

SQA Advanced Unit specification

General information for centres

Unit title: Analogue Electronics: An Introduction

Unit code: HT7J 46

Unit purpose: This Unit is designed to enable candidates to develop knowledge, understanding and demonstrate a range of analogue electronic devices and circuits. It will also provide candidates with the underpinning knowledge to further their studies in other Units that include analogue electronics.

On completion of this Unit the candidate should be able to:

- 1 Explain the characteristics and operation of a range of analogue electronic devices.
- 2 Describe the applications of a range of analogue electronic devices.
- 3 Demonstrate the applications of a range of analogue electronic devices.

Credit points and level: 1 SQA Credit at SCQF level 6: (8 SCQF credit points at SCQF level 6*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to doctorates.*

Recommended prior knowledge and skills: Candidates should have a basic knowledge and understanding of analogue electronic devices. This may be evidenced by possession of some of the following NQ Units: D133 11 Semiconductor Applications: An Introduction, E9S2 12 Amplification and D186 11 Applied Electronics. However, entry requirements are at the discretion of the centre.

Core skills: There may be opportunities to gather evidence towards the following listed Core Skills or Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components:

- ◆ Written Communication (reading) at National 5
- ◆ Numeracy at National 5
- ◆ Using Information Technology at National 5
- ◆ Critical Thinking at National 5
- ◆ Working with Others at National 4

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Context for delivery: This Unit was developed for the SQA Advanced Diploma in Electrical Engineering. If the Unit is delivered as part of another Group Award it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Assessment: The written assessment for Outcomes 1 and 2 in this Unit should consist of one assessment paper taken at one assessment event lasting one and a half hours.

The practical assessment, for Outcome 3, should consist of pre-constructed analogue electronic circuits that candidates will test. The duration of the practical assessment should be two and a half hours.

SQA Advanced Unit specification: statement of standards

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Explain the characteristics and operation of a range of analogue electronic devices

Knowledge and/or skills

- ◆ diodes
- ◆ bipolar transistor
- ◆ JFET
- ◆ operational amplifier

Outcome 2

Describe the applications of a range of analogue electronic devices.

Knowledge and/or skills

- ◆ diode circuits
- ◆ single stage transistor amplifier
- ◆ operational amplifier circuits

Outcome 3

Demonstrate the applications of a range of analogue electronic devices.

Knowledge and/or skills

- ◆ diode circuits
- ◆ single stage transistor amplifier
- ◆ operational amplifier circuits

Evidence requirements for Outcomes 1 and 2

Evidence for the knowledge and/or skills in Outcomes 1 and 2 will be provided on a sample basis. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the items shown under the knowledge and skills items in these Outcomes. In any assessment of the Outcomes **one device**

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from each of the four knowledge and/or skills items should be sampled from Outcome 1 and **two applications from each of the three** knowledge and skills items from Outcome 2.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of **one device from each of the four** knowledge and/or skills items from Outcome 1 and **two applications from each of the three** knowledge and/or skills items from Outcome 2 are required each time the Unit is assessed. Candidates must provide a satisfactory response to all items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

Outcome 1

- ◆ explain the characteristics and operation of **one** diode from: rectifier, zener, light-emitting and photo
- ◆ explain the characteristics and operation of **one** bipolar transistor from: NPN, PNP
- ◆ explain the characteristics and operation of **one** JFET from: n-channel, p-channel
- ◆ explain the characteristics and operation of an operational amplifier

Outcome 2

- ◆ Describe **two** applications of diodes from:
 - (i) rectifier diode
 - (ii) voltage reference source
 - (iii) light-emitting diode
 - (iv) photo-diode

Describe **two** applications of transistors from:

- (i) common-emitter amplifier
- (ii) common-source amplifier
- (iii) electronic switch

- ◆ Describe **two** applications of operational amplifiers from:
 - (i) inverting amplifier
 - (ii) non-inverting amplifier
 - (iii) voltage follower
 - (iv) summing amplifier; (v) difference amplifier

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed-book conditions and candidates should not be allowed to bring any textbooks, handouts or notes to the assessment.

Assessment guidelines for the Unit

The written assessment for Outcomes 1 and 2 in this Unit should consist of one assessment event of one and a half hours. The question paper should be composed of a suitable balance of short answer, restricted response and structured questions. The written assessment should be conducted under controlled, supervised conditions. It should be noted that, in order to pass the Unit, candidates must achieve all of the minimum evidence specified for each Outcome.

Evidence requirements for Outcome 3

Candidates will need to demonstrate their knowledge and/or skills by showing that they are able to complete a practical assessment on pre-constructed circuits.

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ Demonstrate **one** diode application from:
 - (i) rectifier diode
 - (ii) voltage reference source
 - (iii) light-emitting diode
 - (iv) photo-diode

AND

- ◆ Demonstrate **one** application of transistors from:
 - (i) common-emitter amplifier
 - (ii) common-source amplifier
 - (iii) electronic switch

AND

- ◆ Demonstrate **one** application of operational amplifiers from:
 - (i) inverting amplifier
 - (ii) non-inverting amplifier
 - (iii) voltage follower;
 - (iv) summing amplifier
 - (v) difference amplifier

The practical assessment should be carried out on an individual basis. Checklists should be used as evidence for the practical assessment.

The practical assessment should consist of pre-constructed analogue electronic circuits that candidates will test. Two and a half hours should be allowed for the practical assessment. Checklists should be used as evidence for the practical assessment.

The time allocated to each Outcome allows for both the written and practical assessment.

Administrative information

Unit code:	HT7J 46
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SQA Advanced Unit specification: support notes

Unit title: Analogue Electronics: An Introduction

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit has been written in order to allow candidates to develop their knowledge, understanding and skills in the following areas:

- 1 The characteristics and operation of a range of discrete semiconductor and integrated circuit devices used in analogue electronic circuits.
- 2 Describe the applications of a range of analogue electronic devices.
- 3 Demonstrate the use of analogue electronic devices in a range of applications.

This Unit has been developed as a stand-alone topic in Analogue Electronics within the Options Section of the SQA Advanced Diploma in Electrical Engineering. This is a 1-credit Unit at SCQF Level 6 (8 SCQF credit points at SCQF Level 6).

In designing this Unit, the writers have identified the range of topics they would expect to be covered by lecturers. The writers have also given recommendations as to how much time should be spent on each Outcome. This has been done to help lecturers to decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for centres to use this list of topics it is strongly recommended that they do so to ensure continuity of teaching and learning.

A list of topics is given below. Lecturers are advised to study this list of topics in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit.

1 Explain the characteristics and operation of a range of analogue electronic devices (8 hours).

Operation

- ◆ operation of power rectifier diode including forward bias, reverse bias and depletion region
- ◆ operation of zener diode including two types of reverse breakdown, avalanche and zener breakdown
- ◆ operation of LED when forward-biased
- ◆ operation of photo-diode when reverse-biased
- ◆ basic transistor operation of npn and pnp transistors including forward and reverse bias and direction of currents
- ◆ operation of n- and p-channel JFETs, reverse-biased gate-source region, depletion-mode operation
- ◆ operation of operational amplifiers

Characteristics

- ◆ forward and reverse I/V characteristics of rectifier and signal diode indicating and explaining regions of importance such as forward and reverse blocking, forward and reverse conduction, forward voltage drop and reverse breakdown voltage, slope resistance
- ◆ forward and reverse I/V characteristics of zener diode
- ◆ forward characteristic of LED
- ◆ reverse characteristic of photo-diode
- ◆ Data sheets of diodes to determine important parameters
- ◆ input and output characteristics of bipolar transistors
- ◆ data sheets of bipolar transistors to determine important parameters
- ◆ transfer and drain characteristics of JFETs
- ◆ data sheets of JFETs to determine important parameters
- ◆ characteristics of ideal and practical operational amplifiers

2 Describe the applications of a range of analogue electronic devices (16 hours).

Diode applications

- ◆ use of rectifier diode in half- and full-wave rectifier circuits
- ◆ use of zener diode as a voltage reference source
- ◆ use of infra-red and indicator LED
- ◆ use of photo-diode
- ◆ use of opto-couplers consisting of an LED and a photodiode or phototransistor

Transistor applications

- ◆ use of bipolar junction transistor and field effect transistors as electronic switches
- ◆ common-emitter amplifier to include bias as a Class-A amplifier using potential divider bias with resistive load and emitter resistor stabilisation of the operating point; calculation of circuit voltages given component values; calculation of circuit components given circuit voltages
- ◆ frequency response of a.c. coupled amplifier
- ◆ common-source amplifier with self-bias and resistive load

Operational amplifier applications

- ◆ ideal operational amplifier as an inverting amplifier, closed-loop voltage gain, virtual earth concept
- ◆ ideal operational amplifier as a non-inverting amplifier, closed loop voltage gain
- ◆ operational amplifier as a voltage follower, closed loop voltage gain, input impedance and output impedance
- ◆ ideal operational amplifier as a summing amplifier with a maximum of three inputs, unity-gain summing amplifier, gain greater than unity, averaging amplifier and scaling amplifier
- ◆ ideal operational amplifier as a difference amplifier
- ◆ the operation of all the above amplifiers can be described using a mathematical model

3 Demonstrate the applications of a range of analogue electronic devices (16 hours).

Practical assignments on diode circuits

Areas for practical assignments should include, but are not limited to the following:

- ◆ half and full wave rectification with resistive load
- ◆ zener diode circuit as a voltage regulator
- ◆ LED and photodiode
- ◆ opto-coupler

Practical assignments on transistor amplifier circuits

Areas for practical assignments should include, but are not limited to the following:

- ◆ common-emitter amplifier
- ◆ common-source amplifier
- ◆ transistor switch

Practical assignments on operational amplifier circuits

Areas for practical assignments should include, but are not limited to the following:

- ◆ inverting amplifier
- ◆ non-inverting amplifier
- ◆ voltage follower
- ◆ summing amplifier
- ◆ difference amplifier

Guidance on the delivery and assessment of this Unit

This Unit has been designed as an optional Unit for candidates on the SQA Advanced Diploma in Electrical Engineering. The Unit should provide SQA Advanced Diploma candidates with knowledge, understanding and skills about analogue electronic components and circuits. The Unit should provide them with the underpinning knowledge that will allow them to further their studies in analogue electronics and related subjects such as Power Electronics.

This Unit has been designed to incorporate sufficient time to allow lecturers to teach all the analogue electronic principles contained in the Unit. There is also sufficient time for candidates to practice what they have learnt through appropriate formative written exercises and practical laboratory work. Where possible, students should construct circuits on breadboard when they are carrying out practical exercises for Outcome 3. Circuit simulation, using suitable software packages, should be undertaken but is not part of the assessment procedure. Some of the practical work will be assessed as stated under Evidence requirements and Assessment guidelines for Outcome 3 in the SQA Advanced Diploma Unit specification: statement of standards section. Circuits constructed during the practical activities for the Unit could be used for the practical assessment.

It is recommended that the written assessment takes place after completion of Outcomes 1 and 2. The practical assessment should take place after completion of Outcome 3.

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of online support. However, with regards to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessment, whether done at a single or multiple events, was conducted under controlled, supervised conditions.

To keep administrative arrangements to a minimum, it is recommended that a single assessment paper taken by candidates at a single assessment event be used for distance learning candidates.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* (SQA 2000)

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Analogue Electronics: An Introduction

This Unit has been designed to allow you to develop your knowledge, understanding and skills in analogue electronic devices and circuits so that you can further your studies with more advanced Units which include analogue electronic devices. The Unit can be used as a stand-alone Unit in analogue electronics if you do not wish to advance your studies beyond SCQF Level 6. It can also be used by other engineering students who wish to broaden their knowledge.

You will have the opportunity to improve your knowledge, understanding and skills about discrete and integrated circuit semiconductor devices that are widely used in electronic circuits. By the completion of the Unit you should be competent in the understanding of a wide range of analogue electronic devices, be able to interpret data sheets and gain practical skills in the handling and testing of components and circuits. You should also be able to recognise the relationship between the theoretical knowledge gained and the practical assignments undertaken.

Outcome 1 will introduce you to discrete and integrated circuit semiconductor devices used in electronic circuits. At the end of the Outcome you will have knowledge and understanding about the characteristics and operation of these devices. Outcome 2 allows you to understand the practical applications of the devices studied in Outcome 1. You will also gain valuable experience during Outcome 3 by carrying out some practical exercises using test equipment such as digital multimeters and dual beam oscilloscopes.

You will learn about the operational amplifier which is widely used in analogue linear circuits to perform mathematical operations such as addition, subtraction, multiplication and division.

The written assessment for this Unit will consist of one assessment paper lasting for one and a half hours. The assessment will be conducted under closed book, controlled, supervised conditions. You will not be allowed to take notes or textbooks into the assessment but you will be allowed to use a scientific calculator. The assessment will normally take place at the end of the Unit.

The practical assessment will consist of one practical laboratory exercise, selected by your lecturer, from Outcome 3 of this Unit. This assessment will take place under controlled and supervised conditions. You will be expected to carry out the practical assessment on an individual basis within a given time limit.