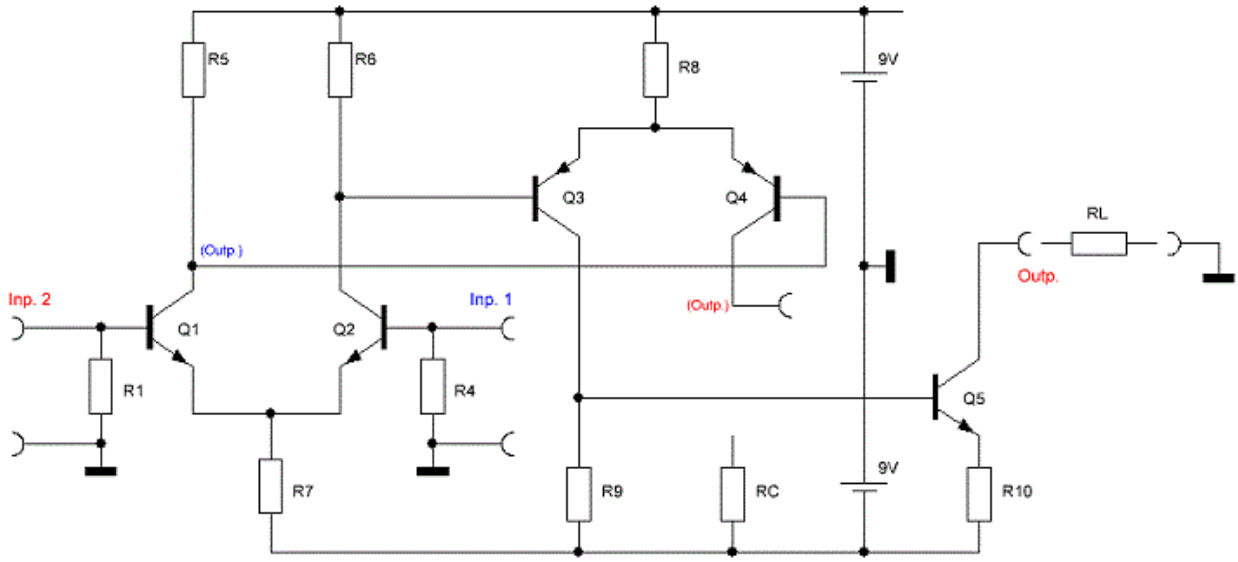
A guide to

OREAD's Core - the five transistor operational amplifier

How do we create a common output whose potential we can define as a voltage relative to the reference-, the earth or ground point?

§12



In other words, the symmetrical bridge voltage must be related (as one voltage) to ground. We should be able to add both opposing output voltages; with the result $Y_{+}(x)$ plus $Y_{-}(x)$ equal zero, $Y_{+}(x)$ minus $Y_{-}(x)$ leads to 2 times Y(x). An automatic gain of 6dB!

Now we remember the bipolar transistor as an inverting amplifier element and connect an emitter circuit to one of the two outputs, preferably to the one that has already been recognized as a negative output.

We immediately remember the two equal collector currents of Q3 and Q4, each with 1mA in the balanced state - want this value to also flow through Q5, and after the following step this current will even be $I_{(Q4,Q5)}$ itself.

Add and just try to keep R10 as small as possible so that it does not get in the way of the maximum possible level of the amplifier in relation to the supply rails (here -9V).

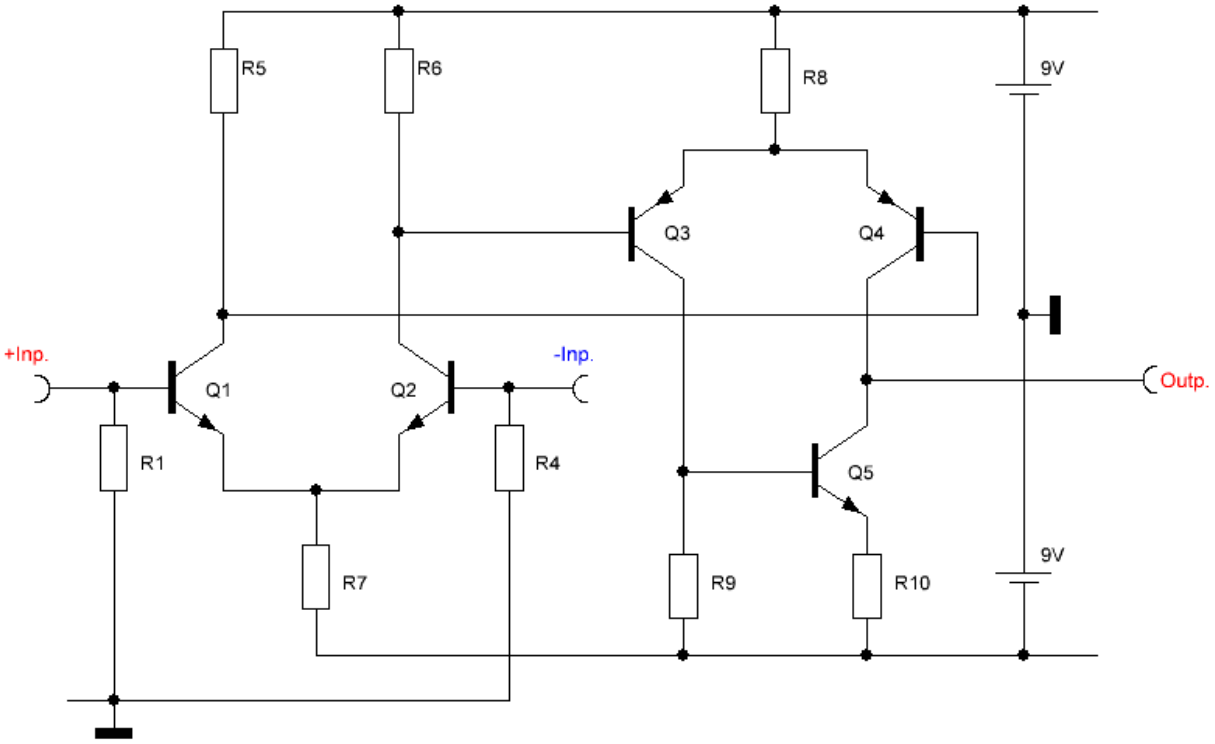
Now we simply make a gut estimate: U_{R10} = 0.5V. This immediately results in a value of 500Ω for R10. R9 follows on the foot, (0.5V+0.7V) / 1mA = 1200Ω. From the E24 series I choose 1k2 and instead of 510 I prefer one level higher.

R9 = 1.2kΩ
R10 = 560Ω

But where do we find the working resistance of Q5 ?, a change in current to anything must cause a change in voltage!

In the rce of Q4 and for Q4 in the rce of Q5.
We look simply at the differential output resistance (of the respective circuit halves) as rce.

§13



As soon as we realize that both collectors with their conducted potential will move in the same direction under a signal modulation, we can consequently also connect both electrodes with each other - especially since the same currents, even one and the same one, are flowing.

That's the whole trick and at the same time the summation with the correct sign.

Viewed from a high-impedance observation post, we can see how our new output can move back and forth (or jump) between the rails (+/-9V) in proportion to the differential input voltage.

However, the topology we have now has a supposed disadvantage: it cannot be loaded without negative feedback - and would probably rest on one of the two rails and take a nap. Returning the output to the negative input wakes up the sleeper and makes it a real champion.

Now that we have intuitively found a suitable circuit and know all the required output values, we can use it to build a functional amplifier, for example with an AF transistor of type BC550C & BC560C. R1 & R4 as well as the complex feedback are already known from the introduction, the first part.

But now it makes sense to run extensive simulations with the template you found called OREAD.