A Guitar Preamp with fully solid-state Vibrato

Here is a fully solid state preamplifier and vibrato unit for use with electric guitars. Completely self contained and powered from a small 9V battery, the unit employs a novel vibrato system which does not include a fragile and inefficient flashing lamp.

by Anthony Leo

Last month we described a compact and self-contained single stage preamplifier which would provide the extra gain needed to enable an electric guitar to be used with an ordinary hi-fi amplifier. We were made aware of the possible need for such a device by a situation involving a relative of one of the staff members.

With the help of the preamp, valuable practice could be performed without the expense of the usual high power amplifier and speaker system. Apart from the normal tone controls found on most hi-fi amplifiers, however, the usual amplifier system used for practice will not embody any of the "frills," including vibrato and "fuzz," often found on a guitar amplifier.

This has prompted us to design a second preamplifier which still performs the same basic job of providing the requred extra gain, but which at the same time provides a vibrato facility. Not only can such a preamplifier be used with a practice amplifier but it may also be used with a suitable power amplifier to make up a guitar amplifier system complete with a vibrato facility.

Those already adequately equipped with guitar amplifiers and speaker systems may also be interested in using the design as an extra outboard vibrato unit, which could prove useful where one amplifier is being used with two guitars. In such a situation it may not always be desired to apply the vibrato effect to both guitars simultaneously. Using one, or possibly two of the outboard units, vibrato could be applied to each guitar individually.

In any vibrato system, it is essential that the low frequency vibrato modulation signal does not itself appear at the amplifier output, to be fed to the loudspeaker. If it does, it will cause the loudspeaker to "pump" in and out — sometimes resulting in an audible distortion, and in any case increasing the risk of speaker damage when a high power amplifier is used.

Up to the present time, the vibrato systems which we have described have all used the fairly popular optical modulating system, consisting of a light dependent resistive signal divider and a flashing lamp, to overcome the problem of speaker pumping. While this system proved very effective it was, nevertheless, rather clumsy in both a physical and electrical sense. Furthermore, it was not very compact, this latter shortcoming being accentuated when transistorised circuitry was used.

However the most significant disadvantage of the optical vibrato system is the power consumed by the incandescent lamp which is necessary in a transistorised version. In a valve circuit where higher voltages are involved it is possible to use a neon lamp which, perhaps paradoxically, consumes much less power.

It was this last factor, more than any other, which prompted us to consider an alternate system of modulation. The method which we have used takes advantage of the variable drain-source resistance characteristic of a junction field effect transistor to modulate the guitar signal. As such, it is completely electronic and has no flashing lights or other clumsy hardware.

For low signal levels of either polarity applied between the drain and source, a FET behaves as a linear resistor which can be varied by a bias applied to its gate. If a low-frequency alternating bias is applied to the gate then the resulting slow alternation in drain-source resistance can be used to modulate a signal in a similar manner to the previously used light dependent resistor.

Compared with the light dependent resistor, the FET resistance is very low, of the order of a few hundred ohms. However, the low resistance is a distinct advantage in transistorised circuitry, making possible a more convenient means of modulation. Reference to the circuit will show how modulation is accomplished.

The vibrato circuit consists essentially of the same amplifier configuration used in the preamp circuit described last month. However, it will be seen that there are two resistors in series in the emitter circuit of the BC109 transistor.

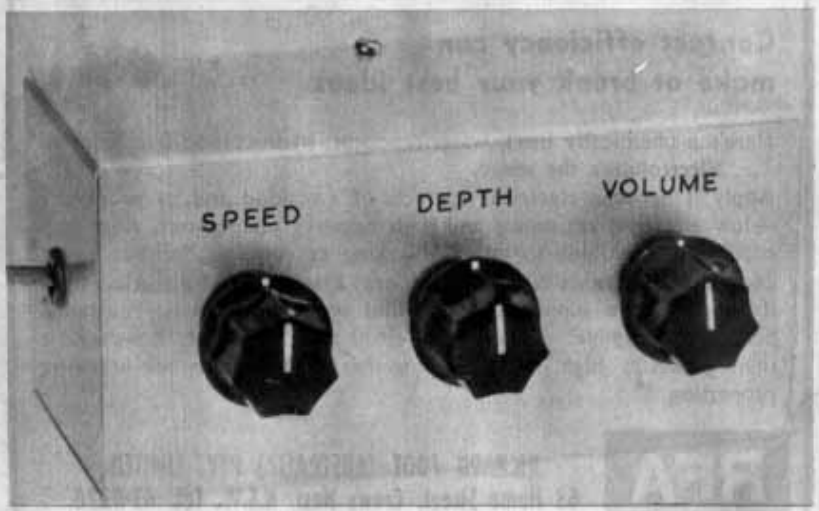
The FET is connected across the lower 1.2K resistor via a 20uF tantalum electrolytic capacitor. It is by this means that the signal is modulated with the vibrato frequency. So far as the signal is concerned, degenerative feedback in the preamp emitter is provided by the 180 ohm resistor in series with the parallel combination of the 1.2K resistor and the FET resistance, about 580 ohms.

Because the preamp stage gain is an inverse function of the degenerative emitter feedback, it can be varied by the FET resistance in the emitter circuit. Hence, by applying an alternating bias to the FET's gate the gain of the transistor preamplifier will be modulated at the vibrato frequency.

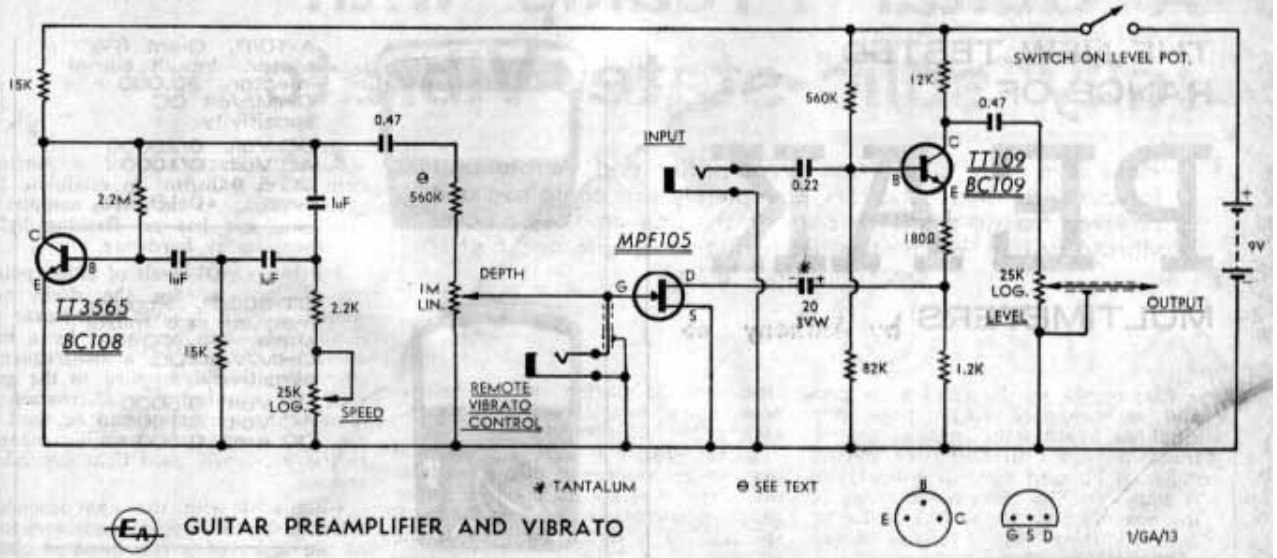
The vibrato modulating frequency, which is roughly sinusoidal, is generated by a one-transistor phase shift oscillator. The oscillator is essentially a voltage amplifier with a phase shifting network from output back to input. The network effectively reverses the phase of the output to make it in phase with the input, a condition which is sufficient to ensure continuous oscillation. By making one of the resistors in the phase-shift network adjustable in value, the oscillation frequency may be varied. This allows adjustment of vibrato "speed."

The 1uF capacitors used in the phase shift network are specified as plastic types with a 10 per cent tolerance. Ceramic or electrolytic capacitors should not be used, otherwise the oscillator may not function as a result of excessive capacitor losses.

The signal at the collector of the oscillator, which is about 2V peak to peak, is applied to the gate of the



The prototype vibrato preamplifier is shown above, housed in a small aluminium utility box.



GUITAR PREAMPLIFIER AND VIBRATO

FET through an attenuating network consisting of a 560K resistor in series with a 1M linear potentiometer. The pot thus functions as a vibrato "depth" control, with maximum depth corresponding to the highest modulating signal amplitude applied to the FET gate. When the pot is turned right back, zero signal is applied to the gate, and the vibrato is effectively "off."

The maximum modulating voltage applied to the gate should be somewhat less than the pinch-off voltage of the FET, otherwise a prominent "plop" will be heard in the absence of signal.

Because the pinch-off voltage varies from device to device, facility for setting the maximum gate voltage has been provided. This takes the form of a resistor in series with the depth control with a value set at 560K in the prototype.

With the depth control in the maximum position, the resistor value should be adjusted to a point just above that which produces the "plopping" sound in the speaker. With most FETs the resistor can be reduced in value from the 560K shown, but in the few cases of devices with low pinch-off voltage it will be found necessary to increase the resistor value.

If readers desire to switch the vibrato in and out by means of a remote foot switch, it should be arranged to short the FET's gate to its source, as shown in the circuit diagram. The switch could alternatively be arranged to disable the oscillator, but it was found with the prototype that the oscillator required a few seconds to re-start.

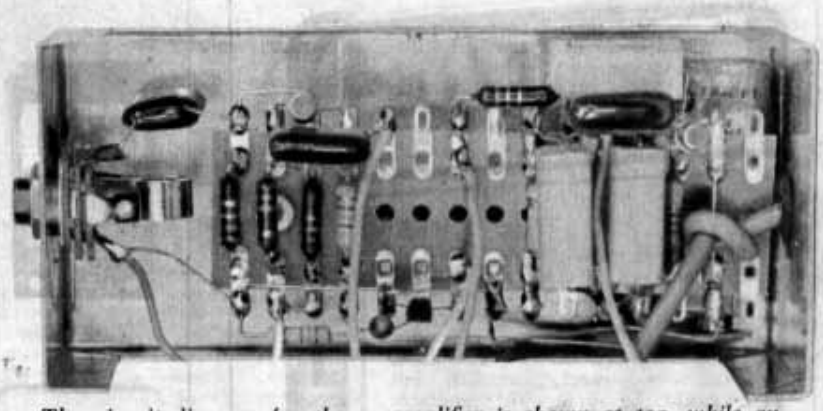
While we did not include the remote facility as a permanent facility in the prototype, we did make a temporary connection. A non-shorting type jack-socket should be used for connection of the remote shorting switch. Also, it is necessary to use shielded cable to connect to the switch, so as to avoid injecting hum at the gate of the FET, and subsequent hum modulation of the signal. The inner conductor of the shielded cable should connect to the gate, and the shield to the source.

The gain of the preamplifier stage, without vibrato modulation, is about 20 times with a maximum undistorted output of about 2V RMS, or 5.6V peak to peak. This means, then, that the signal should not be more than approximately 280mV peak to peak.

We actually measured the preamp output when fed from a typical Hawaiian steel guitar and found it to be no more than 200mV peak to peak with maximum volume control setting. Thus there would appear to be a reasonable overload margin of some 80mV peak to peak.

In the prototype we included an output level control on the panel, together with the speed and depth controls. However, the level control could take the form of a pre-set tab mounting pot, as with the preamp described last month, or it could be discarded in the interests of simplicity, and the level control on the guitar used instead.

If the level control is omitted an alternate on/off switch may have to be provided. However, with a current



The circuit diagram for the preamplifier is shown at top, while an inside photograph showing the placement of components is shown immediately above.

List of Parts:

HARDWARE
- *1 Aluminium box, 5in x 2¼in x 2¼in.*
- *1 9V battery.*
- *1 15-lug length of miniature resistor panel.*
- *1 Standard jack socket and plug.*

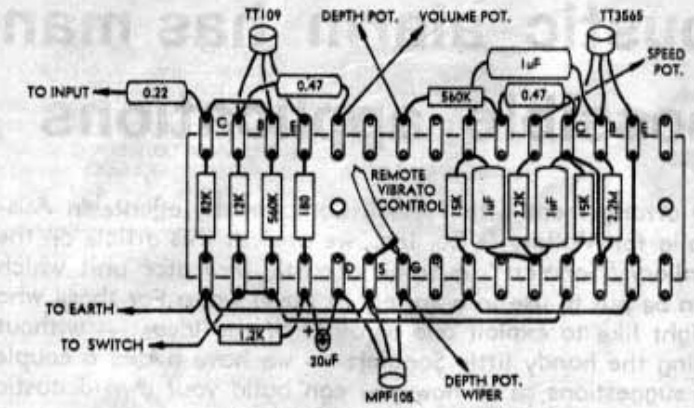
TRANSISTORS
- *1 TT109, BC109, etc.*
- *1 TT3565, BC108, etc.*
- *1 MPF105 Motorola FET.*

POTENTIOMETERS
- *1 25K log, with switch.*
- *1 25K log.*
- *1 1M lin.*

RESISTORS
- *2 560K, 1 x 82K, 1 x 12K, 2 x 15K, 1 x 2.2K, 1 x 1.2K, 1 x 180 ohms.*

CAPACITORS
- *1 20uF 3VW tantalum electrolytic.*
- *3 1uF low voltage plastic.*
- *2 0.47 low voltage plastic.*
- *1 0.22 low voltage plastic.*

NOTE: Motorola field effect transistors may be ordered from Cannon Electric (Aust.) Pty. Ltd., of 58 Cluden Street, East Brighton, Vic. 3187, P.O. Box 25, Mascot, N.S.W. 2020, or Commonwealth Aerodrome, Parafield, S.A. 5106.



A wiring diagram of the miniature resistor panel is shown above; this will assist with the placement of most of the components used in the preamp.

drain of only 0.7mA for the complete unit it could almost be left on continuously with a probable battery life of not much less than normal shelf-life.

For this version of the preamp we again used a small aluminium utility box, which measured 5in x 2¼in x 2¼in. The three controls were mounted in the U-shaped lid with sufficient lead length to facilitate easy lid removal for battery replacement. The battery was held to the bottom of the box with a clamp made from some scrap aluminium.

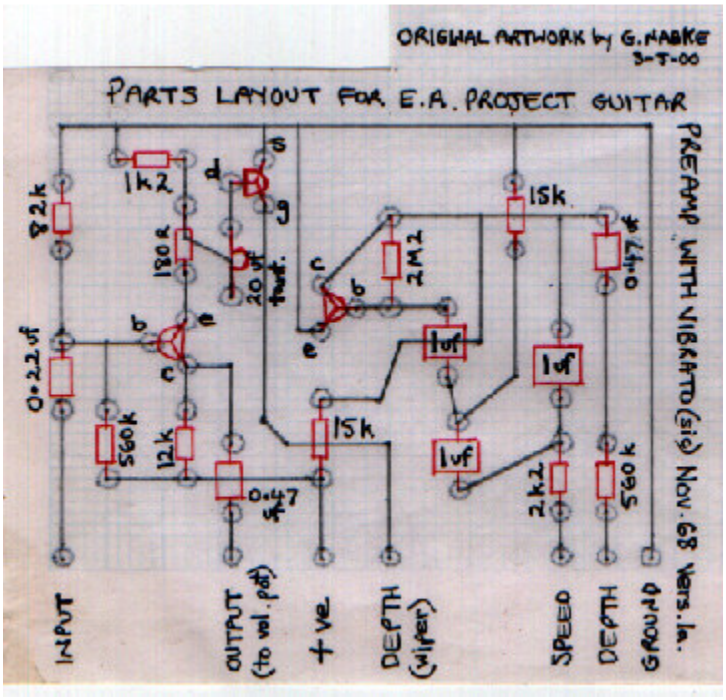
Most of the components were mounted on a 15-lug strip of miniature resistor panel. The panel is divided roughly into two halves, one end for the oscillator components and the other for the preamp, with the FET about in the middle.

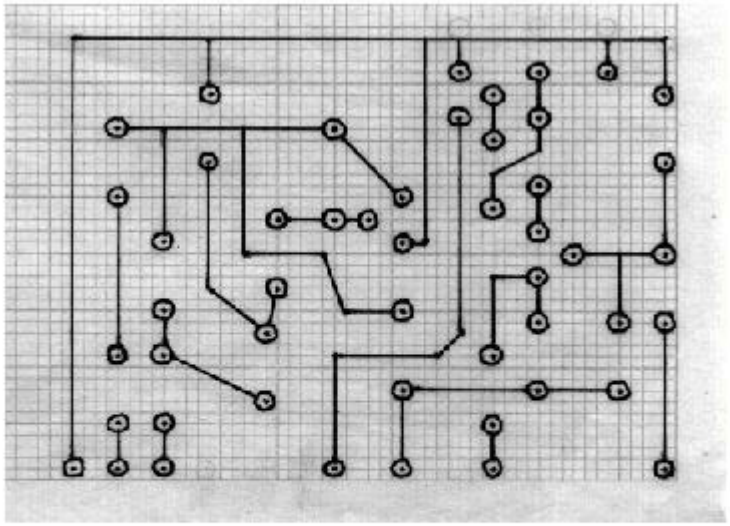
We used a tantalum electrolytic capacitor to couple the FET into the preamp emitter, because it has extremely low current leakage. Significant leakage in the coupling capacitor would modulate the DC conditions of the preamplifier stage to cause "pumping" and severe distortion with larger input signals. Furthermore, tantalum electrolytic capacitors apparently have no tendency toward drying out and subsequent loss of capacitance, as occasionally occurs with other electrolytic capacitors.

The length of miniature resistor panel was supported by two 1¼in countersunk screws, using nuts to space the panel. It should be spaced from the bottom of the box just sufficiently to clear the battery, otherwise the components projecting from the panel will foul with the potentiometers in the lid.

The input connection to the preamp is made via a standard jack socket, while a captive length of shielded cable fitted with a standard jack plug is used for the output. The shielded cable is passed through a grommet and knotted to prevent undue strain on the electrical terminations.

The lid which, completes the unit, is held in place by two small countersunk screws in the sides of the box. The lettering on the top panel of the box was applied to the prototype using black indian ink and a drawing pen and lettering stencil. The lettering was then lightly sprayed with clear lacquer to render it permanent. ■





Artwork for E.A. Project : Guitar Preamp with Vibrato
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