THAT Corporation Design Note 123

# Operating Log/Anti-log VCAs Off ±24V Supplies

It is often desirable to use ±24V supplies in pro audio applications to maximize system dynamic range. However, raising the supply voltage is not a cure-all, since some devices are not able to run off ±24V. These lower-voltage devices can limit dynamic range, and require an additional supply to be routed around the PCB. This, in turn, complicates the requisite de-coupling, since the ±15 V devices which interface to ±24 V devices will need to be de-coupled to both supplies to avoid ground loops.

Fortunately, none of this is the case with THAT Corporation's log/anti-log VCAs. Utilizing the THAT 2180's (or THAT 2181) current in/current out topology allows the VCA to run off ±24V supplies without introducing an additional regulated supply voltage and without compromising system dynamic range.

The circuit shown in Figure 1 solves the problem of operating a VCA specified for ±18V operation on ±24V supplies. This circuit takes advantage of the facts that a) the signal

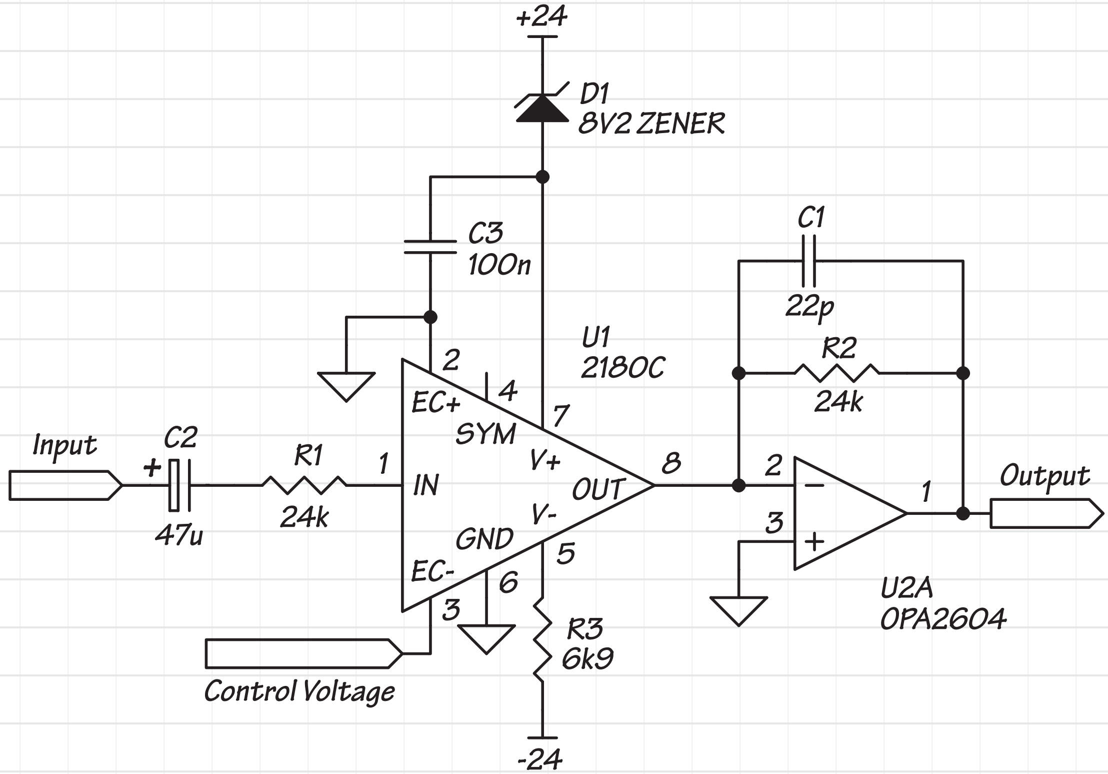


Figure 1. Operating the THAT 2180 off ±24V supplies

inside the VCA is processed in the current domain, and both the input and the output of the THAT 2180 stay at virtual ground, b) that the negative supply of the VCA is biased with a current, and resides three diode drops below ground, and c) that the signal is in the logged domain inside the VCA, and only requires about 5V of headroom to handle even the largest signals.

 

The input of the VCA is actually the inverting input of an op-amp configured as a log amplifier, and this input is at virtual ground. R1 converts the input signal, which is presumed to swing within approximately one volt of the rail, into a current:

$$I_{in\ peak} = \frac{(24V - 1V)}{24\,k\Omega} \cong 1mA_{peak}$$

which is well within the range allowed for this device.

The output current is calculated in a manner similar to the input current:

$$I_{out\ peak} = \frac{(24V - 1V)}{24\,k\Omega} \cong 1mA_{peak}$$

Unlike the VCA, the output amplifier must be capable of running directly off ±24V in order to avoid compromising the dynamic range. The circuit in Figure 1 uses an OPA2604.

The negative supply of the VCA is current biased, and must be capable of sinking the sum of the input, output, and quiescent current. Since the input current and the output current have the same polarity, and the quiescent current is 650µA, the bias current should be:

$$I_{Bias} = 2 \times 1mA + 650\mu A = 2.65mA$$

Since the negative supply is three diode drops below ground, the required bias resistor is:

$$R_{Bias} = \frac{(24V \times 90\% + 3 \times 0.78V)}{2.65mA} = 7.27\,k\Omega \cong 6.9\,k\Omega$$

The supply voltage is multiplied by 90% to account for the fact that the supply and the bias resistor can vary by 5% each, and 0.78V is approximately a single diode drop at zero degrees Celsius. 6.9kΩ is the closest 5% value to 7.27kΩ.

Because the signal exists as a current within the VCA, there is sufficient headroom to allow an 8.2V zener diode to be added in series with Vcc to keep the VCA within its recommended operating supply. Since zener diodes only have their specified reverse drop at their rated test current, the designer should use a device specified at low currents, such as the MMSZ4596 from General Semiconductor. If layout permits, the designer can pair up VCAs and let 2 VCAs run off a single zener diode specified for 5mA.

This circuit enables a VCA specified for ±18V to operate on ±24V supplies. By taking advantage of the VCA's current-mode topology, the signal is passed through the VCA without any supply-related reduction in the signal's dynamic range. This circuit could even be modified to operate off higher voltages using the principles outlined above.