

Variable Gain Amplifier Notes

Piyush Sud

10/13/2024

1 High Level Design

- What range of amplitudes are we looking for?
- Based on this: <https://forum.allaboutcircuits.com/threads/voltage-on-an-antenna-88982/>
- It seems like FM receiver gain is generally on the order of 100 - 120 dB and the input is typically in the low μV to low mV range.
- The power gain of the input stage is -3 dB, HF amp is 31.5 dB, mixer is 2.4 dB, fm detector is 0 dB, and output headphone amplifier is 20 dB. This means that the overall gain is 50.9 dB.
- This seems like a good variable gain amplifier: <https://www.digikey.com/en/products/detail/ti/instruments/VCA824IDGST/1766828?s=N4IgTCBcDaIGoGECCAOMAWAkgEQOIGUAVE>
- Bandwidth is 320 MHz, which is much higher than what we need.
- The gain can be adjusted from 2 to 32 dB.
- With 2 variable gain amplifiers in series, the overall gain of the system ranges from 54.9 dB to 114.9 dB. This accomodates a wide range of signal strengths.

2 Detailed Design

- The maximum gain is set by the resistors R_F and R_G .
- For some reason (probably because it creates a pole, reducing the BW), they used small resistor values for R_f and R_g in their example circuits, so let's do the same. Let's choose $R_f = 500$ ohms. Since we want the gain to be able to up to 32 dB (40 V/V), then we need R_g to go down to 12.5 ohms. If we want the gain to down to 3 dB (2V/V), then we need $R_g = 250$. Therefore the pot range we are looking for is [12.5, 250]. The bottom value in the range should be easy to achieve since most pots can typically go down to 1 to 2 percent of their max value.
- It seems like a resistor between the feedback pin and the input is only used if we need the output voltage to be both a function of V_g and V_{in} .

However, in this case, we only really need it to be a function of V_{in} since we can set R_f/R_g using a potentiometer, and the output voltage is also proportional to R_f/R_g .

- The input impedance is high impedance, so we can just put a 50 ohm resistor to ground.
- The output also needs a 50 ohm output resistor in series.
- We can use the following circuit from the datasheet:

(two capacitors to ground and one across the supplies) enables the VCA824 to achieve the low second-harmonic distortion reported in [Electrical Characteristics- \$V_S = \pm 5\text{ V}\$](#) .

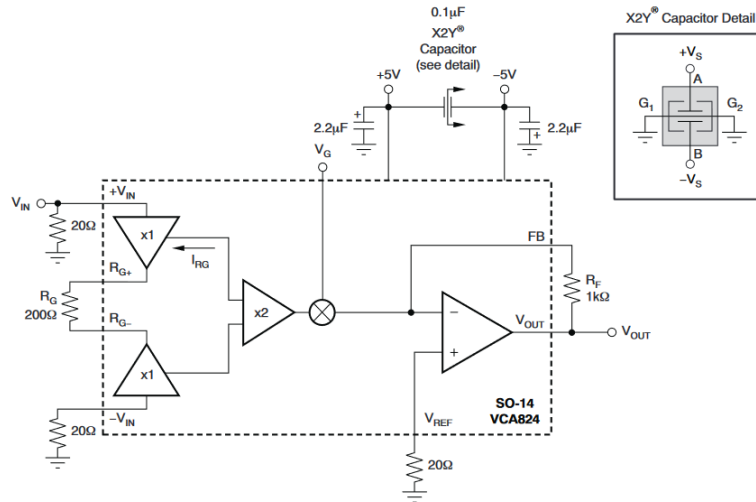


Figure 75. DC-Coupled, $A_{VMAX} = 10\text{ V/V}$, Bipolar Supply Specification and Test Circuit