

ACTIVE GUITAR

Dimitri Danyuk and George Pilko

Some of the most important functions in sound reinforcement systems are performed by low-level preamplifiers. They must amplify signals from millivolt level with a minimum amount of electronic noise and hum. Considering a guitar magnetic pickup as a signal source, the input impedance specification is of particular importance.

The output impedance of guitar pickups can vary by a factor of 40:1 over the audio band. The d.c. output resistance of pickups lies in the range 3 - 15k Ω and their inductance is around 2 - 10H. Before a signal enters the amplifier input, it has been passed through a long shielded cable. Cable capacitance and pickup inductance form a parallel resonant circuit which shifts the pickup resonance several octaves lower.

The guitar signal is amplified by an overdriven amplifier to achieve the required sound. This reduces the signal dynamic range so interference such as hum, clicks and pops produced by the long cable become evident. A possible solution is to use a noise gate, but the gate's switching effects are audible.

This article describes an active front-end circuit which allows

one to properly interface a magnetic pickup and combo amplifier. Rejection of unwanted signals and increase in the output dynamic range produces marked improvement in performance.

Usually, the active electronics circuit consists of a battery driven, op-amp based voltage follower placed inside the guitar [1]. This is not very convenient since the user needs to be aware of the battery state. An advantage of the proposed circuit is that it shares the same cable and jacks and is ready to operate when the combo amplifier is turned on.

The circuit diagram of the amplifier minus the power supply is shown in Figs 1 and 2. It is based on the authors' previously published circuit [2]. This has been redesigned to achieve the lowest signal to noise level and to increase the amount of control. The guitar unit is a common source stage with transistor Q1 and employs passive, noiseless equalisation to produce 'Presence' (switch 52) and 'Middle cut' (switch 51) effects.

Both controls being combined with a certain degree of overdrive in combo amplifier implements interesting artistic effects. If the pickup has a pronounced middle frequency 'voice', one can

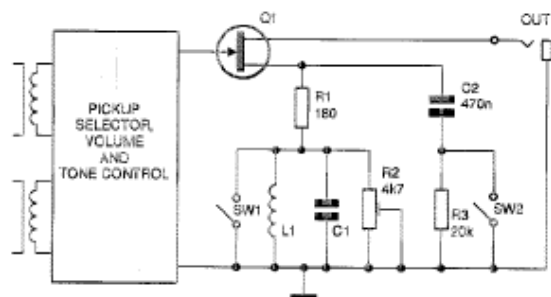


Fig. 1 Active electronics: guitar unit

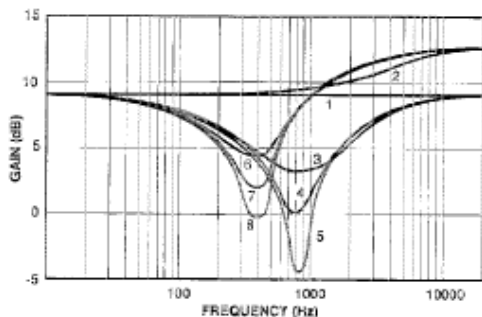


Fig. 2 Active electronics: combo amplifier unit

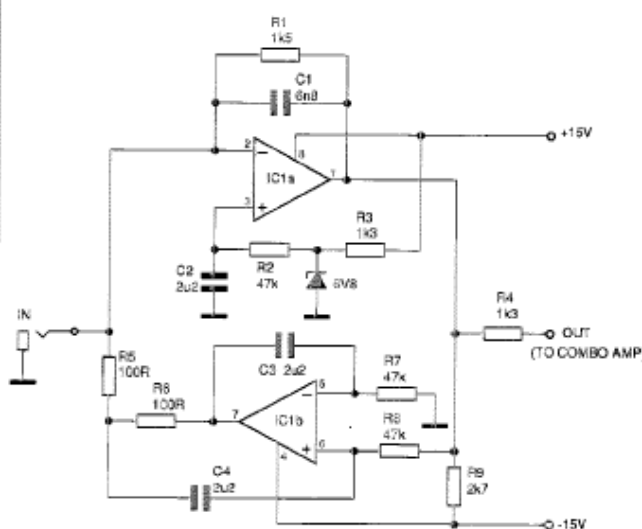


Fig. 3 Set of frequency responses for the active guitar electronics: curve 1 - switch S1 is closed and S2 is opened, curve 2 - both switches are closed ('Presence' effect is enabled), curves 3-5 - both switches are opened ('Middle cut' effect is enabled), curves 6-8 - switch S1 is opened and S2 is closed (both effects are enabled). Curves 3,6 - R2 = 510 Ω , curves 4, 7 - R2 = 1k Ω , curves 5, 8 - R2 = 2.2 k Ω .

ELECTRONICS

change the components C1 and L1 to muffle it. For example, with the DiMarzio GH-1201 humbucking pickup, it was found $C1 = 0.22 \mu\text{F}$ and $L1 = 0.2 \text{ H}$. The set of measured frequency responses with these elements is given in Fig.3.

Transistor Q1 is a 2N4416, 2N5270, 2N5459 or similar, preferably low-noise type, with $I_{\text{dss}} = 10\text{mA}$ and $V_{(\text{p})\text{gs}} = -3 \text{ V}$. The pinch-off voltage $V_{(\text{p})\text{gs}}$ must exceed the peak output of the pickup being used to prevent clipping in common source stage. The quiescent drain current is set by resistor R1 and should be equal or slightly higher than half of the drain current saturation value I_{dss} .

The combo amplifier unit consists of a current-to-voltage converter with d.c. servo loop built around IC1 (5532). The input of the unit becomes a virtual earth and the interference which originated in the cable vanished. The non-inverting integrator IC1b implements a multi-loop feedback via C3 and C4. The integrator output impedance at audio frequencies is much higher than R1 thus the noise contribution of IC1a is negligible. The unit was placed inside Marshall 2100 JCM900 valve amplifier and fed from the amplifier filament supply through a simple

voltage regulator. As the overall gain is nearly equal to 3, the peak output from the unit reaches a few volts and allows the input valve to be overdriven.

The guitar unit and combo amplifier unit are interconnected with a conventional shielded cable and 1/4 inch jacks. The circuit works with cable length up to 300 feet and is also very handy for piezo-electric pickups.

References

- E. Meinel, *Elektrogitarren* (VEB Verlag Technik, Berlin 1987), pp. 83 - 84, 136 - 142
- D. Danyuk and G. Pilko, "Active Guitar Electronics," *Electronics Australia*, May 1994, p. 65

Article details

Article title - Active Guitar Electronics

Author - Danyuk, D.

Journal title - ELECTRONICS TODAY INTERNATIONAL -ENGLISH EDITION-

Bibliographic details - 1995, VOL 24; NUMBER 2 pp. 52-53

Publisher - ARGUS SPECIALIST PUBLICATIONS

Country of publication - Great Britain