

TRANSISTORS

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TRANSISTORS

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2. SIMPLE USE OF A TRANSISTOR

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AN INTRODUCTION TO TRANSISTORS

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Transistors is a semiconductor device, that can be regarded as a type of switch, as can many electronic components. They are used in a variety of circuits and you will find that it is rare that a circuit built in a school Technology Department does not contain at least one transistor. They are central to electronics and there are two main types; NPN and PNP. Most circuits tend to use NPN. There are hundreds of transistors which work at different voltages but all of them fall into these two categories.

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TYPICAL
NPN
TRANSISTOR



TYPICAL PNP
TRANSISTOR



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NPN TRANSISTOR PIN/LEAD LAYOUT

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Transistors are manufactured in different shapes but they have three leads (legs).

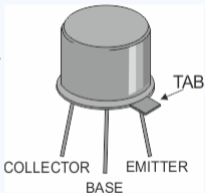
The **BASE** - which is the lead responsible for activating the transistor.

The **COLLECTOR** - which is the positive lead.

The **EMITTER** - which is the negative lead.

The diagram below shows the symbol of an NPN transistor. They are not always set out as shown in the diagrams to the left and right, although the 'tab' on the type shown to the left is usually next to the 'emitter'.

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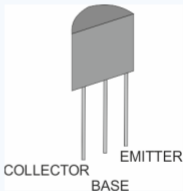
PNP TRANSISTOR PIN/LEAD LAYOUT

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The layout to the leads / pins of the PNP transistor are different to the NPN transistor.

The leads on a transistor may not always be arrangement being shown here. When buying a transistor, directions will normally state clearly which lead is the BASE, EMITTER or COLLECTOR.

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TRANSISTOR SYMBOL

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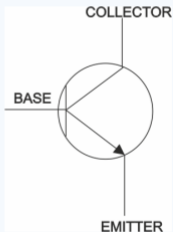
Transistors are manufactured in different shapes but they have three leads (legs).

The **BASE** - which is the lead responsible for activating the transistor.

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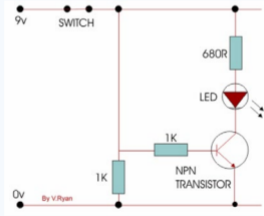


SIMPLE USE OF A TRANSISTOR

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The circuit below, shows an NPN transistor which is often used as a type of switch. A small current or voltage at the base, allows a larger voltage to flow through the other two leads (from the collector to the emitter). When the switch is pressed a current passes through the resistor into the base of the transistor. The transistor then allows current to flow from the +9 volts to the 0vs, and the LED 'lights'.

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THE DARLINGTON PAIR

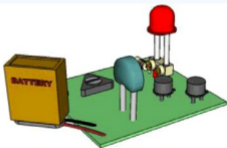
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A darlington pair is used to amplify weak signals so that they can be clearly detected by another circuit or a computer/microprocessor.

The circuit below is a temperature sensor.

When the temperature drops below zero the LED lights. This type of system is often seen in a car and warns the driver of the possibility of icy conditions. The two transistors are known as a darlington pair. Without a darlington pair the circuit would probably fail. The two transistors amplify the weak current in the circuit allowing the LED to light.

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information /
an exercise**



ARRANGEMENT OF TWO TRANSISTORS
A 'DARLINGTON PAIR'

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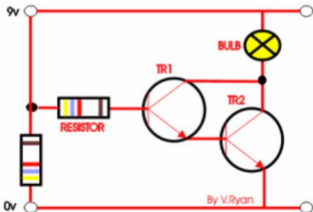
THE DARLINGTON PAIR

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The lamp shown in the circuit below, 'lights' when power is supplied. A second transistor has been added to the circuit, to amplify the signal into the base of the second transistor, which in turn allows current to flow through the lamp/bulb.

The amount by which the weak signal is amplified is called the '**GAIN**'.

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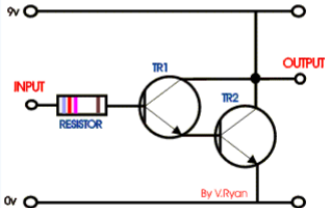
THE DARLINGTON PAIR

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The circuit below is a 'Darlington Pair' driver.

The first transistor's emitter feeds into the second transistor's base and as a result the input signal is amplified, by the time it reaches the output. The important point to remember is that the Darlington Pair is made up of two transistors and when they are arranged as shown in the circuit, they are used to amplify weak signals.

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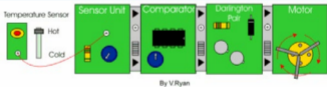


THE DARLINGTON PAIR

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Below is a system designed to monitor the temperature of a car radiator. When the radiator temperature becomes too high the voltage from the temperature sensor and sensor unit changes. The comparator detects this change in voltage and activates the darlington pair. The ***darlington pair driver provides enough amplified current for the motor to operate***, cooling the car radiator.

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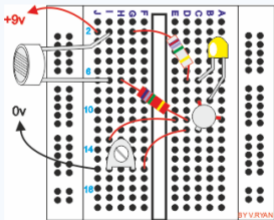


TRANSISTOR BREADBOARD PROJECT

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When light shines into the LDR its resistance is high and consequently current cannot flow from positive 9 volts to negative 0 volts. If the LDR is completely covered its resistance falls dramatically. Current then flows into the base of the transistor switching it on. Consequently current can flow through the collector and emitter - therefore, the LED lights.

Tap the image for more detail and component values



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TRANSISTOR BREADBOARD PROJECT

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Tap the Link Button for a 'breadboard instruction sheet', for the transistor circuit shown on the previous page / slide



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TRANSISTOR FORMULAS

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Transistors are used to amplify current and so in an examination you could be asked to find the BASE current or COLLECTOR current or the GAIN. The GAIN is simply the amount of amplification. The formula is set out below:

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$$\begin{array}{l} \text{CURRENT GAIN} = \frac{\text{COLLECTOR CURRENT}}{\text{BASE CURRENT}} \\ \text{BASE CURRENT} = \frac{\text{COLLECTOR CURRENT}}{\text{CURRENT GAIN}} \\ \text{COLLECTOR CURRENT} = \text{BASE CURRENT} \times \text{CURRENT GAIN} \end{array}$$

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TRANSISTOR QUESTION

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1. If the collector current of a transistor is 0.12 amps and the gain is 40, what is the base current?

Tap the **ANSWER** for more questions

$$\begin{aligned} \text{BASE CURRENT} &= \frac{\text{COLLECTOR CURRENT}}{\text{CURRENT GAIN}} \\ &= \frac{0.12}{40} \end{aligned}$$

$$= 0.003 \text{ amps or 3 milli-amps}$$

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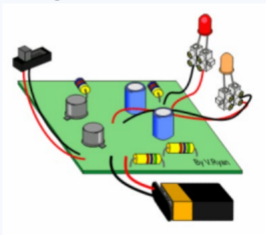


DUAL TRANSISTOR MULTIVIBRATOR CIRCUIT

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A multivibrator circuit is a circuit that has identical components arranged on the left and right hand sides. In the case of the example below, the two PNP transistors, the capacitors and the LEDs are the key components. This circuit will trigger itself repeatedly and in this way the LEDs flash alternately.

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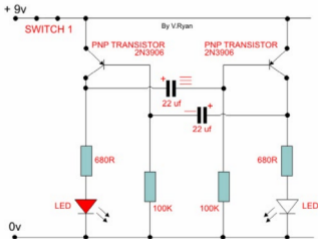


DUAL TRANSISTOR MULTIVIBRATOR CIRCUIT

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Increasing the value of the two electrolytic capacitors increases the time each LED remains on/off. The transistors are general PNP type. It is important to protect the LEDs and this is achieved by adding the 680R (or lower if necessary) fixed resistors.

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Tap the image for starter exercise – DUAL TRANSISTOR MULTIVIBRATOR CIRCUIT

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COMPONENT	NAME	FUNCTION
		Used to connect to mains electricity. TRUE / FALSE _____ _____
		Shines brightly and uses little electrical power. _____ _____
		Is a type of sensor used to detect light / dark. _____ _____
		Stores and discharges electricity. TRUE / FALSE _____ _____
		Used to increase and decrease _____ _____
		Used to protect other components such _____ _____

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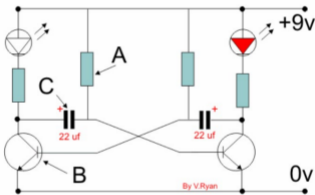
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EXAMINATION QUESTION

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Tap / click on the image below, for an examination question on transistor, multi-vibrator circuits. Use the electronics Section of www.technologystudent.com to help with the answers



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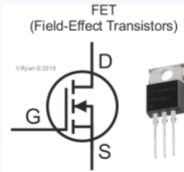
FIELD EFFECT TRANSISTORS (FETS)

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FETs have a source, drain and gate, which are arranged in a similar way, to the 'pins' of a bipolar junction transistor (BJTs), such as an NPN or PNP transistor - collector, base and emitter.

The gate of a FET, plays a similar role as the base of a BJT. When the gate is triggered, it allows current to flow through the drain and source. However, it requires very little current to trigger the gate, unlike BJTs.

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SOME ADVANTAGES OF FETS

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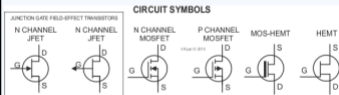
FETs are digital devices, acting as a 'switch' or as an 'amplifier'. They have a relatively high input resistance, which is an advantage over BJT's.

FETs offer more protection to a secondary circuit.

FETs are physically smaller than BJT's.

Although FETs are more expensive to manufacture than BJT's, they are preferred in most commercial circuits, with the exception of amplifier circuits

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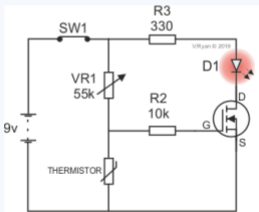


FIELD EFFECT TRANSISTORS (FETS)

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This temperature sensor circuit, depends in part on the MOSFET. As the temperature drops, the LED illuminates, as a warning light. As the temperature drops to below 3 degrees centigrade, the LED illuminates. Altering the setting of the variable resistor, determines when the LED illuminates. When the Gate is triggered, current flows through the Drain and the Source, allowing the LED to illuminate.

Tap the image for information / an exercise



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