

Overview

This standard covers a broad range of basic electrical and electronic engineering competences. It will prepare you for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment.

The electrical and electronic engineering activities will include the wiring and termination of a range of wire/cables, electrical components, circuit boards and electronic components. This will involve using a range of tools and equipment, along with soldering techniques and anti-static protection techniques.

You will be required to select the appropriate tools, materials and equipment to use, based on the operations to be performed and the components/circuits to be connected. You will be expected to use appropriate tools and techniques for the assembly and wiring of the various electrical and electronic components and connectors that make up the circuit. The wiring and testing activities will include making all necessary checks and adjustments to the circuit (such as continuity, polarity, insulation resistance, current, voltage and waveform values), and ensuring that the circuit functions to the specification.

Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the electrical and electronic wiring and testing activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the wiring and testing activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you carry out.

Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate electrical and electronic wiring and testing procedures and techniques safely. You will understand the wiring and testing methods and procedures used, and their application, and will know about the various cables and components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

You will understand the safety precautions required when carrying out the wiring and testing activities, especially those for ensuring the safe isolation of the equipment and circuits produced. You will be required to demonstrate safe

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

working practices throughout, and will understand the responsibility you owe to yourself and others in the workplace.

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

Performance criteria

- You must be able to:*
- P1 work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
 - P2 plan the electrical and electronic wiring and testing activities before you start them
 - P3 use appropriate sources to obtain the required specifications, circuit diagrams and test information
 - P4 obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition
 - P5 mount and secure the electrical and electronic components safely and correctly, to meet specification requirements
 - P6 install and terminate the cables to the appropriate connections on the components
 - P7 use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification
 - P8 deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve
 - P9 leave the work area in a safe and tidy condition on completion of the wiring and testing activities

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

Knowledge and understanding

You need to know and understand:

- K1 the specific safety practices and procedures that you need to observe when wiring and testing electrical and electronic circuits (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
- K2 the hazards associated with wiring and testing electrical and electronic circuits and equipment, and with the tools and equipment used (such as heat, toxic fumes, spilled/splashed chemicals/solder, static electricity, using sharp instruments for stripping cable insulation, connecting clips/probes into circuits), and how they can be minimised
- K3 the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
- K4 what constitutes a hazardous voltage and how to recognise victims of electric shock
- K5 how to reduce the risks of a phase to earth shock (such as insulated tools, rubber mating and isolating transformers)
- K6 the interpretation of circuit diagrams, wiring diagrams, and other relevant specifications (including BS and ISO schematics, wiring regulations, symbols and terminology)
- K7 the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used
- K8 the different types of cabling and their application (such as multicore cables, single core cables, solid and multi-stranded cables, steel wire armoured (SWA), mineral insulated (MI), screened cables, data/communications cables, fibre-optics)
- K9 the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, junction boxes, consumer units, relays, solenoids, transformers, sensors and actuators)
- K10 the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, residual current device (RCD))
- K11 the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)
- K12 how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies (such as capacitors, diodes, transistors, integrated circuit chips, and other discrete through-hole or surface-mounted components)
- K13 how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)
- K14 methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts and bolts, screws and masonry)

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

- fixing devices)
- K15 methods of laying in or drawing cables into conduit, trunking and traywork systems, and the need to ensure the cables are not twisted or plaited
- K16 the techniques used to terminate electrical and electronic components and equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)
- K17 the use of BS7671/IET wiring regulations when selecting wires and cables, and when carrying out tests on circuits
- K18 methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)
- K19 the tools and equipment used in the wiring activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
- K20 how to check that tools and equipment are free from damage or defects, and are in a safe, calibrated, PAT tested and usable condition
- K21 the importance of conducting inspections and checks before connecting to the supply (such as visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)
- K22 the care, handling and application of electrical and electronic test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments, oscilloscopes, signal generators and logic probes)
- K23 applying approved test procedures; the safe working practices and procedures required when carrying out the various tests, and the need to use suitably fused test probes and clips
- K24 how to identify suitable test points within the circuit, and how to position the test instruments into the circuit so as to ensure the correct polarity and without damaging the circuit components
- K25 how to set the instrument zero readings; obtaining instrument readings and comparing them with circuit parameters
- K26 the problems that can occur with the wiring and testing operations, and how these can be overcome
- K27 the fault-finding techniques to be used if the equipment fails to operate correctly
- K28 when to act on your own initiative and when to seek help and advice from others
- K29 the importance of leaving the work area and equipment in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to the designated location, cleaning the work area, and removing and disposing of waste)

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

Additional Information

Scope/range related to performance criteria

You must be able to:

1. Carry out **all** of the following during the wiring and testing activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 ensure the safe isolation of services during the wiring and testing activities
 - 1.3 follow job instructions, circuit and assembly drawings and test procedures at all times
 - 1.4 check that tools and test instruments to be used are within calibration date and are in a safe, tested and usable condition
 - 1.5 ensure that the components used are free from damage, dirt or other contamination
 - 1.6 prepare the electrical and electronic components for the assembly and wiring operations (such as pre-forming and cleaning pins)
 - 1.7 where appropriate, apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards (such as the use of grounded wrist straps and mats)
 - 1.8 return all tools and equipment to the correct location on completion of the wiring and testing activities

2. Use **three** of the following types of cable when producing the electrical and electronic circuits:
 - 2.1 single core
 - 2.2 armoured
 - 2.3 fibre optics
 - 2.4 wiring loom/harness
 - 2.5 multi core
 - 2.6 coaxial
 - 2.7 screened
 - 2.8 data/communication
 - 2.9 PVC twin and earth
 - 2.10 ribbon cables
 - 2.11 flexible (such as cotton or rubber covered)
 - 2.12 mineral insulated (such as FP 200)

3. Wire up **three** of the following electrical circuits/systems:
 - 3.1 domestic lighting circuits

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

- 3.2 vehicle heating or ventilating
 - 3.3 air conditioning control circuits
 - 3.4 domestic power circuits
 - 3.5 vehicle lighting
 - 3.6 refrigeration control circuits
 - 3.7 motor control circuits
 - 3.8 vehicle starting and ignition
 - 3.9 heating/boiler control circuits
 - 3.10 instrumentation and control circuits
 - 3.11 emergency lighting systems
 - 3.12 aircraft lighting circuits
 - 3.13 alarm systems (such as fire, intruder, process control)
 - 3.14 avionic circuits and systems
 - 3.15 electro-pneumatic or electro-hydraulic control circuits
 - 3.16 communication systems
 - 3.17 other control circuits (such as pumps, fans, blowers, extractors)
 - 3.18 computer systems
 - 3.19 power generation and control circuits
 - 3.20 other specific electrical circuits
4. Apply wiring methods and techniques, to include **all** of the following:
- 4.1 positioning and securing of equipment and components
 - 4.2 crimping (such as spade end, loops, tags and pins)
 - 4.3 determining current rating and lengths of cables required
 - 4.4 stripping outer coating without damage to conductor insulation
 - 4.5 soldering and de-soldering
 - 4.6 attaching suitable cable identification
 - 4.7 stripping cable conductor insulation/protection
 - 4.8 leaving sufficient slack for termination and movement
 - 4.9 adding cable end fittings (such plugs, sockets multi-way connectors)
 - 4.10 secure wires and cables (such as glands, clips, plastic strapping, lacing, harnessing)
 - 4.11 making mechanical/screwed/clamped connections
5. Assemble electronic components to produce **four** of the following types of circuit:
- 5.1 audio amplifiers
 - 5.2 filters
 - 5.3 regulated power supplies
 - 5.4 signal converters
 - 5.5 microprocessor-based applications (such as PIC chips)
 - 5.6 logic function controls
 - 5.7 signal generators
 - 5.8 comparators
 - 5.9 display circuits

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

- 5.10 counter-timers
 - 5.11 power amplifiers
 - 5.12 ADC and DAC hybrid circuits
 - 5.13 oscillators
 - 5.14 motor control
 - 5.15 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
 - 5.16 digital circuit (such as process control, microprocessor, logic devices, display devices)
 - 5.17 signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)
 - 5.18 alarms and protection circuits
 - 5.19 other specific circuit
6. Use **two** of the following test instruments during the wiring and testing activities:
- 6.1 low reading ohmmeter
 - 6.2 clamp meter
 - 6.3 insulation resistance tester
 - 6.4 voltage indicator
- Plus **three** more of the following:
- 6.5 multimeter
 - 6.6 signal generator
 - 6.7 oscilloscope
 - 6.8 signal tracer
 - 6.9 logic probe/clip
 - 6.10 stabilised power supplies
 - 6.11 logic analyser
 - 6.12 measuring bridges
 - 6.13 pulse sequencing analyser
 - 6.14 software diagnostic programs
 - 6.15 counter-timers
 - 6.16 data communications test set
 - 6.17 signature analysers
 - 6.18 bus exerciser/analyser
 - 6.19 protocol analyser
7. Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include **three** of the following:
- 7.1 making visual checks (such as signs of damage, incorrect termination/orientation, solder bridges, dry joints, incorrect value components)
 - 7.2 movement checks (such as loose wires, fittings and connections, incorrectly seated devices/packages)
 - 7.3 testing that the equipment operates to the circuit specification
 - 7.4 carrying out fault finding techniques (such as half-split,

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

input/output, unit substitution)

Plus **six** more from the following:

- 7.5 protective conductor resistance values
 - 7.6 ac voltage/current levels
 - 7.7 frequency values
 - 7.8 insulation resistance
 - 7.9 logic states
 - 7.10 inductance
 - 7.11 continuity
 - 7.12 clock/timer switching
 - 7.13 RCD disconnection time
 - 7.14 polarity
 - 7.15 oscillations
 - 7.16 modulation/demodulation
 - 7.17 power rating
 - 7.18 attenuation
 - 7.19 amplification
 - 7.20 resistance
 - 7.21 pulse width/rise time
 - 7.22 signal noise/interference levels
 - 7.23 capacitance
 - 7.24 open/short circuit
 - 7.25 dc voltage/current levels
 - 7.26 waveform analysis
8. Produce electrical and electronic circuits which comply with **one** or more of the following standards:
- 8.1 BS 7671/IET wiring regulations
 - 8.2 other BS and/or ISO standards
 - 8.3 company standards and procedures

SEMPEO2-67 - SQA Unit Code F3BK 04

General electrical and electronic engineering applications

Developed by SEMTA

Version number 2

Date approved December 2011

Indicative review date December 2016

Validity Current

Status Original

Originating organisation SEMTA

Original URN 67

Relevant occupations Engineering and manufacturing technologies; Engineering;

Suite Performing Engineering Operations Suite 2

Key words engineering, engineering operations, electrical engineering applications, electronic engineering applications, manufacturing, wiring, termination, electrical components, electronic components, soldering