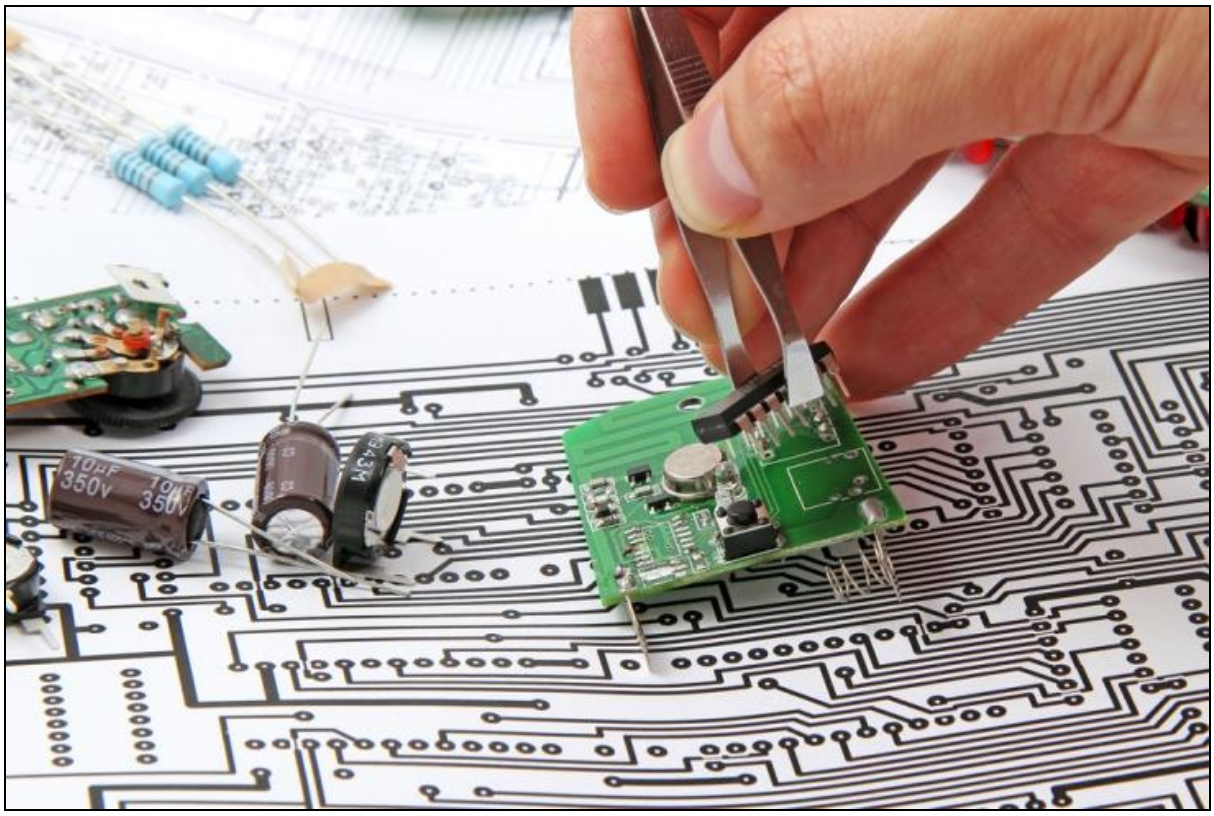
Course Support Notes

National 4 Practical Electronics Course Support Notes



Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

July 2013, version 1.1

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Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering the National 4 Practical Electronics Course. They are intended for teachers and lecturers who are delivering the Course and its Units. They should be read in conjunction with the *Course Specification*, the *Added Value Unit Specification* and the Unit Specifications for the Units in the Course.

General guidance on the Course

Aims

As stated in the *Course Specification*, the aims of the Course are to enable learners to develop:

- knowledge and understanding of key concepts in electronics and apply these in a range of contexts
- a range of practical skills in electronics, including skills in analysis and problem solving, design skills, skills in the safe use of tools and equipment, and skills in evaluating products and systems
- awareness of the importance of safe working practices in electronics
- an understanding of the role and impact of electronics in changing and influencing society and the environment

This Course will also give learners the opportunity to develop thinking skills and skills in numeracy, employability, enterprise and citizenship.

Progression into this Course

Entry to this Course is at the discretion of the centre. However, learners would normally be expected to have attained some relevant skills and knowledge through prior experience.

Skills and knowledge developed through any of the following, while **not mandatory**, are likely to be helpful as a basis for further learning in this Course.

Other SQA qualifications

- Access 3 Physics Course, particularly the *Energy* Unit
- Numeracy (National 3) Unit

Experiences and outcomes

National Courses have been designed to draw on and build on the curriculum experiences and outcomes as appropriate. Qualifications developed for the senior phase of secondary education are benchmarked against SCQF levels. SCQF level 4 and the curriculum level 4 are broadly equivalent in terms of level of demand although qualifications at SCQF level 4 will be more specific to allow for more specialist study of subjects.

Learners who have completed Curriculum for Excellence experiences and outcomes will also find these an appropriate basis for doing the Course.

For this Course, any of the following may be relevant:

- I can apply the skills of critical thinking when evaluating the quality and effectiveness of my own or others' products or systems. (TCH4-14b)
- By contributing to investigations into the properties of a range of electronic components, I can select and use them as input devices in practical electronic circuits. (SCN4-09b)
- Using my knowledge of electronic components and switching devices, I can help engineer an electronic system to provide a practical solution to a real-life situation. (SCN 4-09c)

Other experience
Learners may also have relevant skills and knowledge gained through other education systems or from their own interests and informal learning.

Skills, knowledge and understanding covered in this Course

This section provides further advice and guidance about skills, knowledge and understanding that could be included in the Course.

Note: teachers and lecturers should refer to the *Added Value Unit Specification* for mandatory information about the skills, knowledge and understanding to be covered in this Course.

The mandatory skills may be developed throughout the Units of the Course. The table below shows where there are the most significant opportunities to develop these in each of the individual Units.

Mandatory skills and knowledge	Circuit Design	Circuit Simulation	Circuit Construction	Added Value Unit
awareness of some aspects of the impact of electronic systems on society and the environment	✓			
awareness of safe working practices in electronics			✓	✓
analysing, with guidance, straightforward electronic problems, and designing solutions to these problems	✓			✓
simulating, testing and evaluating solutions to electronic problems, with guidance		✓	✓	✓
skills in using basic test equipment			✓	✓
constructing simple electronic circuits using permanent (soldering) and non-permanent methods, using given layouts			✓	✓
basic knowledge and understanding of the systems approach to electronics	✓			
basic knowledge and understanding of a range of electronic components	✓	✓	✓	✓
introductory knowledge and understanding of combinational logic	✓			✓
understanding of key electrical concepts — current, voltage, resistance, analogue/digital	✓	✓		
applying basic electronic knowledge and skills in a range of straightforward contexts		✓	✓	✓

Progression from this Course

This Course or its components may provide progression to:

- National 5 Practical Electronics
- National Certificate Group Awards in a range of engineering disciplines
- other technological or science subjects at National 4
- Skills for Work Courses in Energy and in Engineering Skills

and ultimately, for some, to:

- employment, apprenticeships and/or training in electronics and related fields
- a range of engineering-related Higher National Certificates (HNCs) and Higher National Diplomas (HNDs)
- degrees in Engineering, Physics and related disciplines
- careers in engineering

Hierarchies

Hierarchy is the term used to describe Courses and Units which form a structured sequence involving two or more SCQF levels.

It is important that any content in a Course and/or Unit at one particular SCQF level is not repeated (unless required for consolidation) if a learner progresses to the next level of the hierarchy. The skills and knowledge should be able to be applied to new content and contexts to enrich the learning experience. This is for centres to manage.

The Course is designed in hierarchy with the corresponding Course at SCQF level 5 (National 5). The Practical Electronics Courses at both levels have the same structure of three Units with corresponding titles.

Each of the three Units — *Circuit Design*, *Circuit Simulation*, and *Circuit Construction* — is in hierarchy with the corresponding Unit at SCQF level 5. Both Courses also lead to a practical assessment activity which is similar in structure; in the National 4 Course, this is described in the *Added Value Unit Specification*; in the National 5 Course this is described in the *Course Assessment Specification.*

The design of the Units means that teachers may be able to design learning activities that are appropriate for a class with learners working at different levels.

Appendix 2 contains a table showing the relationship between the mandatory National 4 and National 5 knowledge and understanding. This table may be useful for:

- designing and planning learning activities for groups including National 4 and National 5 learners
- ensuring seamless progression between levels
- identifying important prior learning for learners at National 5

Teachers should also refer to the Outcomes and Assessment Standards for each level when planning delivery.

Approaches to learning and teaching

Practical Electronics, like all new and revised National Courses, has been developed to reflect Curriculum for Excellence values, purposes and principles.

The approach to learning and teaching developed by individual centres should reflect these principles. Learners should spend less time passively listening to the class teacher; instead learners, often working together, talk, listen, write, read or reflect on a topic while the teacher acts as a facilitator.

Throughout the teaching of this Course the stimulation of learners' interest and curiosity should be a prime objective.

An appropriate balance of teaching methodologies should be used in the delivery of the Course. Whole-class, direct teaching opportunities should be balanced by activity-based learning on practical tasks.

Learning should be supported by appropriate practical activities, so that skills are developed simultaneously with knowledge and understanding. Practical activities and investigations lend themselves to group work, and this should be encouraged. While 'working in a group' is not specifically identified as one of the skills for life, learning and work for this Unit, and therefore not assessed, it is a fundamental aspect of working in the electronics industry and so should be encouraged and developed by teachers.

Assessment activities, used to support learning, may usefully be blended with learning activities throughout the Course.

For example:

- sharing learning intentions/success criteria
- using assessment information to set learning targets and next steps
- adapting teaching and learning activities based on assessment information
- boosting learners' confidence by providing supportive feedback

Self- and peer-assessment techniques should be encouraged wherever appropriate.

Working towards Units and Course
Learning and teaching activities should be designed to develop both:

- skills and knowledge to the standard required by **each Unit** and to the level defined by the associated Outcomes and Assessment Standards
- the breadth of knowledge and understanding required to complete the **Added Value Unit** successfully

Meeting the needs of all learners
Within any class, each learner has individual strengths and weaknesses.

Within a National 4 class, there may be learners capable of achieving National 5 standards in some aspects of the Course. Where possible, they should be given the opportunity to do so.

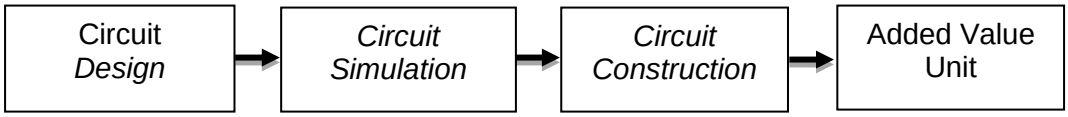
Teachers need to consider both the Outcomes and Assessment Standards, and the tables of concepts (Appendix 2), to identify opportunities where learners may achieve National 5 standards.

When delivering this Course to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners. This is particularly appropriate where the National 5 learners have come direct from the broad general education without doing National 4. However, where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation. For example, in the *Circuit Construction* Unit it would be better to choose different circuits for the National 5 learners to build rather than just asking them to do a more complex version of a circuit they built the previous year.

Learning about Scotland and Scottish culture will enrich the learners' learning experience and help them to develop the skills for learning, life and work they will need to prepare them for taking their place in a diverse, inclusive and participative Scotland and beyond. Where there are opportunities to contextualise approaches to learning and teaching to Scottish contexts, teachers and lecturers should consider this.

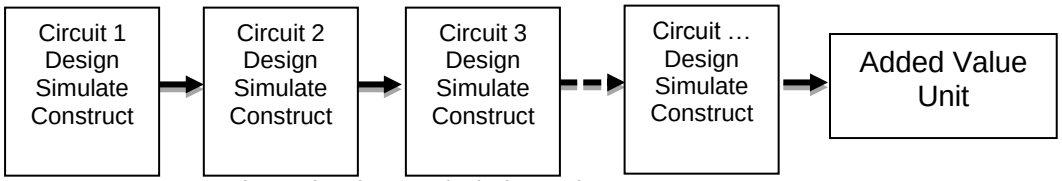
Sequence of delivery
The sequence of delivery of the Units within the National 4 Practical Electronics Course is at the discretion of the centre and the models suggested below simply exemplify possible approaches which may be developed to suit individual circumstances and resources.

Delivering the Units sequentially



While it would be possible to deliver the Units in sequence (*Circuit Design – Circuit Simulation – Circuit Construction – Developing an Electronic Solution*), this approach may not be the most natural and effective way of delivering the Course, as it would not allow for integration of learning and skills. The sequence of design, simulate, construct is applicable to **each** circuit being developed, rather than to the overall delivery of the Course.

Combined delivery of the Units



In this integrated approach, the Course would be designed around a series of circuits (not necessarily four, as shown in the diagram) of increasing complexity.

The Course might start with an introduction to general workshop safety, use of tools, the importance of following instructions carefully, maintaining a logbook or e-portfolio and an introduction to components and concepts.

Circuit 1 may only involve simple components and concepts, such as resistors and resistance. Learners may then simulate circuits involving these components using suitable software, then they could build these circuits on prototype board.

Circuit 2 could introduce additional components, with the same pattern of activities, perhaps continuing right through to constructing permanent circuits using soldering.

As the Course progresses, the degree of complexity can be gradually advanced, both in conceptual understanding and in level of skill required in circuit construction and simulation. In effect, this is a continuous loop of: theory–simulation–construction, spiralling upwards.

This approach suits mixed classes, as the more able may progress to National 5 level concepts and complexity, with others achieving success at National 4 level.

A useful mnemonic for the integrated approach is **DD SS BB RR**.
For each circuit, the following stages can be applied:

- **Define:** the process of looking for an objective or being given an objective that can be achieved by the construction of a circuit.
- **Design**: considering the components required, how they interact and work together, and calculating values.

- **Simulate**: checking (and probably modifying) the design by simulating using a software package.
- **Shop**: gathering or purchasing of components.

- **Build**: construction of the circuit (using permanent or non-permanent methods).
- **Bench test**: comparing the finished circuit with its simulation to check it does what it's supposed to, and identifying any faults.

- **Repair**: fixing any problems until proper function is achieved.
- **Report**: may be verbal, written, electronic, and include description, circuit diagram and/or photograph, as required.

These stages may be iterative, with a problem discovered at any stage requiring a return to an earlier stage.

Some use could be made of commercial kit projects (with circuit diagrams) where the sequence can be shortened to **BB RR** — build, bench test, repair, report —

with the simulation and theory of their design taking place at any time during the work.

Fitting the Added Value Unit into a Course plan
As the Added Value Unit is intended to allow the learner to apply knowledge, understanding and skills developed through the other Units, it will normally be delivered at the end of the Course. However, it may be possible to begin work on the Added Value Unit at an earlier stage, but only where it is clear that learners have already gained the required skills and knowledge.

Advice on distribution of time
The distribution of time between the various Units is a matter for professional judgement and is entirely at the discretion the centre. Each Unit is likely to require an approximately equal time allocation, although this may depend on the learners' prior learning in the different topic areas.

Within the notional time for the Added Value Unit (*Developing an Electronic Solution*), time will be required for:

- preparation for the task, which could include considering exemplar tasks and practising the application and integration of skills
- carrying out the stages of the task, with teacher guidance and support
- assessing the process and completed solution

Resources
Resources required for each Unit can be found listed in the *Unit Support Notes.*

Developing skills for learning, skills for life and skills for work

Guidance on the development of skills for life, skills for learning and skills for work is to be found in the support notes for each of the component Units.

Approaches to assessment

See the *Unit Support Notes* for guidance on approaches to assessment of the Units of the Course.

Added value

Courses from National 4 to Advanced Higher include assessment of added value. At National 4 the added value will be assessed in the Added Value Unit. At National 5, Higher and Advanced Higher, the added value will be assessed in the Course assessment.

Information given in the *Course Specification* about the assessment of added value is mandatory.

Full details of assessment of added value are included in the *Added Value Unit Specification.*

The Added Value Unit will assess the application of skills and knowledge which learners will have developed through the other Units. Evidence for this Unit will be generated through a practical task in which learners will be required to solve a straightforward electronics problem.

Combining assessment across Units

If an integrated approach to Course delivery is chosen, then there may be opportunities for combining assessment across Units.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Course Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Course.

It is important that centres are aware of and understand SQA's assessment arrangements for disabled learners, and those with additional support needs, when making requests for adjustments to published assessment arrangements. Centres will find more guidance on this in the series of publications on Assessment Arrangements on SQA's website: www.sqa.org.uk/sqa//14977.html.

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications are available on SQA's website at: www.sqa.org.uk/sqa/14977.html.
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- Overview of Qualification Reports
- Principles and practice papers for curriculum areas
- *SCQF Handbook: User Guide* (published 2009) and SCQF level descriptors (to be reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
- *Skills for Learning, Skills for Life and Skills for Work: Using the Curriculum Tool*

Appendix 2: Comparison of National 4 and National 5

This table shows the relationship between the mandatory National 4 and National 5 knowledge and understanding.

This table may be useful for:

- designing and planning learning activities for groups including National 4 and National 5 learners
- ensuring seamless progression between levels
- identifying important prior learning for learners at National 5

Teachers should also refer to the Outcomes and Assessment Standards for each level when planning delivery.

Design and simulation		
Topic	**National 4**	**National 5**
Concepts	current, voltage and resistance analogue/digital	current, voltage and resistance analogue/digital resistor networks capacitance magnetic effect of current
Components	power supplies resistors (including variable) LEDs, diodes, lamps capacitors, transistors, switches connectors and wires ICs (logic gates, 555 timer)	power supplies resistors (including variable) LEDs, diodes, lamps capacitors, transistors, switches connectors and wires ICs (logic gates, 555 timer, 741 op-amp, 7400 series or equivalent) op-amp circuits
Combinational logic	AND, OR and NOT	AND, OR, NOT, NAND, XOR and NOR
Devices	**Input devices**, including LDR, thermistor and switch **Process devices**, including transistor switch and logic gates **Output devices**, including lamp, LED, motor and buzzer Voltage dividers	**Input devices**, including LDR, thermistor, switch, optical and IR detector **Process devices**, including transistor switch, logic gates, counter, and amplifier **Output devices**, including lamp, LED, motor, buzzer, relay, speaker and solenoid Voltage dividers
Circuit Complexity	Minimum of 2 inputs, 1 output	Multiple inputs, more than one output

Impacts on society and environment		recycling pathways social, environmental, economic impact miniaturisation

Construction		
Topic	**National 4**	**National 5**
Construction materials	Use of prototype board, stripboard and PCB	Use of prototype board, stripboard and PCB Awareness of other types of construction, including tripad and surface mount technology Uses of cable types, including single strand, multi-strand, ribbon, twisted pair, co-axial cable and fibre optic cable
Wiring and assembly techniques	crimp connections, terminal block heat shrink, spiral wrap cable ties, markers stripping and connecting bundling and fixing	crimp connections, terminal block heat shrink, spiral wrap cable ties, markers stripping and connecting bundling and fixing
Safe working practices	safe use of tools including: ♦ soldering irons ♦ eye protection	safe use of tools including: ♦ soldering irons ♦ eye protection ♦ COSHH sheets

Administrative information

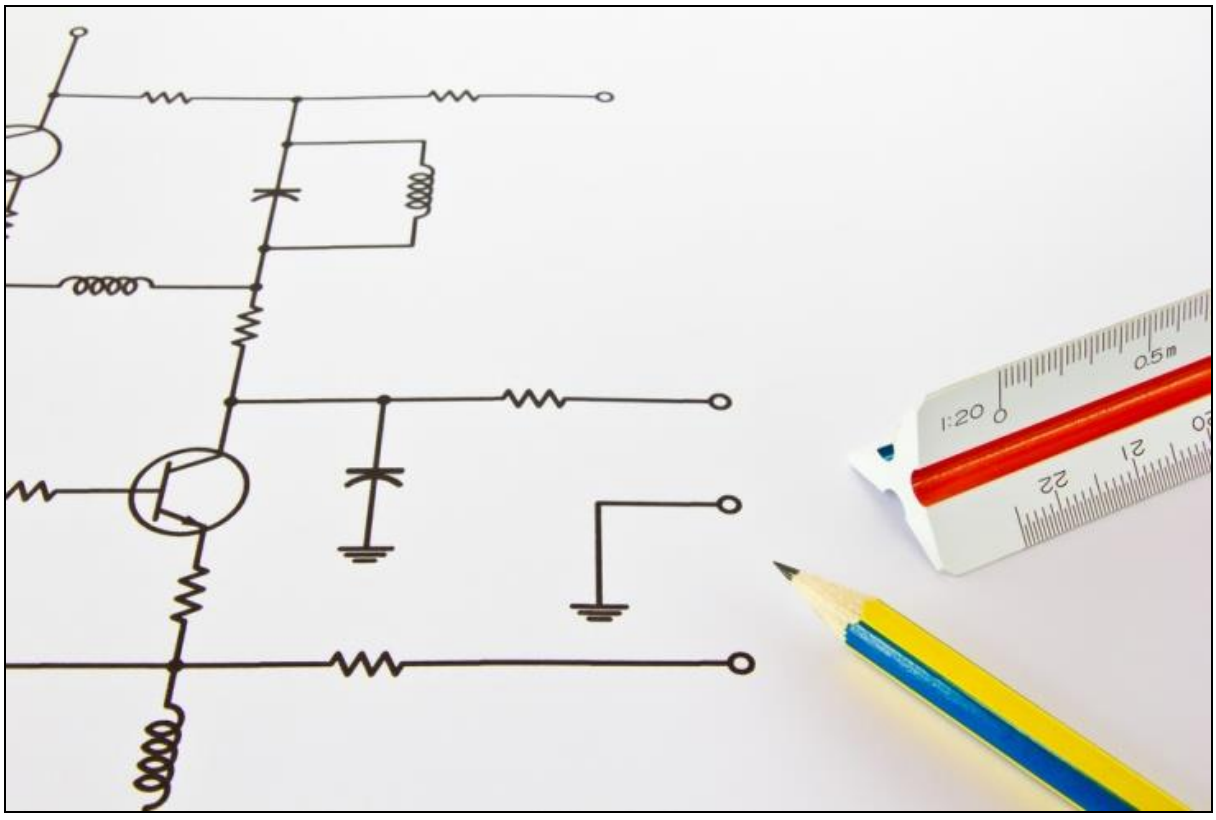
Published: July 2013 (version 1.1)

History of changes to Course Support Notes

Course details	Version	Description of change	Authorised by	Date
	1.1	Minor changes to notes on assessment.	Qualifications Development Manager	July 2013

Unit Support Notes

Unit Support Notes — Practical Electronics: Circuit Design (National 4)



Please refer to the note of changes at the end of this template for details of changes from previous version (where applicable).

Introduction

These support notes are not mandatory. They provide advice and guidance to support the delivery of the *Practical Electronics: Circuit Design* (National 4) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Specification*
- the *Course Specification*
- the *Added Value Unit Specification*
- the *Course Support Notes*
- appropriate assessment support materials

General guidance on the Unit

Aims

The general aim of this Unit, as stated in the *Unit Specification*, is to develop a basic understanding of key electrical and electronic components, and how they can be combined into simple electronic circuits. Learners will, with guidance, analyse straightforward electronic problems and design solutions to these problems. In addition, learners will explore some aspects of the impact of electronics on society and the environment.

This Unit will also give learners the opportunity to develop their thinking skills as well as their skills in numeracy, employability, enterprise and citizenship.

The Unit can be delivered:

- as a stand-alone Unit
- as part of the National 4 Practical Electronics Course

Progression into this Unit

Entry to this Unit is at the discretion of the centre.

Learners may have gained relevant skills and knowledge through the broad general education, other education systems or from their own interests and informal learning.

Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the National 4 Practical Electronics *Course Support Notes.*

If the Unit is being delivered as part of the National 4 Practical Electronics Course, the teacher should refer to the 'Further mandatory information on Course coverage' section within the *Added Value Unit Specification* for detailed content.

If this Unit is being delivered on a free-standing basis, teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Progression from this Unit

On successful completion of this Unit, the following Units and Courses provide appropriate progression pathways for learners:

- *Practical Electronics: Circuit Simulation* (National 4) Unit
- *Practical Electronics: Circuit Construction* (National 4) Unit
- *Practical Electronics: Circuit Design* (National 5) Unit
- National Certificate Group Awards (NCGAs) in a range of engineering disciplines
- other technological or science subjects at National 4

Approaches to learning, teaching and assessment

The Unit is designed to provide flexibility and choice for both the learner and the teacher.

Learning and teaching activities should be designed to stimulate learners' interest, and to develop skills and knowledge to the standard required by the Outcomes and to the level defined by the associated Assessment Standards.

The *Course Support Notes* provide broad guidance on approaches to learning and teaching which apply to all of the Units of the Course.

Sequence of delivery

The distribution of time between the various Outcomes is a matter for professional judgement and is entirely at the discretion the centre.

The sequence of delivery and the distribution of time is a matter of professional judgement and is also entirely at the discretion of the centre. Two main approaches are suggested, but other possibilities exist.

Delivering Outcomes 1, 2 and 3 sequentially
In this approach, each Outcome is delivered and assessed in turn.

1. Digital circuits. NOT, AND and OR gates. Systems approach. Analysing and designing simple circuits to solve straightforward problems.
2. Analogue circuits. Use of input and output devices, eg thermistor, LDR, switches, LED, buzzer and motor. Analysing and designing simple circuits to solve straightforward problems. Use the terms 'current', 'voltage' and 'resistance' appropriately.
3. Impact of electronics. Describe some disposal methods of electronic devices. Give examples of the increasing impact of electronics on society.

Delivering Outcome 2 before Outcome 1
Some teachers may prefer to consider analogue circuits first, so that learners understand the various components required for input and output from digital circuits.

Topic approach
There is no requirement to deliver Outcomes 1 and 2 independently. Some teachers may prefer to take a topic-by-topic approach, combining the learning of Outcomes 1 and 2, for example:

1. Resistors. Colour code, resistor notation, combining resistors in series and parallel, varying resistance and some uses.
2. Diodes. One way current, LEDs and some uses.
3. Transistors. NPN and PNP, transistor amplifier, use as an electronic switch.
4. Capacitors. Storing electric charge.
5. Integrated circuits. Should include logic gates AND, OR and NOT.
6. The systems approach. Should include: input devices, LDR, thermistor and switch; process devices, transistor switch and logic gates; output devices, LED, lamp, motor and buzzer.

7. Impact of electronics. An investigation into, for example, the disposal of electronic devices or into the increasing use of electronic devices.

Integrated approach
If the Unit is being delivered as a component of the National 4 Practical Electronics Course, any of the approaches described above can be delivered in an integrated way with the other two Units of the Course. For example, when teaching about digital circuits, these can be simulated and/or constructed as part of the learning activities. Learners will gain a richer experience by learning about concepts and components while actually constructing them on prototype board, stripboard and PCBs in a series of practical activities. Similarly, circuits can be simulated and tested at the same time, for example investigating resistor networks on prototype boards and comparing the colour code with an actual measurement using an ohmmeter. This can then be simulated on appropriate software.

Delivering Outcome 3
When delivering the Unit as part of the National 4 Practical Electronics Course, Outcome 3 may be delivered at any stage in the Course, blended with learning from other Units.

Meeting the needs of all learners
When delivering this Unit to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners.

For example, while National 4 learners are working on identifying electronic components, National 5 learners could be progressing on to designing electronic systems. Similarly, when National 4 learners are on the benefits of electronics on society, National 5 learners could be moving on to consider both the benefits and any negative impacts of electronics recycling and disposal.

Where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation. For example, different problems and circuits should be used from those studied the previous year. This would allow similar topics to be covered but in a fresh context, thus maintaining motivation.

In line with the underlying principles of Curriculum for Excellence, learners should be encouraged, and expected, to take an active role in their own learning. Where Course activities and materials allow them to progress in an independent manner, this will allow teaching of the two groups to happen most effectively.

Useful resources

Electronic components can be purchased from a range of commercial suppliers such as Rapid Electronics.

Electronic systems kits, such as the Angus system boards (JJM Electronics), Unilab Alpha modular kits.

Optoelectronics College kits are a useful resource for investigating LEDs and other components.

Suitable texts for reference include:

- *A Practical Approach to System Electronics*, Gregory, Hackett and Vincent-Smith, 1985.
- *Electronics for Dummies*, Dickon Ross
- *Electronics: a Systems Approach*, Dr Neil Storey

Suitable texts for learners, containing relevant material on basic electrical and electronic concepts, include:

- Intermediate 1 and 2 Physics handbooks, Campbell White
- *Standard Grade Physics*, Baillie and McCormick
- *Standard Grade Physics*, Campbell and Dobson

The Virtual Physics Intermediate 1 and Intermediate 2 Physics **digital textbooks** from Flash Learning also contain lots of useful material and interactive activities.

The **software package** Absorb Physics also has some useful notes, diagrams and quizzes on electronics.

There are many useful **online videos**. For example, on YouTube there are several useful electronic tutorials on ‘expert village’ and ‘make’.

Various **Logic Simulators** are available, including Logic-Lab from the neuroproductions website.

Learner materials can be adapted from the Intermediate 1 Applied Practical Electronics Course.

Approaches to delivering and assessing each Outcome

The learner must demonstrate attainment of **all** of the Outcomes and their associated Assessment Standards. Assessment must be valid, reliable and fit for purpose.

SQA does not specify the methods of assessment to be used; teachers should determine the most appropriate method for their learners. In many cases, evidence (which may be oral or observational) will be gathered during normal classroom activities, rather than through formal assessment instruments. Centres are expected to maintain a detailed record of evidence, including oral or observational evidence. Evidence in written or presentation format should be retained by the centre for verification.

Authentication of evidence
All evidence should be gathered under supervised conditions.

In order to ensure that the learner's work is their own, the following strategies are recommended:

- personal interviews with learners where teachers can ask additional questions about the completed work
- asking learners to do an oral presentation on their work
- ensuring learners are clear about acknowledging sources
- using checklists to record the authentication activity

Assessment evidence may be produced in a variety of formats including presentations, web pages, digital photographs, digital video, podcasts and blogs, and these can be stored by the learner (or teacher) within a proprietary e-portfolio, or simply by storing them in a secure folder. It should be noted that centres should verify that this evidence is indeed that of the learner and ensure that no credit is given for archive information without further analysis or comment by the student.

Outcome 1

The learner will:

1 Design simple digital electronic circuits by:

1.1 Analysing, with guidance, straightforward problems requiring digital solutions
1.2 Using simple multi-input combinational logic, involving NOT, AND and OR
1.3 Combining components and/or sub-systems into complete simple circuit designs
1.4 Describing how familiar, simple digital circuits work, using appropriate terminology

Notes on delivery of Outcome 1
For Outcomes 1 and 2, devices should include resistors, LEDs, diodes, capacitors, transistors, switches, and some integrated circuits. Typical circuits should involve a power supply, up to two input devices, simple processing, and an output device.

A suitable approach to this Outcome could involve practical activities following teacher introduction, brainstorming on mini-whiteboards, circuit simulation and construction on prototype board or commercial systems boards.

Notes on assessment of Outcome 1
Suitable evidence for each Assessment Standard could include oral or written response to questions, photographs of completed circuits and printouts of circuit diagrams and/or simulations.

Outcome 2

The learner will:

2 Design simple analogue electronic circuits by:

2.1 Analysing, with guidance, straightforward problems requiring analogue solutions
2.2 Identifying required common input, process and output devices and their symbols
2.3 Combining components and/or sub-systems into complete simple circuit designs
2.4 Describing how familiar, simple analogue circuits work, using terminology, including current, voltage and resistance, appropriately

Notes on delivery of Outcome 2
For Outcomes 1 and 2, devices should include resistors, LEDs, diodes, capacitors, transistors, switches, and some integrated circuits. Typical circuits should involve a power supply, up to two input devices, simple processing, and an output device.

A suitable approach to this Outcome could involve practical activities following teacher introduction, brainstorming on mini-whiteboards, circuit simulation and construction on prototype board or commercial systems boards.

Notes on assessment of Outcome 2
Suitable evidence for each Assessment Standard could include oral or written response to questions, photographs of completed circuits and printouts of circuit diagrams and/or simulations.

Outcome 3

The learner will:

3 Describe, in simple terms, some aspects of the impact of electronics by:

3.1 Describing appropriate disposal methods for electronic devices
3.2 Describing examples of the increasing use of electronic devices

Notes on delivery of Outcome 3
A suitable approach to this Outcome would involve web-based investigations. Groups within the class could investigate different aspects of the use and disposal of electronic devices, and present their findings. Visits to a local industrial site could be arranged through a STEM ambassador.

Notes on assessment of Outcome 3
Suitable evidence for each Assessment Standard could include the learner's contribution to a group presentation.

Developing skills for learning, skills for life and skills for work

Learners are expected to develop broad generic skills as an integral part of their learning experience. The *Unit Specification* lists the skills for learning, skills for life and skills for work that learners should develop through this Course. These are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and must be built into the Unit where there are appropriate opportunities. The level of these skills will be appropriate to the level of the Unit.

The table below highlights opportunities to develop these skills during this Unit.

2	**Numeracy**	
2.3	Information handling	Drawing and interpreting system diagrams Drawing and interpreting circuit diagrams

5	**Thinking skills**	
		Naming common electronic components Describing the function of electronic components
5.2	Understanding	Describing how some simple electronic systems work Describing, in simple terms, how electronic devices impact on society

The Unit may also provide opportunities to develop or consolidate other skills for life, learning and work, including:

- Reading and writing
- Number processes
- Working with others
- Enterprise and citizenship
- Applying and evaluating

Combining assessment within Units

It may be possible to develop learning/assessment activities which provide evidence that learners have achieved the standards for more than one Outcome within the Unit, thereby reducing the assessment burden on learners. Combining assessment of Outcomes (or parts of Outcomes) in this way is perfectly acceptable, but needs to be carefully managed and recorded to ensure that all assessment standards and Outcomes for the Unit are covered.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and that the alternative approach to assessment will, in fact, generate the necessary evidence of achievement.

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications on SQA's website: http://www.sqa.org.uk/sqa/14976.html
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- Overview of Qualification Reports
- *Principles and practice papers for curriculum areas*
- *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- *Coursework Authenticity — a Guide for Teachers and Lecturers*
- *SCQF Handbook: User Guide (published 2009)* and SCQF level descriptors (to be reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
- *Skills for Learning, Skills for Life and Skills for Work: Using the Curriculum Tool*
- SQA Guidelines on e-assessment for Schools
- SQA Guidelines on Online Assessment for Further Education
- SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

Administrative information

Published: July 2013 (version 1.1)

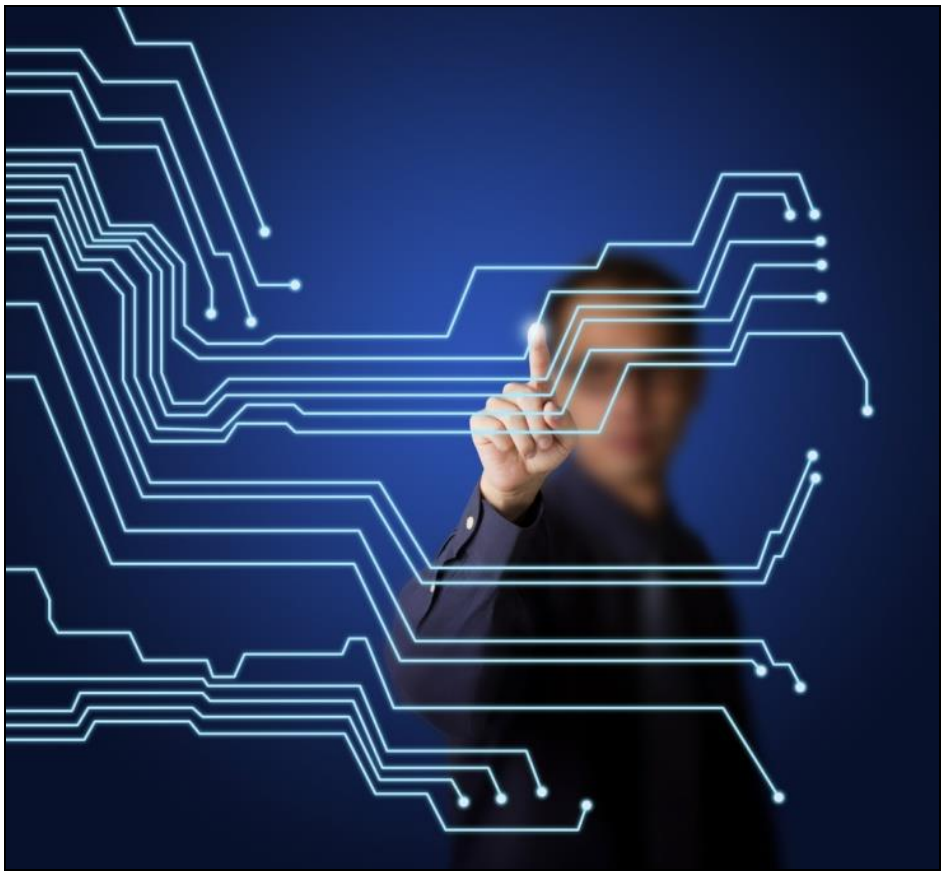
Superclass: XL

History of changes to Unit Support Notes

Unit details	Version	Description of change	Authorised by	Date
	1.1	Minor changes to notes on assessment.	Qualifications Development Manager	July 2013

Unit Support Notes

Unit Support Notes — Practical Electronics: Circuit Simulation (National 5)



Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

Introduction

These support notes are not mandatory. They provide advice and guidance to support the delivery of the *Practical Electronics: Circuit Simulation* (National 4) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Specification*
- the *Course Specification*
- the *Added Value Unit Specification*
- the *Course Support Notes*
- appropriate assessment support materials

General guidance on the Unit

Aims

The general aim of this Unit, as stated in the *Unit Specification*, is to develop skills in the use of simulation software in the context of practical electronics. Learners will, with guidance, use software to assist in the design, construction and testing of simple electronic circuits.

This Unit will also give learners the opportunity to develop their thinking skills as well as their skills in numeracy, employability, enterprise and citizenship.

The Unit can be delivered:

- as a stand-alone Unit
- as part of the National 4 Practical Electronics Course

Progression into this Unit

Entry to this Unit is at the discretion of the centre.

Learners may have gained relevant skills and knowledge through the broad general education, other education systems or from their own interests and informal learning.

Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the *Course Support Notes.*

If the Unit is being delivered as part of the National 4 Practical Electronics Course, the teacher should refer to 'Further mandatory information on Course coverage' section within the *Added Value Unit Specification* for detailed content.

If this Unit is being delivered on a free-standing basis, teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Progression from this Unit

On successful completion of this Unit, the following Units and Courses provide appropriate progression pathways for learners:

- *Practical Electronics: Circuit Construction* (National 4) Unit
- *Practical Electronics: Circuit Simulation* (National 5) Unit
- National Certificate Group Awards (NCGAs) in a range of engineering disciplines
- other technological or science subjects at National 4

Approaches to learning, teaching and assessment

The Unit is designed to provide flexibility and choice for both the learner and the teacher.

Learning and teaching activities should be designed to stimulate learners' interest, and to develop skills and knowledge to the standard required by the Outcomes and to the level defined by the associated Assessment Standards.

The National 4 *Course Support Notes* provide broad guidance on approaches to learning and teaching which apply to all the Units of the Course.

Sequence of delivery

The sequence of delivery and the distribution of time is a matter of professional judgement and is entirely at the discretion of the centre. Two main approaches are suggested, but other possibilities exist.

Delivering Outcomes 1 and 2 sequentially

It is possible to deliver the two Outcomes in sequence with the transferable skills of Outcome 1 being used as a basis to develop further skills in Outcome 2.

Integrated approach

When delivering the Unit as part of the National 4 Practical Electronics Course, this Unit lends itself to a more holistic delivery approach, integrated with the *Circuit Design* and *Circuit Construction* Units. In this approach, the learner would be introduced to appropriate software package/packages when required within each stage of the design process and the construction and testing phase. This would allow learners to experience the industrial pattern of the design, simulation and construction phases of a project. In this approach, assessment evidence will be built up throughout the Course, and will need to be carefully recorded and stored.

Meeting the needs of all learners

When delivering this Unit to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners.

Lessons for the common skills can be delivered to all learners and those skills required for National 5 learners alone may be delivered as extension exercises to this group.

As the learning is likely to be based around a series of practical tasks, a mixed class will naturally self-differentiate based on speed of progression through the tasks. It is expected that those learners for National 5 will demonstrate a higher pace and level of independence of work through the Unit. The complexity of the circuits that National 5 learners are working with should ensure that they still require the same amount of time to complete the Unit.

Where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation. For example, different problems and circuits should be used from those studied the previous year. This would allow the same basic knowledge and skills to be developed but in a fresh context, thus maintaining motivation.

In line with the underlying principles of Curriculum for Excellence, learners should be encouraged, and expected, to take an active role in their own learning. Where Course activities and materials allow them to progress in an independent manner, this will allow teaching of the two groups to happen most effectively.

Useful resources

Before choosing and installing software, check that the relevant specification will be compatible with your current hardware.

ECAD simulation packages

There are many electronic schematic editors and PCB layout packages available, many of them free. Many have simulation elements based on variations of SPICE and will deliver what the Course requires. **ECAD list** is a website which contains links to over 60 packages of various types which you may investigate. The most consistent entry-level education package appears to be **Yenka** (formerly known as Crocodile Clips). This Scottish company specifically design with education in mind and their products are used widely in Scottish centres.

An examples of useful software includes **VeeCAD**, a free-to-download stripboard layout package which works in conjunction with **TinyCAD**, an open source electronic schematic editor. These may be used to assist in layout of circuits

Approaches to delivering and assessing each Outcome

The learner must demonstrate attainment of **all** of the Outcomes and their associated Assessment Standards. Assessment must be valid, reliable and fit for purpose.

SQA does not specify the methods of assessment to be used; teachers should determine the most appropriate method for their learners. In many cases, evidence (which may be oral or observational) will be gathered during normal classroom activities, rather than through formal assessment instruments. Centres are expected to maintain a detailed record of evidence, including oral or observational evidence. Evidence in written or presentation format should be retained by the centre.

Authentication of evidence
All evidence should be gathered under supervised conditions.

In order to ensure that the learner's work is their own, the following strategies are recommended:

- personal interviews with learners where teachers can ask additional questions about the completed work
- asking learners to do an oral presentation on their work
- ensuring learners are clear about acknowledging sources
- using checklists to record the authentication activity

Assessment evidence may be produced in a variety of formats including presentations, web pages, digital photographs, digital video, podcasts and blogs, and these can be stored by the learner (or teacher) within a proprietary e-portfolio, or simply by storing them in a secure folder. It should be noted that centres should verify that this evidence is indeed that of the learner and ensure that no credit is given for archive information without further analysis or comment by the student.

Outcome 1

The learner will:

1 Use software in the design of simple electronic systems by:

1.1 Simulating, with guidance, basic electrical concepts
1.2 Simulating, with guidance, simple electronic systems
1.3 Investigating the behaviour of simple simulated circuits

Notes on delivery of Outcome 1
Typical circuits simulated should involve a power supply, up to two input devices, simple processing, and an output device.

Suitable circuits might include:

- simple resistive series circuits
- simple resistive parallel circuits

- circuits containing switches
- variable resistors and potential dividers
- potential dividers with sensors, using meters
- transistor switches
- output circuits — lights, motors, relays
- protection devices, fuses, diodes and resistors
- simple combinational logic plus output
- analogue input, to digital logic
- digital logic to analogue output
- mini projects leading towards the Added Value Unit

This Outcome could be delivered by a series of teacher-led demonstrations followed by individual experiential learning, with learners making direct use of the simulation package(s). The demonstration materials should be available to students in either electronic or hard copy format to allow for direct differentiation based on ability and speed of progression. This material should include clear statements of the success criteria the teacher/lecturer assigns each activity to allow for the student's self-assessment as part of the process.

Note: when delivering this Unit as a component of the National 4 Practical Electronics Course, this Outcome could be delivered in an integrated way with the *Circuit Design* Unit.

Typical software operations which will be developed in Outcome 1 are listed below:

- locating components in libraries
- placing components
- selecting/changing component values
- rotating components
- checking component polarity (if needed)
- adding ammeters in line with components
- adding voltmeters across components
- choosing meter ranges or selecting autorange
- adding wires to complete circuit
- adding text to annotate circuit
- saving and printing circuit diagram
- collecting simulation readings/data by changing component states/values
- recording readings/data manually/electronically
- presenting readings/data in report form

The range of simulation skills listed should be available in most educational versions of current ECAD packages.

Notes on assessment of Outcome 1
The teacher should maintain an observational record for each learner's work.

This should be supplemented by each learner building up a portfolio of completed simulations. This could include saved electronic and printed circuit diagrams of a selection of suitable circuits. Each item should be labelled with the circuit name, learner's name and date of production. The completed portfolio must include examples of work sufficient to demonstrate full coverage of the Outcome and Assessment Standards. Although learners are expected to simulate and

investigate many circuits, portfolio evidence is only required of one circuit for each Assessment Standard.

Outcome 2

The learner will:

2 Use software in the construction and testing of simple electronic systems by:

2.1 Creating simple circuit diagrams
2.2 Converting simple circuit diagrams to PCB layouts
2.3 Using simulations to assist testing of simple circuits

Notes on delivery of Outcome 2

Typical circuits should involve a power supply, up to two input devices, simple processing, and an output device (see list for Outcome 1).

This Outcome could be delivered by a series of teacher-led demonstrations followed by individual experiential learning, with learners making direct use of the simulation package/packages. The demonstration materials should be available to students in either electronic or hard copy format to allow for direct differentiation based on ability and speed of progression. This material should include clear statements of the success criteria the teacher/lecturer assigns each activity to allow for the student's self-assessment as part of the process.

Note: when delivering this Unit as a component of the National 4 Practical Electronics Course, this Outcome could be delivered in an integrated way with the *Circuit Construction* Unit.

Additional operations which will be developed for Outcome 2 are listed below:

- export drawing for other uses
- transfer drawing to PCB tools software
- place components on PCB manually
- add manual tracks (simple circuit only)
- use automatic layout and track tools
- add text to PCB
- generate PCB masks
- export machining file (if available)
- print PCB masks

Notes on assessment of Outcome 2

The teacher should maintain an observational record for each learner's work.

This should be supplemented by each learner building up a portfolio of completed simulations. This could include printouts of PCB layouts and PCB masks of a selection of suitable circuits. Each item should be labelled with the circuit name, learner's name and date of production. The completed portfolio must include examples of work sufficient to demonstrate full coverage of the Outcome and Assessment Standards. Although learners are expected to simulate and investigate many circuits, portfolio evidence is only required of one circuit for each Assessment Standard.

Developing skills for learning, skills for life and skills for work

Learners are expected to develop broad generic skills as an integral part of their learning experience. The *Unit Specification* lists the skills for learning, skills for life and skills for work that learners should develop through this Course. These are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and must be built into the Unit where there are appropriate opportunities. The level of these skills will be appropriate to the level of the Unit.

The table below suggests opportunities to develop these skills during this Unit.

4 Employability, enterprise and citizenship	
4.2 Information and communication technology (ICT)	Using simulation software in the design of circuits Using software to create layouts Using simulation software to test circuits

5 Thinking skills	
5.1 Remembering	Identifying correct component symbols
5.2 Understanding	Developing skills in using software packages Interpreting the results of testing circuits, using simulation packages

The Unit may also provide opportunities to develop or consolidate other skills for life, learning and work, including:

- Reading and writing
- Number processes and information handling
- Working with others
- Enterprise and citizenship
- Applying and evaluating

Combining assessment within Units

It may be possible to develop learning/assessment activities which provide evidence that learners have achieved the standards for both Outcomes within the Unit, thereby reducing the assessment burden on learners. Combining assessment of Outcomes (or parts of Outcomes) in this way is perfectly acceptable, but needs to be carefully managed to ensure that all assessment standards and Outcomes for the Unit are covered.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and that the alternative approach to assessment will, in fact, generate the necessary evidence of achievement.

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications on SQA's website: http://www.sqa.org.uk/sqa/14976.html
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- Overview of Qualification Reports
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- *Principles and practice papers for curriculum areas*
- *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- *Coursework Authenticity — a Guide for Teachers and Lecturers*
- *SCQF Handbook: User Guide (published 2009)* and SCQF level descriptors (to be reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
- *Skills for Learning, Skills for Life and Skills for Work: Using the Curriculum Tool*
- *Template and Guidance for Unit Assessment Exemplification*
- SQA Guidelines on e-assessment for Schools
- SQA Guidelines on Online Assessment for Further Education
- SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

Administrative information

Published: July 2013 (version 1.1)

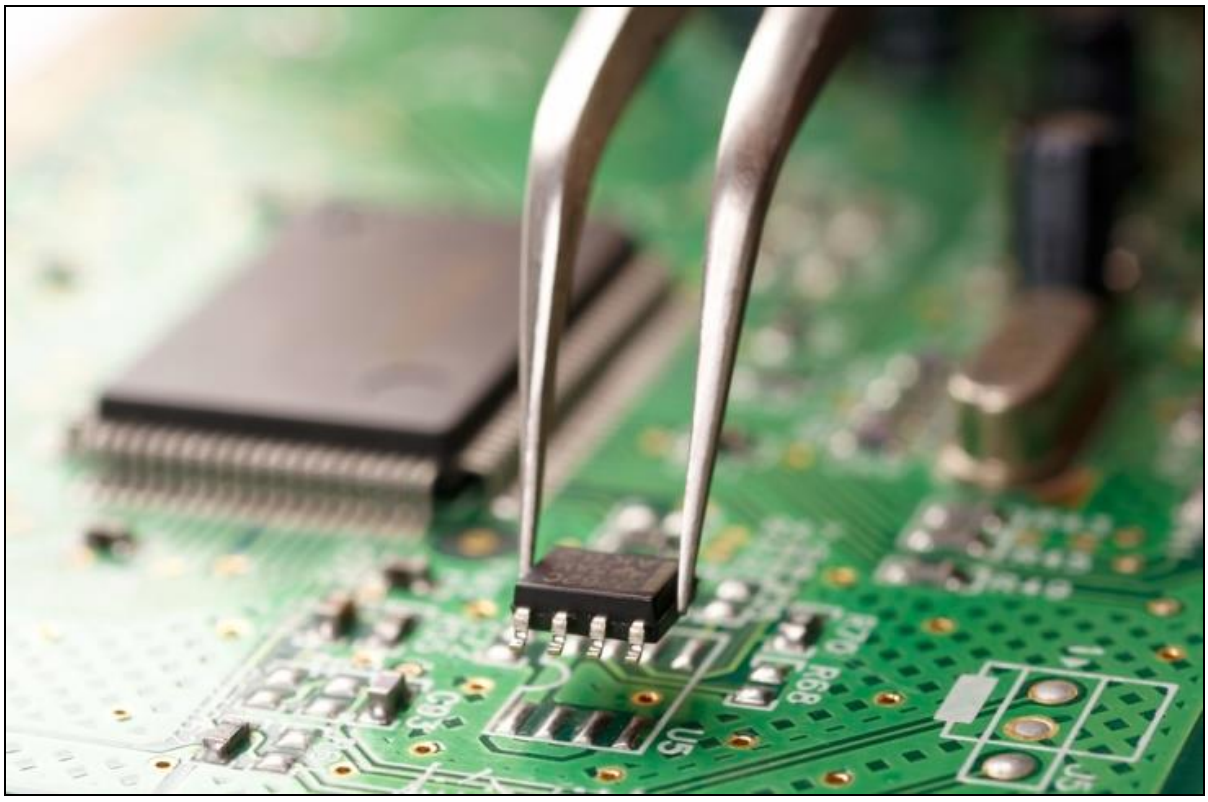
Superclass: XL

History of changes to Unit Support Notes

Unit details	Version	Description of change	Authorised by	Date
	1.1	Minor changes to notes on assessment.	Qualifications Development Manager	July 2013

Unit Support Notes

Unit Support Notes — Practical Electronics: Circuit Construction (National 4)



Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

Introduction

These support notes are not mandatory. They provide advice and guidance to support the delivery of the *Practical Electronics: Circuit Construction* (National 4) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Specification*
- the *Course Specification*
- the *Added Value Unit Specification*
- the *Course Support Notes*
- appropriate assessment support materials

General guidance on the Unit

Aims

The general aim of this Unit, as stated in the *Unit Specification*, is to develop skills in assembling a range of simple electronic circuits, using permanent and non-permanent methods, to construct complete working devices. Learners will also develop skills in basic testing and fault-finding.

This Unit will also give learners the opportunity to develop their thinking skills as well as their skills in numeracy, employability, enterprise and citizenship.

The Unit can be delivered:

- as a stand-alone Unit
- as part of the National 4 Practical Electronics Course

Progression into this Unit

Entry to this Unit is at the discretion of the centre.

Learners may have gained relevant skills and knowledge through the broad general education, other education systems or from their own interests and informal learning.

Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the *Course Support Notes.*

If the Unit is being delivered as part of the National 4 Practical Electronics Course, the teacher should refer to the 'Further mandatory information on Course coverage' section within the *Added Value Unit Specification* for detailed content.

If this Unit is being delivered on a free-standing basis, teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Progression from this Unit

On successful completion of this Unit, the following Units and Courses provide appropriate progression pathways for learners:

- *Practical Electronics: Circuit Construction* (National 5) Unit
- National Certificate Group Awards (NCGAs) in a range of engineering disciplines
- other technological or science subjects at National 4

Approaches to learning, teaching and assessment

The Unit is designed to provide flexibility and choice for both the learner and the teacher.

Learning and teaching activities should be designed to stimulate learners' interest, and to develop skills and knowledge to the standard required by the Outcomes and to the level defined by the associated Assessment Standards.

The *Course Support Notes* provide broad guidance on approaches to learning and teaching which apply to all component Units of the Course.

Sequence of delivery

The sequence of delivery and the distribution of time is a matter of professional judgement and is entirely at the discretion of the centre. Two main approaches are suggested, but other possibilities exist.

Each learner is expected to plan, construct and test several circuits during this Unit. Each Outcome represents one of the three main stages in circuit construction. It is therefore unlikely that a simple sequential approach is appropriate, as this would involve planning several circuits, then constructing them, then testing them.

Applying Outcomes 1, 2 and 3 sequentially to a series of circuits

A more appropriate approach is to develop a series of circuits of increasing complexity, building up skills with each circuit, until each learner reaches a level where the teacher has evidence that they have achieved the appropriate standard.

Each circuit would be developed through the following phases:

Outcome 1 (planning):

- design
- simulation
- 'purchase' of components

Outcome 2 (construction):

- breadboard try-out
- solder and connect

Outcome 3 (testing):

- test and evaluate

Assessment evidence could be collected from any stage of any of the circuits.

Topic approach
In this approach (with all constructing the same circuits) the following sequence of main topics would give opportunities to develop all of the required skills:

1. Constructing circuits on breadboard
2. Soldering and safety introduction
3. Constructing circuits on stripboard
4. Ordering components
5. Soldering small commercial PCB project or kit
6. Connection technologies

On completion of these topics, learners should have demonstrated the required standards, and so be ready to progress to the Added Value Unit.

Integrated approach
When delivering the Unit as part of the National 4 Practical Electronics Course, this Unit lends itself to a more holistic delivery approach, integrated with the *Circuit Design* and *Circuit Simulation* Units. In this approach, each circuit studied could be designed, then simulated, and then constructed, using software as appropriate in the design and construction phases. This would allow learners to experience the industrial pattern of the design, simulation and construction phases of a project. In this approach, assessment evidence will be built up throughout the Course, and will need to be carefully recorded and stored.

Meeting the needs of all learners
Construction activities for National 4 and National 5 are similar; however, National 5 requires some additional skills, and construction of more complex circuits.

When delivering this Unit to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners.

At each stage, the common elements could be taught first to the whole class. National 5 learners can be given extended specifications or variations on the class circuit while National 4 learners complete their tasks.

Where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation. For example, different problems and circuits should be used from those studied the previous year. This would allow similar topics to be covered but in a fresh context, thus maintaining motivation.

In line with the underlying principles of Curriculum for Excellence, learners should be encouraged, and expected, to take an active role in their own learning. Where Course activities and materials allow them to progress in an independent manner, this will allow teaching of the two groups to happen most effectively.

Useful resources
Suitably ventilated area for soldering (this depends on school safety policy and type of soldering irons and solder used).

Safety equipment

- safety glasses (optionally, with magnification)

Tools

- soldering irons
- soldering iron stand
- wire strippers
- solder sucker
- track cutter, side cutters, end cutters
- crimp tools
- multimeters, continuity testers
- magnifying light
- breadboards
- power supplies
- oscilloscope (can be PC plug-in)
- screwdriver, pliers, etc

Consumables

- lead-free solder (ideally rosin-free)
- stripboard
- range of components
- wire, wire markers, cable ties, etc

Books

Some useful books include:
Electronics for Dummies: UK Edition by Ross, Shamieh and McComb
Make: Electronics: Learning Through Discovery by Charles Platt

Component suppliers

Electronic components and kits can be obtained from wide range of suppliers, including RS components, Picaxe, Rapid Electronics and Velleman.

Safety considerations and good practice

- No mains voltage work should be attempted by students, and students should be reminded that this Course does not qualify them to work on any mains circuit.
- Students should not construct any kind of radio transmitter or laser.
- Students should be aware of the dangers of using large capacitors, transformers or high voltage circuits; suggested limit 12V.
- Solder should be lead-free and the care of soldering irons should be covered before soldering begins.
- Students should know the location of a cold water tap when soldering.
- Keep the soldering tip tinned.
- When soldering, students should have soldering iron and solder in hands, work positioned or held correctly, and have safety glasses on.
- Wire work: preparing wires for insertion on stripboard and breadboard should be practiced by all students. Wires should lay flat on the surface, between the correct holes, with stripped ends a reasonable length. Other wire stripping should be practised with a range of wire stripping tools.

Approaches to delivering and assessing each Outcome

The learner must demonstrate attainment of **all** of the Outcomes and their associated Assessment Standards. Assessment must be valid, reliable and fit for purpose.

SQA does not specify the methods of assessment to be used; teachers should determine the most appropriate method for their learners. In many cases, evidence (which may be oral or observational) will be gathered during normal classroom activities, rather than through formal assessment instruments. Centres are expected to maintain a detailed record of evidence, including oral or observational evidence. Evidence in written or presentation format should be retained by the centre.

Authentication of evidence
All evidence should be gathered under supervised conditions.

In order to ensure that the learner's work is their own, the following strategies are recommended:

- personal interviews with learners where teachers can ask additional questions about the completed work
- asking learners to do an oral presentation on their work
- ensuring learners are clear about acknowledging sources
- using checklists to record the authentication activity

Assessment evidence may be produced in a variety of formats including presentations, web pages, digital photographs, digital video, podcasts and blogs, and these can be stored by the learner (or teacher) within a proprietary e-portfolio, or simply by storing them in a secure folder. It should be noted that centres should verify that this evidence is indeed that of the learner and ensure that no credit is given for archive information without further analysis or comment by the student.

Outcome 1

The learner will:

1 Plan the construction of simple electronic circuits by:

1.1 Listing and sourcing the required components
1.2 Choosing, with guidance, a construction method
1.3 Interpreting a layout diagram

Notes on delivery of Outcome 1
For each circuit, learners should be shown how to create a list of required components, and then could be asked to produce an online shopping basket from a supplier, or physically select components from class supplies. Peer checking could be used.

Depending on the stage in the Course, learners may be choosing (with guidance) to build the circuit on breadboard, stripboard or using a proprietary kit or PCB.

Students should be able to understand a simple layout diagram and use it to decide where to put each component.

Notes on assessment of Outcome 1
It is expected that the learner will plan many circuits during the Unit, gradually developing confidence and independence. Learners would be expected to compile a component list for one or more circuits. Evidence of competence of Assessment Standards 1.2 and 1.3 may be by observation, supported by answers to teacher questioning.

Outcome 2

The learner will:

2 Construct simple working electronic circuits by:

2.1 Inserting components on to prototype board to a given layout
2.2 Soldering components on to stripboard or pre-printed PCB to a given layout
2.3 Applying a range of wiring techniques
2.4 Applying safe working practices

Notes on delivery of Outcome 2
The delivery of this Outcome should be based on actual construction of a series of electronic circuits, carefully chosen to develop and consolidate a full range of practical construction skills. Practice at crimping, tinning and fixing wires could be done to produce an example board of techniques. Video demonstrations of soldering techniques can be used. Safe working practices should be taught as a natural part of the learning activities. A safety poster could be produced by learners in groups.

Notes on assessment of Outcome 2
It is expected that the learner will construct many circuits during the Unit, gradually developing competence. Suitable evidence for Assessment Standards 2.1, 2.2 and 2.3 will be a range of completed and working circuits, which show the full range of skills required. It is not necessary for all of these to be retained by the centre; photographic evidence may be used to supplement actual circuits. Evidence of safe working practice will be by teacher observation.

Outcome 3

The learner will:

3 Test simple electronic circuits by:

3.1 Following a testing checklist
3.2 Using multimeters and continuity testers
3.3 Measuring resistance, current and voltage

Notes on delivery of Outcome 3
Activities using existing circuits could be used to develop the skills required for this Outcome. These could be combined with activities for the *Circuit Design* Unit. It is important that the teacher explains and models the checking/fault finding/problem solving approach, rather than just fixing problems for the learner.

Notes on assessment of Outcome 3
Evidence for this Outcome may be observational.

Developing skills for learning, skills for life and skills for work

Learners are expected to develop broad generic skills as an integral part of their learning experience. The *Unit Specification* lists the skills for learning, skills for life and skills for work that learners should develop through this Course. These are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and must be built into the Unit where there are appropriate opportunities. The level of these skills will be appropriate to the level of the Unit.

The table below suggests opportunities to develop these skills during this Unit.

2 Numeracy	
2.3 Information handling	Drawing and interpreting circuit diagrams

5 Thinking skills	
5.2 Understanding	Interpreting layout diagrams Using multimeters and continuity testers appropriately
5.3 Applying	Choosing (with guidance) appropriate construction methods Applying safe working practices Using checklists to identify faults

The Unit may also provide opportunities to develop or consolidate other skills for life, learning and work, including:

- Reading and writing
- Number processes
- Working with others
- Enterprise and citizenship
- Evaluating

Combining assessment within Units

It may be possible to develop learning/assessment activities which provide evidence that learners have achieved the standards for more than one Outcome within the Unit, thereby reducing the assessment burden on learners. Combining assessment of Outcomes (or parts of Outcomes) in this way is perfectly acceptable, but needs to be carefully managed to ensure that all assessment standards and Outcomes for the Unit are covered.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in this document is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and that the alternative approach to assessment will, in fact, generate the necessary evidence of achievement.

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications on SQA's website: http://www.sqa.org.uk/sqa/14976.html
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- Overview of Qualification Reports
- *Overview of Qualification Reports*
- *Principles and practice papers for curriculum areas*
- *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- *Coursework Authenticity — a Guide for Teachers and Lecturers*
- *SCQF Handbook: User Guide (published 2009)* and SCQF level descriptors (to be reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
- *Skills for Learning, Skills for Life and Skills for Work: Using the Curriculum Tool*
- *Template and Guidance for Unit Assessment Exemplification*
- SQA Guidelines on e-assessment for Schools
- SQA Guidelines on Online Assessment for Further Education
- SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

Administrative information

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Superclass: XL

History of changes to Unit Support Notes

Unit details	Version	Description of change	Authorised by	Date
	1.1	Minor changes to notes on assessment.	Qualifications Development Manager	July 2013