



National Unit Specification: general information

UNIT Electrical Testing and Measurement (SCQF level 6)

CODE F5HN 12

SUMMARY

This Unit is designed for candidates with little or no prior knowledge of electrical testing and measurement but who wish to develop knowledge and skills in this important area of electrical engineering. The Unit is particularly suitable for those candidates training to be electrical technicians.

On successful completion of this Unit candidates should be able to use electrical test equipment to make correct and safe measurements in electrical circuits and installations. Candidates will also gain knowledge and understanding of the principles of operation of a moving coil instrument, electrodynamic wattmeter and kWhr meter.

This Unit may form part of an National Qualification Group Award or may be offered on a free-standing basis.

OUTCOMES

- 1 Describe the features and operation of electrical measuring instruments and state their sources of error.
- 2 Carry out current and voltage measurements in direct current (dc) and alternating current (ac) networks.
- 3 Carry out resistance measurements in electrical circuits and electrical installations.
- 4 Carry out frequency and phase difference measurements in ac circuits.
- 5 Carry out power measurements in dc and ac circuits and explain the operation of power measurement instruments.

Administrative Information

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National Unit Specification: general information (cont)

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RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

- ◆ Standard Grade Physics — Credit Level
- ◆ NQ Unit *Electrical Principles* at SCQF level 5
- ◆ NQ Unit *Electrical Principles* at SCQF level 6
- ◆ NQ Unit *Electrical Testing and Measurement* at SCQF level 5

CREDIT VALUE

1 credit at SCQF level 6 (6 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 Access 1 to Doctorates.*

CORE SKILLS

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

This Unit provides opportunities for candidates to develop aspects of the following Core Skills:

- ◆ Problem Solving (SCQF level 6)
- ◆ Working with Others (SCQF level 6)
- ◆ Numeracy (SCQF level 6)
- ◆ Communication (SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

National Unit Specification: statement of standards

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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.

OUTCOME 1

Describe the features and operation of electrical measuring instruments and state their sources of error.

Performance Criteria

- (a) State correctly the differences between analogue and digital measuring instruments.
- (b) State correctly different types of analogue instruments.
- (c) State correctly sources of error in electrical measurement in terms of the limitations of the instrument used, operator error and the impact of the instrument on the circuit.
- (d) State correctly the advantages of digital instruments over analogue instruments.
- (e) Describe correctly the safety precautions that should be adopted when using electrical measuring instruments.
- (f) Describe correctly the principle of operation of a moving coil instrument.

OUTCOME 2

Carry out current and voltage measurements in direct current (dc) and alternating current (ac) networks.

Performance Criteria

- (a) State correctly the definitions of current and voltage.
- (b) Carry out accurately and safely voltage and current measurements in a series — parallel resistance network supplied from a dc voltage source.
- (c) Carry out accurately and safely voltage and current measurements in a series — parallel resistance network supplied from an ac voltage source.
- (d) Explain correctly any sources of error that may arise as a result of making voltage and current measurements in electrical networks.

National Unit Specification: statement of standards (cont)

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OUTCOME 3

Carry out resistance measurements in electrical circuits and electrical installations.

Performance Criteria

- (a) State correctly the definition of electrical resistance.
- (b) Explain correctly the difference between resistance as a lumped and distributed quantity.
- (c) Measure accurately and safely lumped resistances in an electrical network using the ammeter voltmeter method.
- (d) Compare the results, including sources of errors, of making resistance measurements using the ammeter voltmeter method with measurements made using an instrument that can measure resistance directly.
- (e) Carry out accurately and safely a continuity test and an insulation resistance measurement on an electrical installation.
- (f) Carry out accurately and safely the measurement of resistance using the Wheatstone Bridge method.

OUTCOME 4

Carry out frequency and phase difference measurements in ac circuits.

Performance Criteria

- (a) Carry out correctly basic procedures for setting up and operating an oscilloscope.
- (b) Carry out accurately and safely the measurement of frequency of an ac sinusoidal voltage using an oscilloscope.
- (c) Carry out accurately and safely the measurement of frequency of an ac sinusoidal voltage using a frequency meter.
- (d) Compare the results of making frequency measurements using an oscilloscope and a frequency meter and correctly identify any sources of error in using the two types of instruments.
- (e) Carry out accurately and safely the measurement of phase difference between two ac sinusoidal quantities using an oscilloscope.

OUTCOME 5

Carry out power measurements in dc and ac circuits and explain the operation of power measurement instruments.

Performance Criteria

- (a) Carry out accurately and safely measurement of powers in a dc electrical network using an ammeter and voltmeter.
- (b) State correctly any sources of error that arise as a result of using an ammeter and voltmeter to measure power in a dc electrical circuit.

National Unit Specification: statement of standards (cont)

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- (c) Explain correctly the principle of operation of the electrodynamic wattmeter.
- (d) Carry out accurately and safely power measurements in ac circuits using the one and two wattmeter methods.
- (e) Explain correctly the principle of operation of a kWhr meter.

EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate the candidates have achieved all Outcomes and Performance Criteria.

Outcome 1

Written and/or recorded oral evidence:

The evidence for Outcome 1, with the exception of performance criterion (f), should be produced under controlled, supervised, closed-book conditions in which candidates should not be permitted to bring any notes, handouts, textbooks into the assessment event. The assessment event should last 30 minutes.

With regard to Outcome 1 (performance criteria a to e):

- ◆ a minimum of three analogue instruments should be identified
- ◆ a minimum of two sources of error should be stated under each category
- ◆ a minimum of three advantages of digital instruments over analogue instruments should be stated
- ◆ a minimum of three safety precautions should be identified

Evidence for Outcome 1 pc (f) should be produced in the candidates own time.

Outcomes 2, 3, 4 and 5

Written and/or recorded oral and performance evidence supplemented by an assessor observation checklist.

The evidence for Outcomes 2, 3, 4 and 5 (except Outcome 5 performance criterion (c) and performance criterion (e)) should be produced under supervised conditions in a practical electrical environment(s). Assessment should take place at appropriate points during the delivery of this Unit.

With regard to Outcome 2:

- ◆ a minimum of two current and voltage measurements should be made

With regard to Outcome 3:

- ◆ two resistance measurements should be made

With regard to Outcome 5:

- ◆ two power measurements should be made

National Unit Specification: statement of standards (cont)

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Evidence for Outcome 5 pc (c) and pc (e) should be produced in the candidates own time. The evidence for Outcome 1 pc (f) and Outcome 5 pc (c) and pc (e) may be produced as part of one assessment activity undertaken by the candidate.

The Assessment Support Pack for this Unit provides sample assessment materials. Centres wishing to develop their own assessments should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

UNIT Electrical Testing and Measurement (SCQF level 6)

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 is a restricted core Unit within the National Certificate in Electrical Engineering at SCQF level 6. This Unit can also be delivered as a free-standing Unit.

The aim of this practical Unit is to allow candidates to develop the knowledge, understanding, skills and confidence to make accurate and safe measurements of dc voltages and currents, ac voltages and currents, resistance, frequency, phase angle and dc and ac power in lumped electrical networks. Candidates will also learn how to undertake continuity and insulation resistance measurements in electrical installations.

The focus in delivering the Unit should not just be on candidates making correct and safe electrical measurements (although this is very important) but also on encouraging candidates to understand that no electrical measurement is absolutely accurate. Candidates need to learn that any electrical measurement may be subject to error. They need to know and understand what gives rise to these sources of error. They also need to learn that any electrical measurement may need to include a +/- tolerance.

Centres may wish to show candidates how the balance equation for a Wheatstone Bridge is developed. However, candidates should not be expected to prove this equation in any assessment.

There may be opportunities to integrate this Unit with some of the Electrical Principles Units in the National Certificate in Electrical Engineering at SCQF level.

Candidates who are unsuccessful in achieving this Unit may, nevertheless, have gathered sufficient evidence to satisfy the Outcomes and Performance Criteria in the Unit *Electrical Testing and Measurement* (SCQF level 5). Centres may wish to develop appropriate checklist to identify if this is the case or not.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This Unit may be delivered by a combination of lectures, demonstrations and candidate practical exercises done individually or as part of a group. The Unit could be delivered in an electrical laboratory and/or electrical installation workshop. Diagrams, wall charts and other forms of visual aids will help candidates to learn how electrical instruments work and how they should be connected to electrical circuits. The Internet also provides a rich source of information on electrical instruments and how electrical measurements are made.

National Unit Specification: support notes (cont)

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Centres may wish to provide candidates with an induction session at the start of the Unit into the safe use of electricity and electrical instruments. However, safety should be emphasised throughout the delivery of the Unit. Candidates should be trained to lift and transport electrical instruments with care and not leave them in situations where they could be dangerous to the candidate or others or where they could be damaged. It is strongly advised that candidates are not allowed to energise electrical circuits and make measurements until circuits have been checked by their lecturer.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Elements of the Core Skill of *Problem Solving*, that is, Critical Thinking, Planning and Organising, Reviewing and Evaluating, will be naturally developed and enhanced as candidates undertake the Unit. Identifying and analysing a complex range of factors influencing the safe use of electrical equipment is essential to achievement. Considering potential sources of error that could affect results, candidates must select appropriate equipment and work efficiently and safely to complete practical electrical testing and measurement. Practical work can provide an environment in which to discuss, review and evaluate the process, allowing opportunities to enhance skills in oral communication and working with others. Candidates could be encouraged as a group to discuss approaches taken, and agree the nature and scope of team goals, roles and responsibilities in electrical testing work. They could be asked to explain or demonstrate methodology and resources selected, reviewing and evaluating their own contribution to the workplace environment.

Candidates perform a series of complex calculations and measurements as they undertake testing. Numeracy skills will be naturally enhanced, with the focus throughout on accuracy and practical interpretation of numerical and graphical information. Formative practical activities should be designed to develop accuracy and confidence in handling concepts in an electrical engineering context.

Access to and evaluation of technical literature and other complex information, including health and safety requirements, could strengthen communication skills and provide and support underpinning knowledge. Candidates should be encouraged to produce and present written reports to industry standard using accepted formats, terminology and structures.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Formative assessment exercises involving candidates in wiring up circuits, taking electrical measurements and analysing sources of error should play a particularly important role in allowing candidates to develop knowledge, understanding, skills and confidence in doing electrical testing and measurement work

The suggested approach to summative assessment in this Unit is as follows:

Outcome 1 (except pc (f)) — an assessment paper comprising of a combination of short answer and restricted response questions taken at a single assessment event lasting 30 minutes. This assessment event should be conducted under controlled, supervised, closed-book conditions in which candidates should not be allowed to bring any notes, handouts or textbooks into the assessment.

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Outcomes 2, 3, 4 and 5(except Outcome 5 pc (e)) — a series of practical electrical exercises conducted under supervised conditions. It is left to centres to decide the number of practical electrical exercises they require candidates to undertake to cover the various Performance Criteria in the four Outcomes. Total assessment time for the practical exercises should not exceed 2 hours and 30 minutes.

Outcome 1 pc (f) and Outcome 5 pc (c) and pc (e) may be assessed by candidates producing a report, in their own time, in which they explain the principles of operation of a moving coil instrument, an electrodynamic wattmeter and a kWhr meter. Candidates may use diagrams in their reports. Centres should make every reasonable effort to ensure the assignment solution is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding.

For those Performance Criteria in Outcomes 2, 3, 4 and 5 requiring candidates to state or explain something evidence should be produced either orally or in writing. Such evidence may be generated as part of the practical assignments for Outcomes 2, 3, 4 and 5.

Where candidates work in groups when undertaking summative practical exercises centres need to ensure that each candidate has satisfactorily met the requirements of the Performance Criteria in Outcomes 2, 3, 4 and 5. Centres may wish to develop an appropriate checklist to record evidence that each candidate is satisfying the Performance Criteria.

Centres should take every opportunity to integrate assessment. For example, the measurement of direct currents and voltages in the series-parallel network in Outcome 2, the measurement of lumped resistance in Outcome 3 and the measurement of power in a dc network in Outcome 5 could be undertaken within one combined practical assignment. Similarly the measurement of alternating currents and voltages in the series-parallel network in Outcome 2 and the measurement of frequency in Outcome 4 could be undertaken as part of one practical assignment.

Opportunities for the use of 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 e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

National Unit Specification: support notes (cont)

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DISABLED CANDIDATES AND/OR THOSE WITH ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website

www.sqa.org.uk/assessmentarrangements