Common Collector Amplifiers

Objectives:

Describe the operating characteristics of a common collector amplifier.

Describe the purpose of individual components in a common collector amplifier.

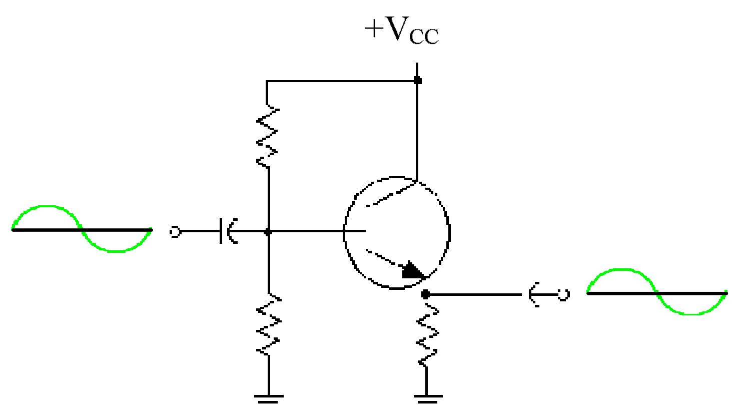
Describe methods to determine class of operation.

Describe methods to determine voltage gain.

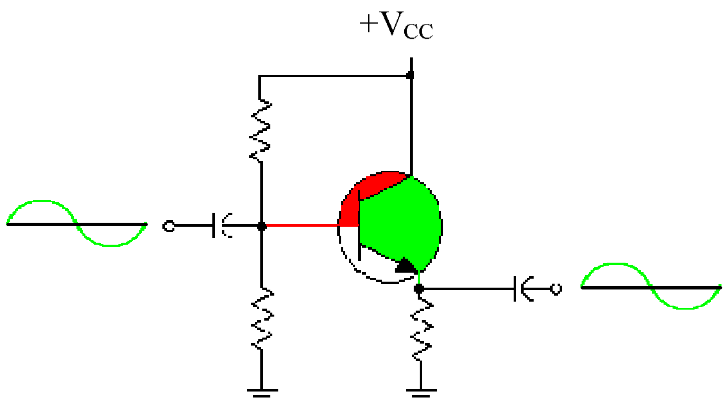
This is a typical common collector amplifier circuit, also know as an emitter-follower.

The amplifiers output is controlled by an input signal.

The output signal is a replica of the input signal.

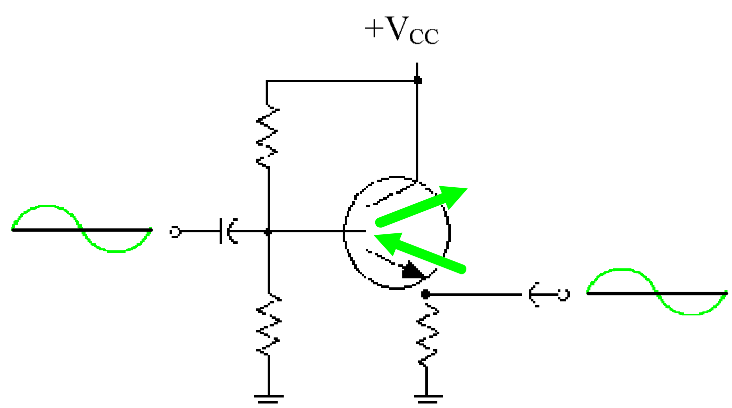


There are two parts to this amplifier circuit:
Input - Base-to-Collector
Output - Collector-to- Emitter



Notice the collector is common in both parts.
This means that a change on the input side affects the output side.

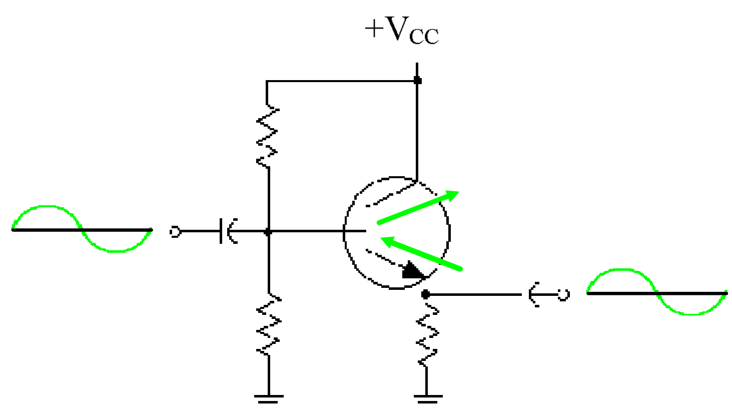
A changing input signal changes the bias voltage on the base of the transistor.
When the input signal increases, the bias voltage increases.
An increase in bias voltage affects current flow in the emitter collector circuit.
Current increases.



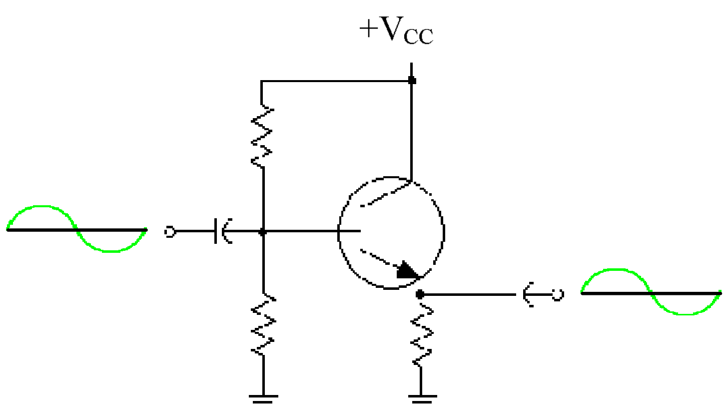
When the input signal decreases, the bias voltage decreases.

A decrease in bias voltage affects current flow in the emitter collector circuit. Current decreases.

The effects of a changing input signal are seen in a changing output signal.



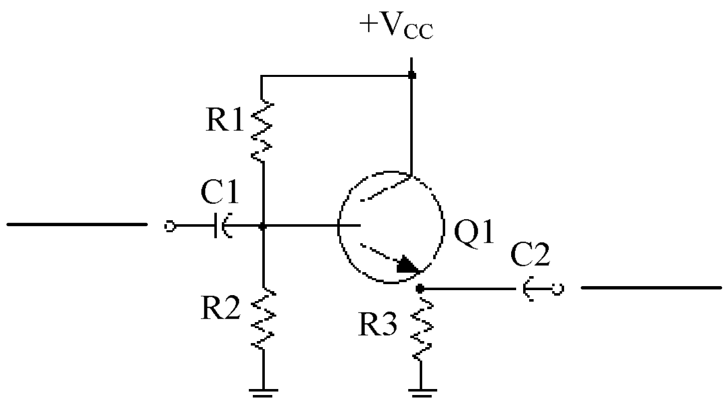
Note, an increasing input signal produces an increasing output signal.
A decreasing input signal produces a decreasing output signal.
The input signal controls the output signal.



Transistor bias is determined by R1, R2, and R3.

When an input signal is applied to the base of Q1, it's combined with the fixed bias voltage established by R1 and R2.

R1 and R2 form a voltage divider that is operated by $+V_{CC}$. A fixed DC voltage is always present on the base of Q1.



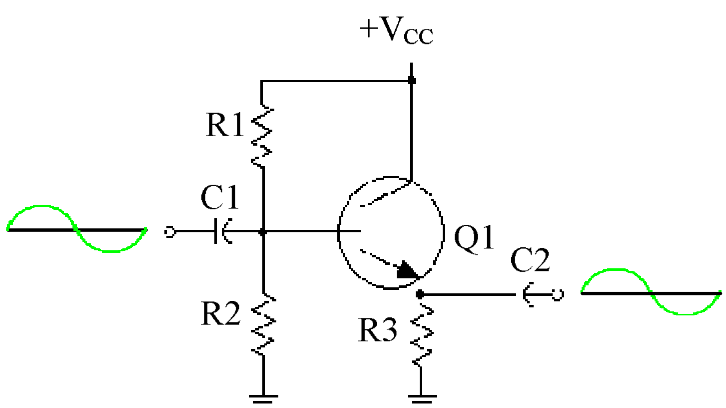
Any change in the fixed bias of Q1 produces a predicted change at the output.

The collector is biased by $+V_{CC}$

The output signal is determined by emitter load resistor R3.

When the emitter to collector current increases, more voltage drops across R3 and the output signal increases.

When current decreases, less voltage is dropped across R3 and the output signal decreases.

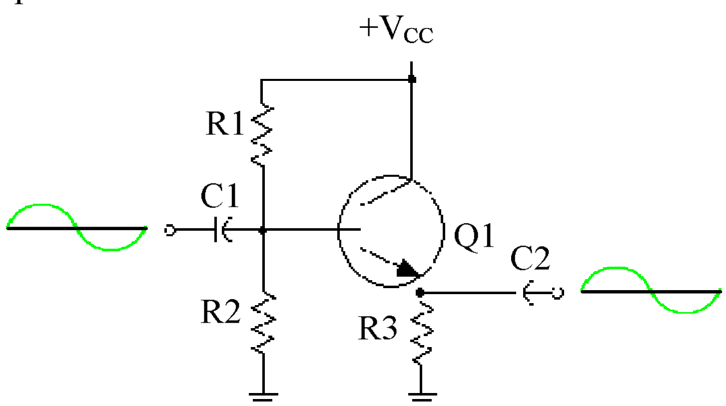


The result is a signal on the output that is a replica of the input signal.

Two more important components to the amplifier circuit are C1 and C2.

C1 is an input coupling capacitor that stops any DC voltage from reaching the base of the transistor. It couples the AC signal from the previous stage to the base of Q1.

C2 is an output coupling capacitor that prevents the DC bias on the collector from reaching the output.

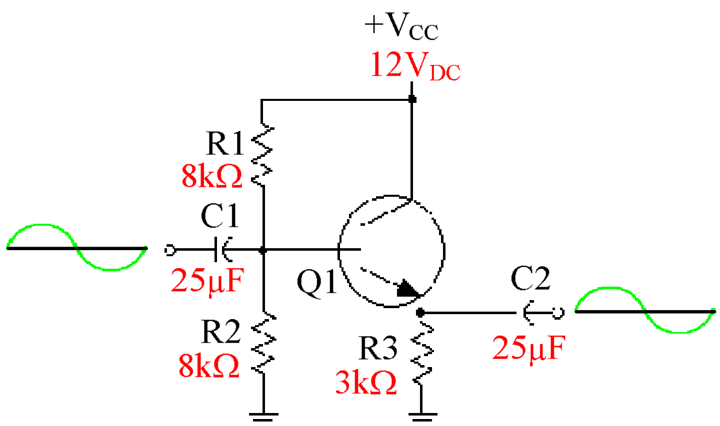


The coupling capacitors do not effect the bias voltages on Q1.

The class of operation and the voltage gain (Av) are needed to identify normal operation of a common collector amplifier.

The class of operation is determined by the bias placed on the base of Q1 by R1 and R2.

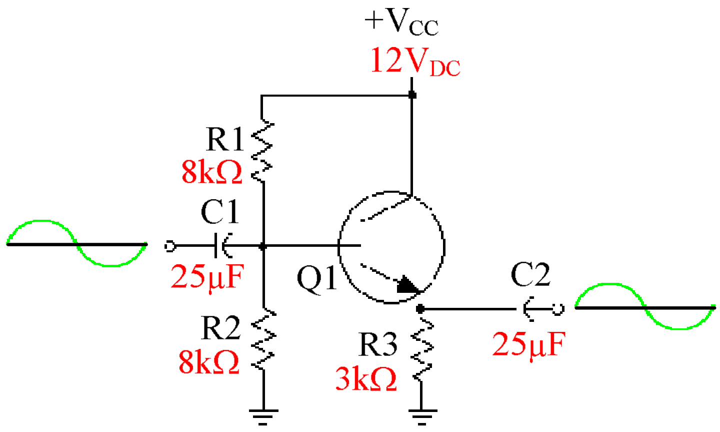
The voltage gain is determined by the base-to-emitter PN junction.



If class of operation and voltage gain are known, normal operation is determined by comparing input and output signals.

The voltage gain of a common collector amplifier is always 1.

This common collector circuit shows class A operation because the base voltage is well above .6 volts.



If the transistor is cutoff at any point on the input signal, the class of operation is AB.

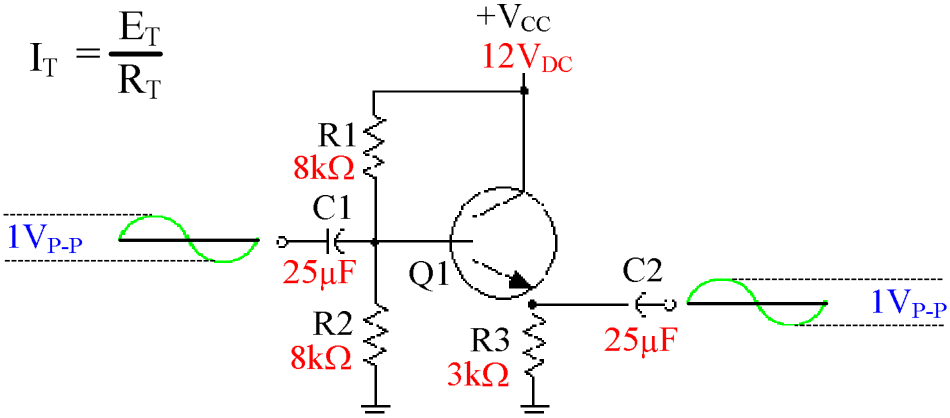
The base bias voltage can be calculated by finding the voltage across of R2 because R2 is between the base and ground.

Step 1. Find R_T for the voltage divider on the base.

$R_T = R1 + R2$

Step 2. Find I_T for the voltage divider.

$$I_T = \frac{E_T}{R_T}$$

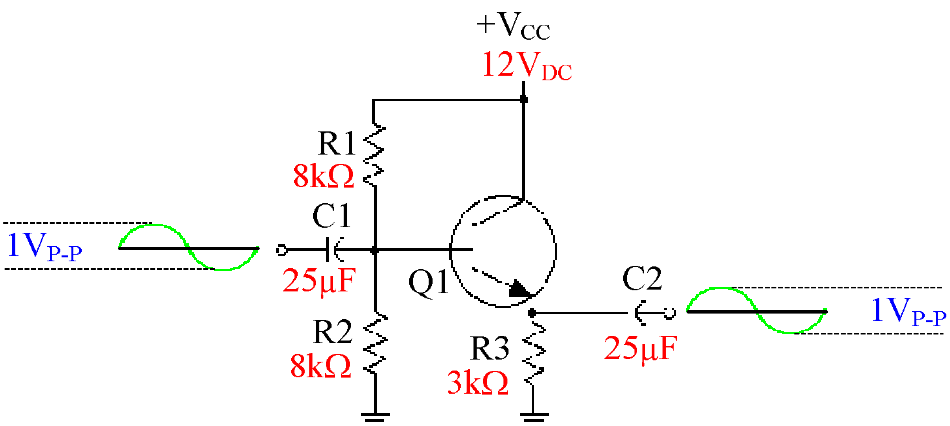


Step 3. Find voltage of R2.

$E_{R2} = I_T \bullet R2$

$E_B = E_{R2}$

The 6V bias at Q1 verifies class A operation.
Since the input and output signal are 1V $_{P-P}$, gain (Av) equals 1.

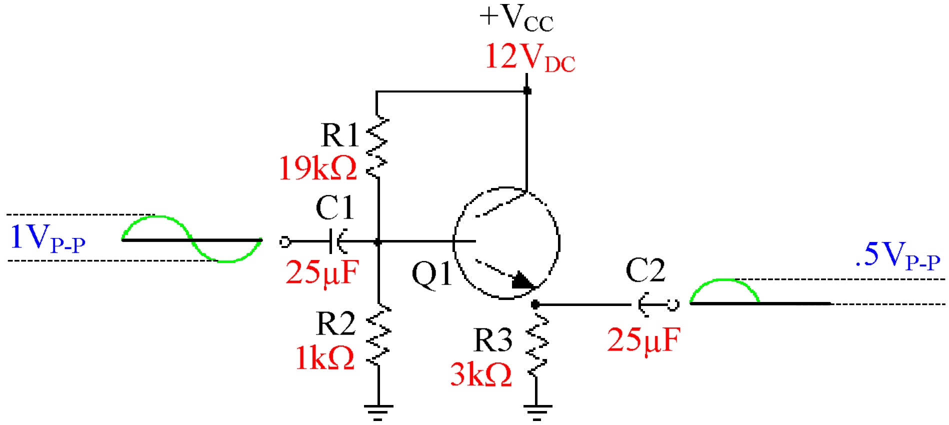


$$Av = \frac{E_{out}}{E_{in}}$$

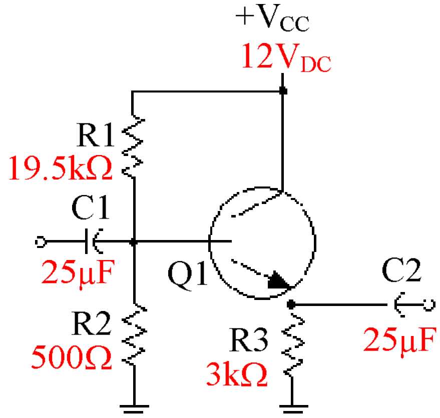
If the bias on Q1 is equal to .6 V, the class of operation becomes class B.

The output signal shows only 180 °.

The transistor is driven into cutoff during the negative half cycle of the input signal; therefore, the transistor only reproduces half of the signal on the output.



Determine class of operation for this common emitter circuit.

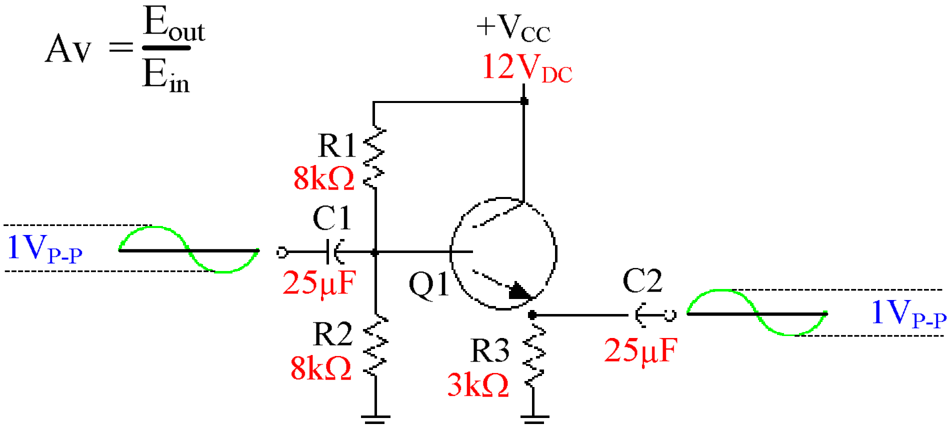


Once the class of operation is determined, the gain (Av) is found by comparing the input and output signals.

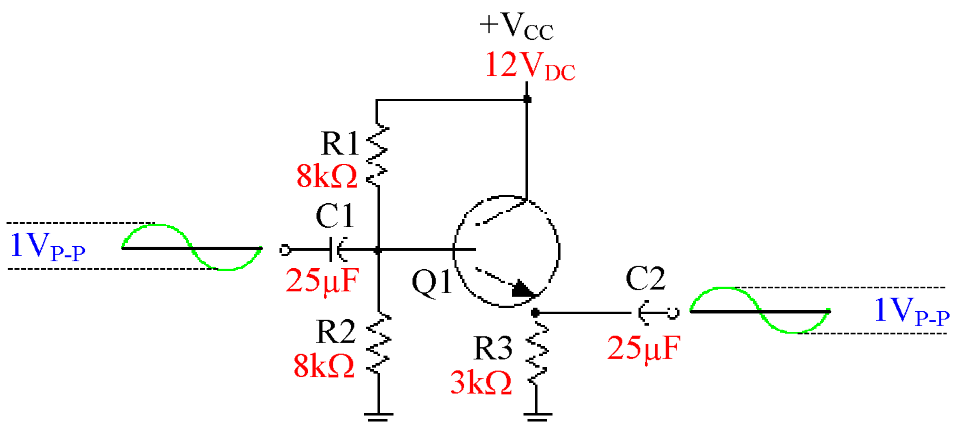
Gain (Av) is calculated using the following formula:

The expected gain is 1, use the formula to verify this value.

$$Av = \frac{E_{out}}{E_{in}}$$



Let's see why gain (Av) is 1 on a common collector amplifier.
The DC bias voltage is 6 volts.
The voltage drop across the base-to-emitter PN junction is .6 volts.
The emitter bias voltage is .6 volts less than the base voltage making it 5.4 volts.

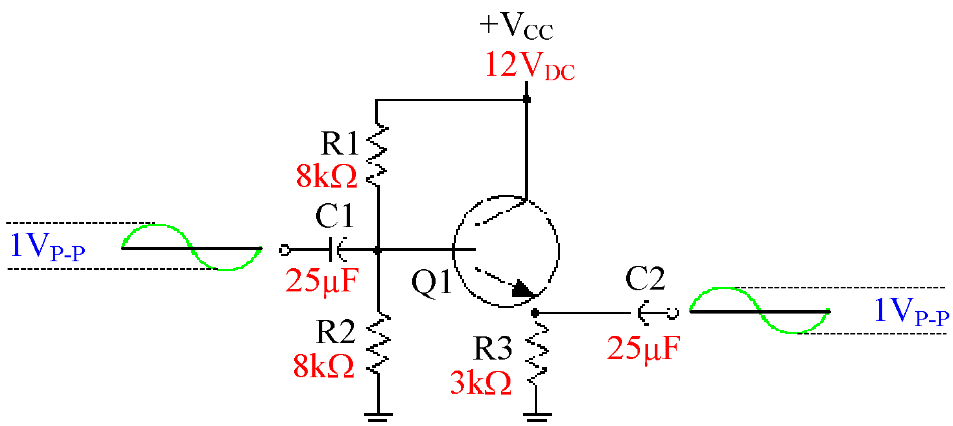


An input voltage of $1V_{P-P}$ changes the base voltage from 6 volts to a range of 6.5V to 5.5V.

The emitter voltage changes from 5.5 volts to a range of 5.9V to 4.9 V.

$1V_{P-P}$ is the difference between 6.5V and 5.5V as well as 5.9V and 4.9V.

The changing emitter voltage passes through C2 and produces a $1\ V_{P-P}$ output.



It is important to remember that common collector amplifiers produce a large current gain even through the voltage gain is 1.

Like a common emitter amplifier, base current is small while emitter current is large.