Skills for Employment Investment Program (SEIP)

COMPETENCY-BASED LEARNING MATERIAL

(STUDENT GUIDE)

FOR

ELECTRONICS

(LIGHT ENGINEERING SECTOR)

Finance Division, Ministry of Finance
Government of the People's Republic of Bangladesh

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How to Use this Competency-based Learning Material

Welcome to the competency-based learning material for Electronics for use in light engineering works. These modules contain training materials and activities for learners to complete in order to become competent and qualified as an Electrician.

There are five (5) modules that make up this course which comprises the skills, knowledge and attitudes required to become a skilled worker including:

1. Test electronic components
2. Connect and terminate electrical wiring and circuits
3. Assemble electronic products
4. Service consumer products and systems
5. Service industrial products and systems

As a trainer, you are required to guide the learners through a series of activities in order to complete each learning outcome of the module. These activities may be completed as part of structured classroom activities or they may be required to work at their own pace.

These activities will require the learners to complete associated learning and practice activities in order to gain knowledge and skills they need to achieve the learning outcomes. Refer to **Learning Activity Page of each module** to know the sequence of learning tasks and the appropriate resources to use for each task.

This page will serve as the road map towards the achievement of competence. If you read the **Information Sheets,** these will give you an understanding of the work, and why things are done the way they are. Once the learners have finished reading the Information Sheets, they are required to complete the questions in the **Self-Check Sheets**.

The self-check process follows the Information Sheets in the learning guide. Completing self-checks will help the learners know how they are progressing. To know how they fared with self-checks, they can review the **Answer Key**.

The learners are required to complete all activities as directed in the **Job Sheet**. This is where they will apply their newly acquired knowledge while developing new skills. When working, high emphasis should be laid on safety requirements. The learners should be encouraged to raise relevant queries or ask the facilitator for assistance as required.

When the learners have completed all the tasks required in the learning guide, an assessment event will be scheduled to evaluate if they have achieved competency of the specified learning outcomes and are ready for the next task.

List of Icons

Icon Name	Icon
Module content	
Learning outcomes	
Performance criteria	
Contents	
Assessment criteria	
Resources required	
Information sheet	
Self-check Quiz	
Answer key	
Activity	
Video reference	
Learner job sheet	
Assessment plan	
Review of competency	

Module 1: Test electronic components

MODULE CONTENT

Module Descriptor: This unit covers the skills, knowledge and attitudes required to test electronic components. It specifically includes identifying basic electronic components, determining testing criteria, planning testing approach, and testing components.

Nominal Duration: 40 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee should be able to:

1.1. Identify basic electronic components

1.2. Determine testing criteria

1.3. Plan testing approach

1.4. Test components

PERFORMANCE CRITERIA:

1. Different components are identified and described.
2. Symbols of different components are identified.
3. Different terminals are identified and described.
4. Work instructions are obtained and clarified based on client requirements.
5. Responsible person is consulted for effective and proper work coordination.
6. Data sheets are obtained and interpreted based on manufacturers specifications.
7. Testing criteria is defined to ensure components meet technical and quality requirements.
8. Document and communicate testing criteria to relevant personnel.
9. Testing method is identified based on type of electronic component.
10. Characteristics of testing method to be used are determined.
11. Testing method is selected pursuant to testing strategy.
12. Plan for testing components is developed and documented.
13. Tools and testing devices are prepared and checked as per standard operating procedure.
14. Recording system is established to document testing results, including problems and faults.
15. Component testing is carried out to ensure products meet creative, production and technical requirements.
16. Problems, faults and remedial steps required are documented in records system.
17. Problems and faults are resolved in accordance with standard operating procedure.
18. Products are evaluated against testing criteria.
19. Testing process is reported to relevant personnel.

Learning Outcome 1.1 - Identify Basic Electronic Components

Contents:

- Identify and describe different components
- Identify symbols of different components
- Identify and describe different terminals

Assessment criteria:

- Different components are identified and described.
- Symbols of different components are identified.
- Different terminals are identified and described.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Basic electronic components
- Stationery
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 1.1.1

Learning Activity	Resources/Special Instructions/References
Identify and describe different components	▪ Information Sheet: 1.1.1 ▪ Self-Check Quiz: 1.1.1 ▪ Answer Key: 1.1.1

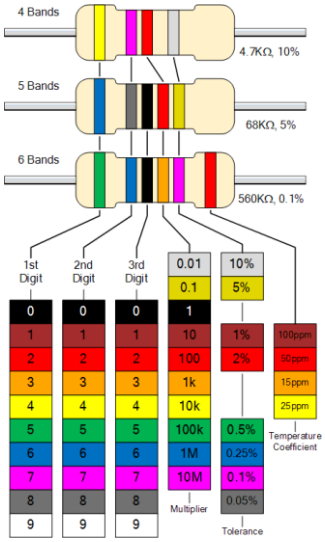
INFORMATION SHEET 1.1.1

Learning Objective: to identify and describe different components.

Resistors: Resistors are the most commonly used components in electronic circuits and devices. The main purpose of a resistor is to maintain specified values of voltage and current in an electronic circuit. A Resistor works on the principle of Ohm's law and the law states that the voltage across the terminals of a resistor is directly proportional to the current flowing through it. The unit of resistance is Ohm. There are different types of resistors available in the market with diverse rating and sizes.

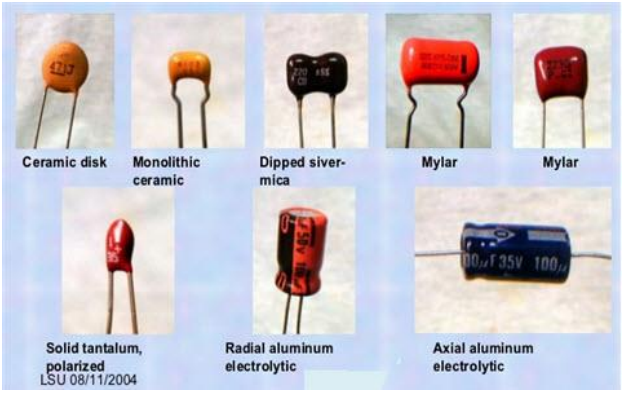
- Wire wound resistors
- Metal film resistors
- Thick film and Thin film resistors
- Network and Surface Mount Resistors
- Variable Resistors
- Special resistors

Types of Resistor



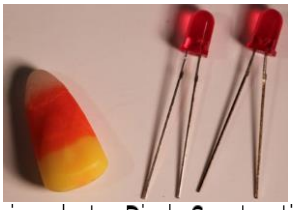
Colour code of Resistor

Capacitors: Next to resistors, capacitors are probably the second most commonly used component in electronic circuits. A *capacitor* is a device that can temporarily store an electric charge.

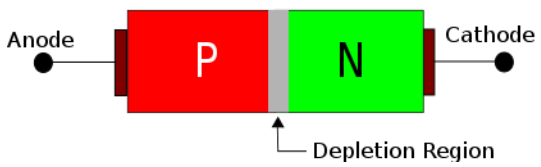


Diodes: A *diode* is a device that lets current flow in only one direction. A diode has two terminals, called the *anode* and the *cathode*. Current will flow through the diode only when positive voltage is applied to the anode and negative voltage to the cathode. If these voltages are reversed, current will not flow.

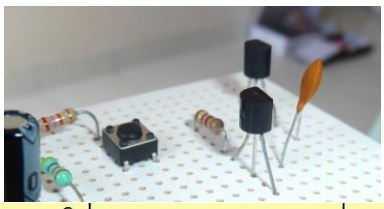
A **diode** is formed by joining two equivalently doped P-Type and N-Type semiconductor. When they are joined an interesting phenomenon takes place. The P-Type semiconductor has excess holes and is of positive charge.

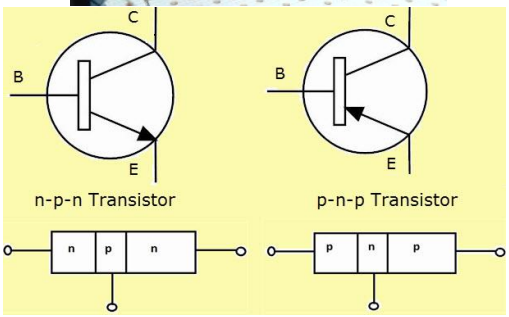


Semiconductor Diode Construction



Transistors: A *transistor* is a three-terminal device in which a voltage applied to one of the terminals (called the *base*) can control current that flows across the other two terminals (called the *collector* and the *emitter*). The transistor is one of the most important devices in electronics.
A transistor is a semiconductor device used to amplify or switch electronic signals and electrical **power**. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit.





Integrated Circuits: An *integrated circuit* is a special component that contains an entire electronic circuit, complete with transistors, diodes, and other elements, all photographically etched onto a tiny piece of silicon. Integrated circuits are the building blocks of modern electronic devices such as computers and cellphones.

SELF-CHECK QUIZ 1.1.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. If the arrow of crystal diode symbol is positive W.R.T. bar, then diode is forward biased.

---------- 2. The forward voltage drop across a silicon diode is about 3.

---------- 3. The number of depletion layers in a transistor is 4.

---------- 4. A transistor is a current operated device.

---------- 5. Formation of a junction between a sample of P-type and N-type material causes rectifying action.

LEARNING ACTIVITY 1.1.2

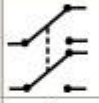
Learning Activity	Resources/Special Instructions/References
Identify symbols of different components	▪ Information Sheet: 1.1.2 ▪ Self-Check Quiz: 1.1.2 ▪ Answer Key: 1.1.2

INFORMATION SHEET 1.1.2

Learning Objective: to identify symbols of different components.

The electronic circuit is defined as it is a combination of various electronic components that allow the flow of electric current. The electronic components consist of two or more terminals that are used to connect one component to another component to design a circuit diagram. The electronic components are soldered on circuit boards to make a system. If you want to focus on core side projects like electronics/ electrical, you should know the basic concepts of electronic circuit symbols and their usage. This article gives an overview of electronic circuit symbols with their functionality.

Electronic circuit diagram components (symbols)

Symbol	Component	Symbol	Component	Symbol	Component
	Joined conductors		Crossing conductors -no connection		Single-Pole-Single-Throw switch (SPST) (normally open)
	Fixed resistor		Diode		Single-Pole-Single-Throw switch (SPST) (normally closed)
	Potentiometer		Light-Emitting Diode (LED)		Single-Pole-Double-Throw switch (SPDT)
	Preset potentiometer		NPN transistor		Double-Pole-Double-Throw switch (DPDT)
	Thermistor		Amplifier		Push-To-Make switch (PTM)
	Light-dependent resistor		Fuse		Push-To-Break switch (PTB)
	Polarised capacitor	 2 pin	Resonator		Dry-reed switch
	Non polarised capacitor	 3 pin			Opto switch
 usually drawn with added detail e.g +9V 0V	Power supply		Primary or secondary cell	 RL	Relay (with double-throw contacts - contact symbol varies with type used)
			Battery (of cells)		

SELF-CHECK QUIZ 1.1.2

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. The image to the right is of a Light Emitting Diode  .

---------- 2. To close and open an electric circuit electrical component use is called extension.

---------- 3. Battery, wire and bulb are parts of a circuit.

---------- 4. The image to the right is of a diode. 

---------- 5. The image to the right is of a capacitor. 

LEARNING ACTIVITY 1.1.3

Learning Activity	Resources/Special Instructions/References
Identify and describe different terminals	▪ Information Sheet: 1.1.3 ▪ Self-Check Quiz: 1.1.3 ▪ Answer Key: 1.1.3

INFORMATION SHEET 1.1.3

Learning Objective: to Identify and describe different terminals.

A terminal is the point at which a conductor from an electrical component, device or network comes to an end and provides a point of connection to external circuits. A terminal may simply be the end of a wire or it may be fitted with a connector or fastener. In network analysis, terminal means a point at which connections can be made to a network in theory and does not necessarily refer to any real physical object. In this context, especially in older documents, it is sometimes called a pole. On circuit diagrams, terminals for external connections are denoted by empty circles. They are distinguished from nodes that are entirely internal to the circuit, which are denoted by solid circles.

The connection may be temporary, as seen in portable equipment, may require a tool for assembly and removal, or may be a permanent electrical joint between two wires or devices.

All electric cells have two terminals. The first is the positive terminal and the second is the negative terminal. The positive terminal looks like a metal cap and the negative terminal looks like a metal disc. The current flows from the positive terminal, and out through the negative terminal, replicative of current flow (positive (+) to negative (-) flow). The basic terminals are: Splices, Cups, Hooks, Solder Lugs, Tongue Crimp terminals (ring terminals), Turrets, Test probes (pogo terminals), Clips, Screw terminals, Tab terminals (quick-connect, quick-disconnect), Wire nuts.

SELF-CHECK QUIZ 1.1.3

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. In photodiodes, an increase in light intensity increases the reverse current.

---------- 2. The maximum peak voltage for tunnel diodes 100 mV.

---------- 3. The p-n junction of a tunnel diode is doped at a level from one hundred to several thousand times that of a typical semiconductor diode.

---------- 4. 7905.2IC is a fixed regulator of 5 V.

---------- 5. Linear regulators are devices with three terminals.

Learning Outcome 1.2 - Determine Testing Criteria

Contents:

- Work instructions are obtained and clarified based on client requirements
- Data sheets are obtained and interpreted based on manufacturers specifications
- Testing criteria is defined to ensure components meet technical and quality requirements

Assessment criteria:

- Obtain and clarify work instructions based on client requirements.
- Obtain and interpret data sheets based on manufacturers specifications.
- Define testing criteria to ensure components meet technical and quality requirements.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material.
- Stationery
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 1.2.1

Learning Activity	Resources/Special Instructions/References
Obtain and clarify work instructions based on client requirements	▪ Information Sheet: 1.2.1 ▪ Self-Check Quiz: 1.2.1 ▪ Answer Key1.2.1

INFORMATION SHEET 1.2.1

Learning Objective: to obtain and clarify work instructions based on client requirements.

Working electronic components are crucial to operating virtually any electronic device. Components such as resistors, capacitors and transistors create circuits that allow TVs, stereos, cell phones and laptops to

work properly. Each component has a specific role in a circuit. Resistors limit current. Capacitors store charge. Transistors amplify an electrical signal.

Repairing an electronic device begins with testing these electronic components through a multimeter. Multimeters can measure resistance and voltage. They can test devices powered by either AC or DC voltages and work in or out of circuit. Multimeters are simple to use because of their readable display and multitude of measuring functions. A handheld multimeter is low cost, easy to use and gives accurate readings. Using one to test your electronic components lets you determine if they need to be repaired or replaced.

When using a multimeter to check electrical components, following these steps to obtain an accurate reading:

- Switch on the multimeter. Turn the knob to the resistance setting marked by the symbol for the Greek letter Omega. Your knob setting should match the resistor value. If the value is unknown, start with the lowest setting and increase in gradual increments as you test the resistor.
- Place a multimeter probe on each resistor lead. Record the resistance. Switch probes and note the resistance again.
- Place the multimeter probes on other components leads. This can include diodes, capacitors and photocells. Measure the resistance using the same method as with the resistor. Photocells should be tested twice – near a light source and far away from that same light source.
- Expect varying resistance measurements for certain electrical components. With diodes, you will experience a small amount of resistance only when the probes are placed one way but not the other. Capacitor resistance, on the other hand, should be almost limitless or else it is damaged.

SELF-CHECK QUIZ 1.2.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. In case of Prototyping capacitor, if positive terminal is connected with negative of supply and negative terminal is connected with positive of supply. The capacitor will be damaged.

---------- 2. An electronic component which can process the signal s are called passive component.

---------- 3. While checking a capacitor with a multimeter, if the pointer deflects and remain there that means the capacitor is short.

---------- 4. Conventional current is in the opposite direction to a flow of electrons.

---------- 5. Inductor is a passive component.

LEARNING ACTIVITY 1.2.2

Learning Activity	Resources/Special Instructions/References
Data sheets are obtained and interpreted based on manufacturers specifications	▪ Information Sheet: 1.2.2 ▪ Self-Check Quiz: 1.2.2 ▪ Answer Key: 1.2.2

INFORMATION SHEET 1.2.2

Learning Objective: to obtain and interpret data sheets are based on manufacturers specifications.

Design the electronic circuitry to ensure an adjustment range from normal adjustment settings of variable components. Provide a range of adjustment to compensate for composite variations in the associated circuitry due to changes in part values during the normal or specified life of the device. Ensure the range of adjustment can compensate for variations in replacement parts within the specified tolerances. Derate electronic components by 20% with regard to ambient temperature, applied voltage, and power dissipation. Mark the circuit reference symbol next to the component

Capacitors: Provide industrial grade capacitors. Insulate the capacitors. Mark capacitors with their capacitance value, working voltage, and polarity. Provide capacitor encasements resistant to cracking, peeling, and discoloration due to humidity and changes in temperature. Provide electrolytic capacitors capable of operating at least 185°F. Do not use electrolytic capacitors of less than 1.0 microfarad.

Diodes: If low forward drop is required in logic circuit applications, furnish justification for use of Germanium diodes prior to incorporation in the design. Mark diodes with the JEDEC part number, using an industry approved colour code or clearly legible printing. Indicate the diode polarity on the diode case by the use of the diode symbol, by the 360° band on the cathode end, or by the shape of case

Indicators: Use solid-state (LED) indicators with a useful life at least 25,000hr.

Integrated Circuits: Print the manufacturer's part number and any information required to install the integrated circuit assembly upon the package.

Potentiometers and Rheostats: Use industrial grade potentiometers. Use potentiometers with a power rating at least 100% greater than the maximum power requirements of the circuit.

Relays: Install diodes across the coils for transient suppression in DC relays. Provide replaceable relays that do not require special tools for replacement.

Resistors: Use fixed composition insulated resistors in accordance with the performance requirements of MIL-R-11.Provide industrial grade resistors with a 15-yr. design life. Mark with their resistance value, using EIA colour codes or industry approved marking technique. Use resistors with a 10% tolerance or better and a resistance variation of no more than 5% over the temperature range 0°F to 165°F. Do not use resistors with a power rating greater than 2Wunless special ventilation or heat sinking is provided. Insulate these resistors from the printed circuit board.

Transistors: Use JEDEC registered transistors. Mark the JEDEC part number on the case. Designate the emitter or collector by use of an industry approved marking technique.

Transformers: Mark transformers with the manufacturer's part number on the case or frame, using a Radio-Electronics-Television Manufacturers Association (RETMA) colour code or numbered in a manner to facilitate proper installation.

SELF-CHECK QUIZ 1.2.2

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. For 180 K ohm Resistor with 10% tolerance, the colour band will be in the sequence of brown-grey-yellow-silver.

---------- 2. The rating of an Electrolytic capacitor is measured in Farads.

---------- 3. In Electronics the term IC denotes integrated circuit.

---------- 4. Integrated circuits that are three terminal devices and provide a fixed output voltage has series 78XX.

---------- 5. LM317IC can provide a load current to load which is over 1.5 A.

LEARNING ACTIVITY 1.2.3

Learning Activity	Resources/Special Instructions/References
Define testing criteria to ensure components meet technical and quality requirements	▪ Information Sheet: 1.2.3 ▪ Self-Check Quiz: 1.2.3 ▪ Answer Key: 1.2.3

INFORMATION SHEET 1.2.3

Learning Objective: to define testing criteria to ensure components meet technical and quality requirements.

It is essential that an electronic component passes the testing stage if it is to be made for mass production. Using a system ensures that technical errors can be found and determines whether it meets quality compliance which reduces a customer's risk of bringing a new product to market.

The user friendliness and reliability of a product usually depends upon how well the product was tested after the design stage. Quality testing professionals ensure that standards are met from the processing stage right through to the final release, ensuring that any defects are found as early as possible and any problems are solved. The process involves analysing input data, then compiling test results and recommending changes to the product developers.

- Development tests – Quality testing can be performed before a product goes to market.
- Software tests – This testing can ensure standards are met with error free operation, user friendliness and stability.
- Prototype tests – This platform testing verifies stated specifications, evaluates workmanship quality and identifies any problems that could cause serious consequence after they go to market.
- Production tests – Experts can develop tests to evaluate the level of quality control on the manufacturing floor. This includes manual and automated tests to determine the product's functionality.
- AGW test nearly all manufactured products using a 100% sample size.
- Quality Testing - All test procedures are reviewed prior to their use by the Company as part of the Quality assurance system.

Testing also involves any inspections of outbound products leaving the factory. This will prevent any products leaving the factory which are defected and stop them from reaching the hands of the consumer.

SELF-CHECK QUIZ 1.2.3

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. A systematic process of isolating, identifying and correcting a fault in a circuit or system is called troubleshooting.

---------- 2. An electronic device that represents information in visual form generator.

---------- 3. A type of four terminal thyristor that has two gate terminals that are used to trigger device ON and OFF is SCS.

---------- 4. An electronic device that generates a series of beeps when person carrying it is being paged is called generator.

---------- 5. A circuit using diodes and capacitors that increases input voltage by two, three or four times is voltage multiplier.

Learning Outcome 1.3 - Plan Testing Approach

Contents:

- Define testing method based on type of electronic component
- Prepare and check tools and testing devices as per standard operating procedure
- Establish recording system to document testing results, including problems and faults

Assessment criteria:

- Testing method is identified based on type of electronic component.
- Tools and testing devices are prepared and checked as per standard operating procedure.
- Recording system is established to document testing results, including problems and faults.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material.
- Tools and equipment
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 1.3.1

Learning Activity	Resources/Special Instructions/References
Define testing method based on type of electronic component	▪ Information Sheet: 1.3.1 ▪ Self-Check Quiz: 1.3.1 ▪ Answer Key: 1.3.1

INFORMATION SHEET 1.3.1

Learning Objective: To define testing method based on type of electronic component.

A method of judging whether an electronic component is good or defective in accordance with a response output signal by inputting a test signal to the IC to be tested, wherein a common test signal is input to

respective electronic devices A1 and A2 of a group of electronic devices composed of a plurality of electronic devices, and in accordance with a response signal thereof, the group of electronic devices as a whole subjected to the test is judged to be good or defective.

SELF-CHECK QUIZ 1.3.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

1. ---------- The determination of a digital signal's frequency and wave shape is best accomplished with an oscilloscope.
2. ---------- Recheck the power source is the next step after discovering a faulty gate within an IC.
3. ---------- A +5 V PCB power source that has been "pulled down" to a +3.4 V level may be due to circuit short.
4. ---------- The use of a multimeter with digital circuits allows the measurement of pulse width.
5. ---------- A multi-trace oscilloscope test equipment best allows a comparison between input and output signals.

LEARNING ACTIVITY 1.3.2

Learning Activity	Resources/Special Instructions/References
Prepare and check tools and testing devices as per standard operating procedure	▪ Information Sheet: 1.3.2 ▪ Self-Check Quiz: 1.3.2 ▪ Answer Key: 1.3.2

INFORMATION SHEET 1.3.2

Learning Objective: to prepare and check tools and testing devices as per standard operating procedure.

The testing equipment used to detect faults in the operation of electronic devices by creating stimulus signals and capture responses from electronic devices under test is known as electronic test equipment. If any faults are detected, then identified faults can be traced a rectified using electronic testing equipment. Most often all electrical and electronic circuits are tested and troubleshooted to detect faults or abnormal functioning if any.

Voltmeter: A basic electronics device or instrument used to measure voltage or electrical potential difference between two points in electrical circuits is known as voltmeter. There are two types of voltmeters: analog and digital. An analog voltmeter moves a pointer across a scale in proportional to the voltage of the electrical circuit. A digital voltmeter measures an unknown input voltage by converting the voltage to a digital value by using a converter and then displays the voltage in numeric form.

Ohmmeter: An electrical instrument that measures electrical resistance is known as an ohmmeter. The instrument used to measure small value of resistance are micro-ohmmeters. Similarly, meg-ohmmeters is used to make large resistance measurements. Resistance values are measured in ohms (Ω). Originally, ohmmeter is designed with a small battery to apply a voltage to a resistance.

Ammeter: A measuring instrument which is used to measure the electric current in a circuit is known as an ammeter. The units of measurement for electric current is amperes (A) Earlier ammeters were laboratory instruments which depend on the earth's magnetic field for operation. In an era of the 19th

century, improved instruments were designed which could be placed in any position and allows accurate measurements in electric power systems.

Multimeter: A multimeter is an electronic instrument used to measure the three basic electrical characteristics: voltage, current and resistance. It has multiple functions and acts like ohmmeter, voltmeter and ammeter and also used for household wiring, electric motors, testing batteries and power supplies. The multimeter is a handheld device with a needle over a numeric LCD digital display for indication purpose. It is also used to test continuity between two points in an electrical circuit. There are three types of multimeters made available in the market such as: digital multimeter, analog multimeter and fluke multimeter.

Voltmeter

Ohmmeter

Ammeter

Multimeter

SELF-CHECK QUIZ 1.3.2

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. To increase the current sensitivity below 10 mV, electronic instrument uses amplifiers.

---------- 2. In potentiometric type DVM, the adjustment of sliding contact is done by A single phase servomotor.

---------- 3. Electronic voltmeters can be designed to measure both very small and very high voltages.

---------- 4. In the beginning, all the outputs of the successive approximation type register are at Toggling

---------- 5. In electronic voltmeter, the range of input voltages can be extended by using input attenuator.

LEARNING ACTIVITY 1.3.3

Learning Activity	Resources/Special Instructions/References
Establish recording system to document testing results, including problems and faults	▪ Information Sheet: 1.3.3 ▪ Self-Check Quiz: 1.3.3 ▪ Answer Key: 1.3.3

INFORMATION SHEET 1.3.3

Learning Objective: to establish recording system to document testing results, including problems and faults.

For those who are not too familiar with what metadata is, a commonly used analogy is that of a library catalog card, which contains high level information about a book, including, its author, title, subject, etc. The purpose of the catalog card is to make it easier for a person to find a specific book stored within the library's entire collection.

Likewise, the main purpose of metadata is to facilitate in the discovery of relevant information. In some cases, metadata may also be used to provide supplementary information about the data, such as:

- To capture audit trail information about the electronic record
- To classify the electronic record and facilitate navigation
- As a parameter within an automated business process
- To provide business intelligence metrics

In order to determine the specific regulatory impact, the first thing we need to do is identify the electronic records that are being managed within a given computerized system. In some cases, the electronic records may be in the form of discreet data elements, such as test results from an HPLC laboratory instrument. In other cases, the records may be in the form of documents, stored within an Electronic Document Management System (EDMS).

A Standard Operating Procedure (SOP) is stored as a PDF document within an EDMS and is used in the context of regulated activities. Metadata is used to describe key attributes of the document, including its Title, Document Type, Effective Date, Department, etc. Metadata is also used to capture audit trail information and to automatically provide users with access to the record based on the department to which they belong.

Should the metadata on the document not accurately reflect the SOP's information, the system could mistakenly provide users with access to the incorrect SOP, or the record's audit trail information could be inaccurate. In this example, the metadata plays a crucial role in a regulated process and therefore poses a regulatory risk.

SELF-CHECK QUIZ 1.3.3

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. The use of triggered sweep when using an oscilloscope provides more accuracy in timing.

---------- 2. Key components of spatial data quality include temporal accuracy.

---------- 3. Current tracer device would best aid in shorted track detection.

---------- 4. Interpolation is made possible by a principle called spatial auto-correction.

---------- 5. Metadata is data about data.

Learning Outcome 1.4 - Test Components

Contents:

- Problems, faults and remedial steps required are documented in records system
- Problems and faults are resolved in accordance with standard operating procedure

Assessment criteria:

- Document problems, faults and remedial steps required in records system.
- Resolve problems and faults in accordance with standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 1.4.1

Learning Activity	Resources/Special Instructions/References
Document problems, faults and remedial steps required in records system	▪ Information Sheet: 1.4.1 ▪ Self-Check Quiz: 1.4.1 ▪ Answer Key: 1.4.1

INFORMATION SHEET 1.4.1

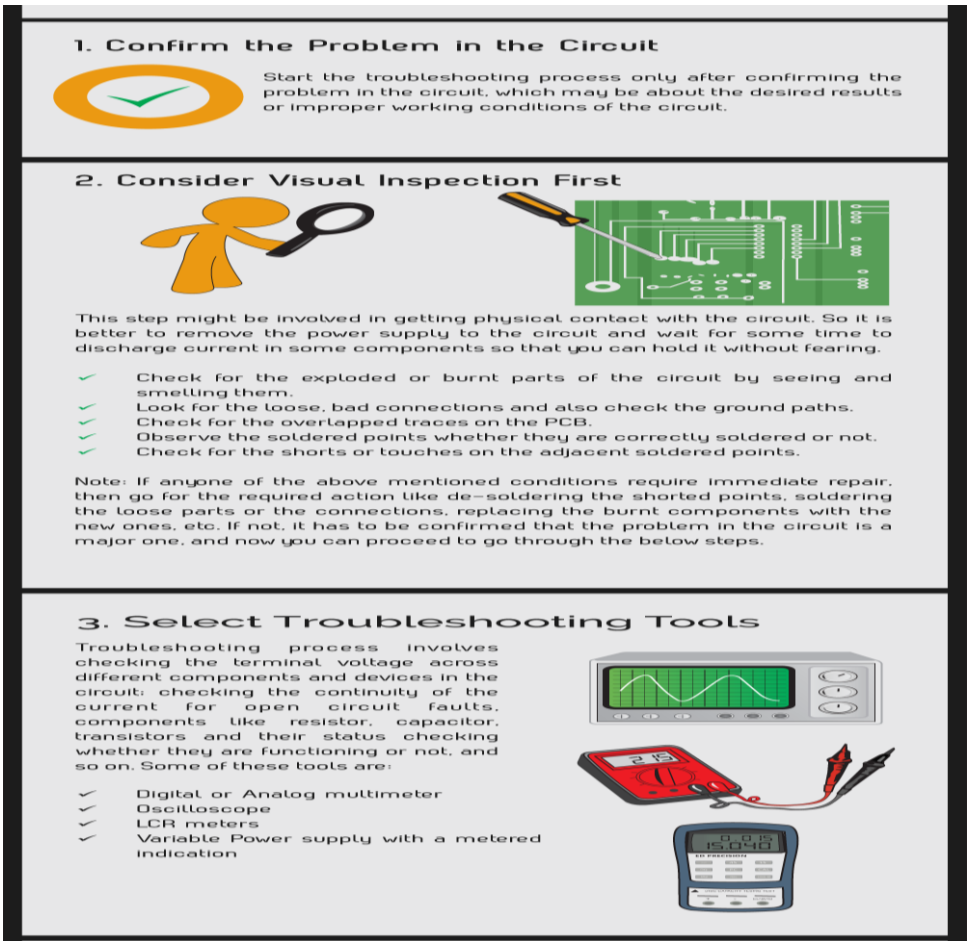
Learning Objective: to document problems, faults and remedial steps required in records system.

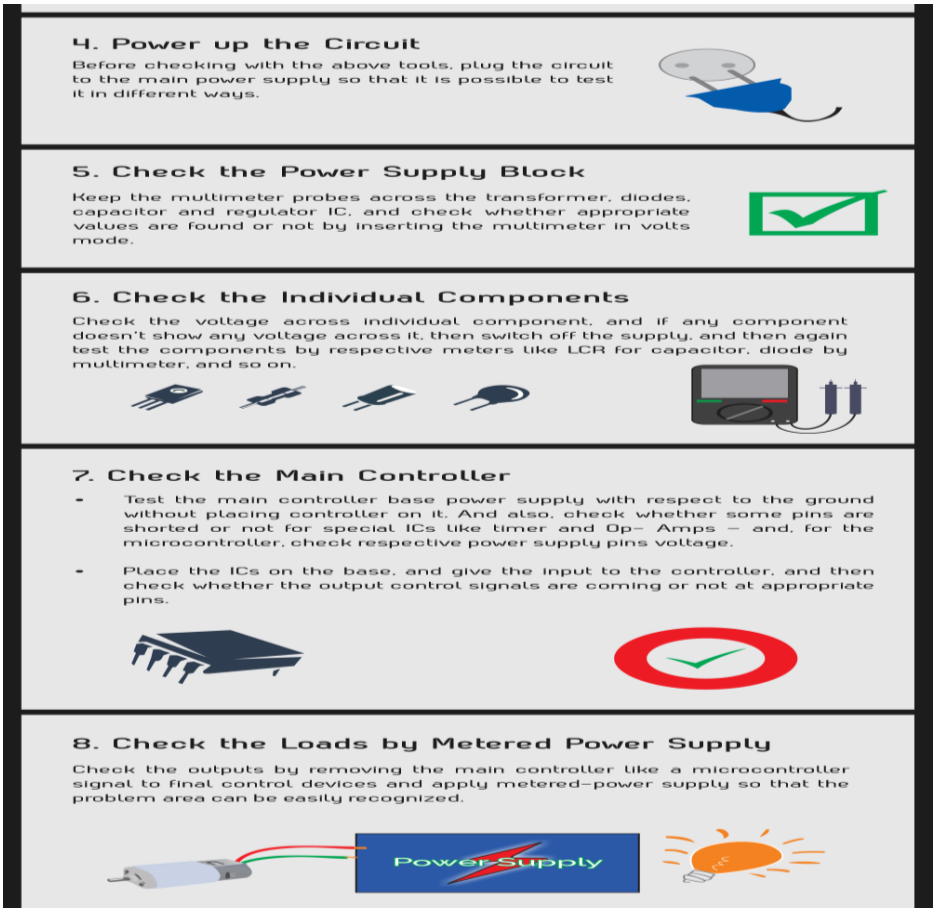
Troubleshooting of an electronic circuit is a process of having a special outlook on components that comes out with remedies to repair it. The unexpected behaviour exhibited by the circuit is due to improper

locating or soldering of components, component damage due to aging, faults, overheat, and so on. Such a type of behaviour can cause undesired results or even circuit damage.

Therefore, these unexpected results of the electronic circuit may require some troubleshooting and testing procedures for making it a ready to use project. It is very common for the hobbyists and circuit designing learners to anticipate the desired or actual results after completion of the circuit at once. The best way to become proficient in troubleshooting even to tackle difficult electronic problems is decided by hands-on experience with the electronic circuits.

Troubleshooting is the process that determines the cause of the problem in the electronic circuit by examining the affected area of it, and then by taking appropriate action. For minor problems, troubleshooting requires a little knowledge about the circuit and its components' working because it involves checking the connections only. However, the major problems of these circuits require deeper knowledge of the circuit operation and the way of using various troubleshooting tools.





SELF-CHECK QUIZ 1.4.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. In case of short circuit infinite current will flow in the circuit**.**

---------- 2. Rheostat is a three-terminal resistor with one or more sliding contacts which functions as an adjustable voltage divider.

---------- 3. During the reverse biased of the diode, the back resistance decreases with the increase of the temperature.

---------- 4. Diffusion production method to prevent unwanted interaction between elements within chip.

---------- 5. The insulating medium between the two plates of capacitor is known as Dielectric.

LEARNING ACTIVITY 1.4.2

Learning Activity	Resources/Special Instructions/References
Resolve problems and faults in accordance with standard operating procedure	▪ Information Sheet: 1.4.2 ▪ Self-Check Quiz: 1.4.2 ▪ Job Sheet 1 ▪ Answer Key: 1.4.2

INFORMATION SHEET 1.4.2

Learning Objective: to prepare and check tools and testing devices as per standard operating procedure.

Power check: This is the first thing you should do. It is amazing how many times a simple issue such as a blown fuse, or a flat battery is the cause of the circuit malfunction. So initially, ensure that the power cord is plugged in and that the fuses are not blown. If the circuit is powered from batteries, make sure that their voltage level is acceptable. If a power supply rectifier is present, check the level of the voltage at the output and make sure that the circuit is powered with the correct polarity.

Visual inspection: This inspection is part of the sensory checks. Sensory checks rely on your senses to detect a possible fault. The visual inspection of the PCB is the simplest troubleshooting technique (which is very effective in half of the cases). The soldered joints have to be inspected thoroughly. If any doubt exists about the quality of a certain joint, it has to be re-soldered. The PCB has to be inspected visually for any burnt components. Sometimes, components that overheat leave a brownish mark on the board. They can be used as "starting points" in the troubleshooting process and the reasons why they overheat have to be determined. It is bad practice simply to replace such components, without trying to find out what actually caused the component to overheat. In many cases the reason is a faulty (or out of range) component in the vicinity of the failed component. It also has to be replaced.

Using a sense of touch: This is another sensory check. Overheated components can be detected by simply touching them. However, this check has to be performed with extreme caution. The circuit has to be turned off, and some time allowed for the biggest capacitors to discharge. Always touch the components with your *right* hand only! This is important because in the case of electric shock it is less likely that the current will pass through your heart. If possible, wear insulated shoes. In addition, care should be taken not to burn your fingers. Using the sense of touch is a very useful troubleshooting technique in circuits, where everything seems to work properly for a while, and then the circuit fails, due to overheating of a certain component. Identifying such components helps to detect the possible cause of the fault. Special freezing sprays are available, which allow instant freezing of components. If the circuit begins to operate properly immediately after the heated component is sprayed, this is an indication that this component is causing the circuit failure. Before replacing the component, further investigation is needed to determine what caused the overheating in the first place.

Smell check: When certain components fail due to overheating it is possible in most cases to detect a smell of smoke. This is usually the case, if the technician happens to be there at the time the accident occurred. If not, it is usually possible to detect the failed component by visual inspection afterwards.

Component replacement: This troubleshooting method relies mostly on the operator's skills and experience. Certain symptoms are an obvious indication of a particular component failure. This statement is especially true for an experienced electronic technician. For example, some TV service technicians can unmistakably identify the failed component in a TV set (even before opening it), by just briefly examining the symptoms. Component replacement is a good troubleshooting technique for an experienced electronics technician, as it saves a lot of time and money. Moreover, this technique guarantees the success of the repair, because if enough components are replaced, eventually the faulty one will be replaced too. However, it is recommended that the amateur technician initially applies some logical thinking to the troubleshooting process.

Signal tracing: This troubleshooting technique is not the most common one, but it is the most desirable as it requires intelligent and logical thinking from the troubleshooter. This method is based on the measuring of the signal at various test points along the circuit. A test point in the circuit is the point, where the value of the voltage is known to the operator. This troubleshooting technique relies on finding a point, where the signal becomes incorrect. Thus, the operator knows that the problem exists in that portion of the circuit, between the point where the signal becomes incorrect, and the point where the signal appeared correct for the last time. In other words, the operator constantly narrows the searched portion of the circuit, until he finds what causes the fault. There are two basic approaches in conducting the signal tracing. In the first approach, the signal check starts from the input, checking consecutively the test points towards the output. The checks are carried out, until a point, with an incorrect signal is found. The second approach is to start from the output and to work backwards towards the input in the same manner until a correct signal appears.

SELF-CHECK QUIZ 1.4.2

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. 15% of fault occur in the power system is line to line fault.

---------- 2. Double line to ground fault is the most commonly occurring fault.

---------- 3. The positive sequence current is always equal to negative sequence current.

---------- 4. Single line to ground fault results into a three phase faults.

---------- 5. Voltage at the fault point does the magnitude of the fault current depend.

JOB SHEET 1	
Job Title:	Assemble Electronic Components on Bread Board, DC power supply
Personal protective equipment:	Gloves, dust mask, safety shoes, hard hat, belt/body harness, goggles, working clothes, apron
Tools and equipment:	Pliers, Screwdrivers, Wrenches, Hand drills, Hack saw, Files, Tin snip, Hammer, Variable DC power supply, Digital VOM, Analogue VOM, Dual trace triggered oscilloscope, Function generator
Materials:	▪ Step down transformer ▪ Rectifier diode (4007) ▪ Capacitor (1000µF/25) ▪ Some wire ▪ IC (7805) ▪ Copper clade board
Procedure:	1. Collect required tools and materials required for the task. 2. Study the given electronic circuit. 3. Study the Bread Board internal connections. 4. As per circuit diagram (which will be given to you by your assessor), assemble the components on the bread board. 5. Check all the connections. 6. Clean tools, equipment, machinery and work area. 7. Dispose of waste materials and excess materials.

ANSWER KEYS

ANSWER KEY: 1.1.1

1. TRUE
2. FALSE
3. TRUE
4. TRUE
5. TRUE

ANSWER KEY: 1.1.2

1. TRUE
2. FALSE
3. TRUE
4. TRUE
5. TRUE

ANSWER KEY: 1.1.3

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.2.1

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.2.2

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.2.3

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.3.1

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.3.2

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.3.3

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.4.1

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 1.4.2

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

Module 2: Connect and terminate electrical wiring and circuits

MODULE CONTENT

Module Descriptor: This unit covers the skills, knowledge and attitudes required to connect and terminate electrical wiring and circuits. It specifically includes identifying measuring devices and accessories, preparing for connection and termination, performing connection and termination, carrying out soldering, and testing connection and termination of electrical wiring and circuits.

Nominal Duration: 40 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee should be able to:

2.1. Identify measuring devices and accessories

2.2. Prepare for connection and termination

2.3. Perform connection and termination

2.4. Carry out soldering

2.5. Test connection and termination

PERFORMANCE CRITERIA:

1. Measuring devices and accessories are identified.
2. Measuring devices and accessories are collected and checked.
3. Materials are checked according to job specification.
4. Appropriate tools and equipment are selected as per job requirement.
5. Job requirement is planned as per standard operating procedure.
6. Electrical wiring and electronic circuits are prepared for connection/termination as per job requirement.
7. Appropriate ranges of methods in connection/termination are employed as per job and manufacturers specification.
8. Correct sequence of operation is followed according to job specification and standard operating procedure.
9. Accessories are adjusted as per job specification, if necessary.
10. Confirmation of connection/termination is undertaken to ensure quality completion of job as per job specification.
11. Components are mounted and soldered in accordance with soldering principles.
12. Soldered components are checked to ensure compliance with international standards and job requirement.
13. Testing of completed connections/terminations is carried out to ensure compliance.
14. Wiring and circuits are checked using specified testing procedures.

15. Unplanned events or conditions are responded to in accordance with standard operating procedure.

Learning Outcome 2.1 - Identify Measuring Devices and Accessories

Contents:

- Identify measuring devices and accessories

Assessment criteria:

- Measuring devices and accessories are identified.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment (measuring)
- Accessories
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 2.1.1

Learning Activity	Resources/Special Instructions/References
Identify measuring devices and accessories	▪ Information Sheet: 2.1.1 ▪ Self-Check Quiz: 2.1.1 ▪ Answer Key: 2.1.1

INFORMATION SHEET 2.1.1

Learning Objective: to identify measuring devices and accessories.

Ammeter:	Measures current
Capacitance meter:	Measures the capacitance of a component
Curve tracer:	Applies swept signals to a device and allows display of the response
Electricity meter:	Measures the amount of energy dissipated
LCR meter:	Measures the inductance, capacitance and resistance of a component

Microwave power meter:	Measures power at microwave frequencies
Multimeter:	General purpose instrument measures voltage, current and resistance
Network analyser;	Measures network parameters
Ohmmeter:	Measures the resistance of a component
Oscilloscope:	Displays waveform of a signal, allows measurement of frequency, timing, peak excursion,
Signal analyser:	Measures both the amplitude and the modulation of a RF signal
Signal generator:	Generates signals for testing purposes
Spectrum analyser:	Displays frequency spectrum
Wattmeter:	Measures the power
Voltmeter:	Measures the potential difference between two points in a circuit

SELF-CHECK QUIZ 2.1.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. Resistances can be measured with the help of an ohmmeter and resistance bridge.

---------- 2. Indicating instruments measure the total quantity of electricity delivered at a specific time.

---------- 3. Ampere-hour and Watt-hour meters are integrating instruments.

---------- 4. The switchboard instruments should be mounted in horizontal position**.**

---------- 5. A moving-coil permanent-magnet instrument can be used as ammeter by using a low resistance shunt.

Learning Outcome 2.2 - Prepare for Connection and Termination

Contents:

- Check materials according to job specification
- Select appropriate tools and equipment as per job requirement
- Prepare electrical wiring and electronic circuits for connection/termination as per job requirement

Assessment criteria:

- Materials are checked according to job specification.
- Appropriate tools and equipment are selected as per job requirement.
- Electrical wiring and electronic circuits are prepared for connection/termination as per job requirement.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 2.2.1

Learning Activity	Resources/Special Instructions/References
Check materials according to job specification	▪ Information Sheet: 2.2.1 ▪ Self-Check Quiz: 2.2.1 ▪ Answer Key: 2.2.1

INFORMATION SHEET 2.2.1

Learning Objective: to check materials according to job specification.

Understanding Wire Sizing: The proper wire size is critical to any electrical wire installation. Wire sizing indicates the diameter of the metal conductor of the wire and is based on the American Wire Gauge (AWG) system. The gauge of a wire relates to the wire's current-carrying capacity, or how much amperage the wire can safely handle. When choosing the right size of wire, you must consider the gauge of the wire, the wire capacity, and what the wire will be used for.

Non-Metallic (NM) Sheathed Cable: Most interior wiring is done with non-metallic, or NM, cable—also known by the popular brand name "Romex." NM cable is made of three or more wires wrapped inside a flexible plastic jacket, or sheathing. It is used for most interior circuits, such as those for outlets, switches, light fixtures, and appliances. Learn the basics of NM cable to choose the right type for your next electrical project.

Electrical Wire Color Coding: Color-coding is used both on the outer sheathing of bundled electrical cables, and also on the individual conduction wires within cables or inside conduit. Understanding this color coding can help you identify what the wiring is used for and helps maintain consistency within an electrical system.

Cable coloring relates to the size of the wires inside the cable and the cable's amperage rating. For example, white-sheathed NM cable is used for 15-amp circuits, while yellow NM cable is rated for 20-amp circuits.

The coloring on individual conducting wires usually does not indicate a size or rating but rather the standard or preferred use of the wire. For example, black and red wires typically are used for current-carrying, or "hot" connections, and white wires usually are grounded "neutral" conductors. Green-insulated wires, and bare copper wires, are used for grounding wires.

Understanding Electrical Wiring Labeling: Electrical wires and cable have markings stamped or printed on their insulation or outer sheathing. These markings provide important information about the wiring and insulation, including the wire size and material, the type of insulation, the number of wires contained (inside a cable), and any special ratings or characteristics of the wire.

While looking at the color of wire or cable will help you narrow down the options at the store, reading and understanding the labels on wiring is the best way to ensure you get the properly rated material for your project.

Direct Burial Cable: Standard electrical cable is designed to be run indoors, where it stays dry and is protected by wall, ceiling, or floor structures. For outdoor projects or when running wiring underground, you must use *direct burial cable*, which can be installed underground with or without conduit (depending on local building code rules). With direct burial cable, the individual conducting wires are embedded in solid vinyl to fully protect them from moisture.

SELF-CHECK QUIZ 2.2.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. Three core cores are used in a cable for the transmission of voltages up to 6 kV.

---------- 2. The cable best suited for the transmission of voltages from 33 kV to 66 kV is pressure cables.

---------- 3. Belted cables are generally suited for the voltages up to 11 kV.

---------- 4. Skin effect dominates is not preferred for the voltages exceeding 66 kV.

---------- 5. Non-magnetic and conducting material is suitable for the manufacture of armour in a single core cable.

LEARNING ACTIVITY 2.2.2

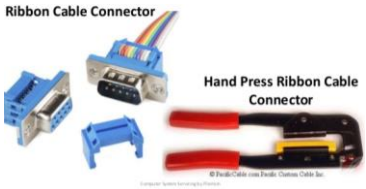
Learning Activity	Resources/Special Instructions/References
Select appropriate tools and equipment as per job requirement	▪ Information Sheet: 2.2.2 ▪ Self-Check Quiz: 2.2.2 ▪ Answer Key: 2.2.2

INFORMATION SHEET 2.2.2

Learning Objective: to select appropriate tools and equipment as per job requirement.

A **soldering gun** is an approximately pistol-shaped, electrically powered tool for soldering metals using tin-based solder to achieve a strong mechanical bond with good electrical contact. The tool has a trigger-style switch so it can be easily operated with one hand. The body of the tool contains a transformer with a primary winding connected to mains electricity when the trigger is pressed, and a single-turn secondary winding of thick copper with very low resistance. A soldering tip, made of a loop of thinner copper wire, is secured to the end of the transformer secondary by screws, completing the secondary circuit. When the primary of the transformer is energized, several hundred amperes of current flow through the secondary and very rapidly heat the copper tip. Since the tip has a much higher resistance than the rest of the tubular copper winding, the tip gets very hot while the remainder of the secondary warms much less. A tap on the primary winding is often used to power a pilot lamp which illuminates the workpiece.

The main point of ribbon cables is to allow mass termination to specially designed IDC connectors in which the ribbon cable is forced onto a row of sharp forked contacts (the phrase "IDC connector" is widely used, even though it is redundant - an example of RAS syndrome).



The crimping tool is used for non-welding and standard electrical connection. The mould of the crimping dies is made of hardened tool steel. Crimper is lightweight and easy to carry.

A desoldering pump, colloquially known as a *solder* sucker, is a manually-operated device which is used to remove solder from a printed circuit board. There are two types: the plunger style and bulb style (an electrically-operated pump for this purpose would usually be called a vacuum pump).

SELF-CHECK QUIZ 2.2.2

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. Soldering iron is made of wedge shape in order to retain heat.

---------- 2. The commonly used flux for brazing is resin.

---------- 3. A soldering iron 'bit' is made of brass.

---------- 4. A braze joint may be satisfactorily used on components made of brass.

---------- 5. Heat for soldering process is supplied by electric resistance method.

LEARNING ACTIVITY 2.2.3

Learning Activity	Resources/Special Instructions/References
Prepare electrical wiring and electronic circuits for connection/termination as per job requirement	▪ Information Sheet: 2.2.3 ▪ Self-Check Quiz: 2.2.3 ▪ Answer Key: 2.2.3

INFORMATION SHEET 2.2.3

Learning Objective: to prepare electrical wiring and electronic circuits for connection/termination as per job requirement.

Steps in building the circuit

1. Decide the regulator to be used and its input voltage: Here our requirement is to have a constant voltage of 5V at 20mA with positive polarity of the output voltage. For this reason, we need a regulator which would provide a 5V output. An ideal and efficient choice would be the regulator IC LM7805. Our next requirement is to calculate the input voltage requirement for the regulator. For a regulator, the minimum input voltage should be the output voltage added by a value of three. In that case, here to have a voltage of 5V, we need a minimum input voltage of 8V. Let us settle down for an input of 12V.
2. Decide the transformer to be used: Now the unregulated voltage produced is a voltage of 12V. This is the RMS value of the secondary voltage required for a transformer. Since the primary voltage is 230V RMS, on calculating the turns ratio, we get a value of 19. Hence we have to get a transformer with 230V/12V , i.e. a 12V, 20mA transformer.
3. Decide the value of the filter capacitor: The value of the filter capacitor depends on the amount of current drawn by the load, the quiescent current (ideal current) of the regulator, the amount of allowable ripple in the DC output and the time period.

For the peak voltage across the transformer primary to be 17V(12*sqrt2) and the total drop across the diodes to be (2*0.7V) 1.4V, the peak voltage across the capacitor is about 15V approx. We can calculate the amount of allowable ripple by the formula below:

4. Decide the PIV (peak inverse voltage) of the diodes to be used: Since the peak voltage across the transformer secondary is 17V, the total PIV of the diode bridge is about (4*17) i.e. 68V. So, we have to settle down for diodes with PIV rating of 100V each. Remember PIV is the maximum voltage which can be applied to the diode in its reverse biased condition, without causing breakdown.

SELF-CHECK QUIZ 2.2.3

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. Batteries are generally connected in series.

---------- 2. In a parallel circuit, the total resistance is greater than the largest resistance in the circuit.

---------- 3. To prevent a DC return between source and load, it is necessary to use capacitor between source and load.

---------- 4. To prevent a DC return between source and load , it is necessary to use inductor between source and load.

---------- 5. In a CB amplifier the maximum efficiency could be 25%.

Learning Outcome 2.3 - Perform Connection and Termination

Contents:

- Employ appropriate ranges of methods in connection/termination as per job and manufacturers specification

Assessment criteria:

- Appropriate ranges of methods in connection/termination are employed as per job and manufacturers specification.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material.
- Tools and equipment
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 2.3.1

Learning Activity	Resources/Special Instructions/References
Employ appropriate ranges of methods in connection/termination as per job and manufacturers specification	▪ Information Sheet: 2.3.1 ▪ Self-Check Quiz: 2.3.1 ▪ Answer Key: 2.3.1

INFORMATION SHEET 2.3.1

Learning Objective: to employ appropriate ranges of methods in connection/termination as per job and manufacturers specification.

Step 1 – Melting the Solder

This is the very first step in the entire wave soldering process. It is the basic requirement of the process to melt the solder. The wave soldering machine has solder contained in a tank. The tank is heated to melt

the solder. Appropriate temperature is reached to meet the right consistency, so that the process of soldering can be carried out further.

Step 2 – Cleaning the Components

This is a very crucial step to be carried out. The components to be soldered are cleaning thoroughly in this step. If any oxide layers are formed on the components, then they are removed. This is done by the process called fluxing. There are two main types of fluxing – corrosive (high acidity) and noncorrosive (high acidity).

Step 3 – Placement of the PCB

After melting the solder and cleaning the components to be soldered, the printed circuit board is placed on the melted solder. The board is held with the metal clasps of the machine, which ensure the firm positioning and placement of the PCB.

Step 4 – Application of Solder

Now that the PCB is placed properly, molten solder is applied, and is allowed to settle. Sufficient time is given to this step to allow the solder to settle into the joints completely, and ensure no bumps are formed.

Step 5 – Cleaning

This is the final step in the wave soldering process. Any flux residues formed during the process are cleaned in this step. The circuit board is washed and cleaned with the help of deionized water and solvents.

Hope the above post helped you in gaining some important and valuable knowledge about wave soldering. All this explains what makes wave soldering so important in the electronics industry. Wave soldering or any other type of soldering technique for that matter requires a lot of expertise. One cannot afford to make mistakes in soldering, as it can lead to spoiling the PCB design. Therefore, it is always a good idea to leave the job to the experts. One such expert, who is known to provide quality wave soldering services is Accelerated Assemblies. The company has a vast experience in manufacturing PCBs of different specifications and capabilities.

SELF-CHECK QUIZ 2.3.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

1. ---------- The composition of electrician solder is lead-70%, tin-30%.
2. ---------- It is good to use a lot of solder when placing components on boards.
3. ---------- Soldering iron, solder, flux needed to solder circuit boards.
4. ---------- Resistors, capacitors, diodes are common names for some primary discrete components used on circuit boards.
5. ---------- Defluxer spray, compressed air, or water used to clean circuit boards when you are finished soldering.

Learning Outcome 2.4 - Carry Out Soldering

Contents:

- Mount components and solder in accordance with soldering principles

Assessment criteria:

- Components are mounted and soldered in accordance with soldering principles.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Soldering equipment and materials
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITIY 2.4.1

Learning Activity	Resources/Special Instructions/References
Mount components and solder in accordance with soldering principles	▪ Information Sheet: 2.4.1 ▪ Self-Check Quiz: 2.4.1 ▪ Job Sheet 2 ▪ Answer Key: 2.4.1

INFORMATION SHEET 2.4.1

Learning Objective: to mount components and solder in accordance with soldering principles.

Prepare the components for soldering. Select the correct component by checking its type and value carefully. With resistors, check their colour code. Bend leads correctly, if necessary, being careful not to exceed the stress specs (e.g., by too sharp a bend), and clinch leads to fit the board.

Be extremely careful and solder only in an appropriate environment. Always solder in a well-ventilated area, using breathing and eye protection. Make sure to safely place the iron (using a fireproof stand or holder) when it is on but not in use. Irons can start fires quite easily by burning into your workbench or paper or plastic.

"Tin" the soldering iron tip. Melt a small blob of solder on end of the soldering iron. This process is called tinning and it helps to improve heat flow from the iron to the lead and pad, keeping the board safe from prolonged heat.

Feed the solder wire onto the interface between the pad and lead. Flux from the solder wire is only active very briefly maximum after melting onto the joint. It is burned off slowly (this is the smoke rising from the joint) and loses its effectiveness as it does so. The component lead and the pad should be heated enough for the solder to melt into the connection point. The molten solder should "cling" to the pad and lead together via surface tension. This is commonly referred to as wetting.

Stop feeding new solder when all the surfaces have been wetted. When the gaps are filled and the surfaces are wet, you should stop adding more solder. No more than a drop or two of solder should be necessary for most joints, though it will vary slightly for different components.

SELF-CHECK QUIZ 2.4.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. Tin is not needed for soldering.

---------- 2. 7 k home is the resistance of a resistor having colour code yellow violet orange.

---------- 3. 100 k home is the resistance of a resistor having colour code brown, black, yellow.

---------- 4. Capacitor is an electronic component that opposes the flow of current.

---------- 5. 25 watts the power of the soldering iron used by you in the lab.

JOB SHEET 2	
Job Title:	Perform soldering and de-soldering for the given electronic circuit purpose printed circuit board (PCB)
Personal protective equipment:	Gloves, dust mask, safety shoes, hard hat, belt/body harness, goggles, working clothes, apron
Materials:	PCB board for given circuit, soldering iron (10W or 35W), Solder (60/40 grade), Copper plate, Flux, Connecting wires, Lead, Nose plier
Tools and equipment:	Tools: Pliers, Cutters, Screwdrivers, Soldering iron Equipment: Soldering gun, Multi-tester, De-soldering pump (Sucker)
Procedure:	1. Collect required tools, equipment, machinery and materials required for the task (refer to the list provided to you by the assessor. 2. Clean the given PCB board. 3. Clean the tip of the soldering iron before heating and also clean the components which are to be soldered. 4. Heat the soldering iron and apply solder to the tip as soon as it is hot to melt on it. 5. Trim excess component lead with side cutter. 6. If the mirror image alone is considered, then the copper plate is ready to be drilled and a considered component for the circuit is taken. 7. Clean tools, equipment, machinery and work area. 8. Dispose of waste materials and excess materials. <u>Desoldering:</u> 1. Hold the component to be unsoldered by a nose plier. 2. Place the tip of the soldering iron on the joint until the solder is melt. 3. When the solder is melted, removed the component with a tweezer and brush away the molten solder. 4. Clean the components so that they can be used to make other circuits.

ANSWER KEYS

ANSWER KEY: 2.1.1

1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

ANSWER KEY: 2.2.1

1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

ANSWER KEY: 2.2.2

1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

ANSWER KEY: 2.2.3

1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

ANSWER KEY: 2.3.1

1.	TRUE
2.	FALSE
3.	TRUE
4.	TRUE
5.	TRUE

ANSWER KEY: 2.4.1

1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

Module 3: Assemble electronic products

MODULE CONTENT

Module Descriptor: This unit covers the skills, knowledge and attitudes required to assemble electronic products. It specifically includes preparing to assemble products, preparing printed circuit board (PCB) modules, mounting and soldering components, performing assembly, and testing and inspecting products.

Nominal Duration: 40 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee should be able to:

3.1. Prepare for assemble products

3.2. Prepare printed circuit board (PCB) modules

3.3. Mount and solder components

3.4. Perform assembly

3.5. Test and inspect products

PERFORMANCE CRITERIA:

1. Assembly workplace is prepared as per standard operating procedure.
2. Work instructions are obtained and clarified based on client requirements.
3. Responsible person is consulted for effective and proper work coordination.
4. Tools and equipment are prepared and checked in accordance with job requirement.
5. Materials are prepared and checked in accordance with job requirement.
6. Parts and components needed are identified and prepared as per job requirement.
7. Printed circuit board (PCB) layout is checked for conformity with schematic diagram as per layout rules.
8. PCB layout is transferred to copper-cladded board per acceptable method.
9. Thru-hole is drilled and PCB is cleaned.
10. PCB functionality is tested and visual inspection is carried out.
11. Mounting technique is identified and selected.
12. Components are mounted and soldered in accordance with soldering principles.
13. Soldered components are checked to ensure compliance with international standards and job requirement.
14. Assembly procedures are carried out as per standard operating procedure.
15. Modules and accessories are connected into final product as per job specification.
16. Excess components and materials are disposed of pursuant to waste management procedure.

17. Testing and inspection of finished products is carried out in accordance with quality standards and standard operating procedure.
18. Job completion is recorded and reported as per standard operating procedure.

Learning Outcome 3.1 - Prepare for Assemble Products

Contents:

- Prepare and check tools and equipment in accordance with job requirement

Assessment criteria:

- Tools and equipment are prepared and checked in accordance with job requirement.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 3.1.1

Learning Activity	Resources/Special Instructions/References
Prepare and check tools and equipment in accordance with job requirement	▪ Information Sheet: 3.1.1 ▪ Self-Check Quiz: 3.1.1 ▪ Answer Key: 3.1.1

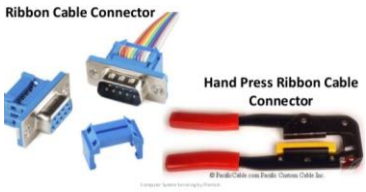
INFORMATION SHEET 3.1.1

Learning Objective: to select appropriate tools and equipment as per job requirement.

A **soldering gun** is an approximately pistol-shaped, electrically powered tool for soldering metals using tin-based solder to achieve a strong mechanical bond with good electrical contact. The tool has a trigger-style switch so it can be easily operated with one hand. The body of the tool contains a transformer with a primary winding connected to mains electricity when the trigger is pressed, and a single-turn secondary winding of thick copper with very low resistance. A soldering tip, made of

a loop of thinner copper wire, is secured to the end of the transformer secondary by screws, completing the secondary circuit. When the primary of the transformer is energized, several hundred amperes of current flow through the secondary and very rapidly heat the copper tip. Since the tip has a much higher resistance than the rest of the tubular copper winding, the tip gets very hot while the remainder of the secondary warms much less. A tap on the primary winding is often used to power a pilot lamp which illuminates the workpiece.

The main point of ribbon cables is to allow mass termination to specially designed IDC connectors in which the ribbon cable is forced onto a row of sharp forked contacts (the phrase "IDC connector" is widely used, even though it is redundant - an example of RAS syndrome).



The crimping tool is used for non-welding and standard electrical connection. The mould of the crimping dies is made of hardened tool steel. Crimper is lightweight and easy to carry.

A de-soldering *pump*, colloquially known as a *solder sucker*, is a manually-operated device which is used to remove solder from a printed circuit board. There are two types: the plunger style and bulb style (an electrically-operated pump for this purpose would usually be called a vacuum pump).

SELF-CHECK QUIZ 3.1.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. Soldering iron is made of wedge shape in order to retain heat.

---------- 2. The commonly used flux for brazing is resin.

---------- 3. A soldering iron 'bit' is made of brass.

---------- 4. A braze joint may be satisfactorily used on components made of brass.

---------- 5. Heat for soldering process is supplied by electric resistance method.

Learning Outcome 3.2 - Prepare Printed Circuit Board (PCB) Modules

Contents :

- Transfer PCB layout to copper-clad board per acceptable method

Assessment criteria:

- PCB layout is transferred to copper-cladded board per acceptable method.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Electrical materials and components
- PCB
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 3.2.1

Learning Activity	Resources/Special Instructions/References
Transfer PCB layout to copper-clad board per acceptable method	▪ Information Sheet: 3.2.1 ▪ Self-Check Quiz: 3.2.1 ▪ Answer Key: 3.2.1

INFORMATION SHEET 3.2.1

Learning Objective: to transfer PCB layout to copper-cladded board per acceptable method.

Step 1: Sketch a Schematic and Check the Math

This project in particular requires LEDs, resistors, a switch and some type of battery. The goal is to use a normally closed switch to keep the LEDs off when the door is shut and to turn them on once the door is opened. Sketch out a circuit and track down all required components. Be sure to do your Ohm's Law check to make sure all parts are sufficiently rated. In my case, I found the current going through each

LED on fully charged 18650 cell (my battery of choice) would be a tad high. However, I decided to continue with this set up to prevent the LEDs from getting too dim as the cell dies. Plus, I had a plethora of 100 Ω resistors leftover from a previous project that were just waiting to have a purpose! Step 1: Sketch a Schematic and Check the Math

Step 2: Input your Design into a PCB Design Software

Using a decent PCB Design platform can save a lot of time while designing the layout of your PCB. Programs such as Eagle and EasyEDA allow you to design your schematic then build directly from this schematic. This ensures component sizes and connection points are accurate and accounted for on the PCB. Another timesaver of this software is the auto router tool. This will lay out all traces in paths that only interfere with components and other traces that are connected. After the PCB has been laid out and the circuit connections have traced, verify the circuit one final time prior to printing.

Step 3: Transfer the Layout to the Board

To ensure an accurate transfer, tape this print out over top of a copper clad laminate PCB. Using a pushpin, stab through the paper where each component lead will penetrate the board. This will leave dots on the copper where these components go. The small indentation on the copper will also help the drill bit find the exact location the lead will go. Remove the printed sheet and make sure all components are marked on the copper. Use a 1/32" (maximum) bit to drill out the holes that were marked on the board. Once all the holes are drilled, clean the top of the copper plate with a piece of sandpaper. Using a permanent marker, draw to traces between all the components referencing the printed PCB layout. Allow some time for the ink to dry and touch up the board where the marker is faint.

Step 4: The Etching Process

Once the second coat of marker is completely dry it is time to give the board a bath in ferric chloride. Ferric chloride is a corrosive, acidic chemical compound that will eat away all copper on the board that is not protected by the marker's ink. Pour a modest amount of ferric chloride into a plastic container with a lid; just enough to cover the board completely. Let the board soak for 10 minutes, make sure the lid is properly secured and agitate it every few minutes by rocking the container back and forth. After 10 minutes inspect the board and if no copper is visible, remove the board while wearing a latex glove. Pat the board dry with a disposable rag to remove all ferric chloride from the board. Rinse the board with acetone that will make quick work of the marker ink to reveal your unharmed traces. The etching process is complete!

Step 5: Populate the Board and Test Your Circuit

After the board has been etched, use a multimeter to do a continuity test. Make sure all traces were successful and also begin and terminate in the correct locations before applying power to the circuit. Once all traces have been verified, add the components to their correct position and solder them in. Apply voltage and watch in awe as your perfectly etched circuit functions exactly as planned.

SELF-CHECK QUIZ 3.2.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. PCB stands for Printed Circuit Board.

---------- 2. The use of 3D component models in the PCB layout can assist with electrical clearance.

---------- 3. Colour code for 1-ohm resistance is brown, black gold.

---------- 4. If a circuit uses 1200 volts at 800mA, the input power is 300 watts.

---------- 5. PCB's should be fabricated with even number of layers.

Learning Outcome 3.3 - Mount and Solder Components

Contents:

- Mount and solder components in accordance with soldering principles

Assessment criteria:

- Components are mounted and soldered in accordance with soldering principles.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Soldering equipment and materials
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

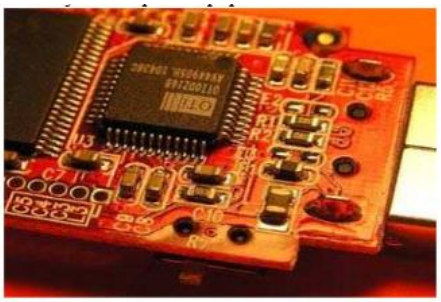
LEARNING ACTIVITY 3.3.1

Learning Activity	Resources/Special Instructions/References
Mount and solder components in accordance with soldering principles	▪ Information Sheet: 3.3.1 ▪ Self-Check Quiz: 3.3.1 ▪ Answer Key: 3.3.1

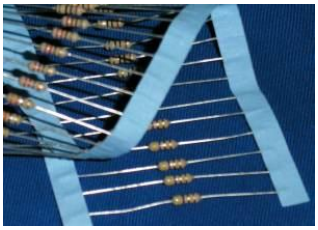
INFORMATION SHEET 3.3.1

Learning Objective: to mount and solder components in accordance with soldering principles.

The use of surface-mounted devices was the fastest growing development in the printed circuit board's industry, in the second half of the 1980s. Surface mounting is the technique of attaching components and devices only to the surface of the board. No holes or terminals are used in this process: only the board pads are soldered. If any plated-through holes are used, they serve as via-holes or interconnect-holes. The pad size corresponds to the foot-print of the surface mounted device (SMD) and these foot-prints are very small and allow a high density of component population.



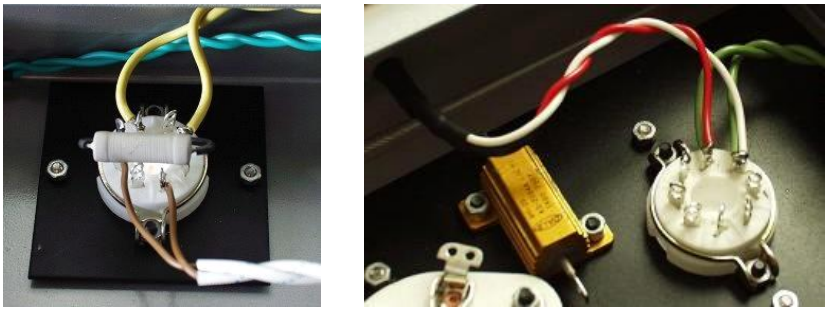
Through-hole technology (also spelled "thru-hole"), refers to the mounting scheme used for electronic components that involves the use of leads on the components that are inserted into holes drilled in printed circuit boards (PCB) and soldered to pads on the opposite side either by manual assembly (hand placement) or by the use of automated insertion mount machines.



Point-to-Point Mounting: The technology is characterized by:

- type of component terminals: (a) wire, (b) lug, (c) clamp, (d) plug;
- component mounting by: (a) screwing, (b) clamping, (c) soldering to lugs, (d) insertion in a socket;
- interconnections are performed using: (a) hook-up wire, (b) chassis

Point-to-Point Mounting technology started together with the first electrical and electronic appliances.



Point-to-Point Mounting

Lug
(variable resistor)

Clamp
(capacitor)

Wire
(resistor)

Plug
(vacuum tube)

Different types of terminals in electronic components suitable for point-to point mounting

SELF-CHECK QUIZ 3.3.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. Electric soldering methods is also renowned as 'High Frequency Resistance Soldering'.

---------- 2. SOP packages does not belong to the category of 'Small Outline Package'.

---------- 3. High current circuits are purposely located or placed near the edge of PCB in accordance to the supply lines for removal of heat.

---------- 4. The number of depletion layers in a transistor is one.

---------- 5. Double-sided PCB requires minimum soldering on component side in order to avoid replacement-oriented difficulties.

Learning Outcome 3.4 - Perform Assembly

Contents :

- Connect modules and accessories into final product as per job specification.

Assessment criteria:

- Modules and accessories are connected into final product as per job specification.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material.
- Tools and equipment
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 3.4.1

Learning Activity	Resources/Special Instructions/References
Connect modules and accessories into final product as per job specification	▪ Information Sheet: 3.4.1 ▪ Self-Check Quiz: 3.4.1 ▪ Answer Key: 3.4.1

INFORMATION SHEET 3.4.1

Learning Objective: to connect modules and accessories into final product as per job specification.

The various stages in the PCB assembly process including adding solder paste to the board, pick and place of the components, soldering, inspection and test. All these processes are required and need to be monitored to ensure that product of the highest quality is produced. The PCB assembly process described below assumes that surface mount components are being used as virtually all PCB assembly these days uses surface mount technology.

- ***Solder paste:*** Prior to the addition of the components to a board, solder paste needs to be added to those areas of the board where solder is required. Typically, these areas are the component pads. This is achieved using a solder screen.

  The solder paste is a paste of small grains of solder mixed with flux. This can be deposited into place in a process that is very similar to some printing processes.

  Using the solder screen, placed directly onto the board and registered in the correct position, a runner is moved across the screen squeezing a small amount of solder paste through the holes in the screen and onto the board. As the solder screen has been generated from the printed circuit board files, it has holes on the positions of the solder pads, and in this way, solder is deposited only on the solder pads.

  The amount of solder that is deposited must be controlled to ensure the resulting joints have the right amount of solder.

- ***Pick and place:*** During this part of the assembly process, the board with the added solder paste is then passed into the pick and place process. Here a machine loaded with reels of components picks the components from the reels or other dispensers and places them onto the correct position on the board.

Typical pick and place machine in use

  The components placed onto the board are held in place by the tension of the solder paste. This is sufficient to keep them in place provided that the board is not jolted.

  In some assembly processes, the pick and place machines add small dots of glue to secure the components to the board. However, this is normally done only if the board is to be wave soldered. The disadvantage of the process is that any repair is made far more difficult by the presence of the glue, although some glues are designed to degrade during the soldering process.

  The position and component information required to programme the pick and place machine is derived from the printed circuit board design information. This enables the pick and place programming to be considerably simplified.

- ***Soldering:*** Once the components have been added to the board, the next stage of the assembly, production process is to pass it through the soldering machine. Although some boards may be passed through a wave soldering machine, this process is not widely used for surface mount components these days. If wave soldering is used, then solder paste is not added to the board as the solder is provided by the wave soldering machine. Rather than using wave soldering, reflow soldering techniques are used more widely.

- ***Inspection:*** After the boards have been passed through the soldering process they are often inspected. Manual inspection is not an option for surface mount boards employing a hundred or more components. Instead automatic optical inspection is a far more viable solution. Machines are available that are able to inspect boards and detect poor joints, misplaced components, and under some instances the wrong component.

- ***Test:*** It is necessary to test electronic products before they leave the factory. There are several ways in which they may be tested. Further views of test strategies and methods may be found on the "Test and Measurement" section of this website.

- ***Feedback:*** To ensure that the manufacturing process is running satisfactorily, it is necessary to monitor the outputs. This is achieved by investigating any failures that are detected. The ideal place is at the optical inspection stage as this generally occurs immediately after the soldering stage. This means that process defects can be detected quickly and rectified before too many boards are built with the same problem.

SELF-CHECK QUIZ 3.4.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. A voltmeter is connected in a parallel with the circuit component across which potential difference is to be measured.

---------- 2. The use of 3D component models in the PCB layout can assist with electrical clearance.

---------- 3. A VTVM has more input resistance than that of a multimeter.

---------- 4. SOP packages does not belong to the category of 'Small Outline Package'.

---------- 5. The material used to coat inside the face of CRT is silver.

Learning Outcome 3.5 - Test and Inspect Products

Contents:

- Carrey out testing and inspection of finished products in accordance with quality standards and standard operating procedure

Assessment criteria:

- Test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Electrical products
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 3.5.1

Learning Activity	Resources/Special Instructions/References
Test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure	▪ Information Sheet: 3.5.1 ▪ Self-Check Quiz: 3.5.1 ▪ Job Sheet 3 ▪ Answer Key: 3.5.1

INFORMATION SHEET 3.5.1

Learning Objective: to test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure.

There are various methods by which PCB inspection can be achieved:

- ***Manual PCB inspection:*** As the name implies, manual inspection involves individual inspectors looking at boards or other assemblies to inspect them for problems. This approach has been proved to be costly and yielding poor results. Before automation, it was the only way that inspection could be performed.
- ***AOI PCB inspection:*** Automatic or automated optical inspection is the preferred method of PCB inspection. It utilizes an optical system that takes an image of a good assembly and compares the two images to detect any faults or other issues. This form of PCB inspection is widely used and has been perfected so that it operates very reliably.
- ***AXI PCB inspection:*** With density on PCBs increasing and new IC mounting technologies being used, not all solder joints may be visible. Particularly when new boards are being manufactured and new set-ups being used, it is very important to check that solder joints on packages such as BGAs (Ball Grid Arrays) are being correctly soldered. Optical inspection cannot achieve this because the solder joints are not visible. The only option is to use an X-Ray system - Automated X-Ray Inspection, AXI, that is able to look under the chips to view the solder joints. Although expensive and only used for a small proportion of the solder joints, etc, they are necessary in many instances.

SELF-CHECK QUIZ 3.5.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. The power demand can be estimated approximately by statistical method.

---------- 2. Over voltage is the reason for excess reading of the energy meter.

---------- 3. The output power of the cascaded amplifier/attenuator system can be determined using actual gain of amplifier and attenuator.

---------- 4. Testing of earth resistance is to be conducted on wiring installations.

---------- 5. In a three-phase converter, the number of notches per cycle is six.

JOB SHEET 3	
Job Title:	Assemble Electronic Product (IPS)
Personal protective equipment:	Gloves, dust mask, safety shoes, hard hat, belt/body harness, goggles, working clothes, apron
Materials:	Soldering wire, SMD soldering paste, Wires (stranded/solid/hook-up), Assorted electronic components, Battery 12V, Circuit (Main board), Inverter Transformer, Load and casing
Tools and equipment:	Tools: Screwdrivers, Wrenches, Allen wrench, Allen keys, Soldering iron, De-soldering tools, Multi-testers (analogue/digital), Utility knife/stripper, Pliers, Cleaning brush, High-grade magnifying glass (with lamp) Equipment: Variable power supply, Variable transformer, Hot air soldering station, Table top reflow oven, Function/signal generator, ESD-free work bench with mirror, Oscilloscope (digital), Flashlight/headlamp, Assorted electronic sensors
Procedure:	1. Collect required tools, equipment, machinery and materials required for the task (refer to the list provided to you by the assessor). 2. Check that all electric connections and contacts to terminals, coils, switches and junctions are tight. 3. Measure the individual phase currents with a clamp-on ammeter on the power supply immediately before the connection terminals with the appliance switched on full and compare the currents with the 'technical data'. 4. Inspect internal wiring 5. Check the cooking zones for continuous operation. Check power consumption with the largest possible pan filled with water. 6. Check the generator and cooling block for internal contamination. 7. Check the fan for operation and dirt. Note when the fan cuts in (should cut in after approx. 1-2 min. under full load). Fan must spin freely and should turn when subjected to a current of air. 8. Check switch for easy movement and correct function and check the power switch steps. 9. Check the green operating lamp located on the control panel. The lamp must be on at all switch settings from 1 to 10. 10. Check the pan detection system by turning the switch to 9 and placing a metal pan containing water onto the cooking zone. 11. Check the ceramic plate and wok bowl for any splits, cracks or wear and tear. 12. Check the mechanical fixation of the induction coil and ferrite parts. 13. Check the seal between the ceramic plate/bowl and the cover. 14. Clean tools, equipment, machinery and work area. 15. Dispose of waste materials and excess materials.

ANSWER KEYS

ANSWER KEY: 3.1.1

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 3.2.1

1. TRUE
2. TRUE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 3.3.1

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 3.4.1

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE

ANSWER KEY: 3.5.1

1. TRUE
2. FALSE
3. TRUE
4. TRUE
5. TRUE

Module 4: Service consumer products and systems

MODULE CONTENT

Module Descriptor: This unit covers the skills, knowledge and attitudes required to service consumer products and systems. It specifically includes preparing for work, installing products and systems, diagnosing faults and defects, repairing products and systems, and testing products and systems.

Nominal Duration: 60 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee should be able to:

4.1. Prepare for work

4.2. Install products and systems

4.3. Diagnose faults and defects

4.4. Repair products and systems

4.5. Test products and systems

PERFORMANCE CRITERIA:

1. Consumer products and systems are checked and defects are identified, verified and recorded against customer description.
2. Service manuals and information required for installation are identified.
3. Repair and maintenance history are confirmed with consumer as per standard operating procedure.
4. Workplace is prepared for installation as per job requirement.
5. Tools and equipment are identified and selected as per job requirement.
6. Materials are identified and obtained as per job requirement.
7. Products and systems are installed in accordance with manufacturer's instructions.
8. Products and systems are tested and inspected as per standard operating procedure.
9. Unplanned events or conditions are responded to in accordance with standard operating procedure.
10. Report on installation and testing of equipment is prepared as per organisational policy.
11. Workplace is cleaned and cleared of all debris.
12. Troubleshooting techniques are identified.
13. Pre-testing procedure is carried out as per manufacturer's instructions.
14. Circuits are checked and isolated using as per standard operating procedure.
15. System defects or fault symptoms are identified using appropriate troubleshooting technique.
16. Control settings and adjustments are checked to ensure compliance with service-manual specifications.

17. Results of diagnosis and testing are recorded accurately.
18. Customer is informed of status and serviceability of product or system.
19. Electro-static discharge (ESD) protection procedure is followed in accordance with industry standards.
20. Defective parts are repaired or replaced as per manufacturer's instructions.
21. Repaired or replaced parts are mounted and soldered as per job requirement.
22. Control settings and adjustments are checked to ensure compliance with service-manual specifications.
23. Repaired product or system is reassembled.
24. Product or system is cleaned as per standard operating procedure.
25. Workplace is cleaned and cleared of all debris.
26. Product or system is tested and inspected in accordance with quality standards and standard operating procedure.
27. Job completion is recorded and reported as per standard operating procedure.

Learning Outcome 4.1 - Prepare for Work

Contents:

- Check and identify defects, verify and record consumer products and systems against customer description
- Identify and select tools and equipment as per job requirement

Assessment criteria:

- Consumer products and systems are checked and defects are identified, verified and recorded against customer description.
- Repair and maintenance history are confirmed with consumer as per standard operating procedure.
- Tools and equipment are identified and selected as per job requirement.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Consumer products
- Instruction sheet/manual
- Personal protective equipment

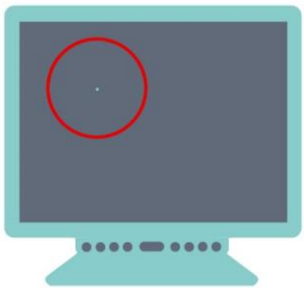
LEARNING ACTIVITY 4.1.1

Learning Activity	Resources/Special Instructions/References
Check and identify defects, verify and record consumer products and systems against customer description	▪ Information Sheet: 4.1.1 ▪ Self-Check Quiz: 4.1.1 ▪ Answer Key: 4.1.1

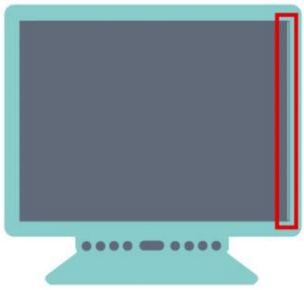
INFORMATION SHEET 4.1.1

Learning Objective: to check and identify defects, verify and record consumer products and systems against customer.

Display Control: With the ever-increasing size, resolutions and widespread use of monitors in everyday gadgets, the demand for fast and reliable automated inspection has also increased. Fortunately, the resolutions of sensors have also kept up with it, enabling inspection of even the largest 4K monitors.



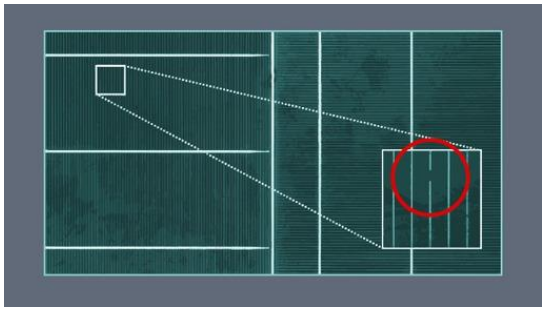
Dead Pixels

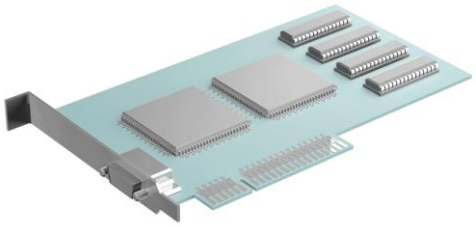


Incorrect Alignment

Incorrect Colors / Mura Effects

The **CVB Foundation Package** provides all of the tools necessary for screen inspection, including colour space conversion and look-up-tables (LUTs) to allow cameras' colour response to be calibrated.





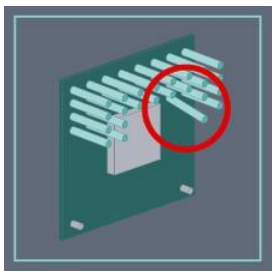
Silicon Solar Wafers: When converting silicon into solar cells, the raw materials undergo very high-temperature operations before they are in their polar state, ready to be sliced into 200-micron thick wafers. They then need to be very carefully handled, cleaned, positioned and inspected to ensure they maintain their crystalline structure. Metal fingers) that help collect the electrons generated are positioned on top of the wafers. These also need to be inspected to ensure there are no breaks.

Busbar/Finger Breaks: The line scan bar is perfect for the inspection of solar wafers as the technology is suited for the high-speed inspection of flat surfaces. Its compact, self-contained design houses the sensor, lens, and light. So, there's no need for any adjustments once the system is mounted.

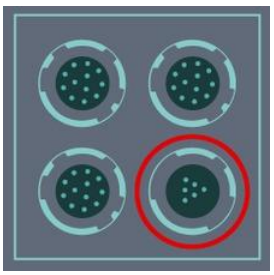
If the solar cell is made to run a reverse bias (reverse current) it actually emits infrared light at wavelengths between 1100 to 1200nm. This electroluminescence emits at a lower intensity in regions where there are microcracks in the crystalline structure. These can be detected by using a SWIR camera before it is fully assembled into a larger unit.

Heat Dissipation Analysis: Electronic components can get quite hot when they are operating at their maximum loads, and they need to be checked to ensure they do not overheat. By using an infrared camera and machine vision software temperature measurements can be fully integrated into automated inspection processes.

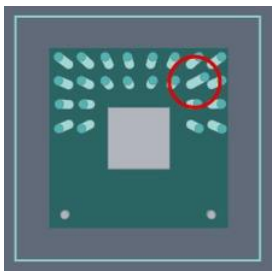
Connectors/Pins: Pin and connector checks are critical in automated production processes as they help to communicate / relay signals in operations. Incorrectly aligned pins can even cause damage to the mating connector. The pattern matching tools found in many vision tool kits can check that the correct connector is being used. They work by locating and classifying objects and patterns, providing a score based on how much they "match" the trained pattern and/or a location / rotation (so they can be used for robotic pick and place applications).



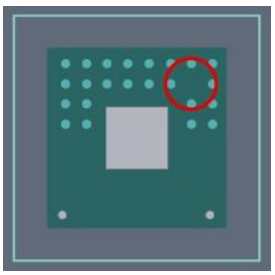
BENT PIN



Incorrect connector



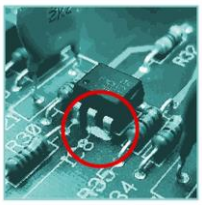
Incorrect Pin Height



Missing Pin

Adding a **liquid lens** to the end of the lens configuration can enable additional parts of the pins to be inspected. By moving liquid around a polymer membrane, the shape-changing lens can quickly adjust the focal point of the set-up. This means that the whole length of the pins can be inspected. Checking for the location of the bases, their height, the shape of the tips and how straight they are.

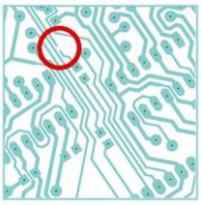
Printed Circuit Boards: There are many potential sources of PCB failure. From variations in the raw materials and components used at the start, right the way through to the stresses they undergo during operational testing. Carrying out inspections at as many points as possible during their manufacture helps to minimize losses due to adding processes/parts onto defective PCBs later on in the production process. And, wherever possible, automating these inspections helps to keep costs and missed defects down.



Solder Bridging

Component Misalignment

Missing Components



Wire Breaks

Open Solder Joints

SELF-CHECK QUIZ 4.1.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. 'Hall Effect' phenomena help to determine the concentration and mobility of charge carriers.

---------- 2. High current circuits are purposely located or placed near the edge of PCB in accordance to the supply lines for isolation of stray current.

---------- 3. Spectrum analyser can be used to analyse the frequency response of a room.

---------- 4. A semantic error type of software bugs does not belong to the 'Execution Category'.

---------- 5. Meniscus rise testing s carried out for the generation of solder sample due to immersion of wire or sheet metal specimen in a bath of molten solder.

LEARNING ACTIVITY 4.1.2

Learning Activity	Resources/Special Instructions/References
Identify and select tools and equipment as per job requirement	▪ Information Sheet: 4.1.2

	▪ Self-Check Quiz: 4.1.2 ▪ Answer Key: 4.1.2

INFORMATION SHEET 4.1.2

Learning Objective: to identify and select tools and equipment as per job requirement.

The testing equipment used to detect faults in the operation of electronic devices by creating stimulus signals and capture responses from electronic devices under test is known as electronic test equipment. If any faults are detected, then identified faults can be traced a rectified using electronic testing equipment. Most often all electrical and electronic circuits are tested and trouble-shooter to detect faults or abnormal functioning if any.

Voltmeter: A basic electronics device or instrument used to measure voltage or electrical potential difference between two points in electrical circuits is known as voltmeter. There are two types of voltmeters: analog and digital. An analog voltmeter moves a pointer across a scale in proportional to the voltage of the electrical circuit. A digital voltmeter measures an unknown input voltage by converting the voltage to a digital value by using a converter and then displays the voltage in numeric form.

Ohmmeter: An electrical instrument that measures electrical resistance is known as an ohmmeter. The instruments used to measure small value of resistance are micro-ohmmeters. Similarly meg-ohmmeters is used to make large resistance measurements. Resistance values are measured in ohms (Ω). Originally, ohmmeter is designed with a small battery to apply a voltage to a resistance.

Ammeter: A measuring instrument which is used to measure the electric current in a circuit is known as an ammeter. The units of measurement for electric current is amperes (A) Earlier ammeters were laboratory instruments which depend on the earth's magnetic field for operation. In an era of the 19th century, improved instruments were designed which could be placed in any position and allows accurate measurements in electric power systems.

Multimeter: A multimeter is an electronic instrument used to measure the three basic electrical characteristics: voltage, current and resistance. It has multiple functions and acts like ohmmeter, voltmeter and ammeter and also used for household wiring, electric motors, testing batteries and power supplies. The multimeter is a handheld device with a needle over a numeric LCD digital display for indication purpose. It is also used to test continuity between two points in an electrical circuit. There are three types of multimeters made available in the market such as: digital multimeter, analog multimeter and fluke multimeter.

Voltmeter


Ohmmeter

Ammeter


Multimeter

SELF-CHECK QUIZ 4.1.2

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. To increase the current sensitivity below 10 mV, electronic instrument uses amplifiers.

---------- 2. In potentiometric type DVM, the adjustment of sliding contact is done by a single-phase

servomotor.

---------- 3. Electronic voltmeters can be designed to measure both very small and very high voltages.

---------- 4. In the beginning, all the outputs of the successive approximation type register are at Toggling.

---------- 5. In electronic voltmeter, the range of input voltages can be extended by using input attenuator.

Learning Outcome 4.2 - Install Products and Systems

Contents:

- Identify and obtain materials as per job requirement
- Test and inspect products and systems as per standard operating procedure
- Prepare report on installation and testing of equipment as per organisational policy

Assessment criteria:

- Materials are identified and obtained as per job requirement.
- Products and systems are tested and inspected as per standard operating procedure.
- Report on installation and testing of equipment is prepared as per organisational policy.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Consumer products and systems
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITIES 4.2.1

Learning Activity	Resources/Special Instructions/References
Identify and obtain materials as per job requirement	▪ Information Sheet: 4.2.1

INFORMATION SHEET 4.2.1

Learning Objective: to identify and obtain materials as per job requirement.

Same as ***Information Sheet 2.2.1 (page 31)***

LEARNING ACTIVITY 4.2.2

Learning Activity	Resources/Special Instructions/References
Test and inspect products and systems as per standard operating procedure	▪ Information Sheet: 4.2.2

INFORMATION SHEET 4.2.2

Learning Objective: to test and inspect products and systems as per standard operating procedure.

Same as ***Information Sheet 3.5.1 (page 54)***

LEARNING ACTIVITY 4.2.3

Learning Activity	Resources/Special Instructions/References
Prepare report on installation and testing of equipment as per organisational policy	▪ Information Sheet: 4.2.3

INFORMATION SHEET 4.2.3

Learning Objective: to prepare report on installation and testing of equipment as per organisational policy.

Same as ***Information Sheet 1.2.3 (page 15)***

Learning Outcome 4.3 - Diagnose Faults and Defects

Contents:

- Identify troubleshooting techniques
- Carry out pre-testing procedure as per manufacturer's instructions
- Check and isolate circuits using as per standard operating procedure

Assessment criteria:

- Troubleshooting techniques are identified.
- Pre-testing procedure is carried out as per manufacturer's instructions.
- Circuits are checked and isolated using as per standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Electrical materials and components
- Consumer products and systems
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 4.3.1

Learning Activity	Resources/Special Instructions/References
Identify troubleshooting techniques	▪ Information Sheet: 4.3.1

INFORMATION SHEET 4.3.1

Learning Objective: to identify troubleshooting techniques.

Same as ***Information Sheet 1.4.1 (page 21)***

LEARNING ACTIVITY 4.3.2

Learning Activity	Resources/Special Instructions/References
Carry out pre-testing procedure as per manufacturer's instructions	▪ Information Sheet: 4.3.2

INFORMATION SHEET 4.3.2

Learning Objective: to carry out pre-testing procedure as per manufacturer's instructions.

Same as ***Information Sheet 1.2.3 (page 15)***

LEARNING ACTIVITY 4.3.3

Learning Activity	Resources/Special Instructions/References
Check and isolate circuits as per standard operating procedure	▪ Information Sheet: 4.3.3 ▪ Self-Check Quiz: 4.3.3 ▪ Answer Key: 4.3.3

INFORMATION SHEET 4.3.3

Learning Objective: to check and isolate circuits as per standard operating procedure.

Step 1: Electricity

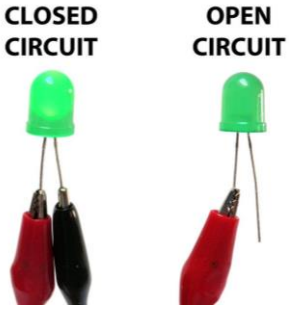
There are two types of electrical signals , those being alternating current (AC), and direct current (DC).

With alternating current, the direction electricity flows throughout the circuit is constantly reversing. You may even say that it is *alternating* direction. The rate of reversal is measured in Hertz, which is the number of reversals per second. So, when they say that the US power supply is 60 Hz, what they mean is that it is reversing 120 times per second (twice per cycle).

With Direct Current, electricity flows in one direction between power and ground. In this arrangement there is always a positive source of voltage and ground (0V) source of voltage. You can test this by reading a battery with a multimeter.

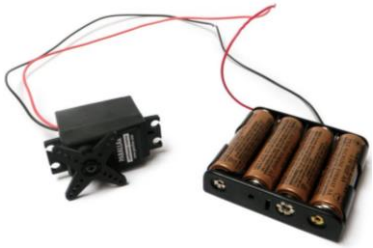
Step 2: Circuits

A circuit is a complete and closed path through which electric current can flow. In other words, a closed circuit would allow the flow of electricity between power and ground. An open circuit would break the flow of electricity between power and ground.



Anything that is part of this closed system and that allows electricity to flow between power and ground is part of the circuit.

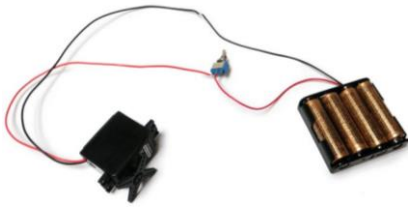
Step 3: Resistance

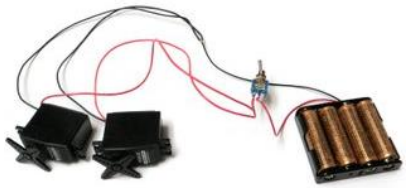


The next very important consideration to keep in mind is that electricity in a circuit must be used. For instance, in the circuit above, the motor that electricity is flowing through is adding resistance to the flow of electricity. Thus, all the electricity passing through the circuit is being put to use.

In other words, there needs to be something wired between positive and ground that adds resistance to the flow of electricity and uses it up. If positive voltage is connected directly to ground and does not first pass through something that adds resistance, like a motor, this will result in a short circuit. This means that the positive voltage is connected directly to ground.

Step 4: Series Vs. Parallel

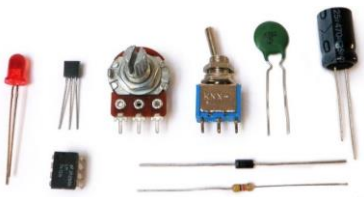




There are two different ways in which you can wire things together called series and parallel.
When things are wired in series, things are wired one after another, such that electricity has to pass through one thing, then the next thing, then the next, and so on.
In the first example, the motor, switch and battery are all wired in series because the only path for electricity to flow is from one, to the next, and to the next.
When things are wired in parallel, they are wired side by side, such that electricity passes through all of them at the same time, from one common point to another common point

Step 5: Basic Components

In order to build circuits, you will need to become familiar with a few basic components. These components may seem simple but are the bread and butter of most electronics projects. Thus, by learning about these few basic parts, you will be able to go a long way.



Step 6: Resistors

As the name implies, resistors add resistance to the circuit and reduces the flow of electrical current. It is represented in a circuit diagram as a pointy squiggle with a value next to it.

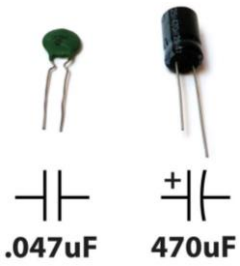
The different markings on the resistor represent different values of resistance. These values are measured in ohms.

Resistors also come with different wattage ratings. For most low-voltage DC circuits, 1/4-watt resistors should be suitable.

Step 7: Capacitors

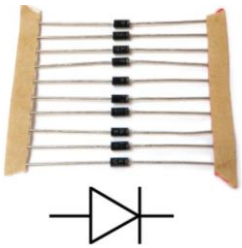
A capacitor is a component that stores electricity and then discharges it into the circuit when there is a drop-in electricity. You can think of it as a water storage tank that releases water when there is a drought to ensure a steady stream.

Capacitors are measured in Farads. The values that you will typically encounter in most capacitors are measured in picofarad (pF), nanofarad (nF), and microfarad (uF). These are often used interchangeably, and it helps to have a conversion chart at hand.



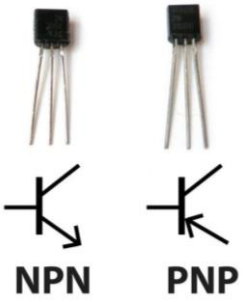
Step 8: Diodes

Diodes are components which are polarized. They only allow electrical current to pass through them in one direction. This is useful in that it can be placed in a circuit to prevent electricity from flowing in the wrong direction.



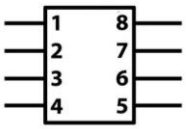
Step 9: Transistors

A transistor takes in a small electrical current at its base pin and amplifies it such that a much larger current can pass between its collector and emitter pins. The amount of current that passes between these two pins is proportional to the voltage being applied at the base pin. There are two basic types of transistors, which are NPN and PNP. These transistors have opposite polarity between collector and emitter.

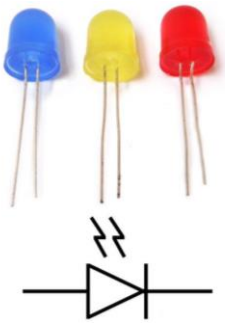


Step 10: Integrated Circuits

An integrated circuit is an entire specialized circuit that has been miniaturized and fit onto one small chip with each leg of the chip connecting to a point within the circuit. These miniaturized circuits typically consist of components such as transistors, resistors, and diodes.



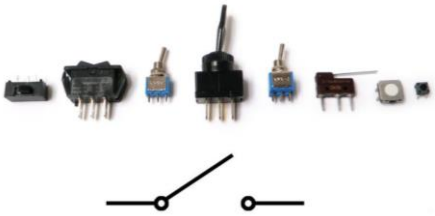
Step 11: LEDs



LED stands for light emitting diode. It is basically a special type of diode that lights up when electricity passes through it. Like all diodes, the LED is polarized, and electricity is only intended to pass through in one direction.

There are typically two indicators to let you know what direction electricity will pass through and LED. The first indicator that the LED will have a longer positive lead (anode) and a shorter ground lead (cathode). The other indicator is a flat notch on the side of the LED to indicate the positive (anode) lead. Keep in mind that not all LEDs have this indication notch (or that it is sometimes wrong).

Step 12: Switches

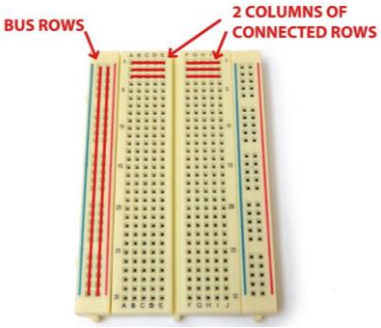


A switch is basically a mechanical device that creates a break in a circuit. When you activate the switch, it opens or closes the circuit. This is dependent on the type of switch it is.

Normally open (N.O.) switches close the circuit when activated.

Normally closed (N.C.) switches open the circuit when activated.

Step 12: Breadboards



Breadboards are special boards for prototyping electronics. They are covered with a grid of holes, which are split into electrically continuous rows.

In the central part there are two columns of rows that are side-by-side. This is designed to allow you to be able to insert an integrated circuit into the center. After it is inserted, each pin of the integrated circuit will have a row of electrically continuous holes connected to it.

In this way, you can quickly build a circuit without having to do any soldering or twisting wires together. Simply connect the parts that are wired together into one of the electrically continuous rows.

SELF-CHECK QUIZ 4.3.3

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

---------- 1. A switch has two states.

---------- 2. A differentiating circuit is a simple RC circuit with output taken across C.

---------- 3. The switch that has the fastest speed of operation is electronic switch.

---------- 4. When a transistor is used as an amplifier, it is operated in the saturation region.

---------- 5. A relay is superior to a mechanical switch because it combines control with power amplification.

Learning Outcome 4.4 - Repair Products and Systems

Contents:

- Repair or replace defective parts as per manufacturer's instructions

Assessment criteria:

- Defective parts are repaired or replaced as per manufacturer's instructions.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Consumer products and systems
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 4.4.1

Learning Activity	Resources/Special Instructions/References
Check and isolate circuits as per standard operating procedure	▪ Information Sheet: 4.4.1

INFORMATION SHEET 4.4.1

Learning Objective: to check and isolate circuits as per standard operating procedure.

Same as ***Information Sheet 1.4.2 (page 24)***

Learning Outcome 4.5 - Test and Inspect Products

Contents:

- Carrey out testing and inspection of finished products in accordance with quality standards and standard operating procedure

Assessment criteria:

- Test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Electrical materials and components
- Consumer products and systems
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 4.5.1

Learning Activity	Resources/Special Instructions/References
Test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure	▪ Information Sheet: 4.5.1

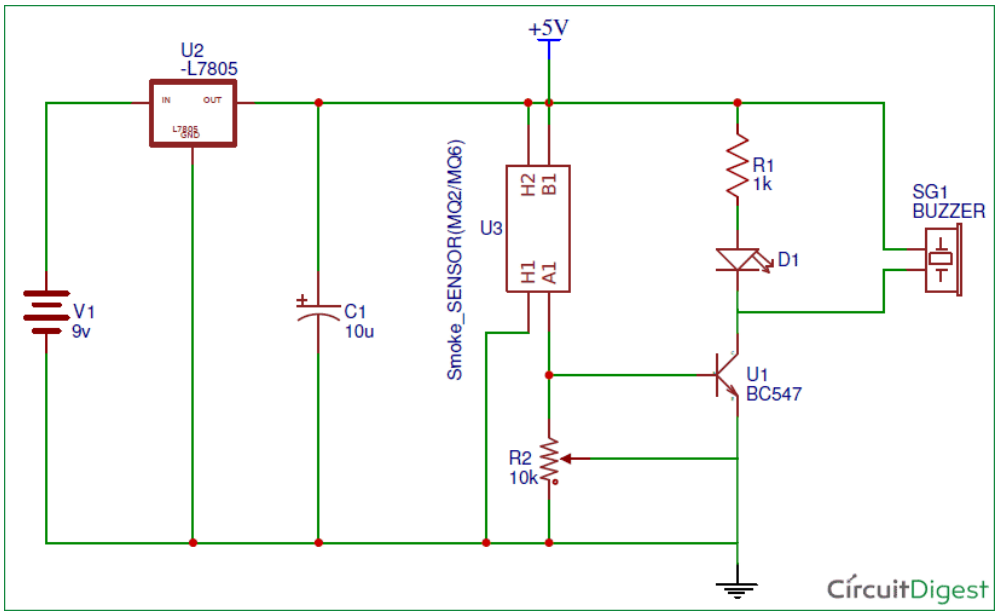
INFORMATION SHEET 4.5.1

Learning Objective: to test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure.

Same as ***Information Sheet 3.5.1 (page 54)***

JOB SHEET 4	
Job Title:	Interface proximity sensor (Smoke detector)
Personal protective equipment:	Gloves, dust mask, safety shoes, hard hat, belt/body harness, goggles, working clothes, apron
Materials:	Sensor, Transistor, IC, Capacitor and Variable resistor
Tools and equipment:	Tools: Screwdrivers, Wrenches, Allen keys, soldering iron, De-soldering tools, Multi-testers (analogue/digital), Utility knife/stripper, Pliers, Ball been hammer, Test jig, Cleaning brush, High-grade magnifying glass (with lamp) Equipment: Variable power supply, Step-down transformer, Hot air soldering, station, Table top reflow oven, Function/signal generator, ESD-free work bench with mirror, Oscilloscope (digital), Multi-testers, Flashlight/headlamp, High voltage probe, Assorted wires, Assorted electronic sensors
Procedure:	1. Obtain a unit for this activity from your assessor. 2. Given the tools, equipment and materials, check for the defect/s of the unit. 3. Disassemble the unit for any defect detected. 4. Repair the unit according to the requirement. 5. Test runs the unit for functionality. 6. Clean tools, equipment, machinery and work area. 7. Dispose of waste materials and excess materials.

Circuit Diagram of this *Smoke Detector Project* is given below:



ANSWER KEYS

ANSWER KEY: 4.1.1	
1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

ANSWER KEY: 4.1.2	
1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

ANSWER KEY: 4.3.3	
1.	TRUE
2.	FALSE
3.	TRUE
4.	FALSE
5.	TRUE

Module 5: Service industrial products and systems

MODULE CONTENT

Module Descriptor: This unit covers the skills, knowledge and attitudes required to service industrial products and systems. It specifically includes preparing for work, installing products and systems, diagnosing faults and defects, repairing products and systems, and testing products and systems.

Nominal Duration: 60 hours

LEARNING OUTCOMES:

Upon completion of the module, the student/trainee should be able to:

5.1. Prepare for work

5.2. Install products and systems

5.3. Diagnose faults and defects

5.4. Repair products and systems

5.5. Test products and systems

PERFORMANCE CRITERIA:

1. Industrial products and systems are checked and defects are identified, verified and recorded against customer description.
2. Service manuals and information required for installation are identified.
3. Repair and maintenance history are confirmed with consumer as per standard operating procedure.
4. Workplace is prepared for repair as per job requirement.
5. Tools and equipment are identified and selected as per job requirement.
6. Materials are identified and obtained as per job requirement.
7. Products and systems are installed in accordance with manufacturer's instructions.
8. Products and systems are tested and inspected as per standard operating procedure.
9. Unplanned events or conditions are responded to in accordance with standard operating procedure.
10. Report on installation and testing of equipment is prepared as per organisational policy.
11. Workplace is cleaned and cleared of all debris.
12. Troubleshooting techniques are identified.
13. Pre-testing procedure is carried out as per manufacturer's instructions.
14. Circuits are checked and isolated using as per standard operating procedure.
15. System defects or fault symptoms are identified using appropriate troubleshooting technique.
16. Control settings and adjustments are checked to ensure compliance with service-manual specifications.
17. Results of diagnosis and testing are recorded accurately.
18. Customer is informed of status and serviceability of product or system.

19. Electro-static discharge (ESD) protection procedure is followed in accordance with industry standards.
20. Defective parts are repaired or replaced as per manufacturer's instructions.
21. Repaired or replaced parts are mounted and soldered as per job requirement.
22. Control settings and adjustments are checked to ensure compliance with service-manual specifications.
23. Repaired product or system is reassembled.
24. Product or system is cleaned as per standard operating procedure.
25. Workplace is cleaned and cleared of all debris.
26. Product or system is tested and inspected in accordance with quality standards and standard operating procedure.
27. Job completion is recorded and reported as per standard operating procedure.

Learning Outcome 5.1 - Prepare for Work

Contents:

- Check industrial products and systems and identify, verify and record defects against customer description
- Identify and select tools and equipment as per job requirement

Assessment criteria:

- Industrial products and systems are checked and defects are identified, verified and recorded against customer description.
- Tools and equipment are identified and selected as per job requirement.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Electrical materials and components
- Industrial products and systems
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 5.1.1

Learning Activity	Resources/Special Instructions/References
Check industrial products and systems and identify, verify and record defects against customer description	▪ Information Sheet: 5.1.1 ▪ Self-Check Quiz: 5.1.1 ▪ Answer Key: 5.1.1

INFORMATION SHEET 5.1.1

Learning Objective: to check industrial products and systems and identify, verify and record defects against customer description.

- Drive Input: Analyzing the power going into the motor drive is an excellent first step to determine if a feeder circuit to the drive has distortion, disturbance or noise that may be affecting power ground.
- DC Bus: The conversion of AC to DC inside the drive is critical. Having the correct voltage and adequate smoothing with low ripple is required for the best drive performance. High ripple voltage may be an indicator of failed capacitors or incorrect sizing of the connected motor. The record function of a Fluke MDA-500 Series Motor Drive Analyzer can be used to check DC bus performance dynamically in the operating mode while a load is applied.
- Drive Output: Testing the drive output is critical to proper motor operation and can offer clues to problems within the drive circuits.
- Motor Input: Voltage supplied at the motor input terminals is key, and cable selection from drive to motor is critical. Incorrect cabling selection can result in both drive and motor damage due to excessive reflected voltage peaks. These tests are mostly identical to those for drive output above.
- Motor Shaft Voltage: Voltage pulses from a motor drive can couple from a motor's stator to its rotor, causing a voltage to appear on the rotor shaft. When this rotor shaft voltage exceeds the insulating capacity of the bearing grease, flashover currents (sparking) can occur, causing pitting and fluting of the motor bearing race, damage that can cause a motor to fail prematurely.

SELF-CHECK QUIZ 5.1.1

Check your understanding by answering following questions. Write true or false on the space provided for the following statement:

1. ---------- The consideration involved in the selection of the type of electric drive for a specific application depends upon speed control range and its nature.
2. ---------- Synchronous motor is preferred for traction work.
3. ---------- The consideration involved in the selection of the type of electric drive for the load variation application depends upon continuous variable load.
4. ---------- When quick speed reversal is a consideration, the motor preferred is synchronous motor.
5. ---------- Group drive is also called as line shaft drive.

LEARNING ACTIVITY 5.1.2

Learning Activity	Resources/Special Instructions/References
Identify and select tools and equipment as per job requirement	▪ Information Sheet: 5.1.2

INFORMATION SHEET 5.1.2

Learning Objective: to identify and select tools and equipment as per job requirement.

Same as ***Information Sheet 4.1.2 (page 63)***

Learning Outcome 5.2 - Install Products and Systems

Contents:

- Identify and obtain materials as per job requirement
- Test and inspect products and systems as per standard operating procedure
- Prepare report on installation and testing of equipment as per organisational policy

Assessment criteria:

- Materials are identified and obtained as per job requirement.
- Products and systems are tested and inspected as per standard operating procedure.
- Report on installation and testing of equipment is prepared as per organisational policy.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Industrial products and systems
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 5.2.1

Learning Activity	Resources/Special Instructions/References
Identify and obtain materials as per job requirement	▪ Information Sheet: 5.2.1

INFORMATION SHEET 5.2.1

Learning Objective: to identify and obtain materials as per job requirement.

Same as ***Information Sheet 2.2.1 (page 31)***

LEARNING ACTIVITY 5.2.2

Learning Activity	Resources/Special Instructions/References
Test and inspect products and systems as per standard operating procedure	▪ Information Sheet: 5.2.2

INFORMATION SHEET 5.2.2

Learning Objective: to test and inspect products and systems as per standard operating procedure.

Same as ***Information Sheet 3.5.1 (page 54)***

LEARNING ACTIVITY 5.2.3

Learning Activity	Resources/Special Instructions/References
Prepare report on installation and testing of equipment as per organisational policy	▪ Information Sheet: 5.2.3

INFORMATION SHEET 5.2.3

Learning Objective: to prepare report on installation and testing of equipment as per organisational policy.

Same as ***Information Sheet 1.2.3 (page 15)***

Learning Outcome 5.3 - Diagnose Faults and Defects

Contents:

- Identify troubleshooting techniques
- Carry out pre-testing procedure as per manufacturer's instructions
- Check and isolate circuits using as per standard operating procedure

Assessment criteria:

- Troubleshooting techniques are identified.
- Pre-testing procedure is carried out as per manufacturer's instructions.
- Circuits are checked and isolated using as per standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Industrial products and systems
- Electrical materials and components
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 5.3.1

Learning Activity	Resources/Special Instructions/References
Identify troubleshooting techniques	▪ Information Sheet: 5.3.1

INFORMATION SHEET 5.3.1

Learning Objective: to identify troubleshooting techniques.

Same as ***Information Sheet 1.4.1 (page 21)***

LEARNING ACTIVITY 5.3.2

Learning Activity	Resources/Special Instructions/References
Carry out pre-testing procedure as per manufacturer's instructions	▪ Information Sheet: 5.3.2

INFORMATION SHEET 5.3.2

Learning Objective: to carry out pre-testing procedure as per manufacturer's instructions.

Same as ***Information Sheet 1.2.3 (page 15)***

LEARNING ACTIVITY 5.3.3

Learning Activity	Resources/Special Instructions/References
Check and isolate circuits as per standard operating procedure	▪ Information Sheet: 5.3.3

INFORMATION SHEET 5.3.3

Learning Objective: to check and isolate circuits as per standard operating procedure.

Same as ***Information Sheet 4.3.3 (page 67)***

Learning Outcome 5.4 - Repair Products and Systems

Contents:

- Repair or replace defective parts as per manufacturer's instructions

Assessment criteria:

- Defective parts are repaired or replaced as per manufacturer's instructions.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Electrical materials and components
- Industrial products and systems
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 5.4.1

Learning Activity	Resources/Special Instructions/References
Repair products and systems	▪ Information Sheet: 5.4.1

INFORMATION SHEET 5.4.1

Learning Objective: to repair products and systems.

Same as ***Information Sheet 1.4.2 (page 24)***

Learning Outcome 5.5 - Test and Inspect Products

Contents:

- Carrey out testing and inspection of finished products in accordance with quality standards and standard operating procedure

Assessment criteria:

- Test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure.

Resources required:

Students/trainees must be provided with the following resources:

- Workplace (simulated or actual)
- Relevant drawings, manuals, codes, standards and reference material
- Tools and equipment
- Testing equipment
- Electrical materials and components
- Industrial products and systems
- Instruction sheet/manual
- Personal protective equipment

LEARNING ACTIVITY 5.5.1

Learning Activity	Resources/Special Instructions/References
Test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure	▪ Information Sheet: 5.5.1 ▪ Job Sheet 5

INFORMATION SHEET 5.5.1

Learning Objective: to test and inspect of finished products is carried out in accordance with quality standards and standard operating procedure.

Same as ***Information Sheet 3.5.1 (page 54)***

JOB SHEET 5	
Job Title:	Maintain and repair microwave oven
Personal protective equipment:	Gloves, dust mask, safety shoes, hard hat, belt/body harness, goggles, working clothes, apron
Materials:	Sensor, Transistor, IC, Capacitor and Variable resistor
Tools and equipment:	Tools: Screwdrivers, Wrenches, Allen keys, soldering iron, De-soldering tools, Multi-testers (analogue/digital), Utility knife/stripper, Pliers, Ball been hammer, Test jig, Cleaning brush, High-grade magnifying glass (with lamp) Equipment: Variable power supply, Step-down transformer, Hot air soldering, station, Table top reflow oven, Function/signal generator, ESD-free work bench with mirror, Oscilloscope (digital), Multi-testers, Flashlight/headlamp, High voltage probe, Assorted wires, Assorted electronic sensors
Procedure:	1. Identify the internal and external parts of micro wave oven. 2. Identify the different touch pad controls and their functions. 3. Test for high voltage diode. 4. Identify the HV capacitor and discharge it. 5. Rectify the fault leading to fuse blows off when cooking is initiated. 6. Rectify the fault leading to not responding of touch switches. 7. Rectify the fault leading to dead set. 8. Rectify the fault leading to long cooking time. 9. Clean tools, equipment, machinery and work area. 10. Dispose of waste materials and excess materials.

ANSWER KEYS

ANSWER KEY: 5.1.1

1. TRUE
2. FALSE
3. TRUE
4. FALSE
5. TRUE