20W instrument practice amplifier

This basic instrument practice amplifier has inputs for four instruments and a basic mixer which feeds into an integrated 20W power amplifier. The whole thing runs from a 12V battery or mains supply.

As instruments typically have their own volume controls (and volume can be adjusted based on how they are played), there are no volume or gain controls.

Instead, the instrument signals fed into CON1-CON4 and are AC-coupled straight into a virtual-earth mixer with a fixed gain of around two times. The 330kΩ input impedance suits most pickups.

The mixed signals are amplified and inverted by op amp IC1, a JFET-input type to keep the input impedance high. Its non-inverting input is held at half the supply voltage due to a voltage divider filtered by a 47µF capacitor to remove supply noise. Diode D2 ensures that this rail drops quickly at switch-off.

The signal from IC1 is AC-coupled to input pin 1 of IC2, a dual power amplifier configured in bridge mode. This can drive a 4Ω speaker, and must do so to get the rated 20W with a 12V supply. The upper stage is configured with a gain of +201 times while the lower stage has a gain of -200 times, therefore driving the speaker in bridge mode with a total gain (in this stage) of 401 times.

The feedback is a little complex but consider that the signal at the inverting input of the upper op amp must match the incoming signal in closed-loop mode.

This AC signal also appears at the junction of the two 10Ω resistors. If you consider the lower amplifier to be a standard inverting configuration, its gain is therefore -200 times (-1 × 2kΩ ÷ 10Ω; ignore the lower 10Ω resistor as it has no effect here).

Next, consider that the junction of the 2kΩ resistor and 10Ω resistor is the 'virtual earth' point of the inverting amplifier and therefore, there is no AC signal there.

That means you can consider the two 10Ω resistors to be in parallel in terms of the behaviour of the upper amplifier stage, and so its feedback resistor network is 1kΩ at the top and 5Ω at the bottom, for a total gain of 201 times (1kΩ ÷ 5Ω + 1).

Taking account the gain of two in the preamplifier stage (IC1), total system gain is around 800 times, enough to get the full 20W into 4Ω (which requires around 9V RMS) with an input signal of around 10mV RMS.

If using a higher impedance speaker, the supply voltage can be increased up to about 24V to maintain a reasonable power level. A laptop supply might be a good choice in that case.

The capacitors connected between BS1/BS2 (pins 11 & 7) and output pins 10 and 8 are necessary to achieve maximum power with low distortion, especially at lower frequencies. However, if you don't need the full 20W, you can leave them off and instead connect BS1/BS2 directly to $+V_S$ (pin 9).

LEDs1 & 2 light up to show when there is output, and their brightness is proportional to the signal level. Each output also has a Zobel network (100nF/1Ω) which is required for stability. Fuse F1 and diode D1 provide reversed supply polarity protection as F1 will blow in this case, or if there is some other circuit fault.

IC1 needs to be mounted on a heatsink rated at no more than 4°C/W to avoid thermal shutdown at high power levels. A slightly smaller heatsink could be used if the 20W power rating is not required, or will only be achieved in short bursts.

Petre Petrov,
Sofia, Bulgaria. ($70)