

## **SQA Advanced Unit Specification**

### **General information for centres**

**Unit title:** Digital Communications in Measurement and Control Engineering

**Unit code:** HV62 47

**Unit purpose:** This Unit is designed to enable candidates to gain knowledge and understanding of digital communications in Measurement and Control technology and apply that knowledge to industrial situations.

On completion of the Unit the candidates should be able to:

- 1 Explain data characteristics.
- 2 Explain communication standards.
- 3 Explain transmission media.
- 4 Explain transmission protocols and networks.

**Credit points and level:** 1 SQA 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 National 1 to Doctorates.*

**Recommended prior knowledge and skills:** Access to this Unit will be at the discretion of the centre and the following recommendations are for guidance only.

Candidates should have a basic knowledge of process measurement and control engineering. This may be evidenced by the possession of Higher Process Measurement or Higher Process Control or NQ Units in Measurement and Control or NC Measurement and Control or NC Multidisciplinary Engineering.

**Core Skills:** There are opportunities to develop the Core Skills of Written Communication (Writing), Written Communication (Reading) and Problem Solving (Critical Thinking) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

**Context for delivery:** If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

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**Assessment:** The assessment for Outcomes 1, 2, 3 and 4 could be integrated into an end test of no more than 3 hours. Alternatively, individual assessments of 1 hour duration could be used for each Outcome. Assessments should consist of a balance of short answer, restricted response and structured questions. The assessments should be conducted under closed-book, controlled, supervised conditions.

**Unit specification: statement of standards**

**Unit title:** Digital Communications in Measurement and Control Engineering

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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**

Explain data characteristics

**Knowledge and/or skills**

- ◆ Digital codes
- ◆ Communication modes
- ◆ Transmission characteristics

**Evidence Requirements**

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- ◆ explain one digital code
- ◆ compare two communication modes
- ◆ explain one transmission characteristic

Evidence should be generated through assessments undertaken in controlled supervised conditions.

**Assessment guidelines**

Assessments should be conducted under closed-book conditions and as such candidates must not be allowed any text books, handouts or notes in the assessment. Questions used to elicit candidate evidence may take the form of short answer or restricted response questions.

The assessment for Outcome 1 could be integrated with Outcomes 2, 3 and 4 into an end test of no more than 3 hours. Alternatively, an individual assessment of 1 hour duration could be used for Outcome 1.

### Outcome 2

Explain communication standards

#### Knowledge and/or skills

- ◆ Serial transmission standards
- ◆ Parallel transmission standards
- ◆ Universal serial bus
- ◆ Error detection

#### Evidence Requirements

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis. The evidence may be provided in response to specific questions.

Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.

In any assessment three out of the four knowledge and/or skills should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of three out of the four knowledge and/or skills is required each time the Outcome is assessed.

Candidates must provide a satisfactory response to all three items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ explain serial transmission standards
- ◆ explain parallel transmission standards
- ◆ explain the use of Universal serial bus (USB)
- ◆ explain error detection

Evidence should be generated through assessments undertaken in controlled supervised conditions.

#### Assessment guidelines

Assessments should be conducted under closed-book conditions and as such candidates must not be allowed any text books, handouts or notes in the assessment. Questions used to elicit candidate evidence may take the form of short answer or restricted response questions.

The assessment for Outcome 2 could be integrated with Outcomes 1, 3 and 4 into an end test of no more than 3 hours. Alternatively, an individual assessment of 1 hour duration could be used for Outcome 2.

## **Outcome 3**

Explain transmission media

### **Knowledge and/or skills**

- ◆ Cables
- ◆ Modems
- ◆ Multiplexing
- ◆ Noise/interference

### **Evidence Requirements**

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis. The evidence may be provided in response to specific questions.

Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.

In any assessment three out of the four knowledge and/or skills should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of three out of the four knowledge and/or skills is required each time the Outcome is assessed.

Candidates must provide a satisfactory response to all three items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ compare different types of cables
- ◆ explain the operation of a modem
- ◆ explain multiplexing
- ◆ explain what is meant by noise/ interference and one method of noise/ interference protection

Evidence should be generated through assessments undertaken in controlled supervised conditions.

### **Assessment guidelines**

Assessments should be conducted under closed-book conditions and as such candidates must not be allowed any text books, handouts or notes in the assessment. Questions used to elicit candidate evidence may take the form of short answer or restricted response questions.

The assessment for Outcome 3 could be integrated with Outcomes 1, 2 and 4 into an end test of no more than 3 hours. Alternatively, an individual assessment of 1 hour duration could be used for Outcome 3.

### Outcome 4

Explain transmission protocols and networks

#### Knowledge and/or skills

- ◆ Network architecture
- ◆ Network protocols
- ◆ Transmitter transmission specifications
- ◆ ISO seven layer model
- ◆ Fieldbus networks

#### Evidence Requirements

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis. The evidence may be provided in response to specific questions.

Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.

In any assessment four out of the five knowledge and/or skills should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of four out of the five knowledge and/or skills is required each time the Outcome is assessed.

Candidates must provide a satisfactory response to all four items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ explain network architecture
- ◆ compare two network protocols
- ◆ explain one transmitter transmission specification
- ◆ explain the ISO seven layer model
- ◆ explain Fieldbus networks

Evidence should be generated through assessments undertaken in controlled supervised conditions.

#### Assessment guidelines

Assessments should be conducted under closed-book conditions and as such candidates must not be allowed any textbooks, handouts or notes in the assessment. Questions used to elicit candidate evidence may take the form of short answer or restricted response questions.

The assessment for Outcome 4 could be integrated with Outcomes 1, 2 and 3 into an end test of no more than 3 hours. Alternatively, an individual assessment of 1 hour duration could be used for Outcome 4.

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### Administrative information

<b>Unit code:</b>	HV62 47
<b>Unit title:</b>	Digital Communications in Measurement and Control Engineering
<b>Superclass category:</b>	CD
<b>Original date of publication:</b>	November 2017
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#### History of Changes:

Version	Description of change	Date

**Source:** SQA

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**FURTHER INFORMATION:** Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our [Centre Feedback Form](#).

### Unit specification: support notes

#### Unit title: Digital Communications in Measurement and Control Engineering

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 in order to allow candidates to develop knowledge, understanding and skills in the following areas:

- 1 Digital data codes and transmission characteristics.
- 2 Serial and parallel transmission standards and error detection.
- 3 Transmission cables, modems, multiplexing and interference in transmission systems.
- 4 Network architecture and protocols (including ISO seven layer model) and transmitter transmission specifications.

The Unit is at SCQF level 7 and the Unit has been developed as part of the SQA Advanced Certificate/Diploma in Measurement and Control Engineering. However this does not preclude the use of this Unit in other awards where award designers feel it is appropriate.

In designing this Unit, the writer has identified the range of topics that they would expect to be covered by lecturers. The writer has also given recommendations as to how much time should be spent on each Outcome. This is done to help lecturers to decide what depth of treatment should be given to the topics attached to each Outcome.

A list of topics for each Outcome is given below. Lecturers are advised to study the list in conjunction with the assessment exemplar pack so that they can get a clear indication of the standards of achievement expected of candidates in this Unit.

#### Outcome 1

Explain data characteristics. (7 hours inc. assessment)

- ◆ Digital codes (Binary, Gray, BCD and Hex)
- ◆ Communication modes (simplex, half duplex and full duplex)
- ◆ Asynchronous and synchronous transmission
- ◆ Transmission characteristics:
  - Signal rate
  - Data rate
  - Bandwidth
  - Signal to noise ratio (SNR)
  - Data throughput
  - Error rate



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### Outcome 2

Explain communication standards (15 hours inc. assessment)

- ◆ Serial data communication standards (RS 232/ 423/ 422 and 485)
- ◆ Parallel data communication standards (GPIB and Centronics)
- ◆ General Purpose Interface Bus (GPIB):
  - Physical connection configurations
  - GPIB bus structure
  - GPIB handshaking and data transfers
  - GPIB device types
- ◆ Universal serial bus (USB):
  - USB structure and topology
  - Host hubs and host hub controller
  - External hubs
  - Hardware driver
  - Communication flow
  - Signalling and wiring
  - High speed and low speed cables
- ◆ Error detection:
  - Parity checking
  - Double parity
  - Hamming code
  - Hamming distance

### Outcome 3

Explain transmission media (9 hours inc. assessment)

- ◆ Cables:
  - Twisted pair
  - Co-axial cables
  - Fibre optic cables
- ◆ Advantages and disadvantages of the above:
  - Bandwidth
  - Distance
  - Attenuation
  - Error rates
  - Galvanic isolation
  - Interference
  - Crosstalk
  - Use in hazardous areas
- ◆ Noise/interference:
  - Types of noise
  - Frequency analysis of noise
  - Sources of electrical noise:
    - Electrical coupling (impedance)
    - Electrostatic
    - Magnetic/inductive
    - Radio frequency
  - Shielding and earthing requirements

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- ◆ Modems:
  - Types of modems
  - Modem states (on line, command and comatose)
- ◆ Radio modems:
  - Modes and features
  - Data compression techniques
- ◆ Multiplexing:
  - Space division, frequency division and time division
  - Terminal and statistical multiplexers

### Outcome 4

Explain transmission protocols and networks (9 hours inc. assessment)

- ◆ Protocol structures:
  - ASCII
  - Mod bus
  - MAP/TOP
  - HART (Highway addressable remote transducer)
- ◆ Bell 202 communication standard
- ◆ ISO seven layer model (part of):
  - Physical layer
  - Data link layer
  - Application layer
- ◆ Network architecture and protocol:
  - Topologies — star, ring and bus
  - Physical and protocol issues
  - Fieldbus networks and communications standards
- ◆ Ethernet standard — topology, protocol, operation, hardware requirements, performance, collision avoidance
- ◆ Token ring and bus standard
- ◆ Inter network connections — repeaters, bridges, switches and routers
- ◆ Typical specification of field transmitters

### Guidance on the delivery and assessment of this Unit

This Unit is designed to enable candidates to gain knowledge and understanding of digital communications in Measurement and Control technology and apply that knowledge to industrial situations.

The content of each Outcome means that each Outcome should be delivered in order. Practical examples should be used where practicable to aid learning.

Details on approaches to assessment are given under Evidence Requirements and Assessment guidelines under each Outcome in the SQA Advanced Unit specification: Statement of Standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

#### *Opportunities for developing Core Skills*

There are opportunities to develop the Core Skills of Written Communication (Writing), Written Communication (Reading) and Problem Solving (Critical Thinking) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

### Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on line support. With regard to assessment, planning would be required of the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessments were conducted under controlled, supervised conditions. Arrangements would need to be made to ensure that the candidate could perform practical work. This could involve the candidate attending the centre or utilising video conferencing. Alternatively, special arrangements could be made for the candidate to demonstrate the practical work to a designated, responsible person local to the candidate.

For information on open learning, please refer to *SQA guide assessment and quality assurance of open and distance learning (A1030, Feb 2001)*.

### Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements).

### General information for candidates

#### **Unit title:** Digital Communications in Measurement and Control Engineering

This Unit has been designed to provide you with knowledge and skills that will enable you to understand and implement digital communications within Measurement and Control.

This Unit may be assessed using one written assessment covering all four Outcomes or by four separate assessments covering one Outcome each. All assessments will be undertaken under supervised conditions. You will not be allowed to take notes, handouts, textbooks etc into the assessment.

In Outcome 1 you will learn about some of the different codes used in digital communications. You will also learn about communication modes and some transmission characteristics.

In Outcome 2 you will learn about serial and parallel transmission, universal serial bus and error detection.

In Outcome 3 you will learn about different types of cable used for transmission and different types of modems and the modes that they use. You will also learn about multiplexing and interference.

In Outcome 4 you will learn about network architecture and network protocols including Fieldbus. You will learn about the ISO seven layer model, Ethernet and token ring systems. You will also learn about field transmitter specifications.