



National Unit Specification: general information

UNIT Electronic Test Equipment and Measurement (SCQF level 6)

CODE F5DJ 12

SUMMARY

This Unit is intended for candidates with little or no prior knowledge or skills in using electronic test equipment. This Unit is suitable for those candidates training to be an electronics technician. This Unit is also suitable for candidates whose primary trade is not electronics but who require knowledge and skills in electronic test equipment and measurement. The aim of this Unit is to provide candidates with the knowledge and skills to set up electronic test equipment and carry out measurements and tests on electronic circuits. Candidates will perform measurements on both analogue and digital circuits and verify correct circuit operation. Frequency meters are included in the Unit to allow the candidate to verify the operating frequency of electronic circuits and waveforms displayed on the oscilloscope. The testing of digital circuits includes both combinational and sequential logic devices.

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

OUTCOMES

- 1 Use analogue and digital multimeters to carry out and record measurements in electronic circuits.
- 2 Use an oscilloscope to display, measure and record waveforms in electronic circuits.
- 3 Use function generators and frequency counters in testing electronic circuits.
- 4 Use a logic probe and logic clip to trace signals through combinational and sequential logic circuits.

Administrative Information

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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 in a Science or Technology subject — Credit Level

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 Skill:

- ◆ Problem Solving (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

Use analogue and digital multimeters to carry out and record measurements in electronic circuits.

Performance Criteria

- (a) The selection of measurement instrument is appropriate for a given task.
- (b) The connection of the instrument to the circuit is correct.
- (c) The measured values are recorded accurately.
- (d) State correctly the loading effect of multimeters when configured as ammeters and voltmeters in electronic circuits.
- (e) The candidate uses measurement instruments in a safe manner.

OUTCOME 2

Use an oscilloscope to display, measure and record waveforms in electronic circuits.

Performance Criteria

- (a) The adjustment and calibration of an oscilloscope is correct.
- (b) The connection of an oscilloscope to the circuit under test is correct.
- (c) The measurement and recording of the displayed waveform is correct.
- (d) The correct function of specified electronic test circuits is verified by using an oscilloscope.
- (e) The candidate uses the oscilloscope in a safe manner.

OUTCOME 3

Use function generators and frequency counters in testing electronic circuits.

Performance Criteria

- (a) The selection of function generator is appropriate for a given task.
- (b) The adjustment of controls to obtain a specified output is correct.
- (c) The specified waveform is verified.
- (d) The frequency of the specified waveform is verified by the use of the frequency counter.
- (e) The function of specified electronic circuits is verified using a function generator and frequency counter.
- (f) The candidate uses the function generator and frequency counter in a safe manner.

National Unit Specification: statement of standards (cont)

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OUTCOME 4

Use a logic probe and logic clip to trace signals through combinational and sequential logic circuits.

Performance Criteria

- (a) The selection of a logic probe and logic clip is appropriate for a given task.
- (b) The use of a logic probe and logic clip to measure digital signals is correct through given combinational and sequential logic circuits.
- (c) The correct function of specified electronic test circuits is verified by using a logic probe and logic clip.
- (d) The candidate uses the logic probe and logic clip in a safe manner.

EVIDENCE REQUIREMENTS FOR THIS UNIT

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

Performance evidence as well as written and/or recorded oral evidence is required which demonstrates that the candidate has achieved all Outcomes to the standards specified in the Outcomes and Performance Criteria.

This evidence must be produced under supervised, controlled conditions at appropriate points throughout the Unit either on an Outcome by Outcome basis or as integrated assessments. All calculations and measurements should be given using the relevant SI units of measurement.

An assessor observation record/checklist must be used to record the candidate performance in all Outcomes during the given tasks and be retained by the centre as well as the candidate producing a record of measurements taken.

The required written and/or oral evidence generated under open-book conditions for all Outcomes is as follows:

- ◆ the candidate will be required to record the verification of given electronic circuits on the worksheets provided
- ◆ the candidate will be required to state the loading effect of multimeters when used as an ammeter or voltmeter on an electronic circuit
- ◆ the candidate must use all instruments in a safe manner

The performance evidence generated under supervised controlled conditions is as follows:

For Outcome 1 the candidate is provided with two pre constructed circuits; each to include a five resistor series/parallel network.

National Unit Specification: statement of standards (cont)

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The resistor networks should be connected to both direct current (dc) and alternating current (ac) power supplies, in turn. The candidate must:

- ◆ correctly select the measurement instrument for the given task
- ◆ correctly connect the measurement instrument to the circuit
- ◆ correctly carry out voltage, current and resistance measurements on the circuits provided
- ◆ correctly carry out a total of 15 measurements from each circuit: five each of voltage, current and resistance

For Outcome 2 the candidate is provided with an oscilloscope where the controls have been incorrectly set. The candidate must:

- ◆ correctly adjust the controls to obtain a signal trace
- ◆ calibrate the oscilloscope using the external controls available
- ◆ correctly measure the periodic time and peak to peak voltage of two sinusoidal waveforms
- ◆ correctly measure the periodic time, peak to peak voltage and mark to space ratio of two rectangular waveforms
- ◆ correctly measure the periodic time, peak to peak voltage of two triangular waveforms
- ◆ correctly measure the periodic time, peak to peak voltage and mark to space ratio of two pulse waveforms

For Outcome 3 the candidate is provided with function generators and frequency counters where the controls are incorrectly set. The candidate must:

- ◆ correctly select an appropriate function generator for the given task
- ◆ correctly set the function generator controls to produce sine waveforms of given voltage and frequency
- ◆ correctly set the function generator controls to produce rectangular waveforms of given voltage and frequency
- ◆ correctly set the function generator controls to produce triangular waveforms of a given voltage and frequency
- ◆ correctly set the function generator controls to produce pulse waveforms of a given voltage, frequency and mark to space ratio
- ◆ correctly set the function generator controls to produce a suitable input signal for given pre constructed electronic circuits
- ◆ correctly set the frequency counter controls to measure signal waveforms from the given circuits

For Outcome 4 the candidate is provided with two pre constructed combinational logic circuits (one each of TTL and CMOS) containing three, two input logic gates. **The candidate must:**

Correctly select and connect a suitable logic probe for the task and correctly take suitable measurements for each of the two combinational logic circuits in order to verify correct circuit operation.

National Unit Specification: statement of standards (cont)

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The candidate is provided with a sequential logic circuit for the assessment of the logic clip, eg a decoder or demultiplexer integrated circuit requiring the monitoring of multiple test points simultaneously. **The candidate must:**

- ◆ correctly select and connect a suitable logic clip for the task and correctly take suitable measurements for circuit provided in order to verify correct circuit verification

The candidate is given layout and circuit schematic diagrams.

The candidate will be informed of the test equipment available and the number of measurements to be made.

The Assessment Support Pack for this Unit illustrates the type of electronic circuits that should be used to carry out measurements using the appropriate test equipment. An assessor observation checklist is also included in the Assessment Support Pack. Centres wishing to develop their own instruments of assessment should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

UNIT Electronic Test Equipment 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 mandatory Unit within the National Certificate in Electronic Engineering at SCQF level 6. It may also form part of the other National Qualifications Group Awards in engineering but may also be offered as a free-standing Unit.

The Unit may be taught in conjunction with other Units that make up the award, this may allow the candidate further opportunities to develop knowledge and skills. Electronic circuits designed, simulated and/or constructed in other Units could be used as test circuits.

The aim of this Unit is to introduce candidates to a range of electronic test equipment and to develop the skills and techniques for carrying out measurements and tests in electronic circuits.

The Unit requires candidates to state the loading effects of multimeters when connected to electronic circuits therefore a basic knowledge of electrical principles would be desirable.

Safety regulations and safe working practices and procedures should be observed at all times.

Candidates will work on a range of practical electronic tasks which will enable them to develop the skills and techniques for setting up electronic test equipment and carrying out measurements and tests on electronic circuits. Candidates should also provide evidence that they can state the effects of connecting test equipment to electronic circuits and explain waveforms displayed on the cathode ray oscilloscope.

The function of each measurement instrument should be explained and demonstrated by the tutor before the candidate is exposed to any of the practical tasks in the Unit.

Outcomes 2 and 3 are best integrated into one assessment.

Outcome 1

Precautions to be taken before connecting measuring instruments to electronic circuits should be explained and demonstrated by the tutor. Use of moving coil and electronic multi range instruments for the measurement of ac and dc voltage and current should be demonstrated. Resistance measurements should also be carried out on electronic components and circuits. Zero setting and accuracy, to include parallax error. Range selection and scale factor. State the loading effect of multimeters when configured as ammeters and voltmeters in electronic circuits. Use of manufacturers' instrument specification data.

Electronic circuits may include a five resistor series/parallel network connected to both alternating current (ac) and direct current (dc) power supplies.

National Unit Specification: support notes (cont)

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Outcome 2

Practical demonstrations and activities should include: adjustment of oscilloscope controls to obtain a trace with no signal input, oscilloscope calibration, selection of suitable 'Y' input sensitivity and 'X' time division for a particular measurement, adjustment of triggering controls.

Precautions to be taken before connecting oscilloscope to electronic circuits should be explained and demonstrated by the tutor.

The measurement of dc, sinusoidal, square, pulse and triangular waveforms should be carried out.

The measurement of peak to peak values, periodic time, and mark to space ratio for each of the waveforms should be carried out and recorded on worksheets.

Electronic circuits that may be used could include: resistor/capacitor (RC) and capacitor/resistor (CR) passive networks, circuits constructed around the 555 timer integrated circuit, electronic oscillators, common emitter transistor amplifiers or operational amplifiers.

The candidate should be given a brief description of the function and operation of any circuit he/she is to test or verify.

Explanation of waveforms displayed on the oscilloscope should be given and recorded on worksheets.

Examples of test probe types.

Outcome 3

Practical demonstrations and activities may include selection of a suitable function generator and frequency counter to carry out the task.

Adjustment of function generator controls to obtain a specific frequency, voltage and waveform.

Adjustment of frequency counter controls to measure the frequency of specified waveforms.

Methods of connecting function generators and counters to test circuits.

Precautions to be taken before connecting function generators and frequency counters to electronic circuits should be explained and demonstrated by the tutor.

National Unit Specification: support notes (cont)

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Outcome 4

Practical demonstrations and activities may include selection of suitable logic probe and logic clip to carry out specific tasks.

Precautions to be taken before connecting logic probe and logic clip to electronic circuits should be explained and demonstrated by the tutor.

Measurement of input and output logic levels in TTL and CMOS combinational and sequential logic circuits should be demonstrated, then candidates provided with practical tasks on electronic circuits.

The candidate should be given a brief description of the function and operation of any circuit he/she is to test or verify. The use of truth tables to record logic levels should also be explained.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This is a mandatory Unit within the National Certificate in Electronic Engineering at SCQF level 6, however it can also be taken as a free-standing Unit.

This Unit should be taught in a workshop/laboratory environment.

Candidates should be given the opportunity to work both individually and in small teams.

Safety regulations and safe working practices and procedures should be explained and demonstrated to the candidate before he/she is allowed access to the test equipment to be used.

Where this Unit forms part of an Engineering course it should be used to further develop the knowledge and skills gained in other Units. Opportunities may also exist to integrate assessment.

Circuits to be used for measurement and testing may have been designed and constructed in other Units.

Outcomes 2 and 3 may be integrated using the function generator as a signal source and the oscilloscope and frequency counter to obtain signal measurements from the circuit under test.

In all Outcomes the use of pre constructed circuit boards may be used allowing the student maximum time in measurement and testing activities.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Core Skill of *Problem Solving* will be developed as candidates carry out complex measurements and test electronic circuits.

They have to consider regulations and safety factors before selecting methods and techniques suited to a series of practical tasks. They perform measurements and tests safely and accurately to the given specification, recording and explaining results. As correct functions are evaluated and verified candidates could be given constructive feedback to encourage analytical evaluation of achievement.

National Unit Specification: support notes (cont)

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GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

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 communications 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)*. This Unit could be assessed using a number of Structured Practical Exercises.

Evidence for Outcomes 2 and 3 may be generated by means of integrated assessments, Outcomes 1 and 4 should be assessed on an Outcome by Outcome basis.

The assessment of Outcome 1 should take the form of two practical exercises, candidates are provided with the pre constructed circuits and an incomplete handout containing results tables for the recording of measurements. The candidate will select appropriate test equipment for carrying out the required measurements and record the instrument readings on the worksheets provided.

An observational checklist must be used to record the candidate evidence and should be retained by the centre. The candidate will be required to state the loading effect of multimeters when used as an ammeter or voltmeter on an electronic circuit.

The assessment of Outcome 2 should take the form of practical exercises in which the candidate demonstrates the calibration of the oscilloscope and then uses the calibrated instrument to carry out a series of measurements. The assessment of this Outcome may be integrated with Outcome 3 by using the function generator as the signal source for the generation of the sine, square, triangular and pulse waveforms to be measured with the oscilloscope and frequency counter. The input signal for the pre constructed electronic circuit may also be provided from a suitable function generator. The candidate will select appropriate test equipment for carrying out the required measurements and record the instrument readings and settings on the worksheets provided. An observational checklist must be used to record the candidate evidence and should be retained by the centre.

The assessment of Outcome 4 could take the form of three practical exercises which allow the candidate to demonstrate the correct selection of test instrument. The candidate then uses the instrument to carry out the correct measurements from the given pre constructed digital electronic circuits and records the instrument readings on the worksheets provided.

An observational checklist must be used to record the candidate evidence and should be retained by the centre.

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