

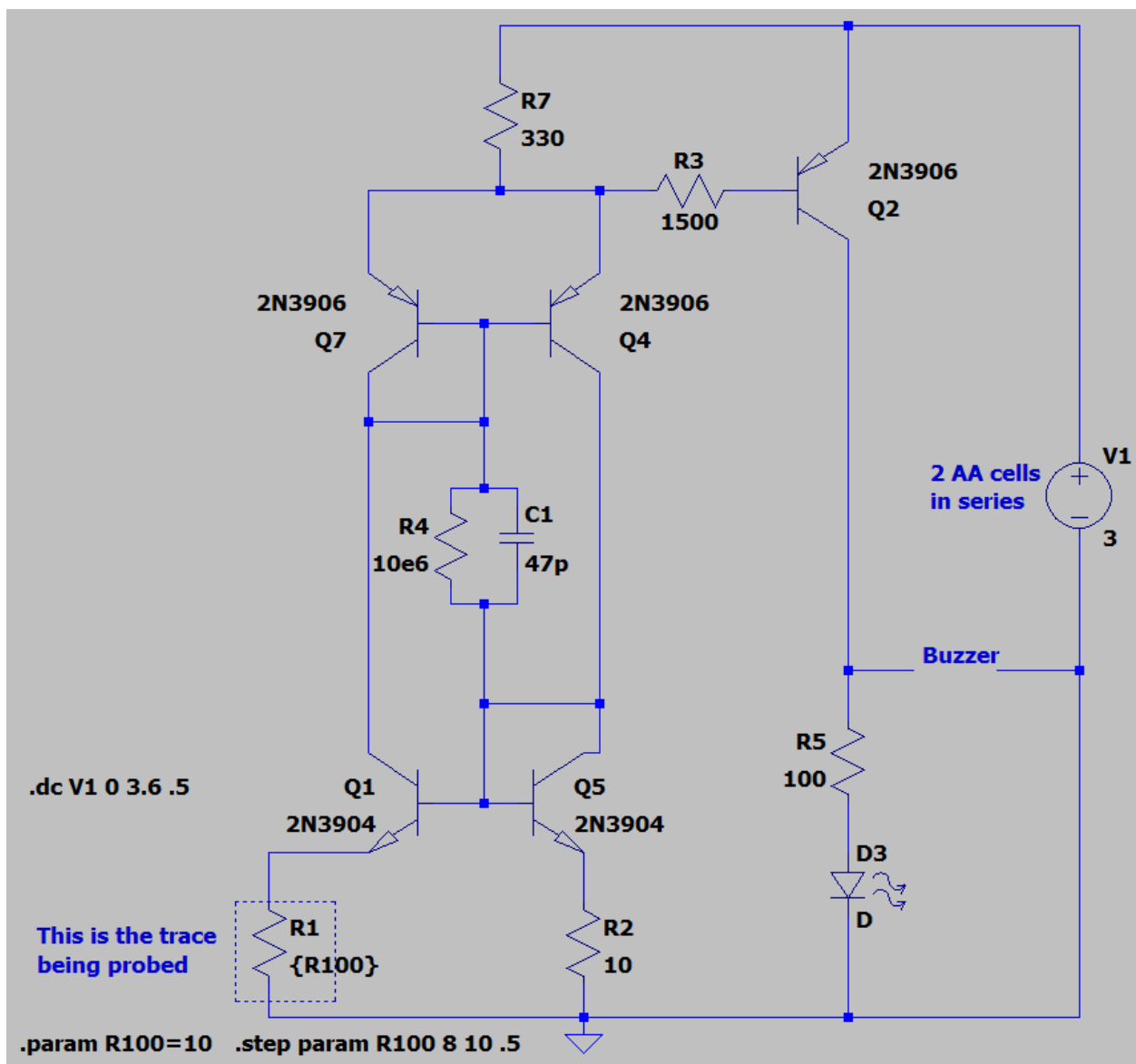
Continuity Checker

Gord Rabjohn, March 2023

I accepted a challenge to make a continuity checker for tracing wires. The goals were to:

- Respond to less than 10 ohms (the resistance of any reasonable piece of wire),
- Not respond to over 20 ohms (to ignore most resistors and leakage),
- Less than 5mA probe current (to not overly stress anything),
- Less than 0.2V open circuit probe voltage (to not stress anything and not turn on junctions, even Schottky or germanium junctions),
- No need for a power switch.

Here's what I came up with:



Q1 and Q5 form a current mirror, the current ratio depends on the values of the emitter resistors. If they are identical, the current gain is approximately 1. Q4 and Q7 also form a current mirror, current gain approximately 1. Hook them together so they feed each other, and the feedback either drives current to infinity (limited by R7) or zero (we do not want to go to zero, that is "off" so R4 trickles a small current through it all times). If R1 (the probe, the unknown outside path) is larger than R2, feedback turns the currents off. If R1 is less than R2, feedback flips it to the high current state, turning on Q2. Little errors put the threshold at about 14 ohms (measured) rather than 10 ohms, and make the transition gradual, not sudden. The C prevents oscillation. Q2 simply drives what ever annunciator you want, a buzzer or LED or some sort of tone generator. R7 is selected to get enough current through R1 and R2 so that a small difference in resistances will be enough to change currents appreciably. If you make R7 too large, sensitivity drops.

Leakage current is about 0.5uA (measured) when off, so battery life with the AA cells should be about 100 years. At 12 ohms, the LED is full brightness. At 15 ohms it is dull, at 18 ohms, it is out. Short-circuit current is about 5mA. The open circuit voltage is defined by subtracting diode drops, so is difficult to measure. With a 10M DVM, it is about 0.2V. It certainly does not respond to any junction I tried.

Q1 and Q5 need not be matched, but should be from the same batch, not obviously different. Similarly, for Q4 and Q7. I picked mine at random and it worked out, but there is an offset. When $R1=R2$, there should be no voltage across R4, but you will find that the resistors need to be a little different to get null. (In my case $R1=11.7$ ohms resulted in zero volts across R4)