strong. As a result, ceramic-magnet pickups are usually favoured by players requiring a strong, articulate tone, particularly in modern rock and metal styles, as they retain clarity and definition under heavy distortion.

Conversely, Alnico-magnet pickups generally sound sweeter when used with clean and medium-gain settings and are often the first choice for the majority who play blues, rock'n'roll and lighter rock styles. ▶

BIOGRAPHY

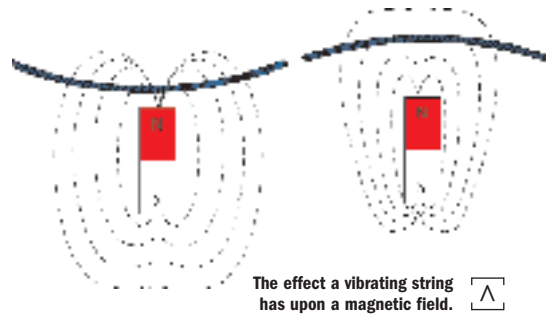
The Author

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METHOD GUITAR TECH: PICKUPS

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The effect a vibrating string has upon a magnetic field.

► **The importance of the coil**

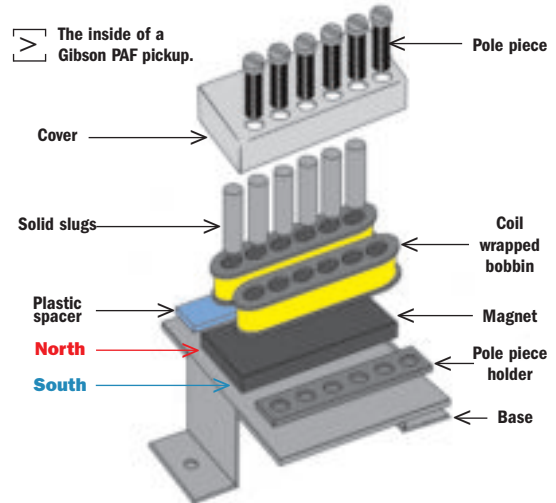
The wire wrapped around the pickup magnet is made of copper and is incredibly thin – 42 gauge (the most commonly used thickness) is only 0.06mm in diameter – and consequently it’s very fragile. The closer the coil can get to the magnet, the more sensitive the pickup will be. The thicker the wire used, the brighter and cleaner the sound, but it won’t be possible to get as many turns of the wire near the magnet, so the sensitivity will be reduced.

The taller the magnet, the more coils can be wound around it, or the thicker the wire can be, but it also makes the magnet more expensive. Also, the longer and thinner the wire is, the higher its electrical resistance, which results in a loss of higher frequencies.

So as you can see, the design of a pickup involves compromising the conflicting requirements of the number of turns in the coil, the thickness of the wire, and the strength and size of the magnet to produce a pleasing tone.

The humbucker pickup

As the name suggests, the humbucker was designed to reduce (or ‘buck’) hum caused by electrical interference. Seth Lover invented the humbucker when he was working at Gibson. He had already designed an



amplifier using the same concept, and then applied the principle to the guitar pickup. Gibson manufactured the first humbucker in 1955, four years before the patent was eventually granted. Because the pickup bore the label ‘PAF’ (Patent Applied For) during that four-year period people started referring to the models as PAF pickups, and the name stuck.

The principle of noise cancellation in a humbucker is very similar to that of balanced cables (see the Ten Minute Master on Cabling on page 66 for more about that). The humbucker uses two single-coil pickups, one of which is placed over the magnet’s North pole and the other over its South pole. This means that the signal induced by the guitar string in each pickup coil will be out of phase with the other. However, noise will be picked up by both coils and will be in phase, because its induced by an incident electromagnetic field – not the pickup’s magnet. Thus, when the output from one of the coils is inverted and added to the other, the signal level is doubled, while the noise is cancelled out. If ►

Adjusting your pickups

Pickups have standard height settings, but you can set them up to your liking...

Pickups are not always attached directly to the body of the guitar; they’re usually suspended by a spring and screw, often connected to the scratchplate. This enables you to easily adjust the distance between the polepieces and the strings.

If the polepieces are too far from the string, the response will be too low. However, if the polepiece and string are too close together, this can result in what’s called ‘string pull’, whereby the magnetic field tries to pull the string towards it, changing the way the string vibrates. This results in distortion, and can ‘choke’ the string, losing some of its sustain. It’s more prevalent in single-coil pickups than in humbuckers, as the magnetic field is more concentrated at one part of the string, so humbucker pickups can be placed closer to the strings, enabling a higher output signal.

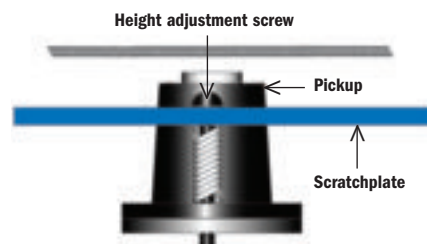
There are standard heights, but it depends upon the exact model of pickup – check your manual for details – but it’s better to have yours set to your own personal preference.

Here’s how:

- 1 Set the pickups about 6mm below the string.
- 2 Plug the guitar in, and slightly raise one side of the bridge pickup.
- 3 Play a few notes, and listen to the loudness, the tone and the sustain, not forgetting to try fretted and open notes.
- 4 Adjust the other side of the bridge pickup, and listen again.
- 5 Repeat the procedure, each time listening to the way the sound changes. Eventually, you will hear a strange kind of distortion – this is often called ‘wolf tone’.
- 6 Lower the pickup until you find a blend between level and sustain. Although it might seem counterintuitive, the further down the pickups are, the more sustain you will get. Even slight adjustments can make an audible difference to the sound.

7 Repeat the procedure for the other pickups.

It can take a while until you’re happy with the results, but once you’re familiar with your guitar, it gets easier. Personally, I hardly use my middle pickup, so I have it set back quite far. I also like a fairly distorted tone much of the time, so I keep my bridge pickup fairly close for a high output level. Bear in mind the kind of tone you want as you make the adjustments, and you’ll find you can dramatically improve the sound of your guitar.



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▶ that's all a bit confusing, the diagram on page 60 should clarify the principles involved.

As the two coils pick up slightly different parts of the string, their output signals are not exactly out of phase. This results in a rolloff of high frequency response, resulting in what is often described as a warmer sound.

Some studios have a major problem with noise, most of which is caused by the mains power source. This manifests itself as a 50Hz buzz (or 60Hz in the USA). Humbuckers significantly reduce this, so switching your pickup can sometimes be the easiest way around the problem. However, do bear in mind that the amp and lead can introduce the noise back into the signal chain – and you may end up with a pickup tone that you don't really want!

The piezoelectric pickup

These are most commonly found on acoustic instruments, but can also be fitted on solid-bodied guitars. For example, the Line 6 Variax guitar has no visible pickups because it uses a hexaphonic piezo pickup under the bridge.

Piezo (meaning 'pressure') pickups are made of certain crystals that create a tiny current when they're put under pressure. If placed firmly against a vibrating object (the body of a guitar, for example), they will output the vibrations as an electrical signal.

When used on a solid-bodied guitar, the output signal can sound fairly similar to an acoustic. Some guitarists have a piezo pickup fitted in addition to a regular pickup – especially when playing live, where switching from one instrument to another mid song would be awkward.

The hexaphonic pickup

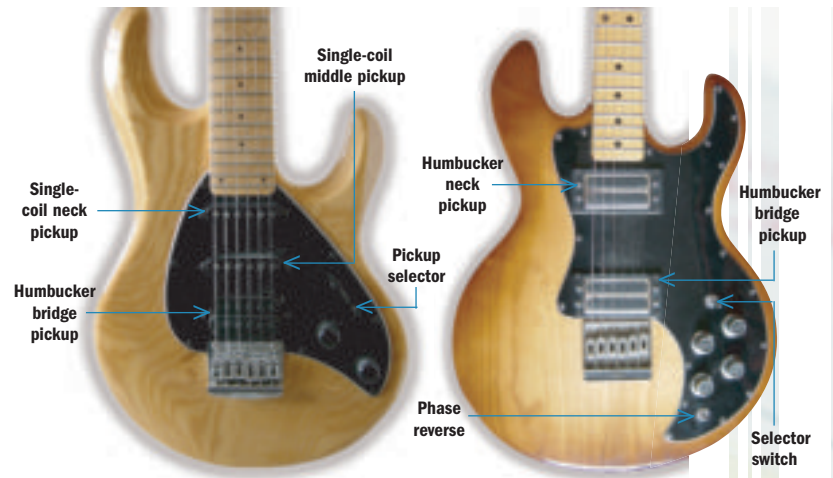
Made famous by Eddie Van Halen with his Kramer Ripley guitar, hexaphonic pickups have separate magnets and coils for each string, enabling the player to have much greater control over the level balance. The Kramer Ripley guitar even had a separate volume pot for each string. Hexaphonic pickups also allow for a stereo output from the guitar. Usually the low E, D and B pickups are directed to one output, and the A, G and high E pickups to the other, although of course this can be configured to the player's own taste.

If you're using a MIDI guitar, a hexaphonic pickup such as the Roland GK-2A is necessary so that the pitch-to-MIDI converter can clearly distinguish the frequencies of each individual string.

Pickup positioning

The closer a pickup is to the bridge, the brighter the sound will be; the closer to the neck, the better the low-frequency response. Switching to the neck pickup also tends to pick up more of the second harmonic, giving a very rounded, warm sound. As you would expect, a middle pickup gives a balance between the two.

If two humbuckers are used, the magnets of one could interfere with the other, so one of the pickups



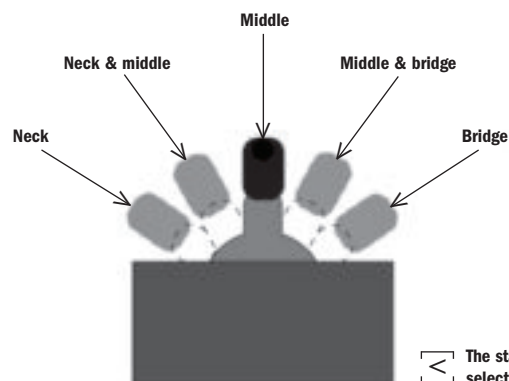
is turned around. This is very noticeable on some Les Pauls, where you can see the polepiece screws on opposite sides of the pickups.

Phase reverse

Because of the different positions of the pickups, they will not produce exactly the same signal, even if they are identical designs. This means that if you phase reverse one of the outputs, they will not completely cancel each other out when added together. Many guitars enable you to change the phase of their pickups, either using a dedicated switch, or a position on the pickup selector. This tends to reduce the low-frequency output level, and give a more 'hollow' sound, that I have found works quite well with heavily distorted guitars.

Selector switches

Though some guitars have separate on/off switches for each pickup, but it's more common for a sliding switch to be fitted. The original Fender Stratocaster used a three-position switch, which only enabled the player to choose between the neck, middle and bridge pickups. Later versions enabled more than one pickup to be selected at a time. Guitarists found that if you carefully balanced the switch between positions, you could combine together the outputs from two pickups. This led to the introduction of the five-position switch, which Fender fits as standard to most new Strats, and also includes in the accessory pack for American Vintage ▶



Σ The standard five-way pickup selector switch settings.

Σ A Musicman Silhouette, with one humbucker and two single-coil pickups.

∧ A Peavey T60 with two coil-tapped humbuckers. Unusually, the pickup is tapped when the tone control is turned up above 7.

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Choosing and fitting a pickup

Fitting good-quality pickups to a budget guitar can make a huge difference.

Upgrading your pickups is both a productive and cost-effective way of improving your guitar's tone. Many budget guitars are very playable, but the sound quality doesn't quite match up. Fitting a new set of pickups can transform the instrument dramatically, and cost a lot less than buying a new guitar.

There are a number of factors to consider when you choose a pickup:

- Firstly, ensure that the spacing between the polepieces matches the string spacing of your guitar – if not, the pickup won't work properly.
- If you're planning to replace a single-coil pickup with a humbucker, check to see whether you will need to rout a bigger cavity in the guitar body –

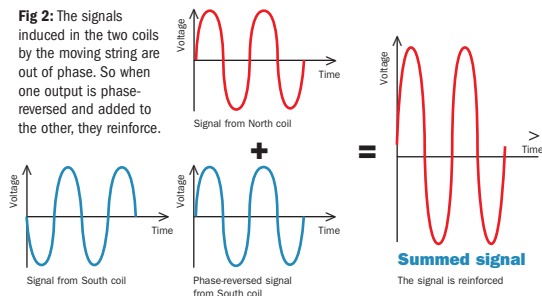
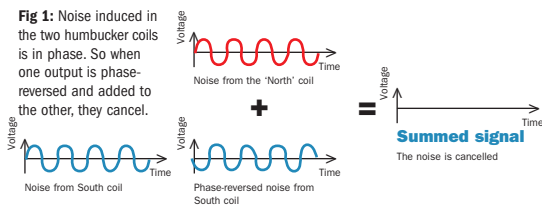
and bear in mind that this can change the tonality of the guitar. You will probably have to cut a larger hole in the scratchplate as well.

- Don't forget the battery. If you're installing active circuitry, you'll need somewhere to put it! Unless you're experienced with woodworking tools, it's worth considering getting a professional to do this for you. Your local music shop should be able to recommend somebody.

Once you've got all the parts fitting, it's time to solder everything together. This isn't a particularly difficult task, but you should only attempt it yourself if your soldering skills are up to scratch. I would recommend both guitarists and engineers learn to solder – it can save a vast amount of

money in repairs and cables. The pickup should come with a wiring diagram, so there should be no problems figuring out what goes where. If for any reason you haven't got one, there are dozens of websites and books out there that will probably have the specific pickup layout you are looking for.

If you're combining different pickups from different manufacturers, be careful not to wire them backwards! If one is wired opposite to the others, it will be phase reversed, which will lead to a loss in low-frequency response. There's no standard colour convention between manufacturers, so it's worth checking your wiring diagrams. Most manufacturers have websites with all the information you need.



The principle behind how the two coils of a humbucker pickup reduce unwanted noise, while reinforcing the desired signal.

- ▶ Series guitars. The five positions are usually neck, neck & middle, middle, middle & bridge, and bridge.

It is possible to get switches with more positions (with coil tapping, for example), additional pickup combinations and phase-reverse selection, but there is no standard configuration.

The active pickup

Active pickups use heavier gauge wire in the coil than other 'passive' pickups. As we already discussed, the thicker the wire, the cleaner and brighter the sound will be, but the lower the output level. To compensate for this, active pickups have a built-in preamp stage to boost the output signal. This produces a clean signal that will lose less high frequencies over long cable runs, and also boost the input stage of your amplifier to give more distortion, should you want it.

It's important to distinguish between a guitar that has active pickups and one that has active EQ circuitry (although, of course, it can have both). The EQ on most guitars is passive; that is, it can only cut signals. Active

EQ circuits can cut and boost the signal, and are therefore more versatile.

Active circuits require power. Usually this is provided by a battery, so don't forget to change it regularly; the sound quality will degrade as the battery discharges. Always remember to take spares to gigs and recording sessions – it's amazing how many guitarists forget to do this.

As you can see, there is a great deal to the subject of pickups, and there's a great debate between guitarists as to the advantages and disadvantages of different designs. The most important thing is, as ever, to listen to the differences and make up your own mind. [MTM](#)

TECH TERMS

Wolf tone

The strange tones caused by string pull, when the pickup is too close to the string.

Trembucker

A bridge humbucker, for use with wider-spaced strings. Needed for guitars fitted with a Floyd Rose (or similar).

Splitting humbuckers

This enables them to operate as a single-coil pickup, offering more versatility from the instrument. The output of one of the coils is connected to earth, effectively shorting it out.

Tapping pickups

A wire is connected to the centre of the coil, enabling you to switch between different numbers of pickup windings. The fewer windings, the lower the output level, but the warmer the tone.

Potting

If the windings in a pickup can move when the guitar body vibrates, this results in the pickup becoming 'microphonic', and will tend to cause feedback. To fix this, the pickup is dipped in wax, which holds the windings in place when it solidifies – a process known as 'potting'.

Resonance peak

This is the frequency at which an object will vibrate most easily. In a guitar pickup, this results in a boost in sensitivity at that frequency, contributing to the unique timbre of the pickup.

Hand-wound

Originally, the winding of the pickup was done by hand. This resulted in each pickup being slightly different – some sounding better than others. These days, almost all pickups are wound by machine, resulting in more uniform pickup performance.