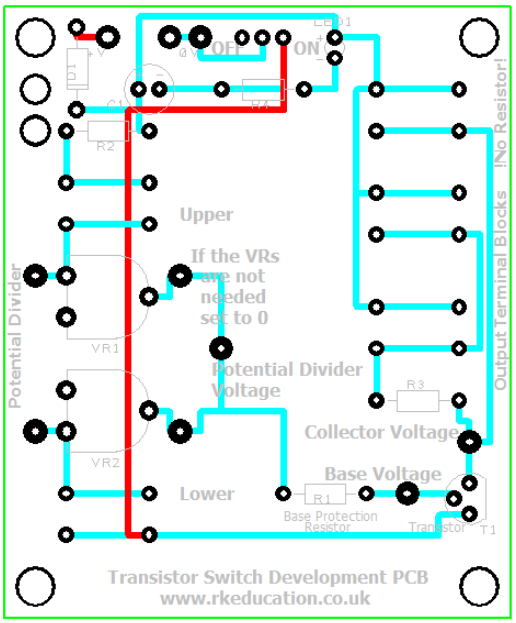
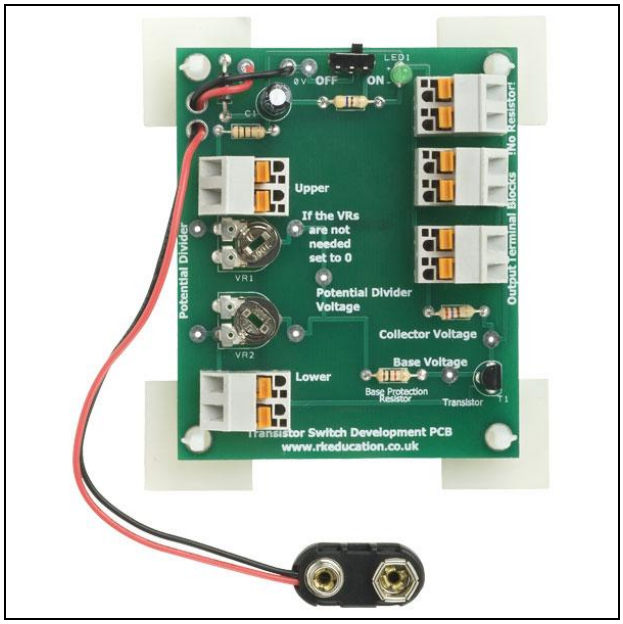
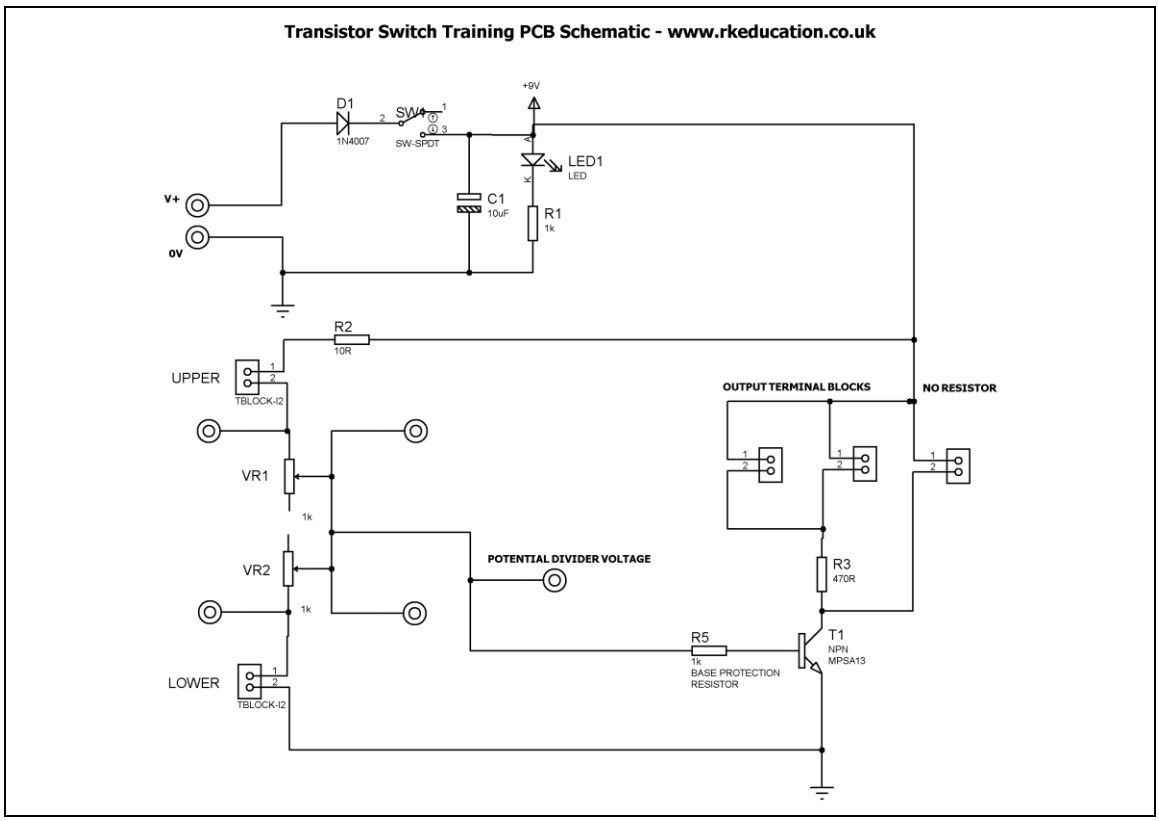
Transistor Switch Training PCB Component List and Instructions



PCB layout



Constructed PCB



Schematic Diagram

Description

This system has been specifically designed to be used alongside the Transistor Switch Project, **70-6024**. Using this system allows students to gain an understanding of the operation and application of the transistor switch circuit and this system also helps students make important decisions that will affect the final outcome of their project.

- Simple, low cost and portable
- Curriculum-based
- Uses a potential divider and transistor to switch on an output
- Allows students to model a light, temperature and moisture sensing circuit
- Allows students to test their designs prior to final construction
- Battery powered to remove the need for power cables and access to power sockets
- Screwless terminal blocks are used to allow students to easily insert different values for the potential divider section
- Clear silkscreen text has been used to aid learning
- Large pads have been included to allow the potential divider, base and collector voltages to be measured using a digital multi meter - DMM
- Professional double-sided PCB with clear white silkscreen and solder-resist
- Suitable for **Key Stages 2, 3 & 4** (ages 7 to 16)
- Powered from 1 PP3 battery
- High quality, professional double sided PCB
- Power switch and LED power indicator
- Perfect for nightlights, temperature alarms and moisture detectors

Component List

Battery clip – PP3 with PCB leads - **SOLDER LAST!**
C1 – Smoothing cap, 10uF electrolytic or suitable alternative
Power Switch – Ultra miniature slide switch
D1 – 1N400x
R1, R4 – 1k ~ BROWN, BLACK, RED
R2 – 10R ~ BROWN, BLACK, BLACK (this can be changed to 0R)
R3– 470R ~ YELLOW, VIOLET, BROWN
LED1 – 3 or 5mm Green LED
T1 – MPSA13 darlington transistor or equivalent
VR1, VR2 – 100k preset resistor 085 type or equivalent
2 way screwless terminal blocks x5
PCB feet x4

When constructing always start with the components that have the lowest profile and work high, for example start with the resistors and end on the electrolytic capacitor. For this kit please solder the battery clip last. The battery clip leads should be threaded thorough the 2 holes to the left of R2, it is advisable to twist the wires of the battery clip together.

Please only attempt to construct this unit if you are confident you are able to do this, if you are not confident please purchase a constructed unit. We will not accept responsibility for damaged and faulty units due to poor soldering.

Instructions

This PCB has been designed to be used alongside the Transistor Switch Project, **70-6024.** For details of the **Transistor Switch Project** and other projects please visit our website, www.rkeducation.co.uk

There are 6 areas to familiarize yourself with.

1. Power
2. Pads for measuring values
3. Screwless terminal blocks
4. Potential divider
5. Transistor
6. Outputs

Connecting Power

The first step is to power the PCB, use a 9V PP3 battery attached to the battery clip. It is also possible to use other battery voltages using a suitable battery case, for example 4 x AA batteries giving a supply of 6VDC. Never use mains electricity with this unit, only use low voltage batteries.

The system can now be turned on using the ultra-miniature slide switch at the top of the PCB, it is marked **ON** and **OFF.** The green power LED should light up, it is below the power switch. If it does not light up it may indicate faulty batteries or power supply, check them carefully or a short circuit.

Pads for measuring values

There are several large pads around the PCB that are used to measure voltages and resistances so the user can observe what is happening. The pads located either side of the variable resistors – **VR1** and **VR2** – are used to measure the resistance of the variable resistors. To measure the resistance simply put the probes from a digital multi meter, DMM, on each of the pads. There are 2 further pads that are located near the transistor T1, these are to measure the base and collector voltages, to measure these voltages use a DVM between the 0V pad and either the base or collector pad.

Screwless terminal blocks

This PCB has been designed around screwless terminal blocks, these allow components to be quickly and easily inserted and changed. Screwless terminal blocks are located around the PCB where the user may want to change/vary components, for example changing an output. This innovative approach allows for flexible project outcomes as the student experiment with their designs prior to manufacture in order to achieve the desired practical outcome. To insert a component simply press the levers on the terminal block and insert the leads into the holes, care should be taken to ensure a good contact.

Potential/Voltage Divider

This transistor switch circuit is based around the potential divider, the voltage from the potential divider will turn on or off the transistor which in turn will turn on or off an output. A potential divider divides a voltage, the output voltage from the divider is dependent on values of resistance. When two resistors of equal value (e.g. 10K) are connected across a supply, current will flow through them. If a meter is placed across the supply it will register 9V. If the meter is then placed between the 0v and the middle of the two resistors it will read 4.5v. The battery voltage has been divided in half. This is useful when using resistive sensors such as LDRs and thermistors, when either is used with a fixed resistor in series a simple sensor circuit is created, if an LDR is used then we have a light sensor and when a thermistor is used we have a temperature sensor.

Transistor

The potential divider in this circuit is used to switch on or off the MPSA13 darlington transistor – T1. The MPSA13 will switch on when approximately 0.7VDC is applied to the base (middle leg). This type of circuit is known as a transistor switch circuit. There is a base protection resistor (1k) that protects the base from excessive currents. The collector of the transistor is connected to the outputs. The collector and base voltages can be measured with a DVM in order to observe the transistor operating.

Outputs

The collector of the transistor is connected to 3 outputs, these are in parallel and 2 are protected with a resistor (470R) and are intended for use with LEDs. The top output has no resistor, this is clearly marked and is for transducers such as buzzers and bulbs, never use an LED in this output or put a short circuit across as it will permanently damage the circuit.

Using the PCB

The PCB has been designed to be simple to use. In order to become familiar with the unit it is advisable to do the following.

- Insert shorting links into the **UPPER** and **LOWER** terminal block of the potential divider – for example a piece of wire or 0R resistors. This is because only the variable resistors are to be used
- Insert an LED into an output terminal block – do not use the top terminal block as it does not have a resistor and it will damage the circuit, be sure to insert the longer leg above the shorter leg
- Adjust the variable resistors using a terminal screwdriver, doing so should turn the LED on and off, this is due to the voltage from the potential divider at the base of the transistor going above and below approx. 0.7VDC

Now try the following

- Take an LDR (light dependent resistor) and 0R resistor (one black band)
- Insert the LDR in the **LOWER** terminal block and set **VR2** to 0Ω using a DMM

- Insert the 0R resistor in the **UPPER** terminal block, set **VR1** to approx 50kΩ using a DMM
- Insert an LED into an output terminal block – not the terminal block without a resistor
- Cover and uncover the LDR, this should turn the LED on and off
- If this does not happen adjust **VR1**, this adjusts the sensitivity
- Now swop the 0R and LDR, observe how the circuit behaves differently
- When VRx is set at the correct resistance measure using a DVM, make a note of the value. Then set VRx to 0Ω and insert a resistor of the measured value or nearest value into the appropriate terminal block
- The circuits are light and dark activated transistor switch circuits
- Use a buzzer in the terminal block without a resistor to make an alarm

This circuit can also be used with a thermistor to make a temperature activated transistor switch circuit and with a moisture sensor to make a moisture sensitive switch.

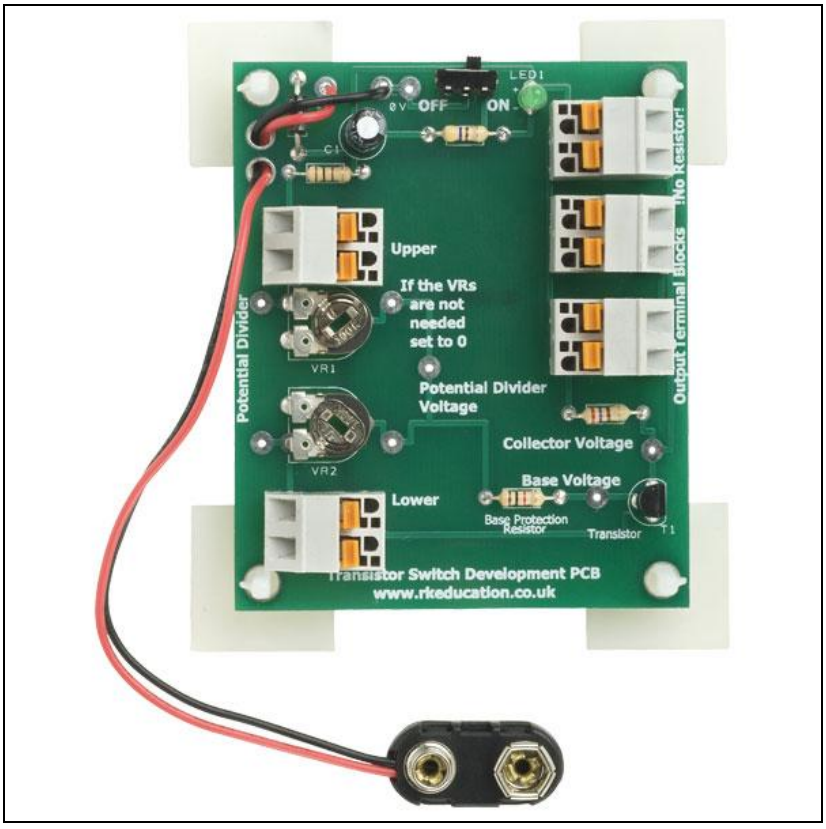
Use this PCB to help make design decisions when completing a project

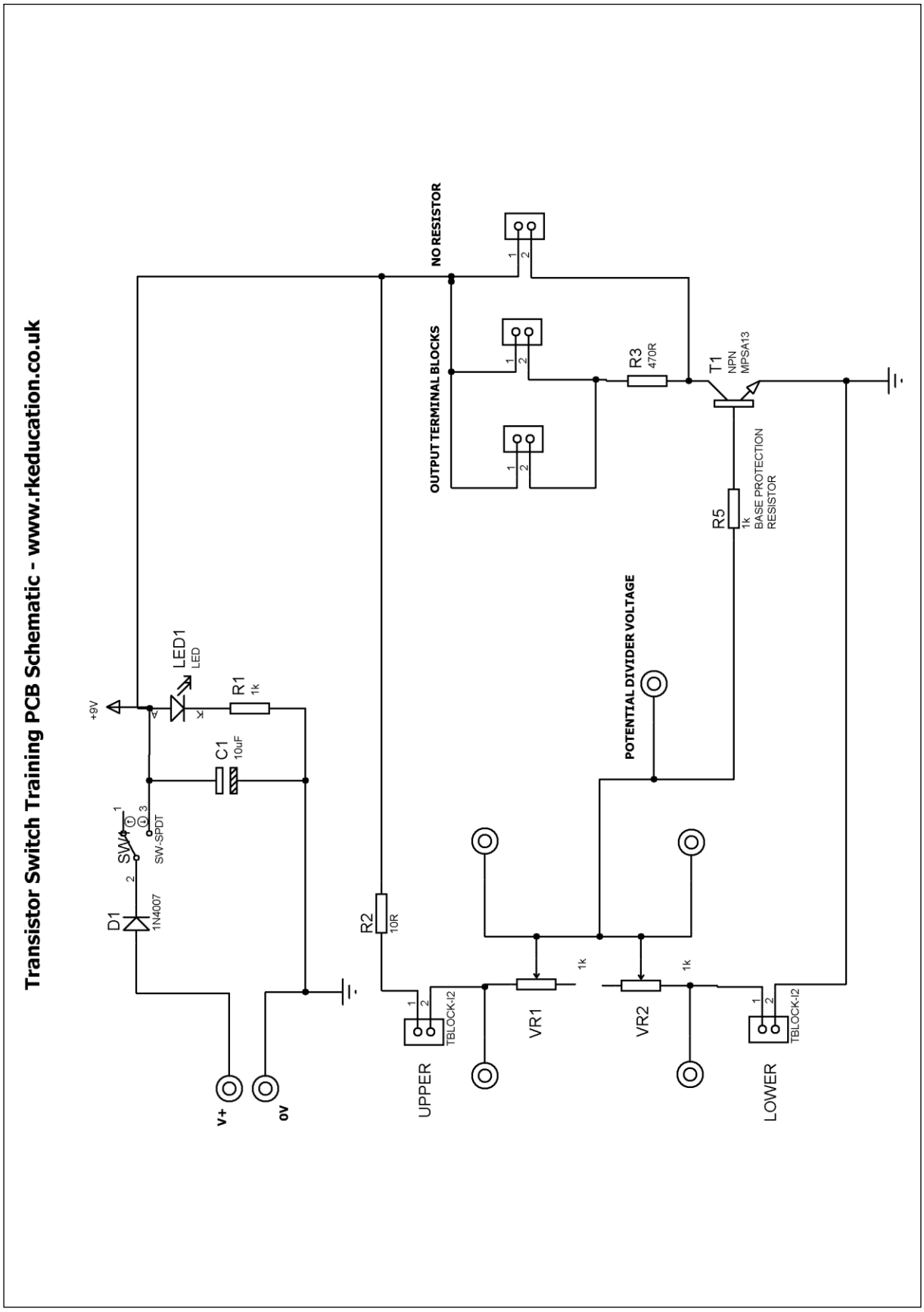
Please visit our website

www.rkeducation.co.uk

If you have any comments or queries please email us at

technical@rkeducation.co.uk




Transistor Switch Training PCB Schematic - www.rkeducation.co.uk
NO RESISTOR
OUTPUT TERMINAL BLOCKS
R3
470R
T1
NPN
MPSA13
R5
1k
BASE PROTECTION
RESISTOR
POTENTIAL DIVIDER VOLTAGE
LED1
LED
R1
1k
+9V
C1
10uF
SW1
SW-SPDT
D1
1N4007
R2
10R
VR1
1k
VR2
1k
TBLOCK-I2
UPPER
LOWER
v+
0v