



National Unit Specification: general information

UNIT Applications of Programmable Logic Controllers (SCQF level 6)

CODE F5H0 12

SUMMARY

This Unit is designed to develop the candidate's skills in solving typical industrial related problems by the application of Programmable Logic Controllers (PLC) to the systems. This Unit is suitable for candidates wishing to embark upon a career in electrical and/or electronic engineering. It is also relevant to candidates studying other branches of engineering, science or technology. The candidate will be introduced to the general structure of a PLC and to their naming and symbol conventions. The candidate will also be introduced to the creation of programmes/ladder diagrams and to the concept of interfacing a PLC to external hardware for control purposes. The candidate will then apply this knowledge in order to create a programme to control a typical industrial process.

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

OUTCOMES

- 1 Demonstrate knowledge and understanding of PLC interfacing and programming techniques.
- 2 Prepare and describe the operation of a PLC programme.
- 3 Create PLC programmes to control typical industrial related processes.

RECOMMENDED ENTRY

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

Standard Grade Physics and/or Technology subject — Credit Level

Administrative Information

Superclass: XL

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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.

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

- ◆ *Communication* (SCQF level 5)
- ◆ *Problem Solving* (SCQF level 5)

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

Demonstrate knowledge and understanding of PLC interfacing and programming techniques.

Performance Criteria

- (a) Sketch and label the block diagram of a typical PLC correctly.
- (b) Describe examples of interfacing techniques between external hardware and the Input and Output modules of a PLC correctly.
- (c) Apply the naming conventions associated with PLC systems correctly in terms of inputs, outputs and internal functions.
- (d) Apply the symbol conventions used in PLC systems correctly.
- (e) Apply the functions of typical PLC instructions correctly in terms of their function and, where appropriate, their address field.
- (f) Demonstrate correctly the conversion of Ladder Diagram to Statement List and vice-versa for PLC systems.
- (g) Describe correctly the way in which a PLC executes a program in terms scanning, timing and updating.

OUTCOME 2

Prepare and describe the operation of a PLC programme.

Performance Criteria

- (a) Apply the procedure for creating a PLC programme correctly in terms of allocating inputs, outputs and internal functions.
- (b) Prepare and enter a programme into the PLC correctly and demonstrate the ability to edit an existing PLC programme correctly in terms of amending existing instructions or adding new instructions. Verify that a PLC programme has been entered correctly in terms of *syntax* errors.
- (c) Verify and demonstrate the operation of a PLC programme correctly.
- (d) Describe the operation of a PLC programme correctly.

National Unit Specification: statement of standards (cont)

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OUTCOME 3

Create PLC programmes to control typical industrial related processes.

Performance Criteria

- (a) Describe typical safety considerations when dealing with the control of industrial processes correctly.
- (b) Create the flow diagram for a PLC programme that controls a typical industrial related process correctly.
- (c) Apply correctly the operation of internal sequence control functions in a PLC.
- (d) Prepare and design a PLC programme that simulates a typical industrial related process correctly.
- (e) Verify and demonstrate the operation of a PLC programme that simulates a typical industrial process correctly.
- (f) Record the entire design process in terms of allocating inputs, outputs and internals, flow diagram, ladder diagram, statement list, description of programme operation, functionality test and troubleshooting guide.

National Unit Specification: statement of standards (cont)

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EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved correct responses for all Performance Criteria in order to pass the assessment.

Evidence for Outcome 1 could be provided by a written assessment undertaken in closed-book, supervised conditions.

Evidence for Outcomes 2 and 3 could be provided in the form of a holistic practical assignment. Candidates may make reference to their support notes, Log Book and relevant PLC manuals when undertaking the assessment.

The required written and/or recorded oral evidence is as follows:

The Instrument of Assessment should include structured questions that will allow the candidate to demonstrate their knowledge and understanding of the descriptive pc's within Outcome 1 and will include:

- ◆ a sketch of a typical PLC showing inputs, process and outputs and arrows to indicate the direction of data flow
- ◆ a description of the function of each of these elements
- ◆ a description of typical interfacing techniques
- ◆ a description of the naming conventions used on their particular PLC
- ◆ describe the function of typical PLC instructions in terms of operand and, where applicable, their address
- ◆ convert from statement list to ladder or from ladder to statement list
- ◆ describe the process by which a PLC executes a programme

Candidates' work in Outcomes 2 and 3 should be assessed against an assessment checklist, which should be included in the Instrument of Assessment. The candidate should be encouraged to use their Log Book to help them with their control programme.

The practical assignment must involve the use of a minimum of four inputs, four outputs, a latch, two timers and two counters.

The practical assignment should ask the candidate to create a PLC programme to control an industrial related process.

A candidate's response can be judged to be satisfactory where the evidence provided demonstrates the candidate is able to:

- ◆ design a programme that is valid and that shows the safe control of an industrial process
- ◆ correctly allocate PLC input, output and internal addresses
- ◆ enter/edit the programme into the PLC
- ◆ demonstrate the correct testing procedure
- ◆ demonstrate the correct operation of the PLC making reference to input and output indicators and the internal monitoring processes of the PLC

National Unit Specification: statement of standards (cont)

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- ◆ produce a report that includes:
 - a summary of the design task
 - the allocation of inputs, outputs and internals
 - a ladder diagram of the programme
 - a programme statement list
 - an explanation of the programme operation
 - an explanation of the programme's safety features

National Unit Specification: support notes

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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 sits within the National Certificate in Electronic Engineering at SCQF level 5 and SCQF level 6 and it also sits in a number of other National Certificates in Engineering. This Unit can also be delivered on a free-standing basis.

This Unit is of a practical nature and the candidates should get a very much ‘hands-on’ experience. The precise delivery of this Unit will depend on the specific make of PLC that the centre is using therefore the technical manual appropriate to the make of PLC should be readily available to the candidates.

The content of Outcome 1 is of a generic nature but will still have to be put into context by reference to the specific PLC being used for delivery. Reference should be made to the necessity for inherently safe processes.

Outcomes 2 and 3 are of a practical nature and will involve programming the specific PLC. In the context of ‘industrial related’ processes, there should be hardware available, with appropriate interfacing, that can be driven by the PLCs and this could include conveyor belts and compressed air mechanisms, all with the appropriate sensors built in.

Although this Unit is pitched at a fairly introductory stage of PLC usage, it would be beneficial if the candidates are using a product that is representative of something they might see in a real industrial situation, ie most of the PLCs that are currently used to control real industrial processes are programmed and driven via PC download. If the PLCs being used for delivery are of an older genus, the candidates should be at least made aware of the newer technology.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Throughout the course of this Unit the candidate could be encouraged to keep a Log Book of all their activities and to use this for reference purposes when creating new programmes, this could include the assessment.

Outcome 1 — The candidate could be introduced to the concept of interfacing between the PLC and external hardware. They could also be introduced to the terminology and operation of the elements used in PLCs in terms of inputs, outputs and internal functions, eg normally open/closed switches, output relays, internal relays, internal pulses, timers and counters. The concept of Ladder diagrams will be covered and it could be stressed that they are of a logical rather than a physical nature. By the completion of this Outcome the candidate could be comfortable in creating a Ladder diagram from a given Programme Statement List and vice-versa and they could also be aware of how a PLC actually executes its programme.

National Unit Specification: support notes (cont)

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Outcome 2 — This Outcome will concentrate on the creation of a PLC programme and heavy emphasis could be placed on the appropriate allocation of inputs, outputs and internal functions. They could be introduced to the editing features of their particular PLCs. The candidates could be able to create PLC programmes to control fairly simple processes and they could then test and describe their operation.

Outcome 3 — This Outcome builds on the work done in Outcome 2 but the processes could be of a more complex nature in line with *typical industrial related processes*. The use of the specific PLCs internal sequence control features could be discussed and the candidate could use these features to control external hardware via an appropriate interface. Emphasis should be placed on the creation of inherently safe processes.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Reading component of the Core Skill *Communication* at SCQF level 5 may be developed in all three Outcomes while candidates are reading materials on aspects of programmable logic controllers from paper based and electronic sources.

The Writing component of the Core Skill *Communication* at SCQF level 5 may be developed in all three Outcomes while candidates are preparing written responses to formative and summative assessments.

The Using Graphical Information component of the Core Skill *Numeracy* at SCQF level 5 may be developed in all three Outcomes while candidates represent programmable logic controllers in suitable diagram format.

The Critical Thinking component of the Core Skill *Problem Solving* at SCQF level 5 may be developed in Outcomes 2 and 3 while candidates design suitable programmable logic controller circuits.

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

It is recommended that the evidence is produced by a document that will consist of structured questions leading in to a practical assignment. The structured questions could serve to focus the candidate on the forthcoming design problem. The design problem could involve the use of suitably pre-interfaced existing hardware but this is not essential. The following programme is an example of what could be undertaken:

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A chemical mixing process has to be controlled to carry out the following sequence of events;

1ST STAGE

- ◆ a heater is to be switched on
- ◆ when the base solution reaches set point, the heater is to be switched off
- ◆ a conveyor system will then dispatch 6 chemical elements into the base solution and the conveyor then stops
- ◆ a 30 second delay is required to allow the elements to dissolve completely

2ND STAGE

- ◆ when the 30 second delay has elapsed, a 2nd conveyor is started. This conveyor holds containers that are passed along then stopped underneath a filler spout.
- ◆ when a container is in position, the solution will be dispensed for 4 seconds and then the conveyor will re-start until the next container is in position.

Once 20 containers have been filled, the vat is empty and the 2nd conveyor will stop.

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