Unit 040  Wiring and testing programmable controller based systems

Level: 2
Credit value: 15
NDAQ number: 500/9514/6

Unit aim
This unit covers the skills and knowledge needed to prove the competences required to wire and test programmable controller based systems. This will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment.

The learner will be expected to prepare for the programmable controller wiring and testing activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the activities and the sequence of operations they intend to use. It involves connecting and wiring up the equipment and the development, editing, inputting, testing and de-bugging of simple programs. The learner will be expected to connect peripheral components and communication links, and to load/download process controller programs, check them for errors, and create back-up copies of completed programs.

The learner’s responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the programmable controller maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner’s knowledge will provide an understanding of their work, and will enable them to apply safely the appropriate wiring and connection techniques and procedures for programmable controller equipment. The learner will understand the programmable controller wiring and testing process, and its application, and will know about the controller and peripherals being wired and tested, and the tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the wiring and testing activities (especially those for ensuring the equipment is correctly isolated), and when using the various tools and test equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.
Learning outcomes
There are two learning outcomes to this unit. The learner will be able to:

1. Wire and test programmable controller based systems
2. Know how to wire and test programmable controller based systems

Guided learning hours
It is recommended that 68 hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards
This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 40: Wiring and testing programmable controller based systems (Suite 2).

Support of the unit by a sector or other appropriate body
This unit is endorsed by Semta.

Assessment
This unit must be assessed in a work environment and must be assessed in accordance with the ‘Common Requirements for National Vocational Qualifications (NVQ) in the QCF’ which can be downloaded from Semta’s website: http://www.semta.org.uk/training_providers__awarding/national_occupational_standard/qca_assessment_requirements.aspx

Additional assessment requirements have been published by Semta. These additional assessment requirements are set down in Semta’s Performing Engineering Operations Level 2 unit assessment strategy which can be downloaded from Semta’s website: http://www.semta.org.uk/training_providers__awarding/national_occupational_standard/qca_assessment_requirements.aspx

Unit specific additional assessment requirements:

In order to prove their ability to combine different wiring and testing operations, at least one of the PLC systems worked on must be of a significant nature, and must cover a minimum of five of the items listed in assessment criteria 1.9.
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Outcome 1  Wire and test programmable controller based
systems

Assessment criteria

Practical skills
The learner will be able to:

1. work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

2. carry out all of the following during the wiring and testing of the programmable controller equipment:
   - adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations
   - ensure the safe isolation of services during the wiring activities
   - follow job instructions, wiring drawings and test procedures at all times
   - check that the tools and test instruments are within calibration date and are in a safe and usable condition
   - ensure that the programmable controller system is kept free from foreign objects, dirt or other contamination
   - where appropriate, apply procedures and precautions
   - return all tools and equipment to the correct location on completion of the installation activities

3. connect and test equipment for one of the following types of programmable controller systems:
   - monitoring system
   - process/product control system
   - diagnostic system
   - combination system
   - building services system
   - other specific system

4. plan the programmable controller wiring and testing activities before they start them

5. use appropriate sources to obtain the required circuit diagrams, wiring, programming and test information

6. obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition

7. use two of the following test instruments during the wiring and testing activities:
   - multimeter
   - signal generator
   - other specific test equipment
   - programming devices (such as loader terminal, hand held programmer, personal computer)

8. position and secure the programmable controller components and peripheral devices safely and correctly, to meet specification requirements
9. connect up and test **one** of the following types of programmable controller equipment/components:
   - fixed input/output (I/O) units
   - rack mounted controller units
   - modular controller units

   Plus **five** more items from the following:
   - sensors (such as proximity, temperature, colour, optical)
   - actuators (such as pneumatic or hydraulic)
   - switches (such as limit, pressure, timer)
   - safety interlocks
   - motor starters
   - barcode scanners
   - PC peripheral devices
   - modems
   - printers panels and sub-assemblies
   - electrical wires and cable connections
   - signal transmission components/cables
   - overload protection devices
   - other devices

10. connect and terminate the cables to the appropriate connections on the components

11. apply wiring and connection methods and techniques, to include **five** of the following:
   - locating and securing equipment in the correct positions
   - making mechanical/screwed/clamped connections
   - soldering and de-soldering connections
   - sealing and protecting cable connections
   - crimping (such as tags and pins)
   - connecting all input and output devices
   - attaching suitable cable identification
   - routeing and securing wires and cables
   - using heat shrinking devices or boots
   - stripping cable insulation/protection
   - adding cable end fittings

12. develop programmable controller programs, using the appropriate techniques and programming language

13. develop programs which use one of the following, as applicable to the type of controller:
   - ladder and logic diagrams
   - function diagrams
   - statement lists

14. use appropriate test methods and equipment to check and prove the program integrity

15. prove and edit the programmable logic controller program, using **five** of the following:
   - single block run
   - program save/store facilities
   - search facilities
   - program override controls
   - taking test measurements
   - using monitoring mode
   - using process simulation techniques (forcing contacts on/off)
   - edit facilities
   - data input facilities
   - program full run
   - graphic displays
16. wire up and test programmable controllers, in accordance with one or more of the following standards:
   - equipment manufacturer's specification/operation range
   - BS7671/IEE wiring regulations
   - other BS and/or ISO standards
   - company standards and procedures

17. deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

18. use three of the following diagnostic techniques, tools and aids:
   - visual checks (such as signs of damage, missing parts, wear/deterioration)
   - movement checks (such as loose fittings and connections)
   - fault finding techniques (such as input/output, half-split, unit substitution)
   - diagnostic aids (such as manuals, logic diagrams, troubleshooting guides)
   - test instrumentation measurement (such as continuity, voltage, resistance, current)

19. carry out all of the following on completion of the programming activity:
   - check and review program format and content
   - edit programs using the correct procedure (where appropriate)
   - check that the program is correctly titled and referenced
   - ensure that programs are stored safely and correctly in the correct format (such as disk, EPROM, hard copy)
   - create a separate backup copy of the program in case of file corruption

20. leave the work area in a safe and tidy condition on completion of the wiring and testing activities
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Outcome 2 Know how to wire and test programmable controller based systems

Assessment criteria

Underpinning knowledge
The learner will be able to:

1. describe the health and safety requirements, and safe working practices and procedures required when wiring and testing programmable controller equipment
2. describe the hazards associated with wiring and testing programmable controller equipment, and with the tools and equipment used (such as live electrical components, process controller interface, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down procedures), and how they can be minimised
3. describe the importance of wearing appropriate protective clothing and equipment, and of keeping the work area safe and tidy
4. describe the interpretation of circuit and wiring diagrams, and specifications used for the wiring and testing activities (including BS and ISO schematics, wiring regulations, symbols and terminology)
5. describe the basic principles of operation of the programmable controller equipment/circuits being connected and tested, and the purpose of the individual modules/components used (such input and output devices)
6. describe the techniques used to connect programmable controller equipment (such as plugs, soldering, screwed, clamped and crimped connections)
7. describe the use of BS 7671/IEE wiring, and other regulations, when selecting wires and cables, and when carrying out tests on systems
8. describe the main programmable controller types that are available, and the importance of understanding that a different programmable controller may use completely different codes for similar functions
9. describe the programming languages commonly used with programmable controller based systems (such as linear, structured, ladder, statement lists, logic function blocks, Boolean algebra)
10. describe the common programmable controller numbering systems (such as binary, octal, decimal, hexadecimal, binary coded decimal (BCD))
11. describe the different programming codes used to identify factors such as sensor inputs, actuator and other outputs, process management and auxiliary functions
12. describe the information and data required in order to produce a complete and accurate programmable controller program, and how to translate the operating criteria into logic programming format
13. describe the factors to be taken into account when producing programs (including the type of programmable controller (fixed IO, modular, rack mounted) and its control capabilities); safety considerations and the product/environment being controlled by the process
14. describe the methods and procedures used to check that the completed program will control the required parameters safely, accurately and efficiently (such as checking the program for
errors against expected performance with regard to sequence of operations; checking that programmed instructions cover all operational requirements; using monitoring devices and test measurements to check inputs and outputs; using techniques such as ‘force on- force off’ to simulate process conditions; checking that failsafe devices and system emergency stops are operating correctly)

15. explain how to identify system errors, and how to search a program within the programmable controller for specific elements and rectify the causes of the errors

16. explain how to save the completed programs in the appropriate format (such as disks, tapes, EPROMS, hard copy), and the need to store the program safely and correctly, away from contaminants and electromagnetic sources

17. explain how to back up completed or edited programs, and the implications if this is not carried out effectively

18. describe the fault-finding techniques to be used when the equipment fails to operate correctly

19. explain when to act on their own initiative and when to seek help and advice from others

20. describe the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to its designated location, cleaning the work area, and removing and disposing of waste)