Lab 4 – Tape Follower/ Mobile Platform

Learning Objectives:
This lab is intended to introduce you to using sensors to perform useful tasks. We will use reflective IR to create a mobile platform that can follow a course delineated with white tape on a black floor.

Minimum Parts Required:
One each of your choice of micro-controller board, LM339, ULN2003, two OPB703/ QRB 1114 reflective sensors, DC motors of your choosing, and various resistors. You could also use a QTR-8RC Reflectance Sensor Array instead of the 2 sensors, or you can use the AITRIP sensor modules, which have the comparator circuits built-in.

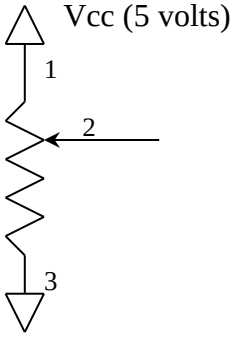
General Task:

Your task is to create a mobile platform that can follow a course delineated with 2-inch wide white tape on very dark grey (almost black) foam flooring. Your platform should be able to follow the sample course laid out on the north side of the lab plaza. You must carry the Microcontroller, any electronics you create, and your power supply (batteries). You may not have a 'tethered' device with wires attaching elsewhere, or leave any parts on the ground.

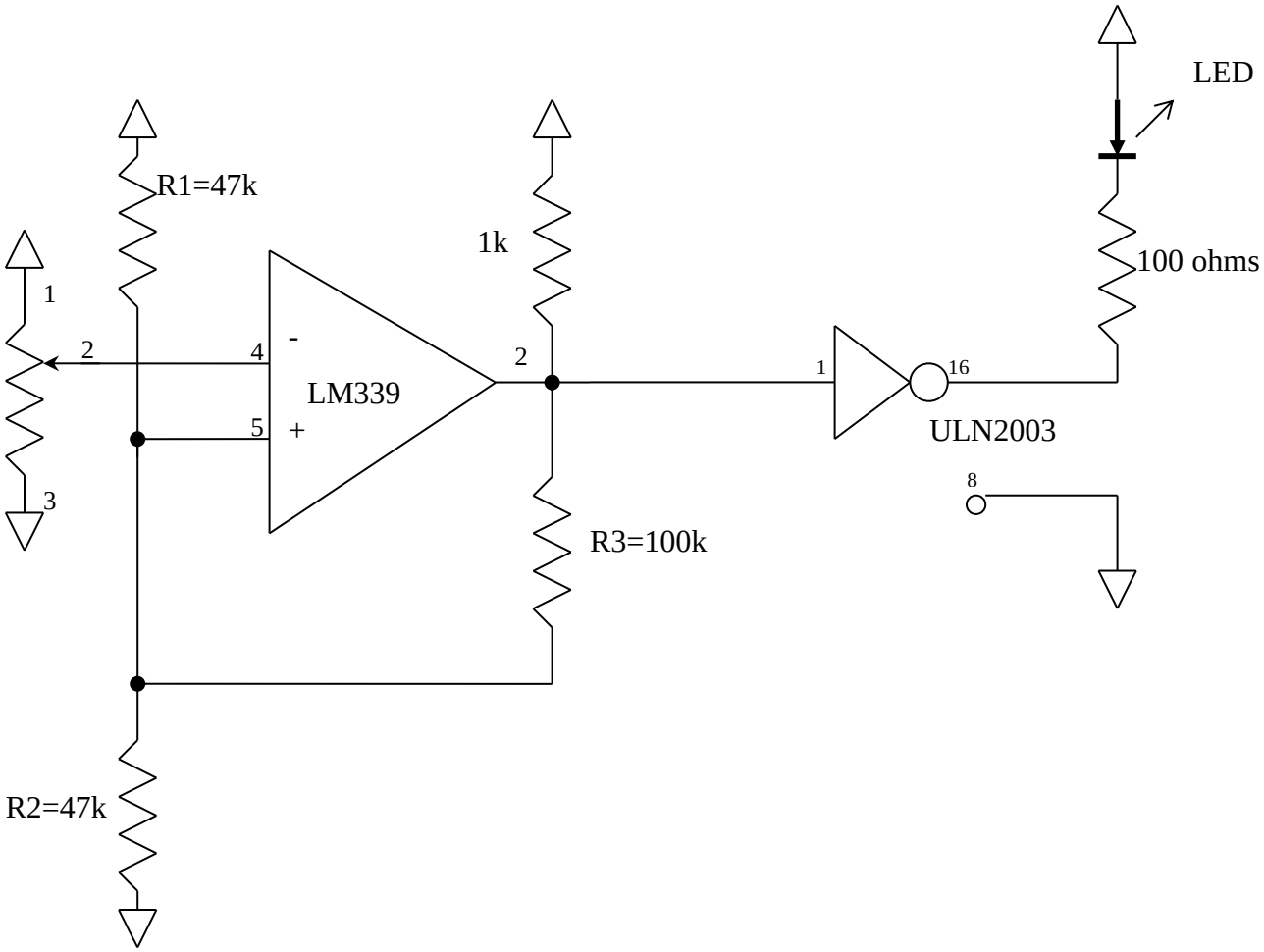
This lab should be completed with your 5/6-person project team. This lab is intended as a prelude to the project. This is your chance to design a mobile platform that you may or may not use for the project. If you decide to use a different design for the project, there should be plenty of time to redesign. But if your mobile platform works well, you may be able to save valuable time by moving straight to other design issues. Legos work well for pure prototypes, but probably the best avenue is to use a crude but robust platform that is similar to your current design plan for your project robot (e.g., a piece of scrap plexiglass with motors strapped down with zip ties and some simple wheels).

Pre-Lab (Optional)

First, connect your potentiometer as below. The middle pin will almost always be the 'wiper.' Look at pin 2, the wiper, with the scope or the multimeter. Watch the voltage level change as you turn the 'pot.' NB: The arrow down is ground, arrow up is Vcc.



Build the following circuit. This is a basic inverting comparator with a 'hysteresis' band. There are two set points determined by the resistors R1, R2, and R3. The upper trip point is the voltage level above which the output will go low. So if the voltage set by the potentiometer is higher than the upper trip point, the LED should go off. The lower trip point is the voltage below which the output will go high. If the voltage set by the potentiometer is lower than the lower trip point, the LED should go on. **Be sure to connect Vcc and ground on the LM339 and ground on the ULN2003 (pin 8)**.

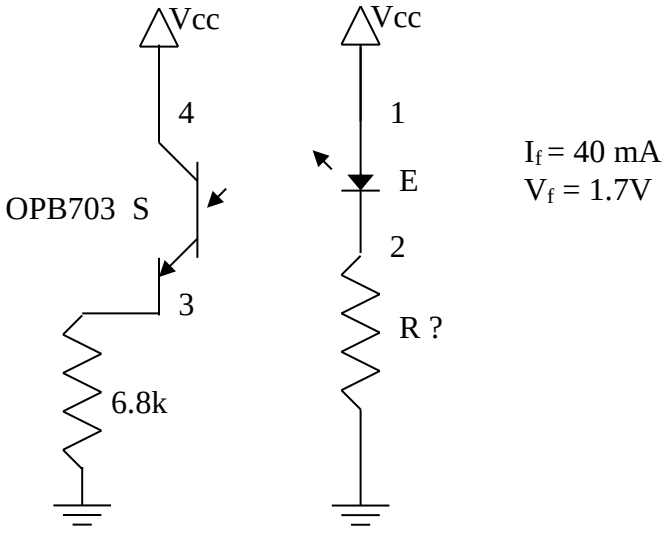


Using the potentiometer to vary the input voltage, determine where the trip points are set. What is Va1, the upper trip point? What is Va2, the lower trip point?

What happens between Va1 and Va2? Does it matter whether the voltage is rising or falling?

Refer to the handout or application note AN-74 (on www.national.com), to learn more about an inverting comparator with hysteresis. Using the formulae in the app note, calculate Va1 and Va2. Do they match your experimentally determined values? **Do NOT dismantle your circuit.**

Use the QRB1114 reflective sensor to create a simple black/tape sensor. Attach the sensor circuit as shown below. (Reading from E to S the pins are numbered 1 – 4 from left to right.) Important specs for the OPB703 are listed below (so that you can size the resistor). Check the voltage levels with your scope to find a reliable cutoff and resize your comparator from above so that you can reliably tell from the LED whether the sensor is seeing black foam or yellow tape. (I have yellow tape if you need some.)



Part 1 – Tape Follower Sensor Circuit

You will need to use your reflective sensors to determine whether the sensor is over the yellow tape, or not (black foam). You will probably want to use a comparator so that you can send your microprocessor a digital signal. If you go this route, you will probably want to include potentiometers to adjust the thresholds for your tape sensors in changing light conditions. You could also use the micro's analog to digital converter (A2D). This would allow software adjustment of the threshold levels. If you are new to comparators, you may want to do the optional Pre-Lab first.

Part 2 – Tape Follower Code

Your code should be fairly simple. Use events that are triggered by the tape sensors changing state to alter variables that will determine the branch executed in the main loop. It is possible to build a tape-follower with just hardware (no micro), but I ***highly encourage you to use the micro to get used to handling input and output***. You are encouraged to use the micro that you plan to handle the motors for your robot, and the motor drivers that you will use (probably the SparkFun drivers that were in your Arduino kit). Be very careful with battery power: LiPos have VERY high current capacities, and can fry a circuit instantly.

Once your platform following tape, get a signoff or take a video take a video if we aren't handy.

Signoff

I have witnessed team _____'s

mobile platform follow the tape on the tape course.

Witness _____ Date _____