Basic Transistor Amplifiers (1)

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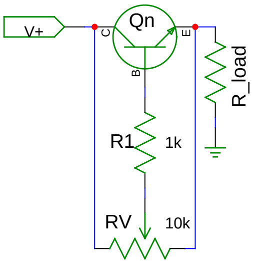
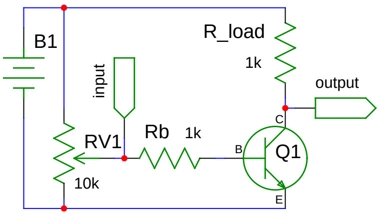
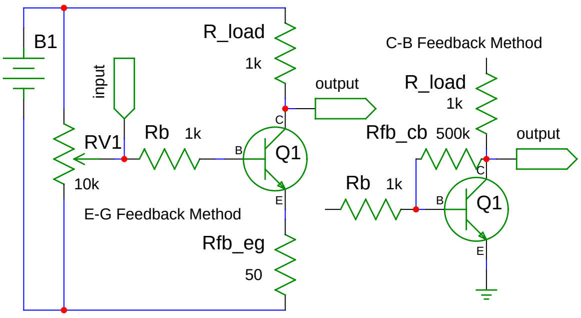


Voltage Follower (Buffer)
Common Collector Amplifier
Has no voltage gain but
does have current gain.

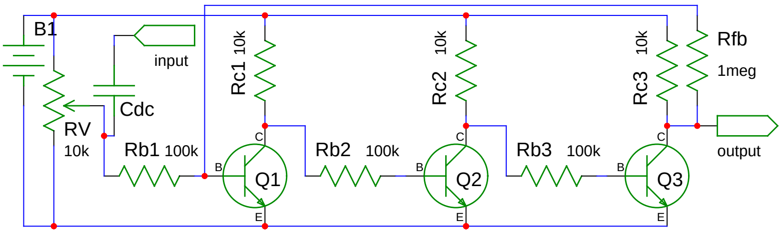


Common Emitter Amplifier (Class A, Inverted Output)
RV1 is used to bias the transistor to the half way voltage of the transistor's base operational range (usually 2.8-3.3v)..
Gain = R_load / Rb
R_load converts current into voltage (Ohm's Law) for the output.
This forms a type of variable voltage divider with the transistor.
This circuit doesn't have feedback and can have temperature problems.
This can mess with the B-E diode characteristics (linearity performance).
Feedback can also stop thermal runaway.
An input capacitor may be needed to block/protect source from DC offset. An output capacitor may be needed to block DC offset.

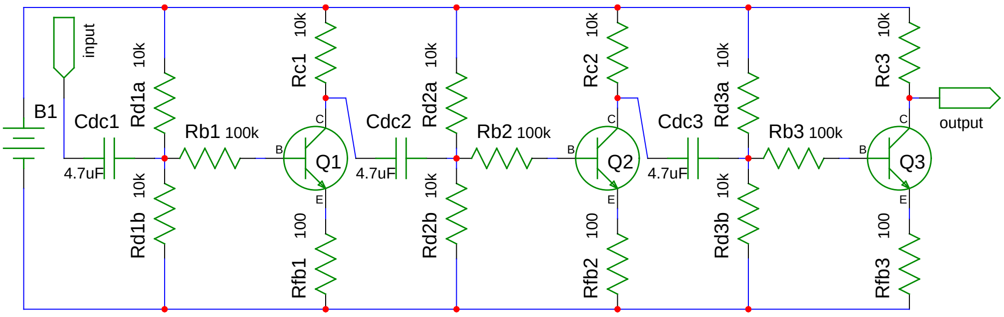


Common Emitter Amp with Feedback (Class A, Inverted Output)
Depending on the desired setup, DC block capacitors may need to be added to input and/or output.
Clipping tests for a properly biased sine wave showed that the top rail had semi-soft clipping and the bottom rail soft cliped.
Rb will move the half voltage base point up and down enough that RV1 will have to be readjusted. Higher resistance Rb will move the voltage up, lower will move it down. This probably has something to do with the gain partially being dependent on current. Smaller Rb's tend to have higher output gains.
R_load forms the top half of the variable voltage divider. Larger resistance means higher gain but also less output drive. The 0v signal line will go towards the bottom rail and RV1 will have to be readjusted. Lower resistance means the voltage gain being swamped by Vsupply and the 0v signal output going to the upper rail. Since the transistor is part of the voltage divider, a large enough resistor should be chosen to give the transistor adequate working room.
Negative feedback will increase bandwidth and decrease distortion at the cost of gain. For high gains, gain = Rfb / Rin. For lower gains, beta becomes part of the gain calculation. Feedback eliminates many of the quirks in a transistor and gain depends on beta to a much lesser extent. Feedback will help control thermal runaway of the transistor. Multiple feedback methods are often combined.
A trick to keep maximum gain using feedback is to parallel a capacitor with the feedback resistor forming a high pass filter. AC frequencies go through but DC get caught and controlled (preventing thermal runaway). This method will mostly set the gain back to the beta value (which may or may not be desirable since beta fluctuates with temperature).
For Emitter-Ground feedback (Rfb_eg), the resistor drops a voltage based on the load current. Since the emitter is essentially a buffer, V_emitter=Vin. If the emitter voltage is reduced by the Rfb_eg, then Vin also gets pulled down (negative feedback).
Math: Rfb_eg voltage drop + Vout = Vin. A larger Rfb_eg is larger feedback in this model.
The Collector-Base feedback resistor (Rfb_cb) works much like the op-amp method and feeds back an inverted signal to the positive signal input. Larger Rfb_cb is lesser feedback.
The value of Rfb will raise or lower the half voltage base point. Heavier feedback will reduce the output voltage swing (dropping gain). Rfb_eg will hold the top peak of the waveform steady and push the bottom peak towards it as feedback increases.
Rfb_cb will hold the bottom peak of the waveform stead and push the top peak towards it as feedback increases.

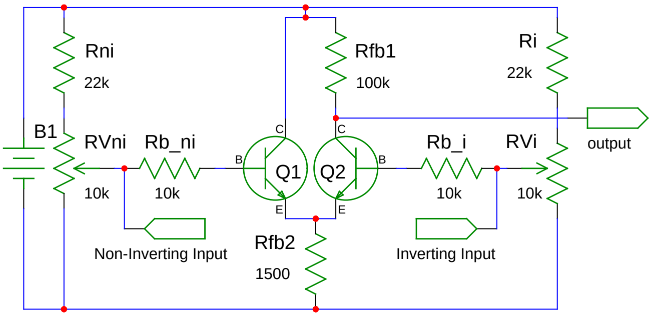
Variation: RV1 is replaced by a straight resistor (Rbias) to Vsupply.
This variation doesn't work very well and is tempromental.
Rbias <1k will reduce the signal input. Rbias >2k seems to be a minimum point. 10k would probably be a good choice. When the signal input is reduced, it doesn't shift up or down.
Rfb_eg, Rfb_cb, and Rb don't change behavior.
R_load still moves the signal up and down and works with gain, but it is overly sensitive and must be calibrated near perfectly.
The bottom rail is much higher and readily soft clips. The top rail now hard clips. The signal is attenuated compared to the raw in.



Multi-Stage Common-Emitter Amp (Direct Coupled)
Q+Rb+Rc each form a single gain stage (3 shown total).
Each gain stage inverts the signal
Odd number of gain stages will have the output inverted.
Even number of gain stages will have the output non-inverted.
The global feedback resistor (Rfb) must be on the last inverted output.
Gain from each stage gets multiplied together for a very high output.
Gain is roughly Rfb/Rb.
This feedback topology is rare. Usually there's an emitter-ground resistor for feedback and a DC blocking and voltage divider biaser for each base. This handles AC signals much better.



Multi-Stage Common Emitter Amp
This is the more common version.
Each Cdc+Rda+Rdb+Rb+Rfb+Rc+Q forms a separate gain stage.
Unlike the more simple version of this circuit, each gain stage can have a different gain.
Cdc blocks any bias creep and is good for AC signal amplification.
Cdc+Rb can form a high pass filter. Choose values carefully.



Simple Differential Amplifier
This is more example than practical.
It has nonlinear and symmetrical problems.
Gain = Rfb1 / Rfb2