

Luthier's Guide to Volector Installation

The Volector is a joystick used on an electric guitar to integrate the functions of two volume controls and a selector switch into a single unit. Volector installation requires wiring different from a typical electric guitar.

What we provide in our volector joystick kit

1) A dual-axis joystick fitted with 55 degree arc 150KOhm long-life conductive plastic element potentiometers.

The current joysticks use 1/8" shaft pots, which are smaller than I would like. The highest resistance available is 150k, which loads the pickups more than the customary 500k, and may roll off the highest treble slightly. However, even these were hard to source, and they are adequate. It's worth noting that some guitar effects devices load the guitar's output as much as ten times more than that. The substantial benefits of the Volector circuit make these worth using while we are developing improved parts.

2) Special wire that has a long lifetime when flexed frequently, and that does not resist flexing. This is intended only for wiring the potentiometer that swings when the joystick works. (Use shielded wire in this project wherever practical.)

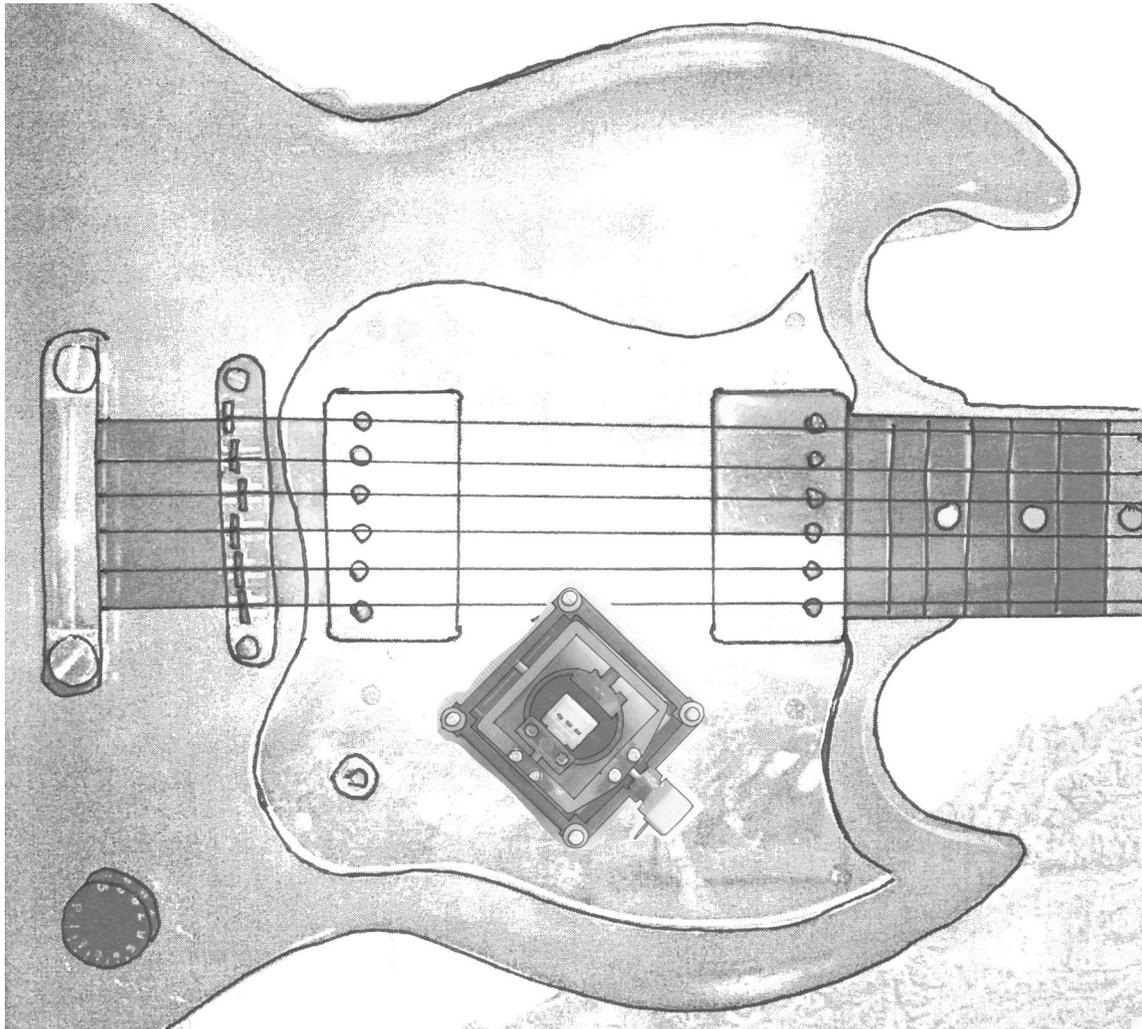
3) A fingertip cup for the joystick handle.

Setting up your Volector project

The Volector control circuit is designed for two pickups, outputting to two channels. An example of a suitable project guitar is an SG style guitar with two humbucker pickups. The electric guitar's body must be thick enough to accommodate the joystick depth of 32mm, and the body shape must allow the joystick to be placed properly for convenient use.

The joystick should be located below the customarily picked section of the strings, where it is convenient to use with the free fingers of the picking hand while playing.

Here's a diagram showing “an X-ray view” of the preferred joystick body position in the guitar's body. The body of the joystick will actually be hidden behind the pickguard, with its handle protruding out through a motion range limiting hole:



Our joysticks are 55mm x 70mm and need 32mm behind the pickguard. (That's 2 & 3/4in by 2 & 3/16in by 1 & 5/16in.)

You will need a fingertip cup handle for the joystick. A door lock “button” from the door of a 60s-70s car works well. I like Volvo 140 series – we include one of these in our joystick kit.

You will need a double-pole double-throw (DPDT) switch to use as the Volector circuit's phase switch. It can be a simple toggle, such as Digikey EG2409-ND.

You will need a 0.33uf, 400-or-more Volt metal film capacitor to isolate the signal ground wiring from the shield ground wiring.

You will need some wire with two conductors and a braided shield (see the discussion below in “Wiring the Volector”). Our current joystick comes with special extra-flexible wire that allows the moving potentiometer attached to the inner “gimbal” frame to swing freely.

Since the controls are being changed, you will need to make a new pickguard with a square joystick “bezel” hole. We like to make our pickguards from 1/8" mirrored lucite stock (see the discussion below in “Mounting the joystick”). There's photos of guitars with such a pickguard in the [Mounting the joystick](#) section, and in the [User's Guide](#).

The output is a stereo jack.

A proper “stereo” cable is needed. I recommend the “Signal TRSSC00 2 pair” ones made by Procables N Sound:

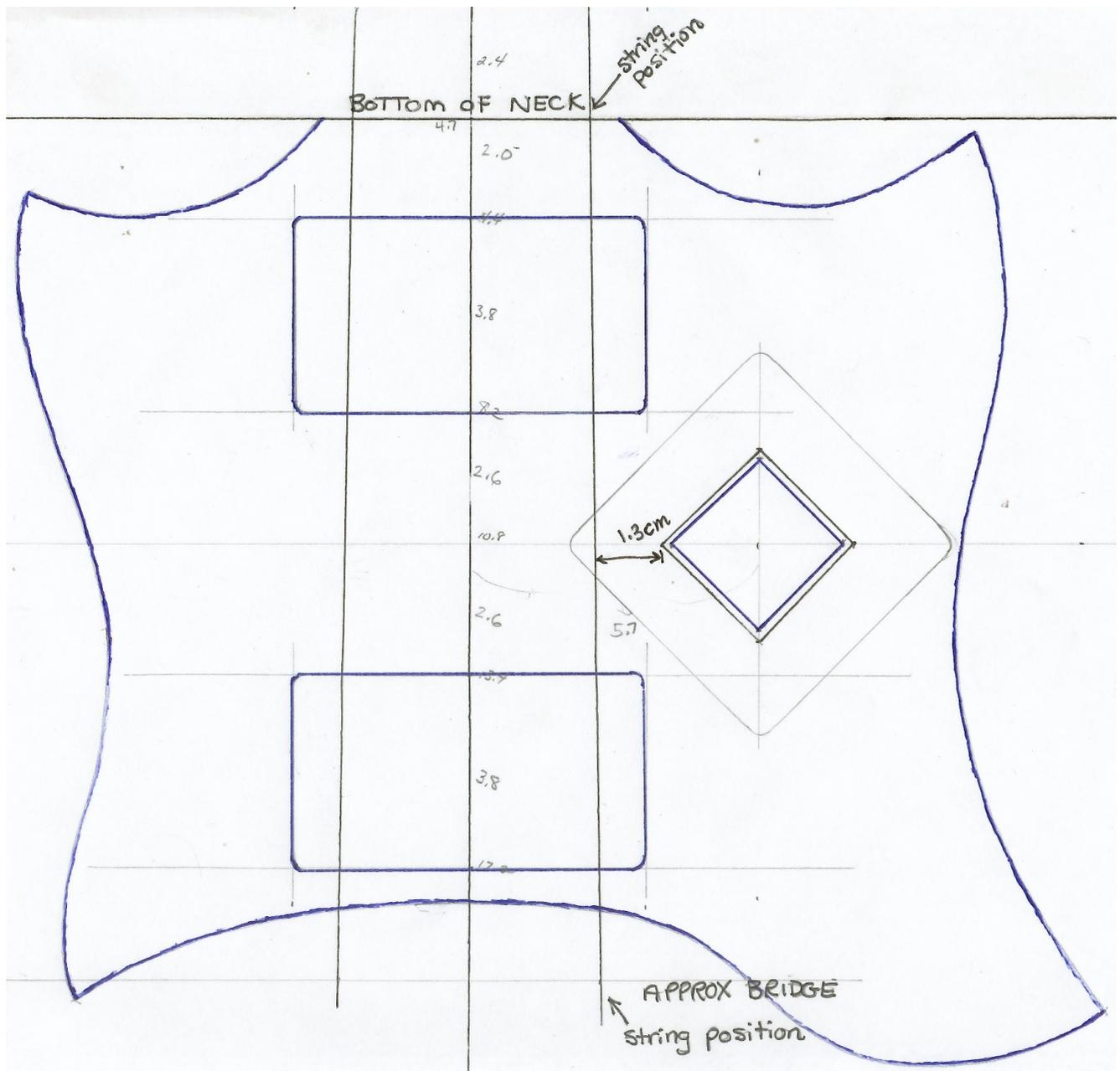
<http://procablesnsound.com/items/guitar-cables/signal-trssc20-2-pair-6012a-detail.htm>

(<http://procablesnsound.com/> sales@procablesnsound.com 586-634-2411)
(aka www.greatcables.us)

Create the new control layout

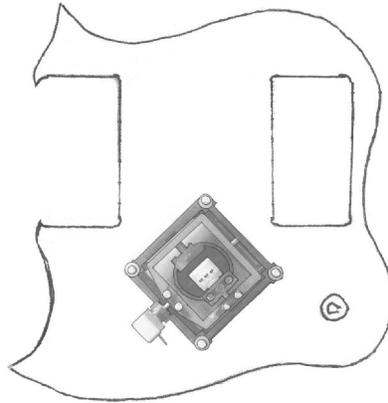
Below is a sample drawing made to create the router template for a pickguard. The joystick limit hole in the pickguard is a square, with its axes at 45 degrees to the midline of the guitar's strings. The center of the hole is 3.2cm from the closest string. The hole is 2.7cm square on the pickguard's outer face, narrowing to 2.4cm square inside. Corner to corner diagonally, that's approximately 3.8 and 3.4cm. The outer-face corner of the hole closest to the strings is 1.3cm from the nearest string.

The drawing is full-scale (1:1), of course, but it is shown here at about 80% size:



Remove the strings and old pickguard. Rout or carve a cavity to receive the joystick body. Since these potentiometers are linear taper, and can thus be wired with full off and full on at either end, you can choose your joystick orientation to put the outer potentiometer sticking out from the most convenient side. The diagram above in "Setting up your Volojector project" shows the orientation with the outer potentiometer facing the bottom horn of the SG body, most often the best choice.

The diagrams above show the joystick from the top, the handle side. When the joystick is mounted to the pickguard, you will of course be looking at it from the bottom as you wire it. Here is a diagram of the bottom of a pickguard with the recommended orientation of the joystick:



Design and cut a template for your new pickguard. Test-mount the joystick. Stretch the high E string to make sure the joystick's relationship to the strings is acceptable (see the discussion below in “Mounting the joystick”).

Wiring the Volector

Shielding, grounding, and safety:

Traditionally wired electric guitars have been known to kill players by electrocution. For a discussion of the ways this can happen see:

<http://www.guitarnuts.com/technical/electrical/safety/index.php>

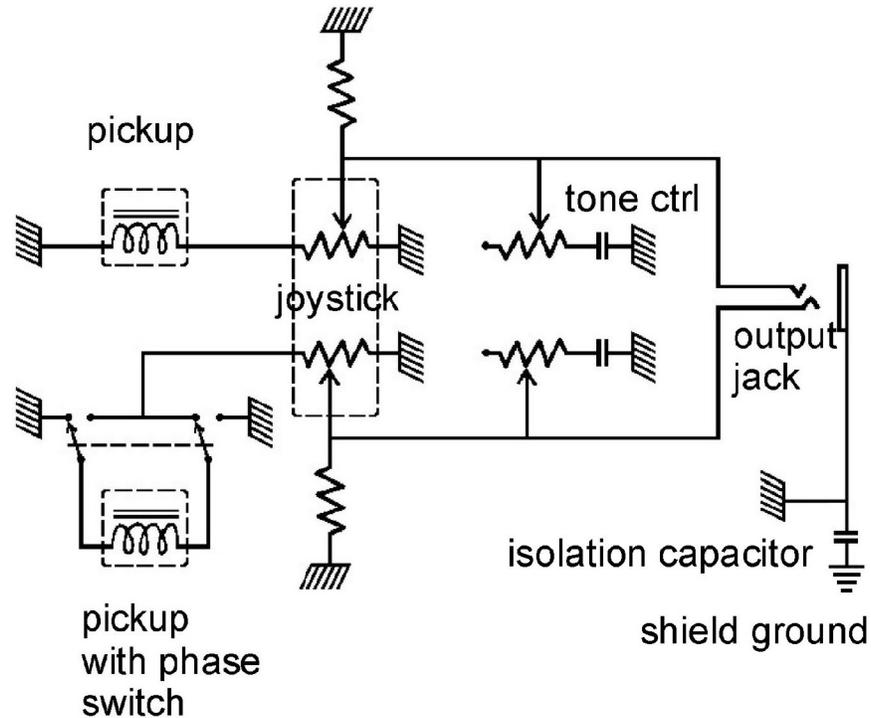
I strongly recommend that you isolate at least the strings and bridge of all electric instruments with a capacitor as shown at:

<http://www.guitarnuts.com/wiring/shielding/shield3.php>

Please, don't shrug this off; it can save lives.

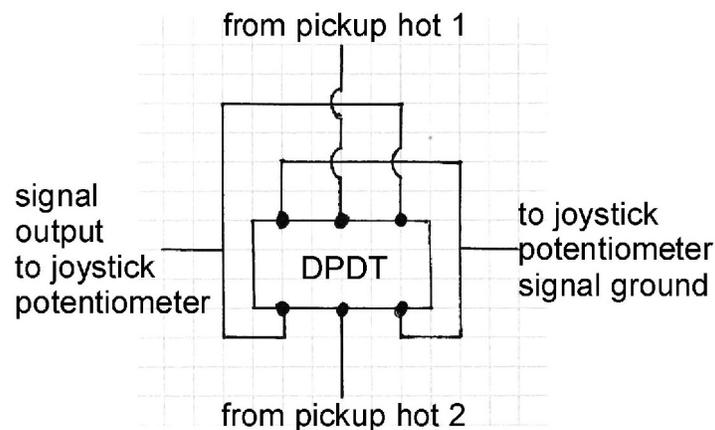
Wire with two conductors and a braided shield should be used for all internal connections. The shield should never be used as signal ground, and should be attached to ground at one end only, to avoid ground loops. Some newer pickups are already wired this way, others will require rewiring. Also make sure that pickguard or body shielding doesn't contact metal pickup shells that are grounded through the wire shield.

Wiring and signal chain



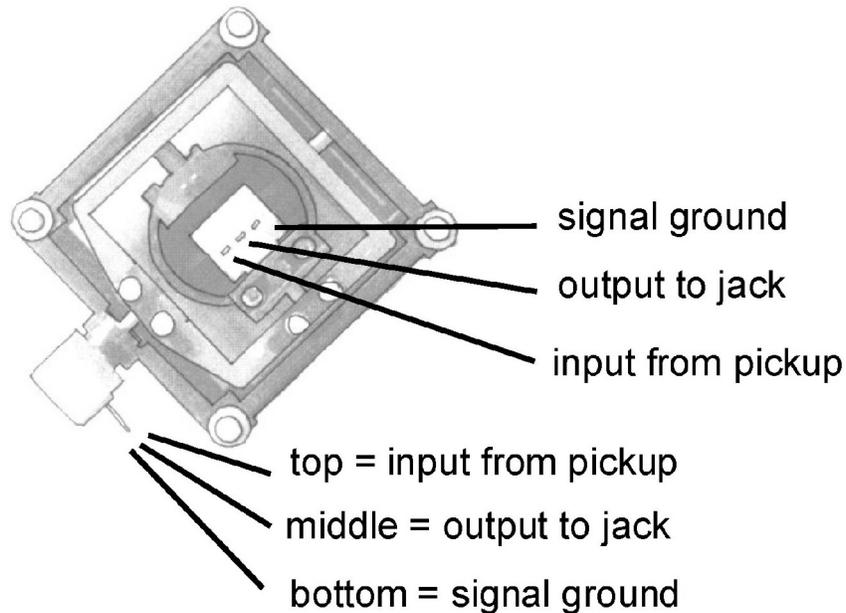
All the “rake symbol” grounds in the above diagram are signal ground, not shield ground. (This precaution confines the danger of accidental lethal shock from D.C. to the jack itself.)

One pickup connects directly to the outer terminals of its joystick potentiometer. One pickup connects to a polarity reversal switch, then to the other joystick pot. I recommend that the switch select normal polarity (“in phase”) when it is flipped toward the neck, and reverse polarity (“out of phase”) when it is flipped toward the bridge.



In normal polarity mode ("in phase") the joystick is used to set any static blend of the two pickups, or for swells, or tremolo. In reverse mode, since one signal is 180 degrees out of phase, the lower frequencies cancel when mixed, making the joystick work something like a wah-wah or phase shifter.

Each of the joystick's potentiometer outer (track end) terminals are connected one to a pickup input, and one to signal ground. Here is the configuration for this joystick in the preferred orientation:



This is looking at the bottom of the joystick, so "top" is closest to you, and is actually the bottom lead when the joystick is handle-up.

The joystick's two center (wiper) potentiometer terminals are each connected to one channel of a stereo phone jack. (See The jack, below. Tone controls on the way there are optional.)

Mounting the joystick

The bezel that came with these joysticks is slightly too small to allow for joystick travel over the full range of resistance, so I don't use it. I've been using 1/8" mirrored lucite stock, which looks great and the mirror layer is an effective shield and ground plane for switch and pot bodies. It's available at:

<http://www.delviesplastics.com/mm5/merchant.mvc?>

Screen=CTGY&Store_Code=DPI&

Category_Code=Mirrored_Acrylic_Sheet

If you want to outsource the work of cutting the pickguard, try a laser-cutting service, such as those that sell truss rod covers on eBay.

With the right templates, router equipment makes cutting the pickguard and its holes yourself much easier. I have a large router with straight and 45degree bits that we use to cut the pickguard outer edge and pickup holes. On early pickguards, I roughed out the joystick limit hole with a beveling router bit, and finished it with files.

For cutting the joystick limit hole in the pickguard, I now have a Dremel 4000 rotary tool, the cutting guide from the Dremel 565 Multipurpose Cutting Kit (the 335-01 Plunge Router Adapter seems more awkward), and a Rockler 60degree 1/8in Shank Miniature Router Bit #68732.

The Rockler 45Degree with 1/8in Shank Miniature Router Bit #68709 for the Dremel may be of interest. (These tools mentioned are all available through Amazon.com in July 2010.)

The hole should be oriented 45 degrees to the strings, about 27mm square at the outside of the hole bevel, with a 24mm square hole. The corner radius should be smaller than the joystick shaft. The hole edges should be beveled about 27 ½ degrees to match the angle of the joystick at its limit. When the joystick is in the full off position, at the corner adjacent to the strings, it should be almost (or just) touching them. Here's a photo:



With the joystick mounted to the pickguard the bezel limits should be tested and adjusted as follows:

With the joystick at the full off position, loosen the clamps holding the potentiometer shafts. With a small screwdriver, adjust the shafts until the wiper terminals of both pots are at the point where they first measure zero ohms to signal

ground. Tighten the clamps, and confirm that the pots' measured resistance starts to rise immediately as the joystick is moved toward the center.

As the joystick is moved clockwise along the edge of the bezel, to the neck only position, the pot for the bridge pickup should stay at zero along the entire edge.

At the neck only position the pot for the neck pickup should measure zero ohms from the wiper to the neck hot terminal. This reading also should stay at zero as the joystick is moved along the bezel to the full on position.

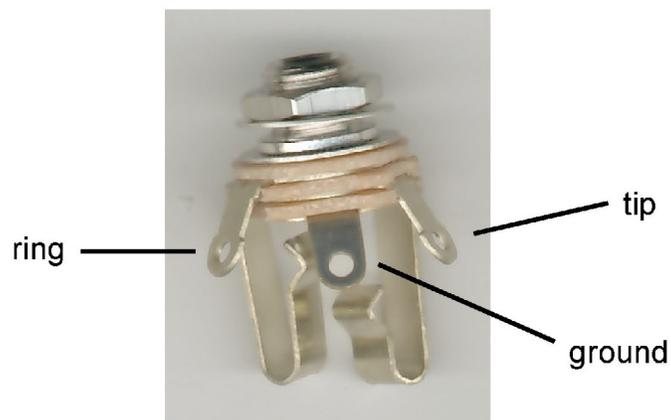
At this point the bridge pickup wiper should measure zero ohms to the bridge hot terminal, staying at zero as the joystick is moved to the bridge only position.

Here the neck pickup wiper should stay at zero ohms to signal ground as the joystick is moved back to full off.

Use the special flexible wire for the connections to the joystick's inner potentiometer mounted on the moving gimbal. I recommend bending over the terminals after soldering the wires, toward the little double post on the black center domed gimbal. Use hot glue or something similar to tack the wire to these posts for a strain relief, loosely twisting the wires beyond that point and routing them to another strain relief and their connections to shielded wire. Check the routing carefully to avoid interference and to assure trouble-free operation.

The jack

The Volector's jack wiring convention is that the tip is the neck/rythmn pickup signal, and the ring is the bridge/lead pickup signal. This is so that if a mono cable is used, the neck/rythmn pickup is selected.



A stereo to dual mono cord connects (optionally through one or two effects chains) to two inputs of the (mono) guitar amp. If it is necessary to combine the channels to use a single input amp, you must use a summing network with two 50-100k resistors. Don't just combine the signals with a Y adapter, or turning down one pickup will affect both of them. Please note that if the signals are not summed at the amp, the phase

cancellations in reverse polarity mode will not work. Latency delay from digital effects lacking a hard bypass will also alter or disable this effect.

The handle

If you are providing your own “fingertip cup” knob, drill its stalk with a 5/32in hole to fit the metal handle of the joystick.

Trim the joystick's metal handle, and the “fingertip cup” knob's stalk, to the desired length. The knob's stalk should be short enough to miss the bezel – that is, the metal handle should be what contacts the bezel. The stalk should be long enough that the cup clears the nearest string when the handle is tilted toward the strings. Check that there is sufficient clearance for the knob when the guitar is in its case.

EOF. by P.M. and K.G.H. Nicholes Updated 7 August 2011 by K.G.H. Nicholes

User's Guide

The volectar is a passive device, it requires no battery, doesn't need to be turned on or off. The guitar is cabled to a two-input amplifier via a stereo guitar cable in the usual way. Standard effects equipment may also be connected normally.

Setup

A "Volectar" (a guitar with a volectar control circuit) provides its output as two separate signals, one from each pickup. It is intended to be used with a cable that terminates in two jacks. Such cables are sometimes called stereo guitar cables.

Electrically, the output of the volectar is equivalent to that of two "regular" guitars. If your amp does not have two inputs, the signals must be mixed together.

There are two ways to combine signals properly, that is, without the level control on one affecting the other. A proper passive "Y" will reduce the output levels by about 8dB. An active mixer can maintain or boost output levels, but requires a power source.

Of course, even more fun is playing your guitar through two amps at once.

Another advantage of separate signals is the opportunity to use different effects units on the two signals. Panning between the pickups then can select and blend the effects.

Setup care must be taken if you want to play out-of-phase pickups through external effects. Digital effects units often delay the output by a small interval, and the delay on the two signals must be matched to get the full comb filter effect.

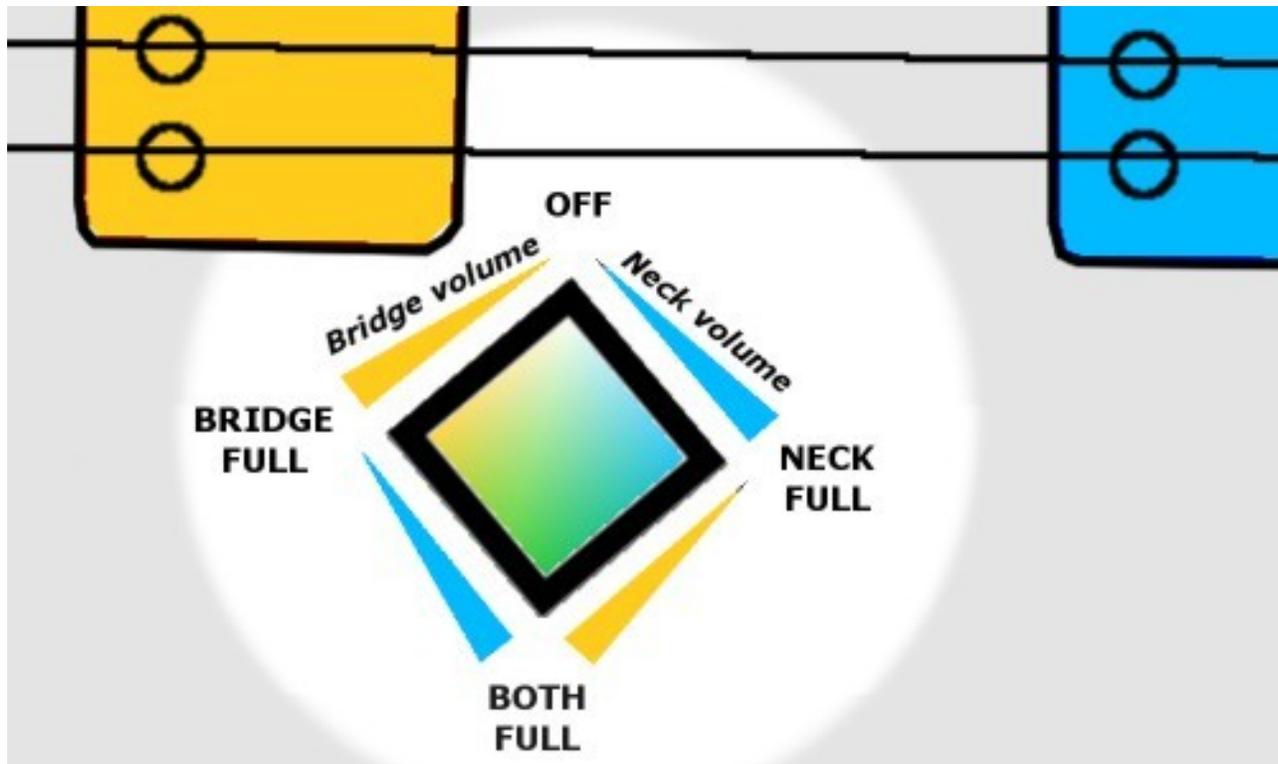
The best choice of effects units, number of amplifiers, and signal merging method depends on what music you are making.

Q: What happens if you use a regular mono guitar cable?

A: If you plug a regular one-jack cable into a volectar circuit, you will only hear one of the two pickups' signals. We wire ours so that the bridge pickup's signal is the one you get. The joystick will control that pickup's level as usual.

Basic control

The control pattern is simple: tilt the joystick handle forward along the strings (toward the neck pickup) to fully select the neck pickup signal. Tilt it back toward the bridge pickup to select the bridge pickup signal. Tilt the handle up, toward the strings, to mute/suppress the sound. Tilt the handle down, away from the strings, for full volume from both pickups. Intermediate positions produce intermediate signal mixes, as you would expect. Because the two pickup signals have different sounds, this easy, smooth panning selection enables a tremendous range of expressive phrasing.



The volector joystick is easy to move to any position within its travel limit. It stays where it's put, so it can be used like traditional controls often are; you can "set it and forget it."

To set overall volume, think up-soft and down-loud. To choose pickup balance, shift sideways toward a desired pickup, or keep to the middle for both pickups equally.

In its simplest use for occasional changes, a nudge to the stick is all that's needed.

Taking it further

More advanced volector technique includes changing pickup balance while playing a phrase. A riff can start clean, and slide toward a distorted crescendo. Or start with an echo, and resolve to intimate clarity.

Preliminary setup is choosing your desired tones or effects for the two pickups' signals. The natural sounds of pickups in different locations on the guitar's body are normally quite distinct, so the use of effects modules is not needed to take advantage of the voicings' versatility.

The joystick is located conveniently close to the picking area of the instrument strings. Once playing begins, the stick can be moved while picking to select from (or slide along) the entire spectrum between one signal's sound and the other.

Below is a picture showing a good picking hand posture for continuous joystick control. The pick is held normally between the thumb and first finger. Any free finger's tip may rest gently in the fingertip cup, so that moving the hand forward or back along the strings naturally draws the cup along with it, shifting the balance of the pickups' signals.



A simple linear movement of the picking hand along the strings takes the stick's end with it. The familiar tone control accomplished by picking near the bridge for a lead riff, or close to the neck for a rhythm phrase, is enhanced as the joystick tilts with the hand's movement to alter the blend of the signals toward the appropriate pickup.

For a swell, moving the cup downward increases overall volume. The bottom point of the joystick's travel square is full volume from both pickups. Conversely, stick straight up toward the strings mutes the output. For tremolo, wiggle the stick up and down.

Overall volume = up-soft, down-loud.

Pickup balance = sideways toward a desired pickup, middle is both.

For experimenters:

The envelope of notes and phrases can be finely controlled with a volectar. Rhythmic circling or patterned movement of the cup while playing can produce interesting results.

The volectar is also excellent for fine control of feedback.

Using the polarity switch:

In normal mode ("in phase", switch "0" position) the joystick is used to set any static blend of the two pickups, or for swells, or tremolo.

In reverse mode, since one signal is 180 degrees out of phase, specific lower frequencies cancel when mixed, making the joystick work something like a wah-wah or phase shifter.

For "out of phase" pickup signals, set the switch to the "180" position. Movement of the cup while playing dynamically alters the ratio of signals of opposite polarity. Signal frequency cancellation creates a changing filter that can produce timbres unavailable to any guitar heretofore.

For repairs or assistance, please contact

Volectar

10 Jawbone Rd

Martinsdale MT 59053

Support 406-572-3323, sales 800-262-2617

kgbn@ttc-cmc.net or visit <http://volectar.com>

Normal hours are 9-430 Mountain Time.

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