Higher National Unit Specification

General information for centres

Unit title: Printed Circuit Board Design, Manufacture and Test

Unit code: DG51 34

Unit purpose: This Unit is designed to develop candidates' skills in PCB design, manufacture and test. It also enables candidates to apply instrumentation and testing skills to a practical circuit, comparing results obtained with a given specification.

On completion of the Unit candidates should be able to:

1. Use an Electronic Design Software Package to Design a Printed Circuit Board artwork.
2. Manufacture a PCB
3. Populate a PCB
4. Verify the operation of a Populated PCB.

Credit value: 1 HN Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**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.*

Recommended prior knowledge and skills: Candidates should have knowledge and understanding of electrical circuit theory, standard electronic schematic diagram symbols. They should be able to use conventional test equipment such as multimeters, function generators and oscilloscopes. This may be evidenced by possession of the HN Units Electronic Construction Skills, Electronic Testing Skills, or equivalent experience.

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

Context for delivery: This Unit was developed for the HNC/D Electronics award. If the Unit is used in other group awards it is recommended that it should be taught and assessed within the context of the particular group award to which it contributes.

Higher National Unit Specification

General information for centres (cont)

Assessment: It is intended that candidates will obtain credit for this Unit by the construction of a functioning circuit assembled on a PCB they have fabricated by safely using a layout artwork based on a circuit diagram they have captured using suitable electronic design software and suitable tools and equipment. A brief report discussing automated PCB assembly processes is to be submitted.

The assessment for Outcomes 2, 3 and 4 may also take place separately if centres choose to prepare layout artworks and fabricated PCBs for use by candidates who may otherwise be temporarily disadvantaged by, for example, equipment failure.

Higher National Unit specification: statement of standards

Unit title: Printed Circuit Board Design, Manufacture and Test

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

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

Outcome 1

Use an Electronic Design Software Package to Design a Printed Circuit Board artwork.

Knowledge and/or skills

- Schematic diagram conventions for electronic circuits.
- Electronic design software concepts.
- Electronic schematic capture of a given circuit.
- Circuit simulation.
- Generation of a PCB layout of the given circuit using software.
- Manufacturing and environmental issues
- Creation of:
  - artwork master
  - component layout diagram
  - connection lists
- Verification of the layout.

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will be by the generation of an effective artwork master suitable to be used in the fabrication of a bare PCB which meets the requirements of the given circuit.

Given the possible complexity of the software used, candidates' evidence may be generated with the assistance of notes and documentation associated with the software used.

Higher National Unit specification: statement of standards (cont)

Unit title: Printed Circuit Board Design, Manufacture and Test

Assessment guidelines

Candidates should be given individual circuits on which to base their PCB design. The Outcome may be assessed on its own, or in conjunction with Outcomes 2, 3 and 4.

Outcome 2

Manufacture a PCB

Knowledge and/or skills

- PCB fabrication processes.
- Safe fabrication of a PCB.
- Visual and electrical checking of fabricated PCB.

Evidence requirements

A fabricated PCB with documented test results.

Assessment guidelines

The PCB should be fabricated from the data generated in Outcome 1. However, in some circumstances candidates may be issued with an artwork and component layout diagram.

Outcome 3

Populate a PCB

Knowledge and/or skills

- Board cleaning and fluxing requirements.
- Component identification, handling and preparation.
- Manual and automated assembly processes.
- Safe, efficient manual assembly.

Evidence requirements

A safely assembled neat PCB with correctly located and oriented components. Written evidence of candidates' ability to describe automated assembly processes.

Assessment guidelines

The PCB assembled should normally be the one fabricated in Outcome 2. However, in some circumstances candidates may be issued with one previously fabricated and component layout data.

Outcome 4

Verify the operation of a Populated PCB.

Knowledge and/or skills

- Assembly faults.
- Visual inspection techniques.
- In-circuit component testing techniques.
- Inspection and electrical test of a populated PCB.
- Component removal and replacement techniques.
- Safe and efficient repair of identified faults.

Evidence requirements

A functioning PCB with associated test documentation. Written evidence of candidates' ability to describe testing techniques.

Assessment guidelines

The PCB should normally be that which has been fabricated and assembled for Outcomes 2 and 3. However, in some circumstances candidates may be issued with one previously assembled.

Administrative Information

Unit code: DG51 34

Unit title: Printed Circuit Board Design, Manufacture and Test

Superclass category: XL

Date of publication: May 2004

Version: 01

Source: SQA

Higher National Unit specification: support notes

Unit title: Printed Circuit Board Design, Manufacture and Test

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

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

Guidance on the content and context for this Unit

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

1. The use of Electronic Design software to produce schematic diagrams and PCB artworks.
2. Manufacture, assembly and testing of PCBs.

This Unit has been written to introduce candidates to PCB design, manufacture and assembly practices. It can stand alone or be used in association with a circuit from any suitable Unit. It is at SCQF level 7 and is included within the Optional section of the HNC and HND Electronics awards. On completion of the Unit, candidates should have an appreciation of PCB design and manufacture processes.

No specific Electronic Design software is recommended, it is left to centres to identify and utilise appropriate packages. It may suit some centres to separate the schematic and layout activities using separate packages, others may wish to utilise integrated software. The time suggested for Outcome 1 (24 hours) is designed to permit candidates to both learn procedures in the designated package and capture, simulate and layout the given circuit. Candidates should be issued with a realistic circuit on which to base their work. Examples are: voltage regulator, timer, amplifier or combinational logic circuit. Candidates should follow current conventions and standards for schematic symbology. Artworks should be checked against the given schematic before fabrication.

The safe fabrication of PCBs can likewise be carried out in accordance with a centre's facilities and the design requirements. For example, the Unit does not preclude the use of Surface Mount Devices (SMDs) or 2-sided PCBs, but candidates may achieve credit in the Unit with a PCB constructed on a single layer with through-hole components.

Chemical and drilling processes must be carried out in association with the centre's Health and Safety procedures.

Assembly should only occur after visual and electrical checks of the fabricated PCB. Continuity checks should be performed in association with the design schematic. Failing boards may be reworked or, if this is not possible, a new board fabricated. Components should be safely and efficiently soldered into place using appropriate equipment.

Higher National Unit specification: support notes (cont)

Unit title: Printed Circuit Board Design, Manufacture and Test

The assembled PCB is to be visually and functionally tested and any faults found repaired.

A range of topics to be covered has been identified and delivery time recommendations have been made. This list of topics is not mandatory, but centres may ensure suitable learning experiences by following it.

Outcome 1
Use an Electronic Design Software Package to Design a Printed Circuit Board artwork (24 hours)

- Schematic diagram conventions for electronic circuits, including formats, design and origin data.
- Electronic design software concepts.
- Electronic schematic capture of a given circuit using standard connections and component symbols, to a given format.
- Simulation of circuit.
- Generation of a feasible and efficient PCB layout of the given circuit using software. Manufacturing and environmental issues; layers, component location, track widths, clearances and copper infill.
- Creation of artwork master, component layout diagram and connection lists.
- Verification of the layout against the given circuit requirements.

Outcome 2
Manufacture a PCB (4 hours)

- PCB fabrication processes; PCB materials, photoresist, pattern transfer, development, etching, resist removal, tinning, cleaning.
- Chemical handling requirements; protective equipment
- Safe fabrication of a PCB from an artwork.
- Drill processes; safety, hole diameters, connections between layers.
- Visual and electrical checking methods; track and pad damage, open and short circuits, electrical continuity, verification against schematic/connection list.

Outcome 3
Populate a PCB (6 hours)

- Board cleaning and fluxing requirements.
- Component identification, handling and preparation; Electro-static discharge prevention and protection, lead forming and cutting, component orientation and mounting.
- Manual and automated assembly processes; placement equipment, automated soldering equipment.
- Safe, efficient manual assembly and soldering of the PCB

Higher National Unit specification: support notes (cont)

Unit title: Printed Circuit Board Design, Manufacture and Test

Outcome 4
Verify the operation of a Populated PCB. (6 hours)

- Assembly faults; incorrect component location, short circuits, open circuits, dry joints, component damage, record keeping.
- Visual inspection techniques.
- In-circuit component testing techniques.
- Inspection and electrical test of a populated PCB.
- Component removal and replacement techniques.
- Safe and efficient repair of identified faults.

Guidance on the delivery and assessment of this Unit

The use of specialist software means that this Unit cannot be easily delivered in conjunction with other Units. However, it may prove possible for centres to utilise electronic circuits studied in other Units, (analogue or digital). Given circuits should not be overly complex. Examples might be a modulo 60 counter or a 2 stage active filter. For some candidates Outcomes 2, 3 and 4 could be assessed with PCBs assembled for their HN Project.

The Unit has been designed to allow sufficient time for candidates to learn and practice electronic design software skills. Centres may use any suitable packages. Candidates already in possession of these skills should still be assessed across all four Outcomes.

Open learning

Given the specialist equipment required to fabricate PCBs, it is unlikely that this Unit can be offered by distance learning.

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

Special needs

This Unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering special alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

General information for candidates

Unit title: Circuit Board Design, Manufacture and Test

This Unit has been designed to allow you to develop knowledge, understanding and skills in PCB layout, fabrication, assembly and testing.

You will be provided with the opportunity to study electronic design software techniques. By the end of this Unit, you will be expected to assemble a PCB using information produced by you using the software.

Your assessment will be based on a given circuit, you will not have to design a circuit to meet a specification. Assessment of the four Outcomes may be integrated in that Outcomes 2, 3 and 4 depend on successfully completing the design activities in Outcome 1. Lecturing staff will review each stage with you as you complete it. Credit for the Unit requires a safely assembled PCB with documentation showing PCB artworks, component list, layout and test results.

The individual circuit issued to you may be associated with another Unit from the technology group you have studied. You will be able to make use of notes and help files while being assessed.