ENGINEERING PROGRAMMABLE SYSTEMS

INCLUDED ON THE
KS4 PERFORMANCE TABLES

Examiners' report

OCR Level 1/Level 2

Cambridge National in

Engineering Programmable Systems

J824

For first teaching in 2022 | Version 1

R047 Summer 2025 series

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Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

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R047 series overview

This component of the Programmable Systems qualification consists of two sections: Section A and Section B.

Section A consists of ten multiple choice questions, with each having one correct answer and three distractors.

Section B of the paper consists of six questions, which are designed to test candidate's knowledge of the wider specification and their ability to respond to key command words.

To do well in this paper, candidates need to have a good understanding of circuit components and their uses, as well as the design, development, and manufacture of printed circuit boards, using various methods and technologies.

A high proportion of candidates attempted all 16 Questions, but their knowledge of some sections of the specification appeared to be limited in a number of cases. This was apparent, especially among questions linked to test equipment and super capacitors, where candidates may have limited first-hand experience of some areas within these topics.

Several questions still saw a high proportion to which no response was given. Candidates should be advised to attempt all questions.

The standard of presentation and handwriting was sometimes poor, making some responses difficult to follow.

It was good to note that a large proportion of candidates obtained high marks by carrying out calculations correctly, ensuring that all stages of workings were shown, supported using the correct formulas and units.

In several cases, it was clear that candidates had not read questions carefully enough before giving their answers, resulting in a loss of marks. This was evident in questions where candidates were asked to state what was meant by specific circuit parameters.

The mandatory NEA components (R048 and R049) allow candidates to apply some of the knowledge that they will need to recall in R047, as well as doing it in a more practical manner.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• analysed scenarios, leading to the selection of suitable circuit components • accurately explained the function of input components and process devices • produced clear and justified responses for the Level of Response question • performed accurate calculations, showing clear workings, supported by units • accurately applied knowledge of command words to respond to questions set • applied prior knowledge of output components to evaluate their suitability for specific applications.	• found it difficult to select specific circuit components, especially in unfamiliar situations • showed limited knowledge linked to the function of process devices • produced responses to the Level of Response question that lacked depth and understanding of commercial production methods • were unable to use justification to support responses • showed limited knowledge of circuit test equipment and its safe use.

Section A overview

Section A consists of ten multiple choice questions, with each having one correct answer and three distractors. Candidates should be advised to read all available options carefully before selecting an appropriate answer.

Question 1

1 Which of these describes a **smart sensor**?

(a) A sensor that has a built-in screen ☐

(b) A sensor that has WiFi capability ☐

(c) A sensor that must be wired into a circuit ☐

(d) A sensor that requires an additional power source ☐

[1]

Most candidates correctly chose 'A sensor that has WiFi capability', with very few selecting the three distractors.

Question 2

2 Which of these unit submultiples means divide the value by 1000?

(a) Micro ☐

(b) Milli ☐

(c) Nano ☐

(d) Pico ☐

[1]

Candidates who did well on this question correctly identified 'Milli' as the correct response.

Some candidates showed limited understanding of submultiples, with a proportion incorrectly selecting 'Micro'.

Question 3

3 Which of these process devices adds up the number of input signals that it receives?

(a) Amplifier ☐

(b) Counter ☐

(c) Latch ☐

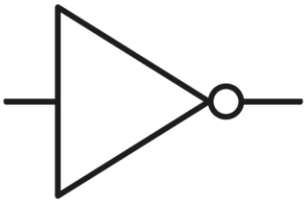
(d) Timer ☐

[1]

Many candidates were able to correctly identify 'Counter' as the correct response.

Question 4

4 What logic gate does this circuit symbol represent?



(a) AND ☐

(b) NAND ☐

(c) NOT ☐

(d) OR ☐

[1]

Most candidates correctly chose 'NOT', with few selecting the three distractors.

Question 5

5 Which of these is an advantage of using block-based programming editors?

(a) Code is inputted as a series of 1s and 0s ☐

(b) Does not require knowledge of actual programming code ☐

(c) Offers maximum programming functionality ☐

(d) Uses standard symbols and arrows to show program flow ☐

[1]

Generally well-answered by candidates, selecting 'Does not require knowledge of actual programming code'. Several candidates chose the distractor of 'Code is inputted as a series of 1s and 0s'.

Question 6

6 Which of these describes photo etching?

(a) A PCB production process where a CNC tool is used to remove excess copper ☐

(b) A PCB production process where chemicals are used to remove excess copper ☐

(c) A PCB assembly process where components are attached using solder paste ☐

(d) A PCB assembly process where components are manually soldered in place ☐

[1]

Successful responses identified 'A PCB production process where chemicals are used to remove excess copper' as the correct answer. Several candidates chose the distractor of 'A PCB production process where a CNC tool is used to remove excess copper'.

Question 7

7 Which of these circuit prototyping methods involves physically placing components in rows of holes, without any soldering?

(a) Breadboarding ☐

(b) CAD modelling ☐

(c) Making a PCB ☐

(d) Stripboarding ☐

[1]

Generally well-answered by candidates, selecting 'Breadboard' as the correct response. Several candidates chose the distractor of 'Strip boarding'.

Question 8

8 Which of these resistor types has a resistance value that changes when a screw fitting or knob is turned?

(a) Fixed ☐

(b) Light dependent ☐

(c) Temperature dependent ☐

(d) Variable ☐

[1]

Most candidates correctly chose 'Variable', with very few selecting the three distractors.

Question 9

9 Which of these is the correct formula for Watt's Law?

(a) $P = I^2V$ ☐

(b) $P = IV$ ☐

(c) $P = IV^2$ ☐

(d) $P^2 = IV$ ☐

[1]

Many candidates were able to correctly identify 'P=IV' as the correct response.

Question 10

10 Which of these display screen types could be used as an input device for a railway ticket machine?

(a) Backlit with a lamp ☐

(b) Liquid crystal display ☐

(c) Plasma display ☐

(d) Touchscreen ☐

[1]

Most candidates correctly chose 'Touchscreen', with very few selecting three distractors.

OCR support

Further guidance, support and resources for delivering this component can be found on the subject page.

Section B overview

Section B of the paper consists of six questions, which are designed to test candidate's knowledge of the wider specification and their ability to respond to key command words.

Question 11 (a) (i)

11 You are developing a safety light system to make people more visible when walking at night.

The system must produce a flashing light when manually turned 'on' by the user.

(a)
(i) Identify **two input** devices that could be used to manually turn the flashing light on.

State how **each input** device would function to achieve this outcome.

Input device 1 .....

How it functions .....

.....

[2]

Input device 2 .....

How it functions .....

.....

[2]

A large proportion of candidates were able to identify two suitable input devices that could manually turn on the flashing light, with most selecting push-to-make and single pole single throw switches.

Where responses were not awarded marks for the input devices selected, this was due to them being too vague and were not specific input devices, such as 'switch', 'button' or 'sensor'.

Candidates did less well when it came to describing the function of the chosen input devices, with a large proportion giving vague or incorrect descriptions that did not link to the chosen device.

Those that did well were able to state how the specific input device functions, with a large proportion linking it to current flow.

Assessment for learning

Candidates should be advised to practice identifying components to various scenarios, supported by how the specific component functions.

Exemplar 1

State how **each input** device would function to achieve this outcome.

Input device 1 Single pole single throw (SPST) switch

How it functions allows current to flow when closed and stops current flow when open so light starts when switch is pressed and closed. **[2]**

Input device 2 sensor

How it functions when pressed by another conductive medium (finger), the light can be turned on. **[2]**

For input device 1, the candidate has correctly identified an SPST switch as a suitable input device to manually turn the flashing light on.

They have stated how the chosen input device would function, linking the response to current flow and contact positions. This should be seen as good practice.

The candidate has given a vague response of 'sensor' for input device 2. This would be seen as being too vague, with no marks being awarded for this response.

Due to the candidate receiving no marks for the chosen input device, they are unable to gain any marks for how that chosen component functions.

Question 11 (a) (ii)

(ii) Identify **one non-programmable** process device that would be capable of producing the signals to flash the light.

State how the process device would function to achieve this outcome.

Process device .....

How it functions .....

.....

[2]

Responses to this question were found to be very mixed, with a proportion of candidates showing limited knowledge of processes devices that were suitable for making the light flash.

Where candidates did select a suitable process device, most focused around 'timer', with some specifically given 'pulse generator'.

A high proportion of candidates incorrectly stated 'flashing LED' as a process device.

Few candidates were able to state how the chosen process device functioned, with many responses being vague.

It is suggested that candidates identify a use for all process devices shown on page 18 of the OCR specification, as well as being able to describe how each of them function.

Question 11 (b)

(b) A light emitting diode (LED) is to be used as the output device for the safety light system.

Evaluate the suitability of an LED for this application.

.....

.....

.....

.....

.....

..... **[4]**

A generally well-answered question, with a high proportion of candidates achieving two to three marks.

It was clear that candidates had used LEDs within their centres and were able to apply this knowledge to give reasons why this output device is suitable for the given application.

Where higher marks were awarded for this question, candidates were able to expand the point fully, with suitable justification.

Question 12 (a) (i)

12
(a) What are each of these electronic circuit parameters?

(i) Power

.....

..... **[1]**

A high proportion of candidates were unable to define 'Power' as a circuit parameter, with many responses stating the 'unit' of Watts.

Where marks were awarded for this question, it was clear that candidates had practised recalling the definition for this circuit parameter. This should be seen as good practice.

A full list of circuit parameters can be found on page 16 of the OCR specification.

Question 12 (a) (ii)

(ii) Potential difference

.....

..... **[1]**

A high proportion of candidates were unable to define 'Potential difference' as a circuit parameter, with many responses stating the 'Volts'.

This question also saw a high number of no responses.

Where candidates were awarded the mark, they were able to link their answer to the difference in electrical potential between two points in a circuit.

Question 12 (a) (iii)

(iii) Frequency

.....

..... **[1]**

This question saw a high proportion of no responses (NR)

Where candidates were awarded marks, they were able to link their answer to the number of waves generated per second or that pass a 'fixed point'.

Question 12 (b) (i)

(b)

(i) A 12 Ω, 33 Ω and a 180 Ω resistor are connected in a series arrangement.

Calculate the total resistance of this arrangement.

Give your answer in ohms.

Show all your working.

Total resistance = ... Ω **[3]**

A generally well-answered question, with a high proportion of candidates achieving two out of three marks.

Where candidates did not gain full marks, this was due to them failing to state the formula for series resistors as the first step.

A small number of candidates gave the formula for a parallel resistor arrangement.

Question 12 (b) (ii)

(ii) The resistor arrangement described in **(b)(i)** is connected to a 5V battery.

Calculate the current flowing through the arrangement.

Give your answer using the correct unit.

Show all your working.

Current = ... Unit = ... **[4]**

A high proportion of candidates were able to recall Ohm's law and correctly apply it to the values given.

Most candidates showed all stages of working, laying out the response in a logical order, leading to the correct answer and units.

Where candidates did not do so well, it saw some confusion, with candidates dividing 225 by 5 to give an answer of 45.

Exemplar 2

Show all your working.

$V = I R$

$I = \frac{V}{R}$

$\frac{5}{225} = 0.02$

Current = 0.02 Unit = A **[4]**

The candidate has stated the correct formula for Ohm's law and shown it correctly rearranged.

They have taken the battery voltage from the question and divided this by the total resistance from the previous Question (12 b (i)).

Having shown that they can substitute the correct values, they have then calculated the answer to two decimal places and supported this with the correct unit for current for full marks to be awarded.

Question 13 (a)

13

(a) State **two** advantages and **two** disadvantages of using flow soldering to assemble circuits.

Advantage 1 .....

.....

Advantage 2 .....

.....

Disadvantage 1 .....

.....

Disadvantage 2 .....

.....

[4]

Responses to this question saw many vague responses, with candidates giving responses such as 'cheap', 'simple' and 'quick'.

Where marks were awarded, candidates were able to state advantages linked to it being a fast process and the fact that it uses automation.

Where marks were awarded linked to disadvantages, these tended to focus on the high initial setup costs linked to this process.

It is suggested that where equipment is unavailable, candidates might benefit from online video clips to demonstrate the process.

Question 13 (b)

(b) Discuss the reasons why **pick and place assembly** is used to construct commercial circuits.

.....

.....

.....

.....

.....

..... **[6]**

Candidates who did well on this question were able to give a thorough discussion, typically consisting of three to four points linked to the reasons why pick and place assembly is used to construct commercial circuits.

A large proportion of candidates were only able to identify one to two relevant points, with most discussions linking to speed, reduction in time and human error.

Although a large proportion were able to identify these relevant points, many did not develop these further to access the higher mark bands.

Candidates may benefit from practising this style of question for a range of different topic areas shown within the OCR specification, ensuring that points raised are then developed using phrases such as 'so….'.

Exemplar 3

Pick and place is more accuate than manual workers and is more consistent between circuits. Although it costs more money to buy the machines and costs requires more electricity to run them, the fact that they can work 24/7 and produce very few defective circuits means that they can are financially profitable. Also, manual workers require training which is not needed for a machine since it is already programmed to do so, which saves more time and money.

The candidate has given a thorough discussion linked to the reasons why pick and place is used in constructing commercial circuits.

They have shown a good understanding of the topic, with a range of reasons being clearly given, such as accuracy, cost and programming.

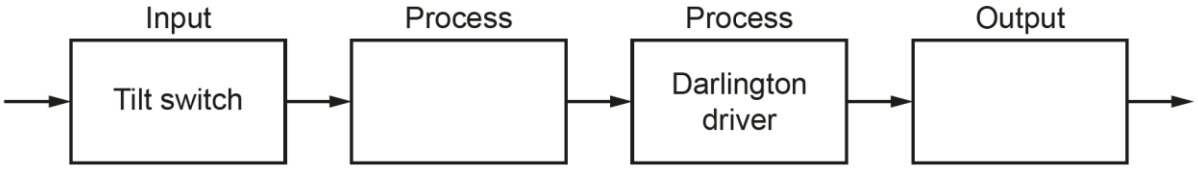
For the reasons identified, they have developed these further with support of appropriate terminology to be awarded full marks.

Question 14 (a)

14 You are designing a system that can detect and make a sound when an object is tilting at an angle.

An incomplete block diagram for the system is shown below.

(a) Complete the block diagram by adding a **buzzer** and a **microcontroller** into the correct blocks.



[2]

Generally well-answered by the candidates, with most being able to place the 'microcontroller' and 'buzzer' in the correct blocks.

Question 14 (b)

(b) Describe the purpose of the arrows in the block diagram in **(a)**.

.....

.....

.....

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

Candidates who did well on this question linked their response to the direction of flow in the system.

Few candidates referred to the fact that these are 'signal arrows', with a high proportion of candidates incorrectly giving responses linked to 'the order' of the components.

It is advised that this topic is discussed further when creating system block diagrams as part of topic 1 of the R049 NEA.

Question 14 (c)

(c) Explain the function of the **Darlington driver** within the system.

.....

.....

.....

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

This question saw a high number of incorrect or no responses (NR).

Where candidates did give a response, a high proportion gave vague comments linked to the Darlington driver 'sending signals to the buzzer' or 'powering the buzzer'.

Where candidates did show an understanding of the driver, they were able to give comments linked to it boosting the current or making the buzzer louder.

Question 14 (d)

(d) Explain **two** advantages of using a microcontroller in this system.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[4]

Many candidates clearly had experience of using microcontrollers from unit R049 of the specification.

A high proportion of candidates were able to identify two advantages, with most linking to it replacing physical hardware and the fact that it can be reprogrammed.

Most candidates did not go on to 'explain', for them to be awarded two marks for each response.

OCR support

Candidates could be directed to the OCR command words guidance on page 9.

Question 15 (a)

15

(a) State **one** use of a capacitor within a circuit.

.....

..... **[1]**

Candidates who did well on this question linked their answer to the fact that a capacitor can store charge or that it can be used as a time delay.

A large proportion of candidates knew that this component was a storage device, but their comments incorrectly linked to its ability to store energy, power, electricity or current.

Question 15 (b)

(b) Explain the difference between a polarised capacitor and a non-polarised capacitor.

.....

.....

.....

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

Candidates generally achieved one mark for this question.

Those who did well were able to give responses linked to both polarity and orientation of the polarised and non-polarised capacitors.

A large proportion of candidates were able to explain that a polarised capacitor has a positive and negative leg, but they did not go on to make any comparison against this and a non-polarised capacitor.

Some responses showed a lack of understanding of what these passive components do.

Question 15 (c) (i)

(c)
(i) State **three** applications of supercapacitors when they are used as power supplies.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

This question was generally awarded low marks.

Where marks were awarded for this question, candidates gave applications linked to their use as a backup power supply, regenerative braking system and powering electric busses/trains.

A high proportion of candidates gave vague responses linked to mobile phones, tablets and car batteries, without giving its specific application within these devices.

Candidates may benefit from practising this style of question for the four power supplies shown on page 19 of the OCR specification.

Question 15 (c) (ii)

(ii) Explain **two** reasons why supercapacitors are more sustainable power supplies than batteries.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[4]

A high proportion of candidates were able to give reasons why a capacitor may be used instead of a battery but showed few links to one being more sustainable than the other, therefore being awarded no marks for their response.

Candidates who did well on this question linked their responses to the fact that supercapacitors use less hazardous materials/chemicals and their ability to be charged more times without degradation.

Question 16 (a)

16

(a) State **three** safety precautions that should be taken when using a logic probe to test the functionality of a circuit.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

A proportion of candidates were able to state one safety precaution when using a logic probe, with most of these linking to exposed wires, sharp points on the probe or water being nearby.

Many responses incorrectly referred to the use of goggles and aprons.

It is suggested that candidates practice identifying safety precautions for different test equipment, as shown on page 20 of the OCR specification.

Question 16 (b)

(b) Describe **five** steps that should be followed when using a signal generator to test a circuit.

Step 1 .....

.....

Step 2 .....

.....

Step 3 .....

.....

Step 4 .....

.....

Step 5 .....

.....

[5]

This question was generally awarded low marks, with many no responses (NR) being given.

It was clear that many candidates had little experience of using a signal generator and were unfamiliar of the reason why it would be used to test a circuit (as this may have helped when working out the five steps).

This led to candidates being unfamiliar with where the signal generator should be connected to a circuit, with some candidates becoming confused between this and an oscilloscope.

A proportion of candidates gave vague steps such as 'turn it on' and 'plug it in', which were awarded no marks.

Candidates who did well on this question gave steps linked to turning on the signal generator, setting the wave type and observing the tested circuit.

It is suggested that where test equipment is unavailable, candidates might benefit from online video clips to demonstrate the process. Please see page 20 of the OCR specification for a full list of test equipment.

Question 16 (c)

(c) Explain **one** characteristic of flexible PCBs.

.....

.....

.....

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

The majority of candidates showed good understanding of flexible PCBs, giving comments linked to the fact that it can be bent or that it will not break when it is bent or twisted.

A high proportion of candidates achieved one mark for this question due them not explaining the one characteristic, by expanding the identified characteristic with comments such as 'so that……'.

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