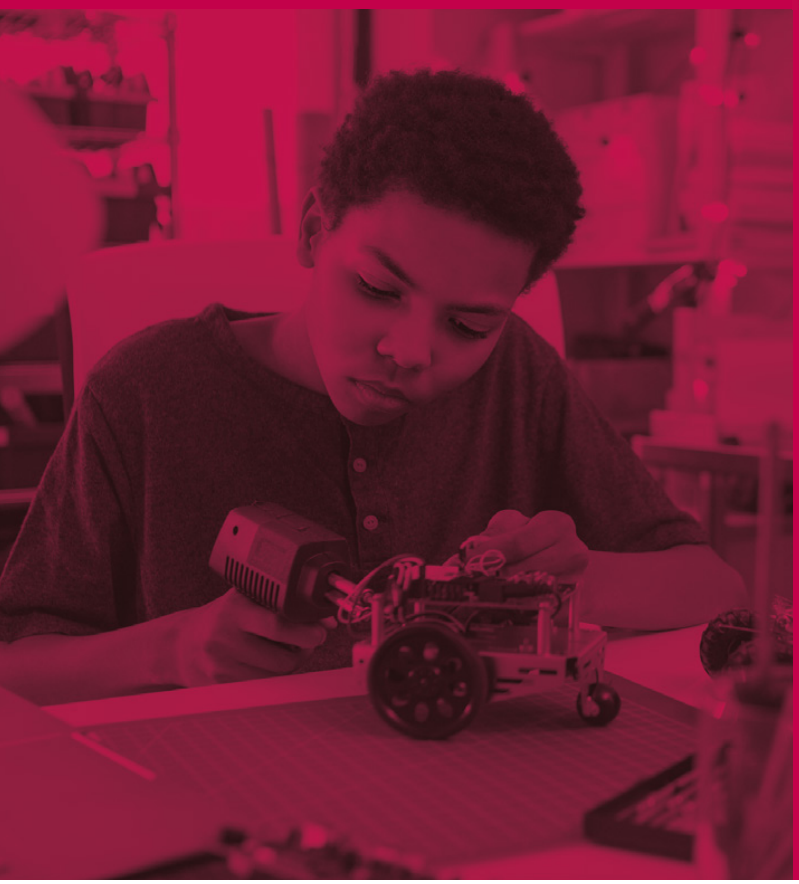
ENGINEERING PROGRAMMABLE SYSTEMS



INCLUDED ON THE
KS4 PERFORMANCE TABLES

Specification

OCR Level 1/Level 2

Cambridge National in

Engineering Programmable Systems

J824

Version 2 (First teaching September 2022)

ocr.org.uk/cambridgenationals

Cambridge Nationals

OCR
Oxford Cambridge and RSA

Specification updates

Key changes have been listed below:

Section	Change	Version and date issued
Qualification overview Section 6.1.1: Centre and teacher/ assessor responsibilities Section 6.2: Requirements and guidance for delivering and marking the OCR-set assignments Section 6.3: Feedback Section 6.4.4: Reattempting work before submitting marks to OCR	Updated to clarify information relating to NEA resubmissions.	Version 2 (May 2022)
Section 6.5: Moderating NEA units	Updated information on how to submit moderated units.	
Section 6.6: Resubmitting moderated work to OCR to improve the grade Section 6.7: Recording feedback and decisions	New sections added to clarify information relating to NEA resubmissions.	
Section 7: Administration	Updated information to clarify administrative arrangements.	
Appendix A: Guidance for the production of electronic evidence	Updated information related to 'Submit for Assessment'.	
All	Weblinks updated.	

Contents

1 Why choose OCR?

Choose OCR and you've got the reassurance that you're working with one of the UK's leading exam boards. We have developed our specifications in consultation with teachers, employers and subject experts to provide students with a qualification that's relevant to them and meets their needs.

We're part of Cambridge University Press & Assessment. We help millions of people worldwide unlock their potential. Our qualifications, assessments, academic publications and original research spread knowledge, spark curiosity and aid understanding around the world.

We work with a range of education providers, including schools, colleges, workplaces and other institutions in both the public and private sectors. Over 13,000 centres choose our A Levels, GCSEs and vocational qualifications including Cambridge Nationals and Cambridge Technicals.

1.1 Our specifications

We believe in developing specifications that help you bring the subject to life and inspire your students to achieve more**.** We've created teacher-friendly specifications based on extensive research and engagement with the teaching community. They're designed to be straightforward and accessible so that you can tailor the delivery of the course to suit your needs.

1.2 Our support

We have a range of support services to help you at every stage, from preparation to delivery.

- A wide range of high-quality creative resources including resources created by leading organisations within the industry.
- Textbooks and teaching and learning resources from leading publishers. For more information about all the published support for the Cambridge Nationals that has been endorsed by OCR please go to the Cambridge Nationals page on our website.
- Professional development for teachers to fulfil a range of needs. To join our training (either face-to-face or online) or to search for training materials, please go to the Professional Development page on our website.
- Active Results is our free results analysis service to help you review the performance of individual students or whole schools.
- ExamBuilder is our free question-building platform that helps you to build your own tests using past OCR exam questions.
- OCR subject advisors provide information and support to centres including specification and non examined assessment advice, updates on resources developments and a range of training opportunities. They work with subject communities through a range of networks to share ideas and expertise to support teachers.

Further help and support

Whether you are new to OCR or already teaching with us, you can find useful information, help and support on our website. Or get in touch:

support@ocr.org.uk

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1.3 Aims and learning outcomes

Our Cambridge National in Engineering Programmable Systems will encourage students to:

- understand and apply the fundamental principles and concepts of Engineering Programmable Systems, including the principles of electronic circuits, the components and devices used in electronic and programmable systems, and how to construct and test them
- develop learning and practical skills that can be applied to real-life contexts and work situations
- think creatively, innovatively, analytically, logically and critically
- develop independence and confidence in using skills that would be relevant to the maintenance, installation and repair sector and more widely
- use computer aided design (CAD) software to produce diagrams and simulate circuits
- construct and test electronic circuits for a specific purpose, using tools and equipment to assemble printed circuit boards
- solve problems using microcontroller programs to develop programmable systems and test that they solve such problems.

1.4 What are the key features of this specification?

The key features of OCR's Cambridge National in Engineering Programmable Systems for you and your students are:

- a simple and intuitive assessment model, consisting of an externally assessed unit that focuses on knowledge and understanding and two skills-based, non examined assessment units (NEA)
- a specification developed with teachers specifically for teachers. The specification lays out the subject content clearly
- a flexible support package formed after listening to teachers' needs. The support package will help teachers to easily understand the requirements of the qualification and how it is assessed
- a team of OCR Subject Advisors who support teachers directly and manage the qualification nationally
- the specification has been designed to progress onto Level 3 Vocational Engineering, Design and Technology at A Level, or a range of related Apprenticeships in the sector.

This qualification will help students to develop:

- valuable practical skills that are highly sought after in the workplace
- a deep understanding of the key principles that underpin how electronic and programmable technologies work.

All Cambridge Nationals qualifications offered by OCR are regulated by Ofqual, the Regulator for qualifications offered in England. The qualification number for OCR's Cambridge National in Engineering Programmable Systems is QN 603/7088/9.

2 Qualification overview

2.1 OCR Level 1/Level 2 Cambridge National in Engineering Programmable Systems at a glance

Qualification number	603/7088/9	**OCR Entry code**	J824
First entry date	01/09/2022	**Approved age range**	14-16
Guided learning hours (GLH)	120	**Performance information**	We've designed this qualification to meet the Department for Education (DfE) requirements for qualifications in the Technical Award category of the 14-16 performance tables
Total qualification time (TQT)	143	**Eligible for funding**	It's designed to meet the funding requirements of a 14-16 study programme.
This qualification is suitable for students	• aged 14-16 on a full-time study programme wanting to develop applied knowledge and practical skills in engineering programmable systems • who want to progress onto other related study, such as qualifications in Engineering or Design and Technology • as it is designed to meet the Department for Education's characteristics for a Technical Award.		
Entry requirements	There is no requirement for students to achieve any specific qualifications before taking this qualification.		
Qualification requirements	Students must complete three units: • one externally assessed unit (exam) • two centre-assessed units (NEA).		
Assessment method/ model	Unit R047 is assessed by an exam and marked by us. Your teachers will assess the NEA units and we will moderate them either using the OCR Repository or postal moderation.		
Assessment series each year	• January • June		
Terminal assessment	The exam must be taken in the final assessment series before qualification certification. The result from the exam taken in the final series will be the one that counts towards a student's overall grade.		
Grading	All results are awarded on the following scale: Level 2 – Distinction* (*2), Distinction (D2), Merit (M2), Pass (P2) Level 1 – Distinction (D1), Merit (M1), Pass (P1) and Fail/Unclassified.		
Exam resits	Students can resit the exam but the result from the exam taken in the series where students certificate would be the result to count towards performance measures.		

Repeat submission of students' NEA work	If students have not performed at their best during the assessment of NEA units, they can improve their work and submit it to you again for assessment. They must have your agreement and you must be sure it is in the student's best interests. We use the term 'resubmission' when referring to student work that has previously been submitted to OCR for moderation. Following OCR moderation a student can attempt to improve their work, for you to assess and provide the final mark to us. There is one resubmission opportunity per NEA assignment. All work submitted (or resubmitted) must be based on the assignment that is live for the series of submission. For information about feedback see section 6. The final piece of work must be completed solely by the student and teachers must not detail specifically what amendments should be made.

2.2 Qualification structure

For this qualification, students must achieve **three** units: one externally assessed and two Non Examined Assessment (NEA) units.

Key to units for this qualification:

M = Mandatory	Students must achieve this unit
E = External assessment	We set and mark the exam
N = NEA	You assess this and we moderate it

Unit no.	Unit title	Unit ref. no. (URN)	Guided learning hours (GLH)	How are they assessed?	Mandatory or optional
R047	Principles of electronic and programmable systems	H/618/5835	48	E	M
R048	Making and testing electronic circuits	K/618/5836	36	NEA	M
R049	Developing programmable systems	M/618/5837	36	NEA	M

OCR
Oxford Cambridge and RSA

OCR Level 1/Level 2 Cambridge National in Engineering Programmable Systems

Qualification number: 603/7088/9

Type of qualification: Technical Award

Purpose statement

Overview

Who is this qualification for?

The OCR Level 1/Level 2 Cambridge National in Engineering Programmable Systems is aimed at students aged 14-16 and will develop knowledge, understanding and practical skills that would be used in the maintenance, installation and repair sector.

You may be interested in this if you want an engaging qualification where you will use what you learn in practical, real-life situations, such as:

- Understanding electronic circuits
- Constructing and testing an electronic circuit
- Developing a programmable system.

This will help you to develop independence and confidence in using skills that would be relevant to the maintenance, installation and repair sector.

The qualification will also help you to develop learning and skills that can be used in other life and work situations, such as:

- Solving problems by identifying and rectifying any faults in electronic circuits
- Analysing information and showing the ability to make informed decisions
- Planning a sequence of processes. This will involve managing your time and identifying the resources you will need, as well as reviewing your plans if necessary.

This qualification will complement other learning that you're completing for GCSEs or vocational qualifications at Key Stage 4 and help to prepare you for further study.

What will you study as part of the qualification?

You will study how electronic and programmable technologies work, and have the opportunity to apply what you learn through a number of practical experiences. This will involve you studying three mandatory units:

- **R047: Principles of electronic and programmable Systems**
  This is assessed by an exam.
  In this unit you will learn about the relationships between voltage, current, resistance and power, and the ways in which systems are represented, tested and assembled. Topics include:
  - Basic electronic circuit principles
  - Electronic and programmable systems, components and devices
  - Methods of prototyping and testing systems and circuits
  - Commercial circuit production and construction methods.
- **R048: Making and testing electronic circuits**
  This is assessed by a set assignment.
  In this unit you will learn how to use Computer Aided Design (CAD) software to simulate electronic circuits, as well as how to construct and test them. Topics include:
  - Drawing and simulating electronic circuits
  - Constructing electronic circuits
  - Testing electronic circuits
- **R049: Developing programmable systems**
  This is assessed by a set assignment.
  In this unit you will learn how to how to determine hardware and system requirements to meet a given brief, and select appropriate input and output devices. Topics include
  - Plan the development of programmable systems
  - Develop programmable systems
  - Test programmable systems.

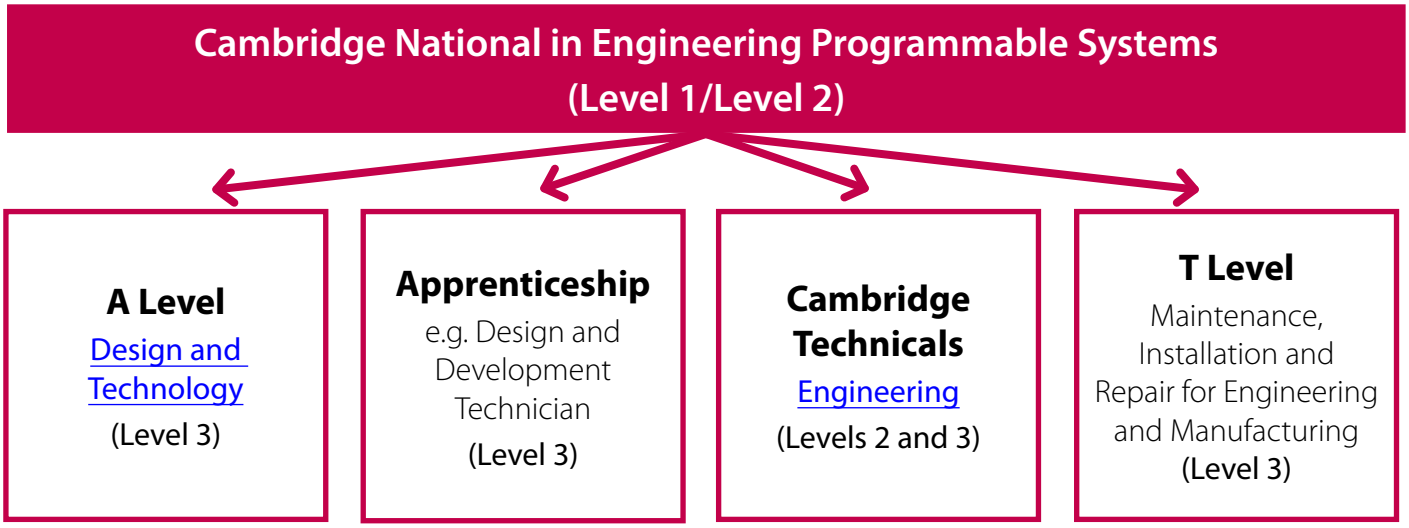
What knowledge and skills will you develop as part of this qualification and how might these be of use and value in further studies?

This qualification will enable you to learn about basic electronic circuits and understand the different components and devices that can be used in programmable systems. You will develop the ability to draw and simulate electronic circuits so that you can construct and test them. You will also learn how to develop and test a programmable system.

These skills will help you progress onto further study in the maintenance, installation and repair sector.

This may be Level 3 vocational qualifications, such as the Cambridge Technical in Engineering, A-Levels, such as A-Level Design and Technology, or one of the number of Maintenance and Operations Engineering Technician Apprenticeships. It is anticipated that these qualifications will also enable you to progress onto a T Level such as Maintenance, Installation and Repair, when they are available.

The diagram below shows the possible progression routes for your further study:



Which subjects will complement this course?

Other subjects that supplement or complement this qualifications include:

- Cambridge National in Engineering Design
- Cambridge National in Engineering Manufacture
- GCSE Design and Technology
- GCSE Computer Science
- GCSE Science.

Further details

More information about the Cambridge National in Engineering Programmable Systems can be found in these documents:

Specification

Sample Assessment Material (SAM)

Guide to our Sample Assessment Material

Student guide to NEA assignments

Understanding the assessment: examined and moderated

3 About this qualification

3.1 Qualification size (GLH and TQT)

The size of the qualification is described in terms of Guided Learning Hours (GLH) and Total Qualification Time (TQT).

GLH indicates the approximate time (in hours) the teacher will spend supervising or directing study and assessment activities. We have worked with people who are experienced in delivering related qualifications to determine the content that needs to be taught and how long it will take to deliver.

TQT includes two parts:

- GLH
- an estimate of the number of hours a student will spend on unsupervised learning or assessment activities (including homework) to successfully achieve their qualification.

OCR Level 1/Level 2 Cambridge National in Engineering Programmable Systems is 120 GLH and 143 TQT.

3.2 Language

This qualification and its assessment materials are available in English only.

Only answers provided in English will be assessed.

3.3 Performance information

We've designed this qualification to meet the Department for Education (DfE) requirements for qualifications in the Technical Award category of the 14-16 performance tables.

You'll find information on performance tables for England on the Department for Education website.

4 Units

4.1 Guidance on unit content

This section describes what must be taught so that students can access all available marks.

4.1.1. Externally assessed unit (R047)

The externally assessed unit is made up of a number of topic areas. Each topic area has related teaching content that must be taught. A direct question may be asked about any content in the teaching content column.

The breadth and depth column helps to clarify the breadth and depth of teaching needed, and indicates the range of knowledge and understanding that may be assessed in the exam. This column also confirms any aspects that you do **not** need to teach in relation to the content as 'does not include' statements.

Knowledge and understanding

Students will need to **understand** the content unless the breadth and depth column identifies it as knowledge only.

- Any item(s) that should be taught as knowledge only will start with the word 'know' in the breadth and depth column.
- All other content is expected to be taught as understanding.

The table below explains what we mean by knowledge and understanding.

Knowledge	• Be able to identify or recognise a given item, for example on a diagram • Use direct recall to answer a question, for example the definition of a term.
Understanding	• To assess and evidence the perceived meaning of something in greater depth than straight identification or recall. • Understanding will be expressed and presented using terms such as: how; why; when; reasons for; benefits and drawbacks of; advantages and disadvantages of; purpose of; suitability of; recommendations for improvement; pros and cons; appropriateness of something to/in different contexts.

Students need to be taught the information in both the teaching content and breadth and depth columns.

4.1.2 NEA Units (R048 and R049)

The NEA units are made up of a number of topic areas with associated teaching content which details what must be taught as part of each topic area. The NEA units also have an exemplification column that provides more information about, and examples relating to, the teaching content. This helps to exemplify the teaching expected so that students are equipped to successfully complete their assignments.

4.1.3 Command words

Appendix B gives information about the command words that will be used in both the external assessments and the NEA marking criteria and the expectations of them.

4.1.4 Performance Objectives (POs):

Each Cambridge National qualification has related Performance Objectives. There are four Performance Objectives in the OCR Level 1/Level 2 Cambridge National in Engineering Programmable Systems.

Performance Objectives	
PO1	Recall knowledge and show understanding
PO2	Apply knowledge and understanding
PO3	Analyse and evaluate knowledge, understanding and performance
PO4	Demonstrate and apply skills and processes relevant to the subject area

PO1 is only relevant to the exam. PO4 is only relevant to the NEA assessments.

The weightings of the Performance Objectives across the units is:

Performance Objective	Externally assessed unit (range)	NEA units	Overall weighting
PO1	16.5%–20%	n/a	16.5%–20%
PO2	13.5%–17%	18%	31.5%–35%
PO3	5%–7%	15%	20%–22%
PO4	n/a	27%	27%
Overall weighting of assessments	**40%**	**60%**	**100%**

4.2 Unit R047: Principles of electronic and programmable systems

Aims

Electronic and programmable systems are all around us. From the technologies that protect our homes and businesses to the smart phones in our pockets, they play an ever-increasing role in our everyday lives. As this sector continues to grow at an increasingly fast rate, the role of electronic and programmable systems engineers will continue to become even more vital in the future.

In this unit, you will learn the key principles that underpin how electronic and programmable technologies work. You will learn about the relationships between voltage, current, resistance and power, and the ways in which systems are represented, tested and assembled commercially.

You will also develop your knowledge and understanding of electronic circuit components, including what different types of sensors and output devices do, and the methods used to program microcontrollers.

Unit R047: Principles of electronic and programmable systems

Topic Area 1: Basic electronic circuit principles

Teaching content	Breadth and Depth
1.1 Electronic circuit parameters	
1.1.1 Electronic circuit parameters and their SI or SI derived units of measurement: □ Potential difference ▪ volt (V) □ Current ▪ amp (A) □ Resistance ▪ ohm (Ω) □ Capacitance ▪ farad (F) □ Power ▪ watt (W) □ Frequency ▪ hertz (Hz)	To include: • The meaning and definition of each parameter
1.1.2 Unit multiples and submultiples: □ Mega (M) □ Kilo (k) □ Milli (m) □ Micro (μ) □ Nano (n) □ Pico (p)	To include: • Simplification and conversion of units between different multiples and submultiples

Unit R047: Principles of electronic and programmable systems

1.2 Electronic circuit theory, laws and associated calculations

1.2.1 Circuit theory: □ Electron flow □ Types of circuits ▪ series circuits ○ calculation of total resistance ▪ parallel circuits ○ calculation of total resistance □ The characteristics of types of signals and their waveforms: ▪ analogue ▪ digital □ Types of current ▪ alternating current (AC) ▪ direct current (DC)	To include: • What electron flow is in electrical circuits • The difference between series and parallel circuits • Use of circuits and signals in context • The advantages and disadvantages of analogue and digital signals • Sine waveform and square waveform including amplitude, frequency and periodic time • Calculation of total resistance of series and parallel circuits with a maximum of three resistors • The difference between alternating current and direct current Does not include: • Calculation of resistance in circuits that combine both series and parallel arrangements
1.2.2 The relationship between voltage, current and resistance: □ Ohm's Law ▪ calculations of voltage, current or resistance using V = I R	To include: • Calculations that involve rearranging the formula V = I R
1.2.3 The relationship between power, current and voltage: □ Watt's Law (power) ▪ calculations of power, current and voltage using P = I V	To include: • Calculations that involve rearranging the formula P = I V Does not include: • Calculating values using $P = I^2 R$

Topic Area 2: Electronic and programmable systems, components and devices

Teaching content	Breadth and Depth
2.1 Methods of representing electronic circuits and systems and interpretation of them	
□ The systems approach and system block diagrams: ▪ open and closed loop systems ▪ input, process and output blocks ▪ signal arrows ▪ feedback loops □ Circuit schematics □ Printed circuit board (PCB) layouts	To include: • The purpose of each method of representation • The difference between open and closed loop systems • Interpretation of block diagrams, circuit schematics and PCB layouts with a maximum of four system blocks and their associated components • Completing partially drawn block diagrams, circuit schematics and PCB layouts

Unit R047: Principles of electronic and programmable systems

2.2 The purpose, function and typical applications of electronic circuit components and devices including the recognition and interpretation of circuit symbols

2.2.1 Input components and devices: □ Switches: ▪ Single Pole Single Throw (SPST) switches ▪ push-to-make and push-to-break switches ▪ tilt switches ▪ reed switches ▪ Quantum Tunnelling Composite (QTC) switches □ Sensors: ▪ Light Dependent Resistors (LDRs) ▪ photodiodes ▪ NTC thermistors ▪ pressure sensors ▪ infrared sensors ▪ smart (WiFi enabled) sensors □ Touch screens	To include: • Drawing diagrams or schematics of specific circuits
2.2.2 Process components and devices: □ Amplifiers □ Counters □ Timers □ Latches □ Pulse generators □ Analogue to digital converters □ Logic functions, devices and their truth tables: ▪ AND ▪ OR ▪ NOT ▪ NAND ▪ application of logic gates singly and in combination	To include: • Drawing a logic circuit • The combination of logic gates up to two levels Does not include: • Drawing diagrams or schematics of specific circuits
2.2.3 Output components and devices □ Lamps □ Light emitting diodes (LEDs) □ LED displays □ Liquid crystal displays (LCDs) □ Buzzers □ Piezo sounders □ Motors	Does not include: • Drawing diagrams or schematics of specific circuits
2.2.4 Drivers and interface devices □ NPN transistors □ Darlington drivers □ Relays	Does not include: • Drawing diagrams or schematics of specific circuits

Unit R047: Principles of electronic and programmable systems

2.2.5 Passive components □ Resistors ▪ fixed ▪ variable □ Diodes □ Capacitors ▪ polarised ▪ non-polarised	Does not include: • Drawing diagrams or schematics of specific circuits
2.2.6 Power supplies □ Batteries □ Photovoltaic (solar) cells □ Supercapacitor □ Mains adaptor	To include: • The suitability of each power supply for different applications including consideration of sustainability Does not include: • Drawing diagrams or schematics of specific circuits
2.2.7 Wiring types and their characteristics □ Single strand (solid core) wire □ Multi-strand (flexible) wire	To include: • The suitability of each wiring type for different applications Does not include: • Multi-core cable (ribbon cable, domestic electrical wiring)
2.3 Programmable components and systems	
2.3.1 The main characteristics and typical applications of programmable components: □ Microcontrollers □ Programmable logic controllers (PLCs)	To include: • The advantages and disadvantages of using programmable components in the design and manufacture of systems
2.3.2 Types of programming languages and systems and their main features: □ Text-based languages □ Block-based editors □ Flowchart systems	To include: • The advantages and disadvantages of each type of programming language or system • Comparing the relative merits of each type for a specific application Does not include: • Writing/producing programs, either using general programming commands or via specific languages or systems

Topic Area 3: Methods of prototyping and testing systems and circuits

Teaching content	Breadth and Depth
3.1 The purpose and characteristics of methods of prototyping circuits and systems	
□ CAD modelling and simulation of circuits and programmable systems □ Modular systems kits □ Breadboard □ Stripboard □ Printed circuit boards (PCBs)	To include: • The advantages and disadvantages of each method and the reasons why they are used

Unit R047: Principles of electronic and programmable systems

3.2 The main characteristics, purpose and use of physical and virtual measurement and test equipment

□ Multimeter □ Continuity tester □ Oscilloscope □ Signal generator □ Logic probe	To include: • the process and safety precautions to follow when using each item of equipment to test a circuit • The benefits and limitations of each item of equipment • The safe setup and use of multimeter to measure DC voltage, current and resistance

Topic Area 4: Commercial circuit production and construction methods

Teaching content	Breadth and Depth
4.1 Printed circuit boards (PCBs)	
4.1.1 The methods and processes for safely producing printed circuit boards (PCBs): □ Photo etching □ CAM milling/routing	To include: • The advantages and disadvantages of each method and the reasons why they are used
4.1.2 The types, characteristics and typical uses of commercial PCBs: □ Single sided □ Double sided □ Flexible	Does not include: • Designing PCBs of each type
4.2 The characteristics and processes of commercial circuit assembly methods	
4.2.1 The types, characteristics and typical uses of commercial PCBs: □ Surface mount technology (SMT): ▪ pick and place assembly ▪ flow soldering □ Through-hole construction □ Manual soldering	To include: • The advantages and disadvantages of using each method and the reasons why they are used

Assessment guidance

This unit is assessed by an exam. The exam is 1 hour 15 minutes. It has two Sections — Section A and Section B.

- Section A has 10 marks
- Section B has 60 marks
- The exam has 70 marks in total

This will be conducted under examination conditions. For more details refer to the Administration area.

The Engineering Programmable Systems 'Exploring our exams: a guide to our sample assessment material' gives more information about the layout and expectations of the exam.

A range of question types will be used in the exam, but it will always require students to use the skills of analysis and evaluation.

Teaching content	
1.2.1	• Students will be expected to be able to calculate the total resistance of series and/or parallel circuits containing up to three resistors in each. • Students will not be expected to calculate resistances within circuits that combine both series and parallel arrangements, or for circuits containing more than three resistors.
1.2.2	• Students may be required to recall the formula. • Students will be expected to calculate different values using V = I R and P = I V, including through rearranging each formula, but not $P = I^2 R$. • Students should show their working and include the correct unit where required.
2.1	• Students may be asked to complete partially drawn block diagrams, circuit schematics and PCB layouts in the examination, but will not be expected to produce them from scratch. • Students may also be asked to interpret them and identify the main components or system blocks. Systems and circuits covered will have a maximum of four system blocks along with their associated components.
2.3.2	• Students will be expected to have an understanding of the characteristics, advantages and disadvantages of the types of programming languages and systems listed, but will not be expected to write or interpret programs using them in the examination.

Synoptic assessment

This unit allows students to gain underpinning knowledge and understanding relevant to the qualification and sector. The NEA units draw on and strengthen this learning with students applying their learning in a practical, skills-based way. The synoptic grids at the end of the NEA units show these synoptic links.

More information about synoptic assessment within this qualification can be found in section 5.2 synoptic assessment.

4.3 Unit R048: Making and testing electronic circuits

Aims

Electronic systems need to work correctly in order to meet the needs of consumers and to be successful in the marketplace. It is therefore essential that electronic engineers have the practical skills required to make and test circuits effectively.

In this unit you will learn the skills required to construct and test electronic circuits. You will learn how to simulate circuits using CAD software and physically inspect and test them once assembled. You will learn how to produce printed circuit boards (PCBs) similar to those used in commercial products and use tools and equipment to populate and assemble them with components. You will also develop your ability to identify common faults in circuits that do not work as expected.

Unit R048: Making and testing electronic circuits

Topic Area 1: Drawing and simulating electronic circuits

Teaching content	Exemplification
1.1 Use Computer Aided Design (CAD) software to produce diagrams and electronic circuits	
□ Circuit schematics □ Printed circuit board (PCB) layouts	To include: • Circuits with a maximum of four system blocks and their associated components • Circuit schematics using standard component symbols • PCB layouts from schematics. This should include: ○ use of track and component views ○ export of schematic diagrams ○ use of component libraries Does not include: ▪ Hand drawing of schematics and PCB layouts ▪ Programmable components and systems – these are covered in Unit R049
1.2 Use CAD software to simulate/test circuit schematics	
□ Overall circuit function □ Function of inputs, processes and outputs	To include: ▪ Circuits with a maximum of four system blocks and their associated components ▪ Use of virtual instruments within CAD software to measure voltage, current, resistance and signal waveforms

Unit R048: Making and testing electronic circuits

Topic Area 2: Constructing electronic circuits

Teaching content	Exemplification
2.1 Safely produce printed circuit boards (PCBs)	
□ Production of single sided PCBs □ Drilling holes for components	To include: • Production of PCBs using either etching or CAM milling (routing) techniques • Use of PCB drills or CAM equipment to drill holes in pads for components • Following safety procedures relevant to the equipment used. This could include the use of: ○ gloves, safety goggles and tongs when etching ○ guards and emergency stops when CAM milling ○ safety goggles and jigs when using a PCB drill Does not include: ▪ Production of double sided or flexible PCBs ▪ SMT circuit devices
2.2 Safely use tools and equipment to populate and assemble PCBs with components	
□ Soldering irons and solder □ Wire cutters □ Wire strippers □ Pliers □ De-soldering tools □ Helping hands	To include: • PCBs with a maximum of four system blocks and their associated components • Positioning and soldering components and wiring external components to PCBs • Trimming component legs • Cutting wires to size and stripping insulation • Removing excess solder • Following safe working procedures when using tools and equipment

Unit R048: Making and testing electronic circuits

Topic Area 3: Testing electronic circuits

Teaching content	Exemplification
3.1 Safely test and evaluate electronic circuits	
□ Visual inspection □ Functional testing of assembled PCBs	To include: • Visual inspection of tracks, pads and soldered joints • Checking the function of assembled circuits and their inputs, processes and outputs against expected values • Measurement of electronic circuit parameters using appropriate equipment • Following safe working procedures when performing functional testing and using test equipment
3.2 Identify common faults in circuits	

□ Incorrect component placement
□ Non-functioning or damaged components
□ Track and pad faults
□ Incorrectly soldered joints
	To include:
	• Checking polarised components are placed the correct way around
	• Checking component placement matches the PCB layout
	• Problems with tracks and pads could include:
	  ○ lifting from the PCB
	  ○ gaps in or broken tracks
	• Problems with soldered joints could include:
	  ○ dry joints
	  ○ application of too much or too little solder

Marking criteria

Section 6.4 provides full information on how to mark the NEA units and apply the marking criteria. The marking criteria command words are further explained in Appendix B *Command words*.

The tables below contain the marking criteria for the tasks for this unit. If a student's work does not meet the Mark Band 1 (MB1) criteria for any task, you must award zero marks for that task.

Unit R048 – Topic Area 1: Drawing and simulating electronic circuits		
MB1: 1–2 marks	**MB2: 3–4 marks**	**MB3: 5–6 marks**
Produces circuit schematic diagram with **limited** accuracy using CAD software.	Produces circuit schematic diagram with **partial** accuracy using CAD software.	Produces **fully** accurate circuit schematic diagram using CAD software.
MB1: 1–2 marks	**MB2: 3–4 marks**	**MB3: 5–6 marks**
Undertakes **basic** testing of the circuit, using circuit simulation and test features of CAD software prior to PCB design, to show the circuit functions correctly. Takes **few** appropriate actions based on the outcomes of testing.	Undertakes **adequate** testing of the circuit, using circuit simulation and test features of CAD software prior to PCB design, to show the circuit functions correctly. Takes **some** appropriate actions based on the outcomes of testing.	Undertakes **comprehensive** testing of the circuit using circuit simulation and test features of CAD software prior to PCB design, to show the circuit functions correctly. Takes **fully** appropriate actions based on the outcomes of testing.
MB1: 1–3 marks	**MB2: 4–6 marks**	**MB3: 7–9 marks**
Uses CAD software to produce a PCB layout showing track and component views, with **limited** accuracy.	Uses CAD software to produce a PCB layout showing track and component views, with **partial** accuracy.	Uses CAD software to produce a PCB layout showing track and component views, that is **fully** accurate.

Unit R048 – Topic Area 2: Constructing electronic circuits–		
MB1: 1–3 marks	**MB2: 4–6 marks**	**MB3: 7–9 marks**
Demonstrates **limited** skills to produce a PCB using an appropriate method. **Dependent** upon assistance to produce a PCB. **Dependent** upon reminders of safety requirements in order to work safely.	Demonstrates **adequate** skills to produce a PCB using an appropriate method. **Assisted** to produce a PCB. Worked safely with **some** reminders of safety requirements.	Demonstrates **effective** skills to produce a PCB using an appropriate method. Works **independently** to produce a PCB. Worked safely at **all** times without additional instruction.
MB1: 1–4 marks	**MB2: 5–8 marks**	**MB3: 9–12 marks**
Demonstrates **limited** skills to populate and assemble a PCB using appropriate tools and equipment. **Dependent** upon assistance to populate and assemble a PCB. **Dependent** upon reminders of safety requirements in order to work safely.	Demonstrates **adequate** skills to populate and assemble a PCB using appropriate tools and equipment. **Assisted** to populate and assemble a PCB. Worked safely with **some** reminders of safety requirements.	Demonstrates **effective** skills to populate and assemble a PCB using appropriate tools and equipment. Works **independently** to populate and assemble a PCB. Worked safely at **all** times without additional instruction.

Unit R048 – Topic Area 3: Testing electronic circuits		
MB1: 1–3 marks	**MB2: 4–6 marks**	**MB3: 7–9 marks**
Undertakes **basic** visual and functional testing of the operation of the electronic circuit. Undertakes **basic** fault identification in electronic circuits.	Undertakes **adequate** visual and functional testing of the operation of the electronic circuit. Undertakes **adequate** fault identification in electronic circuits.	Undertakes **comprehensive** visual and functional testing of the operation of the electronic circuit. Undertakes **comprehensive** fault identification in electronic circuits.
MB1: 1–3 marks	**MB2: 4–6 marks**	**MB3: 7–9 marks**
Undertakes a **basic** evaluation of final circuit construction and its operation.	Undertakes an **adequate** evaluation of final circuit construction and its operation.	Undertakes a **comprehensive** evaluation of final circuit construction and its operation.

Task	Assessment guidance
Task 1	• You should ensure that students have access to CAD software that is capable of circuit schematic entry, simulation and which can also produce PCB layouts. Component libraries within the software will need to have components required for the circuit in the scenario. As these are common components these should be available in most CAD software. • Students will need to show clearly, step by step, how they have used CAD software to schematically enter the circuit, perform simulation and create a PCB layout. This can be done with a series of annotated screen shots which must be individual to each student, so it would be highly unusual to see the same output from all students in a cohort. Simulation will require component values to be modified with the effects of this being investigated as part of the simulation. • Students will need to show both track and component side views of the PCB layout.
Task 2	• You should ensure that students have access to components, tools and equipment required to safely manufacture a bare PCB, to assemble components to the PCB and to make interconnections from the PCB to external components. • The bare PCB can be manufactured using any suitable process (e.g. etching, CAM milling/routing). • Students will require electronic components (e.g. resistors, capacitors etc.) to be able to construct the circuit. They will also require tools (e.g. soldering iron, solder, pliers, side cutters etc.) to enable construction to take place. • Students should show clearly, step by step, how they have safely manufactured the bare PCB and constructed the circuit. They must show how they have safely used equipment, tools, and techniques (e.g. soldering) to construct the circuit. This can be done with a series of annotated photos or a video which must be individual to each student, so it would be highly unusual to see the same output from all students in a cohort. • Safe working and safe working practices must be addressed by students before manufacture and construction starts and followed throughout the activity. Photographic or video evidence generated by students should also show safe working practices being followed. • You should complete a Teacher Observation Record for this task.
Task 3	• You should ensure that students have access to suitable test equipment to test the functionality of their completed circuit. Should their circuit function as expected i.e. 'work first time' then you should provide students with further circuits with known faults. This will enable students to identify these faults using common fault-finding techniques. • Students should show clearly, step by step, how they have visually and functionally tested their finished PCB and circuit. They will need to show how they have applied fault finding techniques to their own circuit, or ones supplied by the you, to identify and rectify faults. • It is vital that students always work safely. Students must show that they have safely used test equipment and testing techniques. Students can do this with a series of annotated photos or a video which must be individual to each student, so it would be highly unusual to see the same output from all students in a cohort. • When measuring circuit parameters, students should compare these with expected values to demonstrate functional testing. A final evaluation of the circuit should explain how well the physical circuit operates compared to the simulation performed in Task 1.

Synoptic assessment

Some of the knowledge, understanding and skills required when completing this unit will draw on the learning developed in Unit R047.

The following table details where these synoptic links can be found:

R048: Making and testing electronic circuits		R047: Principles of electronic and progammable systems	
Topic area		**Topic area**	
1	Drawing and simulating electronic circuits	1	Basic electronic principles
		2	Electronic and programmable systems, components and devices
		3	Methods of prototyping and testing systems and circuits
2	Constructing electronic circuits	4	Commercial circuit production and construction methods
3	Testing electronic circuits	1	Basic electronic principles
		2	Electronic and programmable systems, components and devices
		3	Methods of prototyping and testing systems and circuits

More information about synoptic assessment within this qualification can be found in section 5.2 Synoptic assessment.

4.4 Unit R049: Developing programmable systems

Aims

Programmable systems form the brain of almost every modern electronic device in the world today. From washing machines to smart lighting systems, at their centre you will find microcontrollers that have been programmed by an engineer.

In this unit you will learn the skills required to develop programmable systems. You will learn how to draw block diagrams of systems and how to determine hardware and system requirements to meet a given brief, including the selection of appropriate input and output devices. You will use software to program microcontrollers and test systems to make sure that they work correctly.

Unit R049: Developing programmable systems

Topic Area 1: Plan the development of programmable systems

Teaching content	Exemplification
1.1 Draw block diagrams of programmable systems, including	
□ Input, process and output blocks □ Signal arrows □ Feedback	To include: • Systems with no more than two input devices, no more than two output devices, and a microcontroller as the process device • Open loop systems (without a feedback loop) and closed loop systems (with a feedback loop) • Block diagrams drawn by hand or through the use of computer software Does not include: • Drawing circuit schematics – these are covered in Unit R048
1.2 Determine the requirements for programmable systems in order to meet a given brief	
□ System requirements: ▪ programming system and/or language to be used ▪ method of downloading programs □ Hardware requirements: ▪ microcontroller type ▪ input and output devices required	To include: • Hardware and software requirements for systems with no more than two input devices, no more than two output devices, and a microcontroller as the process device

Unit R049: Developing programmable systems

Topic Area 2: Develop programmable systems

Teaching content	Exemplification
2.1 Safely connect input and output devices to the programmable system	
□ Selection of appropriate method or methods of connection □ Physically connecting input and output devices	To include: • Following safety procedures. • Methods of connection: o crocodile clips o wires with screw connections o terminal blocks o plugs and sockets Does not include: • Producing and soldering components to a printed circuit board (PCB) - this is covered in Unit R048
2.2 Microcontroller programs	
2.2.1 Produce microcontroller programs that perform different functions □ Controlling output components □ Reading and responding to input components: ▪ analogue sensors ▪ digital sensors and switches □ Timers/counters □ Latches □ Logic functions: ▪ AND ▪ OR ▪ NOT □ Feedback loops □ Analogue to digital conversion	To include: • The use of a suitable programming system or language. This could be text based, block based or flowchart based • Programs that respond to a maximum of two input devices and control a maximum of two output devices
2.2.2 Simulate and download programs: □ Simulate functionality of programs prior to download □ Download programs onto microcontroller hardware	To include: • Simulation of programs in programming software and correcting any errors found • Downloading programs onto to microcontroller hardware using an 'in circuit' method

Topic Area 3: Test programmable systems

Teaching content	Exemplification
3.1 Safely test and evaluate programmable systems	
□ Visual inspection of system □ Functional testing of system	To include: • Completion of a test plan and record • Following safety precautions • Checking that the program has downloaded correctly • Checking that the program controls the system hardware as expected • Visual inspection of input and output device connections

Marking criteria

Section 6.4 provides full information on how to mark the NEA units and apply the marking criteria. The marking criteria command words are further explained in Appendix B *Command words*.

The tables below contain the marking criteria for the tasks for this unit. If a student's work does not meet the Mark Band 1 (MB1) criteria for any task, you must award zero marks for that task.

Unit R049 – Topic Area 1: Plan the development of programmable systems		
MB1: 1–2 marks	**MB2: 3– 4 marks**	**MB3: 5–6 marks**
Draws a block diagram with **limited** accuracy for a programmable system.	Draws a block diagram with **partial** accuracy for a programmable system.	Draws a **fully** accurate block diagram for a programmable system.
MB1: 1–3 marks	**MB2: 4– 6 marks**	**MB3: 7–9 marks**
Provides a **basic** justification of the hardware and software requirements to satisfy the programmable system problem.	Provides an **adequate** justification of the hardware and software requirements to satisfy the programmable system problem.	Provides a **comprehensive** justification of the hardware and software requirements to satisfy the programmable system problem.

Unit R049 – Topic Area 2: Develop programmable systems		
MB1: 1–2 marks	**MB2: 3– 4 marks**	**MB3: 5–6 marks**
Few appropriate connection methods selected. **Dependent** upon assistance to physically connect input and output devices to a programmable system safely.	**Some** appropriate connection methods selected. **Assisted** to physically connect input and output devices to a programmable system safely.	**Fully** appropriate connection methods selected. Works **independently** to physically connect input and output devices to a programmable system safely.
MB1: 1–3 marks	**MB2: 4– 6 marks**	**MB3: 7–9 marks**
Produces a program that solves **few** aspects of the programmable system problem. Selects **few** appropriate programming functions. **Dependent** upon assistance to produce a program.	Produces a program that solves **some** aspects of the programmable system problem. Selects **some** appropriate programming functions. **Assisted** to produce a program.	Produces a program that solves **all** aspects of the programmable system problem. Selects **wholly** appropriate programming functions. Works **independently** to produce a program.
MB1: 1–4 marks	**MB2: 5–8 marks**	**MB3: 9–12 marks**
Undertakes **limited** simulation of the program to ensure its functionality. **Dependent** upon assistance to make any necessary corrections. **Dependent** upon assistance to safely download the program to a programmable system.	Undertakes **adequate** simulation of the program to ensure its functionality. **Assisted** to make any necessary corrections. **Assisted** to safely download the program to a programmable system.	Undertakes **comprehensive** simulation of the program to ensure its functionality. Works **independently** to make any necessary corrections. Works **independently** to safely download the program to a programmable system.

Unit R049 – Topic Area 3: Test programmable systems		
MB1: 1–2 marks	**MB2: 3–4 marks**	**MB3: 5–6 marks**
Produces a **basic** test plan to enable functionality of the programmable system to be tested. **Superficially** records outcomes of testing against the test plan.	Produces an **adequate** test plan to enable functionality of the programmable system to be tested. **Adequately** records outcomes of testing against the test plan.	Produces a **comprehensive** test plan to enable functionality of the programmable system to be tested. **Clearly** records outcomes of testing against the test plan.
MB1: 1–4 marks	**MB2: 5–8 marks**	**MB3: 9–12 marks**
Undertakes **basic** visual and functional testing of the programmable system. Undertakes a **basic** evaluation of the programmable system based on testing.	Undertakes **adequate** visual and functional testing of the programmable system, recording outcomes against the test plan. Undertakes an **adequate** evaluation of the programmable system based on testing.	Undertakes **comprehensive** visual and functional testing of the programmable system, recording outcomes against the test plan. Undertakes a **comprehensive** evaluation of the programmable system based on testing.

Assessment guidance

Task	Assessment guidance
Task 1	• You should ensure that students have access to a suitable programmable system and programming software with simulation capability. Programming can be performed using a text based, block based or flowchart-based system. Students will also require access to suitable input and output devices to enable development of programmable system. Students can produce their block diagram by hand or using digital resources. To allow students to meet the assessment requirements you must provide: ○ a suitable range of input and output devices for students to select from ○ Information (e.g. data sheets) for the programmable system, software and input/output devices for students to use as reference. • Students should use the scenario and specification provided in the set assignment to plan for the development of a programmable system. It is acceptable you to ensure students work within the resource constraints within their centre, e.g. limited to a particular programmable system and software, and students should draw on their understanding of programmable systems from R047 to make their justifications. Please remind students about the requirement to reference all sources.
Task 2	• You should ensure that students have access to suitable programming software, which is capable of simulation, and physical hardware (i.e. programmable devices, input, and output devices, connecting leads and terminals). • It is not necessary for every student to have their own hardware; they could use hardware common to the class, but must select and demonstrate the connection of input and output devices and download the program to the programmable system individually. • Safe working and safe working practices must be addressed by students before any practical work starts and followed throughout the activity. • Photographic or video evidence generated by students should also show safe working practices being followed. You should complete a Teacher Observation Record for this task.
Task 3	• You should ensure that students have access to the physical system on which they downloaded their completed program, so that they can test it. • Please ensure that students work safely when completing any practical work in this task. • Students must produce a test plan and record which shows how they will visually check the system (e.g. connection of input and output devices) and functionally test the system. We have provided a test plan and record template for you to give your students. However, students can design their own test plan and record if they prefer. • Students are required to show clearly, step by step, how they have tested their completed system (i.e. program operation and physical hardware). This can be done with a series of annotated photographs that must be individual to each student, so it would be highly unusual to see the same output from all students in a cohort. • Students must base their evaluation on the outcomes of their testing and suggest improvements they might make. However, there is no requirement to undertake these improvements.

Synoptic assessment

Some of the knowledge, understanding and skills required when completing this unit will draw on the learning developed in Unit R047. The following table details where these synoptic links can be found:

R049: Developing programmable systems		R047: Principles of electronic and progammable systems	
Topic area		**Topic area**	
1	Plan the development of programmable systems	2	Electronic and programmable systems, components and devices
2	Develop programmable systems	3	Methods of prototyping and testing systems and circuits

More information about synoptic assessment within this qualification can be found in section 5.2 Synoptic assessment.

5 Assessment and grading

5.1 Overview of the assessment

Entry code	Qualification title	GLH	Reference
J824	**OCR Level 1/Level 2 Cambridge National in Engineering Programmable Systems**	**120***	**603/7088/9**
Made up of three mandatory units: • Units R047, R048 and R049.			

*the GLH includes assessment time for each unit

Unit R047: Principles of electronic and programmable systems	
48 GLH 1 hour 15 minute written examination 70 marks (80 UMS) OCR-set and marked Calculators are allowed in this exam	This question paper has two parts: • Part A – includes 10 multiple choice questions (MCQs) • Part B – includes short answer questions and extended response questions. One extended response question will be assessed using a levels of response mark scheme.
Unit R048: Making and testing electronic circuits	
36 GLH OCR-set assignment 60 marks (60 UMS) Centre-assessed and OCR moderated	This set assignment contains 3 practical tasks. It should take approximately 10-12 GLH to complete.
Unit R049: Developing programmable systems	
36 GLH OCR-set assignment 60 marks (60 UMS) Centre-assessed and OCR moderated	This set assignment contains 3 practical tasks. It should take approximately 10-12 GLH to complete.

OCR-set assignments for units R048 and R049 will be available on our secure website for teachers, Teach Cambridge.

5.2 Synoptic assessment

Synoptic assessment is a built-in feature of this qualification. It means that students need to use an appropriate selection of their knowledge, understanding and skills developed across the qualification in an integrated way and apply them to a key task or tasks.

This also helps students to build a holistic understanding of the subject and the connections between different elements of learning, so they can go on to apply what they learn from this qualification to new and different situations and contexts.

The externally assessed unit R047 allows students to gain underpinning knowledge and understanding relevant to maintenance, installation and repair, and the non examined assessment (NEA) units R048 and R049 draw on and strengthen this learning by letting students apply their learning in a practical, skills-based way through making and testing circuits and programmable systems.

It is important to be aware of the synoptic links between the units so that teaching, learning and assessment can be planned accordingly. Then students can apply their learning in ways which show they are able to make connections across the qualification when they are assessed.

5.3 Transferable skills

This qualification also allows students the opportunity to gain broad, transferable skills and experiences that can be applied as they progress into their next stages of study and life and to enhance their preparation for future employment.

Students will have the opportunity to develop and demonstrate the following skills that are transferable to different real-life contexts, roles or employment:

- Solving problems by identifying and rectifying any faults in electronic circuits
- Analysing information and showing the ability to make informed decisions
- Planning a sequence of processes. This will involve managing time and identifying the resources needed, as well as reviewing plans if necessary.

Problem solving is an important skill for any engineering workplace. Employers appreciate it when an employee identify issues or inefficiencies in a process or procedure.

Through the requirement to prepare a production plan you will have the opportunity to identify and rectify any faults in circuits.

5.4 Grading and awarding grades

All results are awarded on the following scale:

- Distinction* at Level 2 (*2)
- Distinction at Level 2 (D2)
- Merit at Level 2 (M2)
- Pass at Level 2 (P2)
- Distinction at Level 1 (D1)
- Merit at Level 1 (M1)
- Pass at Level 1 (P1).

The shortened format of the grade will show within results files and results reports. However, the full format of the grade will be on the certificates issued to students.

The boundaries for Distinction at Level 2, Pass at Level 2, and Pass at Level 1 are set judgementally.
Other grade boundaries are set arithmetically.

The Merit (Level 2) is set at half the distance between the Pass (Level 2) grade and the Distinction (Level 2) grade. Where the gap does not divide equally, the Merit (Level 2) boundary is set at the lower mark (For example, 45.5 would be rounded down to 45).

For the examined unit, the Distinction* (Level 2) grade is normally set at about 0.75 of the D2-M2 distance above the D2 boundary mark.

To set the Distinction (Level 1) and Merit (Level 1) boundaries, the gap between the Pass (Level 1) grade and the Pass (Level 2) grade is divided by 3, and the boundaries set equidistantly. Where this division leaves a remainder of 1, this extra mark will be added to the Distinction (Level 1) to Pass (Level 2) interval, meaning

the Distinction (Level 1) boundary will be lowered by 1 mark. Where this division leaves a remainder of 2, the extra marks will be added to the Distinction (Level 1) to Pass (Level 2) interval, and the Merit (Level 1) to Distinction (Level 1) interval, meaning the Distinction (Level 1) boundary will be lowered by 1 mark, and the Merit (Level 1) boundary will be lowered by 1 mark.

For example, if Pass (Level 2) is set judgementally at 59, and Pass (Level 1) is set judgementally at 30, then Distinction (Level 1) is set at 49, and Merit (Level 1) is set at 39.

Grades are indicated on qualification certificates. However, results for students who fail to achieve the minimum grade (Pass at Level 1) will be recorded as unclassified (U or u) and **will not** be shown on certificates.

This qualification is unitised. Students can take units across different series and can resit units (see section 7.7 Unit and qualification resits). Grade boundaries are set per unit, per series, so may be set in different places for a unit in different series. When working out students' overall grades, OCR needs to be able to compare performance on the same unit in different series when different grade boundaries may have been set, and between different units. We use a Uniform Mark Scale (UMS) so this can be done.

A student's uniform mark for each unit is calculated from the student's raw mark on that unit. The raw mark boundary marks are converted to the equivalent uniform mark boundary. Marks between grade boundaries are converted on a pro rata basis.

When unit results are issued, the student's unit grade and uniform mark are given. The uniform mark is shown out of the maximum uniform mark for the unit (for example, 42/60).

The table below shows the Raw marks and UMS marks for each unit:

Marks	Exam	NEA1	NEA2
Raw marks	70	60	60
UMS	80	60	60

The uniform mark boundaries for each of the assessments do not change and are shown below:

Unit GLH	Max Unit Uniform Mark	Unit Grade							
		Distinction* at L2	Distinction at L2	Merit at L2	Pass at L2	Distinction at L1	Merit at L1	Pass at L1	U
36	60	54	48	42	36	30	24	18	**0**
48	80	72	64	56	48	40	32	24	**0**

The student's uniform mark for Unit R047 will be combined with the uniform mark for the NEA units to give a total uniform mark for the qualification. The student's overall grade will be determined by the total uniform mark. The following table shows the minimum total mark for each overall grade:

Max Uniform Mark	Qualification Grade							
	Distinction* at L2	Distinction at L2	Merit at L2	Pass at L2	Distinction at L1	Merit at L1	Pass at L1	U
200	180	160	140	120	100	80	60	**0**

A calculator is available on the OCR website to help you convert raw marks to uniform marks.

5.5 Performance descriptors

Performance descriptors give a general indication of likely levels of attainment by representative students performing at boundaries: Distinction at Level 2, Pass at Level 2 and Pass at Level 1.

Performance descriptor – Distinction at Level 2

Students will be able to:

- recall, select and apply **detailed** knowledge and understanding of engineering
- present information **clearly** and **accurately**, using a **wide range** of technical language and engineering terminology
- apply **relevant** knowledge, understanding and skills in a **range** of situations to plan and carry out investigations and tasks **effectively**, testing their solutions, and working safely and with a **high degree** of **precision**
- analyse and evaluate the evidence available, reviewing and adapting their methods **where appropriate**
- make **reasoned** judgements and **substantiated** conclusions
- work **confidently and independently** to create material which reflects **effective** planning, **skilled** development and **perceptive** evaluation as well as **demonstrating** practical skills at a **high level**.

Performance descriptor – Pass at Level 2

Students will be able to:

- recall, select and apply **sound** knowledge and understanding of engineering
- present information with **some accuracy**, using a **range of** technical language and engineering terminology
- apply knowledge, understanding and skills in a **range** of situations to plan and carry out investigations and tasks, testing their solutions, and working safely and with **precision**
- review evidence available, analysing and evaluating **some** information and making **adequate** adaptations to their methods
- make **judgements** and draw **appropriate** conclusions
- work with some **independence** to create material which reflects **adequate** planning, development and evaluation and an ability to demonstrate **sound** practical skills.

Performance descriptor – Pass at Level 1

Students will be able to:

- recall, select and apply knowledge and understanding of **basic** aspects of engineering
- present **basic** information, using **limited** engineering terminology
- apply **limited** knowledge, understanding and skills to plan and carry out **simple** investigations and tasks, with an awareness of the need for safety and precision
- review evidence and draw **basic** conclusions
- work, with **regular** assistance, to create material which demonstrates a degree of planning, development and evaluation and **limited** practical skills.

6 Non examined assessment (NEA) units (R048 and R049)

This section provides guidance on the completion of the NEA units (R048 and R049). The NEA units are designed so that students can build a portfolio of evidence to meet the topic areas for the unit.

Assessment for this qualification must adhere to JCQ's *Instructions for Conducting Coursework*. Please **do not** use JCQ's *Instructions for Conducting Non-examination Assessments* – these are only relevant to A Level and GCSE specifications.

Units R048 and R049 are centre assessed and externally moderated by us.

You **must** make sure that you have read and understood all of the rules and guidance provided in this section **before** your students complete and you assess the set-assignments.

If you have any queries please contact us for help and support.

6.1 Preparing for NEA unit delivery and assessment

6.1.1 Centre and teacher/assessor responsibilities

For the NEA units of this qualification we assume the teacher is the assessor.

Before you plan to get approval from us to offer this qualification you must be confident your centre can fulfil all the responsibilities described below. Once you're approved, you can offer any of our general qualifications and/or Cambridge Nationals without having to seek approval for individual qualifications.

The quality of the delivery of teaching and the integrity of assessments and quality assurance is paramount. Systems must be in place so that assessments are fair, valid, reliable and authentic. One of the key factors behind valid, fair and reliable assessment is the expertise of those doing the assessment and internal quality assurance.

With this in mind, here's a summary of the responsibilities that your centre and teachers must be able to fulfil. It is the responsibility of the head of centre[1] to make sure our requirements are met:

- there are enough trained or qualified people to teach and assess the expected number of students you have in your cohorts and they will complete the OCR Essentials for *Internal Assessment* training prior to assessment of the set-assignment
- teaching staff have the relevant level of subject knowledge and skills to deliver and assess this qualification
- teaching staff will fully cover the knowledge, understanding and skills requirements in teaching and learning activities
- necessary resources are available for teaching staff and students during teaching and assessment activities, to give students every opportunity to meet the requirements of the qualification and reach the highest grade possible
- there's a system of standardisation in place so that all assessment decisions for teacher-marked (centre assessed) assignments are consistent, fair, valid and reliable (see internal standardisation in section 6.4.3)
- there's enough time for effective teaching and learning, assessment and internal standardisation
- processes are in place to make sure that students' work is individual and confirmed as being authentic (see Ways to authenticate work in section 6.2.1)
- you must use the OCR-set assignments for students' summative assessments
- the OCR-set assignments must not be used for practice (see section 6.2, Requirements and guidance for delivering and marking the OCR-set assignments)
- students understand what they need to do to get the highest marks possible
- students understand what it means when we say work must be authentic and individual and they

1 This is the most senior officer in the organisation, directly responsible for the delivery of OCR qualifications, For example, the headteacher or principal of a school/college. The head of centre accepts full responsibility for the correct administration and conduct of OCR exams.

(and you) must follow any requirements we set out to make sure their work is their own

- students know they must not reference another individual's personal details in any evidence produced for summative assessment in accordance with the General Data Protection Regulations (UK GDPR). It is the student's responsibility to make sure evidence that includes another individual's personal details is anonymised
- marks submitted to us are correct and are accurately recorded
- assessment of set assignments must adhere to JCQ Instructions for Conducting Coursework.
- a declaration is made at the point you're submitting any work to us for assessment that confirms:
    - all assessment is conducted according to the specified regulations identified in the Administration area of our website,
    - students' work is authentic
    - marks have been transcribed accurately
- centre records and students' work are kept according to the requirements below:
    - students' work must be kept until after their unit has been awarded and any review of results or appeals processed. We will not consider any review if the work has not been kept
    - internal standardisation and assessment records must be kept securely for a minimum of three years after the date we've issued a certificate for a qualification
- All cases of suspected malpractice involving teachers or students must be reported (see 'Reporting suspected malpractice' in section 6.3.1).

6.2 Requirements and guidance for delivering and marking the OCR-set assignments

The assignments are set by us, taken under supervised conditions, marked by the teacher and moderated by us. Assignments will be available on our secure website, Teach Cambridge.

The set assignments give an approximate time that it will take to complete all tasks. These timings are for guidance only, but should be used by you, the teacher, to give students an indication of how long to spend on each task. You can decide how the time should be allocated between each part or individual task. You are also permitted to spread the tasks across several sessions, and therefore it is permissible for evidence to be produced over several sessions.

We will replace the set assignments each year, published on 1st June for teaching from the following September. You must check our secure website Teach Cambridge and use the set assignment that is live for assessment. The live assessment dates will be shown on the front cover.

Assessment of the set assignments must adhere to JCQ *Instructions for Conducting Coursework*.

Appendix A of this specification gives guidance for creating electronic evidence for the NEA units. Please read Appendix A along with the unit content and marking criteria grids as it might help you plan your delivery of the units.

The rest of this section deals with how we expect you to manage the delivery and marking of the set assignments, so that assessment is valid and reliable. Please note that failing to meet these requirements may be deemed to be malpractice.

Here is a summary of what we need you to do.

You **must**:

- have covered the knowledge, understanding and skills with your students and be sure they are ready for assessment before you start the summative assessment
- give students the Student Guidance document before they start the assessment
- make sure students are clear about the tasks they must complete and the criteria they are expected to meet. You can:
    - explain the task
    - provide a copy of the marking criteria to students
- allow students a reasonable amount of time to complete the assignments and be fair and consistent to all students. The time you allow should be in line with the estimated time we think it should take which is stated in the OCR-set assignments. Within that time students can work on

the tasks any time until the date the centre collects the work for centre assessment

- tell the students the resources and sources of assets that they can use in the assignment before undertaking the assessment tasks
- only give students OCR-provided templates. If they opt to use a template from a book, a website or course notes when, for example, creating a plan for the production of a prototype, they must make sure the source is referenced
- monitor students' progress to make sure work is capable of being assessed against the marking criteria, on track for being completed in good time and is the **student's own** work:
    - work must be carried out with enough supervision to make sure that the work submitted can be confidently authenticated as the student's own work
    - NEA work **must** be completed during normal curriculum time and supervised and marked by the teacher/assessor
    - if you provide any material to prepare students for the set assignment, you must adhere to the rules on using referencing and on acceptable levels of guidance to students set out within the Plagiarism and Feedback sections (see 6.2.2 Plagiarism and 6.3 Feedback)
    - students must produce their work independently (see 6.2.1 and 6.3 on Ways to authenticate work and Feedback)
    - you must make sure students are aware of the requirement to keep their work secure, not share with other students and keep their passwords secure
- allow students to take the initiative to improve any element of their work as they work through the assignment
- use the marking criteria to mark students' work

Before submitting a final mark to us, you can allow students to repeat any element of the assignment and rework their original evidence. But, any feedback given to students on the original (marked) evidence, must only be generic and must be recorded and available to the moderator (see section 6.3 on Feedback and section 6.4.4 on resubmitting work).

You **must not**:

- change any aspect of the OCR-set assignments (scenarios or tasks)
- accept multiple resubmissions of work where small changes have been made in response to feedback
- allow teachers or students to add, amend or remove any work after students have submitted work for moderation. This will constitute malpractice
- give detailed advice and suggestions to individuals or the whole class on how work may be improved to meet the marking criteria
- practise the OCR-set assignment tasks with the students
- create practice assignments and practice data which are similar in nature to those set by us
- use past OCR-set assignments, or amend past set assignments, for practise purposes.

6.2.1 Ways to authenticate work

You must be confident that the work you mark is the student's own. Every student must produce their own work independently. You must use enough supervision, or complete sufficient checks, to be able to judge the authenticity of the student's work.

Wherever possible, the teacher should discuss work-in-progress with students. This will make sure that work is being completed in a planned and timely way and provide opportunities for you to check authenticity of the work.

You must:

- make sure students and other teachers understand what constitutes plagiarism and not accept plagiarised work as evidence (you might find the JCQ document *Plagiarism in Assessments* helpful)
- use supervision and questioning as appropriate to confirm authenticity
- make sure students and teachers fill in declaration statements.

6.2.2 Plagiarism

When producing final 'written' pieces of work for the set assignments, students must use their own words to show they have genuinely applied their knowledge and understanding. When students use their own words, ideas and opinions, it reduces the possibility of their work being identified as plagiarised. Plagiarism is the submission of someone else's work as your own and/or failure to acknowledge a source correctly. Plagiarism makes up a large percentage of cases of suspected malpractice reported to us by moderators. Teachers must make sure they do not accept plagiarised work as evidence.

Plagiarism often occurs innocently when students do not know that they must reference or acknowledge their sources or aren't sure how to do so. It's important to make sure your students understand:

- the meaning of plagiarism and what penalties may be applied
- that they can refer to research, quotations or evidence produced by somebody else but they must list and reference their sources and clearly mark quotations
- quoting someone else's work, even when it's properly sourced and referenced, doesn't evidence understanding. The student must 'do' something with that information to show they understand it. For example, if a student has to analyse data from an experiment, quoting data doesn't show that they understand what it means. The student must interpret the data and, by relating it to their assignment, say what they think it means. The work must clearly show how the student is using the material they have referenced **to inform their** thoughts, ideas or conclusions.

We have a guide to referencing on our website *The OCR Guide to Referencing* and we have also produced a poster on referencing and plagiarism which may be useful to share with students.

Some useful tips are:

- Best practice is to always reference material copied from the internet or other sources. This applies to infographics (graphical information providing data or knowledge) as well
- Teach your students how to reference and explain why it's important to do it. At Key Stage 4 it is sufficient if they:
    - use quote marks to show the beginning and end of the copied work
    - for website text, list the html address and ideally the date they accessed the website
    - for other publications, list the name of the resource/book/printed article and ideally the year in which it was published.
- Students must also identify information they have copied from teaching handouts and presentations for the unit, using quote marks and stating the text is from class handouts.

Identifying copied/plagiarised work

Inconsistencies throughout a student's response are often indicators of plagiarism. For example:

- different tones of voice, sentence structure and formality across pieces of work
- use of American expressions, spellings and contexts (such as American laws and guidelines)
- dated expressions and references to past events as being current
- sections of text in a document where the font or format is inconsistent with other sections.

What to do if you think a student has plagiarised

If you identify plagiarised work at the point of marking or moderation:

- this must be taken into account when applying the mark scheme.
    - the work should be included with any work that is sent to the moderator if it is part of the moderation sample, with a note on the Unit Recording Sheet to state that there is plagiarism in the work and that marks have been adjusted accordingly
-
- the student(s) must be reported for plagiarism in line with the JCQ document Suspected Malpractice Policies and Procedures
    - Fill in the *JCQ form M1*

In line with the policy and procedures of JCQ on suspected malpractice, the penalties applied for plagiarism would usually result in the work not being allowed or the mark being significantly reduced.

6.3 Feedback

Feedback to students on work in progress towards summative assessment

You can discuss work-in-progress towards summative assessment with students to make sure it's being done in a planned and timely way. It also provides an opportunity to check the authenticity of the work. You must intervene if there's a health and safety risk.

Generic guidance to the whole class is also allowed. This could include reminding students to check they have provided evidence to cover every aspect of the task. Individual students can be prompted to double check for gaps in evidence providing that specific gaps are not pointed out to them.

You can give general feedback and support if one or more students are struggling to get started on an aspect of the assignment or following a break between sessions working on the assignment. For example, if a student is seeking more guidance that suggests they are not able to apply knowledge, skills and understanding to complete their evidence you can remind them that they had a lesson which covered the relevant topic. The student would then need to review their own notes to find this information and apply it as needed.

Feedback must not provide specific advice and guidance that would be construed as coaching. This would compromise the student's ability to independently perform the task(s) they are doing and constitutes malpractice. Our moderators use a number of measures to assure themselves the work is the student's own.

Once work has been marked, feedback must be provided to students on the work they submitted for assessment.

Feedback **must**:

- be supportive, encouraging and positive
- tell the student what has been noticed, not what the teacher thinks (for example if you have observed the student completing a task you can describe what happened, what was produced and what was demonstrated).

Feedback **can**:

- identify what task and part of the task could be improved, but not detail how to improve it. You could show the student work from a **different** unit that demonstrates higher achievement, but you must not detail to the student how they could achieve that in their work. If you are using another student's work as a model answer, please anonymise this work. You could remind students that they had a lesson on a specific topic and that they could review their notes, but you must not tell them how they could apply the teaching to improve their work.
- comment on what has been achieved, for example *'the evidence shows an **adequate** understanding for MB2'*
- identify that the student hasn't met a command verb or mark band requirement. For example, '*This is a description, not an evaluation*'
- use text from the specification, assignment or marking criteria in general guidance to clarify what is needed in the work. For example you need to consider all bullet points relating to the testing of programmable systems. You have produced a **comprehensive** test plan to test the functionality of the system, but only provided **adequate** records of the testing against the test plan
- point out where the work sits within the mark bands but students must make their own decisions as to what to improve and how. For example, the feedback can say 'this shows a **sound** understanding' (for mark band 2) but not precisely what should be added to make it show a **comprehensive** understanding (for mark band 3).

Feedback **must not**:

- point out specific gaps , for example you must not prompt the student to include specific detail in their work, such as *'You need to improve this by giving more detail'*
- be so detailed that it
    - leads students to the answer, for example you must not give model answers on the **same** unit being taken or explain specifically what amendments should be made. If work from another student on a **different unit** is being used to model answers, please ensure it is anonymised.
    - provides a step-by-step guide on what to do to complete or improve work, for example you must not give headings or templates that include examples which give all or part of what students have to write about or produce.
- talk the student through how to achieve or complete the task.
- give detail on where to find information/evidence.

In other words, feedback must help the student to take the initiative in making changes. It must not direct or tell the student what to do to complete or improve their work in a way that means they do not need to think how to apply their learning. Students need to recall or apply their learning. You must not do the work for the student(s).

Neither you nor the student can add, amend or remove any work after the final mark has been submitted for moderation.

Please see additional guidance for students who wish to resubmit their work following OCR moderation in Section 6.7.

What over-direction might look like

When we see anything that suggests the teacher has led students to the answer, we become concerned because it suggests students have not worked independently to produce their assignment work. The following are examples of what may indicate over-direction by the teacher:

- prompts that instruct students to include specific detail in their work, such as, 'You need to define the difference between sketching techniques. How are they used? Which techniques are most appropriate?'
- headings or templates that include examples which give all or part of what students have to write about or produce, such as planning the manufacture of a prototype.

Moderators will report suspected malpractice when they cannot see differences in content between students' work in the sample they are moderating. An exception is when students have only used and referenced technical facts and definitions. If the moderator is in any doubt, they will report suspected malpractice. The decision on whether or not to investigate is made by us not the moderator.

6.3.1 Reporting suspected malpractice

It is the responsibility of the head of centre to report all cases of suspected malpractice involving teachers or students.

A JCQ Report of Suspected Malpractice form (JCQ/M1 for student suspected malpractice or JCQ/M2 for staff suspected malpractice) is available to download from the JCQ website and must be completed as soon as possible and emailed to us at malpractice@ocr.org.uk.

When we ask centres to investigate instances of malpractice, heads of centres must act promptly and report the outcomes to us.

More information about reporting and investigating suspected malpractice, and the possible sanctions and penalties which could be imposed, is in the JCQ publication: Suspected Malpractice Policies and Procedures. You can also find out more on our website.

6.3.2 Supervision

NEA work must be completed in normal curriculum time and supervised and marked by the teacher. You must use enough checks so you're confident the student's work is authentic.

For example, you can use questioning to confirm the depth and breadth of their understanding of the topic they've covered in a specific piece of work.

6.3.3 Student and centre declarations

Both students and teachers must declare that the work is the student's own:

- **each student** must sign a declaration before submitting their work to their teacher. A candidate authentication statement that can be used is available to download from the OCR website. These statements should be kept within the centre until all enquiries about results, malpractice and appeal issues have been resolved. **A mark of zero must be recorded if a student cannot confirm the authenticity of their work**
- **teachers** must declare the work submitted for centre assessment is the student's own work by completing a centre authentication form (CCS160) for each unit. Centre authentication forms should be kept within the centre until all post-results issues have been resolved.

6.3.4 Group working

We do not assess the skills associated with group work in this qualification and the OCR-set assignment will not include it. If it is necessary to use group work to make the delivery of the assignment more manageable, you must make sure that all practical tasks and evidence submitted for assessment that shows the student has met the marking criteria is entirely the individual's own work.

6.3.5 Methods of assessment

It is your responsibility to choose the best method of assessing a student in relation to their individual circumstances. The methods chosen must be:

- valid
- reliable
- safe and manageable
- suitable to the needs of the student.

Valid

Validity can be compromised if a student does not understand what is being asked of them. For example, one valid method of assessing a student's knowledge and understanding is to question them. If the questions posed are difficult for the student to understand (not in terms of the content but the way they are phrased, for example) the validity of the assessment method is questionable.

As well as assessment methods being valid, the evidence presented must also be valid. For example, it would not be appropriate to present an organisation's equal opportunities policy as evidence towards a student's understanding of how the equal opportunities policy operates within the organisation. It would be more appropriate for the student to incorporate the policy within a report describing different approaches to equal opportunities.

Reliable

A reliable method of assessment will produce consistent results for different assessors on each assessment occasion. Internal moderators must make sure that all assessors' decisions are consistent.

Safe and manageable

Assessors and internal moderators must make sure that the assessment methods are safe and manageable and do not put unnecessary demands on the student.

Suitable to the needs of the student

We are committed to ensuring that achievement of these qualifications is free from unnecessary barriers. You must follow this commitment through when amending tasks and/or considering assessment. If you are amending tasks and are not sure what is acceptable, contact us.

Observation and questioning

The primary evidence for assessment is the work submitted by the student, however we consider the following assessment methods suitable for teachers/assessors to use for these qualifications:

- **observation** of a student doing something
- **questioning** of the student or witness.

Observation

The teacher/assessor and student should plan observations together but it is the teacher's/assessor's responsibility to record the observation properly (for example observing a student undertaking a practical task). Find more information in the Teacher Observation Records section below.

Questioning

Questioning the student is normally an ongoing part of the formative assessment process and may, in some circumstances, provide evidence to support achievement of the criteria.

Questioning is often used to:

- test a student's understanding of work which has been completed outside of the classroom
- check if a student understands the work they have completed
- collect information on the type and purpose of the processes a student has gone through.

If questioning is to be used as evidence towards achievement of specific topic areas, it is important that teachers/assessors record enough information about what they asked and how the student replied, to allow the assessment decision to be moderated.

6.3.6 Teacher Observation Records

It is a requirement that a teacher completes the Teacher Observation Record form, located on our secure website, Teach Cambridge, for the **following OCR set-assignments Unit R048 and R049** for each student as evidence of their construction of electronic circuit (R048) and their construction and simulation of a microcontroller program (R049). The Teacher Observation Record form should support evidence of a student assembling a PCB with components (R048), connecting input and out devices, selecting appropriate programming functions and simulating the operation of the program (R049), alongside evidence such as annotated photographic evidence.

Teacher observation **cannot** be used as evidence of achievement for a whole unit. Most evidence should be produced directly by the student. Teacher observation should only be used where specified as an evidence requirement (for example, the construction of an electronic circuit in R048 and the construction and simulation of a microcontroller program in R049).

Teacher Observation Records must be suitably detailed for each student, to help assessors to determine if the grading criteria have been met. You must follow the guidance provided in the 'guidance notes' section of the form so that the evidence captured and submitted is appropriate. Both the student and the teacher must sign and date the form to show that you agree its contents.

Where the guidance has not been followed, the reliability of the form as evidence may be called into question. If doubt about the validity of the Teacher Observation Record form exists, it cannot be used as assessment evidence and marks based on it cannot be awarded. Moderators will be instructed to adjust centre marks accordingly.

6.3.7 Presentation of the final piece of work

Students must observe the following procedures when producing their final piece of work for the NEA tasks:

- work can be word processed or hand-written
- tables and graphs (if relevant) may be produced using appropriate ICT
- any copied material must be suitably acknowledged
- quotations must be clearly marked and a reference provided
- a completed Unit Recording Sheet must be attached to work submitted for moderation. The Unit Recording Sheet can be downloaded from the qualification page
- Centres **must** provide guidance on the Unit Recording Sheet (URS) to show where specific evidence can be found. This may be through the use of the 'page number' column and/or by referencing file names and locations
- Work submitted digitally for moderation should be on electronic media (for example, on our portal, CD or USB Drive), and be in a suitable file format and structure, as detailed in Appendix A at the end of this specification. Students must submit their completed product(s) in an electronic format that is suitable for the client in the set assignment.

6.4 Marking NEA units

All NEA units are internally marked by teachers using the OCR marking criteria and guidance and externally moderated by the OCR-appointed moderator. Assessment of the set assignments must adhere to JCQ *Instructions for Conducting Coursework.*

The centre is responsible for appointing someone to act as the assessor. This could be the teacher who has delivered the programme or another person from the centre.

The marking criteria must be used to mark the student's work. These specify the levels of skills, knowledge and understanding that the student is required to demonstrate.

6.4.1 Use of a 'best fit' approach to marking criteria

The assessment tasks should be marked by teachers/assessors according to the OCR marking criteria using a 'best fit' approach. For each of the marking criteria, teachers/assessors select the band descriptor provided in the marking grid that most closely describes the quality of the work being marked.

Marking should be positive, rewarding achievement rather than penalising failure or omissions. The award of marks **must be** directly related to the marking criteria.

- Each band descriptor covers all the relevant content for the topic areas.
- The descriptors should be read and applied as a whole.
- Make a best fit match between the answer and the band descriptors.
- An answer does not have to meet all of the requirements of a band descriptor before being placed in that band. It will be placed in a particular band when it meets more of the requirements of that band than it meets the requirements of other bands.
- Where there is more than one strand within the band descriptors for a topic area and a strand has not been addressed at all, it is still possible for the answer to be credited within that mark band depending upon the evidence provided for the remaining strands. The answer should be placed in the mark band most closely reflecting the standard achieved across all strands within the band descriptors for topic areas; however in this scenario, the mark awarded for that band should reflect that a strand has not been addressed.

When deciding the mark within a band, the criteria below should be applied:

- the extent to which the statements within the band have been achieved. For example:
    - an answer that convincingly meets nearly all of the requirements of a band descriptor should be placed at or near the top of that band. Where the student's work convincingly meets the statements, the highest mark should be awarded
    - an answer that meets many of the requirements of the band descriptor should be placed in the middle of the band. Where the student's work adequately meets the statements, the most appropriate mark in the middle range should be awarded
    - if an answer is on the borderline between two bands but it is decided that it better fits the descriptors for:
        - the lower of these two bands - it should be placed near the top of the lower band
        - the higher of these two bands - the lowest mark for the higher band should be awarded.
- If a student's work does not meet Mark Band 1 (MB1) criteria for any task, you must award zero marks for that task.

Teachers/assessors should use the full range of marks available to them and award full marks in any band for work that fully meets that descriptor. This is work that is 'the best one could expect from students working at that level'.

6.4.2 Annotating students work

Each piece of NEA work should show how the marks have been awarded in relation to the marking criteria.

Writing comments on students' work and Unit Recording Sheet (URS) provides a means of communication between teachers during the internal standardisation, and with the moderator if the work is part of the moderation sample.

6.4.3 Internal standardisation

It is important that all teachers/assessors work to common standards. Centres must make sure that, within each unit, the internal standardisation of marks across teachers/assessors and teaching groups takes place using an appropriate procedure.

This can be done in a number of ways. In the first year, reference material and OCR training meetings will provide a basis for centres' own standardisation. In following years, this, or centres' own archive material, may be used. We advise centres to hold preliminary meetings of staff involved to compare standards through cross-marking a small sample of work. After most marking has been completed, a further meeting at which work is exchanged and discussed will help final adjustments to be made.

If you're the only assessor in your centre for this qualification, then it's still advisable to make sure your assessment decisions are internally standardised by someone else in your centre, ideally someone who has experience of the nature of this qualification (For example, is delivering a similar qualification in another subject) or relevant subject knowledge and asking them to review a sample of the assessments.

You must keep evidence of internal standardisation in the centre for the moderator to see.

We have a guide to how internal standardisation may be approached on our website.

6.4.4 Reattempting work before submitting marks to OCR

As described in Section 6.2, before submitting a final mark to us, you can allow students to repeat any element of the assignment and rework their original evidence – we refer to this as a '**reattempt**'. This is to allow the student to reflect on the feedback, which must be recorded, and improve their work. It is not an iterative process where they make small modifications through ongoing feedback to eventually achieve the desired grade.

6.4.5 Submitting marks

All work for NEA units is marked by the teacher and internally standardised by the centre. Marks are then submitted to us. You can find the key dates and timetables on our website.

There should be clear evidence that work has been attempted and some work produced. If a student submits no work for a NEA unit, the student should be identified as being absent from that unit.

If a student completes any work at all for a NEA unit, then the work should be assessed according to the marking criteria and the appropriate mark awarded. This may be zero.

6.5 Moderating NEA units

The purpose of external moderation is to make sure that the standard of marking is the same for each centre and that internal standardisation has taken place.

The administration pages of our website provide full details about how to submit work for moderation. This includes the deadline dates for entries and submission of marks. For moderation to happen, centres must submit their marks.

6.5.1 Sample requests

Once you have submitted your marks, we will tell you which work will be sampled as part of the moderation. Samples will include work from across the range of attainment of students' work.

Work for moderated units can be uploaded to us using our Submit for Assessment service or sent by post.

Copies of students' work must be kept until after their units have been awarded and any review of results or appeals processed.

As it is essential for us to have sample work available at awarding meetings, we may ask some centres to release work for awarding and archive purposes. We will let you know as early as possible if we need this from you and always appreciate your co-operation.

6.5.2 Outcome of moderation

Centres will receive the final outcomes of moderation when the provisional results are issued. Results reports will be available for you to access. More information about the reports that are available is on our administration pages.

6.6 Resubmitting moderated work to OCR to improve the grade

We use the term '**resubmission**' when referring to student work that has previously been submitted to OCR for moderation. Following OCR moderation, if you and the student feel they have not performed at their best during the assessment, the student can, with your agreement, improve their work and resubmit it to you again for assessment. You must be sure it is in the student's best interests to resubmit the work for assessment. There is one resubmission opportunity per NEA assignment.

Students can only resubmit work using the **same** assignment if the assignment is still live. The live assessment dates will be shown on the front cover of the assignment. We will not accept work based on an assignment that is no longer live.

If students wish to resubmit a unit after the live assessment date has passed, they must submit work using the new live assignment.

6.7 Recording feedback and decisions

For reattempts and resubmissions, you must record the reasons why a student has been allowed to reattempt or resubmit in your centre's assessment decisions records. You must also follow our guidelines on giving feedback and record the feedback given to the student. All feedback given to the student for the purpose of a reattempt or resubmitting work must be recorded. We have created a feedback form, available on the OCR website, which you can use to help support this. We monitor the assessment decisions you make. You must follow the guidelines outlined in Section 6.

We reserve the right to request the written feedback and the work in its original state. If you do not meet the requirements this will be treated as malpractice.

Neither you nor the student can add, amend or remove any work after the final mark has been submitted for moderation.

See Section 7.2 for terminal assessment rules.

7 Administration

The information in this section gives an overview of the processes involved in administering this qualification. All of the following processes require you to submit something to OCR by a specific deadline. More information about the processes and deadlines involved at each stage of the assessment cycle can be found in the Administration area of the OCR website.

7.1 Assessment availability

There are two assessment series available each year in January and June to all students. Students can be entered for different units in different assessment series.

All students must take the exam at a set time on the same day in a series. Certification (where students achieve the qualification) is available each January and June.

Series	Unit availability	
	Unit R047	Units R048 and R049
January	✓	✓
June	✓	✓

- First assessment for externally assessed unit R047 is January 2024.
- First assessment for NEA units R048 and R049 is January 2023.
- Certification is available from January 2024.

7.2 Entry rules

Terminal assessment

The externally assessed unit must be taken as terminal assessment. This means that the exam for unit R047 must be taken at the end of the students' course of study. This exam contributes 40% of the total marks available for the qualification.

NEA units can be submitted in any series but must be submitted either before or in the same series as the externally assessed unit.

Certification entries

- For a student to achieve the qualification, you need to make a qualification certification entry (aggregation)
- You can make certification entries:
    - at the same time as unit entries for the exam
    - after you have received results for the exam as a late certification request for that series
    - after you have received results for the exam as a certification entry in a later series
- You can make certification entries in the January or June series – this is the series that will appear on the qualification certificate
- Certification entries and late certification requests are free of charge

Resitting units before certification

- Students **can** take the exam before all the NEA units are completed. This is classed as a 'practice attempt'
    - 'Practice attempts' do not count towards the student's overall grade or in performance tables. The student will be issued with a unit result only
    - When the student has completed all the NEA units, if you do not make a certification entry when you enter for the exam, the exam will be classed as a practice attempt unless you make a late certification entry or a certification entry in a subsequent series
    - If a student takes the exam again after a practice attempt, the result of the latest attempt will count towards the qualification result, even if the practice attempt result was higher
- An NEA unit can be re-submitted once before the overall qualification is awarded. We will use the best result of both attempts towards the qualification result.

Retaking the qualification

- After a student has achieved a qualification result, they can resit the externally assessed unit and

submit the NEA units again in a later series to improve their qualification result:

  - Students can resit the exam without resubmitting the NEA units
  - Students cannot resubmit the NEA units only to improve results. In order to meet terminal assessment requirements, they must also resit the exam if they are resubmitting NEA units

- Students can only resubmit work using the **same** assignment if the assignment is still live. The live assessment dates will be shown on the front cover of the assignment. We will not accept work based on an assignment that is no longer live.

  If students wish to resit a unit after the live assessment date has passed, they must submit work using the new live assignment.

- The result from the first overall qualification result is used towards the performance tables.

7.3 Equality Act information relating to Cambridge Nationals

The Cambridge Nationals require assessment of a broad range of skills and, as such, prepare students for further study and higher-level courses.

The Cambridge Nationals qualifications were reviewed to check if any of the competences required presented a potential barrier to disabled students. If this was the case, the situation was reviewed again to make sure that such competences were included only where essential to the subject.

7.4 Accessibility

There can be adjustments to standard assessment arrangements on the basis of the individual needs of students. It's important that you identify as early as possible whether students have disabilities or particular difficulties that will put them at a disadvantage in the assessment situation and choose a qualification or adjustment that allows them to demonstrate attainment.

If a student requires access arrangements in assessments that need approval from us, this must be gained in Access Arrangements Online. You must select Cambridge Nationals at time of application; approval from GCSE or A Level applications do not extend to Cambridge Nationals. However, more than one qualification type can be selected when making an application. For guidance or support please contact the OCR Special Requirements Team.

The responsibility for providing adjustments to assessment is shared between your centre and us. Please read the JCQ booklet *Access Arrangements and Reasonable Adjustments* at www.jcq.org.uk.

If you have students who need a post-examination adjustment to reflect temporary illness, indisposition or injury when they took the assessment, please read the JCQ document *A guide to the special consideration process*, available at www.jcq.org.uk.

If you think any aspect of this qualification unfairly restricts access and progression, please email or call our Customer Support Centre.

The access arrangements permissible for use in this specification are as follows:

Access arrangement	Yes/No	Type of assessment
Reader/Computer reader	Yes	All assessments
Scribes/Speech recognition technology	Yes	All assessments
Practical assistants	Yes	All assessments
Word processors	Yes	All assessments
Communication professional	Yes	All assessments
Language modifier	Yes	All assessments

Access arrangement	Yes/No	Type of assessment
Modified question paper	Yes	Timetabled examinations
Extra time	Yes	All assessments with time limits

7.5 Requirements for making an entry

We provide information on key dates, timetables and how to submit marks on our website.

Centres must be registered with OCR in order to make any entries. We recommend that centres apply to become a registered centre with us, well in advance of making their first entries. Details on how to register with OCR can be found on our website.

It is essential that unit entry codes are quoted in all correspondence with OCR.

7.5.1 Making estimated unit entries

Estimated entries are not required for Cambridge Nationals in Engineering Programmable Systems.

7.5.2 Making final unit entries

When making an entry, centres will need the unit entry codes and component codes. Students submitting work must be entered for the appropriate unit entry code from the table below.

Work for moderated units can be uploaded to us using our Submit for Assessment service or sent by post.

The short title for these Cambridge National qualifications is CAMNAT and will display as such on our secure website, 'Interchange' and some of our administrative documents.

You do not need to register your students first. Individual unit entries should be made for the series in which you intend to submit an NEA unit or sit the externally assessed examination.

Only make a certification entry using the overall qualification code (see section 7.6) in the final series.

Unit entry code	Component code	Assessment method	Unit titles
R047	01	Written paper	Principles of electronic and programmable systems
R048	01	Moderated – Upload	Making and testing electronic circuits
R048	02	Moderated – Postal	Making and testing electronic circuits
R049	01	Moderated – Upload	Developing programmable systems
R049	02	Moderated – Postal	Developing programmable systems

7.6 Certification rules

Students must be entered for qualification certification separately from unit assessment(s). If a certification entry is **not** made, no overall grade can be awarded. Students must entered for:

- OCR Level 1/Level 2 Cambridge National in Engineering Programmable Systems - certification code J824.

7.7 Unit and qualification resits

Students may resit the externally assessed unit R047**. Please see section 7.2 for information relating to our terminal assessment approach.**

Students may resit each NEA unit once. The best unit result from the NEA units will be used to calculate the certification result.

You must make sure that when arranging resit opportunities they are fair to all students and do not give students an unfair advantage over other students. For example, the student must not have direct guidance and support from the teacher in producing further evidence for NEA units. When resitting a NEA unit, students must submit new, amended or enhanced work, as detailed in the *JCQ Instructions for conducting coursework*.

Centres must make sure that when arranging resit opportunities they do not adversely affect other assessments being taken.

Arranging a resit opportunity is at the centre's discretion. Summative assessment series must not be used as a diagnostic tool and resits should only be planned if it is clear that the student has taken full advantage of the first assessment opportunity and formative assessment process.

7.8 Post-results services

A number of post-results services are available:

- reviews of results – if you think there might be something wrong with a student's results, you may submit a review of marking or moderation
- missing and incomplete results – this service should be used if an individual subject result for a student is missing, or the student has been omitted entirely from the results supplied
- access to scripts – you can ask for access to marked scripts
- late certification – following the release of unit results, if you have not previously made a certification entry, you can make a late request, which is known as a **late certification**. This is a free service.

Please refer to the JCQ Post-Results Services booklet and the OCR Administration page for further guidance about action on the release of results.

For internally assessed units the review of results process cannot be carried out for one individual student; the outcome of a review of moderation must apply to a centre's entire cohort.

Appendix A: Guidance for the production of electronic evidence

Structure for evidence

The centre-assessed (NEA) units in this qualification are units R048 and R049. For each student, all the tasks together will form a portfolio of evidence, stored electronically. Evidence for each unit must be stored separately.

An internal assessment portfolio is a collection of folders and files containing the student's evidence. Folders should be organised in a structured way so that the evidence can be accessed easily by a teacher or moderator. This structure is commonly known as a folder tree. It would be helpful if the location of particular evidence is made clear by naming each file and folder appropriately and by use of an index called 'Home Page'.

There should be a top-level folder detailing the student's centre number, OCR candidate number, surname and forename, together with the unit code (R048 and R049), so that the portfolio is clearly identified as the work of one student.

Each student's internal assessment portfolio should be stored in a secure area on the centre's network. Before submitting the portfolio to OCR, the centre should add a folder to the folder tree containing the internal assessment and summary forms.

Data formats for evidence

In order to minimise software and hardware compatibility issues it will be necessary to save students' work using an appropriate file format.

Students must use formats appropriate to the evidence that they are providing and appropriate to viewing for assessment and moderation. Open file formats or proprietary formats for which a downloadable reader or player is available are acceptable. **Where this is not available, the file format is not acceptable.**

Evidence submitted is likely to be in the form of word processed documents, presentation documents, digital photos and digital video.

To make sure files are compatible, all files submitted electronically must be in the formats listed below. Where new formats become available that might be acceptable, we will provide further guidance. We advise against changing the file format that the document was originally created in. Files should be exported in a generic format that can be opened on a PC computer system without any specialist software applications. It is the centre's responsibility to make sure that the electronic portfolios submitted for moderation are accessible to the moderator and fully represent the evidence available for each student.

Standard file formats acceptable as evidence for the Cambridge Nationals are listed here.

File type	File format	Max file size*
Audio	.3g2 .3ga .aac .aiff .amr .m4a .m4b .m4p .mp3 .wav	25GB
Compression	.zip .zipx .rar .tar .tar .gz .tgz .7z .zipx .zz	25GB
Data	.xls .xlsx .mdb .accdb .xlsb	25GB
Document	.odt .pdf .rtf .txt .doc .docx .dotx .pages	25GB
Image	.jpg .png .jpeg .tif .jfif .gif .psd .dox .pcx .bmp .wmf	15MB
Presentation	.ppt .pptx .pdf .gslides .pptm .odp .ink .potx .pub	25GB
Video	.3g2 .3gp .avi .flv .m4v .mkv .mov .mp4 .mp4v .wmp .wmv	25GB
Web	.wlmp .mts .mov-1 .mp4-1 .xspf .mod .mpg	25GB

*max file size is only applicable if using our Submit for Assessment service.

Submit for Assessment is our secure web-based submission service. You can access Submit for Assessment on any laptop or desktop computer running Windows or macOS and a compatible browser. It supports the upload of files in the formats listed in the table above as long as they do not exceed the maximum file size. Other file formats and folder structures can be uploaded within a compressed file format.

When you view some types of files in our Submit for Assessment service, they will be streamed in your browser. It would help your moderator or examiner if you could upload files in the format shown in the table below:

File type	File format	Chrome	Firefox
Audio	.mp3	Yes	Yes
Audio	.m4a	Yes	Yes
Audio	.aac	No	Yes
Document	.txt	Yes	Yes
Image	.png	Yes	Yes
Image	.jpg	Yes	Yes
Image	.jpeg	Yes	Yes
Image	.gif	Yes	Yes
Presentation	.pdf	Yes	Yes
Video	.mp4	Yes	Yes
Video	.mov	No	Yes
Video	.3gp	Yes	No
Video	.m4v	Yes	Yes
Web	.html	Yes	Yes
Web	.htm	Yes	Yes

Appendix B: Command words

External assessment

The table below shows the command words that will be used in exam questions. They show what we mean by the command word and how students should approach the question and understand its demand. Remember that the rest of the wording in the question is also important.

Word(s)	Students will....
Analyse	• Separate or break down information into parts and identify their characteristics or elements • Explain the pros and cons of a topic or argument and make reasoned comments • Explain the impacts of actions using a logical chain of reasoning
Annotate	• Add information, for example, to a table, diagram or graph until it is final • Add all the needed or appropriate parts
Calculate	• Get a numerical answer showing how it has been worked out
Choose	• Select an answer from options given
Circle	• Select an answer from options given
Compare and contrast	• Give an account of the similarities and differences between two or more items or situations
Complete	• Add all the needed or appropriate parts • Add information, for example, to a table, diagram or graph until it is final
Create	• Produce a visual solution to a problem (for example: a mind map, flowchart or visualisation)
Describe	• Give an account including all the relevant characteristics, qualities or events • Give a detailed account of
Discuss	• Present, analyse and evaluate relevant points (for example, for/against an argument)
Draw	• Produce a picture or diagram
Evaluate	• Make a reasoned qualitative judgement considering different factors and using available knowledge/experience
Explain	• Give reasons for and/or causes of • Use the words or phrases such as 'because', 'therefore' or 'this means that' in answers
Fill in	• Add all the needed or appropriate parts • Add information, for example, to a table, diagram or graph until it is final
Identify	• Select an answer from options given • Recognise, name or provide factors or features
Justify	• Give good reasons for offering an opinion or reaching a conclusion
Label	• Add information, for example, to a table, diagram or graph until it is final • Add all the necessary or appropriate parts
Outline	• Give a short account, summary or description
State	• Give factors or features • Give short, factual answers

Non examined assessment (NEA)

The tables below show the command words that will be used in the NEA Marking Criteria grids. They explain the type of evidence that you should expect to see to meet each command word.

Mark Band (MB1) Words:

Command word	Meaning
Basic	• Work includes the minimum required. It is a starting point but is simplistic and not developed. • Understanding and skills are applied in a way that partly achieves the wanted or intended result, but it would not be useable without further input or work.
Brief/Briefly	• Work includes a small number of relevant facts or concepts but lacks detail, contextualisation or examples.
Dependent	• The student can perform a task when given regular assistance or help
Few	• Work produced is restricted or narrow. It includes less than half of the information or examples expected for a full response.
Inefficient	• Outputs are produced but with great expense or effort because of poor organisation or design and not making the best use of available resources.
Limited	• Work produced is restricted in range or scope and includes only some of the information required. It evidences partial rather than full understanding. • Work produced is a starting point rather than a developed process, concept or output.
Minimal	• Includes very little in amount or quantity required.
Simple	• Includes a small number of relevant parts, which are not related to each other.
Superficial	• Work completed lacks depth and detail.

Mark Band (MB2) Words:

Command word	Meaning
Adequate(ly)	• Work includes the appropriate number of relevant facts or concepts but does not include the full detail, contextualisation or examples.
Assisted	• The student can perform a task with occasional assistance or help.
Part(ly)/Partial	• To some extent but not completely. • Work produced is inclusive in range and scope. It evidences a mainly developed application of understanding, performance or output needed. • Work produced results in a process, concept or output that would be useable for its purpose.
Some	• Work produced is inclusive but not fully comprehensive. It includes over half the information or examples expected for a full response.

Command word	Meaning
Sound	• Valid, logical, shows the student has secured most of the relevant understanding, but points or performance are not fully developed. • Applies understanding and skills to produce the wanted or intended result in a way that would be useable.

Mark Band (MB3) Words:

Command word	Meaning
Accurate(ly)	• Acting or performing with care and precision. • Correct in all details.
All	• Work produced is fully comprehensive and wide-ranging. It includes almost all, or all the information or examples expected for a full response.
Clear(ly)	• Focused and accurately expressed, without ambiguity.
Complex	• Includes many relevant parts, all of which relate to each other logically.
Comprehensive(ly)	• The work produced is complete and includes everything required to show depth and breadth of understanding. • Applies the understanding and skills needed to successfully produce the wanted or intended result in a way that would be fully fit-for-purpose.
Consistent(ly)	• A level of performance which does not vary in quality over time.
Critical	• Objective analysis and evaluation in order to form: a judgement, evaluation of the evidence or effective trouble shooting/fault finding.
Detailed	• Gives point by point consideration of all the key information.
Effective	• Applies the skills required to the task and is successful in producing the desired or intended result. • The work produced is effective in relation to a brief.
Efficient	• Able to produce results or outputs with the minimum expense or effort, because of good organisation or design and making the best use of available resources.
Full(y)	• Work produced is comprehensive in range and scope. It evidences a fully developed application of understanding, performance or output needed. • Work produced results in a process, concept or output that would be fully fit-for-purpose.
Independent(ly)	• The student can perform a task without assistance or reliance on others
Justify/Justified	• The reasons for doing something are explained in full.
Most(ly)	• Includes nearly all of what is expected to be included.
Wide (ranging)	• Includes many relevant details, examples or contexts; all of which are fully detailed, contextualised or exemplified.

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