

GENERAL CERTIFICATE OF SECONDARY EDUCATION

DESIGN AND TECHNOLOGY

Systems & Control Technology (Electronics Option)

Paper 4 (Higher Tier)

1957/04

Candidates answer on the Question Paper

OCR Supplied Materials:

None

Other Materials Required:

None

Wednesday 26 May 2010

Afternoon

Duration: 1 hour 15 minutes



Candidate
Forename

Candidate
Surname

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).
- Show all working for calculations.
- All necessary formulae are provided within the questions. No extra formulae sheet is required.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **50**.
- Marks will be awarded for the use of correct conventions.
- Dimensions are in mm unless stated otherwise.
- This document consists of **16** pages. Any blank pages are indicated.

- 1 Electronic product cases normally need holes drilling to allow the fitting of switches and external components.
2D CAD software has been used to draw a drill template.

(a) State **two** benefits of using CAD, rather than hand drawing, for the drill template design.

Benefit 1 [1]

Benefit 2 [1]

(b) Holes to match those in a PCB are included in the CAD drawing of a template shown in Fig. 1.

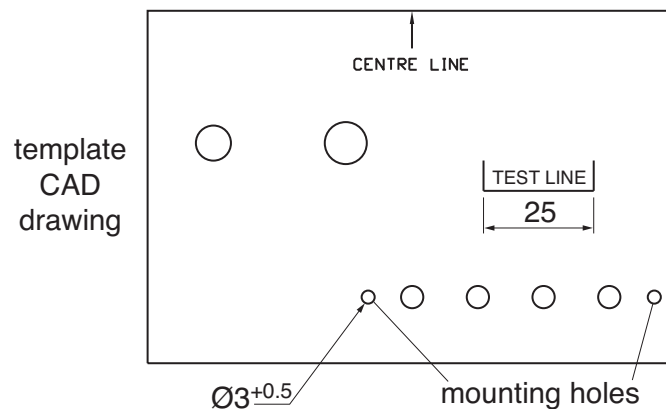


Fig. 1

The diameter of the mounting holes for the PCB is shown on the drawing as $\text{Ø}3^{+0.5}$, giving a tolerance of +0.5 mm.

Give the likely reason for allowing a tolerance on the hole diameter.

Reason [1]

(c) Output from the CAD drawing can be printed as a paper template or used in a laser cutter for production of an acrylic template.
Fig. 2 shows both outputs.

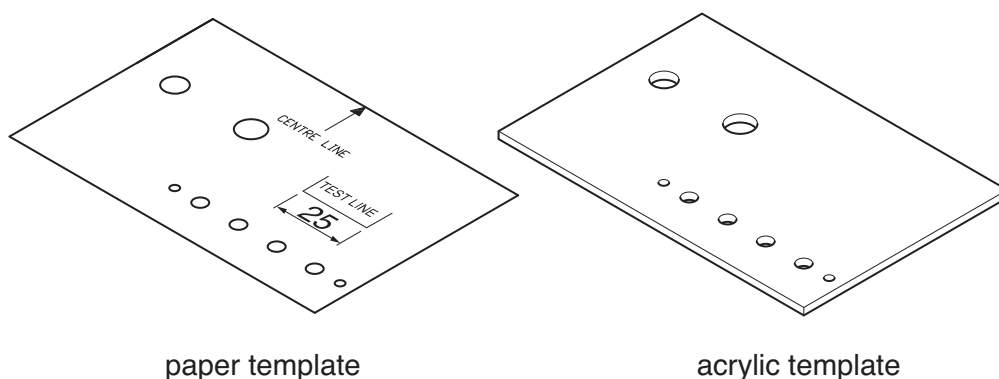


Fig. 2

(i) Give **one** method of checking the accuracy of the paper template before use.

..... [1]

- (ii) Explain why the laser cut template is likely to be more accurate in use than the paper template.

.....

.....

..... [2]

- (iii) Fig. 3 shows the laser cut template and the case lid that is to be drilled.

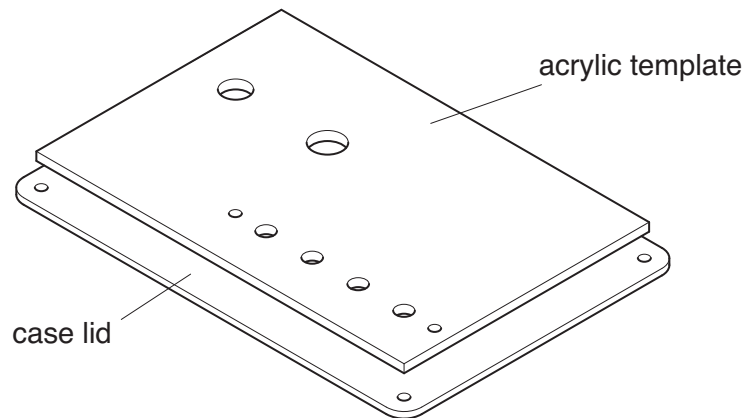


Fig. 3

Use notes or sketches to show a method of accurately securing the acrylic template to ensure that all the holes line up.

[2]

- (d) When an electronic product is no longer required it should be possible to recycle the materials.

Give **two** pieces of information that should be included on the case to make recycling easier.

1 [1]

2 [1]

[Total: 10]

Turn over

- 2 Fig. 4 shows a hand held detector used for finding concealed mains cable, other metals and timber framing.

The device is powered by a 9V battery and includes a white LED torch.

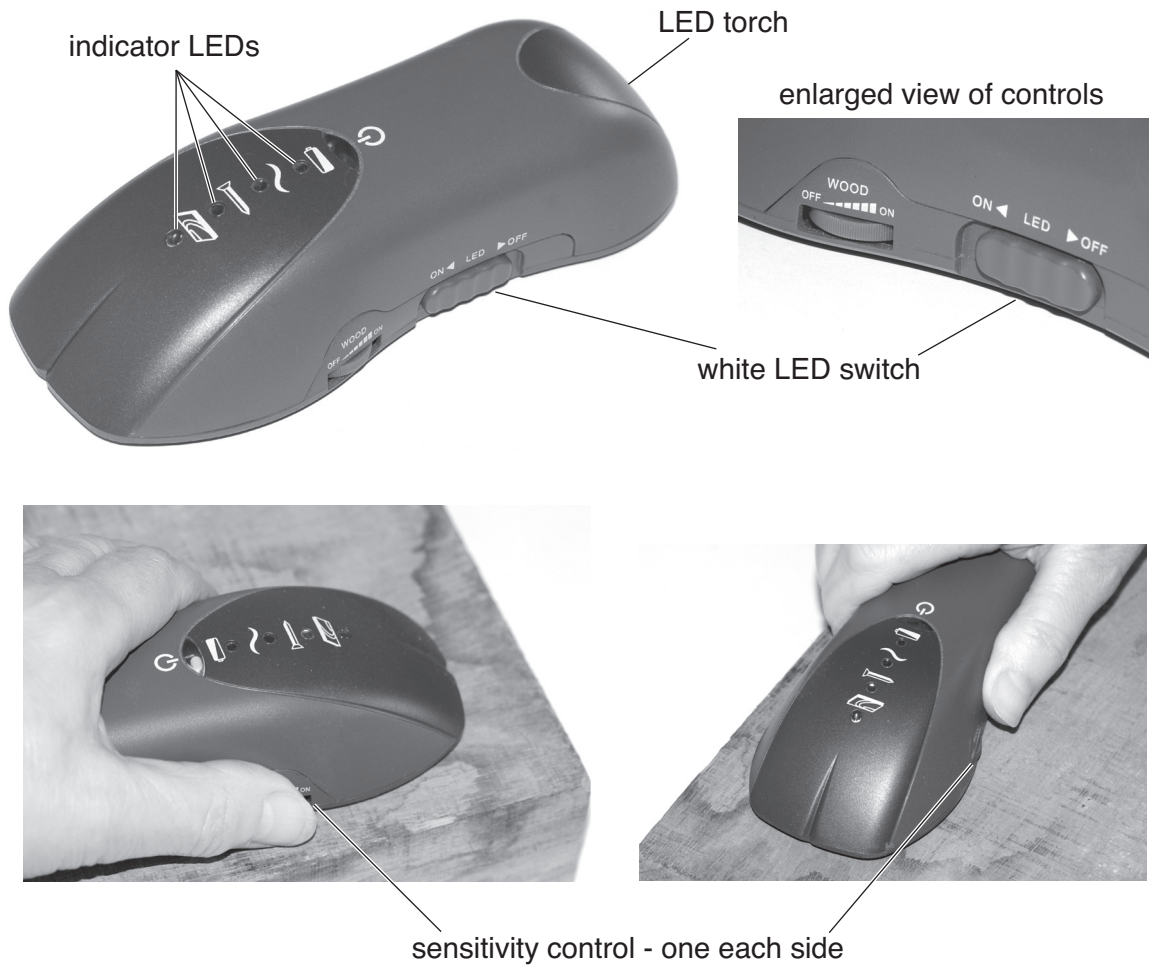


Fig. 4

- (a) Give **two** factors that contribute to the ergonomic design of the detector.

- 1 [1]
- 2 [1]

- (b) The case is injection moulded with the base held in place by self tapping screws as shown in Fig. 5.



Fig. 5

- (i) Give **one** reason for using self tapping screws to secure the base during manufacture.

.....
 [1]

- (ii) State why the symbols next to the indicator LEDs and controls in Fig. 4 must have been applied after the moulding had taken place.

.....
 [1]

- (c) Fig. 6 shows a view of the circuit board.

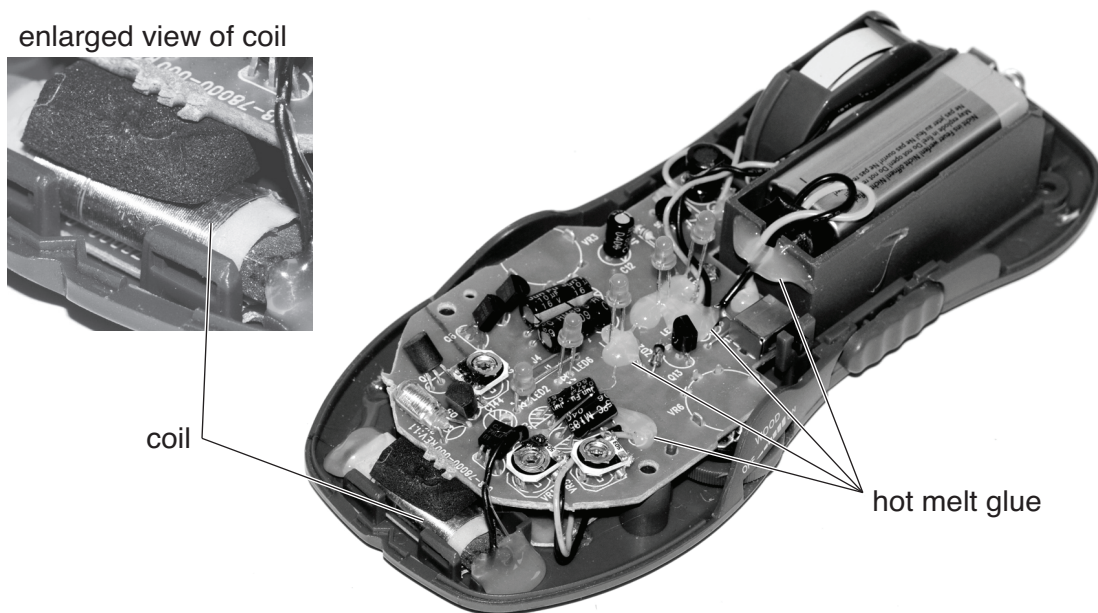


Fig. 6

- (i) Give **one** reason for connecting wires being held in place with hot melt glue.

..... [1]

- (ii) The sensor for the detector uses enamelled copper wire in a coil.
 State a reason for the use of enamel on the copper wire.

.....
 [1]

- (d) Fig. 7 shows the LED indicators on the circuit board. The LEDs have been soldered into position at varying heights to match the curve of the case.

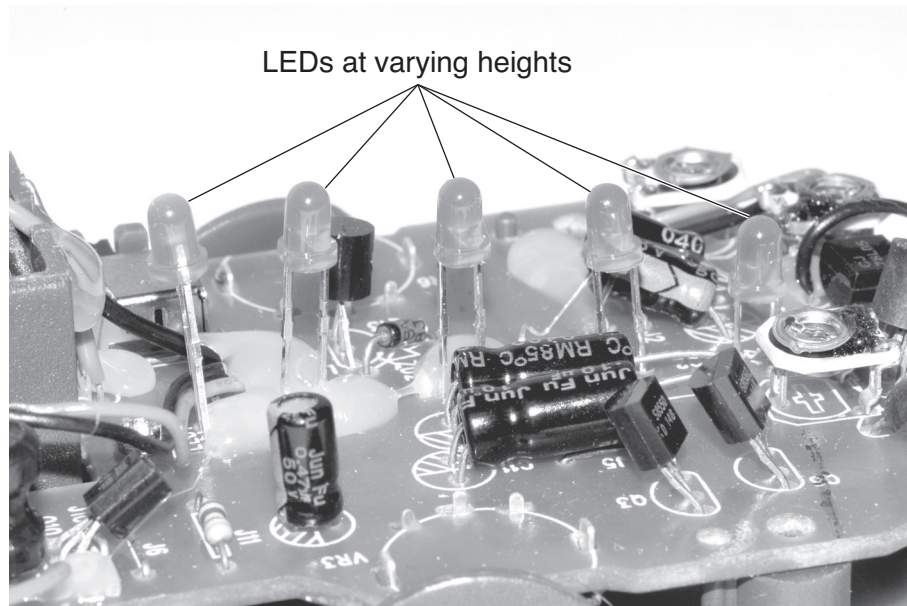


Fig. 7

- (i) Use notes or sketches to describe how the LED heights could be accurately controlled when assembling a batch of boards.

- (ii) Fig. 8 shows two radial capacitors on the circuit board, bent to a horizontal position.

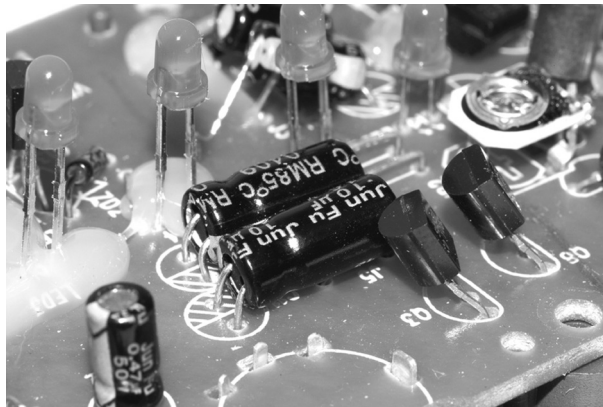


Fig. 8

Explain why it may be better to use either shorter radial capacitors or axial capacitors.

.....

.....

..... [2]

[Total: 10]

- 3 The water temperature in a tropical fish tank has to be carefully controlled. Fig. 9 shows the thermistor to be used for sensing the temperature of the water.

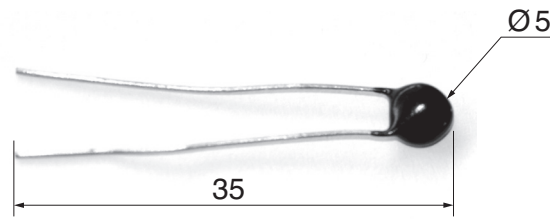


Fig. 9

- (a) Use notes or sketches to describe a method of protecting the thermistor from water when it is placed in the tank.

[3]

- (b) The signal from the thermistor is taken to **two** comparators as shown in Fig. 10.

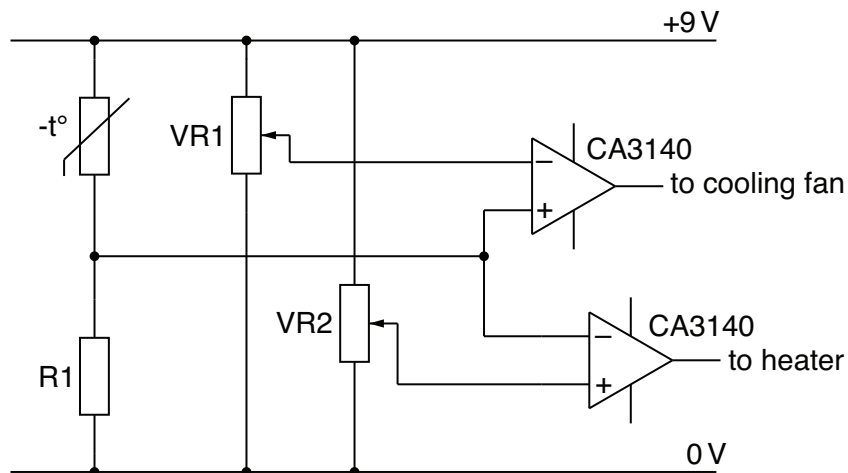


Fig. 10

- (i) Tick the **two** true statements describing a comparator circuit.

If the + input is greater than the – input the output is high

☐

If the – input is greater than the + input the output is high

☐

If the + input is greater than the – input the output is low

☐

If the – input is greater than the + input the output is low

☐

[2]

- (ii) It is found that a double comparator IC is available to replace the single version specified in Fig 10. Two versions of the IC are shown in Fig. 11.

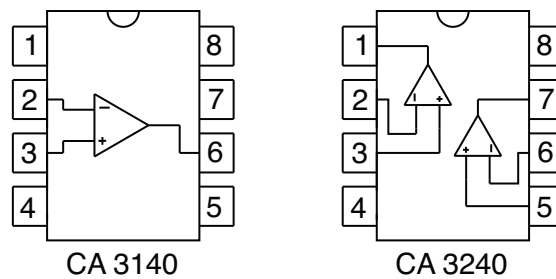


Fig. 11

State **one** benefit, apart from cost, of using the double comparator IC.

..... [1]

- (c) Fig. 12 shows a multi-turn preset resistor, needing 10 turns to cover the full range of resistance.

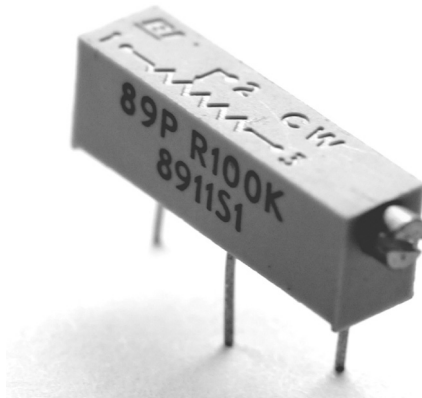


Fig. 12

State the reason for using the multi-turn preset resistors as VR1 and VR2 in Fig. 10.

..... [1]

- (d) (i) When necessary the comparators will operate a cooling fan and a heater. The cooling fan is rated at **12V DC 7.9W**. Calculate the maximum current flow in the cooling fan circuit. Use the formula $P = V \times I$.

.....

..... [2]

- (ii) From the list below select the most suitable fuse to protect the cooling fan circuit.

250 mA 1 A 800 mA 630 mA 2.5 A

..... [1]

[Total: 10]

Turn over

- 4 (a) A kitchen timer circuit is based on a 4017B decade counter IC. The count advances on a clock pulse occurring once every minute. The IC counts from 0–9 before automatically resetting to 0. A breadboard layout shown in Fig. 13 is used to test that the IC is working. A bargraph display with ten LEDs is used on the breadboard.

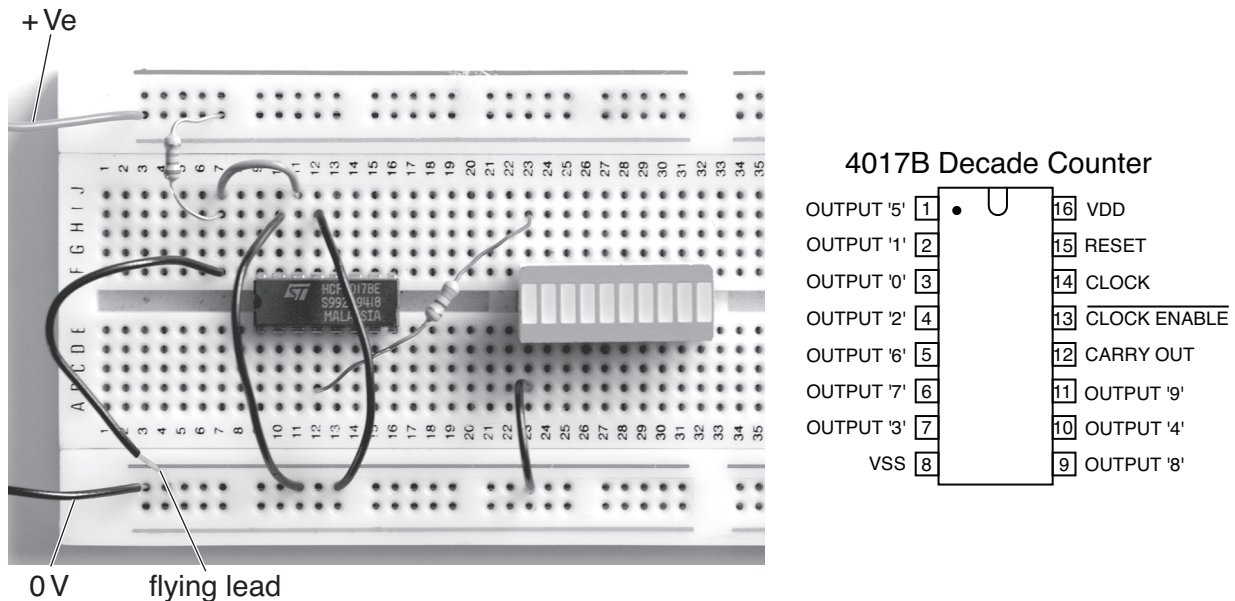


Fig. 13

- (i) Add the **VSS** and **VDD** connections to the breadboard. [2]
- (ii) The clock arrangement used for testing the circuit consists of a pull up resistor and a flying lead. Describe the problem with using this arrangement for testing the IC.
 [1]
- (iii) State the maximum time that will be counted by the circuit if the reset connection is moved to output 7 (pin 6).
 [1]
- (b) The output of the circuit is to be connected to a separate display board using a ribbon cable and connector as shown in Fig. 14.

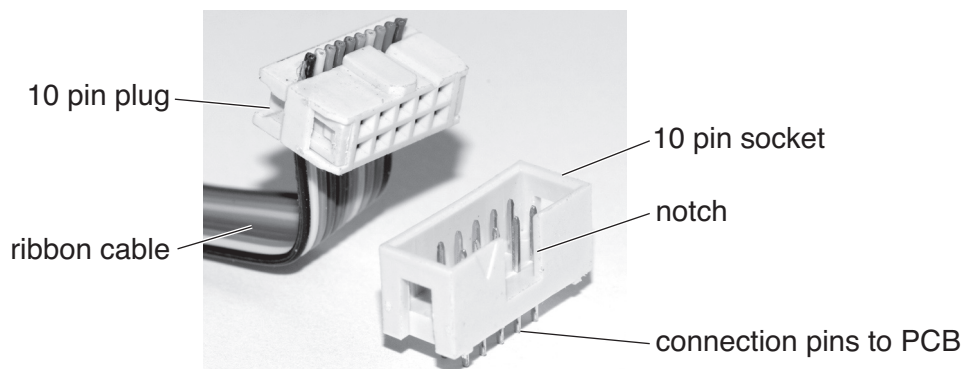


Fig. 14

- (i) Give **one** benefit of using ribbon cable with a plug and socket system to connect two circuit boards together.

..... [1]

- (ii) A notch is visible in the case of the 10 pin socket.
State the purpose of the notch.

..... [1]

- (c) Part of the PCB layout for the circuit is shown in Fig. 15.

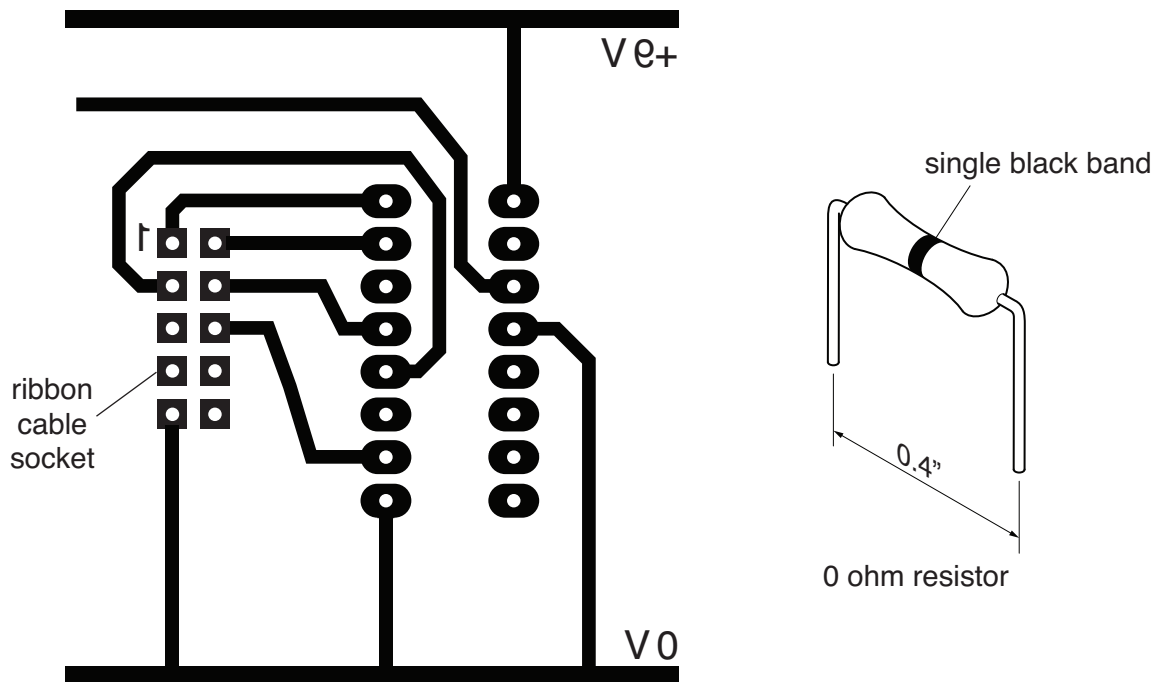


Fig. 15

- (i) Add the following **two** connections using a 0 ohm resistor to form a link if necessary.
Tracks must not be taken through the narrow gaps between pads.

**Pin 6 on the ribbon cable socket to output 4 (pin 10) on the IC.
Reset connection to output 7 (pin 6).**

[2]

- (ii) Explain how the use of 0 ohm resistors rather than a link wire could assist with batch production.

.....
.....
..... [2]

[Total: 10]

- 5 In a quiz competition the first of two teams to press their switch can answer the question. A logic system is used to decide which team pressed first.

- (a) (i) Complete Fig. 16 to show a switch arrangement that will produce a logic 1 signal at point **X** when the switch is pressed and a logic 0 signal when it is released.

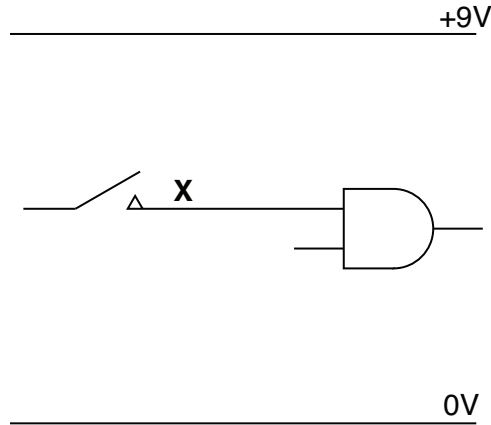


Fig. 16

[1]

- (ii) Fig. 17 shows part of the circuit diagram for the system.

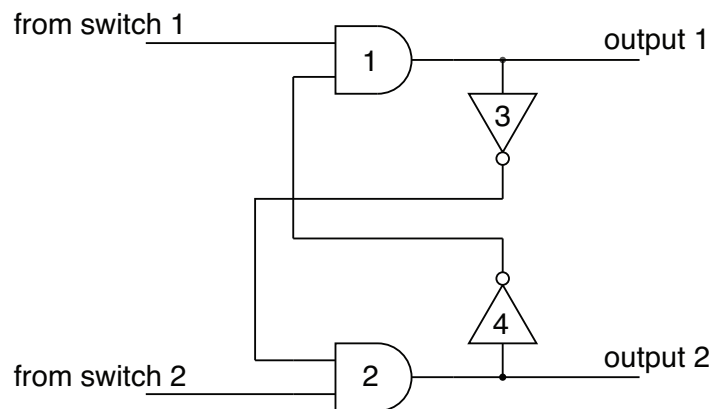


Fig. 17

Gates 3 and 4 connect the inverted output from an AND gate to an input of the other AND gate.

Describe the result of this connection from inverter to AND gate input.

.....
 [1]

(b) Complete Fig. 18 to show the logic levels of each gate when SW2 is pressed first.

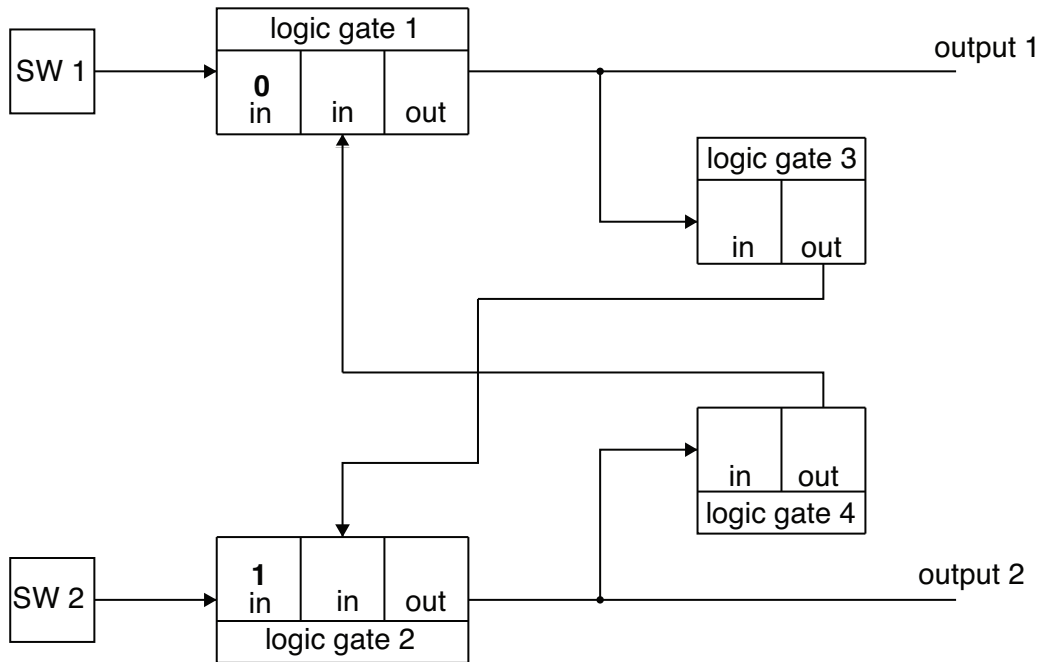


Fig. 18

[4]

(c) On Fig. 19 add a suitable logic gate and complete the connections to show how either output can operate the buzzer.

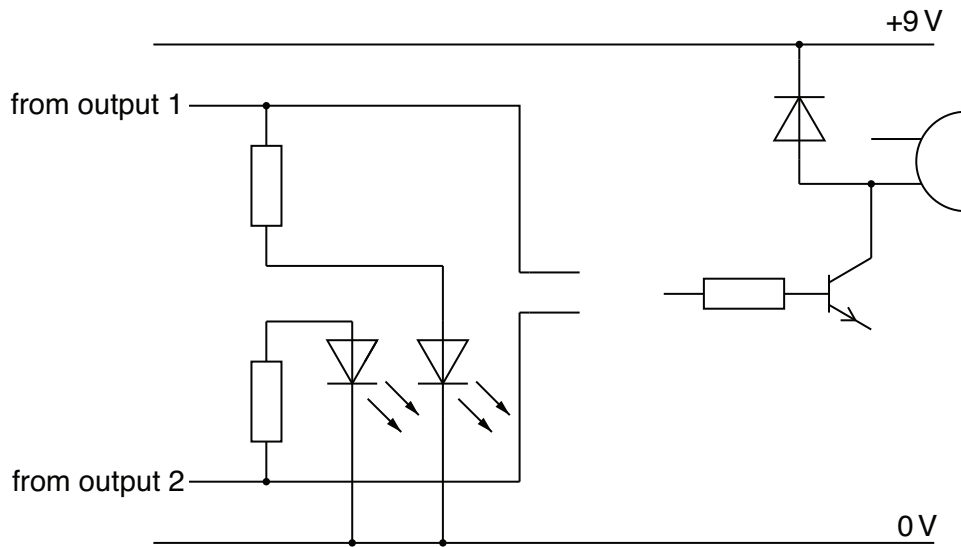


Fig. 19

[2]

(d) A PIC circuit could be an alternative method to the use of logic gates. Explain how the two circuits could be evaluated to find the most suitable.

.....

.....

..... [2]

[Total: 10]

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