



Higher National Unit specification

General information

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Unit code: H949 34

Superclass: XJ

Publication date: May 2015

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to provide learners with an introduction to a variety of electrical and electronic principles together with the basic components that form the key building blocks of aircraft avionic and electrical systems.

The Unit provides the underpinning knowledge necessary before a learner undertakes progression to further studies at SCQF level 8.

Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Describe electrical fundamentals and components and solve DC electrical network problems.
- 2 Describe the fundamentals of AC sine-wave circuits and the fundamentals of Aircraft Power Generation.
- 3 Explain the fundamental principles of common two-terminal semiconductor devices.
- 4 Explain the basic principles, construction and characteristics of Transistors and Operational amplifier devices.
- 5 Explain the operation of the Transistor and Operational Amplifier, simple and multi-stage circuits and their applications.
- 6 Describe combinational logic circuits and their applications.

Credit points and level

2 Higher National Unit credits at SCQF level 7: (16 SCQF credit points at level 7).

Higher National Unit Specification: General information (cont)

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Recommended entry to the Unit

Entry is at the discretion of the centre. The Unit has no pre-requisites; however, it would be beneficial if the learner has knowledge of Mathematics and Physics at SCQF level 6 or have successfully completed an NC in an Engineering discipline at SCQF level 6.

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

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.

Higher National Unit specification: Statement of standards

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

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. Learners 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

Describe electrical fundamentals and components and solve DC electrical network problems.

Knowledge and/or Skills

- ◆ Ohms Law, V, I, R and Power, Kirchhoff's Laws
- ◆ Series resistive circuits
- ◆ Parallel resistive circuits
- ◆ Combination resistive circuits
- ◆ Properties of components: Resistors, Capacitors, Inductors, Switches, Circuit Protection devices and Relays
- ◆ Component Schematic symbols

Outcome 2

Describe the fundamentals of AC sine-wave circuits and the fundamentals of Aircraft Power Generation.

Knowledge and/or Skills

- ◆ AC sine-wave fundamentals
- ◆ Magnetism and electromagnetic principles
- ◆ Series RLC circuits
- ◆ Power in reactive circuits, Transformer theory.
- ◆ Aircraft storage batteries: Lead-acid, NiCad and Lithium-Ion
- ◆ Basic aircraft DC and AC single and three phase power generation

Higher National Unit specification: Statement of standards (cont)

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Outcome 3

Explain the fundamental principles of common two-terminal semiconductor devices.

Knowledge and/or Skills

- ◆ Basic fundamental principles of semiconductor PN junctions
- ◆ Operation and construction of rectifier diodes
- ◆ Rectifier diode characteristics
- ◆ Diode applications including full and half-wave rectifier, clippers and clamping circuits
- ◆ Operation, construction and characteristics of LEDs, SCRs, Photoconductive, Varactor, Varistor, Zener and other common two-terminal semiconductor devices
- ◆ Diode Schematic symbols

Outcome 4

Explain the basic principles, construction and characteristics of Transistors and Operational amplifier devices.

Knowledge and/or Skills

- ◆ Principles, operation and characteristics of BJT devices
- ◆ Principles, operation and characteristics of JFET devices
- ◆ Principles, operation and characteristics of MOSFET devices
- ◆ Principles, operation and characteristics of Operational, Instrumentation and Comparator Amplifiers
- ◆ Transistor and IC (Integrated Circuit) Schematic symbols

Outcome 5

Explain the operation of the Transistor and Operational Amplifier, simple and multi-stage circuits and their applications.

Knowledge and/or Skills

- ◆ Principles of Transistor biasing
- ◆ Single stage Transistor circuits
- ◆ Principles of negative and positive feedback
- ◆ Multistage Transistor circuits and coupling techniques
- ◆ Common Operational Amplifier circuits including: inverting, non-inverting, summing, integrator and differentiating and their application

Higher National Unit specification: Statement of standards (cont)

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Outcome 6

Describe combinational logic circuits and their applications.

Knowledge and/or Skills

- ◆ Basic principles of digital circuits and logic gates
- ◆ Schematic symbols for logic gates
- ◆ Generation of truth tables
- ◆ Basic combinational logic circuits
- ◆ Basic Boolean algebra
- ◆ Characteristics of different families of logic (CMOS, TTL, ECL, etc)

Evidence Requirements for this Unit

The assessment for this Unit can be done on an Outcome by Outcome basis or as part of a combined assessment event. Learners are required to provide written and/or oral recorded evidence, generated under supervised closed-book conditions.

Evidence for the Knowledge and/or Skills in this Unit will be generated through sampling. Any sampling process must be 'unseen' by the learner before the assessment. Learners are expected to fully prepare the range of knowledge and skills and not be able to predict a chosen sample.

Outcome 1

Learners will need to provide evidence to demonstrate they can examine three of the six Knowledge and/or Skills items.

Subject to the sampling process described above, learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the fundamentals of electron current flow and the movement of electrons within conductors, insulators and semi-conductors.
- ◆ perform calculations using Ohms Law, relating to voltage, current, resistance and power.
- ◆ perform simple calculations on series resistive circuits with no more than six resistors.
- ◆ perform simple calculations on parallel resistive circuits with no more than six resistors.
- ◆ perform simple calculations on combination resistive circuits with no more than six resistors.
- ◆ describe the properties of components and their application: Resistors, Capacitors, Inductors, Switches, Circuit Protection devices and Relays.
- ◆ describe component schematic symbols accurately.

Higher National Unit specification: Statement of standards (cont)

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Outcome 2

Learners will need to provide evidence to demonstrate they can examine three of the six Knowledge and/or Skills items.

Subject to the sampling process described above, learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the fundamentals of AC sine-waves.
- ◆ explain magnetism and electromagnetic principles.
- ◆ perform simple calculations in series resistive-inductive reactive circuits.
- ◆ perform simple calculations in series resistive-capacitive reactive circuits.
- ◆ perform simple calculations in series RLC circuits.
- ◆ perform simple calculations on power in reactive circuits.
- ◆ explain the principles and function of power transformers, both single phase and three phase typically found in aircraft systems.
- ◆ explain the fundamental principles of aircraft storage batteries: Lead-acid, NiCad and Lithium-Ion.
- ◆ explain the fundamental principles of basic aircraft DC and AC single and three phase power generation.

Outcome 3

Learners will need to provide evidence to demonstrate they can examine three of the six Knowledge and/or Skills items.

Subject to the sampling process described above, learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the basic fundamental principles of semiconductor PN junctions.
- ◆ explain the operation and construction of rectifier diodes.
- ◆ describe silicon and germanium rectifier diode characteristics.
- ◆ describe diode applications including full and half-wave rectifier, clippers and clamping circuits.
- ◆ explain the operation, construction, characteristics and typical application of LEDs, SCRs, Photoconductive, Varactor, Varistor, Zener and other common two-terminal semiconductor devices.
- ◆ describe diode schematic symbols accurately.

Higher National Unit specification: Statement of standards (cont)

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Outcome 4

Learners will need to provide evidence to demonstrate they can examine three of the five Knowledge and/or Skills items.

Subject to the sampling process described above, learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the principles, operation and characteristics of BJT devices.
- ◆ explain the principles, operation and characteristics of JFET devices.
- ◆ explain the principles, operation and characteristics of MOSFET devices.
- ◆ explain the principles, operation and characteristics of Operational, Instrumentation and Comparator Amplifiers.
- ◆ describe Transistor and IC (Integrated Circuit) Schematic symbols accurately.

Outcome 5

Learners will need to provide evidence to demonstrate they can examine three of the five Knowledge and/or Skills items.

Subject to the sampling process described above, learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the basic principles of transistor biasing.
- ◆ describe single stage transistor amplifier circuits.
- ◆ explain the principles of negative and positive feedback within amplifiers and oscillators.
- ◆ describe multistage transistor circuits and coupling techniques.
- ◆ describe the operation of and carry out simple gain calculations using common operational amplifier circuits including: inverting, non-inverting, summing, integrator and differentiating and their applications.
- ◆ explain the basic operation and function of comparator operational amplifiers.
- ◆ explain the principles of instrumentation amplifier circuits and their applications.

Higher National Unit specification: Statement of standards (cont)

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Outcome 6

Learners will need to provide evidence to demonstrate they can examine three of the six Knowledge and/or Skills items.

Subject to the sampling process described above, learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the basic principles of digital circuits and logic gates.
- ◆ describe schematic symbols for logic gates accurately.
- ◆ draw and interpret truth tables for combinational logic circuits with no more than four inputs.
- ◆ produce/draw combinational logic circuits using no more than eight logic gates.
- ◆ derive Boolean algebra statements from a truth table and a combinational logic circuit.
- ◆ describe and explain the characteristics of different families of logic (CMOS, TTL, ECL, etc).



Higher National Unit Support Notes

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 80 hours.

Guidance on the content and context for this Unit

This is an optional Unit within the HNC and HND Aircraft Engineering Group Awards. The Unit is primarily intended to provide the learner with the essential underpinning knowledge of modern aircraft electrical and electronic systems and to prepare them for a career in the aircraft engineering industry as a technician in either the design/manufacture of operations/maintenance sectors.

This Unit links to the following Semta National Occupational Standards (NOS):

SEMAER2_17	Assembling aircraft electrical components
SEMAER2_08	Carrying out maintenance on aircraft electrical/electronic systems by component replacement

Outcome 1

The emphasis of this Outcome is on the fundamental principles of what electricity is and how electrons behave in a circuit. The basic laws are examined and the learner learns how to carry out basic calculations concerned with electrical and electronic components. All the fundamental passive components are discussed and how they function and operate within typical electrical and electronic circuits. Through the process of circuit investigation and calculation the learner should gain a good understanding of fundamental electrical and electronic circuits found in aircraft avionic and power systems.

Outcome 2

Outcome two provides learners with the basic principles and laws which govern AC circuits and components. Magnetism and electromagnetic principles are introduced before explanation of capacitive and inductive reactance. Learners learn how to calculate simple series reactive circuits with no more than four components and are given an appreciation of the working principles and applications of transformers typically found in aircraft power systems.

Higher National Unit Support Notes (cont)

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Basic power generation methods are discussed within aircraft, covering the main engine powered generators, the APU (auxiliary power Unit), the RAT (ram air turbine) and aircraft batteries. Aircraft batteries should include Lead-acid, Nickel-cadmium and Lithium-ion types together with how to maintain these batteries.

Health and safety measures should be mentioned when discussing battery maintenance together with actual maintenance practices.

Outcome 3

Outcome three is concerned with the principles, construction and operation of semiconductor PN junction devices such as Rectifier diodes, LEDs, Zener diodes, Varactor diodes and other common two-terminal devices. Emphasis is on the real world application of these devices particularly in the aircraft engineering field. Other two-terminal devices such as Varistors, Thermistors and Diacs might also be discussed. Simple half wave and full wave rectifier circuits should be discussed together with their applications.

Outcome 4

The focus of this Outcome is on the more complex semiconductor devices, their construction, operation and application. Devices to be discussed should include BJTs, JFETs and MOSFETs. Complex integrated circuits such as Operational amplifiers, Instrumentation amplifiers and Comparators should also be examined. The use of manufacturers data sheets should be stressed and show how various devices might be selected.

Outcome 5

This Outcome builds on the previous two Outcomes and introduces multi-stage circuits using BJTs, JFETs, MOSFETs and ICs. Biasing and inter-circuit coupling is discussed together with methods of interfacing circuits such as amplifiers and oscillators with other circuits. Operational amplifier circuits such as the summing amplifier, inverting and non-inverting amplifiers, integrating and differentiating amplifiers should be examined and basic calculations carried out to calculate gain and frequency response.

Outcome 6

The focus of this Outcome is on digital electronics, building from basic principles and the differences between analogue and digital to the construction of logic gates. The construction of combinational logic circuits and how to construct truth tables should be discussed. Basic Boolean algebra and its application to combinational circuits and how it is applied to logic problems.

Guidance on approaches to delivery of this Unit

This Unit is designed to provide learners with the professional knowledge and skills for the specific occupational area of aircraft engineering. This Unit should be delivered sequentially by Outcome, with a mixture of assignments and exercises. Having access to publications and diagrams is recommended to assist in teaching and tutorial sessions. Small scale practical demonstrations of various circuits (perhaps using locktronic) would also be beneficial.

Higher National Unit Support Notes (cont)

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Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Evidence for this Unit could be generated on an Outcome by Outcome basis or as a combined assessment event. As a recommendation, Outcomes 1, 3, 4 and 6 could be assessed as a combined assessment event.

The assessment could consist of a mixture and balance of restricted response and short answer questions covering all knowledge.

Outcomes 2 and 5 could be assessed through the submission of an investigative report/case study, one during the first semester and the second in the next semester.

It is recommended that the total assessment time for all Outcomes should not be more than 3 hours. Learners should not know in advance the questions on which they will be assessed and different questions should be set on each occasion. Assessments must be carried out under supervised closed-book conditions. In order to gain an assessment pass, learners will need to demonstrate that they can achieve the minimum requirements for the Unit.

The assessment instruments used for assessing this Unit should follow the general guidelines offered by the Scottish Qualifications Authority (SQA) assessment model. Each centre should make a model answer as a marking guide for each question asked and learners awarded marks for the key points and the presentation of answers. Learners can supplement written answers with sketches and diagrams to clarify points and be allowed to use scientific calculators to carry out calculations. Programmable calculators should not be allowed.

For learners who fail to achieve the pass mark for each assessment, centres may allow learners to re-sit the assessments at an appropriate time using a significantly different assessment(s).

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at www.sqa.org.uk/e-assessment.

Higher National Unit Support Notes (cont)

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

Opportunities for developing Core and other essential skills

Learners will have opportunities to develop the Core Skills of *Communication (Written)*, and *Numeracy (Using Number)*, at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Communication (Written) — this could be achieved through the answering of short restrictive response questions, where all essential ideas/information with some supporting detail are appropriately presented in a logical order. These entries would use a structure and/or conventions mainly appropriate to purpose and audience; and use spelling, punctuation and sentence structures which are mainly accurate.

Numeracy (Using Number) — this could be achieved through the calculations of formula to answer questions on electrical and electronic theory, where the learner would need to use given information to calculate the solution to engineering problems.

History of changes to Unit

Version	Description of change	Date

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General information for learners

Unit title: Aircraft Electrical and Electronic Principles (SCQF level 7)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit is designed to introduce the fundamental principles of electrical and electronic subjects with specific application to aircraft power supplies and avionic systems. The Unit may be of interest if you wish to pursue a career in aircraft engineering, as it covers fundamental aspects of design and operation of aircraft electrical and electronic circuits.

It may also be of interest to other engineering students who are interested in electrical and electronic related subjects.

On completion of this Unit you will be able to:

- 1 Describe electrical fundamentals and components and solve DC electrical network problems.
- 2 Describe the fundamentals of AC sine-wave circuits and the fundamentals of Aircraft Power Generation.
- 3 Explain the fundamental principles of common two-terminal semiconductor devices.
- 4 Explain the basic principles, construction and characteristics of Transistors and Operational amplifier devices.
- 5 Explain the operation of the Transistor and Operational Amplifier, simple and multi-stage circuits and their applications.
- 6 Describe combinational logic circuits and their applications.

You will be assessed on aspects of all six Outcomes of this Unit and evidence will be generated under closed-book supervised conditions. In order to complete the Unit successfully, you will have to achieve a satisfactory level of performance in the assessment event/s.

There will be opportunities to develop the Core Skills *Communication* (Written) and *Numeracy* (Using Number) at SCQF level 5 within this Unit, although there is no automatic certification of Core Skills or Core Skills components.