Designing an NPN Differential Amplifier

Introduction

Last semester we looked at the three basic bipolar transistor amplifiers. The common emitter amplifier produced a reasonable voltage gain. Here we look at the differential amplifier to provide linear voltage gain:

On the left is a differential amplifier using two matched NPN transistors. Biasing is done using a current sink and the transistors share the emitter supply equally if the differential inputs (the two bases) are at equal voltages. If the base voltages differ the emitter current is differentially steered (The transistor with the higher base voltage conducts more current). Sorry, but I left determining resistor values to you.

R3 and R4 generate the differential out voltage

R1 and R2 are small emitter degeneration resistors (to linearize the amplifier and stabilize gain via negative feedback)

R6 tries to bias the Base of Q1 to ground, but due to base current, the voltage goes somewhat negative and R5 is a larger resistor to compensate for the base current.

Note that the outputs are at a positive DC value that allows a reasonable voltage swing without distortion. DC coupling the output to the next stage requires "level shifting" as the output amplifier stage will want it's input at 0 volts DC.

You should easily get a gain of 50 or more at very low distortion from this amplifier configuration.