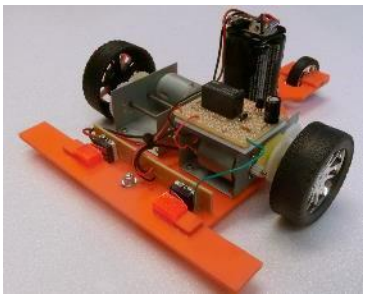
EXPLORER TIME DELAY – OFF TIMER

DESCRIPTION



The *EXPLORER* is a small autonomous vehicle that changes its direction of travel when it bumps into an object.

Both motors have the same time delay built in (the length of time the microswitches are engaged plus a short reaction time). Thus it can occur that – especially when approaching a straight wall - that both sets of microswitches are activated and both motors reverse.

This can result in the *EXPLORER* not being able to ”escape”. To avoid this situation it is possible to build a small electronic circuit, to provide an additional time delay timer for one motor.

SECTION 1: COMPONENTS REQUIRED

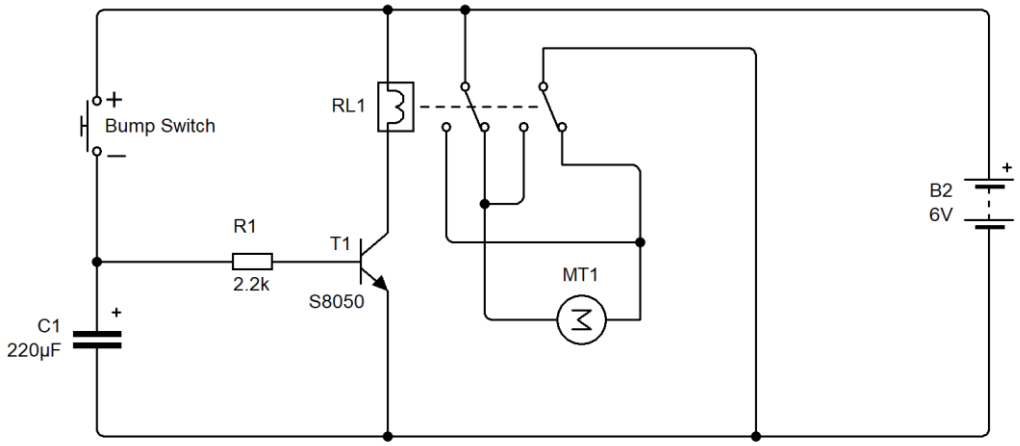
1.1 COMPONENTS REQUIRED

The following components are required to modify one *EXPLORER:*

☐	1 x	Protoboard	(PCB-PROTO)
☐	1 x	Transistor S8050	(TRANSS8050)
☐	1 x	220uF Electrolytic Capacitor	(CAP220UF)
☐	1 x	2.2K Resistor	(RES2.2K)
☐	1 x	1N4004 Diode	(DIO1N4004)
☐	1 x	5V Relay	(RELAY)
☐	Length	Tinned copper wire (for wire links)	(TCW)

SECTION 2: THE DELAY PCB

This PCB circuit could be added to one motor of the Explorer.



The circuit diagram above can be used to reverse one motor on the Explorer. The reverse time is controlled by changing Capacitor C1. The 220uF (micro Farad) capacitor has been selected after testing, as the optimum value.

- Using a smaller capacitor (100uF) the motor does not reverse long enough
- A larger capacitor (470uF) causes the *EXPLORER* to spin in a complete circle and go back to where it started.
- If a larger value than 470uF is used the *EXPLORER* will spend most of its time spinning in circles.

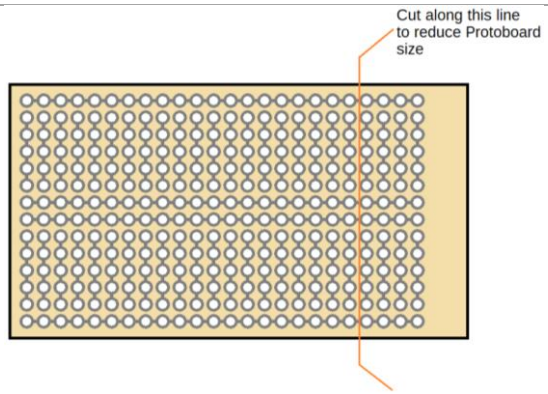
Once the circuit is constructed on a Protoboard it needs to be wired in place to the motor and Bump Switch.

SECTION 2: PREPARING THE PROTOBOARD

The PCB is 50mm x 30mm – before assembly it should be cut down to fit above one of the gearboxes.

Before you begin the construction of the Protoboard Time Delay circuit board it has to be shortened.

Use a fine bladed hacksaw or fret sat to cut off the length of board shown below.
- Use a fine file or sandpaper to clean up the end of the Protoboard before assembling the components and wires.



SECTION3: ASSEMBLING THE PCB

Wiring locations for components and links.

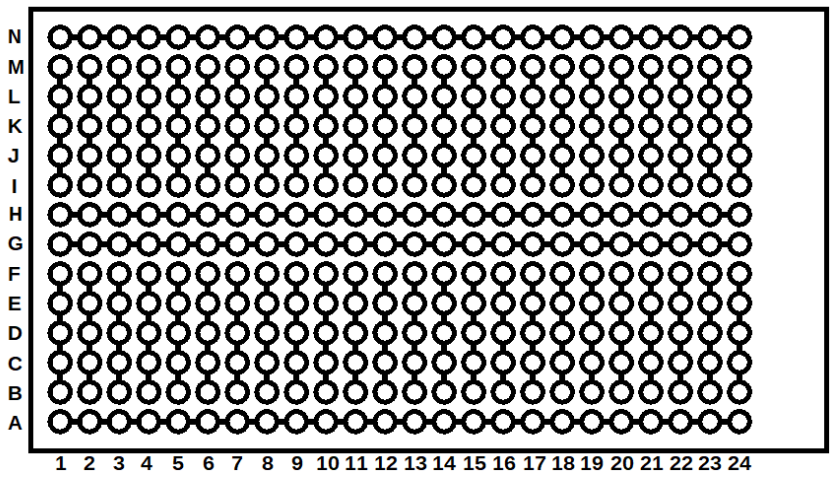
Use the following picture to help you correctly locate the component leads and wire links.

The rows are marked by letters and columns are marked by numbers. A1 would identify the hole in the bottom left hand corner of the Protoboard.

The information shown below works like this:

- 2.2K Resistor, J1-J5 indicates that the 2.2K resistor's leads fit into holes J1 and J5.

- For the wire links A2-B2 indicates a wire link fits into holes A2 and B2.



Components

2.2K Resistor, J1-J5, 1N4004 Diode, F6 Pos – I6 Neg, S8050 Transistor, Emitter D4-Base D5-Collector D6, 100uF Electrolytic Capacitor D1 Pos - D2 Neg, Relay I8-F8 I11-F11 I13-F13 I15-F15.

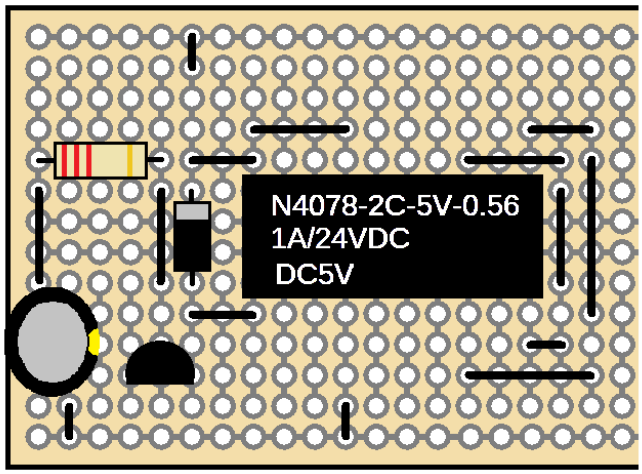
Wire Links

F1-I, A2-B2, A4-B4, F5-I5, M6-N6, E6-E8, J6-J8, K8-K11, A11-B11, C13-C17, J13-J16, D15-D16, K15-K17.

Wires

M1 – Bump Switch PCB, N17 – Battery Positive on Bump Switch PCB, A17– Battery Negative on Bump Switch PCB, M13 to Positive Terminal on Motor, B13 to Negative Terminal on Motor

1. Identify the components.
2. Identify the direction that they must be mounted.
3. Position the components as shown. Check against the information given for locating their positions.
4. Straighten the tinned copper wire and bend it to fit between the holes shown.
5. Check against the picture that everything is in correct position. Correct any mistakes.



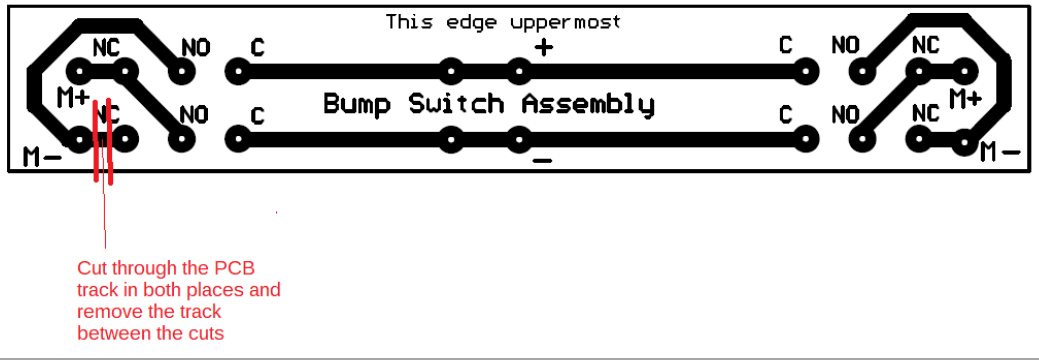
6. Turn over the Protoboard and solder all the leads and wires in position.
7. Cut off the wires and leads next to the solder.

SECTION 4: MODIFYING THE BUMP SWITCH PCB

Once the circuit is constructed the Protoboard must be wired to the motor and Bump Switch PCB.

The Bump Switch Printed Circuit Board (PCB) needs to be modified as follows:

1. Use a sharp knife (eg. a Stanley knife) to completely cut through the track in two places as shown



2. Place a hot Soldering Iron tip on the copper track between the 2 cuts you made.

3. Press and hold the hot tip on the short piece of track. Continue pressing down on the track. Heat from the Soldering Iron will melt the glue holding the copper track to the PCB base. As you continue to press the tip down onto the copper track drag it slowly towards you. If you have cut all the way through the copper track in both places the small piece of copper track will slide and come off the base material. This whole procedure will take about 10 seconds.

SECTION 5: WIRING

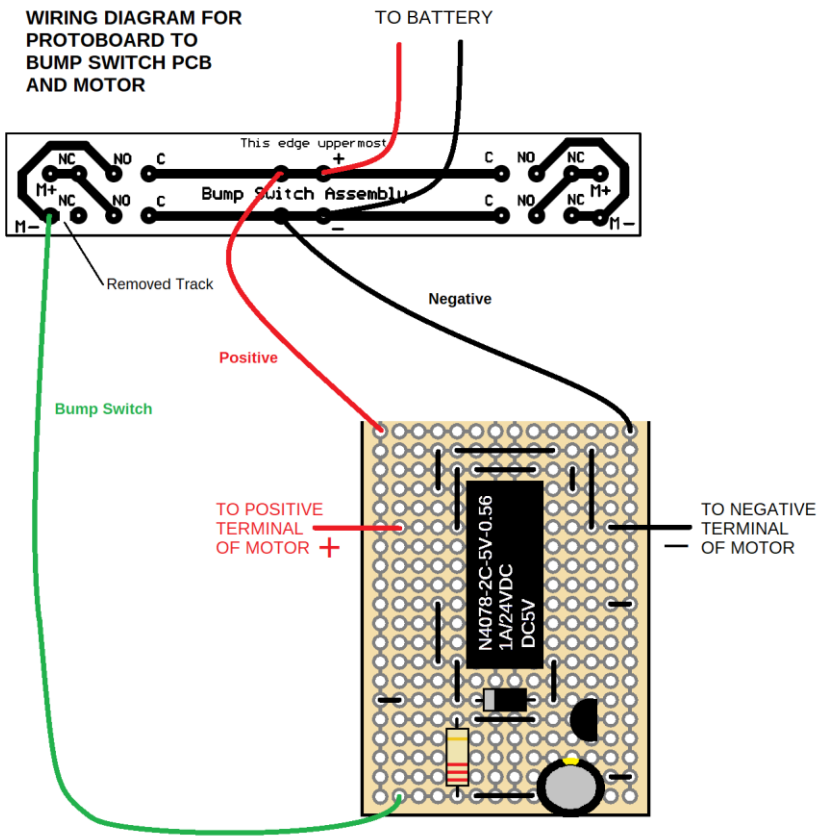
Following the information shown in the picture:

1. Solder the Bump Switch wires from the Protoboard to M- and Pad marked NC.

2. Solder the motor wires from the Protoboard to the motor.

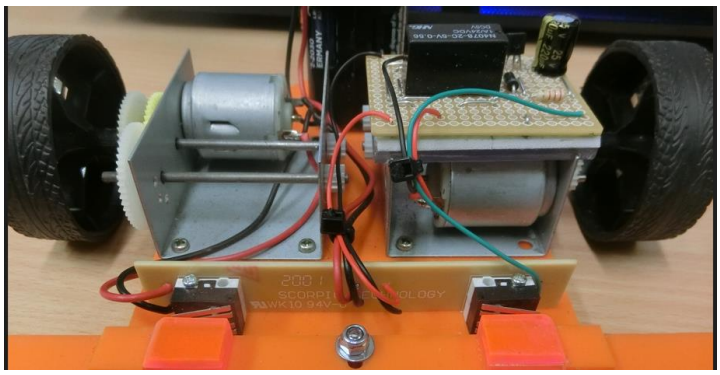
Pay attention to the connections for the Bump Switch to the Switch position on the Protoboard. Do not get + and − wires mixed up.

The *EXPLORER* can now be tested for operation. If the motor you rewired turns in the wrong direction, reverse the wires to the motor.



SECTION 6: MOUNTING THE PCB

Once assembled the PCB can be mounted on the *EXPLORER* as shown here:

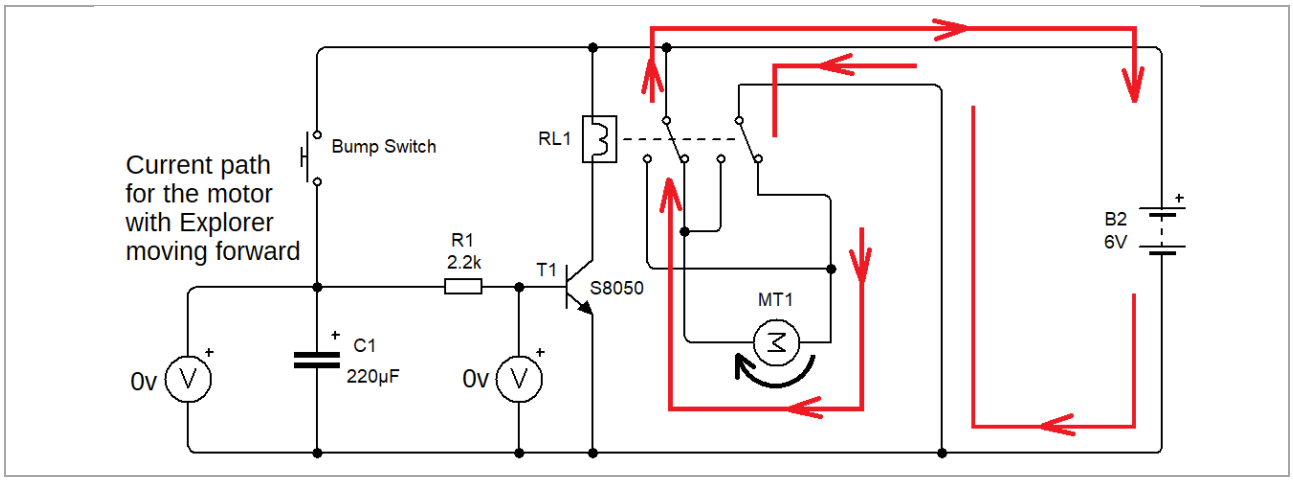


SECTION 7 USING 2 DELAY OFF PCBS

It is possible to modify your *EXPLORER* by putting in two time delay circuits, one for each wheel. If this modification is made, the procedure will also require the removal of the short piece of track between the NC and M- pads at the other end of the Bump Switch Assembly PCB.

SECTION 8: THEORY - HOW THE CIRCUIT WORKS

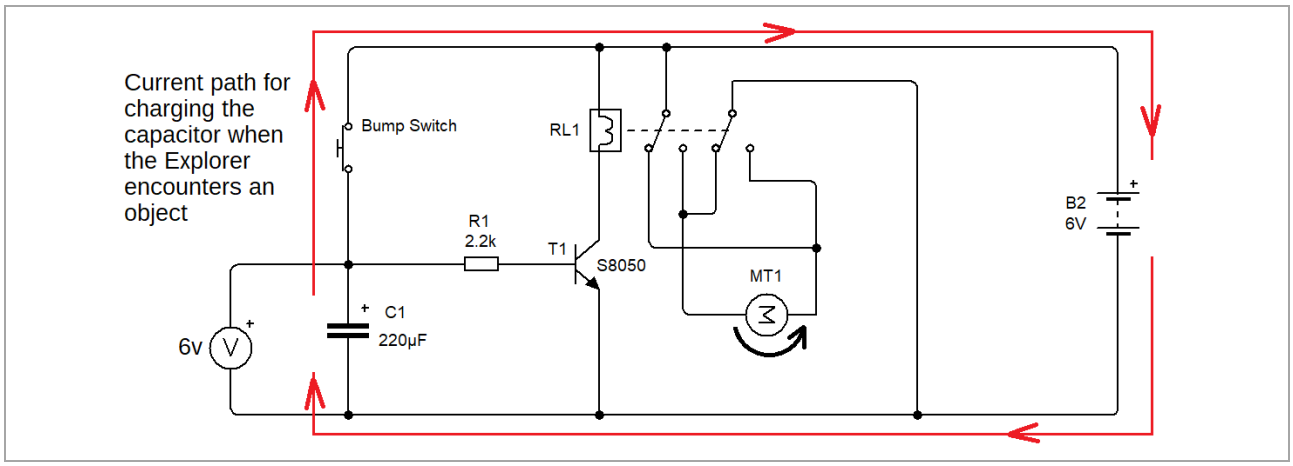
Initially when the *EXPLORER* is turned on the capacitor is not charged. The voltage connected to the base of the Transistor is at zero. This means the Transistor is turned off. This also means that the Relay does not have any voltage applied to its coil. The Relay contacts are in their normal position. This allows current from the battery to flow through the Relay contacts and through the motor, causing it to spin. In the circuit shown below the current path through the Relay contacts is shown and it also shows that in this example the motor is spinning in a clockwise direction.



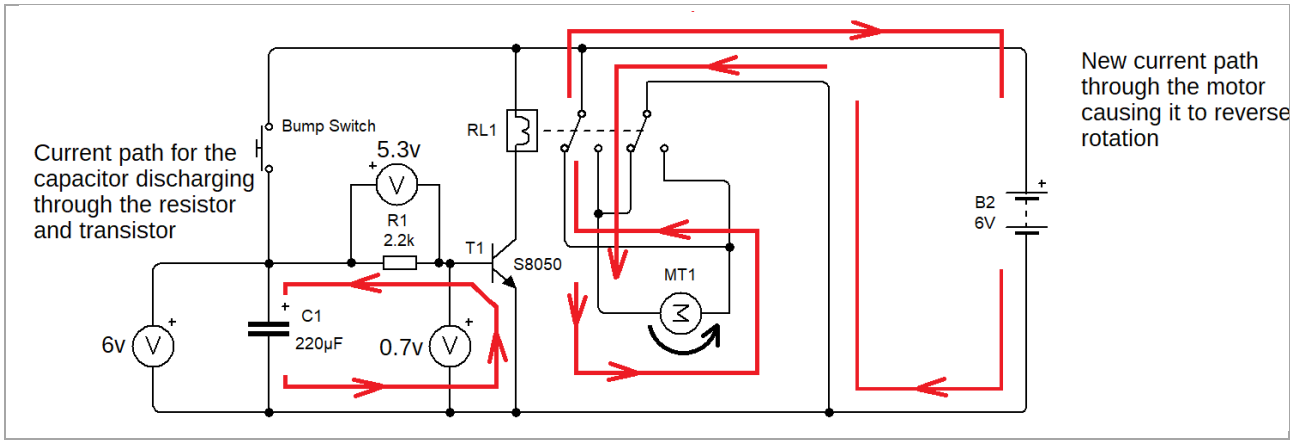
When the *EXPLORER* bumps into an object the Bump Switch normally turned off, is operated and turns on. It is important to note that the switch only operates for the time it is in contact with the object. Once the *EXPLORER* reverses away from the object the Bump Switch returns to it's off position.

In the short time the Bump Switch is on the 220 uF (220 micro Farad)

Capacitor charges up to the same voltage as the battery. In the example shown it is 6 volt.



Once the voltage at the base of the Transistor reaches 0.7 volt, the Transistor turns on and the relay operates. The Relay contacts change position (compare the Relay contacts from the first circuit to the circuit shown below). Current will flow through the motor in the opposite direction causing the motor to reverse its rotation and turn Anticlockwise.



When the motor reverses the *EXPLORER* will also reverse. When the *EXPLORER* moves away from the object it encountered, the Bump Switch returns to its normally off position. Once the Capacitor is disconnected from the Battery it begins to discharge through the 2.2K Resistor (R1) and the Transistor, as shown above.

The time the Capacitor takes to fully discharge (lose all its voltage) depends upon the value the Resistor and the value of the Capacitor. A larger value Capacitor or Resistor will cause the Transistor to be turned on for longer. This means that the Relay is turned on for longer, reversing the Explorer for a longer period of time.

As the Capacitor discharges, its voltage begins to drop. The difference between the Capacitor's voltage and the voltage between the Base and Emitter of the Transistor is across the 2.2K Resistor.

While the Transistor has 0.7 volts at its Base the Relay will be on. In this diagram you can see the direction of current flow through the Relay contacts and how the direction of current flow through the motor is changed, which causes the motor to turn in the opposite direction.

Eventually the voltage present at the Base of the Transistor will drop below 0.7 volt. When that happens the Transistor turns off, stopping the Relay from operating. The motor then reverts to turning in its original direction (as shown in the first diagram) and the *EXPLORER* begins to travel forward again. You can try changing the values of the Capacitor and Resistor to get different reverse times. Capacitor values between 100uF and 470uF and Resistor values between 1K and 2.2K could be tried. Larger or smaller Capacitor values will result in either very short or excessive reverse times. Resistor values of less than 1K may result in damage to the Transistor. Larger than 2.2k may prevent the Transistor from operating.