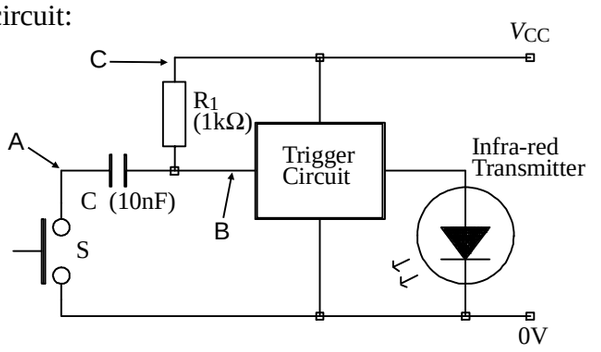
Analogue Circuits Assignment

It was late on Friday afternoon when you went to see your tutor to ask him something about last Tuesday's experiment. You found him sitting at his desk, head in hands, staring at a piece of paper on which was drawn the following circuit:

The trigger circuit triggers on a negative going edge at B when the voltage at B reaches $V_{CC}/2$. A push closes the switch, S, and a release opens it.



He explained that he was trying to do an experiment that required him to be in two places at once. To get over this problem he had built a circuit that was supposed to let him control some of his equipment remotely - but unfortunately it didn't perform as he had expected. "Can you see what's wrong with it?" he asked.

"Easy!" you replied, "you need a resistor between points A and C."

Having an enquiring mind, your tutor was eager to understand the reason for his problem so he asked you why.

1) What did you tell him?

Your tutor thanked you for your lucid explanation but then wondered what value of resistor he should use. You told him that you needed more information about his application before you could answer that question. He explained that the unit was supplied by a 9V PP3 battery so he didn't want to waste energy and that he might need to press the button as often as twice per second!

2) What is the maximum value of resistance that your tutor can put between A and C for a maximum button pushing rate of 2 per second? (Assume that your tutor's button pushing style results in a 250ms push followed by a 250ms release.)

You realise that this is quite a subtle problem but that by breaking the problem down it should be tractable. Since the circuit works for low values of $R_{A\text{-}C}$ but not for a value of infinity, there must be some value of $R_{A\text{-}C}$ for which the circuit is just on the border between working and not working.

Being intrigued by your tutor's energy conservation concerns, you decide to work out just how long his PP3 is likely to last. The trigger circuit draws a current of 0.5µA at all times and the LED is pulsed , taking a current of 20mA for a period of 5µs every time the button is pushed.

3) What is the power used by the RC button pressing circuit, the trigger circuit and the LED, assuming that your tutor is operating at his maximum button pressing rate? How long would his PP3 last under these conditions? (Assume that the capacity of a PP3 is 0.11Ah)