

FACTFILE: GCE TECHNOLOGY & DESIGN

1.17 ELECTRONIC SYSTEMS: PART 5

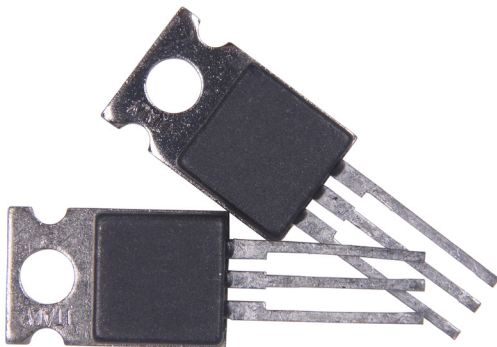


Darlington Pair

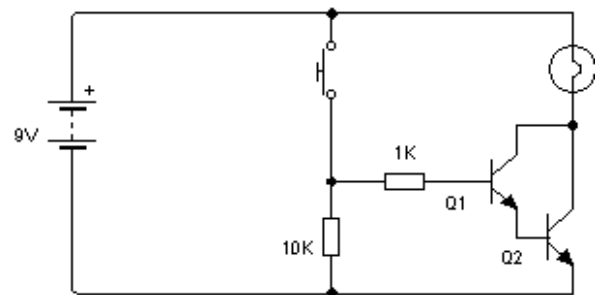
Learning Outcomes:

- Demonstrate knowledge and understanding of the following system:
 - Darlington pair;
 - incorporate these devices into applications to meet specified criteria;

Course Content



Transistors are available with a range of properties. Some have a large current gain ($h_{fe} = I_c / I_b$) and a small power rating (i.e. they cannot carry a large current without overheating). Others may have a low current gain and high power rating. Applications which require both a high current gain and a high power rating may use a Darlington Pair. This is a configuration of two transistors devised by Sidney Darlington which may be achieved using two separate transistors or two transistors in a single package.



Here the first transistor should have a high current gain. The second usually has a high power rating. The emitter current of the first transistor becomes the base current for the second transistor.

- The total current gain is the product of the two current gains:
Total current gain = current gain₁ x current gain₂
 $2 = h_{fe1} \times h_{fe2}$
- In order to switch on the Darlington Pair, the voltage required must switch on both transistors and so equals 1.2 V (0.6 V + 0.6 V)

Advantages over a single transistor

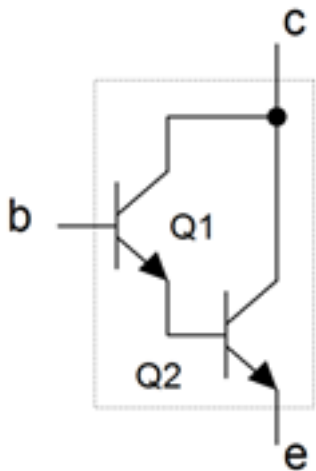
1. High current gain

Since the current gain is so large, the base current for the first transistor is usually tiny. This means that a large current through the load at the collector terminal may be switched on and off using an extremely small current at the base terminal. This could be used for instance in a touch-sensitive switch. A typical Darlington Pair would have a

current gain with a value of over 1000, meaning that a current of 1 mA in the base would easily switch on a lamp requiring a current of 1 A in the collector circuit.

2. Small size

Since the two transistors may be manufactured in a single package, there may be an overall reduction in circuit size. The single package version of the Darlington Pair may be a direct replacement for a single transistor with the terminals marked e, b and c replacing the emitter, base and collector

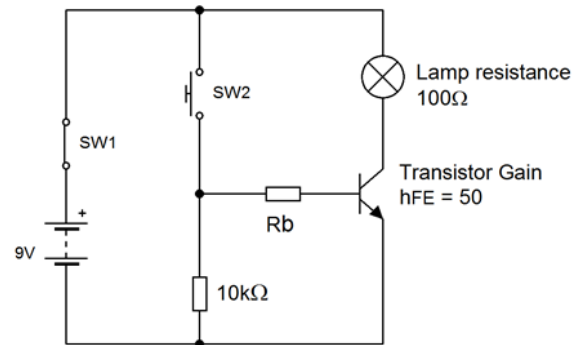


terminals on a single transistor.

Disadvantages of the Darlington Pair

1. A major drawback in some applications is the larger voltage required to switch on a Darlington Pair i.e. 1.2 Volts instead of 0.6 V.
2. When the Darlington Pair is switched on fully, the collector voltage cannot fall to 0V. This means that there is a reduced voltage available to power the load. This also increases the heat dissipation in the Darlington Pair.

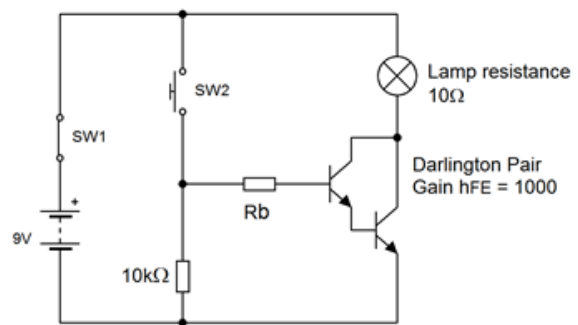
Worked Example



The circuit diagram shows a simple circuit to operate a lamp when SW2 is closed. It is desired to replace the 100Ω lamp with one which has a resistance of 10Ω. In order for the circuit to operate effectively, it is necessary to replace the single transistor with a Darlington Pair which has an hfe = 1000.

(a) Redraw the circuit to include a Darlington Pair.

Answer:



(b) State the value of V_{be} required to switch on the 10 Ω lamp.

Answer: 1.2 V (0.6 V + 0.6 V)

? Revision Questions

- 1 A Darlington Pair is often used to switch on output devices. State **two** main reasons why this arrangement is used.

Source: CCEA AS Jan 2011

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- 2 The following modification has been suggested for a basic temperature alarm circuit shown in Figure 1
- Replacing TR1 with a Darlington Pair

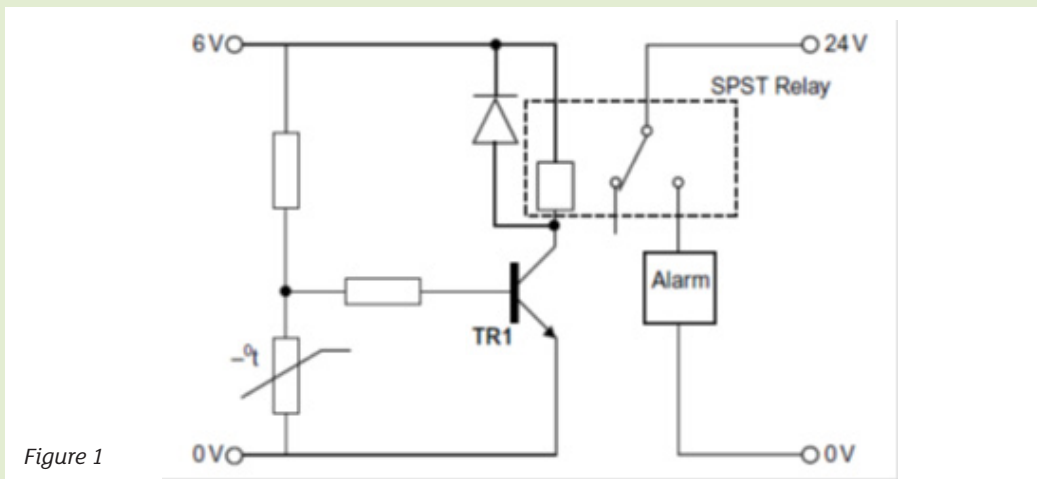


Figure 1

- (i) State **one** reason why Darlington Pairs are used.

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? Revision Questions

- 2 (ii) Show with the aid of a diagram how transistors are arranged in a Darlington Pair



Source: CCEA AS May 2009

