Contents

WJEC GCSE in Electronics

For Teaching from 2009
For Award from 2011

This is a unitised specification: candidates may be entered for separate units at stages during the course.

For subject awards from summer 2014, this specification will not be available to centres in England: centres in England will be required to follow the linear version of this specification.

GCSE ELECTRONICS
SUMMARY OF ASSESSMENT

Unit 1: Discovering Electronics (35%) **Written Paper: 1 hour** **60 marks (70 UMS)**
Section A: 40 raw marks consisting of questions targeted at grades C-G **Section B:** 20 raw marks consisting of questions targeted at grades A*-B. Assessment is by on-screen e-assessment.
Unit 2: Applications of Electronics (40%) **Written Paper: 1 hour** **60 marks (80 UMS)**
Section A: 40 raw marks consisting of questions targeted at grades C-G **Section B:** 20 raw marks consisting of questions targeted at grades A*-B. Assessment is by on-screen e-assessment.
Unit 3: Electronics System Design & Realisation (25%) **Controlled Assessment** **60 marks (50 UMS)**
Candidates/teachers devise a design task. They realise and write a report on the development of the task. The assessment is undertaken entirely under the supervision of the teacher.

AVAILABILITY OF ASSESSMENT AND CERTIFICATION

	Entry Code		**June 2010**	**June 2011 and each year thereafter**
	Subject	Option*		
Unit 1	4161	01 or W1	✓	✓
Unit 2	4162	01 or W1		✓
Unit 3	4163	01 or W1	✓	✓
Subject Award	4160	SA or GU		✓

*** Option Codes**
English Medium 01, Welsh Medium W1 - for units
English Medium SA, Welsh Medium GU - for subject award

Qualification Accreditation Numbers
500/4571/4 until 2013
600/5565/0 from 2014

ELECTRONICS

1 INTRODUCTION

1.1 Rationale

This specification is intended to provide a framework around which courses can be planned to meet the needs and aspirations of students entering a progressively more technological society.

A systems approach is adopted to complex problem solving. Underlying this philosophy is the breaking-down of a task into manageable blocks, each of which performs its own unique function.

The blocks themselves may be considered at two levels. At the systems level, it is the terminal properties of the block that are of interest and not the detail of how these properties are arrived at within the block itself. At the circuit level, however, the engineer is primarily concerned with the design of the circuit contained within the block to produce the required terminal properties. The circuit level is treated on those occasions when a greater knowledge of the circuitry within a block itself is deemed necessary for the more effective use of the block.

It is fully intended that courses based around the specification will be directed towards design, where solutions to a given task are conceived through a systems approach and subsequently built as experimental models.

Electronics is a practically based subject where practical skills must be developed alongside theory to allow candidates to attain a deeper understanding. This specification is structured to allow prominence to be given to technological aspects of studying electronics. The direction of development should start with real applications of electronics and then move towards the principles necessary to understand these applications and not vice versa. It is intended to develop candidates' capability through a flexible and broad-based approach.

From the earliest stages of the course candidates should be given practical experience of electronic systems being used to solve specific design problems. Wherever possible, individual components should be treated in terms of their function as part of an electronic building block or sub-system rather than in terms of the physics of their behaviour.

This specification encourages the investigation and study of electronics in a variety of contexts - home, school, recreation, community, business and industry. Candidates from all cultures and both genders can develop their interest in, enjoyment of, and critical reflection about electronics as an integral part of modern society. Candidates should have the opportunity to analyse and evaluate situations, design and make electronic products and then appraise their performance. They should be provided with the opportunity to work with a range of components. Candidates should be encouraged to consider the relationship between electronics and society.

Some of the material covered may appear in other GCSE specifications. This should add strength through reinforcement and should broaden horizons by giving alternative viewpoints to similar concepts, thus providing a more enriching educational experience.

Consideration of safety inevitably arises in Electronics necessitating that emphasis be placed on working practices that promote safety consciousness at all times.

1.2 Aims and Learning Outcomes

Following a course in GCSE Electronics should encourage students to:

- develop their interest in, and enthusiasm for, electronics;
- develop a critical approach to scientific evidence and methods;
- acquire and apply skills, knowledge and understanding of how science works and its essential role in society;
- acquire scientific skills, knowledge and understanding necessary for progression to further learning.

1.3 Prior Learning and Progression

Although there is no specific requirement for prior learning, this specification builds upon the Programmes of Study for Science and Technology in Key Stage 3.

This specification provides a basis for the study of Electronics at Advanced Subsidiary, Advanced GCE and other applied qualifications.

1.4 Equality and Fair Assessment

GCSEs often require assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare candidates for a wide range of occupations and higher level courses.

The revised GCSE qualification criteria have been reviewed to identify whether any of the competences required by the subject presented a potential barrier to any disabled candidates. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject. The findings of this process were discussed with disability groups and with disabled people.

Since there are no subject criteria for GCSE Electronics, the proposal has been reviewed in itself and with reference to the review by the regulators of the criteria for GCSE Science. Requirements for the Electronic System Design and Realisation (Controlled Assessment) are sufficiently flexible for all candidates to participate. Depending on the severity of the disability, candidates with visual and motor impairments may have difficulty in demonstrating skills related to the assembly of an electronic circuit (part of Assessment Objective AO3). This amounts to 10% of the available marks in this component which itself has a weighting of 25%.

Units 1 and 2 are assessed electronically by on-screen e-assessment. Arrangements will be made for alternative assessments for those who are unable to access them.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in the Joint Council for Qualifications document *Regulations and Guidance: Access Arrangements, Reasonable Adjustments and Special Consideration.* This document is available on the JCQ website (www.jcq.org.uk).

Candidates who are still unable to access a significant part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award. They would be given a grade on the parts of the assessment they have taken and there would be an indication on their certificate that not all of the competences have been addressed. This will be kept under review and may be amended in future.

1.5 Classification Codes

Every specification is assigned a national classification code indicating the subject area to which it belongs. The classification code for this specification is 1730.

Centres should be aware that candidates who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

Centres may wish to advise candidates that, if they take two specifications with the same classification code, schools and colleges are very likely to take the view that they have achieved only one of the two GCSEs. The same view may be taken if candidates take two GCSE specifications that have different classification codes but have significant overlap of content. Candidates who have any doubts about their subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

2 CONTENT

UNIT E1: DICOVERING ELECTRONICS
Items which appear in bold type will targeted at grades B to A* candidates

TOPIC	On completion of this module, candidates should be able to:
1.1 ELECTRONIC SYSTEMS	apply a systems approach to electronics; understand that electronic systems can be divided up into three sections: input sensor(s); signal processing and output device(s); provide examples of electronic systems that are encountered in everyday life; identify the input, process and output sections in such systems; describe possible applications of an electronic system from a block diagram; produce a block diagram for a system to solve a given problem; design and test electronic systems.
1.2 ELECTRONIC SUB-SYSTEMS	use the following sub-systems as part of a block diagram : input units: *light, temperature, rotation, magnetic, moisture, sound, pressure pad/switch and pulse generator:* output devices: *lamp, buzzer, motor, solenoid and LED;* signal processing : *inverter, AND gate, OR gate, latch, time delay and comparator;* state the function of a transducer driver.

TOPIC	On completion of this module, candidates should be able to:
1.3 CIRCUIT CONCEPTS	recognise standard symbols for components included within the module; apply the *current at a junction* rule; apply the *voltage divider rule;* explain how voltage at a point can be indicated relative to a 0 V reference; appreciate that resistance is the opposition to current flow and that it is measured in ohms; understand the relationship between current, voltage and resistance in qualitative terms; select and use $R = \frac{V}{I}$; recognise that analogue signals are continuously varying and digital signals are two state; state that power is dissipated when current flows through resistance and is measured in watts; understand the relationship between current, voltage and power in qualitative terms; perform calculations involving P = V I; recognise and use the following multiple and sub-multiple indicators: p, n, μ, m, k and M.

TOPIC	On completion of this module, candidates should be able to:
1.4 COMPONENTS IN SENSING CIRCUITS	
1.4.1 RESISTORS	understand that resistance can be increased by connecting resistors in series; understand that resistance can be decreased by connecting resistors in parallel; select and use the equation $R = R_1 + R_2$ to perform calculations involving the combined resistance of two resistors in series; **select and use the equation** $\mathbf{R = \frac{R_1 R_2}{R_1 + R_2}}$ **to perform calculations involving the combined resistance of two resistors in parallel;** describe how fixed and variable resistors can be used in voltage dividers; describe how potentiometers can be used as variable resistors and voltage dividers; use the colour and printed code to work out the value and tolerance of a resistor; select appropriate preferred values from the E24 series;
1.4.2 LIGHT DEPENDENT RESISTORS (LDRs)	state that the resistance of an LDR falls as light intensity increases (non-linear);
1.4.3 NTC THERMISTORS	state that the resistance of ntc thermistors decreases as temperature increases (non-linear);
1.4.4 SWITCHES	distinguish between the following types of mechanical switches: *push, toggle, reed, micro, tilt, rotary*

TOPIC	On completion of this module, candidates should be able to:
1.5 DESIGNING SENSING CIRCUITS	incorporate the components given in sections 1.4 into voltage divider circuits.
1.6 OUTPUT CIRCUITS	choose an appropriate output device for a given application from: *buzzer, lamp, led, motor, solenoid**;*** **calculate the value of current limiting resistor required when using a LED or other device on a given DC supply.**

TOPIC	On completion of this module, candidates should be able to:
1.7 SWITCHING CIRCUITS	
1.7.1 INTRODUCTION	understand that switching circuits are often used: as an interface between analogue and digital sub-systems; as a transducer driver to drive output devices;
1.7.2 NPN TRANSISTOR	draw a circuit diagram to show how npn transistors can be used as part of a switching circuit; identify the base, collector and emitter leads on a transistor; state that a small base current can be used to control a much larger load current; apply the following rules to a given transistor switching circuit: *for V_{IN} < 0·7V, the transistor is off* *for V_{IN} > 0·7V, the transistor is on;*
1.7.3 N CHANNEL MOSFET	draw a circuit diagram to show how a MOSFET can be used as part of a switching circuit; identify the gate, source and drain on a MOSFET; state that a gate voltage can be used to control a large load current; **explain why a MOSFET should be used to drive heavy loads due to the limited output capability of logic systems;**
1.7.3 THYRISTOR	identify the gate, anode and cathode on a thyristor; state that a small gate voltage can be used to latch a large load current; draw a circuit diagram to show how a thyristor can be used as a latching transducer driver incorporating a reset switch.

TOPIC	On completion of this module, candidates should be able to:
1.7.4 VOLTAGE COMPARATORS	know that comparators have greater sensitivity than transistor switches; use data sheets to identify pin connections on a dedicated comparator IC; predict the output voltage given the input voltages in a comparator circuit; appreciate the current driving limitations of comparators; **design comparator circuits which cause output devices to respond to information from sensors**; **design circuits to increase the output capabilities of a comparator circuit by the addition of a transistor switch.**
1.9 APPLICATIONS OF DIODES	understand that a diode will only conduct when forward biased; understand that a diode can be used to allow a current in one direction and prevent current in the opposite direction in parts of a circuit; appreciate that the forward volt drop across a forward biased silicon diode is about 0·7 V; state that a diode is used to protect transistors and comparators for circuits which drive motors and solenoids; incorporate diode protection for circuits which drive motors and solenoids.

TOPIC	On completion of this module, candidates should be able to:
1.9 COMBINATIONAL LOGIC SYSTEMS	
1.9.1 LOGIC	recognise high/low, 1/0 as two-state logic levels;
1.9.2 TRUTH TABLES	draw symbols and construct truth tables for AND, OR, NOT, NOR and NAND gates; produce a truth table for a system of up to five gates; devise a system of gates from a truth table; design simple systems using logic gates to solve a given problem; **use Boolean notation as a shorthand method of expressing a truth table;**
1.9.3 USE OF DATA SHEETS	use data sheets to: select a logic IC for given applications; identify pin connections of logic gates;
1.9.4 NAND GATE IMPLEMENTATION	**show how other gates can be made up from NAND gates;** **implement a given logic circuit using NAND gates;** **remove double inversions;**
1.9.5 PULL UP/DOWN RESISTORS	**recognise the use of pull up/down resistors to provide the correct logic levels at a gate input.**

UNIT E2: APPLICATIONS OF ELECTRONICS

TOPIC	On completion of this module, candidates should be able to:
2. TIMING CIRCUITS	
2.1.1 RESISTOR - CAPACITOR NETWORK	know that a capacitor-resistor network can be used to produce a time delay, and explain in qualitative terms how a time delay may be changed; appreciate that a time delay circuit has to be buffered to be of practical use;
2.1.2 MONOSTABLE CIRCUITS	appreciate that a monostable produces a single pulse when triggered; describe a range of applications for a monostable; recognise a 555 timer configured as a monostable; **draw the trigger circuit for a 555 monostable consisting of a pull up resistor and push switch/sensor;** **perform calculations using the formula T = 1.1RC ;**
21.4 ASTABLE CIRCUITS	appreciate that an astable produces a continuous train of OFF-ON pulses; describe a range of applications for an astable; recognise a 555 timer configured as an astable; explain in qualitative terms how the frequency may be changed; measure the amplitude and period of the output waveform from an oscilloscope trace or graph; **calculate the frequency of an astable from an oscilloscope trace or graph;** **perform calculations given the formula for the frequency of an astable.**

TOPIC	On completion of this module, candidates should be able to:
2.2 SEQUENTIAL SYSTEMS	
2.2.1 D-TYPE FLIP-FLOPS	describe the action of a rising-edge-triggered D-type flip-flop; draw a timing diagram for a D-type flip-flop used for data transfer and as a latch; **draw a circuit diagram showing how a D-type flip-flop can be set up to form a latch, including a reset;**
2.2.2 BINARY COUNTERS	explain, and illustrate, how a D-type flip-flop can be set up to produce a divide-by-two function; complete timing diagrams for a 1-bit counter; **show how two D-types flip flops can be connected together to form a 2-bit binary up-counter;** **complete timing diagrams for a 2-bit counter;** realise that counters are available in a number of formats e.g. up/down, binary/BCD/decade; design and analyse simple systems that use a counter and combinational logic to produce a sequence of events; make a counter reset at a given value;
2.2.3 BCD COUNTER	explain the function of BCD counters; complete a truth table to show the signals needed to display a given character on a common cathode 7-segment display; realise that dedicated decoder/driver ICs are available in a number of formats to drive common cathode/common anode 7-segment displays; recognise and analyse the block diagram for a single digit decimal counting system;
2.2.4 DECADE COUNTER	describe the operation and use of a decade counter; **draw simple timing diagrams for a decade counter.**

TOPIC	On completion of this module, candidates should be able to:
2.3 INTERFACE CIRCUITS	
2.3.1 INTERFACING TO INPUTS	Compare the merits of transistors, comparators, and Schmitt inverters as interfaces between analogue sensors and digital systems; **use the property that a Schmitt inverter gate has two different input switching levels to draw the output signal for a given analogue input signal;** **explain why a Schmitt inverter is required to debounce mechanical switches and analogue sensors connected to a counting system**;
2.3.2 INTERFACING TO OUTPUTS	**select transistors in terms of current gain and collector current;** **apply the following rules to a given transistor switching circuit:** **for $V_{IN} < 0{\cdot}7$ V: $V_{BE} = V_{IN}$ and V_{CE} = Supply Voltage,** **for $V_{IN} > 0{\cdot}7$ V: $V_{BE} = 0{\cdot}7$ V and $V_{CE} = 0$ V;** **design transistor switching circuits which cause output devices to respond to information from sensors;** **state that $I_C = h_{FE}I_B$ until saturation is reached**; **calculate values for resistors and input switching voltages in transistor switching circuits.**

TOPIC	On completion of this module, candidates should be able to:
2.4 ANALOGUE COMMUNICATIONS	
2.4.1 GENERAL AMPLIFIER SYSTEMS	understand that amplifiers increase the power (VI) of signals; describe the function of the following sub-systems of a typical amplifier system: *signal source (eg microphone)* *preamplifier (ie voltage amplifier)* *mixer* *power (current) amplifier* *loudspeaker;* select and use the formula $G = \frac{V_{OUT}}{V_{IN}}$; understand what is meant by the bandwidth of an amplifier; **measure the bandwidth of an amplifier from a graph of voltage gain against frequency;** **explain and draw graphs to illustrate the meaning of output clipping for a given input signal;** **understand the trade-off between gain and bandwidth and the role of multiple stage voltage amplifiers in retaining bandwidth;**
2.4.2.OP-AMP VOLTAGE AMPLIFIERS	draw the circuit diagram for a non-inverting amplifier; select and use the formula $G = 1 + \frac{R_F}{R_1}$ to calculate the gain of a non-inverting amplifier **draw the circuit diagram for an inverting amplifier;** **select and use the formula $G = -\frac{R_F}{R_{IN}}$ to calculate the gain of an inverting amplifier** **in each case, use the gain formulae to select resistors to produce a given gain;** interpret and produce graphs showing input and output signals;

TOPIC	On completion of this module, candidates should be able to:
2.4..3 MIXING SIGNALS	**draw a circuit for a mixer based on an op-amp summing amplifier;** **use the gain formula to calculate the output voltage for a given summing amplifier circuit.**
2.5 PROGRAMMABLE CONTROL SYSTEMS	
2.5.1 SEQUENCE CONTROLLERS	understand the procedure needed to write and read content to memory addresses; design and analyse systems that use a memory IC as a programmable logic device;
2.5.2 SOFTWARE BASED CONTROLLERS	know that simple control systems consist of software, computer or micro-controller, interface, input sensors and output devices; know that the sensing circuits and output devices listed in the specification can be interfaced to a computer or micro-controller; use the following operations in flowcharts: inputting data, outputting data, counting, branching, testing data, simple arithmetic operations; design and analyse flowcharts for simple programs to make output devices: perform a sequence of actions, respond to information from sensors, make use of feedback; describe a range of applications of software-based control systems; appreciate the social, economic, ethical and cultural implication of this technology for improving the quality of life, employment and leisure.

UNIT E3: ELECTRONICS SYSTEM DESIGN AND REALISATION

TOPIC	On completion of this module, candidates should be able to:
3.1 DESIGNING, PROTOTYPING, TESTING AND EVALUATING	define a problem; draw up a specification for an electronic solution to the problem; design appropriate electronic solutions, as a series of sub-systems; select the most appropriate solution; use a systems approach treating each sub-system block in a design, build, test, evaluate and redesign process.
3.2 TESTING SYSTEMS	design and carry out suitable tests for systems.
3.3 MANUFACTURING	produce a circuit layout design for stripboard or PCB construction; plan for testing by inclusion of test-points in layouts; cost the materials for an electronic product.
3.4 EVALUATION	evaluate an electronic product designed and made by the student.
3.5 DOCUMENTATION	write a detailed report on the development of the project.

SAFETY (to pervade all modules)

TOPIC	GUIDANCE
SAFE WORKING PRACTICE	In addition to compliance with Health & Safety guidelines for pupils working under supervision in a school workshop/laboratory, candidates should be aware of the following safety procedures applicable to adults working in such an area: the need for proper safety precautions regarding equipment used e.g. correct fusing, earthing, insulation and RCCD protection; the need for disconnection from mains before investigating ANY faults in mains-powered equipment; the importance of using British Standard approved equipment; the correct procedure for dealing with a victim of electrocution; the danger from charged large capacitors and the need to discharge through a resistor; the danger of explosion of electrolytic capacitors of connection with wrong polarity, even at low voltages; the knowledge that some components contain poisonous substances.

3 ASSESSMENT

3.1 Scheme of Assessment

Assessment for GCSE Electronics is untiered, i.e. all components/units cater for the full range of ability and allow access to grades A*-G for the subject award. Questions and tasks will be designed to enable candidates to demonstrate what they know, understand and can do.

The scheme of assessment will consist of:

Written Paper/Unit 1: Discovering Electronics (1 hour, 35%)

The paper consists of 2 sections – A and B.
Section A: This section contains 40 marks and comprises questions targeted at grade C-G candidates. No questions will be set in this section on specification content which is **emboldened**.
Section B: This section contains 20 marks, targeted at A*/A/B candidates. Questions may draw upon emboldened material.

Written Paper/Unit 2: Applications of Electronics (1 hour, 40%)

The paper consists of 2 sections – A and B.
Section A: This section contains 40 marks, and comprises questions targeted at grade C-G candidates. No questions will be sent in this section on specification content which is **emboldened**.
Section B: This section contains 20 marks, targeted at A*/A/B candidates. Questions may draw upon emboldened material.

Controlled Assessment/Unit 3: Electronics System Design and Realisation (25%)

Candidates will be expected to design, realised and test an electronic solution to a problem agreed with their teachers.

3.2 Assessment Objectives

Candidates will be required to demonstrate the following assessment objectives in the context of the prescribed specification content.

AO1: Knowledge and understanding of science and how science works

Candidates should be able to:

(a) demonstrate knowledge and understanding of the scientific facts, concepts, techniques and terminology in the specification.

(b) show understanding of how scientific evidence is collected and its relationship with scientific explanations and theories.

(c) show understanding of how scientific knowledge and ideas change over time and how these changes are validated.

AO2: Application of skills, knowledge and understanding

Candidates should be able to:

(a) apply concepts, develop arguments or draw conclusions related to familiar and unfamiliar situations.

(b) plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

(c) show understanding of how decisions about science and technology are made to different situations, including contemporary situations and those raising ethical issues.

(d) evaluate the impact of scientific developments or processes on individuals, communities or the environment.

AO3: Practical, enquiry and data-handling skills

Candidates should be able to:

(a) carry out practical tasks safely and skilfully.

(b) evaluate the methods they use when collecting first-hand and secondary data.

(c) analyse and interpret qualitative and quantitative data from different sources.

(d) consider the validity and reliability of data in presenting and justifying conclusions.

The weighting of assessment objectives across examination components is as follows:

	AO1	AO2	AO3	Total
Written Paper/ Discovering Electronics	**10.5%**	**21%**	**3.5%**	**35%**
Written Paper/ Applications of Electronics	**8%**	**24%**	**8%**	**40%**
Controlled Assessment	**2.5%**	**5%**	**17.5%**	**25%**
Total Weighting	**21%**	**50%**	**29%**	**100%**

This is achieved by having a raw mark allocation in each unit approximately as follows:

	Raw marks			
	AO1	**AO2**	**AO3**	**Total**
Written Paper/ Discovering Electronics	**18**	**36**	**6**	**60**
Written Paper/ Applications of Electronics	**12**	**36**	**12**	**60**
Controlled Assessment	**6**	**12**	**42**	**60**

3.3 Quality of Written Communication

Assessment unit 2, Applications of Electronics, includes a question requiring an extended written response.

Assessment unit 3, the Electronics System Design and Realisation, includes extended writing.

In these parts of these units, candidates will be assessed on the quality of their written communication (QWC).

4 AWARDING, REPORTING AND RE-SITTING

GCSE qualifications are reported on an eight point scale from A* to G, where A* is the highest grade. The attainment of pupils who do not succeed in reaching the lowest possible standard to achieve a grade is recorded as U (unclassified) and they do not receive a certificate.

This is a unitised specification which allows for an element of staged assessment. Units may be re-taken once only (with the better result counting) before aggregation for this subject award. Results for a unit have a shelf-life limited only by the shelf-life of the specification.

At least 40% of the overall assessment must be taken at the end of the course (terminal assessment).

Individual unit results are reported on a uniform mark scale (UMS) with the following grade equivalences:

GRADE	MAX	A*	A	B	C	D	E	F	G
E1	70	63	56	49	42	35	28	21	14
E2	80	72	64	56	48	40	32	24	16
E3	50	45	40	35	30	25	20	15	10
Qualification	200	180	160	140	120	100	80	60	40

5 ADMINISTRATION OF CONTROLLED ASSESSMENT

The WJEC GCSE Electronics specification meets the regulations for controlled assessment as laid down by the regulatory authorities.

The controlled assessment task is worth 25% of the total marks available for the specification.

The controlled assessment tests assessment objective AO3 for GCSE Electronics.

RATIONALE FOR CONTROLLED ASSESSMENT

The controlled assessment is a compulsory part of GCSE Electronics. It complements the external examinations by offering a distinct means of assessment. It is important for a number of reasons:

- it enables candidates to engage in the design process in a real context, to make them aware at the appropriate level of the processes undertaken by engineers
- it enables candidates to test circuit blocks and complete systems, implementing the techniques they have learnt in units 1 and 2, and to compare the realised system with the theoretical performance
- it provides a platform for candidates to evaluate and to communicate the functioning of an electronics system

LEVELS OF CONTROL

The regulation of controlled assessment in GCSE Electronics is split into three stages:

- task setting
- task taking
- task marking

For each stage, WJEC specifies a certain level of control to ensure authenticity and reliability.

TASK SETTING

Overall this aspect has a **low** level of control.

Candidates must undertake one electronics system design and realisation task. The candidate must start with a task title, which may be proposed by the candidate or the teacher. The task should be appropriate to the capabilities of the candidate and should enable the candidate to demonstrate positive achievement. It is not desirable for many different candidates to undertake the same outline task, although this is not expressly forbidden. **Teachers are required to ensure that no two candidates develop the same, or very closely aligned, detailed system specifications.**

The WJEC will provide, on request, a number of tasks which centres can use.

TASK TAKING

The completed controlled assessment task takes the form of the research, design, realisation, evaluation and report on an electronic system to answer a specific design brief. There is no specified length of report, but it is possible to obtain full marks from a 15 page report.

The task contains the following elements:

1 production of a detailed design brief and specification from the project title
2 development of a system diagram containing subsystem blocks
3 design, production, testing and evaluation of the subsystems
4 connecting the subsystems into a functioning system and evaluating it in terms of the detailed design brief
5 production of a report on the construction and testing of the subsystems and the complete system

BRIEF DEVELOPMENT, RESEARCH AND SYSTEM DESIGN

Overall this aspect has a **limited** level of control.

Authenticity control:
This stage the task can have limited supervision but **it is required that a significant fraction of the research and design task be done in lesson time under teacher supervision**, so that the teacher is in a position to authenticate the work of the candidate**.**

Feedback control:
In this stage, the teacher can teach. It is permissible to give the same degree of assistance as in a normal lesson situation. Teachers can comment on work completed by candidates and offer feedback on its suitability, where appropriate.

Collaboration control:
The work of individual candidates may be informed by discussing with others at this stage, but candidates must produce an individual response ultimately. The teacher needs to be clear that the work is the candidate's own.

CONSTRUCTION, TESTING AND REPORT WRITING

Construction and testing this aspect have a **medium** level of control.
The report writing has a **high** level of control, being carried out under formal supervision.

Authenticity control:
A substantial fraction of the construction and testing phase of the controlled assessment must be undertaken under formal supervision, normally in lesson time. This is to ensure that the candidate has ownership of the project.

Feedback control:
During this phase of the project teachers are allowed to advise candidates. Some candidates will need more intervention than others. The extent of support given at this stage should be recorded by teachers and should be borne in mind when marking the work as the marking criteria require this to be assessed.

Candidates are encouraged to present the report in electronic format. They may opt to produce a handwritten report.

Time control:
The controlled assessment should be normally completed within 25 – 30 hours of supervised time. This does not need to be in one block. It can be spread over a series of sessions. Candidates with specific learning difficulties can be given extra time if appropriate.

Collaboration control:
All candidates must complete the controlled assessment task independently.

Resource control:
There are no resource controls.

TASK MARKING

Overall this aspect has a **high** level of control.

Initial marking
Teachers at the centre mark the controlled assessment using the mark scheme approved by the WJEC. Each project report should be accompanied by the Coursework Mark Booklet – see pages 35-38 of this specification – and must be authenticated by both teacher and candidate. It is a requirement that the work be annotated to show where a candidate achieves each marking criterion.

Internal moderation
Internal moderation is the process whereby the work of candidates in different teaching groups within a centre is checked for accuracy and consistency. This applies where more than one teacher undertakes the initial assessment and should be done before the moderation sample is chosen. A teacher responsible for the course should check that the agreed standards of marking have been consistently applied, and adjust the marks if necessary. The results of any internal moderation should be clearly shown on the coursework report forms and details provided with the necessary documentation when the sample is sent to the WJEC moderator.

Authentication of Controlled Assessments
Candidates are required to sign that the work submitted is their own and teachers/assessors are required to confirm that the work assessed is solely that of the candidate concerned and was conducted under the required conditions. A copy of the authentication form, which forms part of the cover sheet for each candidate's work is provided on p 35. It is important to note that **all** candidates are required to sign this form, and not merely those whose work forms part of the sample submitted to the moderator. Malpractice discovered prior to the candidate's signing the declaration of authentication need not be reported to WJEC but must be dealt with in accordance with the centre's internal procedures.

Before any work towards the Controlled Assessment is undertaken, the attention of candidates should be drawn to the relevant JCQ Notice to Candidates. This is available on the JCQ website (www.jcq.org.uk) and included in *Instructions for Conducting Coursework/Portfolios.* More detailed guidance on the prevention of plagiarism is given in *Plagiarism in Examinations; Guidance for Teachers/Assessors* also available on the JCQ website.

External moderation
External moderation is the process whereby the marks awarded by the centre are checked for accuracy and consistency. This is done by checking a sample of the work from a centre which is completed by a moderator appointed by WJEC. Instructions for the administration of internally-assessed work are given in the WJEC *Internal Assessment Manual.*

The work will have been carried out in class under the supervision of a teacher. **It is the teacher's responsibility to confirm this and to authenticate the work, by signing the appropriate box on the relevant forms.**

6 FURTHER GUIDANCE ON CONTROLLED ASSESSMENT

6.1 Approach

The aims set out for courses designed to satisfy this GCSE Electronics specification are particularly relevant to project work in which candidates use the skill and knowledge acquired during the course to solve real meaningful design problems. The structure for the assessment of the project work has been organised so as to encourage the development of a systems approach to problem solving and product development.

Candidates must produce a project report which documents the progress of the project. **Credit can only be given where there is documentary evidence.** This also provides the most appropriate place to assess the quality of the candidates' written communication.

It is expected by the Board that candidates do not design systems incorporating mains power or systems requiring Home Office approval. It is also expected that standard safe working practices will apply at all times.

A set of suggested design tasks is available from WJEC but centres are encouraged to use design tasks of their own devising and to encourage candidates to suggest their own. Candidates should be encouraged to adopt a design task which imposes a challenge that is demanding, but not so demanding that there exists a risk of non-completion of the design, test and evaluation processes. It is far better that candidates have the opportunity to complete all these processes than to be excluded from the final test and evaluation processes by non-completion of the design section.

The assessment scheme has therefore been designed to allow two approaches. There is always a danger that candidates may waste precious time at a critical period in the examination season in hunting dry joints or layout problems on system designs which have already been proven in prototype form. This specification therefore makes it possible for candidates to demonstrate all of the design skills without doing any soldering. These candidates can, in a separate task, be provided with the circuit diagram of a proven design and asked to produce it on PCB or stripboard. The standard of layout and construction skills can then be assessed separately, with this assignment imposing no demand on the candidates for fault finding.

It is, however, also possible for a candidate to design and test an electronic system, and proceed to assemble and solder it, having layout and constructional skills assessed with a circuit of the candidate's own design. It is left to the discretion of the Centre to apply the more appropriate of these two models. An assembly task is available separately from the Board.

6.2 Minimum requirement

To qualify for an award, photographic evidence of an artefact of minimal construction must accompany the project report with the artefact’s having at least one active device capable of being switched to a suitable power supply.

6.3 The marking and standardisation of the coursework project

6.3.1 The assessment scheme is divided up into seven areas:

1. Project brief and specification.
2. Preparatory planning and research.
3. Project development.
4. Performance of the system.
5. Manufacturing.
6. Initiative.
7. Documentation and Written Communication.

6.3.2 In the first 6 section the criteria in each section are divided into groups, each of which is divided into 2-4 levels of response. Within each group, marks for the higher-level response may only be awarded if the lower level responses have also been credited. In the last section, the criteria are applied on a "best fit" basis: e.g. it is possible to obtain 5 marks in this section by completely fulfilling one criterion in the highest level or partially fulfilling both criteria.

6.4 Moderation and supporting evidence

6.4.1 The sample of candidates' work to be sent for moderation must consist of written work, photographic evidence (as necessary), completed project assessment forms and coursework cover sheets. Moderation of the internal assessments will take place on the basis of detailed scrutiny by a WJEC appointed moderator.

6.4.2 For each candidate included in the sample, the work provided for inspection by the moderator must support the final mark submitted for each skill. The evidence must be presented in a clear and helpful way for the moderator.

An indication must be given on the front cover of the Mark Booklet of any guidance, given by the teacher (or other person), which has significant assessment implications.

6.5 Problems with individual candidates

6.5.1 In a scheme of internal assessment of candidates' work, teachers should be able to accommodate occasional absence by ensuring that the opportunity is given for candidates to make up assessment missed by absence.

6.5.2 The marks for candidates where no assessment can be made for one or more skills should be aggregated, using a zero where no assessment is possible. Where it is not possible to make any assessment for a candidate for the coursework as a whole, no mark should be awarded and 'ABS' should be recorded on the Project Assessment form.

6.5.3 Where, as a result of illness or other exceptional circumstances, the work available from a candidate does not meet the scheme requirements or where it meets requirements but does not support the mark which the centre feels appropriate for the candidate, the centre should provide all relevant information about the circumstances of the assessment made by submitting a request for special consideration to the WJEC office, using the relevant form, accompanied, where appropriate, by medical evidence. A similar procedure should be followed in cases where a candidate has completed work but suffers from some form of disability or handicap which may have affected his/her work.

6.5.4 Where work is misplaced in circumstances beyond the candidate's control, the WJEC should be notified immediately of the date of the loss, how it occurred and upon whom responsibility for the loss rests. The WJEC will provide details of the procedures to be followed in such a case.

6.5.5 Where special help which goes beyond the normal learning support is given, the WJEC must be informed so that account can be taken of such help when assessment and moderation takes place.

6.6 Retention of evidence

6.6.1 Centres are asked to retain candidates' marked coursework under secure conditions, as far as practicable, until 31 October following the examination, to allow for the possibility of enquiry about results or a request for a review of results.

7 GRADE DESCRIPTIONS

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The descriptions must be interpreted in relation to the content specified by the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of candidates' performance in the assessment may be balanced by better performances in others.

Grade F

Candidates demonstrate a limited knowledge and understanding of electronics content and how science works. They use a limited range of the concepts, techniques and facts from the specification, and demonstrate basic communication and numerical skills, with some limited use of technical terms and techniques.

They use and apply their knowledge and understanding of simple principles and concepts in some specific contexts. With help they plan an electronics task, such as a practical procedure, testing an idea, answering a question, or solving a problem, using a limited range of information in an uncritical manner. They are aware that decisions have to be made about uses of electronics and, in simple situations familiar to them, identify some of those responsible for the decisions. They describe some benefits and drawbacks of scientific developments with which they are familiar and issues related to these.

They follow simple instructions for carrying out a practical task and work safely as they do so.

Candidates identify simple patterns in data they gather from first-hand and secondary sources.
They present evidence as simple tables, charts and graphs, and draw simple conclusions consistent with the evidence they have collected.

Grade C

Candidates demonstrate a good overall knowledge and understanding of electronics content and how science works, and of the concepts, techniques, and facts across most of the specification. They demonstrate knowledge of technical vocabulary and techniques, and use these appropriately. They demonstrate communication and numerical skills appropriate to most situations.

They demonstrate an awareness of how scientific evidence is collected and are aware that scientific knowledge and theories can be changed by new evidence. Candidates use and apply scientific knowledge and understanding in some general situations relevant to electronics. They use this knowledge, together with information from other sources, to help plan an electronics task, such as a practical procedure, testing an idea, answering a question, or solving a problem. They describe how, and why, decisions about uses of electronics are made in some familiar contexts. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They carry out practical tasks safely and competently, using equipment appropriately and making relevant observations, appropriate to the task. They use appropriate methods for collecting first-hand and secondary data, interpret the data appropriately, and undertake some evaluation of their methods.

Candidates present data in ways appropriate to the context. They draw conclusions consistent with the evidence they have collected and evaluate how strongly their evidence supports these conclusions.

Grade A

Candidates demonstrate a detailed knowledge and understanding of electronics content and how science works, encompassing the principal concepts, techniques, and facts across all areas of the specification. They use technical vocabulary and techniques with fluency, clearly demonstrating communication and numerical skills appropriate to a range of situations.

They demonstrate a good understanding of the relationships between data, evidence and scientific explanations and theories. They are aware of areas of uncertainty in scientific knowledge and explain how scientific theories can be changed by new evidence.

Candidates use and apply their knowledge and understanding in a range of tasks and situations. They use this knowledge, together with information from other sources, effectively in planning an electronics task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

Candidates describe how, and why, decisions about uses of electronics are made in contexts familiar to them, and apply this knowledge to unfamiliar situations. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They choose appropriate methods for collecting first-hand and secondary data, interpret and question data skilfully, and evaluate the methods they use. They carry out a range of practical tasks safely and skilfully, selecting and using equipment appropriately to make relevant and precise observations.

Candidates select a method of presenting data appropriate to the task. They draw and justify conclusions consistent with the evidence they have collected and suggest improvements to the methods used that would enable them to collect more valid and reliable evidence.

8 THE WIDER CURRICULUM

Key Skills

Key Skills are integral to the study of GCSE Electronics and may be assessed through the course content and the related scheme of assessment as defined in the specification. The following key skills can be developed through this specification at levels 1 and 2:

- Communication
- Problem Solving
- Information and Communication Technology
- Working with Others
- Improving Own Learning and Performance

Mapping of opportunities for the development of these skills against Key Skills evidence requirement is provided in 'Exemplification of Key Skills for Electronics, available on the WJEC website.

Opportunities for use of technology

There are many opportunities for candidates to use ICT in this specification.

Candidates may use circuit simulations both to investigate the behaviour components and circuits during the teaching of the course and in the design of their system in the controlled task.

Preparation of the report on the controlled assessment affords the opportunity for word processing, image importing (from circuit-simulation software) and data handling.

Spiritual, Moral, Ethical, Social and Cultural Issues

This specification provides opportunities for candidates to develop an understanding of spiritual, moral, ethical, social and cultural issues as they relate to the electronics designer, manufacturer or user. For example, in Section 2.5.2 candidates are required to *appreciate the social, economic, ethical and cultural implications of this technology for improving the quality of life, employment and leisure.*

The specification provides a framework and includes specific content through which individual courses may address these issues. Project work may serve to extend understanding of these issues in order that a balanced appreciation of the conflicts and dilemmas involved in the design and manufacture of electronic products or systems be encouraged.

The specification also provides opportunities to promote enterprise and entrepreneurial skills through the process of identifying an opportunity to design an electronic product or system to meet a specific need, investigating the work of professional engineers and the electronics industry, developing their own product or system and finally evaluating the whole process. The project provides opportunities to develop independent thinking skills, through candidates identifying relevant sources of information and developing specific performance criteria for their designs to guide their thinking.

Citizenship

Whilst the direct impact of a study of electronics on the citizen is limited, the understanding of engineering in general and electronics in particular allows students to become capable of interpreting the impact and possibilities of technology and so to make informed decisions on the technological problems faced by society.

Environmental Issues

As an engineering subject, electronics has major environmental implications, not least in the mitigation of the impact of the application of technology. This may be addressed throughout the course, e.g. the use of time-delay circuits, in section 2.1.2, to switch on lighting for a restricted period limits the use of electricity and hence the environmental impact of its generation. The controlled task affords the opportunity of taking environmental impact into consideration.

Health and Safety Consideration

Health and safety issues are at the core of all work in electronics, as indicated in the section on safe working provision on page 19 and controlled task criterion 5a (page 38). Candidates are expected to consider these factors when designing and making their own electronic product or system in the project and the project.

Controlled Assessment

Mark Booklet

ES2

Electronics System Design & Realisation

Centre Name _____

Centre Number _____

Candidate's name (in full) _____

Candidate number _____

A. Have you received any help or information from anyone other than your subject teacher in the production of this work?
Please answer yes/no

B. If the answer is yes, give the name(s) of the person(s) who helped you.

_____

_____

C. What help did they give you?

_____

_____

Declaration by teacher or lecturer	Declaration by candidate
I certify that the candidate has been properly supervised during the preparation of this coursework. I also certify that, to the best of my knowledge, with the exceptions stated, this is the candidate's own unaided work. Signature: ..... Date: 2010	The attached coursework, with the exception stated, is my own unaided work. Signature: .....Date:..... 2010

Appendix C – Assessment criteria for GCSE Electronics Controlled Assessment.

The criteria in each section are divided into groups, each of which is arranged into 2 – 4 levels of response. Within each group, the highest appropriate mark should be awarded. If the lowest level response is not achieved a mark of 0 should be given.

The project report must contain evidence to support the awarding of marks.

1. Project brief and specification:

	The report contains:	**Marks available**	**Mark awarded**
a	a title for the project;	1	
b	a title for the report and a description of the problem to be solved	2	
c	any form of specification for the solution to the problem;	1	
d	a partial specification in both qualitative and quantitative terms;	2	
e	a detailed specification with most aspects of the problem considered.	3	

2. Project planning and research:

The candidate has:

a	researched sources of information;	1	
b	justified the relevance of the researched information	2	
c	attempted to identify an electronic solution to the problem;	1	
d	identified a realistic electronic solution to the problem;	2	
e	given a labelled block diagram for the complete system;	1	
f	explained how the system works in terms of the function of each block in the system	2	

3. Project development:

The candidate has developed the solution as a series of subsystems and:		Marks available	Mark awarded
a	set up and tested prototypes for at least one sub-system;	1	
b	set up and tested prototypes for at least three sub-systems;	2	
c	set up and tested prototypes for at least five sub-systems;	3	
d	presented at least one sub-system circuit diagram;	1	
e	presented at least three sub-system circuit diagrams;	2	
f	presented at least five sub-system circuit diagrams;	3	
g	given an account, with results, of testing at least one sub-system;	1	
h	given an account, with results, of testing at least three sub-systems;	2	
i	given an account, with results, of testing at least five sub-systems;	3	
j	given an account, with results, of testing at least five sub-systems and included at least one relevant current measurement;	4	
k	evaluated the performance of 1 subsystem;	1	
l	evaluated the performance of 3 or more subsystems.	2	

The candidate has:

m	set up and tested a prototype for the complete system;	1	
n	given an account, with results, of testing the complete system prototype;	2	
o	given an account, with results, of testing the complete system prototype including at least one relevant electrical measurement;	3	
p	presented a circuit diagram for the complete system;	1	
q	presented a high-quality fully-labelled circuit diagram for the complete system;	2	
r	performed relevant calculations on 1 occasion;	1	
s	performed relevant calculations on 2 or more occasions.	2	

4. Performance of the system:

a	At least one sub-system worked;	1	
b	At least three sub-systems worked;	2	
c	At least five sub-systems worked;	3	
d	The complete system worked at some time;	1	
e	The complete system worked reliably.	2	
f	The candidate undertook an evaluation of the performance of the complete system which was valid in some respects;	1	
g	The candidate undertook an evaluation of the performance of the complete system which was valid in most respects.	2	

5. Manufacturing:

The circuit soldered by the candidate:		**Marks available**	**Mark awarded**
a	was produced observing all necessary safety procedures;	1	
b	was produced observing all necessary safety procedures has all wire connections made to an acceptable standard;	2	
c	in addition to 5c, has inputs, outputs, and power supply connections clearly identified;	3	
d	shows some attempt to plan the layout;	1	
e	shows a good standard of planning of the layout;	2	
f	has some components soldered to an acceptable standard;	1	
g	has all components soldered to an acceptable standard;	2	
h	shows a satisfactory standard of construction;	1	
i	shows a high standard of construction.	2	

6. Initiative :

The candidate has:

a	worked without support for much of the time;	1	
b	worked alone with only occasional need for guidance;	2	
c	developed the project clearly, coherently, and in an organised manner throughout;	1	
d	demonstrated tenacity and diligence in the development of the project;	2	
e	attempted a project sufficiently enterprising in terms of **either** level of demand **or** depth of investigation;	1	
f	successfully completed a project sufficiently enterprising in terms of **both** level of demand **and** depth of investigation.	2	

7. Documentation and Written Communication:

The candidate produced a project report which included:

a	a complete component list;	1	
b	a complete component list including component costs and total cost.	2	

The candidate has produced:

c	an outline account of the work done and a basic user guide; [*QWC* limited, presenting material with limited coherence and containing errors of spelling, punctuation and grammar.]	1-2	
d	a satisfactory account of the work done and user guide; [*QWC* is generally good, presenting appropriate material in a coherent manner with few errors of SPG.]	3-4	
e	a well-presented and structured account of the work done and a comprehensive user guide; [*QWC* is excellent, presenting wholly appropriate material in a coherent and logical manner with few, if any, errors of SPG.]	5-6	

Total mark (Maximum 60)		