

Figure 20-5 Distribution amplifier.

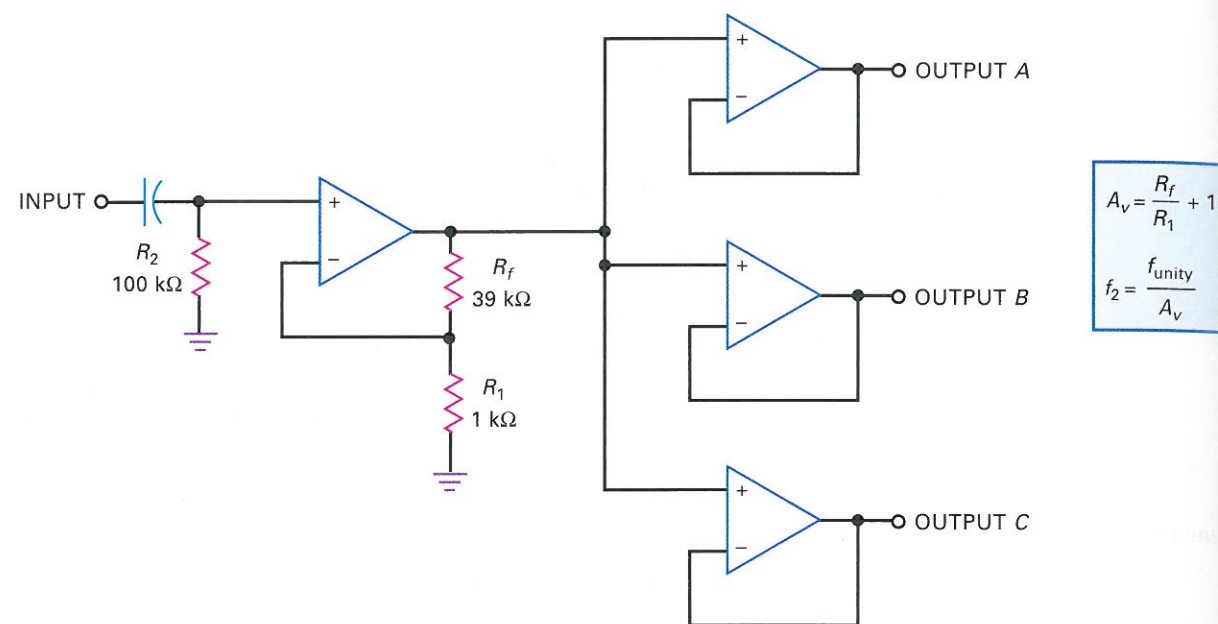
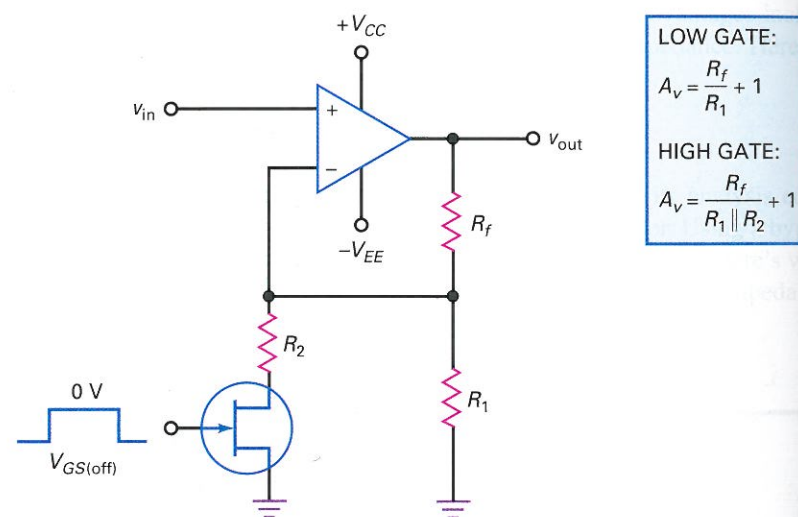


Figure 20-6 JFET switch controls voltage gain.



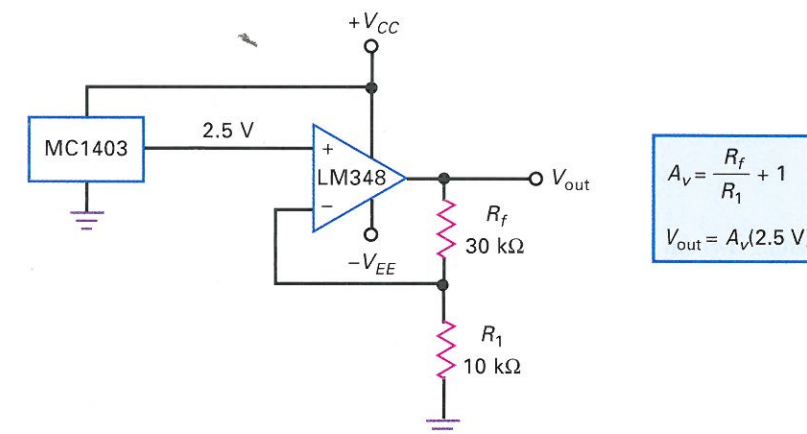
In this case, R_2 is ungrounded and the voltage gain is given by the usual equation for a noninverting amplifier (the top equation in Fig. 20-6).

When the control voltage is high, it equals 0 V and the JFET switch is closed. This puts R_2 in parallel with R_1 , and the closed-loop voltage gain decreases to:

$$A_v = \frac{R_f}{R_1 \parallel R_2} + 1 \quad (20-2)$$

In most designs, R_2 is made much larger than $r_{ds(on)}$ to prevent the JFET resistance from affecting the closed-loop voltage gain. Sometimes, you may see several resistors and JFET switches in parallel with R_1 to provide a selection of different voltage gains.

Figure 20-7 Voltage reference.



Voltage Reference

The MC1403 is a special-function IC called a **voltage reference**, a circuit that produces an extremely accurate and stable value of output voltage. For any positive supply voltage between 4.5 to 40 V, it produces an output voltage of 2.5 V with a tolerance of ± 1 percent. The temperature coefficient is only 10 ppm/ $^{\circ}\text{C}$. The abbreviation *ppm* stands for “part per million” (1 ppm is equivalent to 0.0001 percent). Therefore, 10 ppm/ $^{\circ}\text{C}$ produces a change of only 2.5 mV for a 100 $^{\circ}\text{C}$ change in temperature (10×0.0001 percent $\times 100 \times 2.5$ V). The point is that the output voltage is ultra-stable and equal to 2.5 V over a large temperature range.

The only problem is that 2.5 V may be too low a voltage reference for many applications. For instance, suppose we want a voltage reference of 10 V. Then, one solution is to use an MC1403 and a noninverting amplifier as shown in Fig. 20-7. With the circuit values shown, the voltage gain is:

$$A_v = \frac{30 \text{ k}\Omega}{10 \text{ k}\Omega} + 1 = 4$$

and the output voltage is:

$$V_{out} = 4(2.5 \text{ V}) = 10 \text{ V}$$

Because the closed-loop voltage gain of the noninverting amplifier is only 4, the output voltage will be a stable voltage reference of 10 V.

Example 20-1

One application for Fig. 20-6 is in a **squelch circuit**. This kind of circuit is used in communication receivers to reduce listener fatigue by having a low voltage gain when no signal is being received. This way, the user does not have to listen to static when there is no communication signal. When a signal comes in, the voltage gain is switched to high.

If $R_1 = 100 \text{ k}\Omega$, $R_f = 100 \text{ k}\Omega$, and $R_2 = 1 \text{ k}\Omega$ in Fig. 20-6, what is the voltage gain when the JFET is on? What is the voltage gain when the JFET is off? Explain how the circuit can be used as part of a squelch circuit.