

For a the VFB amplifier of figure 3, the transfer function is obtained utilizing the following equations:

$$\begin{aligned} V_i &= 0 \\ V_O &= -A(s)V_2 \\ \frac{V_i - V_2}{R_1} &= \frac{V_2 - V_O}{R_2} \end{aligned}$$

The transfer function of a VFB amplifier, configured as figure 3, is:

$$\frac{V_O}{V_i} = \frac{-\frac{R_2}{R_1}}{1 + \frac{R_2}{1 + \frac{R_1}{A(s)}}}$$

As $A(s)$ approaches infinity, the closed loop-gain is $-(R_2/R_1)$. The denominator of the transfer function determines the frequency response of the closed-loop circuit. The noise gain $(1 + R_2/R_1)$ and the frequency dependent source appear in the denominator. This links the closed-loop gain and bandwidth. A high gain configuration circuit will have less bandwidth than a lower gain circuit. As the circuit moves to lower gains, bandwidth increases, but phase margin is lost, causing instability.

For the CFB amplifier of figure 3, the transfer function is obtained utilizing the following equations:

$$\begin{aligned} V_i &= 0 \\ V_O &= Z(s)I_{inv} \\ \frac{V_i}{R_1} + I_{inv} &= -\frac{V_O}{R_2} \end{aligned}$$

The transfer function of a CFB amplifier, configured as figure 3, is:

$$\frac{V_O}{V_i} = \frac{-\frac{R_2}{R_1}}{1 + \frac{R_2}{Z(s)}}$$

As $Z(s)$ approaches infinity, the closed-loop gain is $-(R_2/R_1)$. Notice that only the feedback resistor appears in the term with $Z(s)$. Only the feedback resistor affects the closed-loop frequency response.

A CFB op amp is commonly compensated for maximally flat response at a specified gain with a specified feedback resistor. The closed-loop bandwidth is determined by the feedback resistor, not the gain. This says that a feedback resistor twice the value of the manufacturers recommended value will have half the bandwidth. As the feedback impedance is reduced, there is a loss of phase margin. When $R_2/Z(s)$ equals negative one, the loop is unstable.

The design trade-offs between CFB amplifiers and VFB amplifiers differ. In general, VFB amplifiers offer:

- Lower Noise
- Better DC Performance
- Feedback Freedom

In general, CFB amplifiers offer:

- Gain-Bandwidth Impedance
- Faster Slew Rates
- Lower Distortion
- Feedback Restrictions

A common error in implementing a CFB amplifier is to short the output to the inverting input in order to configure a unity-gain buffer. This will cause the circuit to oscillate. The circuit requires the recommended feedback resistor in the feedback in place of the short to maintain stability.

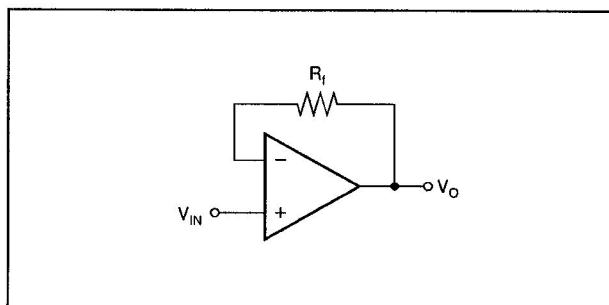


FIGURE 4. Unity-Gain Buffer.

Another example is an integrator circuit. This is commonly accomplished by placing a capacitor between the inverting input and the output of the amplifier. Keep in mind that at high frequencies a capacitor could easily have impedance less than that required for stability. The proper feedback resistor should be placed in series with the feedback capacitor. This will stabilize the amplifier, and introduce a high-frequency zero into the integrator transfer function.

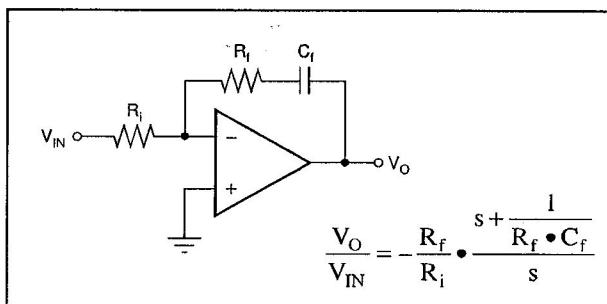


FIGURE 5. Integrator Circuit.