SEMPEO236

Assembling and testing electronic circuits

Overview

This standard covers a broad range of basic competences you need to assemble and test electronic circuits. 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 activities will include the assembly of a range of electronic components such as resistors (fixed and variable), capacitors (fixed and variable), diodes, transistors and other semiconductor devices, integrated circuits (analogue and digital), miniature transformers, switches, indicators, wire links and a range of connectors, spacers and brackets to form various types of circuits. This will involve using a range of tools and equipment along with soldering techniques and anti-static protection techniques.

The assembly activities will include making all necessary checks and adjustments to the circuits, including continuity checks, voltage, current and resistance values, waveform 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 electronic assembly activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the assembly and wiring 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 electronic assembly, wiring and testing procedures and techniques safely. You will understand the assembly methods and procedures used, and their application, and will know about the various 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 electronic component assembly activities, and with using the associated tools and equipment. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself and others in the workplace.

Specific Standard Requirements

In order to prove your ability to combine different electronic assembly and testing activities, at least one of the electronic assemblies produced must be of a significant nature, and must contain a minimum of **ten** of the components listed in scope 5.

Performance criteria

You must be able to:

1. work safely at all times, complying with health and safety legislation, regulations, directives and other relevant guidelines
2. plan the electronic assembly, wiring and testing activities before you start them
3. use appropriate sources to obtain the required specifications, circuit diagrams, component assembly and test information
4. obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition
5. use the appropriate methods and techniques to assemble the components in their correct positions
6. assemble and secure the components, using the specified connectors, securing devices and soldering techniques
7. wire and terminate cables to the appropriate connections on the circuit boards
8. use appropriate test methods and equipment to check that the completed assembly is safe and meets all aspects of the specification
9. 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
10. leave the work area in a safe and tidy condition on completion of the electronic assembly and testing activities

Knowledge and understanding

You need to know and understand:

1. the specific safety practices and procedures that you need to observe when assembling and testing electronic circuits (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
2. the hazards associated with assembling and testing electronic circuits (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
3. the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
4. the precautions to be taken to prevent electrostatic discharge (ESD) damage to electronic circuits and components (such as use of earthed wrist straps, anti-static mats, special packaging and handling areas)
5. what constitutes a hazardous voltage and how to recognise victims of electric shock
6. how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)
7. how to use and extract information from circuit diagrams, block and schematic diagrams, equipment manuals, data sheets, test procedures and instructions (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
8. the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)
9. 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)
10. 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)
11. the basic principles of operation of the electronic circuits being assembled, and the purpose of the individual modules/components within the circuits
12. the application and use of circuit protection equipment (such as fuses and other overload protection devices)

13. the preparation requirements for components to be used in the assembly (such as pre-forming component pins/legs)
14. methods of mounting and securing electronic components to various surfaces (such as the use of manual soldering techniques, surface mount technologies and mechanical fixing devices, use of heat sinks/shunts)
15. methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)
16. the use of calculations, and regulations, when selecting wires and cables and when carrying out tests on electronic circuits
17. the importance of making visual checks of the completed assembly (such as examination for excessive solder or solder spikes which may allow short circuits to occur, correct orientation of components for pin configuration or polarity, obvious signs of damage (such as heat damage) or strain on terminations)
18. the tools and equipment used in the electronic assembly activities (including the use of cable stripping tools, crimping tools, soldering irons, specialist assembly tools)
19. the importance of ensuring that all tools are in a safe and serviceable condition, are used correctly and are returned to their correct location on completion of the assembly activities
20. the care, handling and application of electronic test and measuring instruments (such as multimeter, oscilloscope, signal generators, stabilised power supplies, logic probes/analyzers, measuring bridges)
21. checking that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); how to check that equipment is within current calibration approval dates and tested
22. checking that the test equipment is suitable for the tests you are to carry out and can cover the range and values you are to measure
23. connecting to an approved power supply and, where appropriate, signal source; identifying correct test points in the circuit; how to position test instruments into circuits without damaging circuit components (such as using test probes, ensuring correct polarity, taking antistatic precautions); setting instrument zero readings; obtaining instrument readings and comparing them with expected results
24. making adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components
25. the fault-finding techniques to be used when the equipment fails to operate correctly (such as half split, unit substitution and input/output)

26. the problems that can occur with the assembling and testing operations, and how these can be overcome
27. when to act on your own initiative and when to seek help and advice from others
28. the importance of leaving the work area in a safe and clean condition on completion of the electronic assembly and testing activities (such as returning hand tools and test equipment to the designated location, cleaning the work area, removing and disposing of waste)

Scope/range related to performance criteria

1.

Carry out **all** of the following during the electronic assembly 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 follow job instructions, assembly drawings and test procedures at all times
1.3 ensure that the components are free from damage, dirt or other contamination
1.4 prepare the electronic components for the assembly operations (such as pre-forming and cleaning pins)
1.5 use safe and approved techniques to mount the electronic components on the circuit boards
1.6 check that the tools and test instruments are within calibration date and are in a safe, tested and usable condition
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 follow clean work area protocols, where appropriate
1.9 return all tools and equipment to the correct location on completion of the assembly activities

2.

Assemble **one** of the following circuit types:

2.1 single-sided circuit
2.2 thick film circuit
2.3 thin film circuit
2.4 flexible circuit
2.5 double-sided circuit
2.6 hybrid circuit

3.

Assemble electronic components using **two** of the following:

3.1 manual soldering techniques
3.2 surface mount techniques
3.3 mechanical fixing methods

4.

Assemble circuits using **four** of the following tools:

4.1 heat shunts/tweezers
4.2 component forming devices
4.3 mechanical fasteners (screwdriver, spanners)
4.4 snipe or long nosed pliers
4.5 wire strippers
4.6 anti-static packaging, mats and straps
4.7 sleeving pliers

4.8 side or end cutters
4.9 specialised assembly tools/equipment

5.

Assemble circuits to the required specification, to include using **fifteen** of the following types of component:

5.1 fixed resistors
5.2 variable resistors
5.3 potentiometers
5.4 encoders or resolvers
5.5 transistors
5.6 inverters or servo controllers
5.7 thyristors
5.8 edge connectors
5.9 thermistors
5.10 light dependant resistors (LDR)
5.11 analogue or digital integrated circuits
5.12 wiring pins/tags/wire links
5.13 fixing spacers
5.14 fixed capacitors
5.15 variable capacitors
5.16 insulators
5.17 surface mount packages
5.18 rectifiers
5.19 small heat sinks
5.20 electrolytic capacitors
5.21 switches
5.22 cables
5.23 diodes
5.24 Zener diodes
5.25 light emitting diodes (LEDs)
5.26 mini transformers
5.27 decoders
5.28 protection devices
5.29 cable connectors
5.30 regulators
5.31 relays
5.32 inductors
5.33 other specific electronic components

6.

Assemble electronic components to produce **five** of the following types of circuit:

6.1 audio amplifiers
6.2 filters
6.3 regulated power supplies
6.4 signal converters
6.5 microprocessor based applications (such as PIC chips)
6.6 logic function controls

6.7 signal generators
6.8 comparators
6.9 display circuits
6.10 counter/timers
6.11 power amplifiers
6.12 ADC and DAC hybrid circuits
6.13 oscillators
6.14 motor control
6.15 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
6.16 digital circuit (such as process control, microprocessor, logic devices, display devices)
6.17 signal processing circuit (such as frequency modulating/ demodulating, amplifiers, filters)
6.18 alarms and protection circuits
6.19 other specific circuit

7.

Carry out visual checks on the completed circuits, to include **all** of the following:

7.1 soldered joints are clean, shiny, free from solder spikes, bridges, holes, excess solder and flux
7.2 components are correctly mounted for best physical support, and are correctly orientated
7.3 excess component leads have been trimmed off to the standard required
7.4 circuit tracks are free from faults (such as lifting, breaks, bridges, hot spots)
7.5 there are no obvious signs of damage, to components or to the substrate
7.6 all required connectors, wire links, spacers and other ancillary items are in place

8.

Use **five** of the following types of test equipment:

8.1 multimeter
8.2 signal generator
8.3 oscilloscope
8.4 signal tracer
8.5 logic probe/clip
8.6 stabilised power supplies
8.7 logic analyser
8.8 measuring bridges
8.9 pulse sequencing analyser
8.10 software diagnostic programs
8.11 counter/timers
8.12 data communications test set
8.13 signature analysers
8.14 bus exerciser/analyser
8.15 protocol analyser

9.

Carry out checks, adjustments and fault rectification where appropriate to the

circuits being assembled, to include **six** of the following:

9.1 logic states
9.2 pulse width/rise time
9.3 inductance
9.4 dc voltage/current levels
9.5 open/short circuit
9.6 frequency modulation/demodulation
9.7 ac voltage/current levels
9.8 resistance
9.9 amplification
9.10 clock/timer switching
9.11 capacitance
9.12 signal noise/interference levels
9.13 oscillations
9.14 waveform analysis
9.15 attenuation

10.

Produce electronic circuits in accordance with **one** of the following:

10.1 BS or ISO standards and procedures
10.2 customer standards and requirements
10.3 company standards and procedures
10.4 other international standards

Behaviours

Additional Information

You will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as:

- strong work ethic
- positive attitude
- team player
- dependability
- responsibility
- honesty
- integrity
- motivation
- commitment

SEMPEO236

Assembling and testing electronic circuits

Developed by	Enginuity
Version Number	3
Date Approved	30 Mar 2017
Indicative Review Date	31 Mar 2020
Validity	Current
Status	Original
Originating Organisation	Semta
Original URN	SEMPEO2-36
Relevant Occupations	Engineering, Engineering and Manufacturing Technologies
Suite	Performing Engineering Operations Suite 2
Keywords	engineering; engineering operations; assembling electronic circuits; testing electronic circuits; manufacturing; electronic components; resistors; capacitors; diodes; transistors