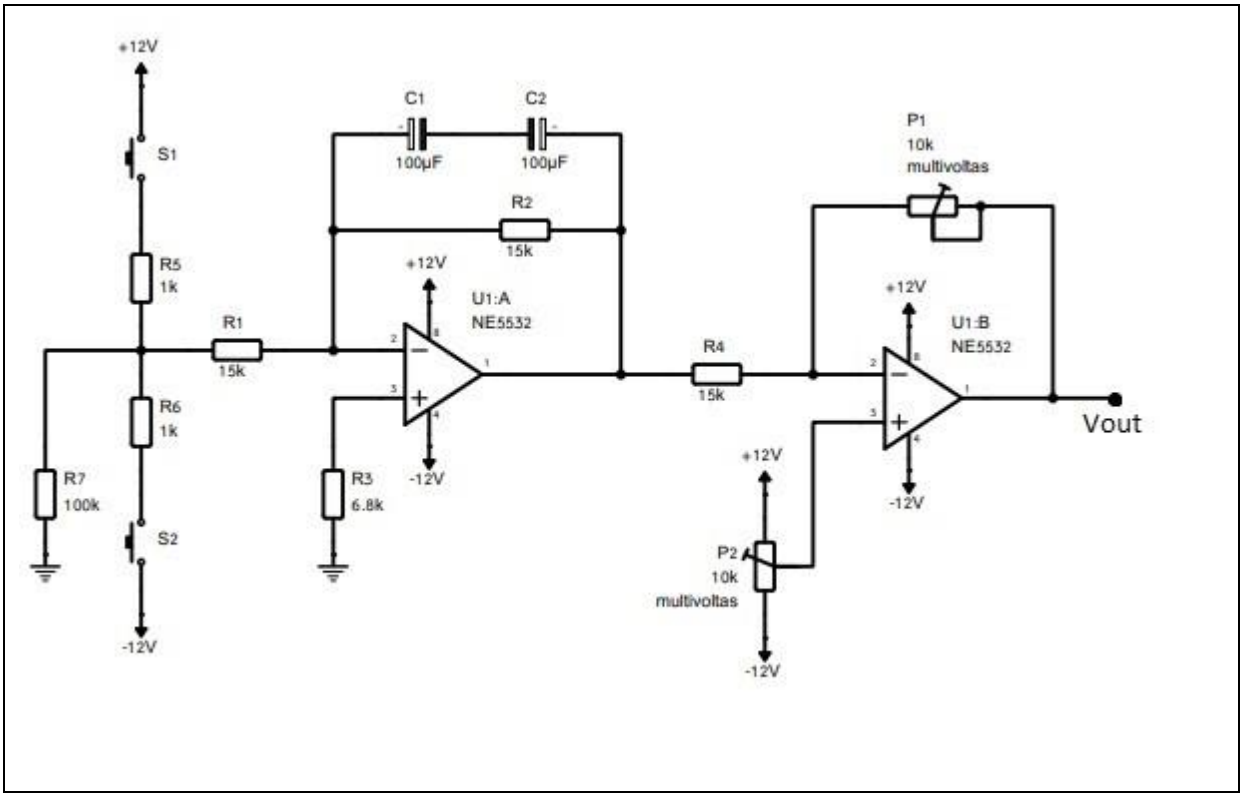
Imagine a situation where you have a circuit able to activate and deactivate a purely resistive load with a microcontroller. It is required to control the load power over time depending on the situation and the power cannot be instantly changed from 0% to 100%. Explain in simple words a method to achieve such effect, looking at both hardware and firmware aspects of the system. If an inductive load is used instead of a resistive load, can the same triggering method be used or do special precautions need to be taken?

To control power in a load, it's very common to use PWM and change its duty cycle, but since power can't vary shortly from 0 to 100%, we can't use this technique.

For this condition, it's still possible to use PWM. However, between the microcontroller's GPIO and the load, it's possible to use a circuit with an operational amplifier in an integrator configuration. This way, the square waveform present at the GPIO becomes a sawtooth wave at the load.

The figure below depicts a circuit where modulation at S1 and S2 can control the voltage Vout. Switches S1 and S2 can be activated through a BJT or FET. In the first stage, there is an integrator circuit, in the second stage there is an inverter circuit.



In the first stage, switches S1 and S2 changes the voltage Vout between 0 and 5 volts. By keeping both switches open, Vout is equal to 2.5 volts. Keeping S1 pressed and S2 released, Vout gradually increases to 5 volts. Keeping S2 pressed and S1 released, Vout gradually decreases to 0 volts.

In the second stage, the trimmer potentiometer P1 adjusts the attenuation, and the trimmer potentiometer P2 adjusts the signal offset.

With this type of circuit, it is possible to control the power in resistive, inductive, and capacitive loads, as Vout varies slowly with the activation of switches S1 and S2.