Unit 22: Programmable Logic Controllers

Unit code: A/601/1625
QCF level: 4
Credit value: 15

● Aim
The aim of this unit is to investigate programmable logic controller (PLC) concepts and their applications in engineering.

● Unit abstract
The unit focuses on the design and operational characteristics and internal architecture of programmable logic control systems. It examines the signals used and the programming techniques that can be applied. The unit also provides learners with the opportunity to produce and demonstrate a program for a programmable logic controller device (for example produce a programme for an engineering application, store, evaluate and justify approaches taken).

● Learning outcomes
On successful completion of this unit a learner will:
1. Understand the design and operational characteristics of a PLC system
2. Understand PLC information and communication techniques
3. Be able to apply programmable logic programming techniques
4. Understand alternative implementations of programmable control.
Unit content

1. Understand the design and operational characteristics of a PLC system

   Design characteristics: unitary; modular; rack-mounted

   Input and output devices: mechanical switches; non-mechanical digital sources; transducers; relays

   Communication links: twisted pair; coaxial; fibre-optic; networks

   Internal architecture: central processor unit (CPU); arithmetic logic unit (ALU); storage devices; memory; opto-isolators; input and output units; flags; shift; registers

   Operational characteristics: scanning; performing logic operations; continuous updating; mass input/output (I/O) copying

2. Understand PLC information and communication techniques

   Forms of signal: analogue (0-10 v dc, 4-20mA); digital

   Digital resolution and relationships: 9-bit; 10-bit; 12-bit

   Number systems: decimal; binary; octal; hexadecimal; Binary-Coded Decimal (BCD)

   Evaluate communication standards: comparison of typical protocols used in signal communication

   Evaluate networking methods and standards: master to slave; peer to peer; ISO; IEE; MAP

   Logic functions: writing programmes using logic functions based on relay ladder logic (AND; OR; EXCLUSIVE OR; NAND; NOR)

3. Be able to apply programmable logic programming techniques

   Write programs: use of ladder and logic diagrams; statement lists; Boolean algebra; function diagrams; graphical programming languages; production of a PLC

   Advanced functions: less than; greater than; binary to BCD conversion; proportional feedback control

   Producing and storing text: contact labels; rung labels; programming lists; cross-referencing

   Test and debug programs: forcing inputs, forcing outputs; changing data; comparing files (tapes, EPROM, disc); displayed error analysis

   Associated elements: contacts; coils; timers; counters; override facilities; flip-flops; shift registers; sequencers

4. Understand alternative implementations of programmable control

   PICs and other programmable devices: specification and use of PICs and other programmable devices; embedded controllers

   PLC simulators: compare operation and functionality; advantages and limitations
# Learning outcomes and assessment criteria

<table>
<thead>
<tr>
<th>Learning outcomes</th>
<th>Assessment criteria for pass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On successful completion of this unit a learner will:</strong></td>
<td><strong>The learner can:</strong></td>
</tr>
</tbody>
</table>
| LO1 Understand the design and operational characteristics of a PLC system | 1.1 evaluate the design characteristics of typical programmable logic devices  
1.2 describe different types of input and output device  
1.3 evaluate the different types of communication link used in programmable logic control systems  
1.4 describe the internal architecture and operational characteristics of the CPU of a typical programmable logic device |
| LO2 Understand PLC information and communication techniques | 2.1 evaluate the different forms of signal used in programmable logic control  
2.2 describe the resolution and relationship between analogue inputs and outputs and word length  
2.3 express numbers using different number systems  
2.4 describe typical protocols used in signal communication and evaluate networking methods and networking standards |
| LO3 Be able to apply programmable logic programming techniques | 3.1 identify elements associated with the preparation of a programmable logic controller program  
3.2 write programs using logic functions based on relay ladder logic  
3.3 evaluate the range and type of advanced functions of programmable logic controllers  
3.4 use and justify methods of testing and debugging hardware and software |
| LO4 Understand alternative implementations of programmable control | 4.1 evaluate PICs and other programmable devices as programmable devices and embedded controllers  
4.2 compare the operation, functionality, advantages and limitations of PLC simulators. |
Guidance

Links

This unit may be linked to Unit 46: Plant and Process Control, Unit 49: Computer Control of Plant, Unit 58: Microprocessor Systems and Unit 71: Combinational and Sequential Logic.

Essential requirements

Centres delivering this unit must be equipped with, or have access to, industrial-standard programmable logic control units and development software.

Employer engagement and vocational contexts

Visits to industrial PLC installations will be of value to supplement the learning activities.