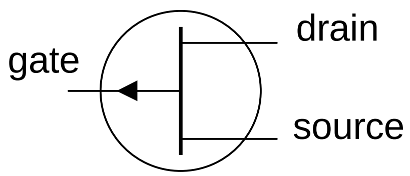
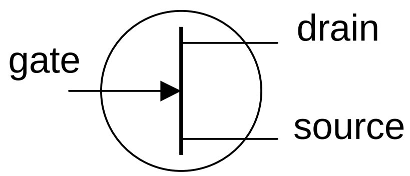
# *The JFET*

The Junction Field Effect Transistor is another type of transistor, which can be used in the same kinds of circuits as bipolar junction transistors. It has a higher input impedance than the BJT.



P-channel JFET



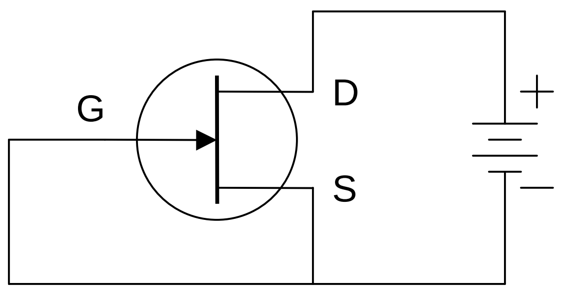
N-channel JFET

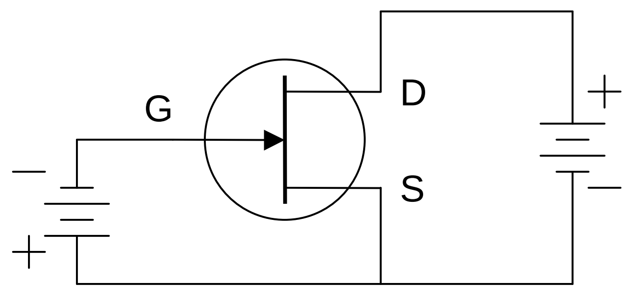
The JFET is a three-terminal device. Its terminals are known as the gate, drain, and source. The gate of a JFET is much like the base of a BJT in that it provides the input which controls current through the transistor. Unlike the BJT, however, it is the gate *voltage* that controls current flow (in a BJT, the base *current* controls the flow of current through the transistor).

P-channel and N-channel JFETs operate identically, except that all polarities are reversed between the two.

# N-Channel JFET Biasing

For an N-channel JFET, the voltage between the gate and source determines the amount of current which flows from the drain to the source.



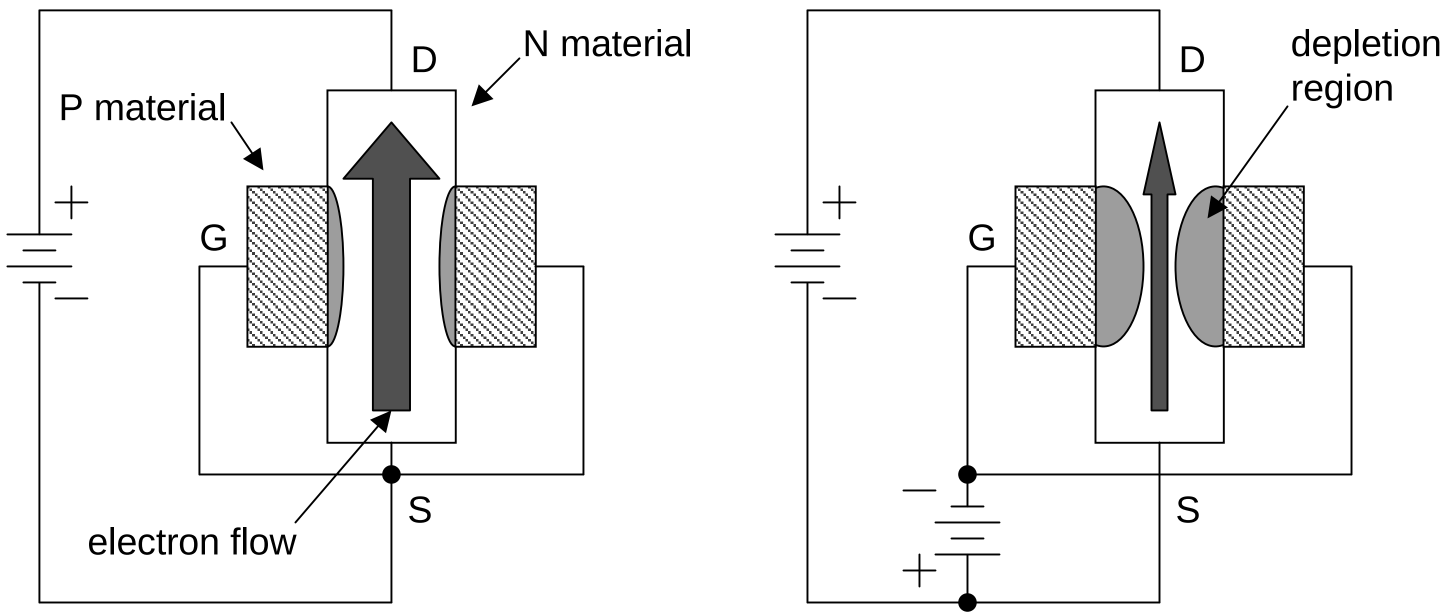




When the gate and the source are at the same voltage, the JFET freely conducts. The current flowing from drain to source is limited only by the resistance of the semiconductor materials making up the transistor.

Current from drain to source is controlled by making the gate voltage more negative than the source voltage. If the voltage at the gate is made sufficiently more negative than the voltage at the source, the JFET is cut off--no current will flow from drain to source.

(Remember--for the p-channel JFET, reverse the polarity of each of the voltages.)

# N-Channel JFET Construction



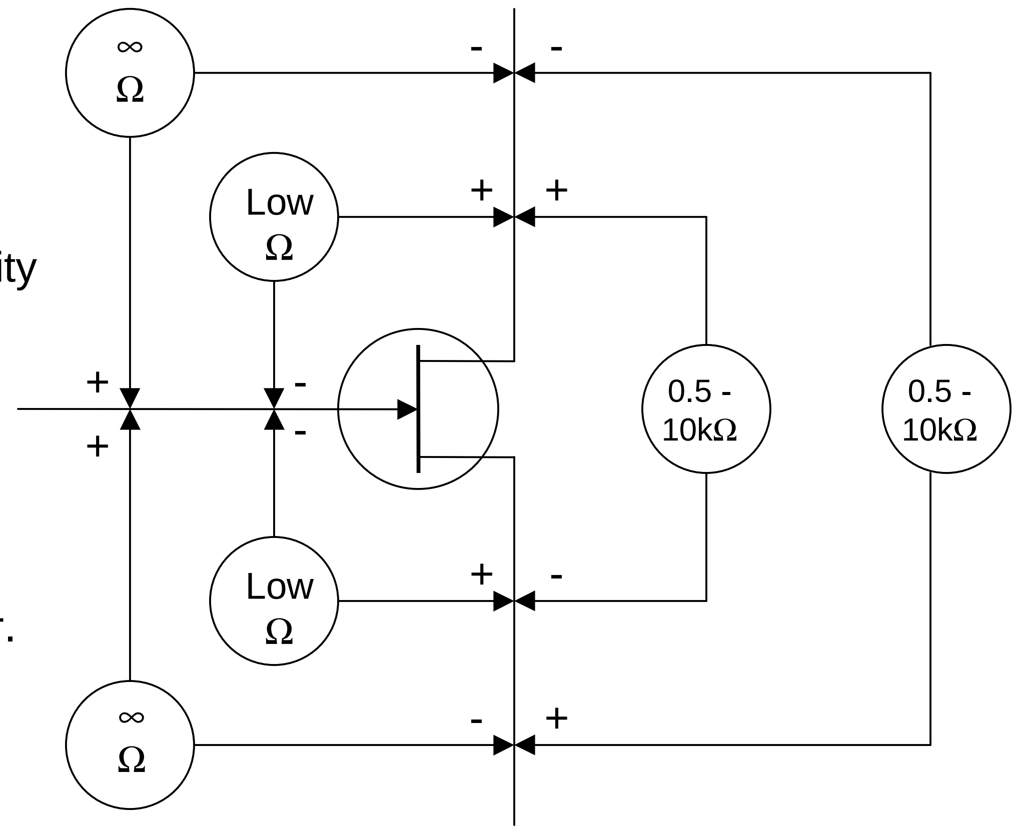

The drain and source are at opposite ends of a continuous length of n-type semiconductor. The gate is constructed of two regions of p-type semiconductor. When the gate-source junctions are reverse biased, a depletion region (free of charge carriers--electrons and holes) is created. This forces the electron flow to channel into a smaller area, effectively increasing resistance and reducing current flow.

# Testing the JFET

The JFET can be easily tested using an ohmmeter:

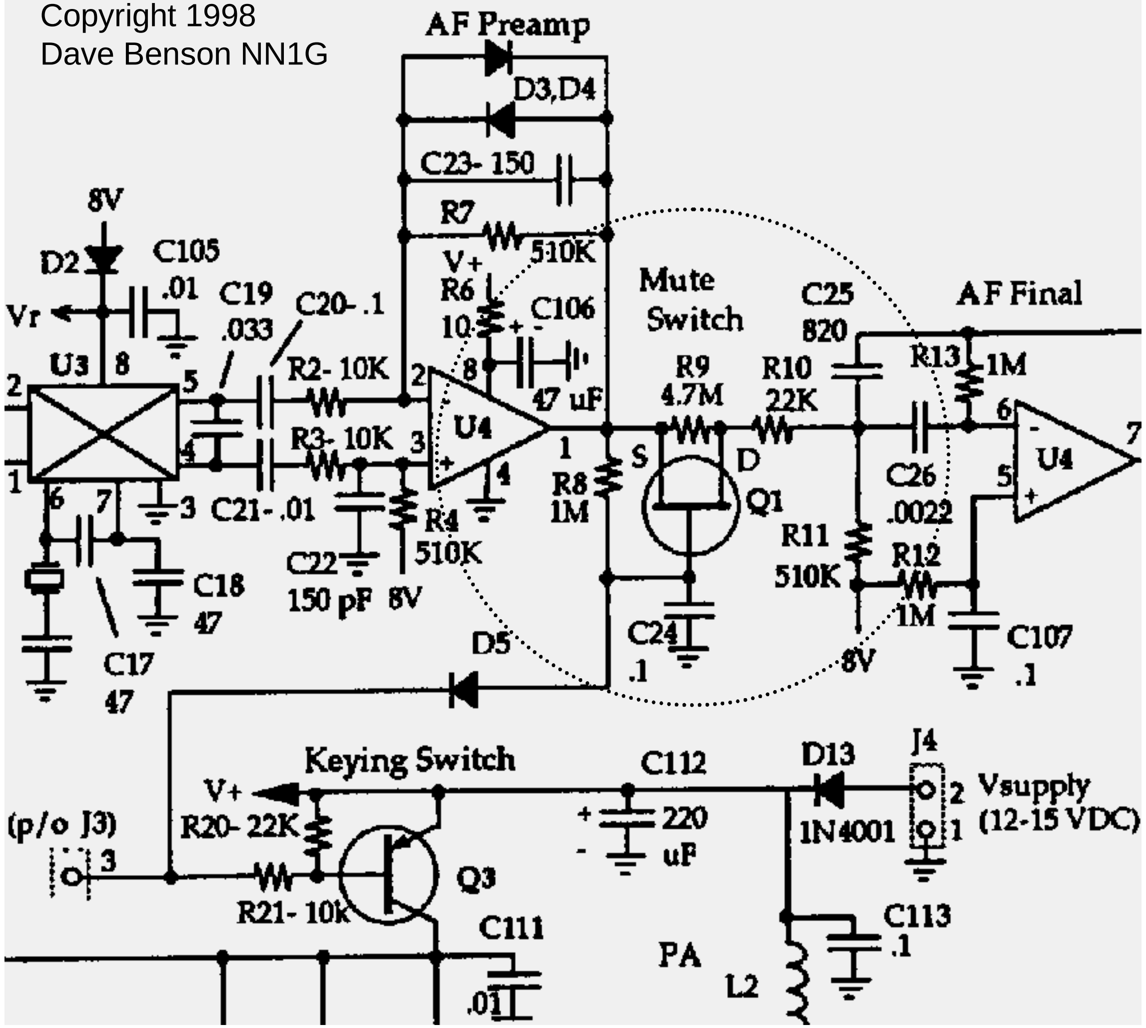
1) Resistance between source and drain will be the same with either polarity (a few kΩ)

2) Between the gate and either the source or the drain will depend upon the polarity of connection of the ohmmeter. Resistance should be high with one polarity and low with the other. This behavior is identical to that observed when testing a diode with an ohmmeter.



# The SW+ Mute Switch





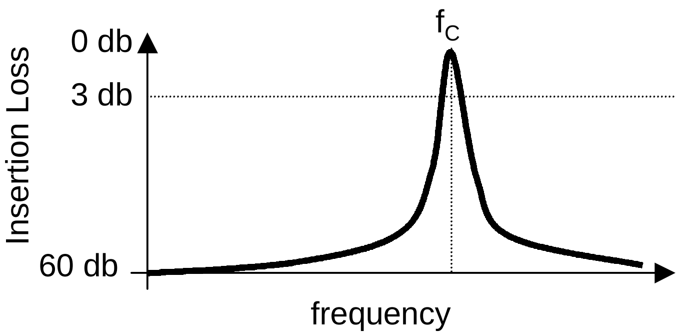

With the key up, no current flows through R8, making the voltage the same at both the gate and source of Q1. Under this condition, Q1 conducts freely. When the key line is grounded, current flows through R8, and the gate becomes negative with respect to the source. This causes Q1 to cut off, muting the receiver.

Since part of the transmitted signal gets into the receiver, resistor R9 leaks a bit of the transmitted signal past Q1 and into the receiver final amplifier, creating the sidetone for the transmitter.

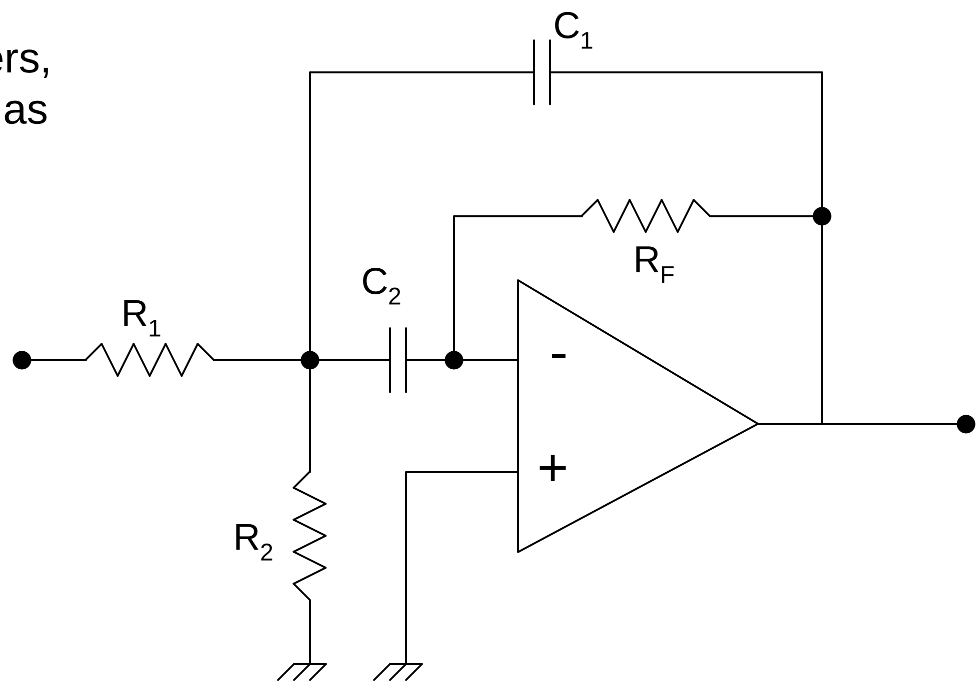
When the key is let up, current through R8 decreases to zero “gradually” as C24 charges, until current ceases to flowand the gate and source are at the same voltage again. Now Q1 is conducting again.

# Active Bandpass Filter

In addition to low-pass and high-pass filters, the op amp can be configured to operate as a band-pass filter.



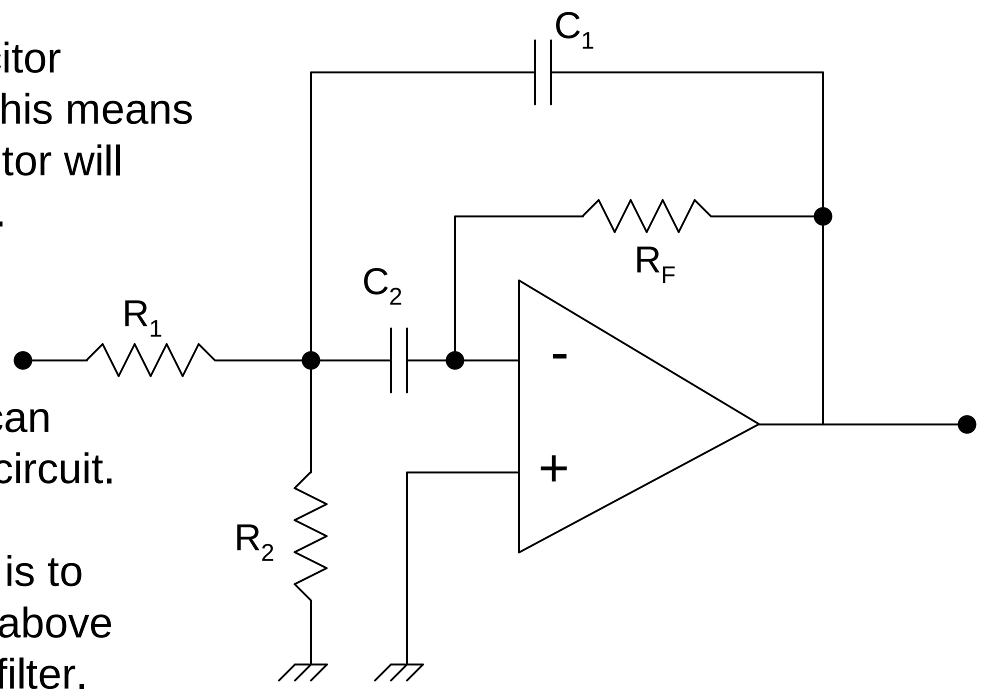

Band-pass filter




Capacitors C1 and C2 act to pass only a certain range of frequencies in this circuit. The capacitance of C1 is much less than the capacitance of C2. The action of C1 is to allow the amount of feedback to increase with frequency, providing the limiting of high frequency in the output. The function of C2 is to limit the passing of lower frequencies into the input.

This circuit acts as an inverting amplifier because the signal is applied to the inverted input.

# *Below the Passband*



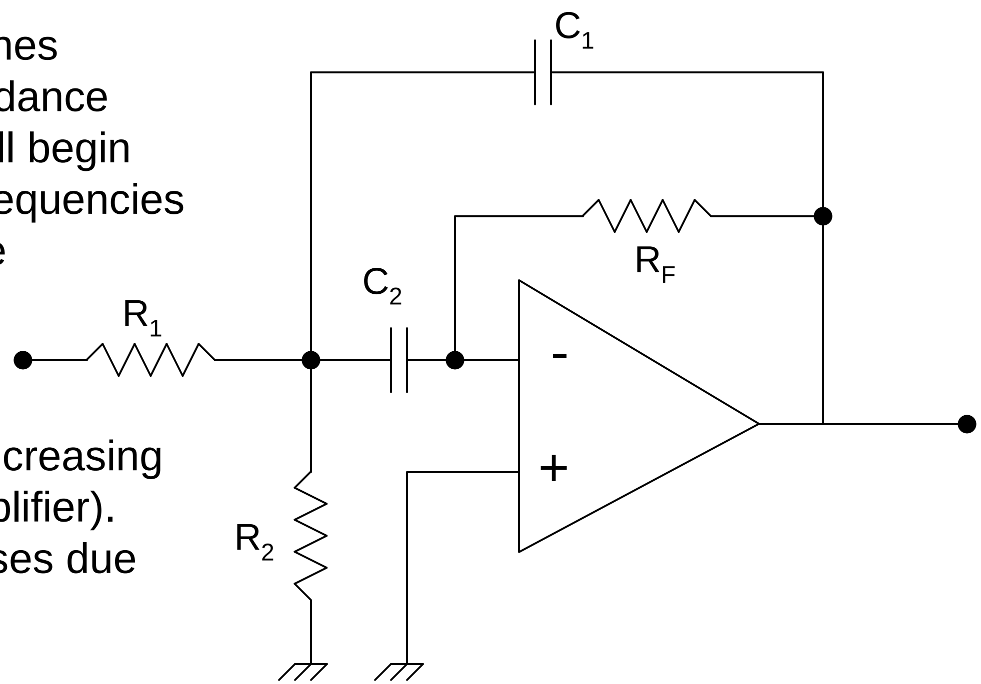

Remember that the impedance of a capacitor *decreases* as its capacitance *increases*. This means that for a given frequency, a bigger capacitor will pass more signal than a smaller capacitor.

Also, remember that the impedance of a capacitor decreases as frequency increases. Below a certain frequency we can think of a capacitor as being like an open circuit.

In the active bandpass filter, the job of C2 is to allow signals to pass only if they are at or above the lower cutoff frequency desired for our filter. At that frequency, C2 will begin to pass signals, but C1 will not since it is a smaller capacitor. C1 will behave as an open circuit.

Summary: below the passband, neither C1 or C2 will conduct. Once the lower edge of the passband is reached, C2 will begin to conduct but C1 will not.

# *Above the Passband*



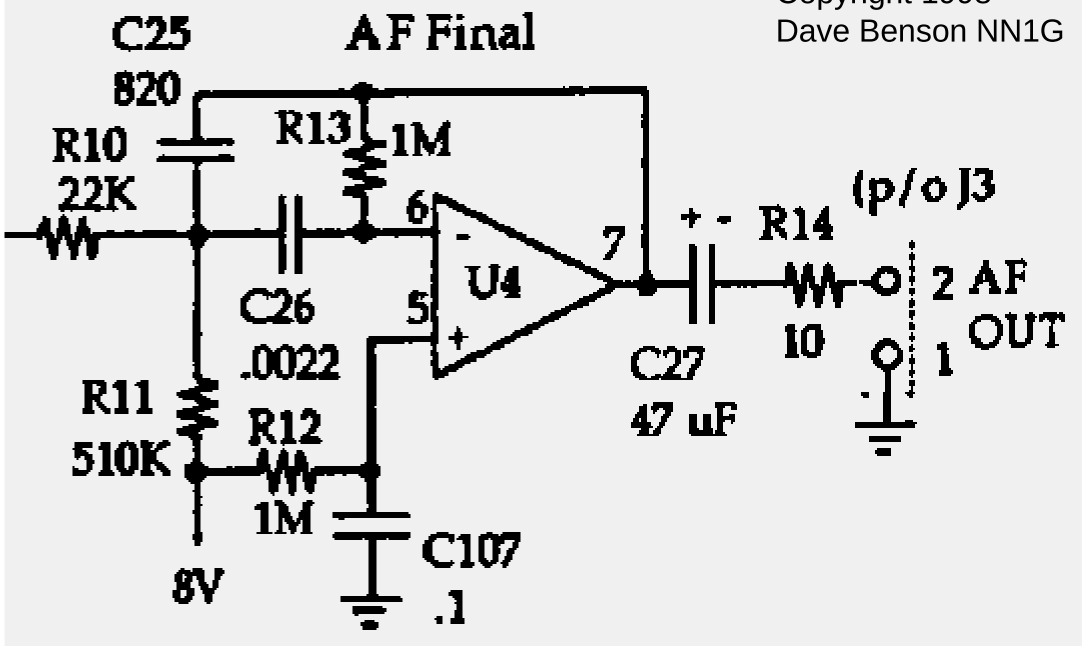

As the frequency increases and approaches the upper end of the passband, the impedance of C1 will become small enough that it will begin to conduct. This means that the higher frequencies in the output signal will be fed back to the inverting input (negative feedback) and the result is that they help to cancel out the high-frequency portions of the input signal (remember, increasing the feedback reduces the gain of the amplifier). So, as frequency increases, gain decreases due to the feedback conducted through C1.

C2, meanwhile, continues to pass high-frequency signals, but those signals are being reduced by the feedback.

Summary: above the passband, both C1 and C2 are conducting. C1 provides negative feedback whose magnitude increases with frequency, canceling the high-frequency parts of the signal.

# *The SW+ Final Audio Amplifier*

In the SW+, 8 volts is applied to both inputs of U4 as a DC bias about which the signal voltage will vary. R10 and R13 are used to set the gain for the amplifier, while C25 and C26 determine the bandpass filter characteristics. In this filter, the gain is about 33 at the peak response of about 800 Hz. The signal is applied to the inverted input of the op amp.






At the output side of the amplifier, a large capacitor is used to block the DC on the output from reaching the headphones. The capacitor is large because we want its impedance to be small at the audio frequencies. Resistor R4 serves to limit the current which the op amp will try to pump through low-impedance headphones, preventing the amplifier's current-limiting circuitry from kicking in and clipping the output (resulting in distortion).

# *Construction*

- Install the following components:
  - R6, R8-R14
  - D5
  - Q1
  - C24-C27, C106, C107

- Test:
  - connect the tuning pot, gain pot, power connector, and headphone jack to the board
  - connect headphones and a key
  - turn the gain all the way up
  - attach a temporary antenna to the side of C40 which does not connect to diodes D7-D10 (10 or more feet of wire should do)
  - connect power
  - tune and listen for signals. Adjust T1 for maximum background noise. If T1 doesn’t peak, change C1 to a higher value (try 68 pF)
  - key the rig and listen for sidetone